The AMOC interdecadal mode related to westward propagation of density anomalies in CMIP5

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Climate models show a broad variety of Atlantic meridional overturning circulation (AMOC) variability with the leading modes exhibiting different amplitudes, periods and potential driving mechanisms. The effect of these modes on climate varies significantly as well - the correlation between the North Atlantic SST and the AMOC varies between 0.2 and 0.8 with a few year lag. Simple theoretical models and our computations using ocean GCMs suggest that on interdecadal timescales this variability can be controlled by an internal mode of the AMOC associated with westward propagation of depth-integrated temperature (density) anomalies in the North Atlantic Ocean. The quadrature phases of this mode correspond to the strengthening of the AMOC followed by the development of a broad warm temperature anomaly in the northern Atlantic. We investigate whether this mode operates in the CMIP5 models and what role in climate it may play. Out of the 25 models investigated, we find that roughly one third to one half of the models exhibit variability consistent with this mode (e.g. GFDL-CM3 and GFDL-ESM2M). The most relevant modal features includes statistically significant spectral peaks in the band between 15 and 30 years, the westward propagation of density anomalies in the upper ocean correlated with a certain lag with the AMOC variations, temperature variations lagging AMOC by roughly a quarter-period, and the predominant effect of temperature on ocean density anomalies with a small compensation from salinity. On the whole, our results confirm the importance of this interdecadal AMOC mode for climate variability in the North Atlantic.