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SHORT COMMUNICATION

The inflow in the Baltic Proper as recorded in January—February 2015

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Summary Inflowing saline waters of the Major Baltic Inflow (MBI) in 2014 were recorded in the Baltic Proper in January 2015. After 12 years of stagnation, this inflow brought highly saline (about 20) waters into the Bornholm Basin. As in the previous inflow in January 2003, saltwater moved in the near-bottom layer with a current speed of approx. 25 cm s^{-1}. This paper presents data collected in January and February 2015 and compares them to earlier records from 2000 to 2014.

1. Introduction

Since the 1980s stagnation without any inflow has become the usual state in the deep waters of the Baltic Sea (Dahlin et al., 1993; Jakobsen, 1995; Liljebladh and Stigebrandt, 1996; Matthäus and Lass, 1995). However, extreme non-periodic saltwater inflow events, exchanging water between the North Sea and the Baltic, occur at different intervals, ranging from a few years to about a decade (Franck et al., 1987; Matthäus and Franck, 1992). The occurrence of inflows depends mainly on atmospheric forcing, and over 90% of such events take place during late autumn (Matthäus and Franck, 1992). Until the 1980s the longest period without an inflow event was about 3 years; thereafter, however, a decade elapsed between the major inflows observed in 1983, 1993 and 2003 (Franck et al., 1987; Piechura and Beszczyńska-Möller, 2004). Already over 11 years had passed since the last such event in January 2003. Measurements carried out by the Institute of Oceanology, Polish Academy of Sciences (IO PAN) in January 2015 revealed record-high salinities in the deep layers of the Baltic Proper.

Large inflows (100—250 km^3), usually carrying highly saline waters (salinity 17—23 PSU), represent the most important mechanism by which the deep waters of the Baltic Sea are displaced and renewed (Franck et al., 1987; Matthäus and Franck, 1992). The inflows propagate over the bottom but still substantially mix with the overlying surface water (Burchard et al., 2005; Stigebrandt and Gustafsson, 2003).

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Small inflows (10—20 km^3) are insufficient to displace the deep waters and, because of their much lower density, are eventually trapped between the halocline and bottom water on their pathway (Matthäus, 2006; Stigebrandt, 2001). Large and medium-sized inflows are extremely important to the ecosystem, because they oxygenate the deep basins of the Baltic Sea (Matthäus and Lass, 1995).

The main aim of this paper is to describe the recent saltwater inflow from the North Sea into the Baltic Proper as recorded after passing the Danish Straits and the Arkona Basin.

2. Material and methods

2.1. Study area

The high-resolution hydrographic transects used in this paper were obtained using a towed profiling CTD (Conductivity, Temperature, Depth) system. The main transect (Fig. 1) ran along the axis of deep basins, starting from the Arkona Basin (AB), through the Bornholm Deep (BD) and the Słupsk Furrow (SF), and ending in the Gdańsk Deep (GD).

Since 2000 repeated hydrographic measurements, focused on monitoring the origin of waters flowing into the southern Baltic, have been made in different seasons (at least 4 times per year) during regular cruises of r/v 'Oceania' (Fig. 2). This paper focuses on measurements made during two cruises in 2015 (on January 5—9 and February 23—27).

2.2. Field data

The profiling system consisted of a CTD probe (Seabird 49) suspended in a steel frame towed on a cable behind the vessel (Paka et al., 2006). To ensure measurements of high quality, the temperature and conductivity sensors were calibrated annually by the manufacturer. The suspension system maintained the probe in a horizontal position during profiling, the steel frame protected it from mechanical damage, while a chain fixed below the frame reduced the risk of bottom contact. To obtain a profile, the CTD system was lowered and raised between the surface and bottom by releasing or hauling in a towing cable. The horizontal resolution of about 200—500 m was obtained at a constant ship speed of approx. 4 knots for a basin with a typical depth of 60—120 m. With the CTD probe operating at a frequency of 10 Hz, the vertical resolution of the towed measurements was about 30 measurements per metre. Since 2013, high-resolution profiles of dissolved oxygen concentration have been obtained along the hydrographic transects with the Rinko-I sensor mounted on the towed system.

The velocity and direction of sea currents were recorded continuously using the vessel-mounted Acoustic Doppler Current Profiler (RDI ADCP 150 kHz), set up with a cell width of 4 m.

Data provided by the International Council of the Exploration of the Sea (ICES) were used to extend the Bornholm Deep distribution of temperature and salinity. ICES Oceanographic database, Extractions January 1978—December 1995; Hydrological data. ICES, Copenhagen.

3. Results

During the recent inflow, the temperature distribution along the main transect was slightly different from the typical winter situation in the last decade (Rak and Wieczorek, 2012) in that the waters in the Bornholm Deep and Słupsk Furrow in January 2015 were slightly warmer (about 10°C) than the surrounding ones (Fig. 3). This warm layer was about 10 m thick in the Bornholm Deep and almost twice as thick in the Słupsk Furrow. In the Słupsk Furrow the warm layer was formed by the waters previously occupying the deep layer of the Bornholm Deep, which were raised to 50 m depth and in consequence were able to pass over the Słupsk Sill at the

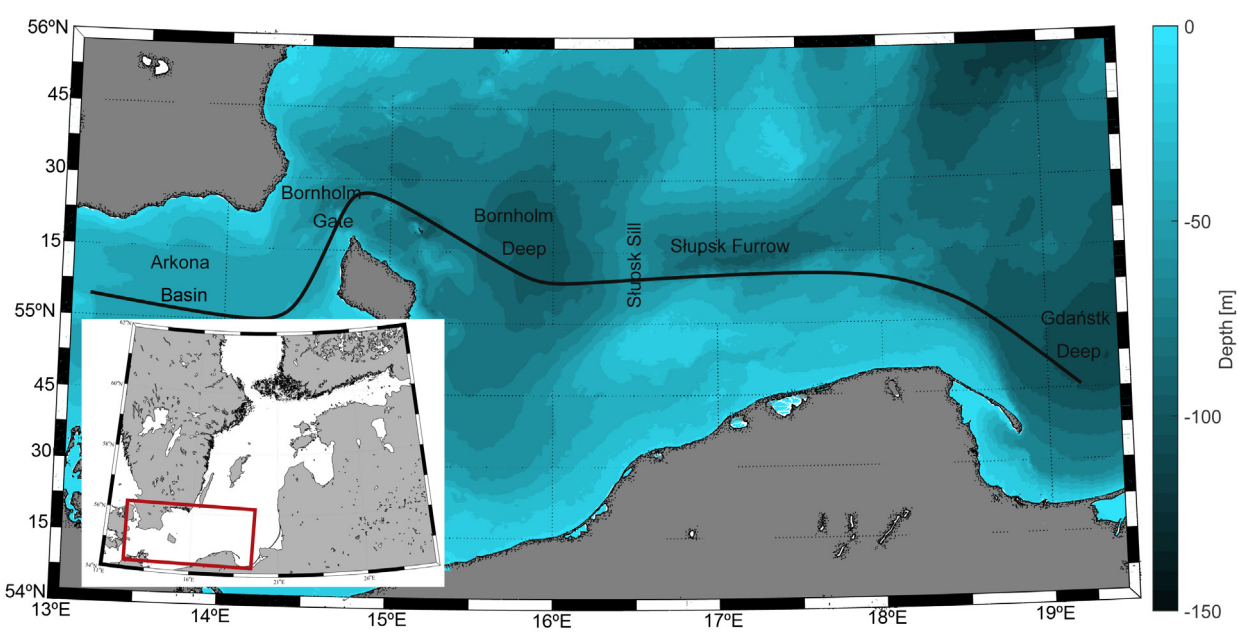

Figure 1 Location of measurements. The main hydrographic transect along the deep basins of the Baltic Proper (2000—2014) is shown as a black line.