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Intrinsic variability in the eddying ocean at low frequency: climate-relevant fingerprints.

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Idealized studies (see the review by e.g. Dijkstra and Ghil, 2005) have shown that the nonlinear ocean circulation spontaneously generates low-frequency variability under constant atmospheric forcing. This phenomenon is chaotic and gets stronger with increasing Reynolds number. In the eddying regime, this intrinsic ocean variability has typical timescales of 1-10 years, and particularly affects the horizontal circulation. Nonlinear processes have been proposed to explain its generation, e.g. eddy-eddy interactions (Arbic et al. 2011), eddy PV fluxes or turbulent rectification (Spall 1996; Dewar 2003; Berloff et al 2007).

Identifying the magnitude, spatial structure and fingerprints of this intrinsic chaotic variability in the real ocean would have important implications (e.g. for climate monitoring/hindcasting/forecasting, model assessment, etc). This can hardly be done from observations only since intrinsic and atmospherically-forced variabilities are entangled, but may be attempted from recent global, high-resolution, multi-decadal Ocean General Circulation Model simulations. In this presentation, we address the issues mentioned above by comparing a 327-year seasonally-forced simulation (no interannual forcing) performed with the Drakkar NEMO-based global 1/4° model, with its 50-year counterpart driven by a realistic forcing including the full range of timescales (i.e. with interannual forcing).

Our seasonally-forced simulation reveals the imprint of the intrinsic interannual variability on various climate-relevant ocean variables, e.g. sea-level anomalies, sea-surface temperature, mixed layer depth, meridional overturning streamfunction. Comparing these intrinsic variances with their total counterpart (from the second simulation) then provides us with estimates of this chaotic component's fingerprint on climate-related variabilities. We show that intrinsic variances, which are negligeable in laminar IPCC-like ($\sim$2°) ocean models, may exceed their atmospherically-forced counterparts in eddying regions and leave a large imprint on several climate-relevant variables. This raises interesting issues about ocean and climate variabilities in future IPCC climate prediction systems which will include eddying ocean models.