Turbulence integral scales and data filtering for bora wind

Ana Šljivić, Željko Večenaj, Damir Ptičar and Branko Grisogono
ana.sljivic@cirus.dhz.hr

Bora is a strong, gusty wind, whose microscale characteristics, especially its turbulence, are not fully explored yet. Integral scale is a good indicator of the size of the eddies that dominate the turbulence spectrum. It is estimated from the atmospheric wind speed measurements using autocorrelation function (ACF) and Fourier spectrum. In theory, their ratio should be a constant. Besides being a fundamental property in the theory of turbulence, the integral scale is used as an important variable in numerical weather prediction (NWP) and climate models. Therefore, it is of essential importance to estimate properly the integral scale from the atmospheric wind speed measurements using ACF and Fourier spectrum, in order to be able to validate NWP and climate models. However, the values of integral scale obtained from ACF and Fourier spectrum are very sensitive to preprocessing of the data, such as the data filtering, so one has to be very careful in preparing the data for ACF and Fourier spectrum analysis. In this work, we study the sensitivity of integral scale values for bora flows (obtained using ACF and Fourier spectrum analysis) on the data filtering, which is in practice a first step in the analysis of the atmospheric turbulence in general.

The measurements that were used were performed on a micrometeorological tower installed near the Maslenica Bridge north of the city of Zadar, Croatia, with a sampling frequency of 20 Hz. The 10 m tall tower was equipped with three levels of Gill WindMaster ultrasonic anemometers (2, 5 and 10 m) gathering the 3D wind speed and sonic temperature. For the period from October 9, 2015, to October 9, 2016, 48 events of bora flow were abstracted.

The main objectives of this work are to examine the effect of data filtering on integral scale values for bora flows, obtained from ACF and Fourier spectrum, the effect on their ratio and to try to find out a suitable high-pass filtering period. The results show that integral scales obtained by the filtered data using filter periods close to averaging time scale (30 min) are not significantly sensitive to filtering. When using shorter filter periods, it is better to estimate integral scales from the Fourier spectrum. Given that the ratio is relatively conserved over the length of the filter, it is difficult to say, for bora flows, whether the raw data should be filtered or not.

Key words: numerical weather prediction, averaging time scale, autocorrelation function, Fourier spectrum, micrometeorological tower, Maslenica bridge