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DETECTION OF INTENSE METEOROLOGICAL SYSTEMS AND THEIR MOVEMENT THROUGH WEATHER SATELLITE PICTURES

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Abstract: Monsoon spells in Pakistan have a significant importance in the weather of our country. This importance of monsoons tracks really comes out in summers. Monsoon conditions are best developed as northeast (winter) and southwest (summer) monsoon in the sub-tropics. The rainy season associated with the southwest monsoon is the outstanding feature of the climate of these regions and the term monsoon is popularly used to denote these rains, without reference to the winds. This study states that intense low-pressure systems affecting Pakistan during the Monsoon seasons cause heavy rainfall and floods. This study has been carried out to determine the tracks of movement of some specific cases of the depressions from their formation to recurvature and inflexion till dissipation. Meteorological date plotted on the mean sea level charts have been used to calculate the center of pressure systems, upper air data have also been used to determine the convergence pattern and centers of these low-pressure systems. The actual cloud formation and resulting precipitation areas have been identified and delineated with the help of weather satellite pictures of NOAA 9, 10, 11 and 12. Thus the study has been carried out, keeping in view the surface position, the upper air position and satellite picture of an intense monsoon system. The results derived have given some very interesting aspects regarding the behavior and movement of the monsoon storm tracks. Although this work is at preliminary stage, it is hoped that these observations and findings would open a new gateway in the field of forecasting the movement of the monsoon depressions over Indo-Pak sub-continent.

Keywords: Intense meteorological system, monsoon, weather satellite pictures.

INTRODUCTION

Generally speaking meteorological conditions over Pakistan cannot be separated from the influence of meteorological conditions prevailing over south Asia. The weather situation over the entire landmass extending from Arabian Sea and Bay of Bengal is the region of our interest. The daily and economical life of our people is affected by monsoons [Shamshad]. The industrial development also gets affected. This research helps us to formulate two important factors:

1. Bifurcation of the cloud system
2. Causes of heavy rainfall resulting in floods in our country and causing heavy damages.

THE MONSOONS

The word “monsoon” is used to denote different phenomenon singularly or plurarly. For example, the Malayan Monsoon, the European monsoon, the Indo-Pak monsoon or monsoons and the Asiatic monsoon or monsoons. Monsoon when used singularly relates to ‘planetary winds’

that affects the upper layer of the atmosphere. Also it represents the 'regional winds' systems that changes the wind blowing in lower atmosphere annually [Piere 1963].

Through studies it has been observed that there are three regional systems:

1. The Indo-Pak Monsoon
2. The Malayan Monsoon
3. The Japanese Monsoon

THE INDO-PAK MONSOON

The winter monsoon of Indo-Pak consists of airflow from northwest, while the pattern of summer monsoon follows its southwest and southeast track. During winter the mountains protect Indo-Pak subcontinent from Siberian air and during summer causes the equatorial maritime air to curve round the northwest so that it does not cross the Himalayas [Shamshad].

The Centers of Action

There is a seasonal reversal of pressure belts between Asia and Indian Ocean. In July the maritime air moves from south to north between high southeast of Madagascar and depressions of northwest India [Weisberg 1976].

The Monsoon Climates of Southern Asia

It has been observed that the existence of Asian monsoon is due to the seasonal shifting of low pressure and winds. Much of the rainfall is caused by 'monsoon depressions' that usually forms over Bay of Bengal and then moves either westward or northwards, some of them developing into intense cyclones. Amount of rainfall depends upon two factors:

1. Depth of monsoon air
2. Frequency and tracks of monsoon depressions

In Indo-Pak subcontinent monsoon and tropical storms or cyclones are the main factors of heavy rainfall. July and August are the rainiest months and about two tropical storms develop from Bay of Bengal and their tracks changes yearly [Austin Miller 1931]. In July there are two different areas where storm causes monsoon rainfall.

1. Bay of Bengal
2. The Arabian Sea

In July the thermal low develops over Pakistan, with its trough towards India. Some of the tropical depressions developing over Bay of Bengal and Arabian Sea are termed 'Cyclones'. Weather in monsoon results due to low and dark clouds giving heavy rainfall. The monsoon track reaches south of Indian peninsula by mid May, Mumbai and Gujrat by first week of June and northern Pakistan in start of July. Although Pakistan is situated nearer to Arabian Sea than Bay of Bengal but much of the rainfall

comes from Bay of Bengal. The following are the main factors for the total rainfall in Indo-Pak subcontinent:

1. Tropical disturbances
2. Low level easterly disturbances
3. High level westerly disturbances
4. Western disturbances
5. Monsoon trough
6. Monsoon convergence zone
7. Seasonal low over Balochistan
8. Jet stream

There are three types of depressions that occur:

1. Pre monsoon depressions
2. Monsoon depressions
3. Post monsoon depressions

During June-September an intense low-pressure system developed over Balochistan as a result of surface heating. The target of monsoon currents is low pressure of Balochistan. As the place is a complete desert so in this region the upward movements do not cause heavy rainfall [Fein and Stephens 1974]. Sometimes we experience a break in monsoon systems. In July and commonly in August there are spells of about one week or more over most parts of the Indo- Pak subcontinent when the rainfall ceases. The duration of break varies from 3 to 21 days. The normal break lasts from 5 to 7 days but abnormal break lasts up to three weeks. The duration and frequency of breaks tends to increase during the second half of the monsoon i.e. in August and September. Monsoon is divided into two currents. Each current has its own importance and amount of rainfall varies between the two. Main thing common to both is low-pressure intensity over Sindh and Balochistan. Main sequence of the system changes and also changes the wind speed and direction of cyclonic storms. Though majority of the depressions and cyclones originate in Bay of Bengal, some of the depressions originate in Arabian Sea and they move northward or northwestward. The one that moves northward affect Pakistan and adjoining India and the other affects Oman coast. Sometimes Arabian Sea branch and Bay of Bengal branch give a combined effect and bring air that is both from southwest and southeast directions. In such a condition wide spread rainfalls are experienced over northern parts of Pakistan [Lockwood 1974]. In addition to this, southwesterly winds originating in Arabian Sea give heavy rainfall when they combine with westerly waves affecting Pakistan.

Bay of Bengal Branch

The majority rainfall affecting Pakistan depends upon the depressions forming in Bay of Bengal and then moving northwestward in general. The monthly track of depressions varies during the monsoon season. This current is generally southeasterly and brings in lot of moisture even into

the areas in northern Punjab in Pakistan. Some intense rainfall occasions occur due to the combined effect of westerly wave and the depression, which had originated over Bay of Bengal.

DATA AQUISITION

FIRST MONSOON SPELL (1st August to 8th August 1988)

The data (longitude and latitude) was noted of above mentioned spell period from weather satellite pictures. The cloud system formed due to monsoon low centered itself at 84E 24N dated 01-08-88 at 10 30 UTC (Fig. 1). It then moved northwestward and on 02-08-88 it was detected at 79E 25.5N at 10 15 UTC. The system then moved southwards very slowly and on 03-08-88 it was found at 79E 25N at 10 10 UTC. Then the system moved northwestward and on 04-08-88 it was at 76E 27.5N at 11 35 UTC. Onwards 04-08-88 the cloud system bifurcated into two parts. The first path followed the southwestward track and the other moved northeastward. The first bifurcated part was located at 72.5E 24N dated 05-08-88 at11 UTC. Finally on 06-08-88 it was centered at 67.5E 22.5N at 03 00 UTC ending up in Arabian Sea. The other bifurcated part moved northeastward and was centered at 79E 29N dated 07-08-88 at 11 00 UTC. Finally the system was located centering itself at 79E 31N dated 08-08-88 at 1055 UTC.

Findings

This is the bifurcation case. The interesting thing is that satellite track didn't originate from Bay of Bengal but well above it. Onwards 04-08-88 the cloud system bifurcated into two parts. This bifurcation is the result of western disturbances moving from west to east and part of the system is connected to its tail and the other half of the system moves southwestward ending up in Arabian Area.

SECOND MONSOON SPELL (19th September to 26th September 1988)

The satellite pictures show that the cloud system was formed at 80E 17N dated 19-09-88 at 10 00 UTC (Fig. 2). This track then moved north-eastward and was located at 82E 18.5N on 20-09-88 at 09 45 UTC. The system then moved very slowly northward and was detected at 82E 19N dated 21-09-88 at 09 40 UTC. The cloud system formed due to monsoon depression then moved northwestward with a greater speed and was centered at78E 25N on 23-09-88 at 10 55 UTC. The cloud system then moved north northwestward with same speed and formed its low at 77E 32N dated 24-09-88at 10 40 UTC. From here the cloud system curved and shifted southwestward and was located at 76E 31N on 25-09-88 at 1030 UTC. Finally the cloud system re-curved eastward and formed its low at 77.5E 31.2 dated 26-09-88 at 10 20 UTC.

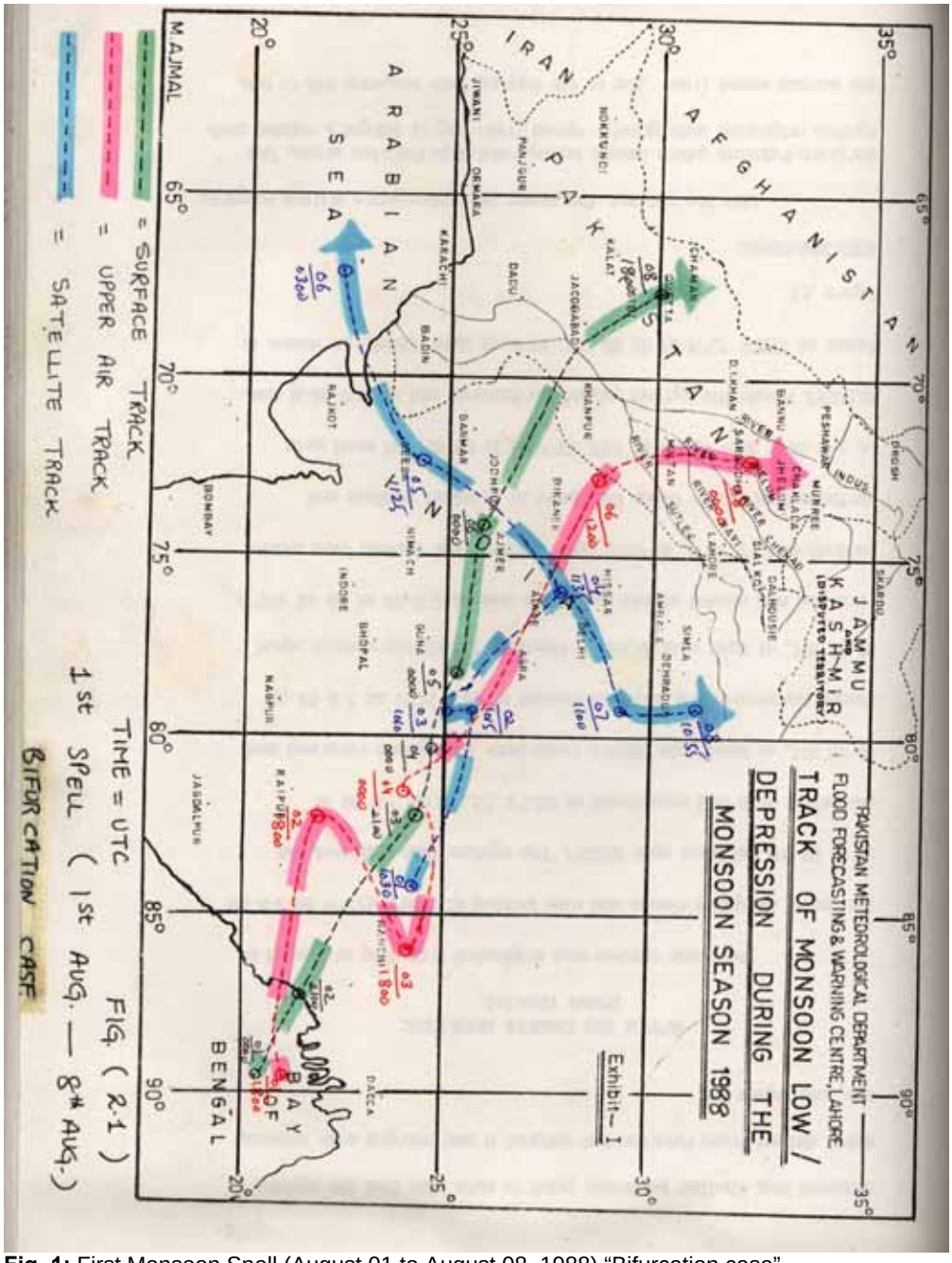

Fig. 1: First Monsoon Spell (August 01 to August 08, 1988) “Bifurcation case”.

Findings

The monsoon track originated near Bay of Bengal and re-curved twice. The system was then connected with the westerly disturbances moving in northern latitudes and that is why it got deflected or re-curved. Heavy

rainfall occurred at Lahore Airport. This took place when low pressure from Arabian sea got mixed with the seasonal low and almost diffused into it.

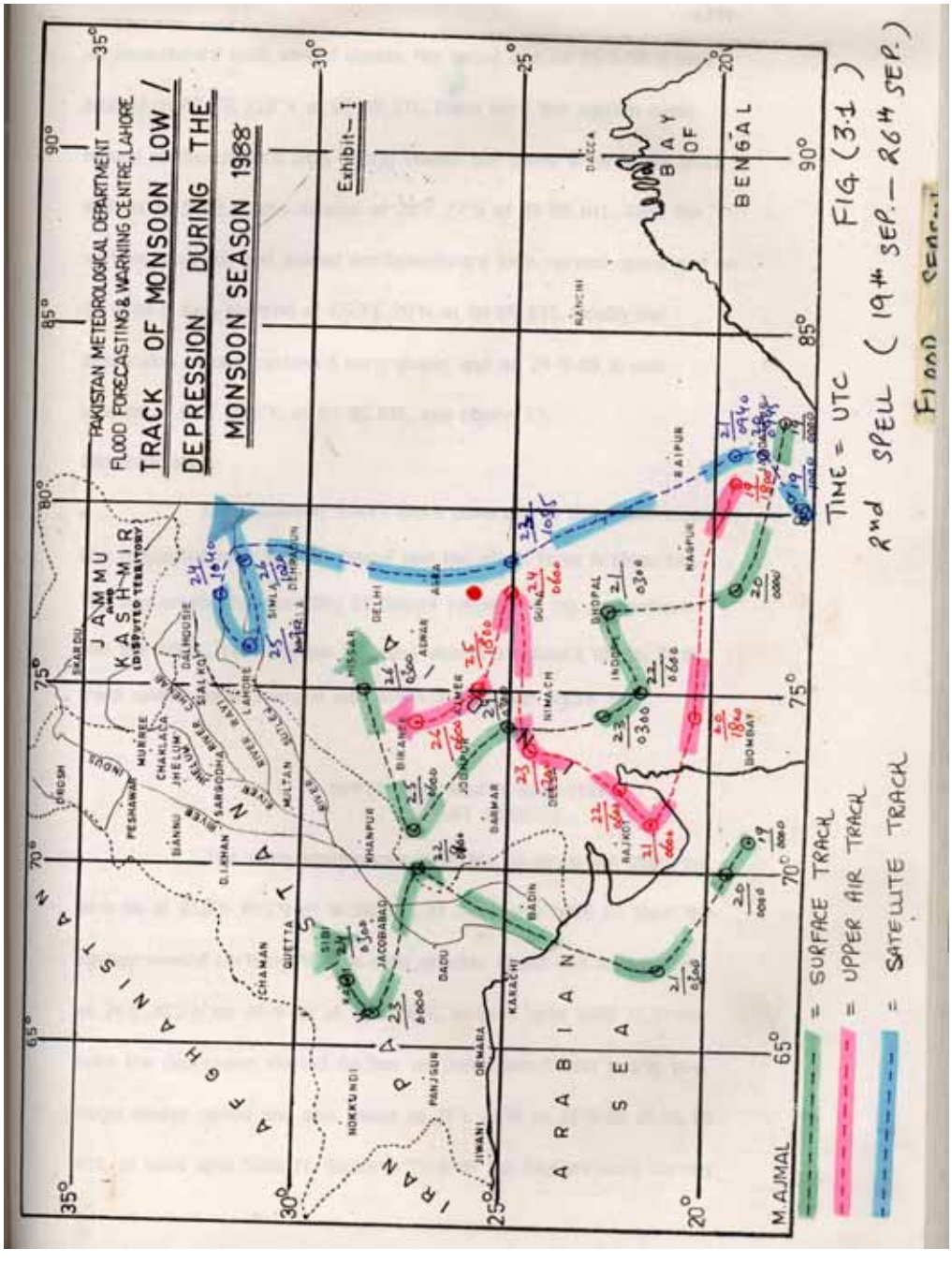

Fig. 2: Second Monsoon Spell (September 19 to September 26, 1988).

THIRD MONSOON SPELL (27th August to 1st September 1991)

The cloud system formed as a result of monsoon low was detected above Bay of Bengal with its center at 84.5E 21N on 28-08-91 at 13 30 UTC (Fig. 3). It moved northwestward and on 29-08-91 it was present at 81.5E 23.5N at 01 50 UTC. From then onwards it moved northwestward again and was detected at 78.5E 26N on 30-08-91 at 01 30 UTC. Then the system moved further northwestward and was detected at 77E 28N on 31-08-91 at 0240 UTC from where it followed the re-curving track like surface and upper air and finally moved northeastward where it centered itself at 87E 27.5N on 01-09-91 at 02 15 UTC.

Findings

The cloud system on weather satellite pictures almost followed both the surface and upper air systems except that its point of inflexion took place on 31-08-91 from where it re-curved and got linked with the western disturbances. An interesting point was observed that on satellite pictures the system re-curved a day later from surface and upper air charts. On weather satellite pictures the cloud system re-curved after traveling between surface and upper air charts. The speed of the system after re-curving increased as compared before re-curving.

RESULTS AND CONCLUSIONS

The intensive and deep observations of monsoon system indicate that a low pressure monsoon system originates from Bay of Bengal ending up by entering Pakistan and giving rain and floods destroying the economic setup of our country. The monsoon track gets bifurcated between 75 – 85E such that a part of it moves northeastwards and the other moves southwestwards ending up in Arabian Sea. The strength of these tracks gets weakened with the passage of time along with the western disturbances. It is also noted that the system re-curves and gets deflected where it connects with the western disturbances. Heavy rainfall may occur when low pressure (depression) from Bay of Bengal and sometimes from Arabian Sea merges with the seasonal low and diffuses into it.

RECOMMENDATIONS

The various observations and results may be put to use for future predictions of the monsoon tracks. It is also recommended that a verification schedule may be prepared while predicting the future movement of monsoon systems in the light of the parameters determined in the study. In addition it is also suggested that the findings may be applied only to those months, particularly for which the study has been carried out.

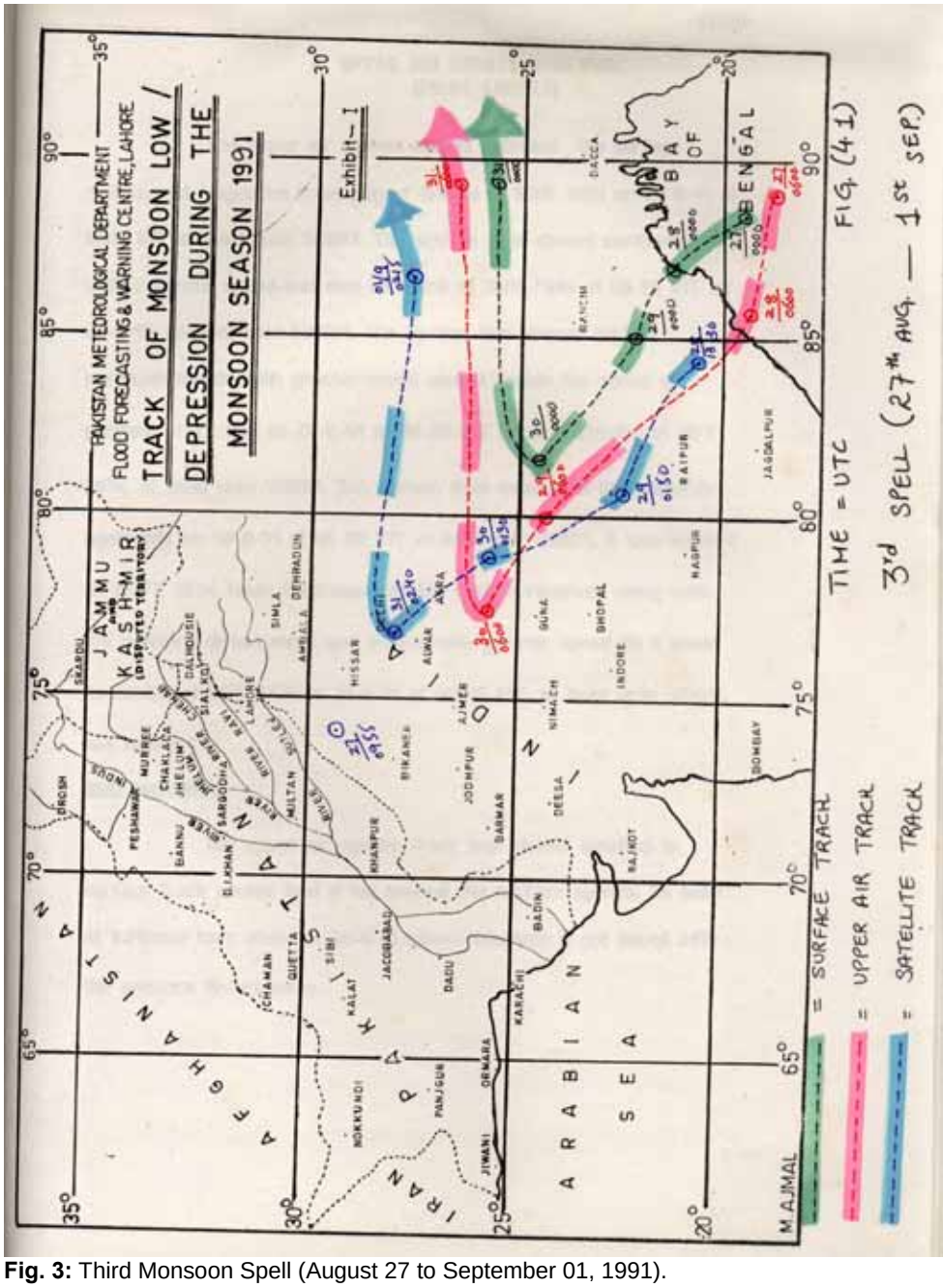

Fig. 3: Third Monsoon Spell (August 27 to September 01, 1991).

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