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Observational constraints on interannual variability projections in CMIP5

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Impacts of climate change are sensitive not only to changes in the mean state but also to potential changes in the internal variability of the climate system at diurnal to interannual and multi-decadal time scales. Internal variability arises from nonlinear interactions and complex feedbacks between ocean, sea ice, atmosphere and land surface without any external forcing. However, an external forcing may change both magnitude, spatial patterns and the time scales of these variations.
It is crucial to understand whether and on what temporal and spatial scales internal variability will undergo changes under anthropogenic radiative forcing and to identify the underlying mechanisms. To address these questions, we here use model simulations of the Coupled Model Intercomparison Project Phase 5 database (CMIP5) with historical (1850-2005) - RCP8.5 (2006-2100) concentration pathway.
First, we show over which latitudes CMIP5 models simulate robust changes in variability. Second, we explore whether models with low present-day internal variability project changes that substantially differ from those models with high present-day internal variability. Such an inter-model relationship is found over the high-latitudes of both hemispheres. For the regions and seasons, for which a relationship across the multi-model ensemble exists, we use observations and reanalyses, to constrain the model projections. This model constraint is based on the assumption that models with a more realistic representation of present-day variability yield more reliable projections. Once a relationship is identified, physical understanding becomes crucial because it must have a strong physical grounding to justify the constraint. We explore mechanisms that explain the inter-model correlation between current variability and its future change especially at high latitudes. We use a "joint projection" approach, which is based on the fact that multiple climate variables are correlated over different scales in order to understand basic mechanisms and to put forward hypotheses that explain what is observed in multi-model projections. Furthermore, the coupling between variables allows a more precise quantification of these relationships which ultimately should enable us to reduce the uncertainty associated with their joint projections.