Multi-year prediction of the Atlantic Meridional Overturning Circulation at 26.5 °N possible

Climate scientists around Dr. Daniela Matei and Prof. Dr. Jochem Marotzke from the Max Planck Institute for Meteorology (MPI-M) and Prof. Dr. Johanna Baehr from Hamburg University's Cluster of Excellence „CliSAP" have now shown for the first time that the strength of the Atlantic Meridional Overturning Circulation at 26.5 °N can be skillfully predicted for up to four years. Their results have been recently published in Science.

The Atlantic Meridional Overturning Circulation (AMOC) - colloquially known as "Gulf Stream" - transports warm surface waters into the high latitudes, where they cool, sink and return southwards at depth as cold North Atlantic Deep Water. Variations in AMOC can significantly affect the northward ocean heat transport and therefore the European and North Atlantic climate. Through its influence on sea surface temperature (SST), AMOC can further impact climate phenomena such as Sahel droughts or the frequency of Atlantic hurricanes. Therefore, it is of outmost importance to be able to predict these climate variations on a time horizon from years to decades. Multi-year climate predictions have so far been limited to predicting surface temperature variations and hurricane frequency, but have not addressed the prediction of any dynamical quantity such as the AMOC.

In the near term (inter-annual to decadal timescales), climate variations are influenced by both anthropogenic forcing and natural variability. This is why the near-term climate prediction models must be started ("initialized") from the present state of the ocean.

The skill of any prediction system is assessed retrospectively, by performing the so-called "hindcast" or "retrospective forecast" and comparing them with observations. In the present study, ensemble hindcasts have been performed starting in January of each year between 2004 and 2007. The AMOC strength in the hindcasts closely follows the observations for up to four years.

The results of the coupled atmosphere-ocean-model ECHAM5/MPI-OM of the MPI-M have been evaluated against the only continuous available observations of the AMOC over the period April 2004 to March 2009. The AMOC observations were and will be performed in the RAPID-MOC project.

The good agreement between the hindcasts and the observations has motivated Dr. Daniela Matei and her colleagues to also produce AMOC forecasts (more details on the method in the original publication). An ensemble of nine forecasts spanning 10 years has been constructed for each of the Januaries from 2008 to 2011. For all start years the ensemble mean forecasts until 2014 indicate a generally stable AMOC (Fig.). However, the forecast initialized in January 2010 shows a pronounced minimum in March 2010. This brief minimum was induced by an extremely negative NAO (North Atlantic Oscillation) during the winter 2009/2010.

According to the findings of the working group, the AMOC predictive skill arises predominantly from the basin-wide upper-mid-ocean geostrophic transport. The results of the study demonstrate that the skill of climate prediction arises not only from the large ocean thermal inertia, but also from the long timescales of internal ocean dynamics.

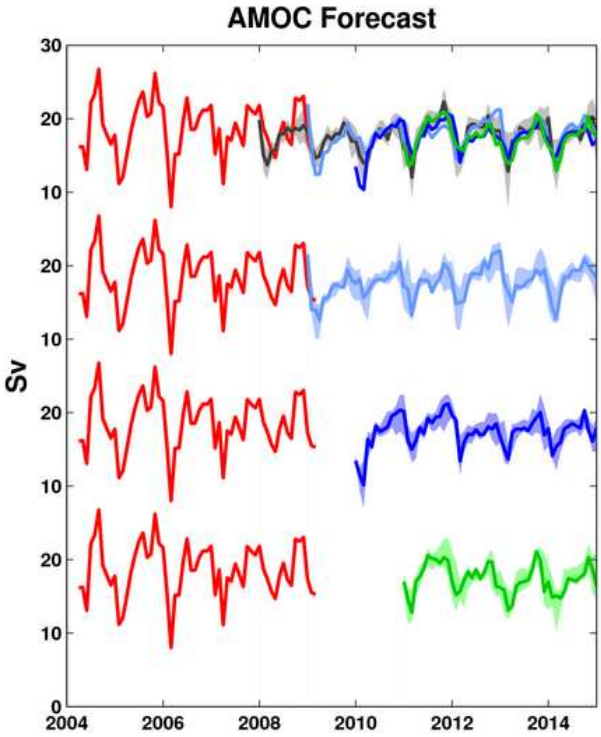

Figure: Multi-year predictions of AMOC transport. RAPID/MOCHA time-series are shown in red, ensemble mean forecast in dark grey/light blue/dark blue/green for the forecasts starting in Jan 2008/Jan 2009/ Jan 2010/Jan 2011.

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Original publication:

Matei, D., J. Baehr, J.H. Jungclaus, H. Haak, W. A. Müller und J. Marotzke: Multi-year prediction of the Atlantic Meridional Overturning Circulation at 26.5°N. Science, 6 January 2012.

More on the RAPID-MOC project:

http://www.mpimet.mpg.de/en/news/press/press-releases/german-british-project-for-investigation-of-the-gulf-stream.html

Project Nordatlantik II:

http://www.mpimet.mpg.de/en/science/funded-projects/projects-with-mpi-m-participation/north-atlantic-ii.html

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