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Hélène Vérèmes, Valentin Dufлот, Nelson Bègue, Guillaume Payen, Nicolas Marquestaut, et al.. Profiling of aerosols and clouds in Reunion Island (21°S, 55.5°E). 8th International EarthCARE Science Workshop, Nov 2019, Fukuoka, Japan. hal-02945763

**HAL Id: hal-02945763**

**<https://hal.science/hal-02945763v1>**

Submitted on 22 Sep 2020

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

Hélène Vérèmes<sup>(1,2)\*</sup>, Valentin Duflot<sup>(1,2)</sup>, Nelson Bègue<sup>1</sup>, Guillaume Payen<sup>2</sup>, Nicolas Marquestaut<sup>2</sup>, Olivier Bousquet<sup>1</sup>, Jean-Pierre Cammas<sup>(1,2)</sup>, Alain Hauchecorne<sup>3</sup>, Sergey Khaykin<sup>3</sup> and colleagues from LACy<sup>1</sup>, UMS<sup>2</sup> and LATMOS<sup>3</sup>

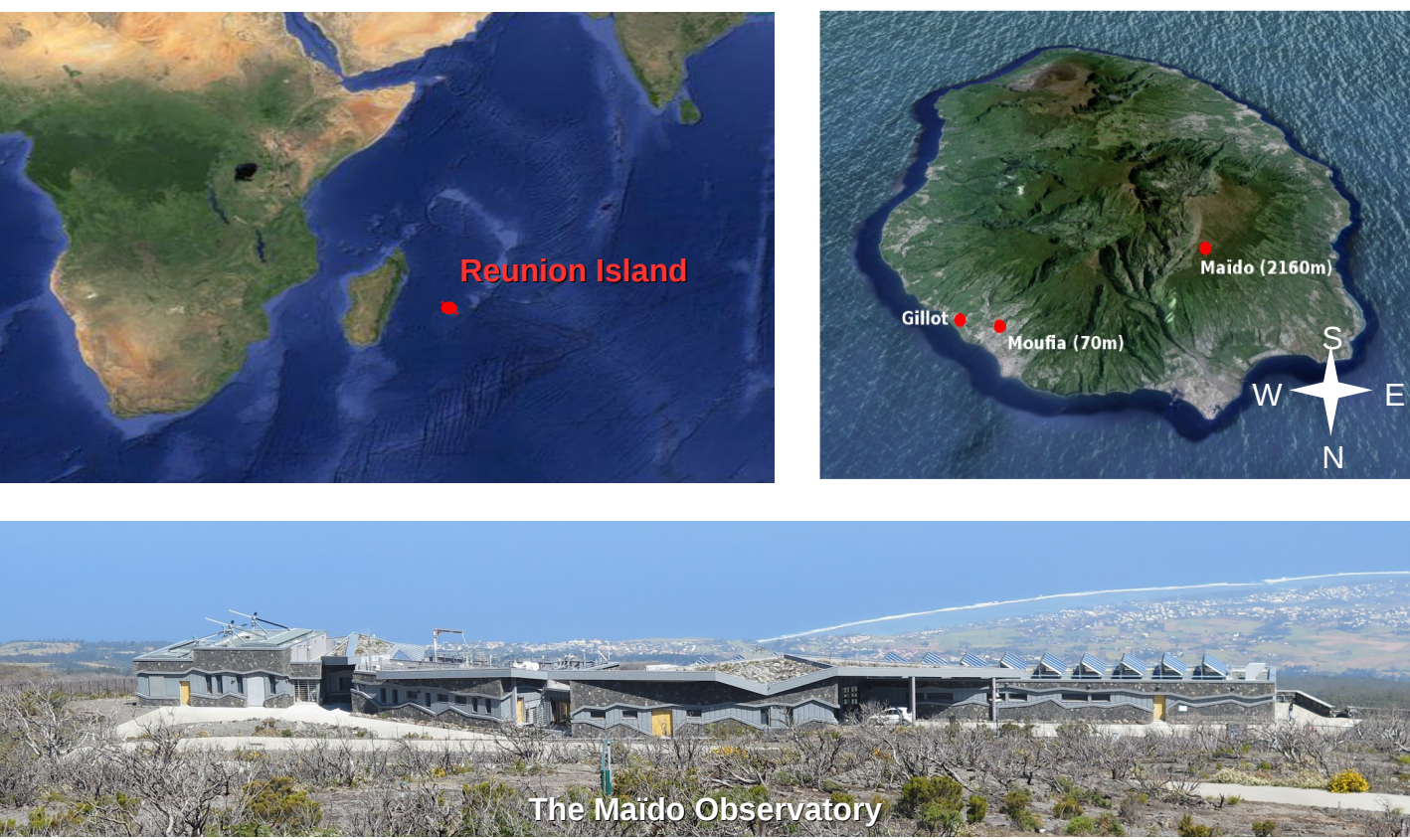
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<sup>2</sup>Observatoire des Sciences de l'Univers de La Réunion, UMS3365, Saint-Denis de la Réunion, France,  
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## ATMOSPHERIC PHYSICS OBSERVATORY OF REUNION ISLAND

### • 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

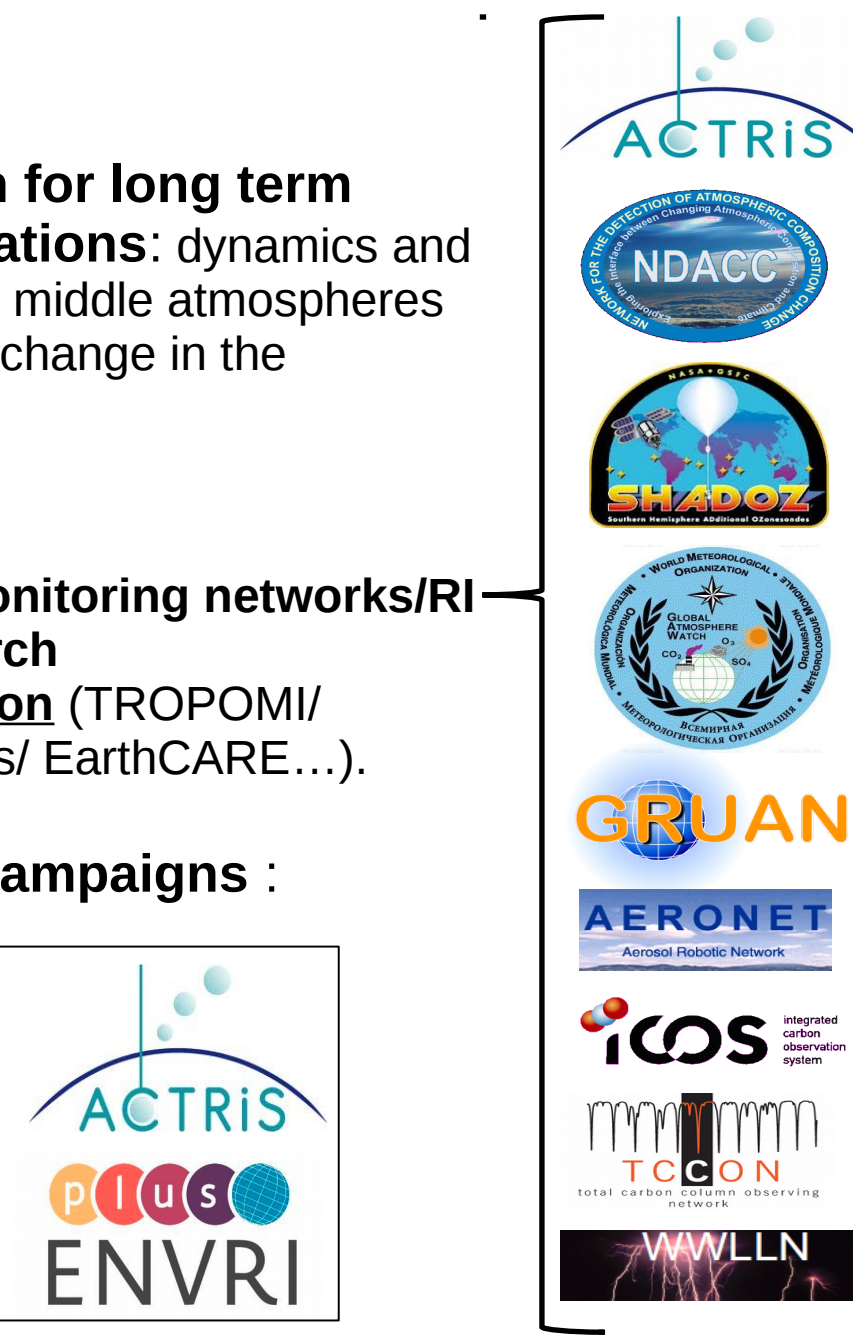
Be a permanent station for long term atmospheric observations: dynamics and chemistry of the low and middle atmospheres in the context of climate change in the Southern Hemisphere

Provide (open) data for:

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

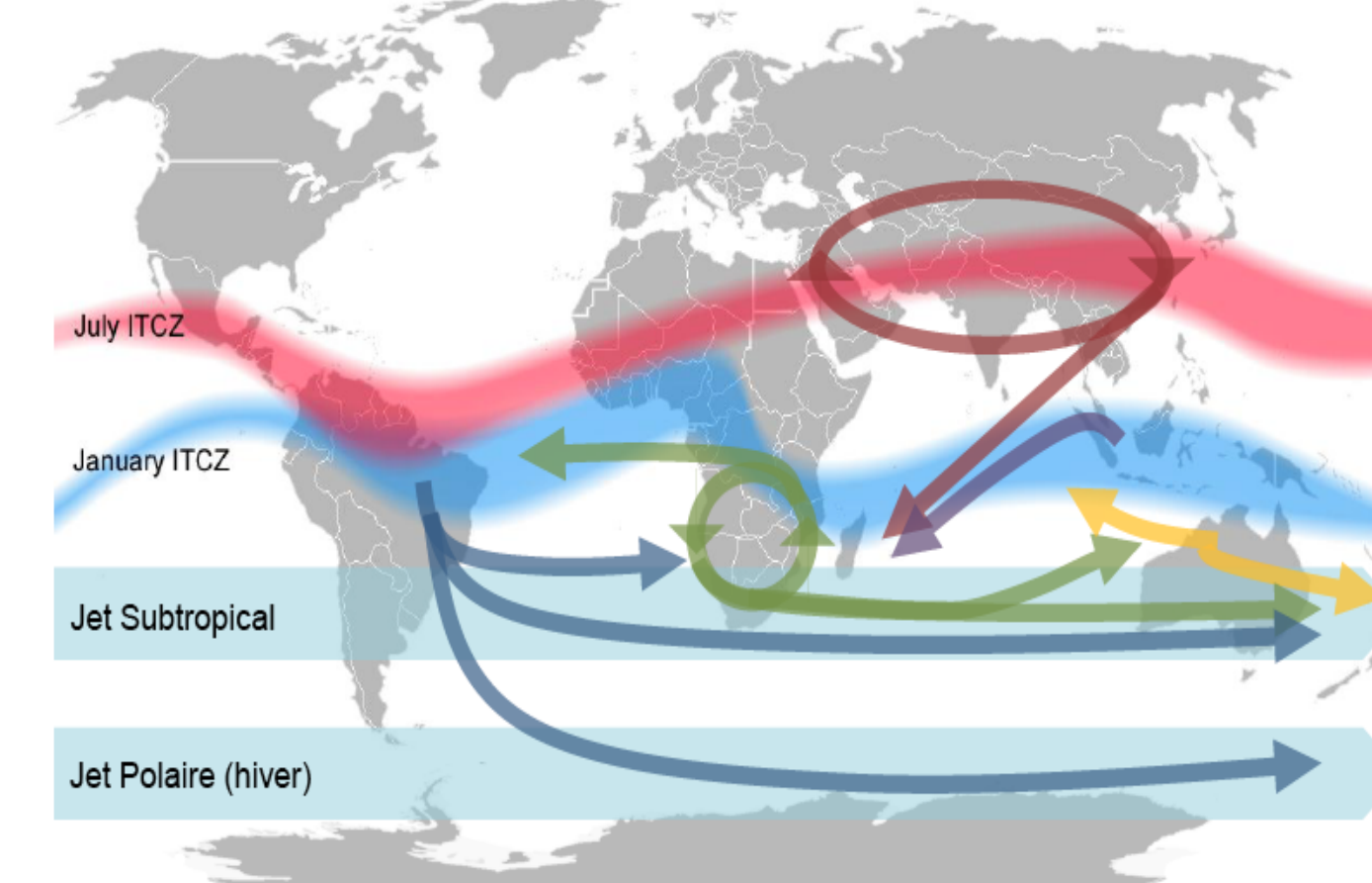
### Host scientific teams/campaigns :

Trans-National Access  
European programs



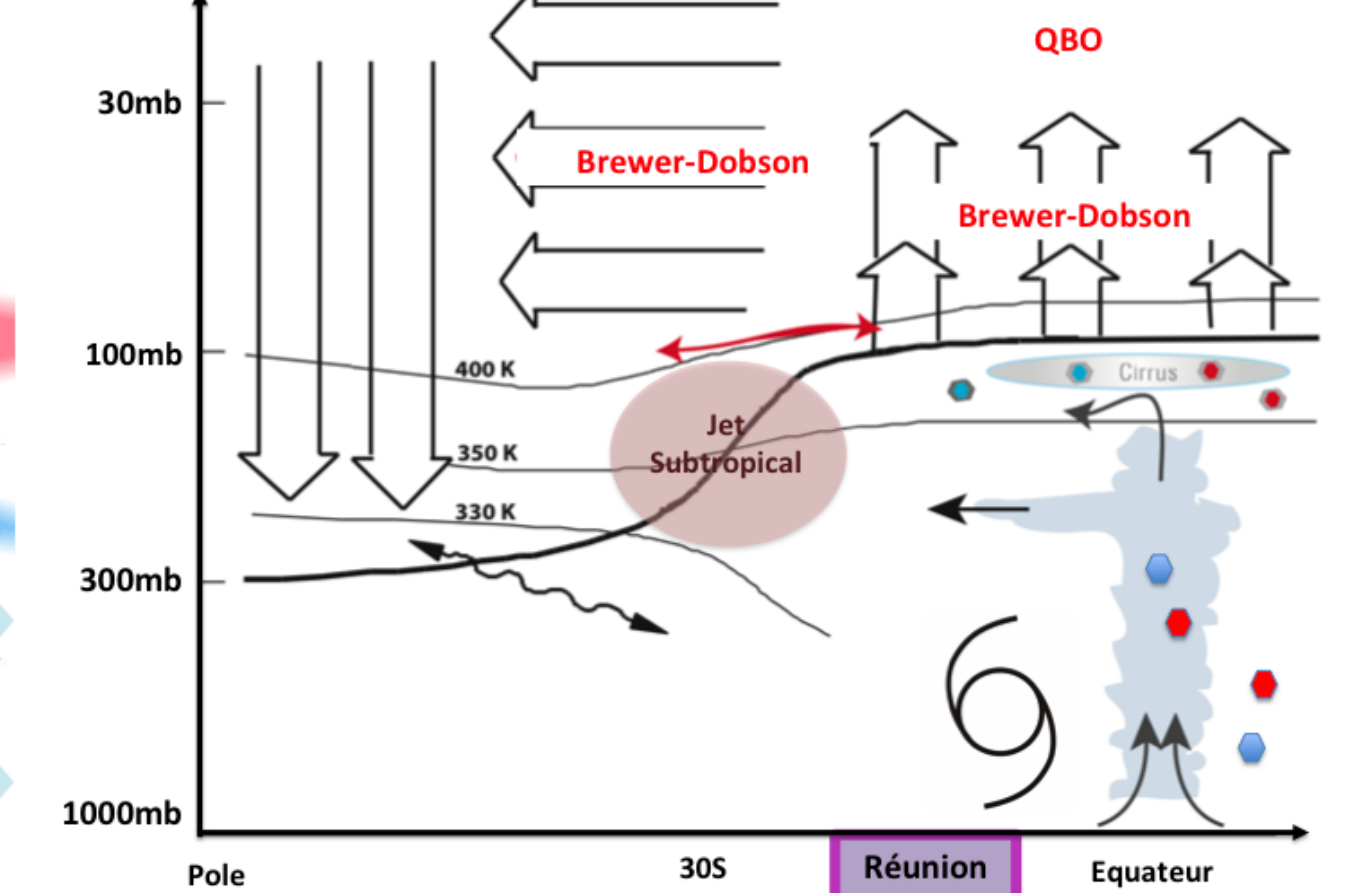
## CONTEXT

### • Free troposphere



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

### • Tropical tropopause layer

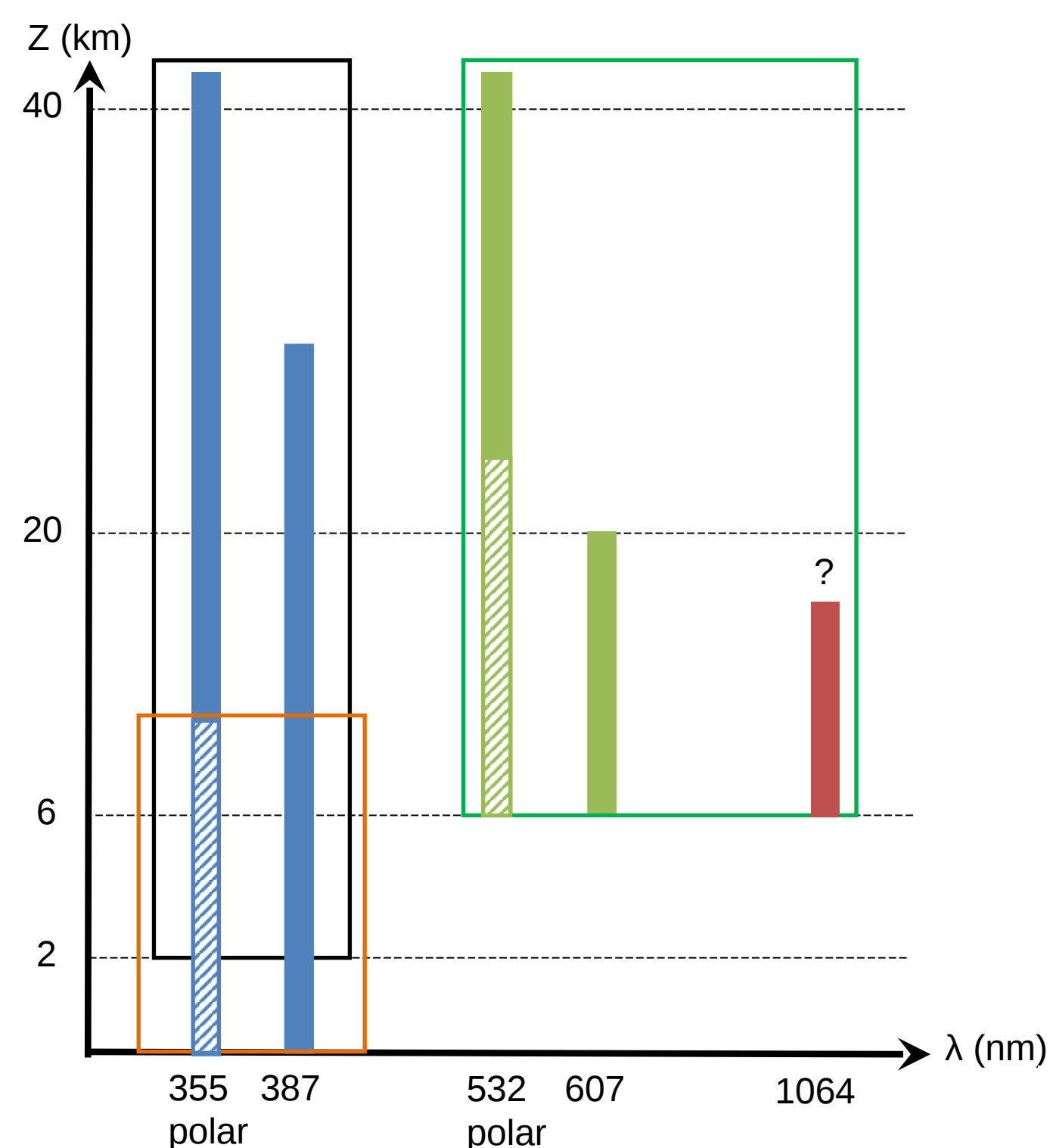


- Stratosphere-troposphere exchanges (STE)
- Cirrus clouds
- Volcanoes (long-range)
- Deep convection
- Cyclones

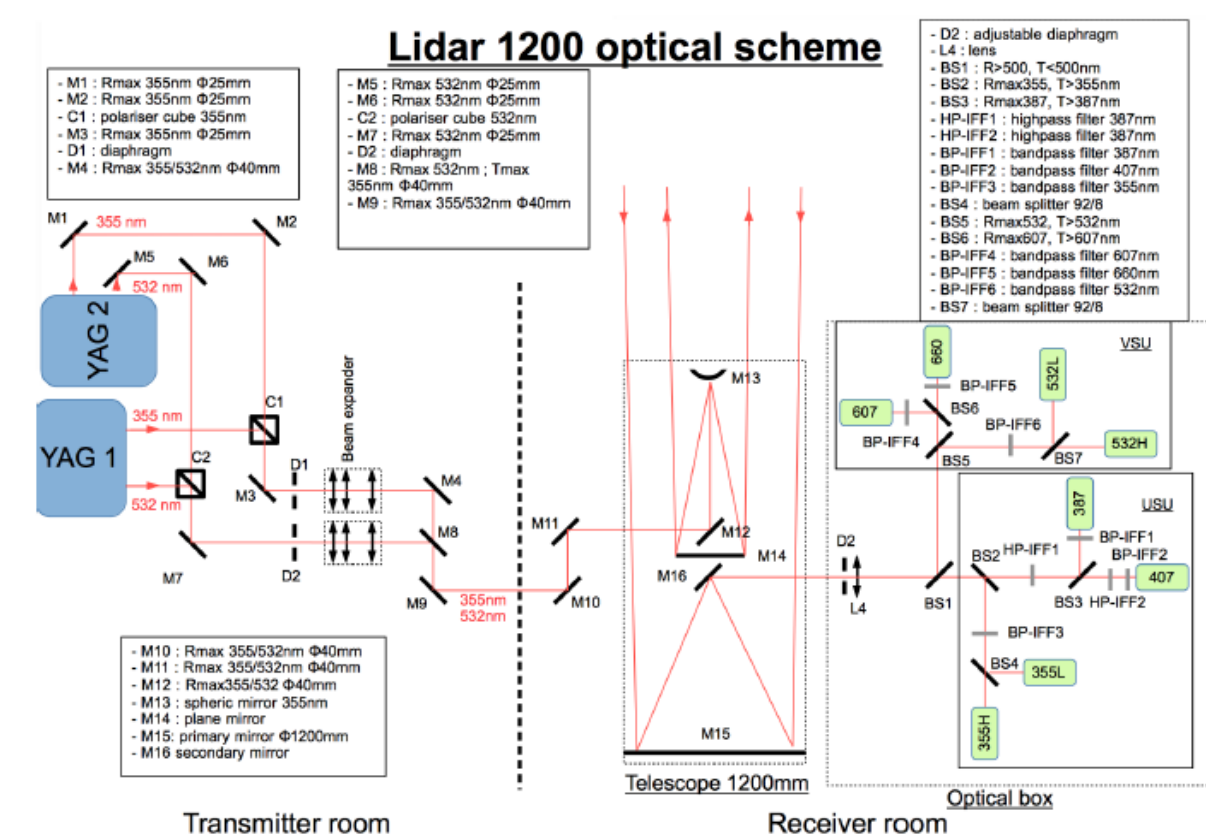
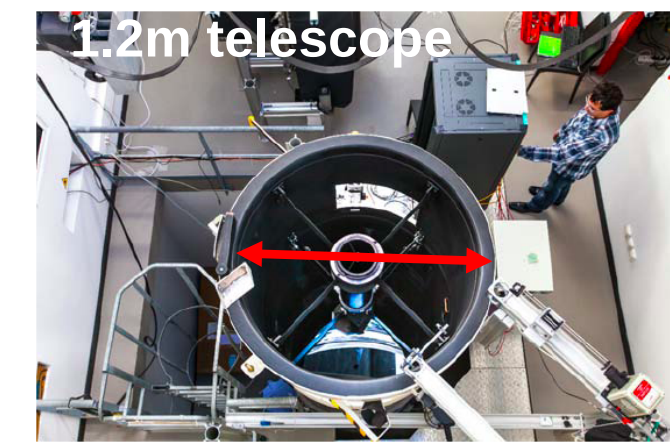
## PROFILING OF AEROSOLS

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.

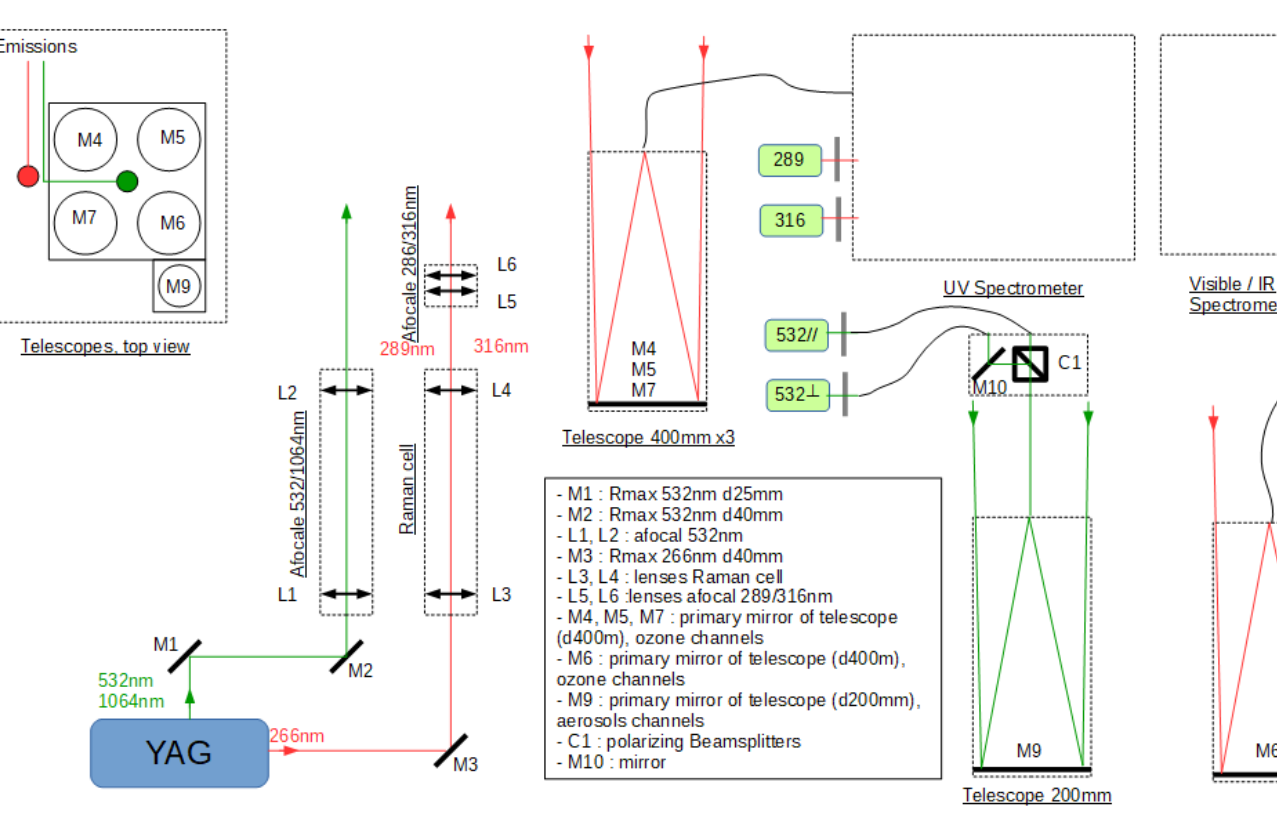
### • Observation capabilities



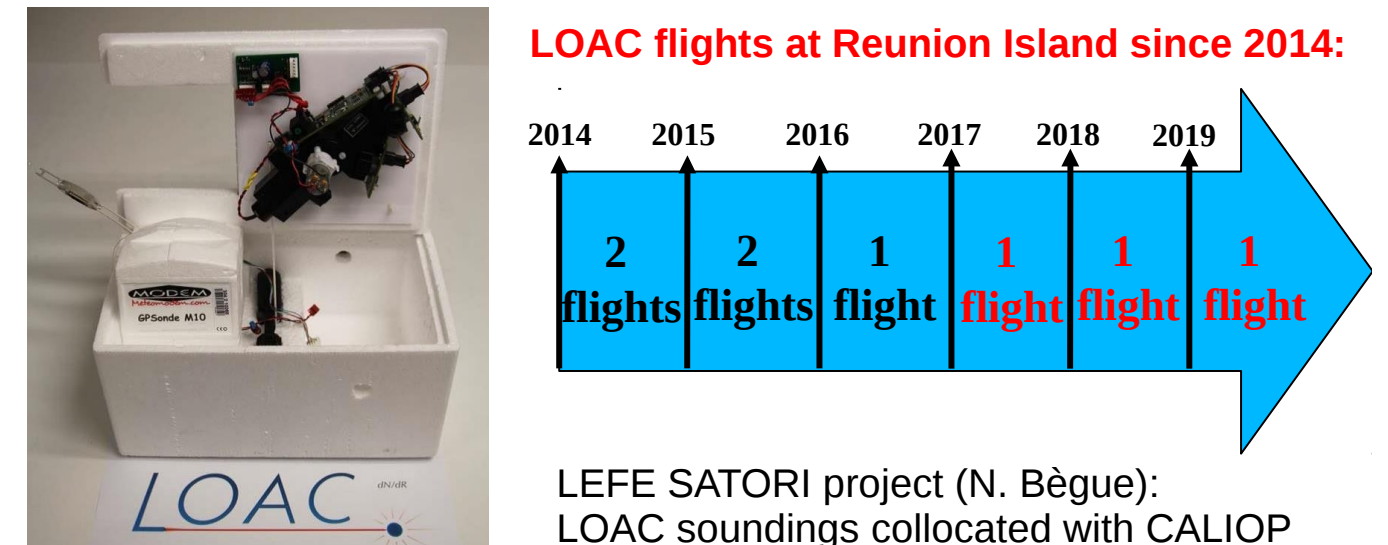
**Lidar1200**  
(T°, H<sub>2</sub>O, aerosols)  
355 & 387nm  
2.2-40km range



**LIO3T** (O<sub>3</sub>, aerosols)  
532 (L & I), 607 & 1064nm  
6-40(20)km range



### + LOAC (Light Optical Aerosols Counter)



LEFE SATORI project (N. Bègue):  
LOAC soundings collocated with CALIOP

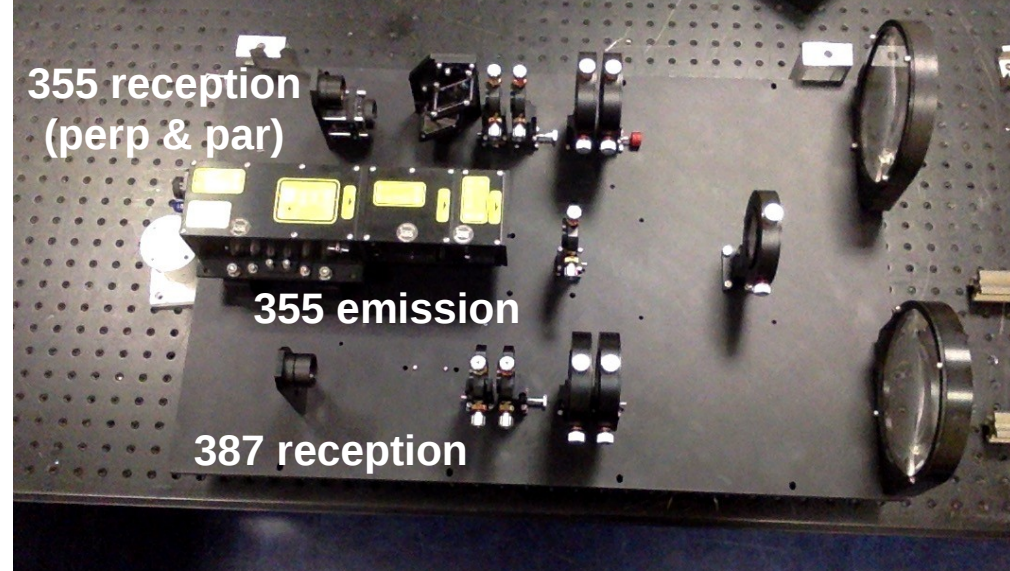
## PROFILING OF CLOUDS

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 N<sub>2</sub> 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

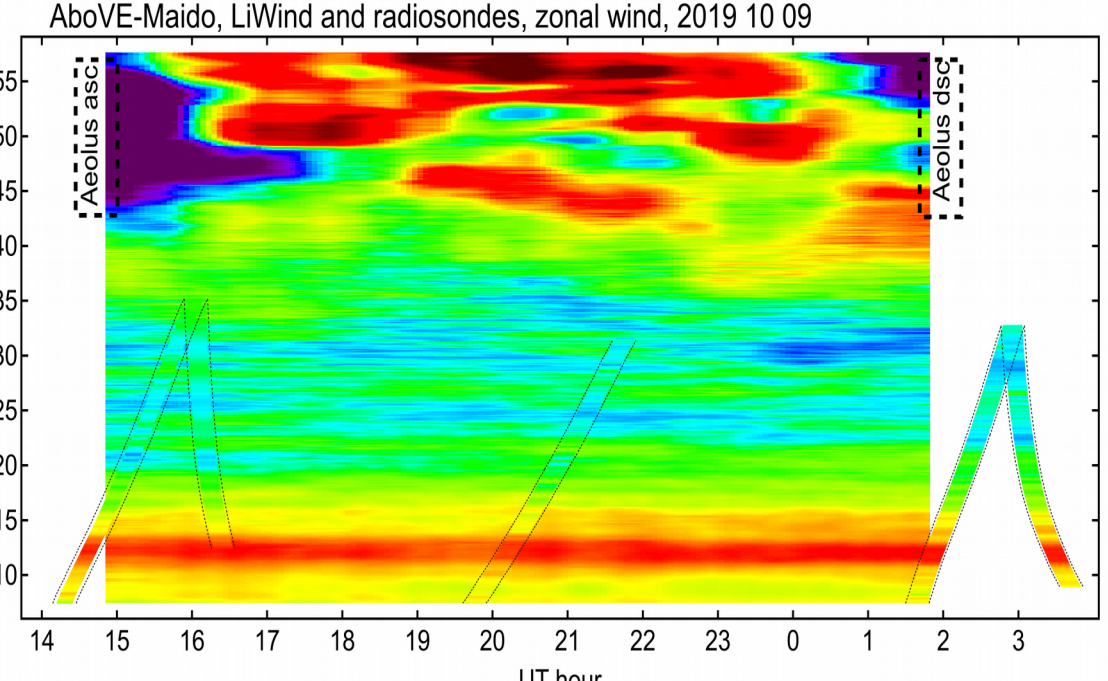


Campbell CS135  
905nm  
5m resolution  
10km range

## 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

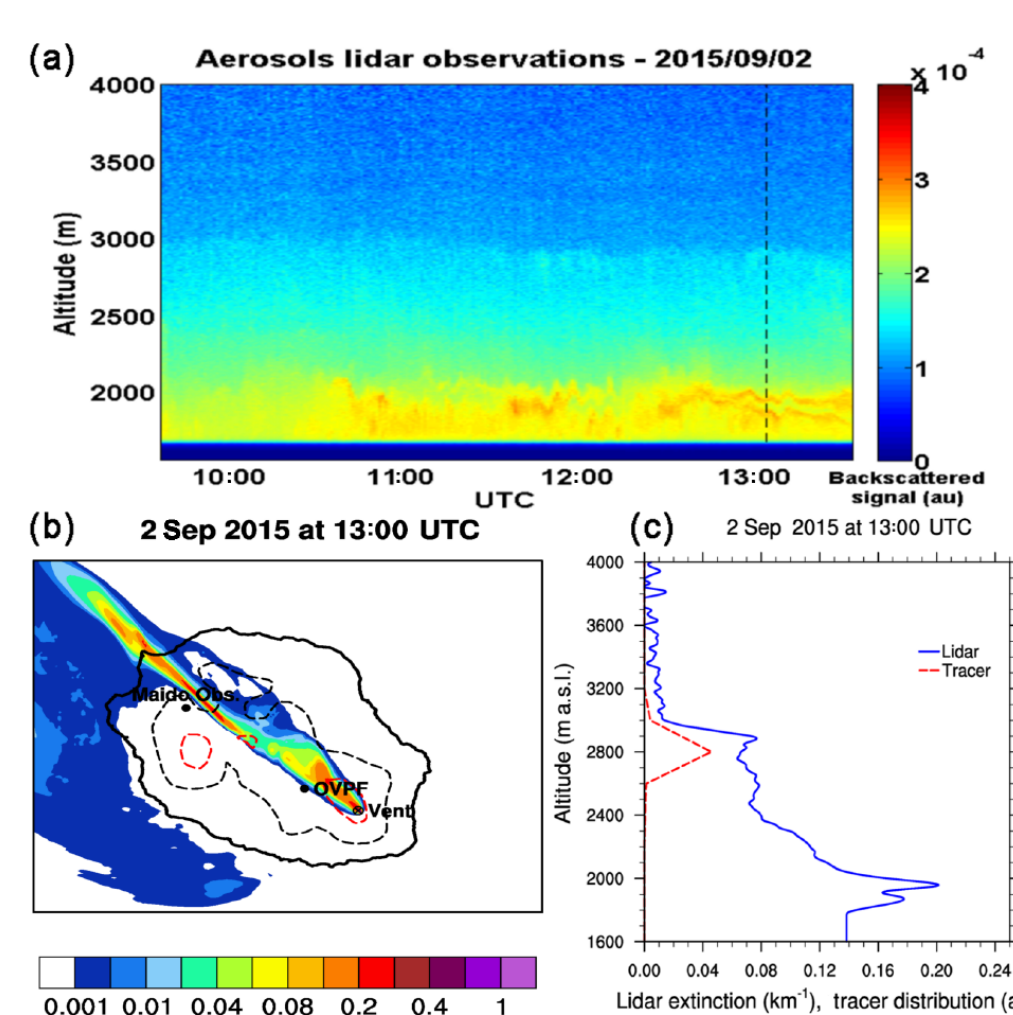
Maïdo Observatory	Gillot
Lidar O3S	FTIR
Lidar O3T	Scantron
Lidar 1200	OPS
Wind lidar	Aethalometer
IR radiometer	Chemical filters
WIRA-C	CPC
GNSS	Nox analyzer
TLE camera	O <sub>3</sub> analyzer
All-Sky	SO <sub>2</sub> analyzer
WVLN antenna	Picarro 4 gases
Infrasound station	Picarro water isotops
ODS	Rainwater collection
Meteorol. station	Visible cameras
Cobald sondes	CFH sondes
GNSS	MAX-DOAS

## → 2015: Piton de La Fournaise eruptions

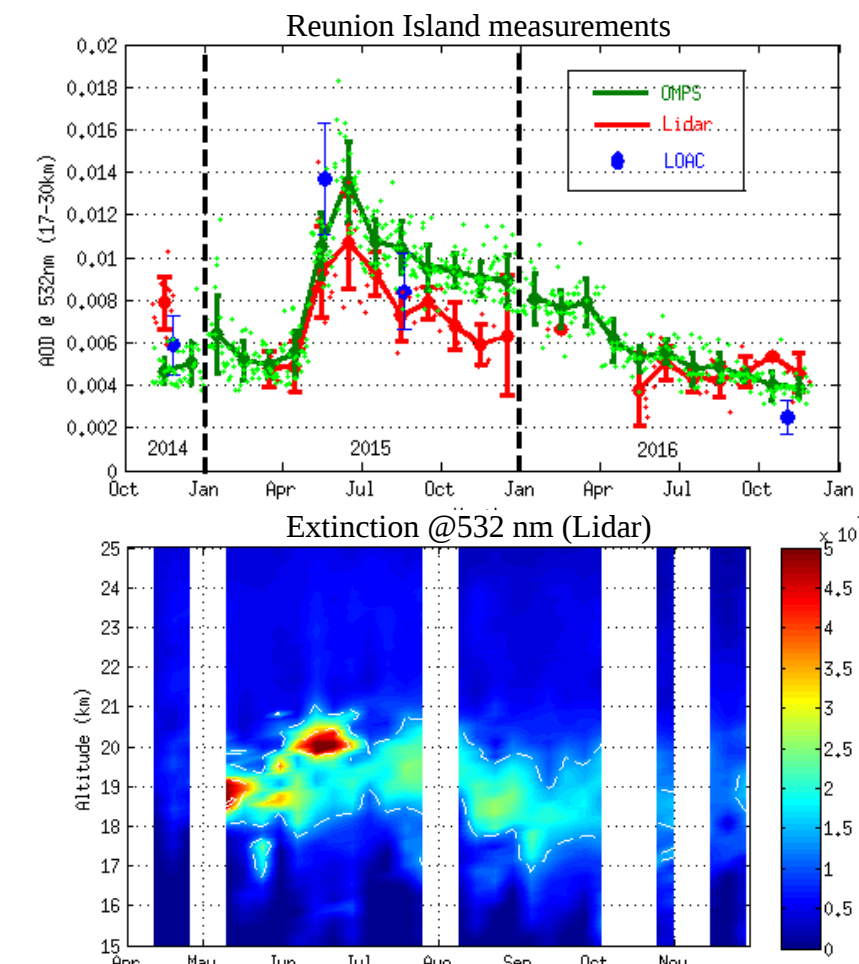


Tulet et al., 2017

LR<sub>355</sub>  
= 42 +/- 10 sr for fresh plume (16km from the vent)



## → 22 April 2015: the Calbuco eruption

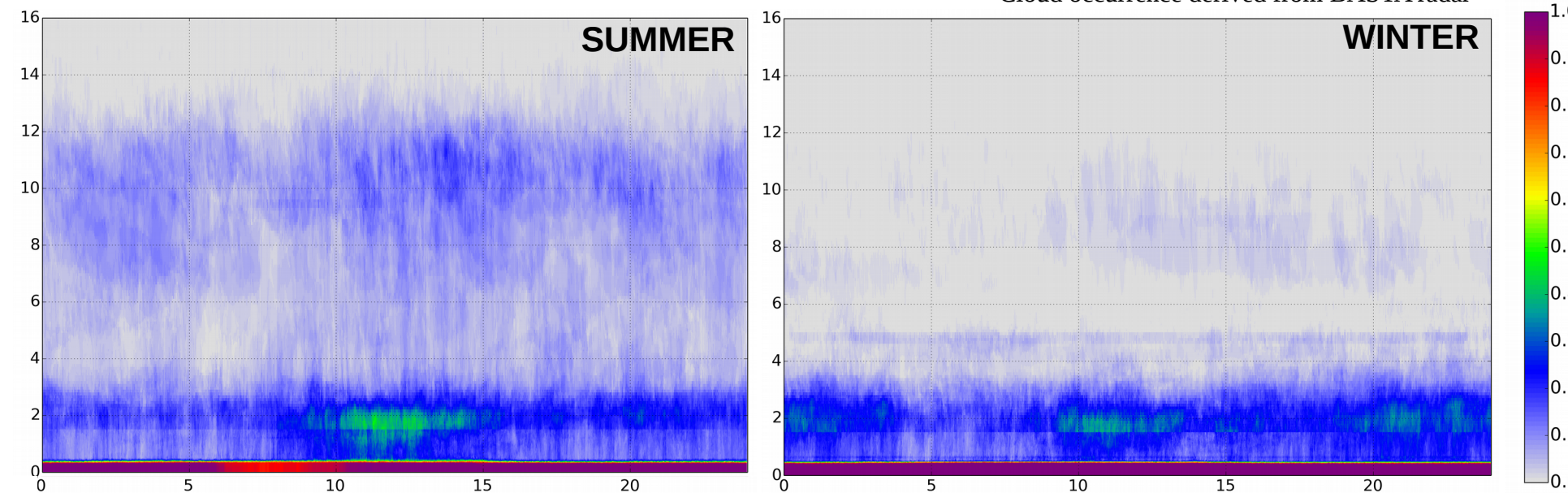


Bègue et al., 2017

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)

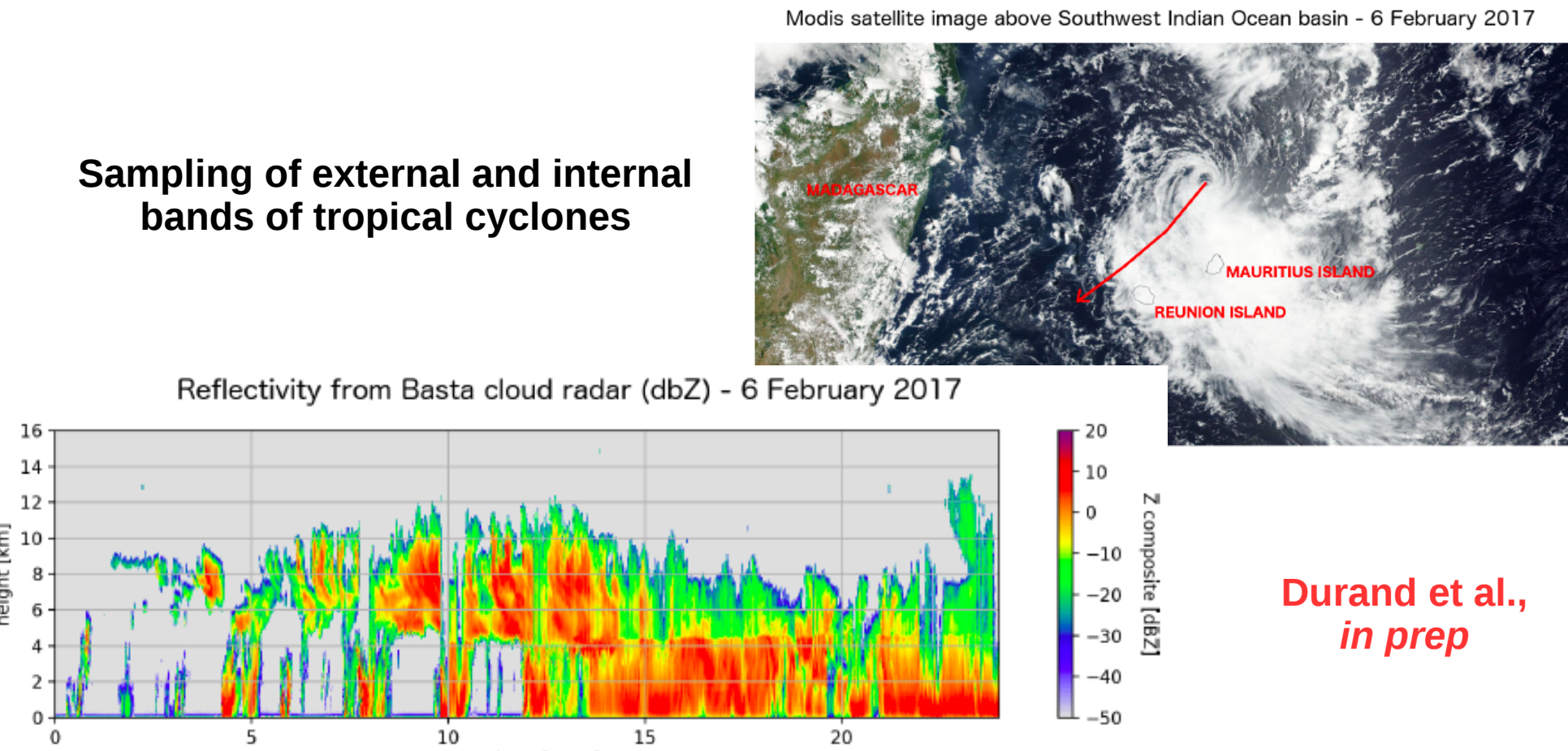
## SCIENTIFIC RESULTS

### → Seasonality of the cloud occurrence



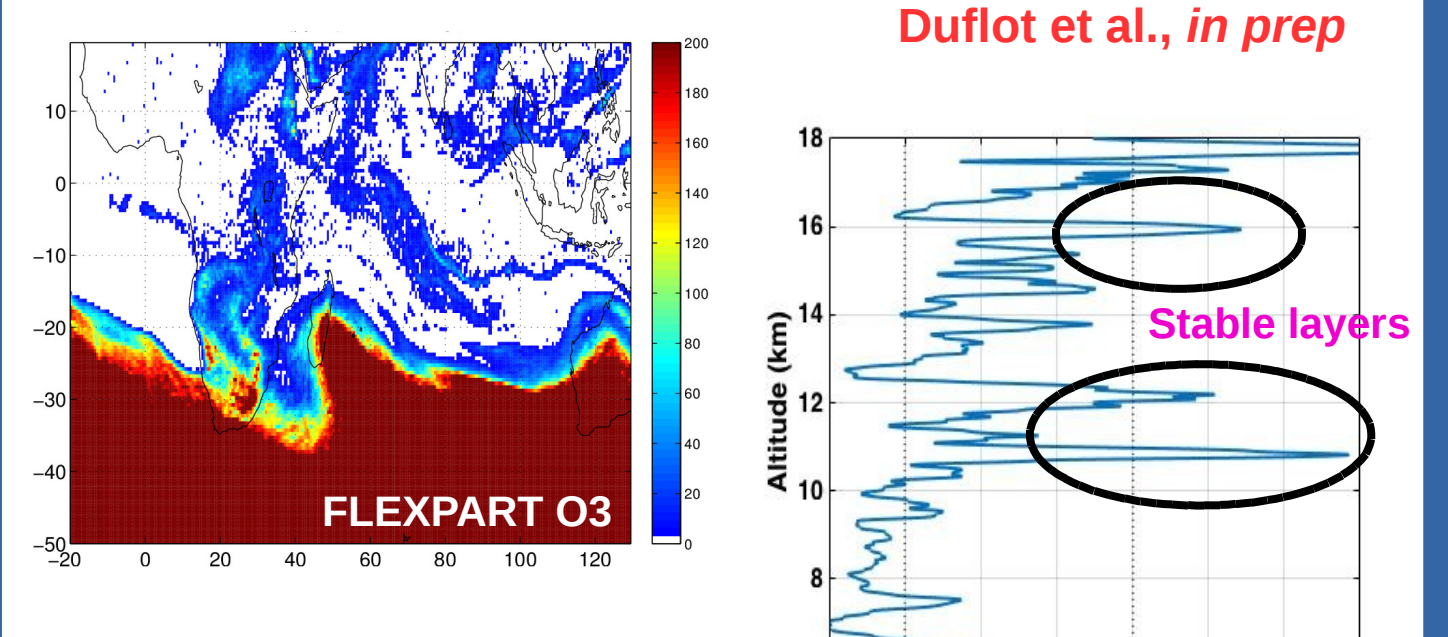
Diurnal cycle: 1 max. at 10:00-15:00UTC in summer  
2 max. at 10:00-14:00UTC and 19:00-02:00UTC and dominance of low clouds (< 5km asl) in winter

### → Observations of the tropical storm CARLOS

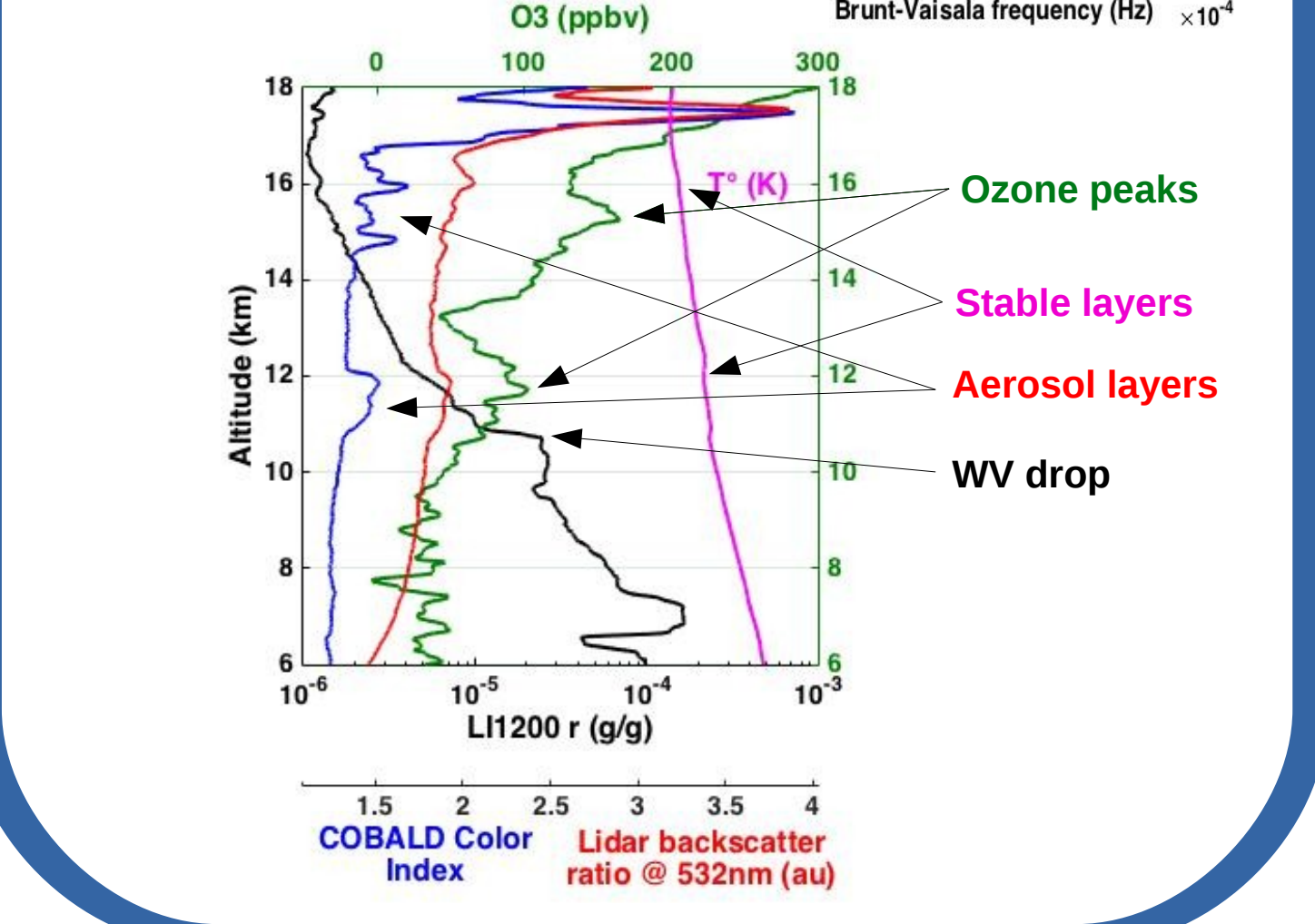


## INSTRUMENTAL SYNERGY

### → 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:

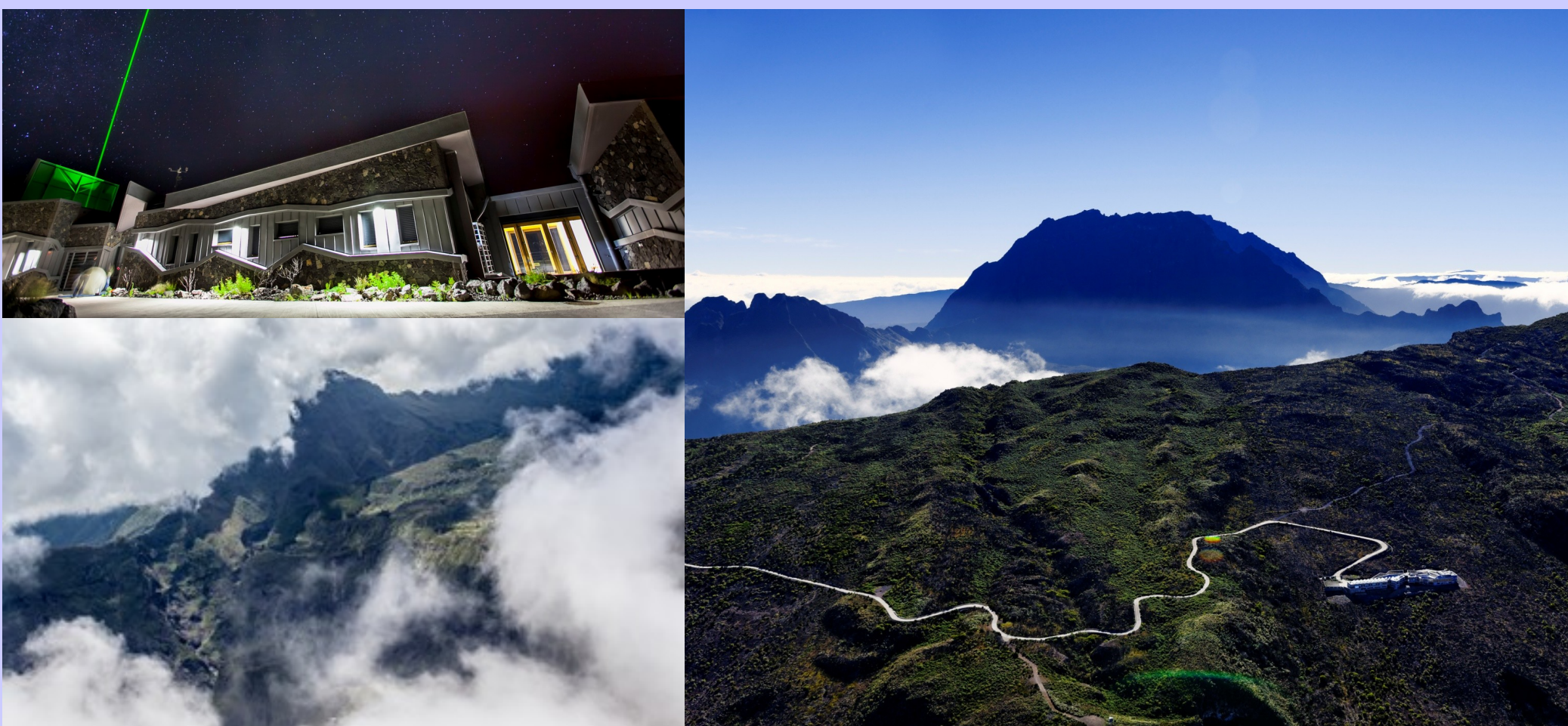
532 (T, L+I) + 1064 => CALIPSO v4; 355+387 => Aeolus & EarthCARE

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 [osuniv-reunion@univ-reunion.fr](mailto:osuniv-reunion@univ-reunion.fr) to obtain data download login / password.

## ACKNOWLEDGMENTS

The authors acknowledge the European Community, the Région Réunion, CNRS, and Université de La Réunion for their support and contributions in the construction phase of the research infrastructure OPAR. OPAR is presently funded by CNRS (INSU) and Université de La Réunion and managed by OSU-R (Observatoire des Sciences de l'Univers de La Réunion, UMS 3365). The authors also gratefully acknowledge Eric Golubic, Patrick Hernandez and Louis Mottet, who are deeply involved in the routine lidar observations at the Maïdo facility. H. Verèmes' postdoctoral program is funded by Région Réunion, the European Commission (FEDER INTERREG) and the University of La Réunion, as the ReNovRisk-TRANSFERTS project. We thank Julien Delanoë, Scientific PI of the BASTA network, and Jonathan Durand. We thank Jérôme Brioude for the flexpart run of the STE event with volcanic aerosols.