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COMPARATION OF THE RE-ANALYSIS "ERA-40" AND THE RE-ANALYSIS "NCEP/NCAR" WITH THE RADIOSONDES OVER ARGENTINA AND CHILE

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1. INTRODUCTION

Actually there is an intense demand of the Re-analysis data The European Center for Medium-Range Weather Forecasts Reanalysis (ERA-40) and the National Centers for Environmental Prediction / National Center for Atmospheric Research Reanalysis (NN) data are used for a great variety of scientific investigation, over all in the atmospheric sciences. Availability observational network data is very poor in the south hemisphere because it has a high percentage of oceanic surfaces, so the Re-analysis utility is very important. With the recent apparition of ERA-40 (ECMWF Newsletter, 2004), and with the older and widely used NN (Kalnay, E., 1996), two extended atmospheric data are available.

The goal of this work is to compare the differences (biases) between Re-analysis data (the new ERA-40 and the widely used NN) and aerological network observational data of Argentina and Chile.

2. DATA AND METHODOLGY

The representative monthly mean (January, April, July and October) upper air observations from stations in table 1 were compared with the re-analysis values. Observation of geopotential height (H) and temperature (T) were compared at 850 hPa, 700 hPa and 500 hPa levels; whereas specific humidity (q) was only compared at 850 hPa level. The stations in table 1 were chosen based on data completeness: Chile station (1-4 in table 1) for 1987-2002 period and Argentina station (5-13 in table 1) for 1971-1984 periods. The station observation for Argentina and Chile were obtained from Argentina Weather Service (SMN).

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Both NN and ERA-40 are available on 2.5º by 2.5º grid every 6-hour, although both are run at higher resolutions (T-159/125 km for ERA-40 and T-62/209 km for NN) and downgraded to a 2.5º resolution. ERA-40 contains 60 vertical levels (23 standard pressure levels) compared to the 28 vertical (17 standard pressure levels) of NN.

The representative monthly means grided values were calculated from the reanalysis data and were bilinearly interpolated to the observational station locations (Bromwich, D., 2004). Then, BIAS for H, T and q between reanalysis and observation were calculated. Here BIAS refers to the mean reanalysis values over the given period minus the mean observed value.

Station name	Lat.	Long.	H. (m)	N.	Data Av.
Antofagasta	23.3ºS	70.3ºW	120	1	91%
Quinteros	32.5ºS	71.2ºW	8	2	92%
Puerto Montt	41.3ºS	72.6ºW	86	3	84%
Punta Arenas	53.0ºS	70.5ºW	37	4	85%
Salta	24.5ºS	65.3ºW	1221	5	97%
Resistencia	27.3ºS	59.0ºW	52	6	94%
Cordoba	31.2ºS	64.1ºW	474	7	89%
Mendoza	32.5ºS	68.5ºW	704	8	96%
Ezeiza	34.5ºS	58.3ºW	20	9	99%
Santa Rosa	36.3ºS	64.2ºW	191	10	93%
Neuquen	38.6ºS	68.1ºW	271	11	89%
Cte. Espora	38.4ºS	62.1ºW	74	12	95%
C. Rivadavia	45.4ºS	67.3ºW	46	13	85%

TABLE 1: Coordinates, height and data available of all stations used en the study. Horizontal line separates groups of stations as outlined in the text: 1-4 is Chile stations, and 5-13 Argentina stations.

3. RESULTS

a. T and H

Before presenting the results, it must explained that when it is said that there is an over or underestimation of either ERA-40 or NN at a given location station it means an over or underestimation of either of the two reanalysis with respect to observation station. Overestimation cases occur when BIAS > 0 and underestimation when BIAS < 0.

Figure 1 shows that in January there is a domain of underestimation of T at 850 hPa over central eastern - southeastern Argentina stations (6 -13 in table 1) in both reanalysis, but this is smaller for NN (except Resistencia station). At the Antofagasta and Salta stations both reanalysis overestimate T, but ERA-40 overestimates being smaller. At the two same stations, there is a greater overestimation of H at 850 hPa in Antofagasta in both reanalysis while in Salta the ERA-40 underestimation is smaller compared to NN.

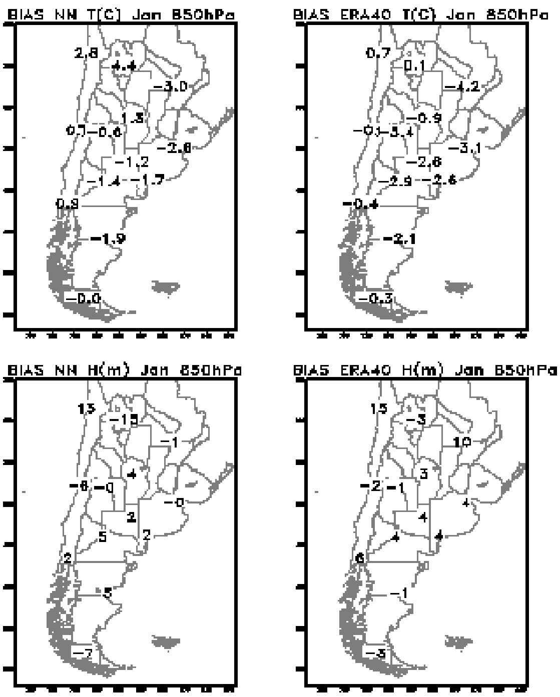

Figure 1: January mean differences (BIAS) between observed and reanalysis T (up) and H (down) values for NN (left) and for ERA-40 (right) at 850 hPa level.

At the 700 hPa level (Figure 2) the underestimation of T over southeastern are still present in both renalysis, but this are diminished. And at Salta the greatest underestimation of T is present in both reanalysis. The H BIAS in Antofagasta and Salta stations are weakly reduced.

In Figure 3 there are now a domain overestimation of T in central and south of Argentina station with the exception of Ezeiza where there is a main underestimation. And the H BIAS shows a general negative value for ERA-40 and positive value for NN at 500 hPa level.

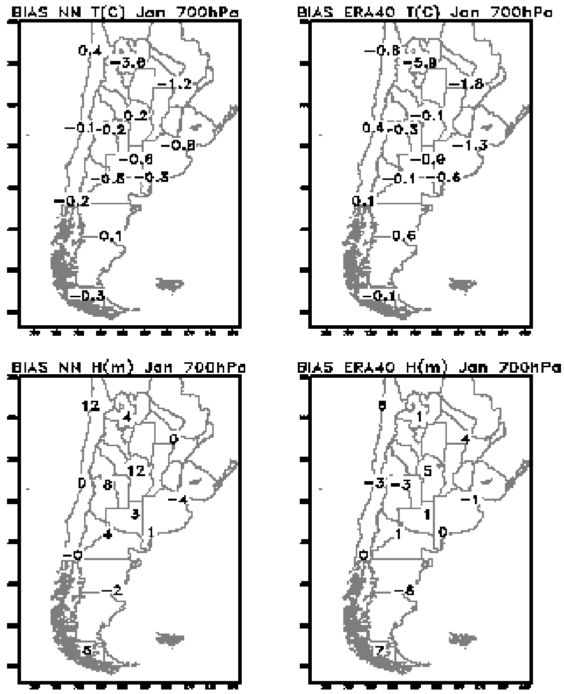

Figure 2: Same as in Fig. 1 but at 700 hPa level.

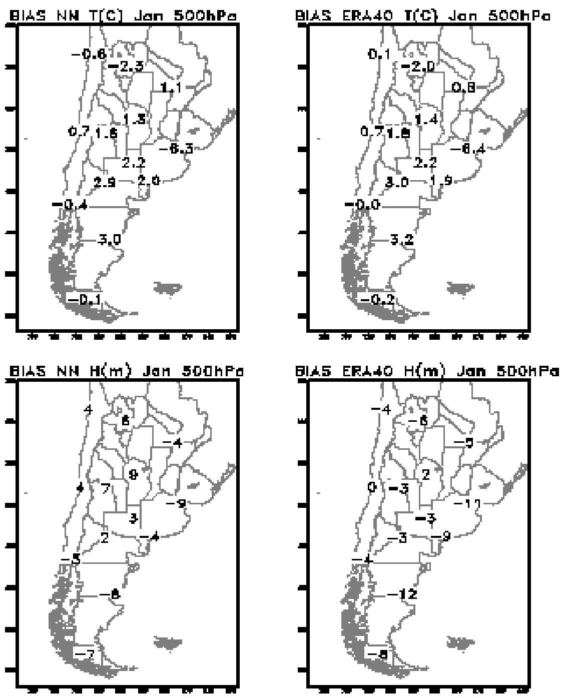

Figure 3: Same as in Fig. 1 but at 500 hPa level.

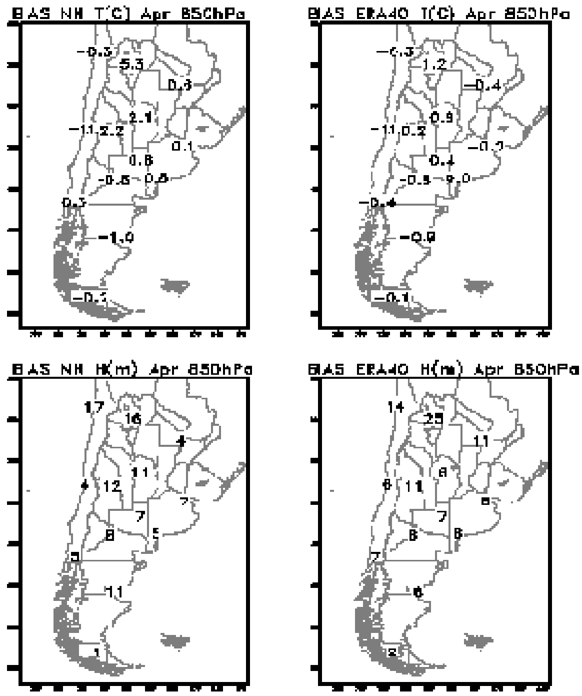

Figure 4: April mean differences (BIAS) between observed and reanalysis T (up) and H (down) values for NN (left) and for ERA-40 (right) at 850 hPa level.

T at 850 hPa in April (Figure 4) presents the same pattern of differences for both reanalysis, with underestimations in Quinteros and Antofagasta and overestimations in the center north of Argentina. However, the magnitude of the differences with the radiosonde records is smaller than in the ERA-40, particularly in Salta, Cordoba and Mendoza. Practically all the T BIAS values at the 700 hPa and 500 hPa levels are reduced (Figures 5 and 6).

Figures 4, 5 and 6 shows that in April (autumn) there is a dominance of overestimated H at 850 hPa, 700 hPa, and 500 hPa (except at Quinteros and Antofagasta) in both reanalysis. Again, Salta and Antofagasta stations (the surroundings of Bolivian Plateau Region) show greater differences with the radiosonde records than at the remaining stations. These features bring out how difficult it is for reanalysis to represent the variables in this region.

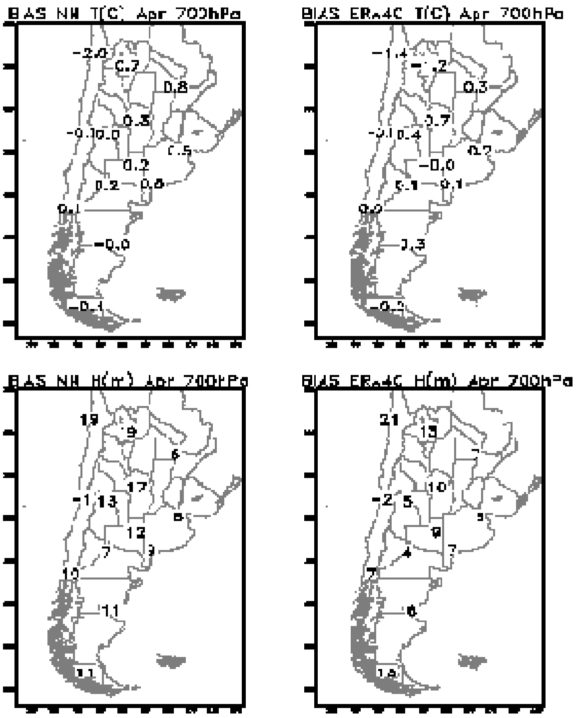

Figure 5: Same as in Fig. 4 but at 700 hPa level.

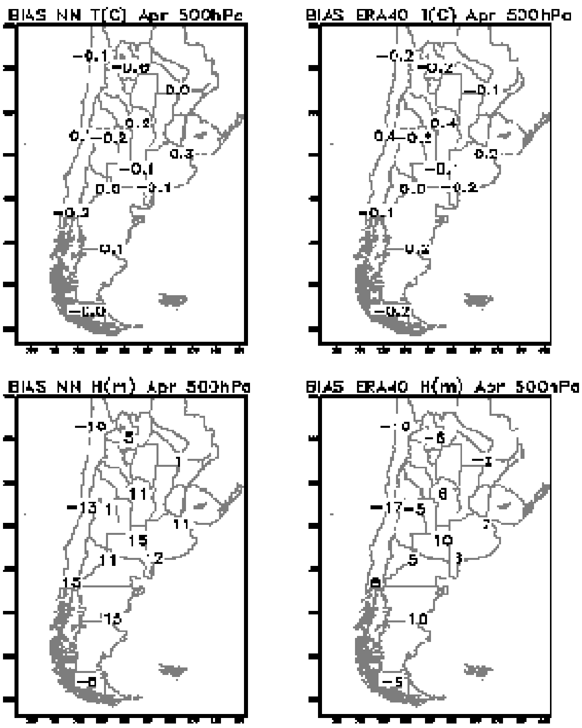

Figure 6: Same as in Fig. 4 but at 500 hPa level.

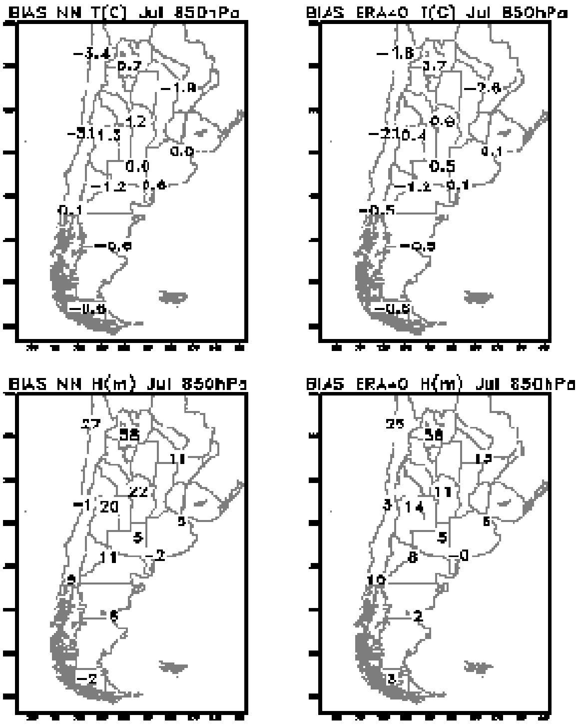

Figure 7: July mean differences (BIAS) between observed and reanalysis T (up) and H (down) values for NN (left) and for ERA-40 (right) at 850 hPa level.

Like in the month of April, for the 850 hPa level, the difference for T in July (Figure 7) show significant underestimations in the reanalysis in Quinteros and Antofagasta and overestimations in Salta, Cordoba and Mendoza. However, the values in this pattern are lower in the ERA-40, in relation to the NN. This bring out again how difficult it is for the reanalysis to represent temperature windward and leeward of the Andes when the flow from the west is more intense and at the same time more disturbed by the presence of the mountain range extending north south. At 700 hPa, Figure 8 shows that magnitude of T BIAS is not reduced, with a general underestimations in all stations for both reanalysis(higher negatives values north stations). And at 500 hPa, Figure 9 shows that a domain continues with greater T BIAS and with greater T BIAS at the Argentine stations than the Chilean ones. In this case, however, contrary to what was found for January, T underestimates appear in the reanalysis.

In July (winter) a dominance of H overestimations persists at 850 hPa and 700 hPa in both reanalysis, with smaller magnitudes in ERA-40 (Figure 7 and 8). Higher positive H BIAS values appear again in Salta and Antofagasta at 850 hPa and in Salta at 700 hPa in both reanalysis. And higher negative values (~20m), in ERA-40 and NN too, appear in Quinteros at 700 hPa and at 500hPa (Figures 8, and 9).

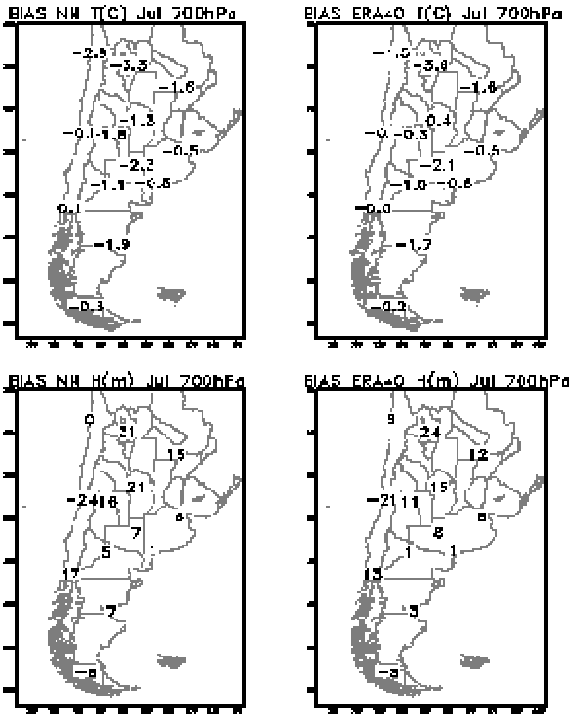

Figure 8: Same as in Fig.7 but at 700 hPa level.

To end with T and H, in October (spring) at 850 hPa and 700 hPa there is a general drop in the T BIAS compared to July with the exception of Cordoba, Mendoza and Salta stations where overestimations persist in the NN (Figures not show here) and both reanalysis underestimate this variable in Resistencia. And as to T BIAS in July, in october at 500 hPa (Figure not show here) shows that a domain continues with greater differences between the reanalysis and the radiosonde records at the Argentine stations than the Chilean ones (contrary to what was found for January, too). For the 500 hPa level in general, the differences of the reanalysis with the T radiosonde records at the Argentine stations were higher than for the Chilean network (Figures 3 and 9). This is probably related to the different periods of radiosonde records available: in the Argentine records from 1971 to 1984, 9 of the 14 years correspond to the “pre-satellite era” which is when reanalysis present greater differences with the observed values (Bromwich D., 2004).

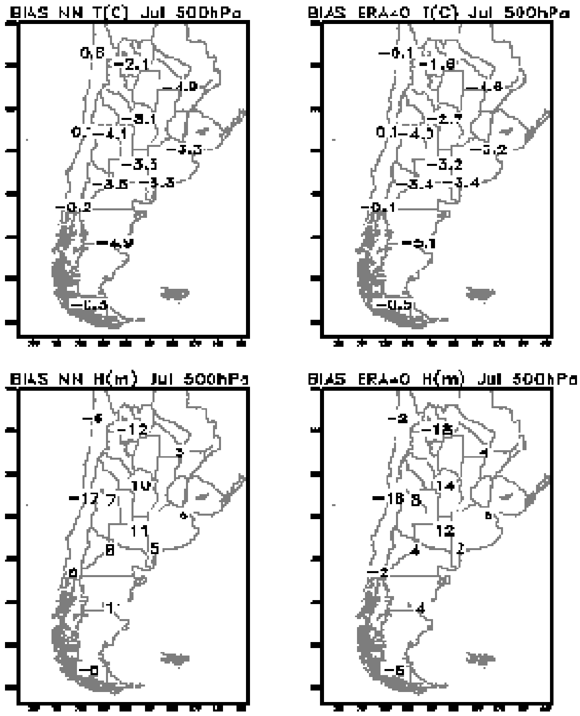

Figure 9: Same as in Fig. 7 but at 500 hPa level.

And in October no major differences appear as compared to July in the H BIAS. The dominance of overestimation persists at 850 hPa and 700 hPa in the two reanalysis compared to the radiosonde records with significant values at the Salta and Antofagasta stations (Figures not shown here).

b. q

Figures 13 and 14 show the main difference between the NN and the ERA-40 values of q BIAS at 850mb at the stations of Antofagata and Salta. The NN overestimate the mean q value at 850 hPa during the 4 representative months at these stations, the overestimation reaching a value of +6 g/kg in January. On the other hand, the ERA-40 present BIAS absolute values not higher than 1.5 g/kg at the Antofagasta and Salta stations. This shows that the difficulty of representing the low level mean water vapor content in the surroundings of the Bolivian Plateau Region, associated to the regional orography, that in these case is better resolved by the ERA-40 reanalysis than by those of NCEP/NCAR.

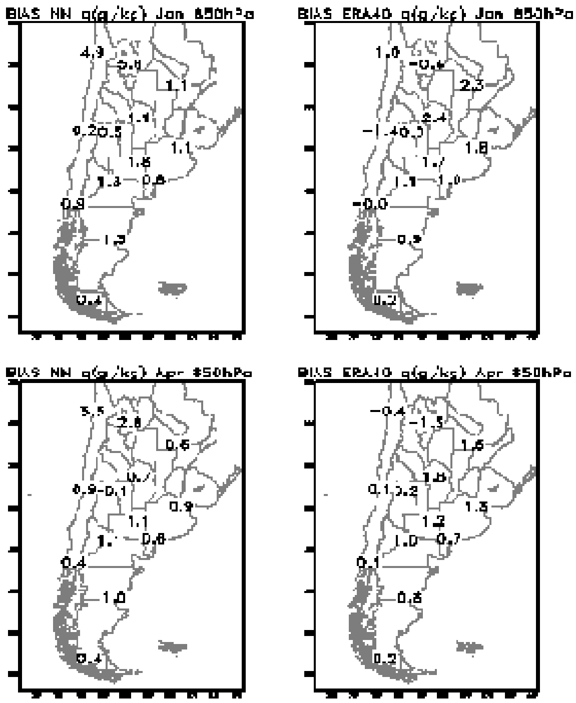

Figure 10: January (up) and April (down) mean differences (BIAS) between observed and reanalysis q values for NN (left) and for ERA-40 (right) at 850 hPa level.

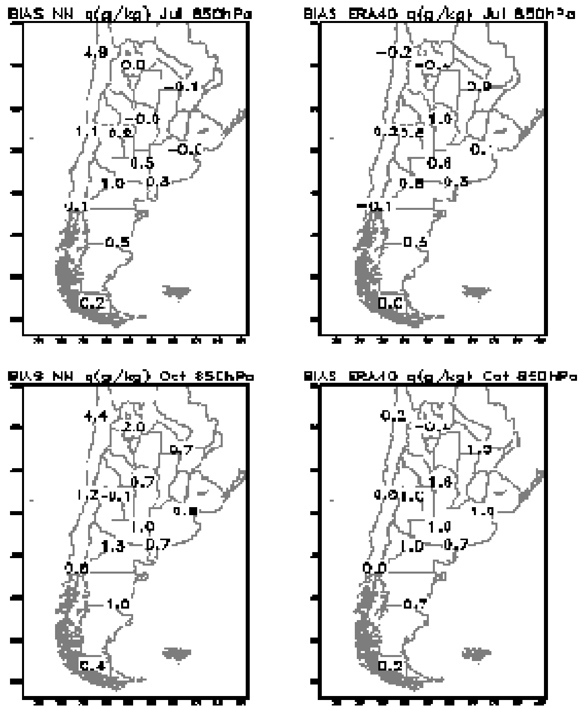

Figure 11: Same as in Fig. 10 but for July (up) and October (down)

On the other hand, during the four representative months, the NN in northeast Argentina (Resistencia, Cordoba and Ezeiza stations) are smaller than those corresponding to the ERA-40. This is consistent with Viale (2005) results for meridional circulation at 850mb in the sense that the NN are closer than the ERA-40 to the mean northerly wind observed in Resistencia; it would, therefore, be associated to a better representation of moisture transport from low latitudes at this level.

4. SUMMARY AND CONCLUSION

The local climatologies from the NN and ERA-40 were compared with radiosonde records at the 850 hPa, 700 hPa and 500 hPa levels, for Temperature and geopotential Height variables, except specific humidity which was only analyzed at 850 hPa.

As to H, overestimates were observed in the lower troposphere (850 hPa, 700 hPa) during the transition seasons and in July. In general, these were greater in the NN than in the ERA-40. At 500 hPa, overestimates stand out for April and July in the center-east and south region, while both ERA-40 and NN underestimated mainly the variable in Quinteros. Values of H in January in general are overestimated by the NN and underestimated by the ERA-40.

In general, both reanalysis underestimate T at 850 hPa in January (summer), except in Salta and Antofagasta. At the 700 hPa level T is underestimated in the center-north of Argentina, and overestimated in the western region and in Patagonia. The same pattern is observed for April, July and October at 850 hPa, i.e., underestimates T at Chilean and Patagonian stations and in Resistencia, while overestimates are observed for both reanalysis in the western and central of Argentina (here ERA-40 however represents T better). This general pattern (not observed in January) suggest how difficult it is for reanalysis to represent T in region associated to the orography.

At the 500 hPa level, in general, important differences were observed at the Argentine stations, while they were smaller at the Chilean ones. This is probably related to the different aerological record periods taken for the reanalysis. In Argentina most of the records considered belong to the presatellite era, which affected the quality of the reanalysis.

Finally, q at 850 hPa is overestimated in the northeast of Argentina where the values of NN are smaller. But Smaller BIAS are observed in the ERA-40 at the stations of Salta and Antofagasta.

The different assimilation schemes between ERA-40 and NN could lead to the discrepancies observed here. And both reanalysis present main climatologically differences with observations.

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