SESSION: (B1) Mechanisms of S2D predictability

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Dynamical and thermodynamical impacts of the Atlantic Multidecadal Variability on the European climate

Cassou, Christophe (1), Qasmi, Saïd (1), Boé, Julien (1)

CECI, Université de Toulouse, CNRS, Cerfacs, Toulouse, France

The Atlantic Multidecadal Variability (AMV) is known for influencing the mid-latitudes climate variability. The physical mechanisms between the AMV and the European winter climate are assessed with the CNRM-CM5 model with large ensembles of simulations in which the North Atlantic Sea Surface Temperature (SST) is restored to SST anomalies characterizing the observed AMV. The restoring pattern is obtained with the superimposition of observed SST anomalies (computed from the regression of the observed interannual SST on the standardized AMV index) on the model's monthly climatology. The influence of the AMV amplitude on the teleconnection has been evaluated with three sets of 40-member of 10 years for each AMV phase. Each set corresponds to SST anomalies related to one, two or three standard deviations of the observed AMV (respectively named 1*AMV, 2*AMV and 3*AMV experiments). Each member starts from a random date of the so-called pre-industrial control run (a 850-yr long integration where all external forcings are kept constant to their estimated 1850 pre-industrial values).

We find that a change of the AMV phase in the 1*AMV experiment is not associated with a significant anomaly of surface air temperature (SAT) over Europe. Conversely, in the 2*AMV and 3*AMV experiments, a significant warming is found up to ~0.5°C over western Europe, and up to 1°C over Scandinavia. Precipitation changes in the 1*AMV experiment are not significant but an increase of ~6% is found over central Europe in the 2*AMV and 3*AMV experiments.

We quantify the impacts of the AMV on the European climate with an analog method separating the influence of large-scale circulation changes from the thermodynamical effect due to the SST variability. The decomposition shows that SAT over Europe in the 1*AMV experiment is equally driven by both the circulation anomalies and the residual (mainly containing the thermodynamic effects). In the 2*AMV and 3*AMV experiments, SAT anomalies are driven by the residual while the amplitude of the dynamical response remains stable, at the 1*AMV level. For the precipitation anomalies, both dynamical and residual influences contribute to the total response in the three experiments. We show that the residual component is mainly driven by the advection of heat and humidity from the ocean by the mean westerly flow. The dynamical component related to the circulation anomalies over Europe is found to be likely explained by the tropical Atlantic where a Gill-like response influences the position and the speed of the jet, which enhances the northward propagation of Rossby waves during a positive phase of the AMV. An influence from the North Pacific is also detected with the propagation of longer Rossby waves potentially interacting with the shorter ones propagating from the tropical Atlantic.