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The OCCIPUT ensemble simulation: describing the ocean variability as an atmospherically-modulated oceanic ”chaos"

Mesoscale ocean turbulence is the best-known expression of Chaotic Intrinsic Variability (CIV), which spontaneously emerges from the unstable ocean circulation regardless of the atmospheric variability. Substantial amounts of CIV are also found up to the scale of basins and decades, potentially produced by large-scale baroclinic instability or resulting from spatiotemporal inverse cascade processes.

A 56-year atmospherically-forced 50-member 1/4° large ensemble simulation of the global eddying ocean/sea-ice system has been performed in the context of the OCCIPUT project to explore these phenomena using the NEMO model. We first show that the low-frequency large-scale (LFLS) CIV has climate-relevant imprints over most of the globe, is largest in western boundary currents and south of about 30°S, and competes with (and in certain zones exceeds) the atmospherically-forced ocean variability (AFV) in terms of amplitude.

However, the separability of AFV and CIV is questionable in the general case. Concepts from non-autonomous dynamical systems and information theories are leveraged to avoid this separation, and to probabilistically describe the ocean variability as an atmospherically-modulated oceanic "chaos". The partly random character of multi-scale ocean fluctuations in the eddying regime questions the attribution of observed signals to sole atmospheric drivers, the turbulent ocean predictability and its potential influence in high-resolution coupled simulations