Retrieval of aerosol properties using airborne polarimetric and sun-photometer observations during the AEROCLO-sA field campaign in Namibia.

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Motivations : AEROCLO-sA campaign

Main AEROCLO-sA's objectives :

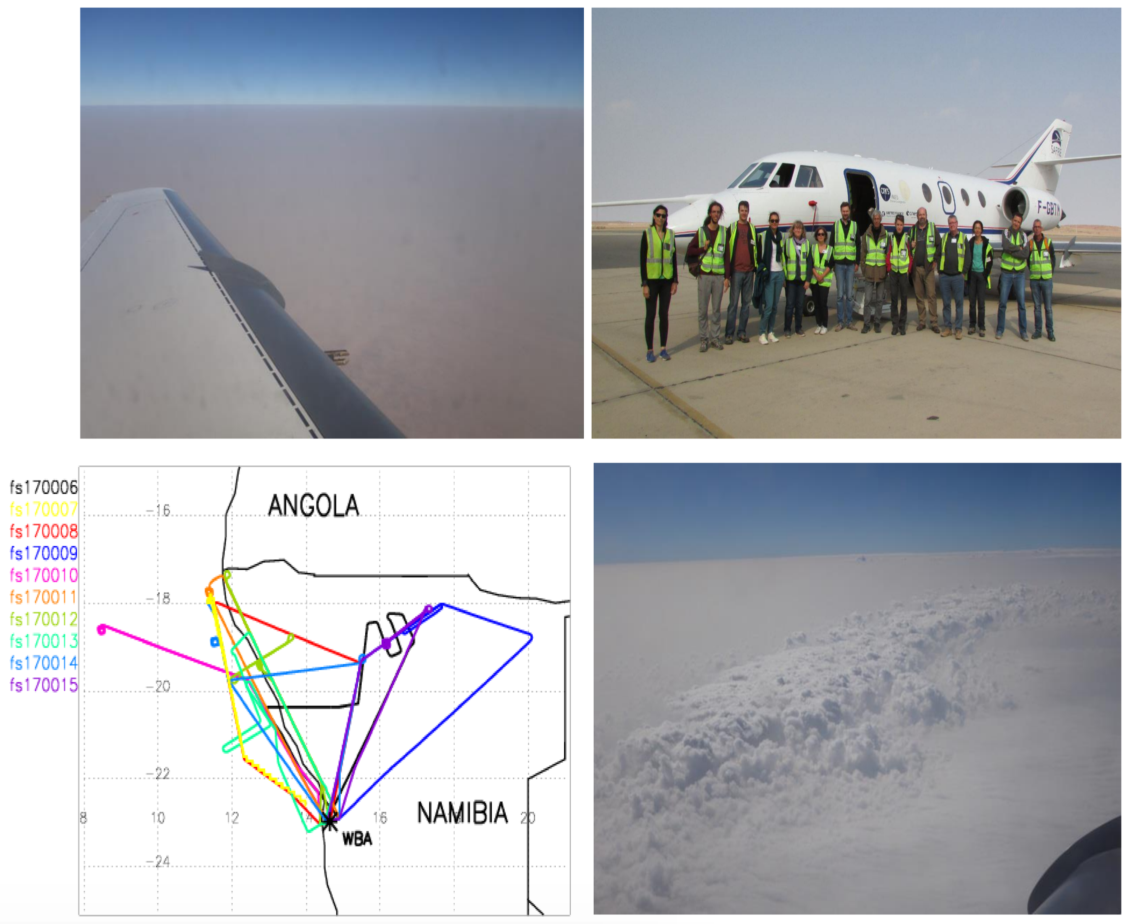
- Which are the aerosol optical and hygroscopic properties?
- How are they distributed with respect to the clouds?
- Which are the dynamical processes responsible for their emission and transport?
- Which is their spatial distribution? Which is their direct, semi-direct and indirect effect?

2 main objectives from airborne measurements:

- Development of new aerosol retrieval algorithms for the future spaceborne 3-MI/ESA sensor (MetOp-SG/2021).
- Study the effects of aerosols on clouds and climate.

Facilities :

- **10 scientific flights** over cloud, land and ocean.
- **Multiple measurement conditions** (high and low altitudes, spiral descents over cloud and in clear-sky conditions).
- **Instrumental synergy** with airborne in-situ, ground based, and satellite remote sensing measurements.

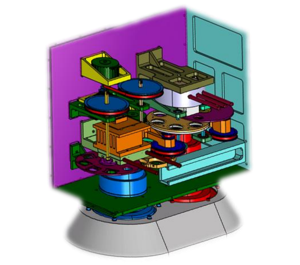


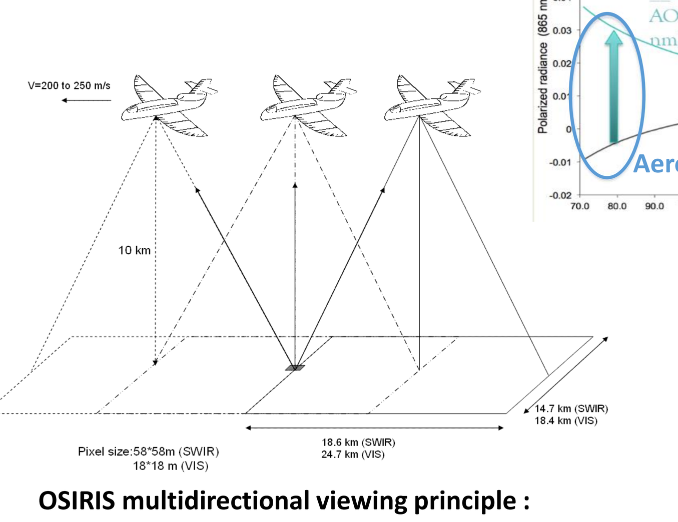

OSIRIS installed on SAFIRE F20

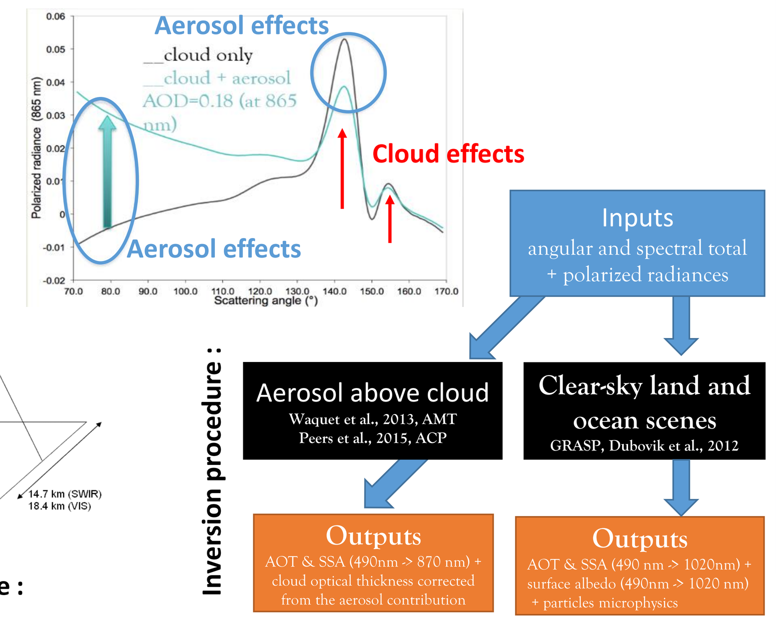
Tools : passive instruments on-board F20

The OSIRIS instrument on-board the F-20
Simulator of the future spaceborne 3MI instrument of ESA (2021/MetOp-SG)

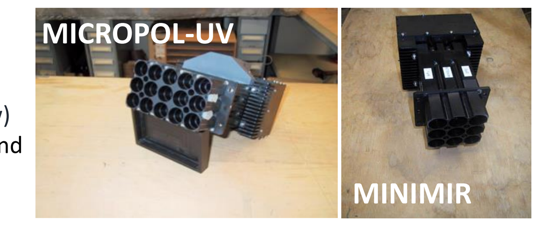
- POLDER concept : **a wide field of view polarimeter imager**
- Two optical systems : **VIS-NIR (440-940nm)** and **SWIR (940-2200 nm)**
- Thanks to its 2-dimensional CCD cameras, this instrument acquires a series of images, which allow the target to be seen from **up to 16 views**


OSIRIS technical view :


OSIRIS multidirectional viewing principle :

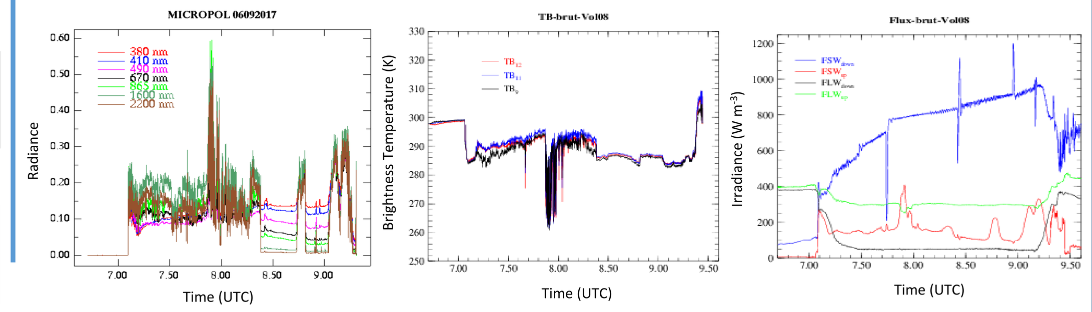


- **PLASMA** active tracking sun-photometer
  => Spectral AOT (10 bands 380->1640 nm)
  => Water vapor content
  => Aerosol extinction & particles size distribution

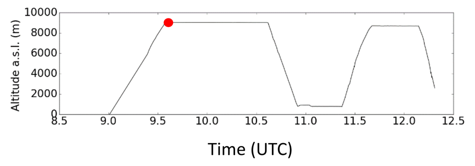


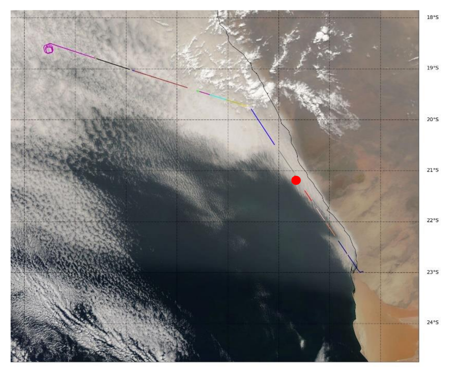
- **MICROPOL-UV & MINIMIR** (0.380->2.2 microns / polarization / single view)
  => Angle view of 15° (backward) for MINIMIR and nadir view for MICROPOL

- **CLIMAT** infrared radiometer : 8.7, 10.5 et 12 µm (IR)
- **Pyranometer and Pyrgeometer** : SW and LW flux measurements (up and down)



Above cloud : Aerosol and Cloud properties





Cloud :

- Formations of the primary (140°) and secondary cloud-bows (between 150° and 180°) in polarization measurements due to liquid droplets.

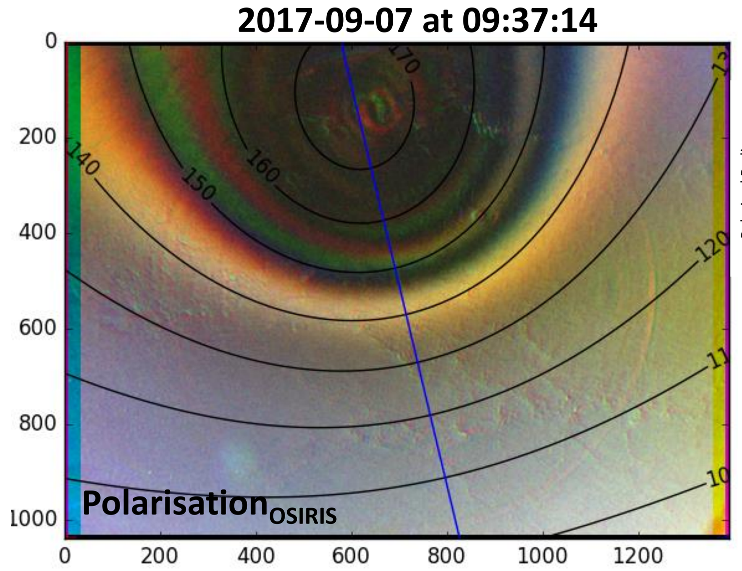
-> simulation at 1620 nm : r_{eff} = 9,8 µm ; v_{eff} = 0,0035

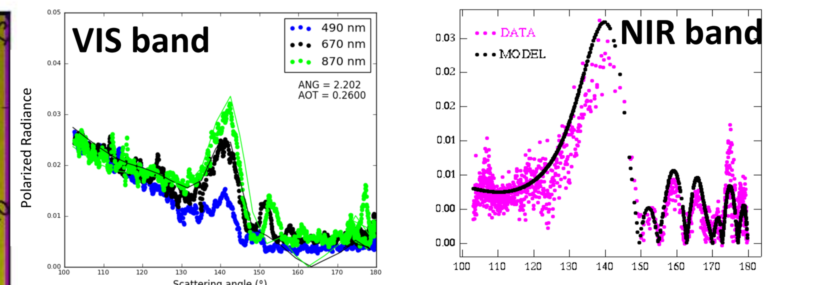
Aerosol :

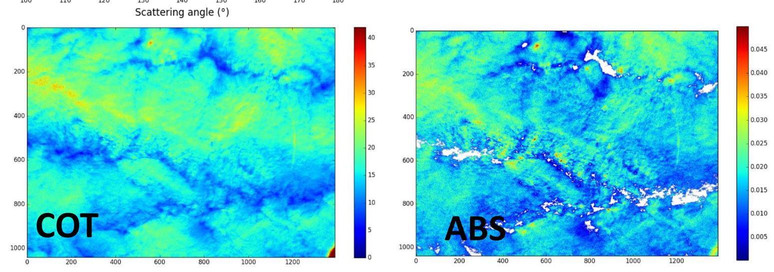
- The cloud-bow turns brown due to polarisation of aerosols at 870 nm.

-> simulation at 870 nm : AOT = 0.26 ; ANG = 2,20 + cloud optical depth (COT) and aerosol absorption (ABS).

2017-09-07 at 09:37:14

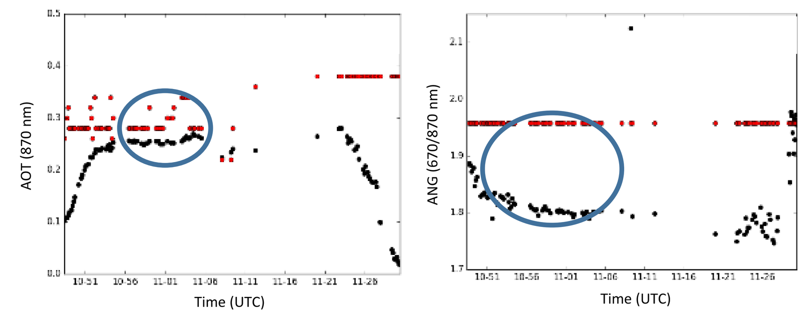


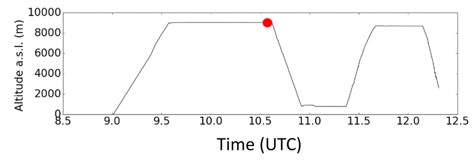


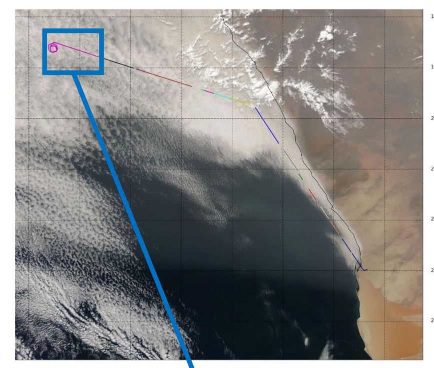


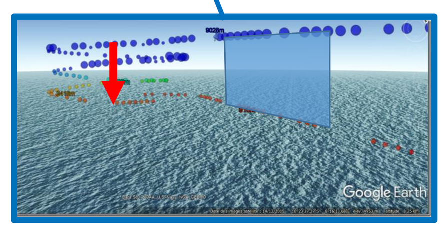
Spiral descent : an opportunity for instrumental synergy

OSIRIS / PLASMA





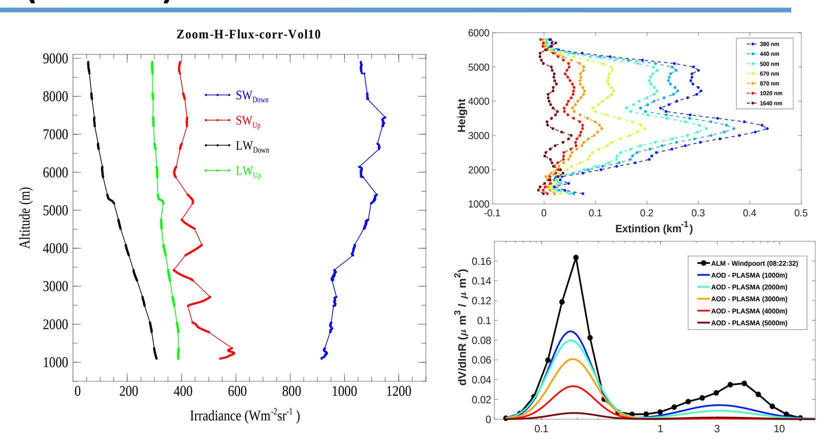




- Closer AODs for time interval < 30 min (blue zone).
- Fine mode particles retrieved (ANG values close to 2) but a bias steel present.

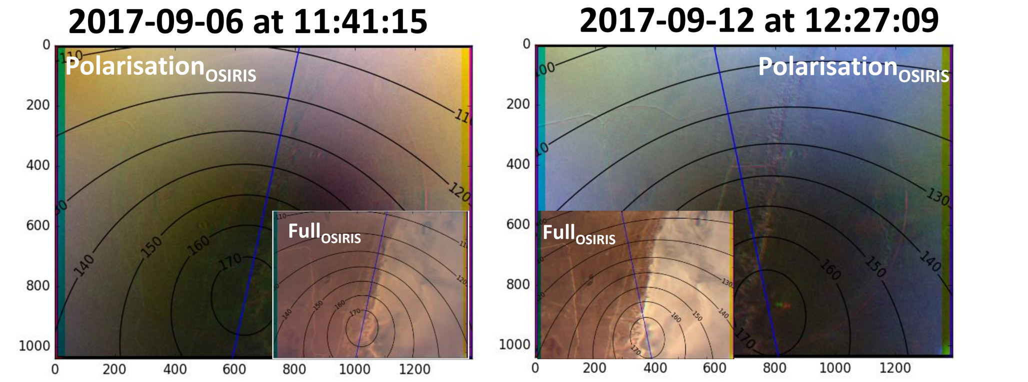
Pyranometer and PLASMA (+GRASP)

Radiation and Aerosol properties are retrieved during ascent and descent with "hippodrome" plateau.

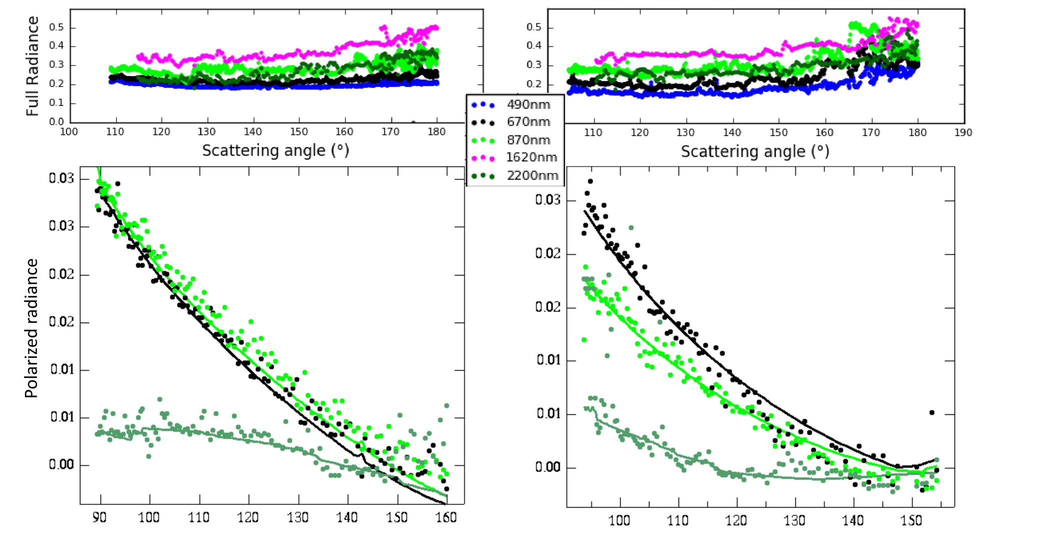


Clear sky : high spectral and spatial resolution

2017-09-06 at 11:41:15 — 2017-09-12 at 12:27:09



- For the same scene : Strong aerosol influence for the 6th of compared to the 12th of September.
- Polarisation radiances are less sensitive to ground properties than total radiances in the VIS range (**670 nm** and **870 nm**)
- **2200 nm** = surface contribution
- AOT inversions from OSIRIS close to AERONET ground based measurements



6th / 9 UTC	AOT670	AOT865
OSIRIS fine	0.49	0.28
AERONET total	0.54	0.35

12th / 9.5 UTC	AOT670	AOT865
OSIRIS fine	0.16	0.08
AERONET total	0.27	0.18

Highlights:

- Large amount of absorbing biomass burning aerosols (**AOT up to 1.5 at 500 nm** for some events)
- Observations from passive and active remote sensing instruments with high spectral (**from UV to NIR**) and spatial resolutions (**around 20 m at the ground**) from OSIRIS measurements).
- Inversions of **aerosol and cloud properties simultaneously** over clouds, bright deserts and clear-sky ocean scenes.

Next steps :

- Study of microphysical and radiative aerosol properties from vertical measurements.
- Does stratocumulus and aerosol layer situations influence the global radiative budget ?
- Constrain climate models and satellite inversions.

Acknowledgments :

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