Deriving inherent optical properties and associated Inversion: A case study in the River Vantaa

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In coastal waters, mainly influenced by sediment load from river outlets, the light propagation in the water column is influenced by suspended particles. Empirical and semi-analytic algorithms have been developed to obtain estimates of inherent optical properties (IOPs) from remotely sensed reflectance data. One of the advantages of semi-analytical models over empirical ones is their capability to retrieve several parameters simultaneously and their global (generic) application. In previous studies the absorption of colored dissolved matters (CDOM) and non algal particulates (NAP) are considered as one because of their similar spectral slope. In addition, the spectral slope for backscattering particulate matter (bspm) is predicted using a power-law function fitted in the near infrared and extrapolated to 440 nm. These values were assumed constant in order to reduce the inversion uncertainty and errors. Hence wrongly assumed spectral shapes will lead to significant errors in the derived inherent optical properties (IOPs). In this paper the semi-analytical model called Garver-Siegel-Maritorena model (GSM) is modified to derive the IOPs and their spectral dependencies. The research questions include: Does including the spectral variation of backscattering of particulate matter (bspm) by taking into account particulate absorption (adapted from Doxaran et al, 2009) improves the derived IOPs? Is there a way to de-convolve the absorption spectrum of NAP from that of CDOM? Using a state of the art hand held spectrometer WISP-3, hyper spectral reflectance data were collected in parallel with extensive laboratory analysis for validating the model. The inversion of the GSM model is adapted to derive seven parameters in visible bands covering the wavelengths from 400nm to 850nm. The model was able to derive a linear relationship between measured and derived IOPs with R2 value 0.847, 0.944, 0.952 for absorption of NAP, CDOM and coefficient of bspm respectively. But it fails to estimate Chl-a absorption (R2 = 0.43) probably because the spectrum is dominated by suspended particulate matter (SPM). The RMSE values were 1.91, 0.37, 1.11, 2.06 for absorption of Chl-a, NAP, CDOM and bspm respectively. The inversion uncertainty of the derived IOPs directly proportional with turbidity. The SPM concentration varies from 8-200 mg/l causing high variability in derived IOPs such as Chl-a (0.1-0.6m-1), and bspm (4.6-19.1m-1).The modified GSM algorithm performs well in turbid waters with higher CDOM. The WISP-3 provides hyperspectral reflectance data which can be used for validation of future application of the algorithm on satellite images such as MODIS.