Trend detection of the Atlantic Meridional Overturning Circulation

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The Atlantic Meridional Overturning Circulation (AMOC) has been monitored by the RAPID array since 2004 at $26.5°$ N. A main question is whether a decline is occurring, as it could affect the climatically crucial northward heat transport. Several recent studies have investigated the presence of a trend, however it is difficult to distinguish a long-term trend from decadal variability due to the shortness of the record. Using a statistical model, we create 1000 ensemble simulations of an extended AMOC time series containing the observed trend, variance, and autocorrelation from the RAPID annual data. These parameters are used to replicate the variability and short-term memory of the fluctuations of the AMOC. We fit a generalised least squares (GLS) model to the simulations and determine the number of years required in order to detect the trend ($p<0.05$) with 95% confidence. This estimation is then repeated using parameters from twenty numerical simulations of the Coupled Model Intercomparison Project Phase 5 (CMIP5) under the "business-as-usual" future scenario (from 2006 to 2100). We find that $\sim$31 years of data are required to detect a signicant trend ($p<0.05$) using the RAPID data and $\sim$42 years using the CMIP5 ensemble mean (+/-10 years). Additional years of RAPID monitoring are therefore necessary to robustly detect a trend. This work supports the importance of maintaining high quality operational AMOC observations.