The origin of the low-frequency variability of the Atlantic Meridional Overturning Circulation (AMOC) is investigated from 1/4° and 1/12° global ocean/sea-ice simulations performed by the DRAKKAR Group. A 327-year climatological simulation, driven by a repeated seasonal cycle (no interannual forcing) is shown to spontaneously generate a significant fraction of the low-frequency AMOC variability obtained in a 50-year « fully-forced » hindcast (reanalyzed atmosphere with interannual timescales). The actual AMOC variability is thus partly forced by the atmosphere and, to a substantial extent, by oceanic non-linearities as well.

The intrinsic AMOC variance is maximum at the latitude of the Gulf Stream, and is shown to account for 50% of the fully-forced low-frequency AMOC variance in the Agulhas region where inter-basin exchanges are modulated by chaotic mesoscale activity and Rossby modes propagating into the South Atlantic. Several intrinsic AMOC variability features are shown to be consistent at ¼° and 1/12°.

The fully-forced AMOC variability clearly exhibits dominant timescales (between 3 and 8 years) depending on the latitudes considered. In several regions, similar (yet smaller) peaks are found in the intrinsic AMOC variability spectra. These analyses are extended over 256 years, and yields a time-frequency description of intrinsic, multi-decadal AMOC variability throughout the whole Atlantic.

Our results suggest that intrinsic/chaotic variability processes should be taken into account for the monitoring, attribution and investigation of low-frequency AMOC variability.