EGU23-4968, updated on 05 Feb 2024
https://doi.org/10.5194/egusphere-egu23-4968
EGU General Assembly 2023

Evaluating Memory Properties in Convection Schemes Using Idealised Tests

Yi Ling Hwong[1], Maxime Colin[2], Philipp Aglas[1], Caroline Muller[1], and Steven Sherwood[3]
[1]Institute of Science and Technology Austria, Austria
[2]Leibniz Centre for Tropical Marine Research, Germany
[3]Climate Change Research Centre, University of New South Wales, Australia

Two structural assumptions are frequently employed in convective parameterisation: the diagnostic and quasi-equilibrium assumptions. The former assumes an instantaneous relationship between the large-scale environment ("macrostate") and subgrid-scale convective activity, while the latter postulates that convective processes are almost in equilibrium with slowly evolving large-scale forcing at all times. Both assumptions do not take into account the role of convective memory ("microstate" memory), which is defined as the dependence of convection on its own history. Here, we present the memory behaviour of three convection schemes by comparing their responses in two idealised RCE experiments in single-column models (SCMs) to those of a cloud-resolving model (CRM). Three main findings from these tests will be discussed. First, when the large-scale environment is held constant ("FixMacro"), precipitation remains invariant in time with the Zhang-McFarlane scheme, confirming that the scheme does not parameterise convective memory and is fully diagnostic. The *org* scheme (Mapes & Neale, 2011) displays similar behaviour to the CRM in that precipitation increases in the first moments after FixMacro starts, with larger entrainment rates associated with slower growth. However, its logarithmic growth shape differs from that of the CRM, which displays exponential growth, and can be explained using the scheme's governing equations. Second, when the prognostic convective memory variable is set to zero at one time step (essentially wiping out microstate memory), the *org* scheme displays remarkably similar behaviour to the CRM, with precipitation dropping to zero and then recovering to its RCE value over a recovery time scale t_{mem}. In comparison, precipitation in the LMDZ cold pool scheme (Grandpeix & Lafore, 2010) responds in the opposite direction: it grows and then falls back to its RCE value. Finally, the mean and temporal variance of the *org* variable were found to correlate strongly with memory strength (t_{mem}), indicating that *org* has captured important aspects of convective memory. Overall, our results indicate that the *org* and LMDZ cold pool schemes partially, but do not fully capture CRM memory behaviour and are limited by their structural assumptions. They also demonstrate the usefulness of our simple idealised experiments to probe the memory behaviour of convection schemes.