ECPC Long Lead Seasonal Climate Forecast

Contributed by E. Yulaeva, M. Kanamitsu, J. Roads

Experimental Climate Prediction Center, Scripps Institution of Oceanography UCSD,

1. ECPC Coupled Prediction System

At the Experimental Climate Prediction Center (ECPC) of the Scripps Institution of Oceanography, we have developed the ECPC Coupled Prediction Model (ECPM) for long lead (up to 12 months) experimental seasonal forecasts. The coupled model consists of the ECPC Global Spectral Model (GSM) (Kanamitsu et al, 2002a, 2002b) coupled to the Jet Propulsion Laboratory (JPL) version of the Massachusetts Institute of Technology (MIT) ocean model (Fukumori, 2002) used for an ocean analysis each month beginning in 1993. The GSM uses spherical harmonic basis functions. The horizontal resolution is T62 (~200 Km). There are 28 vertical sigma coordinate levels. Physical processes originated from NCEP-DOE reanalysis (R-2). The JPL MIT model has 1°x1° horizontal resolution with a telescoping (1/3°) resolution near the equator. The model also has fine vertical resolution with 46 vertical levels. The vertical depth goes down up to 5800 m, with the first 23 levels located in the upper 400 meters. The coupling is performed every 24 hours. The atmospheric model nets heat, fresh water, short wave radiation fluxes together with wind stresses that are passed to the ocean component, while the atmosphere is forced with the SSTs obtained from the oceanic module. No flux adjustment is used in the coupled system. The detailed description of the model is provided in Yulaeva et al., 2007.

Investigation of the long-term skill of ECPM and assessment of its retrospective seasonal forecasts skill was documented in Yulaeva et al., 2007. Briefly, the ECPM climatology and internal variability derived from a 56-year long coupled integration were compared to observations and reanalysis data. Though the ECPM exhibits climatological biases, these biases are relatively small and comparable to the systematic errors produced by other well known coupled models, including the recent NCEP Climate Forecast System (CFS). The internal variability of the model, especially the tropical variability, resembles observations. The ECPM simulates ENSO variability reasonably well, and the simulation of the mechanism of ENSO evolution is qualitatively similar to the observations.

We performed ECPM retrospective forecasts for different months during 1993-2006. The initial oceanic conditions were obtained directly from the JPL ocean analysis. Since we use the same ocean model configuration as the JPL analysis, our model forecast starts smoothly from the ocean analysis, without any noticeable initial shocks. The climatology derived from these retrospective forecasts is now used to obtain the anomalies for the real-time forecast.

The skill of the NINO3.4 predictions, measured by the correlation between the simulated SST NINO3.4 anomalies and the observation, demonstrates that the quality of the forecasts initiated in winter usually drops by the fourth month (spring barrier), but then picks up again and stays high for up to 12 months after the coupled model dynamics starts to influence the predictability. The skill of the forecasts started in summer is very high for up to 9 months lead time. The ECPM skill seasonal dependency is similar to the one obtained from the NCEP Climate Forecast System (Saha et al 2006) and to the skill of the coupled UCLA AGCM/JPL MIT model (Cazes-Boezio et al, 2007)

2. ECPM Long Lead Seasonal Forecast

Based on this initial ensemble of predictions, we have now started to produce near real-time experimental seasonal forecasts (see http://ecpc.ucsd.edu/COUPLED/CM/coupled.html). The 5 member ensemble of the ECPM NINO3.4 SST anomalies prediction started at the end of November is shown in Figure 1. The runs were initiated from 5 different initial atmospheric conditions (six hours apart) that were originally extracted from the R2 (Kanamitsu et al. 2002b) The oceanic initial conditions were the same for the corresponding ensemble members, and were extracted from JPL MIT 4-D ocean data assimilation.

Basically, ECPM predicts moderate strength La Nina with the predicted future duration for at least a few more seasons. The spread during the first two seasons is very small. However, it gets larger starting in the spring and going forwards.

Figure 2 shows a depth–longitude temperature cross section along the equator in the Pacific. Shallower than normal thermocline is observed in the eastern Pacific, accompanied by deeper than normal thermocline in the western Pacific.

Figure 3 shows the spatial pattern of SST and wind stress anomalies in the tropical Pacific predicted by ECPM for the next 3 non-overlapping seasons. Again, ECPM predicts La Nino SST conditions will last through the most part of next year with westward wind stress anomalies forcing the ocean.

Figure 4 provides the corresponding precipitation forecast. The precipitation is predicted to be above average over the Pacific Northwest, the northeast coast of South America, and over parts of Australia.

Figure 5 shows the corresponding 2m temperature forecast. Temperatures over the western third and northeastern parts of US are predicted to be cooler than normal. Most of Europe and Asia are predicted to be warmer than normal during DJF and cooler during the next two seasons. Temperatures over most of Australia are predicted to be cooler than normal.

References:

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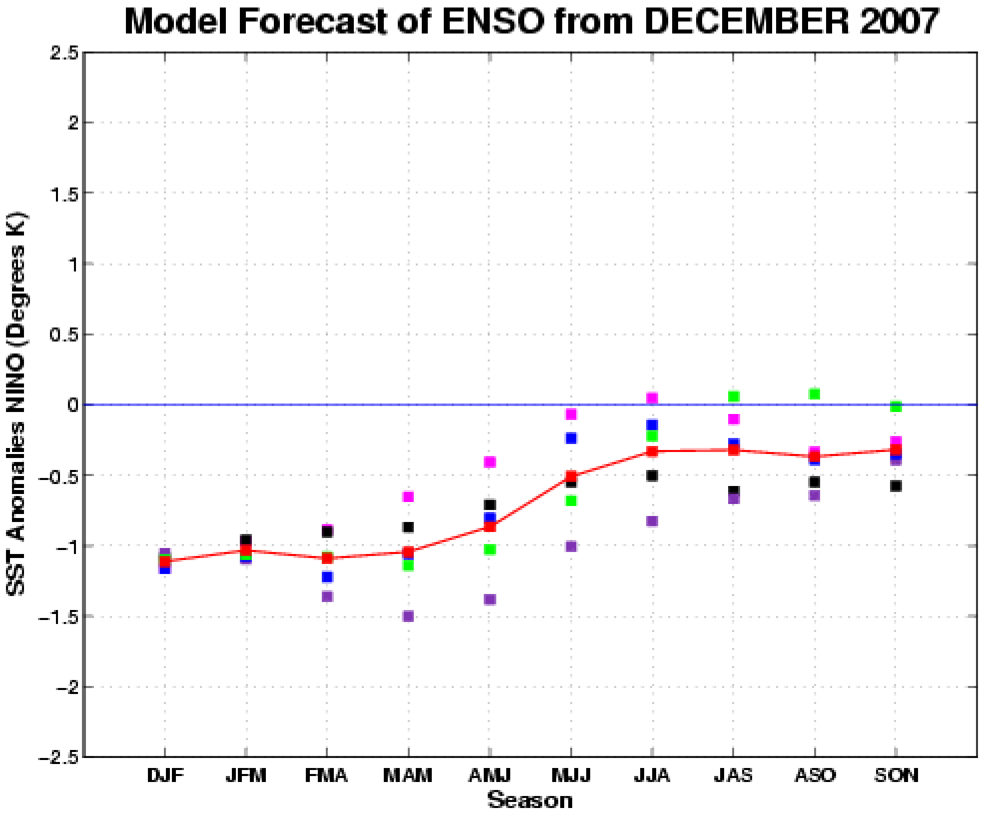


Figure 1: The 5 member ensemble of the ECPM NINO3.4 SST anomalies prediction started at the end of November. The runs were initiated from 5 different initial atmospheric conditions (six hours apart) that were extracted from R2. The oceanic initial conditions were the same for the corresponding ensemble members, and were extracted from JPL MIT 4-D ocean data assimilation. Solid red line corresponds to the mean value.

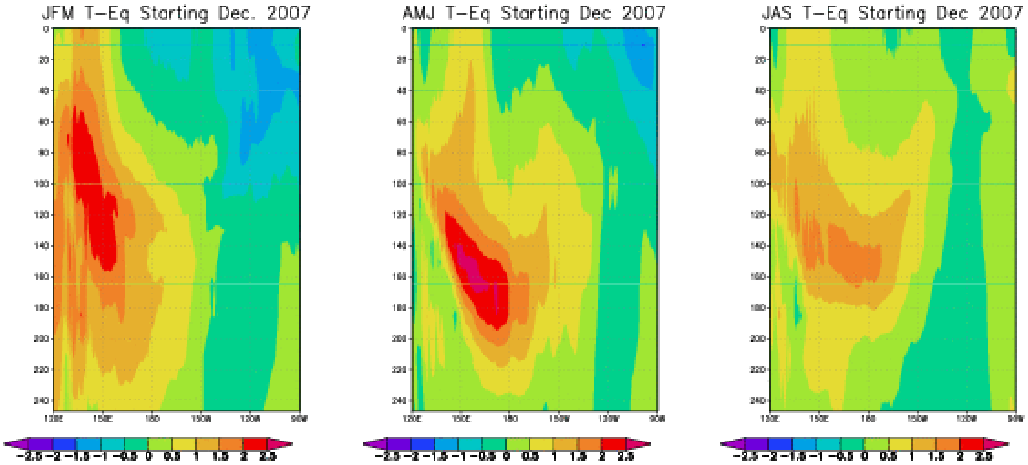


Figure 2: Depth–longitude temperature cross section along the equator in the Pacific predicted by ECPM for the next 3 non-overlapping seasons. Contour interval is 0.5 K

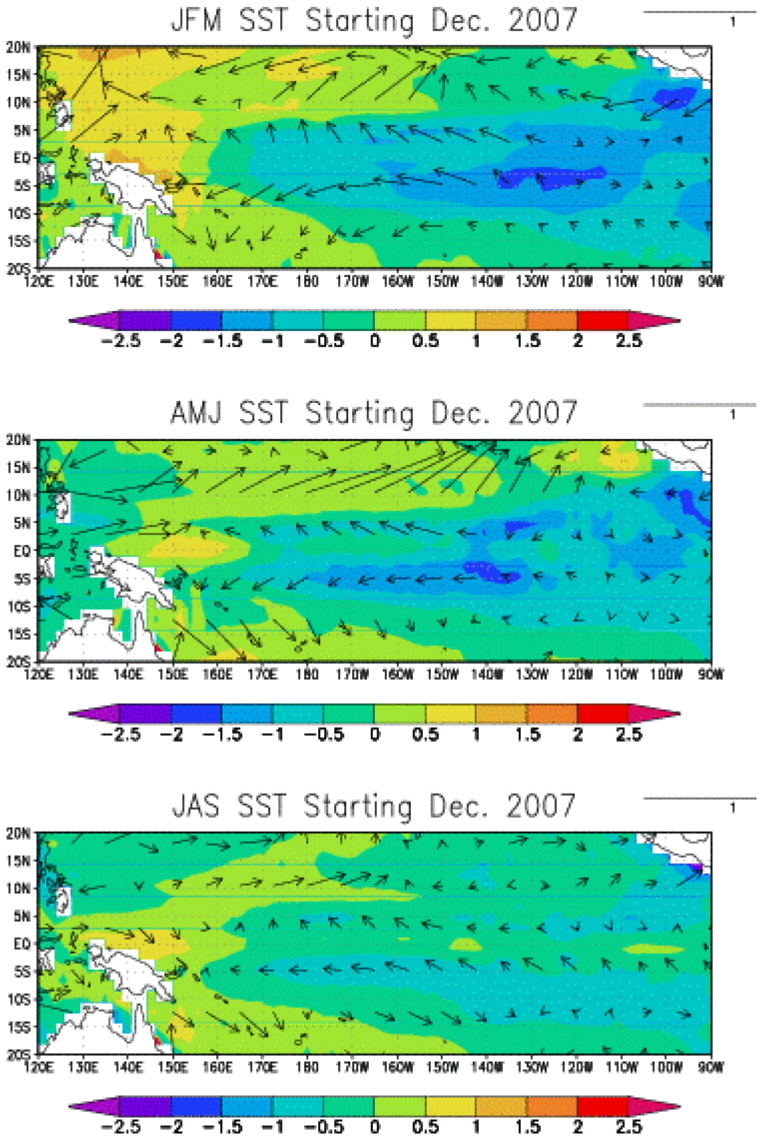
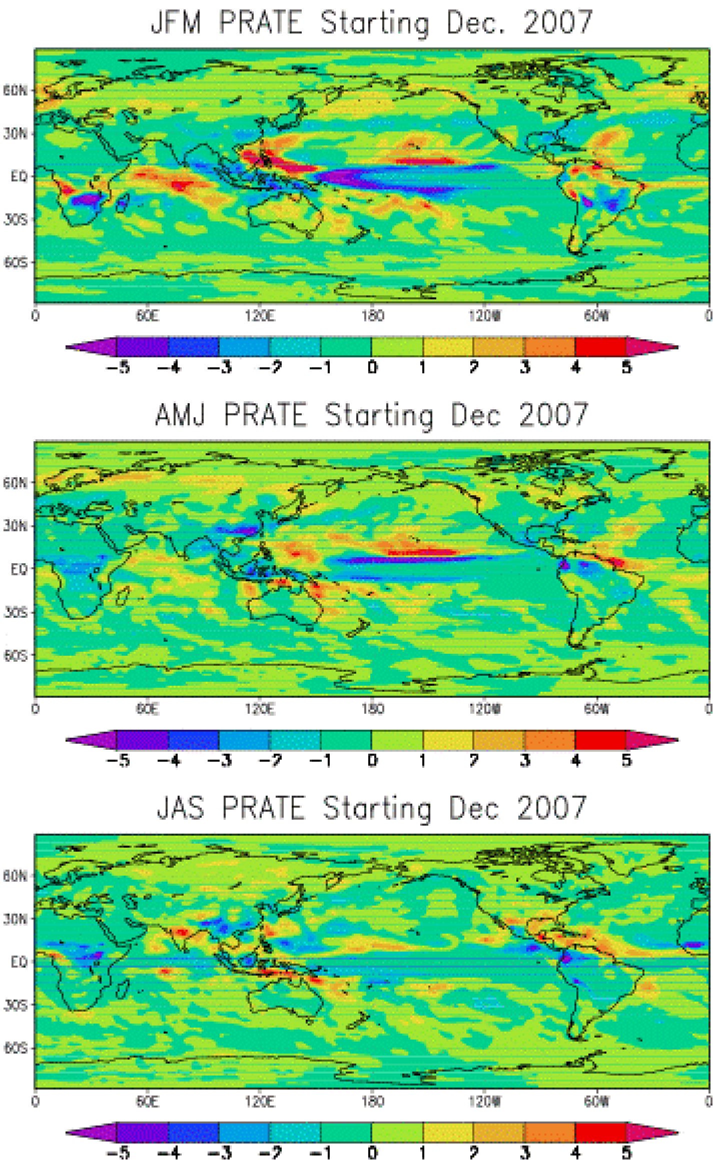


Figure 3: SST and wind stress anomalies in the tropical Pacific predicted by ECPM for the next 3 non-overlapping seasons. Contour interval is 0.5 K for SST anomalies. Wind stress anomalies were multiplied by 10, and the units are N m^{-2} K^{-1}



JFM PRATE Starting Dec. 2007

AMJ PRATE Starting Dec 2007

JAS PRATE Starting Dec 2007

Figure 4: Global precipitation forecast for the next 3 non-overlapping seasons. Contour interval is 1 mm Day^{-1}

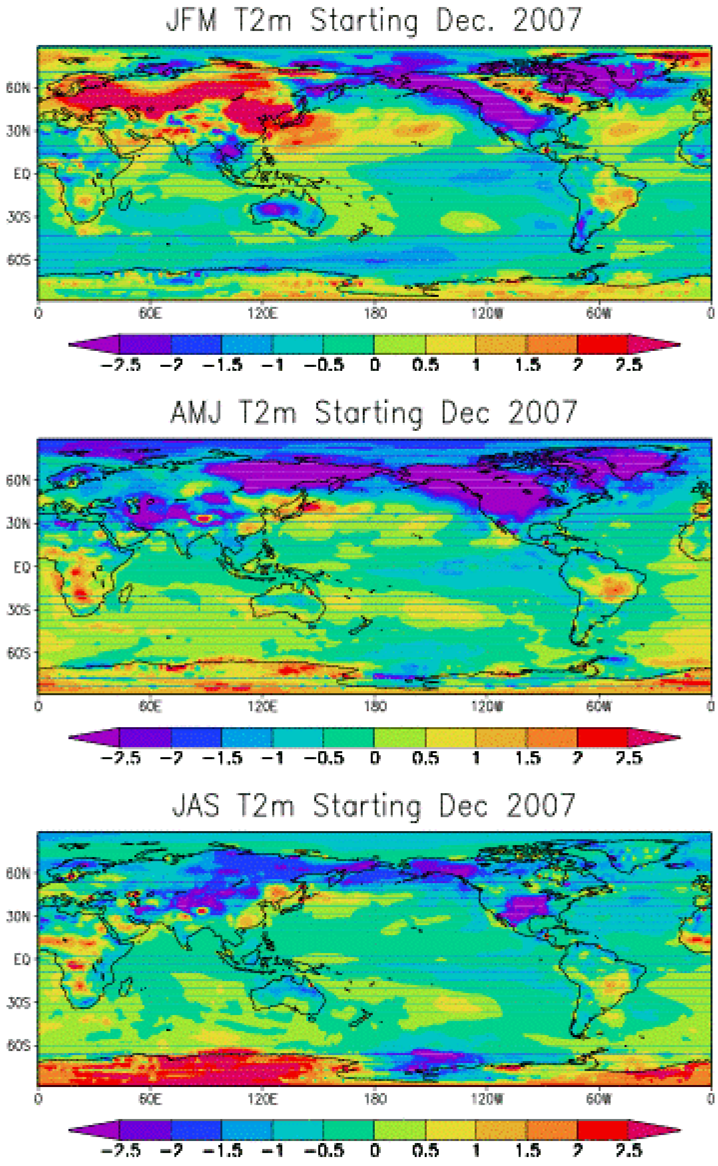


Figure 5: Global 2m temperature forecast for the next 3 non-overlapping seasons. Contour interval is 0.5º K.