Contribution of POLDER to Water Vapor observation

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POLDER1 algorithm
examples of use
POLDER2 algorithm
experimental results over dark surfaces

POLDER instrument:
Polarization and Directionality of Earth Reflectances

Onboard ADEOS-1 (NASDA-CNES) and ADEOS-2

- sunsynchronous ~ 10h30
- swath ~ 2400 km
- full resolution 6 -7 km; products @ 20km2 or 60 km2

November 1996 to June1997 April 2003 until now

solar domain: 443[P], 490, 565, 670[P], 763, 765, 865[P], 910 nm

for water vapour: 865 nm et 910 nm

differential absorption

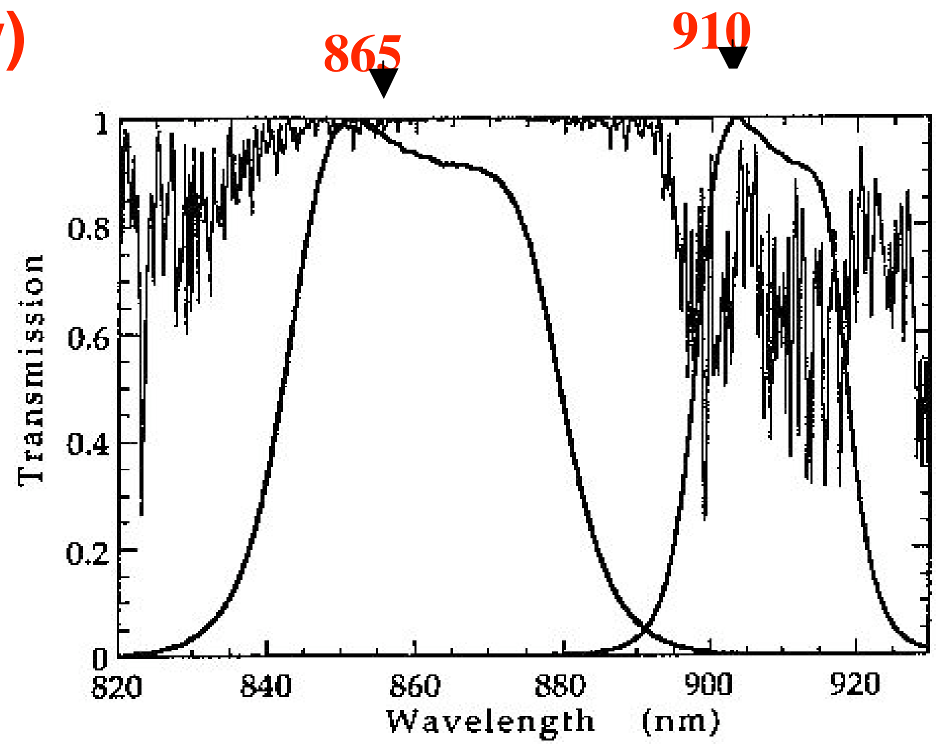
absorption contrast

between 865 & 910 nm (clear sky)

white surface hypothesis

$$Rsurf910 \sim Rsurf865$$

$$X = \frac{R_{910}}{R_{865}} \approx \frac{t_{910}}{t_{865}}$$



Total Column Water Vapour content

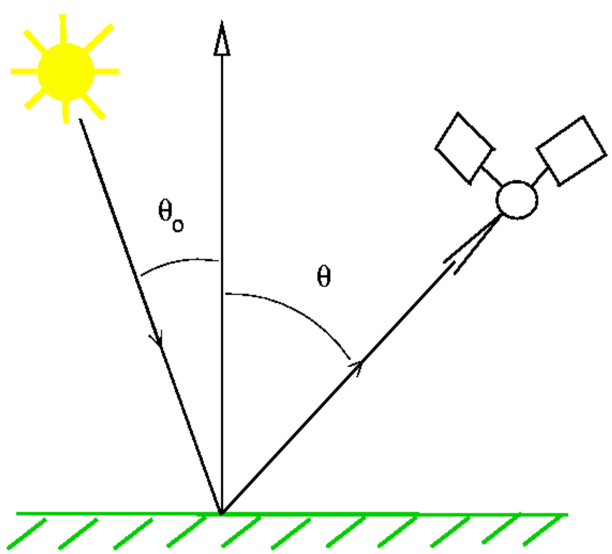
$$TCWV = U = \int_{0}^{p_{surf}} \frac{q(p)}{g} dp \qquad (kg.m^{-2})$$

polynomial fit

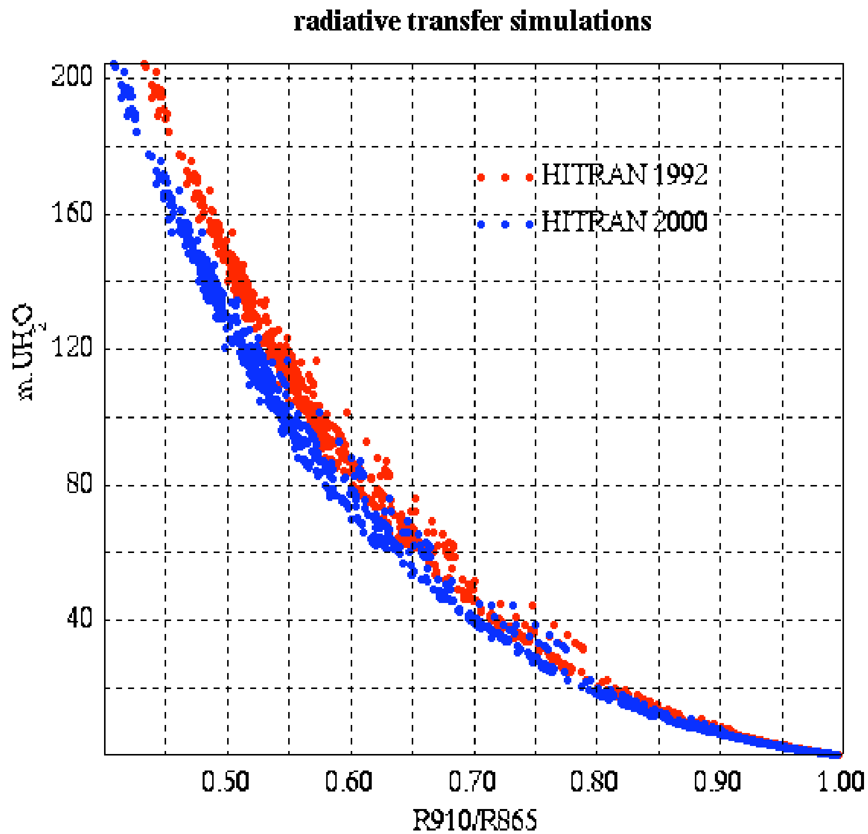
$$m \,.\, TCWV = a2\, ln(X)^2 + a1\, ln(X)$$

two-way air mass

$$m = \frac{1}{\theta_o} + \frac{1}{\theta}$$



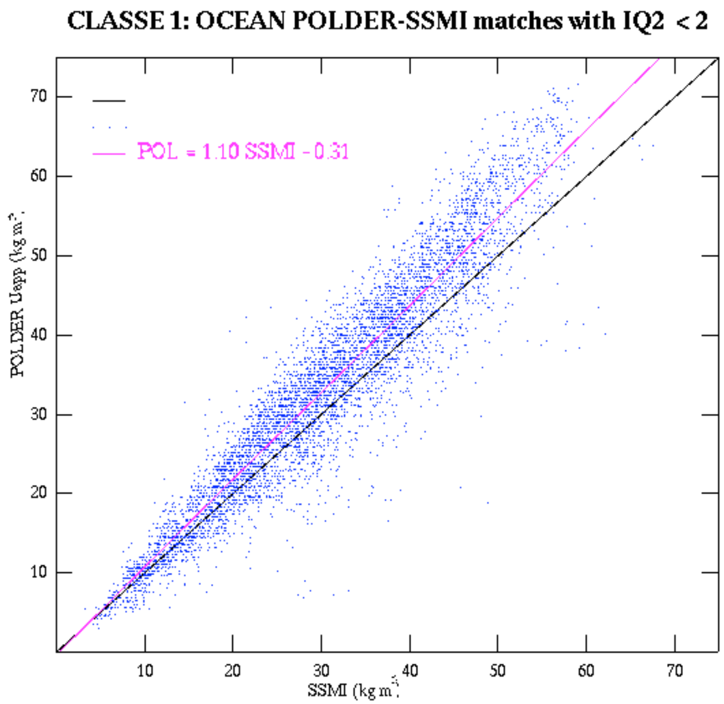
polynomial fit



$$m \,.\, TCWV = a2 \ln(X)^2 + a1 \ln(X)$$

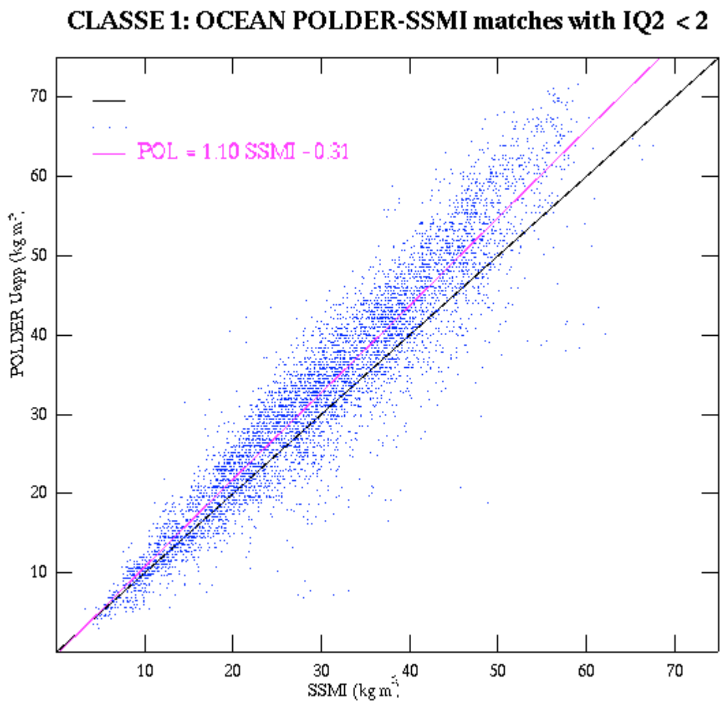
coefficients from radiative transfert simulations

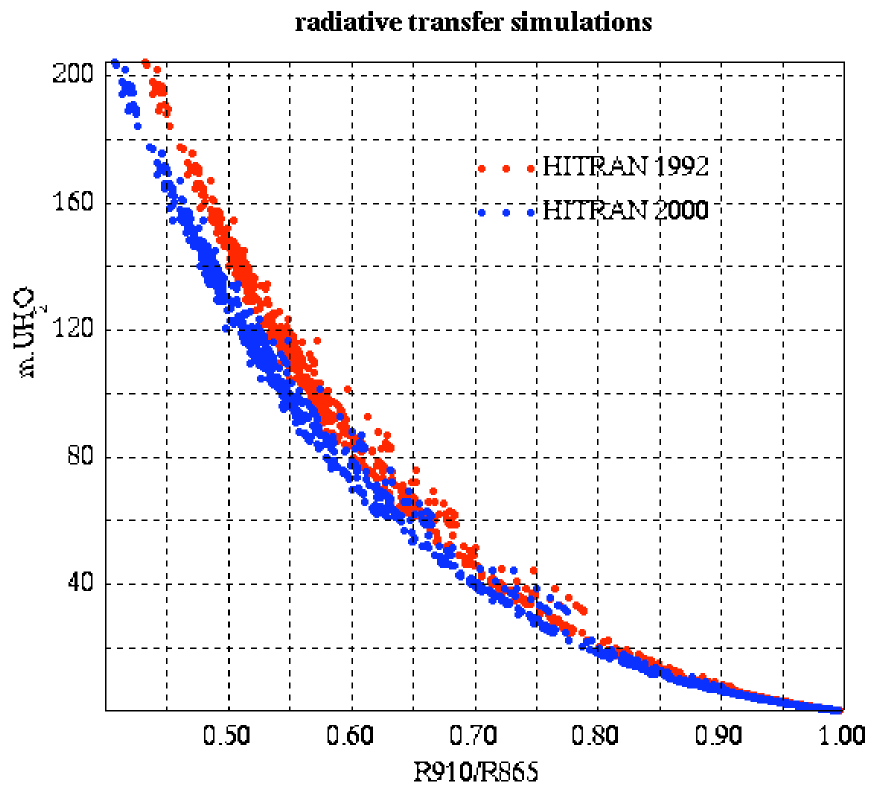
POLDER 1: Validation



overestimation of large contents

POLDER 1: Validation

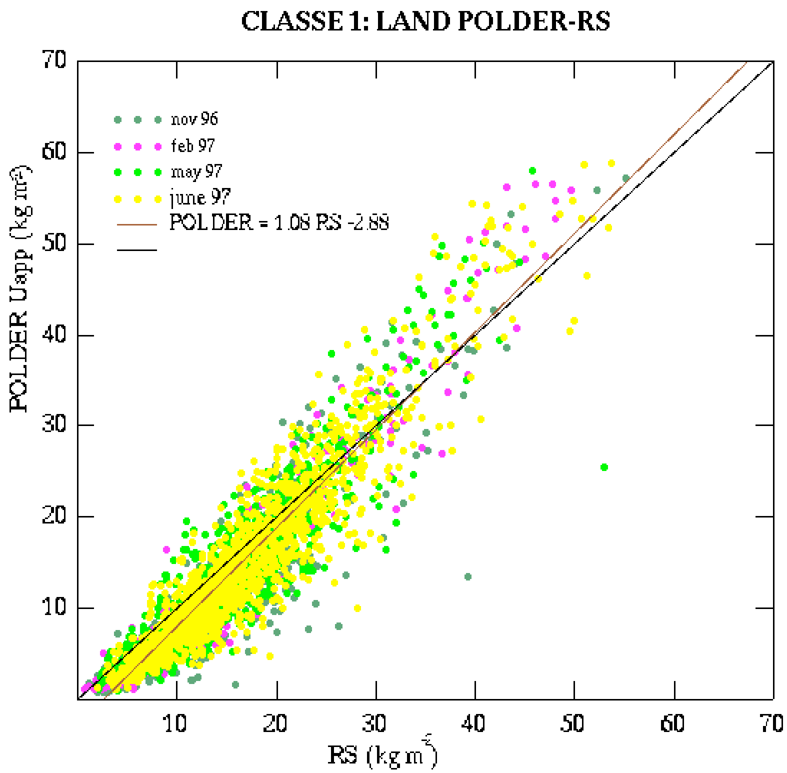




overestimation of large contents

HITRAN 1992 > HITRAN 2000

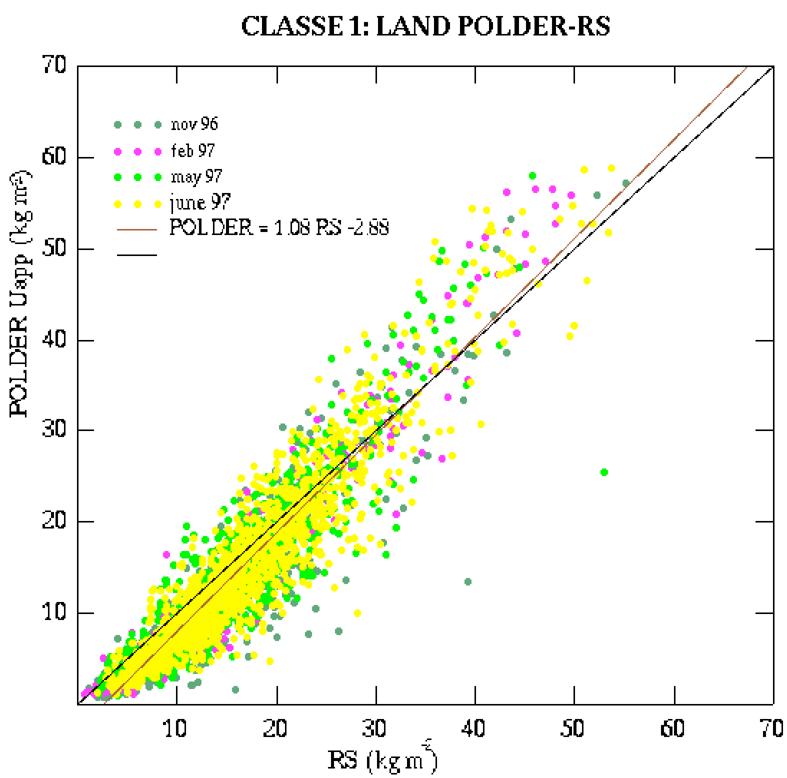
POLDER 1: Validation over land

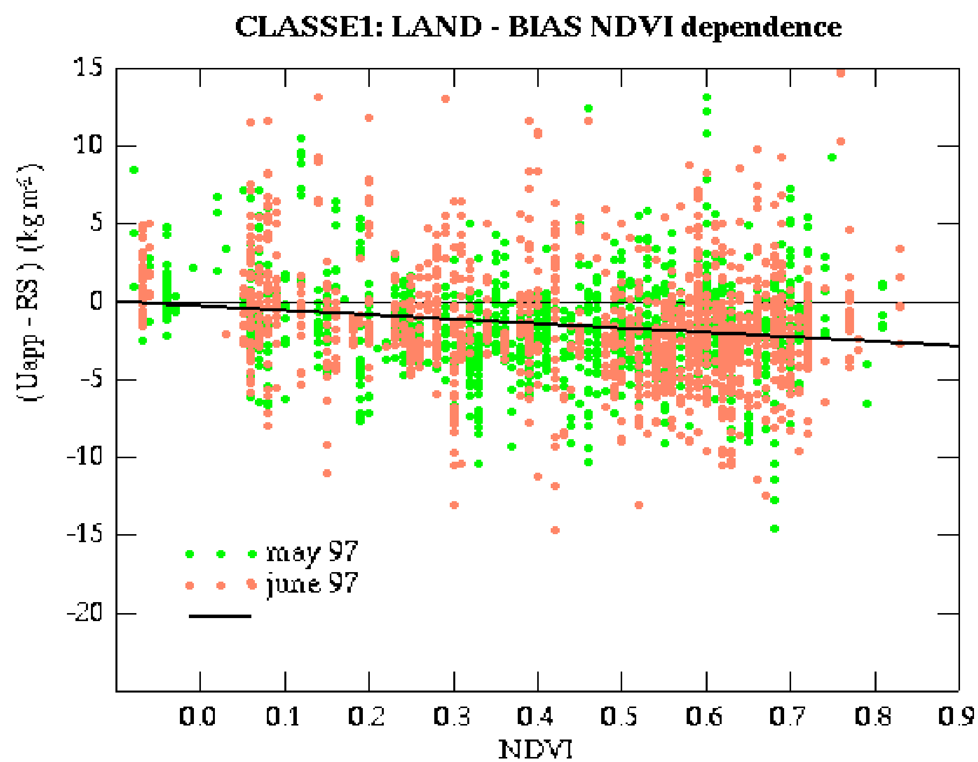


surface bias

underestimation of small contents

POLDER 1: Validation over land





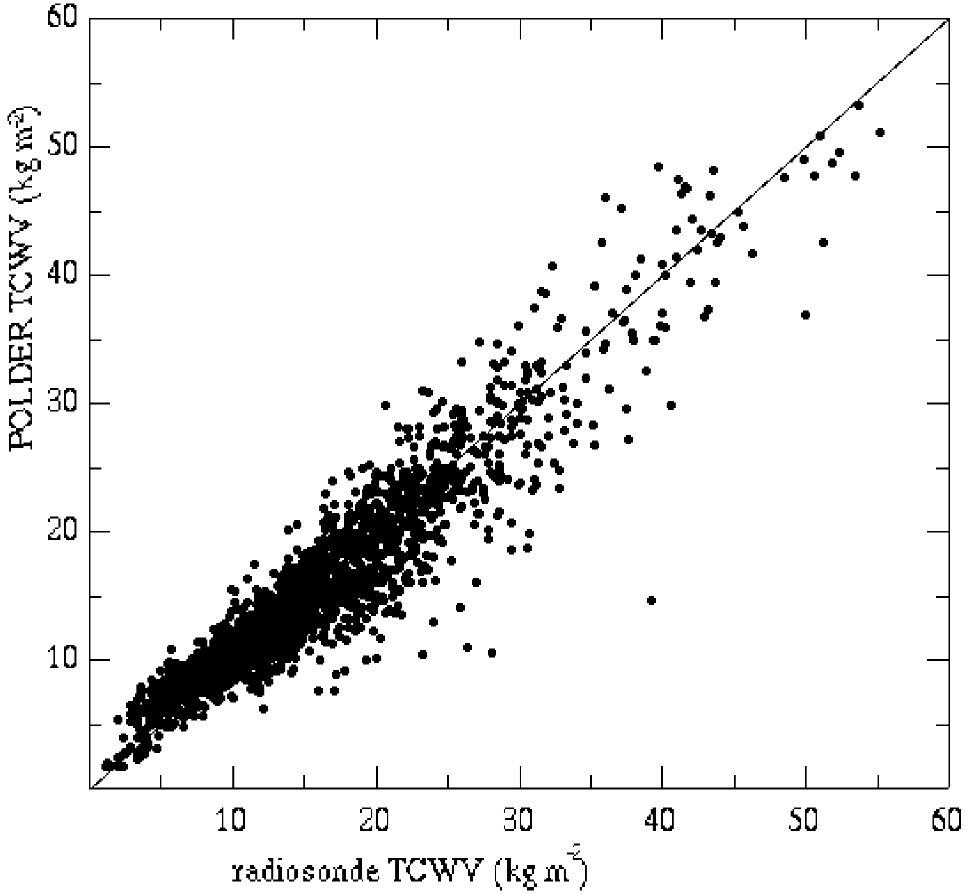
surface bias

underestimation of small contents

off line surface correction

fct (R865/R765)

off line correction



RMSE = 2.8 kg/m^2

< radiosondes ~ 5 kg/m^2

retrieval limitations

near-infrared solar domain

daytime only

1 obs per day only

absorption based technique

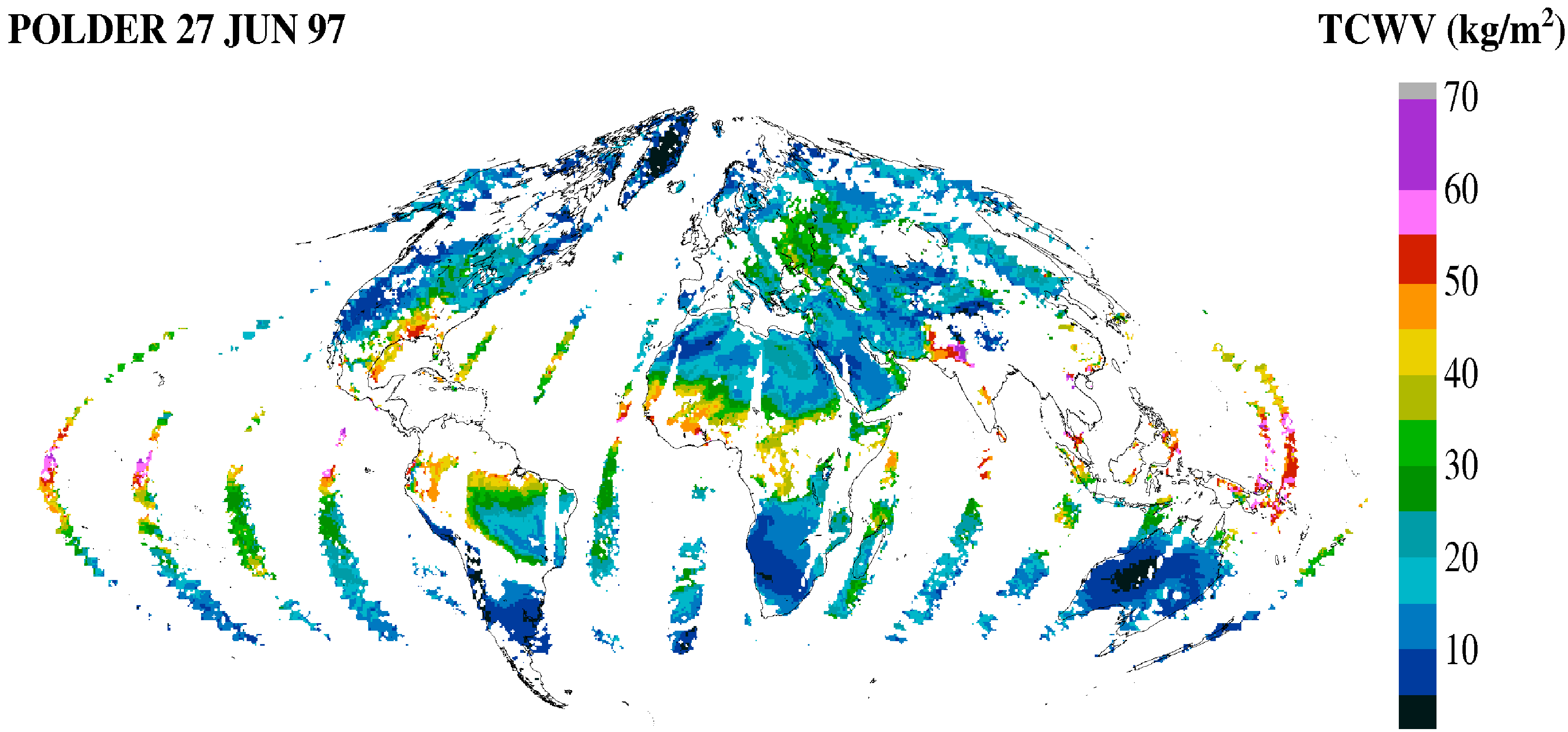
small scattering effects

clear sky only

high surface-reflected signal
/scattering effects

land and ocean glitter

POLDER water vapor content

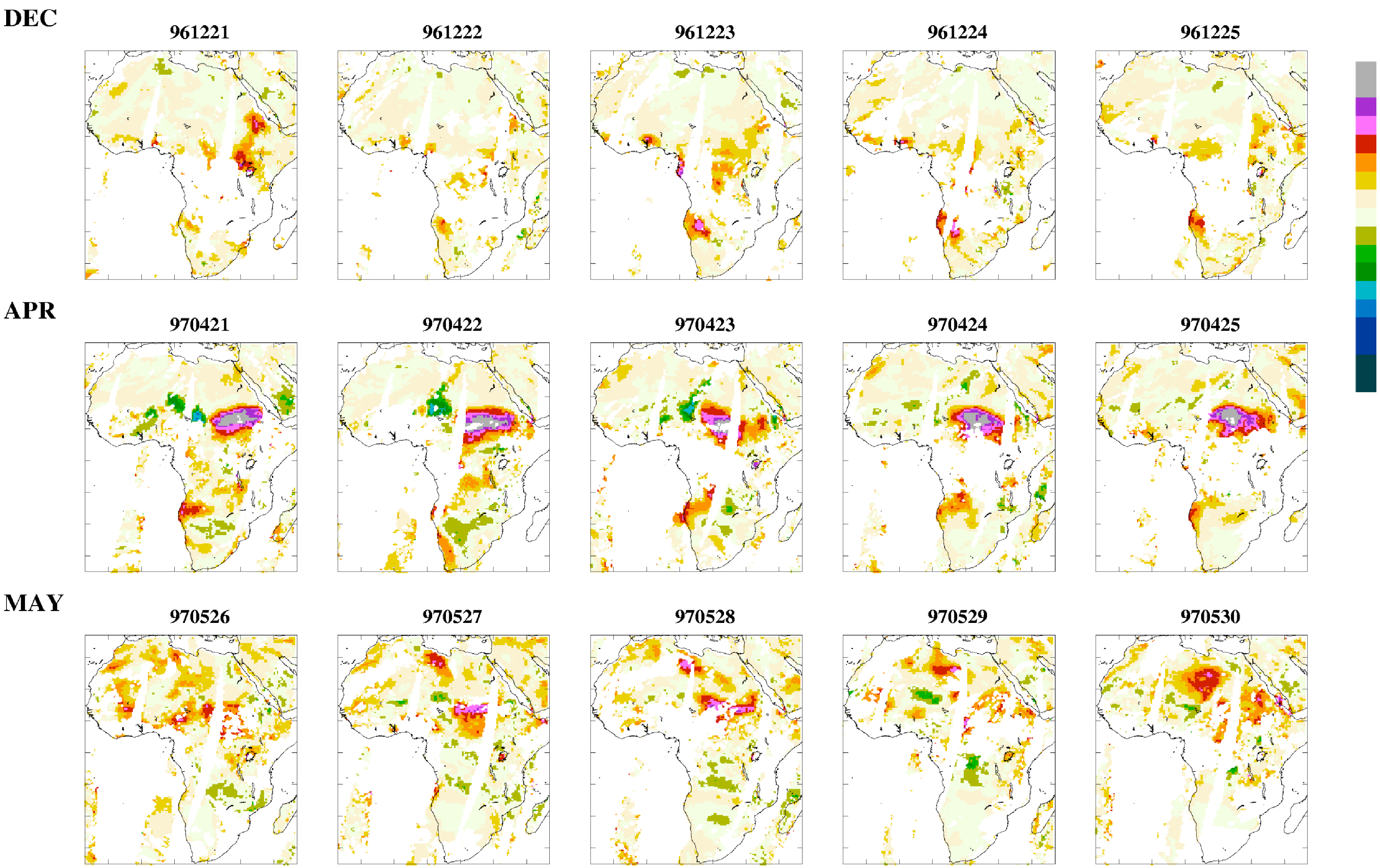


LAND: valuable spatial coverage (clear sky)

OCEAN: ~ 1/3 of the swath (clear sky and glitter)

Comparisons to meteorological analyses

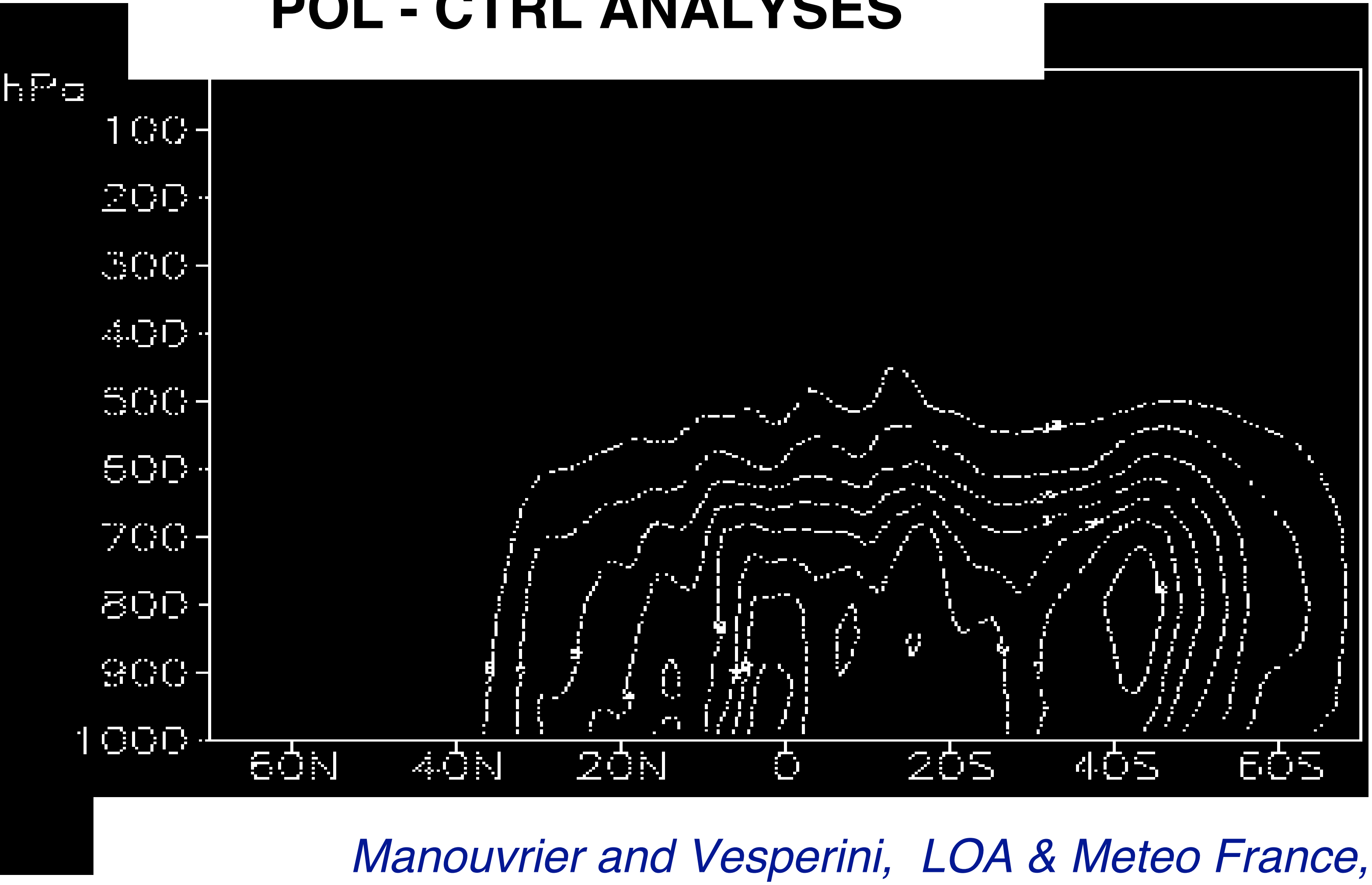
ECMWF - POLDER (1996-1997)



Vesperini, RSE, 2002

assimilation experiments

POL - CTRL ANALYSES



max drying:

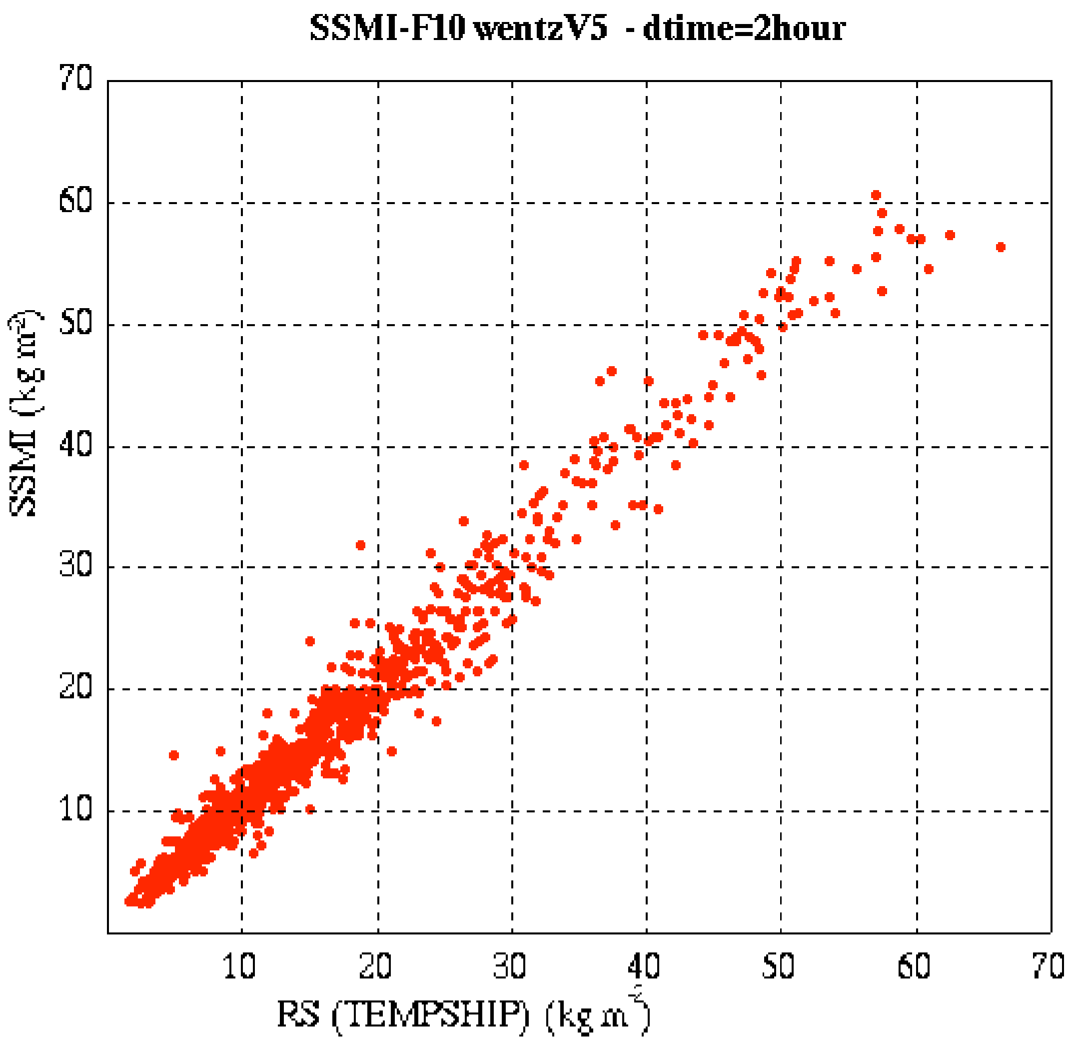
0.35 g/kg

Manouvrier and Vesperini, LOA & Meteo France, 2000

POLDER CLASSE 2 algorithm

calibration over ocean glitter targets

reference to SSMI F10 - Wentz algo version 5

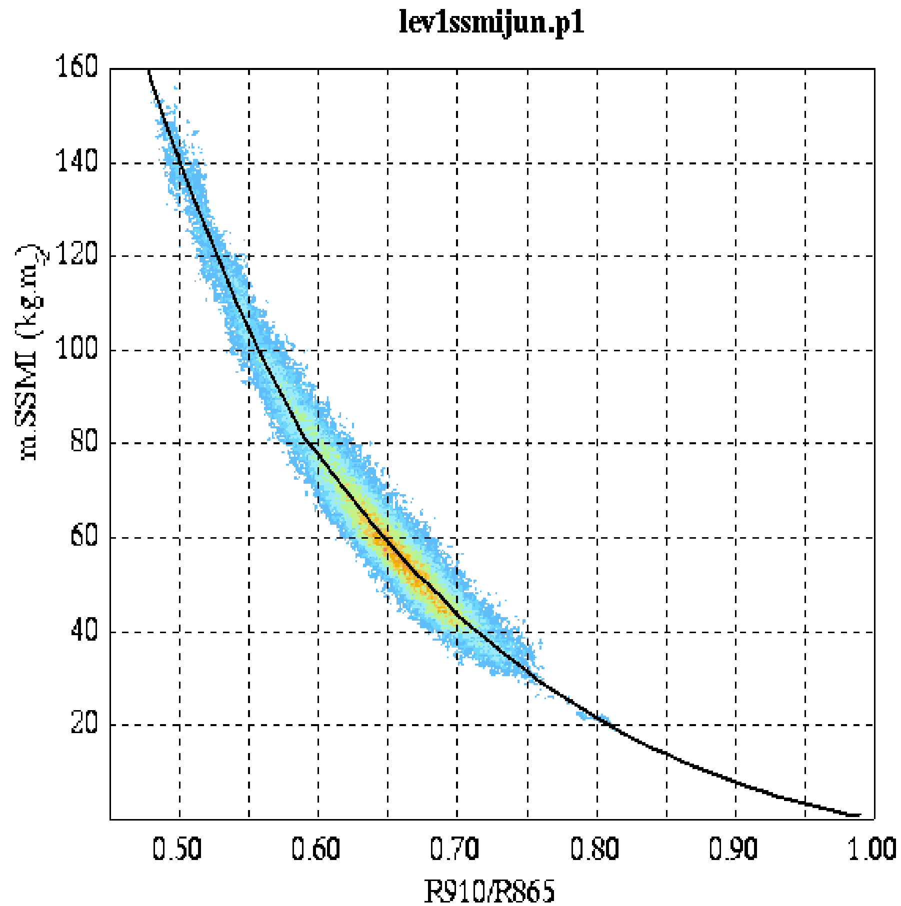


SSMI = 1.00 RS + 0.33 (kg.m^{-2})

RMS = 1.55 kg/m^2

POLDER CLASSE 2 algorithm:

for selected clear sky glitter scenes (POLDER lev1 / SSMI)



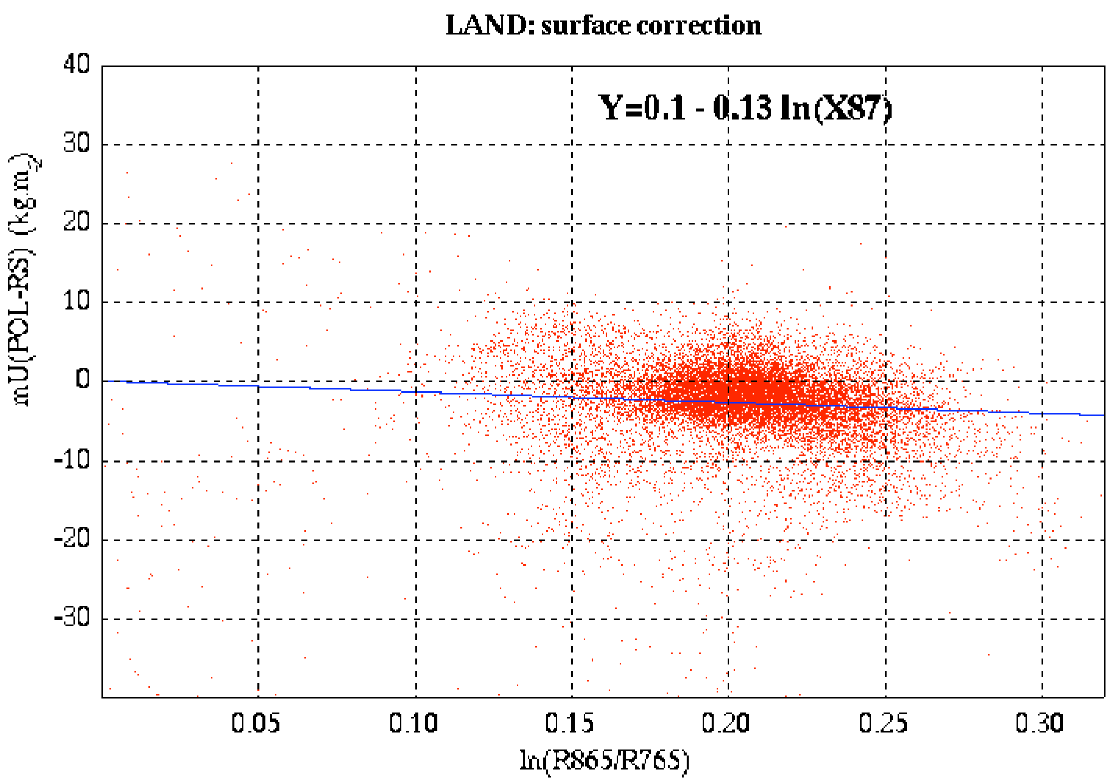
weak absorption:

$$m.U_{h2o} = a_2 \ln(X)^2 + a_1 \ln(X)$$

strong absorption:

$$m.U_{h2o} = a_2 \ln(X)^2$$

POLDER CLASSE 2: land surface correction



conclusion and perspectives

POLDER water vapor (total column)

experimental algorithm over ocean in any geometry

operational product over land or in glitter geometry

clear sky

daily (1 a day)

~ 3 kg/m^2 precision

sensitive to the lower troposphere

to complement sounding instruments

conclusion and perspectives

African Monsoon Multidisciplinary Analysis project

need for water budget

provide fine scale humidity analyses

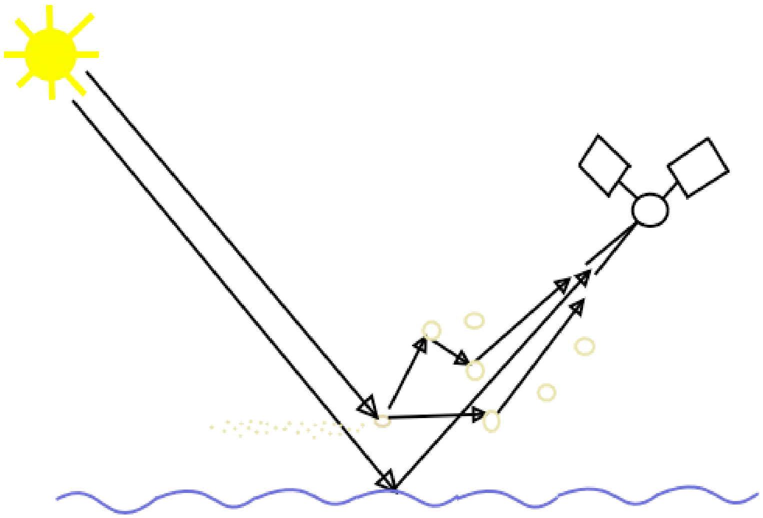
over land and ocean

differential absorption retrievals over land

(POLDER/MODIS/MERIS)

+ *μ*wave and IR sounding

Differential Absorption Technique Over Ocean



in any viewing geometry

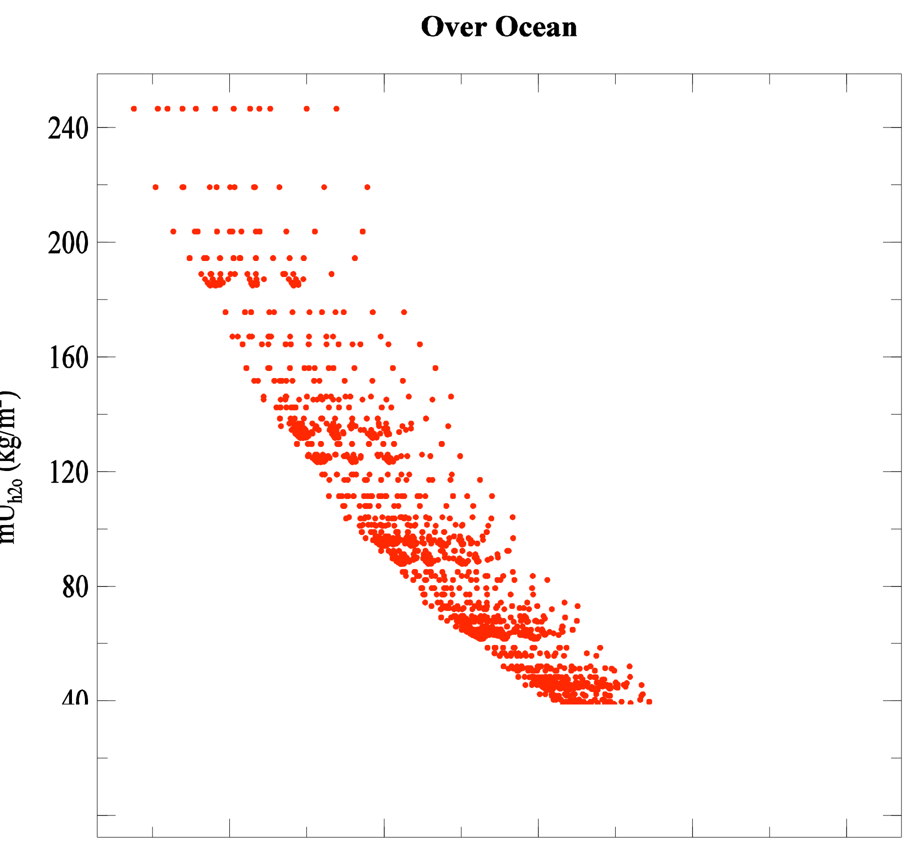
small reflectance for the surface

coupling between scattering and water vapor absorption

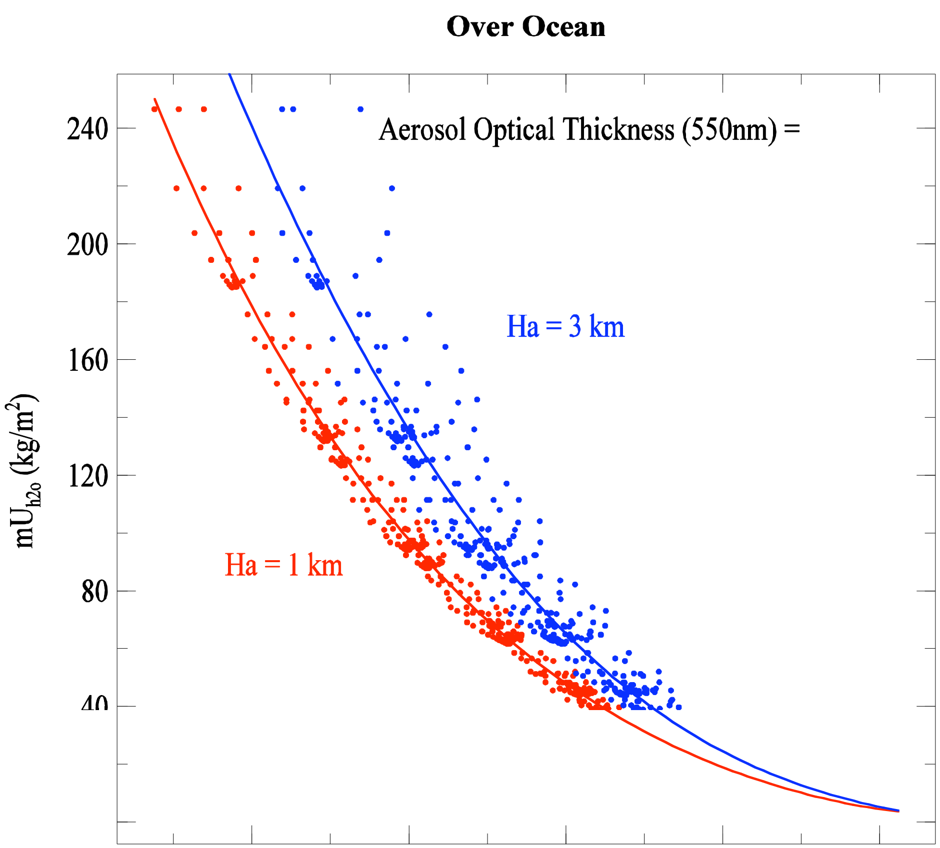
Instrument noise on top-of-atmosphere signal

Effects of Aerosol Scattering

All cases



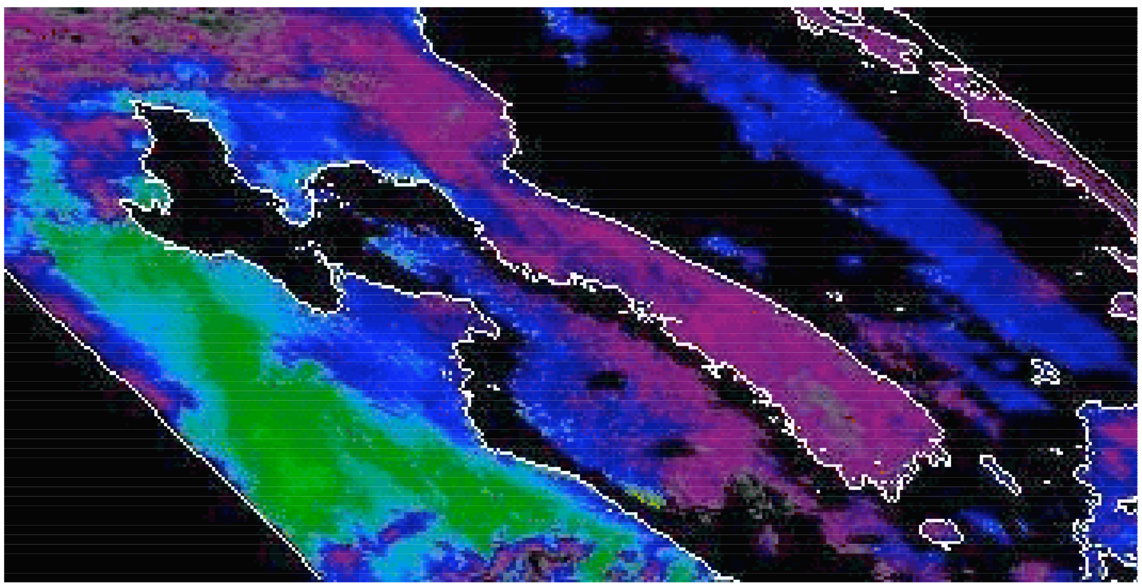
As a function of **_a and H_a**.



Water vapor over land and ocean

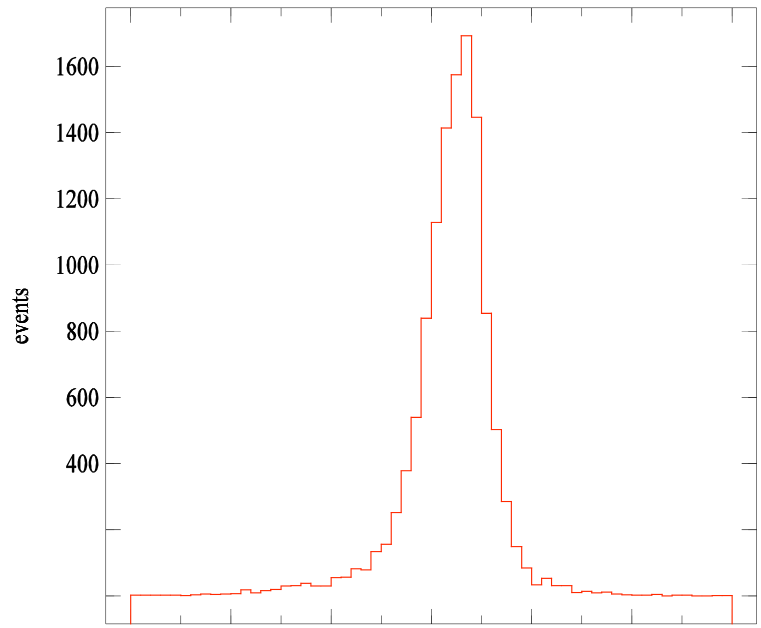
Water vapor content:

Continuity between land and ocean is observed

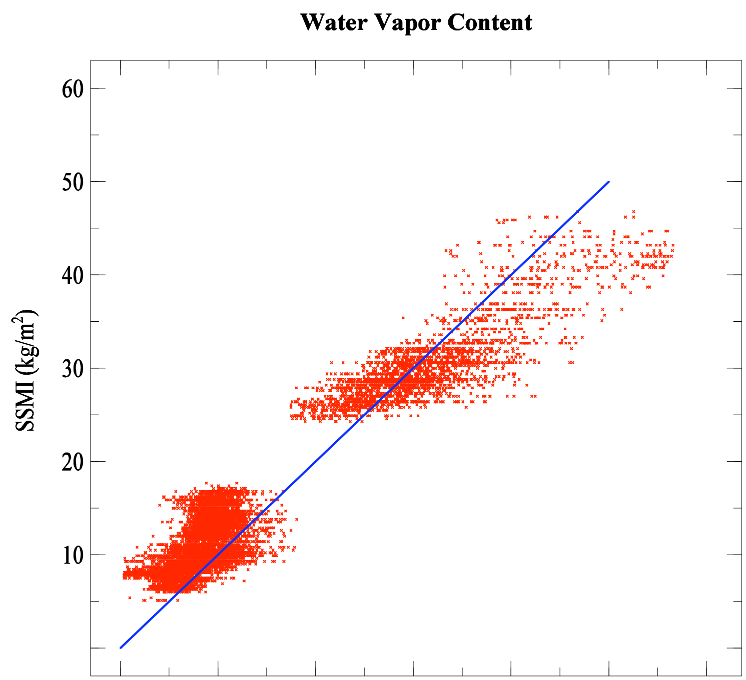


Comparisons with SSMI data

Histogram: SSMI -POLDER



Comparisons SSMI/POLDER



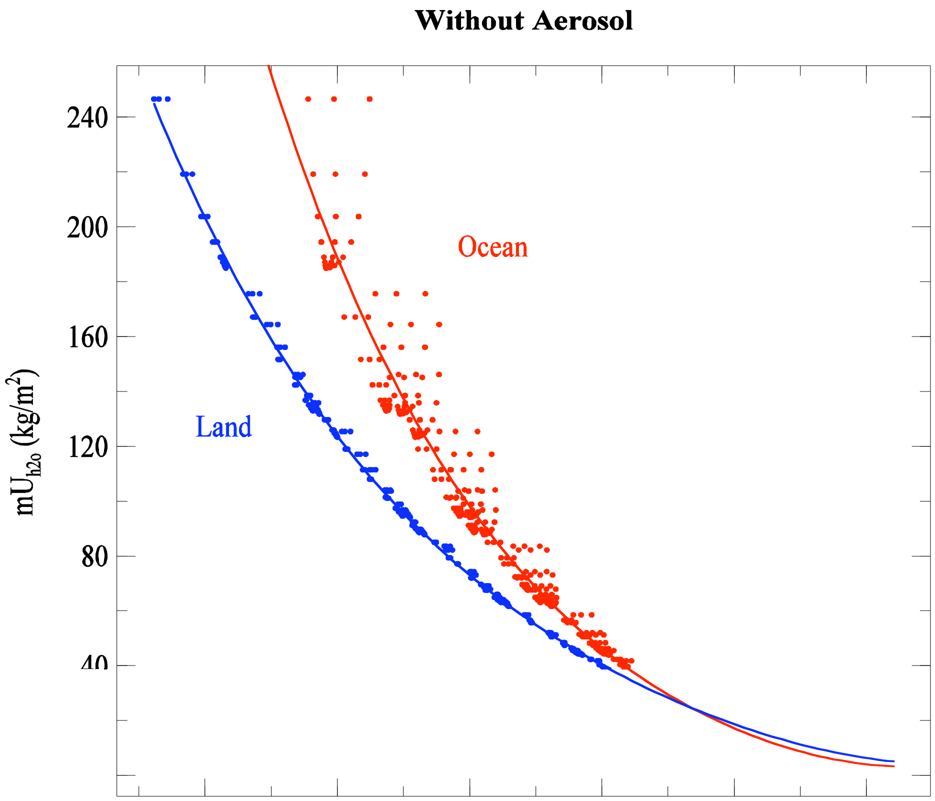
Mean ~ + 1.8 kg/m^2 : due to the accuracy of the radiative transfer code
RMS error ~ 4 kg/m^2 : overestimation of large contents

Radiative Transfer Modeling

Radiative transfer code : GAME

- Absorption: correlated k-distribution from a Line-By-Line (LBL) code for gaseous absorption
- Spectral resolution: 10 cm^{-1}.
- HITRAN 2000 spectroscopic database
- CKD2.4 parameterization for the water vapor continuum
- Discrete Ordinates Method (DOM) for absorption, emission and multiple scattering processes.
- Sea-surface reflectance: specular and diffuse reflection

Differential Absorption Technique Over Ocean



Reflectance Ratio calculated with the GAME code:

Without aerosol

Rayleigh scattering

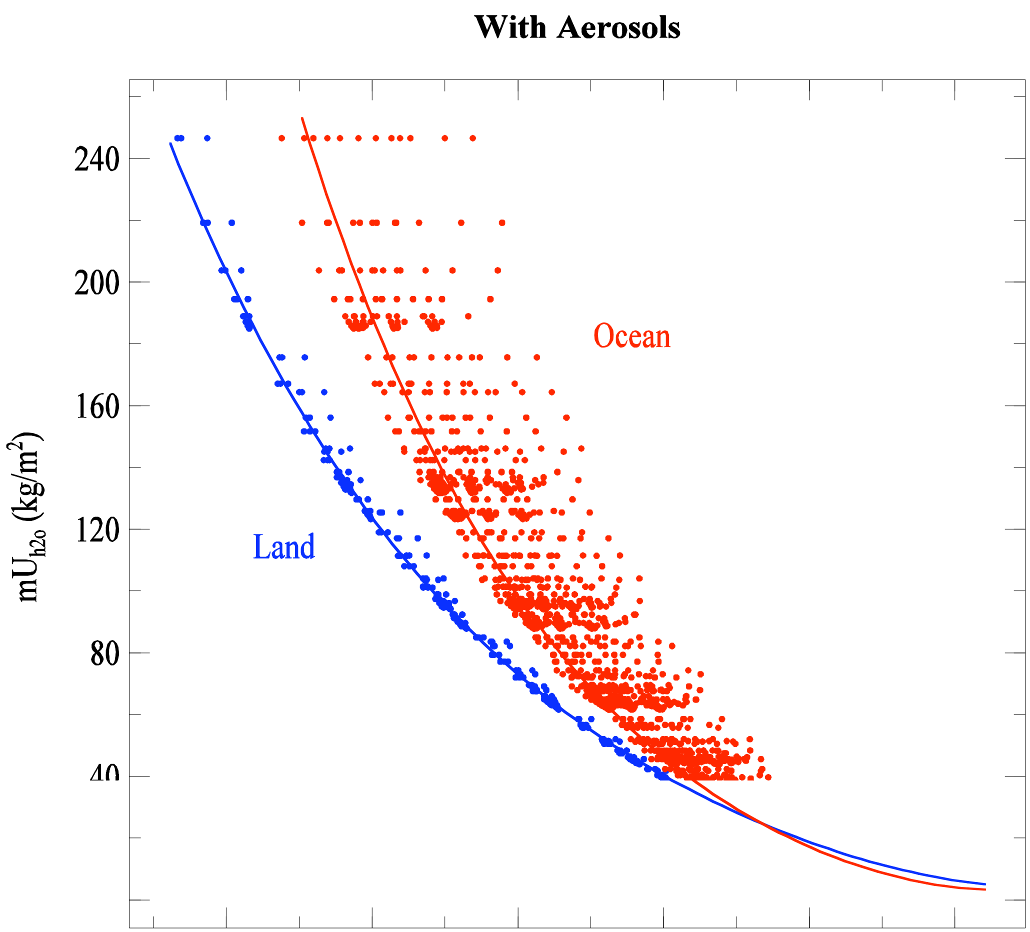
Over Land or Ocean

Solar angle 0 < _s < 60º

View angle0 < _v < 60º

4 < U_{h2O} < 60 kg/m²

Effects of Aerosol Scattering



Aerosol properties:

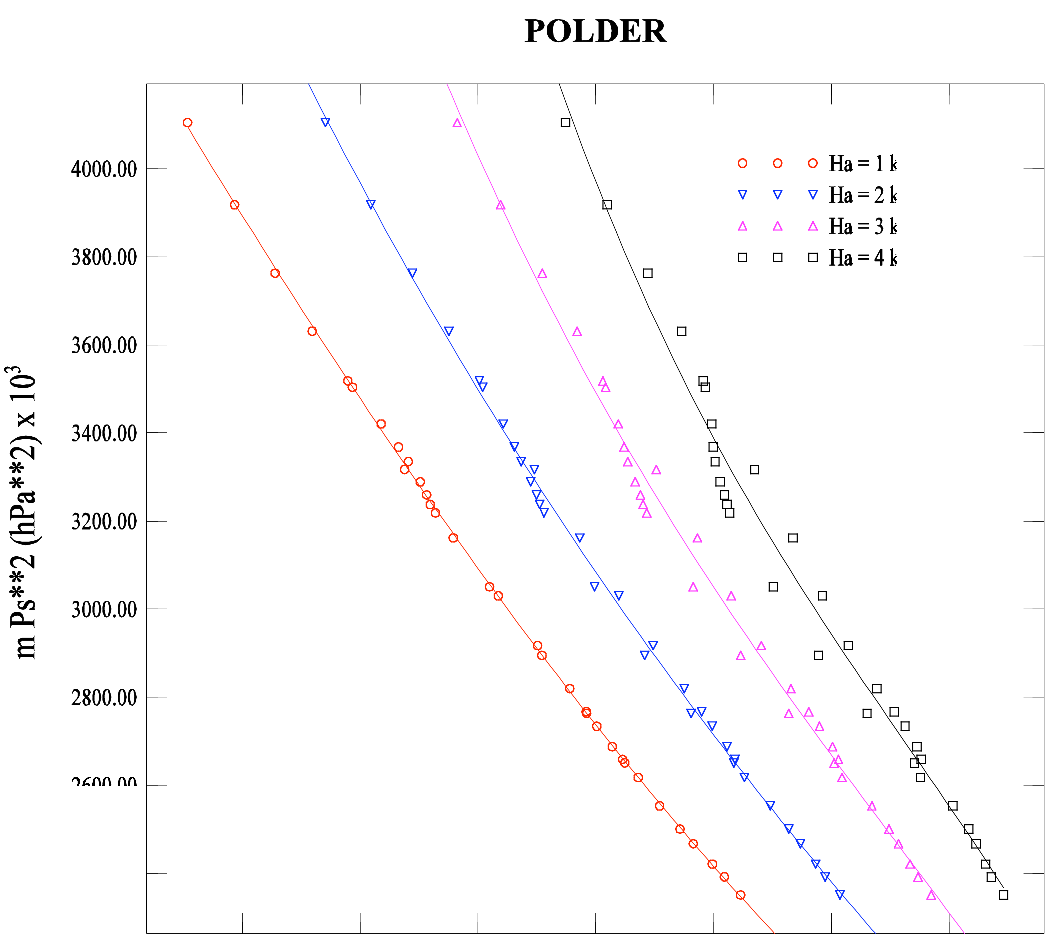
Optical Thickness:

_a (550nm): 0.1 to 0.3

Maritime model (Mie theory)

Scale Height H_a: 1 and 3 km

Aerosol Scale Height



POLDER oxygen bands:

At 863 and 865 nm

Estimate of the surface pressure P_s

From the airmass m and the reflectance ratio R(863/865nm)

Inversion Scheme

- Look-Up-Tables: calculated with the radiative transfer code

  polynomial regressions for :

  $mU_{h2o} = R_{H2O}$ (910nm/865nm)

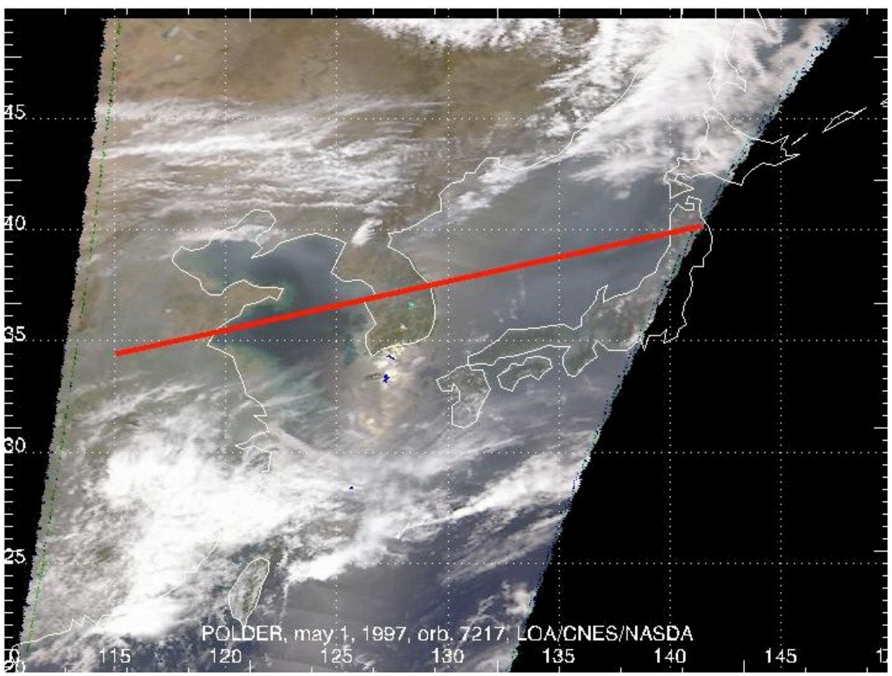
  $mP_s^2 = R_{O2}$ (763nm/765nm)

  as a function of $\_{a}$ is and H_a
- R_{H2O} and R_{O2} are deduced from POLDER data
- $\_{a}$ is a POLDER product
- H_a is estimated from an iterative procedure when:

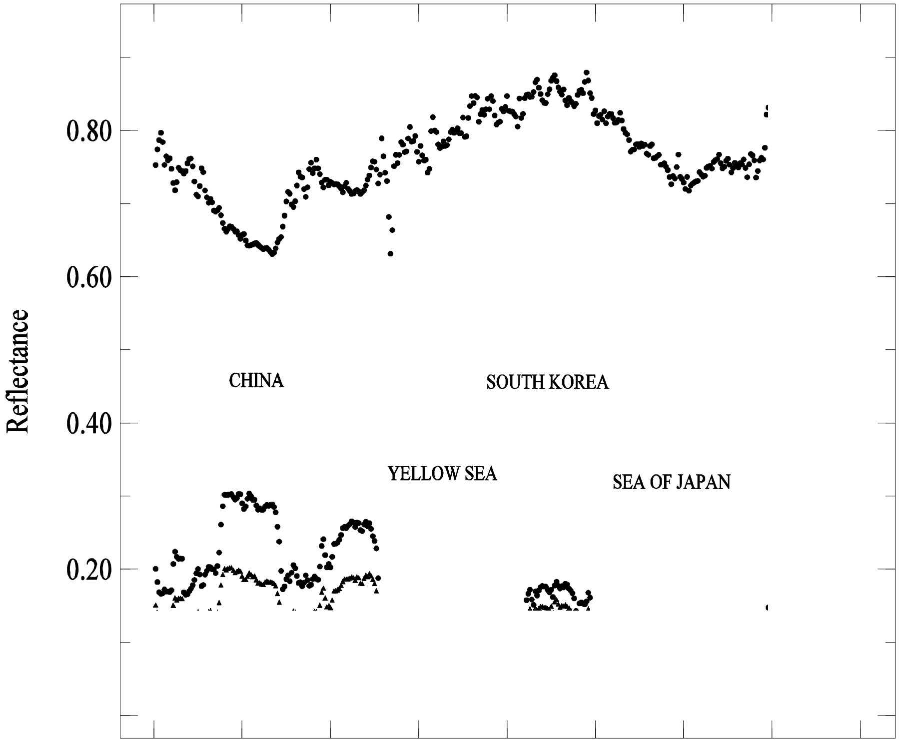
  $P_{app}(H_a) = P_s$ (ECMWF)

Study Case over East Asia

Polder scene over East Asia

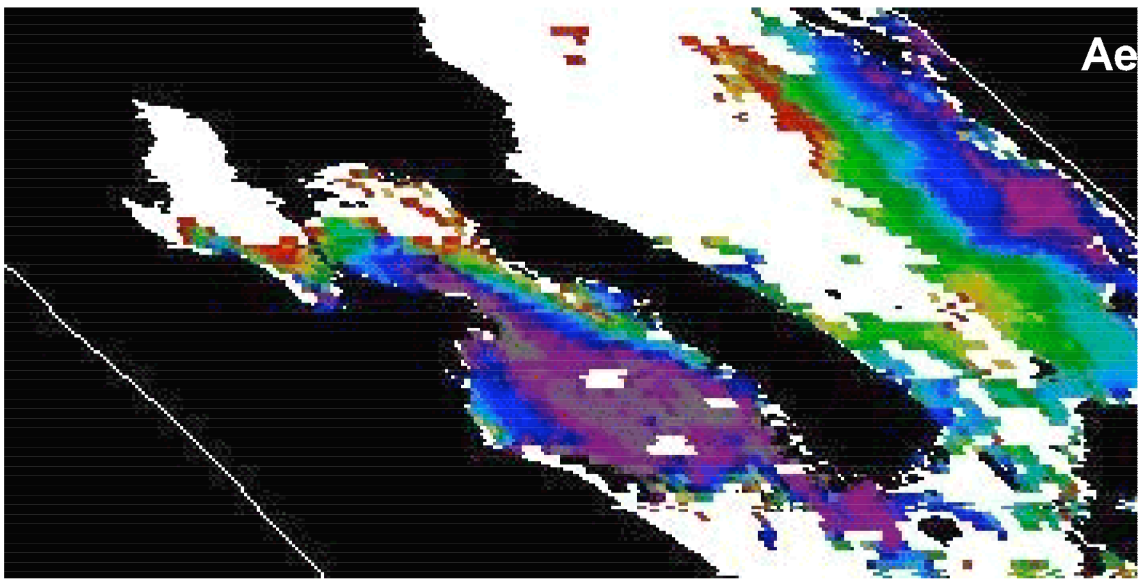


Reflectance and reflectance ratio in the POLDER channels at 865 and 910 nm



POLDER aerosol Product

Aerosol Optical thickness at 865 nm from the POLDER algorithm



Conclusion

POLDER water vapor (total column)

Operational product over land or in sunglint conditions

- clear sky, daily (1 a day)
- ~ 2 kg/m^2 precision

Experimental algorithm over ocean:

- first results: satisfactory agreement for a case study
- improvement of the method: line-by-line approach
- global validation to test the robustness of the method
- effects of thin clouds

International TOVS Study Conference, 13th, TOVS-13, Sainte Adele, Quebec, Canada, 29 October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.