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Identifying Downburst Events using INSAT-3D Satellite System

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Introduction

- Convective downdraft motions and related outflow winds considered as an eventual source of severe damage.
- Microburst is a downdraft in a thunderstorm that occurs in spatial scale of less than 4 km on reaching the surface and spread outward in all directions from the downdraft center.
- The main cause of microburst is buoyancy changes within storm which leads to large negative buoyancy and powerful concentrated downdraft to the surface penetrating storm.
- Brightness temperature difference (BTD) between INSAT-3D satellite water vapour channel (6.8 μm) and thermal infrared channel (11.3 μm) is used to highlight the regions of downbursts.
- The regions where BTD > 0, considered as regions of over shooting convection and the regions where BTD < 0 as dry air notch that signifies the channeling of dry air into the rear flank of a convective storm.
- Microburst Wind Speed Potential Index (MWPI) is an index that can be used for identifying the region associated with downburst events.

INSAT -3D Overview

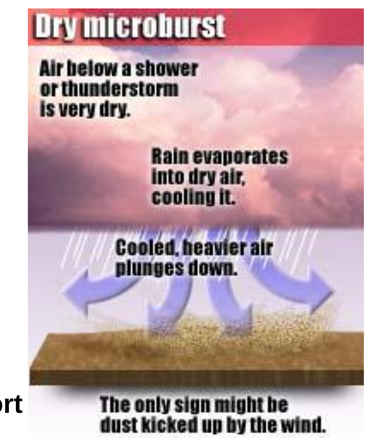
- INSAT-3D is a meteorological, data relay and satellite aided search and rescue satellite developed by the Indian Space Research Organisation and was launched successfully on 26 July 2013 from French Guiana. It is positioned at 82 Degree East longitude.
- INSAT-3D has a 6 channel imager and 19 channel sounder payload. This adds a new dimension to weather monitoring through its atmospheric sounding system, which provides vertical profiles of temperature (40 levels from surface to ~70 km), humidity (21 levels from surface to ~15 km) and integrated ozone from surface to top of the atmosphere. Multi-spectral Imager (optical radiometer) capable of generating the images of the earth in six wavelength bands.

Spectral Band	Wave length (in μm)	Ground Resolution
Visible	0.55 – 0.75	1 Km
Shortwave IR	1.55-1.70	1 Km
Middle IR	3.80-4.00	4 Km
Water Vapor	6.50-7.10	8 Km
Thermal IR1	10.3-11.3	4 Km
Thermal IR2	11.5 – 12.5	4 Km

Downburst Types

Wet Microburst:

Duration: 5 to 20 minutes
Precipitation: Moderate or heavy.
Cloud bases: As high as 850 hPa.
Primary catalyst: Evaporative cooling.



Dry Microburst:

Duration: 2 to 5 minutes
Precipitation: Little or none.
Cloud bases: As high as 500 hPa.
Primary catalyst: Downward transport of higher momentum.

Microburst Wind Speed Potential Index (MWPI)

The MWPI value is calculated based on the National Center for Medium Range Weather Forecasting (NCMRWF)-Global Forecast System (GFS) analysis using the following formula:

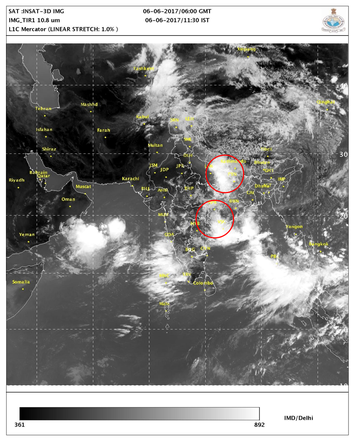
$$MWPI = (CAPE/100) + \Gamma + [(T - T_d)_{850mb} - (T - T_d)_{670mb}]$$

Γ = temperature lapse rate (in °C km^{-1}) from lower level (850 mb) to upper level (670 mb), the term $(T - T_d)$ is the dewpoint depressions (in °C) and CAPE (Convective Available Potential Energy) is surface based. MWPI values do not represent absolute wind gust speed but gives an indication of relative convective wind gust potential which can be statistically related to surface wind gust speed.

Case study 1 – 06 June 2017 Downbursts

At 0600 UTC of 06 June 2017, strong downbursts were observed over the East Uttar Pradesh and north Andhra Pradesh.

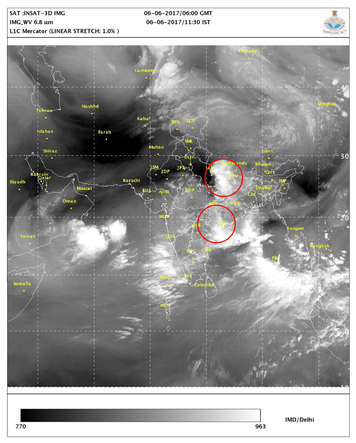
TIR1 of INSAT-3D



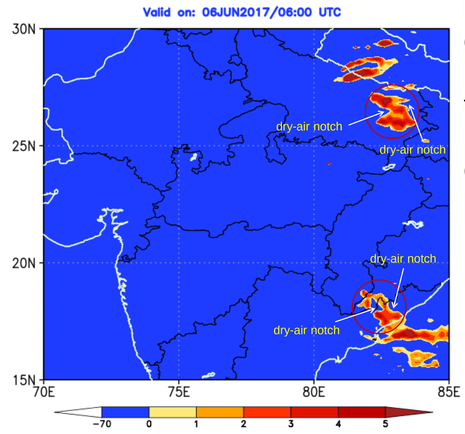
At 0600 UTC, INSAT-3D TIR1 imagery shows deep convective cloud (white colour) over the East Uttar Pradesh and north Andhra Pradesh regions.

At 0600 UTC, INSAT-3D WV imagery shows the moist air (white colour) over the same area.

WV of INSAT-3D



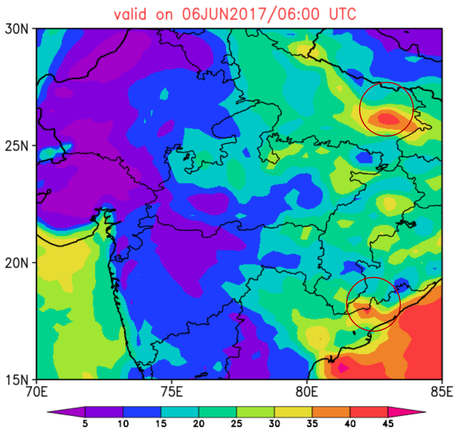
BTD between WV and TIR1



At 0600 UTC, BTD imagery shows several dry air notches on the periphery of the thunderstorm complex near the time of downburst occurrence.

At 0600 UTC, the MWPI image illustrates the widespread values over East Uttar Pradesh and north Andhra Pradesh with high values (red).

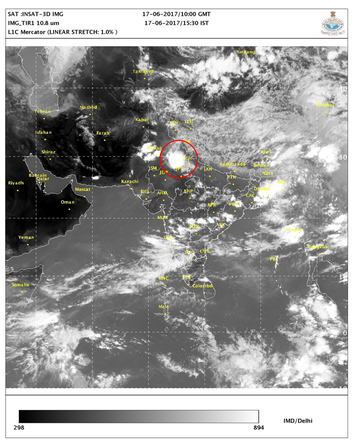
MWPI



Case study 2 - 17 June 2017 Downburst

At 1200 UTC of 17 June 2017, strong downburst was observed over the north Rajasthan region.

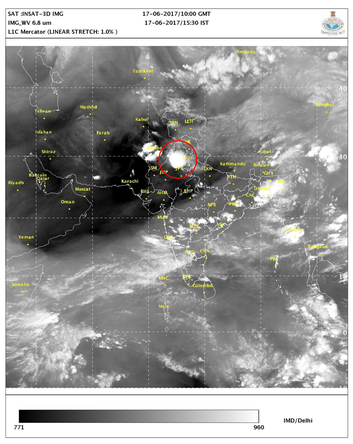
TIR1 of INSAT-3D



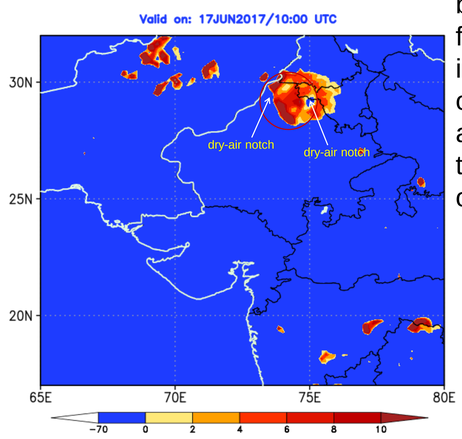
At 1000 UTC, INSAT-3D TIR1 imagery shows deep convective cloud (white colour) over the north Rajasthan regions

At 1000 UTC, INSAT-3D WV imagery shows the moist air (white colour) over the same area.

WV of INSAT-3D



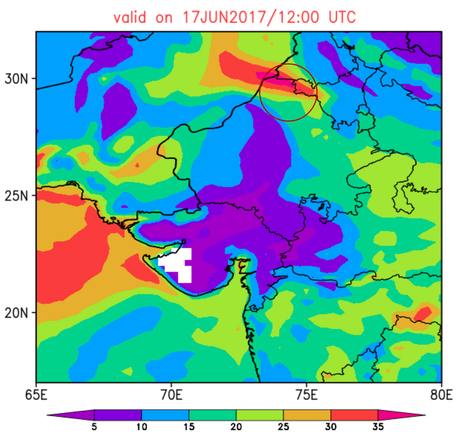
BTD between WV and TIR1



At 1000 UTC, the dry-air notch on the western flank of the thunderstorm complex became the dominant feature, most likely indicating an increase of mid-tropospheric dry-air inflow surrounding the time of downburst occurrence.

At 1000 UTC, the MWPI image illustrates the widespread values over the north Rajasthan with high values (red).

MWPI



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The 21st International TOVS study Conference (ITSC), Darmstadt, Germany, 29 November - 5 December 2017
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