Use case: CMEMS INSTAC Products in the Baltic Sea

Approach: the Swedish Meteorological and Hydrological Institute (SMHI) proposed different products based on numerical models and in situ data (http://www.smhi.se/hfa_coord/BOOS/boos.html).

Product used:

- Baltic Sea - In Situ Near Real Time Observations [INSITU_BAL_NRT_OBSERVATIONS_013_032].
- Baltic Sea - In-situ Observations Yearly Delivery in Delayed Mode (1990-2014) [INSITU_BAL_TS_REP_OBSERVATIONS_013_038].

Accumulated inflow in the Baltic Sea through the Öresund

The Baltic Sea is a semi-enclosed sea with open boundary towards the North Sea. The water and salt exchanges take place through the Danish straits: the Öresund, the Great Belt and the Little Belt.

Located between Denmark and Sweden (Fig. 1), Öresund is the fastest and therefore the most important connection for the inflowing water from Kattegat to the deeper parts of the Baltic Sea, where ventilation of the bottom layers is dependent on the intrusions. The inflows are restricted by the shallow sill depth in Öresund of 8 meters. The Great and Little Belts, with a sill depth of 18 meters, are located between the Danish islands further to the west and imply longer transits, which result in a higher rate of dilution of the incoming ventilating water.

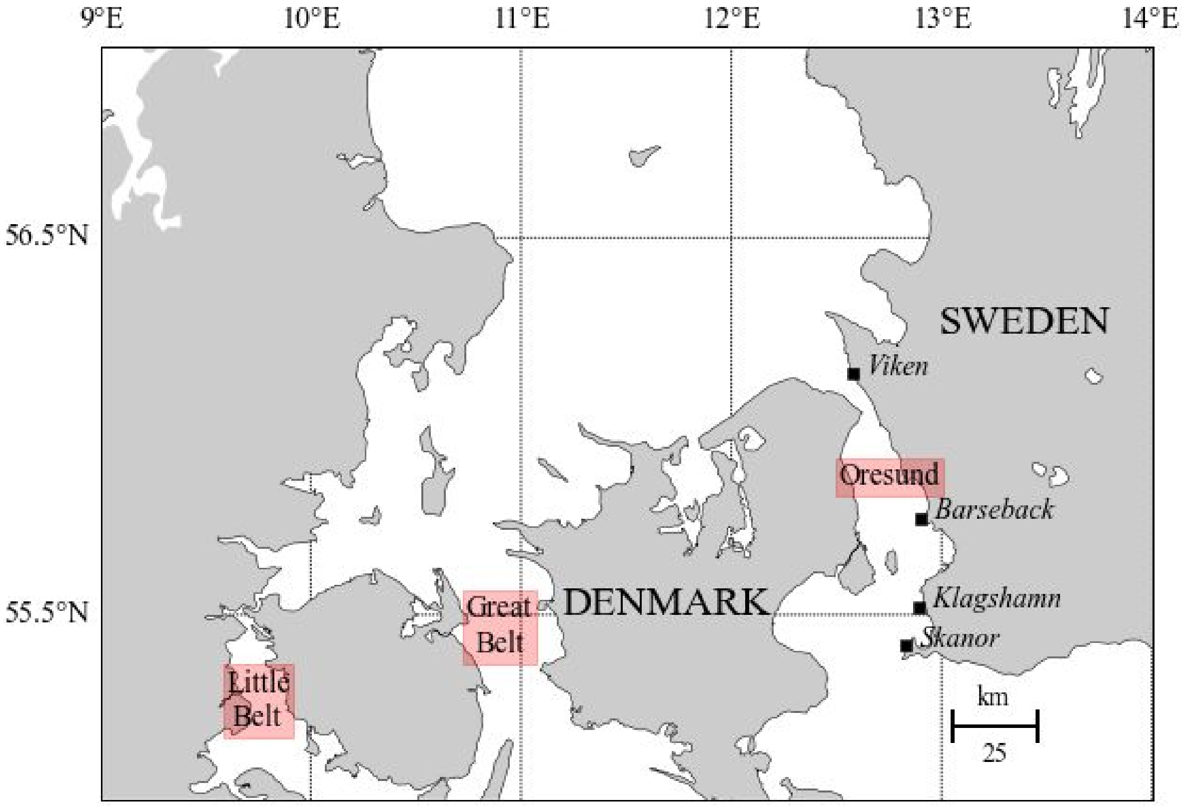

Figure 1. Map over the inflow area with the three Danish straits highlighted.

The inflow through the Öresund regulates the salt transport into the Baltic Sea and hence the stratification. Due to the strong stratification of the Baltic Sea the bottom layers easily becomes oxygen deficient, it has been shown that the Baltic ecosystem and the fish stocks are sensitive to the salinity conditions [Lintrup 1999]. The primary reason to monitor the inflows is due to the low oxygen level in the Baltic Sea bottom layers. The bottom layers are replaced (fully or partly) by intrusions of denser water which pushes, lifts and mixes the old bottom water. The inflowing water from Kattegat is denser, with higher salinity and has a higher concentration of dissolved oxygen due to more recent contact with the atmosphere.

Product

The inflow is calculated from the sea level difference over the entrance, using the measurements from *Viken* and *Klagshamn* stations (Fig. 2). Time series of accumulated inflow are available from 1977 to now (http://www.smhi.se/hfa_coord/BOOS/Oresund.html). They show the seasonal and inter-annual variability of the signal.

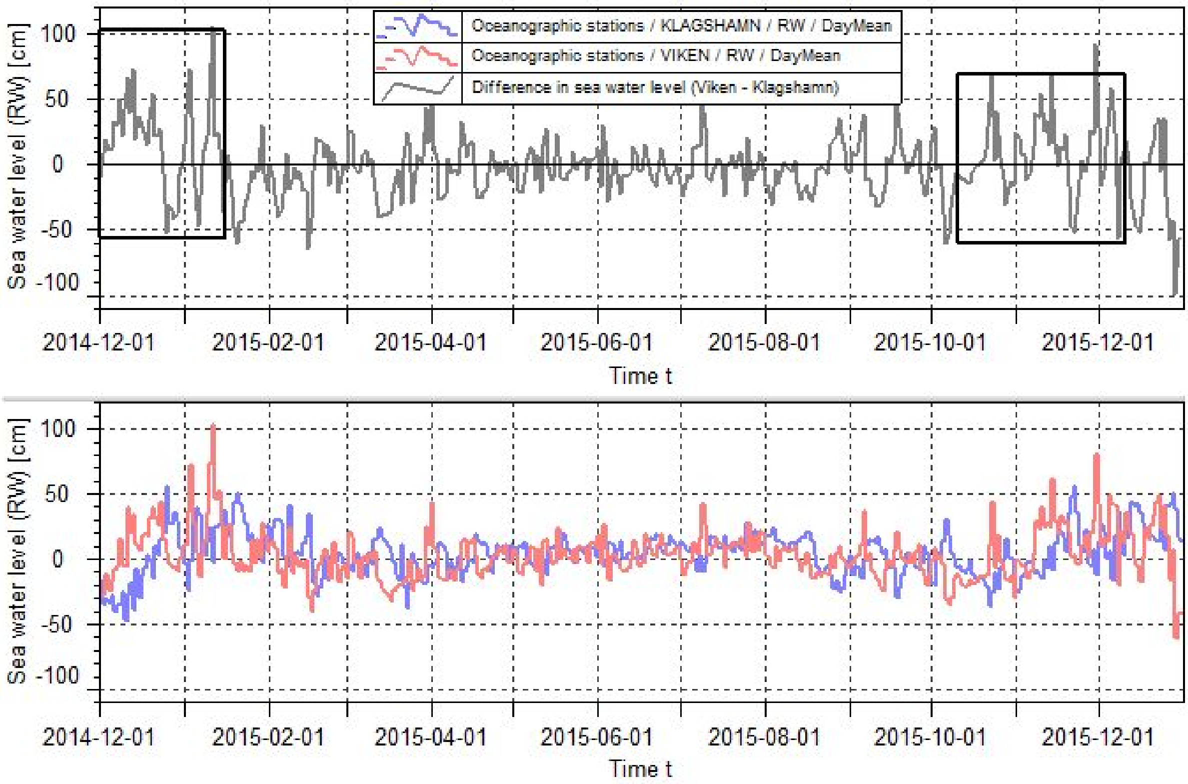

Figure 2. Lower panel showing sea water level in Klagshamn (blue) and Viken (red). See Fig.1 for locations. Upper panel showing the difference in sea water level between Viken and Klagshamn. Occasions when sea levels at Viken is higher than or comparable to the sea level at Klagshamn (favorable for inflows), are marked with black rectangles.

The 2015 accumulated flow (Fig. 3) exhibits a positive value for the first weeks of the year, then the accumulated inflow is negative for the rest of the year. An extreme event of Baltic inflow took place in January 1993 (Fig. 4), possibly the strongest event of the 20th century [Jakobsen 1995]. Salinity measurements indicated values increasing from 9 to 27 PSU in a few weeks during that month.

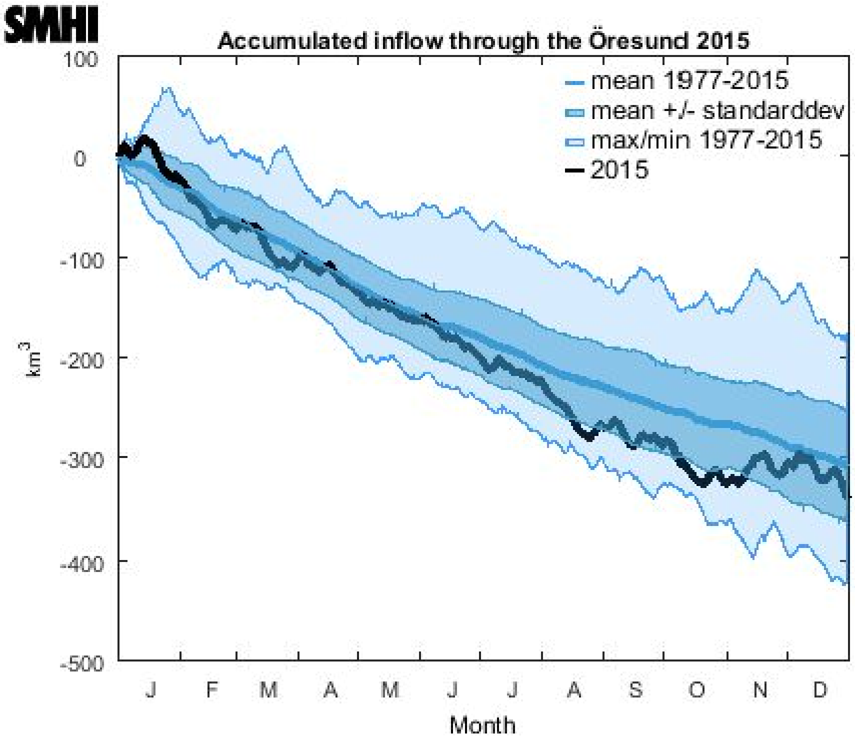

Figure 3. Accumulated inflow through the Öresund in 2015.

References

F. Jakobsen (1995), The major inflow to the Baltic Sea during January 1993, *Journal of Marine Systems*, **6**: 227-240

M. J. Lintrup and Fl. Jakobsen (1999), The importance of Öresund and the Drogden Sill for Baltic inflow, *Journal of Marine Systems*, **18**: 345-354. doi: 10.1016/S0924-7963(98)00018-9

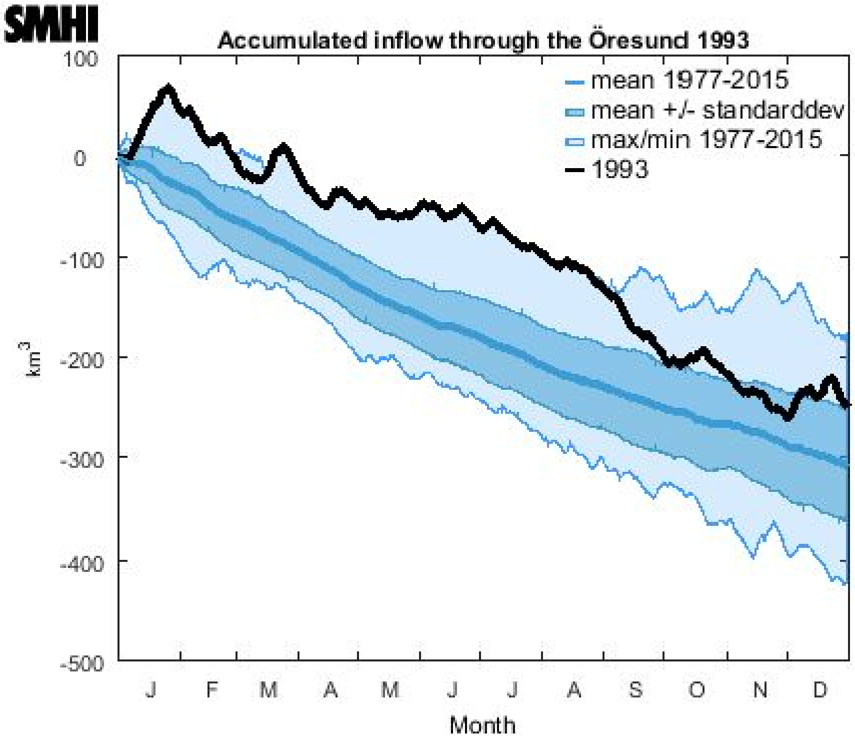

Figure 4. Accumulated inflow through the Öresund in 1993.