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Pathways of deep cyclones associated with large volume changes (LVCs) and major Baltic inflows (MBIs)

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Large volume changes (LVCs) and major Baltic inflows (MBIs) are essential processes for the water exchange and renewal of the deep stagnant deep water in the Baltic Sea deep basins. MBIs are considered as subset of LVCs transporting with the large water volume a big amount of highly saline and oxygenated water into the Baltic Sea. Since the early 1980s the frequency of MBIs has dropped drastically from 5 to 7 events to only one inflow per decade, and long lasting periods without MBIs became the usual state. Only in January 1993, 2003 and December 2014 MBIs occurred that were able to interrupt the stagnation periods in the deep basins of the Baltic Sea. However, in spite of the decreasing frequency of MBIs, there is no obvious decrease of LVCs. Large volume changes have been calculated for the period 1887-2014 filtering daily time series of Landsort sea surface elevation anomalies. The Landsort sea level is known to reflect the mean sea level of the Baltic Sea very well. Thus, LVCs can be calculated from the mean sea level variations. The cases with local minimum and maximum difference resulting of at least 100 km^3 of water volume change have been chosen for a closer study of characteristic pathways of deep cyclones. The average duration of a LVC is about 40 days. During this time, 5-6 deep cyclones will move along characteristic storm tracks. We obtained three main routes of deep cyclones which were associated with LVCs, but also with the climatology. One is approaching from the west at about 58-62°N, passing the northern North Sea, Oslo, Sweden and the Island of Gotland, while a second, less frequent one, is approaching from the west at about 65°N, crossing Scandinavia south-eastwards passing the Sea of Bothnia and entering Finland. A third very frequent one is entering the study area north of Scotland turning north-eastwards along the northern coast of Scandinavia. Thus, the conditions for a LVC to happen are a temporal clustering of deep cyclones in certain trajectory corridors. We also found an increasing linear trend of the number of deep cyclones for the period 1950-2010.