Climate Change Initiative (CCI) - Phase Two - OCEAN COLOUR

OC-CCI, Aerosol and SST Option Management, Technical and Administrative Proposal

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For: ESA / ESRIN
Ref: RFQ/3-13904/13/I-NB
We note:

- Missing data (indicated by low values of daily coverage) are not randomly distributed.

- Regions with low coverage are often associated with high chlorophyll values.

- Areas of poor coverage are often areas of high aerosol optical thickness (may be high cloud cover as well).

- If missing data are not randomly distributed, and if missing data are associated with high-chlorophyll values, then satellite-derived composites of chlorophyll values will be biased towards the low end.

- Implications for applications such as computation of primary production.
Correlation between chlorophyll and aerosol optical thickness is different, depending on whether monthly values are used or the anomalies after the mean seasonal cycle has been removed.

Need to go from correlation to understanding the causes.

Dust fertilisation of the oceans?

Marine biota serving as sources for marine aerosol? (e.g. Meskhidze & Nenes, 2010, Krüger & Graßl, 2011)
Objectives:

- Analyse implications of missing ocean-colour data: are the missing data random or systematic? Are there regional differences?
- Evaluate dependence of missing data in ocean-colour products on SST and aerosol, and if possible, include clouds
- Compare ocean-colour aerosol-related by-products from atmospheric correction against in situ data and aerosol CCI data
- Compare sea-surface reflectance from aerosol-CCI with oc-cci products

Tasks:

- Analyse relationships between occurrences of missing data in ocean-colour fields and SST and aerosol fields
- Explore underlying mechanisms for missing data
- Compare OC-CCI aerosol by product (or analogue) against in situ and independent satellite data
Impact of Decrease in Light due to Aerosols on Primary Production
Impact of Decrease in Light due to Aerosols on Primary Production

PP sensitivity to surface irradiance

\[ \frac{\text{d}P}{\text{d}I} \]

- Blue: Chl = 0.01 mg m\(^{-3}\)
- Cyan: Chl = 0.1 mg m\(^{-3}\)
- Green: Chl = 1.0 mg m\(^{-3}\)
- Yellow: Chl = 10 mg m\(^{-3}\)
- Orange: Chl = 50 mg m\(^{-3}\)

I\(^{\text{HI}}\) vs. Chl concentrations.
MULTI-ECV CONNECTIONS:
OC – SST – SEA ICE
Why should we care about it?

While at first sight a simple phenomenon, it reflects several key processes that shape ecosystem dynamics, including:

- Phytoplankton growth
- Species succession
- Nutrient dynamics
- Physical mechanisms (optical and mechanical)
- Top-down control
- Transfer of energy and matter through the food web
- Carbon fluxes

It is a sentinel of ongoing changes in the functioning of the Arctic marine ecosystems.

Still a matter of debate for the global ocean (cf. Sverdrup hypothesis...)

Marcel Babin, IOCS SF 2015
Change of Primary Production

Annual pan-Arctic: Increase by 15-30%

Pabi et al. (2008)
Arrigo et al. (2008)
Arrigo et al. (2011)
Bélanger et al. (2013)
Petrenko et al. (2013)
Arrigo & van Dijken (2015)

Bélanger et al. (2013)
Highest latitude reached by spring bloom is increasing

POSTER # 122

Renaut et al. (unpubl.)
Recommendations with regard to OCRS

- Combine data from multiple polar orbiters to mitigate the impact of clouds on data availability
- Develop methods for flagging and correcting contamination of the signal by sea ice
- Improve atmospheric corrections and push their limit in terms of maximum \( \theta_s \) (e.g., 70° → 74° provides an additional 7 Mkm\(^2\))
- Tune and validate semi-analytical IOP algorithms in the Arctic
- Validate and implement empirical models of Chl(z)
- Document the atypical phytoplankton photophysiological parameters in Arctic to improve PP estimates
- Develop new approaches for dealing with under-ice phytoplankton blooms
- Explore new avenues for PFTs specific to the Arctic Ocean
• **Ocean Colour CCI & SST CCI**
  - studying Chl-a and SST at the sea ice edge
    - target spatial resolution 4km or better
  - requires identification of clear sky water observations next to sea ice → masking of clouds and sea-ice (=clear sky) and separating sea ice from clouds
    - not easy with optical sensors alone!
    - different spatial resolutions in VISNIR – SWIR – TIR & MW

• **Sea Ice CCI**
  - Sea ice concentration derived from passive microwave radiometers
  - 25km spatial resolution
Workpackage in OC CCI

• Objective
  (1) to improve the consistency of the sea ice mask across Ocean Colour, SST and Sea Ice CCI projects,
  (2) to improve the quality of the OC ECVs (water leaving radiance and Chl) in the specific area of the marginal ice zone
  - a corresponding option of the SST CCI was not funded

• Tasks
  ▪ Improvements of Sea Ice detection through instrument synergy (MERIS & AATSR, future OLCI & SLSTR)
  ▪ Sea Ice Mask intercomparison (OC, CCT, Sea Ice)
  ▪ Analysis of ocean colour and SST products in the marginal ice zone

• New Partners
  ▪ DMI, involved in SST CCI and Sea Ice CCI, joined the OC CCI team