OBSERVATION OF THE EVOLUTION OF EDDIES IN THE BALTIC SEA USING SAR, SST, OCEAN COLOR DATA AND IN SITU MEASUREMENTS

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Eddies and fronts are frequently observed on SAR images in the northern Baltic Proper during the spring and autumn blooms when natural films cover the sea surface.

Two upwelling related eddies were detected in the Baltic Sea on satellite sea surface temperature images (MODIS-Moderate Resolution Imaging Spectroradiometer, AATSR-Advanced Along-Track Scanning Radiometer) on 23rd and 24th September 2008. On 24th and 25th September 2008 the same eddies were captured on SAR images (ASAR-Advanced Synthetic Aperture Radar, ERS/SAR-European Remote Sensing satellite). A correspondence between low backscatter areas on SAR and low temperature values on SST image was observed. The properties of eddies were also characterized by in situ measurements from the line ferry (Algaline project) that passed the region along two different transects (Travemünde-Helsinki and Stockholm-Helsinki). In situ data consisted of temperature, salinity, chlorophyll measurements and water samples of nutrients (PO_4, P_{tot}, NO_{32}, NO_{tot}). To reduce the errors that are caused by speckle the data from water samples (~15 samples per transect) was compared with averaged values of 3x3 pixel subsets on SAR image. Meteorological measurements from the station on the N-W Estonian coast showed that satellite images from 24-25 September captured the relaxation period of an upwelling that had formed during 20-23 September.

Similar dataset was also available for 22nd April 2008 when meso-scale eddy emerged from a front in the northern Baltic Proper. In addition to these two events five datasets comprising of in situ measurements and SAR data were analyzed to estimate the effect of different physical and biological parameters on SAR image.

The aim of the study was to analyze how temperature differences and natural film influence the manifestation of eddies on SAR images. It was also intended to describe the evolution/dynamics of upwelling related eddies using multi-sensor data.

Comparison of data sets showed generally good accordance between SAR data and biological in situ measurements while the accordance with the physical parameters was lower. Considering all the data the correlation between SAR and in situ chlorophyll a in the region where surface slicks were present was 0.6. The lower correlation coefficient occurred in July and August when the value was ~0.5. The correlation coefficients from July and August (which is the time of cyanobacterial blooms) were influenced/reduced by the fact that chlorophyll a is not a dominant pigment in cyanobacteria and therefore the in situ measurements of chlorophyll a concentration describe only the general distribution of cyanobacterial accumulations. While on SAR images the low backscatter areas are influenced by total biological production. The correlation between SAR data and in situ temperature data was approximately 0.4 in studied region. The analysis showed that in both cases the biological parameters (clorohpyll a, nutrients) had greater influence on SAR data compared to physical parameters (temperature, salinity).

The comparison of sea surface temperature images and SAR data from September and April also showed good accordance in the eddy region. The location of eddies that were observed on consecutive images in September 2008 did not change significantly which was due to the low wind conditions in the region.