MEASUREMENTS OF CARBON DIOXIDE PARTIAL PRESSURE IN THE AIR AND SURFACE SEA WATER ON BOARD THE ICEBREAKER "SHIRASE" (ABSTRACT)

Gen HASHIDA[1], Takakiyo NAKAZAWA[1], Shohei MURAYAMA[1], Masayuki TANAKA[1], Shuhji AOKI[2], Takashi YAMANOUCHI[2] and Sadao KAWAGUCHI[2]

[1] *Upper Atmosphere and Space Research Laboratory, Faculty of Science, Tohoku University, Aramaki Aoba, Aoba-ku, Sendai 980*
[2] *National Institute of Polar Research, 9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173*

Continuous measurements of the CO_2 partial pressure in the air and surface sea water were made on board the icebreaker "SHIRASE" between Japan and Antarctica for the periods from November 1987 to April 1988 and from November 1988 to May 1989. The atmospheric CO_2 concentration was high in the mid-northern hemisphere, decreased rapidly southward to a minimum in the mid-southern hemisphere, and increased slightly in the Antarctic region. Irregular variations of the CO_2 concentration were clearly observable, especially in the mid-northern hemisphere, mainly due to alternation and mixing of the continental and maritime air. The CO_2 partial pressure in surface seawater (pCO_2) showed high values in the equatorial region, decreased poleward, and increased again in the Antarctic region. By comparing pCO_2 with the salinity and surface sea temperature measured concurrently, it was found that pCO_2 variations were closely related to upwelling of the deep seawater which is rich in CO_2. The difference of the CO_2 partial pressure between the air and surface seawater (ΔpCO_2) showed negative values in mid-latitudes of both hemispheres and positive values in the equatorial region. This fact implies that the mid-latitude and equatorial oceans act as a sink and source for atmospheric CO_2, respectively. The Antarctic Ocean was generaly a source, but ΔpCO_2 was highly variable there, due to local ocean conditions.

(Received November 6, 1989; Revised manuscript received April 11, 1990)

RADIATION BUDGET OBSERVATION AT ASUKA CAMP, ANTARCTICA, IN 1988 —CLOUD RADIATIVE FORCING—(ABSTRACT)

Teruo AOKI[1] and Takashi YAMANOUCHI[2]

[1] *Meteorological Research Institute, 1–1, Nagamine, Tsukuba 305*
[2] *National Institute of Polar Research, 9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173*

Upward and downward radiation on the snow surface wereobserved at Asuka Camp (72°31′S, 24°08′E, 930 m a.s.l.), Antarctica, from January to December 1988. We have studied the effect of clouds on the surface radiation budget and have found that the long wave (LW) greenhouse effect of clouds exceeded the short wave (SW) albedo effect of clouds, so that net (SW+LW) cloud-radiative forcing on the snow surface was heating. The heating mechanism is explained

as follows:

(1) Short wave: The downward short wave radiation on a cloudy day is only slightly less than that on a clear day due to the multi-reflection effect between cloud and snow surface. On the other hand, there is no significant difference of snow albedo between clear and cloudy days. Therefore, the net radiation on a cloudy day does not largely decrease from that on a clear day. That is, SW cloud-radiative forcing is only weak cooling.

(2) Long wave: The downward long wave radiation on a cloudy day increases from that on a clear day, because of additional emission from the cloud. In addition, since the air temperature is very low and the water vapor contained in the atmosphere is very little on a clear day, the equivalent black body temperature of the downward radiation is very low so that the difference of downward radiation between clear and cloudy days is large. On the other hand, the difference of upward radiation between clear and cloudy days is not so large. Therefore the net longwave radiation on a cloudy day largely increases from that on a clear day. That is, LW cloud-radiative forcing is strong heating.

(Received October 30, 1989; Revised manuscript received March 3, 1990)

ON SNOW CRYSTALS OF "DOUBLE GOHEI TWIN" TYPE (ABSTRACT)

Katsuhiro KIKUCHI and Hiroshi UYEDA

Department of Geophysics, Faculty of Science, Hokkaido University, Kita-10, Nishi-8, Kita-ku, Sapporo 060

Observations of snow crystals of low temperature types were carried out at Alta (69°56′N, 23°16′E) and Kautokeino (69°01′N, 23°03′E), Finnmarksvidda, Norway from December 17, 1987 to January 31, 1988.

As a result, a peculiar shape of snow crystals of low temperature types was observed at both observation sites on January 1 and 10, 1988. The external shape of this crystal closely resembles that of the gohei twin types. However, the crystal grows from a center nucleus to both sides. Therefore, the crystal was named "Double Gohei Twin" types.

Considering the growth mechanism of snow crystals of this type, we were reminded of our laboratory experiments carried out about ten years ago. Based on the experiments, it is understood easily that if the airborne ice fragments come in contact with the surface of supercooled cloud droplets, some of the droplets are frozen in a twin type manner. If one of the snow crystals was grown from the frozen droplets under the temperature conditions in which the column types are suitable to grow, the crystal might grow the double gohei twin type, rarely.

(Received November 20, 1989)