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Using ensemble covariances to separate structural anomalies from internal variability.

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It is clear that current climate models have substantial skill in simulating many aspects of the Earth system, but still suffer from a range of systematic problems. It is widely accepted that a multi-model ensemble contains more information than can be obtained from any single model, since there is some cancellation between systematic errors of different models. The WCRP Coupled Model Intercomparison Project, Phase 5 (CMIP5) provides a multi-model ensemble of unprecedented size and complexity. 48 named models have contributed simulations of the historical period. Some of these are closely related (e.g. MIROC-ESM, MIROC-ESM-CHEM), others have been run with a variety of configurations (e.g. the GISS-E2-R has 3 different major configurations of the aerosol representation and a further 7 minor variations on the first of these). Hence the number of distinguishable models could be larger or smaller than 48. Structures of climate variability are often analysed in terms of Empirical Orthogonal Functions (EOFs) defined from the temporal covariance of simulations or observations. Such EOFs show patterns of internal variability. This presentation looks at EOFs defined from the intra-ensemble covariance. The leading modes are dominated by persistent differences between models: the differences between models is generally much greater than the internal variability estimated from the ensembles run with a fixed model. This clear separation provides a basis for elimination of the principal structural errors from the ensemble.