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Interaction between the Madden-Julian Oscillation and the North Atlantic Oscillation at intra-seasonal timescale

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Bridging the traditional gap between the spatio-temporal scales of weather and climate is a significant challenge facing the atmospheric community. In particular, progress in both medium-range and seasonal-to-interannual climate prediction relies on our understanding of recurrent weather patterns and the identification of specific causes responsible for their favoured occurrence, persistence or transition. Within this framework, evidence is presented here that the main climate intra-seasonal oscillation in the tropics--the Madden-Julian Oscillation (MJO)--controls part of the distribution and sequences of the four daily weather regimes defined over the North Atlantic-European region in winter. North Atlantic Oscillation (NAO) regimes are the most affected, allowing for medium-range predictability of their phase far exceeding the limit of around one week that is usually quoted. The tropical extratropical lagged relationship is asymmetrical. Positive NAO events mostly respond to a mid-latitude low-frequency wave train initiated by the MJO in the western-central tropical Pacific and propagating eastwards. Precursors for negative NAO events are found in the eastern tropical Pacific-western Atlantic, leading to changes along the North Atlantic storm track. Wave-breaking diagnostics tend to support the MJO preconditioning and the role of transient eddies in setting the phase of the NAO. A simple statistical model is built to quantitatively assess the potential predictability of the daily NAO index or the sign of the NAO regimes when they occur. Forecasts are successful in 70 per cent of the cases based on the knowledge of the previous 12-day MJO phase used as a predictor. This promising skill could be of importance considering the tight link between weather regimes and both mean conditions and the chances of extreme events occurring over Europe. These findings are useful for further stressing the need to better simulate and forecast the tropical coupled ocean atmosphere dynamics, which is a source of medium-to-long range predictability and is one of the Achilles' heel of the current seamless prediction suites.