CPTEC
Centro de Previsão de Tempo e Estudos Climáticos

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

SOME OBSERVED CARACTERISTICS ON SOUTH AMERICAN LOW LEVEL JETS STREAMS

Sergio Henrique S. Ferreira

Manoel Alonso Gan

Dirceu Luis Herdies

WWW.CPTEC.INPE.BR

Introdution

- **The Low Level Jet streams (LLJ) are intense air currents that occur at the border of principal mountain barrier in the worlds.**

- **The studies of LLJ that occur at border of Eastern Andes are especially difficult due the lack of radiosonde stations in this region.**

- **The South America Low Level Jet Experiment (SALLJEX) in 2003 provided a set of extra observation for study.**

- **Data with high spatial and temporal resolution and the use of a numerical model is necessary for more detailed studies.**

Actual upper air station net in SALJEX region

Introduction (cont)

The objective of this work is to investigate the principal physical characteristics of LLJ using a combination of observed data during SALLJEX
and numeric fields obtained with WRF model.

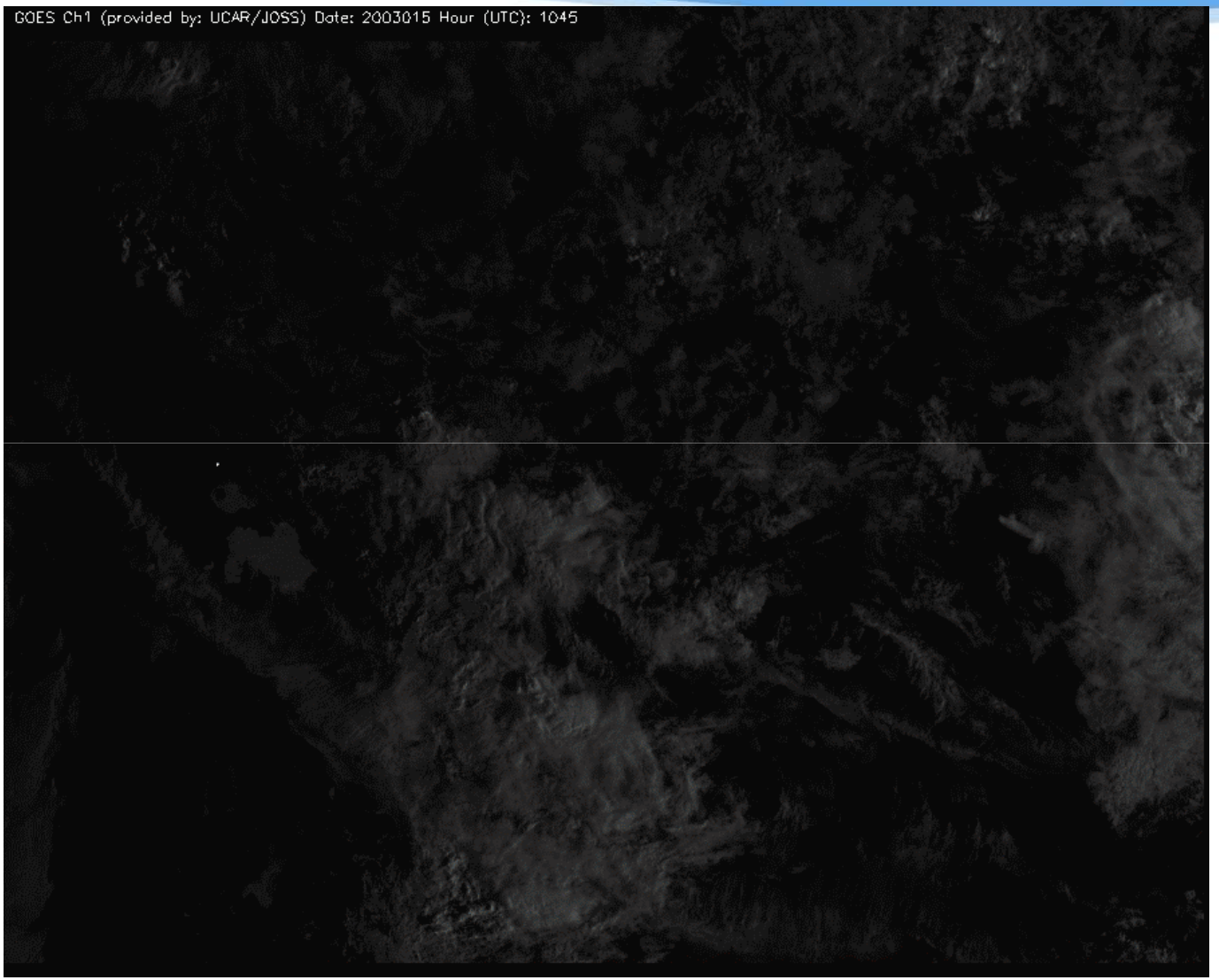
Outline:

1. Anlise of some observed data from NOAA-P3 aircraft and satellite
2. Comparation between WRF-ARW model and Observed data
3. Daily cycle of simulated by WRF model
4. Coupling between LLJ and circularion in upper levels
5. Other examples

Analysis of observed data

LLJ Episode
2003-01-15

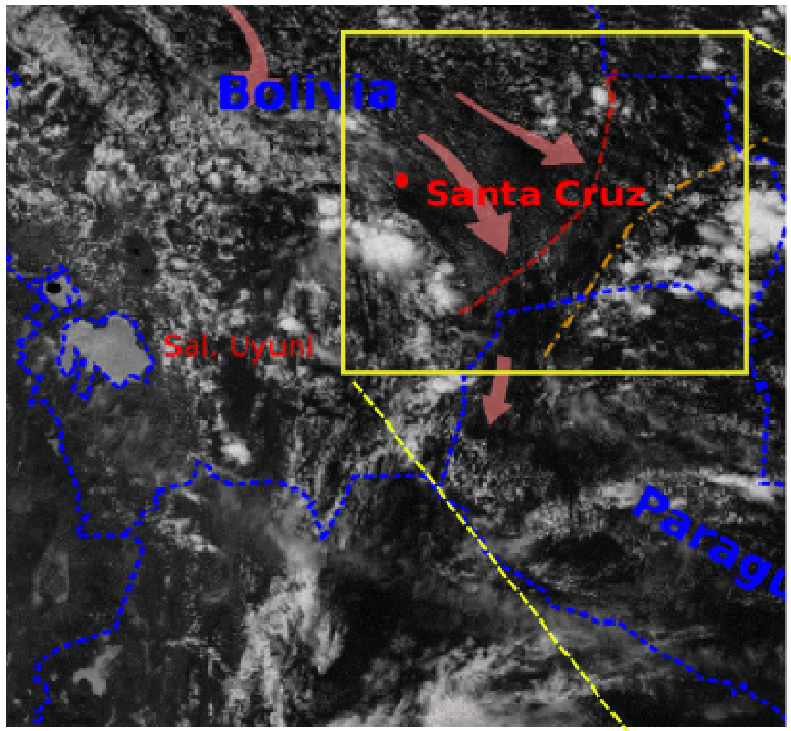
Visible
channel



The LLJ can be identified in the image by the displacement of low clouds, and also by the absence of clouds deep in the center of maximum wind speed

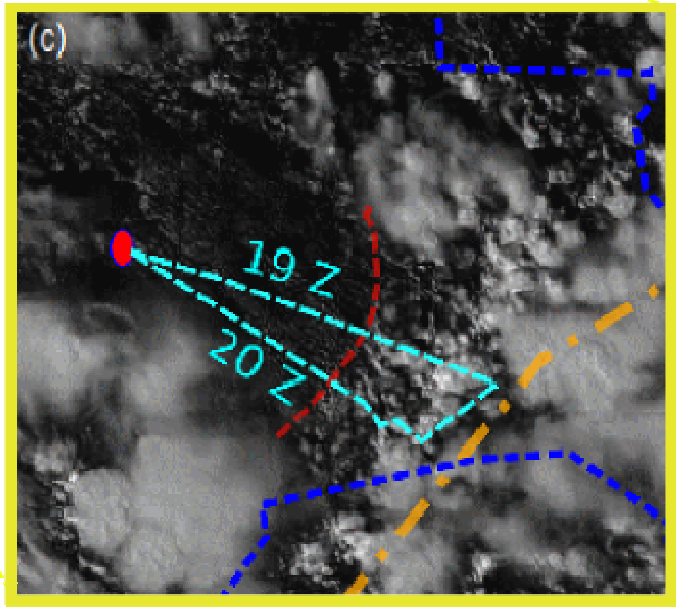
http://www.nssl.noaa.gov/projects/pacs/salljex/

SATTELITE IMAGES and aircraft trajetory in 2003-02-14 at 19Z and 20Z



16:15Z IR image

The aircraft cross the region of LLJ from Santa Cruz to LLJ exit

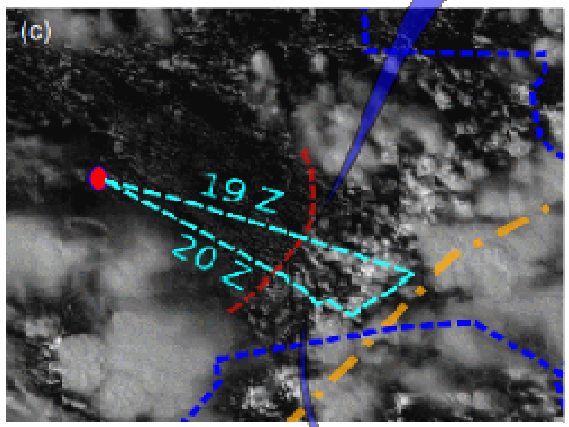


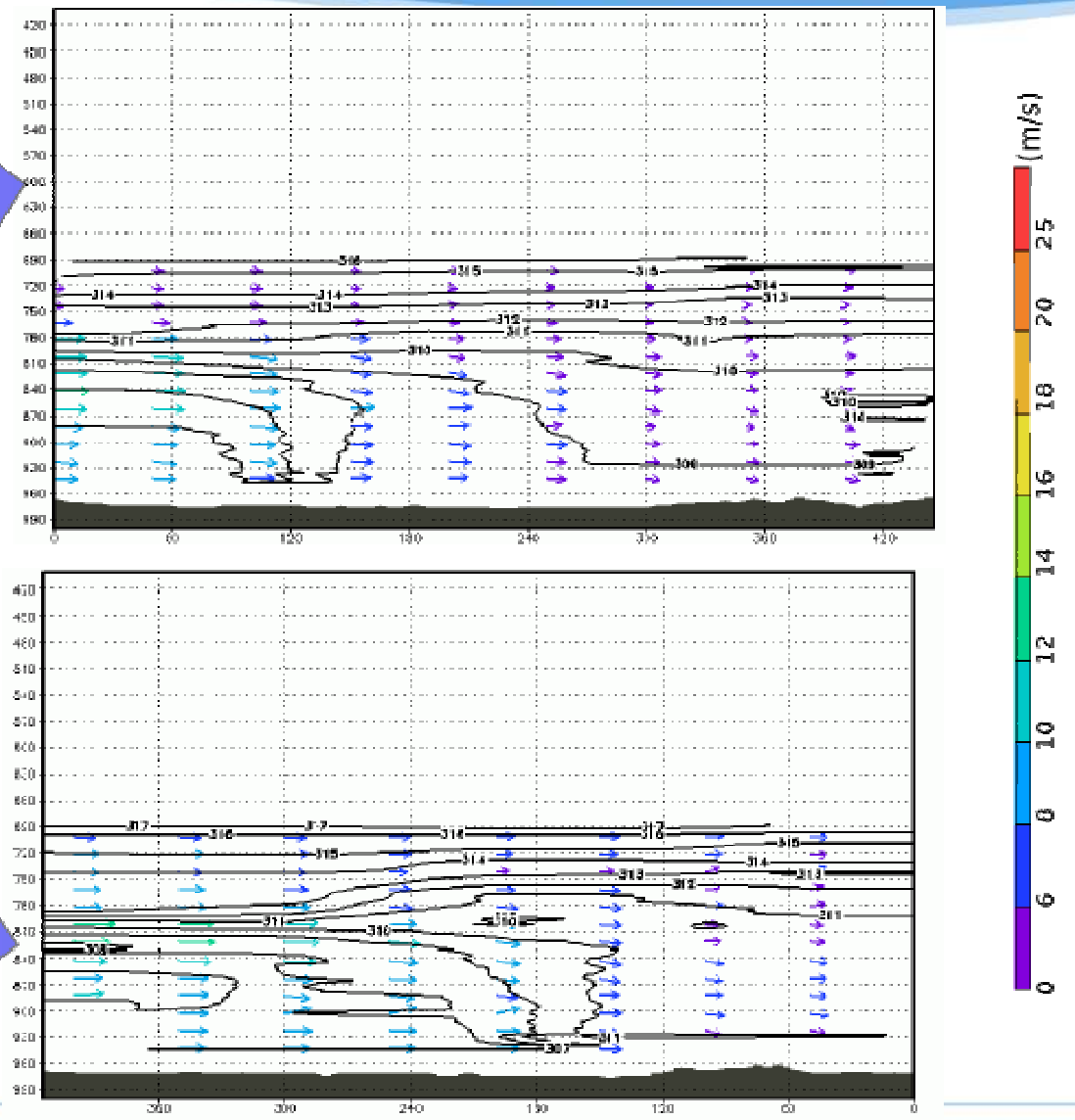
Aicraft trajetory + 19:15Z IR image

NOAA-P3 AIRGRACT DATA 15/01/2003

Potential temperature and component tangential of wind along aircraft trajectory.

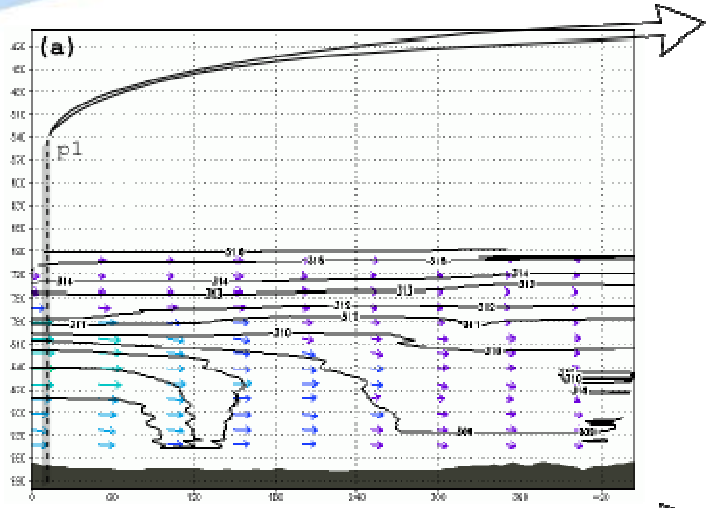
The normal component of the wind has small values and indicates that the aircraft followed roughly the same direction of flow

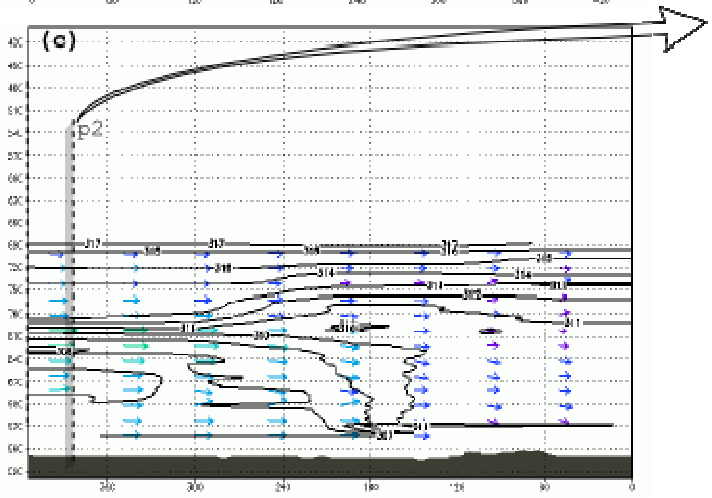


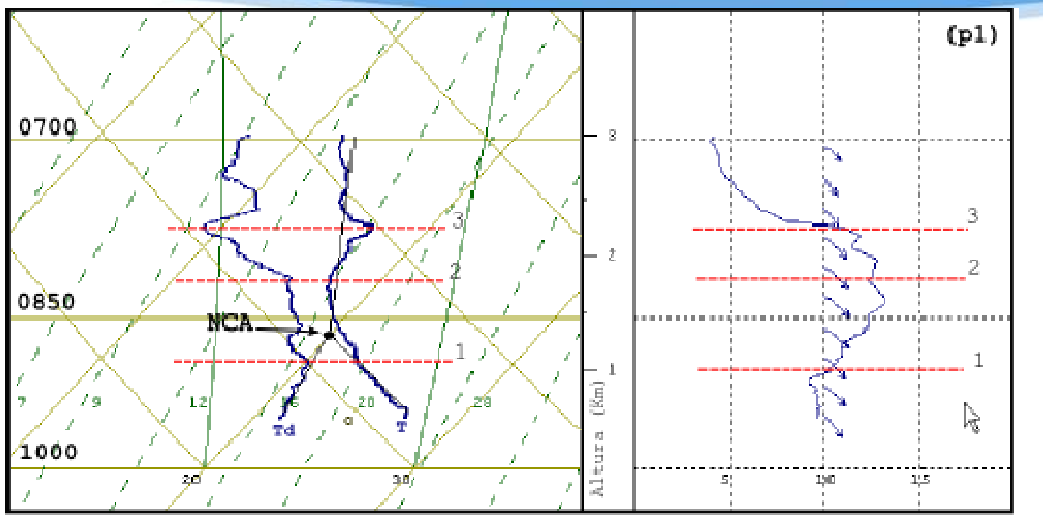


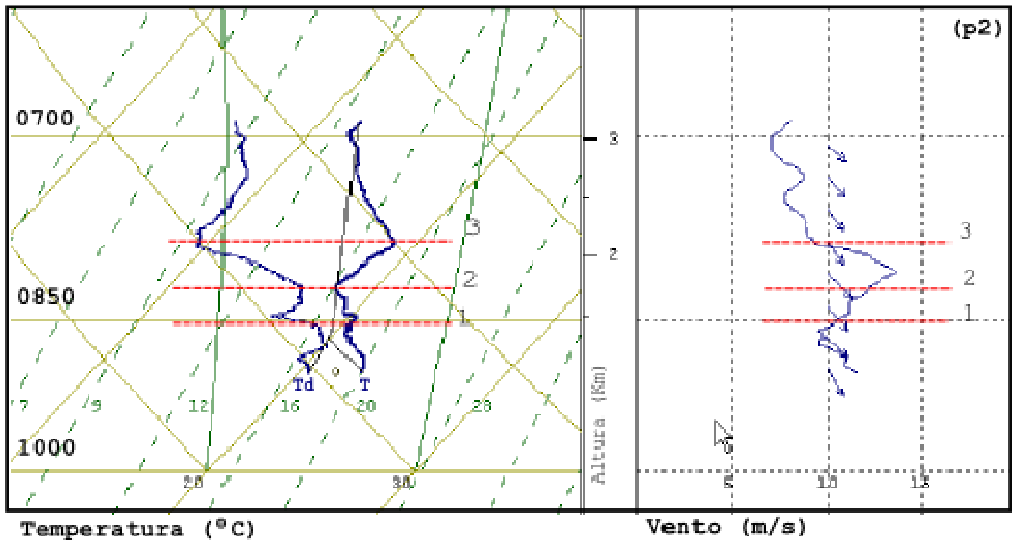
The wind speed and thermal inversion were intense close Santa Cruz.
At the LLJ exit, the reduction of wind speed indicate convergence and difluence of flows as also as adiabatic heating by turbulent transport

Profile from NOAA-P3 data









Exemple of Typical clouds during LLJ episodes

Cumulus fractus spreading out by the wind

Exemple of Typical clouds during LLJ episodes

Cumulus (Cu) and Stratocumulus (Sc) at different heights

NOAA-P3 AIRGRACT DATA 15/01/2003

At the exit of LLJ the surface air becomes warmer and drier while in mean levels colder and wetter

Potential temperature

Specific humidity

19:00 Z

20:00 Z

Short forecast from WRF model

WRF-ARW was used to produlce 03h and 06h intercalated forecast to 00,03, 06, 09, 12, 15 18 21 UTC. Horizontal resolution= 20 km. vertical resolution=25 hPa

The mean squared error and the bias errors were estimated between model fields and observed data at observation point for temperature, humidity, geopotencial and wind . The results shows that quality of model fields are satisfatory

Model configurations used

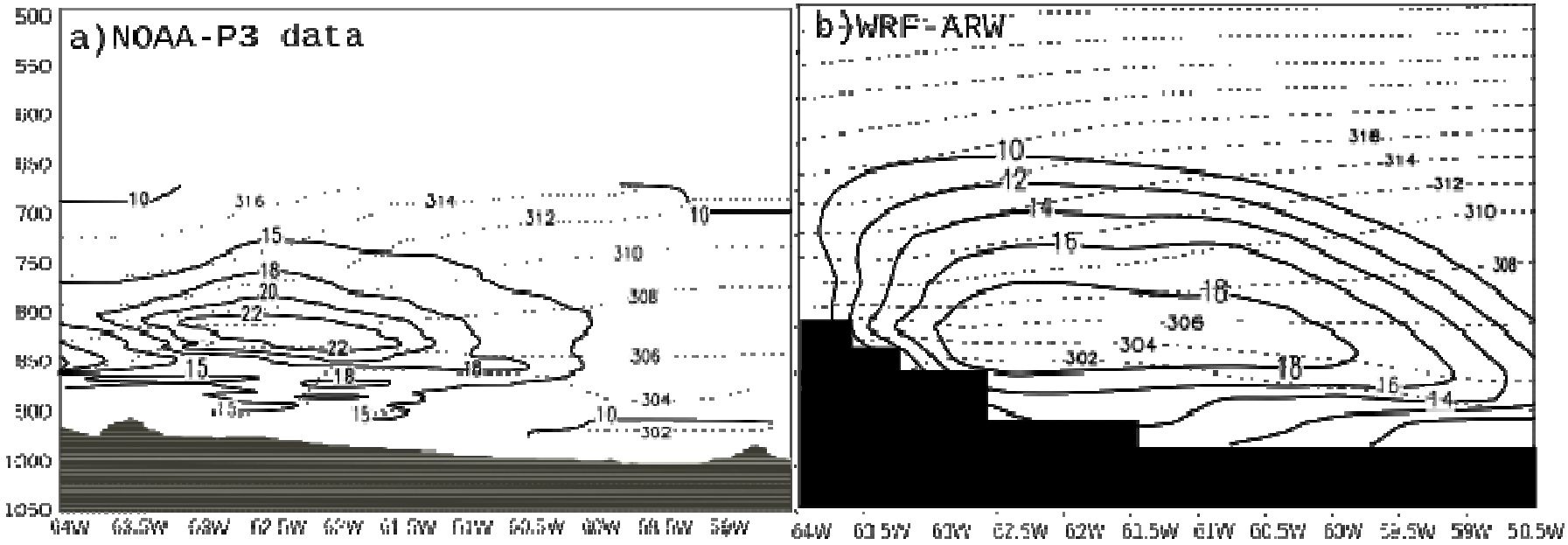
a) Microphysics: "*WRF Single-Moment 3 class scheme*"
b) Long wave radiation : "*RRTM scheme: Rapid Radiative Transfer Model*"
c) Short wave radiation:.*Dudhia scheme*
d) Surface layer : *M5 similarity: Based on Monin-Obukhov with Carslon-Boland viscous sub-layer and standard similarity functions from look-up tables*.
e) Boundary layer parametrization : Yonsei University scheme: Non-local-K scheme with explicit entrainment layer and parabolic K profile in unstable mixed layer.
f) Cumulus Physics: *Kain-Fritsch scheme: Deep and shallow convection sub-grid scheme using a mass flux approach with downdrafts and CAPE removal time scale*.

Initial condition from reanalysis field of NCEP with inclusion of South American Low Level Jets Experiment (SALLJEX-2003) Obteined by Herdies et al.(2007)

HERDIES, D. L.; KOUSKY, V.E.; EBISUZAKI, W. The impact of High-Resolution SALLJEX Data on Global NCEP Analyses. Journal of Climate, v.20, p.5765-5782, 2007.

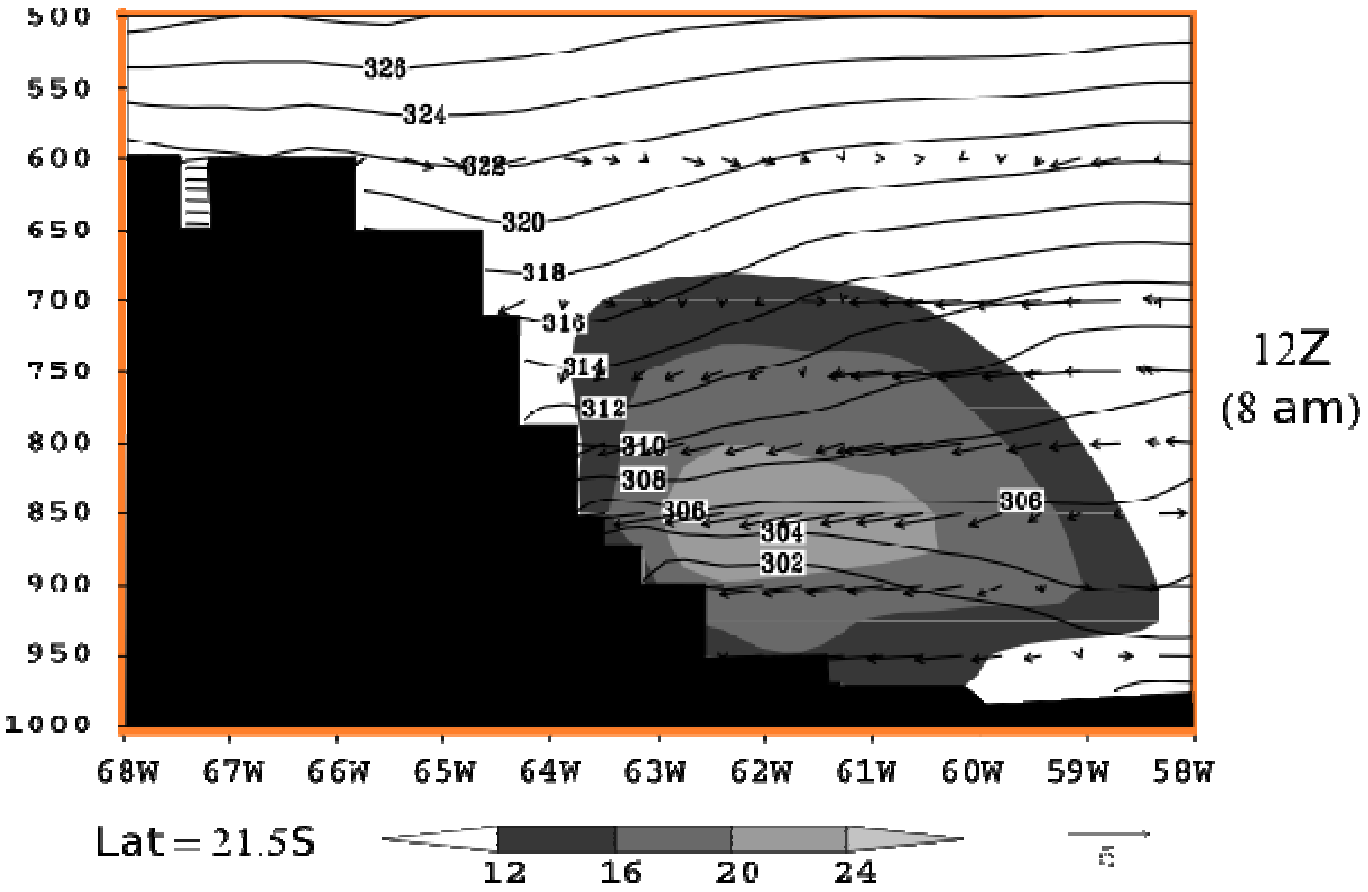
WRF model and Aircraft data (2003-02-04 12:00Z)

Isentropic and meridional wind component



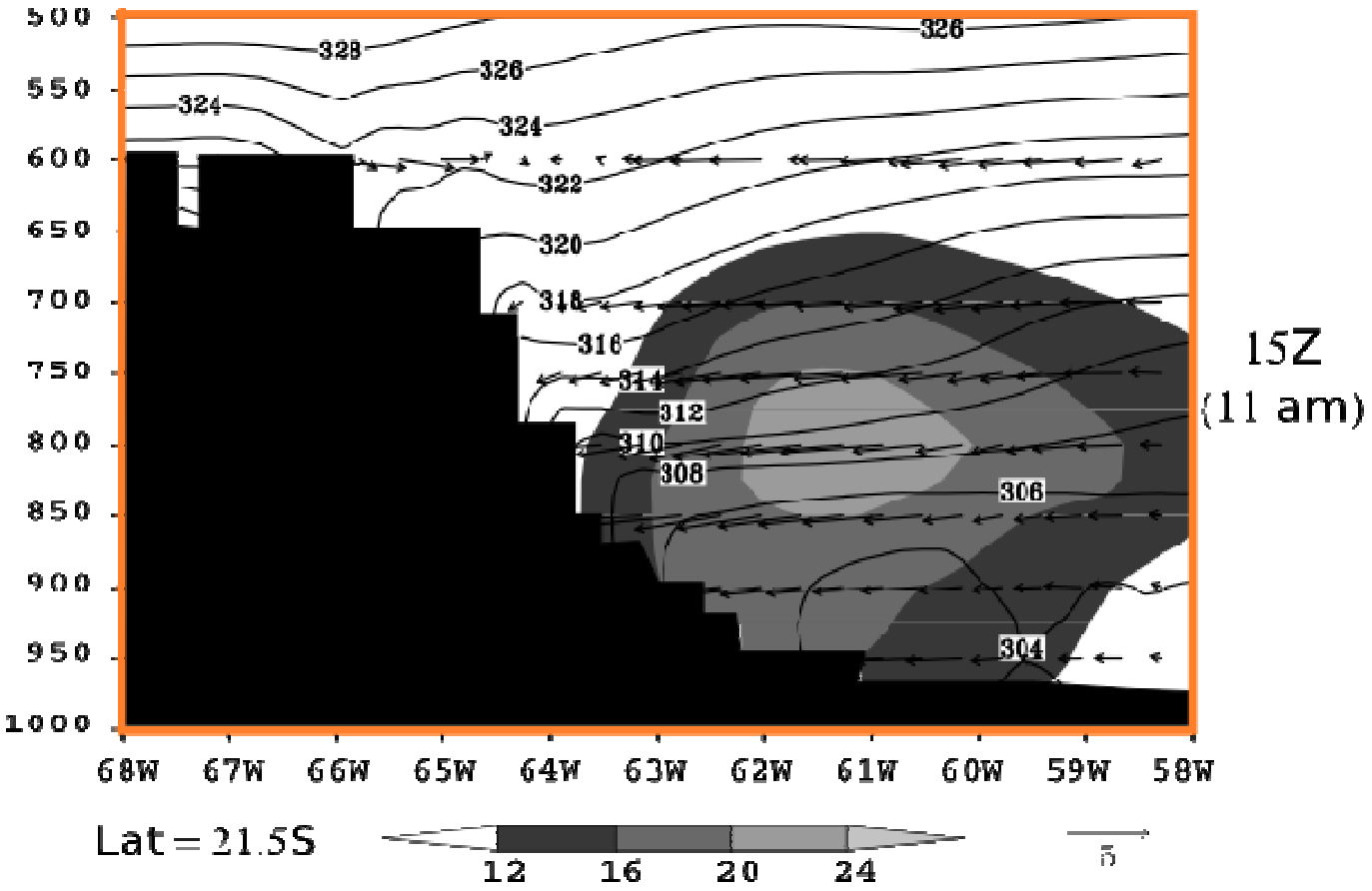
The inclination of isentropic indicates the warming over the Andes, and the shape of meridional winds along of 306K isentropic are similar in both figures. It is consequence of indirect air circulation superposed on the LLJ stream

Daily cycle as simulated by WRF



-Isentropics (line); tangential wind component (vector) ; meridonal wind (shaded)

Daily cycle as simulated by WRF



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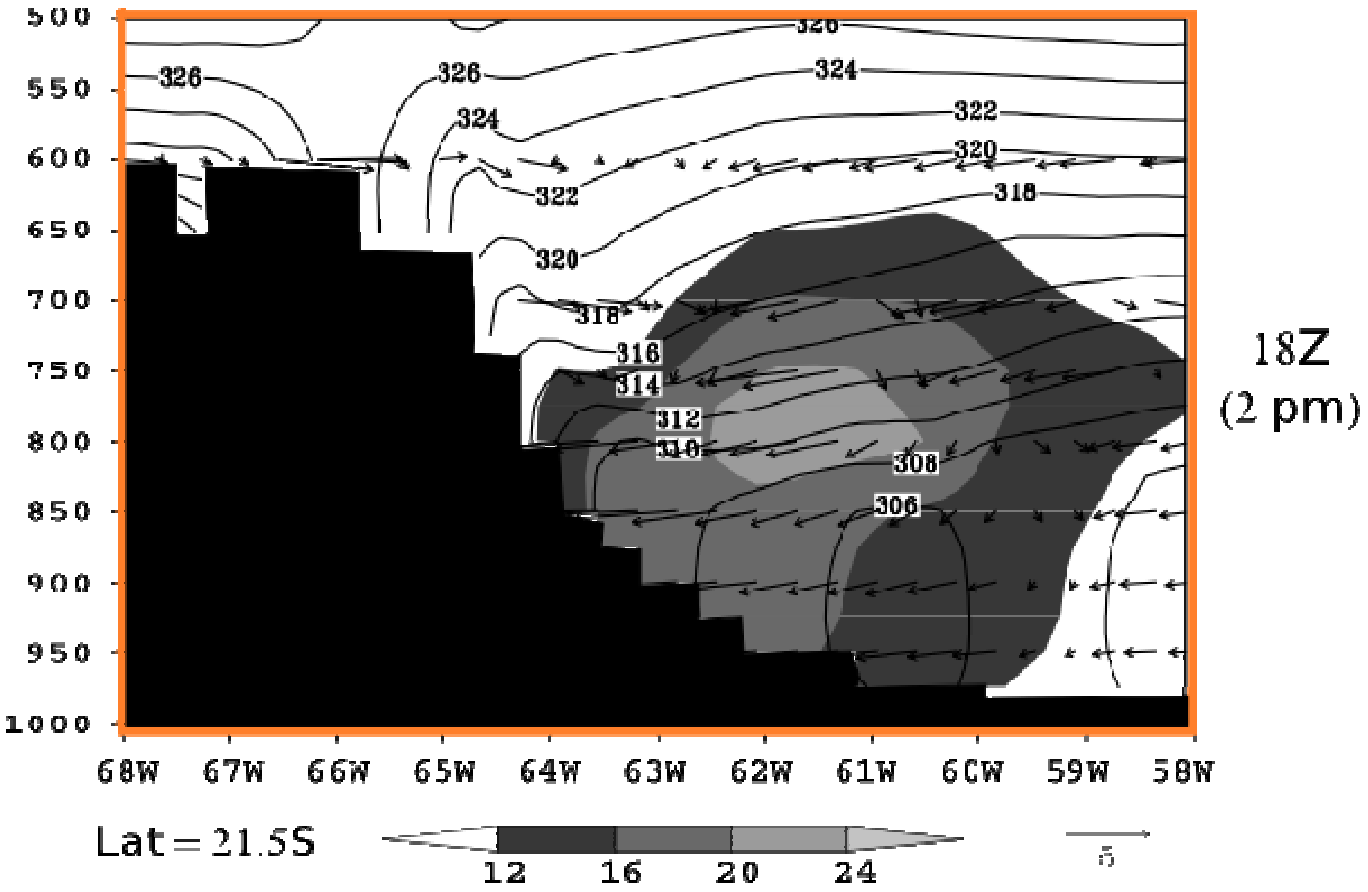

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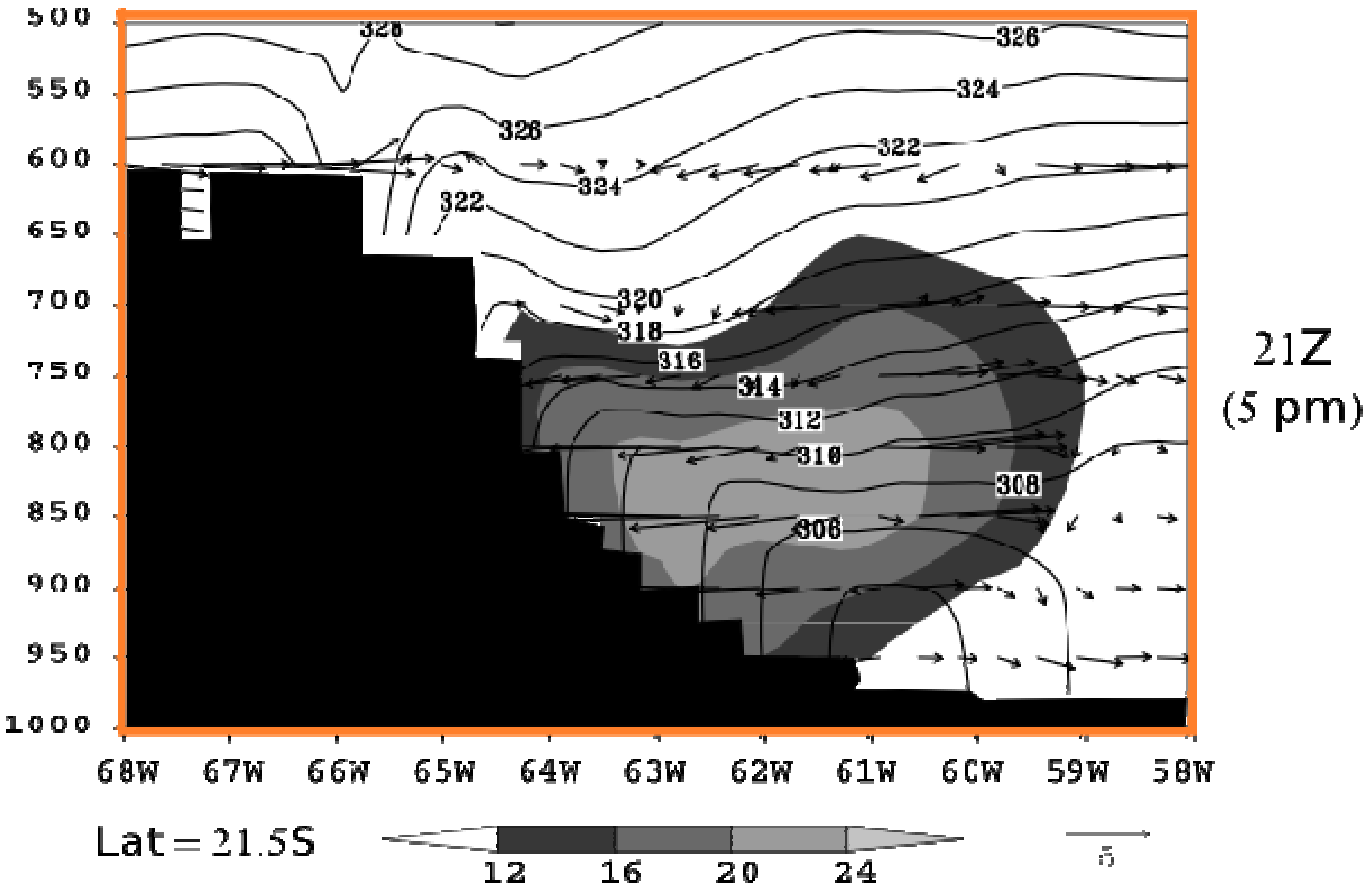

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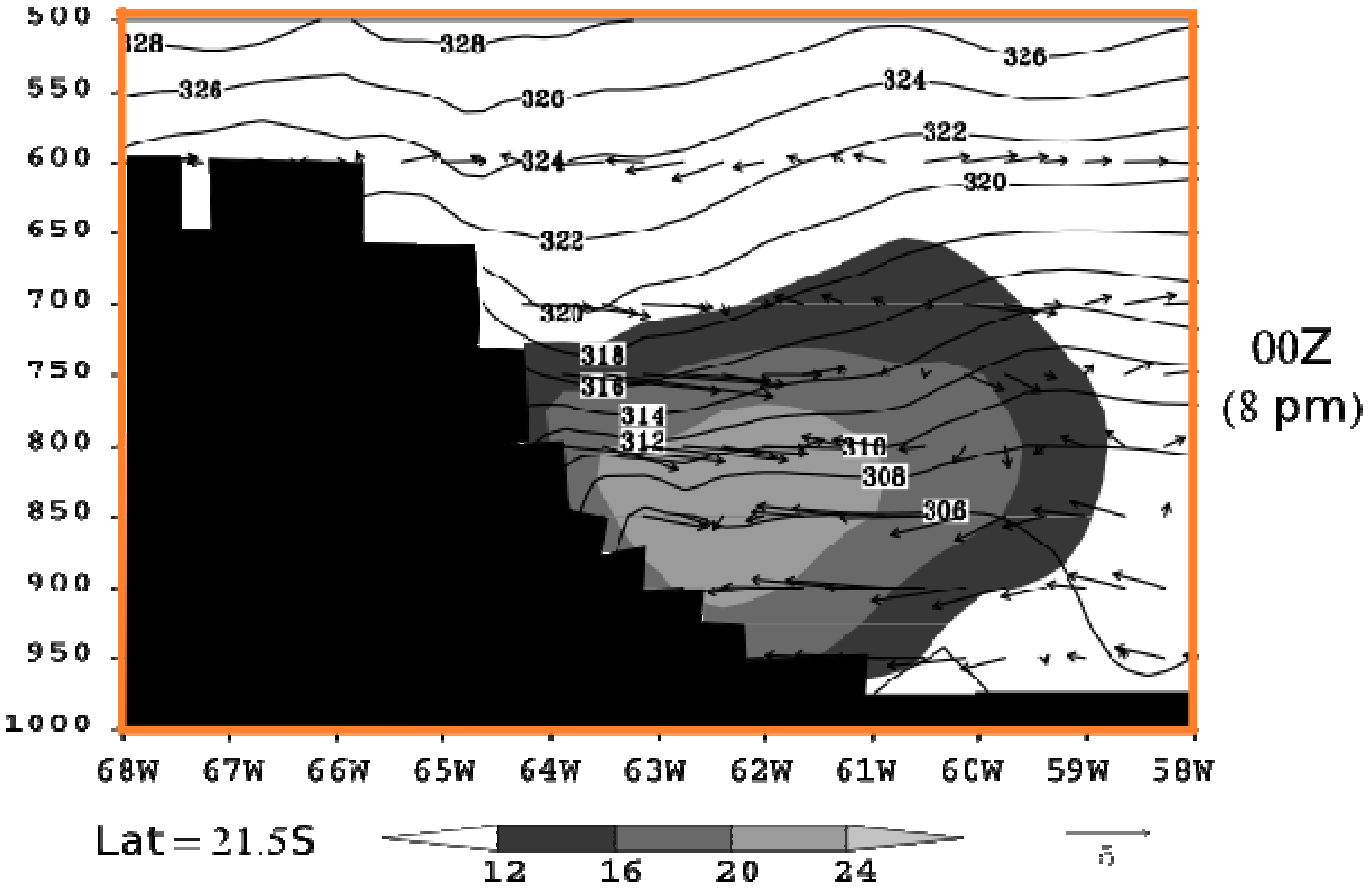

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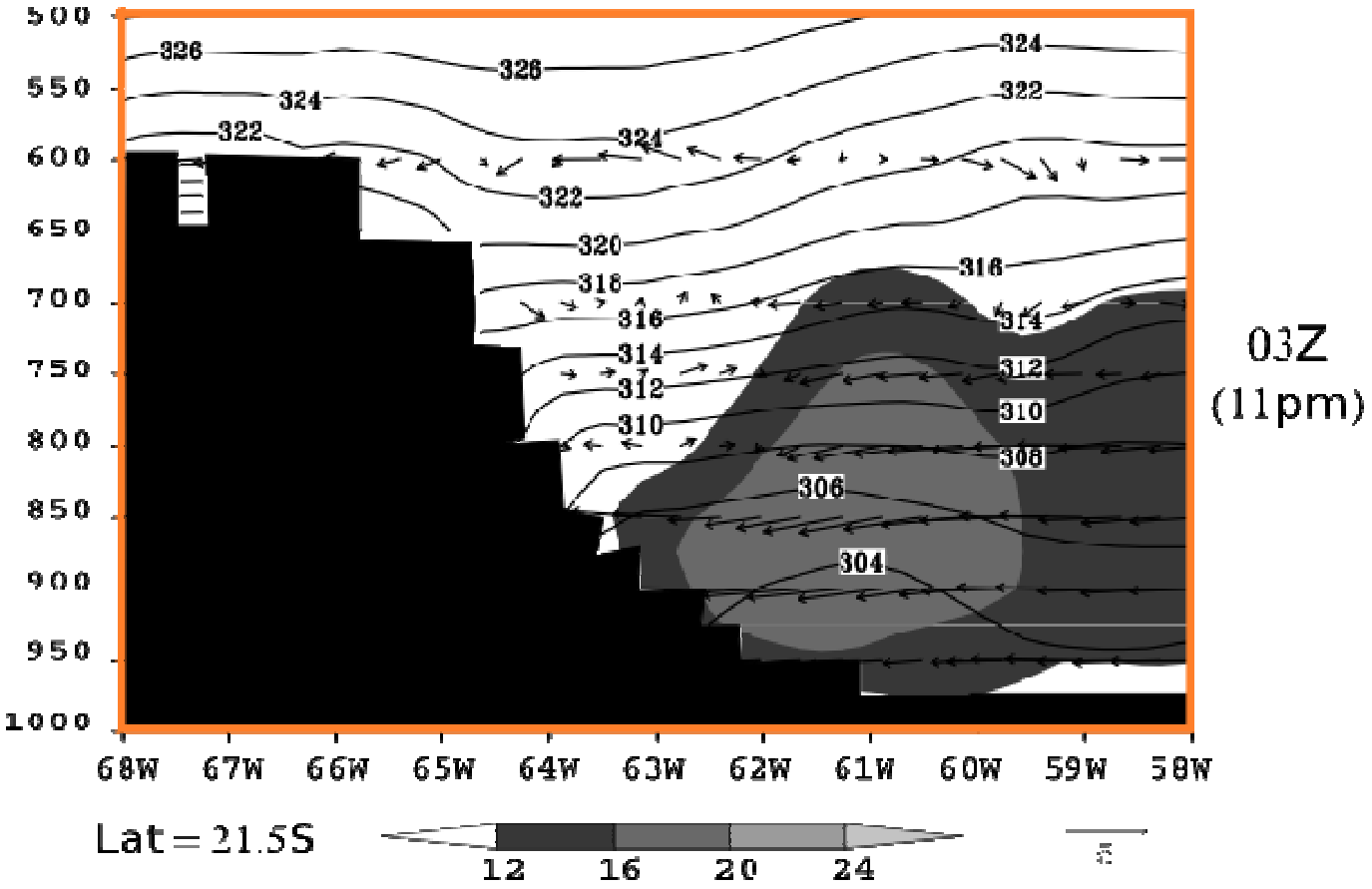

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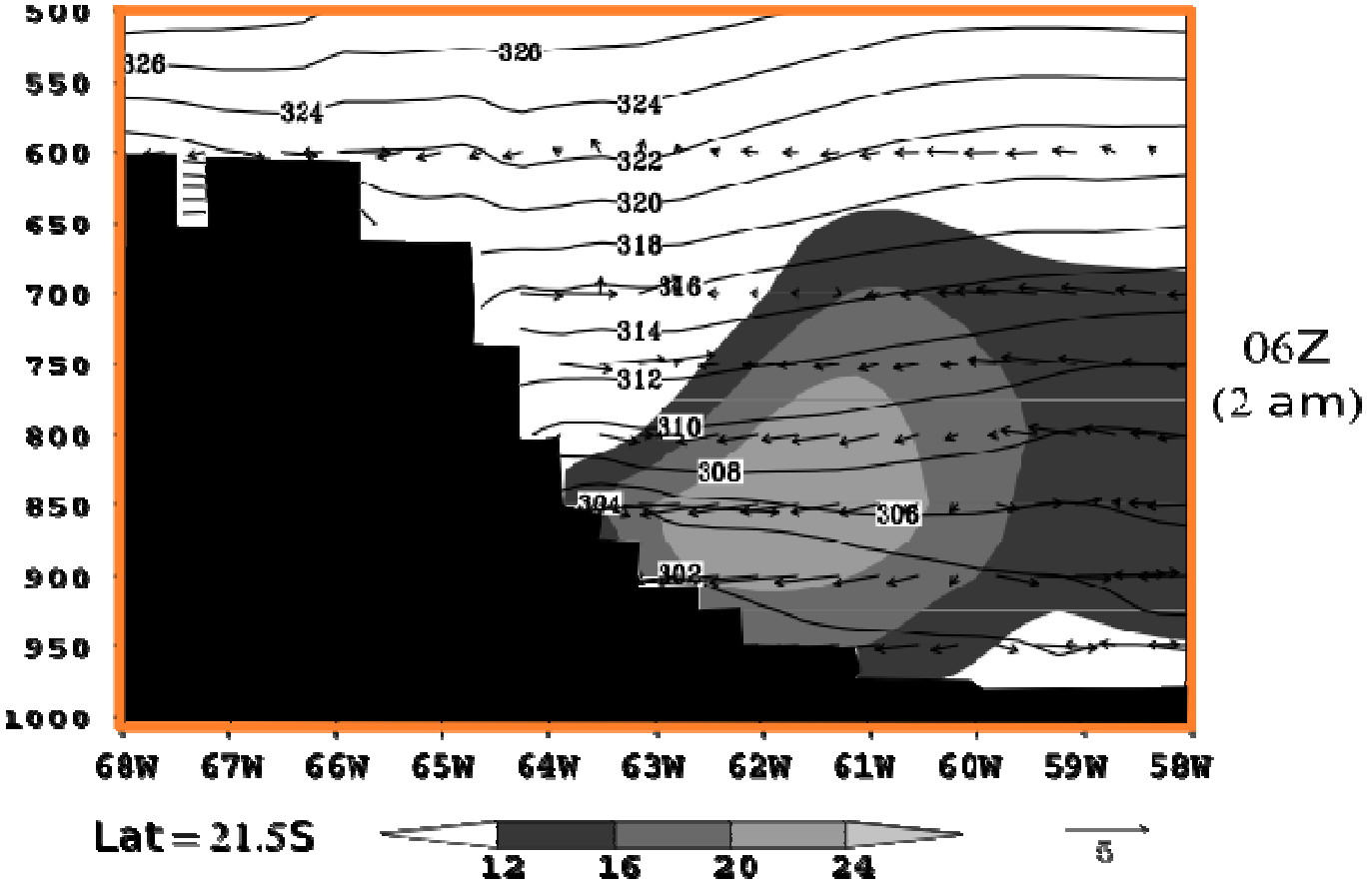

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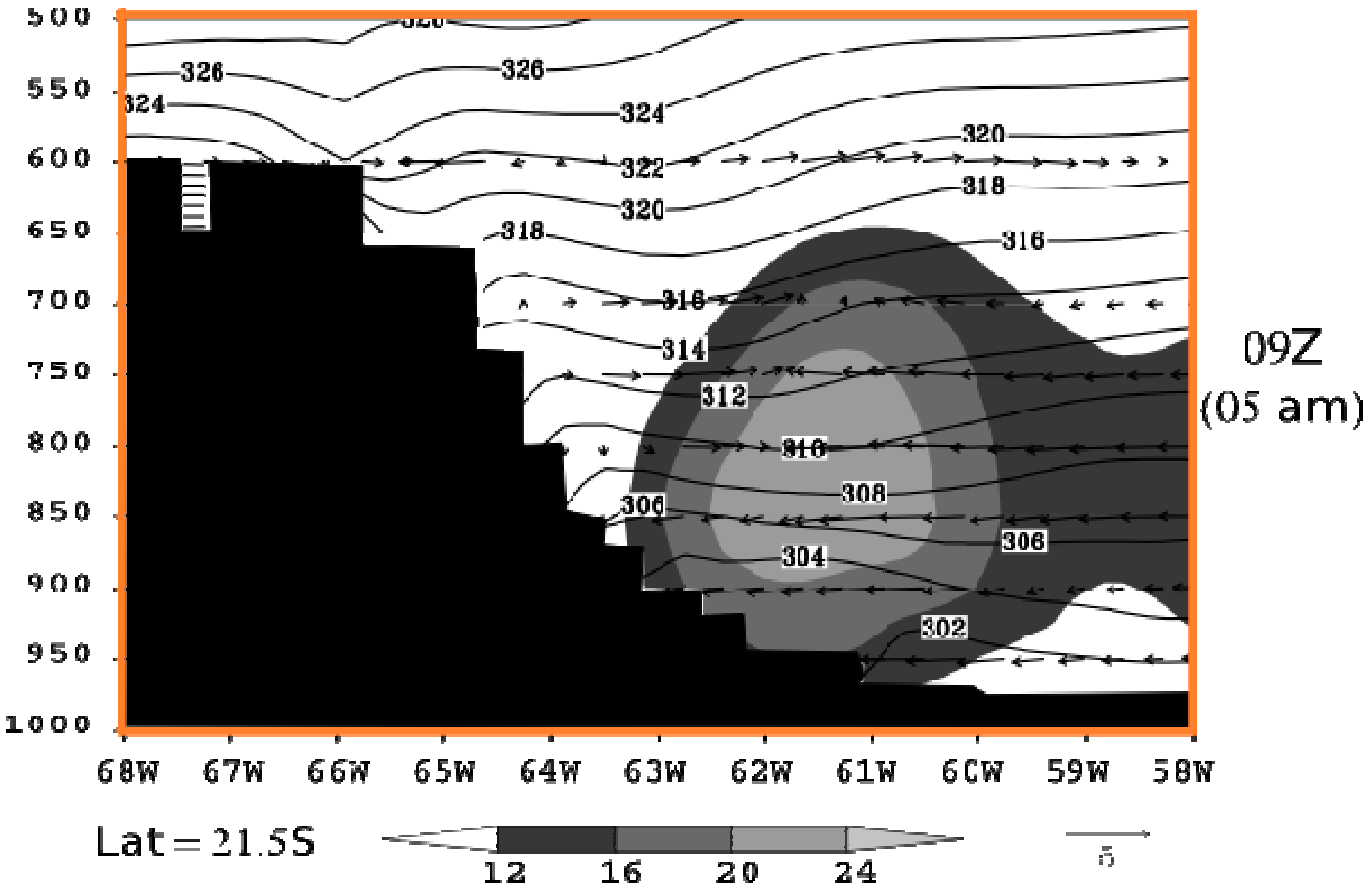
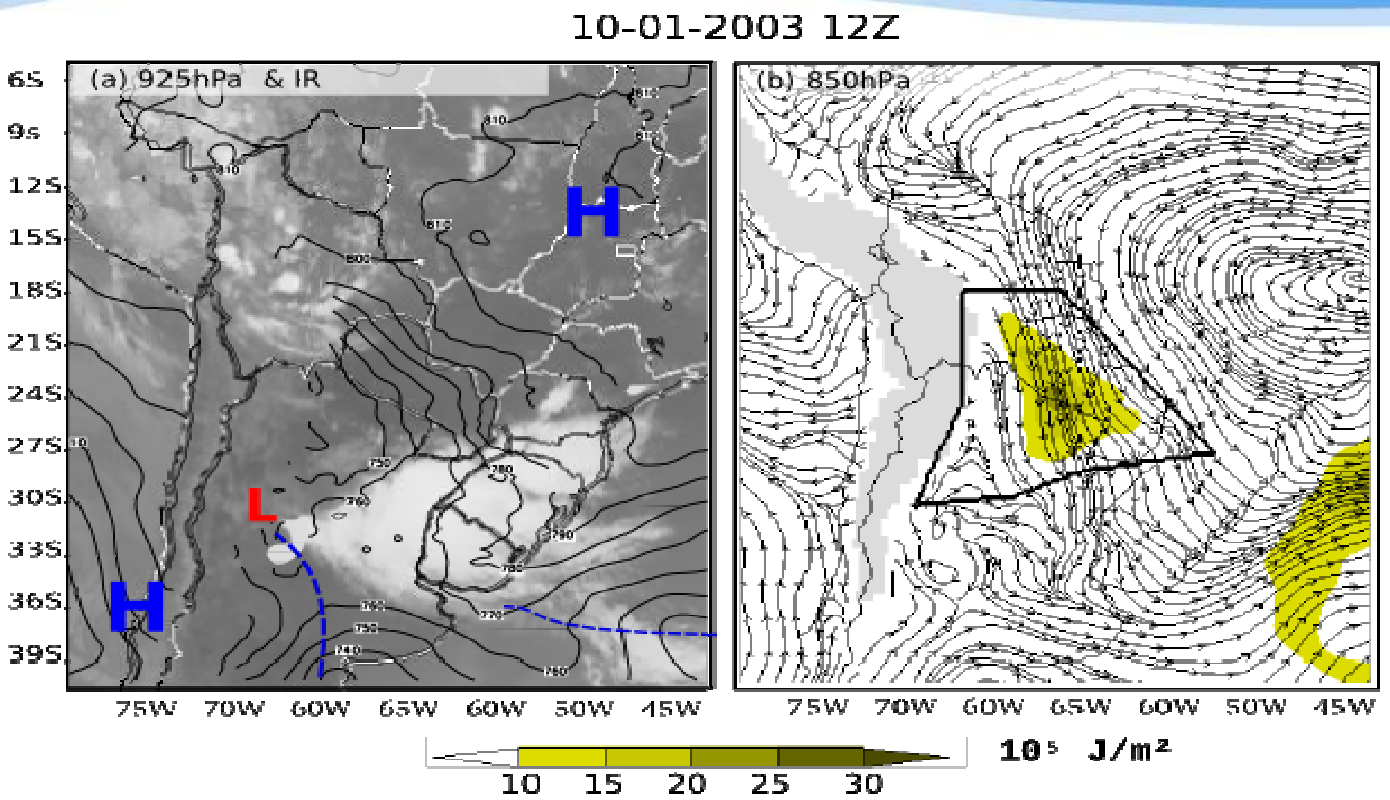


-Isentropics (line); tangential wind component (vector) ; meridonal wind (shaded)

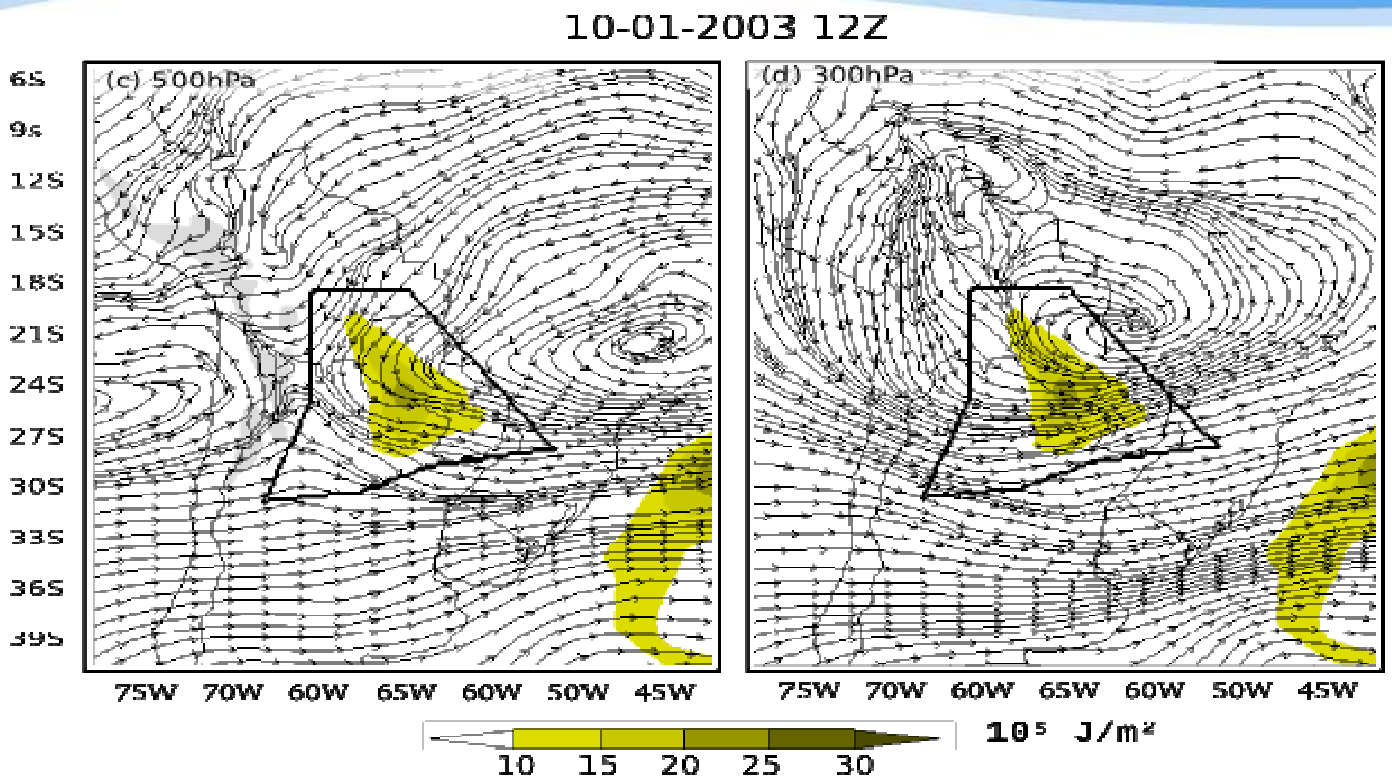
Coupling between Low and Hight levels



(L) Northwestern Argentina Low Pressure Center.

Stream lines and kinetic energy for LLJ

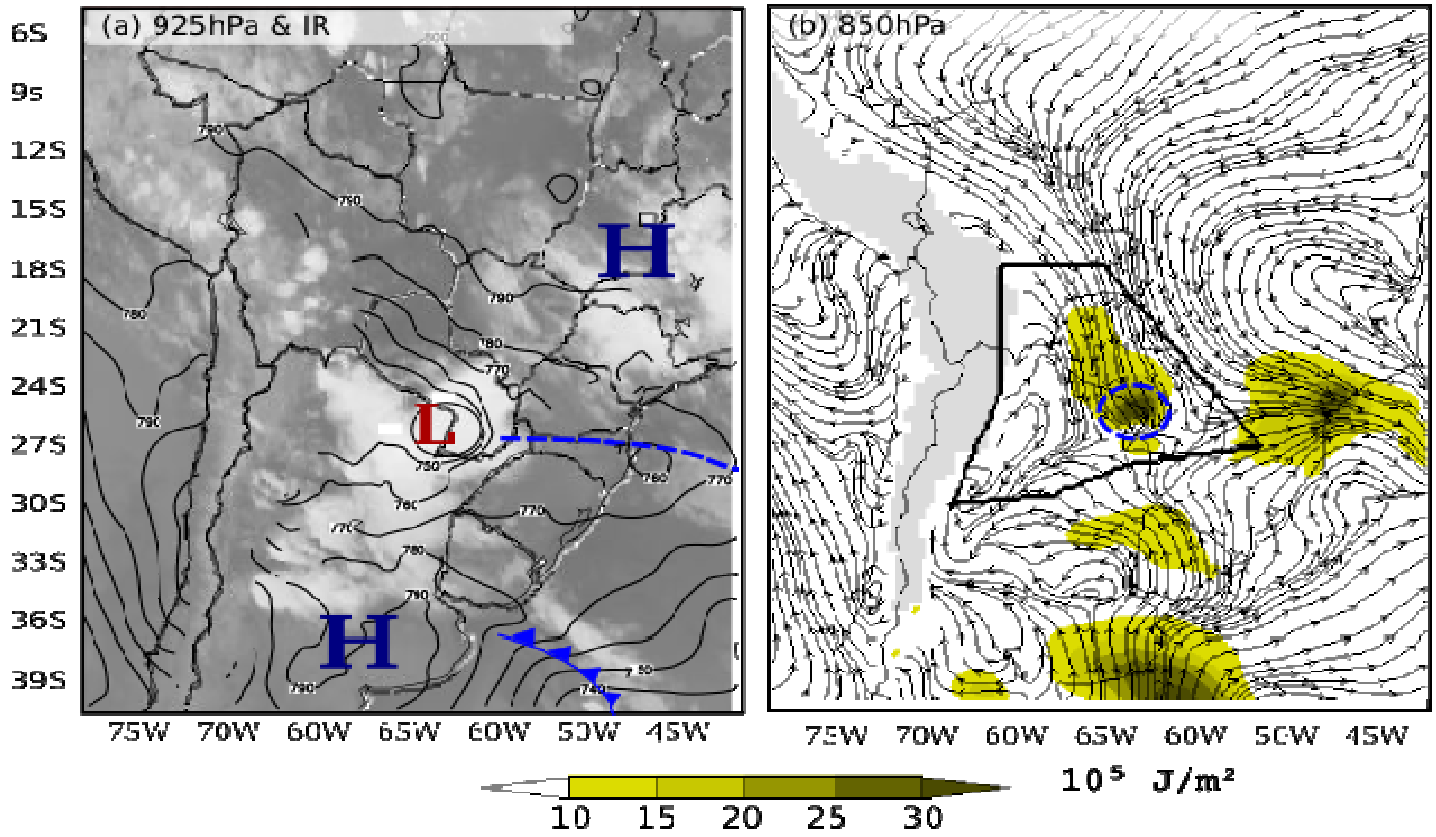
Coupling between Low and Hight levels



The flow in mid-level cross the Andes (500 hPa), the effect of conservation of potential vorticity causes deflection of the wind direction. The eastern winds deflect to the south and westerly winds deflect to the north.

There is divergence of the flow of the jet stream at high levels while passing through the Andes. The point of divergence at high levels corresponds to the point of convergence of the LLJ, indicating coupling between low and high levels at this point.

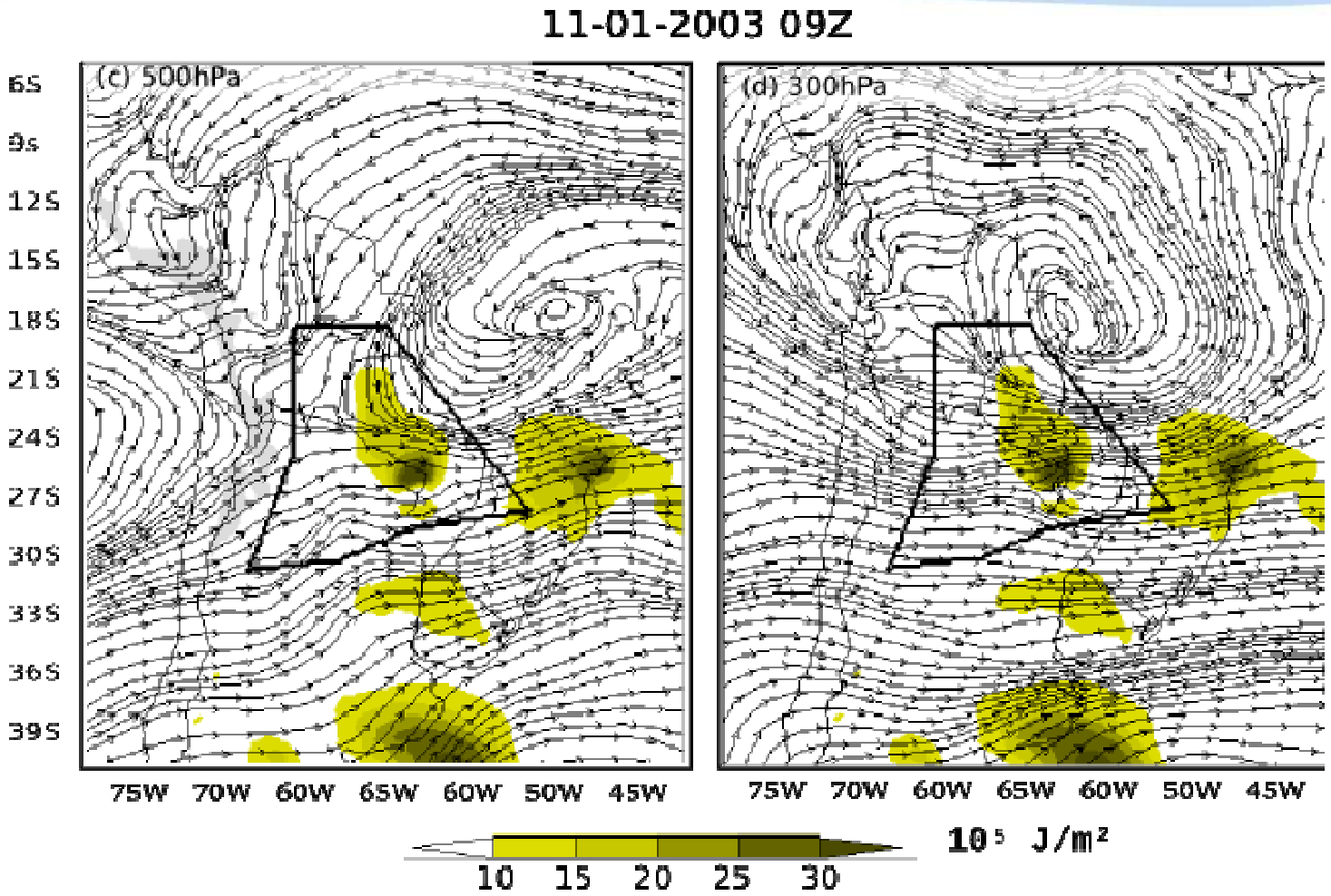
Coupling between Low and Hight levels



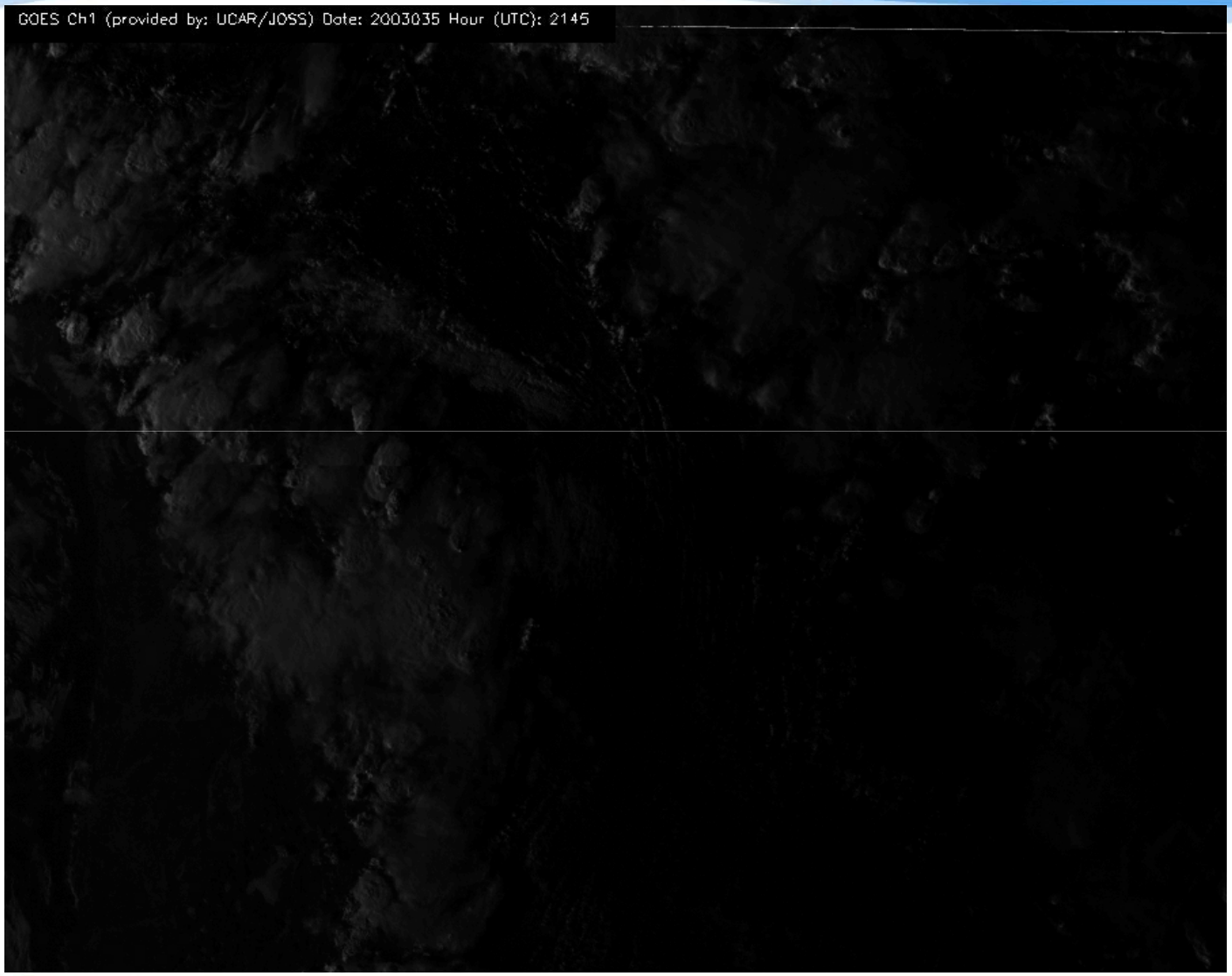
(L) Chaco Low Pressure Center.

Stream lines and kinetic energy for LLJ

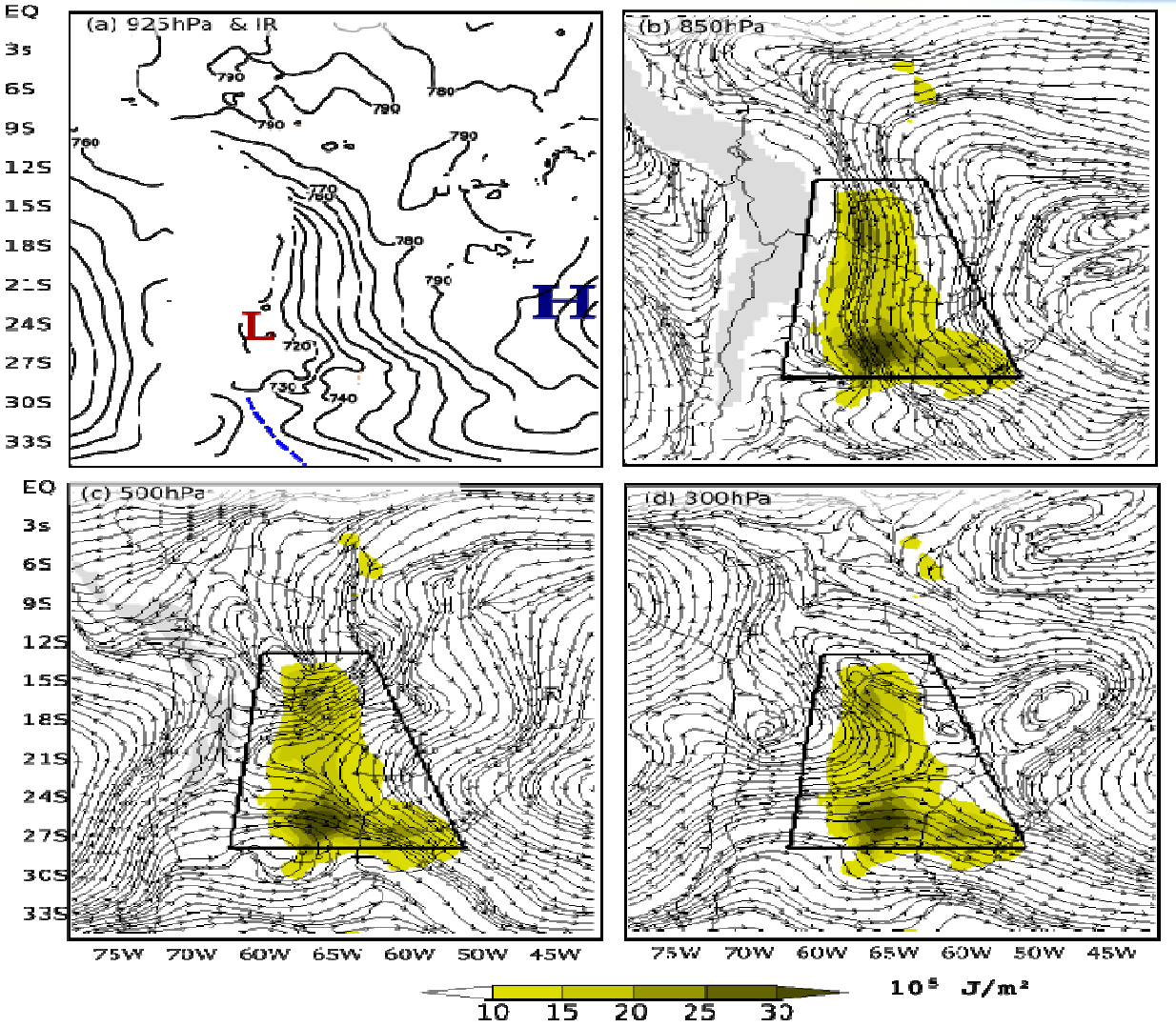
Coupling between Low and Hight levels



Example of LLj episode in 2003-02-04



The WRF simulation 2003-02-04 15Z



Final Comments

Although some errors in the model fields in comparation of data, the results can be considerated realistic for the purpose of this work and show evidence of interaction between the mountain valley circulation, as also as the coupling between LLJ and upper level circulation.

The coupling between LLJ and the upper level circulation usually occurs associated with other sinoptic systems. For examplo, cold fronts or upper level cyclonic vortices were observed during LLJ episode as a part of circulation

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Thank you

sergio.ferreira@cptec.inpe.br

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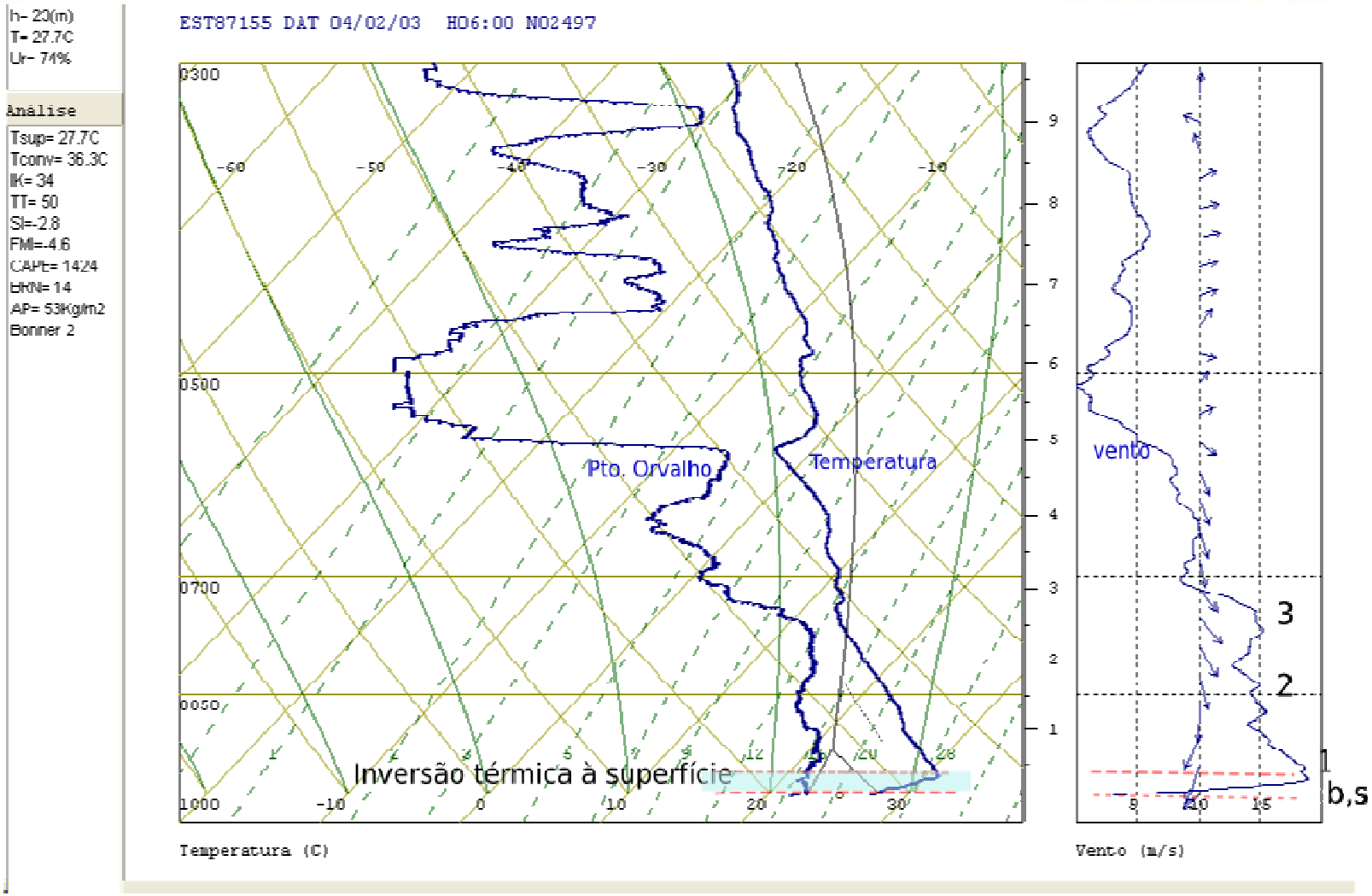
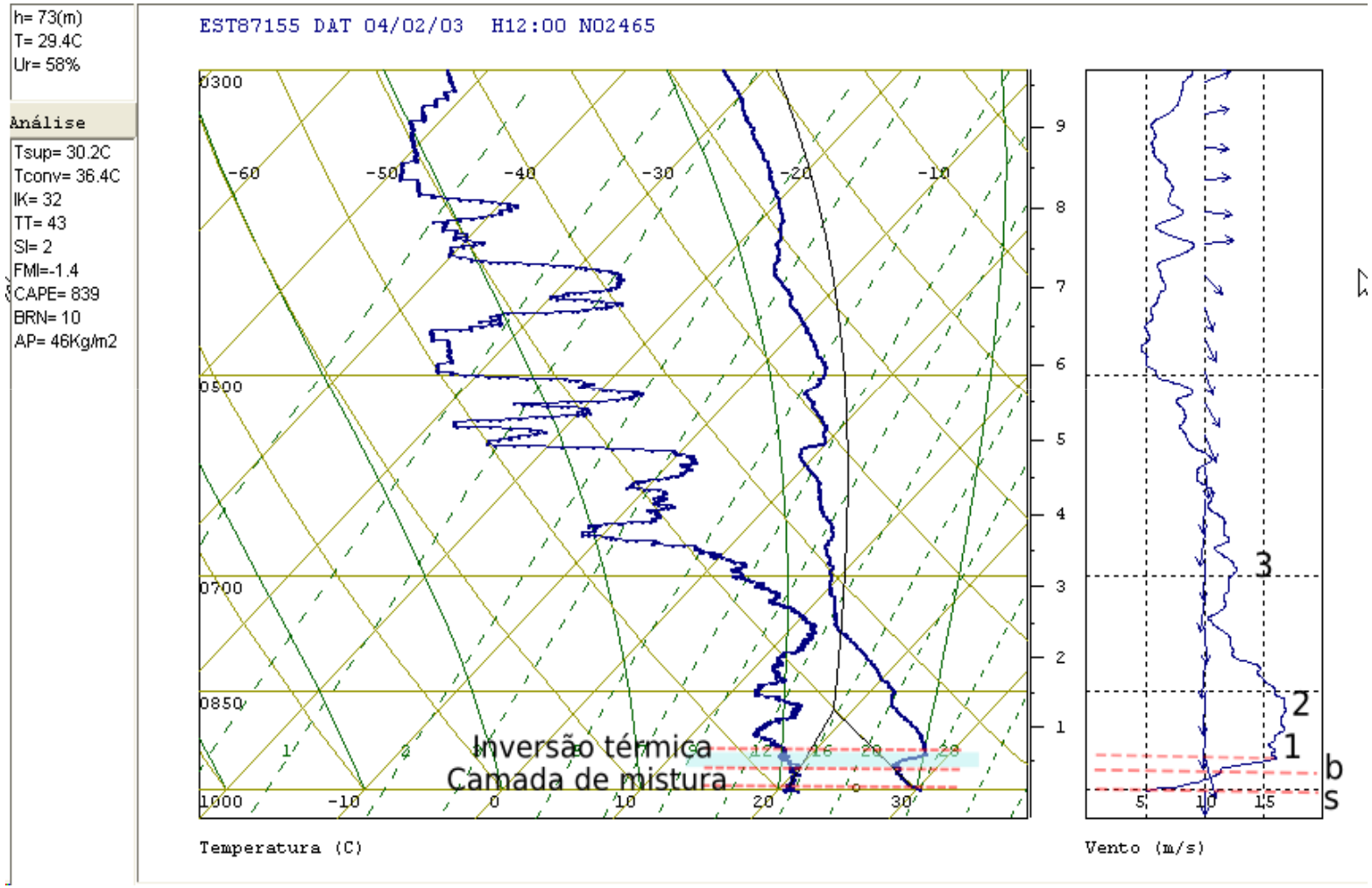
LLJ associated to nocturnal cooling



LLJ associated to nocturnal cooling



LLJ associated to nocturnal cooling