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Constraining the MOC influence on the 20th century global temperature trends

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The multidecadal changes in Meridional Overturning Circulation (MOC) have been proposed as one of the factors influencing the 20th century global temperature trends. The proposition is not absolutely implausible if one considers the facts that global temperature seems to be influenced by the North Atlantic temperature anomaly we call Atlantic Multidecadal Oscillation (AMO) as well as the observed anticorrelated multidecadal variations between surface and subsurface tropical North Atlantic. If MOC is not only a northward hear conveyor but also a multidecadal air-sea heat exchange cycle than it is justifiable to treat changes in MOC as an additional forcing of surface temperature on interannual and decadal time scales.

We used multiple regression analysis to allocate the contribution of separate forcings on the 20th century global temperatures. The forcings we used were, with one exception, the same as in previous published studies using this approach: both anthropogenic (greenhouse gases, aerosols and the ENSO) and natural (solar and volcanic). The new "forcing" we added to the set is the detrended AMO index. The analysis aim is to constrain the possible contribution of AMO to global temperature trends on the multidecadal time scale. We treat our results as upper constraints because AMO, being a simple index of North Atlantic surface temperature, is not an direct index of ocean overturning circulation, being contaminated by the effect of other forcings (AMO values will be changed by any forcing that influences surface temperatures of North Atlantic) and even the global temperature itself (even after detrending AMO, it correlates with global temperature). Therefore, we have additionally performed the regression analysis for AMO values partly corrected for this contamination by subtracting AMO regressed onto the relevant forcings from the standard AMO index values. This is especially important in the case of anthropogenic aerosol forcing which being stronger in the Northern Hemisphere could influence North Atlantic surface temperatures, and thus AMO, more than it influenced the global temperature average.

Our final results, the upper constrain of ocean circulation variability on global temperature trend can potentially be helpful in estimating the error of climate sensitivity values calculated using historical forcing and temperature data.