P12.4 WIND PATTERNS IN FNL AND MM5 SIMULATIONS DURING THE EPIC2001 PROJECT

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1. INTRODUCTION

Uncertainties still remain about the mechanisms that control the development of deep convection over the East Pacific tropical ocean, that result in poor weather predictions with numerical models in the region. The East Pacific Investigation of Climate (EPIC2001) was carried out during September and October, 2001 (Raymond et al. 2004, Bretherton et al. 2004), to understand, among other topics, the location, intensity and variability of deep convection in the ITCZ. The wind fields, especially at the surface, appear to be an important factor in convective development and intensification in the region (Raymond et al. 2003; McGauley et al. 2004) and require a correct representation in numerical models.

Comparisons of the wind field from the Final Analyses (FNL) of NCEP and observational data from EPIC encouraged us to use the analyses to initialize and provide the boundary conditions for a simulation with MM5 for the whole EPIC period. The results from the simulation with MM5 were also compared with observational data to determine how well the wind field was reproduced during the period of study.

2. EPIC2001 DROPSONDES

Dropsondes were launched from two research aircraft during EPIC2001, the P3 from NASA and the C130 from NCAR. A detailed description of the flight missions as well as the respective flight patterns followed during the experiment can be found in Raymond et al. (2003). The ITCZ missions were carried out in a 4º x 4º domain centered at 10N, 95W (EPIC domain) with the main objective of study the ITCZ in the East Pacific. The 95W missions were designed to study the cold tongue, the SST front and the convective region along this longitude. Wind profiles obtained from dropsondes launched in both missions were used for this study.

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3. FNL ANALYSES

FNL is the Final Global Data Assimilation System (GDAS), run operationally by NCEP on 1º x 1º degree grids, four times a day. FNL data for September-October 2001 were acquired for this study, distributed in 26 vertical pressure levels from 1000hPa to 10hPa.

4. THE MM5 SIMULATION

A numerical simulation for the whole EPIC period was performed with the MM5 model (Grell et al. 1994) from 1 September to 15 October, 2001. The FNL analyses were used to provide the initial and boundary conditions every six hours for the simulation. A single domain delimited by 120W and 75W and by 10S and 30N in longitude and latitude, respectively, was used with a horizontal resolution of 90km.

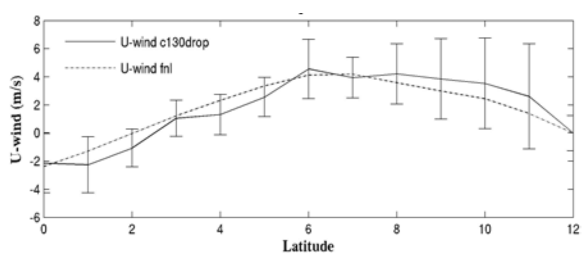

Figure 1. U-wind at the surface averaged over the eight flights. The solid line represents the C130 dropsonde data and the dashed line the FNL data. Error bars represent the standard deviation in the dropsonde measurements.

5. PRELIMINARY RESULTS

Dropsonde data from 95W missions were used to compare the FNL data against observations. Figures 1 and 2 show the *u* and *v*-component of the wind at the surface from the dropsondes and the FNL data averaged over the eight flights along the 95W longitude.

Both figures show a very good correspondence in the wind at the surface. The largest variability in the zonal wind is observed in the convective region between 8 and 12N. As the correlation with observations of both variables decreases at 850hPa (not shown), vertical-meridional plots of the root mean square error of the zonal and meridional wind were made (Figs. 3 and 4) to determine quantitatively the accuracy of the FNL wind field.

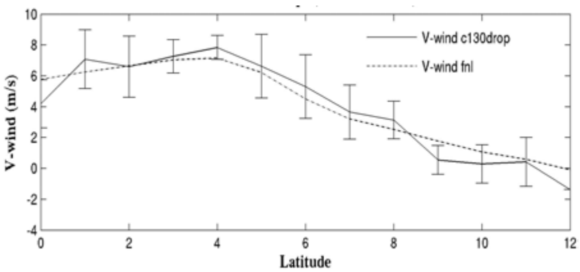

Figure 2. Same as in Fig.1 except for the V-wind at the surface.

Figure 3 shows that the best correlations in the zonal wind are present approximately between 900 and 1000hPa. The agreement decreases in this layer between 6-12N in accordance with the larger variability observed in this zone. The worst correlations are observed above 900hPa between 0-6N and in the convective region 8-12N. This could be related to the two different convective regimes that exist from 0 to 12N. Near the equator, the stratus clouds associated with the cold tongue region dominate (Bretherton et al. 2004), while in the ITCZ, deep convective clouds are predominant (Raymond et al. 2003). To simulate these convective regimes and the transition between them is a great task for any model, combined with the lack of observational data in this region.

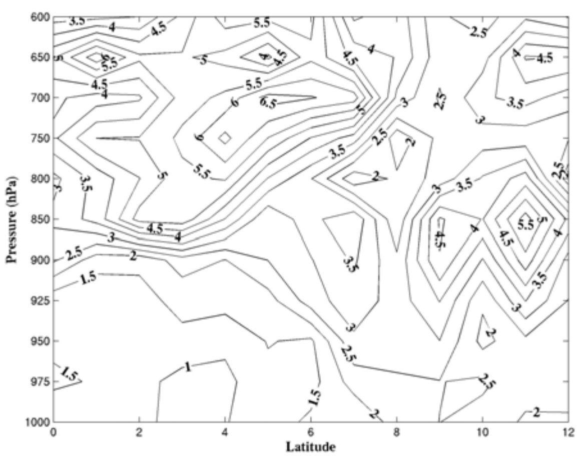

Figure 3. Vertical and meridional distribution of the root mean square error of the *u*-wind between the C130 dropsondes and the FNL data. Data were averaged over the eight flights.

A similar behavior in the meridional wind is observed in figure 4. Good agreement is observed at the surface and decreases with height at all latitudes with the smallest error present at approximately 900-925 in the convective region between 8-10N and near the equator above 700hPa.

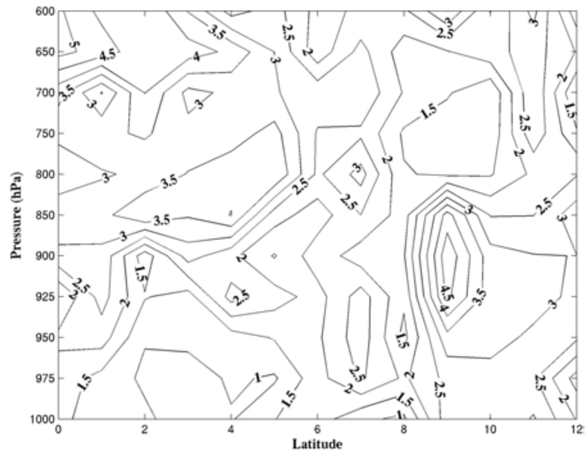

Figure 4. Vertical and meridional distribution of the root mean square error of the *v*-wind between the C130 dropsondes and the FNL data.

Dropsondes launched within the EPIC domain were used to analyze the wind field in the MM5 simulation and the FNL data in the ITCZ region.

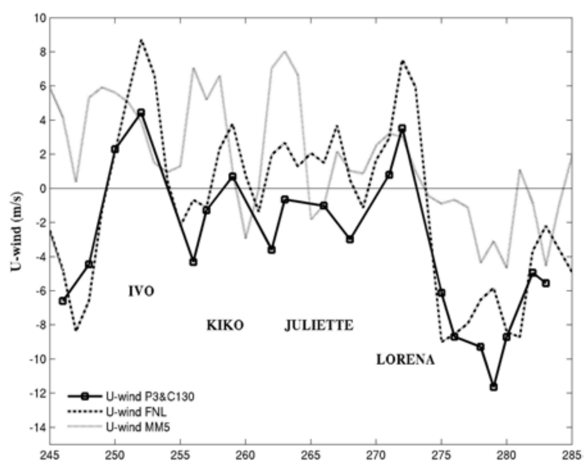

Figure 5. Time-serie of *u*-wind at 850hPa averaged over the EPIC domain. Solid line represents the dropsondes, the dashed line represents the FNL data and the dotted line the MM5 simulation. The names indicate tropical storms that developed during this period from easterly waves.

Figure 5 shows the time evolution of the *u*-component at 850hPa from the dropsonde and the FNL data and the MM5 simulation, averaged over the EPIC domain. The variations in the zonal wind observed during the experiment, from westerlies to easterlies and vice versa, are associated with the passage of easterly waves, which later developed into tropical storms. Their names are indicated in the figure, located at the date of the wave passage. The FNL data seem to represent better the variations in the zonal wind observed than the MM5 simulation. However, both models tend to overestimate its strength during the wave episodes.

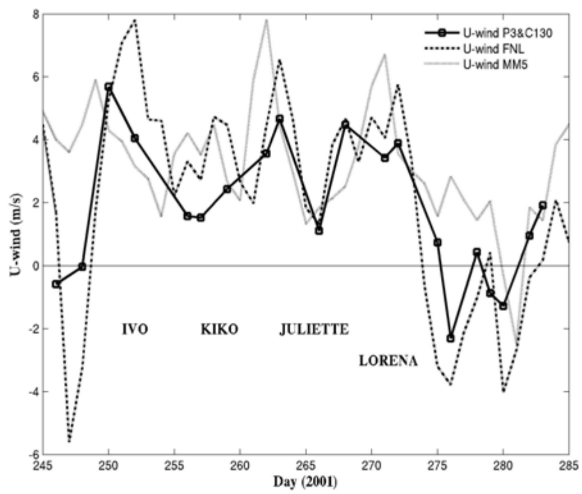

Figure 6. Same as in Figure 5 but for the *u*-component at the surface.

This indication of easterly wave passage can also be observed at the surface (Fig. 6), where once again, the MM5 simulation presents the worst correlation with the observed values.

The FNL data present a very good correlation with the observations but overestimate in magnitude the zonal wind in both phases, westerlies and easterlies. This overestimation in the FNL data can also be observed in the time evolution of the meridional wind at the surface (Fig. 7), which presents better correlation than MM5.

The MM5 simulation does not reproduce very well the transitions between westerlies and easterlies (Fig. 6) and northerlies and southerlies (Fig. 7) at the surface. However, this change in wind direction is better reproduced at 850hPa for both the zonal (Fig.5) and the meridional wind (not shown). FNL analyses reproduce the transitions adecuately.

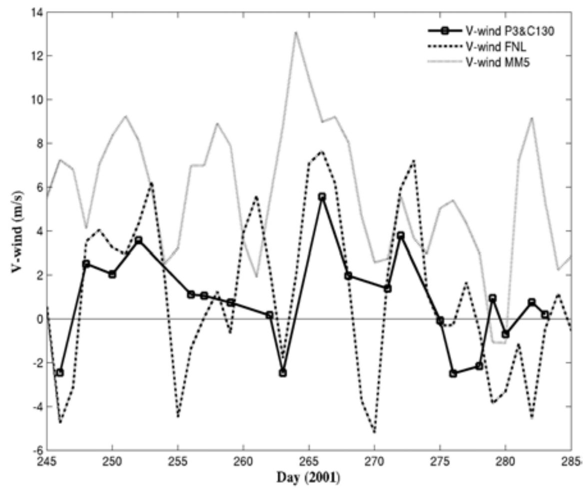

Figure 7. Time-series of *v*-wind at the surface averaged over the EPIC domain. Solid line represents the dropsondes, the dashed line represents the FNL data and the dotted line the MM5 simulation.

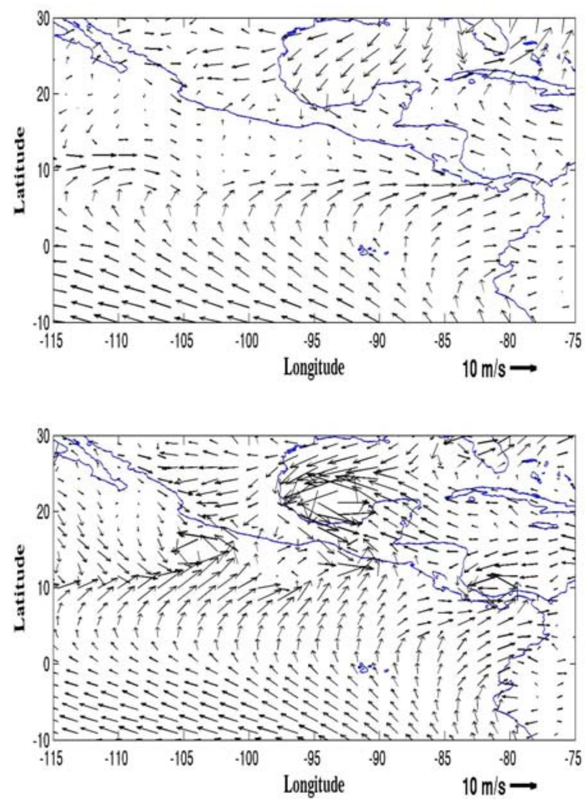

Figure 8. Wind field at the surface. Above: FNL data. Below: MM5 simulation. Comparison for 15 September, 2001 at 00 UTC.

The comparison of the horizontal distribution of the wind field at several pressure levels, between FNL and MM5 indicated the presence of many more cyclonic vortices simulated by the MM5 than observed in the analyses.

Figures 8 and 9 show this comparison at the surface and at 850hPa for 15 September, after the passage of tropical storm Ivo. In the simulation, tropical storms tend to persist longer in time than in the analyses and the model also tends to generate new storms from preexisting ones. These persistent storms also extend in the vertical.

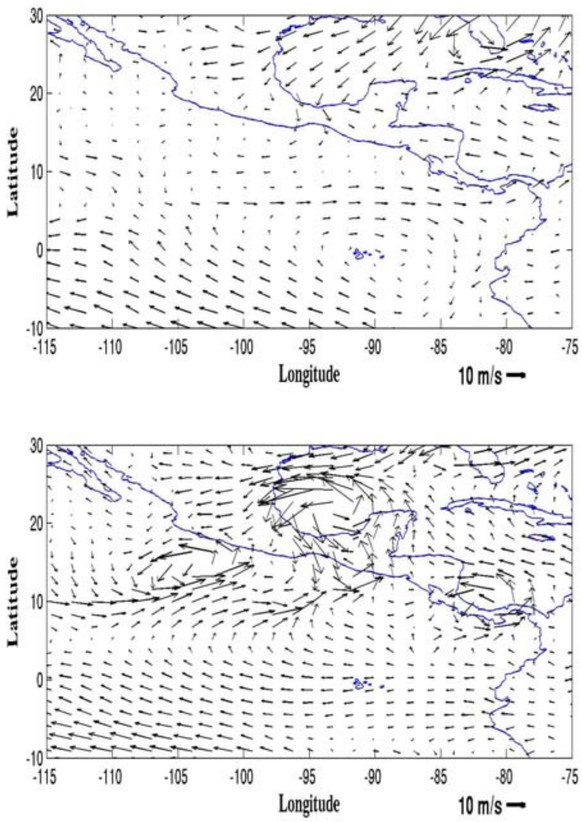

Figure 9. Same as in Figure 8 but for the wind field at 850hPa.

6. CONCLUSIONS

In terms of the wind field, the FNL data seem to be marginally aceptable for studies of the large-scale characteristics in the East Pacific region, as well as to initialize numerical models in the region. These results, however, are only related to averages along the 95W and within the EPIC domain. Recent comparisons between individual flights and the FNL data have shown that differences in the agreement may be related to the development of deep convection.

Good agreement at the surface is observed between the FNL wind field data and observations along the 95W. This agreement decreases with height for all latitudes and it is worst in the zones where different convective regimes exist: the stratocumulus region near the equator and the convective region within the ITCZ.

Results presented here and other comparisons showed that the wind field in the FNL data compared better with observations than the MM5 simulation in the EPIC domain. The MM5 simulation also clearly indicated a bias in the model towards the generation of tropical storms in the East Pacific region that were not observed.

The analysis of other variables in the FNL data is needed to strengthen the validity of its use in the Eastern Pacific region. Changes in the parameterizations used in the MM5 will be carried out in order to better assess its performance in the region.

Acknowledgments

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