Local wind phenomena at the Waldstein/Weidenbrunnen FLUXNET site

STEPHANIE SCHIER (1), FRANZ X. MEIXNER (2,3), THOMAS FOKEN (1)

(1) University of Bayreuth, Micrometeorology Department, Bayreuth, Germany
(2) Max Planck Institute for Chemistry, Biochemistry Department, Mainz, Germany
(3) University of Zimbabwe, Physics Department, Harare, Zimbabwe

Introduction

The vertical wind profile at the Waldstein/ Weidenbrunnen FLUXNET site (DE-Bay) in the Fichtelgebirge/Germany (see Fig. 1) is influenced by the topography. Local wind phenomena found are nocturnal low-level jets (LLJ) and a strong turn of the wind direction with increasing height. Both events are well known at this site. A secondary circulation over the canopy at midday was newly discovered.

The data for this work were collected in two Intensive Observation Periods (IOP) during the EGER project (ExchanGE processes in mountainous Regions). It focused on the detailed quantification of relevant processes within the soil-vegetation-atmosphere system by observing diurnal and annual cycles of energy, water and trace gases.

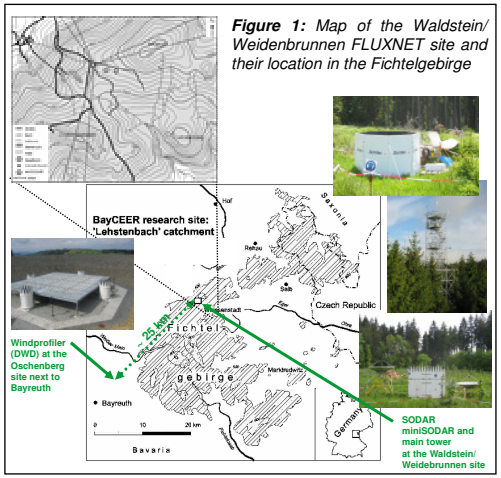

Figure 1: *Map of the Waldstein/ Weidenbrunnen FLUXNET site and their location in the Fichtelgebirge*

IOP1 was conducted from September to October 2007, IOP2 in June and July 2008. The atmospheric boundary layer was profiled with an acoustic and radar remote sensing system (SODAR-RASS) up to 500 m a.g.l. A second SODAR (referred to as miniSODAR) without a RASS-extension was used during IOP2 and provided mean profiles up to 200 m a.g.l. Additionally the data of a 2D Sonic anemometer in 32 m a.g.l. at the main tower and the data from the windprofiler (WPR) at the Oschenberg next to Bayreuth were used (see Fig. 1).

Results

General wind direction

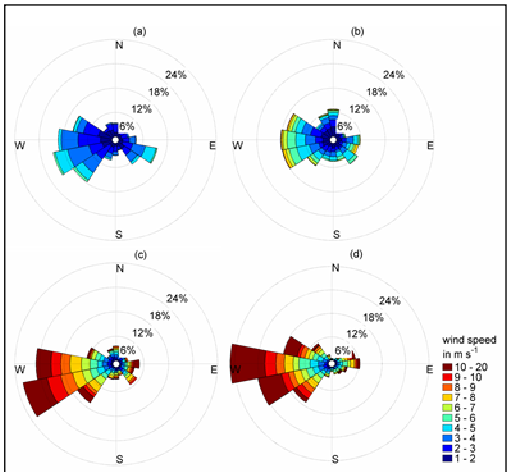

Figure 2: *Wind roses of 30-min means (a) in 32 m (2D Sonic, n = 1937), (b) in 80 m (miniSODAR, n = 1399), (c) in 200 m (SODAR, n = 1408) and (d) in 1050 m (WPR, n = 1717) a.g.l., IOP2. In general the wind reaches the site from the west direction. In 32 m a.g.l. a secondary maximum can be found for the wind from south-easterly directions.*

Wind shear

At night times and during the morning hours the profile of the wind vector often showed a strong turn of the wind direction with increasing height (> 70 °, between 32 and 1050 m a.g.l.). The flows above the canopy came from the east to the south-east direction while the geostrophic wind approached from south-westerly directions (see Fig. 3). This phenomenon was observed during both IOPs independent of the general weather situation except for easterly weather situations. This turn in the wind direction is mostly accompanied by small wind speeds. The topography and resulting canalizing effects are the most likely reasons.

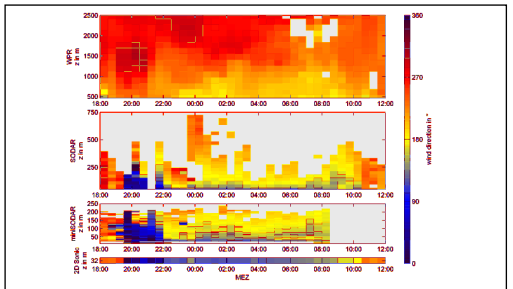

Figure 3: *Time-height cross section of 30-min mean wind direction observed by WPR, SODAR, miniSODAR and 2D Sonic, June 24-25, 2008*

Low-level Jets (LLJ)

During IOP1 in 8 of 19 nights nocturnal LLJs with duration times of several hours were observed. In IOP2 in 11 of 39 nights LLJ-activities were found.

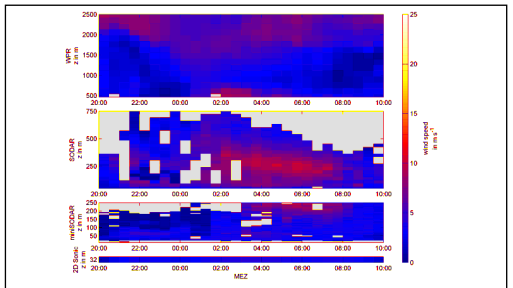

Figure 4: *Time-height cross section of 30-min mean wind speed observed by WPR, SODAR, miniSODAR and 2D Sonic, June/July 30-01, 2008 shows a low-level jet*

Maximum horizontal wind speed (v_{h_max}) was in the range of 8.2 to 13.0 m s^{-1}. The height of v_{h_max} varied between 100 and 400 m a.g.l. A positive relation for the height of v_{h_max} and the jet height was found. Most of the LLJ events in IOP1 were characterized by an approaching flow from south-westerly directions. In IOP2 they were found from south-easterly directions. The direction was found to be dependent on the general weather situation. An example of a LLJ is shown in Fig. 4.

Secondary circulation

In some profiles a stream from the south above the canopy could be observed in a general appearing flow from westerly directions (see Fig. 5). At night times and in the early morning hours advection processes seem to be the reason. At midday secondary circulations due to convection over a big clear cut in the south of the site are possible.

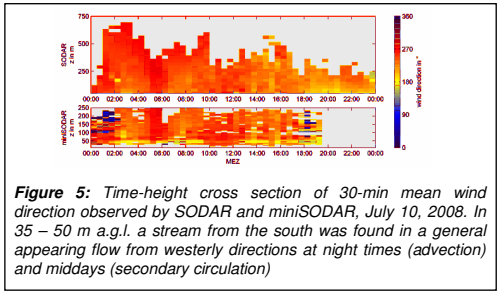

Figure 5: *Time-height cross section of 30-min mean wind direction observed by SODAR and miniSODAR, July 10, 2008. In 35 – 50 m a.g.l. a stream from the south was found in a general appearing flow from westerly directions at night times (advection) and middays (secondary circulation)*

Conclusion

The nighttime shear in the wind direction is understood very well and the appearance of LLJs is in detail described. Regarding to the local circulations above the canopy more experimental investigations are necessary to find their reason and understand the surrounding meteorological circumstances.

Contact: stephanie.schier@uni-bayreuth.de
www.bayceer.uni-bayreuth.de/mm