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Toward satellite remote sensing of photosynthetic carbon fixation in inland and coastal waters with particular reference to the application of MERIS

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Productivity of algae and cyanobacteria in well-mixed optically deep waters can be computed from near-surface concentrations of chlorophyll a as an indicator of biomass and the vertical attenuation coefficient of downward irradiance. Global oceanic carbon fixation could be remotely estimated using the impact of chlorophyll absorption on blue to green reflectance band ratios since the advent of the Coastal Zone Colour Scanner. Regarding inland and coastal waters in general, same computation could not be applied, because absorption by chlorophyll and terrigenous materials overlap. Thus a second type of algorithms has been developed for detection of chlorophyll in eutrophic inland and coastal water, based on the impact of chlorophyll absorption on the near-infrared to red reflectance ratio. These algorithms are applicable to imagery from the recent MERIS instrument aboard ENVISAT. Because the high-resolution mode of MERIS provides a 300-m pixel, remote sensing of chlorophyll can be performed for coastal waters as well as many lakes with concentrations > 5 mg m^{-3}. In oligotrophic lake and seawater this chlorophyll signature is overwhelmed by absorption by water. Therefore neither the blue to green band ratios for oceanic waters nor the near-infrared to red band ratios for inland and coastal waters can be applied for oligotrophic lakes, including the largest storages of surface freshwater on Earth, namely the Laurentian Great Lakes and Lake Bajkal. In this paper, the problem is illustrated by comparing reflectance spectra obtained from the highly eutrophic Green Bay of Lake Michigan and the oligotrophic Keweenaw Bay of Lake Superior. It is also shown that a third type of algorithm may be applied using the current imagery from MERIS, by exploiting chlorophyll fluorescence to detect chlorophyll concentrations < 1 mg m^{-3}. Fluorescence-based algorithms may bridge the chlorophyll detection

gap between open oceans and eutrophic inland and coastal waters.