Assimilation of OC-CCI data into the coupled ocean-biogeochemical model MITgcm-REcoM

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The coupled model: MITgcm - REcoM

MITgcm

notes:
- designed to study ocean, atmosphere and climate.

Global configuration
- 80°N - 80°S
- 30 layers

Resolution:
- lon : 2 deg
- lat : 2 deg in North. up to 0.38 deg in South
- depth : 10 m – 500 m.

Figure: Model domain
Ecosystem part: REcoM2

Figure: Regulated Ecosystem Model - 2 (Hauck et al., 2013) and its pathways

Features:
- Internal stoichiometry of cells depends on light, temperature, nutrients (Geider et al., 1998)
- Uptake of nutrients based in internal concentrations
- Two phytoplankton groups: Small phytoplankton and Diatoms
Logical separation of the assimilation system

- Each model integration can be parallelized.
- All model tasks are executed concurrently.

Open source: Code and documentation available at http://pdaf.awi.de
Extending the coupled model for data assimilation

- Add three subroutines to coupled model
- Modify parallelization for ensemble
- Compute assimilation step in model

Legend:
- Model
- Extension for data assimilation
Chlorophyll-a data is taken from European Space Agency- Ocean Color Climate Change Initiative (OC-CCI).

Data features:
- Available are Daily, 5-day, 8-day & monthly data.
- Chlorophyll, remote sensing reflectance and inherent optical properties.
- Lot of missing data, due to cloud cover.

source: (https://www.oceancolour.org/)
Data Assimilation Experiments

Simulation strategy:
The coupled model simulation is continued for a year after a four year spin-up.

Assimilation methodology:
- 5 days forecast/analysis cycles.
- Ensemble size = 24
- Assumed observation error relative error of 30%
- Ensemble Kalman filter (LESTKF, *Nerger et al. 2012*)
- Localization radius = 10 degrees.
Assimilation influence on total chlorophyll

1st March

no assimilation

with assimilation

Model Chl-a

Observation

mg/m³
Influence of assimilation on phytoplankton groups

**Small phytoplankton**

- **no assimilation**
- **with assimilation**

**Diatoms**

1st March

mg/m$^3$
Conclusion

Initial data assimilation experiments
• Successful assimilation of Chl-a data with ensemble filter
• Improvement of total chlorophyll
• Both phytoplankton groups modified differently

Plans
• improve model by
  • estimate spatially varying parameters
    (e.g. chlorophyll degradation rate)

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