Characterization of Wind Channeling Around Longyearbyen, Svalbard

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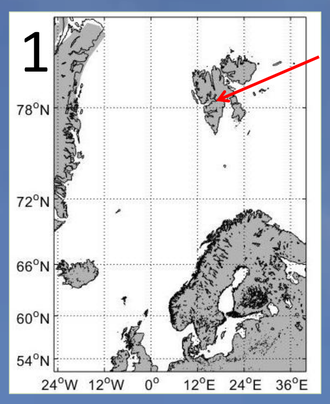


Study area

Svalbard (*Fig. 1*) is an archipelago located in the high Arctic and Longyearbyen is the main settlement there. It is closer to the north pole (1300 km) than to Oslo (2000 km). Longyearbyen lies in a valley, Longyeardalen (*Fig. 2*), which ends in a fjord and is surrounded by plateaus high up to 500 m.

2

View on Longyeardalen. Landmarks indicate the weather stations: Airport (*out of sight, blue arrow*), Longyeardalen (*red triangle*) and Gruvefjellet (*green triangle*). The topography of the area is illustrated in the corner.

Aim of the research

Despite its importance in the region, relatively little meteorological research has specifically addressed the valley Longyeardalen, where the wind conditions heavily influence the onset of dangerous snow avalanches. The weather station that represents Longyearbyen area in the weather model AROME Arctic is located in another valley, Adventdalen. Hence, the data from this site could differ from the conditions in Longyeardalen due to wind channeling effects caused by the shape of the valleys, which are almost perpendicular to each other.

Which types of wind channeling are going on in the two valleys? Can the station at the airport represent the conditions of Longyeardalen?

Methods

A weather station (*Fig. 3*) was deployed in Longyeardalen and its data were compared with other two stations: the official station at the airport, in Adventdalen, and a station located on top of the plateau Gruvefjellet. Data from Gruvefjellet was used to keep track of the conditions aloft, due to the privileged position of this site, while the other two stations were representing the valleys. The field campaign lasted for 41 days, from March 1st to April 10th 2018. The data was then analyzed with statistical tools (linear correlation, RMSE) using MATLAB.

3

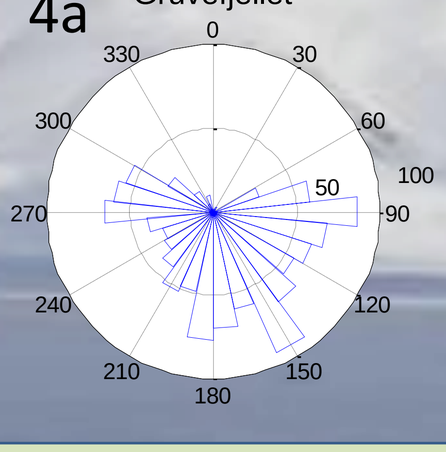
Results

Rose plots display all the wind direction values recorded by the three stations during the field campaign. It can be seen that Gruvefjellet (*Fig. 4a*) has a good variability while Longyeardalen (*Fig. 4b*) and the airport (*Fig. 4c*) have rather stable values, with Longyeardalen having southerly winds and the other station having easterlies.

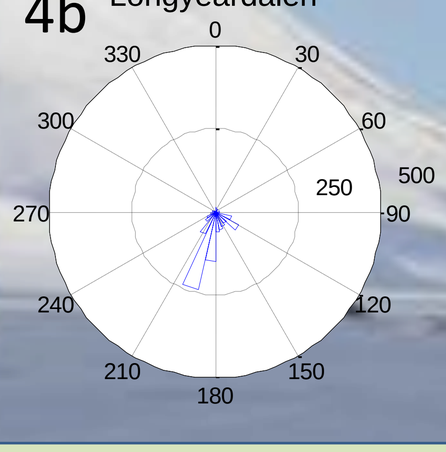
Temperature trends (*not shown*) are similar, despite Gruvefjellet is constantly colder. Such difference is largely caused by the difference in altitude (which is about 400 m), as the potential temperature is found to be similar.

Wind speed (*not shown*) has a lot of variability, which is connected to the different synoptic scenarios. Longyeardalen measurements are systematically lower than the others, meaning that while the wind blows at the airport with the same intensity as aloft, in this valley it gets slowed down or it has a completely different source.

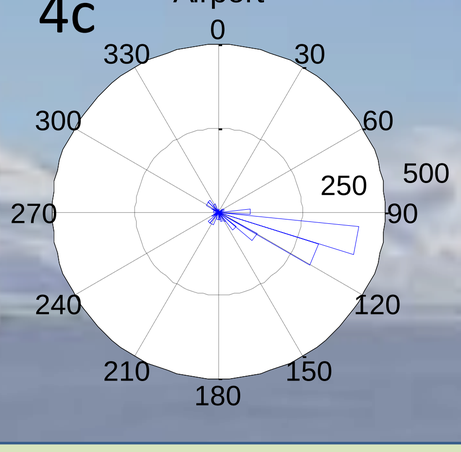
4a Gruvefjellet



4b Longyeardalen



4c Airport



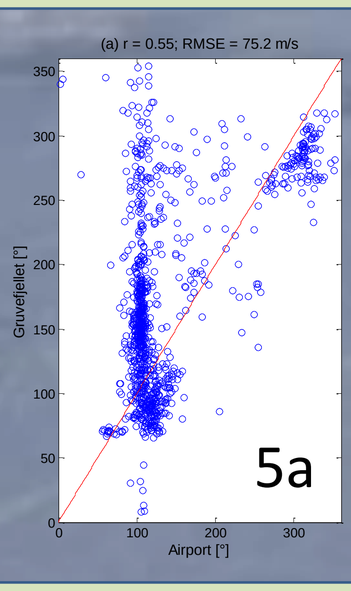
Discussion: Types of channeling

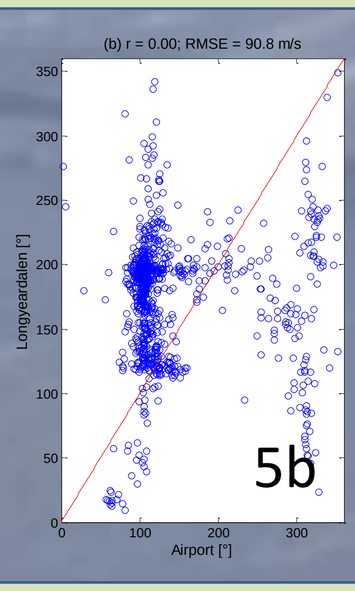
41 case studies of 24h each were used to assess the prevailing wind channeling phenomena and fill a table (*shown on the right*). In Longyeardalen the prevailing phenomenon is the thermal circulation (46%), while downwards momentum transport (44%) plays an important role as well. Thermal circulation is caused by temperature differences at the two sides of the valleys, which happen to be a cold glacier and warm fjord. The other phenomenon instead is the extension of the conditions aloft down inside the valleys, hence winning the topographic barrier. In order for that to happen, the atmosphere has to be locally unstable. At the airport, forced and pressure driven channeling prevail (80%). It means that the wind aloft, which often has at least an easterly component, is forced by the topography to follow the valley walls.

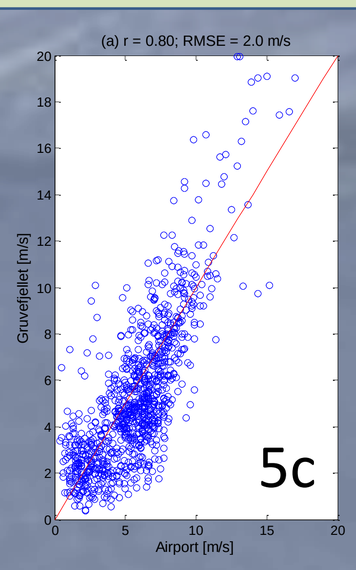
	Therm. [%]	Downw. mom. [%]	Pres./For . [%]
Longyeardalen	46	44	10
Airport	20	0	80

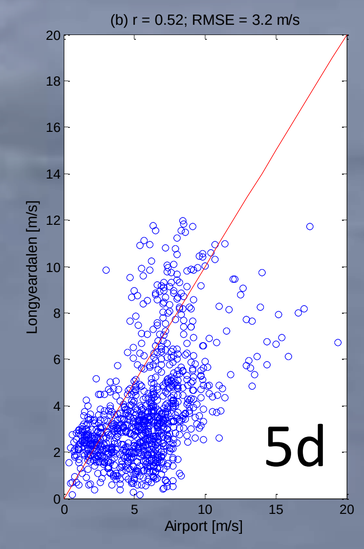
Discussion: Airport data representativity

Temperature data are in good agreement with both the sites (*not shown*). Wind direction is quite off: no matter the conditions aloft, the airport reports easterly winds, or northerly if the forcing is from north (*5a*). The comparison with Longyeardalen scores a correlation of zero (*5b*). Wind speed has a good correlation when the airport and Gruvefjellet are compared (*5c*). Longyeardalen instead has a poor correlation and weaker winds (*5d*).









Conclusion

Different types of channeling occur in the two valleys, causing the wind conditions at the airport and in Longyeardalen to be different. Hence, the station at the airport cannot represent Longyeardalen, as the wind direction is constantly along the valley axis in both the sites, with lower wind speed in Longyeardalen.

This poster is based on the thesis *"Characterization of Wind Channeling Around Longyearbyen, Svalbard"* by Michael Lonardi.
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