One Decade Monitoring of Water Turbidity in the Wadden Sea Using Coupled Water-Atmosphere Radiative Transfer Models and Remote Sensing Observations

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Abstract:
Mapping Total Suspended Matters from satellite data is hampered by optical complexity and often extreme turbidity. Extremely high concentrations of Suspended Particulate Matter (SPM), Chlorophyl (Chl) and Coloured Dissolved Organic Matter (CDOM), local differences, seasonal and tidal variations, and resuspension are important factors that lead to lack of efficiency in application of simple hydro-optical models in highly turbid waters. On the other hand atmospheric correction can be problematic if atmospheric haze is spatially variable. In this study, a coupled atmospheric radiative transfer model was used to investigate the seasonal and annual variation of water parameters concentration in the extremely turbid Wadden Sea for one decade. 150 MEdium Resolution Imaging Spectrometer (MERIS) images captured in 2000-2010 were used to provide top of atmosphere radiance, atmospheric and geometric parameters in the Wadden Sea. MODerate resolution atmospheric TRANsmission model (MODTRAN) was applied to implement atmospheric correction. We set several atmospheric conditions as input for MODTRAN simulations, and calculated three atmospheric correction parameters for each atmospheric scheme. Next, we applied these three parameters to MERIS observations and derived water leaving reflectance (Rrs) in different images. Simultaneously, the 2SeaColor forward model was utilized to simulate Rrs by setting up a series of Chl, SPM andCDOM concentration. Afterwards, these two Rrs (one was from MODTRAN atmospheric correction and the other one (was from 2SeaColor forward model simulation) were combined to find out the best case of atmospheric state and the corresponding Rrs from all the Rrs images which were generated by MODTRAN. At the same time, water parameters concentration could be retrieved from the look-up table created by the 2SeaColor model when the Rrs was definite. With the Chl-a, SPM, CDOM maps from different times, simple analyses on the spatial dynamics and the diurnal cycle of these parameters were done based on some statistical methods. The Validation showed the suggested coupled model can estimate the water parameter concentrations accurately and it was in full agreement with collected ground measurements in the Wadden sea for one decade.

Keywords: water turbidity, radiative transfer models, MODTRAN, MERIS images, Wadden Sea