Multi-sensor data base over desert sites for calibration purpose

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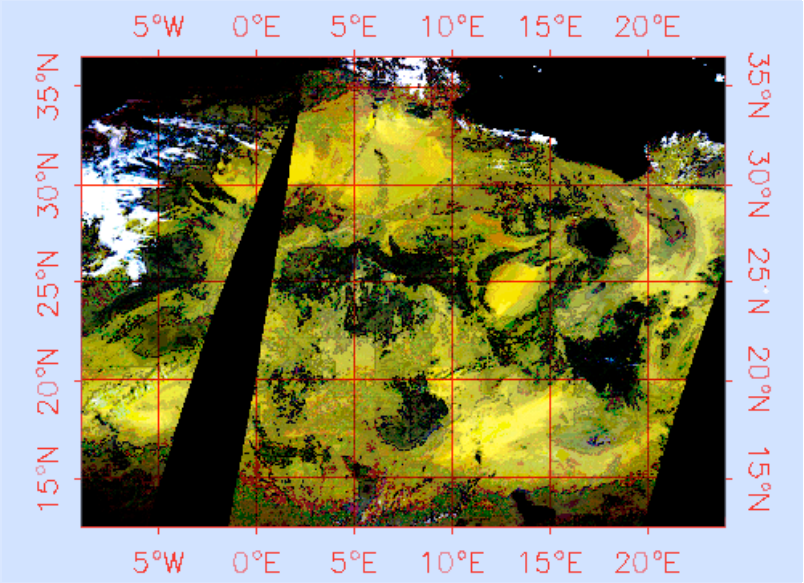

Outline

Introduction

SADE database

Calibration method

Some results

Desert characterization

Conclusion

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Introduction (i)

Initial objectives :

- **In orbit vicarious calibration to assess :**
  - **Multiangular calibration (detectors normalization in the f.o.v.)**
  - **In time calibration monitoring (on-board calibration verification)**
  - **Intercalibration of sensors**

Main characteristics of the requested sites :

- **Stable in time : no vegetation…**
- **Easy to access : low cloud coverage, good atmospheric conditions**
- **High reflectance : to reduce the impact of atmospheric effects**
- **Low directional effects**

⇒ Choice : Desert sites

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Introduction (ii)

Sites selection :

- **Spatial uniformity**
  - **Better than 2% for 100x100 km^2 area**
  - **Statistics using Meteosat acquisitions**
- **Stability over time (seasonal effect)**
  - **Stability better than 20% (after atmospheric effect filtering)**
  - **1 year of Meteosat data (1 per day)**
- **Low directional effect**
  - **Directional effects less than 15%**
  - **1 month of AVHRR data completed with Meteosat data**

Sites characterization :

- **Ground truth measurements in Algeria (1993)**

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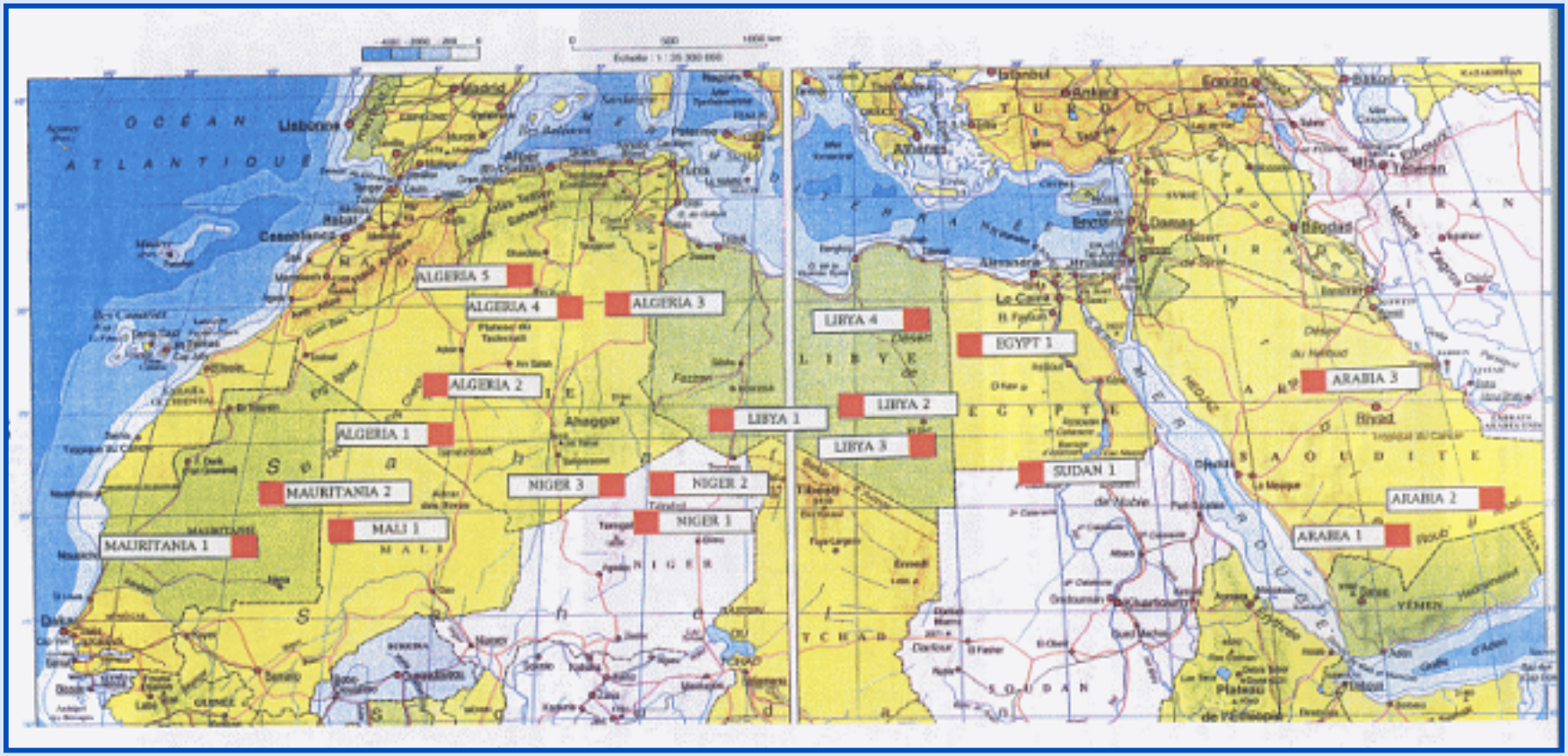
Introduction (iii)



20 sites selected over North Africa and Arabia

SADE Data Base (i)

Systematic collect of satellite acquisitions over the 20 sites :

- ***POLDER 1*** **(oct. 1996- june 1997) –** ***POLDER*** **2 (2003)**
- **Since 1990 : 'some' SPOT high resolution**
- **Since 1998 :** ***SeaWiFS, VEGETATION 1 & 2, AVHRR 14 & 16***
- **Since 2001 :** ***MERIS, MODIS***

  + ***MISR, ATSR2, AATSR…***

  + Meteo data

Storage in a data base :

- **SADE data base : "Structure d'Accueil de Données d'Etalonnage"**
- **Easy data management**
- **Link between satellite measurements and calibration results (traceability)**

Nota : the SADE data base also includes calibration measurements over ocean, sun glint, clouds and snowy sites.

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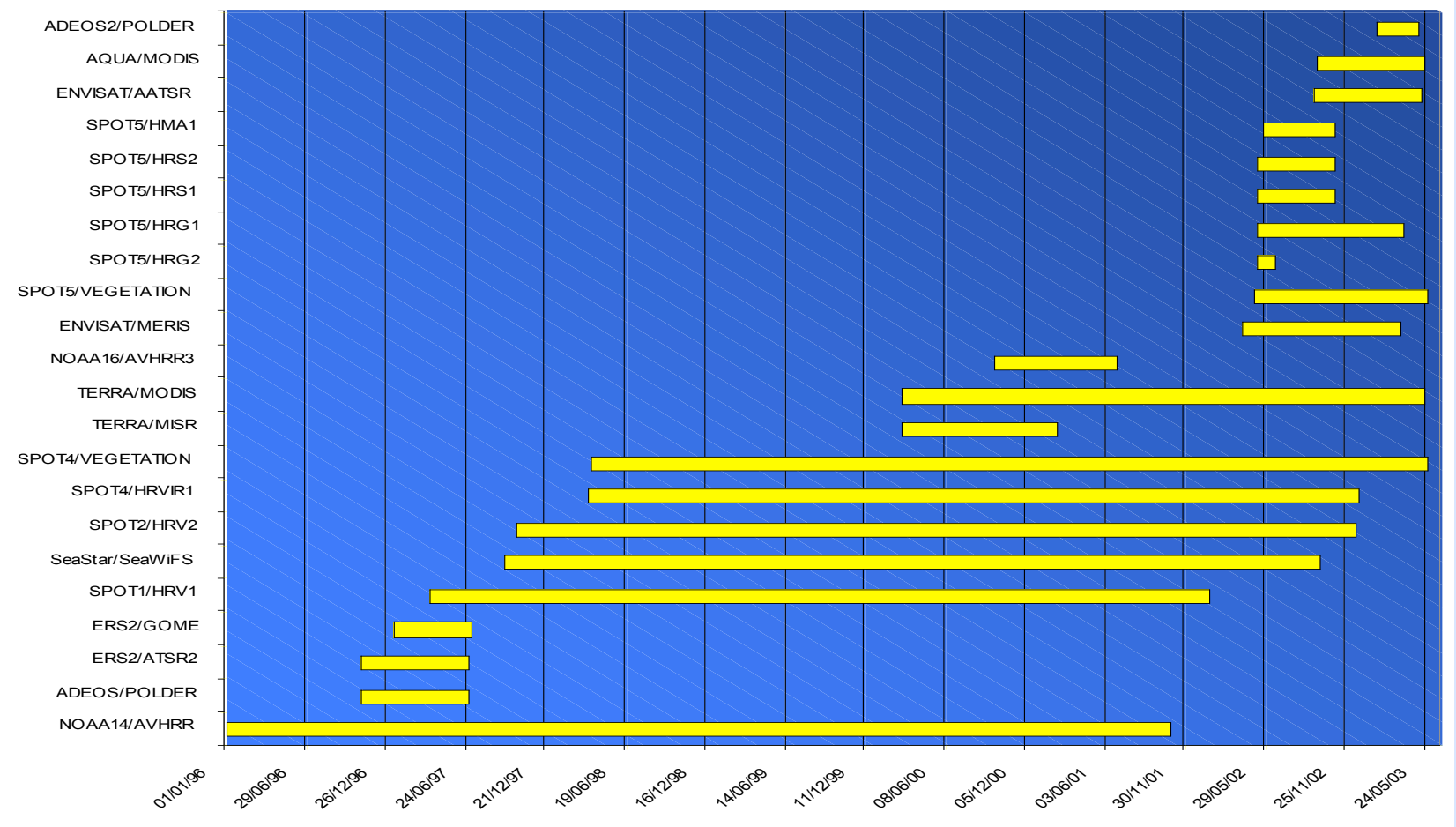
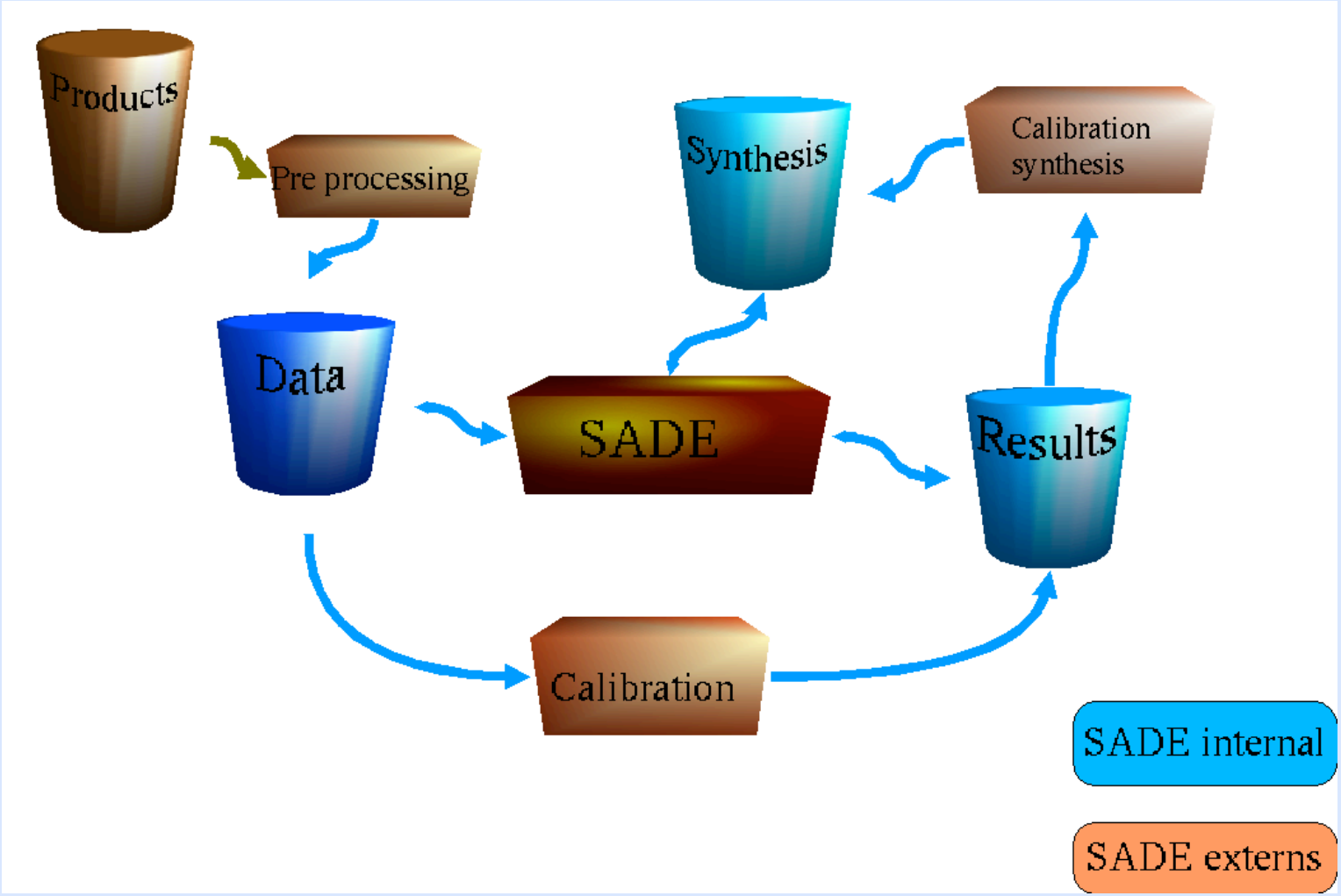
SADE Data Base (ii)



More than 150000 multispectral acquisitions available in SADE

SADE Data Base (iii)



Structure of the SADE data base

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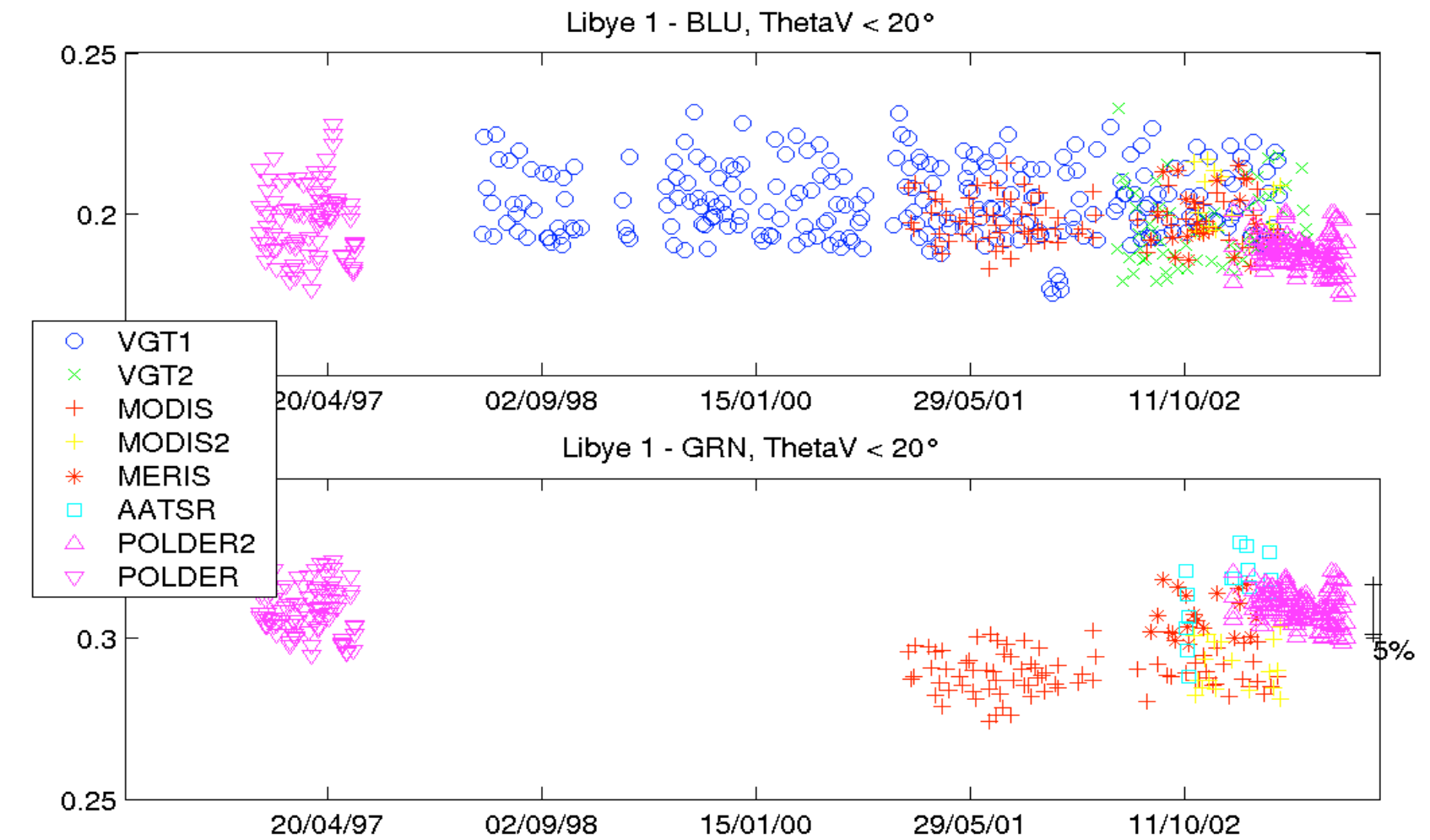
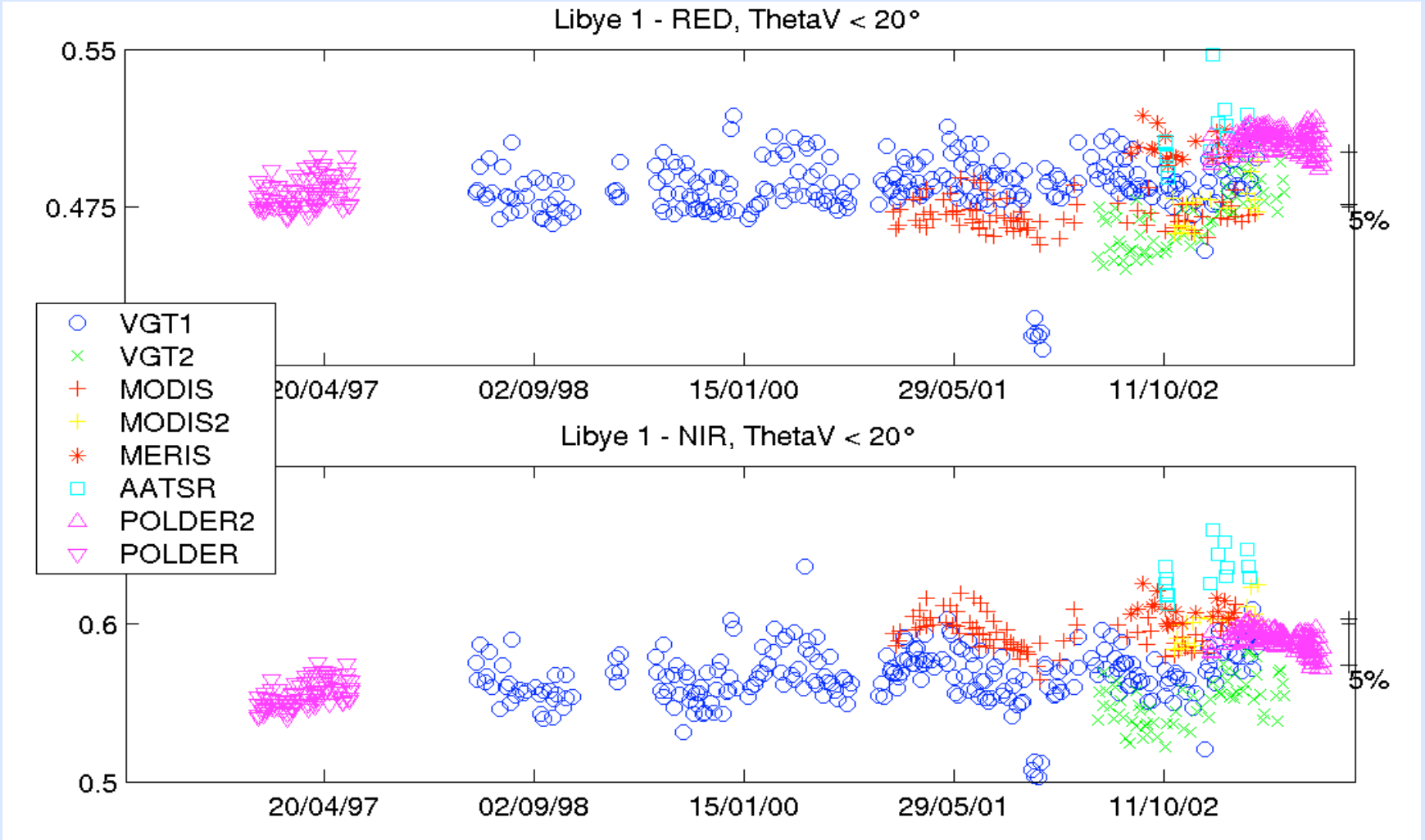
SADE Data Base (iv)



ToA reflectance comparison

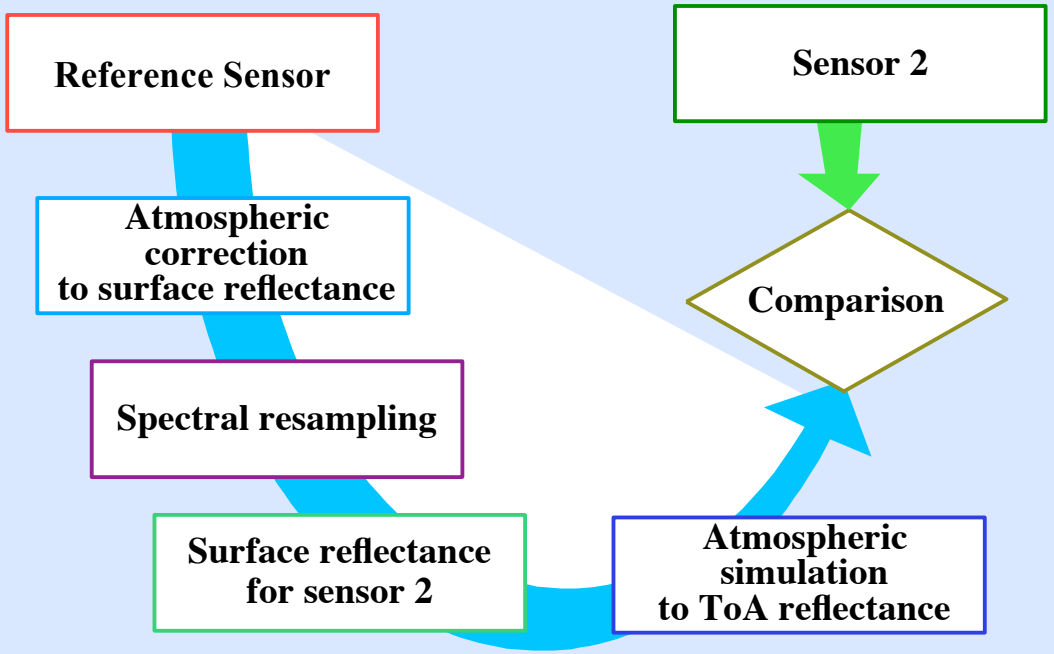
SADE Data Base (v)



ToA reflectance comparison

Calibration method (i)

- **Compare two sensors :**
  - **One sensor as reference**
  - **Comparison at TOA level**
- **Needs accounting for:**
  - **Directional effects**
  - **Atmospheric conditions**
  - **Spectral discrepancies**



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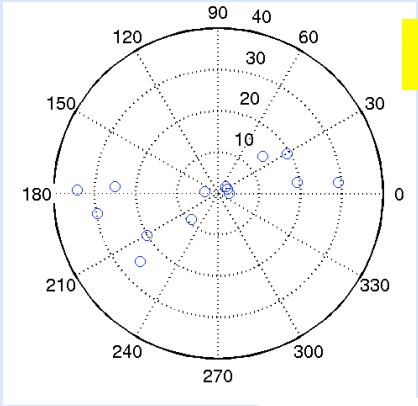
Calibration method (ii)

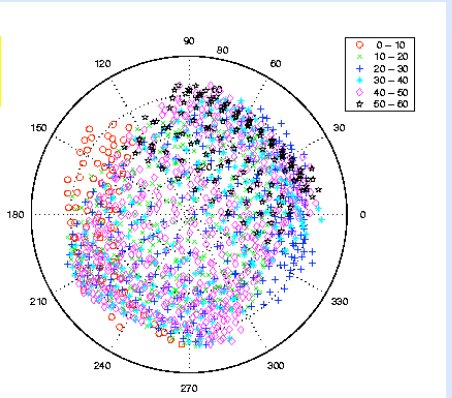
Directional effects :

- **Direct comparison of measurements in the same geometry**
- **Use of reciprocity principle to extend field of matching geometries**

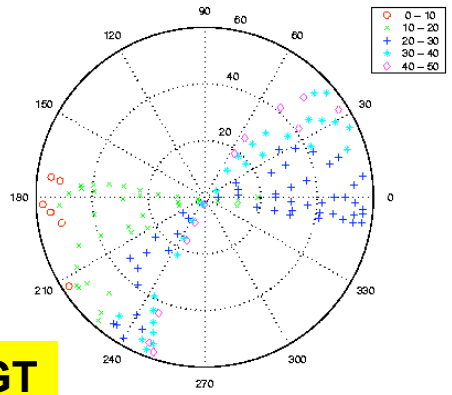


MERIS

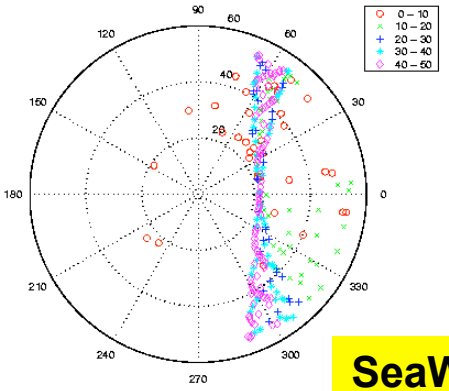
POLDER



Available geometries for Libya 1



VGT



SeaWiFS

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Calibration method (iii)

Atmospheric correction :

- **Atmospheric correction performed using SMAC and meteo data :**
  - **Rayleigh scattering correction**
  - **Water vapour**
  - **Ozone**
  - **Other contributors : CO2, CO, NO2, CH4 (constant values)**
- **Problem : aerosol correction…**
  - **Desert model**
  - **Aerosol optical thickness Tau =0.2**
- **Comparison performed at ToA level**
  - **Reference sensor ToA data are corrected to obtain ground reflectances**
  - **ToA Sensor 2 reflectances are simulated using these ground reflectances and meteo data at the date of Sensor 2 acquisition**

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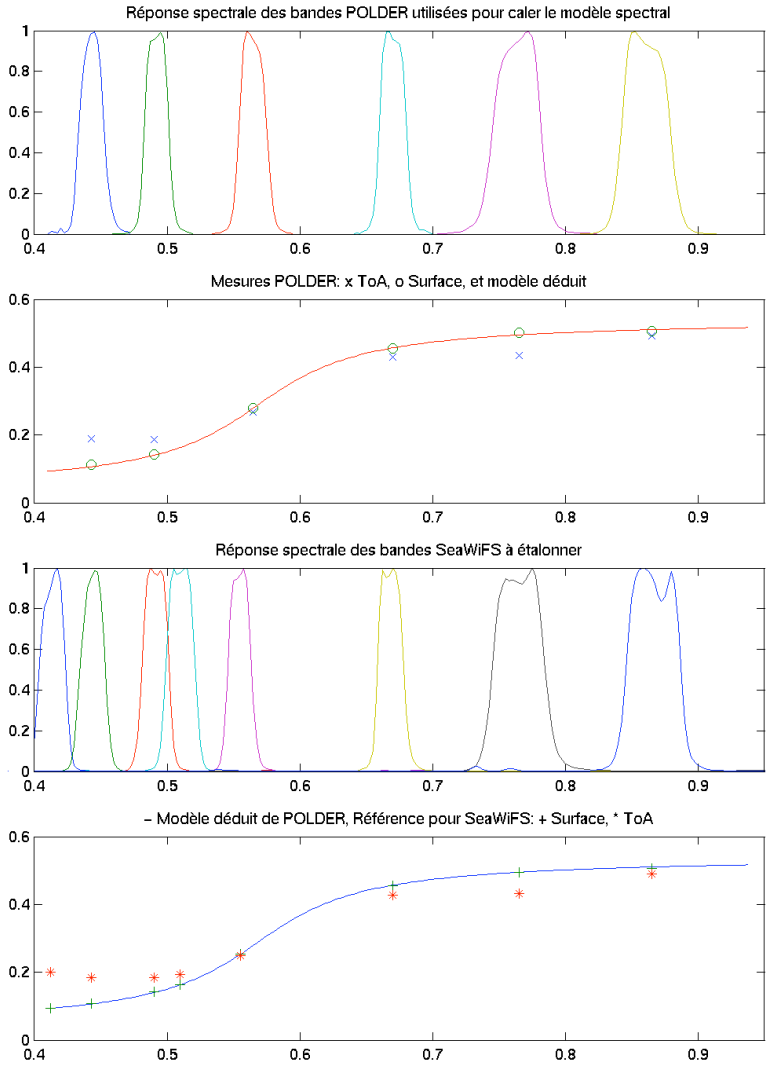
Calibration method (iv)



Spectral resampling :

- **Performed after atmospheric correction**
- **Reference sensor measurements used to fit an empirical spectral model (4 parameters) :**

$$Ro = A \arctan[\, a\, (\lambda - \lambda_0)\,] + B$$

- **'Arctan' model integrated in the Sensor 2 spectral bands**

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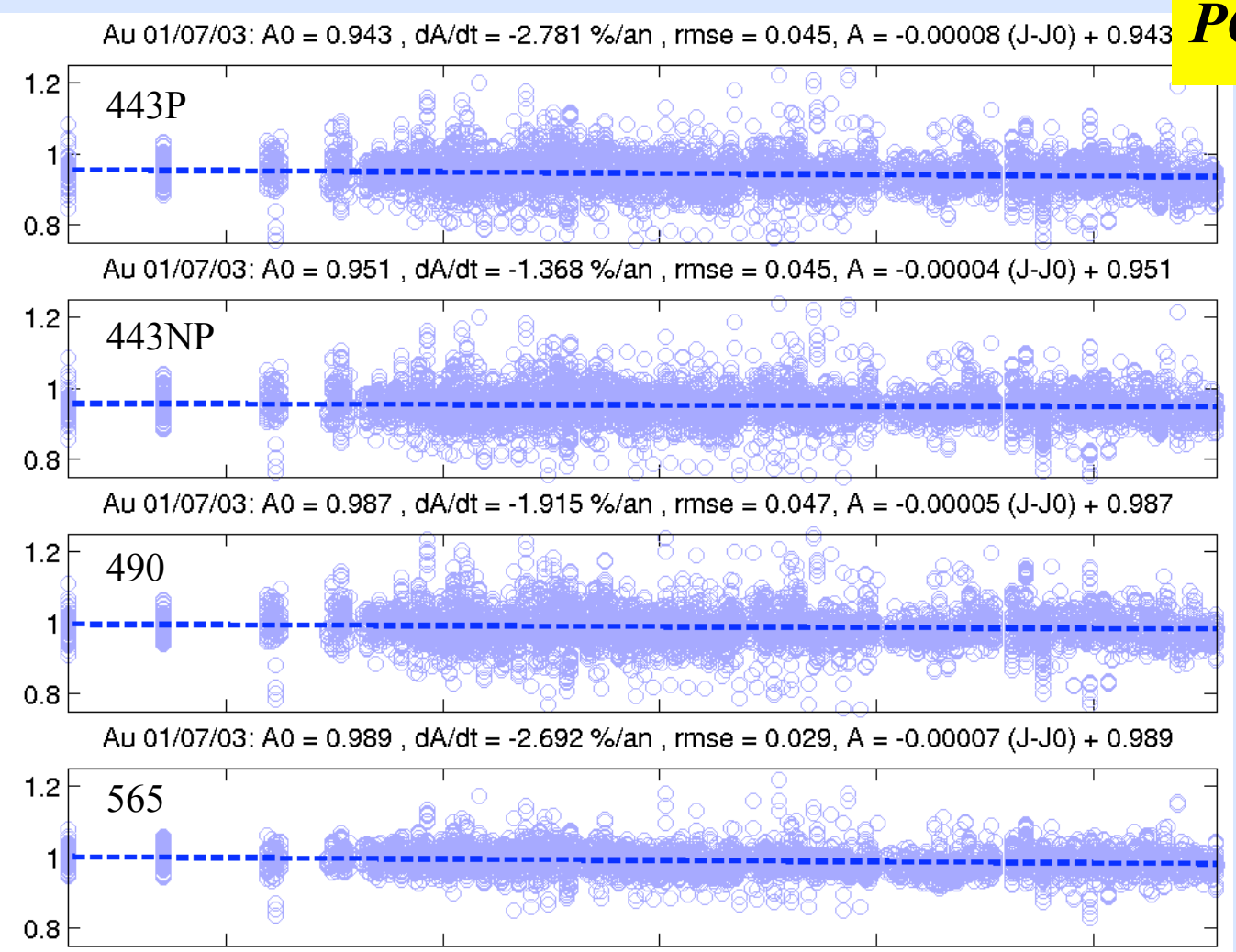
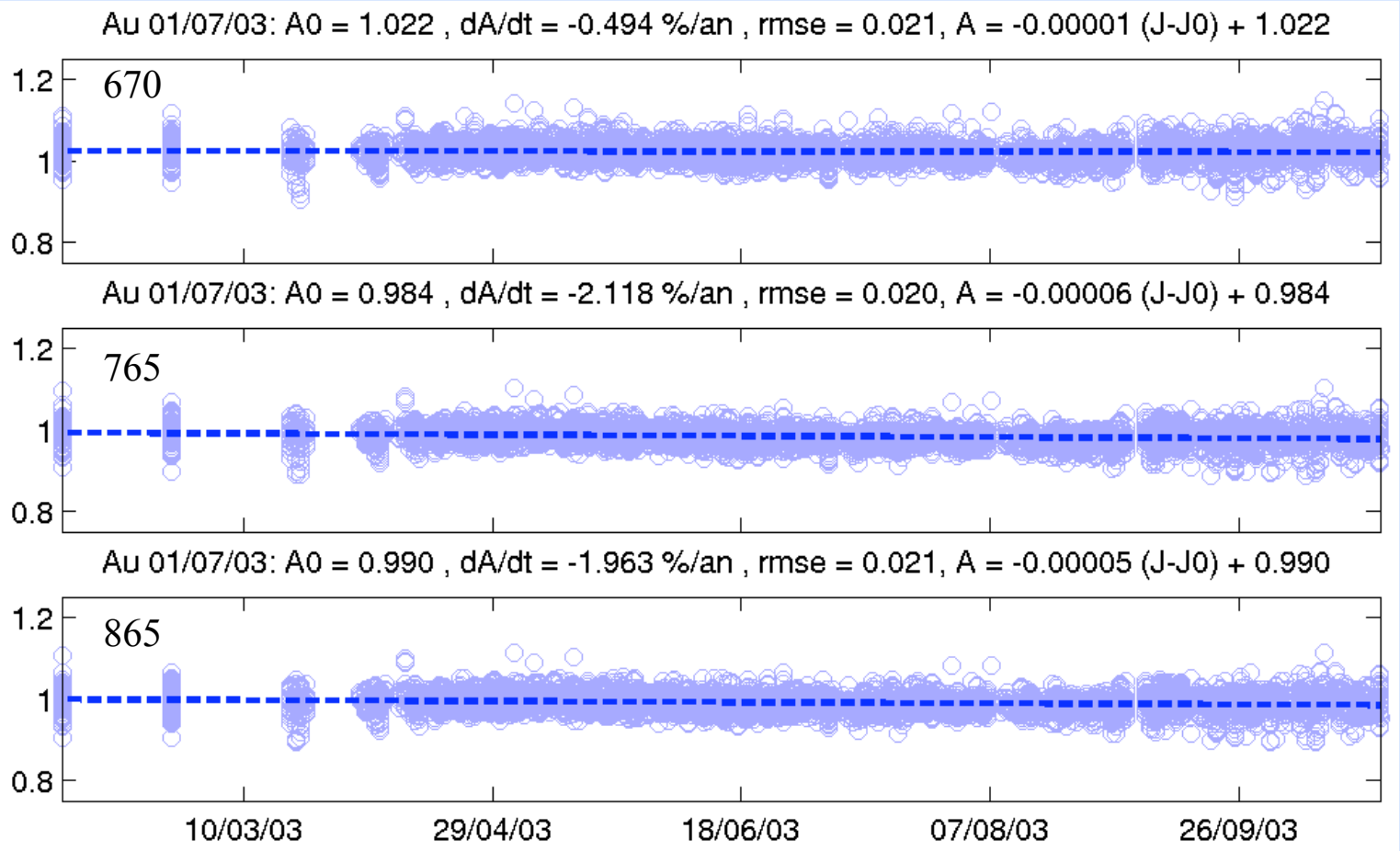
Some results (i)

POLDER2* vs *POLDER1



Some results (ii)

POLDER2* vs *POLDER1



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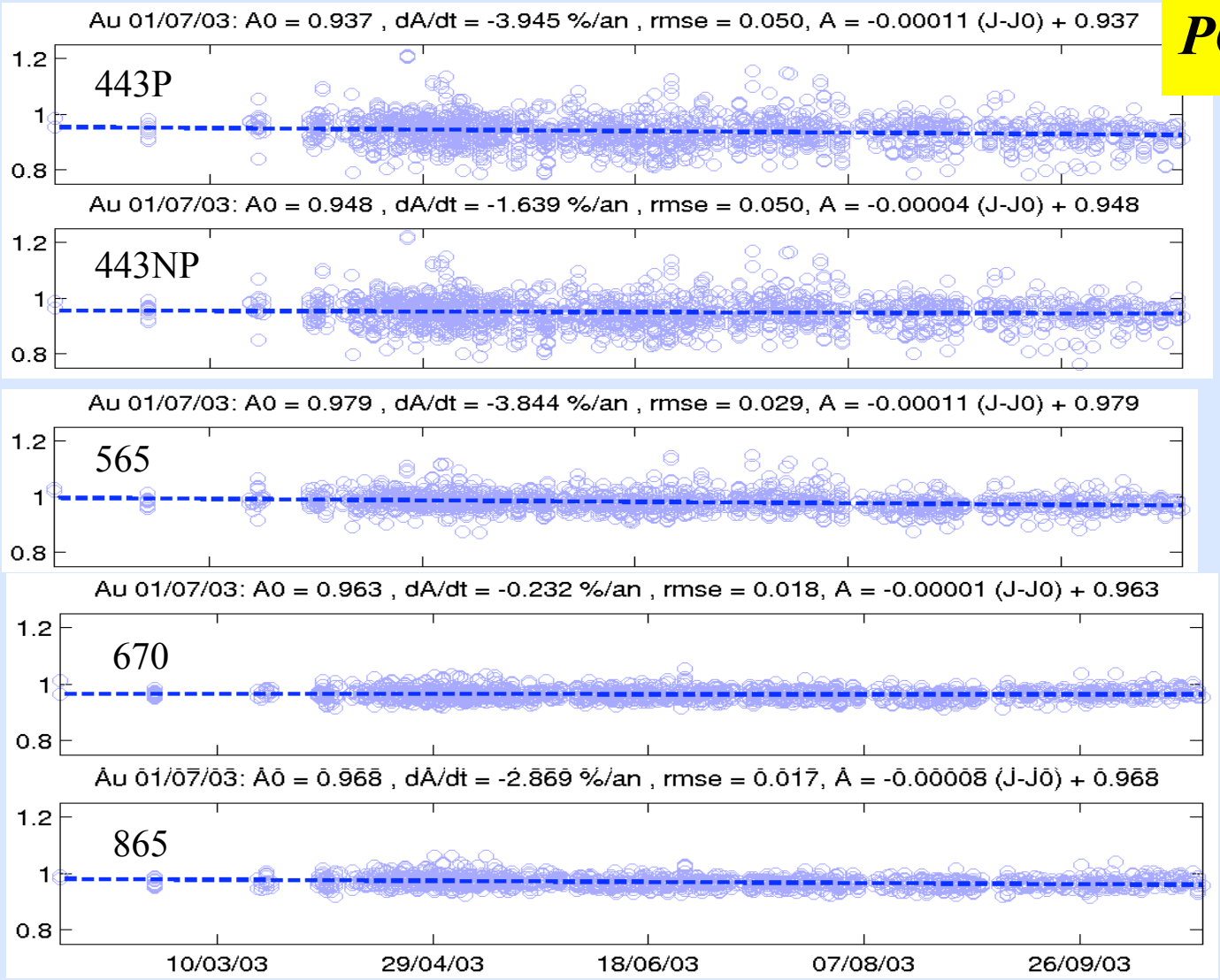
Some results (iii)

POLDER2* vs *MODIS



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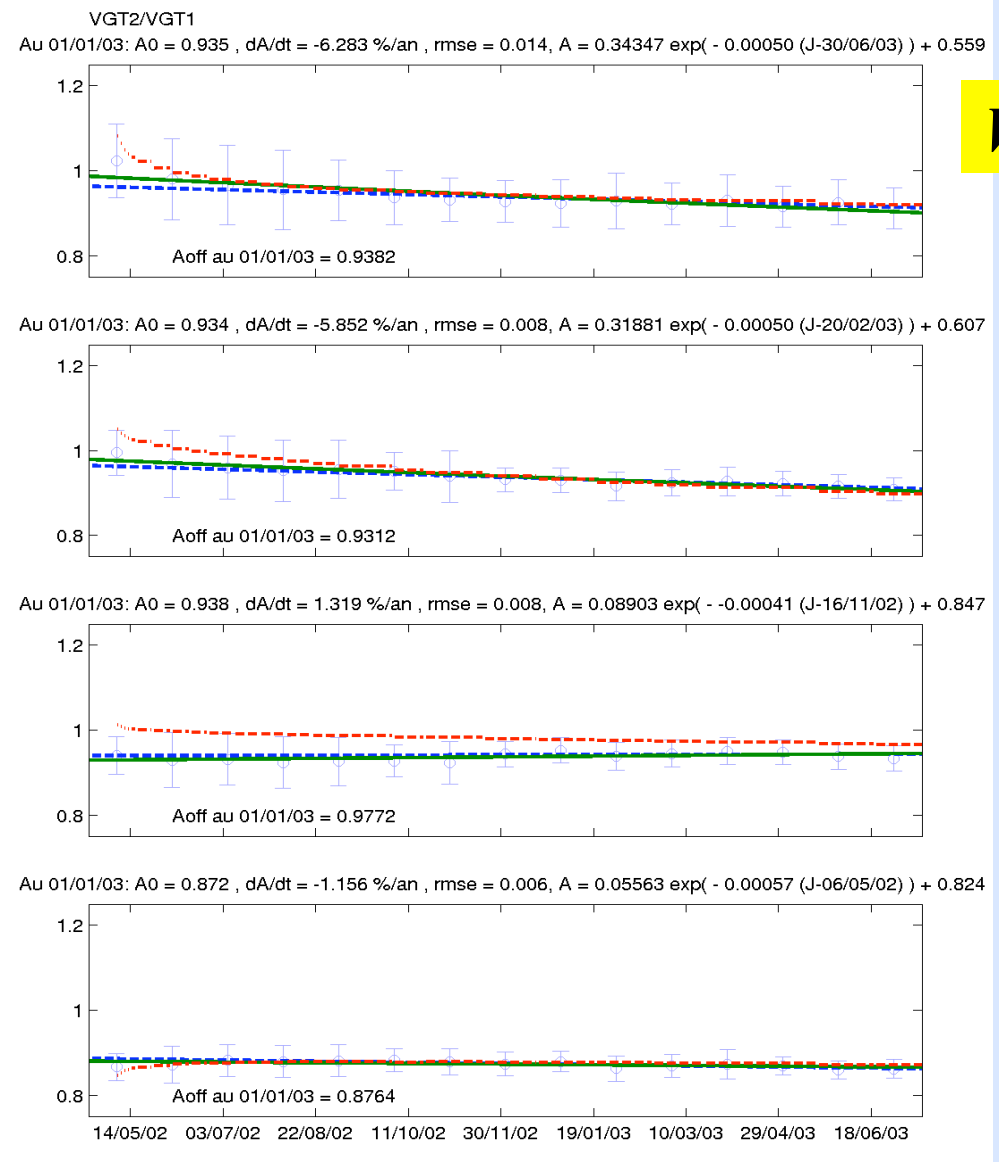
Some results (iv)



VGT 1* vs *VGT 2

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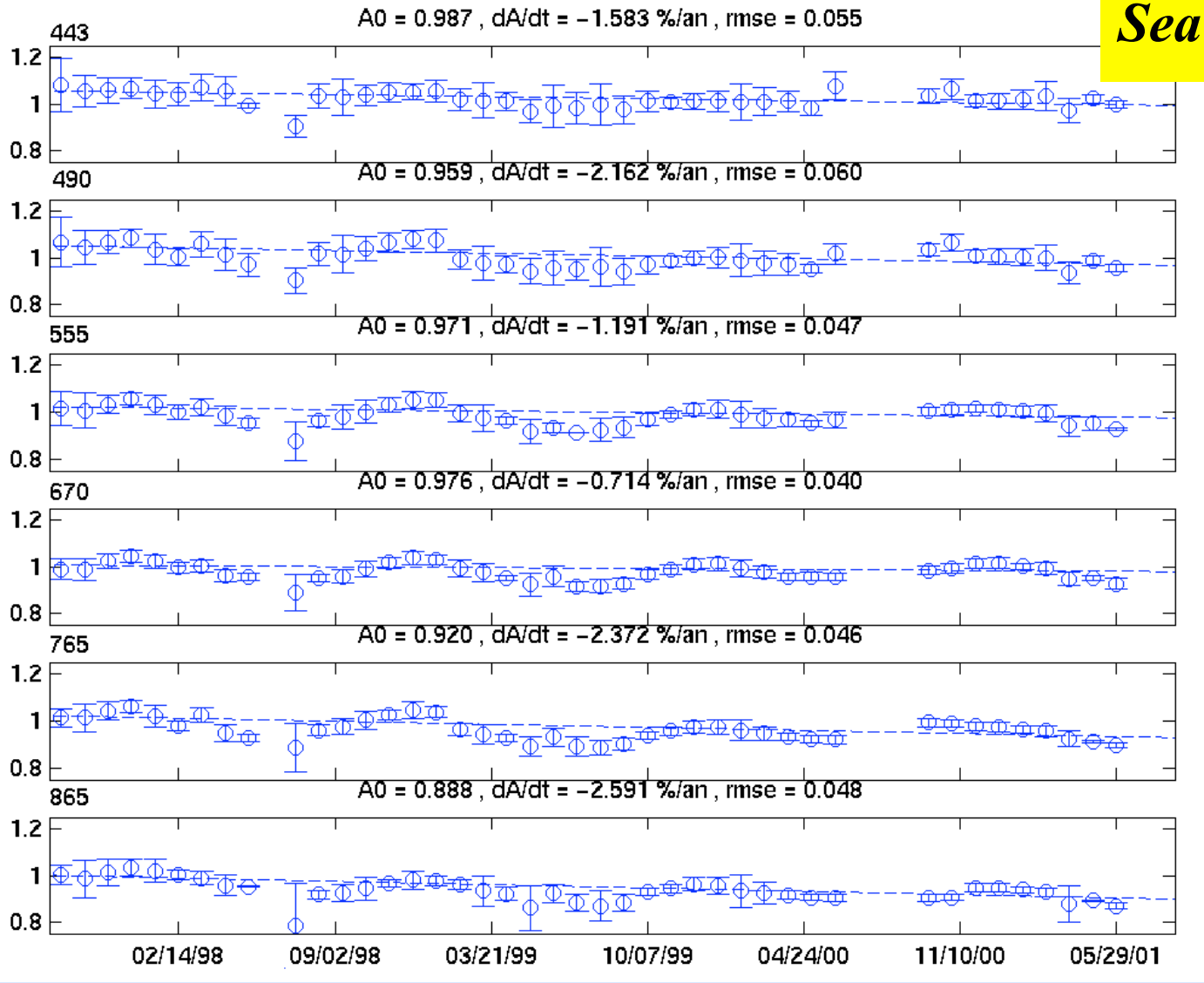
Some results (v)

SeaWiFS* vs *POLDER

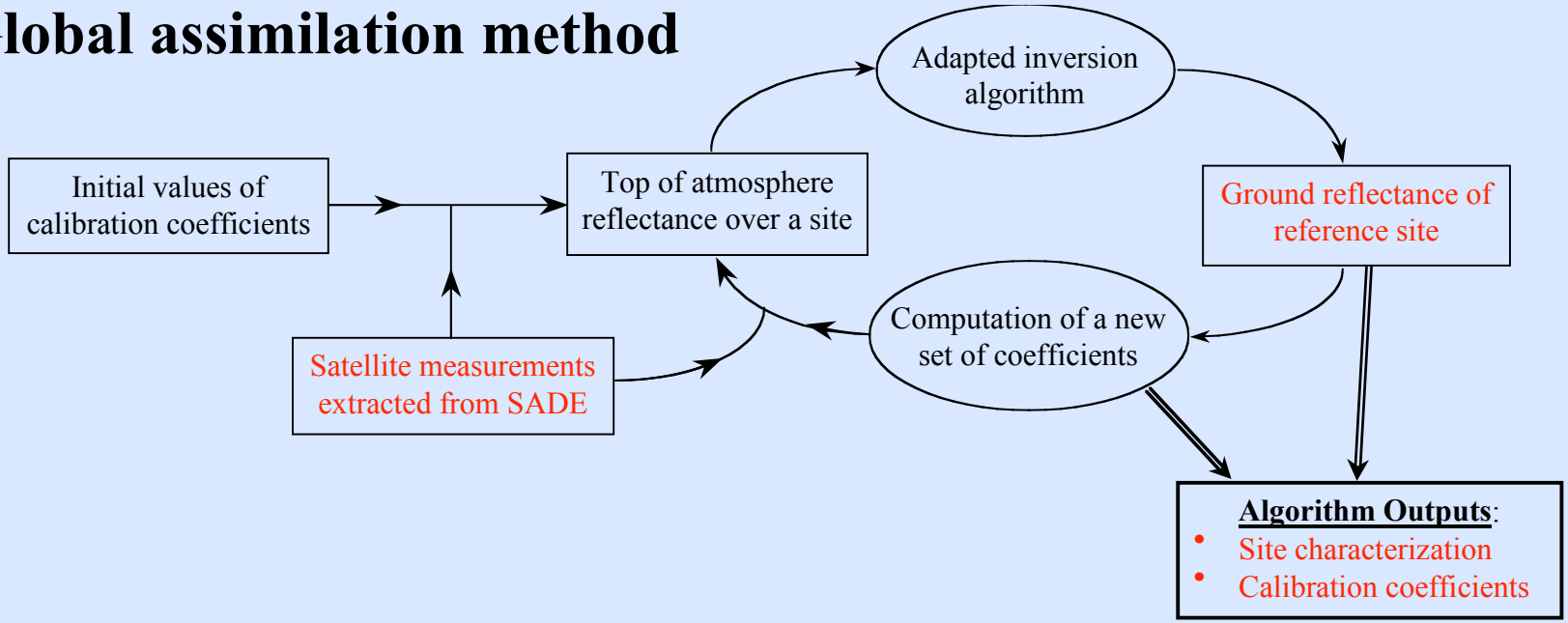


Desert characterization (i)

Objective : Use of SADE data to characterize the desert sites behavior

- **First step : spectral characterization**
- **Second step : directional characterization**
- **Finally : spectral and directional model**

How : Global assimilation method



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Desert characterization (ii)

Problem :

- **Characterization of the desert reflectance using a large number of satellite data coming from different instruments (and spectral bands)**

Method :

- **Initial assumptions :**
  - **Atmospheric parameters are known (SADE)**
  - **Sensors are inter-calibrated**
- **Determination/choice of a spectral or directional model**
- **Development of an adjustment algorithm able to deal with data of various origins (reflectance integrated in the spectral bands)**

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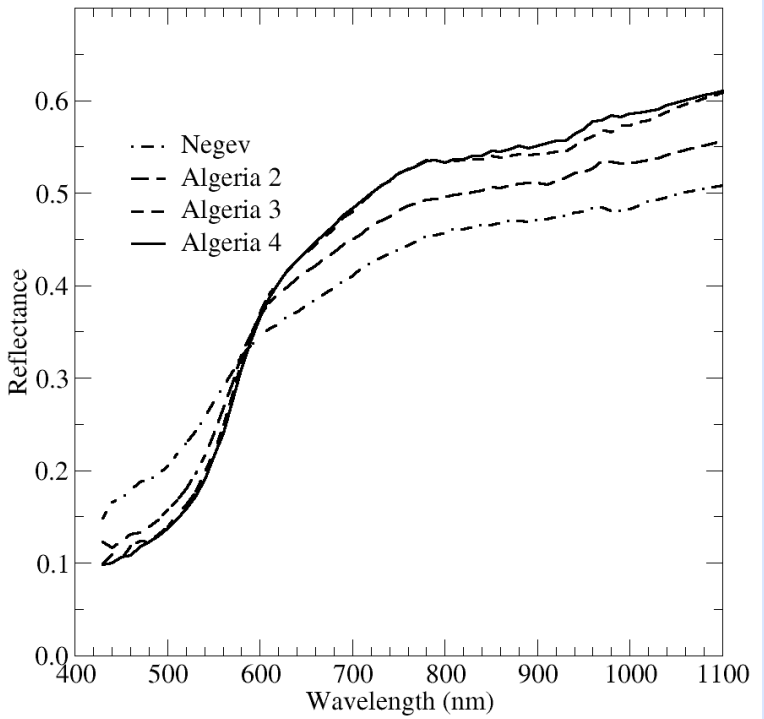
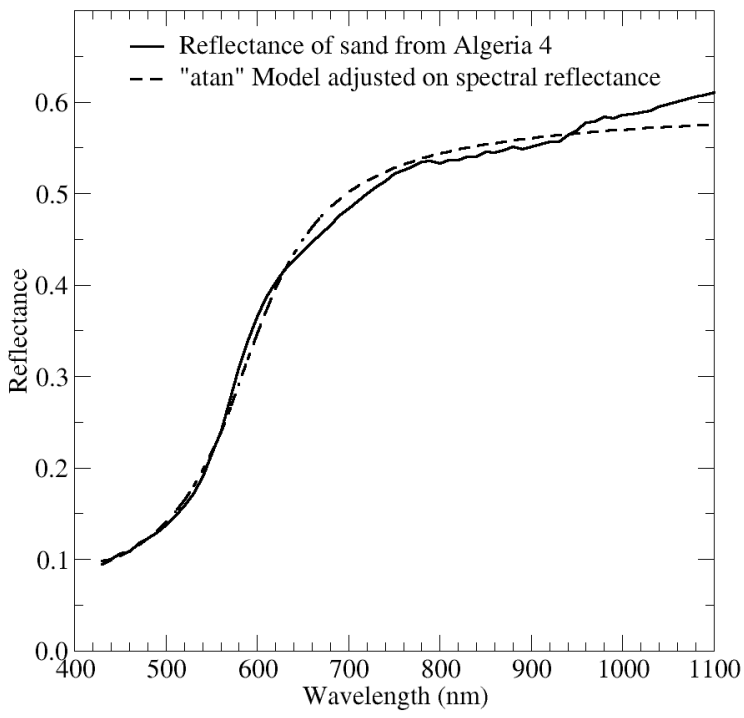
Desert characterisation (iii)

First step : spectral characterization

- **Determination of an ad-hoc spectral model of sandy desert from desert samples characterized with ONERA devices**



=> use of a simple « arctan » model (4 parameters)



Typical spectral behaviour of desert sand

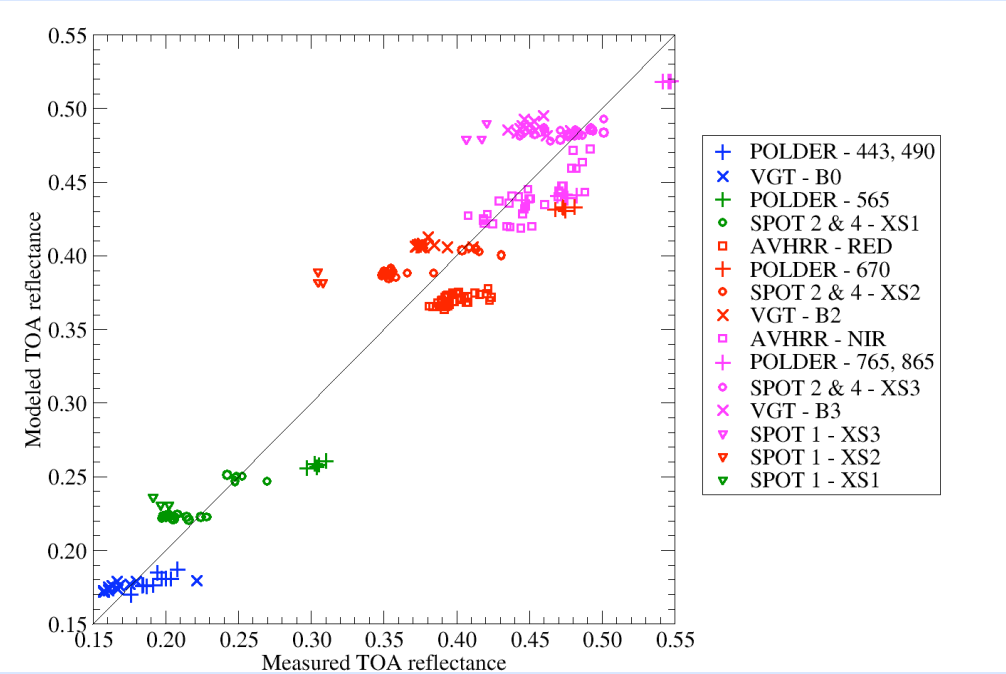
Desert characterisation (iv)

Fit of the model with a satellite data set over Libya 1:

=> use of POLDER, VGT, SPOT and AVHRR data

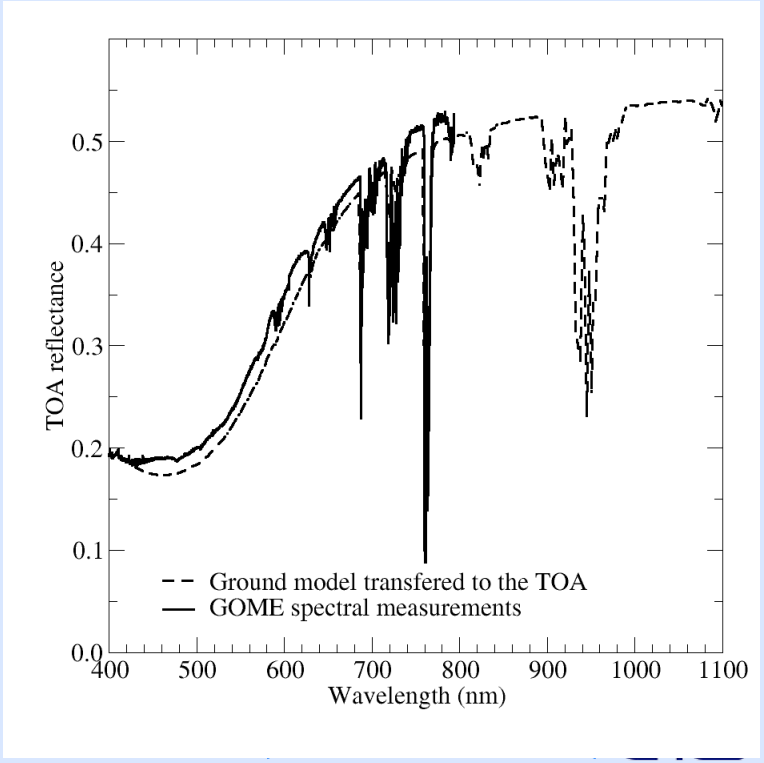
Adjustment:

the simulated TOA data using the adjusted ground model are compared to original data



Comparison with GOME:

the adjusted model is transferred at TOA and is compared to a GOME acquisition

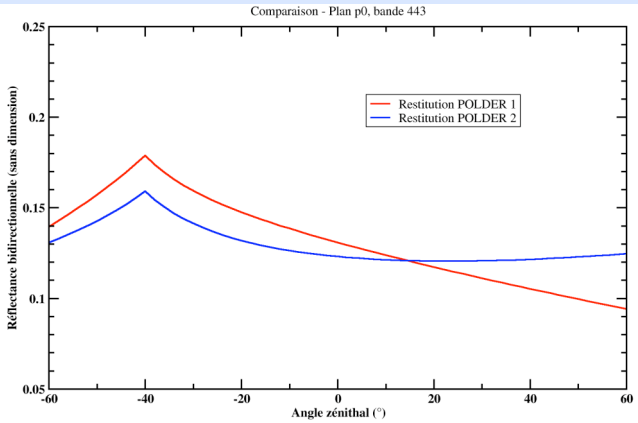


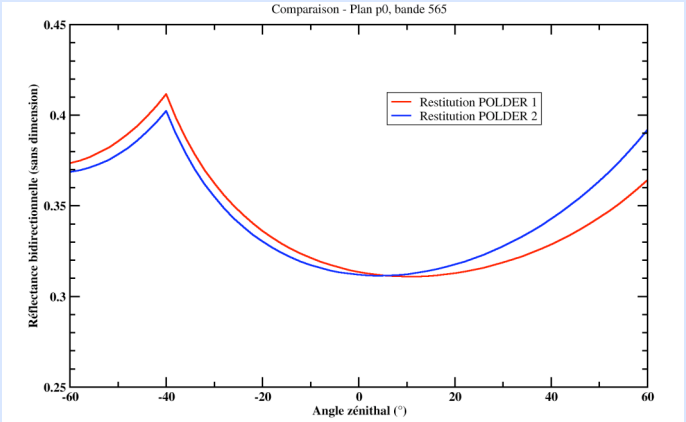
Desert characterisation (v)

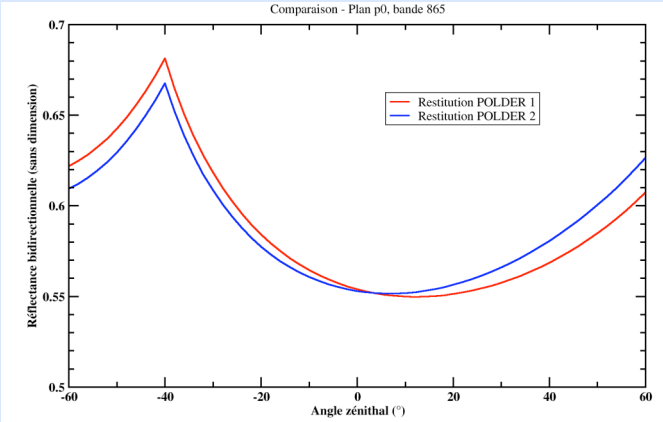
<u>Second step : directional characterization</u> (study in progress)

- **Use of a Rahman directional model**
- **Fit of the model using satellite data (at ToA level)**

<u>First results are encouraging</u> :







Comparison of directional model obtained over Libya 1 using separately *POLDER 1* and *POLDER 2* data (principal plan for θ_s=40°)

Conclusion and perspectives

Site characterization improvement

- **Finalize current studies on desert directional characterization**
- **Establish spectral & directional model for each site**

Atmospheric correction improvement

- **Set up a CIMEL photometer on one site to improve the aerosol correction (probably in Libya)**

Extension of the data base

- **Continue the collect of satellite data over the sites (long term series + new sensors)**

Open the data base to other users

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