Snowdrift and blowing snow in East Antarctica:
Preliminary observations towards modelisation in COSMO-CLM

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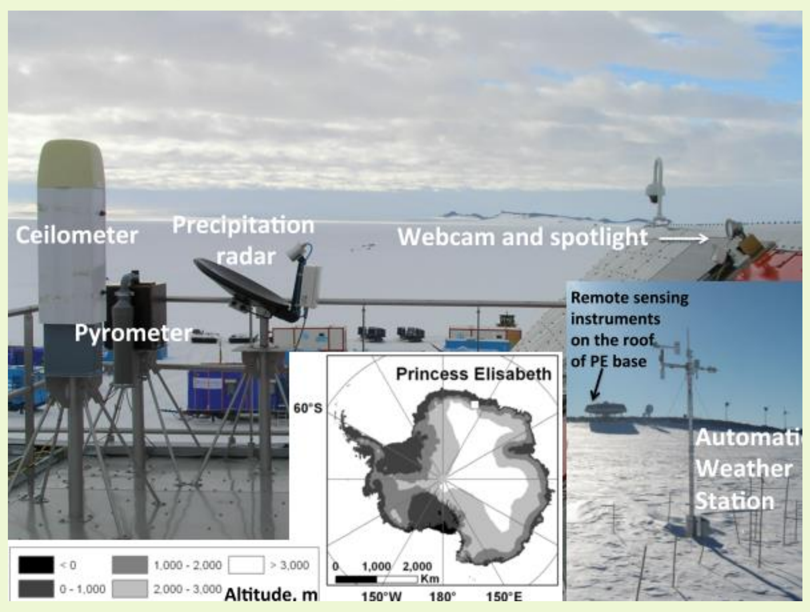
1. STORY OF THE PROJECT

- **Sea level rise : the importance of the Antarctic ice sheet mass balance**
- **Antarctic surface mass balance not well constrained : scarcity of observations and challenges of regional climate modeling**
- **Large uncertainty on the contribution of drifting/blowing snow events on surface mass balance: relocation of snow (accumulation or erosion) and drifting snow sublimation**
- **Challenges of their representation in climate modeling**

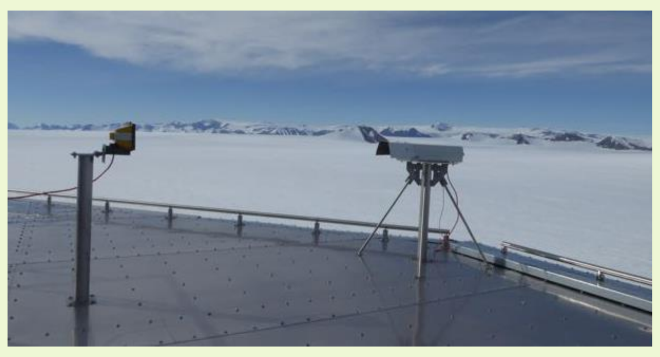
2. THE INSTRUMENTS

- **A cloud- precipitation observatory has been set up on the roof of the Belgian Princess Elisabeth station, located in East Antarctica (72° South, 23° East, 1380 m asl)**



Fig, 1: The cloud–precipitation meteorological observatory. The picture shows the various instruments (center and right lower inset) The middle inset shows the location of the PE station on the Antarctic ice sheet together with the orography (meters above sea level). The Roi Baudouin ice shelf is located up north of the Station, on the Antarctic coast. (Gorodetskaya et al., 2015)

- **Since 2009, the robust set of instruments delivers ground-based remote sensing data :**
  - **ceilometer: backscatter profiles to detect cloud base heights and top of the drifting snow layers**
  - **micro-rain radar: snowfall rates**
  - **pyrometer : cloud base temperature profiles**
  - **automatic weather station: the near-surface air temperature, wind speed and direction, relative humidity with respect to ice, atmospheric surface pressure and broadband radiative fluxes (in- and outgoing short and longwave radiative fluxes) as well as snow temperatures at various depths and snow height changes**
  - **webcam and its spotlight to monitor the instruments**
- **A snowflake video imager was installed during the 2015-2016 summer campaign and gives information about particles size distribution, fall speed and precipitation rates.**



Fig, 2: The snowflake video imager: camera pointing towards a halogen lamp

3. CASES OF BLOWING/DRIFTING SNOW DETECTION

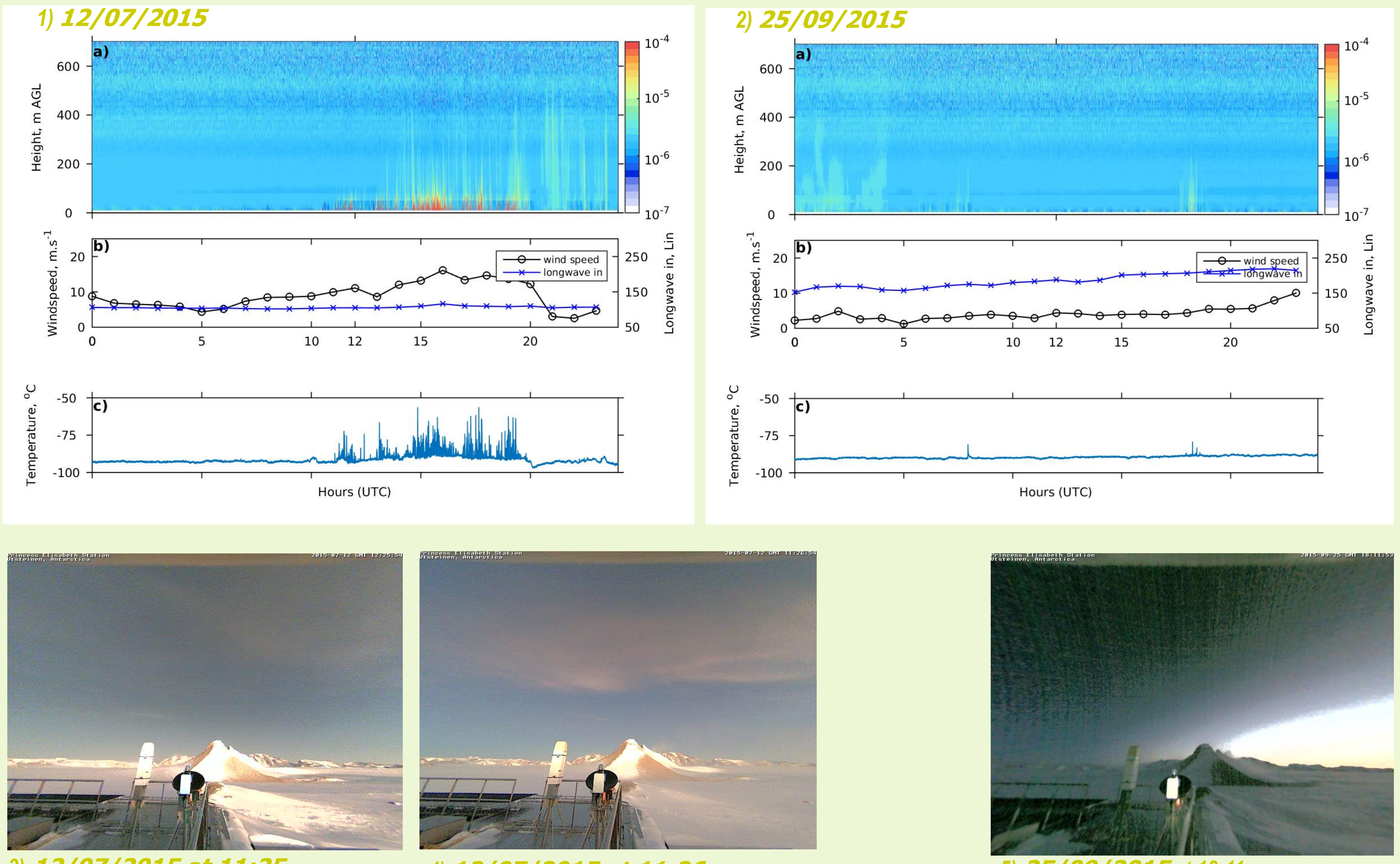
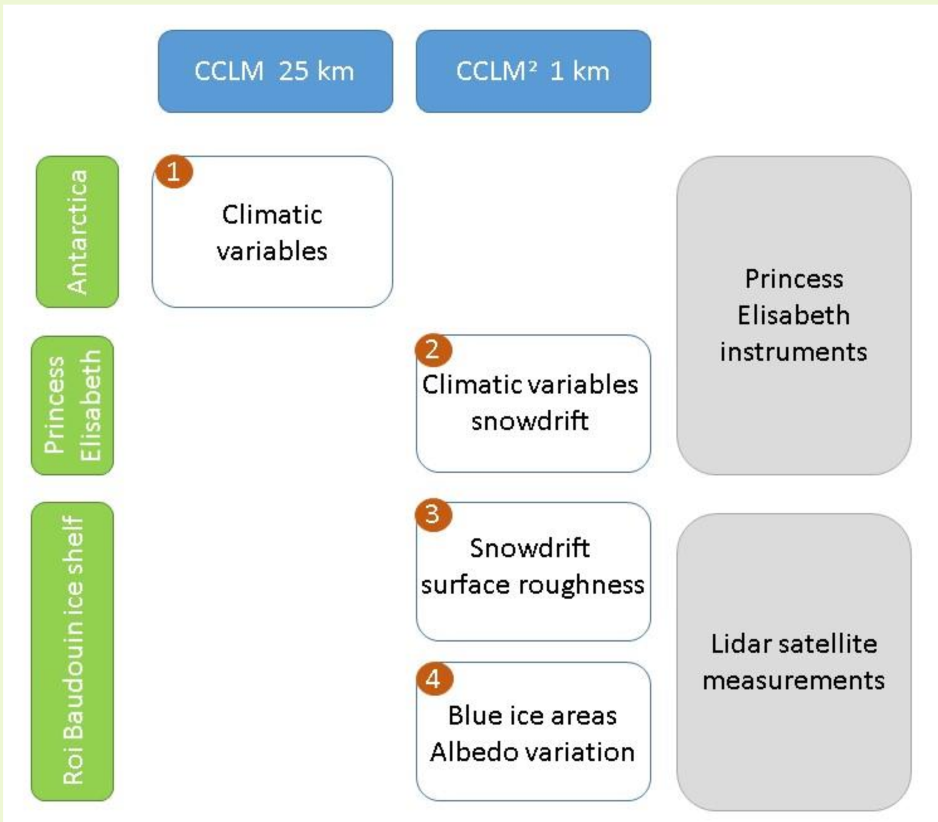


Fig.3: 1) and 2) drifting snow cases from 12/07/2015 and 25/09/2015.
Daily plot for the different instruments:
a) ceilometer attenuated backscatter profile (10-4.km^{-1} sr^{-1})
b) windspeed (m.s^{-1}) and incoming longwave (W. m^{-2})
c) cloud base temperature profile (°C)
3), 4) and 5) webcam images corresponding to the events

The ceilometer attenuated backscatter profiles (910nm) permits to detect clear-sky blowing snow events :
- **if the backscatter profile decreases from the ground upwards**
- **in the absence of clouds and precipitations**
- **increase in windspeed (above 4m.s^{-1}) and variations in the pyrometer profile can support these observations, as well as webcam images**

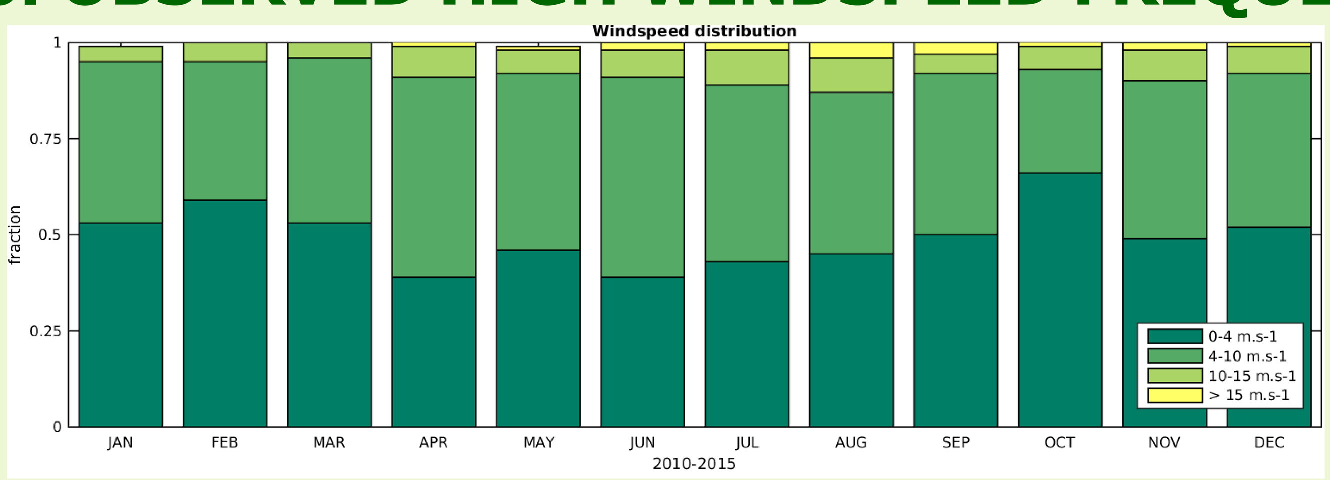
4. WHAT ABOUT COSMO?

- **Use the observations to tune the model at 1 km resolution, nested in the 12 km-run over the whole continent**
- **Test the ability to reproduce blowing snow conditions and blowing snow events**
- **Implementation of blowing snow in CCLM²**
- **Evaluate surface roughness and albedo changes**



Fig, 3: steps (1-4) to evaluate the performance of CCLM over Antarctica and CCLM² for snowdrift processes and related climatic variables (indicated in the white boxes) The model runs are represented in blue at the top, the domain is indicated in the left green boxes. The tools used for the evaluation are in the grey boxes on the left,

5. OBSERVED HIGH WINDSPEED FREQUENCY



- **Main trigger of blowing snow, together with surface topography and fresh snow availability**
- **Basic comparison to model performance possible**

Fig. 4 : monthly distribution of the frequency of different windspeed categories (in m.s^{-1}). Global values for the 2010-2015 period.

6. NEXT STEPS TO BE TAKEN:

- **Routine to robustly detect blowing snow events**
- **Run the model over Princess Elisabeth and assess the performance of the model regarding blowing snow events representation**
- **Tuning based on test cases of days to weeks**
- **Longer run for 2 to 3 years (when measurements are available during the 2010-2015 period) and statistical comparison will be performed**

• References

Gorodetskaya I.V., S. Kneifel , M. Maahn, K. Van Tricht, W. Thiery, J.H.Schween, A. Mangold, S. Crewell, and N.P.M. van Lipzig (2015), Cloud and precipitations properties from ground-based remote sensing instruments in East Antarctica, The Cryosphere, 9, 285 - 304,

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