The International Siberian Shelf Studies: selected results and challenges of 2012

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- Scientific plan for 2012
 Activities accomplished
 Key findings
 Conclusions
- Future plans

Scientific motivation



The total area is 2.1×10⁶ km² area (~25% of the Arctic Shelf, ~8% of the World Ocean's continental shelf;

 ~75% is shallower than 50 m (mean depth of the continental shelf is 130 m); sedimentary basins are up to 20 km thick; C_{org} content is up to 12%.

 shallowness determines alteration of dry position (cold epochs)/ submerged position (warm epochs), which occurs due to lea level fluctuation

Basic component of the ESAS environment is sub-sea permafrost



A) 80% of the total area of subsea permafrost (shown in lilac) is in the ESAS;



B) Shallow hydrates underlain more than 80% of the ESAS area (shown in grey).

The ESAS accumulates fresh water from 6 Arctic Siberian Rivers and it is major ice factory of the Arctic Ocean



 6 Siberian Rivers – Khatanga, Olenek, Lena, Yana, Indigirka and Kolyma bring their waters to the ESAS – 7x10¹¹ m³

 Total area of watershed of the Lena River alone is comparable with that of the ESAS (2.5x10⁶) km²

Scientific plan for 2012

Goal: Detect regional environmental changes identifying major processes and factors controlling CO₂ and CH₄ releases from the ESAS to quantitatively assess current and future atmospheric emissions.

Major targets:

- Thermodynamic features and current state of subsea and coastal permafrost;
- 2) Formation of gas migration pathways;
- 3) Role of water/sediment warming, winds and hydrological factors in transport of CH_4 ;

Drilling-2012



A) Location of 15 winter (March 20-April 15, 2012) oceanographic stations (red circles), electromagnetic stations (blue circles), and drilling sites (black tower) accomplished; dotted line shows location of the open water trench in the fast ice; B) Thermal data from the borehole 2D-12

Drilling campaign 2012: logistics



Drilling campaign 2012:Challenges



The open water trench in the fast ice (*C*, *E*), which propagated from the thousand end of Bour-Khaya Bay northward to the Lena Polynya that restricted the study area and prevented the expeditions from drilling in the hot spot areas targeted for drilling in 2011 and 2012 (photo by I. Semiletov)

Another challenge of the drilling campaign-2012



<u>Goal</u>: To improve understanding of the current state of subsea permafrost



Bubbles visually observed in the sea ice (A) and recorded by ROV (B)



Results of in-situ experimental work performed in the ESAS in winter-2012





Lithology and geochemistry of the drilling core (2012)



Grain-size composition of the sediments: 1 - medium sand, 2 - fine sand, 3 - silty sand, 4 - clayey silt, 5 Đ silty clay. Sediments textures: 6 - cryogenic (dense dehydrated silty sand), 7 Đ layered, 8 Đ lenticular. Inclusion: 10 - gravel and pebble components, 11 - plant detritus.

Study area: summer-2012



A) Round trip vessel track starting from Murmansk: B) Location of 50 stations performed during September 1-October 12, 2012; C, D, E) Density of the transects performed to obtain geophysical and electromagnetic data in P1 (C), P2 (D), and P3 (E)

New temperature data contributing to the benthic temperature reconstructions

Locations of the benthic temperature measurements



The red crosses mark the region within which a warming effect of the Lena River outflow is significant.

Mean summer temperature trend in the coastal zone







Red triangles represent in-situ measurements (ISSS cruises).

Understanding sufficiency of the microbial bio-filter



Methane oxidation rates determined with tritium-labeled methane tracer, were ranging from **10's of picomoles per liter per day to 3 nM per liter per day**. The turnover time for the methane pool was hundreds to thousands days. *This points to insufficiency of the microbial bio-filter in the ESAS waters (M. Joye et al., AGU-2011 GC418-0808)*.

Conclusions

- Rates of CH₄ release from the ESAS are determined by levels of subsea permafrost degradation;
- Gas migration pathways form as a result of permafrost thaw, upward movement of gas front and ice-scouring;
- Winds history is very important as it determines significant variability of water column inventory and consequent sea-air emissions.

Planning cruise-2013

Cruise 2013 supposed to revisit stations and geophysical transects accomplished in 2011



ISSS oceanographic stations accomplished in (2003-2010)

