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Variability of Atmospheric Circulation Patterns associated with Major Baltic Inflows

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Due to the narrow and shallow Danish Straits the water exchange between the North Sea and the Baltic Sea is greatly restrained. As a consequence the salt flux into the Baltic Sea is reduced, so that during stagnation periods where no strong inflows occur the permanent halocline weakens, and even disappears in some basins. Only Major Baltic inflows (MBIs), when large volumes of highly saline and oxygenated water invade over the sills, are capable to flow as dense bottom currents into the central deeps and replace the stagnant water there, simultaneously improving living conditions to biota. MBIs are typically forced by a sequence of easterly winds lasting for about 20 days followed by strong to very strong westerly winds of similar duration. Since the mid-1970s, the frequency and intensity of major inflows have decreased, and they were completely absent between February 1983 and January 1993.

As the major inflows are mainly forced by the atmosphere, the reason for this kind of change is assumed to be connected to variations in the atmospheric circulation. There have been several studies where the changes in regional atmospheric circulation have been described through local wind climatology or modes of large scale low-frequency circulation variability, defined by means of principal component analysis. Another way to describe atmospheric circulation patterns is by classifying them into different atmospheric circulation types. The latter are well suited for describing sequences of circulation patterns in appropriate temporal (in hours) and spatial (regional to local) scales. Circulation types reflect real circulation patterns, which are easy to interpret, unlike the modes of variability, that cannot be considered as typical patterns of airflow, but just as building bricks for describing variability of the atmospheric circulation. Hence, our aim was to characterize the variability of sequences of atmospheric circulation patterns at the time of MBIs, to use this knowledge for studying their recurrence in different time periods.

We defined the patterns of air flow over the Danish Straits by using the Jenkinson-Collison types (JCT) of atmospheric circulation. The JCT is based on six different flow indices, that quantify the zonal and meridional airflow and its vorticity. JCT could be called also synoptic weather types, which describe the positions of cyclones and anticyclones that determine the airflow. The gridded dataset of sea level pressures from NCEP/NCAR Reanalysis have been classified for 6 hourly data subsets into 26 circulation patterns over the period 1948-2013.

The sequence and variability of circulation patterns over 60 days long periods, including 30 days before the main inflow period have been analyzed. During all 11 MBI events there was dominant SW, W or NW air flow, with very similar zonal gradient at the first day of inflow for all cases. The pre-inflow period was dominated by anticyclonic vorticity, while during the inflow period and the post-period cyclonic vorticity prevailed. These conclusions are in good accordance with previous studies. However, the detailed inspection of the JCT flow indices revealed high variability.