☐ **MEMBER COUNTRY: RUSSIA**

National Report to SCAR for 2013/2014

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A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS

LIFE SCIENCES

During the 2013-2014-field season, the long-term sea-ice ecological research under umbrella of the Russian Antarctic Expedition and Russian Academy of Sciences was continued. The observations were conducted in the same area 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). Sea ice cores and under ice water samples were collected for chemical and biological analysis. The sea ice thickness was varied between 137 and 154 cm in direction from the coastal area to center of fjord. As during previous observations, the salinity was wide-ranging within the ice thickness from the fresh water values in upper layers to marine water in the bottom ones. Due to beginning of sea ice melting 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.

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GEOSCIENCES

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, Federal Agency for Mineral Resources).

FIELD ACTIVITY

Marine geophysics (PMGE).
Region: Mawson Sea (area between 96.5E and 116E; 61S and 66S).
Data: 3200 km of MCS data, c. 4500 km of magnetic and gravity data; 8 OBS (along MCS line crossing Mawson Sea in S-N direction from the upper continental rise to abyssal plane). MCS data were recorded with a 352-channels digital streamer and airgun array of 2860 cub. in. in total volume.

Airborne geophysics (PMGE)
Region: Princess Elizabeth Land (area between 83E and 88E; 67.5S and 68.3S).
Data: c. 5600 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 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)
Activity (region): refraction seismic experiment in the central part of Lake Vostok.
Data: seismic data were acquired along the S-N striking line. Explosives (up to 900 kg) were used as seismic source (offset: 1-60 km).

Geological studies/mapping
Activity (regions):
1) Rauer Islands Prydz Bay, East Antarctica (PMGE);
2) Cape Burcks (the area of Russkaya Station), Marie Byrd Land, West Antarctica (VNIIOkeangeologia).

INTERNATIONAL AND NATIONAL INDOOR PROJECTS (VNIIOkeangeologia)

Commission for Geological Map of the World (CGMW). Subcommission for Antarctica.
http://www.ccgm.org

The explanatory notes booklet to the Tectonic Map of the Antarctic at 1:10 M published in 2012 is under preparation and is expected to be submitted for publication by CGMW in 2015.

A new project "Geological and Geophysical Maps of the Lambert Glacier Area" was launched in 2014 by the CGMW Subcommission for Antarctica. This project is aimed to integrate all available geological and geophysical data in the area of Lambert Glacier and to compile geological and geophysical maps at 1:1M Scale (bedrock topography map, magnetic anomaly map, gravity anomaly map, geological map, tectonic map.

Antarctic Digital Magnetic Anomaly Map (ADMAP). SCAR Expert Group.
The new version of ADMAP is in progress and current (draft) version included AWI data collected in western Dronning Maud Land, BGR data collected in Victoria Land and some IceBridge Project data from costal areas of Antarctica. Magnetic data acquired by other organizations after 2000 are anticipated.

Antarctic Paleotopography (AntScape). Subproject of the PAIS SCAR Scientific Program.
The map of thickness of Cenozoic sediments on the East Antarctic margin has been compiled. This map is planned to be used for estimation of pre-Cenozoic paleobathymetry in the Southern Ocean.

Enderby Land Project (National Project).
The project was launched in January 2014 and aimed to integrate all available geological and geophysical data in the area of Enderby Land and to compile maps at 1:1 M Scale.

SELECTED PUBLICATIONS OF 2013-2014

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PHYSICAL SCIENCES

Meteorology

Russian Antarctic Automatic Weather Station network data are collected for data verification procedure based on historic and current observation data at manned Russian Antarctic station, and for SCAR READER database update.

The first multi-year data record of meteorological parameters over Lake Untersee (Shirmasher Oasis) based on US automatic meteorological station data for 2008-2013 period. e above AWS data are compared and calibrated with Russian Novolazarevskaya station surface meteorological data. The mean annual solar flux at Lake Untersee was determined to be 98±2.5 W m^{-2}. The mean annual temperature at Lake Untersee was determined to be −10.6 ± 0.6º C. The average of the wind speed recorded was 6 m/s, the maximum, of readings taken once a minute, was 33 m/s, and the average daily maximum was 15 m/s. The wind speed was higher in the winter – daily maximums typically reaching about 22 m/s. Summer maximums were about 14 m/s. The dominant wind direction for strong winds is from the South for all seasons, with a secondary source of strong winds in the summer from the Northeast. The low summer temperatures and high wind speeds result is glacial-like conditions at the surface of the lake ice and the adjacent Anuchin glacier resulting in sublimation rather than melting as the main mass loss processes. An important difference between the Lake Untersee climate and the regional climate of the McMurdo Dry Valley lakes is the relative importance of evaporation from the ice compared to melting. Lake Untersee summer is colder, however winter is warmer than the Dry Valleys. The warming in the winter is due to persistent katabatic winds.

In the frames of Joint Chilean-Russian cooperation the negative trend for the Lambertian Equivalent Reflectivity data over the west region of the Southern Ocean due to variations in the cloud cover and in the sea ice extension are studied based on multi-satellite-based LER dataset for 1979-2012

October-March period comparison with of cloud cover and sea ice concentration satellite data and Russian Antarctic standard meteorology and solar radiation dataset . Despite a relatively high cloud fraction as measured from the International Satellite Cloud Climatology Project (ISCCP) and Moderate Resolution Imaging Spectroradiometer (MODIS), in agreement with a previous study, the influence of the sea ice is stronger than the cloud cover in the LER data and drives the variability and the trend of the LER over the Southern Ocean. This seems to occur when the sea ice concentration, derived from satellite passive microwave radiometers, is higher than about 30%. The best correlations (r) between LER and sea ice were found in the case of the Weddell sea (r=0.86), the Ross sea (r=0.86) and the Indian ocean (r=0.87) for November; while in the case of Bellingshausen/Amundsen sea (r=0.85) and the Pacific ocean (r=0.81), for February and December, respectively. In contrast, a loss of correlation has been found in the proximity of the coastlines of the west Antarctica in October. The reflectivity of the sea ice usually shows an apparent seasonal cycle with the lower reflectivity in January-February; in contrast, the Weddell sea presents weak seasonal variations. LER data distributions for different regions and months show a marked double peak in the reflectivity dependent on the season. The highest relative frequency is driven by the sea ice and peaks at about 90 Reflectivity Units (RU) for the Weddell sea, Ross sea and Indian Ocean in October. The secondary peak of about 50 RU is visible mostly in summer in all regions and it is likely caused by the cloudiness. Statistically significant trends in the reflectivity of the grid cells characterized by sea ice concentration greater than 30% were found for the Bellingshausen/Amundsen seas and the Weddell sea. The trend in the reflectivity of the ice-free pixels is generally positive in the whole Southern ocean for the October-March period.

Joint Indian-Russian Studies of land-ice-air-ocean interaction over the Schirmacher Oasis (SO) reveals that a unique ecosystem prevails over this oasis, where all the physical and biological components interact in a complex pattern. The climate at SO is dominated by the extreme contrasts between the seasonal inputs of solar radiation. It experiences sub-zero mean temperature throughout the year except in the summer peak. The surface wind regime is dominated by katabatic wind component from the southeast direction, which is the direction of maximum slope around the Indian Maitri station site. Pressure forms half yearly cycle and influenced for the formation of cyclones. The humidity and precipitation are although low but have significant relationship for the growth of microorganisms. Surface albedo also has great effect on the warming and cooling of the surface of SO and in formation of atmospheric convection The type of fog in SO are advection fog. In future it is predicted that frequent fog may occur in Antarctica. The cytological mechanisms of the microbiotic communities of SO, which used fog moisture are unclear and research on this aspect will be fruitful. The convective or unstable atmospheric conditions in the lower atmospheric boundary layer help carry upward the spores/pollens of the micro-flora in the SO and facilitate their dispersive capacity to a larger distance. In Antarctica, katabatic winds represent atmospheric conditions when microorganisms are forcefully transported from the interior towards the icy periphery and the ocean, but the rocky oases regions may provide a shelter/protection for their survival and growth. In the present model of coupled mechanism, thermal convection over the ocean transports fine living materials and propagates towards the interior of the continent during local summer.

Physical oceanography

In January – February 2014 during 58th Russian Antarctic expedition (RAE) more than 40 CTD/O_2 stations were made from r/v *Akademik Fedorov,* including 7 soundings in the vicinity of the Balleny Islands (~68° S, 162° E), 17 soundings – in the poorly sampled area near the Russian coastal station Russkaya in the Pacific sector (74° -74.5° S, 132° -136° W), and 17 soundings – in the Marguerite Bay, Bellingshausen Sea (66° -68° S, 70° -72° W). Additionally 34 XBT soundings were made in different areas. The data will be used to refine the structure of the water masses and their characteristics in these areas.

Solar activity

Relation of the Antarctic stratospheric circumpolar circle with the solar activity has been studied. Antarctic circumpolar circle is formed during a winter season by zonal winds flowing with a speed up to 75 m/ s at heights of 30-35 km (10 gPa) in the latitude zone of 50-60°. The inter-annual variations of circumpolar circle parameters, such as speed of stratospheric winds and their duration, have been studied in their relation to the solar activity evaluated by the F10.7 index. It is shown that formation of the stratosphere circumpolar circle is controlled by the temperature gradients between the polar and subpolar regions. During the winter season the solar UV irradiation, related to solar activity, impacts on the ozone total content and temperature in the subpolar stratosphere, but does not influence the dark polar region. As a result, the temperature gradients in the latitude zone of 50-60° vary according to temperature changes in the subpolar stratosphere related to solar activity.

Deep drilling at Vostok and glaciological studies

In the 2013-2014 austral season (59th Russian Antarctic Expedition) the drilling of deep hole 5G-3 at Vostok Station was resumed. More than 180 m of the new core of accreted (Lake Vostok) ice were recovered from a depth range between 3543.56 and 3724.42 m. Continues ice texture studies and electric conductivity measurements performed on this ice core in the field laboratories have allowed to correlate the depths of identical ice layers in holes 5G-1, 5G-2 and 5G-3 and with a high accuracy to estimate the remaining ice thickness between the bottom of 5G-3 hole and the ice-water interface, which by the end of the season decreased to 44.9±0,5 m. The precise knowledge of the depth at which the new hole 5G-3 should breach the lake will be used for preparation and implementation of the second controlled unsealing of Lake Vostok, which is planned for the next austral season 2014-2015. At a depth of about 3607 m a 30-cm thick layer of relatively large mineral inclusions presumably trapped from the lake bottom have been found and collected for detailed biological and mineralogical analyzes.

Based on the geochemical investigations of the ice core drilled 105 km inland from Mirny Station, the air temperature and snow accumulation rate in the Davis sea sector of East Antarctica over the past 250 years have been reconstructed. The core was dated by counting the annual layers depicted in the stable water isotope content profiles (dD and $d^{18}O$) and using the absolute date marker (Tambora volcano layer). The accumulation rates were then deduced from the thickness of the annual layers multiplied by the core density. The isotope content was transformed into the air temperature using a transfer function established by the comparison of the isotope data with the instrumental meteorological record from Mirny station. The reconstructed temperature series demonstrates a 0.5°C warming over the last 250 years. At the same time, snow accumulation rate was decreasing at least since the middle of the XIX century. The climatic characteristics demonstrate cyclic variability with the periods of 6, 9, 19, 32 and about 120 years.

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