Lagrangian modeling for Reunion and other activities at la Reunion

S. Evan, J. Brioude, S. Meier, J. M. Metzger, F. Posny H. Vérèmes, G. Payen, V. Duflot, J. Leclair de Bellevue, R. Dirksen, H. Vömel, J. P. Cammas



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# Existing water vapor measurements at Reunion island



At Maido Observatory (~2km ASL), 1 to 3 profiles/week

At Maido Observatory (~2km ASL)

Weekly M10/O3 sonde as part of SHADOZ (Airport)

➤To maximize the scientific outcome of sonde launches/lidar measurements, we need a tool to predict interesting water vapor/O3 features to measure.

# FLEXPART

FLEXPART is a Lagrangian particle dispersion model (LPDM) It uses different meteorological fields from numerical weather prediction models (ECMWF, GFS...) :

- U,V,W to calculate the transport by resolved wind
- T, RH, surface heat flux, PBL height, U10, T2m, Precipitation etc ... to calculate:
  - Turbulence in the boundary layer
  - Subgrid convective transport
  - Wet and dry deposition, settling velocity of aerosols

#### A LPDM can calculate 3d concentration fields



Air particles (or trajectories) can transport a mass of a chemical species, aerosol, water vapor, etc... The mass can vary along the trajectory by deposition (wet, dry), chemical reaction, microphysics...

# Transport pathways for Reunion

- Origin of air masses over Maido Observatory?
- FLEXPART 15-day backward trajectories initialized each day between Sept 2013 and Aug 2014 over Maïdo Observatory (Altitude 2.2km)
- Consider 4 altitude regions: ground (2.2-2.3km ASL, 50,000 traj), Free troposphere (2.3-8km ASL, 300,000 traj), Upper troposphere (8-14km ASL) and UTLS (14-20km ASL, 300,000 traj)
- Use ECMWF operational AN and FC: 3-hourly, 0.5°x0.5°, 137 vertical level (ECMWF grid in 2013 is T1279 = 16km grid)
- FLEXPART Output grid: 2°x2°, 4 layers 0-2km, 2-8km, 8-14km, 14-20km



#### from Turner and Annamalei (2012), Nature Climate Change

#### Ground



#### Upper troposphere



## UTLS





## CFH/M10/RS92 launch, 18 Nov 2014

Visit of S. Meier funded by ACTRIS (TNA activity)









Plots courtesy of Ruud Dirksen

### CFH/Lidar, 18 Nov 2014



LIDAR calibration method described in Dionisi et al., AMT, 2015. Calibration coefficients calculated through hourly GNSS IWV,

#### FLEXPART Backward trajectories, 18 Nov 2014



20,000 trajectories initialized on Nov 18 from 19:34 UTC to 20:04 UTC = altitudes 8-11 km above (21.13°S, 55.4°E) until Nov 17, 13UTC FLEXPART+ Hourly Operational ECMWF 0.125°x0.125°, 137 vertical levels





20

60°E

SHITC

260K

240K

#### French National Program INSU LEFE: VAPEURDO (22k€/3years)

- METEOSAT 7, Cloudsat : Identification of deep convection
- IASI, AIRS, MLS: Water Vapor Distribution and comparison with CFH/lidar/M10 profiles
- IASI, MLS CO/O3: Study transport pathways over the Indian Ocean
- Operational High resolution ECMWF+FLEXPART = forecast tool for measurements at Maido Observatory



#### CONCIRTO : CONvection, CIRus, tropical waves and tropical Tropopause over the Indian Ocean

Letter of intent submitted to ANR (French National Research Agency) in October 2014

Scientific goals:

1) Determine the mechanism by which deep convection affects the TTL over the Indian Ocean?

2) Characterize the properties of cirrus clouds and assess formation mechanisms over the Indian Ocean?

3) Characterize the fine-scale vertical structure and temporal variability of the tropical tropopause region over the Indian Ocean?

#### Tools:

FLEXPART, MESO-NH (French Mesoscale model) Sondes for Water + Aerosol + Maïdo measurements

Budget: 326k€ for 3 years including Equipment 154k€, Staff 132k€

## What's next for 2015?

 MORGANE: Maïdo ObservatoRy Gas and Aerosols NDACC Experiment

NASA shipment finally made it to Reunion

27 Apr to end of May 2015, Scientific referee is Thierry Leblanc Measurements : Maïdo&NASA lidars , Radiosoundings (Ozone, Water vapor (M10/RS92/CFH, Aerosol)

- Calibration chain for the water vapor lidar by PIs V. Duflot&P. Keckhut, G. Payen
- 2 CFH launches, one Sept, one Nov
- Flexpart forecast tool + Satellite