COMPUTATIONAL RESEARCH in BOSTON and BEYOND SEMINAR

Short weather forecasts inform long-term climatology of sudden stratospheric warming

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ABSTRACT:

In some physical systems such as the Earth's atmosphere, the most extreme and rare events matter a great deal, both for their human impact and for their dynamical consequences. A prototypical example is sudden stratospheric warming (SSW), a rapid breakdown of the winter stratospheric polar vortex, which causes extreme mid-latitude cold spells and alters surface weather for months. The historical scarcity of observations, and an unusually SSW-rich 2000's decade, lead to uncertain SSW climatology: when do they occur, how often, and how predictably? Long, expensive model runs could answer these statistical questions, but with a tradeoff between cost and bias. We instead utilize weather forecast ensembles that are high-resolution, but short (subseasonal) in duration. A simple coarse-graining procedure chains them together to estimate key climate statistics, such as annual frequencies and timing distributions of SSW events, as formulated in Transition Path Theory. Using forecast ensembles initialized between 1996 and 2018, we find that the SSW statistics match well with 20th-century reanalysis. Our method extrapolates the climatology well beyond what is possible with the short observational dataset that initialized the forecasts, yielding accurate estimates of 1 in a century events. This suggests exciting new uses for ensemble forecasts in rare event analysis.

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