GLOBCOLOUR
New Products and Perspectives

Globcolour/Medspiration workshop

Frascati, 19-20 November 2008

André Morel

OVERVIEW

1- Straightforward Developments from the initial GlobColour products such as radiances, Chl (1 and 2), CDM,tau..:

-1.1 From spectral radiances to incident PAR at the ocean surface
- (normalization of the FLH to incident irradiance, PPP..)

-1.2 From [Chl] and geometry, to turbidity-related radiance excess
→ turbidity quantification in coastal zones ;
→ cocoolithophores (calcite) detection offshore

-1.3 From [Chl] to diffuse attenuation coefficient: Kd(490)
→ Bio-optical modelling

Properties of the upper layer

OVERVIEW (cont.d)

2- New Products for Case 1 waters (include a downward extrapolation into the water column)

2.1 From Kd(490) to Kd(PAR): thickness of the heated layer

2.2 From near-surface [Chl], to the Secchi disk depth (visibility, water quality)

2.3 From near surface [Chl], to the depth of the euphotic layer (primary production application)

OVERVIEW (cont.d)

3- Perspectives:
(under development or implementation):

- 3.1 Colored dissolved organic matter (alternate method to GSM)

– 3.2 Primary Production modelling,

- 3.3 Phytoplankton Functional Types (PFT), maps (?)

The following presention is based on papers (not exhaustively)

Turbidity quantification :

Morel, A. and S. Bélanger, **(2006)** Improved Detection of turbid waters From Ocean Color information, *Remote Sensing of Environment*, **102**, 237-249

Morel, A. and B. Gentilli **(2008).** Practical application of the "turbid water" flag in ocean color imagery: Interference with sun-glint contaminated pixels in open ocean. *Remote Sensing of Environment*, 112/3, 934-938

New products (Zeu, Zhl, Zsd)

Morel, A., Huot, Y., Gentili, B., Werdell, P.J., Hooker, S.B. and B.A. Franz **(2007).** Examining the consistency of products derived from various ocean color sensors in open ocean (Case 1) waters in the perspective of a multi-sensor approach. *Remote Sensing of Environment*, 111, 69-88.

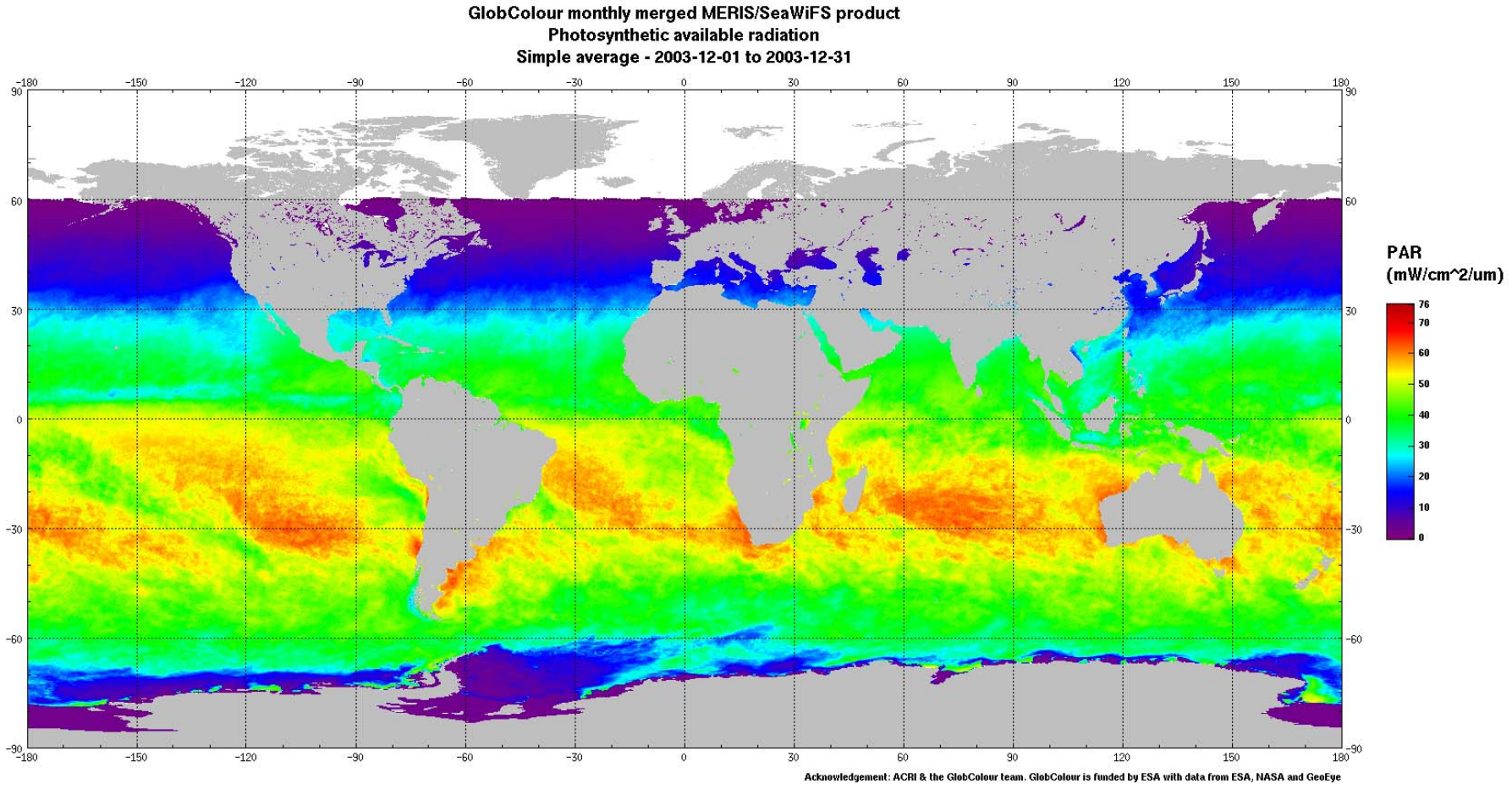
Perspectives (PP, PFT)

Antoine, D. and A. Morel **(1996).** Oceanic primary production : I. Adaptation of a spectral light-photosynthesis model in view of application to satellite chlorophyll observations, *Global Biogeochemical Cycles*, **10**, 43-55.

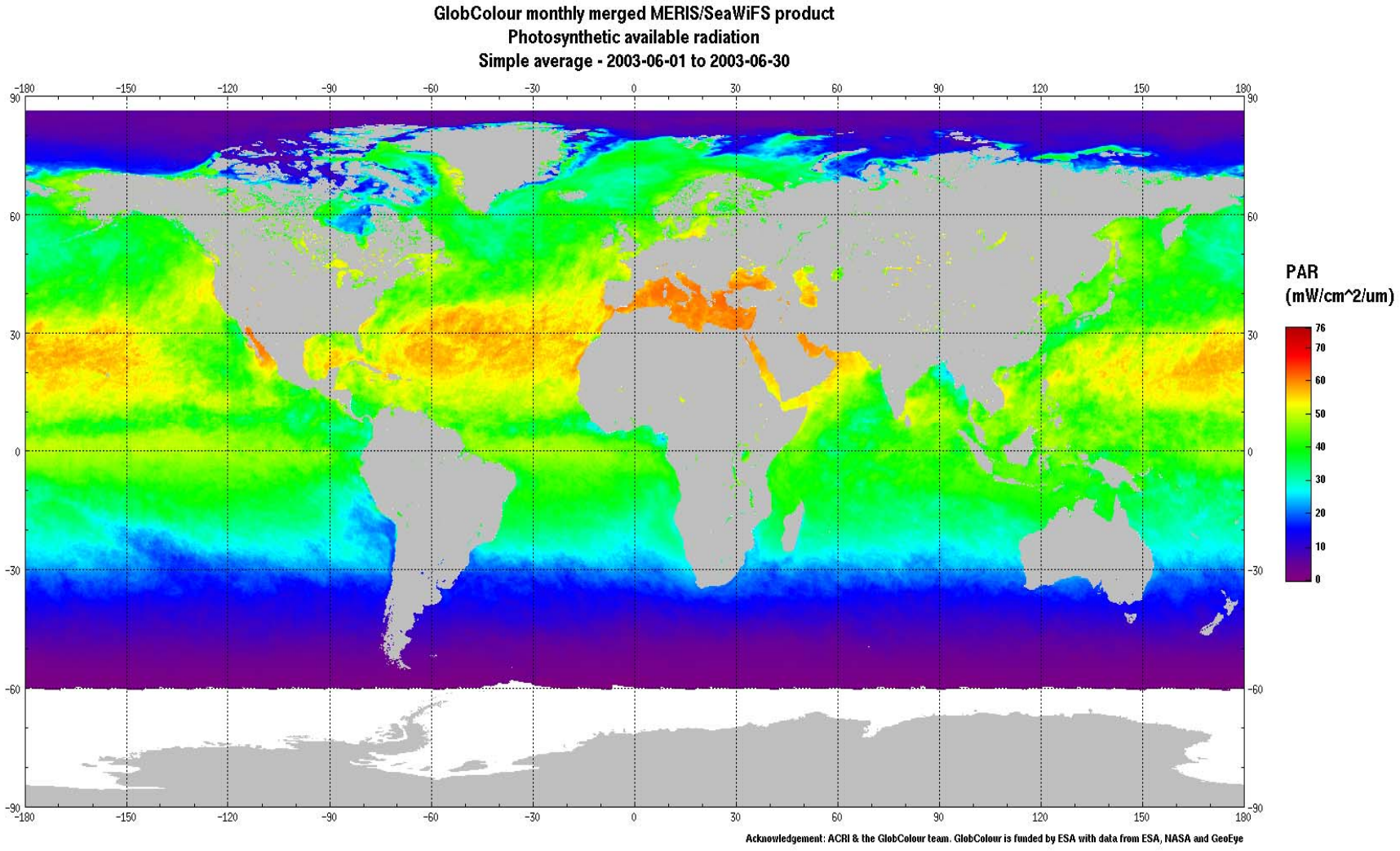
Antoine, D., Morel, A., Gordon, H.R., Banzon, V.F. and R.H. Evans **(2005)** Bridging ocean color observations of the 1980's and 2000's in search of long-term trends. *Journal of Geophysical Research*, VOL. 110, C06009, doi:10.1029/2004JC002620

Uitz, J., Claustre, H., Morel, A., Hooker, S. **(2006).** Vertical distribution of phytoplankton communities in open ocean: an assessment based on surface chlorophyll . *Journal of Geophysical Research*, 111, (C08005, doi:10.1029/2005JC003207)

Applic. 1.1: Photosynthetically Available Radiation (PAR) – Frouin's algorithm- Example for December-2003



PAR, June 2003



(Application 1.2)

Detection of turbid (sediment) zones through an excess of the Normalized Radiance $[Lw]_N$ at λ = 555 nm. Quantification of this excess.

Upper limit value for Case 1 oceanic water:

$$[Lw(\lambda)]_N\text{-}lim(\theta s, \theta v, \Delta\varphi) =$$

$$Rlim(\lambda, Chl, \theta s)\, F0(\lambda)\, \Re(\theta v, W) / Q(\theta s, \theta v, \Delta\varphi, Chl, \lambda)$$

(lookup Tables for Rlim and Q available)

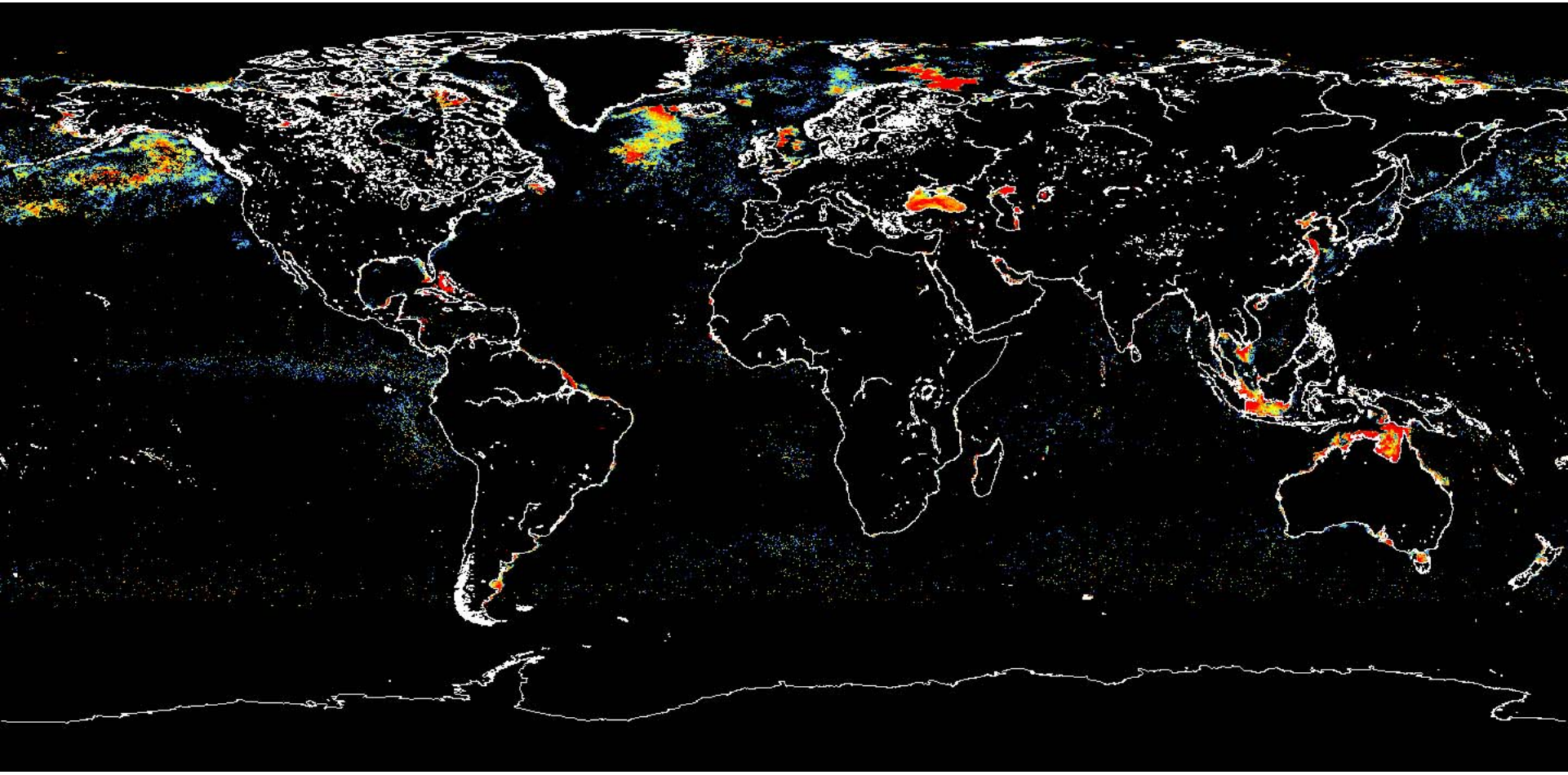
---->FLAG, then, the relative excess of radiance can be quantified through:

$$\Delta[Lw]N / [Lw]N_{lim} = 100\,([Lw]N_{detected} - [Lw]N_{lim}) / [Lw]N_{lim}$$

(Application 1.2)

Excess of Radiance at 555nm (= « turbidity index »)

- (Example: July 2002 - GlobColour merged product) -

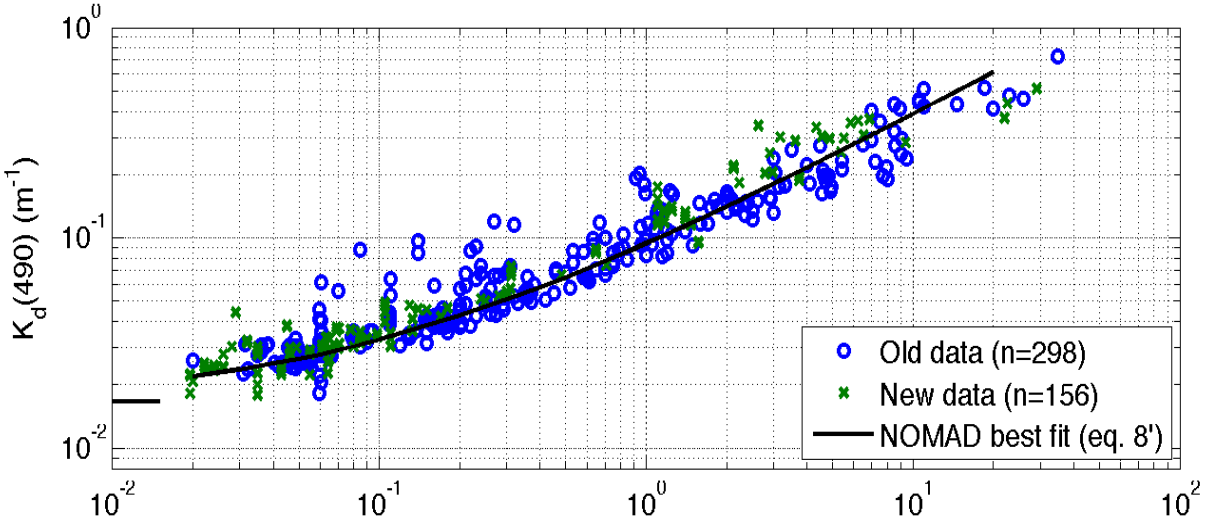


(Application 1.3)

Attenuation coefficient, Kd(490), and [Chl] empirical relationships (Case 1 waters only) . Field data.

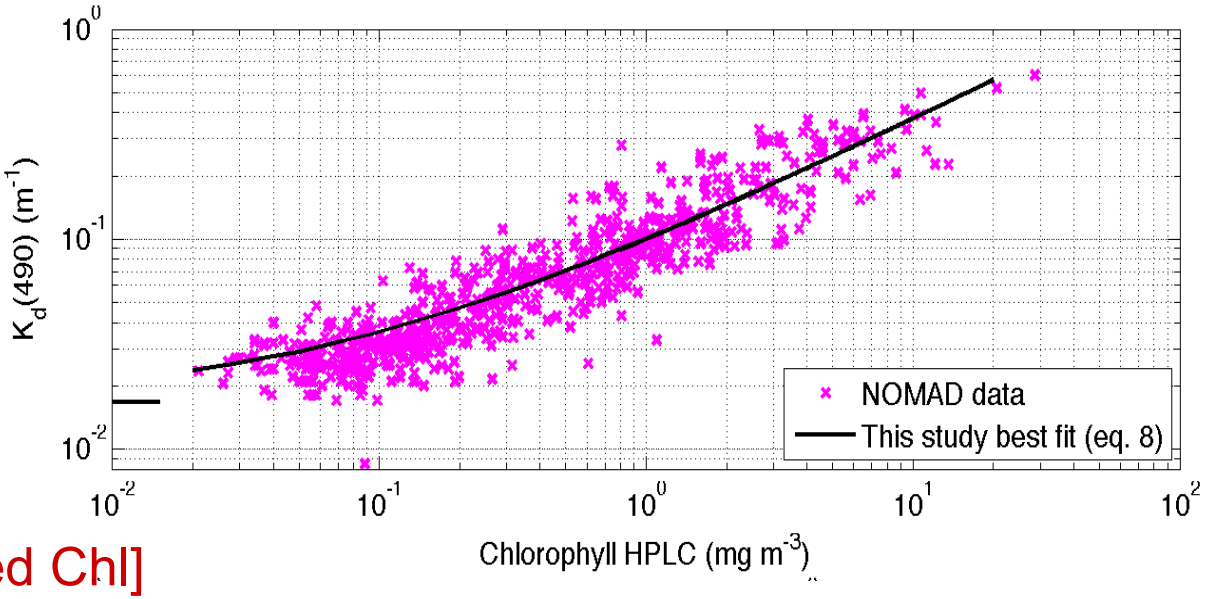
LOV data (old + new)

NOMAD best fit



NOMAD data

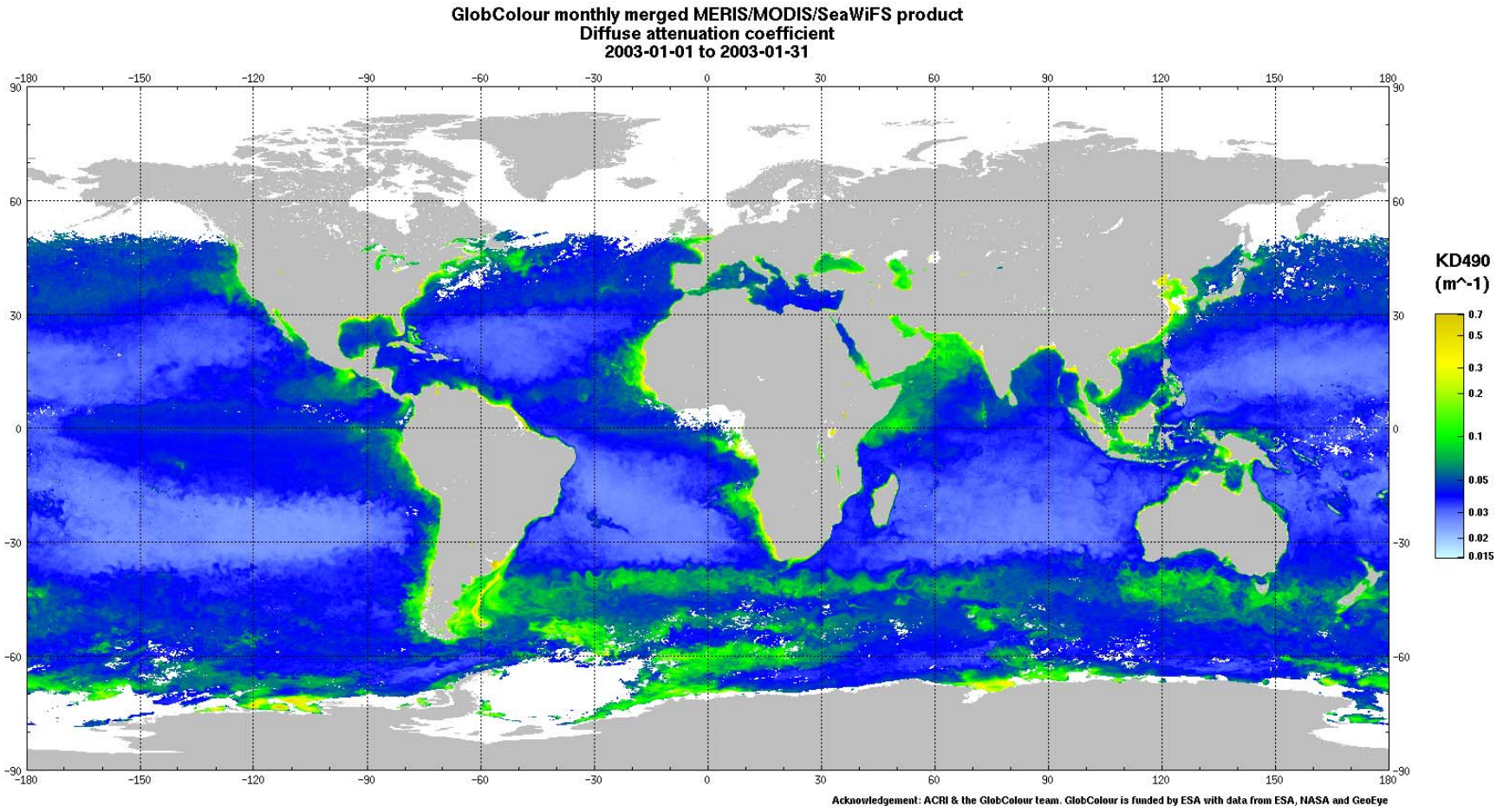
LOV best fit (Morel-Maritorena, 2001)



Therefore,

Kd(490) can be derived Chl]

Application1.3
KD(490) -January, 2003-



OVERVIEW (cont.d)

2- New Products for Case 1 waters (include a downward extrapolation into the water column)

2.1 From Kd(490) to Kd(PAR): thickness of the heated layer

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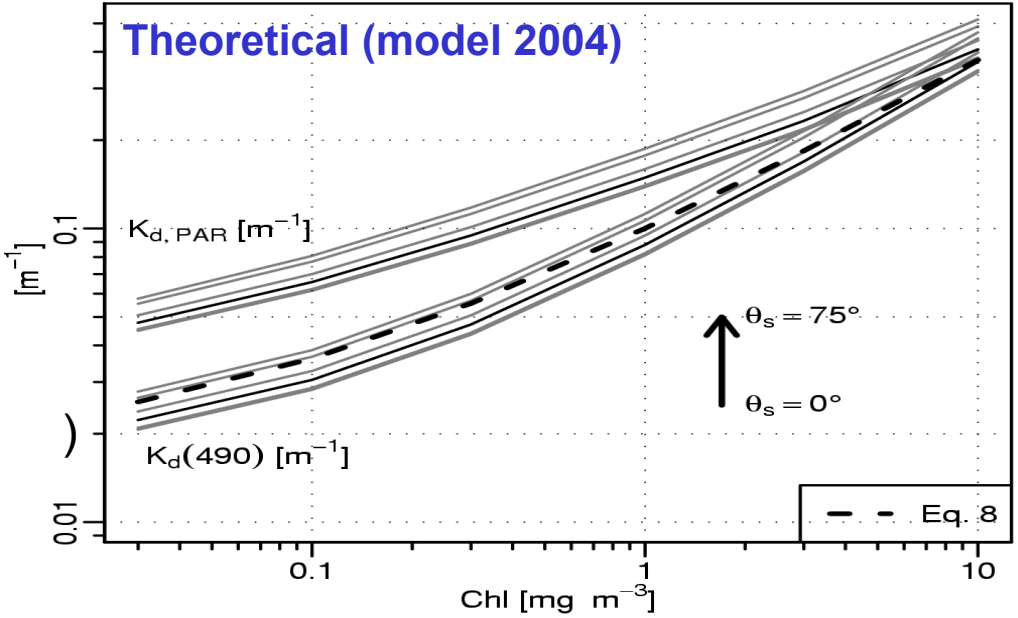
2.3 From near surface [Chl], to the depth of the euphotic layer (primary production application)



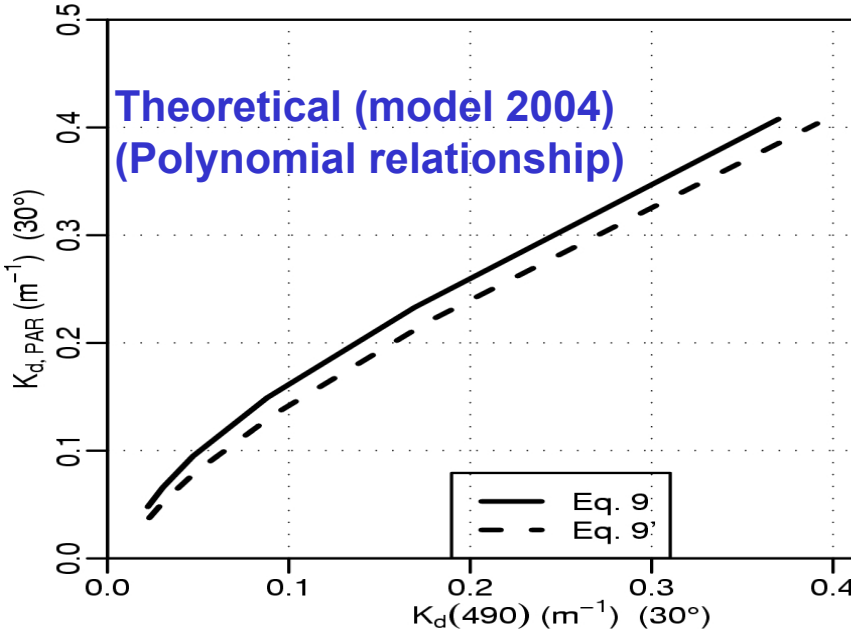
(Application 2.1):

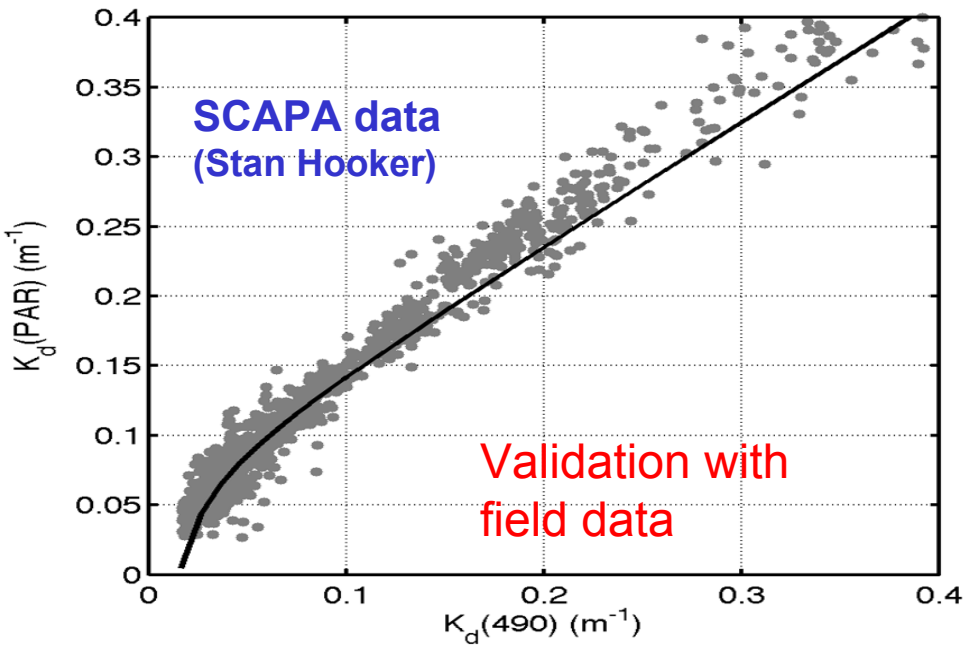
K_d (PAR) from K_d(490), then,

$2 / K_d(PAR) = Zhl$

Heated layer Thickness

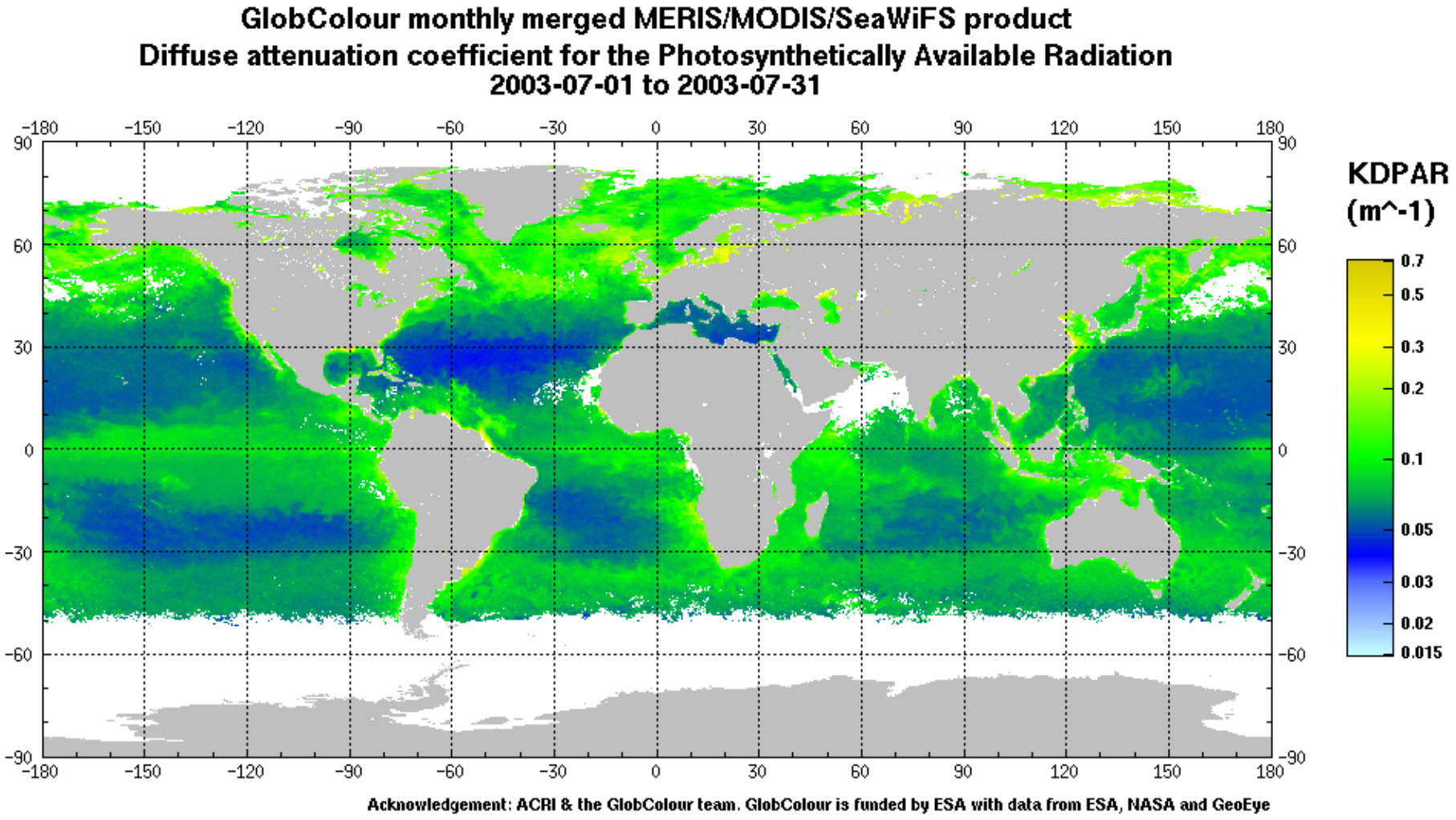
(96% of heat deposition occur within this layer)





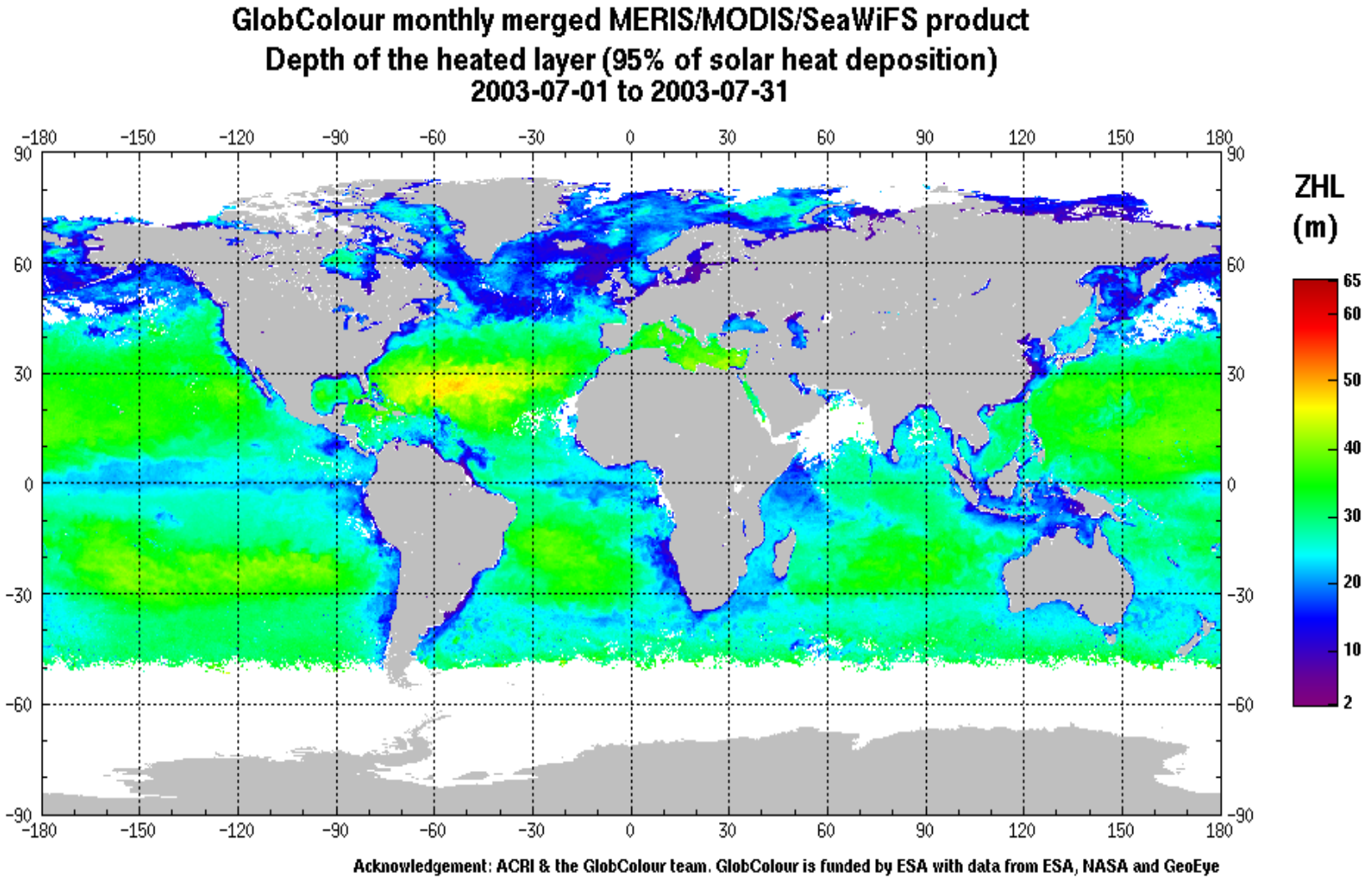
Application 2.1

KDPAR, July2003



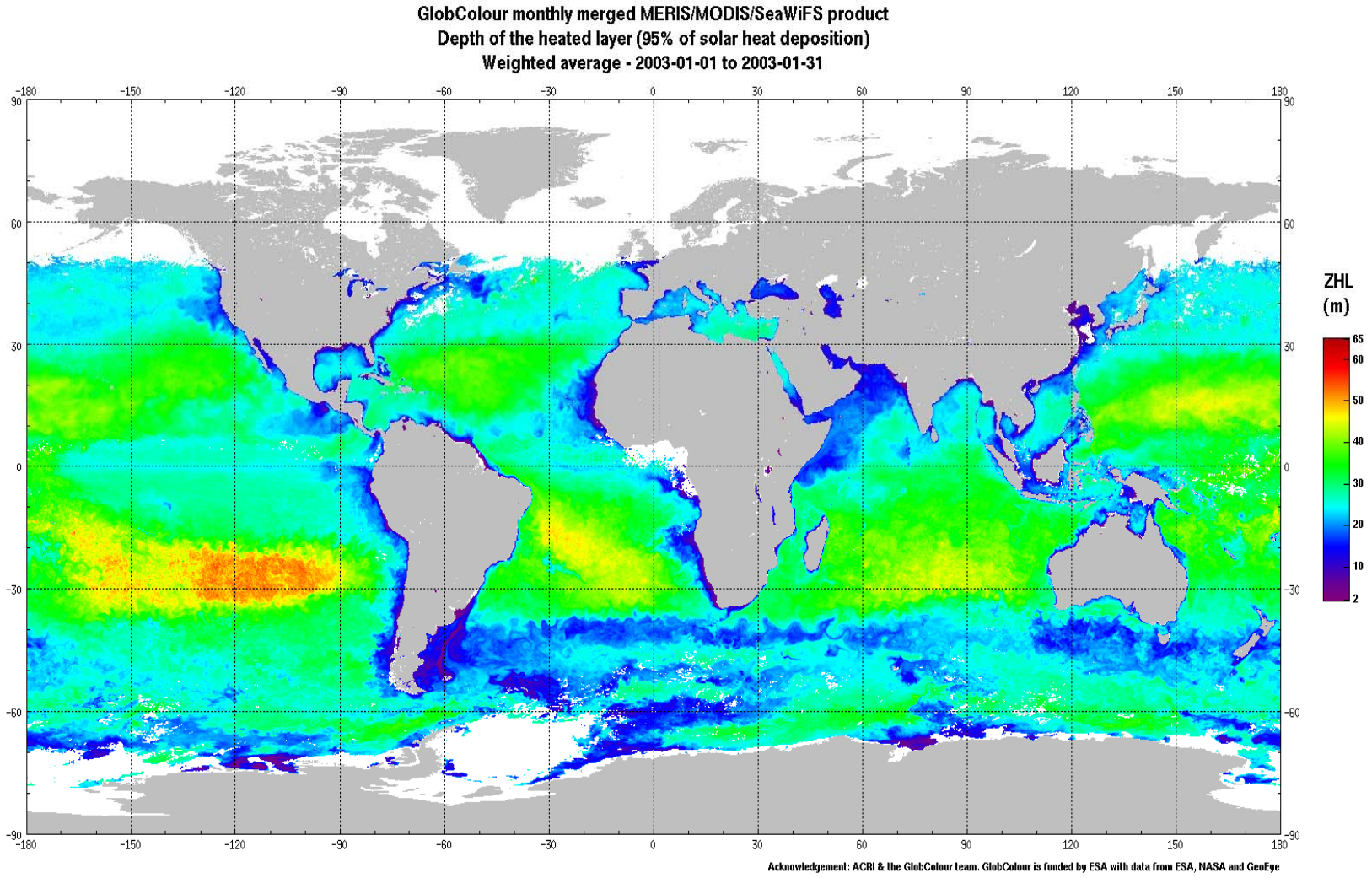
Application 2.1

Thickness of the Heated Layer (July 2003)



Application 2.1

Thickness of the Heated Layer (Jan. 2003)



Application 2.2

Secchi disk depth estimate via (Chl]

$$Zsd = \Gamma / [cv\,(Zsd \rightarrow 0) + Kd,v\,(0 \rightarrow Zsd)]$$ Tyler's Equation

(v= visual "scotopic human vision")

cv and Kd,v are computed through **Case 1 water model**, and related to [Chl]

$$Kd,v\,(0 \rightarrow Zsd) = [1/(Zsd)]\ \ Ln\,[Ev(Zsd)/\,Ev\,(0)]$$

and

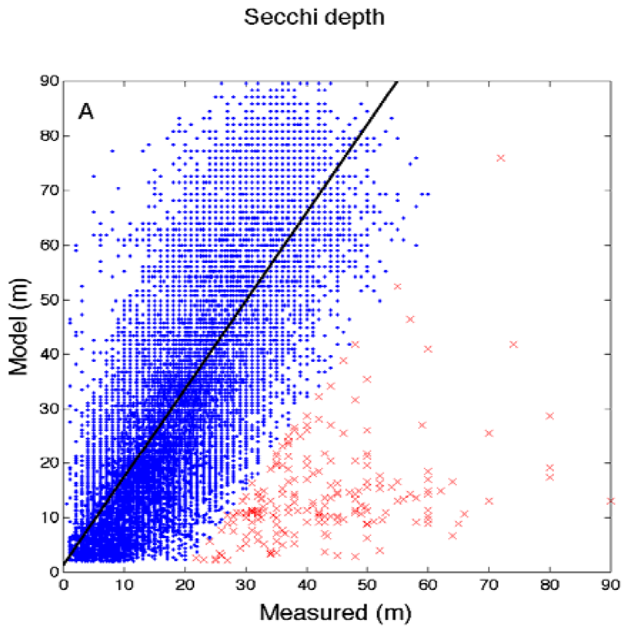
$$cv\,(Zsd \rightarrow 0) = [1/(Zsd)]\ \ Ln\ \{\ \ Ev(\lambda,Zsd)\,d\,\lambda\ /\ Ev(\lambda,Zsd)\,\exp(-c(\lambda)zsd)\,d\,\lambda\ \}$$

(iterative solution needed)

Finally, Polynomial expression :

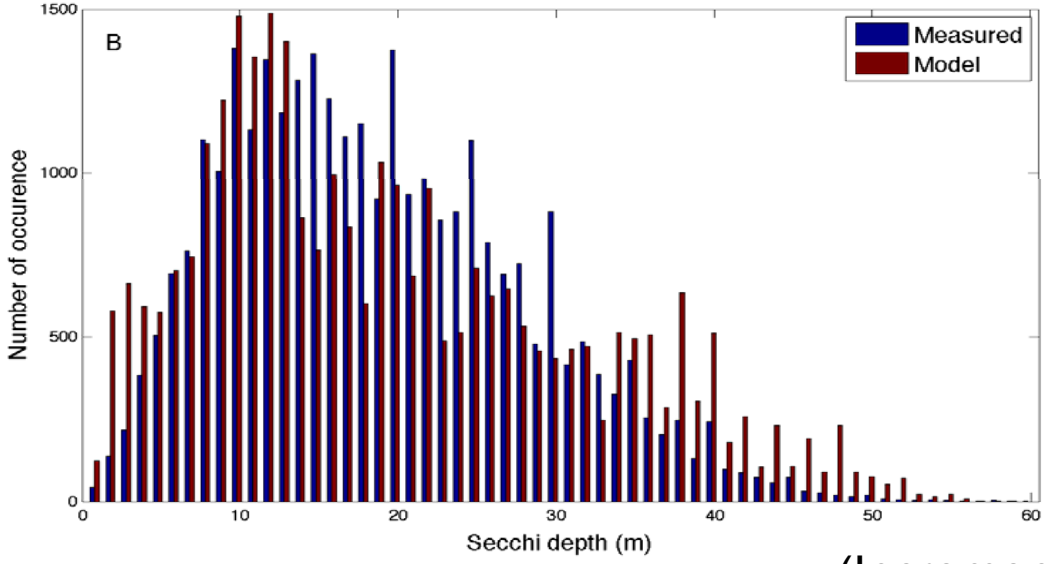
$$Zsd = 8.59 - 12.55\,X + 8.17\,X\uparrow 2 - 2.35\,X\uparrow 3$$

where $X = \log 10\,[Chl]$



Validation of Zsd

Secchi disk depth computed
From near-surface [Chl]
vs. measured

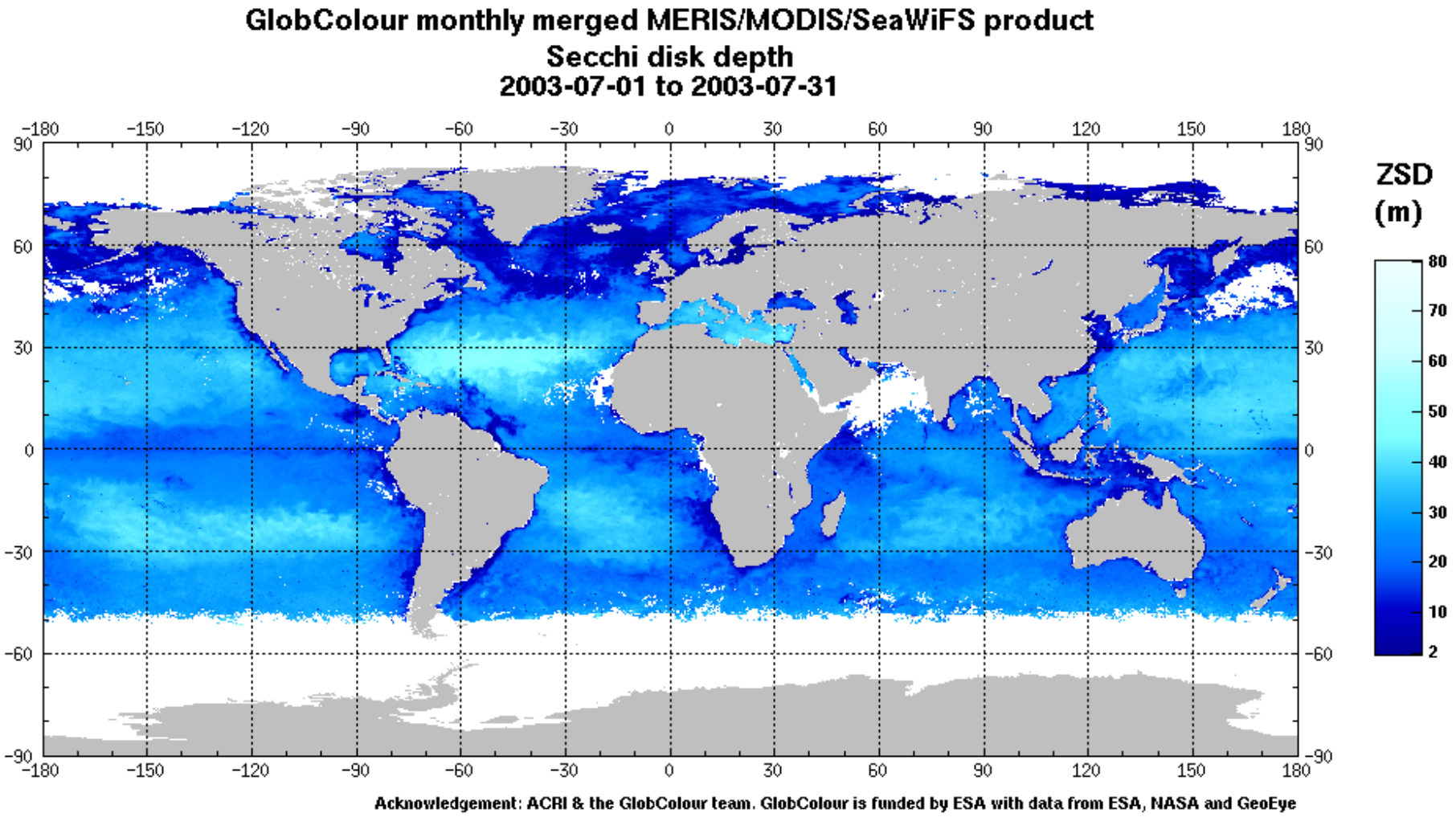


(Increment 1m)

Zsd from
MODIS - Chl
(Summer 2003)
versus
NODC Zsd
1900-1990
(All summers)

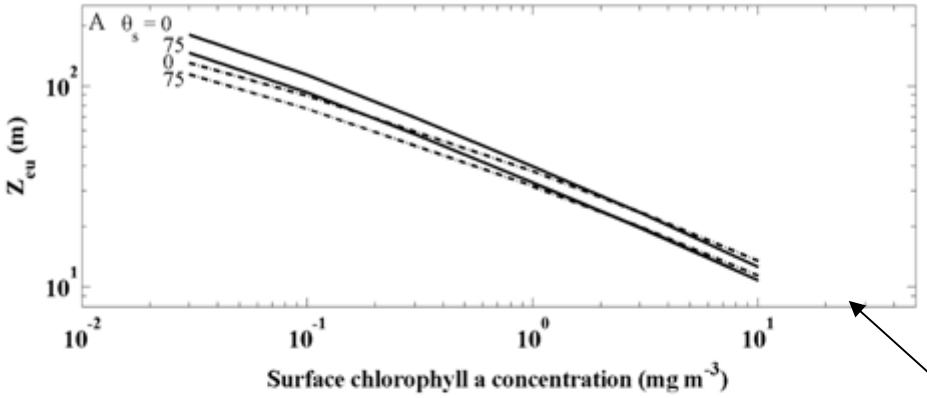
(N= 66009 data)

Application 2.2: Secchi disk depth

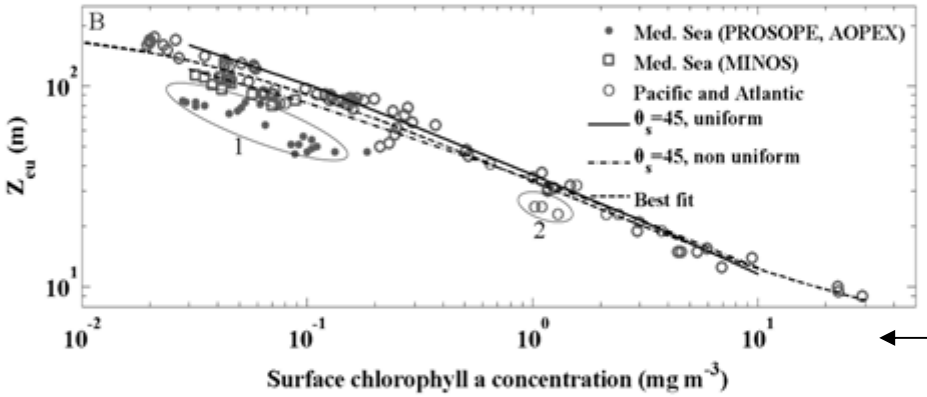


Application 2.3

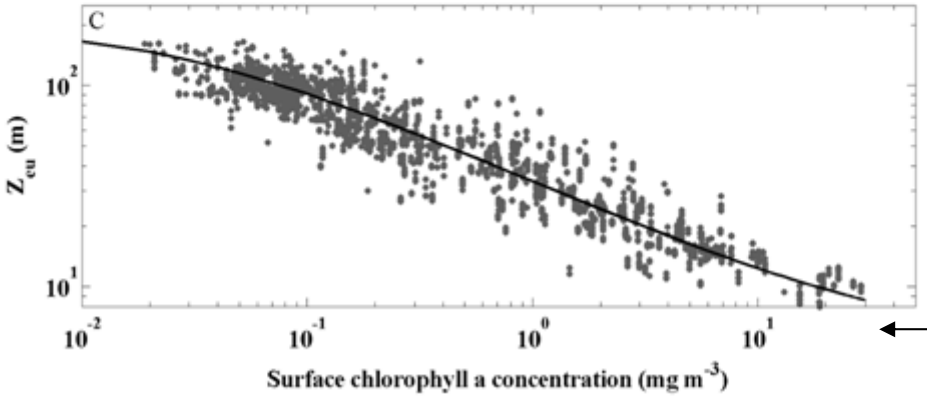
Euphotic depth (Zeu) from near-surface [Chl]



Theoretical computations (Morel-Gentili, 2004)

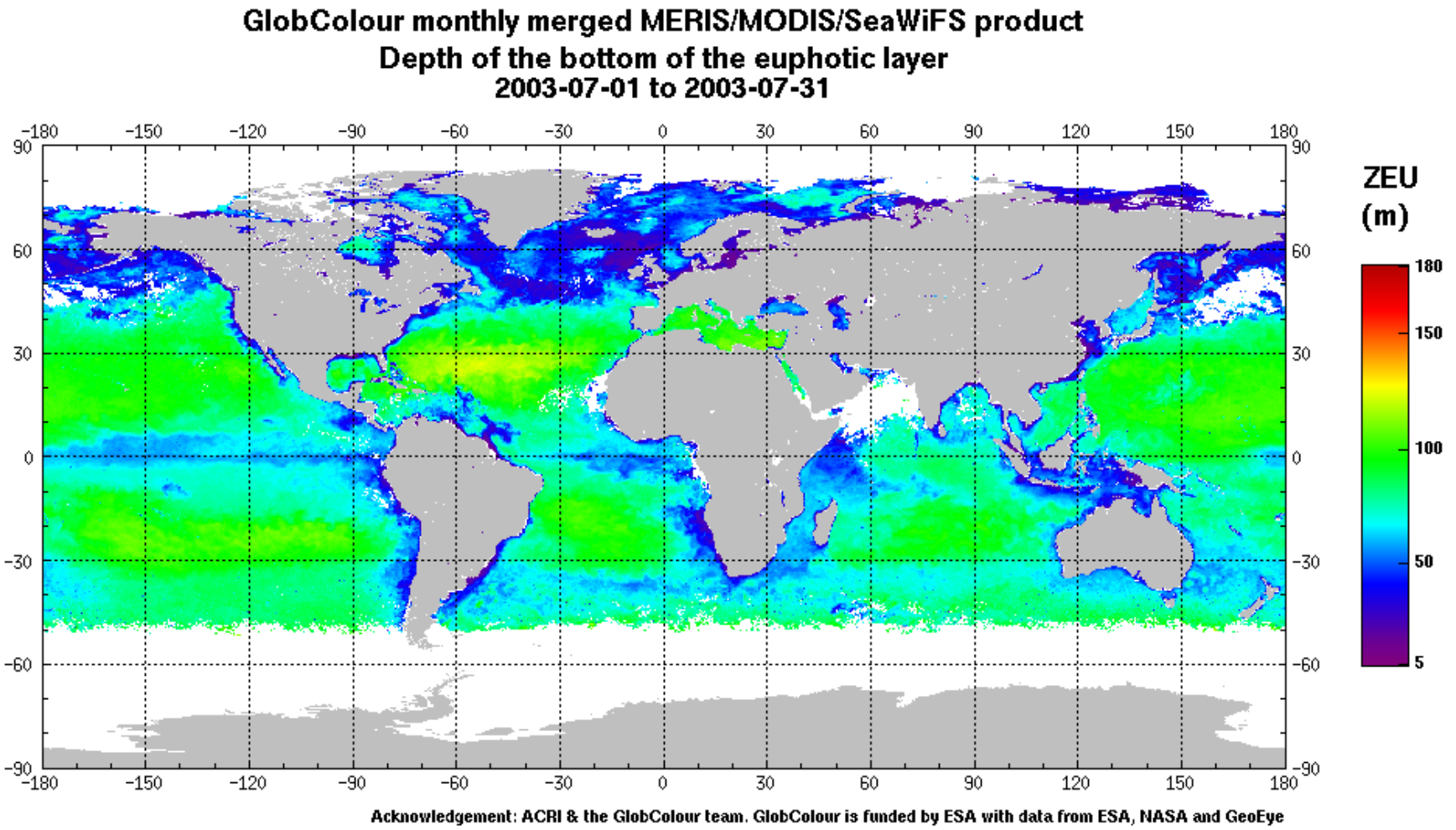


Recent (LOV) data



SCAPA bank (Stan B.Hooker)

Application 2.3 Euphotic depth (July 2003)



OVERVIEW (cont.d)

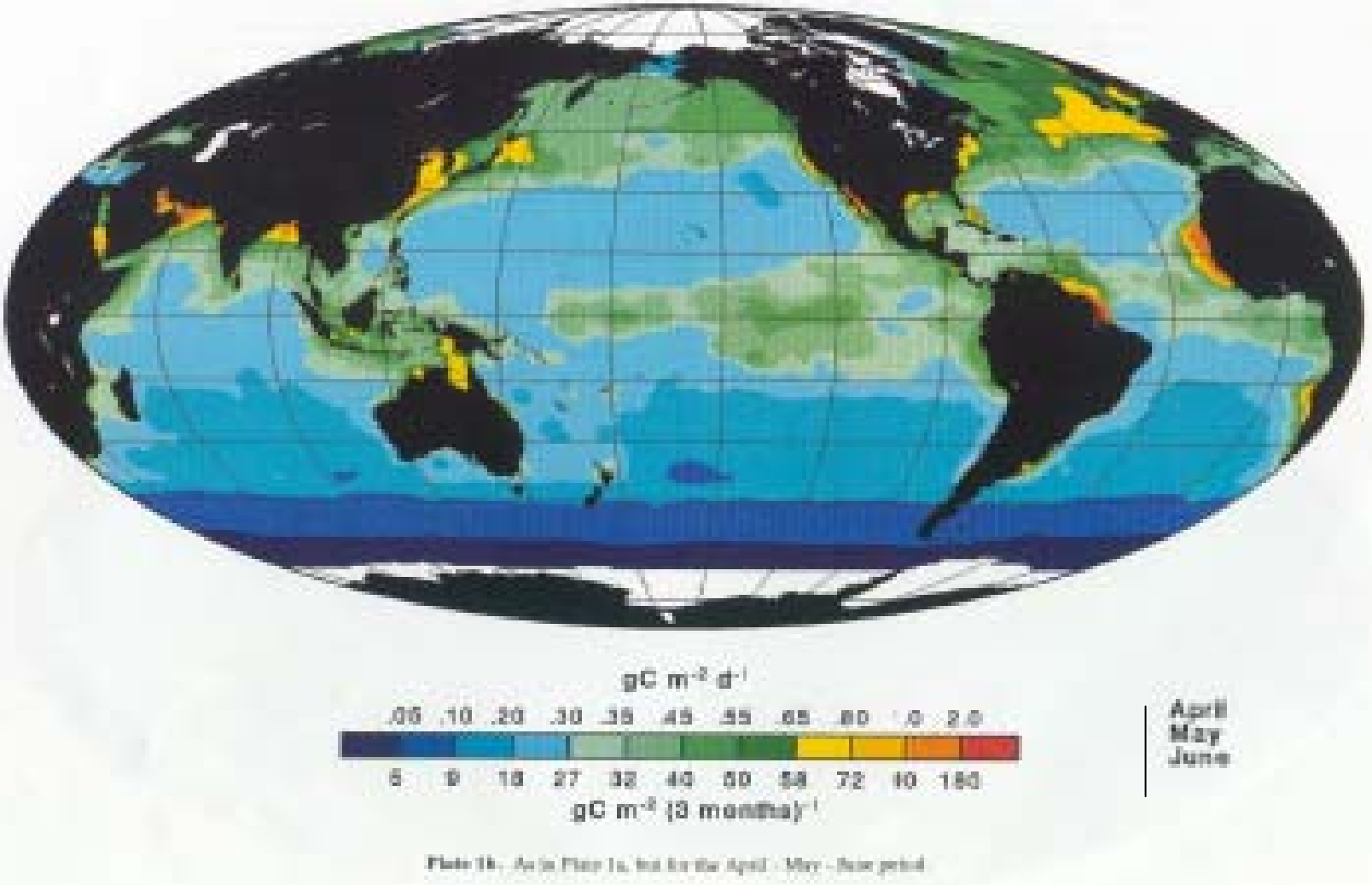
3- Perspectives:
(under development or implementation):

- 3.1 Colored dissolved organic matter (alternate method to GSM)

– 3.2 Primary Production modelling,

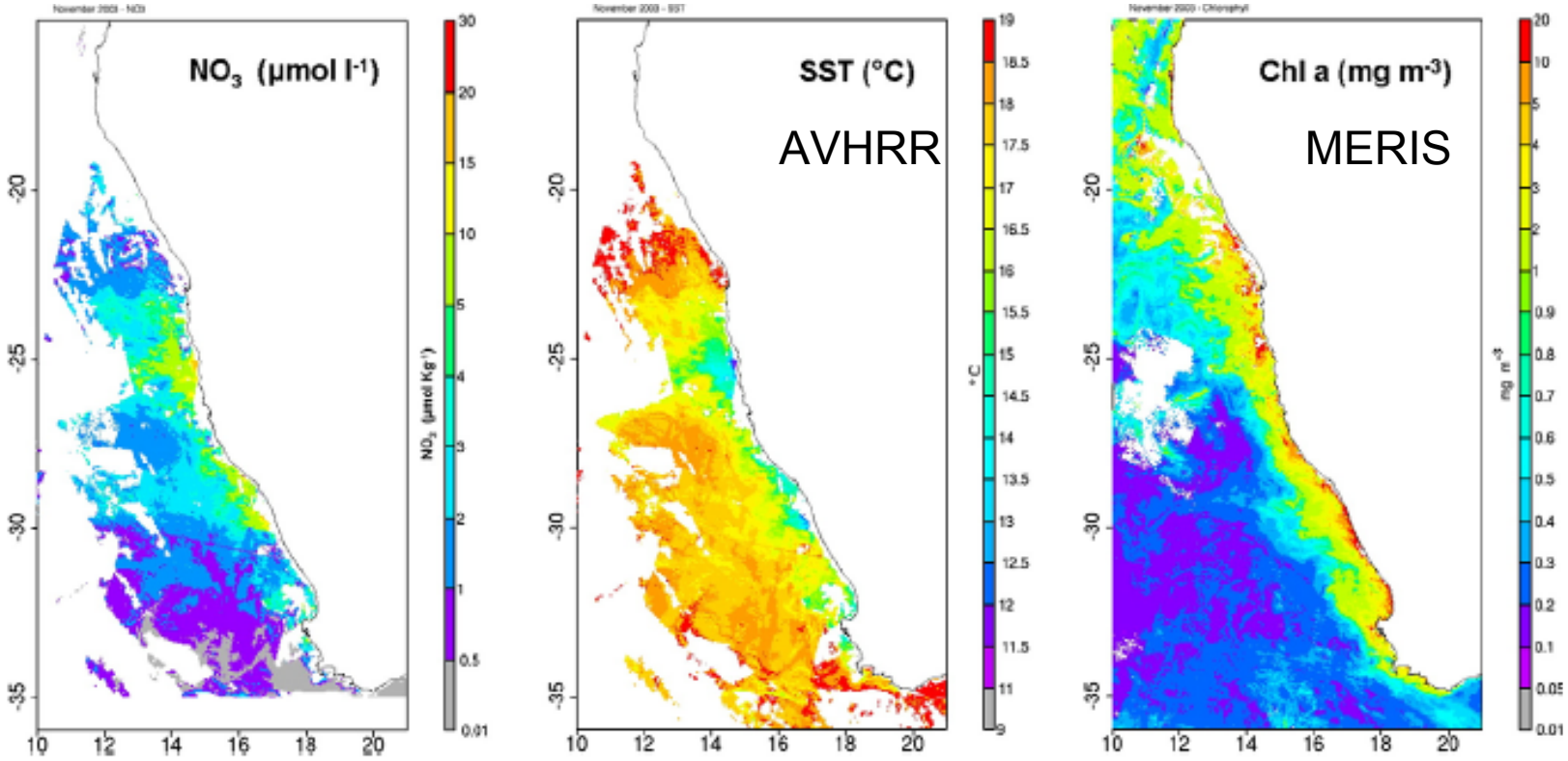
- 3.3 Phytoplankton Functional Types (PFT), maps (?)

Perspective 3.2: Primary production computation
Needed: Chl, SST, Mixed layer, cloud climatology..**and** photophysiology)



From CZCS climatological data JGR, 1995))

Computation of the « New production »
from Chl, Nitrate flux derived from temperature field



A. Silvio-Calzada, A. Bricaud, B. Gentili, RSE, 2008

Perspective 3.3: Phytoplankton Functional Types

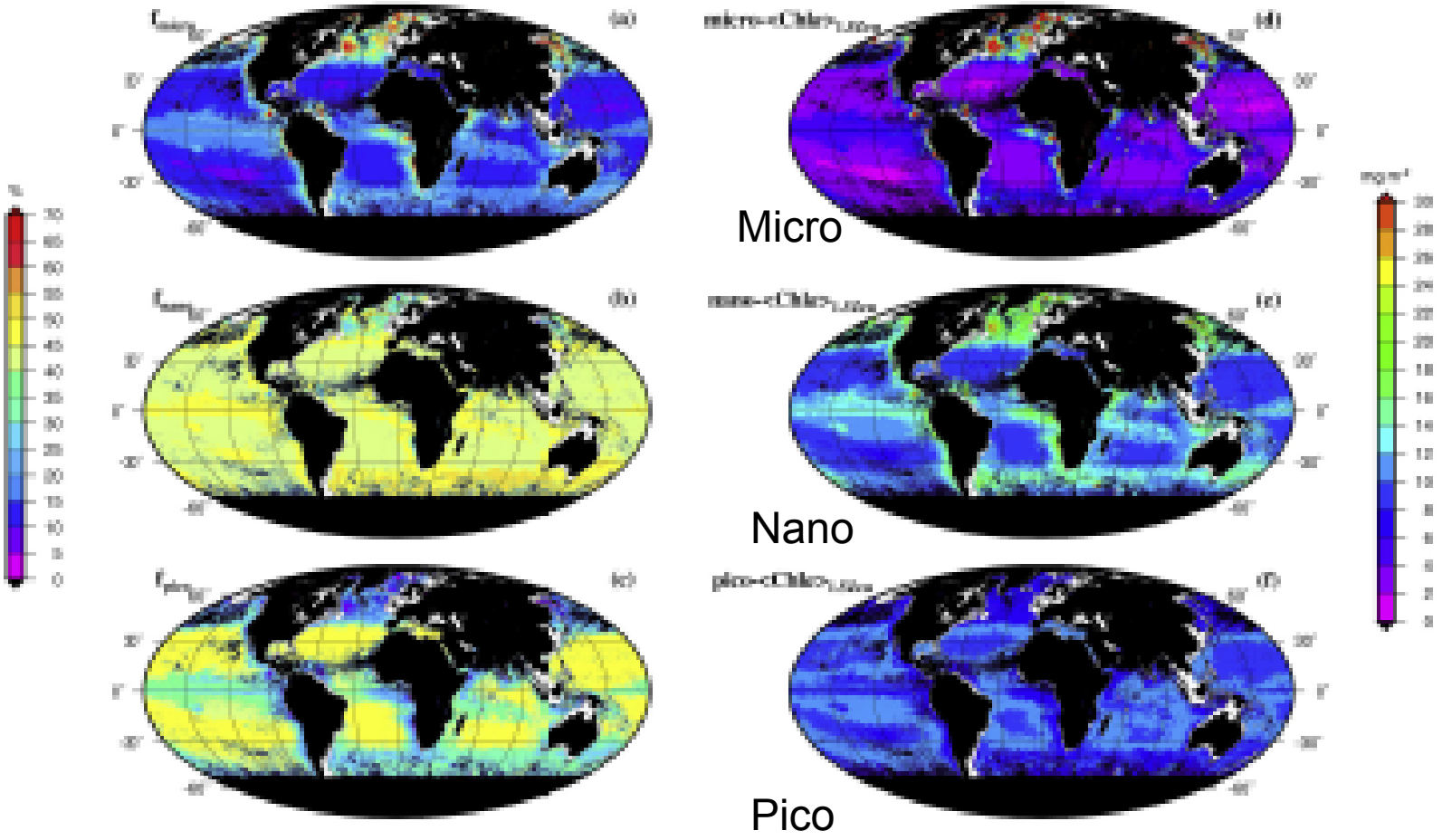


Figure 13. Phytoplankton community composition for June 2000 (SeaWiFS composite): (a–c) fractions (%) of micro-Chla, nano-Chla and pico-Chla within the 0–1.5 Z_{eu} layer, and (d–f) integrated contents within the same layer (mg m^{-2}). Coastal areas (less than 200 m deep), large lakes and inland seas are represented in white. Red indicates a percentage of 70 and more (Figures 13a–13c) or an integrated content of 30 mg m^{-2} and more (Figures 13d–13f).

Uitz et al., JGR, 2006

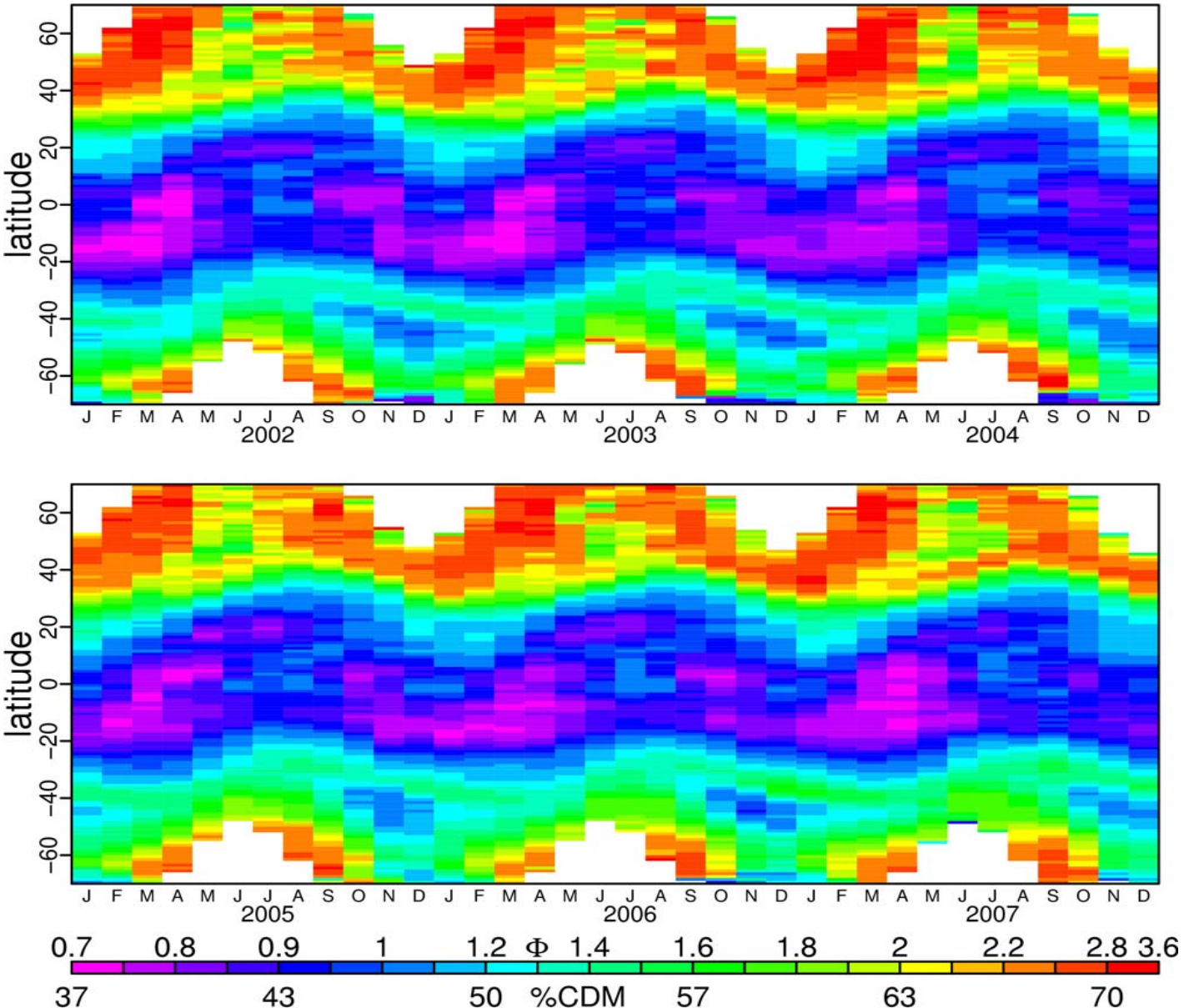
Perspective: 3.1 Colored Detrital Material (alternate method wrt GSM)

Relative CDM abundance

$$(\%)CDM = \frac{a_{CDM}}{(a_{CDM} + a_{phyto})}$$

Time (month)
Latitude (1°)
Distribution

(From SeaWiFS 2002-2007 archived data)



Conclusive Remarks
Perspectives and new products

- Several already existing products or by-products could be systematically developped (e.g. heated layer thickness, euphotic depth, CDM…..),
  depending on actual demands (IOCCG/IOCCP/MetOffice/end users)

- Candidates for new useful products are emerging (e.g. PFT, Size index..); to be examined.

- Combination of products with modelling approaches (e.g. total primary production, new PP..) is possible on a routine basis (consensus?)

- Reprocessed MERIS data will require a GlobColour entire revision.
  Extension of the merging process to New OC sensors (HY-1C, OCM-2..)?
  -GOCI new experience-

- Maintaining the Long-term climate quality data stream and data exploitation via Consolidated GlobColour activity.