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The influence of the MJO on the North Atlantic Oscillation as inferred from idealized numerical experiments

Sebastien Fromang (1) and Gwendal Rivière (2)

(1) CEA, Department of Astrophysics, France (sebastien.fromang@cea.fr), (2) Ecole Normale Superieure, Laboratoire de Meteorologie Dynamique, Paris, France

Several observational studies have shown that the North Atlantic Oscillation (NAO) is influenced by the Madden-Julian Oscillation (MJO): the positive (negative) phase of the NAO is favored 10-15 days after enhanced (reduced) convection is located over the Indian Ocean, a configuration known as MJO phase 3 (phase 6). Using a quasi-geostrophic model on the sphere, we investigate the dynamical origin of this influence. A simplified forcing of the potential vorticity (PV) in the tropics is used to mimic the effect of the MJO. This is the main originality of the present study: the idealized nature of the numerical setup allows us to determine the distinct roles respectively played by stationary and synoptic waves as well as to quantify the importance of nonlinear interactions. This is done by means of several series of 10,000 short runs, each of thirty days, that are used to study and quantify the modifications of the flow induced by the MJO on the atmospheric variability over the atlantic. We find that the MJO excites a stationary Rossby wave that propagates over the North Pacific all the way to the North Atlantic and influences the synoptic activity over both oceans basins. In accordance with observations, we find an increase by about 30% of the positive (negative) phase of the NAO following phase 3 (phase 6) of the MJO. The prevalence of each NAO phases scales linearly with the amplitude of the MJO, but some degree of nonlinearity is noticeable when comparing phases 3 and 6 of the MJO. These results, in addition to providing a dynamical explanation for the link between the MJO and the NAO, may help improve the predictability of the different NAO phases on subseasonal timescales.