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Wave-Current Interactions in the Southern North Sea: The Impact on Salinity

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The interplay between wind waves and currents in the coastal zone of the Southern North Sea, along with the resulting changes in the salinity distribution, are quantified using simulations with the unstructured-grid ocean model SCHISM coupled with the wind wave model WWM III. Several sensitivity runs carried out to estimate the individual contribution of different physical mechanisms and forcing demonstrated that the density gradients in the coastal zone reduce the tidal current by 18 %, whereas the wind waves enhance the circulation in some cases. The latter happens when strong winds blow resulting in long-shore currents following the western Dutch coast and the German Wadden Sea islands. The wave-induced transport of salt leads to changes in the horizontal salinity distribution, which are very pronounced in regions of fresh water influence. The weak stratification dominating the patterns of salinity in the coastal zone is mostly destroyed by wind waves. Thus, effects created by wind waves tend to substantially modify the estuarine circulation. An explanation of these important processes in the coastal zone has been given based on an analysis of ratio between significant wave height and tidal range. This control-parameter, which is relatively small under mild weather conditions, can exceed unity under strong-wind condition in the coastal zone, thus mixing due to waves becomes dominant. The effect of fresh-water fluxes from subterranean estuaries is relatively small and confined only in the vicinity of corresponding sources.