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Accounting for the light attenuation caused by particulate inorganic material in a coastal ecosystem using remote sensing products and in-situ measurements

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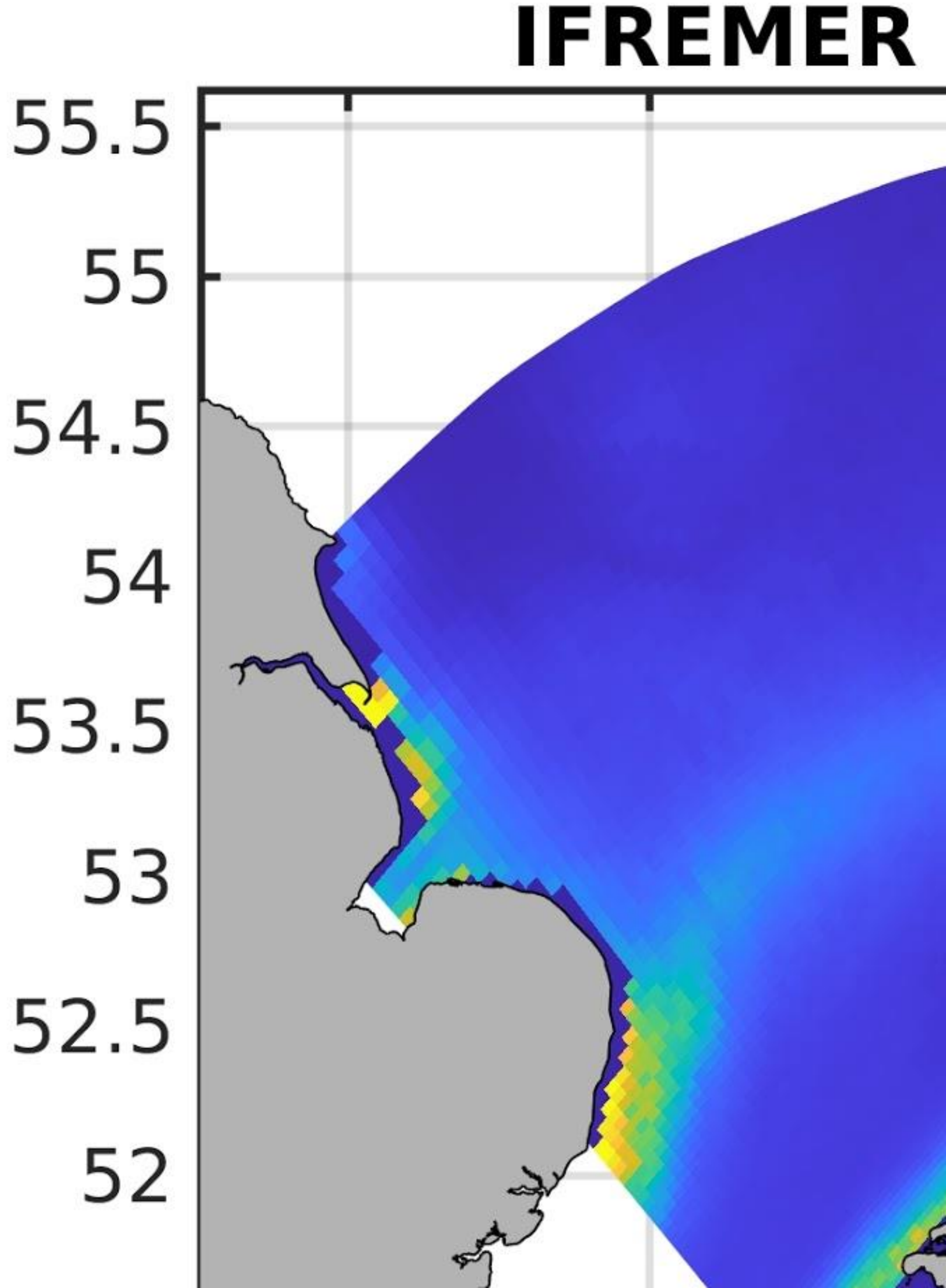
Abstract

Primary production (PP) by phytoplankton is a key process for marine ecosystem functioning. It is dependent on the availability of nutrients and light. Representation of the light climate in coastal systems, especially regarding the particulate inorganic material (PIM), is still a major problem. Particularly for assessing the eutrophication status of a coastal system, misrepresentation of light climate may cause misleading estimates of PP, e.g., by ecosystem models. A number of models exist that directly calculate PIM concentrations, but coupling these with ecosystem models leads to computational overheads.

In this study, we aim to derive a monthly climatology of PIM concentrations based on observation data within the southern North Sea (SNS), which can then be used as a forcing field in an ecosystem model. We combine 20 years' worth of data from GlobColour and IFREMER to compute climatological monthly means in the SNS (Fig. 1). Quality of the satellite products within the nearshore, partially inter-tidal regions of this system is questionable (Fig. 2), which we therefore seek to improve using in-situ data. We analyze the structure of error in relation to environmental variables, like season of year, salinity, grain size, sediment type and bottom depth (e.g., Fig. 3). Based on these relationships, we derive a unifying correction function and apply this within the entire domain, and thereby achieve an improved representation of PIM within the SNS. Finally, we test the use and relevance of this approach by using the resulting PIM estimates as forcing in an ecosystem model, and show that the spatio-temporal patterns in estimated nutrient and light limitation, and consequently the PP is significantly altered relative to a reference model where the turbidity due to PIM is assumed to be constant over time and space, representing the implicit assumption commonly made in ecosystem models.



IFREMER
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Fig. 1: long-term average of IFREMER data, interpolated onto the model grid

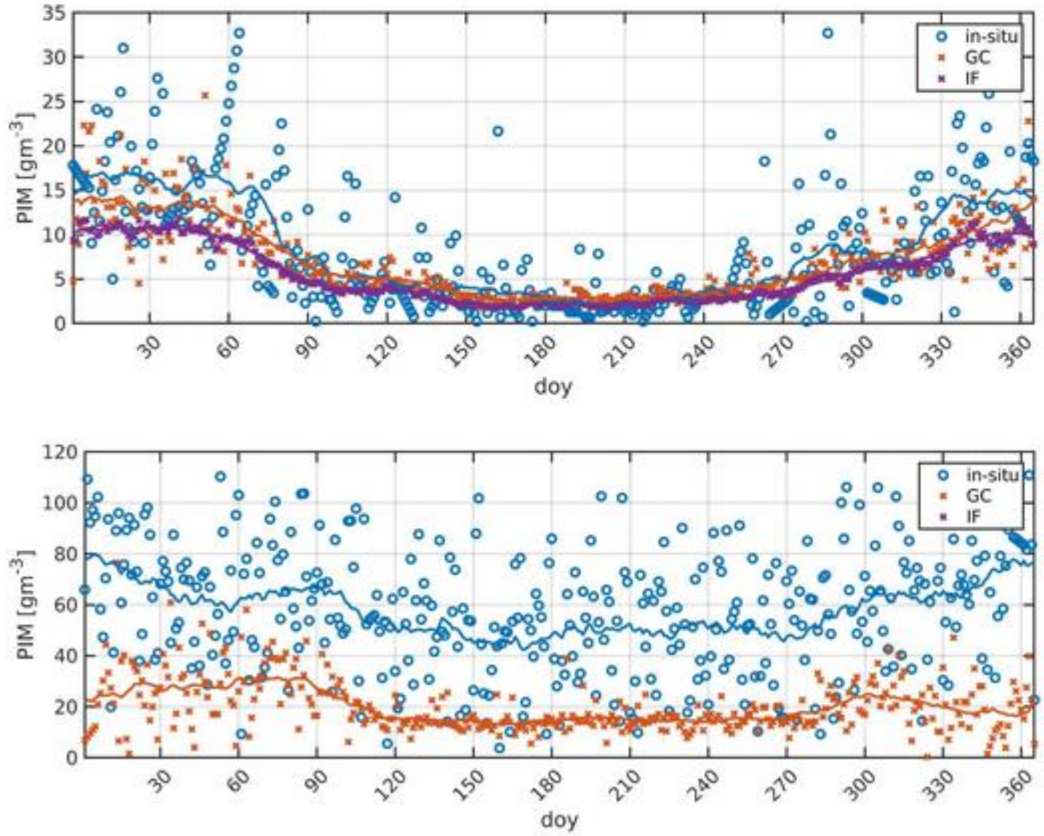

Fig. 2: daily climatology, linearly interpolated, for >20 years at an offshore (top, 23m depth) and a nearshore station (bottom, 8m depth). Blue: in-situ, red: GlobColour, purple: IFREMER

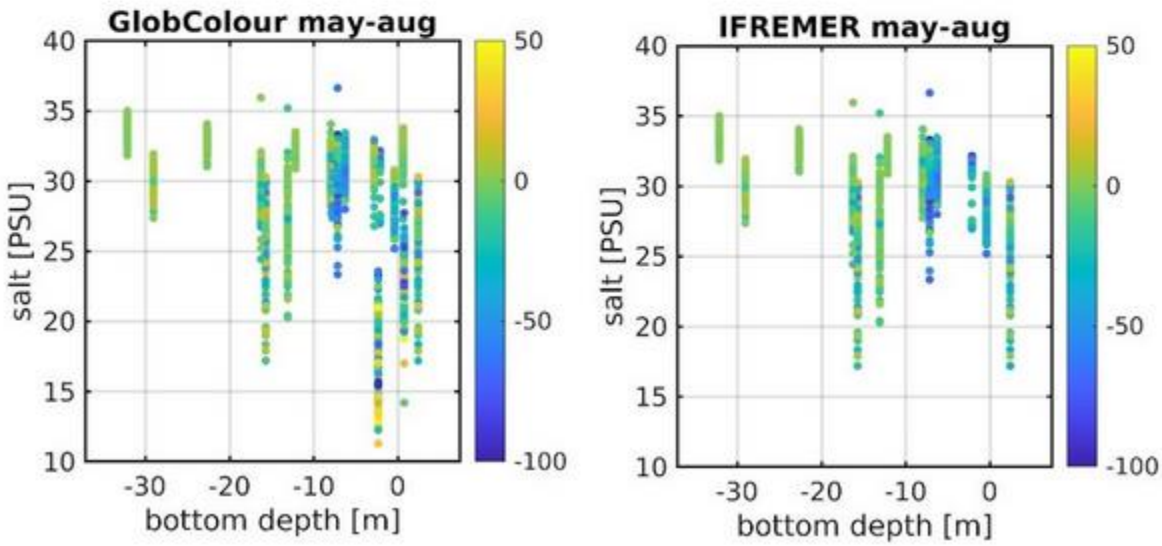

Fig 3: Difference between satellite and station data (color) as a function of bottom depth and salinity.

Keywords

light, ecosystem model, SPM, PIM