

MEMBER COUNTRY: RUSSIA**National Report to SCAR for 2011/2012**

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A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS

LIFE SCIENCES

Ecological research in Nella Fjord (Prudz Bay)

During the IPY field seasons, the project “Study of the Antarctic Sea Ice Ecosystems” (SASIE) was launched. SASIE was a part of the IPY cluster project “Integrated analyses of circumpolar Climate interactions and Ecosystem Dynamics” (ICED) which is an international initiative aimed at coordinating integrated, multidisciplinary, circumpolar analyses of Southern Ocean ecosystems under umbrella of SCAR. The SASIE field observations were conducted at Nella Fjord (Prudz Bay) nearby the Russian continental station “Progress” (69° 22’ S and 76° 23’ E) located at Ingrid Christensen Coast (Larsemann Hills, Princes Elizabeth Land, Eastern Antarctic).

In 2011-2012 field season a long-term ecological research under umbrella of the Russian Antarctic Expedition and Russian Academy of Sciences was continued in the same area (Nella Fjord). The sea ice cores and under ice water samples were collected for chemical and biological analysis. The sea ice thickness was varied between 164 and 213 cm in direction from the coastal area to center of fjord. Salinity was wide-ranging within the ice thickness from the fresh water values in upper layers to maximum 3 ppt in the bottom ones. Due to beginning of melting season the accumulation of fresh water under ice was observed: the under-ice water salinity ranged from 0.6 ppt in coastal samples (the terrestrial snow melting impact) to 21 ppt in samples collected in the center of fjord (strong marine water influence). The algae species distribution within the ice thickness and under-ice water samples was determined by salinity stratification: the dinoflagellates cists were dominated in collected ice cores but diatoms in the under-ice water samples. This phenomenon may be explained by differences in physiological adaptation of algae: dinoflagellates prefer to develop in brackish water condition in contrary to diatoms which are more adapted to marine conditions.

During the 2011 – 2012 field season (56-th RAE) from 17.01.2011 up to 28.02.2011 at the Bellingshausen station scuba-diving hydrobiological investigations have been conducted in the near shore zone of the King George Island. Scientists of the Zoological Institute RAS studied taxonomical and quantitative compositions of the benthic communities up to depth 50 m. The representative collections have been sampled at these depths in which more than 200 species benthic animals of different groups of invertebrates were previously identified. These data give a possibility to compare the structure of the near shore bottom communities around of the King George Island with the same ones of the Nella fjord (Prudz Bay) near the Russian station Progress, which had been studied in the 52-d and 54-th RAE.

Botanic and zoological investigations

The new data of the lichenoflora, terrestrial and freshwater mosses of the some lakes of the Shirmacher Oasis (Novolazarevskaya Station) nearby the Progress and Molodezhnaya station areas have been taken and their taxonomical composition and distribution patterns have been studied. Rare and new plant species have been found and new collections of living nematoda associating with lichens, mosses and soil were sampled. Last field season the same investigations were done at other areas.

At the Bellingshausen Station (King George Island) in February 2012 all-year round geobotanic and floristic terrestrial and freshwater investigations were begun. At the Haswell Island (Mirny Station) calculations of nesting bird species have been carried out and ringing of chickens and young birds have been done.

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Federal Research Institute for Geology and Mineral Resources of the World Ocean, VNIIOkeangeologia (Ministry of Natural Resources and Ecology).
Polar Marine Geosurvey Expedition, PMGE (Ministry of Natural Resources and Ecology).
Arctic and Antarctic Research Institute (AARI)
Alfred Wegener Institute (AWI), Germany

1. Field activity

Marine geophysics (PMGE)

Season: February-March 2011.

Region: eastern Weddell Sea (between 85E and 94.5E; 60S and 64.5S).

Data/Observations: 3235 km of MCS lines, 3 500 km of gravity and magnetic lines, 8 sonobuoys.

Season: February-March 2012 (PMGE and AWI).

Region: Prydz Bay (between 72E-81E).

Data/Observations: 2670 km of MCS lines, more than 3 000 km of magnetic and gravity lines; refraction experiment with use of 8 bottom stations (across Prydz Bay shelf).

In both field seasons, MCS data were recorded with a 352-channels digital streamer and airgun array of 2860 cub. in. in total volume. Refraction seismic experiment was carried out using AWI bottom stations.

Airborne geophysics (PMGE)

Season: January-March 2011

Region: Princess Elizabeth Land (between 72S and 71S; 77E and 81E).

Data/Observations: About 5300 km of airborne survey including magnetic and radio-echo sounding observations.

Season: January-March 2012.

Region: Princess Elizabeth Land (between 69.3S and 70.3S; 81.6E and 85.5E).

Data/Observations: 5 500 km of airborne survey including magnetic and radio-echo sounding observations.

Short-range airplane AN-2 was used for data acquisition in both seasons. The RES studies were carried out using a 60-MHz radio-echo sounder. Flight lines were generally oriented north-south and spaced 5 km apart.

Ground-based geophysics (PMGE, AARI)

Season: January-February 2011

Region: Antarctic interior between the Progress Station and the point with coordinates ~72.5S; 88E

Data/Observations: About 1 060 km of RES observations along 2 parallel lines (40 km apart)

Season: January 2011

Region: Southern Lake Vostok

Data/Observations: Refraction and reflection seismic experiment along line running from the Vosrok Station northward. Explosives were used as seismic source (offsets: 17 km and 35-58 km).

Season: January 2012

Region: western shore of Lake Vostok

Data/Observations: Refraction and reflection seismic experiment with explosives (offset: 20 km).

Geology (PMGE)

Season: January-March 2011 and 2012.

Region: of Vestfold Hills and Rauer Islands

Investigations: geological mapping, structural studies, rock sampling for geochronology and paleomagnetic studies)

2. Indoor activity

Tectonic Map of Antarctica (VNIIOkeangeologia)

After 5 years of compilation, Tectonic map of Antarctica with insets and brief description (A0 Sheet) is in press and will be displayed and distributed by CGMW at the 34th International geological Congress in Brisbane, Australia.

Antarctic Digital Magnetic Anomaly Map, ADMAP (VNIIOkeangeologia & ADMAP Consortium)

New Magnetic Anomaly Map for the Southern Ocean and coastal region between 0 and 150E (East Antarctic margin) based on all available marine and airborne magnetic has been compiled (see selected publications).

ACE Scientific Program: Circum Antarctic Stratigraphy and Paleobathymetry (CASP) and Antarctic Paleotopography (AntScape) projects (VNIIOkeangeologia and PMGE).

Results of recent activity include: 1) Revised seismic stratigraphy model for the Wilkes Land margin; 2) Structural maps for Southern Ocean between 7E to 150E, including total sedimentary thickness, thickness of post-70 Ma unit, thickness of Middle-Late Eocene sequence, thickness of syn-glacial (post-34 Ma) unit.

GIS Project for Lambert Glacier Area

New project (started in 2011) will provide a basis for compilation of digital geological and tectonic maps in scale 1:1000000 to 1:5000000 for the region of the Mac. Robertson Land and the Princess Elizabeth Land between 67S-76S and 60E-80E (based on ArcGis 9.3 software platform).

Information included: bedrock topography, magnetic and gravity anomaly fields, geological sample locations, geochronological data, geochemical, petrographical, petrological geological data and other information).

Selected publications

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PHYSICAL SCIENCES

Atmosphere studies

Total ozone content (TOC) was measured regularly with a filter instrument M-124 at the Russian Antarctic stations Mirny (66.56°S, 93.00°E), Novolazarevskaya (70.78°S, 11.82°E), and Vostok (78.46°S, 106.84°E). Daily means of TOC measurements (preliminary data) have been presented in the Antarctic Ozone Bulletin (<http://www.wmo.int/pages/prog/arep/gaw/ozone/index.html>).

An updated set of time series of derived aerosol optical depth (AOD) from a number of Antarctic stations was analyzed to determine the long-term variations. The Antarctic data-set comprises sun-photometer measurements performed at Mirny (1982 - 2009), Neumayer (1991 - 2004), Terra Nova Bay (1987 - 2005), and at South Pole (1977 - 2010). The long-term variation in Antarctic AOD was estimated to be stable, within $\pm 0.10\%$ per year, at the three coastal sites, and nearly null at South Pole.

Snow accumulation/ Paleoclimate studies

The time-series of temperature and snow accumulation rates reconstructed from the data of 8 snow pits and 4 shallow cores drilled near Vostok station shows that the regional climate is dominated by the quasi-periodic oscillations of these parameters with the period of 40-50 years. Average accumulation rate varies from 1,2 to 3,0 g/cm² being 2,01 g/cm² in average. Temperature varies from -56.5°C to -54.0°C . The cyclic character of the changes in the region during the last three centuries is confirmed by the temperature data in the upper 100 m of glacier as well as by instrumental measurements of air temperature. The correlation of temperature and snow accumulation rates with circulation indices of Southern Hemisphere shows that the climate of this region is mainly governed by the type of circulation in the SH. In cases of zonal circulation the negative anomalies of temperature and precipitation rate are observed, whereas the sign of anomaly is opposite during the periods of meridional circulation. It has been found that in 1970 the sign of the relationship between many climatic parameters has changed which is likely related to the rearrangement of the climate system of the SH. The data suggest that during the past 350 years such events have happened at least 5 times.

The obtained results of radiocarbon dating and diatom analysis of bottom sediments from 8 lakes and terrestrial deposits from 4 cores allowed describing environmental changes and diatom flora evolution in the Schirmacher Oasis: the shallow fresh-water lakes with diatom flora had existed in the oasis before Last Glacial Maximum; the time of the oasis territory recolonization by diatom flora is 7000-6000 yrs BP; during Holocene, the living conditions of diatom flora in the oasis lakes were on the whole similar to present ones; development of the diatom flora in different lakes was depended strongly on short-term climatic fluctuations in the region (relative warming 3400–2600, 550–450 and 150 yrs BP; relative cooling 2200–1000, 300–200 and 100 yrs BP) and local factors.

The interstadial marine deposits stratum was described in the Fildes Peninsula (King George Island) due to field and laboratory investigations during 2008-2012. The stratum fragments occur in the peninsula in following forms: sections of soft sediments, containing fossil shells, marine algae, bones of marine animals and rich marine diatom complexes in situ (11 sites); fragments of shells and bones on the surface (25 sites). According to the results of radiocarbon

dating, these deposits were accumulated within the period 19–50 ky BP. Geographical and altitude settings of the sites, age characteristics, taxonomy of fossil flora and fauna, and good safety of the soft deposits stratum allow to make following conclusions: during interstadial, sea water covered significant part of the island up to the present altitude of 40 m a.s.l., and the island glaciation had smaller size then; environmental conditions for the interstadial deposit stratum accumulation were at least not colder than today; probably, the King George island territory was covered entirely by ice masses of Last glacial maximum not earlier than 19 ky BP; during LGM, King George Island was covered by thin, “cold”, not mobile glaciers.

Oceanography

In January 2012 during 56th Russian Antarctic expedition (RAE) three CTD/O₂ transects were made from r/v *Akademik Fedorov* in the area to the west of Prydz Bay. Transects include 18 soundings along 70° E (at the same station’s positions as in 2011 survey), 14 soundings along 69° E and 14 soundings along 71° E. Additionally 9 stations were made along the Amery Ice Shelf front and several stations were made from the fast ice of the Sadnefjord Bay.

Data of the last several surveys show that *Antarctic Shelf Water* and its modification, *Ice Shelf Water*, goes to the north along western border of Amery Depression and then flows down the continental slope in the region to the west of Prydz Channel (~ 72° E). High spatial resolution of the section along 70° E at the shelf break and above the upper steep part of the slope has allowed detailing of mesoscale peculiarities of the near-slope convective plumes. Sections along 70° E were repeated six times from the r/v *Akademik Fedorov* during the period 2004 – 2012. Sinking of dense water plumes along continental slope was not found in the region to the east of 72° E. Descending water in the region to the west of Prydz Channel results in deep water ventilation and bottom water formation. *Prydz Bay Bottom Water* (PBBW) with the potential temperature –0.3 –1.6°C and salinity 34.54 psu – 34.62 psu is found between 62° E and 72° E at the depth 1300 – 2000 m. PBBW is colder and less saline than *Antarctic Bottom Water* observed in this region. The results of convection modeling show that sinking of cooled water along the continental slope at thermal convection is significantly three-dimensional. The scale of process of the slope of convection does not exceed a few tens of meters in space and a few tens of minutes time. The thickness of the modeled plume is about 100 m. The modeled vertical speed at the slope convection is about 1 cm/s. Given the extent of the continental shelf and slope where the processes of downslope convection have been found, we can estimate the production rate of bottom water of about 1.5 Sv.

Lake Vostok studies

In February 5, 2012 deep hole 5G-2 drilled at Vostok Station by the Russian Antarctic Expedition reached the surface of subglacial Lake Vostok. The non-stop round the clock drilling operations began on January 2 and continued until morning of February 6. Ethanol/water mixture was not used to facilitate drilling in “warm ice”. The relatively high performance of the electromechanical drill KEMS-135 designed at St. Petersburg Mining Institute was maintained due to the adjustment of the drill parameters to changing properties of accreted ice. The average rate of the ice coring was about 50 cm per drilling run and about 1.9 m per day with no tendency to decrease at greater depths. The drill hit the surface of Lake Vostok at a depth of 3769.3 m. The pressure drop during the penetration exceeded 5 bars. The hydraulic shock when water surged up the borehole was strong enough to smash the ice core and press its fragments to the top of the core barrel. One minute after the penetration, the kerosene began outflow through the top of the hole. The uncontrolled surface outflow persisted for about 5 minutes. Then the fluid head decreased and the kerosene dropped back into the hole to its normal level. The measurements show that the water rose to 600 meters above the lake surface. The texture and fabric analysis of obtained ice core was performed on the continuous basis meter by meter following the

drilling advance. The study revealed an increase of the crystal size with depth as typical for columnar ice formed in the ordinary surface lakes. The coring of water ice refrozen in hole is planned for the next austral season.

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