Top-down lidar characterization of exceptional dust transport event above the Annecy lake during L-WAIVE in June 2019

Julien Totems
Patrick Chazette
Alexandre Baron

Laboratoire des Sciences du Climat et de l'Environnement (LSCE)

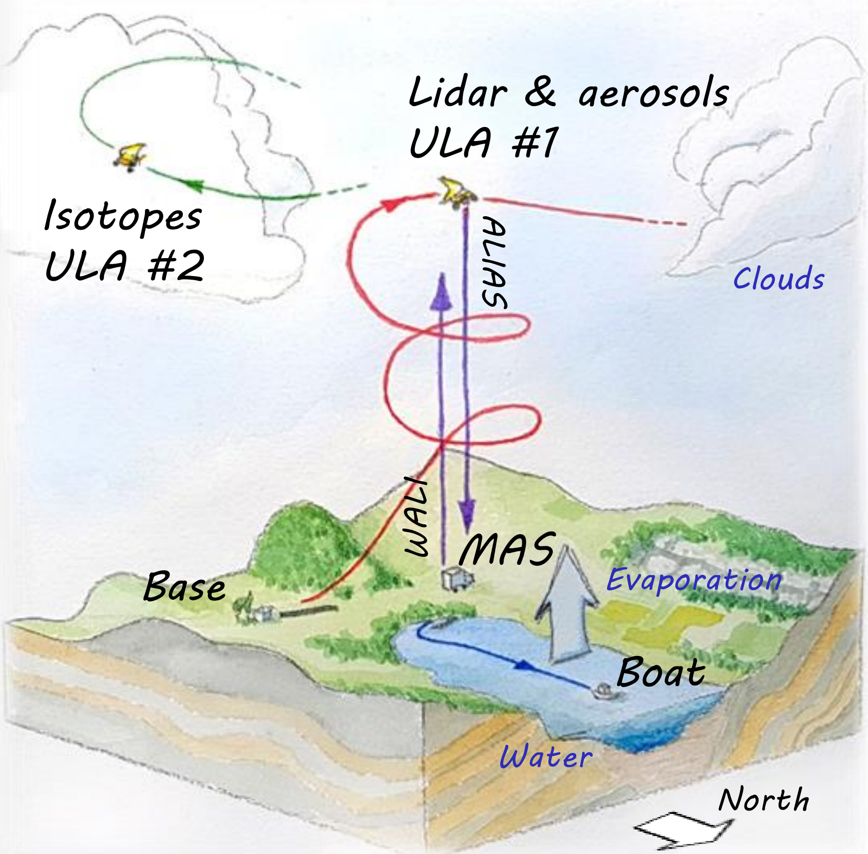
Elsa Dieudonné

Laboratoire de Physico-Chimie de l'Atmosphère
Université du Littoral Côte d'Opale

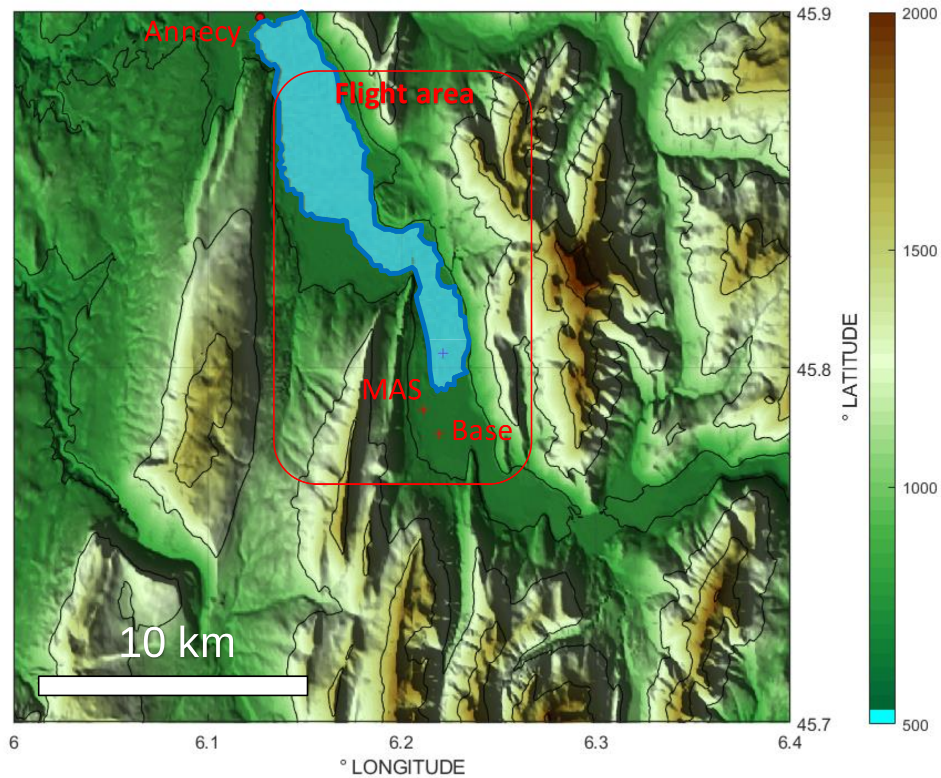
PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR
ANR grant: WAVIL
ANR-16-CE01-0009

L-WAIVE campaign at Annecy lake (12-23 June 2019)

Primary aim: constrain the water vapor isotope cycle over the lake surface



(French Alps, 35 km south of Geneva)



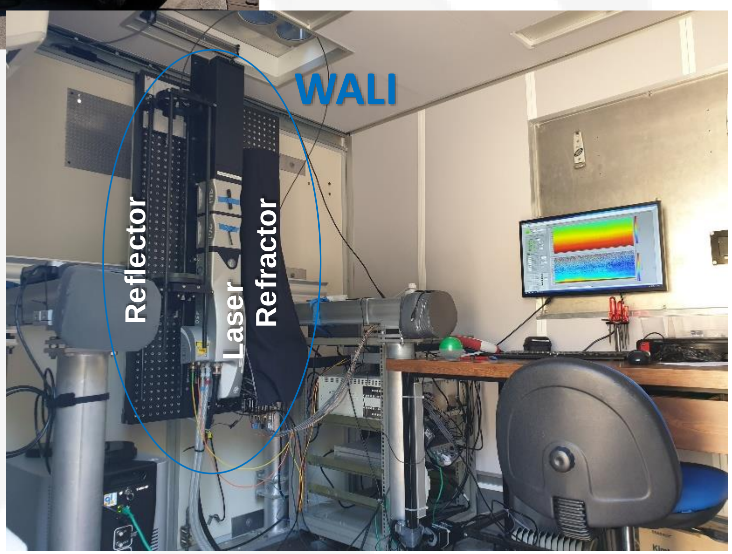
Here we use:

On ULA #1: ALIAS aerosol backscatter lidar, FIDAS particle counter
In Mobile Atmospheric Station (MAS) : WALI weather & aerosol lidar

Instrumentation

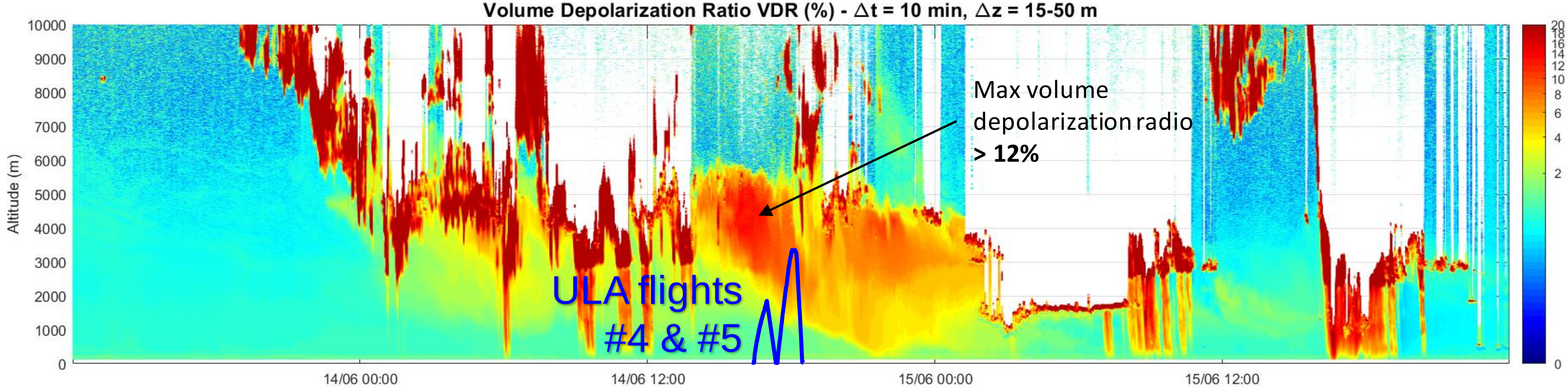
Mobile Atmospheric Station ◀

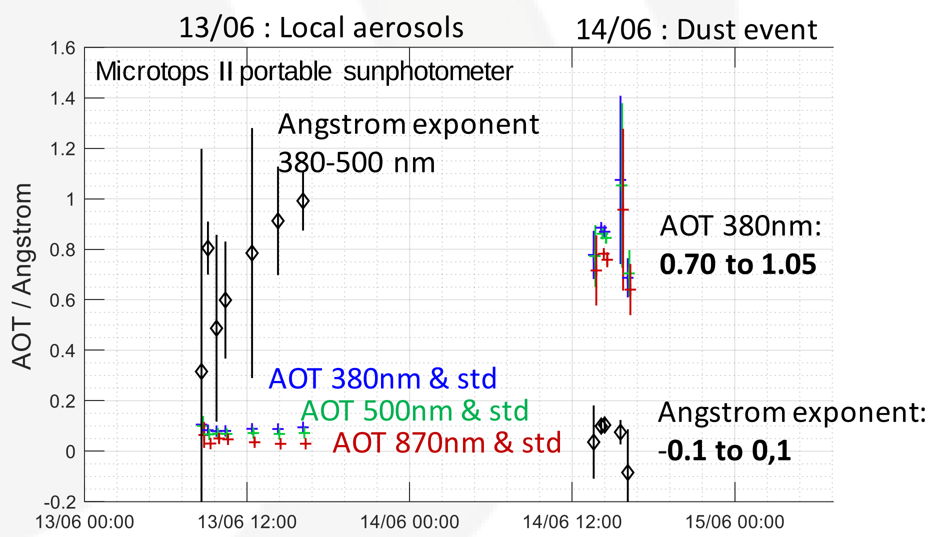
Tanarg Ultra-Light Aircraft ▶

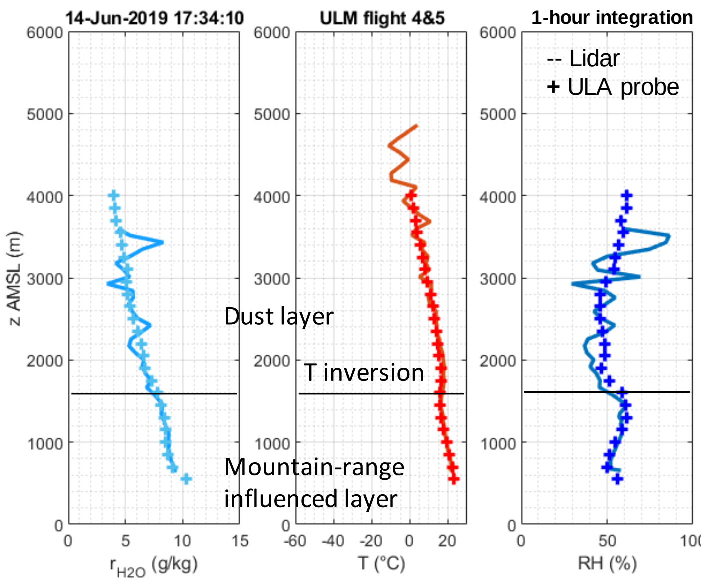


	WALI	ALIAS
Emitter	100 mJ @ 354.7 nm SLM-injected	30 mJ @ 354.7 nm
Receiver	150 mm refractor (2 Rayleigh-Mie channels) & fibered reflector (4 Raman channels)	150 mm refractor (2 Rayleigh-Mie channels)
FOV	3.3 x 0.7 mrad & Ø1.6 mrad	3.3 x 0.7 mrad
Filtering	Elastic (354.7nm, co-/cross-pol) Vib Raman (N_2@387.6nm, H_2O@407.5nm) Rot Raman (High J @353.1nm, Low J @354.0nm) for temperature	Elastic (354.7nm, co-/cross-pol)
Digitizer	NI PXI-5124: 12-bit, 200 MHz (photon counting post digitization)	

Observation of a major dust transport event

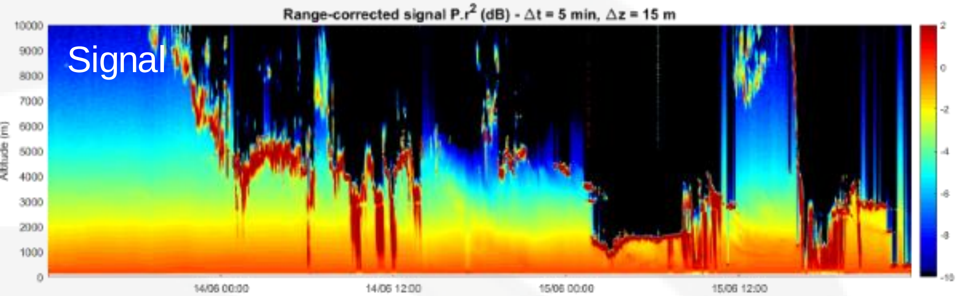


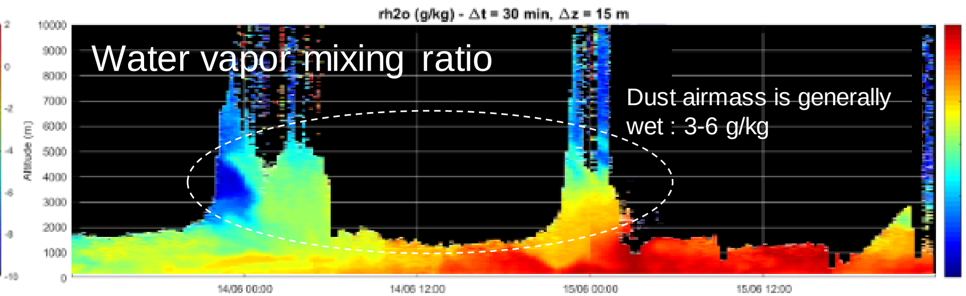


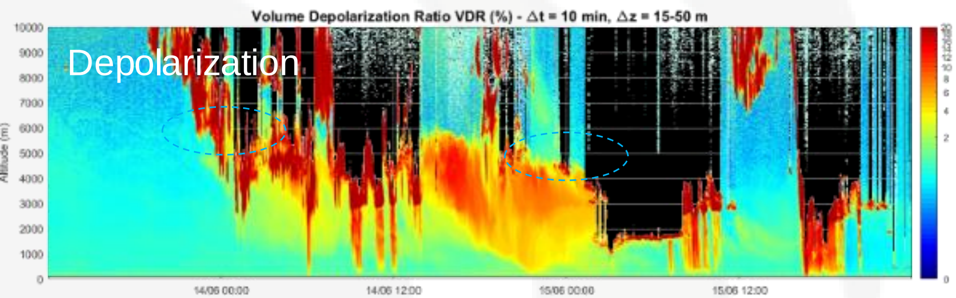


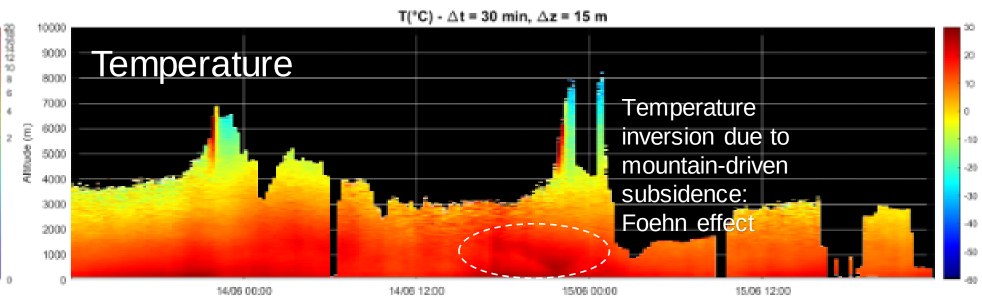
WALI multi-channel results

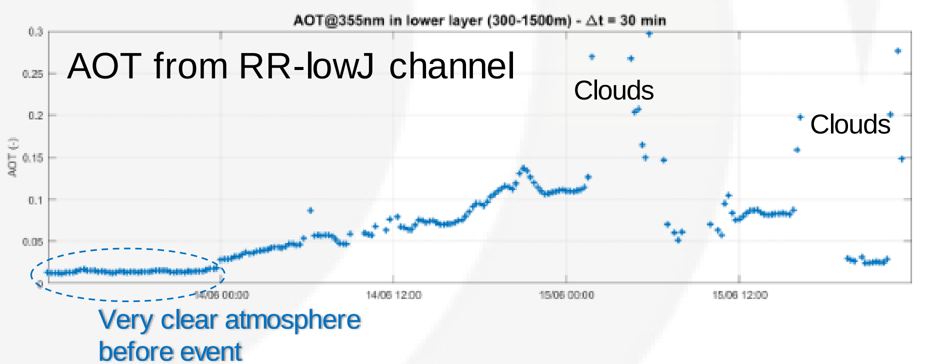
For H2O / T calibration, see presentation by Baron et al., Relative humidity fields in the Annecy Alpine valley observed by Ro-Vibrational Raman lidar in the framework of L-WAIVE

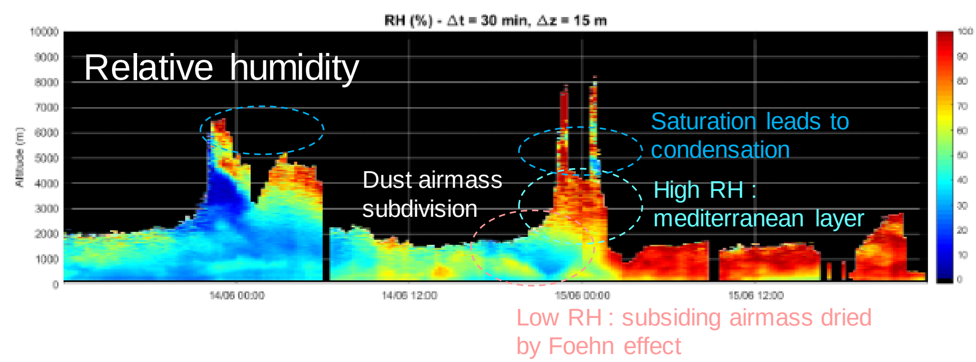




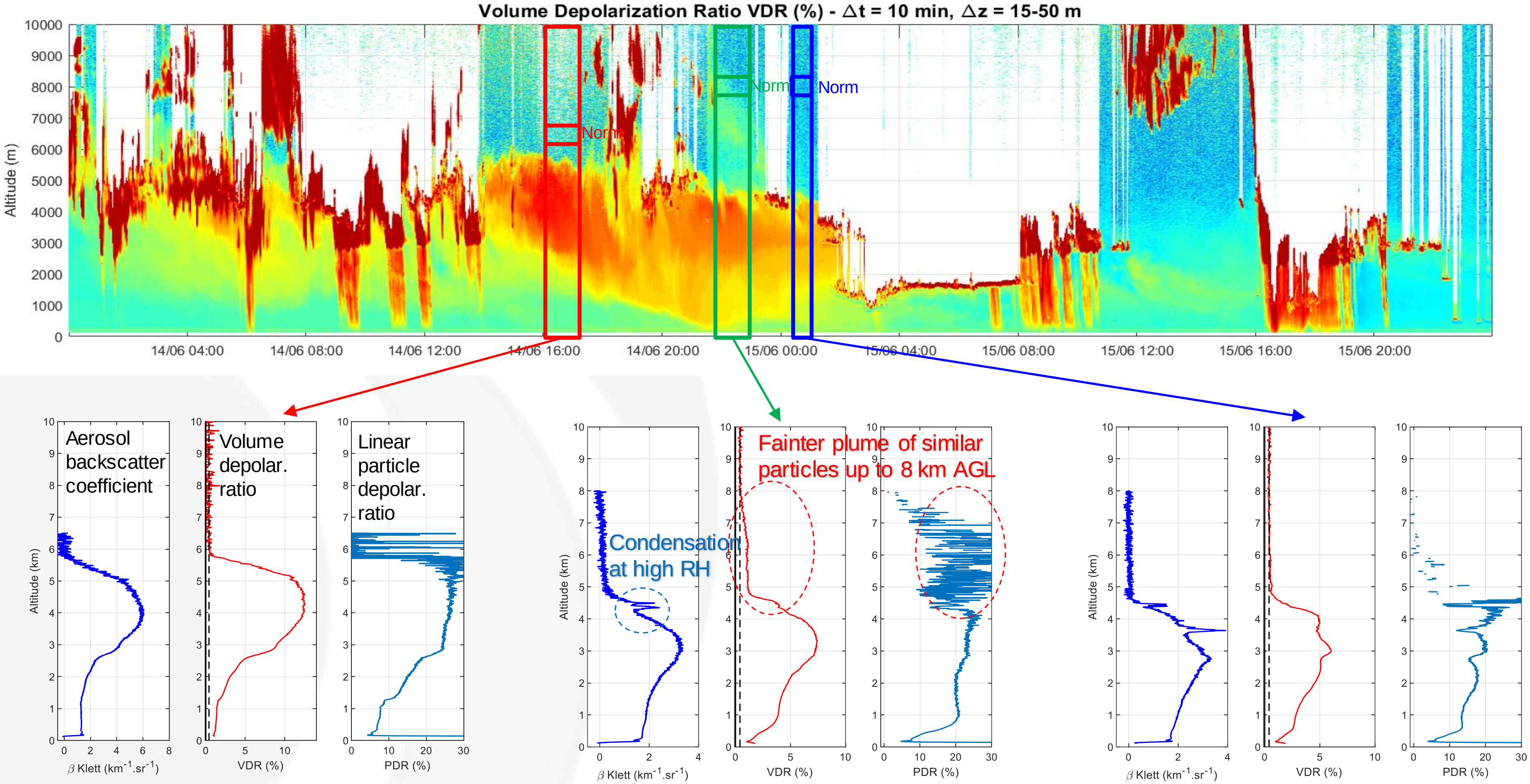








Profile inversions for retrieval of aerosol optical properties



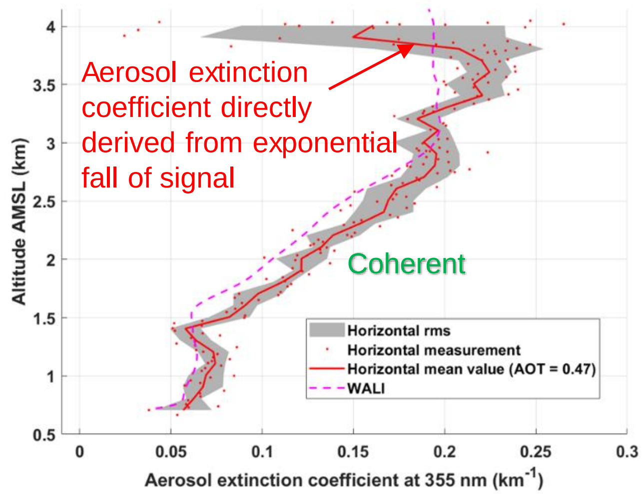
AOT by lidar = 0,82 ± 0,06
AOT by sunphotometer = 0,7 ± 0,1

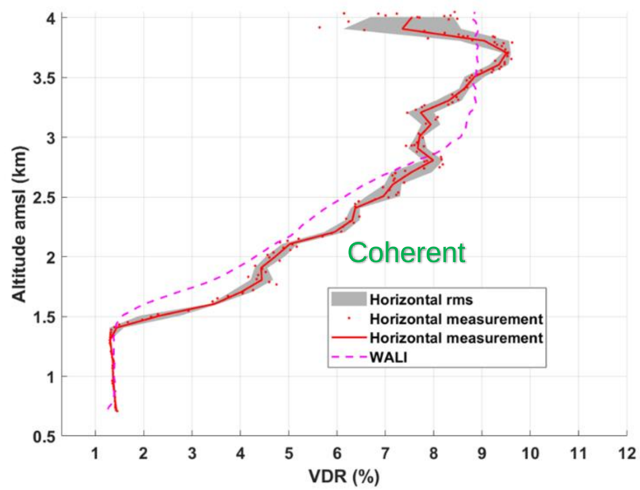
Maximum aerosol extinction : 0.28 km^{-1} @ 355 nm

Klett AOT and Rot-Raman AOT best fit for **LR = 48±5 sr**, N_2 Raman AOT best fit for **Angstrom exp = -0.25 ± 0.25**
PDR from 15% to 26 % depending on level of mixing

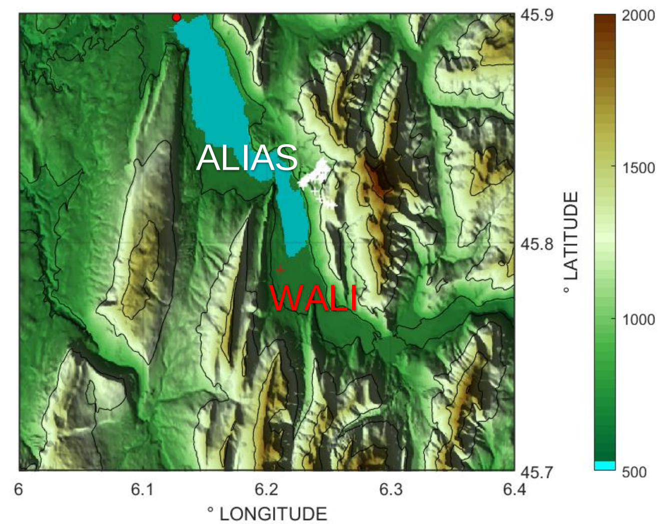
ALIAS lidar measurements

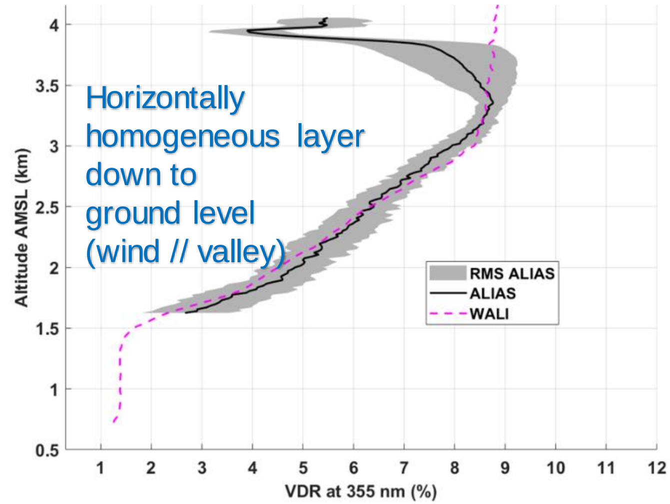
1) ULA ascent near base, horizontal lidar





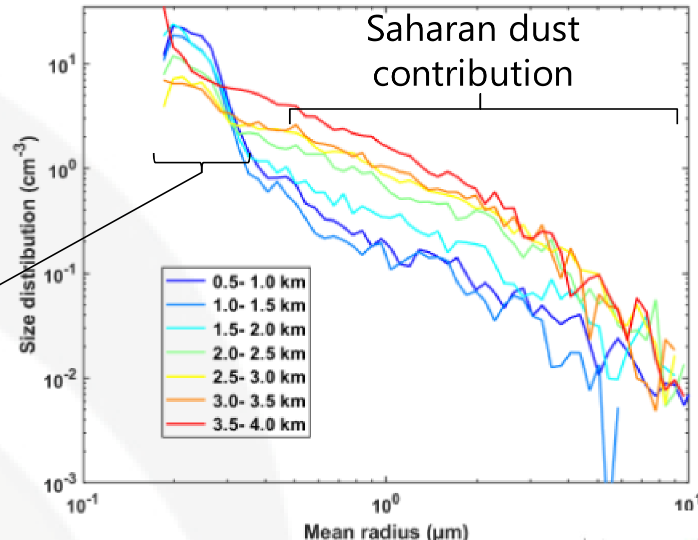
2) ULA above other side of valley, vertical lidar



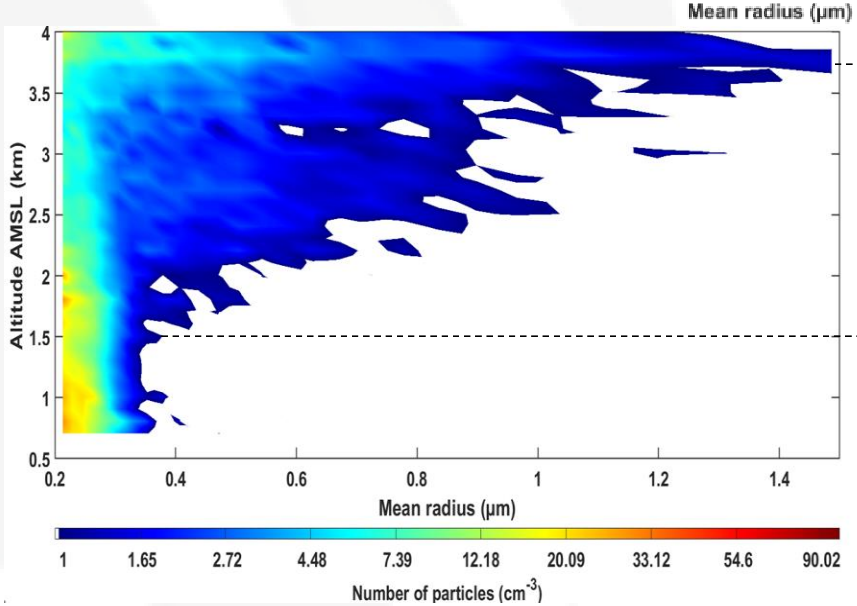


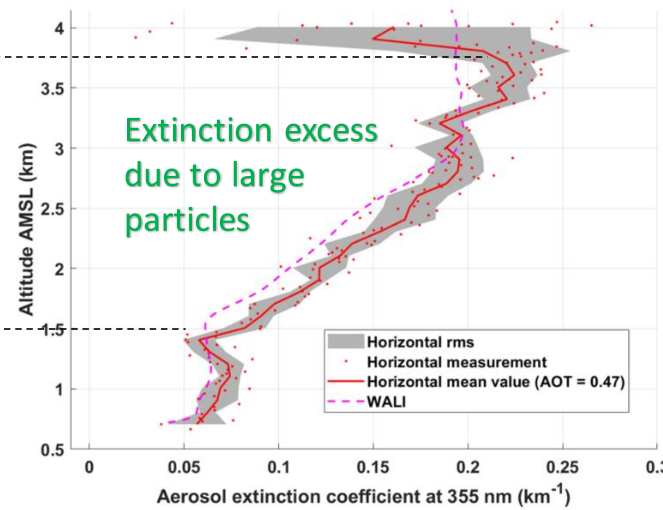
Particle size distribution

Accumulation mode due to local aerosols

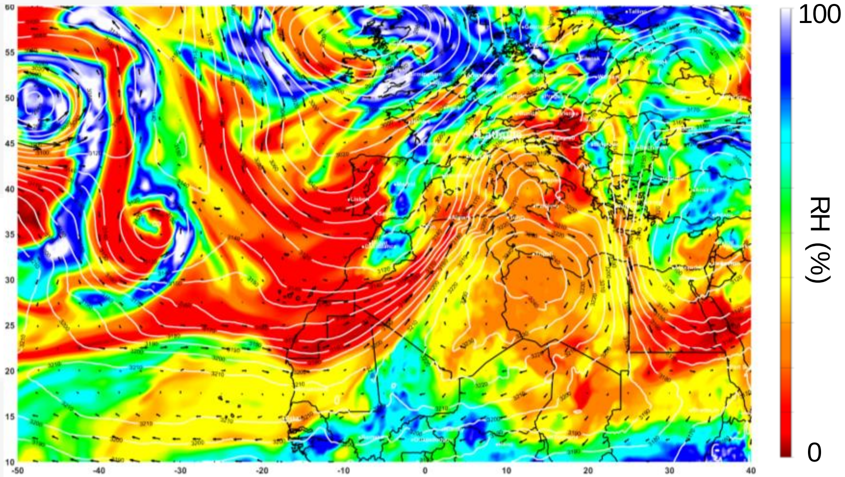


Particle size distribution from FIDAS optical particle counter





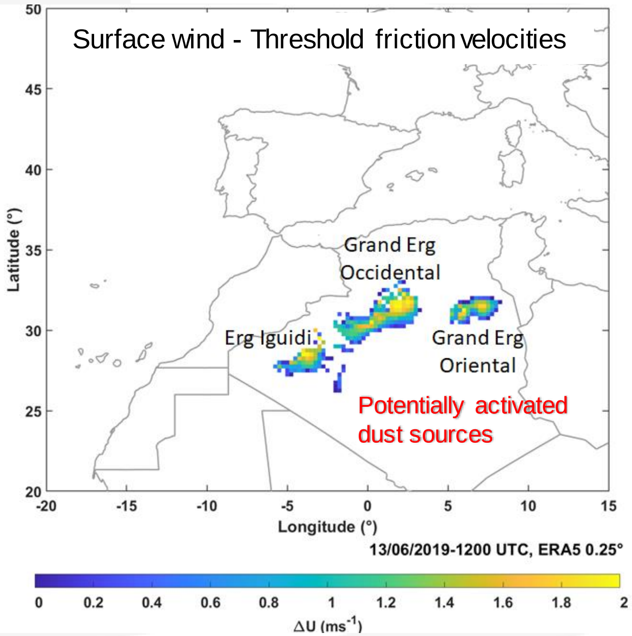
Satellite observations & model outputs

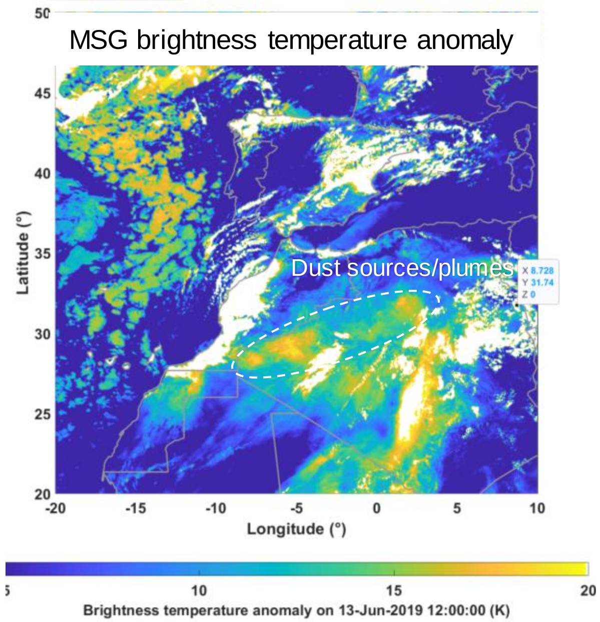


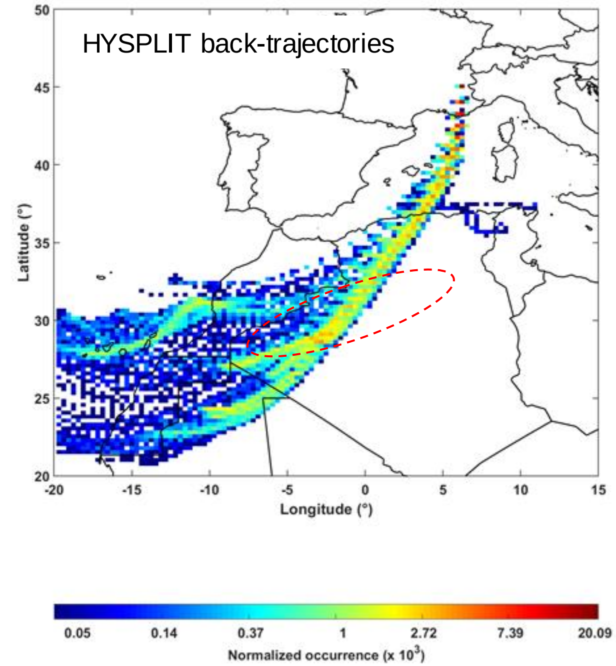
Weather situation on 14 June 0:00UTC

ECMWF/IFS ERA5 reanalyses
Geopotential, winds and RH at 700 hPa level

Low on British Isles & High above Lybia bring strong winds over Sahara all the way to the Alps.







Conclusions

- Opportunity measurements during L-WAIVE campaign over Annecy lake in the French Alps highlighted a particularly intense dust event:
  - spanning 1 to 8 km AMSL altitudes, with AOT above 0.8, and Angstrom exponent ~ 0
  - clearly associated with humid airmasses
  - subsidence leading to dry lower layers
  - horizontally homogeneous concentrations over the valley

- Strong interest of weather & aerosol lidar to study this kind of process involving layers with different water vapor mixing ratio and potential temperature, which helps interpreting the origins and history of airmasses as well as the local dynamic.

- Synergy between ground/airborne platforms is a strong asset for studies of atmospheric processes at high temporal and spatial resolutions.

Friendly acknowledgements to: local authorities of the town of Lathuile R. Aumaître, H. Bourne, F. Lambert; L-WAIVE campaign participants E. Dieudonné, A. Monod, H. Sodemann, C. Diana, P. Doira, F. Maignan, S. Ravette, A. Durand, C. Flamant ; instrument providers F. Arthoud; ULA pilots F., L., F. Toussaint.