Current results on mobile system prototypes development for aerosol Cal/Val activities

ESA/IDEAS Project   / WP 3440-1/3/5

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AERONET Europe Facility

Mobile Exploratory and Calibration/Validation Platform

- Upgrade European AERONET Facility (instrument, calibration system, traceability, link with other networks/partners,…)

- Develop & provide AERONET-compatible mobile observations
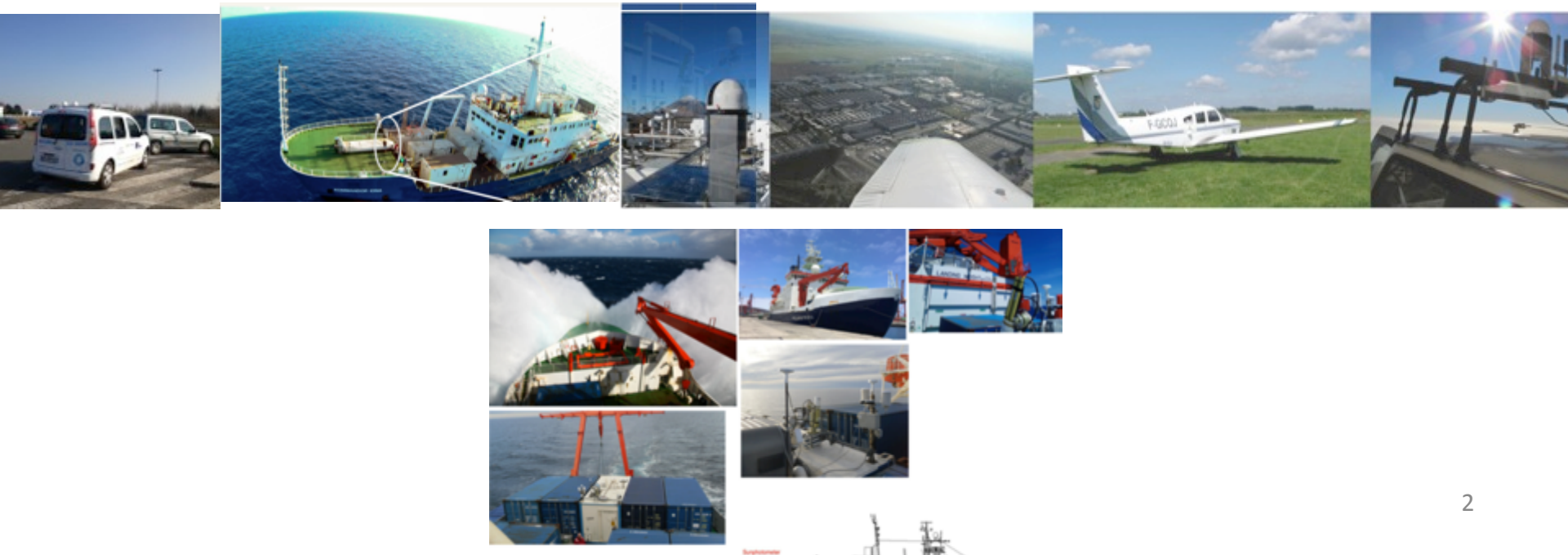
Organisation of the presentation

Part 1.   Reminder of december 2017 (Frascati) conclusions/ perspectives

Part 2. Improvement of current existing photometer and validation during a new campaign. (limitation = low speed mobility)

Part 3. Design of new robot for generic use of mobile photometer (low, moderate & high speed mobility).

Part 4. Schedule to end of phase 3

Part 5. Some Perspectives

Part 1. December 2017, Frascati conclusions

Main Conclusions

- First AOD data on ship using automatic standard AERONET compatible photometer :
  AQABA campaign (overview on Youtube) :OK

- Verification against MAN/AERONET microtops and nearest AERONET fixed station: OK

- Day time AOD processing at LOA in Near Real Time : OK

- Night time AOD processing : OK (but few data), need new campaign to check.

- First sky radiances data in the almucantar : OK but need to store exact geometry (viewing + azimutal angles)

- First AOD+sky radiance inversion => quite reasonable results : analysis under progress (B. Torres, LOA)

- Ship heading + humidity sensors + seaspray contamination
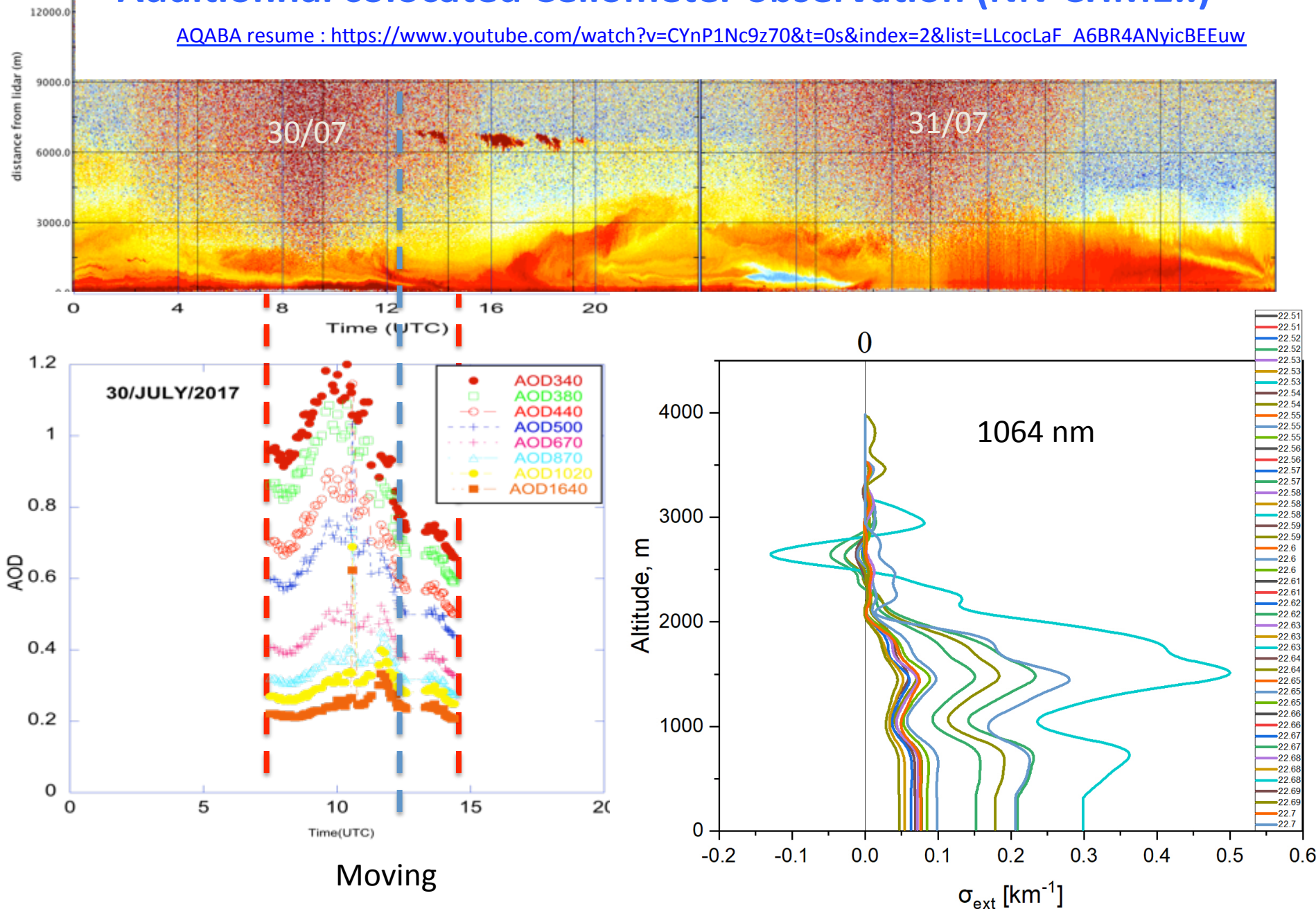 issues : underprogress

Part 1. December 2017, Frascati's perspectives

- New approach to measure ship heading : **(done)**

- Measure and storage of precise viewing zenith and azimuth angles, to use exact angles in the aerosol inversion/ retrievals : **(done)**

- Synergy between AOD, sky radiance and attenuated backscatter Ceilometer or LiDAR data (e.g. GARRLIC or BASIC softwares) : **under progress (see next-slide)**

- Full autonomy needed (no external Inertial Measurement Unit-IMU) and automatic photometer, AERONET-compatible : **done**

- Design and construction of specific robot (compacity for other vectors like airborne, car, etc…, water protection) + coupling with CE318T head : **under progresss**

- Future ship campaigns to evaluate (2018, …) : **1 done + 1 scheduled**

- Automatise retrievals : Level 0-> Level 1 (partly done);   Level 1-> Level 2 (GRASP-Based) : **future activities**

- Metrology and traceability :
    Sky radiance with NASA for AERONET Europe / ACTRIS (**done**) – every 3-4 month
    Sky radiance with NPL for AERONET Europe / ACTRIS (**not done),**
   AOD with PMOD for AERONET Europe / ACTRIS , **in progress,** LOA-PMOD meeting at Davos, 03/2018.

Additionnal colocated Ceilometer observation (NN-CHM1..)

AQABA resume : https://www.youtube.com/watch?v=CYnP1Nc9z70&t=0s&index=2&list=LLcocLaF_A6BR4ANyicBEEuw

Retrieval of aerosol profiles during AQABA (Air Quality and Climate Change in the Arabian Basin) campaign, F.Unga et al., (EGU 2019), The Cyprus Institute Energy, Environment and Water Research Centre (EEWRC)

Part 1. December 2017, Frascati's perspectives

- New approach to measure ship heading under investigation: **(done)**

- Measure and storage of precise viewing zenith and azimuth angles, to use exact angles in the aerosol inversion/ retrievals : **(done)**

- Synergy between AOD, radiance and attenuated backscatter Ceilometer or LiDAR data (e.g. GARRLIC softwares) : **under progress (see next-slide)**

- Full autonomy needed (no external Inertial Measurement Unit-IMU) and automatic photometer, AERONET-compatible : **done**

- Design and construction of specific robot (compacity for other vectors like airborne, car, etc…, water protection) + coupling with head : **under progresss**

- Future ship campaigns (2018, …) : **1 done + 1 scheduled**

- Automatise retrievals : Level 0-> Level 1 (partly done); Level 1-> Level 2 (GRASP-Based) : **future activities**

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Part 2. Improvement of current existing photometer and validation during the OCEANET campaign

From South America-to-Germany
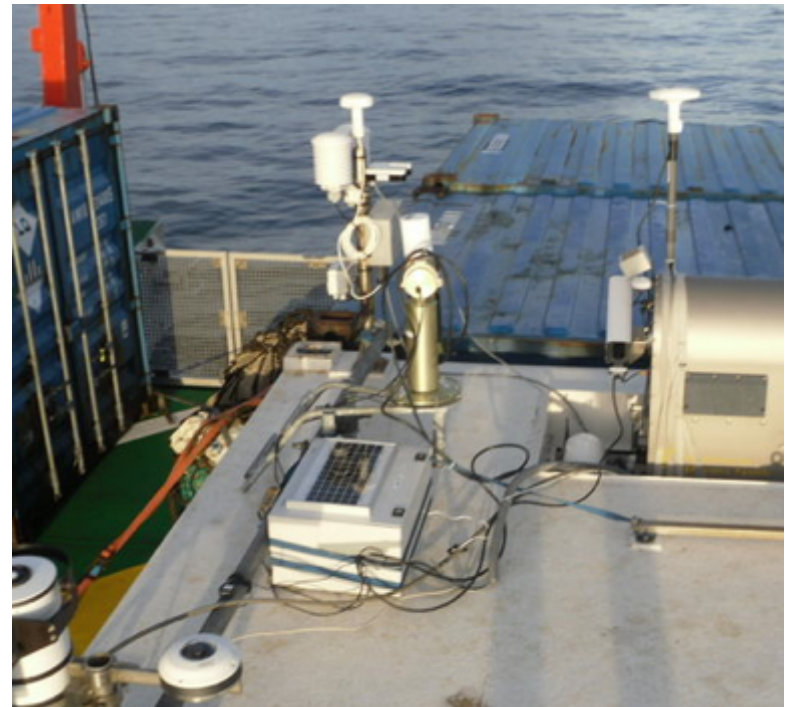

POLARSTERN
Coop. TROPOS,
Leipzig, Germany

Protection against sea spray contamination

After one month of operation, no degration !

Very negligible change in the calibration after the campaign. (< 0.3%)

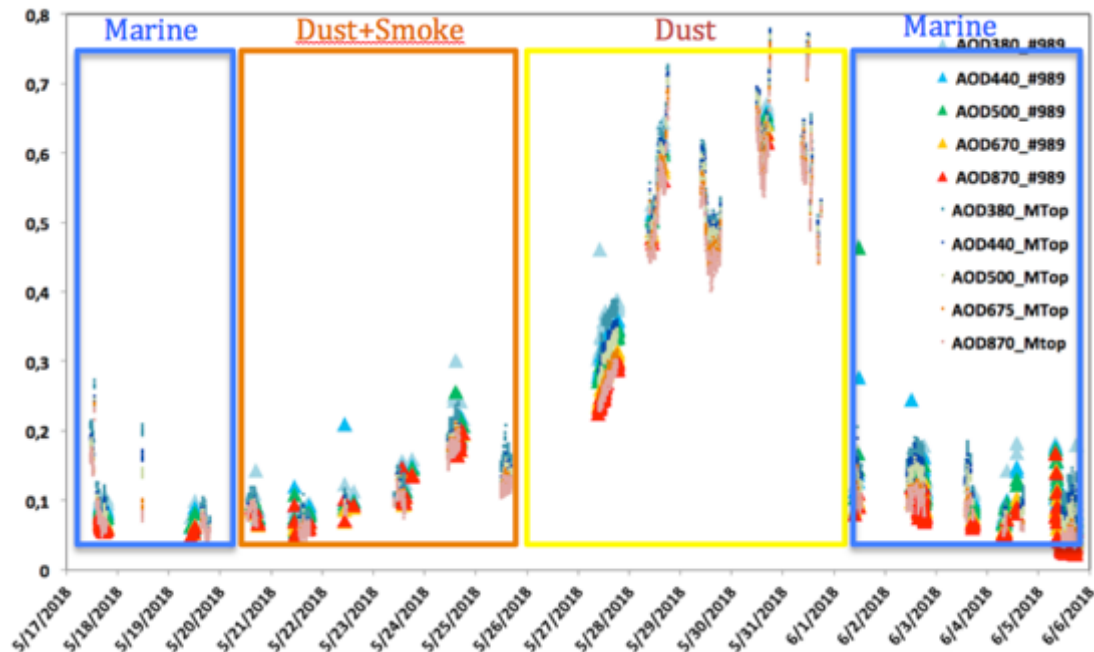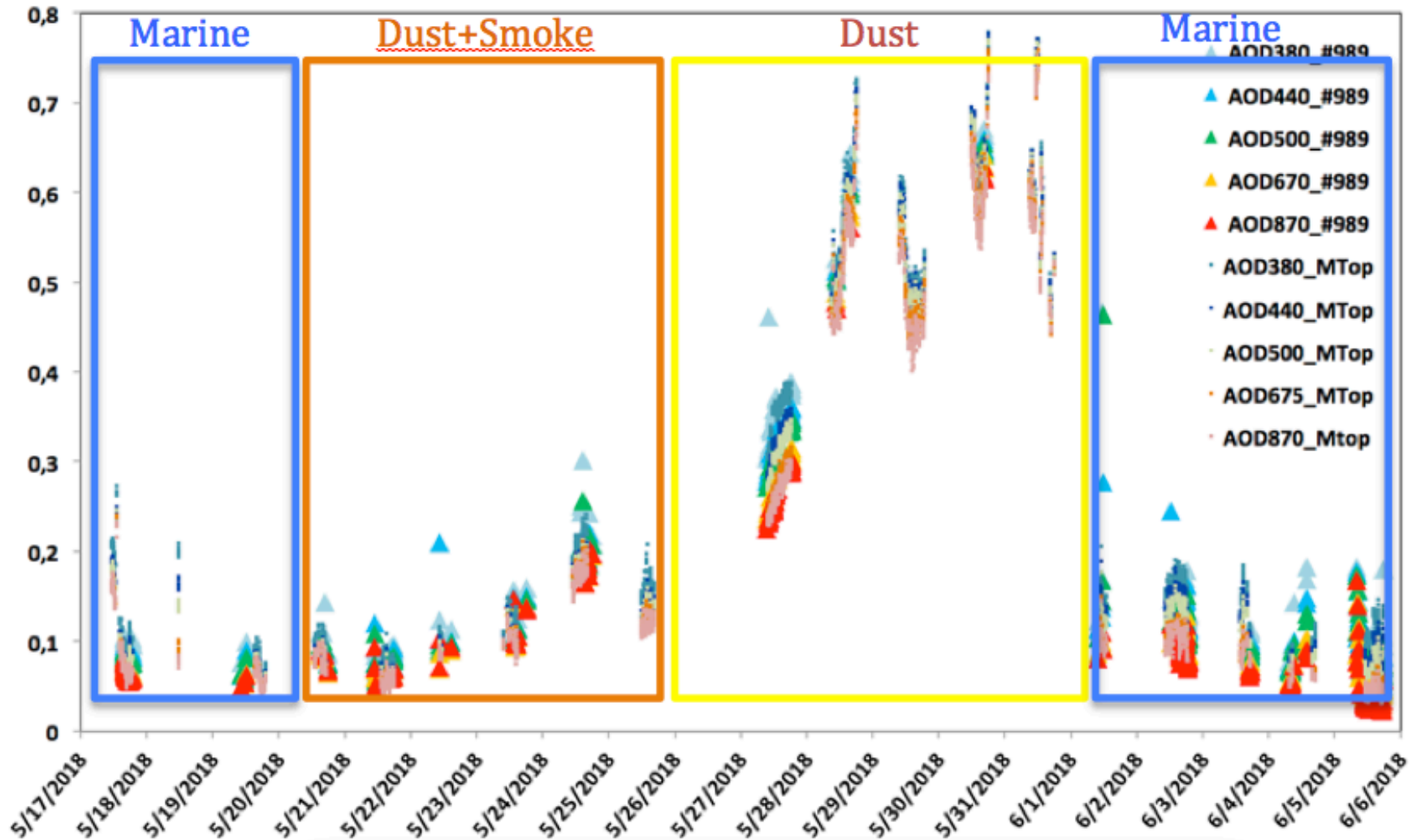# South America-to-Germany transect

May – June 2018

CE318T automatic AOD

CE318T automatic & manual MAN microtops AOD

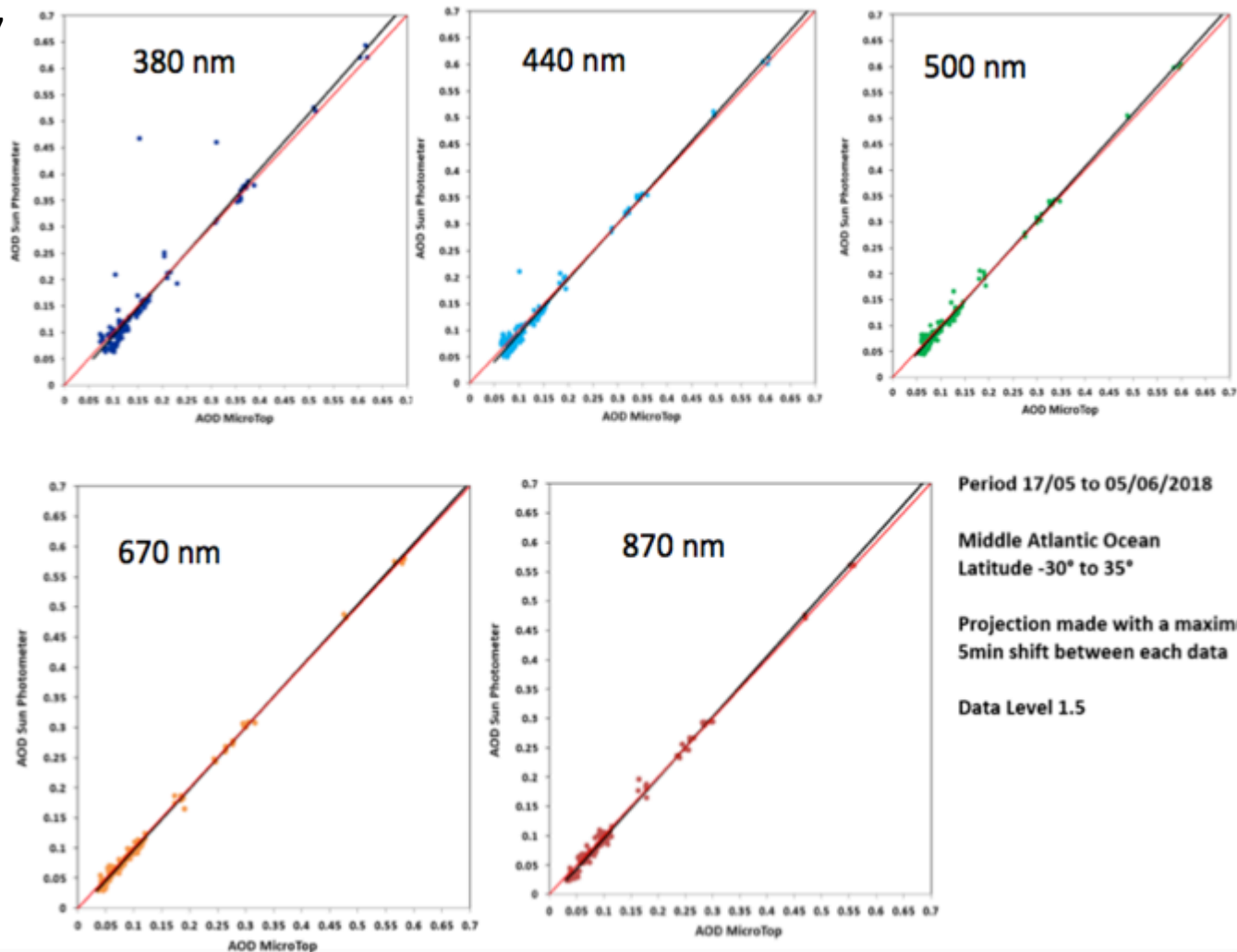Red : 0.70 , Blue : < 0.10

AOD variability

Comparison with handheld photometer

- Microtops calibrated at NASA/GSFC and part of AERONET/MAN network
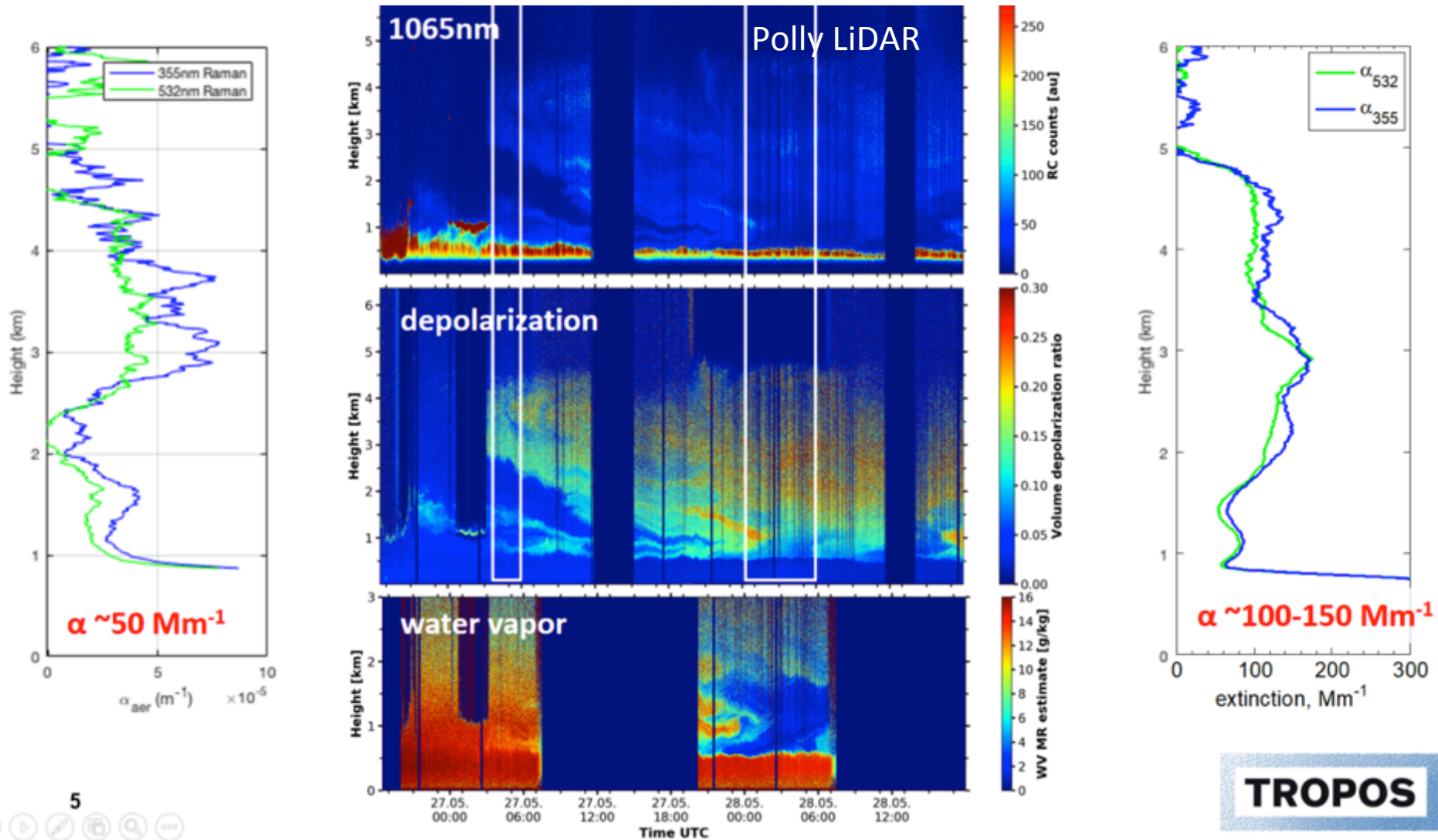- CIMEL CE318T # 989 calibrated by AERONET-Europe (LOA)

Polarstern campaign AOD CIMEL Automatic (#989) Vs AERONET MicroTop (#22499)

Period 17/05 to 05/06/2018

Middle Atlantic Ocean
Latitude -30° to 35°

Projection made with a maximun of
5min shift between each data

Data Level 1.5

LIDAR and photometer together

Joint aerosol retrieval possible with GRASP/**GARRLIC**

A second OCEANET campaign !

- With CE318T & new Navigation system (IMU/GPS)

- From Bremerhaven to Cape Town in October/November 2018
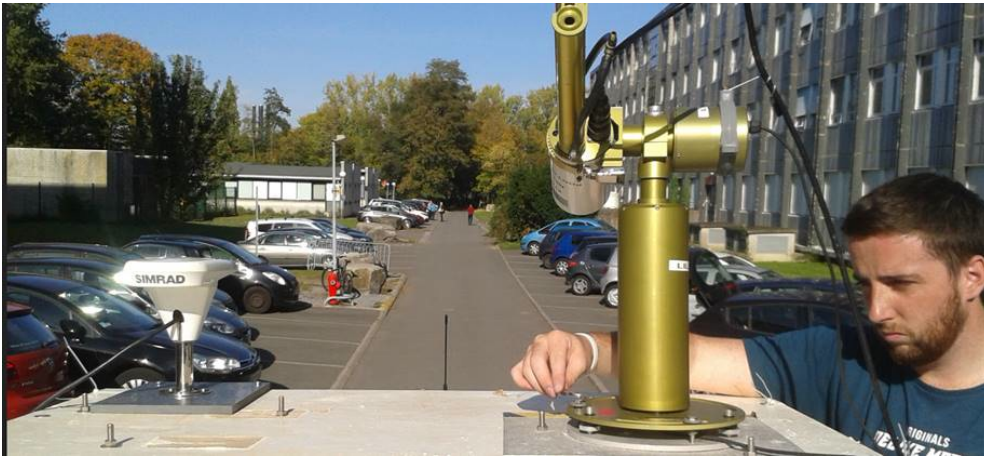
New navigation system on test on car this week in Lille

Part 3. Design of a new robot for generic (universal) use of mobile photometer for low, moderate and high speed mobility.

What previous results show ?

- A modified CE318T photometer can be considered for some applications like satellite calibration/validation activity on board **low speed** vehicle.

- More accurate navigation system (IMU) must be integrated (ship heading)

- Exact viewing geometry must be recorded for aerosol inversion process.

- Daytime and nighttime AOD and their combination with ceilometer possible (AQABA campaign).

- Less expansive solution (system exist and add-on component has been developed and almost fully validated) has :

    1) an easy setup and maintenance including protection against sea-spray
    2) 100% AERONET-compatible,
    3) but cannot be used in all speed conditions,

To overcome this speed limitation, a second project, run in parallel, consists in developing a prototype robot and make use of standard CE318T head.
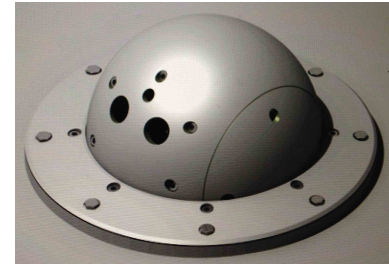
*Future mobile sun/sky/lunar photometer (credits: R Loisil, LOA/CNRS).*

Targeted results:

- More compact instrument (and with a better aerodynamism) for a more generic use (low to high speed vehicle).

- New observation scenarios to be taken into account in the processing chains.

- The calibration and maintenance of the instrument will be much more easy and the instrument will remain 100%-AERONET-compatible.
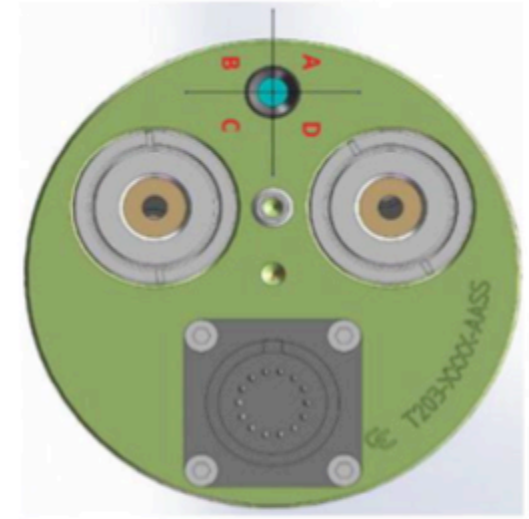
Current development status
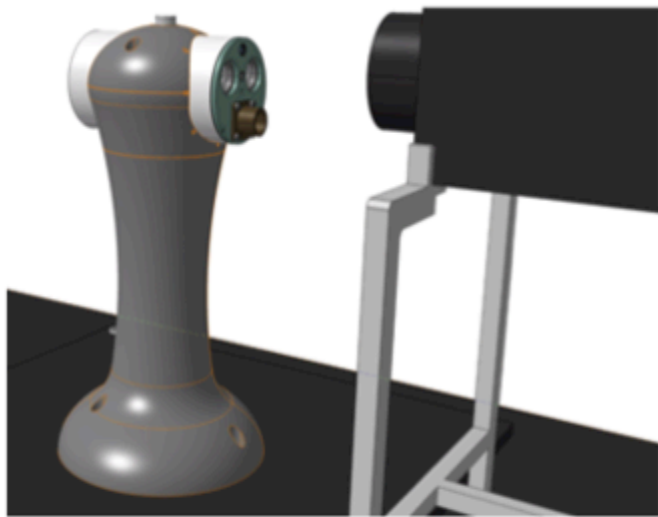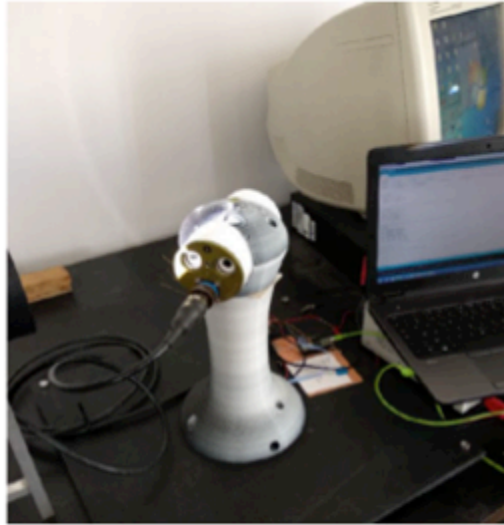
(a)   (b)   (c)

(a) schematic of the prototype robot supporting the CIMEL head targeting a solar simulator light source; (b) real system under test in LOA; (c) view of the CE318T entrance lenses and four quadrant tracking system- (credits : R. Loisil and C. Delgove, LOA/CNRS).

Part 4. Schedule for end of phase 3

 September-October 2018:
- Development of a new control box by LOA to control both head and robot.
- The new control box will integrate a small IMU/GPS system.
- Further analysis of validation campaigns

November-December 2018:
-Building of the prototype robot with a 3D printer.
-Further analysis of validation campaigns

 January-March 2019:
- test and first data with the new control box, head and robot.
- Further analysis of validation campaign

April-June 2019:
- short campaign for evaluation of performances of first prototype
- writing IDEAS+ final report (deliverable).

Part 5. Ideas & Perspectives (1/4)

Instrumentation : Mobile photometer, platform and services

- New service for *mobile Observation*

- *ocean color option* for the mobile photometer to be considered

- MAP-OI (Marion Dusfresne Atmospheric Project - Océan Indien) project
to setup a first permanent system in the Marion Dufresne Ship (mostly in the Indian ocean) with University of La Réunion Island.

- Airborne certification will be requested, for civil use in France, with the French Airborne Service Unit SAFIRE.

Part 5. Ideas & Perspectives   (2/4)

Instrumentation : AERONET Europe calibration facility

- *Observation continuity could be offered* to European users with additional instruments (no cut in the time series)

- AOD-to-Sky radiance calibration method needs instrumental characterization (PMOD)

- Radiance traceability (NPL and NASA radiance standards)

- AOD traceability

Part 5. Ideas & Perspectives   (3/4)

- **Data Pre-processing Development**

More automatisation of data pre-processing (QC/data filtering, …) needed.

- **Data processing Development for aerosol retrievals**

Integration of **Day and Night time AOD** into a near real time GRASP-AOD based retrieval scheme has to be performed (B. Torres & I. Popovici, LOA)

Integration of **AOD and sky radiance** level 1 data from mobile platform into GRASP retrievals has to be done (B. Torres & I. Popovici, LOA)

Relevance of integration into infrastructure serving users like ACTRIS for exploratory mobile platforms.

Thank you

AQABA campaign, 2017