Comparison between CloudSat and in-situ radar snowfall rates in East Antarctica.

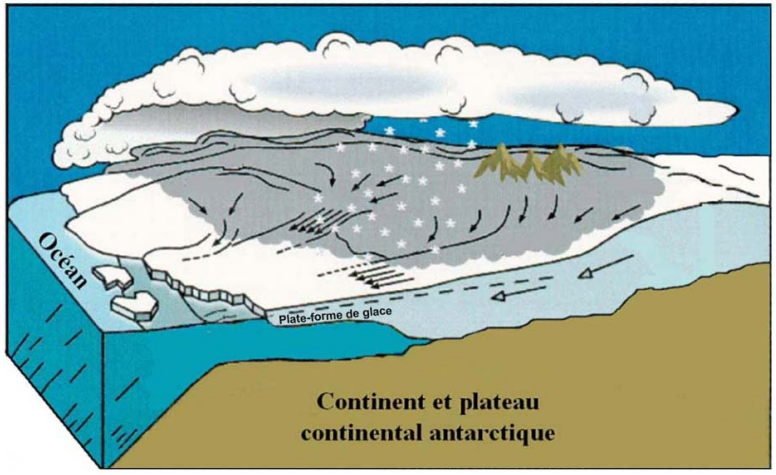
Florentin Lemonnier, PhD student

Laboratoire de Météorologie Dynamique / IPSL, CNRS – Paris, France

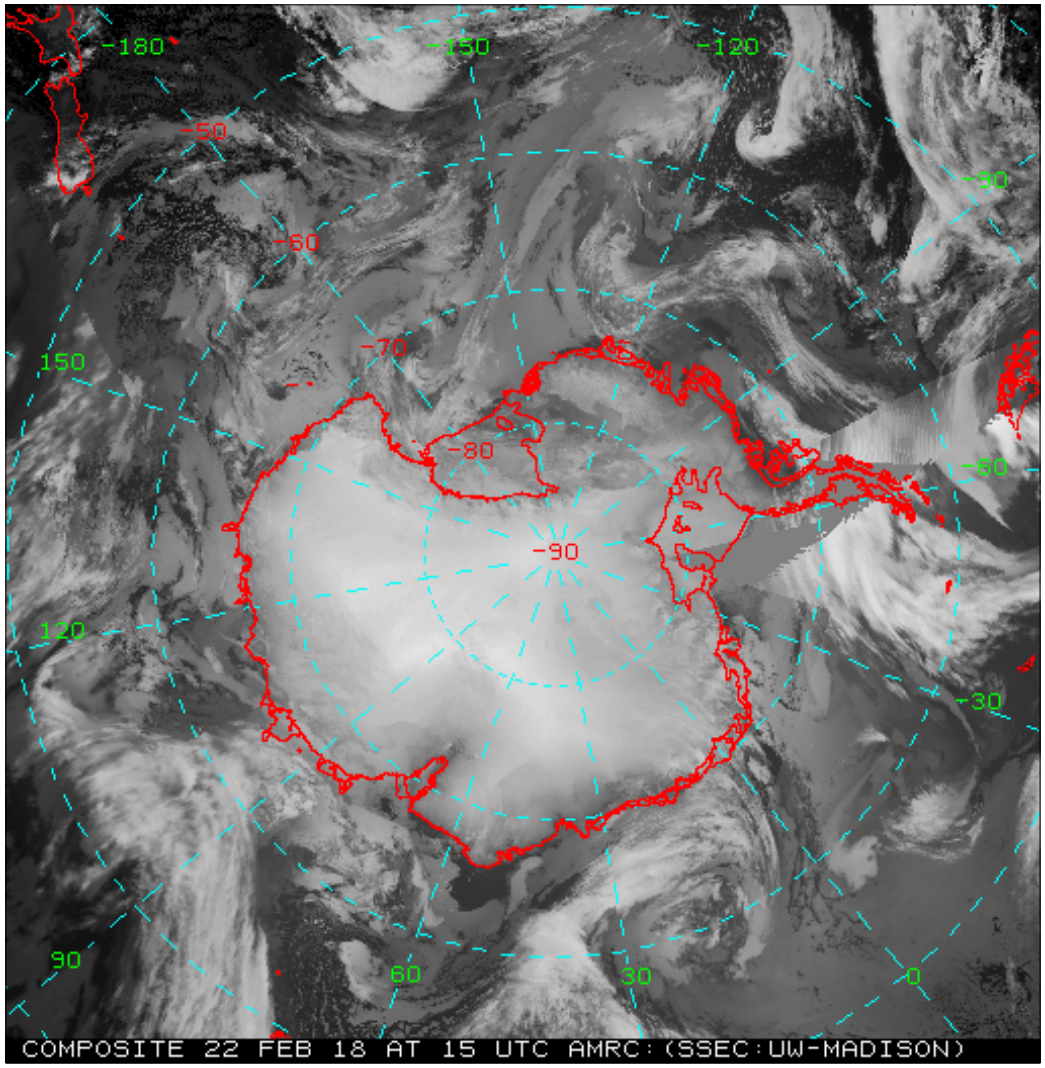
J.B. Madeleine, C. Claud, N.Wood, T. L'Ecuyer, C. Genthon, G. Krinner, C. Duran-Alarcon, A. Berne, C. Palerme, N. Souverijn & N. Lipzig

Introduction : Antarctica

- Resources :
  - 75 % of the global fresh water.
- Surface mass balance :
  - Snow precipitation and accumulation over the ice cap.
  - Glacier calving, sublimation and meltwater runoff.
  - Wind erosion and drifting snow.
- Evolution of the ice-cap :
  - Constrain the contribution of the precipitation.

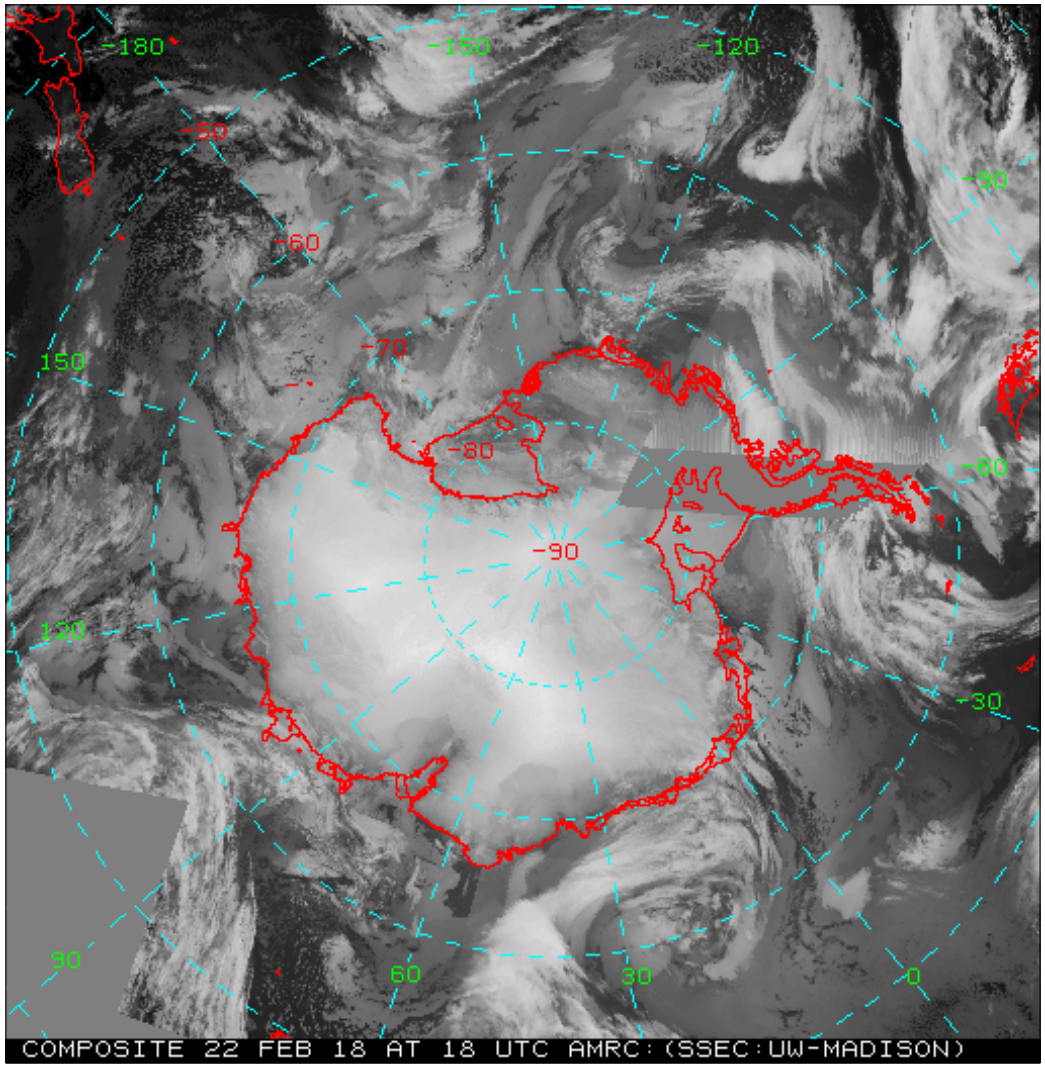


Introduction : Antarctica



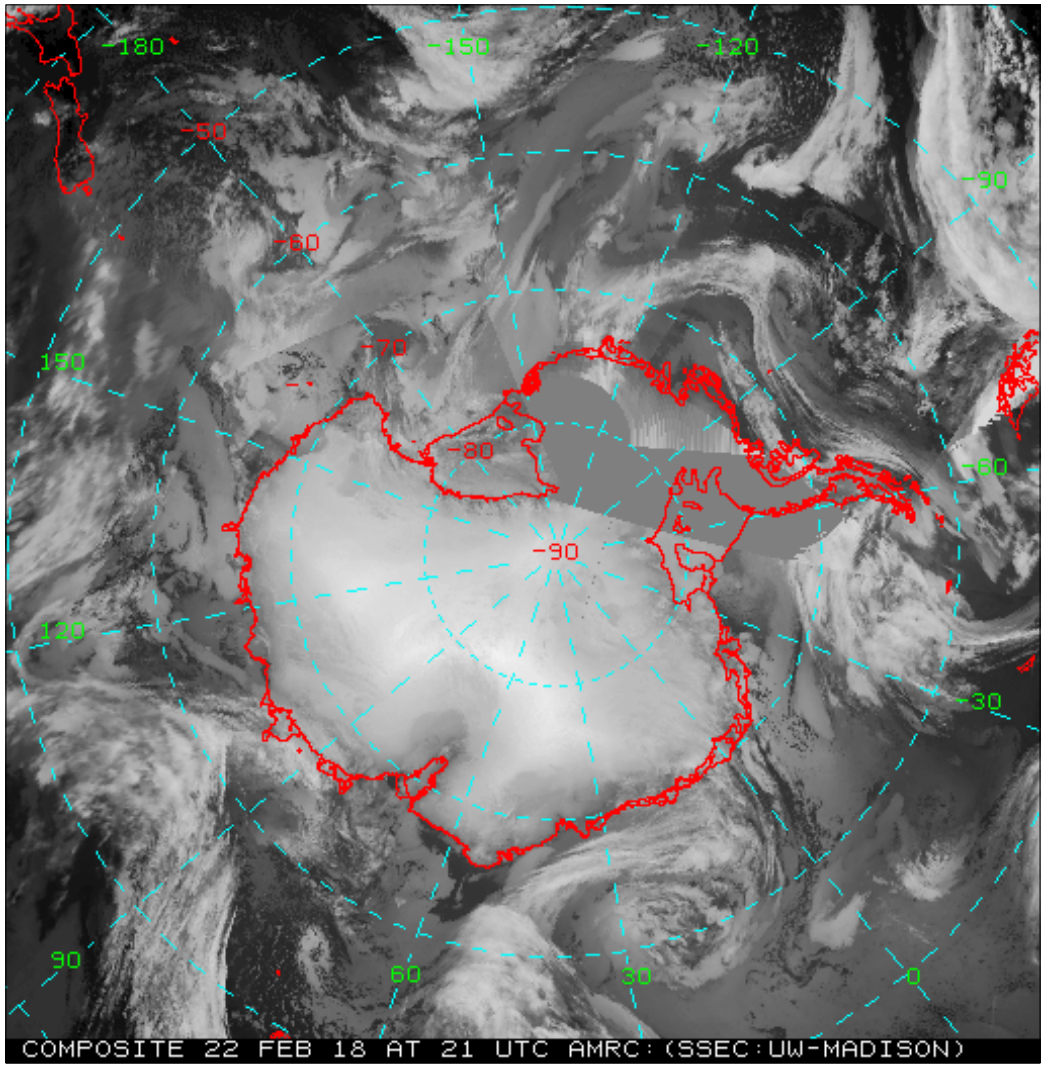
Frame 1/5
Infrared composite

Introduction : Antarctica



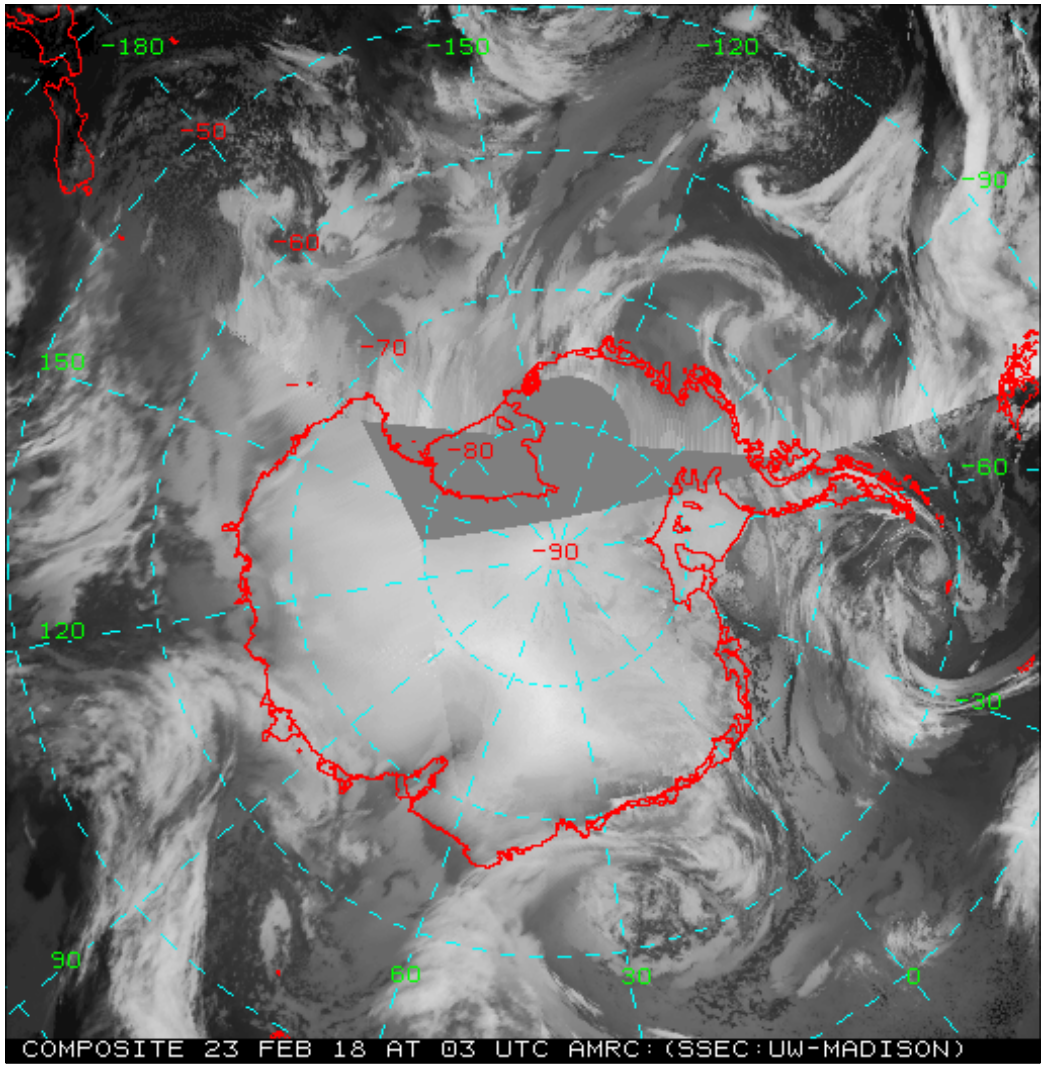
Frame 2/5
Infrared composite

Introduction : Antarctica



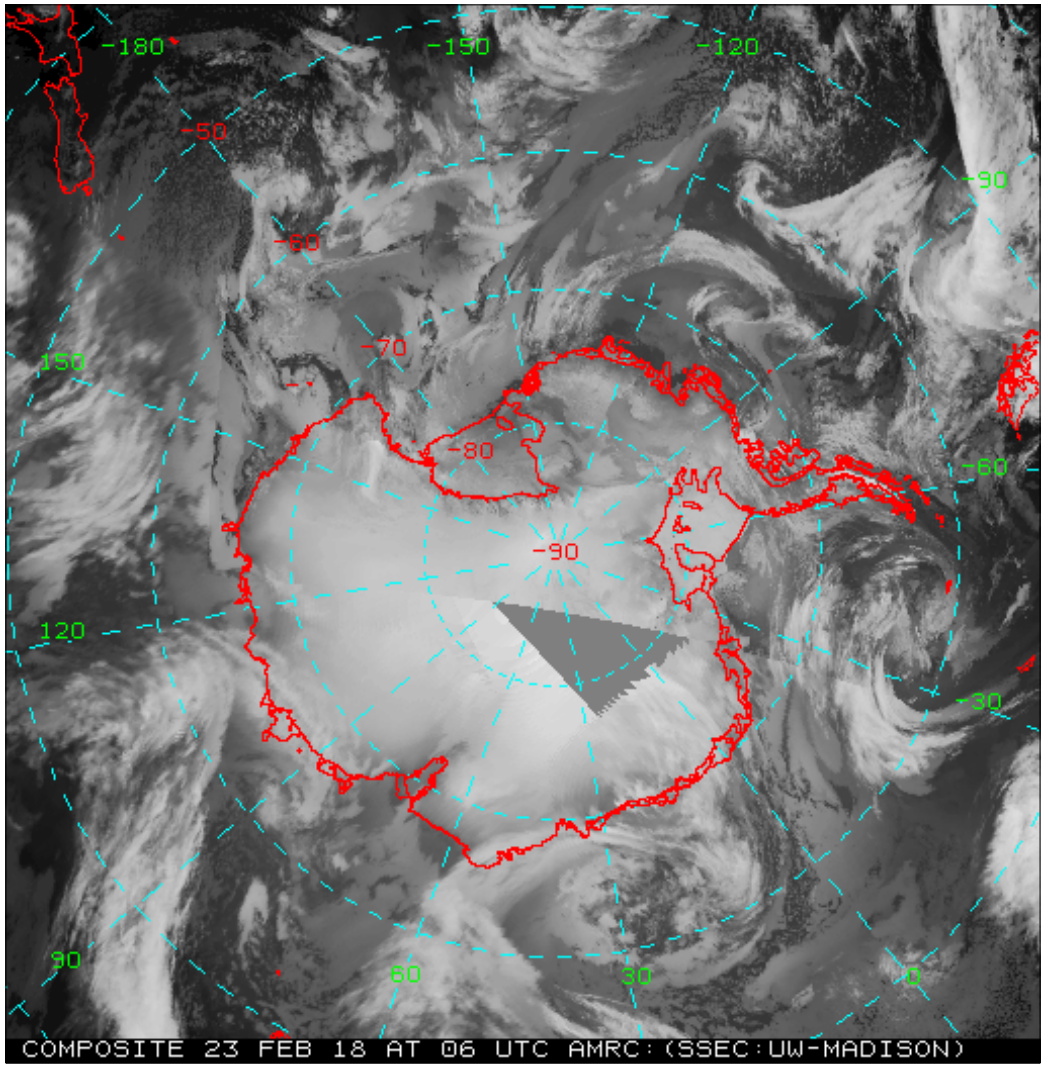
Frame 3/5
Infrared composite

Introduction : Antarctica



Frame 4/5
Infrared composite

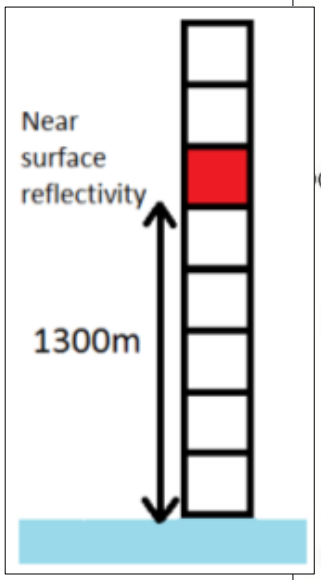
Introduction : Antarctica

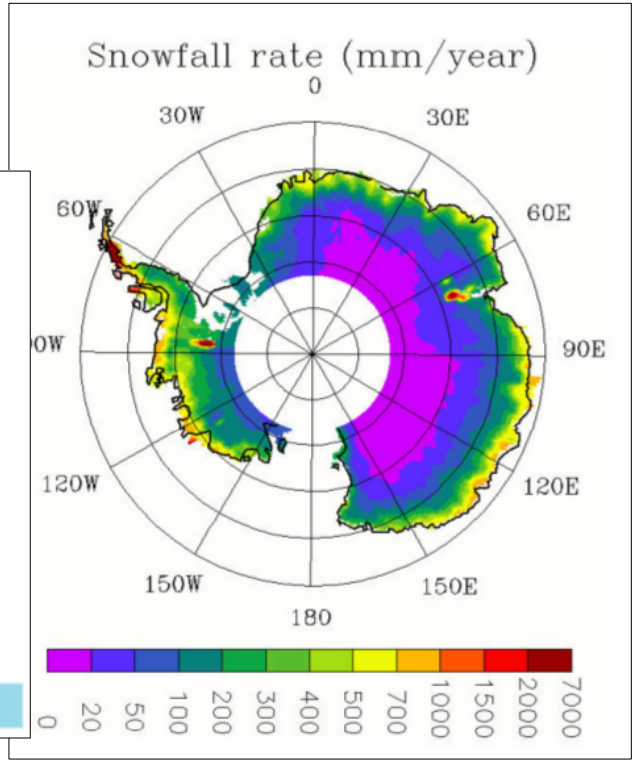


Frame 5/5
Infrared composite

Introduction : CloudSat

- Earth observation satellite belonging to the A-train (NASA).
- Meteorological radar :
  - Clouds and precipitation observations.
  - Altitude limit for observation : ~ 1,2km.
  - 94 GHz frequency.
- Uncertainties : **from 50 up to 175%** *[Wood, 2011]*

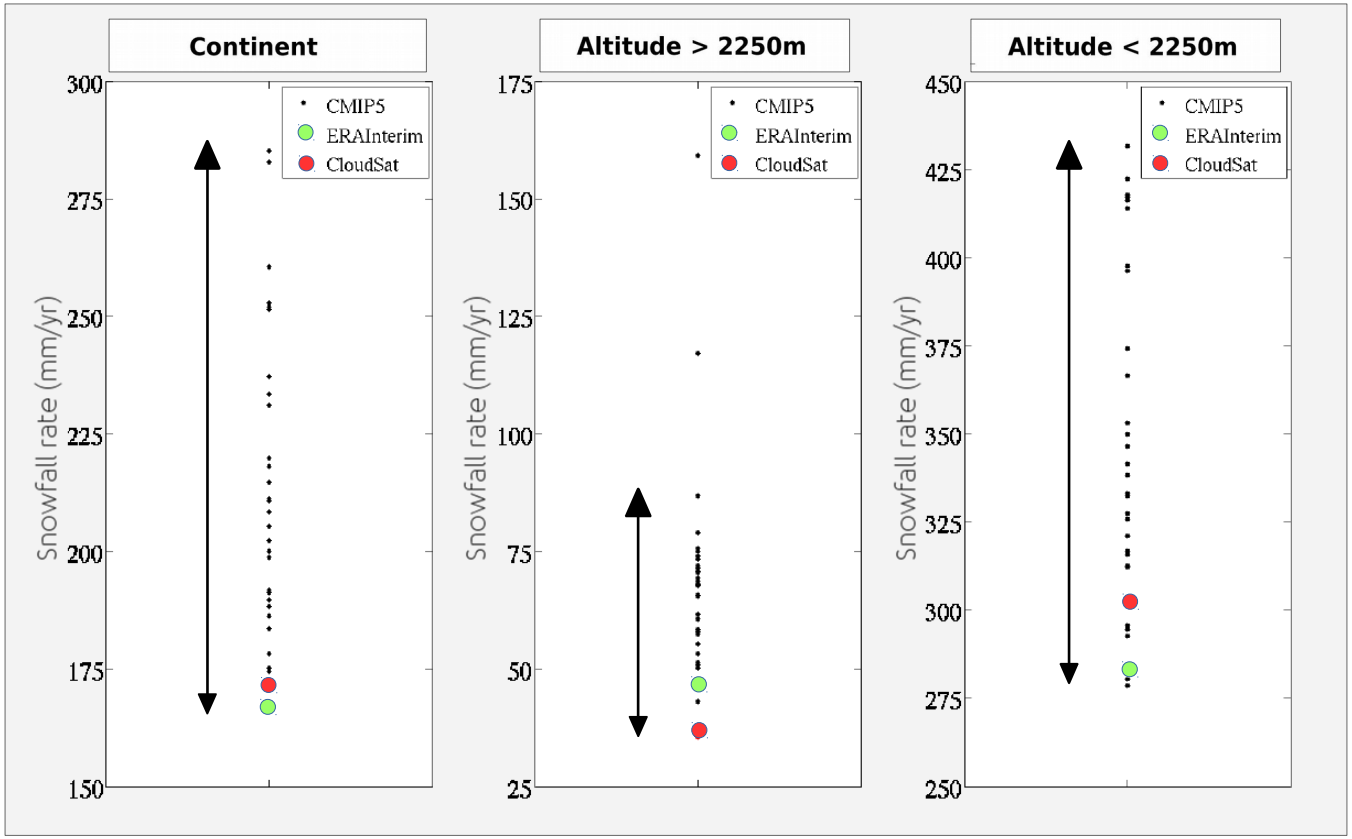




Haynes et al., 2009
Palerme et al., 2014

Introduction : Antarctica

- Precipitation prediction still remains doubtful.
- CMIP5 model are ranging snowfall rate from 160 mm/yr up to 300 mm/yr.



General questions

- Geographical and seasonal distribution of precipitation ?
- Processes controlling snowfall ?

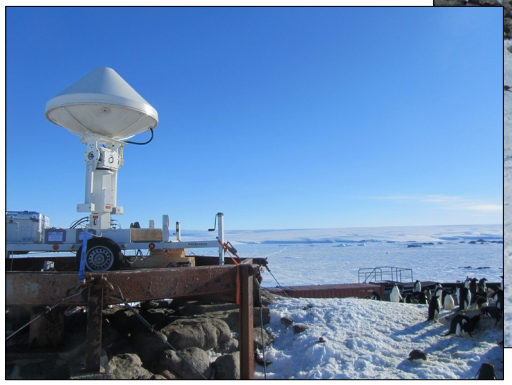
The APRES3 project

- **A**ntarctic **P**recipitation, **Re**mote **S**ensing from **S**urface and **S**pace project from the National Research Agency.
- France-Switzerland collaboration.
- **Goal** : Improve Antarctic precipitation.

APRES3

The APRES3 project

- Two phases :
  - Snowfall observations.
    → Field campaigns and remote sensing observations.
  - Polar climate modeling.
    → With a global climate model (LMDz) and a mesoscale model.



The APRES3 project

- Micro-Rain radars (**MRR**) to observe precipitation.
  → Vertically profiling radar.
  → Resolution : 100 m (from 300 until 3000 m high).

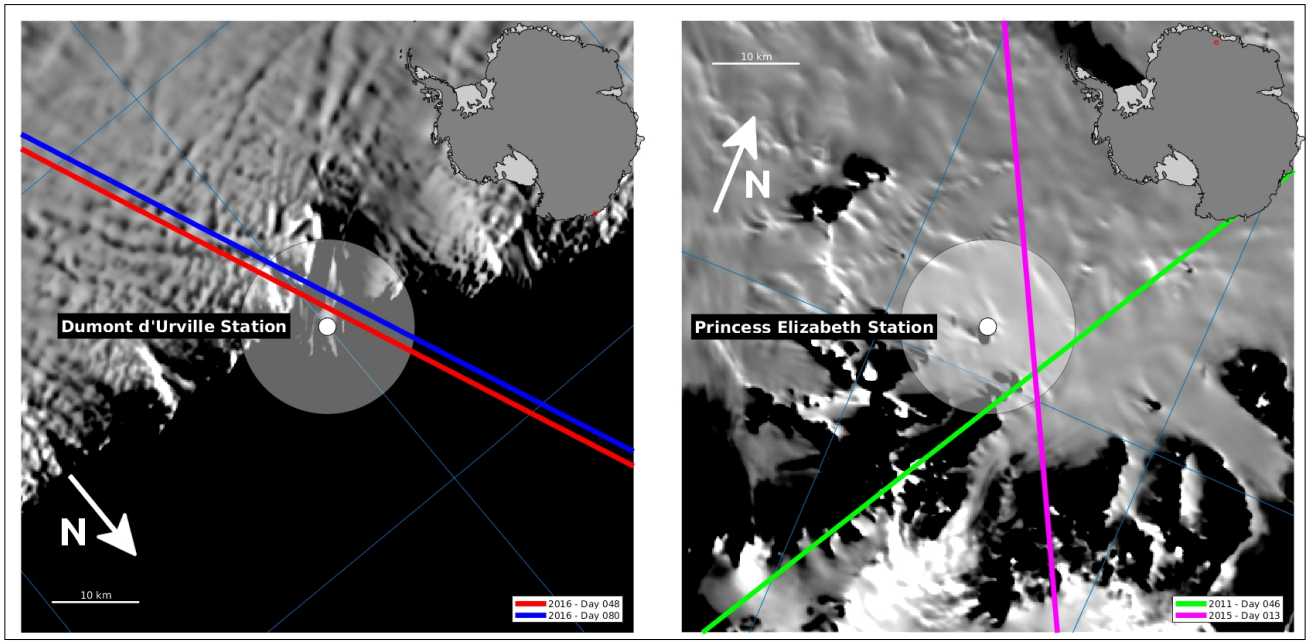
- Conversion of radar reflectivity into snowfall rate by Ze/Sr relation :
  - At Dumont d'Urville : 95% confidence (Grazioli et al., 2017).
  - Additional data at Princess Elizabeth : 40% confidence (Souverijns et al., 2017).

Outstanding questions

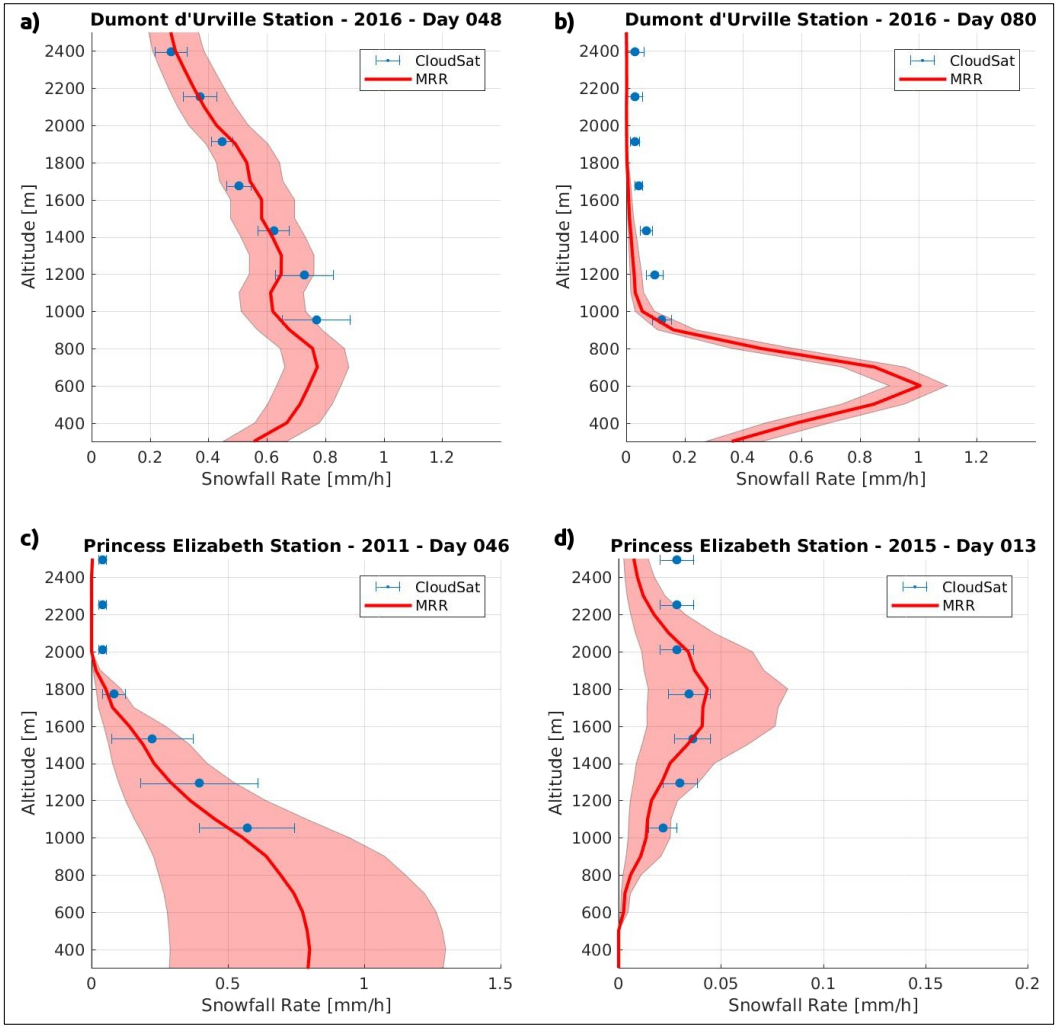
- Agreement between in-situ data and CloudSat data ?

Events and data selection

- 4 precipitation events, 2 per station.
- CloudSat data passing through a 10 km – radius around stations.
  - About 20 profiles per track.

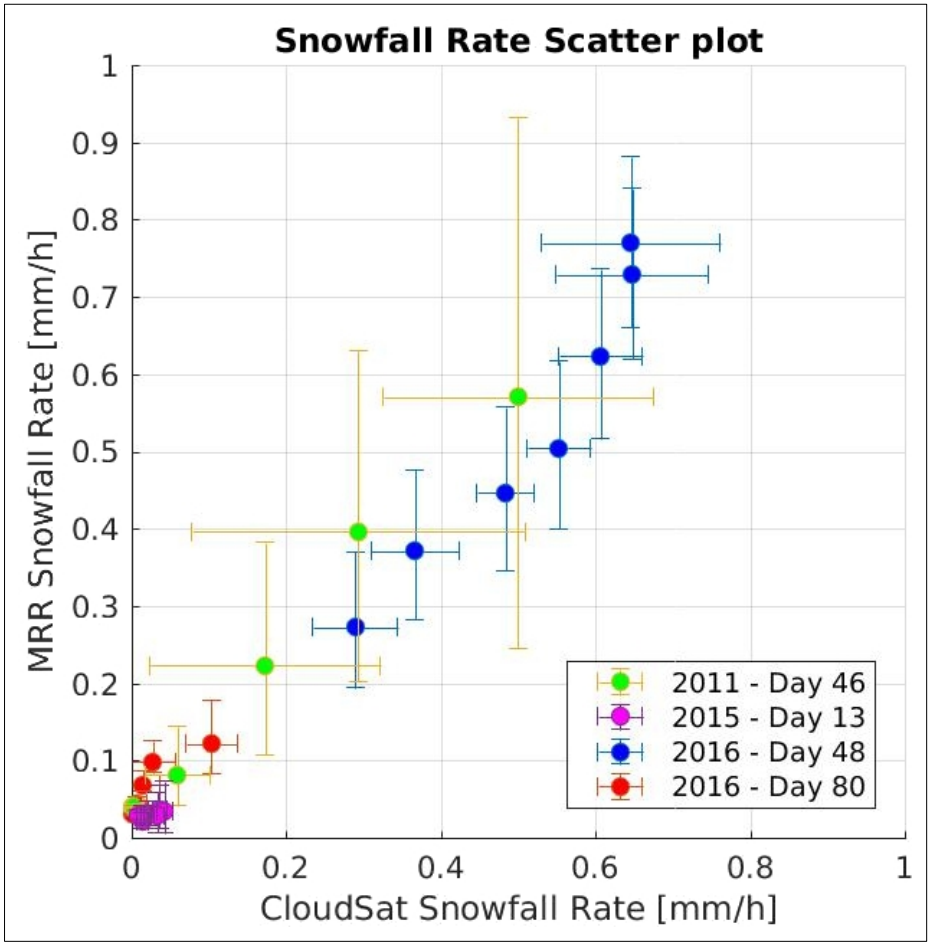


Precipitation profiles comparison



- Cases **a** & **c** : good agreement.
- Cases **b** & **d** : Snowfall rate too weak.

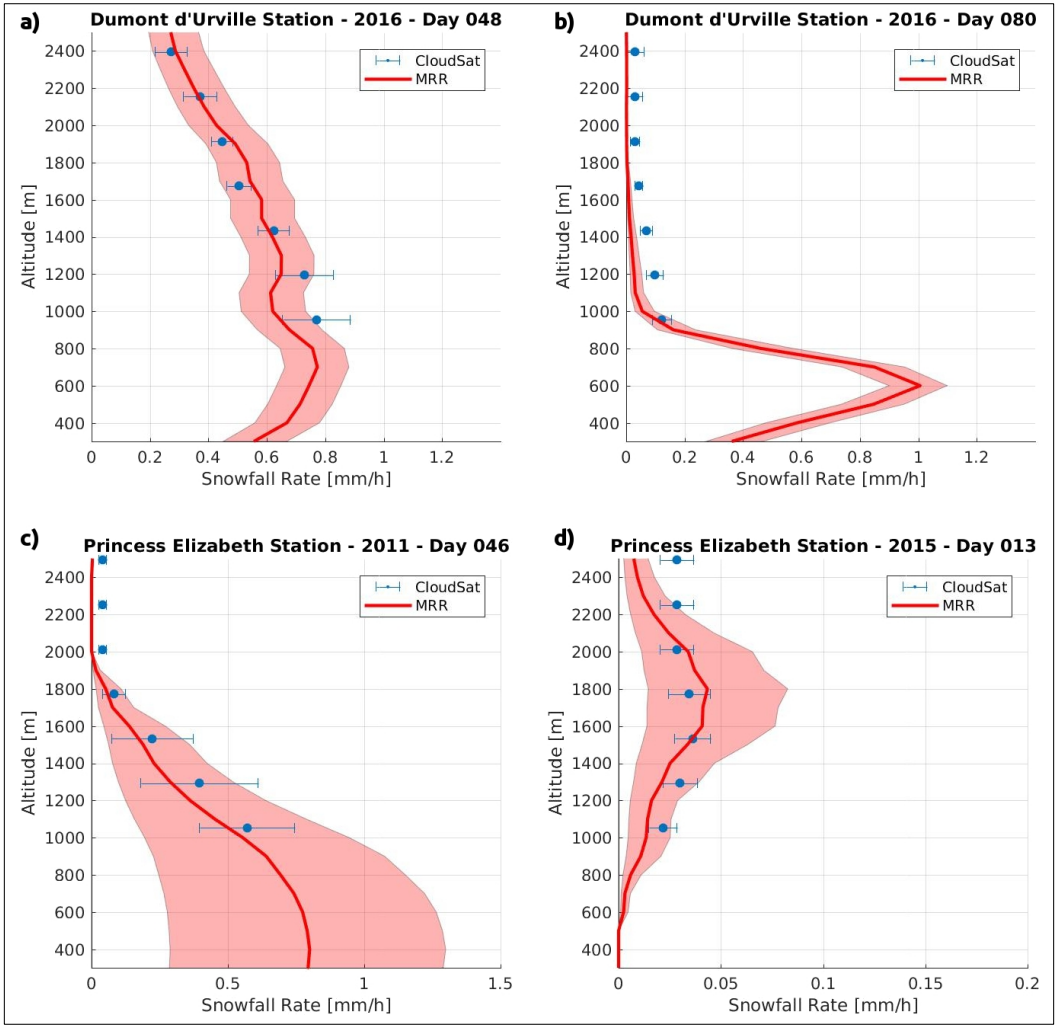
Precipitation profiles comparison



- Correlation coefficient of 99,41 %.
- Reassessment of uncertainties by calculating CloudSat deviation from MRR :

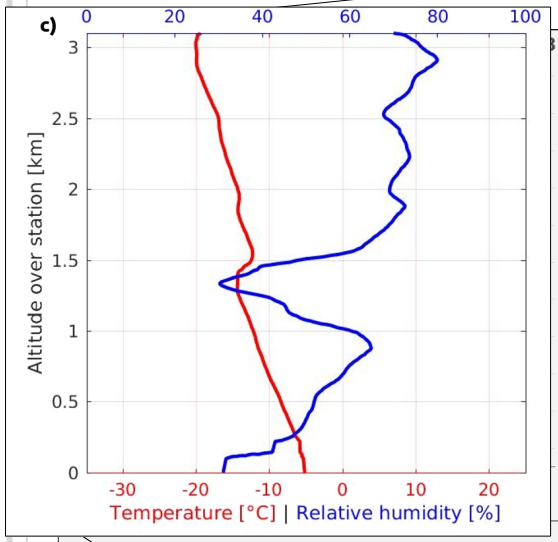
→ [-21,20% ; +25,43%]

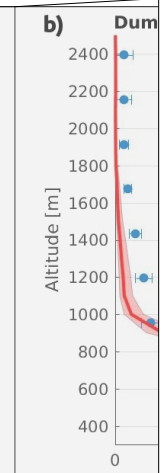
Precipitation profiles comparison

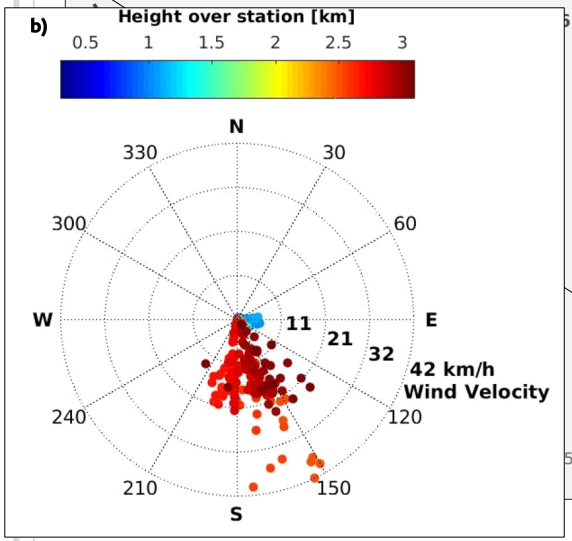


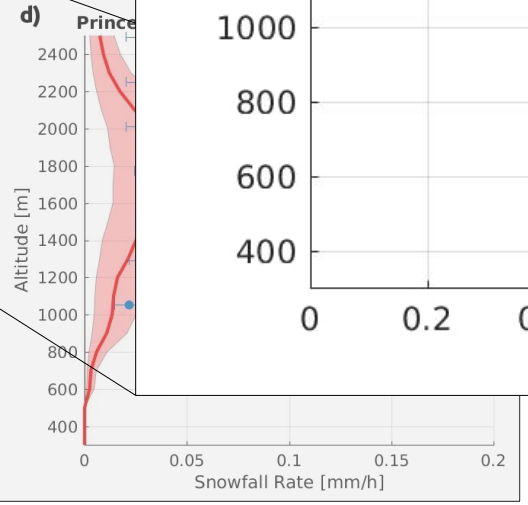
- Cases **a** & **c** : good agreement.
- Cases **b** & **d** : Snowfall rate too weak.

Precipitation profiles comparison







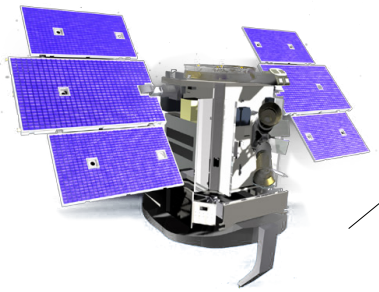


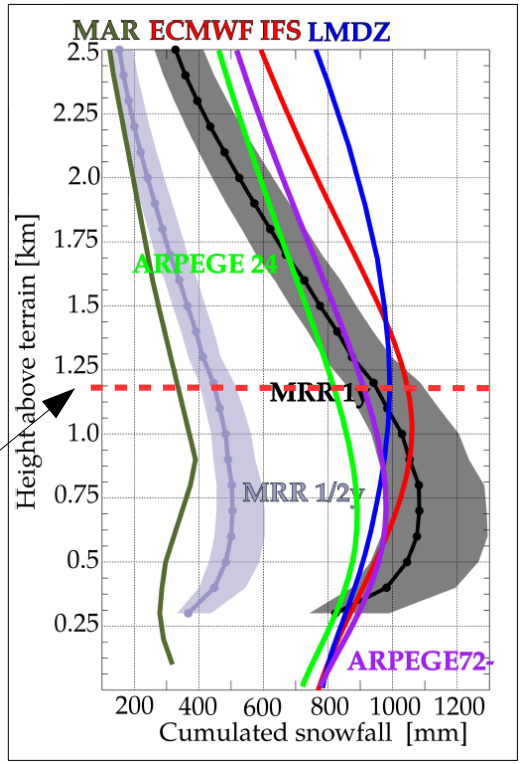
Conclusion.

➞ Snow sublimation processes were observed for the first time in Antarctica.

➞ We must not compare CloudSat with surface observations and surface CMIP6 simulations.

➞ We can trust observed precipitation by using CloudSat.

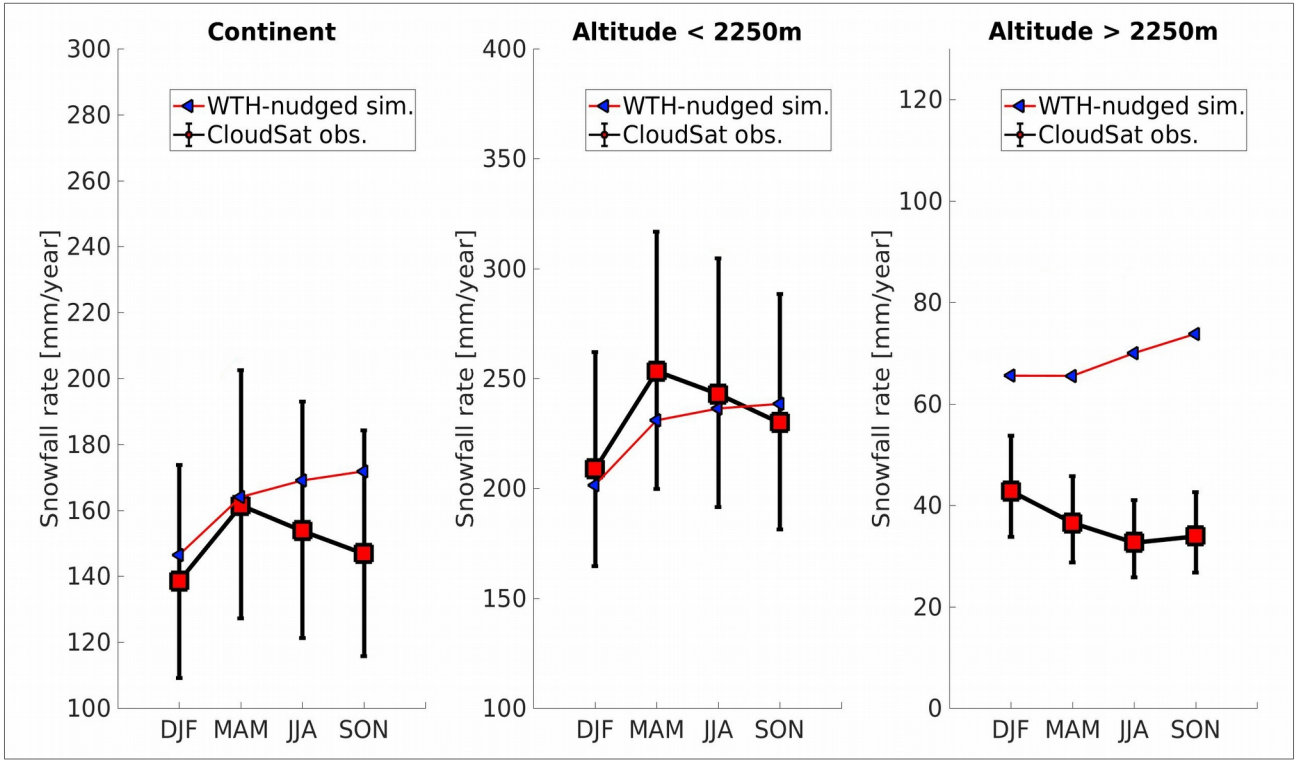




[Grazioli et al., 2017]

Outlooks.

➔ Geographical and seasonal distribution of precipitation ?



(Please visit my poster "Precipitation in Antarctica : comparison between Cloudsat observations and the LMDz global climate model.")