IOCCG Calibration Workshop

30 October 2004, Fremantle, Australia

"In-Flight Calibration of Satellite Ocean-Color Sensors"

Purpose

The purpose of the workshop was to review the calibration of ocean-color sensors, to compare various approaches to meet requirements, to identify problems and areas of improvements, and to make recommendations.

Participants

Twenty-two investigators and scientists from the international ocean-color community attended and contributed to the workshop with presentation material and ideas

Format

In the first part, invited experts and representatives of international space agencies gave invited talks on various aspects of calibration, including definitions and requirements, the various techniques developed and applied, and the selection of final calibration coefficients.

In the second part, issues centered around three major themes, i.e., calibration requirements, adequacy of calibration techniques, and definition of a common calibration strategy were discussed and recommendations worked out.

Presentations

1. Calibration of ocean color sensors: Definitions and requirements (Howard Gordon, University of Miami, USA)

2. CNES contribution to ocean color calibration (Bertrand Fougnie, Centre national d'Etudes Spatiales, France)

3. GLI calibration results for ocean color channels (Mayumi Yoshida, Remote Sensing Technology Center, Japan)

4. MERIS onboard calibration (Jean-Paul Huot, European Space Agency, the Netherlands)

5. Vicarious calibration of MERIS level-1b observations: Early results obtained at the Villefranche AERONET site (David Antoine, Observatoire Oceanologique de Villefranche, France)

Presentations (cont.)

6. In-flight vicarious radiometric calibration using in situ measurements by the SIMBADA network (Pierre-Yves Deschamps, University of Lille, France)

7. Vicarious calibration of ocean color sensors in the red and near infrared (Robert Frouin, Scripps Institution of Oceanography, USA)

http://genius.ucsd.edu/~frouin/IOCCG_Cal/present.html

Main Points/Recommendations

1. To achieve the requirements for scientific applications, e.g., 30% accuracy on chlorophyll concentration, radiometric calibration should be accurate to a fraction of 1%. This is not achievable by standard techniques, but the target accuracy should be 2%.

2. Reflectance calibration has a number of advantages compared with radiance calibration. The solar constant does not need to be known, and it is much easier to do on-orbit reflectance calibration than radiance calibration. But the bi-directional reflectance of the reference target should be monitored for stability. Furthermore, in the atmospheric correction process the molecular reflectance is given in look-up tables, and transforming this reflectance into radiance may greatly increase the error in water-leaving radiance.

Main Points/Recommendations (cont. 1)

3. Sensors have non-ideal performance that must be understood. They should be characterized for out-of-band response, polarization sensitivity, bright target/scattered light response, non-linearity, etc.

4. Vicarious calibration or calibration adjustment is needed to meet accuracy objectives. "Radiometric" vicarious calibration techniques should be applied first. "System" vicarious calibration, i.e., calibration of the sensor and the atmospheric correction algorithm, should be applied only to refine the coefficients obtained by the "radiometric" vicarious techniques.

Main Points/Recommendations (cont. 2)

5. Calibration sites should be selected so that the satellite signal is computed with the best accuracy possible, i.e., far from land, in homogenous oceanic regions, etc. Coastal sites are generally not adequate, although they are necessary for algorithm validation. Varied sites, with varied instrumentation, are needed to ensure proper accuracy.

6. The data used for sensor calibration should be made available to the ocean-color community at large. This would allow investigators to perform their own calibration, using their own radiation transfer codes.

7. JAXA, CNES, and NASA calibration schemes all differ. Some resolution needs to occur. A common strategy should be applied to all the sensors.

Schedule

Definitions, formalism, and requirements (Howard Gordon, University of Miami, USA)

Calibration using onboard devices (Edward Zalewski, University of Arizona, USA)

Vicarious calibration techniques (Bertrand Fougnie, Centre National d'Etudes Spatiales, France)

Draft report by Fall 2005

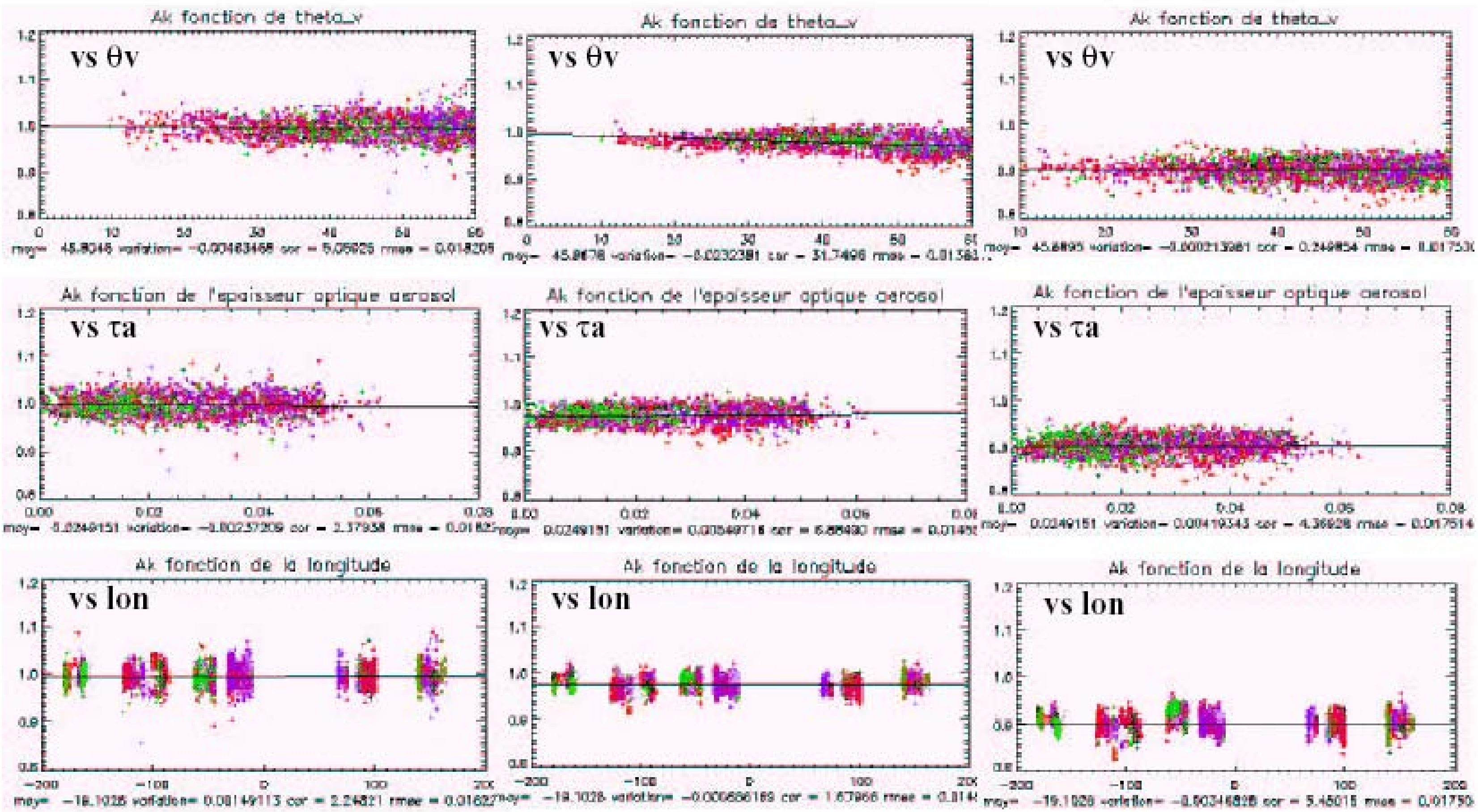
Calibration over Rayleigh Scattering : results

POLDER-2

670 Ak=0.995 σ=0.019

490 Ak=0.976 σ=0.014

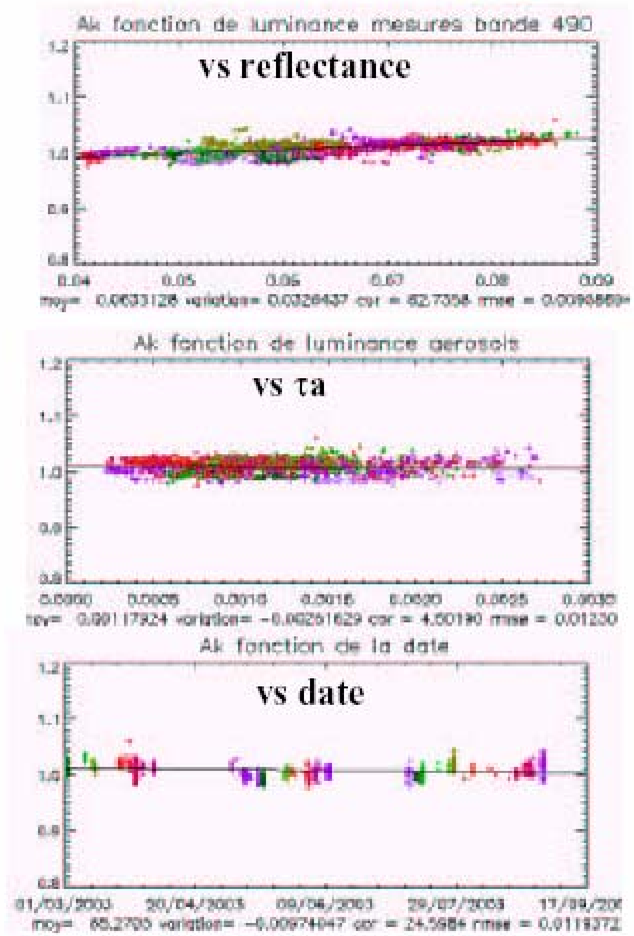
443 Ak=0.902 σ=0.017



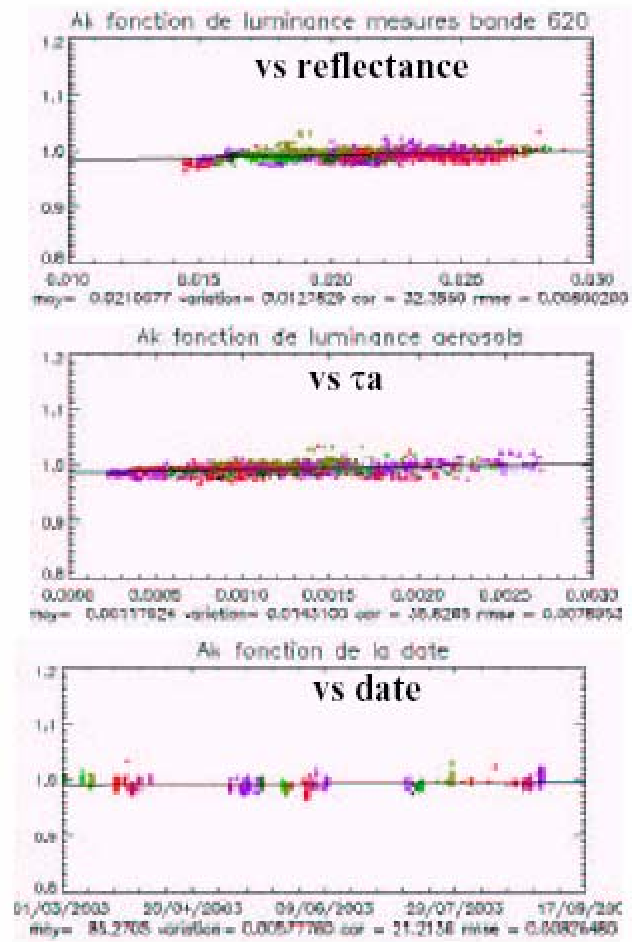
Calibration over Rayleigh Scattering : results

MERIS

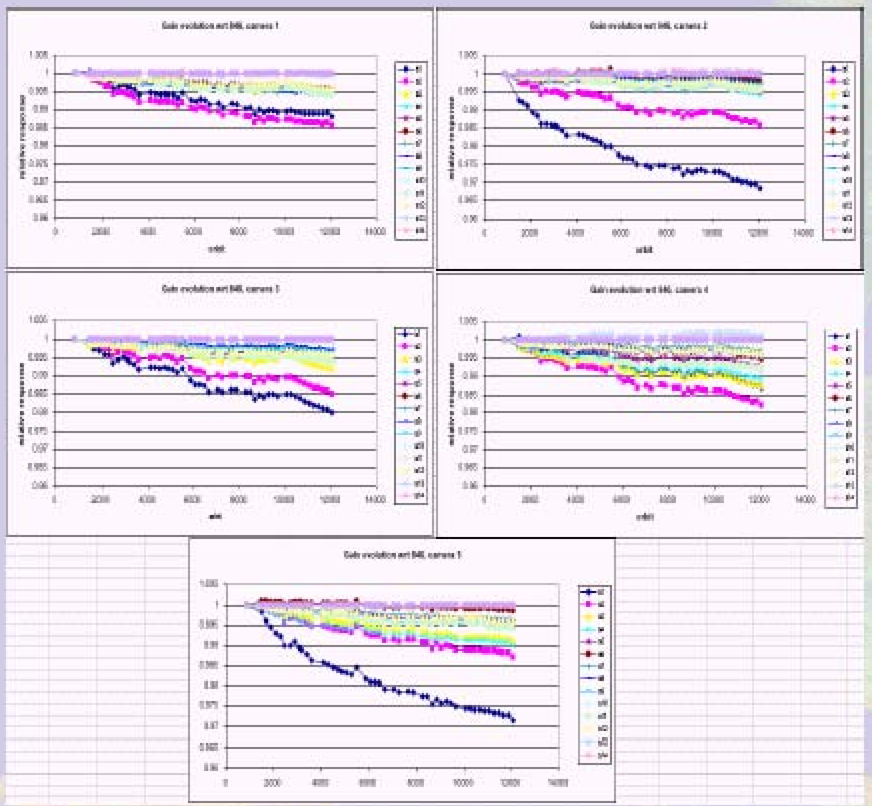
490 Ak=1.008 σ=0.012



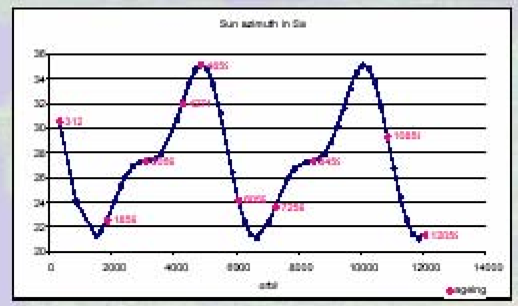
620 Ak=0.994 σ=0.010



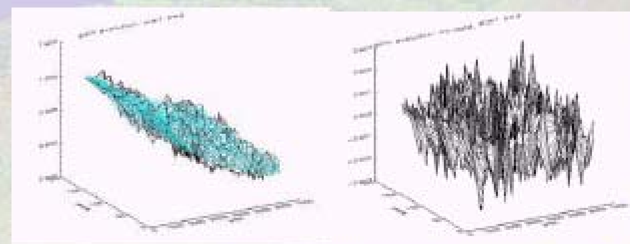
MERIS Instrument Degradation



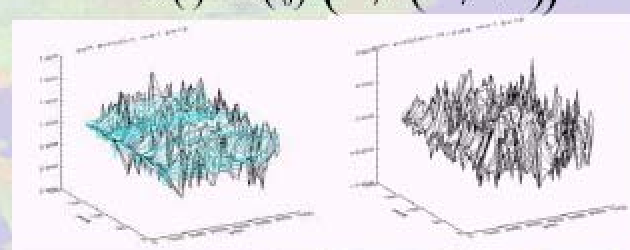
Degradation is < 3% after more than 2 years in space



Diffuser illumination



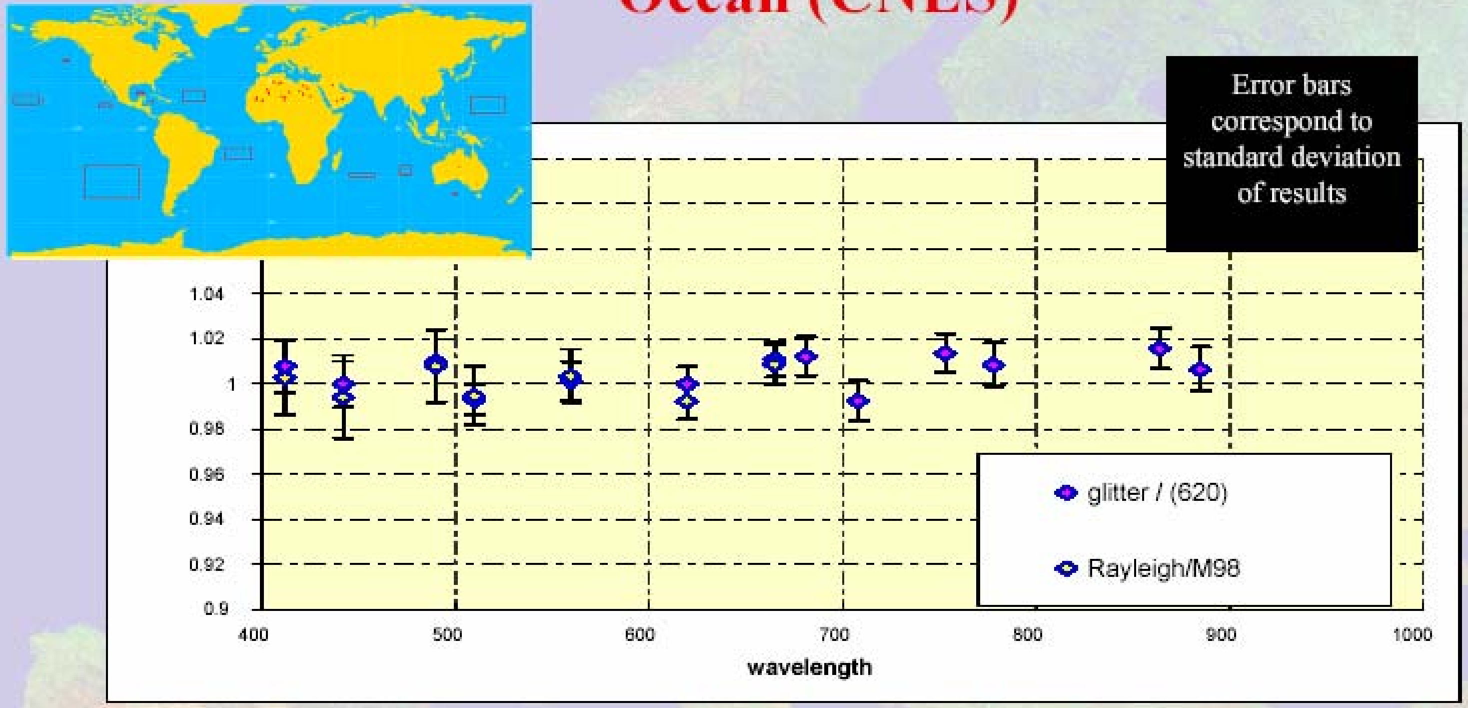
$$G(t) = G(t_0)\cdot\left(1-\beta\cdot\left(1-\gamma\cdot e^{-\delta t}\right)\right)$$



Degradation Model based on the SeaWifs model (Barnes et al.)

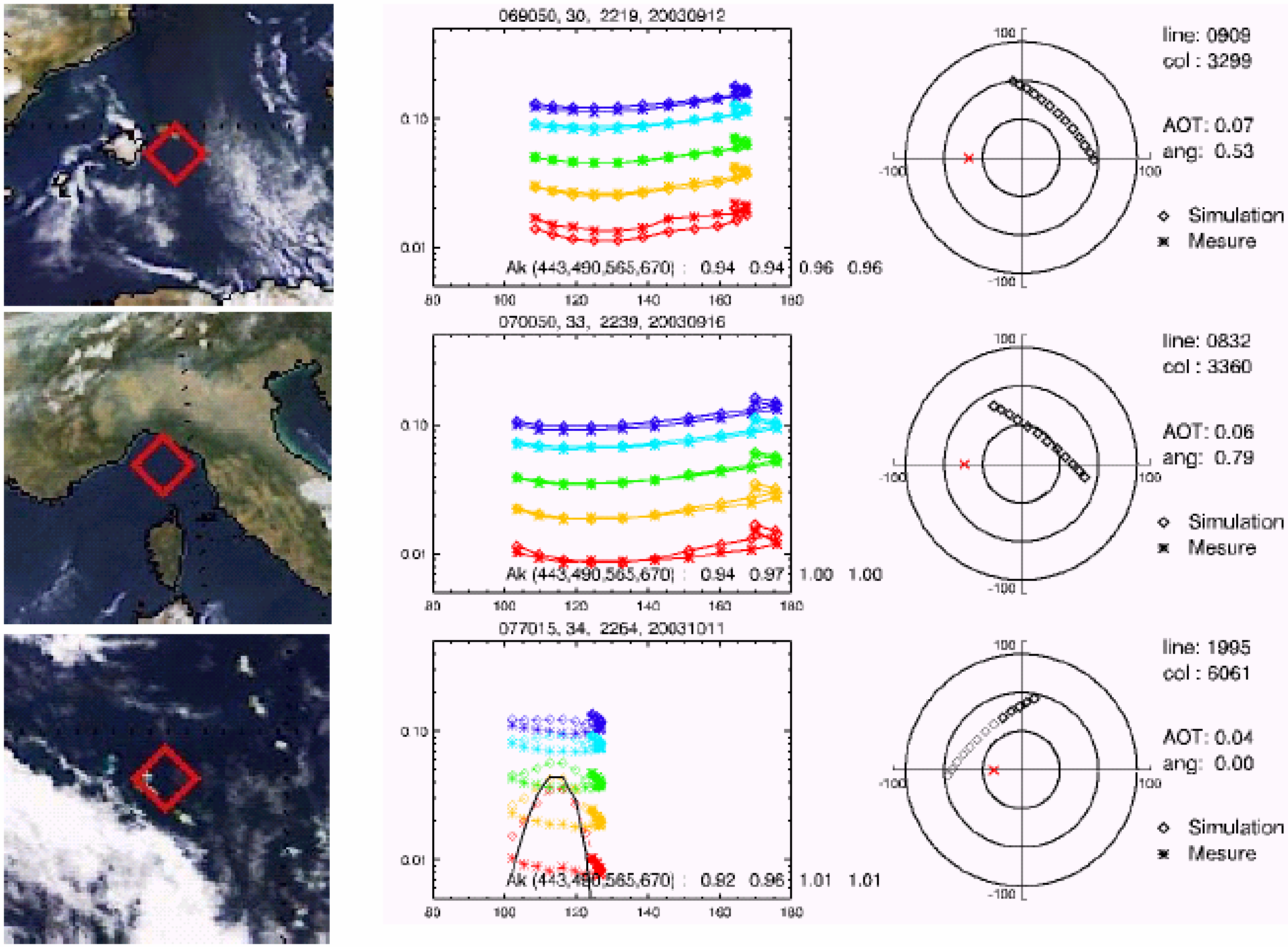
MERIS Vicarious Calibration

Ocean (CNES)

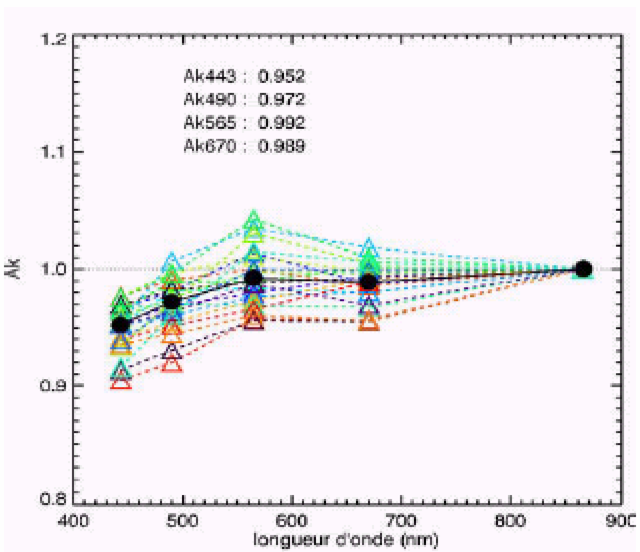


- Incredibly good consistency between Rayleigh and Glitter
- All results within 1.5% of MERIS official calibration
  - best result ever seen with these methods
- No significant variation with time

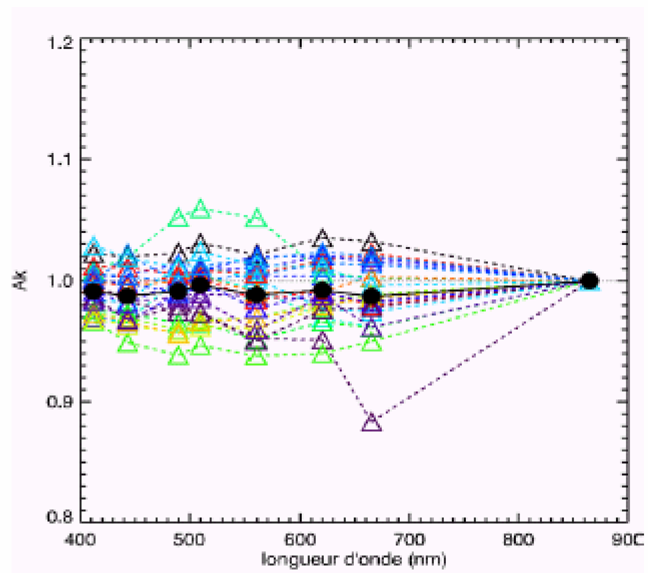
Vicarious radiometric calibration using SIMBADA network (3)



POLDER-2



MERIS

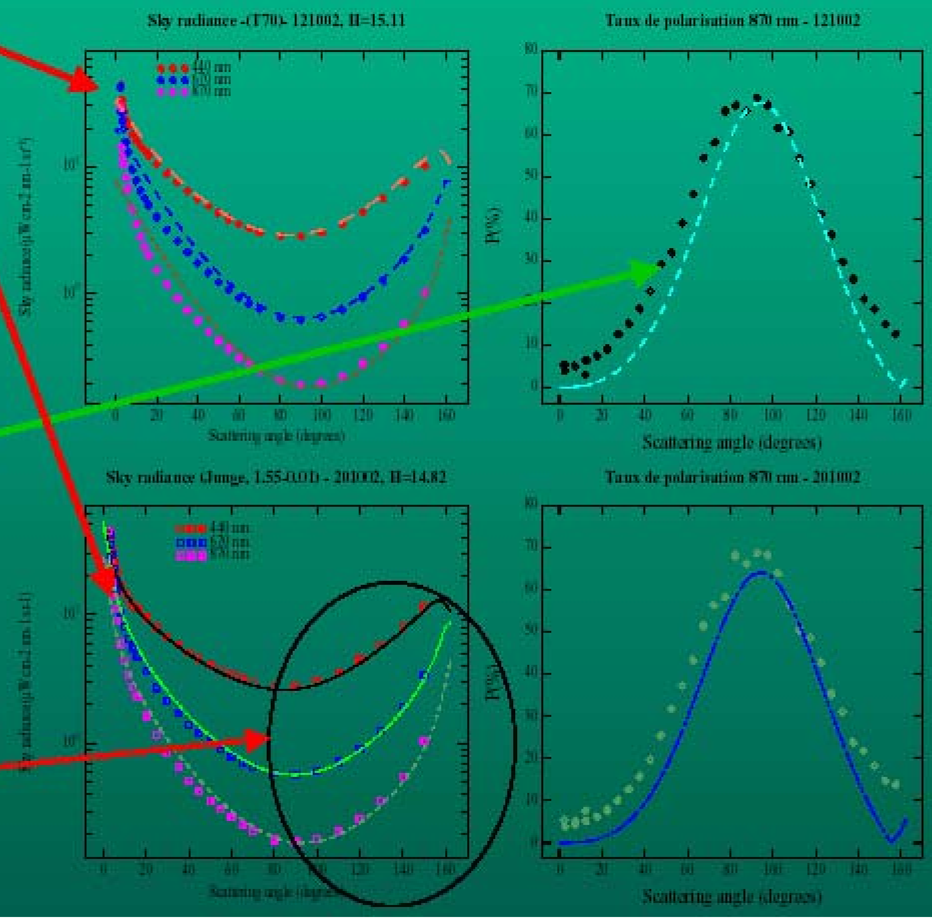


Example of the retrieval the aerosols properties

Sky radiances (measured : dots; computed : dashed line)

Polarization rate (measured : dots; computed : dashed line)

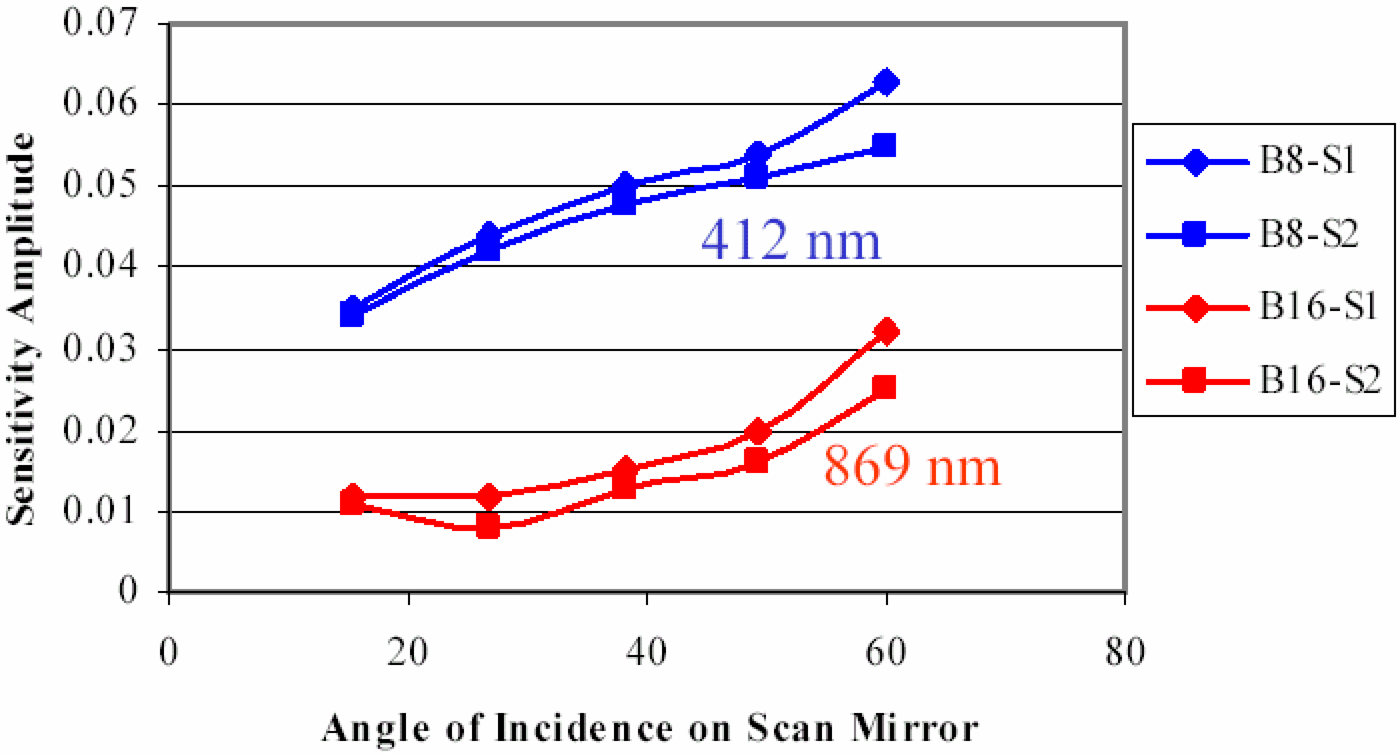
Best fit is estimated on the basis of scattering angles > 90°



How large are a and δ? How large is P?

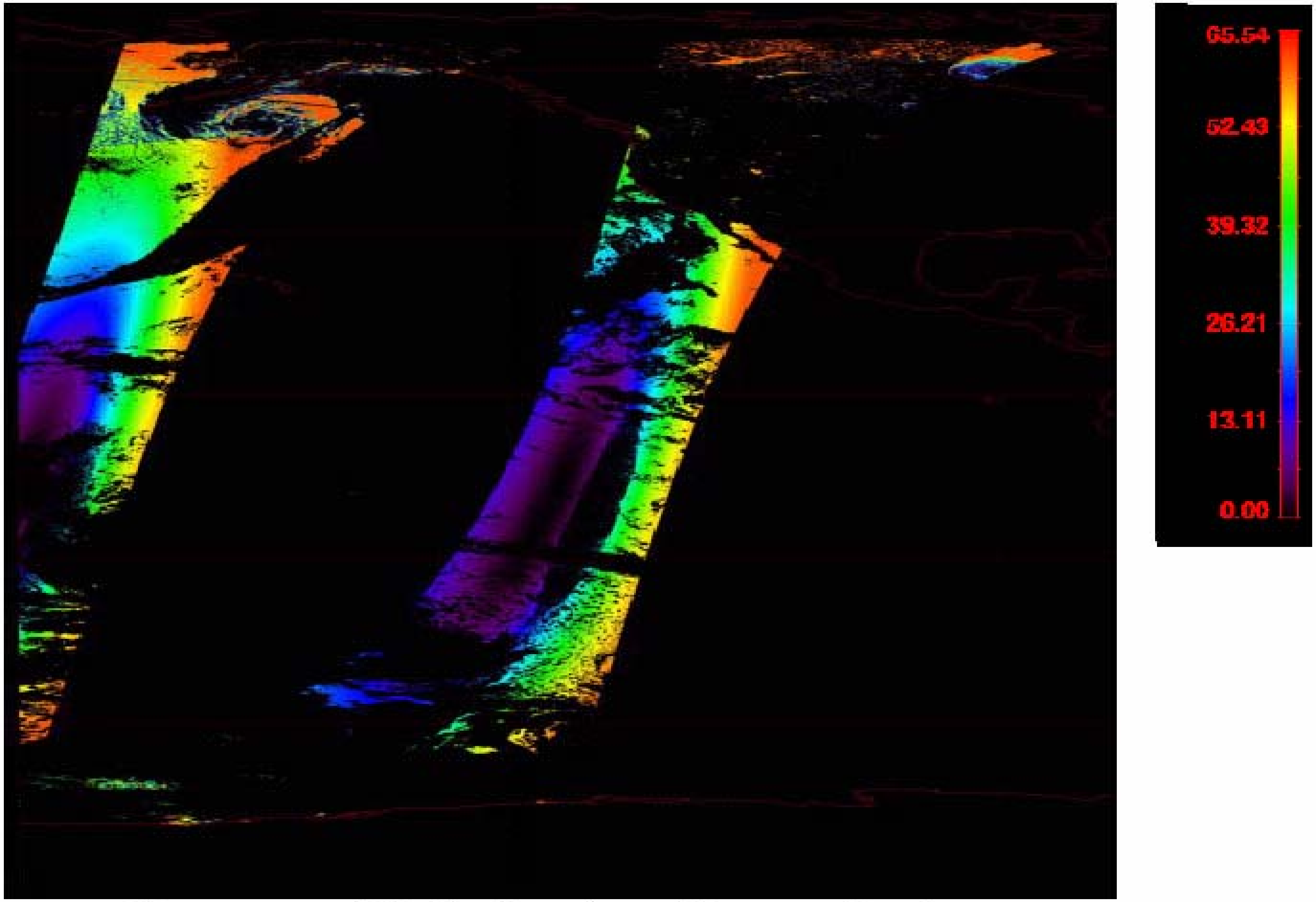
Physics

TERRA/MODIS



Physics

Rayleigh Component Only



Degree of Polarization (December)