

# RESEARCH ON CYCLONES : METEO-FRANCE LA REUNION ACTIVITIES

S. Westrelin<sup>1</sup>, D. Barbary<sup>1</sup>, M. Bessafi<sup>2</sup>, F. Chane-Ming<sup>2</sup>, R. Lee-Ah-Siem<sup>1</sup>, J.-M. Willemet<sup>1</sup>

<sup>1</sup> Direction InterRégionale de Météo-France La Réunion  
Corresponding author address : samuel.westrelin@meteo.fr  
<sup>2</sup> Laboratoire de Physique de l'Atmosphère, Université de La Réunion

## 1. INTRODUCTION

The Météo-France « research on cyclones team », created five years ago and settled in La Réunion RSMC (Regional Specialized Meteorological Center), is willing to introduce its activities to the research community on cyclones. Our main goals are to improve the knowledge of the tropical cyclones and to make our progress available into operations. At first we would like to put the stress on our global model performances in forecasting cyclones over the South West Indian Ocean in comparison with other global models used by forecasters. Then we will focus on our current work undertaken with a non hydrostatic meso-scale model with sophisticated physics. This will be a laboratory to study the cyclones and we hope to improve the tracks and intensity of cyclones forecasts by the way. Finally we present two examples of fundamental research work : one concerning a study with Météo-France Doppler radar data and another dealing with the Madden-Julian oscillation.

## 2. GLOBAL MODEL PERFORMANCES

We present the performances of Météo-France numerical model and other global models used by the forecasters at the RSMC La Réunion.

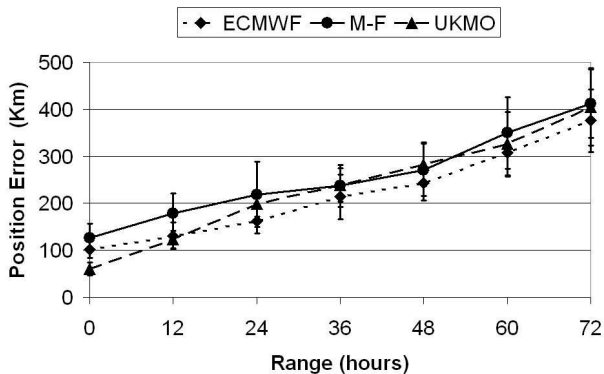


Figure 1 : Evolution of mean forecast error of cyclones position by a few numerical models as a function of range over the South West Indian Ocean over the 2002-2003 cyclonic season. The vertical bars figure the 95% gaussian confidence interval.

The figure1 shows the evolution of the forecast mean error with the model's range. ECMWF stands for European Center for Medium range Weather Forecast, UKMO for United Kingdom Meteorological Office, and M-F for Météo-France. The samples used in the calculations are not the same so that a rigorous comparison between the models can not be inferred. However this picture gives a good idea of

the models behaviour. The biggest differences appear in the 24 first forecast hours and seem significant because confidence intervals are relatively narrow. The bogussing of vertical wind profiles around the cyclone center in the UKMO assimilation scheme appears to be efficient since the analysis of this model is the more precise one. Météo-France model's bogussing consists only in assimilating the estimated mean sea level pressure at the cyclone center. ECMWF model is not bogussed. After 36 hours range, the gap between the models decreases but the confidence associated with the mean score is lower. The ECMWF model keeps the best ability to precisely locate a cyclone with range.

Météo-France model now belongs to the models which show a good skill in forecasting cyclones tracks.

## 3. USE OF A MESO-SCALE MODEL

On the 22<sup>th</sup> of january at 14UT, the severe tropical cyclone « DINA » was at the nearest of La Réunion island. Wind gusts faster than 250 km/h blew and cumuls of precipitations of more than 1500mm over 72 hours were gauged.

In order to study the cyclone and try to better predict it, we began to use the Meso-NH atmospheric simulation system (Bougeault et al, 1996), a non hydrostatic meso-scale model. This model simulates the atmospheric motions, ranging from the large meso-alpha scale down to the micro-scale, using the so-called « interactive grid-nesting technique ». It is also possible to increase to very high resolutions and predict phenomena like the lifecycle of a cyclone eye which can be seen on the radar doppler pictures. Our first results are very promising not only concerning the track of the cyclone but also the winds extensions which are very influenced by the steep relief of La Réunion island.

## 4. THE DOPPLER RADAR

The Météo-France meteorological S-band Doppler radar (10 cm) is operational since late 1993 and located at the north of La Réunion island for cyclone survey. Since 2000 the radar data can be used for different research activities such as the comparison with TRMM data, the rainfall estimation, the statistical analysis of rain field structure, the observation of wind structure of tropical cyclone through the « Ground-Based Extended Velocity Track Display » method using a single ground-based Doppler radar and use of radar data in Meso-NH model [Nuissier et al., 2003]. The GB-EVTD method

was applied on Doppler radar observations of intense tropical cyclone Dina near La Réunion island in the southwestern Indian Ocean, on 22<sup>th</sup> of January 2002 [Roux et al., 2002; 2003].

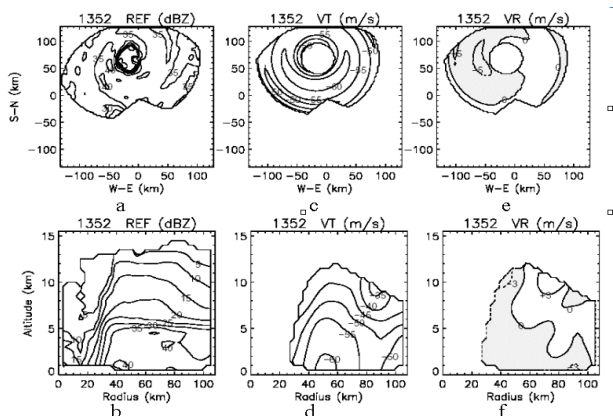


Figure 2 : Mean reflectivity distribution (a) (b) and tangential (b) (d) and radial wind (e) (f) at 2-km height at 13h52 UT.

## 5. THE MADDEN-JULIAN OSCILLATION

The modulation of tropical cyclone activity by the Madden-Julian oscillation have been reported in the Australian region (Hall et al., 2001) and the Eastern North Pacific (Maloney et al., 2000). Following these previous works, our team is studying the effect of the MJO on the TCs genesis over the South Indian Ocean during the November-April 1991-2001 period. For the present study, only TCs genesis formed east of 50°E were selected in the best tracks database from the RSMC. The temporal feature of the MJO was given by the first two principal components (PCs) time series derived from the projection on the first two EOFs of the space-time filtered tropical OLR data (available by courtesy of Matthew Wheeler at the BMRC) over the 1991-2001 November-April period. Following Matthews (2000) and Hall (2001), the MJO was divided into four categories labelled A, B, C, D each covering a quarter of the MJO cycle in a two-dimensional phase space defined by PC1(t) and PC2(t). For each category, the number of TCs genesis is summarized in Table 1 below.

MJO category	Number of days	Number of TCs genesis
A	351 (19.4%)	16 (4.5%)
B	354 (19.5%)	23 (6.5%)**
C	346 (19.1%)	13 (3.8%)
D	359 (19.8%)	5 (1.4%)‡
NONE	403 (22.2%)	19 (4.7%)
<b>TOTAL</b>	<b>1813 (100%)</b>	<b>76 (4.2%)</b>

Table 1. Number of days encountered for each MJO category and observed TCs genesis. In parenthesis is added respectively the percentage of the number

of days of one particular MJO category during the entire 10-years period and the percentage of the genesis days within the corresponding category. Categories where TC numbers were significantly above (below) average at 95% significant levels are indicated by \*\* (‡) respectively.

More TCs genesis occurred during the category B of the MJO which is consistent with enhanced convection over the south eastern Indian ocean. On the opposite fewer cyclogenesis appeared over the eastern region during category D compared to the climatology.

## 6. REFERENCES

- Bougeault, P., S. Bélair, S.M. Carrière, J. Cuxart, V. Ducrocq, C. Fischer, P. Hérelil, J.P. Lafore, P. Mascart, V. Masson, J.P. Pinty, E. Richard and J. Stein. The Meso-NH atmospheric simulation system : scientific documentation, Météo-France and CNRS, 1996.
- Hall, J. D., Matthews, A. J., and Karoly D. J., 2001: The modulation of tropical cyclone activity in the Australian region by the Madden-Julian Oscillation. *Mon. Wea. Rev.*, **129**, 2970-2982.
- Maloney, E. D., and D. L. Hartmann, 2000: Modulation of eastern North Pacific hurricanes by Madden-Julian oscillation. *J. Climate*, **13**, 1451-1460.
- Matthews, A. J., 2000: Propagation mechanisms for Madden-Julian oscillation. *Quart. J. Roy. Meteor. Soc.*, **126**, 2637-2652.
- Nuissier, O., R.F. Rogers and F. Roux, 2003: Numerical simulations of a mature tropical cyclone: Hurricane Bret on 21-22 August 1999. *Quart. J. Roy. Meteor. Soc* (in revision, May 2002).
- Roux F., F.Chane-ming, A. Lasserre-bigorry, O. Nuissier, Structure and evolution of intense tropical cyclone Dina near La Réunion on 22 January 2002: GB-EVTD analysis of single Doppler radar observations, *J. Atmos. Oceanic. Technol.* (in revision : nov. 2003)
- Roux, F., F. Chane-ming, A. Lasserre-bigorry and O. Nuissier, 2002: Doppler radar observations of tropical cyclone Dina as it passed near La Réunion on 22 January 2002. *Proceedings of the Second European Conference on Radar Meteorology (ERAD)*, Delft, Pays-Bas, 18-22 Novembre 2002, 6 pp.