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The effects of wind and waves on in-situ surface drift in the Baltic Sea

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Wind and waves often have a strong influence on surface drift, especially in the strongly stratified Baltic Sea. However due to the limitations of wave models and analytical solutions, the quantification of the influence of the waves is a complicated problem. In this study we employ a more observational approach by utilizing one of the longest time series of in-situ surface drifters deployed in the Gulf of Finland, Baltic Sea for the period of 2011–2019. Analysis is performed both qualitatively and quantitatively to understand the effects of the wind and waves on surface drift. The forty-seven in-situ surface drifters utilized were designed to follow the uppermost 2 m layer of currents. In addition, a web-based software (DrifterTrack) was specifically developed for real time data monitoring, data collection, storage and access solution. The wind and wave data were obtained by wave buoys and meteorological stations located in the central part of the gulf.

Several hypothesis tests combined with statistical analysis of drifter trajectories, wind and wave data were utilized for the analysis. Qualitatively the drifter trajectories displayed a variety of shapes and maneuvers, hinting the complexity of the surface drift. Nevertheless, drifter trajectory maps showed for most years a predominance of surface drift towards the east which also coincides with the predominant wind and wave direction. Interestingly the results also suggest that when surface drift towards the west occurred it was generally quicker than the drift to the east. The average current speed was in the range of 0.05–0.15 m/s for approximately 45% of the occurrences. The drifter speed within the range of 0.3–0.5 m/s accounted for approximately 9% of the occurrences. The drifter speed was found to vary between 1.5–2.5 % of the wind speed. Hypothesis tests show that wave heights of >1 m (created by >10 m/s wind speed) have the most significant effect on the drifter speed within the range of 0.15–0.3 m/s. These tests also demonstrated that wind and waves effects are not the only forces influencing strong surface drift in the gulf. Several other processes (e.g. eddies, density gradients, upwellings, downwellings etc.) can substantially contribute to the surface drift.