P2.17 The New ECPC GSM/MIT Coupled Seasonal Prediction Model

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http://ecpc.ucsd.edu/COUPLED/CM/coupled.html

Coupled Modeling Approach

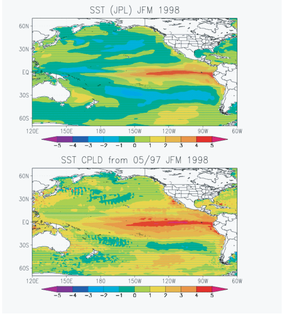
- **Goal:** Coupled data assimilation model for seasonal (up to 12 months) climate prediction
- **Components:**
  - ECPC Atmospheric Global Spectral Model
  - MIT Oceanic General Circulation Model (JPL version)
- **Coupled:** every 24 hours
- **Initialization:** from atmospheric reanalysis and assimilated ocean states.

Coupled Model Experiments

1. **Long Run (currently 20+ years) – climatology**
2. **Retrospective forecast experiments**
   - 12 months forecasts starting the first day of every months for 11-year (1994-2004) time period . Skill of the model depends on lead time
3. **Experimental Forecasts for each month based on the climatology from retrospective forecasts**

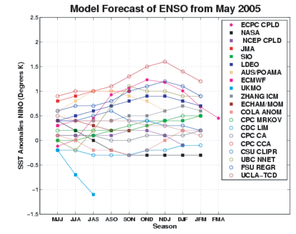
JFM 1998 ocean forecast (05/97)

Comparison between predicted (lower panel) and assimilated at JPL (upper panel) SST anomalies for JFM 1998. The coupled model run was started May 1-st, 1997. For "strong forcing" year, the model successfully predicts the main patterns of the SST anomalies for up to 11 months lead.

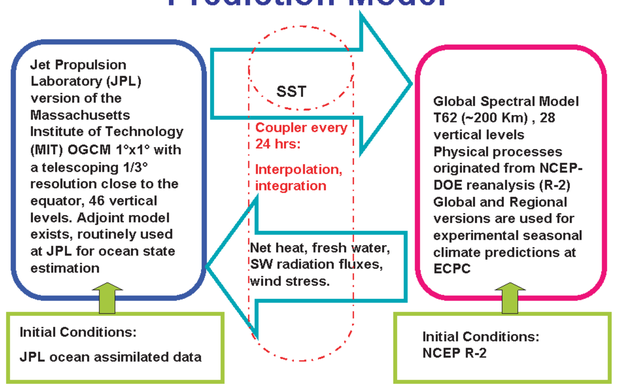


Experimental ECPC Coupled forecast

The graph compares May forecast made by the ECPC Coupled model with forecasts made by other dynamical and statistical models for SST in the Nino 3.4 region for ten overlapping 3-month periods. The data for other models was obtained from IRI.

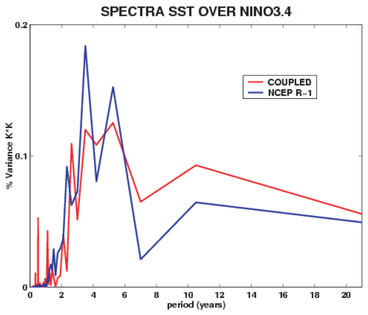


ECPC Coupled Seasonal Prediction Model



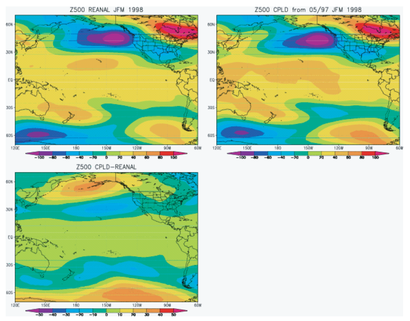
Skill of the long integration

Spectra of the time series of the simulated and observed SST anomalies averaged over NINO3.4 region (5˚N-5˚S, 170˚W-120˚W). Both model and observations have picks in between 3 and 5 years



JFM 1998 atmospheric forecast (05/97)

Comparison between predicted Z500 (right panel) and Z500 from Reanalysis (left panel) for JFM 1998. The coupled model run was started May 1-st, 1997. The difference is much smaller than the response.



Summary

- Experiment with the long run has shown that the current version of the coupled model produces realistic intrinsic variability. The drift is negligible, thus no flux adjustment is necessary.
- The validation of the retrospective forecasts revealed that the skill of the model improves after a few months due to coupling.
- The current ECPC NINO 3.4 SST forecast lies within the scatter of the IRI forecasts

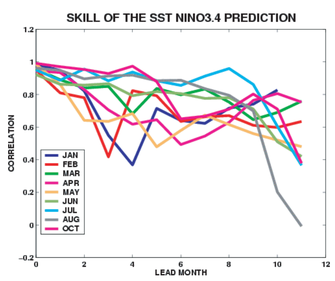
MIT Ocean General Circulation Model

http://www.ecco-group.org/

- Primitive equations on the sphere
- ECCO package
- GM eddy parameterization
- Full surface mixed layer model
- 360x224 (1°x1° horizontal resolution telescoping towards the equator to 1/3°) horizontal resolution with 46 vertical levels
- Adjoint MIT model exists and is routinely used in JPL together with the forward model for 3D ocean state estimation

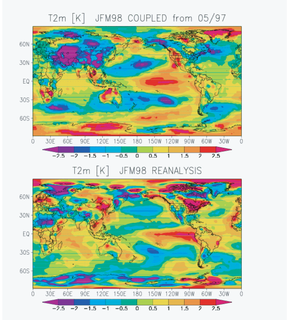
Skill of the El Nino Prediction

Prediction skill of the coupled model. Correlation between the predicted and observed NINO 3.4 SST anomalies. The skill for winter months drops by the 4-th month, but then picks up after the coupled model dynamics starts to influence the predictability. For summer months the skill stays relatively high up to the 9th month, and then drops sharply.



JFM 1998 atmospheric forecast (05/97)

Comparison between predicted 2m Temperature (T2m) and T2m from Reanalysis II for JFM 1998. The coupled model run was started May 1-st, 1997. Model does not reproduce the main features over North America



Coupled Model Development

- **Evaluation of the coupled model skill:** Continue the retrospective forecasts starting at different seasons (will include another fourteen years period of 1980-1993 for which the ocean assimilated data is available).
- **Model speed up:** Implementation of flux coupler that will provide parallel tools for inter-grid interpolation, time averaging and accumulation, merging data from multiple components for use by another component, etc.
- **Investigation of the role of coupling in determining the atmospheric predictability:** Comparison of coupled and two tiered prediction models.
- **Improvement of the model's physics:** Inclusion of a realistic sea-ice model, improvement of the atmospheric and ocean components.

Spectral Model ECPC Global

http://ecpc.ucsd.edu/projects/G-RSM/docs/index.html

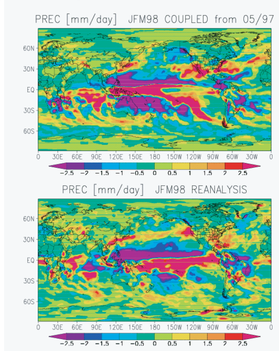
- Spectral T62 (~200 Km) , 28 vertical levels model
- Physical processes originated from NCEP_DOE reanalysis (R-2) (*see Kanamitsu et. al, 2001 NCEP-DOE AMIP-II Reanalysis (R-2) BAMS*)
- Global and Regional versions of the model are used for experimental seasonal climate predictions at ECPC
- Can be pre-processed for different platforms
- Optimized for SIO PC Linux cluster (ROCKS 3.2).

Skill of mid-latitude (170°E - 150°W; 45°N-65°N) Z500 prediction

Forecast starts	*3 months lead*	*6 months lead*
January	**0.2 (AMJ)**	**0.1 (JAS)**
February	**0.4 (MJJ)**	**0.1 (ASO)**
March	**0.6 (JJA)**	**0.1 (SON)**
April	**0.3 (JAS)**	**0.4 (OND)**
May	**0.2 (ASO)**	**0.1 (NDJ)**
June	**0.4 (SON)**	**0.3 (DJF)**
July	**0.3 (OND)**	**0.3 (JFM)**
August	**0.3 (NDJ)**	**0.1 (FMA)**
September	**0.4 (DJF)**	**0.1 (MAM)**
October	**0.3 (JFM)**	**0.1 (AMJ)**

JFM 1998 atmospheric forecast (05/97)

Comparison between predicted precipitation and precipitation from Reanalysis II for JFM 1998. The coupled model run was started May 1-st, 1997. In addition to the equatorial dipole, the model reproduces above normal precipitation over southwest and east of the United States, below normal precipitation over Pacific Northwest and west coast of Canada.



Publications

- Kanamitsu, M., E. Wesley, J. Woollen, S. -K. Yang, J. J. Hnilo, M. Fiorino, and G. L. Potter, 2002: NCEP-DOE AMIP-II reanalysis (R-2). Bull. Amer. Meteor. Soc. 83, 1631-1643.
- Kanamitsu, M., Cheng-Hsuan Lu, Jae Schemm and W. Ebisuzaki, 2003: The predictability of soil moisture and near surface temperature in hindcasts of NCEP Seasonal Forecast Model. J. Climate, 16, 510-521.
- Kanamitsu, M. and Kingtse, Mo, 2003: Dynamical Effect of Land Surface Processes on Summer precipitation over the Southwestern United States. J. Climate, 16, 496-509
- Kanamitsu, M. and Seong-On Hwang, 2005: Role of Sea Surface Temperature in Reanalysis. Submitted for publication in Mon. Wea. Rev.
- Stammer, Detlef 2002: State estimation in modern oceanographic research. EOS, Transactions, American Geophysical Union.