Reunion Island
NDACC Lidar operations
2016-2018

OPAR
Observatoire de Physique de l'Atmosphère de la Réunion

UNIVERSITÉ DE LA RÉUNION
CNRS - MÉTÉO FRANCE
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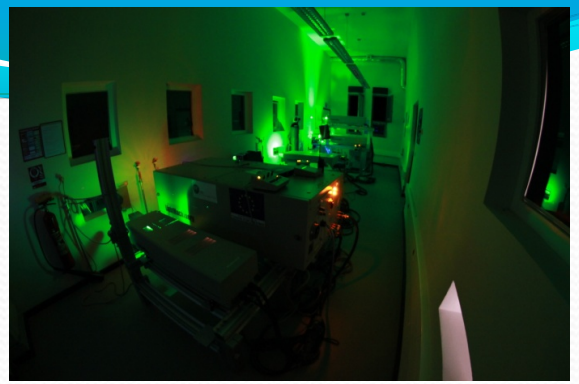
LATMOS

OSU-RÉUNION
Observatoire des Sciences de l'Univers de La Réunion

Réunon lidar systems



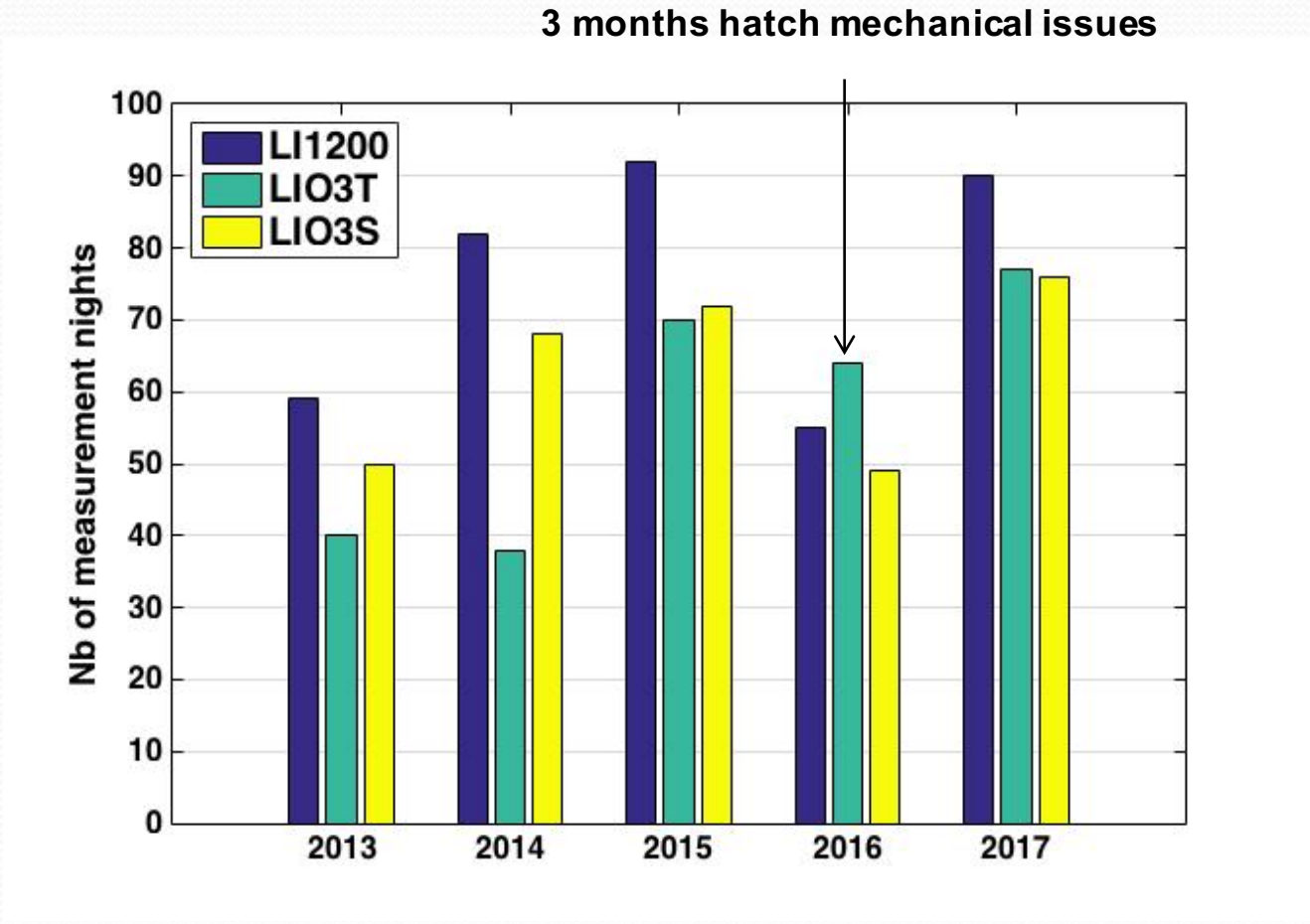
- Wind Doppler **(A. Hauchecorne, S. Khaykin)**
- Mobile aerosols (PBL and free troposphere) **(V. Duflot)**

- **DIAL stratospheric O_3 (T. Portafaix, S. Godin-Beekman)**
- **LI1200: T° (A. Hauchecorne)**
  Water vapor (P. Keckhut, V. Duflot)
- **DIAL tropospheric O_3 (V. Duflot)**

Processing: local (will be centralised within AERIS Data Center for T°, O_3 and water vapor)

NDACC database: up to date for T° and stratospheric and tropospheric O_3 (H_2O is waiting for formatting)

Lidar measurements



Basics:

- **3 technicians+2 engineers dedicated to lidar operation/optimisation/upgrade**
- **Nighttime measurements**
- **Routine operations twice/week**

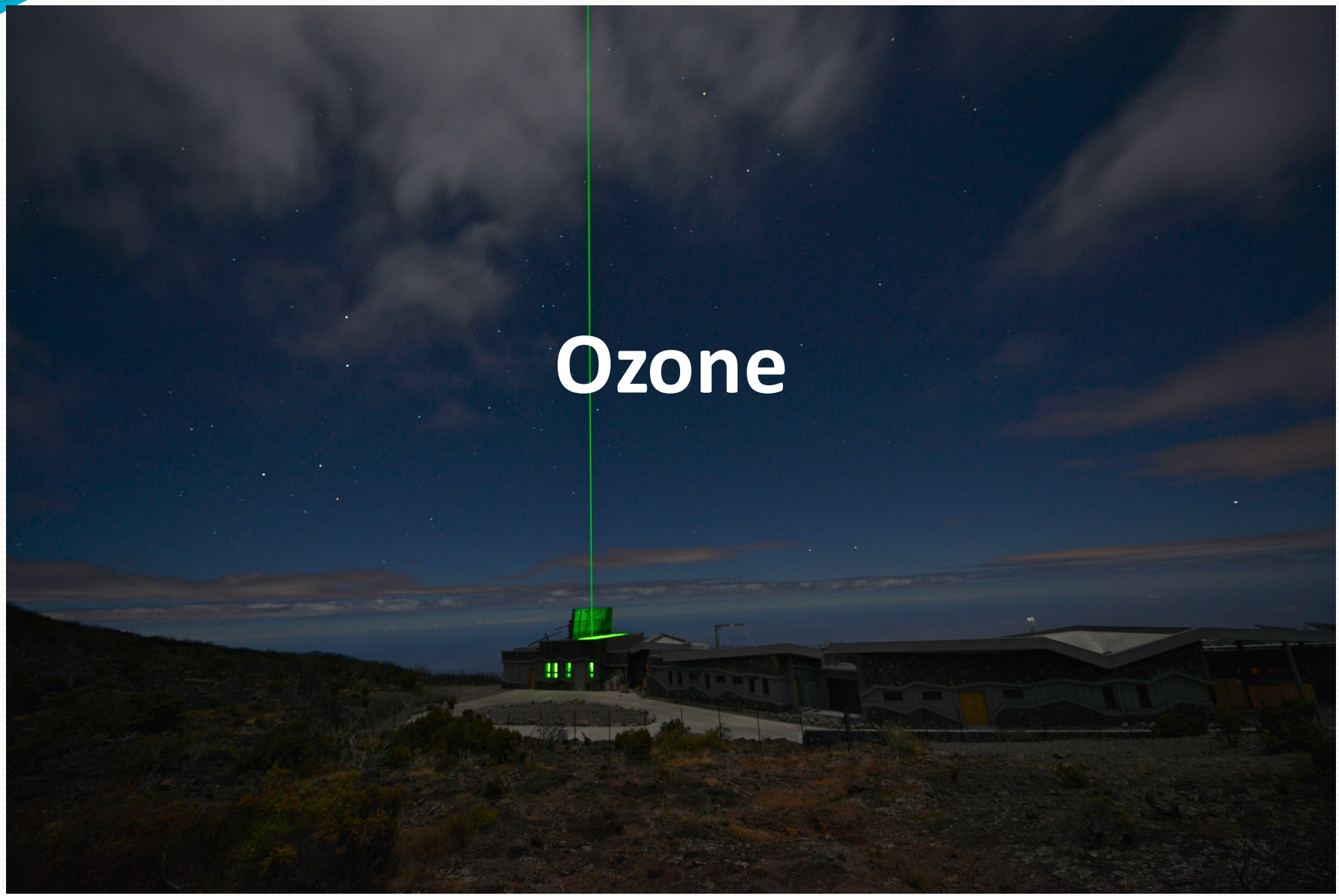
What's new since last LWG ?

LIO3T & LI1200 H2O: NDACC labellised

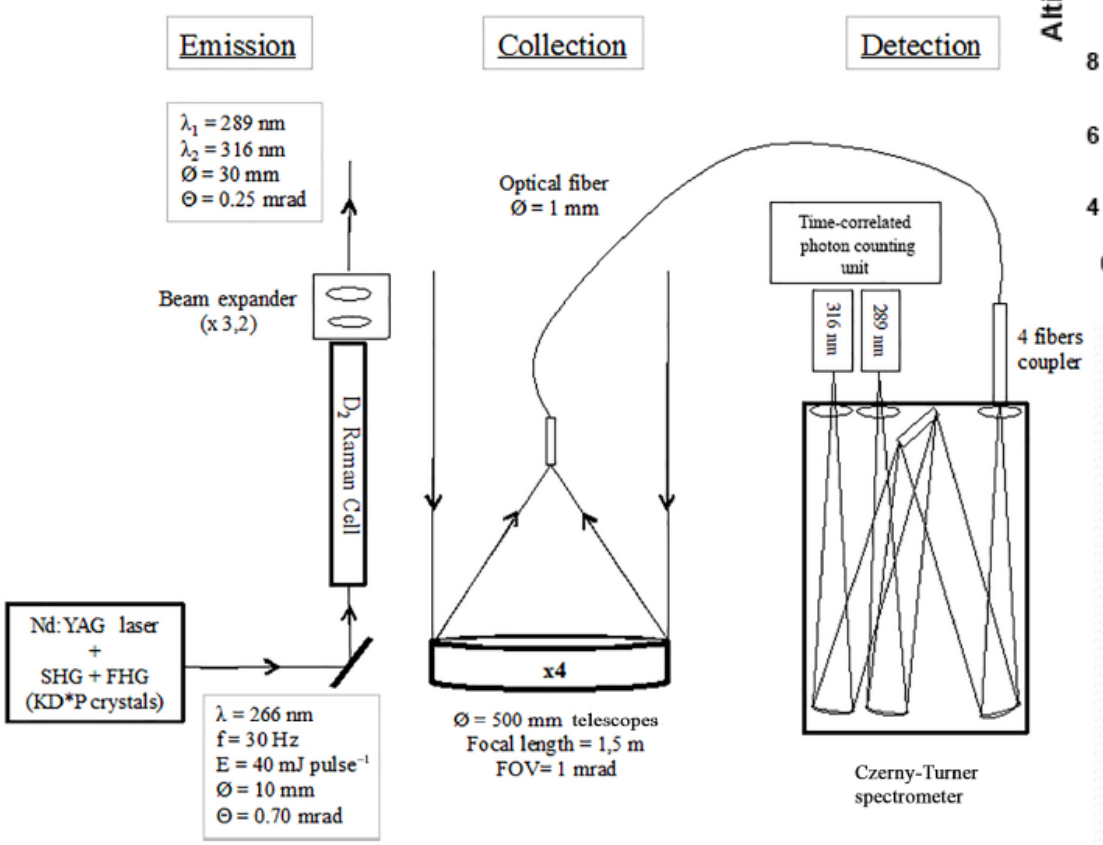
(Duflot et al., AMT2017 ; Vérèmes et al., AMTD2017)

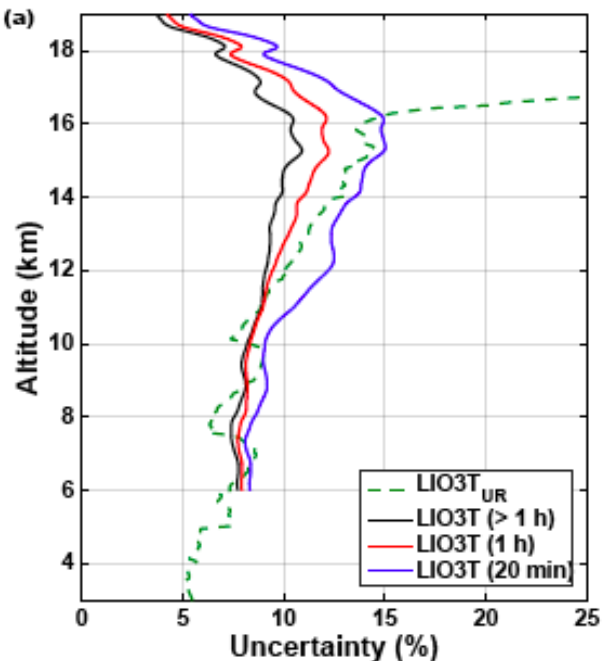
New channels for aerosol detection

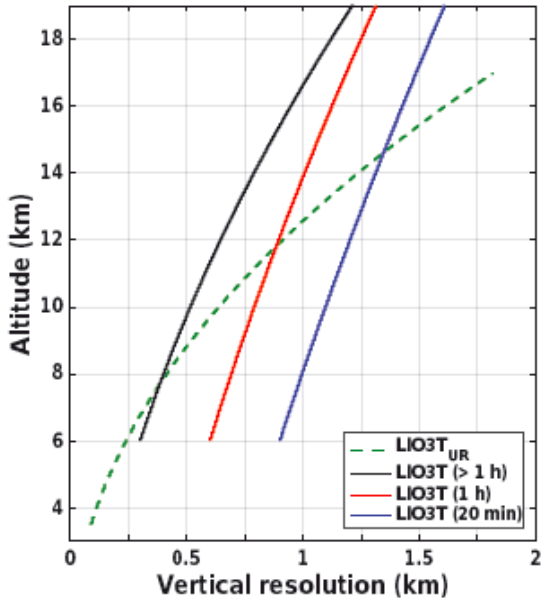
Hatch issues


Ozone

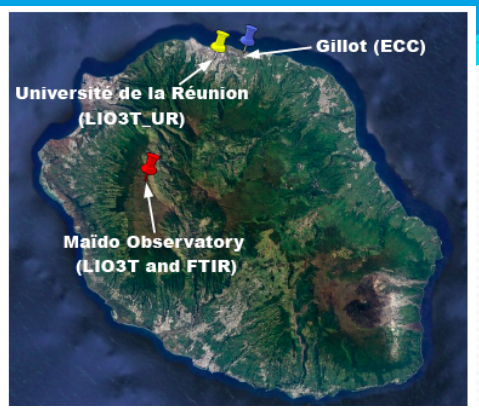
Tropospheric ozone lidar: technical features

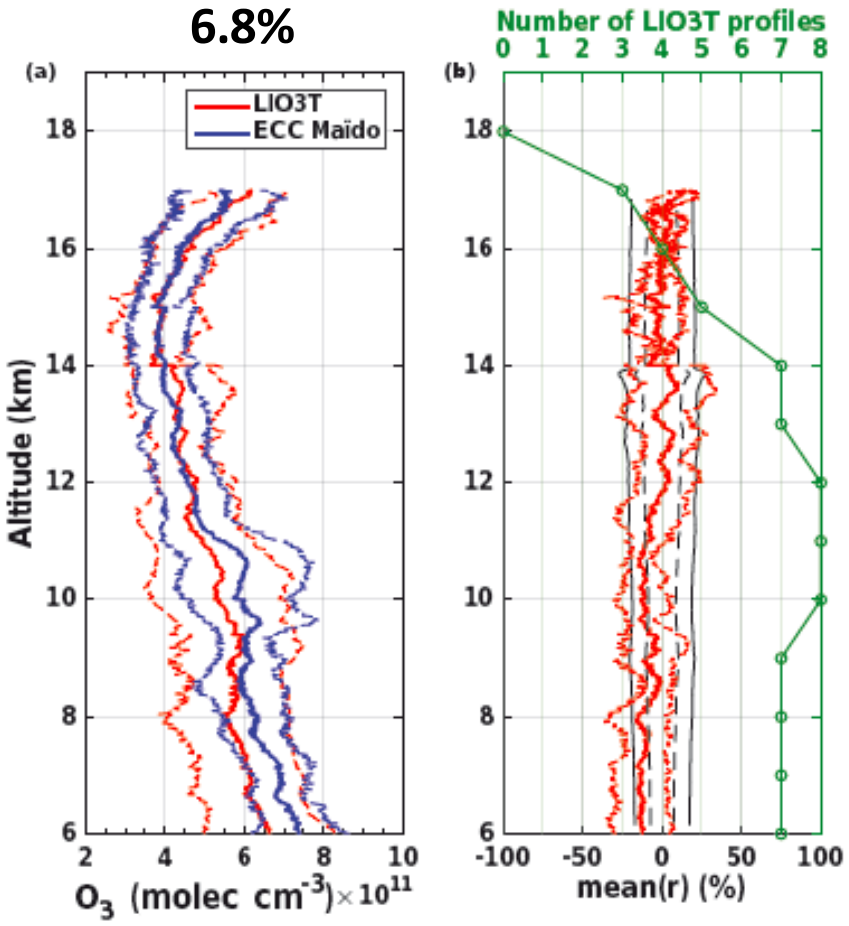


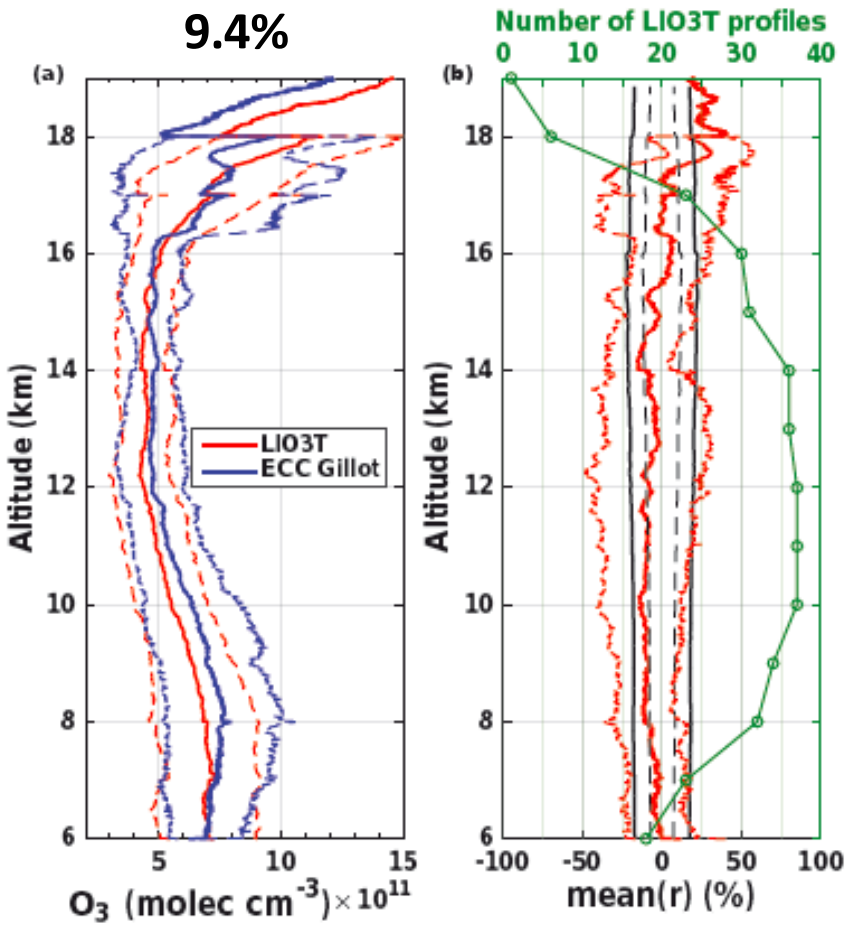




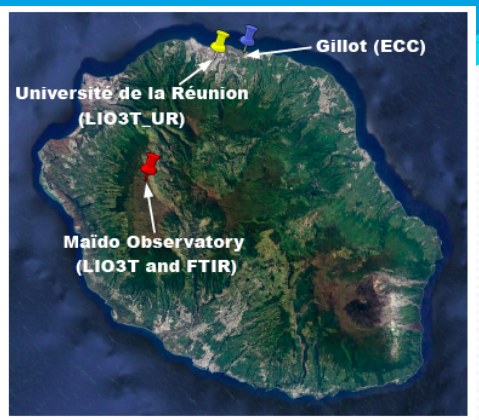
Tropospheric ozone lidar: validation

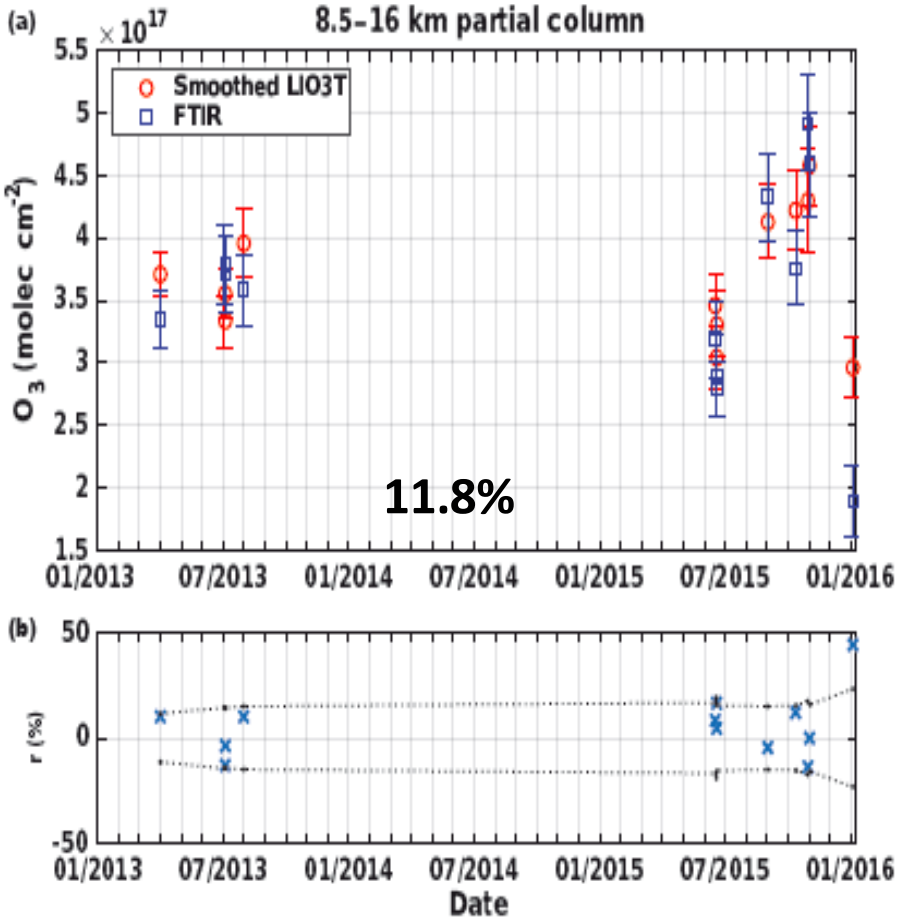


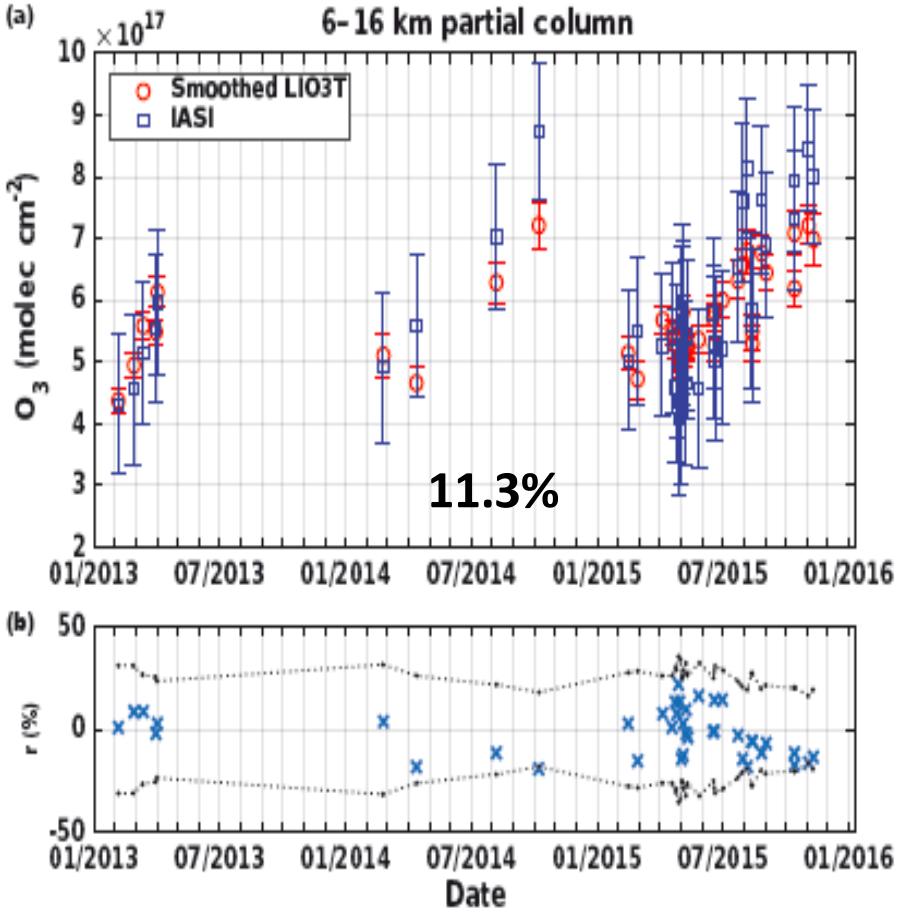




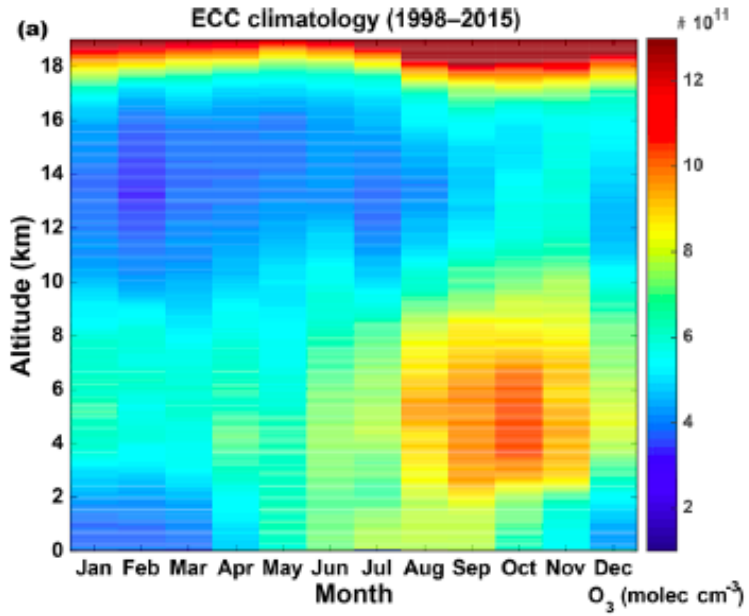
Tropospheric ozone lidar: validation

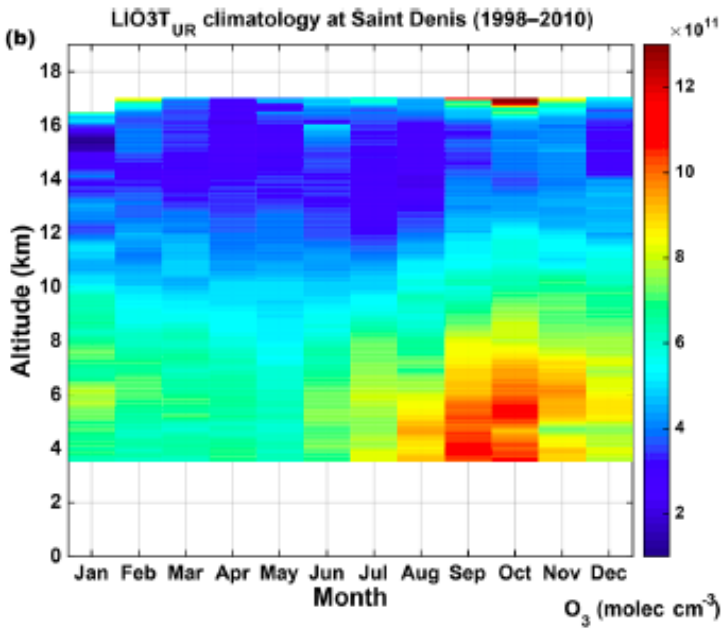




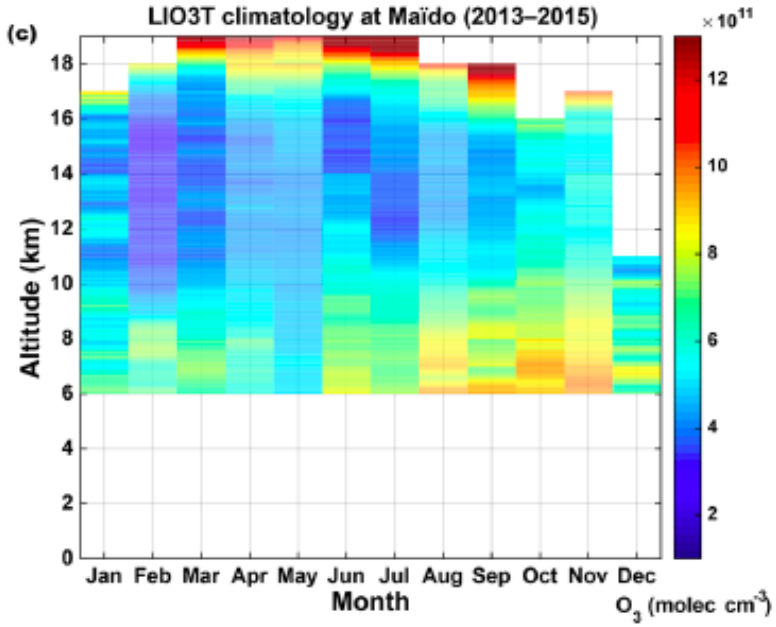


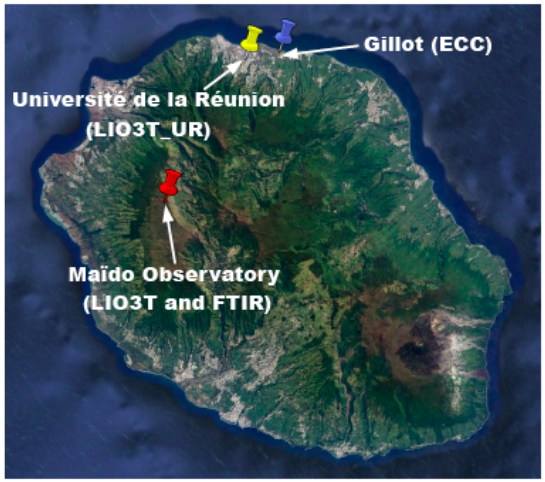
Tropospheric ozone lidar: time series





Involved in TROPOMI cal/val





Improvements:

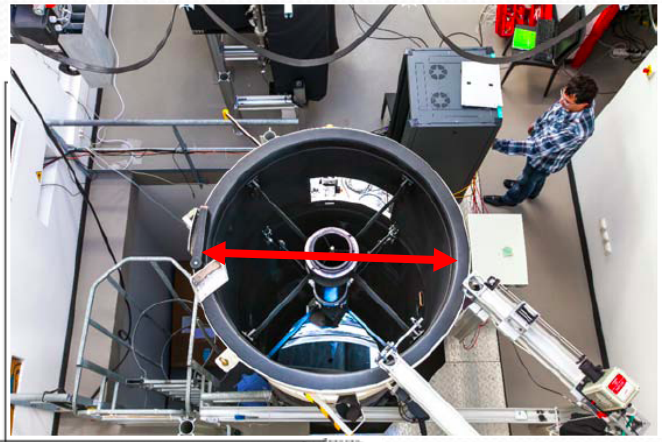
- **uncertainties: interfering gases, background & saturation correction**
- **O3 cross sections**

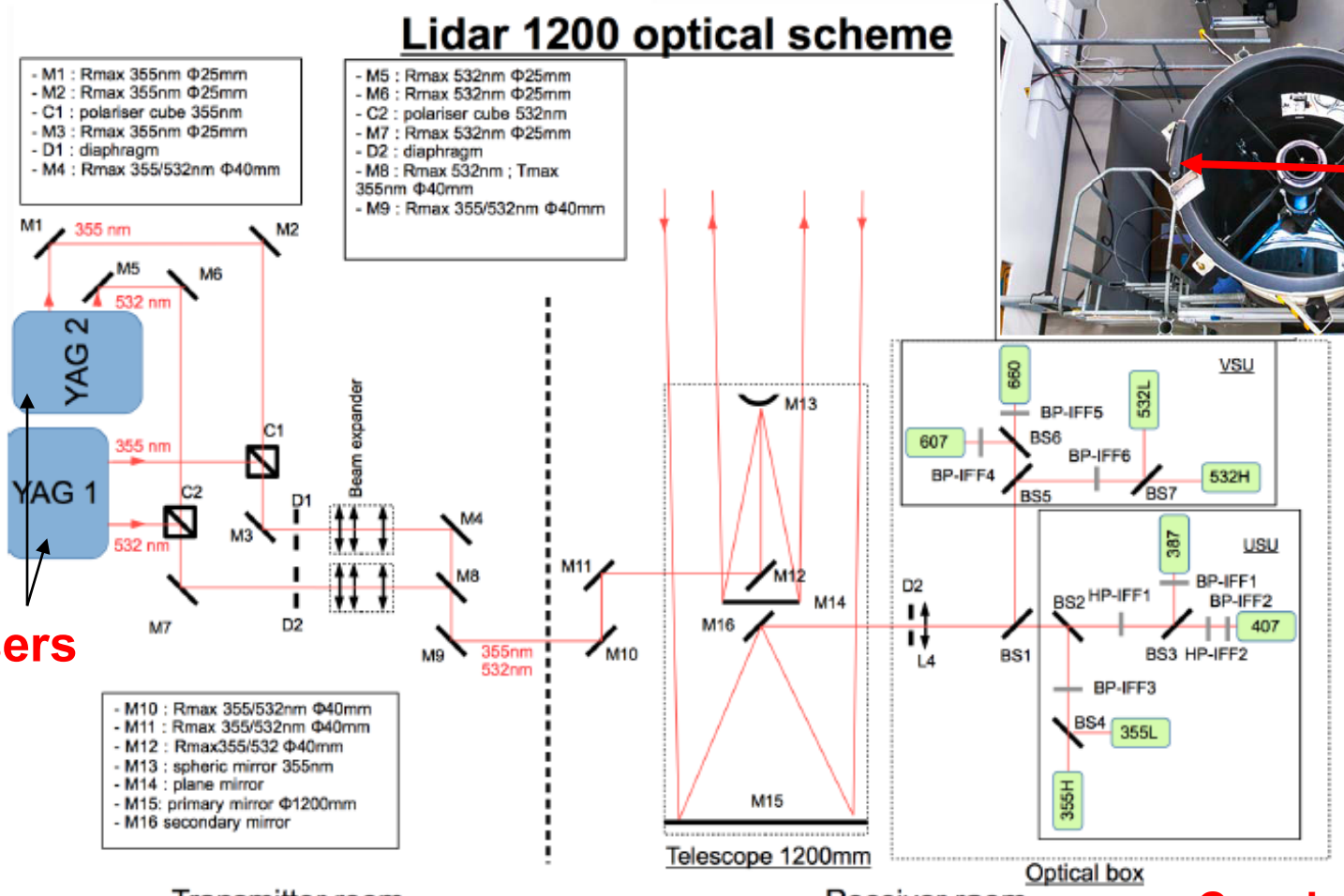
Duflot et al., AMT2017


Water Vapor

Water Vapor: technical features

1.2m telescope



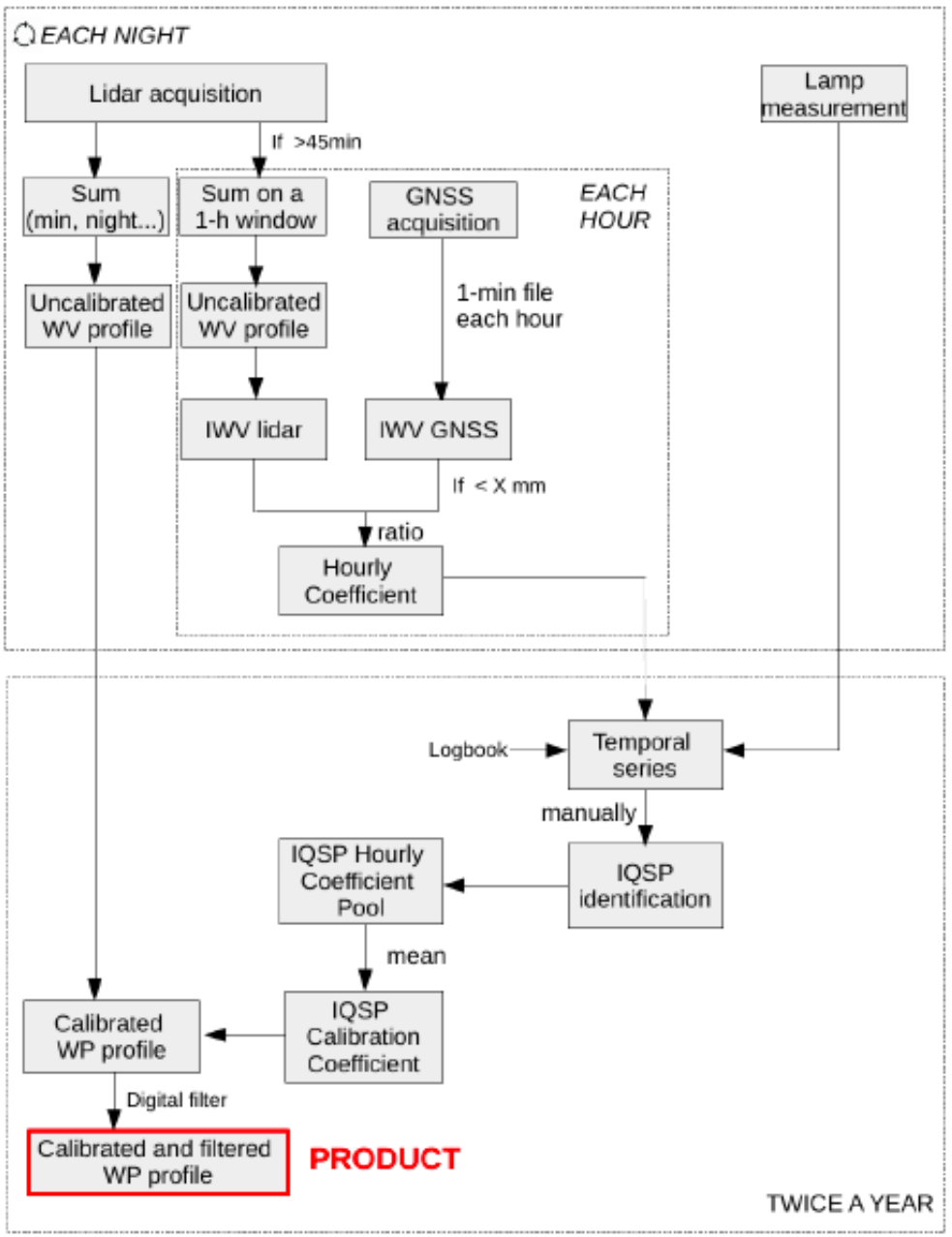


2 lasers

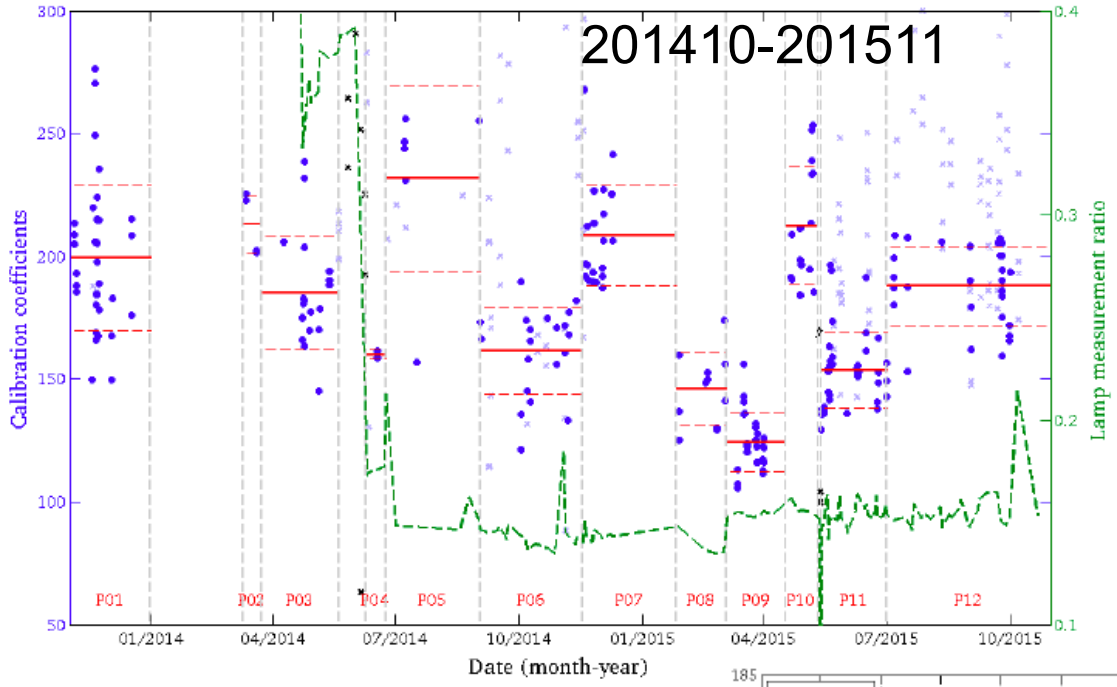
No optical fibers

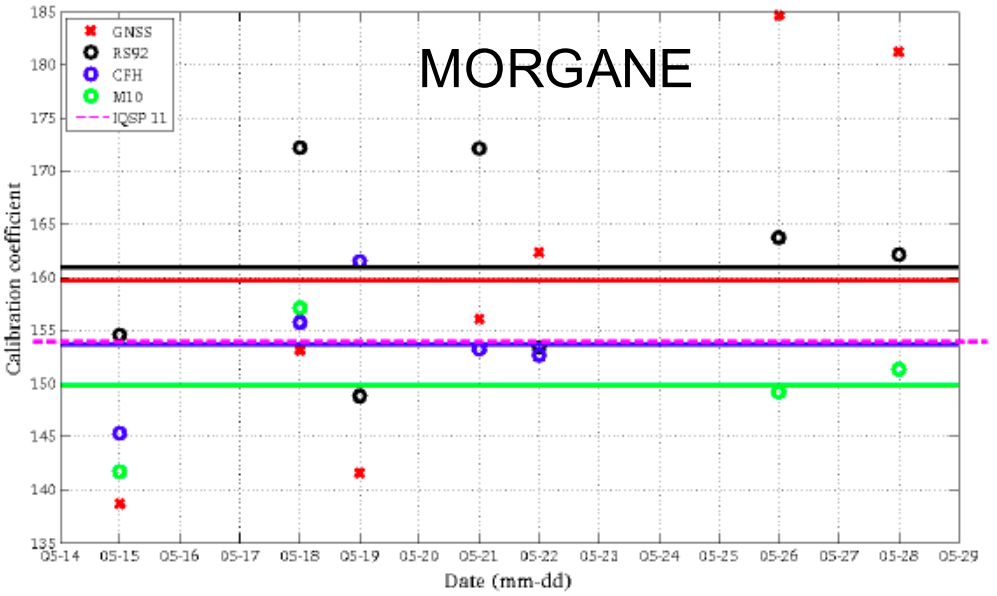
Coaxial emission/reception

Water Vapor: calibration scheme



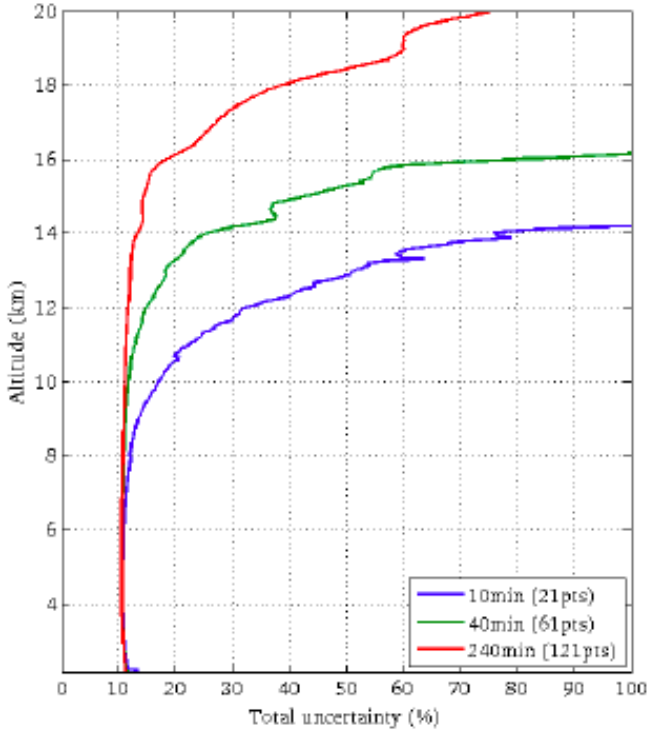
Water Vapor: calibration coefficient

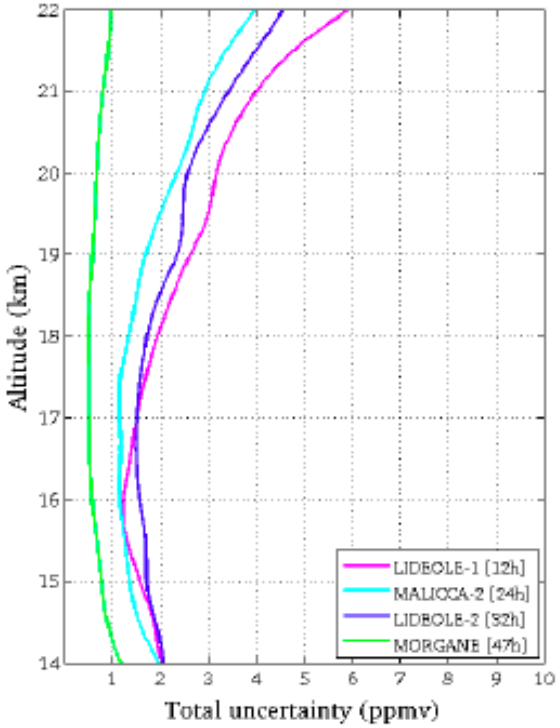


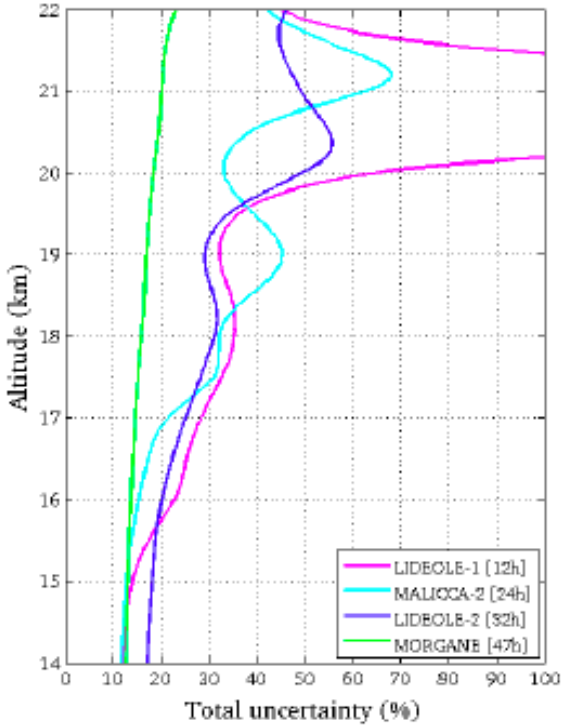


Water Vapor: uncertainties

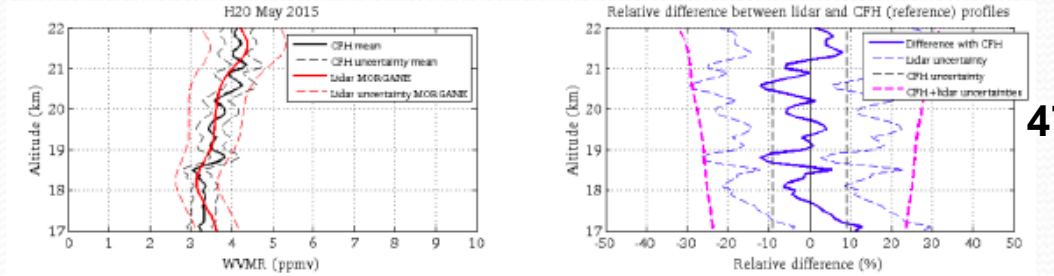
GRUAN (for trend detection)	UT	LS
Vertical Resolution	<1km **(600m)**	<1km **(750m)**
Total uncertainty	<60% **(<25%)**	<20% **(<15%)**
Time resolution	<1h **(40min)**	- **(47h)**





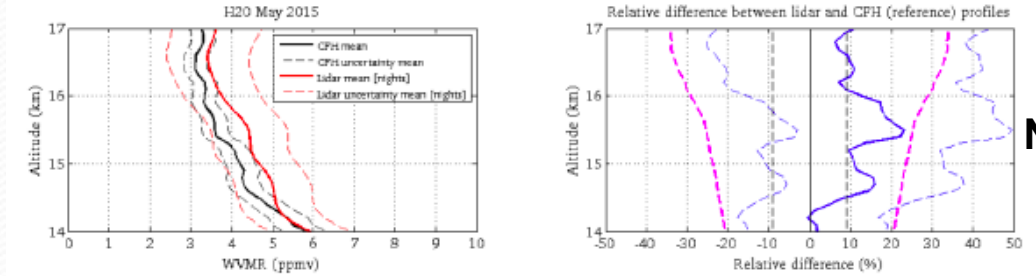


Water Vapor: validation (MORGANE)



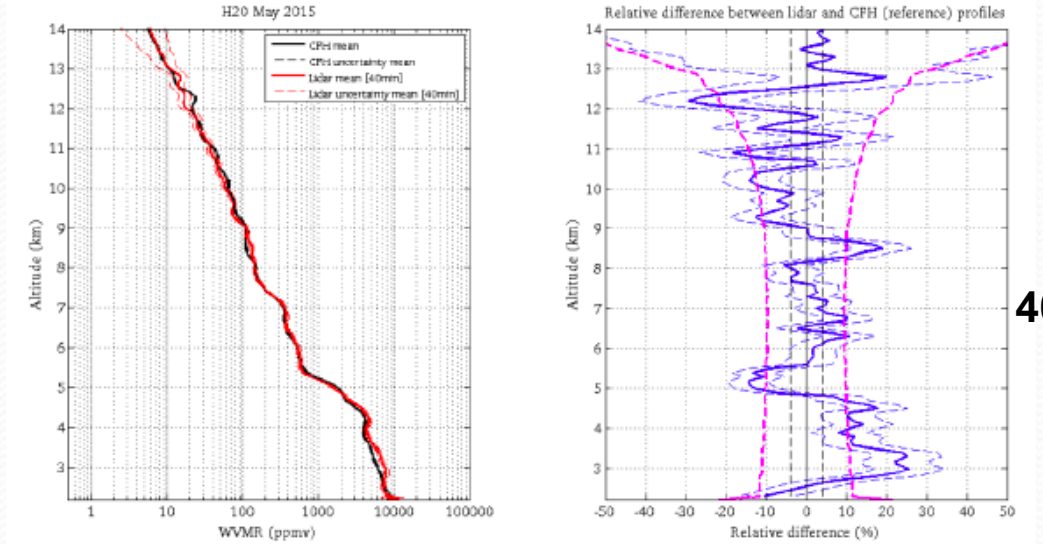
47h profiles

B)



Night profiles

C)

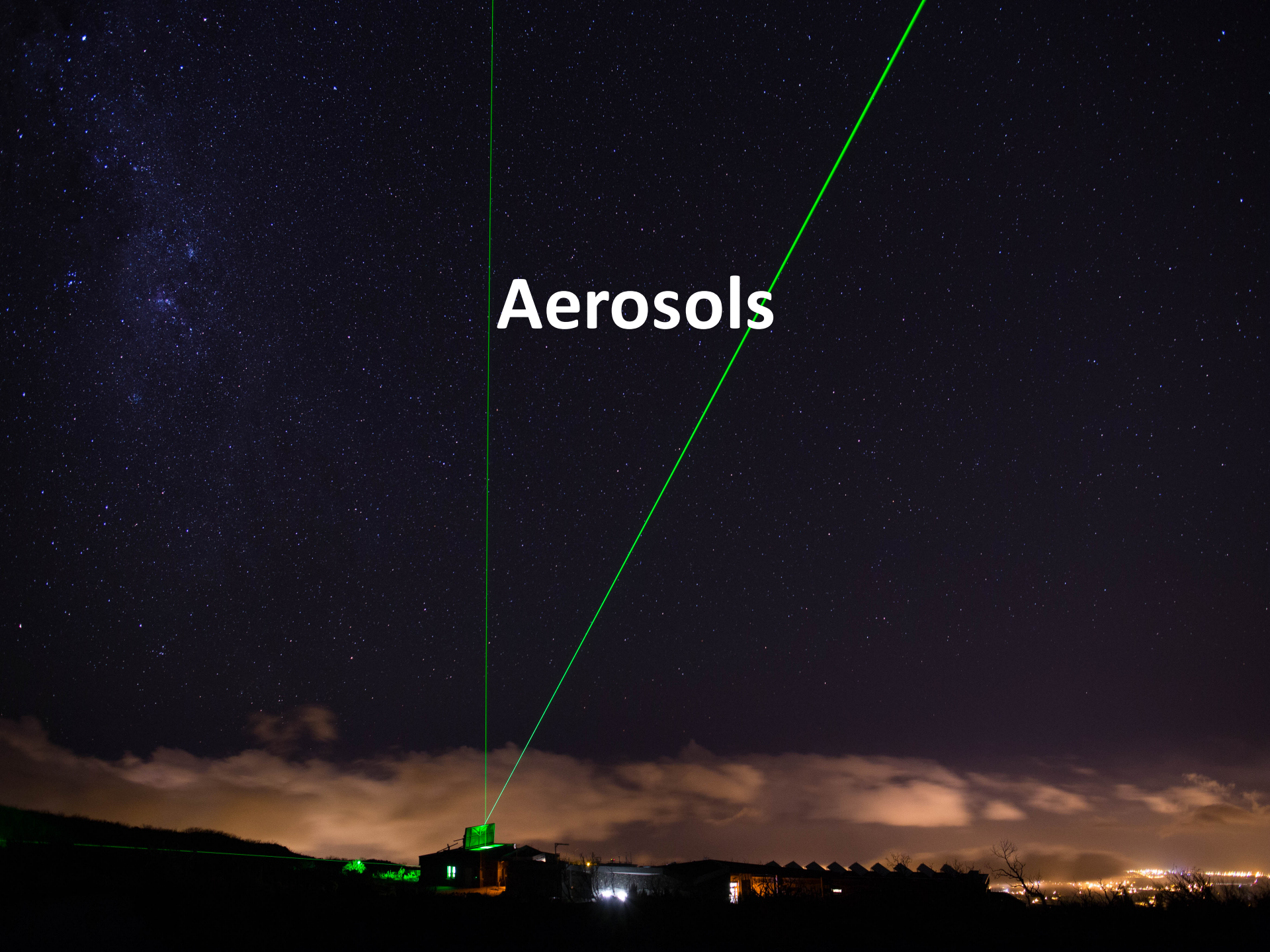


40min profiles

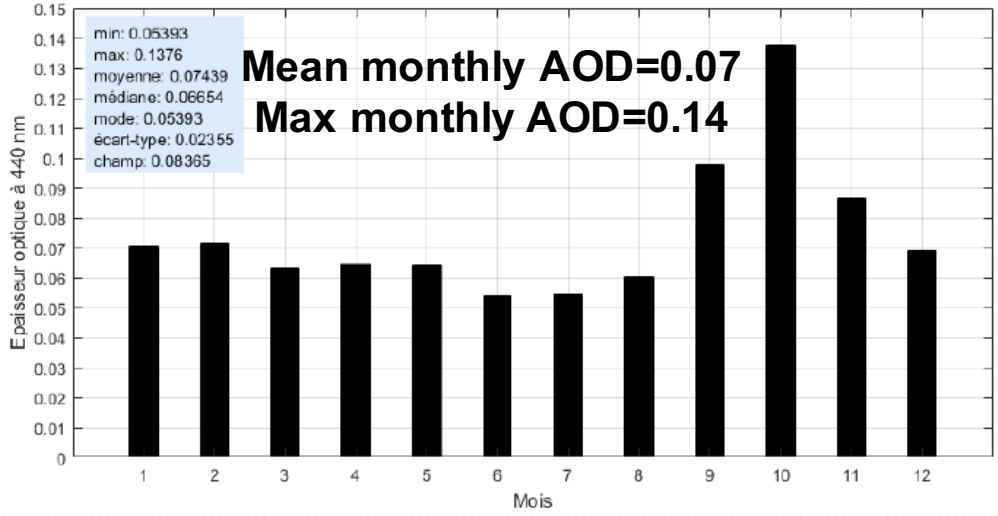
Involved in GRUAN

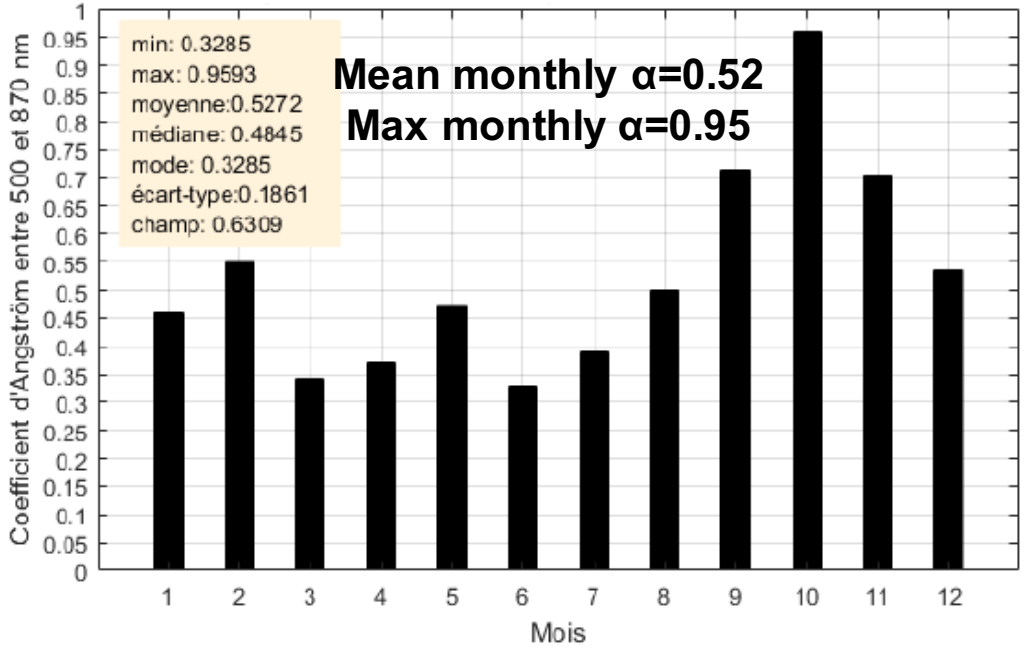
Improvements:
- **GNSS IWV temporal resolution**
- **mirror UV coating**
- **PMT cooling**

Vérèmes et al., AMTD2017

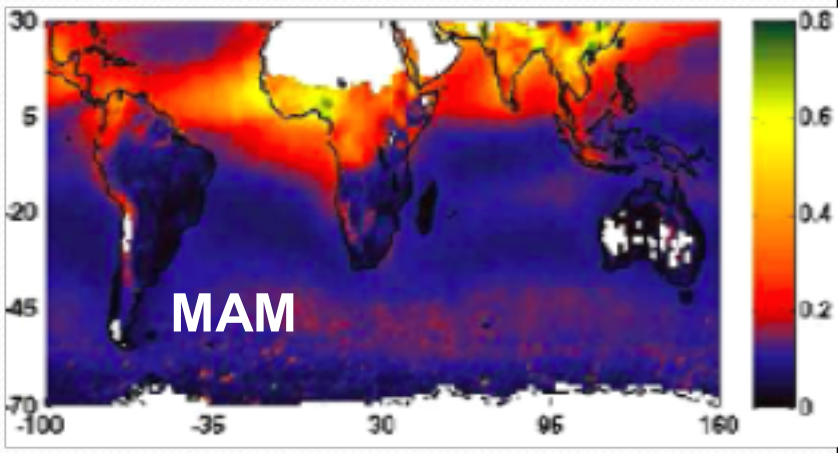

Aerosols

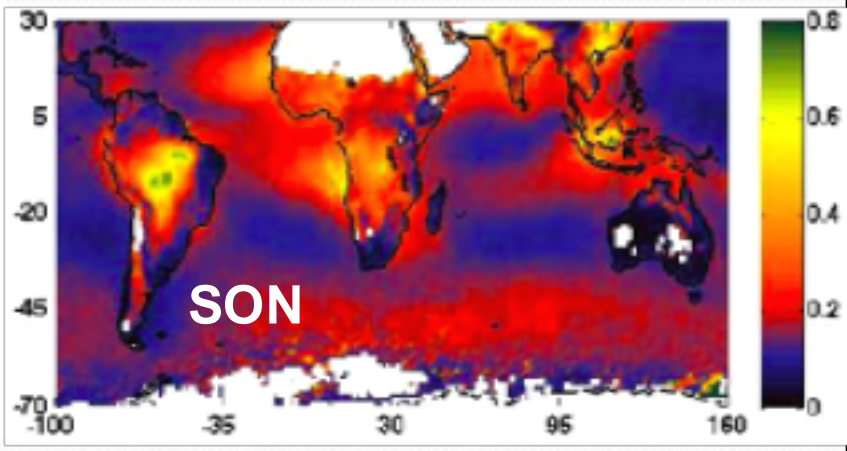
Aerosols: context



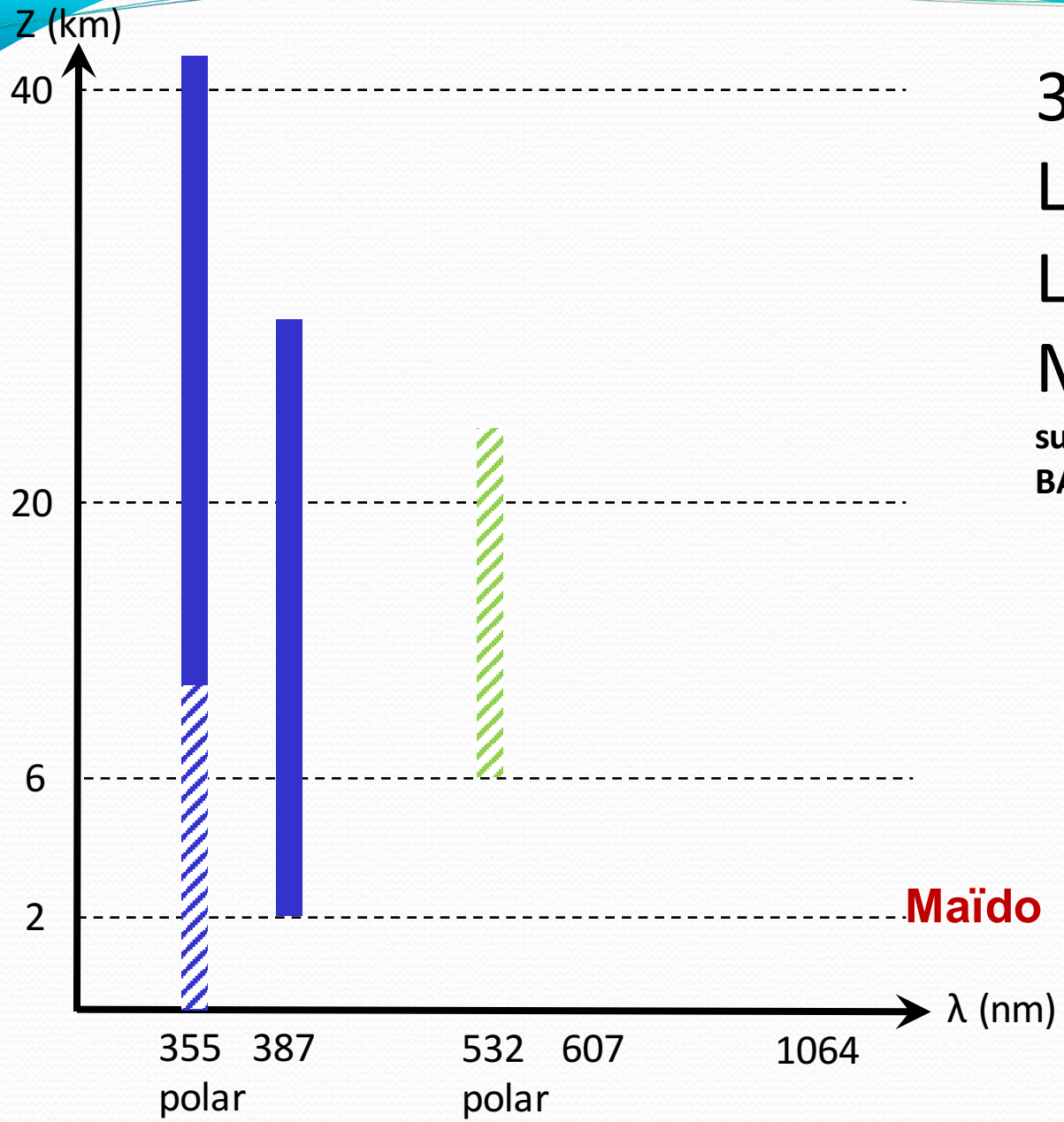


"Clean" area => Low AOD
BB season=>AOD doubling
Difficult area for satellites sensing=>need for GB obs.





Profiling of aerosols: observation capabilities



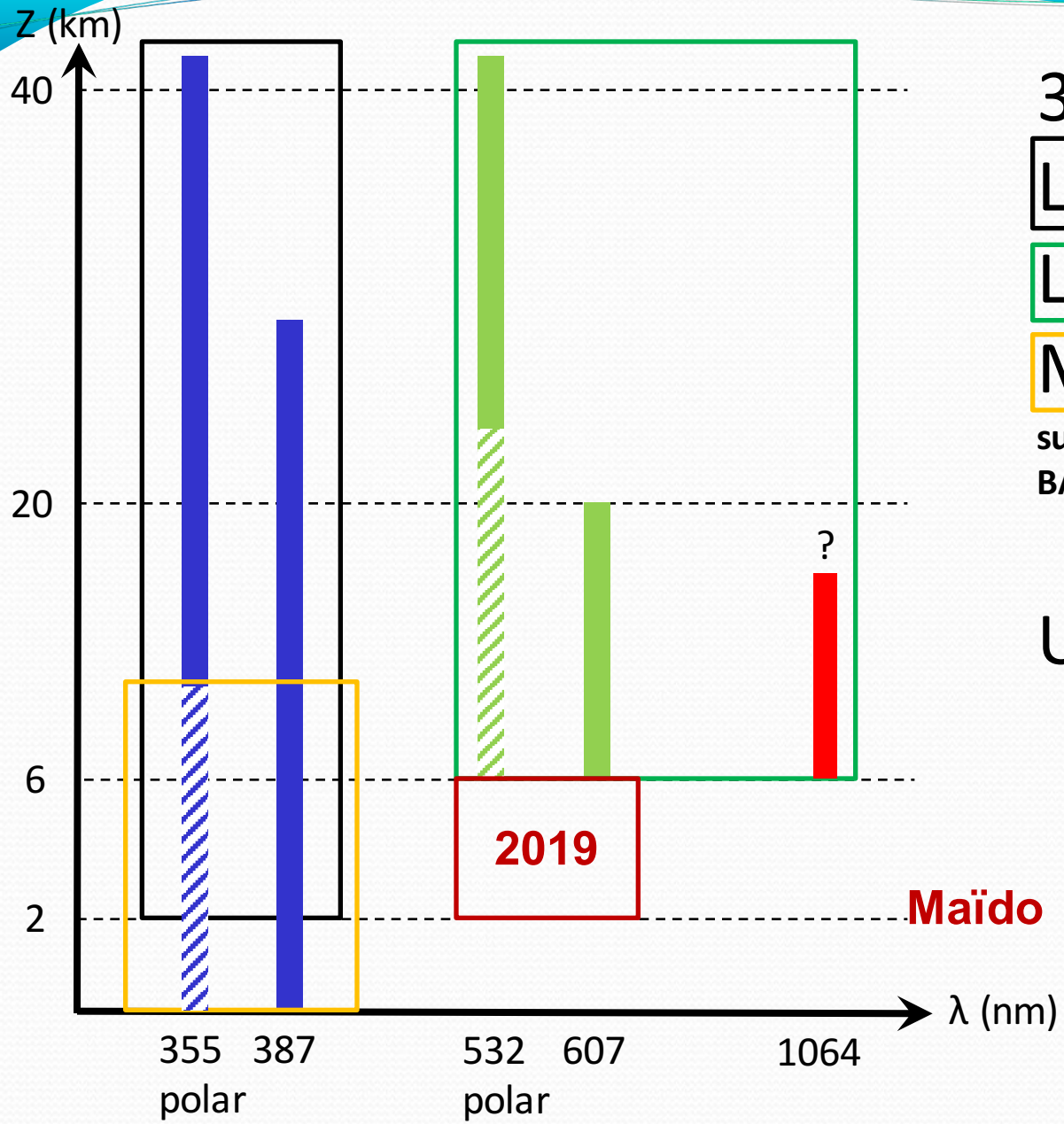
3 lidar systems:

LI1200

LIO3T

MARLEY **(collocated with sunphotometer and cloud radar BASTA – sea side)**

Profiling of aerosols: observation capabilities



3 lidar systems:

LI1200

LIO3T

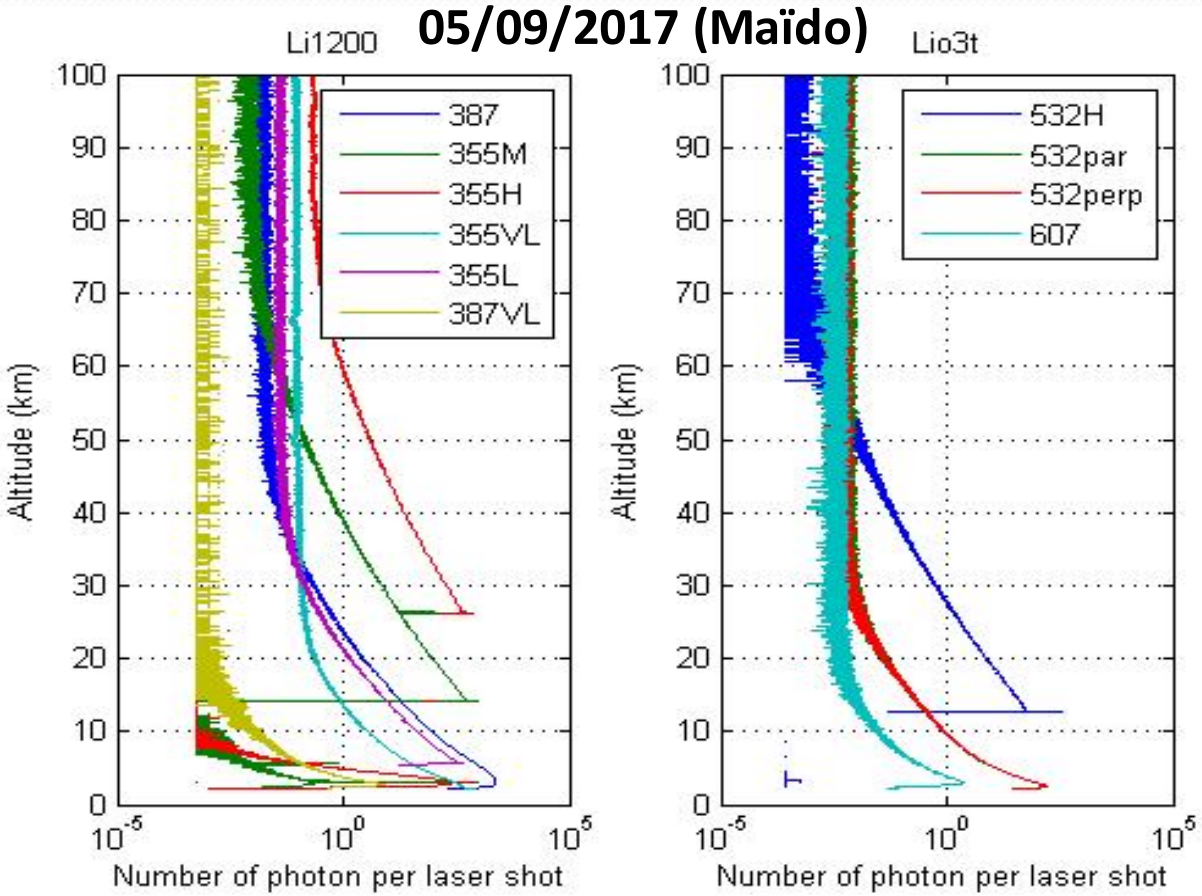
MARLEY (collocated with sunphotometer and cloud radar BASTA – sea side)

Upgraded in 2017

NETWORK FOR THE DETECTION OF ATMOSPHERIC COMPOSITION CHANGE
Exploring the Interface between Changing Atmospheric Composition and Climate
NDACC

(futur) candidate

Profiling of aerosols: first raw data for multi-λ



λ (nm)	Maïdo Domain of validity
355nm	3 – 45 km
387nm	3 – 25 km
532nm	6 – 45 km
607nm	6 – 15 km
1064nm	6 – ? km

Now part of EECLAT (Expecting EarthCARE, Learning from A-Train) consortium for CALIPSOv4 & EarthCARE cal/val

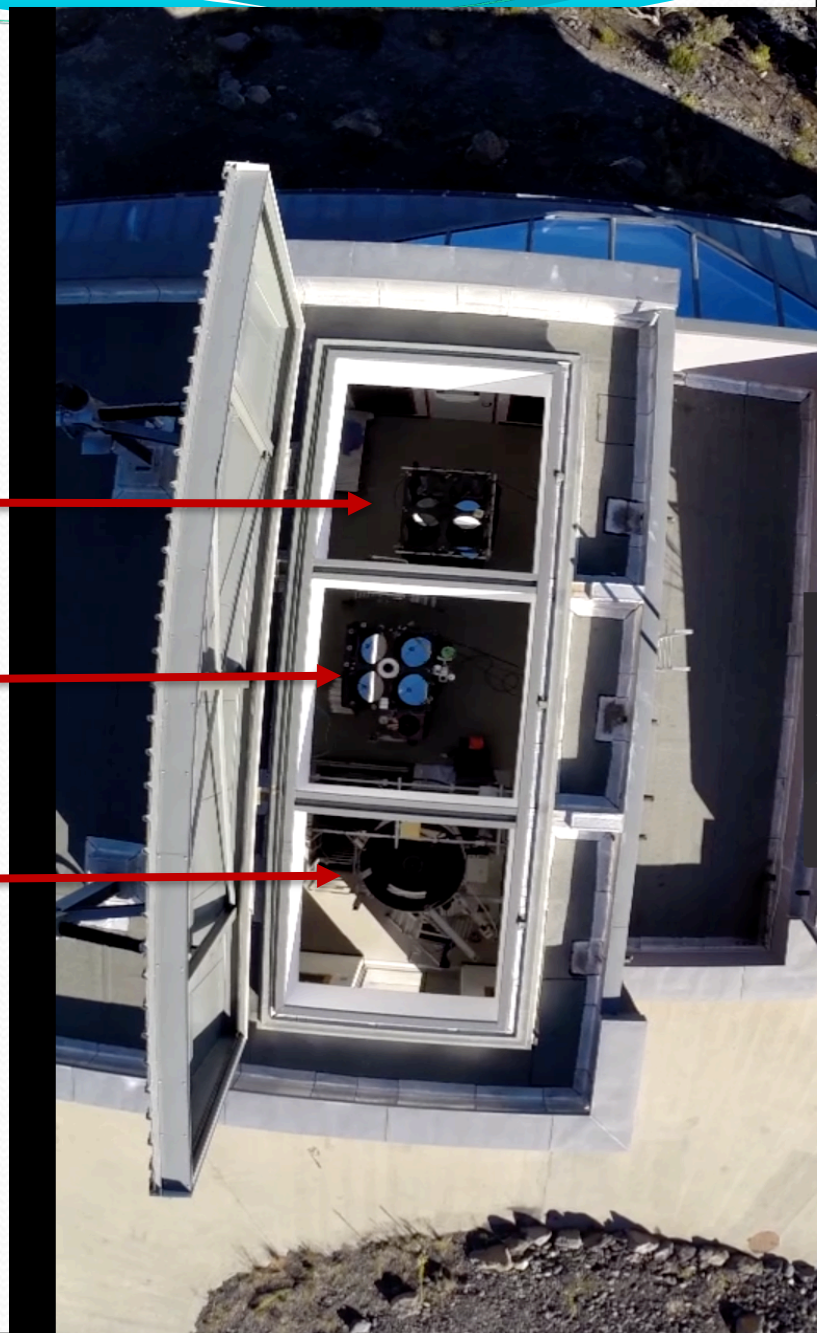

The HATCH

The HATCH

Bad initial design:
Threat on the building structure

Observations stopped till a solution is found

- DIAL stratospheric O_3
- DIAL tropospheric O_3
- LI1200: T°
  Water vapor



The HATCH

Meanwhile, work on:

DIAL stratospheric O_3 ← replacing the chopper

DIAL tropospheric O_3 ← adding a very low channel for aerosol @532
adding a low channel for ozone

LI1200: T°
Water vapor ← implementing semi automatisation

Published papers using Reunion NDACC lidar data since 2016:

Bègue et al., ACP2017, Stratospheric long range transport of the Calbuco plume
Bègue et al., AG2017, Mesospheric inversion layers above Reunion and Mauna Loa
Duflot et al., AMT2017, Tropospheric ozone lidar at Maïdo
Vérèmes et al., JGR 2016, Multiple subtropical intrusions over Reunion Island
Vérèmes et al., AMTD2017, Raman water vapor lidar at Maïdo
Vérèmes et al., ILRC2017, Water vapor at Maïdo: two first years time series

Leblanc et al., *in prep.* for AMT, MORGANE campaign overview
Portafaix et al., *in prep.* for AMT, Stratospheric ozone lidar at Reunion Island
Hauchecorne et al., *in prep.* for AMT, Temperature lidar at Reunion Island
Duflot et al., *in prep.* for ACP, STE with Calbuco volcanic aerosols
Payen et al., *in prep.* for AMT, A new lidar at Maïdo for multiwavelength observation of aerosols

Conclusions & Futur plans (2016 slide)

Conclusions

Maïdo observatory:

- ✓**Financially secured**
- ✓**Routinely operated twice/week**
- ✓**Performing numerous (lidar) campaigns**
- ✓**Providing an increasing number of measurements/year**
- ✓**"Base publications" for lidar systems and data coming soon**
- ✓**Geophysical science papers coming afterwards**

} **MORGANE** 

Futur plans

Submit NDACC applications for tropospheric O3 and water vapor measurements 

Perform more campaign-based measurements to feed water vapor UTLS database 

Expand observations to aerosols measurements (tropo & strato) 

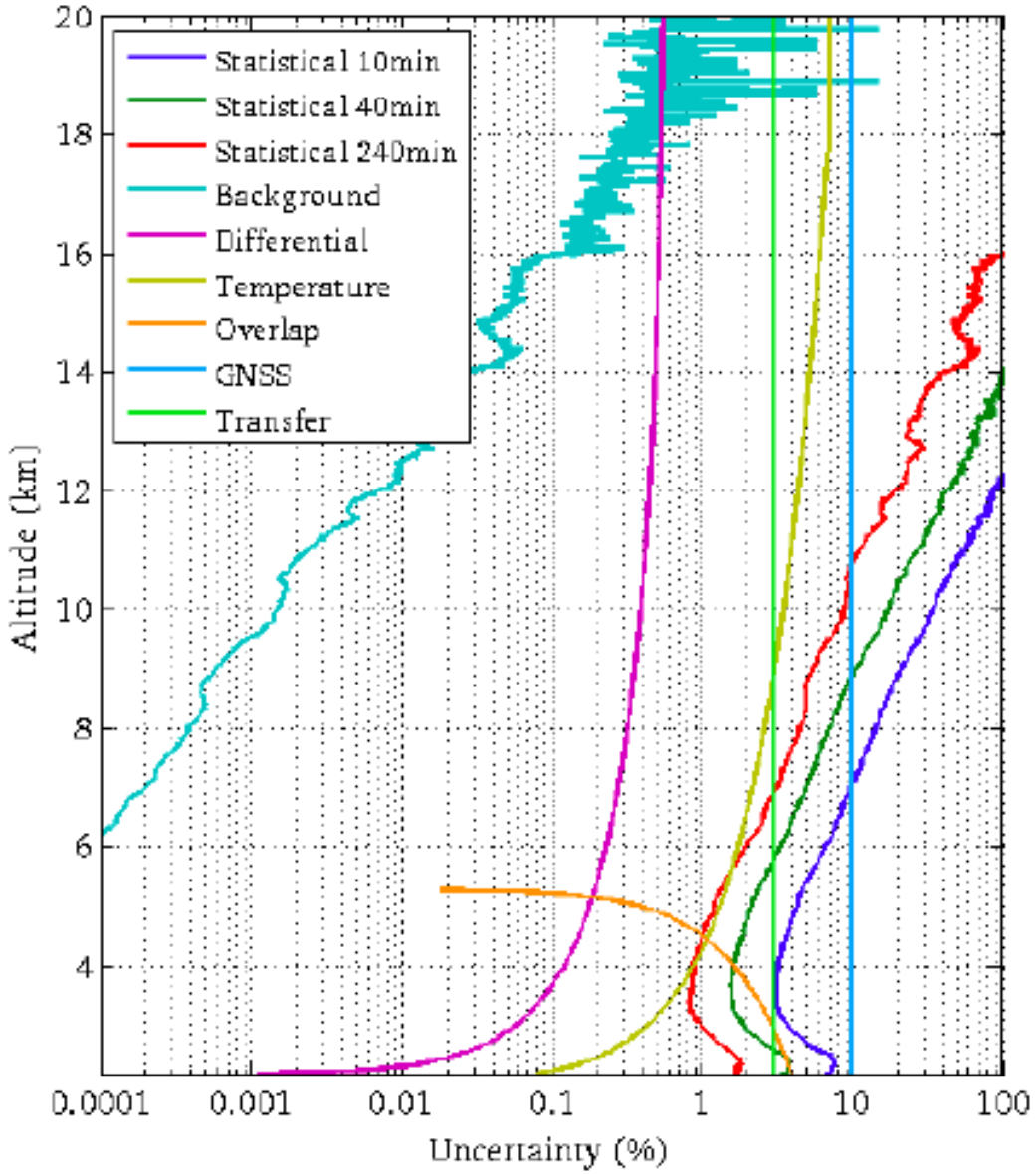
OPAR
Observatoire de Physique
de l'Atmosphère de la Réunion

Summary

!!! Hatch issues !!!

	Status	Database	Papers (2016-2018)	Actions running	Actions planned
Lidar T°	OK	1994-2006; 2008-2009; 2013-2015; 2017	1	Semi automatisation (late 2018)	
Lidar H_2O	OK	2013-2015 (ready for formatting)	3		
Lidar O_3 strato	NOK	2000-2008 2013-2017	1 (for aerosol)	Chopper replacement Involved in CAMS	Semi automatisation (2019)
Lidar O_3 tropo	~OK	2013-2017	2	Raman cell leak fixing	Low channel (2020) Semi automatisation (2020) TOLNet candidacy ? (2020)
Aerosol	~OK	-	-	1064nm channel investigation	Low 532 channel (2019) Semi automatisation (2020) NDACC candidacy (2020)

More slides


Statistical 10min
Statistical 40min
Statistical 240min
Background
Differential
Temperature
Overlap
GNSS
Transfer
Altitude (km)
Uncertainty (%)
20
18
16
14
12
10
8
6
4
0.0001
0.001
0.01
0.1
1
10
100