Geophysical Research Abstracts
Vol. 21, EGU2019-2073-2, 2019
EGU General Assembly 2019

How long does my run need to be? Machine dependence and the identification of uncertainties in climate models

Maria Vittoria Guarino (1), Louise Sime (1), David Schroeder (2), Grenville Lister (2,3)

(1) British Antarctic Survey, Cambridge, United Kingdom (m.v.guarino@bas.ac.uk), (2) University of Reading, Meteorology Department, Reading, United Kingdom, (3) National Centre for Atmospheric Science, Reading, United Kingdom

When a same weather or climate simulation is run on different High Performance Computing (HPC) platforms, model outputs may not be identical for a given initial condition. While the role of HPC platforms in delivering better climate projections is often discussed in literature, attention is mainly focused on scalability and performance rather than on the impact of machine-dependent processes on the physical solution. At the same time, machine dependence is an overlooked source of uncertainty when it comes to discussing the model spread observed within the Coupled Model Intercomparison Projects (CMIP).
Here we propose to investigate what is the impact of machine dependence on model results and quantify, for a selected case study, what is the magnitude of the uncertainty attributable to it.
We consider the Preindustrial (PI) simulation prepared by the UK Met Office for the forthcoming CMIP6. The simulation uses the global coupled HadGEM3-GC3.1 model. A copy of the PI control simulation was ported from the MONSOON HPC platform, where it was originally run, to the ARCHER HPC platform. Discrepancies between the means of key climate variables like SST, Sea Ice Concentration, 2m Air Temperature, LW and SW TOA radiation fluxes, and etc. were analysed at different timescales, from decadal to centennial.
Although the two versions of the same PI control simulation do not bit-compare, we found that the long-term statistics of the two runs are similar and that, on pluri-centennial timescales, the considered variables show a signal-to-noise ratio (SNR) less than one. However, inconsistencies between the two runs increase and become significant (SNR > 1) for smaller timescales, being the largest at decadal timescales. For example, when a 10-year averaging period is used, machine dependence can account for up to 0.2 °C global mean air temperature anomalies, or 1.2 million km2 Southern Hemisphere sea ice area anomalies.
Differences between the two simulations can be linked to variations in the strongest modes of climate variability. In the Southern Hemisphere, this results in large SST anomalies where ENSO teleconnection patterns are expected that can reach 0.6 °C (and SNR ∼1) even on centennial timescales.
Finally, we note that the relationship between global mean differences and timescale exhibits a ∼2/3 power law behaviour, regardless the physical quantity considered. This suggests a consistent time-dependent scaling of the machine-induced bias across the whole climate simulation.