Evaluation of short-lived radium concentration in the Chukchi Sea, Arctic Ocean

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Introduction

The reduction in sea ice cover, lengthening of the ice melt season, and a general decrease in ice thickness result in an increase in light penetration in the Arctic Ocean and a dramatic increase in primary productivity (Arrigo et al., 2014). This leads to intense seasonal blooms of phytoplankton due to the favourable micro and macro-nutrient. The results here presented are part of research efforts in the eastern part of Chukchi Sea, with the objective is to trace Fe, a limiting nutrient for phytoplankton growth, by using Radium as an isotopic trace technique. These data present high concentrations of the short-lived Radium isotopes ^{223}Ra and ^{224}Ra in the study region.

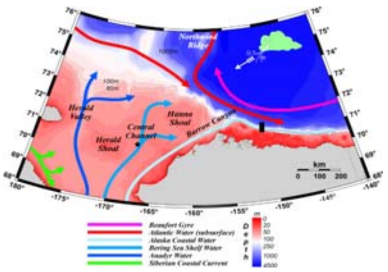

Fig. 1: Map of the circulation over the Chukchi Sea showing the three branches of the inflowing Pacific water. Image courtesy from Seth Danielson, UAF.

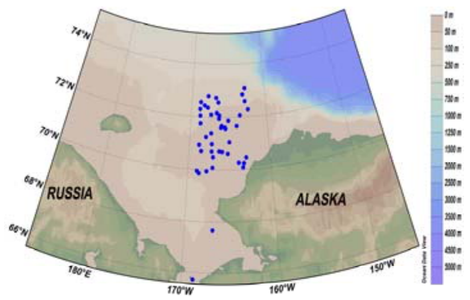

Fig. 2: Chukchi Sea map showing sampled stations during the SUBICE 2014 cruise.

Methods

During the SUBICE program, we sampled the Chukchi Sea continental shelf in the period 14 May - 20 June 2014 onboard the USCGC *Healy*. Fig 2 shows the location of the 45 sampling stations. Water samples (~ 200 L) were collected at approx. 10m depth by Niskin bottles or the ship's underway seawater supply. The water was filtered through a column filled with MnO_2-impregnated acrylic fiber (~20 g). After partially drying, the Mn-fibers were counted on a Radium Delayed Coincidence Counter (RaDeCC)

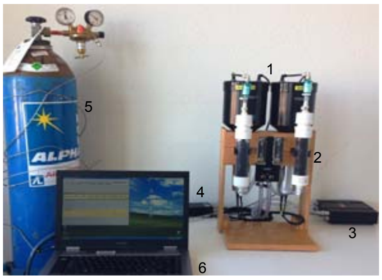

Fig.3: Two detector RaDeCC system, where: 1) Scintillation Cells; 2) cartridge filled with Mn-fibers; 3) diaphragm pump; 4) power supply amplifier; 5) helium gas bottle; 6) computer with the software developed for RaDeCC system.

Results

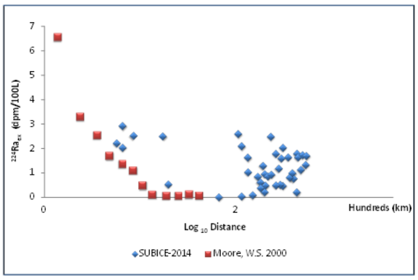

Fig. 4: Comparison between the distributions of $^{224}Ra_{ex}$ presented in Moore, 2000, and those in the SUBICE cruise.

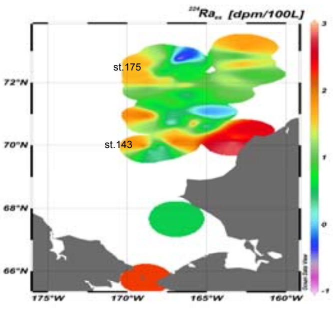

Fig. 5: Distribution of $^{224}Ra_{ex}$ concentration. Discussed stations are numbered.

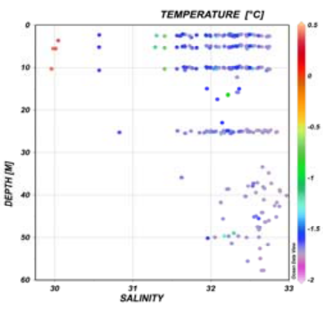

Fig. 6: Vertical temperature and salinity distribution.

- Overall high concentration of the short-lived radium isotope $^{224}Ra_{ex}$ were observed (Fig. 5), contrasting with low activity of ^{223}Ra (max. 0,13dpm/100L) - both being weakly correlated.
- At most stations the water column was fully mixed, with temperatures close to the freezing point and low salinity (Fig 6).
- The high concentrations of $^{224}Ra_{ex}$ 200-300 km offshore (Fig. 4) contrast with the pattern described in Moore (2000), who showed a near-exponential decrease for both $^{224}Ra_{ex}$ and ^{223}Ra with distance from the coast.
- The high $^{224}Ra_{ex}$ activity (e.g. 2,5 and 1,75 dpm/100 L at stations 143 and 175; 300km away from each other) cannot be attributed to the transport of radium enriched water between stations. Weingartner (2005) described a speed of 8 cm/s for the Bering Sea Shelf Water (Fig 1), whereas only a speed of 95cm/s could account for our data. Hence there was constant supply of ^{224}Ra from sediments.

Conclusion

The enrichment of $^{224}Ra_{ex}$ in the shallow Chukchi Sea waters can be explained by the substantial and constant shelf sediment supply.

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