Evaluating Northwestern Pacific Tropical Storm Density Forecast in the Subseasonal to S2S Prediction Project Hindcast Database

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Goal To assess the potential for tropical storm forecasting on S2S timescales, the forecast skill of tropical storm density is evaluated using S2S Prediction Project Hindcast Database.

Data and Method The evaluation period is from May 1 to Oct. 31, 1999 to 2010. Tropical storm density, defined as the probability of presence of tropical storm within 500 km of a location, is computed from the ensemble forecasts from six operational centers: BoM, CMA, ECMWF, JMA, CNRM and NCEP and tropical storm location data from Joint Typhoon Warning Center. The Boreal Summer Intraseaosonal Oscillation Index (BSISO) is based on Lee et al. (2013)

Results In both observation and these six forecast systems, the tropical storm density is modulated by BSISO, which can be depicted by the BSISO indices, BSISO1 and BSISO2. During BSISO1 phases 1, 5, 6, 7, and 8, the northwestern Pacific region is dominated by an anomalous cyclonic circulation and positive precipitation anomaly, and tropical storm density tends to be enhanced (Fig. 2). Similarly, during phases 1, 2, 3, 4, and 8 of BSISO2, the tropical storm density also tends to be enhanced. Six models can reproduce the modulation of tropical storm density by BSISO with some skill. The de-biased Brier Skill Score is also used to compare the tropical storm density forecast skill of these models. The ECMWF forecasting system has positive de-biased Brier Skill Score when forecast lead time is from 11 to 30 days, indicating slightly better tropical storm forecast than reference forecast based on climatology.

WMO S2S Prediction Project Database (Hindcast)

System	Lead Time (day)	Resolution (°)	Hindcast Period	Freq. Hindcast	Hindcast (Ens Size)	Coupled with Ocean	Coupled with Sea Ice
BoM	0-62	2° x 2°	1981-2013	Times/Mon	33	Yes	No
CMA	0-60	1° x 1°	1994-2014	Daily	4	Yes	Yes
ECMWF	0-46	0.25° x 0.25°(0-10 days) , 0.5°x 0.5°(after 10 days)	Past 20years	2Times/Week	11	Yes	No
JMA	0-33	0.5° x 0.5°	1981-2010	3Times/Mon	5	No	No
CNRM	0-44	0.7° x 0.7°	1993-2014	2Times/Mon	15	Yes	Yes
NCEP	0-44	1° x 1°	1999-2010	Daily	4	Yes	Yes

Table 1 Details of six S2S forecast systems in the WMO S2S Prediction Project Database whose 30 day hindcasts from May 1 to Oct. 31, 199 to 2010 were used in present research. The content of the table is based on Vitart et al. (2017).

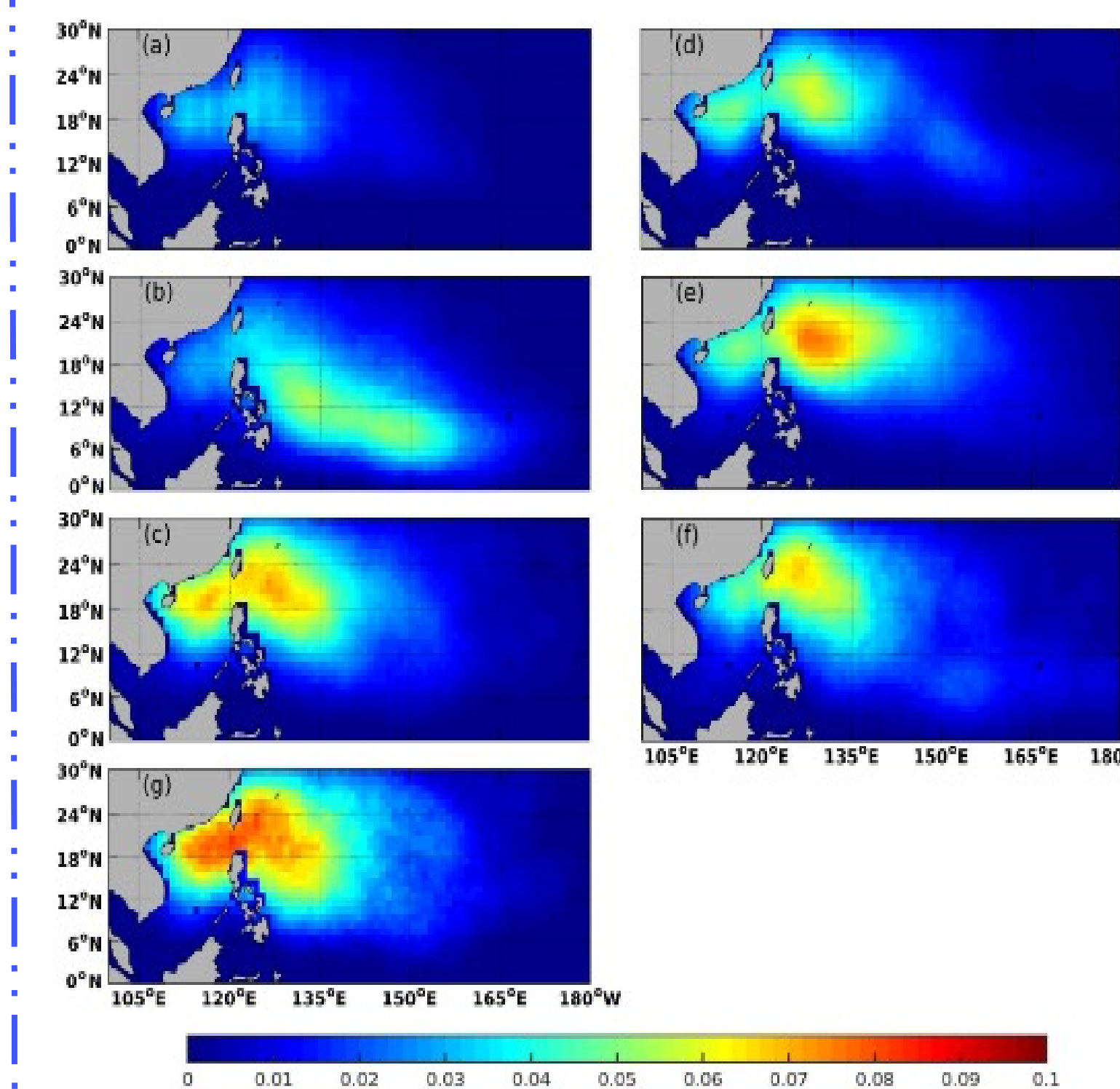## Climatological Tropical Storm Density

Fig. 1 Climatological tropical storm density from the six forecast systems, (a) BoM, (b) CMA, (c) ECMWF, (d)JMA, (e) CNRM, (f)NCEP, and (g) observation. These systems have various skills in reproducing the climatological tropical storm density.

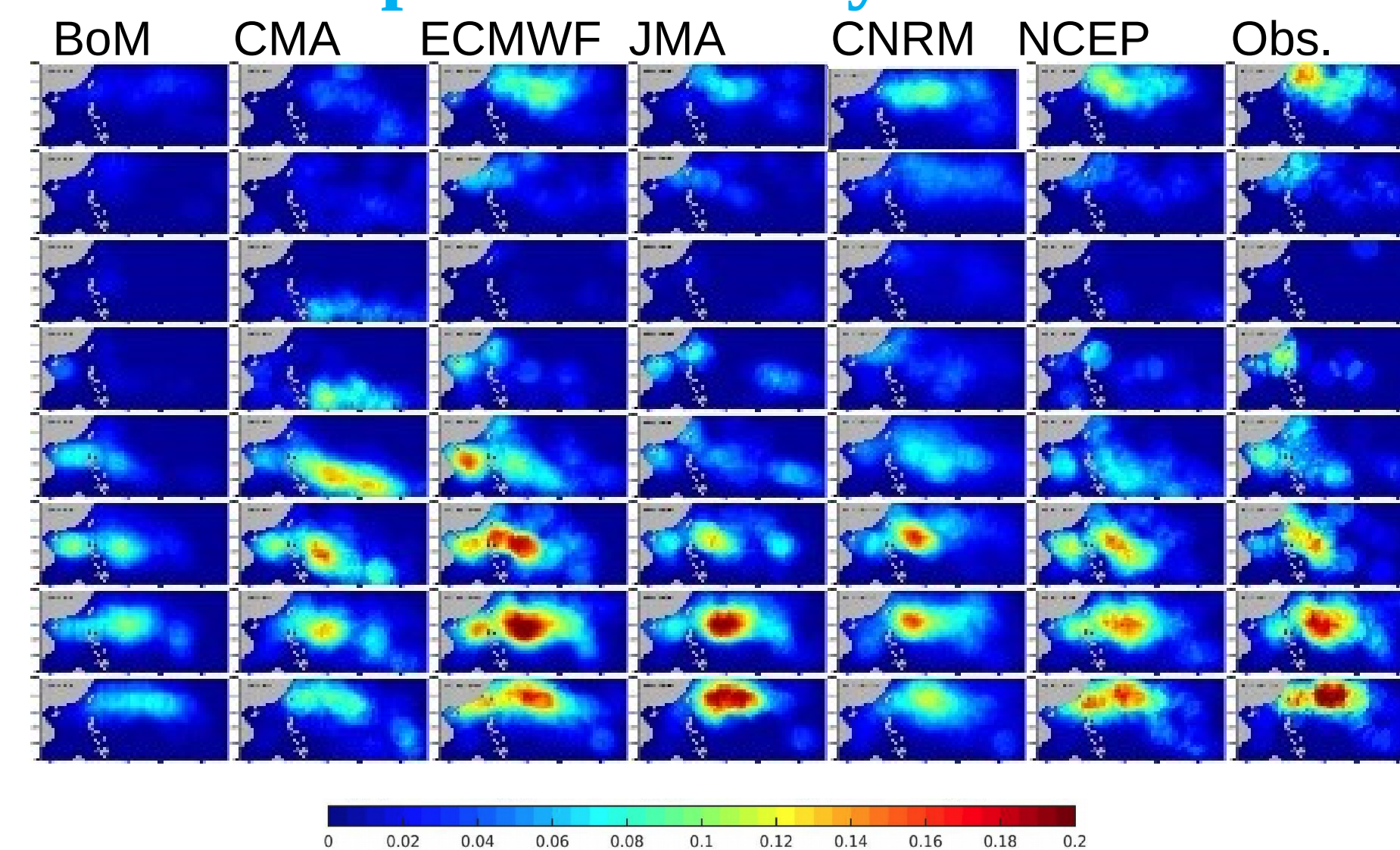## Modulation of Tropical Storm by BSISO

Fig. 2 Composite tropical storm density for six forecast systems for different phases of BSISO1.The rows from top to bottom are for phases 1 to 8 of BSISO1 when BSISO1 is greater than 1.5. The columns 1 to 7 are for six forecast systems (BoM, CMA, ECMWF, JMA, CNRM, and NCEP) and observations.
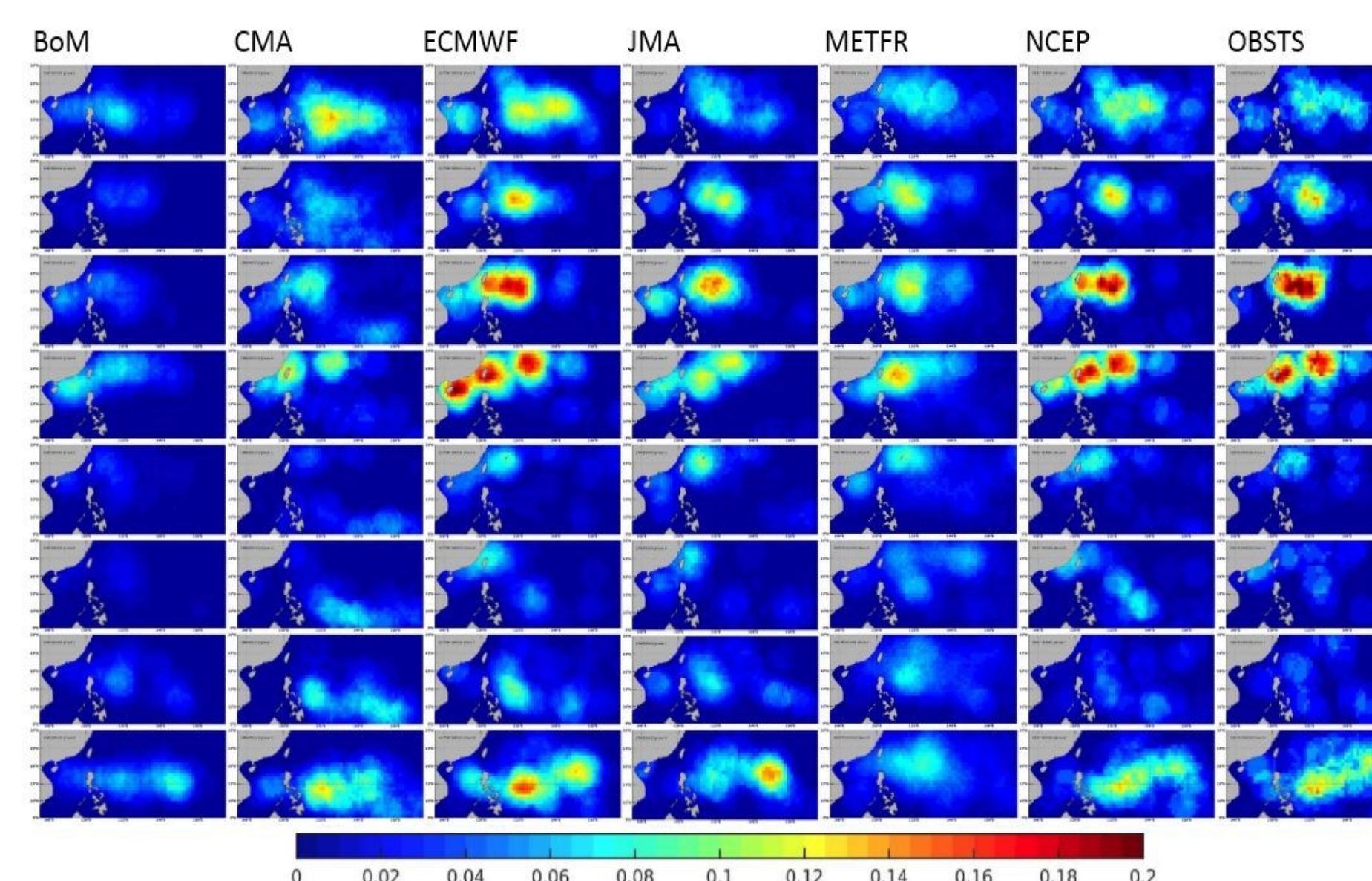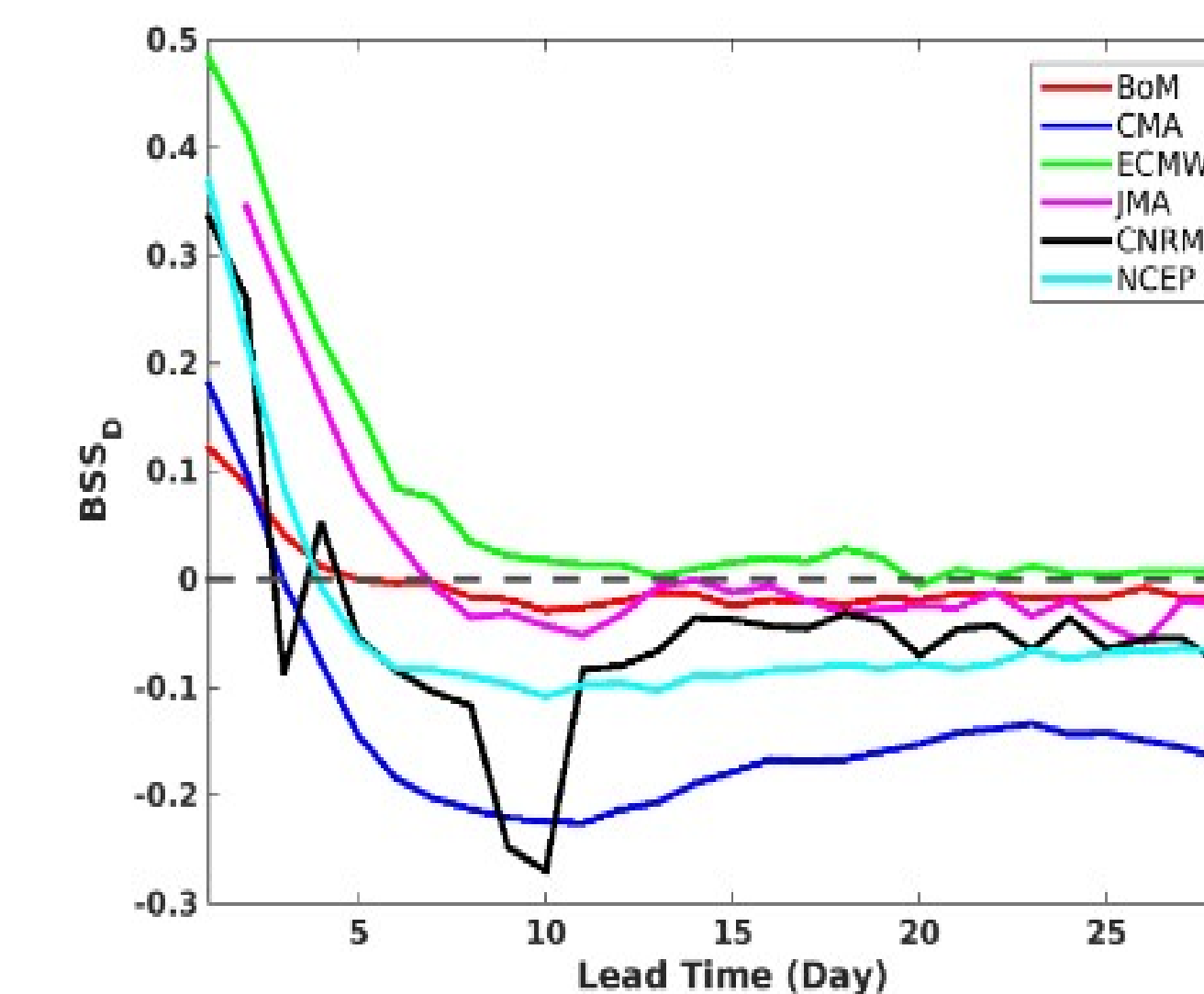

Fig. 3 Composite tropical storm density for six forecast systems for different phases of BSISO2.The rows from top to bottom are for phases 1 to 8 of BSISO2 when BSISO2 index is greater than 1.5. The columns 1 to 7 are for six forecast systems (BoM, CMA, ECMWF, JMA, CNRM, and NCEP) and observations.

De-biased Brier Skill Score of S2S TC Prediction

$$BSS_D = 1 - \frac{\langle BS \rangle}{\langle BS_{CI} \rangle + D}$$

Fig. 4 Avergaed De-biased Brier Skill Score for ensemble forecast of tropical storm density inthe region of 10°-30°N, 105°E-150°E. The abscissa is lead time in days. The ordinate is de-biased Brier Skill Score.

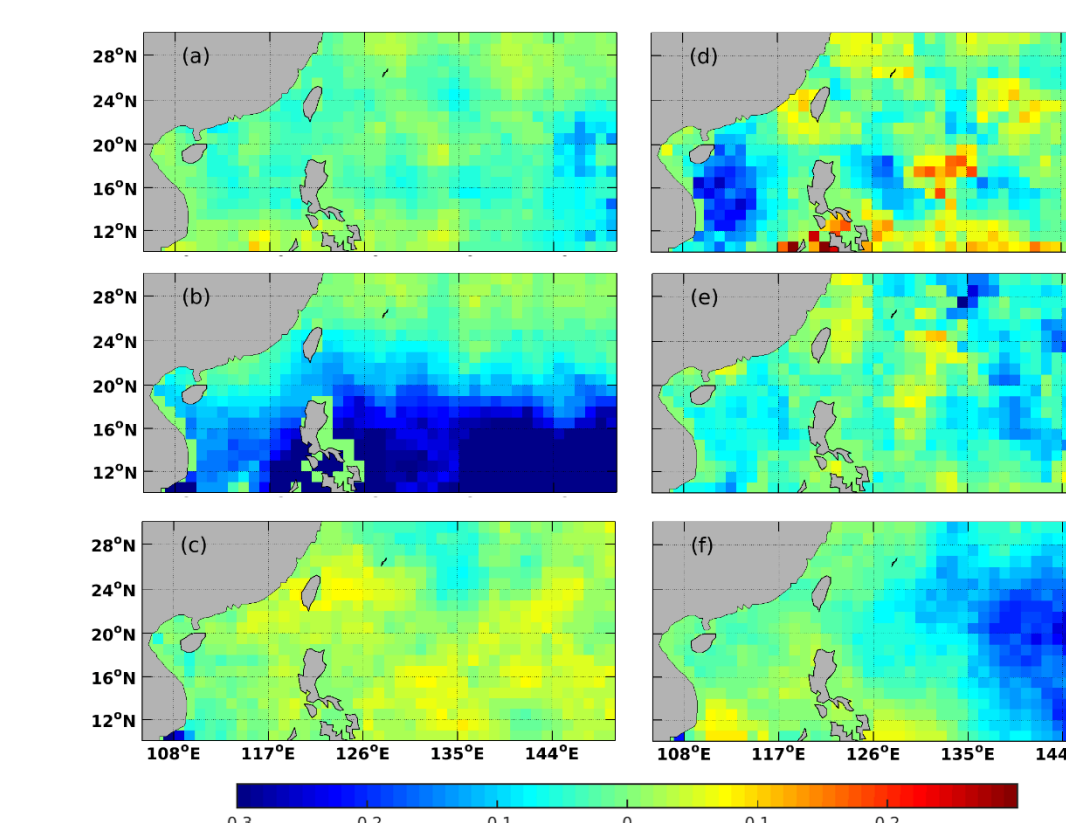## Spatial Distribution of De-biased Brier Skill Score

Fig. 5 De-biased Brier Skill Score with lead time 17 days for the six forecast systems. Regions with poor skill are the regions where forecast systems can not reproduce observed climatological tropical storm density and the modulation tropical storm by BSISO. Fig. 5a-f are for different forecast systems, BoM, CMA, ECMWF, JMA, CNRM, and NCEP, respectively.

Future Work

The S2S timescale forecast is still at a very early stage. Conducting experimental forecasts and real-time performance evaluation will help its further improvement and societal applications.

References

Lee J, Wang B, Wheeler M C., Fu X, Waliser D E and Kang I.-S., 2013, Real-time multivariate indices for the boreal summer intraseasonal oscillation over the Asian summer monsoon region, Claimte Dynamis, 493-509

Vitar F, Ardilouze C, Bonet, 2017, The subseasonal to Seasonal (S2S) Prediction Project Database, Bulletin of the American Meteorological Siciety, 98(1), 163-173

Weigel A P, Liniger M A, Appenzeller C, 2007, The Discrete Brier and ranked probability skill scores, Weather Review, 135(1), 118-124

Zhao, H, Jiang X, Wu L, 2015, Modulation of northwest Pacific tropical cyclone genesis by the inraseasonal varaiability, Journal of the Meteorological Society of Japan, 93(1), 81-97

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