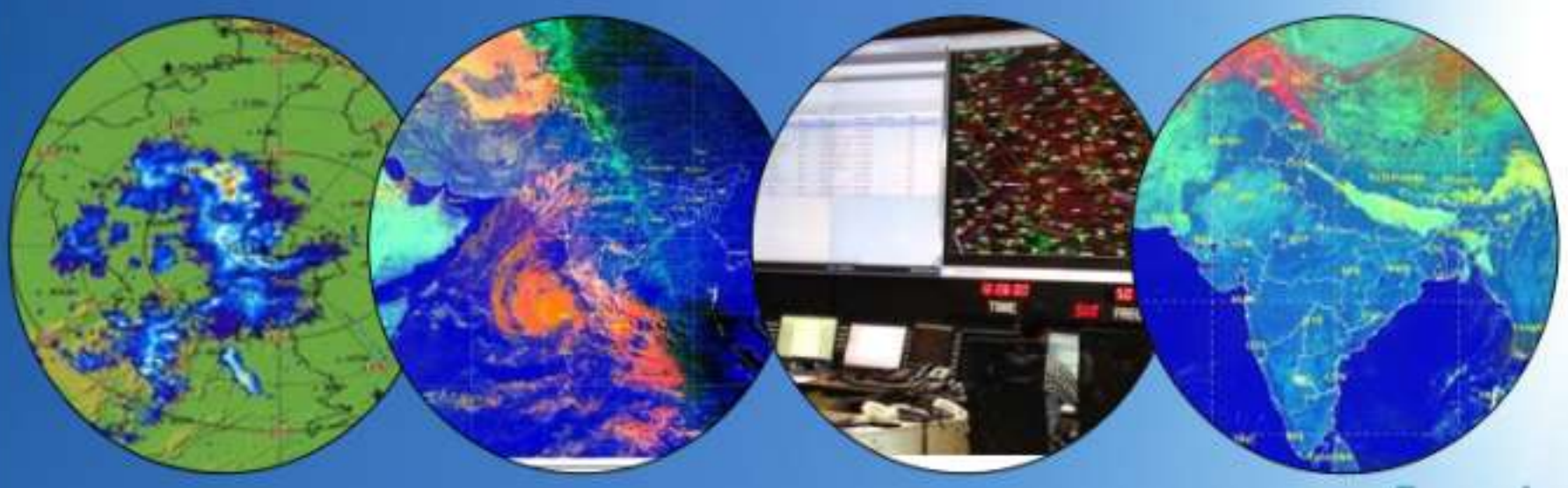
WEATHER INFORMATION PORTAL FOR INDIAN POWER SYSTEM

Reference Document



Power System Operation Corporation Ltd.

(A Government of India Enterprise)

WEATHER INFORMATION PORTAL
FOR
INDIAN POWER SYSTEM

Reference Document

Power System Operation Corporation Ltd.
(A Government of India Enterprise)

B-9, Qutub Institutional Area,
Katwaria Sarai,
New Delhi - 110016

Message from Chairman and Managing Director

Electricity demand is largely dependent on the weather conditions and its wide variation over the day, season poses challenges to the System Operators in terms of secure and reliable grid operation. Advent of large growth of Renewable Energy resources, which are highly influenced by the Weather, further accentuates these challenges.

In order to tame the renewable resources, System Operators, worldwide, need more and more accurate forecasting of renewables and demand. In an initiative to strengthen the tools for the System Operators in this direction, IMD has partnered with Power System Operation Corporation and developed a web Portal, providing a variety of information related to Weather. The weather portal is a pioneering collaborative effort aimed at the Power Sector similar to the dedicated forecasts provided by the IMD for the aviation sector. This has helped in equipping the System Operators across the country with adequate weather forecasts, real time weather information, and has enabled better power system operation.

I am very happy to note that a Reference Document has been developed to facilitate enhanced utilisation of the weather portal in all spheres of Power sector. I am sure that this Reference Document will be of immense help to the System operators in taking timely decisions and achieve delivery of more quality Power to the consumer.

KVS Baba

Chairman & Managing Director, POSOCO

डॉ. के. जे. रमेश
मौसम विज्ञान विभाग के महानिदेशक
एवं
विश्व मौसम विज्ञान संगठन में भारत के स्थाई प्रतिनिधि
एवं कार्यकारी परिषद के सदस्य

Dr. K. J. Ramesh
Director General of Meteorology &
Permanent Representative of India with W.M.O.
and Member Executive Council of W.M.O.

भारत सरकार
पृथ्वी विज्ञान मंत्रालय
भारत मौसम विज्ञान विभाग
मौसम भवन, लोदी रोड़
नई दिल्ली–110003

Government of India
Ministry of Earth Sciences
India Meteorological Department
Mausam Bhawan, Lodi Road
New Delhi - 110003

24th August, 2018

MESSAGE

I am happy to note that Power System Operation Corporation Limited (POSOCO) is bringing out a Reference Document for effective utilization of weather portal in the power sector.

Weather plays an important role of public life in various ways. It is inextricably linked with the agriculture, industry & commerce and social life of any country. The role of weather in power sector becomes very crucial since both electricity demand and supply are subject to changing temperature conditions, on which power load demand varies. There is always a challenge to provide ever changing weather information from grid operation point of view. To overcome this challenge, a dedicated weather portal was jointly developed by IMD and POSOCO.

This partnership initiative has proved to be helping the nation in delivering reliable and cost effective grid based power to the end consumer. The Reference Document on Weather Information for power sector would further help the system operators and other professionals to work together and help in nation building with overall uninterrupted power supply framework.

I am sure that this partnership with power sector would prove to be an effective professional engagement for national development.

(K J Ramesh)

Phone : 91-11-24611842, Fax : 91-11-24611792, Resi. : 91-11-26257374
E-mail : kjramesh2607@gmail.com / dgmmet@gmail.com / kj.ramesh@nic.in / kj.ramesh@imd.gov.in

Message from Joint Secretary (Trans.)

Day-to-day weather variations have an impact on demand and energy production, transmission and distribution management, as well as energy prices. Weather conditions such as cold wave, heat wave and high humidity condition in summer months lead to variation in demand. Power System also often suffers in the aftermath of extreme weather conditions such as Cyclones, Floods, High Silt conditions etc. Therefore, proactive steps are required to mitigate the adverse effects of weather on power and deliver reliable power to the consumer. The dedicated Weather Portal for Power sector jointly developed by POSOCO and IMD is helping System Operators to deliver secure and reliable power to the consumers. I am sure that the Reference Document on Weather Portal would further improve the insight of Power Sector professionals about various meteorological parameters which would help in seamless integration of Renewable Energy and also make the Indian Grid secure from the vagaries of weather.

Bharati

Bharati
Joint Secretary (Trans.), Ministry of Power

Message from Director Market Operation

Weather is one of the major factors influencing the power demand and in turn effects the grid management. The Weather Information Portal for Power System jointly developed by POSOCO & IMD has enabled the Indian grid operators to be more aware and thus remain more vigilant in the event of inclement weather conditions. Pictures from RADAR have enabled System Operators to know the location of rain, its movement and intensity which helps in real time estimations of demand changes. Colour composite images from Satellite have enabled operators to take decisions regarding operation of HVDC in Reduced voltage mode/Normal mode of operation on Foggy nights. Further, the information available on the Weather Portal regarding weather forecast is also helpful to Generation, Transmission and Distribution alike to take pro-active steps regarding short term and medium term operational planning through bilateral and Power exchange.

I am confident that the Reference Document on weather would be immensely helpful to all the stake holders in the Power Sector to further improve their efficiency, reliability and enable them to provide power to end consumers at all time and at right price.

P.K Agarwal

Director (Market Operation),POSOCO

INDEX

1. Executive Summary

The Indian grid has total installed capacity of around 330 GW. The installed capacity comprises of 218.95 GW of Thermal, 44.96 GW of Hydro, 60.15 GW of Renewable and 6.78 GW of Nuclear Generation. The Government of India has revised its target of Renewable energy capacity to 1,75,000 MW till 2022, comprising of 100,000 MW Solar, 60,000 MW Wind, 10,000 MW Biomass and 5000 MW Small Hydro. Hence, we can expect a markedly high growth in commissioning of Wind and Solar plants in the country which are highly dependent on weather.

Extreme Weather conditions can affect both power system elements and its operation to a large extent. The Indian weather is driven by the Asiatic Monsoon system. In addition, the Himalayas and the Thar Desert play a vital role to influence it. There is a diversity of weather conditions ranging from tropical wet to tropical dry and subtropical humid to dry with a huge variation. During summer period, massive convective thunderstorms dominate Northern India's weather. The temperatures in the North India rise accompanied with strong, gusty, hot and dry winds. In summer months, with increase in temperature, power demand increases sharply. These weather conditions coupled with frequent thunderstorms lead to sudden load crash in pockets due to sudden drop in temperatures and tripping/opening of distribution feeders leading to high voltages in the Northern Grid. The load returns within few hours after short and temporary effects of thunderstorm.

In winter season the cold weather conditions lead to decrease in temperature. Western disturbances in winter season bring moderate to heavy rain in low lying areas and snow fall in mountainous areas of the Northern Region.

Cyclones affect thousands of Indians living in coastal regions. This is particularly common in the northern reaches of the Indian Ocean in and around the Bay of Bengal. Cyclones include heavy rains, large storm surges, and strong winds that often cut power supply to the affected areas.

Accurate anticipation of extreme weather conditions i.e. snowstorms, dust storms, High winds, and thunderstorms, heavy rain, cyclones etc. facilitate advance operation planning, secure system operation and early restoration of the affected areas. Timely and effective forecasting of Weather is one of the key issues in enabling integration/higher penetration of renewable generation in the Indian

Power system in the times to come. In future meteorologists may be called upon to integrate solar irradiance/wind forecast into load for economic optimisation of generation. Meteorologists can use their statistical background and forecast expertise to better bracket the intra- day and day ahead renewable energy forecast and load forecast. They are uniquely equipped to integrate the science of meteorology into informed operational decisions in power system

The Weather Portal provides both near real time weather information and forecast of different weather parameters across the country. Accurate anticipation of the weather variations would pave the way for efficient, secure and reliable operation of the Indian power grid.

2. Introduction

Earth System Science Organization, India Meteorological Department (ESSO-IMD), Under the Ministry of Earth Sciences and Power System Operation Corporation Ltd. (POSOCO), signed a Memorandum of Understanding for optimum use of weather information / forecast in the power sector.

Salient features of the MoU signed in the presence of senior officers from the Ministry of Power and the Ministry of Earth Sciences include:

- All weather information provided by ESSO-IMD shall be used by the Power System Operators across India for better management of Indian Power System and for the purpose of analysis.
- ESSO-IMD shall make available current weather information for the identified stations; and forecasts at different time scales (Nowcast to medium range scales) of temperature, humidity, wind speed, wind direction, rainfall and other meteorological parameters of the identified stations/sectors.
- ESSO-IMD shall provide weather warnings about likely occurrences of thunderstorm, heat wave, cold wave, rainfall, fog etc. over various states up to next 72 hours.
- ESSO-IMD shall provide state / region wise Monthly /Seasonal outlooks of weather conditions.
- Both the parties agreed to provide expert opinion and knowledge support in areas of Weather information and its effect on power distribution system.
- Data & Inputs shall be exchanged to encourage further study and research work.
- POSOCO shall endeavour for economic assessment of impact of weather & climate information. Regular feed mechanism shall be put in place for continued up-gradation of the services.

The MoU essentially brings out the fact that energy sector is one of the most pivotal spheres of human activity which are highly dependent on weather conditions. To increase the efficiency of power sector

and to make it weather proof, it is not sufficient to act after they have taken place. Proactive steps are required to minimise the possible adverse impacts.

(Signing of MOU between POSOCO and IMD on 18th May 2015 at Shram Shakti Bhawan, New Delhi)

Weather information on different time scales is essential both in day-to-day energy management and for the generation and distribution infrastructures. Day to day weather variations have an impact on load demand and power production, transmission and distribution management. Extreme events such as heat waves or cold waves, wind storms or floods can of course have dramatic consequences on the electrical grid of a country including physical damage to the infrastructure. In addition to short & medium-term management processes the long-term production and supply planning require climate data and future climate scenarios. In order to manage the risks associated with weather and climate conditions on all time scales from a few minutes to days, reliable weather forecasts and climate information — past, present and future are therefore crucial to reduce the uncertainty in supply and demand forecasts, as well as market dynamics. In pursuance to this MOU, dedicated weather portal for the power sector has been developed jointly by POSOCO and IMD. The weather portal contains information related to weather forecast, real time weather scenario and past data of various locations across the country.

3. Important Terminology

1. Meteorological seasons over India :

Winter Season	:	January – February
Pre Monsoon Season	:	March – May
Southwest Monsoon Season	:	June - September
Post Monsoon Season	:	October – December

2. Weak Monsoon:

- Rainfall is less than half the normal (over the land area)
- Wind speed is upto 12 knots (over the Sea).

3. Normal Monsoon:

- Rainfall is half to less than 1½ times the normal (over the land area).
- Wind speed is between13 and 22 knots (over the Sea).

4. Active Monsoon:

- Rainfall is 1 ½ to 4 times the normal.
- The rainfall in at least two stations should be 5 cm, if that sub-division is along the west coast and 3 cm, if it is elsewhere.
- Rainfall in that sub-division should be fairly widespread to widespread. (over the land area) Wind speed is between 23 and 32 knots (over the Sea).

5. Vigorous Monsoon:

- Rainfall is more than 4 times the normal.
- The rainfall in at least two stations should be 8 cm, if the sub-division is along the west coast and 5 cm, if it is elsewhere.
- Rainfall in that sub-division should be fairly widespread or widespread. Wind speed is 33 knots and above (over the Sea).

6. **Southwest Monsoon**: The South westerly wind flow occurring over most parts of India and Indian Seas gives rise to southwest monsoon over India from June to September. The Southwest monsoon normally sets in over Kerala around 1st June. It advances northwards, usually in surges, and covers the entire country around 15th July.

7. **Northeast Monsoon (post monsoon season)** : The large indentation made by the Bay of Bengal into India's eastern coast means that the flows are humidified before reaching Kanya Kumari and rest of Tamil Nadu. Therefore, Tamil Nadu and some parts of Kerala experience significant precipitation in the post-monsoon and winter periods. However, parts of West Bengal, Orissa, Andhra Pradesh, Karnataka and North-East India also receive minor precipitation from the northeast monsoon.

8. **Cloud coverage:** Measurement of cloud coverage

Clear sky	:	0 octa
Mainly clear	:	1-2 octa of sky covered
Partly cloudy	:	3-4 octa of sky covered
Generally cloudy	:	5-7 octa of sky covered
Cloudy	:	> 7 octa of sky covered
Overcast sky	:	Sky completely covered by cloud

9. **Classification of rainfall intensity based on total rainfall in 24 hours:**

Very light rain	:	< 2.4 mm
Light rain	:	2.5 - 15.5 mm
Moderate rain	:	15.6 - 64.4 mm
Heavy rain	:	64.5 – 115.5 mm
Very heavy rain	:	115.6 – 204.4 mm
Exceptionally heavy rain	:	> 204.5 mm

10. Classification of rainfall intensity based on hourly rainfall data:

Rainfall Category	Percentile	Rainfall in cm/hour
Light spell	Upto 50th percentile	Rainfall up to 1 cm/hour
Moderate spell	Up to 80th percentile	Rainfall up to 1-2 cm/hour
Intense spell	90th percentile	Rainfall 2-3 cm/hour
Very Intense spell	99.9th percentile	Rainfall 3-5 cm/hour
Extremely intense spell	>99.99 percentile	Rainfall 5-10 cm/hour
Cloud burst		Rainfall >10 cm/hour

11. Classification of snowfall intensity based on total snowfall in 24 hours:

Terminology	Percentile	Snowfall depth in cm
Light snowfall	Less than 50th percentile	10.4 cm or less
Moderate snowfall	50-95	10.5-64.4 cm
Heavy snowfall	95-99	64.5-115 cm
Very heavy snowfall	99.0-99.9	115.6-204.4 cm
Extremely heavy snowfall	>99.9	204.5 cm or more

12. Rainfall category and their description:

Rainfall Category	Description	Details
WS	Wide spread/At most places	(76-100)% of stations get rainfall
FWS	Fairly wide spread/At many places	(51-75)% of stations get rainfall
SCT	Scattered /At few places	(26-50)% of stations get rainfall
ISOL	Isolated /At one or two places	<=25% stations get rainfall
Dry	No rain	No station report rainfall

13. Probability forecasts of rainfall or weather:

Term	Probability
Unlikely	Probability of occurrence less than 25%
Likely	Probability of occurrence between 25 & 50%
Very likely	Probability of occurrence between 51% & 75 %
Most likely	Probability of occurrence above 75%

14. Classification of Tropical disturbances :

Classification of Tropical disturbance	Wind Speed
Low	Less than 31 km/hr
Depression	31-51 km/hr
Deep Depression	52-62 km/hr
Cyclone	63-87 km/hr
Severe Cyclone	88-117 km/hr
Very Severe Cyclone	118-221km/hr
Super Cyclone	222 km/hr and above

15. Forecast:

- Long range forecast : 10 day – a season or a year
- Extended range : 15 -30 days
- Medium range forecast : 3 days-9 days
- Short range forecast : 3 hours – 3 days
- Nowcast : 1-3 hours

These days a five- day weather forecast is generally as reliable as a three-day forecast of two decades ago. Seasonal climate predictions can be forecasted up to a month, three months or six months ahead although these climate predictions are probabilistic in nature.

16. UTC Time: The world's weather communities use a twenty four hour clock, similar to "military" time based on the 0° longitude meridian, also known as the Greenwich meridian. Prior to 1972, this time was called Greenwich Mean Time (GMT). Now it is referred as Universal Time Coordinated (UTC). It is also known as "Z time" or "Zulu time".

To obtain local time (IST) in INDIA, **5 hours and 30 minutes** shall be added to UTC time.

17. Thunderstorm: A thunderstorm is defined as a meteorological phenomenon in which one or more sudden electrical discharges are manifested by a flash of light (Lightning) and a sharp rumbling sound (thunder) occurs from a cloud of vertical development.

18. Dust Storm: Dust storm is an ensemble of particles of dust or sand energetically lifted to great heights by a strong and turbulent wind. Often the surface visibility is reduced to low limits; the qualification for a synoptic report is visibility below 1000m.

19. Cyclonic Circulation :

- Atmospheric wind flow in upper levels associated with any low pressure system.
- The wind flow is counter clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

20. Anticyclonic Circulation :

- Atmospheric wind flow in upper levels associated with any high pressure system.
- The wind flow is clockwise in the Northern Hemisphere and counter clockwise in the Southern Hemisphere.

21. **Western Disturbance** : Weather disturbances noticed as cyclonic circulation/trough in the mid and lower tropospheric levels or as a low pressure area on the surface, occurs in middle latitude westerlies and originate over the Mediterranean Sea, Caspian Sea and Black Sea and move eastwards across north India. From January to February Western disturbances bring heavy burst of rain and snow.

22. **Western Depression:** Weather system which originates over the Mediterranean Sea, Caspian Sea and Black Sea and approaches northwest India, is defined by two or more closed isobars on the surface. (The greater the pressure contrast over an area, the shorter the distance between isobars on a weather map depicting the area. Wind blows from areas of high to low pressure. The greater the contrast in pressure difference between two areas, the faster the wind will blow, hence closer the isobars on a weather map predict higher velocity winds)

23. **One or Two spells of rain/showers:** During 24 hrs period, rain occurring with a frequency of 1-2 spells.

24. **A Few Spells of rain/showers:** During 24 hrs period, rain occurring with a frequency of more than 2 spells coupled with well-defined dry spells in between.

25. **Intermittent rain:** During 24 hrs period, rain occurring with a frequency of more than that defined in "A Few Spells" but is discontinuous and without presenting the character of a shower.

26. **Continuous rain/shower:** Rain occurring almost throughout the 24-hour period.

27. **Drizzle:** Liquid precipitation in the form of water drops of very small size (by convention, with radius of water drops between about 100 and 500 μm).

28. **Shower:** Solid or liquid precipitation from a vertically developed cloud is designated a shower and is distinguished from the precipitation, intermittent or continuous, from layer clouds. Showers are often characterized by short duration and rapid fluctuations of intensity (by convention, with radius of water drops more than2500 μm).

29. **Mist Dew:** Mist is a phenomenon in which small droplets suspended in air Condensate to water vapour on a surface, whose temperature is reduced by radiational cooling to below the DEW-POINT of the air in contact with it.

30. **Frost:** Frost occurs when the temperature of the air in contact with the ground, or at thermometer-screen level, is below the freezing-point of water ('ground frost' or 'air frost', respectively). The term is also used for the icy deposits which may form on the ground and on objects in such temperature conditions (glaze, hoar-frost).

31. **Haze:** Haze is traditionally an atmospheric phenomenon where dust, smoke and other dry particles obscure the clarity of the sky.

32. **Weekly/Seasonal rainfall distribution on Regional scale :**

- **Excess:** Percentage departure of realised rainfall from normal rainfall is + 20% or more.
- **Normal:** Percentage departure of realised rainfall from normal rainfall is between - 19 % and + 19 %.
- **Deficient:** Percentage departure of realised rainfall from normal rainfall is between – 20 % and - 59 %.
- **Scanty:** Percentage departure of realised rainfall from normal rainfall is between – 60 % to - 99 %.
- **No rain:** Percentage departure of realised rainfall from normal rainfall is – 100 %.

33. **Rainfall distribution on all India scale :**

- **Normal:** Percentage departure of realised rainfall is within ±10 % of the long period average.
- **Below Normal:** Percentage departure of realised rainfall is < 10% of the long period average.
- **Above Normal:** Percentage departure of realised rainfall is > 10% of the long period average.

34. Terms used for description of temperatures :

a) Temperature departures:

Markedly below normal	**: -5°C or less**
Appreciably below normal	**: -3°C to -5°C**
Below normal	**: -1.6°C to 3°C**
Normal	**: -1.5°C to 1.5°C**
Above normal	**: 1.6°C to 3°C**
Appreciably above normal	**: 3.1°C to 5°C**
Markedly above normal	**: 5°C or more**

b) 24 hrs temperature changes:

Marked fall	**: -4.1°C or less**
Appreciably fall	**: - 2.1°C to -4.0°C**
No large change	**: -2°C to +2°C**
Appreciably rise	**: 2.1°C to 4°C**
Marked rise	**: 4.1°C or more**

35. Hail: It is solid precipitation in the form of balls or pieces of ice (hailstones) with diameters ranging from 5 to 50 mm or more. Hail can be extremely dangerous and can cause extensive damage in only a few minutes.

36. Heat Wave: A continuous spell of abnormally hot weather. Heat wave is considered if the maximum temperature of a station reaches at least 40°C or more for Plains and at least 30°C or more for Hilly regions.

a) Based on departure from Normal Temperature

Heat wave	: Departure from normal is 4.5°C to 6.4°C
Severe heat wave	: Departure from normal is > 6.4°C

b) Based on actual Maximum Temperature

Heat wave : When actual maximum temperature ≥ 45°C

Severe heat wave : When actual maximum temperature ≥ 47°C

c) Warm Night: It should be considered only when maximum temperature remains 40°C or more. It may be defined based on departure or actual minimum temperature as follow:

Warm night : Minimum temperature departure is 4.5°C to 6.4°C

Very warm night : Minimum temperature departure is > 6.4°C.

d) Criteria for describing Heat Wave for coastal stations

When maximum temperature **is** 4.5°C or more from normal, Heat Wave may be described provided actual maximum temperature is 37°C or more.

37. Cold Wave: A rapid fall in temperature within 24 hours to a level requiring substantially increased protection to agriculture, industry, commerce and social activities.

a) When normal minimum temperature is equal to 10°C or less for plains and 0°C or less for hilly regions.

- **Based on Departure:**

Cold wave : Negative departure from normal is 4.5°C to 6.4°C

Severe cold wave : Negative departure from normal is > 6.4°C

- **Based on actual Minimum Temperature(for plain station Only):**

Cold wave : When actual minimum temperature ≤ 04°C

Severe cold wave : When actual minimum temperature ≤ 02°C

b) Cold day: It should be considered when minimum temperature is equal to 10°C or less for plains and 0°C or less for hilly regions.

Warm night : Maximum temperature departure is -4.5°C to -6.4°C

Very warm night : Maximum temperature departure is <- 6.4°C.

c) **Cold Wave for coastal stations:**

When minimum temperature departure is -4.5°C or less over a station, *"Cold Wave"* may be described if the minimum temperature is 15°C or less.

cold day/ cold wave or heat wave /warm night should be described, if conditions are satisfied simultaneously.

38. **Fog:** Fog is a phenomenon of small droplets suspended in air and the horizontal visibility is one kilometre or less.

39. **Gales:** A gale is a very strong wind (34 to 47 knots).

40. **Squall:** A squall is a strong, sudden wind which generally lasts a few minutes then quickly decreases in speed.

41. **Gust:** A rapid increase in the strength of the wind relative to the mean strength at the time.

4. Information Available on the Weather Portal

Weather Portal for Power System has been developed using readily available products of IMD. Weather information provided on the Portal is being used by the Power System Operators across India for better management of Indian Power System.

Regional Weather portals for all the five regions were made operational as per the details given below:

- **Northern Region** : with effect from 14.03.2017
- **North Eastern Region** : with effect from 29.04.2017
- **Southern Region** : with effect from 01.05.2017
- **Eastern Region** : with effect from 05.05.2017
- **Western Region** : with effect from 01.06.2017

The Home Page of the Portal (http://amssdelhi.gov.in/NRLDC/index.html) contains following Report/Product under different tabs:

- All India Weather Inference
- All India Weather Forecast
- All India Weather Warning
- Nowcast warning
- Satellite
- Regions

The details of above Report/Product are given below:

4.1 All India Weather Inference

Weather Inference is issued based on meteorological analysis of weather data. It contains information about weather systems and it is updated 4 times in a day.

Morning	:	08:00 hrs	-	08:30 hrs
Mid-day	:	11:00 hrs	-	11:30 hrs
Evening	:	16:00 hrs	-	16:30 hrs
Night	:	20:00 hrs	-	20:30 hrs

राष्ट्रीय मौसम पूर्वानुमान केन्द्र
भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय

National Weather Forecasting Centre
India Meteorological Department
Ministry of Earth Sciences

Monday 15 January 2018

Time of Issue: 1100 hours IST

Based on 0830 hours IST Observations

All India Weather Inference (MID-DAY)

- Northeast monsoon rainfall has ceased over Tamilnadu & Puducherry, Kerala and adjoining parts of Andhra Pradesh and Karnataka from today, the 15th January 2018.
- The feeble trough over at mean sea level Equatorial Indian Ocean and adjoining southeast Bay of Bengal persists.
- The trough of low at mean sea level from Maldives area to north Maharashtra coast now runs from Maldives area to eastcentral Arabia Sea.
- The cyclonic circulation over southeast Bangladesh & neighbourhood persists and now extends upto 2.1 km above mean sea level.
- A fresh Western Disturbance is likely to affect Western Himalayan region from 17th January.

Sample of all India Weather Inference

4.2 All India Weather Forecast

All India weather forecast provides information about the following:

- Significant weather features
- Weather observations
- Meteorological analysis
- Weather forecast for next 5 days and subsequent 2 days
- Weather warning for 5 days
- Met Sub division wise rainfall forecast
- Maximum &Minimum temperature during last 24 hours
- Departure of maximum and minimum temperature from normal temperature

Above reports are updated 4 times in a day:

Morning	:	08:00 hrs	-	08:30 hrs
Mid-day	:	13:00 hrs	-	13:30 hrs
Evening	:	16:00 hrs	-	16:30 hrs
Night	:	20:00 hrs	-	20:30 hrs

Details of reports available under all India Weather Forecast

- **Significant weather features**: This report provides the present outlook of all India weather condition i.e. Fog, rainfall etc.

Tuesday 16 January 2018

EVENING

Time of Issue: 1630 hours IST

ALL INDIA WEATHER SUMMARY AND FORECAST BULLETIN

Significant weather features:

♦ **Dense to very dense fog** observed at many places over Bihar; at a few places over East Uttar Pradesh and Tripura; at isolated places over Punjab, Coastal Andhra Pradesh and **moderate to dense fog** at isolated places over Marathawada, Gangetic West Bengal, Assam & Meghalaya. **The lowest visibility (in meters)** observed at Amritsar, Bahraich, Gorakhpur, Bhagalpur & Kailashahar-25 each; Patna, Purnea, Agartala & Bapatla-50 each; Varanasi, Dibrugarh & Tezpur-200 each and Sultanpur, Malda, Kolkata (Alipur) & Aurangabad-500 each from 0230 hours IST to 0830 hours IST of today.

♦ The western disturbance currently located over northeast Afghanistan is likely to approach northwest India during next 24 hours. Associated changes in wind pattern might cause a rise in the night minimum temperatures by 2-3°C over the plains of northwest India tomorrow. However, this could be short lived and the likely setting in of northwesterly winds may lead to further fall in minimum temperatures from 18th night. Dense fog, cold wave and ground frost are likely over parts of northwest India during next 3 days .

♦ Yesterday, **Severe cold day conditions** was observed at many places over Bihar; at a few places over East Uttar Pradesh and at isolated places over Tripura; cold day conditions at isolated places over West Bengal & Sikkim.

♦ **Severe cold wave** conditions observed at isolated places over Gangetic West Bengal and **Cold wave** conditions at isolated places over East Uttar Pradesh, Bihar, Jharkhand and Odisha.

- **Weather observations:** This report provides the details of Rainfall recorded in last 24 hours and Maximum & Minimum Temperature Departures from Normal Temperature.

Main weather observations

♦ Rainfall recorded (from 0830 hours IST of yesterday to 0830 hours IST of today):

♦ At a few places over Andaman & Nicobar Islands and at isolated places over Assam and Arunachal Pradesh.

Amount of rainfall (1cm or more) are; Long-Islands-2 and Mayabander-1.

♦ **Maximum temperature departures as on 15-01-2018:** Maximum temperatures were **markedly above normal (5.1°C or more)** at many places over Jammu & Kashmir; **appreciably above normal (3.1°c to 5.0°c)** at most places over West Rajasthan & Rayalaseema; at a few places over Coastal Andhra Pradesh & Telangana; **above normal (1.6°C to 3.0°C)** at most places over Punjab, Haryana, Chandigarh & Delhi, Saurashtra & Kutch, Vidarbha and Marathwada; at many places over Himachal Pradesh, East Rajasthan, Konkan & Goa and Jharkhand; at a few places over Madhya Pradesh, Gujarat Region, Madhya Maharashtra, Tamilnadu & Puducherry and Interior Karnataka; at isolated places over Assam & Meghalaya and Odisha. They were **markedly below normal (-5.1°C or less)** at most places over East Uttar Pradesh and Bihar; at a few places over West Uttar Pradesh; **appreciably below normal (-3.1°c to -5.0°c)** at many places over West Bengal & Sikkim; at isolated places over Nagaland, Manipur, Mizoram & Tripura. **Yesterday, the lowest maximum temperature of 11.7°C** was recorded at **Gorakhpur (East Uttar Pradesh)** in the plains of the country.

♦ **Minimum temperature departures as on 16-01-2018**: Minimum temperatures are **appreciably below normal (-3.1°C to -5.0°C**) at most places over Jharkhand; at many paces over Gangetic West Bengal and Odisha; **below normal (-1.6°C to -3.0°C)** at many places over Punjab and East Madhya Pradesh; at a few places over Haryana, Chandigarh & Delhi and at isolated places over Rajasthan, Uttar Pradesh and Chhattisgarh. They are **markedly above normal (5.1°C or more)** at many places over Gujarat; at a few places over Madhya Maharashtra; **appreciably above normal (3.1°C to 5.0°C)** at many places over Konkan & Goa; **above normal (1.6°C to 3.0°C)** at most places over Jammu & Kashmir; at many places over Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura and Coastal Andhra Pradesh and at isolated places over Himachal Pradesh and near normal over rest parts of the country. **The lowest minimum temperature of 0.0°C recorded at Sikar (East Rajasthan)** in the plains of the country.

- **Meteorological analysis:** This report is generated based on current set of observations taken from different weather stations. It provides the outlook of disturbances observed in weather condition. It is issued 4 times in a day.

Meteorological Analysis (Based on 0830 hours IST)

- Northeast monsoon rainfall has ceased over Tamilnadu & Puducherry, Kerala and adjoining parts of Andhra Pradesh and Karnataka from today, the 15th January 2018.
- The feeble trough over at mean sea level Equatorial Indian Ocean and adjoining southeast Bay of Bengal persists.
- The trough of low at mean sea level from Maldives area to north Maharashtra coast now runs from Maldives area to eastcentral Arabia Sea.
- The cyclonic circulation over southeast Bangladesh & neighbourhood persists and now extends upto 2.1 km above mean sea level.
- A fresh Western Disturbance is likely to affect Western Himalayan region from 17th January.

- **Weather forecast for next 5 days and subsequent 2 days:** This report provides the weather forecast for Next 5 days and subsequent 2 days which include rainfall, significant changes in maximum & minimum temperature from normal temperature, fog and thunderstorm etc.

Weather Forecast for next 5 days * upto 0830 hours IST of 22nd January 2018

- **Meteorological sub-division wise detailed 5 days precipitation forecast is given in Table.**
- Minimum temperatures are likely to fall by 2-3° C over parts of northwest & central India during next 3-4 days.
- **Shallow to moderate fog** during late night & morning hours very likely over parts of plains of northwest and eastern India during next 2 days.

Weather Outlook for subsequent 2 days from 22ndJanuary to 24th January 2018

- Rainfall at many places likely over Andaman & Nicobar Islands and at isolated places over southern most Peninsular India.
- An easterly-westerly interaction is likely to start, resulting in isolated rainfall over parts of western India on 22nd and at a few/many places over northwest India on 23rd January.
- Weather likely to be dry over remaining parts of the country.

- **Weather warning for 5 days:** This section of the report provides weather warning for heat wave, cold wave, fog, snowfall, rainfall etc. for next 5 days.

Weather warning during next 5 days

16 January (Day 1):♦ **Dense to very dense fog** at many places very likely over Bihar and Sub-Himalayan West Bengal; at a few places over Punjab, Haryana, Chandigarh & Uttar Pradesh and at isolated places over Uttarakhand, Coastal Andhra Pradesh, Nagaland, Manipur, Mizoram & Tripura; **Dense fog** at isolated places over Himachal Pradesh and Assam & Meghalaya, ♦ **Cold Day to severe cold day conditions** at many places very likely over Bihar; at isolated places over East Uttar Pradesh and West Bengal ♦ **Cold wave** conditions at isolated places very likely over Punjab, Himachal Pradesh, Uttarakhand, north Rajasthan, East Uttar Pradesh, Jharkhand, Bihar, interior Odisha.♦ **Ground frost** conditions very likely at a few places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and at isolated places over East Uttar Pradesh and north Rajasthan.

17 January (Day 2):♦ **Dense to very dense fog** at many places very likely over Bihar and Sub-Himalayan West Bengal; at a few places over Punjab, Haryana, Chandigarh & Uttar Pradesh and at isolated places over Uttarakhand ,Nagaland, Manipur, Mizoram & Tripura; **Dense fog** at isolated places over Himachal Pradesh and Assam & Meghalaya and Coastal Andhra Pradesh ♦ **Cold Day to severe cold day conditions** at many places very likely over Bihar; at isolated places over East Uttar Pradesh, Sub-Himalayan West Bengal ♦ **Cold wave** conditions at isolated places very likely over Himachal Pradesh, Uttarakhand, Punjab, north Rajasthan East Uttar Pradesh, Jharkhand, Bihar, interior Odisha♦ **Ground frost conditions** very likely at a few places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and at isolated places over East Uttar Pradesh and north Rajasthan.

18 January (Day 3):♦ **Dense to very dense fog** at a few places very likely over East Uttar Pradesh, Bihar and Sub-Himalayan West Bengal; at isolated places over Uttrakhand and **dense fog** at isolated places over Assam & Meghalaya and Nagaland, Manipur, Mizoram & Tripura, West Uttar Pradesh, Himachal Pradesh and Punjab ♦ **Cold Day to severe cold day conditions** at a few places very likely over Bihar **and** at isolated places over East Uttar Pradesh♦ **Cold wave to severe cold wave conditions** at a few places very likely over Punjab and north Rajasthan and at isolated places over Himachal Pradesh, Uttarakhand; **Cold wave** conditions very likely at isolated places over Jammu & Kashmir, Haryana, Chandigarh, Uttar Pradesh, Jharkhand, Bihar and interior Odisha♦ **Ground frost conditions** very likely at a few places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and at isolated places over East Uttar Pradesh Punjab, Haryana and north Rajasthan.

19 January (Day 4):♦ **Dense to very dense fog** at a few places very likely over Bihar and Sub-Himalayan West Bengal; at isolated places over East Uttar Pradesh Uttrakhand and **dense fog** at isolated places over Assam & Meghalaya and Nagaland, Manipur, Mizoram & Tripura,♦ **Cold Day to severe cold day conditions** at a few places very likely over Bihar **and** at isolated places over East Uttar Pradesh♦ **Cold wave to severe cold wave conditions** at a few places very likely over Punjab and north Rajasthan and at isolated places over Himachal Pradesh, Uttarakhand; **Cold wave** conditions very likely at isolated places over Jammu & Kashmir, Haryana, Chandigarh, Uttar Pradesh, Jharkhand, Bihar and interior Odisha♦ **Ground frost conditions** very likely at a few places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and at isolated places over East Uttar Pradesh Punjab, Haryana and north Rajasthan.

20 January (Day 5):♦ **Dense to very dense fog** at a few places very likely over Bihar and Sub-Himalayan West Bengal; at isolated places over East Uttar Pradesh Uttrakhand and **dense fog** at isolated places over Assam & Meghalaya and Nagaland, Manipur, Mizoram & Tripura.

- **Met Sub division wise rainfall forecast:** This section of the report provides Met Subdivision (State) wise rainfall forecast for the next 5 days.

Table-1

5 Day Rainfall Forecast (MID-DAY)

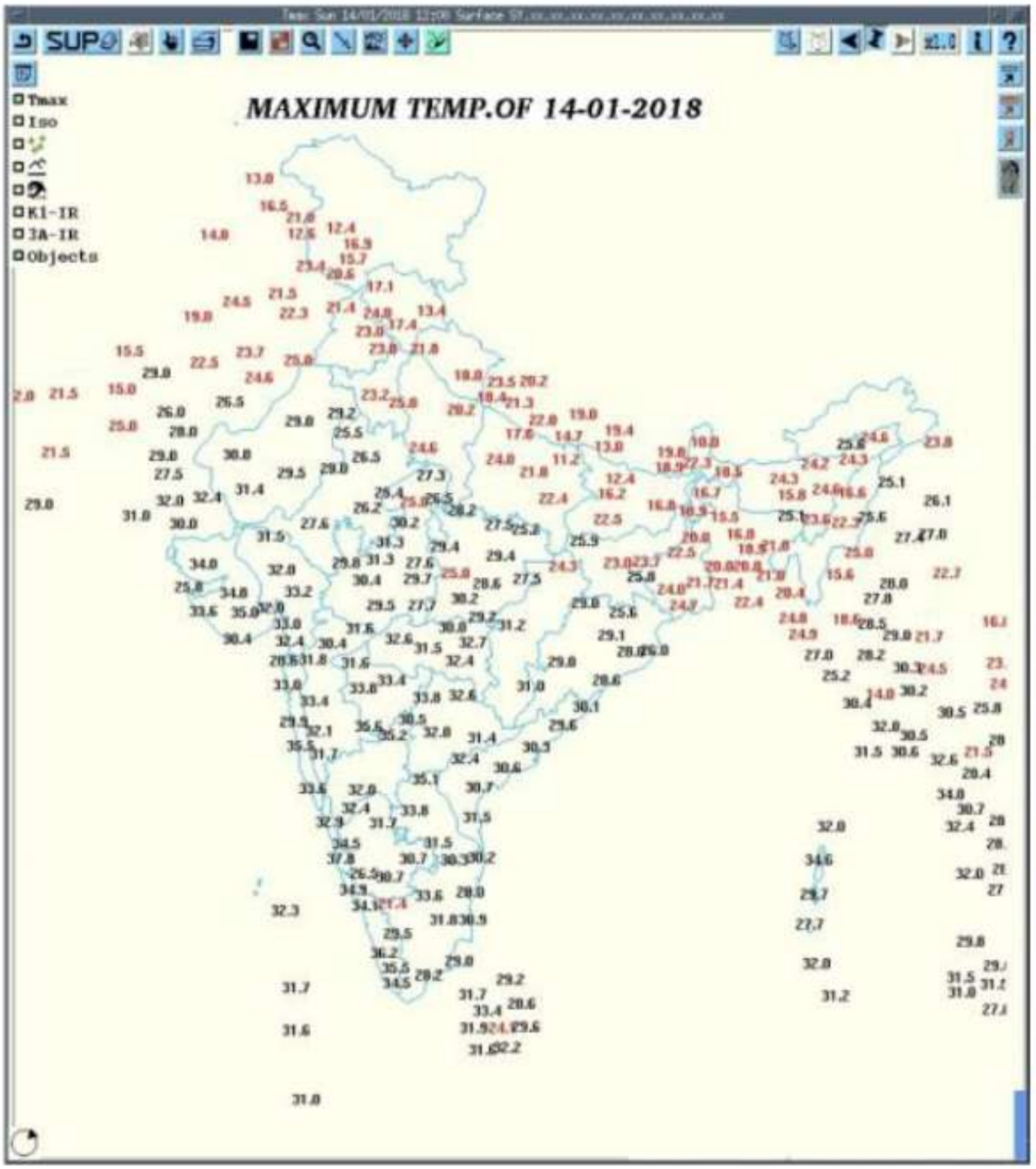
15-January-2018

Met-Sub-Division	15-Jan Today	16Jan Tue	17Jan Wed	18Jan Thu	19Jan Fri
1. Andaman & Nicobar Islands	ISOL	ISOL	SCT	SCT	SCT
2. Arunachal Pradesh	ISOL	DRY	DRY	DRY	DRY
3. Assam & Meghalaya	ISOL	DRY	DRY	DRY	DRY
4. N. M. M. & T.	DRY	DRY	DRY	DRY	DRY
5. S.H. West Bengal & Sikkim	ISOL	DRY	DRY	DRY	DRY
6. Gangetic West Bengal	DRY	DRY	DRY	DRY	DRY
7. Odisha	DRY	DRY	DRY	DRY	DRY
8. Jharkhand	DRY	DRY	DRY	DRY	DRY
9. Bihar	DRY	DRY	DRY	DRY	DRY
10. East Uttar Pradesh	DRY	DRY	DRY	DRY	DRY
11. West Uttar Pradesh	DRY	DRY	DRY	DRY	DRY
12. Uttarakhand	DRY	DRY	DRY	DRY	DRY
13. Haryana, Chd & Delhi	DRY	DRY	DRY	DRY	DRY
14. Punjab	DRY	DRY	DRY	DRY	DRY
15. Himachal Pradesh	DRY	DRY	ISOL	DRY	DRY
16. Jammu & Kashmir	DRY	DRY	ISOL	ISOL	DRY
17. West Rajsthan	DRY	DRY	DRY	DRY	DRY
18. East Rajasthan	DRY	DRY	DRY	DRY	DRY
19. West Madhya Pradesh	DRY	DRY	DRY	DRY	DRY
20. East Madhya Pradesh	DRY	DRY	DRY	DRY	DRY
21. Gujarat Region	DRY	DRY	DRY	DRY	DRY
22. Saurashtra & Kutch	DRY	DRY	DRY	DRY	DRY
23. Konkan & Goa	DRY	DRY	DRY	DRY	DRY
24. Madhya Maharashtra	DRY	DRY	DRY	DRY	DRY
25. Marathawada	DRY	DRY	DRY	DRY	DRY
26. Vidharbha	DRY	DRY	DRY	DRY	DRY
27. Chhattisgarh	DRY	DRY	DRY	DRY	DRY
28. Coastal Andhra Pradesh	DRY	DRY	DRY	DRY	DRY
29. Telangana	DRY	DRY	DRY	DRY	DRY
30. Rayalaseema	DRY	DRY	DRY	DRY	DRY
31. Tamilnadu & Puducherry	DRY	DRY	DRY	DRY	DRY
32. Coastal Karnataka	DRY	DRY	DRY	DRY	DRY
33. North Interior Karnataka	DRY	DRY	DRY	DRY	DRY
34. South Interior Karnataka	DRY	DRY	DRY	DRY	DRY
35. Kerala	DRY	DRY	DRY	DRY	DRY
36. Lakshadweep	DRY	DRY	DRY	DRY	DRY

% Station Reporting Rainfall

% Stations	Category	% Stations	Category
76-100	[illegible]	26-50	Scattered (SCT/ A Few Places)
51-75	Fairly Widespread (FWS/Many Places)	1-25	Isolated (ISOL)
No Rain	Dry		

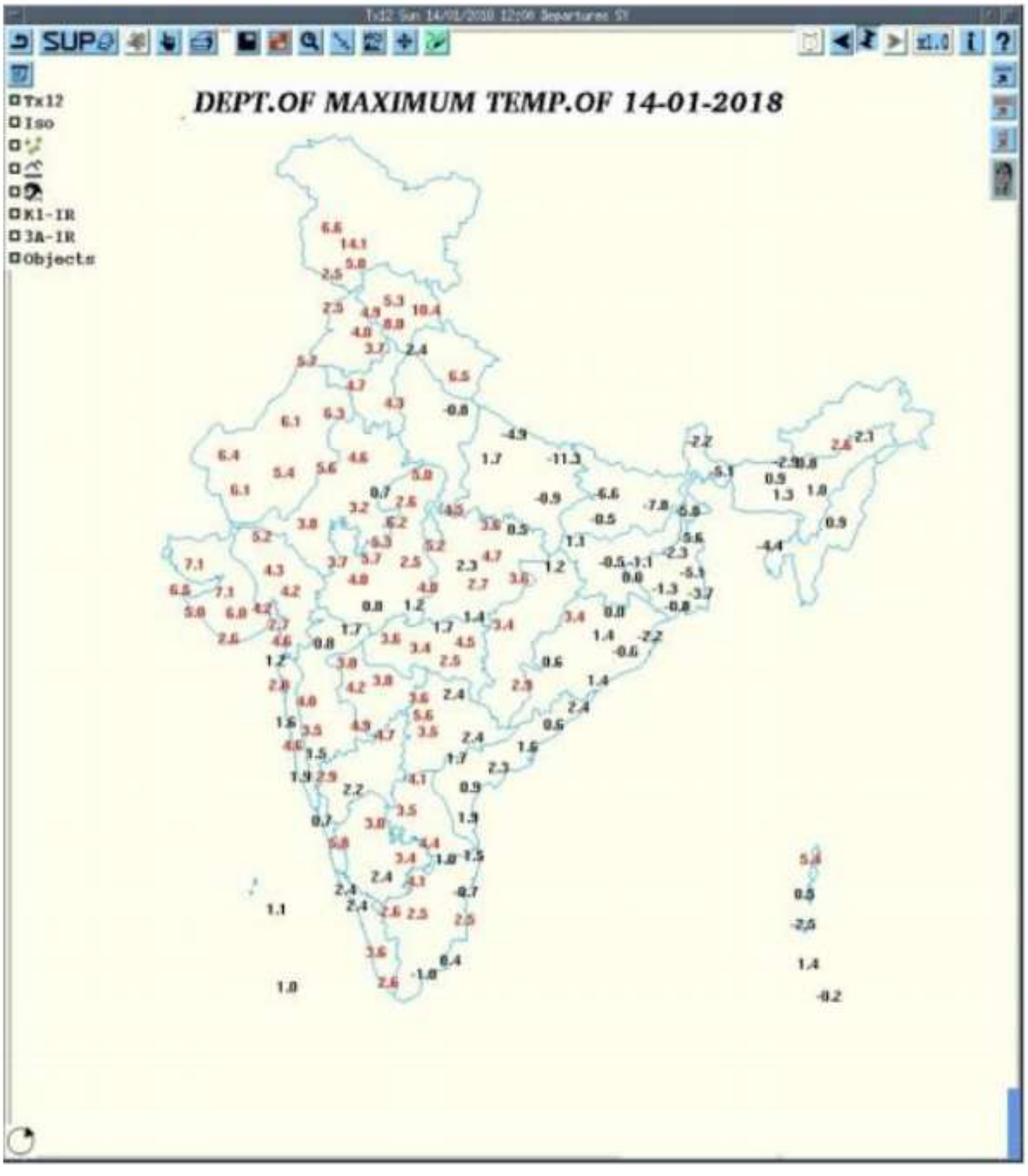
- **Maximum and Minimum Temperature in last 24 hours:** In this section of report maximum and minimum temperature in last 24 hours across the country are depicted. The colour code is used to distinguish the temperature from above the normal temperature or below the normal temperature.



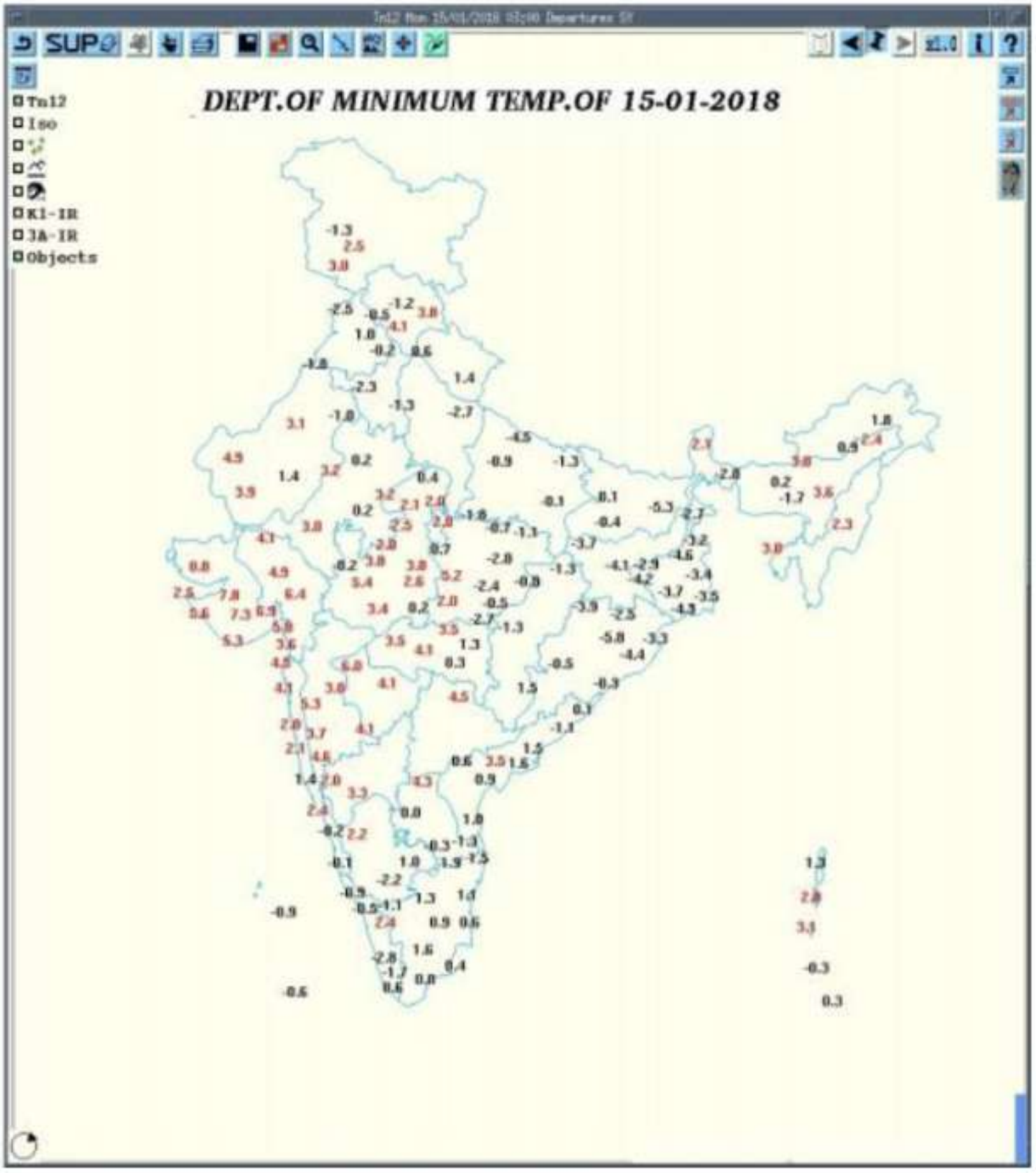
Above picture shows the Maximum Temp. in last 24 hours

Above picture shows the Minimum Temp. in last 24 hours

- **Departure of Maximum and Minimum Temperature from Normal Temperature:** In this section of report departure of maximum and minimum temperature from normal temperature in last 24 hours across the country are depicted. The colour code is used to distinguish the departure from normal temperature.



Above picture shows the departure from Maximum Temp. in last 24 hours.



Above picture shows the departure from Minimum Temp. in last 24 hours

4.3 All India Weather Warning

It provides weather warning for the next 6 days with colour code .The different colour coding, symbol representation and sample warming are shown below:

The symbol shown in above picure have following representation.

Heavy Rain	Heavy Snow	Thunderstorm	Dust Storm
Strong Winds	Visibility	Cyclone	Squall/ Hail
Frost	Cold Wave	Heat Wave	Sea State

The colours shown in above Image have following representation.

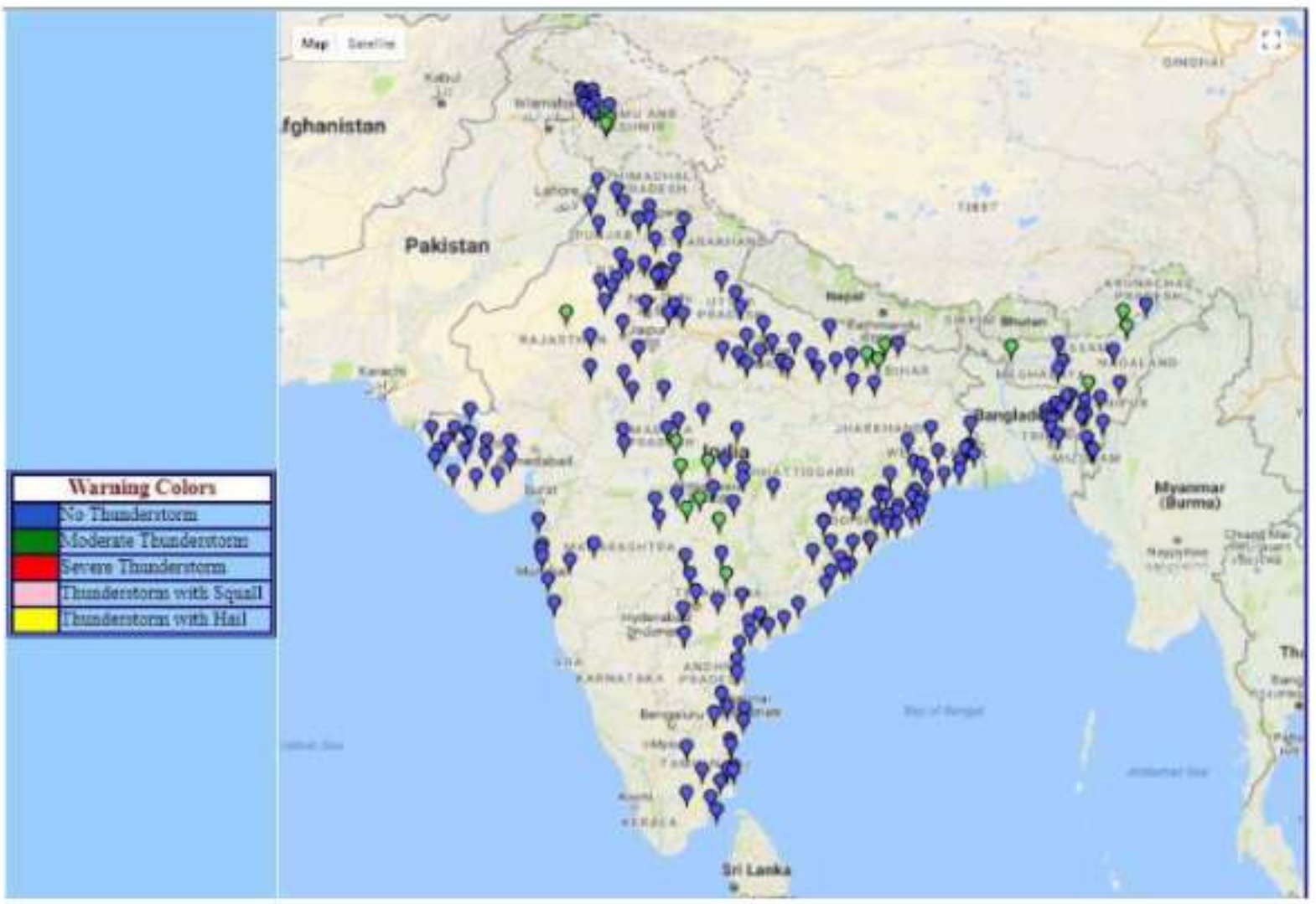
WARNING (TAKE ACTION)
ALERT (BE PREPARED)
WATCH (BE UPDATED)
NO WARNING (NO ACTION)

This report is also updated 4 times in a day.

Morning	:	0800 hrs	-	08:30 hrs
Mid-day	:	13:00 hrs	-	13:30 hrs
Evening	:	16:00 hrs	-	16:30 hrs
Night	:	20:00 hrs	-	20:30 hrs

4.4 Nowcast Warning

The current weather and forecasts upto a few hours ahead are given under Nowcast warning. The Nowcast warning is issued mainly for severe weather conditions such as squall, hailstorm and flash heavy rainfall for the next 2 to 3 hours based on WDSS II(Warning Decision Support System) and various DWR (Doppler weather Radar) product . This helps in estimating reduction in electricity demand in the concerned region.



Warning Colours:-

5. Satellite

Background: Space technology can be utilised for many applications in Power Sector such as sedimentation study, siltation analysis, real time water level observation of rivers, mapping of transmission assets on GPS platform, pollution mapping, time synchronisation of information, real time weather observations, forecasting & disaster management. In real time grid management, system operators are utilising the Satellite images for monitoring of fog, thunderstorm, cyclone movement and its intensity.

5.1 Satellite Meteorology: Satellite meteorology refers to the study of earth's atmosphere and oceans using data obtained from Remote sensing devices flown on-board satellites orbiting the earth. Satellite makes measurements indirectly by sensing electromagnetic radiations coming from the earth surface.

Types of Satellite: Two type of satellites are used for weather information:

- **Geostationary Satellite**: Satellites in this orbit are called geostationary because they are stationary with respect to the earth and appear to be fixed in the sky. It revolves around the earth at about 36000 km above the equator.
- **Polar Orbiting Satellite**: These satellites revolve around earth from pole to pole or in inclined plane to cover the area of interest or more area of the globe. It revolves around the earth at about 879 km above the earth.

Satellite is the one of the most important tool to monitor the development, intensification and movement of Tropical Cyclone when it is in the deep sea. IMD monitors Tropical Cyclone through INSAT 3D, INSAT 3DR and Kalpana-1. The image is updated every 30 minutes.

The upwelling radiation sensed by a satellite sensor is governed by emission from the earth's surface transmitted through the atmosphere and emission from the atmospheric layers transmitted through the outer layers of the atmosphere.

INSAT-3D Imager: INSAT-3D carries a multi-spectral Imager (optical radiometer) capable of generating the images of the earth in six wavelength bands significant for meteorological observations, namely, visible, shortwave infrared, middle infrared, water vapour and two bands in thermal infrared regions, offering an improved 1 km resolution in the visible band for the monitoring

of mesoscale phenomena and severe local storms. The two new SWIR and MWIR bands with a resolution of 1 km and 4 km, respectively, enables better land-cloud discrimination and detection of surface features like snow image etc. Various bands and their specifications are enumerated below:

Spectral Band	**Wave length**	**Ground Resolution**
VIS (Visual)	0.55 – 0.75	1 km
SWIR (Shortwave Infrared)	1.55-1.70	1 km
MIR (Mid Infrared)	3.80-4.00	4 km
WVP (Water Vapour)	6.50-7.10	8 km
TIR 1 (Thermal Infrared 1)	10.3-11.3	4 km
TIR 2 (Thermal Infrared 2)	11.5 – 12.5	4 km

The Imager generates images of the Earth disk from geostationary altitude of 36,000 km every 26 minutes and provides different types of Geophysical parameter products such as atmospheric motion vector winds, outgoing long wave radiation (OLR), upper troposphere humidity (UTH), sea surface temperature (SST), quantitative precipitation estimates (QPE), fire, smoke, fog, snow cover and aerosols.

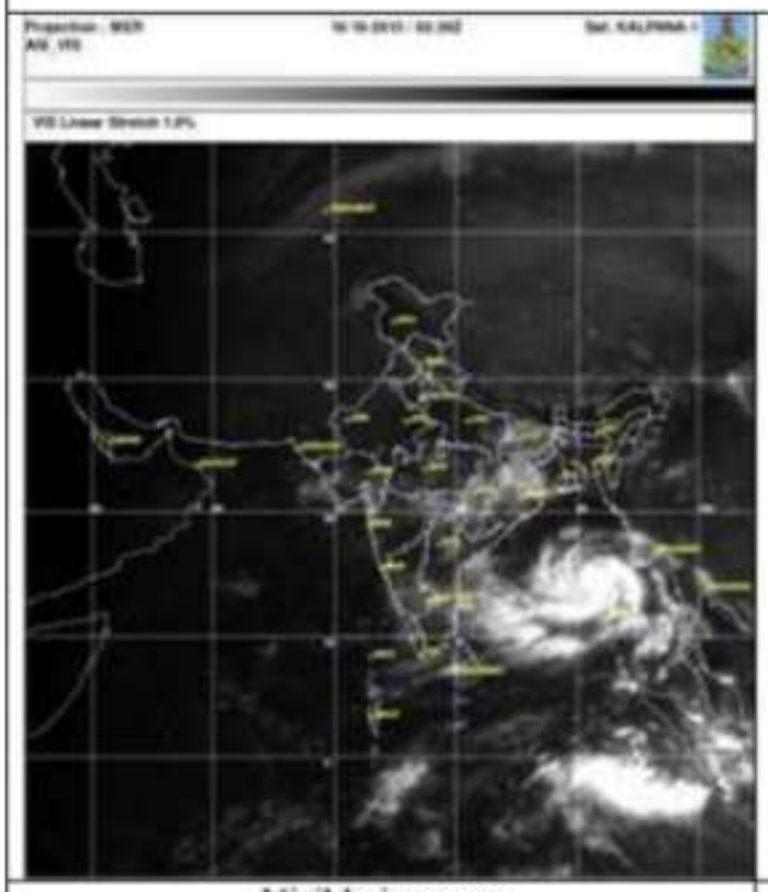
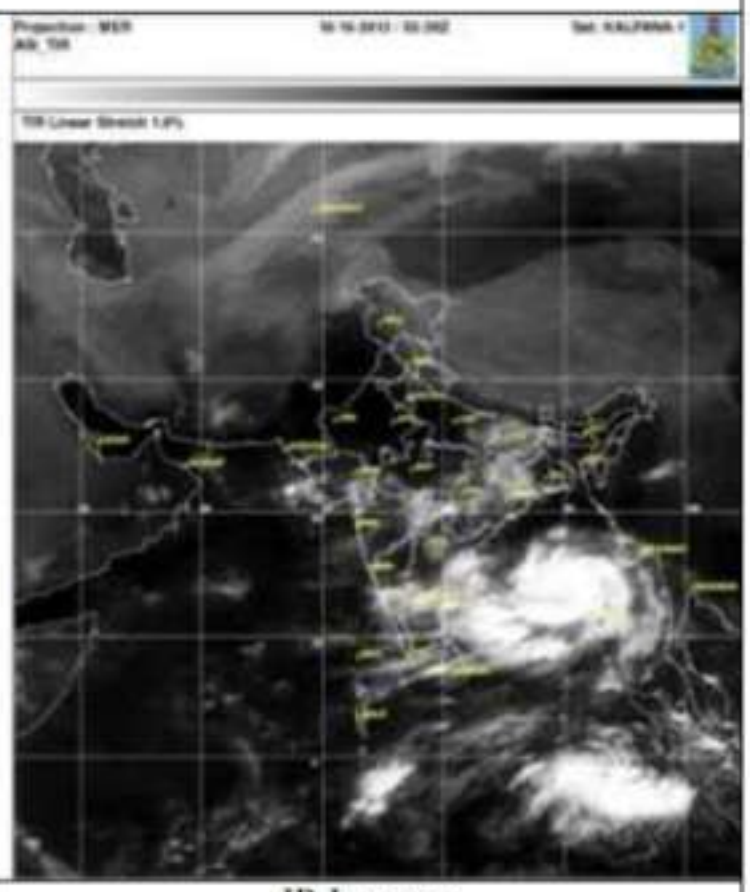
INSAT-3D carries a newly developed 19 channel sounder, which is a first such payload to be flown on an ISRO satellite mission. The Sounder has eighteen narrow spectral channels in shortwave infrared, middle infrared and long wave infrared regions and one channel in the visible region. The ground resolution at nadir is nominally 10 x 10 km for all nineteen channels. The specification of Sounder is as follows.

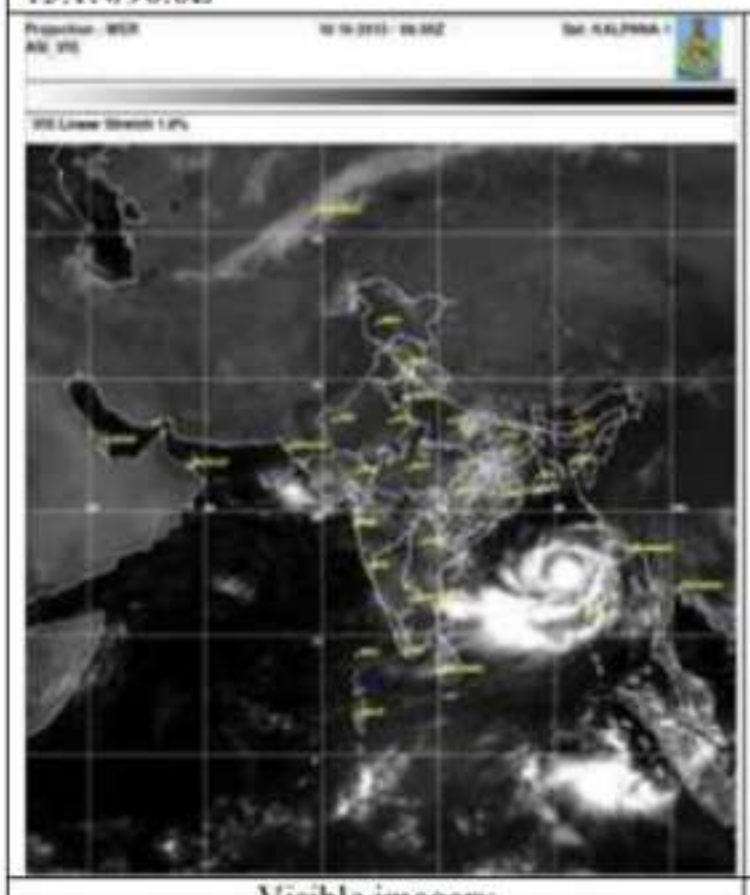
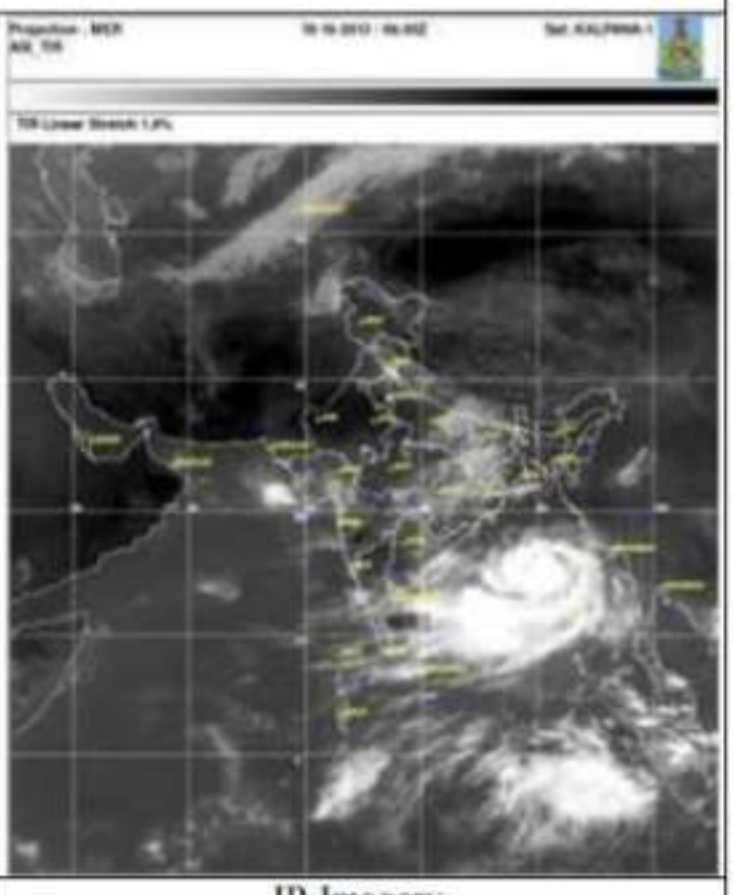
Spectral Band	**Spectral Range Microns**	**Ground Resolution**
VISIBLE	067-0.72	10 km x 10 km
SWIR	3.67-4.59	10 km x 10 km
MIR	6.38-11.33	10 km x 10 km
LWIR	11.66-14.85	10 km x 10 km

Geophysical parameters available from Sounder are temperature, humidity profile and ozone, layer perceptible water, total perceptible water, lifted index, wind index etc. These profiles are available for a selected region over Indian landmass on an hourly basis and for the entire Indian Ocean Region on a six hourly basis.

5.2 Visible Imagery: The visible channel of the satellite measures light using the same wavelengths as visible to the human eye. In other words, looking at a visible satellite picture is the same as if an astronaut took a photo of the clouds. **Objects with higher albedo (ability to reflect sunlight) appear brighter on the satellite image. Objects with lower albedo appear dark on the satellite image**. Cloud free land and water will typically be dark while clouds and snow appear bright. Thicker clouds have a higher reflectivity and appear brighter than thinner clouds. However, it is difficult to distinguish among low and high level clouds in a visible satellite image. Visible satellite image is available only during the day time. Visible Satellite images can be utilized for snow cover, fog, thunderstorms etc.

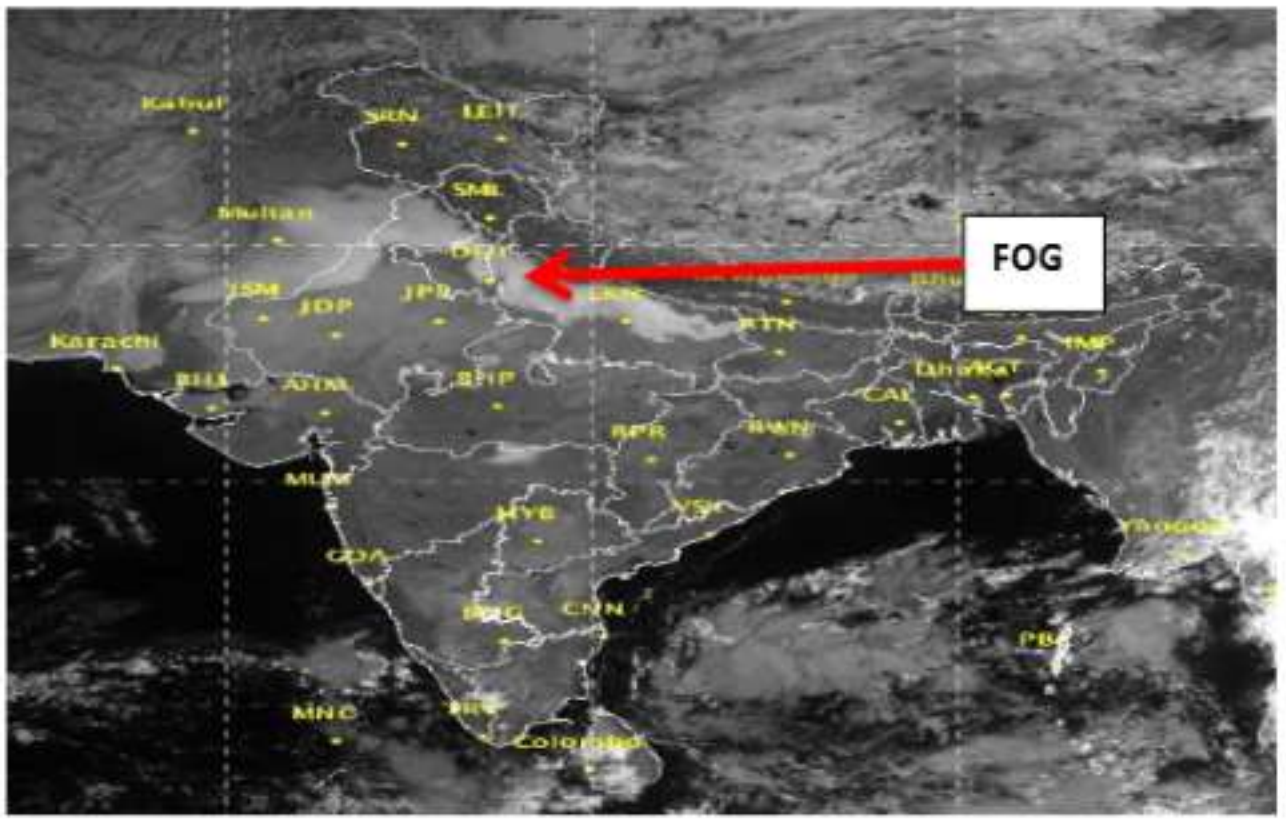
5.3 Infrared Satellite Image: Infrared satellite measures radiation output from the earth into space. In other words, it measures temperature and one can infer clouds based on the different temperatures being measured. **The colder an item is, such as a high cloud or a cold air mass, the brighter it is. The warmer an item is, such as a warm lake or clouds near the ground, the darker it is. It can be used for Night time satellite pictures, cyclone development, fog etc. Most of the derived products are obtained from IR image.**

Intensification into Severe Cyclonic Storm (T3.5), 0230 UTC 10.10.2013, Centre 14.7N/91.1E	
	
Visible imagery	IR Imagery

Intensification in Very Severe Cyclonic Storm (T4.0). 0600 UTC, 10.10.2013, Centre 15.1N/90.6E	
	
Visible imagery	IR Imagery

Typical sattelite Imageries in different stages of cyclone Phalin

5.4 SWIR (Shortwave Infra-Red images): Sensing in the shortwave infrared (SWIR) range (wavelengths from 0.9 to 1.7 microns) provides good picture of low clouds and fog. It is available during day time only.



5.5 Colour Composite Imagery: RGB composite images are produced by composing satellite images coloured in Red, Green and Blue (RGB). Two application specific RGB products Day Microphysics RGB, Night Microphysics RGB are generated by IMD by using data from INSAT-3D Imager.

a) Day Microphysics RGB Imagery

Channel combination "recipe" of the Day Microphysics RGB

- **RED beam** - The visible reflectance at 0.64 µm approximates the cloud optical depth (thickness) and amount of cloud water and ice. Typically, water cloud is more reflective than ice cloud and thus will have a stronger red beam component. This channel also gives information about the surface of the earth.
- **GREEN beam** – The 1.67 µm SWIR (shortwave infrared) solar reflectance gives a qualitative measure of cloud particle size and phase. Typically smaller water droplets or small ice particles have a higher reflectivity, resulting in a stronger green beam component. A sandy earth surface also has a strong reflectance in this channel.

- **BLUE beam** - The 10.8 μm TIR1 brightness temperature is a function of surface and cloud top brightness temperature (BT). The scaling for this beam results in a strong blue beam component for warm surfaces, whereas cold cloud tops will not have any contribution in this beam. This colour scheme is useful for cloud analysis, convection, fog, snow and fire.

Day time microphysics RGB scheme:

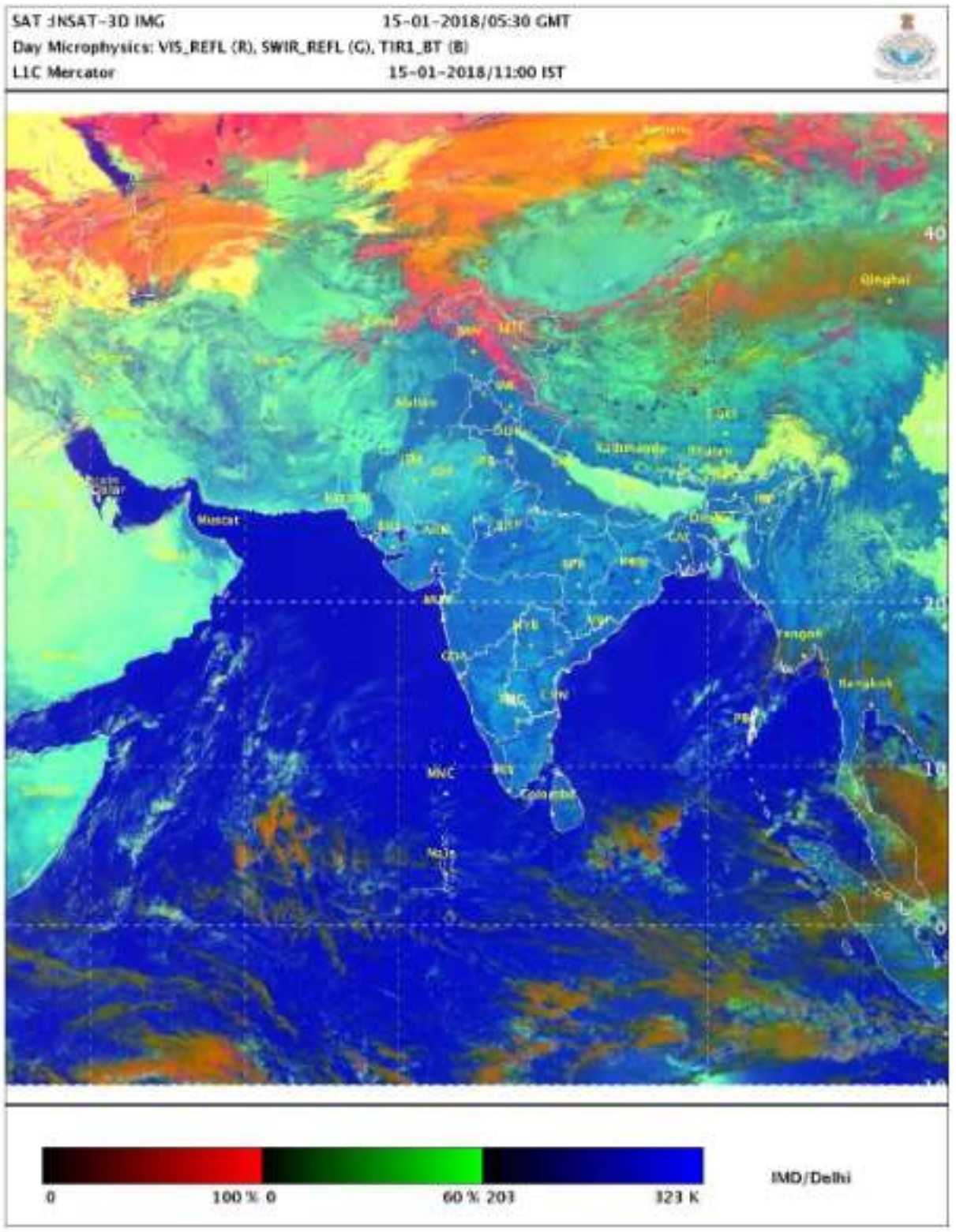
Beam	Channel	Range
Red	VIS (0.55to 0.75)	0...to +100%
Green	SWIR (1.67 um)	0...to +60%
Blue	IR (10.8 um)	+203...to 323degree Kelvin

This product is used during the daytime because a solar reflectance component is adopted. **Day time fog** can be viewed and analysed by visible imagery, SWIR imagery, Day-time Microphysics RGB Imagery. Fog will have a sharp boundary, while low clouds will have disperse boundary. In animation fog will remain stationary while low clouds will show some movement.

In day time micro physics RGB imagery **low clouds, medium clouds, snow and dust** would look as follows:

FOG	
LOW CLOUDS (Nearest to Satellite)	
MID LEVEL ORGAPHIC CLOUD	
CB CELL (Developed cloud)	
SNOW	
SAND /DUST	

Sample day time microphysics RGB image :



b) Night-time Microphysics RGB Imagery :

The Night Microphysics RGB product is designed and tuned for monitoring the evolution of night time fog and stratus clouds. Other secondary applications include detecting fires, classification of clouds in general, snow and low-level moisture boundaries. The distinction between low clouds and fog is often a challenge. While the difference in the TIR1 10.8μm and MIR 3.9μm channels is applied to meet this challenge, the Night time Microphysics RGB adds TIR2 12.0μm channel difference to indicate cloud thickness and enhance areas of warm clouds where fog is more likely.

Channel combination recipe of the Night Microphysics RGB

- **RED beam:** This channel gives an indication of optical depth. It uses TIR2 – TIR1. There is a strong signal in this beam for thick clouds. For thin meteorological cloud there is greater absorption by the "dirty window" 12 μm channel. In addition the 12 μm radiations are absorbed more strongly in ice phase cloud compared to water phase clouds.
- **GREEN beam**: This channel is used in fog/low clouds detection method. It uses TIR1 – MIR. The 3.9 μm radiation has lower emissivity compared to the 10.8 μm radiation for small water droplet clouds. Therefore there is a large contribution to the green beam in this RGB product for water clouds with small droplets. There is also a significant contribution from desert surfaces.
- **BLUE beam**: The 10.8 μm infrared brightness temperature is a function of surface and cloud top temperatures. The scaling for this beam results in a strong blue beam component for warm surfaces.

Night-time microphysics RGB scheme

Beam	Channel	Range
Red	IR12.0 μm - IR10.8 μm(TIR2)	-4 ... +2 K
Green	Green IR10.8 μm - IR3.9 μm (TIR1-MIR)	-4 ... +6 K
Blue	IR10.8 μm (TIR1)	+243 ... +293 K

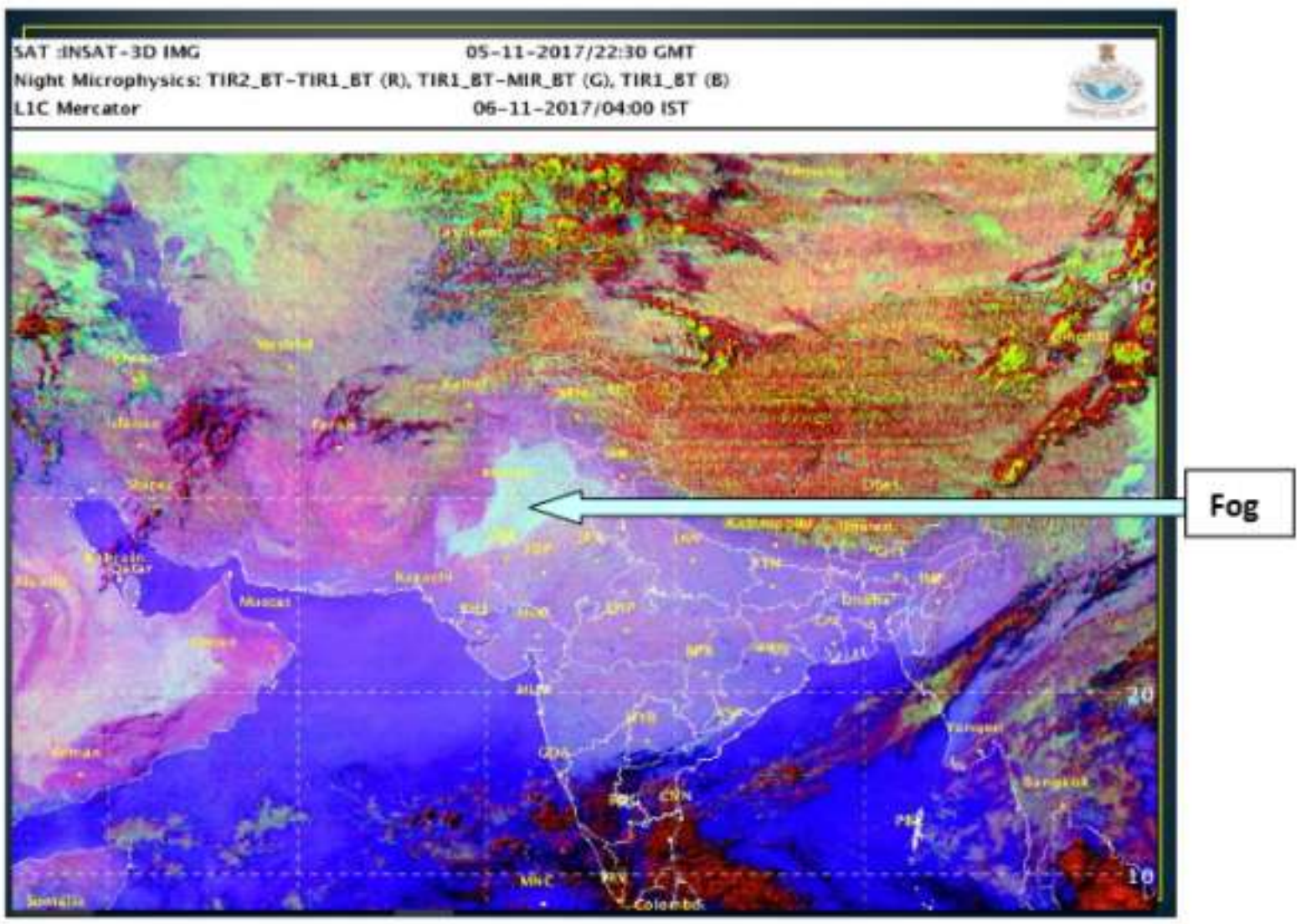
Fog can also be detected through Night-time Microphysics RGB Imagery. Fog and low clouds in warm climates tend to have aqua or light blue areas in the RGB. This appears very light green in colder climates because the 10.8 μm thermal channel used for the blue band contributes less.

The 3.9 μm channel is subject to noise at very cold temperatures. Fog at high latitudes in winter may have noise in the pixels representing fog. Similarly, the depiction of very high, cold clouds (i.e. cumulonimbus tops) will have yellow pixels mixed in areas of dark red for this RGB due to the 3.9 μm channel noise at such temperatures.

In night time microphysics RGB imagery, **Low clouds, medium clouds, Snow and dust** would look as follows :

FOG	
LOW CLOUDS (Nearest to Satellite)	
MID LEVEL ORGAPHIC CLOUD	
CB CELL (Developed cloud)	
SNOW	
SAND /DUST	

Sample night time microphysics RGB image:



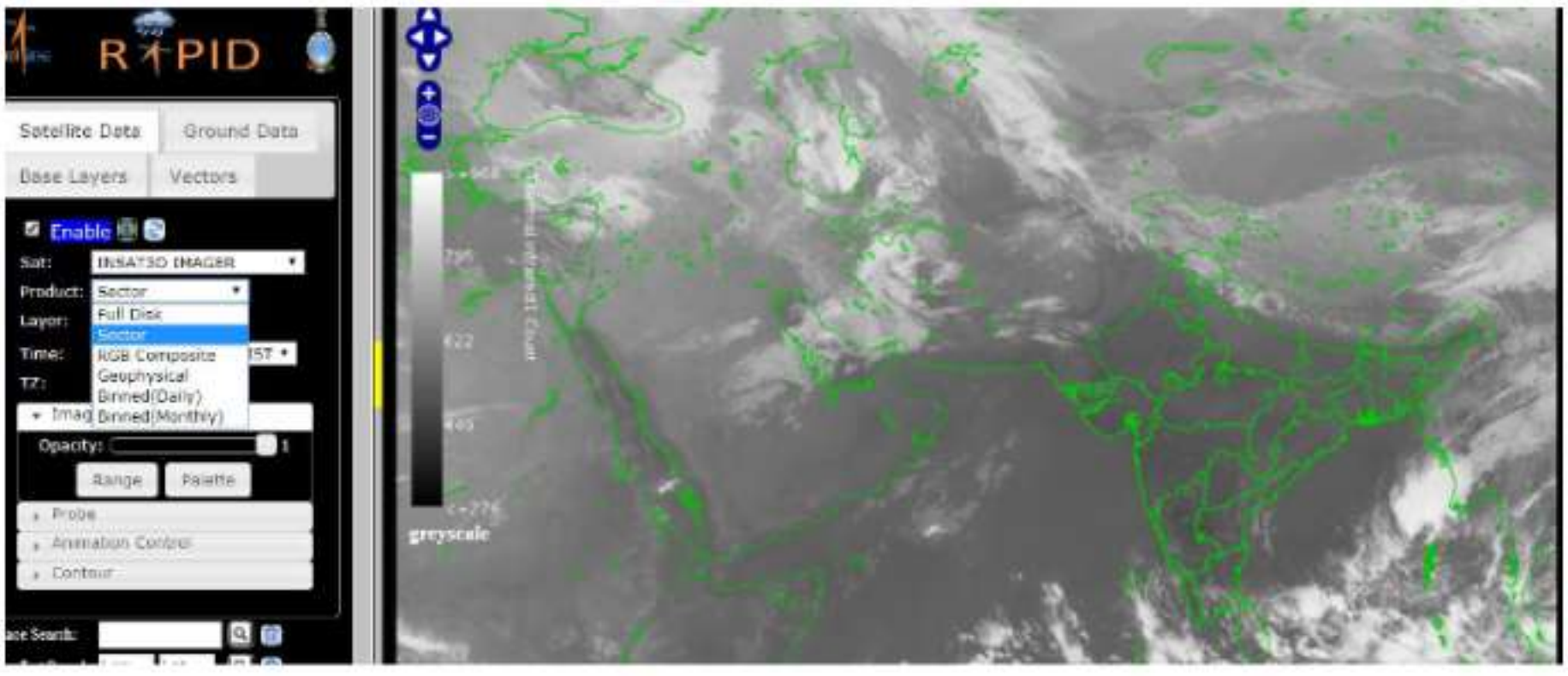
5.6 RAPID

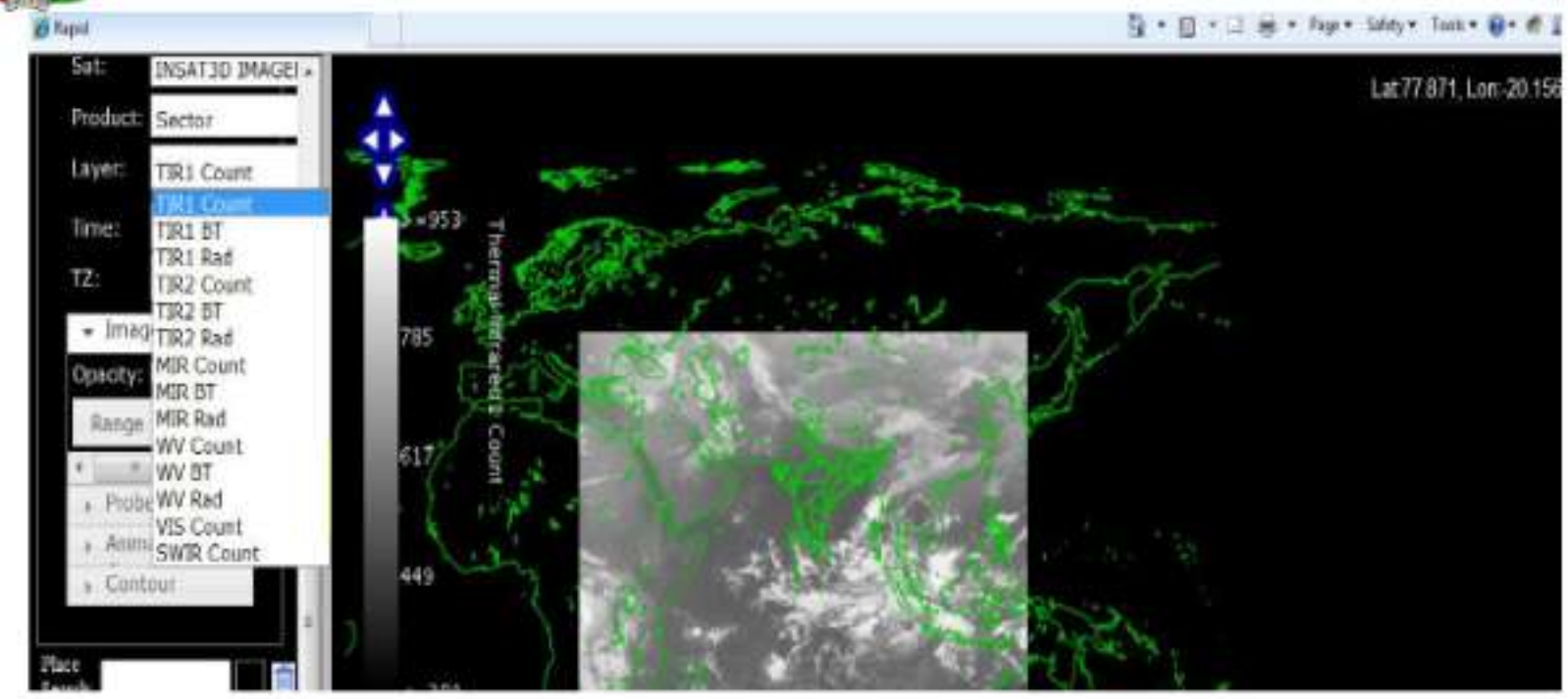
Real time Analysis of Products and Information Dissemination is a web based quick visualization and analysis tool for satellite data on a real time basis. This tool was conceptualized and developed by Satellite Application Centre (SAC), ISRO in consultation with India Meteorological Department (IMD), New Delhi to enhance the visualization and analysis of INSAT Meteorological Satellite data on real time basis by the forecasting community. Using RAPID one can interact like actual satellite workstation and may zoom to any actual resolution.

Data Selection Pane: This is the area where the user can select the data that is to be visualized. This has 4 main options viz. satellite data, ground data, base layers and vector. Using data selection pane and data viewer pane different Geo-Physical Parameters (GPR) derived from INSAT-3D Imager, INSTAT -3D Sounder. KALPANA-1 VHRR and INSAT -3D, IMD Nowcast can be selected and analysed such as Day Microphysics, Night Microphysics, Outgoing Long Wave Radiation, Upper Troposphere Humidity, Sea Surface Temperature, Land Surface Temperature(LST- satellite derived).IMSRA (INSAT Multi-Spectral Rainfall Algorithm), Global Precipitation Index (GPI), Aerosol Optical Depth(AOD), Snow, Lifted Index etc.

Full Disk: Shows the full disk scan image of the sensor of the satellite.

Sector: Shows India and adjacent portion.



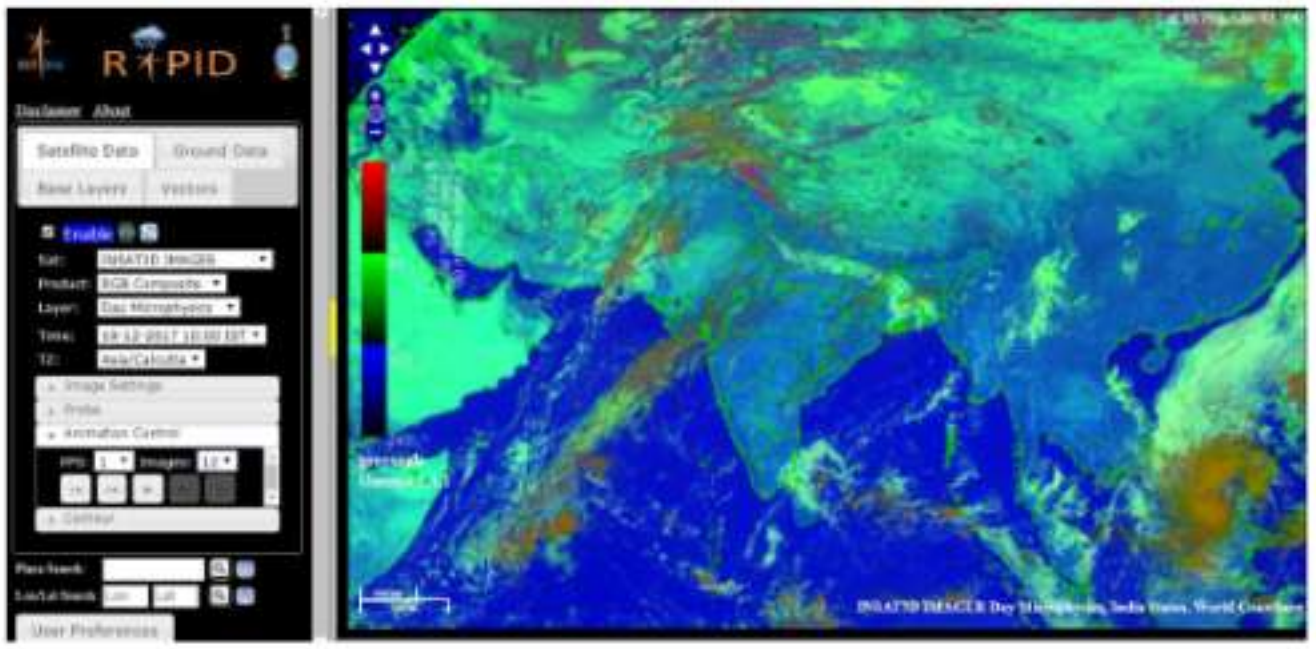


RGB Composite: This product would be useful for the system operator to see the past satellite images to estimate the movement of clouds, fog formation etc. To analyse RGB composite following selection is to be made:

IN SAT Option	: **INSAT 3D Imager**
In Products	: **RGB Composite**
In layer drop box	: **Select either Day Microphysics or Night Microphysics**
Time zone	: **Asia/Calcutta**

In animation control select number of frames and then run the program.

The RAPID software will play the selected number of frames. The operator can visualise the movement of clouds, cyclone, fog formation etc. using this feature.



(i) **If Day-time Microphysics** RGB is viewed and analysed through RAPID, the **fog** pixels value lies in the following range:

VIS albedo	25 to 50 %	
SWIR albedo	35 to 60%	
TIR 1	270 degree Kelvin to 290 degree Kelvin	

(ii) **If Day-time Microphysics** RGB is viewed and analysed through RAPID, the **low clouds** pixels value lies in the following range :

VIS albedo	30% to 45%	
SWIR albedo	40% to 60%	
TIR 1	255 degree Kelvin to 270 degree Kelvin	

(iii) **If Day-time Microphysics** RGB is viewed and analysed through RAPID, the **mid level orgaphic cloud** pixels value lies in the following range :

VIS albedo	30% to 50%	
SWIR albedo	40% to 60%	
TIR 1	245 degree Kelvin to 260 degree Kelvin	

(iv) **If Day-time Microphysics** RGB is viewed and analysed through RAPID, the developed **cloud** (which can bear rain) pixels values lies in the following range:

VIS albedo	>50 %	
SWIR albedo	<25%	
TIR 1	< 245 degree Kelvin	

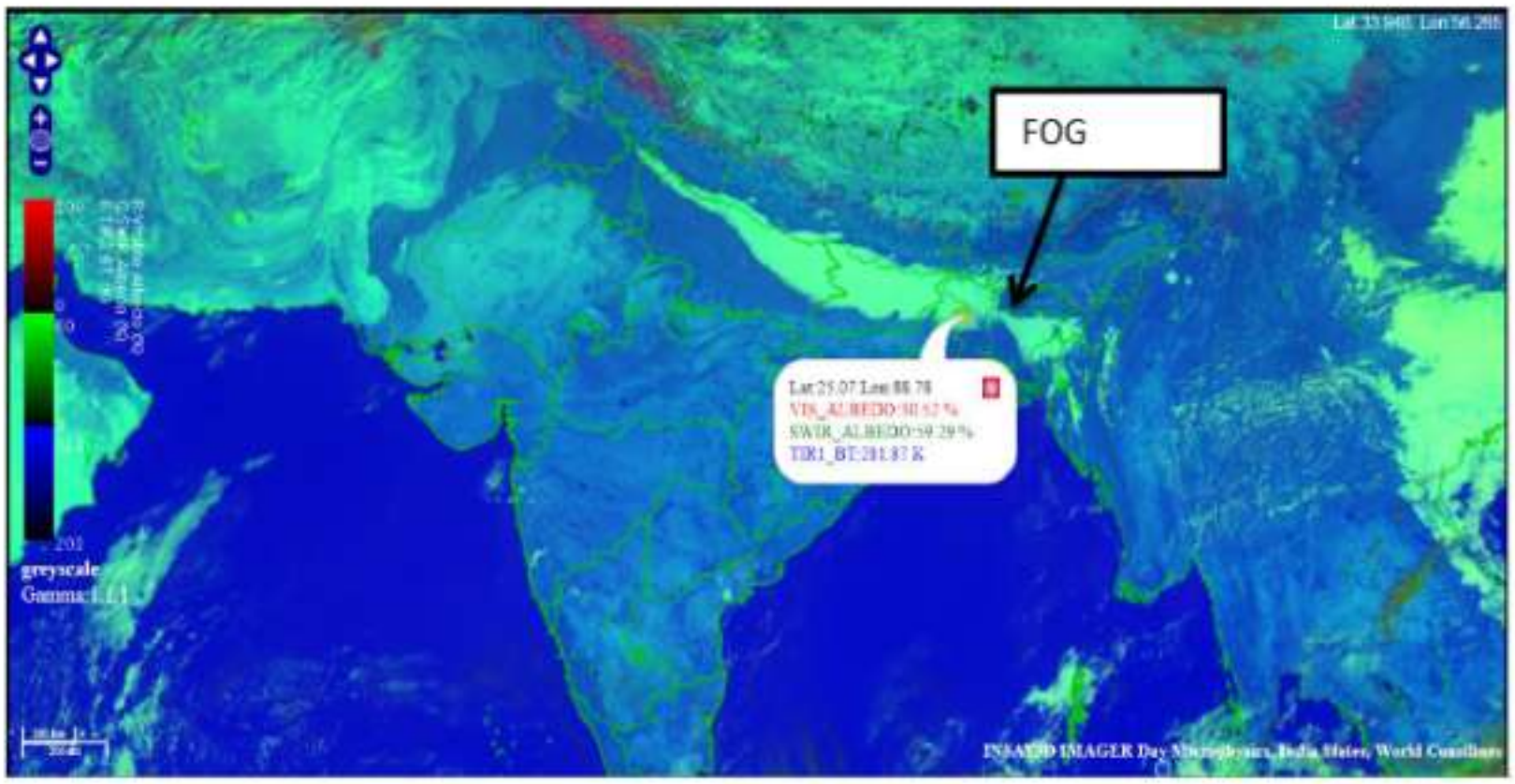
(v) **If Day-time Microphysics** RGB is viewed and analysed through RAPID, the **snow** pixels value lies in the following range :

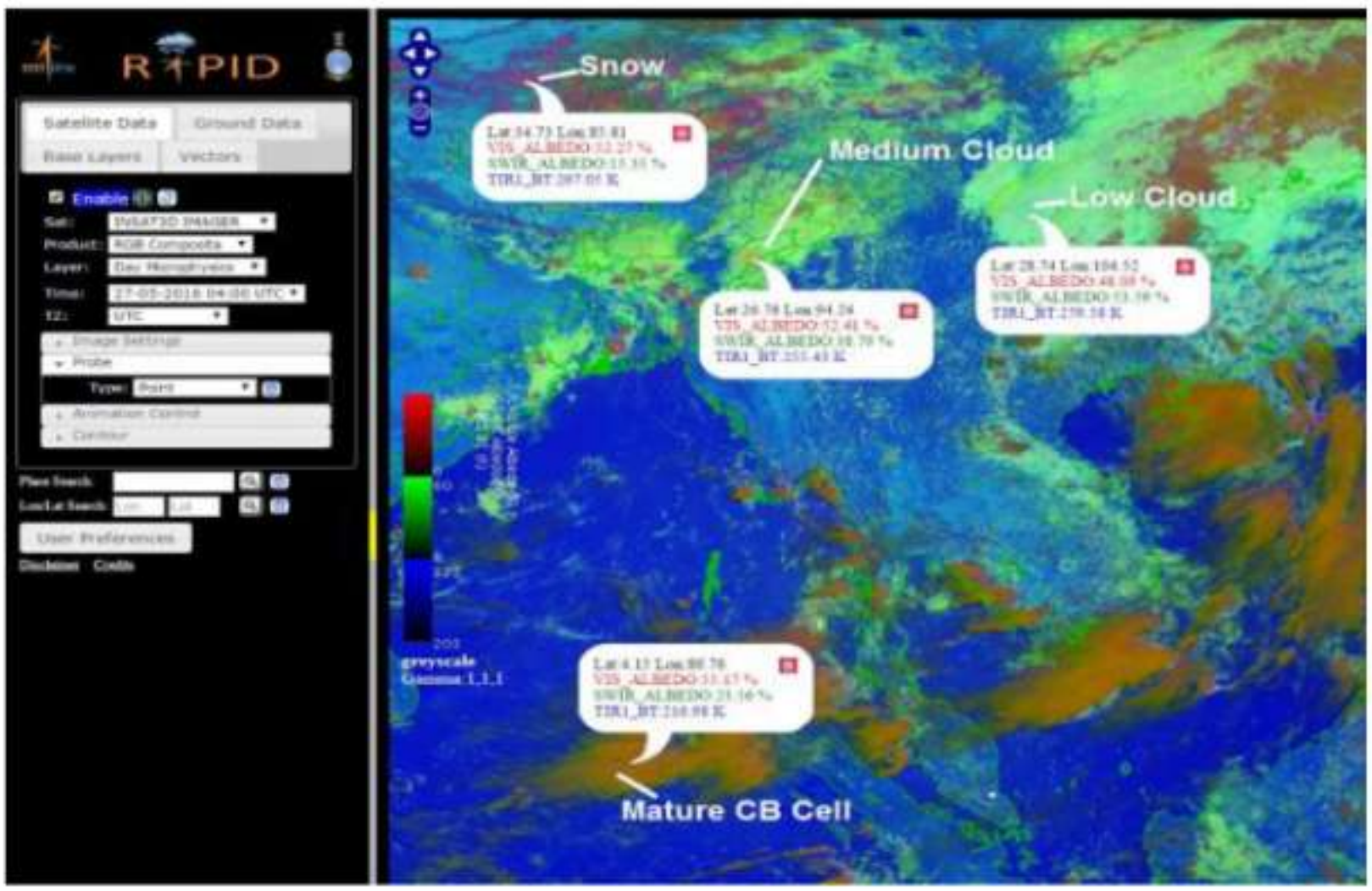
VIS albedo	>35%	
SWIR albedo	<20%	
TIR 1	260 degree Kelvin to 280 degree Kelvin	

(vi) **If Day-time Microphysics:** RGB is viewed and analysed through RAPID, the **sand/dust** pixels values lies in the following range:

	Sand	**Dust**	
VIS albedo	20% to 30%	20 to 30%	
SWIR albedo	40 % to 70%	30% to 40%	
TIR 1	290 degree Kelvin to 320 degree Kelvin	275 degree Kelvin to 295 degree Kelvin	

Visualisation of **fog, snow, low cloud, medium cloud and devloped cloud** on day time Microphysics RGB image using probe in **RAPID :**





(i) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the **fog** pixels value lies in the following range:

TR2BT-TR1BT	Negative	
TR!BT-MIRBT	>2.5 degree Kelvin	
TR1BT	270 degree Kelvin to 290 degree Kelvin	

(ii) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the **low clouds** pixels value lies in the following range:

TR2BT-TR1BT	Positive	
TR!BT-MIRBT	Positive	
TR1BT	250 degree Kelvin to 265 degree Kelvin	

(iii) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the **mid level clouds** pixels value lies in the following range:

TR2BT-TR1BT	Positive	
TR!BT-MIRBT	Positive	
TR1BT	245 degree Kelvin to 260 degree Kelvin	

(iv) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the developed **Cloud** pixels value lies in the following range:

TR2BT-TR1BT	Positive	
TR!BT-MIRBT	Negative	
TR1BT	<245 degree Kelvin	

(v) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the **snow** pixels value lies in the following range:

TR2BT-TR1BT	Negative	
TR!BT-MIRBT	Negative	
TR1BT	260 degree Kelvin to 290 degree Kelvin	

(vi) **If Night-time Microphysics** RGB is viewed and analysed through RAPID, the **sand/dust** pixels value lies in the following range:

	Sand	Dust	
TR2BT-TR1BT	Negative	Negative	
TR!BT-MIRBT	Negative	Negative	
TR1BT	280 degree to 290 degree Kelvin	275 degree to 285 degree Kelvin	

6. Region Specific Products

6.1 Regional Weather Summary (Outlook for the next few days): This forecast is being issued based on different types of chart analysis (surface chart, upper air chart and change chart), monitoring of satellite picture and with running of Numerical Weather Prediction (NWP) model. This section contains regional weather inference, expected change in temperature for the next 48 hours, Met Subdivision wise (State) rainfall forecast for the next 5 days and weather warning for heavy rainfall, fog, thunderstorm etc. It is updated 4 times in a day. The sample image of the regional weather summary is shown below:

REGIONAL METEOROLOGICAL CENTRE
NEW DELHI

DELHI REGIONAL MORNING INFERENCE DATED : 01/01/2018

REGIONAL INFERENCE

The western disturbance as a cyclonic circulation over north Pakistan and adjoining Jammu & Kashmir between 3.1 & 3.6 Km above mean sea level persists.The trough aloft with its axis at 5.8 km above mean sea level roughly along longitude 73.0°E and to the north of latitude 30.0°N persists. The upper air cyclonic circulation over Haryana & neighbourhood between 1.5 and 3.1 km above mean sea level persists. The cyclonic circulation over southwest Rajasthan & neighbourhood at 1.5 km above mean sea level persists. A fresh Western disturbance is likely to affect Western Himalayan regions from 4th January 2018.

FORECAST VALID FOR NEXT 05 DAYS

No significant change in minimum temperatures over northwest-India during next 48 hours and fall by 1-2 deg. Cel. thereafter.

FIVE DAYS RAINFALL FORECAST (FROM 05:30 HOURS OF 01/01/2018 TO 0830 HOURS OF 06/01/2018)

MET SUB DIVISIONS	01/01/2018	02/01/2018	03/01/2018	04/01/2018	05/01/2018
J&K	ISOL	DRY	DRY	ISOL	ISOL
HP	DRY	DRY	DRY	DRY	DRY
UTTARAKHAND	DRY	DRY	DRY	DRY	DRY
PUNJAB	DRY	DRY	DRY	DRY	DRY
HAR, CNG / DLH	DRY	DRY	DRY	DRY	DRY
WEST-U.P	DRY	DRY	DRY	DRY	DRY
EAST-U.P	DRY	DRY	DRY	DRY	DRY
WEST-RAJ	DRY	DRY	DRY	DRY	DRY
EAST-RAJ	DRY	DRY	DRY	DRY	DRY

LEGEND: NO RAIN (DRY), VERY LIGHT RAIN / MAINLY DRY (M.D.), 1-25 ISOLATED (ISOL), 26-50 SCATTERED / A FEW PLACES (SCT), 51-75 FAIRLY WIDESPREAD / MANY PLACES (FWS), 76-100 WIDESPREAD / MOST PLACES (WS).

OUTLOOK FOR THE REGION FOR SUBSEQUENT TWO DAYS (FROM 06/01/2018 TO 08/01/2018)

Weather is likely to be dry over Northwest-India.

WARNING

01/01/2018	DAY-1	Dense fog at many places with very dense fog at a few places over east- Uttar Pradesh. Dense fog at a few places with very dense fog at isolated places very likely over Punjab, Haryana, Chandigarh, Delhi and West-Uttar

6.2 Station/City wise local Weather Report and Forecast

Local weather report and forecast are available for important cities

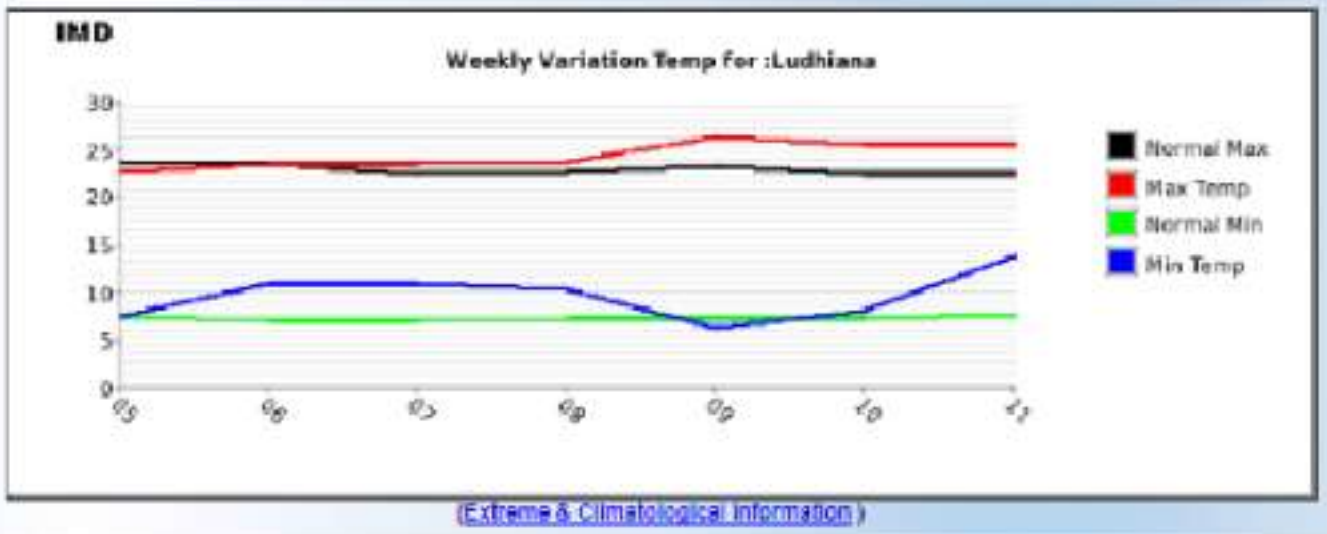
The city weather report consists of last 24 hours weather data (maximum/minimum temperature, departure from normal, rainfall, humidity, sunrise/moonrise and sunset/moonset time) and forecast for next 7 days. It is valid for a radius of 50 KM and is updated 4 times in a day. City wise local report and forecast have been mapped to the nearest electrical stations/power stations in each States.

Local Weather Report and Forecast For: Ludhiana Dated :Dec 11, 2017

Past 24 Hours Weather Data	
Maximum Temp(°C) (Recorded on 10/12/17)	25.6
Departure from Normal(°C)	3
Minimum Temp (°C) (Recorded on 11/12/17)	13.6
Departure from Normal(°C)	6
24 Hours Rainfall (mm) (Recorded from 0830 hrs IST of yesterday to 0830 hrs IST of today)	0.2
Relative Humidity at 0830 hrs (%)	76
Relative Humidity at 1730 hrs (%) (Recorded on 10/12/17)	43
Todays Sunset (IST)	17:25
Tommorows Sunrise (IST)	07:14
Moonset (IST)	13:23
Moonrise (IST)	00:41

7 Day's Forecast

Date	Min Temp	Max Temp	Weather	
11-Dec	14.0	23.0		Generally cloudy sky with possibility of rain or Thunderstorm or Duststorm
12-Dec	14.0	21.0		Generally cloudy sky with possibility of rain or Thunderstorm or Duststorm
13-Dec	15.0	22.0		Partly cloudy sky with possibility of rain or Thunderstorm or Duststorm
14-Dec	12.0	22.0		Partly cloudy sky with possibility of rain or Thunderstorm or Duststorm
15-Dec	11.0	23.0	FOG	Fog or Mist would occur in early morning
16-Dec	10.0	23.0	FOG	Fog or Mist
17-Dec	9.0	24.0	FOG	Fog or Mist



(Extreme & Climatological Information)

7. Doppler Weather Radar (DWR)

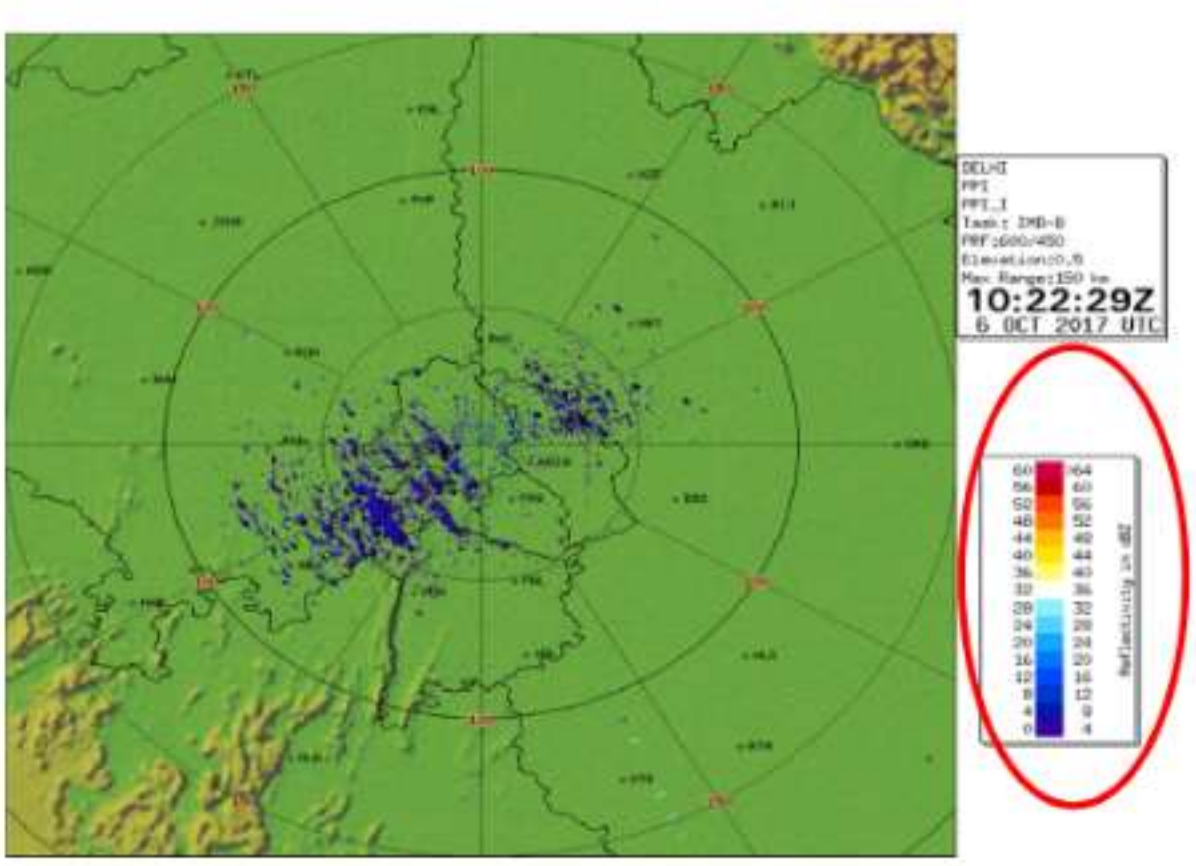
DWR is the best tool for Now casting. DWR is used to track Tropical Cyclone when it comes under DWR ranges. Thunderstorms/squalls are also tracked/forecasted by DWR.

- Radar transmitter transmits electromagnetic waves through a directional antenna in any given direction. Part of energy is absorbed by the atmosphere and fraction of it is scattered back by the targets and is received by the receiver. The received power depends upon the transmitted power, wavelength, vertical and horizontal beam width, scattering cross section of targets (rain drops, snow, hail etc.). Reflectivity is a measure of water content in the cloud.
- Return power provides information about weather intensity and azimuth and elevation of antenna gives location and height of cloud, time taken by electromagnetic waves in to and fro Journey gives range of the target.
- Doppler Weather Radar employs doppler principle to provide speed and direction of the targets. (When the source for signals and observers are in relative motion then there is change in frequency observed by the observer In case the source and the observer are moving closer, frequency increases and Vice Versa)
- **Reflectivity:** "Reflectivity" is the amount of transmitted power returned to the radar receiver. The colours on the legend are the different echo intensities (reflectivity) measured in dBZ, typically, light rain is occurring when the dBZ value reaches in between 20-35 dBZ, 35-40 dBZ moderate rain, 40-50 dBZ moderate to heavy rain, 50-55 dBZ heavy rain .Hail is a good reflector of energy and will return very high dBZ values i.e more than 55 dBZ.
- The Doppler Weather Radar generates Six (6) different displays and derived products of practical utility based on standard algorithms. Presently IMD radar at Mausam Bhawan has following elevation for scanning -0.5 degree, 1.0 degree, 2.0 degree, 3.0 degree, 6.0 degree, 9.0 degree, 12.0 degree, 16.0 degree & 21.0 degree. Radar completes the process of scanning with all these elevation and sends the data within 10 minutes. These displays are updated at every 10 minutes. The location and range of Radars are given below:

Region	No. of Radars	Location	Range (KM)
Northern Region	5	Delhi, Lucknow, Patiala, Srinagar and Jaipur	250 km except Srinagar (100 km)
Eastern Region	4	Kolkata,Patna &Paradip,Gopalpur	250 km
Western Region	5	Mumbai, Goa,Nagpur ,Bhopal , Bhuj	250 km
Southern Region	7	Chennai,Hyderabad,Kochi,Karaikal, Machilipatnam,Vishakhapatnam, Thiruvananthapuram	250 km
North Eastern Region	2	Agartala & Mohanbari	250 km

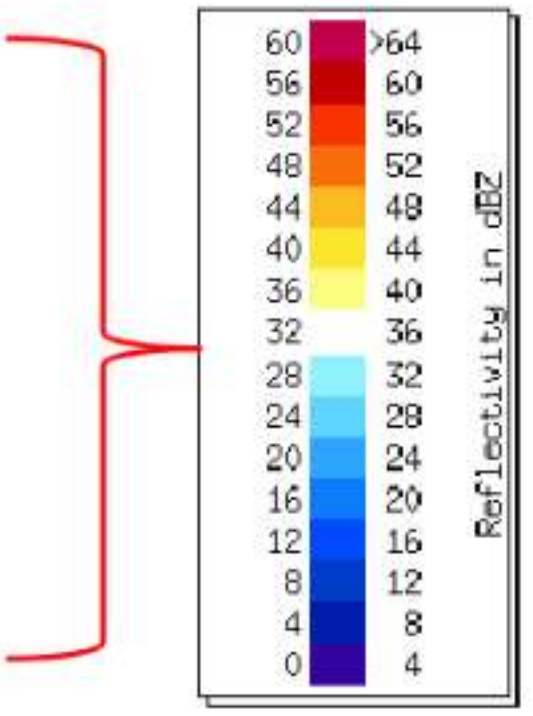
- **The Different Products of DWR are detailed below:**

(a) **Plan Position Indicator (PPI)** : A constant elevation surface data is presented as a cloud image around the Radar station. The data depicted is on the slant range depending on the elevation angle (generally 0.5 degree).

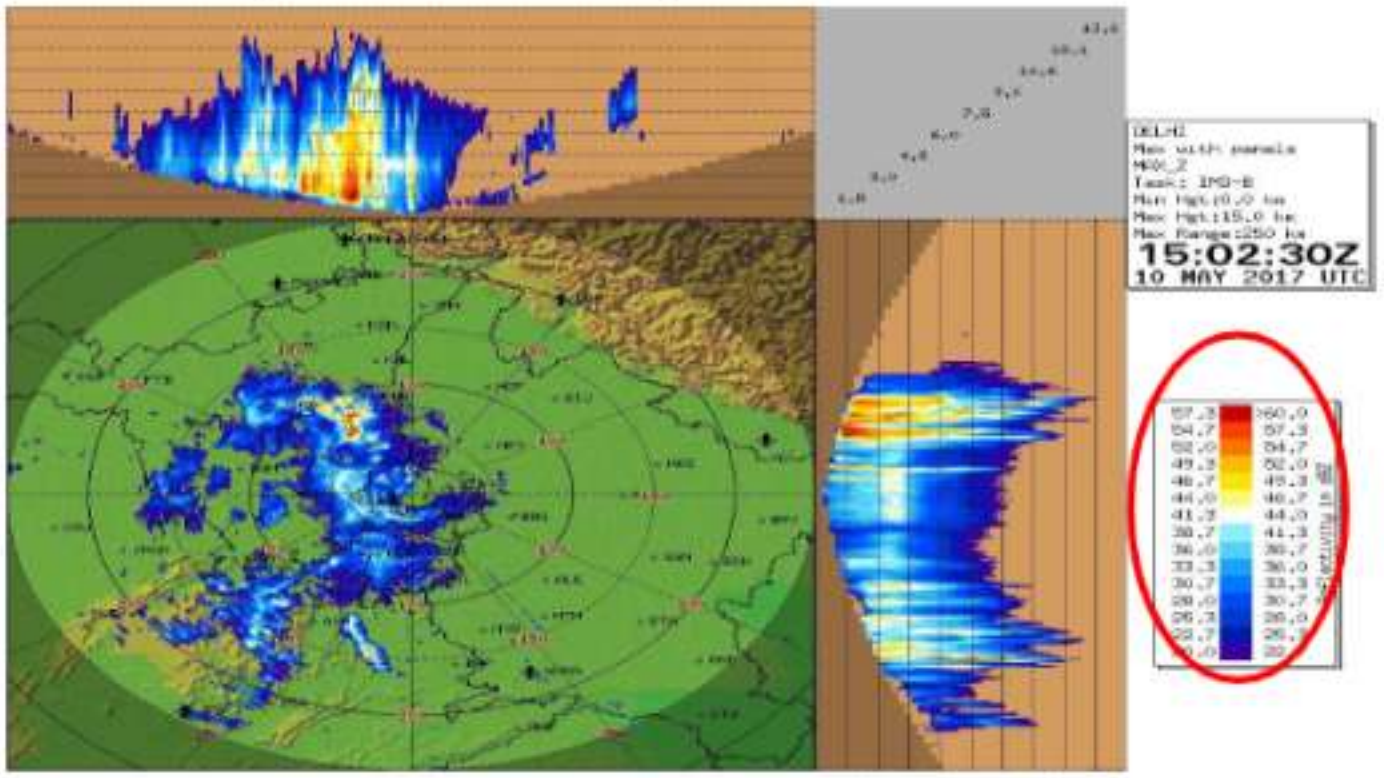


The interpretation of colour in the image can be derived from reflectivity scale shown in the image.

Light rain	: 20-35dBZ
Moderate rain	: 35-40dBZ
Moderate to heavy rain	: 40-50dBZ
Heavy rain	: 50-55dBZ
Hail	: more than 55 dbZ

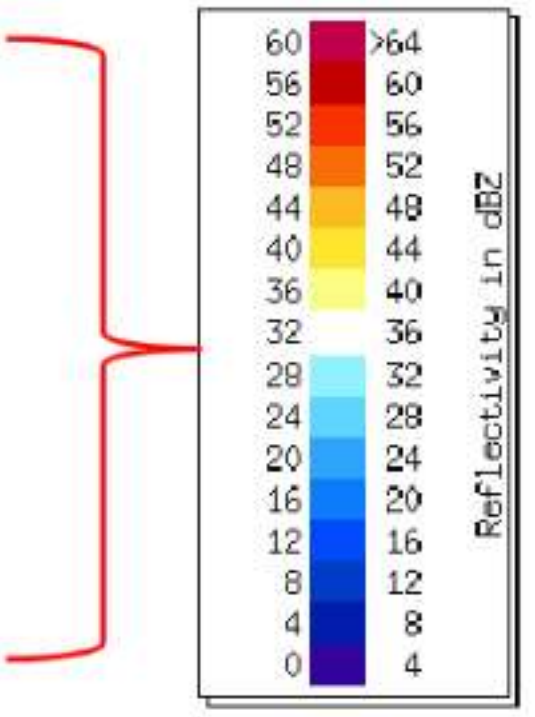


(b) Plan Position Indicator (Max-Z) : This product is used to see both the intensity of cloud as well as height of the cloud. According to colour of cloud in radar Image the reflectivity value can be estimated from the reflectivity scale. Its maximum range is 250 km. A display of cloud is generated for the range on the X-axis and height of the cloud surface on Y-axis.

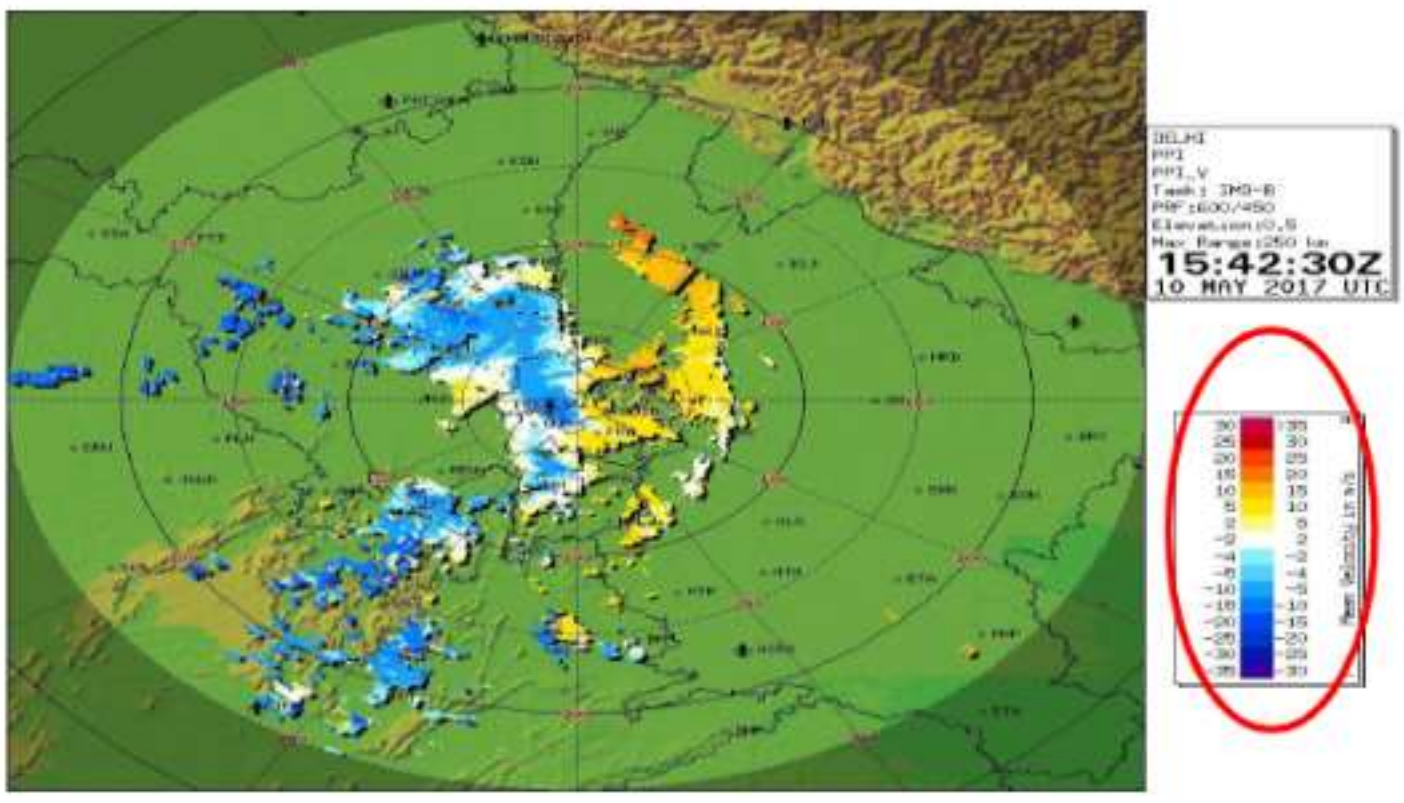


The interpretation of colour in the image can be derived from reflectivity scale shown in the image.

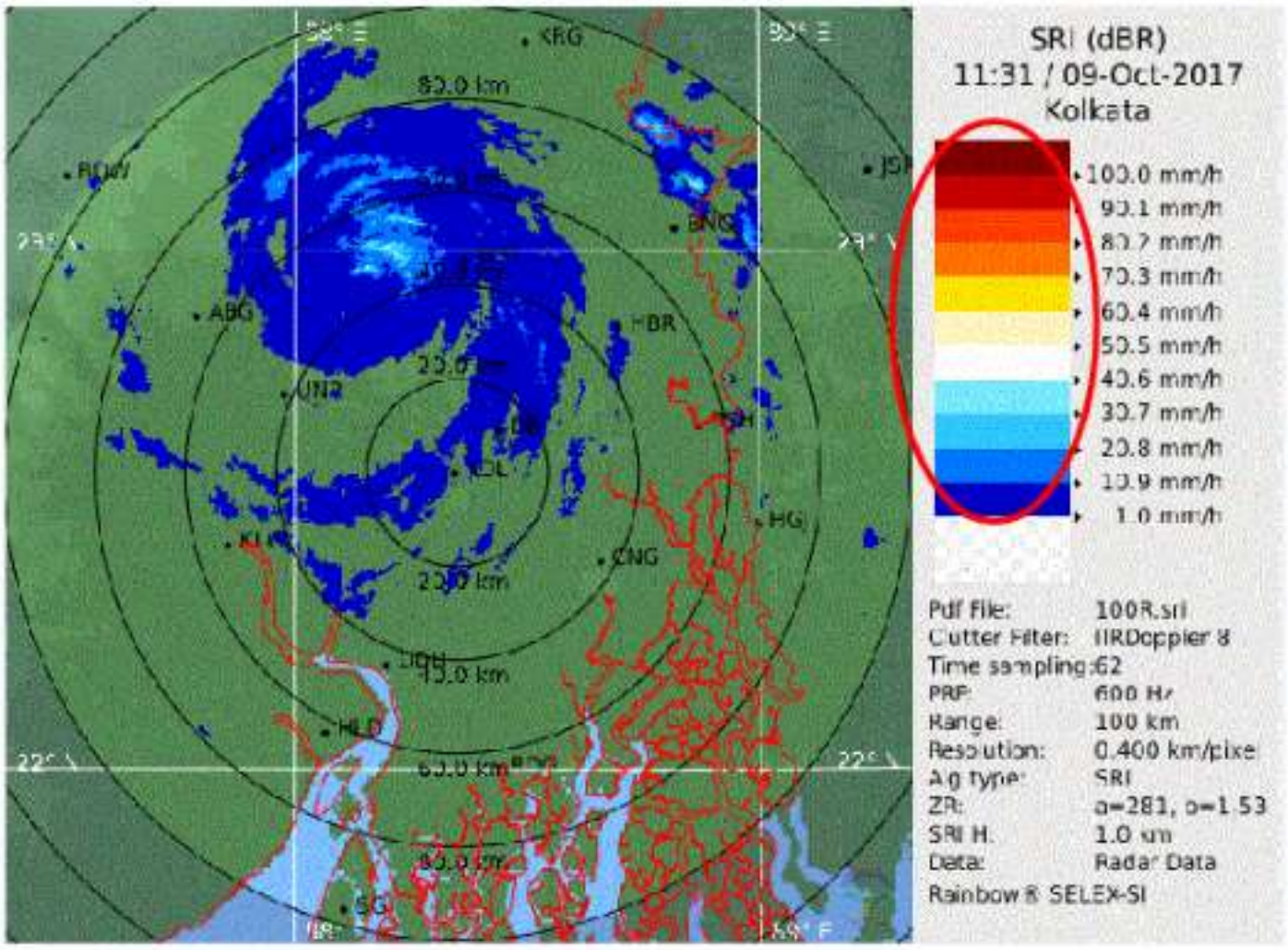
Light rain	: 20-35dBZ
Moderate rain	: 35-40dBZ
Moderate to heavy rain	: 40-50dBZ
Heavy rain	: 50-55dBZ
Hail	: more than 55 dbZ



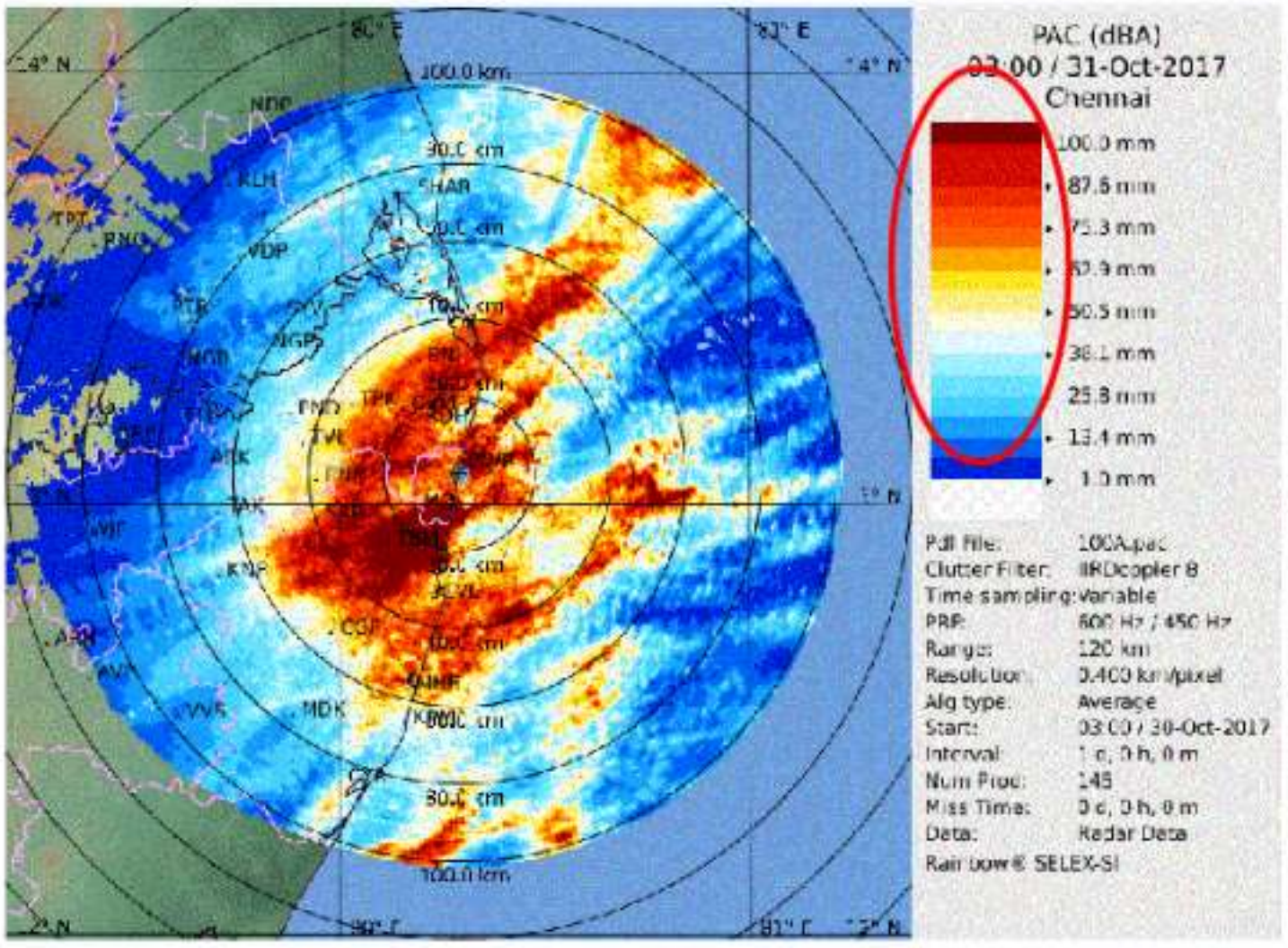
(c) Plan Position Indicator (Mean Velocity m/s) : Indicate the mean velocity of cloud and its direction. Cloud moving towards Radar (-ve Mean Velocity), moving away from Radar (+ve Mean Velocity). The mean velocity of cloud can be estimated from the corresponding colour code shown in the scale.



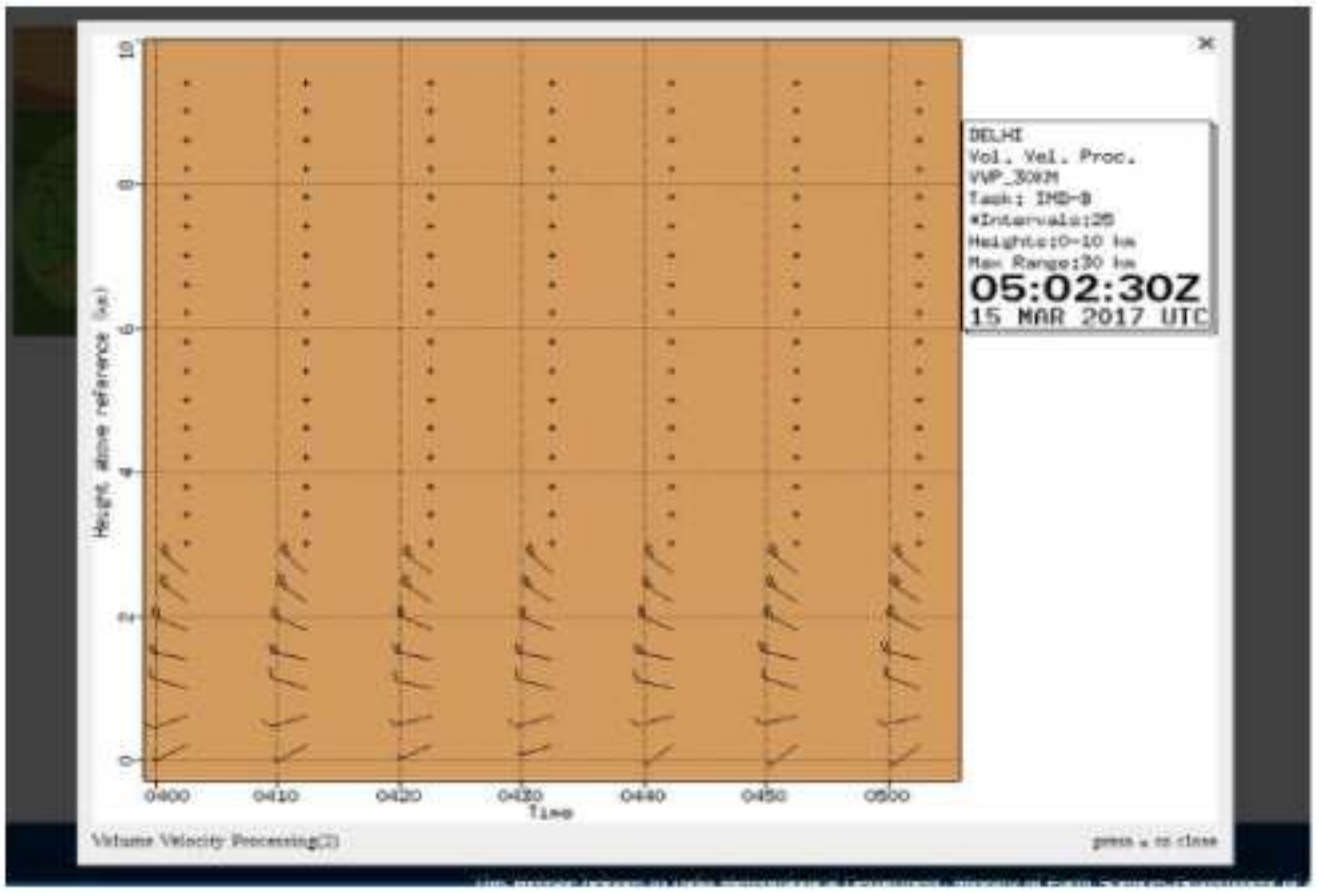
(d) Surface Rainfall Intensity (mm/Hr) : The SRI gives an image of the rainfall intensity at surface layer with constant height above the ground. It is calculated based on Marshall-Palmer equation Z=ARb where R is the rainfall intensity and A and b are constants. The value of A & b varies from season to season and from place to place. The rainfall intensity can be estimated from the corresponding colour code shown in the scale.



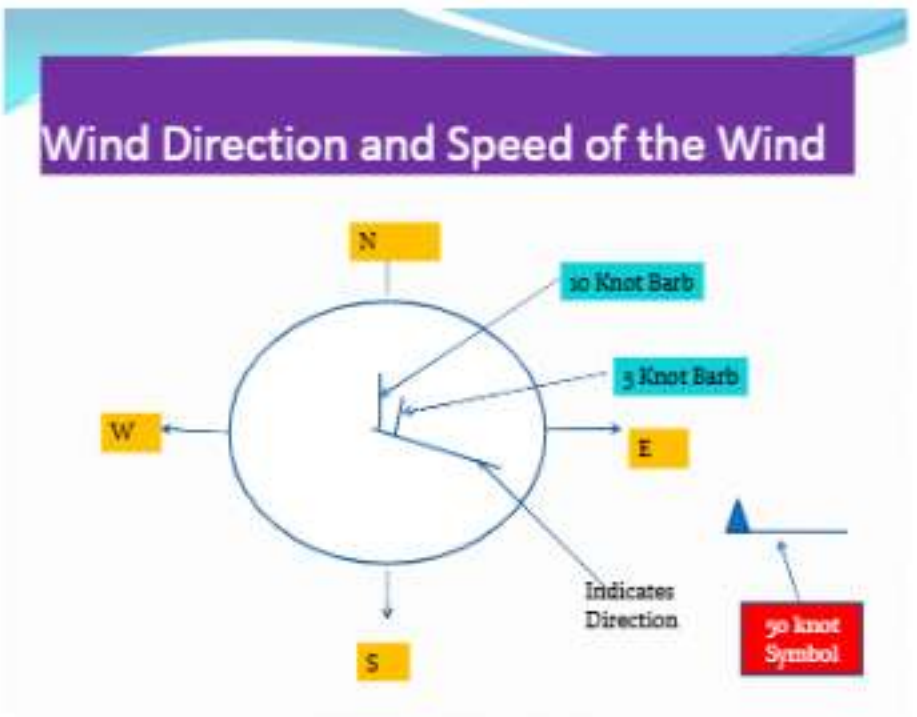
(e) **Precipitation Accumulation (mm)**: The PAC product is a second level product. It takes SRI products of the same type as input. The display shows the colour coded rainfall amount in (mm) for the defined time period. Precipitation accumulation estimation by the Radar can be useful to work out water inflow in catchment area of Rivers, flood forecasting in the absence of conventional rain gauge network. Presently it takes SRI products and accumulates the rainfall at a time period of 24 hours.



(f) Volume Velocity Processing: This displays the wind velocity and wind direction in a vertical column above the Radar site. Wind speed and direction are calculated at different vertical layers and are displayed in the form wind barbs.



Reading Wind barbs: The tail of the barb indicates direction



Conversion formula for Knot to Meter per second= Knot x0.51= m/s

- **Use of RADAR Products for System Operation :**

(a) Identifying distance and height of clouds (km)

(b) Movement of clouds /thunderstorm/rains

(c) Location of rainfall and its intensity in mm/this would help in assessing the impact and advance control measures required to maintain the Grid security.

(d) Total rainfall in mm in the last 24 hours (mm)

- Assessment of demand in next 24 hours
- To estimate precipitation in the catchment area of rivers

(e) Wind speed and direction at the location of Radar (Knots)

- Load reduction due to factors, like, switching off of distribution lines to prevent collateral damage/distribution network outage.

Limitation in Measurement of Rainfall by Radar:

- The Radar beam width and thus the sampling volume increases with range, Therefore Radar resolution at long distances are poorer.
- **Sea-Clutter:** Sea Clutter are disturbing Radar-echoes of sea wave crests
- **Attenuation of Radar beam**: The attenuation of Radar beam by rain at close distances may obscure precipitating echo at long ranges. The stronger echo at long distance may appear weak. Also, the precipitation area observed by the radar may be less than actual.
- **Obstruction of Radar beam**: If the beam is obstructed by manmade and natural objects (buildings, tress, hills etc,), the radar will not be able to probe beyond the range of obstruction. If the beam is partially blocked, observations will not be true representative of the area.

The abbreviation of city codes (city Name) on Radar image is enclosed as **Annexure-II**

8. Meteogram

The Meteogram available at Weather Portal provide plots of Meteorological variables such as rainfall, cloud cover, temperature, humidity, wind speed, sea level pressure, indices for thunderstorm etc. for 10 days with a resolution time of three hours. Each Meteogram provides the information for the area of 10 km radius. It updates at 00:00 hrs UTC (05:30 AM, IST) and 12:00 hrs UTC (05:30 PM, IST). Region wise list of available Meteogram locations are given below:

Region	Total no. of locations	State wise locations
Northern Region	117	UP-39,Uttarakhand-14, Punjab & HP -10, Chandigarh-1,Rajasthan-29,Delhi-2, Haryana-5, Jammu and Kashmir-7
North Eastern Region	33	Assam-10,Arunachal Pradesh-4, Nagaland & Meghalaya-1, Tripura-2, Manipur & Mizoram-1
Western Region	115	Maharastra-40, MP-35, Gujrat-35, Chattisgarh-8, Goa-3
Southern Region	101	Tamilnadu-32, Andhra Pradesh -24, Karnataka-32, Telangana-10,Kerala-9, Lakshdweep-4
Eastern Region	69	West Bengal-24, Oddisa-20,Bihar-15, Jharkhand-9, Sikkim-1

List of various parameters available in a Meteogram is given below:

A. Conditions for the lower troposphere (up to 500 millibars)

B. 1000-500 mb Thickness

C. Sea Level Pressure

D. Stability Indices

E. Wind at 10 meter Height

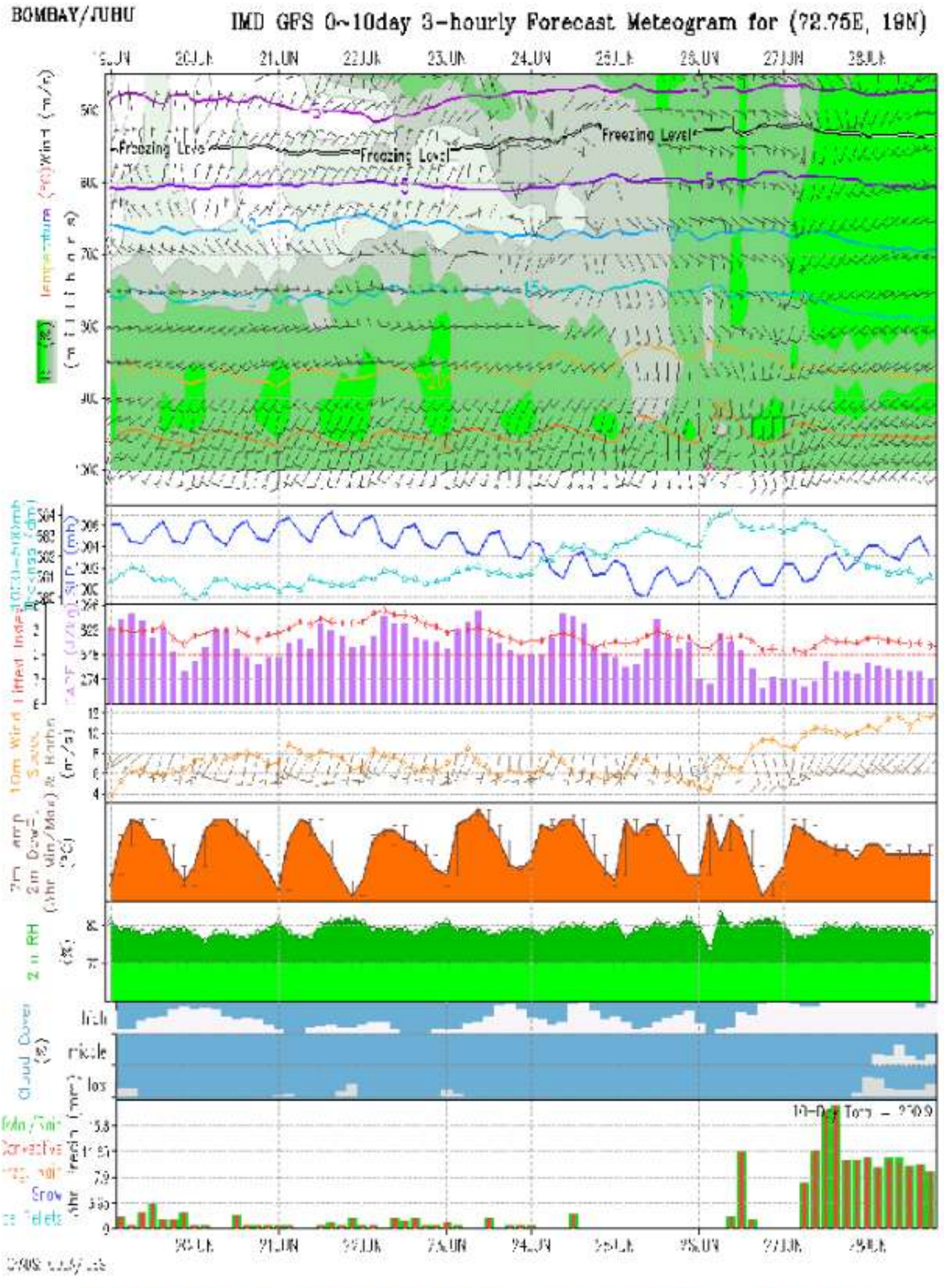
F. 2-meter Temperatures

G. Relative Humidity 2-Meter Height

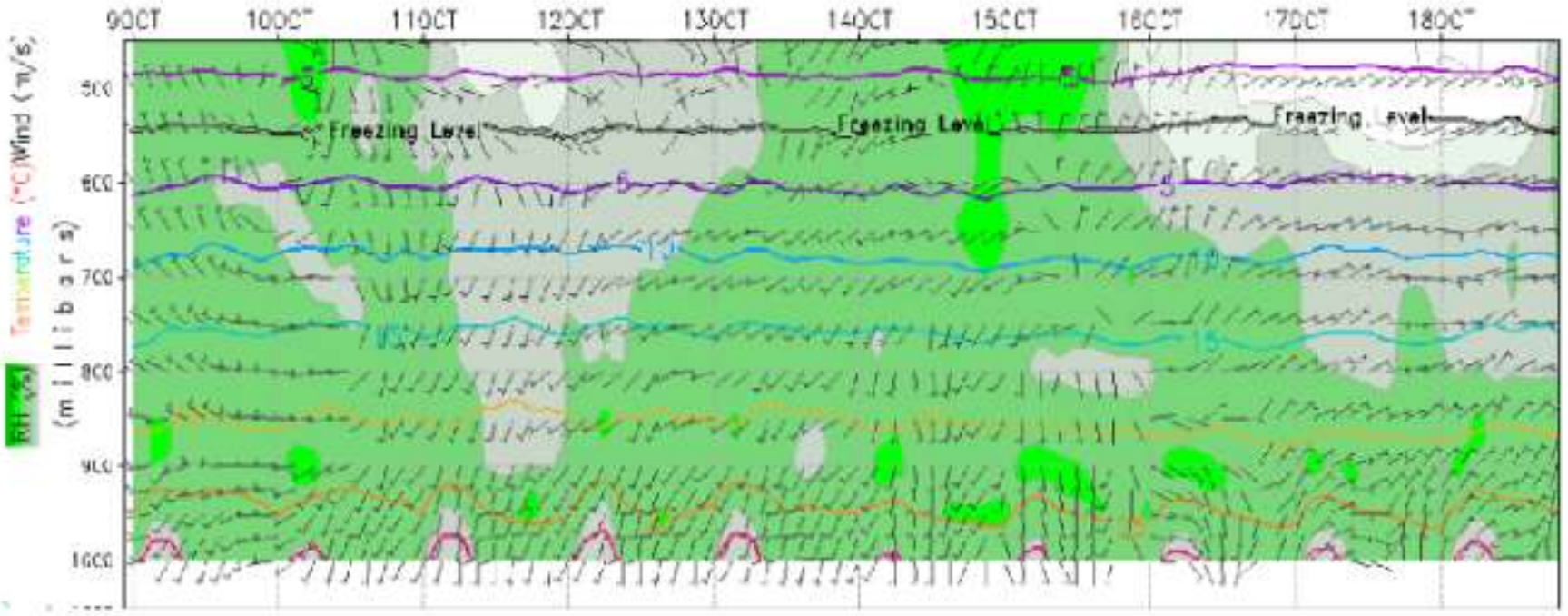
H. Cloud Cover

I. Precipitation

The Sample Meteogram picture and details of various parameters are given below:

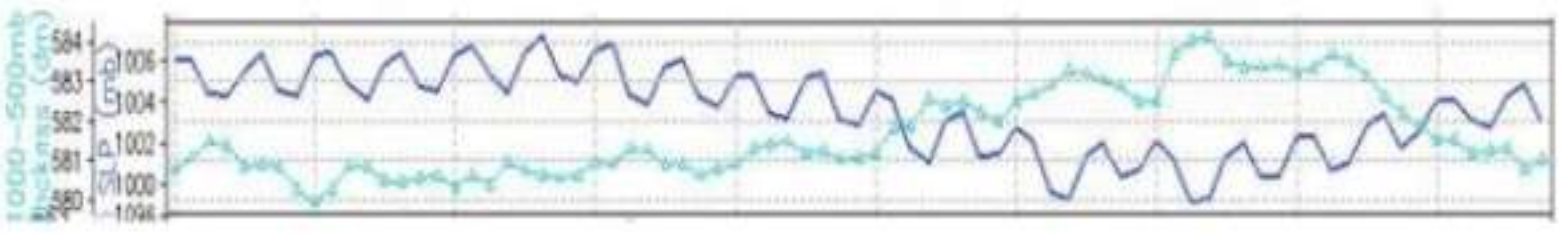


A. Conditions for the lower troposphere (up to 500 millibars) (Wind ,Temperatures and Relative humidity) are shown in the profile:



- **Wind**
  - **(i)** The barbs indicate the direction and speed of the wind, rounded to the nearest 5.
  - **(ii)** The unit is m/s. The speed can be calculated by counting the barbs. (Full barb =10 Knots, Short barb=5 Knots, Pennant=50 Knots)
- **Temperature**
  - **(i)** The coloured contours indicate the profile of temperature.
  - **(ii)** The unit is °C.
  - **(iii)** The freezing level (32°F or 0°C) is indicated by the double black line labelled FR.
- **Relative Humidity**
  - **(i)** The graduated green shading indicates relative humidity.
  - **(ii)** The unit is percent.

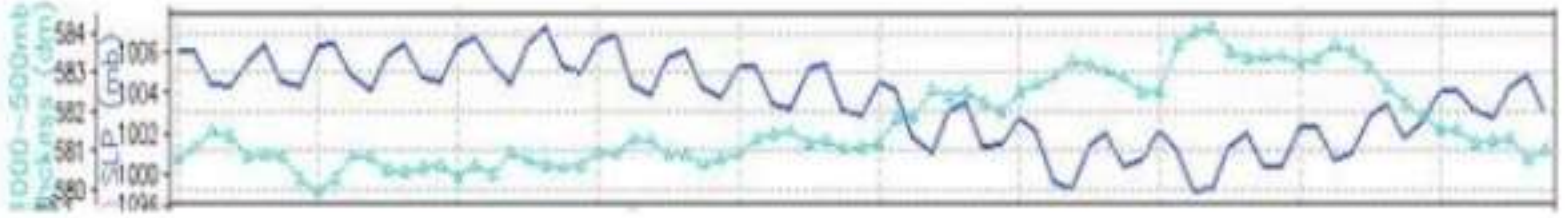
B. 1000-500 mb Thickness :



It is the vertical distance between two pressure levels. In general the distance will be a function of the density of the air between the two pressures levels, which is directly related to the temperature of the air. Thus, thickness is a good indicator of the mean temperature in the layer of

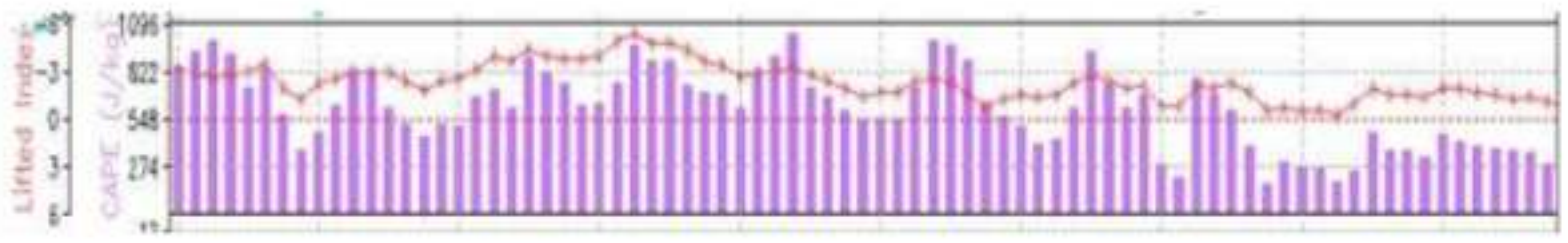
atmosphere between the two levels. Greater thickness indicates warmer air. The units are dekameter (1 deka meter=10 meter, 10 meter is about 33 feet). One rule of thumb is that if the thickness of this layer is less than 540 dm, then any precipitation will be in the form of snow.

C. **Sea Level Pressure:** Sea level pressure (SLP) is the surface pressure interpolated down to sea level from the altitude of the grid box of the model. This corresponds to the barometric pressure one hears reported on local radio or TV weather reports. The blue line indicates SLP. The unit is millibar.



Valleys in SLP often indicate frontal passages and often coincide with pronounced changes in wind direction, temperatures and humidity. In subtropical regions (the deserts of the Southwest and much of the Sunbelt during summer) the SLP often oscillates daily with a peak in the early morning and a trough during mid-afternoon.

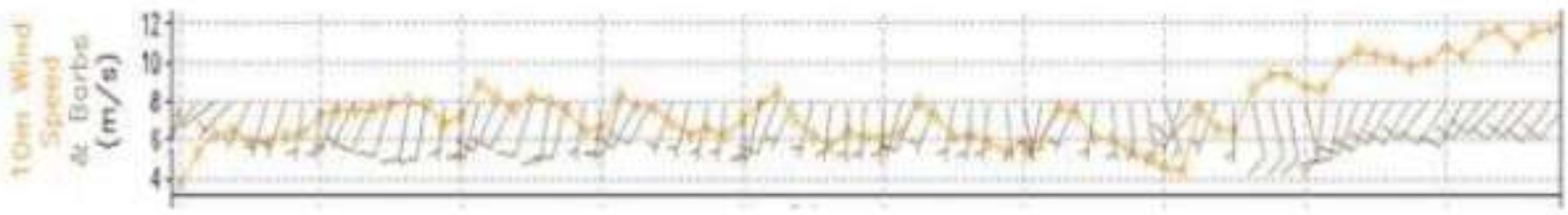
D. **Stability Indices**: The stability indices are measure of the potential for strong or severe weather. The indices shown here are the Lifted Index (LI) and the Convective Available Potential Energy (CAPE).



- **Lifted Index:** The LI, indicated by the red line is a measure of the thunderstorm potential.
  - i) LI values greater than 0 indicates that thunderstorms are unlikely.
  - ii) LI values between 0 and -2indicates that thunderstorms are possible with good trigger.
  - iii) LI values between -3 and -5 indicates that thunderstorms are probable.
  - iv) LI values less than -5 indicates a strong potential of severe thunderstorms.

- **CAPE** (Convective Available Potential Energy) : The purple bars indicate the CAPE value at the surface in units of J/kg. CAPE is a measure of the buoyancy of a layer. The larger the CAPE, the greater the potential for severe weather. Any value greater than 1000 J/kg indicates instability and the possibility of thunderstorms. The base line for the bar graph of CAPE is 0(zero).

E. Wind at 10 meter Height : 10-Meter Winds (about 33 feet above the ground) correspond to typically measured winds at weather stations.

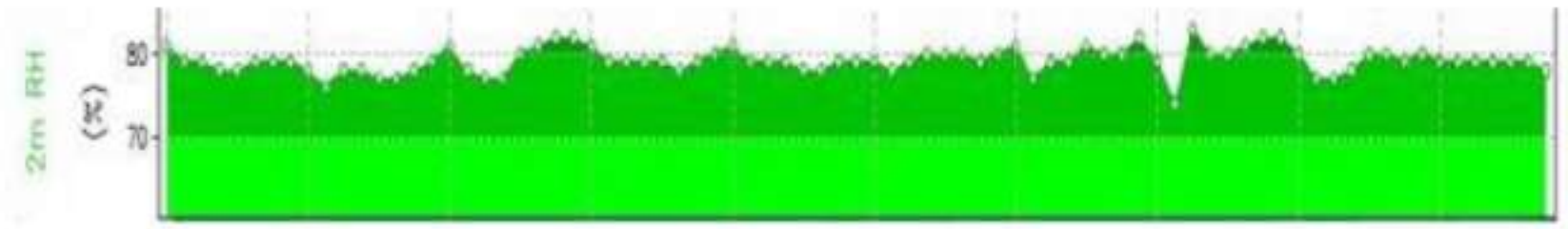


The yellow line indicates wind speed. The unit is in m/s.

F. 2-meter Temperatures: Air temperature and dew point temperature are given at the 2-meter level (6½ feet above ground). The dew point temperature is the temperature that a sample of air would have if it were cooled (at constant pressure) until it reached saturation. The dew point temperature is an alternative way to describe the amount of moisture or humidity in the air. If the dew-point temperature is close to the air temperature, the relative humidity is high and if the dew point is well below the air temperature, the relative humidity is low.

Air temperature is indicated by the red line (with colour shading below the line to aid interpretation). Dew point temperature is indicated by the grey line. The unit of Temperature is Degree Celsius. The freezing level is drawn with a dot-dashed black line. Temperatures at the specified times are given, so low and high temperatures may fall between the hours specified, and thus exceed the range shown.

G. Relative Humidity 2-Meter Height :



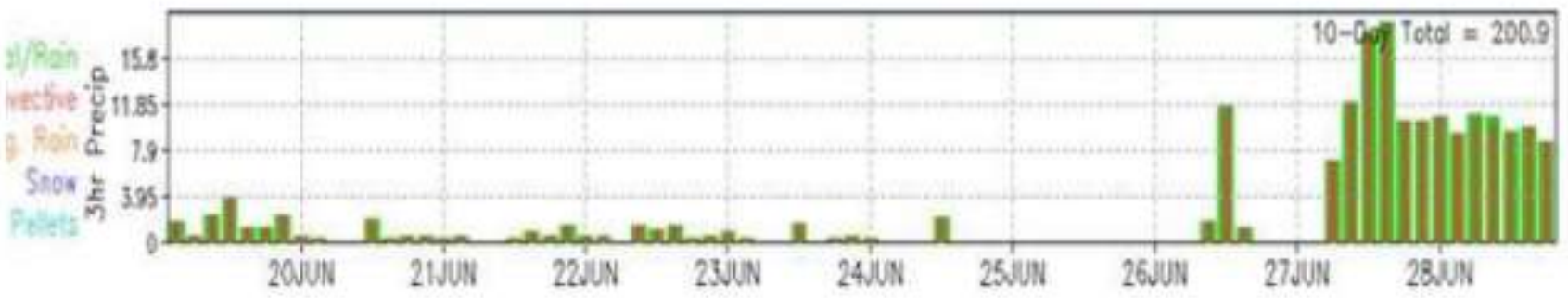
The green line and graduated green shading indicates relative humidity at 2 meter height. The units are percent.

H. Cloud Cover: Clouds are aggregate of very small water droplets, ice crystals or a mixture of both with its base above the earth's surface. A classification is made in level – high, medium or low – at which the various cloud genera are usually encountered. In temperate regions, the approximate limits are high, 5-13 km (16500 – 45000 ft); medium, 2-7 km (6500 – 23000 ft); low, 0-2 km (0 – 6500 ft).

As shown in picture above the panel has a blue background to show the cloud-free areas. The panel is divided into three horizontal layers for the display of low, middle, and high cloud cover, which are drawn as white bars. If the white bar covers the full height of its layer, that is 100% cloudiness. Cloud cover is measured in Octa. In meteorology, an octa is a unit of measurement used to describe the amount of cloud cover at any given location such as a weather station. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 octa (completely clear sky) through to 8 octa (completely overcast).

Clear sky	0 Octa
Mainly clear	1-2 Octa of Sky covered
Partly cloudy	3-4 Octa of Sky covered
Generally cloudy	5-7 Octa of Sky covered
Cloudy	>7 Octa of Sky covered
Overcast sky	Sky completely covered by cloud

I. **Precipitation:** The bar graph as shown in image below indicates predicted precipitation types and amounts.

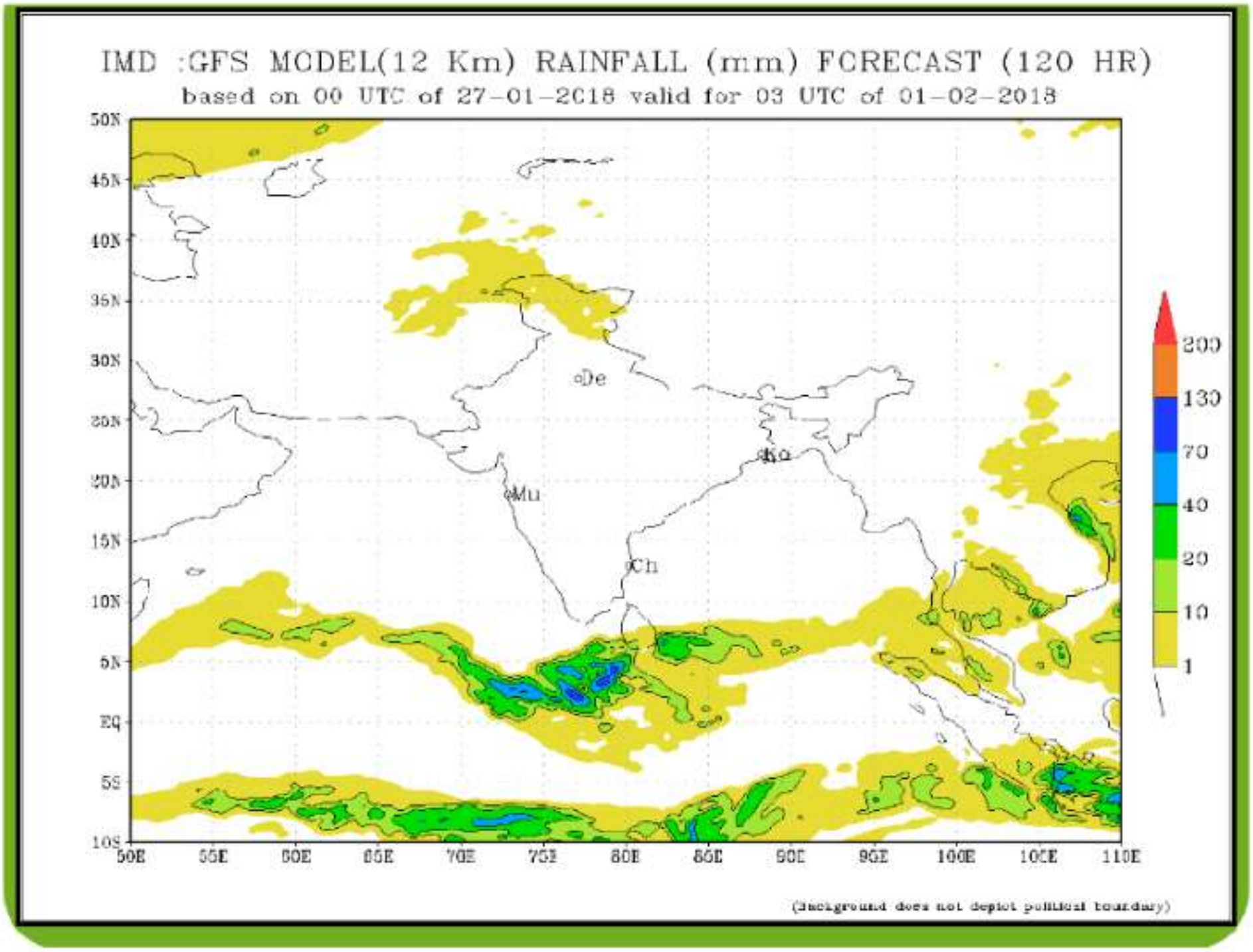


Precipitation Type: The colour indicates the type of precipitation, rain, sleet, snow or ice pellets. Narrow red bars within the other bars indicate the portion of precipitation likely to come from convection (showers and thunderstorms). The unit is in millimetre. At the right end corner it shows the total rainfall for the next 10 days in mm.

The state wise Meteogram can be visualised by clicking of Meteogram tab on Regional Weather Portal.

The Meteogram graphs of any location in the country can be viewed by clicking on all India Meteogram tab on the home page of Weather Portal.

8.1 GFS model for rainfall forecast: It provides daily rainfall forecast for 10 days based on current day observations. This is an effective visualisation based planning tool available with system operators.



9. METAR (Meteorological Terminal Aviation Routine Weather Report)

METAR is scheduled observation taken at the end of each hour/half hour at important airports. METAR is a format for reporting weather information. A METAR weather report is predominantly used by pilots for fulfilment of a part of a pre-flight weather briefing and by meteorologists, who use aggregated METAR information to assist in weather forecasting. METAR is the scheduled observation taken at the end of each hour/half hour at important airports. A typical METAR contains data for the temperature, dew point, wind direction and speed, precipitation, cloud cover and height, visibility and barometric pressure. A METAR may also contain information on precipitation amounts, lightning, and other information that would be of interest to pilots or meteorologists. The visibility at an airport can provide a good idea about status of fog/smog.

Decoding a typical METAR:

Sample *METAR* Code: VIDP 091730 Z 09006KT 2500 HZ FEW 030 SCT 100 17/11 Q1009 NOSIG

VIDP: Station Code (IGI New Delhi)

091730 Z: Date and Time in UTC (Z) i.e. Date 09th, Time 17:30

09006KT: Speed of wind in Knots

2500 HZ: Visibility 2500 meter (Haze) {Most important for system operators for estimating fog at a particular location}

FEW 030 SCT 100: Few clouds at 3000 meter and scattered cloud at a height of 10000 meter

17/11: Air Temperature is 17 degree and dew point temperature is 11 degree

Q1009: Pressure in hPa

NOSIG: No significant change is expected in the reported conditions for next two hours.

Abbreviations used in METAR code is enclosed at Annexure-I

10. Region Specific Forecast

(i) Fog Forecast: Fog Forecast is issued from five airports of the Northern Region.it gives the outlook of fog for the first 6 hours and also for the subsequent 12 hrs.

INDIA METEOROLOGICAL DEPARTMENT
METEOROLOGICAL OFFICE I.G.I. AIRPORT
NEW DELHI

FOG FORECAST OF DELHI REGION

HOME

DATE : 02-01-2018. TIME OF ISSUE 02/0000 UTC.

VALIDITY	VALID FROM DATE/TIME 02/0030 UTC. VALID UPTO DATE/TIME 02/0630 UTC.	FROM DATE/TIME 02/0630 UTC. TO 02/1830 UTC.
STATION	**FORECAST**	**OUTLOOK FOR NEXT SUBSEQUENT 12 HOURS**
(VIDP) I.G.I. AIRPORT, DELHI	VISIBILITY MAY REMAIN 0200M IN FOG TILL 02/0400 UTC IT MAY IMPROVE TO 0500M IN SHALLOW FOG FROM 02/0600 UTC.	VISIBILITY LIKELY IMPROVE TO 1000M AND ABOVE IN SMOKE FROM 02/0700UTC.
(VILK) LUCKNOW AIRPORT	VISIBILITY LIKELY REDUCZE TO 0500M IN SHALLOW FOG FROM 02/0130 UTC.I T MAY IMPROVE TO 1000M IN MIST FROM 02/0600 UTC.	NO DENSE FOG DURING THE PERIOD.
(VIJP) JAIPUR AIRPORT	NO FOG DURING THE PERIOD.	NO FOG DURING THE PERIOD.
(VIAR) AMRITSAR AIRPORT	VISIBILITY LIKELY REMAIN BELOW 0050M IN VERY DENSE FOG(CAT -III VERY DENSE FOG) TILL 02/0400 UTC IT MAY IMPROVE TO 0500M IN FOG FROM 02/0600 UTC.	VISIBILITY LIKELY IMPROVE TO 1000M AND ABOVE IN MIST FROM 02/0700 UTC. IT MAY RECUDR TP 0200M IN DENSE FOG FROM 02/1800 UTC.
(VEBN) BABATPUR AIRPORT	VISIBILITY LIKELY REDUCE TO 0300M IN FOG FROM 02/0100 UTC.I T MAY IMPROVE TO 1000M IN MIST FROM 02/0630 UTC.	NO DENSE FOG DURING THE PERIOD.

(ii) Bay Bulletin: This is issued in Eastern Region and Western Region .This part contains two type of bulletin.

- **Sea Area Bulletin**: It contains information regarding visibility and wind over sea area.

GOVERNMENT OF INDIA
INDIA METEOROLOGICAL DEPARTMENT
REGIONAL METEOROLOGICAL CENTRE, KOLKATA - 27

29-01-2018

FROM : AREA CYCLONE WARNING CENTRE, KOLKATA (WEATHER OFFICE, ALIPORE)
RPT: PORTBLAIR RADIO (FAX 03192-233683)
RPT: KOLKATA PORT WIRELESS (FAX 2469-3888)

AURORA OBSERVATION Date : Monday 29 January 2018

PART ONE:- NO STORM WARNING.

PART TWO:- Yesterday's trough of low over central parts of South Bay of Bengal and adjoining equatorial Indian ocean now lies over equatorial Indian ocean and adjoining Southwest Bay of Bengal . Weather seasonal over rest Bay of Bengal and Andaman Sea.

PART THREE: SEA AREA FORECAST VALID FROM 29 0900 UTC TO 29 2100 UTC

NORTH WEST BAY.	**WIND** **VISIBILITY**	Variable; 05 to 10 knots. Good.
EAST CENTRAL BAY (West of longitude 92° E).	**WIND** **VISIBILITY**	Mainly Northerly; 10 to 15 knots. Good.
SOUTH WEST BAY.	**WIND** **VISIBILITY**	Mainly Northeasterly; 15 to 20 knots. Good becoming moderate in rain.

- **Coastal Area Bulletin:** This contains information regarding visibility, wind, weather, sea condition and port warning.

GOVERNMENT OF INDIA
INDIA METEOROLOGICAL DEPARTMENT
REGIONAL METEOROLOGICAL CENTRE, KOLKATA - 27

DATE: 29-01-2018

DAILY ONE BULLETIN FOR ANDAMAN AND NICOBAR COAST DATED 29-01-2018

Weather seasonal over Andaman Sea.

FORECAST VALID FROM 291000 UTC TO 292200 UTC: -

WIND: North to Northeasterly; 10 to 15 knots.

WEATHER: Rain or thundershower likely to occur at isolated places over Nicobar coast. Weather dry over Andaman coast.

VISIBILITY: 08 to 06 km reducing to 04 km in rain over Nicobar coast and 10 to 12 km over Andaman coast.

SEA: Smooth to Slight .

PORT SIGNAL: Nil.

T.O.O :
29 January 12:30 hrs IST

(M. B. Roychowdhury)
DUTY OFFICER
AREA CYCLONE WARNING CENTRE,
KOLKATA

DAILY ONE BULLETIN FOR WEST BENGAL COAST DATED 29-01-2018

Weather seasonal over Northwest Bay of Bengal.

FORECAST VALID FROM 291000 UTC TO 292200 UTC: -

WIND: Variable; 05 to 10 knots.

WEATHER: Dry weather most likely.

VISIBILITY: 10 to 12 km.

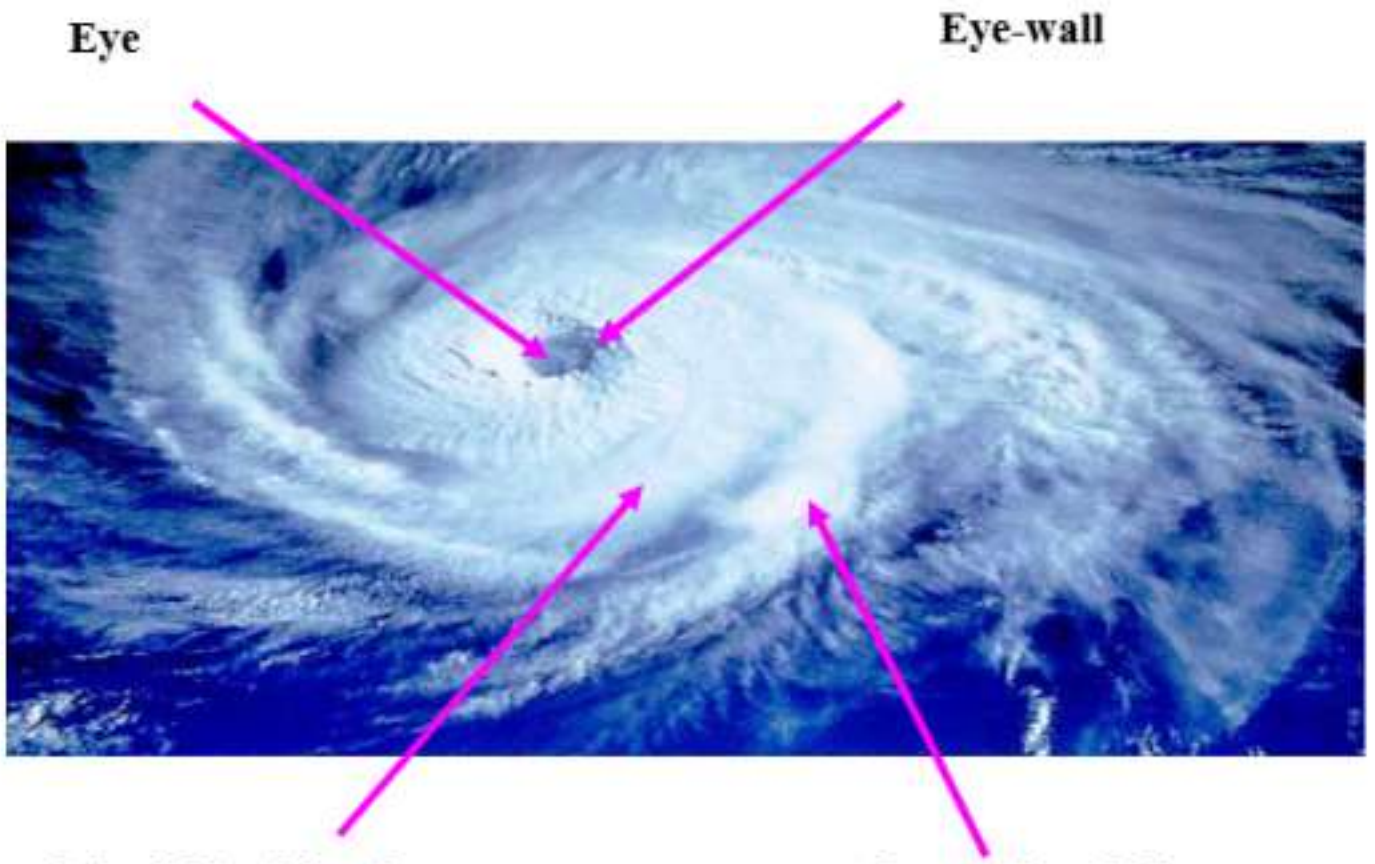
SEA: Smooth.

PORT SIGNAL: Nil.

T.O.O :
29 January 12:30 hrs IST

(M. B. Roychowdhury)
DUTY OFFICER
AREA CYCLONE WARNING CENTRE,
KOLKATA

(iii) Cyclone Alert: Cyclones are intense low pressure areas - from the center of which pressure increases outwards. The amount of the pressure drop in the center and the rate at which it increases outwards gives the intensity of the cyclones and the strength of winds. Tropical cyclones are warm core low pressure systems having a large vortex in the atmosphere, which is maintained by the release of latent heat by convective clouds that form over warm oceans. In the northern hemisphere, the winds in a cyclone blow anticlockwise in the lower troposphere and clockwise in the upper troposphere. However, in the southern hemisphere, the winds of the cyclone blow in the opposite direction i.e. clockwise in the lower levels and anticlockwise in the upper levels. A full-grown cyclone is a violent whirl in the atmosphere with 150 to 1000 km diameter and 10 to 15 km height. Gale winds of 150 to 250 kmph or more spiral around the center of very low pressure area with 30 to 100 hPa below the normal sea level pressure. In a fully developed cyclonic storm, there are four major components of horizontal structure viz. eye, wall cloud region, rain/spiral bands and outer storm area. A schematic diagram is given below:



The most spectacular part of a matured cyclonic storm is its 'eye', which forms at the centre of the storm inside a Central Dense Overcast (CDO) region. The eye has a diameter of about 10 to 50 km, which is generally cloud free and is surrounded by thick wall clouds around it. The eye is surrounded by a 10-15 km thick wall of convective clouds where the maximum

winds occur. This is the most dangerous part of a cyclonic storm. The height of the wall goes up to 10 to 15 km. The intense convection in this wall cloud region produces torrential rain, sometimes of the order of 50 cm in 24 hrs. Beyond the eye wall region, the major convective clouds in a cyclonic storm, responsible for heavy rains, have a spirally banded structure. These spiral bands are sometimes hundreds of kilometres long and a few kilometres wide. The spiral bands are easily identifiable in radar and satellite pictures, as a number of thunderstorm cells (Cumulonimbus clouds) are embedded in them that produce heavy rainfall (typical rate 3 cm/hr, which in extreme cases may reach upto 10 cm/hr).

There are four stages of Cyclone Warning

- **Pre Cyclone Watch**: This is issued to Cabinet Secretary and other senior officials indicating formation of a cyclonic disturbance having potential to intensify into tropical cyclone and the coastal belt likely to be affected.
- **Cyclone Alert**: The alert issued at least 48 hours in advance indicating expected adverse weather conditions.
- **Cyclone Warning**: The warning is issued at least 24 hours in advance indicating latest position of tropical cyclone, intensity, time and point of landfall, storm surge height, type of damages expected and actions suggested.
- **Post landfall Outlook**: This is issued about 12 hours before the landfall and till cyclone force wind prevails. District collectors of interior districts besides the coastal area are also informed.
- Finally a 'De-warning 'message is issued when the tropical cyclone weakens into depression stage.

The average life span of a cyclonic storm is about 4 to 5 days.

Cyclone intensity and damage expected to power system and communication lines:

Intensity	**Damage Expected to Power and Communication Lines**
Deep Depression (52-62 km/hr)	Nil
Cyclone Storm (63-87 km/hr)	Minor
Sever Cyclone Storm (88-117 km/hr)	Minor
Very Severe Cyclonic Storm (118-221km/hr)	Large scale disruption of power and communication lines
Super Cyclone (222 km/hr and above)	Total disruption of power and communication lines

(iv) Port Warning: The India Meteorological Department (through the area cyclone warning centres (ACWCs)/ cyclone warning centres (CWCs) maintains a port warning service by which the port officers are warned by high priority telegrams about disturbed weather likely to affect their ports. On receipt of the warning telegrams from the ACWC/CWC, the port officers hoist appropriate visual signals prominently on signal masts so that they are visible from a distance. Mariners and other sea-faring people, including fishermen who may not be literate, are generally aware of the meaning of these signals and the port authorities are always ready to explain them whenever necessary. At some ports, the meanings of the signals are displayed in English as well as in the local languages prominently on a notice board. While the India meteorological department is responsible for issuing the warnings, the port authorities arrange the display of signals. In addition to hoisting the signals, the port officers have, in most cases, make arrangements for disseminating the warnings received by them, to country craft and sailing vessels in the harbours.

(v) Forecast for Andaman and Nicobar islands: This forecast is issued in Eastern Region. The forecast provides district level weather forecast (Rainfall) and weather warning for rain, squall and thunder squall for Andaman and Nicobar islands.

11. LAUNCH OF WEATHER PORTAL

The Weather Portal for Power Sector was launched by Shri Piyush Goyal Union Minister of State (IC) for Power, Coal, and New& Renewable Energy on 23rd June 2017:

Press Coverage:

Press Information Bureau

Government of India

Ministry of Power

23-June-2017 18:05 IST

Shri Piyush Goyal launches POSOCO-IMD Weather Portal for Power Sector

Shri Piyush Goyal Union Minister of State (IC) for Power, Coal , New & Renewable Energy and Mines launched Weather Portal for Power Sector in association with POSOCO and IMD at the meeting of the Forum of Regulators here today .

Day to day weather variations have an impact on load demand and energy production, transport and distribution management, as well as energy prices. Extreme events such as heat waves or cold waves, wind storms or floods can of course have dramatic consequences on the production means or the electrical grid of a country including physical damage to the infrastructure. The information available in the portal regarding weather forecast shall help state discoms to take pro-active steps regarding short term and medium term management processes and supply planning requirements and also for better planning for infrastructure availability to ensure cost effective and reliable supply.

12. Workshops and Other Initiatives

A. Workshops: Workshop on "Deployment of Meteorological data in Power Sector" was carried out in all Regions as per the following schedule.

- Northern Region : 15th September 2015
- Southern Region : 31st July 2015 & 27th October 2015 (at RMC Chennai)
- Western Region : 24th August 2015
- Eastern Region : 6th November 2015
- North Eastern Region : 12th September 2015

Representatives from central and state sector power utilities participated in the Workshops.

B. Presentation on the weather portal was delivered in the 19th meeting of FOLD (Forum of Load Dispatchers) on 12th June 2017 held at NRLDC, New Delhi.

C. Presentation on the weather portal was delivered in the OCC meetings and special meetings taken by Central Electricity Authority (CEA) on renewable integration.

D. A weather group (weather_power@googlegroups.com) for power sector has been created for sharing weather warnings and other important developments in weather.

E. Meteogram data such as rainfall (mm), dew point temperature, maximum and minimum temperature (degree C), humidity (%), wind speed at 10 meter height (m/s), cloud cover (%) (low, medium and high) and indices for thunderstorm (J/Kg) for more 400 locations have been made available to the system operators across the country. The available data is for 10 days with a resolution time of 3 hours

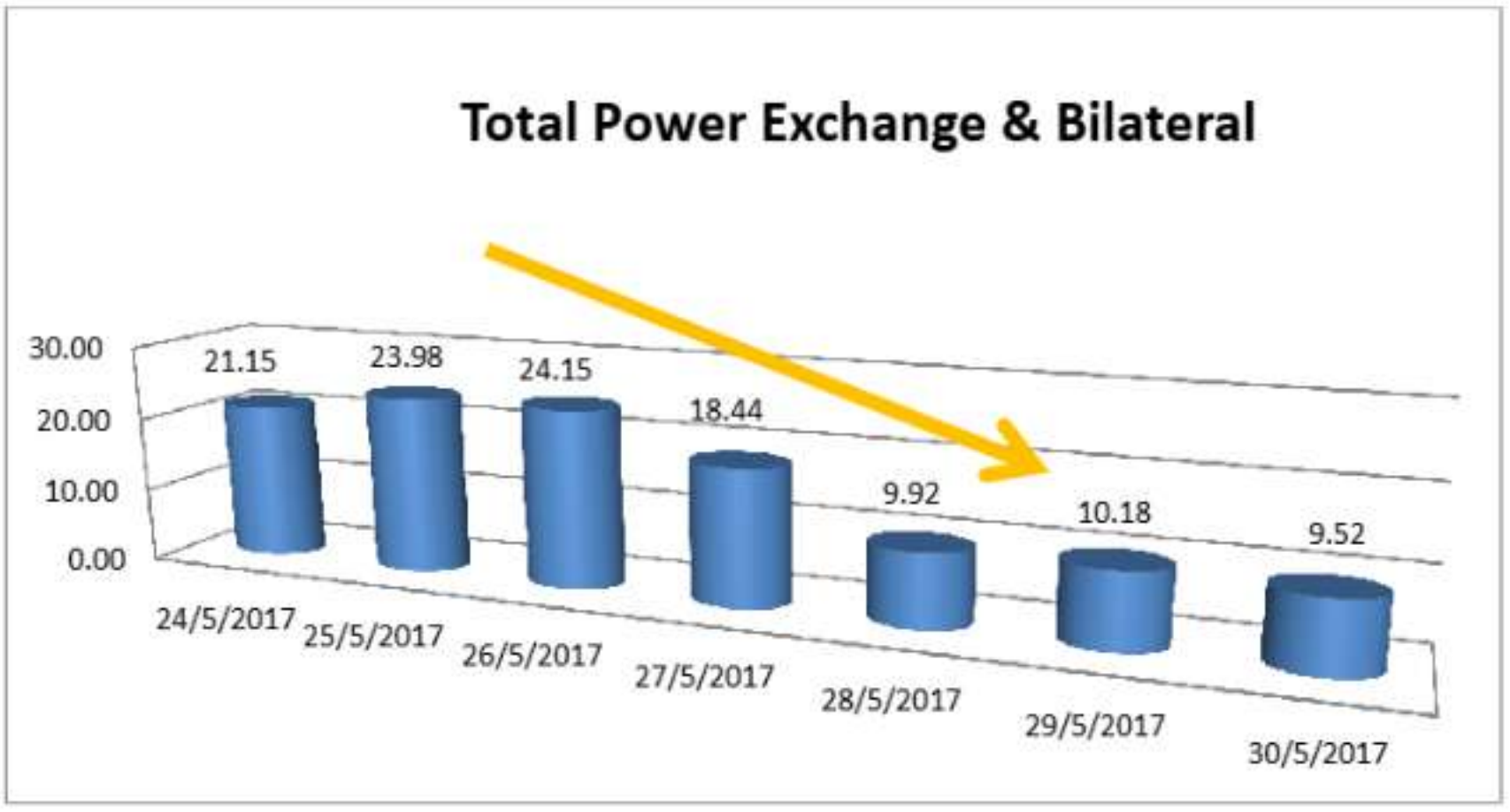
13. Experience so far

All the RLDCs, NLDC and constituents have started using the products / features available on the weather Portal on regular basis. The forecast available at the portal helps constituents to take pro-active steps such as demand estimation, decisions on STOA (Short Term Open Access) etc. The near real time information available from Radar and Satellite help system operators to take real time decisions related to Grid operation.

Northern Region

Uttar Pradesh:

(i) Meteogram, wind and rain forecast for 27/28/29-05-2017 helped in better load assessment of UP control area by U.P. State Load Despatch Centre. As anticipated, UP demand went down from 19000 MW to 17000 MW due to change in weather conditions. Accordingly STOA & purchase from power exchange of the order of 2000 MW was reduced i.e. backing down of approximately 13 MU of costly thermal generation.



(ii) Meteogram, wind and rain forecast for 21 to 24 September, 2017 helped in load assessment and demand forecast of UP control area. It has reduced demand from 18000 to 15000 MW accordingly STOA from IEX and bilateral/banking of about 2000 MW was not scheduled. Approximately 17MU direct purchase from IEX and thermal backing of costly power station were carried out. In real time operation, it was also helpful in managing over drawl/under drawl quickly.

(iii) BRPL (BSES Rajdhani Power Ltd): The Delhi's Discom BRPL has managed to take proactive action to manage its drawl from the grid and purchases from power exchange/bilateral contracts. The discom has made savings by utilising weather portal. BRPL has used meteogram to predict the increasing temperature and therefore increase in demand, based on which requests were made to SLDC Delhi to bring on bar additional units. This also helped in following merit order despatch, by avoiding costly power exchange purchases during peak summer. In addition to meteogram, live radar imagery helped sending in timely revision for backing down of generating stations in anticipation of thunderstorms/ rain, which saved under drawl of power thereby also ensuring grid security. The summary of savings made by the discom on different occasions is as follows:

S.no	Date	Savings (Mus)
1	10/05/2017	0.24
2	31/05/2017	0.48
3	20/06/2017	1.49
4	30/08/2017	1.43
5	31/08/2017	1.26
6	22/09/2017	2.19
7	23/09/2017	1.87

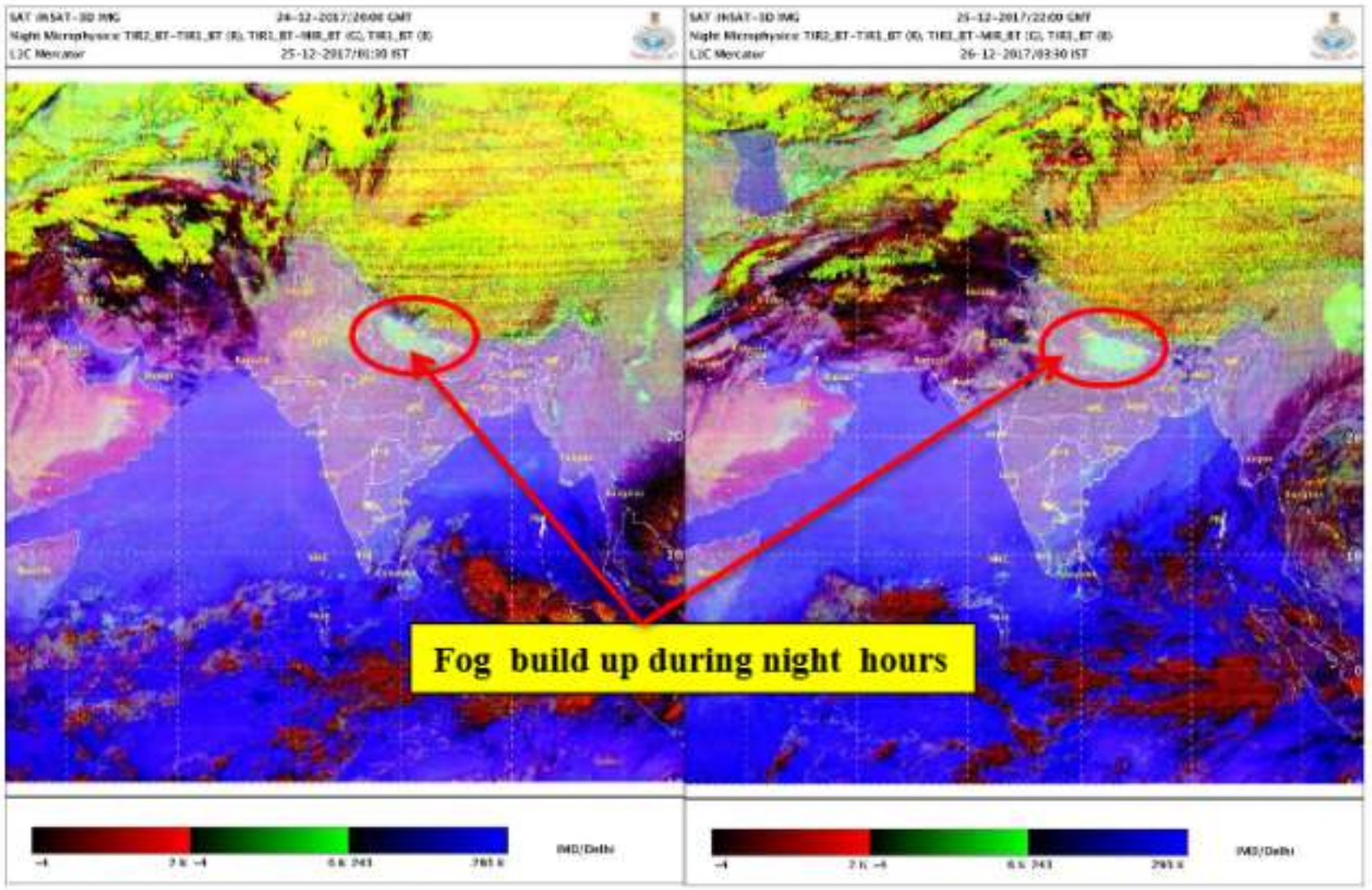
The details shared by BRPL is enclosed as **Annexure-III**

(IV) Northern Regional Load Despatch Centre (NRLDC) : Northern Region and Eastern Region of the power system in India face foggy conditions during night and early morning hours of winter months. The fog coupled with pollution leads to tripping of EHV lines. To mitigate the adverse effect of tripping on power system, Grid operators have taken successful action based on near real time colour composite images of fog from Satellite image. Two such cases have been explained in detail.

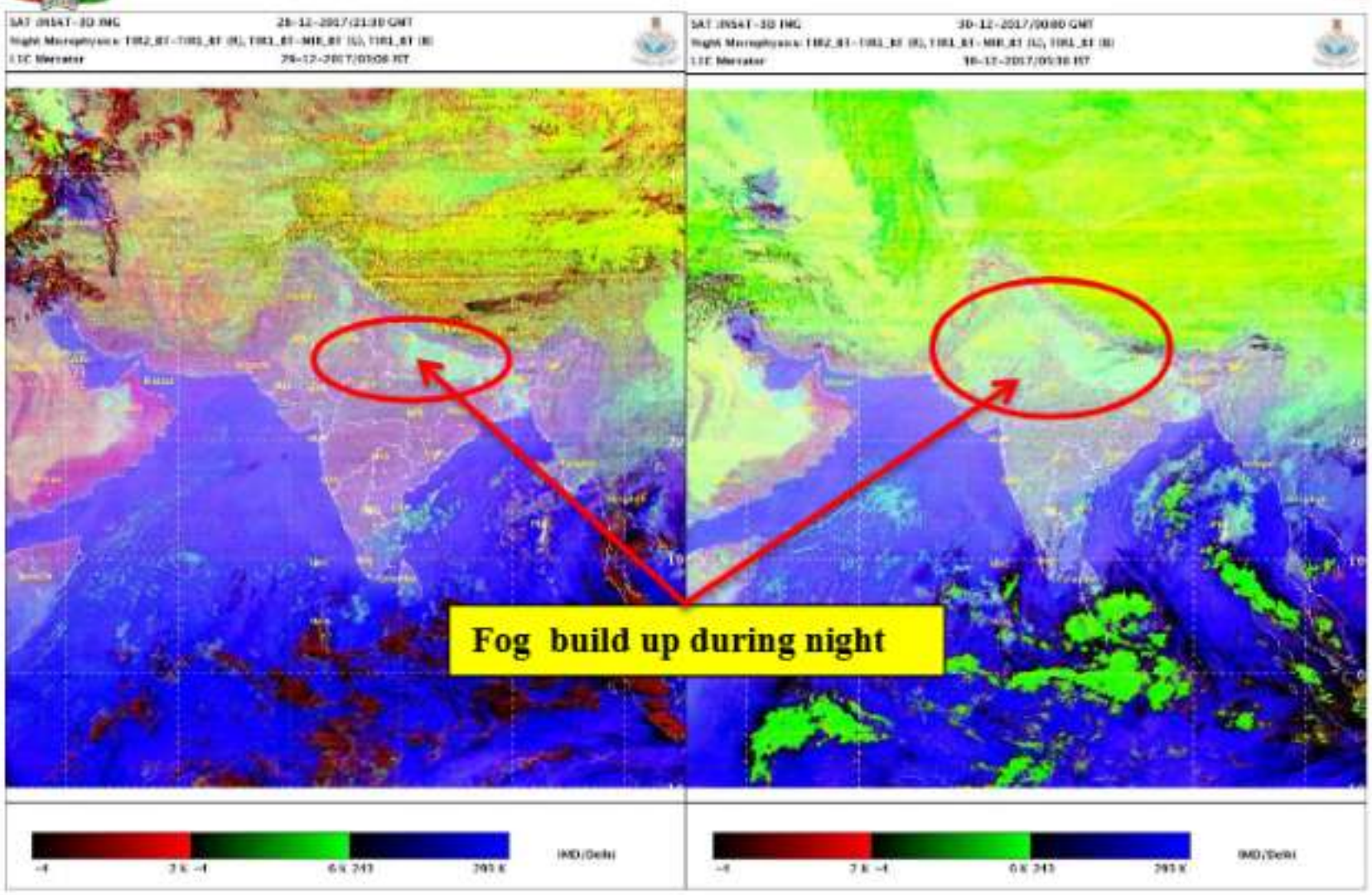
(a) Tripping of 765kV Anpara C-Unnao.

*Frequent*_tripping of 765kV Anpara C-Unnao line attributed due to fog during winter nights (25.12.17- 01.01.18)

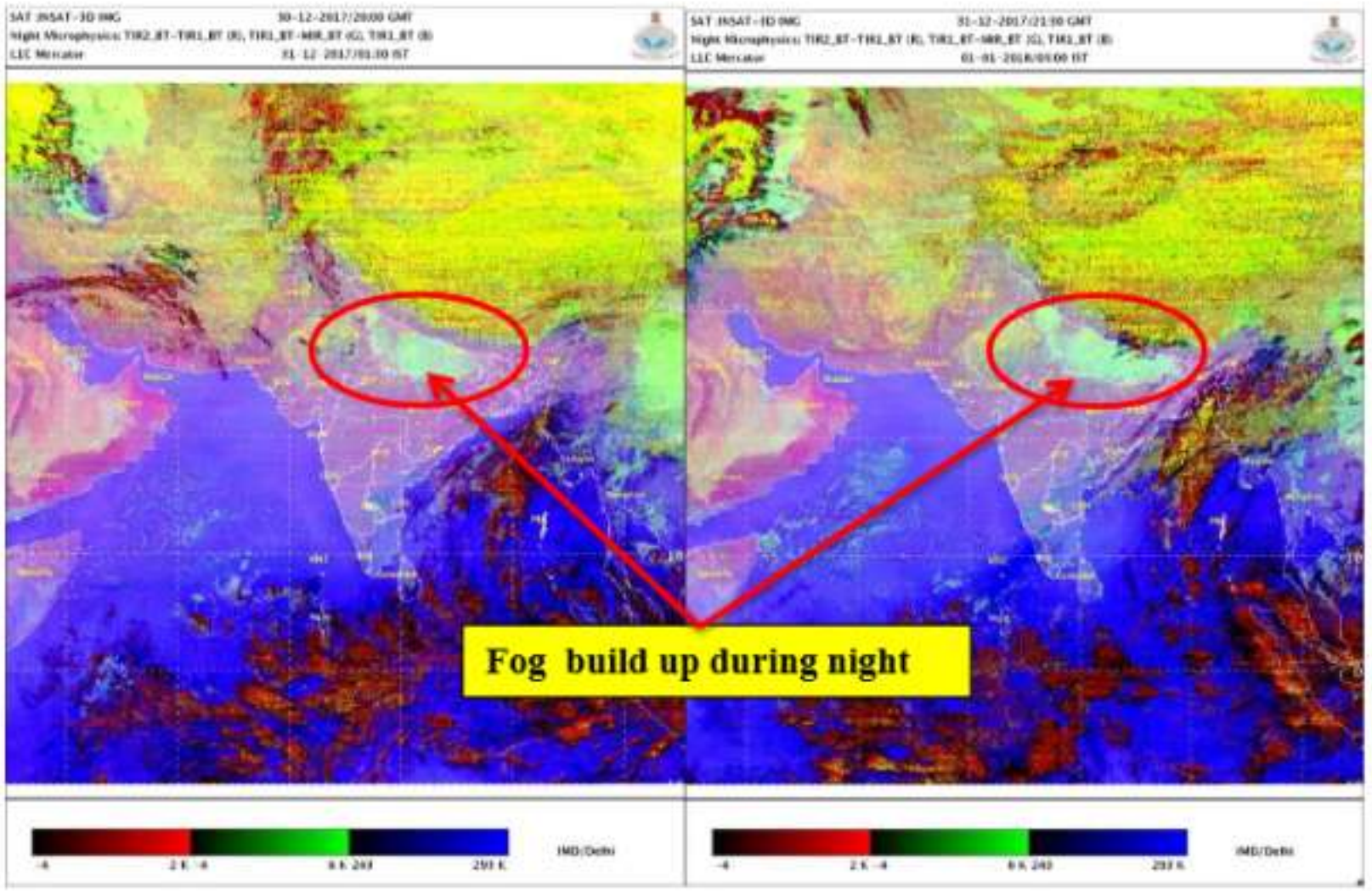
Date	Time of Tripping	Time of Revival
25.12.17	01:38 hrs	16:31 hrs
26.12.17	03:49 hrs	10:06 hrs.
29.12.17	03:30 hrs	10:48 hrs.
30.12.17	06:24 hrs	10:53 hrs.
31.12.17	01:55 hrs	18:45 hrs.
01.01.18	03:18 hrs	10:59 hrs.



Satellite image at 01:30 hrs dated. 25.12.17 Satellite image at 03:30 hrs dated. 26.12.17



Satellite image at 03:00 hrs dated. 29.12.17 Satellite image at 05:30 hrs dated. 30.12.17



Satellite image at 01:30 hrs dated. 31.12.17 Satellite image at 03:00 hrs dated. 01.01.18

It was observed that due to tripping of 765kV Anpara C – Unnao line, line loadings of other 400kV lines especially 400kV Anpara - Sarnath D/C increased beyond permissible limits (>700MW per ckt). Operating these lines on such high loading poses a threat to grid security.

Action taken: From the inputs of weather portal regarding spread of fog, UP was advised to back down generation in Anpara complex and increase generation in other plants to meet its load, in the interest of grid security. Low generation in Anpara complex ensures that in the event of tripping of 765kV Anpara C-Unnao line or any other 400kV line in Anpara complex (due to fog), the loading of other lines does not exceed operating limits. This gives operator an increased time window for corrective action.

(b) Transients in HVDC Rihand-Dadri during foggy winter nights

Transients in HVDC Rihand-Dadri were observed during night shifts for the period (25.12.17-01.01.18). To prevent the occurrence of flash over RVMO mode of HVDC was utilized.

Action taken: Visualization of fog from Satellite image at the weather portal was used to ascertain the requirement of putting the HVDC in RVMO mode.

RRVPNL has shared its experience in following words: ***"It is a great experience to browse through the weather portal. It has been quite useful for our load forecasting as well"***.

Eastern Region

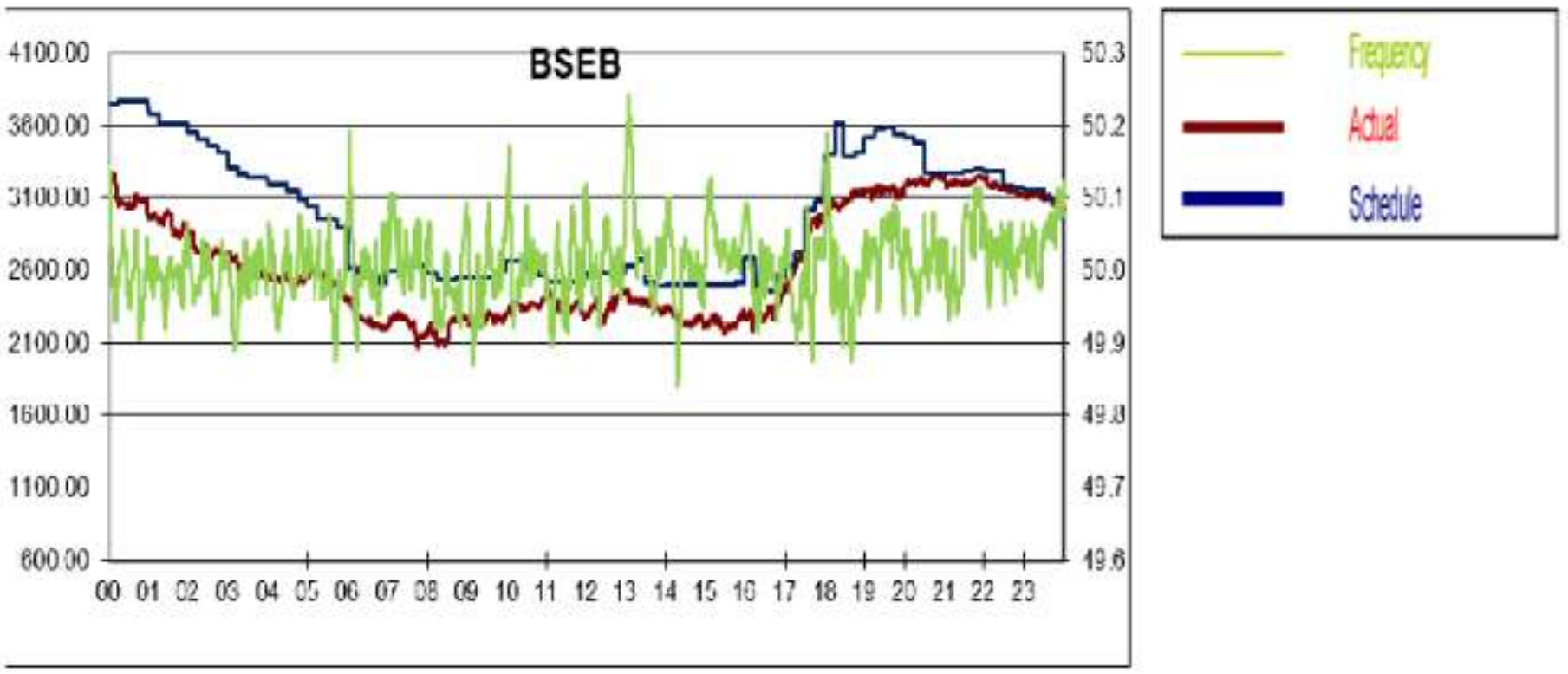
(i) Depression over northwest Bay of Bengal on 09.12.17

There was a depression over northwest Bay of Bengal on 09.12.17.It was known beforehand from the weather website that heavy rain at isolated places was very likely over West Bengal and Odisha. Anticipating lower demand and high frequency, ERLDC suggested NLDC to issue regulation down instruction in advance which helped in maintaining frequency profile.

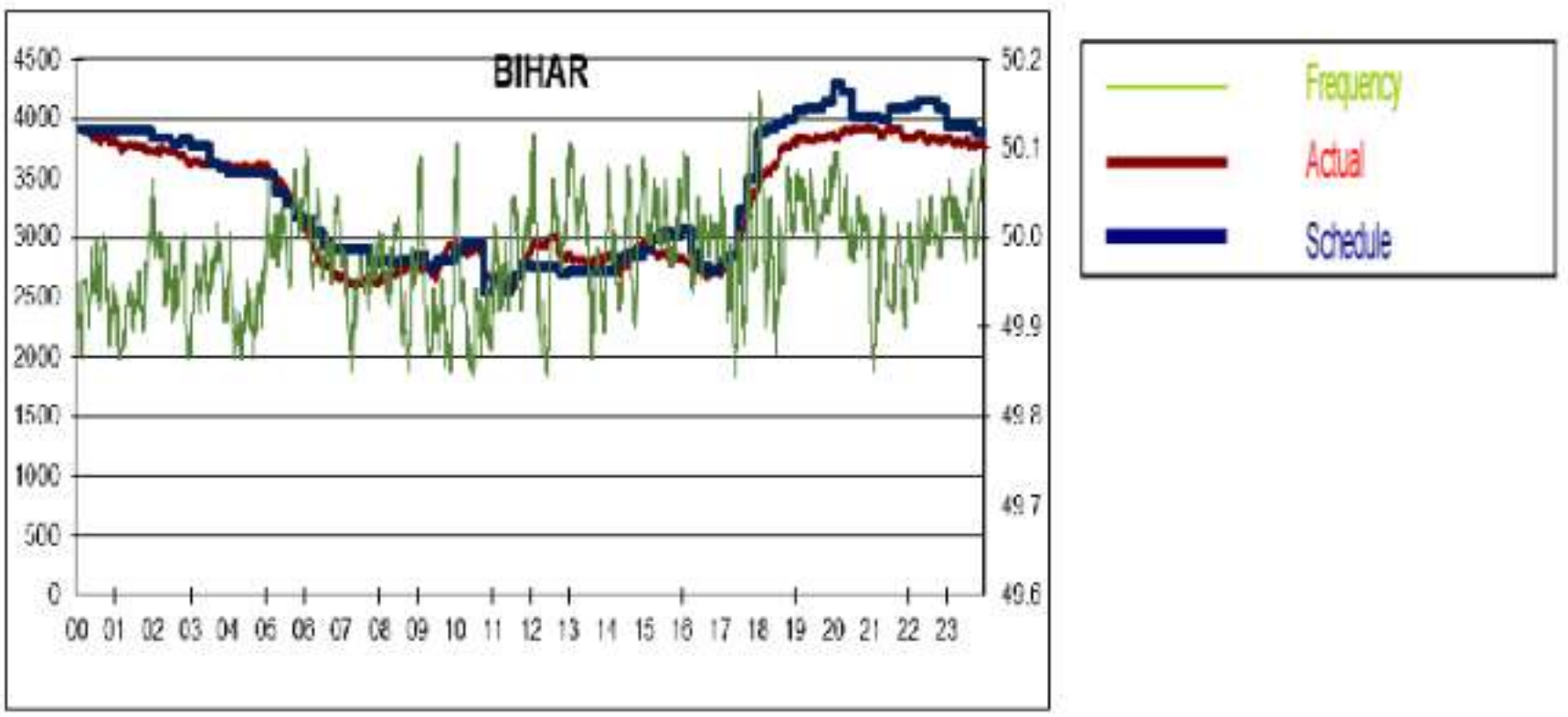
(ii) Demand prediction of Bihar

Earlier Bihar was not capable of predicting demand profile accurately, causing a large difference between schedule and actual exchange. With the introduction of weather portal the demand prediction of Bihar improved remarkably. Here is a comparison of schedule and actual exchange on 08th October of 2016 and 2017.

Scheduled and Actual exchange of Bihar on date: 08.10.16



Scheduled and Actual exchange of Bihar on date: 08.10.17



(iii) Depression over north-west Bay of Bengal on 09.10.2017

As per the day-ahead warning obtained from weather website it was known that depression over Gangetic West Bengal had intensified and heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places is very likely over Gangetic West Bengal during next 24 hours and

isolated heavy to very heavy rainfall during subsequent 24 hours. Accordingly the following course of action was decided to battle the situation:

- Restore the lines which are out on overvoltage in order to ensure system connectivity and reliability.
- Plan the generation backing down required in West Bengal according to estimated demand reduction.
- In case of sudden load crash, inform NLDC for support through RRAS down dispatch.
- Sensitize all the SLDCs and generating stations in the region regarding the cyclone.

(iv) Proactive action by West Bengal based on weather data:

Meteogram, wind and rain forecast for 09.10.17 helped in better load assessment of West Bengal control area by W.B State Load Dispatch Centre. As anticipated, West Bengal demand went down from 7051 MW to 5929 MW due to change in weather conditions. Accordingly, purchase of power through STOA (day-ahead) & Power Exchange was reduced by West Bengal from 22.86 MU (on the previous day) to 18.23 MU for 09.10.17 which resulted in overall saving of power procurement cost.

So with the implementation of the website, advance planning was possible to handle situations of extreme weather conditions.

Southern Region

Cyclone OCKHI- Southern Region

Weather portal for Southern Region helped the system operator and the system reliability team to take precautionary measures in issuing warning notes to the Southern States to prepare for a bad weather and a probable cyclone. Weather portal gave timely warning on the depression formed over southwest Bay of Bengal near southeast Sri Lanka coast in the morning of 29th November, 2017. It was identified that this depression would develop into a cyclonic storm during the next 12 hours.

System reliability and study group of SRLDC prepared an alert report explaining the probable cyclone and various precautions to be taken during the cyclone period by the system operator. The following aspects were of utmost importance for the system operation.

1. **Rainfall Information and Wind Warning:** It was informed that there would be widespread rainfall in parts of southern Tamilnadu and Kerala.
    - Tamilnadu was advised to be prepared for a demand reduction of approx. 1000 MW due to this and thus have reduced their internal Generation.
    - Kerala also witnessed a 350 MW reduction in demand; internal generation was regulated by 200 MW.
    - Totally internal generation of Southern Region was reduced by 2500 MW.

2. **Precautions Taken**
    - It was expected that a voltage rise would occur in the Southern Grid due to load loss.
    - All the Bus-Reactors were made available to combat over-voltages.
    - Thermal generators were instructed for maximizing reactive power absorption
    - All the transmission line outages were deferred during the cyclone period.

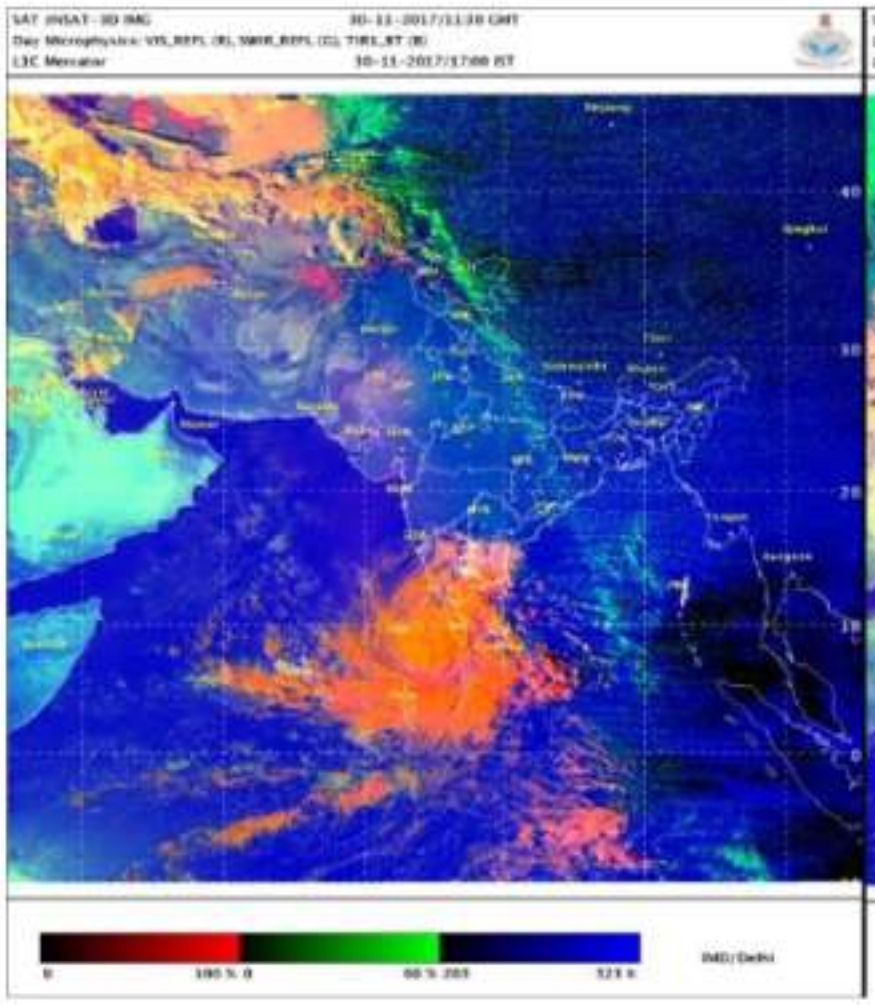
3. **Kudankulam Nuclear Power Station (2 x 1000 MW)**

    Since the cyclone was passing close by to this nuclear station, a plan was prepared for restoration of supply in-case of any emergency.

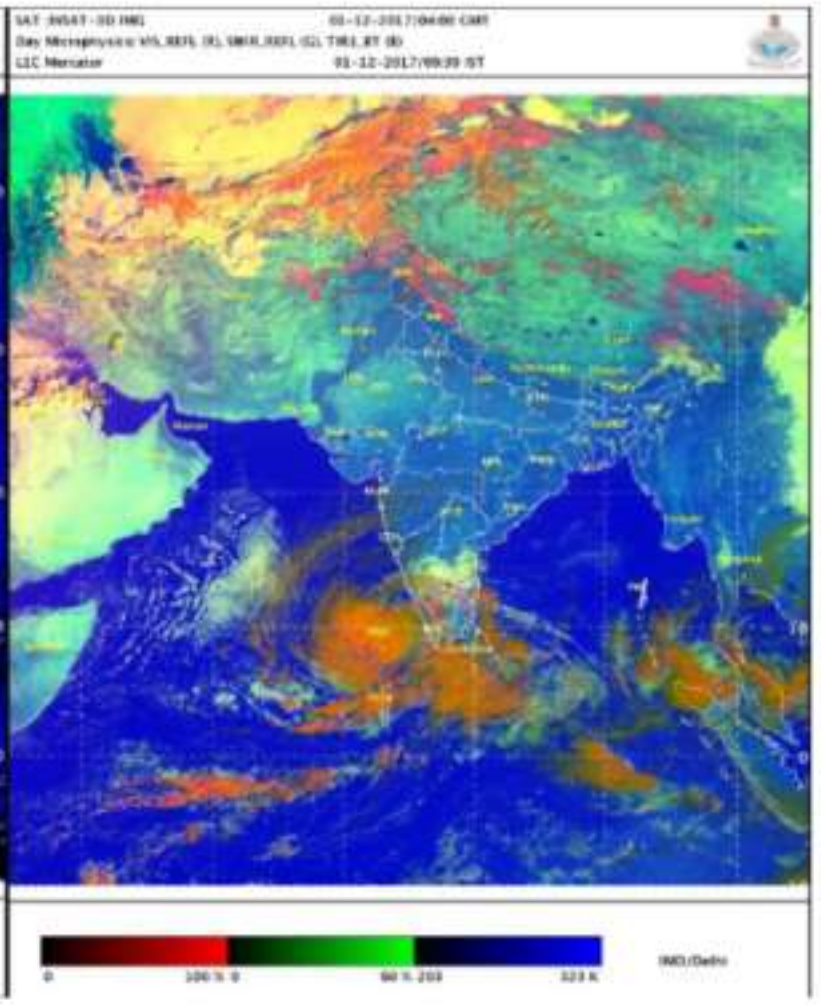
4. **Traction Supply**

    All the important feeder points were identified for South Western Railways for immediate restoration. There was no loss of traction supply in Tamilnadu and Kerala.

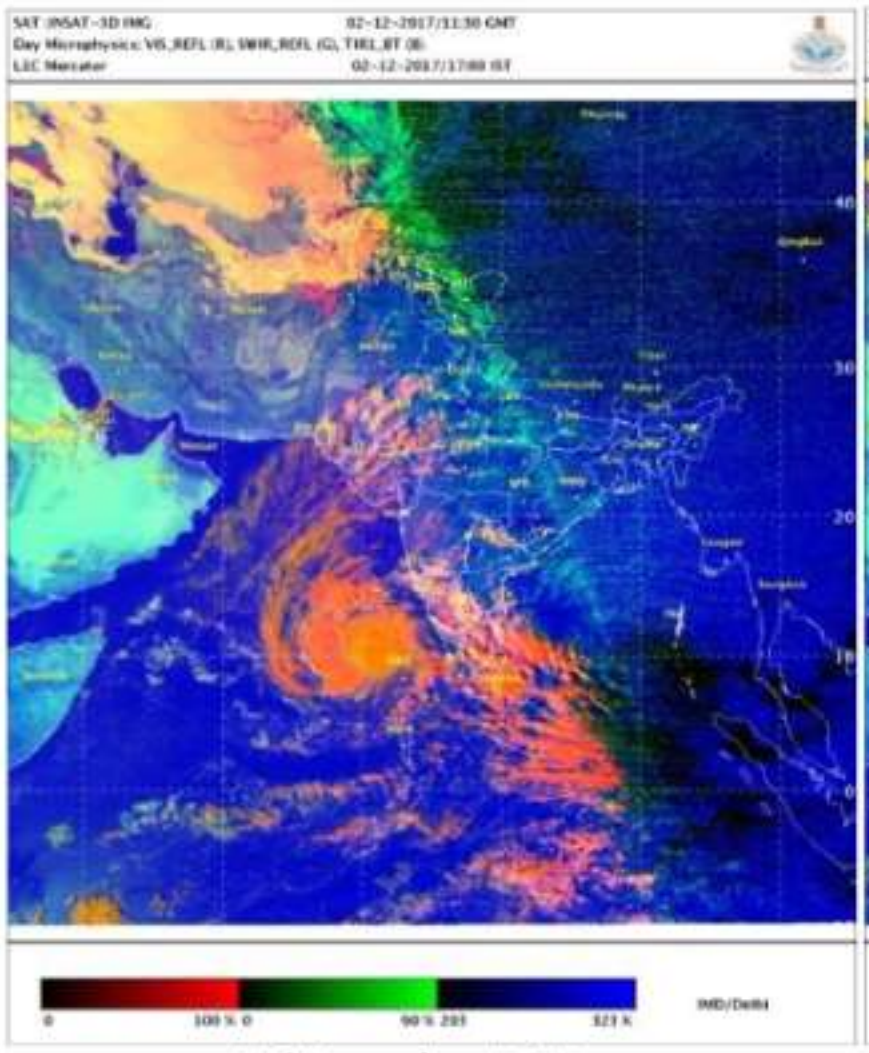
Monitoring of Cyclone OCKHI



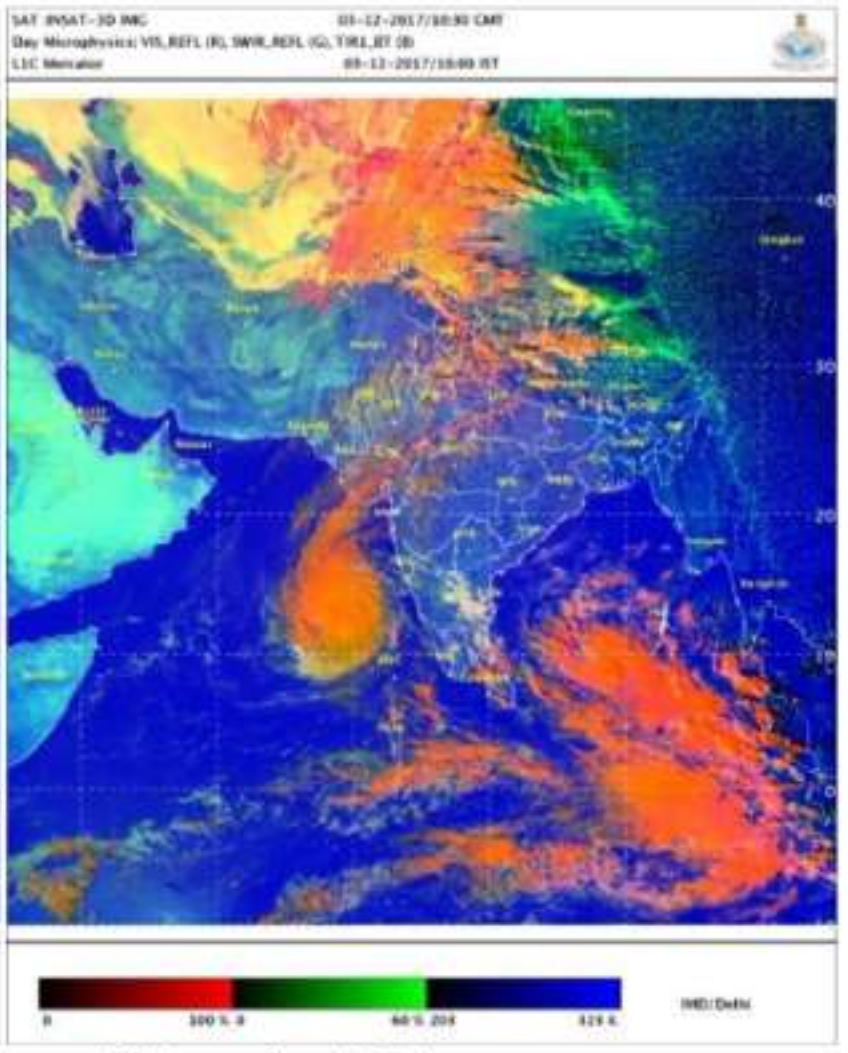
30Th November 2017



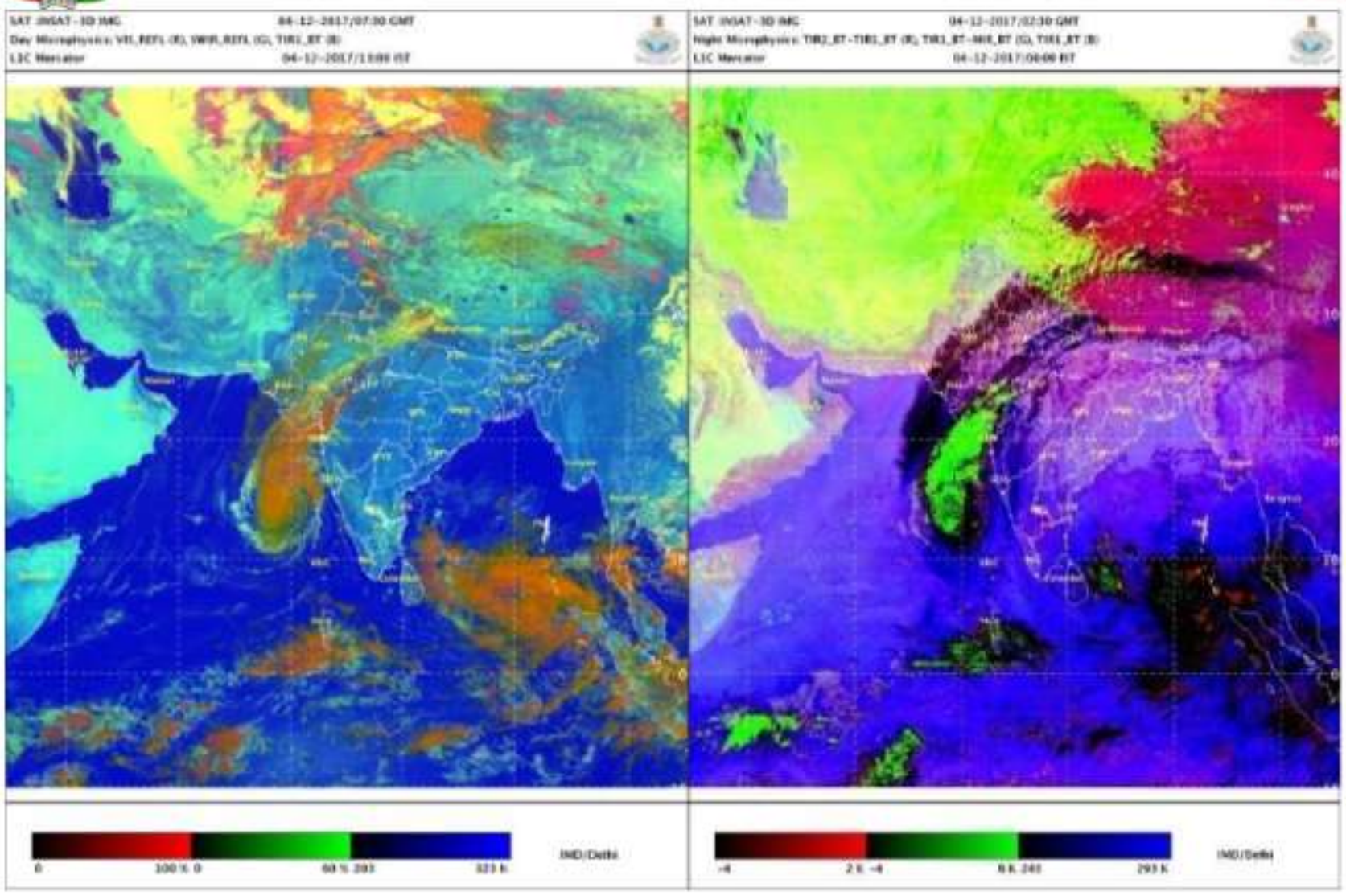
1st December 2017



2nd December 2017



3rd December 2017



4th December 2017

5th December 2017

5th December 2017 (night hours)

North Eastern Region

NERLDC delivered a presentation on weather portal of North Eastern Region during 132nd OCC meeting held at Guwahati on 12th May, 2017. Scientists from RMC, Guwahati also delivered a presentation on the weather portal of North Eastern Region during 134th OCC meeting held at Guwahati on 28th July, 2017.

Since inception of the Weather Portal, NERLDC is using the portal of North Eastern Region for Real-Time Grid Management and the same is made available as a separate TAB in NERLDC website for easy reference.

Usage of weather portal of North Eastern Region by NERLDC is mentioned below:

1. **Usage of Weather Portal on Daily Basis:**
   - Regional weather forecast report is mailed to all the SLDCs, ISGSs for taking appropriate measures on Daily Basis.
   - Nowcast data of 7 (seven) cities are available as of now which are monitored from time to time.
   - 3 hours forecasted maximum temperature, relative humidity and rainfall data are used by the system operators of NERLDC for hydro dispatch scheduling and as well as mailed to all the SLDCs for computation of load forecast and ISGSs for generation planning on daily basis.

2. **Usage of Weather Portal for Cyclone Warnings:**

   Cyclone "MORA":

   Cyclonic storm "MORA" over east central Bay of Bengal was issued by Indian Meteorological Department vide bulletin no 12 dated 29.05.17. The same was also available in cyclone warning tab in weather portal of North Eastern Region. Heavy rainfall warning was issued Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura.

   NERLDC immediately informed all the SLDCs and ISGSs about the upcoming cyclonic storm "MORA". NERLDC also informed all the SLDCs and ISGSs that due to the cyclonic effect there may be extensive load crash as well as the generation loss in the NER especially in Tripura. To tackle emergency situations, the generators were informed that they may be requested to maintain the technical minimum or units may be asked to back down for the security of the power system. All the SLDCs and ISGSs responded to the Cyclone "MORA" warning and

reported its preparedness to take care of the situation. Time to time update about the path of Cyclone "MORA" were monitored by real time operators and all SLDCs and ISGSs were also informed about the same.

Load crash due to adverse weather conditions was also reported by Assam, Manipur, Mizoram and Meghalaya during cyclone "MORA". The brief details of total amount of load and generation loss is given below:

Date	States Affected	Total Load Loss	Total Generation Loss
30.05.17	Assam, Manipur, Mizoram, Meghalaya	558	Nil
31.05.17	Assam	194	Nil

3. **Usage of Weather Portal for Weather Warnings:**

- Weather warnings as issued by Indian Meteorological Department regarding rainfall, foggy conditions are informed to the SLDCs and ISGSs and are requested to be vigilant. The warnings are used for real time grid management also by NERLDC system operators.
- Based on the warnings on fog, gas based generators were informed to maintain adequate filters in stock to tackle any emergency situation.

4. **Usage of Weather Portal for Load Forecasting:**

- NERLDC is working on the usage of weather data for load forecasting. Currently 3 hours forecasted maximum temperature, relative humidity and rainfall data are only available from IMD. Currently load forecasting is being done for 15 mins time block and high forecasted error is coming for usage of repetitive data for 3 hours. Minimum of 1 hour forecasted maximum temperature, relative humidity and rainfall shall be used for minimizing the forecasted error.
- For better load forecasting, the seasonal pattern of variation of load with respect to temperature, relative humidity, rainfall, wind speed, wind direction etc. is being studied.

5. **Usage of Weather Portal for Real Time Grid Operation:**

- In real time, the "Nowcast" feature of weather portal is extensively used for monitoring and alerting the SLDCs.
- The SLDCs are made aware of any disturbance in weather conditions and they are advised to manage their load accordingly.
- The weather portal also allows the real-time grid operator to remain more vigil as in case of heavy wind, cyclone, or heavy lightning, the events of tripping also increase.

6. **Usage of Weather Portal for Scheduling:**

- The warnings of inclement weather help in predicting sudden unprecedented decrease in demand.
- In such cases where demand is low due to inclement weather, generation schedule of hydro machines is revised such that only optimal numbers of hydro units are running to meet the reduced demand.
- The states are advised to monitor the weather conditions at various locations in their respective states and revise their power requisition, if needed.

14. Road Ahead

- Structured weather services for power sector.
- Use of Radar products and Satellite image in real time grid operation.
- Use of Meteogram, Satellite image and Radar data for load forecasting/RE generation forecasting.
- Use of Meteogram for generation planning and transmission outage planning.
- Inflow forecasting: Generation from a run of river hydro power station depends upon the water inflow into river basin. Weather monitoring stations and RADAR may be utilized to estimate precipitation.
- Inclusion of power system network as a base layer in RAPID software. Upon successful inclusion, system operators can interact like actual satellite workstation and may zoom to any substation or transmission line path and make themselves aware of weather conditions.
- Establishment of IMD desk at National Load Despatch Centre for power sector with following assignments.
    - Daily National/Regional weather report generation.
    - Providing monthly /seasonal weather outlook.
    - Providing weather data for load/RE forecasting.
    - Deciphering Satellite images / RADAR images for system operators.
    - Rainfall estimate in catchment area of hydro plants for inflow forecasting /silt forecasting.
    - Coordination with IMD for value added weather information.
    - Conducting workshops for power sector professionals.
- The Indian Air Force (IAF) has joined hands with IMD to share real time lightening related data. IAF has installed more than 142 sensors to detect lightening across the country. Tripping of lines due to lightening is almost 3 times higher in North Eastern Region compared to other parts of the country. Predicting lightening incidents by IMD shall be very useful for system operators and transmission companies.

15. Regional Contact details of IMD

- **Northern Region :**
  Director
  AMSS
  M.O. Palam, I.G.I. Airport,
  New Delhi
  Telefax: 91-011-25652398
  Phone: 91-011-25653509
  E-mail: amss20042000@yahoo.co.in

- **North Eastern Region:**
  Regional Meteorological Centre
  LGB International Airport
  Guwahati, Assam, (INDIA)
  Guwahati - 781015
  Phone : 0361 - 2840238 / 2840243
  Tele Fax : 0361 - 2840243
  E-mail : ddgm-rmc-guw@nic.in

- **Eastern Region**:
  Deputy Director General of Meteorology,
  Regional Meteorological Centre,
  4, Duel Avenue, Alipore, Kolkata - 700027.
  Telephone :033-24793782
  Fax :033-24793782
  e-mail :rmckol@dataone.in

- **Western Region**:
  Deputy Director General of Meteorology
  Regional Meteorological Centre,
  Near R.C Church, Next Ashwini Naval Hospital,Colaba, Mumbai-400005.
  Telephone: 022- 22150517/22174707

- **Southern Region**:
  Deputy Director General of Meteorology,
  Regional Meteorological Centre,
  50 (New 6) College Road,Chennai 600006.

- **For all weather related enquiries contact**

Duty officer
Area Cyclone warning Centre (24 hours)
Telephone: 044-28271951
Fax: 044-28271581
E-mail: acwctp@gmail.com

Annexure-I

Type	Abbreviation	Meaning	Abbreviation	Meaning
Intensity	-	Light intensity	blank	Moderate intensity
Intensity	+	Heavy intensity	VC	In the vicinity
Descriptor	MI	Shallow (French: Mince)	PR	Partial
Descriptor	BC	Patches (French: Bancs)	DR	Low drifting
Descriptor	BL	Blowing	SH	Showers
Descriptor	TS	Thunderstorm	FZ	Freezing
Precipitation	RA	Rain	DZ	Drizzle
Precipitation	SN	Snow	SG	Snow Grains
Precipitation	IC	Ice Crystals	PL	Ice Pellets
Precipitation	GR	Hail (French: Grêle)	GS	Small Hail and/or Snow Pellets (French: Grésil)
Precipitation	UP	Unknown Precipitation		
Obscuration	FG	Fog	VA	Volcanic Ash
Obscuration	BR	Mist (French: Brume)	HZ	Haze
Obscuration	DU	Widespread Dust	FU	Smoke (French: Fumée)
Obscuration	SA	Sand	PY	Spray
Other	SQ	Squall	PO	Dust or Sand Whirls
Other	DS	Duststorm	SS	Sandstorm
Other	FC	Funnel Cloud		
Time	B	Began At Time	E	Ended At Time
Time	2 digits	Minutes of current hour	4 digits	Hour/Minutes Zulu Time

Annexure-II

City Code in Radar Image

Northern Region		
	Abbreviation	Meaning
Delhi NCR	IGI	IGI Airport New Delhi
Delhi NCR	GUR	Gurugram
Delhi NCR	FRD	Faridabad
Delhi NCR	GZB	Gaziabad
UP	BAG	Bagpat
UP	MRT	Meerut
UP	MZF	Muzaffarnagar
UP	BIJ	Bijnaur
UP	MRD	Muradabad
UP	SHB	Sambhal
UP	BDS	Bulandsahar
UP	SWN	Sahsawan
UP	BDN	Badaun
UP	BRY	Bareilly
UP	ALG	Aligarh
UP	HTH	Hathrash
UP	ETA	Eta
UP	MNP	Mainpuri
UP	ETW	Etawah
UP	PLB	Pilibhit
UP	RMP	Rampur
UP	LKP	Lakhimpur
UP	KNJ	Kannauj
UP	KNP	Kanpur

UP	LKN	Lucknow
UP	UNO	Unnao
UP	CHK	Chitrakoot
UP	JHN	Jhansi
UP	MHP	Mauranipur
UP	LLT	Lalitpur
UP	ALB	Allahabad
UP	FZD	Faizabad
UP	GDA	Gonda
UP	BRC	Bahraich
UP	BST	Basti
UP	SKN	Santkabirnagar
UP	GKP	Gorakhpur
UP	MTR	Mahrajganj
UP	KGN	Kushinagar
UP	DOR	Deoria
UP	MAU	Mau
UP	BLA	Balia
UP	JNP	Jaunpur
UP	VNS	Varanasi
UP	SRN	Santravidasnagar
UP	MZP	Mirzapur
Haryana	PLW	Palwal
Haryana	HDL	Hodal
Haryana	NUH	Nuh
Haryana	REW	Rewari
Haryana	NAR	Narnaul
Haryana	JHJ	Jhajjar
Haryana	ROH	Rohtak
Haryana	BWN	Bhiwani

Haryana	HSR	Hisar
Haryana	PNP	Panipat
Haryana	FTB	Fatehabad
Haryana	SSA	Sirsa
Haryana	KTL	Kaithal
Haryana	KNL	Karnal
Haryana	KSH	Kurukshetra
Haryana	YAN	Yamuna nagar
Haryana	AMB	Ambala
Rajasthan	ALW	Alwar
Rajasthan	BRP	Bharatpur
Rajasthan	DHP	Dhulpur
Rajasthan	DSA	Dausa
Rajasthan	KRL	Karauli
Rajasthan	TNK	Tonk
Rajasthan	JPR	Jaipur
Rajasthan	BDI	Bundi
Rajasthan	BRN	Baran
Rajasthan	JHW	Jhalwar
Rajasthan	CHG	Chittorgarh
Rajasthan	BLW	Bhilwara
Rajasthan	RJM	Rajasmand
Rajasthan	UDP	Udaipur
Rajasthan	AJM	Ajmer
Rajasthan	JDP	Jodhpur
Rajasthan	JLR	Jaisalmer
Rajasthan	SRH	Sorohi
Rajasthan	NGR	Nagaur
Rajasthan	BKN	Bikaner
Rajasthan	JHUN	Jhunjhunu

Rajasthan	PLM	Pilani
Rajasthan	CRU	Churu
Rajasthan	HMS	Hanumangarh
Rajasthan	GGN	Ganganagar
Punjab	DVGR	Devigarh
Punjab	PTL	Patiala
Punjab	SNGR	Sangrur
Punjab	MNS	Mansa
Punjab	BTD	Bhatinda
Punjab	MNDBL	Mandidawali
Punjab	ABHR	Abohar
Punjab	FZLK	Fazilka
Punjab	MKTSR	Muktsar
Punjab	FDKT	Faridkot
Punjab	FZPR	Ferozepur
Punjab	ZIRA	Zira
Punjab	NBH	Nabha
Punjab	KHNA	Khanna
Punjab	LDN	Ludhiana
Punjab	NSHR	Nawanshahr
Punjab	NKD	Nakodar
Punjab	JLNDR	Jalandhar
Punjab	NGL	Nangal
Punjab	ADMPR	Adampur
Punjab	HSRPR	Hoshiarpur
Punjab	DSUA	Dasuya
Punjab	GDP	Gurudaspur
Punjab	BTL	Batala
Punjab	AJNL	Ajnala
Punjab	AMRTSR	Amritsar

Punjab	KPRTL	Kapurthala
Punjab	CHD	Chandigarh
J&K	SRN	Srinagar
J&K	GDB	Ganderbal
J&K	KGN	Kangan
J&K	SHP	Shopian
J&K	KLG	Kulgam
J&K	ANG	Anantnag
J&K	QZD	Qauzigund
J&K	KNG	Kokernag
J&K	BNL	Banihal
J&K	RJR	Rajouri
J&K	PNH	Poonch
J&K	URI	Uri
J&K	TGR	Tangdhar
J&K	GLM	Gulmarg
J&K	BRM	Baramulla
J&K	HDW	Handwara
J&K	KUP	Kupwara
J&K	BDP	Bandipora
J&K	SMG	Sonamarg
J&K	BTL	Baltal
J&K	ANC	Amarnath
J&K	PHL	Pahlgam
Eastern Region		
West Bengal	KOL	Kolkata
West Bengal	DD	Dumdum
West Bengal	UNP	Udaynarayanpur
West Bengal	KLG	Kolaghat
West Bengal	DDH	Diamond harbour

West Bengal	CNG	Canning
West Bengal	HLD	Haldia
West Bengal	RDG	Raidighi
West Bengal	ABG	Arambagh
West Bengal	HBR	Habra
West Bengal	BSH	Bashirhat
West Bengal	HGJ	Hinagalganj
West Bengal	BNG	Bongaon
West Bengal	KRG	Krishnanagr
West Bengal	BDW	Bardhman
West Bengal	MDP	Medinpure
West Bengal	JRM	Jhagram
West Bengal	BNK	Bankura
West Bengal	DGP	Durgapur
West Bengal	SKT	Shantiniketan
West Bengal	SGR	Sagar
West Bengal	DGH	Digha
West Bengal	ASL	Asansol
West Bengal	SUR	Suri
West Bengal	BRP	Berhampore
West Bengal	PRL	Purulia
Bihar	PTN	Patna
Bihar	CHP	Chhapra
Bihar	JNG	Jahanabad
Bihar	ARA	Aara
Bihar	BXR	Buxar
Bihar	SRM	Sasaram
Bihar	ABD	Aurnagabad
Bihar	GYA	Gaya
Bihar	NWD	Nawada

Bihar	BHR	Bihar sharif
Bihar	SMP	Samastipur
Bihar	MZF	Muzzafarpur
Bihar	SWN	Siwan
Bihar	BHB	Bhabua
Bihar	DTG	Daltonganj
Bihar	CHT	Chauparan
Bihar	HZB	Hazaribagh
Bihar	KDM	Koderma
Bihar	GDH	Giridih
Bihar	DGR	Deoghar
Bihar	BNK	Banka
Bihar	BGP	Bhagalpur
Bihar	JMI	Jamui
Bihar	LKS	Lakhisarai
Bihar	MGR	Munger
Bihar	BGS	Begusarai
Bihar	KGR	Khagria
Bihar	SHS	Saharsha
Bihar	SPL	Supaul
Bihar	MDP	Madhepura
Bihar	DBG	Darbhanga
Bihar	MDB	Madhubani
Bihar	STM	Sitamarhi
Bihar	GPG	Gopalganj
Bihar	MTH	Motihari
Bihar	BTH	Bettiah
Bihar	KDPR	Krushnandapur
Bihar	JSP	Jagatshingpur
Bihar	JJPR	Jajpur

Bihar	DNKL	Dhenkanal
Bihar	ANGUL	Angul
Bihar	NYGH	Nayagarh
Bihar	GNJM	Ganjam
Bihar	TLCR	Talcher
Bihar	KEJR	Keonjhar
North-Eastern Region		
Tripura	AGT	Agartala
Tripura	UDP	Udaipur
Tripura	BLN	Belonia
Tripura	SBR	Sabroom
Tripura	AMB	Ambassa
Tripura	KML	Kamalpur
Mizoram	AZL	Aizwal
Assam	MBR	Mohanbari
Assam	TSK	Tinsukia
Assam	DGB	Digboi
Assam	SBG	Sivasagar
Assam	LKP	Lakhimpur
Assam	JRT	Jorhat
Assam	GHP	Gohpur
Assam	GLT	Golaghat
Assam	TZP	Tezpur
Assam	NGO	Nagaon
Assam	LMD	Lumding
Arunachal Pradesh	PSG	Pasighat
Arunachal Pradesh	ALN	Along
Arunachal Pradesh	DPJ	Daporijo
Arunachal Pradesh	ZRO	Zero
Arunachal Pradesh	KNS	Khonsa

Southern Region		
Tamilnadu	NGR	Nagalpuram
Tamilnadu	VLR	Vellore
Tamilnadu	KAN	Kanchipuram
Tamilnadu	CGP	Chengalpattu
Tamilnadu	PLC	Pulicat
Tamilnadu	SHR	Sriharikota
Tamilnadu	TPL	Tirupati
Tamilnadu	GDR	Gudur
Tamilnadu	AMB	Ambur
Tamilnadu	YEL	Yelagiri
Tamilnadu	PLR	Polur
Tamilnadu	TVM	Tiruvannamalai
Tamilnadu	TDV	Tindivanam
Tamilnadu	CEY	Cheyur
Tamilnadu	PDC	Puducherry
Tamilnadu	CDL	Cuddalore
Tamilnadu	NLR	Nellore
Tamilnadu	NLP	Nellore palem
Tamilnadu	RJM	Rajamet
Tamilnadu	RYC	Rayochoty
Tamilnadu	MDP	Madanpalle
Tamilnadu	MUL	Mulbagal
Tamilnadu	KRG	Krishnagiri
Tamilnadu	HAR	Harur
Tamilnadu	KLK	Kallkurichi
Tamilnadu	CHD	Chidambaram
Tamilnadu	ARL	Ariyalur
Tamilnadu	SLM	Salem
Tamilnadu	UDG	Udayagiri

Telangana	HYD	Hyderabad
Telangana	SBD	Shamshabad
Telangana	BHG	Bhuvangiri
Telangana	SGD	Sangareddy
Telangana	MDC	Medchal
Telangana	MDK	Medak
Telangana	SDP	Siddipet
Telangana	JGN	Jangaon
Telangana	WGL	Warangal
Telangana	NLG	Nalgonda
Telangana	DVK	Devarkonda
Telangana	MBN	Mehbubnagar
Telangana	NGKR	Nagarkurnool
Telangana	WNP	Wanaparthy
Telangana	NSG	Nagarjunasagar
Telangana	SYP	Suryapet
Telangana	GNT	Guntur
Telangana	KHM	Khammam
Telangana	MBB	Mahbubabad
Telangana	BHU	Bhupalpally
Telangana	KRM	Karimnagar
Telangana	JGT	Jagtial
Telangana	MCH	Mancherial
Telangana	ASB	Asifabad
Telangana	NIR	Nirmal
Telangana	NZB	Nizamabad
Telangana	NPT	Narayanpet
Karnataka	RCH	Raichur
Telangana	GDW	Gadwal
Andhra Pradesh	KRN	Kurnool

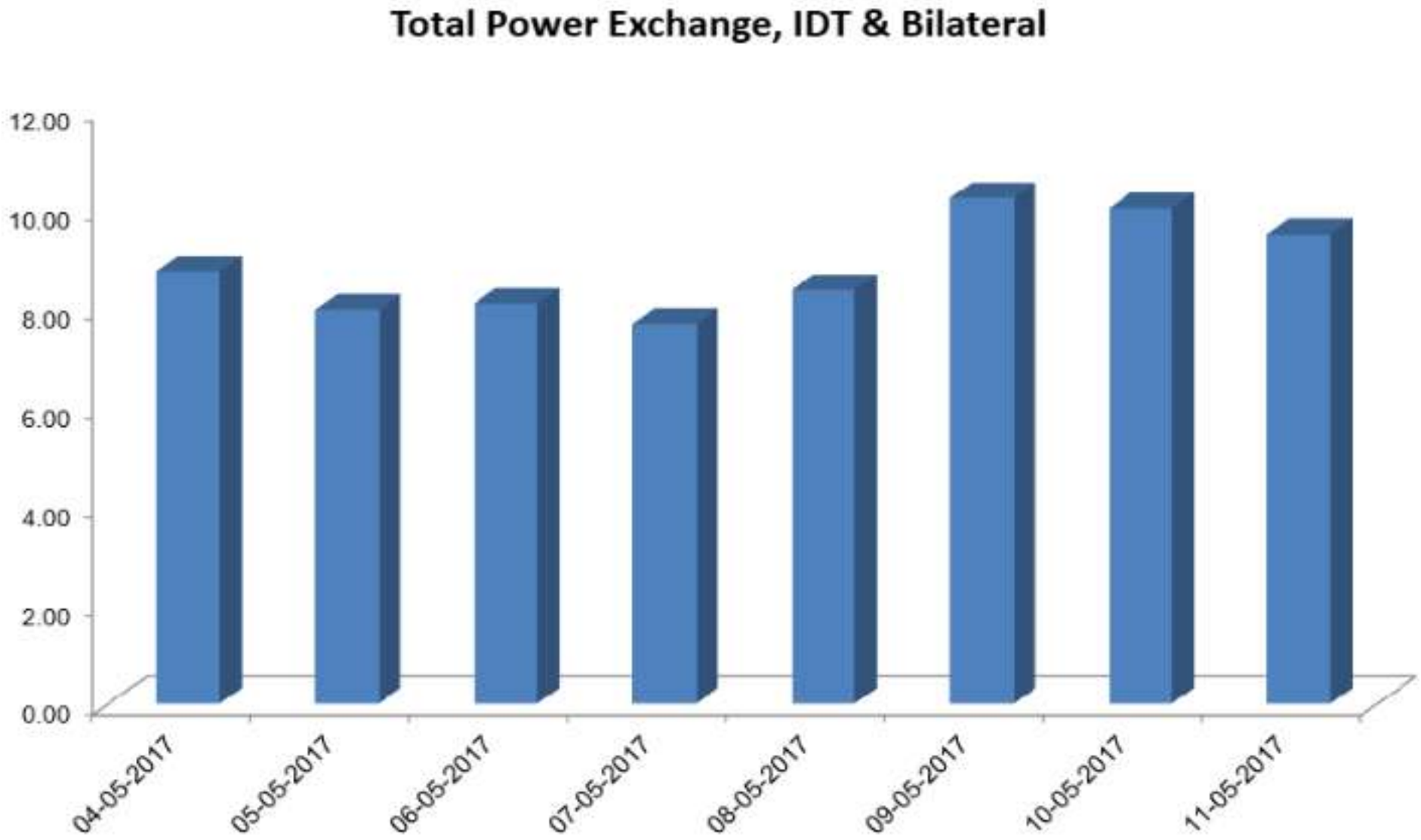
Telangana	RMG	Ramagundam
Telangana	PDP	Peddapalli
Telangana	VKB	Vikrabad
Andhra Pradesh	VJA	Vijayawada
Andhra Pradesh	MPT	Machilipatnam
Andhra Pradesh	NSP	Narsapur
Andhra Pradesh	RJY	Rajahmundry
Andhra Pradesh	KND	Kakinada
Andhra Pradesh	VSK	Vishakhapatnam
Andhra Pradesh	VZM	Vizianagram
Andhra Pradesh	KLN	Kalingapatnam
Western Region		
GOA	PNJ	Panjim
GOA	ANJ	Anjuna
GOA	MOR	Morjim
GOA	DBIM	Dabolin
GOA	SHI	Shiroda
GOA	MRGAO	Mormugao
GOA	PON	Ponda
GOA	VAL	Valpoi
GOA	SQLH	Sanquelim
GOA	PER	Pernem
GOA	VNG	Vengurla
GOA	DVG	Devbagh
GOA	QPM	Quepem
GOA	CRNZL	Caranzol
GOA	SNGM	Sanguem
GOA	CAN	Canacona
GOA	NET	Netravali
GOA	VRLM	Verlem

GOA	DWD	Dudhsagr
Madhya Pradesh	BRS	Berasia
Madhya Pradesh	NRG	Narsinghgarh
Madhya Pradesh	BRA	Biaora
Madhya Pradesh	SGP	Sarangpur
Madhya Pradesh	KAD	Kannod
Madhya Pradesh	ITS	Itarasi
Madhya Pradesh	UDP	Udaipur
Madhya Pradesh	GBSD	GanjBasoda
Madhya Pradesh	SIG	Siroj
Madhya Pradesh	ASK	Ashoknagar
Madhya Pradesh	TKG	Tikamgarh

BRPL
Case Study on Savings due to Weather Portal

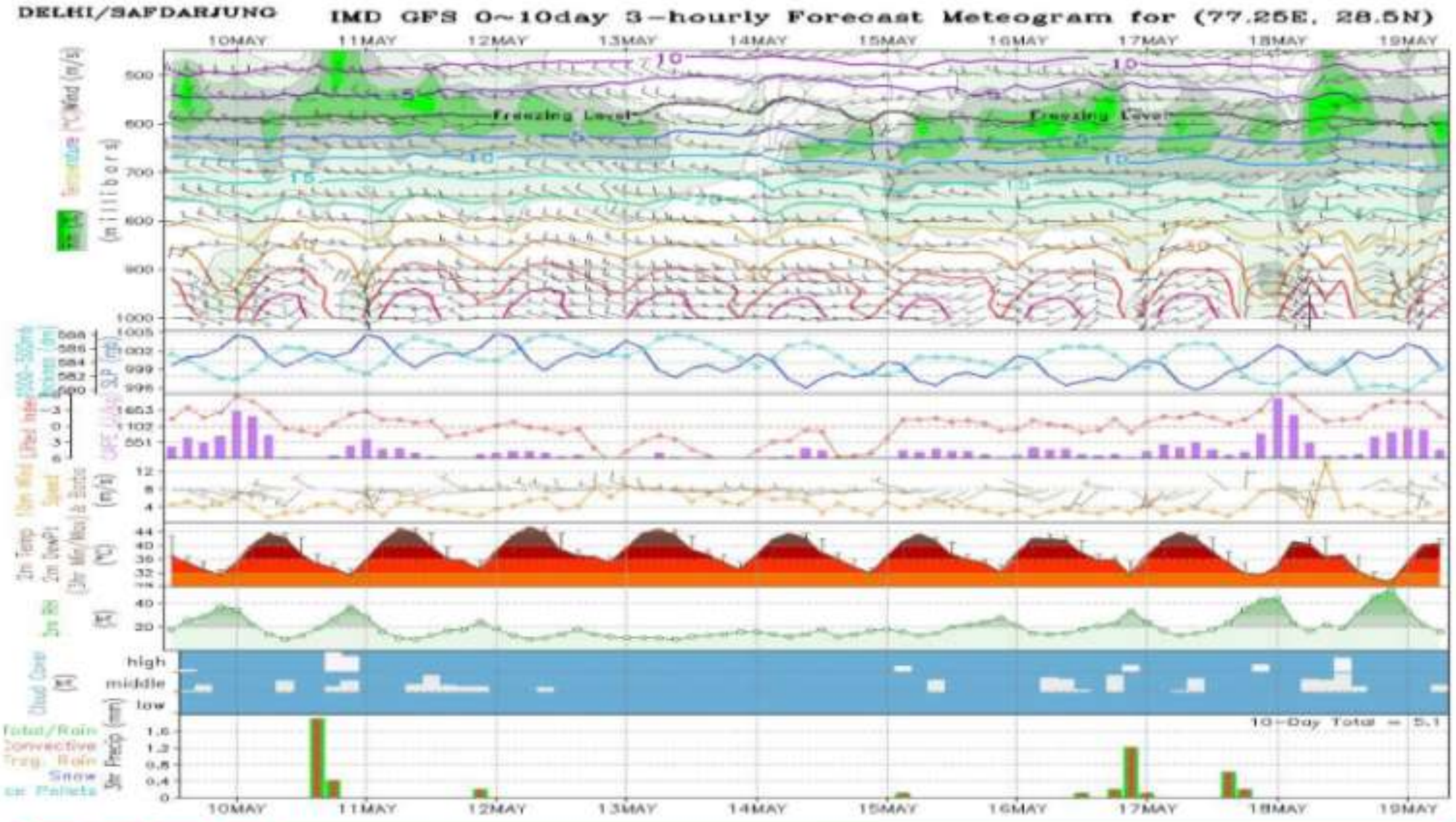
INDEX

BRPL : Case Study for 10.05.2017



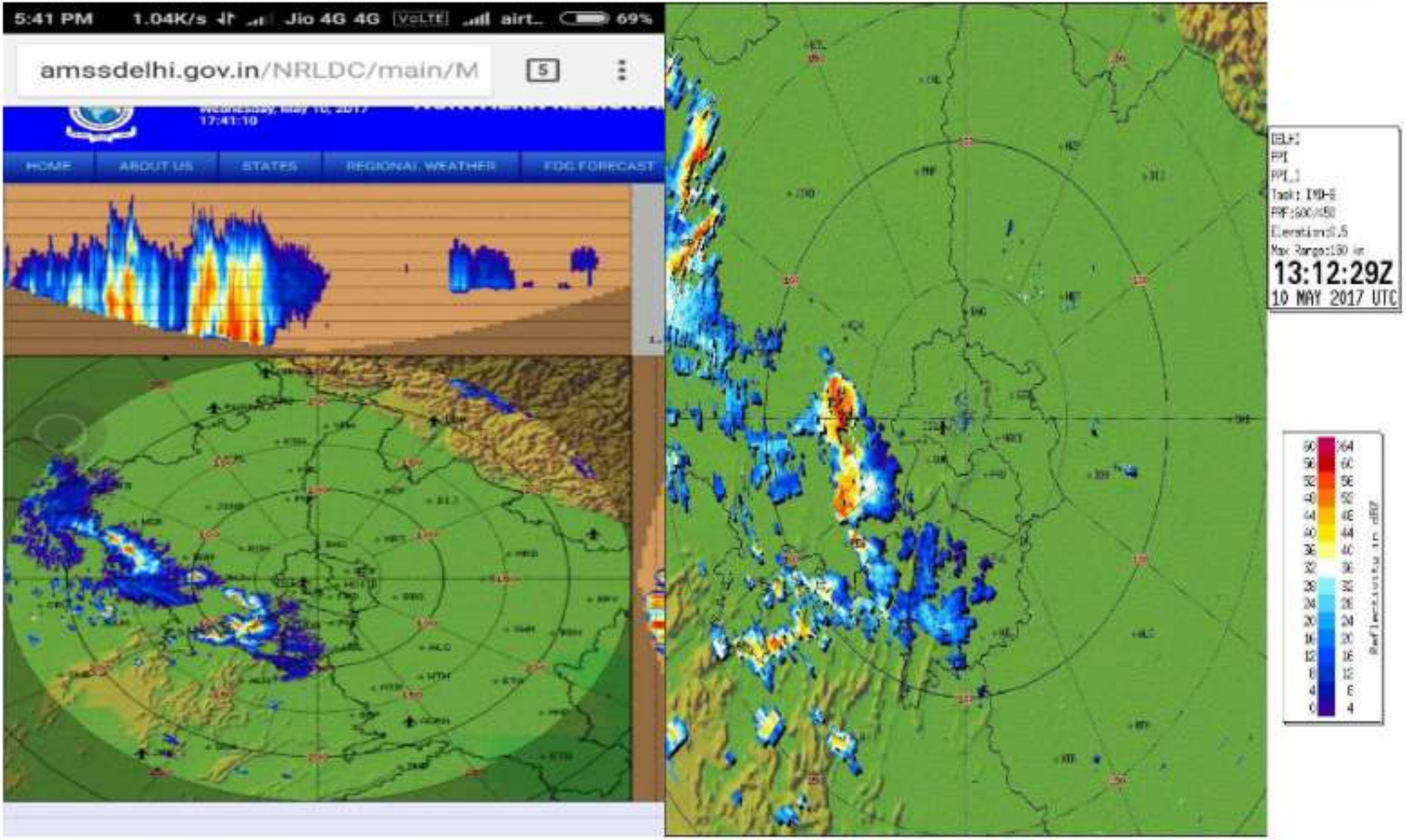
BRPL : Case Study for 10.05.2017

Weather Forecast

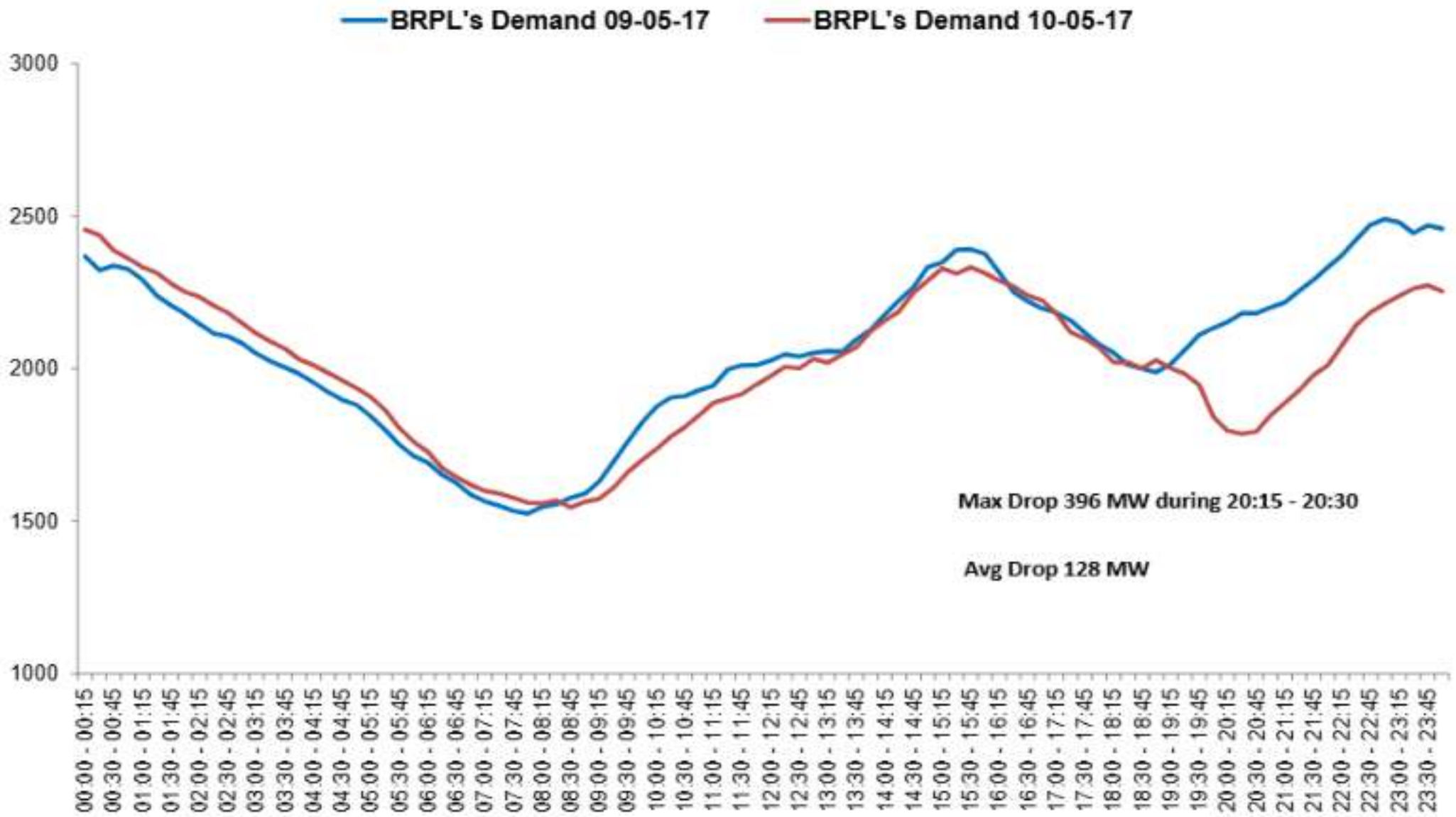


BRPL : Case Study for 10.05.2017

Radar Image



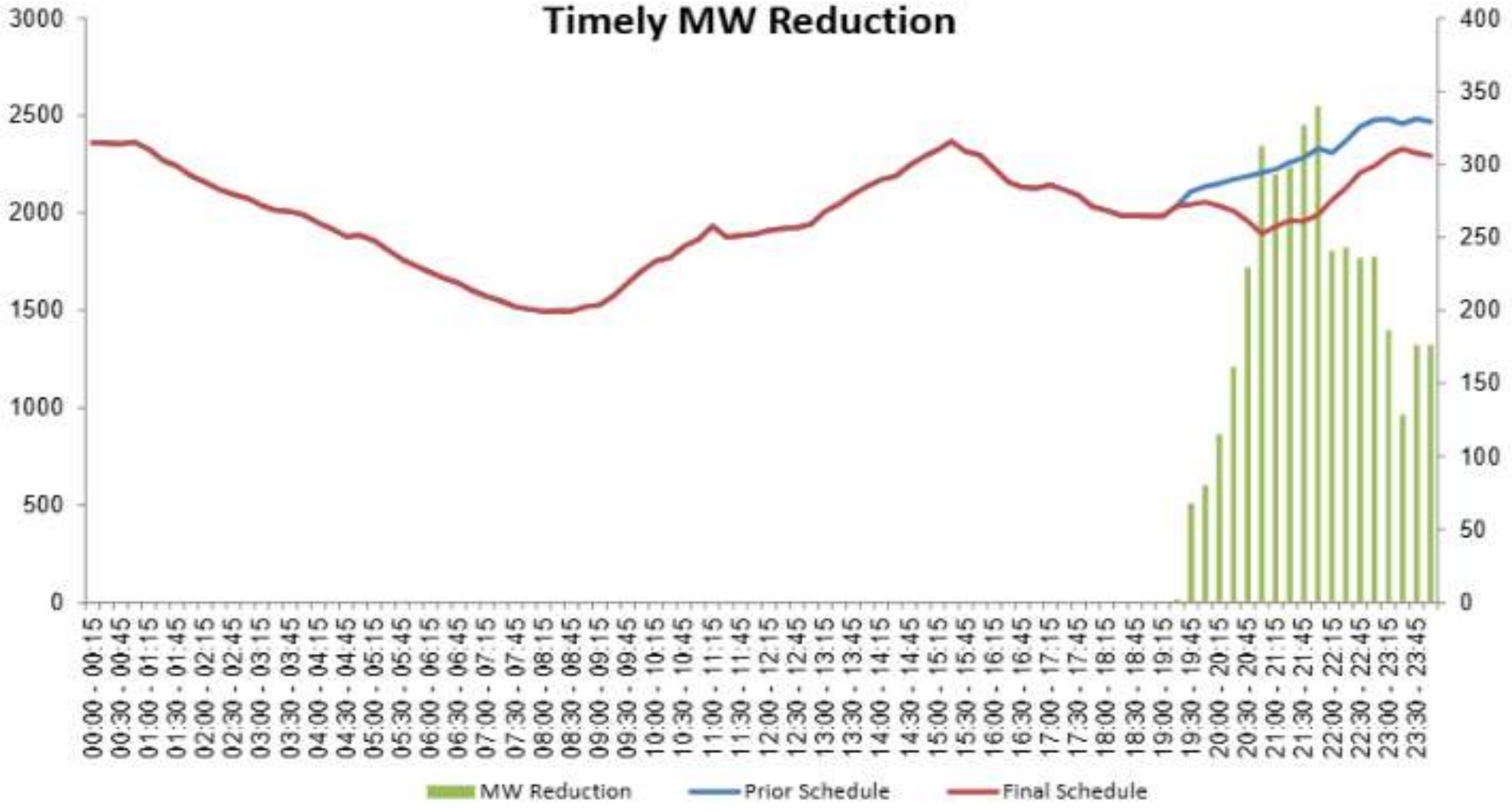
BRPL : Case Study for 10.05.2017



BSES

BRPL : Case Study for 10.05.2017

Date: 10.05.2017

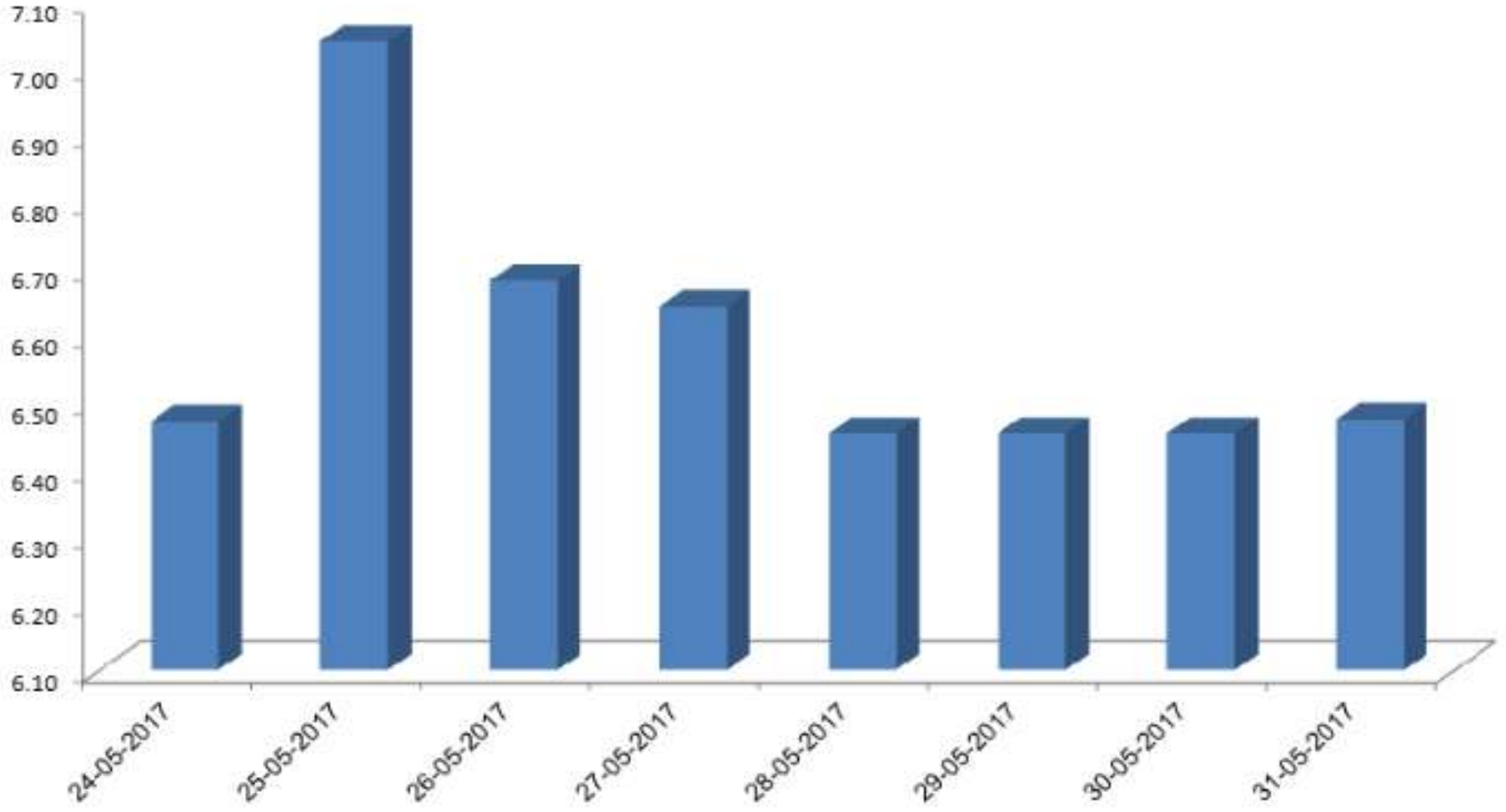


Total MUs reduced = 0.24 MUs

BSES

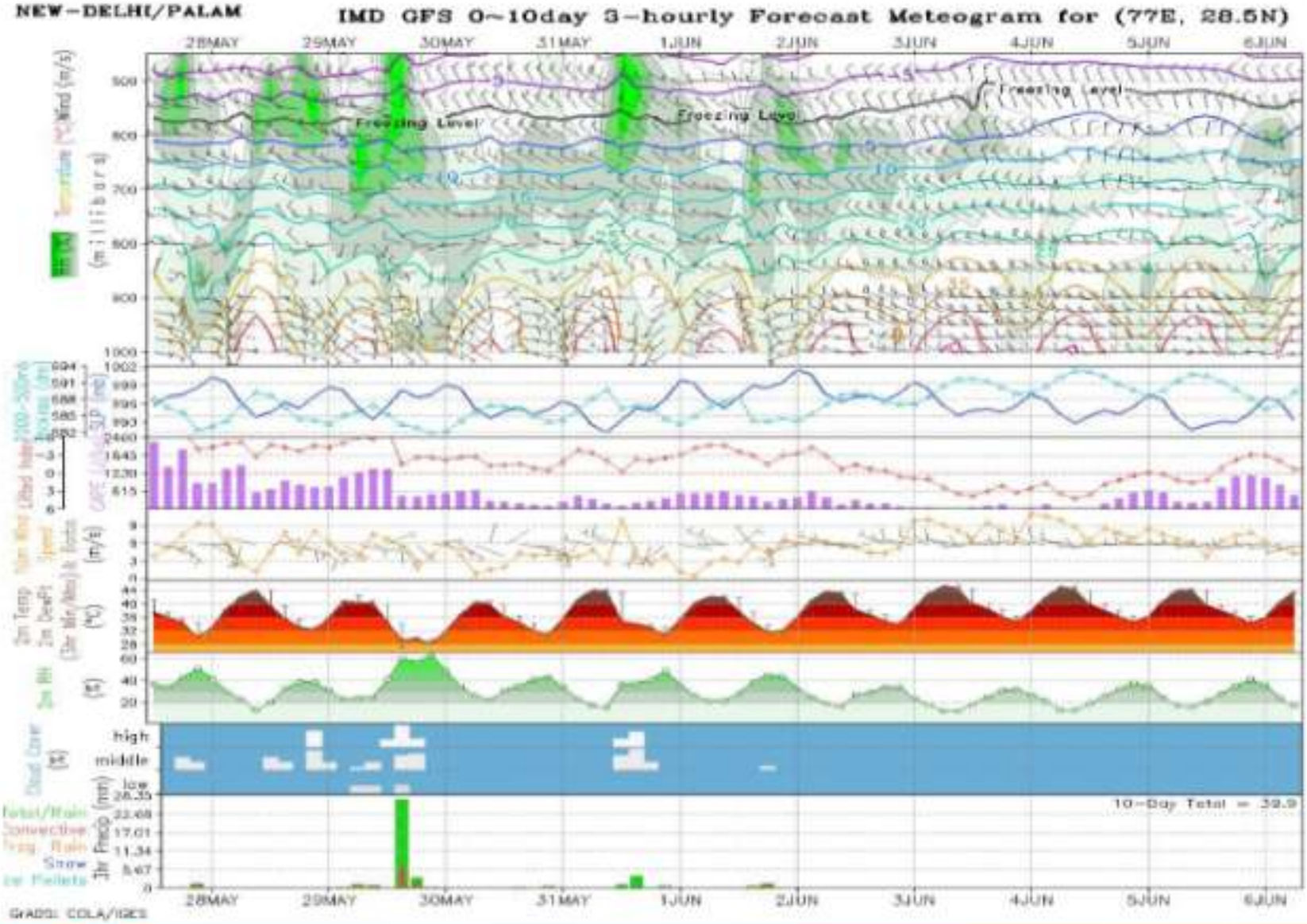
BRPL : Case Study for 31.05.2017

Total Power Exchange & Bilateral

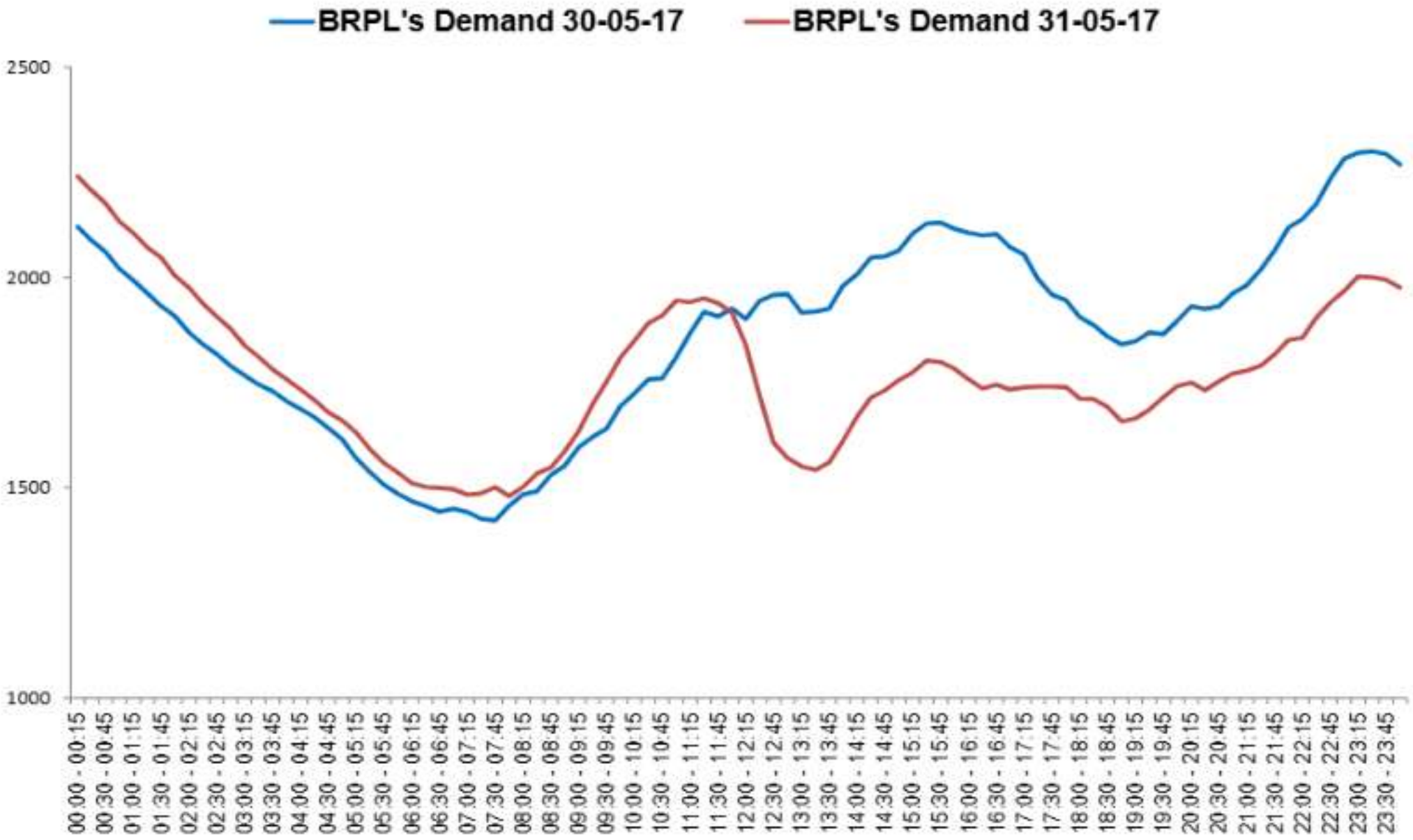


BRPL : Case Study for 31.05.2017

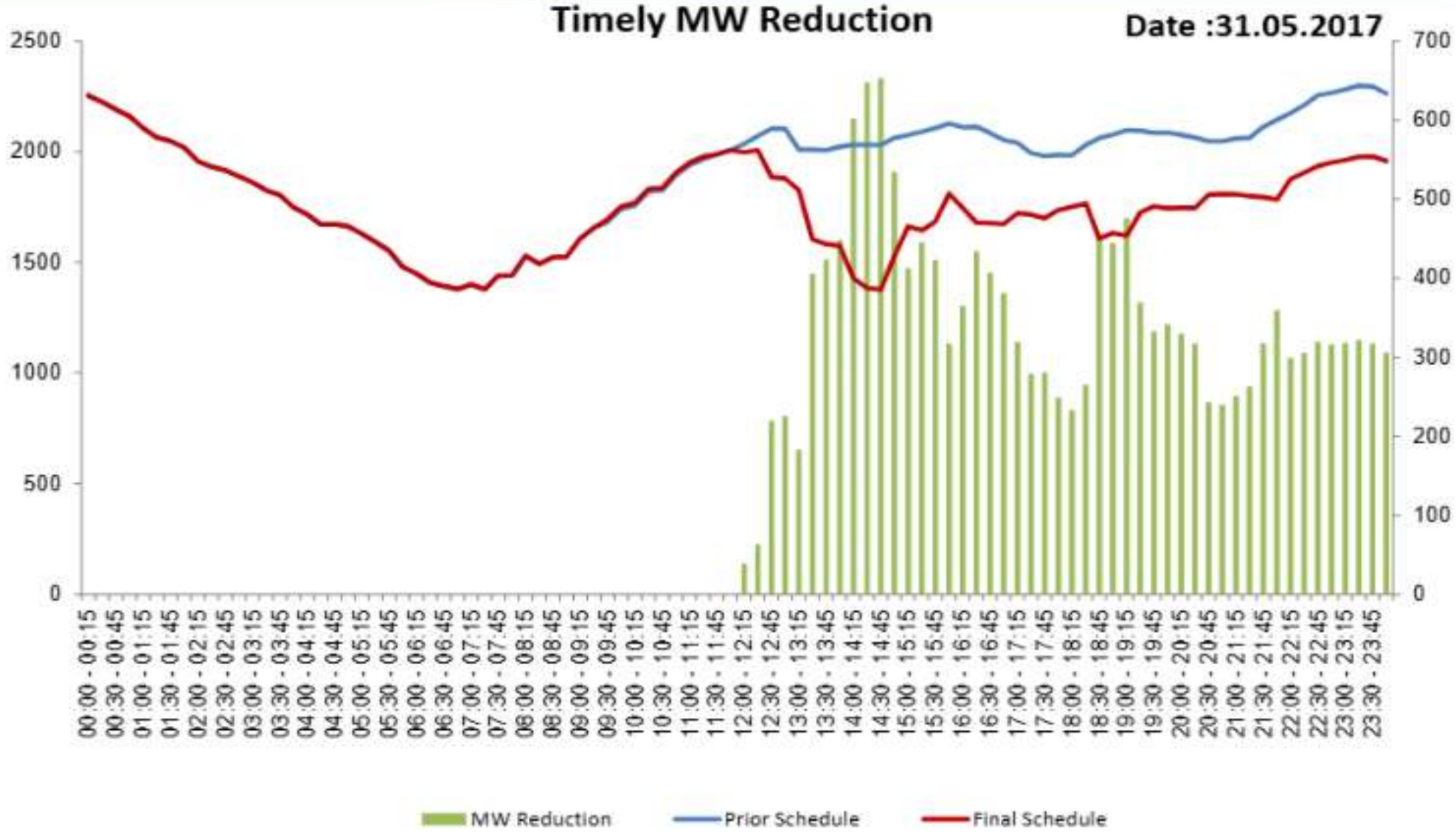
Weather Forecast



BRPL : Case Study for 31.05.2017

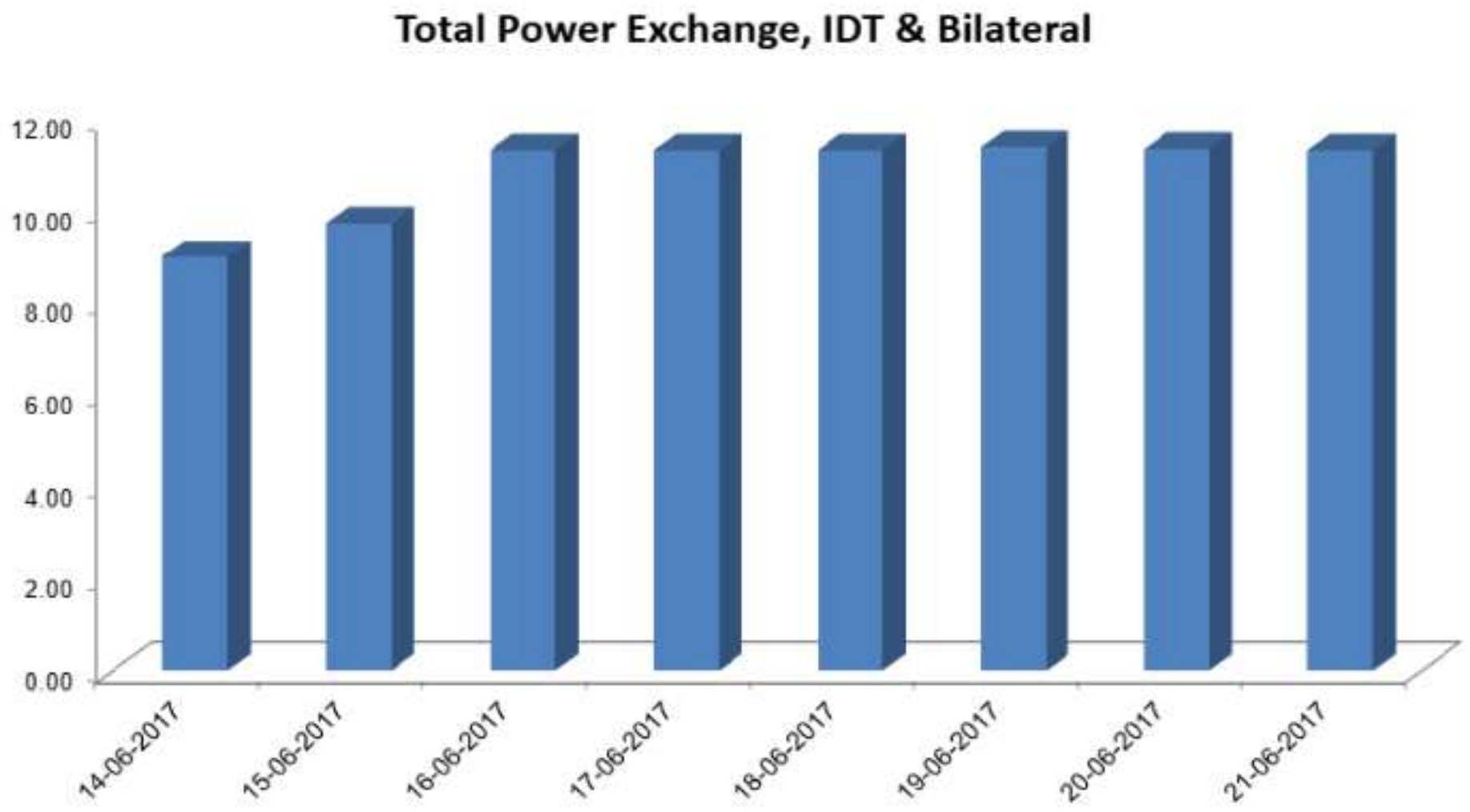


BRPL : Case Study for 31.05.2017

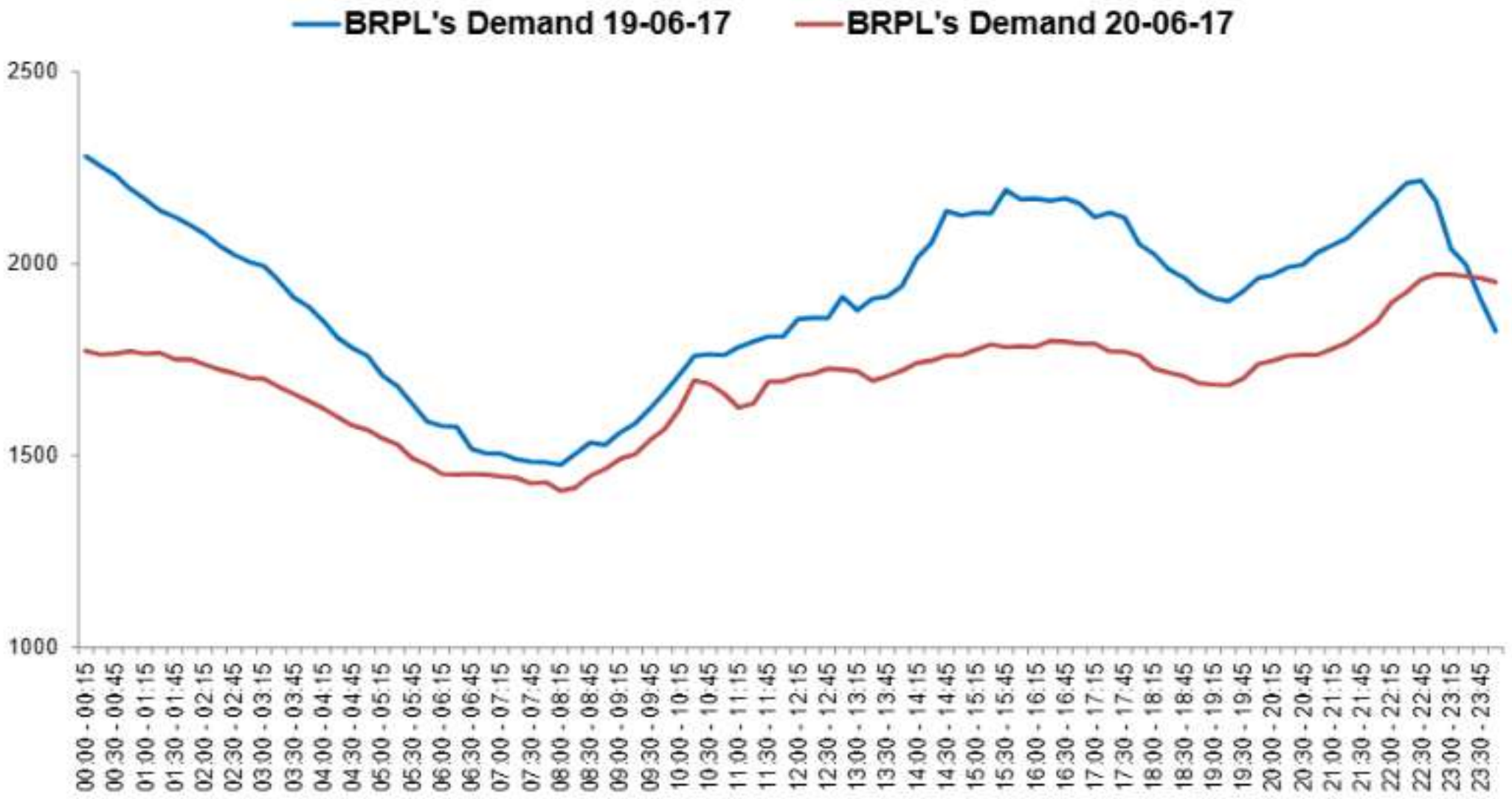


Total MUs reduced = 0.48 MUs

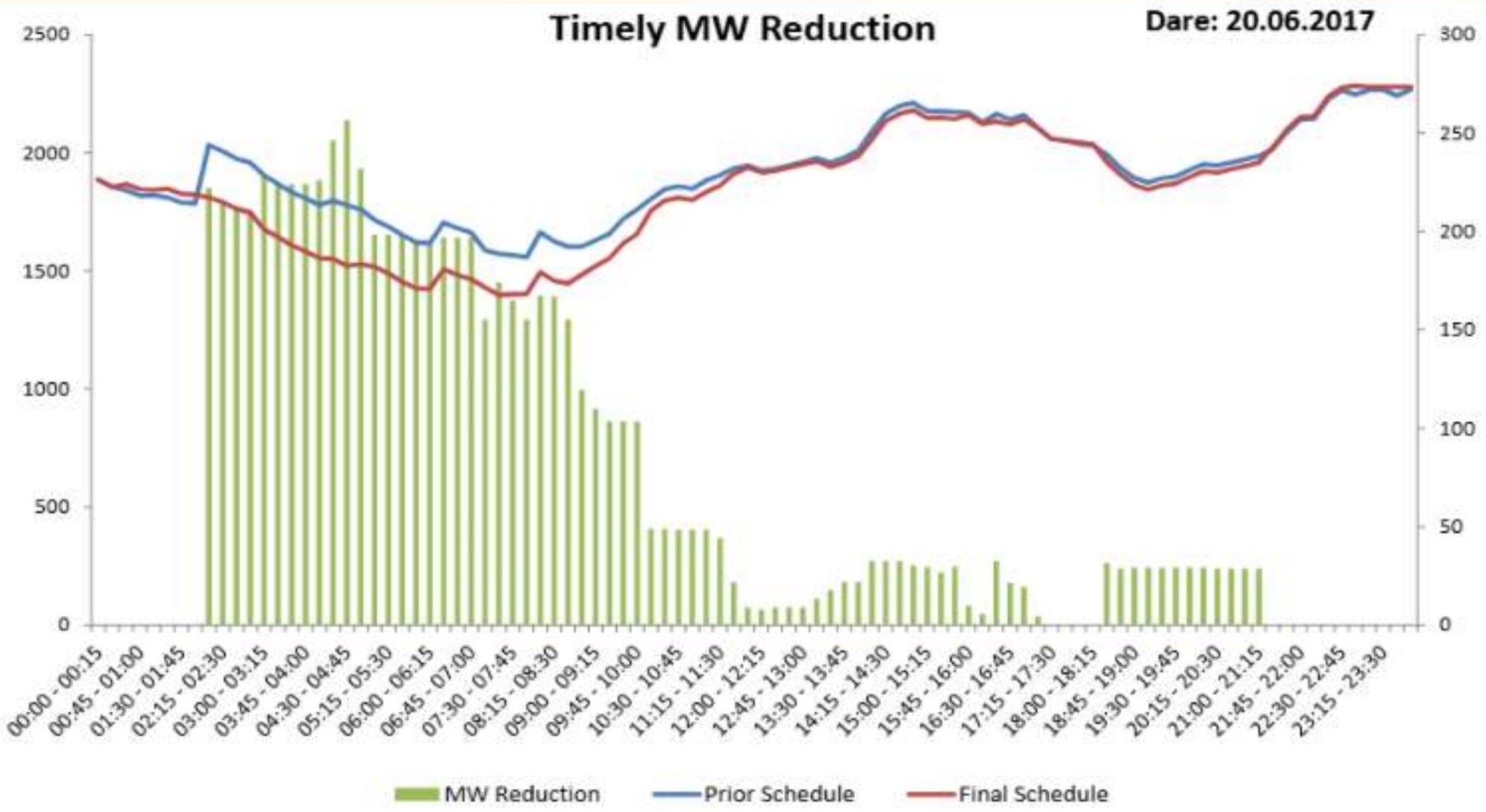
BRPL : Case Study for 20.06.2017



BRPL : Case Study for 20.06.2017



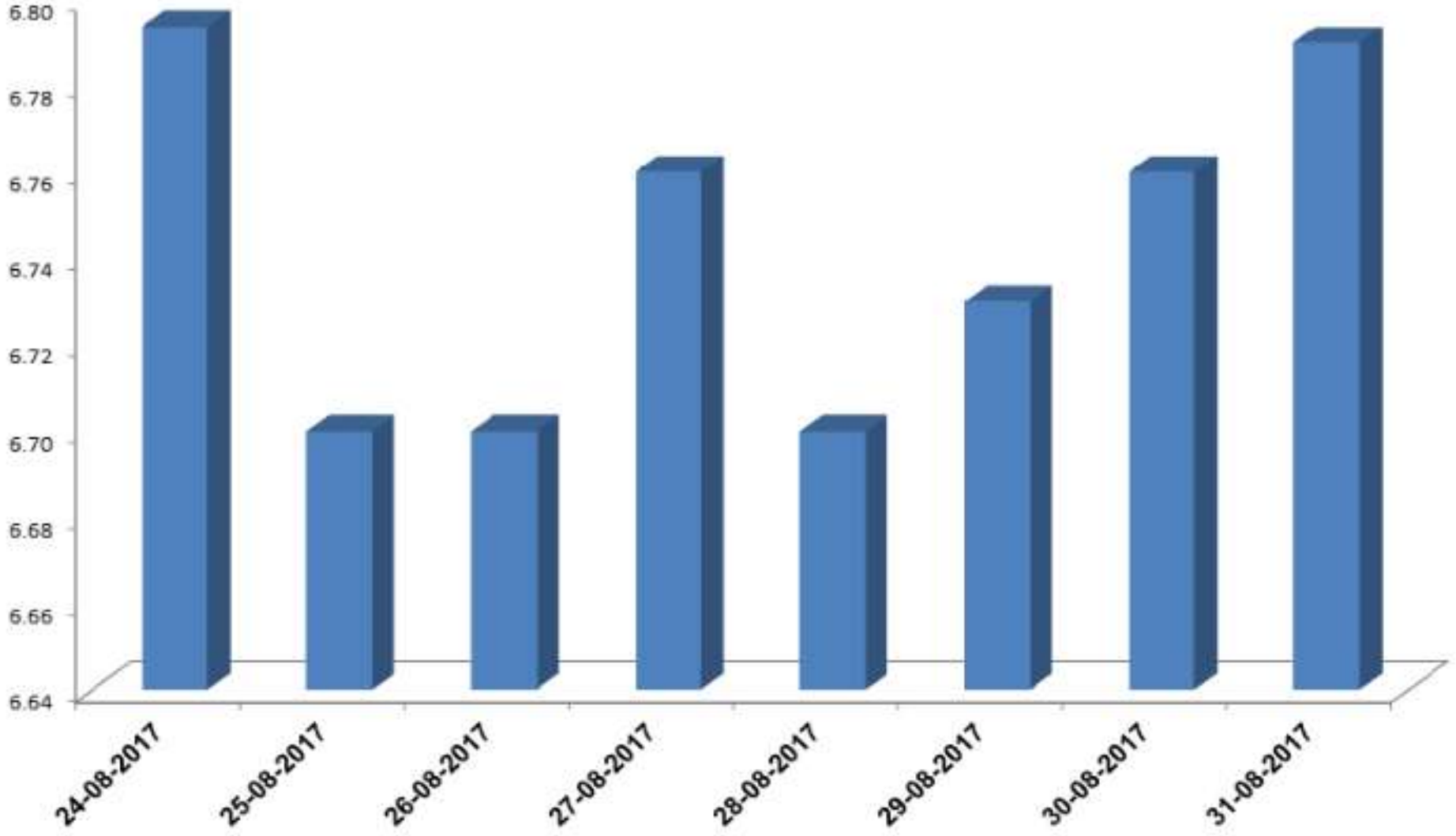
BRPL : Case Study for 20.06.2017



Total MUs reduced = 1.49 MUs

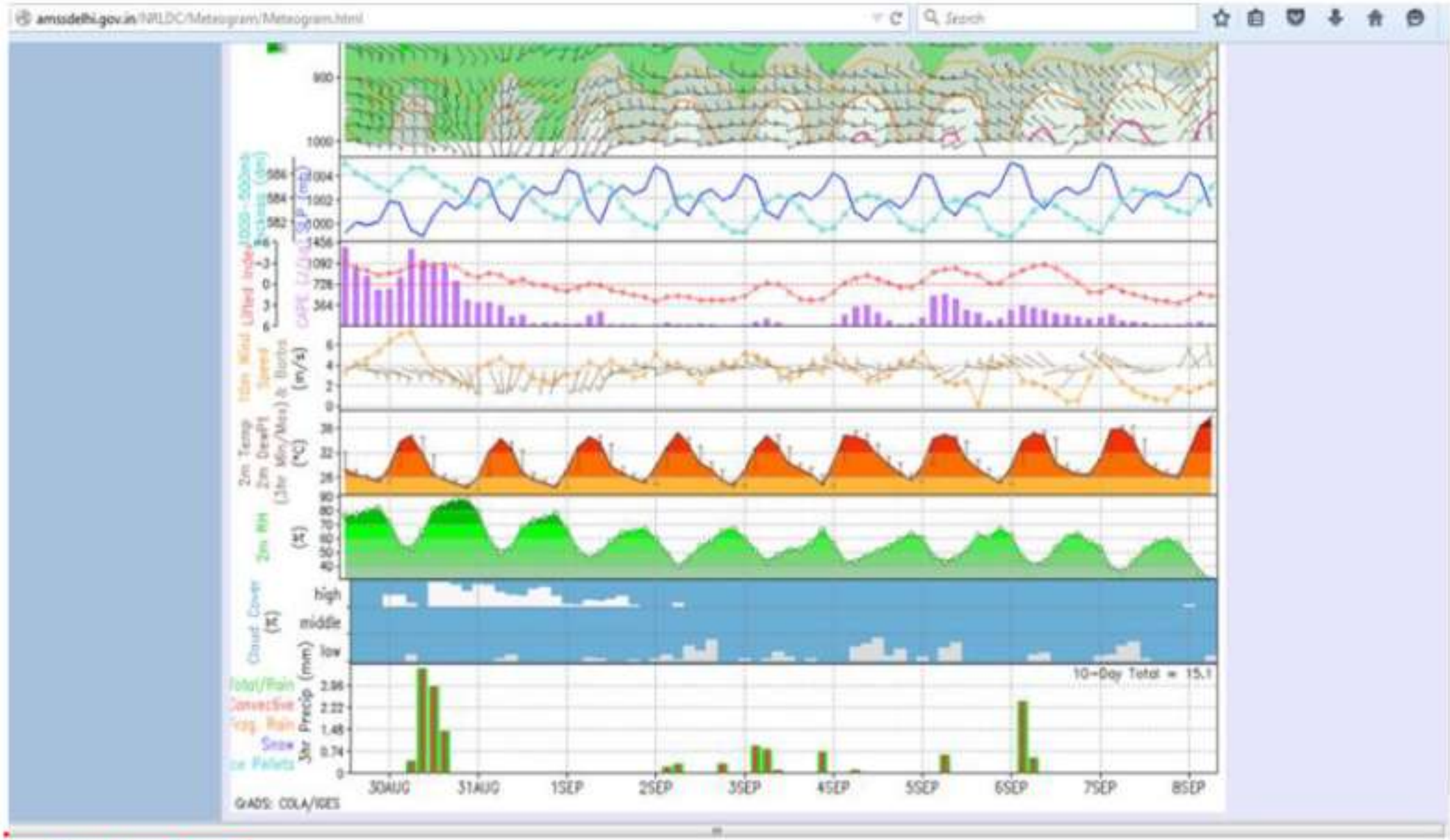
BRPL : Case Study for 30.08.2017

Total Power Exchange, IDT & Bilateral

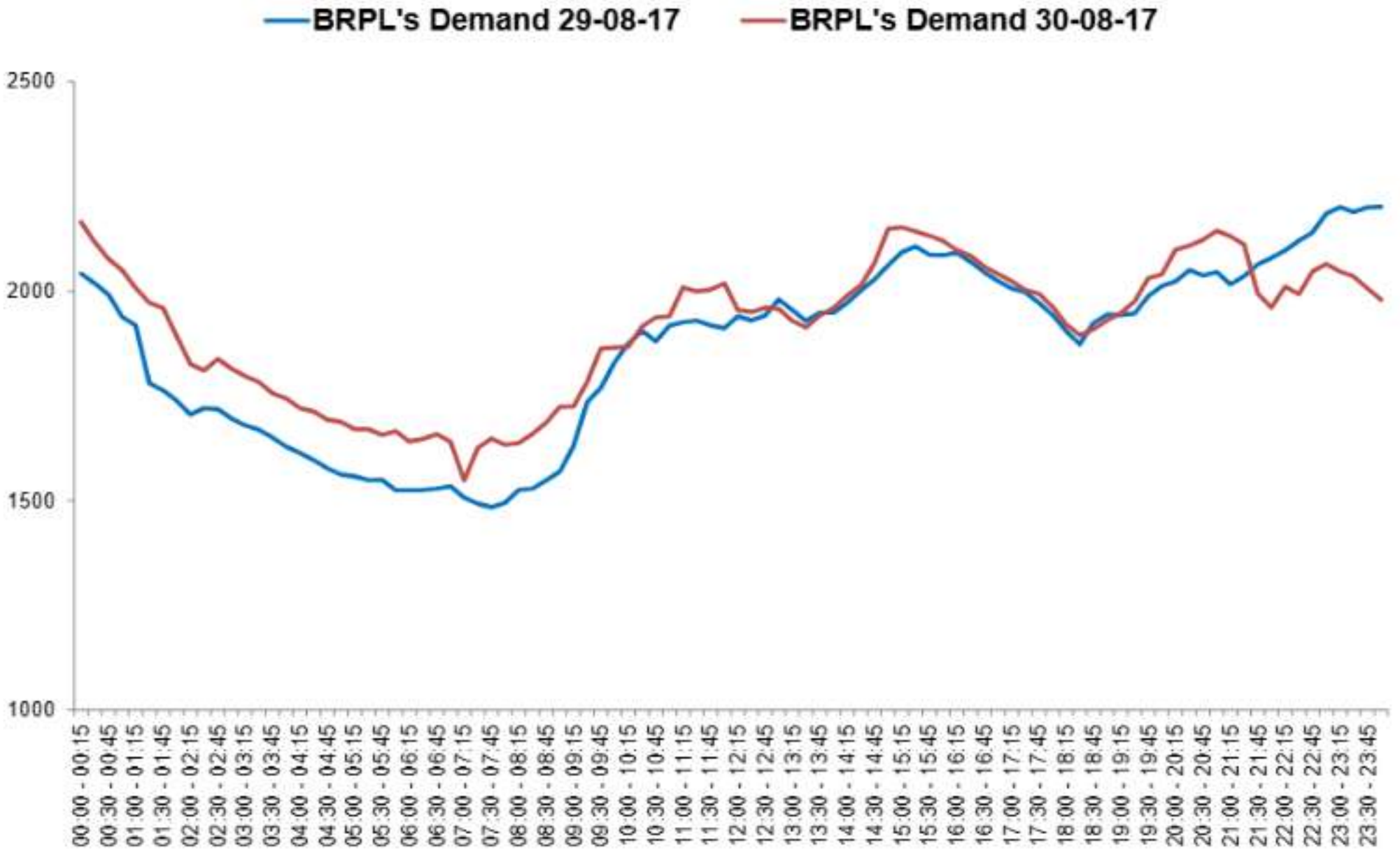


BRPL : Case Study for 30.08.2017

Weather Forecast

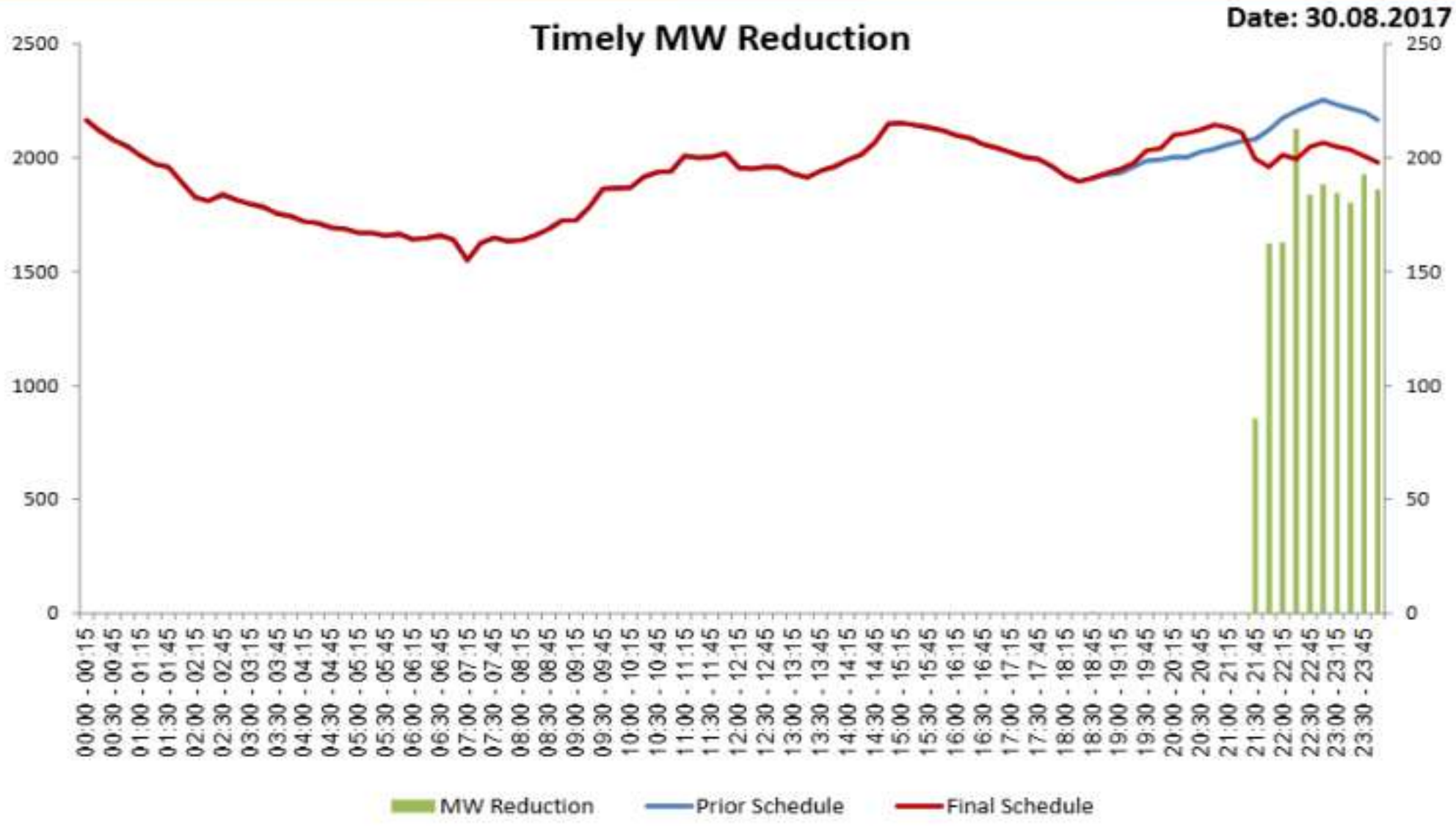


BRPL : Case Study for 30.08.2017



BSES

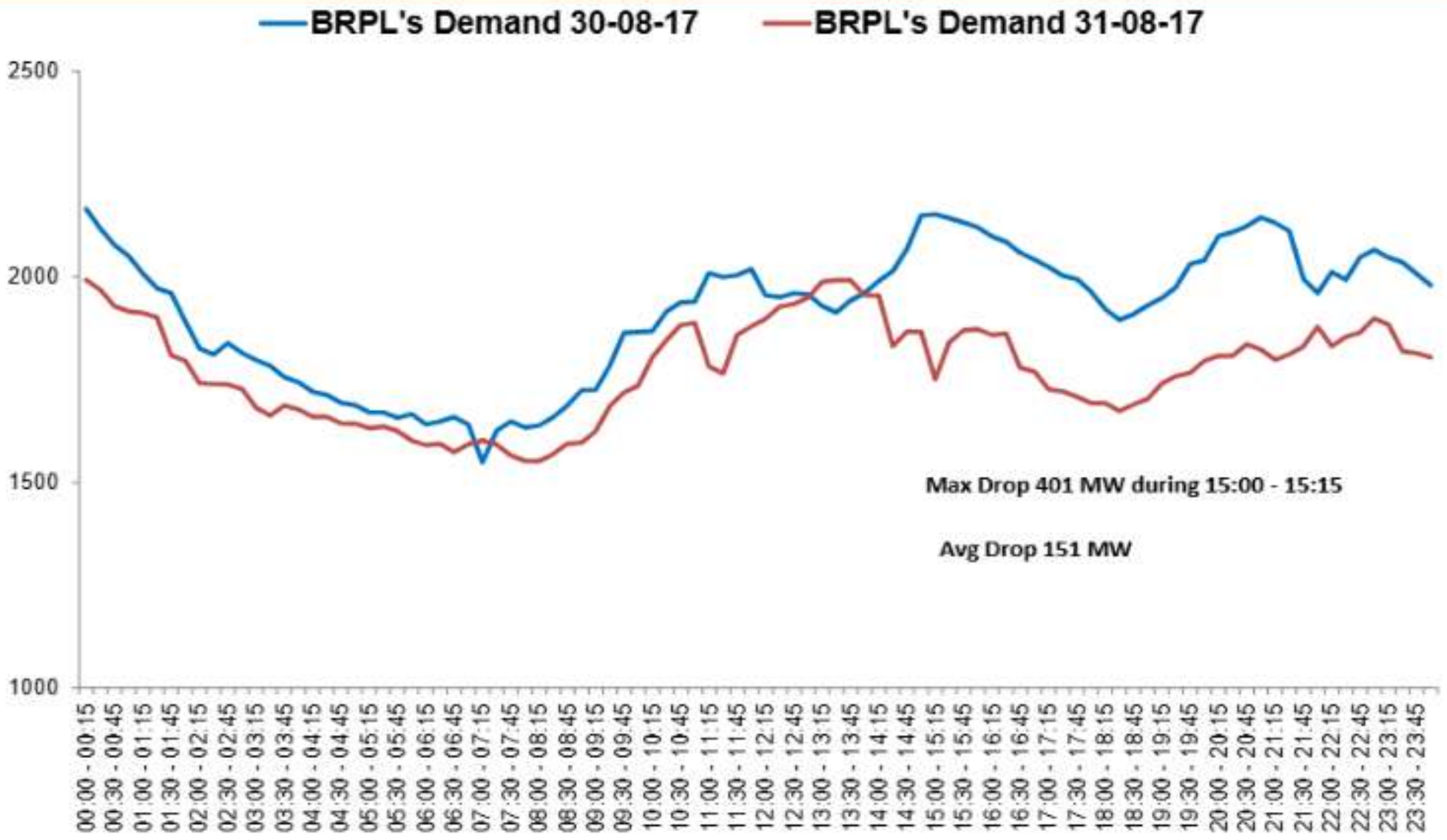
BRPL : Case Study for 30.08.2017



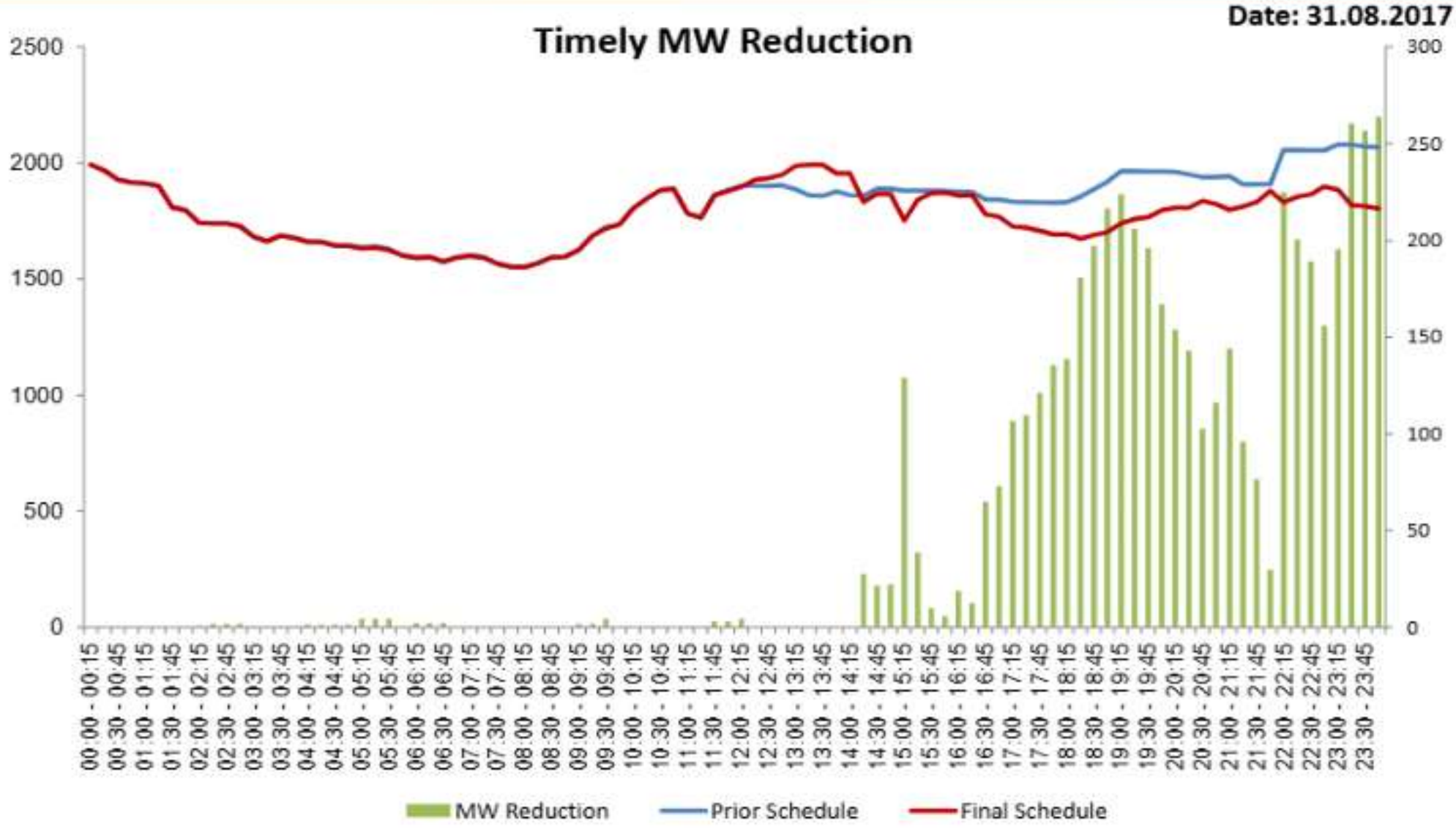
Total MUs reduced = 0.43 MUs

BSES

BRPL : Case Study for 31.08.2017

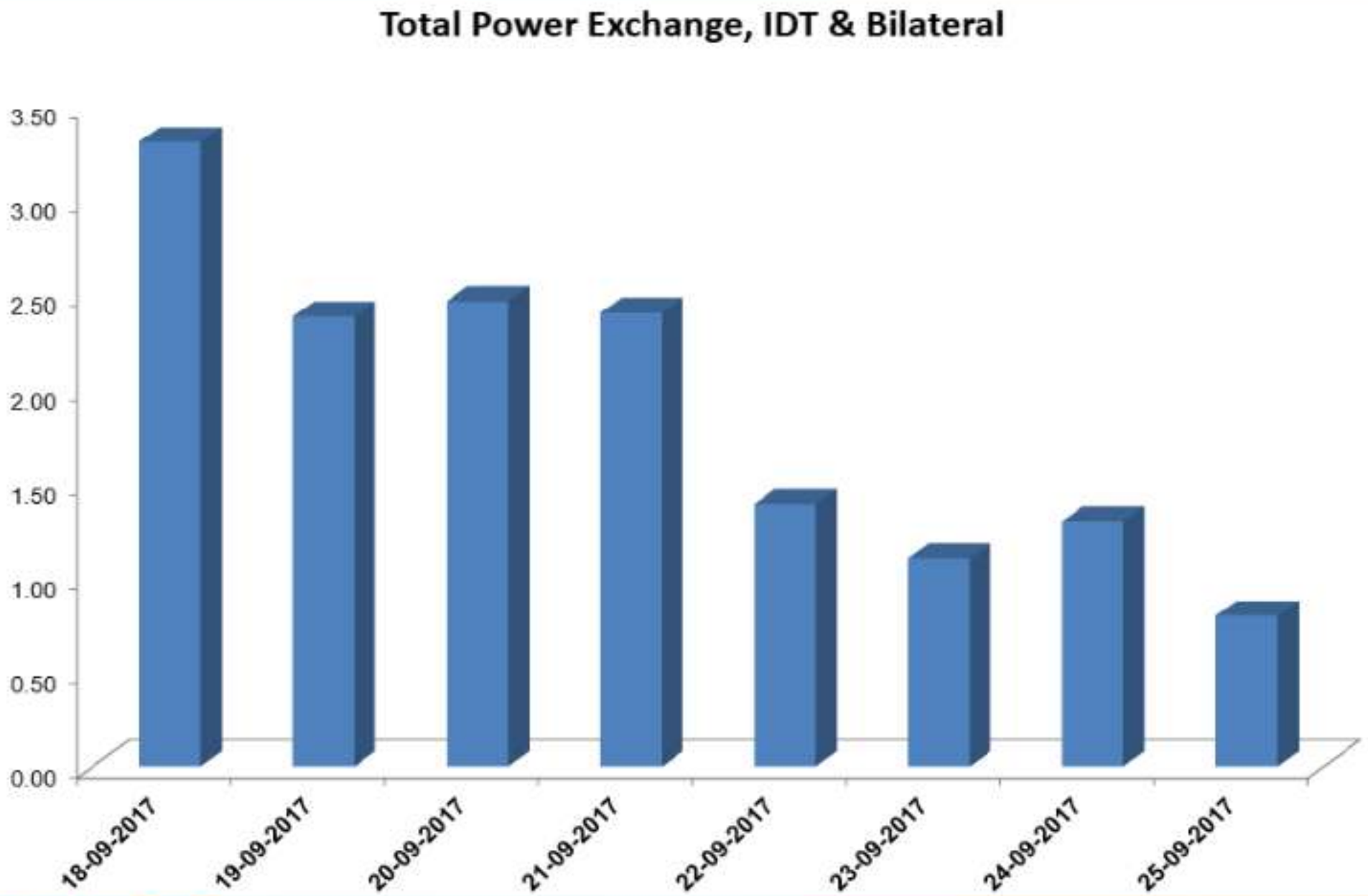


BRPL : Case Study for 31.08.2017



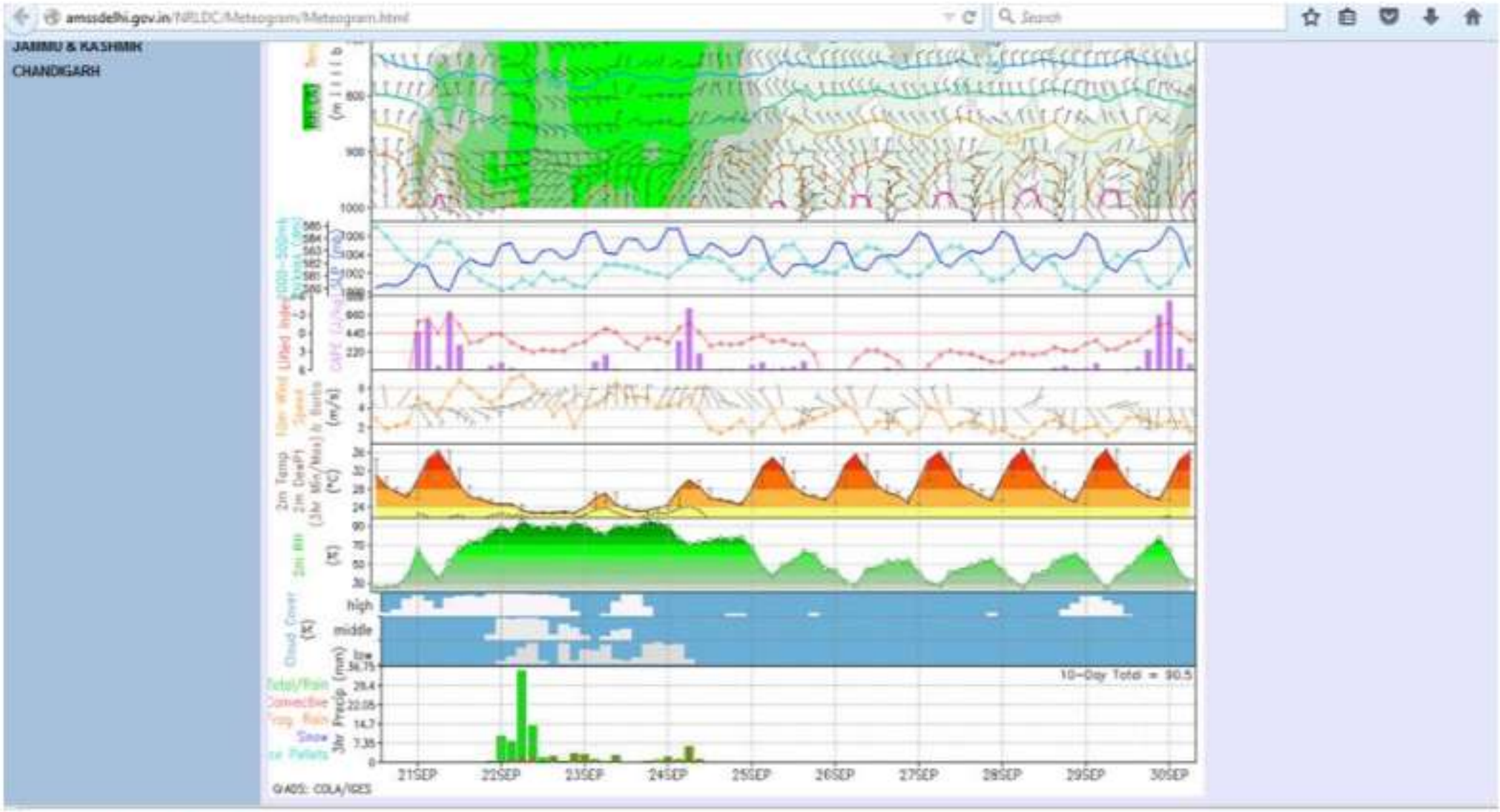
Total MUs reduced = 1.26 MUs

BRPL : Case Study for 22.09.2017

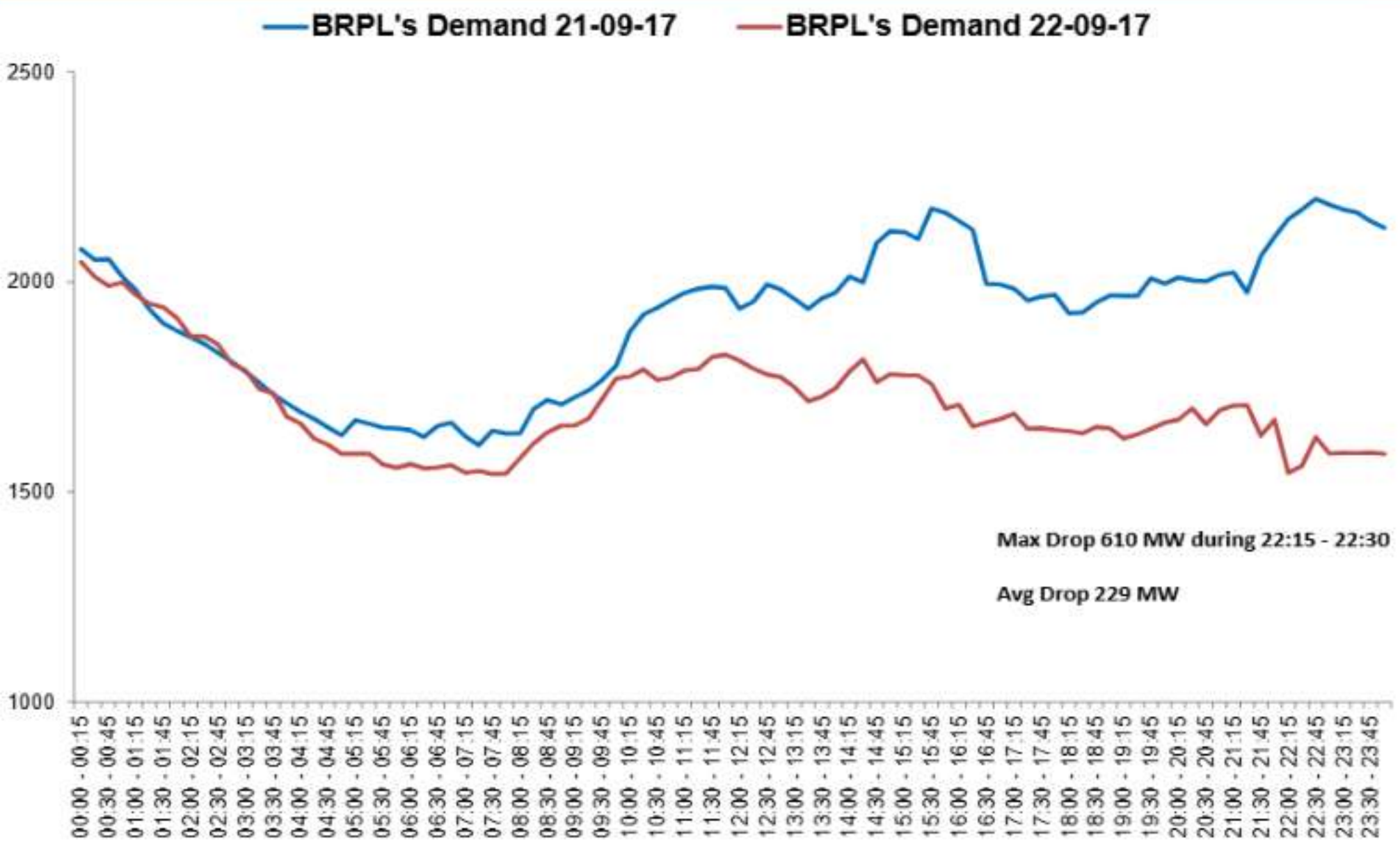


BRPL : Case Study for 22.09.2017

Weather Forecast

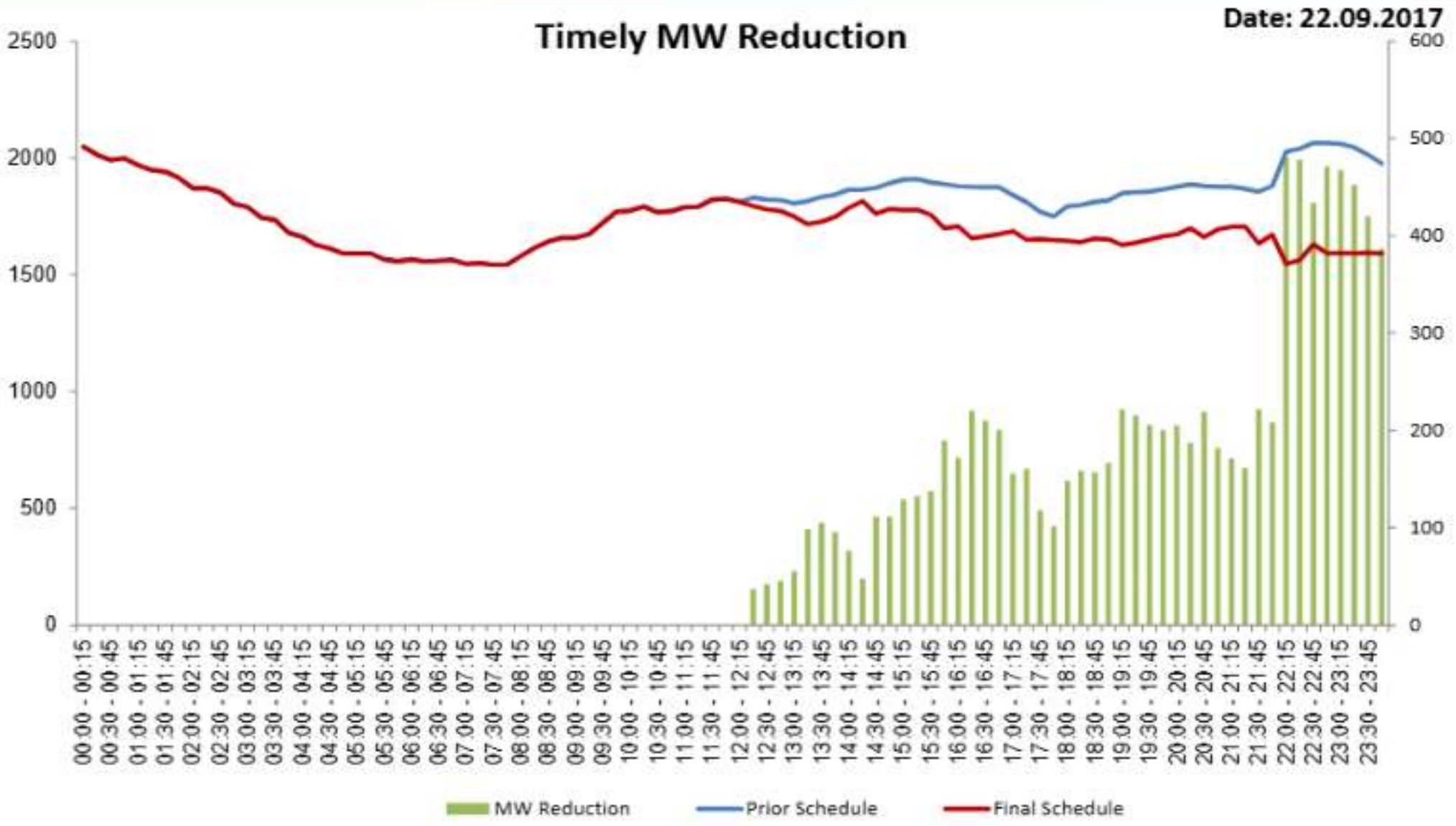


BRPL : Case Study for 22.09.2017



BSES

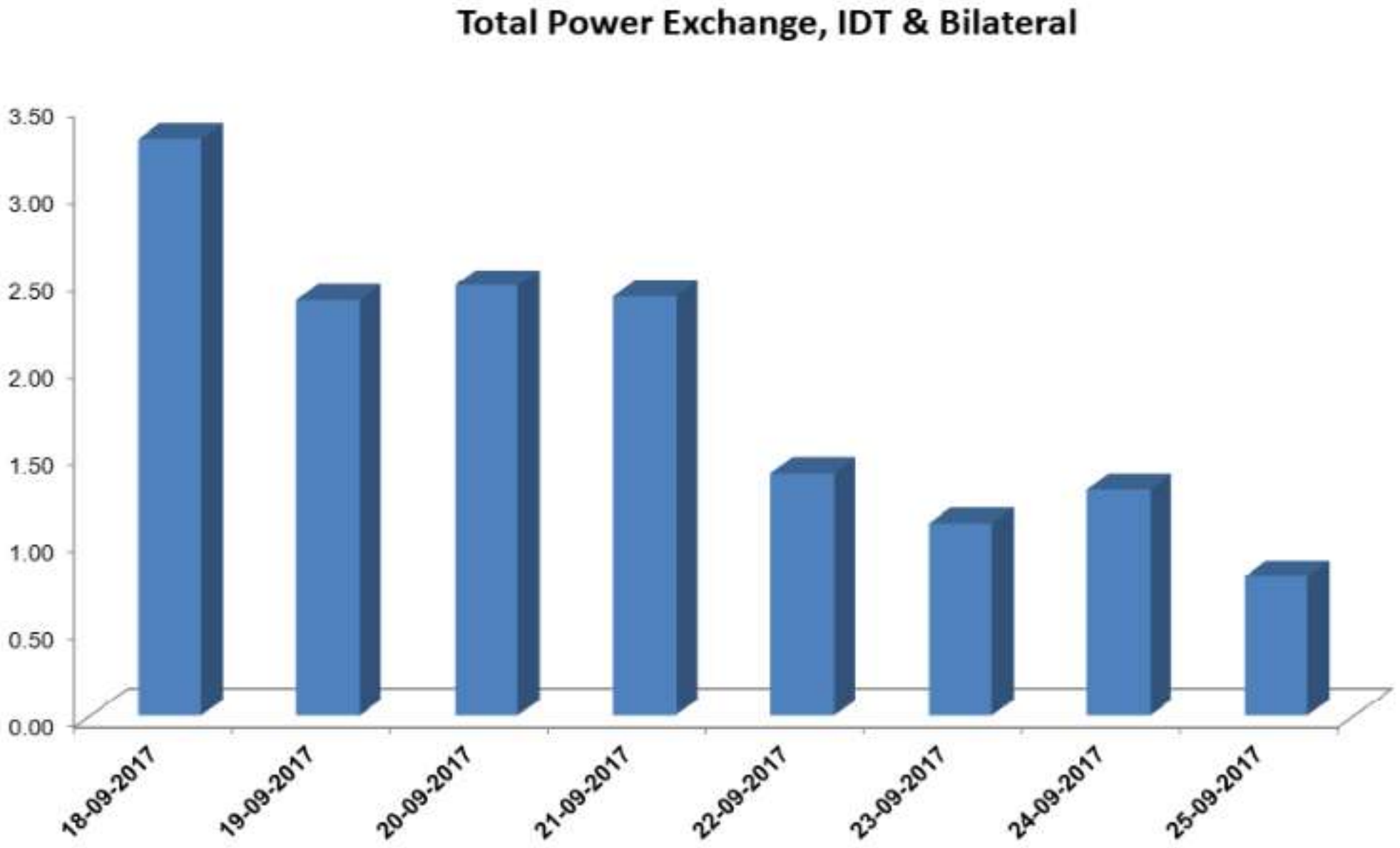
BRPL : Case Study for 22.09.2017



Total MUs reduced = 2.19 MUs

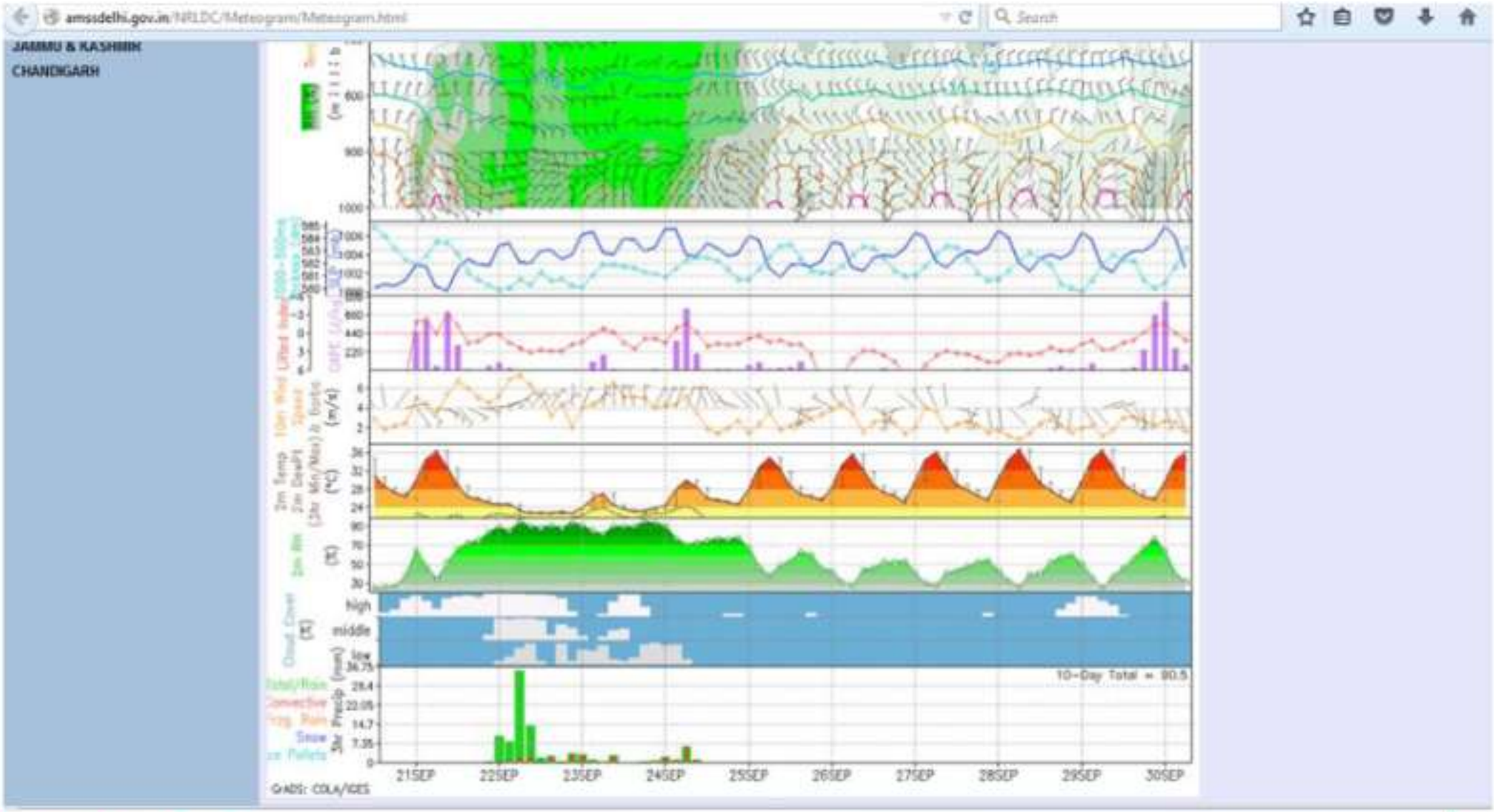
BSES

BRPL : Case Study for 23.09.2017

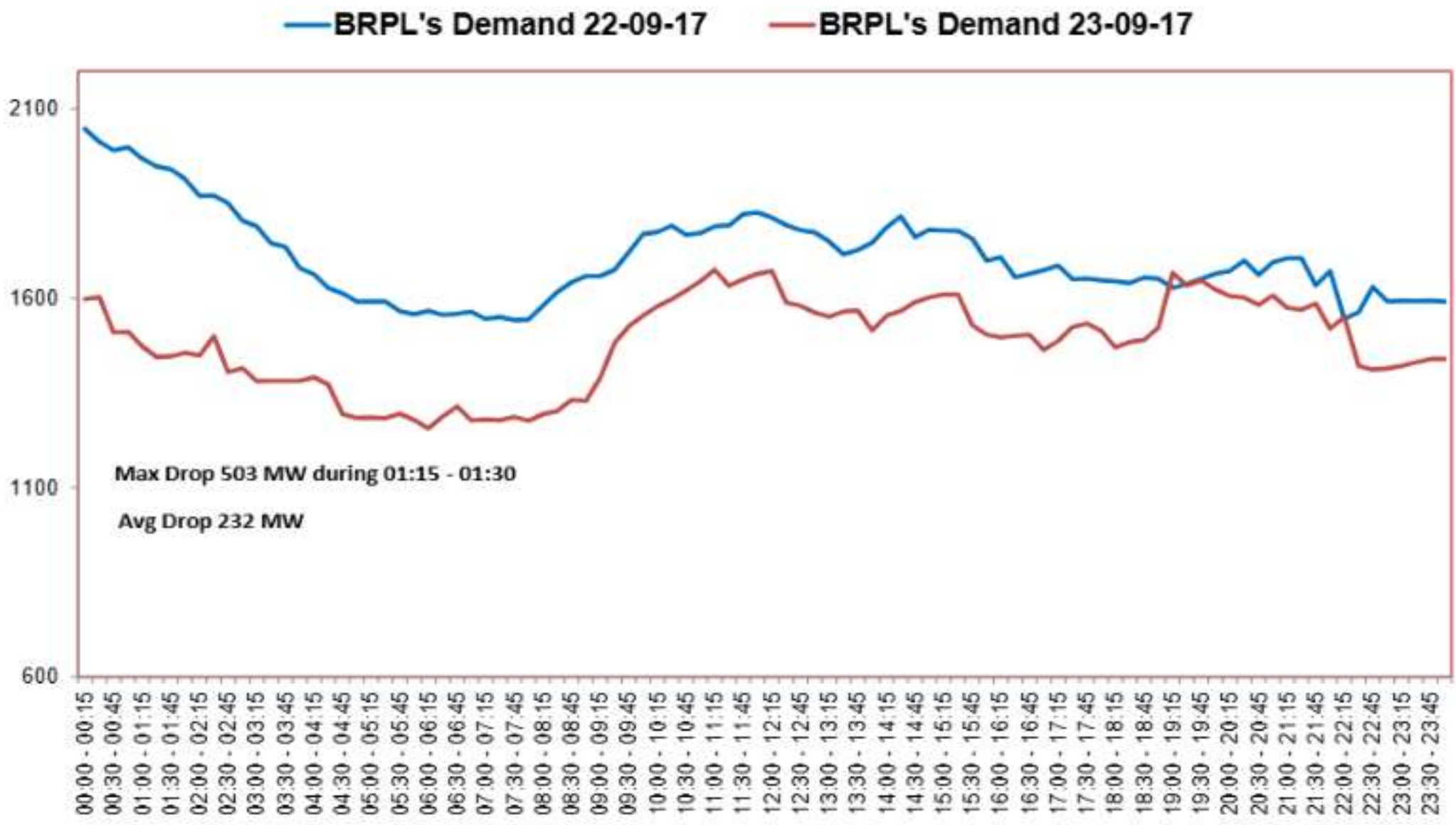


BRPL : Case Study for 23.09.2017

Weather Forecast

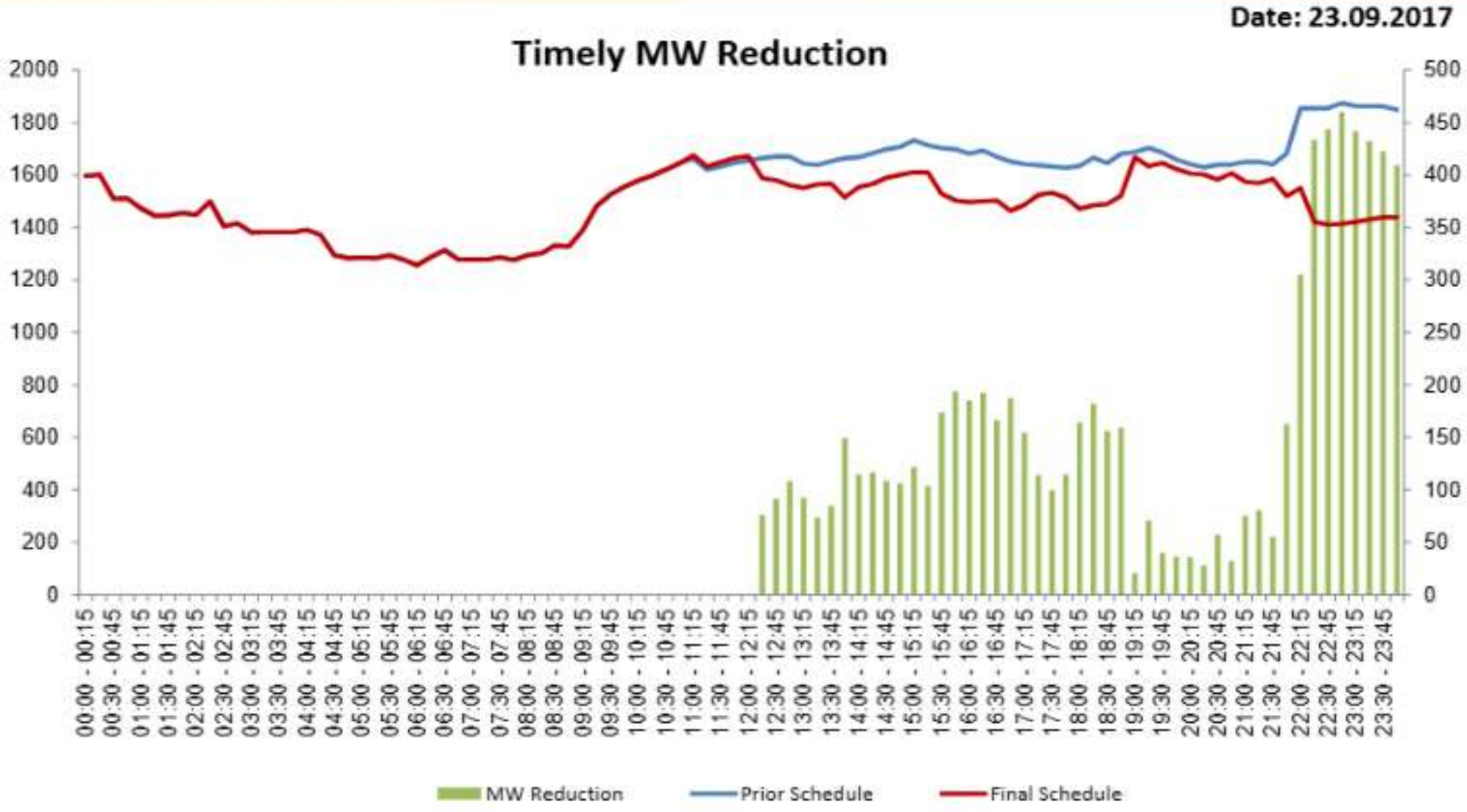


BRPL : Case Study for 23.09.2017



BSES

BRPL : Case Study for 23.09.2017



Total MUs reduced = 1.87 MUs

Acronyms

AOD	Aerosol Optical Depth
BRPL	BSES Rajdhani Power Limited
CEA	Centre Electricity Authority
DWR	Doppler weather Radar
FOLD	Forum of Load Despatchers
GPI	Global Precipitation Index
GPR	Geo-Physical Parameters
IMD	India Meteorological Department
IMSRA	INSAT Multi-Spectral Rainfall Algorithm
LST	Land Surface Temperature
LWIR	Long Wave Infra-Red
MIR	Medium Wave Infra-Red
NLDC	National Load Despatch Centre
NRLDC	Northern Region Load Despatch Centre
OCC	Operation Coordination Committee
OLR	Outgoing long wave Radiation
PPI	Plan Position Indicator
POSOCO	Power System Operation Corporation
QPE	Quantitative Precipitation Estimates
RAPID	Real time Analysis of Products & Information Dissemination
RMC	Regional Meteorological Centre
RLDC	Regional Load Despatch Centre

RRVPNL	Rajasthan Rajya Vidyut Prasaran Nigam Limited
RRAS	Reserves Regulation Ancillary Services
SAC	Satellite Application Centre
SLDC	State Load Despatch Centre
SRLDC	Southern Region Load Despatch Centre
SST	Sea Surface Temperature
STOA	Short Term Open Access
SWIR	Short Wave Infra-Red
UTH	Upper Troposphere Humidity
WDSS II	Warning Decision Support System

DISCLAIMER

This disclaimer is applicable to the Reference Document on Weather Portal for Indian Power System. The document has been prepared based on the presentations given by IMD on various occasions in POSOCO and information available in public domain. By using or accessing the Reference Document you agree with the disclaimer without any qualification or limitation. In no event, Power System Operation Corporation Ltd. (POSOCO) will be liable for claim made by the users including seeking any clarification for any of the inaccuracies in the information provided in this reference document, though all efforts have been made to ensure accuracy. Under no circumstances, the POSOCO would be liable for any expense, loss or damage, without limitation, indirect or consequential loss or damage, or any other expense, loss or damage whatsoever arising from use, in connection with the use of this Reference Document on Weather Portal for Indian Power System or contents appearing thereon.

Power System Operation Corporation Ltd.

(A Government of India Enterprise)