Variability in the inherent and apparent optical properties of the Baltic Sea and consequences for ocean colour algorithm development

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The main components that affect the ocean colour in Case 2 (including Baltic Sea) waters are chromophoric dissolved organic matter (CDOM), phytoplankton, and non-pigmented particulate matter (e.g. sediments and detrital material). Their contributions to absorption and backscattering vary independently of each other. Development of ocean colour algorithms for Baltic waters is demanding task, involving knowledge of (1) variations in the concentrations of optically active in-water constituents, (2) variations in their inherent optical properties (IOPs), and (3) their interrelations to apparent optical properties (AOPs) that determine ocean colour. Further complications arise from atmospheric disturbances. In this presentation we summarize our recent studies of IOPs and AOPs of the Baltic Sea.

Spatial and seasonal variation of absorption properties of CDOM were studied in different sub-basins of the Baltic Sea. CDOM absorption $a_{CDOM}(375)$ ranged from 0.75 to 11.2 m^{-1} and the slope of CDOM absorption $S_{CDOM}(350\text{-}600)$ varied within a narrow range from 0.0175 to 0.0239 nm^{-1}. Clear non-linear relationship, characterized by hyperbolic function, was observed between $a_{CDOM}(375)$ and $S_{CDOM}(350\text{-}600)$. DOC specific CDOM absorption coefficient, $a_{CDOM}(375)^*$ varied from 1.43 to 9.08 nM^{-1} m^{-1}. Significant linear relationship was observed between $a_{CDOM}(375)^*$ and S_{CDOM}. Parameters and relationships for CDOM presented in this study provide useful information for variable ecological, bio-optical and remote sensing applications used throughout the whole Baltic Sea.

For natural samples, nonlinear relationships have been presented between Chl*a* concentration and Chl*a*- specific phytoplankton spectral absorption $a_{ph}^*(\lambda)$, suggesting that package effect varies predictably with Chl*a* concentration. For the pooled data of our studies in the Baltic Sea, it is clear that variability in this relationship is large. In the northern Gulf of Finland, seasonality in the phytoplankton spectral absorption and in the package effect was related to physical forcing of the water column and phytoplankton community succession. Mixing depth and abundance of picophytoplankton, together explained 87% and 82% of the variability in $a_{ph}^*(676)$ and $a_{ph}(437) : a_{ph}(676)$, respectively. Also water temperature was closely related to Chl*a* specific absorption coefficient.

A SeaWiFS Photometer Revision for Incident Surface Measurements (SeaPRISM) has been installed on the Helsinki Light House Tower in the Gulf of Finland, Baltic Sea, to determine normalised water leaving radiances $L_{WN}(\lambda)$ at centre-wavelengths of interest for ocean colour applications. A first analysis of MODIS and SeaPRISM $L_{WN}(\lambda)$ match-ups indicates an underestimate of 63 and 20% for MODIS $L_{WN}(\lambda)$ at 412 and 667 nm, respectively. By contrast, average differences are within ±5% at 443, 488 and 551 nm.

Our results will support development of optical instruments and algorithms for multivariate retrieval of optically active in-water constituents from ocean colour data in the Baltic Sea.