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Partitioning climate projection uncertainty with multiple Large Ensembles and CMIP5/6

Flavio Lehner^{1,2}, Clara Deser², Nicola Maher³, Jochem Marotzke³, Erich Fischer¹, Lukas Brunner¹, Reto Knutti¹, and Ed Hawkins⁴

¹Institute for Atmospheric and Climate Science, ETH Zürich, Zürich, Switzerland

²Climate and Global Dynamics Laboratory, National Center for Atmospheric Research, Boulder, USA

³Max Planck Institute for Meteorology, Hamburg, Germany

⁴National Centre for Atmospheric Science, Dept. of Meteorology, University of Reading, Reading, UK

Partitioning uncertainty in projections of future climate change into contributions from internal variability, model response uncertainty, and emissions scenarios has historically relied on making assumptions about forced changes in the mean and variability. With the advent of multiple Single-Model Initial-Condition Large Ensembles (SMILEs), these assumptions can be scrutinized, as they allow a more robust separation between sources of uncertainty. Here, we revisit the framework from Hawkins and Sutton (2009) for uncertainty partitioning for temperature and precipitation projections using seven SMILEs and the Climate Model Intercomparison Projects CMIP5 and CMIP6 archives. We also investigate forced changes in variability itself, something that is newly possible with SMILEs. The available SMILEs are shown to be a good representation of the CMIP5 model diversity in many situations, making them a useful tool for interpreting CMIP5. CMIP6 often shows larger absolute and relative model uncertainty than CMIP5, although part of this difference can be reconciled with the higher average transient climate response in CMIP6. This study demonstrates the added value of a collection of SMILEs for quantifying and diagnosing uncertainty in climate projections.