Integrated Mobile System of Two-wavelength Polarization Micro-pulse Lidar and Photometer for Aerosol Properties Retrievals: Comparisons with Reference Lidar

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04. Synergistic use of multiple instruments and techniques, networks and campaigns
Monday_ 04_P01

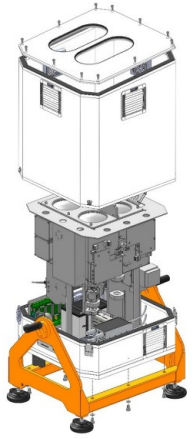
The 30th International Laser Radar Conference (ILRC) virtual conference, June 26th – July 1st, 2022.

Introduction

The lidar-photometer synergetic observations are widely used for monitoring of atmospheric aerosols properties. In particular, measurements of both instruments on board mobile platforms offer the capability to study the spatio-temporal variability of aerosols in an extensive range of scenarios.

Mobile Automatic Aerosol Monitoring

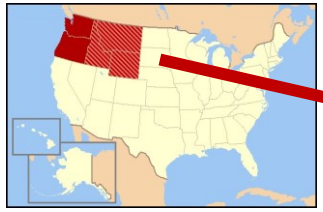
CIMEL CE376 micro-pulse lidar providing measurements at 532 nm and 808 nm, depolarization at 532 nm, coupled with sun/moon photometers providing spectral Aerosol Optical Depth (AOD) were integrated for mobile monitoring of aerosols properties during field campaigns.



A first dataset during FIREX-AQ Campaign in summer 2019

"Fire Influence on Regional to Global Environments and Air Quality"

(FIREX White paper, 2019)



Northwestern US

Bad air quality due to wildfires

Despite the extreme environmental conditions limited the performance of instruments, we were able to investigate smoke optical properties close to the fire source.

Continuous observations at ATOLL platform in Lille-France

Algorithmic and instrumental assessment took place at ATOLL platform (ATmospheric Observatory of liLLe) operated by LOA-University of Lille

50°36'41.2"N 3°08'26.5"E, 60 m a.s.l.

METIS, an operational CE376 lidar, continuously performing and co-located with photometers and with LILAS, a lidar part of EARLINET-ACTRIS, are considered for test and data validation, prior to mobile campaigns.

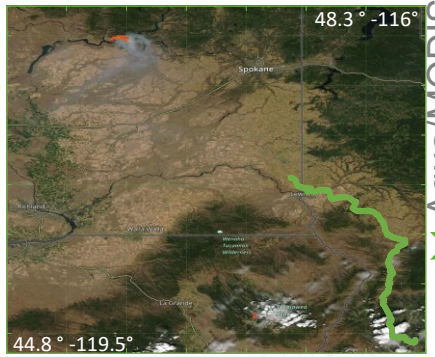
Mobile observations during FIREX-AQ campaign in 2019

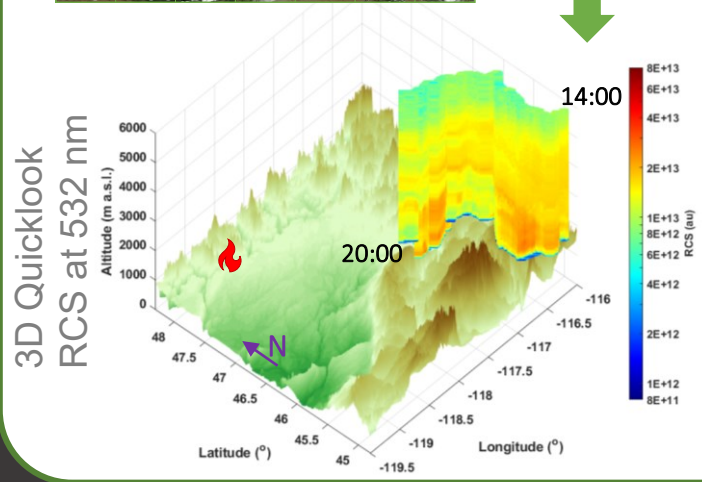
A CE376 lidar and a CIMEL CE318-T photometer were installed in the mobile platform called DMU (Dragon Mobile Unit) following the design of MAMS (Mobile Aerosol Monitoring System) described in *Popovici et al. (2018)*.
The DMU performed measurements along the roads around the major fire sources.

Spectral AOD and Angstrom Exponent (AE) spatial distributions were obtained from the photometer.
Applying the AOD constrained Klett inversion method in BASIC code (*Mortier, 2013*) on the lidar-photometer dataset: backscatter, extinction profiles and column-integrated Lidar Ratio (LR) were derived in addition to VLDR profiles.

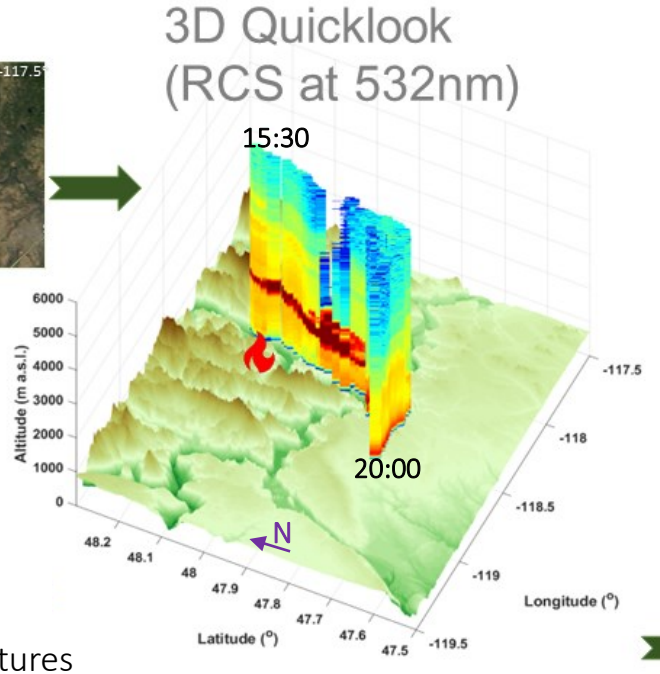
Study Case: William Flats Fire (47.98 N, 118.62 W)

August 4th, 2019



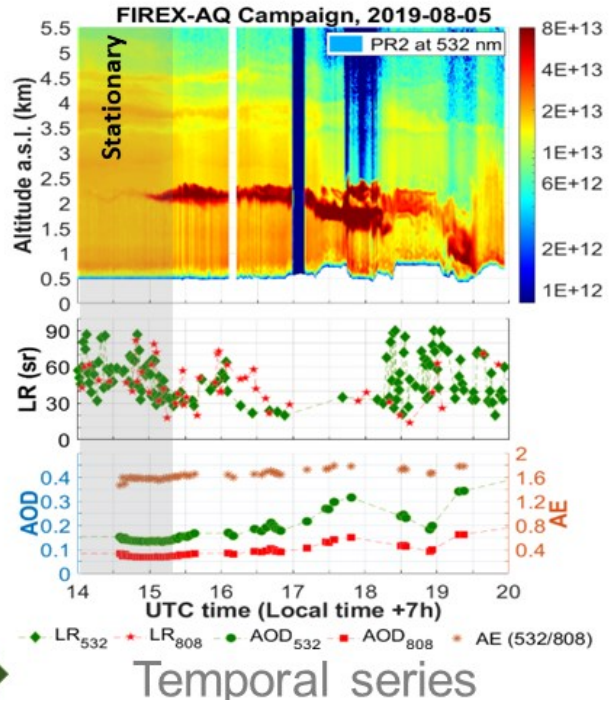


August 5th, 2019



The campaign allowed also to monitor the instruments performance under extreme conditions:

- High temperatures
- Complex terrain
- Difficult roads
- Thick smoke plumes

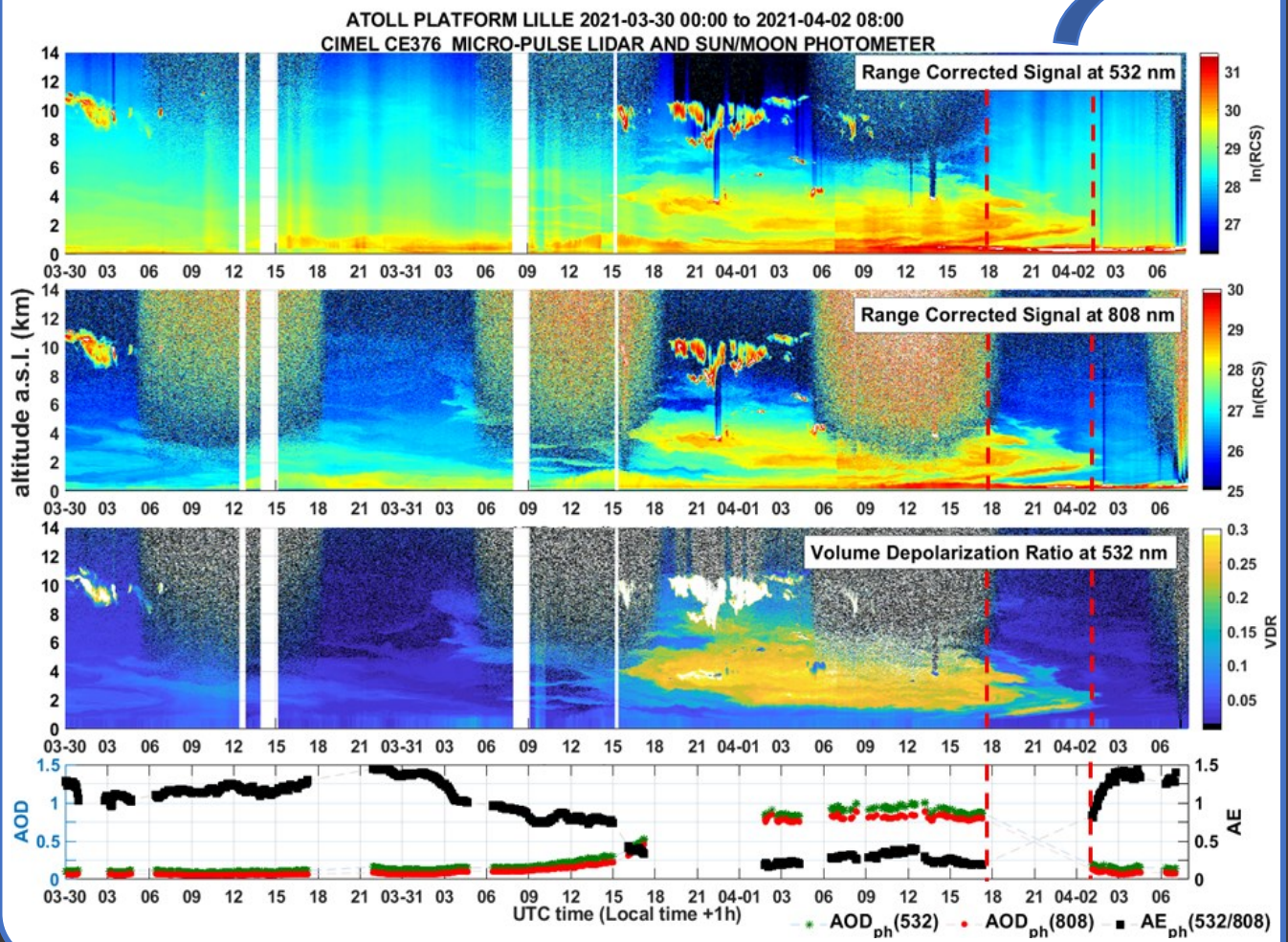


Previous studies of fresh smoke transported one day far from source reported LR of 60-85 sr for 532 nm
(Alados-Arboledas et al, 2011; Tesche et al., 2009; Tesche et al., 2011)

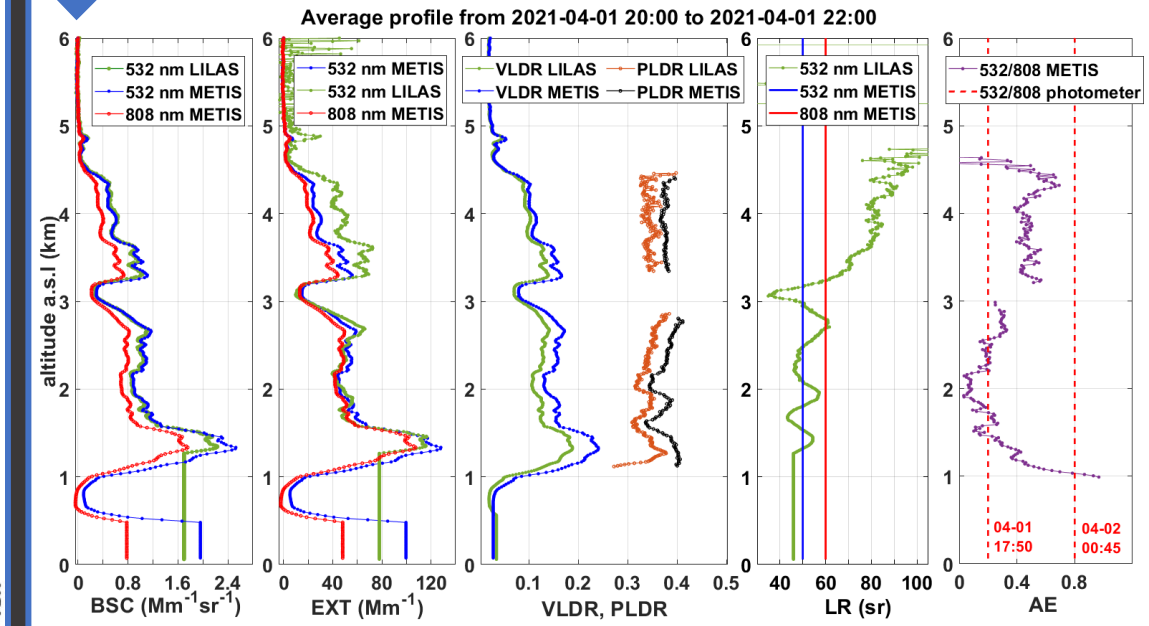
Continuous observations at ATOLL platform in Lille-France: Data validation

Study Case of Saharan dust transport

Overview of synergetic measurements of METIS lidar and sun/moon photometers during an event of Saharan dust transport from March 30th to April 2nd of 2021



LILAS-METIS intercomparisons of aerosols retrievals for the averaged measurements between 20:00 to 22:00 UTC on 2021-04-01



Optical aerosols properties are retrieved with:

- A modified two-wavelength klett inversion for METIS
- Raman inversion for LILAS

To constraint the inversions for METIS profiles we used the AOD values at 2021-04-01 17:50 UTC and 2021-04-02 00:45 UTC.

Conclusions and perspectives

FIREX-AQ campaign

- We were able to obtain height integrated optical properties of smoke aerosols at different ageing states.
- Also, a first assessment of lidar performances and limitations were achieved in the frame of the next CE376 version development.

METIS-LILAS intercomparisons

- The results show good agreement when comparing backscatter and extinction profiles at 532 nm.
- VLDR profiles at 532 nm derived from METIS show absolute differences of 0.03 with respect to LILAS, mainly related to differences in the optical design of the systems.
- For future campaigns of METIS-photometer embarked on mobile platforms, we are positive on obtaining valuable information on aerosols optical properties such as spectral extinction and depolarization in variable scenarios.

Further work will include three main directions:

- Uncertainties assessment
- More elaborated joint retrieval combining spectral AOD and downward sky radiance from CE318T photometer and RCS at 2-wavelength from CE376 lidar
- Application to data obtained during mobile observations campaigns

¡GRACIAS! THANKS! MERCI !

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