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Multifractal predictability of short-time forecast

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In the emergency situations, the meteohydrological alert systems require more and more detailed space-time information and reliable short time forecasts, in particular of the rain. Furthermore, an accurate estimate of the uncertainties is rather indispensable. The current weather forecasting models or the statistical methods of radar and satellite image processing cannot fully answer to these requirements: many parameterizations, long spin-up and computation times or the strong nonlinearities of the dynamics are not taken into account (e.g. for the displacement and deformation of the stormy cells. As an alternative, a multifractal approach, physically based on the cascade processes of dynamics and rain, takes into account the hierarchy of the structures and their nonlinear interactions over wide range of space-time scales, as well as the scaling anisotropy between time and space. Furthermore, this approach is parsimonious, since uses only a very limited number of parameters, which moreover have a strong physical significance.

In this framework, the intrinsic predictability limits can be theoretically analyzed and numerically simulated. We analyze the respective behaviour of the corresponding structures and remain dominant at large scales, whereas the latter is generated by their nonlinear instabilities and contaminates larger and larger scales. We determine the power-law growth of the characteristic scale separating the two regimes where one of these fluxes is dominant and show the fundamental role of intermittency in the loss of predictability.

We apply these ideas to a multifractal procedure for rain forecast using radar data and in particular to case of study of an extreme storm in the Mediterranean part of France.