Proceedings of 8 ICSHMO, Foz do Iguaçu, Brazil, April 24-28, 2006, INPE, p. 51-56.

AN EVALUATION OF THE ETA MODEL DURING SALLJEX

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1. INTRODUCTION

The South American Low Level Jet Experiment took place during austral summer 2002-2003 and provided unique data sets to evaluate the ability of models to represent atmospheric motions in the vicinity of the central Andes. The experiment focused on the wind maximum east of the Andes (SALLJ, South American Low Level Jet, Paegle et al at http://www.met.utah.edu/jnpaegle/research/ALLS.html) and its role to transport moisture that feeds meso-scale convective systems over the La Plata basin. Such systems, as well as the SALLJ, exhibited a pronounced diurnal oscillation during SALLJEX, with maximum values at night. Special radiosonde observations were collected during this experiment at 06 and 18 UTC, when the diurnal cycle displays maximum amplitude. Such observations were not incorporated in the operational analyses and thus provide a unique data set to test the ability of models to reproduce the amplitude of diurnal oscillations in this region.

At the University of Maryland, Collini and Berbery integrated and archived the runs of the workstation version of the National Centers for Environmental Prediction (NCEP) Eta model at 80 and 22km resolution, eight times a day, over two regions of different extent, in real time. These runs, when compared against radiosonde measurements of winds, moisture and temperature profiles, allow identification of model biases related to resolution, boundary conditions, and model description of the diurnal cycle. The presentation explores the ability of the model to regionally downscale large scale features and its potential use for regional climate assessments based on its performance over this particular season of enhanced observations.

2. DESIGN OF MODEL EXPERIMENTS

The Eta model (Mesinger et al. 1988, Rogers et al. 1996) was used by Berbery and Collini (2000) to downscale atmospheric circulations over South America. That paper links the nocturnal maximum of the SALLJ with precipitation over the La Plata basin. The extensive data gaps over central South America have impeded efforts to evaluate the veracity of model simulations, and their representation of the diurnal cycle. The difficulty is partly due to the fact that most observations are taken at 12 UTC, while peaks in the diurnal cycle are expected at 06 and 18 UTC. To more accurately represent diurnal variability, Eta model results are archived every 3 hours. Integrations are started at 0 UTC and carried out for 36 hours. The forecasts are initialized with the operational GDAS (Global Data Assimilation System) produced by NCEP/NOAA/USA. The archives consist of successive 24 hour forecasts which result from discarding the first 12 hours of integration to eliminate spin-up effects. The model performance was discussed in Silva and Berbery (2006). Although a positive bias is noticed over the South American Monsoon region (SAMS), the Eta model captures well the temporal variability of precipitation events both over the SAMS region and a region further south, usually known as Southeastern South America. Likewise, the model reproduces the distribution of precipitation rate over SESA, but not over SAMS.

3. RESULTS

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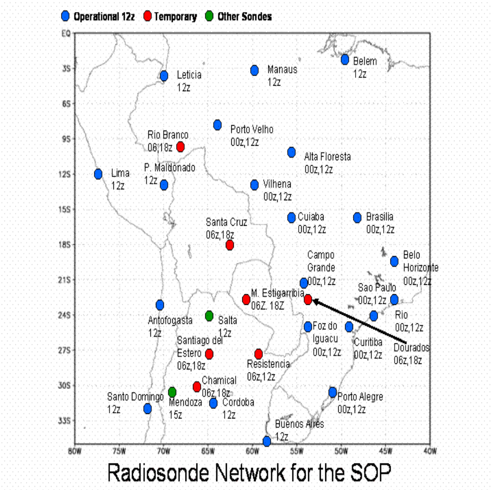

Figure 1. Radiosonde Network during SALLJEX

The figure shows that the majority of the operational radiosondes are launched at 12 UTC, while most of the special observations collected during the experiment are available at 6 and 18 UTC. The focus here is on the month of January, during the special observing period of SALLJEX and on the radiosonde sites with observations at the peak of the diurnal cycle. These are: Santa Cruz (Bolivia), Resistencia and Santiago del Estero (Argentina), and Mariscal Estigarribia (Paraguay). Difficulties at some of the stations resulted in a launching schedule that did not meet the original expectations. Sample radiosonde data is illustrated in Figure 2 for the month of January.

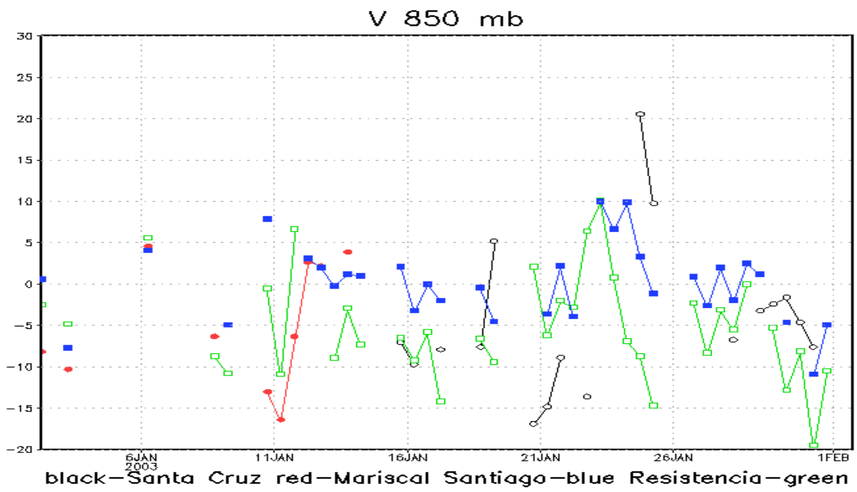

Figure 2. 850 mb meridional wind for January 2003 at 06 and 18 UTC, for Santa Cruz, Bolivia (black), Mariscal Estigarribia, Paraguay (red), Resistencia (green) and Santiago del Estero (Blue, Argentina),

Santiago del Estero and Resistencia (see Fig. 2) offer the most complete data coverage. Nevertheless, the other two stations are of key importance to document the SALLJ. Mariscal Estigarribia is climatologically located at its core, and Santa Cruz is close to the foothill of the Andes, where this cordillera exhibits maximum altitude.

Figure 3 shows time series of the Eta model extracted at the latitude and longitude of Santa Cruz

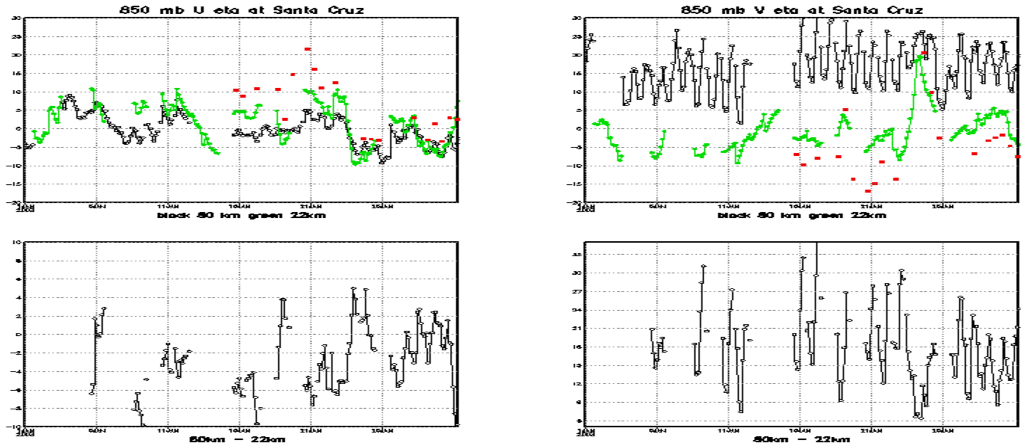

Figure 3. 850 mb U (left) and V (right)) , top panels, for the Eta model run with 80 km (black) and 22km (green) resolution, in m/s. Radiosonde observations are shown in red. Lower panels show the difference between the 80 and 22 km runs.

The figure shows that available Eta data exhibits different gaps. The 80 km resolution displays a very strong and regular diurnal cycle at 850 mb not supported by available data at this site. The meridional wind is always positive in the 80km run at this location. This is only found at altitudes below the 700 mb level (not shown). The 22km run captures the southerly burst in January 25th, and approximates observations better than the 80 km run. The 80 km run tends to have a strong meridional component which results in larger meridional and lower zonal wind components. Both runs capture the decreasing temperature and humidity during the January 25th cold burst (see Fig. 4), though the model overestimates these values .

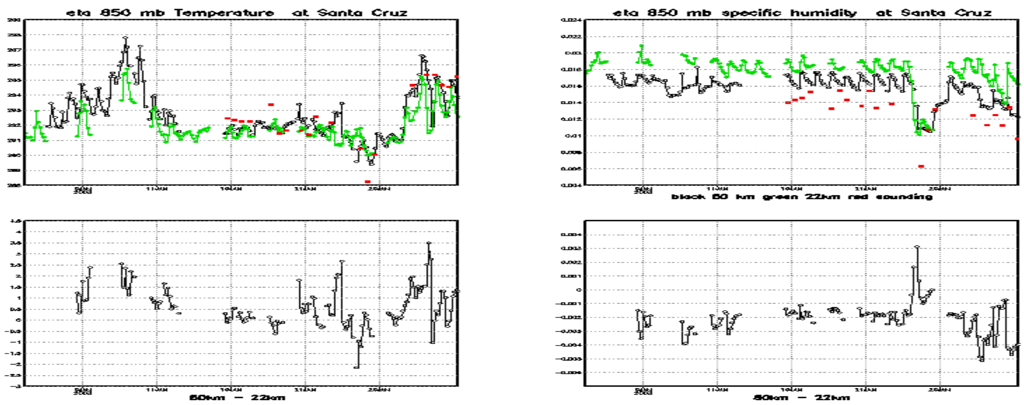

Figure 4. Same as Fig. 3 but for temperature (left, K) and q (right).

Figure 5 and 6 show a better agreement between the two runs for Resistencia, a location more distant from the Andes than Santa Cruz, and thus less influenced by representation of processes that are strongly influenced by orography. 80 km runs are warmer and more humid, in general, than the 22 km runs for Resistencia, while they are drier at Santa Cruz showing the horizontal dependence of humidity model estimates with resolution .

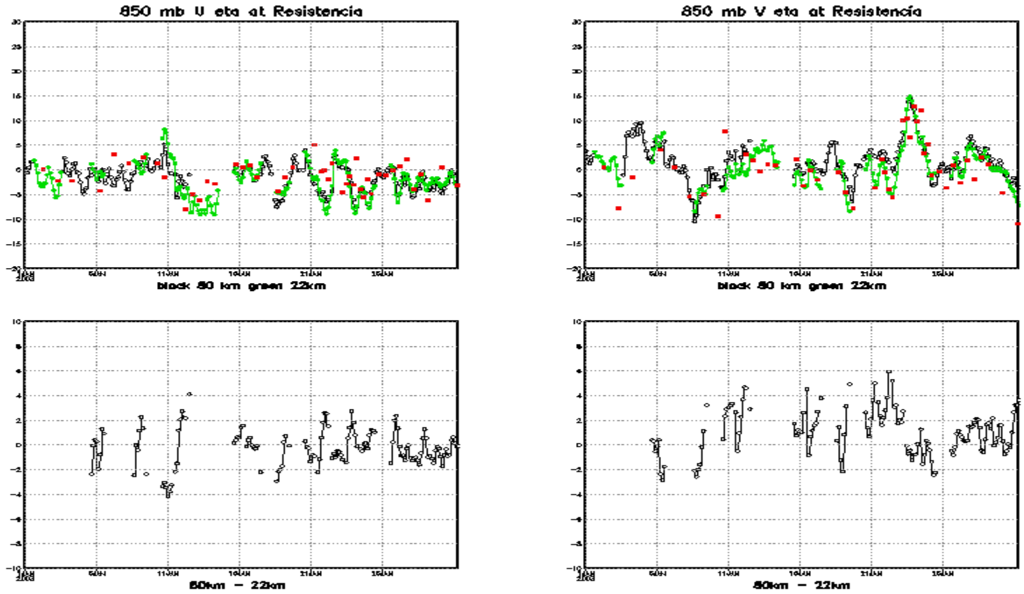

Figure 5. Same as 3, but for Resistencia.

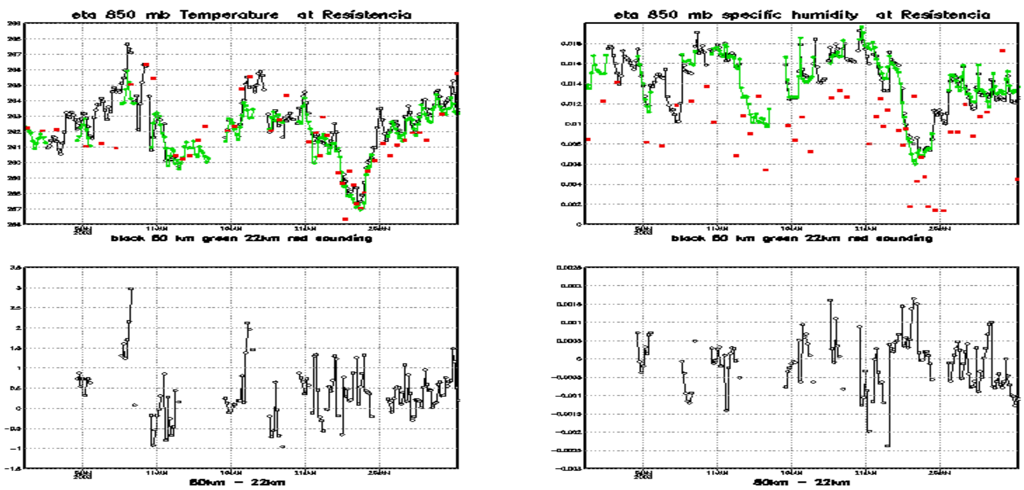

Figure 6. Same as 4, but for Resistencia.

Radiosonde launches at Resistencia at 06 UTC coincide in time with available 22km Eta data nineteen times, and there are fourteen such soundings at 18 UTC. Some of the overall statistics from these values are shown next. Results from other stations are included in the conference presentation.

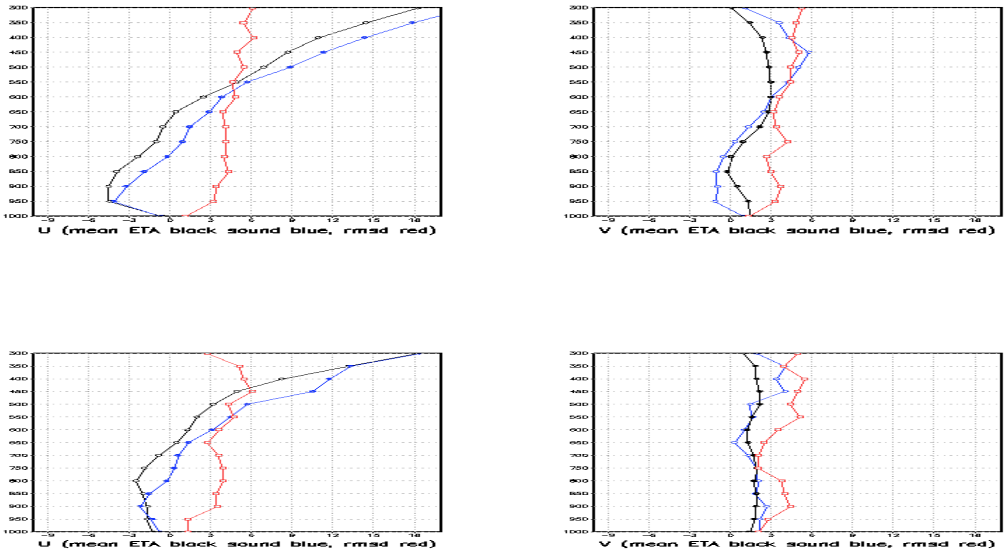

Figure 7. 6 (top) and 18 (bottom) UTC for U (left) and V (right) for Resistencia. Eta (black) and sounding (blue), root mean square difference (RMSD) between the Eta model and sounding (red), in m/s.

RMSD are about half of the average zonal wind values, with both soundings and model depicting very similar vertical profiles. Low level easterlies are about twice as strong at night than during the day, with slightly stronger northerlies at 06 than at 18 UTC

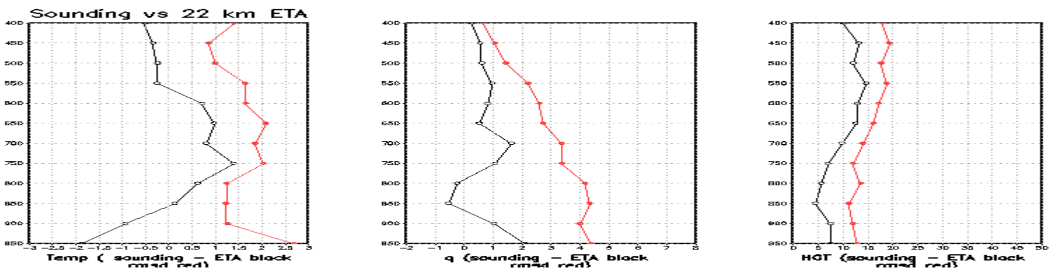

Figure 8. Temperature (left), moisture (middle) and heights (right) at 06 UTC, sounding – ETA 22km (black) and RMSD (red).

The Eta model exhibits a warm bias at low levels at night (Fig. 8, left panel) , and cool bias during the day (not shown). At night, differences reach 1.5 K at 750 mb, reversing with height at 600 mb. Below 800mb, the RMSD for specific humidity display values up to 4 g/kg, larger than the averaged difference between model and observations, showing the difficulties that the model experiences in capturing moisture day to day variability.

4. SUMMARY

Preliminary results indicate the higher resolution run more accurately describes the three-dimensional structure of the SALLJ close to the Andes. A problem with the 80 km run close to the turning point of the Andes (Santa Cruz) is found at low levels (below 700mb) which is not present for the 22 km runs.

This might be due to the local character of low level circulations present at this location, which is strongly affected by the nearby mountains that rise from almost sea-level to the Bolivian Altiplano with heights over 3,500 m within a couple of grid-points. Furthermore, the Andes have a north-west to south-east orientation north of Santa Cruz, reversing to north-east to south-west south of Santa Cruz, presenting difficult problems for the accurate representation of atmospheric flows at relative coarse resolution.

The amplitude of the diurnal cycle at low levels is underestimated at several stations. Results are shown for Resistencia for the 22km run, which depicts temperatures warmer at night and cooler during the day than the soundings. The poster presents results for other stations and both model reolutions .

5. ACKNOWLEDGEMENTS

This research was partly funded by PACS/NOAA grants NA030AR4310094 (Nogués-Paegle) and NA76GP0479 (Berbery).

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