POWER SPECTRAL PARAMETERIZATIONS OF ERROR AS A FUNCTION OF RESOLUTION IN GRIDDED ALTIMETRY MAPS

Alexey Kaplan, Mark A. Cane, Dake Chen
alexeyk@ldeo.columbia.edu mcane@ldeo.columbia.edu dchen@ldeo.columbia.edu
Climate Modeling Group, Division of Ocean and Climate Physics
Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, United States

1. INTRODUCTION

Data assimilation procedures interpret observed data as if they could be represented in terms of the average over model grid box areas. In reality, however, observations are either point-wise values (in cases of in situ data) or averages over certain footprints (in cases of satellite data). Therefore, the difference between observations and model values might reflect the difference of the unresolved variability of the observed quantity at the locations of the footprint minus the unresolved variability of the quantity on the model grid and by the observational system. This difference must not be a major contributor to the effective data error and needs to be taken into account in data assimilation procedures. Multisatellite missions to date have created in-satellite altimetry fields of unprocessed resolution which, in turn, make it possible for us to obtain detailed descriptions of mean and short-term variability of sea surface height. Error models suitable for use in data assimilation procedures were developed. They are verified by comparing satellite altimetry with in situ (tide gauge) data.

2. SMALL-SCALE VARIABILITY AND EDDY KINETIC ENERGY

Connection between surface geostrophic kinetic energy and small-scale variability (left panel) in sea surface height: $\frac{C_{<r}}{C_{(L_x^2+L_y^2)}^{1/2}} < \alpha$, where $C_{<r}$ is the energy differences and $\alpha$ depends on the wave number power spectrum of the sea surface height. Parameter $\alpha$ shows how small differences in sea surface height scale to the $L_x$-$L_y$ box. Stammer et al. (1997) midtidal and tropical spectral approximations are spliced together for the use in this work (right).

3. FORMALISM VALIDATION

Spatial patterns of one-dimensional coefficients

4. SCALING FOR POWER-LAW SPECTRAL FORMS:

$$P(k) = A/k^n$$

5. Definition of Representation Error

The power-law fit is used for data assimilation purposes, to reflect the differences arising from physical laws by the data assimilation procedure. Systematic errors introduced by the model and by different types of observing systems. This difference needs to take into account the error due to the assimilation procedures.

What is the error of the data with regards to the model grid? The model grid values $\Omega$ should be specified for the data assimilation system.

In addition to assimilation error, the data, we need to take into account the need to reflect the difference in averaging of the physical field by the model and the different types of the observing systems.

6. ERROR MODELS FOR ALTIMETRY AND TIDE GAUGES

Validation of TP error estimates by comparison with the tide gauge records, October 1992 – March 2001. The top panel compares monthly tide gauge sea level height anomalies at Christmas Island (dashes) with altimetric measurements from the corresponding grid box (centered at 2N and 158W) of Chelton et al. [1994] TP product. Dots show values from individual altimetry passes, and the solid line shows their monthly averages for this grid box. Temporal RMS values of the intrabox variability $s$ inside the gridbox, the sampling error estimate $\sigma$ for the gridbox mean, and the RMS difference between the gridbox and tide gauge monthly means $d$ are indicated as well. In the lower left panel, circles are differences between 31 tide gauges and T/P bins. Differences would fall along the solid line if the only errors were the "optimistic" estimate of T/P errors. The dashed line illustrates these optimistic estimates by a factor of 1.5. In the lower right panel, thin lines show constraints on the inflation factor alpha and tide gauge error $r$ for various tidal gauges. The thick line shows the median constraint.


7. RESULTS

1. Effective data error depend on the model resolution (and averaging intrinsic in individual observations)

The richness of satellite data allows us to specify and use for error modeling spectral representations of assimilated fields. Error due to averaging differences may exceed the nominal measurement error.

2. We have derived a connection between eddy kinetic energy and small-scale sea surface height variability; a coefficient in this connection characterizes the sea surface height wave number spectrum. It cannot be used to infer spectral representations for error modeling. Error due to averaging differences may exceed the nominal measurement error.

3. We analyzed the ratio of temporal and spatial variance contributions to the small-scale sea surface height variability. This ratio has proved useful for modeling effective error in tide gauge data.

REFERENCES:


