Effect of increasing atmospheric resolution on Prediction Skill of ENSO in Climate Forecast System (CFS) Model

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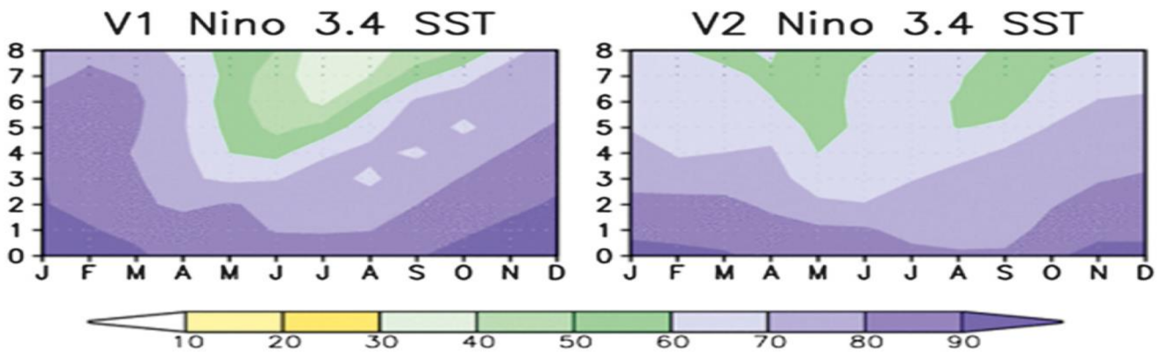
BACKGROUND

- **When a model is initialized before and across boreal spring, a quick decline of prediction skill along with prominent error growth in eastern and central pacific is observed; this drop in prediction skill is termed as "spring predictability barrier" (SPB) of ENSO (Yu and Kao 2007; Kumar et al. 2017)**

- **Niño3.4 region (190°E–240°E, 5°S–5°N) is important for ENSO forecasters community in terms of ENSO SST index as the SST averaged over this region is strongly associated with other ENSO-related oceanic/ atmospheric variability, and remote worldwide climate anomalies are highly influenced by SST anomalies over Niño3.4 region (Barnston et al. 1997).**

- Prediction skill of Niño 3.4 SST has not improved for CFSv2 (T126) in comparison to CFSv1 (T62).



Saha et al. 2014
Journal of Climate

- Anomaly correlation coefficient (ACC) of SST for Niño 3.4 region become lower for winter target months in CFSv2 compared to CFSv1 at long leads and higher for summer target months. This increase in prediction skill of Niño 3.4 region for summer target months reduces SPB in CFSv2 compared to CFSv1. (Barnston and Tippett (2013), Saha et al. 2014)

DETAILS OF MODEL

Model Used: CFSv2 (T126) & CFSv2-IITM (T382)

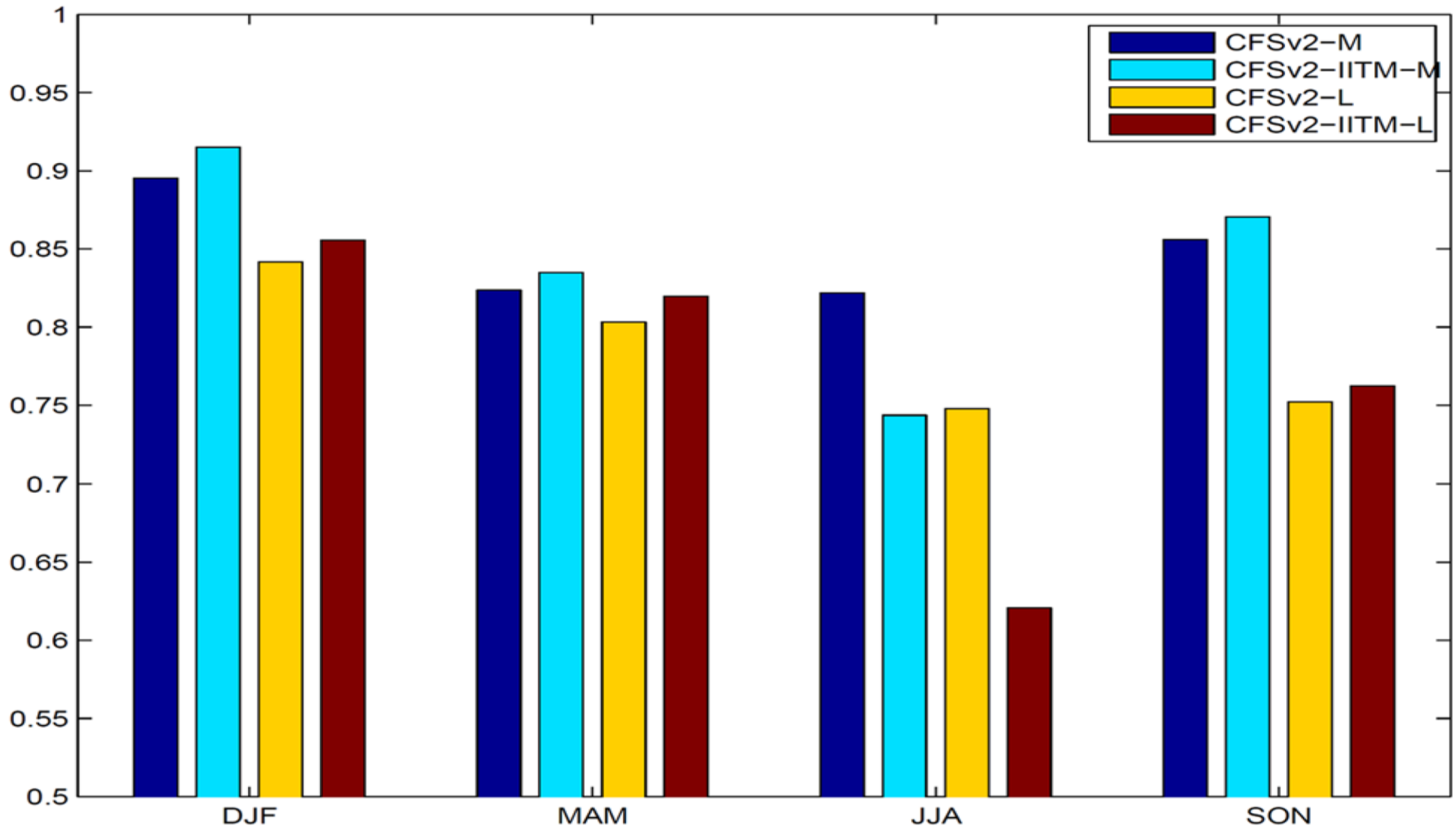
Monthly averaged hindcast data for each initial month (Jan through Dec)

Hindcast Period 1982–2008

Model is initialized twice a day at 00 UTC and 12 UTC for each IC and integrated for 9 months

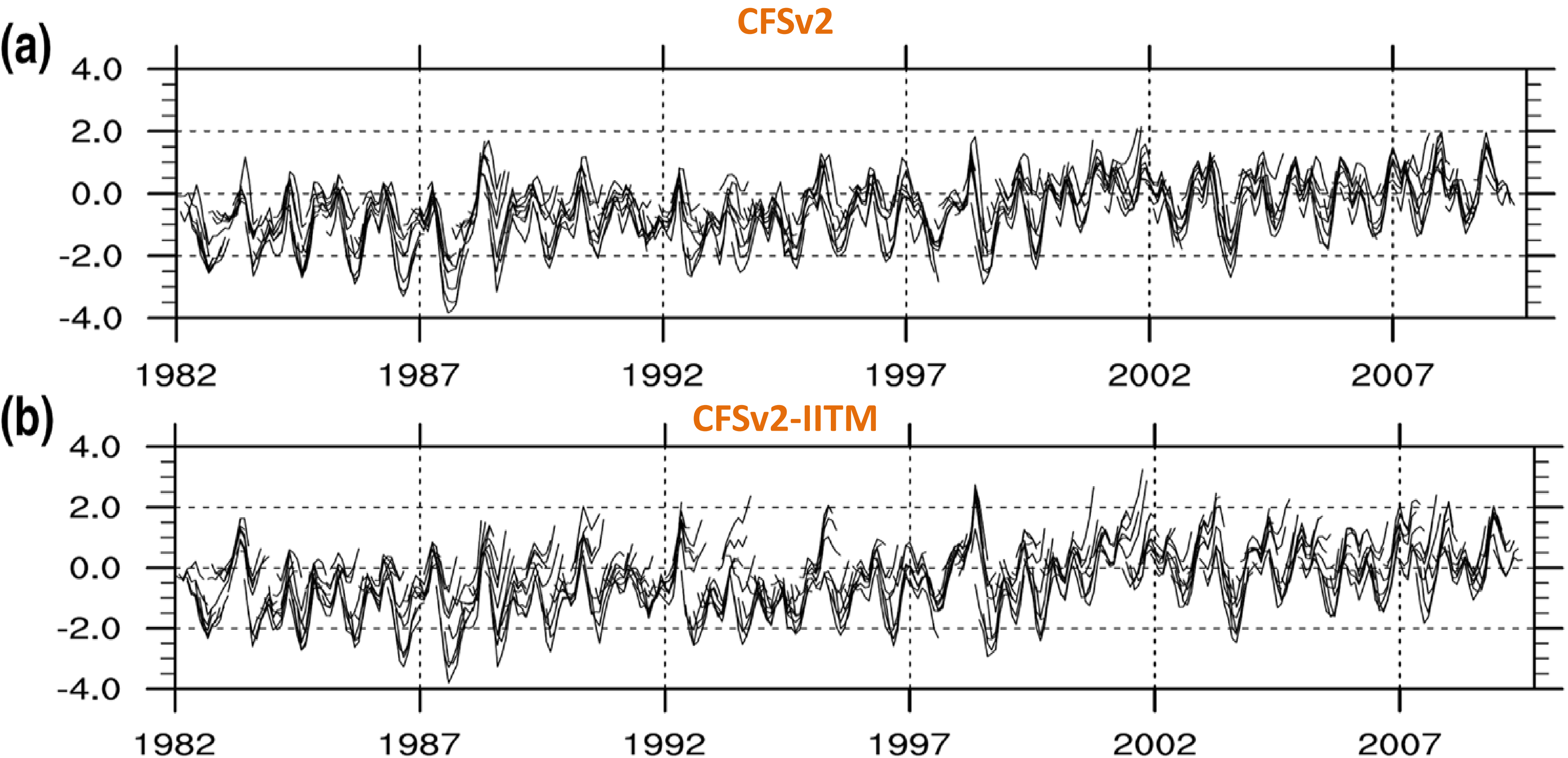
Thus, total number of ensembles (Initial conditions) for each month is 10–12.

Month	Dates for initialization of models (IC)
JAN	6, 11, 16, 21, 26
FEB	5, 10, 15, 20, 25
MAR	2, 7, 12, 17, 22, 27
APR	1, 6, 11, 16, 21, 26
MAY	1, 6, 11, 16, 21, 26, 31
JUN	5, 10, 15, 20, 25, 30
JUL	5, 10, 15, 20, 25, 30
AUG	4, 9, 14, 19, 24, 29
SEP	3, 8, 13, 18, 23, 28
OCT	3, 8, 13, 18, 23, 28
NOV	2, 7, 12, 17, 22, 27
DEC	2, 7, 12, 17, 22, 27

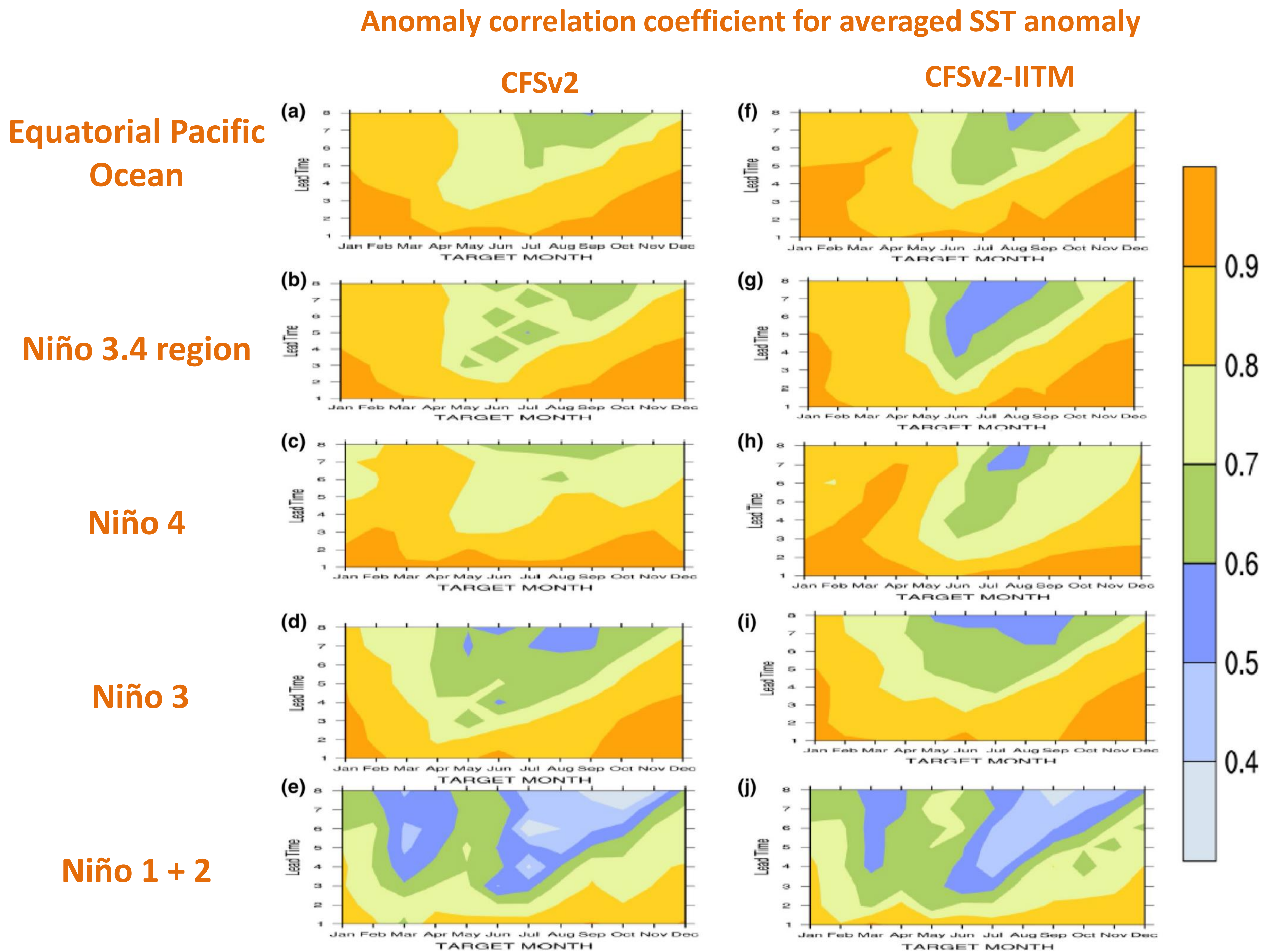


Skill of SST anomaly for four seasons (DJF, MAM, JJA and SON) in retrospective runs of CFSv2 and CFSv2-IITM and observations for medium (M) and long leads (L) for the period 1982–2008 for Niño 3.4 region

SST prediction error for each IC over Niño 3.4 region

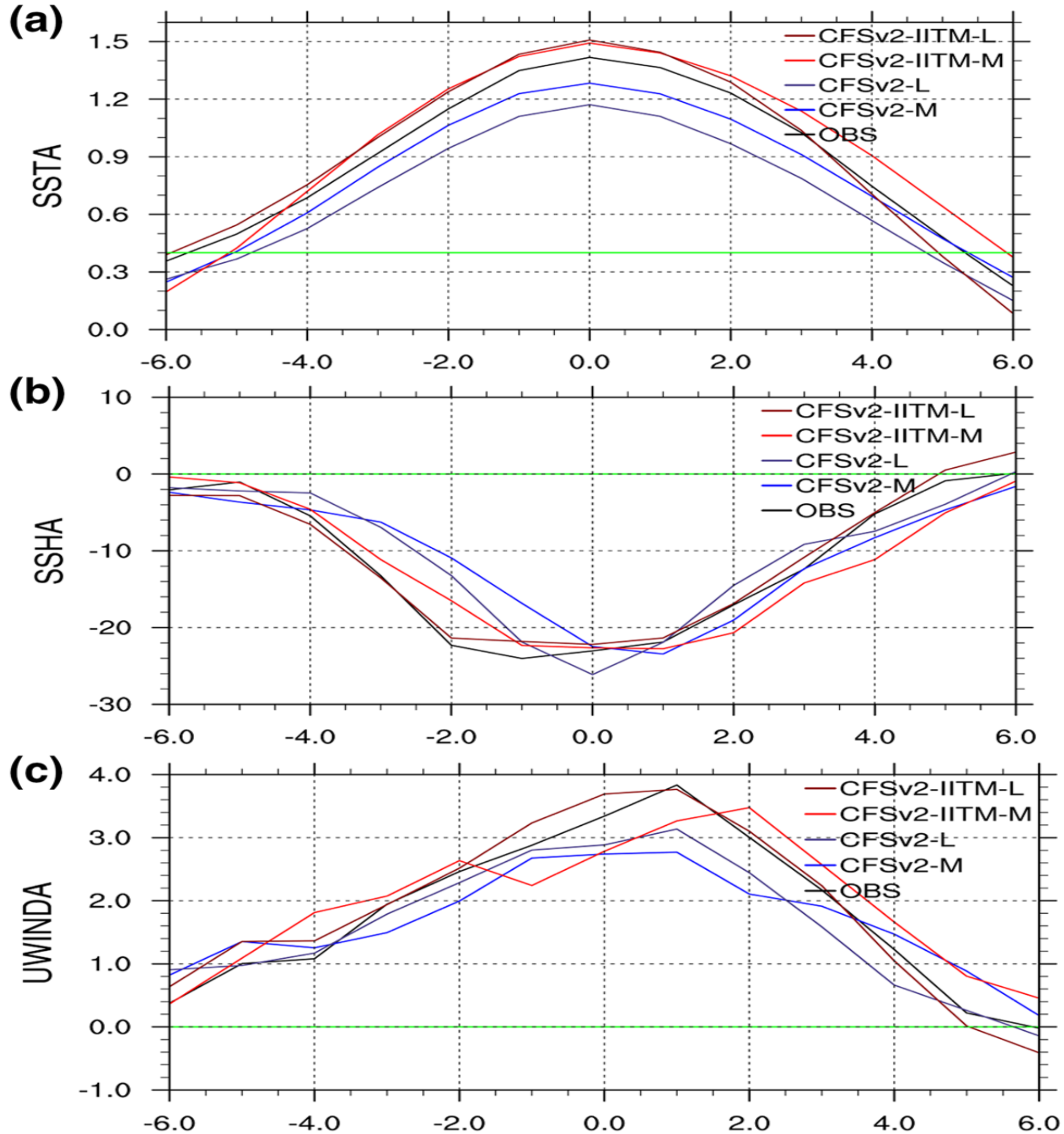


SST anomaly is calculated using dual set of climatology (1982–1999, 1999–2010) averaged over Niño 3.4 region for each lead time



Anomaly correlation coefficient for averaged SST anomaly
CFSv2
CFSv2-IITM
Equatorial Pacific Ocean
Niño 3.4 region
Niño 4
Niño 3
Niño 1 + 2
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
Lead Time
TARGET MONTH
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.9
0.8
0.7
0.6
0.5
0.4

Composite Analysis with respect to peak month of ENSO for 1982-2008



(a) SST anomaly (°C) averaged over Niño 3.4 region

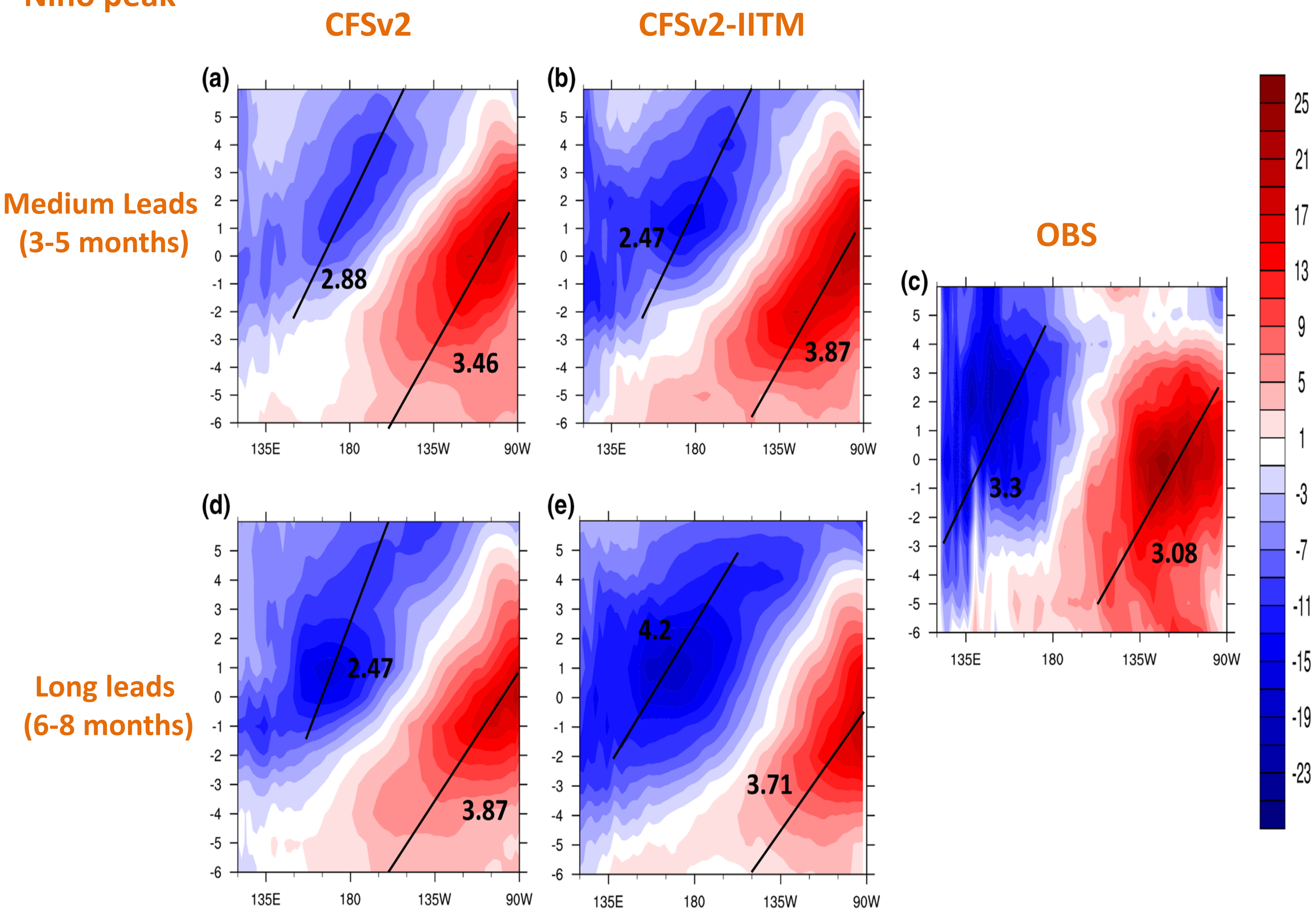
(b)Thermocline slope index (m)

Difference between western Pacific (160°E–150°W, 5°S–5°N) and eastern Pacific (90°–140°W, 5°S–5°N) 18 °C isotherm depth anomalies

(c) zonal wind anomaly (m/s) at 850 hPa averaged over Niño 4 region

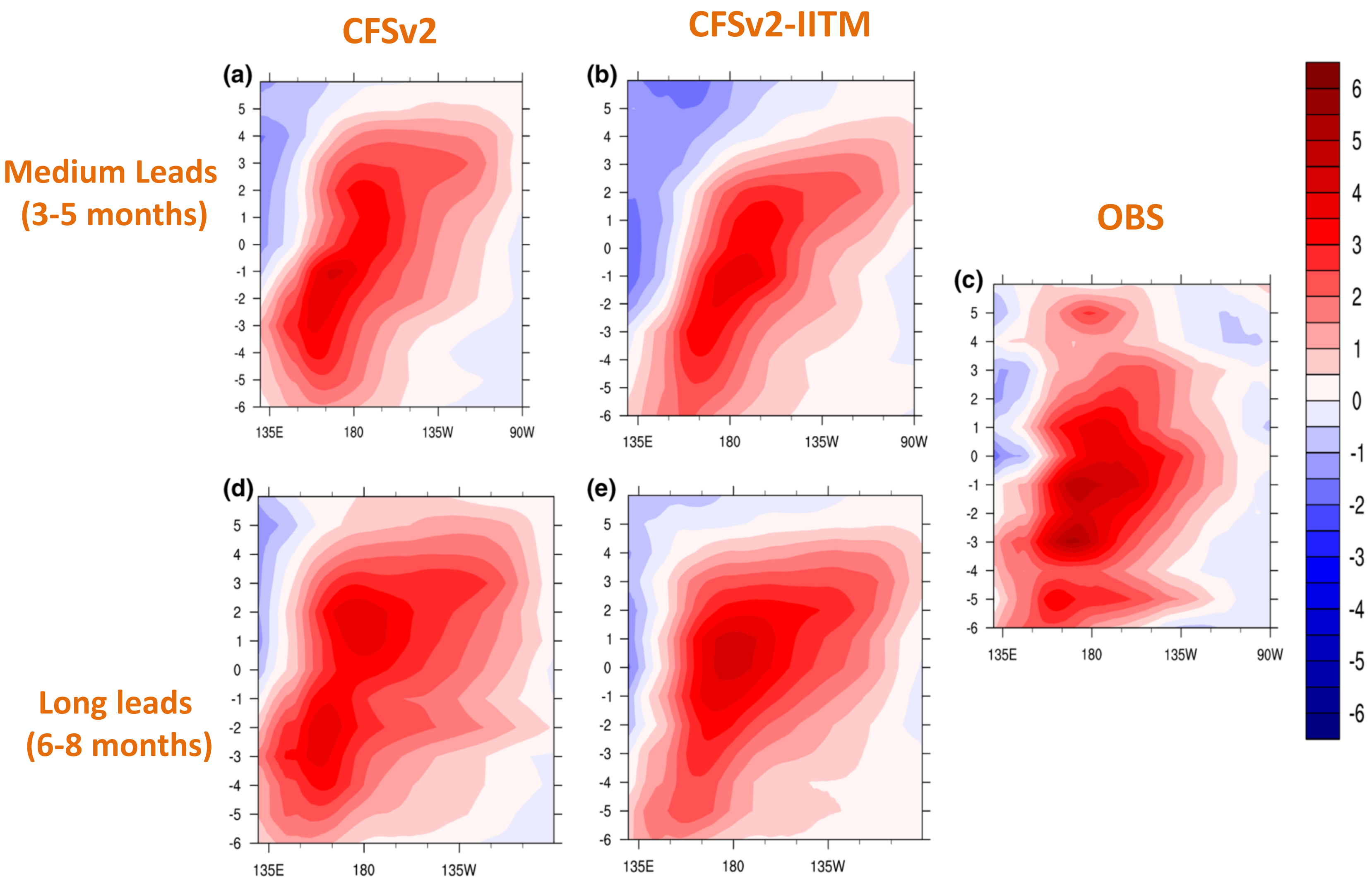
X axis represents months before and after peak month of ENSO

Composite of 18 °C isotherm depth anomaly averaged over 5°S–5°N with respect to El Niño peak



Phase speed (in m/s) along maximum and minimum values of 18 °C isotherm depth anomaly

Composite of u wind anomaly at 850 hPa averaged over 5°S–5°N wrt El Niño peak



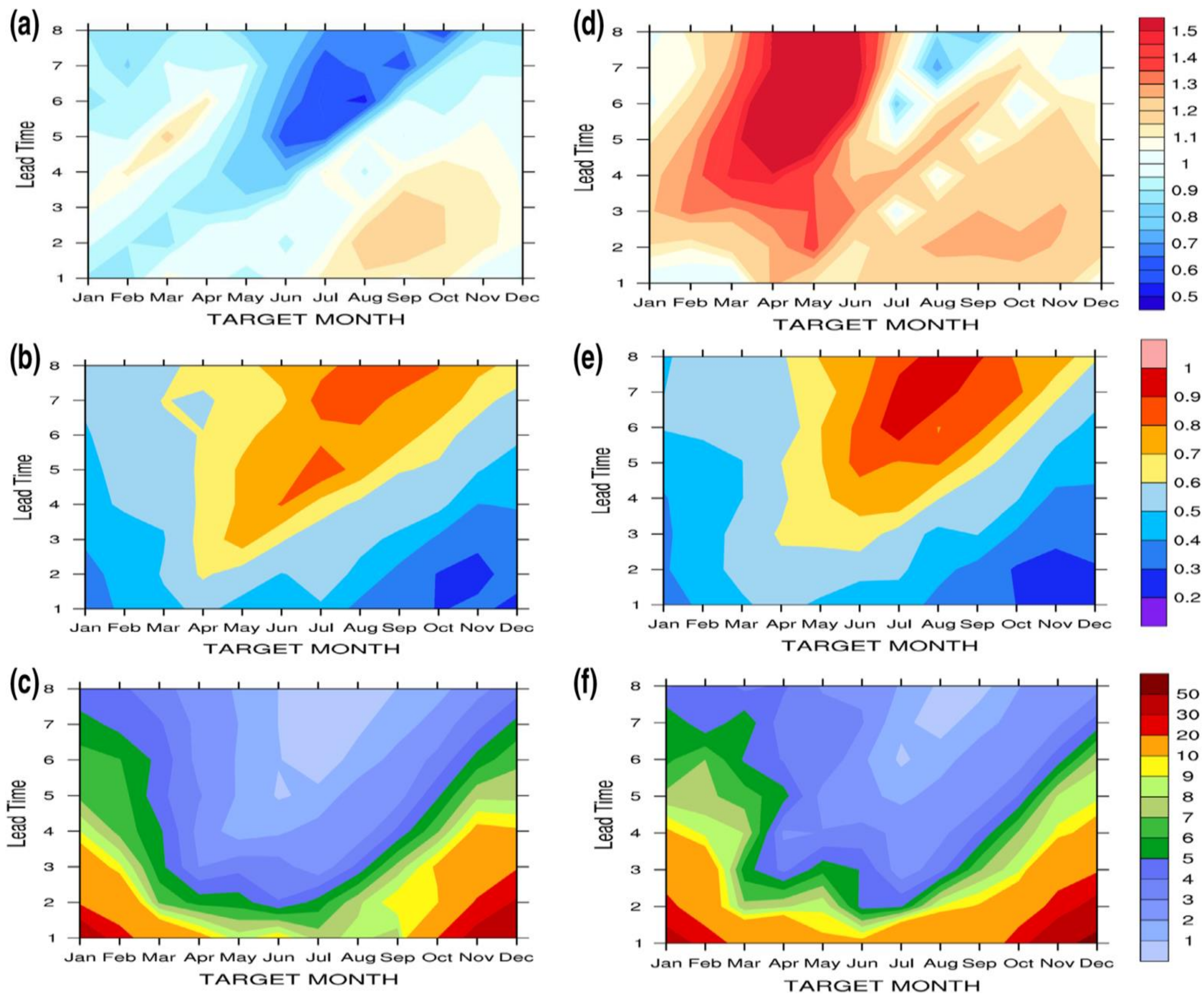
SST anomaly averaged over Niño 3.4 region

CFSv2 | CFSv2-IITM

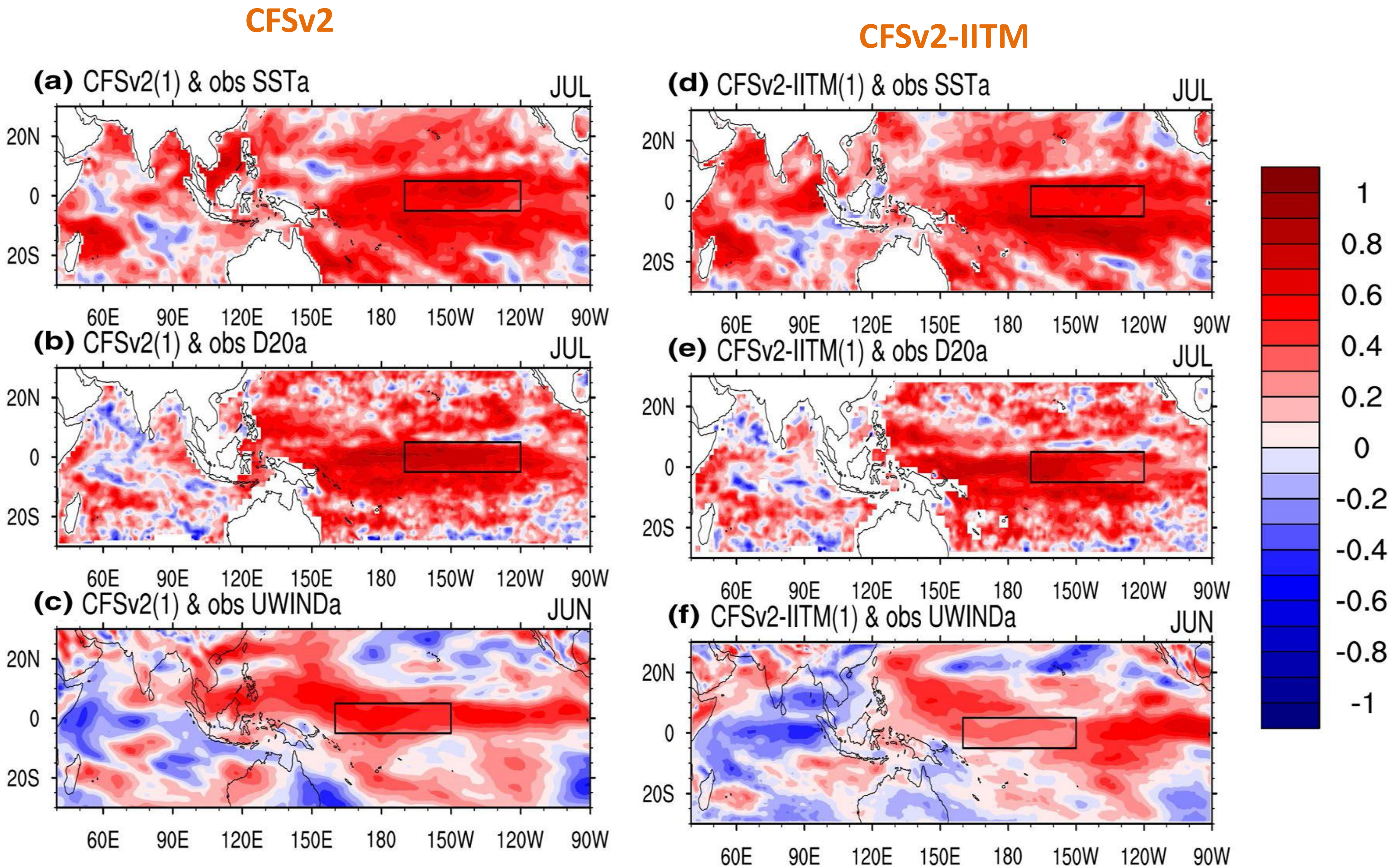
Normalized standard deviation

RMSE

Signal-to-Noise ratio

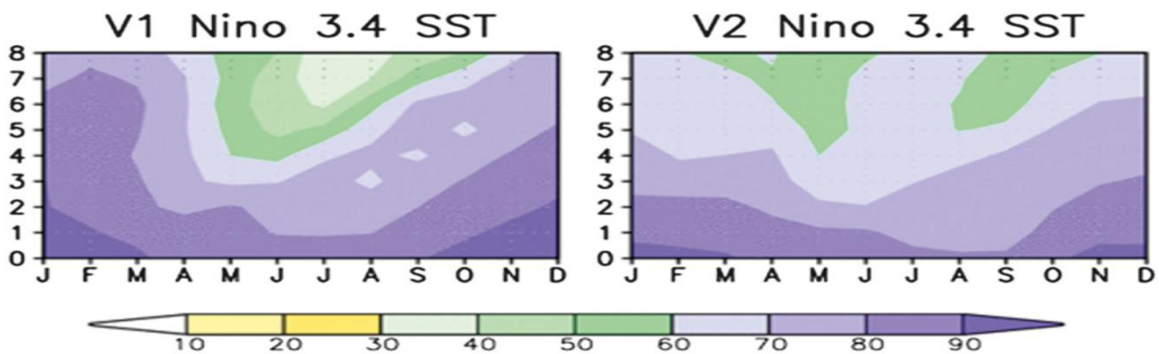


Correlation Coefficient between observation and model for January IC



Summary

- Atmospheric resolution in NCEP-CFS coupled model is increased from T126 (CFSv2) to T382 (CFSv2-IITM) keeping same ocean model and initialization
- Prediction skill significantly drops in summer target months (JJA) with lead time of 6–8 months coinciding with spring predictability barrier (SPB) for both the models. Drop is moderately more (~ 0.1) in CFSv2-IITM compared to CFS v2



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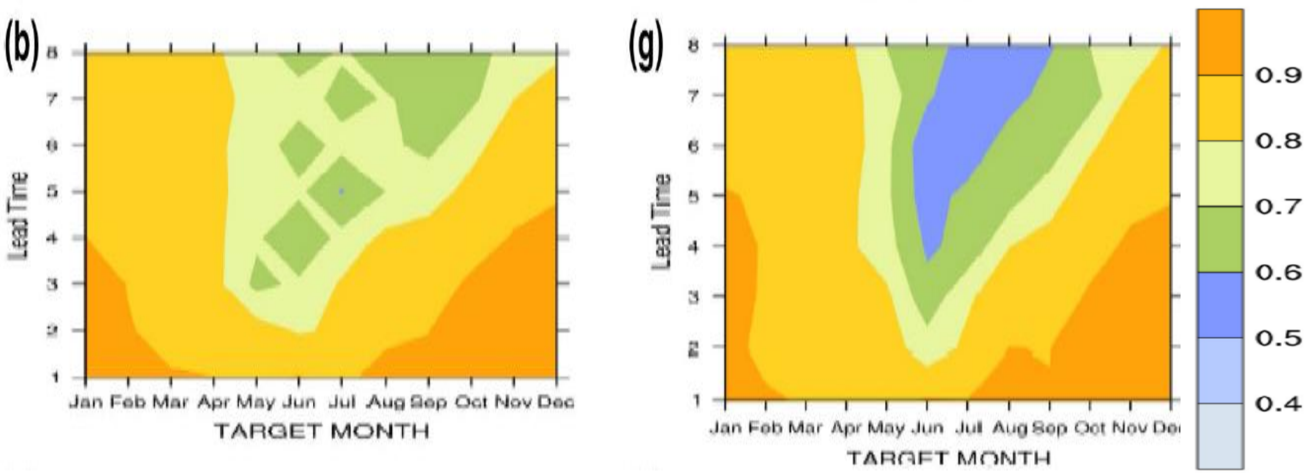

Arora et al 2018
Climate Dynamics

Thank You For Your Attention