Inhomogeneous and Nonstationary Feature Analysis: Melding of Oceanic Variability and Structure (INFAMOVS)

Dr. Arthur J. Mariano
RSMAS, MPO, University of Miami
4600 Rickenbacker Cswy
Miami, FL 33149
Telephone: 305-361-4193
Fax: 305-361-4622
E-mail: amariano@rsmas.miami.edu

Dr. Toshio M. Chin
RSMAS, MPO, University of Miami
4600 Rickenbacker Cswy
Miami, FL 33149
(On a one year leave of absence to JPL)
Telephone: 305-361-4816
E-mail: tchin@rsmas.miami.edu

Award #: N00014-95-1-0257

http://www.rsmas.miami.edu/people/amariano

LONG-TERM GOALS

One of the primary research goals at RSMAS is real-time forecasting of both Eulerian fields, such as temperature and velocity, and Lagrangian trajectories. The five primary components are (i) MICOM, the Miami Isopycnal Coordinate Ocean Model, (ii) satellite-derived sea surface temperature and height fields and data from Lagrangian drifters, (iii) an Extended Kalman Filter (EKF) with a second-order Gauss-Markov Random Field (GMRF) model for spatial covariances, (iv) a random flight turbulence model for Lagrangian trajectory prediction, and (v) contour-based parameter estimation and assimilation techniques.

OBJECTIVES

Documenting, understanding, and predicting ocean variability through the use of new data analysis and assimilation techniques.

APPROACHES

Our data analysis and assimilation approaches are based on motion-compensated space-time interpolation algorithms, state space reduction techniques, hodography, and multi-scale field decomposition.

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TASKS COMPLETED

Satellite-derived SST fields, starting from 1986, are being assimilated into the MICOM using the parameter matrix objective analysis algorithm. Preliminary results indicate a more realistic Gulf Stream, improved estimates of both the Meridional Overturning Circulation and the range of subtropical mode water.

Twin experiments using our MRF-based EKF for assimilating Sea Surface Height (SSH) into a multi-layer MICOM double gyre simulations are being performed. Prediction errors and filter performance were evaluated for a suite of updating strategies, subspace projections/covariance parameterizations, initial conditions, data sampling, and model variance to measurement variance ratios. Experiments with realistic coastlines and topography in the DAMEE-NAB are being analyzed.

An algorithm for applied Lagrangian prediction has been tested in model simulations (Ozgokmen et al., 1998) and Gulf Stream search and rescue simulations with real drifter data (Schneider, 1998) with encouraging results (with A. Griffa, D. Olson, T. Ozgokmen, L. Piterbarg (USC)).

Online regional and global data sets are available through an ftp site at playin.rsmas.miami.edu. In particular, satellite-derived quasi-global sea surface temperature fields at 18 km, 2 day resolution for 1985 to mid 1998 are now online. The Gulf Stream Northern Edge Position (GSNEP) data set has been extended to include paths from 1982-1996.

Model-data comparisons for sea surface temperature (Wilson-Diaz et al., 1998) and sea surface velocity (Han et al., 1998) have been completed for the Arabian Sea and Indian Ocean, respectively. Model-data comparisons studies are underway with Mike Clancy (FNMOC) and the Navy real-time model.

Semi-annual to interannual variability in the position of the Gulf Stream was investigated as a function of wind- and buoyancy-forcing indicators (Mariano et al., 1998).

RESULTS

The prognostic fields from a highly nonlinear multi-layer MICOM data assimilation experiments exhibit stable behavior during the two-years of simulations with decreasing forecast errors (manuscript in preparation).

Based on our analysis with the GSNEP data set and 14 forcing indicators, we find that, on the average, the Gulf Stream moves south as winds increase, as temperature decrease and the large-scale sea surface thermal gradient increases. The south-to-north displacement from the first PC time series, that explains 46% of GSNEP variability, is coherent at the 95% confidence level with (i) the root-mean-square (rms) wind stress over the Gulf Stream on time scales between 9 months and six years, (ii) the rms wind stress south of the Gulf Stream on 5-6 year time scales, and (iii) the North Atlantic Oscillation on 12-18 months time scales. The first PC is also marginally coherent, 80%, with the Florida Strait cable transport on annual time scales and the rms wind stress south and north of the stream on time scales greater than one and two years, respectively (Mariano et al., 1998).

The meridional component of the second PC time series, that explains 15% of GSNEP variability, is coherent, at the 95% confidence level with the large-scale thermal gradient across the Gulf Stream on 9-18 month time scales and (ii) with the rms wind stress south, over, and north of Gulf Stream for six months to six year time scales. The second PC is also marginally coherent, 80%, with the Florida Strait cable transport on annual time scales. The first two PC time series were not coherent with the Southern Oscillation Index or the mean latitude of the large-scale zero wind-stress curl in the North Atlantic. The results of the coherence calculations and a PCA indicate that wind-forcing and buoyancy-forcing are equally important for determining the mean latitude of the Gulf Stream east of Cape Hatteras (Mariano et al., 1998).

The first mode explains 64% of sea temperature variability in the Arabian Sea and is associated with wind-forcing. The second mode explains 31% of the variability and is associated with radiative heating (Wilson-Diaz, et al., 1998).

Please see the progress report by Griffa and Ozgokmen for details of the Lagrangian work.

IMPACT/APPLICATION

Our work continues to be well reviewed by the oceanographic community and constitutes significant advances in data analysis and assimilation. We believe that this work will lead to improved ocean forecasts that will save lives and resources.

TRANSITIONS

The lead PI presented four lectures at the oceanography division of NRL, Stennis Space Center, MS on data analysis and assimilation. I interacted with quite a number of researchers during my week long visit. In particular, the use of my parameter matrix objective analysis for motion-compensated space-time interpolation of global satellite data sets was discussed with Dr. Barron and the MRF-based EKF was discussed with Drs. Shulman and Smedstad.

RELATIONSHIPS

Mariano and Chin are affiliated with the RSMAS remote sensing group and work closely with the MICOM modeling group. Strong collaboration with RSMAS scientists A. Griffa, D. Olson, T. Ozgokmen, as well as, M. Swenson (AOML), and L. Piterbarg (USC) on applied Lagrangian prediction will continue to be one of our primary near-term research activity. We are working with A. Moore (CS) on error growth and contour-based assimilation and with L. Shay on the analysis of in-situ ocean observations. Model-data comparison studies for sea surface velocity and Lagrangian prediction studies are underway with M. Clancy (FNMOC).

PUBLICATIONS FOR 1998

Bauer S., M. Swenson, A. Griffa, A. Mariano and K. Owens, 1998. Eddy-mean flow decomposition and eddy-diffusivity estimates in the Tropical Pacific Ocean. (In press, J. Geophys. Res.)

Chin, T.M., R.F. Milliff, and W.G. Large, 1998. Basin-scale, high-wave number sea-surface wind fields from a multiresolution analysis of scatterometer data. J. Atm. Ocean. Tech., 15, 741--763.

Chin, T.M., A.J. Mariano, and E.P. Chassignet, 1998. Spatial regression and multi-scale approximations for sequential data assimilation in ocean models. (Accepted, J. Geophys. Res.)

Han, W., J.P. McCreary, Jr., D.L.T. Anderson, and A.J. Mariano, 1998. On the dynamics of the eastward surface jets in the Equatorial Indian Ocean. (Accepted, J. Physical Ocean.)

Mariano, A.J., T.M. Chin, E.H. Ryan, R. Kovach, and O.B. Brown, 1998. On Gulf Stream Path Variability. (First draft being reviewed at RSMAS, will be submitted to J. Physical Ocean.)

Milliff, R.F., W.G. Large, J. Morzel, G. Danabasoglu, T.M. Chin, 1998. Ocean general circulation model sensitivity to forcing from scatterometer winds, (Submitted, J. of Physical Ocean.)

Moore, A.M. and A.J. Mariano, 1998. The Dynamics of Error Growth and Predictability in a Model of the Gulf Stream. I: Singular Vector Analysis. J. Physical Oceanography, (In press, J. Physical Ocean.)

Ozgokmen, T.M., A. Griffa, L. Piterbarg, and A.J. Mariano, 1998. Assimilation of Lagrangian data for the prediction of particle motions in a numerical ocean model. EOS Trans. AGU, 79(1), OS36.

Ozgokmen, T.M., A. Griffa, L. Piterbarg, and A.J. Mariano, 1998. On the predictability of Lagrangian Trajectories in the Ocean. (Submitted, J. Physical Ocean.)

Paiva, A.M., E.P. Chassignet, and A.J. Mariano, 1998: Numerical simulations of the North Atlantic subtropical gyre: Sensitivity to boundary conditions and horizontal resolution. (Submitted, Deep-Sea Research)

Schneider, T., 1998. Lagrangian drifter models as search and rescue tools. (Master Thesis, U. of Miami), 84 pp.

Shay, L.K., A. J. Mariano, S.D. Jacob, and E. H. Ryan, 1998. Mean and Near-Inertial Ocean Current Response to Hurricane Gilbert. J. of Physical Oceanography, 28(5), 858-889.

Wilson-Diaz, D., A.J. Mariano, R.E. Evans, and M.E. Luther, 1998. A Principal Component Analysis of Sea Surface Temperature in the Arabian Sea. (Submitted, Deep-Sea Research).