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Control Simulation Experiments with the Lorenz-96 Model

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The successful development of numerical weather prediction (NWP) helps better preparedness for extreme weather events. Weather modifications have also been explored, for example, when enhancing rainfalls by cloud seeding. However, it is generally believed that the tremendous energy involved in extreme events prevents any attempt of human interventions to avoid or to control their occurrences.

In this study, we investigate the controllability of a chaotic dynamical system by adding small perturbations to generate amplified effects and to prevent extreme events. The high sensitivity to initial conditions would ultimately lead to modifications of extreme events with infinitesimal perturbations. Based on this idea, we extend the well-known observing systems simulation experiment (OSSE) and design the control simulation experiment (CSE) with the Lorenz-96 model, a widely-used toy system in data assimilation studies. We also study the sensitivity of the control to the amplitude of the perturbation, the forecast length, the localized perturbation and the partial observations. The CSE would be applicable to other chaotic dynamical systems including realistic numerical weather prediction models.