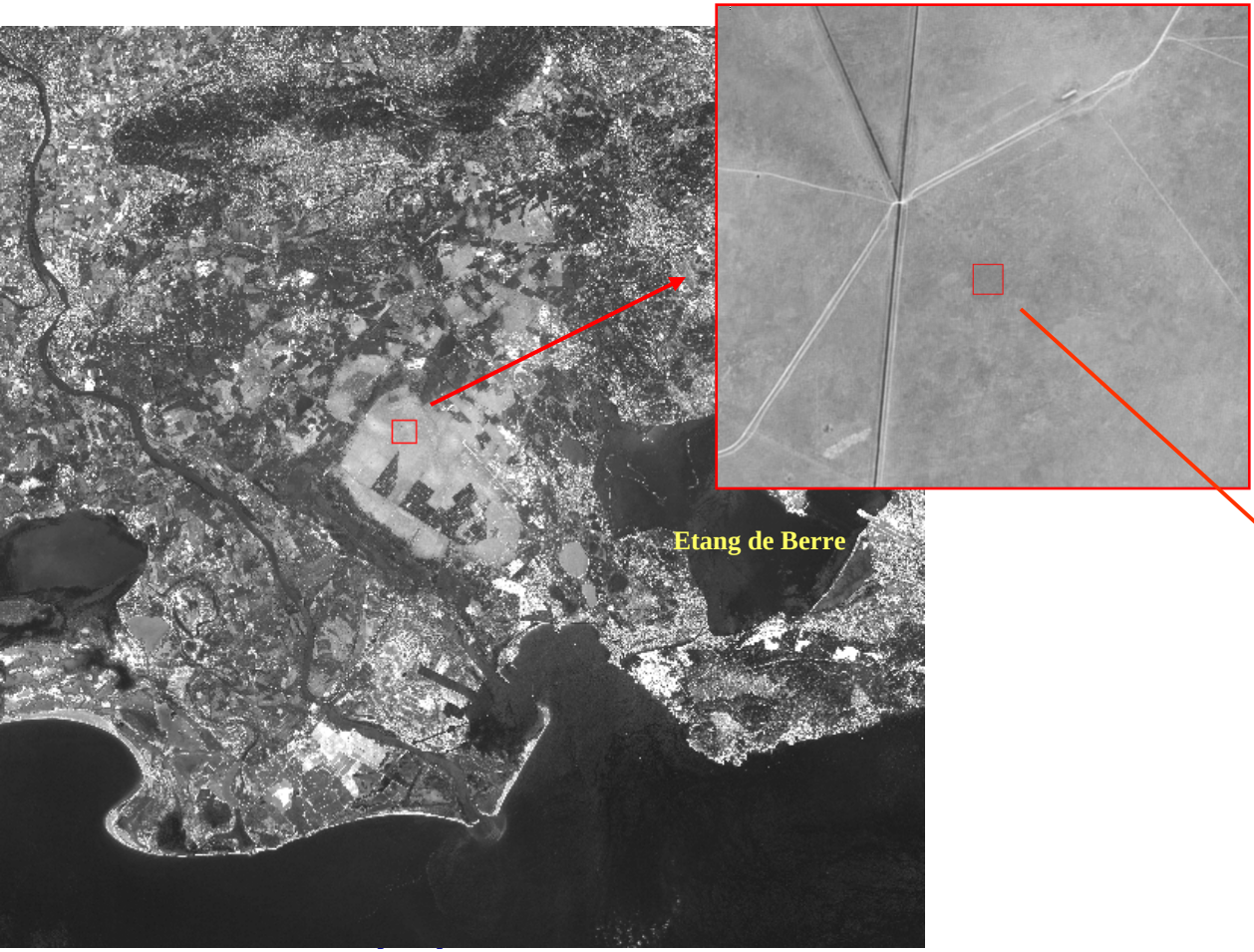
La Crau - ROSAS

(RObotic Station for Atmosphere and Surface)

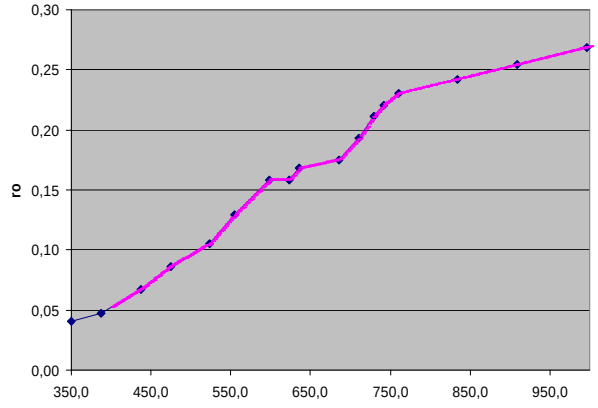
P. Henry - A. Meygret



La Crau, SPOT5 THR

The calibration site

- Situation: La Crau
  - located South-East of France (lat. = 43.56° ; long. = 4.86°)
  - rather good surface stability (dry area with small rocks)
- Calibration historic
  - first CNES campaign in march 1989 (coop. with LOA and INRA)
  - 9 SPOT 1 calibrations (1989 ⇒ 1993)
  - In 1994 : decision to develop an automatic calibration station



The calibration instrument

- CIMEL Instrument
  (derived from AERONET one)

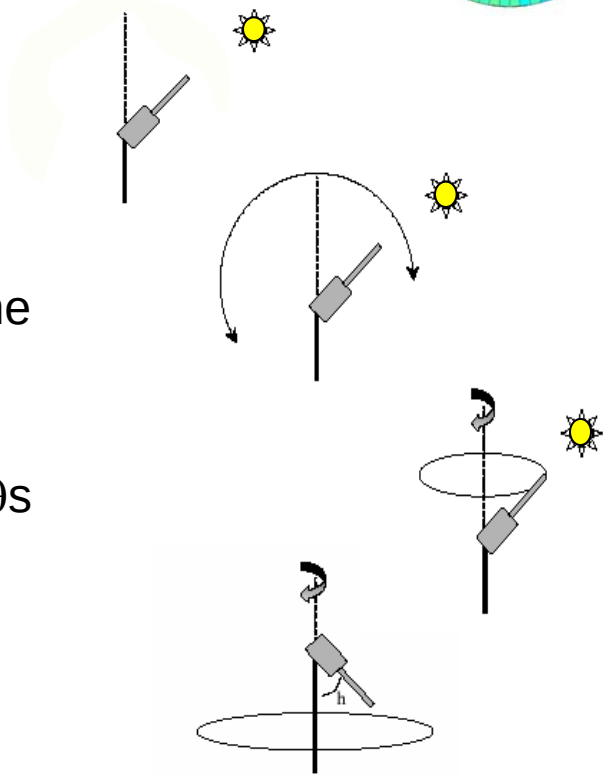
- Filters wheel : 8 filters + 1 dark plate
- 2 collimators and 2 detectors: Si and InGaAs

#	1	2	3	4	5	6	7	8	9	10	11	12	13
λ(nm)	870Si	1600 InGaAs	670Si	1020 InGaAs	550Si		440Si		380Si	870InGaAs	1020Si		937Si

- Maintenance including calibration once a year

Measurements protocol

- « Sun » protocol
  - Direct sun view : extinction measurement
- « Principal plane » protocol
  - Sky radiance : measurements in the principal plane
- « Almucantar » protocol
  - Sky radiance : complete azimuth rotation for $\theta v = \theta s$
- « Ground » protocol (specific to this prototype)
  - Ground radiance measurements for different θv



⇒ Automatic and continuous acquisition :
first morning acquisition air mass<5 - last evening acquisition air mass>5

⇒ Complete measurement set every 90 min. : *SUN + ALM + PPL + GND (1st elevation) + SUN + GND (2nd elevation) +…+ GND (12th elevation) + SUN*

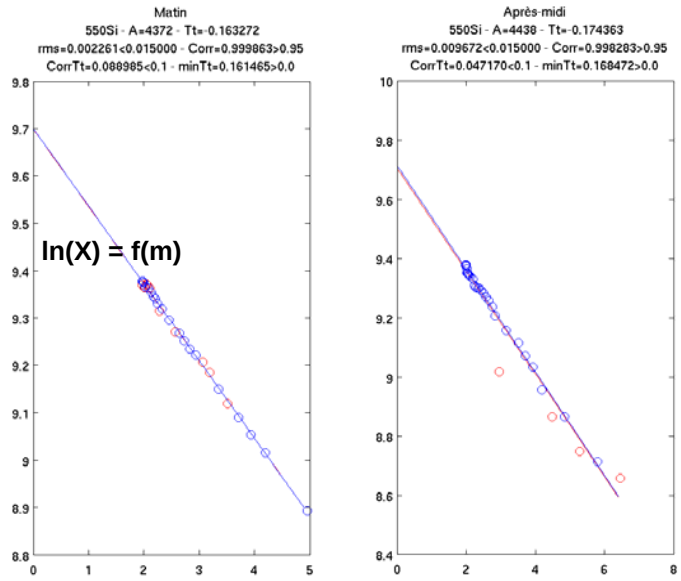
⇒ Transmitted to CNES every evening via a GSM link

Instrument calibration (1/4)

- Irradiance calibration
  - based on the Bouguer-Langley extinction law (all wavelength)

$$X_k = A_k * G_{uk} * I_k$$
(direct sun viewing)

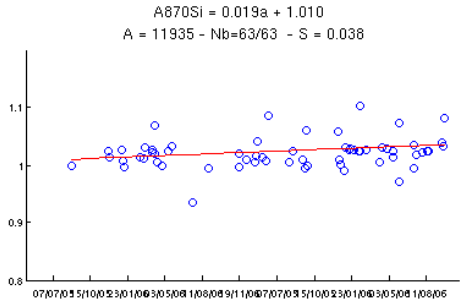
$$I_k = I_{0k} * (d/d_0) * \exp(-m.\tau_k)$$

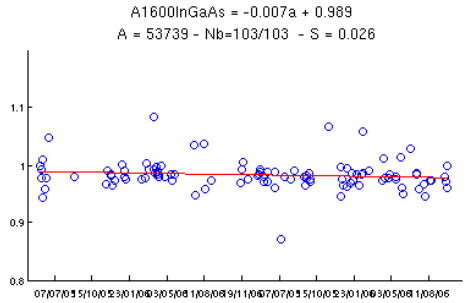


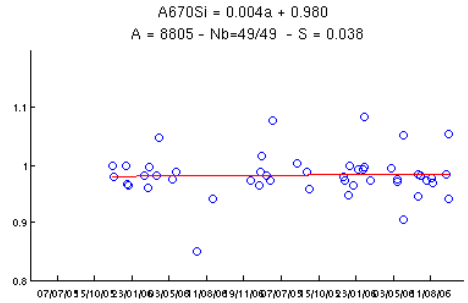
A_k = instrument irradiance calibration coefficient

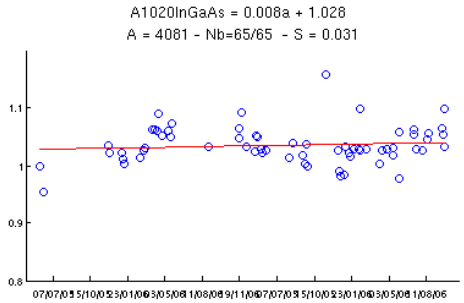
Instrument calibration (2/4)

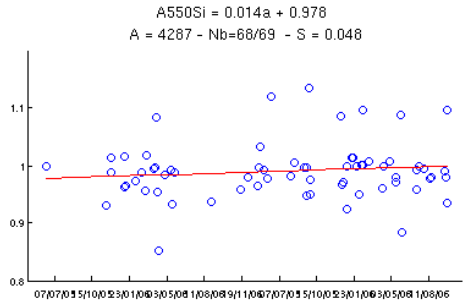
- Irradiance calibration performed every day : A_k monitoring

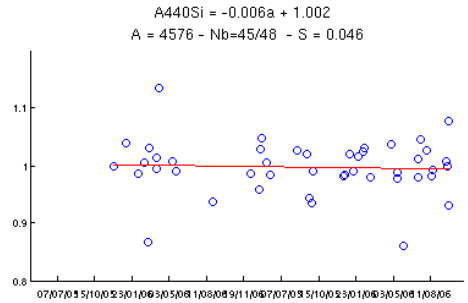


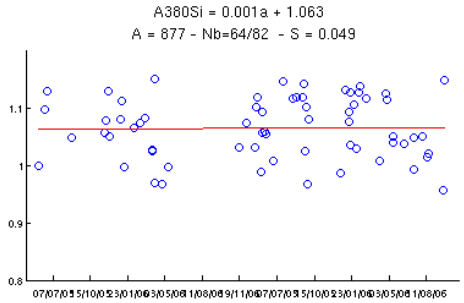


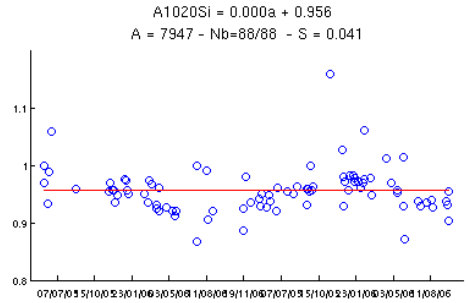












Instrument calibration (3/4)

- Radiance calibration
  - based on Rayleigh scattering for 380, 440, 550 nm bands

$$X_k = B_k * G_{kk} * L_k$$

(sky radiance in the principal plan)

L_k estimated using a radiative transfert code

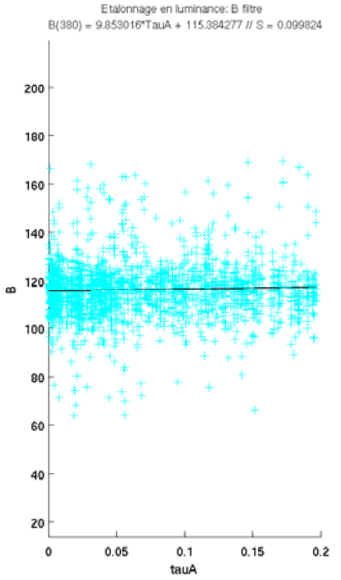
B_k = instrument radiance calibration coefficient

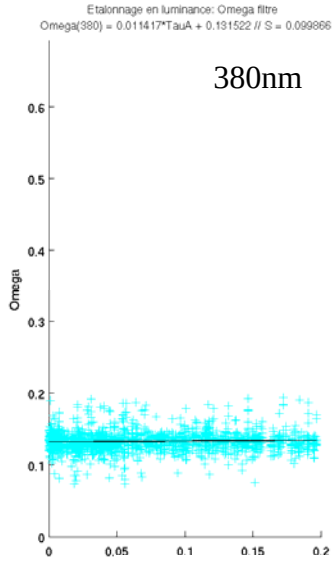
- $\Omega = B_k / A_k$: instrument solid angle (wavelength independent)

$\Rightarrow$ Computation of the radiance calibration coefficient for the other spectral bands (red, NIR and SWIR)

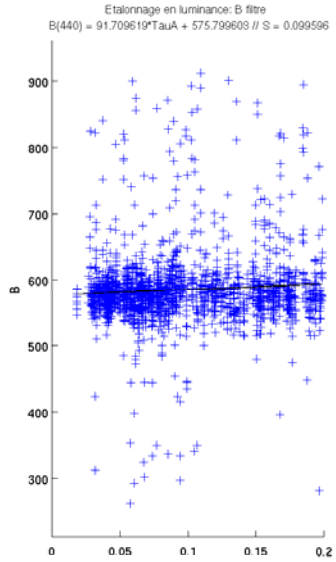
Instrument calibration (4/4)

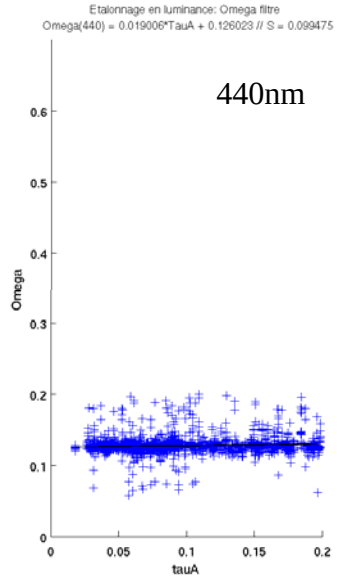
- Rayleigh scattering calibration and Ω estimation



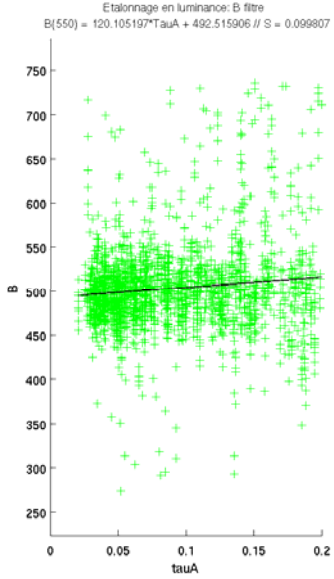


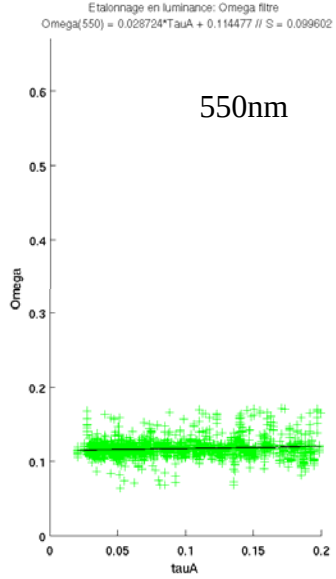
380nm





440nm



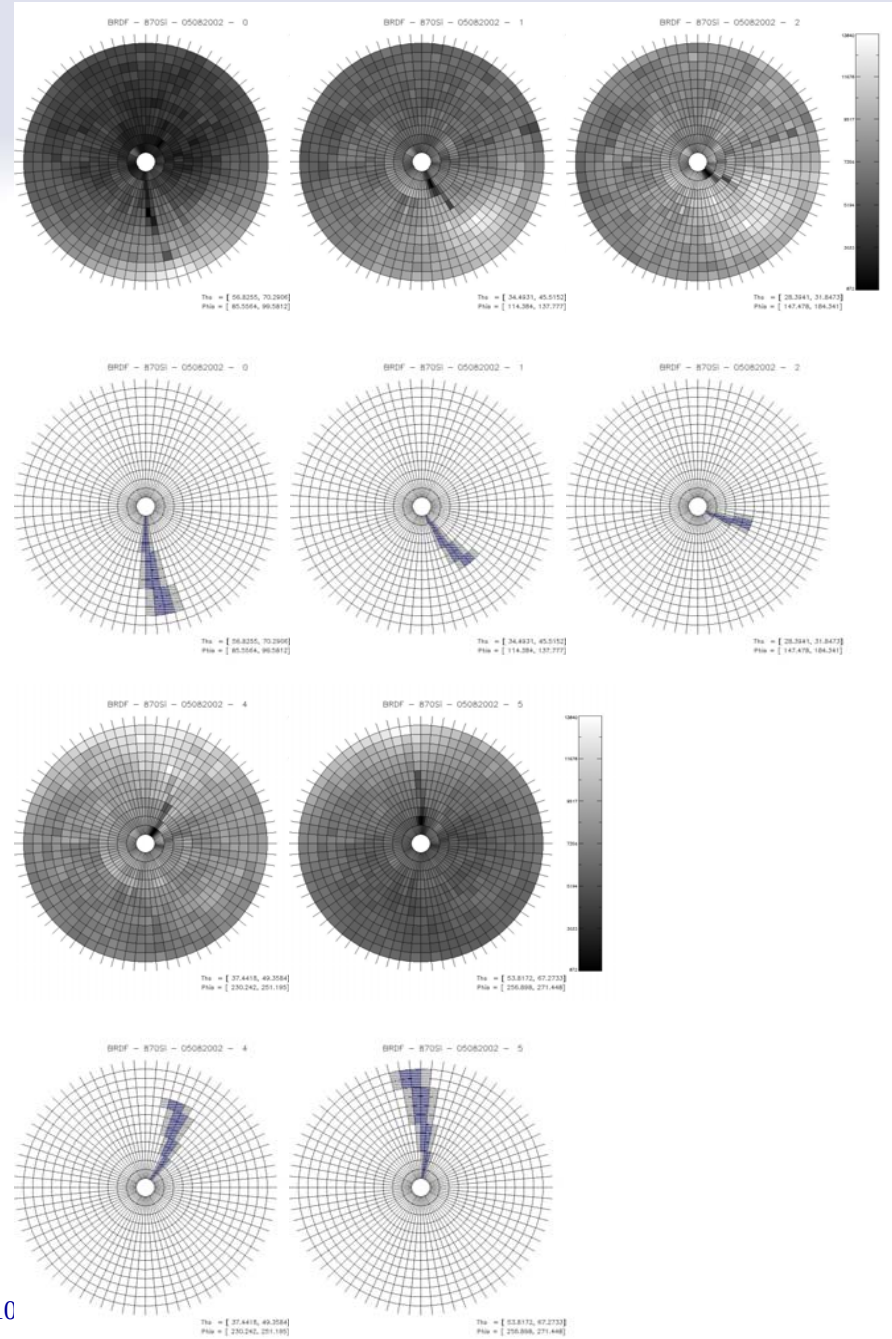


550nm

Period: January 2006 – December 2006

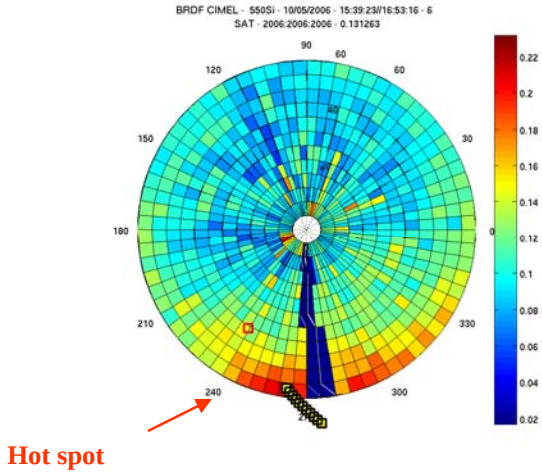
Ground reflectance

Shadow mask of the pole

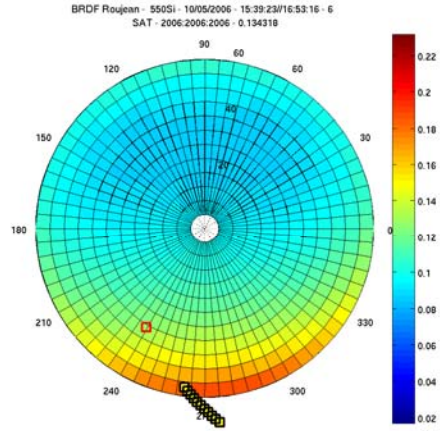


Ground reflectance

- Adjustment of a BRDF model (iterative filtering)

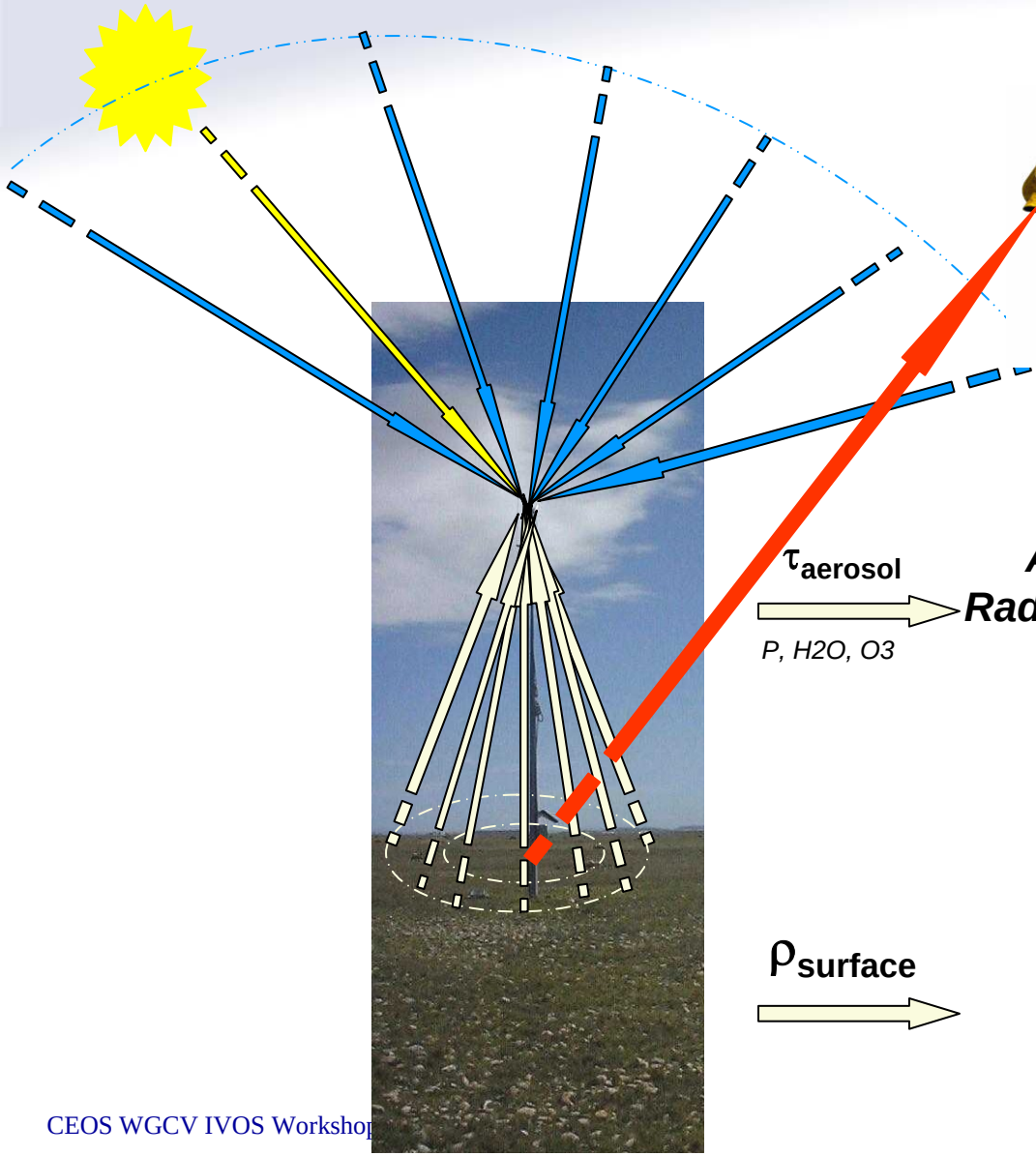


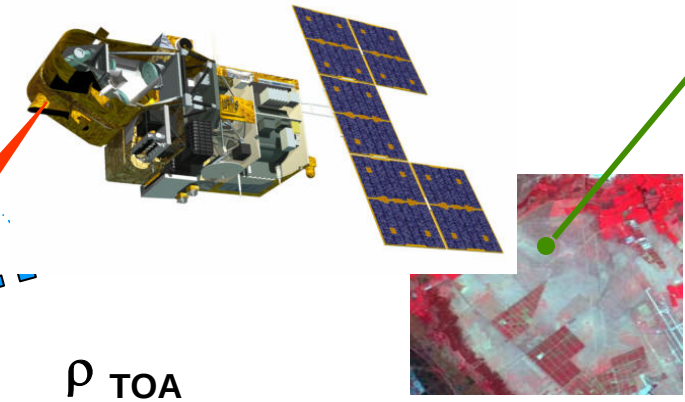
ROSAS ground reflectance (550nm)



Estimated BRDF model (550nm)

In flight calibration procedure





ρ_{SAT}

ρ_{TOA}

$\tau_{aerosol}$

P, H2O, O3

Atmospheric Radiative Transfert Model

+

$\rho_{surface}$

Spectral resampling

Calibration coefficient

ρ_{SAT} / ρ_{TOA}

SPOT4 calibration

Date	B1 (green)	B2 (red)	B3 (NIR)
07-Nov-05	0.720	0.819	0.771
13-Mar-06	0.752	0.764	0.763
23-Mar-06	0.801	0.826	0.836
03-Apr-2006	0.770	0.824	0.786
02-Nov-06	0.732	0.822	0.794
13-Nov-06	0.751	0.842	0.796
22-Nov-06	0.729	0.807	0.789
Average	**0.751**	**0.815**	**0.791**
Standard deviation	**0.026**	**0.023**	**0.022**
Official cal. (01/06/06)	**0.743**	**0.821**	**0.809**
Discrepancy	**+1.1%**	**-0.7%**	**-2.2%**

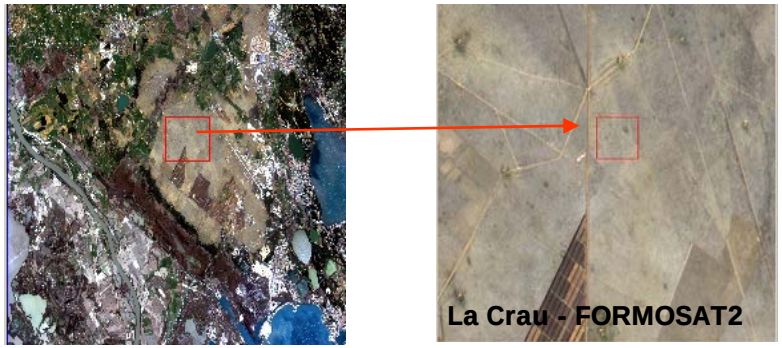
☺ **Low scattering over 7 measurements**

☺ **Good consistency with the official calibration**

☹ **No calibration for the SWIR band**

Present status

- ROSAS : operational for SPOT calibration
  - one calibration campaign per year
- Successfully tested with a set of Formosat 2 images



- Development of an operational software for ROSAS data archiving, testing and processing
  - industrial development
  - friendly interfaces, calibration results traceability, expertise toolbox
  - acceptance : October 2010

Prospects

- Improve the calibration method :
  - H_2O content using the 937nm band
  - extend the calibration to the SWIR domain
- Transfer the ROSAS software to the operational calibration team
- Calibrate Pleiades using ROSAS during in-flight commissioning
- Try to install a 2nd ROSAS system on a new calibration site
- Study a ROSAS evolution for the Sentinel-2 in-flight calibration