A fluctuation-dissipation relation for the ocean subject to turbulent atmospheric forcing

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We establish the fluctuation-dissipation relation for a turbulent fluid layer (ocean) subject to frictional forcing by a superposed lighter fluid layer (atmosphere), using a hierarchy of mathematical models.

The fluctuation-dissipation relation reflects the fact that air-sea interaction not only injects energy in the ocean but also dissipates it. Energy injection and dissipation must therefore be related. The competition between the two processes determines the oceanic energy budget. When applying the fluctuation-dissipation relation to a two-dimensional two-layer Navier-Stokes model with turbulent dynamics, in the atmosphere and the ocean, coupled by a quadratic friction law, the friction parameter is estimated within 8% of the true value, while the estimation of the mass ratio between the atmosphere and the ocean fails, as the forcing time-scale is not faster than the characteristic time-scale of the atmospheric dynamics.