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Physics of the Eddy Memory Kernel of a Baroclinic Midlatitude Atmosphere

Elian Vanderborght[1], Jonathan Demeayer[2], Henk Dijkstra[1,5], Georgy Manucharyan[3], and Woosok Moon[4]

[1]Utrecht University, Institute for Marine and Atmospheric research Utrecht (IMAU), Physics, Netherlands (elianvdb@hotmail.com)

[2]Royal Meteorological Institute, Brussels, Belgium

[3]School of Oceanography, University of Washington, Seattle, WA, USA

[4]Department of Environmental Atmospheric Sciences, Pukyong National University, 48513 Pusan, South Korea

[5]Center for Complex Systems Studies, Utrecht University, Utrecht, the Netherlands.

In recent theory trying to explain the origin of low-frequency atmospheric variability, the concept of eddy-memory has been suggested. In this view, the effect of synoptic scale heat fluxes on the mean flow depends on the history of the mean meridional temperature gradient. Mathematically, this involves a convolution of an integral kernel with the mean meridional temperature gradient over past times. In atmospheric studies, it has been proposed that the shape of this integral kernel is linked to the baroclinic wave life cycle. However, this hypothesis has yet to be supported by numerical and observational evidence. In this study we use a low-order two layer quasi-geostrophic atmospheric model (Demaeyer et al., 2020). By perturbing the model with a known forcing, linear response theory can be used to estimate the shape of the integral kernel. Using this methodology, we find an integral kernel that resembles the shape of an exponentially decaying oscillation, different from the simple exponentially decaying integral kernel assumed in most previous studies. By computing the energies and performing a sensitivity analysis, we link the shape of the integral kernel to atmospheric dynamical processes.

References:

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