Introduction

Usual approaches which aim to recognize events in the stably stratified atmospheric boundary layer (ABL) assume certain physical processes and then search for a trace of these in atmospheric time series. However, many events in atmospheric time series result from yet unidentified physical processes. A statistical method was recently developed by Kang et al.1,3 to detect events in noisy time series without assuming any underlying physical processes. We analyzed this method and applied it to the SNOHATS dataset which includes long term measurements of turbulent quantities collected in the stable boundary layer.

Goal:

To separate nonstationary turbulence events from noise in a time series

Main assumption: Background noise is always present in the time series and events are separated by noise.

Details: By using a sliding window with predefined length, subsequences are obtained. The event detection method is applied to each subsequence. The event detection is performed on overlapping sequences rather than on separated blocks. To separate events from noise, three steps are performed on these subsequences. Figure 4 shows the order in which the tests are applied to each subsequence. First the Philip Perron (PP) test is applied to the subsequence and it checks if the subsequence is stationary. If it is stationary, according to the Philip Perron test, the Zivot and Andrews (ZA) test is performed. Otherwise the noise test is performed after the Philip Perron test. Events are defined as those subsequences which are significantly different from pure noise.

Before starting the noise test, the type of noise has to be chosen. Stationary turbulence and red noise can be well represented by an AR(1) process. Hence, we used red noise.

Results

The choice of the time window length, which is directly linked to the length of the possible events, is so far made subjectively and is based on experience and context. This could be solved by using a different method which determines the relevant time scales, before applying the event detection procedure. Another option which was used is a multiscale approach. A multiscale analysis allows a verifiable choice of the scale, if it cannot be determined in a different way. We analyzed submesoscale motions which we defined as motions from 1 to 30 minutes. Figure 5 shows the results of the multiscale approach.

Identification of Non-Stationary Turbulent Events for Different Regimes of Stable Boundary Layer Turbulence

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Description of the Data

The SNOHATS data was collected over the Plaine Morte Glacier in the Swiss Alps in 2006 by the EFLUM laboratory at EPFL. This analysis is based on 3D wind velocity component, temperature and humidity measurements of 4 sonic anemometers (5, 6, 7 and 8) out of 12. We will focus on the wind velocity and temperature dynamics. Figure 0 shows the set up of the sonics. The analysis was based on four times series of 8 hour length that were isolated in a study by Vercauteren and Klein. 4. Time series 2 and 4 are characterized by being very stable while time series 1 and 3 are weakly stable.

Goal:

To check if there is a relation between mean wind speed and wind direction we look at the wind roses for all time series (Figure 6).

The colour shows the wind speed and the length shows the frequency of a wind direction. Based on the wind rose plots we can conclude that in time series 3 and 4 the mean wind is slow while in time series 1 it is faster. The wind direction is more stable in time series 2, and variable in cluster 4 mainly for slow wind events.

Conclusions

- In the two very stable time series there was a higher number of nonstationary events detected which were also longer and the mean wind was slower. Contrary in the weakly stable time series there was a lower number of detected nonstationary events and they were shorter. The mean wind for these time series was higher.
- The method was determined to give reliable results because we were able to compare the results from the measurements of one sonic with the results from three neighbour sonics. Most events were detected in all four measurements.
- Limitations: The results from the event detection method by Kang et al.1,3 is sensitive to the scale at which it is applied.
- Solution: A multiscale approach is an option to work around this scale dependency. In general, the multiscale approach is a good way to identify which average and time window gives the most reasonable output.