A windy cruise at the central Baltic Sea and Gulf of Finland, cruise Salme 2015_24

Project Acronym & Title: PROSID2014 – Propagation of the saltwater inflow from December 2014

Area: Gulf of Finland, Eastern Gotland Basin, Northern Gotland Basin

Research Vessel: RV "Salme", Marine System Institute at Tallinn University of Technology (Estonia)

Principal investigator & Chief scientist: Dr. David Meyer & Dr. Michael Naumann, Leibniz-Institute for Baltic Sea Research Warnemünde (Germany)

Other project partners: Marine System Institute at Tallinn University of Technology (Estonia), Institute of Analytical Chemistry and Food Chemistry, Graz University of Technology (Austria), Dept. of Environmental Sciences /Aquatic Sciences, University of Helsinki (Finland)

Date: 2015, October 20th – 28th

RV "Salme" (© R. Prien)

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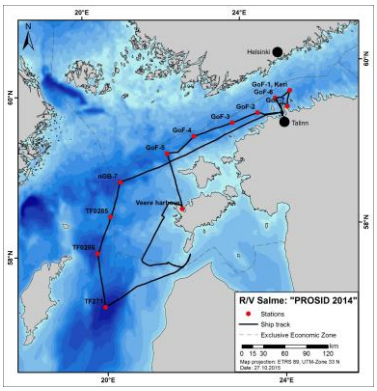

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"Summed up it was a windy week! About 60 % of the cruise was interrupted by strong wind phases which makes cruise planning adventurous. We could sample only 11 out of 50 expected stations, but used the time "waiting on weather" in sheltered areas for testing of two different pH sensor prototypes from Graz University and BONUS pinbal project. The detection of environmental changes caused by the large salt water inflow of December 2014 and methane oxidation rates was limited. Despite poor weather conditions it was a nice atmosphere on board, even in harsh conditions the good mood continued and time was spent for comprehensive discussions on various marine topics. Close contacts for upcoming studies were build. In September 2016 the sensor groups met again in Warnemünde and planned future developments and testing scheme" – Dr. Michael Naumann, Leibniz-Institute for Baltic Sea Research Warnemünde (Germany)

Main objectives

The cruise was used gathering hydrographic, chemical, biological and geological data in the Gulf of Finland, Eastern Gotland Basin and Northern Gotland Basin to follow the environmental change in the deep-water of the central Baltic Sea caused by the Major Baltic Inflow of December 2014. The ecological state of the Baltic Sea depends crucially on the periodic deep water renewal by means inflow events of saline oxygen rich water. Due to the strong density stratification these inflows are the solely source of deep water ventilation. Since the early 1980's the frequency of inflow events has fallen dramatically from 5 to 7 major inflows per decade to only one inflow per decade. This December 2014 inflow is classified as one of the rare very strong events and third largest in the history of measurements since the year 1880. The measurements of this cruise contribute to a high resolution dataset of the changing ecosystem by the inflowing water in a row of 17 cruises during the year 2015.

Following specific scientific questions are worked on:

1. How the saline and oxygen rich water masses of the MBI are distributed?
2. How do the properties of the hydrological regime have changed?
3. Is there any effect on the ecosystem?
4. Did a new stagnation period and thus the return of hypoxic conditions already started?
5. How much water and salt is transported through the Northern Baltic and into the Western Baltic and the Gulf of Finland, respectively?
6. Research and development of pH, Alkalinity and CO_2 sensor systems.

Work progress and main achievements

Ecosystem change in the central Baltic Sea (questions 1-5)

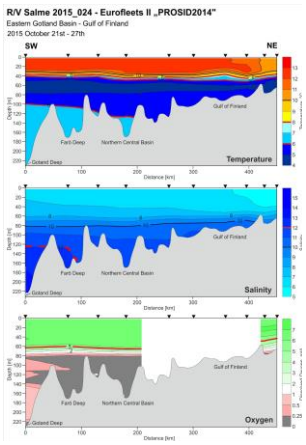
For this topic the outcome is sparse, limited by the low number of measured stations. The ventilation of the Eastern Gotland Basin since spring/summer 2015 can be traced, but in the northerly areas stagnation and oxygen deficiency are still dominating. High oxygen consumption rates turned the Eastern Gotland Basin back into a hypoxic state already 6 months after the starting ventilation of the Major Baltic Inflow of December 2014. At farther north areas, like the Farö Deep, the salinity although slightly increases, but is not yet influenced by the inflowing water. This increase is related to uplifted and transported former bottom water of Gotland Deep. The overflow of these water leads to a decrease of hydrogen sulphide in the Farö Deep.

Analysis of methane, nitrous oxide and determination of methane oxidation rates

In the framework of this study we investigated the effects of the Major Baltic Inflow event (December 2014) on the concentration of CH_4, N_2O and the microbial methane turnover in the water column of the central Baltic Sea. Gas extractions from water samples were carried out onboard to determine CH4, N_2O concentrations and the stable carbon isotopic composition of methane. Furthermore, ^{14}C incubation experiments were performed in the onboard laboratory to investigate the pelagic methane turnover. The collected gas samples were analyzed using gas chromatography and isotope ratio mass spectrometry and the incubation experiments further processed at the laboratory of the University of Helsinki.
The generated data will be integrated and published within a long term observation study of CH4 and N2O dynamics within the central Baltic Sea and will further support the process understanding of microbial methane oxidation in marginal seas.

Research and development of pH, Alkalinity and CO_2 sensor systems

Two different pH measurement techniques were applied and compared during the cruise (TU Graz: pH optode that was mounted to the CTD for in-situ measurements and also connected to the Ferry Box system; IOW/ BONUS pinball: spectrophotometric pH measurements of discrete samples taken from the CTD casts and another flow-through system that continuously measured surface water pH taken from the Ferry Box system). During the meeting with RV “Poseidon” the flow-through system was also operated from Poseidon with water supply from IOW’s pump CTD to obtain a high resolution profile. Furthermore tests and validation of new developed optodes for carbon dioxide (TU Graz) were conducted stepwise and in profiling mode. The evaluation of the measured response of the carbon dioxide sensor showed an erratic increase of CO_2 at around 40 m. For all these sensor development topics more data than expected could be obtained, because the waiting time in sheltered areas of the island Saaremaa was intensly used. Despite this we did a coastal excursion at the island and explored isostatic uplifted former coastlines, typical



Cross sections from the eastern Gotland Basin to the Gulf of Finland showing temperature, salinity and dissolved oxygen. (© M. Naumann)

Development of pH sensors TU Graz & IOW (© M. Naumann)

For more information: http://www.io-warnemuende.de/baltic-inflow-of-december-2014.html

http://www.io-warnemuende.de/pinbal-home.html

http://analytchem.tugraz.at/analytchem_contao/index.php/chemo-und-biosensorik

http://www.helsinki.fi/ymparistotieteet/english/nitrogen.html