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Tailored mesoscale ensemble forecasts: application to Western Mediterranean high impact weather

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Numerical weather forecasts are inherently uncertain due to the absence of complete knowledge of the initial state of the atmosphere and the imperfect modelling of some physical processes. Therefore, not only the state of the system but also its uncertainty must be assessed. Probability theory is the adequate theoretical framework to model uncertain physical systems and the state of the system is described by means of a probability density function (PDF), a multidimensional function defined over the phase space, which represents all possible states of the system. Although the solution of the Liouville or Fokker-Planck equations provides the full evolution of the PDF, in real world applications, only a discrete sample of the PDF can be considered and thus choosing a sampling strategy is a key question for ensemble prediction systems (EPS). Within this general problem, the rare nature of high impact weather events sets an additional challenge to their prediction, with most common underdispersive forecasts.

A popular analysis PDF sampling technique based on the dynamics of the system is the Breeding Method, which uses the full nonlinear dynamics of the system to identify fast-growing modes in the model. Traditional bred vectors developed at the National Centers for Environmental Prediction are obtained from the difference between a control run and a previously perturbed run rescaled at regular time intervals. In this work, we explore the potential of a new methodology to generate initial condition perturbations based on bred vectors by modifying the spatial scale of the perturbations and use this ability to tailor the EPS and adapt the forecasting system for severe weather prediction: Tailored ensemble perturbations based on bred vectors. The proposed technique possesses the persuading potential of allowing full control on ensemble spread and seamless scale representation of uncertainties in high resolution EPS. The perturbations design, as well as the characteristics of the resulting ensemble, will be presented and the results analysed in terms of ensemble dimension, and by means of verification scores.