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Estimation of the dynamical contribution to European temperature variations.

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Europe is one of the fastest-warming region of the world and temperatures of the recent years have been systematically higher than best estimates of the forced response. This may be due to internal variability in favor of warmer situations, or it may indicate that the forced response is underestimated.

In Europe, inter-annual temperature variations are primarily linked to the variability of North Atlantic atmospheric dynamics. The temperature T for a given day and year can be written as the sum of the forced response μ (the non-stationary climate normal) and the internal variability D + ε (D the atmospheric dynamics and ε the residual).

We investigate two methods for estimating the forced response in transient simulations, via a denoising of the temperature T from the dynamical term D. To test these methods, we use a perfect model framework, here the large ensemble of 50 MIROC6 transient simulations. The mean of the large ensemble provides an accurate estimate of the forced response (the « truth »), to which estimates from individual members can be compared.

The contribution of the D term is first estimated with a circulation analogues method. We reconstruct the temperatures of one individual member from similar atmospheric situations of the other 49 members. The analogues are calculated on the T-μ series, rather than on the T series directly.

Second, we reconstruct temperatures using deep neural networks. Using a U-NET, we estimate the function f in the equation $T=\mu+f(X)+\varepsilon$, where X is the sea level pressure. Our network is trained on the different members of the large ensemble.