Dynamically Based Forecasts for Tropical Pacific SST Using a Hybrid Coupled Ocean-Atmospheric Model

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Forecasts of the tropical Pacific SST are presented here using a hybrid coupled ocean-atmosphere model (HCM) developed jointly at Scripps Institution and the Max Planck Institute for Meteorology (MPI) (Barnett et al. 1993).

The original HCM-1 ocean model, created at MPI (Latif 1987), is a fully nonlinear GCM bounded by 30N-30S latitude and by Asia and South America. It has 13 vertical levels, with 10 in the top 300 m. The seasonal cycle is governed by a Newtonian heat flux and observed wind stress (Goldenberg and O'Brien 1981). The vertical mixing scheme is dependent upon the Richardson number (Pacanowski and Philander 1981). The atmospheric model is statistical, deriving the wind stress forcing for the ocean GCM using the GCM's SST. This is done with a CCA-like regression model, using historical observed fields of SST and the corresponding wind stress. The coupling process includes a MOS-like statistical correction of the SST fields produced by the ocean GCM. The HCM is initialized with wind stress fields derived from observed SST data; thus, it is indirectly "spun up" with SST information. Over the 1965-93 period the model demonstrated statistically significant predictive skill out to 12-18 months, with best performance for the central equatorial Pacific and for winter forecasts (Barnett et al. 1993). The model was developed using data from 1965-85, leaving 1986 onward for independent forecasting.

The improved HCM-3 (Pierce 1996) is similar to the HCM-1 in most respects. The main difference is in the ocean GCM used, which is the HOPE2 from the Max Planck Institute in Hamburg (Wolff and Maier-Reimer 1992). While the resolution is approximately as in HCM-1, the numerical scheme is improved to reduce the numerical diffusion, especially in the vertical, resulting in a better representation of the main thermocline across the tropical Pacific. A MOS corrector is still used, but the magnitude of the correction is generally only 1C or less--a marked improvement over HCM-1. Statistical atmospheres were constructed using both the FSU and the da Silva (da Silva et al. 1994) wind data sets. Model performance was independent of which set was used, as long as a 3 to 5 month smoother was applied to the wind stress prior to model construction. The final model used the da Silva wind data. Model anomalies are calculated relative to climatology based on the period 1965-1993, using da Silva's SST data set.

The HCM-3 model produces better hindcasts than did HCM-1, with correlation skill scores exceeding 0.8 for 3-6 month lead times covering most of the tropical Pacific, dropping to 0.6 in the far west. The skill is also moderately high nearly to the South American coast. Independent sample forecast skills are approximately comparable to those of the LDEO and NCEP models. In similar fashion to the LDEO, skills for the 1980s and early 1990s are much higher than during the 1970s.

The Hybrid Coupled Model is predicting the current warm (El Nino) conditions in the tropical Pacific to fade back to normal conditions by June of 2010.

Caveat: The forecasts shown above are experimental in nature. The reader is forewarned that the methods/forecasts are new and subject to future change and improvement.

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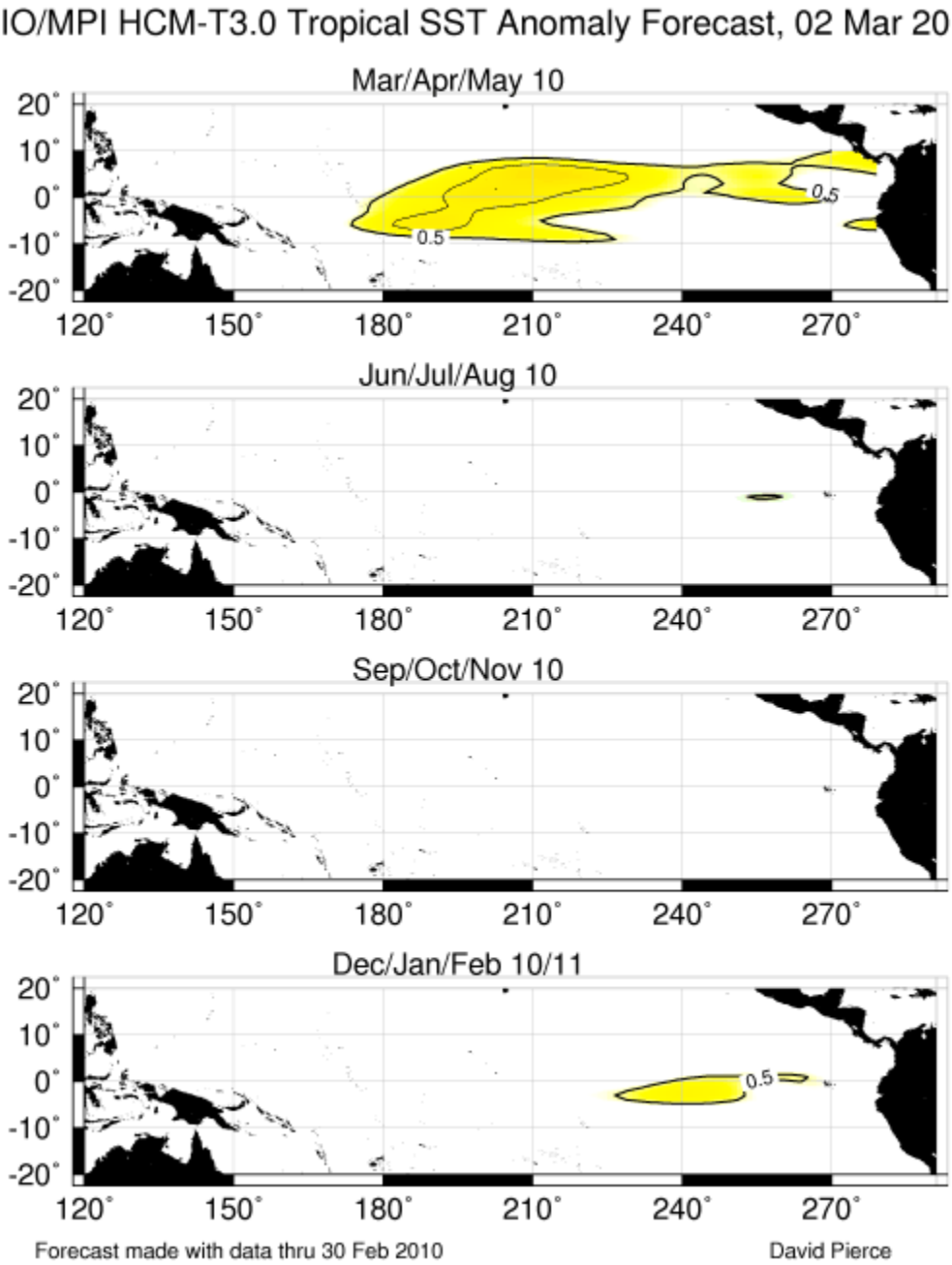

Fig. 1. Scripps/MPI hybrid coupled model (HCM-3) forecast of tropical Pacific SST anomaly (C) for MAM 2010, JJA 2010, SON 2010, and DJF 2010/2011. Observed data through 30 Feb 2010 were used to produce the forecast. Contour interval 0.25C, but contours of magnitude less than 0.5C are not shown.