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Floods in Karnataka during 2009 : A synoptic study

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सार – दक्षिणी–पश्चिमी मानसून ऋतु के दौरान वार्षिक वर्षा की 73 प्रतिशत वर्षा दक्षिणी प्रायद्वीप भारत के कर्नाटक राज्य में होती है। जटील प्राकृतिक भूगोल की वजह से इस राज्य में वर्षा की प्रवृत्तियों में 50 से 350 से. मी. की स्थानिक परिवर्तनशीलता को काफी देखा गया है। मानसून वर्षा की अंतः वार्षिक परिवर्तनशीलता सहसंबंध तटीय कर्नाटक में 15 प्रतिशत और अंदरूनी कर्नाटक में 20 से 30 प्रतिशत होते है। इस राज्य में होने वाली वर्षा मुख्यतया पश्चिमी तट के समीप अपतटीय द्रोणी मानसून ऋतु के दौरान बंगाल की खाडी में बनने वाले निम्नदाब तंत्रो से प्रभावित होती है। 28 सितंबर से 3 अक्टबर 2009 के दौरान बंगाल की खाडी में निम्नदाब क्षेत्र बनने से उत्तरी कर्नाटक में जान और माल का भारी नुकसान हुआ। इस शोध पत्र में इस तंत्र के सिनॉप्टिक लक्षणों की जाँच करने का प्रयास किया गया है जिनकी वजह से इस राज्य के अनेक जिलों में भारी वर्षा होती है और फलस्वरूप राज्य में दूर दूर तक तबाही होती है।

ABSTRACT . Karnataka a State in south peninsular India receives 73% of its annual rainfall during southwest monsoon season. Because of the complex physiographical features, the rainfall pattern over the State shows large spatial variation from 50 to 350 cms. The coefficient of interannual variation of the monsoon rainfall is about 15% over coastal Karnataka (CK) and between 20-30% over interior Karnataka. The precipitation over this State is mainly dominated by semi permanent systems like off shore trough running along the west coast, low pressure systems forming over the Bay of Bengal during the monsoon season. A well marked low pressure area during 28 September - 3 October 2009 over the Bay of Bengal caused widespread damage to life and property in north Karnataka. In this study, an attempt has been made to examine the synoptic features of this system that caused heavy rainfall over many districts of the State leading to widespread destruction.

Key words – Monsoon, Floods, Synoptic, Off-shore trough.

1. Introduction

Karnataka State in south peninsular India is confined within the 11.5° and 18.5° N latitudes and 74° and 78.5° E longitudes respectively. The south-west monsoon is the principal rainy season during which it receives 73% of its annual rainfall. It has basically four physiographical regions (Fig. 1) *viz*., the coastal plains comprising of three districts namely Uttar Kannada, Dakshin Kannada and Udipi, the ghat region comprising of four districts namely Shimoga, Chikmangalur, Hassan and Kodagu, southern districts and north interior Karnataka. This State has three meteorological subdivisions *viz*., coastal Karnataka (CK), south interior Karnataka (SIK) and north interior Karnataka (NIK). The orography plays a very important role in the rainfall pattern over the coastal and ghat regions of the State. The monsoon rainfall over the entire State varies from 50 to 350 cm. The CK which lies on the windward side of Western Ghats receives very heavy rain amounting to 317 cm due to interaction between the orography and the monsoon flow. The normal rainfall over NIK and SIK are 47 and 66 cm respectively. The northern interior districts of the State are comparatively dry and have large coefficient of variability of rainfall as compared to the southern districts. The north interior districts of NIK namely, Bijapur, Raichur, Bellary and southern half of Gulbarga record lowest rainfall varying from 50 to 60 cm. Overall, the rainfall pattern over the State shows large spatial variation. The coefficient of interannual variation of the monsoon rainfall is about 15% over CK and between 20-30% over interior Karnataka.

The monsoon precipitation over Karnataka is dominated by the off shore trough running along the west coast. The strengthening of the westerlies or south-westerlies along the west coast causes good rainfall. The other synoptic scale systems that cause rainfall are the lows and the depressions forming in west-central (WC)

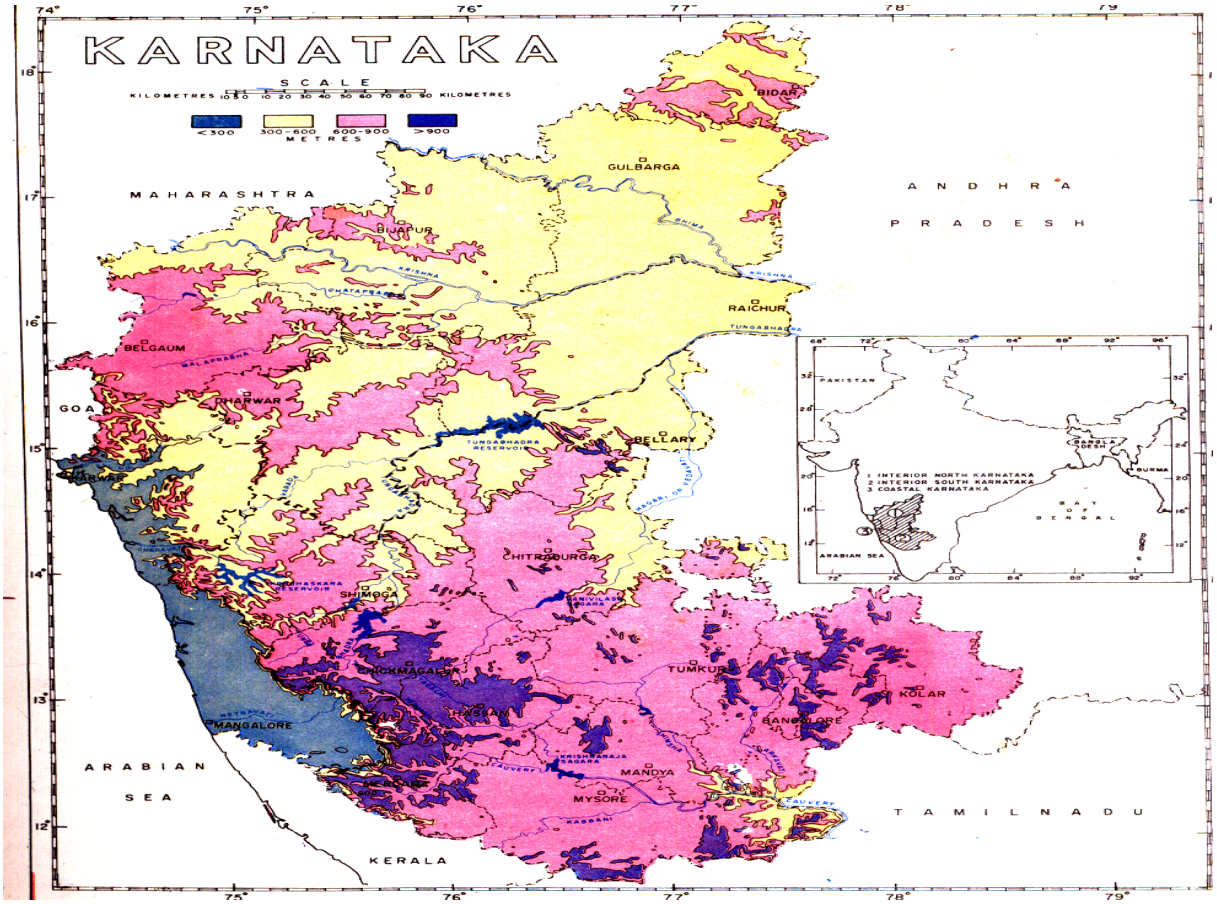


Fig. 1. Physiographical features of Karnataka State

and north-west (NW) Bay of Bengal and their movement in a westerly to north-westerly direction (Rao 1976). These systems enhance the south-westerly monsoon current over the State leading to the increased interaction of the monsoon current with the orography and hence rainfall. During the active south-west monsoon conditions, the winds are of the order of 20-40kts in the lower levels and heavy (>7cm) to very heavy rainfall (12-24cm) activity is confined only to the coastal and ghat regions of the State.

During the period of 6 days from 28 September to 3 October 2009, there was huge damage to the life and property due to incessant rains over the entire State. The rains caused havoc in as many as 11 districts of NIK which is usually a rain deficient region. Bijapur and Raichur in NIK were the worst affected districts of the rest of districts. The houses in north Karnataka are made of wood and mud primarily and continuous rain for nearly 6 days has added to the devastation. The rainfall departure for the period of 1 June to 27 September 2009 for the State as a whole was 13% showing that monsoon rainfall was normal. As per the records of the State Government, all the dams in the State were nearly full owing to normal monsoon rainfall. During the period of 28 September to 3 October 2009, the rainfall departure was 378% for the State as a whole and was 340, 698 and 117% for CK, NIK and SIK met subdivisions respectively. According to the press reports, nearly 1.8 lakh people were rendered homeless following the heavy rains and flash floods in north Karnataka. The sources from the State Agriculture Department testified that there was widespread damage to the Kharif crops and horticulture crops. According to the press reports, a bridge across the Tungabhadra River was washed away in the flash floods. The torrential rains in Uttar Kannada district triggered landslides near Karwar killing 21 people. Met Office (MO) Karwar recorded 18 and 43 cms of rainfall on 2 and 3 October 2009. Rainfall of 43 cms is the highest ever recorded in the month of October by this station. It is known that if 3 mm of rainfall occurs in 15minutes, it is considered as a heavy rainfall spell. Fig. 2 the hyetogram of MO Karwar, shows that maximum rainfall of 38 cms occurred during 0900 to 1500 hrs (IST) of the 2 October 2009. The Raichur observatory in NIK, Bellary in SIK received a rainfall of 25 and 14 cms respectively on 2 October 2009 which are the highest

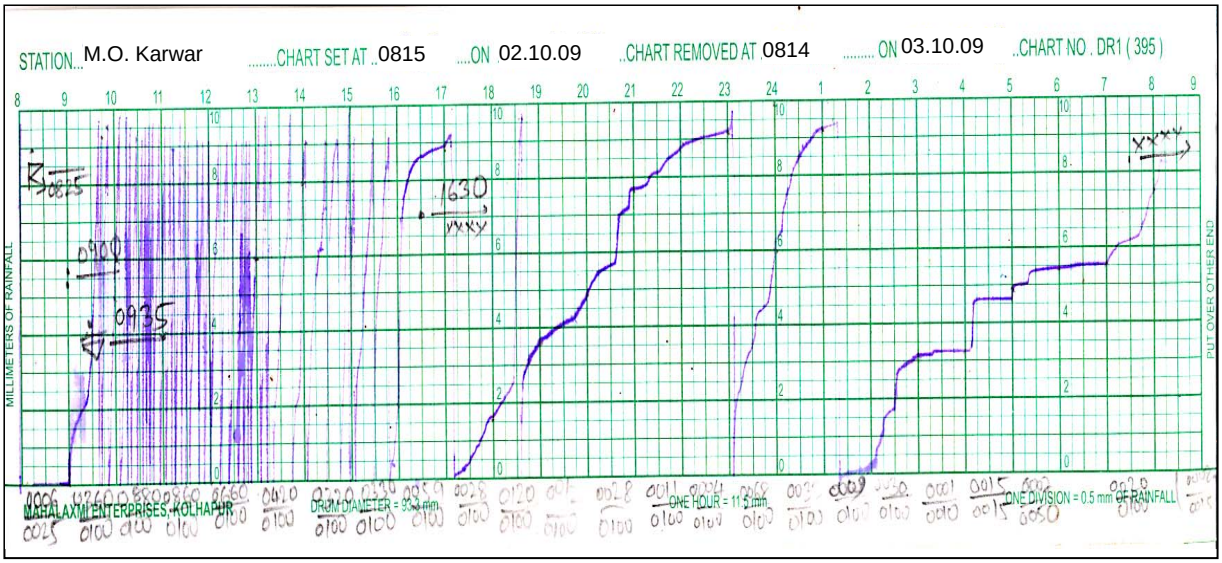


Fig. 2. Hyetogram of Met Office Karwar on 3 October 2009

TABLE 1

	Surface data	Upper air	Autographic instruments
Temporal scale	3 hours	12 hours	continuous

ever recorded by these stations during this month. Normal life was disrupted due to heavy rains, flash floods and landslides. In this paper, the synoptic situation that contributed to the unusual rainfall over Karnataka during the monsoon season has been discussed.

2. Data and methodology

The synoptic and the upper air data during the period 28 September to 3 October 2009 was collected from the Meteorological Centre (MC) Bangalore. The self recording rainguage (SRRG) charts from the departmental observatories were collected from MC Bangalore and were analyzed for finding out the intensity of the rainfall. The frequency of the data from surface, upper air and autographic instruments is provided in the Table 1.

3. Results and discussion

3.1. *Synoptic Situation during 28 September – 3 October 2009*

On 28 September 2009 a low pressure area (LOPAR) was lying over WC Bay of Bengal and neighborhood. The associated cyclonic circulation (CYCIR) was extending up to mid tropospheric levels (MTL) tilting SW-wards with height. On 29 September, the LOPAR over the WC Bay lay as the well-marked LOPAR (WML) over the same region and persisted there on 30 September 2009. On 1 October, it moved in the westerly direction and lay over WC Bay and adjoining north-coastal Andhra Pradesh (N-CAP) and south-coastal Orissa. On the 2 October, this WML moved a little westward and lay over Telangana and adjoining CAP. On 3 October, the WML persisted over Telangana and neighborhood. On all the days, the associated CYCIR was extending upto MTL.

Some of the very heavy to extremely heavy (>24.5cm) amounts of rainfall in cm during 30 September to 3 October 2009 are given below :

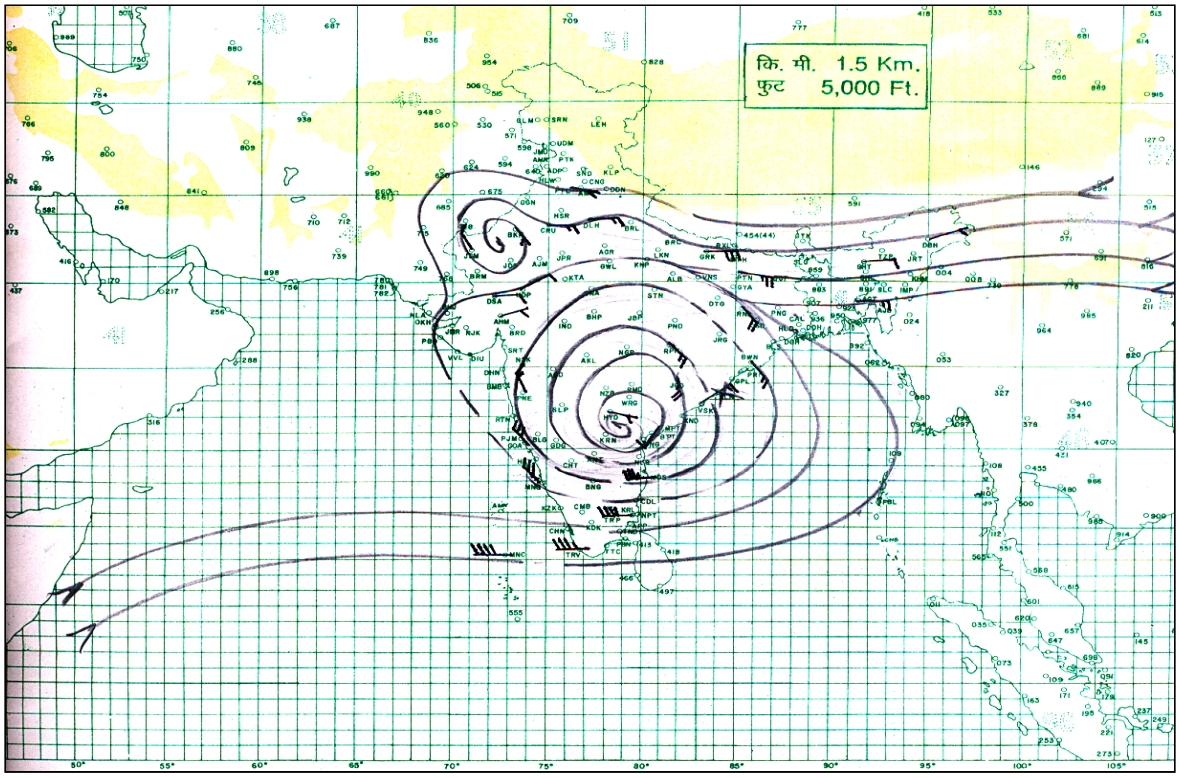
30 September 2009 : Gersoppa 22, Soundatti 17, Nagatana, Bhatkal and Honavar 13 each and Karwar 12.

1 October 2009 : Devarahippargi 15, Siruguppa 14, Sindhanur and Sandur 12 each.

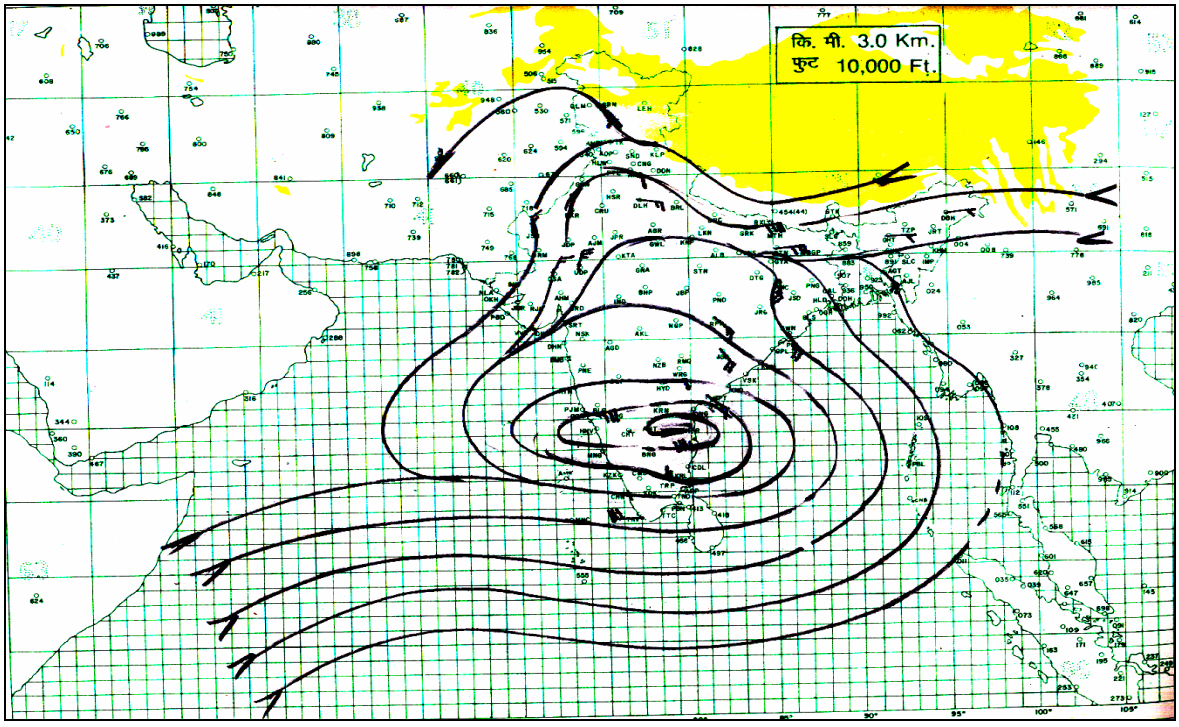
2 October 2009 : Sindhanur 29, Siruguppa & Raichur 25 each, Manvi 22, Karwar and Narayanpura 18 each, Gangavathi 17, Dharamsthala 16, Bellary, Sandur, Belthangadi 15 each, Subramanya, Mudagal and Maski 14 each, Yelburga 13, Deodurga, Badami, Jamakhandi, Karkala & Bhatkala 12 each.

3 October 2009 : Karwar 43, Ankola 18, Kumta 17, Agumbe 15, Honavar 14, Sringeri and Kundapura 13 each.

(a)



(b)



Figs. 3 (a&b). Streamline flow on 0000 UTC of 2 October 2009 at (a) 850 hPa and (b) 700 hPa

(c)

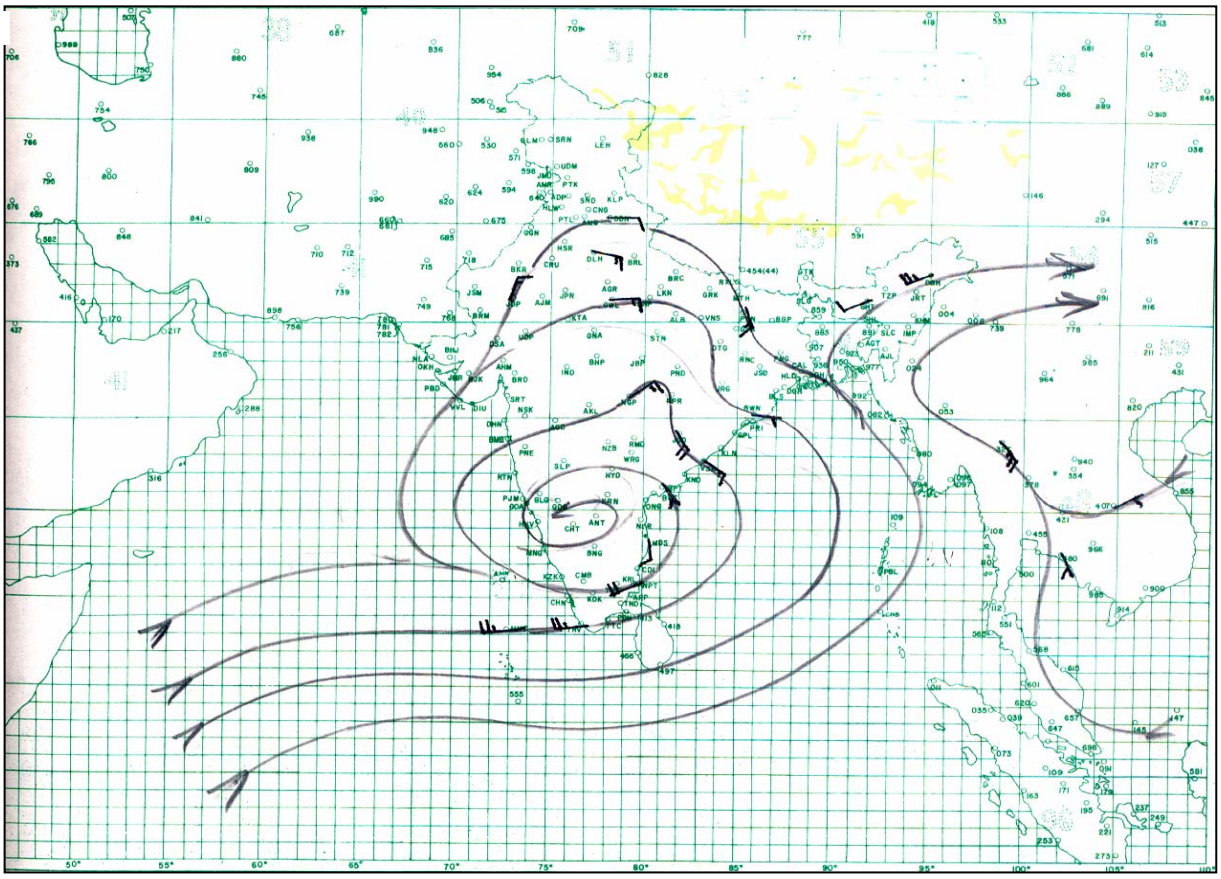


Fig. 3 (c). Streamline flow on 0000 UTC of 2 October 2009 at 500 hPa

During the entire life period, the low pressure system was very strong and was extending up to 400 hPa in the vertical. The streamline analysis at 850, 700 and 500 hPa [Figs. 3(a-c)] of 2 October 2009 are presented for brevity. It is seen from this figure that the lower level winds up to 700 hPa were very strong, of the order of 30-35kts. This caused a deep penetration of the moisture over the entire south peninsula from the Arabian Sea and the Bay of Bengal. Maximum moisture convergence was due to the strong low level westerlies to the south of the centre of the system.

Fig. 4(a) shows the 24 hour pressure change (P_{24} P_{24}) at 0300 UTC of 2 October 2009. This shows that the system is moving primarily in the westerly direction. The pressure change is of the order of 2 hPa. The pressure departure from normal [Fig. 4(b)] was of the order of -8 to -6 hPa over the entire south peninsula. The movement of the system was quite slow overland and also it persisted over N-CAP and Telangana region for nearly 2 days. The 24 hr accumulated rainfall on 2 and 3 October 2009 are shown in Figs. 5 (a&b).

4. Conclusions

The heavy rainfall over Karnataka in association with the system in Bay of Bengal during 28 September to 3 October 2009 is due to :

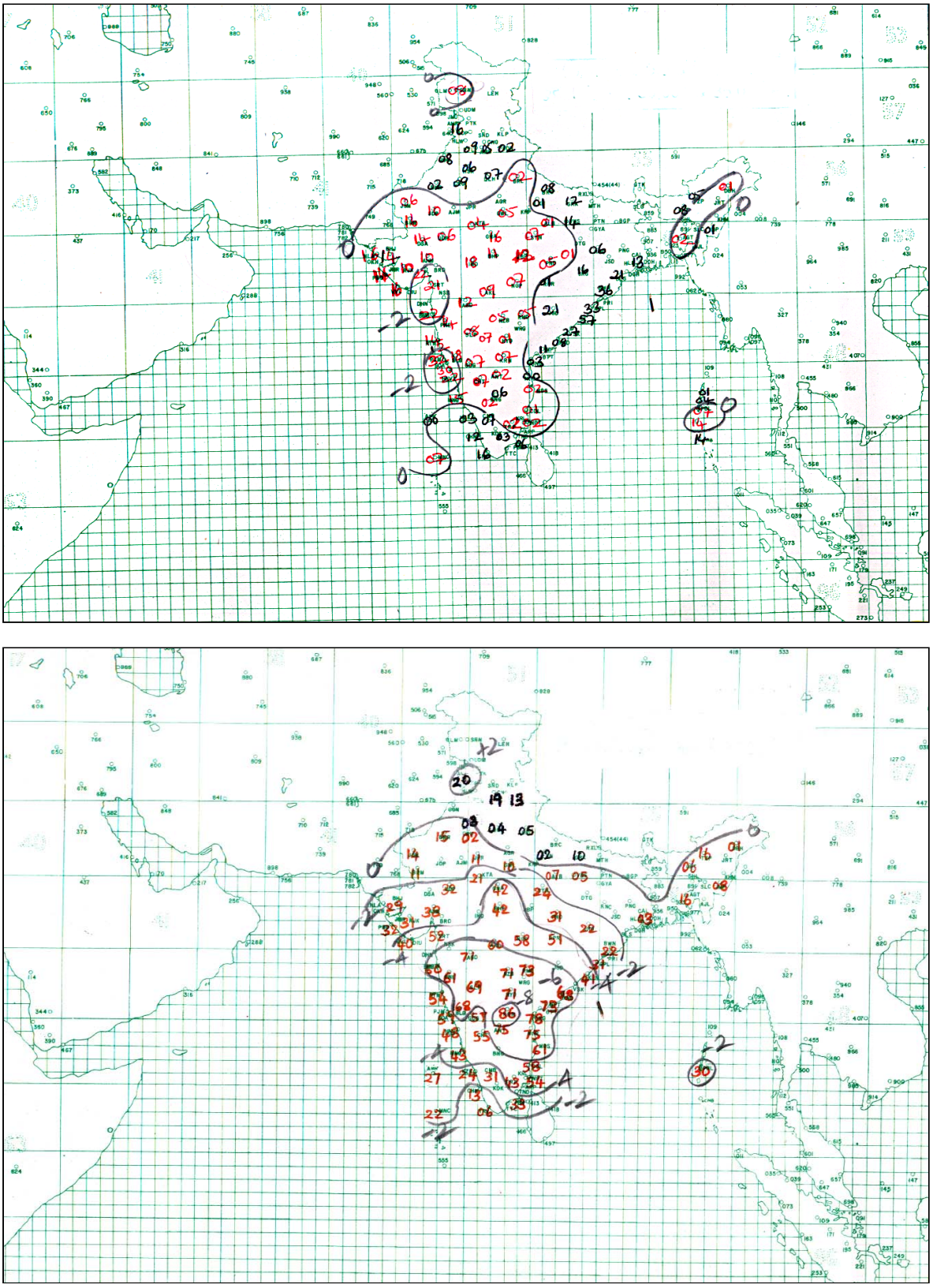
(*i*) Formation of the system in the southerly latitude and its movement in the westerly direction.

(*ii*) The strong westerly winds in the lower levels contributed to strong moisture incursion from the Arabian Sea into the peninsular India causing widespread rainfall.

(*iii*) The floods in Karnataka were due to the already full dams in the State owing to the normal monsoon rains.

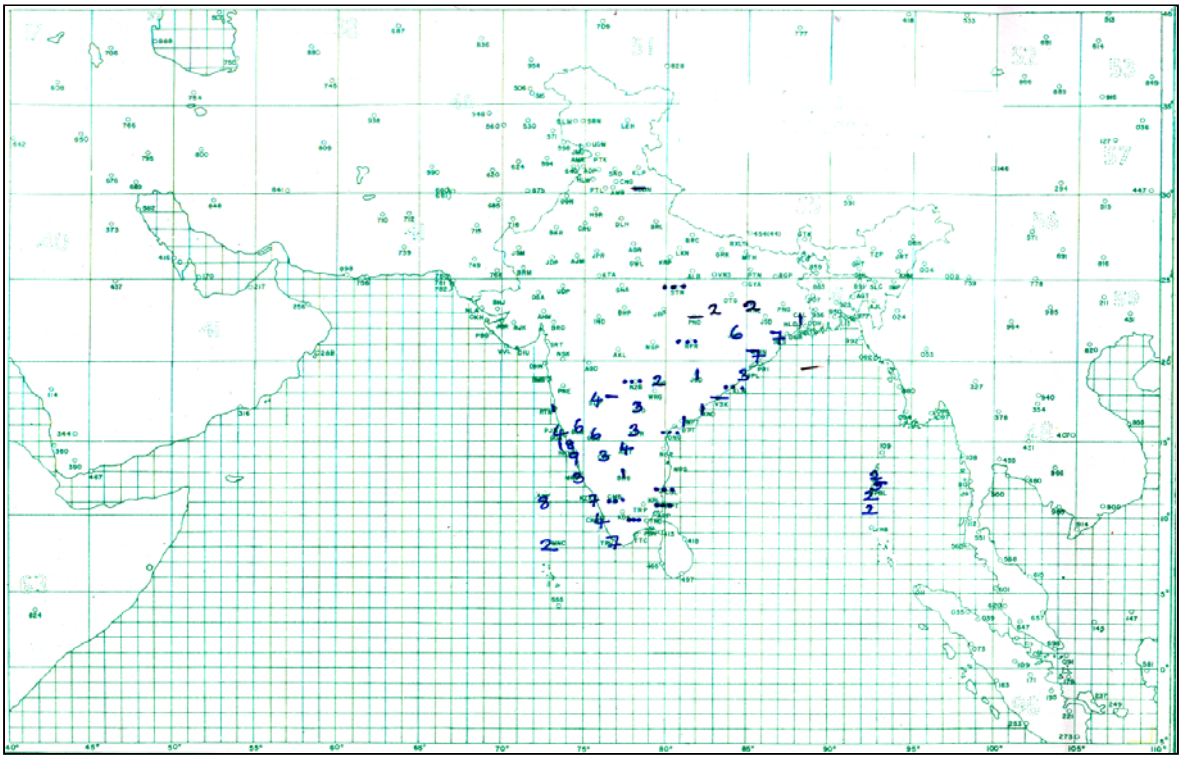
(a)

(b)

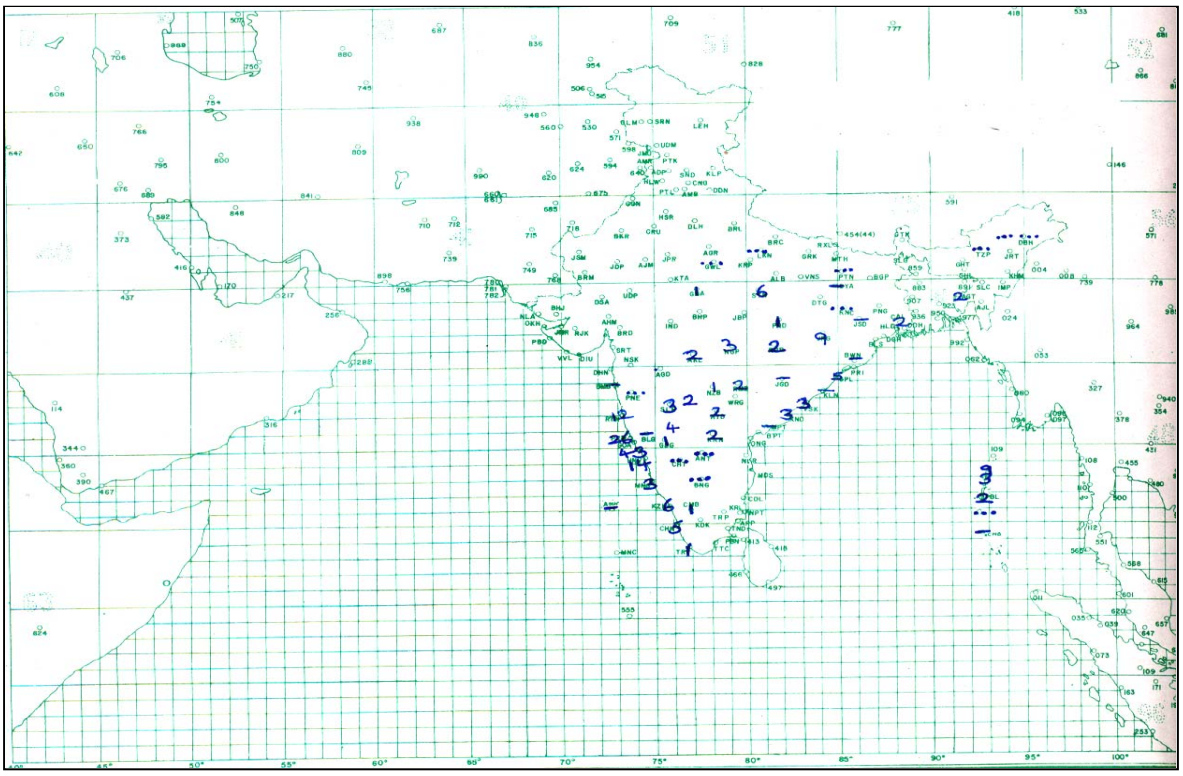


Figs. 4 (a&b). (a) Pressure change during 24 hrs and (b) Pressure departure from normal at 0300 UTC of 2 October 2009

(a)



(b)



Figs. 5(a&b). 24 hr accumulated rainfall observed at 0300 UTC (a) 2 October 2009 (b) 3 October 2009

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