Optical *in situ* and geostationary satellite-borne observations of suspended particles in coastal waters

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Particles suspended in seawater include sediments, phytoplankton, zooplankton, bacteria, viruses, and detritus, and are collectively referred to as suspended particulate matter, SPM. In coastal waters, SPM is transported over long distances and in the water column by biological, tide or wind-driven advection and resuspension processes, thus varying strongly in time and space. These strong dynamics challenge the traditional measurement of the concentration of SPM, [SPM], through filtration of seawater sampled from ships. Estimation of [SPM] from sensors recording optical scattering allows to cover larger temporal or spatial scales. So-called ocean colour satellites, for example, have been used for the mapping of [SPM] on a global scale since the late 1970s. These polar-orbiting satellites typically provide one image per day for the North Sea area. However, the sampling frequency of these satellites is a serious limitation in coastal waters where [SPM] changes rapidly during the day due to tides and winds. Optical instruments installed on moored platforms or on under-water vehicles can be operated continuously, but their spatial coverage is limited. This work aims to advance in situ and space-based optical techniques for [SPM] retrieval by investigating the natural variability in the relationship between [SPM] and light scattering by particles and by investigating whether the European geostationary meteorological SEVIRI sensor, which provides imagery every 15 minutes, can be used for the mapping of [SPM] in the southern North Sea.

Based on an extensive in situ dataset, we show that [SPM] is best estimated from red light scattered in the back directions (backscattering). Moreover, the relationship between [SPM] and particulate backscattering is driven by the organic/inorganic composition of suspended particles, offering opportunities to improve [SPM] retrieval algorithms. We also show that SEVIRI successfully retrieves [SPM] and related parameters such as turbidity and the vertical light attenuation coefficient in turbid waters. Even though uncertainties are considerable in clear waters, this is a remarkable result for a meteorological sensor designed to monitor clouds and ice, much brighter targets than the sea! On cloud free days, tidal variability of [SPM] can now be resolved by remote sensing for the first time, offering new opportunities for monitoring of turbidity and ecosystem modelling. In June 2010 the first geostationary ocean colour sensor was launched into space which provides hourly multispectral imagery of Korean waters. Other geostationary ocean colour sensors are likely to become operational in the (near?) future over the rest of the world's seas. This work allows us to maximally prepare for the coming of geostationary ocean colour satellites, which are expected to revolutionize optical oceanography.