Aerosol Remote Sensing at Lille observation platform: upgrade of profiling capabilities

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LILAS is a multiwalength Raman LiDAR in operation since 2014 and has been continuously upgraded and improved thanks to ACTRIS-2 workshops, LICAL training session and very close cooperation with I. Veselovskii. End 2018, LILAS is almost fully automatized and remotely controllable. and regularly follows LICAL/ACTRIS QC protocols. Lille observation platform has excellent aerosol profiling capabilities which make it a relevant candidate to National Facility linked to CARS and ACTRIS-DC.

LILAS has a high level of automation : A mobile phone is used to switch on/off, to calibrate and to monitor LILAS observation, safely









Remote LASER	Camera for alignment dichroic mirrors (2016)	Automatic switch off Laser when aircraft is detected by RADAR and restart after a time delay. Permanent operating authorization from DSAC (2018)	ON OF 1 - Push the button ON one time! 2 - Push the button OF one time 2 - After 20 sec the pump will be ON 3 - Push the button OF one time 2 - After 20 sec the pump will be ON 3 - Push the button OF one time 2 - After 20 sec the noncome 8 - For close the soft push STOP button ONLY! Program Live from Licel to verify and adjust the 2 misron adjust the 2 mis	Program to control the Laser/ stop with rain/ Stop and start with aircraft detection
		and electronic noise (July 2018)	V II 841807.3 V	ffree: 32 Move to -43 0/256 steps Move to -43 0/256 steps Clear log Clear log Exit Exit Exit







Range-corrected signals are normalized in 3000–4000m range.
Deviations of the normalized signals from the mean.

All the profiles are vertical smoothed (10 points, i.e. the range resolution is 75 m).

The deviation below 1000 m range is more than 10% and falls to less than 10% between 1000 and 10000 m.





Measured Volume Linear Depolarization Ratio (%) in a clean atmosphere on 07 November 2017. The light-colored lines are without smoothing and the deep-colored lines represent 10-point vertically averaged results.

The molecular depolarization ratios measured by LILAS

A smoothing window of 20 points is used to vertically average the profiles, hence, the vertical resolution of the profile is 150 m. The lidar signal is normalized to the molecular profile (Standard atmospheric temperature and pressure profiles are used) in the range of 5000–6000 m. All the analog channels show deviation less than 5% till at least 10000 m. The two cross-polarized channel at 1064 nm shows relatively worse performance, with approximately 10% deviation at 11000 m. All the photon-counting channels can go up to 20000 m with deviation smaller than 5% or even less.



The data-quality check proves that LILAS system is well maintained regarding the Rayleigh fit, telecover test and polarization capability. The Rayleigh fit indicates that LILAS signal can reach about 20000 m with the deviation to molecular scattering less than 10%. The telecover test shows that, above 1000 m, LILAS system is of good symmetry except for the 387 nm channel. It is due to the misalignment of the mirror

for 387 nm. After adjusting, this anomaly has been diminished to some extent. Figures showing the telecover test for 387 nm after adjustment are shown in the Appendix. The polarization calibration procedure is presented in detail and the molecular depolarization ratio of LILAS system is shown.

Dust and smoke layers, October 2017 (LILAS) Optical properties from Raman (36+2a) - nigthime-Log10 of RCS, 1064 nm Volume Depolarization, %, 1064 nm 2E+01 12 000 11 00 11 000 10 00 8.5E+00-10 000 1.6E+01-9 000 8 000 1.2E+01-7 000 6 000 6 000-5 00 5 000 .5E+00-8E+00-4 000-3 000 3 000 2 000 2 0 0 0 4E+00 16 17 18 19 20 21 22 23 00 01 02 03 04 05 0E+00 UTC Time, H

Lidar observation on 16, 17 and 18 October 2017, Lille. (a) Lidar signal at 1064 nm, 16-17 October, (b) VLDR at 1064 nm, 16-17 October,

LILAS Atmospheric Profiling Capabilities

Aerosol Optical properties profiled by LiDAR during the extraordinary event (AOD close to 2.7) from October 2017. Multiple Saharan dust and Smoke layers overlapped and were distinguished thanks to depolarisation capabilities.

Joint photometer and LiDAR inversion (GRASP/GARRLiC) to derive aerosols column and height-resolved properties during a Saharan dust event. The retrieved optical properties have been compared to Lidar-stand alone retrieval based on SCC processing (Single Calculus Chain).

<figure>

Instrument

- New Licel card 16 bits for 1064 nm analog channels (better dynamic)
- Cloud detection with AAG_CloudWatcher to control Laser
- ADS system (from Clermont Ferrand) to stop laser if aircraft.
- Methane channel (CH4), (see Veselovskii et al., AMTD, 2018)

Data Preprocessing and Processing

- Routine Data Preprocessing and preparation
- Automatic Level 0 Data submission to ACTRIS-France DC
- Centralisation of level 0 SCC formatting before submission to SCC processing at CNR

Aerosol Inversion

- Internal processing tools (LiDAR stand alone and GRASP)
- AERIS/ICARE Data Processing (GARRLiC/GRASP)

Conclusions / Perspectives

Synergies

- with METIS, a new LILAS compagnion, is a new biwavelength elastic micro LiDAR developped by CIMEL and continuously operated (3 channels 532 s, p and 808 nm). METIS is a compact system (35 kg, 43x60x70 cm), overlap 100 m
- with in situ aerosol measurements

References:

Hu et al., 2018, Ph. D Thesis, December 2018) Hu et al., ACPD, 2018 http://loa-ptfi.univ-lille1.fr/lidar/

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