Spatio-Temporal Variability of delayed and normal advancement of Bay of Bengal branch of Monsoon over Gangetic West Bengal

ICTP-IITM-COLA Targeted Training Activity (TTA): Towards improved monsoon simulations | (smr 2896)

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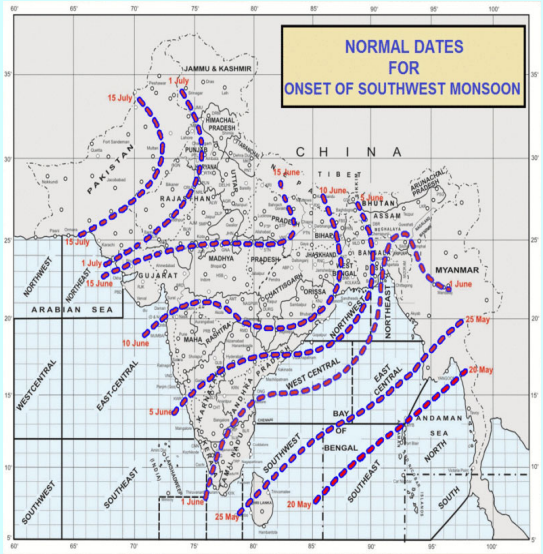
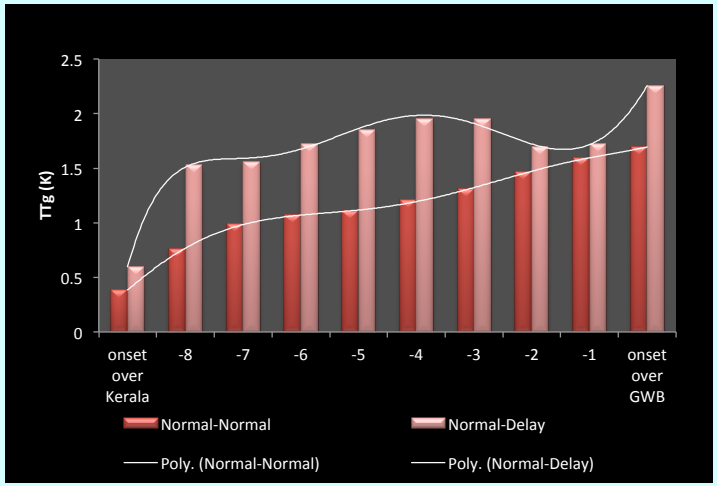
The arrival of the summer monsoon is also of great importance and most awaited phenomena over India. Normal, Advance and Delay arrival of monsoon rain has strong impact on Indian agriculture as well as economy.

The onset of monsoon is recognized as a rapid increase and characteristic persistency of rainfall and the rainfall amount increases from 5 to 15 mm/day (Soman and Kumer, 1993). The Southern tip of Indian coast (Kerala) get first onset of monsoon around 1 June. Progress of the monsoon may be divided into two branches – Arabian Sea branch and Bay of Bengal branch (BOB) of monsoon. BOB branch propagates northwards into central BOB and reaches Assam by first week of June and after that it is deflected by southern barrier of Himalayan and moves westwards. After that BOB branch moves Gangetic plain rather than towards Myanmar.



Data:

- For this study, NCEP reanalysis daily wind data at 500mb and from 1000mb to 850mb, air temperature from 600mb to 200mb are collected (Kanamitsu et. al., 2002).
- The interpolated OLR data are provided by NCEP reanalysis data sets (Liebmann, B. and C. A. Smith, 1996).
- Specific Humidity data are also from NCEP reanalysis. All these data are available at 2.5°×2.5° resolution. 0.25°×0.25° fields of daily sea surface temperature anomaly (SSTa) from NOAA are used (Reynolds et. al., 2007). These data sets are collected for period 1981-2014 in this study.
- Onset dates of Monsoon and rainfall for JJAS periods from 1981-2014 are collected from IMD.
- NCEP CFSv2 model products

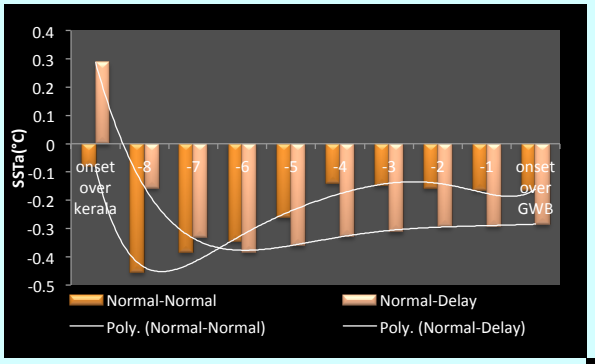


The tropospheric temperature gradient is thought to drive the Indian monsoon (Fu and Fletcher,1985).

Figure 1: Variation of Tropospheric temperature Gradient (TTg) (K) during Normal-Normal year and Normal-Delay year

North (22.5°-15°N, 80°-95°E)

(a)



South (15°-5°N, 80°-95°E) Bay of Bengal

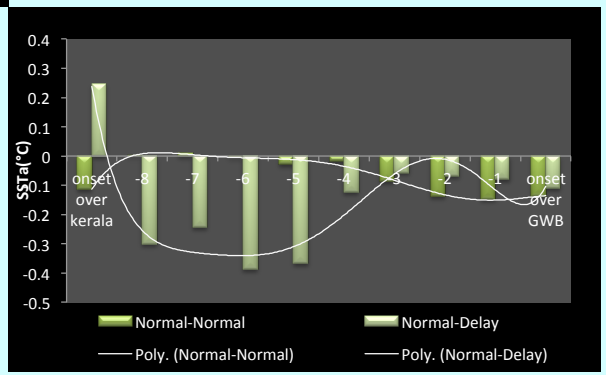
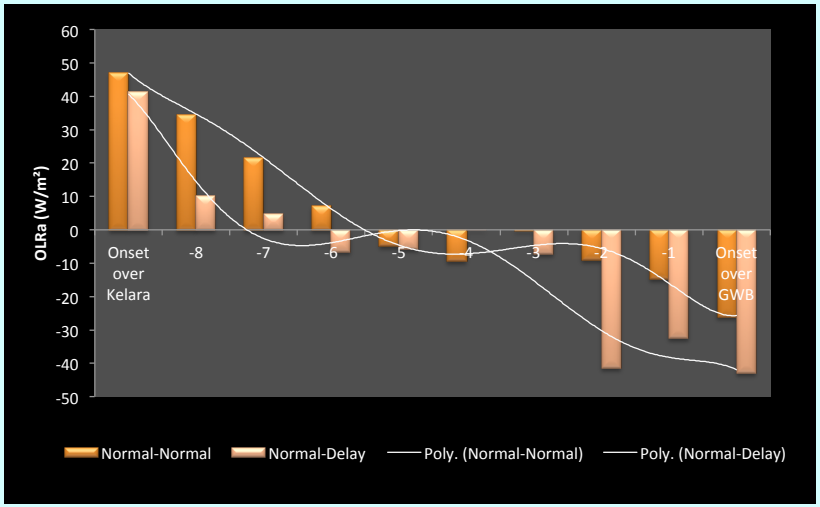


Figure 2: Variation of Sea Surface Temperature Anomaly (SSTa) (°C) over (a) North Bay of Bengal and (b) South Bay of Bengal during Normal-Normal and Normal-Delay year.


60
50
40
30
20
10
0
-10
-20
-30
-40
-50
OLRa (W/m²)
Onset over Kelara
-8
-7
-6
-5
-4
-3
-2
-1
Onset over GWB
Normal-Normal
Normal-Delay
Poly. (Normal-Normal)
Poly. (Normal-Delay)

(a)

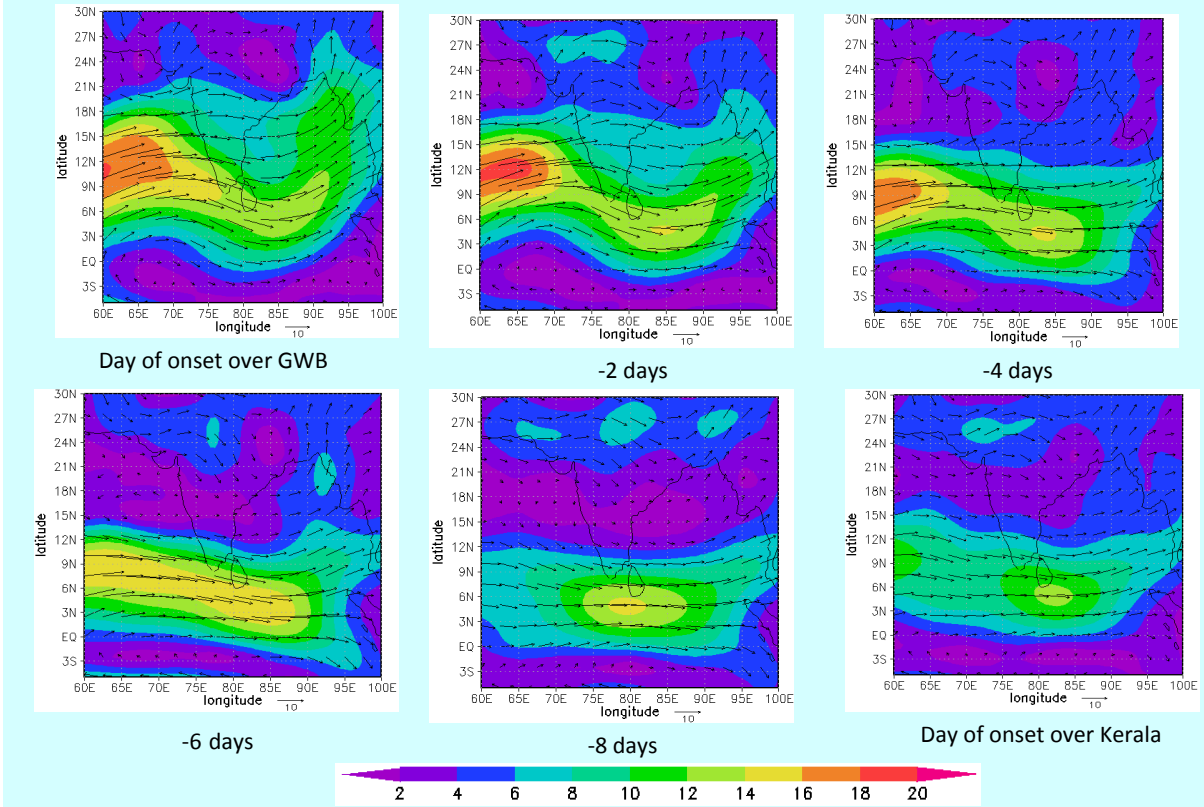


Figure 6: Variation of Wind (m/s) at 850mb during Normal-Normal year.

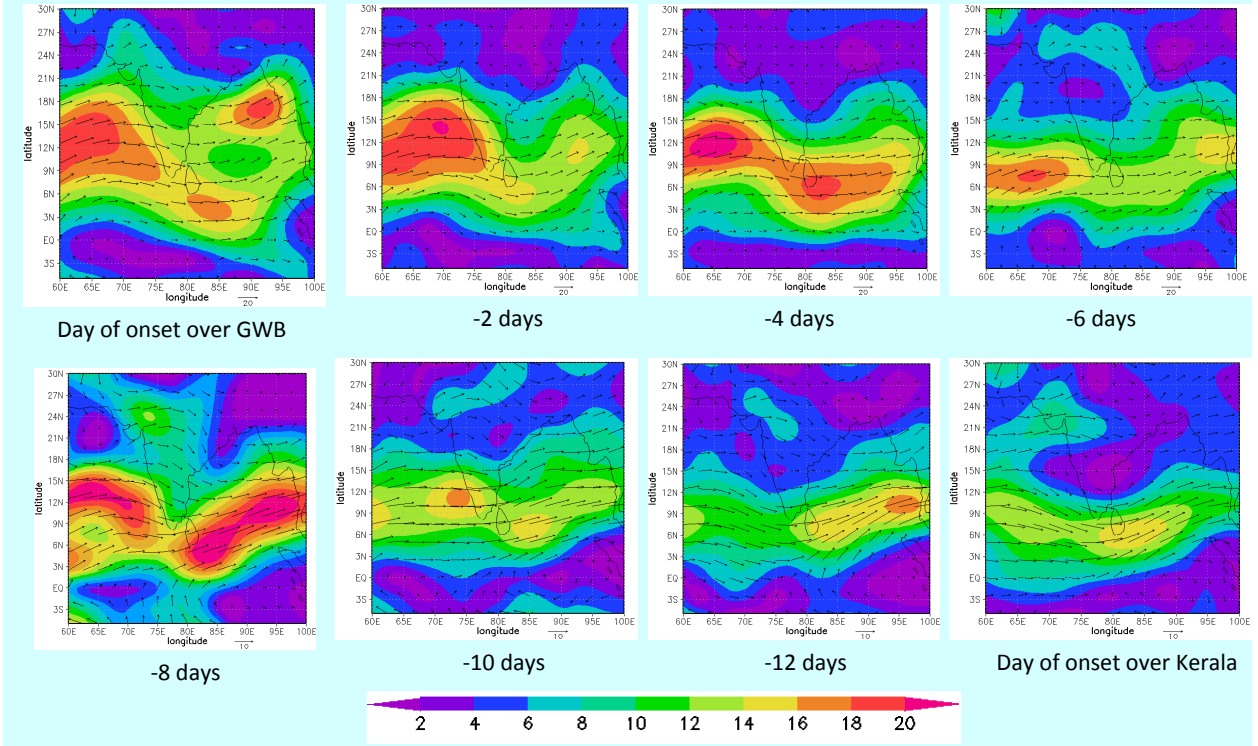


Figure 7 Variation of Wind (m/s) at 850mb during Normal-Delay year.

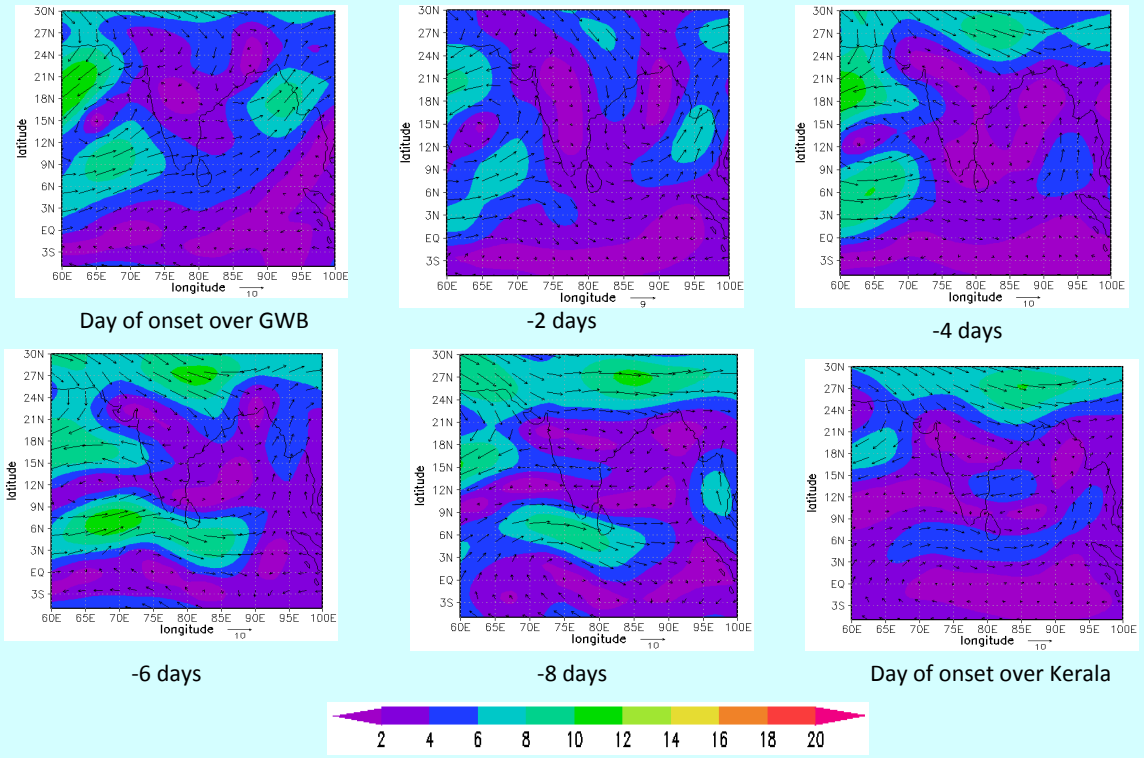


Figure 4 Variation of Wind (m/s) at 500mb during Normal-Normal year.

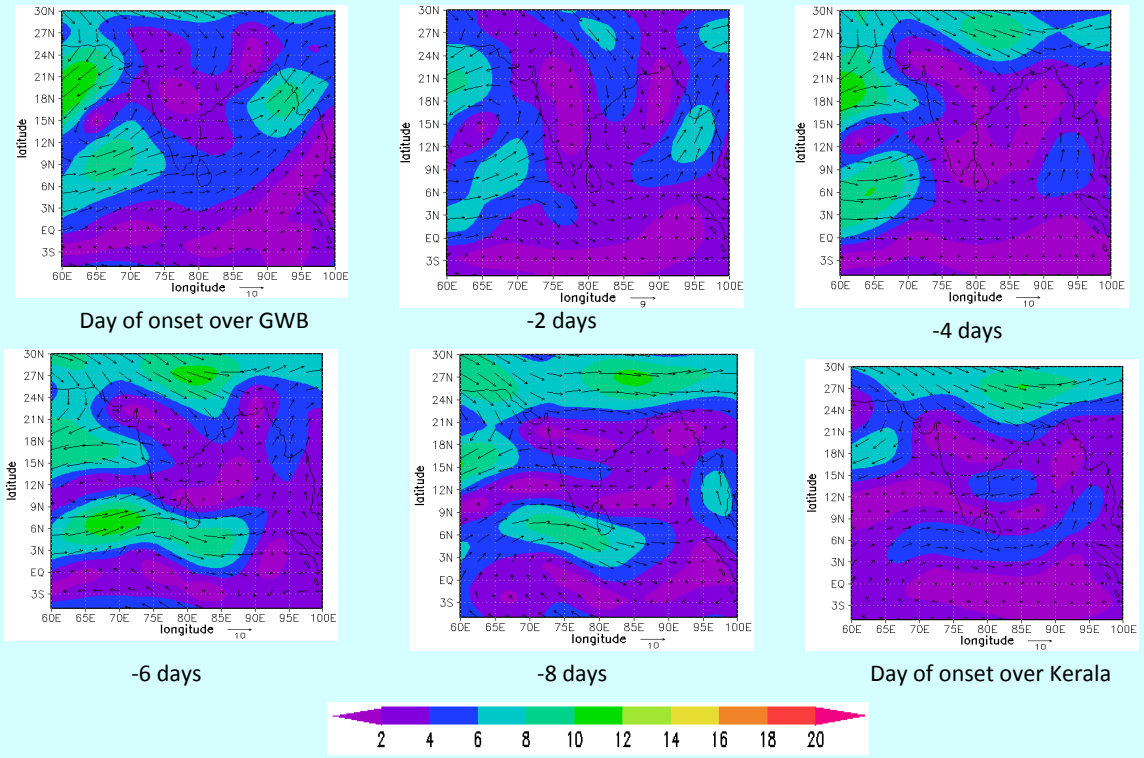


Figure 4 Variation of Wind (m/s) at 500mb during Normal-Normal year.

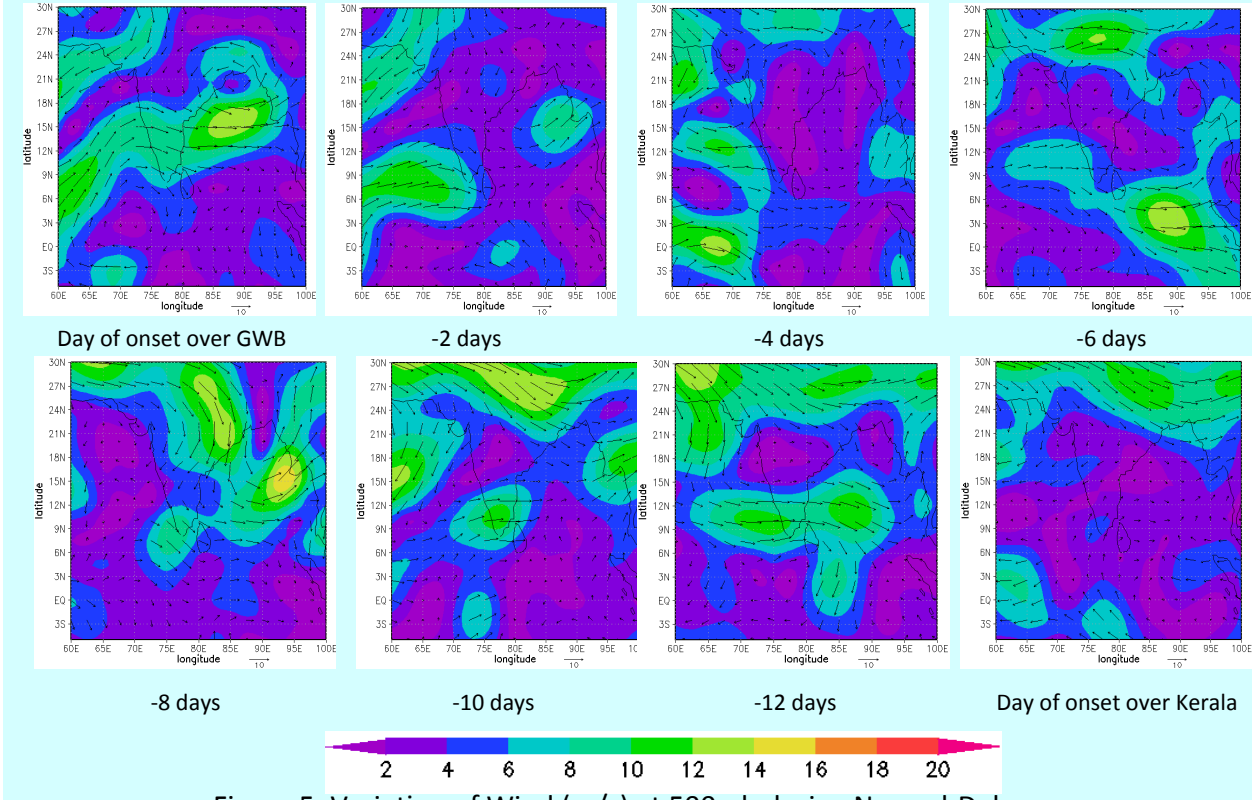


Figure 5: Variation of Wind (m/s) at 500mb during Normal-Delay year.

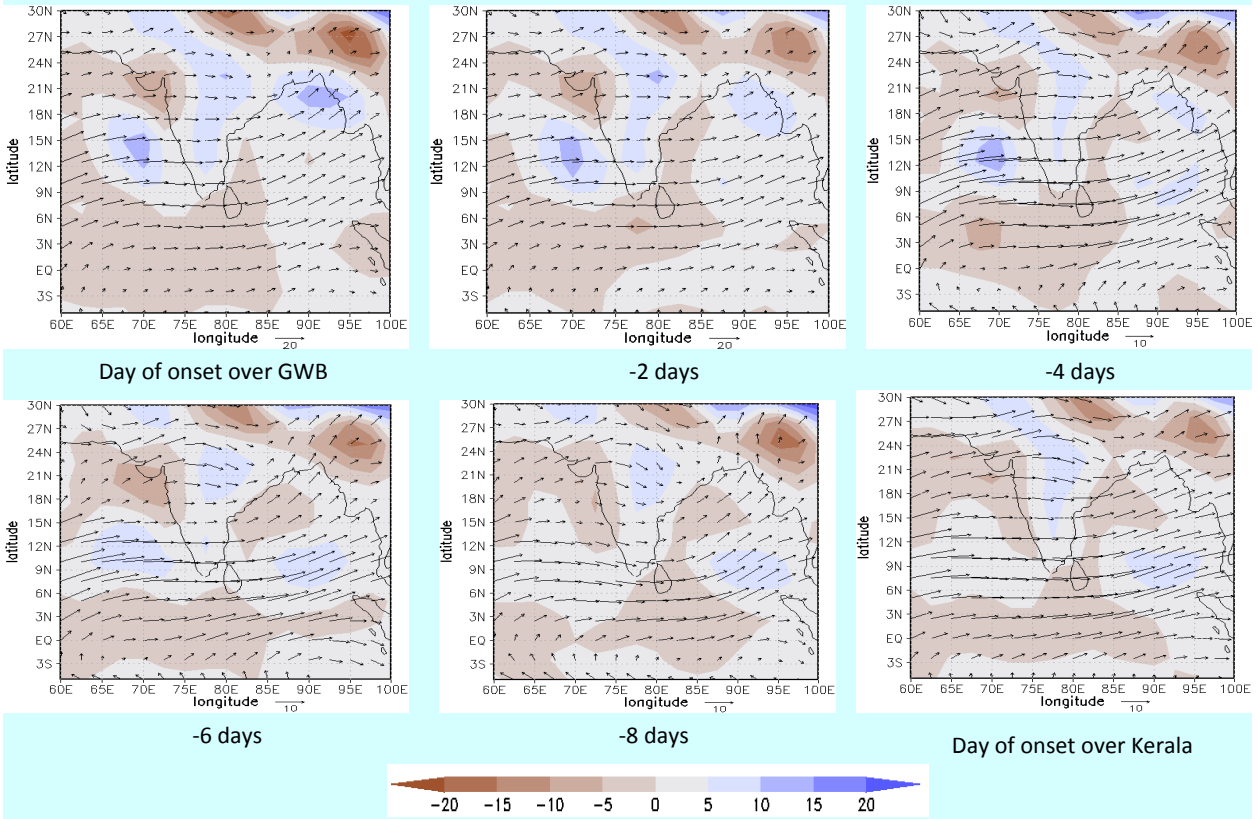


Figure 8: Variation of moisture convergence ($10^{-}4$ $kgm^{-2}s^{-1}$) during Normal-Normal year.

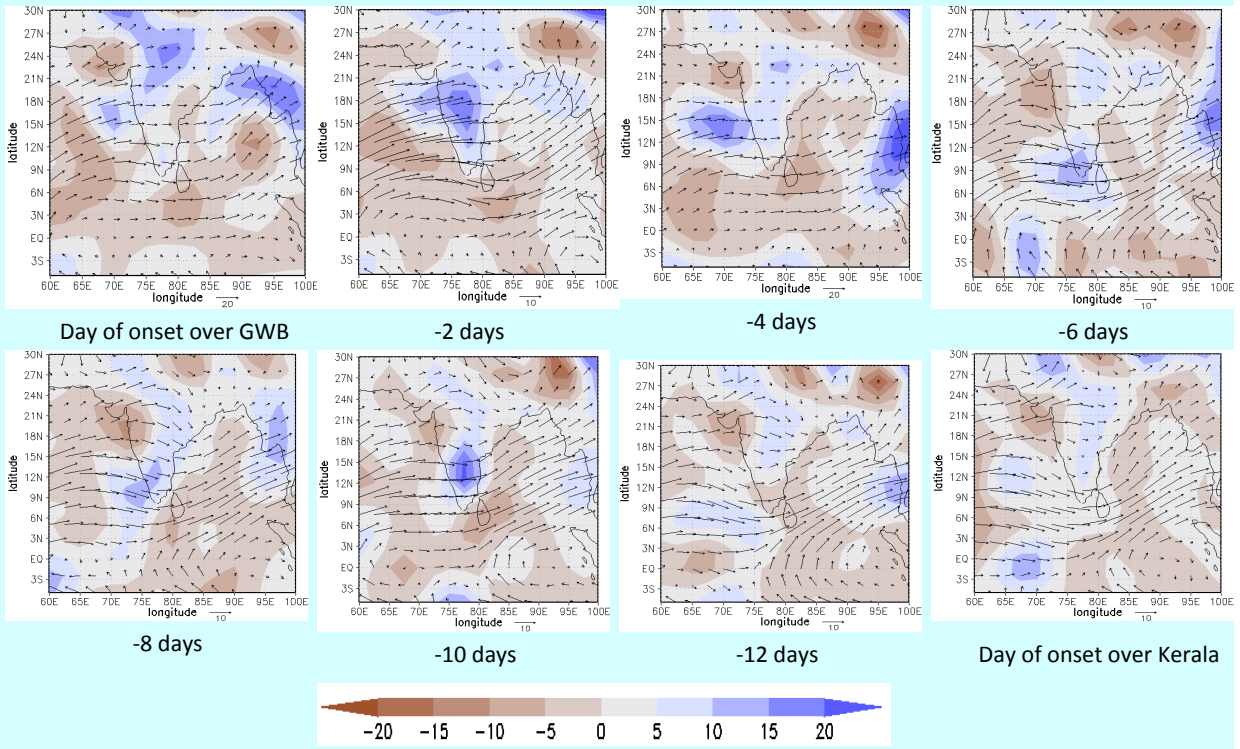


Figure 9: variation of moisture convergence ($10^{-}4$ $kgm^{-2}s^{-1}$) during Normal-Delay year.

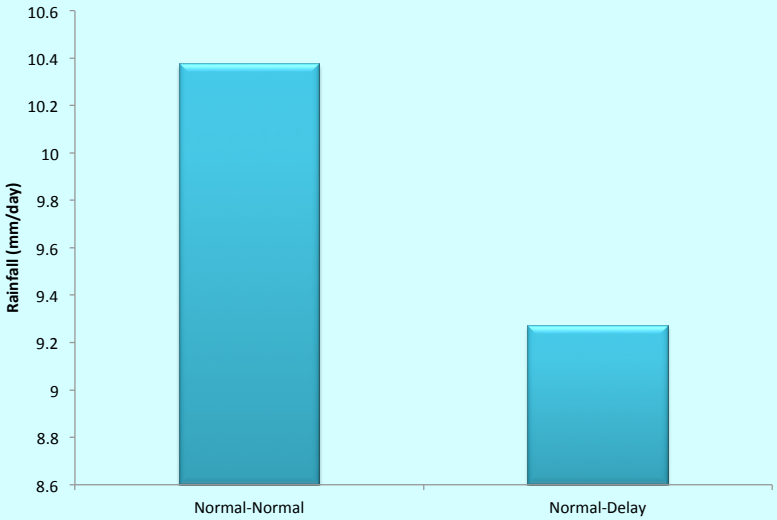
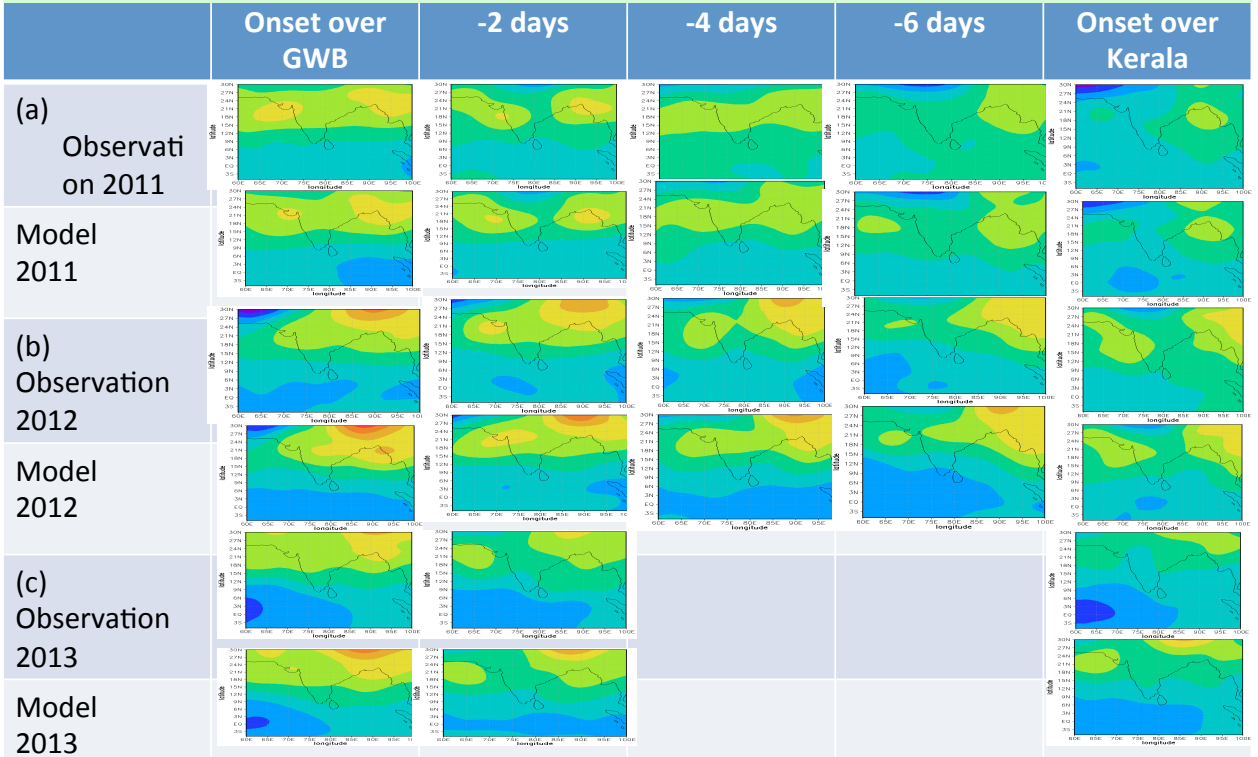
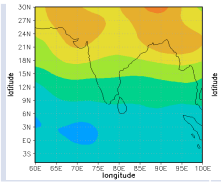
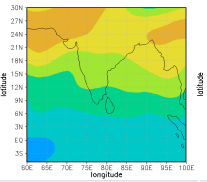
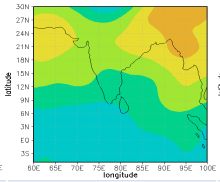
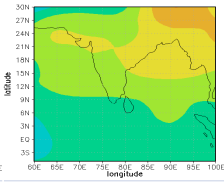
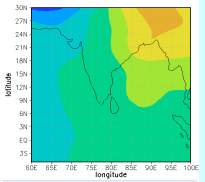
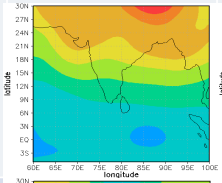
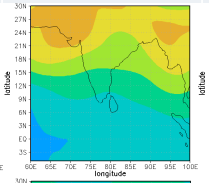
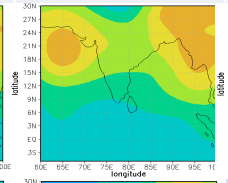
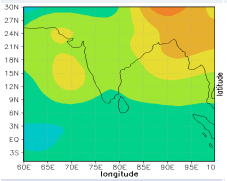
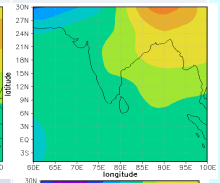
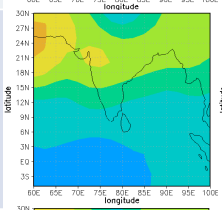
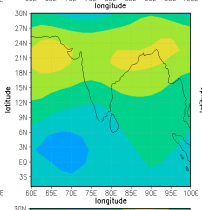
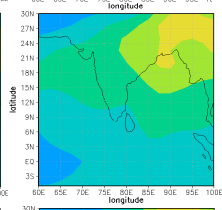
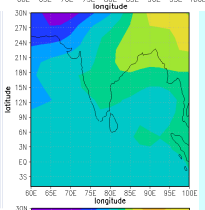
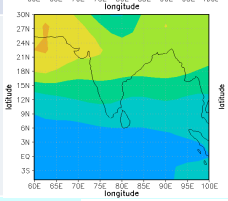
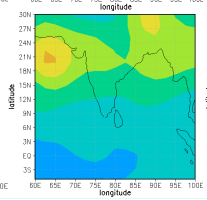
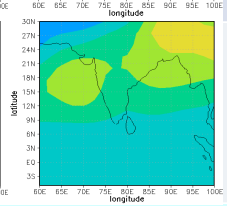
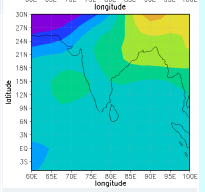


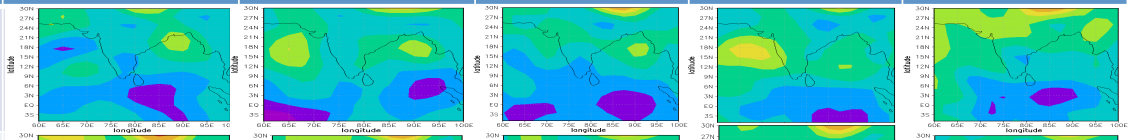
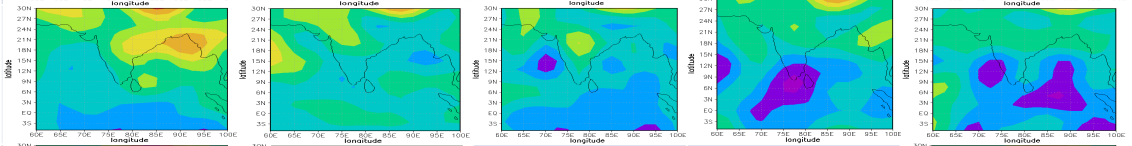
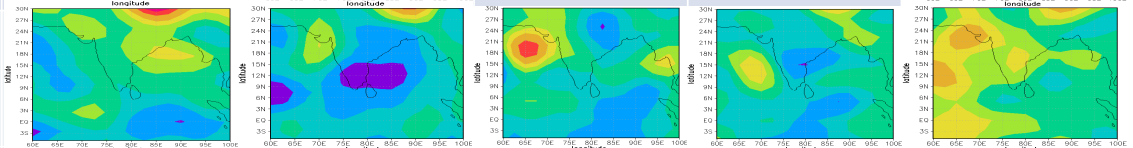
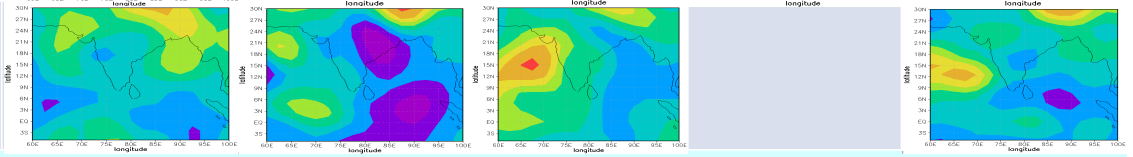
Figure 10 Shows variation of rainfall rate (mm/day) during Normal-Normal and Normal-Delay year from 1982-2014 of JJAS periods over GWB.

Variation of Tropospheric Temperature (TT) (600-200mb) (°C) in (a)2011, (b)2012, (c)2013, (d)2014, (e)2015

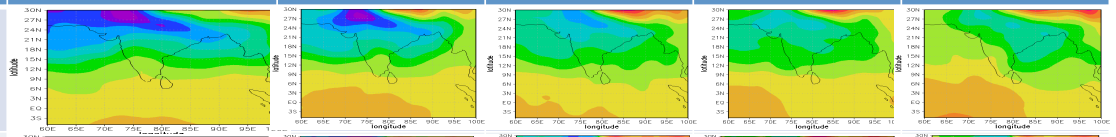
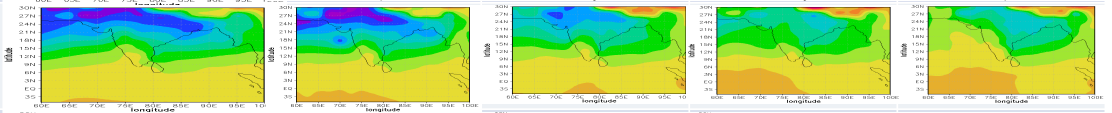
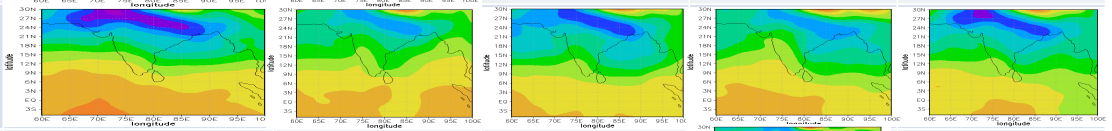
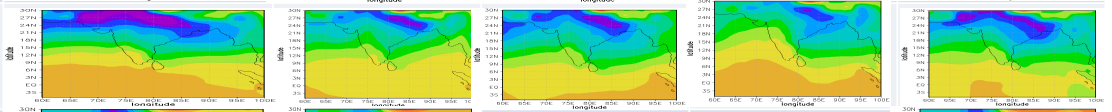
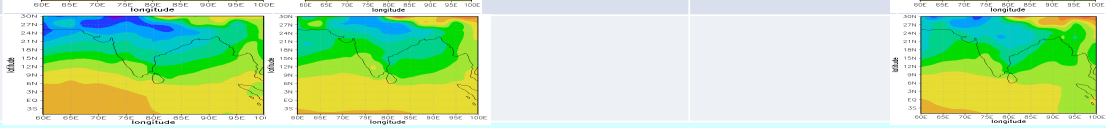


	Onset over GWB	-2 days	-4 days	-6 days	Onset over Kerala
(d) Observation 2014					
Model 2014					
(e) Observation 2015					
Model 2015					

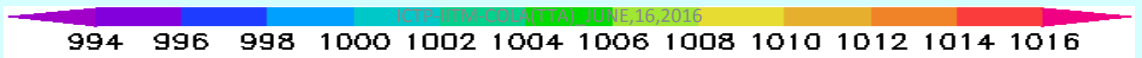
Model Tropospheric Temperature(TT) bias in °C

	Onset over GWB	-2 days	-4 days	-6 days	Onset over Kerala
2011					
2012					
2013					
2014					
2015					

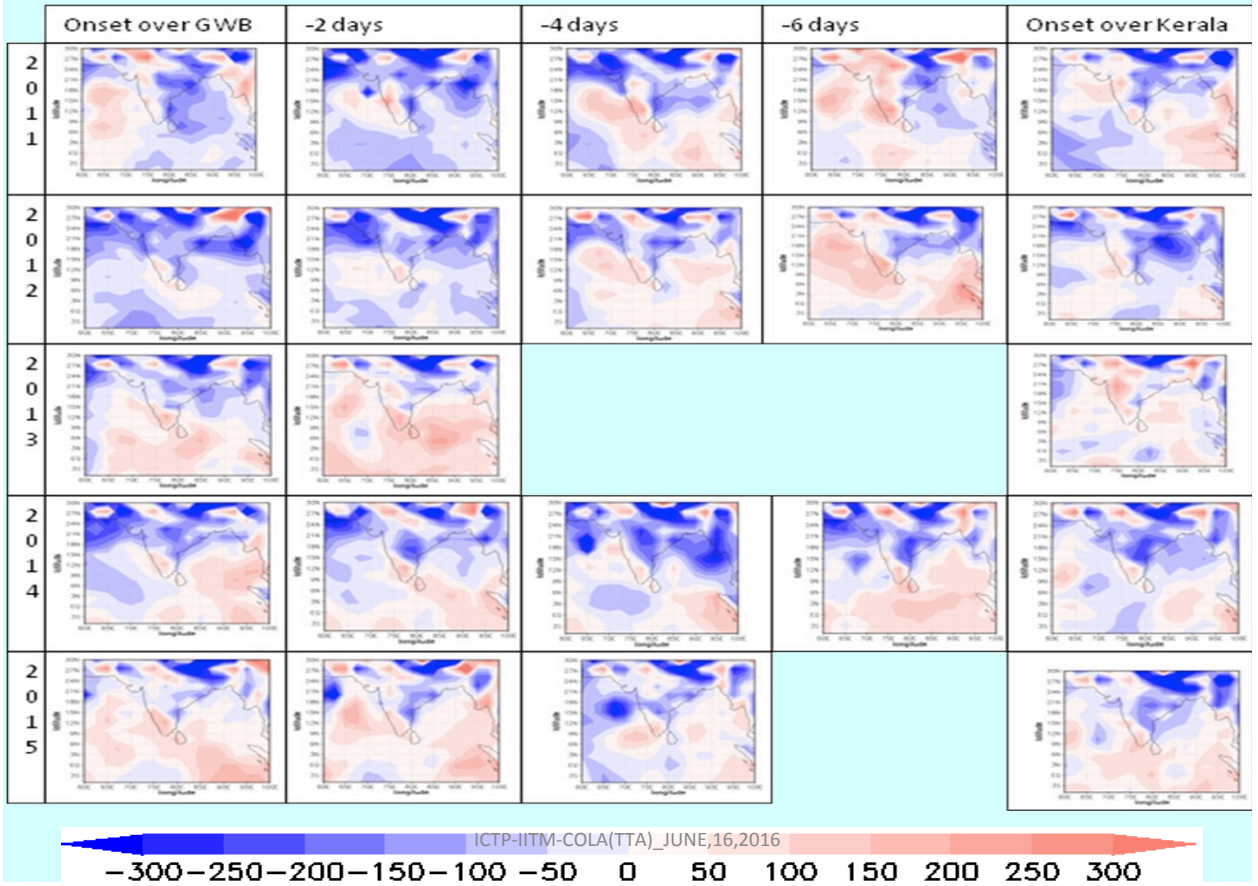
Variation of Mean Sea Level Pressure(MSLP)(hPa) in (a)2011, (b)2012, (c)2013, (d) 2014, (e)2015

	Onset over GWB	-2 days	-4 days	-6 days	Onset over Kerala
(a) Observation 2011					
Model 2011					
(b) Observation 2012					
Model 2012					
(c) Observation 2013					
Model 2013					

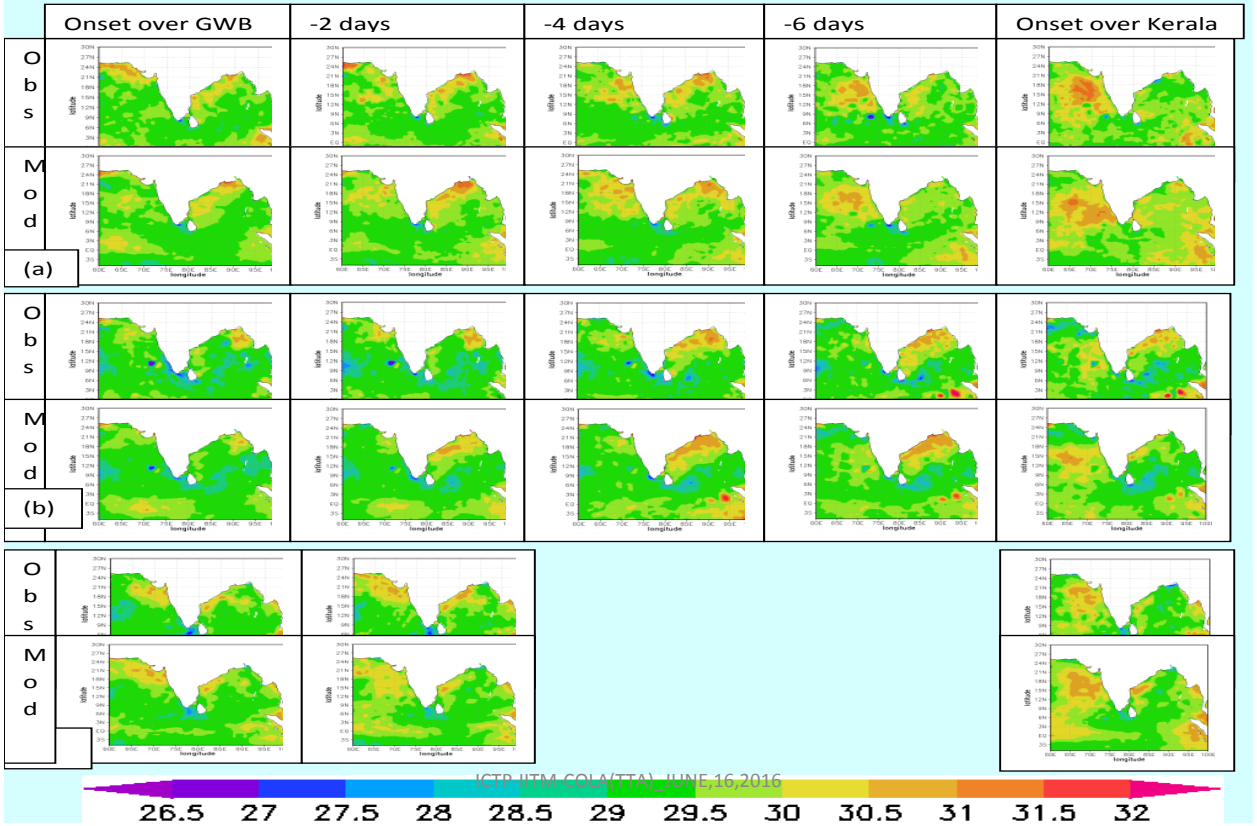
	Onset over GWB	-2 days	-4 days	-6 days	Onset over Kerala
(d) Observation 2014					
Model 2014					
(e) Observation 2015					
Model 2015					

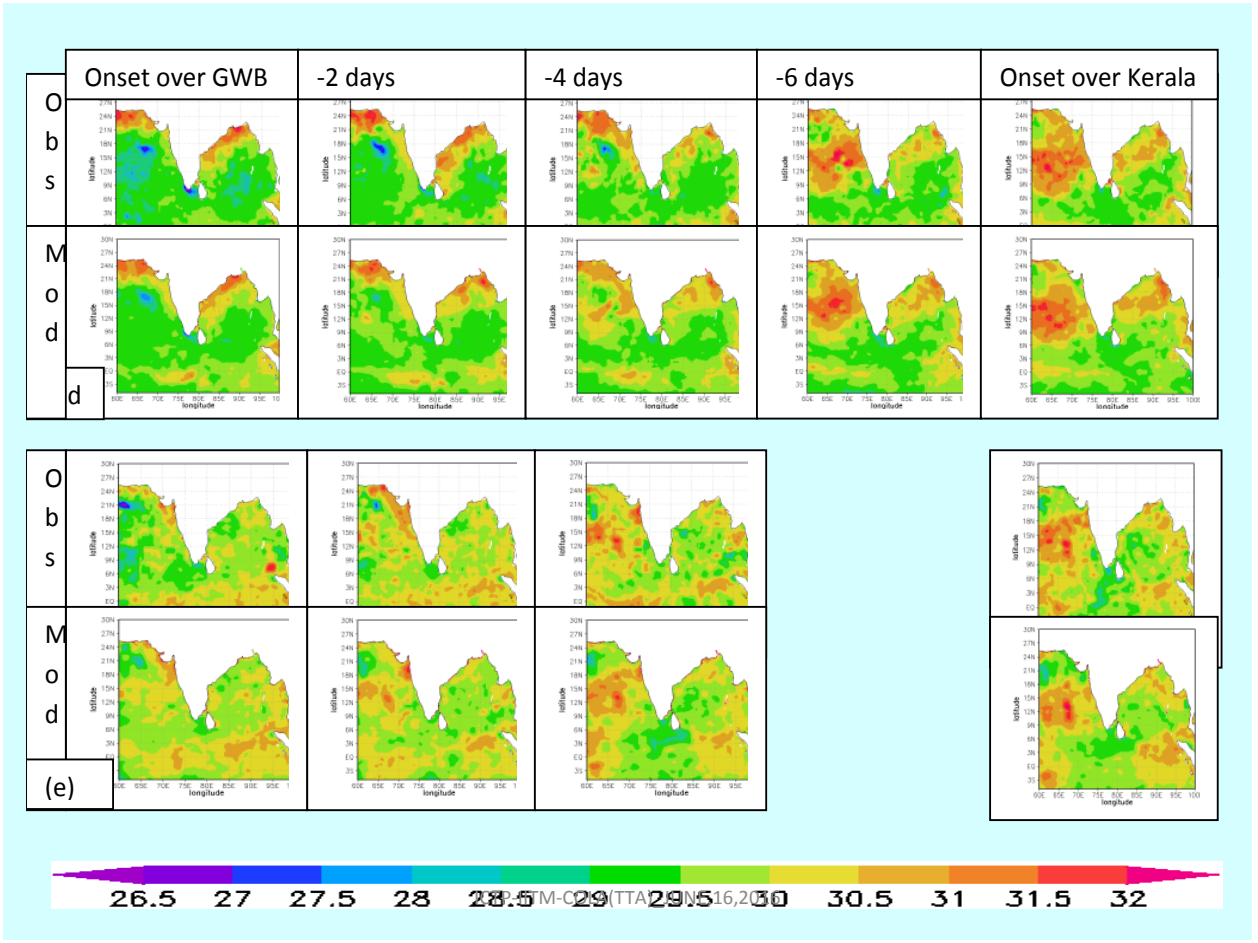


Model Mean Sea Level Pressure (MSLP) Bias in hPa

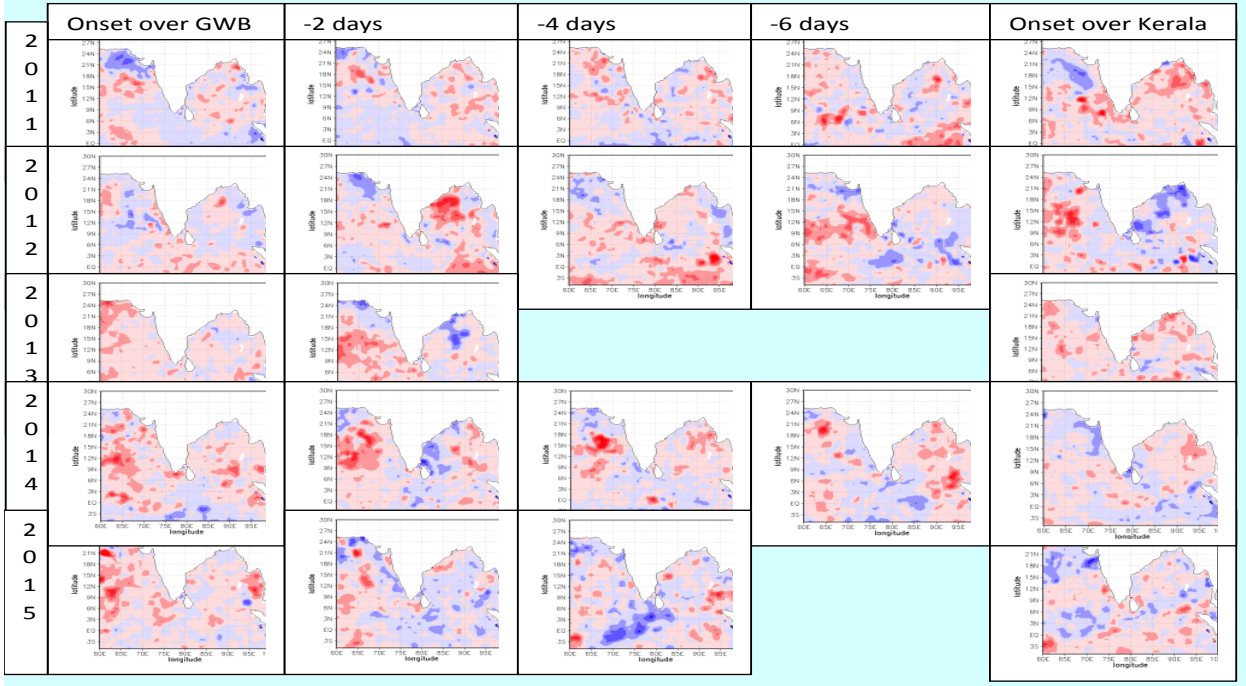


Variation of Sea Surface Temperature (SST) (°C) in (a)2011, (b)2012, (c)2013, (d)2014, (e)2015.

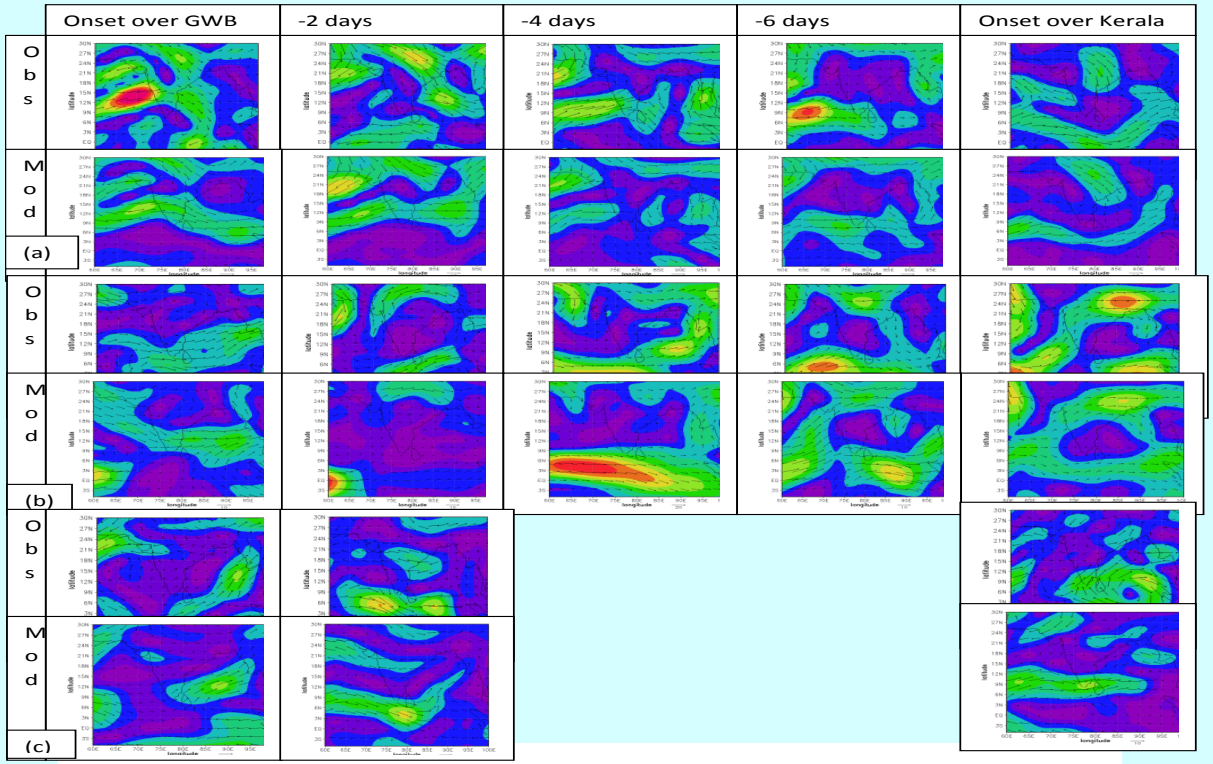


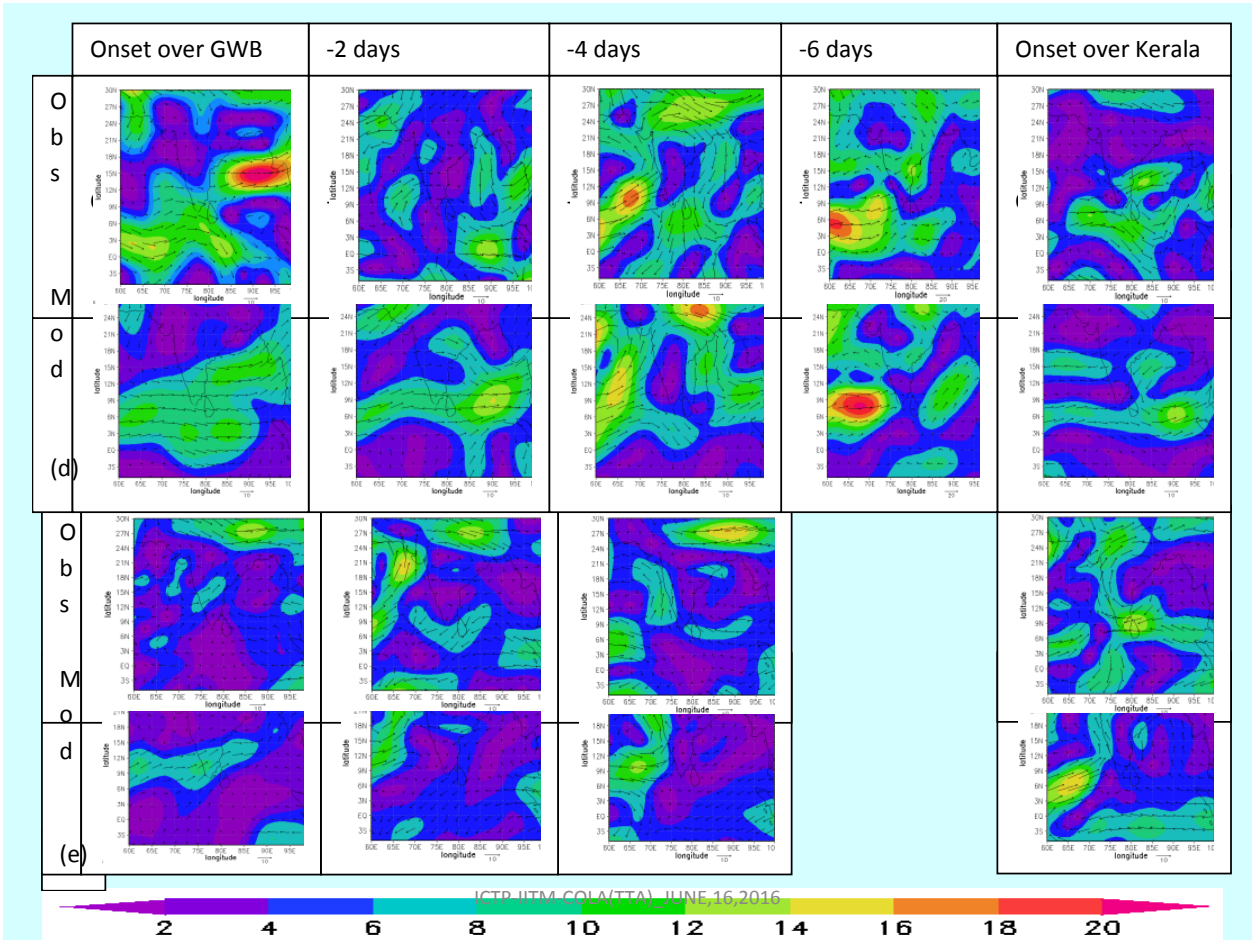

Onset over GWB
-2 days
-4 days
-6 days
Onset over Kerala
Obs
Mod
(d)
Obs
Mod
(e)
26.5 27 27.5 28 28.5 29 29.5 30 30.5 31 31.5 32

Variation of SST bias (°C)

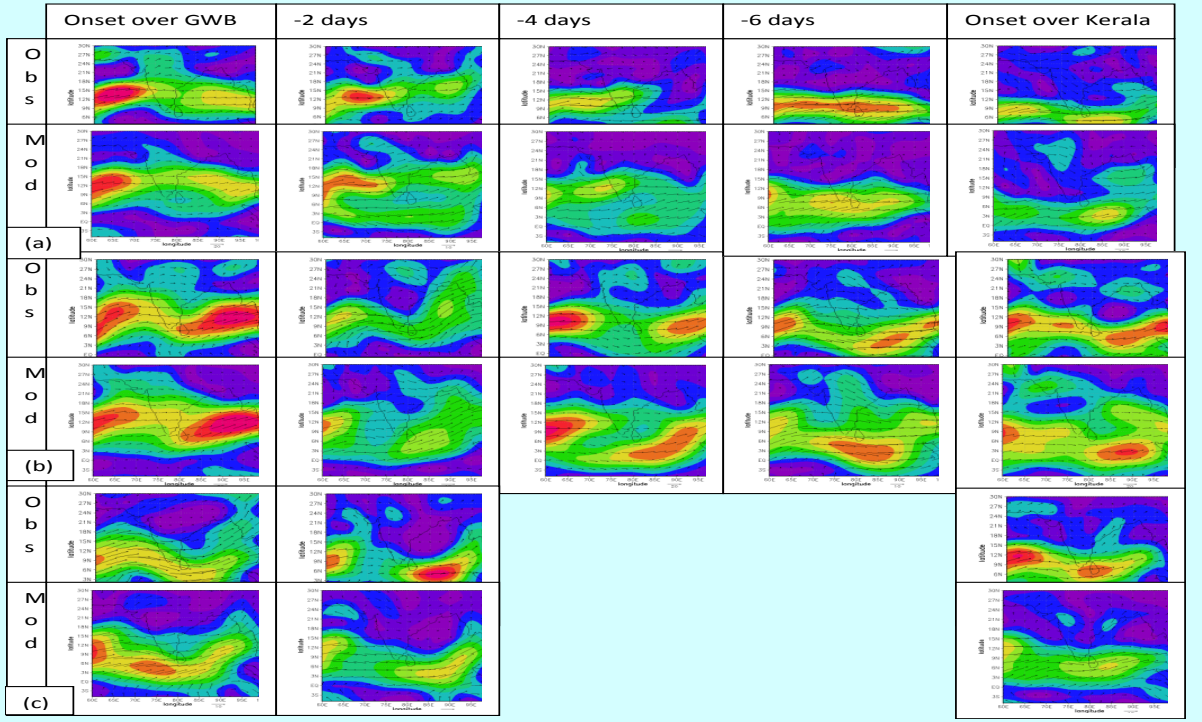


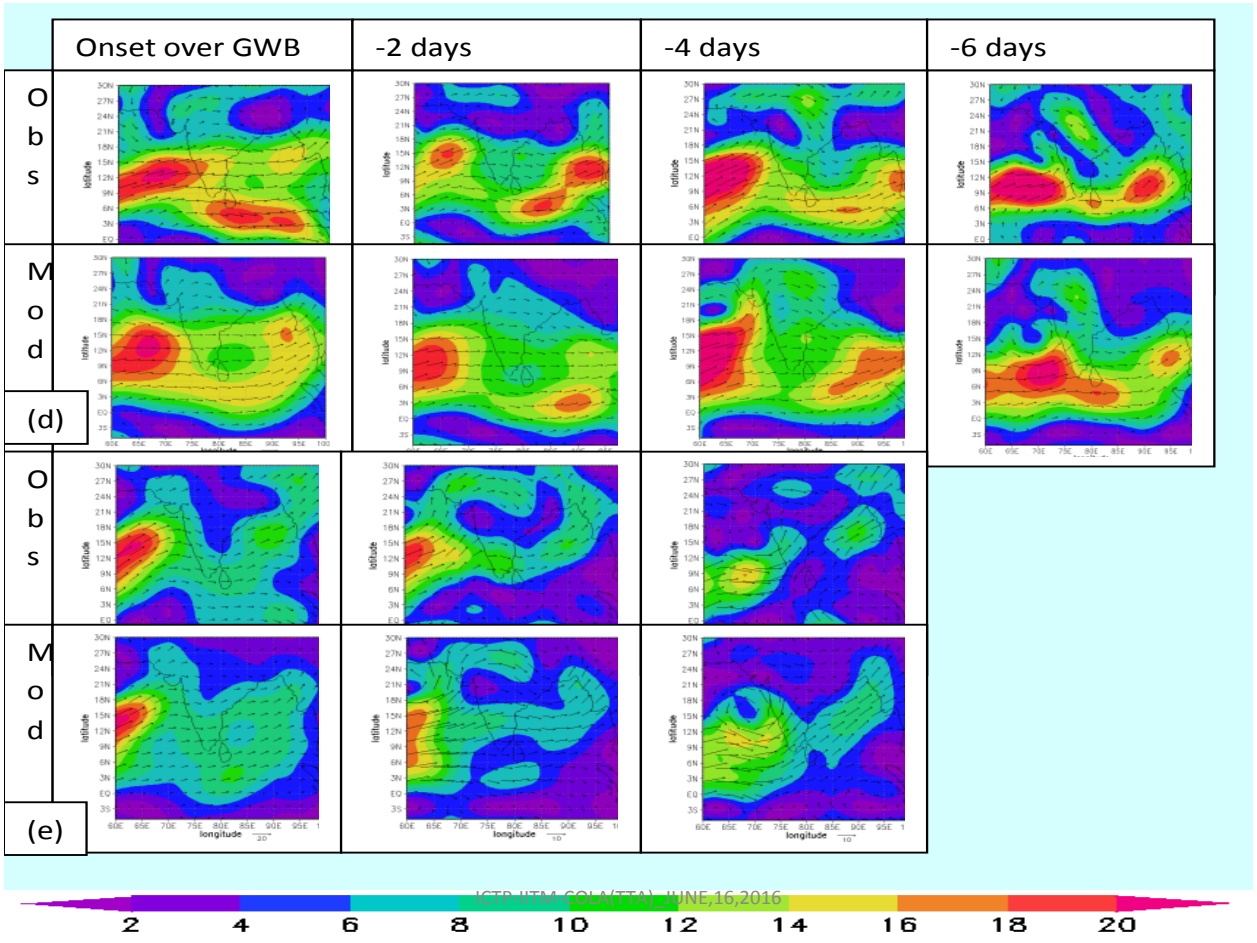
Variation of wind at 500mb (m/s) in (a) 2011, (b) 2012 (c) 2013, (d) 2014, (e) 2015




Onset over GWB
-2 days
-4 days
-6 days
Onset over Kerala
Obs
Mod
(d)
Obs
Mod
(e)
2
4
6
8
10
12
14
16
18
20

Variation of wind at 850mb (m/s) in (a) 2011, (b) 2012, (c) 2013, (d) 2014, (e) 2015




Onset over GWB
-2 days
-4 days
-6 days
Obs
Mod
(d)
Obs
Mod
(e)
latitude
longitude
ICTP-IITM-COLA(TTA) JUNE,16,2016
2
4
6
8
10
12
14
16
18
20

Variation of rainfall bias (mm/day) for JJAS period from 2011-2015

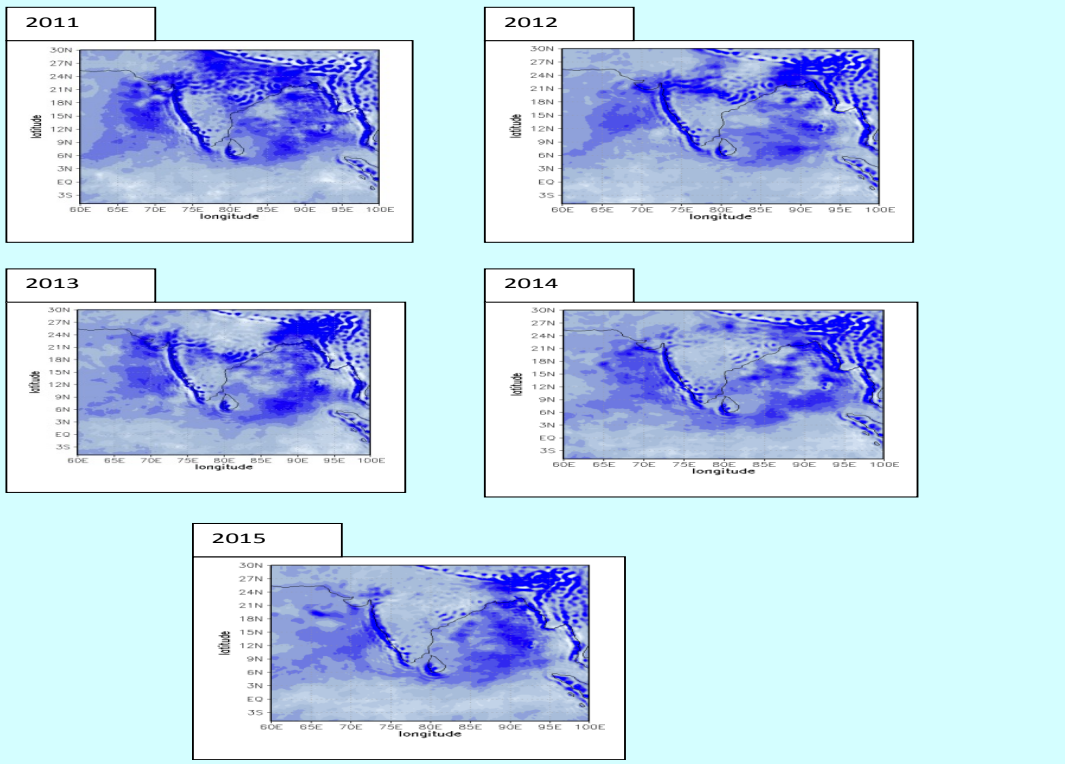


Table 1: Bias of the parameters for the period 2011-2015 with the location

TT Bias		**2011**	**2012**	**2013**	**2014**	**2015**
Day of Onset over GWB	BOB near GWB coast	Warm	Warm	Warm	Warm	Warm
	ABN near Kerala coast	Cold	Cold	Warm	Warm	Cold
Day of Onset over Kerala	BOB near GWB coast	Warm	Warm	Warm	Warm	Warm
	ABN near Kerala coast	Cold	Cold	Warm	Warm	Cold
MSLP Bias		**2011**	**2012**	**2013**	**2014**	**2015**
Day of Onset over GWB	BOB near GWB coast	Low	Low	Low	Low	Low
	ABN near Kerala coast	High	High	High	High	High
Day of Onset over Kerala	BOB near GWB coast	Low	Low	High	Low	Low
	ABN near Kerala coast	Low	High	High	High	High
SST Bias		**2011**	**2012**	**2013**	**2014**	**2015**
Day of Onset over GWB	BOB near GWB coast	Warm	Warm	Warm	Warm	Cold
	ABN near Kerala coast	Cold	Warm	Warm	Cold	Cold
Day of Onset over Kerala	BOB near GWB coast	Cold	Cold	Warm	Cold	Cold
	ABN near Kerala coast	Warm	Cold	Warm	Warm	Warm
Wind at 500hPa		**2011**	**2012**	**2013**	**2014**	**2015**
Day of Onset over GWB	BOB	Weak	Strong	Strong	Weak	Strong
	ABN	Strong	Strong	Weak	Weak	Strong
Day of Onset over Kerala	BOB	Weak	Strong	Weak	Weak	Weak
	ABN	Weak	Weak	Strong	Strong	Strong
Wind at 850hPa		**2011**	**2012**	**2013**	**2014**	**2015**
Day of Onset over GWB	BOB	Strong	Strong	Strong	Strong	Weak
	ABN	Weak	Weak	Strong	Strong	Weak
Day of Onset over Kerala	BOB	Strong	Strong	Weak	Weak	Strong
	ABN	Weak	Weak	Weak	Weak	Strong

Increasing TTg may help to drag the monsoonal wind at 850mb towards north-east India over BOB during Normal-Normal year. Presence of westerly tough at 850mb over north-east India extended over north BOB indicating low pressure area over that region also may influence the monsoonal wind direction towards north-east India over BOB during normal-normal years which is not observed during normal-delay year.

Wind magnitude at 850mb is high during normal-delay compare to normal-normal year over BOB.

Divergence is more over BOB during delayed advancement .May be due to the presence of this divergence advancement is delayed.

It is very clear from the analysis that delay onset over GWB may not responsible for the less rainfall amount over the same study region.

model is unable to depict clockwise or anti-clockwise vortex as per observation at 500 hPa

Wet rainfall bias is observed from 2011-2014 over GWB except in 2015. Overall, Model depicts strong monsoonal flow compared to observation towards GWB during 2011-2015.

Thank you