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CWB CFS 1-Tier Hindcast Analysis and Forecast Verification

Tzu-Yu Wu[1, 4], Hann-Ming Henry Juang[2, 4], Yun-Lan Chen[1], Pang-Yen Liu[1], Shin-I Lin, Jen-Her Chen[3], and Mong-Ming Lu[5]

[1]*Meteorology Research and Development Center, Central Weather Bureau, Taiwan*
[2]*Environmental Modeling Center, NCEP, NWS, NOAA, USA*
[3]*Meteorological Information Center, Central Weather Bureau, Taiwan*
[4]*Department of Atmospheric Sciences, National Central University, Taiwan*
[5]*Department of Atmospheric Sciences, National Taiwan University, Taiwan*

1. Introduction

One-tier global atmospheric and oceanic seasonal and climate modeling is a trend for both research and operational centers. NCEP developed dynamical seasonal forecast system before 2000 (Kanamitsu *et al.* 2002) and moved to one-tier model CFS v1.0 (NCEP GFS coupled with GFDL MOM3) in 2004 (Saha *et al.* 2006). ECMWF started improving system 1 (Stockdale *et al.* 1998) since 1996, and moved to one-tier with system 2 (T95L40) in 2003 (Anderson et al. 2003), and recently with higher resolutions.

In 2010, Central Weather Bureau (CWB) in Taiwan began to develop its own global atmosphere-ocean coupling model. Based on NCEP CFS package, NCEP global atmospheric model was replaced by CWB's own global atmospheric model (CWB GFS in resolution of T119L40, Paek *et al.* 2015) and coupled with the GFDL MOM3 (TCWB1T). It takes six years to build the couple model to be routinely operation, including workflow construction, model tuning with adjusting cloud physics *etc*., 20 more years hindcast, and ensemble member bias correction etc. It is used to provide seasonal forecast and ENSO forecast up to 9 months. It started operating routinely in 2017 at Taiwan CWB.

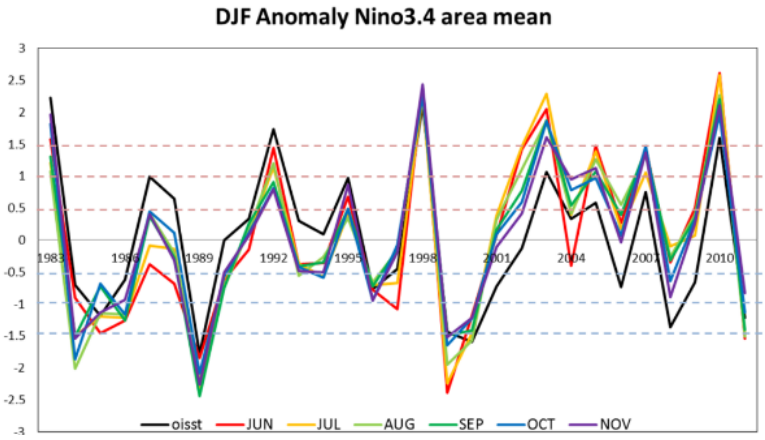

Fig 1 Niño 3.4 regional SST anomaly forecast for DJF by TCWB1T was close to the OISST trend at the initial time from June to November.

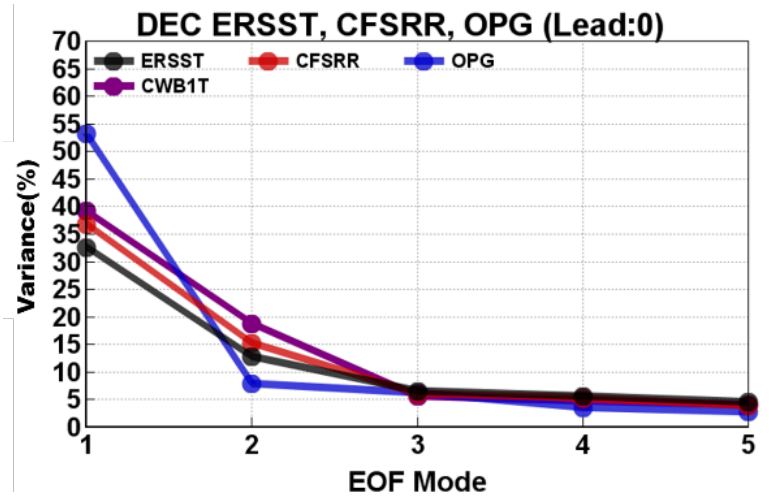

Fig 2 Fraction of variance explained by EOF modes 1 through 5 for SST anomaly. purple line is TCWB1T, black line is ERSST.

2. Data and experimental design

Based on NCEP CFS v2 reforecast (hindcast) data set, we follow the method of their hindcast member selection for our hindcast design. The NCEP CFS v2 hindcast was running 4 cycles for selected 6 dates for any

Correspondence to: Tzu-Yu Wu, Meteorology Research and Development Center, Central Weather Bureau, Taiwan, and Department of Atmospheric Sciences, National Central University, Taiwan; E-mail: luoyin@cwb.gov.tw

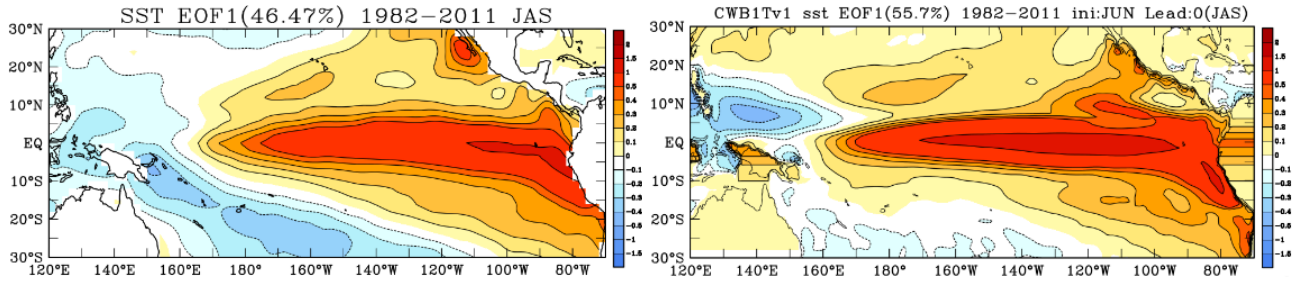

Fig. 3-1 The EOF1 of ERSST (left) and TCWB1T (right) lead 0 month SST forecast.

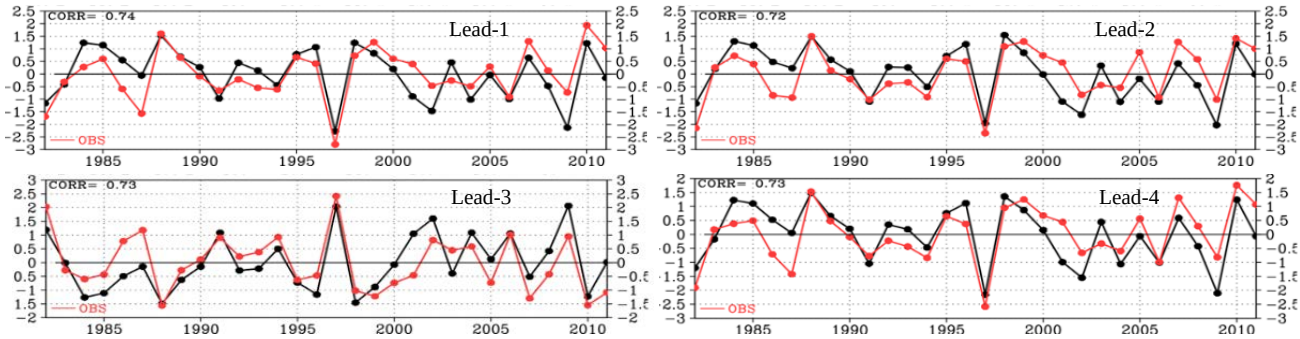

Fig. 3-2 The leading (from lead 0 to lead 4) anomaly correlations of PCA are above 0.72.

given month. The dates are 1, 6, 11, 16, 21, and 26 of any given month. Due to our resource problems, we did two experiments. The first set, we have accomplished two cycles, 00z and 12z with dates of 1, 6, 11, 16, 21, and 26, and the second, we have only accomplished one cycles 00z with dates of 1, 3, 6, 8, 11, 13, 16, 18, 21, 23, 26, 28 of any given month. The results shows that more dates are more important than more cycles, so we choose one cycle 00z, the second set, to do reforecast from 1982 to 2011.

3. Results

3.1 Hindcast analysis (1982-2011)

By analyzing SST of hindcast data from 1982 to 2011, we found that NINO3.4 regional SST anomaly forecast for DJF was close to the OISST trend at the initial time from June to November (Fig. 1). Figure 2 show the fraction of variance explained by EOF modes 1 through 5 for SST anomaly. TCWB1T (purple line) is close to ERSST (black line). The result of EOF1 analysis shows that El Niño pattern of TCWB1T similar to ERSST (Fig. 3-1), the anomaly correlation between TCWB1T and ERSST is more than 0.72 from lead-012 (JAS) to lead-456 (NDJ) (Fig. 3-2).

The SST forecasting ability is better than T2M and precipitation, only captured over tropical sea. The forecasting ability of TCWB1T shows that winter is better than summer (Fig. 4).

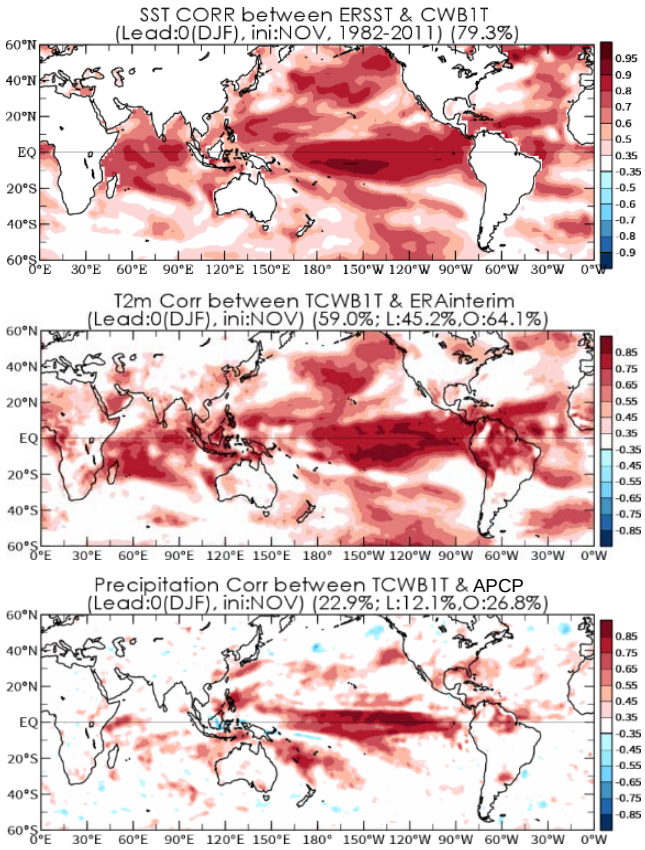

Fig. 4 The DJF forecast anomaly correlations of SST, T2M, precipitation between TCWB1T and observation/reanalysis in November. Only correlations significant at 0.05 are presented.

3.2 Forecast verification

We are starting MJO analysis on the operational forecast results of TCWB1T this year. During the season of DJFM from 2012 to 2018, 22 days of correlation coefficient between the observation and the forecast of RRM1 and RRM2 index from the model of TCWB1T are higher than 0.5 (Fig. 5). It indicates that CWB CFS1Tier can be used for ENSO as well as MJO forecasts.

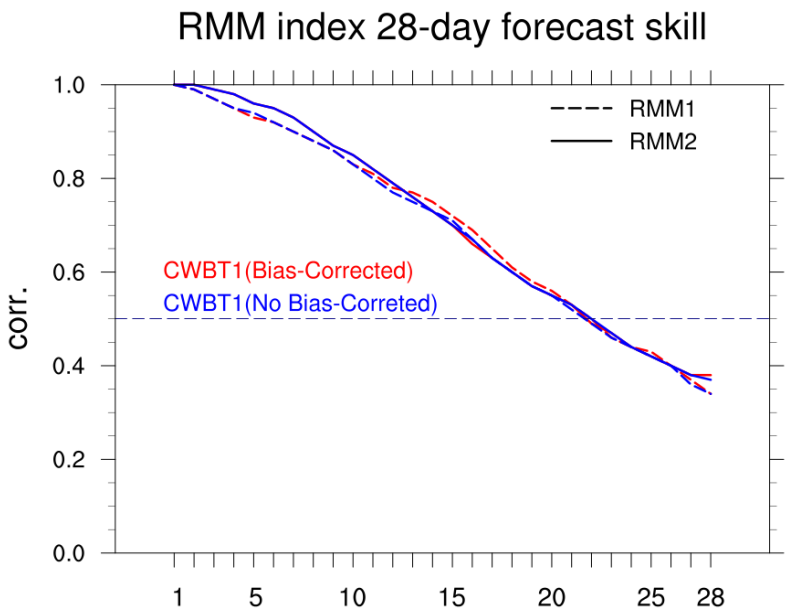

Fig. 5 From 2012 to 2018, the 28-day forecast anomaly correlations of DJFM RMM1 and RMM2 index.

4. Future work

We will have a newly updated TCWB1T this year 2019. It will have improved dynamic, corrected low boundary conditions, adjusted microphysics, better initial condition and climatology fields. And we will finish everyday hindcast run from 1999 to present in August. In the future, we will increase model resolution of atmosphere and ocean model. For example, CWB GFS T239L60 couple with GFDL MOM3 or MOM5. CWB 1-Tier is a seasonal forecast model that will be used for operational S2S in the near future (ex. MJO and BSISO (Boreal Summer Intraseasonal Oscillation) forecasts).

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