Profiling of aerosols and clouds in Reunion Island (21°S, 55.5°E)

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

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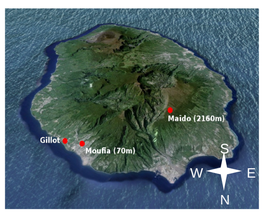
ATMOSPHERIC PHYSICS OBSERVATORY OF REUNION ISLAND

• 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 :

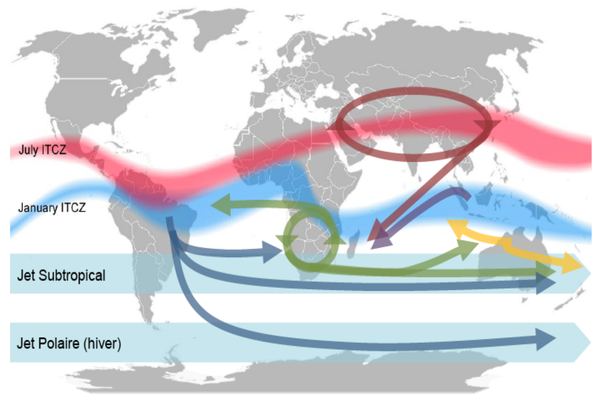
Trans-National Access European programs

ACTRiS PLUS ENVRI

ACTRiS, NDACC, SHADOZ, GRUAN, AERONET, ICOS, TCCON, WWLLN

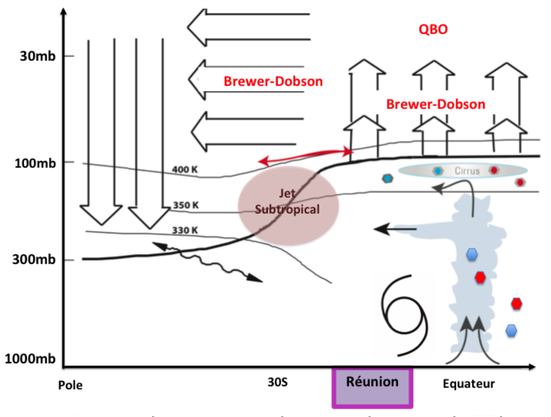
CONTEXT

• Free troposphere



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

• Tropical tropopause layer

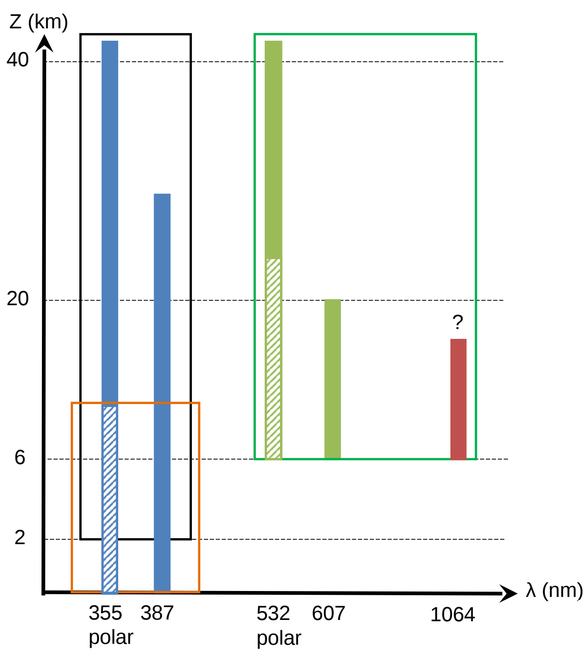


→ Stratosphere-troposphere exchanges (STE)
→ Cirrus clouds
→ Volcanoes (long-range)
→ Deep convection
→ Cyclones

PROFILING OF AEROSOLS

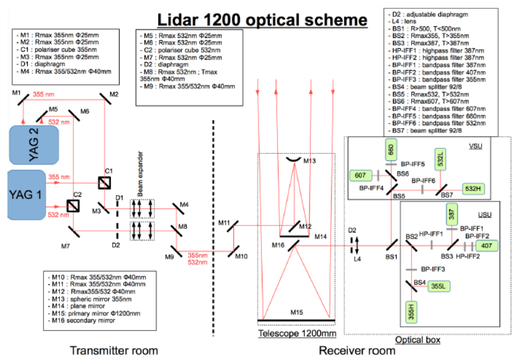
Reunion Island is located in a **« clean » area, i.e. the AOD is low**, but, during **the biomass burning season in the Southern Hemisphere, the AOD doubles**. The Indian Ocean region is a difficult area for satellite sensing, it is **necessary to make ground-based observations**.

• Observation capabilities



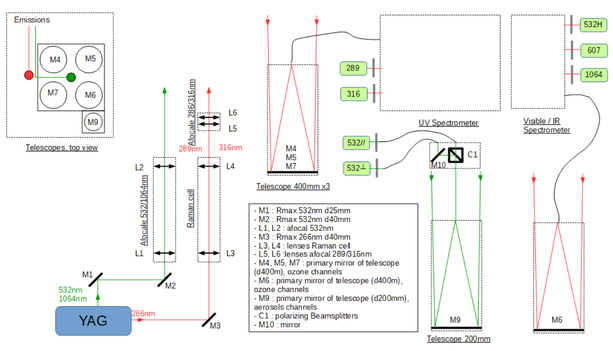
Lidar1200 (T°, H_2O, aerosols)

355 & 387nm
2.2-40km range



LIO3T (O_3, aerosols)

532 (L & //), 607 & 1064nm
6-40(20)km range



+ LOAC (Light Optical Aerosols Counter)

LOAC flights at Reunion Island since 2014:

2014	2015	2016	2017	2018	2019
2 flights	2 flights	1 flight	1 flight	1 flight	1 flight

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

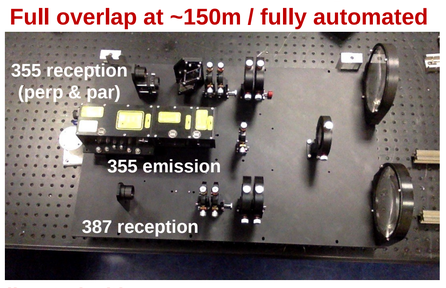
PROFILING OF CLOUDS

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 (**M**obile **A**erosol **R**aman **L**idar for troposph**E**re surve**Y**)

Leosphere ALS450 + Raman N_2 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

Ceilometer

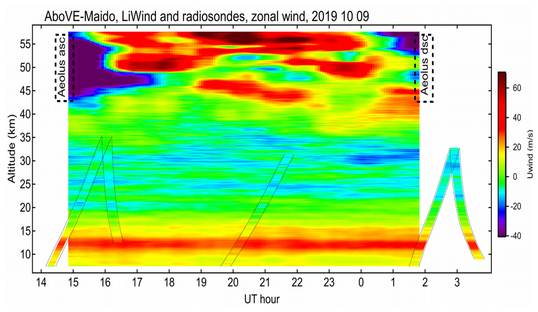
Campbell CS135
905nm
5m resolution
10km range

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	
Lidar O3S	FTIR
Lidar O3T	Scanotron
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
WWLNN antenna	Picarro 4 gases
Infrasound station	Picarro water isotops
ODS	Rainwater collection
Meteorol. station	Visible cameras
Cobald sondes	CFH sondes
GNSS	MAX-DOAS

Gillot	
GNSS	LOAC sondes
M10 sondes – O_3 ECC	

Le Port	
MAX-DOAS	POPS sonde

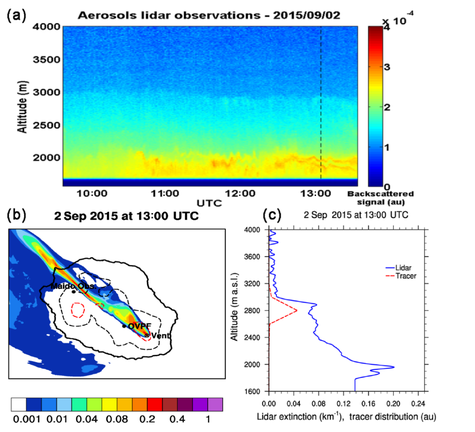
Moufia	
FTIR	UV spectrometer
SAOZ	Mini-SAOZ
CIMEL	BASTA radar
MARLEY	Disdrometer
Micro-tops	Meteorol. station
Picarro 3 gases	

SCIENTIFIC RESULTS

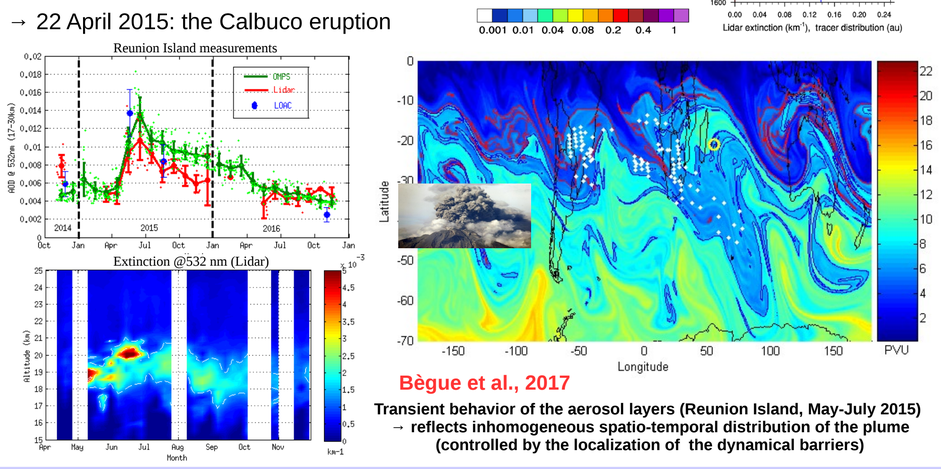
→2015: Piton de La Fournaise eruptions

Tulet et al., 2017

LR_{355} = **42 +/- 10 sr** for fresh plume (16km from the vent)



→ 22 April 2015: the Calbuco eruption



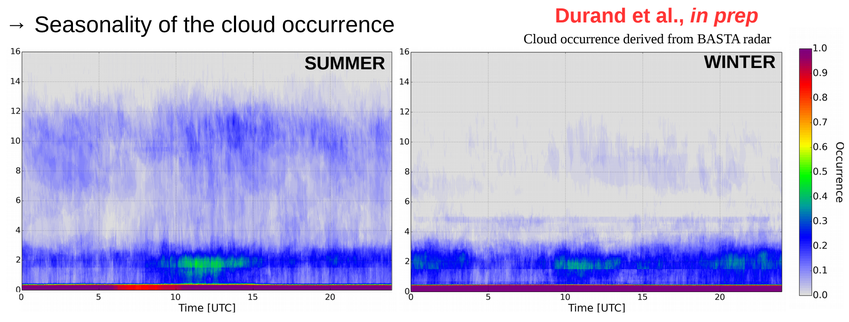
Bègue et al., 2017

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)

→ Seasonality of the cloud occurrence

Durand et al., *in prep*

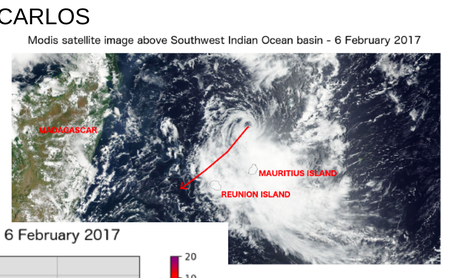
Cloud occurrence derived from BASTA radar

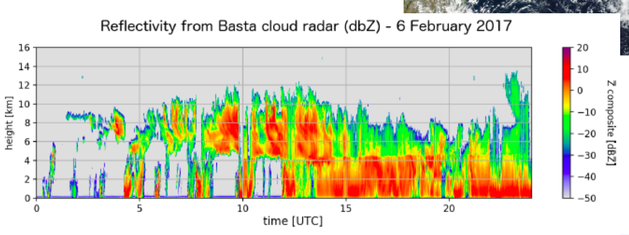


Diurnal cycle: 1 max. at 10:00-15:00UTC in summer
2 max. at 10:00-14:00UTC and 19:00-02:00UTC and dominance of low clouds (< 5km asl) in winter

→ Observations of the tropical storm CARLOS

Sampling of external and internal bands of tropical cyclones



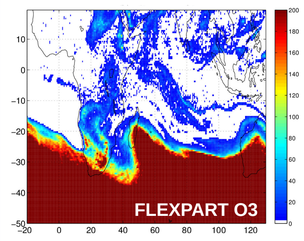


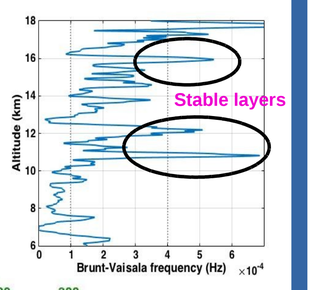
Durand et al., *in prep*

INSTRUMENTAL SYNERGY

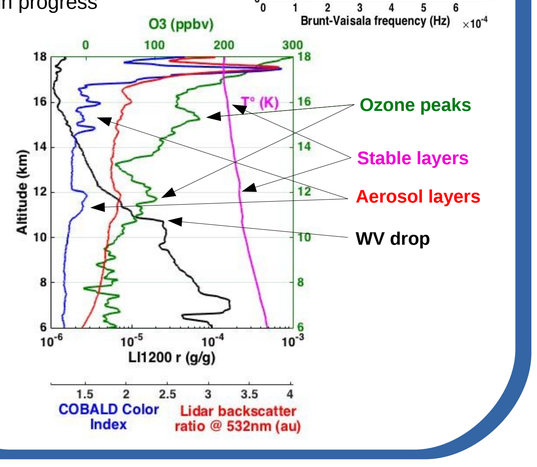
→ STE with volcanic aerosols

Duflot et al., *in prep*





Work in progress



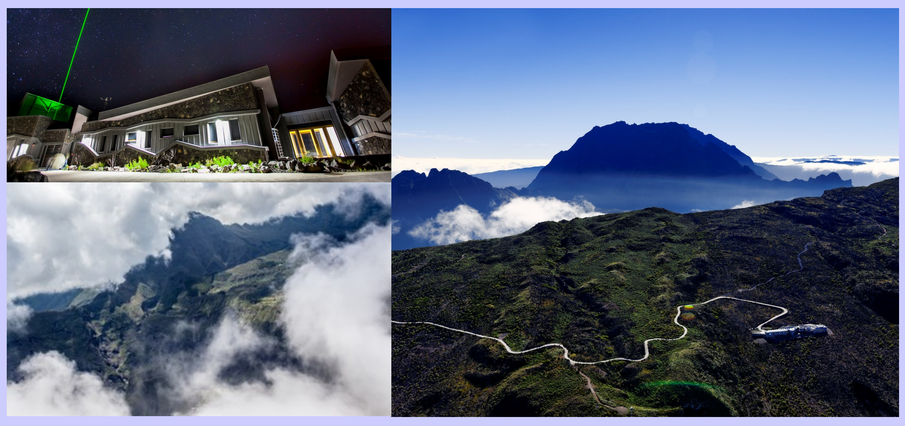
SUMMARY AND FUTURE DIRECTIONS

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+//) + 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**



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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-informatique@univ-reunion.fr to obtain data download login / password.

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