The Scientific Coordination between all the NOAA funded Russian-American oceanographic expeditions

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Detection of Environmental Changes: approach and scientific observations

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Motivation: to become a continuing part of NOAA Climate Observations and Analyses Program, RUSALCA must be a source of long-term climate –quality data, suitable for climate change detection and modeling (*Calder and Crane, 2005*)

Major Gaps exist in observation and modeling in the Pacific sector of the Arctic (*PSA*). Ocean including the **Bering Sea**, (which is the sea of primary common interests among the U.S., and Russia), the **eastern Chukchi Sea (CS), the East-Siberian Sea (ESS) and eastern Laptev Sea (LS)**.

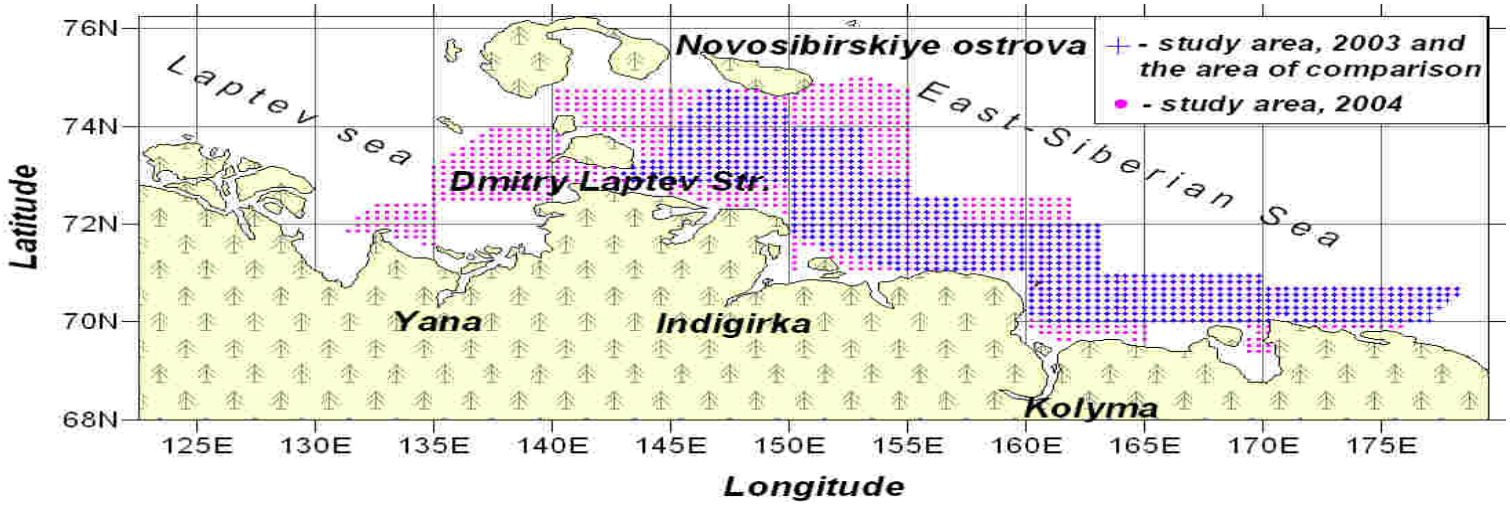
1) The Siberian portion of PSA shelf, which covers the largest part of the PSA marginal seas, has never been investigated by modern techniques (instead of a few moorings in the Bering Strait (BS), and recent RUSALKA and IARC-FEBRAS transects)) despite the progress that has been made in new technologies useful for measuring ocean characteristics of interest.
2) Although the climate significance of the enormous runoff is well recognized, the mechanism responsible for freshwater dispersal and transport over the shelves (and into the basin interior) are poorly understood. Little is known about the Siberian Coastal Current which is originated in the eastern LS-western ESS.
3) Notably, the Arctic Ocean's role in determining regional CO2 and CH4 balance has been ignored, though the role of the Siberian Arctic seas plays the role in global carbon cycling, especially in the coastal zone where the redistribution of carbon between terrestrial and marine environments occurs.

Major Gaps (continuation):

4) Characteristics of carbon exchange in the atmosphere-land-shelf system are poorly known, while permafrost thawing and degradation onshore and offshore (coastal, bottom, and riverbank erosion, gas hydrate decay and etc) may change global carbon cycling and greenhouse gas balance.

5) At present it is impossible to evaluate the Pacific effects on the Arctic ocean because mechanism of the Upper and Low Halocline Water formation and its transport and fate in PSA is still poorly known (comparable role of the CS and ESS and etc), while numerous expensive moorings, and multi-national (US, Russia, Canada, Japan) transects were already done to explore the role of the Atlantic Intermediate Water (AIW) in PSA which must be relatively small in PSA comparing with the Pacific inflow on a time scale of human concern. Note that AIW can penetrate occasionally onto the PSA shelf only at horizons below 100m.

Quantitative detection of environmental changes in the land-shelf system may be done in PSA using the approach recently described by Shakhova, Semiletov, and Panteleev (GRL, 2005). All measured parameters (hydrological and biogeochemical) are integrated through the water mass in the selected "comparing area". Each year non-expensive expedition is required to detect inter-annual changes in the long-term perspective in the coastal PSA zone.



Общее количество (запасы) избранных индикаторов (A) рассчитывалась для *области сравнения* (область, окрашенная в голубой цвет на Рис) по формуле:

$$\iint_{S,H(s)} A(s,z)\,dzds$$

где *s=(x,y)*, *z* –горизонтальные и вертикальные координаты , соответственно, *H(s)*-глубина, *A(s,z)*- пространственное распределение выбранного индикатора, величина *A(s,z)* была рассчитана путем вертикальной и горизонтальной линейной интерполяции между станциями где проводились. Впервые такая оценка для области сравнения была выполнена для расчета запасов метана (Shakhova et al., 2005)

Scientific observations: acquisition of high-frequency, long term data series or high resolution profiles are feasible and artifacts resulting from filtration or sample storage can be avoided when measurements are made using the WETStar DOM fluorometer (*Belzile, Roesler, Christensen, Shakhova, and Semiletov, CSR, 2005,accepted; Semiletov, Shakhova, and Belzile, GRL, 2005, in preparation*)

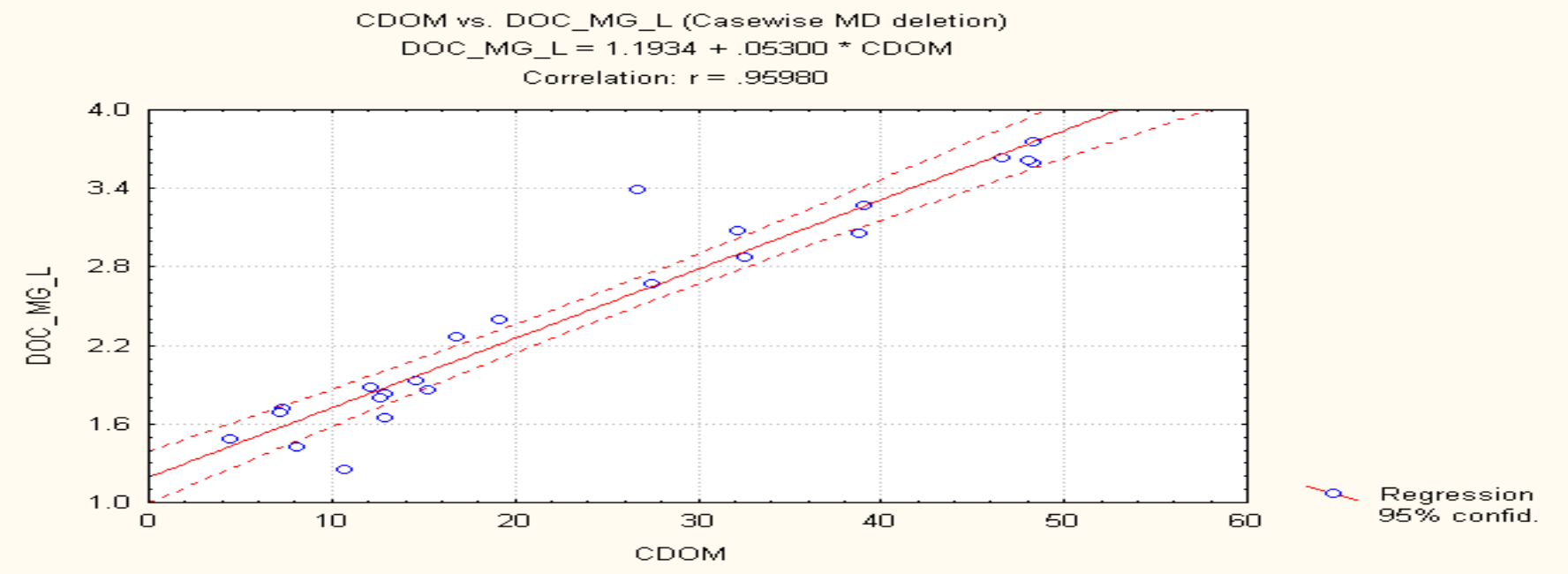


Fig.Correlation between values of CDOM (detected usin WELStar CDOM sensor) and DOC.

Корреляция между значениями *CDOM* измеренного с помощью WETStar CDOM fluorimiter и значениями РОВ (на оси ординат обозначен как *DOC*).

Результаты сравнения величин CDOM с величинами РОУ (DOC), измеренными в лабораторных условиях, показали высокую линейную зависимость (r=0.96), что позволило рассчитать величины РОУ по результатам прямых измерений CDOM по формуле:

РОУ =1.1934 + 0.53*CDOM

Scientific observations: Correlation (r=0.95) found between NTU values measured by D&A OBS-3 (mounted on the Seabird-19+) and PM concentration (measured by filtering technique) was used to obtain high resolution profiles and detail time-space PM dynamics in the ESS and other Siberian Arctic seas (Semiletov, Shakhova, Dudarev, GRL, in preparation).

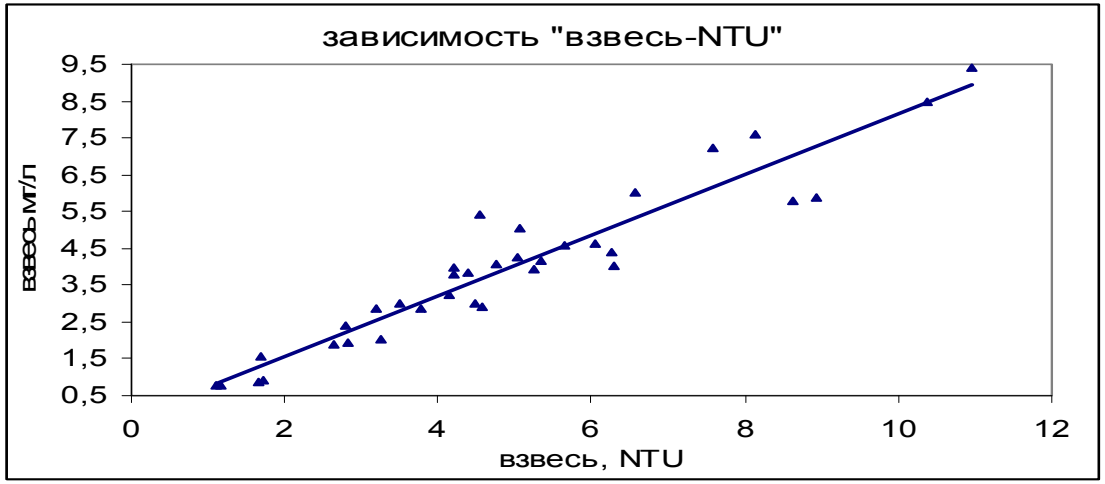


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Рис. Калибровочный график для пересчета данных по содержанию взвеси полученных датчиком D&A OBS-3 ***установленном на*** **зонде «Sea-Bird SBE19plus».**

связывающий данные измерений концентрации взвешенного вещества (ВВ) с помощью зонда (turbidity) и их реальной концентрацией полученной методом ультрафильтрации. При помощи данного графика была получена формула зависимости «взвешенное вещество (PM)– NTU»:

$$PM=0.8228*NTU-0.0804 \qquad (12)$$

На основе уравнения (12).были рассчитаны реальные значения концентрации взвеси (ВВ) по данным зондирования, выполненных в 2003 и 2004 годах. Оказалось, что погрешность зондовых измерений составляет 0,66 мг/л (коэффициент корреляции между значениями NTU и ВВ, r=0,95), что позволяет использовать *результаты зондовых измерений для интерпретации динамики полей ВВ даже без калибровки по фильтрационным данным*. -

Recommendations

1) To establish non-expensive and effective monitoring for quantitative detection of environmental changes in the coastal PSA zone with focus in the ESS and CS were "starting data" are available.

2) To use the same appropriate CDOM and turbidity sensors in all RUSALKA expeditions (and RUSALKA-affiliated cruises)

3) In **climate perspective**: to validate the satellite data (1970s-present) using the advanced ship surface data. That gives an opportunity to exten modern hi-tech measurements (CDOM/DOC, turbidity and etc) over the ice-free PSA waters beyond three decades.

4) To detect **past climate changes in circulation patterns** (in term of Zn-mode vs Az mode) by exploration of changing position of the fronta zone between Pacific and local ESS waters recorded in the sediments (using approach described by Semiletov et al. (GRL, 2005). A cruise with detail coring in the key ESS area is required.

Some publications relevant for the RUSALCA goals:

Accepted, submitted, in preparation

Belzile C., Roesler C., Christensen J., Shakhova N., and I.Semiletov. Fluorescence measured using the WETStar DOM fluorometer as a proxy dor dissolved matter absorbtion, CSR, accepted (September 2005)

Semiletov I., Pipko, I, Makshtas A., Repina I., and N.Shakhova, Carbonate chemistry dynamics and carbon dioxide fluxes across the atmosphere-ice-water interfaces in the Arctic ocean: Pacific sector of the Arctic, J.Mar.Systems, to be submitted in November 2005

Shakhova N., and I.Semiletov, Methane anomalies in the Laptev and East-Siberian seas: a sign of gas hydrate decay, J.Mar.Systems, to be submitted in November 2005

Semiletov I., Shakhova N., and G.Panteleeev, Detection of Environmental changes in the Arctic land-shelf system: the East-Siberian Sea, GRL, to be submitted in December 2005

Semiletov I., Shakhova N., C.Belzile, and O.Dudarev, Variability of DOC and turbidity in the East-Siberian and Laptev seas, GRL, to be submitted in January 2006

Published

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Pipko I, Semiletov I, Tishchenko P., Pugach S., and J. Christensen, Carbonate chemistry dynamics in Bering strait and the Chukchi sea, Progress in Oceanography, 55, 2002, 77-95

Semiletov, I. Carbon cycle in the land-shelf system in the Arctic with a special eye for the importance of the East-Siberian Sea / O. Dudarev, K.-H. Shin, I. I. Pipko, et al. // Proceedings of the 4th International Workshop on Global Change: Connection to the Arctic 2003 GCCA4), (Japan, 6-7 November 2003 y.). - Toyokawa, 2003. - P. 53-58.