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Characterization of the spatio-temporal evolution of ensembles of initial perturbations

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The evolution of ensembles of initial perturbations plays an important role in ensemble forecasting since these perturbations will determine if the ensemble of forecasts is predictive and represents correctly the uncertainty existing in the prediction. An ensemble is predictive if the real variable evolves as one more member of the ensemble of forecasts. In spatiotemporal chaotic systems, the perturbations grow forming spatial patterns that affect to the evolution of the ensemble of forecasts. We present a novel approach to characterize and graphically represent in a 2D diagram the spatiotemporal evolution of an ensemble of perturbations in spatiotemporal chaotic systems. Previous studies have characterized how perturbations grow and correlate in time without considering the spatial counterpart. The novel approach, based on the logarithm of the perturbations, shows how both the temporal and the spatial components are essential in the dynamics of the perturbations. The spatial mean and variance of the logarithm of the perturbations totally describe the spatiotemporal growth of the perturbations. Both a toy model (Lorenz 96) and numerical weather prediction systems are used to illustrate the methodology. The 2D diagram allows uncovering some basic features of the spatio-temporal dynamics of both ensembles of perturbations.