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On estimating decadal-scale predictability in regional climate change over river basins in response to changes in tropical SST patterns

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The predictability of regional climate change is limited by uncertainties in (1) the expected forcing, (2) the response to this forcing, and (3) the internal variability of the fully coupled climate system. Of these three, we explore the second by isolating the regional response to a set of known forcings, namely the anomalous sea surface temperature (SST), that contributes to climate change over land. In so doing, we are assessing the capabilities of atmospheric general circulation models (AGCMs) to respond to SST forced changes. Through this decomposition of uncertainties, we are able to address the impact of structural differences in climate models associated with the modeled atmospheric physics.

We investigate how to identify and assess teleconnection signals between anomalous patterns of SST changes and climate variables related to hydrologic impacts over different river basins. The regional climate sensitivity to tropical SST anomaly patterns is examined through a linear relationship given by the global teleconnection operator (GTO, also generally called a sensitivity matrix or an empirical Green's function). We assume that the GTO defines a multilinear relation between SST forcing and regional climate response of a target area. The sensitivities are computed based on data from a large ensemble of simulations using the NCAR Community Atmospheric Model version 3.1 (CAM 3.1). Additionallly, we will examine GTO results using more recent AGCMs including: NCAR CAM4, CAM5, and GFDL AM2.1. These can help identify the structural uncertainty associated with individual atmospheric models.

To explore predictability issues, the linear approximation is evaluated by comparing the linearly reconstructed response with both the results from the full non-linear atmospheric model and observational data. We find that the linear approximation can capture regional climate variability that the CAM 3.1 AMIP-style simulations produce at seasonal scales for multiple river basins. Overall, this approach provides a tool for exploring the climate change response over large regions as a first order assessment of the river basin hydrology. Furthermore, the decomposition of the uncertainty helps identify key directions where further research is required to improve predictive skill.