SIMBIOS Project

Spectral Data Assimilation for Merging Satellite Ocean Color Imagery

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Ocean Color Data Merging

Goals

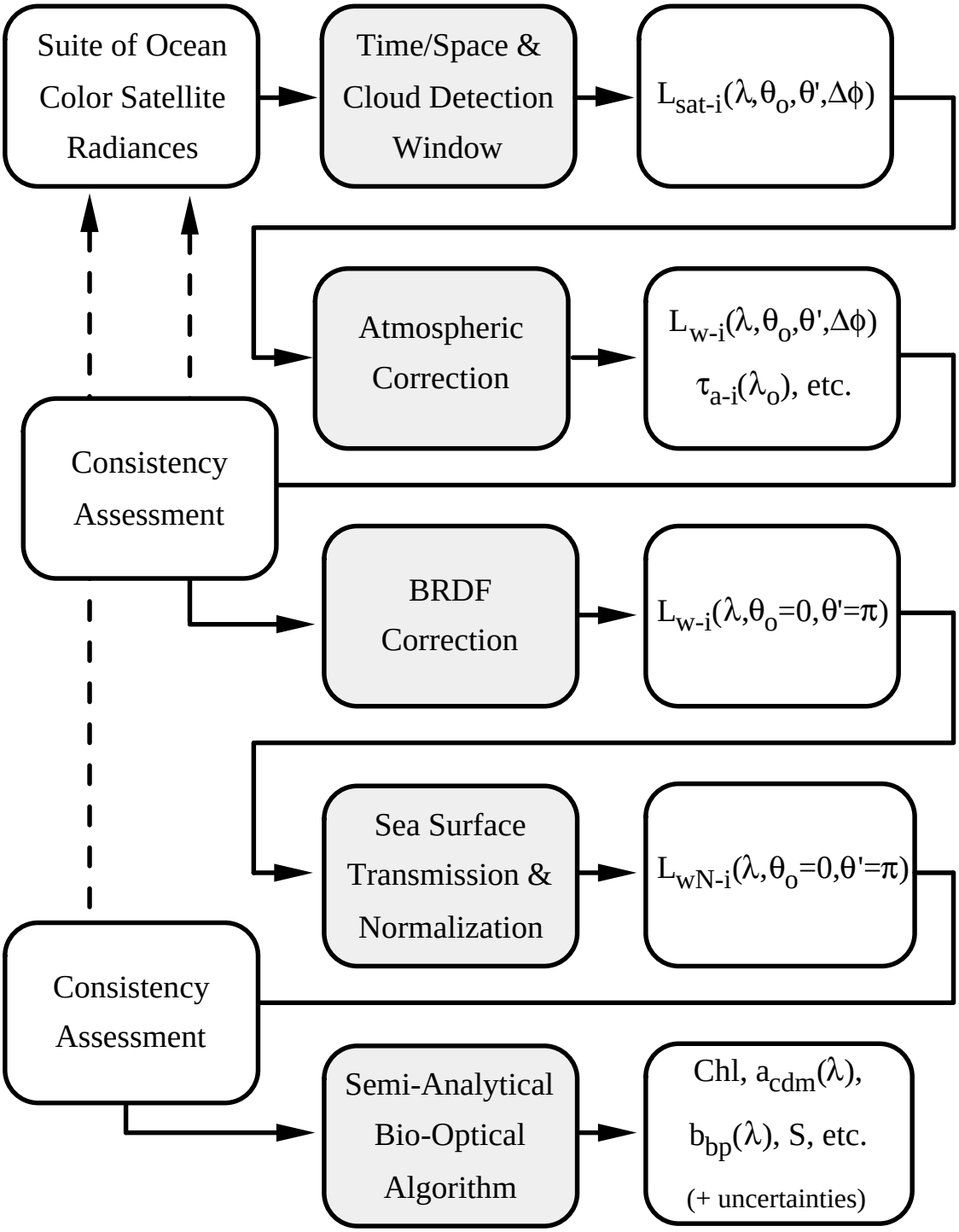
- Improve diversity & utility of products,
- Reduce uncertainties in products
- Provide products on shortest space & time scales.

Tool

Spectral Data Assimilation (SDA)

- Exploit differences in the sensor suite to extend spectral information,
- Utilize redundancies to assess data & model consistency,
- Employ state-of-the-art algorithms,
- Propagate uncertainty throughout the merging process, &
- Provide uncertainty estimates for the final merged products.

Example SDA Data Flow



Semi-Analytical Bio-Optical Algorithm

Garver & Siegel (1997) Model

$$R_{rs}(0\text{-},\lambda) = \sum_{i=1}^{2} g_i \left(\frac{b_b(\lambda)}{b_b(\lambda) + a(\lambda)} \right)^i$$

From Gordon *et al.* (1988)

$$Rrs(0\text{-}, l) = \sum_{i=1}^{2} gi \left(\frac{b_{bw}(l) + \mathbf{b_{bp}(l_0)}(l / l_0)^{-n}}{b_{bw}(l) + \mathbf{b_{bp}(l_0)}(l/l_0)^{-n} + a_w(l) + \mathbf{C}a^*_{ph}(l,C) + \mathbf{acdm(}l_0\mathbf{)}\exp(-S(l - l_0))} \right)^i$$

Input : Remote-sensing reflectance (or L_{wN})
Output : [Chl *a*], $a_{cdm}(\lambda_o)$, $b_{bp}(\lambda_o)$

Non-linear least-square technique

Semi-Analytical Bio-Optical Algorithm

Algorithm parameterization

- Literature-based parameterization

  $a_w(\lambda)$: Pope & Fry (1997)
  $a_\phi^*(\lambda)$: Bricaud et al., (1998)
  …

- Optimal tuning of the model

  Simulated annealing
  Expanded SeaBAM data set

The model IS the merger !

- Data from different sources are ingested directly

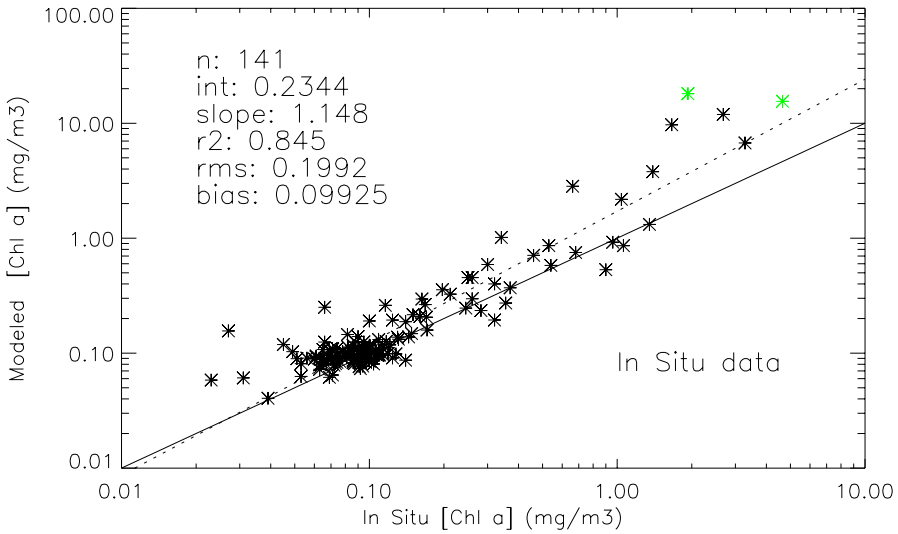
- An uncertainty level can be set at each wavelength and for each data set which allows the input data to be weighted according to their accuracy (cost function).

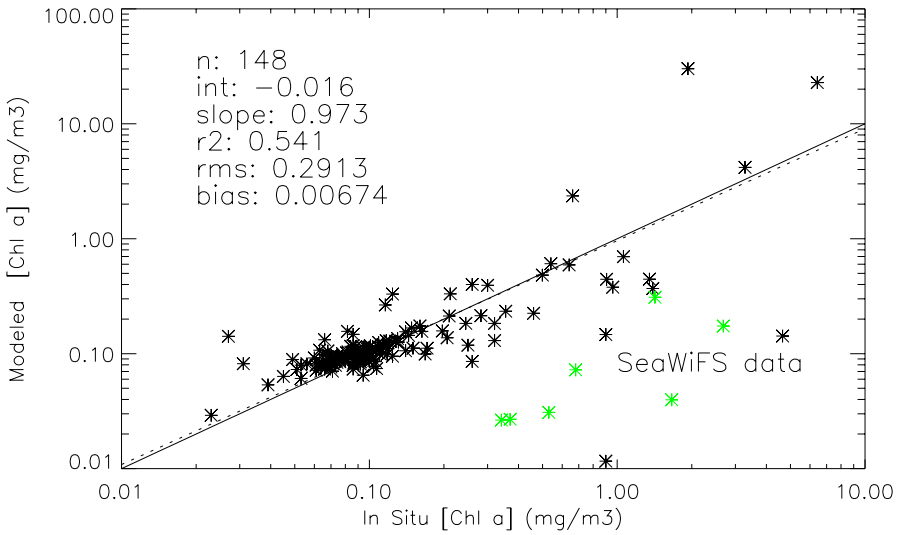
$$\varepsilon = \sum_{i=1}^{N_{sat}} \sum_{j=1}^{N_{\lambda-i}} \left(\frac{f(\hat{\theta}, \lambda_j) - L_{wN\text{-}i}(\lambda_j)}{\sigma_i(\lambda_j)} \right)^2$$

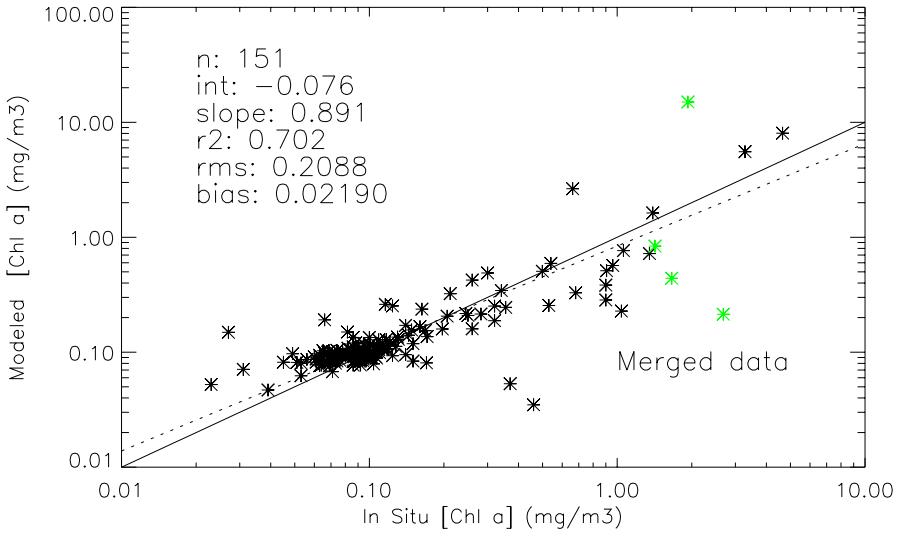
- Current testing of the merger with the SIMBIOS and the MOBY matchup data sets.

Example :

In Situ data --> GS97-Merger --> Products
SeaWiFS data --> GS97-Merger --> Products
In Situ + SeaWiFS data --> GS97-Merger --> Products


n: 141
int: 0.2344
slope: 1.148
r2: 0.845
rms: 0.1992
bias: 0.09925
In Situ data
Modeled [Chl a] (mg/m3)
In Situ [Chl a] (mg/m3)
100.00
10.00
1.00
0.10
0.01
0.01
0.10
1.00
10.00


n: 148
int: −0.016
slope: 0.973
r2: 0.541
rms: 0.2913
bias: 0.00674
SeaWiFS data
Modeled [Chl a] (mg/m3)
In Situ [Chl a] (mg/m3)
100.00
10.00
1.00
0.10
0.01
0.01
0.10
1.00
10.00


n: 151
int: −0.076
slope: 0.891
r2: 0.702
rms: 0.2088
bias: 0.02190
Merged data
Modeled [Chl a] (mg/m3)
In Situ [Chl a] (mg/m3)
100.00
10.00
1.00
0.10
0.01
0.01
0.10
1.00
10.00

FUTURE

- **Work on the uncertainty aspects**
  - **Input (weighting function)**
  - **output (confidence intervals of the retrievals)**

- **Work on redundancy/complementarity of bands (consistency checks, increase of spectral information,…).**

- **Finalize the Optimal tuning approach**
  - **Test on SeaWiFS data**
  - **Need for an adapted data set**