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Atmospheric forcing of coastal upwelling in the southern Baltic Sea basin

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Upwelling, defined as an ascending motion of deeper layer water to the surface, is driven mainly by atmospheric conditions. In the moderate climate zone, the phenomenon is best recognized in summer, when the strongest stratification in the marine environment is found and warm surface waters overlay colder deeper water masses. Therefore only summer months (Jun-Aug) were taken to the analysis in this study. Upwelling cases were identified on the basis of the daily mean sea surface temperature maps from the period 1982-2017 derived from the NOAA OI SST V2 High Resolution Dataset. Atmospheric conditions were considered as the pressure fields and the following wind characteristics over the region of the study. The pressure patterns of different spatial scales were taken into consideration and their contribution to triggering or suppressing upwelling was evaluated. Indices of macroscale circulation patterns, such as the North Atlantic Oscillation, East Atlantic and Scandinavian were derived from NOAA Climate Prediction Center datasets and engaged to the analysis. Furthermore, local circulation indices (zonal and meridional) were computed using NCEP/NCAR sea level pressure reanalysis data, and their correlations with upwelling events along different coast sectors within the southern Baltic Sea basin were evaluated. Upwelling along semi-zonally-oriented coastal sections, such as the Polish coast and southern parts of Swedish coast appeared to be sensitive to the zonal circulation. Finally, regional circulation patterns inducing/inhibiting upwelling in particular coast sections were recognized and described as the fields of sea level pressure and accompanying wind conditions (ERA-Interim data used to this end). For example, circulation pattern with an anticyclone spreading over north Europe and having its center over Scandinavia induces the north-eastern flow, which causes upwelling along the Polish Baltic coast. The opposite pressure conditions with a trough of low pressure encompassing Scandinavia cause a western flow over the southern part of the Baltic basin, which efficiently inhibits the process of upwelling along this coastal section. Concluding, it can be stated that in the Baltic Sea, which is a semi-enclosed basin of a relatively small size, upwelling is a frequent phenomenon observed almost constantly along different coast sections. Its occurrence strongly depends on prevailing wind conditions which are a consequence of regional and macroscale pressure patterns.