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Fisher-Shannon Complexity of High Frequency Wind Speed in Urban area

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Wind speed profile analysis and modelling are important topics in fundamental and applied research. Due to its turbulent nature and extreme distributions, wind speed analysis in urban zones is a challenging task. To gain insight into the complex behaviour of wind speed in built-up areas, high-quality data and efficient exploratory tools are necessary.

The present research aims to quantify the complexity of wind speed and its relationship with the atmospheric variables. The real dataset consists of two months of wind speed time series measurements at 1Hz frequency in a street canyon recorded at 7 levels from 1.5 to 25.5 meters from the ground. Comprehensive traditional exploratory data analysis was performed using kernel density modelling, Fourier and temporal (cross)correlation analyses.

The main results of the current study can be summarized as follows.
Firstly, the Fisher-Shannon Complexity (FSC) measure, which is defined as the product of the Fisher information and the Shannon entropy power, decreases with the height. In particular, this shows that the relationship of wind speed with height is non-linear.
Secondly, the daily FSC unveils a clustering tendency between the measurements below and above the average height of the buildings, suggesting different wind dynamics induced by the building layout.
Thirdly, the daily FSC shows a clear correlation with the daily variance of temperature. This is confirmed by a statistical testing procedure.

This study shows that wind structure is considerably modified in the urban setup, which is confirmed in this research with the FSC measure.

Further interesting work could be in investigating spatially distributed monitoring networks of wind speed and other meteorological parameters with FSC measure.

Reference

F. Guignard, D. Mauree, M. Lovallo, M. Kanevski, L. Telesca. Fisher-Shannon complexity analysis of high-frequency urban wind speed time series, 2018. arXiv : 1812.00822