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Global modelling of surface and internal tides

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Almost 250 years ago Laplace formulated a system of hydrodynamical equations that can describe the dynamics of ocean tides given astronomical forcing and global topography. But these equations lack dissipation that is required to cause the observed slowdown of Earth's rotation. During the last 100 years the importance of two dissipative processes has been recognised: energy loss to a turbulent bottom boundary layer in shallow seas and, more recently, energy conversion from surface to internal tides (i.e. internal waves at tidal frequency). And this internal tide is now thought to play an important role in setting the global oceanic circulation, and, therefore, climate on Earth.

Here, a new global numerical model of ocean tides is described. Special emphasis is placed upon accounting for the energy loss to internal tides in a simplified but physically consistent way, which is achieved via explicit modelling of linear internal wave generation at specified tidal frequencies. The model resolution is sufficiently high to resolve a few low-mode internal tides which capture the majority of barotropic-to-baroclinic energy conversion. The advantages (and limitations) of this approach are examined, by comparison with the model results obtained with popular internal wave drag parametrization schemes. Although our purely dynamical model is less accurate than data-constrained models, it is more flexible and can be used to explore tidal regimes of the past and future and their climatological implications.