

MEMBER COUNTRY:Russia

National Report to SCAR for 2010/2011

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Scientific highlights 2010-2011

PHYSICAL SCIENCES

Atmosphere/climate studies

Surface and upper air meteorology data sets of the Russian Antarctic network has been completed based on July 2010 – June 2011 routine observations for all standard measurement programs. Monthly mean values of more than 140 key climatic parameters are presented at www.aari.aq and updated every month. Detailed statistical analysis results for each indicated above time-series are presented also.

In recent few decades (except last decade) the Antarctic Peninsula area is getting warm faster than anywhere else in the Southern Hemisphere. The remarkable regional warming of the lowest few kilometers of the atmosphere has been accompanied by cooling of the lower stratosphere, by decreasing of the intra-monthly air temperature variability, and by decreasing of cloud cover layers number. In addition, sea ice duration in Maxwell Bay, King George Island, shortened from six to three months over 1968 – 2011, and the thickness of the fast ice formed near Bellingshausen station decreased from 90 to 30 cm over the same period. Photographic registration of Maxwell Bay sea ice conditions and coastal snow line was organized.

In the frames of IPY and post-IPY activities Russian Antarctic soil active layer monitoring network was created based on Bellingshausen, Novolazarevskaya and Progress stations geocryological polygon observations as the part of International circumpolar active layer monitoring net. Preliminary results of King George Island ice free permafrost areas study demonstrate continuous transformation of year-round permafrost into its seasonal form.

Oceanography

In the period 2nd - 3rd February 2010 during 55th Russian Antarctic Expedition (RAE) 16 CTD stations were made from r/v *Akademik Fedorov* near the West Coast of the Antarctic Peninsula. This section along ~ 63°30'S was made for Synoptic Antarctic Shelf-Slope Interaction (SASSI) project.

During 14th – 18th February 2010 XBT section (78 soundings up to 760 m depth) has been done along SR2 CLIVAR line between Africa and Antarctica for Climate of the Antarctica and Southern Ocean (CASO) project.

In the period 15th January - 2nd February 2011 during 56th RAE 68 CTD stations were made from r/v *Akademik Fedorov*. Stations include 18 soundings in the area to the west of Prydz Bay along 70° E, 10 stations in the Prydz Bay (9 of them along the Amery Ice Shelf front), 38 stations in the Sadnefjord Ice Bay, and 2 stations in the Davis Sea. Stations in the Sadnefjord Bay have been done by Sea Cat 19, all other soundings were made with Sea Bird 911+. Additionally 3 stations were made from the fast ice of the Sadnefjord Bay.

Lake Vostok/ Paleoclimate/ Glaciology studies

In the austral season of 2010-2011, the 56th RAE resumed deep drilling of the Antarctic ice sheet at Vostok Station. With an electromechanical drill adapted for drilling in “warm ice”, Russian drillers were able to reach a depth of 3,720 m thus leaving less than 50 meters of undrilled ice between the

bottom of 5G-2 hole and subglacial Lake Vostok. The advance in drilling of 5G-2 branch hole in 2009-2011 yielded in total 120 meters of new ice core: 66 m of the replicate core and 54 m of the core representing uninvestigated so far thickness of the lake (accreted) ice.

The studies of the fresh ice core performed in the field laboratory allowed to continuously document the evolution of the accreted ice fabric and texture with depth as the hole approached the ice-water interface. The presence of the gas hydrate inclusions in accreted ice was for the first time confirmed by the direct microscopic observations performed on the thin sections of the fresh ice core. This finding suggests a high concentration of gases in the lake water.

More than 1200 samples of the new ice core were collected for the detailed isotopic, gas and biological analyses to be performed in Russian laboratories.

The results of paleogeographic studies of the ice-free Antarctic sites allowed delineating four main phases of deglaciation of the marginal zone of Antarctica: 1). earlier 7.5 kyr BP, when the rate of melting and destruction of the ice sheet was accelerated; 2). 7.0 – 4 kyr BP, when the rate of ice sheet destruction has significantly decreased; 3). 4.0 – 1.0 kyr BP– the period of expansion of ice domes; 4). 1.0 kyr BP – present time, when the state of the ice sheet remained stable.

An assessment of the mass balance of Antarctic glaciers for the last 50 years was made in the main ice catchment basins. The analysis was based on high resolution satellite images. The mass balance of the most studied area of the Antarctic continent remains positive.

Solar activity studies

The complex studies of pulsed signals in the nature phenomena and experimental processes are carried out at the Novolazarevskaya station to find the tracks of the solar fluctuations under anthropogenically clear conditions of Antarctica.

The following methods were used:

- spectral UV observations in zenith of free atmosphere with use of spectrometer Avantes-2048;
- measurements of diurnal and synodic variations in the photo-effect processes;
- measurements of ^{239}Pu α -intensity and the heat neutron flux.

There were revealed fluctuations related to:

- function of solar declination during the yearly Earth's movement,
- solar activity index F10.7cm,
- energy of total solar irradiance,
- synodic period (29 days).

LIFE SCIENCES

During the 2010 – 2011 field season (56th RAE) different hydrobiological investigations and observations were conducted at the Bellingshausen station, King George Island. Year-round observations of the pelagic ecosystem of the Ardley Bay (part of Maxwell Bay, to the north of Ardley Island) were continued as a monitoring study of this ecosystem in order to determine taxonomical composition, inter-annual and seasonal variability of zooplankton at three stations conducted during 5 years yet (from the 51st RAE). This work has been done in the framework of post-IPY CLICOPEN Project. The results demonstrate northern species expansion into Antarctic Peninsula area.

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) nearby the Russian station Progress, which had been studied in the 52^d and 54th RAE.

The new data about the lichenoflora, terrestrial and freshwater mosses of the some lakes of the Shirmacher Oasis (Novolazarevskaja station) and from Molodezhnaja station area have been taken and their taxonomical composition and distribution patterns have been studied. Rare and new species of the plants have been found as well as new collections of living nematoda associating with lichens, mosses and soil were sampled.

In the frames of post-IPY CLICOPEN Project the continued hydrobiological investigations of the krill community in the Maxwell Bay area demonstrated northern species expansion over Antarctic Peninsula area.

The main result of the studies under the program of microbiological monitoring in the Antarctic carried out in RAE was the determination of a phenomenon of anthropogenic modification of the communities of microorganisms in natural ecosystems and in the isolated human habitats.

Appearance of aggressive (conventionally pathogenic and pathogenic) strains and of decomposers of construction materials and structures in the areas of anthropogenic influence in the Antarctic was detected. The studies of diversity of Antarctic fungi were supplemented by studies of the diversity of bacterial communities, which has significantly expanded the existing knowledge of microbiological communities at the sixth continent.

In the course of the expedition studies, sampling of natural and anthropogenic substrates that are of interest in mycological and microbiological respect was made. They include soil from a different depth, primary soil under the moss and lichen cover, cyanobacterial mats, rocky substrates with biofouling indications, snow, ice, water, feathers and bones of birds, guano, bones of marine mammals, timber, construction and finishing materials, tissues, paper, dust from open surfaces and air medium of open space and closed quarters.

It was experimentally shown that most micromycetes revealed are characterized by a wide spectrum of enzymic activity, which can be considered as an important adaptation factor to the extreme conditions in the Antarctic. The enzymic activity can change significantly under different temperatures. The non-uniformity of the populations of micromycetes is shown by the spectra of enzymic activity. An assessment of the numbers and composition of bacteria of the surface layer of ecologically clean localities was performed. A molecular-genetic analysis of snow concentrates of ecologically clean

habitats in the vicinity of Antarctic stations and seasonal field bases was carried out. The bacterial diversity of snow communities at the study stations differs significantly. These differences can be determined by peculiarities of habitats and by the sources and ways of spreading of microorganisms.

The data obtained have significantly expanded the existing knowledge of the microbiological diversity of the Antarctic continent, adaptation conditions to the extreme environment, influence of microorganisms on the health of the expedition participants and on reliability of construction structures.

REPORT OF RUSSIAN GEOSCIENCE ACTIVITIES IN 2010-2011

ORGANIZATIONS INVOLVED:

Federal Research Institute for Geology and Mineral Resources of the World Ocean, VNIIOkeangeologia (Ministry of Natural Resources and Ecology, Federal Agency for Mineral Resources).

Polar Marine Geosurvey Expedition, PMGE (Ministry of Natural Resources and Ecology).

1. FIELD ACTIVITY

Marine geophysics (PMGE).

Season: February-March 2011

Region: western Dronning Maud Land margin (area between 12W and 0; 65.5S and 70.5S).

Data: 3200 km of MCS data, about 6 000 km of magnetic and gravity data; 8 sonobuoys (along a dip MCS line). MCS data were recorded with a 352-channels digital streamer and airgun array of 2860 cub. in. in total volume.

Airborne geophysics (PMGE)

Season: January-March 2011

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

Data: 5 300 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 MPI-60 radio-echo sounder with a dynamic range of 180 dB and a pulse width of 750 ns. Flight lines were generally oriented north-south and spaced 5 km apart.

Ground-based geophysics (PMGE)

Season: January-February 2011

Activity (region): 2 Radio-echo sounding lines between Progress Station and the point of Antarctic hinterland at about 72,5S; 88E

Data: 1 060 km of continuous observations

Activity (region): refraction and reflection seismic observations in the southern part of Vostok Lake.

Data: seismic data were acquired along the S-N striking line (about 60 km) with use of explosive as a seismic source.

Geology (PMGE)

Season: January-February 2011.

Activity (region): geological mapping in the northern Prince-Charles Mts. (Atos Mt, Portos Mt.)

INTERNATIONAL PROJETS

Tectonic Map of Antarctica (VNIIOkeangeologia)

A final draft of the tectonic map of the Antarctic (CGMW IPY Project) at 1:10 M scale has been compiled. The map is planned to be published by CGMW in 2012.

Antarctic Digital Magnetic Anomaly Map, ADMAP (VNIIOkeangeologia; & ADMAP consortium)

A new version of magnetic anomaly map for the Indian Ocean Sector of Antarctica (from 0 to 150E) has been compiled using all available (and recently collected) magnetic data.

Circum Antarctic Stratigraphy and Paleobathymetry (CASP; subproject of the ACE SCAR Scientific Program; VNIIOkeangeologia and PMGE). The set of structural maps (including: total sedimentary thickness, depth to basement, thickness of major seismic units has been compiled for the East Antarctic margin from 7E to 150E).

Selected publications

Grikurov G.E., Leitchenkov G.L., Mikhalsky E.V. 2010. Antarctic Tectonic Evolution in the light of modern geodynamic concepts. In: Leonov J.G. (Ed.) Structure and Evolution of the Lithosphere. Series: Contribution of Russia to International Polar Year 2007/08, pp. 91-110. In Russian

Leitchenkov G.L., Guseva Yu.B., Gandyukhin V.V., Gohl K., Ivanov S.V., Golynsky A.V., Kazankov A.Ju. 2010. Crustal tectonics and depositional history in the Southern Indian Ocean (East Antarctica: Cooperation Sea, Davis Sea, Kerguelen Plateau). Structure and Evolution of the Lithosphere. Series: Contribution of Russia to International Polar Year 2007/08, pp. 9-38. In Russian.

Mikhalsky E.V., Belyatsky B.V., Lepekhina E.N., Sergeev S.A. 2010. The Palaeoarchaeon age, Sm-Nd characteristic and the REE distribution in zircon in granitoid from the southern Prince Charles Mountains (East Antarctica). Doklady Earth Sciences. Vol. 433A, 2, pp. 1114-1118.

Mikhalsky E.V., Henjes-Kunst F., Belyatsky B.V., Roland N.W., Sergeev S.A. 2010. New Sm–Nd, Rb–Sr, U–Pb and Hf isotope systematics for the southern Prince Charles Mountains (East Antarctica) and its tectonic implications. Precambrian Research. Vol. 182, 1–2, pp.. 101–123

Belyatsky B.V., Rodionov N.V., Antonov A.V., Sergeev S.A. 2011. The 3.98-3.63 Ga zircons as indicators of major processes operating in the ancient continental crust of the East Antarctic Shield (Enderby Land). Doklady Earth Sciences.. Vol.438, 2, pp. 770-774.

Leychenkov G.L., Belyatsky B.V., Antonov A.V., Rodionov N.V. 2011. First information about geology of central Antarctica, based on the study of mineral inclusions in ice cores of the Vostok Station borehole. Doklady Earth Sciences. In press.

Wilson D.S., Jamieson S.S.R., Barrett P.J., Leitchenkov G., Gohl K., Larter R.D. 2011. Antarctic Topography at the Eocene-Oligocene Boundary. Palaeogeography, Palaeoclimatology, Palaeoecology. In press.

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