Master research project  
2018-2019

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

Title of the research project: Observation and simulation of snow walls in Adélie Land, Antarctica

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Nature of the project:

Theory: X
Numerical modeling: X
Experiments: 
Data analysis: XXX
Instrumentation:

Subject:

The Antarctic near-surface winds are among the strongest near-surface winds on Earth. Over the long icy slopes of the ice sheet, continuous surface cooling forces fierce and very constant downslope gravity winds – so-called “katabatic winds” - especially over the steepest (near-coastal) parts of the ice sheet. These winds frequently transport drifting or blowing snow and they exert a strong control on the atmospheric circulation in the Southern hemisphere and on the production of sea-ice. When reaching the ocean or the sea-ice, the continental air piles up generating a pool of cold air responsible for a pressure gradient force opposing the katabatic wind. This phenomenon leads to a strong increase in the depth of the katabatic layer and to a sharp decrease in the speed of the wind. This type of event can be interpreted as a hydraulic jump - so-called Loewe’s phenomenon - and is particularly intense when the large scale wind is weak or when a sea-breeze opposes the katabatic flow. In the narrow region of flow regime transition, the blowing snow is vertically transported by large turbulent eddies resulting in a “wall” of snow whose height can exceed 1km. Although a few studies used numerical simulations to analyse the dynamics of katabatic jumps, the climatology of these events and the characterization of their vertical structure remains unknown.

Since the austral summer 2015-2016, ground-based remote sensing observations of the atmosphere have been made at the french antarctic station Dumont d’Urville, Adélie Land, coastal...
Antarctica (APRES3 campaign, http://apres3.osug.fr). In particular, a radar and a lidar were deployed and they were shown to capture some snow-wall events.

The aim of this project is to gain insight into the dynamics of the katabatic jumps and associated snow-walls making use of radar and lidar measurements as well as numerical simulations with the meso-scale model Polar-WRF. The student will first make a climatology of snow walls at Dumont d’Urville station using in-situ observations by meteorologists and radar/lidar data. Then the student will focus on two particular cases and study their dynamics using in-situ observations of wind, temperature, pressure and blowing snow as well as radar and lidar measurements and numerical simulations. If time permits, the third part of the internship could consist in using radar data to retrieve some physical information like the snow content and/or the turbulent energy associated to vertical air motions. This will be critical to evaluate the ability of the numerical model to reproduce these very extreme events.

Suggested literature:

* Renfrew, I. A. The dynamics of idealized katabatic flow over a moderate slope and ice shelf. Q. J. R. Meteorol. Soc., 130, 1023–1045

This is not a cloud but a wall of blowing snow at Dumont d’Urville station, credits: François Mariotti, http://terreadelie-antarctique.blogspot.com/2017/08/un-record-de-vent.html