Maintenance for ground-based validation instruments calibration laboratory

Gael Picoulet, Luc Blarel, Thierry Podvin, Alexandre Lapionak,
Rene Lecoq, Maxime Catalfamo, Philippe Goloub

Service National d'Observation PHOTONS/AERONET
AERONET-EUROPE Calibration Facility (ACTRIS)
Laboratoire d'Optique Atmosphérique
Université de Lille - CNRS

LOA Calibration/Maintenance Facility

LOA calibration facility is covering a wide spectrum : UV to Thermal infrared
LOA maintenance facility is covering mostly AERONET activity
LOA contributes to QA/QC activity within AERONET-EUROPE

Why ?
To adress LOA needs like instrumental developpment (sunphotometer, airborne prototypes POLDER-type, 3MI Simulator, …)
&
Ground-based network needs (sun/skyphotometer (AERONET), LiDAR, UV spectro-radiometer (NDACC), …)

What ?

Main calibration infrastructure located in LOA (joint Unit CNRS/University of Lille).

Secondary calibration platforms

- at Carpentras (South of France) in close cooperation with Meteo France (solar)
- at Izana (Tenerife) in close cooperation with Meteo Spain (AEMET) (solar)

Platforms for AOD calibration (solar calibration)

Absolute Calibration : « Reference » instrument

- Izana
- Uncertainty on AOD < 0.005 (AERONET)
- New couple of Reference instrument every 3 months
- Operational mode
- Calibration Tools

Platforms for AOD calibration (solar calibration)

Inter-calibration : Reference-to-Field instrument transfer

- **Carpentras** (and Valladolid in Spain in ACTRIS)

– uncertainty on AOD = 0.01 (visible)

– uncertainty on AOD = 0.02 (UV)

- Re-calibration every 12 month

- Operational mode
- Calibration Tools

Platforms for AOD calibration (solar calibration)

Calibration link : with GAW/PMOD (PFR)

Not operational yet

2006 Campaign at Davos (LOA), GEOMON/FP7 Project

Wavelengths	Master or reference instruments			Field instruments		
	Mean absolute difference	RMS	N. of Obs. days	Mean absolute difference	RMS	N. of Obs. days
PFR500 vs. CIMEL500	0.0037	0.0071	132 days	0.00247	0.00411	3 days
PFR862 vs. CIMEL870	0.0023	0.0051		0.00208	0.00428	
PFR368 vs. CIMEL380	0.0047	0.0086		0.00384	0.00554	
PFR412 vs. CIMEL440	0.0044	0.0078		0.00747	0.00834	

Table 1 : Intercomparison campaign Davos, 2006, Réf : GEOMON/FP7 Project (computation made by LOA)

AERONET-EUROPE vs GAW/WRC

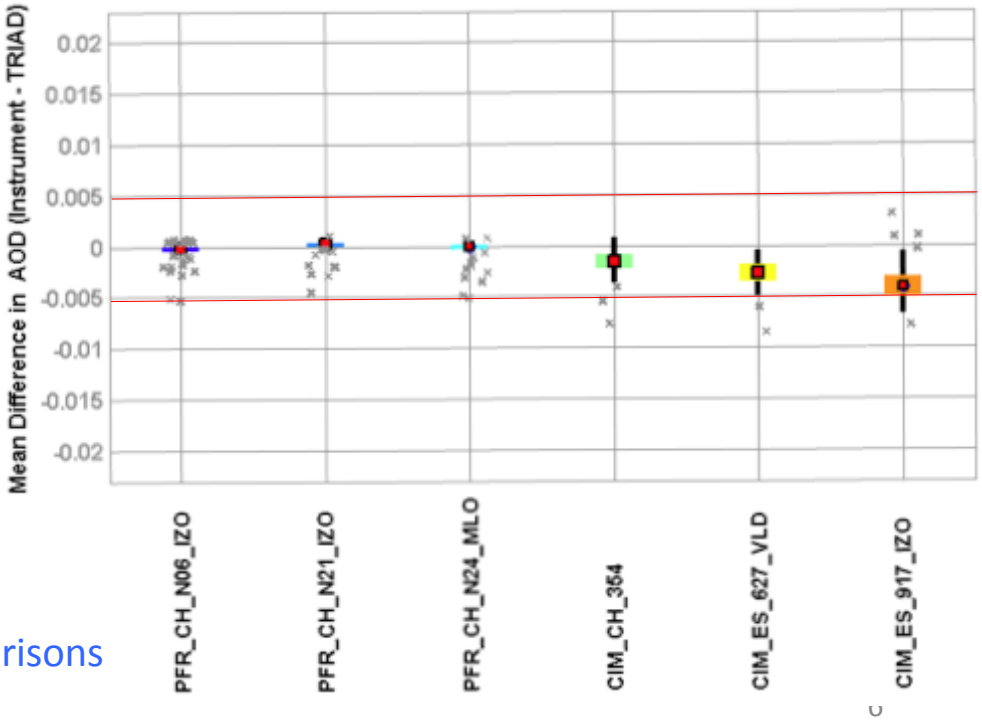
Preliminary Results of last October campaign (AE, 2015)

Contacts : Stelios Kazadzis and Natalia Kouremeti (PMOD/WRC, PFR network)

- Joint experiment in Davos/PMODWRC, oct. 2015 (instruments from LOA, GOA and AEMET)
- Evaluation of spectral AOD Standard CIMEL CE318-N and new CE318-T (field and master)

Wavelength	ΔAOD	(AOD)
PFR512 vs CIMEL 500	< 0.005	(0.025)
PFR862 vs CIMEL 870	< 0.004	(0.010)
PFR367 vs CIMEL 380	< 0.007	(0.040)
PFR412 vs CIMEL 440	< 0.007	(0.030)

Table 1 : Intercomparison campaign, Davos, 2015, End of September, computations made by PMOD/WRC (analysis in progress)



Results : very good in AOD

-> Mention on AE calibration certificate

-> Future : routine AE/Cimel - GAW/PFR comparisons at IZO (Izana Obs.), accepted

Long-term (2004-2012) CIMEL-PFR comparison at Izana, Romero-Campos et al., 2015 (in preparation)

- Comparison of 9 years of AOD and Angstr. Exponent data obtained by 1 PFR and 15 AERONET reference sun-photometers at Izaña.
- The AOD provided by both instruments in the common channels 500 and 870 nm is **almost the same with differences that are within the accuracy of both instruments** (< 0.0065 for AOD < 0.1)
- There are no trends in AOD and Angstr. Exponent differences series.
- The AOD and Angstr. Exponent data series and the derived aerosol climatology obtained with both instruments are equivalent.
- Continuous comparisons of GAW-PFR/PSR and AERONET will be performed.

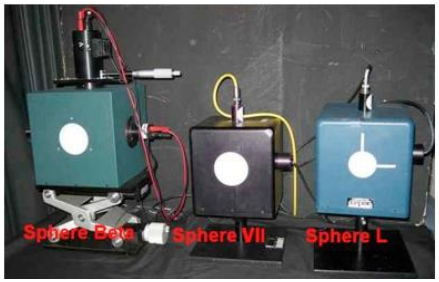
Radiance Calibration

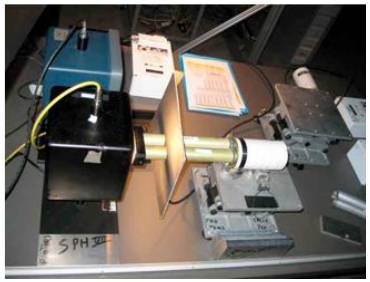
(operational mode)

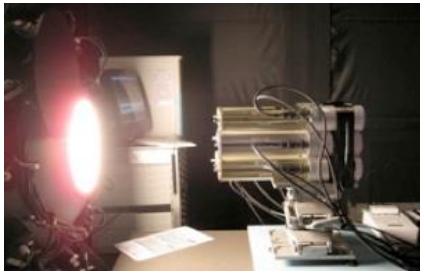
- In Laboratory (Integrating spheres)

=> Production of radiance, L , (W/m2/um/str)

Source Type	Diameter	Aperture	Power	Control
Labsphere LPS-45-H HLS-100-20SL	6”	2”	20W (3.3A)	Yes
Labsphere LPS-200-H HLS-100-75SF	6”	2”75	75W (6.25A)	Yes
SpherOptics LRS-8z ITHS 150	8"	2.8"	100W / 150W	Yes
11 Lamps	40"	11"	4000 W	Yes







Radiance Calibration (operational mode)

- Travelling « Master » (NASA-AERONET / AERONET-EUROPE)

Within AERONET-EUROPE, integrating sphere are intercalibrated to NASA/AERONET reference sphere through travelling instrument (2 or 3 times each year).

Radiance Calibration

(not operational)

AOD-to-Radiance(*) transfer (***research mode***)

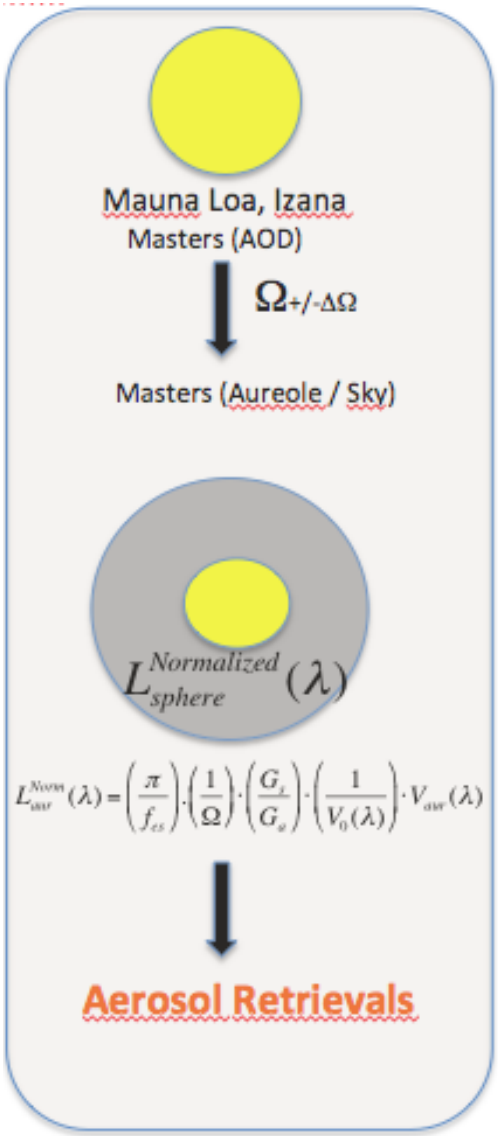
(*) Production of normalized radiance $\pi L/Es$ (no unit)

Only normalized radiance are used in aerosol inversion code

- Accurate AOD calibration for reference instrument (direct sun measurement)
- Instrument solid angle (Ω) : well known (precise mechanical design and/or experimental measure)
- Transfer AOD to Radiance : Final uncertainty of radiance (1-2%)

Calibration coeff in Normalized radiance = f(Ω) . (Calibration coeff. in AOD)

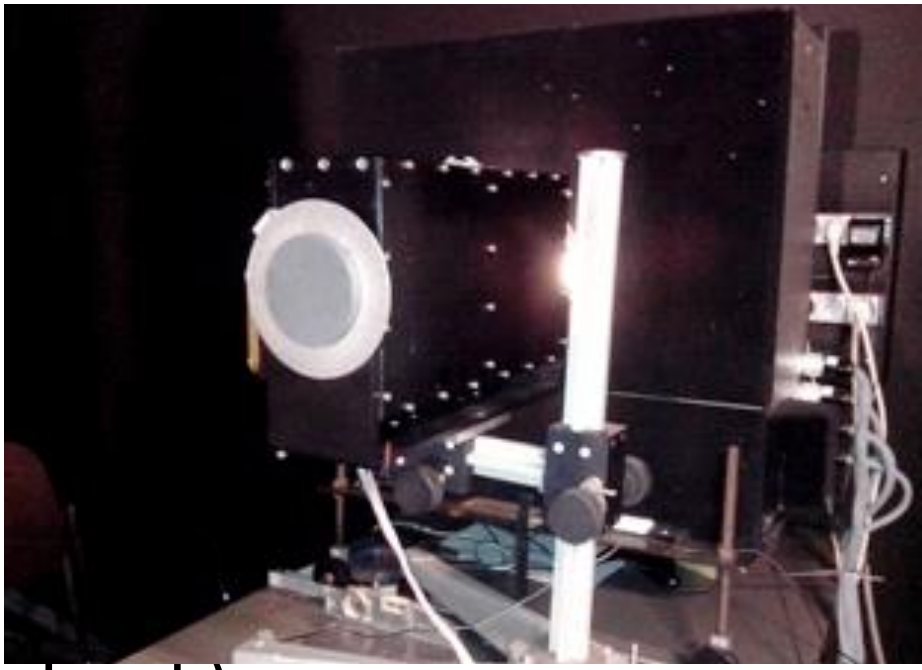
(Z. Li, P. Goloub et al.,)



Polarisation calibration

- **Laboratory (Automatized Pol. Box) – operational mode**

Change polarisation degree (linear) 0 to 65 %
Change polarization orientation
Absolute uncertainty on P < 0.2%



- **On field calibration (control) – (research mode)**

Direct sun measurement (natural light, P=0,

Sky radiance (Rayleigh scattering in very clean atmosphere condition, at short wavelength)

QA/QC Activity

Goal: Having the best data as possible all along the year to get quality insured to Level 2 afterwards by AERONET.

Consists in:

- Checking photometers data (Batteries, error status, AOD calculated..)
- Remotely detecting possible instrument/hardware/software defections
- Solving problems with on site help

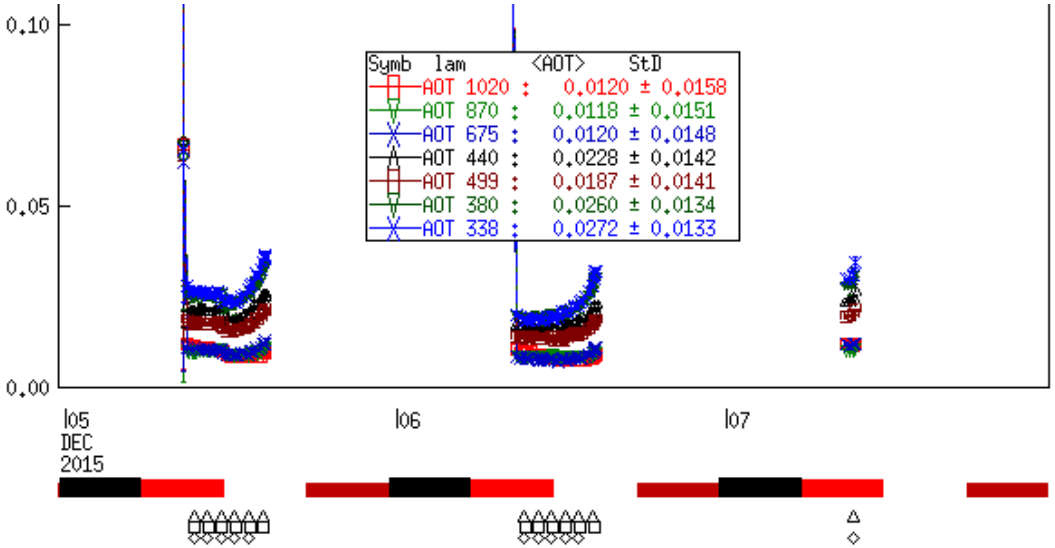
Tools used:

- AERONET automatic flags generation (daily, weekly)
- Data and services data check via demonstrate base (NASA) or Horodata (PHOTONS)

#73 [Carpentras]	Robot Errors	68 Week, 29 Daily Max, 29 on 06:12:2015		View Data	Thierry Podvin: thierry.podvin@univ-lille1.fr Send Mail
	Filter Wheel Errors	77 Week, 32 Daily Max, 31 on 06:12:2015			
	Bad Sun Tracking	3 Days, Triplets: 4 Possible; 0 Level 1.0; 0 Level 1.5			

Examples

Num/Site	03/12/2015	04/12/2015
#354 Standard N Davos By Email Z- Z+	03/DEC/2015 STA, alm, blk, gain, hum, pp1, prt, sun, decal, , GS, GT Pro data: aot15, alm.rad, pp1.rad, TimePH(16h15:20)= 0s BatPH=5.652 BatextPH=12.904 Temp.PH=7.539° Hum Head = 0.0	04/DEC/2015 STA, alm, blk, gain, hum, pp1, prt, sun, decal, , GS, GT Pro data: aot15, alm.rad, pp1.rad, TimePH(16h15:43)= 1s BatPH=5.648 BatextPH=13.007 Temp.PH=6.263° Error P = 1 Hum Head = 0.0



Other calibration Tools in LOA

Infrared

- Calibration system for infrared radiometers
- Calibration of Pyrgeometer (hemispherical flux)

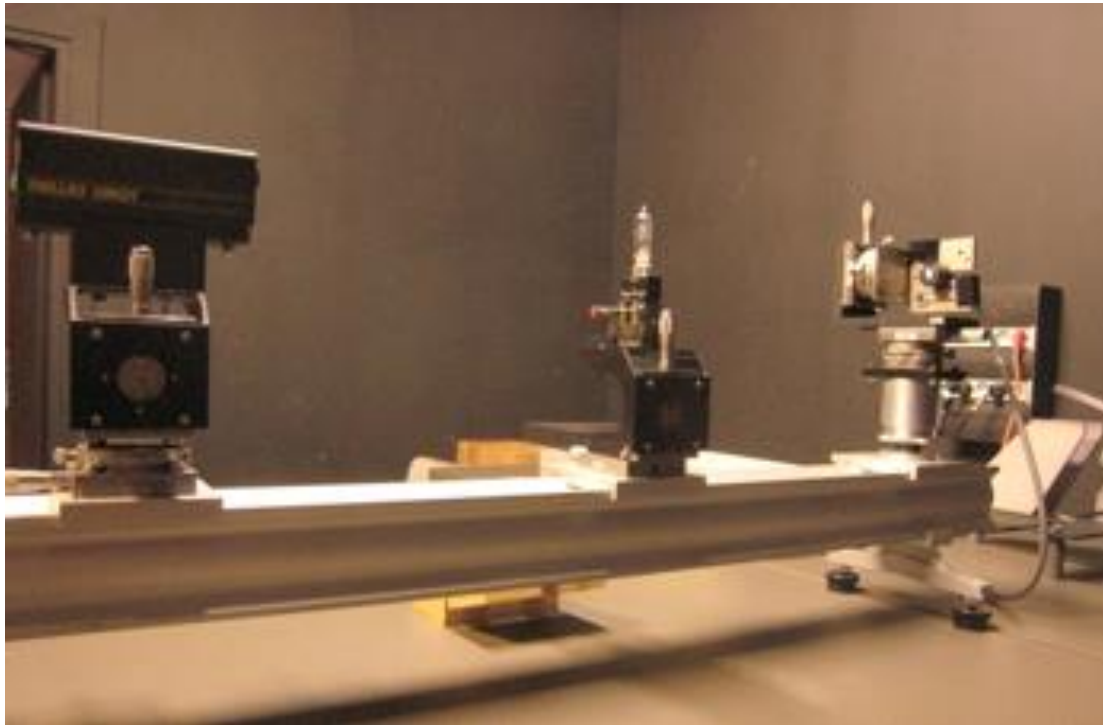
(Black-body : -100°C to +100°C)

Other calibration Tools in LOA

UV

- Calibration system for UV (reference source)

Contribution to NDACC France



Collaboration/Synergies

Calibration aspect :

AOD calibration : traceable link with PFR
Radiance : develop links with ESA calibration
Polarisation ?
Need to continue upgrading of AERONET-EUROPE calibration facility (New CE318T)
Select/define sites with colocated complementary instruments

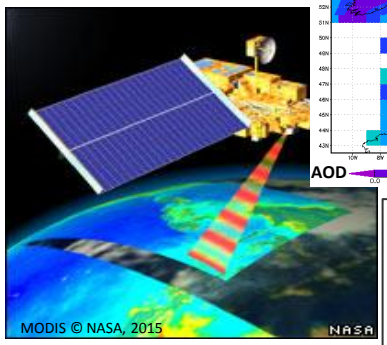
Validation aspect :

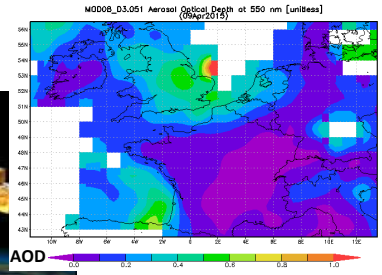
Ground-based instrumentation and aerosol products: NRT products (pre-DISC)

Airborne/mobile capabilities (PLASMA+LiDAR), campaign, sites

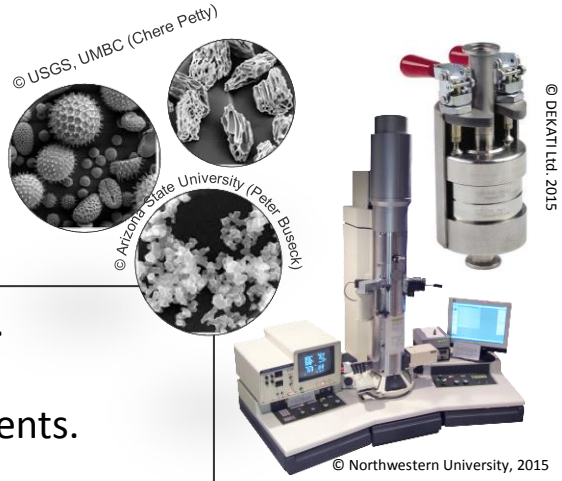
Mobile Sunphotometry for satellite validation

Satellite





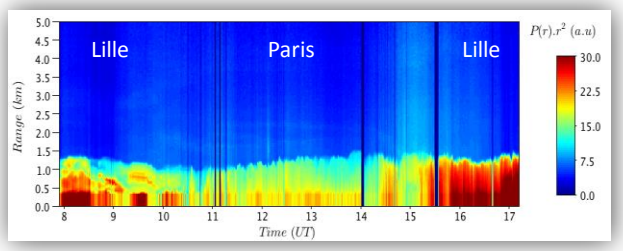
In situ

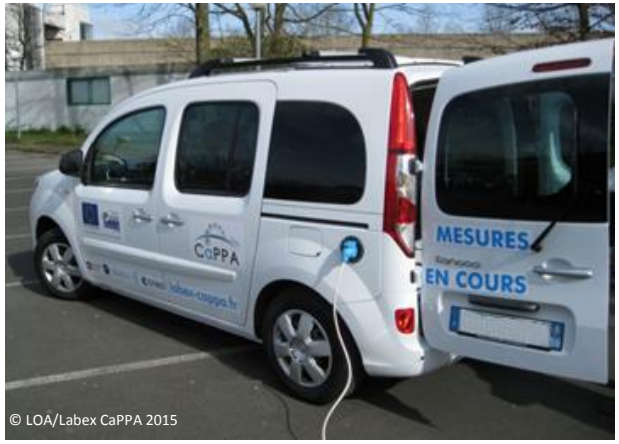


Motivation

- Lack of information on **aerosol spatial variability**.
- Fast exploration of regions in case of pollution events.
- Validation of air quality forecasts using field measurements.
- Validation of satellite measurements.
- Use of the mobile system in regions across the world where implementing fixed instrumented sites is not possible.

Mobile observing system





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Possible vectors

ATR42 (Unité SAFIRE)

SMILE (Labex CaPPA)

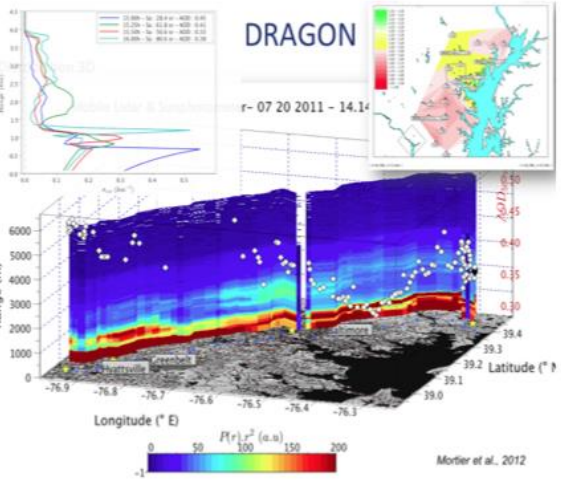
TETHYS II
(Division Technique INSU)

TGV - TER
(SNCF)

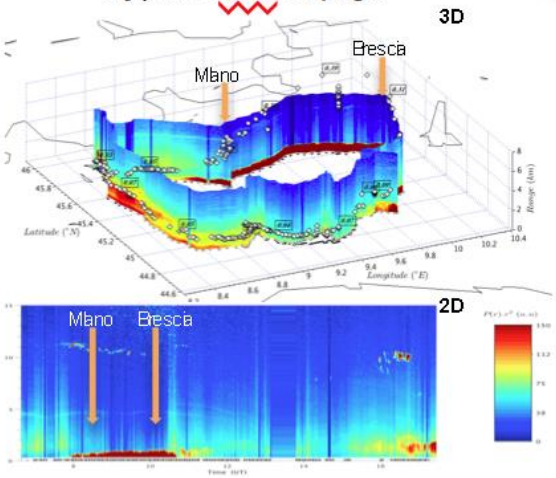
Campaigns (past, present, future)

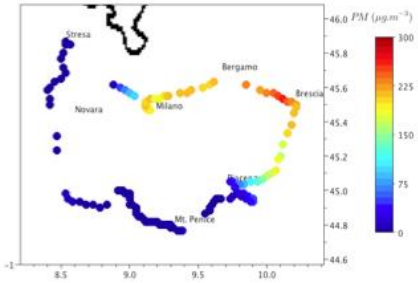
Mobile sun-photometer/LIDAR/ in situ

USA (Washington, DRAGON campaign)



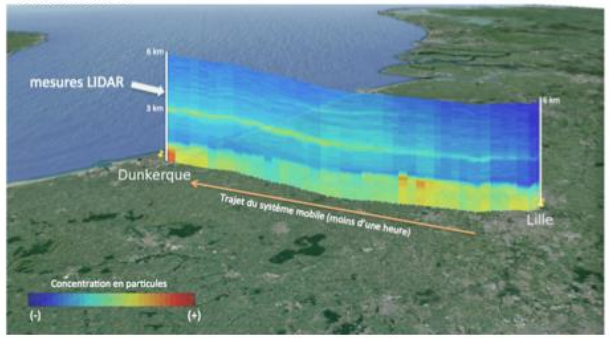
Italy (Milano-Stresa Campaign)





Nord-Pas de Calais Region

Road network



Canal Boat Network

Railway Network

Preliminary setup of the mobile system

- LiDAR CE370 (CIMEL)
- Acquisition PC (Dell)
- GPS (Garmin)
- Microtops II hand-held sun-photometer (Solar Light)
- Calitoo hand-held sun-photometer (Tenum)

Mobile measurements

9th April 2015: Lille-Paris
10th April 2015: Lille-Dunkerque
14th April 2015: Nord-Pas de Calais tour-Belgium
15th April 2015: Lille (city)
23rd April 2015: Lille-Dunkerque

Upgrade of the mobile system

- LiDAR CE370 (CIMEL)
- Acquisition PC (Dell)
- GPS (Garmin)
- PLASMA photometer (LOA) *
- Microtops II hand-held sun-photometer (Solar Light)
- Calitoo hand-held sun-photometer (Tenum)
- Nephelometer (Ecotech)
- Particle counter (GRIMM)

Mobile measurements

4th June 2015: Lille (city)
25th June 2015: Lille-Orchies (suburbs-countryside)

* PLASMA measurements will be performed in future field campaigns

Pollution event on 9th April 2015 (Lille-Paris)

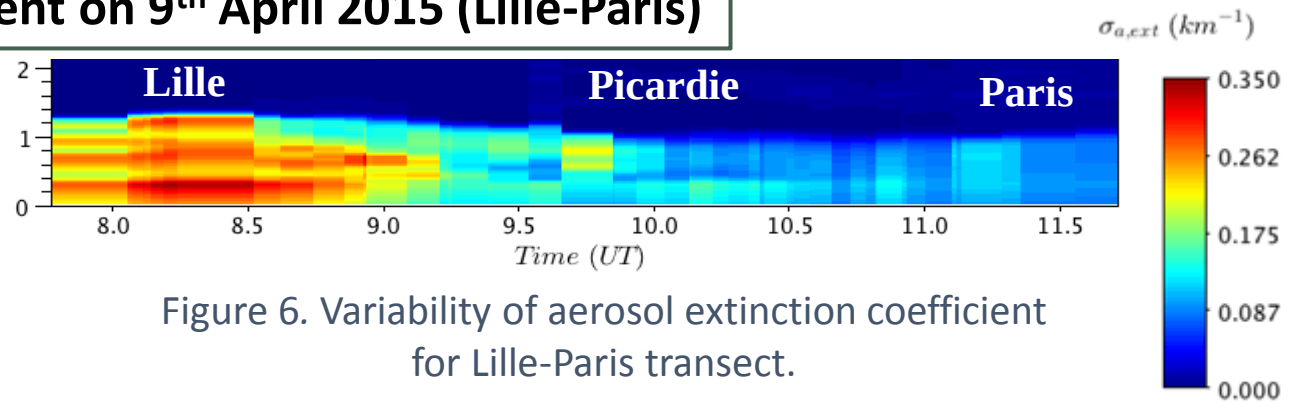


Figure 6. Variability of aerosol extinction coefficient for Lille-Paris transect.

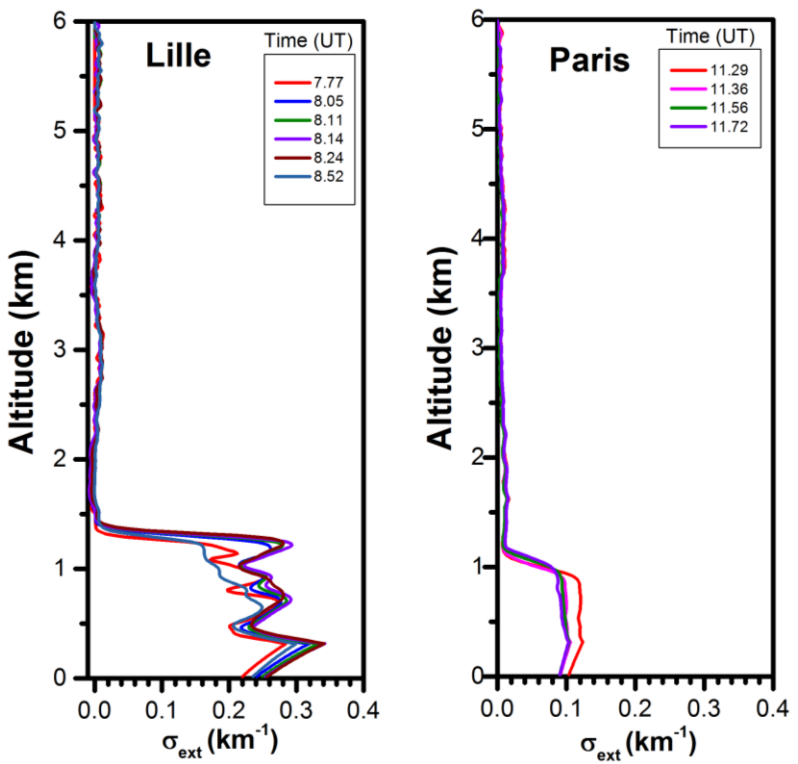


Figure 7. Aerosol extinction profiles for different locations along Lille-Paris transect

- Boundary layer extended up to 1.5 km at Lille
- Maximum of extinction in Lille, $\sigma_{ext} \approx 0.32$ km^{-1} at 400 m.
- Average $\sigma_{ext} \approx 0.15$ km^{-1} at ground level, in spring (Lille)
- Aerosol load decreases by a factor 2 towards Paris

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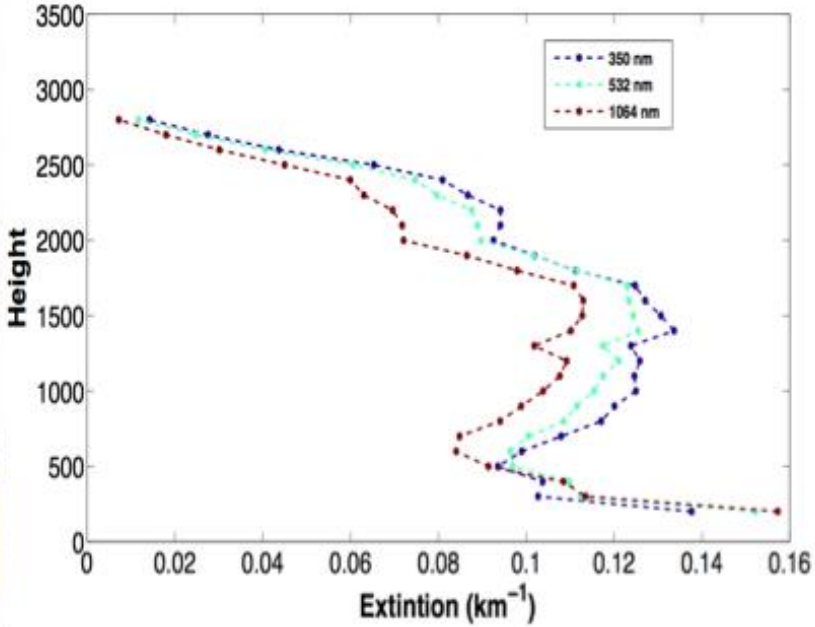
Airborne Measurements

SHADOW 2 Campaign

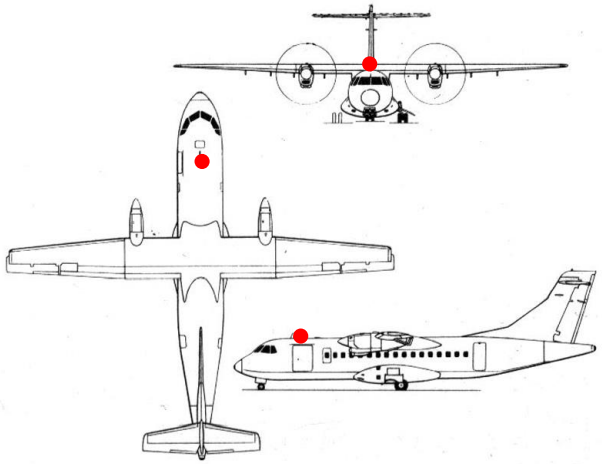
http://www.labex-cappa.fr/SHADOW



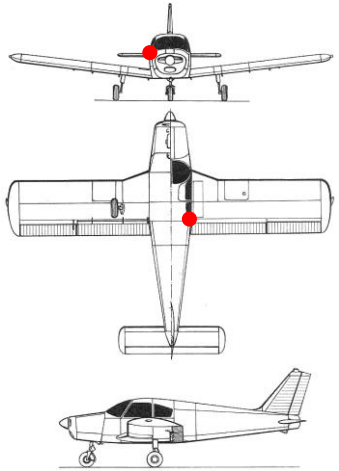
(a) *(b)*

Figure 1: Aerosol profile during a dust event in Senegal (SHADOW-CaPPA campaign, 28 March 2015).

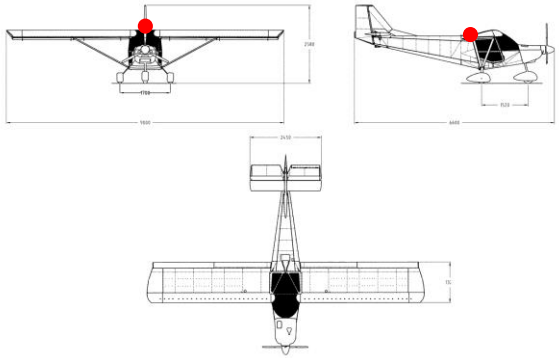
PLASMA1 ou 2 : Vecteurs



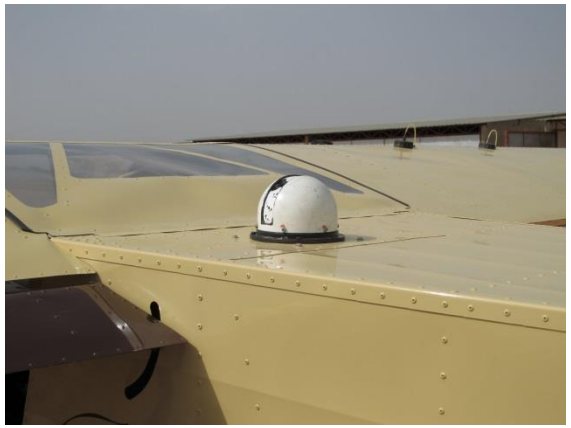
ATR42



PIPER



SAVANNAH



IDEAS+ Level 1 meeting, 8 and 9 December, PMOD-WRC

Thanks for providing feedback on your availability for the Level 1 meeting, and we confirm that this will go ahead starting at 14:00 on 8 and finishing by 16:00 on 9 December at PMOD-WRC.

I have prepared a draft agenda below:

1. Introduction

- **Objectives – Bojan Bojkov (ESA) and Gareth Davies (Serco);**
- Major points arising from the first Level 1 meeting in June 2013 (and LPVE/APVE) – Gareth Davies;
- Overview of IDEAS+ Task 3 activities – Gareth Davies;

2. L1 activities:

- Calibration and data quality toolbox – Steve Mackin (EOSense);
- Radiometric Uncertainty Tool – Javier Gorrono (NPL);
- IMPETuS (Intercomparison of Multi sPEctral data over Test Sites) – Alessandro Burini (Rhea);

3. **Atmosphere and ground-based measurements:**

- Ground-Based Instrument Calibration – A Pulsed Tuneable Laser System for the Characterisation of Spectrometers (ATLAS) – Julian Groebner (PMOD-WRC);
- OMI validation and Pandoras – Alexander Cede (Luftblick);
- Maintenance for ground-based validation instruments calibration laboratory – Gael Picoulet (Lille);

4. **Terrestrial (including airborne measurements):**

- Landsat 8 validation – Ray Soffer (NRC);
- Time Series Fusion and other topics to be confirmed – Sebastien Saunier (Telespazio);

5. **Collaboration/synergies – all;**
6. **Discussion of major points and recommendations - all;**
7. **Summary of actions – Bojan Bojkov and Gareth Davies;**
8. **Scope and date of next meeting – all.**

Please can you let me know if you have any comments on the draft agenda. **Please can you also prepare presentations (lasting about 20** minutes each) according to the agenda.

I look forward to seeing you at Davos.