Estimating primary production at a Southwest Greenland fjord using remote sensing and in situ data

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Introduction

Remote sensing allows to estimate net primary production (NPP) on large scales with high temporal resolution. However, these NPP estimates depend on remote sensing observations and theoretical models, which often have difficulties at depth and in coastal regions. *In-situ* methods can measure NPP directly but have their own challenges and are often limited in spatial and temporal coverage. Here, we compare *in-situ* and remote sensing-based estimates.

Material and Methods

In-situ measurements

The program MarineBasis Nuuk, part of the Greenland Ecosystem Monitoring program (G-E-M.dk)[1], take monthly measurement at the entrance of Nuup Kangerlua (Godthåbsfjord) in southwest Greenland. We incubate ^{14}C-DIC enriched water samples at different depths for about 2h and extrapolate the NPP, using local light measurements. NPP is then integrated over the water column.

Remote sensing-based estimates

The remote sensing-based estimates are based on MODIS satellite images and the carbon-based CAFE[2] model in a 18 km grid resolution retrieved from the Ocean Productivity site[3]. We used monthly averages and compared that data with *in-situ* measurements (± 45 km from the monitoring station). We then performed a Mann-Kendall test for trend analyses.

Conclusions

Remote sensing based NPP estimates are still challenged compared to *in situ* data in fjords, due to the often high sediment concentrations and/or strong tidal mixing.

For detecting trends in the Arctic, remote sensing offers a great tool to study larger areas at high temporal resolution, which is not possible with more time-consuming *in situ* methods.

Results and Discussion

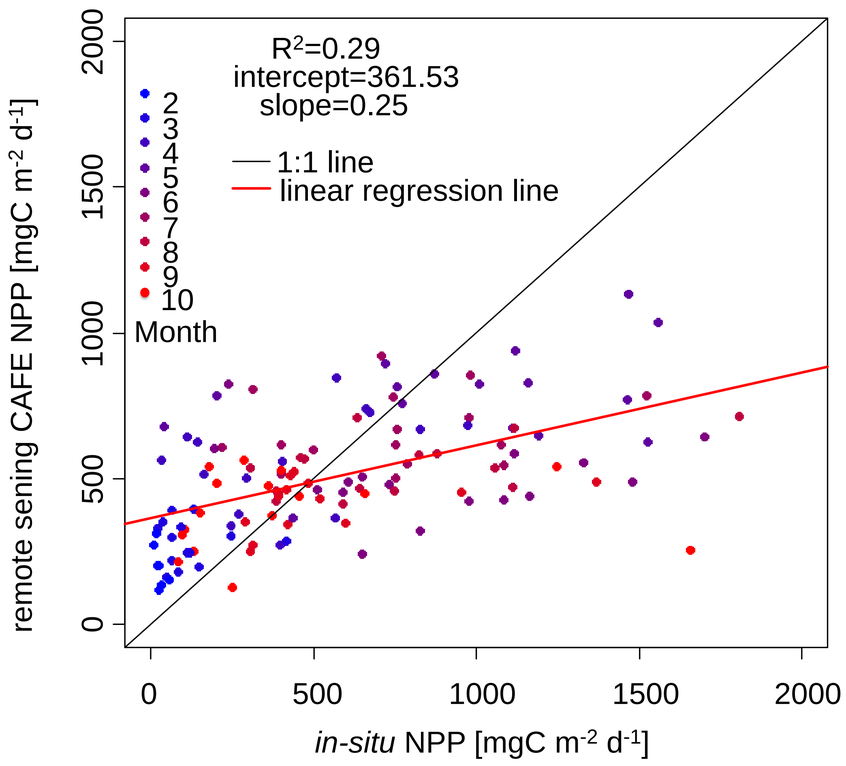

Fig. 1: In situ measurements of NPP at GF3 vs remote sensing (MODIS) based NPP data modelled via CAFE in an area ±45km.

Compared to *in situ* data, CAFE-modelled NPP estimates appear to overestimate NPP in the area outside Nuuk, especially at low values (lm slope=0.25, Fig 1). The regression is overall poor (R^2=0.29), indicating limitations in either dataset.

CAFE-data being based on a much larger area, may be part of the explanation. In fact, yearly transect measurements often show chlorophyll peaks off the shelf. However, OCCI4 based chlorophyll data estimated close (±1 km ± 3 days) to the monitoring station (GF3) also compare poorly OCCI[4] *in situ* data (R^2=0.3), indicating a more systematic problem in the fjord.

Sediment inputs at the *in situ* monitoring station may be one reason for the overestimated CAFE-based NPP, common in coastal areas. But strong vertical tidal mixing, homogenizing phytoplankton and nutrients through the deep water column, can be another reason for phytoplankton with lower NPP than modelled via CAFE.

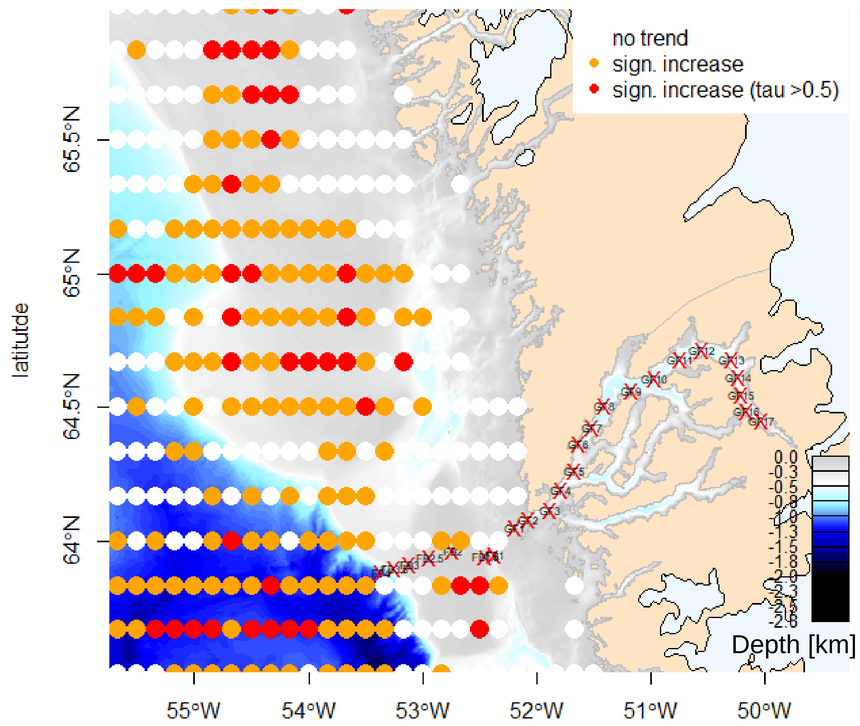

Fig. 2: Mann-Kenndall trend test results of the remote sensing based (MODIS) based NPP data modelled via CAFE off the coast of Nuuk.

By now GEM produced a 16-year times series of NPP at GF3 allowing trend analyses, but no changes in NPP can be detected. Also, CAFE-based estimates show no significant trends along the coast (Fig 2). Only when testing for trends on the shelf and open Ocean, we could detect significantly increasing primary production (Fig 2), as described for the rest of the Arctic.

[1] Greenland Climate Research Centre, Greenland Institute of Natural Resources, Nuuk, Greenland

References
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3 - Ocean Productivity site, http://sites.science.oregonstate.edu/ocean.productivity/index.php, last accessed: 03/2022
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