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Daily variation of the fractal dimension of the velocity components in the turbulent surface layer

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The turbulence is a dominant property within the Planetary Boundary Layer (PBL). It is the main characteristic of the mixing in the lower atmosphere since the atmospheric turbulent fluxes are more efficient than the molecular diffusion. Turbulence can be observed in time series of meteorological variables (wind velocity for example). The sampling rate of observation in that time series has to be high in order to detect the turbulent regime. The analysis of these series presents a self-similarity structure, so the wind velocity can be considered as a fractal magnitude. This work shows a study of the fractal dimension of the wind perturbation series $u^{'}$ and $w^{'}$ components of the wind speed. Fractal dimension of velocity components can be related to others turbulent characteristics of the fluxes close to the ground. Fluctuation of longitudinal and, specially, vertical components depend on stability and, therefore, on the solar cycle. In consequence, the behaviour of fractal dimension should be in agreement with that cycle also. These series have been obtained once it has carried out the necessary transformation to get the mean wind series in short intervals, namely 5 minutes, to ensure the consistent properties of turbulence. The original records available were taken every thirty minutes by sonic anemometers (20 Hz sampling rate) during a week of a field campaign. The data analysed was recorded in the experimental campaign SABLES-98 at the Research Centre for the Lower Atmosphere (CIBA), located in Valladolid province (Spain).

It has been calculated the fractal dimension (Komolgorov capacity or box- counting dimension) of the time series of fluctuations of the velocity component along of the mean wind direction and the vertical component ($u' = u - U$, $w' = w - W$), both in the physical spaces (velocity-time). It has been studied the time evolution of the fractal dimension during several days and at three levels above the ground (5.8 m, 13.5 m, 32 m). The fractal dimension of the$u^{'}$ and $w^{'}$ components of wind velocity series have been studied, as well as the influence of different turbulent parameters depending on daily cycle: turbulent kinetic energy, friction velocity, difference of temperature between the extreme of the layer studied close of the surface ($\Delta \mathrm{T}_{50-0.22m}$),etc. It has been observed that there is a possible correlation between the fractal dimension and some of these turbulent parameters. Finally, it has been analysed the variation of the fractal dimension versus stability obtained from the Richardson number along of the day.