• A ship-based marine program along the entire Eurasian-Arctic continental shelf with combined biogeochemical and geophysical observations

R/V Yakov Smirnitsky, 69 m
20 crew & 30 scientists
15 Aug. to 25 Sept., 2008
- Kirkenes to Kirkenes 15 Aug to 25 Sept, 2008 about 13 000 km
- 130 stations occupied for air- water- and sediment sampling as well as geophysical measurements
Why study the Biogeochemistry of Arctic Coastal Seas?

- Siberian-Arctic records large warming (NOAA)
- Huge amount of carbon "locked up" in drainage basin, coastal ice-complex, and shallow subsea permafrost
- Changes in freshwater, sea ice and maybe shelf transport
- East Siberian Arctic Shelf – LARGEST - Understudied
Objectives

Transformation and transport of organic carbon in the East Siberian Sea

- Input of organic carbon from rivers and coastal erosion
- Biogeochemical transformation on the shelf, sedimentation and transport to the Arctic central deep basin
- Supply and transport of micronutrients and trace element isotopic tracers from the Siberian Arctic rivers, across the continental shelf, and into the central Arctic Ocean
- Release of CH$_4$ and CO$_2$ from the shelf sediments
- Benchmark the current state to and how it might be affected by climate change?
<table>
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<th>Theme</th>
<th>Principal Investigators</th>
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<tr>
<td>Air-Sea exchange fluxes (energy, CH4, CO2)</td>
<td>Anatoly Salyuk and Natalia Shakhova Far Eastern Branch of Russian Academy of Sciences, Pacific Oceanological Institute + IARC</td>
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<tr>
<td>Biogeochemistry</td>
<td>Örjan Gustafsson Stockholm University</td>
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<td>Geophysics/seismics</td>
<td>Viktor Karnaukh, FEBRAS-POI</td>
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<td>Marine chemistry</td>
<td>Leif Anderson, Göteborg University, Igor Semiletov, IARC, FEBRAS-POI</td>
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<td>Methane dynamics</td>
<td>Igor Semiletov and Natalia Shakhova IARC, FEBRAS-POI</td>
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<td>Physical oceanography</td>
<td>Göran Björk, Göteborg University</td>
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<td>Sedimentology</td>
<td>Oleg Dudarev, FEBRAS-POI</td>
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<td>Trace elements and their isotopes</td>
<td>Per Andersson, Swe Museum of Natural History, Don Porcelli, Oxford Univ.</td>
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</table>
• Oceanography, CTD, turbidity

• Marine chemistry, nutrients, carbonate system & CFC

• Meteorology/fluxes CH₄ & CO₂, ADCP

• Biogeochemistry, DOC, TOC, POC δ¹³C-POC

• TerrOC biomarkers, ¹⁴C-TerrOC biomarkers

• Sedimentology/mineralogy

• Geophysics/geology
• Surface waters from the mixed layer collected using a 14m glasfibre flagpole extended 7m from the bow. Water was pumped directly into a lab container

• Go-Flo (60L) on a Kevlar line to obtain waters from below the mixed layer

• On board filtration 0.22μm membrane filters. Ultrafiltration in surface water using Millipore prep scale system

• Planned analytical work
  Fe concentration (surface waters) and Fe isotopes (in particles). Luleå university of Technology (LuTU)
  Trace metals (Al, Ni, Cd, Cu, Co, Mn). LuTU, Oxford university (OU)
  Trace metal speciation. Stockholm university (SU)
  Nd isotopes, REE, Ba, U-Th and Cr. Swedish Museum of Nat. Hist. (NRM) and OU
  Hf isotopes, Geomar, Germany
  Cd isotopes, Imperial College, London
  He isotopes, Scripps Inst. of Oceanography
  Si isotopes, LuTU
  O isotopes (in water), SU
  $^{234}$Th in water and particles, SU. (no counter onboard, samples analysed after returning to Stockholm)

• First results will be presented at the Goldschmidt meeting in Davos, June 2009
Is coastal erosion contributing more particulate organic matter to the Arctic Seas than all rivers combined?

Coastal erosion transect
The subsea permafrost methane issue

Methane hydrates exist in the tundra and in the sediment underneath the shallow shelf seas. The subsea methane is exposed to warmer surroundings (seawater)

Amount of methane hydrates under ESAS is $1000 - 3000 \times 10^{15}$ gC

Climate models: 1% of this CH4 to the atmosphere sufficient to cause abrupt climate change (Archer, 2006)
Filtration of water samples on R/V Yakov Smirnitsky
Rare Earth Element and Nd isotope input to the Arctic Ocean: The importance of rivers and geochemical processes on the shelf

(Porcelli et al. 2009; Andersson et al. 2008)
Nd isotopes (143Nd/144Nd) in the Arctic Ocean:
The importance of exchange processes on the shelf

(Porcelli et al. 2009; Andersson et al. 2008)
• Successful Russian-Swedish coordination of 45-day complex oceanographic expedition on Siberian Arctic Seas

• Contribution to alleviate scarcity of biogeochemical and geophysical observations on the East Siberian Arctic Seas

• Field data and samples collected from 130 stations; lab work in progress
Conclusions from ISSS for the future GEOTRACES plans in the Arctic

• The importance of the large Siberian shelf areas for the input of elements to the central Arctic Basin

• Large freshwater input

• Carbon storage in permafrost