Abstract View

Volume 18, Issue 8 (August 1988)

Journal of Physical Oceanography
Article: pp. 1093–1107 | Abstract | PDF (1.16M)

Data Constraints Applied to Models of the Ocean General Circulation. Part II: The Transient, Eddy-Resolving Case

Paola Malanotte-Rizzoli

Department of Earth, Atmospheric and Planetary Sciences, Center for Meteorology and Physical Oceanography, Massachusetts Institute of Technology, Cambridge, Massachusetts

William R. Holland

National Center for Atmospheric Research, Boulder, Colorado

(Manuscript received September 1, 1987, in final form December 28, 1987)

DOI: 10.1175/1520-0485(1988)018<1093:DCATMO>2.0.CO;2

ABSTRACT

Options:
- Create Reference
- Email this Article
- Add to MyArchive
- Search AMS Glossary

Search CrossRef for:
- Articles Citing This Article

Search Google Scholar for:
- Paola Malanotte-Rizzoli
- William R. Holland

In Part I of the present work we performed assimilation experiments with a multilayer, quasi-geostrophic (QG) eddy-resolving model of the ocean general circulation. In Part I we studied the quasi-linear, steady state and the assimilated data were density measured along hydrographic sections. The major result of this study was that the most effective sections are long, meridional ones located at distance from the western boundary. The model estimates are significantly improved over the entire region extending from the data section to the western boundary itself.

In this second part we extend the study to the more realistic time-dependent, fully eddy-resolving ocean. Again we capitalize upon the two assumptions that the available models are imperfect and that data are measured only locally at meridional sections. The location of the sections are chosen according to (i) distance from the western boundary; (ii) energetics of the region. Also, here we compare assimilation of density alone versus density and velocity.

A crucial problem emerges when assimilating data into a fully nonlinear, time-dependent model, that is the problem of model predictability The assimilated data can in fact be viewed as “perturbations” introduced into the model at a specific location. The important question is then: is data insertion performed only locally, i.e., along sections, sufficient to “drive” the model to the reference ocean overcoming the model inherent loss of predictability.

Different data sections are compared and the model performance is quantified monitoring two global rms (root mean square) errors, the rms DIFF1 between the model with inserted data and the reference ocean and the rms DIFF2 between the model with inserted data and without.

Two major results emerge from the present study. First, and differently from the quasi-linear steady case, a single data section is very ineffective in driving the model towards the reference ocean over time scales of $\sim$100 days, comparable with the time scale of predictability loss. The rms-error DIFF2 is used to quantify the effectiveness of the different section as the “true” rms-error DIFF1 exhibits only random fluctuations around a mean equilibration value. The overall error level depends upon the balance between criteria (i) and (ii) above. Results are rationalized by dynamical considerations showing that the internal boundary forcing provided by the data insertion is equivalent to an additional stress-curl (vorticity source) imposed impulsively along a line in each layer. Also, the assimilation of barotropic and baroclinic information versus baroclinic only (velocity and density versus density only) has no effect on the error levels and error growth rates on the short time scale of mesoscale variability. In general, the error growth rates are not significantly different for any of the considered sections, both for the global rms errors measured over the entire basin and for local rms-errors measured over localized regions. On the short time scale of mesoscale variability, all the considered sections are equally ineffective.

A single section of data is shown instead to be quite effective in driving the model to the reference ocean if the data insertion process is carried out for time durations longer than the model equilibration time. With ten years of data assimilation, the climatological mean of the model becomes extremely similar to the climatological mean of the reference ocean. This result can now be quantified using the “true” rms-error DIFF1, which exhibits an unambiguous decreasing trend during the last years of assimilation, thus improving the estimate of the climatology up to 25%. Thus, single hydrographic sections might still be useful in providing a better model climatology if time series of data were available longer than the model equilibration time.

top ▲

Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
Allen Press, Inc. assists in the online publication of *AMS* journals.