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Space-Time Scaling In The Atmospheric Boundary-Layer

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We study the (multi-) scaling properties of the velocity time-increments as function a height (between 50 and 150m) using wind measurements from the well known Growian experiment. The Growian wind turbine experiment was a German Federal Ministry of Research and Technology's project that took place over the years 1983 to 1987. The experiment provides vertical wind profiles of wind speed and direction at 2.5Hz at 50, 75, 100, 125, and 150m. Velocity vectors are computed from the wind speed and direction allowing us to analyse the vertical velocity profiles in the so-called 'mixing-layer'.

Plotting the scaling exponents of the structure functions of the time-increments of the velocity as a function of height shows that the space and time scalings of the velocity increments can be easily related to each other through their corresponding space-time fractal and multi-fractal properties. These properties are then confirmed for other datasets.

Since the fractal and multi-fractal properties of a field are directly related to the extremes of field we are able to propose a high-order statistical model for wind extremes in the atmospheric boundary-layer (ABL). The same model can be used to generate synthetic ABL wind fields that can be useful for numerical model inflow conditions.