TEST OF A MESOSCALE MODEL OVER THE SOUTH WEST INDIAN OCEAN FOR CYCLONE ANALYSIS AND PREDICTION

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1. CONTEXT

Over the last decades, the global models have achieved great progress concerning the track forecasts but their representation of the cyclone itself remains very poor due to rough horizontal resolutions, including in the initial state. Improvements in cyclone track and intensity predictions are expected with a better simulation of the cyclone structure that can be obtained with a mesoscale model. Moreover such a model can be finely adapted to the area of interest, with relevant climatological background errors statistics and assimilation of high density satellite observations.

In the present work are exposed the first tests of a mesoscale assimilation/prediction suite on cyclone forecasts, built to become operational in the next months at the RSMC (Regional Specialized Meteorological Center) of La Réunion.

2. MODEL DESCRIPTION

The limited area model run over the south west Indian ocean is the Aladin model (Bubnová et al, 1993 ; Radnóti et al, 1995 ; Horányi et al, 1996) coupled with the Météo-France global model Arpege (Courtier et al, 1991) at a uniform resolution. The domain roughly covers the RSMC zone of La Réunion. It has its own assimilation scheme which uses the 3D Var algorithm (Courtier et al, 1998) with a six hour window and a linear beta-plane balance. In the following, the observations dataset is the same as the one from the coupling model which contains in particular a mean sea level pressure bogus. The forecast model is run at the same resolution as the analysis.

Three different versions of Aladin have been tested :

ALAD1 : the horizontal resolution is 21,6 km in both latitude and longitude. The calculation grid is quadratic. The background errors covariances have been computed with the lagged-NMC method (Široká et al, 2003) over the first quarter 2004 corresponding to warm season meteorological conditions. A rapid scan of these matrices showed that they contain some specific structures linked to the characteristics of the domain.

ALAD2 : the horizontal resolution is 10 km. The calculation grid is linear. The background errors covariances have been computed with the analysis ensemble technique (Berre et al, 2006) over the same period as version 1.

ALAD3 : same as the version 2 with non linear and omega balances (NLO) included in the assimilation scheme (Fisher, 2003).

In a nutshell, these balances make the background covariance model dependent on the flow, forcing the background errors to be spatially heterogeneous : the larger either the wind force, gradient or/and curvature are, the larger the local background error standard deviations will be. This approach allows at mid latitudes a better analysis of the jets (entrances and exits), while in tropical zones it is expected to improve cyclone analyses at high resolution.

3. GLOBAL MODEL AND LIMITED AREA MODEL COMPARED PERFORMANCES

A first step is to quantify the contribution of the resolution increase .

Both versions ALAD1 and ALAD2 have been run over several cyclone cases :

-ALAD1 : Bento from 20 to 30 November 2004 and Juliet from 5 to 14 April 2005 ;

-ALAD2 : Daren from 18 to 22 January 2006 and Ernest from 18 to 24 January 2006.

On average, the cyclone forecast position is better with Aladin than with Arpege while in both models the cyclone is analysed at the same position. The interesting feature is the smaller growth of position error with range obtained in Aladin.

Let's now focus on the analysed structure of cyclones with the case of Bento, for which forecasters issued regular warnings between the 20th and 30th of November 2004. Bento intensified very suddenly on the 22nd and on the 23rd it was an intense tropical cyclone (figure 1).

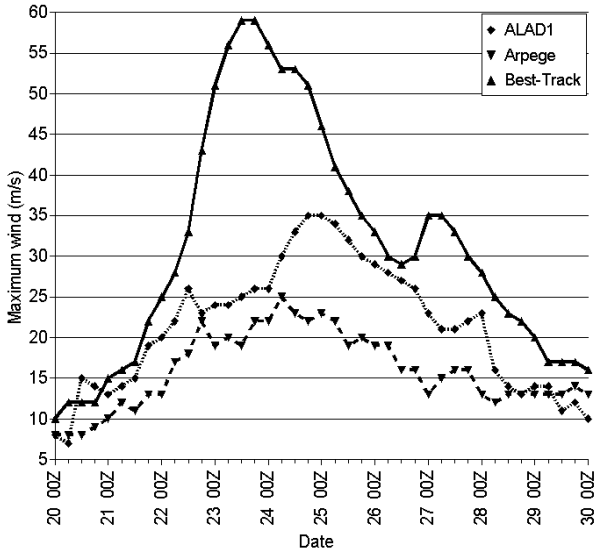

Figure 1 : *Maximum wind analysed by the forecasters, Arpege and ALAD1 on cyclone Bento (November 2004)*

The intensity is better analysed by ALAD1 than by Arpege, with a maximum wind 10 $m.s^{-1}$ stronger. However ALAD1, as Arpege, can not see the quick rise on the 22nd. The radius of this maximum wind gives a

good picture of the ability of the model to simulate a cyclone. As shown on figure 2, the maximum wind radius analysed by ALD1 is in better agreement with the reality than Arpege's one. This more realistic analysis has a positive impact on all ranges of the two day forecast and not only in the few following hours.

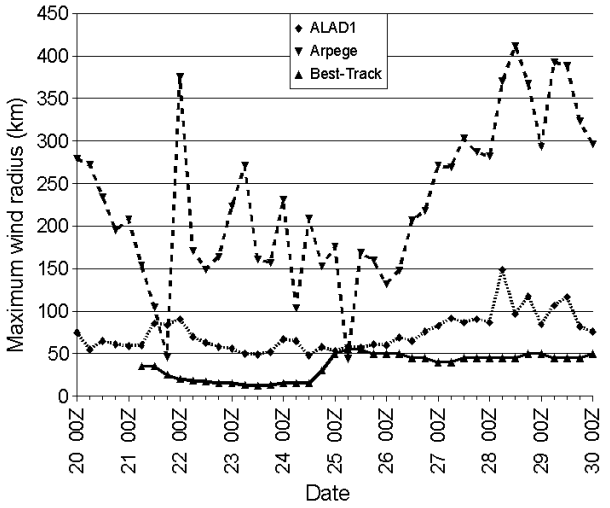

Figure 2 : *Radius of maximum wind analysed by the forecasters, Arpege and ALAD1 on cyclone Bento (November 2004)*

4. NON LINEAR AND OMEGA BALANCES

After raw improvements of cyclone analyses obtained mainly with a higher resolution, we focus now on core analysis enhancements that better model cyclonic circulations : the non linear and omega balances.

To estimate the impact of these balances, a first comparison of versions ALAD2 and ALAD3 has been performed during a 7-day long simulation.

One of the most interesting features during this period is the very quick intensification of the future « intense tropical cyclone » Ernest, with a central pressure drop of 25 hPa in 24 hours (20 Jan.) and of more than 40hPa in 48 hours (20 – 21 Jan.). This deepening was not forecast by any model, except GFDN which predicted an intensification 24 hours in advance -but much weaker than the actual one.

While the reference (ALAD2) version of Aladin barely adds any value to global models, the NLO version (ALAD3) forecasts on the 19 at 00Z a deepening similar to the GFDN's one, and even forecasts on the 20 at 00Z a very realistic drop of pressure, with -43hPa in 48h (figure 3).

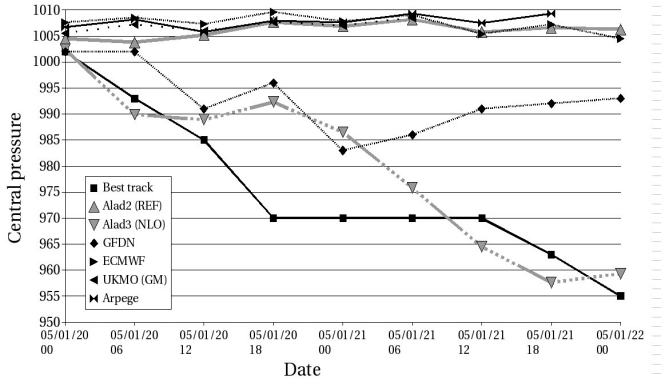

Figure 3 : *48h forecasts of the central pressure of Ernest ; start at 00Z on the 20th January 2005 ; best track and 6 models (Limited Area or Global)*

This first experiment is too short to lead to any definitive conclusions, but it already gives a very positive signal for the use of non linear and omega balances for cyclone analyses.

5. CONCLUSION AND PERSPECTIVES

The limited area model Aladin is able to analyse much more realistic cyclones both in structure and intensity, leading to better forecasts than the global coupling model.

The *a priori* positive impact of non linear and omega balances will be more deeply studied before choosing which version, between ALAD2 and ALAD3, will become operational in 2006. Then the future developments will focus on the assimilation of satellite observations to :

-obtain a better sea surface temperature analysis, a crucial parameter for cyclogenesis ;

-better describe the cyclone body itself, in which most of satellite observations are not assimilated because they are contaminated by rain or strong winds.

6. REFERENCES

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