

## Quikscat scatterometer wind data impact on tropical cyclone forecasts by a mesoscale model

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The project describes the positive impact of QuikSCAT Scatterometer data on tropical cyclone analyses and forecasts using a mesoscale model (MM5). QuikSCAT data is especially valuable because they are available in the data sparse genesis regions of tropical cyclones, and because they are available in cloudy and rainy conditions. The model used in the study, MM5, is known as fifth generation NCAR/Penn State Mesoscale model (MM5), which is the non-hydrostatic version of the model. The Scatterometer Seawinds launched onboard QuikSCAT in June 1999, observes surface wind vectors over the ocean with the swath of 1800 km. In order to understand and investigate the impact of QuikSCAT Scatterometer wind data, simulation with and without assimilation of Scatterometer data has been performed for a few tropical cyclone cases during the period 1999 to 2003. For a cyclonic situation, data of few ships of opportunity and of some coastal or island stations are only available. For the assimilation of observed data into MM5, a few passes of QuikSCAT at different times are available. The results showed that the initial field with the inclusion of Scatterometer data was nearer to the actual situation. In the prediction experiment, it was also shown that the inclusion of satellite data improved the prediction up to 48 hrs.

## Comparison of satellite derived sea surface winds with NWP model analysis & forecast

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Sea Surface winds play a major role in various phenomena and ocean atmospheric processes. However, due to the limited number of conventional observation over the oceans, the information of sea surface wind is quite insufficient for carrying out many studies. During last few years, the satellites are providing this information by microwave remote sensing technique. In present study, sea surface wind retrieved from Special Sensor Microwave Imagers (SSM/I) onboard DMSP satellites are compared with NWP model analysis and forecast over Indian summer monsoon over peninsular India. Global spectral model (T-80 L-18) is adopted for this purpose. Comparative study is carried out in qualitative, quantitative and statistical sense and in both the hemispheres separately. The results show that the SSM/I derived sea surface winds constitute an important set of additional data to fill up the data-gap regions surrounding India for many applications relating to ocean-atmospheric phenomena.

## MODIS Atmospheric Data Validation and Application for Meso - Scale Processes Studies

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The atmospheric profile product data from recently launched MODIS sensor on board Terra and Aqua Satellites was used to study the meso scale processes embedded in the large scale atmospheric systems, in the South East Arabian Sea. This satellite data was processed for validation of Temperature and Humidity profiles with concurrent ARMEX Radiosonde data. It was found that the RMS error of Temperature below 500 hPa was in the range 1-2.5 K, which is very encouraging considering the level 2 product grid is of 5 KM resolution. In the case of Dew Point Temperature the RMS error upto 780 hPa was in the range of 1.5-3.5 K. The results obtained for specific humidity profiles were most encouraging as the RMS error was less than 2g/ kg even in the lower levels . These have wide implications for meso scale models as the level 1 data is available at a grid of 1 km. Similarly the comparisons of stability index (Total totals index) showed encouraging results. The maps of various parameters and Stability Indices were able to reveal the convective regions in the South East Arabian Sea The MODIS data can give an insight into the thermodynamic structure of the meso scale systems, something which was not possible with the earlier satellite data.

## Validation of 3G-wam wave predictions over Arabian sea for operational implementation in naval environment

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Knowledge of the ocean winds, waves and the resulting sea state is very important for operational deployment of ships at sea as well as for planning design and execution of deep water/off-shore projects. Thus, it is now possible to exploit the voluminous satellite derived data over an otherwise data sparse oceanic region for assimilation in day-to-day operational sea state forecasting methods by blending these data with the in-situ observations. In this study, the '3g-WAM' model predicted ocean wave parameters (significant wave height and direction) over the Arabian Sea bounded between 5° 25° N and 50° 80° E are validated with the in-situ observations (ship based as well as moored buoys) and the satellite derived wave measurements for different seasons of the year. The comparisons have shown that the 3g-WAM generated wave output are conforming well with

the in-situ observations. The model simulated monthly mean Significant Wave Heights agree very well with the TOPEX derived values. However, it is seen that the model predicted values are generally an overestimate when compared to the in-situ observations. Further, the 5-day forecast generated by the numerical model is reliable for the first 48 hours of forecast and the correlations are below average beyond 2 days. This could be attributable to the inaccuracy of the input NCMRWF forecast wind fields beyond 48 hours.

## Ocean Circulation Modeling using Satellite Data

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The North Indian Ocean shows profound impact of variation in lower tropospheric winds. Climatological monthly winds are used to force a non-linear reduced gravity model to simulate surface circulation and sea surface height anomaly. The kinetic energy variation in North Indian Ocean with special reference to equatorial region and the boundaries are studied. The sea surface height anomaly obtained from the model run is compared with TOPEX data. The model successfully simulates the varying eddy structure and current pattern of North Indian Ocean. The kinetic energy along the coasts and Equatorial wave guide region is analysed.

## Investigations into relationship between extreme wet/dry conditions over India and space-based OLR observation over global tropics

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In this present study, large scale changes in the symmetric/asymmetric OLR field over global tropics are evaluated in relation to extremely wet and dry years over India. The relationship between OLR and the precipitation across India has been investigated using OLR data estimated from the window channel observations of the NOAA orbiting satellites for the period 1974-1999. There is a strong negative correlation between total OLR and precipitation over tropical areas where the effect of clouds is greatest. The same pattern is also found in case of OLR anomaly as well as the asymmetric component of the OLR with precipitation. The movements of deep convection have been examined by using the symmetric/asymmetric components of OLR and found an agreement with the migration of the ITCZ. The study suggested that though there were considerable differences in the

asymmetric component of the OLR field between the wet and dry years it was not that prominent during the monsoon season. It may be noted that the OLR-rainfall relationship is region specific and period specific and hence its application is limited. In general very heavy rainfall is underestimated from NOAA OLR values.

## Rainfall estimation over Indonesian region using Arkin's technique

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On the assumption that global geography enriches general circulation of the atmosphere and significantly influences the global distribution and pattern of rainfall, rainfall estimation using relevant technique was applied to meet the requirement. In this study, the 10 days to monthly scale rainfall is estimated using Arkin's technique over a grid of  $1.5^{\circ} \times 1.5^{\circ}$  covering Indonesian region. The variability of rainfall and cloudiness is also studied over the same region on a grid of  $1.5^{\circ} \times 1.5^{\circ}$  using 3 hourly GMS (Geostationary Meteorological Satellite) data. The comparison of 10 days monthly rain maps with ground based and other satellite measurements are carried out for wet season during 1997/1998 over Indonesian region. A good qualitative agreement is found between GMS and ground based rain maps. However, in quantitative terms, correlation between GMS estimation and ground rain measurements is found about 60% in January 1997 and 61% in February 1997 when the boxes with high topography are excluded.

## Break and active monsoon over Nepal

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Using INSAT and ground truth data for the four years (1994-1997) of 12 stations of Nepal and 18 subdivisions of India, an attempt has been made to establish a relationship between Nepal and three different regions selected of India on break and active monsoon over Nepal. The three different meteorologically homogeneous regions of India west central, peninsular and north east India have been selected for the present study. Generally these three regions of India are more related to Nepal's monsoon especially during break monsoon conditions. Weekly rainfall data of the area have been analysed statistically. Similarly satellite imageries and synoptic charts have also been used to study the movement of cloud and trough line. The nature of the weekly variations over the different regions in four representative months of the year is discussed.

## Retrieval, validations and applications of sea surface temperatures

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Sea surface temperature was retrieved from AVHRR level 1-B HRPT data (May 1999-June 2000) around west coast of Sri Lanka using two algorithms viz. PCSAT and ILWIS. The retrieved SST was compared with the near simultaneous ship observations and it was found that PCSAT and ILWIS algorithm derived SST have an rms of 3.7 K and 1.9 K respectively. Some of the oceanic thermal features like warm pool, eddies and upwelling were also studied using the derived SST images. A study to examine the relationship between SST anomalies in NINO 2, NINO 3 and NINO 4 regions with respect to the rainfall anomaly at Colombo was also carried out and a negative correlation (-0.52) was found for SST anomaly in NINO-2 region in January with rainfall anomaly at Colombo in April.

## Wave modeling over the south china sea

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Vietnam has more than three thousand kilometers coast line, and has strong winds in this area. Normally, eight to twelve cyclones affects Vietnam every year. In the case of cyclones, wave height can be more than 6m heights. There are many economic areas concerning to sea state, such as fisheries, transportation of industrial and petroleum products, etc. In the present study, experiments performed with the state of the art numerical wave model, WAM have been discussed. The WAM model solves the complete action density equation including non-linear wave-wave interactions with no presumption of initial shape of the spectra. In this project, model runs have been made for the South China Sea region comprising of 100°E-125°E; 0°N-25°N for year 2001. To derive the wave model, satellite wind data of Quikscat scatterometer has been utilized. The comparison of hindcast parameters has been done with Topex radar altimeter derived parameters. For the comparison, in-situ data of the Oilrig in the China Sea has also been utilized. The project results show quite good agreement between model derived wave height and altimeter derived wave height (correlation coefficient of 0.9).