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Dynamical mechanisms acting on the persistence of meridional shifting and amplitude pulsing of eddy-driven jets

Loïc Robert (1), Gwendal Rivière (2), and Francis Codron (3)

(1) Hisashi Nakamura Laboratory, University of Tokyo, Tokyo, Japan (loic.robert@atmos.rcast.u-tokyo.ac.jp), (2) Laboratoire de Météorologie Dynamique, École Normale Supérieure, Paris, France (grivière@lmd.ens.fr), (3) Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques, Sorbonne Université, Paris, France (fcodron@gmail.com)

The dynamics of mid-latitudes eddy-driven jets is investigated in a long-term integration of a dry three-level quasigeostrophic model on the sphere. As for most observed jets, the leading mode of variability (obtained using the Empirical Orthogonal Functions method) of the zonal-mean wind corresponds to latitudinal shifts of the jet, and the second mode to pulses of the jet speed. The first principal component (PC1) is also more persistent than the second one (PC2), showing that meridional shifts persists longer than amplitude pulses; this longer persistence arises from different eddy feedbacks both in the short term (i.e. within a few days following the peak of the PCs) and in the long term.

The short-term eddy feedbacks come from two distinct mechanisms. First, a planetary waveguide effect acts as a negative feedback on both PCs. The positive phases of PC1 and PC2, which correspond to poleward-shifted and accelerated jets, respectively, are first driven then canceled by planetary waves reflecting on the equatorial flank of the jet. A similar process occurs for the negative phases when planetary waves reflect on the polar flank of the jet. Second, synoptic waves also exert a short-term negative feedback on PC2: when the jet accelerates, the enhanced meridional wind shear increases the barotropic sink of eddy energy and depletes it very rapidly, therefore preventing synoptic eddies from maintaining the accelerated jet. Finally, at lags longer than their typical time scale, synoptic eddies drive a positive feedback on PC1 only. This feedback can be explained by a baroclinic mechanism in which the jet shift modifies the baroclinicity, causing, first, eddy heat flux anomalies and then, momentum convergence anomalies. This feedback is absent for PC2, despite some changes in the baroclinicity.