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Variability of the Meridional Overturning Circulation

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The spectral variability structure of the meridional overturning circulation (MOC) of the Atlantic Ocean is determined in 500 year simulations with state-of-the-art coupled atmosphere-ocean general circulation models (GFDL and ECHAM5/MPIOM). The power spectra of the monthly stream function are compared with trend-eliminating detrended fluctuation analysis (DFA2). The shapes of the spectra differ substantially between latitudes, depth and the two models with constant (white) behavior for high frequencies as a single common feature. The most frequent property of the spectra is power-law scaling, $S(f) \sim f^{-\beta}$, with nontrivial exponents, mostly $\beta \sim 1$, in agreement with $1/f$ or flicker noise; this is mainly found in the interannual to decadal frequency range ($1/f$ spectra observed for sea surface temperature fluctuations are explained by a stochastically forced ocean energy balance model with vertical diffusion). For lowest frequencies, some spectra show stationary long term memory, while others reveal spectra increasing with frequency. None of the spectra can be considered uniquely as red noise explained by an ocean integrating a white stochastic atmospheric forcing.