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The structure of the lower ABL over antarctic oasis during the summer

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Abstract. The vertical Doppler sodar has been operated during summer 2006-2007 at the Russian Antarctic station Novolazarevskaya at Schirmacher oasis. The typical structures of the ABL over the oasis are classified. Sodar echogrammes reveal wavy structures in the ABL, caused by local orography.

1. Introduction

The single-antenna version of LATAN-3M sodar has been operated during summer 2006-2007 at the Russian station Novolazarevskaya. The station is located 80 km apart from the coast between continental and shelf glaciers at Schirmacher oasis. The structure of the atmospheric boundary layer over the oasis has been studied with a non-Doppler sodar for several years at the Indian antarctic station Maitri [1, 2, 5] which is located about four kilometers to the wet from the Russian station.

In this paper several results of the ABL structure studies with the Doppler mini-sodar are presented.

2. Measuring site and equipment

The Novolazarevskaya station is located at 70°46′S 11°58′E at Schirmacher oasis in Queen Maud land in Antarctica. The oasis is a rocky terrain between the the edge of the Polar cap ice and the ice shelf. The most part of the oasis is elevated over the shelf ice by 50-100 meters.

The sodar has a single 60cm parabolic dish antenna. It was installed close to the glacier slope (Fig. 1). The sodar have been operated with frequency-coded sounding pulse (8 50ms pulses at frequencies 3.32, 3.46, 3.58, 3.66, 3.76, 3.9, 4.02 and 4.13 kHz) with 10m vertical resolution, acoustic power 1W and pulse repetition period 5 seconds. The details on the signal processing can be found in [4]. The data of the automatic weather station have been used in this study as well.

3. Summertime boundary layer structure over Schirmacher oasis

During the summer time the states of the ABL over the Schirmacher oasis can be divided into four classes. The echogrammes and vertical velocity charts for these classes are shown in Fig. 2. The range-corrected echo intensity in dB is plotted in time-height coordinates. Corresponding values of the vertical velocity component are shown with small strokes with black for updrafts

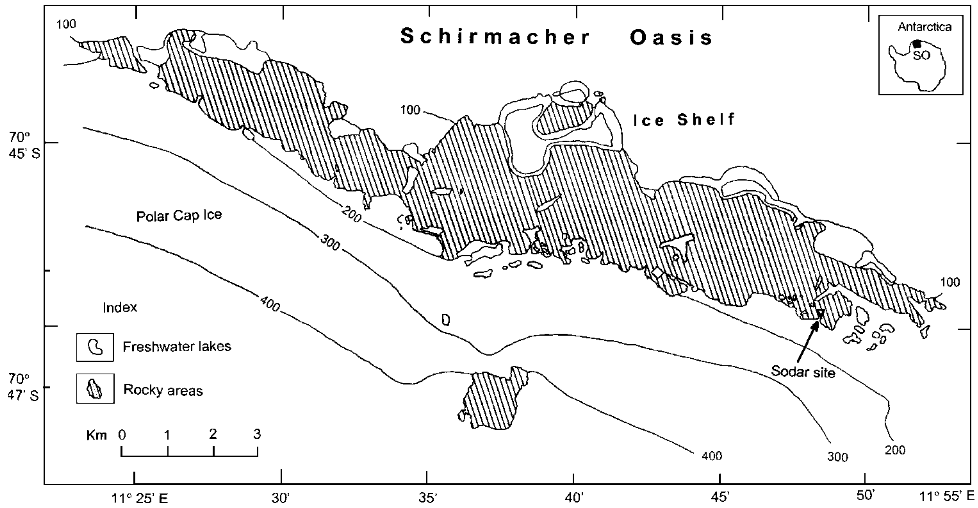

Figure 1. The Schirmacher oasis (adapted from [3])

and grey for downdrafts. The length of a stroke corresponds to the instantaneous value of vertical velocity. These classes can be clearly identified by the data of weather station as well.

The strongest summertime winds (∼ 10..20m/s) have south-eastern direction. This is the direction of very strong wintertime winds associated with the polar vortex. These winds are usually accompanied by cloudy weather. They form the least favourable conditions for the sodar operation due to the thermal homogeneity of the ABL and wind noise which clearely appears at the upper part of the echogramme (Fig. 2a). The turbulence in the ABL is purely shear-driven and no visible structures appear in vertical velocity chart. The state of the ABL under such conditions indicate no pronounced diurnal cycle.

At the calm weather daytime a strong convection develops over the oasis(Fig. 2b). The sodar echogramme clearly identifies the thermals associated with updrafts. The dry air causes the strong attenuation of sound at sodar frequencies, thus not much backscattering is seen in between thermals. Note the coming of even more dry air mass at 15:00 that caused the additional decrease of the echo-signal intensity.

At the calm weather night time at weak synoptic winds the strong katabatic winds form at the slope of the continental glacier. These winds can reach up to 10..15m/s. No clear structures appear on the echogrammes under these conditions (Fig. 2c). The vertical wind chart indicates the dominating of the negative vertical velocity. The main difference of the katabatic wind from the synoptic wind is that it exhibits a clear diurnal cycle.

When the humid and warm sea air mass comes from the North the fog forms. This situation is analysed in [3]. The upper boundary of a fog is seen as an elevated layer in the echogramme (Fig. 2d). The waves are formed by the orographic step at the edge of the oasis. The vertical velocity chart clearly indicates the updrafts and downdrafts in the wavy motion. The typical values of the vertical velocities are about 1..1.5m/s, thus the waves observed in the echogramme are propagating rather than advected structures.

4. Conclusion

The sodar has been used to monitor the summertime ABL steructure over the Schirmacher oasis. We identified the four types of weather system: the synoptic wind, the convection, the katabatic wind and the air mass coming from the sea.

The main factor that limited the range of the sodar during our measurements is the attenuation of sound. At 0°C and 35% relative humidity the attenuation at 3.8kHz exceeds 3 dB

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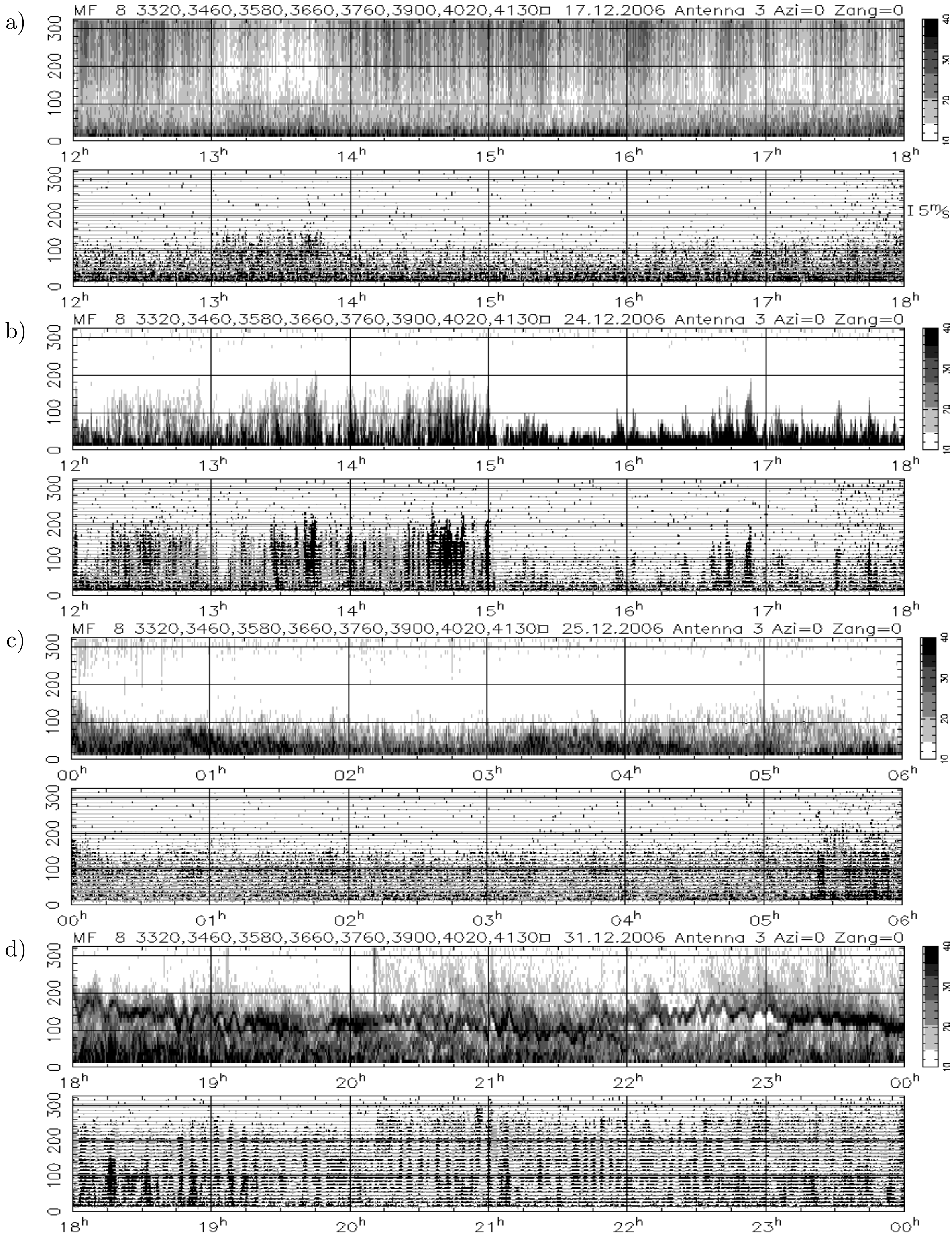

Figure 2. The echogramme and the vertical velocity charts corresponding to four weather types. The heights are in meters a.g.l., the times are GMT. a) strong synoptic wind, b) convection, c) nocturnal katabatic flow, d) humid sea air advection

per 100 meters. In these conditions the use of bigger sodars with lower sounding frequencies is more appropriate and would probably result in a significantly higher data availability.

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