Russian Scientific Center on Spitsbergen

Dr. Anna Nikulina
anikulina@aari.ru
Since 1920, started as Northern Research and Trade Expedition

Drifting station North Pole-1, 1937
Research stations

Svalbard

Billefjorden

Pyramiden

Grønfjorden

Barentsburg
Establishing of the Russian Scientific Center on Spitsbergen (RSCS)

- 11 Russian Institutes of different branches doing research on the archipelago;
- Russian Scientific Center on Spitsbergen (RSCS) is to coordinate and facilitate their activity;
- 2009 – 2013: the main infrastructure was built and renovated;
- 2014: the concept of the Center was approved by the Government of the Russian Federation;
- Since April 4, 2016: the RSCS got independent status, run by AARI;
- Permanent staff of 7 (2016);
- Hosts over 40 researchers (2016).

Next steps

- Infrastructure of Russian institutions on Spitsbergen is to be united;
- Coordinated research programme;
- Student and PhD training;
- Involving more participants.
The infrastructure of Research Center in Barentsburg

Meteo/geophysical Observatory

Satellite Receiving Station

Logistics/Transport

Analytical Laboratory
Satellite receiving / transmission site

- Built and supported by Kongsberg
- Primary processing of satellite images and information before sending to AARI, 2 Tb per year
- Satellite missions of multiple channels, different resolution and swath:
  
  - EOS Mission (USA) TERRA & AQUA
  - NOAA Mission (USA) № 15,17,18,19
  - MetOp-B (EUMETSAT/ESA)
  - Suomi NPP (USA)
  - FY-3 (China)

Barentsburg’s view area with an initial angle of elevation receiving antenna 5°
Mostly ice, wave, sea level forecasts
Synoptic maps: http://gmdss.aari.ru/ &
http://weather.gmdss.org

New tasks:
• To extend the data array beyond ice and synoptic data e.g. glaciers, phytoplankton, vegetation;
• On-the-spot processing and using of information in BB;
• Ground-truth observations to validate remote sense data;
• To receive data from future Arctic-M satellites with highly elliptical orbit over the Arctic region.
Logistics: transport, basic equipment

- Vehicles (snow scooters, quads, cars)
- Boats
- Samplers
- Profilers
- Sample preparation room
- Helicopter and ship by ArcticUgol Trust
**Analytical Lab**

- to support research activity on the archipelago;
- equipped with analytical instruments by Shimadzu, Mettler Toledo, Zeiss, Sartorius etc.

**Sample Preparation**

- Water sample preparation and basic analysis of pH, conductivity, dis. O₂;
- Sediment samples preparation: freeze-drying, pulverising;
- Samples extraction, incubation, storage.

**Microscopy**

- 2 x Zeiss Axio Imager.A2 with achromatic-aplanatic universal condenser 0.9 H D Ph DIC for plankton, benthic, paleo and mineralogical studies.
Analytical Lab

Hydrochemical Lab

- TCN analyser (water), planned one for solid samples;
- Ion chromatographer;
- 2 x Spectrophotometer with a flow cell;
- Automatic titration by Mettler Toledo.

Metals analysis

- AAS with flame and electro-thermal atomisation - get running to the next season;
- Mercury analyser.
Analytical Lab

Organic compounds analysis
• 2 x LC with diode array and fluorescence detectors;
• GC with flame ionisation and electron capture detectors;
• The whole cycle of sample preparation and measurements completed, compared to RPA “Typhoon” lab results, will be intercalibrated with NILU;
• GC – MS quadrupole type to get running.

To do
• Proper supplying of the lab;
• Permanent staff of 3;
• Methods & intercalibration – BareLab project with NILU & NMBU;
• Own research programme – metals accumulations in GF ecosystem with Murmansk Marine Biological Institute, passive sampling with NILU & NIVA.
RSCS research programme

- The basis formed decades ago;
- A lot of monitoring observations.

**Environmental monitoring** by RPA Typhoon

**Archaeology** by Institute of Archaeology of RAS

**Geophysics** by Polar Geophysical Institute of RAS

**Biology and Soils** by Institutes of Russian Academy of Science

**Geological survey** by Polar Marine Geological Expedition

**Glaciology** by AARI and Institute of Geography RAS

**Meteorological observations** by Murmansk Hydromet Station and AARI

**Oceanographic observations** by AARI and Hydromet Agency
Processing of archive data

- Air temperature from Norwegian and Russian stations on Svalbard (1898-2015)
- Sea ice cover data from BB (1937-2015) and Pyramiden (1948-1957)
- Oceanographic data for Grønfjorden and Isfjorden (1900-2015)
- Glaciers retreat (1939-2001)

D. Tislenko, B. Ivanov, 2016
Processing of archive data

- Air temperature from Norwegian and Russian stations on Svalbard (1898-2015)
- Sea ice cover data from BB (1937-2015) and Pyramiden (1948-1957)
- Oceanographic data for Grønfjorden and Isfjorden (1900-2015)
- Glaciers retreat (1939-2001)

AARI report, 2014
Processing of archive data

- Air temperature from Norwegian and Russian stations on Svalbard (1898-2015)
- Sea ice cover data from BB (1937-2015) and Pyramiden (1948-1957)
- Oceanographic data for Grønfjorden and Isfjorden (1900-2015)
- Glaciers retreat (1939-2001)

Time series of max Atlantic Water (AW) temperature with best-fit linear trend for the period 1912-2009

Pavlov et al, 2014
Meteorology and climate

AARI, SPb State University together with UiT, NPI

- Radiation properties of the snow in BB area, spectral analysis of reflected and absorbed radiation;
- Experimental setup: relations “albedo- snow contamination by coal particles”;
- Radiation properties of the glaciers surface;
- Microcirculation over Aldegonda glacier by station HOBOU30 – measurements & data processing in progress.

Ivanov, Sveshchennikov, 2015, Sviashchennikov et al, 2014

Albedo distribution on Aldegonda glacier, A. Tkachenko, 2016
Meteorology and climate

AARI and Institute of Atmosphere Optics RAS

Aerosols in the atmosphere – constant observations:

• spectral aerosol optical depth;
• height of the atmospheric boundary layer;
• influence of aerosol on radiation properties in high latitudes;
• sources of aerosol—local vs global by chemical composition.

Mean spectral dependencies of AOD 2011-2014

Sakerin et al, 2015

Mass concentration of soot in Barentsburg, μg m⁻³

AARI report, 2015
Oceanography

AARI

Dynamic and water structure in Grønfjorden, Nordfjorden, Billefjorden and Isfjorden:

• Fast ice measurements: thickness & morphology;

• Under ice measurements, water column microstructure.
Oceanography

- Fresh water and cold glacier water in the fjords;
- Atlantic water in the fjords: strong interannual variability in the smaller fjords;

AARI report, 2015
Oceanography

- Short and long-term mooring stations in Isfjorden show drastic changes in temperature and current velocity & direction within days strongly affecting smaller fjords.

3 February 2015

\[ V_{\text{max}} = 757 \text{ mm/c} \]

Cape Linne

K. Filchuk, 2015
AARI together with UNIS
(P. Bogorodsky & A. Marchenko)

Experimental set-up at Sveagruve:

Energy and mass exchange in freezing melted puddle, March 2016

- Pools in sea ice and lake ice in Braganza bight;
- Filled with fresh water;
- Synchronous measurements of temperature and salinity by frozen-in instruments;
- Ice morphology.

K. Filchuk, 2016
Glaciers

AARI and Institute of Geography of RAS

- Ablation stake measurements, also by georadar;
- Video registration of snow line;
- Mass-balance estimations;

Glaciers

AARI and Institute of Geography of RAS

- Ablation distribution, surface properties;
- Drainage systems by IG RAS;
- Geophysics - dynamic processes on Nordenskjold glacier, glacier movements, interaction with the ground surface, wave propagation.

Monitoring scheme at Nordenskjold glacier, 2016

Aldegonda glacier: annual ablation, $10^6$ m$^3$

Hydrography

Water balance of the catchment area:

- Snow survey and water supply;
- Snow physical and chemical properties;
- Rivers water and suspended matter discharge, ion discharge, flow rate dynamic;
- Catchment area modelling.

Snow thickness in catchment area in the period of maximal accumulation 2001-2016, cm

Water equivalent of snow cover 2001-2016, mm w.e.

AARI report, 2016
Paleo studies

AARI together with Polar Marine Geological Survey

• Annual expeditions to various regions – paleo-reconstruction of Holocene changes. Collecting samples for \(^{14}\text{C}\) analysis and microfauna;

• Short sediment cores from Kongress and Bretjorna lakes for sedimentation rate analysis, micropaleontology to reconstruct conditions for the past few hundred years.
**Permafrost**

**IISP PSN RAS:** *Thermal state and physico-chemical properties of permafrost in Svalbard*

<table>
<thead>
<tr>
<th><strong>Field work</strong></th>
<th><strong>Laboratory analysis</strong></th>
<th><strong>Scientific output</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>– drilling boreholes;</td>
<td>– $\text{C}^{14}$ dating;</td>
<td>– permafrost response to climate change;</td>
</tr>
<tr>
<td>– collecting frozen cores;</td>
<td>– paleomicrofossils;</td>
<td>– paleogeography of Spitsbergen during Holocene &amp; Pleistocene;</td>
</tr>
<tr>
<td>– monitoring of temperatures in boreholes (TSP program);</td>
<td>– grain size;</td>
<td>– biogeochemical contribution of thawing permafrost to global $\text{CH}<em>4$ and $\text{C}</em>{\text{org}}$ cycles;</td>
</tr>
<tr>
<td>– establishing polygons for active layer thickness monitoring (CALM program).</td>
<td>– dry residue;</td>
<td>– Mars analogy studies, testing instruments for planetary exploration.</td>
</tr>
<tr>
<td></td>
<td>– $\text{CH}_4$;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– organic carbon;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– viable microorganisms etc.</td>
<td></td>
</tr>
</tbody>
</table>

N. Demidov, 2016
Contamination monitoring

RPA “Typhoon”

Monitoring program of local contamination in Barentsburg and adjacent area since 2001;

Defining the sources: coal mining (coal dust), power station, vehicles, sewage, outdoor paint, long-range transport;

PAH, PCB, pesticides, metals in air, snow, fresh & marine water, marine sediments, soil, organisms – different distribution patterns.

Soil ΣHC μg/g dw, 2002-2011

Snow Cu, μg/l 2003-2010

Demin et al, 2011, Demeshkin, 2015
Students involvement

• Annually master and PhD students from SPb State University and Hydromet University work in the research groups:
  • Course field practices;
  • Collecting data for thesis;
  • 2016: Field practice-Summer school for SPbSU POMOR master students with lectures and field experience.
Plans

• Increasing number of researchers staying over the whole year;
• Logistics development, uniting the infrastructure;
• Facilitation of further collaboration between research groups and institutes working in Barentsburg;
• Developing of long-term research projects;
• International cooperation;
• Fostering master and PhD students;
• Internal report on the research in the last decade, also in English.
Thank you for attention!