# Recent improvements in POLDER-2 Ocean Color processing

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SIMBIOS, Baltimore, January 15-17, 2002

# POLDER instrument

- Platform :
  - ⇨ POLDER on ADEOS (nov. 1996-june 1997)
  - ⇨ POLDER-2 on ADEOS-2 (scheduled to launch : nov. 2002)
- CCD matrix of 242 x 274 pixels
- resolution : 6 x 7 km2 at nadir, swath : 2200 km
- Global coverage
- 9 bands including 3 polarized bands
- Radiometry :

| Bands | 443(P) | 443 | 490 | 565 | 670 (P) | 763 | 765 | 865 (P) | 910 |
|---|---|---|---|---|---|---|---|---|---|
| Band width (nm) | 20 | 20 | 20 | 20 | 20 | 10 | 40 | 40 | 20 |
| NEDR (x $10^{-3}$) | 0.25 | 0.44 | 0.14 | 0.20 | 0.42 | 0.57 | 0.42 | 0.42 | 0.52 |

- Mission scientific objectives
  - ⇨ Atmosphere : Aerosol, Earth radiation budget and clouds
  - ⇨ biosphere : Land surfaces, ***Ocean Color***

# POLDER-1 algorithm

- **Atmospheric correction algorithm includes the following features :**
  - Clouds masking based on 865 nm radiance :
    threshold and
    local (neighbours) variations
  - Gaseous absorption correction
    $O_3$ using TOMS data, $H_2O$ using 910 nm channel, $O_2$ using 763 narrow band
  - Rejection of directions contaminated by sun glint
  - Correction of sun glint for slightly contaminated directions
    based on isotropic Cox & Munk model (1954)
  - Accurate molecular scattering correction, including multiple scatterings and polarization.
  - Inversion of aerosols characteristics using NIR bands (865, 765, 670 nm)
  - Correction of aerosols contributions using 12 Shettle and Fenn models

- **Bio-optical algorithm**
  - The directional marine reflectance (all directions) is normalized using the Q factor from Morel and Gentili (1993), for nadir viewing and for solar zenith angle = 0°
  - OC2 (O'Reilly et al., 1998) chlorophyll inversion algorithm

# POLDER-2 improvements : Correction of absorption by aerosols (1)

- **Method**
  - New approach based on multi-directionality
  - Relies on the change of absorption efficacy with molecular scattering and air mass

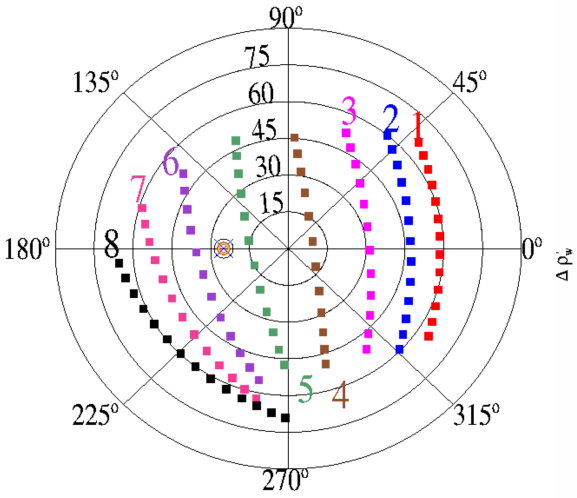
- **Modelisation**
  - Look-Up Tables are computed using a Successive Order of Scattering code (Deuzé, 1989) :

$$\Delta\rho_{abs}(\theta_s, \theta_v, \phi) = \rho_{aer}(\theta_s, \theta_v, \phi) - \rho_{aer}(\theta_s, \theta_v, \phi)(\omega_0=1)$$

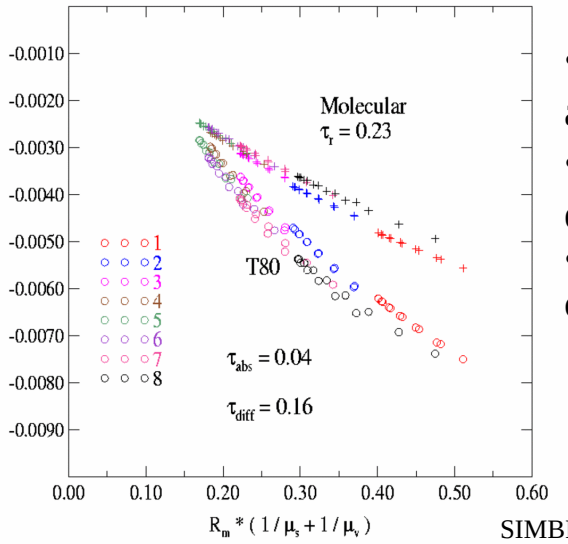
$\rho_{aer}(\theta_s, \theta_v, \phi)$ is the aerosol model reflectance

$\rho_{aer}(\theta_s, \theta_v, \phi)(\omega_0=1)$ is the aerosol model reflectance without absorption

***POLDER geometries examples***




***Absorption effects simulation***

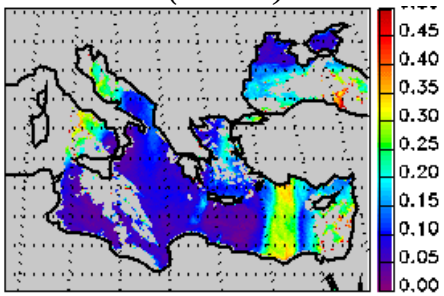



- Those parameters are related almost linearly with $R_m$ x $m^*$
- The slope is related to the efficacy of the absorption.
- Marine reflectance can then be corrected.

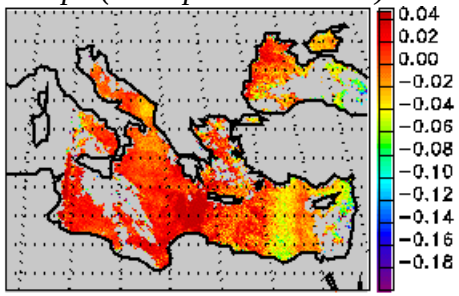
# POLDER-2 improvements : Correction of absorption by aerosols (2)

✔ **Application to POLDER data : correction of a plume of desert aerosols over eastern Mediterranean (may 12, 1997, orbit n° 7378)**

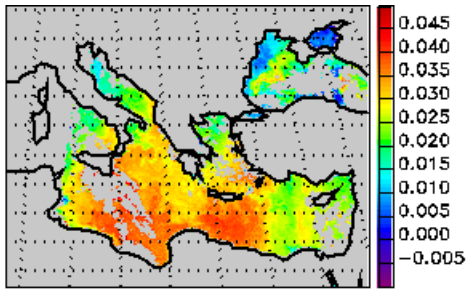
*AOT (865 nm)*



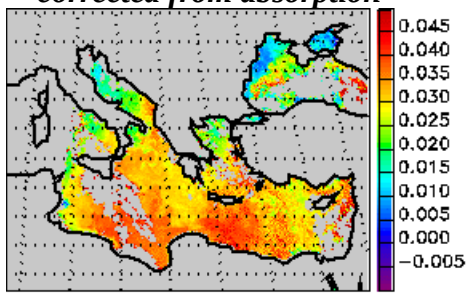

*Slope (absorption indicator)*




*Marine reflectance (+) at 443 nm*




*Marine reflectance (+) at 443 nm* ***corrected from absorption***



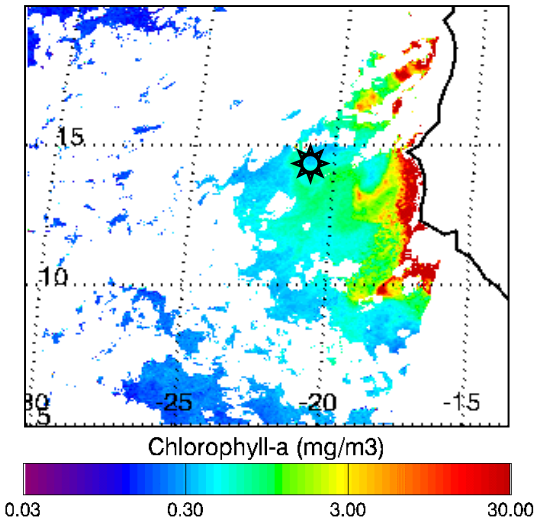

• Standard atmospheric correction is carried on (without absorption)

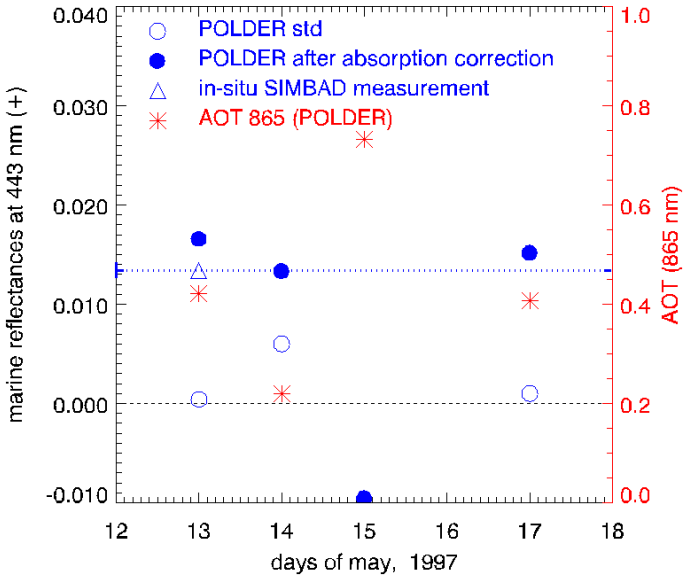
• When the slope is negative, the correction of absorption is activated

• Abnormally low reflectance (over-correction) are adjusted

# POLDER-2 improvements : Correction of absorption by aerosols (3)

✔ **Preliminary validation using SIMBAD *in-situ* measurements during AMT-4**



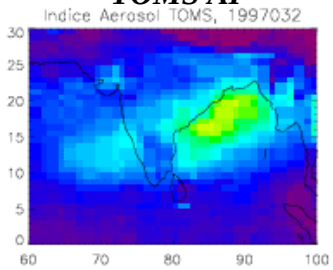




- 1 in-situ measurement (may 13, 1997) off Africa under a desert aerosol plume
- We look at clear POLDER pixels in the 4 days before or after
- Sun glint filter has been relaxed to increase the number of available directions
- Good agreement, except for may 15, ($\tau_{a865}$=0.74 that day)

# POLDER-2 improvements : Correction of absorption by aerosols (4)

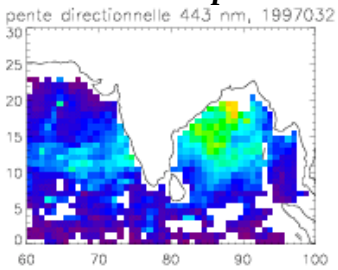
## ✔ Comparison with TOMS / ADEOS Aerosol Index

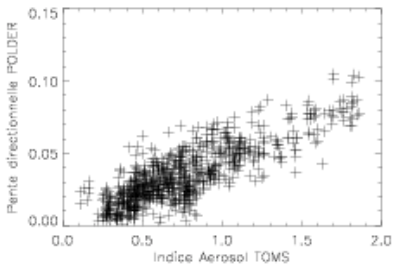
***TOMS AI***



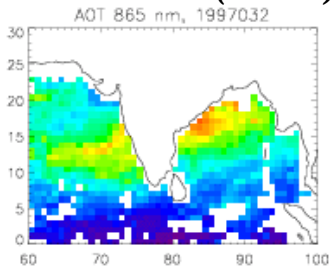

- 10-days synthesis (march 11-20, 1997)
- Absorption measured by POLDER is related almost linearly with TOMS AI

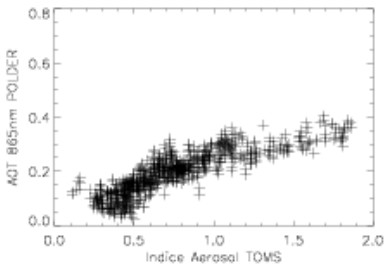
***POLDER Absorption Index***



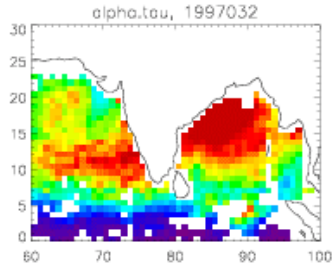



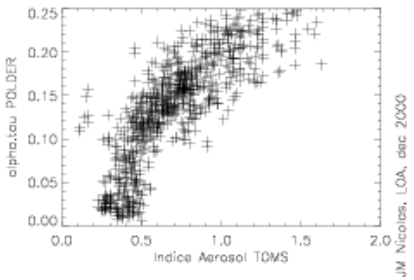

***POLDER AOT (865 nm)***




***POLDER $\alpha . \tau_a$***



# POLDER-2 improvements : “Black pixel assumption” (1)

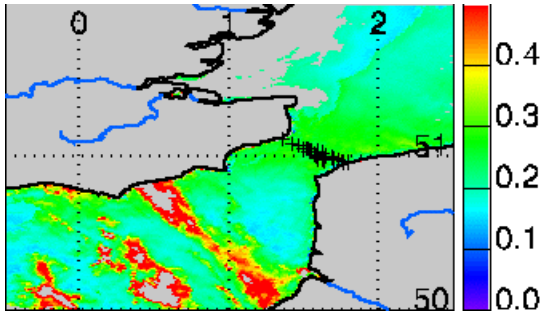
- **The problem :**
  - Waters are assumed black at 670, 765 and 865 nm for aerosols inversion
  - That assumption is not verified for case-2 waters or case-1, eutrophic waters
    - ⇨ Angström coefficient is over-estimated
    - ⇨ Ocean Color bands are over-corrected

- **The solution :**
  - Using an empirical relation between $\rho_{w670}$ and $\rho_{w565}$ in an *non-iterative* algorithm (Viollier, 1980, Deschamps et Viollier, 1987)
  - That relation can be observed using *in-situ* data
  - The approach is tested on SeaWiFS HRPT (HDUN) data

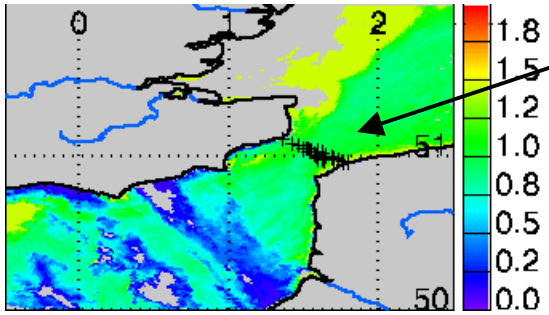
# POLDER-2 improvements : “Black pixel assumption” (2)

- **Application to SeaWiFS data in the Channel (using POLDER algorithm) :**
  - HRPT SeaWiFS data (from HDUN, Dundee station) at 1x1 km²
  - April 1, 1999
  - POLDER atmospheric correction algorithm is applied to SeaWiFS L1.

*AOT 5865 nm)*

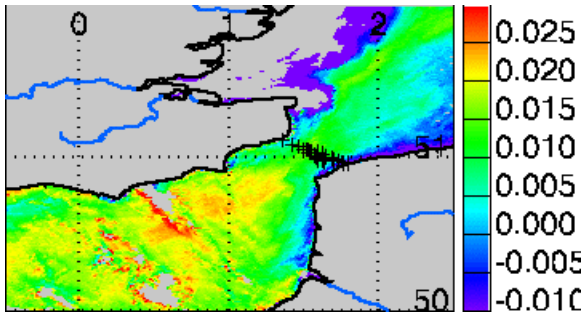



*Angstrom coefficient (510/865)*

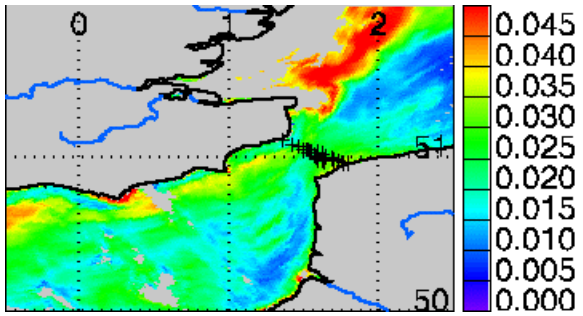



In-situ measurements

*ρ w443 (+)*




*ρ w555 (+)*

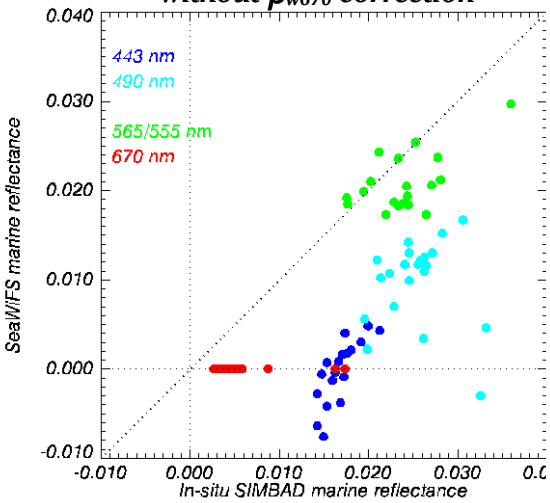


# POLDER-2 improvements : “Black pixel assumption” (3)

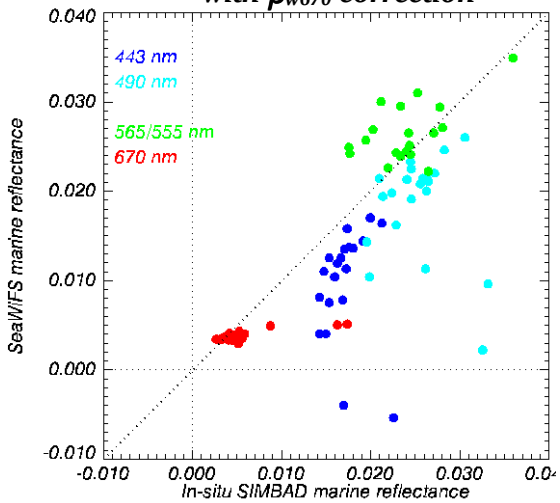
✔ **Validation using in-situ SIMBAD measurement**

• in-situ : SIMBAD measurements made in the Channel between Calais (France) and Dover (England) from a Ferry-boat

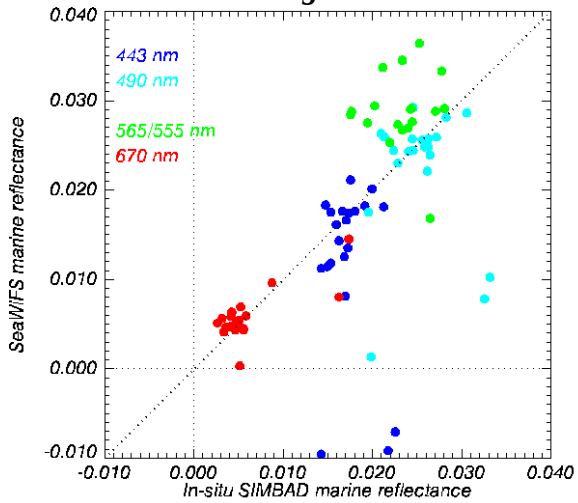
*POLDER algo.*
***without $\rho_{w670}$ correction***




*POLDER algo.*
***with $\rho_{w670}$ correction***




*SeaWiFS SeaDAS V4.0 algo.*
***with Siegel iteration***

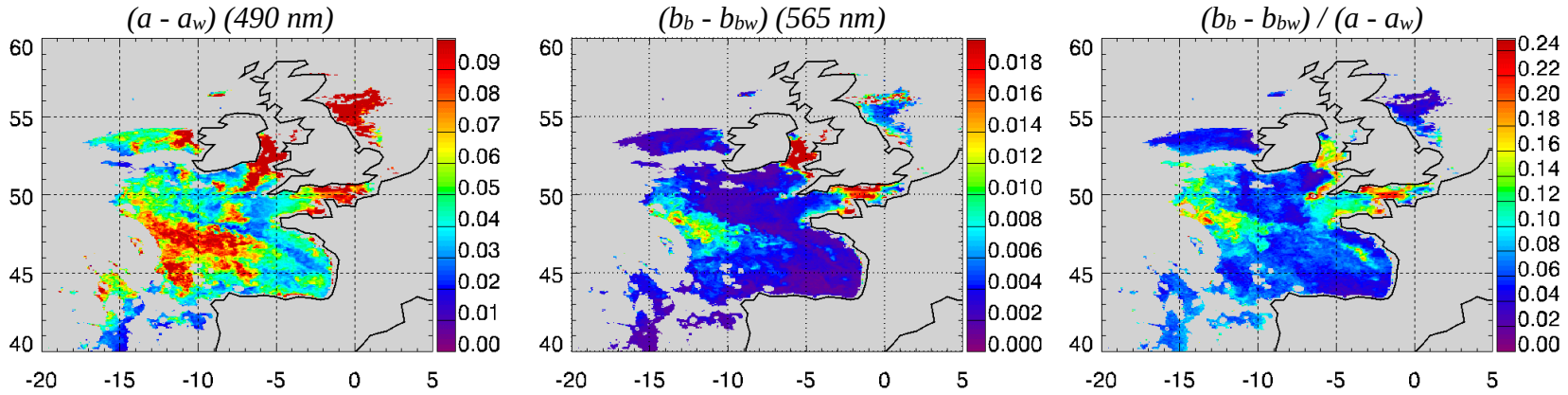



• The new approach clearly improve the atmospheric correction

• Comparison between POLDER algorithm (based on 865/670 bands) and SeaWiFS algorithm (based on 865/765 bands + Siegel iteration) shows quite good agreement

# POLDER-2 improvements : bio-optical parameters

- **New Inherent Optical Properties (IOP) parameters in standard L2 & 3 products**
  - Marine absorption coefficient (at 443 and 490 nm)
  - back-scattering coefficient (at 565 nm)
  - Use of a model from Loisel *et al.* (1998)
  - Example : POLDER, april 10, 1997




- **Two parameters related to chlorophyll-*a* concentration :**
  - one from OC2 or OC3-v4 algorithm (O'Reilly *et al*, 1998)
  - one from Normalized Different Pigment Index (NDPI, Frouin *et al*, 1996)

# POLDER-2 Ocean Color standard products (1)

## ✔ Level 2 products :

- OC2A : Directional product

Directional marine reflectances (over the surface) at 443, 490, 565, *670* nm
AOT at 865 nm
Angström coefficient
aerosol absorbing index *(new)*
Rayleigh corrected normalized radiance at 865

- OC2B : Non-directional product

Diffuse marine reflectances (under the surface) at 443, 490, 565, *670* nm
AOT at 865 nm
Angström coefficient
aerosol absorbing index *(new)*
Chlorophyll-a
Water absorption coefficient ar 443, 490 nm *(new)*
Water backscattering coefficient at 565 nm *(new)*

# POLDER-2 Ocean Color standard products (2)

- **Level 3 products ("binned products"):**
  - geo-coded on a sinusoidal grid, 6480x3240
  - ten-days and monthly mean for all the L2 parameters
  - Quality index, standard-deviation

- **Reformatted products ("mapped product")** ***(new)***
  - HDF-EOS format
  - geo-coded on a cylindrical grid, 4320x2160 (12 pixels / °)
  - ten-days and monthly mean for marine reflectances, chlorophyll-a, AOT, angström coefficient, water absorption coefficient at 443 nm and water backscaterring coefficient at 565 nm
  - Daily synthesis for chlorophyll-a

## POLDER-2 improvements : conclusions

- **POLDER-2 new algorithms still in progress**

- **Reprocessing of POLDER-1 data with the new algorithm scheduled in 2002**

- **POLDER-2 / ADEOS-II : launch scheduled in november 2002**
  - first POLDER-2 Ocean Color data (preliminary) in 2003
  - Validated POLDER-2 data in 2004

- **General information / news on POLDER :**
  http://www-projet.cst.cnes.fr:8060/POLDER/index.html

- **POLDER Ocean Color data :**
  http://www-projet.cst.cnes.fr:8060/POLDER/SCIEPROD/oc9611.htm