Title: Modeling Chaotic Systems: Shadowing in the Atmosphere
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ABSTRACT

Modeling and predicting Earth's atmospheric conditions is difficult due to the climate's chaotic nature. Current weather forecast models quickly diverge from observations as uncertainty in the initial state is amplified by nonlinearity. One measure of the strength of a forecast is its 'shadowing time', the period for which a particular forecast is a reasonable description of reality. Unfortunately, much of the mathematical theory behind shadowing is built on assumptions, which are not applicable to physical systems like the atmosphere. This work uses a simplified nonlinear model of atmospheric conditions to develop new techniques for lengthening the shadowing time. The trajectory of a known initial condition is calculated using a fine resolution version of the system dynamics, and termed the "truth". To create the forecast, an ensemble of initial states is chosen near the known initial condition using knowledge of the local dynamics. Each ensemble member is forecast forward in time using a coarser resolution of the system dynamics. After a given time period, the ensemble of forecasts is compared to the truth to determine the shadowing time and success of the prediction. The first objective is to develop a new technique that would improve the accuracy of the ensemble forecast. The second objective is to determine if such a shadowing forecast trajectory exists. If successful, the method could be utilized to improve the predictions of the future state of any physical system (e.g. El Niño events, magnetic storms, solar wind, the evolution of galactic clusters).