Abstract View

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Data Constraints Applied to Models of the Ocean General Circulation. Part I: The Steady Case

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ABSTRACT

In this work we take a first step in the process of assimilating data into models of the ocean general circulation. The goals is not prediction but rather understanding how the data insertion process affects, and is affected by, the dynamics governing the model. The chosen model ocean is steady, weakly nonlinear and highly frictional Strong vertical friction plays the role of eddy fluxes in driving the circulation in the deep layers.

In the data insertion process we capitalize upon the two principles that (i) the available dynamical models are imperfect; (ii) oceanographic data are measured locally. Three major questions are addressed; 1) what is the influence of local data insertion in terms of improving estimates of the model general circulation? 2) how does the model dynamics affect the spreading of information from the data insertion region? 3) what can we learn about the model physics from the effects of data insertion

Density (or temperature) measurements along long hydrographic or tomographic sections or arrays are chosen as data. We vary the location of the section as well as its orientation. In our highly frictional ocean, the most effective sections are meridional, long and located at a distance from the western boundary. Model estimates are then significantly improved over the broad region extending from the data section to the western boundary itself.

Advective effects are minimal and influence the spreading of information only in the intense western boundary current. Rather, the structure of the gyre interior manifests itself through a quite important steering effect exerted by the motion in the intermediate layer upon the spread of information in the surface layer. Due to this effect the region southwest of the data section is consistently preferred for the improvement of the estimates. Simple analytical

computations are carried out to rationalize the numerical results. This effect is likely to persist in more realistic, fully eddy-resolving simulations in which the interfacial eddy stresses would play the role here given to vertical friction.

The dependence of spreading of information upon the internal physics and/or external forcing is used to examine what is imperfect in the model parameterizations. In a simple analytical example we scan the two-dimensional parameter space defined by internal friction and wind stress amplitude. The “correct” values of the above parameters cannot be inferred by this simple scanning due to the non-uniqueness of the solution.

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