A Dual Assimilation System for Satellite Altimetry

I. Fukumori, T. Lee, D. Menemenlis, L. Fu, B. Cheng, B. Tang, Z. Xing, M. Nakamura (JPL) and R. Giering (FastOpt)

ABSTRACT

Progress has been made in implementing a complimentary, dual data assimilation system for estimating the time-evolving ocean circulation. The system consists of a “cellular” Kalman filter that provides error estimates and a means for routine analyses, and the adjoint method that is used for parameter estimation and rigorous reanalyses. The model is based on the MIT GCM and is global with a reasonably high resolution (Δx=10°, Δy=1/3°, 360×224×64) and advanced mixing schemes (GM & KPP). TOPEX/POSEIDON data are assimilated together with Levitus climatology and NCEP flux estimates.

PRIOR ERROR ESTIMATION

Statistics of prior data and model errors (R, P) may be estimated by comparing observations (D) and the model simulation (M):

\[<DD> = <SS> + 2<SR> + <RR>\]

\[<MM> = <SS> + 2<SP> + <PP>\]

Data constraint error, R, may be uncorrelated over a short distance in space and/or time (e.g., meso-scale eddies in a non- eddy resolving model). Then, the lagged covariances above may be used to estimate <PP> and, then in turn, the zero lagged <RR>.

"CELLULAR" KALMAN FILTER

Certain model errors are approximately uncorrelated from others; e.g., Small-scale errors are independent over large distances. Such near independent errors can efficiently be estimated over a large domain by combining multiple overlapping regional (and/or physical) filters. Example: 1-d non-rotating shallow water model.

ASSIMILATION OF T/P BY KALMAN FILTERS

A global barotropic filter and a regional first baroclinic mode filter are constructed to establish a baseline estimate of the wind-driven circulation of the tropical Pacific Ocean.

BAROCLINIC SIMULATION ERROR ESTIMATE

Model process noise is modeled as wind error. The baroclinic filter consists of amplitudes of the first baroclinic mode defined on a coarse grid spanning the tropical Pacific Ocean (10°×5°, 20°S−20°N, 132 points, 3 variables). Sea level, units in cm^2.

ASSIMILATION BY ADJOINT METHOD

T/P data are assimilated simultaneously with Levitus climatology and NCEP surface flux estimates. A time-hierarchical approach is taken whereby a longer assimilation is initialized by results from a shorter optimization. Results are shown for a three-month period (Jan–March, 1997) optimization.

REDUCTION OF MODEL−T/P DIFFERENCE

The adjustment of initial state plays a much more important role than that of surface forcing during this short period of assimilation. Units in cm^2.

NATURE OF NINO3 TEMPERATURE CHANGE

Analysis of model simulation shows Nino3 temperature change (Ta) is primarily due to zonal subduction (TaU).