

# Precipitation in Antarctica : a comparison between Cloudsat observations and the LMDz General Circulation Model.

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## Summary.

APRES3 project (Antarctic Precipitation, Remote Sensing from Surface and Space) aims to document and understand current precipitation over the Antarctic ice sheet, knowing that current climate models tend to overestimate the snowfall rate values. Remote sensing observations using CloudSat radar [Palerme et al., 2014] give an estimation of the snowfall of 153 mm/yr whereas the LMDz model gives a higher rate of 160 mm/yr.

A comparison between radar observations and solid precipitation modeled by LMDz brings a better understanding of the climate processes over the ice cap.

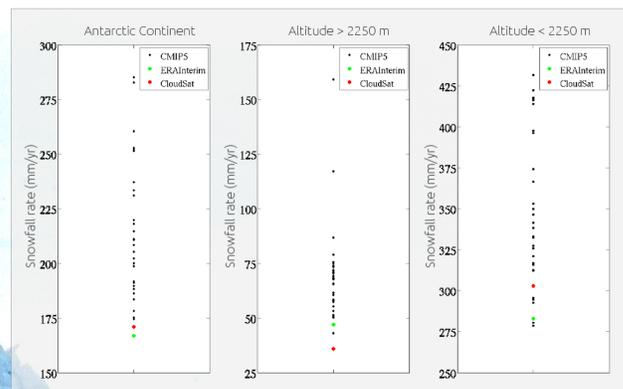


Fig. 1 – Averaged snowfall rates simulated by CMIP models (black), ERA-I on the 1999-2008 period (green) and CloudSat data on the 2007-2010 period (red). All the rates are adjusted to CloudSat observed area (lat < 82°S). [Palerme et al., 2014; Palerme et al., 2016]

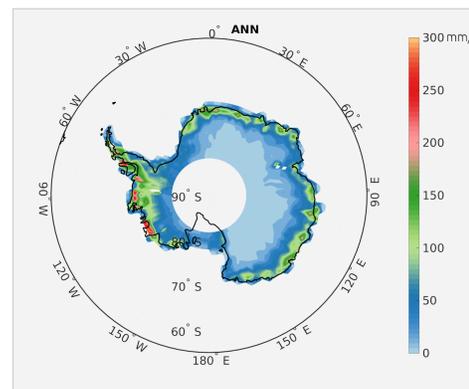


Fig. 2 – Annual snowfall rate obtained by CloudSat radar averaged over the 2007-2010 period. Missing pixels correspond to aberrant values and have been removed.

## Methods.

Palerme et al., 2014 proposed a comparison of the snowfall rate between several climate models and CloudSat radar observations to constrain precipitation rate over Antarctica, however precipitation mostly remains unknown. In LMDz simulation, there is a significant over-estimation of the annual mean snowfall rate and a wrong seasonal variability over the high continental plateau.

### → What is the origin of the differences between LMDz model and data ?

We used LMDz simulations in free and nudged configurations where sea surface temperature and sea ice are prescribed. We compared these simulations to CloudSat radar observations over the whole continent. The satellite blind layer top for observation is fixed at 1,2 km so we selected the same vertical model level to compare the LMDz simulations with data.

## References & Contacts.

Palerme et al., 2014. How much snow falls on the Antarctic ice sheet?. The Cryosphere, 8(4), 1577-1587.  
 Palerme et al., 2016. Evaluation of current and projected Antarctic precipitation in CMIP5 models. Clim. Dynam, 1-15.  
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→ More on <http://apres3.osug.fr>

## Results.

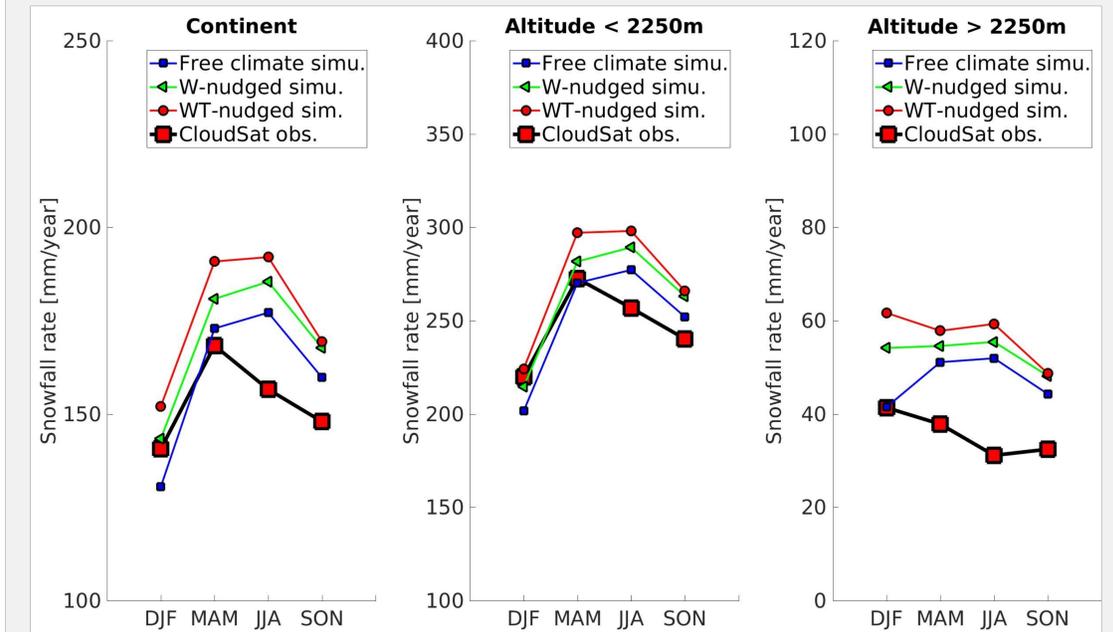


Fig. 3 – Comparisons between LMDz and CloudSat data

### Two simulated seasonal evolutions :

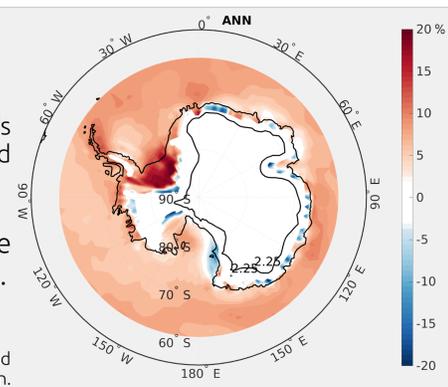
- Free climate simulation (blue) shows coastal precipitation in **good agreement** with the observations and a **wrong seasonal variability** over the high continental shelf.
- Nudged simulations (Wind in green and Wind/Temperature in red) shows **good seasonal variability** but **over-estimate precipitation**.

## Discussions.

Precipitation over the coasts of Antarctica mostly depends on temperature and humidity advections and cloud microphysics..

- **The model is overly too moist** over the southern ocean even when the dynamics is nudged.
- Major biases are located over the ice-shelves.

Fig. 4 – Relative difference in specific humidity at 850 hPa between LMDz and ERA-I in a wind-nudged simulation.



## Conclusion & Outlook.

Precipitation in nudged simulations shows a good seasonal variability but is overestimated due to a positive bias of specific humidity.

- Study of a humidity-nudged simulation to verify the precipitation rate and the seasonal cycle in the model.
- Precipitation analysis at small scale using stretched grid simulation zoomed model and comparison with new Dumont d'Urville's observations : a full year vertical profile of the snowfall rate.

### Antarctica is :

- Twice the size of Australia.
- 75% of the global fresh water.

### The water budget terms are :

- Snow precipitation and accumulation.
- Glacier calving, runoff.
- Wind erosion and drifting snow.
- Surface condensation and sublimation.