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AMOC hysteresis in an eddy-permitting GCM and monitoring indicators

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We conduct idealised experiments with HadGEM3-GC2, which is a pre-CMIP6 eddy-permitting GCM, to test for the presence of thresholds in the AMOC. We add fresh water to the North Atlantic for different rates and lengths of time, and then examine the AMOC recovery. In some cases the AMOC recovers to its original strength, however if the AMOC weakens sufficiently it does not recover and stays in a weak state for up to 300 years.

We test various indicators that have been proposed for monitoring the AMOC with this ensemble of experiments (and other scenarios). In particular we ask whether fingerprints can provide early warning or faster detection of weakening or recovery, or indications of crossing the threshold. We find metrics that perform best are the temperature metrics based on large scale differences, the large scale meridional density gradient, and the vertical density difference in the Labrador Sea. Mixed layer depth is also useful for indicating whether the AMOC recovers after weakening.