Description of the Thermal Low Characteristics using SALLJEX Special Observations

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Introduction

A low pressure system is commonly observed over Northwestern Argentina near the Andean slopes, with a center located approximately at 67ºW: 30ºS. This system is locally known as the Northwestern Argentinean Low (NAL) but usually referred to as the Chaco low, mainly because it is located at the southern portion of the Chaco low itself, resembling an appendix of this thermal system.

Previous studies characterized the NAL as a thermal-orographic system, being much more frequent during summer than in winter (Lichtenstein, 1980). Contrasting with the Chaco low, the NAL exhibits an intermittent behavior, with a mean duration typical of a midlatitude synoptic wave. Through modeling studies, Seluchi et al. (2003) showed that the summer NAL has a significant diurnal cycle and its existence is mostly explained by the sustained surface warming that results from the previous day's circulation, characterized by clear skies that favour the positive radiative surface balance over the region.

Since no upper air-data are available over the region of the NAL, the Seluchi et al (2003) work does not have an observational basis. On the other hand, several studies related to the South American Low level Jet (SALLJ), identified the relationship between the deepening of this low pressure system and the intensification of the northerly low level jet. For this reason, special attention was given to this thermal low during SALLJEX, with a NOAA-P3 flight mission (February 1st, 2003) dedicated to the observation of this feature. This work compiles all the data provided through the enhanced upper air observations and the NOAA-P3 profiles, in order to describe the three dimensional structure of the NAL episode that started by January 29, 2003 and ended by February 4, 2003.

Mean circulation and significant phenomena during this NAL event

As mentioned earlier, the NAL events last around a week, so this case is probably representative of the mean behavior. During its development stages, a strong heat wave episode affected Central Argentina, where many stations reported record maximum surface temperatures on January 30 (e.g. Mendoza -32º 53' S; 68º 49' W- reached 44.4ºC). The system reached its minimum surface pressure between February 1st and February 2nd. In the following days, mesoscale convective systems were reported at the exit region of the low level jet. By February 4th the system entered its decay phase.

In agreement with the Seluchi et al. (2003) results, the evolution of this NAL is mostly controlled by processes in the 900/500 layer, as indicated by the time evolution of the area average geopotential heights within the NAL region (Fig. 1).

Cerne et al. (work in progress), have analyzed the circulation during the 3 pentads previous to the one associated to this NAL event, and distinguished a dominant subsidence motion over the region south of 20ºS which also favoured the sustained warming that leads to the formation of the NAL. The signature of this subsidence is seen in the special radiosonde observation at Santiago del Estero for 1 February 2003, (Fig 2 page 10) which is very close to the low pressure center, and is also detected in several soundings from January 25 onwards (not shown).

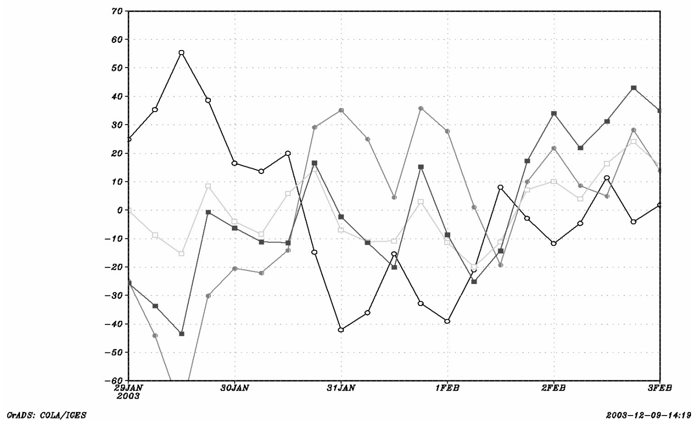

Figure 1: Area average temporal evolution (over the NAL region) of the 500–900-hPa thickness (full circles), and the geopotential heights at the 500-hPa (full squares), the 300-hPa (open squares), and the 900-hPa (open circles) levels. Magnitudes (in gpm) are relative to a reference value for each level/variable.

Description of the February 1st NAL as derived from special observations: preliminary results.

Fig. 2 shows a strong surface warming (reaching above 40ºC at 3 PM local time) and a very deep mixed layer, reaching up to 700 hPa, where the subsidence inversion avoids further penetration of the mixing. Northerly winds dominate the circulation at Santiago del Estero on February 1 st. Fig. 3 shows the NOAA P3 flight tracks, and Figs. 4a, and b (page 17) show soundings obtained

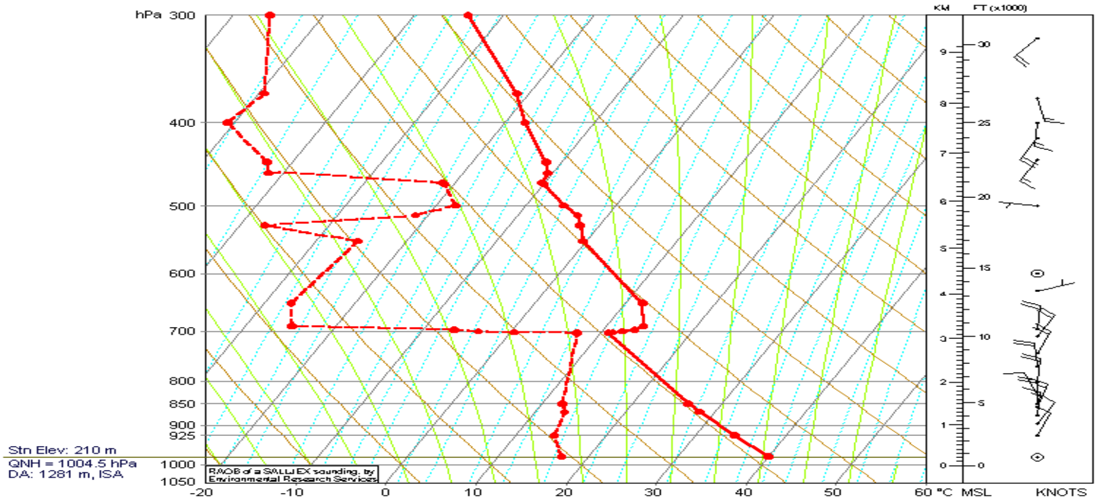

Figure 2: Skew-T diagram at Santiago del Estero, Argentina (27º 48'S; 64º 16'W) corresponding to February 1st, 18:00 UTC

from the aircraft while flying legs 2, 3, 4 and 5 (see captions for details). The vertical stratification indicates that this system is surrounded by very deep mixing layers that reach up to 670 hPa. over the warmer surfaces. The depth of the mixing layers shows an increase towards the low level pressure center. This rather unique stratification of the system has been identified for the first time and is in qualitative agreement with what was expected from previous studies, but more abrupt. Accordingly, with the strong mixing, very weak circulation is detected near the core, but over leg 2 and even at leg 3 northerlies were observed, with maximum wind intensities occurring at higher altitudes following the aircraft track. Another interesting finding is that from the circulation measured with the P3, it could be confirmed that the thermal low exhibits a closed circulation, even at 700 hPa. (Fig 5 page 17).

It is expected that after the quality controlled version of the data becomes available, a more detailed comparison between observations and Global Data Assimilation System (GDAS) analysis as well as model outputs will be carried out. The upcoming research will also contribute to one of SALLJEX objectives, that is to assess how well represented is this system by standard data sets, commonly used for the characterization of synoptic features in the region.

Acknowledgments

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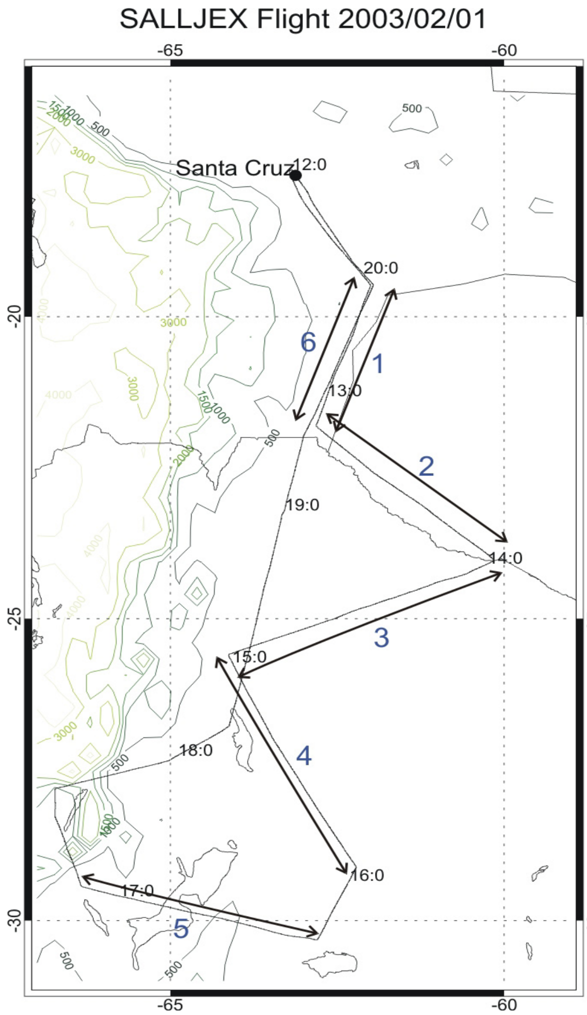

Figure 3: Map of the NOAA-P3 flight track including the trajectory of the aircraft indicated by a continuous line. The small black numbers along the track indicate the time (hh:m) giving an idea of the flight direction. Each leg (referred in the text) is indicated by a large black number.