The stochastic climate model in action: hydrodynamic unprovoked variability in regional seas.

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While the generation of an ensemble of trajectories in models of the global and regional atmosphere, when subject to identical forcing and boundary values but miniscule disturbances for instance in the initial values or the change of by employing a different computing platform, is well known, this issue has received little attention among regional ocean modelers. This phenomenon may be understood in terms of Hasselmann's stochastic climate model, according to which an inert system transforms short-term noise (white spectra) transform into long-term variation (red spectra), if the numerical diffusion is not too strong. The presence of noise has the immediate consequence that for numerical experimentation either very long simulations or ensembles of simulations are needed.

We have examined the formation of unprovoked variability, i.e., variations not related to a forcing, in a series of simulations of the hydrodynamics of the South China Sea (SCS). We first demonstrate that such unprovoked variability, which we call "noise", emerges – less so in coarse-grid resolution models, and more so in fine-grid resolution models. Then, with the help of an ensemble of four 1-year simulations with fine grid-resolution, we determine the intra-ensemble variance after a spatial scale separation (using EOFs). The smaller the scale, the more intense the noise. The larger scales exhibit stronger signal-to-noise ratios, reflecting the direct input of atmospheric forcing.

Having examined a multidecadal fine-resolution, weather-forced simulation of the SCS hydrodynamics, we find noise residing in the eddy dynamics, whose statistics can hardly be conditioned on characteristics of currents, vertical stability or sheer. Other noisy components may be related to internal wave dynamics and other mesoscale features.

Plain language abstract

That dynamical models of the hydrodynamics of the atmosphere do not generate unique trajectories, but an ensemble of such trajectories when miniscule disturbances are introduced is well known. However, in regional ocean modeling this seems not to be common knowledge. we demonstrate and describe this phenomenon, which is a manifestation of Hasselmann's stochastic climate model. It has significant implications, namely the need for employing ensembles and separating signal and noise when doing numerical experimentation.