Oxygen Fingerprints of Variability in the Atlantic Meridional Overturning Circulation

The Atlantic Meridional Overturning Circulation (AMOC) is a part of the global conveyor belt that transports cold, dense water from the poles towards the tropics, and warm, shallow water from the tropics towards the poles (Delworth et al., 2008). This mass movement of water is also referred to as thermohaline circulation, as it is responsible for distributing heat and salt across the ocean. It is already known that the AMOC has a significant impact on climate – for example, Rahmstorf discusses the effects of the recent observed slowing of the AMOC on the melting of the Greenland Ice Sheet (Rahmstorf et al., 2015) and the Category 5 blizzard that hit the East Coast of the United States in January 2016 (Vaidyanathan, 2016). In addition, the reduction in the amount of carbon stored in the oceans has been largely attributed to the recent slowing in the AMOC (Pérez et al., 2013). As such, the ability to accurately describe the AMOC is of extreme importance to being able to visualize and understand the mechanisms that drive our climate.

However, direct time series measurements of the AMOC are limited due to difficulties in measuring the overturning (McCarthy et al., 2014). With a lack of data about past AMOC behavior, it is difficult to conclude how much of the observed changes in climate have been driven by changes in overturning. Therefore, if we can find data that correlates with overturning *and* has a longer time series, such as those of transient tracers, we can better understand how overturning changed in the past. Transient tracers are time-varying chemicals that enter the oceans from the atmosphere and provide us with information about chemical and physical ocean pathways as their distributions change over time (Jenkins, 1996 and Müller et al., 2006).

In this project, we will examine whether the transient tracers concentration of oxygen at shallowest local minimum *(variable name: o2min)* and raw oxygen concentration *(variable name: o2*) can be used to describe ocean overturning at different latitudes across models. The *o2* variable is a 3D profile of oxygen concentration, and is available in the Geophysical Fluid Dynamics Laboratory (GFDL) models, whereas the Lawrence Livermore National Laboratory (LLNL) models only have the *o2min* variable. We can use Ferret tools to decompose the 3D *o2* variable into a profile of the oxygen at shallowest local minimum so that it is comparable with the LLNL *o2min* variable. We will test whether *o2min* and decomposed *o2* behave consistently across models by comparing their correlations with overturning in selected ocean models. If areas of high correlation prove to be consistent, we have reason to believe that we can extend the relationship between *o2min/o2* and overturning to real-world data.

We hypothesize that transient tracers such as concentration of oxygen at shallowest local minimum and raw oxygen concentration can better describe variation in overturning than spot measurements of the overturning. This project addresses the observed relationship that transient tracers have with overturning, and will show whether and how we can use transient tracer data to extend ocean overturning into the past. In addition, through model intercomparison, this project address the robustness of several climate models, and will reveal key differences between models.

References:

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