

Intercomparison of Ocean Color Products Identifying Coccolithophore Blooms on Global and Regional Scales

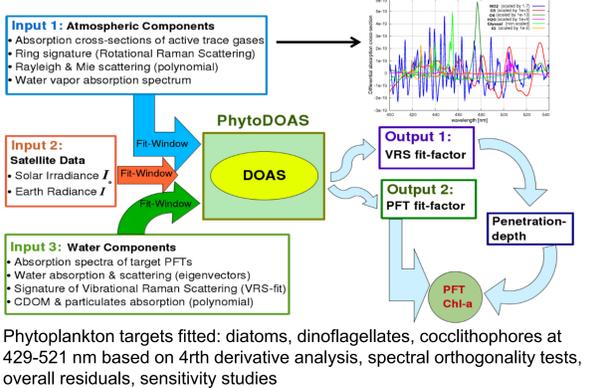
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Objectives

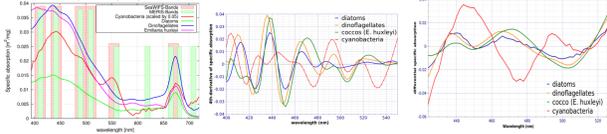
2002-2012 SCIAMACHY data were processed with multi-target PhytoDOAS method to monitor biomass of **coccolithophores** besides diatoms and cyanobacteria:

- Evaluation with other coccolithophore-related satellite data on global scale
- Assessment of retrieval's sensitivity with coupled oceanic-atmospheric radiative transfer model SCIATRAN
- Investigation of temporal variations of coccolithophores using satellite data in selected regions characterized by frequent occurrence of large coccolithophore blooms:
- Intercomparison of ocean color products (coccolithophore chl-a, total chl-a, particulate inorganic carbon)
- Comparison of interannual variations of algal bloom cycles to sea-surface temperature, mixed-layer depth and surface wind speed

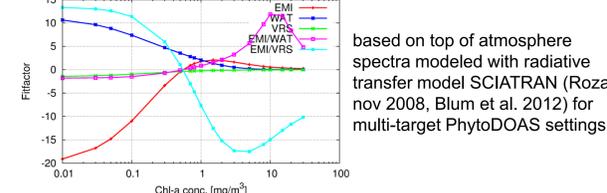
PhytoDOAS: Concurrent Chl-a of Phytoplankton Groups from SCIAMACHY / ENVISAT Hyper-spectral Satellite Data (Bracher et al. 2009 & Sadeghi et al. 2011)



Specific (left), 4th derivative (middle) and differential absorption of phytoplankton groups (right), fitted in multi-target PhytoDOAS



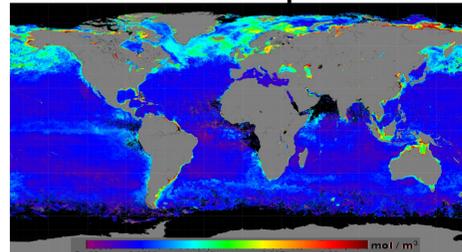
Sensitivity study of PhytoDOAS retrieval



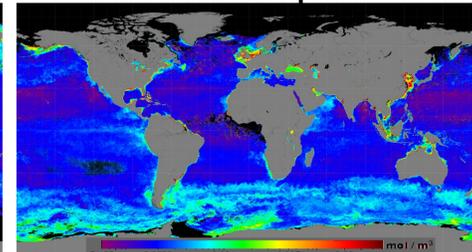
DOAS fit-factors' changes with coccolithophores (EM1) chl-a:
 – Inelastic scattering (VRS) and water absorption (WAT), both correlated with light penetration depth, show definite relationships with increasing chl-a
 – Sensitivity for EMI retrieval improves from 0.01 up to 10 mg/m³ chl-a, when EMI fit-factor is divided by a measure of optical path length (either VRS or WAT)

Global PhytoDOAS Coccolithophores Chl-a Compared to Other Ocean Color Data

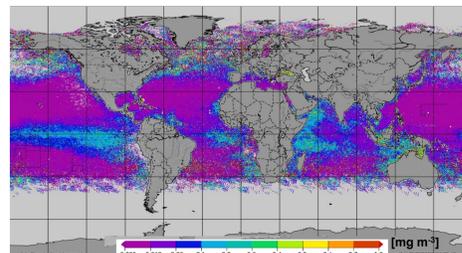
Mean Jun 2005 – Aug 2005 Particulate Inorganic Carbon – MODIS-Aqua



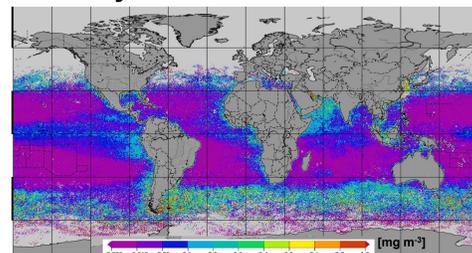
Mean Dec 2005 – Feb 2006 Particulate Inorganic Carbon – MODIS-Aqua



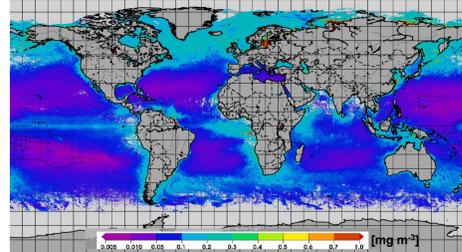
Coccolithophores Chl-a – PhytoDOAS-SCIAMACHY



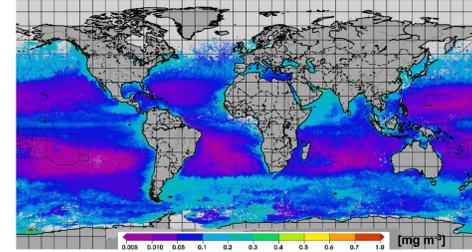
Coccolithophores Chl-a – PhytoDOAS-SCIAMACHY



Haptophytes Chl-a – Hirata et al. 2011-SeaWiFS



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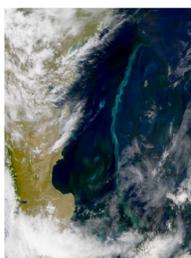


Studying Coccolithophores' Times Series (2003-2010) in Selected Regions (Sadeghi et al. 2012)

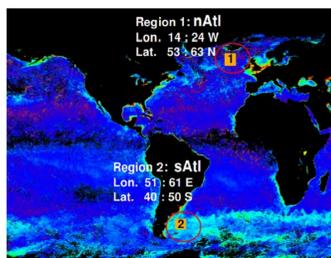
– Study coccolithophore dynamics with respect to total chl-a, particulate inorganic carbon (PIC → coccoliths) and variations in environmental geophysical parameters
 – Test functionality of multi-target PhytoDOAS by quantitative identification of coccolithophore blooms



North-eastern of North Atlantic (22 May 2010 - MODIS Aqua)



Patagonian Shelf - South Atlantic (24 December 2004 - SeaWiFS)



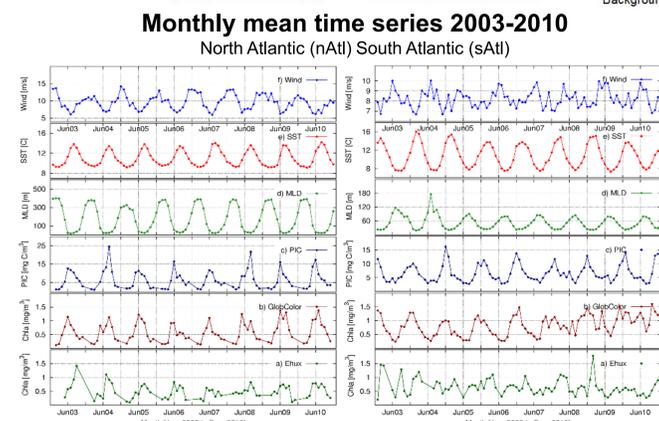
Background map: monthly composite (March 2005) of PIC conc. from MODIS-Aqua.

Satellite data

- E_hux: PhytoDOAS coccolithophore chl-a - SCIAMACHY
- Total chl-a - GlobColour (merged GSM MODIS, SeaWiFS, MERIS)
- PIC: part. inorganic carbon - MODIS-Aqua (<http://modis.gsfc.nasa.gov>)
- SST: sea surface temperature, - AVHRR (<http://nsidc.org/data/avhrr>)
- Wind: surface wind speed - AMSR-E (<http://remss.com>)

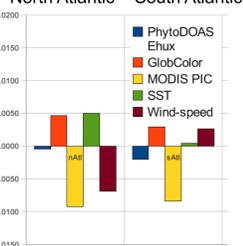
Model data

MLD = mixed layer depth - FNOC model (Ocean Productivity)

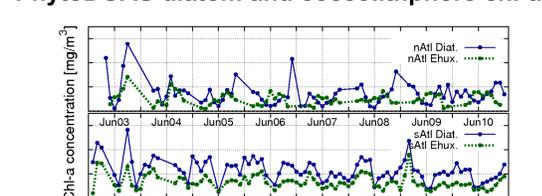


Monthly mean time series 2003-2010 North Atlantic (nAtl) South Atlantic (sAtl)

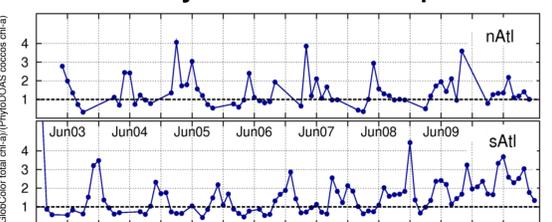
2003-2010 trends North Atlantic South Atlantic



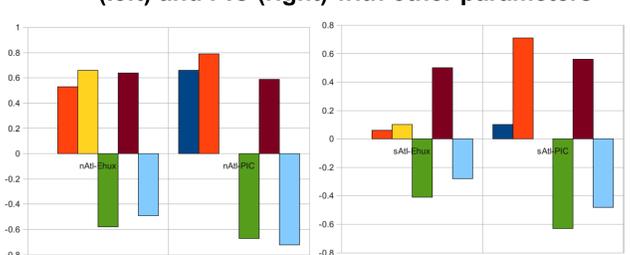
PhytoDOAS diatom and coccolithophore chl-a



Total chl-a / PhytoDOAS coccolithophore chl-a



Correlation of PhytoDOAS coccolithophore chl-a (left) and PIC (right) with other parameters



PhytoDOAS agrees better with PIC and total chl-a in nAtl than in sAtl:

- **Latitudinal difference:** solar radiation, SST [nAtl: 9<T<14°C; while sAtl: 7.5<T<15°C], MLD [nAtl: 50<MLD<450 m; while sAtl: 20<MLD<180 m]
- **Wind patterns:** pronounced irregularities in sAtl and sPac compared to nAtl
- **Regional environmental features:** Malvinas Current & Brazil Current; aerosol loads from Patagonian desert (iron by dust deposition or riverine inputs)

Summary

– PhytoDOAS was improved for quantitative identification of an additional phytoplankton group: **coccolithophores (multi-target fit)**
 – PhytoDOAS data are consistent with other ocean color and model products and support reported dependencies of coccolithophores' dynamics to compared geophysical variables.
 – Results suggest that multi-target PhytoDOAS is a valid method for retrieving coccolithophore chl-a and monitoring their bloom cycles on regional and global scale.
 – The elevated coccolithophore chl-a found in the high reflectance latitudinal belt of the southern hemisphere (at ~30°S to ~60°S) supports the hypothesis of **Great Calcite Belt** (Balch et al. 2011).

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