Geophysical Research Abstracts
Vol. 21, EGU2019-5582, 2019
EGU General Assembly 2019

From reliable initialised forecasts to skilful climate response: a dynamical systems approach

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While weather forecasting models can be tested by performing and evaluating many hindcasts, the limited observational record restricts the degree to which climate projections can be evaluated. Therefore a question of interest is: to what degree can we evaluate the potential skill of a climate model's response to forcing by assessing the reliability of short-range weather and seasonal forecasts produced by the same model? We address this question using a dynamical systems framework and test our predictions using a simplified 'toy model' of the atmosphere. We use linear response theory to provide the mean climate response of a general dynamical system to a small external forcing. We relate this response to the reliability of initial value forecasts. We find that in order to capture the mean climate response, the forecast model must correctly represent the slowest evolving modes of variability in the system. The reliability of forecasts on seasonal and longer timescales, which is sensitive to the representation of these slow modes, could therefore indicate if the forecast model has the correct climate sensitivity and so will respond correctly to an applied external forcing. In this way, the skill of initialised forecasts could act as an 'emergent constraint' on climate sensitivity. However, we also highlight that unreliable seasonal forecasts do not necessarily indicate an incorrect climate projection. This is because correctly representing rapidly evolving modes is also necessary for reliable seasonal forecasts.

Reference:
Christensen and Berner, From reliable initialised forecasts to skilful climate response: a dynamical systems approach, under review in Q. J. R. Meteor. Soc.