Poster abstract

Connecting AMOC Variability and Biological Cycling in two Earth System Models

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We compare the connection between AMOC variability and biological cycling in two Earth System Models run at the Geophysical Fluid Dynamics Laboratory. The models have identical atmosphere, land surface, sea ice and ocean biogeochemical components. The ocean models, however, are different with ESM2M configured using the MOM4 pressure coordinate code and ESM2G configured using the GOLD isopycnal coordinate code.

Interannual biological variability is quite different in the two models, with ESM2G showing much larger amplitude variability in the timing and magnitude of large plankton biomass connected with the overturning circulation. This is likely due to two effects. First, the overturning circulation and associated changes SST and mixed layer depth are bigger in ESM2G than in ESM2M. Second, in ESM2G surface nutrients are drawn down much efficiently, reproducing the observation that most of the North Atlantic is nutrient limited by the end of the season. By contrast, this does not happen in ESM2M. As a result, biological cycling in ESM2G is more sensitive to variations in nutrient supply associated with changes in wintertime convection linked to the overturning. Both the enhanced drawdown in summer and larger variability of overturning may result from the fact that the mixed layer in GOLD can vary continuously and take very small values, in contrast to MOM which is limited by it's 10m resolution. Allowing shallower mixed layers in GOLD means that plankton are less likely to become light-limited in summer months, but may also mean that the model is overly sensitive to buoyancy forcing.

Examination of three regions in ESM2G reveals two (West Greenland and the Bay of Biscay shelf) where significant interannual variability is connected with the overturning changing nutrient supply and one (the Labrador coast) where the warming produced by overturning changes sea ice extent and results in an earlier spring bloom. The last of these is likely to be highly predictable, as the warming associated with a stronger overturning lags the establishment of convection by 4 years. Predictability in other regions is determined by the ability to predict the development of high-latitude salinity anomalies, which in this model are associated with changes in the pattern of wind stress.

Reference

Gnanadesikan, A., J.P. Dunne and R. Msadek, Connecting Atlantic Temperature Variability and Biological Cycling in two Earth System Models, submitted to. J. Mar. Sys.