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ETA MODEL EXPERIMENTS DURING THE SALLJEX PERIOD

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1. INTRODUCTION

During the South America Low Level Jet Experiment (SALLJEX), cases of Mesoscale Convective Systems (MCS) occurred over Northern Argentina, associated with the Low Level Jet (LLJ) to the east of Andes. At that time, the monitoring of the LLJ atmospheric conditions, as well as model forecasting provided by several regional and global models allowed the alerts to flight missions to obtain detailed measures of the atmosphere. Although the models, at that time, could not forecast some of the MCS that occurred, the presence of the LLJ was a guide for such development. A description of the SALLJEX and related subjects are found in Vera (2004), Zipser et al (2004) and other papers at the same CLIVAR exchange issue. In order to analyse the model forecasting results at higher resolution and with different configurations from those analysed at the time of the experiment, two experiments with four integrations were conducted with the Eta model.

2. MODEL EXPERIMENTS

The Eta model was integrated in a range of 72 hours during the SALLJEX period (January 2003), considering a domain that comprises Argentina, Chile, Paraguay, Uruguay, Bolivia, and parts of Southern, Southeastern and Central Brazil. The resolution was horizontal 10 km and 38 vertical levels. NCEP T254 L64 analysis was applied as initial condition and lateral boundaries. Two experiments were performed. One to test the hydrostatic and non-hydrostatic option, and other to analyse the results using two different convection schemes: Betts-Miller(1986) and Kain-Fritch(1990). The model performance for each experiment was evaluated to investigate the need to use the non-hydrostatic version with 10 km resolution, and also to verify which convection scheme had the best representation of precipitation associated with the occurrence of MCS over Northern Argentina and Paraguay during the SALLJEX. Scores, such as anomaly correlation, root mean square (rms), bias and hit rates were calculated to some variables during the period, to 24, 48 and 72 hours forecasting. Some soundings were also compared to the model results.The forecasting of a MCS that developed during the experiment is discussed in the present experiments.

3. RESULTS

3.1. Hydrostatic and Non-Hydrostatic Experiment

The anomaly correlation of geopotential at 500 hPa considering the whole domain has values above 95%, for 24, 48 and 72 hours forecasting, and the results of the two versions are similar (Fig.1). Hit rate for SLP were calculated based on the difference between the forecasting and the observation, considering all observational locations inside the domain. A hit was considered when the difference had values between –1 and 1 hPa. The percentage is above 92% for 24h, above 91 for 48h and above 88% for 72h, and the two versions presented similar results (Fig.2).

Timeseries of spatial average of precipitation, SLP and temperature at 950 hPa for the area where there is development of the MCS (35S-20S and 67.5W-55W) are shown in Fig 3. The daily evolution of the three variables are well forecasted by the model, although the temperature is overestimated. The precipitation magnitude is reasonable well forecasted 1 to 3 days in advance, unless on day 13, when the precipitation is overestimated by the model.

A comparison between the radiosonde data of Foz de Iguaçu (PR) and the forecasts of 48 hours are presented as a timeseries of the temperature differences at 4 levels in the atmosphere (Fig.4). At high level the model underestimates the temperature, and at low level, there is overestimated estimation, during the month. The two versions present the same result, and at the end of the month the model forecast very well the temperature at low and middle levels.

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3.2. Betts-Miller (BM) and Kain Fritsch (KF) experiment

These integrations were performed considering the hydrostatic version. The anomaly correlation of geopotential at 500 hPa, taking into account the whole domain, was the same in both integrations, but the rms was larger for the KF experiment (Fig 5). The hit rate for SLP was also unfavorable to KF, mainly for forecasts at 2 and 3 days in advance (Fig.6). However, comparing the timeseries of precipitation averaged in area (35S-20S and 67.5W-55W), both results are similar and well compared to observations for 24 hours. In both versions there is an overestimated precipitation in the 48 and 72 hours forecasting, larger in KF (Fig.7a). The variability of Sea Level Pressure is well forecasted by the two versions, mainly for 24 hours (Fig.7b). Temperature at 925 hPa is overestimated by the model in both versions, but the daily variability is very well captured (Fig.7c).

The cross section at 17S of the averaged meridional wind for the period (1-31 january) shows two regions of northerly winds, one related to the occurrence of LLJ to the east of Andes, and another one over the east sector of South America, extending from the low levels to the middle levels of the atmosphere. (Fig.8). All forecasts overestimate the magnitude of the wind in the LLJ region in both versions, but mainly for 48 and 72 hours and KF. The structure of the other maximum northerly wind is only captured by the 24 hours forecast with BM scheme. This forecast also represents the structure of the zonal wind better than the other forecasts, which also overestimate this component, mainly for the 72 hours forecasting (Fig.9).

3.3. Case study

The MCS that developed over northern Argentina in January 17th, 18th (Fig.10), was not forecasted at the time of the experiment, by any model, including the regional Eta Model. The observed precipitation is shown in Fig.11. Even in other experiments, the system was not forecasted (Cavalcanti et al, 2003). In the present experiments, using the hydrostatic version with BM and KF, and 10 km horizontal resolution, the MCS was identified in 24, 48 and 72 hours. In 24 and 48 hours the system was forecasted to the south of the observed position, in both versions (Fig. 12 a, b, d, e). The forecast of 72 hours indicated the position and intensity close to the observation, for the KF version (Fig.12 f), while in BM the position was still to the south (Fig.12 c) . The wind flow and the vertical structure of meridional wind indicate the occurrence of the LLJ prior to the MCS development (Fig.13). In this case, both maximum of meridional wind, one over eastern Brazil and the other related to the LLJ are forecasted by the model in both versions. However, both versions overestimate the magnitude of the meridional wind over eastern Brazil and also the vertical extension of the LLJ. The maximum observed precipitation at the Pres. Roque Saens Pena (ARG) station, close to the MCS development, was well forecasted in 24 and 72 hours, for the KF version (Fig.14). Then, it seems that the meridional and zonal wind components intensities obtainned by KF version could represent the real atmospheric condition, that is not verified in the analysis data.

4. CONCLUSION

Although the monthly validation of Hydrostatic and Non-Hydrostatic versions display similar results, when specific cases of MCS are analyzed, there are differences in precipitation and vertical motion, mainly in the last forecasting hours.

For the convection scheme experiment, Kain-Fritch represented the MCS precipitation closer to observations than Betts-Miller, although averaged vertical structure of the meridional and zonal components of the wind during the whole period are better compared with the analysis by BM than by KF. Considering that the resolution of the analysis data is smaller than the model resolution, the LLJ intensity greater in the model than in the analysis, contributed to the MCS convective activity and precipitation.

Additional studies have been performed applying higher resolution in order to explore details of the convection development.

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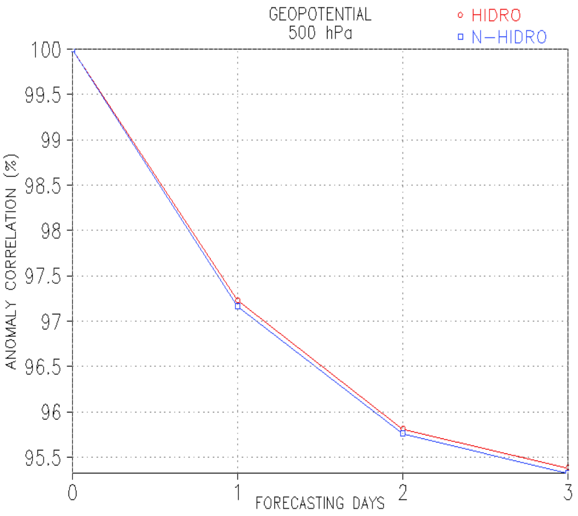


Fig.1: Anomaly correlation of geopotential at 500 hPa with hydrostatic version (red) and non-hydrostatic version(blue).

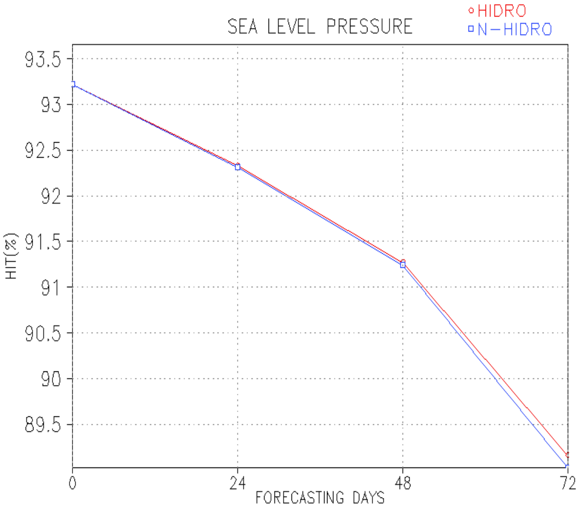


Fig.2: Hit rate of sea level pressure with hydrostatic version (red) and non-hydrostatic version (blue).

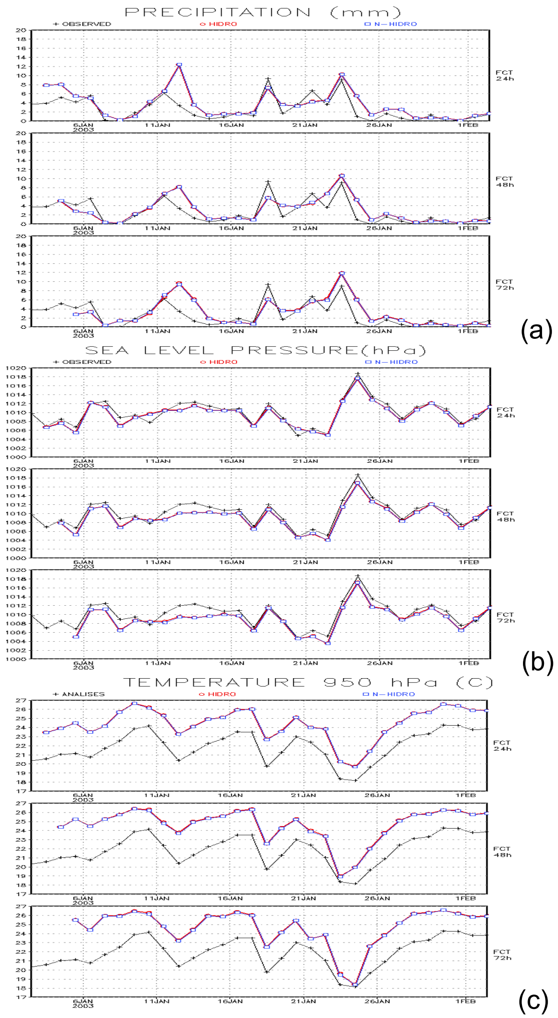


Fig. 3: Timeseries of spatial average of precipitation (a), SLP (b) and temperature at 950 hPa (c) for the area (35S-20S and 67.5W-55W). Betts-Miller scheme (red) and Kain-Fritch scheme (blue).

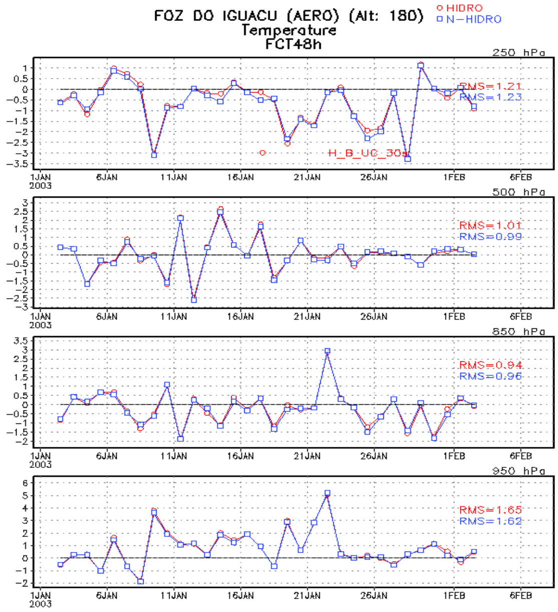


Fig.4: Timeseries of the temperature differences at 4 levels in the atmosphere with hydrostatic version (red) and non-hydrostatic version(blue).

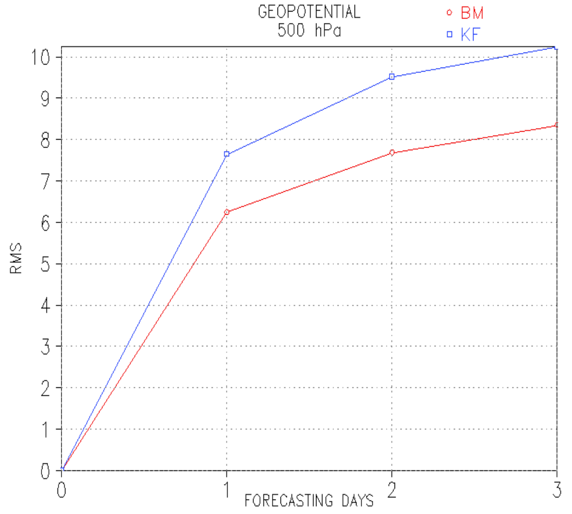


Fig.5: Root Mean Square (rms) of geopotential at 500 hPa with Betts-Miller scheme (red) and Kain-Fritch scheme (blue).

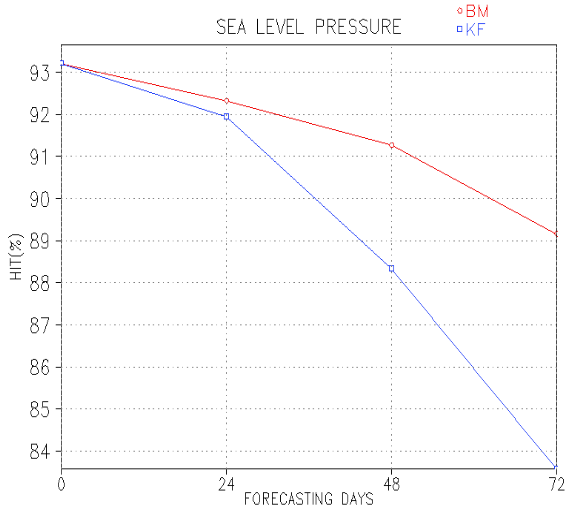


Fig. 6: Hit rate of sea level pressure with Betts-Miller scheme (red) and Kain-Fritch scheme (blue).

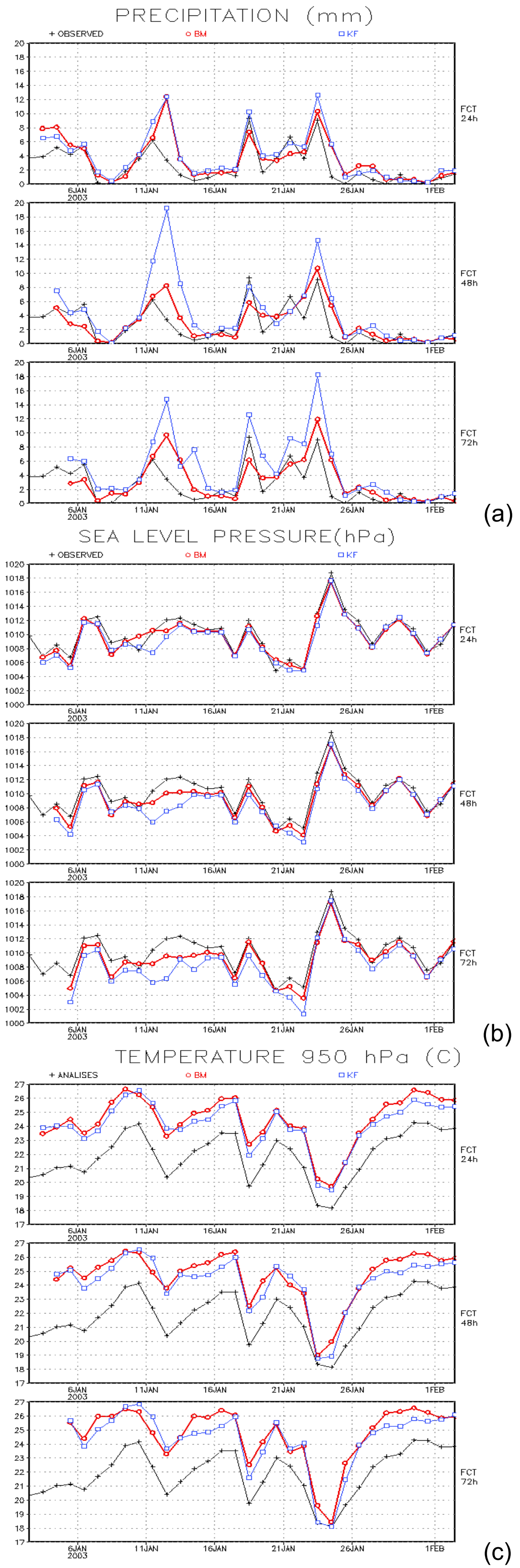


Fig.7: Timeseries of spatial average of precipitation(a), SLP(b) and temperature at 950 hPa(c) for the area (35S-20S and 67.5W-55W). Betts-Miller scheme (red) and Kain-Fritch scheme (blue).

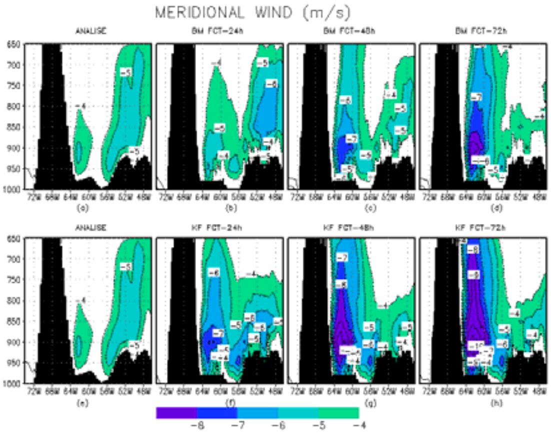


Fig.8: Cross section at 17S of the averaged meridional wind for the period (1-31 january).

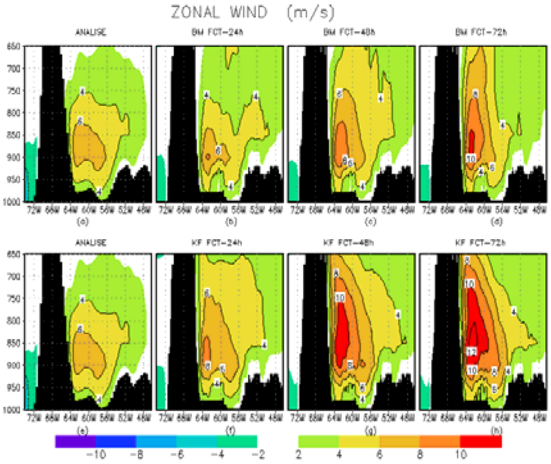
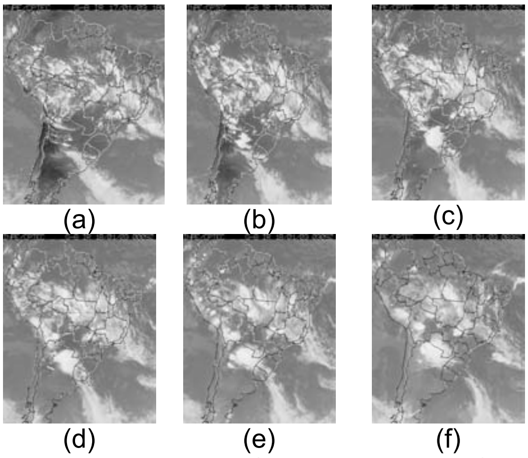


Fig.9: Cross section at 17S of the averaged zonal wind for the period (1-31 january).


(a) (b) (c)

(d) (e) (f)

Fig. 10: Evaluation of satellite imagens for case study valid for 17/01/2003 18Z(a), 20Z(b), 22Z(c) and 18/01/2003 00Z(d), 03Z(e) 08Z(f).

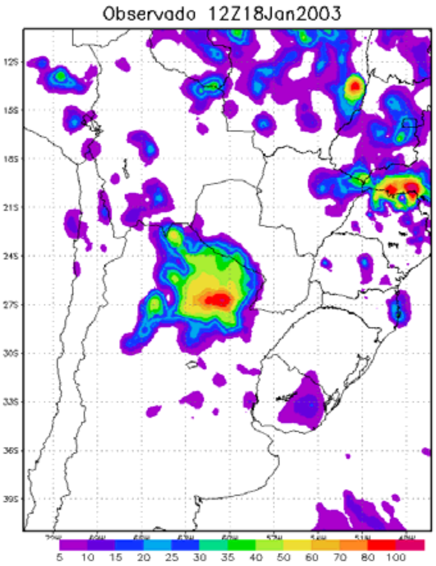
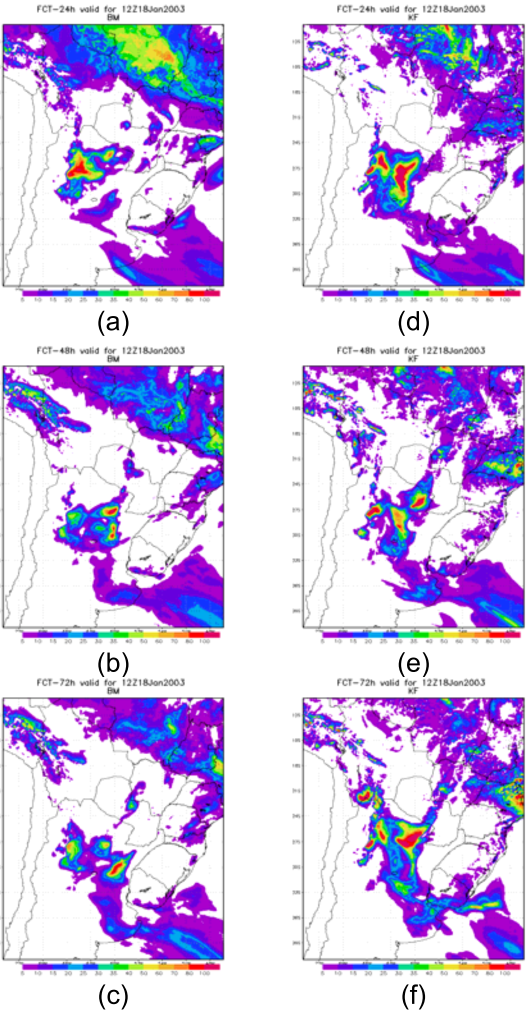


Fig.11: 24 hour observed precipitation (mm) valid for 18/01/2003 12Z .



(a) (d)

(b) (e)

(c) (f)

Fig.12: Forecast precipitation valid for 18/01/2003 12Z . Betts-Miller scheme (a,b,c) and Kain-Fritch scheme (d,e,f).

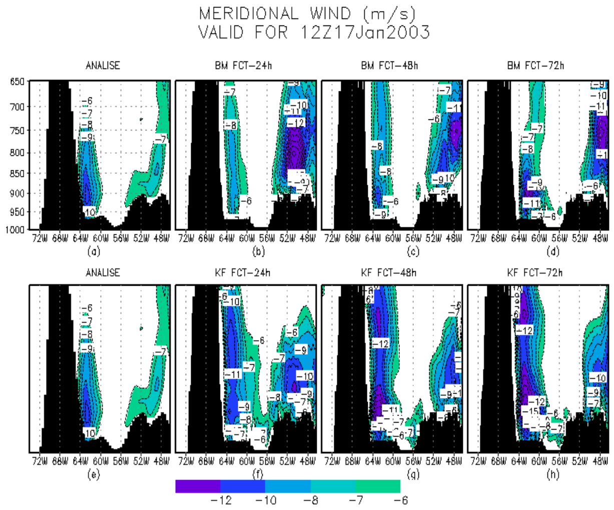


Fig.13: Cross section at 17S of the meridional wind for 17/01/2003 12Z.

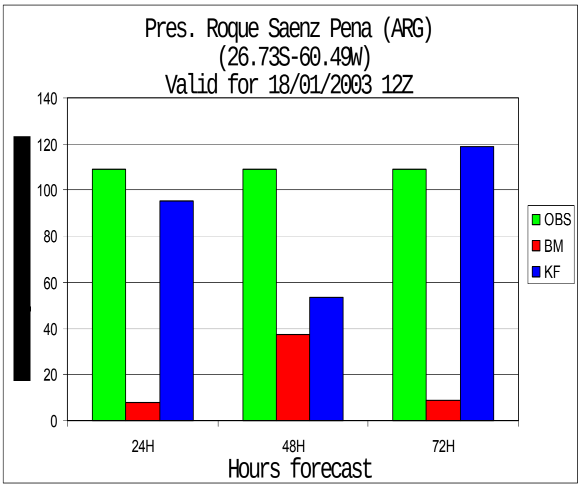


Fig.14: Accumulated Precipitation in 24 hours at Pres. Roque Saenz Pena (observed, BM and KF versions).