Master research project
2018-2019

Laboratory: Environmental Remote Sensing Laboratory (LTE), EPFL, Lausanne

Title of the research project: Atmospheric circulation patterns associated to precipitation events in Adélie Land, Antarctica

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Nature of the project:
Theory: XX
Numerical modeling: X
Experiments:
Data analysis: XXX
Instrumentation:

Subject:

The Antarctic ice-sheet contains about 90% of the world’s ice. In the context of climate change, monitoring the evolution of this ice reservoir is crucial, especially for assessing the sea-level rise. Precipitation is the major input term in the surface mass balance of the ice-sheet. However, the remoteness of Antarctica and its harsh climate make the in-situ measurement of precipitation difficult. Despite the recent first satellite estimations [Palerme et al 2014], the amount and type of precipitation reaching the Antarctic surface are still poorly known.

In the austral summer 2015-2016, a campaign of intensive observations (APRES3 campaign, http://apres3.osug.fr) took place at the french station Dumont d’Urville, Adélie Land, coastal Antarctica. The observations particularly highlighted two striking results. First, the precipitation type that are falling can vary from dry snow to graupel (highly rimed snow), indicating that supercooled liquid water can be present in the air masses in which precipitation form despite the very low antarctic temperatures. Other visual observations at Dumont d'Urville even report rare occurrences of rainfall! Second, the amount of precipitation reaching the ground strongly depends on the local winds. Indeed, the dry katabatic wind blowing down the coastal slopes of the ice-sheet and particularly fierce in Adélie Land [Wendler et al 1997] can evaporate a significant amount of the falling precipitation in the lowest tens/hundreds meters above the surface.
The aim of the proposed research project is to gain insights into the regional atmospheric circulation during precipitation events and to assess to what extent the amount and type of clouds and precipitation over Adélie Land are governed by the regional dynamics. For this purpose, the student will implement algorithms of detection of the extra-tropical cyclones that transit over the austral ocean and that advect humidity - and responsible for precipitation events - towards the ice-sheet. A second algorithm detecting atmospheric fronts will also be implemented. These algorithms basically consist in seeking for strong gradients and extrema of temperature, pressure and potential vorticity. They will be applied on the recent atmospheric reanalyses ERA5 and on numerical simulations carried out with the climate model Polar-WRF. Once the algorithms are operational, she/he will analyse the time evolution of the motion of the cyclones and fronts in parallel with the observations of wind, temperature, pressure and precipitation at Dumont d'Urville. This will make it possible to decipher the complex relationships between regional atmospheric dynamics and precipitation in this remote and extreme region of the globe.

Rain event at Dumont d'Urville station, courtesy of B. Jourdain

Suggested literature:


