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Shadowing Techniques for the Evaluation and Interpretation of Climate Models

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Understanding the implications of climate model projections requires a knowledge of the assumptions made in both constructing the model and in interpreting it in terms of the real world. Exploring the reliability of model based projections is an important pre-cursor to evaluating their societal relevance. Here we will illustrate the use of shadowing concepts to better understand the reliability of climate models in their role of informing us about future global climate. Exploring the timescales on which models can shadow climate scale variables successfully is valuable for guiding both model improvements and model interpretation.

Shadowing is a technique which can be used to identify models which can successfully predict a given trajectory (e.g., Smith 2000) over given time periods. On weather forecasting timescales, this may refer to the successful prediction of a particular variable at each time-step within pre-defined limiting values. Extending this technique to climate timescales for decades or centuries is not necessarily a straight-forward process, particularly with regards to the interpretation of model success. Potentially the largest issue is the fact that it is not possible to have a cycle of prediction and confirmation on these timescales. While acknowledging that observations of the past are in-sample and may have influenced model development, it is nevertheless valuable to explore models' abilities to shadow the past climate record e.g. the 20th century. Indeed, if the models are unable to shadow the climate of the past, we should question their reliability for future prediction.

We will present these concepts along with illustrations of how we might interpret two types of shadowing in terms of the attractor and "climate" of a simple chaotic system.

The capability to shadow will be presented in terms of both varying initial conditions and perturbing model parameters; examples will be taken to explore the perfect model scenario and the imperfect model scenario. Subsequent research will aim to investigate the technique for climate models of simple to intermediate complexities.

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