Estimating Representation Error of Satellite and *in situ* Data for Data Assimilation into Ocean Climate Models

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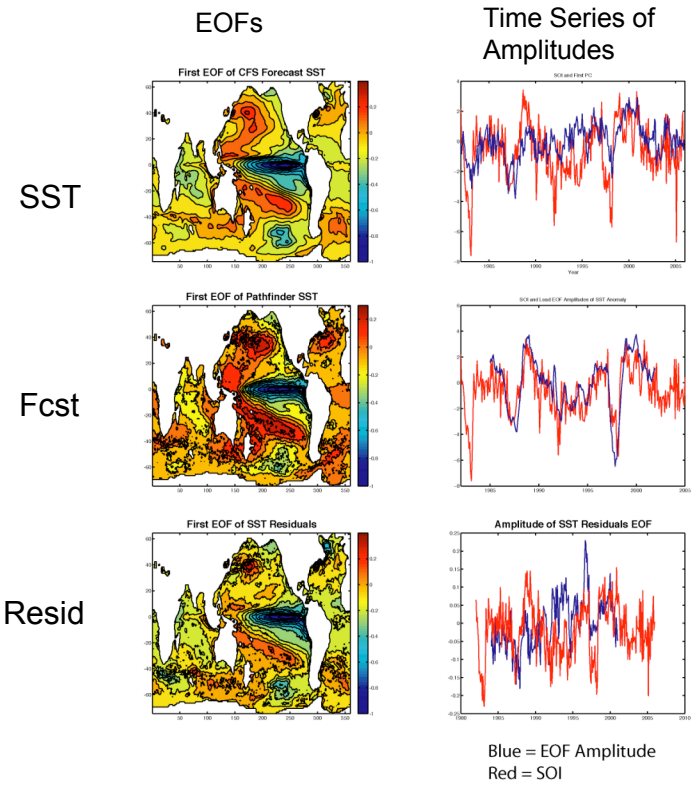
Accomplishments

We have evaluated the 9-month forecasts from the CFS and found that the lead EOFs of the residuals project significantly onto the lead EOFs of the model, indicating the presence of systematic model error

Future Plan

We will estimate representation errors in SST and build a data assimilation system for the ocean component of the CFS based on our new error estimates

EOFs and PCs of SST and 9-Month Forecasts



Introduction

- In many ocean data assimilation (DA) systems, much of the variability in observations is due to physical causes that are not represented in the model
- That part of the variability cannot be usefully assimilated and must be considered as error
- This is a particular problem for climate forecast models, since the output of such models is necessarily consistent with the model physics.
- We have developed methods for statistical estimation of representation error
- Our goal is the incorporation of our statistical methods into operational climate forecast systems

Methods

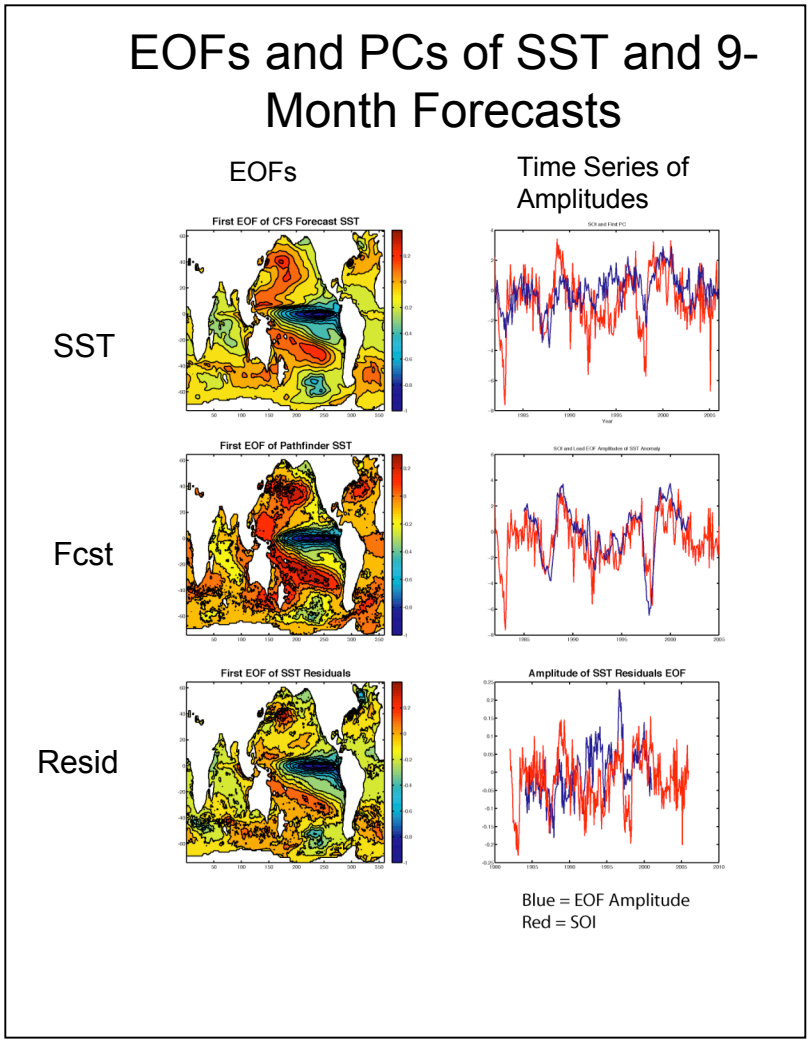
- Calculate EOFs from a long model run and estimate the number of independent degrees of freedom
- Calculate EOFs of time series of data
- Calculate EOFs of model-data misfits
- Project misfit EOFs on model output EOFs; this defines the signal that can be assimilated. Its orthogonal complement provides an estimate of the representation error
- These error estimates can be used to construct DA systems

Previous Results

- For an implementation of POP for the Pacific basin, the leading EOFs of the model and the AVHRR data carry the ENSO signal
- In both cases, the time series of amplitudes of the leading EOF follows the SOI
- The time series of amplitudes of the misfit EOFs is well modeled by a low-order Markov process, and does not correlate significantly with the SOI
- A DA system based on these estimates has been constructed and performs as expected

Current and Ongoing Work

- **We began with comparisons of CFS 9-month restart files with AVHRR data**
- **The lead EOFs of the AVHRR data carry the ENSO signal, and the time series of amplitudes of the lead EOF correlates strongly with the SOI**
- **The time series of amplitudes of the lead EOFs of the model contains the major events, but correlates with the SOI at a level of about 0.4**
- **The amplitude time series of EOFs of the residuals correlate with the SOI at the same level as those of the model, and they project significantly onto the lead EOFs of the model, indicating the presence of systematic model error**



Ongoing Work and Future Plans

- We are now performing similar analyses with MOM4, configured as the ocean portion of the CFS
- We will construct a new DA system with the Reynolds-Smith SST analysis, and compare our new system to present ones. The new system will have a 5-day assimilation cycle
- We will attempt to model the representation error as a random process, and use independent realizations of our random process models to construct ensembles of ocean analyses, and eventually ensembles of coupled model runs

Ongoing Work and Future Plans

- We will use our ensembles to evaluate the reliability of our ocean analyses and coupled forecasts, and to construct ensemble-based DA systems
- We will incorporate our results into operational climate forecast systems at NCEP and GMAO