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Intrinsic variability in the global eddying ocean at interannual timescales: sea-level, sea-surface temperature, overturning

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Several studies have shown in idealized contexts (simplified dynamics, geometry, etc) that constantly- or seasonally-forced turbulent ocean models intrinsically generate low-frequency variability in eddy-active regions. We aim to quantify in a realistic context (from observations and eddying ocean simulations) at global scale the imprint of this intrinsic interannual variability on climate-relevant quantities, i.e. sea-level anomalies (SLA), sea-surface temperature (SST), and meridional overturning circulation (MOC). Our 1/4o global ocean/sea-ice general circulation model reproduces the main observed features of the SLA and SST high- and low-frequency variabilities when driven by the full range of atmospheric timescales. Comparing this "fully-forced" simulation with a second one driven only by the climatological seasonal cycle reveals that the intrinsic part of the total interannual SLA variance exceeds 40% over half of the open ocean area, and exceeds 80% over one fifth of it. This proportion is also large on SST, although slightly smaller (perhaps for numerical reasons since bulk formulae localy damp differences that emerge between SSTs and prescribed atmospheric temperatures). Intrinsic fluctuations of SST and SLA are particularly strong in eddy-active regions (Southern Ocean and Western boundary current extensions) as predicted by idealized studies, as well as within the 20-35o latitude bands. The same simulations were also performed and analyzed at 2o resolution: switching to this laminar regime yields a comparable forced variability (large-scale distribution and magnitude), but almost suppresses the intrinsic variability. The intrinsic MOC variability and its contribution in the total low-frequency MOC variability is then presented, revealing regions where the forced component may be shadowed by more chaotic, intrinsic low-frequency signals. We separate diabatic and adiabatic MOC variations to evaluate possible climate impacts and consequences in terms of observational strategies. These results strongly suggest that (1) laminar ocean models underestimate the oceanic interannual variance because they are devoid of intrinsic variability; (2) the use of eddying ocean components in climate prediction systems is expected to yield a stronger, more chaotic climate variability because eddying oceans intrinsically generate a substantial SST variance at long timescales.