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INITIALIZATION OF MONSOON ONSET VORTEX FROM THE USE OF MSMR SURFACE WIND

1. The onset of Indian summer monsoon is an important event which has great influence in the agriculture sector of the region. The onset of monsoon usually takes place with the formation of low pressure area (called as monsoon onset vortex) over the south east Arabian Sea. A major problem in the use of a Numerical Weather Prediction (NWP) model for the forecasting of onset vortex is the near absence of conventional data as well as inadequacy of non conventional data in the sea areas where the system invariably originates. In view of the importance of accurate oceanic initial conditions in tropical numerical weather prediction, it is necessary to maximize these data from non-conventional sources (Prasad *et al*., 1997; Rama Rao *et al*., 2001). The purpose of the present study is to examine the impact of surface wind from Multi frequency Scanning Microwave Radiometer (MSMR) in the operational model analysis of India Meteorological Department (IMD) for initialization of monsoon onset vortex.

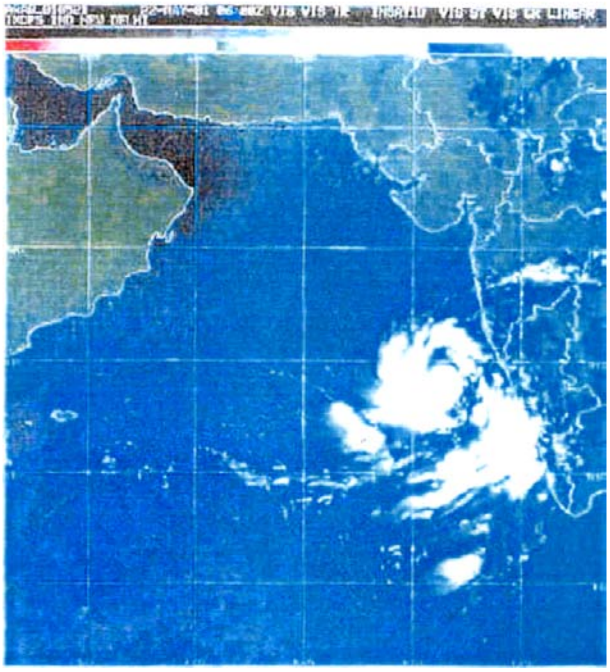


Fig. 1. INSAT picture at 0000 UTC of 22 May 2001 showing cloudiness associated with the cyclonic storm over the Arabian sea

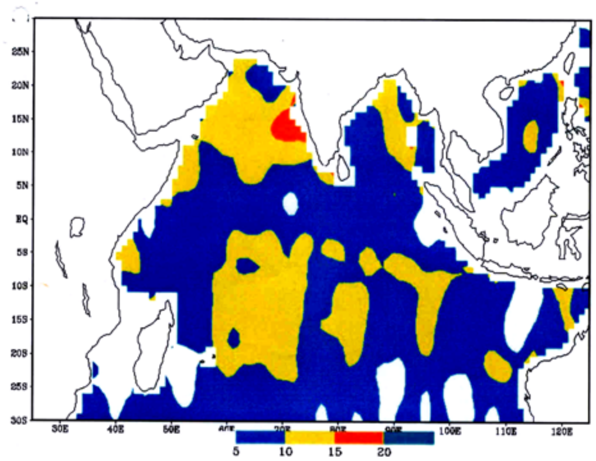


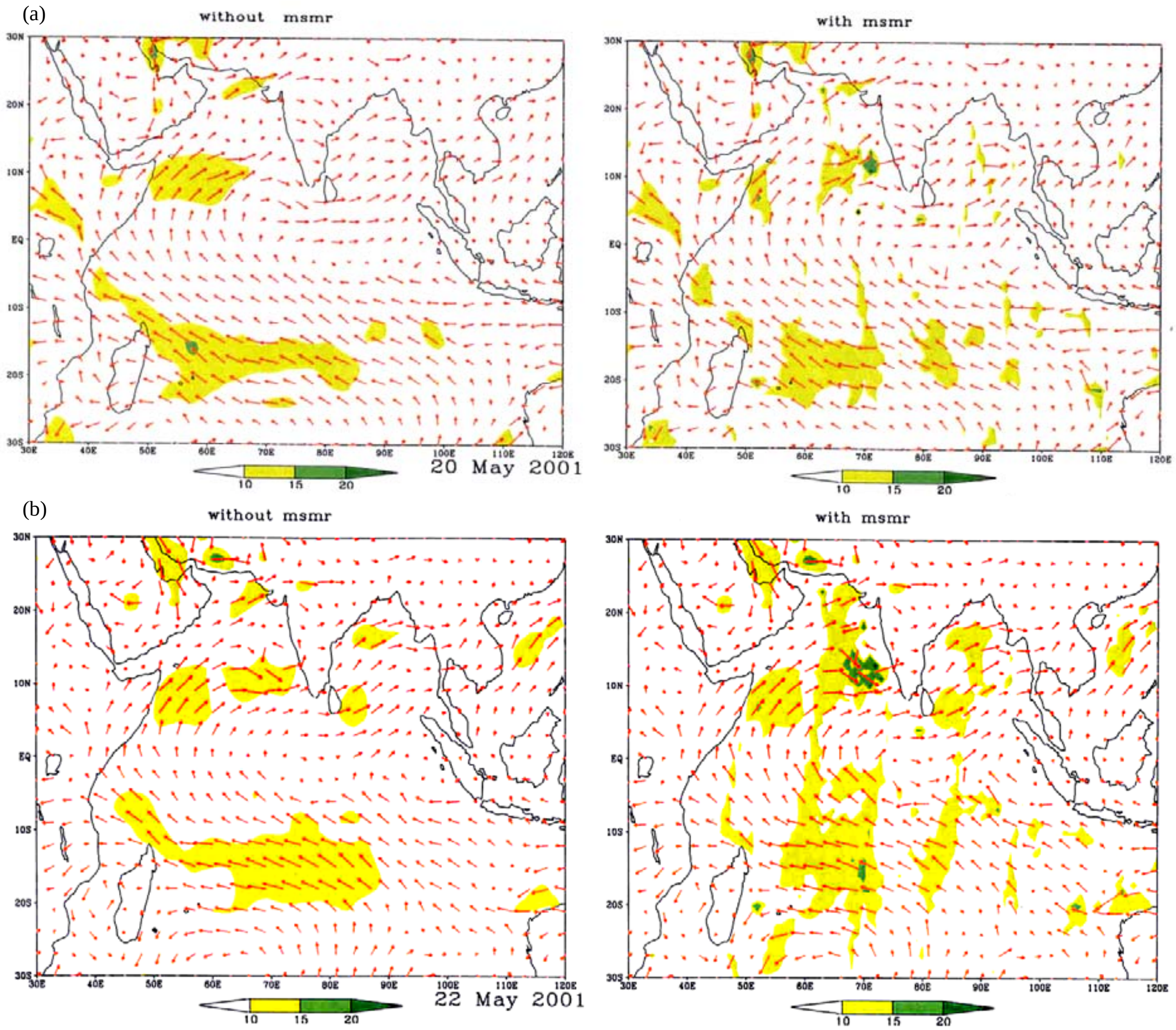
Fig. 2. Geographical distribution of composite MSMR surface wind speed (ms^{-1}) of 22 May

2. The MSMR on board IRS-P4 (Oceansat-1) with capability of global coverage with two day repetivity was an eight band (four frequency in dual polarizations) passive microwave radiometer with a conical scan mechanism. The frequency combinations of MSMR, namely, 6.6, 10.6, 18 and 21 GHz facilitated generation of geophysical parameters: sea surface wind speed, sea surface temperature, total cloud water and total water vapour in the marine atmosphere. The first version of data product software for both the brightness temperature data as well as the geophysical parameters was developed by the IRS-P4 Data Product Project team at the Space Application Center (Indian Space Research Organization) including the geophysical retrieval algorithm software (Gohil *et al*., 2000). The validation study made by Ali (2000) revealed that the surface wind speed as derived from MSMR were fairly accurate and acceptable for use in applications. The present study uses the surface wind speed available at the resolution of 75 km.

3. The operational NWP system of India Meteorological Department (IMD) consists of real time processing of data received on Global Telecommunication System (GTS), decoding and quality control procedure handled by AMIGAS software and a multivariate optimum interpolation scheme. The first guess field for running the analysis is obtained online from the global forecast (T-80/18L) run at National Centre for Medium Range Weather Forecasting (NCMRWF), NOIDA, U.P. The methodology applied for objective analysis scheme is the statistical 3-dimensional multivariate Optimum Interpolation (OI) scheme (Dey and Morone, 1985; McPherson *et al*. 1979).

In order to incorporate the MSMR surface wind in the model analysis, the first guess from NCMRWF (24 hours forecast) of zonal and meridional wind components of 1000 hPa are interpolated at 1° × 1° Latitude/ Longitude. For the grid points where MSMR data are available, wind direction for corresponding grids are computed using the *u*, *v* components of first guess wind. The wind direction thus obtained are used to derive new *u*, *v* components from the MSMR surface wind speed. The first guess field of 1000 hPa wind field is updated with these MSMR *u*, *v* components of winds. The analysis procedure is re-run using this updated first guess to obtain the modified analysis field.

4. In 2001, onset of Indian summer monsoon over Kerala took place on 23 May. The monsoon onset vortex was observed as a depression over the south east Arabian sea in the morning of 21 May. It intensified into a cyclonic storm (with centre near Lat. 14° N/Long. 71° E) in the morning of 22 May. Fig. 1 shows the corresponding INSAT picture of 22 May. The geographical distribution of composite MSMR surface wind speed of 22 May is presented in Fig. 2. The stronger surface wind is found to be confined over the south east Arabian Sea. The system intensified further into a very severe cyclonic storm in the morning of 23 May and attained its peak intensity on 24 evening and maintained same intensity till 25 May morning hours. Thereafter the system started weakening and became a cyclonic storm



Figs. 3(a&b). Model analysis wind field (ms^{-1}) of 1000 hPa for 0000 UTC of (a) 20 May 2001 and (b) 22 May 2001 during the formation and intensification of monsoon onset vortex over the south-east Arabian sea. Shaded regions denote higher magnitude of winds

on 27 morning. The MSSW (Maximum Sustained Surface Wind) over the area of disturbance as reported by RSMC (Regional Specialized Meteorological Centre) of India Meteorological Department (IMD) is shown in Table 1. These are estimated from post storm synoptic analysis based on all available observations (ship, buoy reports and INSAT T number).

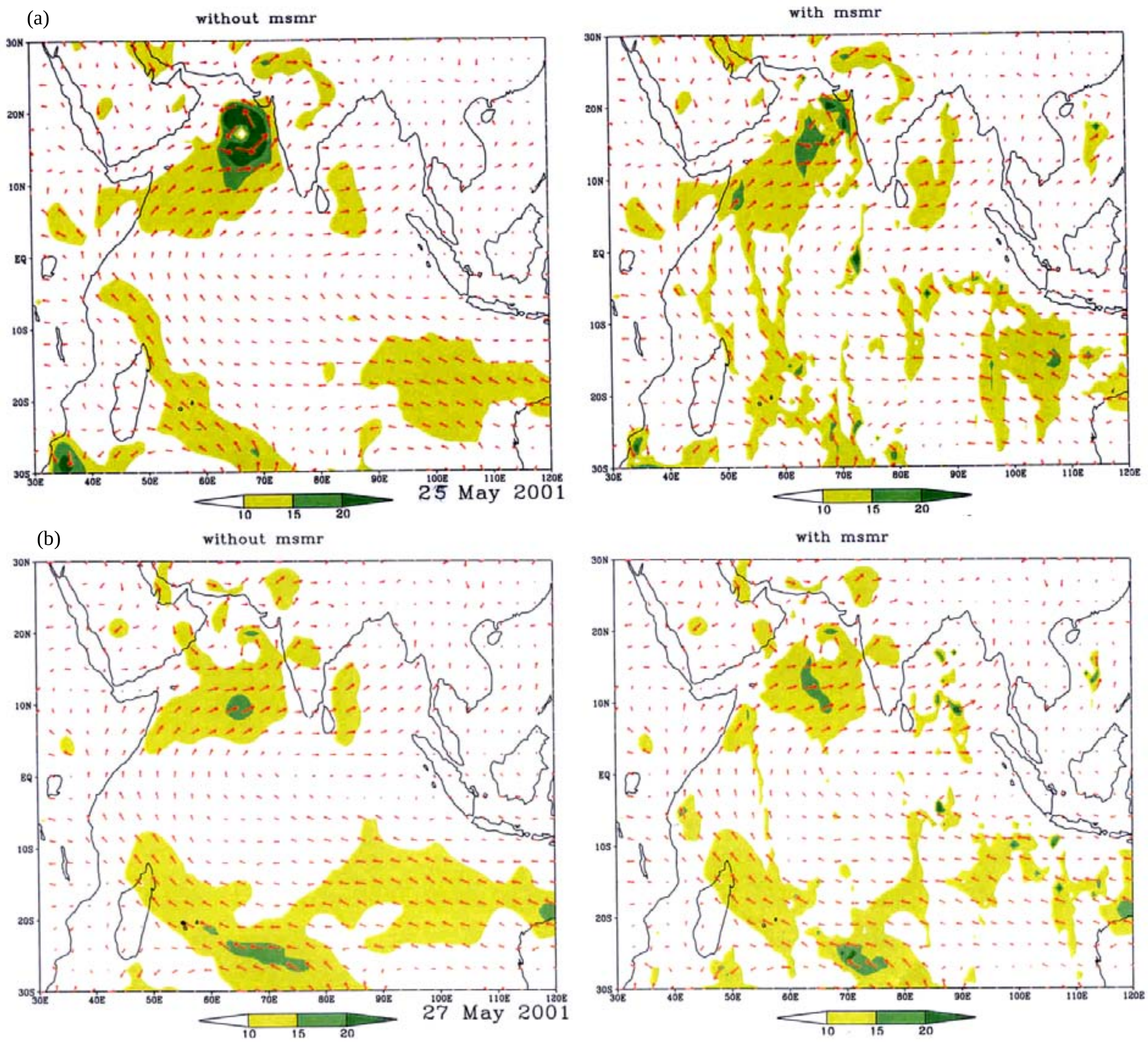
TABLE 1

MSSW (ms^{-1}) based on 0300 UTC observation during 20-26 May 2002

Dates	21	22	23	24	25	26	27
MSSW	13	20	33	45	58	33	28

Figs. 3 (a&b) represents wind analysis of 1000 hPa at 0000 UTC of 20 May and 22 May based on without MSMR wind and with MSMR wind respectively during the formation of monsoon onset vortex and its further intensification into a cyclonic storm. Shaded regions indicate higher magnitude of winds. It is very interesting to note that experimental run (with MSMR) could capture the strengthening of winds (10-15 ms^{-1} compared to around 5 ms^{-1} in the operation run) over the area of disturbance on 20 May, one day prior to the formation of depression. Further strengthening of winds is noticed on 22 May when cyclonic storm was actually formed.

Though both operational as well as experimental run is able to capture the circulation, the magnitude of wind speed was considerably under-estimated by



Figs. 4(a&b). Same as Fig.3 for 0000 UTC of (a) 25 May 2001 and (b) 27 May 2001 during the mature stage and subsequent weakening of the system

the operational run (without MSMR). In the case of experimental run of 22 May, the strength of wind (15-20 ms^{-1}) was closer to the observation as reflected in Table 1. Strengthening of south westerly wind over the south Arabian Sea on 22 May was also consistent with the onset of monsoon over Kerala on 23 May. The comparison clearly shows that the strengthening of wind during the formation and intensification of the system reflected more distinctly in the experimental run. Figs. 4(a&b) illustrates the surface wind analysis of 25 and 27 May respectively during the mature and decaying stages of the cyclonic storm. The system maintained its peak intensity till 25 May, subsequently weakened and became a cyclonic storm on 27 May. Again it is interesting to notice that the experimental run of 25 May shows significant under-estimation of wind speed. This deficiency in the MSMR wind may be due to the presence of high cloud top associated with the intense cyclone . On 27 May when the system became weak, the experimental surface wind analysis is found consistent with the operational run. Thus, the study reveals that during the formation stage of the onset vortex and its intensification into a cyclonic storm, the MSMR wind data has a positive impact on the initial analysis, where as during the mature stage of the cyclone it has a negative impact.

In the 24 hours forecast no significant difference is noticed between control and experimental runs. In this context it needs to be mentioned that an inherent spin up problem arises in most NWP models. The spin up arises due to inconsistency of initial wind and moisture fields.

During this spin up time divergent wind, diabatic heating and surface pressure field undergoes an adjustment (Krishnamurti *et al*., 1991).

5. The study has brought out a distinct positive contribution of MSMR surface wind in the initial analysis of the limited area model which suffers in the oceanic region due to sparsity of data. The model analysis with MSMR surface wind carries interesting signals of monsoon onset vortex formation. Significant improvement in the analysis field is noticed during the processes of development of the monsoon onset vortex (20-22 May) over the east Arabian Sea. However, negative impact (under-estimation) of MSMR surface wind in the analysis field is noticed during the mature stage of the cyclone. This deficiency in the MSMR wind may be due to improper representation of surface wind over the area of active convective zone associated with the intense tropical cyclone. Though no appreciable positive impact is noticed in the forecast, but the improved model analysis appears to provide useful predictive signal for the operational forecasting of monsoon onset vortex.

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