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PROFILING OF AEROSOLS AND CLOUDS IN REUNION ISLAND (21°S, 55.5°E)

Hélène Verèmes^{(1,2)*}, Valentin Duflot^(1,2), Nelson Bègue¹, Guillaume Payen², Nicolas Marquestaut², Olivier Bousquet¹, Jean-Pierre Cammas^(1,2), Alain Hauchecorne³, Sergey Khaykin³ and colleagues from LACy¹, UMS² and LATMOS³

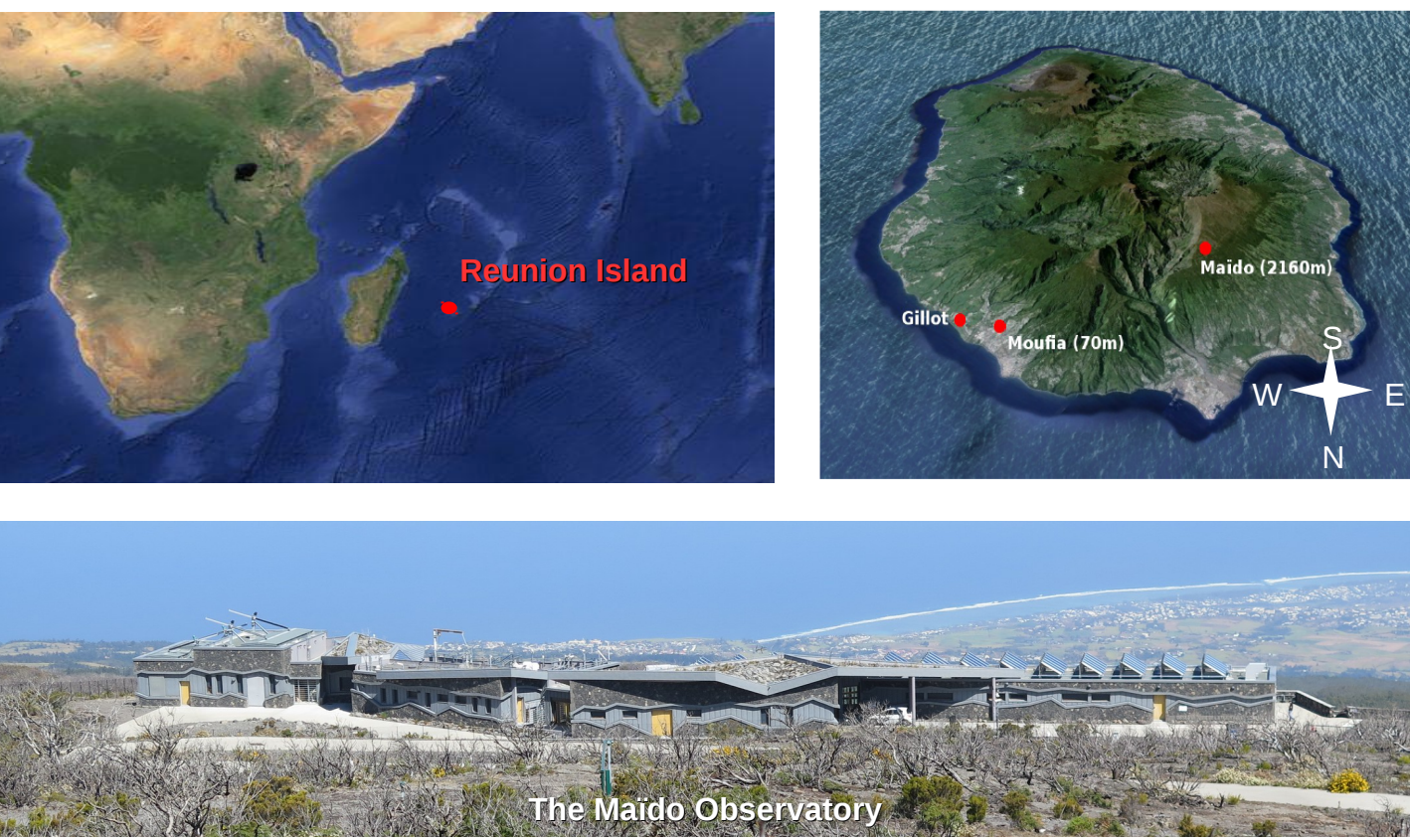
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ATMOSPHERIC PHYSICS OBSERVATORY OF REUNION ISLAND

• Presentation

The Atmospheric Observatory of Reunion Island is a permanent station for long term atmospheric observations. It is composed of a high altitude facility (the Maïdo Observatory; Baray et al., 2013) and coastal sites of measurement in the north of the island.



• Objectives

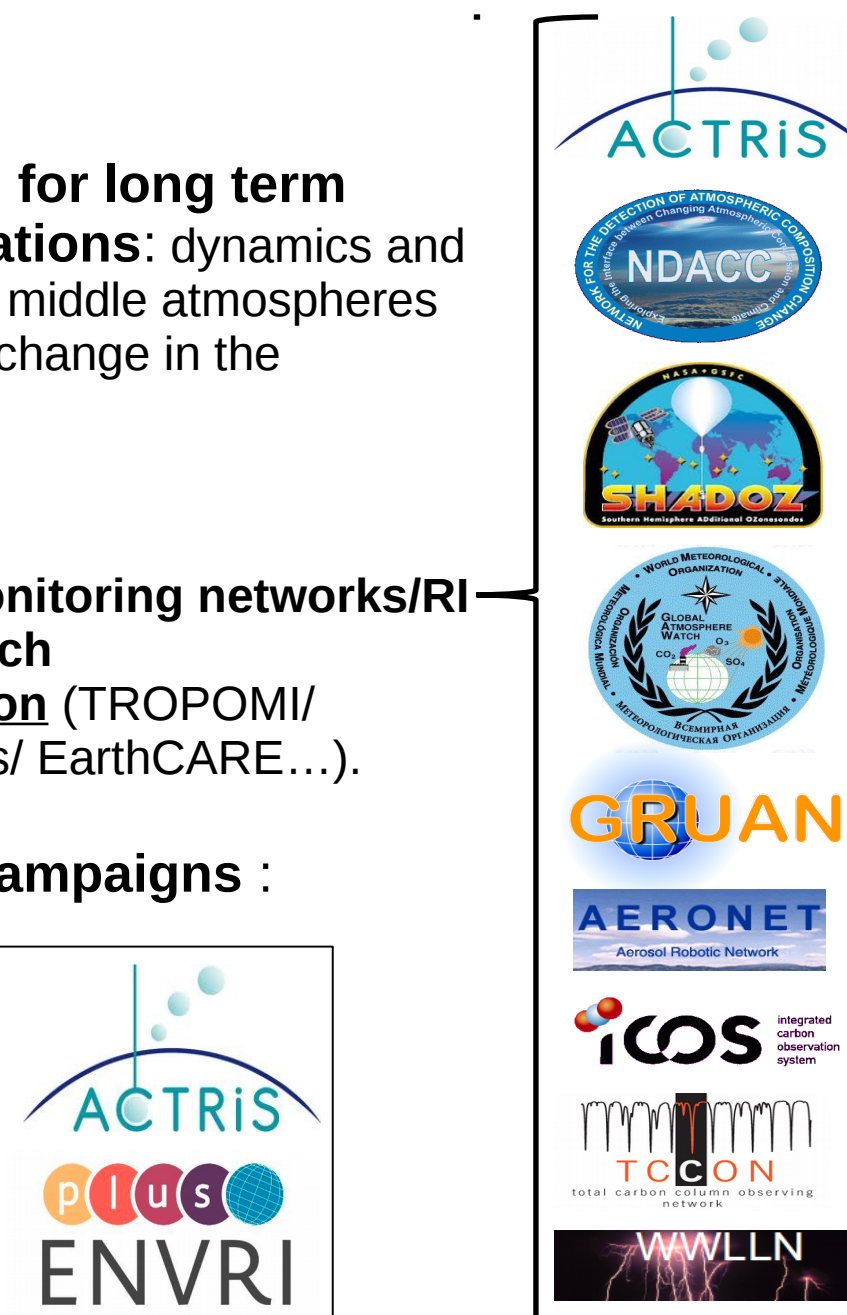
Be a permanent station for long term atmospheric observations: dynamics and chemistry of the low and middle atmospheres in the context of climate change in the Southern Hemisphere

Provide (open) data for:

- international monitoring networks/RI
- scientific research
- satellite validation (TROPOMI/CALIPSO/Aeolus/EarthCARE...).

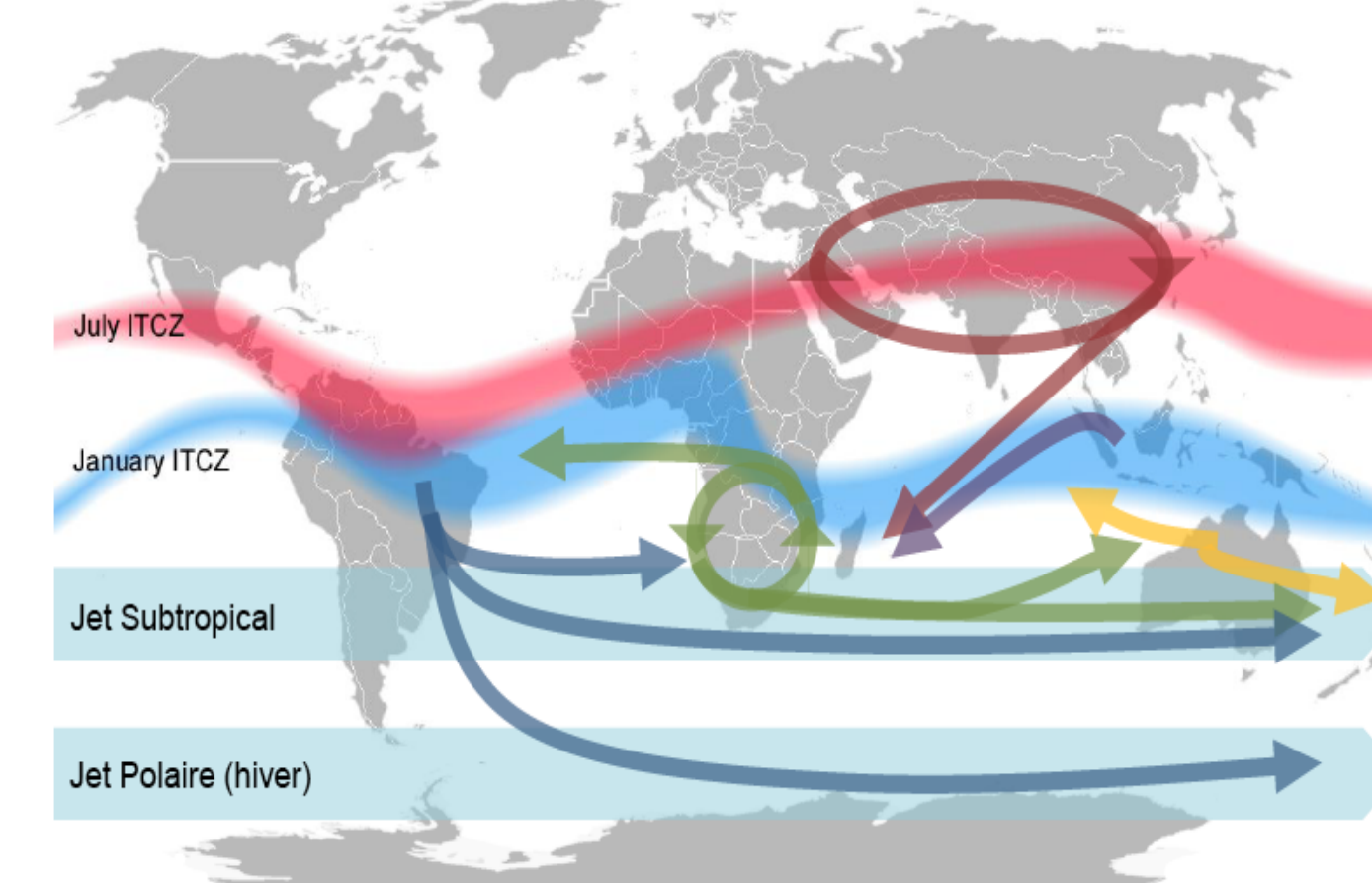
Host scientific teams/campaigns :

Trans-National Access
European programs



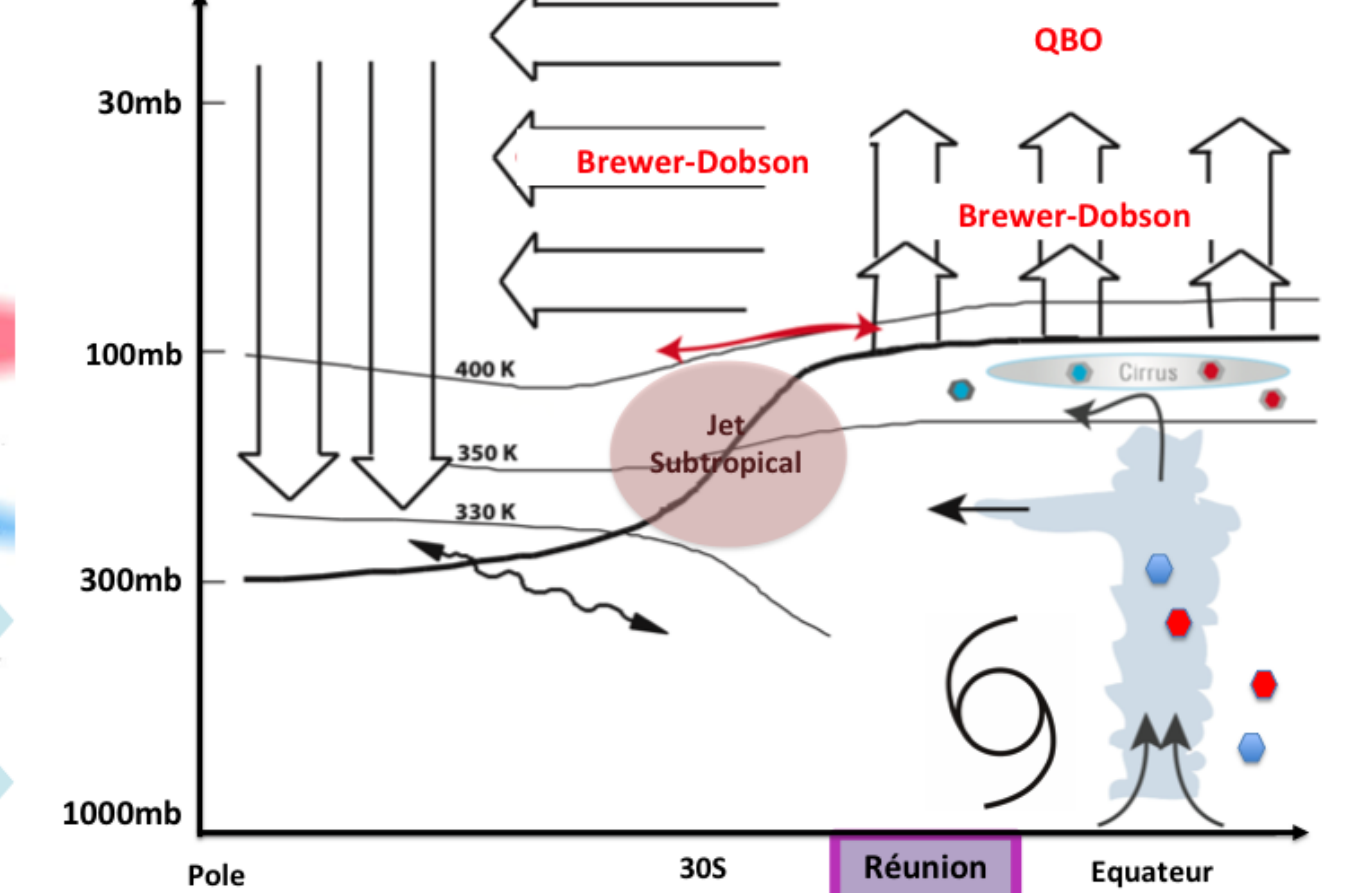
CONTEXT

• Free troposphere



- Austral biomass burning season
- Long-range transport
- Active volcano
- Cyclones/tropical storms
- Heavy rainfall

• Tropical tropopause layer

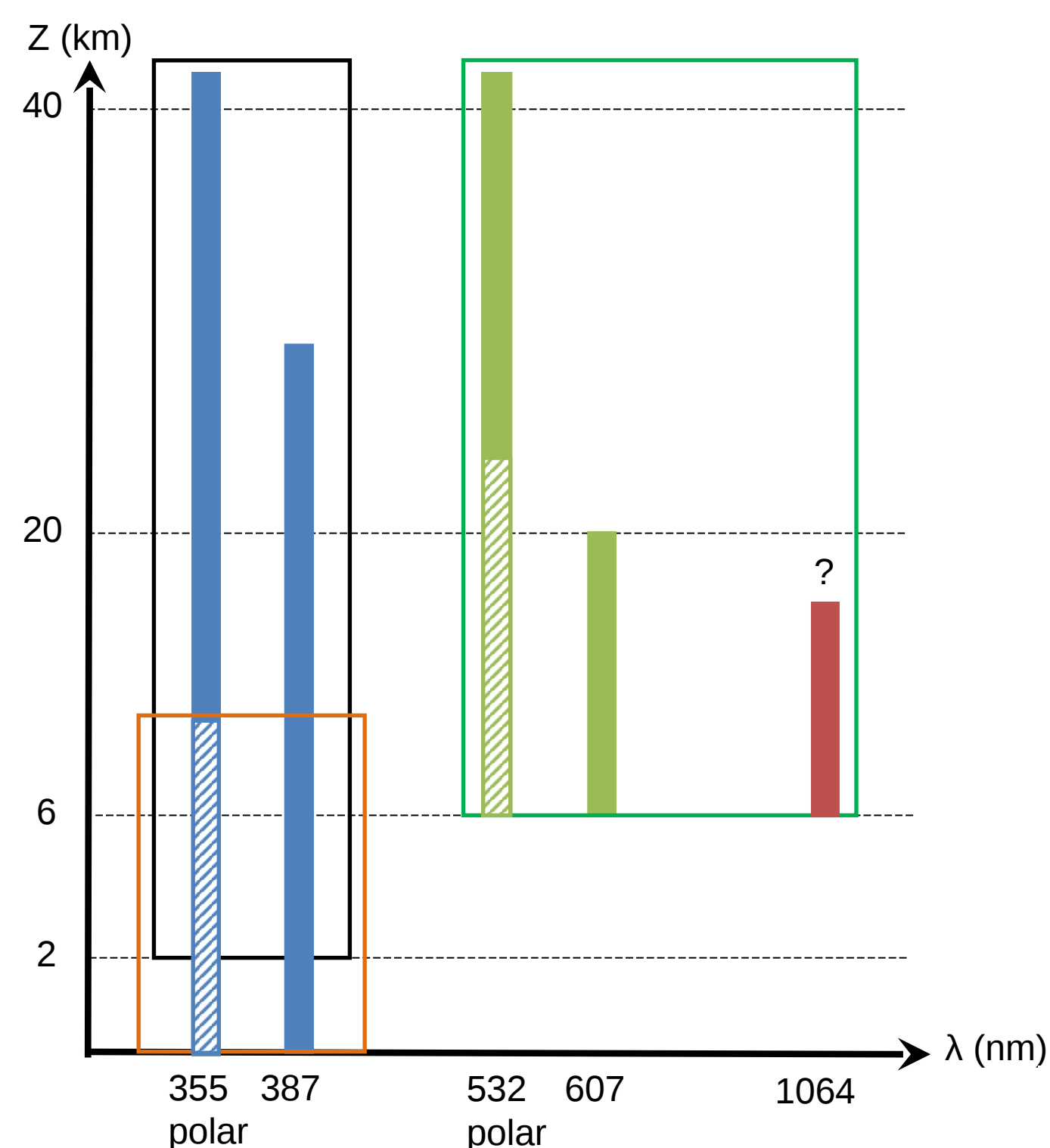


- Stratosphere-troposphere exchanges (STE)
- Cirrus clouds
- Volcanoes (long-range)
- Deep convection
- Cyclones

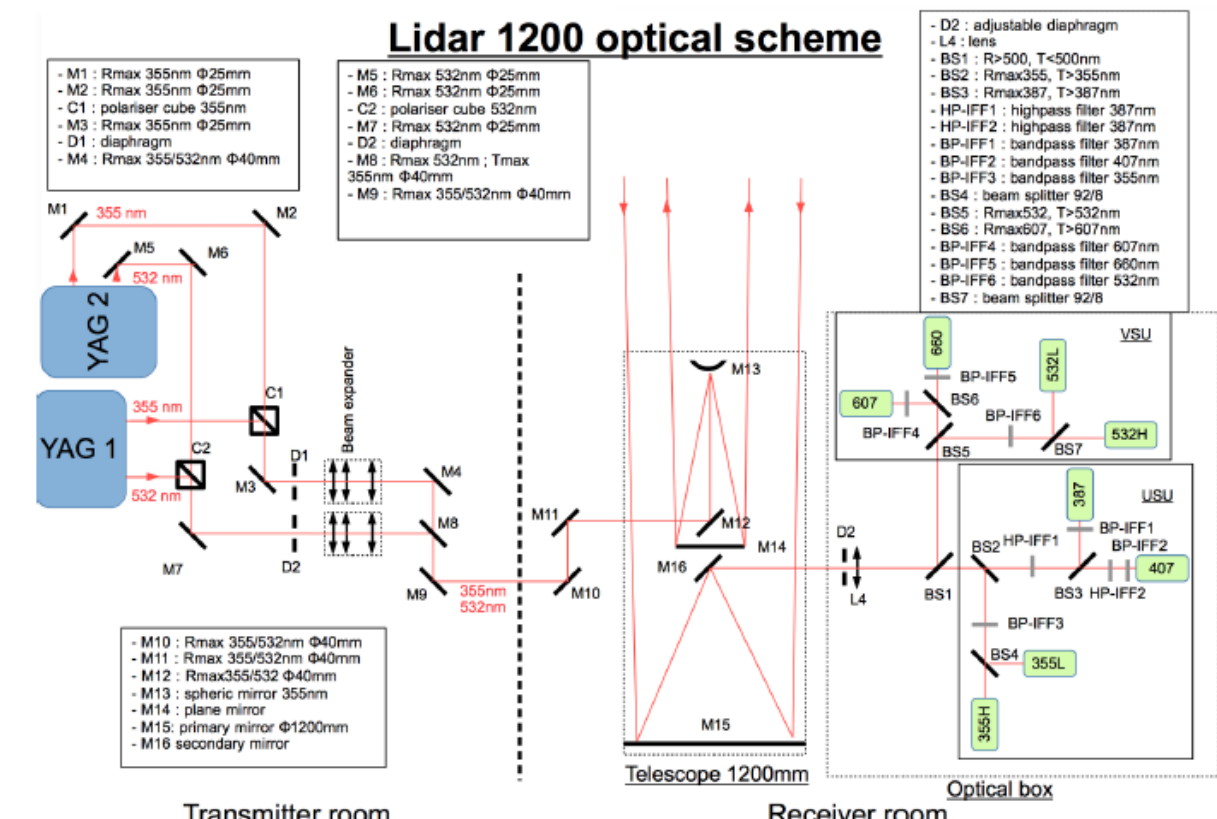
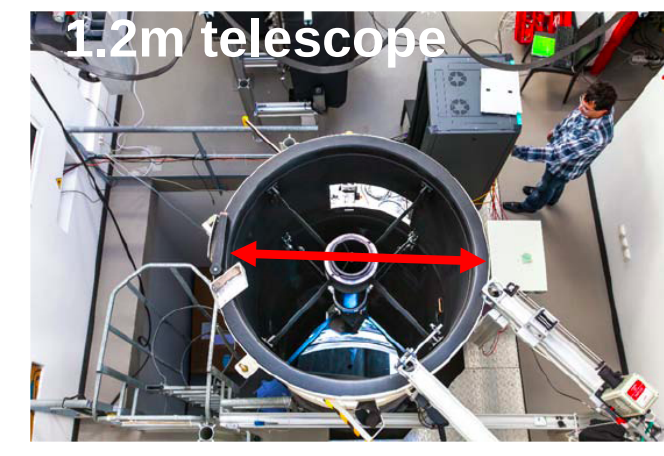
PROFILING OF AEROSOLS

Reunion Island is located in a « clean » area, i.e. the AOD is low, but, during the biomass burning season in the Southern Hemisphere, the AOD doubles. The Indian Ocean region is a difficult area for satellite sensing, it is necessary to make ground-based observations.

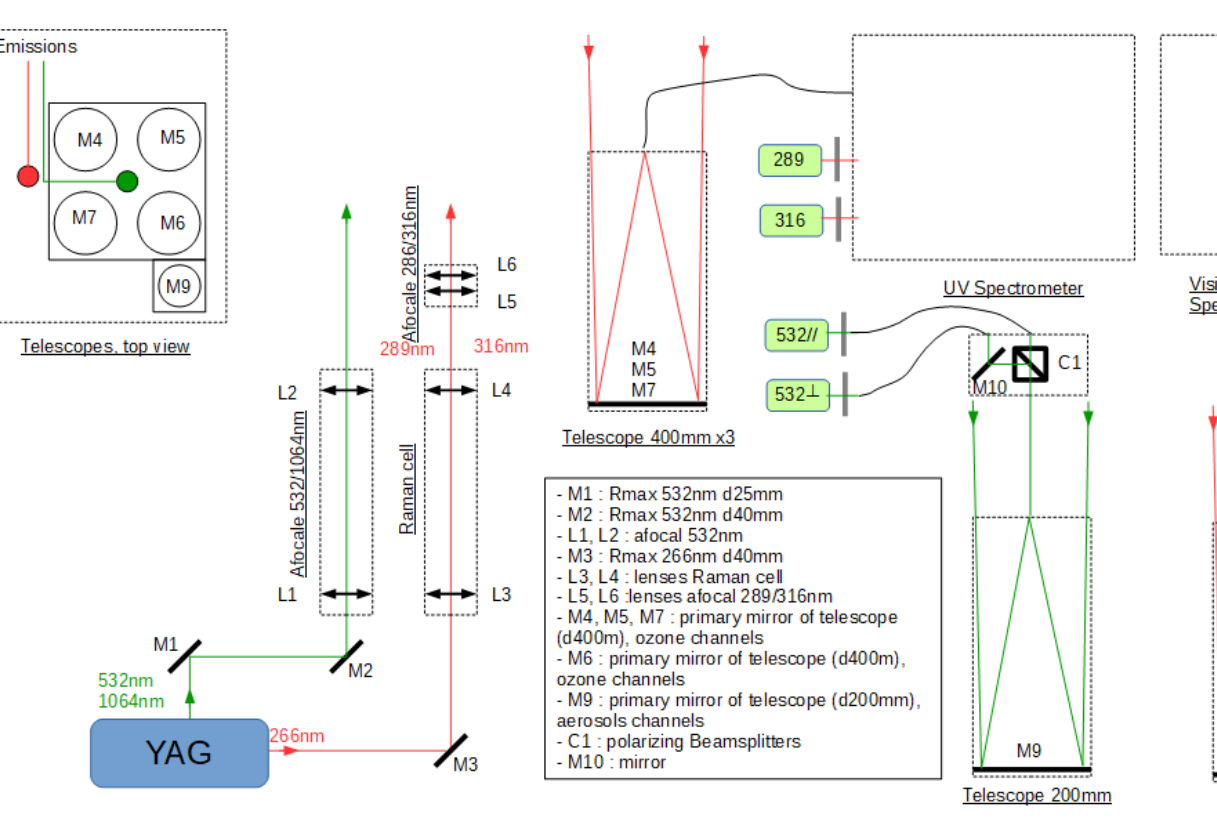
• Observation capabilities



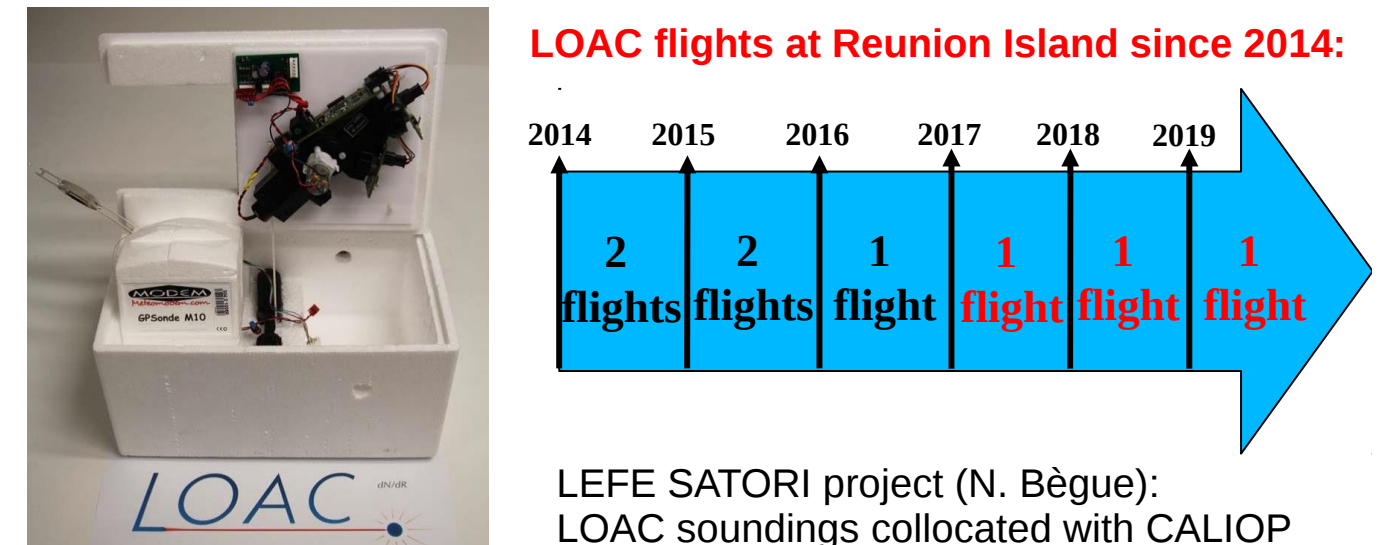
Lidar1200
(T^o, H₂O, aerosols)
355 & 387nm
2.2-40km range



LIO3T (O₃, aerosols)
532 (L & I), 607 & 1064nm
6-40(20)km range



+ LOAC (Light Optical Aerosols Counter)



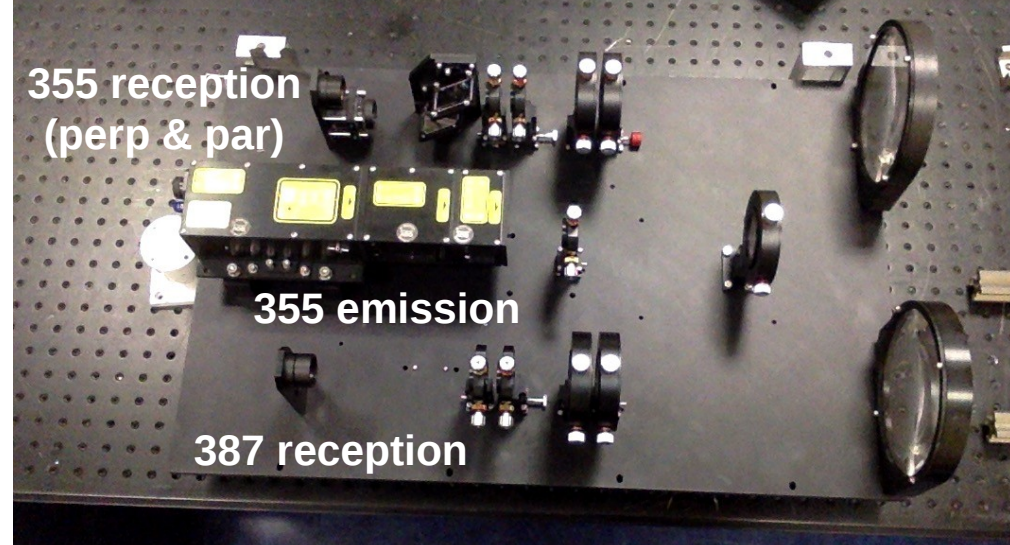
PROFILING OF CLOUDS

There are on average 9.3 systems/year and 4.7 cyclones/year in the southwest Indian Ocean. Reunion Island holds several world records for precipitation.

• Observation capabilities

MARLEY (Mobile Aerosol Raman Lidar for troposphEre surveyY)

Leosphere ALS450 + Raman N₂ channel
Full overlap at ~150m / fully automated



Collocated with:
AERONET sunphotometer and BASTA cloud radar

Radar BASTA



Doppler radar
95GHz
12.5, 25, 100 and 200m modes
6-12km range

Ceiliometer

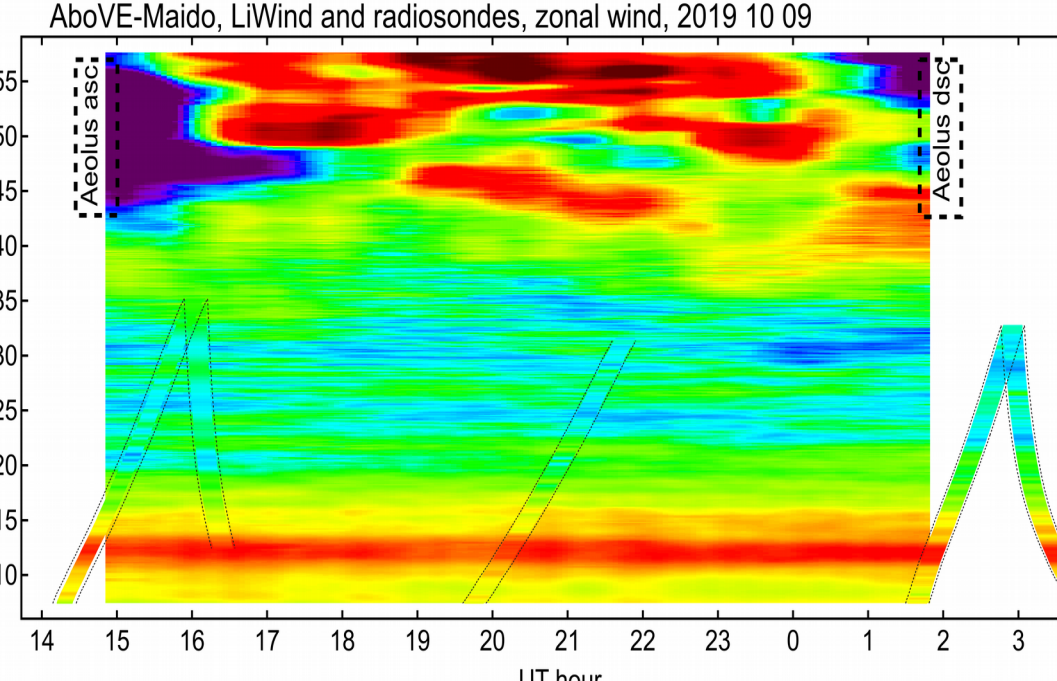


Campbell CS135
905nm
5m resolution
10km range

TRACE GASES AND WIND OBSERVATION CAPABILITIES

• Cal/val

LiWind
Rayleigh-Mie Doppler wind lidar
vertical resolution up to 100m
5-65km range
accuracy: 1m/s up to 30km



AEOLUS cal/val campaign at the Maïdo
Observatory: 16 September to 11 October 2019

• Overview

Maïdo Observatory	Gillot
Lidar O3S	FTIR
Lidar O3T	Scantron
Lidar 1200	OPS
Wind lidar	Aethalometer
IR radiometer	Chemical filters
WIRA-C	CPC
GNSS	Nox analyzer
TLE camera	O ₃ analyzer
All-Sky	SO ₂ analyzer
WVLN antenna	Picarro 4 gases
Infrasound station	Picarro water isotops
ODS	Rainwater collection
Meteorol. station	Visible cameras
Cobald sondes	CFH sondes
GNSS	MAX-DOAS
	LOAC sondes
	M10 sondes - O ₃ ECC
	MAX-DOAS
	POPS sonde
	FTIR
	UV spectrometer
	SAOZ
	Mini-SAOZ
	CIMEL
	BASTA radar
	MARLEY
	Disdrometer
	Micro-tops
	Meteorol. station
	Picarro 3 gases

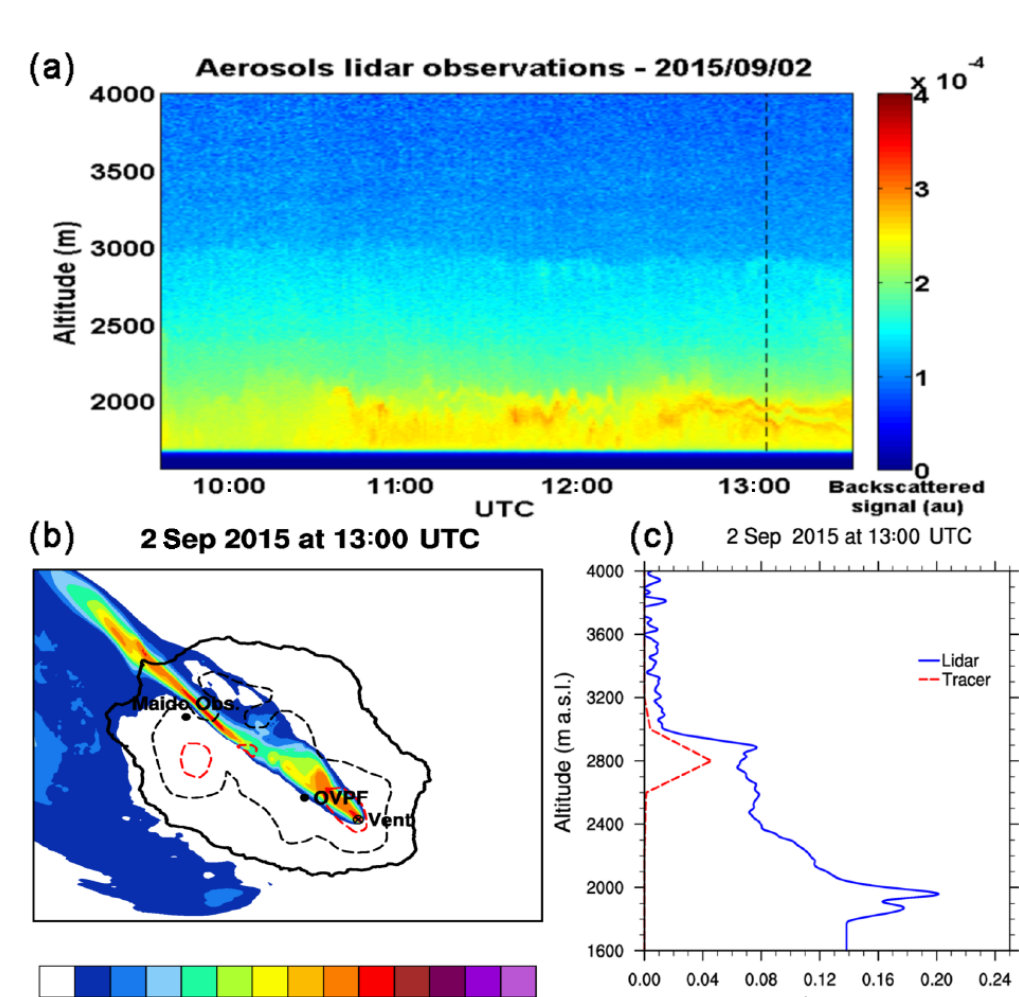
→ 2015: Piton de La Fournaise eruptions



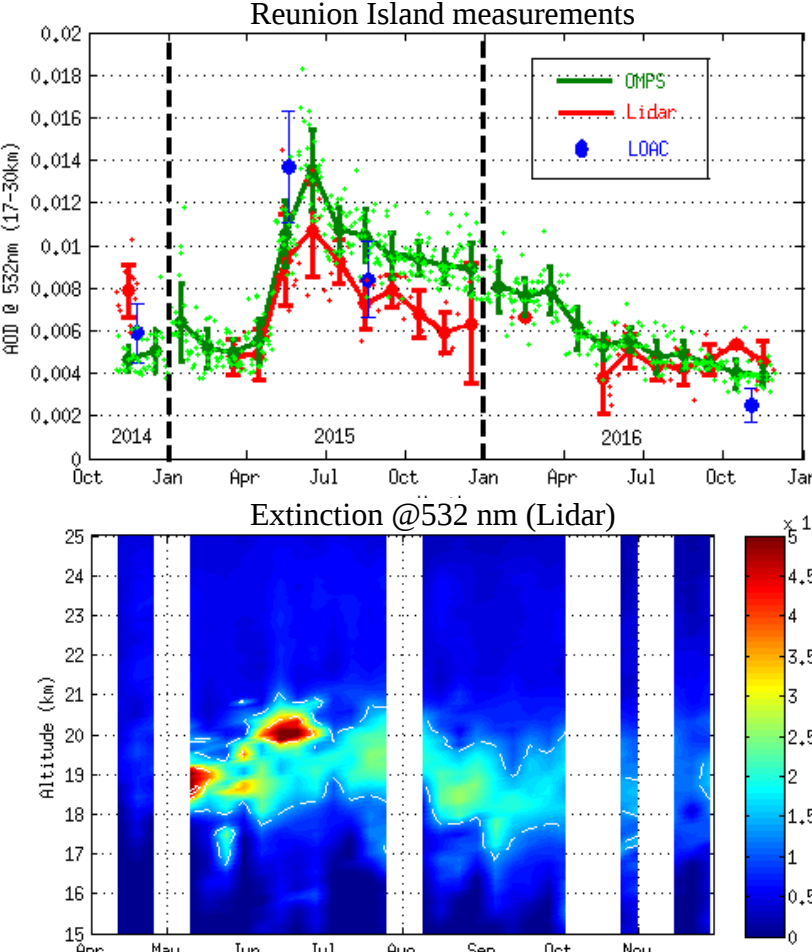
Tulet et al., 2017

LR₃₅₅

=
42 +/- 10 sr
for fresh plume
(16km from the vent)



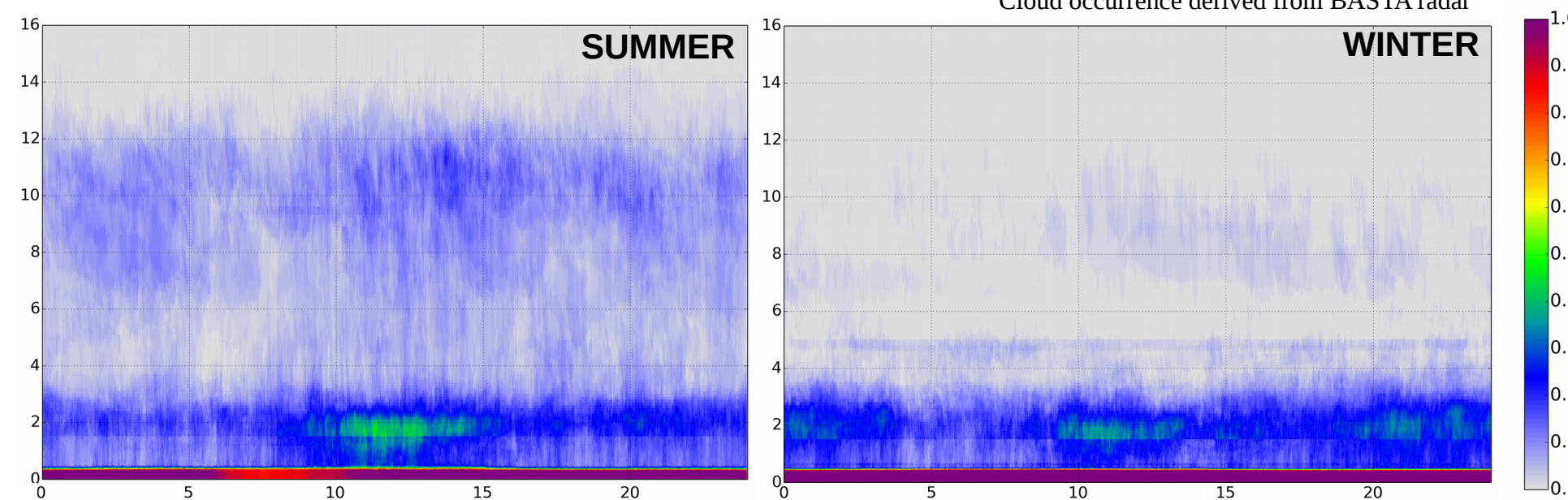
→ 22 April 2015: the Calbuco eruption



Bègue et al., 2017
Transient behavior of the aerosol layers (Reunion Island, May-July 2015)
→ reflects inhomogeneous spatio-temporal distribution of the plume
(controlled by the localization of the dynamical barriers)

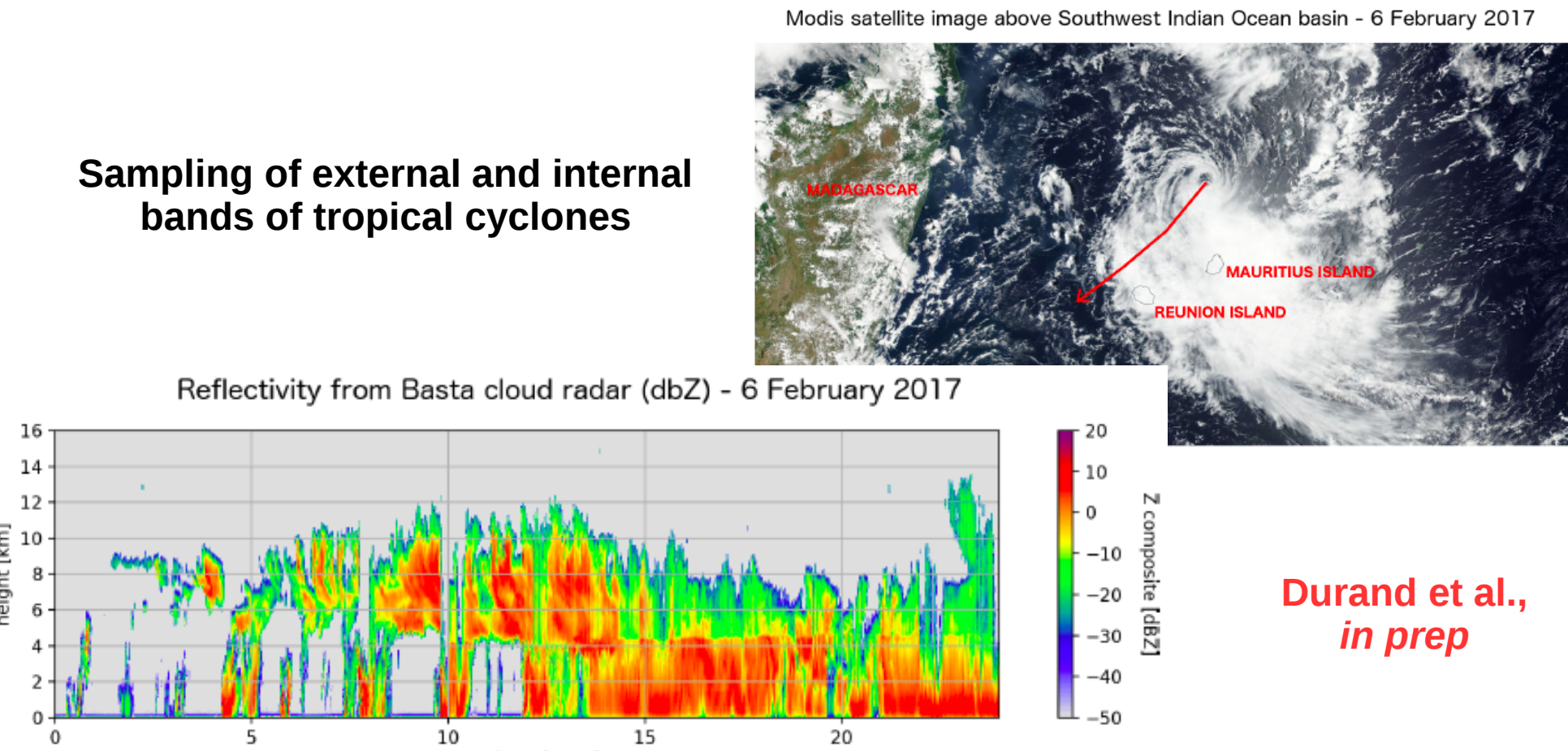
SCIENTIFIC RESULTS

→ Seasonality of the cloud occurrence



Diurnal cycle: 1 max. at 10:00-15:00UTC in summer
2 max. at 10:00-14:00UTC and 19:00-02:00UTC and dominance of low clouds (< 5km asl) in winter

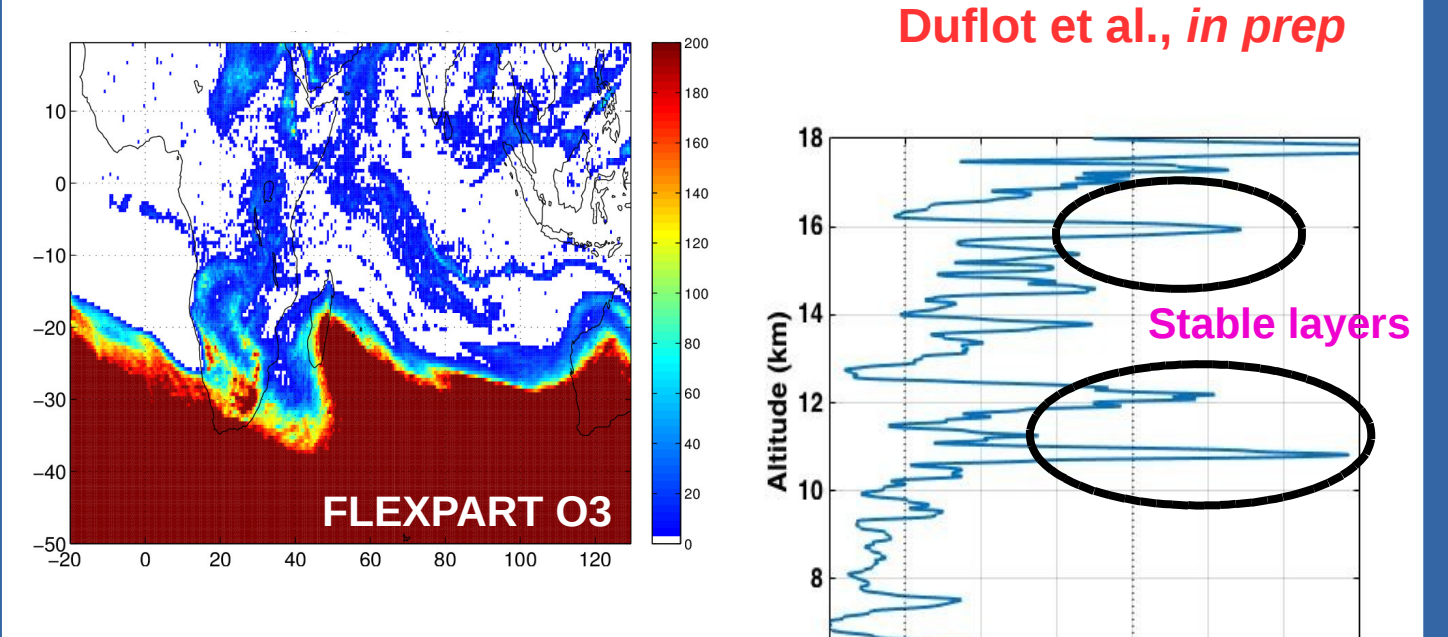
→ Observations of the tropical storm CARLOS



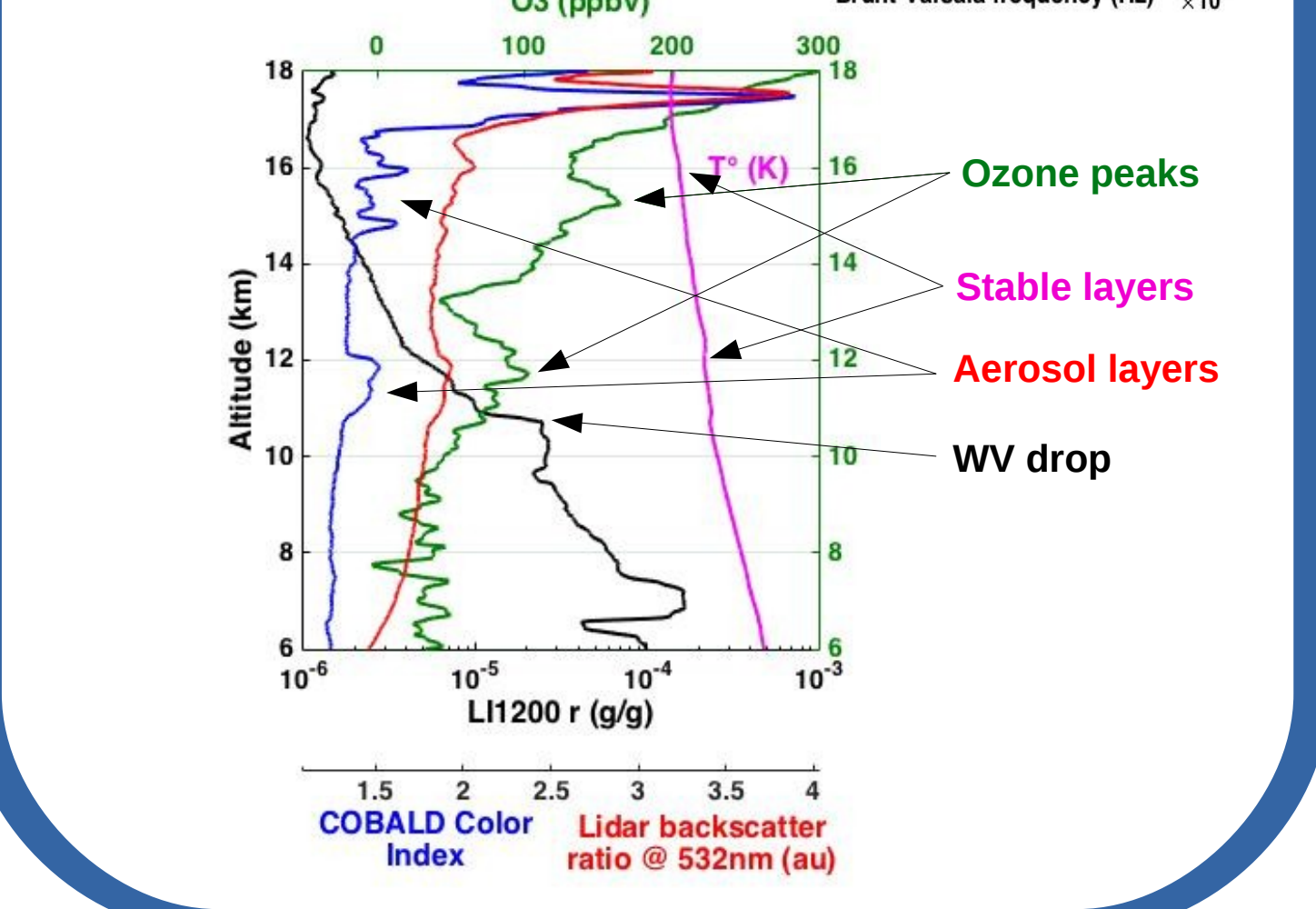
Sampling of external and internal bands of tropical cyclones

INSTRUMENTAL SYNERGY

→ STE with volcanic aerosols



Work in progress



SUMMARY AND FUTURE DIRECTIONS

Atmospheric Physics Observatory of Reunion Island:

- Great capabilities for aerosols and clouds profiling (and trace gases profiling and in situ measurements)
- Working on the use of (brand new) multi-λ lidar signals for aerosols characterization

Contribution objectives within EarthCARE:

- Routine Multi-λ lidar observations for aerosols characterization in a sparsely documented region:

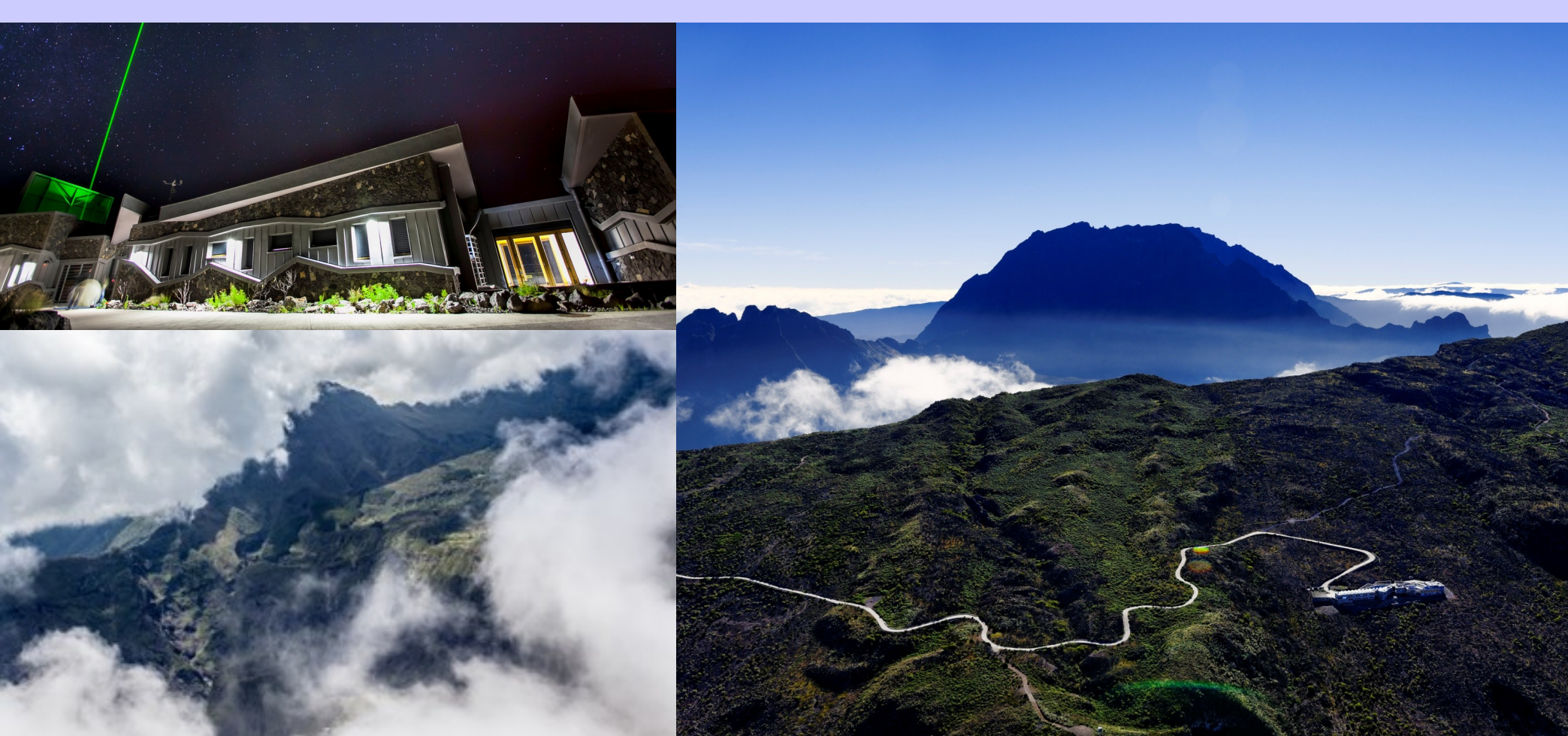
532 (T, L+I) + 1064 => CALIPSO v4; 355+387 => Aeolus & EarthCARE

Having the visible and UV channels operating simultaneously can also contribute to evaluate the effect of the wavelength change between CALIOP (visible) and EarthCARE (UV).

- CALIOP/EarthCARE collocated LOAC soundings

- Routine BASTA measurements

- Radar/lidar synergy



REFERENCES

Baray et al. (2013): Maïdo observatory: a new high-altitude station facility at Reunion Island (21°S, 55°E) for long-term atmospheric remote sensing and in-situ measurements, AMT, 6, 2865-2877.
Bègue et al. (2017): Long-range transport of stratospheric aerosols in the Southern Hemisphere following the 2015 Calbuco eruption, ACP, 17, 15019-15036.
Tulet et al. (2017): First results of the Piton de la Fournaise STRAP 2015 experiment: multidisciplinary tracking of a volcanic gas and aerosol plume, ACP, 17, 5355-5378.

CREDITS

The lidar data can be found at the OPAR (Observatoire de Physique de l'Atmosphère de La Réunion) web portal: <https://opar.univ-reunion.fr>. Please contact us or osureunion-informal@univ-reunion.fr to obtain data download login / password.

ACKNOWLEDGMENTS

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