Ministry of Earth Sciences
India Meteorological Department

An analysis of severe weather prediction using MODIS direct broadcast satellite data and INSAT-3D Sounder profiles receiving real-time at IMD, New Delhi

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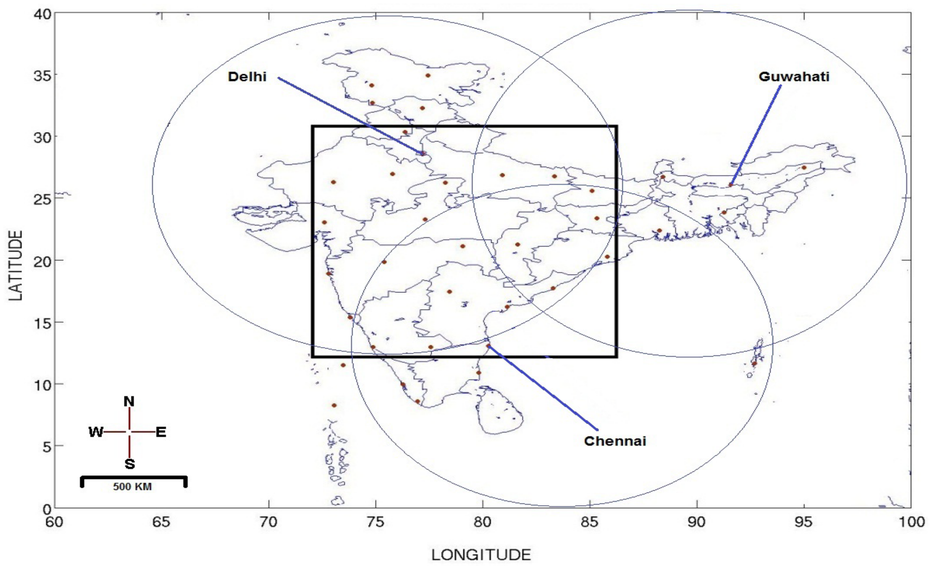
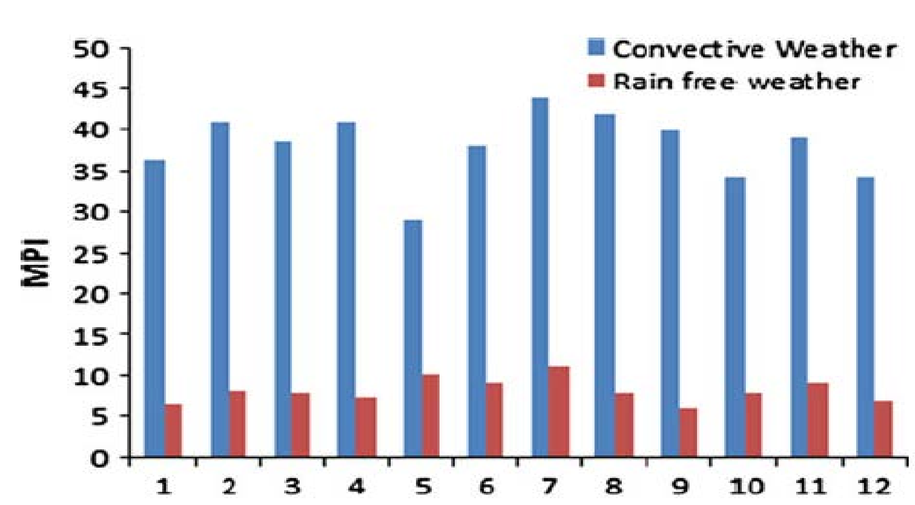
Spatially interpolated sounder derived products can be utilized as an indicator for regional and location specific forecast over the areas where radiosonde data is not available. It can be used as a sensitive measure for very early stages of instability developments such as thunderstorm and rainfall because no other single stability index can provide a distinct threshold value for these events.

Direct receiving and processing systems at IMD

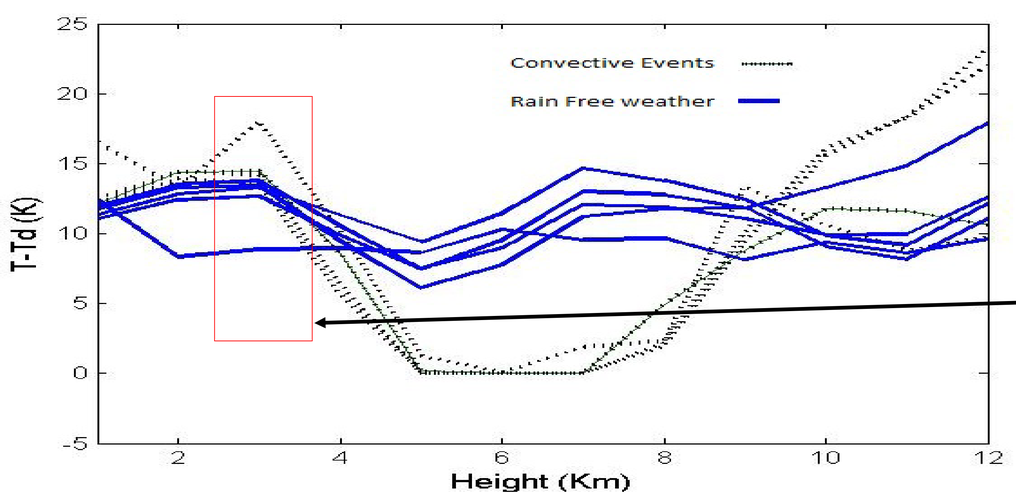


- **It is the intention of the authors to use this study as a pre-operational initiative to augment the body of knowledge pertaining to weather forecasting, particularly for the initial of stages of instability developments and extreme events using real time direct broadcast data and hourly receiving INSAT-3D Satellite data.**

- **The purpose of this study is also to monitoring the atmospheric instability using INSAT-3D and MODIS profile data at regional and local levels so that it can be used as an indicator of instability and to improve the severe weather forecast.**



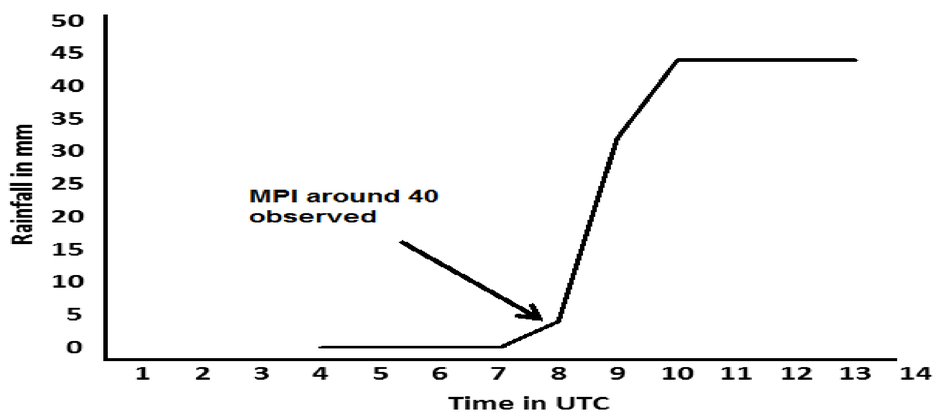
All 12 datasets with an average of 67 MODIS profiles



MODIS profiles of RH with respect to height in hPa for convective and clear weather conditions during pre-monsoon season.

Indices used	Probability of Detection (POD)	False Alarm Rate (FAR)	Accuracy
KI, LI and TT	**0.71**	**0.35**	**73%**
MPI	**0.84**	**0.23**	**79%**

Verification of MPI and radiosonde derived indices in occurrence of rainfall against 24 hours accumulated rainfall during March-June 2011 and 2012



Purpose of the study

During the pre-monsoon season, the occurrence of thunderstorms with rain over north-west and central India are mainly due to synoptic disturbances especially observed in afternoon. It has also been investigated by many researchers that during these seasons none of single indices is suitable enough for use as alone potential index for prediction of extreme events such as occurance/non-occurance of thunderstorms.

Data Used

We utilized entire temperature and moisture profile from MODIS instrument for computation of MPI over the Indian region from March to June 2011 & 12 for clear and convective weather conditions. The training dataset, with an assemblage of 12 vertical profile datasets from MODIS (Terra/Aqua), was constructed for both severe weather i.e. convective events and rain free/clear weather conditions (neither drizzles nor light rain), where each single dataset consisted of 67 temperature/moisture soundings. Thus overall 804 (12x67) sounding associated with each weather conditions.

The authors felt that this was a large enough data set to satisfy requirements for statistical significance of MPI. In the current study, cases with no rain (0.0 mm/day) and heavy rain (> 42 mm/day) accompanied with thunderstorm or severe weather are tagged as a clear weather and convective weather respectively. The value of MODIS Profile Index (MPI) has been computed by integrating the specific humidity for the whole atmospheric height and obtained by performing the integration numerically using the trapezoidal rule from numerical analysis given below:

$$MPI = 1/2g\sum_{i=1}^{n-1}(q_i + q_{i+1})(p_i - p_{i+1})$$

Here g = 9.8 ms-2 is gravitational acceleration; p is the pressure in hPa from surface to top of the atmosphere. As we reach above 100 hPa, the amount of water vapour becomes low and the instruments for humidity measurement (hygrister, used in radiosonde measurement) are not practically reliable. Due to these reasons, we have fixed the upper level up to 300 hPa (Elliot and Gaffen, 1991).

Since the RH describe the amount of water vapor in a mixture of air and water vapor, the figure clearly indicating the presence of water vapor with higher concentration between 700 to 300 hPa. These moisture columns level provide the initial assessment of the potential for convective weather events, resulting the higher MPI values. The occurrence of severe weather is not confined to any selected temperature and moisture profiles of fixed pressure levels as is the case of other instability indices derived from satellites and radiosonde measurements.

The consistent feature of Figure is a steep decline (shown in red) for convective weather events starts at an altitude of 3 km (approximately 700 hPa) and reached up to 5km. Therefore, the occurrence of severe weather is not confined to any selected temperature and moisture profiles of fixed pressure levels as is the case of other instability indices derived from satellites and radiosonde measurements. Such indices typically combine measures of the thermal and the moisture properties and often only use a very small quantity of vertical profile parameters.

Concluding remarks and Future plans

1. **The results from this study suggests that spatially interpolated Sounder data can be utilized as an indicator of adverse impending weather for regional and location specific forecast over the areas where conventional observations are sparse.**
2. **The MPI provides a distinct threshold value between convective and clear weather conditions from the use of entire temperature and moisture profiles unlike other instability indices which often derived from a fixed pressure level quantity of vertical profile parameters.**
3. **To obtain a more generalized index for forecasting, the future work will be focusing on the refinement of MPI using Hourly INSAT-3D sounder data over different seasonal domains with many other surface meteorological parameters to discriminate different classes of weather conditions.**

Acknowledgment

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