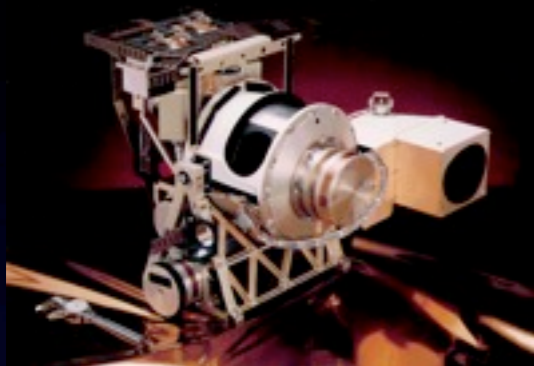# Neuro-variational inversion applied to Ocean Color Remote sensing

Julien Brajard, D. Diouf, H. S. Benavides Pinjosovsky, M. Crépon, R. Santer and S. Thiria
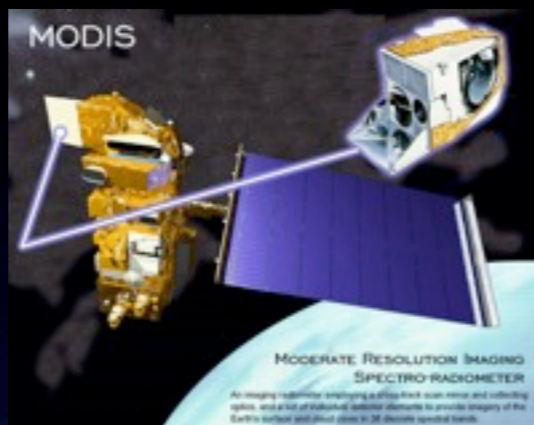
Laboratoire d'Océanographie et du Climat: Expérimentations et approches numériques.
place Jussieu
PARIS, France
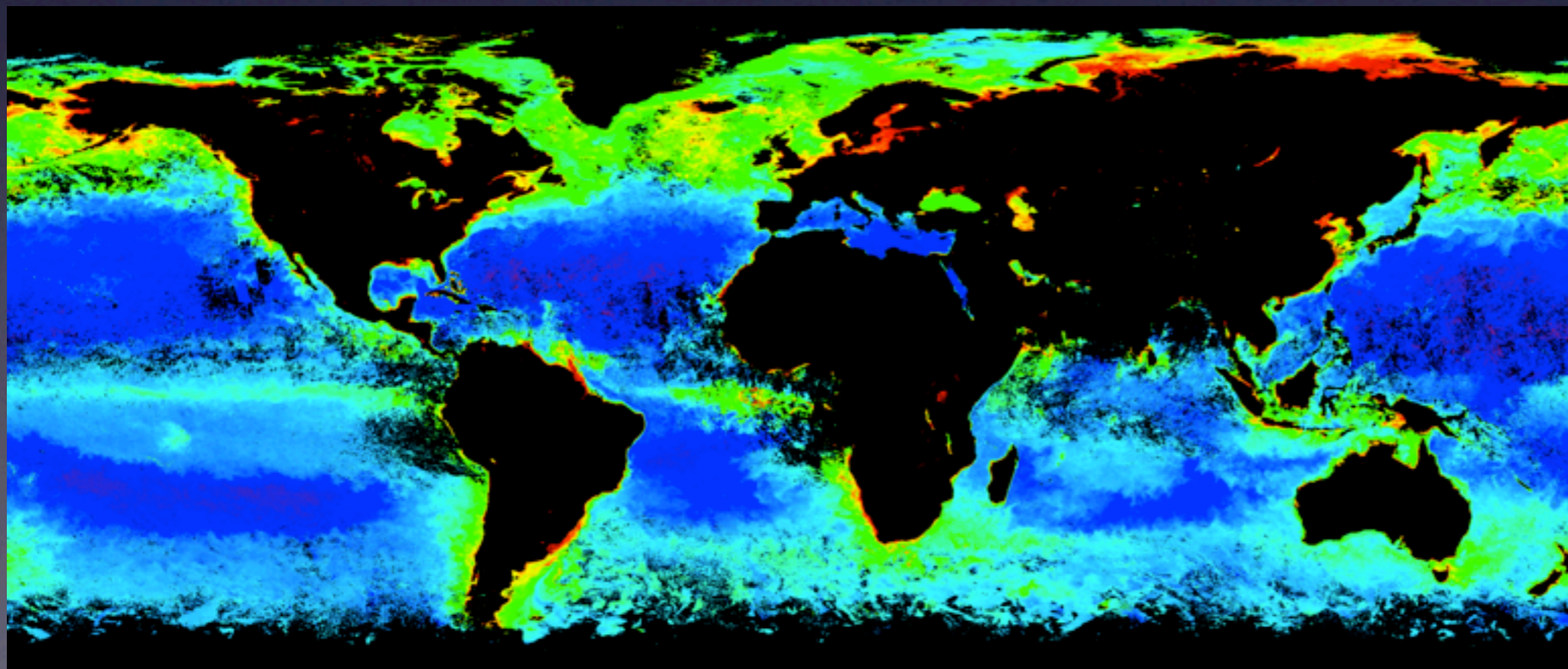
Ocean Color Remote Sensing

SeaWiFS

MODIS

MERIS

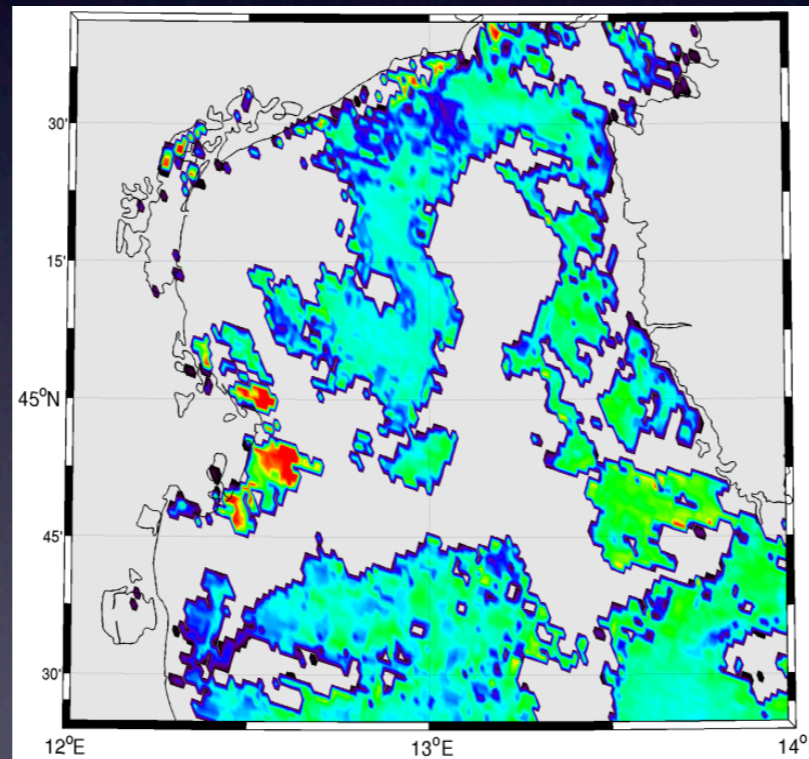...

Satellite observation

inversion
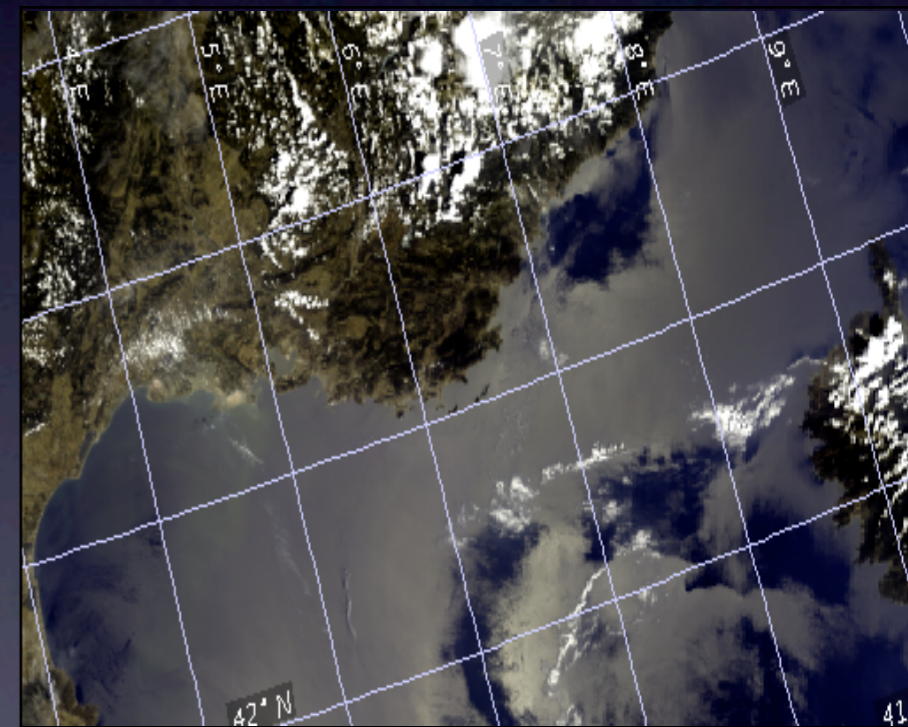
MODIS
mean chlorophyll-a
August 2011

Is the standard treatment suitable for any situation ?
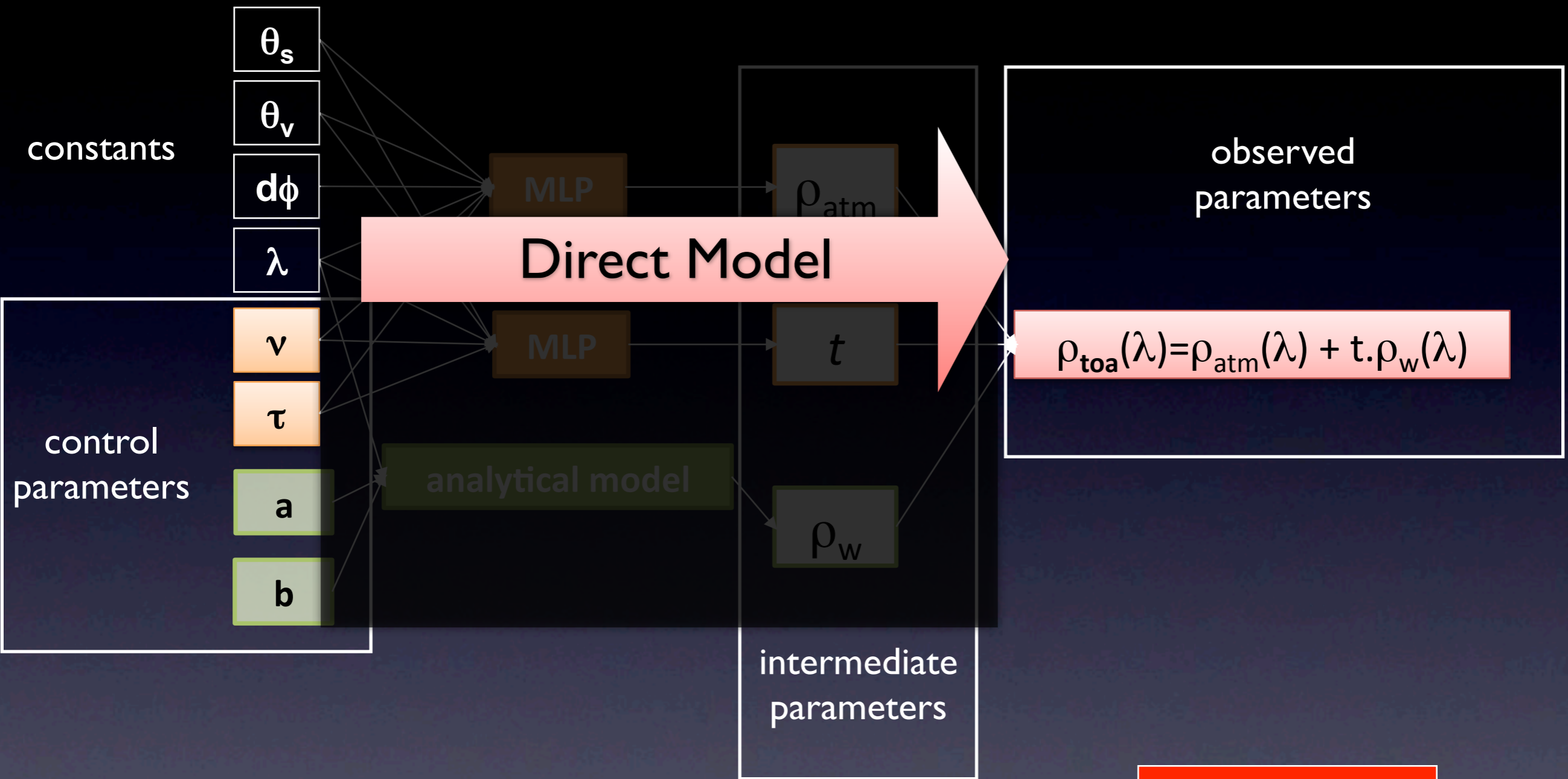

absorbing aeorols and dust
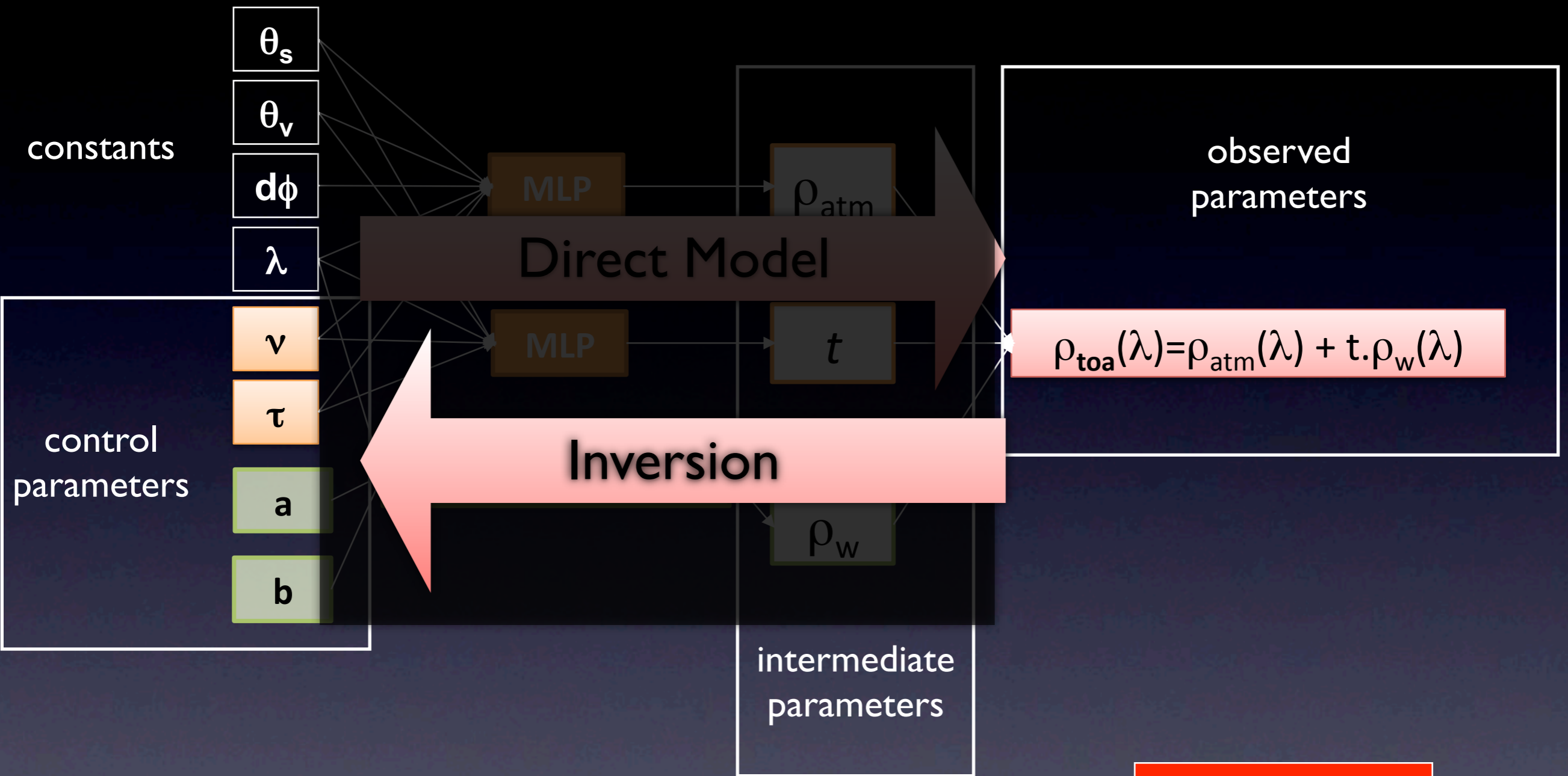
coastal waters

glitter
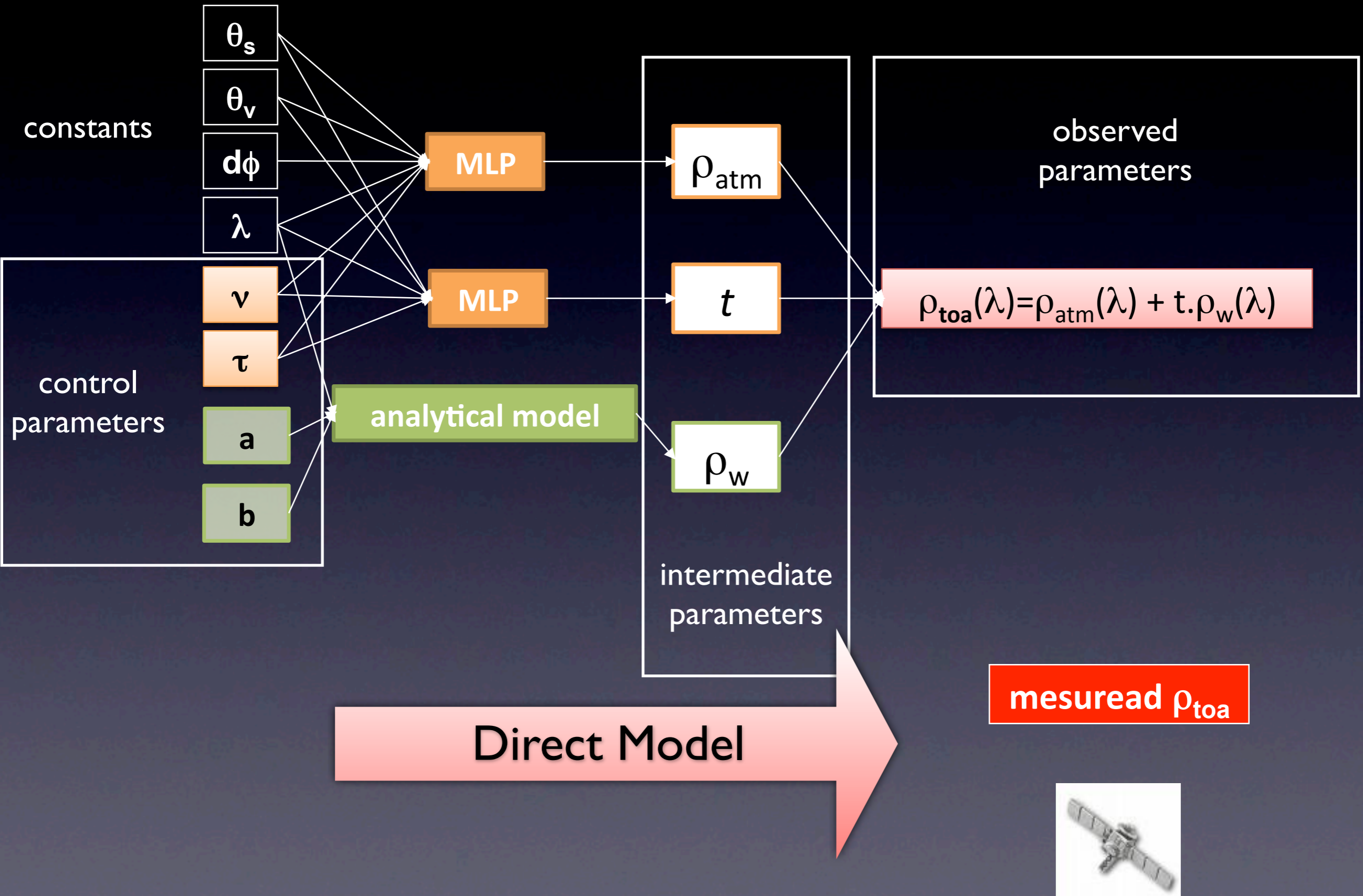
NeuroVaria

mesuread ρ_{toa}

NeuroVaria

constants

control parameters

θ_s
θ_v
$d\phi$
λ
ν
τ
a
b

MLP

MLP

analytical model

Direct Model

ρ_{atm}

t

ρ_w

intermediate parameters

observed parameters

$\rho_{toa}(\lambda) = \rho_{atm}(\lambda) + t.\rho_w(\lambda)$

mesuread ρ_{toa}

NeuroVaria

NeuroVaria

constants

θ_s

θ_v

$d\phi$

λ

control parameters

ν

τ

a

b

MLP

MLP

analytical model

ρ_{atm}

t

ρ_w

intermediate parameters

observed parameters

$$\rho_{toa}(\lambda)=\rho_{atm}(\lambda) + t.\rho_w(\lambda)$$

Direct Model

mesuread ρ_{toa}

NeuroVaria

constants

control parameters

θ_s

θ_v

$d\phi$

λ

ν

τ

a

b

MLP

MLP

analytical model

ρ_{atm}

t

ρ_w

observed parameters

$\rho_{toa}(\lambda) = \rho_{atm}(\lambda) + t.\rho_w(\lambda)$

J : cost function to minimize

mesuread ρ_{toa}

adjoint model
(backpropagation)
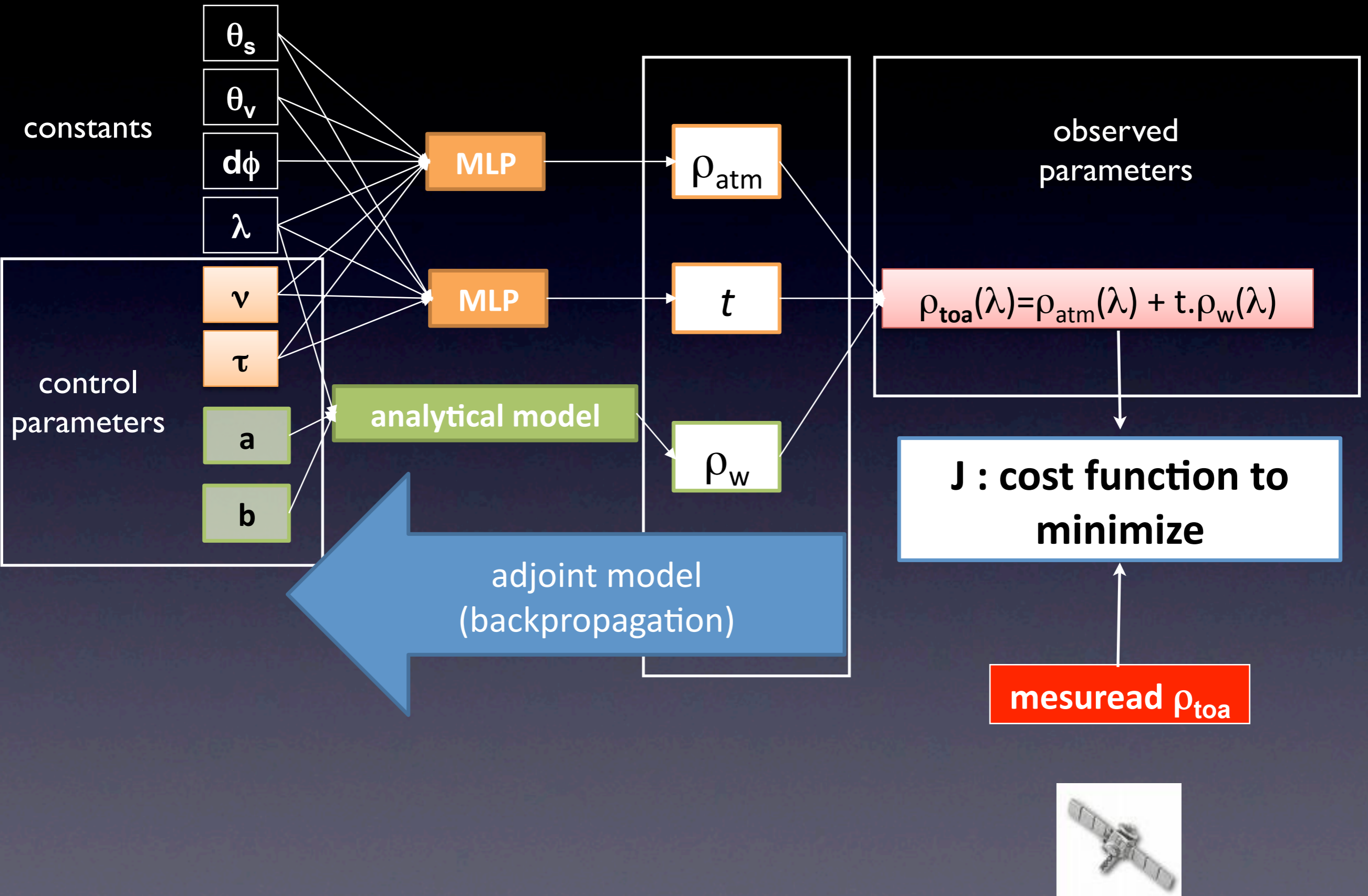
Applications of NeuroVaria
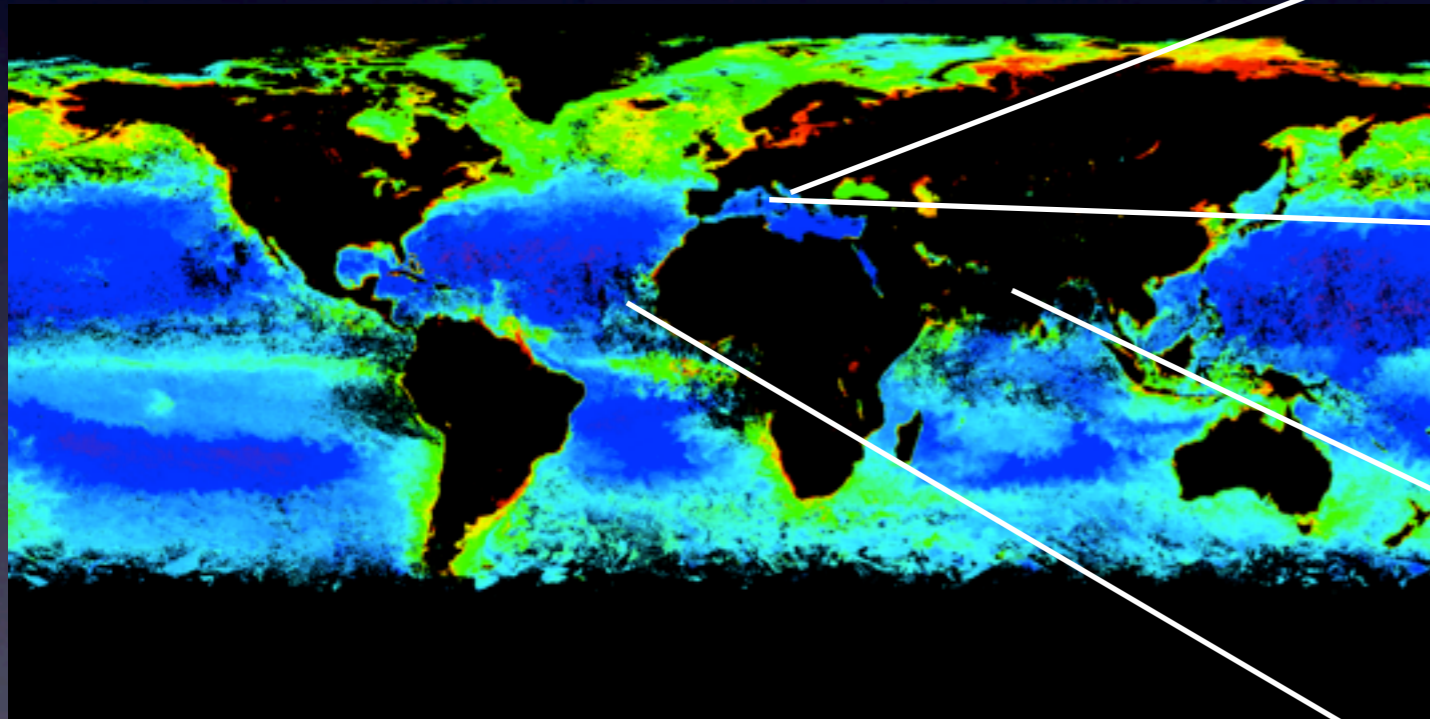
- Case 2 waters
  in the Adriatic sea

- Glitter
  in the Mediterranean sea

- Absorbing aerosols
  off the Indian coast

- Saharan dusts
  off west african coast

Case 2 waters

water-leaving reflectance (490nm) - ρ_w
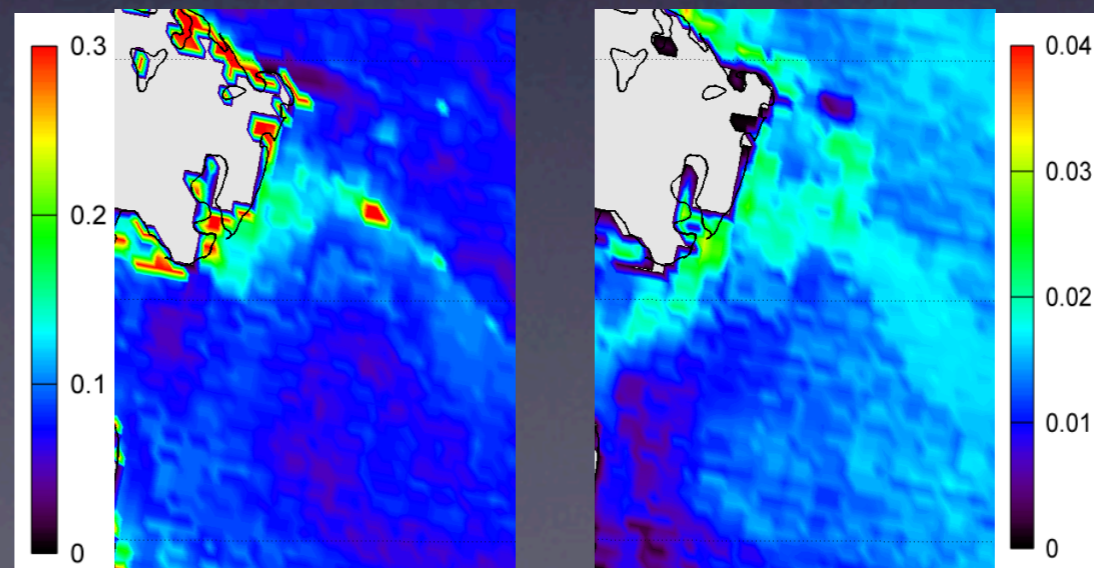
standard processing
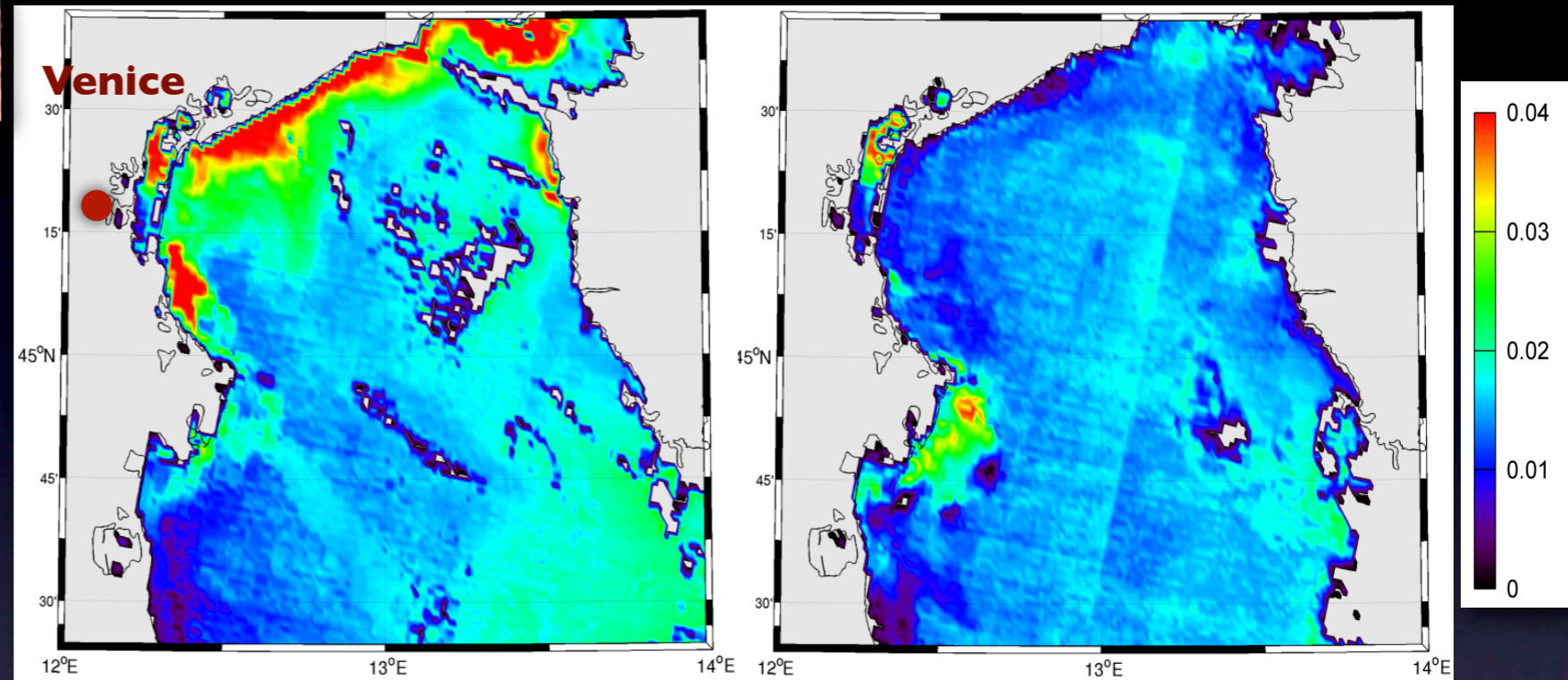
13 August 2002   16 August 2002

- noisy restitutions
- irrealistic marine patterns
- correlations between aerosol optical thickness τ and marine restitutions ρ_w

τ ρ_w

Case 2 waters

water-leaving reflectance (490nm) - ρ_w

standard processing
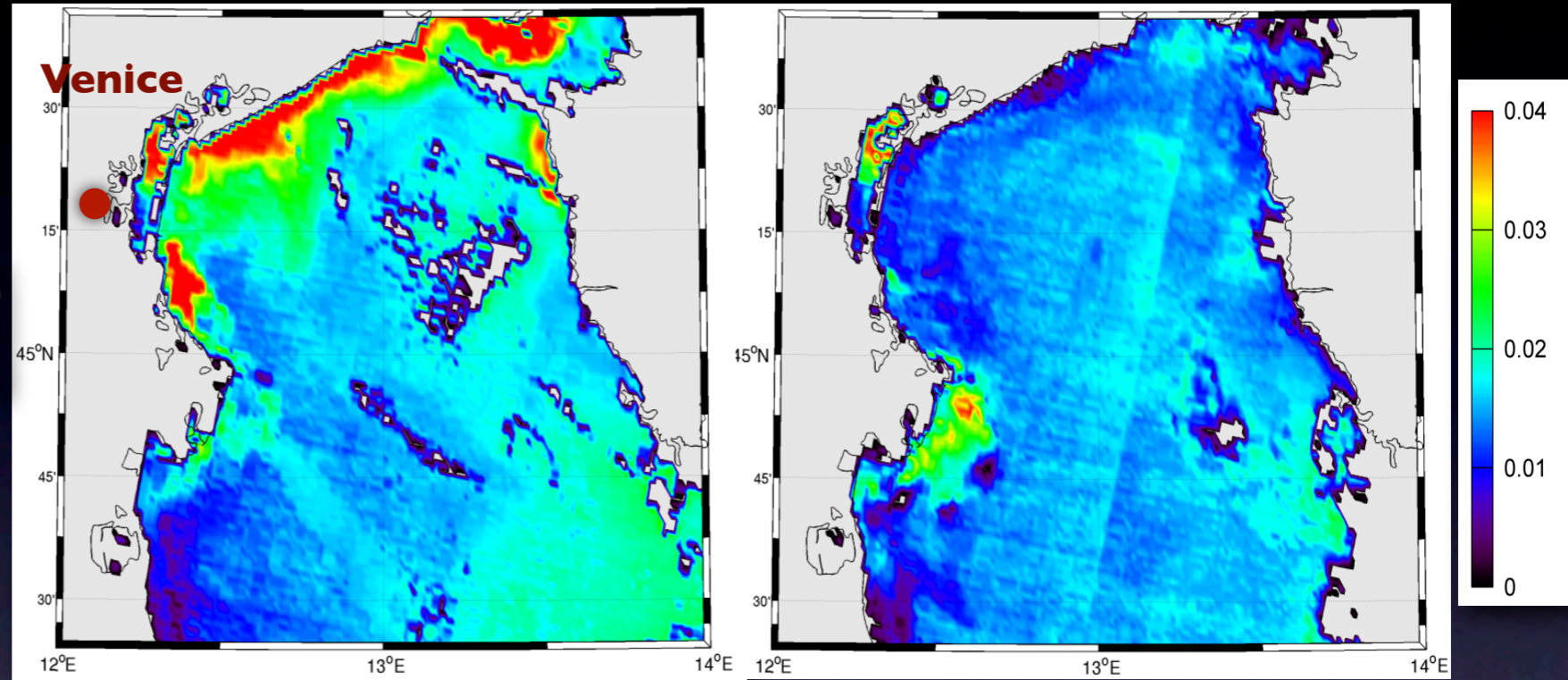
13 August 2002

16 August 2002

NeuroVaria
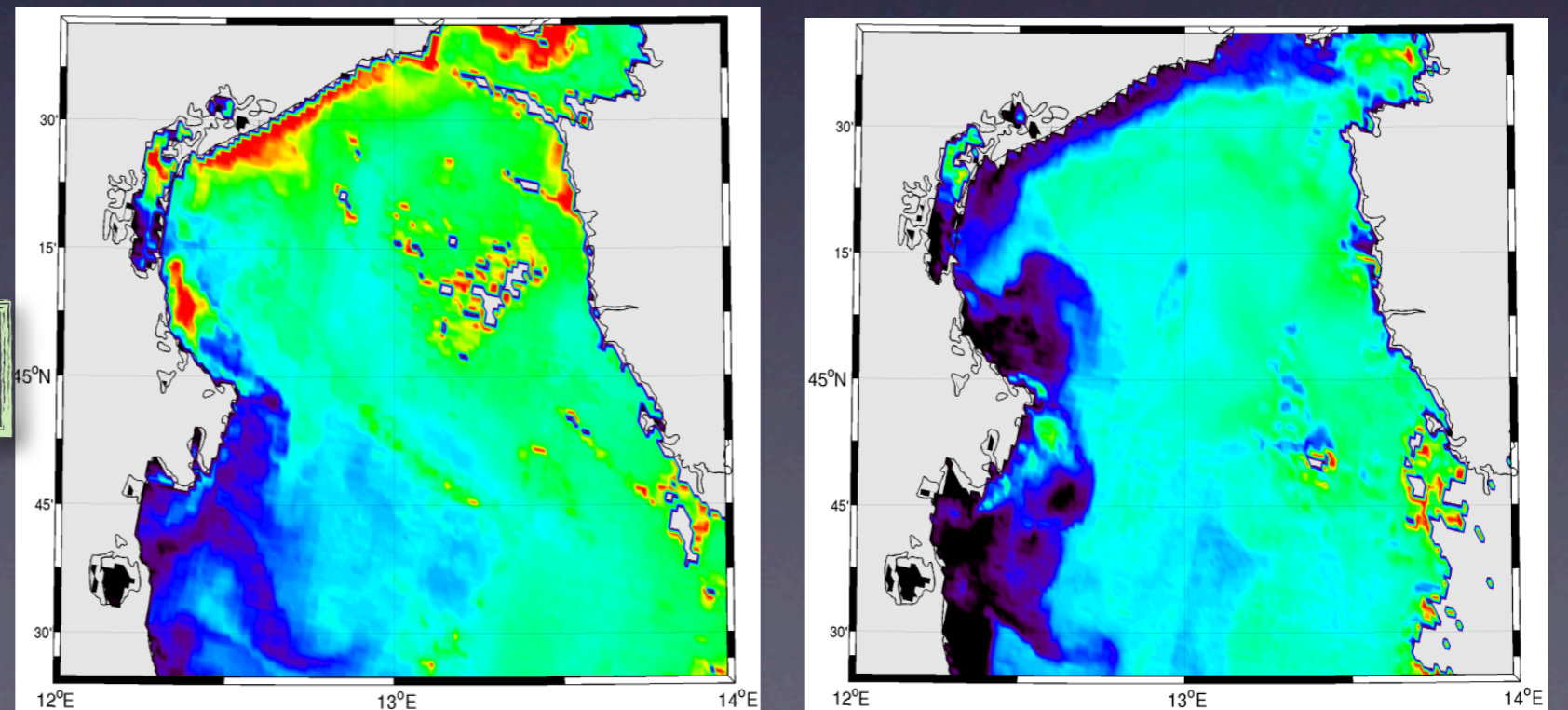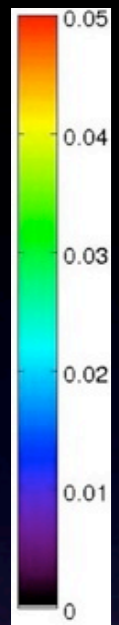
Case 2 waters

validation on in-situ data (AAOT site)

$\rho_w(490)$ satellite Vs $\rho_w(490)$ in situ
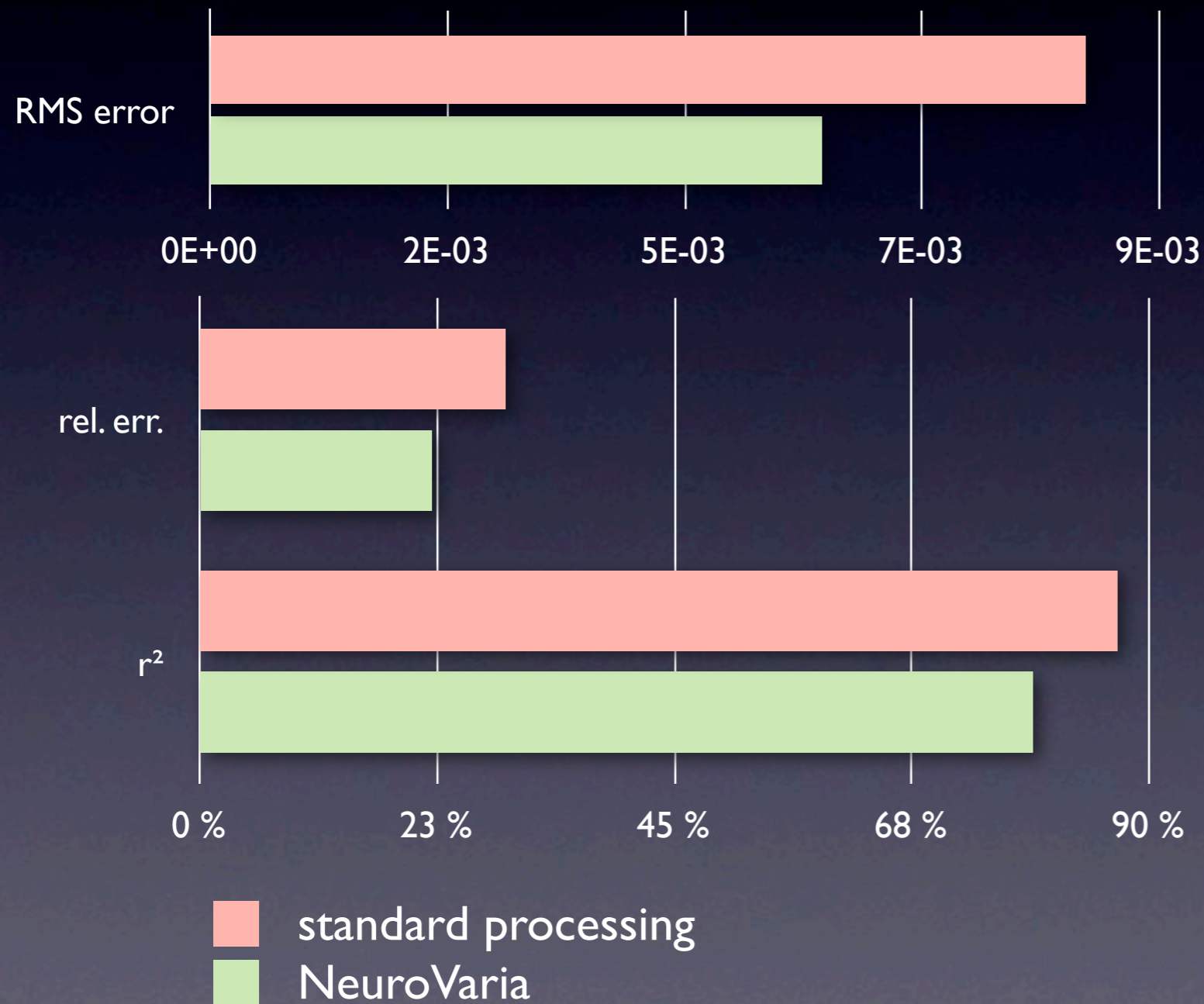
standard processing
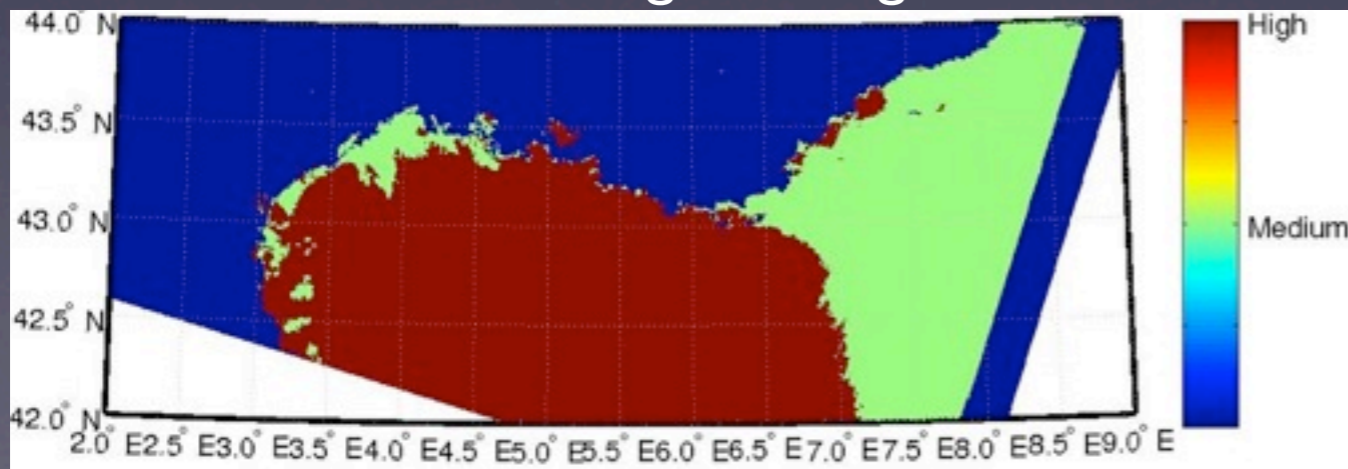NeuroVaria
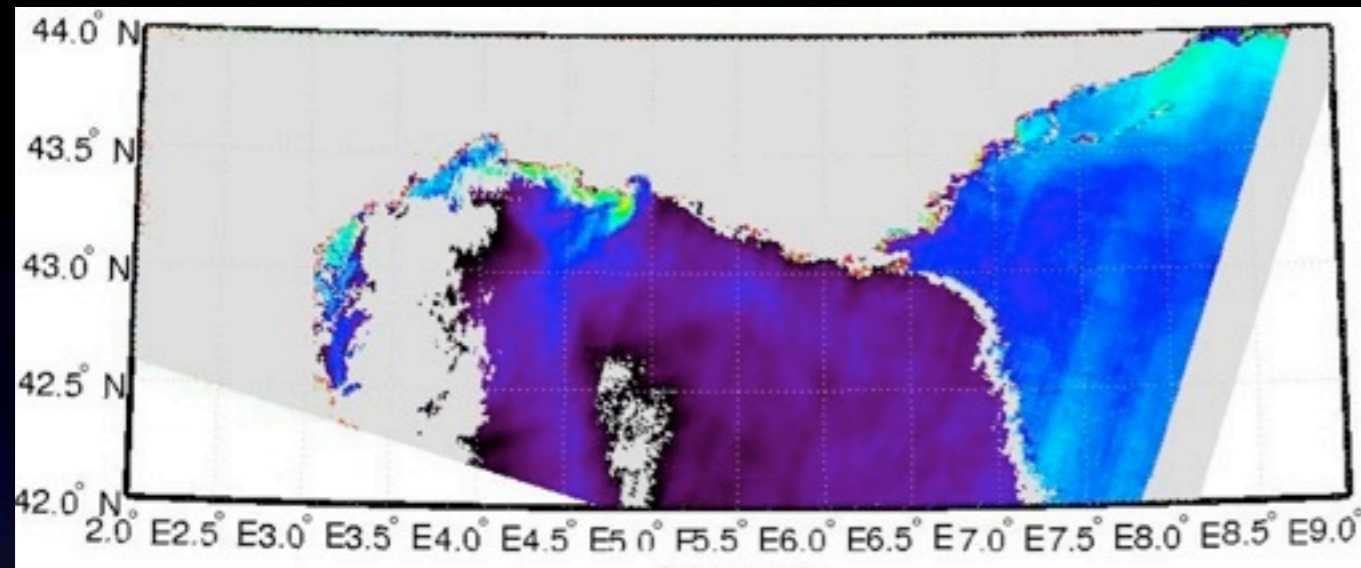
Glitter

water-leaving reflectance (490nm) - ρ_w

standard processing

• bias in the glitter region

MERIS glitter flag

Glitter

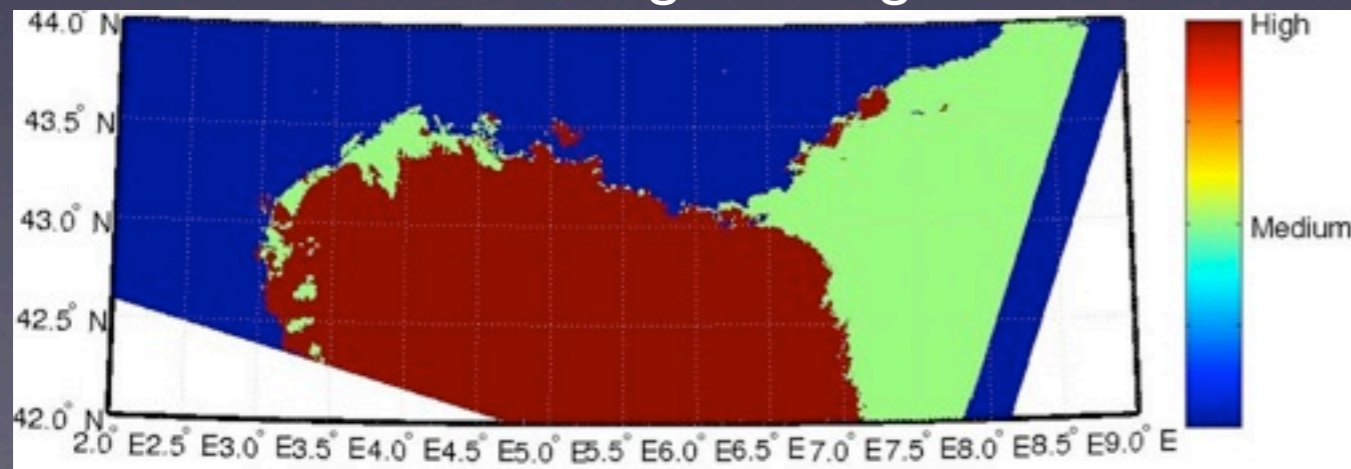water-leaving reflectance (490nm) - ρ_w
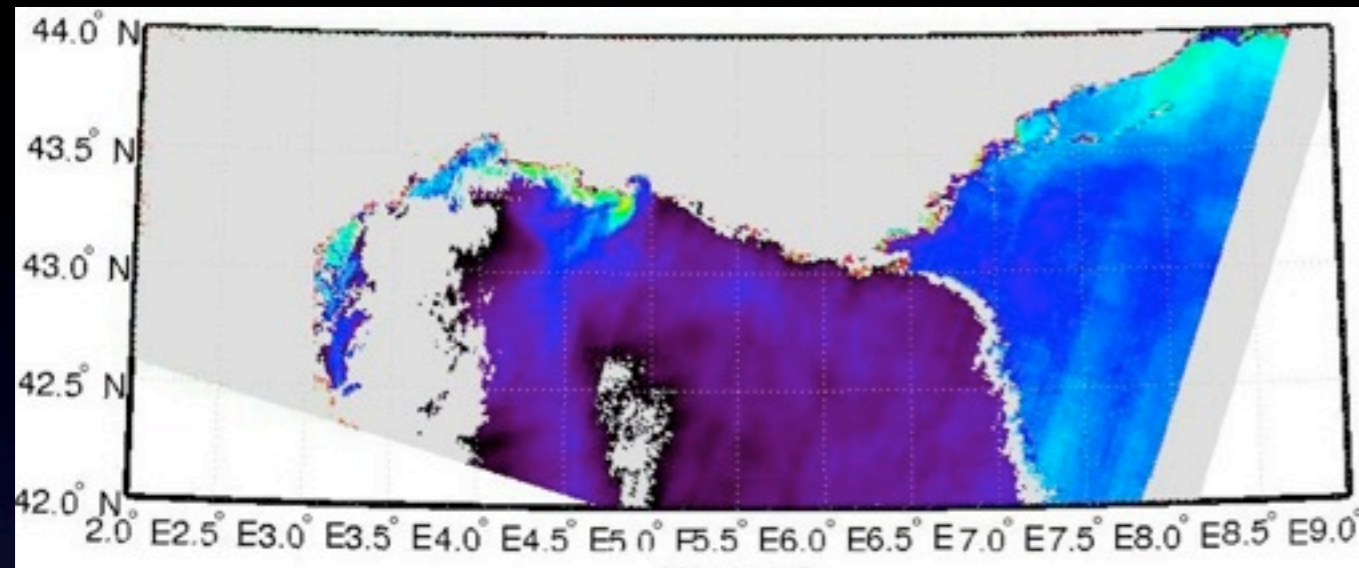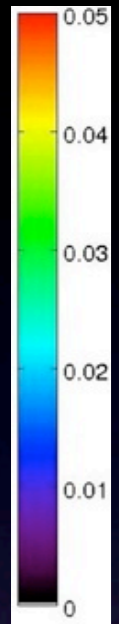
standard processing

- bias in the glitter region

NeuroVaria

MERIS glitter flag

Glitter

water-leaving reflectance (490nm) - ρ_w

standard processing

- bias in the glitter region
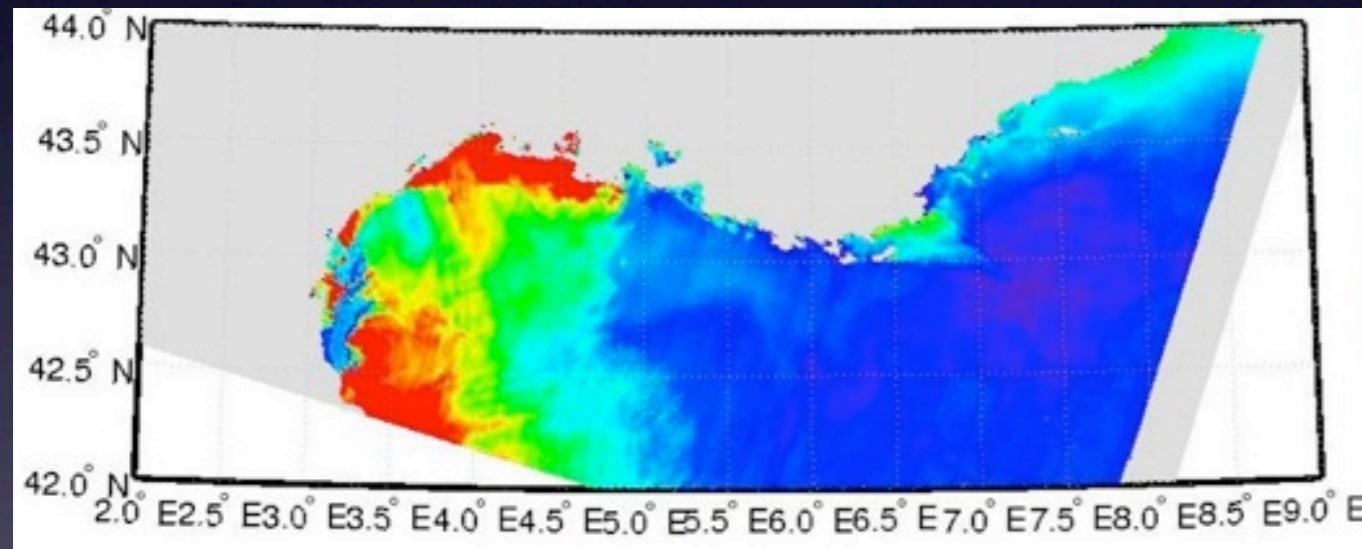
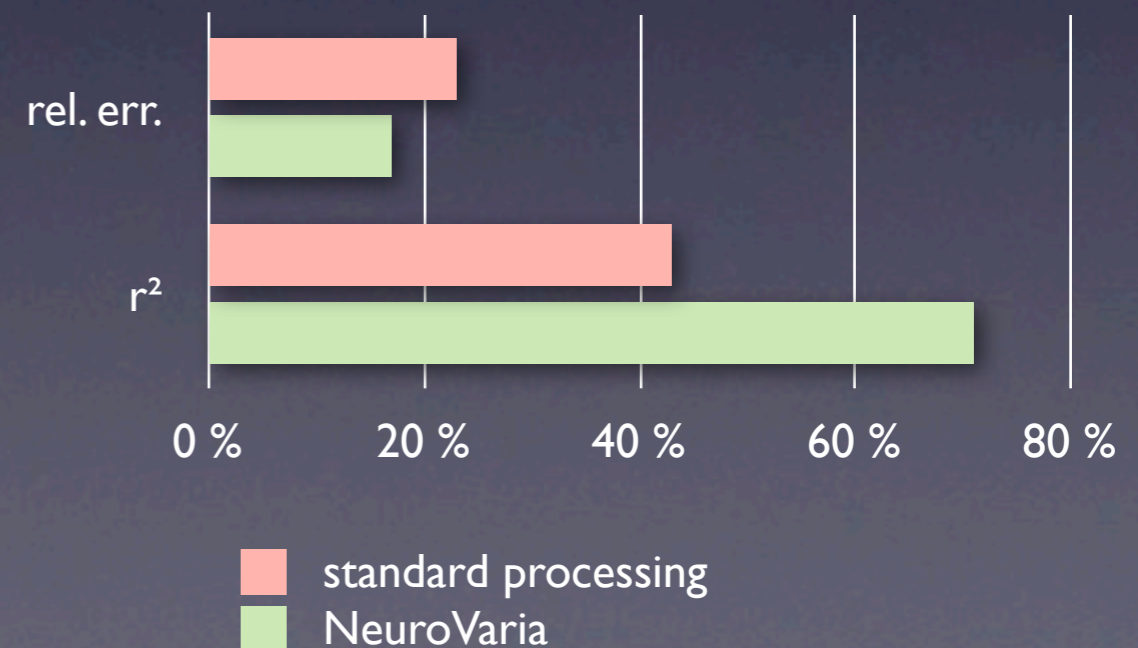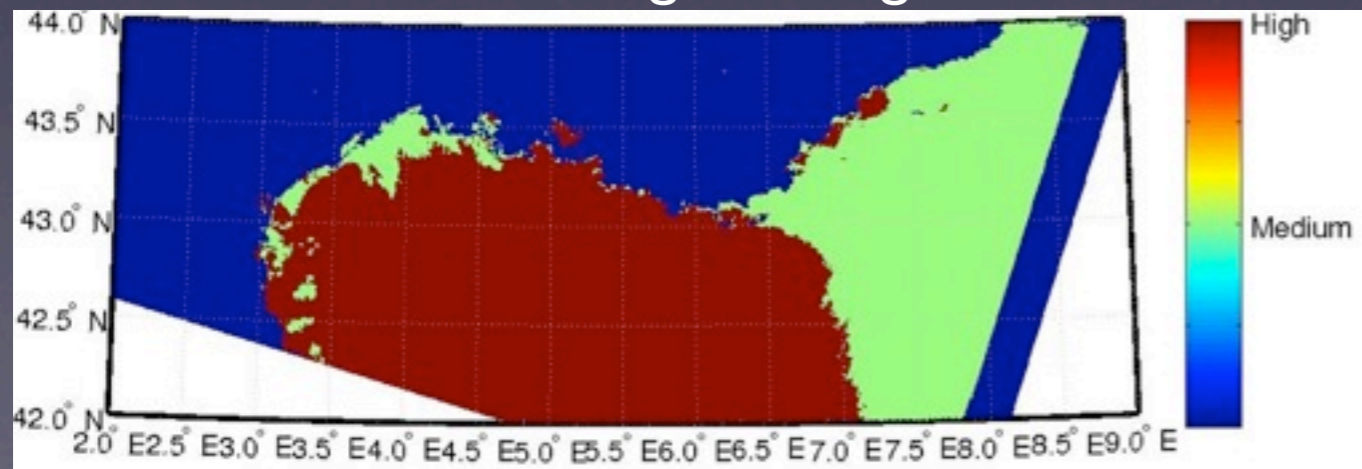MERIS glitter flag

NeuroVaria

validation on in-situ data (BOUSSOLE site)

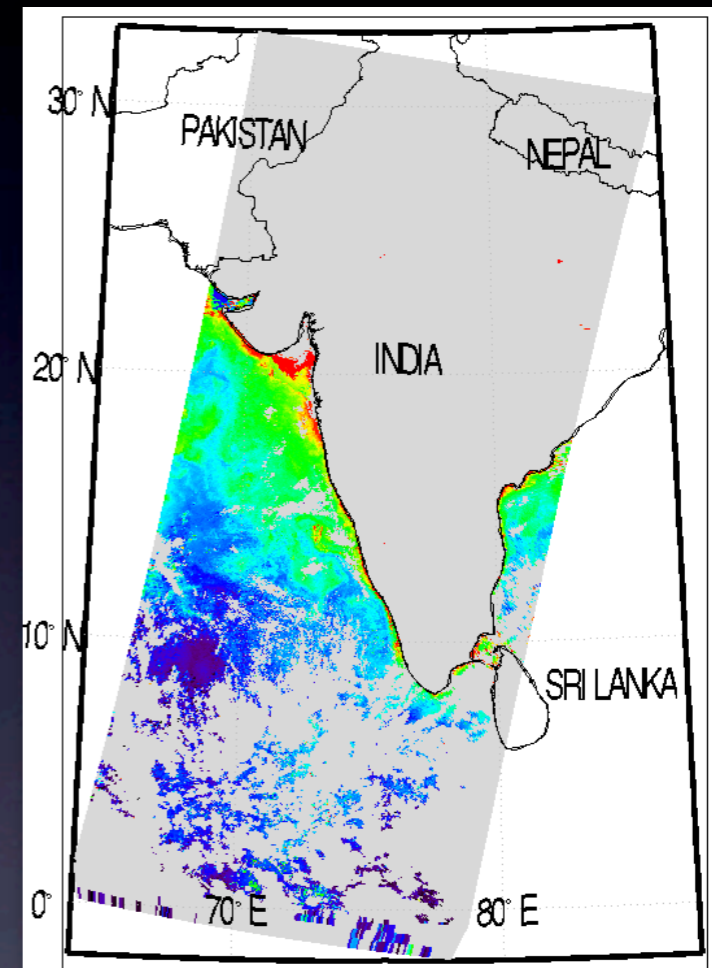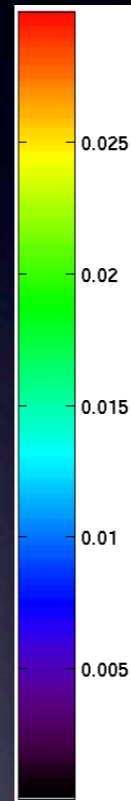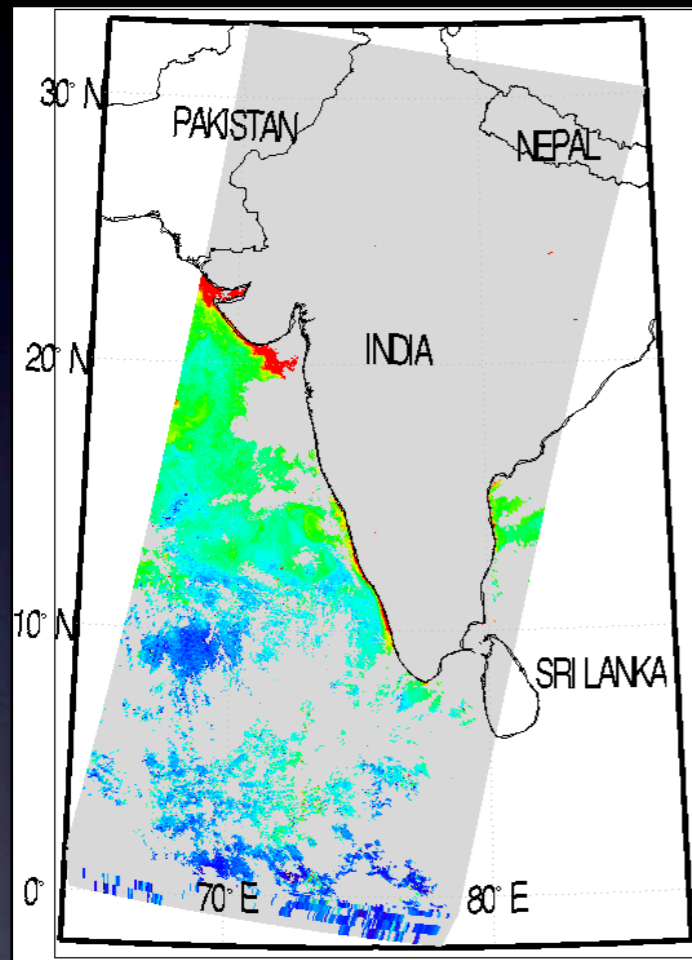$\rho_w(490)$ satellite Vs $\rho_w(490)$ in situ

standard processing
NeuroVaria

Pollution aerosols off the indian coast

Brajard et al. (2006) GRL

chlorophyll-a concentration
2 March 1999

Standard processing

- some pixels no treated
- noisy restitution of chlorophyll-a
- correlation between optical thickness and chlorophylle-a

NeuroVaria processing

- 19.3% additional pixels treated
- smoother patterns of chlorophyll-a
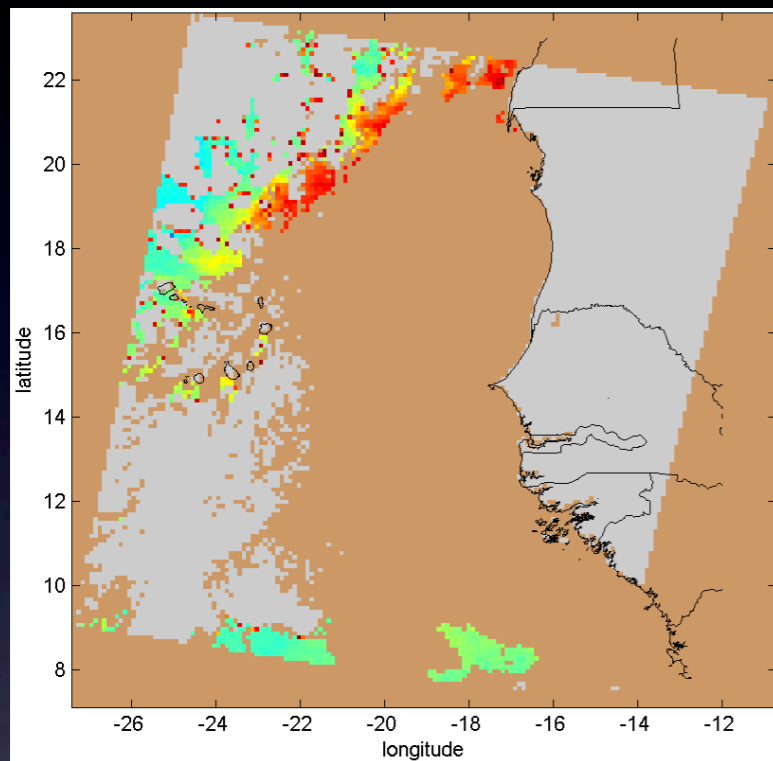- no correlation between the optical thickness and chlorophyll-a

Saharan Dusts

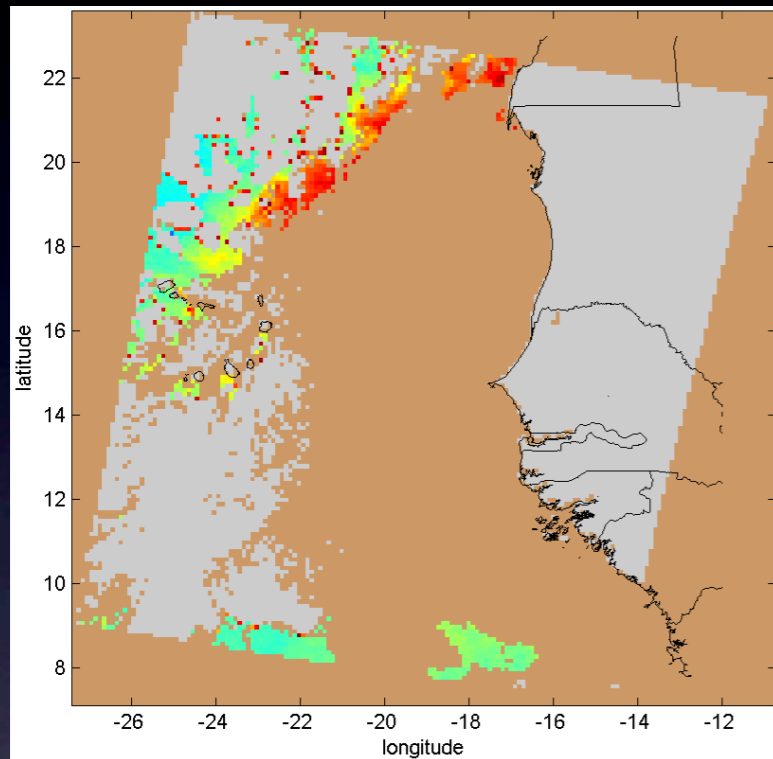D. Diouf, PhD.
Diouf et al. 2011 (submitted)

15 March 2003

Standard processing

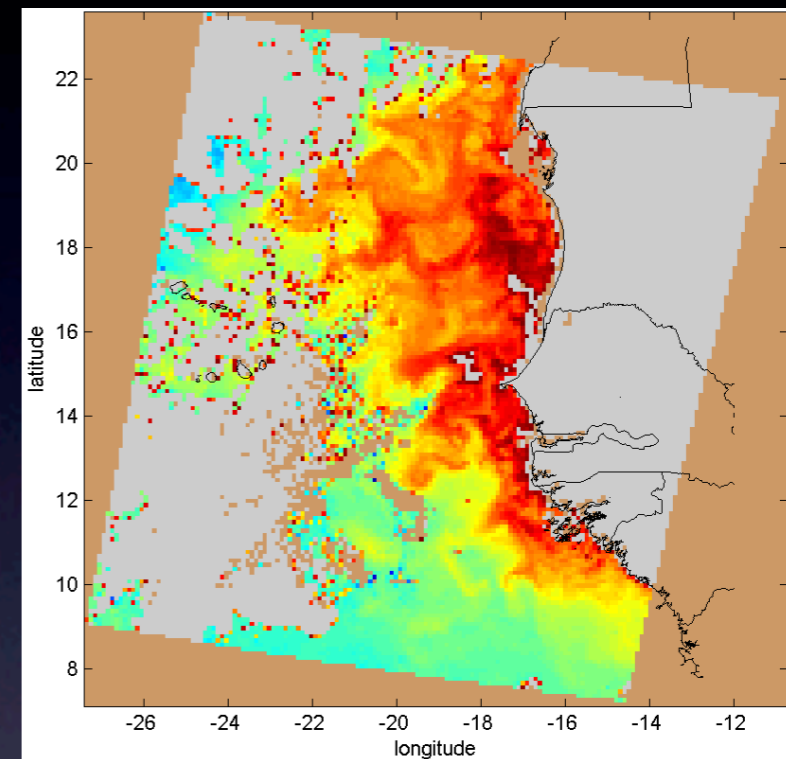- large region not treated
- no characterization of aerosols

Saharan Dusts

15 March 2003

Standard processing

- large region not treated
- no characterization of aerosols

NeuroVaria processing

- more pixels treated (+915%)
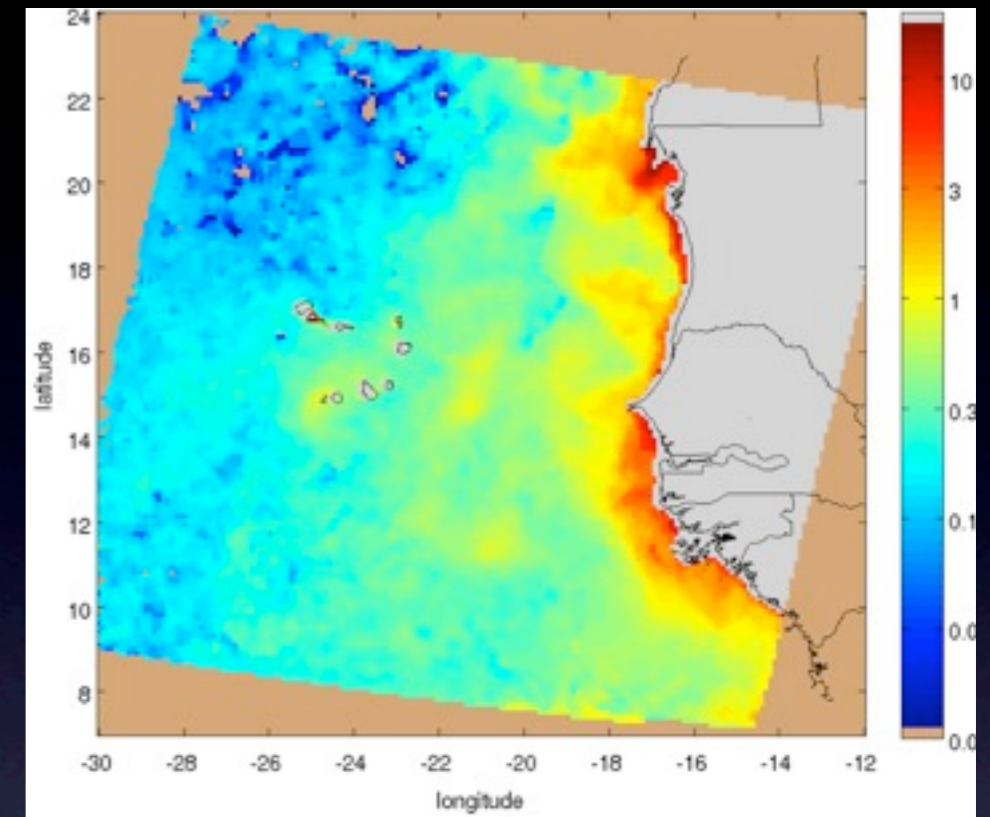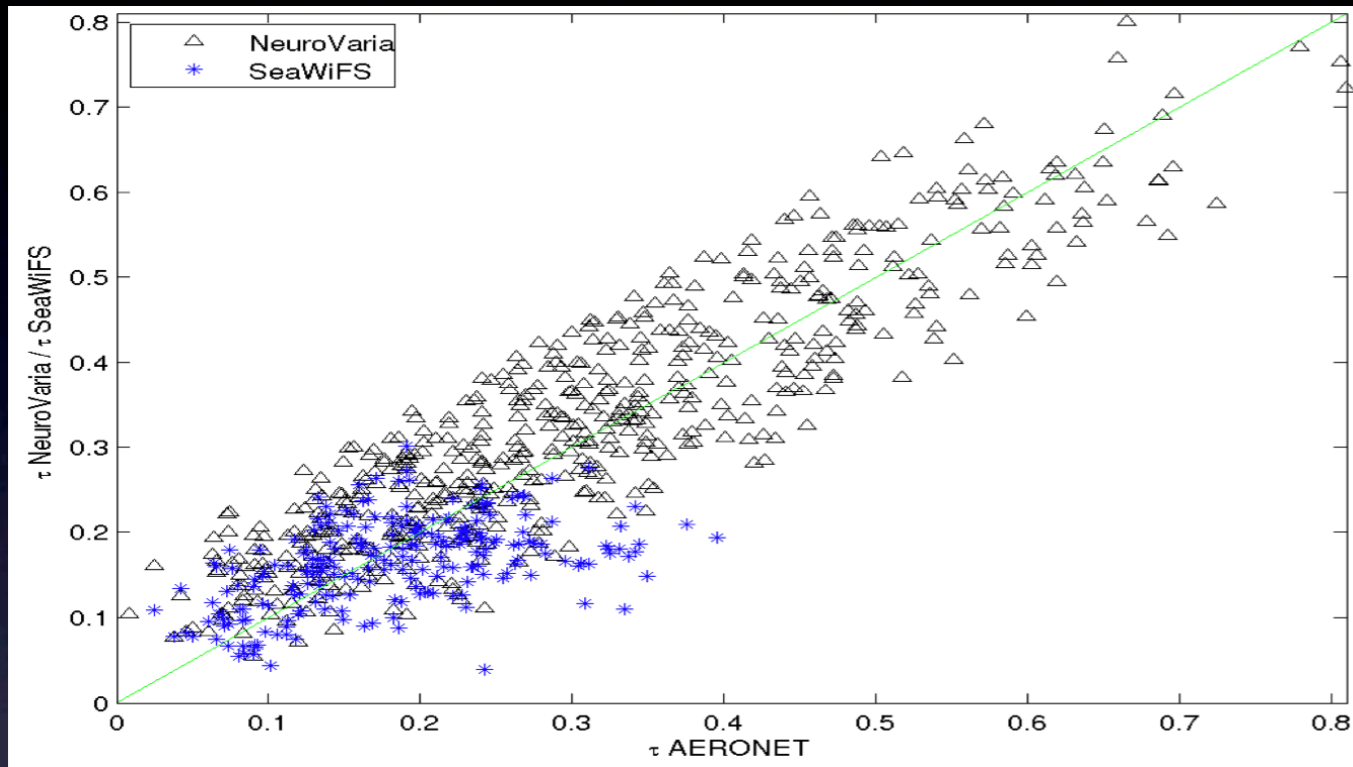- average for 2003 : +701%

Dust Products

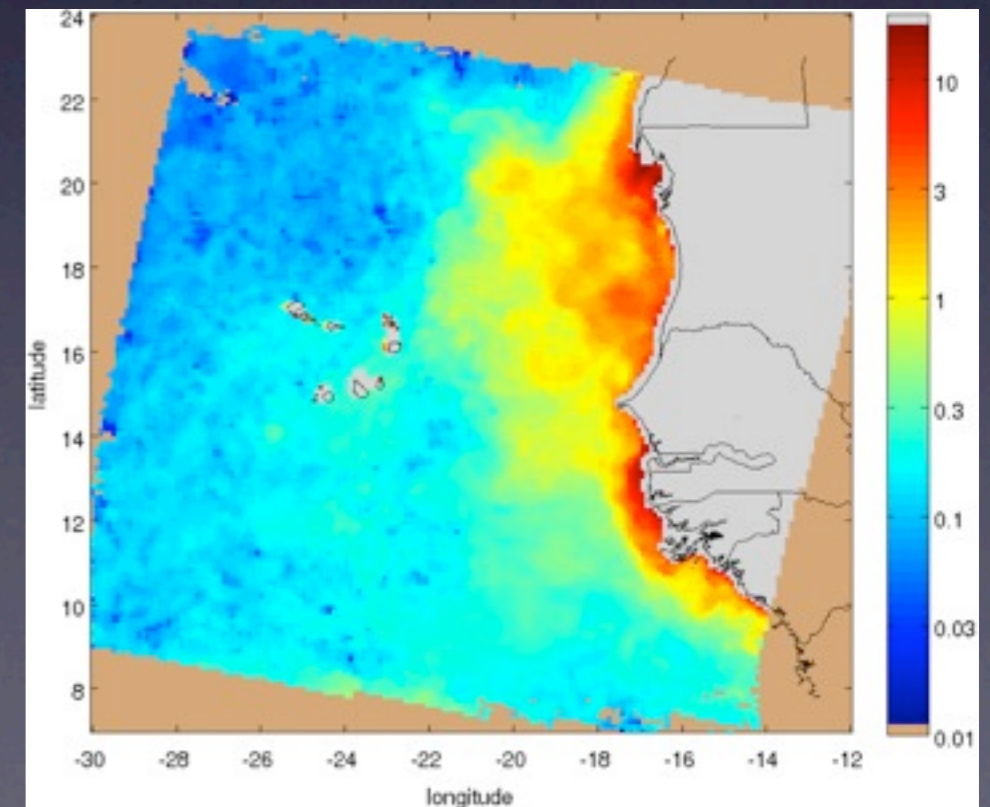in-situ validation
AERONET Dakar 1997 - 2009
570 points Vs 232 SeaWiFS

Study over 12 years (1997-2009)
Products (daily, weekly, monthly and climatology) :
- aerosol type,
- aerosol optical thickness
- chlorophyll-a
- standard deviation

http://www.locean-ipsl.upmc.fr/~POACC/

Conclusions

- An improvement of inverse algorithm using variational inversion and neural networks leads to an improvement of ocean color products

- Useful for geophysical studies

Perspectives

- data assimilation of ocean color data

- Operational algorithms