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Reliable retrieval of atmospheric and aquatic parameters in complex environments based on multilayer neural networks and comprehensive radiative transfer simulations

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Standard atmospheric correction (AC) algorithms work well in open ocean areas where the water inherent optical properties (IOPs) are correlated with pigmented particles. However, the IOPs of turbid coastal waters may vary independently with pigmented particles, suspended inorganic particles, and colored dissolved organic matter (CDOM). In turbid coastal waters standard AC algorithms often exhibit large inaccuracies that may lead to negative water-leaving radiances (Lw) or remote sensing reflectance (Rrs). We introduce new algorithms for retrieval of atmospheric and water parameters based on a multilayer neural network (MLNN) machine learning method. We use a coupled atmosphere-ocean radiative transfer model to simulate top of the atmosphere (TOA) radiances (Ltoa) and Rrs values just above the surface simultaneously, and train a MLNN to derive the aerosol optical depth (AOD) and Rrs values directly from Ltoa radiances. The method has been validated using both synthetic data and Aerosol Robotic Network – Ocean Color (AERONET–OC) measurements. A separate MLNN algorithm has been developed to retrieve aquatic parameters from the Rrs values. Application of these MLNN algorithms to MODIS Aqua images in several coastal areas shows that they are accurate (no negative values), robust, and resilient to contamination due to sunglint or adjacency effects of land and cloud edges. The MLNN algorithms are very fast once the neural networks have been properly trained and are therefore suitable for operational use. A significant advantage of these MLNN algorithms is that they do not need SWIR bands, which implies significant cost reduction for dedicated OC missions. These MLNN algorithms have been extended for application to extreme atmospheric conditions (i.e. strongly polluted continental aerosols) over turbid coastal waters by including appropriate aerosol and ocean bio-optical models to generate the required training datasets. Results of applying these extended MLNN algorithms to VIIRS images over areas with extreme atmospheric and marine conditions (such as the Yellow Sea and the East China Sea) will be provided.