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A feasibility study of monitoring AMOC variability through ocean bottom pressure observations from GRACE

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The Atlantic Meridional Overturning Circulation (AMOC) is a key mechanism in basin-scale northward heat transport and thus plays an important role for global climate.
Mechanistically, ocean bottom pressure (OBP) changes at the eastern and western boundaries completely determine the geostrophic AMOC component, with most of the action centered on the western boundary. We confirm this relationship using model output of two ocean state estimates, ECCO2 and GECCO2. In both products we find strong correlations between AMOC variations and regional OBP variations, mainly along the western slope of the Atlantic basin (see schematic in Fig 1, from Roussenov et. al., 2008):

Fig. 1 (left) Overturning circulation manifests itself in east–west OBP contrast; (right) In the North Atlantic, the signal is concentrated mainly along the western boundary.

We then reconstruct the AMOC variations from OBP changes. A key aspect of our work is the question to what extent space-based observations of ocean bottom pressure via time-variable gravity (such as from GRACE) can be used to infer AMOC variability. To evaluate this, the ECCO2 and GECCO2 OBP fields are smoothed and filtered to resemble the relatively coarse resolution of GRACE. First results indicate that it is possible to infer part of the AMOC variability from GRACE-like OBP observations in the North Atlantic. Fig. 2 shows an example of reconstructed MOC stream function from OBP anomaly time series on an ECCO2 model grid (0.25 deg spacing) and from OBP anomaly time series on a GRACE-type grid (~3 deg spacing), compared to the model's MOC product. Here, we discuss the fidelity of GRACE-like OBP variations for AMOC observations in the North Atlantic at different latitudes and characterize the accuracy as a function of latitude, depth and time-scales.

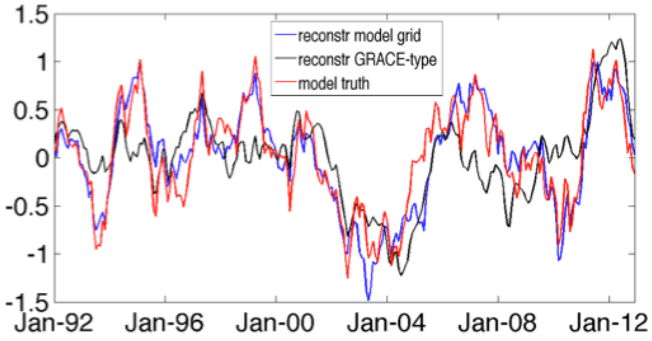

Fig. 2 Model-truth and reconstructed AMOC variations (Sv; 100-1300m) in the North Atlantic at 27N; correlation between model truth and reconstruction at model-resolution is 0.91, and between model truth and reconstruction at GRACE-resolution is 0.66.