CIMEL

EXPLORE THE CLIMATE

FRM4SOC Presentation

Ocean Colour Solutions

Stéphane Victori
Head of R&D Optical lab

Satellite Ocean Colour Validation / Calibration

NPL Presentation

Summary

01 **Presentation**

02 **Products & Applications**

03 **Development Projects**

04 **Conclusion**

EXPLORE THE CLIMATE

1. Presentation

CINEL
EXPLORE THE CLIMATE

Who we are…

French manufacturer of meteorological and atmospheric observation systems for all “weather sensitive” activities

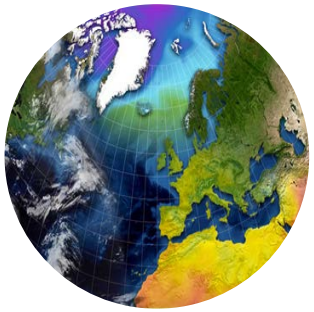
High quality & robustness for harsh environments

Autonomous & reliable field equipment

Smart design & economical systems

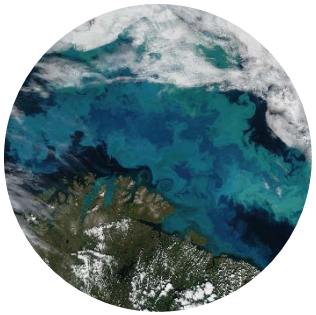
50 years of continuous leading expertise in the core of tomorrow markets

Meteorology



Climate change

Oceanology



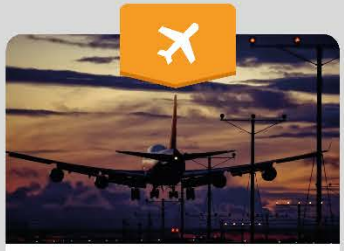
Air quality

What we do…

Automatic Weather Stations

CimMETEO

CimAGRO


CimAWOS

CimSOLAR

Remote Sensing Solutions

CIMEL
EXPLORE THE CLIMATE

Some of our partners…

- Calibration
- R&D lunar AOD
- Data center (operational)

- LiDAR Reference
- Calibration platform

- Calibration
- Measurement campaigns
- Data center (operational)

- Calibration
- R&D Lidar bi-λ
- R&D photometer lunar

2. Products & Applications

CINEL
EXPLORE THE CLIMATE

CIMEL Website : Remote Sensing instruments

REMOTE SENSING INSTRUMENTS

CE312 - High precision IR Radiometer CLIMAT

The CE312 IR radiometer CLIMAT (*) is the benchmark precision instrument for measurements of spectral luminance in 4 to 6 thermal InfraRed bands. Thanks to differential measurement principle, it performs radiation ...

VIEW

CE318-T - Sun Sky Lunar Multiband Photometer

As the only photometer operated by the AERONET international federation of networks since 1992, the CE318 multiband photometer is recognized as the worldwide reference for aerosol observing networks. The latest version, the ...

VIEW

CE332 - Airborne multiband infrared radiometer

CE332 is a very accurate device for measuring simultaneously an aimed target radiance and brightness over three thermal infrared bandwidths The radiometer is specially designed to be used in mobile ...

VIEW

CE351 - Atmospheric multi-band imager

CE351 imager measures the sky radiance in 6 bandwidths from 406 nm to 628 nm. Its original patented design of its telecentric optics (Fish-eye +/- 92°) ensures an absolute measure with ...

VIEW

CE370 - Long Range Automatic Aerosol LiDAR

Eye safe LiDAR for 24/7 aerosol and cloud monitoring up to the stratosphere The CE370 LiDAR provides continuous high performance measurements of aerosol and cloud spatial distribution on an extended range. It ...

VIEW

CE376 - Compact Automatic Aerosol LiDAR

The CE376 is a compact, eyesafe backscatter LiDAR, featuring outstanding performances for the automated continuous monitoring of aerosols. It operates in the visible (green) and/or in the near infrared (NIR) ...

VIEW

CE600 - Underwater multi-band imager

CE600 imager measures underwater multi-spectral radiances in 6 bandwidths from 406 nm to 628 nm. Its original patented design of its telecentric optics (Fish-eye +/- 92°) ensures an absolute measure with ...

VIEW

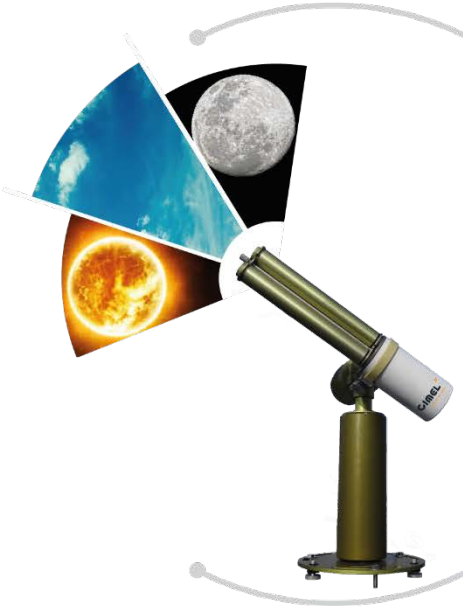
CE318T Photometer in the field

EXPLORE THE CLIMATE

Photometers: new CE318-T version!

CE318-T

Multispectral analysis



- Aerosol quantification (AOD)
- Atmospheric analysis & climate studies
- Satellite calibration & data validation
- Site validation of solar power plants

- Day and night AOD measurements
- Complementary to the LiDAR
- Fully autonomous & user-friendly
- Harsh environmental conditions
- Customisable (filters, scenarios...)

Product models

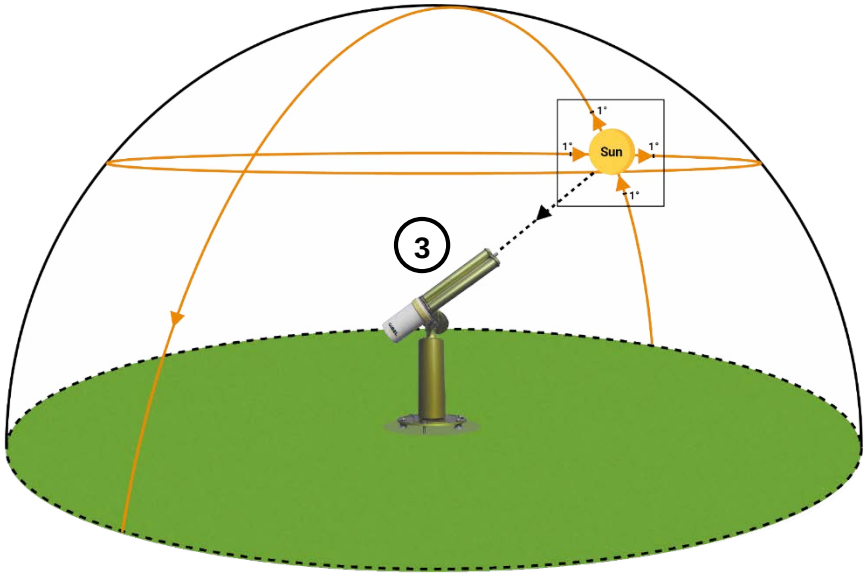
- Standard
- Polarised
- Lunar
- Ocean Colour
- Lake Colour
- BRDF

Principle of measurement

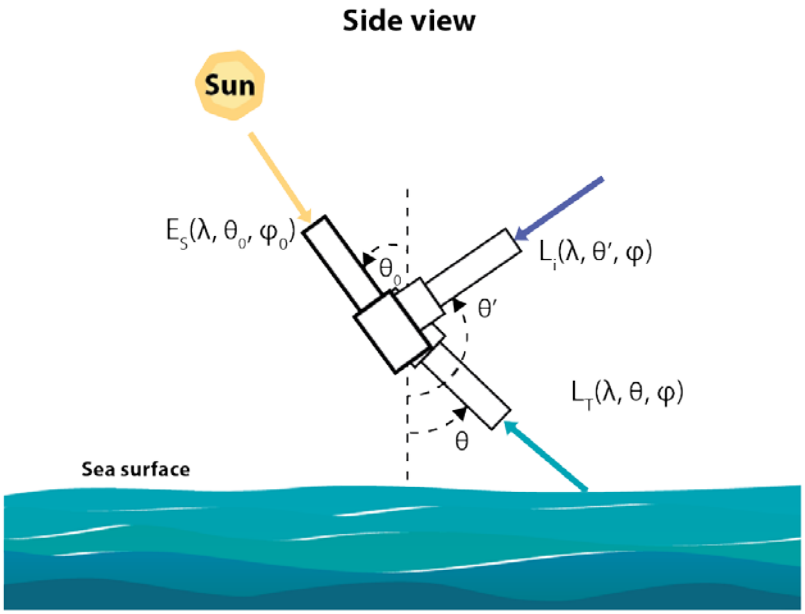
Standard

SUN

Φ ALM & PP & HYB



Ocean / Lake



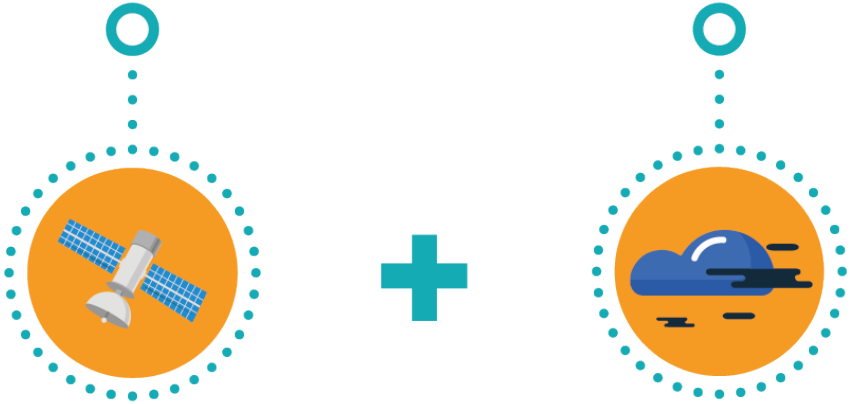
SeaPRISM configuration used to measure direct Sun irradiance E_S, sea-radiance L_T and sky-radiance L_i

CIMEL EXPLORE THE CLIMATE

Applications & Scenarios

Satellite calibration & data validation

Atmospheric correction



SeaPRISM photometer:
Ocean Colour & Lake Colour

400, 412,5, 442,5, 490, 510, 560, 620, 665, **779**, 865, 937, 1020 nm

12 wavelengths

412,5, 442,5, 490, 510, 560, 620, 665, **681**, **709**, 865, 937, 1020 nm

➔ **Customisable (filters, scenarios, polarisation)**

SeaPRISM photometer

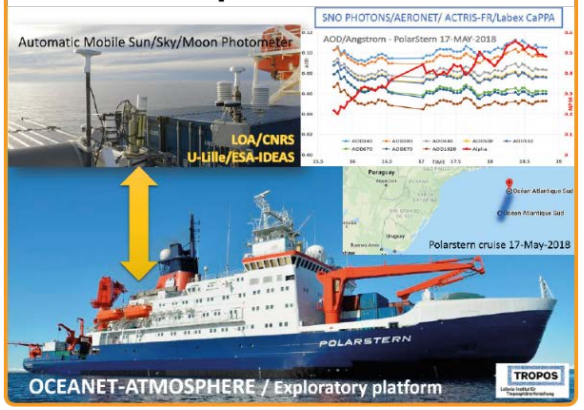
Integration in the NASA
AERONET-OC network

- Water-leaving radiance
- Water vapor
- Single scattering albedo
- Aerosol optical Depth (AOD)
- Global solar radiation
- Refractive index

➔ **Standardised instruments, calibration procedure & data processing**

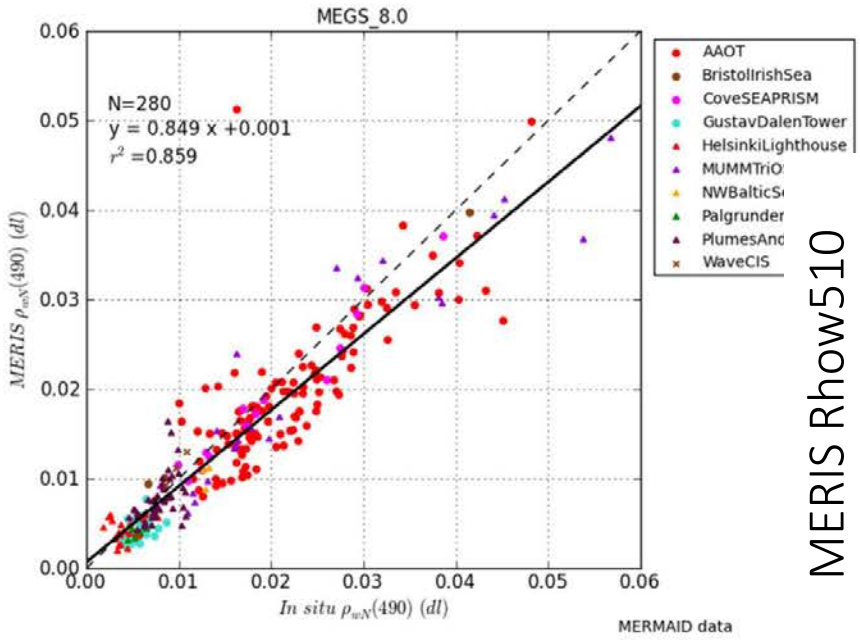
Instrument control

On boat, offshore & coastal platform



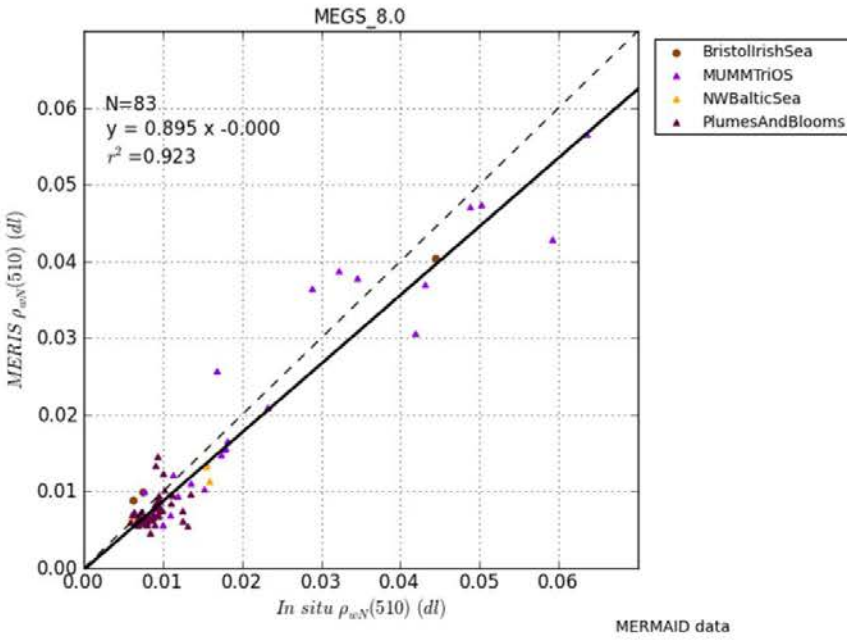
10 years of MERIS validation data

MERIS Rhow490



In situ Rhow490

MERIS Rhow510



In situ Rhow510

1. AERONET-OC stations produce significantly more matchups
2. AND have standardised calibration, processing and Quality Control
3. BUT do not cover all wavelengths

[MERIS 3rd reprocessing data validation report, ACRI, 2012]

Data courtesy of PIs (D. McKee, K. Ruddick, D. Siegel, S. Kratzer) and AERONET-OC PIs (G. Zibordi, G. Schuster, S. Kratzer, B. Gibson), matchup using MERMAID

Courtesy of K. Ruddick

CE351

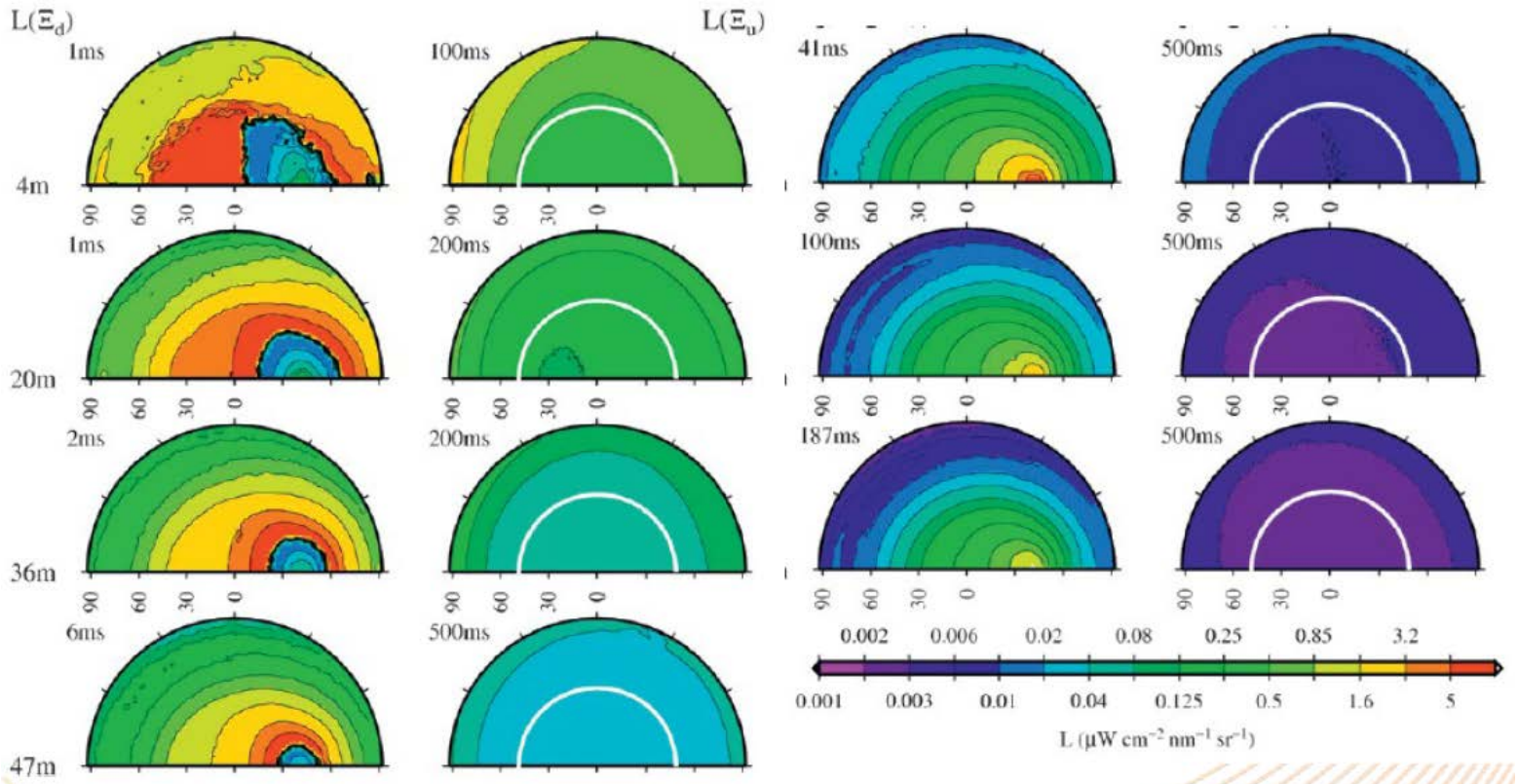
Multiband atmospheric/submarine imager

1. Spectral radiances over the whole hemisphere (184° FOV)
2. 6 bands in the visible
3. Automatic continuous operation
4. Outdoor / submarine
5. Calibrated radiances

➔ Full hemispheric radiance map in RT

CIMEL
EXPLORE THE CLIMATE

CE-351: submarine Radiance map



Arctic (Beaufort Sea) during the Malina cruise in August 2009 (station 235–2). The sun zenith angle was 658, the sky was clear, and the chlorophyll concentration was 0.1 mg(Chl) m23

Courtesy of David Antoine

CINEL
EXPLORE THE CLIMATE

3. Development Projects

3.1 Mobile Photometer

CINEL
EXPLORE THE CLIMATE

AQABA – campaign 2017

➔ First Automatic Sun/Sky/Moon CE318-T photometer on a ship

- **Exploratory Observation** : technology to test
- **First Objective:** Spectral AOD (Day / Night)
- **Second Objective**: Sky Radiance (Almucantar)

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

AQABA– campaign 2017

Inclinometer
Magnetic compass
(replaced by a differential GPS)

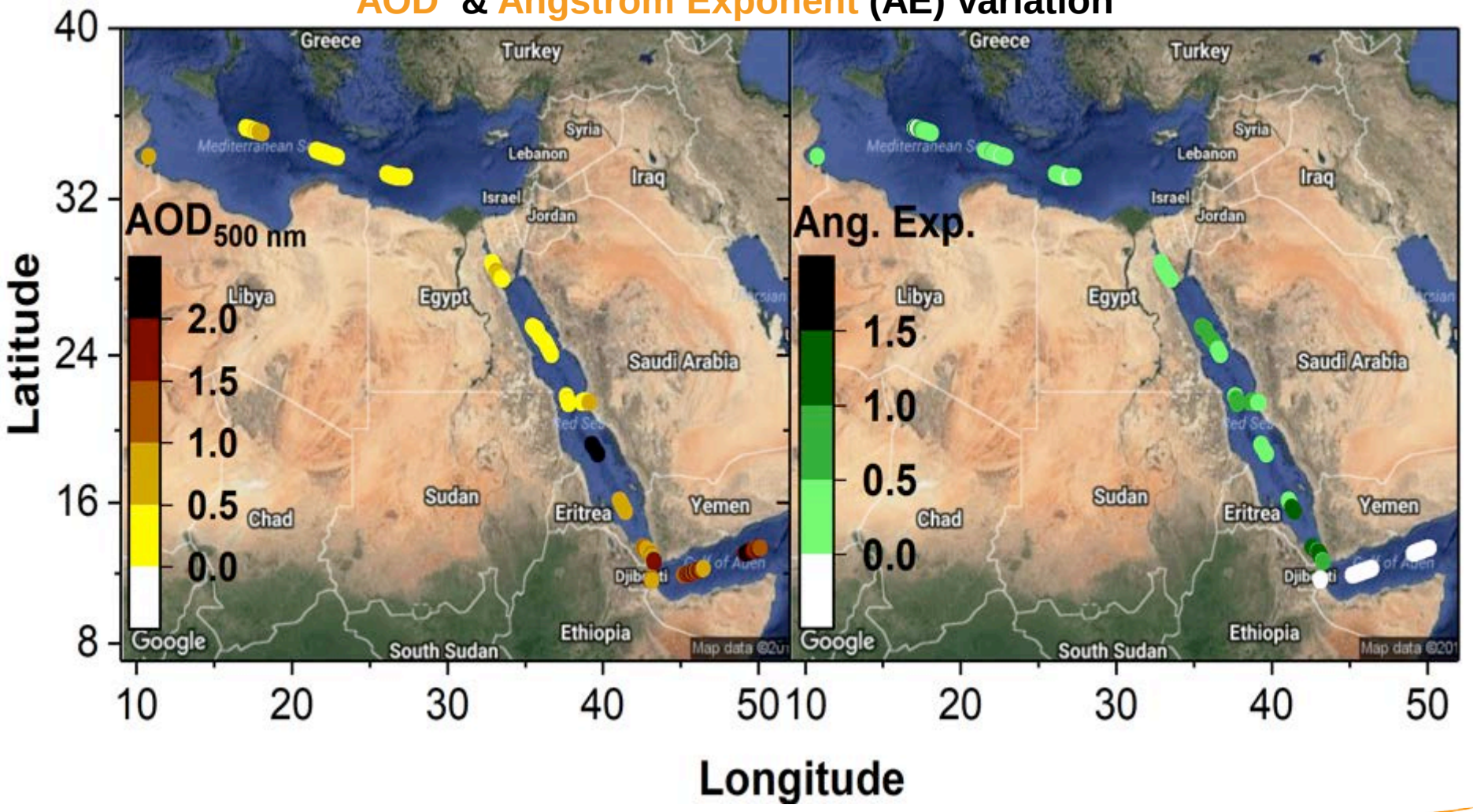
Data logger to control the photometer CE318-T

3G Key or on board internet access ➔ LOA data processing system (NRT)

AQABA– campaign 2017

Overview of the first part of AQABA observation

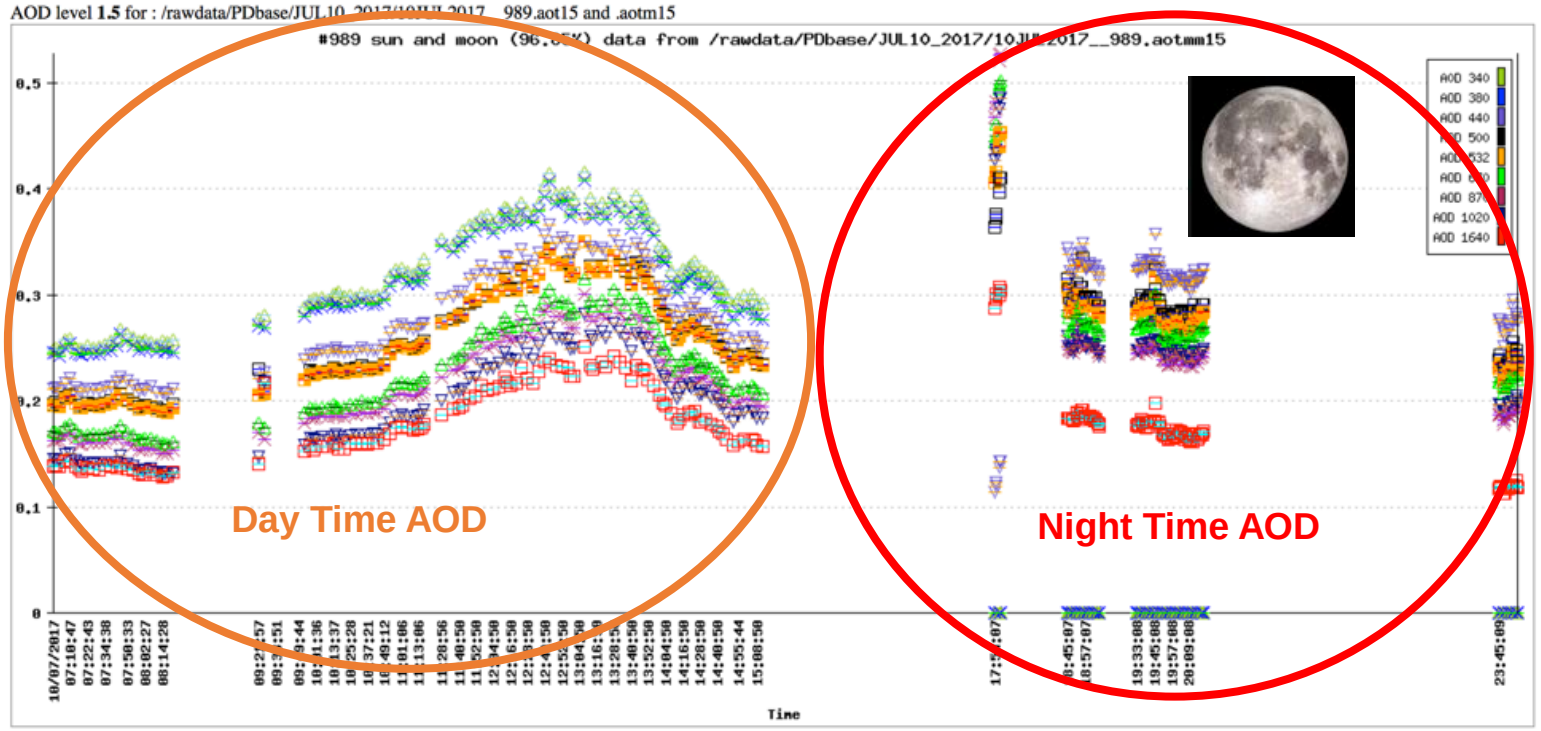
AOD & Angström Exponent (AE) variation



CINEL
EXPLORE THE CLIMATE

AQABA– campaign 2017

AERONET/PHOTON Data Processing System has been adapted to mobile system (AOD)

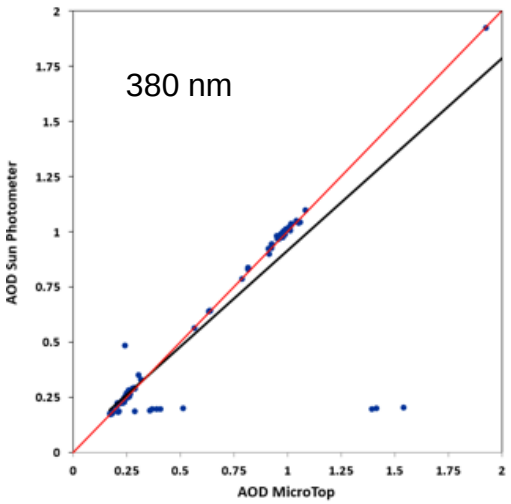


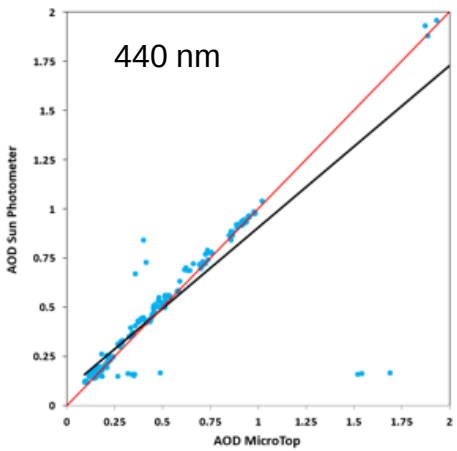
Day time AOD [/rawdata/PDbase/JUL10_2017/10JUL2017__989.aot15] :
Version 2.04 (13.07.2017), SNO PHOTONS, LOA/Univ. Lille/CNRS,0989,K8
Site Lat Lon Alt(m) : Kommandor_Iona 21.4795 38.6642 0.0
Triplet threshold on AOD for cloud screening : 0.010 Uncertainty on AOD : 0.01 (0.02 in UV)
Water-Vapor abundance 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

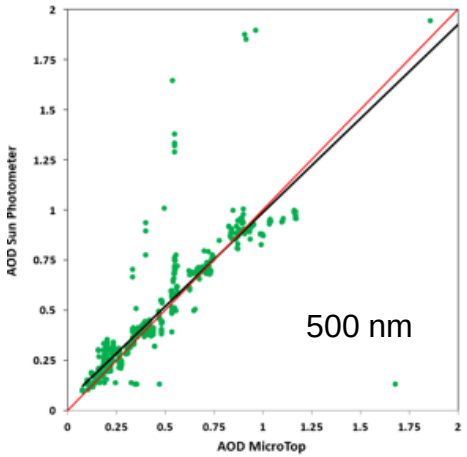
CINEL EXPLORE THE CLIMATE

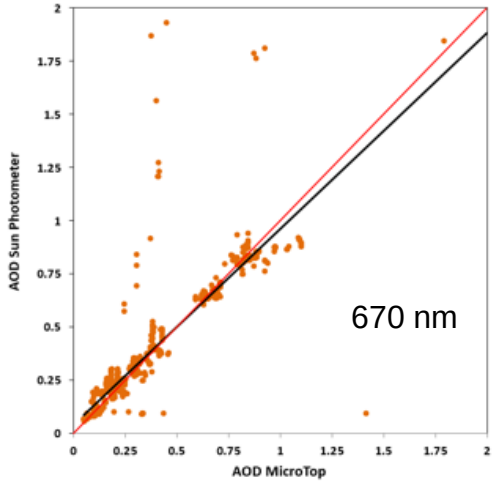
AQABA– campaign 2017

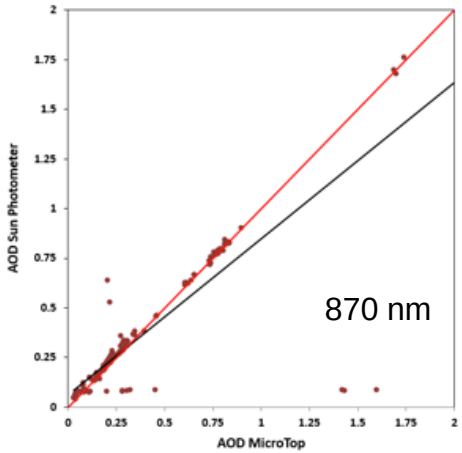
AOD CIMEL Automatic (#989) Vs AERONET MicroTop











Period 07/07 to 01/09/2017

Arabian Sea
Latitude 40° to 10°

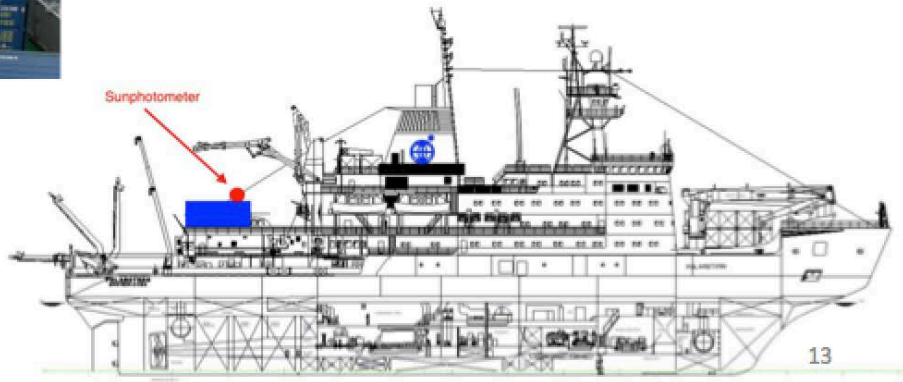
Projection made with a maximun of 5min shift between each data

Data Level 1.5

OCEANET – campaign 2018

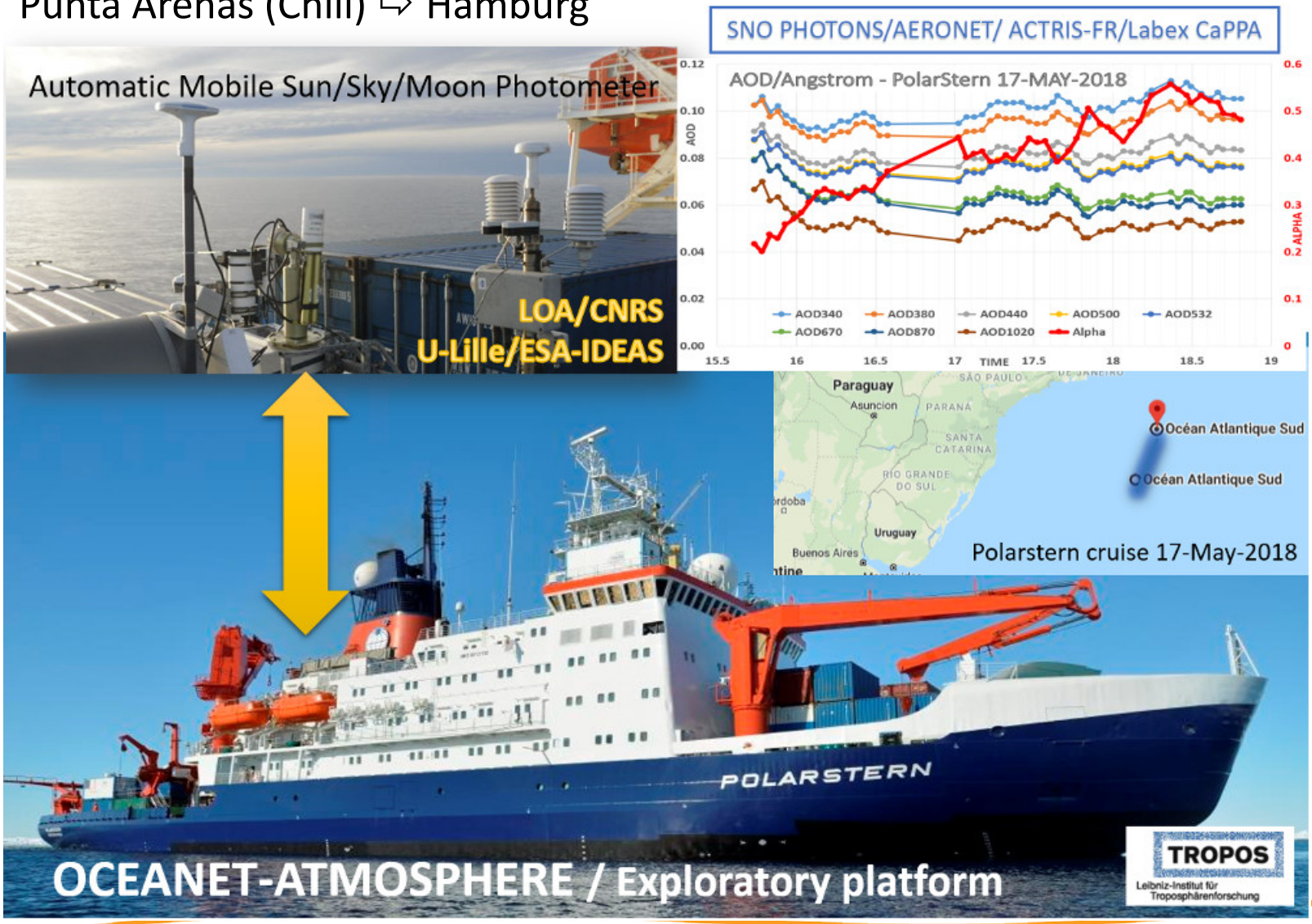
CINEL
EXPLORE THE CLIMATE

TROPOS

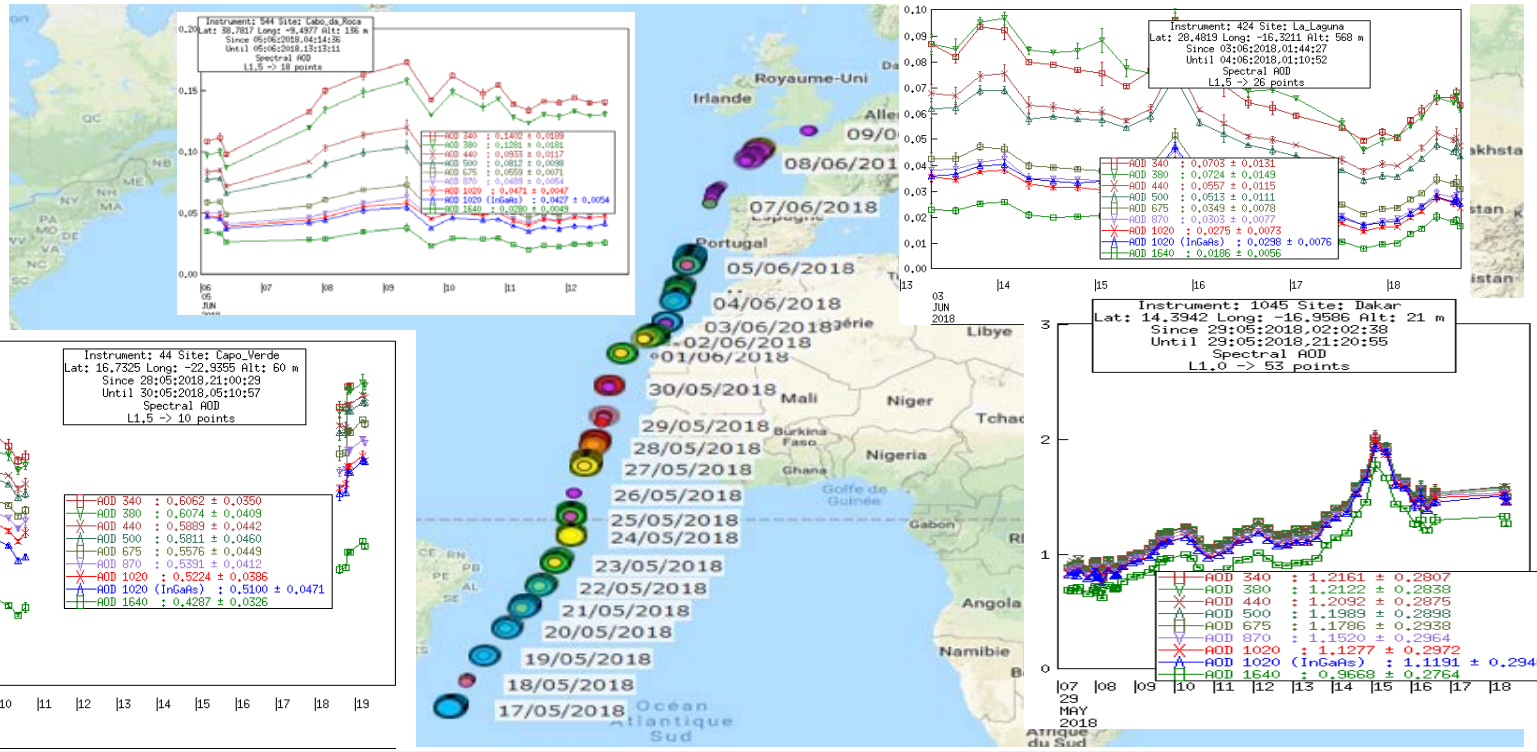


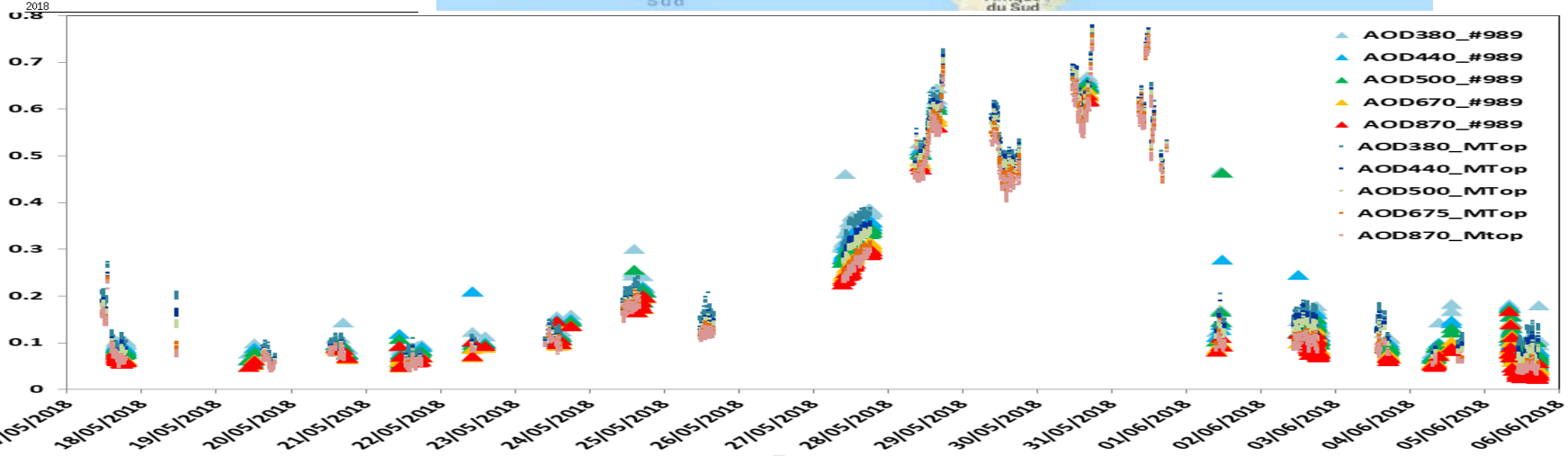
OCEANET – campaign 2018

Punta Arenas (Chili) ⇨ Hamburg



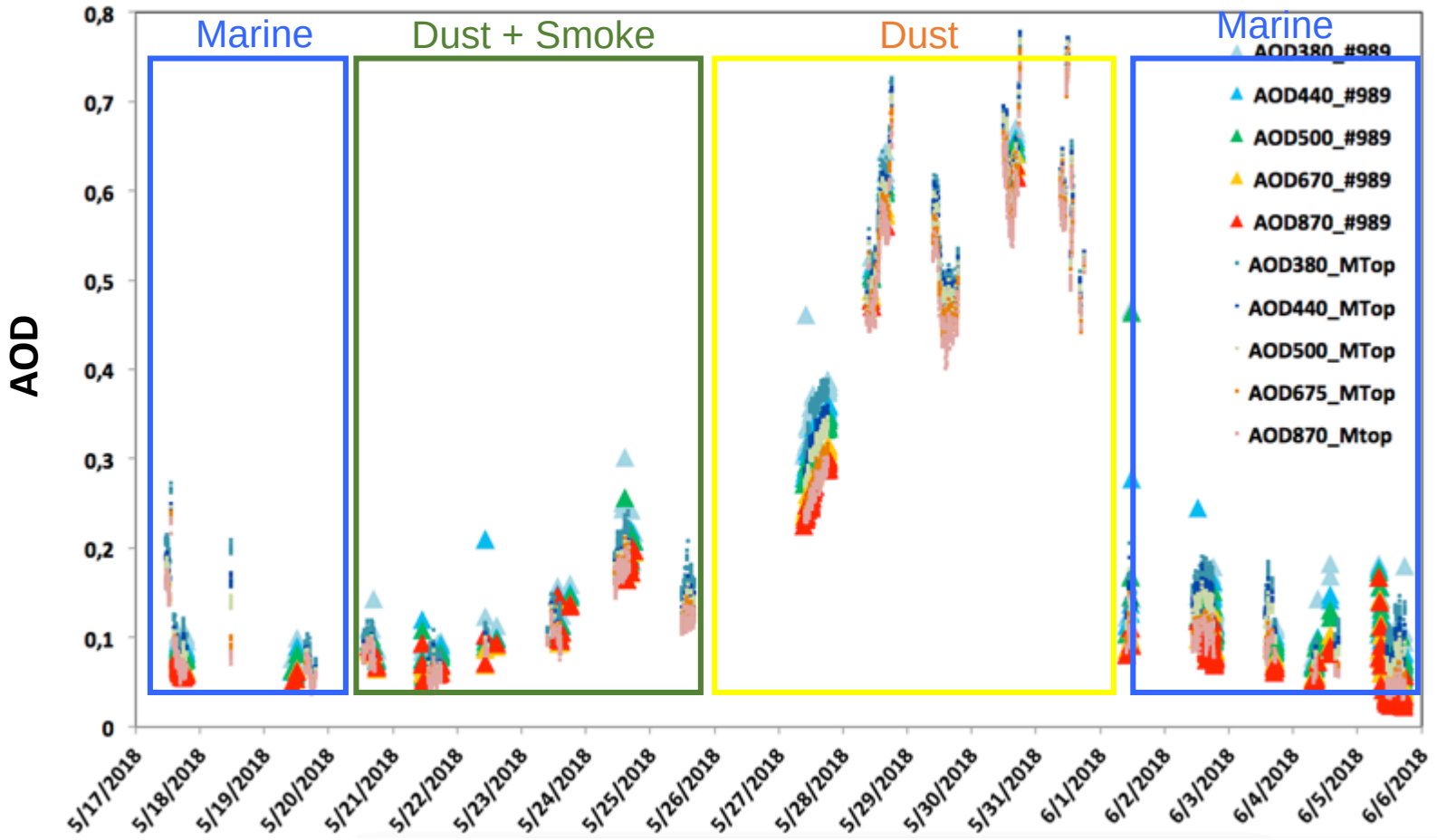
POLARSTERN – campaign 2018





POLARSTERN – campaign 2018

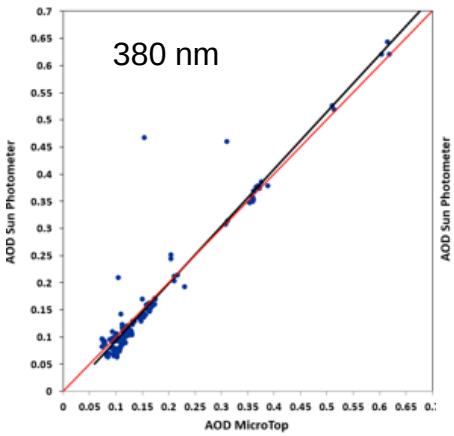
ACTRIS/PHOTONS (CE318T, #989) Vs Microtops (AERONET)

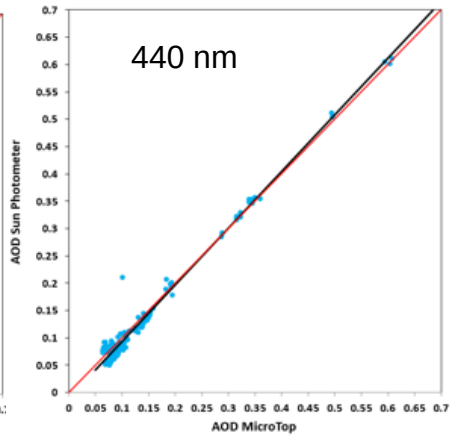


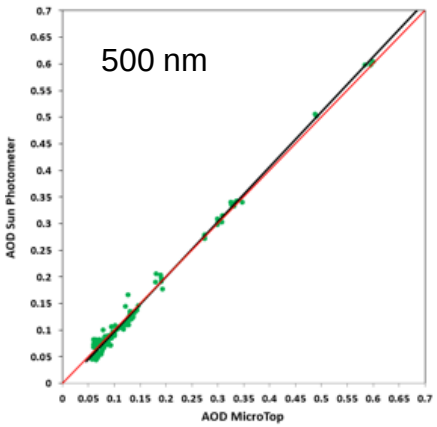
Source: *ACTRIS/PHOTONS data processing*

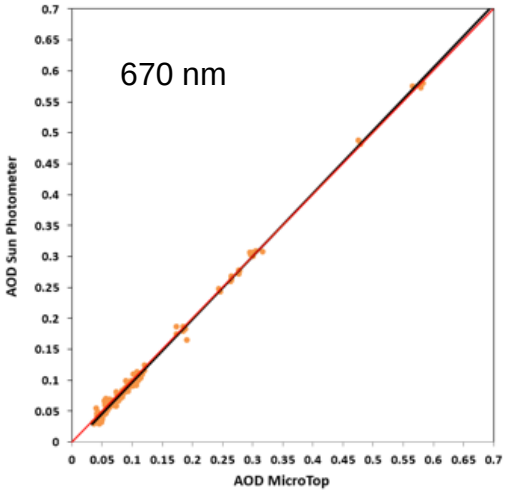
POLARSTERN – campaign 2018

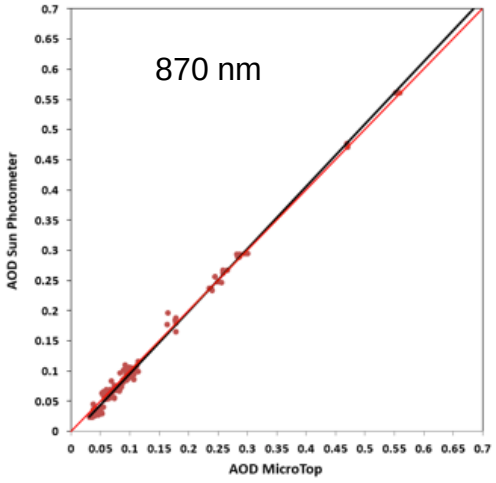
AOD CIMEL Automatic (#989) Vs AERONET MicroTop (#22499)











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

Day time
AOD : OK
Angström exponent : OK
Water Vapour : OK

3. Development Projects

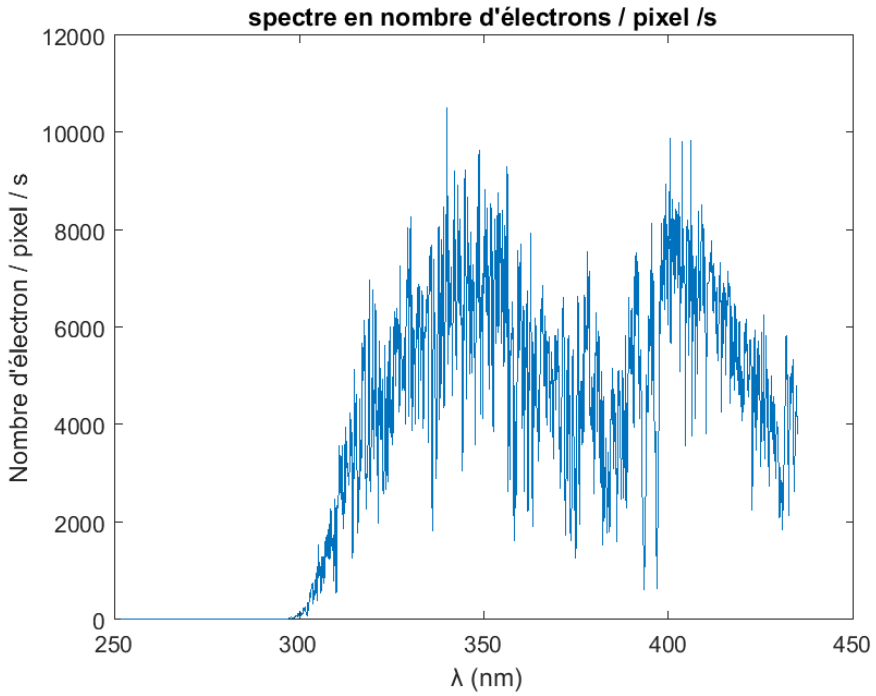
3.2 Spectro-Photometer

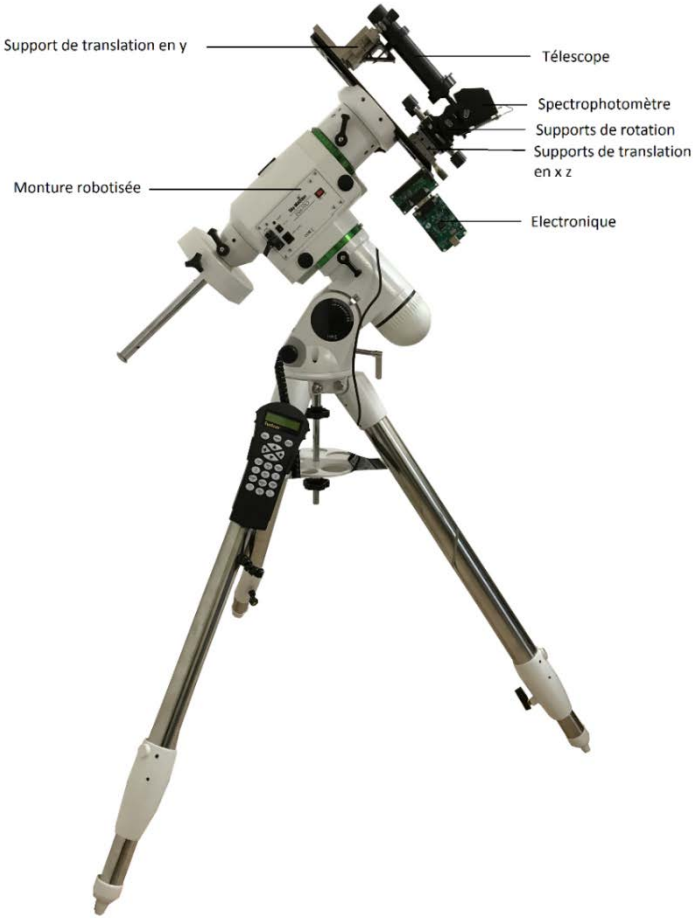
CINEL
EXPLORE THE CLIMATE

Spectrophotometer: add-on photometer

➔ **Project 1**: add-on to the photometer dedicated to the aerosol and gas measurement

- Prototype for O_3 & NO_2 measurements between 250 – 450 nm / 0.27 nm resolution
- Different scenarios ➔ QDOAS analysis software





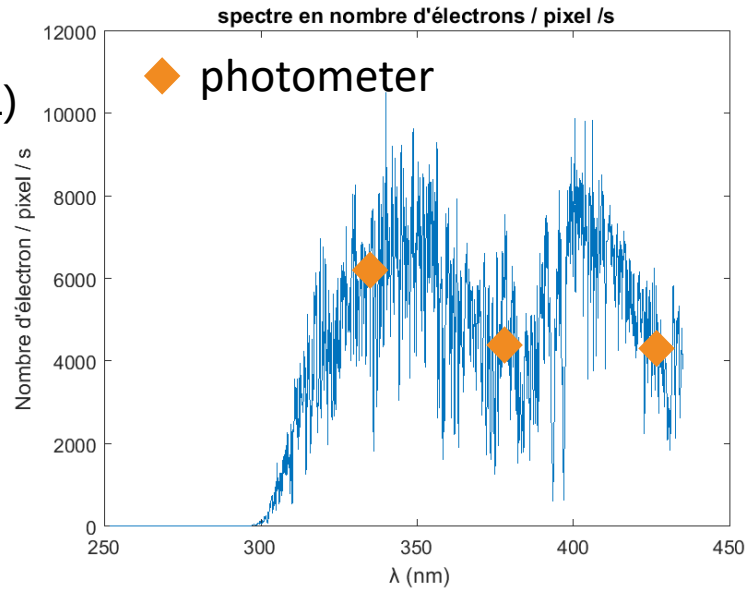
CINEL EXPLORE THE CLIMATE

Spectrophotometer: add-on photometer

➔ **Project 1**: add-on to the photometer dedicated to the aerosol and gas measurement

➔ Calibration: two approaches

- Absolute calibration ⇔ NMI / FRM approach (FEL)
- Instantaneous inter-calibration with a photometer



$$DC_{d,0}^{S} = DC_{d,0}^{M} \frac{DC_{d}^{S}}{DC_{d}^{M}} \exp\left[-m_{atm}(\tau_{atm}^{M} - \tau_{atm}^{S}) - m_{a} AOD_{d}^{M} \left(1 - \left(\frac{\lambda^{S}}{\lambda^{M}}\right)^{-A}\right)\right]$$

CIMEL EXPLORE THE CLIMATE

Spectrophotometer: ROSACE

Radiometry for **O**cean Colour **SA**tellites **C**alibration & Community **E**ngagement

➔ **Project 2:** Preliminary Design of the Copernicus Ocean Colour Vicarious Calibration. Spectrophotometer on a floating buoy.

EUMETSAT ITT

Laboratoire d'Océanographie de Villefranche,
Institut de la Mer de Villefranche

Hellenic Centre for Marine Research

ACRI-ST

UK National Physical Laboratory

University of Tartu, Tartu Observatory

CIMEL Electronique

Spectrophotometer: ROSACE

➔ **CIMEL task:**

- Market research of COTS spectrometers

- **Preliminary optical simulations**:
  - Preliminary estimation of the incoming light flux
  - Preliminary optical design of the light collecting systems
  - Preliminary optical simulation of the opto-electronical chain of measurement

- **Preliminary design of**:
  - Opto-mechanical system,
  - Electronics and acquisition system
  - the communication system

CIMEL EXPLORE THE CLIMATE

Spectrophotometer: ROSACE

➔ CIMEL Outputs :

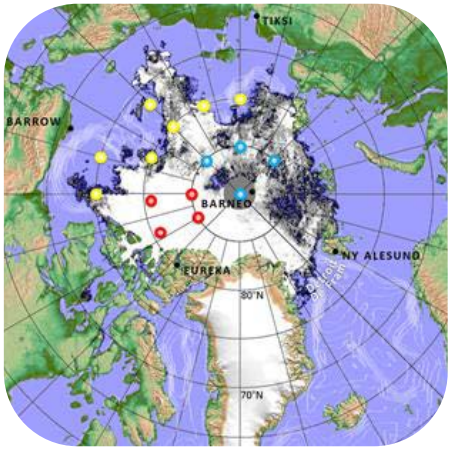
- Concept design of the spectrometers: architecture and estimated performances
- For each non-COTS components:
  - Target specifications and TRL level
  - Methodology to reach TRL8
- Detailed measurement equations
- Uncertainty budget for the system (each measurement chain)
- Communication system specifications
- Specifications for internal monitoring functions
- Price of components and manufacturing of the complete system

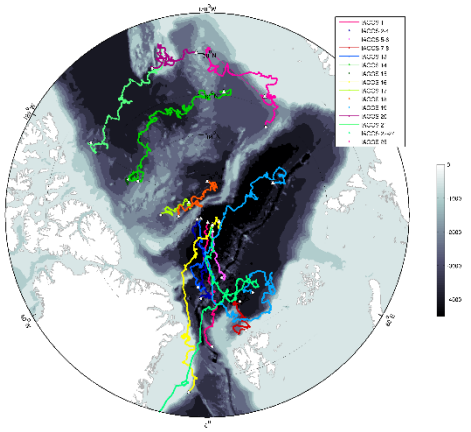
3. Development Projects

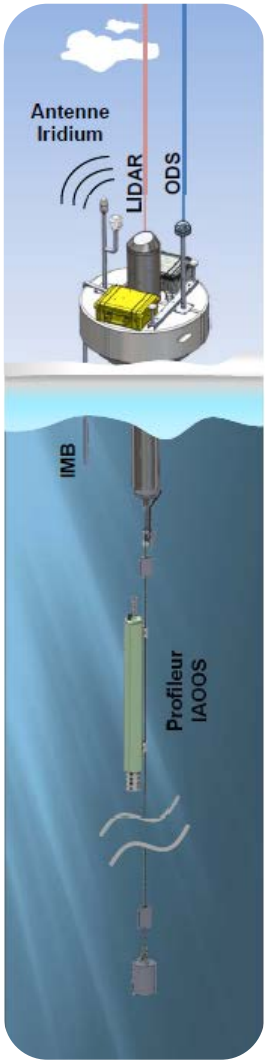
3.3 µLiDAR on floating buoy in the Arctic

CINEL
EXPLORE THE CLIMATE

IAOOS EQUIPEX project







➔ **Development of an integrated system collecting real-time & simultaneous observations of the ocean, ice, snow and atmosphere in the Arctic area**

➔ **Deployment of a thirty platforms' network so far**

Challenges

- No solar panel, autonomous for 2 years with batteries
- Harsh environmental conditions
- Miniaturisation of LiDAR
- Low power consumption (10 W)
- Up to 3 km by day

LATMOS UPMC SORBONNE UNIVERSITÉS cnrs INSU

CINEL EXPLORE THE CLIMATE

3. Development Projects

3.x waiting for the specs !!!

CINEL
EXPLORE THE CLIMATE

4. Conclusion

Conclusion

Well known in the Scientific Community for our expertise

Our **mission** is to be the link between:

Scientific research

Industrial world

Innovative technologies & operational solutions

Stéphane VICTORI, Ph.D
Head of R&D Optical Dpt.
172 rue de Charonne
75011 Paris, FRANCE
+33 (0)1 43 48 79 33
s-victori@cimel.fr
www.cimel.fr

Thank you for supporting Cimel