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Spatial mapping of the multifractal parameters of wind time series in Switzerland

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Wind has been gaining an increasing attention in the context of renewable and sustainable energy. However, the modelling and the understanding of this phenomenon is very challenging. In fact, wind speed is very variable not only in time but also in space. Especially, in complex topography country like Switzerland, which has three important regions (Jura Mountains, Alps, and the plateau). Such orographic features can exert an influence on the speed and the direction of the wind phenomenon and make the modelling task harder.

In this work, 119 times series of daily mean wind speeds are studied (for the period between 2012 and 2016). These times series are provided by the Federal Office of Meteorology and Climatology of Switzerland (MeteoSwiss – IDAWEB server), which manages a dense network of meteorological stations distributed homogeneously in all the country. For each time series, the MultiFractal Detrended Fluctuation Analysis (MFDFA) is applied. As it is well known, the MFDFA is used to identify correlations, persistence, and intermittency of a non-stationary time series [1]. The information extracted by the MFDFA consists of the Hurst exponent, the width, and the asymmetry of the multifractal spectrum. This information is then mapped over Switzerland by using extreme learning machine with X, Y coordinates as inputs.

The obtained maps of the multifractal parameters show clearly the distinction between the three topographic regions of Switzerland. For instance, wind time series on the Swiss plateau are characterized by a persistent behaviour indicated by a Hurst exponent larger than 0.5. In contrast, the Hurst exponent in the Alps has values close to 0.5, which indicates that there is no memory.
In conclusion, this work is a contribution to the characterization of wind speed and to the understanding of the mechanisms that govern its dynamics in complex regions. Further, an implementation of the MultiFractal Detrended Fluctuation Analysis for time series is proposed in the R library MFDFA [2].

References

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