The Energy Balance in Climate Estimation by Combining Data with a Biased Coupled Model

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When a biased coupled model is combined with the climate observing system, understanding its behavior in climate estimation is of critical importance for producing accurate climate analysis and prediction initialization. Due to incomplete representation of observations to the real climate system, especially for the ocean where most of the measurements are available only for the upper part, the knowledge of model bias and its influence on climate estimation and prediction still remain limited. With two CGCMs which are biased with respect to each other, a ?biased? twin experiment, in which atmospheric and oceanic ?observations? that sample one model based on the modern climate observing system are assimilated into the other, is designed to study the impact of coherent atmosphere-ocean data constraints on climate estimation. Given the assimilation model bias of warmer atmosphere and deep ocean as well as colder upper ocean, while the atmospheric-only (oceanic-only) data constraint produces an over-cooling (over-warming) ocean, the constraints with both atmospheric and oceanic data create a balanced and coherent ocean estimate as the observational model. Moreover, the consistent atmosphere-ocean constraint produces the most accurate estimate for North Atlantic Deep Water (NADW), while the NADW appears too strong (weak) if the system is only constrained by atmospheric (oceanic) data. These twin experiment results address the importance of consistent data constraints of multiple components in climate estimation and initialization of a coupled model for decadal predictions