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AMOC Predictability estimated through best analog

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Since Lorenz's work on the atmospheric circulation, we know that even with a hypothetically perfect numerical model, representing all the physical processes without any error, the inherent uncertainties in the initial conditions of the atmospheric problem will grow and disturb the numerical simulation of the transient atmospheric systems. This property, known as sensitive dependence to initial conditions, is a characteristic property of chaotic systems. This property could be generalised to longer timescale (from decadal to centennial) when looking at the climate system as a whole.

In this context, a standard approach to estimate predictability in realistic climate models is based on random perturbations of the initial conditions. This method, which time integrates the model with each individual perturbed initial conditions, requires intensive numerical computation to estimate the impact of error growth due to initial condition. To overcome this difficulty, we test a slightly different approach only based on "offline" diagnostic of a single long simulation (long enough to cover the full attractor of the system). This method considers best analog or similar initial condition (i.e. condition that are close in the phase space). The predictability is thus assessed by diagnosing the divergence of these trajectories.

To compare these two methodologies, we choose an idealised context. We use a chaotic model representing the long timescale variability of the Atlantic Meridional Overturning Circulation. We tested the performance of this approach on initial conditions located in different regions of the attractor of the system. We further studied the dependency on the number of elements required to obtain a estimation of the error growth (i.e. the size of the ensemble). The results suggest that the analog method can be a good tool to estimate predictability in the idealised model. Future work will be directed towards the application of this approach into more realistic time series.

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