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Wind gusts in complex terrain: Analyses of data from Perdigão.

Frederick Letson (1), Rebecca J. Barthelmie (1), Weifei Hu (1), and Sara C. Pryor (2)

(1) Cornell University, Sibley School of Mechanical and Aerospace Engineering, United States (fl368@cornell.edu), (2) Cornell University, Department of Earth and Atmospheric Sciences, United States

An outstanding challenge in understanding flow over complex terrain relates to intermittency and the occurrence of wind gusts. Although it has long been known that the intensity of wind gusts is generally amplified by orographic and land use complexity, relatively little is known about the spatial scales and magnitudes of wind gusts is complex terrain. A more precise statistical description of the occurrence and characteristics of wind gusts is important for many applications including structural loading on wind turbines.

Here we present analyses from sonic anemometers deployed at heights of 20-100 m on 9 meteorological masts within the Vale Cobrão during the NEWA-Perdigão experiment (Jan – June 2017). At the macro-scale, Vale Cobrão is a two dimensional valley within two parallel ridges (maximum height above valley of approximately 200 m) separated by 1.4 km. The vegetation generally has heights of $<$ 20 m and varies in terms of density but is mainly comprises cork trees and eucalyptus. Three of the masts are located on the top of the southwest ridge, one is located slightly in the lee of that slope, two are in the bottom of the valley one is half-way up the northeast ridge and two are aligned along the northeast ridge. The maximum distance between the meteorological masts is 1.7 km. The 100m tower on the northeast ridge has the most complete record and is used as a reference tower. Preliminary results from our analyses of the 18 Hz data from the sonic anemometers indicate:

1. Maximum 3-second wind gust of 25.76 ms^{-1}, and the 95th percentile 3-second wind gust measured at 60-m a.g.l. on the 9 meteorological masts ranged from 9.78 to 14.37 ms^{-1}.
2. At the reference tower, 2.48 % of 10-minute periods exhibited wind gusts in excess of 15 ms^{-1} at a height of 60 m a.g.l. Comparable data for 100 m and 20 m heights are 2.86% and 1.22% respectively.
3. Gust magnitudes (i.e. absolute perturbation from the 10-minute mean wind speed) are typically best described using a Weibull distribution. Based on data collected at 60-m the scale and shape factors range from 2.03 to 2.57 ms^{-1} and 1.51 to 1.81 respectively. Herein a gust is simply defined as the maximum 3-second mean wind speed in each 10-minute period.
4. At the reference tower, wind gusts in excess of 15 ms^{-1} are more likely under flow perpendicular to the ridges and under stable conditions (where stability is determined using the Monin-Obukhov length).
5. Temporal coherence (i.e. co-occurrence in individual 10-minute periods) in the occurrence of wind gusts in excess of the locally-defined 95th percentile 3-second gust speed across the 9 meteorological masts ranges from 36.4% to 85.1%.

Wavelet analysis is currently being conducted to examine the structure of the gust events in more detail and to further explore relationships between micro-pressure fluctuations and seismic response to wind gusts using data from a transect of microbarometers and seismometers deployed by the Cornell team along the southwest ridge.