

Genesis of Diamond Dust, Ice Fog and Thick Cloud Episodes observed and modelled above Dome C, Antarctica

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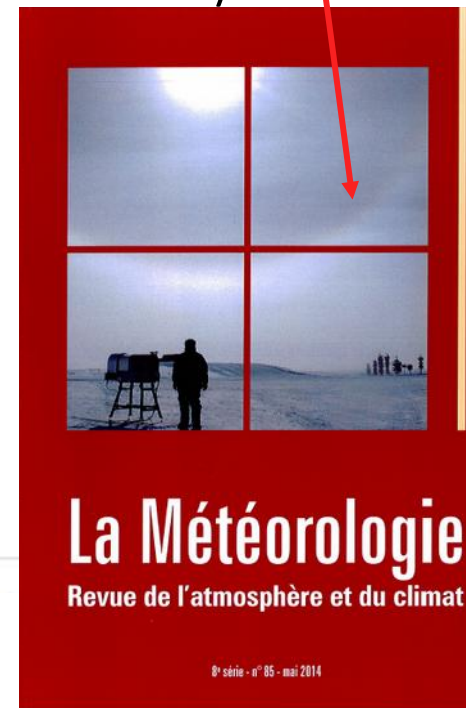
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Motivation

- Clouds vs Climate evolution in Antarctica
- Antarctic Plateau
 - Negative trends in surface temperature
- Water (solid and gas) Budget at Dome C Station
- Studies of Thick cloud (precipitating ice crystals) and Diamond Dust/Ice Fog (ice crystals in suspension in the air)
- Evaluation of NWP



Data Sets

- **HAMSTRAD: IWV, T & H₂O**
- **Aerosol Lidar & Ice-Camera: Aerosol**
- **BSRN: Solar Irradiance**
- **Radiosonde: T & H₂O**
- **CALIOP: Aerosols**
- **ARPEGE NWP model: H₂O, Ice, T, clouds, H₂O & T budgets**
- **BADC: back-trajectories from ECMWF analyses**

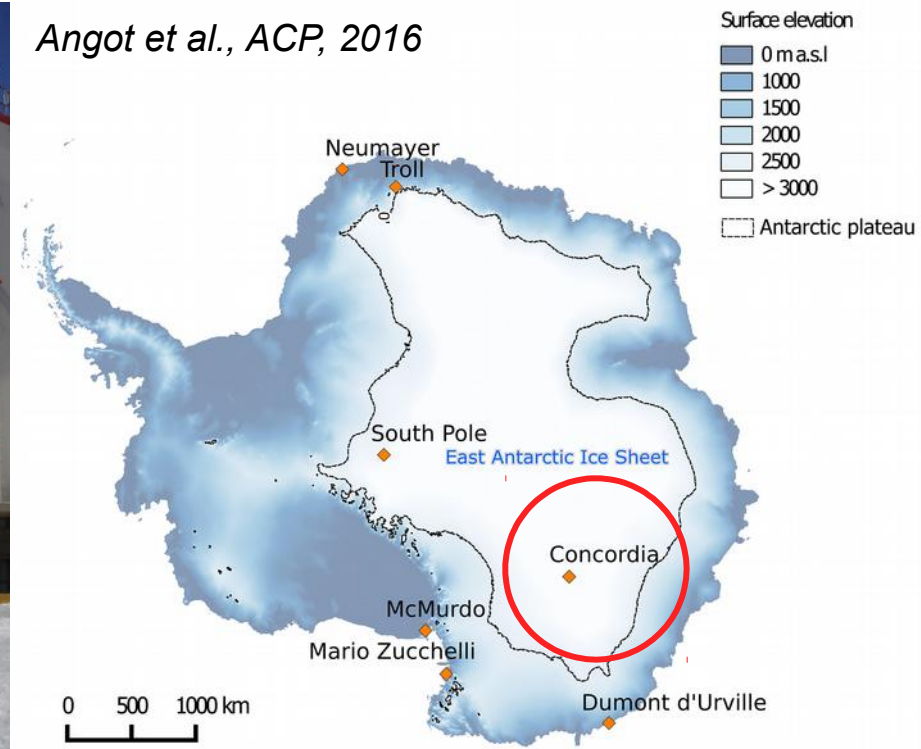
- **Periods**
 - 24-26 March 2011 & **4-5 March 2013**

- *Ricaud et al., Atmos. Chem. Phys., 17, 5221-5237, 2017.*

Dome C



Angot et al., ACP, 2016



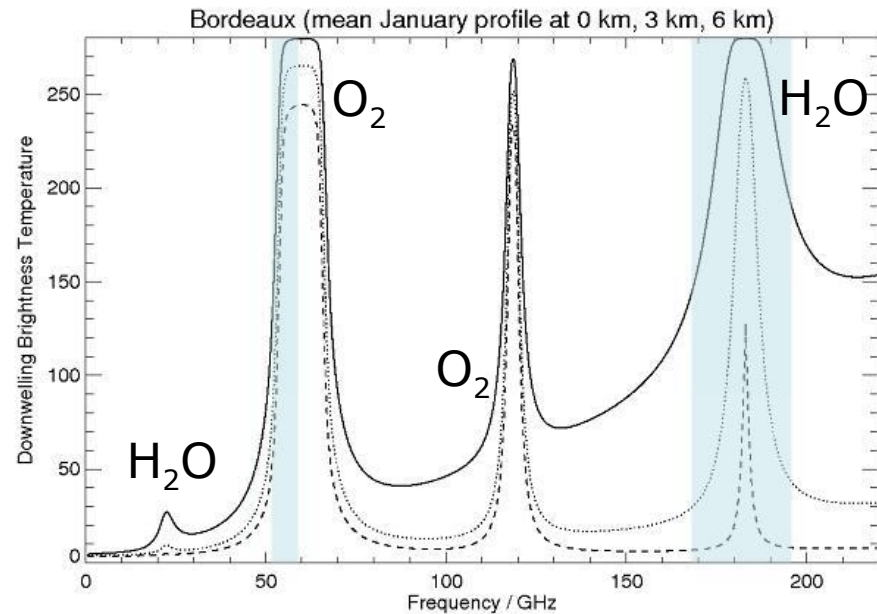
Concordia Station (Dome C)
75°06'S, 123°21'E, 3233 m asml
Maintained by France (IPEV)
and Italy (PNRA)
Summer: ~80 pers.
Winter: ~12 pers.



The HAMSTRAD Radiometer

- Developed by RPG
- 60 GHz (O_2)
 - Temperature
 - 0-10 km
 - 7 channels
- 183 GHz (H_2O)
 - Absolute Humidity
 - 0-10 km
 - 6 channels
- Retrieval
 - Linear/Quadratic Regression
- Vertical Resolution: 80-250 m (H_2O) & 250 m (T)
 - PBL: 30-50 m (H_2O) & 10-20 m (T)
- Time resolution: 1-10 min → 7 min
- Fully automated, data daily transmitted to France via Italy
- Need Liquid Nitrogen Calibration once/twice a year

- Open access to HAMSTRAD data
- <http://www.umn-cnrm.fr/spip.php?article961&lang=en>



HAMSTRAD Set-up

Pic du Midi / 2008



Dome C / 2009



Dome C / 2010 to date



Validation

HAMSTRAD

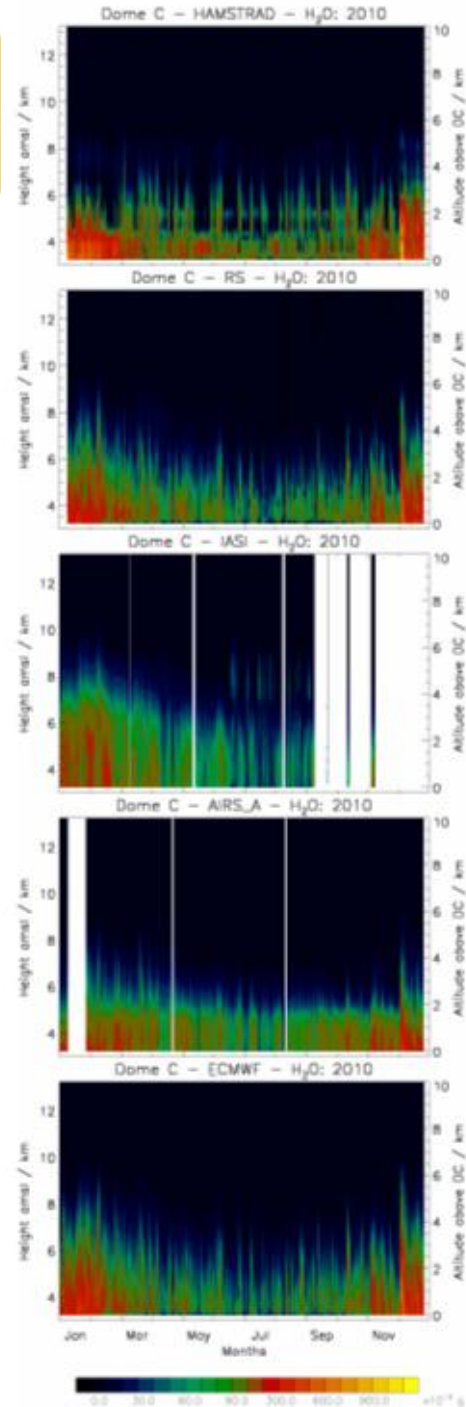
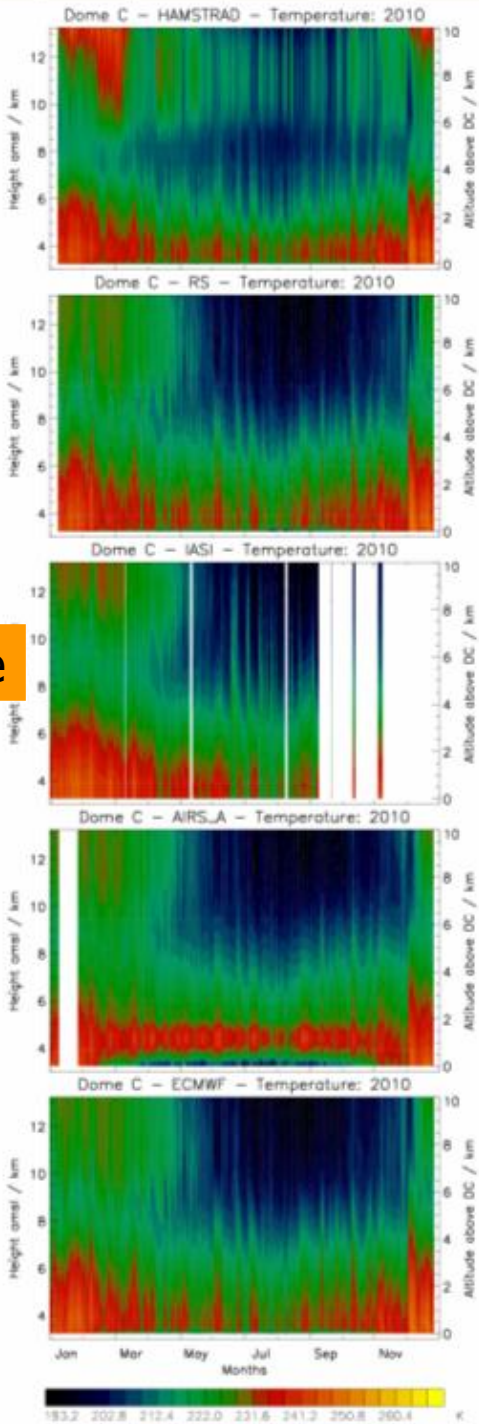
Radiosondes

IASI

AIRS

ECMWF

2010



Temperature

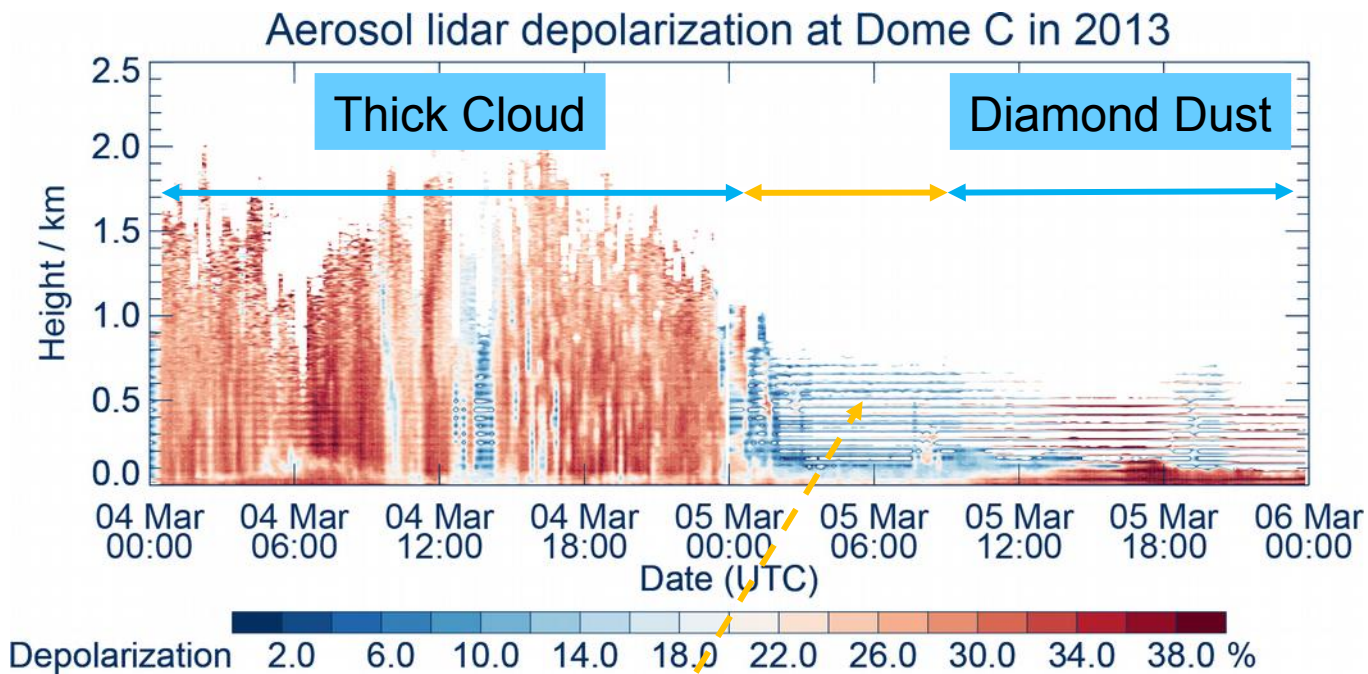
H₂O

Aerosol Lidar

- Laser Quantel Brio (532, lin. pol.)
- Telescope : refractive, 10 cm diameter, f/3
- Data acquisition: Licel GmbH, analog, 2 channels (532 nm p, s)
- Vertical resolution: 7.5 m
- Altitude range: 30 m -12000 m a.g.
- Webcam: analog B/W SK-1004XC/SO with 3.6 mm lens
- <http://lidarmax.altervista.org/lidar/Antarctic%20LIDAR.php>



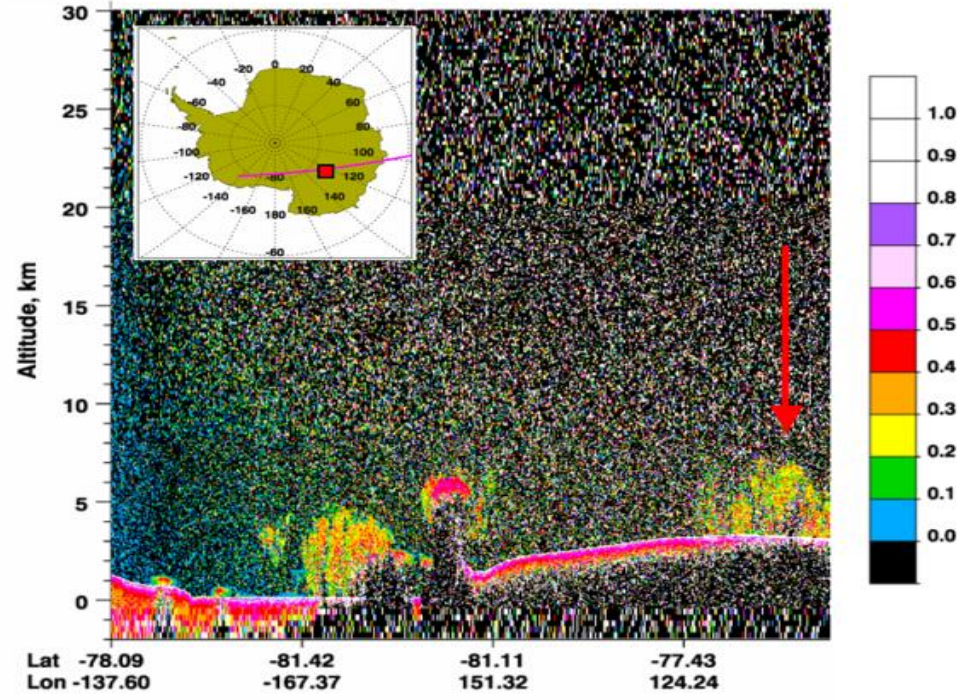
Thick Cloud and Diamond Dust episodes in 2013



Supercooled Liquid Water

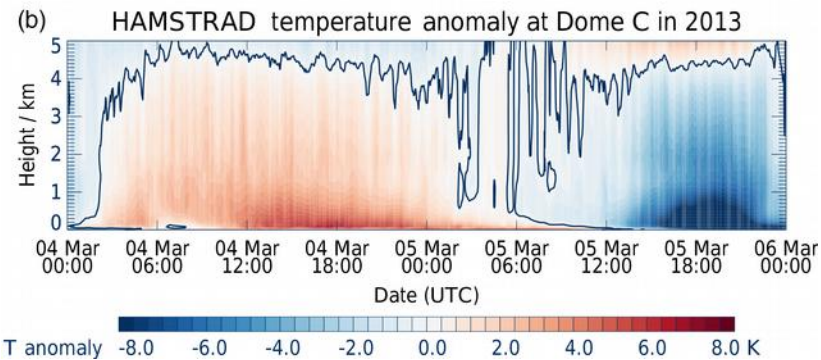
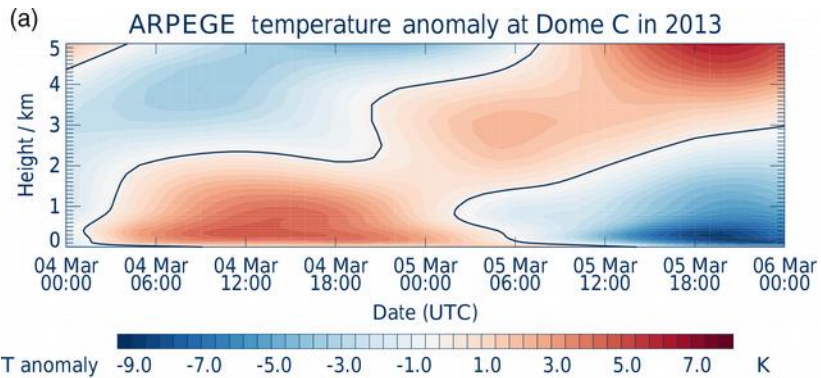
CALIPSO

4 March 2013, Depolarization Ratio

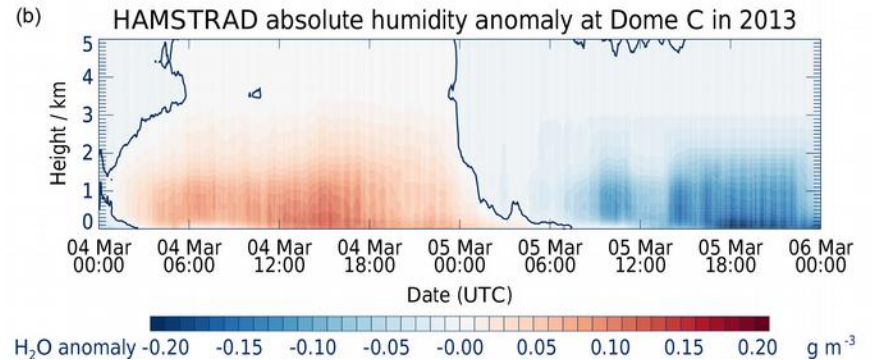
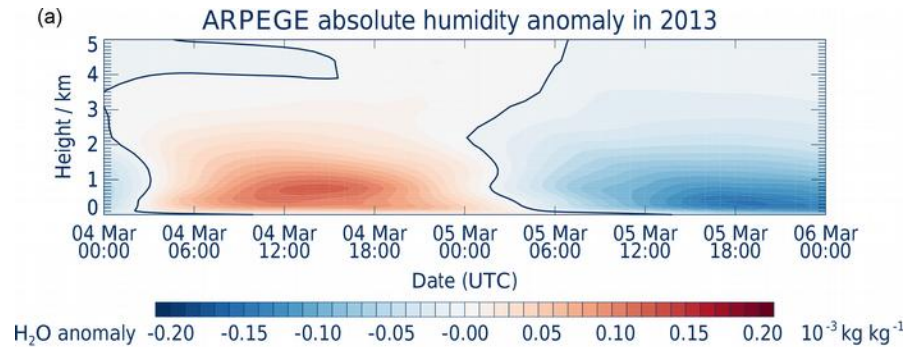


Temperature and H₂O

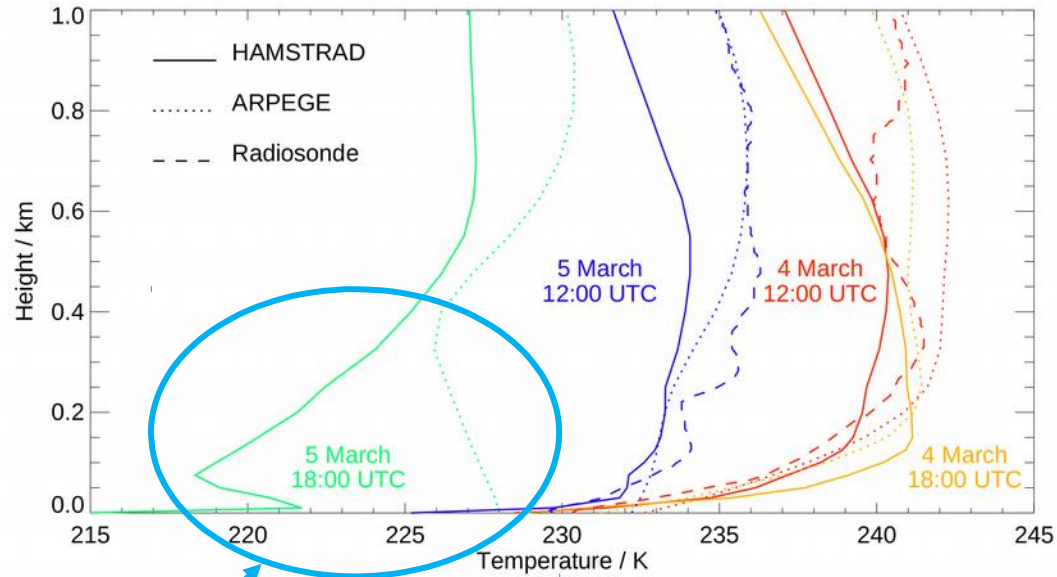
Temperature



H₂O

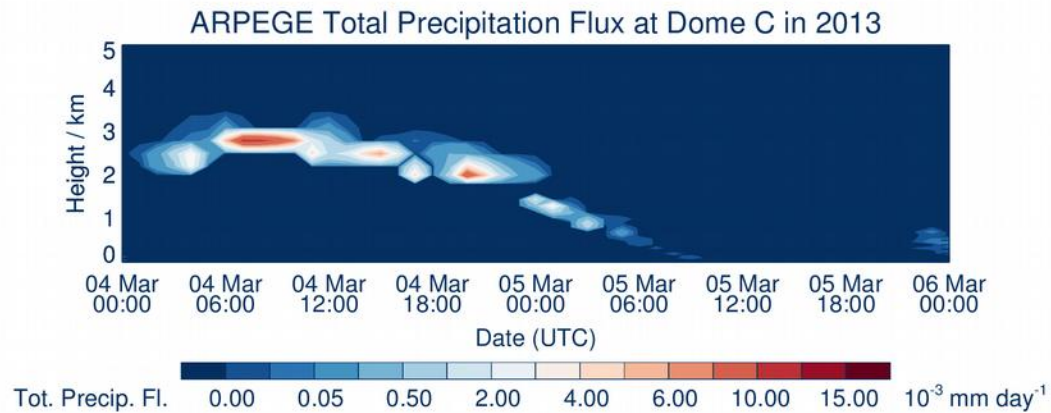
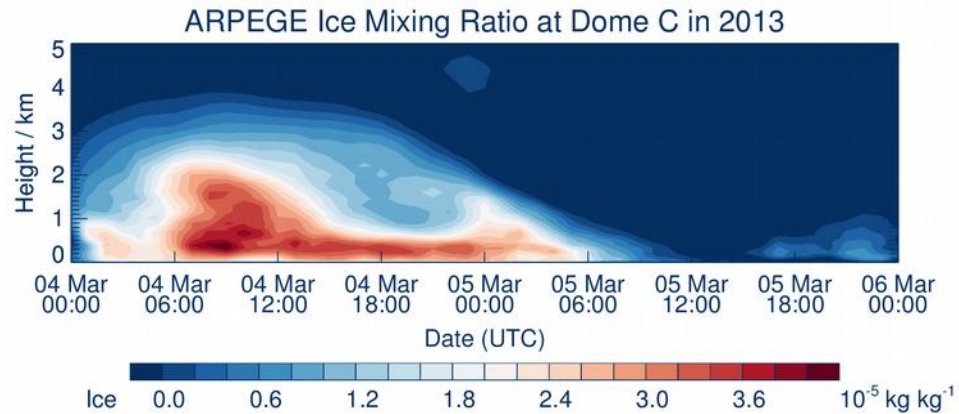


Temperature



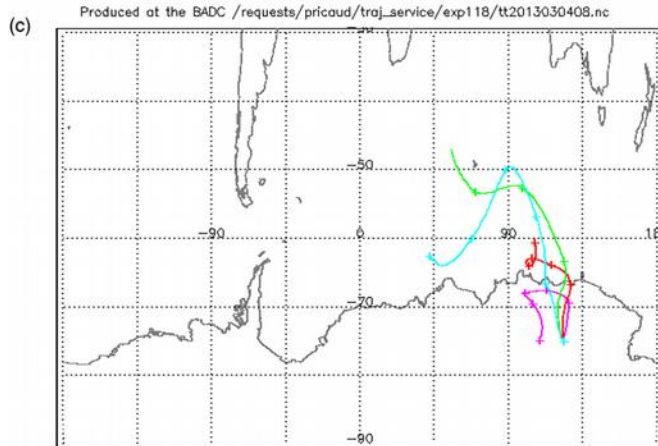
Diamond Dust

Ice and Precipitation



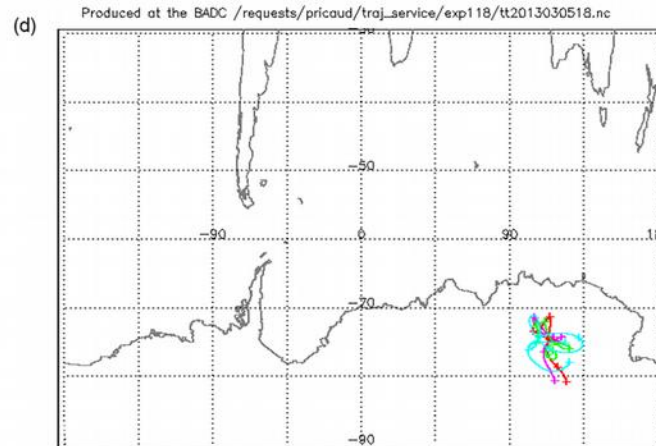
5-day back trajectories

Thick Cloud



650 (pink line), 600 (red line), 500 (green line), 400 (light blue line) and 300 hPa (dark blue line)

Diamond Dust



Thick clouds: warm and wet periods with oceanic-origin air masses
 Diamond Dusts: cold and dry periods with continental-origin air masses

Conclusions

- Processes impacting the presence of thick clouds and diamond dust/ice fog episodes above Dome C
 - Thick clouds
 - Free Troposphere
 - Associated with high Temperature/Humidity with mid/low latitude origin of air masses
 - Well reproduced by ARPEGE
 - Diamond Dust/Ice fog
 - Planetary Boundary Layer
 - Associated with low Temperature/Humidity with Antarctic Plateau origin of air masses
 - Not calculated by ARPEGE

- Perspectives
 - YOPP–endorsed project H2O-DC (HAMSTRAD, Aerosol Lidar, ARPEGE)
 - Water Budget at Dome C
 - Campaign in November 2018-February 2019

Acknowledgment

- The research project HAMSTRAD programme (910) has been performed at the Dome C station and was supported by the French Polar Institute, Institut polaire français Paul-Emile Victor (IPEV), the Institut National des Sciences de l'Univers (INSU)/Centre National de la Recherche Scientifique (CNRS), Météo-France and the Centre National d'Etudes Spatiales (CNES).
- The permanently manned Concordia station is jointly operated by IPEV and the Italian Programma Nazionale Ricerche in Antartide (PNRA).
- We would like to thank all the winterover personnel who worked at Dome C on the different projects over the timeframe of the HAMSTRAD and Aerosol Lidar projects.