# Current results on mobile system prototype development for Aerosol Cal/Val activities

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

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**Laboratoire d'Optique Atmosphérique**
**Université de Lille - CNRS**

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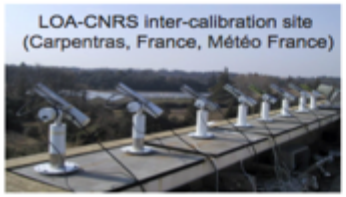
# WP Objectives

# AERONET Europe Facility

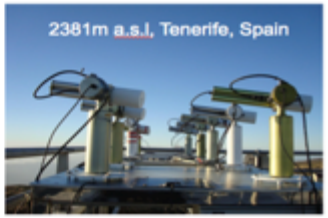
- Wide community needs high quality information on aerosols (space, ground, in between)
- Ground-based observations are organized in networks (permanent, temporary site)
- Mobile Exploratory and Validation Platform are developing
- Data Management system, Data Processing system

**Inter-calibration platforms**



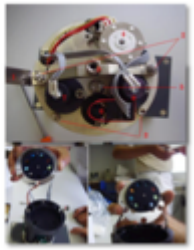


**Master instrument platform**


**Radiance calibration labs**

Sunphotometer lab. Cal. & Maintenance at LOA (Lille)

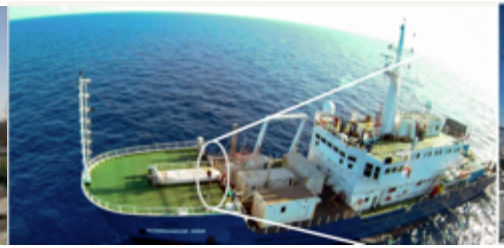



**AEROSOL ROBOTIC NETWORK**

AERONET is a scientific and operational network for global aerosol studies, based on Sun/Moon/Sky-radiance observations

Beginning of 2016, the network has 300 observation sites.

- Upgrade European AERONET Facility with modern technologies (instrument, calibration system, traceability, link with other partner networks,…)
- Develop AERONET-compatible mobile observations



# Upgrade of Calibration Facility, developpment of mobile observation

PHASE 1:

- Support to upgrade calibration facility with modern technologies CE318 T (day + night capability) : 5 Control Units + Sensor Heads=> reference instruments

PHASE 2:

- Upgrade robots used for calibration sites (2 new CIMEL robots, better, faster)
- Step 1 in the design and building of a prototype robot for mobile sun/sky photometry (coop. LOA/ CIMEL)

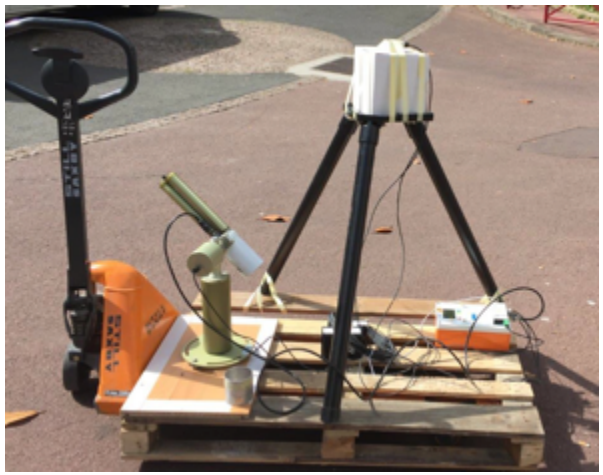
PHASE 3: 2018-mid 2019

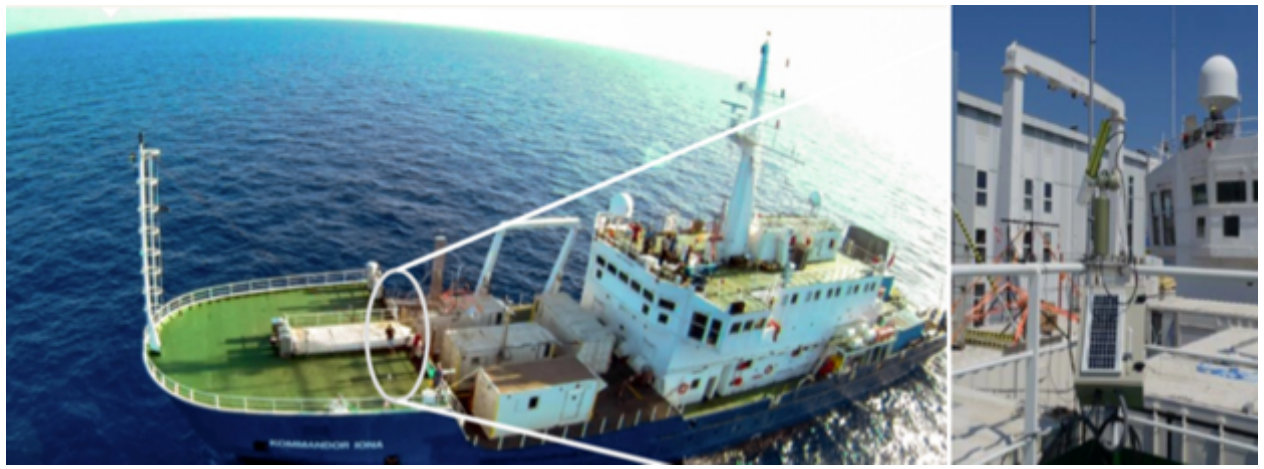
- Two new CE318 T heads, one for Mobile system,one for calibration site
- Follow-on field campaign data analysis
- Step 2 in the mobile photometer development (new compact robot, LOA)
- To be assembled with CE318 T head
- Possible Campaign
- Calibration Traceability (AERONET-Europe, Sky radiance, AOD)

# Mobile Observation
# Strategy for development

**Need Full compatibility with AERONET**

- **Step 1: explore new CIMEL (CE 318T) capability**





# Mobile Observation Strategy for development

## Step 2 : development new robot integrating CIMEL 318 T head

**Prototype Robot/Tracker being designed at LOA**

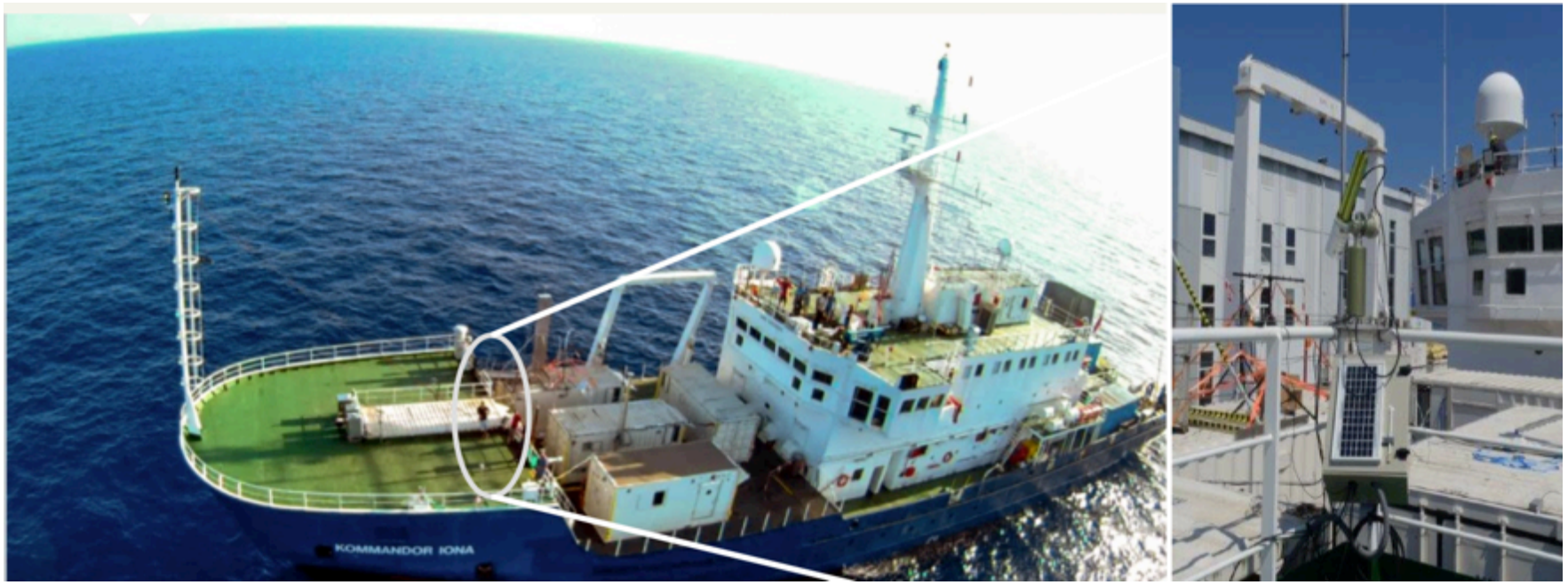
**Steps 1 and 2 are in parallel now and Step 2 learns from Step 1**

Official agreement NDA between LOA & CIMEL

# Step 1 : Automatic CIMEL CE318T on cruise

*(First Automatic Sun/Sky/moon photometrer obs. on a ship)*

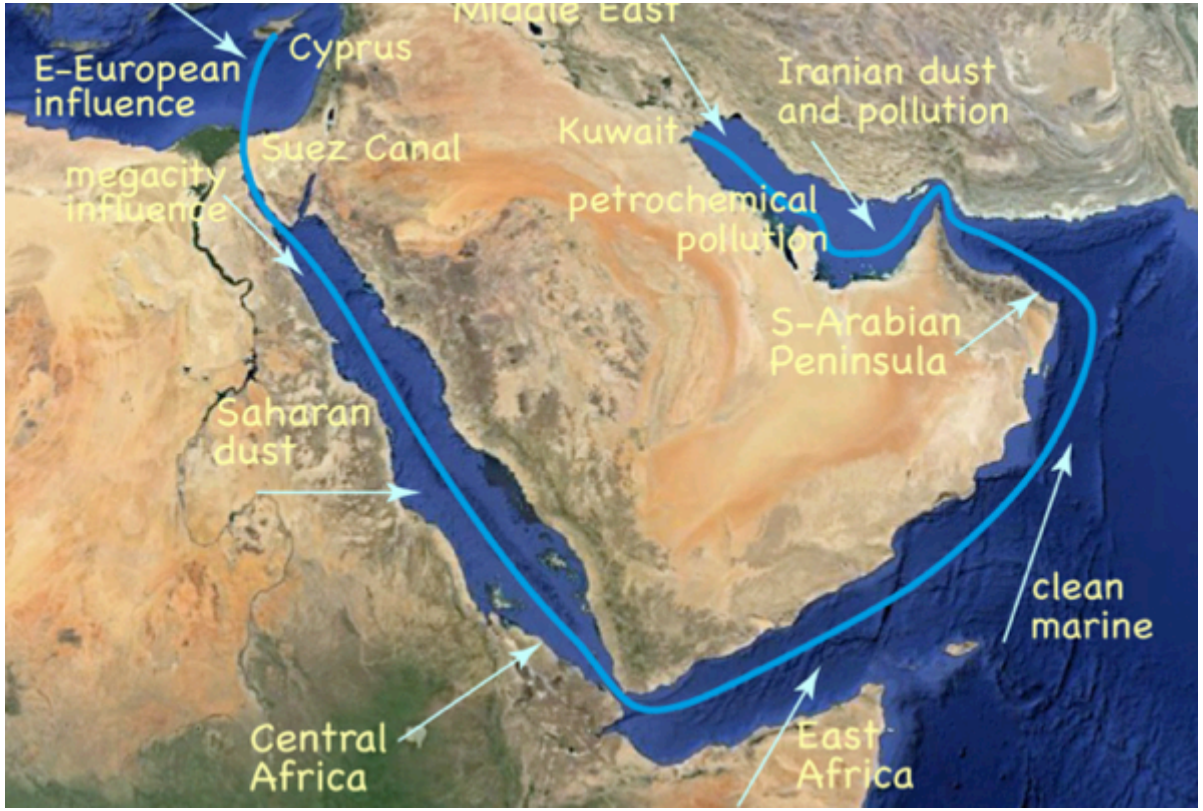
- Exploratory Observation : technology to test
- First Objective : Spectral AOD (Day / Night)
- Second Objectives : Sky Radiance (Almucantar)
- AQABA Campaign opportunity (summer 2017), **Air quality and climate change in the Arabian Basin (AQABA)**




- System Set up at Toulon, France, in Iona Kommandor ship-
- One operator to check time to time

# AQABA Campaign (Cyprus Institute, J. Sciare)

Sailing from Cyprus to Kuwait around the Arabian Peninsula, AQABA will encounter a unique environmental "spectrum", ranging from pristine conditions over the Arabian Sea, unpolluted but dusty air from Africa over the Red Sea, via moderately polluted conditions over the Mediterranean, downwind urban areas (e.g., Cairo) and the Middle East, ship exhausts in the Suez Canal, to exceptional petrochemical emissions in the Persian Gulf area.

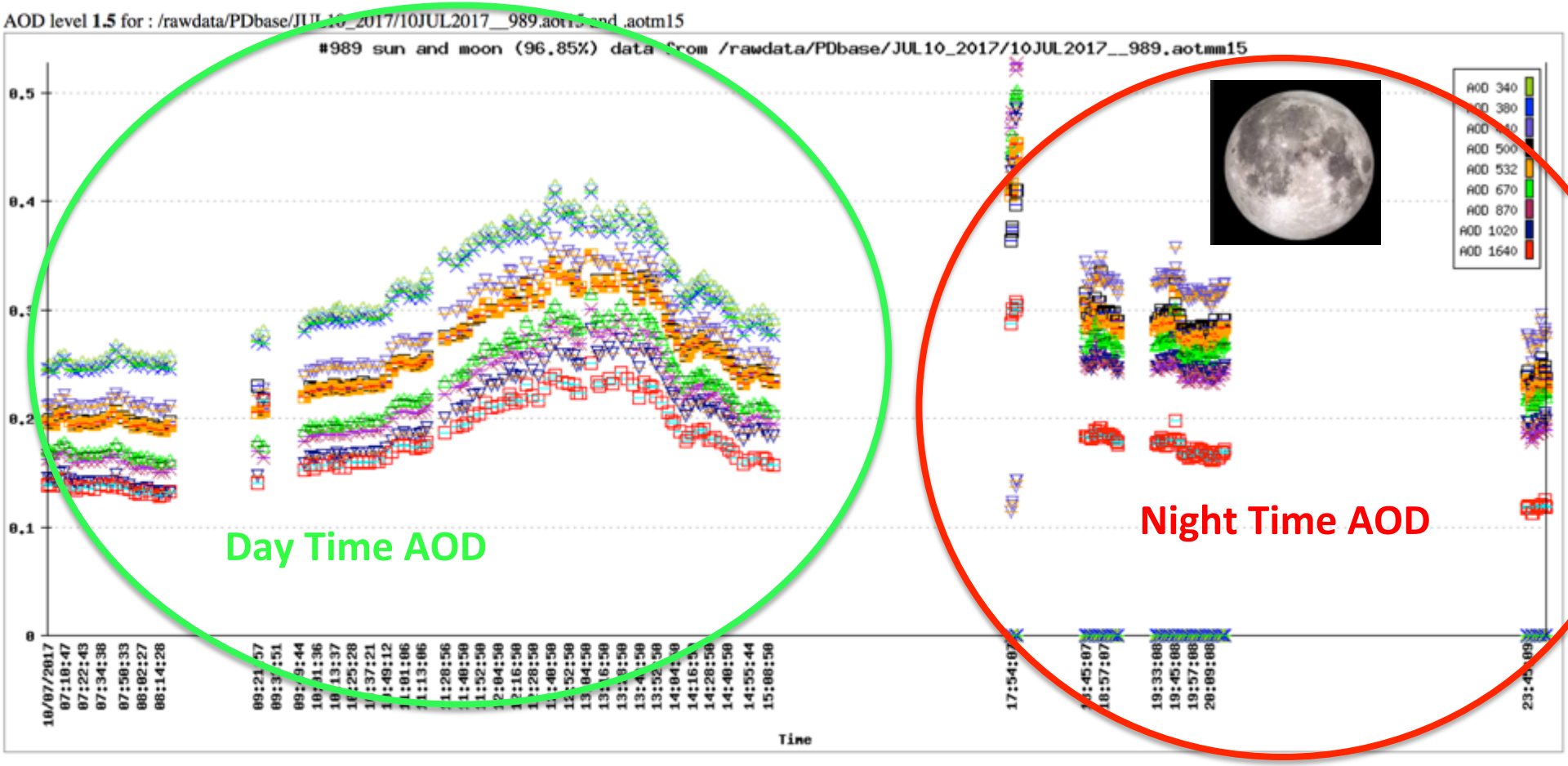


Inclinometer
Magnetic compass
(weak point of the system)

Data logger to control the photometer CE 318T

3G Key or on board internet access => LOA data processing system (NRT).

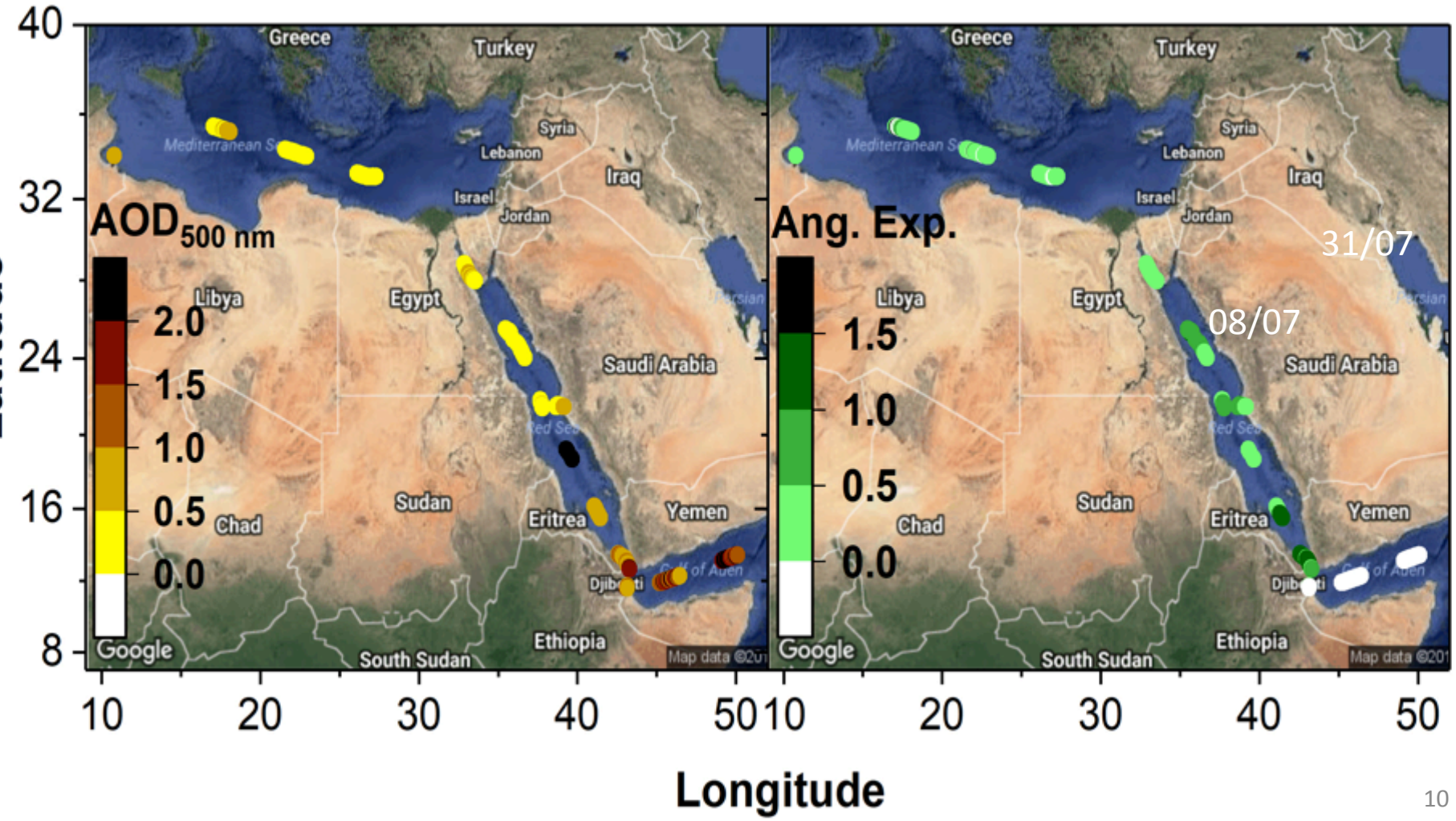
# Data Processing System has been adapted to mobile system (AOD)




**Day time AOD [/rawdata/PDbase/JUL10_2017/10JUL2017__989.aot15] :**
Version 2.04 (13.07.2017), SNO PHOTONS, LOA/Univ. Lille/CNRS,0989,K8
Site Lat Lon Alt(m) : Kommandor_Iona 21.4795 38.6642 0.0
Triplet threshold on AOD for cloud screening : 0.010 Uncertainty on AOD : 0.01 (0.02 in UV)
Water-Vapor abundance constants: 0.6421 0.5975 Processing Date : 2017/07/13 18H34
Values for Patm (hPa), O3 (Dobson), Sun-Earth Correction: 1006.1441 288.3000 0.9667
New Temperature Corrections (1st,2nd) : 0.00334-0.00001 0.00032 0.00000 0.00020 0.00000-0.00003 0.00000-0.00003 0.00000 0.00006 0.00000 0.00017 0.00000
Aerosol Optical Depth (AOD): Lev0.5(No Triplet) | Lev1.0(Cloudy) | Lev1.5(No Cloud) | Lev1.6(Pre-Post-cal)
D,Mt,Year,H ,M ,S ,J.Day, Time(UTC), AOD340, AOD380, AOD440, AOD500, AOD532, AOD670, AOD870, AOD1020, AOD1640, Alpha, Tetas, H2O(g/cm2), T , Lev, Long, Lat, P(hPa)
10,07,2017,06,58,53, 191.2909, 6.9814, 0.2491, 0.2456, 0.2112, 0.1972, 0.1963, 0.1710, 0.1623, 0.1447, 0.1379, 0.3864, 35.1418, 1.9225, 35.2, 1.5, 38.66420, 21.47950,1006.1
10,07,2017,07,00,53, 191.2923, 7.0147, 0.2497, 0.2457, 0.2122, 0.1990, 0.1969, 0.1709, 0.1622, 0.1454, 0.1389, 0.3943, 34.6817, 1.9193, 35.4, 1.5, 38.66420, 21.47950,1007.2

# Overview of the first part of AQABA observation

## AOD and Angström Exponent (AE) variation



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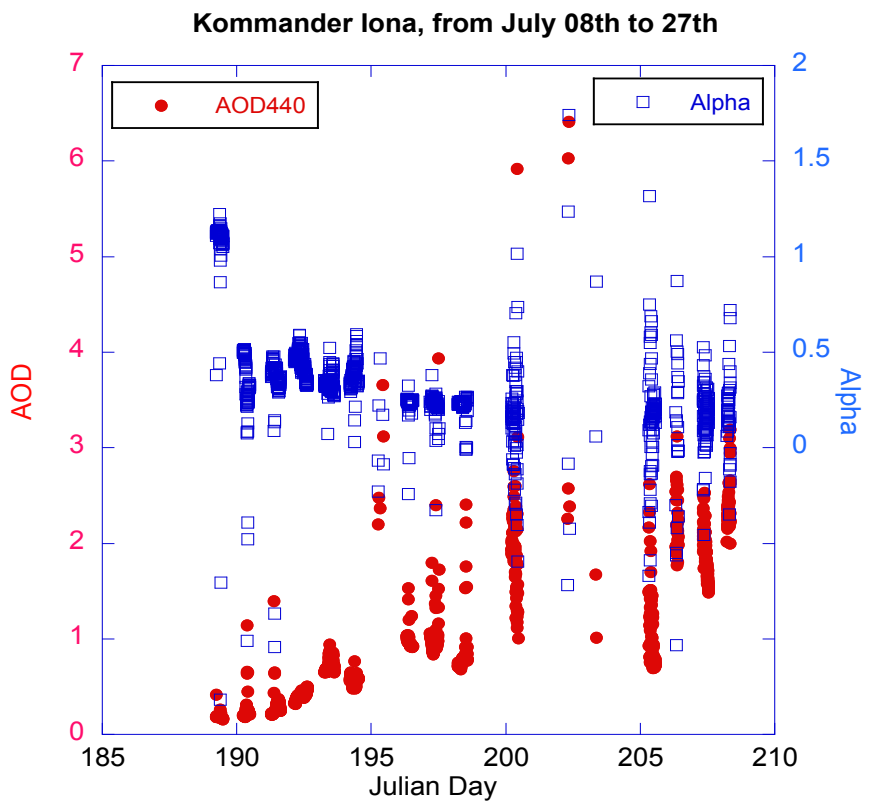
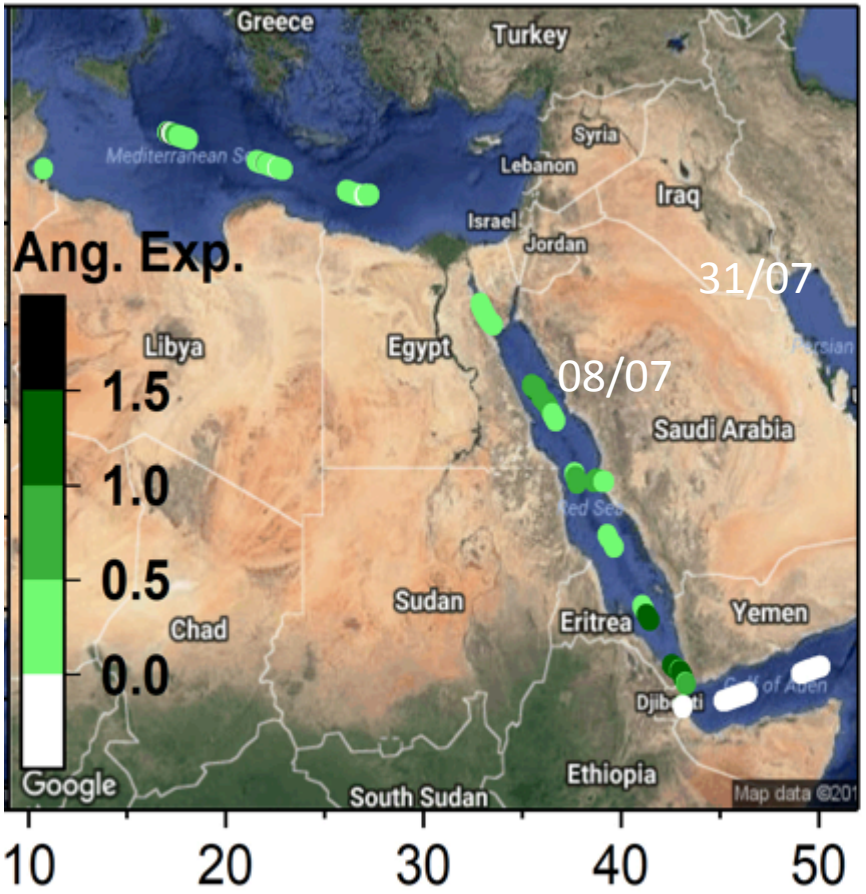
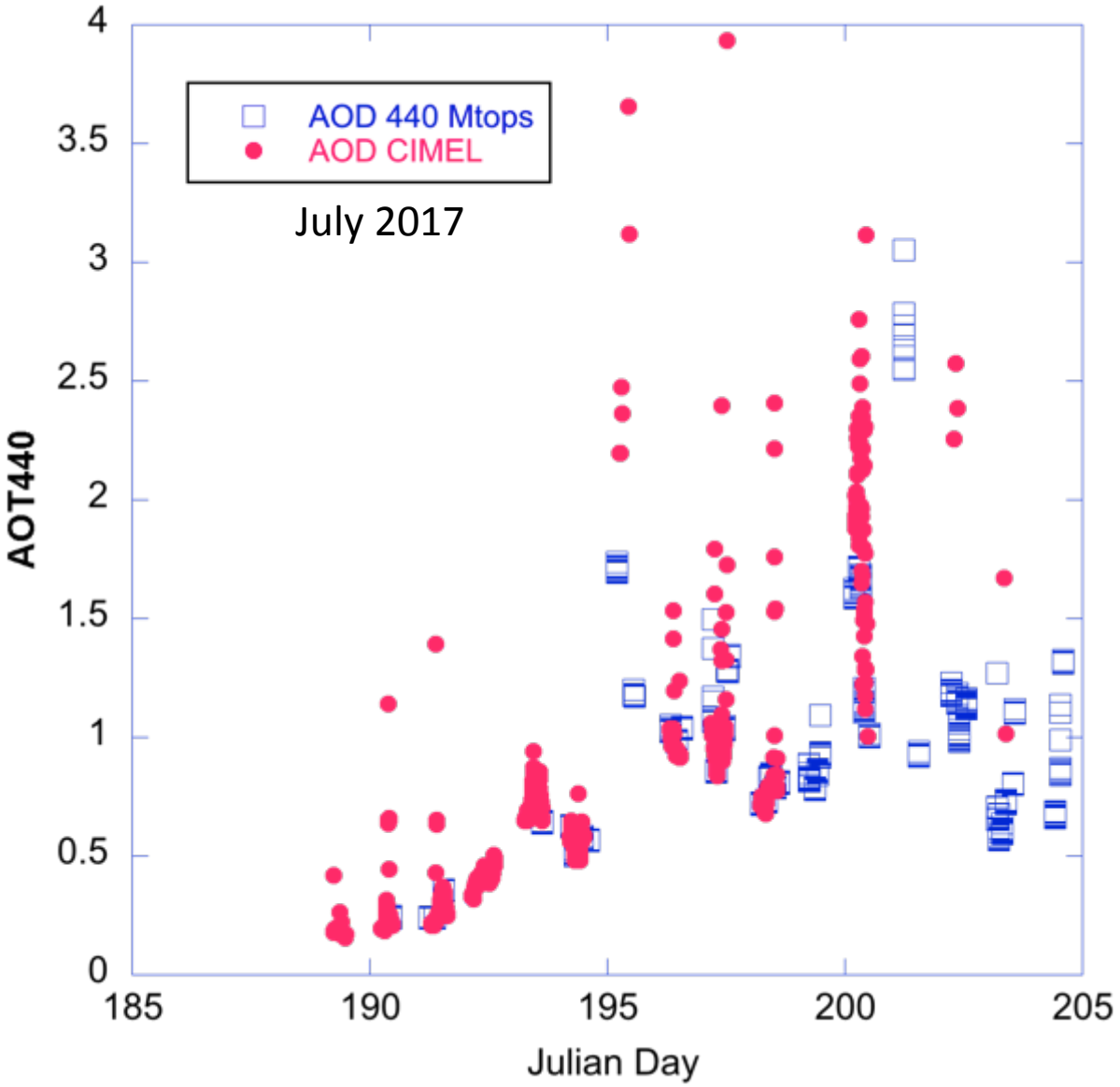


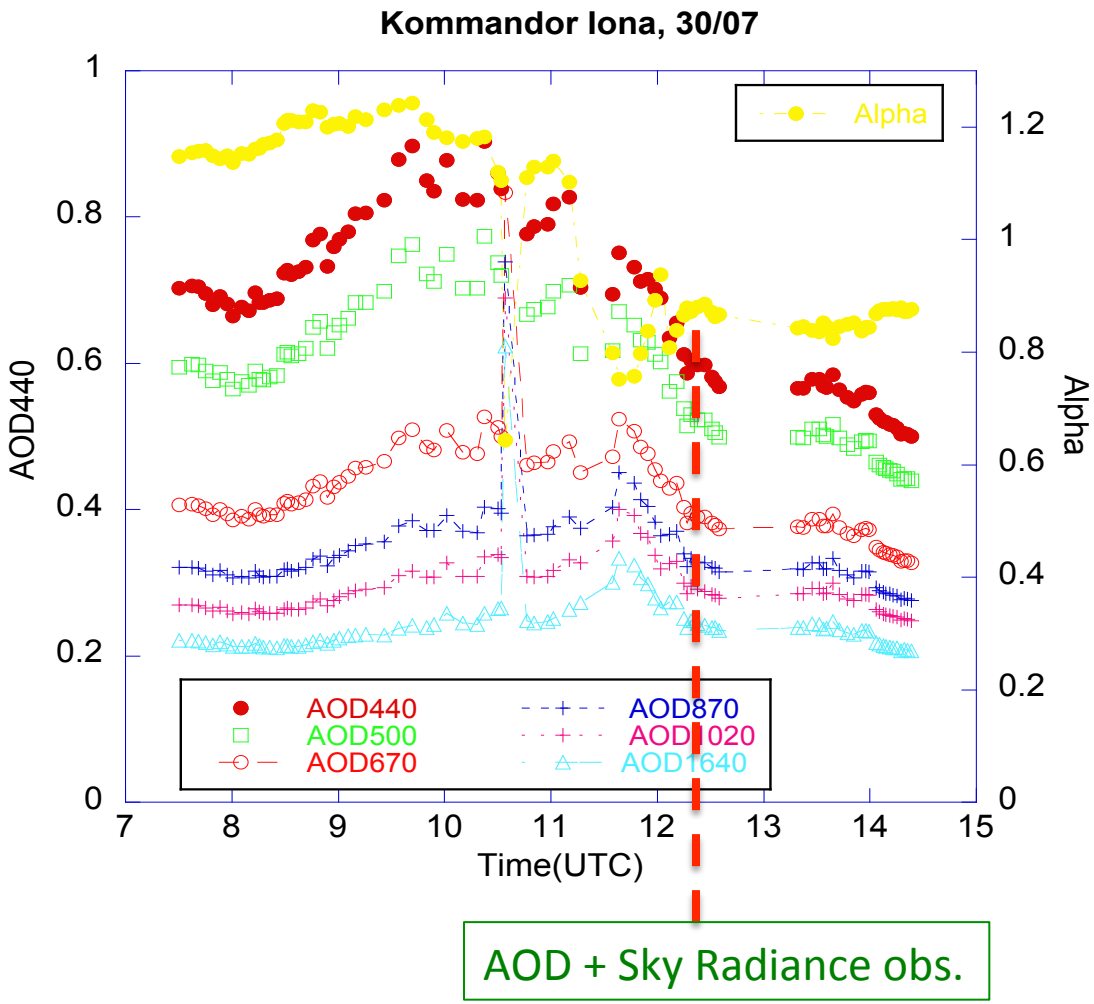
# First Evaluation of AOD

## Comparison with handheld Microtops




**CIMEL and microtops are calibrated by AERONET-Europe**

# 30 July 2017, ship is moving to Kuwait City




In the middle between Kuwait City and Quatar(Persian Gulf)

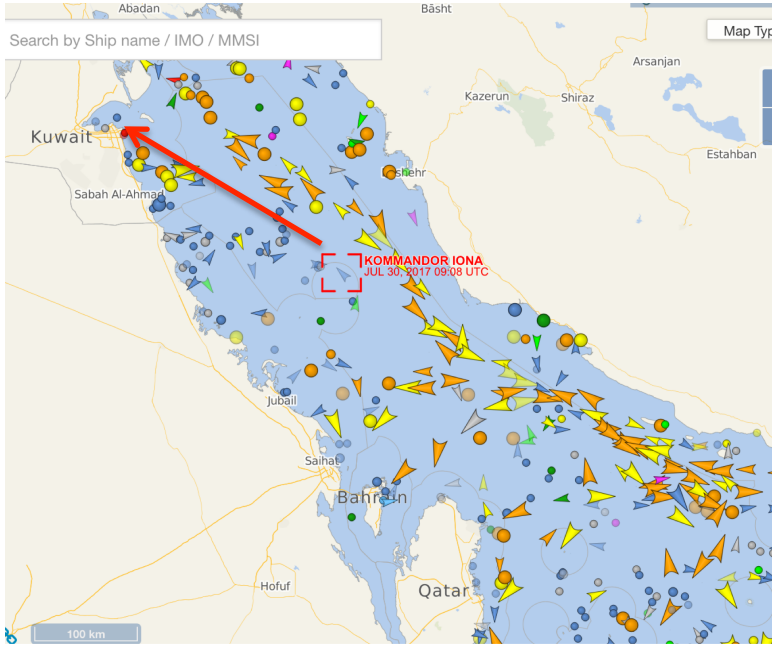


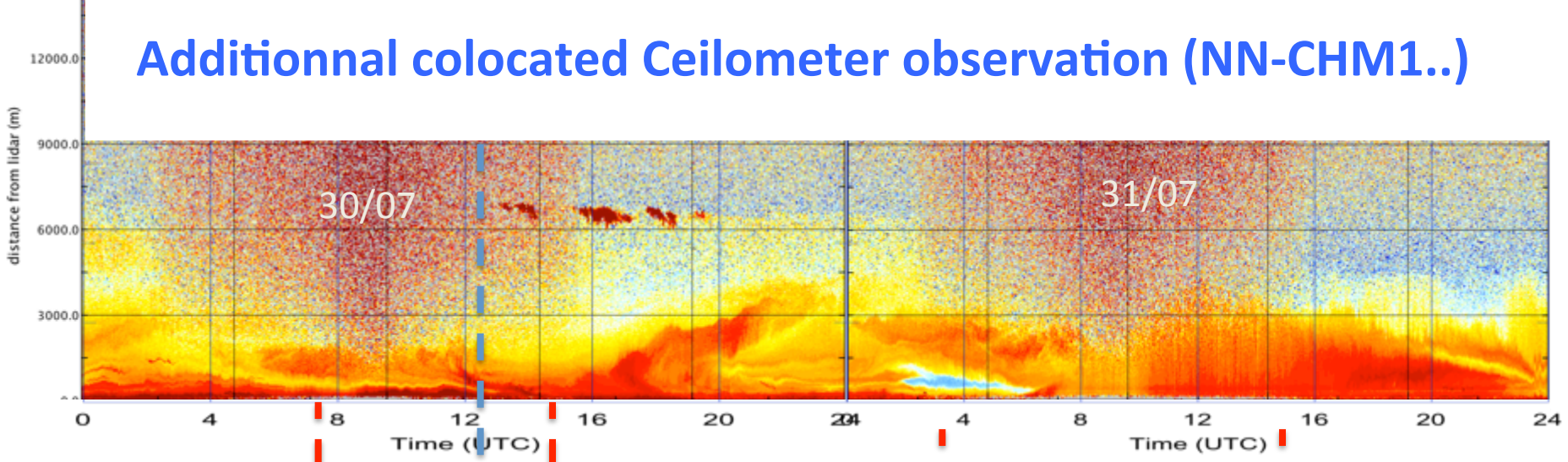

Figure 4 : Location of Kommandor Iona (30th)

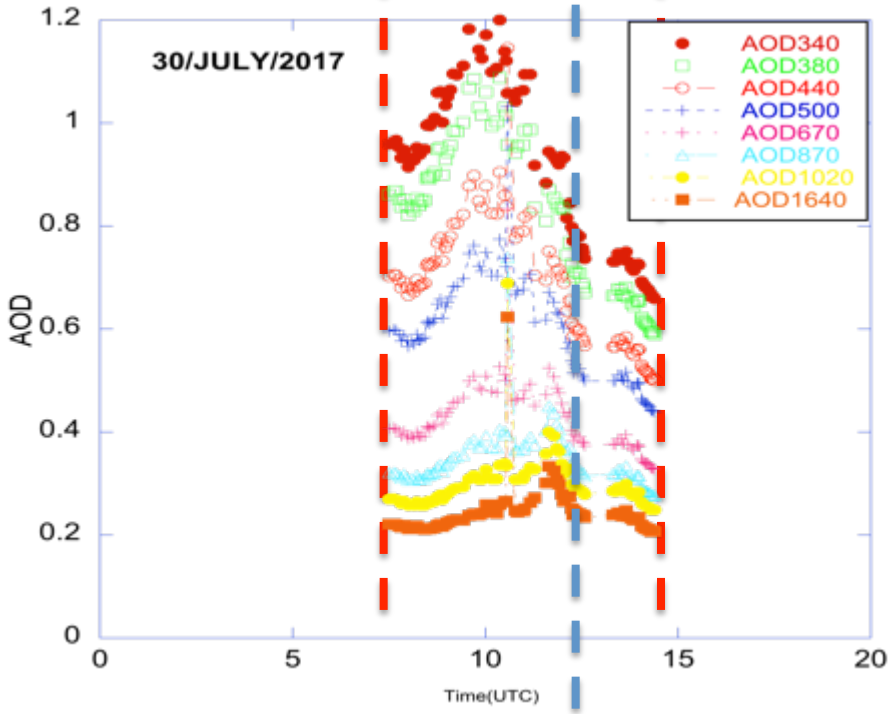
**Can we retrieve more aerosol properties ? YES**

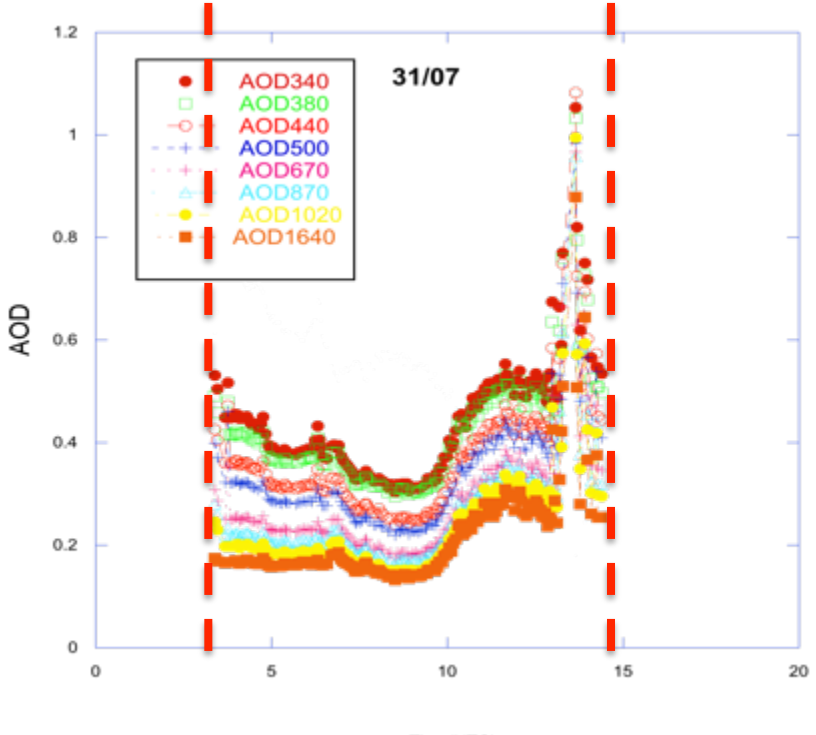
1) Spectral AOD => Volume Size Distribution (Torres et al., 2017, GRASP-AOD algortithm)

2) Spectral AOD and Sky Radiance inversion (GRASP algorithm)

# Additionnal colocated Ceilometer observation (NN-CHM1..)




Moving

Stationnary (Kuwait city)

Inversion Time (no high altitude cloud cont.)

# Inverted Aerosol Properties (30/07, 12h30 UTC)

## Primary Measurements

### Level 1 (AOD # 0.55 at 440 nm + Sky Radiance)

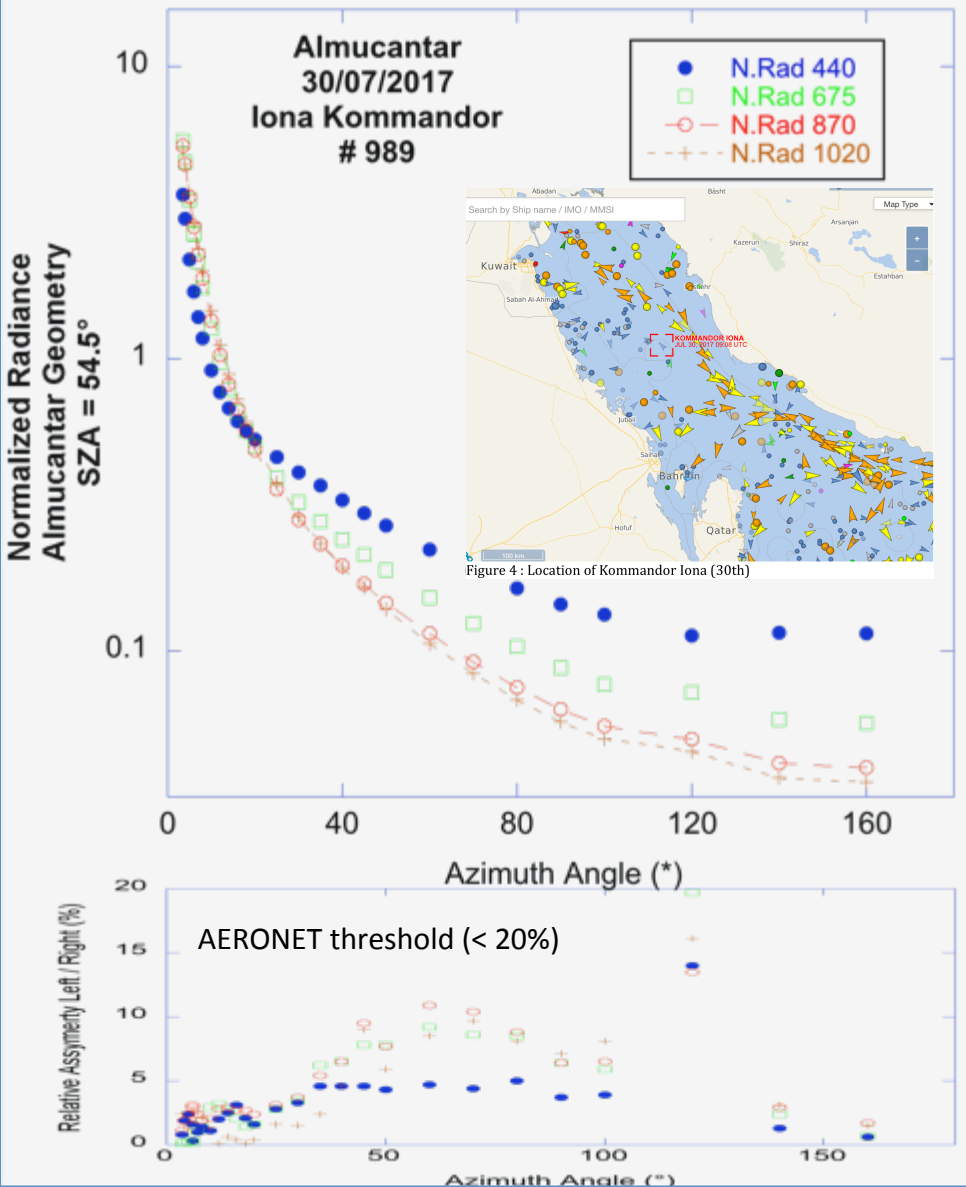
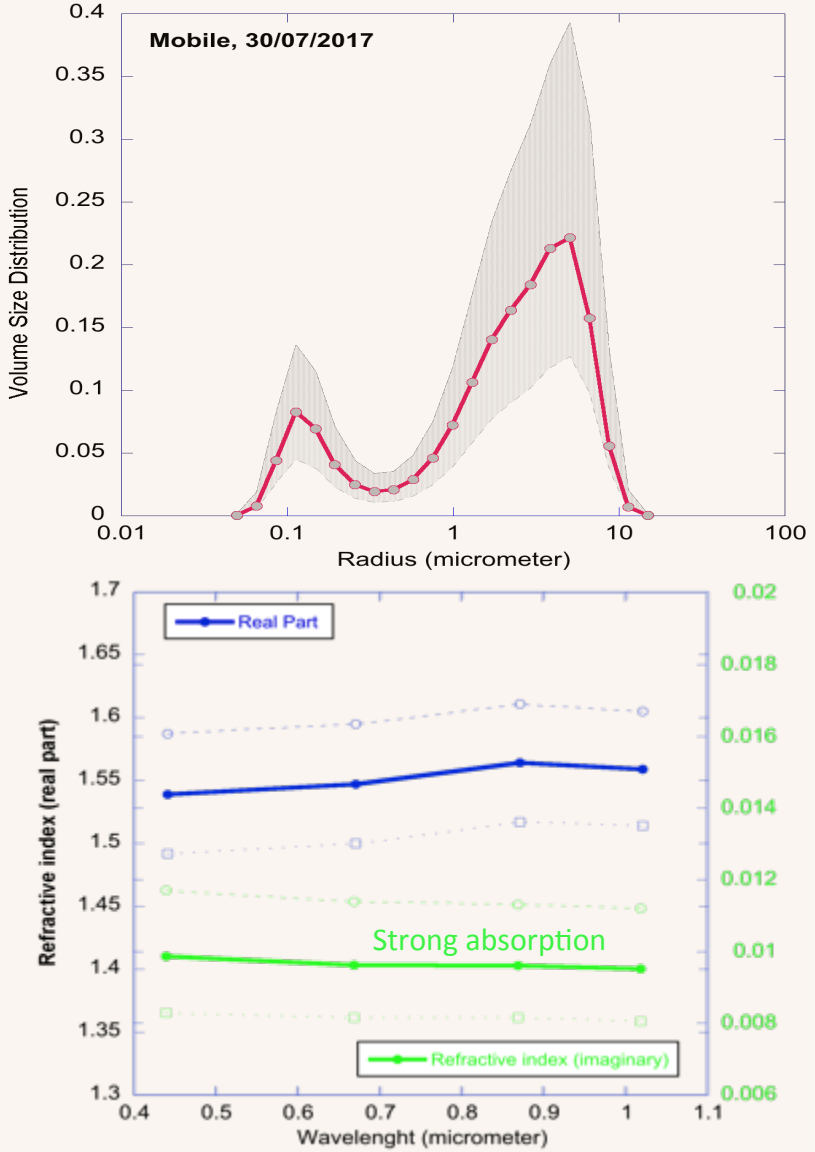


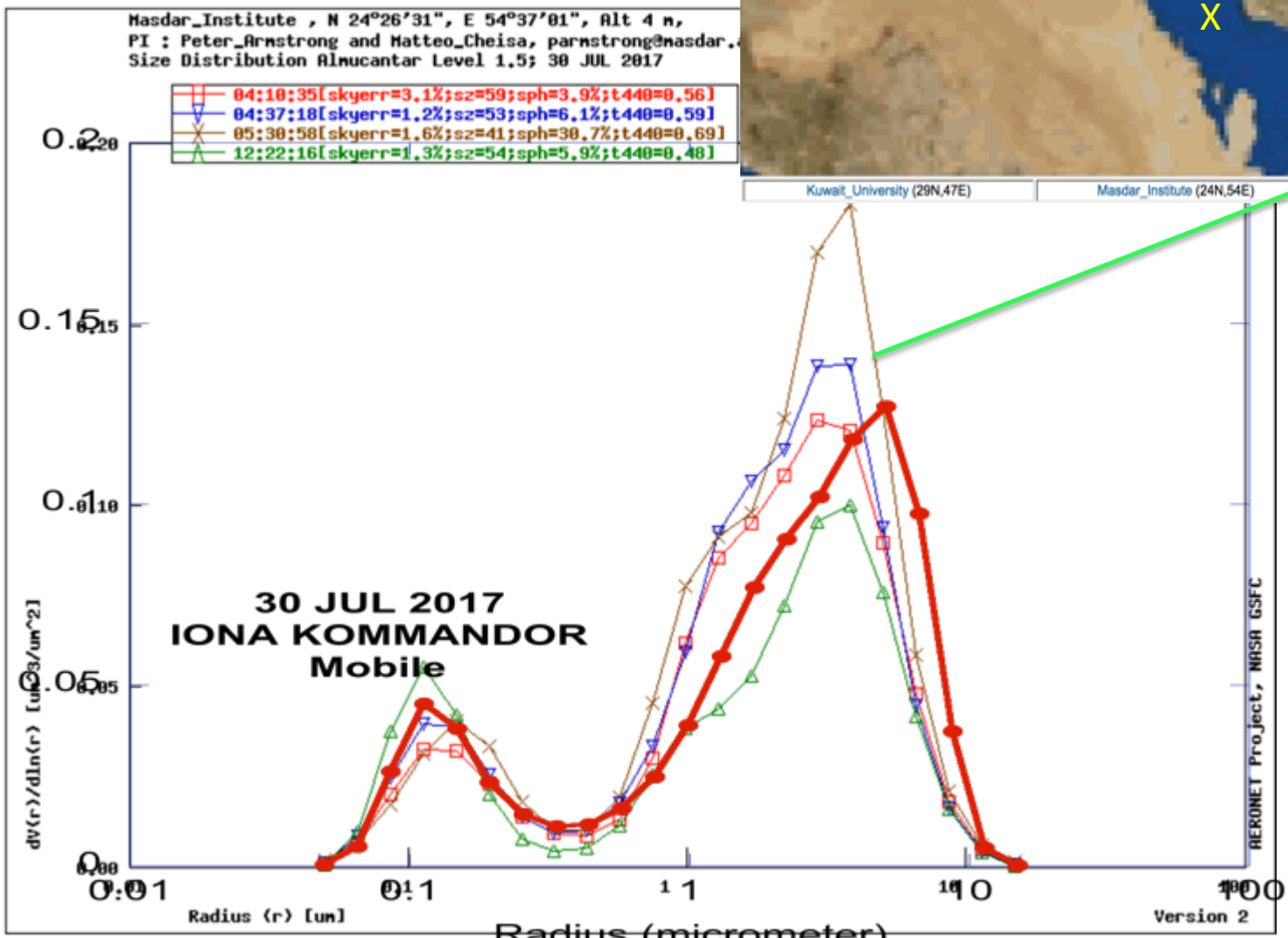

Figure 4 : Location of Kommandor Iona (30th)

## Derived Aerosols Properties

### Level 2 (VSD, CRI,… from GRASP)

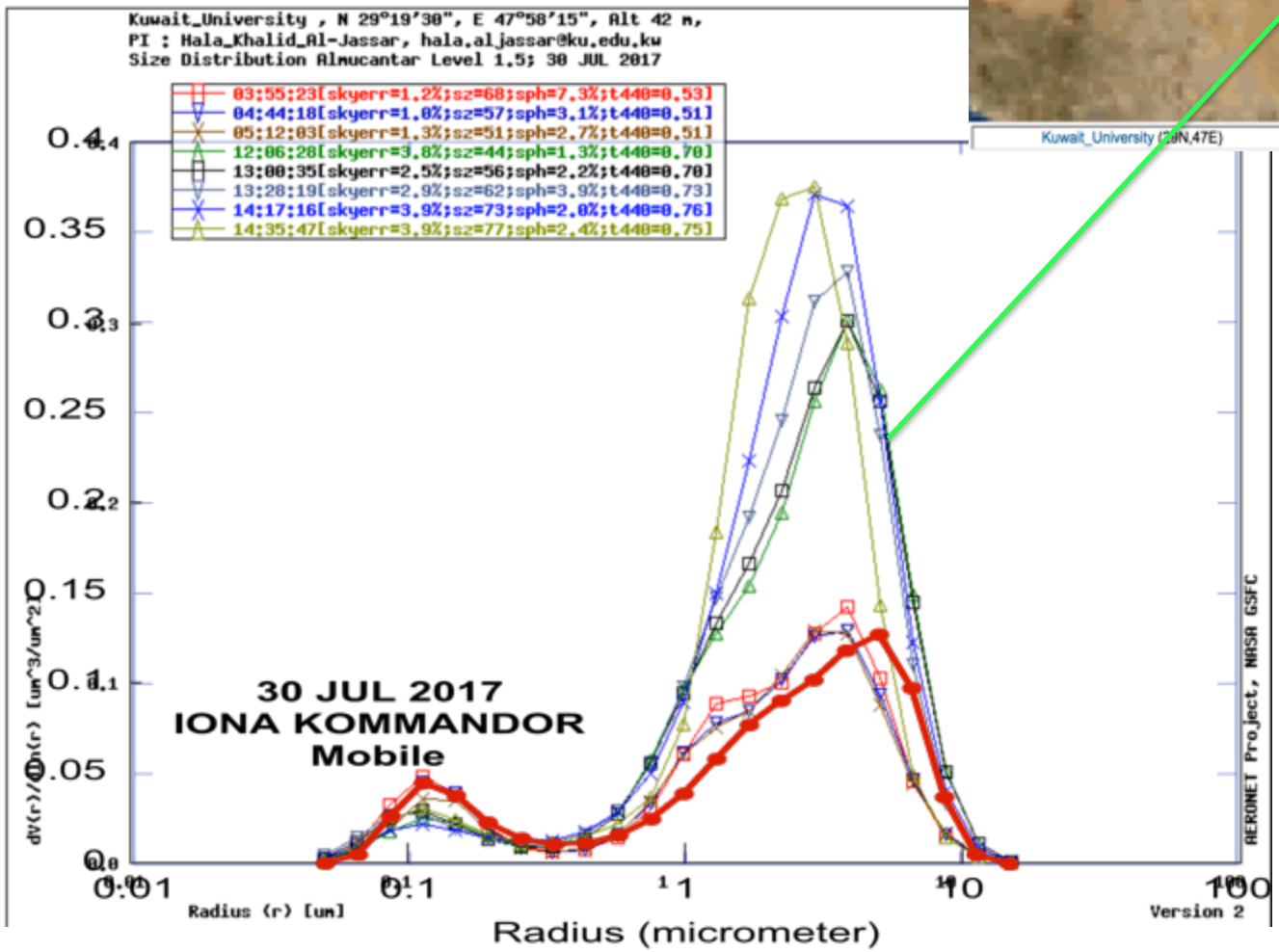


# Masdar Institute 30/07/2017

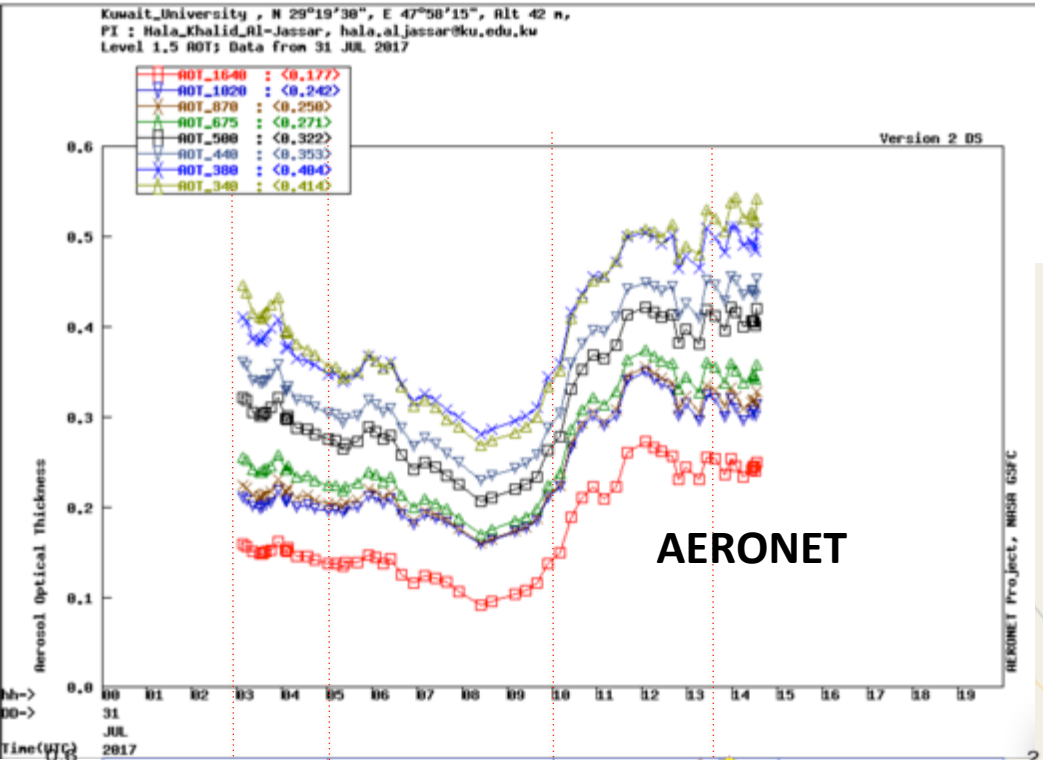

Volume Size Distribution

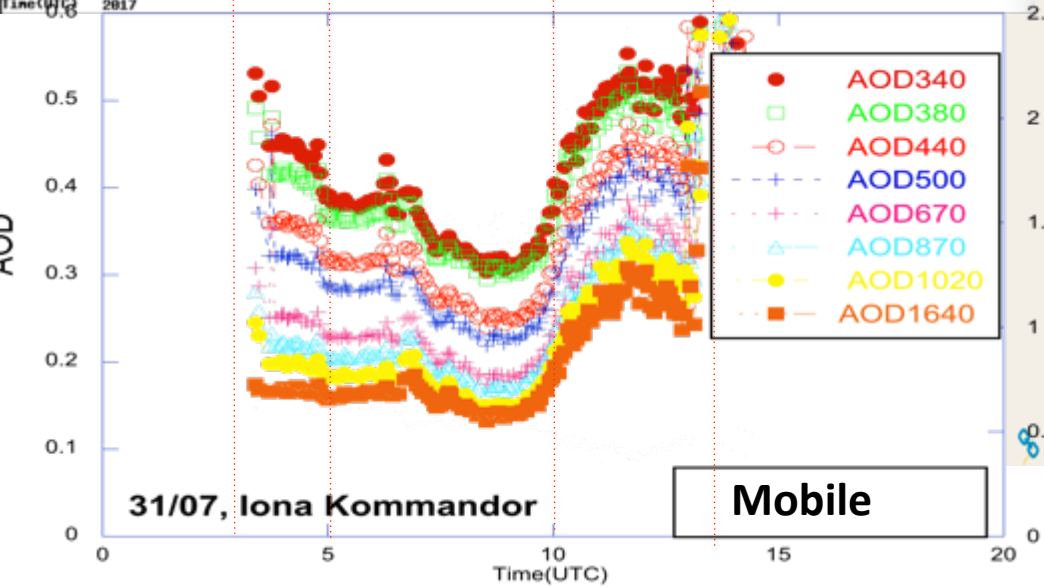
# Kuwait City Univ. 30/07/2017

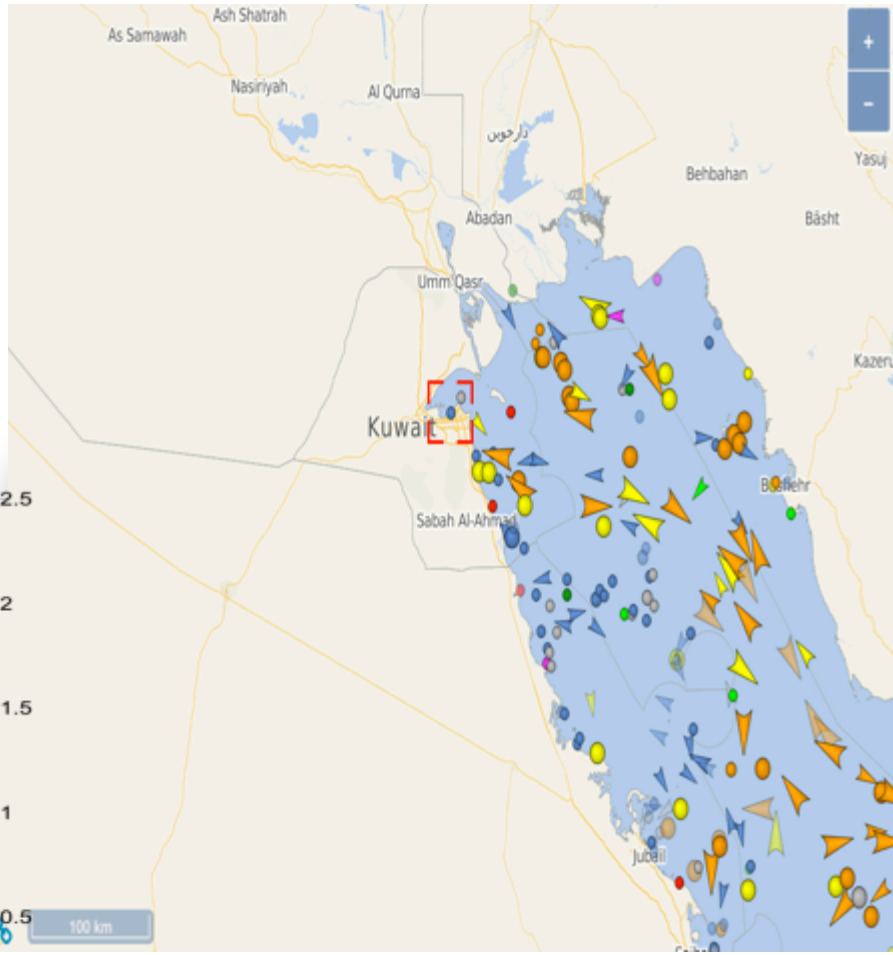



# Comparison with AERONET Station

31 / 07 Kuwait City (stationnary)



# Conclusions / Perspectives

**Main preliminary Conclusions :**

- First AOD data on ship using automatic standard AERONET compatible photometer !
- Verification » against microtops and nearest AERONET fixed station => OK.
- Day time AOD processing at LOA in NRT : OK
- Night time AOD processing : OK (but few data), need new campaign to check, but in principle it is OK.
- First sky radiances data in the almucantar : OK but need to store exact geometry (viewing + azimutal angles-)- Not done yet
- First AOD+sky radiance inversion => quite reasonable results (must continue the analysis)

- Remaining problems : difficulties to measure the ship direction (Cap) + humidity sensors to be changed more frequently or improved)!

# Conclusions / Perspectives

**Next steps (phase 3)**:

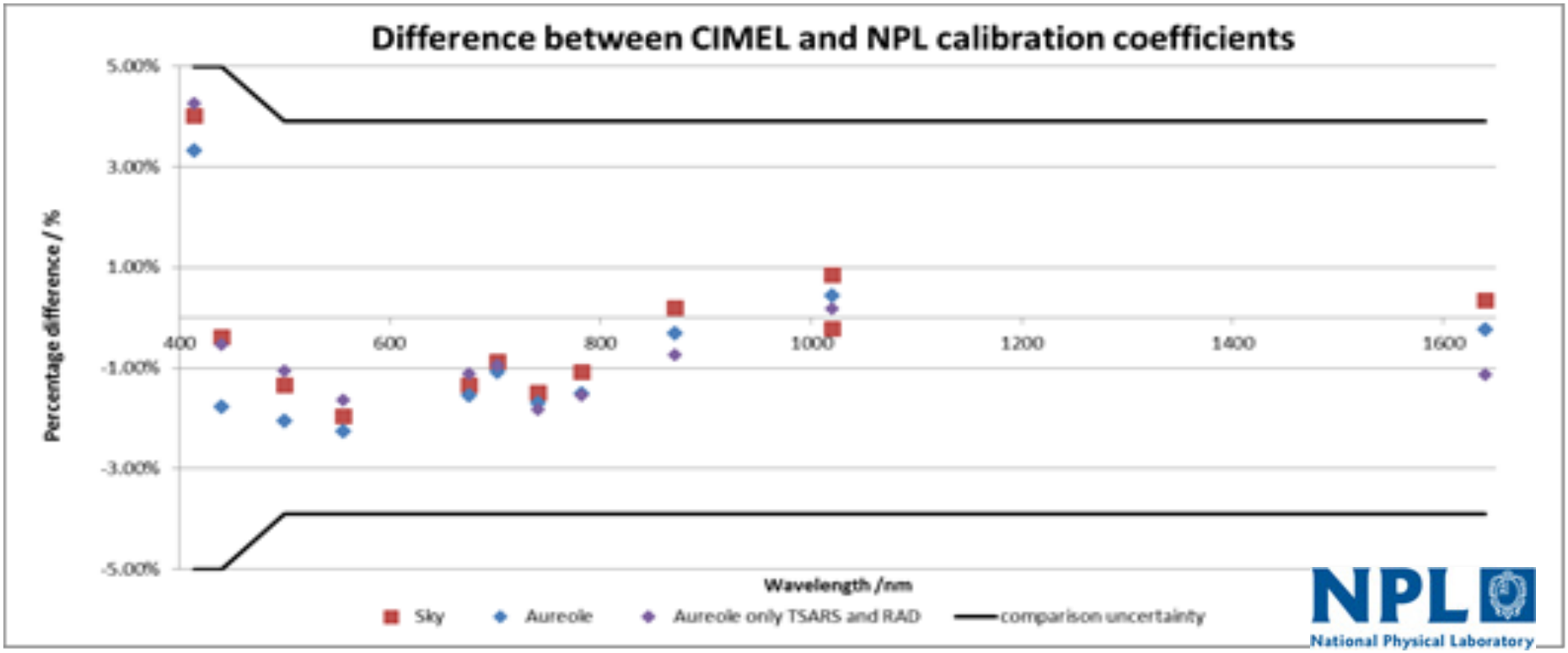
- New approach to measure ship direction under investigation (GPS)
- Analysis of day time and night time AOD
- Measure and storage of precise viewing zenith and azimuth angles, to use exact angles in the inversion
- Potential synergy between AOD, radiance and attenuated backscatter Ceilometer or LiDAR data (e.g. GARRLIC softwares).
- Need full autonomy (no external inertial central) and automatic photometer, AERONET-compatible
- Step 2 (2018) : specific robot building (compacity for other vectors like airborne, car, etc…, water protection) + coupling with nead head.
- Future ship campaigns (2018, …)
- Automatise retrievals : Level 0-> Level 1 (done); Level 1-> Level 2 (GRASP-Based)

# Recommandations for mobile system

Push this potential exploratory facilty in the framework of ACTRIS (as a Service)

Involvement in future Cal/Val activities

# Phase 3: Sky radiance traceability (NPL), AOD (Davos in progress)




How we can establish a formal link in to have traceability with AERONEt Europe on a regular basis ?

Thank you !