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Combined SAR/IR satellite data and circulation model analysis of upwelling in the Baltic Sea

A. Lehmann (1) and E. Gurova (2)

(1) GEOMAR | Helmholtz Centre for Ocean Research Kiel, Germany, (alehmann@geomar.de), (2) Atlantic Branch , P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Kaliningrad, Russia

Cold upwelled water can impose significant changes in the stability of the marine boundary layer as well as in surface water density relative to surrounding waters. Lower wind stress caused by increased stability over colder and denser water contributes to produce lower sea roughness and often creating areas of lower signal values in SAR imagery with sharp or soft gradients to surrounding waters with high resolution details of hydrodynamic features. In other cases upwelling appears on SAR images as an area of alternate dark and light stripes perpendicularly to the coastline, not overlapping with SST contours at all. The appearance of upwelling on SAR and SST can have varied correlation because of other factors affecting SAR imaging - a very detailed view in one area can be replaced by nothing in a neighboring zone. High surface concentrations of floating cyanobacteria during summer blooms also cause changes in roughness and can affect imaging of upwelling on SAR. Such areas of cyanobacteria accumulations can be detected by the use of optical remote sensing data like MODIS under cloud free conditions. To further investigate upwelling events detected by SAR/IR satellite imaging a high resolution coupled sea ice-ocean model of the Baltic Sea has been utilized. The model is able to simulate upwelling events realistically. Over upwelling areas the wind stress is significantly reduced if the mean wind speed is below a certain threshold. The utilization of modeled hydrodynamics and wind stress data together with SAR, SST and optical remote sensing information provides an extended analysis of the upwelling event itself, as well as a deeper understanding of upwelling appearance on SAR images.