



## REMOTE SENSING DATA AND ITS RELEVANCE IN WEATHER AND SOCIETY

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**Abstract:** *Weather and its prediction in global changing scenario have great concern nowadays. Over the last two decades the significant change in climate is due to the human activities or anthropogenic activities. This unequivocal change in climate is predicted by suitable mathematical modeling of such unusual or catastrophic events. This is an integrated framework of climate change scenario in which interdisciplinary machinery is involved to maintain equilibrium in whole ecosystem. The thunder squall behaviors over Bihar region shows that most of the formation occurs at NW and SW sector and dissipation in NE and SE sectors. Latest technological advancement in scientific observations taken through remote sensing platforms (Satellite, Doppler Weather Radar, LIS, and GPS) has tremendous potential of saving the life and property by forecasting in advance. The strategic implementation /transformation of the space based application knowledge in public domain also highlighted. The proper implementation of the plan can help to reduce the vulnerability and associated risk to the common public.*

**Key words:** *Climate change, anthropogenic, westward moving system, remote sensing, Doppler Weather Radar*

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## **INTRODUCTION:**

Weather and impacts on the activities of the bio-sphere is well known from ancient times. In recent past the weather activities are globally affected by the anthropogenic as well as natural activities. The unusual behavior of weather affected the health and attitude of the all the living beings. Throughout of the year various types of temporal and spatial scale weather systems affected the day to day life and future planning of activities. Weather systems are classified in various categories of micro scale, mesoscale, synoptic and planetary scales, which affect the planet throughout the atmosphere in terms of various seasons. This global change results unusual trend of temperature, rainfall and cloud amounts over the India also (Rajeevan, 2004, Rajeevan et al, 2008)). The anomalous rainfall associated with synoptic scale systems weather systems may be due to the anomaly in Sea Surface Temperature (SST). The Westward moving systems commonly known as Western Disturbances (WDs) affect Indian subcontinent throughout the year. Their coverage and persistency decides the potential of the event. Generally during winter westward moving system produces intense amount of rainfall and snowfall over Jammu & Kashmir, Uttar-Pradesh, Himachal Pradesh, Punjab, Haryana and neighboring states. The unusual patterns of rain or snow affect the physical health of the peoples badly. In severe drought or rain the diseases affected skin, throat, eye and heart attack etc are spread more frequently.

## **DATA AND METHODOLOGY:**

The imageries of INSAT, Doppler Weather Radar and data of rainfall, temperature along with other surface parameters used in the study have been taken taken from India Meteorological Department (IMD) New Delhi-3.

## **DISCUSSIONS:**

In the present study few cases of unusual rainfall occurred due to different synoptic conditions and local features have been discussed which can be treated as the effect of global change of weather parameters.

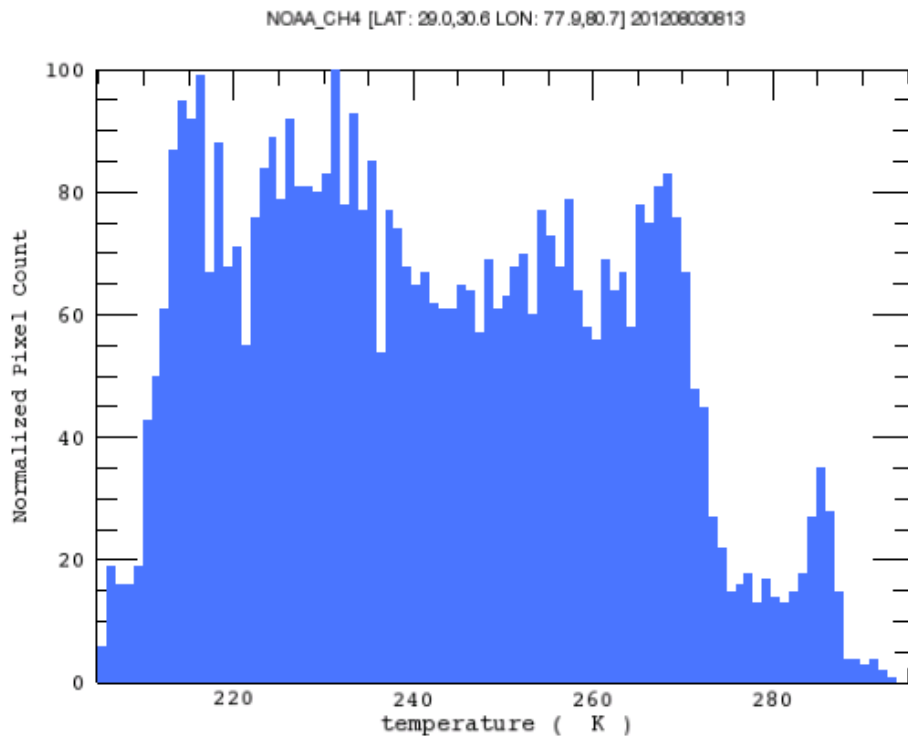
### **Event 1: Torrential rain occurred on 03 August 2012 in Uttarkashi Area:**



**Figure 1: Torrential rain on August 02, 2012 at Uttarkashi District of Uttarakhand**

Source: <http://indiatoday.intoday.in/story/cloudburst-hit-uttarkashi-district-natural-disaster/1/211919.html>

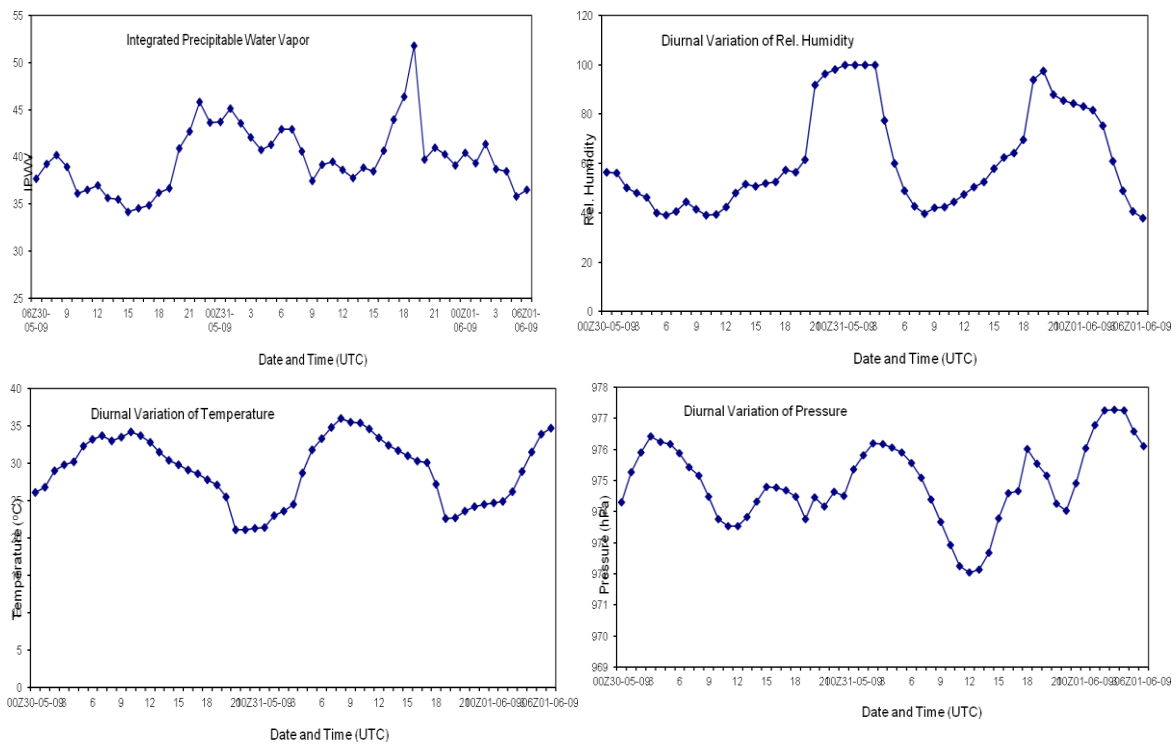
Figure (1) shows the devastation caused by the torrential rain on August 02 August, 2012 night due to the squally weather associated with the intense convection and induced circulation over the area. In this flash flood event more than 30 peoples loss their lives and several others loss property and house. Figure (2) below is the satellite based brightness temperature diagram commonly known as temperature histogram around the Uttarkashi area ( $30.7333^{\circ}$  N,  $78.4500^{\circ}$  E) and most of the pixels lies between 200-250 degree Kelvin temperature range. Decrease of temperature of the pixels is the indication of cloud clusters and its grouping around that area. Brightness temperature range (200-250 K) shows the moderate to intense convection over the area which supports the unusual rainfall activity? Its development was so rapid that its prediction with the help of conventional observations was very difficult. The conventional observations are every 3 hourly in class -1 observatories and they are very few in numbers.



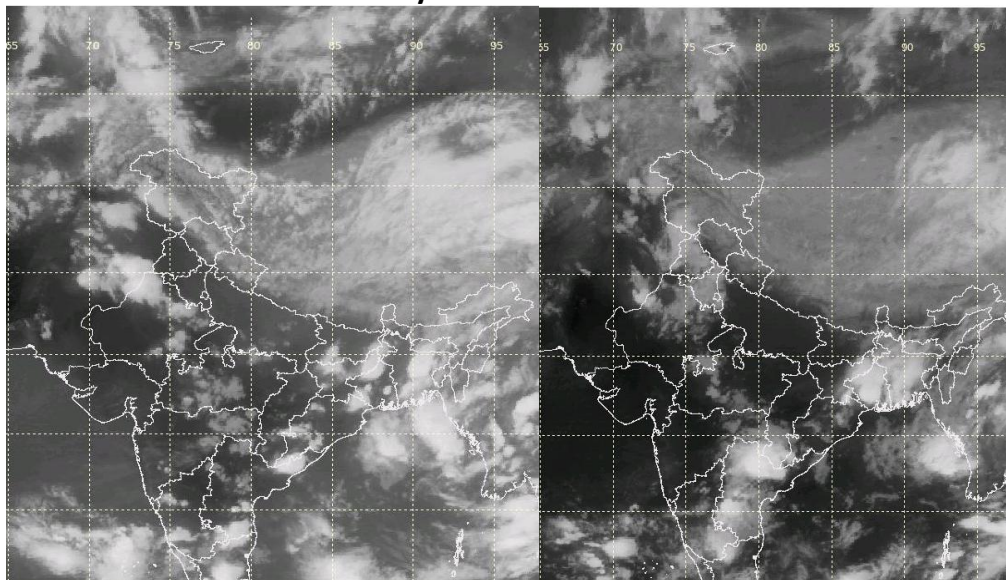
**Figure 2 : Channel 4 image (Temperature) of 08:13 UTC of 03<sup>rd</sup> August 2012 (NOAA-18)**

#### **Event 2: Thunder activity around Delhi 30 May to 1<sup>st</sup> June 2009**

Thunder event around Delhi on 31<sup>st</sup> May 2009 was sudden development and persists up to 1<sup>st</sup> June 2009. The observations of Integrated Precipitable Water Vapour (IPWV), Temperature, Relative Humidity and Pressure recorded by the Delhi based global positioning system (GPS) are shown in Figure (3). Observation shows sudden increase of IPWV in 31<sup>st</sup> May 2009 itself. The values of relative humidity, temperature also supported the convection developed during the event. The value of RH increases before the development of the convection and decreases thereafter. The Same development of convection is also supported by satellite images of Kalpana -1 satellite, figure (4). This rainfall event suddenly changed the weather pattern and hygienic around National Capital Region (NCR). The people affected by throat, Tuberculosis or skin infections are affected badly. The new species of the mosquitoes evolved and produce different kind of fever activities in human especially adults. So, by knowing the weather transitions or climate over the region and the spreading species data base we can monitor it.



**Figure 3: Diurnal variation of (a) IPWV (mm) (b) Rrelative humidity (%) (c) Temperature (°C) and (d) pressure (mb) for thunderstorm activity over Delhi (31<sup>st</sup> May) between on 30<sup>th</sup> May to 1<sup>st</sup> June 2009.**



**Figure 4: Kalpana-1 Infrared imageries for (a) 1200UTC (b) 1900UTC of 31<sup>st</sup> may 2009.**

### Event 3: Monsoon activity:

The southwest monsoon (June –September) season activity is also affected by the global changes of circulation pattern and sea surface temperature anomalous behavior in recent. IPWV and cloud coverage over the Indian subcontinent during 11<sup>th</sup> August 2009 is seen below in figures (5) & (6). The variation of IPWV and cloud coverage shows the progress of

active behavior of the monsoon 2009. The rainfall after a long gap results unhygienic conditions over the NCR region of Delhi. The proper prediction of events can maintain a psychological preparedness to the public. But unusual behavior due to global climate change needs to be investigated by studying long trend of the cloud coverage and IPWV over the area.

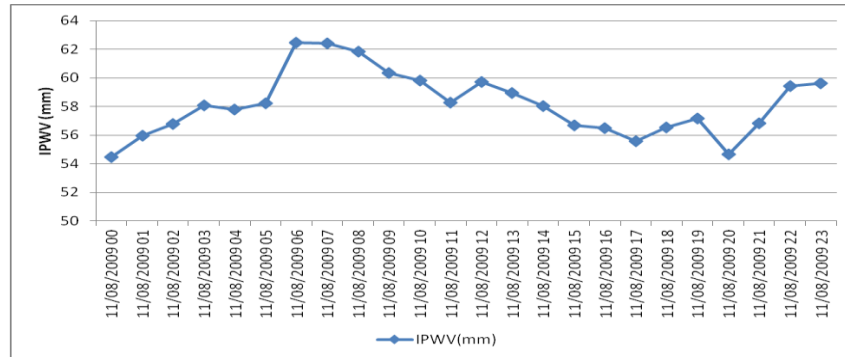


Figure 5: GPS derived IPWV (mm) over Delhi on 11<sup>th</sup> August 2009

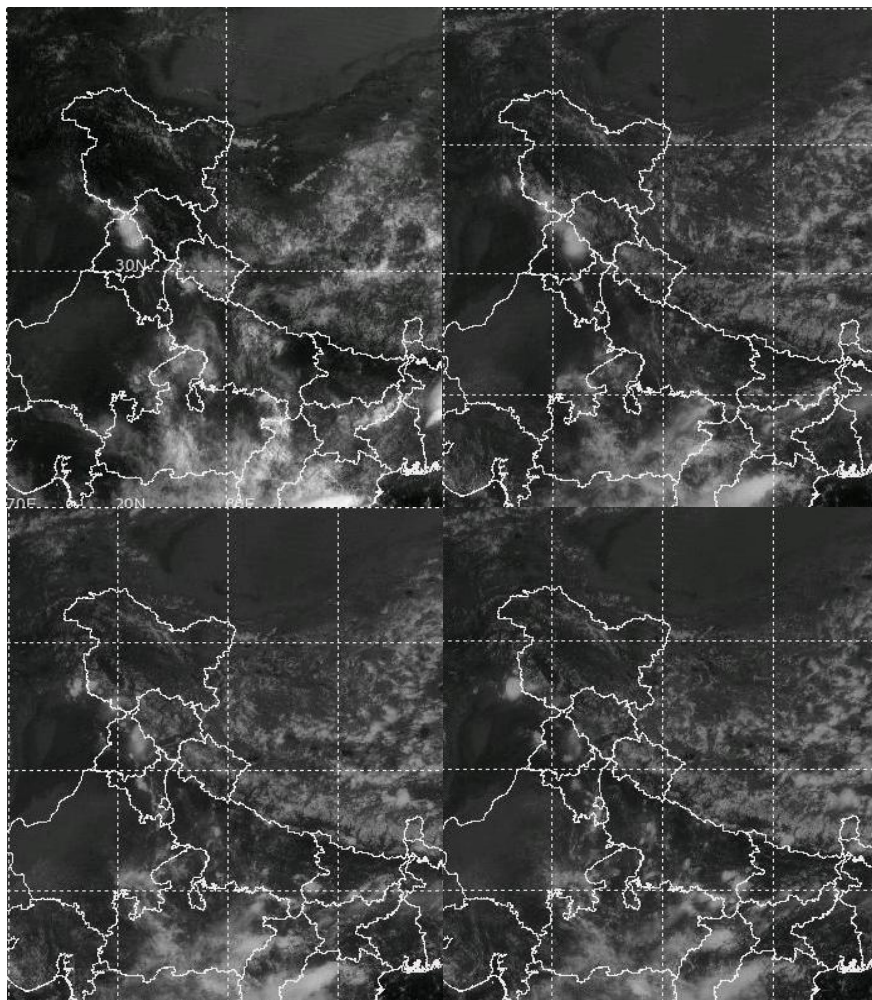


Figure 6: Kalpana-1 visible imageries (a) 0300UTC (b) 0600UTC (c) 0700UTC (d) 0800UTC of 11<sup>th</sup> August 2009.



#### Event -4: Squall monitoring by Doppler weather Radar

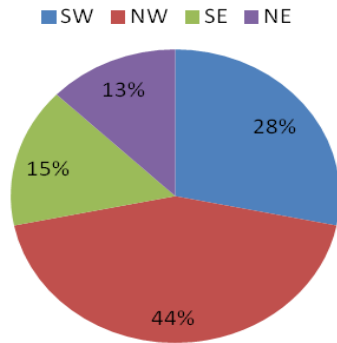
Thunderstorms are mesoscale activities, which are more prominent in pre-monsoon season over Bihar region and locally known as Norwesters. The events are classified as severe, moderate, weak and very weak based on their intensity, speed and clouds heights in recent past over Kolkata region by Pradhan et al , 2012. On the similar footing the thunder events over Bihar region has been analysed with the help of Doppler weather radar (DWR) installed at Patna. The base products which are generated by DWR are radar reflectivity (Z in dBz), radial velocity (V in m/s) and spectrum width (W in m/s). This year on 21-04-2015 Purnea (Bihar) was badly affected by the localized severe squall activity which result divested life and property, fig 7 (a,b) During pre-monsoon season (March to May) Norwester's activities are common over that area. The formation and dissipation zones of the of the pre-monsoon activities during the year 2014-2015 are given in fig 8 (a,b). Figure 8 (a, b) shows the 72 % thunder or squally type of activities are originated in northwest (NW) and southwest (SW) sectors and dissipated mostly (66 %) in northeast (NE) and southeast (SE) sectors. These weather activities disrupt the normal life of the people over the areas. Recently developed Doppler Weather Radar (DWR) tools are a valuable tool to Nowcast in advance of few hours, figures 9 (a,b). The reflectivity spectrum is available in every 10 minutes and used to estimate the time of reaching the storm over the area. Actual wind speed recorded by high speed wind recorder installed at Meteorological Centre Patna, confirms the squall activity around Patna. The sudden increase of wind speed disrupts the normal life of the public.



**Figure 7 (a): Uprooted tree due to squally wind (b) Same as (a) except crop damaged.  
(Purnea-Bihar on 21-04-2015)**



### SECTORS OF FORMATION



### SECTORS OF DISSIPATION

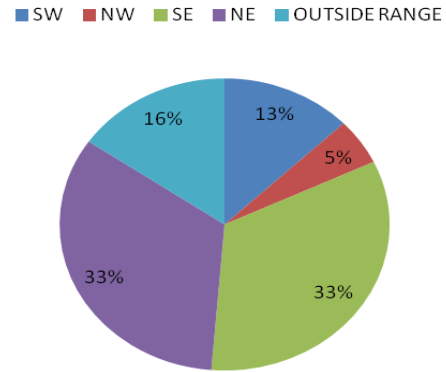


Figure 8 (a): Thunder activities (2014-2015) during pre-monsoon season, formation stage  
(b) same as (a) except dissipation stage.

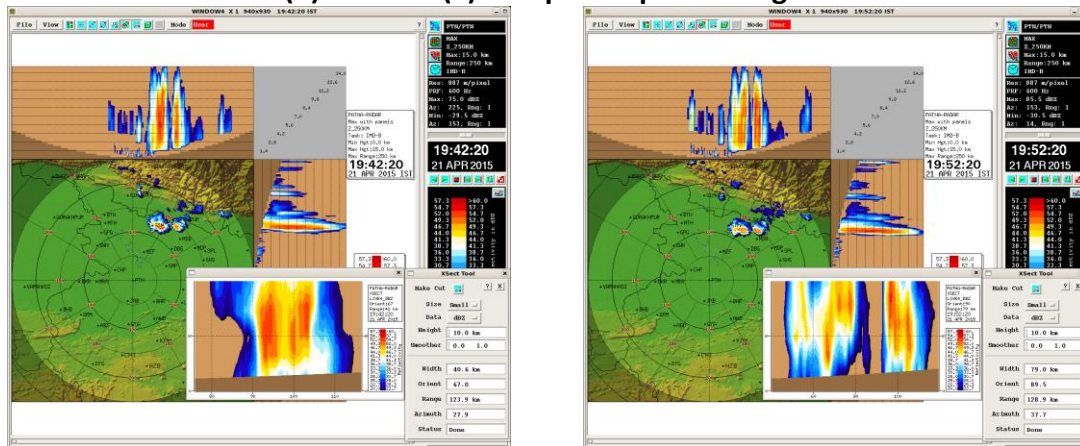


Figure 9 (a) Radar reflectivity of DWR Patna at 19:42 (IST) (b) same except 19:52 (IST)

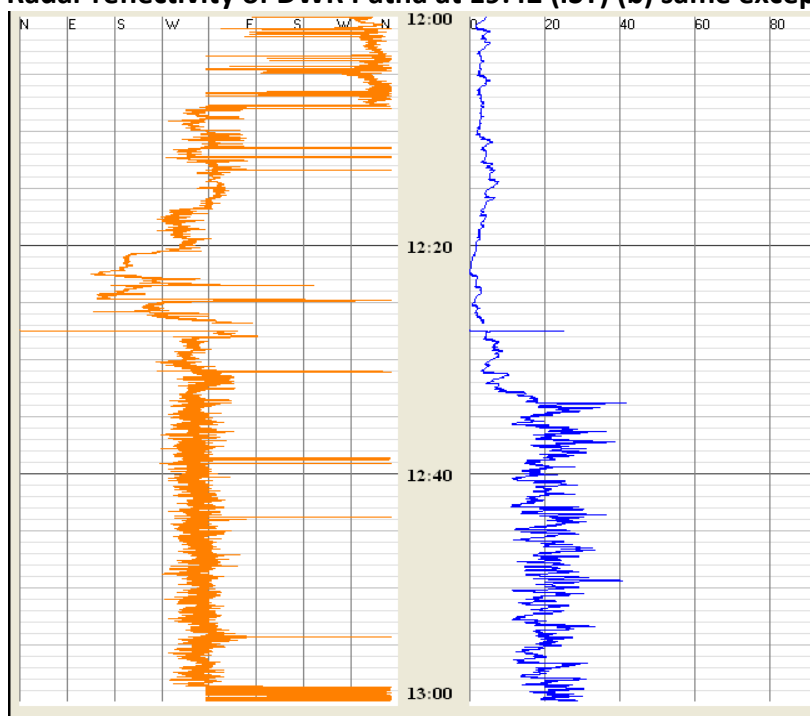


Figure 10 (a) Thunder squall on 07-05-2011-MC-PATNA at (12:27 to 12:28 IST)



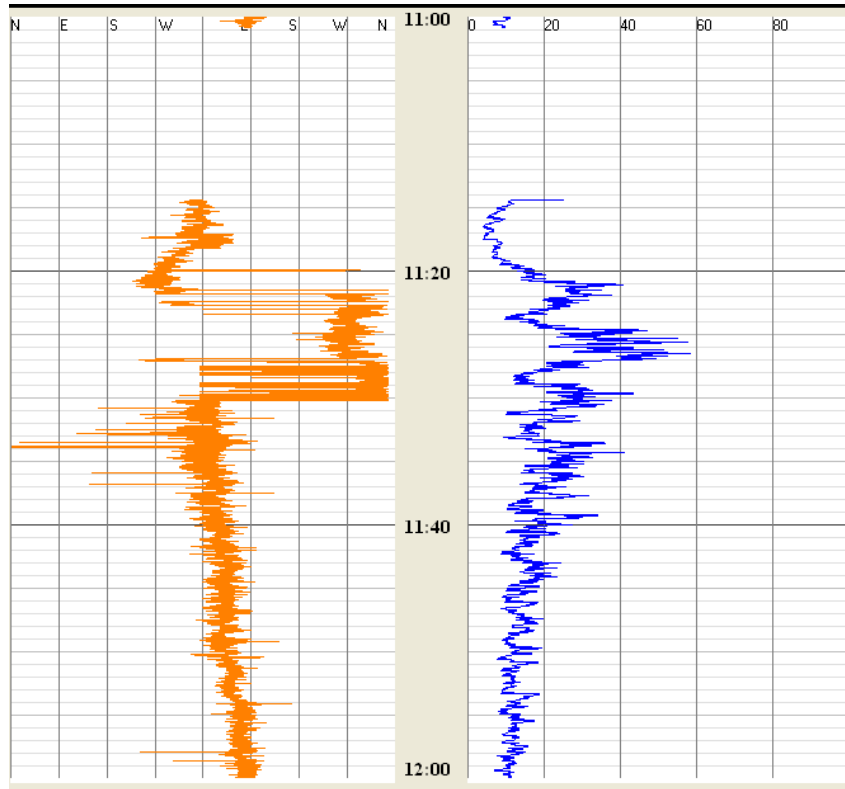


Figure 10 (b) Thunder squalls on 21-05-2011-MC-PATNA at (11:22 to 11:24 IST)

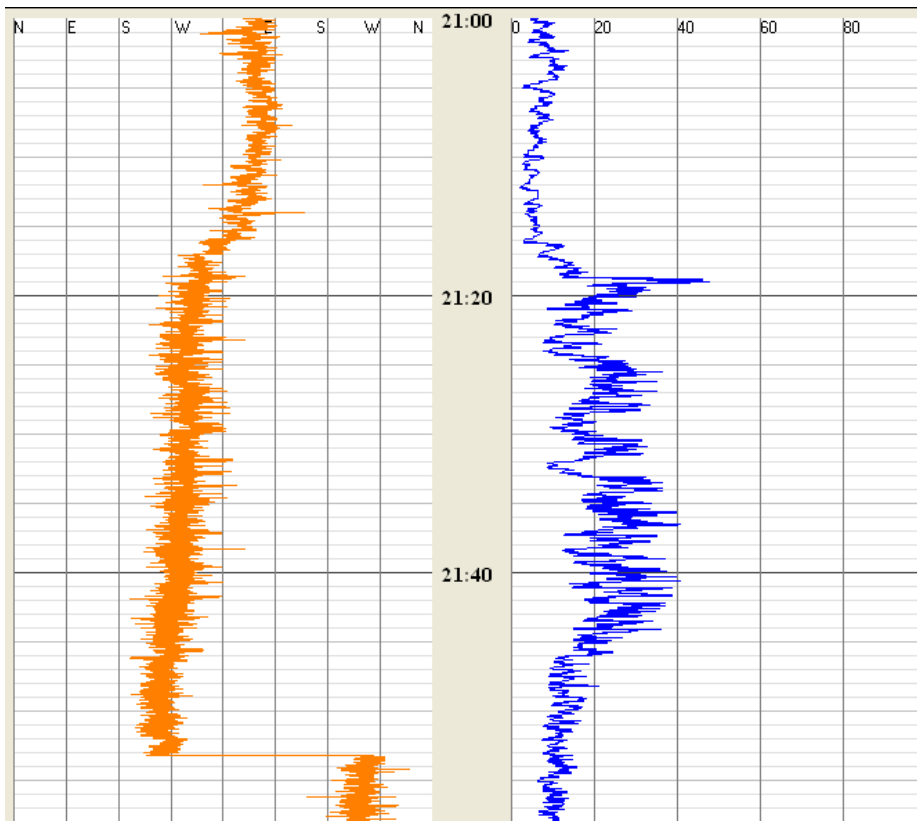


Figure 10 (c) Thunder squalls on 01-06-2012-MC-PATNA at (21:19 to 21:20 IST)



### Lightening detection from space

Space borne instrument is useful to understand the role of lightening in weather and climate. Most of the electrical activity in clouds is not seen nor is it detected by electrical sensors on the ground. (Many people will be familiar with these from TV stations that map lightning strikes during severe weather. Because these use the Earth as part of the detection network, they only show cloud-to-ground strikes. The satellite data also track patterns of lightning intensity over time. In the northern hemisphere, for example, most lightning happens during the summer months. But in equatorial regions, lightning appears more often during the fall and spring. The ocean surface doesn't warm up as much as land does during the day because of water's higher heat capacity. Heating of low-lying air is crucial for storm formation, so the oceans don't experience as many thunderstorms. Forecasting ability has improved over the years as measurement technology, communications, and the understanding of atmospheric processes have improved. Meteorologists use measurements from various types of sensors together with mathematical models describing the physics of the atmosphere to predict its future state.

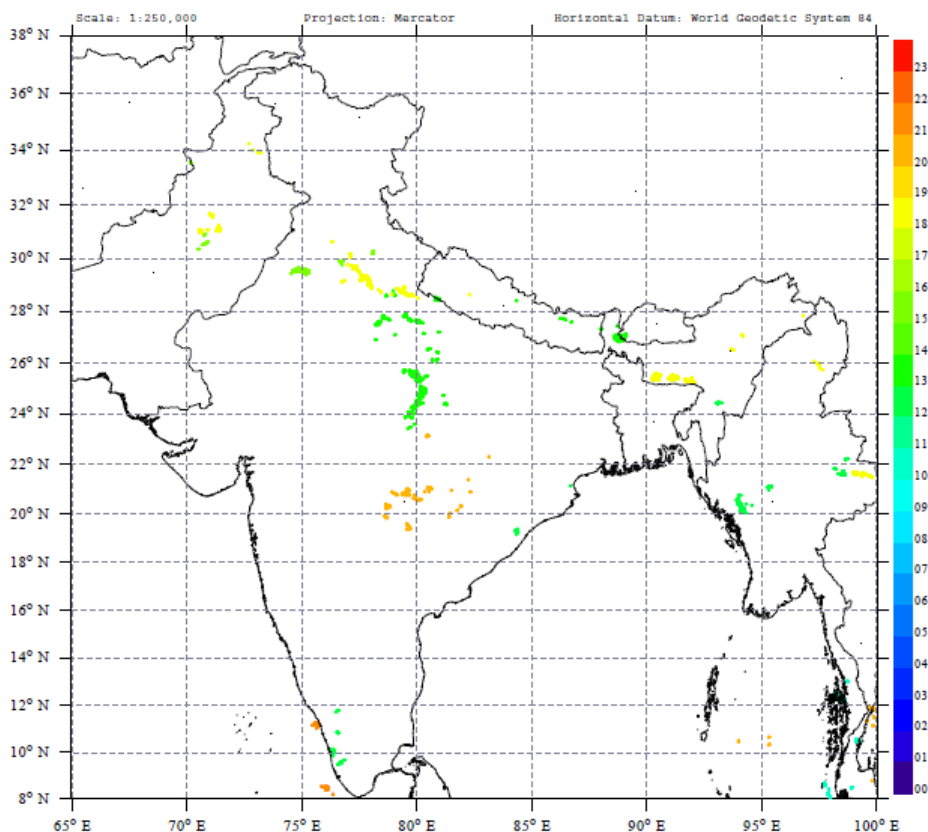


Figure 11: LIS flash events (hourly) on 08-04-2009



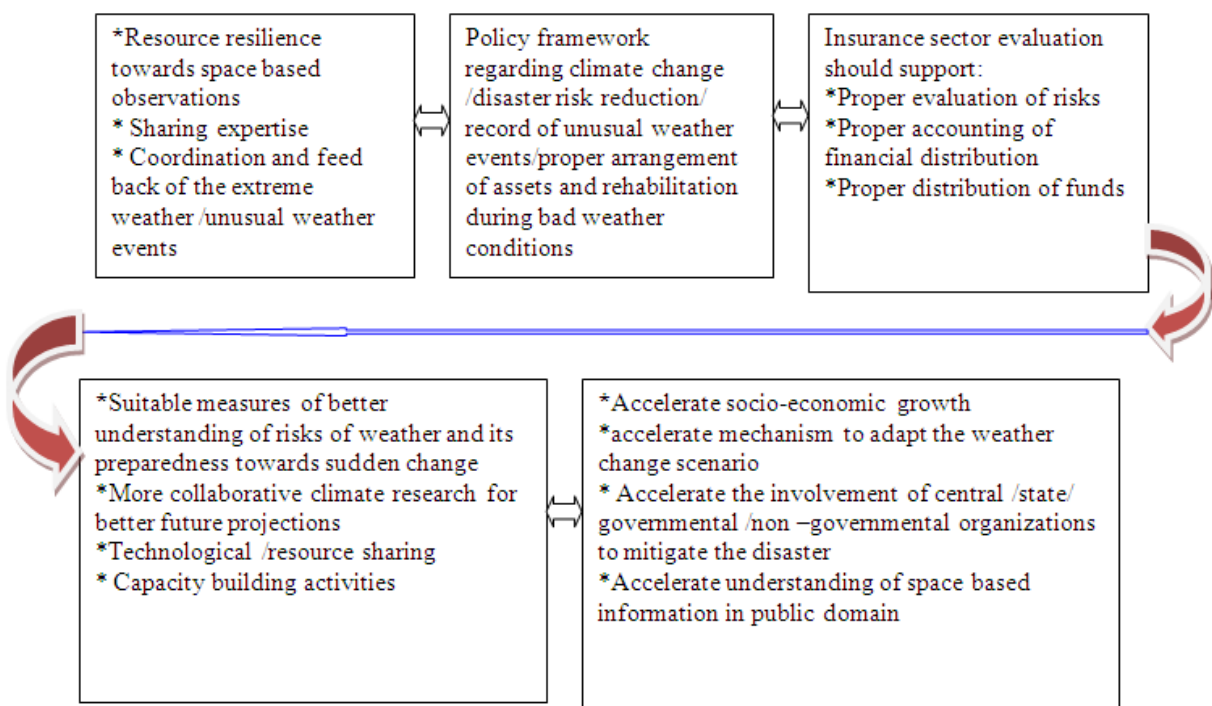
The Lightning Imaging Sensor (LIS) on board tropical rainfall measuring mission (TRMM) monitors lightning flashes on the Earth below by collecting 500 images per second.

The LIS sensor contains an optical staring imager which is used to identify lightning activity by detecting momentary changes in the brightness of the clouds as they are illuminated by lightning discharges [Christian et al., 1983] It provides valuable even life-saving data to weather forecasters. The same updrafts that drive severe weather often cause a spike in the lightning rate [at the onset of] a storm So, measuring the rate of lightning flashes in real time might offer a way to identify potentially deadly storms before they become deadly. The sample of the LIS events is shown in the figure 11.

### Satellite observations and society

Due to increase demand of accurate observations and forecast of winds and atmospheric stability there is a need of technological infusion to upgrade the current existing system of INSAT observations. This advancement expanded the opportunities of better human safety and economic growth. The vulnerability caused by the transport of toxic gases and particles if they were released into the atmosphere at any location, at any time can be monitored by knowing the stability of the atmosphere. The importance is more prominent due to the assimilation of high resolution satellite data into numerical weather prediction models.

### Strategic implementation of space based learning for weather events





## **CONCLUDING REMARKS**

The unequivocal or catastrophic changes of weather can be predicted better by studying the forcing of anthropogenic, direct or indirect in the atmosphere. Space based platform based information (Satellite, Doppler Weather Radar, LIS, GPS) is used predicting in advance the weather information or warnings if any. During winter time Northern India is mostly affected by westward moving system called Western Disturbances (WD's) and Southern Part of India, prominently by easterly waves activities. Other activities like, thunder- squalls, cyclones, very heavy rainfall etc. are actively monitored and forecasted by proper lead time and warnings with the help of space based inputs. WDs frequencies and coverage are variable throughout the year. The thunder squall behaviors over Bihar region shows that most of the formation occurs at NW and SW sector and dissipation in NE and SE sectors. The unusual or extreme change in weather activities can cause different type of diseases and stresses in human mind.

This can be minimized by applying further technological advancements and proper understanding of the anomalies or changing behavior of the space based observatios. The more precise and accurate information within stipulated time can be used for helping the mankind.

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