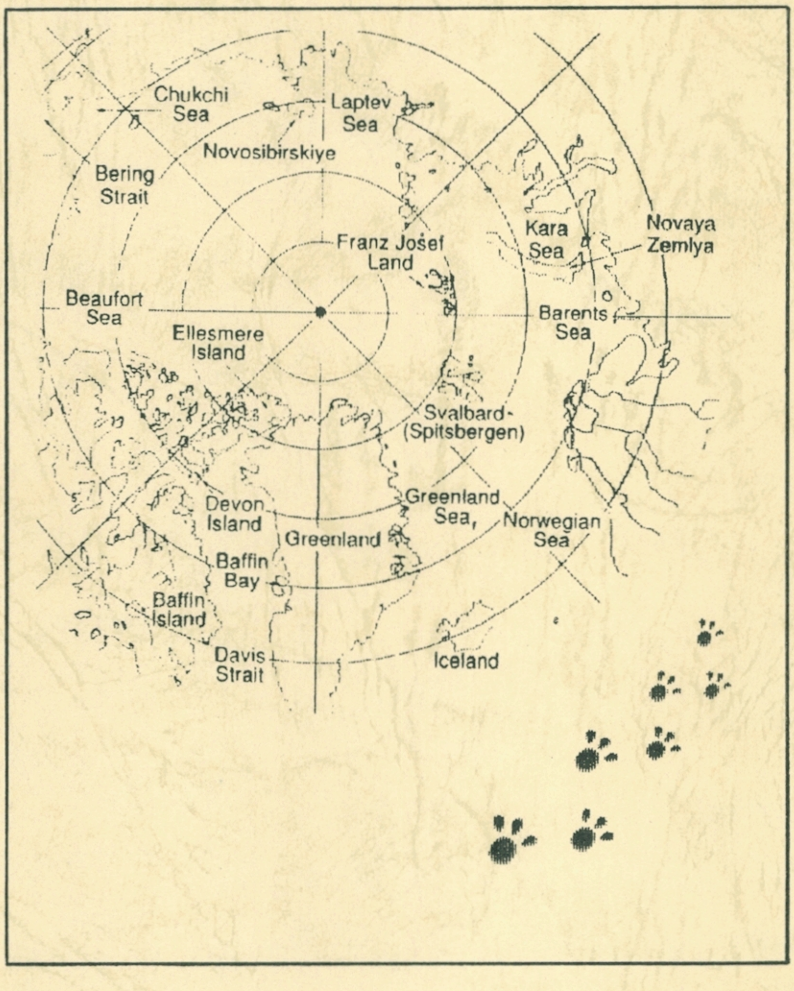
PROGRAM and ABSTRACTS

Second International Symposium on Environmental Research in the Arctic and Fifth Ny-Ålesund Scientific Seminar

23-25 February 2000, NIPR, Tokyo, JAPAN



Jointly Organized:

National Institute of Polar Research, Tokyo (NIPR)

Ny-Ålesund Science Managers Committee (NySMAC)

Ny-Ålesund Large Scale Facility, European Union (NyLSF)

For all participants:

Visiting Tour to NIPR

February 24 17:00-18:00

Those who wish to participate in the tour **convene at the entrance of the main building (1F) at the end of the Poster session (17:00)**. Several guides will introduce you to the different research facilities of NIPR (about 10 persons per group). The detailed descriptions of the activities of each division or center of research can be found in two recent publications "National Institute of Polar Research" and "Japanese Antarctic Activities".

Tour Course:

- *(Main Building)* -

● **Arctic Environment Research Center**	(5F)
● **Arctic and Antarctic Library**	(4F)
● **Antarctic Meteorite Research Center and Exhibition Hall**	(1F)

- *(Research Building)* -

● **Meteorology and Glaciology**	(4F)
● **Upper Atmosphere Physics and Earth Sciences**	(3F)
● **Center for Antarctic Environment Monitoring, Information Science Center, Biology and Lecture Room**	(2F)
● **Logistics and Antarctic Stations**	(1F)

For those who do not wish to participate in the visiting tour, there is the possibility to enjoy **a cup of coffee in the lecture room (2F)** where a movie about the "Japanese Antarctic Research Expedition" will be shown.

Symposium Organizing Committee

Lunch ticket

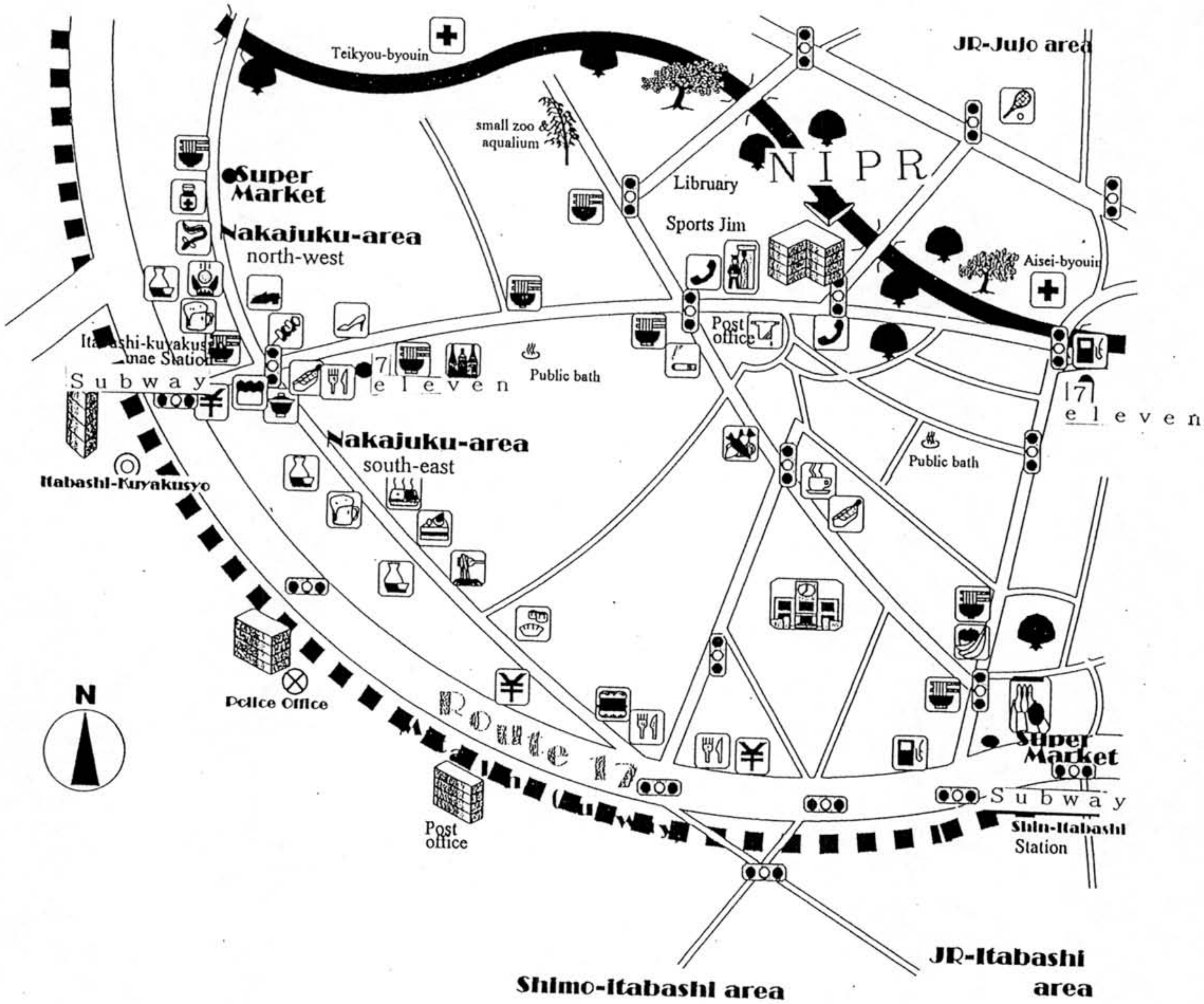
Cost: 500 Japanese Yen

We strongly recommend purchase of box lunches as the number of restaurants is very limited near National Institute of Polar Research. Lunch tickets for box lunches are available at the registration desk. Although the final deadline for purchase of tickets is 9:20 of the morning, we would appreciate it very much if the participants could purchase the tickets in advance upon registration.

Kumiko Goto-Azuma
A member of the Local Organizing Committee

Menu (Japanese style box lunches)

February 23 (Wednesday): Fried chicken, tofu (bean curd), grilled fish, potatoes, steamed rice, etc.
February 24 (Thursday): Omelet, croquette, vegetables, steamed rice, etc.
February 25 (Friday): Fried squid, potatoes with bacon, chicken, steamed rice, etc.



1. Naka-juku area: Near the subway station 'Itabashi-kuyakusyo-mae'. 10 min. by walk from NIPR. You will find many Japanese-style restaurant, pub, bar, store, as well as Pachinko game spots along St. Kyuu-Nakasen-dou.

2. Food & liqure: You can buy daily foods & liqure (beer, whisky, sake, wine etc.) at Nakajuku area. You will get them at 7-eleven (convenience store), too. Open for 24 hr.

3. Opening hours: Most of stores will be opened 10:00 - 19:00.

   Some coffee shop will be opened 7:30 for breakfast. You will find them around south-east side of Nakajuku area.

   Bar (Sake-bar, Japanese style) & pub, as well as Karaoke-bar will be opened for 17:00 - 24:00.

4. Bank [¥]: You can excange the money. Opening hours: 9:00 - 15:00

5. Hospital: There are two general hospitals around NIPR. (Teikyo-byouin & Aisei-byouin Tel: 3964-1211 & 3961-5351, respectively).

Second Internatiional Symposium on Environmental Research in the Arctic

and

Fifth Ny-Ålesund Scientific Seminor

NIPR, Tokyo, 23 - 25 February 2000

Symposium Proceedings Application Form

1. Title of the paper

2. Categories of article (please check)

   Scientific Paper   Scientific Note   Review   Report

3. Author's name (affiliation)

4. Corresponding author

   Name:

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* Please return this form directly at the desk or by FAX before March 10, 2000 to the number below:

Arctic Environment Research Center
National Institute of Polar Research
Fax: +81-3-3962-5701

NOTE TO CONTRIBUTORS

General

The authors of the presentations are encouraged to submit their papers to the symposium proceedings. The proceedings (the title will be given later) will be published as the Memoirs of National Institute of Polar Research, Special Issue, No. 54, from the National Institute of Polar Research (NIPR). It includes papers on the Arctic environmental research, presented at the Second International Symposium on Environmental Research in the Arctic and Fifth Ny-Ålesund Scientific Seminar. The proceedings accepts four categories of paper; scientific papers, scientific notes, review papers and reports. Scientific papers are original articles dealing with major problems related to atmospheric environment, glaciological environment, marine environment, terrestrial ecosystems, upper atmosphere environment and overview of the environment research in the Arctic. Scientific notes are articles dealing with a significant topic, new finding, and preliminary interpretation, etc. These papers are reviewed by referee/s.

Manuscripts for the Memoirs of National Institute of Polar Research, Special Issue, No. 54, (the proceedings) should be sent to:

The Editorial Board of the Proceedings
Arctic Environment Research Center
National Institute of Polar Research
9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173-8515, Japan
Tel: +81-3-3962-5680, Fax: +81-3-3962-5701, E-mail: arctic@pmg.nipr.ac.jp,

by 31 March 2000.

Three copies of the manuscript are required for submission. Information on the corresponding author including his/her address, telephone and fax numbers and e-mail address should be attached.

Preparation of manuscripts

(1) All manuscripts must be written in the English language.
(2) All pages of the manuscript must be typed double spaced on one side of the A4 paper with margins of 3 cm, and assembled in the order; abstract, text, acknowledgments, references, appendices, tables, figure captions and figures.
(3) Total printed pages of the manuscript are to be under 10.
(4) An abstract of not more than 200 words is required.
(5) Use of the International System of Units (SI) is recommended.
(6) The title page should include the author(s) name(s), their affiliations and addresses. In case the title contains more than 50 characters, a running title should be indicated on the title page.

References

(1) The text citation of a reference should consist of the author's name and year of publication (e.g., "according to Kawaguchi (1973)" or "as showon by an earlier study (Kawaguchi et al., 1974)"). All references referred to in the text should be listed at the end of the manuscript under the heading References.

(2) References in the list should be arranged alphabetically in the following style:

Aagaard, K. and Carmack, E.C. (1989): The role of sea ice and other fresh water in the Arctic circulation. J. Geophys. Res., **94**, 14485-14498.

Berner, E.K. and Berner, R.A. (1996): Global Environment: Water, Air, and Geochemical Cycles. Upper Saddle River, Prentice Hall, 371 p.

Krueger, A.J., Stolarski, R.S. and Schoeberl, M.R. (1987): Characteristics of the Antarctic ozone hole derived from Nimbus 7 TOMS data. Proc. NIPR Symp. Polar Meteorol. Glaciol., **1**, 1-9.

Raatz, W.E. (1991): The climatology and meteorology of Arctic air pollution. Pollution of the Arctic Atmosphere, ed by W.T. STURGES. New York, Elsevier, 13-41.

For more examples, refer to recent issues of the NIPR publication.

Tables/Figures

Each table should be typed on a separate sheet of A4 paper and numbered according to their sequence in the text. All figures should be numbered consecutively and referred to in the text. Color figures can be accepted upon request. But the final decision rests with the editor.

Page proofs

Page proofs will be sent to the corresponding author, to be checked for typesetting/editing. The author is not expected to make changes or corrections that constitute departures from the article in its accepted form. Proofs should be returned within 2 days.

Reprints

Fifty reprints of each article are supplied free of charge. Additional reprints can be ordered on a reprint order form, which will be sent to the corresponding author upon receipt of the accepted article by the publisher.

Submission of electronic text

Authors are requested to submit an electronic copy of the final text on a 3.5" diskette after the paper is accepted, which should include a textfile. The name and version of the word processing program should be clearly indicate

Symposium Proceedings Submission Form

Second International Symposium on Environmental Research in the Arctic
and Fifth Ny-Ålesund Scientific Seminar

* Please attach this form at the submission

1. Categories of article (please check)

   Scientific Paper Scientific Note Review Report

2. Title and running title

   Title :

   Running title :

3. Manuscript

   Title, abstract, text ( ), Figure caption ( ), Figure ( ),
   Table ( ), Photo ( ), Plate ( )

4. Author's name

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7. Checked before submission of the paper

- ☐ The length of abstract is less than 200 words.
- ☐ Examine your reference style.
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For the final manuscript

- ☐ Make instruction to printer.
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- ☐ Write your name in each table and illustration.
- ☐ Indicate the name and version of the word-processing program on a 3.5" diskette (DOS text or ASCII).

Second International Symposium

on Environmental Research in the Arctic

and

Fifth Ny-Ålesund Scientific Seminar

23 - 25 February 2000
NIPR, Tokyo

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(Pre registered by 15 December 1999)

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Ny-Ålesund Science Managers Committee (NySMAC)
Ny-Ålesund Large Scale Facility, European Union (NyLSF)

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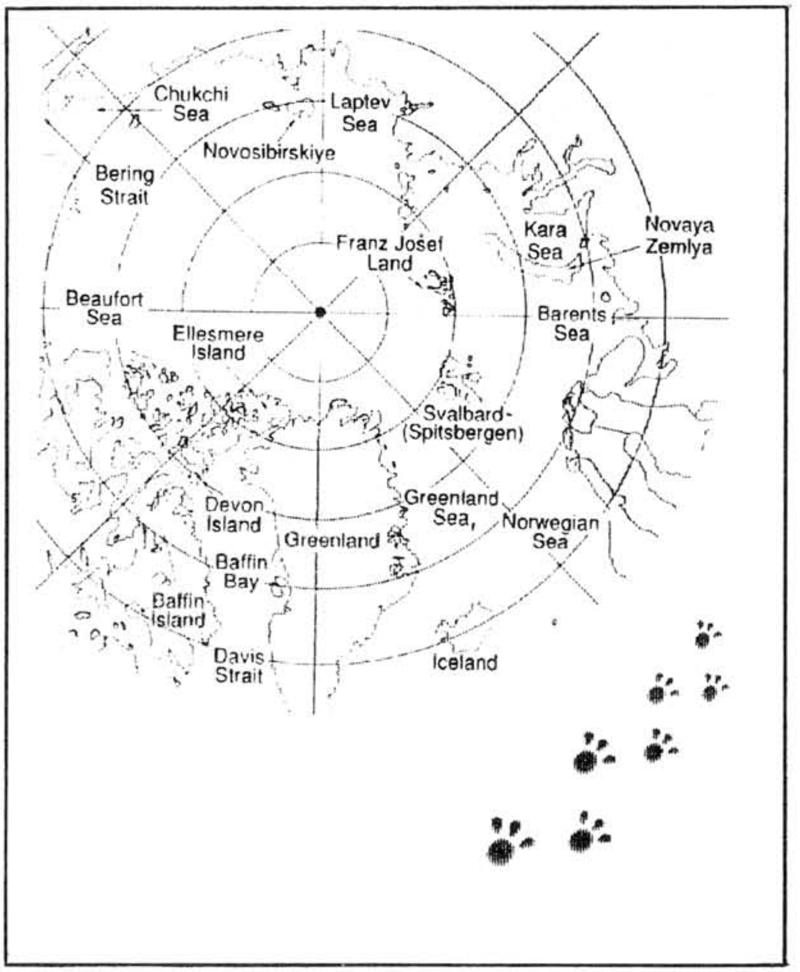
PROGRAM and ABSTRACTS

Second International Symposium on Environmental Research in the Arctic and Fifth Ny-Ålesund Scientific Seminar

23-25 February 2000, NIPR, Tokyo, JAPAN



Jointly Organized:
National Institute of Polar Research, Tokyo (NIPR)
Ny-Ålesund Science Managers Committee (NySMAC)
Ny-Ålesund Large Scale Facility, European Union (NyLSF)

Second International Symposium on Environmental Research in the Arctic
and
Fifth Ny-Ålesund Scientific Seminar

Program

Auditorium (6th Floor)
National Institute of Polar Research
Kaga 1-9-10, Itabashi, Tokyo

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23 February (Wednesday)

08:45 ***Registration***

09:00 ***Opening***

09:15 **Session I: Overview of the Environmental Research in the Arctic (1)**

Chair: Ono, N.

Presentations No. 1-6

10:45 <*Coffee break*>

11:15 Chair: Ohmura, A.

Presentations No. 7-11

12:30 <*Lunch*>

14:00 **Session II: Overview of the Environmental Research in the Arctic (2)**

Chair: Cox, N.

Presentations No. 12-14

14:45 **Session III: Upper Atmosphere Environment**

Chair: Rottger, J.

Presentations No. 15-19

16:00 <*Coffee break*>

16:30 Chair: Hall, Ch.

Presentations No. 20-23

17:30 **Session IV: Atmospheric Environment (1)**

Chair: Stordal, F.

Presentations No. 24-26

24 February (Thursday)

09:00 **Session V: Atmospheric Environment (2)**

Chair: Gernandt, H.

Presentations No. 27-33

10:45 *<Coffee break>*

11:15 Chair: Iwasaka, Y.

Presentations No. 34-38

12:30 *<Lunch>*

14:00 **Poster Session I:**

Chair: Savatyugin, L. M.

Presentations No. 101-130 15:15 *<Coffee break>*

15:45 **Poster Session II:**

Chair: Doronin, N. Y.

Presentations No. 201-231

17:00 ***Tour in NIPR***

18:00 ***Symposium Dinner***

25 February (Friday)

09:00 **Session VI: Glaciological Environment (1)**

Chair: Isaksson, E.

Presentations No. 39-44

10:30 *<Coffee break>*

11:00 Chair: Wakahama, G.

Presentations No. 45-49

12:15 *<Lunch>*

13:45 **Session VII: Glaciological Environment (2)**

Chair: Sato, T.

Presentations No. 50-52

14:30 **Session VIII: Marine Environment**

Chair: Taguchi, S.

Presentations No. 53-58

16:00 *<Coffee break>*

16:30 Chair: Taniguchi, A.

Presentations No. 59-62

17:30 **Session IX: Terrestrial Ecosystems**

Chair: Elster, J.

Presentations No. 63-66

18:30 ***Closing***

Presentation

23 February (Wednesday)

Session I: Overview of the Environmental Research in the Arctic (1)

9:15 ~ 10:45 *Chair Ono, N.*

1 NIPR Arctic Environment Research in 1990-1999
Fujii, Y. (NIPR, JAPAN)

2 Observations of the Arctic troposphere and lower stratosphere with the SOUSY Svalbard radar
Röttger, J. (Max-Planck-Institut für Aeronomie, GERMANY)

3 Climate Change and its Impacts on the Arctic
Weller, G. (Univ. of Alaska, USA)

4 Greenland Summit Environment Observatory
Ohmura, A. (ETH, SWITZERLAND)

5 Circum-Arctic ice core records from small ice caps: a different view on Holocene climate
Koerner, R. (Geological Survey of Canada, CANADA)

6 Chinese First Expedition to the Arctic Ocean
Dong, Z. (Polar Research Institute of China, CHINA) & Qin, W.

11:15 ~ 12:30 *Chair Ohmura, A.*

7 Greenland Sea in Winter
Ito, H. (NIPR, JAPAN) & 11 others

8 The International North Water Polynya Study (NOW) : an Early Synthesis
Fortier, L. (GIROQ, CANADA) & 5 others

9 Greenhouse gas fluxes in winter and thawing period at Arctic tundra Ecosystem
Harazono, Y. (NIAES, JAPAN) & 5 others

10 Persistent organic pollutants in Arctic animals in the Barents Sea area and at Svalbard: levels and effects
Gabrielsen, G.W. (Norwegian Polar Institute, NORWAY)

11 Global Change impacts on terrestrial plant communities: long-term studies in the northern Scandes
Molau, U. (Göteborg Univ., SWEDEN)

Session II: Overview of the Environmental Research in the Arctic (2)

14:00 ~ 14:45 *Chair* *Cox, N.*

12 Activity and Development of Scientific Community Ny-Ålesund

Holmén, K. J. (Stockholm Univ., SWEDEN)

13 What is needed in order to achieve a full scale environmental monitoring station in Ny-Ålesund?

Prestrud, P. (Norwegian Polar Institute, NORWAY)

14 Recent contributions to long-term atmospheric studies at Koldewey-Station

Gernandt, H. (Alfred Wegener Institute, GERMANY) & Neuber, R.

Session III: Upper Atmosphere Environment

14:45 ~ 15:45 *Chair* *Rottger, J.*

15 Climatic mesospheric cooling: the importance of long time-series of ionospheric soundings

Hall, C. M. (Univ. of Tromsø, NORWAY)

16 Geomagnetically Conjugate Auroras between Iceland and Syowa Station

Sato, N. (NIPR, JAPAN)

17 Response of the Thermosphere to High-Latitude Energy Inputs

Maeda, S. (Kyoto Univ. of Art and Design, JAPAN) & Fujiwara, H.

18 Sounding rockets from SvalRak

Nyheim, I. K. (Andøya Rakettskytefelt AS, NORWAY)

19 SS-520-2 Rocket Experiment Plan

Mukai, T. (Institute of Space and Astronautical Science, JAPAN) & Inatani, Y.

16:30 ~ 17:30 *Chair* *Hall, Ch.*

20 Observations of the Arctic mesosphere and D-region with the EISCAT Svalbard radar and the SOUSY Svalbard radar

Röttger, J. (Max-Planck-Institut, GERMANY)

21 Noctilucent cloud observations with CCD cameras in both northern and southern hemispheres during 1997-1999

Sugiyama, T. (Research Institute for Production Development, JAPAN) & 7 others

22 Gravity waves simulated by a high-resolution GCM

Sato, K. (NIPR, JAPAN) & 2 others

23 A study on the polar atmospheric tide by the EISCAT and cooperative observation network: comparisons with observation and theory

Aso, T. (NIPR, JAPAN)

Session IV: Atmosphere Environment (1)

17:30 ~ 18:15 *Chair* *Stordal, F.*

24 Ground based, balloon and aircraft measurements of greenhouse gases in the Arctic
Aoki, S. (Tohoku Univ., JAPAN) & 10 others

25 Ten years of Carbon Dioxide monitoring on Zeppelinfjellet (78°54'N, 11°53'E)
Holmén, K. J. (Stockholm Univ., SWEDEN) & Bazhanov, V.

26 Global quality control for long-lived trace gas measurements
Francey, R. (Commonwealth Scientific and Industrial Research Organization, AUSTRALIA) & 6 others

24 February (Thursday)

Session V: Atmospheric Environment (2)

9:00 ~ 10:45 *Chair* *Gernandt, H.*

27 Forthcoming Arctic field campaign ASTAR 2000 (Arctic Study of Tropospheric Aerosol and Radiation)

Yamanouchi, T. (NIPR, JAPAN) & Herber, A.

28 Aerosol measurements at Ny-Alesund/Spitsbergen and its possible climate impact

Herber, A. (Alfred Wegener Institute, GERMANY) & 12 others

29 Arctic stratospheric aerosols -PSCs and background sulfate particles-

Iwasaka, Y. (Nagoya Univ., JAPAN) & 9 others

30 Chemical composition of total deposition samples from Spitsbergen

Kriews, M. (Alfred Wegener Institute, GERMANY) & 2 others

31 Measurement of atmospheric pollution in the Siberian Arctic

Fukasawa, T. (Hokkaido Univ., JAPAN) & 6 others

32 Preliminary measurements of CH_4 emission at a burnt forest in West Siberia

Nakano, T. (Tokyo Metropolitan Univ., JAPAN) & 3 others

33 Radiative forcing due to anthropogenic activities

Stordal, F. (Norwegian Institute for Air Research, NORWAY) & Myhre, G.

11:15 ~ 12:30 *Chair* *Iwasaka, Y.*

34 Natural variability of the surface spectral and total albedo in Svalbard

Orbek, J. B. (Norwegian Polar Institute, NORWAY) & Claes, S.

35 Three years spectral resolved UV measurements at Koldewey-Station

Groß, C. (Alfred Wegener Institute, GERMANY) & 2 others

36 Estimation of tropospheric Water Vapor content using a network of GPS receivers in Ny-Ålesund

Rius, A. (IEEC/CSIC, SPAIN) & 2 others

37 "In-situ" measurement for a polar low over the Norwegian Sea

Asuma, Y. (Hokkaido Univ., JAPAN) & 5 others

38 Feasibility Study on Scientific Balloon Experiment at Ny-Aalesund

Honda, H. (The Institute of Space and Astronautical Science, JAPAN) & 2 others

Poster Session I:

14:00 ~ 15:15 *Chair* *Savatyugin, L.*

101 Announcement of an EU research program at Ny-Ålesund: The NItrogen Cycle and Effects on the oxidation of atmospheric trace species at high latitudes (NICE)

Beine, H. J. (CNR, ITALY) & 2 others

102 Temporal variations of atmospheric CO_2 concentration and its carbon isotope in Ny-Ålesund, Svalbard

Morimoto, S. (NIPR, JAPAN) & 3 others

103 An intercomparison campaign of ozone and temperature measurements in the Arctic (NAOMI-98, Ny-Ålesund/Spitsbergen)

Neuber, R. (Alfred Wegener Institute, GERMANY) & 8 others

104 Ozone loss rates determined with Match

Schulz, A. (Alfred Wegener Institute, GERMANY) & 35 others

105 Surface energy and radiation balances in the Kongsfjorden area

Georgiadis, T. (CNR-ISAO, ITALY) & 4 others

106 Field reflectance data on different snow covers at Ny-Ålesund

Casacchia, R. (CNR-Institute on Atmospheric Pollution, ITALY) & 6 others

107 Large cloud drops rimed on snow crystals observed at Ny-Ålesund, Svalbard, Arctic

Konishi, H. (Osaka Kyoiku Univ., JAPAN) & Wada, M.

108 Spectral reflectance of melting snow in a high Arctic watershed on Svalbard: Some implications for optical satellite remote sensing studies

Winther, J. G. (Norwegian Polar Institute, NORWAY) & 5 others

109 Glaciological observation on Pioner Ice Cap, Severnaya Zemlya in 1996

Takahashi, S. (Kitami Institute of Tecnology, JAPAN) & 4 others

110 Leaching of chemical compositions in the snowpack at the dome of Austfonna ice cap, Svalbard

Iizuka, Y. (Grad. Univ. Advanced Studies, JAPAN) & 4 others

111 The geochemical phenomenon - Local geochemical fields in the glacier

Makarov, V. N. (Permafrost Institute, RUSSIA)

112 Regional characteristics of chemical constituents in surface snow, arctic cryosphere

Watanabe, O. (NIPR, JAPAN) & 8 others

113 Chemical analysis of the shallow ice core and surface snow samples from North Greenland

Igarashi, M. (NIPR, JAPAN) & 8 others

114 On the detailed density profile of NGRIP-S1 shallow ice cores from Greenland

Narita, H. (Hokkaido Univ., JAPAN) & 3 others

115 The North Water Polynya study : preliminary hydrographic results

Gratton, Y. (INRS-Eau, CANADA) & 3 others

116 Bio-optical characteristics in northern Baffin Bay

Sasaki, H. (Hokkaido Univ., JAPAN) & 3 others

117 Pico and nanophytoplankton distribution in the North Water (76-79°N) as estimated by flow cytometry

Demers, S. (Institut des sciences de la mer de Rimouski, CANADA) & 5 others

118 Species composition, biomass and photosynthetic activity of the bottom ice algae in the North Water Polynya during the springtime

Gosselin, M. (Universite du Quebec, CANADA) & 2 others

119 Physiological study on photosynthetic pigments of phytoplankton in the North Water Polynya

Hayashi, Y. (Himeji Institute of Technology, JAPAN) & 4 others

120 Feeding activities of Arctic copepods in the NOW Polynya.

Hattori, H. (Hokkaido Tokai Univ., JAPAN) & 3 others

121 Respiration and excretion rates of Calanus hyperboreus, C. glacialis and Metridia longa in relation to environmental conditions at North Water Polynya during autumn

Takahashi, K. (Soka Univ., JAPAN) & 2 others

122 Observation of downward particle flux in the North Water Polynnya

Fukuchi, M. (NIPR, JAPAN) & 5 others

123 Vegetation and soil relationships in the recently deglaciated terrains in Ny-Ålesund, Svalbard

Kojima, S. (Tokyo Woman's Christian Univ., JAPAN) & Wada, N.

124 Flora and vegetation of deglaciated area in Ny-Ålesund, Svalbard

Kanda, H. (NIPR, JAPAN) & 3 others

125 Arctic Polygonum viviparum; Growth and reproduction in relation to preformation

Nishitani, S. (Nippon Medical School, JAPAN) & 5 others

126 Comparisons of germination pattern and seeding survival of Potentilla matsumurae(Rosaceae) between alpine fellfield and snowbed habitats

Shimono, Y. (Hokkaido Univ., JAPAN) & Kudo, G.

127 Variations in reproductive characteristics of two sympatric alpine shrubs, Phyllodoce caerulea and Phyllodoce aleutica along a snowmelt gradient

Kasagi, T. (Hokkaido Univ., JAPAN) & Kudo, G.

128 Ecological role of fungal infections of moss carpet in Svalbard

Hoshino, H. (Hokkaido National Industrial Research Institute, JAPAN) & 3 others

129 Occurrence of plants in northern Kuriles, a highly oceanic sector of the subarctic zone. I. Notes on distribution of bryophytes

Minami, Y. (Tamagawa Univ., JAPAN) & 3 others

130 Occurrences of plants in northern Kuriles, a highly oceanic sector of the subarctic zone. II. Distribution of dwarf shrubs and herbaceous plants on Mt. Ebeko, Paramushir Island

Okitsu, S. (Chiba Univ., JAPAN) & 2 others

Poster Session II:

15:45 ~ 17:00 *Chair Doronin, N. Y.*

201 A new aurora spectrograph for collaborative observation with EISCAT Svalbard radar

Okano, S. (Tohoku Univ., JAPAN) & 3 others

202 Interhemispheric conjugacy of auroral poleward expansion observed by conjugate imaging riometers at ~67° and 75° ~ 77° invariant latitude

Yamagishi, H. (NIPR, JAPAN) & 5 others

203 Conjugate imaging riometer observations at Polar Cusp/Cap Stations

Nishino, M. (Nagoya Univ., JAPAN) & 5 others

204 Haze layers and their characteristics observed over Spitsbergen during the AAMP 1998 campaign

Shiobara, M. (NIPR, JAPAN) & 9 others

205 Aircraft observation of carbonyl sulfide (COS) over mid-high latitude of Northern Hemisphere during AAMP98

Inomata, Y. (Nagoya Univ., JAPAN) & 7 others

206 Black carbon and common ionic species in the Arctic atmospheric aerosol

Eleftheriadis, K. (Inst. of Nuclear Techn., GREECE) & 3 others

207 Event-induced aerosol sampling at Spitsbergen

Kriews, M. (Alfred Wegener Institute, GERMANY) & 2 others

208 The production of HONO in Arctic aerosols

Beine, H. J. (CNR, ITALY) & 4 others

209 The possible influence of local pollution sources on chemical compound measurements at Zeppelin: Using SODAR to identify flow pattern

Beine, H. J. (CNR, ITALY) & Argentini, S.

210 Detailed stratigraphy analysis of a NGRIP shallow ice core using laser tomograph system

Takata, M. (Grad. Univ. Advanced Studies, JAPAN) & 4 others

211 Vertical distribution of heavy metals in Vestfonna, Svalbard ice core

Matoba, S. (Hokkaido Univ., JAPAN) & 5 others

212 Contrastive anthropogenic acidification in Arctic and Antarctic cores

Fujii, Y. (NIPR, JAPAN) & 6 others

213 Preliminary results from 289m ice core on Austfonna ice cap, Svalbard

Watanabe, O. (NIPR, JAPAN) & 6 others

214 Asynchronism of glacier fluctuations in the Arctic and in the Alps at the end of 20 century

Khromova, T. (Institute of Geography, RUSSIA) & Chernova, L.

215 Climate Changes and its impact on Northern Eurasia Glaciers reduction by the scenarios of the former climates

Ananicheva, M. (Institute of Geography, RUSSIA) & 2 others

216 Status report on the GPS Positioning at Ny-Ålesund, Svalbard in 1994

Kanao, M. (NIPR, JAPAN) & Wada, M.

217 The determination of the "invariant point" of the VLBI antenna in Ny-Alesund

Tomasi, P. (Istituto di Radioastronomia CNR Bologna Italy, ITALY) & 2 others

218 <Cancelled>

219 Climatic and biological forcing of the vertical flux of biogenic particles under first-year ice in the Canadian Arctic in spring

Fortier, M. (GIROQ, CANADA) & 2 others

220 Observations of CO_2 partial pressure, total inorganic carbon and nutrients in the Greenland Sea in winter season

Yoshimura, S. (Tohoku Univ., JAPAN) & 6 others

221 Oxygen isotope hydrography in Northeastern Greenland Sea in January 1999

Yamamoto, M. (Hokkaido Univ., JAPAN) & 2 others

222 Seasonal difference in stable isotope compositions of arctic copepods

Sasaki, S. (Senshu Univ. of Ishinomaki, JAPAN) & 4 others

223 The most important plankton grazers in Kongsfjorden, Ny-Ålesund. Spatial distribution patterns of three Calanus species in an Arctic glacial fjord.

Kwasniewski, S. (Institute of Oceanology, POLAND) & 3 others

224 Reproductive strategies of the bearded seal, Erignathus Barbatus.

Van Parijs, S. M. (Univ. Studies on Svalbard, NORWAY) & 2 others

225 Soil respiration in relation to primary succession in Ny-Ålesund Svalbard

Koizumi, H. (Gifu Univ., JAPAN) & 5 others

226 Ecosystem Carbon Cycle on a Glacier Foreland in Ny-Ålesund, Svalbard

Nakatsubo, T. (Hiroshima Univ., JAPAN) & 4 others

227 Primary production of mosses in Ny-Ålesund, Svalbard

Uchida, M. (Hiroshima Univ., JAPAN) & 5 others

228 Structure and functional role of moss colony, Sanionia uncinata in different water environments

Ueno, T. (Grad. Univ. Advanced Studies, JAPAN) & 3 others

229 Photosynthetic and water relational characteristics in two co-occurring Polygonum species at a scoria desert in an alpine timber line of Mt. Fuji

Nakano, T. (Yamanashi Institute of Environmental Sciences, JAPAN) & 7 others

230 Biological characteristics of dark colored material in Canadian High Arctic glaciers

Takeuchi, N. (Tokyo Institute of Technology, JAPAN) & 3 others

231 UV-B-Personal-related dosimetry at Koldewey-Station by using an electronic Dosimeter ELUV-14

Naggar, S. E. (Alfred Wegener Institute, GERMANY)

25 February (Friday)

Session VI: Glaciological Environment (1)

9:00 ~ 10:30 *Chair Isaksson, E.*

39 Atmospheric Teleconnection between Japan and the Saint Elias Mountains, Yukon

Holdsworth, G. (Univ. of Calgary, CANADA)

40 Gas diffusion in polar firn and its application to atmospheric composition history and paleothermometry

Chappellaz, J. (CNRS Laboratoire de Glaciologie et Geophysique de l'Environnement, FRANCE)

41 Determination of ice flow velocity in Svalbard from ERS-1 interferometric observations

Lefauconnier, B. (Norwegian Polar Institute, NORWAY) & 2 others

42 Effects on spectral reflectance from snow ageing

Winther, J. G. (Norwegian Polar Institute, NORWAY) & Gerland, S.

43 In-situ snowpack temperature monitoring at an Arctic tundra site: A comparison of manual and automatic measurements

Gerland, S. (Norwegian Polar Institute, NORWAY) & Winther, J. G.

44 Polythermal glaciers in Northern Scandinavia - an important source of paleo environmental records

Holmlund, P (Stockholm Univ., SWEDEN)

11:00 ~ 12:15 *Chair Wakahama, G.*

45 An ice core record from Lomonsovfonna, Svalbard: viewing the isotopic, chemical and structural data between 1920-1997 in relation to instrumental records

Isaksson, E. (Norwegian Polar Institute, NORWAY) & 9 others

46 Sedimentary environment of the glaciers in the northern part of Svalbard recorded in ice cores

Watanabe, O. (NIPR, JAPAN) & 15 others

47 Ice-core chemistry variation on Penny Ice Cap, Baffin Island, Canadian Arctic over the last two centuries

Goto-Azuma, K. (NIPR, JAPAN) & 2 others

48 The North-GRIP deep drilling project in Greenland

Johnsen, S. J. (Niels Bohr Institute for Astronomy, DENMARK) & 2 others

49 Evolution of White Glacier, Canada, in 2xCO_2 climate, a numerical model study

Albrecht, O. (ETH, SWITZERLAND)

Session VII: Glaciological Environment (2)

13:45 ~ 14:30 *Chair Sato, T.*

50 Ocean tides and loading in the Arctic

Bos, M. S. (Bidston Observatory, UK) & Baker, T. F.

51 Inversion of global tide gauge data for present-day ice load changes

Plag, H. P. (Norwegian Mapping Authority, NORWAY)

52 Continuous gravity observation at Ny-Alesund, Svalbard with a superconducting gravimeter CT#039

Sato, T. (National Astronomical Observatory, JAPAN) & 4 others

Session VIII: Marine Environment

14:30 ~ 16:00 *Chair* *Taguchi, S.*

53 Arctic Ocean Change and Consequences to Biodiversity: A Perspective

Carmack, E. (Institue of Ocean Sciences, CANADA)

54 Seasonal cycle of carbon export in the Nordic Seas

Wassmann, P. (Univ. of Tromso, NORWAY)

55 Physical and chemical indicators of changes in the Barents Sea ecosystem in the second half of the 20th century.

Titov, O. (PINRO, RUSSIA)

56 Wind and freshwater driven circulation in an Arctic fjord system

Ingvaldsen, R. (Institute of Marine Research, NORWAY) & 3 others

57 The arctic sea ice ecosystem controlling by global warming

Melnikov, I. A. (Institute of Oceanology, RUSSIA) & 2 others

58 High latitude air-sea-ice interaction: The atmospheric forcing of deep ocean convection

Moore, G. W. K. (Univ. of Toronto, CANADA)

16:30 ~ 17:30 *Chair* *Taniguchi, A.*

59 Thermohaline structures observed in the Greenland - Barents Sea, January 1999

Naya, M. (Tokyo Univ. of Fisheries, JAPAN) & Nagashima, H.

60 Laboratory experiments on frazil ice formation and thermohaline convection with applications to the Arctic marine environment

Zatsepin, A. G. (P. P. Shirshov Institute of Oceanology, RUSSIA) & 4 others

61 Temporal change of phytoplankton distribution in the North Water Polynya

Odate, T. (NIPR, JAPAN) & 3 others

62 Organic Carbon Mineralization by new Types of Psychrophilic Sulfate-Reducing Bacteria in Permanently Cold Sediments off the Coast of Svalbard

Knoblauch, C. (Max-Planck Institut, GERMANY) & 4 others

Session IX: Terrestrial Ecosystems

17:30 ~ 18:30 *Chair* *Elster, J.*

63 Algal primary succession on newly deglaciated Arctic moraine, Ny-Ålesund, Svalbard

Elster, J. (Academy of Sciences of the Czech Rep., CZECH REPUBLIC) & 3 others

64 Response of microbial biomass in arctic soil to artificial warming by using Open top chamber

Bekku, Y. (NIPR, JAPAN) & Kanda, H.

65 The long-term influence of elevated temperature on biological production and carbon cycle in Arctic terrestrial ecosystems

Zamolodchikov, D. G. (Forest Ecology and Production Center, RUSSIA) & Karelin, D. V.

66 Plant speciation and phylogeography in the North Atlantic region

Brochmann, C. (Univ. of Oslo, NORWAY)

NIPR Arctic Environment Research in 1990-1999

Yoshiyuki FUJII
Arctic Environment Research Center, National Institute of Polar Research,
Kaga 1-chome, Itabashi-ku, Tokyo 173-8515

Since the establishment of the Arctic Environment Research Center (AERC) in National Institute of Polar Research (NIPR) in 1990, we have been promoting environment research in the Arctic region in the following scientific fields; upper atmosphere physics, atmospheric science, glaciology, marine science and terrestrial environment science.

In 1991, AERC established a research station at Ny-Alesund in Svalbard as a base of environment research. Ground-based atmospheric observations have been conducted on trace gases, aerosol and water vapor at this station. Focusing on trace substance transport and exchange processes in the Arctic troposphere and stratosphere, and microphysical structure of clouds in the Arctic region, we conducted airborne observation both inside and outside the polar vortex from Japan to Svalbard through Arctic Pole in March 1998.

We joined the EISCAT radar project in 1996 to clarify the nature of atmospheric and electromagnetic environments in the Arctic middle and upper atmosphere and AERC has been conducting radio, radar and optical observations of the aurora and varieties of electromagnetic and atmospheric phenomena in conjunction with the EISCAT radar.

Terrestrial environmental researches at the recently-deglaciated terrain and field experiments using OTC (open top chamber) have been carried out in Svalbard as a part of the ITEX (International Tundra Experiment) to clarify the effect on global change on tundra ecological system.

Oceanographic observations have been conducted in the Greenland Sea where is the major sink of carbon dioxide and in the North Water Polyna in Baffin Bay as an international project to clarify the role of the Polyna in the Arctic climatological, oceanographical and biological environment.

Ice core drillings have been carried out in Greenland as NGRIP and in Svalbard, Canada and Arctic Russia as ICAPP (Ice Core Circum-Arctic Paleoclimate Program) to reconstruct the past Arctic climate and environment.

2

OBSERVATIONS OF THE ARCTIC TROPOSPHERE AND LOWER STRATOSPHERE WITH THE SOUSY SVALBARD RADAR

Jürgen Röttger
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D-37191 Katlenburg-Lindau, Germany
<roettger@linmpi.mpg.de>

The SOUSY Svalbard Radar allows to measure the structure and the three-dimensional wind velocity in the troposphere and lower stratosphere. We will present first results of such observations showing small-scale gravity waves, mountain lee waves, and passages of synoptic- and meso-scale disturbances as well as the structure of the tropopause over Svalbard.

The instrumental design of the SSR will be briefly outlined, and the expansion of the SSR to allow radar imaging will be described.

It will finally be pointed out which contributions the SOUSY Svalbard Radar can provide to further studies of tropospheric and lower stratospheric dynamic meteorology and how such radar observations can be included into future projects in the Arctic.

CLIMATE CHANGE AND ITS IMPACTS ON THE ARCTIC

Gunter Weller
Center for Global Change and Arctic System Research,
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ABSTRACT

Regional assessments of climate change and its impacts are a high priority in the international programs on global change research. In the Arctic, climate models indicate an amplification of the global greenhouse warming, but the observed high-latitude climate trends over the last few decades are much more regional and patchy than predicted by the models. While considerable uncertainties remain in the long-term prediction of change there is some agreement between model results and observed trends by season on shorter time scales. The warming observed over the landmasses of the Arctic over the last few decades is matched by corresponding observed decreases in snow cover and glacier mass balances, by thawing of the permafrost, and by reductions in sea ice extent and thickness. Some of the resulting impacts will have positive ramifications for human activities but most are likely to be detrimental. While uncertainties exist about the future, climate change in the Arctic during the past few decades can be shown to have had major impacts already which will become much more pronounced if present trends continue.

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Greenland Summit Environmental Observatory

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The future sea-level change depends to a great extent on the mass balance of the two largest glaciers, Greenland and Antarctic ice sheets. Because the accumulation in the interiror of the ice sheets is very small, the stability of the ice sheets depends on a large surface of the accumulation area and especially on the dry snow zone with high albedo. In a case of Greenland ice sheet the dry snow zone occupies as much as 40 % of the entire surface. There is, however, an alarming report on a recent decreasing trend of the surface of the dry snow zone on Greenland. The investigation on the radiation and heat exchange on the surface of the dry snow zone including the structure of the stable planetary boundary layer is regarded as one of the most important points in the on-coming US-European Joint Project at Summit. Main scientific problems and possible methods will be presented.

ABSTRACT

2nd International Symposium
on Environmental Research in the Arctic

Circum-Arctic ice core records from small ice caps: a different view on Holocene climate.

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While there is probably no direct past analogue for future climate, we can still use ice core records to gain a better understanding of climate. There is now clear evidence that the early Holocene was warmer than today. Ice cap records from the circum-Arctic region illustrate a very early Holocene thermal maximum, followed by a persistent cooling until about 150 years ago. Thus, the modern warming period is highlighted by its contrast with the climate immediately preceding it, a climate that was the coldest for 10,000 years. Consequently, glaciers today continue to retreat from margins that reached their greatest extent for 10,000 years only 100-200 years ago.

One question worrying modern society, is whether the sudden climate changes seen in ice cores (using $\delta^{18}O$ as a proxy), will occur again, forced by the sudden nature of anthropogenic greenhouse gas warming. Interplay between the Atlantic "conveyor belt" circulation and ice sheet melt-water is seen as the factor responsible for at least some of these sudden climatic changes from warm to cold, and back to warm again. This is when the Atlantic conveyor belt circulation stops when pushed over a critical threshold. The Gulf Stream then fails to deliver heat to the north Atlantic; an area, at least continental in extent, is then plunged into a period of cold climate. The Younger Dryas, 12.7–11.5 ky BP, is a well-studied example of such an event. More recent research has attributed a sudden cooling, registered by a $\delta^{18}O$ step in 8.2 ky old ice in the Camp Century, Dye-3, Grip and Agassiz ice cap cores, to sudden drainage, into the Atlantic, of glacial lakes on the southern margins of the decaying Laurentide ice sheet. Dansgaard-Oeschger events may be similarly explained.

Based on the evidence of these events, it has been suggested that increased land-ice melt, due to a warmer climate, could slow, or stop, the Gulf Stream in the near future. Global warming could then cause a marked *cooling* in Europe. The fact that the 8.2 ky BP sudden event occurred in the present interglacial, i.e. that sudden events are not exclusive to glacial periods, has given impetus to these suggestions. However, all of these events, including that of 8.2 ky BP, occurred in the presence of the great ice sheets. Similar $\delta^{18}O$ steps found in ice deposited during the last interglacial period in the GRIP core, first attributed to climate, have since been shown to be caused by ice dynamics. The question is whether ice from the circum-Arctic land ice masses, can be melted at a sufficiently rapid rate in the future, to stop the conveyor belt. This seems unlikely. Simple calculations show that melting of northern-hemisphere land-ice when the Laurentide/Fennoscandian ice sheets were retreating in the early Holocene, generated far more melt-water than could be produced from present-day land ice in a model-projected, warmer world. However, between 11.5 ky BP and 6 ky BP, when the Laurentide Ice Sheet finally disappeared, the only sudden cooling event occurred when glacially damned lakes released enormous volumes of melt water 8.2 ky BP. For sudden events to occur in the future, they would have to have some other cause than those documented from the past from ice core records.

Chinese First Expedition to the Arctic Ocean

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ABSTRACT

Chinese First Arctic Expedition was carried out from July 1 to September 8, 1999, aboard ice-breaker R/V Xuelong supported by two helicopters and a boat, organized by the Chinese Arctic and Antarctic Administration, State Oceanic Administration. 25 scientists on scientific disciplines of physical oceanography, marine Chemistry, marine biology, biogeochemistry, marine geology, glaciology, atmospheric science and fisheries from 10 research institutions and universities in mainland and Taiwan of China as well as scientists from NIPR, Japan and KORDI, Korea took part in the field investigations. The working areas covered the Canadian Basin, Chukchi Sea and Bering Sea in the Pacific sector of the Arctic Ocean.

The following data and samples were obtained during that expedition for scientific research. For oceanography, more than 100 CTD deep stations, 1423.6 MB of VM-ADCP data and 70 probes of XBT & XCTD in 55 locations above 1000m. For geology, Sediment samples by Box Sampler and Multi-Tube Sampler in 41 locations and 47.92m of column sediment samples in 17 locations. Vertical and horizontal trawls in 110 locations for biology and ecology, and EK-500 and 792DSG fish-finder working in 5800 nautical miles and 19 trawls were operated. A variety of samples of sea water, air and snow and sea ice cores etc for research of chemistry, isotope, primary productivity, microbiology, phytoplankton, nano-plankton, aerosol and samples from sediment traps were obtained at two Ice-Stations on ice floe. Boundary and upper-air observations including ozone and ice-radar measurements of ice thickness were also made. The northernmost station was in 77^{0}N of the Canadian Basin.

All samples and data are on the way of analysis. And cooperative research on them with foreign scientists is mostly welcome.

Greenland Sea in Winter

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Greenland Sea is a remarkable sea in various aspects. Open Water extends to a high latitude, whilst the area exports the sea ice toward south. The surface absorbs CO_2, and the deep water is created at the bottom. Intensive biological activities are also observed, etc. A couple of key factors build up the basic characteristics of the Greenland Sea, and all visible phenomena counted up above are solely presentations of the characteristics of the sea thus built up. One of the key factors is the interaction of waters in the area. Two water bodies with quite different characteristics take contact to each other in this sea area: the Polar Water from the Arctic Sea and the Atlantic Water from the southern part of the sea with the same name. This encounter contributes to the dictation of the characteristics of the Greenland Sea.

The sea has been intensively investigated in recent years. However, most observations were made in the summer. There was very little winter fieldwork. The winter conditions may be similar to those in summer, but may differ from the latter considerably as well. It was hence within the range of speculation.

A cruise observation was carried out in January 1999 (Ito, 1999). The Greenland Sea was investigated in terms of water structure (temperature, salinity), chemistry (pCO_2, $nTCO_2$, nutrient salts, $\delta^{18}O$) and biology (phyto- and zooplankton).

The winter state of the Greenland Sea is generally described in this presentation, whilst individual analyses are not completed yet and each topic will be reported in details in favorite opportunities.

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Co-authors

O. Titov, M. Antsiferov, Y. Tanaka, S. Morimoto, K. Aranami, M. Yamamoto, K. Baba, H. Suetake, D. Kawai, S. Yoshimura and M. Naya

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The International North Water Polynya Study (NOW) : an Early Synthesis

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After three highly successful, multidisciplinary expeditions totaling 180 at sea, what have we learned about the functioning, ecological importance,and future of the North Water ecosystem? The scientific program of NOW comprises 13 projects tightly integrated around a central hypothesis that links spatial and temporal gradients in biological productivity and carbon export to the hydrographic/meteorological forcing of the North Water.

Preliminary interpretations from observations and modeling efforts are summarized concerning (among several other topics), the relative importance of sensible and latent heat processes in maintaining the polynya; the duration, intensity and nature of biological production in the North Water; and the export of carbon to the pelagic food web and at depth.

Greenhouse gas fluxes in winter and thawing period at Arctic tundra Ecosystem

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Introduction

Tundra ecosystem is thought to be a strong source of greenhouse gases. CO_2 and CH_4 efflux in the thawing period has been thought to be large amount, however there have been a few studies. In order to reveal the annual budgets of greenhouse gases of tundra ecosystems, continuous flux measurements were carried out over Arctic coastal tundra at Barrow, Alaska. Micrometeorology and CO_2 exchange were revealed over snow-covered tundra before and after thawing period.

Location and Measurements

Measurement site point (71°19'14.2"N, 156°37'11.1"W, elevation 3m) was at Central Marsh, where the wet sedge tundra extended to several kilometers. The fetch of the site was more than 0.5 km to most directions except the nearest bank-edge where was 140 m far to northeast.

CO_2, sensible and latent heat fluxes were determined by eddy correlation method using 3D-sonic anemometer (Kaijo, DA-600) and CO_2/H_2O fluctuation meter (Advanet, E009a). The sampling rate was 10Hz and continued 27.4 min at 30-min intervals. CH_4 flux was determined by flux-gradient approach using a differential type NDIR-CH_4 analyzer (Horiba, GA360). The vertical CH_4 concentration gradient was measured between two heights of 0.65 & 2.35 m.

The measurements started on April 21, 1999. Micrometeorology and gas concentration data were sampled every 10-second intervals and averaged over 15-minute intervals. Selected data through quality check were averaged over every 30 minutes and combined with eddy flux data.

Results and discussions

In snow-covered period, snow depth decreased from 45 cm in the beginning to 35 cm after 3 weeks. Albedo was 0.8-0.9 in average and midday peak of net radiation Rn ranged 30-80 W/m^2 and ranged -50 -70 W/m^2 in nighttime. Sensible H and latent lE heat fluxes changed in the same manner with around +-20 W/m^2 peak in daytime and nighttime. Daytime Rn increased from June 11 and the thawing was on June 13, then Rn increased up to 500 W/m^2 peak in daytime resulted in the remarkable changes in energy budget.

Positive CO_2 flux (0.1-0.2 gCO_2 m^{-2} h^{-1}) of upward efflux from the ecosystem was observed during snow-covered period that was increased extremely with strong wind by blizzard. CO_2 efflux during blizzard was in proportion to the square of friction velocity that was sucked out from snow pack layer with drive of snow. CO_2 efflux level under low wind speed (friction velocity was less than 0.25 m/s) was lower than 0.09 g m^{-2} h^{-1}.

In clear daytime we could detect the sink CO_2 flux at the snow-covered tundra ecosystem even the snow depth was more than 30 cm. The daytime sink CO_2 flux (less than -0.1 g m^{-2} h^{-1}) was synchronized with solar radiation, but became zero level in snow melting period when the tundra surface was flooded without active plant. We could not find huge CO_2 release just after snowmelt that was observed at many tundra ecosystems, caused by emission from soil layer as accumulated CO_2 in winter season. The flooded water at the site could prevent CO_2 diffusion to the air.

CH_4 concentration gradient was not clear under snow-covered conditions. As CO_2 efflux was enhanced by the blizzard while similar CH_4 efflux could not be detected. From late May, we detected CH_4 concentration but the concentration gradient was not clear under snow-covered conditions. CH_4 flux (emission from the ecosystem) was less than 0.1 gCH_4 m^{-2} d^{-1} and sink CH_4 flux was observed sometimes over snow-covered field, thus the daily variation was not obvious. CH_4 flux decreased around the snowmelt period as the same manner as CO_2 efflux. CH_4 flux increased after mid June with increase of soil temperature and showed and barely daily variation was observed.

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PERSISTENT ORGANIC POLLUTANTS IN ARCTIC ANIMALS IN THE BARENTS SEA AREA AND AT SVALBARD; LEVELS AND EFFECTS

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The presence of persistent organic pollutants (POPs) in the arctic environment has been known for decades. POPs have been widely used for different industrial, agricultural and domestic purposes throughout the world. These compounds are resiststant to decomposition, and due to their their lipophilic properties they bioaccumulate in food chains. POPs are transported by air and water currents into the Arctic where they are biomagnified to higher tropic levels. At Svalbard and in the Barents Sea area, the level of POPs are high in top predators such as glaucous gull (*Larus hyperboreus*), arctic fox (*Alopex lagopus*) and polar bear (*Ursus maritimus*). Despite that the use of many of these chemicals has been curtailed in most parts of the world, there is great concern related to their possible impact on the health of arctic wildlife.

As part of the Arctic Monitoring and Assessment Programme (AMAP), the Norwegian Polar Institute (NP) has been conducting monitoring studies of Arctic birds and mammals in the Barents Sea area and Svalbard since 1990. These studies have revealed high levels of polychlorinated biphenyls (PCBs) and toxaphenes in the glaucous gull, arctic fox and polar bear.

Laboratory studies have most often been used to assess the effects of POPs on animals. Areas of research have addressed questions related to mortality, reproduction, development, growth, neurology, immunology and endocrinology. The response of the organism to POPs is dependent on the magnitude and duration of exposure, the potency of the chemical, the tolerance of the organism, and the interactive effects of other chemicals or stressors. For most wildlife species, the effects and responses of POPs are unknown.

During the last 5 years scientists from the NP and other national and international research groups have collaborated with the aim to; 1) provide baseline data on POPs, 2) assess factors influencing the levels of POPs, and 3) elucidate possible biological/toxic effects of POP exposure on marine mammals and seabirds from the Barents Sea area and Svalbard. Because of high POP levels found in polar bears and glaucous gulls, studies are being conducted on possible toxic effects on the immune system and reproduction of these species. The present paper reports on monitoring studies of Arctic animals and current toxic effect studies of the polar bear and glaucous gull.

Abstract

Global Change impacts on terrestrial plant communities: long-term studies in the northern Scandes.

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Within the framework of the International Tundra Experiment (ITEX), long-term studies were carried out at the Latnjajaure Field Station in the mountains of northernmost Swedish Lapland. The Latnjajaure site is located in a subarctic-alpine area at an altitude of 1000 m a.s.l. Monitoring studies of phenology and flowering were initiated in 1990, whereas the manipulative work commenced in 1993. Climate change was simulated by using ITEX open-top chambers, and for the individual species studied there are now 6–7 year datasets. Manipulative community level experiments were implemented in 1995 in two different plant communities; here a fully factorial design was used with a combination of temperature enhancement and fertilizer addition (mainly nitrogen). Community level responses, e.g., biomass and biodiversity, was the target in these experiments. The various facetts of the ongoing studies are now synthesized in a new project at the landscape level, aiming at a dynamic vegetation model for an entire alpine catchment area under different Global Change scenarios.

The basic ITEX species-oriented studies revealed a differential response to enhanced temperature. Much of this was highly species-specific, but there are trends that are common to broader ecological groups of plant species, i.e., functional types. All species studied showed accelerated phenology of flowering and leaf production, and seed weight increased in most cases as a response to the higher surface temperatures. With regard to growth, evergreen dwarf shrubs generally showed little or no reponse to climate amelioration, whereas all other funtional types (and herbs in particular) responded vigorously in the short term. In the longer term (5 years or more) community level responses started to dominate the picture, when the more slowly responding categories deciduous shrubs and graminoids tended to take over. This was mainly brought about by competition for light and other resources. With fertilizer addition, the graminoids were extremely responsive and increased their biomass rapidly, particularly when this treatment was combined with experimental warming. Also here, the decidous dwarf shrubs responded positively to treatment, although at a somewhat slower rate. The bottom layer cryptogams were generally negatively affected by the treatments, although acrocarpous bryophytes seem to coop better with the warming treatment than other cryptogam groups.

The long-term studies have revealed a combination of immediate species-specific responses at the individual plant level, and slower indirect, competitive responses at the community level, changing the dominance relationships among species and functional types.

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Activity and Development of Scientific Community Ny-Ålesund

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What is needed in order to achieve a full scale environmental monitoring in Ny-Ålesund?

Prestrud, P. (Norwegian Polar Institute, NORWAY)

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RECENT CONTRIBUTIONS TO LONG-TERM ATMOSPHERIC STUDIES AT KOLDEWEY-STATION

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The Koldewey-Station at Ny-Ålesund/Spitsbergen is the German Arctic research station, which has two main tasks. It serves as a platform for research campaigns in many different scientific fields carried out by German scientists in the Kongsfjord area. It also serves as an observatory for long term measurements, mainly for climate and atmospheric research. Herewith the station contributes to several global observing networks like NDSC, BSRN and GAW and others. Validation of the resulting data sets is a regular topic in order to achieve a constant high quality level. This in turn makes data from the Koldewey-Station attractive to others for the validation of remote sensing instrumentation e.g. on satellites or airborne platforms. Data from the station have contributed e.g. to the validation of GOME measurements, and also provided auxiliary data for the ILAS experiment. The Koldewey-Station also participated in several major international campaigns investigating the Arctic ozone layer. Of these the SOLVE and THESEO 2000 campaigns are currently under way.

This paper will firstly give a brief overview on current measurement capabilities at the station. It secondly summarises recent crucial results of long-term measurements, campaigns, and contributions to regional investigations. Observations are focussed to areas in climate research, like measurements of aerosols and trace gases and the climate effect of their long term development, as well as investigations of the atmosphere-surface processes. Regional investigations are for example related to the stratospheric ozone loss problem, which is studied with a "Match" technique combining ozone sonde data from Arctic and mid-latitude sounding stations. Examples of validation efforts and campaigns will cover contributions to satellite experiments and recent results from the NAOMI and SOLVE/THESEO campaigns.

Climatic mesospheric cooling: the importance of long time-series of ionospheric soundings.

C. M. Hall

Climatic change in the troposphere is characterised by global warming. In contrast, a corresponding cooling of the mesosphere is occurring, and this results in a systematic change in atmosheric thickness. Recent studies, notably in Sodankylä in Northern Finland and Juliusruh in Germany, have employed time series of heights of ionospheric layers, determined by ionosondes. As an example, the study in Sodankylä has revealed a fall in the height of the ionospheric F2 region of around 15 km since 1958. Ionosondes have been operating at Tromsø (69 deg. N) since 1935, thus careful analysis of these data should reveal results similar to those from nearby Sodankylä. Furthermore, ionospheric soundings from both Svalbard and Oslo are to be found in the University of Tromsø's archives. At the end of 1999, work began in Tromsø to catalogue these data with a view to exhaustive digitalisation and subsequent analysis. Here, the value of maintaining such datasets will be demonstrated and the extent of data availability from both Tromsø and Svalbard will be reviewed. Analysis of existing data is a substantial task, and possibilities for utilising neural networks are being investigated at Tromsø. Finally, the future plans and recommendations for monitoring the ionosphere will be outlined.

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Geomagnetically Conjugate Auroras between Iceland and Syowa Station

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Ground footprints at each end of a geomagnetic field line in the northern and southern hemispheres are defined as geomagnetically conjugate points. Observations of conjugacy and non-conjugacy of auroral phenomena give us useful information on the generation and propagation mechanism of aurora. Because charged particles in the magnetosphere are generally constrained to move along geomagnetic field lines. However, there are very few conjugate pairs of observations in the northern and southern polar regions. Fortunately, Syowa Station in Antarctica is located very close to (~ less than 100 km) the geomagnetically conjugate station of Husafell in Iceland, making an ideal pair of conjugate stations in the auroral zone.

NIPR carried out the first conjugate campaign at Syowa and Husafell under the International Magnetospheric Study (IMS) program during limited period of August and September in 1977 and 1978. After the first campaign, an enlarged scale conjugate observation throughout a year has been carriedout since 1983.

In the early studies of conjugate auroral events, a variable displacement of the point of best conjugacy and nonconjugate activities in opposite hemispheres were found to be related to geomagnetic activity and to geomagnetic latitude. Since this early work, much important evidence has come to light concerning the generation mechanism of auroras. This evidence has been gathered by satellites and other sophisticated methods. We now realize that the conjugacy of auroras may be affected by an auroral electric field, field-aligned currents, particle acceleration and precipitation processes, plasma density, conductivity, and solar wind-magnetosphere interactions as well as the configuration of geomagnetic field lines.

The auroral zone is located in the boundary region between open and closed field lines, where many intense auroral phenomena occur. Significant physical problems concerning these phenomena remain unsolved. Conjugate observations, such as studies of the exact location of conjugate points and their movements, the movement of conjugate auroras, on-off phase relation of pulsation aurora, the onset time difference of auroral breakup and substorm at conjugate points etc., should help us to infer the physical nature of auroral phenomena which occur between the magnetosphere and the ionosphere.

In my talk, some excellent examples of conjugate and nonconjugate auroras, which were observed recently at Syowa and Husafell, will be presented.

Response of the Thermosphere to High-Latitude Energy Inputs

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It has long been recognized that the high-latitude energy input associated with magnetospheric disturbances drives a storm-time meridional circulation and atmospheric gravity waves. The dynamics and energetics of the thermospheric response to the high-latitude energy input, however, are not totally understood yet. This paper aims to inspect some features of the thermospheric response simulated numerically, and to propose a description to explain the meridional extent of the storm-time global circulation and a preference for atmospheric gravity waves in an energy transport beyond the middle latitudes.

The main features of the simulated wind system and energetics are summarized as follows; (1) the boundary between upwelling of the air due to the high-latitude heating and the balanced downwelling reaches 40 - 50 degree in latitude, (2) the enhancement of the equatorward wind is maximized around 50 degree in latitude, (3) the horizontal advection associated with the enhanced equatorward wind does convey energy to mid-latitudes around 40 degree (see Fig. 1), (4) the rapid increase in the magnetospheric energy excites the large-scale atmospheric gravity waves which sometimes appear as a wind surge propagating to the low latitudes and into the opposite hemisphere, (5) a conveyance of energy to the low latitudes is mainly due to the adiabatic heating/cooling associated with the atmospheric gravity waves (see Fig. 1).

The mechanisms for the restriction of increases in the equatorward wind and the horizontal energy advection are considered in two ways.

(1) During the development of the meridional circulation, the zonal winds are built up via the Coriolis force and the meridional wind and the resultant horizontal advection is restricted.
(2) The energy input is not sufficiently large to drive the extensive horizontal advection, and resultantly the increase in the equatorward wind is restricted.

The dynamics and energetics of the meridional circulation and the atmospheric gravity waves will be discussed in detail.

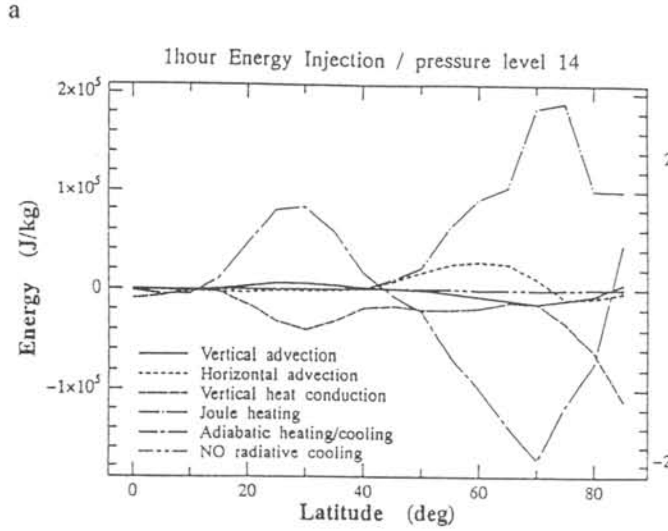

Fig. 1 The time-integrated energy density per unit mass for various forcings at about 250 km height.
The integration time is 24 hours. (a) 1 hour energy injection, (b) 12 hours energy injection.

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Sounding rockets from SvalRak

In 1997, a launch site was set up in Svalbard archipelago in Arctic. It supports rocket studies of the dayside polar cusp, cleft and cap, and can launch rockets up to 3ooo kg.

The high latitude and geomagnetic width at the SVALRAK launch base at Ny Ålesund at 79 deg N latitude make it ideal for scientific exploration of the dayside aurora and processes in the magnetospheric boundary layer. SVALRAK has a sheltered launch pad and has separate preparation and integration facilities. A mobile telemetry station provides telemetry services.

SS-520-2 Rocket Experiment Plan

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The Institute of Space and Astronautical Science is planning to launch a sounding rocket "SS-520-2" from Ny-Alesund during a period of 25-30 November (but may be extended until 5 December), 2000, in collaboration with the Andoya Rocket Range. The main objective is to study ion heating and acceleration processes and associated ion outflowing phenomena occurring at altitudes of ~1,000 km above the dayside cusp/cleft region. The outflow of ionospheric ions, especially from the dayside cusp/cleft region, is an important source of magnetospheric plasma. Much of the ion outflow is caused by ion heating in the perpendicular direction to the geomagnetic field. A number of physical mechanisms have been proposed, but most are hypothetical, poorly understood, or simply conjecture. The goal of the present experiment is to put these mechanisms into perspective. For this purpose, the SS-520-2 rocket is designed to carry nine instruments; TSA (Thermal and Suprathermal ion Analyzer), TECHS (Thermal Electron Capped Hemispherical Spectrometer), XUV (XUV 83.4-nm photometer for oxygen ions), ESA (Electron Spectrum Analyzer), ISA (Ion Spectrum Analyze), PWA (Plasma Wave Analyzer), NEI (Impedance probe for electron density), TEL (Electron temperature probe), and MGF (Magnetic Field instrument). Ny-Alesund is the best site for this experiment, since it is located, on the average, very close to the cusp location at magnetic local noon. The rocket will be launched between 06-12 UT (MLT = UT + 3.2 hours) at a fixed azimuth of 205° due to the range safety. With this azimuth and the elevation angle of 85°, the apogee height of the rocket will be ~1,000 km at ~72° in magnetic latitude. This means that the cusp latitude must be lower than the average, and hence the interplanetary magnetic field (IMF) should be southward for at least an hour before the launch. The IMF and solar wind conditions, which are to be observed by ACE spacecraft, will be monitored on a semi-real time basis via the webpage. The Iceland HF radar data will also be used to identify the cusp/cleft location. The EISCAT radar data (and if possible, optical data as well) taken at Longyearbyen and Tromso will be used to identify the ion heating phenomena above the cusp/cleft region.

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OBSERVATIONS OF THE ARCTIC MESOSPHERE AND D-REGION WITH THE EISCAT SVALBARD RADAR AND THE SOUSY SVALBARD RADAR

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During the recent years two major radar systems have been installed near Longyearbyen on Svalbard (78N, 16E), namely the EISCAT Svalbard Radar (ESR) and the SOUSY Svalbard Radar (SSR). Whereas the ESR is an incoherent scatter radar, essentially used for studies of the magnetosphere-ionosphere coupling, the SSR is an MST radar, which is employed for studies of the mesosphere, stratosphere and the troposphere. Both radars had also been operated in simultaneous experiments for studies of mesosphere-lower ionosphere coupling. In addition useful instrumentation exists in the vicinity, such as imaging riometers and OH spectrometers, which are applied for investigations of the D-region and mesopause region and can comprise beneficial complements to the radar investigations.

We will concentrate on the description of the capabilities of the SOUSY Svalbard Radar and present observations of Polar Mesosphere Summer Echoes (PMSE), which are characteristic for the cold summer mesopause at high latitudes and are related to ice particles embedded in the ionospheric plasma. These studies allow also to investigate winds, tides, gravity waves and turbulence at altitudes of 80 to 90 km. We will discuss simultaneous observations with the ESR and the SSR during PMSE conditions. First observations of the D-region electron density with the ESR will also be described.

An essential addition to such systems would be a meteor radar. Observations with the SSR during the November 1999 Leonid shower show successful results. It is advisable to add a stand-alone meteor radar, since this would allow more continuous observations of winds and temperature in the mesosphere and lower thermosphere.

Noctilucent cloud observations with CCD cameras in both northern and southern hemispheres during 1997-1999

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We are now at the first step for making long-term records of images of noctilucent clouds(NLCs) by CCD cameras in both northern and southern hemisphere. Our scientific objectives of this attempt are as follows:

1. aims to get results within several years

- **a.** We will confirm a 5.5 day periodicity in occurrences of intense NLCs which are suggested by amateur observations in north-western Europe during 1964 to 1992 and are also stressed in polar mesospheric summer echos(PMSEs) observed at Poker Flat during 1982 to 1986.
- **b.** We will investigate the longitudinal distributions of NLCs which have not yet been attempted. They will clarify the cause of their periodic appearacnes whether they are due to the planetary waves or the intrinsic nature of the ionic nucleation of the ice particles in the clouds.
- **c.** We will investigate the similarity and difference of the nature of NLCs in between northern and southern hemisphere.

2. aims of long-term observations

Image records over decades will bring about the information of long-term trends of variations of NLCs in their occurrence frequencies, duration of the season and their variations of intensities. Further, the data base of the ground-based observations will provide valuable knowledge for consentrated projects to investigate NLCs by flight-borne observations such as airplanes, rockets and satillites.

We will show our observational results in

a.) Sweden in 1997
b.) Ushuaia and Punta Arenas during 1998 January to 1999 January
c.) Yakutsk in 1999

We have applied fully automatic observations during summer with CCD imagers in b.) and c.). In short, our results show that NLCs are rare events occurring with intervals of negative nights. In b.), we have confirmed occurrences of NLCs in southern hemisphere, with which we propose to build large-scale VHF radars for PMSEs in Antarctic. We want to co-operate researchers in Alaska to confirm the longitudinal distributions of NLCs.

Gravity Waves Simulated by a High-resolution GCM

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Global characteristics of gravity waves in the lower stratosphere are examined using a GCM (General Circulation Model) with high resolution in both the horizontal (T106, corresponding to about 120 km) and the vertical ($\sim$600 m). The bottom boundary condition of the model is that of an aqua-planet with perpetual February sea surface temperature (SST). The simulated gravity waves are in good agreement with MST (Mesosphere-Stratosphere-Troposphere) radar observations at a middle latitude on the wave structure and on the frequency spectra as a function of height. The frequency spectra of wind and temperature fluctuations are also examined as a function of latitude. Large values of spectral density are observed at frequencies higher than the inertial frequency (f) in a weak wind region around 20 km, consistent with the theoretical characteristics of internal gravity waves. An isolated peak is observed near f for horizontal wind spectra at latitudes higher than 10°, while the energy is distributed in a wide range of frequency at lower latitudes where f approaches zero.

Further analysis is performed of those fluctuations having periods shorter than 24 h and those having vertical wavelengths smaller than 5 km. These are frequently analyzed as gravity waves using observation data. The distribution of energy and momentum fluxes in the latitude-height section is examined. The result indicates that short-period waves mostly propagate upward and poleward from the equatorial region. The wave energy reaches about 50° latitude at the 27 km altitude. A negative (positive) maximum of vertical flux of meridional momentum ($\overline{v'w'}$) is seen above the subtropical jet in the Northern (Southern) Hemisphere for small vertical-scale waves.

In order to identify the sources of gravity waves at middle and high latitudes in the winter lower stratosphere, three dimensional phase movements are examined. In the middle latitude region where baroclinic waves are dominant around the midlatitude eastward jet stream, gravity waves propagate eastward in the region between the jet level (about 10 km) and about 19 km altitude and westward above. The transition level of 19 km corresponds roughly to the edge of theoretically-predicted unreachable region of gravity waves generated associated with vigorous tropical convection. A Hovmöller diagram of the short-period components above 19 km shows that interference of multiple waves sometimes occurs. A movie of meridional cross-section of horizontal divergence components indicates that some waves above 19km propagate upward and poleward from the equatorial region and others propagate downward and equatorward from the stratospheric polar jet. A movie of the polar stereo chart of the horizontal divergence suggests that gravity waves are generated around the polar vortex, in particular, around the edge with large curvature due to modification by planetary-scale waves.

A study on the polar atmospheric tide by the EISCAT and cooperative observation network : comparisons with observation and theory

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The polar middle and upper atmospheric tide has noteworthy variabilities in that it has some possible effects of electromagnetic disturbances from above due to ion drag or Juole coupling and of the polar vortex and wave dynamics in the denser lower atmosphere due to wave interactions propagating from below. EISCAT radar which comprises the tri-static UHF and mono-static VHF radars in the northern Scandinavia and mono-static UHF radar in Svalbard plays an important role in studying the Arctic upper and middle atmosphere environment. EISCAT radar can observe tides in the vast altitude range from the middle atmosphere up to the thermosphere where hydro-magnetic tide is prevailing. To complement the high-powered but intermittent EISCAT radar run, a new meteor radar, which can secure continuous observation at meteor heights, is also planned in Svalbard. Also SSR radar has been installed on site by MPAe, Germany, and Russian group has just started meteor radar observation at Dixon Island. Japanese MF radars are newly under continuous run in Alaska by CRL and in Antarctica by NIPR. Some optical instruments will also join the observation network in near future. Global collaborative observations by these instruments in longitude for zonal wavenumber and in latitude for the Hough function characteristics, in Arctic and Antarctic conjunction for conjugacy study, and multi-instrument observations by radars and optics like lidars and air glow observations for the wind and temperature relationship will all lead to unambiguous delineation of tidal variabilities and underlying physical processes. An overview will be given as to what have been clarified on the climatology of Arctic atmospheric tide by the EISCAT radar by now and what can be clarified by intensive global observation in parallel with theoretical and modeling studies.

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Ground based, balloon and aircraft measurements of greenhouse gases in the Arctic

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In order to elucidate temporal variations of greenhouse gases in the arctic region, ground based observations at Ny-Ålesund, Svalbard have been made since 1991. Air samples were collected once per week and sent back to our laboratory almost every 3 months for analysis. CO_2 and CH_4 concentrations were analyzed by a non-dispersive infrared gas analyzer and a gas chromatograph equipped with FID, respectively. Pure CO_2 was extracted from residual air and the isotopic ratios of $\delta^{13}C$ and $\delta^{18}O$ were analyzed by a mass spectrometer. Seasonal cycles and secular increases of CO_2 and CH_4 concentrations were clearly seen and a number of rejected data because of local contamination was very small. This fact indicate that the site is good for back ground monitoring of atmospheric minor constituents. Observed isotopic data suggested that a temporal reduction of CO_2 increase in 1992 and 1993 which was known as the Pinatubo anomaly was mainly caused by enhanced CO_2 uptake by the land biota.

Continuous measurement of surface O_3 have also been made since 1991 using the DASIBI ozone monitor. Daily mean O_3 concentrations were extremely variable but seasonal cycle with spring maximum and summer minimum could be seen. The phenomenon of ozone destruction which was first pointed out at Alert, Canadian arctic station, was also seen at Ny-Ålesund between April and May ever year.

In order to elucidate the vertical distribution of CO_2, CH_4 and N_2O concentrations, $\delta^{13}C$, $\delta^{18}O$, $\Delta^{14}C$ in CO_2 and $\delta^{13}C$ in CH_4 in the Arctic stratosphere, we collected air samples over northern part of Scandinavian Peninsula on February 22 and March 18, 1997 using a balloon-borne cryogenic sampler. We also made aircraft measurements over the Arctic between March 6 and 13, 1998 using a jet plane. The results showed that the observed values of these components were lower and their vertical gradients were steeper, compared with those obtained over Japan. This fact suggests that CO_2, CH_4 and N_2O intruded into the stratosphere by strong upwelling in the equatorial region are transported poleward slowly and that the transport velocity is slower at higher altitudes than at lower altitudes.

Ten years of Carbon Dioxide monitoring on Zeppelinfjellet (78°54' N, 11°53' E)

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The Department of Meteorology at Stockholm University (MISU) has, with support from the Swedish Environmental Protection Agency since 1988 maintained a CO_2 and related tracer monitoring site on Zeppelinfjellet mountain near Ny-Ålesund (78°54' N, 11°53' E) on Spitsbergen. The Zeppelin station (474 m above sea level) utilized since March 1990 is excellent for background monitoring of CO_2 with minimal local contamination or other disturbance. Carbon dioxide data are available from January 1, 1989 through July 15, 1999. This paper summarizes some important and recent results from these ten years of monitoring

In order to calculate an annual increase and seasonal amplitude of CO_2 at Ny-Ålesund the full data series (January 1, 1989 to December 31, 1998) was fitted to a linearly increasing harmonic function. This procedure yields a linear increase of atmospheric CO_2 at Ny-Ålesund of 0.98 ppm/year and a seasonal amplitude (after subtracting of the annual trend) of 15.8 ppm. During winter (November-March) there is always a high degree of variability, most often towards higher CO_2 values, this we attribute to long-range transport of pollutants from Eastern Europe and Siberia. In spring and summer (May-August) we see similar excursions, but now towards lower CO_2 values. During these periods the air depleted in CO_2, has often spent some time over the waters of the northern North Atlantic prior to arrival to Ny-Ålesund. These waters are then highly undersaturated in CO_2 with respect to the atmosphere, following the initial phytoplankton bloom in early summer. Support for the interpretation that oceanic uptake is seen in the springtime variability is also acquired from our ^{13}C record, trajectory studies as well as 3-D modeling work.

There was an anomalous low CO_2 increase rate that during 1993. During the summer and fall of 1994 a dramatic recovery of the CO_2 trend towards increase rates of 2-3 ppm/year occurred. The increase rate has declined again in late 1996 and 1997. There is mounting evidence that these variations in atmospheric increase rates are responses to changes in the terrestrial biosphere that in turn are either due to climatological variations although human induced land-use changes cannot be ruled out. How these variations in increase rate are connected to climatic variations is currently under intense investigation at MISU with the aid of global general atmospheric circulation models coupled to terrestrial biosphere model. Recent results show that the rapid increase rates seen following an intense El Niño event are strongly related to responses of the equatorial biosphere to climate anomalies.

Future projects include building a capacity to monitor vertical profiles of CO_2 and combining the MISU data sets with other long-term records in Ny-Ålesund and other Arctic monitoring sites to further elucidate the regional carbon cycle responses to climatic variability. Such studies are currently underway in Siberia and Scandinavia.

GLOBAL QUALITY CONTROL FOR LONG-LIVED TRACE GAS MEASUREMENTS

by

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Abstract

At the 10th World Meteorological Organization's (WMO) meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques, Stockholm, 23-26 August 1999, a proposal was put forward to address some of the known problems associated with quality control of global trace gas measurements, in particular, carbon dioxide, methane and their respective isotopes, and proposes some changes to significantly improve on current situation. The meeting was also attended by Research Co-ordination Meeting of the International Atomic Energy Agency's (IAEA) Co-ordinated Research Project on Isotope-aided studies of atmospheric carbon dioxide and other greenhouse gases, The aim of this proposal is greatly improved inter-laboratory comparability for measurement of long-lived atmospheric trace gas species, resulting in improved derivation of source/sink fluxes from spatial and temporal atmospheric composition changes. A network with regional "hubs" responsible for maintaining an efficient means of intercalibrating all laboratories with a much higher frequency than what has been practiced to date is proposed. Mayor needs and components of such a network will be presented. This proposal is supported, in principle, by both WMO and IAEA, and has implications for all scientific groups involved in trace gas measurements

Forthcoming Arctic Field Campaign
ASTAR 2000 (Arctic Study of Tropospheric Aerosol and Radiation)

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A new Japan-German cooperative project on aerosols in the Arctic, ASTAR (Arctic Study of Tropospheric Aerosol and Radiation) 2000 is to be carried out in coming March and April in the vicinity of Svalbard. The goal of the project is to investigate the behavior and radiative effects of tropospheric aerosols in the Arctic (high concentrated layered aerosols are called "Arctic Haze") .

Airborne observations of vertical distribution of physical, chemical and optical properties of aerosols will be made around Svalbard using a German aircraft Polar 4 (Dornier 228) of Alfred-Wegener Institute for Polar and Marine Research. Particle size distribution, absorption and scattering coefficient will be measured by optical particle counters (OPC), a particle soot absorption photometer and an integrating nephelometer, respectively. Extinction coefficients will be measured by sunphotometer. Sampling of aerosols will also be made with filter sampler and impactor to conduct chemical analyses and electron microscope analyses. 15 flights with about 75 flight hours are planned to be conducted based at Longyearbyen airport (78° N, 15° S) during March 15 and April 25, 2000.

Remote sensing of aerosols by Raman lidar, micro-pulse (backscattering) lidar, sky radiometer and sun/star photometers, in situ measurements and sampling of aerosols will be made coordinately at the surface of Ny-Alesund Scientific Station (78° 55' N, 11° 56' E), Svalbard. Also, aerosol sondes will be launched and a tethered balloon with OPC will be tried. Data are compared with the SAGE (Stratospheric Aerosol and Gas Experiment) -II measurements in order to validate satellite aerosol extinction measurement and to derive 3-D distribution of aerosols. These data will be used as the input parameters for the Arctic regional climate model to calculate the radiative forcing and then to discuss climatic impact.

The project is co-organized by National Institute of Polar Research (NIPR) and Alfred-Wegener Institute for Polar and Marine Research (AWI), together with participation from Hokkaido University, Nagoya University, NASA Langley Research Center, Norwegian Institute for Air Research (NILU), Meteorological Institute of Stockholm University (MISU) and Norwegian Polar Institute (NP).

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Aerosol Measurements at Ny-Alesund/Spitsbergen and its Possible Climate Impact

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Radiative forcing of atmospheric aerosols has been investigated by using very simplified models of aerosol optical properties. In this stage aerosol data were used based on the Global Aerosol Data Set (GADS), which only considered the total aerosol optical depths and a homogenous distribution of aerosols for the whole Arctic region. Nevertheless these results have already shown that aerosols might have a significant impact on radiative forcing processes in the troposphere.

The problem to provide appropriate aerosol parameters for model studies is not solved in such a way that consistent data records are available for all regions and areas of interest. For detailed model studies it is necessary to provide data on the temporal and spatial, in particular vertical distribution of aerosols. Furthermore optical parameters as spectral optical depth, extinction coefficient, absorption coefficient, and phase function have to be measured. To get long-term records for all these parameters a large number of different methods and instruments are necessary, including satellite information, like SAGE II.

The problem is getting more complicated for polar regions where the lack of data makes detailed studies even impossible. Recently there is no clear understanding on the impact of tropospheric aerosols on radiative forcing processes in the Arctic. On the other hand the feature called "Arctic Haze" indicates a strong seasonal variability of the aerosol burden. During winter and spring high aerosol concentrations occur, but in summer season the concentration is as low as for clear air masses, i.e.: aerosol background levels. First very simplified studies of radiative forcing for "Arctic Haze" cases have provided qualitative evidences of aerosol impact during "haze" periods. But again no detailed optical properties of aerosols could be up to now considered in those model runs.

In 1991 measurements of aerosols commenced at Koldewey Station (78.95 °N, 11.93°E). Since then observations have been improved and extended by newly developed instruments, such as Sun and Star photometers to retrieve the aerosol optical depth and phase function in the vis and near IR spectral range, the tropospheric Raman-Lidar to measure extinction coefficients and depolarisation as a function of altitude, the aerosol impactor to get the chemical composition and size distribution of atmospheric aerosol particles, and the Fourier transformed IR spectrometer (FTIR) to calculate the aerosol optical depth in the IR spectral range region by measuring emission spectra. Eventually SAGE II (Stratospheric Aerosol and Gas Experiment) satellite observations of stratospheric aerosols are used to separate the tropospheric contribution from total atmospheric aerosol burden and provide information on spatial distributions in the Arctic region.

The combination of these methods is recently used to get as much information as possible on temporal and vertical distributions of atmospheric aerosols and their optical properties. A major contribution in that effort contributes the ASTAR'2000 (Arctic Study of Tropospheric Aerosol and Radiation) campaign. ASTAR 2000 is a joint Japanese-German aircraft campaign in the vicinity of Spitsbergen scheduled for coming spring in 2000. The aircraft measurements will be supported by comprehensive ground-based measurements in Ny-Alesund providing those crucial aerosol parameters like phase function and absorption coefficient as a function of height. All these aerosol data will then be incorporated in the Arctic regional climate model HIRHAM for detailed model studies on the direct radiative forcing of Arctic tropospheric aerosols.

Arctic Stratospheric Aerosols

—PSCs and Background Sulfate Particles—

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Arctic and Antarctic stratosphere play an important role in global budget of particulate matter since the polar stratosphere can act as strong source and sink of particulate material in winter. Form of polar stratospheric clouds is typical source of particles in the polar winter stratosphere. Additionally distributions of stratospheric chemical constituents including stratospheric ozone are largely disturbed by active form and loss of particulate matter through heterogeneous processes on the surface of particles. However detailed information on nature of particulate matter has not been obtained due to lack of observations.

The lidar measurements made at Ny-Aalesund shows noticeable enhancement of aerosol mixing ratio (possibly PSCs forming) in cold winter. It is interesting, from view of PSCs formation theory, that depolarization ratio of particles sometimes shows low levels during the PSCs event. Liquid phase PSCs can be suggested from those measurements.

Balloon-borne and aircraft-borne measurements were made to know size and number concentration of tropospheric and stratospheric particles. Balloon-borne measurements suggested that there were large difference of particle size and number concentration between PSCs and background particles. New particle formation during cold period is speculated, and further observations of CN particles are desired. Aircraft-borne measurement from Japan to arctic region during AAMP 1998 suggested that there some difference between number-size between polar and sub-polar region.

Electron microscopic observation of particles collected during AAMP showed that most of particles were composed of sulfuric acid droplets, suggesting major coponent of stratospheric particles to be sulfate particles. However some of them were certainly chemically modified. It is necessary to make more detailed observation to understand chemical modification processes and its effect on PSCs formation. Vertical profile of COS concentration measured during AAMP showed noticeable decrease above the tropopause in arctic region, showing convertion to particulate matter through photochemical processes in the stratosphere.

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Chemical Composition of Total Deposition Samples from Spitsbergen

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A major pathway of trace metals as well as ionic species to the Arctic ecosystem is the atmospheric transport from the highly industrialized areas at mid latitudes of the northern hemisphere. The highest concentrations of heavy metals in the Arctic atmosphere have been observed in the winter/spring periods. Through dry and wet deposition airborne pollutants reach the marine environment as well as the snow covered land areas . The scavenging of aerosol bound chemical substances by rain and snow has been postulated as the most important process for cleansing the atmosphere. The aim of this study was the investigation of trace metal and ion deposition via snow and rain as well as via dry deposition at Ny Ålesund-Spitsbergen (79°N, 10°E).

Deposition measurements are carried out since September 1993 with two different sampling systems. (i) A simple and reliable total deposition sampler (TDS) was designed, consisting of a precleaned polyethylene funnel connected to an exchangeable bottle. With this permanent open funnel wet and dry fall-out are collected. (ii) A wet-only sampler (WOS) controlled by an optical precipitation sensor was installed in February 1994 to collect snow and rain samples undisturbed by dry deposition thus giving the true concentrations of chemical compounds in rain and snow.

In order to avoid contamination sample preparation was performed under cleanroom conditions. After preconcentration of the samples heavy metal analysis were carried out by Graphite Furnace and Flame Atomic Absorption Spectrometry (GF-AAS, F-AAS)as well as by Inductively Coupled Mass Spectrometry (ICP-MS). Water soluble major ions were measured in none preconcentrated samples by Ionchromatograhy (IC).

In this contribution we will present results for our total deposition sampling period form 2.94-5.99. This data set includes results for the predominantly anthropogenic elements Cd and Pb as well as for the elements Na, Mg, Cl^- which are of marine origin and Al, Ca, K which are tracers for earth crust weathering. Supplementary results for MSA as an indicator for marine biological productivity and for nitrate and none seasalt sulphate and seasalt sulphate will be shown as well.

Deposition rates in the lower $\mu g/m^2d$ range were measured for the trace elements, while the ionic species and major ions showed deposition fluxes up to the mg/m^2d range.

MEASUREMENT OF ATMOSPHERIC POLLUTION IN THE SIBERIAN ARCTIC

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Atmospheric concentrations of aerosol chemical species and pollutant concentrations in birch leaf, moss and soil samples were measured at three sites in the Siberian Arctic; Tiksi (72° N, 129° E), Norilsk (69° N, 89° E) and Yakutsk (62° N, 130° E). Tiksi is located on the coast of the Laptev Sea connecting to the Arctic Ocean, which has no significant emission source. Norilsk is located at the base of the Taimyr Peninsula, which is the largest sulfur dioxide emission source in the world from nickel-copper smelting. Yakutsk is a stock farming city, situated on the middle reaches of the Lena River.

We have carried out continuous sampling of aerosols from August 1993 in Norilsk and Yakutsk, and from August 1994 in Tiksi. Concentrations of aerosol chemical species at Tiksi ranged from 0.06 ~0.3 $\mu g\ m^{-3}$ for elemental carbon, 0.55~1.5 $\mu g\ m^{-3}$ for organic carbon and 0.09~1.6 $\mu g\ m^{-3}$ for SO_4^{2-} from August 1994 to July 1995. The sulfate and elemental carbon concentrations showed remarkable seasonal variations with winter/spring maxima and summer minima. The seasonal variations at Tiksi were consistent with other measurement results of Arctic haze in the Alaskan, Canadian and Norwegian Arctic. On the other hand, there were no significant seasonal variations of pollutant concentrations at Norilsk and Yakutsk. Major aerosol chemical composition was sulfate at Norilsk, and carbonaceous matter at Yakutsk.

Concentrations of heavy metals, such as lead, copper, nickel, and vanadium, also showed remarkable seasonal variations with winter/spring maxima and summer minima at Tiksi. In Norilsk, the range and mean concentrations of each chemical species were Cu, 2 ~ 300, 58; Pb, 0.5 ~ 83, 22 and Ni, 1 ~ 48, 19 $ng\ m^{-3}$ with no significant seasonal trends from December 1995 to December 1996.

The heavy metal concentrations and sulfate concentration in birch leaf, moss and surface soil samples in Norilsk decreased with the distance from a center of the town to sampling sites. Moreover, heavy metal concentrations in 5 – 10 cm surface soils were several times to more than hundred times higher than those in 20 – 30 cm depth soils. In Tiksi, the surface soil also contained several times higher concentrations of heavy metals than that in deeper layer,

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Preliminary measurements of CH_4 emission at a burnt forest in West Siberia

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<Abstract>

Tropospheric methane is one of the greenhouse gases and its concentration levels affect the global climate. It is important therefore to understand methane emission and consumption through ground surface. It has been reported recently that forest fires happen frequently in the Siberian taiga region. The soil of forests is the sink of atmospheric methane. However the soil should change to the methane source in West Siberia, because the forest is distributed on peat soil and the surface would change to wet conditions after forest fires. The purpose of this study is to evaluate a change of methane flux with a change of surface condition caused by a forest fire. Preliminary observation of methane flux was conducted in a birch forest and a burnt forest in West Siberia in the summer of 1999. The surface of the burnt forest was classified into three types: mostly moss, some pools, and an artificial draining channel. The measurements were made at four points including these three type points in the burnt forest and a point in the birch forest. The averaged flux was -0.16 mg CH_4 m^{-2} hr^{-1} at the birch forest, 1.08 mg CH_4 m^{-2} hr^{-1} at the pool in the burnt forest, and 3.65 mg CH_4 m^{-2} hr^{-1} at the draining channel. Methane emission from the moss was nearly zero. This result suggested that soil surface after the forest fire would be the methane source, but depending on the moisture condition of the soil.

RADIATIVE FORCING DUE TO ANTHROPOGENIC ACTIVITIES

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A wide range of anthropogenic as well as natural forcing mechanisms may lead to climate change. We present calculations of the radiative forcing due to anthropogenic emissions leading to changes in the concentrations of several trace gases and aerosols. Increase in all major well mixed greenhouse gases are included as well as changes in tropospheric and stratospheric ozone. The radiative forcing due to certain aerosols is also estimated. The calculations have been performed for the Northern Hemisphere, and the main focus has been on high latitudes and the polar region.

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Natural variability of the surface spectral and total albedo in Svalbard.

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The surface albedo is an important parameter in the arctic energy balance. Large geographical variations in surface albedo exist from snow covered land areas to the open sea, and large seasonal variations are induced during the melting season as the winter snow and sea ice melt away. The surface albedo induces a positive feedback in the arctic climate system, and a warming climate is expected to produce large effects in the polar areas with a significant increase in climate variability with more extreme weather situations, stronger seasonal cycles and increased precipitation.

On Svalbard, the natural variability of the surface radiation fluxes is generally governed by the large annual variation from polar night to polar day conditions, the large changes of surface albedo especially during spring, and the high frequency of cyclone passages during winter with alternating periods of warm, humid maritime air from the south and cold, dry arctic air from the north. Analysis of surface albedo data from Ny-Alesund shows that the transition period from summer to winter conditions in spring is narrow in time with little variation from year to year, whereas the transition period from summer to winter is much broader during autumn. Large variations occur in the surface spectral albedo during the intense melting season reducing the shortwave enhancement due to the multiple reflection and refraction of the shortwave radiation between the atmosphere and the ground. Large regional variations are also seen from ERB satellites reflecting the large inter-annual ice-conditions around Svalbard.

NysMAC Meeting Tokyo, ABSTRACT

Three Years Spectral Resolved UV Measurements at Koldewey-Station

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For long-term field measurements in polar regions we built a non-scanning UV-B spectro-radiometer. The instrument is based on a Bentham DM 150 double monochromator with a multichannel detector system. As detector we use a low-resistance microchannel plate photo-multiplier tube with 32 channels working in a photon counting mode. By this we can record the whole spectral range of the instrument (280 - 322nm) every second. Spectral resolved UV-B measurements are performed on Svalbard since March 1996. Additionally we developed a slightly modified version of the spectroradiometer measuring in the UV-A range (318 - 400nm). Since March 1998 both instruments combined record the whole UV spectral range continuously at Koldewey.

Data evaluation is mainly focused on the dependence of the UV-B irradiation on ground from changes in total ozone including ozone data from ozone sonde soundings and TOMS (Total Ozone Mapping Spectrometer) satellite data. To suppress the dominating influence of cloud variations on the UV radiative transfer, the ozone-index called ratio of the irradiation at two wavelengths (300nm / 320nm) is used [1]. In consideration of the daily available TOMS data the expected anticorrelation of the ozone-index and the total ozone could be verified. For the observation period the comparison of changes in UV and total ozone for different years leads to a quantitative relation between the two measurands, specified as the radiation amplification factor of total ozone.

Another important parameter influencing UV irradiation at ground is the ground albedo. Ny-Ålesund is a measuring place with large variation in ground albedo during the year due to the snow cover in winter melting in summer. The influence of ground albedo on the UV irradiation is evaluated by radiative transfer modelling and pointed out in comparison with UV data recorded at Neumayer-Station (Antarctica), a place with high snow albedo all around the year.

[1] Ch. Groß et al., *UV-Radiation Measurements at Koldewey-Station*, in: *'The Arctic And Global Change'*, Multidisciplinary approach and international efforts at Ny-Ålesund, Svalbard. Proceedings from the Fourth Ny-Ålesund Seminar, Ravello, Italy, 5-6 March 1998.

36 Estimation of tropospheric Water Vapor content using a network of GPS receivers in Ny-Ålesund

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The water vapor distribution and content are critical parameters for the description of the state and evolution of many physical processes in the Earth's atmosphere. For example, water vapor is a greenhouse gas and long-term variations in its global content could potentially be used as an indicator of global climate change.

A new technique, based on the observation of the signal transmitted by the Global Positioning System constellation of satellites, has demonstrated the capability of measuring the integrated water vapor with an accuracy of a few millimeters. The retrieval of this quantity from the GPS data is based on a standard model of the atmosphere where hydrostatic equilibrium is assumed. However, in Polar environments a deeper understanding of the structure of the troposphere is needed in order to obtain the water vapor variable with accuracy and precision. A mechanism for this purpose could be implemented through the concept of assimilating the observed GPS data into more general models in order to get the moisture content of the atmosphere.

We have analyzed data gathered in a geodetic 7-day campaign performed in Ny-Ålesund using a network of nine GPS receivers separated by distance ranging from 1 to 40 km. We used GPS satellite precise orbits and clocks as well as consistent earth-rotation parameters provided by the International GPS Service (IGS), together with the GIPSY/OASIS-II (v.4) software package to estimate Zenith Total Delays at the nine GPS sites with a precision of 5 mm.

The GPS estimates were then assimilated in a 1-dimensional variational (1DVAR) way into a simple meteorological model. The state of the atmosphere is described by 46 model variables (temperature, specific humidity and surface pressure) referenced to 30 pressure levels. Background state as well as the covariance matrix are adapted for the Artic environment and for this seasonal period.

Finally, we compared the 1DVAR results with those obtained with the standard procedure.

"In-Situ" Measurement for a Polar Low over the Norwegian Sea

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As a part of the Arctic Airborne Measurement Program (AAMP '98), airborne measurements were conducted for a polar low over the Norwegian Sea. From the objectively analyzed data set (GANAL), this polar low was formed by the interaction between the upper level potential vorticity anomaly associated with a cold-core polar vortex and the low level baroclinic zone. The target clouds for the "in-situ" airborne measurement were the convective clouds aligned spirally from the polar low center.

The convective clouds reached up to 5.5 km MSL in height with a well developed anvil structure. The aircraft took constant level flights zonally to measure the perpendicular cross section of the convective cloud line, and a strong baroclinity was observed in the lower boundary layer. A temperature difference as much as 6.3 °C was recorded across the cloud at 0.5 km MSL. A strong gale with a prominent meridional wind component was observed in the lower atmosphere. We found that the thermal wind relationship between the meridional wind and zonal temperature gradient was satisfied. From the microphysical "in-situ" airborne measurements, we noted that the cloud droplets were formed in the lower boundary layer and they were quickly blown into the upper level by strong updraft of the convection. The cloud droplets glaciated there and formed ice particles. These ice particles became larger by condensation process, began to fall, continued to grow by collection process and finally formed densely rimed particles or graupel particles by the collection of the supercooled liquid water droplets. Through these processes, only larger precipitation particles were capable of falling into the lower atmosphere against the strong updraft. As a result, large precipitation particles were concentrated in the limited region in the lower boundary layer. The secondary induced convective clouds were produced and identified from the cabin. Air temperature variations due to diabatic processes (condensation and evaporation) were also observed in clouds.

Feasibility Study on Scientific Balloon Experiment at Ny-Aalesund

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Possibilities of scientific ballooning at the North Polar region (Ny-Aalesund) are studied on the basis of useful experiences of balloon experiments carried out at Syowa Station, Antarctica.

From 1980's the scientific ballooning group of the Institute of Space and Astronautical Science (ISAS) has supported the NIPR' s balloon programs at Syowa Station. From 1996 through 1999, the stratospheric air sampling project was performed at Syowa Station conducted by Chemistry of Polar Atmosphere Division of NIPR and Tohoku University. Eight compact grab-samplers and one sophisticated cryogenic sampler were launched and recovered successfully from sea or sea ice. The cryogenic air sampler allowed to collect large amount of air samples at various altitudes in the stratosphere over the Antarctica. Many newly developed ballooning technologies, including launching a large balloon of 30,000 m3, tracking and recovering the payload, were applied to this program. A computer network was also utilized, and linked between the operation rooms at Showa Station and NIPR in Tokyo via INMARSAT. The support members at NIPR could follow the entire processes at Station, and remotely helped the ballooning operations. The expedition team accomplished all the operations by themselves without existence of ballooning specialists.

This paper presents that a stratospheric air sampling experiment using a balloon is feasible at Ny-Aalesund by the help of the balloon operation system used at Syowa Station. Those ballooning technologies can also be applied to other balloon campaigns which will contribute not only to atmospheric sciences but also to those of other fields in the Arctic.

Recently ISAS balloon group developed a unique super-pressure balloon capable of carrying a heavy payload, and its flight test was successfully carried out on May 15, 1999. The applicability of this balloon at the polar regions is also mentioned as a long duration stratospheric observation platform.

Atmospheric Teleconnection between Japan and the Saint Elias Mountains, Yukon

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Abstract

Comparison of the total precipitation time series averaged over five low elevation stations in Japan (33°N to 43°N) for the period 1883-1987 was made with the net snow accumulation time series obtained from an ice core site on Mount Logan (60°N, 5,340 m) in the Saint Elias Mountains for the same time interval. A standard cross correlation reveals a high, significant, positive cross correlation coefficient of about 0.5. In order to investigate this result in terms of it being an atmospheric teleconnection, a review of the oceanology and climatology of the North Pacific Ocean region was made. It was found that a strong coupling between the ocean and the atmosphere exists especially up to and associated with the Polar Front Zone (PFZ) along which major cyclogenesis occurs. Cyclones track generally west to east with a strong northerly component in the eastern sector. PFZ cyclones are modulated by El Nino and by solar cycle processes, as well as other mechanisms. It is necessary to monitor individual PFZ cyclones and moisture trajectories in order to understand that water vapour from mid-latitudes (40°N to 50°N) in the eastern Pacific sector can be advected to high altitudes (> 5000 m) on Mount Logan. A significant part of the physical basis for the teleconnection is thereby made apparent, and allows an explanation of why there are no significant cross correlations with local station data. Thus, a long time span ice core from Mount Logan could provide proxy precipitation data for Japan. Such time series would be of value, for example, in the design of hydrologic systems or in agricultural planning.

Paper to be presented at the Second International Symposium on Environmental Research in the Arctic, NIPR, Tokyo, February, 2000

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GAS DIFFUSION IN POLAR FIRN AND ITS APPLICATION TO ATMOSPHERIC COMPOSITION HISTORY AND PALEOTHERMOMETRY

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The firn overlying ice caps and glaciers in polar regions is a porous medium where gas diffusion takes place, under the combined effects of concentration gradients between the atmosphere and the snow, temperature and pressure variations, and gravitation. It can be used in particular to reconstruct a record of atmospheric gas-phase composition dating back over many decades. The temporal resolution of such record will depend on the firn characteristic and the climatic parameters on site.

As there is nearly no limit in the amount of gas to be sampled in such medium (several cubic meters are reachable), analysis of trace constituents can be performed which are usually forbidden in ice cores, due to the small amount of gas trapped in polar ice and the technical difficulty of extracting the gas from the ice without contamination. In the last few years there has been a sharp increase in interest in firn air studies, and their interpretation in terms of changing atmospheric composition and chemistry. Experiments have included the European Union "FIRETRACC/100" project of firn air measurements in both hemispheres, US-funded firn drilling in both Greenland and Antarctica, and an Australian programme also in Antarctica. A wealth of chemical and isotopic information has been emerging from these projects on issues ranging from the dramatic rise in ozone depleting substances, through changes in man-made radiatively-important gases, to indicators of changing oxidising capacity of the troposphere. I will present a review of some important findings associated with these projects, with a focus on experiments performed in the Arctic.

In addition, it was discovered recently that abrupt temperature anomalies at the snow surface can generate thermal fractionation in the isotopic composition of permanent gases diffusing in the snow layers, with heavy isotopes being enriched in the cold firn when surface temperature rises. This isotopic anomaly diffuses faster in the porous snow layers than the temperature anomaly itself, and it can then be trapped in ice bubbles. Therefore by measuring in great detail the isotopic composition of permanent gases such as molecular nitrogen and argon, paleothermometry can be performed independently from the classical application of the ice isotope / temperature relationship. I will present a review of the recent findings on thermal fractionation in polar firn, with a focus on this paleothermometric tool applied to the Greenland ice cores of GISP2 and GRIP.

DETERMINATION OF ICE FLOW VELOCITY IN SVALBARD FROM ERS-1 INTERFEROMETRIC OBSERVATIONS

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Ice velocity fields have been obtained from satellite radar interferometry over four glacier basins in North-west Spitsbergen. The interferometric pairs were built up from a combination of 3 ERS-1 scenes recorded at the end of the ablation period in September and October 1991. With the use of a DEM based on maps at a scale of 1/100 000, two differential interferogrammes have then been obtained by removing the fringes due to elevation and orbital trajectories. The residual fringes are due to ice movements over 6 and 9 days respectively and a third interferogramme over 3 days was also obtained by difference of the two previous one.

As all the radar data were recorded along the same satellite track, it was necessary to propose a model of the flow lines direction. To do so, the fringe morphology provided relevant information and was partly used as representing real isotachytes at the glacier surface.

Around their equilibrium lines, two valley glaciers, the "D'Arodes" glacier and the "Fourteen of July" glacier, with areas of 16 and 80 km2 reach maximum velocities of 56 mm and 66 mm per day, respectively. Both velocities fall in the range of expected velocities for such glaciers in Svalbard and the result for the Fourteen of July glacier is similar to the velocity measured by W. S. Ahlmann fifty years ago on this glacier.

Kronebreen (1000 km2) fed by two plateaux, Isachsenfonna and Holtedahlfonna, is the most active and calving glacier in Svalbard. Clear fringes along the two plateaux allow to monitor the ice flow over the main part of the basin, while close to the front, the lack of fringes is due to the high velocity and presence of numerous crevasses. Along the longitudinal axis of Isachsenfonna, the velocity is remarkably regular, around 20 cm per day over twenty kilometres while the velocity on Holtedahlfonna increase from zero to 52 cm per day obtained at 15 km to the calving front.

A control has been made by GPS on the change in position during one year of three stakes, settled along the longitudinal axis of Holtedahlfonna. At the three stakes, the result validates the hypothesis made on the flow line direction. The velocities obtained by interferometry are in excess of 58% compared to the annual average. Such difference is estimated to be normal since they are obtained at the end of the ablation period when the higher velocity is still linked to the presence of subglacial meltwater. For example, over the frontal tongue of this glacier, Pillewizer and Voigt have measured in 1963-64, a velocity in summer twice the annual mean velocity.

These relatively high rate of velocity indicates that the basal sliding of Isachsen and Holtedahlfonna is important and that the glacier sole must be at the melting point and overlying soft sediments all along the medial axis of the basins. This singularity for a Svalbard glacier is tentatively explained by the surge history of the Kronebreen.

Effects on spectral reflectance from snow ageing

by

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Abstract

The albedo of snow decreases rapidly after onset of melt in spring when presence of liquid water, intensive metamorphosis, and surface blackening strongly affect the energy exchange over snow-covered surfaces. However, not only the integrated shortwave reflectance (or albedo) decreases during this period, there is also a pronounced change in the spectral reflectance of snow during spring melt-off. Data from the tundra at Ny-Ålesund on Svalbard show that snow albedo in the infrared wavelength region drops in the early phase of the melt season with a less marked decrease in the visible region. This effect is mostly due to the presence of liquid water and increasing (effective) grain size in the snow pack, especially reducing the infrared albedo. Later in the melt season as the snow cover gets thinner, more transparent, and surrounded by an increasing number of snow-free areas, the underlying ground and surface blackening both affect the visible albedo more than the infrared. Surface albedo of sea ice from a nearby locality at Kongsfjorden exhibits a different behaviour. Here the visible albedo decreases first without any measurable changes in the infrared albedo (between 18 May and 3 June 1997). Thereafter, both visible and infrared albedo decreases significantly, however, the infrared albedo decreases most (from 3 to 18 June). The explanation of this may be found in the initial snow thickness above the sea ice that was about 20 cm. Metamorphosis of the cold snow pack (i.e. between 18 May and 3 June) may have made the snow more transparent to visible radiation without affecting the infrared albedo. Also, conditions for metamorphosis of snow i) on tundra and ii) on sea-ice are different due to different temperature gradients. Later, when the snow pack reaches the melting point, the effect caused by presence of liquid water reduces the infrared albedo more strongly than the visible. In General Circulation Models used today the snow albedo is fixed. A better knowledge of albedo variations of snow, especially during springtime, would enable more realistic albedo formulations to be developed in climate models.

In-situ snowpack temperature monitoring at an Arctic tundra site: A comparison of manual and automatic measurements

by

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Abstract

The physical properties of snow in the Arctic play an important role for the surface energy balance. Furthermore, they influence the survival conditions for biota, both those that depend on snow-free tundra and those depending on snow being present. Temperature and other physical properties in the snowpack change dramatically during and after the onset of melt in spring. By measuring snow temperatures, the physical condition of the snowpack can be determined and monitored. Conventionally, snow hydrologists and glaciologists measure snow temperature vs. depth in snow pits. This is a destructive and time-consuming method. An alternative is automated measurements using permanently installed temperature sensors, which are connected to a data-logging unit. At a research site near Ny-Ålesund on the Arctic Svalbard archipelago we did both, temperature measurements in snow pits using a handhold electronic Pt100 thermometer, and parallel automatic temperature logging using a thermistor chain. The chain was installed during the snow-free time in summer 1997 and snowed in during winter 1997/98. The parallel measurements were performed before and after the onset of melt in May and June 1998. The initial snow thickness at the end of the accumulation season was 0.7 m. Our results show that in the deeper part of the snow pack, the measurements from the thermistor chain agree better than ±0.2 °C with the manual snow pit measurements. Some of the deviations measured are likely to be connected to spatially varying snow thickness and properties. In the uppermost 0.1-0.2 m of the snow pack, measurements are likely to be distorted by incoming solar radiation, especially after the onset of melt in June, once the snow is more transparent due to metamorphosis. When measuring in snow pits, this effect can be partly reduced by shadowing the snow surface. However, in snow pits the snow pack temperature might be altered by air infiltrating deeper snow layers from the side. A substantial advantage of the automatic measurements is the better resolution with time. Further, the fixed located automatic measurements do not require a change of location, as it is necessary for the (destructive) snow pit observations.

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Polythermal glaciers in Northern Scandinavia
- an important source of paleoenvironmental records

By

Per Holmlund

Abstract
Ice cores drilled in cold glaciers are known to contain detailed archives on past climates. So far, only few dataset has been retrived from Scandinavia, partly because most Scandinavian glaciers to a large degree are of a temperate type, having a less well preserved climatic signal. However, within the more continental parts of the Scandinavian mountain chain, glaciers often have a substantial cold surface layer in the ablation area. The thickness of such cold surface layers have been mapped by a ground based high resolution radar at 300 to 1000 Mhz at 35 glaciers in northern Sweden. Dry ice, e.g. ice below the freezing point, was found down to depths of 80-120 metres on 43% of the investigated glaciers. The potential to find useful paleo records in other Swedish glaciers is therefore very good.
A 27.5 metre long ice core sampled at M   maglaci   en contained 54 sedimentary layers which are supposed to annual. The layers were identified by conductivity measurements. At two layers there were strong indications of volcanic downfall, most probably from Iceland. The impurities, and thus the measured levels of SO4 were too low to allow determination of the specific volcanic eruptions. Comparisons with dendro records from the area of Tornetr   k, and ice core data from Greenland show a relative dating of a time slot between 1780 and 1840 for the ice core. However, there is an uncertainty in the dating as the Lake (1783) outburst was not detected.
The coring site was situated in the southern cirque of the glacier where sedimentary layers, assumed annual, are well preserved and visible on the ice surface. About 400 layers are identified and the coring site was situated in the middle of this area. The age of the sequence described by the core is thus believed to originate from the Little Ice Age. The ice surface is situated at 1500 m.a.s.l. and the horizontal velocity is 1.5 m/year.
Due to the strong east-west climatic gradient and to local climatic effects, glaciers have reacted differently on present changes. On the west side of massifs glaciers are growing significantly while glaciers on the east side of the mountain range have not increased their mass during the last decade, as their mass basically is governed by summer temperatures, which have not changed. Assuming that past climatic changes can be described as changes in climatic gradient and east west movement in the boundary between maritime and continental climates we have very good proxy temperature archieves in east lying glaciers.

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An ice core record from Lomonsovfonna, Svalbard: viewing the isotopic, chemical and structural data between 1920-1997 in relation to instrumental records

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In April 1997 a 124 m deep ice core was drilled at the ice divide of Lomonosovfonna (78°51'53"N, 17°25'30"E, 1230 m asl), the highest ice field in Svalbard. Radar measurements in the area of the ice core site indicate an ice depth of 126.5 m, suggesting that the bottom of the ice cap was nearly reached. The 137 Cesium content was determined by high resolution gamma spectrometry. The 1963 radioactive layer is situated at 18.7 m, giving a mean annual accumulation of 0.38 m w.eq. for the time 1963-1996. The ice core analysis program also includes DEP, ice structures, oxygen isotopes, deuterium, major ions and MSA.

Here we mainly discuss the data from the uppermost 36 m of the core which we dated to 1920. Several of the ion records show clear cycles that appears to be annual. The apparent seasonality of the signals is preserved even in the deeper parts of the core, although amplitude is reduced.

The records of $\delta^{18}O$, MSA and melt features from the ice core are correlated with air temperature data from Longyearbyen on a multi-year basis suggesting that this core site reflects the local climate to a large degree.

A close comparison of the MSA record an the sea ice record over the 1920-1997 period suggests that they are closely related. MSA concentrations are higher for warm years with reduced ice cover.

There is a large potential to retrieve valuable information of seasonal climatic variability over central Spitsbergen several hundred years back with this ice core.

Sedimentary environment of the glaciers in the northern part of Svalbard recorded in ice cores

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The glacier ice core research in Svalbard for making clear the snow sedimentary environments is one of the Japanese glaciological research activities in the Arctic. The discussion was extended for the ice core at Asgardfonna in the northern part of main land, obtained in 1993, at Vestfonna in 1995 and at Austfonna in 1998 and 1999 in Nord Austland.

Svalbard was located where the oceanic current carries the heat with moisture in the Arctic region. In spite of high latitude, the air temperature was not so low and the there exists temperate glaciers. The climatic information recorded in the ice cores in the region, if it is available, would be connected with the influence of ocean and sea ice. The discussion is available for the vertical distributions of ECM records, oxygen isotopic ratio, soluble contaminants (Na, Ca, Mg, MSA) and the environmental radio nuclei.

Sea salts were main origins of soluble contaminants in the ice cores.

The vertical distributions of nuclear debris and oxgen isotopic ratio suggest the snow horizons in 1963 and 1920. The distributions of snow accumulation rate in the individual regions were opened.

The vertical distributions of oxygen isotopic ratio reveals that there occurred the temperature jump in 1920 in Svalbard area.

Ice-core chemistry variation on Penny Ice Cap, Baffin Island, Canadian Arctic over the last two centuries

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We have drilled an 85m deep ice core on Penny Ice Cap, Baffin Island, Canadian Arctic in 1995. The core was cut into 4-5cm increments and analyzed for ion chemistry and $\delta^{18}O$. Due to the relatively heavy summer melting on the ice cap, seasonal variations of these parameters are not always present. The ice core data, however, provide us with an excellent proxy record for environmental changes over the last two centuries on year-to-year or decadal basis.

Sulfate and nitrate concentrations started to increase at the turn of this century and about 1960, respectively, due to anthropogenic influx transported from the industrialized regions. Sea-salt concentrations decreased about the end of the 18th century and increased again since the middle of the 19th century until the middle of the 20th century. The temporal trends for sulfate and sea-salt ions are similar to those in South Greenland, while they are different from those in the Canadian high Arctic and Central Greenland. The spatial variations of ice core chemistry within the Arctic shed light on causes of the past environmental changes, which will be discussed at the symposium.

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The North-GRIP deep drilling project in Greenland

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During the GRIP and GISP2 deep drilling projects in the Summit area of Central Greenland two cores from surface to bedrock were obtained. Analysis of the cores have revealed unique and highly detailed records of Earth's paleoclimate and paleoenvironment for the past 110 .thousand years. The records did, however, not agree on the nature of the last interglacial, Eem, which called for further deep drilling in Greenland. The reason for the disparity of the deeper part of the records is believed to be disrupted layering caused by the uneven bedrock topography in the Summit area. In order to locate a suitable new drilling site, extensive investigations were undertaken north of Summit by shallow corings and radio echo soundings. A site was found 315 km NNW of Summit with essentially flat bedrock topography 3080 m below surface and with lower accumulation rates than on Summit. The internal radio echo layering is also found to be continuous at depths where we expect to find the Eemian strata. All this should ensure undisturbed layering in the lowest part of the ice sheet.
The North-GRIP deep drilling project is organized by the Department of Geophysics, University of Copenhagen with support from the National Funding Agencies of Denmark, Germany, Japan, France, Belgium, Sweden, Switzerland and the United States of America. The drilling started in 1996 and after some technical problems in 1997 a new hole was started in 1999. The present depth is 1750 m, corresponding to strata from the Last Glacial Maximum around 20 thousand years ago. The preparations for the project, its organization and scientific program together with new isotopic data from the Holocene period will be discussed.

Evolution of White Glacier, Canada, in 2xCO2 climate, a numerical model study

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ABSTRACT. White Glacier, Axel Heiberg Island, N.W.T., Canada, is a well known Arctic glacier. 32 bore holes were drilled (Blatter, 1987b) and 400 soundings were obtained along 15 profiles (Blatter, 1987a). These data give a good idea of the thermal regime and the bed topography along the central flow channel of White Glacier. Additionally, mass balance records from 1960 to 1990 are available (Cogley, 1995).

Using these data a glacier flow model was validated for the time period between 1960 and 1990. Deviatoric stress gradients, lateral shear stresses (Albrecht and others, in print) and the thermodynamic for cold ice are taken into account in this model.

With one transient GCM run from 1990 (present climate) to 2050 (estimated time for reaching 2xCO2 climate), two high-resolution GCM time-slice experiments for 1990 and 2050, and the present measured climate, a mass balance for 2050 was estimated. With a glacier mass balance model (Hock, 1999) a 2xCO2 mass balance for 2050 was derived, taking as input the present measured climate and the differences of temperature and precipitation of the two GCM time slices. Imposing on the glacier model a linearly changing mass balance from present climate to the estimated 2xCO2 climate for 2050, a forecast for White Glacier was made.

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Ocean tides and loading in the Arctic

The ocean tides in the Arctic region are relatively difficult to study. The tide gauge data are sparse and altimetry data from satellites do not cover the region or are not sufficiently accurate yet. Ocean tide modellers have problems obtaining good bathymetry data and modelling the varying ice cover.
At Ny-Alesund an Earth tide gravimeter is installed which measures variations in gravity which are for a large part caused by the ocean tides in the Arctic. These measurements can therefore be used as an extra tool in studying the ocean tides in the region.
It is interesting to investigate the current state of the ocean tide models in the Arctic region to indicate the problem areas. Several hydrodynamic models are compared with each other and with available tide gauge data. Finally it is shown how gravity observations can help to decide which model is more accurate.

INVERSION OF GLOBAL TIDE GAUGE DATA FOR PRESENT-DAY ICE LOAD CHANGES

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Global ocean volume (GOV) and mass (GOM) characterise the ocean as a reservoir in the global hydrological cycle. These two quantities are absolute numbers, which have a rather complex relationship with local relative sea level (RSL) measured by tide gauges. On climatological time scales, the cryosphere has the greatest potential to contribute to changes in GOM, with the relation between such GOM changes and RSL being described by the so-called sea-level equation. Thermal expansion is generally considered as a major contributor to GOV changes, with the resulting RSL changes depending on where heat is being absorbed in ocean water or released. Despite the complex relationship between RSL and GOM/GOV, observations of coastal RSL have been used repeatedly to obtain estimates of a global sea-level rise (GSLR) in a simple arithmetic way, correcting the local RSL trends only for effects of post-glacial rebound. The GSLR estimates have then been taken as constraints for GOV and/or GOM changes.

In a different approach, here the physical relationship between mass changes in the cryosphere and resulting RSL changes is used to invert the RSL trends for changes in the Antarctic and Greenland ice sheets. In a first step, the finger-prints of these two large ice sheets in sea level are fitted to the trends for all available tide gauges to determine average rates of the present-day mass changes in the Greenland and Antarctic ice sheets. A basic uncertainty in this inversion is found to be due to deficiencies in the post-glacial rebound models used to correct for the contribution of past mass changes. However, the results indicate significant present-day changes in the Antarctic and Greenland ice sheets.

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Continuous gravity observation at Ny-Alesund, Svalbard with a superconducting gravimeter CT#039

by

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Abstract

Continuous gravity observation with a superconducting gravimeter (SG) CT#039 has been started on November 20, 1999 at Ny-Alesund, Svalbard, as a cooperative observation program between NAOM (National Astronomical Observatory, Mizusawa), Japan and NMA (Norwegian Mapping Authority), Norway. This observation site is the seventh site of GGP-Japan Network, which is a global observation network with SGs. From many observations made at various places in the world, it is well established that SG has high capabilities compared with conventional gravimeters using the metal spring; i.e. wide observational frequency range of DC to 10 sec, its high resolution of more than 1 nGal and its small drift as being less than a few micro Gal per year in a nominal value. Based on these performances, the observation at Ny-Alesund was planed to detect the following weak gravity signals; for example, the incessant earth's free oscillations, the core under tone, the frequency dependency of the gravity tides, the effect of free core nutation, long-period gravity tides, the gravity effect due to the changes in earth's rotation parameters, and the gravity changes related with the glacial rebound. The observation at Ny-Alesund is expected to give us the interesting gravity signals by comparing with the similar observation carried out at Syowa Station, Antarctica. Because, both sites are located on the very high latitude zone at where such precise gravity observation as using SG is rarely done, also at these two sites, many associated observations, which are needed to implement the gravity data, are carried out; i.e. monitoring of the grand motion with the VLBI and GPS, the ocean variability with the tide gage and the meteorological variations, for instance.

We introduce here the present status of the Ny-Alesund SG observation and preliminary analysis results for the short period tides.

Arctic Ocean Change and Consequences to Biodiversity: A Perspective

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Conservation of biodiversity is arguably the sternest challenge facing earth and ocean scientists in the coming century.

Furthermore, this task must be met against a backdrop of rapidly changing environmental conditions and constraints.

And nowhere is this backdrop changing more rapidly than in the high latitudes. This perspective begins with a general description of ocean currents including basin-wide flow, shelf circulation and shelf-basin interaction.

A review is then given of the remarkable changes that have been observed in the Arctic's climate system over the past decade.

Finally, an effort is made to examine the role of a changing physical environment to geochemistry and biota.

This latter effort requires both bottom-up (e.g. changes in light and nutrient regimes) and top-down (e.g. the impact of fish and large predators on biodiversity) approaches to achieve the level of understanding required to prepare for global change.

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Seasonal cycle of carbon export in the Nordic Seas

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Vertical export of biogenic matter is mainly known from long-term deployment of automatic traps in the deep ocean of the Nordic Seas. Seasonal studies of the vertical export of biogenic matter accompanied by equally intensive plankton investigations in the upper layers are rare. Comparing the data the questions arises, why retention of biogenic matter is significant during periods of extensive new production and why increased export takes place in late summer and autumn? No good answer can be given. However, it is suggested that transport of particulate organic matter to depth not only depends on bottom-up regulation as determined by physical forcing, nutrient availability, stratification and light, but also on the structure and function of the prevailing planktonic food web.

Advection of nutrients and plankton by the North Atlantic Current is important for plankton dynamics and vertical export in the Nordic Seas and adjacent Polar Ocean. Top-down regulation by zooplankton plays a pivotal role for the regulation of passive vertical flux in non ice-covered waters. The dynamics of marginal ice zones deferrer in various sections of the Nordic Seas. They can have high volume-specific new production and high retention, but reduced production and low gravitational export per area. Many arctic research programmes aredominated by lines of thought where straightforward biogeochemistry and bottom-up regulation is the focus. Phyto- and zooplankton as well as process-oriented research activities have to be the focal point of future research if the current comprehension of export from and retention in the upper layers is going to make distinct progress.

PHYSICAL AND CHEMICAL INDICATORS OF CHANGES IN THE BARENTS SEA ECOSYSTEM IN THE SECOND HALF OF THE 20TH CENTURY.

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ABSTRACT

Data on long-term variability of hydrochemical characteristics and water density in the Kola section (70°30' - 72°30'N; 33°30'E) and ice condition of the Barents Sea for 1951-1998 were compared with fluctuations of abundance of shrimp and euphausiids, as well as abundance of recruits and total abundance of cod, capelin and herring.

Interannual variability in anomalies of oxygen saturation in near-bottom layers is characterized by essential minima alternating with more prolonged periods when aeration exceeds the norm insignificantly.

Long-term variability of density anomalies is characterized by periodic "disturbances" of synchronism in different depth layers. It is suggested that such "disturbances" are a consequence of a strong advective transport of the Atlantic waters into the Barents sea shelf. Variation of ice coverage during a specific period of time (velocity) can be considered as one index more for the advection of the Atlantic waters.

Interannual variability of anomalies in phosphate concentrations in a near-bottom layer is characterized by considerable increase of mineral phosphorus concentrations from the early 60s to mid-80s. Processes of accumulating the mineral phosphorus are linked with a "cumulative" trend of attenuation of density stratification of water column under the seasonal pycnocline.

Analysis of variability of mentioned characteristics allowed to suggest the existence of long-term cyclic succession of the Barents Sea ecosystem.

In accordance with the proposed concept, the ecological processes are similar to those of the natural eutrophication during periods of weakened stratification in the Barents Sea. The nutrients are accumulated in the ecosystem, shrimp and euphausiids production increases and the domination of fishes with short cycles (capelin) is observed. At a strong increase of Atlantic waters advection the "disturbance" of synchronism of temporal variability of density, an increase in oxygen saturation, as well as the abundant year-classes of long-lived fish (cod and herring) species appear.

It is supposed that the similar mechanism can as well be peculiar to other marine ecosystems, and it should be considered in the analysis of a relation between global climatic changes and ecosystem dynamics.

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WIND AND FRESHWATER DRIVEN CIRCULATION IN AN ARCTIC FJORD SYSTEM

by

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ABSTRACT

Up to recent years it has been usual to ignore the effect of the rotation of the earth (coriolis effect) on the circulation of water masses in fjords, especially in fjord studies based on analytical models. This may possibly be justified in narrow fjords, but not in broad stratified fjords. Numerical simulations of circulation in simplified strait stratified canals and results from some few field experiments carried out in the nineties have shown that rotational dynamics may have an important impact on fjord dynamics in broad stratified fjords, i.e. *broader than the baroclinic Rossby radius of deformation*. Our knowledge about the effect of the coriolis force and other forces as e.g. centripetal acceleration and cross-fjord pressure gradients in «real» fjords are however still defective.

Broad-fjord dynamics was the main theme in an investigation of physical-dynamical processes in the fjord system Kongsfjord-Krossfjord on West-Spitsbergen. The investigation was based on field experiments and simulations with a three-dimensional numerical hydrodynamic model. One of the main conclusions, which can be drawn from the investigation, is that rotational dynamics has a considerable influence on the circulation pattern in the fjord system. Out-fjord flows take place along the right-hand side of the fjord arms except off a large lagoon in the Kongsfjord where a cross-fjord pressure gradient force the flow off shore. Wind-driven in-fjord flows have a more irregular pattern with eddy formations.

As most of the freshwater is supplied to the fjords from glaciers, the supply occurs in the form of events rather than as a steadily trickle of water. This, together with varying wind conditions, cause the flow of the upper layer to be strongly variable.

Strong interaction is shown to take place between the fjord arms reflected i.e. in that out-fjord flow round the tip of the Kongsfjord, continuing along the east side of the Krossfjord. In the common fjord mouth area the circulation is dominated by an anticyclonic eddy. Obviously, the classic assumption that the circulation in fjords is governed by a hydraulic control in the mouth is not present in this broad fjord system.

Keywords: *fjord, coriolis, circulation, exchange processes*

The arctic sea ice ecosystem controlling by global warming.

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Biological materials obtained in the central Arctic Ocean at the FSU "North Pole stations" in 1975-1981 have shown that the multi-year ice and ice/water interface is of rich and diverse biotop inhabited by the large number of diatoms and invertebrate animals. Two main matter fluxes in the sea ice ecosystem may be distinguished: (1) the inflow of biogenous elements from water into the ice interior where they are assimilated by the microflora during photosynthesis (summer stage), and (2) the outflow - from ice to water - of the organic matter accumulated in the summer due to photosynthesis (winter stage). Accumulation of organic matter within the sea ice interior during the process of photosynthesis may be considered as an energy depot for organisms of the whole trophic network of the arctic sea ice ecosystem.

Recent round-year data from the SHEBA Ice Camp drifted within the Beaufort Gyre 1997-1998 have shown that: (1) sea ice diatoms are very scarce by species and numbers; (2) fresh water green algae are dominated by numbers and distributed within the whole sea ice thickness; (3) invertebrate animals within the sea ice interior are not indicated; (4) invertebrate animals from the ice/water interface are scarce by species and numbers; (5) concentrations of chlorophyll and nutrients in the sea ice are significantly lower of the average concentrations measured before in this region for the same period of time. Remarkable accumulation of the organic mater within the sea ice interior were not indicated. Observed changes in the species composition and dynamic of the arctic sea ice ecosystem may be explained by the growing melting of the sea ice cover during the last decade. We consider several factors and the main of them are: (1) drainage of fresh water throughout sea ice interior; (2) accumulation of fresh water beneath the ice; (3) formation of sharp pycnocline at around 30 m. It is our guess that the recent water/ice system above pycnocline is more a fresh water/brackish system than the real marine system. We suggest that dramatically changes within the sea ice environment can be considered as a result of global warming in the Arctic.

High Latitude Air-Sea-Ice Interaction: The Atmospheric Forcing of Deep Ocean Convection

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The exchange of heat and moisture across the air-sea interface represents an important coupling between the atmosphere and ocean. During the winter at high latitudes, the cooling and salinization of surface waters that occurs as a result of this exchange can result in vertical motions that ventilate the deep ocean. This process, known as deep convection, is an integral component of the thermohaline circulation of the ocean. In the Northern Hemisphere, the only regions where deep ocean convection occurs are the Labrador and Greenland Seas. Atmospheric weather systems known as extra-tropical cyclones play an important role in this process by modulating the magnitude of the surface fluxes. It is conventional to assume that the thermal forcing, i.e. the surface cooling that results from the transfer of sensible and latent heat from the ocean to the atmosphere, is solely responsible for the determining the timing and intensity of convective events in the ocean. The haline forcing, i.e. the change in surface salinity that results from the fresh water flux, is thought to be important in the restratification that occurs after the end of the convective season and on the inter-annual and longer time scales in determining the location and intensity of the convective activity.

In this presentation, I will argue that this conventional view is incorrect in that it ignores the large and dramatic effects that the precipitation can have on the density of the surface waters at high latitudes during the convective season. This arises out of non-linearity in the equation of state for sea water that results in a reduction in the thermal expansion coefficient at cold sea surface temperatures typically found in regions where ocean convection occurs. This reduction in the efficiency of the thermal forcing allows for the possibility that precipitation can have an impact on surface buoyancy as important, but of opposite sign, as that associated with surface cooling.

This will be accomplished by a combination of: the re-analysis of historical data; modelling studies of cases of cyclogenesis; and the analysis of aircraft and ship data from the Labrador Sea region. In particular, we will show that the structure of a typical extra-tropical cyclone is such as to result in a separation of the region in which precipitation occurs from that in which surface cooling occurs. This results in a phase lag of approximately 24 hours between the time in which the buoyancy flux is large and positive due to precipitation and the time in which it is large and negative as a result of surface cooling. We argue that this temporal variability in the buoyancy flux may play an important role in the life cycle of the convective elements in the ocean. Indeed the large positive buoyancy flux associated with precipitation may inhibit convection from occurring or may suppress existing convective activity. In addition I will show that for the Labrador Sea, a representation of the inhomogenities in sea ice cover has a dramatic impact on the simulations of the air-sea interaction, boundary layer development and mesoscale structure both within the marginal ice zone and downstream over the open ocean.

Thermohaline structures observed in the Greenland-Barents Sea, January 1999

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A series of CTD/STD/XCTD observations was carried out in the western part of Barents Sea and the northern east part of Greenland Sea, along the west coast of the Svalbard island in January 1999.Water columns in the western part of Barents Sea were fully occupied with AW(Atlantic Water, $\theta > 2.0$℃, S$\sim$35.0) and showed clear temperature and salinity maximum in subsurface layers. At the southern stations aligned along the west coast of the Svalbard, upper layers were also consist of AW with temperature maximum and were stratified in temperature: a warm and relatively saline surface layer is underlain by cold and fresh water. At the deeper stations, lower water decreased its temperature to −1℃ at around 1000m depth and this was one of the densest bottom water found in this survey. At the northern stations, thermohaline profiles showed the surface layer, the cold and fresh PW(Polar Water, $-1.8 < \theta < 0.0$℃, $33.9 < S < 34.5$) with a temperature minimum and the subsurface layer of warmer and more saline Atlantic-derived Water, and the underlying cold bottom water, typically found deeper than 800m. Between the relatively warm and saline water of Atlantic origin and colder and fresher Arctic water, frontal regions were clearly formed, where vertical profiles of temperature and salinity frequently showed complex structures, such as inversion layers of temperature and salinity, step-like structures and so on. These structures were probably due to interleaving driven by double diffusive convection. Furthermore, density inversion layers of 10$\sim$100m thickness were sometimes found in such frontal regions.

LABORATORY EXPERIMENTS ON FRAZIL ICE FORMATION AND THERMOHALINE CONVECTION WITH APPLICATIONS TO THE ARCTIC MARINE ENVIRONMENT.

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The influence of turbulence on the frazil ice formation due to the differential heat and salt transfer across the density interface between upper fresh and lower cool saline water layers is studied by means of the laboratory experiment. It is obtained that the rate of frazil ice formation in the presence of turbulence may be two orders of magnitude higher than in the case of pure double diffusive transport of heat and salt trough the interface.

The results of the observations of the frazil ice formation in the Arctic fracture in summer are described. It is shown that the existence of the low saline subsurface water layer and its supercooling from the lower layer of cold and saline marine water due to differential heat and salt exchange across the pycnocline play a major role in frazil ice formation. The dependence of the intensity of frazil ice formation on the thermohaline stratification, velocity and direction of ice drift are described.

The description of the early summer field measurements carried out from the fast ice in the area of the Lena river delta - Laptev sea is presented. At the interface between the river and sea waters the tracks of supercooled water are discovered. The thickness of these supercooled layers is about 5-15 cm, while their temperature is down to 0.8 C. deg. below freezing point. The conglomerate of frazil ice are found at the pycnocline depth. Using the expressions obtained in the laboratory experiments the possible rates of the frazil ice formation in the river-sea waters contact zone are estimated for different current velocities and flood stages in the area.

The preliminary results of the experiments on the thermohaline convection under the growing ice sheet are presented and discussed.

Temporal change of phytoplankton distribution in the North Water Polynya

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Temperature, salinity and in vivo fluorescence of surface seawater, which was pumped up from the bottom of the C.C.G.S. Pierre Radisson, were recorded every one minute, using a CTD+fluorometer (AquaPack, Chelsea Instruments Ltd) from August 25 to October 1, 1999 during the NOW99 cruise. During the observation, the 123 samples of surface seawater were collected from a drain of the water tank, in which the CTD+fluorometer was put. The seawater was filtered with Whatman GF/F filter.
The filter was put into a tube, which contained N,N-dimethylformamide (Suzuki and Ishimaru, 1990). Concentrations of chlorophyll a were determined fluorometrically using a Turner Design Model 10R Fluorometer (Parsons et al., 1984) in our laboratory. These data were be used for calibration of in vivo fluorescence into chlorophyll a concentration. Extraction of pigments was also conducted using 90% acetone at 34 points and concentration of chlorophyll a was determined on board. Relatively saline and warm water was observed in the southeastern part of the sea area. Being consistent with the change of water properties, high concentration of chlorophyll a was high in the southeastern part during the Leg 2, although the concentration was low during Leg 1. The elevated phytoplankton abundance seems to be result from algal growth, utilizing nutrients transported by upwelled deep water into the euphotic zone. This is one of ecological significance of sensible heat polynya.

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Organic Carbon Mineralization by new Types of Psychrophilic Sulfate-Reducing Bacteria in Permanently Cold Sediments off the Coast of Svalbard

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More than 90 % of marine sediments are colder than 4 °C, hence most benthic organisms must be active at such low temperatures. One of the most important groups of benthic microorganisms are sulfate-reducing bacteria since they mineralize up to 50% of the organic carbon in marine sea beds. Although many mesophilic sulfate-reducing bacteria, growing between approx. 10 and 40 °C, are known, sulfate reducers that are active at typical temperatures of marine sediments (<4°C), could not be isolated and studied so far. During several cruises in the Barents Sea we collected samples from permanently cold sediments of West Spitzbergen between 77° and 79° N. We measured depth profiles of sulfate reduction rates at the *in situ* temperatures of the sediments, determined the temperature response of the sulfate reducing community in gradient block incubations, isolated 30 new sulfate-reducing bacteria and quantified the bacterial community by 16S rRNA slot blot hybridizations and fluorescent in situ hybridizations (FISH).

Sulfate reduction rates in permanently cold Spitzbergen sediments were similar to those found in warmer environments such as sediments of the North Sea or Baltic Sea. The addition of typical substrates for sulfate-reducing bacteria to intact sediment cores increased sulfate reduction rates up to 12 fold, indicating that substrate limitation rather than low temperatures controlled rates of carbon mineralization by sulfate reducers in these Arctic sediments. The optimum temperature of the sulfate-reducing community decreased from the southern to the northern sampling sites as did the *in situ* sediment temperatures. Highest rates in Hornsund sediments (76.6° N) were measured at 28°C, in Van Mijenfjord sediments (77.5° N) at 24°C and in Krossfjord sediments (79.2° N) at 20°C. Decreasing temperature optima reflect a shift in the sulfate reducing community towards more psychrophilic, i. e. low temperature adapted, organisms in colder sediments.

Cultivation dependent most probable number counts of sulfate reducers in Hornsund sediment indicated the dominance of a psychrophilic sulfate reducer community. For the first time, we could isolate pure cultures of psychrophilic sulfate-reducing bacteria that all grow at –1.8°C, the freezing point of seawater and the *in situ* temperature in many polar sediments. The new strains have temperature optima down to 7°C, hence the lowest ever recorded for anaerobic prokaryotes. The adaptation of the new isolates to permanently low temperatures is reflected not only in low temperature optima but also in their high growth rates and maximum growth yields at 0°C.

By using a new 16S rRNA oligonucleotide probe, which is specific for some of the psychrophilic isolates, we showed that the psychrophiles are the quantitatively most important group of the sulfate-reducing community in Hornsund sediments. The newly isolated psychrophilic sulfate-reducing bacteria are hence responsible for a substantial fraction of the organic carbon mineralization in the Spitzbergen sediments.

ALGAL PRIMARY SUCCESSION ON NEWLY DEGLACIATED ARCTIC MORAINE, NY-ALESUND, SVALBARD

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Cyanobacteria and algae play an important role at the start of the microbial successional chronosequence. The deglaciated "virgin" substratum is successively populated by bacteria, fungi, cyanobacteria and algae. This results in a stabilisation of the loose substratum, but more importantly, in an incorporation of organic matter into and nutrient enrichment of the primary substratum. Organic matter and nutrients accumulated by cyanobacteria and algae, are used in the subsequent successional processes by bryophytes and vascular plants. Terrestrial cyanobacteria and algae colonise the surface and subsurface of the deglaciated virgin substratum.

Czech phycologists have been invited to follow the Japanese research program "The Arctic Terrestrial Ecosystem", led by Prof. Satoru Kojima and Prof. Hiroshi Kanda. Our research interest in microbial primary succession has been incorporated into research aims focussed on "the formation of glacial and periglacial landforms" and on "the plant successional processes".

Diversity (1997, 1998, 1999) and abundance (1999) of soil cyanobacteria and algae were studied along the deglaciated moraine of East Brogger glacier, Ny-Alesund (79°57.8'N, 11°21.2'E), located in the north-western part of Spitsbergen on the southern shore of Kongsfjord. In 1997 and 1998, species diversity was described in a transect (eastern – closer to Ny-Alesund vicinity) along a deglaciated moraine, from the edge of the glacier to 800m distance. Each sampling site represents a 25m distance. Except for the time of deglaciation, the sampling sites differed in surface moraine conditions - soil moisture, soil nutrients and organic matter contents, substrate granulometry, etc. Altogether about 35 species were identified, comprising 21 species of cyanobacteria represented by Chroococcales - 10, Oscillatoriales - 5 and Nostocales – 6, and 14 species of algae represented by Xanthophyceae - 3, Chlorophyceae - 8, and Charophyceae - 3 species. Sixty-three uni-algal strains were isolated for detailed laboratory study.

In 1999, three transects were established along the deglaciated moraine: i) eastern – closer to Ny-Alesund vicinity - 800m in length, ii) central - 1050m, and iii) western-lateral moraine - 1080m. Each sampling site again represents a 25m distance. The transects differ, except for moraine surface conditions and time of deglaciation, also in substratum type. Species diversity was again determined in all three transects. The abundance of Cyanobacteria and algae was estimated as Chlorophyll a concentration (assumed to be proportional to biomass) as well as by direct calculation of cells (trichomes) per gram soil (cell fresh weight). The results from the 1999 season are now being evaluated.

Response of microbial biomass in arctic soil to artificial warming by using Open top chamber

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It is generally anticipated that global warming will accelerate the decomposition of soil organic matter through an increase of soil microbial activity. This results in an increase of CO_2 emission to the atmosphere and a change in the amount of nutrients available for plants. However, we present data indicating that microbial activity may not increase in the high arctic soils that have less substrate for soil microbes.

We examined the response of soil microbial biomass to artificial warming using open top chamber (OTC). Four study sites (Site-1, Site-2, Site-3 and Site-L) were set along with the primary succession at deglaciated area of East Bregger Glacier in Ny-Alesund, Svalbard. The OTC has been set on the soil surface at Site-L since 1994, at Site-2 & -3 since 1997, and at Site-1 since 1998. Soil samples (n=5～10) were collected from inside and outside of OTC at the four study sites. ATP concentration in the soil samples (indicator of soil microbial biomass) was measured with ATP method.

In Site-L, mean ATP concentration (soil microbial biomass) inside OTC was significantly lower than that outside OTC ($p<0.05$). In Site-1 and Site-2, mean ATP concentration tends to be lower inside OTC. In Site-3, ATP concentration did not significantly differ between inside and outside OTC. Two possible causes of this difference in response of soil microbial biomass to artificial warming between study sites will be discussed in relation to (1) substrate limitation for soil microbes and (2) difference in seasonal dynamics of microbial population inside & outside OTC.

The long-term influence of elevated temperature on biological production and carbon cycle in Arctic terrestrial ecosystems

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A growing set of problems connected with the increase of greenhouse gases in atmosphere and global warming results in essential acceleration of investigations of carbon cycling in biosphere. Long-term decades to centuries effects of Global Change are now in focus. One possible way to expose the long-term effects is a study of hot springs as a natural model of global warming. The goal of the present study was to compare the biological production and carbon cycle in hot springs-affected tundra ecosystems with those in permafrost as controls. Field data on ecosystem carbon fluxes, plant biomass, vegetation structure and soil composition were obtained at Chukotskiy Peninsula (Russia) in 1997-1998.

With soil temperature elevated, the wet sedge ecosystems increased their production (R=0.91) and respiration (R=0.85) rates, whereas the drier shrub ecosystems didn't show any clear trends (R=0.07÷0.35). In the sedge ecosystems the increase of soil temperature stimulates the growth of foliage biomass (R=0.92). However, in the shrub ecosystems foliage biomass doesn't depend on soil temperature (R=0.27). In other words, the response of carbon exchange to soil temperature depends on the hydrological regimen of the ecosystem.

Most of carbon in the studied ecosystems is stored in their under-ground components. Within a 3-12°C range of average soil temperatures at the depth of 10 cm, the soil carbon storage is greater in the wet ecosystems under higher temperatures, but it is smaller in the ecosystems under temperatures higher than 12°C. Hence, the soil temperature of +12°C appears to be optimal for carbon storage in wet ecosystems. Differences in soil carbon storage are rather consistent with measured seasonal net carbon sink, which also experienced a decline under high temperatures.

The research was supported by Research Institute of Innovative Technologies for the Earth (Japan) project "Effects of elevated CO_2 and temperature on carbon fluxes and plant photosynthesis in tundra ecosystems".

Plant speciation and phylogeography in the North Atlantic region

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What is the origin and the age of the Nordic flora? These questions have been vigorously addressed by generations of Scandinavian botanists. The arctic-alpine element of the flora is the potentially oldest one, because this is the only element that may have survived the harsh climate of the Pleistocene glaciations *in situ*.. This element contains a few endemic taxa as well as several taxa with disjunct distributions across the Atlantic, frequently cited as evidence for a considerable age of the flora. In this paper, I review some recent molecular studies of speciation and phylogeography carried out at the University of Oslo, including the genera *Saxifraga, Draba, Potentilla, Papaver, Cerastium, Lychnis, Phippsia*, and *Vahlodea*.

Most of the arctic-alpine endemics in Scandinavia and Svalbard are polyploids and appear to have originated directly via allopolyploidy, via primary hybridization between allopolyploids, or, rarely, via (very) slight divergence among allopolyploid populations. Most of them are predominantly autogamous or apomictic. In *Saxifraga*, for example, two local apomictic endemics have probably originated independently via postglacial hybridization between different populations of the same two allopolyploid parental taxa (*S. cernua* and *S. rivularis*) in southern Norway (*S. opdalensis*) and in Svalbard (*S. svalbardensis*). The low number of endemic taxa as well as their potentially rapid mode of formation suggest that the Nordic arctic-alpine flora is young.

Our phylogeographic studies of several taxa support this conclusion: the level of 'genetic endemism' within species is also low in the Nordic arctic-alpine flora. The conspicuous lack of geographically structured differentiation within species in the North Atlantic region provides evidence for recent and extensive dispersal across the sea barriers among Scandinavia, Svalbard, Iceland, and Greenland, although these taxa lack 'classic' adaptations to long-distance dispersal.

Announcement of an EU research program at Ny-Ålesund:

The NItrogen Cycle and Effects on the oxidation of atmospheric trace species at high latitudes (NICE)

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Abstract. Recent findings of NOx production in snow interstitial air suggest that photochemical production of NOx in or above snow surfaces is sufficient to alter the composition of the overlying atmosphere. Diurnal cycles of NOx of up to 35 pmol/mol magnitude were observed above snow surfaces. Polar regions are snow covered year-round, while much of the continental mid-latitudes is snow-covered during portions of the year (> 50% of the land surface north of 20°N is snow covered during winter). If this NOx release significantly altered NOx levels in the overlying atmosphere, the cumulative impact on global NOx and O_3 budget could be substantial. Although the observation of NOx release was made at the surface, it is likely that similar processes also occur in the upper troposphere, upon cirrus ice particles.

The NICE program will be carried out in collaboration with the British University of Essex, the Finnish Meteorological Institute, the Norwegian Institute for Air Research, and the Greek National Center for Scientific Research "Demokritos". Our poster will briefly show the objectives of the program and will show possibilities for participation for interested institutes.

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Temporal variations of atmospheric CO_2 concentration and its carbon isotope in Ny Alesund, Svalbard

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To clarify the relative contributions of the two carbon reservoirs, the ocean and the terrestrial biosphere, to the global carbon cycle is one of the most important problems for understanding the causes of the secular increase and the interannual variability of the atmospheric CO_2 concentration. Carbon isotopic ratio, $\delta^{13}C$, of atmospheric CO_2 has been used as an effective tool for separating the net air-sea fluxes of CO_2 from those between the atmosphere and the terrestrial biosphere, since a degree of isotopic fractionation effect is different in these exchange processes. Therefore, the $\delta^{13}C$ observations covering a wide geographical area have been required.

We have continued weekly air sampling at ground level in Ny Alesund, Svalbard (78° 55' N, 11° 56'E) in cooperation with Norwegian Polar Institute since 1991. The air samples were returned to Japan and analyzed for the CO_2 concentration and its carbon isotope ratio, $\delta^{13}C$. In this paper, we will present the temporal variations of the atmospheric CO_2 concentration and $\delta^{13}C$. In particular, causes of the seasonal and secular variations of the CO_2 concentration will be discussed.

An intercomparison campaign of ozone and temperature measurements in the Arctic (NAOMI-98, Ny-Ålesund/Spitsbergen)

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Stratospheric measurements of ozone, aerosols, and temperature are carried out by various techniques in the stratosphere, including optical ones like lidar, radiometric ones (microwave), or in-situ measurements by balloon borne sensors. At the Primary Stations of the international Network for the Detection of Stratospheric Change (NDSC) all of these techniques are used, often simultaneously. For the Arctic Primary Station of the NDSC in Ny-Ålesund/Spitsbergen an intercomparison campaign was conducted during January-February 1998, involving all instruments measuring stratospheric ozone and/or temperature profiles. In addition to the local instrumentation, the NDSC mobile ozone lidar from NASA/GSFC and the mobile aerosol lidar from AWI participated. The local instrumentation included the multi-wavelength lidar facility operated by the Alfred Wegener Institute (AWI), the microwave radiometer RAM, operated by the University of Bremen, and balloon borne sensors for ozone (ECC-type) and temperature (RS90), both operated by AWI. The aim is the validation of stratospheric ozone and temperature profile measurements according to NDSC guidelines. This paper briefly presents the employed instruments and outlines the campaign. Results of the intercomparison of ozone and temperature profiles are presented.

The results of the ozone intercomparison showed very good agreement between in situ and lidar measurements in the altitude range 15 km to the burst point of the balloons (below 32 km). Agreement within 10 % was found for the two lidars for altitudes up to 42 km. For comparison with the microwave profiles, the altitude resolution of the lidars and balloon sensors was reduced corresponding to the altitude kernels of the microwave retrieval. Then, good agreement was found in the altitude range between 27 and 40 km.

Temperature measurements agreed well throughout the middle stratosphere. Towards stratopause heights the differences between the lidar measurements increase, which might partly be due to different timing of the measurements.

This work has been carried out within the EC-funded project ESMOS/Arctic II, which supports the European contribution to the Network for the Detection of Stratospheric Change in the Arctic.

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Ozone loss rates determined with Match

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As observed for the first time in the mid eighties, each spring the Antarctic stratosphere suffers severe ozone loss, leading to a temporary "ozone hole". The ozone is destroyed through catalytic cycles involving chlorine, which has its source in man made fluorochlorocarbons.

A similar, but less pronounced phenomenon also occurs in the Arctic. Since the winter 1994/95, Match campaigns have been run annually to determine chemical ozone loss inside the polar vortex. The technique uses trajectory calculations to coordinate ozonesonde launches at about 35 northern hemispheric sounding stations in a way that individual air parcels are probed twice or more. This makes it possible to single out and quantify chemically induced ozone changes, that are often superposed by dynamical changes in the Arctic stratosphere.

Including a first study in winter 1991/92, chemical ozone loss rates for different altitudes and periods are now present for six Arctic winter/spring seasons, providing a unique dataset that allows quantitative comparisons between the different years. In spring 1992, and the three years between 1995 and 1997, the Arctic stratosphere was comparably cold, allowing polar stratospheric clouds to form. These give rise to heterogeneous chlorine activation that eventually leads to ozone destruction, which is reflected in high ozone loss rates determined with Match. In winter 1997/98 the temperatures were higher, and only a small part of the vortex suffered ozone loss. Vortex averaged loss rates were therefore much lower than in the preceding years.

The winter 1998/99 provided the warmest and weakest polar vortex examined with Match so far, and no significant ozone loss was observed.

SURFACE ENERGY AND RADIATION BALANCES IN THE KONGSFJORDEN AREA

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Clouds have a dramatic impact on the Arctic climate. The problem is very complex because of the presence of highly reflecting snow and ice, the absence of solar radiation for a large part of the year, low temperatures and water vapour amount. The net cloud radiative forcing results from the competition between the warming due to long-wave cloud emission and cooling due to short-wave cloud albedo effects. These processes directly reflect on the development of turbulence at the surface. An experimental campaign was carried out at Ny-Alesund with the aim to study the daily evolution of the surface turbulence and the influence of the clouds on the surface radiation balance. Through the turbulence measurements performed with a sonic anemometer, some parameterisations useful to compute the value of main turbulence parameters have been determined as well as the value of the roughness length that resulted highly variable because the snow-drift processes and changing surface conditions. Through measurements of cloud cover index, air temperature and water vapour pressure, the long-wave incoming radiation was parameterised. Comparison with the measured long-wave radiation confirmed the high level of confidence of such a parameterisation.

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Field reflectance data on different snow covers at Ny-Ålesund

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This paper studies the relationship between reflectance and physical characteristics of the snow cover in the Arctic. Field data were acquired on different snow/ice surfaces during a survey carried out at Ny-Ålesund, Svalbard in spring 1998.
In each session of measurements the following data were collected: reflectance factor in the spectral range 350-2500 nm by a portable spectroradiometer; snow data including temperature, grain size and geometry, surface layer morphology, vertical profile of the snow pack, snow density and water content, and GPS position data. Local climatic information along with sun elevation were acquired.
The reflectance factor was calculated as the ratio of incident solar radiation reflected from the snow target and the incident radiation reflected from a white reference *Spectralon,* being regarded as a Lambertian reflector. Absolute reflectance is obtained by multiplying this reflectance factor with the reflectance spectrum of the panel. To ensure a correct acquisition of reflectance data the white reference was re-calibrated at the Norwegian Polar Institute Optical calibration Laboratory at Ny-Ålesund during the campaign by intercomparison with a primary standard reference spectralon.
Measurements were performed in different locations and targets were new snow, recent snow, equilibrium forms, wind blown snow, pure ice and ice covered by snow with different thicknesses. The difference in reflectance characteristics of the different surfaces have been tabulated and compared for the purpose of identification by the Landsat TM channels.
Reflectance and snow data have been organised into an archive that can be consulted at the address: *http://gioconda.polar.rm.cnr.it/sispec.php*. This archive also includes field radiometric and snow data collected during a Antarctic survey (austral summer 1998) and in the eastern Italian Alps (spring 1996).
The analysis performed on arctic radiometric data shows that snow/ice reflectance in the visible is mainly determined by the surface characteristics of the snow pack such as morphologic pattern, occurrence of hoar, thickness of the top layer and also on the stratigraphy of the first 10 cm. At longer wavelengths reflectance is mainly controlled by snow grain size and shape. However, even though the observed spectral behaviour of snow and ice is generally well in agreement with literature, it has been observed that snow grain size is often larger than that used in the snow spectral models proposed, especially regarding new and recent snow. Moreover, granulometric characteristics of a snowpack may be made up of 3-4 grain types, different in size and shape, that can thus decisively affect the snow spectral response in the infrared.
Also, grain size, surface hoar and absorbing impurities may be regarded as variable parameters whose effect on reflectance tend to superimpose at several wavelengths. Therefore it is important both to intensify field surveys over different kinds of snow and to repeat the same measurements under different weather conditions to improve the interpretative models of different snow covers to better interpret satellite data. It is also of great importance to collect accurate data about snow physical characteristics along with spectroradiometric data; a correct interpretation of snow spectral response would be extremely difficult without this information.

Large cloud drops rimed on snow crystals observed at Ny-Ålesund, Svalbard, Arctic

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Non-ordinary large cloud drops were found on snow crystals in a wintertime snowfall during an observation period on January 1999 at Ny-Ålesund, Svalbard, Arctic. The maximum size of drops were larger than 200 μm. It is interesting that the cloud drops could grow to large size under supercooled condition below the freezing point. The large supercooled cloud drops were considered to be one of the typical precipitation particles only grown in polar region.

The formation process of the large supercooled cloud drops was investigated by using the data of a vertical pointing radar, a microwave radiometer and a aerosol particle counter. The results show that the particles would fall from shallow convective clouds, which echo top was lower than 3 km and the temperature was about –22℃. The results also revealed that the clouds forming the large supercooled cloud drops would consist of the clean air, which contain much smaller number of aerosol particles than the air at the ordinary snowfall condition. Thus the large cloud drops were grown under the air with the smaller number of condensation nuclei and freezing nuclei. The back trajectory of the air suggests that the clean air have formed with staying for several days in polar region.

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Spectral reflectance of melting snow in a high Arctic watershed on Svalbard: Some implications for optical satellite remote sensing studies

by

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Abstract

Field campaigns were undertaken in May and June of 1992 and 1997 in order to study spectral reflectance characteristics of snow during melt-off. The investigations were performed on snow-covered tundra at Ny-Ålesund, Svalbard (79°N). Spectral measurements were acquired with spectroradiometers covering wavelengths from 350 to 2500 nm. Supporting measurements such as snow thickness, density, content of liquid water, grain size and shape, stratification of snow pack, as well as cloud observations and air temperature, were monitored throughout the field campaigns. Spectral measurements demonstrate that the near-infrared albedo is most affected by the ongoing snow metamorphism while the albedo in the visible wavelength range is more strongly affected by surface pollution. Comparisons of spectral measurements and spectrally integrated measurements emphasise the need for narrow-band to broad-band conversion when applying satellite-derived albedo to surface energy-balance calculations. As an example, Landsat TM Band 4 albedo is shown to produce slightly high albedo values compared to the spectrally integrated albedo (285-2800 nm). Daily albedo measurements from 1981-1997 show that the albedo normally drops from 80% to bare ground levels (~ 10%) within two to four weeks and the date when the tundra becomes snow-free varies from early June to early July. Thus, the changing spectral characteristics of snow during melt-off combined with a general rapid decrease in albedo call for cautious use of satellite-derived albedo, especially when used as absolute numbers. Our data also illustrate the effect of cloud cover on surface albedo for an event in which the integrated albedo increased by 7 per cent under cloudy conditions compared to clear skies without changes of surface properties. Finally, the reflectance of snow increases relative to nadir for measurements facing the sun and at azimuths 90° and 180° by 8, 15, 19, and 26% for viewing angles 15°, 30°, 45°, and 60°, respectively, due to anisotropic reflection.

GLACIOLOGICAL OBSERVATION ON PIONER ICE CAP, SEVERNAYA ZEMLYA, IN 1996

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Glaciological observations were done in Severnaya Zemlya in 1995 and 1996. Severnaya Zemlya consists of three large islands (about 100 km in length): Bolshevik island, Octyabrskoy island and Komsomolets island (Fig. 1). Komsomolets island is almost covered with Akademii Nauk ice cap, which is about 70 km in diameter, 781 m a.s.l. on the top and about 800 m in depth. We aimed to make glaciological observation on Akademii Nauk ice cap at first, but owing to bad weather in summer season we could not reach the top of Akademii Nauk. Instead of that we made an observation on Pioner ice cap on Pioner island. The Pioner island locates on the southwest of Komsomolets island and the top is about 50 km apart from Sednii station. Srednii station is on a small island to the west of Octyabrskoy island and has a runway (usable only in winter) and a meteorological station.

We made a pit observation of 2m depth and a hand drilling in 7m depth for snow/ice sampling on the top of Pioner ice cap (N79° 53' 31.0" E93 ° 01'08.1", 382m a.s.l.) on July 13-14, 1996. As an in-situ observation, density, stratigraphy, particle diameter were observed. Snow/ice samples were cut in about every 10 cm depth and melt for analyses of $\delta^{18}O$, MSA, SO_4, NO_3, Cl, Ca, Mg, K, Na and and heavy metals.

Vertical profiles of stratigraphy and $\delta^{18}O$ showed annual variation of 70 – 80 cm interval, which means the annual precipitation is about 700 mm (Fig. 2). During the observation period it was foggy and air temperature was about −1 ° C. Therefore, on a clear day in summer the surface snow would melt, flow down and form ice layers by refreezing in cold subsurface snow. This melt water movement is not so large and the annual sequence in stratigraphy would be conserved. This situation would be almost the same on the top of Akademii Nauk ice cap.

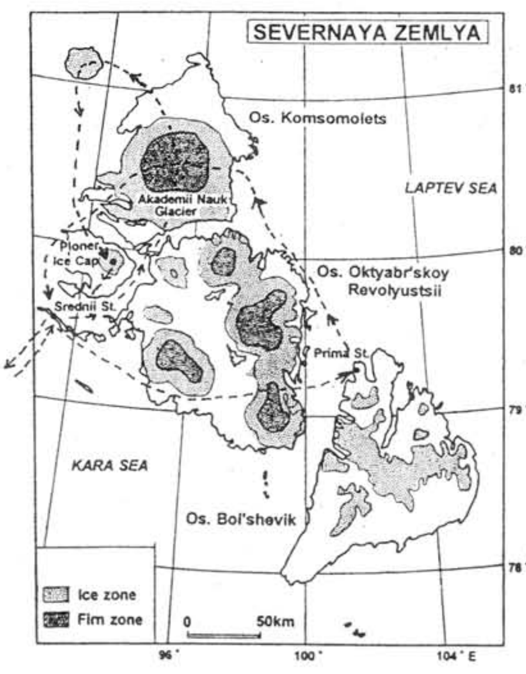

Fig.1 Map of Severnaya Zemlya
Broken line is 1996 flight route.

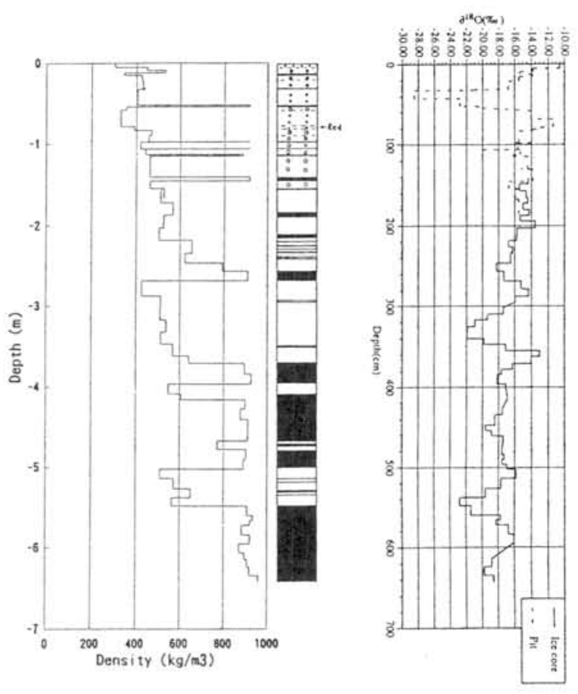

Fig.2 Profiles of density, stratigraphy and $\delta^{18}O$ on Pioner ice cap

Leaching of chemical compositions in the snowpack at the dome of Austfonna ice cap, Svalbard.

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Abstract

Snowpack samples were corrected from the dome of Austfonna ice cap, Svalbard (79°48'03"N、24°00'21"E、750 m a. s. l.) in March and April of 1998. Snowpack samples were analyzed for anion (Cl^-, NO_3^-, SO_4^{2-}), cation (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}), pH, EC and $\delta^{18}O$. The result showed that the concentration levels of ions in melting-experienced snowpack were much lower than those in non-melted snowpack. It shows that the ions were flushed out from the snowpack during the thaw. It was detected that clear difference of the Mg^{2+}/Na^+ ratio between melting-experienced snowpack (0.03 ± 0.02) and non-melted snowpack (0.11 ± 0.02). We propose that the Mg^{2+}/Na^+ ratio become an index which distinguish the firn in the ice core whether melting-experienced or not.

THE GEOCHEMICAL PHENOMENON - LOCAL GEOCHEMICAL FIELDS IN THE GLACIER

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Mountain glaciers accumulate and hold atmospheric moisture as firn ice during the length of time; they represent a unique source of information on changes in the chemical content of the atmosphere. It is believed that precipitation material accumulated in the glaciers does not change significantly from the moment of its fall due to low temperatures (Longway, 1970; Kotlyakov, Gordienko, 1982). Our investigations conducted in the glaciers enable us to establish the existence of local geochemical fields, the formation of which is not related to global climatic factors.

The formation of local geochemical fields in the glaciers results from the sharp geochemical heterogeneity and the geochemical processes occurring in underlying rocks and causing migration of chemical elements and their compounds within ice and snow layers. In the glaciers, migration of chemical elements occurs as ion diffusion along liquid pellicles covering ice and snow crystals at temperatures below or close to 0°C (Fletcher, 1962; Kvlividse et al., 1978; Makarov et al., 1990). Cryogeochemical fields have been detected in the glaciers of different types: in valley and hanging glaciers, in warm and cold glaciers.

Local geochemical fields have qualitative (chemical elements and their compounds) and quantitative (concentration of elements, parameters of geochemical fields) characteristics, which depend on the geochemical peculiarites of underlying rocks; these characteristics have regular distribution whithin the glacier and on its surface.

The vertical range of occurrence of local geochemical fields is established to be restricted to ice thickness in the investigated glaciers, i. e. 134 m; theoretically, it may be as thick as several hundred meters. Generally, geochemical fields on the glacier surfaces are located above the source of anomaly and shifted insignificantly in a direction of glacier movement. High formation rate of local geochemical fields in the glaciers and their morphology, distribution of chemical elements within a glacier, interaction with geophysical anomalies can be explained adequately by an electrochemical model of the geochemical field formation.

The formation of local geochemical fields in the glaciers results from an extremely high rate of subvertical migration of chemical elements and their compounds. These fields are located within an ice layer above the zone of sharp geochemical heterogeneity (geochemical anomalies) in underlying rocks.

Detecting local geochemical fields in the glaciers makes it possible to reveal intensive geochemical anomalies in rocks underlying thick glaciers.

When studying glaciers for paleoclimatic reconstruction and quantitative assessment of substance input, account must be taken of their geochemical heterogeneity related to the existence of local geochemical fields.

Regional characteristics of chemical constituents in surface snow, arctic cryosphere

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For the purpose of clarification of the climatic and environmental changes for the past 100 years in the Arctic, the Japanese Arctic Glacier Expedition conducted a large number of ice coring exercises at many from 1987 to the present. During the same periods, surface snow pit observations and snowfall observations were carried out near ice coring sites to reveal the regional characteristics of environmental conditions at present. The study of atmosphere - snow transfer function is the main subject.

The objective regions for the studies are glaciers in Svalbard, Greenland, Severnaya Zemlya and arctic Canada. The geographical characteristics are various in each other; for instance, latitude, altitude and distance from the coast. The surfaces of glaciers in Svalbard and Severnaya Zemlya are melted in summer season and the chemical substances are washout with percolated meltwater and the water should be refreeezed Therefore the profiles of chemical constituents were reformed secondary.

We show some interesting results. At the Austfonna ice cap, Svalbard, the ratios of anion in the solid precipitation during spring to summer were 50% of Cl, 20% of NO3 and 30% of SO4 in unit of microEq/L. Otherwise the ratios of anion in surface snow cover were 85%, 5%, 10%, respectively. The ions of NO3 and SO4 were run out more quickly than Cl. At the Devon ice cap, arctic Canada, and GRIP and NGRIP, central Greenland, the ratios of anion in the solid precipitation and surface snow cover were the same as 10-40% of Cl, 40-70% of NO3 and 20% of SO4.

For future, the flux of chemical component and its seasonal variation in various regions will be studied to be found out the arctic climatic and environmental systems.

Chemical analysis of a shallow ice core and surface snow samples from North Greenland

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The two deep drilling programs (GRIP and GISP) were done at the Summit of Greenland in 1992 and both of them were acquired ice cores extending nearly to bedrock. The stable isotope ($\delta^{18}O$) profiles of each ice core depicted dramatic temperature changes in Greenland through the last two glacial cycles, including abrupt climatic shifts during the Em/Sangamon Interglaciation, which is elsewhere recorded as a warm and stable period. However there was possible that this drastic climatic changes during the Eemian period, especially the early and the middle part, was due to confusion of the ice layers. The ice layers corresponded to the Eemian period were likely to be influenced by severe flow effects because the layers were very close to bedrock. In order to reveal this problem, the deep ice core extending nearly to bedrock has been drilling at northern part of the Greenland ice sheet by the North GReenland Ice-core Project (NGRIP). In this time, we report about chemical analyses of the shallow ice core and surface snow.

The observation of surface snow was carried out on June 6, 1997. We make a 1.65m depth snow pit westerly 3 km away from main camp (75.1° N, 42.3° W, 2918m a.s.l.). The snow samples for chemical analysis were collected every 5 cm from the wall at the windward side. The shallow ice core of 98.57m long were drilled westerly 280m away from the drilling site of deep ice core from 14 to 17 July, 1997. In-situ, we measured bulk density, ECM and DEP. One of the large peak of ECM was appeared at 60.20 m depth. It seems that this peak was due to the eruption of Mt. Laki. The chemical components (10 kind of anion and 5 kind of cation) were measured by ion chromatography in our institute. The vertical profiles of nitrate and sulfate concentration were shown gradually increase from about 40 m depth to nearly surface.

On the detailed density profile of the NGRIP-S1 shallow ice cores from Greenland

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the layer structure of the shallow depthes at polar ice sheet contains memories of the snow deposition. The layers are recognized by differences in the ice grain matrix such as the grain size and their compaction. The differences are a reflection of the climatic conditions experience since deposition. The formation of grain bonds during snow densification can also be effected by the structure of snow at deposition and metamorphism in the first few meter of the ice sheet. The structure of snow near the surface is reflected and remaining in the structure or the air bubbles after close off. It is important, therefore, to examine the shallow of ice cores in detail.

In order to examine in detail the fluctuations of density and grain properties the following procedure was followed. A 1.5 cm thick sample is cut from the edge of the core. Because the shallower part of ice core is a porous assembly of ice particles, aniline liquid was used to fill the voids in snow and firn at a temperature of about –5°C and this was moved to cold room at –20°C. After the aniline liquid has frozen, the surface of the sample is flattened using a microtome. Black colored powder of Sudan-black B ($C_{29}H_{24}N_6$: organic solvent) is put on the surface. After about 2 hours, the powder is blushed away from surface by a soft hair pensile. A part of the powder attaches to parts of solid aniline, that is, voids in the snow and firn. Thus, ice particles and voids can be easily observed in detail. From photographs of the surface, two dimensional density and ice grain features are examined using image analysis. Since ice-grains of snow and firn are distributed at random (with a few exceptions like a very developed depth hoar) the two dimensional density can be related to the three dimensional density with the equation $L_i/L_0 = A_i/A_0 = V_i/V_0$. Here, L_i/L_0 , A_i/A_0 and V_i/V_0 indicate one, two and three dimensional density, respectively. The results will be compared to $\delta^{18}O$ and ECM data.

The North Water Polynya Study : Preliminary Hydrographic Results

By

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A three year (1997 to 1999) international field program was conducted in the North Water Polynya, in Smith Sound (Northern Baffin Bay). Nine oceanographic moorings were deployed in August 1997, recovered in July 1998 and redeployed for another year. Pressure, temperature, salinity, currents and sediment fluxes were measured. Six major hydrographic surveys of the polynya were carried out : one in August 1997, four in the summer of 1998 (April, May, June and July), and one in September 1999. We present preliminary results from the summer of 1998 data set.

The near-surface (25-100 m) mooring data suggest a cyclonic mean circulation below the polynya, with a southward flow (10-15 cm s-1) on the western, Canadian side and a poleward, weaker flow (5 cm s-1) on the eastern, Greenland side. It was found that mixed layed depths were generally larger and surface water colder on the western side. At depths, there is evidence of a confluence in the central channel between the southard flow and the northward West Greenland Current. The extent of its warm core is clearly visible in the southern East-West hydrographic section.

Bio-optical characteristics in northern Baffin Bay

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The North Water polynya in northern Baffin Bay is among the most productive areas north of Arctic circle. We participated in the international joint project from 26 March to 28 July, NOW 1998 (International North Water Polynya Study) and carried out bio-optical measurements in Baffin Bay during before spring bloom and among spring bloom, 1998. Primary objectives of this study are to do spectral analysis using the spectroradiometer and to develop high latitude algorithm to estimate chlorophyll *a* concentration (chl *a*) more globally and locally. Another objectives are to describe absorption coefficients at the surface layer in the high latitude area, and to evaluate the relationship between the algorithm and absorption coefficients in the high latitude.

We measured downward spectral irradiance (E_d) and upward spectral radiance (L_u) using SPMR (SeaWiFS Profiling Multi-channel Radiometer) (Satlantic. Inc), which has 13 spectral channels (405, 412, 435, 490, 510, 520, 532, 555, 590, 665, 683, 700 nm, bandwidth 10 nm). At the same time, we measured the absorption coefficients of total particulate matter (a_p), phytoplankton (a_{ph}), detritus (a_d), and colored dissolved organic matter (a_y). We determined the specific absorption coefficient of phytoplankton per unit Chl *a* ($a_{\mathrm{ph}}{}^*$).

The ratio of remote sensing reflectance (R_{rs}) of 490 nm and 555 nm [$R_{rs}(490)/R_{rs}(555)$], which named Ocean Chlorophyll algorithm 2 (OC2) is used in-water bio-optical algorithm of SeaWiFS (Sea-viewing Wide Field of view Sensor). We combined the data in Baffin Bay using this algorithm with other areas. The spectral characteristics of absorption coefficient of phytoplankton have been the subject of various studies because of their importance in primary production, radiative transfer in sea water, and in passive remote sensing of phytoplankton. The signature of ratio of R_{rs} and absorption coefficients in the study water will be discussed.

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Pico and Nanophytoplankton Distribution in the North Water (76-79° N) as Estimated by Flow Cytometry

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The physical processes leading to the formation of the North Water (76 - 79oN), an open water surrounded by sea ice, differ along the Greenland Coast and the Canadian Coast of the polynya. These physical processes can lead to different phytoplankton communities and can also affect the duration and intensity of biological production. The abundance and optical characteristics of phytoplankton cells < 20 才 m was determined by flow cytometry from April to June 1998 and from September to October 1999 in the North Water. April was characterised by a strong gradient of small and large phytoplankton with highest values near the east-centre of the polynya. A completely different pattern was observed in May. The abundance of both small and large phytoplankton seems to have moved towards the west-centre of the polynya with the highest number closer to the Canadian coast. The abundance distribution for June was more evenly spread within the polynya. However, contrary to the previous months, large phytoplankton seem to be concentrated near the west coast, while small cells reached highest concentrations in the centre of the North Water. In September and October 1999, a picophytoplankton population (<2 才 m) was identified and quantified in the surface water. Pigment signatures (HPLC) of <5 才 m sample showed high concentrations of zeaxanthin and chlorophyll b. Cyanobacteria were not detected in flow cytometry and, therefore, based on the pigment signatures, this population was probably a picoeukaryote (Prasinophyceae).

Surface concentrations of picophytoplankton were high along the southeast Greenland coast. These results will be discussed in relation to hydrodynamic processes and circulation that favour the maintenance of the polynya.

Species composition, biomass and photosynthetic activity of the bottom ice algae in the North Water Polynya during the springtime.

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Production, biomass and species composition of bottom sea ice algae were measured in the North Water Polynya, northern Baffin Bay, from 7 April to 27 June 1998. At the sampling stations, the percent ice cover ranged from 40 to 100%. The ice thickness and the snow depth varied from 0.1 to 2.0 m and 0 to 0.6 m, respectively. During the sampling period, the bottom ice chlorophyll biomass varied from 0.01 to 71 mg m^{-2} (April: 0.01 - 29.4; May: 0.34 - 71.2; June: 0.22 - 31.5 mg m^{-2}). Highest biomasses were generally observed in the center of the polynya in April and on the western side of the polynya in May and June. Ice algal particulate production ranged from 1 to 382 mg C m^{-2} day^{-1} with mean rates of 86, 142 and 46 mg C m^{-2} day^{-1} in April, May and June, respectively. The average *in situ* production:biomass ratio of ice algae was similar in April and May (ca. 14 mg C mg Chl a^{-1} day^{-1} and decreased in June (ca. 7 mg C mg Chl a^{-1} day^{-1}). There was no difference in ice algal production rate between thin (<1 m) and thick (>1 m) pack ice in April. However, ice algal production was 4 to 5 times higher under thin ice than under thick ice in May. The bottom ice community was generally dominated by pennate diatoms in April and May, and composed of a mixed assemblage of pennate diatoms, centric diatoms and flagellates in June. These results indicate that ice algae are an active biological component of polynya regions in spring and may represent an early and significant source of food for the pelagic and benthic organisms.

Physiological study on photosynthetic pigments of phytoplankton in the North Water Polynya

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Phytoplankton were collected from polynya in Baffin Bay during the cruise of North Water Polynya Project 99 (NOW99) (18 stations, surface and 20 ~ 30 m depth).

Their effective quantum yield (Y) of PS II and non-photochemical quenching (NPQ, heat dissipation of excess light) were measured using pulse amplitude modulation (PAM) system with various light intensity. The Y will show how efficiently the phytoplankton in the polynya of Baffin Bay perform photosynthesis under low temperature and light.

The NPQ will show the protecting efficiency of photosystems by xanthophyll cycle system from higher light.

The samples before and after the light illumination were frozen to analyze the content of photosynthetic pigments.

The pigment composition data will also present the information on the light harvesting systems and the xanthophyll cycle system. We will show the preliminary date in this symposium.

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Feeding activities of Arctic copepods in the NOW Polynya.

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Heverous copepods, *Calanus hyperboreus* and *C. gracialis* are a key species in Arctic plankton communities due to their abundance and size. Their develpoment of the populations are considered to be related to their food as the spring bloom of the phytoplankton and ice algae. To estimate the role of copepods in the sea-ice ecosystem of the NOW Polynya. 34 series of stratified net tow samples including three 24h-observations to observe diel feeding rhythm of copepods were taken from 22 stations located in the NOW Polynya during the cruise of the CCGS Pierre Radisson from April to July, 1998.

22 series of the gut evacuation rate experiments for the copepods were also done at every stratified station. Respiration of copepods were measured at 6 stations in April and May. After these experiments, specimens were stored in the freezer for the dry weight and gut pigment content measurements of copepods at our laboratories.

Clear positive linear relations on the ambient chlorophyll concentration were observed in the gut pigment contents of *Calanus. hyperboreus* (Fig. 1, A) and *C. gracialis* (Fig. 1., B).. However, gut evacuation rate of *C. hyperboreus* (Fig. 1, C) and *C. gracialis* (Fig. 1, D) did not change much under the similar food concentration. These rates were between 0.02 and 0.04 per minute for the adult female. This means the gut turnover time of *C. hyperboreus* and *C. gracialis* during April and July were about 30 minutes and 1 hour, respectively. These results revealed that copepod feeding acitvities were almost constant under the various food concentration. Seasonal change in the feeding activity of the copepods will be discussed at the meeting.

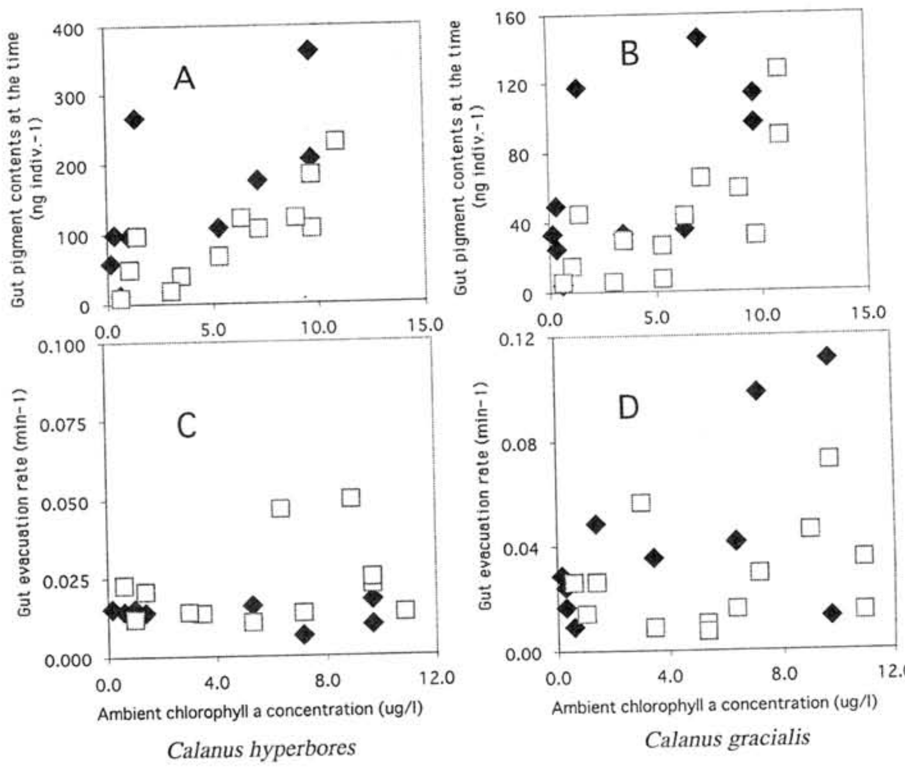

Fig. 1. Gut pigment contents (A, B) and gut evacuation rates (C, D) of *Calanus hyperbores* (A, C) and *C. gracialis* (B, D) at the ambient food concentrations. Filled and open symbols mean adult female and C5, respectively.

Respiration and excretion rates of Calanus hyperboreus, C. glacialis and Metridia longa in relation to environmental conditions at North Water Polynya during autumn.

Kunio Takahashi, Kazutaka Takahashi and Satoru Taguchi (1)

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North Water Polynya could be formed by latent or sensible heat physical mechanisms. These mechanisms conduce to the opening of the polynya, either simultaneously or separately at different times and in different areas of the North Water. The forming mechanism of the North Water Polynya, therefore, would determine the duration and intensity of primary production during ice-melting season. This variation of primary production would in turn contribute to the secondary production of the copepods which are the dominant component in zooplankton communities.

We measured metabolic rate of the dominant copepods in several stations during the period from August to October 1999 in order to estimate the spatial and temporal heterogeneity of biological activity in North Water Polynya.

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Observation of downward particle flux in the North Water Polynnya

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Long-term deployment of time-series sediment traps 200 m above the bottom were made at 5 stations (N2, S5, S4, S2, D1) in northern Baffin Bay (75° to 78° N) from September 1997 through June 1998. Sinking particle samles, collected at bi-weekly to monthly intervals over 10 months, represent the spatial and temporal vareation of downward particle flux in the North Water Polynya in the Baffin Bay.

Maximum sedimentatoin rates occurred during Septmber and October and from April to June at all station .

The highest particle flux occurred at 200 m fromthe bottom near Ellesmere Island (site S5)(76° N) in eastern Baffin Bay. Values at the center of an east-west transect along 76° N latitude were ten-fold lower. Sedimenation rates off the west coast of Greenland (site S2)(76° N)were intermediate to those at the center and western end of the transect.

A north-south gradient was present with maximum values durig early June at 78° N (N2)>76° N(S4)>75° N(D1).

Vegetation and soil relatioships in the recently deglaciated terrains in Ny-Ålesund, Svalbard

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Differentiation of arctic phytogeocoenoses in the recently deglaciated area was studied in Ny-Ålesund, Svalbard. A total of sixty relevés were established to describe vegetation structure and to determine soil characteristics. On the basis of the floristic structure of the vegetation as described by relevé method, seven plant community types were distinguished; they were 1. *Draba* type, 2. *Dryas* type, 3. immature mesic moss type, 4. *Cassiope* type, 5. mature moss type, 6. immature wet moss type, and 7. *Luzula* type. The above order of vegetation types from *Draba* type to *Luzula* type appeared to represent a sequence of the types along a soil moisture gradient from dry to wet. Soil chemical characteristics were analyzed and correlated with the plant community types. It was revealed that, in general, soils of mesic habitats exhibited higher values in cation exchange capacity, exchangeable basic cations and organic carbon as well as total nitrogen. This suggested that mesic habitats tended to accumulate organic matter and associated basic cations much more than dry or wet habitats. The above-listed seven plant community types appeared to have differentiated primarily on the basis of soil moisture and secondarily progress of vegetation succession. It also became apparent that, as vegetation succession progressed, soil organic matter and amount of basic cations increased whereas pH values tended to become low.

Flora and vegetation of deglaciated area in Ny-Å lesund, Svalbard

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The ecological study on the deglaciated area has been carried out in the Ny-Å lesund area in Spitsbergen Island, Svalbard since 1994 as the Japan-Norway collaborative study. As one of the research subjects, vegetation and soil condition have been surveyed during the research period. According to the aerial photograph, East Brogger Glacier near Ny-Å lesund seems to be retreated over 300 m for 30 years. However, there has been very few study on the colonization of the plant at bare ground on glacier moraine so far.

The main purpose is to know the vegetation patterns and species diversity, and relationships between vegetation and environmental factors. These subjects will also become important for assessment of environmental change in global or local scale.

The flora and vegetation of the deglaciated area extending about 1km from the outwash to the glacier edge were surveyed by the line transect method. The successional patterns of the moss and lichen, and vascular plant species are shown on the moraine near the glacier edge exposed recently. As a result, the bare ground of the glacier foreland is important on the successional process and the biological diversity is none too low compared with other vegetation such as *Saxifraga* or *Dryas* communities.

Arctic *Polygonum viviparum*; Growth and reproduction in relation to preformation

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In many perennial plants, early development of organs starts one or more years before they mature. This phenomenon is called preformation. In *Polygonum viviparum*, extremely long period of preformation is reported for alpine population in Colorado (full maturation after 3 years of preformation in the apical bud of a rhizome; Diggle 1997). Our preliminary observation also found the similar pattern of preformation in arctic *Polygonum viviparum*; its apical bud of rhizome contained organ primordia that amounted to the number of the organs for at least two future years. Preformation facilitates rapid establishment of organs at the onset of the growing season, and is hence considered to be adaptive in plants with limited growing period. However, under yearly fluctuating environments like arctic, preformation may be less adaptive because it could restrain flexible response of plants to current year environment. The aim of this study is to examine to what degree the preformation restrains plant performances, and to examine if there are any differences in the pattern of growth and reproduction in relation to the preformation among populations with different potential growing period.

Three study plots were set along a snow thaw gradient (early: early June, intermediate: mid June, late: early July) in Ny-Alesund, Svalbard, Norway (79N, 12E) in 1998. Fifty to sixty plants were tagged at each plot and size and color of individual leaves were recorded in one week interval. For half of the plants, all leaves were clipped at three weeks from snow thaw. If growth and reproduction are determined by preformation strictly, no difference in the performances are expected between control and clipped plants. On the other hand, if plants have some flexibility in response to current environmental conditions, clipped plants could behave differently from control plants.

Average of actual growing period was about 8 weeks and it didn't vary significantly among the three plots. Plants at early snow thaw plot emerged earliest and withered in the middle of summer when temperature condition was still favorable. At this plot, no plants expanded additional leaves after clipping, and there was no difference in the number of bulbils produced between control and clipped plants. At late and intermediate snow-melt plots, on the other hand, the percentage of plants that expanded additional leaves after clipping was about 30, which was higher than the percentage of control plants that expanded new leaves after three weeks from snow thaw. In addition, clipped plants at late snow thaw plot produced less number of bulbils than control plants. These results suggest that degree of restraint by preformation (or degree of preformation itself) varies among plots with different timing of snow thaw.

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Comparisons of germination pattern and seedling survival of *Potentilla matsumurae* (Rosaceae) between alpine fellfield and snowbed habitats

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Potentilla matsumurae has wide distribution ranges from fellfields to snowbeds in Japanese alpine sites. Because environmental factors affecting seedling establishment should differ between the fellfield and snowbed habitats, we examined germination pattern and seedling growth by reciprocal sowing between the habitat types in the Taisetsu Mountains. Seeds derived from the fellfield germinated earlier than that from the snowbed in both habitats. In the fellfield, native seeds started to germinate in early June when mean ground temperature was around 10°C, and germination lasted throughout the season. Whereas germination of snowbed seeds occurred in early July when mean ground temperature increased around 15°C.

Timing of seedling emergence greatly affected subsequent survivorship in the fellfield. Seedlings emerged in the first half of the growing season showed low survival during the current season because of frost and drought damage, but high survival during the winter. Seedlings emerged in the latter half of the growing season showed a contrary tendency. Late emerged seedlings originated from the snowbed showed very low survival in the fellfield. Thus, success of seedling establishment in the fellfield is determined by the balance between the probabilities of survival during the current season and winter. Under such conditions dispersal of germination timing may be available to reduce the risk of seedling extinction. On the other hand, seedling survival was high throughout the season in the snowbed, where short growing season seemed not to be a strong factor affecting seedling survival.

When fellfield seeds were sown in the snowbed, biomass of seedlings highly decreased in comparison with those sown in the fellfield probably due to short growing season. Seedlings grown in the fellfield had thicker leaves than those grown in the snowbed. In the case of snowbed seeds, on the other hand, there were no significant differences in the biomass and SLA between the seedlings grown in the fellfield and snowbed. Therefore, seedlings derived from the fellfield had greater morphological plasticity than that from the snowbed. These results indicate that intraspecific variations in germination and seedling traits can occur within small scale in alpine environment.

Variations in reproductive characteristics of two sympatric alpine shrubs, *Phyllodoce caerulea* and *Phyllodoce aleutica* along a snowmelt gradient

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Phyllodoce caerulea and *Phyllodoce aleutica* often coexist at alpine snowbeds in the Taisetsu Mountains, northern Japan. Both species are predominantly visited by bumblebees. Although flowering phenology was largely determined by the timing of snowmelt, antheses of both species highly overlapped within same places. Flower density of *P. caerulea* was high in early snowmelt places and that of *P. aleutica* enhanced in late places, reflecting physiologically higher tolerance to short growing conditions in *P. aleutica*. Both pollen and ovule numbers per flower decreased and P/O ratio increased in late snowmelt places in both species. Spatial separation between anther and stigma was larger in *P. caerulea* than in *P. aleutica*. Relationship between bumblebee preference and seed-set success indicated that interspecific competition for bumblebee acquisition existed between the species, and the competitive situation changed along the snowmelt gradient. Bumblebees preferred *P. caerulea* to *P. aleutica* in early to middle snowmelt places, but they tended to visit *P. aleutica* more frequently in late places probably due to higher flower density of *P. aleutica*. Extent of pollen limitation in *P. caerulea* was intensive in late snowmelt places and that in *P. aleutica* was obvious in early and middle places. Although both species are physiologically self-compatible, *P. caerulea* was considered to be a more outcrosser and *P. aleutica* was a more selfer in early to middle snowmelt places. However, autodeposition efficiency of *P. aleutica* decreased in late snowmelt places where *P. aleutica* was frequently visited by bumblebees. This indicates that mating system of *P. aleutica* changes relatively from selfer to outcrosser along the snowmelt gradient.

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Ecological role of fungal infections of moss carpet in Svalbard

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Moss vegetation plays an important role as a producer in early stages of primary succession in the Arctic. Moss colonies also offer living space for terrestrial invertebrates such as insects, ticks and nematodes. Therefore, moss communities play an important key role in the terrestrial ecosystems in the Arctic. Microorganisms, especially fungi in the Arctic, are well known for their formation of mycorrhizae, bisidiolichen and decomposer associations. In addition, some fungi have been reported actively to attack mosses growing in the Arctic. However, there have been very few ecological studies on phytopathogenic fungi in the Arctic.

Many moribund moss colonies were found in the moss carpets of *Sanionia uncinata* in Svalbard after the snow bed had melted. We isolated many fungi, *Pythium* spp. from moribund moss. Our isolates killed moss shoots of *S. uncinata* in artificial inoculation, and physiological characteristics of isolates showed cold-tolerance. Thus, isolates could grow at 0 C (Temperate Zone isolates of the same fungus did not grow at 0 C.), although the optimum growth temperature of isolates was 20 C. These results suggest that isolates originally developed from Temperate Zone isolates and adapted to growth under bipolar conditions.

Pathogenic fungi have invaded in a moss carpet and formed patches after several years. Host moss shoots were destroyed in the center part of fungal infections. We often found some higher plants and other mosses in those moribund moss patches. Thus, the invasion of phytopathogenic fungi in a moss carpet of *S. uncinata* is thought to lead to the formation of pathogenic patches as “open spaces” where other plants easily colonize. The formation of pathogenic patches might be the first step of changes in the patterns in plant communities in the Arctic.

Occurrence of plants in northern Kuriles, a highly oceanic sector of the subarctic zone I. Notes on distribution of bryophytes

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V. Ya. Cherdantseva and S. Yu. Grishin (Russian Academy of Science)

The bryophytes in understory vegetation have an extremely important role through the control of the moisture change or the erosion of the soil surface and these plants contain the dominant species at the understory in shrub or tundra vegetation in the northern region. Bryophytes growing on such areas are very important plants to grasp the vegetation dynamics in those region.

In Kuriles where we introduce in this presentation, young volcanoes sprinkled over this area. Surface of soil in this area is unstable and oligotrophic condition because of volcanic ash. Although Kuriles is lower latitude than arctic circle, alpine tundra distributes from relatively lower altitude on the mountain slope. Shortage of the amount of insolation in growing season due to high oceanic climate does not only effect to the plant growth condition in this area, but also instability of soil surface. Kuriles occupies a very important position as the halfway point at the vegetation band on which the chain of the volcanic islands continues the Aleutian Islands from Hokkaido, it is also important to clear the vegetation on this region.

We make a report on the distribution of bryophytes and some vascular plants, and site condition in *Pinus pumila* or *Alnus crispa* community and alpine tundra vegetation in Mt. Ebeko in northern part of Paramshir Island (Î ñò. Ï àðàì ø èð, lat. 51° N., long. 157° E.), especially note some differences in species composition between Okhotsk sea and Pacific ocean sides.

Occurrences of plants in northern Kuriles, a highly oceanic sector of the subarctic zone.
II. Distribution of dwarf shrubs and herbaceous plants on Mt. Ebeko, Paramushir Island.

Okitsu, S. (Chiba Univ.), Minami, Y. (Tamagawa Univ.) and Grishin, S. Yu. (Russian Academy of Science)

Since the World War II the northern Kuriles had been closed to the vegetation survey not only by the Japanese botanists but also by the Russian ones. In 1997 we had an opportunity to visit Paramushir Islands, northern Kuriles to observe the general aspect of the vegetation of the island. This paper reports the outline of the vegetation of the islands, focusing on the phytogeographical relationship of the dwarf shrubs and herbaceous plants on Mt. Eboko in the island, to the wind exposed dwarf shrubs in the Mt. Taisetsu, Hokkaido, Japan. Betula ermanii forest is completely absent in the island, Alnus maximowiczii scrub occur on the lower part of the island. The dwarf shrubs prevails throughout the mountain, being the dominant vegetation. The dominants of the dwarf shrubs include Empetrum nigrum, Loiseleuria procumbens and Arcterica nana. The most abundant herbaceous plants is Geum pentapetalum followed by Calamagrostis purpurascens and Oxytropis revoluta. The alpine tundra vegetation appears only scarcely on the mountain. Such species composition of Mt. Ebeko is quite similar to that of the wind exposed dwarf scrubs in the Mt. Taisetsu. Those two dwarf shrubs both belong to the vegetation of a highly oceanic sector of the subarctic zone, never corresponding to the real arctic or alpine tundra vegetation.

A New Aurora Spectrograph for Collaborative Observation with EISCAT Svalvard Radar

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Spectrum of auroral emission is now believed to be well understood. It is well established what atmospheric species produces what kind of emission in response to precipitating particles with a variety of energy spectrum. However, in order to fully understand the nature of optical aurora, we still need to obtain knowledge about how the auroral spectrum changes both in spatially and temporally with respect to the change in energy spectrum of precipitating particles. For instance, it is still remain unknown whether the spectrum of pulsating aurora does change or not corresponding to its on and off. To accomplish this target, ground based concurrent observations of optical spectrum of aurora with high time resolution, and of energy spectrum of precipitating particles are desired. For this purpose, a new aurora spectrograph, which will be deployed in Longyearbyen for collaborative observation of aurora particles with the EISCAT Svalvard Radar (ESR), is now being prepared at NIPR.

The aurora spectrograph is characterized by its high luminosity. The spectrograph consists of a large fish-eye lens (180-degree FOV, f=6mm, F1.4), a slit which passes the light from the sky along meridian direction, a collimating optics, a grism with 600gr/mm, an imaging optics, and a digital camera with a bare, back-illuminated CCD chip of 512 x 512 pixels. The spectrograph covers a wavelength region of 420-740nm with spectral bandwidth of 0.6nm, and with spatial resolution of 0.18 x 0.18 degrees. Sensitivity is expected to approximately 0.1 cts/pixel/Rayleigh/sec, which enables sampling rate of a few seconds per image. An image data produced by the spectrograph is such that abscissa and ordinate correspond to wavelength and space along a meridian, respectively. Installation of the spectrograph is planned on March 2000 after test and sensitivity calibration using an absolute calibration facility in NIPR.

INTERHEMISPHERIC CONJUGACY OF AURORAL POLEWARD EXPANSION OBSERVED BY CONJUGATE IMAGING RIOMETERS AT ~67° AND 75° ~77° INVARIANT LATITUDE

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Interhemispheric conjugacy of auroral poleward expansion was studied with conjugate imaging riometers at ~67° inv. (invariant latitude) (Syowa Station, Antarctica and Tjornes in Iceland) and at 75~77° inv. (Zhongshan Station, Antarctica, Longyearbyen in Svalbard, and Danmarkshavn in eastern Greenland). 92 poleward expansion events at ~67° inv. observed in 1992~1993 were analyzed. The expansion in this latitude was characterized as a continuous poleward motion of a cosmic noise absorption (CNA) band with a bimodal velocity distribution peaked at 1~1.5 km/s and 3~5 km/s at a polar ionospheric altitude of ~90 km. The expansion velocity difference beween the conjugate stations remain within ±30 % for half of the event. There was a time lag between the passing of CNA band over conjugate stations, and it was typically 30~60 s. Product of this time lag and the poleward progressing velocity gives location of the actual conjugate point. For 87 % of the total events, conjugate point of Syowa was located within ±200 km of Tjornes.

On the other hand, poleward expansion observed at 75° ~77° inv. was characterized as stepwise progression of CNA bands to higher latitudes, i.e., a new CNA band was formed at 50~180 km poleward of the preceded CNA band. Appearence of a new CNA band was often associated with equatorward motion of the preceded CNA band. Similar feature was reported in the poleward expansion of optical aurora in this latitude range.

Although the conjugate pair used in this latitudes was displaced longitudinally by ~500 km, conjugacy were generally good. If we admit ±15 min of time lag, 52 % of the CNA event observed at Longyearbyen had a counterpart in Zhongshan, and 40 % in Danmarkshavn. This rather good conjugacy suggests that the characteristic longitudinal extent of poleward expanding CNA band is in the order of 500 km in the polar ionosphere.

Conjugate Imaging Riometer Observations at Polar Cusp/Cap Stations

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The solar wind flow transfers energy, mass and momentum into the earth magnetosphere through their interaction at the magnetopause. Dayside auroral observations at the polar cap boundary like Ny-Ålesund (geomag. lat. 76°) give us significant signatures for the transfer mechanism. However, optical observations are available only for conditions of dark and clear sky.

The imaging riometer for ionospheric studies (IRIS) measures two-dimensionally ionospheric radio wave absorption using cosmic noise of ~ 30 MHz frequency. The ionospheric absorption in the polar region is caused by energetic-electron (auroral electron) precipitation from the magnetosphere or other ionospheric disturbances. The IRIS has an advantage to be able to observe ionospheric disturbances during years without limitations of sunrise and climate. From the coordinated IRIS observations between Ny-Alesund and Greenland stations it has been found that the daytime absorption in the polar cusp / cleft ionosphere shows two-type features ; ionospheric D-region absorption due to precipitation of drifting energetic electrons associated with nighttime substorm occurrence and E-region absorption due to electron heating by intensified ionospheric electric fields associated with the magnetic merging at the dayside magnetopause. The respective absorption features are considered to be due to the magnetospheric instabilities in the closed and open magnetic field lines, respectively. In order to elucidate more clearly absorption generation mechanism we started conjugate IRIS observations from 1997 between the arctic and Antarctic stations.

This paper presents an example of daytime absorption event observed by IRIS's at Ny-Ålesund / Danmarkshavn in the arctic region and Zhongshan, Antarctica, and reveals conjugate absorption features between the inter-hemispherical stations. The selected event was associated with high solar wind dynamic pressure which could bring any changes for the magnetospheric and ionospheric environments in the polar region.

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Haze layers and their characteristics observed over Spitsbergen during the AAMP 1998 campaign

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Abstract: An aircraft observation campaign was carried out over Spitsbergen, Svalbard on 7-12 March 1998 as part of the Arctic Airborne Measurement Program (AAMP) conducted by the NIPR Arctic Environment Research Center. During the AAMP 1998 campaign, ground-based remote-sensing instruments and in-situ airborne particle probes simultaneously observed haze layers over Spitsbergen. Optical particle counters on board a Gulfstream II aircraft measured vertical changes of the aerosol concentration and size distribution. An AWI Raman lidar and a NIPR micro-pulse lidar (MPL) collocated at the German Koldewey Station and the Japanese Rabben Observatory, respectively, in Ny-Alesund (78.9N, 11.9E) observed temporal change of the vertical structure of haze and cloud layers. The MPL continuous measurements suggested the aerosol-cloud interaction was important for formation and dissipation of clouds. The Raman lidar also measured the extinction coefficient and the result was compared with airborne sun photometer measurements from the ARTIST (Arctic Radiation and Turbulence Interaction Study) flights. Based on these measurements, observational results of haze layers and their characteristics will be shown and discussed in the presentation. The ASTAR (Arctic Study on Tropospheric Aerosol and Radiation) 2000 campaign is planned to follow this collaborative experiment in Svalbard.

Aircraft observation of carbonyl sulfide (COS) over mid-high latitude of Northern Hemisphere during AAMP98

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【Introduction】

Carbonyl sulfide (COS) is the predominant sulfur containing gas in the remote troposphere. The lifetime of COS in the troposphere is sufficiently long, roughly 2 to 7 years, that substantial quantities of the sulfur containing gas may be transported in the lower stratosphere where it is the principal source of sulfur, except for SO_2 injected by volcanic eruptions. In the lower stratosphere, COS is dissociated by solar ultra violet radiation, and its products provide a continuous source of sulfuric acid to sustain the stratospheric sulfate aerosol layer. These aerosols influence to the radiation budget and climate of Earth and possibility also the destruction of ozone in the stratosphere. However, it is still remain unclear of its atmospheric budget including sources and sinks processes. During the period March 6-14, 1998, air samples for measurement of COS were collected on Arctic Airborne Measurement Program 98 (AAMP98)

【Sampling and analysis】

Stratospheric and tropospheric air samples were collected over the range of Japan to arctic region during AAMP98. Air samples were pressurized up to 2.5-6 Bar into 1 L stainless steel canisters by using metal bellows pump. Measurement of COS was performed by GC-FPD (Shimadzu GC-8A) with preconcentration and subsequent analysis system. The analysis volumes were 1000-1800 mL. The precision of this method was $\pm$ 5%.

【Results and discussion】

Concentrations of COS in the troposphere were 431-533 pptv. Relatively higher concentrations of COS were observed in the carbon disulfide (CS_2) detected air samples. As origin of CS_2 is mainly from anthropogenic activities, relatively higher concentration of COS might be influenced by the emission of anthropogenic activities.

Although small variability of concentration was observed over these area, it was almost constant distribution latitudinally and vertically. These distributions were indicated that COS is quite stable and relatively long residence time in the troposphere.

On the other hands, concentrations of COS in the stratosphere were noticeable decreased with increasing altitude above tropopause, suggesting degradation of COS by photochemical processes. It was considered that COS might be converted into the stratospheric sulfate aerosols.

BLACK CARBON AND COMMON IONIC SPECIES IN THE ARCTIC ATMOSPHERIC AEROSOL

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Keywords

black carbon, arctic aerosol, Ny Ålesund

Previous studies on Arctic aerosol characteristics have shown a pronounced winter-spring maximum and summer-autumn minimum in aerosol concentration as a result of long-range transport from industrial regions and relatively inefficient atmospheric removal processes. Species following this behaviour include carbon dioxide, black carbon and sulphate. On the other hand biogenic production of DMS gives rise to locally produced sulphate during the summer. Measurements of black carbon concentration in the atmospheric aerosol were obtained by means of an aethalometer (Magee AE-9) at the Zeppelinfjellet station (474 m asl; 78°54'N, 11°53'E), Ny Ålesund, Svalbard. The period of measurement spans the period August 1998 to June 1999, during which two LSF intensive field campaigns were also conducted. Simultaneous 24 hour measurements of the concentration of key aerosol species like sulphate, ammonium and nitrate together with sulfur dioxide, conducted by the Norwegian Institute for Air Research (NILU) are presented and discussed in order to evaluate the transport processes governing their presence in the High Arctic. Large variations are seen to be superimposed on an overall trend that apparently exhibits higher values in winter than in late summer. Back trajectory analysis of airmasses arriving at Zeppelin station, reveals the expected association of the enhanced concentrations observed for black carbon and sulphate with long range transport of polluted air from Eurasia. Black carbon and sulphate concentrations are also highly correlated. However, correlations between sulphur dioxide, nitrate and ammonium were generally found to be poor. These findings demonstrate that there is a common origin for black carbon and sulphate while the ongoing removal processes for these species during long range transport are either inefficient or affect them in a similar manner. This does not seem to be the case for sulphur dioxide, nitrate and ammonium.

Event-induced aerosol sampling at Spitsbergen

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A major pathway of trace metals to the Arctic environment is the atmospheric transport The scavenging of aerosol bound chemical substances by rain and snow has been postulated as the most important process for cleansing the atmosphere. The aim of this study was the investigation of trace metal washout via snow and rain from aerosol particles at Ny Ålesund/Spitsbergen (79°N, 10°E).

In order to obtain information about the washout processes for trace metals from aerosol particles an automatically working aerosol sampler was installed. This device allows an event induced change of filters.

The aerosol sampler was installed in October 1996 in combination with a wet-only sampler controlled by an optical precipitation sensor. This allows to get aerosol samples during dry and wet periods as well as the corresponding precipitation sample. The standard filter magazine contains 30 filters, which may be applied in any required order. It is also possible to use a filter magazine with 15 filter holders which are equipped with a single stage impactor to get information about the size distribution of the aerosol. The multiple use of filters with identical set of sampling parameters ensures that the optimal deposition capacity is reached. Thus, the operating time between changes of the magazine are maximized, while blank concentration problems during analyses are minimized.

The aerosol sampler operates automatically, even during longer sampling periods. No attendence is required at the sampling site between the magazine changes. In the data processing unit all device and event parameters are recorded in a high time resolution to ensure a complete evaluation of the sampling period. The use of a modem allows on-line control of the saved and updated device and event parameters via the host PC at the home institute by means of telecomunication. It is also possible to change sampling parameters as well as start and stop of the aerosol sampler from the home laboratory.

In this contribution we will present first results and experiences from our study of trace metal washout via rain and snow at Ny Ålesund for the sampling period from October 1996 until October 1999.

THE PRODUCTION OF HONO IN ARCTIC AEROSOLS

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Abstract. The production of NOx in or above snow surfaces currently receives high international attention after measurement campaigns in Greenland, at Alert, Ny-Ålesund, and Antartica. The most likely precursor to NO production is Nitrous Acid (HONO). HONO is found in the Arctic boundary layer despite the presence of sunlight with mixing ratios of up to 10 - 20 pmol/mol. Since it is rapidly photolyzed to yield OH, a continuous source of HONO must be present. In this work we investigate the hypothesis that nitrogen species in the background atmosphere exist in a catalytic cycle, which produces HONO.

Measurements of a number of gaseous and particulate atmospheric trace species were performed at the *Ny-Ålesund International Arctic Research and Monitoring facility* (78°54'N, 11°53'E) at Svalbard during the springs of 1997 - 1999. Samples were taken at the Zeppelin research station (474 m above mean sea level) using a combination of annular denuders, 12-stage impactors and filters. The samples were analyzed within 24 hours by ion-chromatography.

While peroxyacetyl nitrate (PAN) accounts for the major fraction of gaseous nitrogen, nitrogen species in the particulate phase contribute up to ~ 25% to the total nitrogen budget. In this work we will present a nitrogen budget in the Arctic atmosphere during spring, and discuss a possible formation mechanism of HONO through the recycling of HNO_3 in the particulate phase.

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The possible influence of local pollution sources on chemical compound measurements at Zeppelin: Using SODAR to identify flow pattern.

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Abstract.

Using a triaxial Doppler Sodar the planetary boundary layer structure and the wind flow dynamics at the *Ny-Ålesund International Arctic Research and Monitoring Facility* (78°54'N, 11°53'E) at Svalbard have been studied. The measurements were carried out between March 15, 1998 and Sept. 15, 1998.

At times when prevailing south-easterly flow arrived at Ny-Ålesund, Zeppelin recorded southerly flow. This difference is probably due to a local orographic effect from glaciers, mountains and the sea surrounding the site, as well as possible katabatic flows from the glaciers. During this flow pattern little contamination on the chemical measurements is expected from the pollution sources in Ny-Ålesund.

Two flow regimes were identified in which Zeppelin receives northerly flow. During these a contamination of the chemical measurements may be possible. In this work we will present the three most common flow schemes and briefly discuss the possible ramifications for measurements on Zeppelin mountain.

Detailed stratigraphy analysis of a NGRIP shallow ice core using laser tomograph system

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In order to determine the detailed stratigraphy of ice core samples, a high resolution, easy and fast method has been developed by laser tomograph method. We applied the method to a shallow ice core obtained by NGRIP, North Greenland Ice-core Project, in 1997 to study the stratigraphical structure.

Measurement by the laser tomograph method was carried out from 54 to 98 m in depth which density ranged in 750-860 kg/m^3. Relation between bulk density of an ice core and mean density measured by laser tomograph technique indicates good correlation for the ice with density > 800 kg/m^3 and the different relation for the firn with density < 800 kg/m^3. The probable reason is due to the scattering of laser light at air bubbles and grain surfaces, respectively. Conspicuous stratigraphic structures which were developed typical depth hoar, wind packed fine grain snow and ice layers, were detected by present laser tomograph method. Ice layers as thin as 0.5 mm thickness could be detected using modified calculation algorithm. The spectral analysis of pore ratio fluctuation with depth shows the peak of 171 mm in water equivalent, which well corresponds to the recent accumulation rate at NGRIP site. This suggests that seasonality of surface layer formation is well preserved as the corresponding pore ratio changes even below pore closed-off depth. Present study shows that laser tomograph method is useful to detect detailed structure of polar ice cores.

Vertical distribution of heavy metals in Vestfonna, Svalbard ice core

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Natural and anthropogenic activities cause significant changes in the global atmospheric environment. These changes can be followed and evaluated by analysis of ice cores.

A 211m-ice core was obtained from the top of Vestfonna ice cap (79°58'N, 21°02'E) in Nordaustlandet, Svalbard, Norway in 1995 with an electro-mechanical drill by the Japanese Arctic Glaciological Expedition.

Approximately 300g of ice sample were used for each measurement. The outer part of ice core was eliminated with a ceramic knife to remove contamination and small cracks. The samples were warmed to 0°C and washed with ultra pure water. They were stepwise melted and the inner 50g portion of liquid sample was pipetted and added 1N nitric acid. Concentrations of Al, Fe, Cu, Pb and Zn were determined by inductively coupled plasma mass spectrometry (ICP-MS) with a desolvated micro-concentric nebuliser (MCN-6000, CETAC), which permits low sample consumption and high pre-concentration effect.

The concentrations of soluble Al and Fe showed strong variations. Al and Fe can be estimated to have the same origin of crust, because Al in the good correlation with Fe and average value of Fe/Al concentration ratio is relatively close to the crustal value, although in the water-soluble concentration. The concentrations of Pb, Cu and Zn increased from 1950 to 1975. It reflects the increasing emission to the atmosphere by anthropogenic activities.

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CONTRASTIVE ANTHROPOGENIC ACIDIFICATION IN ARCTIC AND ANTARCTIC ICE CORES

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280-year records of the acidity (pH), non-sea salt sulfate (nss sulfate) and nitrate concentrations in ice cores from Site-J, Greenland and H15, Antarctica show the contrastive anthropogenic effect in both polar regions. In Greenland, the anthropogenic effect on precipitation chemistry started in ca. 1860, 40 years earlier than the time previously reported, because of the long-range transport of pollutants from northern middle latitudes. Nss sulfate increased remarkably much more than nitrate because of the rapid increase in solid fossil fuel combustion, but by the early 1970s, the nitrate concentration exceeded the nss sulfate concentration due to the intense increase in liquid fossil fuel combustion since the 1950s. But the anthropogenic effect has not appeared in the Antarctic ice core, probably due to removal of pollutants by precipitation and dry deposition during long-range transport and due to much less anthropogenic activity in the Southern Hemisphere.

Preliminary results from 289 m ice core on Austfonna ice cap, Svalbard

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To reconstruct climatic and environmental changes in Svalbard in the past several hundred years, an ice core was drilled on the summit of Austfonna ice cap, Svalbard (79o48'N, 24o00' E, 750 m a.s.l.) to a depth of 289 m in May, 1999 by a Japan-Norway cooperation project.

Ice core stratigraphy measurement, its digital camera recording, bulk density and electrical conductivity of ice (ECM) measurements are conducted in situ. The ice samples were melted in situ and were filled in pre-cleaned 50 cc bottles. The pH and electrical conductivity (EC) of the melt water were measured in situ. These samples were transported to Japan in a cooled condition. A chemical analysis was performed at the laboratory of National Institute of Polar Research. The analysis included major soluble ion Cl^-, NO_3^-, SO_4^{2-}, Na^+, K^+, Mg^{2+}. Ca^{2+}、 stable oxygen isotope $\delta^{18}O$ and radioactivity (tritium) were continuous operated.

Snow pit observations were carried out; two are near the drilling sites and one is 2 km northward. The fresh falling snow and drifting snow were sampled in a timely manner. The frost accumulating around the surface of the tent rope and the surface hoar on the snow were sampled on occasion. The air up to 1 m above the snow surface was filtered using a cassette type collector with 4 filters. The aerosols were caught first by a 0.2 μm filter, and secondly the gas components in the air were caught by three alkaline filters. The observation was performed once. Air temperature (portable thermometer), wind direction and wind speed (portable instrument), air pressure (semiconductor type), weather, cloud amount and type, and visibility were observed twice a day.

The ice core age of 289 m is about 500 years, based on Laki volcanic event.

Asynchronism of glacier fluctuations in the Arctic and in the Alps at the end of 20 century.

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Abstract

In the report, annual snow accumulation and shifts in glaciers termini in Arctic and the Alps are examined. We used maps of snow cover annual spreading and annual glacier front shifts. These maps are the result of formalized statistical computer-assisted smoothing of the data of every glacier terminus. We used automatic interpolation on a PC to draw every isoline map.

We use annual snow accumulation data and information about glacier front shift in Spitsbergen (Arctic) Scandinavia (Subarctic) and the Alps (the 40-th latitudes) during 1986-1995. Our investigation has shown, that annual glacier front shift in these mountain regions are regularly spread and geometrically similar after temporal averaging over four years.

We have compared the maps of annual glacier termini shift in the Alps and Scandinavia in 1986 - 1995yy with the maps of snow cover annual spread for the same year. The annual glaciers front shifts in Scandinavia and the Alps are a function of snow cover changes.

We have found the synchronous increasing of Scandinavian and Spitsbergen glaciers This increasing was in according to snow accumulation increasing and features of atmospheric circulation in these regions. Some years snow accumulation intensity in high and middle latitudes is not in accordance. That is why in these years glacier dynamics in Spitsbergen and Scandinavia is not the same as in Alps.

This phenomena can be explained using atmosphere circulation mechanism. Because of Atlantic warming these years, the Polar atmospheric front moved to the North. That is why solid precipitation increased in Arctic and diminished in the Alps from 1986 to 1995yy. In result, during these years the retreating of glaciers front accelerated in the Alps. In Arctic the retreating of glaciers front diminished 1996-1991 and transformed to advance in 1992 y.. This advance increased from 1992 to 1995yy. In the report, the corresponding graphs and diagrams will be presented.

Climate Changes and its impact on Northern Eurasia Glaciers reduction by the scenarios of the former climates

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More than 50% of Eurasia Arctic islands is covered by ice sheets. Therefore it is important to understand a behavior of glacier systems under the global climate change. Majority of scientific community consider that the tendency of climate development towards warming will keep in the forthcoming decades.

One of ways to predict climate change in the future is a reconstruction of former climates. Such approach is called a method of paleoanalogues.

In given paper the climatic reconstruction for Holocene optimum (scenario I) and Eemian interglacial (scenario II) were used as a paleoanalogues of the possible future climate warming.

According to these scenarios, the greatest changes of air temperature will be in the Arctic area. For example, under global warming appropriate to the scenario I the mean summer temperature in the Novaya Zemlya archipelago will rise at 4°C; according to the scenario II - at 8°C. At the same time within the 20 - 40°N belt climate practically will not be warmer, and in some mountain areas even cooling is possible.

By both scenarios archipelagoes of Franz Joseph Land, Novaya Zemlya and Severnaya Zemlya will undergo the greatest warming. Annual precipitation will also reach maximum increase in this region (+100 mm under the scenario I and +200 mm under the scenario II in comparison with modern values).

Several original methods based on "actualistic principle" have been used for the estimation of basic glaciological characteristics (such as equilibrium line altitude (ELA) and a glacier area).

According to them, glaciarization on Eurasian Arctic islands will considerably reduce. The rise of ELA for different islands will amount, from 150 up to 450 m according to the scenario I, and from 300 up to more than 600 m by the scenario II. The maximal uplift of ELA will be featured in Novaya Zemlya and Severnaya Zemlya glacier's systems.

If the climate develops by the scenario II, the ice sheets of Novaya Zemlya will disappear. The prospective increase of atmospheric precipitation in this region will not be able to compensate the melting rise. There is only a possibility of the mountain glaciation to be preserved in the highest (southern) part of Northern island.

Under the same climate development the reduction of the Svalbard and Severnaya Zemlya glacier areas are expected to reduce at more than 80%, Novaya Zemlya glaciation - at 73 %, Franz Joseph Land and Ushakov island glaciations - at 60%.

If the warming corresponds to the scenario I, Svalbard and Severnaya Zemlya will lose more than 60 % of their glacier extent, Novaya Zemlya, Franz Joseph Land and Ushakov island - 50%. Due to the continentality of the polar climate in Severnaya Zemlya, its glaciers will retreat less than those on other Arctic archipelagoes, located in more maritime climate conditions.

Status Report on the GPS Positioning at Ny-Ålesund, Svalbard in 1994

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Abstract

GPS positioning was carried out at Ny-Ålesund, Svalbard, Norway in February 15-21, 1994. Thirteen tracking sessions with measuring times less than twelve hours was analyzed by using a Trimble 4000-SST receiver. Sampling interval was 30 s and the elevation mask was limited less than 10° for each session. WGS84-coordinate for the bench-mark on a main building of the Norsk Polarinstitutt (NPF) was obtained. The best PDOP values had a range of 1.9-2.9 for all the observation times. The averaged coordinate for 3D positioning with the best PDOP values for all the sessions was determined as 78°55'24.2520"N, 11°55'54.1770"E, 39.21 [m]. Time variations in receiving conditions such as those of DOP values and 2D/3D positions through the all measuring times are presented by the poster. Since Svalbard Islands locate on a western portion of the Barents Sea, the accurate and relative GPS measurements will give an information concerning geodynamics such as a plate motion of the Svalbard Islands. By combining the other GPS data of some continental stations around Europe and/or Greenland, a tectonic evolution of the Barents Sea and the Arctic Ocean will be clarified. At Ny-Ålesund, furthermore, additional geodetic ties should be conducted between the another space coordinates such as the VLBI, DORIS and PRARE ground stations. Note that the DORIS Beacon system had also begun tracking at present in 1994 besides the GPS bench-mark on NPF.

The determination of the "invariant point" of the VLBI antenna in Ny Alesund.

(NMA 99/1-12)

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Abstract

We present a report of a campaign of measurements carried on between August 25th and September 8th, 1999, in Ny Alesund, to determine the "invariant point" of the VLBI antenna at that site. The importance of a good measure of this point and the observing strategy will be discussed.

We have planned the use of a special retroreflector with wide acceptance angle for this measure. But the original strategy couldn't be followed for the lack of proper retroreflector. Instead, a number of Leica retro-targets were attached (glued) all over the structure of the antenna, and their positions determined (horizontal and vertical angles, along with distance whenever it was possible) with respect to a local reference network.
The positions of two points at opposite edges of the elevation axis have also been pinpointed and measured (only horizontal and vertical angles, in this case).
The local reference network has been measured using direct and inverse intersection depending on different position and mutual visibility of pillars. Occasionally some pillars have been measured using both methodologies.

The positions of several markers on the antenna have been measured for 8 antenna azimuth angles, uniformly spread along 360 degrees, in steps of 45 degrees, at zenith position. In order to measure the offset between azimuth and elevation axes, we did similar measurements of a selected number of markers at different antenna elevation angles, in a range from 90 to 45 degrees, in steps of 15 degrees, and a fixed azimuth angle.

The analysis of these measures will provide both co-ordinates for the position of the "invariant point", and an estimate of the offset between the elevation and azimuth axis in the antenna of Ny Alesund.
We are presenting here preliminary results.

In the last section we list some suggestions for modifications of the local reference network around the VLBI antenna in order to simplify similar future campaigns of measurements.

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Climatic and biological forcing of the vertical flux of biogenic particles under first-year ice in the Canadian Arctic in spring

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Under the ice of Barrow Strait, large interannual differences in the timing, magnitude and nature of the vertical flux of biogenic particles in spring and early summer (May-July) were linked to meteorological events and the composition of the zooplankton assemblage. In 1992, ice algae were released from the ice matrix over a protracted period (ca. 60 d) and were largely intercepted (55-74%) by the exceptionally abundant calanoid Pseudocalanus acuspes.

The persistent snow cover delayed the phytoplankton bloom until after the ice break-up in early July.

In 1994 and 1995, the ice algae were abruptly released following rain (1994) and a heat wave (1995), and sank rapidly to depth with little grazing (<17% of the potential flux intercepted).

The early removal of the snow cover triggered intense under-ice phytoplankton blooms and strong downward fluxes of chloropigments and particulate organic carbon, of which only a small part was intercepted by grazers (<10%).

The analysis of local climate over the years 1950 to 1995 suggests that abrupt releases of ice algae followed by under-ice blooms and intense vertical fluxes before the ice break-up may become the norm under the conditions predicted by global climate change models.

Observations of CO_2 Partial Pressure, Total Inorganic Carbon and Nutrients in the Greenland Sea in Winter Season

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Observations of CO_2 partial pressure (pCO_2), dissolved inorganic carbon (ΣCO_2) and its carbon isotope ratio ($\delta^{13}C$) and concentrations of nutrients (phosphate and silicate) were made in the Greenland Sea in January and February 1999. Air samples that equilibrated with surface seawater and seawater samples were brought back to our laboratory for analysis of pCO_2, ΣCO_2 and $\delta^{13}C$ by gas chromatography, manometric method and mass spectrometry, respectively. Concentrations of nutrients were measured on board ships by absorption spectrophotometry.

We found that spatial variations of pCO_2 in January and February 1999 correlated with sea surface temperature (SST); higher values of pCO_2 appeared at high temperature regions and vice versa. A relation between pCO_2 and SST was 2.0 % $°C^{-1}$ which was smaller than the theoretical value of 4.2 % $°C^{-1}$. The highest, lowest and mean values of pCO_2 were about 381, 263 and 325 μatm, respectively. The mean value was almost 40 μatm lower than that observed in the atmosphere. Our previous experiments revealed that pCO_2 in the Greenland Sea in spring and summer was also lower than the atmospheric pCO_2. Therefore the Greenland Sea acts as CO_2 sink throughout the year.

Vertical distribution of $n\Sigma CO_2$ (normalized by salinity) and $\delta^{13}C$ in January and February 1999 were almost constant of 2.1 mmol kg^{-1} and 0.98 ‰ from the surface to the bottom of the sea. These values were almost the same as those observed in August 1993, June 1995, August 1996, below 200m depth in the Greenland Sea. In a surface layer (0-200m depth), $n\Sigma CO_2$ and $\delta^{13}C$ in summer were lower and higher than those in winter respectively, which were mainly attributed to biological activities such as photosynthesis and respiration.

Concentrations of phosphate and silicate in January and February 1999 were lower at the surface with respective values of 0.5-0.8 and 3-6 μmol kg^{-1} and those values increased with depth to attain values of 0.9-1.0 and 7-9 μmol kg^{-1} at 1000m depth. These distributions below 300m corresponded with those obtained by the TTO/NAS in August 1981.

Oxygen isotope hydrography in Northeastern Greenland Sea in January 1999

Michiyo Yamamoto, Shizuo Tsunogai and Nori Tanaka

During a cruise carried out in Northeastern Greenland Sea and Western Barents Sea in January 1999, we collected water samples vertically at 15 stations and one sea-ice core sample at a selected station for the determination of oxygen isotope composition ($\delta^{18}O$) as well as other hydrographic properties.

Based on T-S diagram, Northeastern Greenland Sea in January 1999 could be grouped into three water types, namely type 1: Atlantic water ($S>34.8$ throughout water column), type 2: warm water with high variability in salinity ($T>6.0$, $34.4<S<35.0$) which is found at a station close to the Norwegian coast, and type 3: cold and less saline surface water ($1.0<T<1.7$, $33.9<S<34.5$) mixing with more saline deeper water.

For the waters classified into the type 3, $\delta^{18}O$-S relationship can further separate into various water types. One extreme was found at stations near the Spitsbergen Island, where the $\delta^{18}O$ values were almost constant, while the salinities decrease from 34.8 in the bottom water to 34.1 in the surface water. This is the typical $\delta^{18}O$-S diagram feature for sea ice melt mixing. The other extreme was found at a northwestern station where the water at 50m depth has a low $\delta^{18}O$ value of –0.3‰(vsSMOW). This is probably due to the water from Arctic Ocean formed through mixing with arctic river water and sea ice formation.

In this study, oxygen isotope information can be used for examining detailed hydrographic feature in Northeastern Greenland Sea. However, in order to come to more quantitative discussion, more observation in space and time is desirable.

Seasonal difference in stable isotope compositions of arctic copepods

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Stable carbon and nitrogen isotope measurements were made to know an isotopic difference in arctic copepods collected in the Barents Sea (May 1998 and July 1999) and in the Greenland Sea (January 1999). Isotopic measurements were also made of POM from both regions. While the surface chlorophyll concentrations in the Barents Sea in spring were higher than 4mg m^{-3}, the integrated chlorophyll standing stocks in the Greenland Sea in winter were nearly zero. Copepods in winter could not feed on living phytoplankton. Results on the isotopic compositon showed a marked difference between the winter copepods from the Greenland Sea ($\delta^{13}C$= -22.2 to -20.6, $\delta^{13}N$ = 8.2 to 12.2) and the spring copepods from the Barents Sea ($\delta^{13}C$ = -22.0 to -19.4, $\delta^{13}N$ = 6.8 to 9.1). This seasonal difference may reflect their diets which could be non-living detritus ($\delta^{13}C$= -26.8 to -24.9, $\delta^{13}N$ = 6.1 to 7.5) in winter and living phytoplankton ($\delta^{13}C$= -22.7 to -21.4, $\delta^{13}N$ = 1.7 to 5.7) in spring.

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The most important plankton grazers in Kongsfjorden, Ny-Ålesund.
Spatial distribution patterns of three *Calanus* species in an Arctic glacial fjord.

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Abstract

Calanoid copepods are the dominant marine herbivores in Arctic marine ecosystems. They play a key role in pelagic marine food webs and therefore influence the energy flow and functioning of productive ecosystems, such as fjords on the western coast of Svalbard. Three *Calanus* species dominate in arctic and sub-arctic oceans, including the two arctic species *Calanus glacialis* and *C. hyperboreus*, and the boreal species *C. finmarchicus*. In Kongsfjorden on Svalbard these species are also present, but in variable abundance. *Calanus glacialis* and *C. finmarchicus* dominated numerically in summers of 1996 and 1997, although the arctic *C. glacialis* was less abundant than the boreal *C. finmarchicus* in 1997. Both years, *C. hyperboreus* was less abundant than the others. The spatial distribution of these species included distinct, life stage-dependent aggregations, which were located in different water masses of the fjord. These aggregations may be a result of individual activities such as surface feeding in younger stages and overwintering of older stages in deep water. Based on the spatial distribution patterns observed, we conclude that *Calanus glacialis* is a resident of Kongsfjorden with a two-year life cycle. *Calanus finmarchicus* consists of two populations; a local population in the inner fjord basin and an advected shelf population in the outer part of the fjord. This species overwinters in the fjord to complete its one-year life cycle. *Calanus hyperboreus* seems to be an expatriate in the fjord system, since it most likely does not spawn in Kongsfjorden within its three to four-year life-cycle in the Arctic.

Reproductive strategies of the bearded seal, *Erignathus barbatus*.

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Little is known about the mating strategies of pinnipeds that copulate in the water. Earlier studies on the aquatic-mating harbour seal suggest that this seal species displays a wide range of reproductive behaviour between geographical areas, but that "singing" seem to be a common component of male reproductive behaviour. The ice-breeding bearded seal also uses acoustic signals during the mating season, the elaborate songs of males of this species can be heard over 10s of kilometres. Studies of the mating system of this Arctic pinniped offers the potential for many interesting comparisons with somewhat better known, temperate seal species. This study took place in Kongsfjorden, Svalbard, during April, May and June 1999. Males produced five vocalisation types and were heard singing from the start of April until August (these results are part of an ongoing study). Numerically speaking, the frequency of male vocalisations increased from the start of April through until the middle of May, and then subsequently began to decrease toward the end of June. Female bearded seals spent more time at sea during the night than during the day, and concomitantly, male vocalisations exhibited a diurnal pattern, with an increase in vocalisations during the night. Localisation techniques suggest that male bearded seals hold small display areas for up to several weeks during the mating season. Vocalising males moved, such that they remained close to ice edges, as land-fast ice areas became smaller through the spring melt and break-up period. Female bearded seals are widely dispersed and are mobile throughout the mating season. Vocalising males were quite uniformly distributed throughout the whole of Kongsfjorden. We suggest that this distribution reflects the widely dispersed nature of oestrus females. These results suggest that the Arctic-living bearded seal exhibit adaptations in the temporal and spatial patterns of their reproductive strategies that are significantly different from those of temperate mating species.

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Soil respiration in relation to primary succession in Ny-Ålesund Svalbard

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It is generally anticipated that global warming will stimulate soil microbial activity and decomposition rate of soil organic matter. In particular, as arctic ecosystems have large carbon pools in permafrost (Melillo et al. 1990), the increase in the decomposition rates may result in a large release of CO_2 to the atmosphere as soil respiration. The increase in soil respiration could affect the regional and possibly global carbon cycle and climate (Oechel and Vourlitis 1994). Thus, understanding of controls of soil respiration rate is important to estimate the effects of warming on decomposition rate and further, carbon cycle in arctic ecosystems. The objectives of this study were to (1) determine the environmental factors controlling soil respiration rate, and (2) estimate the amount of CO_2 emitted as soil respiration from the ecosystems developed on a glacier foreland in Ny-Ålesund. This study is part of a larger study examining the process and function of carbon cycling in arctic primary succession.

Materials & Methods

Three study sites (Site-1, site-2 and Site-3) were set up along with the primary succession at deglaciated area of East Brøgger glacier in Ny-Ålesund, Svalbard, Norway (79° N, 12° E). Soil respiration (SR), air temperatire (AT) and soil temperature (ST) were measured in the three study sites with an open flow system using IRGA during 2 months from July to August 1995. Soil samples were collected at the three sites (n = 10), and soil total carbon and nitrogen contents were measured using a CHN/O elemental analyzer (Perkin Elmer 2400II, Connecticut, USA).

Results and discussion

Soil carbon and nitrogen contents increased with progress of primary succession; 1.6% and 0.02% in Site-1, 2% and 0.05% in Site-2, 7% and 0.4% in Site-3. Soil respiration rate varied among the three sites reflecting successional ages; 5 – 10 mg CO_2 m^{-2} hr^{-1} in Site-1, about 30 mg CO_2 m^{-2} hr^{-1} in Site-2 and 40 – 50 mg CO_2 m^{-2} hr^{-1} in Site-3. Soil respiration rate showed good correlation with AT in Site-1 and Site-2, and with ST in Site-3. Cumulative amount of CO2 emission calculated using these correlation equations was 4.5 gCO_2 m^{-2} in Site-1, 43 gCO_2 m^{-2} in Site-2 and 58 gCO_2 m^{-2} in Site-3 during two months from July to August 1995. These values were extremely low comparing with other warmer ecosystems such as Alaskan tundra (about 600 gCO_2 m^{-2}, Oberbauer et al. 1992), temperate mixed forest (640 gCO_2 m^{-2}, Bowden et al. 1993), tropical moist forest (1360 gCO_2 m^{-2}, Kursar 1989).

Ecosystem Carbon Cycle on a Glacier Foreland in Ny-Ålesund, Svalbard

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Current global warming predictions indicate that warming will be more pronounced at high latitudes in the Northern Hemisphere (IPCC 1996). It is considered that the matter flow rates in the high arctic ecosystem are strongly temperature-limited and therefore especially sensitive to the warming. However, quantitative data on the matter flow in the high arctic terrestrial ecosystem are limited. This study aims to determine the size of carbon pools and the flow rates of carbon in the ecosystems developed on a glacier foreland in Ny-Ålesund.

The study sites were set on an old moraine in the deglaciated area of the East Brøgger Glacier. The sites were characterized by a patterned ground composed of small polygons. A mixed community of bryophytes and vascular plants (mainly *Salix polaris*) covered the marginal part of the polygons, whereas the central part consisted of almost bare ground and/or black crusts of cyanobacteria and lichens.

Total soil respiration rate at each site was measured using a portable infrared gas analyzer (LI-COR, LI-6200) with a soil respiration chamber (LI-COR, LI-6000-09). The root respiration rate was measured using an open-flow gas exchange system with an infrared gas analyzer (LI-COR, LI-6252). The soil microbial biomass was estimated by the substrate-induced respiration procedure (Anderson & Domsch 1978) using the open-flow gas exchange system. Net photosynthesis and dark respiration rates of mosses were determined with a portable infrared gas analyzer (LI-COR, LI-6400).

Total soil respiration during the snow-free months (July and August) was estimated to be 16 - 25 CO_2-C m^{-2}, about 23 - 29% of which was attributed to the root respiration. In spite of the low productivity, the size of the soil carbon pool was comparable to those of boreal forest ecosystems. Microbial biomass C in the mineral soil layer was estimated to be 4 - 5.6 gC m^{-2}, which represented about 0.1% of soil organic C. The amount of C evolved through microbial respiration was much smaller than those in ecosystems under warmer climates. However, respiratory activity per microbial biomass was relatively high as compared with the value reported for a boreal forest ecosystem.

Primary production of mosses in Ny-Ålesund, Svalbard

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It has been predicted that global warming would have a significant impact on the arctic terrestrial ecosystem. Mosses represent a significant proportion of the biomass production in the arctic terrestrial ecosystem. Therefore, if production of mosses changes with global warming, it would have a profound influence on the carbon cycle in the arctic terrestrial ecosystem. However, little is known about the factors affecting the productivity of mosses in the high arctic. As part of the study of carbon cycle on a deglaciated area in Ny-Ålesund, Svalbard, we measured the photosynthetic rate of the dominant moss species in the field and examined the factors affecting the productivity of mosses.

The study site was set on an old moraine in the deglaciated area of the East Brøgger Glacier. A mixed community of bryophytes and vascular plants (mainly *Salix polaris*) covered the marginal part of the poligons, whereas the central part consisted of almost bare and/or black crusts of cyanobacteria and lichens. The dominant moss species, *Sanionia uncinata, Aulacomnium turgidum* and *Dicranum* spp. was used for the measurements. Photosynthetic photon flux density (PPFD), precipitation, temperature and water content of mosses were measured in the growing season (16 July - 14 August 1999). The net photosynthesis and dark respiration rates of the samples were determined using a portable infrafred gas analyzer (LI-COR, LI-6400) with an assimilation chamber (LI-COR, LI-6400-05).

Although the optimal temperature for net photosynthesis of the mosses was about 10-20℃, significant photosynthetic activity was detected even at 3℃. The dark respiration was strongly affected by temperature with the Q_{10} of 2.1. The light saturation point was above 900 μmol m^{-2} s^{-1} PPFD. The optimum water content for net photosynthesis was about 300-500%. The net photosynthesis was below the detectable limit at water contents lower than 30%. The positive net photosynthetic rates were observed within 0.5-2 hours after rehydration. However, the rate continued to increase for more than three days. In the field, water content of the mosses was extremely low (<30%) except in rainy days. It is suggested that moss production in this study site is limited primary by water availability and that net photosynthetic rates in rainy days are largely determined by radiation and/or the extent of recovery from desiccasion.

Structure and functional role of moss colony, *Sanionia uncinata* in different water environments

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Introduction

Pale claw moss (*Sanionia uncinata*) has wide range of habitats from swampy ground to exposed drier ground in polar tundra. The colony structure tends to change according to habitat, especially water environment. However, functional significance of structural changes has not been clarified quantitatively.

The aims of this study are to quantify (1) the change of colony structure according to water environments, and (2) the water holding and heat retaining capacities in each colony, which have close relations with photosynthetic activity.

Materials & Methods

Three study sites(dry site, moist site and wet site) were set up in the deglaciated area of East Brøgger glacier, Svalbard, Norway (79° N, 12° E).

•Colony structure: Colony of *S.uncinata* was collected with cylindrical core(ϕ=4.5cm) and a scissors from the three sites. Thickness of the colony, the colony weight and the shoot density were measured.

•Water holding capacity: The cylindrical colony samples collected from the three sites were set in plastic cup(ϕ=4.5cm, h=2.0cm), and supplied water to saturated water content. Then, the samples were exposed to ambient air in field. Change in water content of colony with time was compared among samples in the three sites.

•Heat retaining capacity: Air and colony temperature was measured in the three sites (dry site, moist site and wet site). Regression line between air temperature and colony temperature was calculated and the cline of the line was compared.

Results & Discussion

Thickness of colony growing at dry site was significantly thinner, the colony weight and the shoot density was higher than those at other sites. The structure of colony growing at dry site was more compact than other sites. Water holding capacity and heat retaining capacity of the colony at dry site were higher comparing with other sites. There is positive correlation between the capacities and colony weight. These features of colony structure in dry site would be important to keep photosynthetic activity in dry habitat.

Photosynthetic and water relational characteristics in two co-occurring *Polygonum* species at a scoria desert in an alpine timber line of Mt. Fuji

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In upper timberline of Mt. Fuji, basaltic scoria desert spreads in a great extent, and only a few species can establish such a volcanic scoria desert. *Polygonum cuspidatum* (Pc) and *Polygonum weyrichii* (Pw) are well known as pioneer species around alpine timberlines of Mt. Fuji. Pw has deeper and thicker tap root system and thicker stem. The growing season of Pw is one month shorter than that of Pc.

The diurnal changes of net photosynthetic rates (P_n) and leaf conductances to water vapor (g_{leaf}) and leaf water potentials (*XPP*) of these species were measured during the daytime on a mid summer day (Jul. 25), a late summer day (Sep. 5) and an autumn day (Sep. 28). The relationships between inter-cellular CO_2 concentration (*Ci*) and P_n were also measured. Water relational parameters were obtained from the Pressure-Volume analysis (the PV curve).

In the mid summer day, P_n was higher in Pw than that in Pc in light saturated condition. g_{leaf} was higher in Pw than that in Pc throughout the day. The major reason for higher P_n in Pw was higher g_{leaf}.

In the late summer day, there were little differences of P_n between Pc and Pw, where as g_{leaf} in Pw was higher than that in Pc. The P_n in CO_2 saturation was not differed between species, however, the slope of P_n to *Ci* tended to be larger in Pc than that in Pw. The reason why P_n was the similar even in different g_{leaf} condition might be the difference of slope of P_n to *Ci* between the species.

In the autumn day, upper-ground parts of Pw were already dead. maximum P_n in Pc in daytime exceeded a half of maximum P_n in the late summer day.

As the g_{leaf} was higher in Pw than that in Pc, leaf transpiration rate was higher in Pw than that in Pc. Little differences were observed in daily pattern of *XPP* between the species throughout the season. Higher water loss from leaves in Pw caused by higher g_{leaf} might be supported by higher soil-to-leaf hydraulic conductance. The minimum values of *XPP* in daytime were nearly turgor loss point in both the two species. As the leaf water relational parameters obtained from PV curves were not differed between species, the ability of leaf drought tolerance was not differed between species.

These facts indicate that Pw, having shorter growing season, maintains high P_n by opening stomata that was supported by high soil-to-leaf hydraulic conductance guaranteed by morphological characteristics such as deeper and thicker tap root system and thicker stems. In contrast, Pc maintain high P_n by having higher ability of photosynthesis in lower *Ci*.

Biological characteristics of dark colored material in Canadian High Arctic glaciers

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Impurities in snow and ice, such as air-bone particles, have been shown to affect the solar heat-intake to glacier, sea ice and seasonal snow cover. Dark colored material on snow and ice can reduce surface albedo (reflection rate) and thus could accelerate melting. Therefore, albedo-reducing material in snow and ice can largely affect cryosphere variation in the world. Recent studies revealed that dark colored material on some glaciers contains much amount of algae and bacteria. This suggests that these microbes play important roles in the formation process of the albedo-reducing material on the glaciers. Since living algae and some microbes have been reported in glaciers in various parts of the world, formation of dark colored material by biological activities may be general phenomenon in glaciers of the world. However, biological characteristics of dark colored material on glaciers are still unknown. Only a few studies have been carried out in some Himalayan glaciers. This study aimed to clarify biological characteristics of dark colored material in Canadian High Arctic glaciers. Distribution, amount, composition, and micro-structure of dark colored material were investigated on glaciers in Devon Ice Cap and Penny Ice Cap.

The mean amount of dark colored material on the surface of the ablation area of the glaciers was 25 g m^{-2} (0.2 - 260 g m^{-2}, dry weight). The amount was much smaller relative to on Himalayan glaciers (mean 300 g m^{-2}). This suggests that the albedo reduction by the material on the glacier surface is smaller in the Arctic glaciers, relative to in Himalayan glaciers. Though the amount of the material on the glacier surface was small, much amount of the material was deposited at bottom of cryoconite holes. The material mainly consisted of small dark colored granules. Size of these granules was approximately 1 mm in diameter (0.1 mm - 1.0 mm, mean value = 0.3 mm). Microscopy of the granules revealed that the granule was aggregation of green algae, blue-green algae, bacteria, mineral particles and organic matter. Results suggested that the dark colored material on the Arctic glaciers is formed by biological activities.

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UV-B-Personal-related dosimetry at Koldewey-Station by using an electronic Dosimeter ELUV-14

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Abstract:

UV-B dosis at personal related level were carried out at Koldewey-Station, Ny-Alesund, from 15.05.99 to 15.08.99 by using an electronic dosimeter (ELUV-14). Individuals carried the dosimeter as badge and at the same time the global UV-B dosises were measured by an equal system and by a spectral radiometer.
The objectives of this project were:

1. Determination of the individual UV-B dosis
2. Determination of the global UV-B dosis
3. Estimation of the UV-B risks at Koldewey-Station by comparing the measured dosis with the maximum dosis which reached the earth surface by sun elevation of 90°.

We have also carried out dosis measurements at Koldewey-Station between 15.6.98 - 13.7.98.
The results show that the maximum measured UV-B daily erythemal weighted global dose was 2200 J/m2 and the personal related one was about 500 J/m2 (about 23% of the global dosis).
Measurements and results of the two years will be presented and discussed.

New persistent organic pollutants of concern

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Most research and monitoring work on persistent organic pollutants (POPs) has mainly been focused on industrial compounds and by-products (e.g. PCBs and dioxins) as well as pesticides (e.g. Lindane, DDT-group and cyclodiene analogues). However, during the last few years there has been an increased interest for ew" xenobiotics, metabolites and the presence of until now not described contaminants.

Several aspects related to the more well known contaminants should be emphasised. The increased number of toxaphene reference compounds has strengthened the ability for acceptable quantification of the most abundant congeners in Arctic samples. Among the interesting findings are the extremely high levels of congeners (after Parlar) 26 and 50 in seal samples east of Svalbard. The presence of metabolites formed by the action of CYP and phase-II enzymes are recognised, but so far not implemented in today environmental monitoring. Reports have shown that the most abundant hydroxy-PCBs in human blood samples equals the presence of PCB-congeners 138, 153 and 180. In addition, many xenobiotics are chiral (exist in mirror images) and hence exist in enantiomeric pairs. These includes α-HCH, *cis*/*trans*-chlordane, oxychlordane, *o,p'*-DDT/DDD as well as toxaphene 26 and 50. This fact has in most cases been overlooked.

The ew" environmental toxins include a number of compounds and compound classes. Current used and more polar pesticides belong to this group. Fragrances and soaps include nitro- and aromatic musk and their metabolites, and alkylphenols. Among the industrial chemicals and by-products, nitroaromatics, phthalates, polychlorinated naphthalenes (PCN), polybrominated biphenyls and diphenyl ethers (PBB/PBDE) as well as polychlorinated paraffins (PCA) are found. Especially the two latter groups have recently got much attention. In contrast to most other xenobiotics, the number of PCA-congeners is extremely high and this fact has turned out to be an analytical challenge. On the other hand, among the brominated flame retardants, only a limited number of the congeners tend to accumulate in high concentration. In sea mammals and human blood samples from the Arctic, the levels of brominated flame retardants (mainly PBDE 47 and 99) are found to equal the presence of PCB.

Among the many thousands of man-made bulk-chemical in use today, only a limited number have been tested or evaluated for their hazard potential. In understanding the possible consequences for human health and the Arctic environment extensive evaluation is needed. The fact that the consequences often are observed decades after emission to the environment, should always be kept in mind. Evaluation criteria have to include long-range transport ability, persistence, bioaccumulation potential and hazard for human health and the environment.

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Jon Borre Orbek, Norwegian Polar Institute:

Opportunities for European Research Collaboration under the Ny-Alesund Large Scale Facility Program 2000 - 2002

Norwegian Polar Institute has successfully received a new contract under the Human Potential Programme of the 5th Framework Programme of the European Union for research exchange in Ny-Alesund. The contract is a continuation of the Ny-Alesund Large Scale Facility programme which has run since 1996, supporting field campaigns for over 120 individual researchers and 70 - 80 research projects. The main aim of the programme is to increase the European collaboration and use of the advanced research facilities in Ny-Alesund through financing from the European Commission. The program gives the partner institutions new possibilities for international collaboration and complementary activities at their research stations, and the guest researchers receive, if their projects are accepted by the evaluation panel, reimbursement of their travel and subsistence costs. The Ny-Alesund LSF is run as a consortium between NP, NILU, NMA, AWI, NERC and Kings Bay in Ny-Alesund, and will offer access to another 70 - 80 research scientists in about 40 - 50 new research projects during the next 3 years.
New interested scientists should visit the LSF web site at http://www.npolar.no/nyaa-lsf for more info about calls for proposals, how to apply etc..

European Network for Arctic-Alpine Multidisciplinary Environmental Research

The European Network for Arctic-Alpine Multidisciplinary Environmental Research - ENVINET is a new thematic network which will be funded under the Human Potential Programme of the 5th Framework Programme of the European Union for the period 2000 - 2002. ENVINET is a network between 15-20 large European research infrastructures from the Arctic to the Alps. The main aim of the network is to establish a forum for increased co-operation and networking between operators and users of research infrastructures in the field of environmental sciences, with special emphasis on multidisciplinary sciences involving marine and terrestrial biology, atmospheric chemistry and physics. The network will also seek to enhance the use of the research infrastructures and to improve the access and services provided for the scientific user community.
Researchers and operators from research stations in 12 countries will participate, with the Ny-Alesund LSF as the central node in the network.
Existing environmental networks and international arctic organisations will also be represented.

Second International Symposium on Environmental Research in the Arctic
and
Fifth Ny-Ålesund Scientific Seminar

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