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Dynamics of model error: Impact of one-way boundary conditions

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The dynamics of model error arising from the systematic use of one-way boundary conditions in regional models is investigated in the light of the theory developed in Nicolis (2004). The analysis of a one-dimensional system displaying spatio-temporal chaos indicates that (i) the mean square error dynamics caused by boundary condition errors depends strongly on the statistical properties of these errors, with an initial linear and quadratic amplifications for a random noise and a systematic perturbation, respectively, and a quartic behavior for a realistic perturbation associated with boundary conditions provided by a coarse-resolution global model; and (ii) the propagation inside the domain also depends strongly on the properties of the boundary perturbations. Next, a state-of-the-art regional weather prediction model for which boundaries are provided by a coarse-resolution global model is analyzed in the same perspective. Although the impact of boundary perturbations cannot be fully decoupled from a small initial error and additional internal model errors, its dynamics bears similar features, with a dramatic amplification of the error close to the boundaries.