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Reduction of long-term drift and construction of multiple-equilibrium states in aquaplanets

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Long-term drift in climate models can be revealed by the evolution of global variables such as ocean temperature or surface-air temperature. This spurious trend reduces the fidelity to initial conditions and influences the equilibrium reached after long simulation times. We show that two global metrics, *i.e.* the energy imbalance at the top of the atmosphere and at the ocean surface, provide useful insight on the nature of the climate drift: the former is an indicator of the limitations within a given climate model (at the level of both numerical implementation and physical parameterisations), while the latter is an indicator of the goodness of the tuning procedure [1].

Using the MIT general circulation model, we find that the interplay between tuning procedure and different configurations of the same climate model (that is various parameterisations for the bulk cloud albedo, inclusion or not of friction heating, different bathymetry configurations) provides crucial information on the stability of the control runs and on the goodness of a given parameterisation.

In particular, we apply the above procedure to aquaplanet configurations, where the ocean covers the entire globe. We show that, by selecting a stable control run where the long-term drift is minimised, we can construct multi-equilibrium states (*i.e.* long-term statistics) by starting from different initial conditions under identical constant climate forcing, and determine the basin of attraction for each equilibrium state.

[1] M. Brunetti and C. Vérard, *How to reduce long-term drift in present-day and deep-time simulations?* Climate Dynamics (2017), https://doi.org/10.1007/s00382-017-3883-7