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Mechanism Denial: Rethinking the Roles of the Atmosphere and Ocean in Long-term Climate Variability

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Both the Pacific and Atlantic oceans have decadal to multi-decadal variability with significant ecological and societal impacts. Numerous mechanisms have been suggested to explain the specific patterns and timescales of these modes of variability. However limited observational data has made it difficult to identify the key elements, or, put differently, to rule out some mechanisms as not being essential. Even with perfect data, or for that matter in a comprehensive climate model, it can be difficult to identify the key mechanisms because of feedbacks among them, and often correlated fields are incorrectly interpreted as indicating causation. In this talk I will present results using an alternative approach in which we eliminate – or 'deny' – various mechanisms in the Community Earth System model, and test the impact of the mechanism denial on the simulation of low-frequency Atlantic and Pacific climate variability. The main elements of the set of CESM experiments are (1) a prescribed ocean circulation (denying interactive ocean circulation), and (2) prescribed clouds (denying cloud-radiative feedbacks). We will also include in this historically forced experiments, and by comparing these to the pre-industrial control runs, we deny the mechanism of time-varying external forcing (atmospheric composition and solar luminosity) driving low-frequency variability. Results show that eliminating the ocean circulation and clouds does not have a significant impact on Atlantic Multi-decadal Variability, while including external forcing does. On the other hand, clouds appear to play an important role in Pacific decadal climate variability, with less role for external forcing and ocean circulation (except on interannual timescales). We discuss the implications of these results for predicting climate changes of the coming decades in the Atlantic and Pacific and their impacts.