

# Work Report for the Period 2001 to 2003

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**Project :** Multisatellite Observations Of Indian Ocean Tropical Cyclones

## **Objectives:**

- To assess the potential of multi-satellite observations in the study of the structure of tropical cyclones
- Identification of parameters leading to intensification/movement of tropical cyclones
- Study of evolution and variability of tropical cyclone features

## **I: Structure of the Tropical Cyclones**

### ***(A) Improved determination of cyclone center***

- ERS-2 and QuikScat scatterometer winds and 85 GHz TRMM observations were used to determine the center of the cyclones under study.
- The centers derived were then compared with the INSAT derived centers provided by IMD. Differences of the order of 0.5 degrees were observed between INSAT and all the three of the above instruments

### ***(B) Study of convection in cyclones using 85 GHz observations from TRMM***

- In this study we have qualitatively analyzed the observations from TRMM Microwave Imager (TMI) and Precipitation Radar (PR) sensors of TRMM.
- Theoretically one expects deepest and strongest convection in the eyewall region, but 85 GHz brightness temperatures show large depressions in the bands and are comparable to those in the eyewall region.

- The Analysis of the patterns of 85 GHz brightness temperatures also reveals an interesting fact that on approaching the land, the intensity, and probably, the depth of rain cells increases. We noticed an average depression of about 30 K in the minimum value of 85 GHz brightness temperatures when a cyclone rain band approaches the land.
- Most intense rainfall is found in eyewall and band regions; from the analysis of SSM/I and TMI data. However, the intensity of rainfall shows a strong diurnal variation in which rainfall in these two regions fluctuates in opposite phase.

## **II: Identification of Parameters Leading to Intensification/Movement of Tropical Cyclones:**

### ***(A) Relationship between Core-Precipitation and Wind Speed***

- A comparison of time series of intense rainfall with that of maximum sustained wind speed (MSW) shows that with each burst of low-level circulation, the convective activity increases abruptly.
- The increase in the area of very intense convection (Rain rate > 16 mm/h) usually occurs about 24 hours before the increase in MSW takes place.

### ***(C) Relationship between CDO Size Variation and Surface Level Moisture Flux***

- Analysis of SSM/I derived Precipitable Water (PW) and surface wind speed (SW) as well as the infrared data from INSAT shows that the changes in CDO size (an indirect measure of cyclone intensity) respond to changes in surface level moisture influx after an interval of 18 hours.
- This shows the potential of passive microwave observations in prediction of tropical cyclone intensity.

## **III: Study of Evolution and Variability of Tropical Cyclone Features**

### ***(A) Study of Convective Band Cycle and Intensification of Tropical Cyclone***

The study of evolutionary changes in the storms under the study was carried out using microwave observations from SSM/I and IR observations from INSAT. The following is the summary of the results:

- SSM/I rain rate and INSAT – IR data shows a clear indication of formation of convective bands during afternoon/evening time.

- During night / early morning time, there is a decay in convective bands and intensification of deep convection at the core region. The area covered by intense precipitation ( $RR > 20$  mm/h) also increases.
- With each intensification of core, there is intensification of maximum sustained wind speed.

***(B) Study of Intensification Potential of Tropical Cyclones***

- Histogram analysis using IR data shows three major types of clouds associated with the cyclones
- The ratio of shallow to deep clouds shows that convective clouds are dominant during the developing stage of cyclone and stratiform clouds are dominant during the decaying stage.
- These ratios can be used to identify the stage of cyclone
- 85 GHz brightness temperature data have also been analyzed to classify the precipitation systems into three categories. These are mesoscale convection ( $TB < 250$  K), Deep convective elements ( $TB_{85} < 225$  K) and decaying systems ( $TB_{85} < 250 < 270$  K). The fraction of deep convective elements to overall cloud area was found to be crucial and correlated to the cyclone's potential for intensification.

**Involvement in other Miscellaneous Activities:**

- Involvement in the analysis of INSAT – CCD images during the launch of PSLV-C3, during October 2001, for providing real time analysis of weather over SHAR, India
- Analysis water vapour images from GMS satellite for studying the movement of tropical cyclones over South China Sea.
- Forecasting the Summer Monsoon Rainfall over India during 2003, using Genetic Algorithm.