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Disentangling forced trends in the North Atlantic jet in CESM2 using deep learning

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According to state-of-the-art climate simulations, the future evolution of the wintertime North Atlantic jet stream is highly uncertain compared to other ocean basins. This has important consequences on the projected daily weather variability and the occurrence of extreme events over Europe. In this context, disentangling the forced trends in the North Atlantic jet caused by an increase in greenhouse gases from its natural variability is a challenging but extremely relevant task.

In this study, we use a deep learning-based method, the Latent Linear Adjustment Autoencoder (LLAE), to separate forced trends from natural variability in an ensemble of fully-coupled Community Earth System Model simulations. The LLAE consists of a variational autoencoder and an additional linear component. The model predicts the component of the wind associated with natural variability from upper-level detrended temperature and geopotential. The residual between this prediction and the original wind field can be interpreted as the component of the wind related to the external forcing. Despite the large variability of the original trends, especially in the historical period, the LLAE is effective in extracting the forced component of the trend, which is similar for all ensemble members. The main characteristics of the forced trend are an increase in the wind speed along a southwest-northeast oriented band and an extension of the jet over Europe. These features are common for different periods and have similarities to the full North Atlantic jet trend in the ERA5 reanalysis.