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The combined impact of Indian Ocean dipole and ENSO on the North Atlantic-European circulation during early boreal winter in re-analysis and in the ECMWF-SEAS5 hindcast

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This study investigates the delayed influence of the Indian Ocean dipole (IOD), isolated and combined with ENSO, on the early winter North Atlantic-European (NAE) circulation. Results reveal that a positive IOD induces a strong response in the NAE region during December, leading to a positive North Atlantic Oscillation (NAO)-like pattern. This circulation response also induces a north-south precipitation dipole and a positive temperature anomaly over Europe. The underlying physical mechanism involves a rainfall dipole response to the IOD in the Indian Ocean, persisting into early winter, which triggers a perturbation in the zonal wind within the subtropical South Asian jet (SAJET) region. This initiates a wave-train that propagates northeastward into the North Atlantic. Additionally, a positive IOD enhances transient eddy activity in the European region. Transient eddy forcing provides strong positive feedback to the NAO-like anomaly. While the ECMWF-SEAS5 seasonal hindcast system reproduces the sign of the response, its magnitude is considerably weaker. The possible reasons for this weak response are investigated. The model can reproduce the delayed rainfall dipole response to the IOD, however, the structure of the response shows some differences with the re-analysis. The zonal wind perturbation in ECMWF-SEAS5 in the SAJET region is only about half of the re-analysis magnitude. Moreover, the wave propagation into the stratosphere, as estimated by the 100hPa eddy heat fluxes, plays a minor role in the re-analysis and the model.