**The Big Breakup:**

**A mid-20th Century Transition in the Behavior of Modes of Climate Variability**

Amy Clement, Jeremy Klavans, Tyler Fenske, Mark Cane, Chengfei He, Lisa Murphy, and Pedro DiNezio

How much of regional climate variability is due to anthropogenic forcing? It is a question of both time and space scales. On interannual timescales and local spatial scales, most of the variability is presumably internal; on global, centennial timescales, it is mostly forced. Then we are left with this large grey area of regional, decadal-to-multidecadal variability, where the relative magnitude of the internal and forced components is not known.

In this paper, we dive into the question of the relative contributions of internal ‘noise’ and externally forced ‘signal’ to modes of decadal to multi-decadal climate variability. To do this we use a hierarchy of climate models including simple heuristic models, idealized dynamical models, comprehensive earth system models, and variants of earth system models with physical processes disabled. These models are put to the experimental test of simulating observations using large ensembles with historical and future forcing, which allows us to formally define the signal to noise ratio. We show that prior to 1950, decadal-to-multidecadal modes of variability are consistent with variability arising from coupling between the ocean and atmosphere internal to the climate system. However, after 1950, external forcing dominates so that modes of variability (and their impacts) are largely forced, disrupting the relationship between the ocean and atmosphere.