Simulation of monsoon disturbances during summer monsoon 1997 in an AGCM

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Monsoon disturbances (MD) such as lows, depressions and cyclones, which produce widespread rainfall during their passage over India, are an important component of Indian Summer Monsoon (ISM). Researchers using observeations have, extensively studied these systems that usually form over Bay of Bengal and move along west/northwest direction. However, very few studies have been reported on the simulation of MDs by Atmospheric General Circulation Models (AGCMs). (Manabe et.al. (1970), Ashok et.al. (2000)). These studies have shown that AGCMs are capable of simulating tropical disturbances although with much lower intensity than the observed. One of the strongest El Niño's in the last century occurred during 1997, the growth rate and intensity of which were exceptional. The sub seasonal behavior of ISM rainfall during June-September (JJAS) 1997 shows pronounced peak in August, which is associated with activity of monsoon depressions. Three depressions formed in August and one each during June and July and a cyclonic storm in September. All these formed in Bay of Bengal and gave widespread rainfall over India (IMD, 1998). The objective of the present work is to investigate whether a relatively low resolution AGCM such as Hadley Center Climate Model (HadAM2b) is capable of simulating MDs in ensemble integrations during 1997. 10-member ensemble integrations for 2-years from 1996-1998, with weekly observed SSTs and initial conditions corresponding to 1st September of 10-years (1986-1995) taken from long term integrations of the same model, are used in the study. The criteria adopted for the classification of MDs is same as that of India Meteorological Department (IMD, 1998). Table-1 shows the frequency of MDs in different categories for JJAS1997 in 10-member ensemble integrations by HadAM2b model.

Table1: Frequency of systems during JJAS1997 in 10-member ensemble simulations by HadAM2b GCM

Ensemble Member	SCIL	DCIL	Depression	Deep Depression	Cyclonic storm	Total
1	9	1	1	0	0	11
2	4	0	1	0	0	5
3	7	1	3	0	0	11
4	4	0	1	0	1	6
5	6	0	0	0	2	8
6	5	0	1	2	2	10
7	4	1	0	0	0	5
8	2	0	0	2	0	4
9	4	0	0	1	0	5
10	8	0	1	0	0	9
Observed	5		1	4	1	11

SCIL stands for Single closed Isobaric Low; DCIL stands for double closed isobaric low

It is seen that the majority of ensemble members simulated the frequency of lows and depressions, reasonably well compared to observations. However, they differ from observations in simulation of frequency of intense systems such as deep depressions and cyclonic storms. Figure 1(a-p) shows spatial distribution of Mean Sea Level Pressure, precipitation, and Relative vorticity at 850hPa and 500hPa, during cyclonic storm simulated by the model for the period 13-16 September respectively. It is seen (Fig.1 (a-d)) that cyclone moves from Bay of Bengal in northwest direction and associated precipitation rate is of the order of 90mm. (fig.1 (e-h)). The cyclonic vorticity with a peak $10*10^{-5}$ sec^{-1} is noticed on 14-15 September. The cyclonic circulation is seen to be significant at 500 hPa (fig.1 (m-p)), which has reduced upward from 850hPa.

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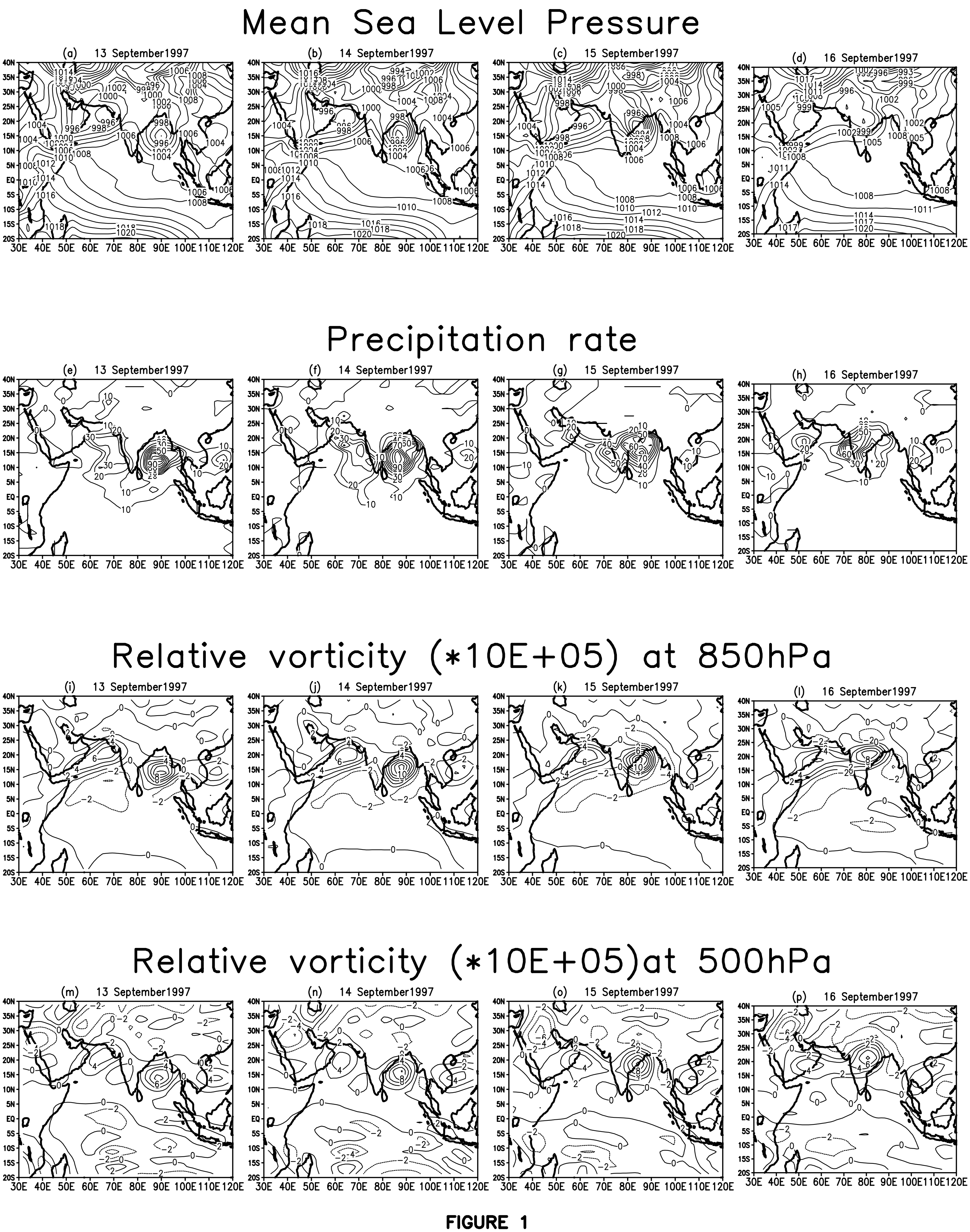
Mean Sea Level Pressure
(a) 13 September1997
(b) 14 September1997
(c) 15 September1997
(d) 16 September1997
Precipitation rate
(e) 13 September1997
(f) 14 September1997
(g) 15 September1997
(h) 16 September1997
Relative vorticity (*10E+05) at 850hPa
(i) 13 September1997
(j) 14 September1997
(k) 15 September1997
(l) 16 September1997
Relative vorticity (*10E+05)at 500hPa
(m) 13 September1997
(n) 14 September1997
(o) 15 September1997
(p) 16 September1997

FIGURE 1