

The followings are published in Vol.9(2).

### **Tundra burning in 2007– Did sea ice retreat matter?**

**Vladimir A. Alexeev, Eugénie S. Euskirchen, Jessica E. Cherry, Robert C. Busey**

The goal of this study was to assess the importance of the 2007 sea ice retreat for hydrologic conditions on the Alaskan North Slope, and how this may have influenced the outbreak of tundra fires in this region. This study concentrates on two years, 2007 and 1996, with different arctic sea ice conditions and tundra fire activity. The year of 2007 is characterized by a low summer sea ice extent (second lowest) and high tundra fire activity, while 1996 had high sea ice extent, and few tundra fires. Atmospheric lateral boundary forcing from the NCEP/NCAR Reanalysis drove the Weather Research and Forecast (WRF) model, along with varying sea ice surface forcing designed to delineate the role of sea ice. WRF runs successfully reproduced the differences between 1996 and 2007. Surprisingly, replacing sea ice conditions in 1996 run by those from 2007 and vice versa (2007 run with 1996 sea ice) did not change the overall picture. The atmospheric circulation in August of 1996 included a significant low-pressure system over the Beaufort and Chukchi Seas. However, in 2007, a high-pressure system dominated the circulation over the Beaufort Sea. It is argued that this difference in large-scale patterns, rather than retreat of sea ice, was responsible for anomalously dry and warm atmospheric conditions over the North Slope in summer and autumn 2007, suitable for high tundra fire activity. Circulation in 2012 is contrasted with that in 2007 to further stress its importance for local weather on the North Slope.

### **Comparison and verification of enthalpy schemes for polythermal glaciers and ice sheets with a one-dimensional model**

**Heinz Blatter, Ralf Greve**

The enthalpy method for the thermodynamics of polythermal glaciers and ice sheets is tested and verified by a one-dimensional problem (parallel-sided slab). The enthalpy method alone does not include explicitly the transition conditions at the cold-temperate transition surface (CTS) that separates the upper cold from the lower temperate layer. However, these conditions are important for correctly determining the position of the CTS. For the numerical solution of the polythermal slab problem, we consider a two-layer front-tracking scheme as well as three

different one-layer schemes (conventional one-layer scheme, one-layer melting CTS scheme, one-layer freezing CTS scheme). Computed steady-state temperature and water-content profiles are verified with exact solutions, and transient solutions computed by the one-layer schemes are compared with those of the two-layer scheme, considered to be a reliable reference. While the conventional one-layer scheme (that does not include the transition conditions at the CTS) can produce correct solutions for melting conditions at the CTS, it is more reliable to enforce the transition conditions explicitly. For freezing conditions, it is imperative to enforce them because the conventional one-layer scheme cannot handle the associated discontinuities. The suggested numerical schemes are suitable for implementation in three-dimensional glacier and ice-sheet models.

### **Comparison and analysis of subglacial bedrock core drilling technology in Polar Regions**

**Jinsong Wang, PinLu Cao, ChunPeng Liu, P.G. Talalay**

The Gamburtsev Mountains, located in East Antarctica, is the direct geomorphological cause of the formation of Dome A. Drilling the core of the Gamburtsev subglacial mountains is one of the primary goals of modern polar research, which is important to understand its formation and evolution process, the ice sheet formation of Dome A, glacial motion, climate change, and so on. This paper describes the status and progress of subglacial bedrock drilling technology. Existing subglacial bedrock drilling technologies are also discussed, including common rig rotary drilling, wire-line core drilling, coiled tubing drilling, and electromechanical drilling. Results of this paper will provide valuable information for Chinese subglacial bedrock core drilling project in the Gamburtsev mountains.

### **Electrical resistivity structure under the western Cosmonauts Sea at the continental margin of East Antarctica inferred via a marine magnetotelluric experiment**

**Tetsuo Matsuno, Yoshifumi Nogi, Nobukazu Seama**

The western Cosmonauts Sea, off the coast of East Antarctica, was a site of rifting of the Gondwana supercontinent and subsequent early seafloor spreading. To improve our understanding of the breakup of Gondwana, we conducted a marine magnetotelluric experiment to determine the electrical resistivity structure within the uppermost several hundred kilometers beneath the western Cosmonauts Sea. Magnetotelluric response functions at two sites, obtained after considering possible influences of non-plane magnetic field sources, suggest that these responses include distortions by topographic variations and conductive anomalies around the observation sites. Three-dimensional forward modeling confirmed that these distortions due to topographic variations and a thin (~2-km thick) conductive layer immediately under the sites (mostly sediments) are severe. Furthermore, three-dimensional forward modeling to investigate the resistivity structure at deeper

depths revealed an upper resistive layer ( $\geq 300 \Omega\text{-m}$ ), with a thickness of 90 Ma), and may suggest a conductive anomaly in the upper mantle produced by mantle convection and/or upwelling.

### **Stable oxygen and hydrogen isotope analyses of bowhead whale baleen as biochemical recorders of migration and arctic environmental change**

Pieter A.P. deHart, Candace M. Picco

An analysis of the stable isotopes of oxygen ( $\delta^{18}\text{O}$ ) and hydrogen ( $\delta\text{D}$ ) was used to examine the linkage between sea ice concentration and the migration of western arctic bowhead whales (*Balaena mysticetus*; WABW). We compared  $\delta^{18}\text{O}$  and  $\delta\text{D}$  variability along the length of WABW baleen with isotopic values of zooplankton prey from different WABW habitat, with published  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data, and with historical sea ice records. Zooplankton signatures varied widely ( $\delta^{18}\text{O} = -13\text{‰}$ – $56\text{‰}$ ;  $\delta\text{D} = -220\text{‰}$  to  $-75\text{‰}$ ), with regional separation between winter (Bering Sea) and summer (eastern Beaufort Sea) habitats of WABW observable in  $\delta\text{D}$ . The  $\delta^{18}\text{O}$  and  $\delta\text{D}$  of WABW varied significantly along the length of baleen ( $\delta^{18}\text{O} = 8\text{‰}$ – $18\text{‰}$ ;  $\delta\text{D} = -180$  to  $-80\text{‰}$ ), confirming seasonal migration and reflecting distinct regional dietary variation in isotopes. WABW migration appears to have varied concomitant with temporal sea ice concentration (SIC) changes; in years with high SIC, the difference in  $\delta\text{D}$  of WABW baleen between seasonal habitats was significantly greater than low SIC periods. This work shows that SIC is not only a determinant of habitat accessibility for WABW, but baleen may also be a record of historical SIC and Arctic climate.

### **Copepod community succession during warm season in Lagoon Notoro-ko, northeastern Hokkaido, Japan**

Yoshizumi Nakagawa, Hideaki Ichikawa, Mitsuaki Kitamura, Yasuto Nishino, Akira Taniguchi

Lagoon Notoro-ko, located on the northeastern coast of Hokkaido, Japan, and connected to the Okhotsk Sea by a human-made channel, is strongly influenced by local hydrography, as water masses in the lagoon are seasonally influenced by the Soya Warm Current and the East Sakhalin Current. We here report on the succession of copepod communities during the warm season in relation to water mass exchange. Copepods were categorized into four seasonal communities (spring/early-summer, mid-summer, late-summer/fall, and early-winter) via a cluster analysis based on Bray-Curtis similarities. Spring/early-summer and early-winter communities were characterized by the temperate-boreal calanoid *Pseudocalanus newmani*, comprising 34.9%–77.6% of the total abundance of copepods during times of low temperature/salinity, as influenced by the prevailing East Sakhalin Current. Late-summer/fall communities were characterized by the neritic warm-water calanoid *Paracalanus parvus* s.l., comprising 63.9%–96.3% of the total abundance, as influenced by the Soya Warm Current. Mid-summer communities comprised

approximately equal abundances of *P. parvus*, *Eurytemora herdmani*, *Scolecithricella minor*, and *Centropages abdominalis* (12.8%–28.2%); this community is transitional between those of the spring/early–summer and late–summer/fall. Copepod community succession in Lagoon Notoro–ko can be largely explained by seasonal changes in water masses.

### **Maturity and fecundity of *Champocephalus gunnari*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus* in South Georgia and Shag Rocks islands**

**M.I. Militelli, G.J. Macchi, K.A. Rodrigues**

The reproductive biology of three species of icefishes (family Channichthyidae), *Champocephalus gunnari*, *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus* in South Georgia and Shag Rocks Islands was studied by means of a histological analysis. Parental care, a widespread behaviour among icefishes such as *C. aceratus*, is not observed in *C. gunnari*, which has a broadcast spawning strategy. There were large differences in total fecundity mainly due to the different sizes reached by each species (total fecundity range was 2,500–21,300 hydrated oocytes). Nevertheless, when comparing relative fecundity values, the average results were, in general, similar for *P. georgianus* and *C. aceratus* (6–9 hydrated oocytes per female gram). However, relative fecundity estimated for *C. gunnari* was 10–37 hydrated oocytes per ovary–free female gram. The difference may be a consequence of the smaller oocyte size of the species as compared to other icefishes. The small diameter of hydrated oocytes was also associated with low values of dry weight. The high relative fecundity recorded for *C. gunnari* may compensate, in part, for a broadcast spawning strategy.

### **Carbon accumulation rate of peatland in the High Arctic, Svalbard: Implications for carbon sequestration**

**Takayuki Nakatsubo, Masaki Uchida, Akiko Sasaki, Miyuki Kondo, Shinpei Yoshitake, Hiroshi Kanda**

Moss tundra that accumulates a thick peat layer is one of the most important ecosystems in the High Arctic, Svalbard. The importance of this ecosystem for carbon sequestration was estimated from the apparent rates of carbon accumulation based on the  $^{14}\text{C}$  age and amount of peat in the active layer. The study site at Stuphallet, Brøgger Peninsula, northwestern Svalbard was covered with a thick peat layer dominated by moss species such as *Calliergon richardsonii*, *Paludella squarrosa*, *Tomenthypnum nitens*, and *Warnstorfia exannulata*. The average thickness of the active layer (brown moss and peat) was approximately 28 cm in 1 August 2011. The calibrated (cal) age of peat from the bottom of the active layer (20–30 cm below the peatland surface) ranged from 81 to 701 cal yr BP (median value of  $2\sigma$  range). Based on the total carbon (4.5–9.2 kg C m<sup>-2</sup>), the apparent rate of carbon accumulation in the active layer was 9.0–19.2 (g C m<sup>-2</sup> yr<sup>-1</sup>), which is similar to or greater than the net ecosystem production or net primary production reported for

other vegetation types in this area. Our data suggest that moss tundra plays an important role in carbon sequestration in this area.

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