

Assimilation of Aqua Ocean Chlorophyll Data in a Global Three-Dimensional Model

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Motivations for Assimilation

1. Data use maximization
2. Parameter Estimation (model improvement)
3. State and Flux Estimation
4. Prediction

NASA Ocean Biogeochemical Model (NOBM)

Winds, ozone, rel. humidity,
pressure, precip. H₂O, cloud %,
LWP, droplet radius,
aerosols

Atmospheric
Forcing Data

Winds,
SST

Radiative
Model

Dust
(Fe) Sea
Ice

Heat

Circulation
Model

Layer Depths

Abundances

Spectral
Irradiance

Biogeochemical
Model

Temp.

Current
Velocities

Layer
Depths

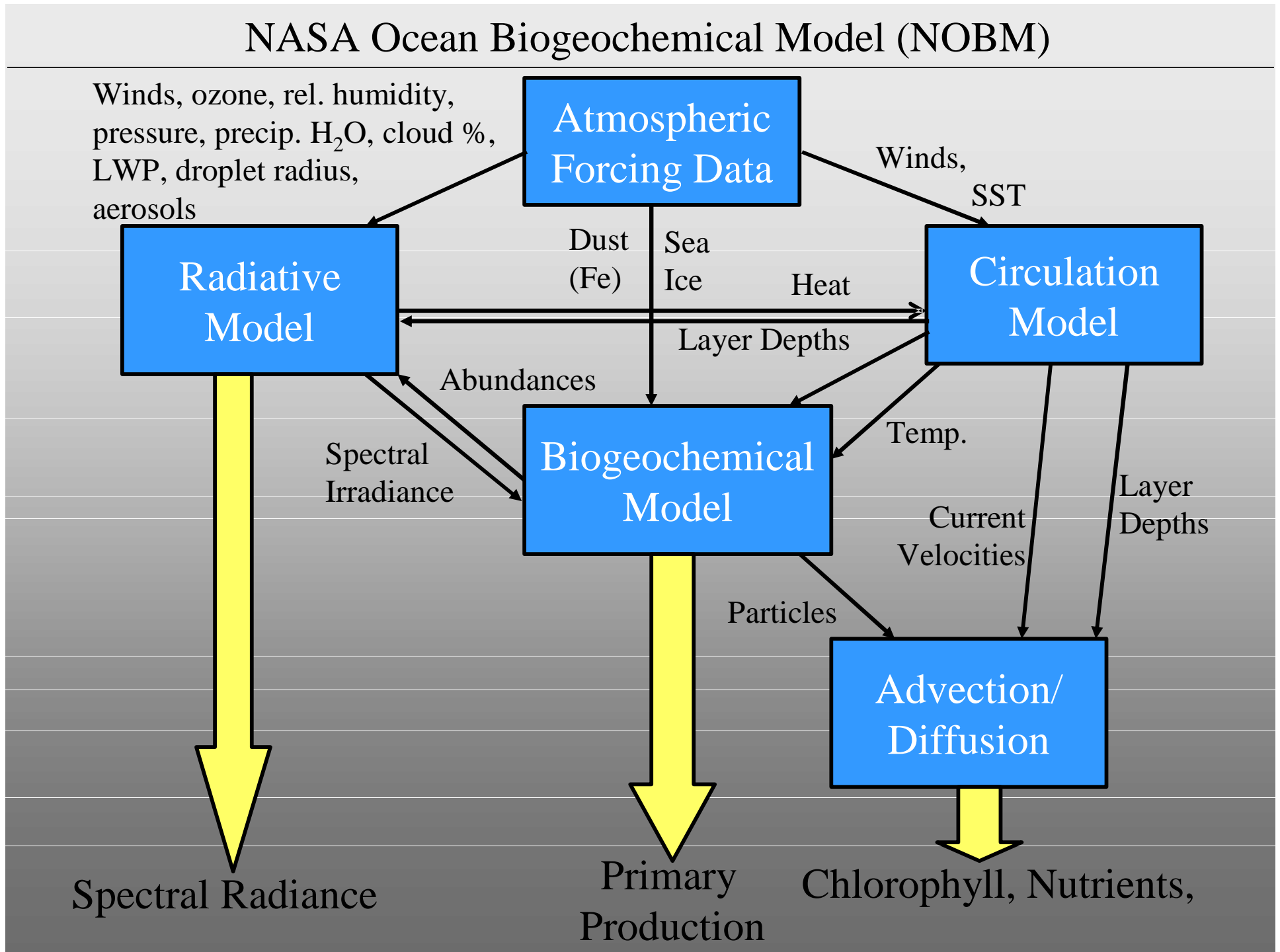
Particles

Advection/
Diffusion

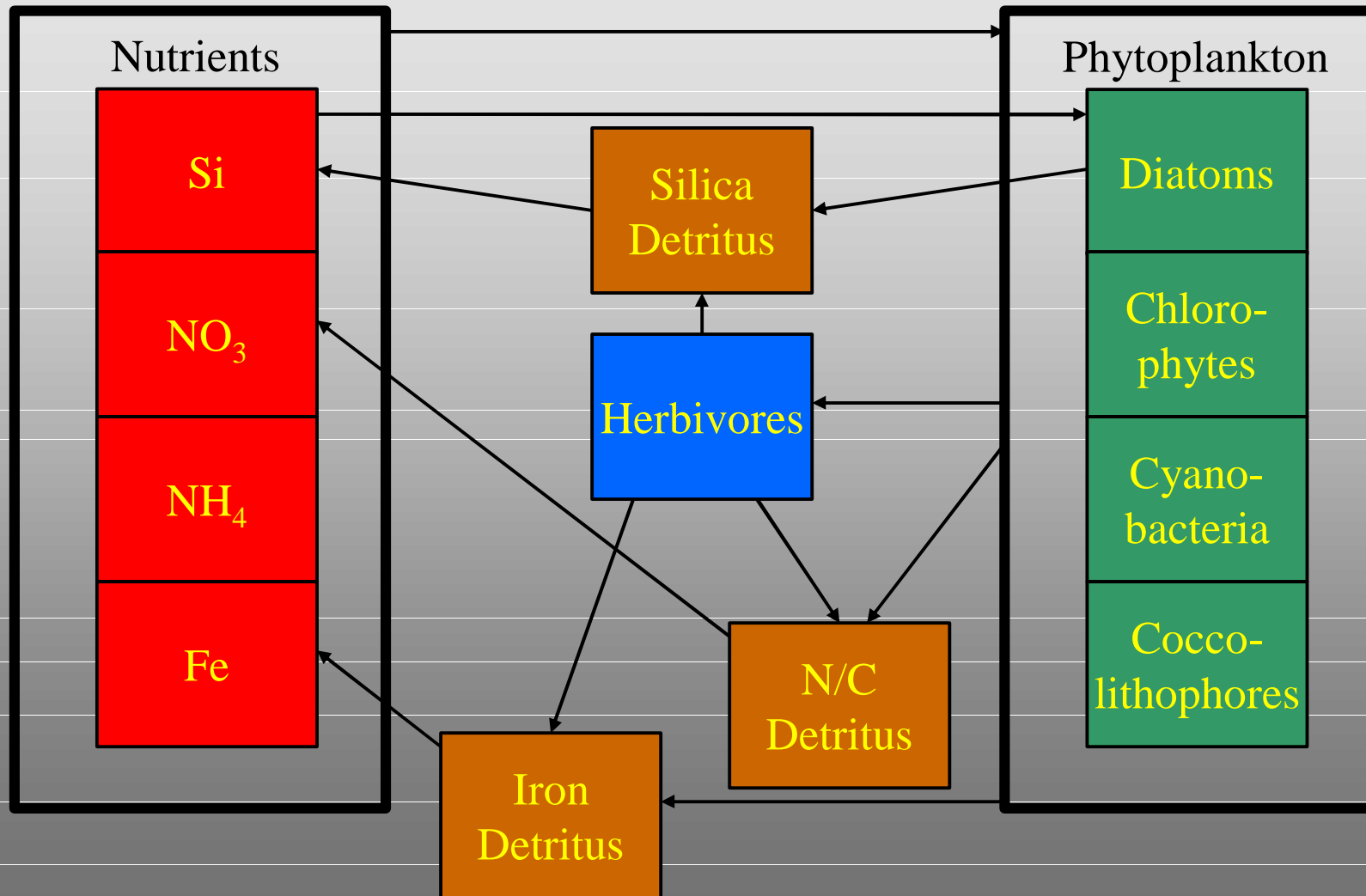
Spectral Radiance

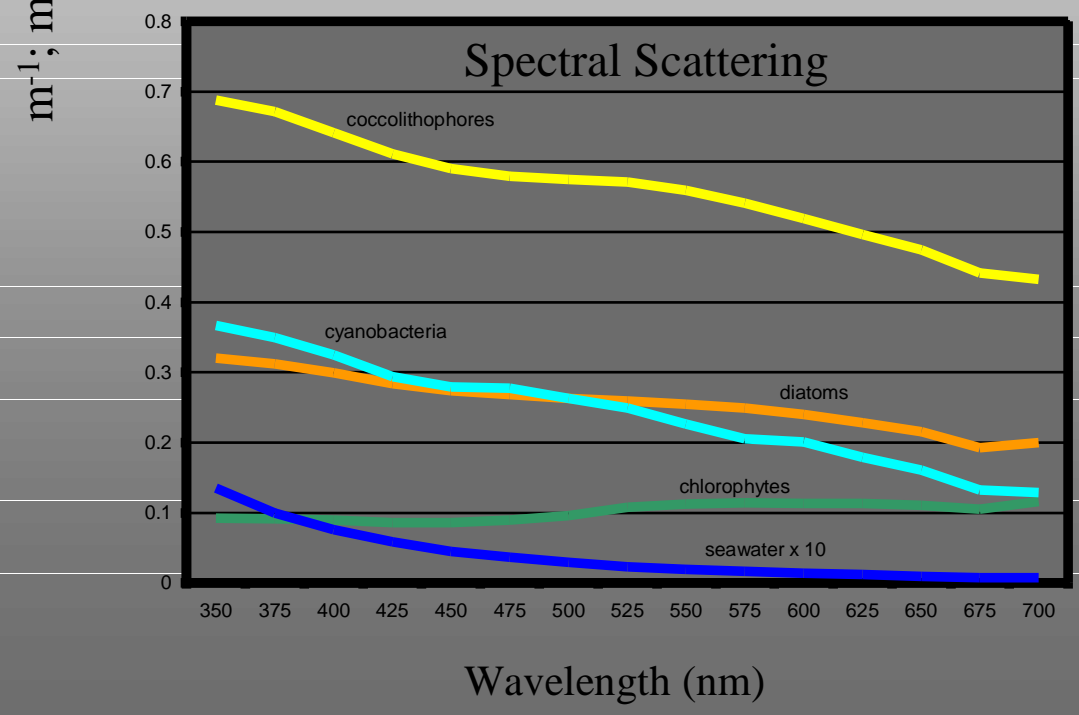
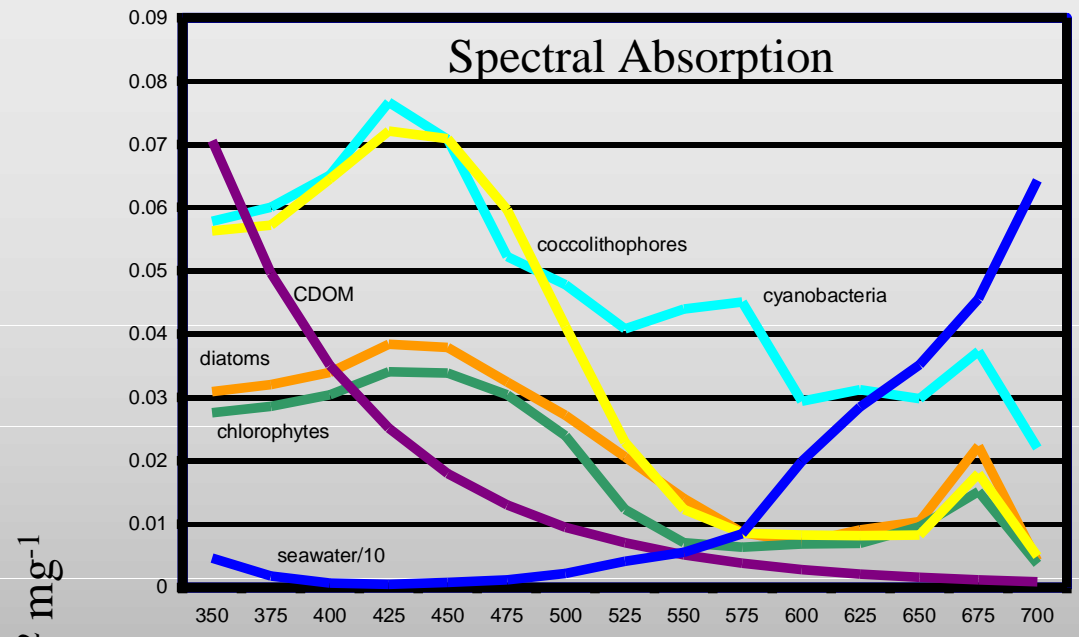
Primary
Production

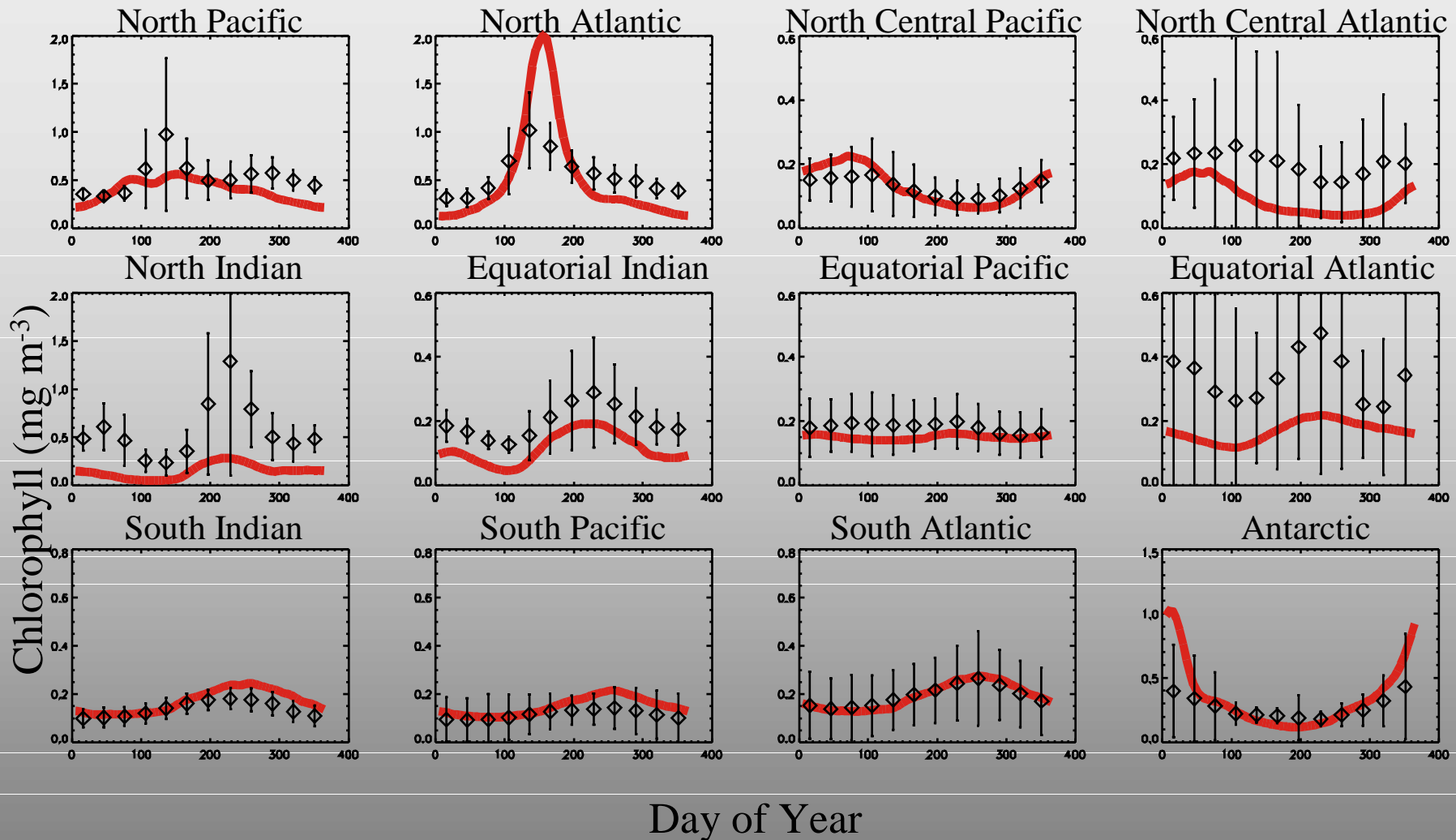
Chlorophyll, Nutrients,



Biogeochemical Model







Statistically positively correlated ($P < 0.05$) all 12 basins

Gregg, W.W., 2002. Tracking the SeaWiFS record with a coupled physical/biogeochemical/radiative model of the global oceans. *Deep-Sea Research II* 49: 81-105.

Gregg, W.W., P. Ginoux, P.S. Schopf, and N.W. Casey, 2003. Phytoplankton and Iron: Validation of a global three-dimensional ocean biogeochemical model. *Deep-Sea Research II*, 50: 3143-3169.

Assimilation of Satellite Ocean Chlorophyll

Conditional Relaxation Analysis Method

$$\nabla^2 M = \nabla^2 M, S$$

Advantages:

Very strongly weighted toward data, less susceptible to model errors

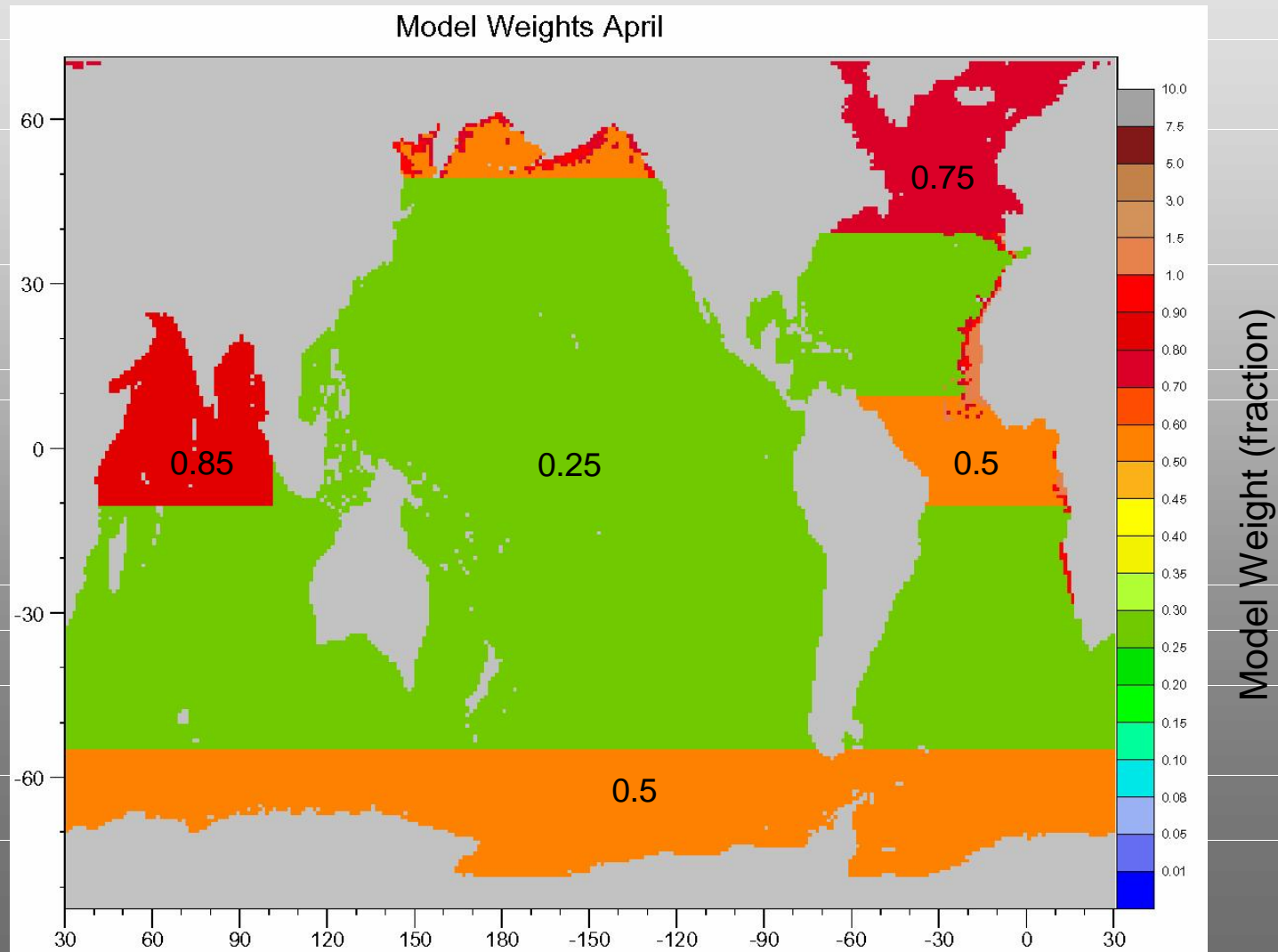
Fast

Disadvantages

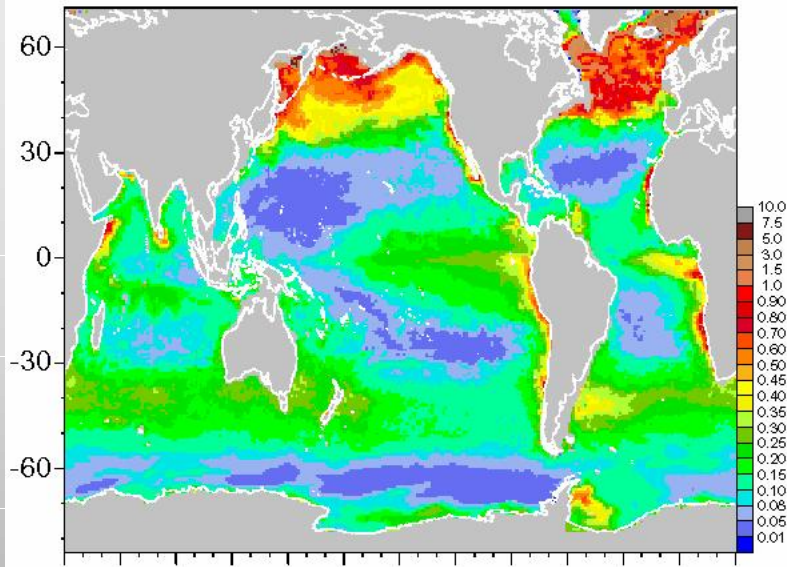
Very susceptible to data errors

To keep assimilation model bounded requires:

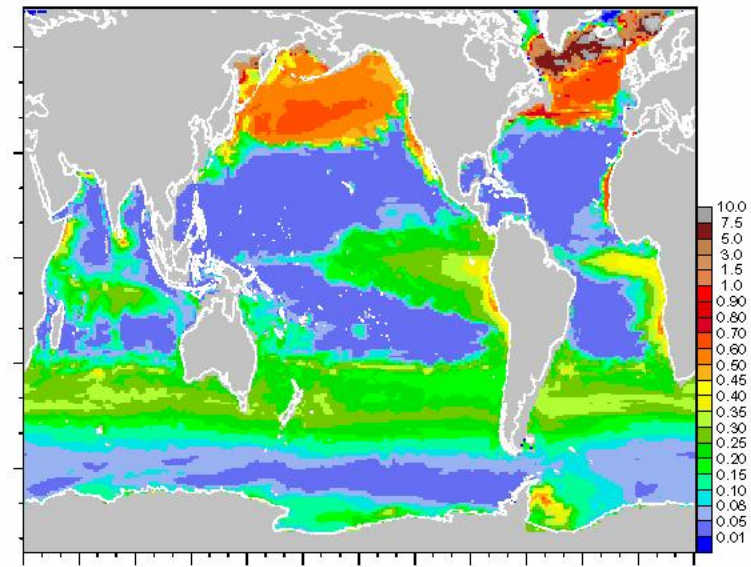
- 1) Smoothing of data (25% monthly mean, 75% daily weight)
- 2) Increase model weighting relative to data



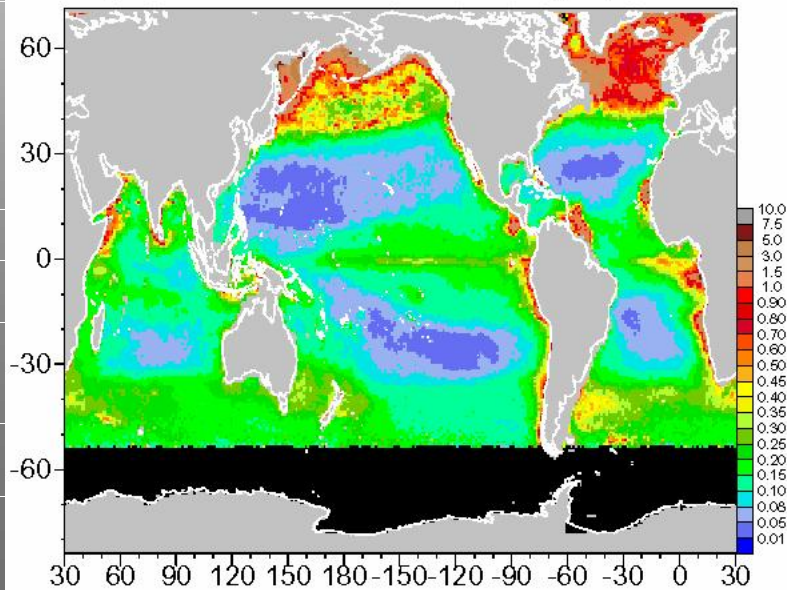
Assimilated Chlorophyll June 4 2001



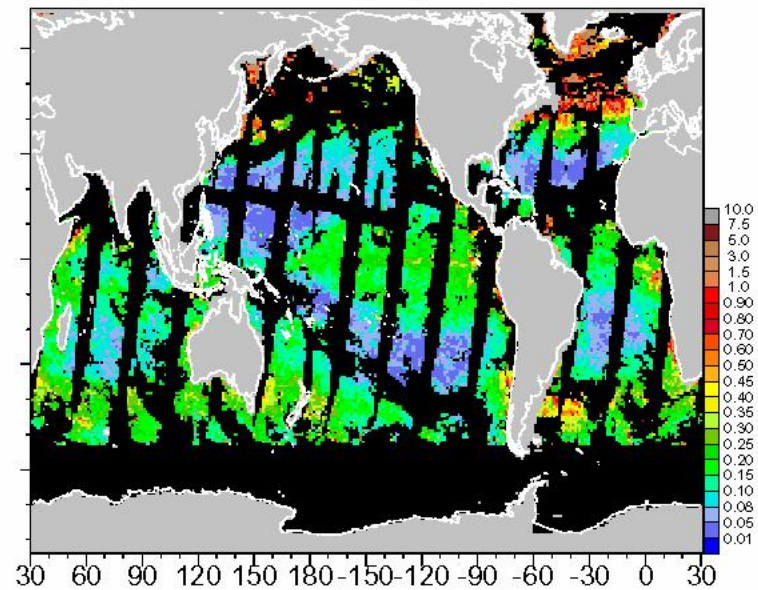
Free Run Model Chlorophyll June 4 2001



Monthly Mean SeaWiFS Chlorophyll June



Daily SeaWiFS Chlorophyll June 4 2001



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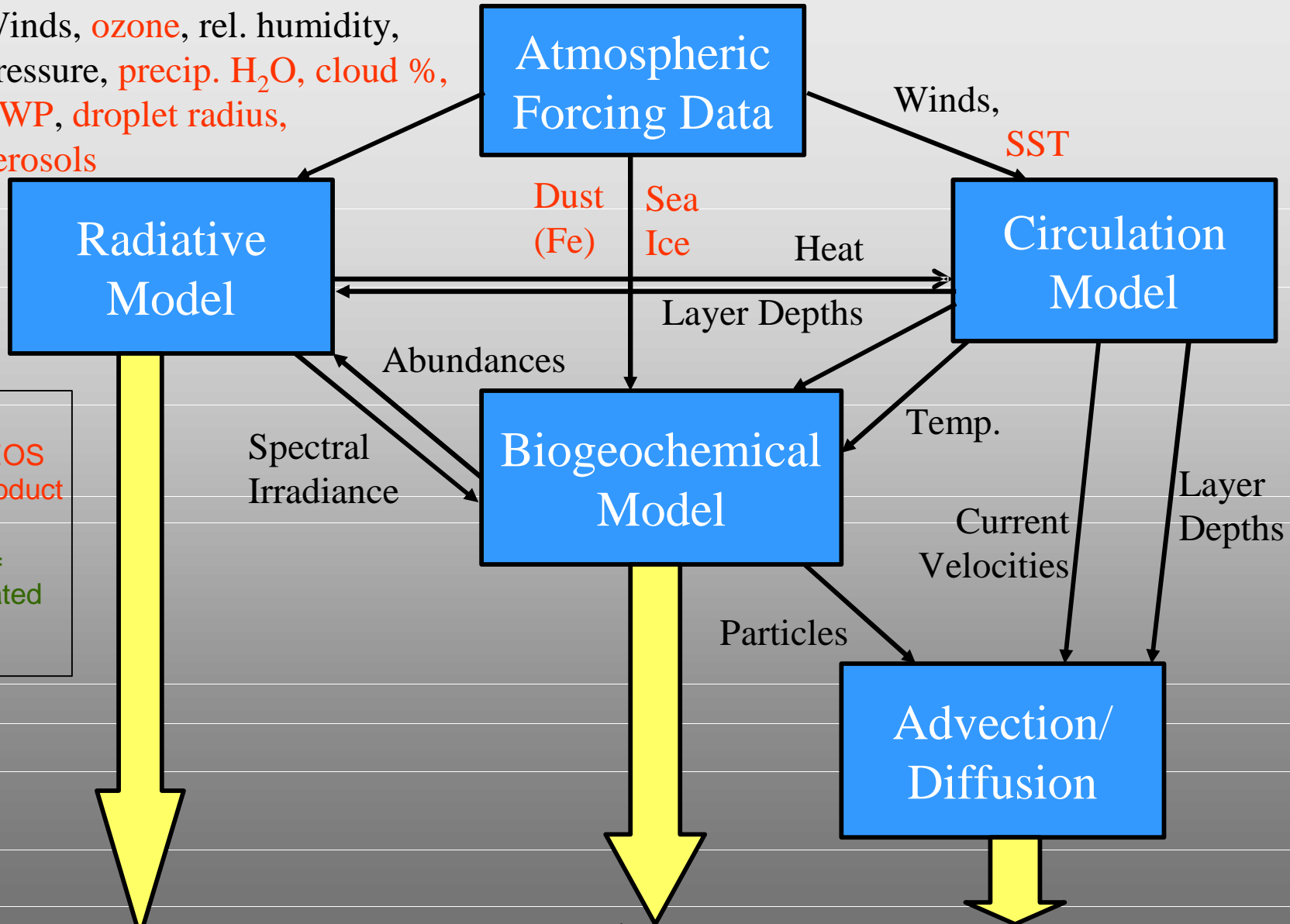
Spectral Radiance

Primary
Production

**Chlorophyll, Nutrients,
POC?, PIC?**

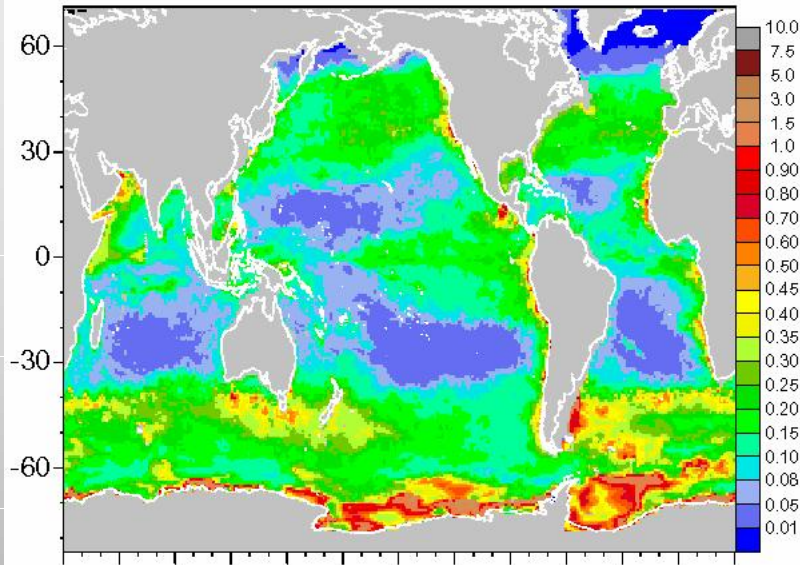
Red = EOS
Data product

Green =
assimilated
variable

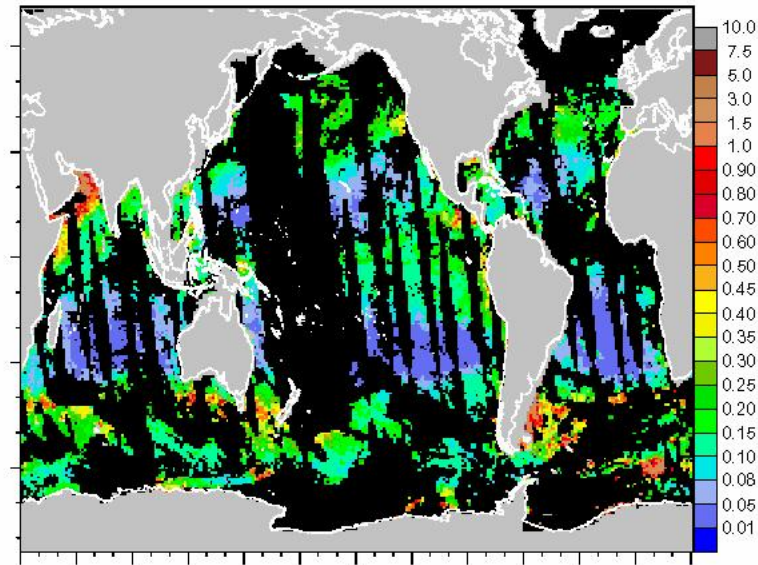


Feb. 1, 2003

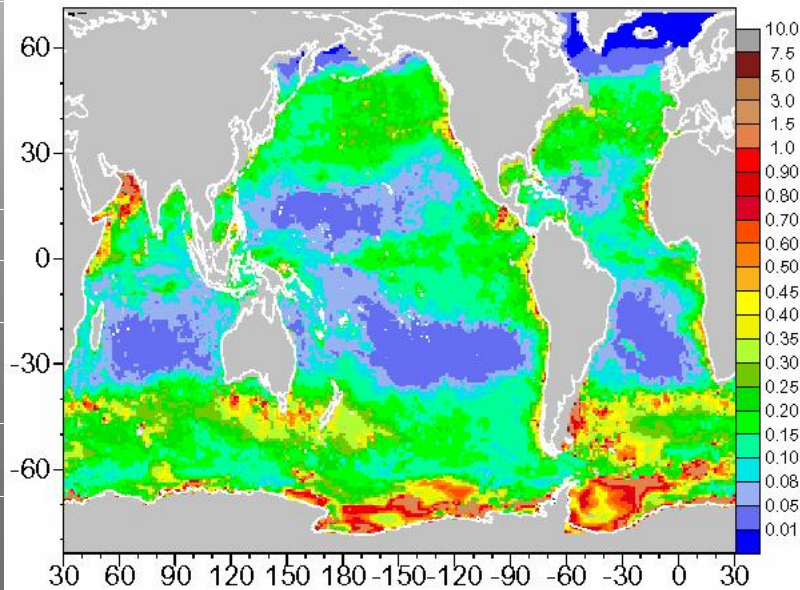
Aqua-assimilation Model; Feb 2003



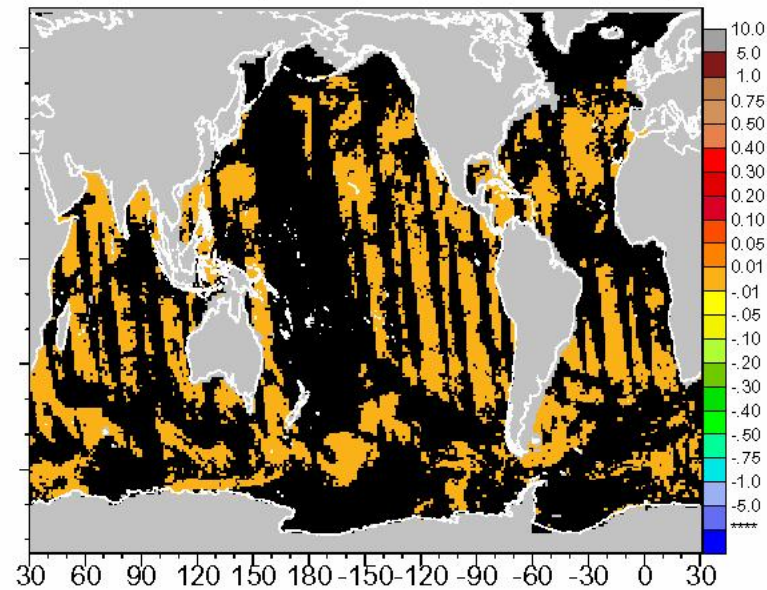
Aqua Chlorophyll; Feb 2003



Aqua-assim Model; Aqua Re-inserted



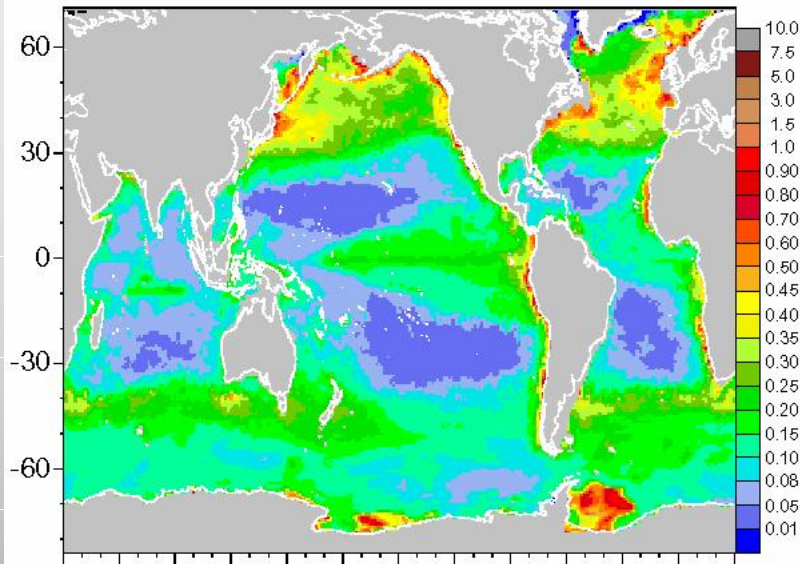
Difference Aqua-Re-insert minus Aqua



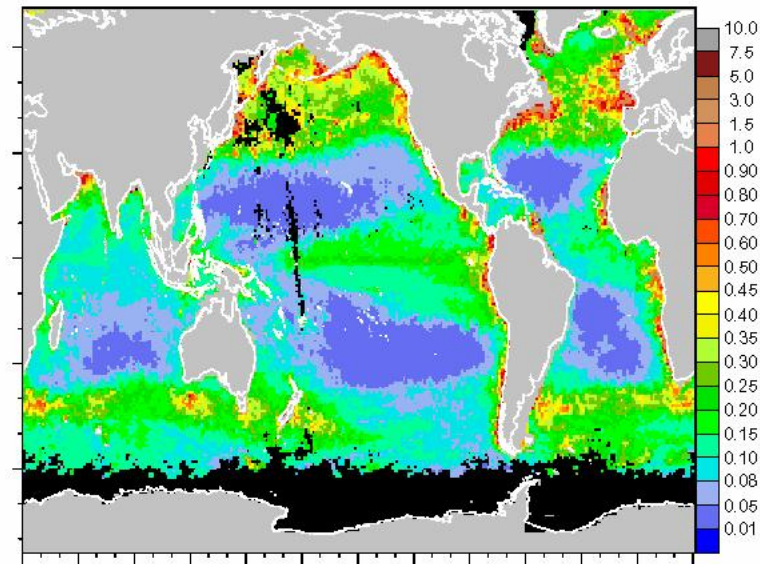
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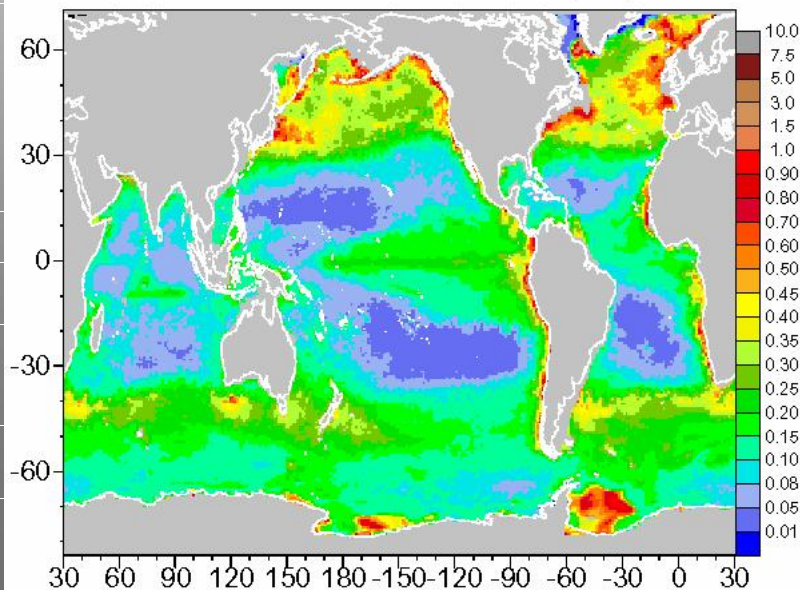
Aqua-assimilation Model; Apr 2003



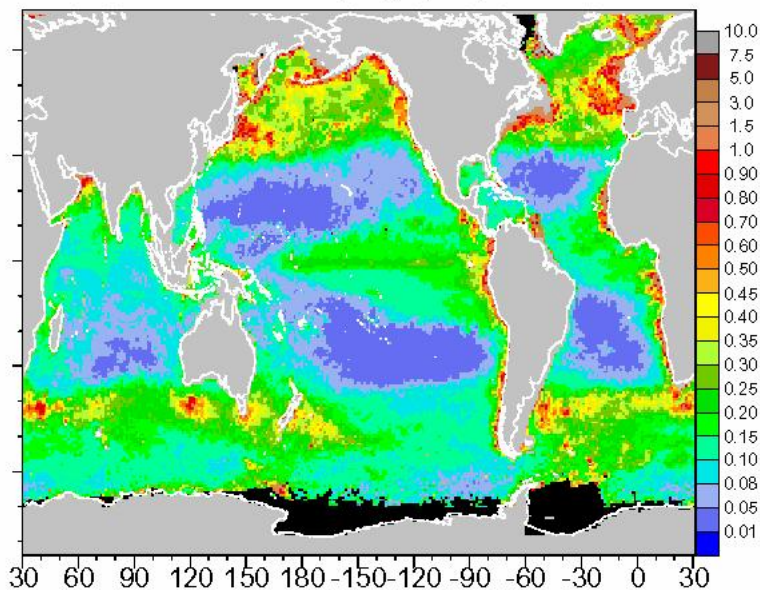
Aqua Chlorophyll; Apr 2003



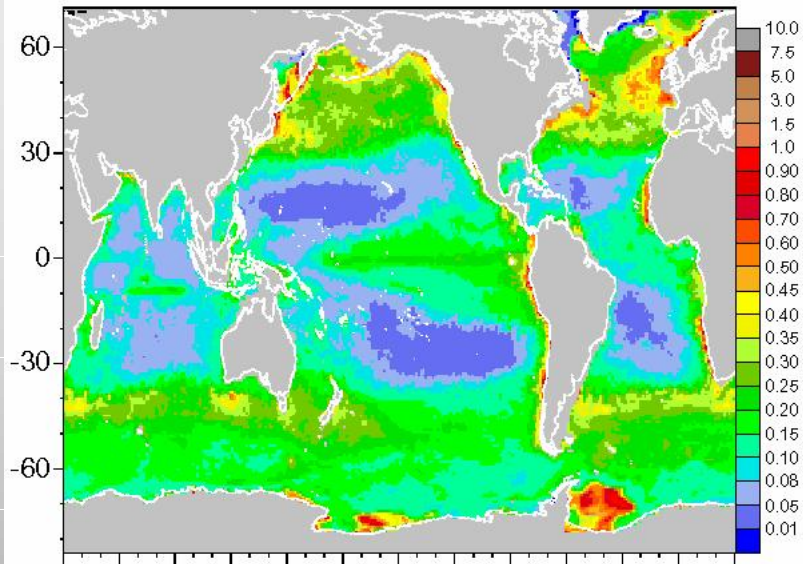
SeaWiFS-assimilation Model; Apr 2003



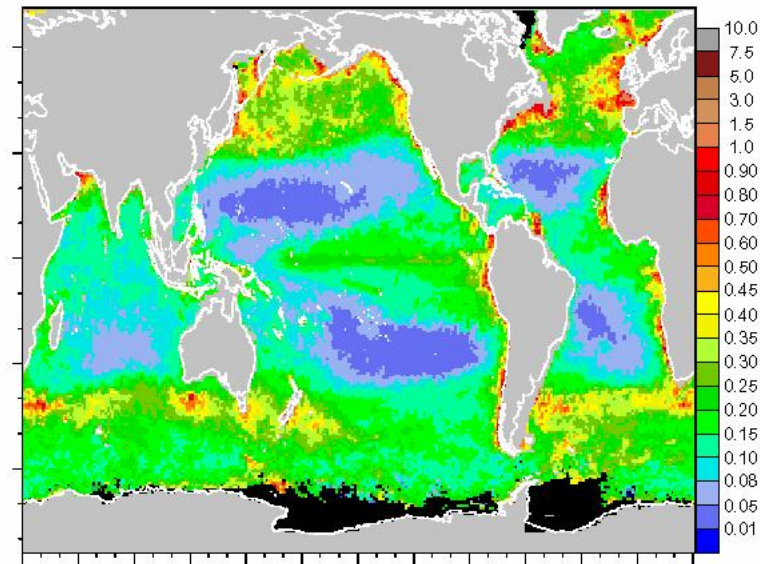
SeaWiFS Chlorophyll; Apr 2003



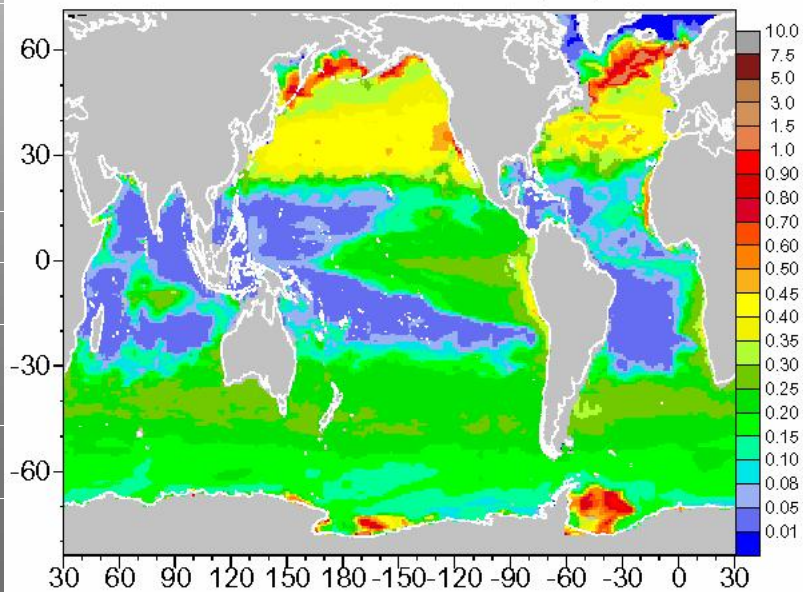
Terra-assimilation Model; Apr 2003



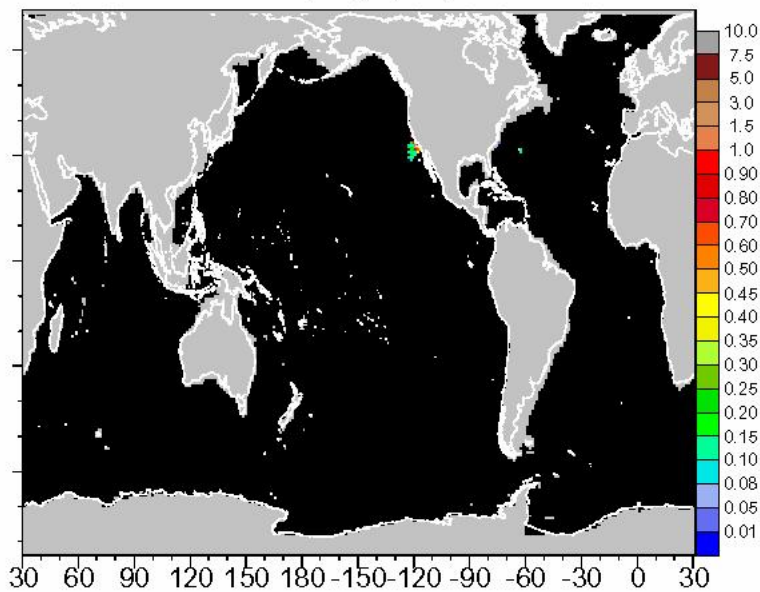
Terra Chlorophyll; Apr 2003



In situ-assimilation Model; Apr 2003



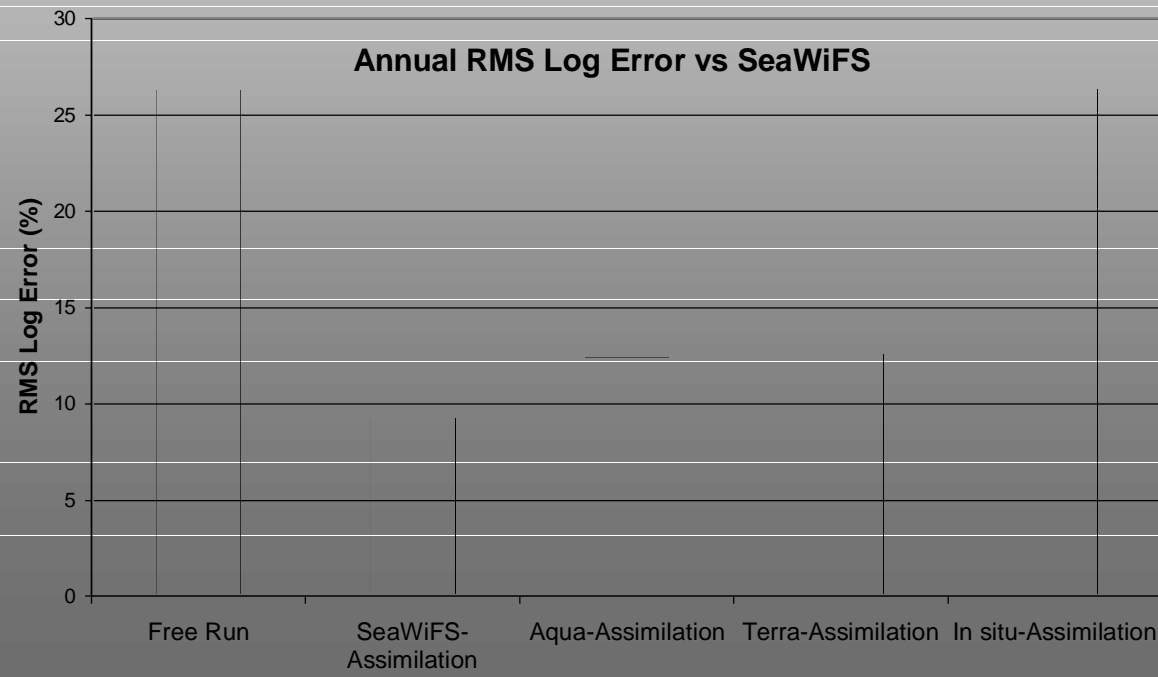
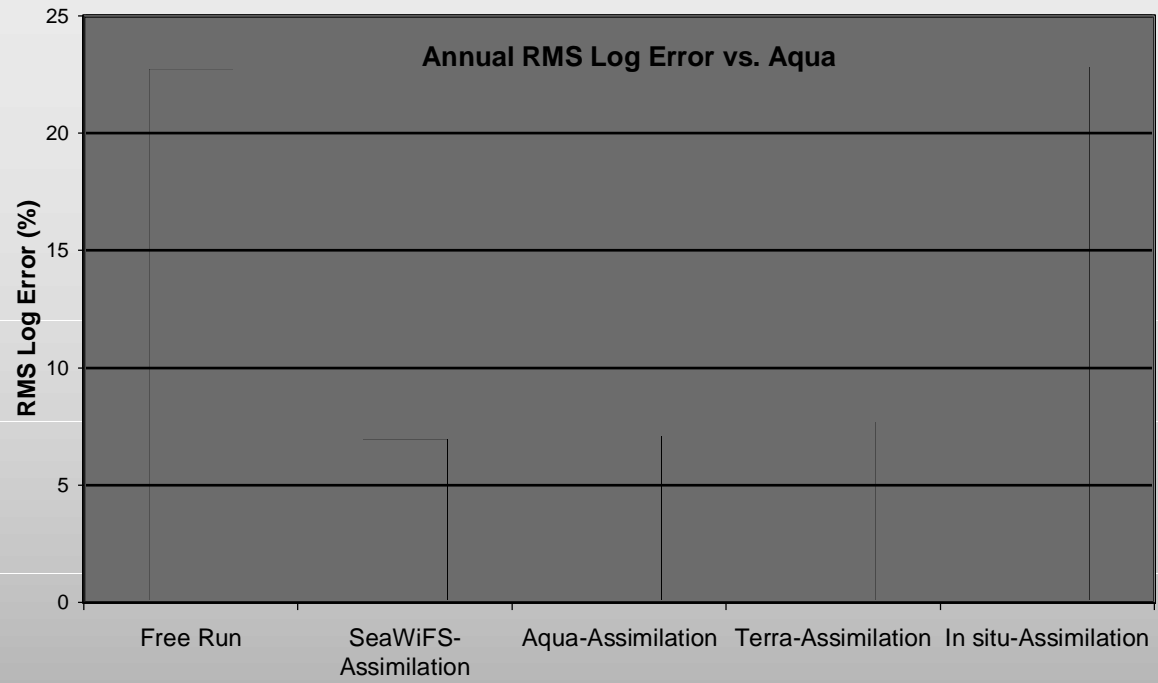
In situ Chlorophyll; Apr 2003



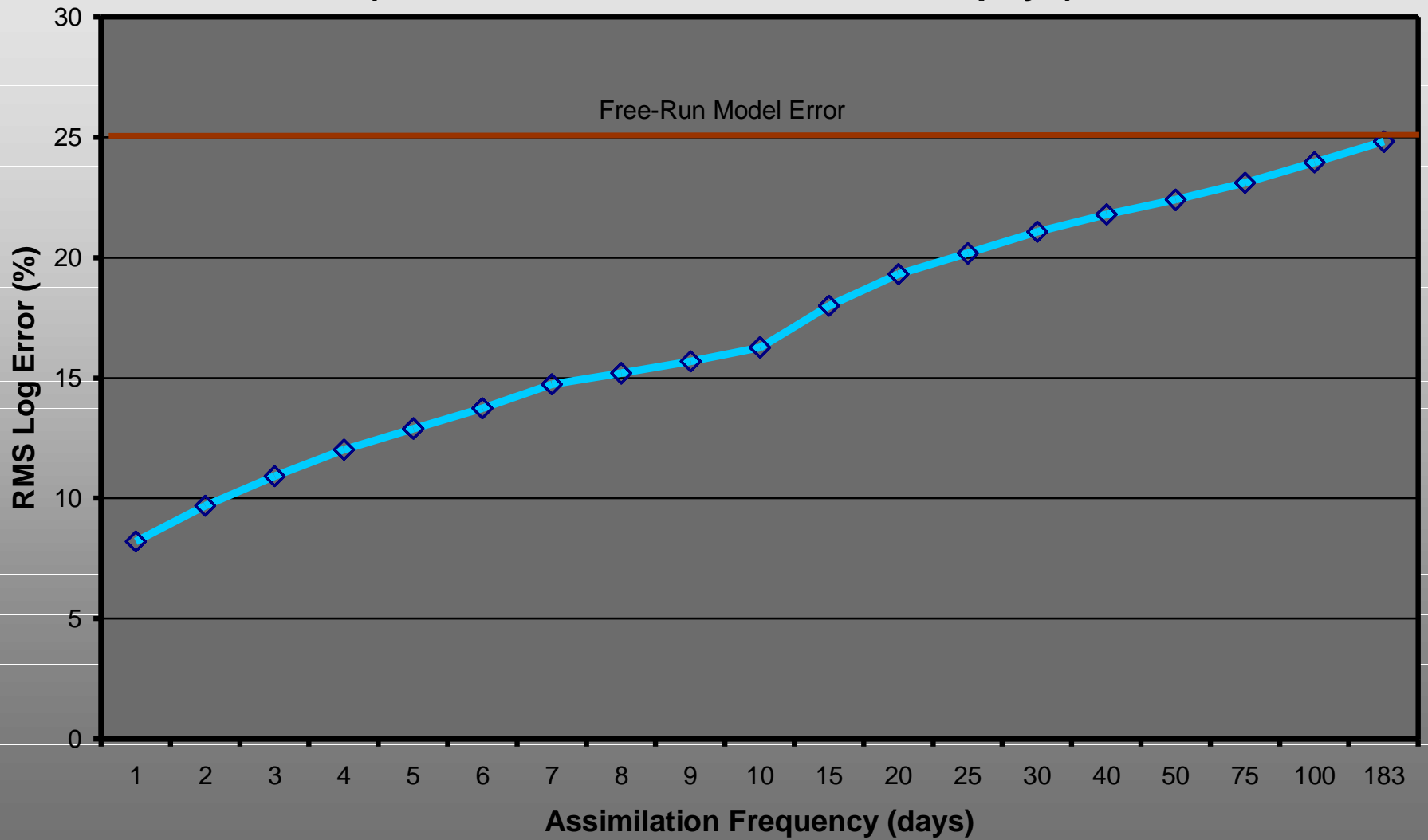
Annual RMS Log Error

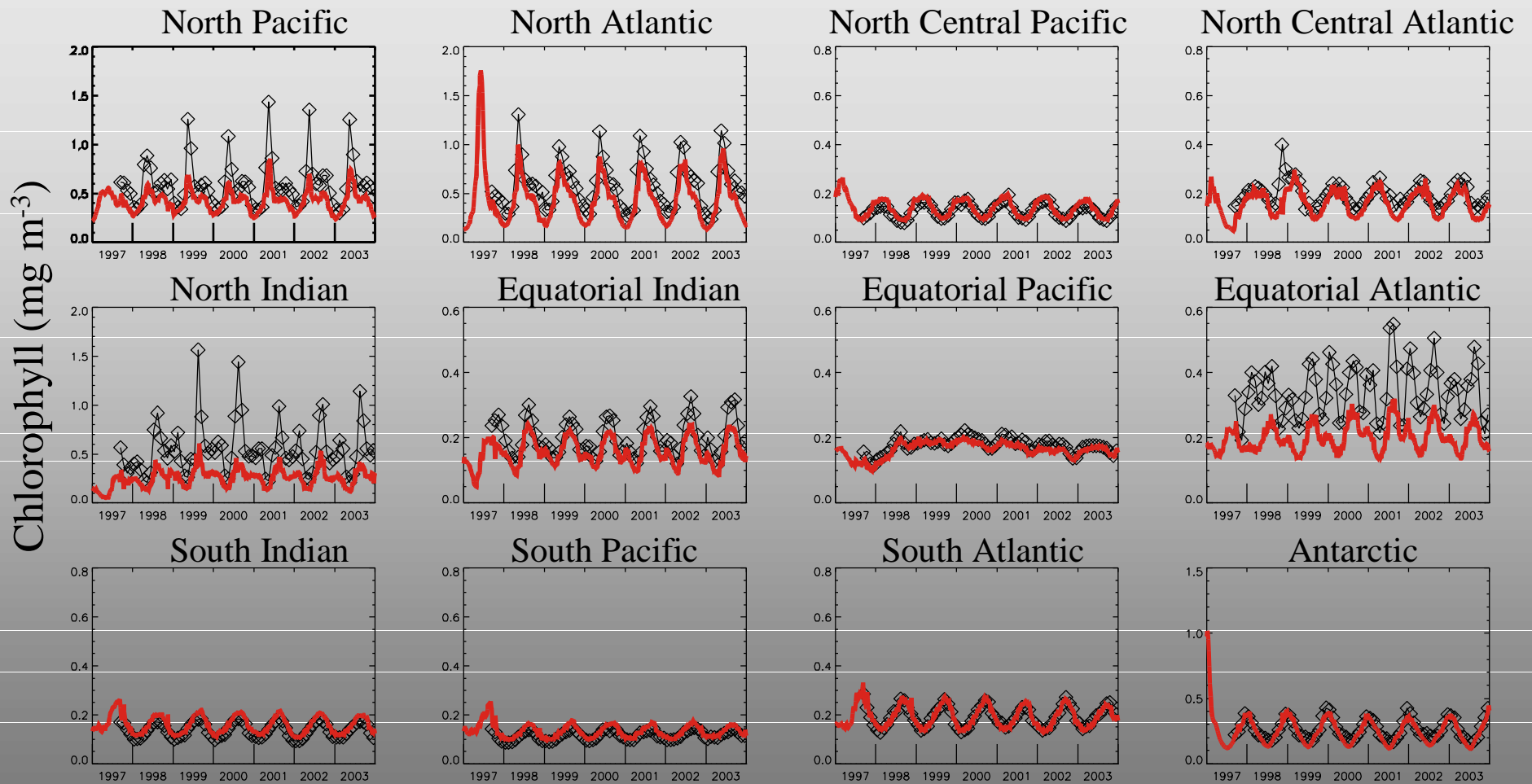
$$\text{RMS}_{\text{mon}} = \frac{\sqrt{\sum (\log_{10} C_{\text{assim}} - \log_{10} C_{\text{aqua}})^2}}{n} \times 100$$

$$\text{RMS}_{\text{ann}} = \frac{\sqrt{\sum \text{RMS}_{\text{mon}}^2}}{12}$$



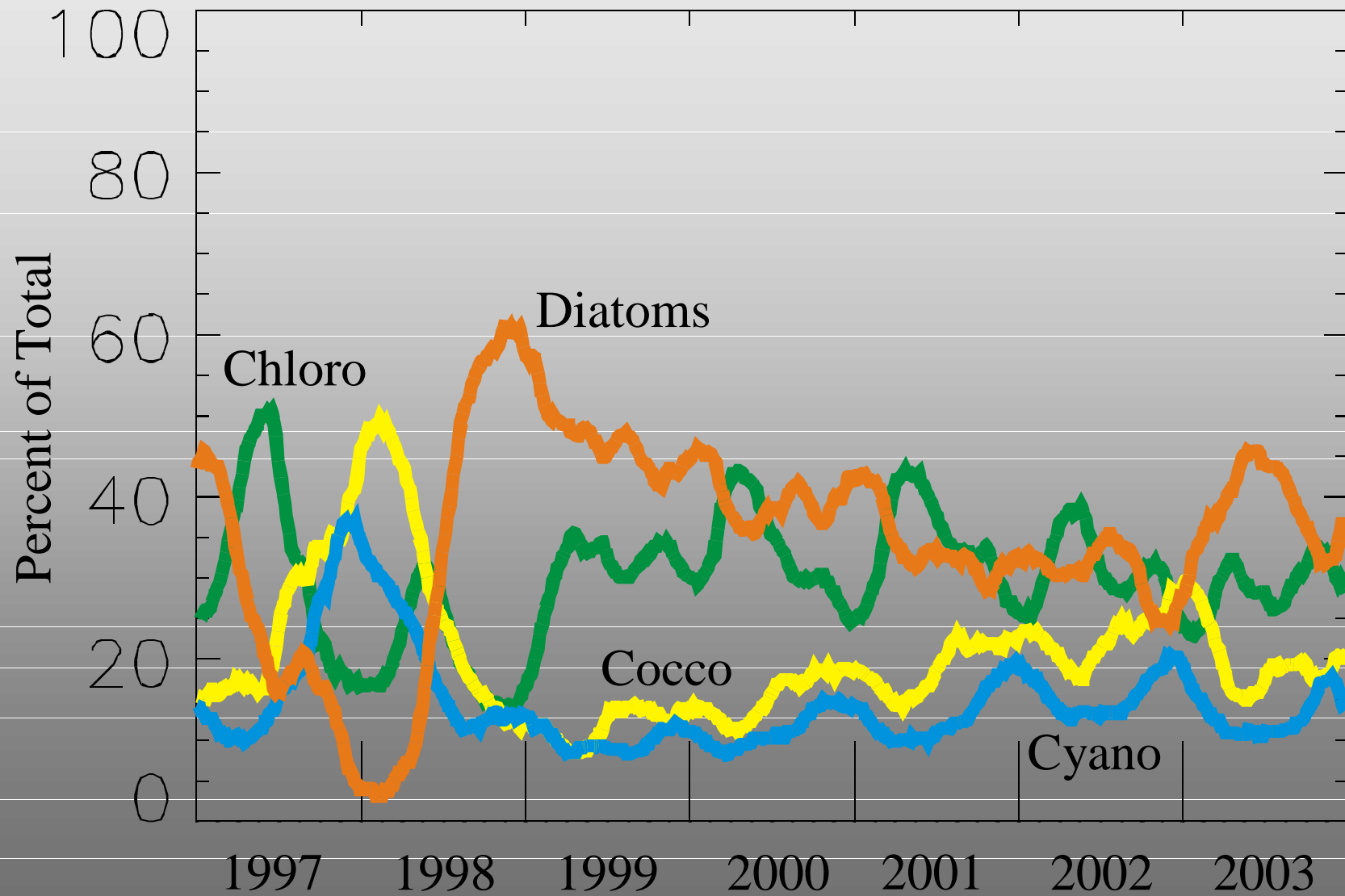
Annual RMS Log Error (Assimilation vs. SeaWiFS Chlorophyll)



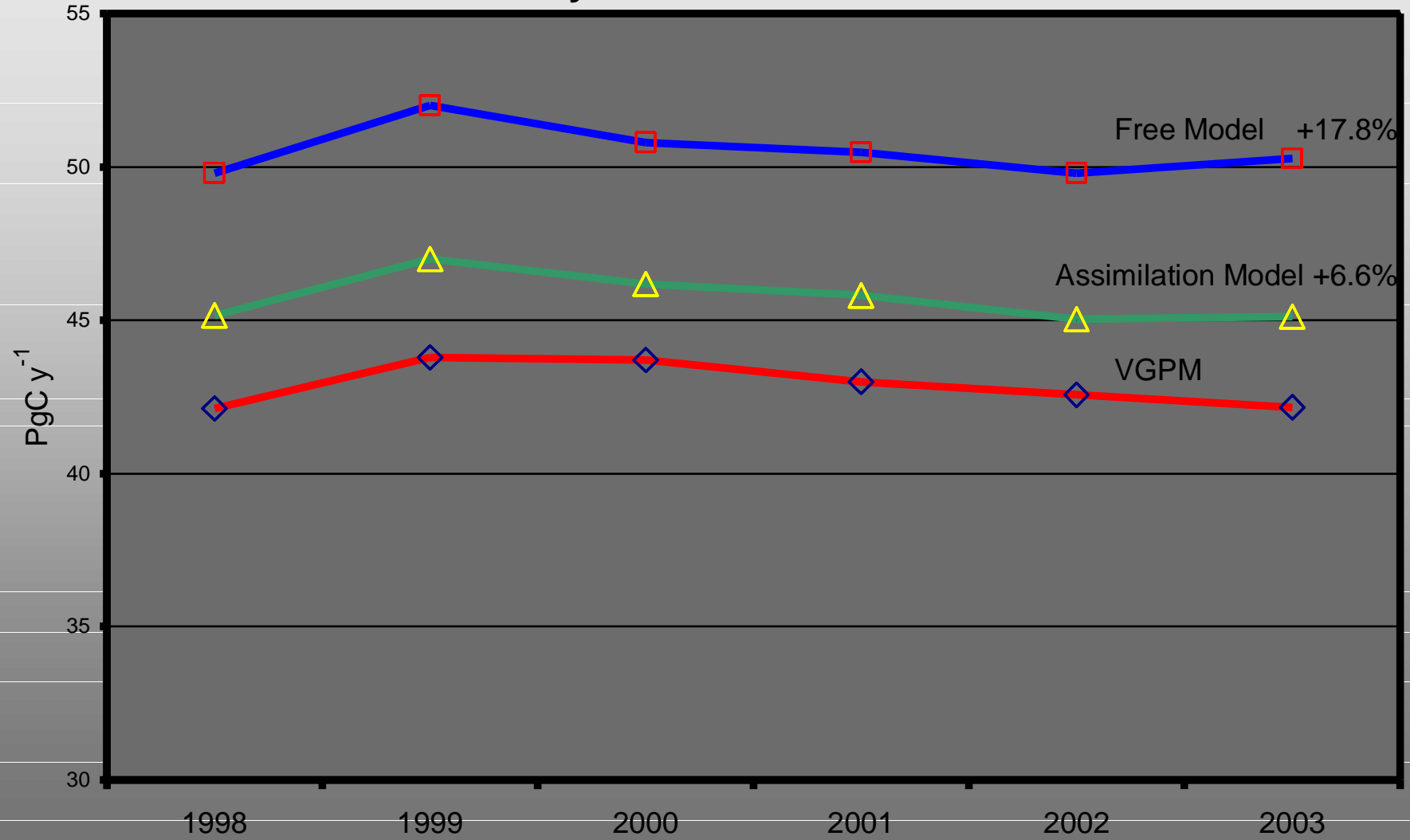


Red = model monthly mean
 Diamonds = SeaWiFS monthly mean

Equatorial Pacific



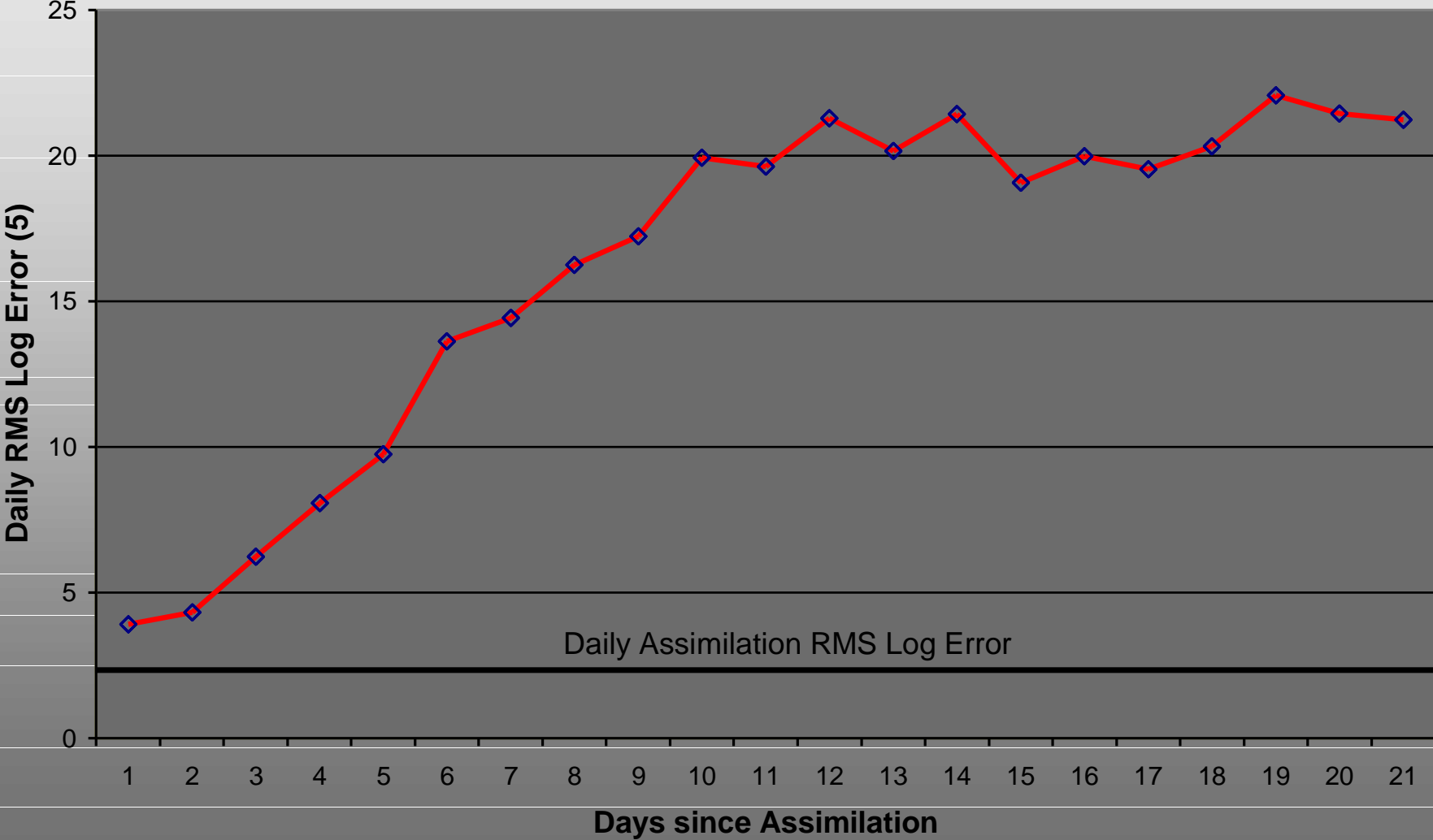
Primary Production 1998-2003



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Model Skill



Summary and Plans

Initial assimilation results promising

Need further analysis new methodologies

Awaiting new SeaWiFS data

Proceed on incorporation of MODIS/GMAO products

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Production

**Chlorophyll, Nutrients,
POC?, PIC?**

Red = EOS
Data product

Green =
assimilated
variable

