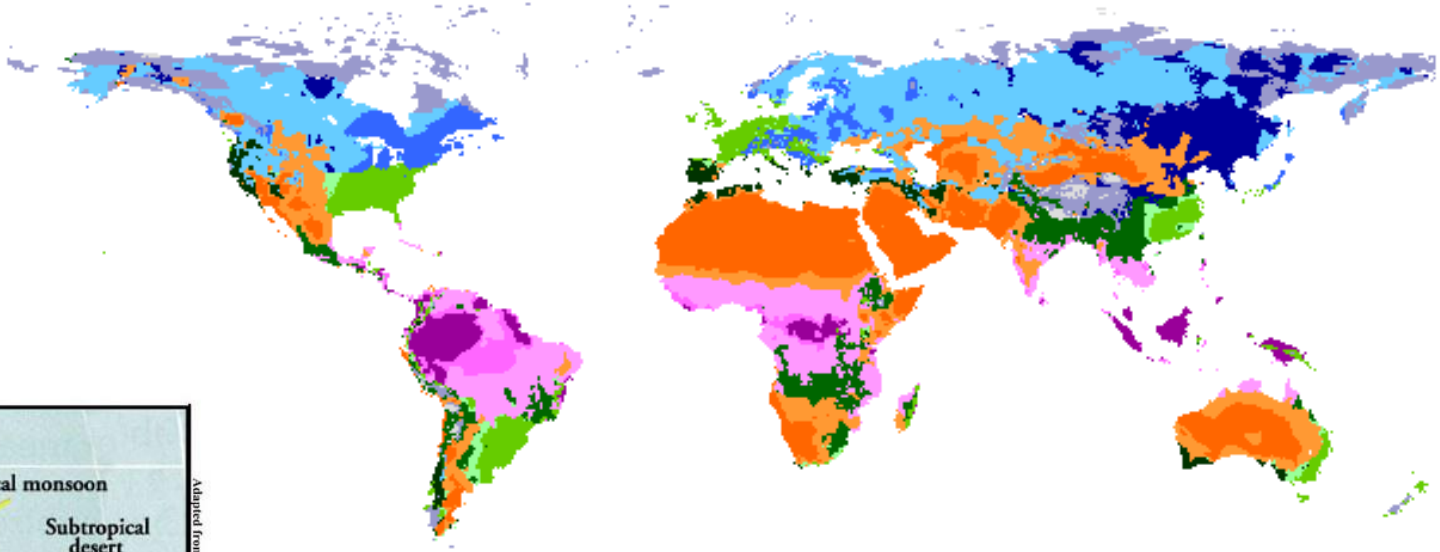
Climas de Sud América

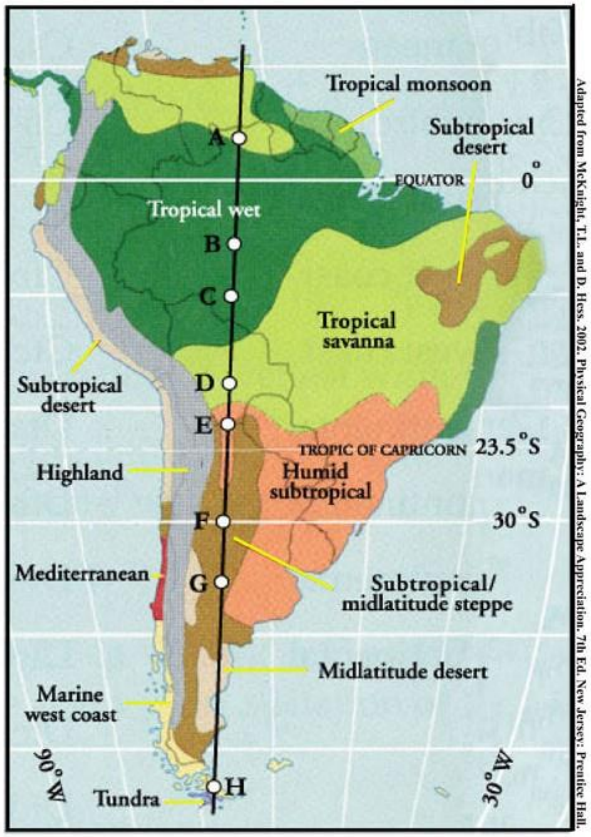
Circulación general + Geomorfología

René Garreaud – Marzo 2020

Una vuelta por el barrio

- Que sistemas de circulación general afectan SA?
- Cuales son las condiciones de borde climáticas para SA?
- Cuales son los rasgos topográficos mas importantes del continente?
- Como los anteriores organizan la circulación atmosférica en niveles bajos sobre SA?
- Que produce las asimetrías de temperatura superficial sobre SA?
- Como es el ciclo anual de la precipitación sobre SA?
- El régimen monzonal de precipitación
- El régimen extratropical de precipitación



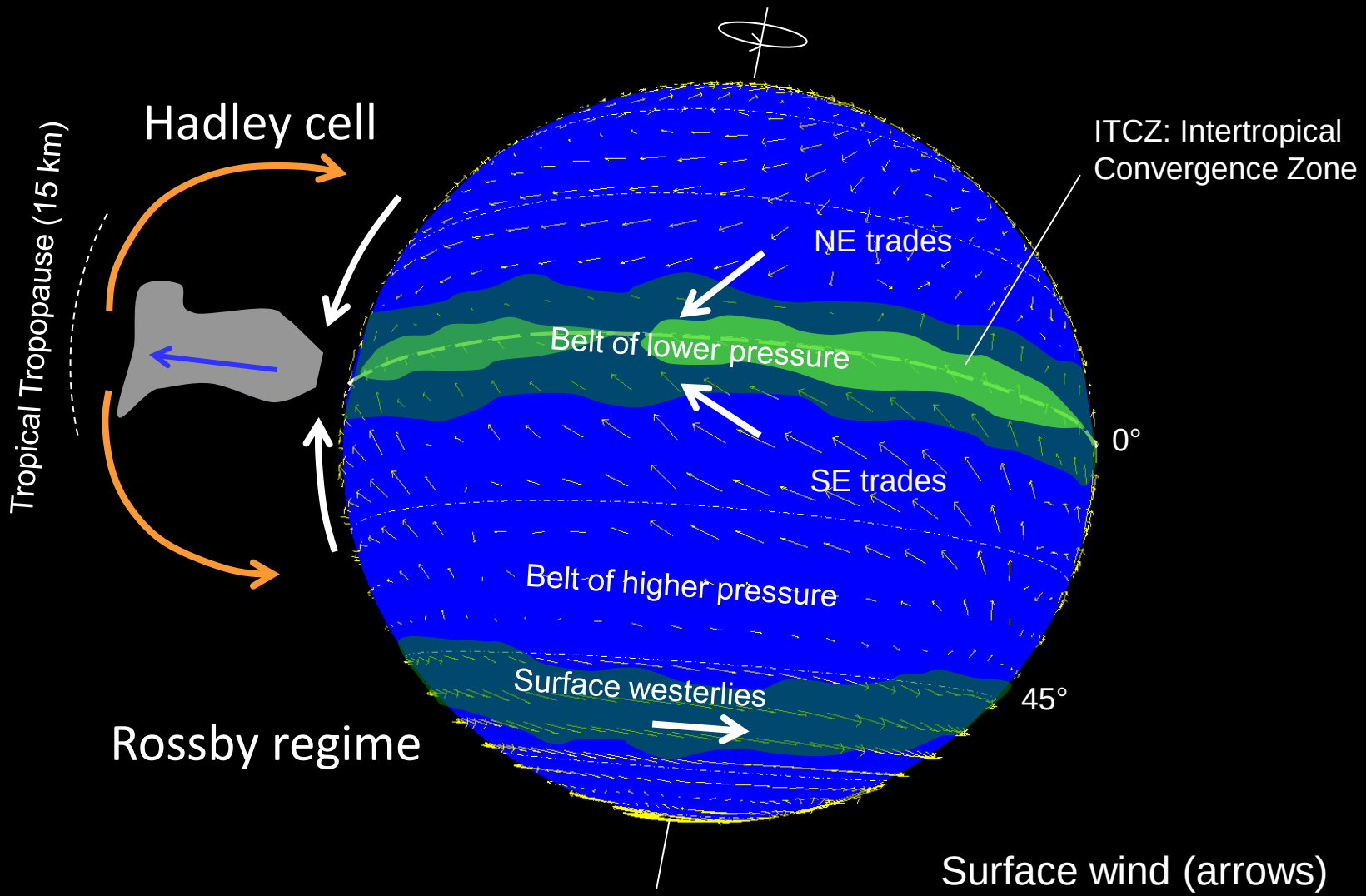


Adapted from McKnight, T.L. and D. Hess. 2002. Physical Geography: A Landscape Appreciation. 7th Ed. New Jersey: Prentice Hall.

South American Climate Zones

Finalmente, circulación general de la atmósfera (y océanos) + topografía + tipo de suelo → biomas característicos que son la base de sistemas de clasificación climática

General circulation in an aqua-planet
Perpetual Equinox



Surface wind (arrows)
Precipitation (green shadow)

Aspectos esenciales de la circulación general de la atmosfera observada en nuestro planeta:

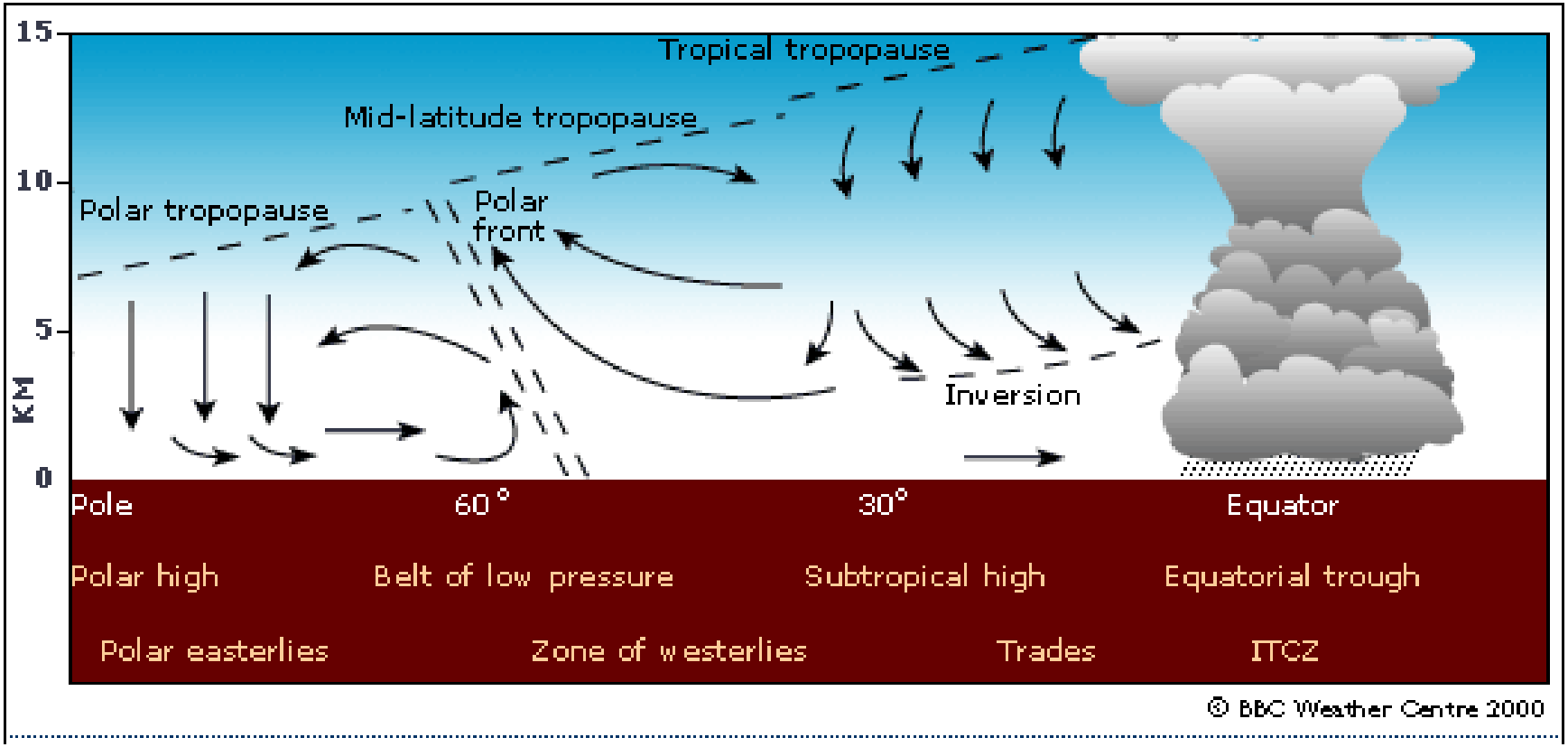
- Régimen tropical (±15°, incluye ITCZ) con altas precipitaciones, alta humedad y temperatura, y flujo medio del este (evidente en superficie y altura)
- Régimen subtropical (en torno a los 30°) asociado a un mínimo de precipitaciones, subsidencia y condiciones estables

Celda de Hadley

- Régimen de latitudes medias (en torno a los 45°), con condiciones variables de tiempo, precipitaciones moderadas y flujo del oeste.
- Condiciones frías y secas en latitudes altas

Regimen de Rossby

Because of its long meridional extent, South America exhibits tropical, subtropical and extratropical climatic regimes



Zonal wind just upstream of the Andes (over the SE Pacific)

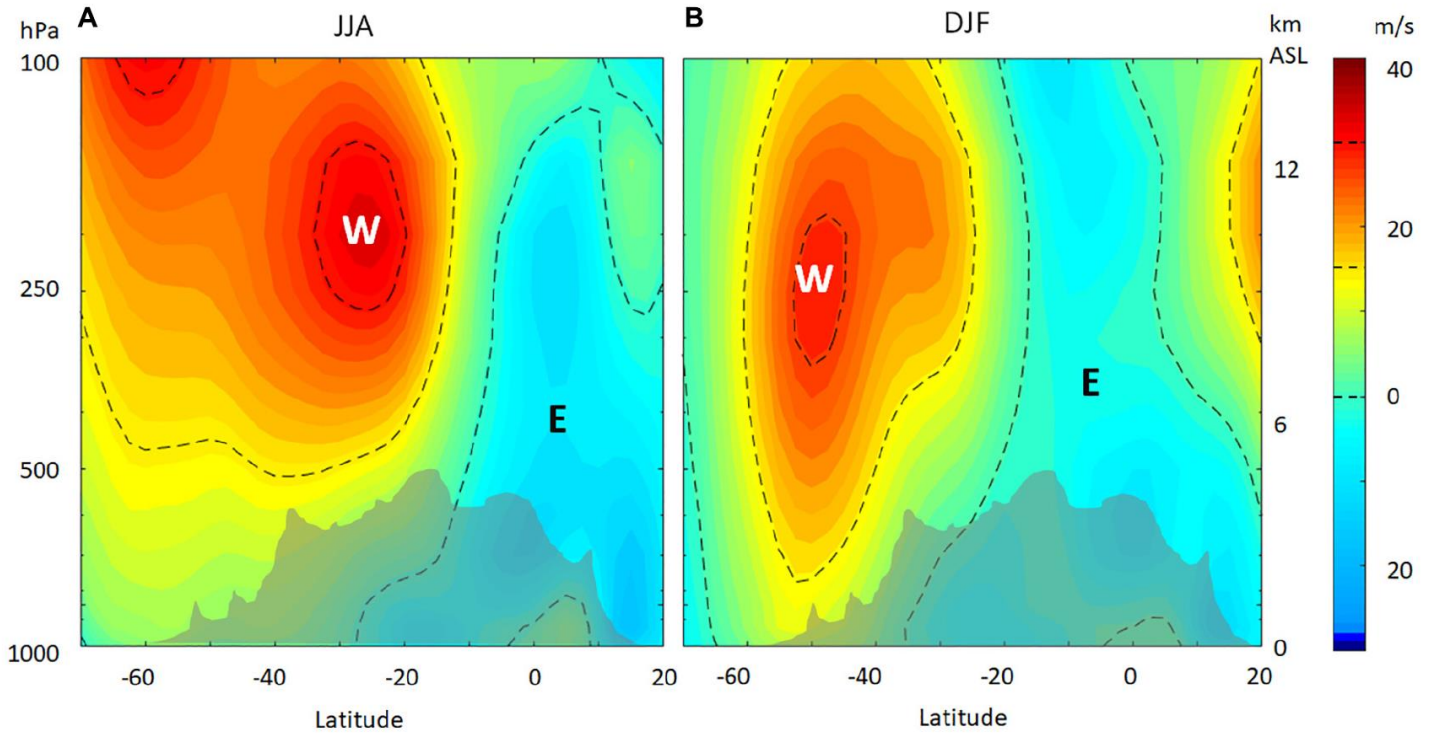
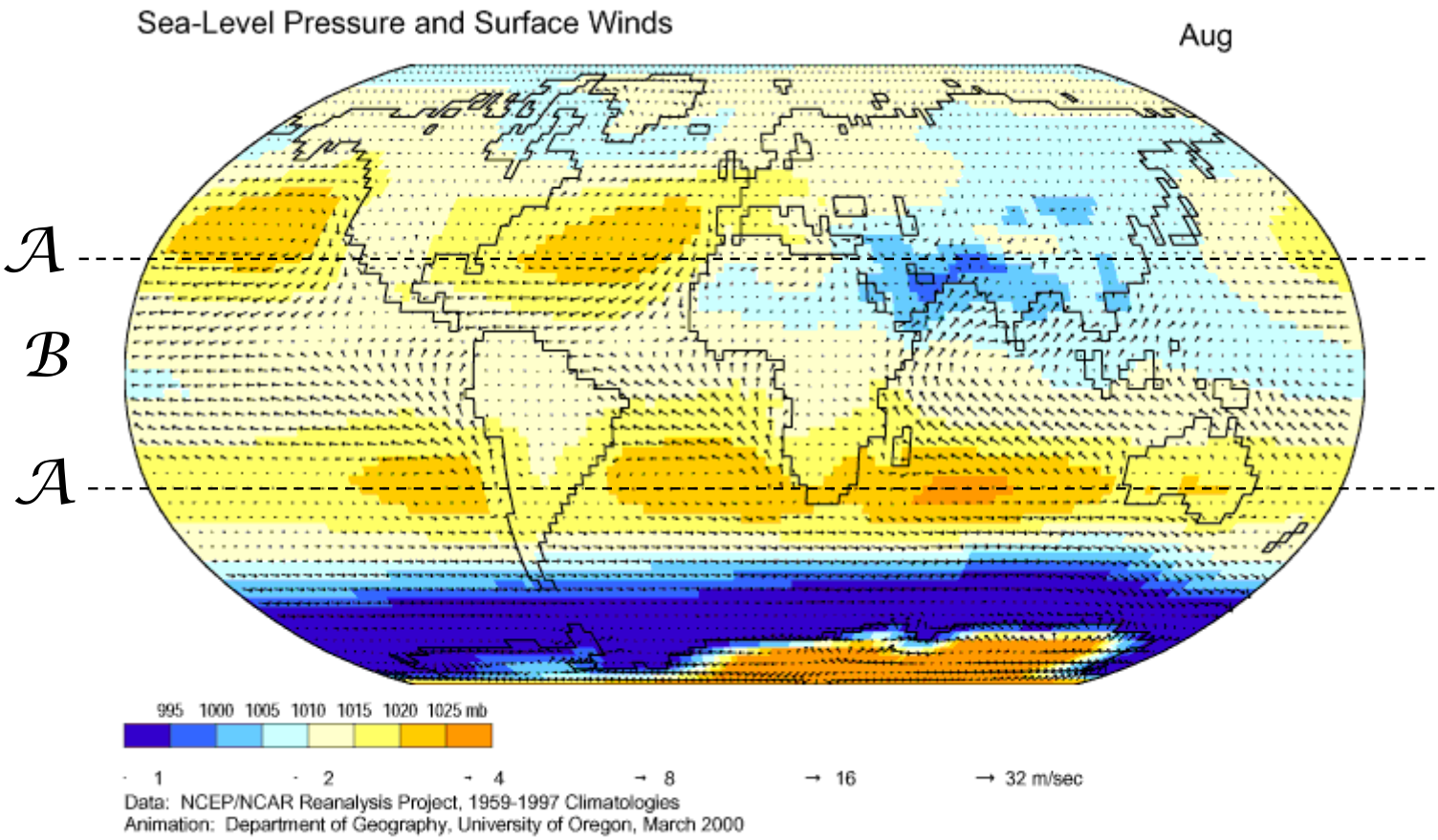


FIGURE 2 | Cross-section of long-term-mean (1981–2020) zonal wind (U) at 70°W for **(A)** austral winter (JJA) and **(B)** summer (DJF). Gray area indicates mean Andes height averaged at 80–60°W. Contours indicate U = 0, 15, and 30 m/s. Data from NCEP-NCAR Reanalysis.

Subsidencia de la celda de Hadley mantiene una banda de altas presiones en los subtropicos …




Geographical setting
Guinas highlands
10°N
Tropic Of Cancer
Llanos
0°N
Equatorial Andes
Amazon basin
SOUTH AMERICA
10S
Brazilian highlands
20°S
Altiplano
Chaco
30S
Subtropical Andes
Tropic Of Capricorn
La Plata basin
Pampas
40°S
Patagonia
50S
60°S

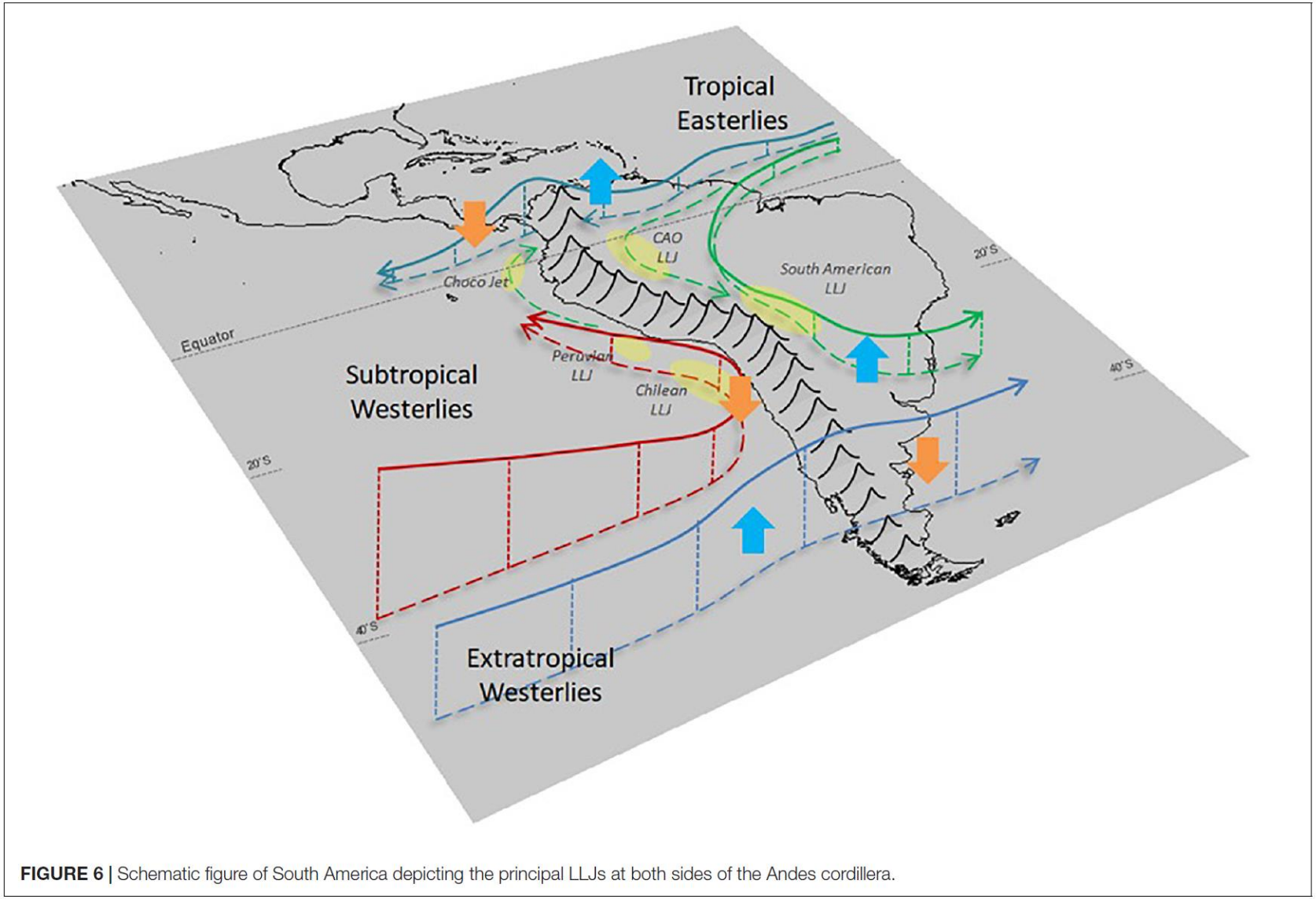
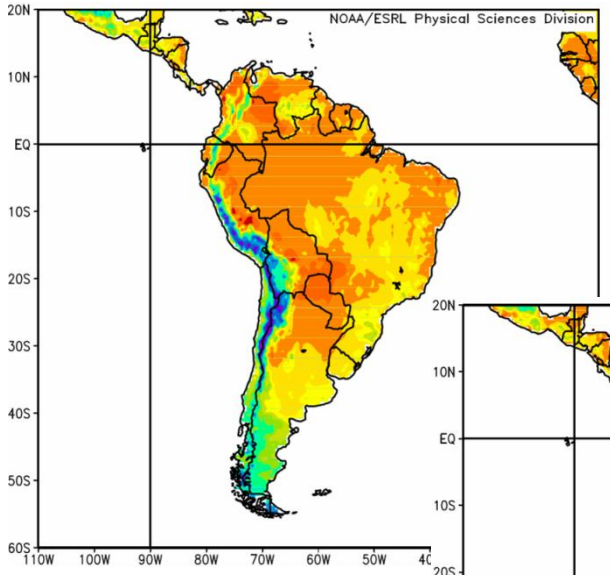
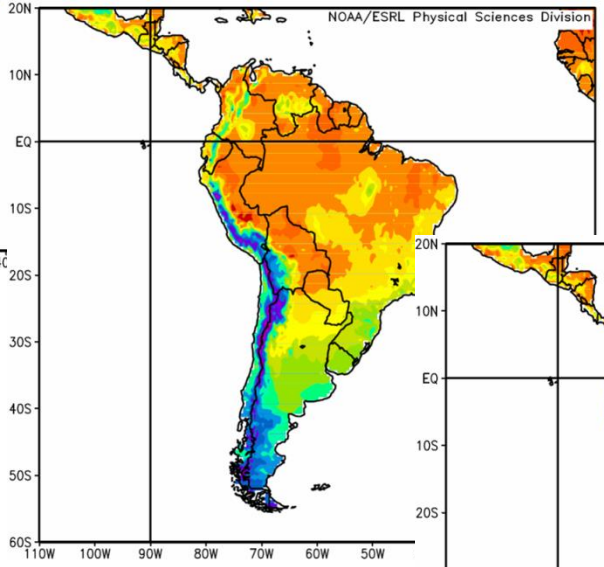


FIGURE 6 | Schematic figure of South America depicting the principal LLJs at both sides of the Andes cordillera.

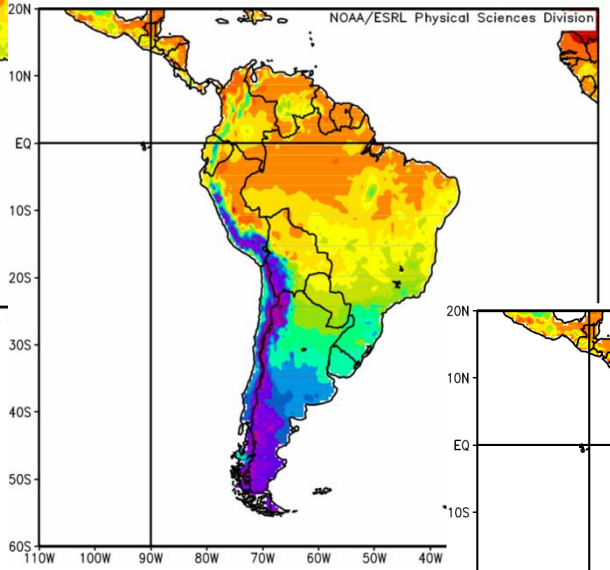
Seasonal long-term mean 2-m air temperature [°C] U. Delaware



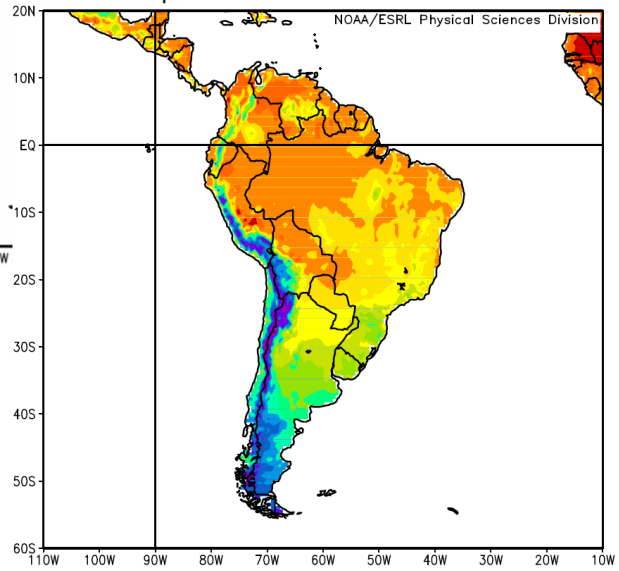
DJF



MAM

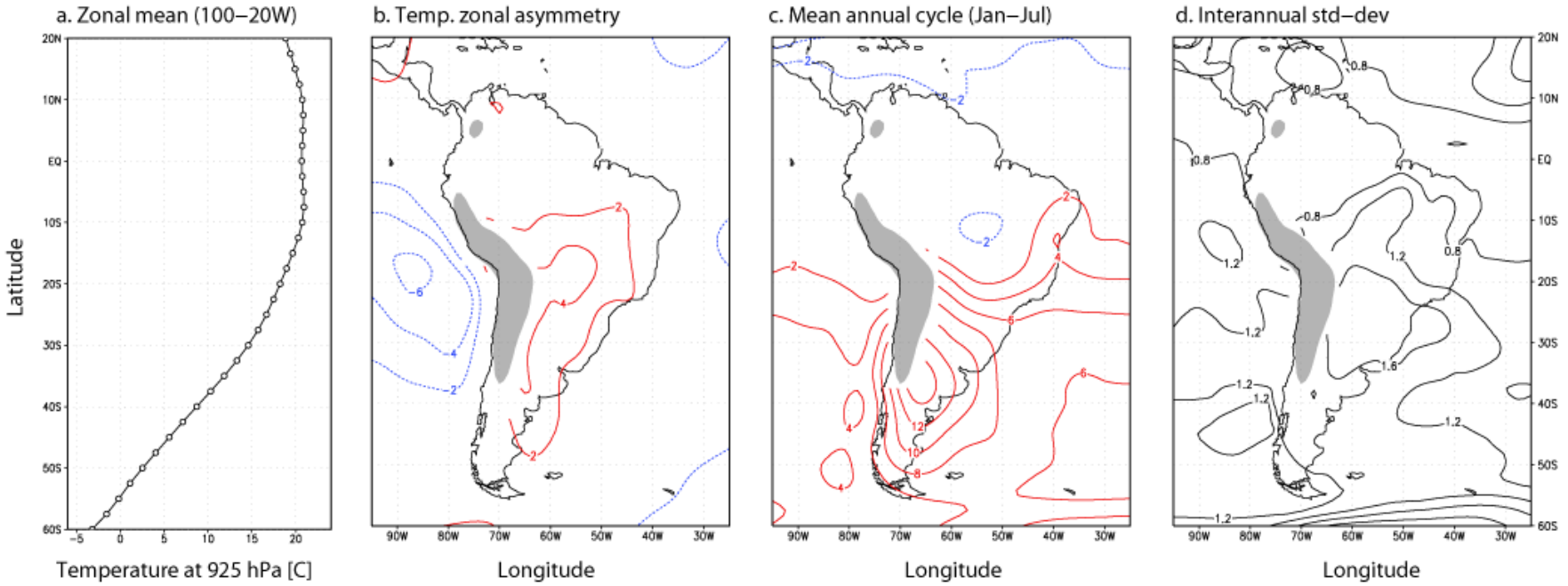


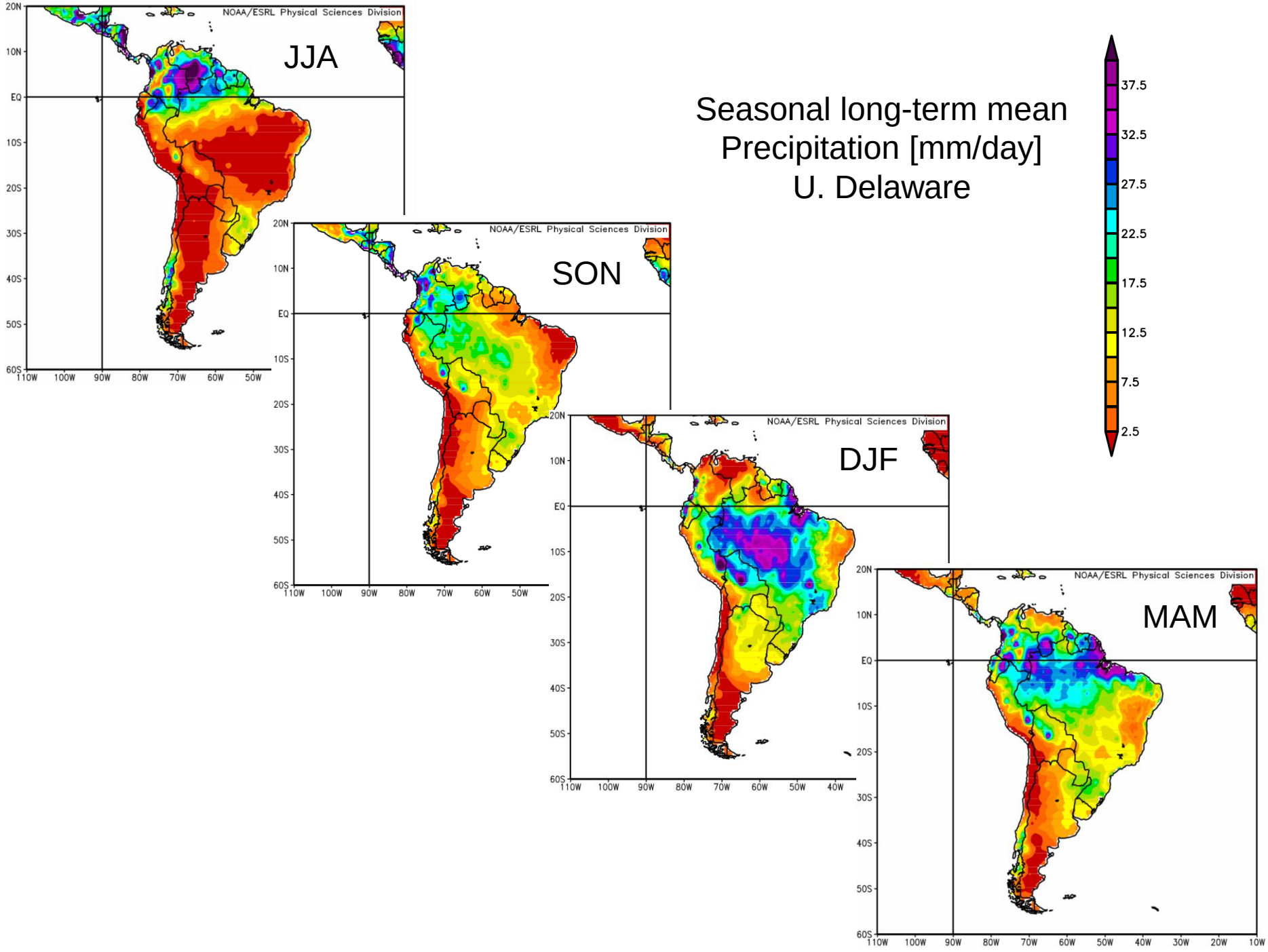
JJA



SON

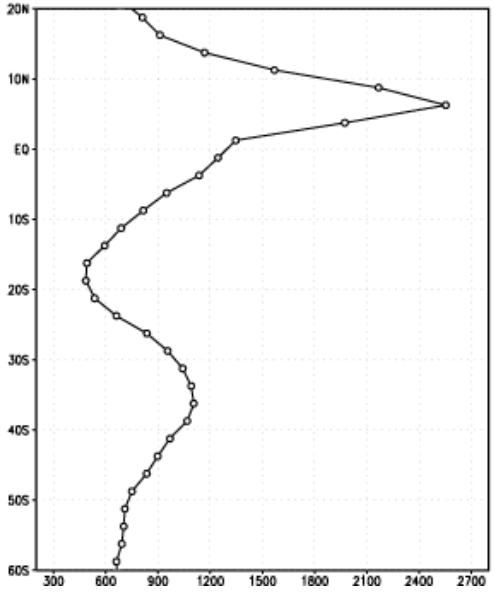
The low-level air temperature field



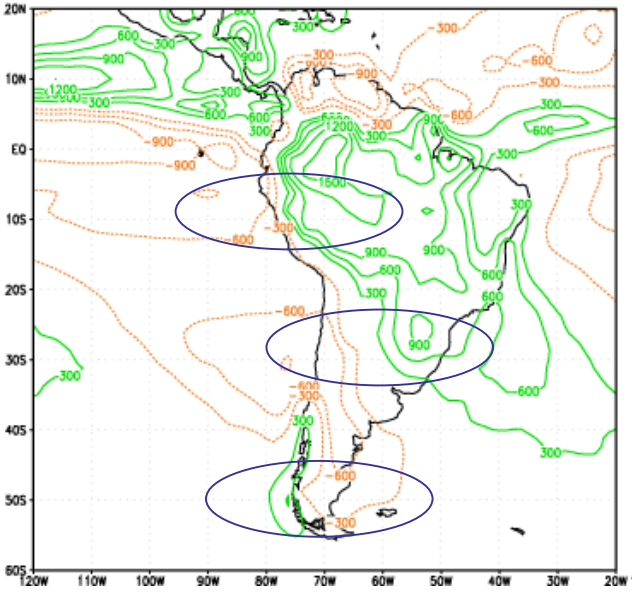

Seasonal long-term mean
Precipitation [mm/day]
U. Delaware
JJA
SON
DJF
MAM
NOAA/ESRL Physical Sciences Division
37.5
32.5
27.5
22.5
17.5
12.5
7.5
2.5

Another Perspective of the Precipitation Field

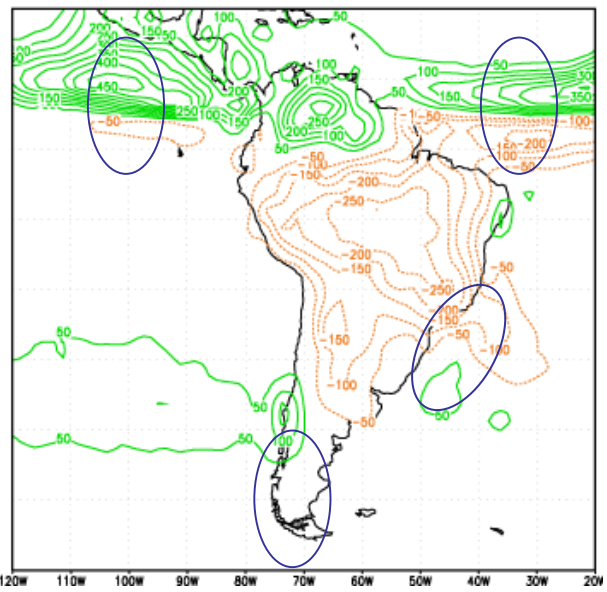
Annual Mean / Zonal Mean

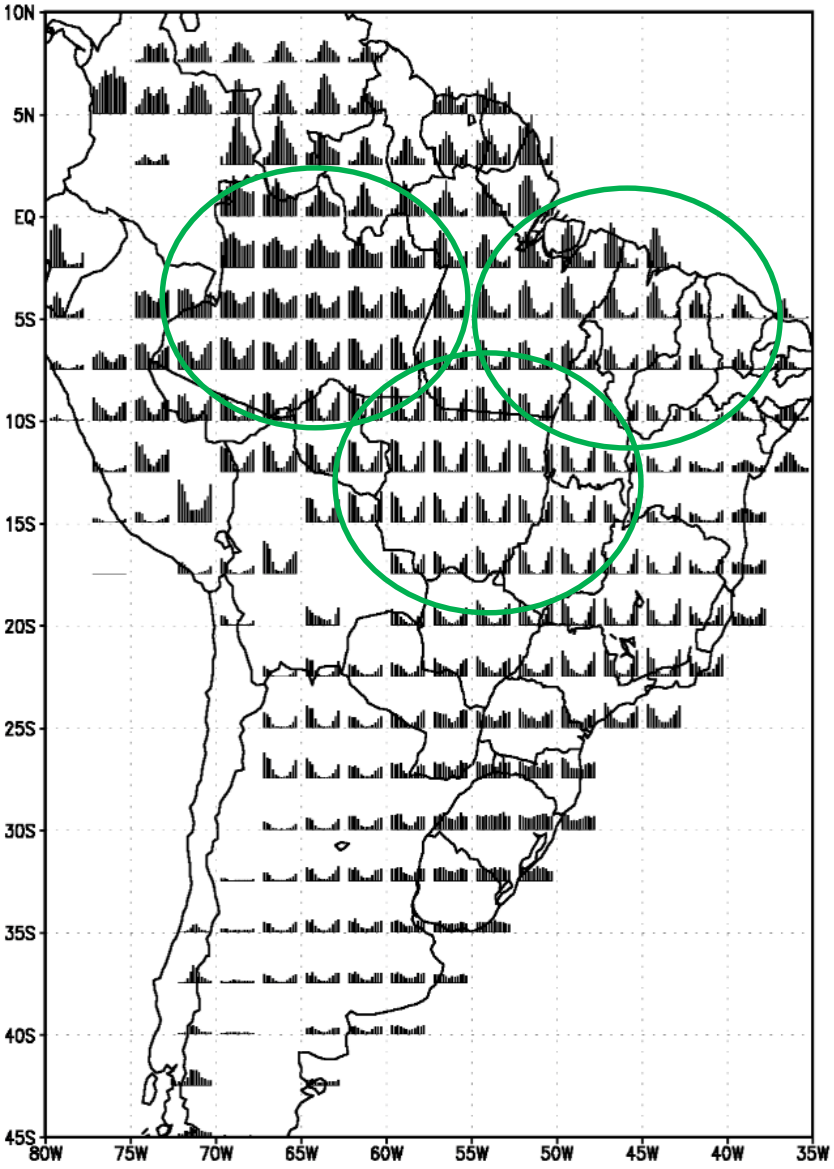


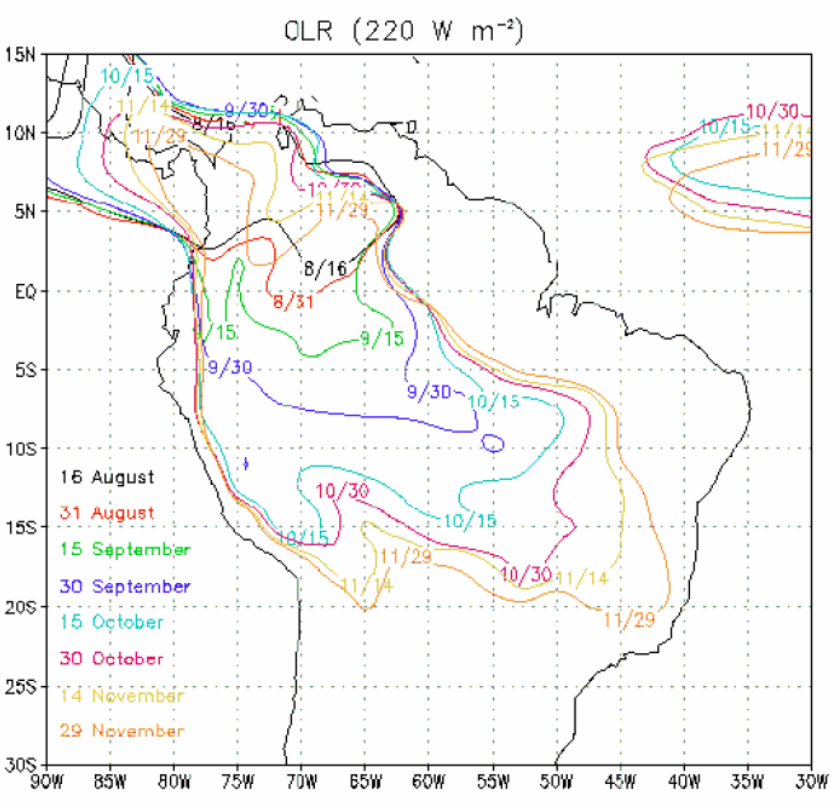
Annual Mean / Zonal asymmetry



January - July Mean







Grimm et al. 199Z
Kousky et al 19XX

Convective rainfall also exhibits a pronounced diurnal cycle

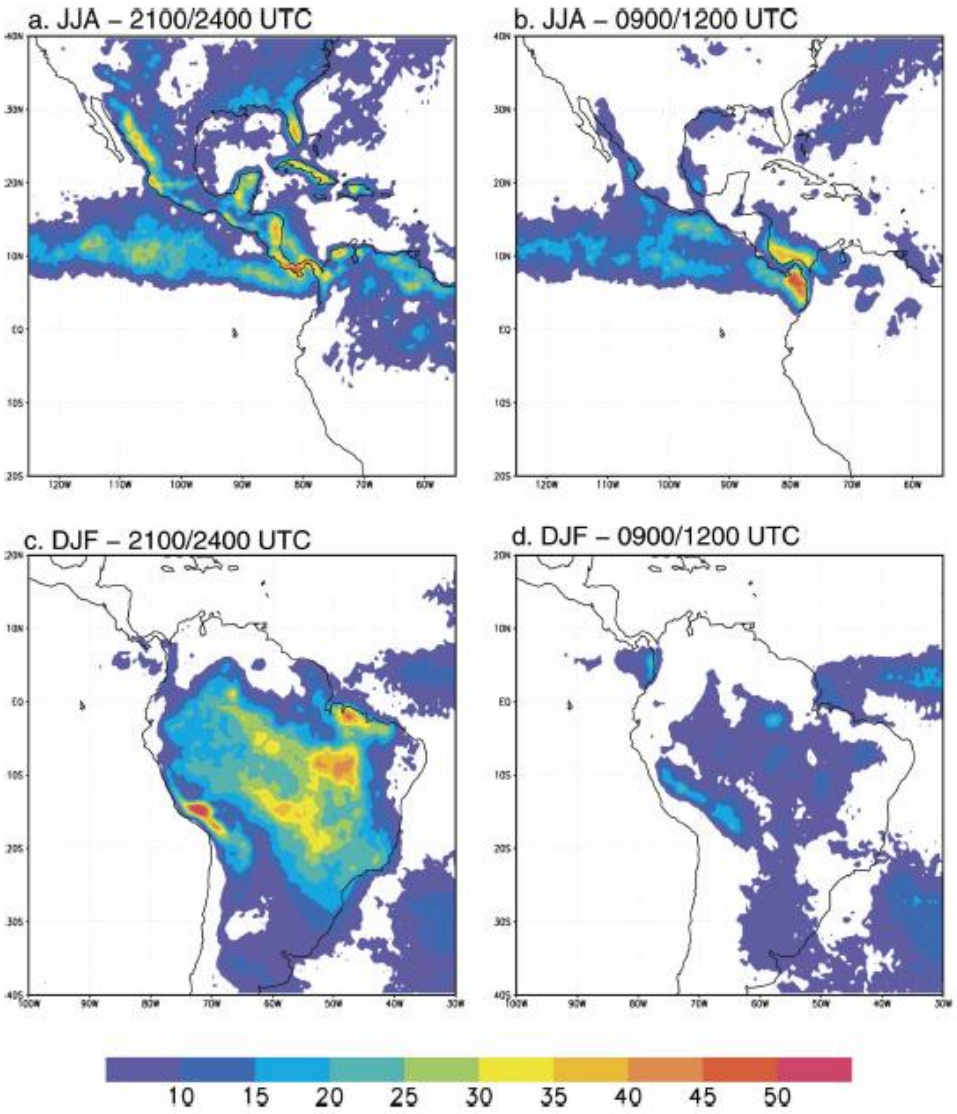
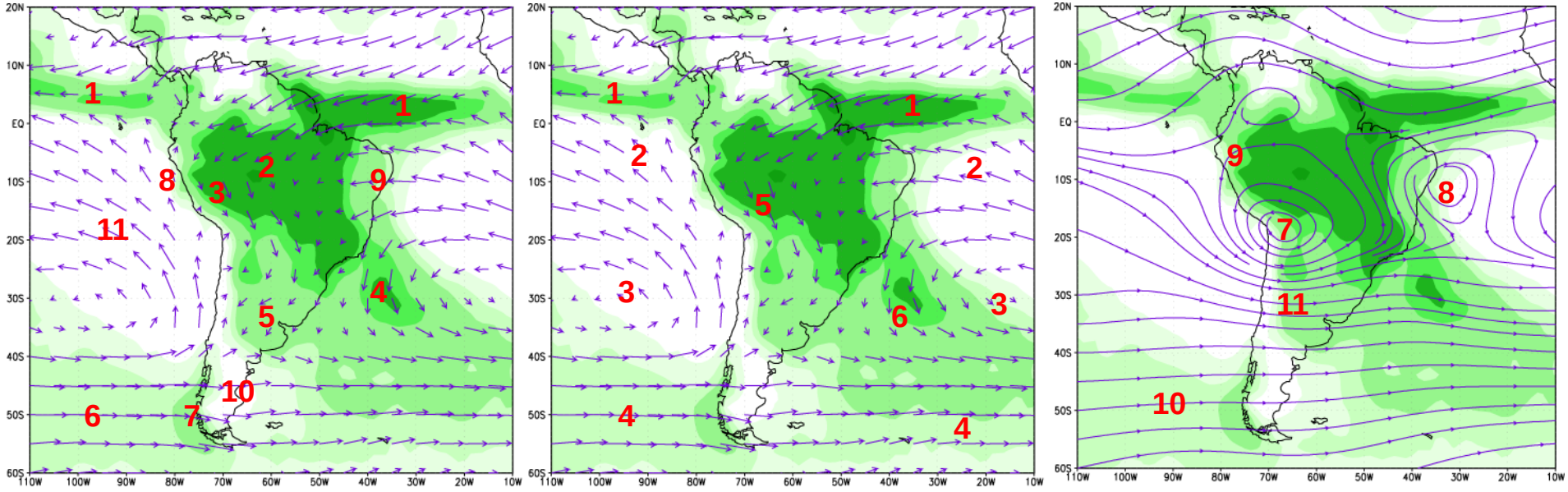


FIG. 5. Evening (2100–2400 UTC) temporal frequency of cold clouds (infrared brightness temperature Tb < 235 K) during the (a) boreal summer (JJA) and (c) austral summer (DJF). Pixel resolution is 0.5° × 0.5°. The period of analysis extends from 1983 to 1991. (b), (d) Same as in (a) and (c), respectively, but for late night and early morning (0900–1200 UTC).



Precipitation features

1. ITCZ
2. Continental convection
3. Altiplano convection
4. SACZ
5. Pampas convection
6. Midlatitude storm track
7. Orographic precipitation
8. Coastal desert
9. NE Brazil semiarid
10. Patagonia dry zone
11. Ocean desert

Circulation features

1. ITCZ
2. Trade winds
3. Subtropical high
4. Midlatitude westerlies
5. Low level jet
6. SACZ
7. Bolivian high
8. NE Brazil trough
9. Tropical easterlies
10. Midlatitude westerlies
11. Jet stream

GEOPHYSICAL RESEARCH LETTERS, VOL. 28, NO. 12, PAGES 2433-2436, JUNE 15, 2001

Mechanisms limiting the southward extent of the South American summer monsoon

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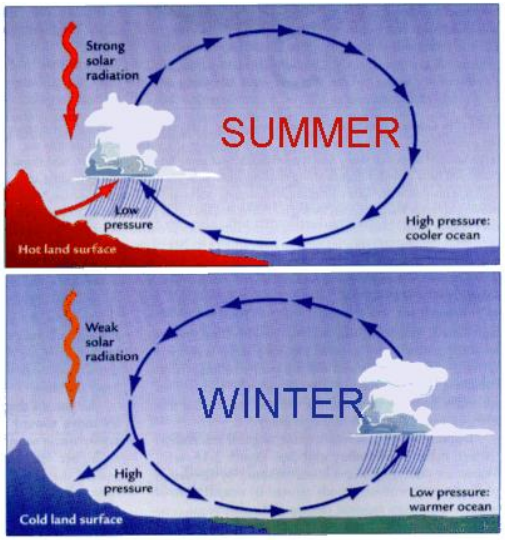
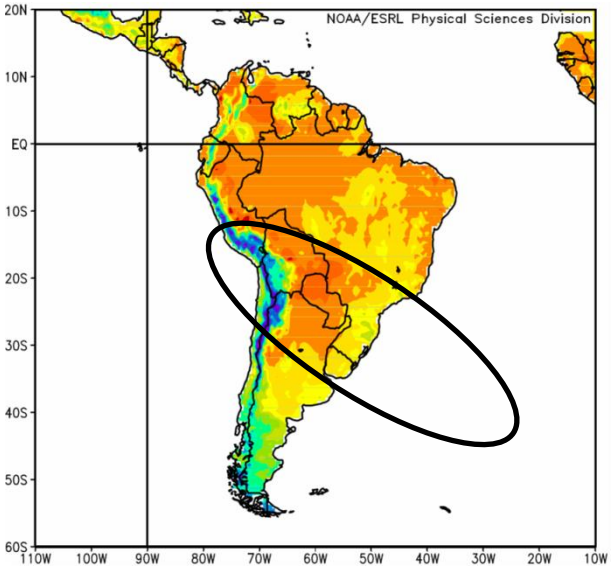
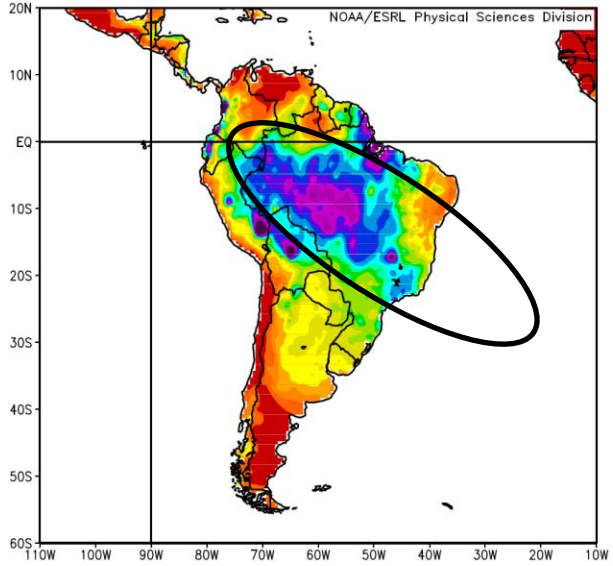






Southeast South America Precipitation (warm season)

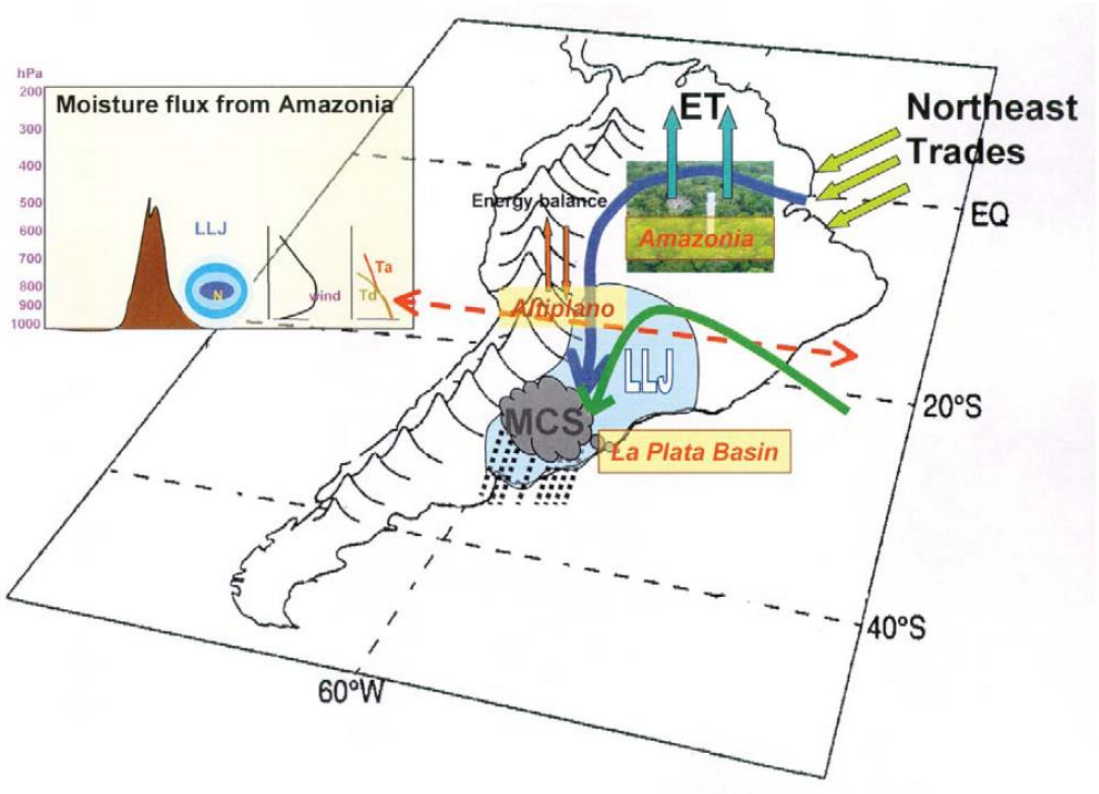
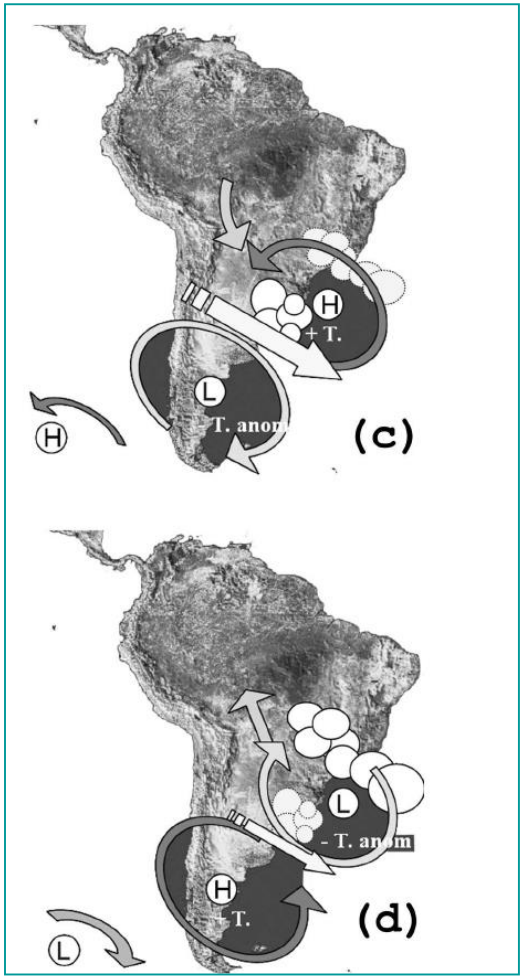


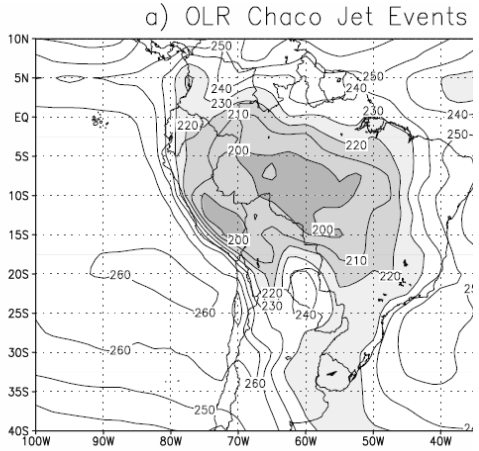
FIG. 1. Schematic diagram of elements relevant to poleward moisture transport over South America. Blue and green arrows depict the moisture transport into the continent from the tropical and South Atlantic Ocean, respectively. The inset represents a vertical cross section of the northerly flow along the red dashed line displayed in the diagram, including wind and temperature profiles representative of the LLJ core.

Vera et al. 2006 (BAMS)



Diaz & Aceituno 2003

Chaco Jet Events



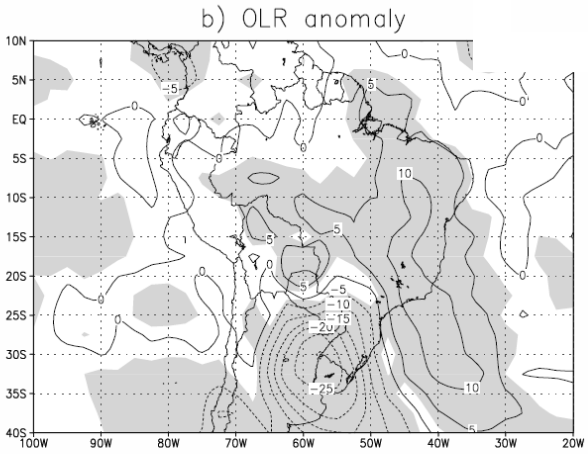
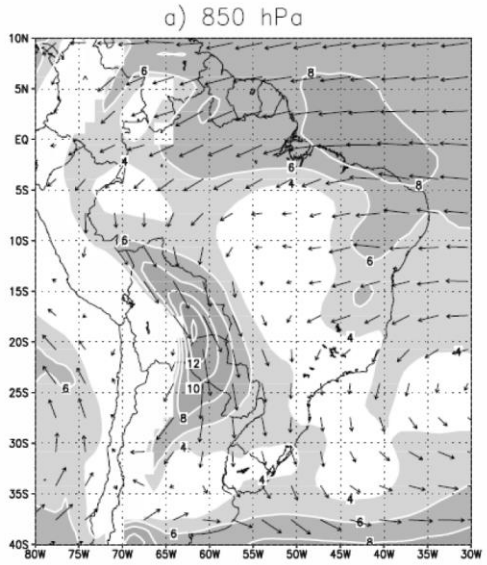
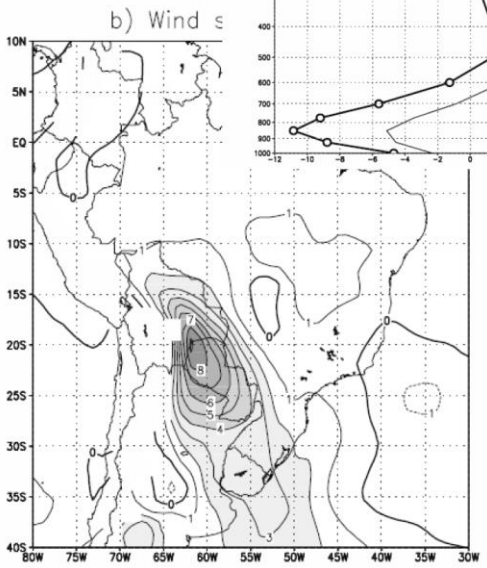


Figure 7. (a) Outgoing longwave radiation composite for CJEs contoured every 10 W m^{-2}. Values lower than 230 W m^{-2} are shaded. (b) Outgoing longwave radiation composite anomalies for Chaco Jet events. Light shading indicates the 95% significance level.





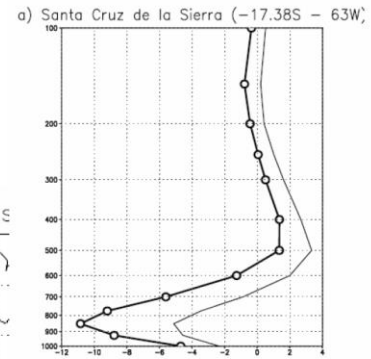
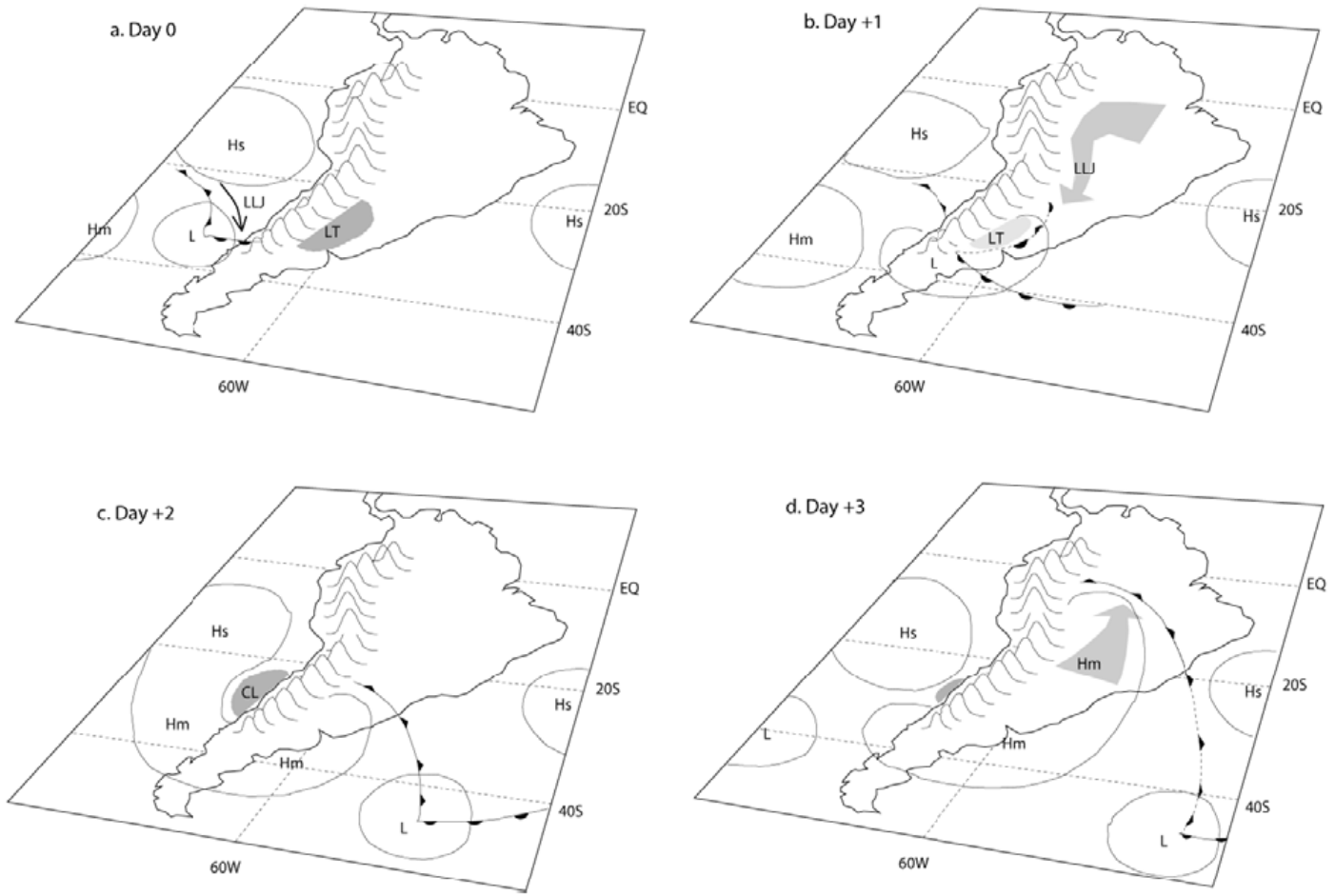
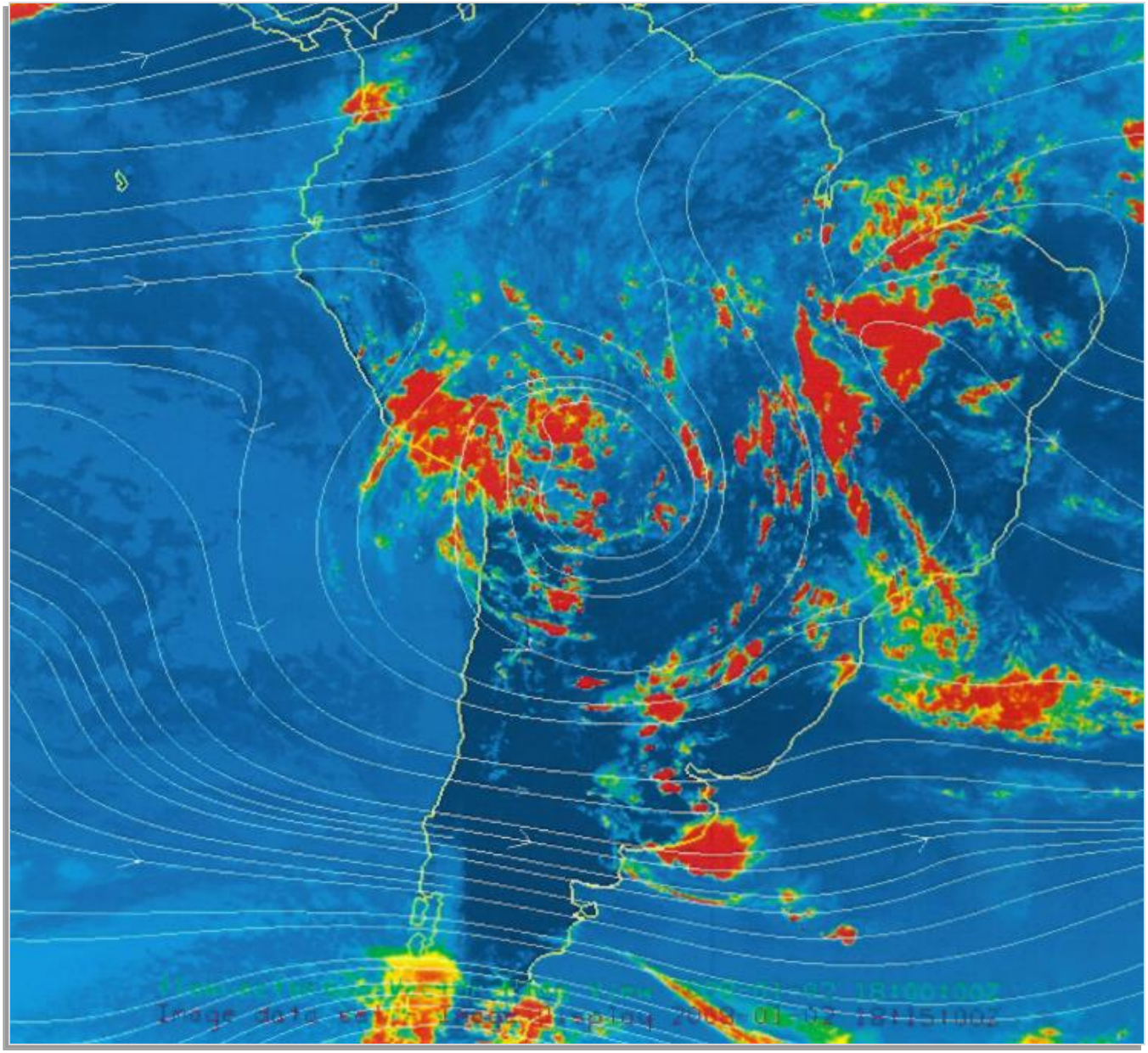


Figure 8. (a) Wind (vector) and wind speed (contoured every 1 m s^{-1}, values greater than 4 m s^{-1} are shaded) composite at 850 hPa for CJEs. (b) Wind speed composite anomalies at 850 hPa for CJEs are contoured every 1 m s^{-1}; values greater than 4 m s^{-1} are shaded.

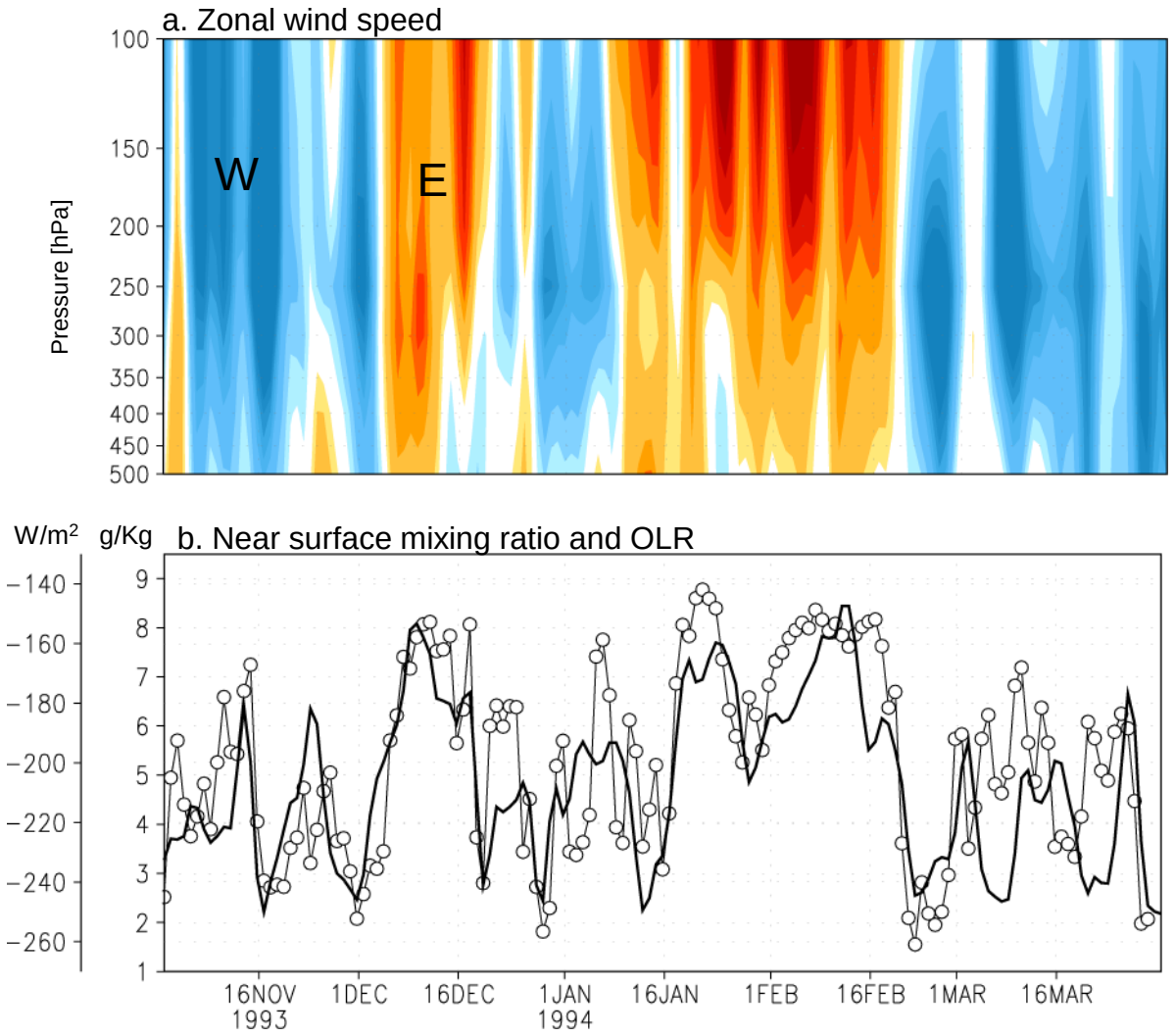
Salio et al. 2002

Northerly low level jet interrupted by cold air incursions that reach as far as the Amazon basin



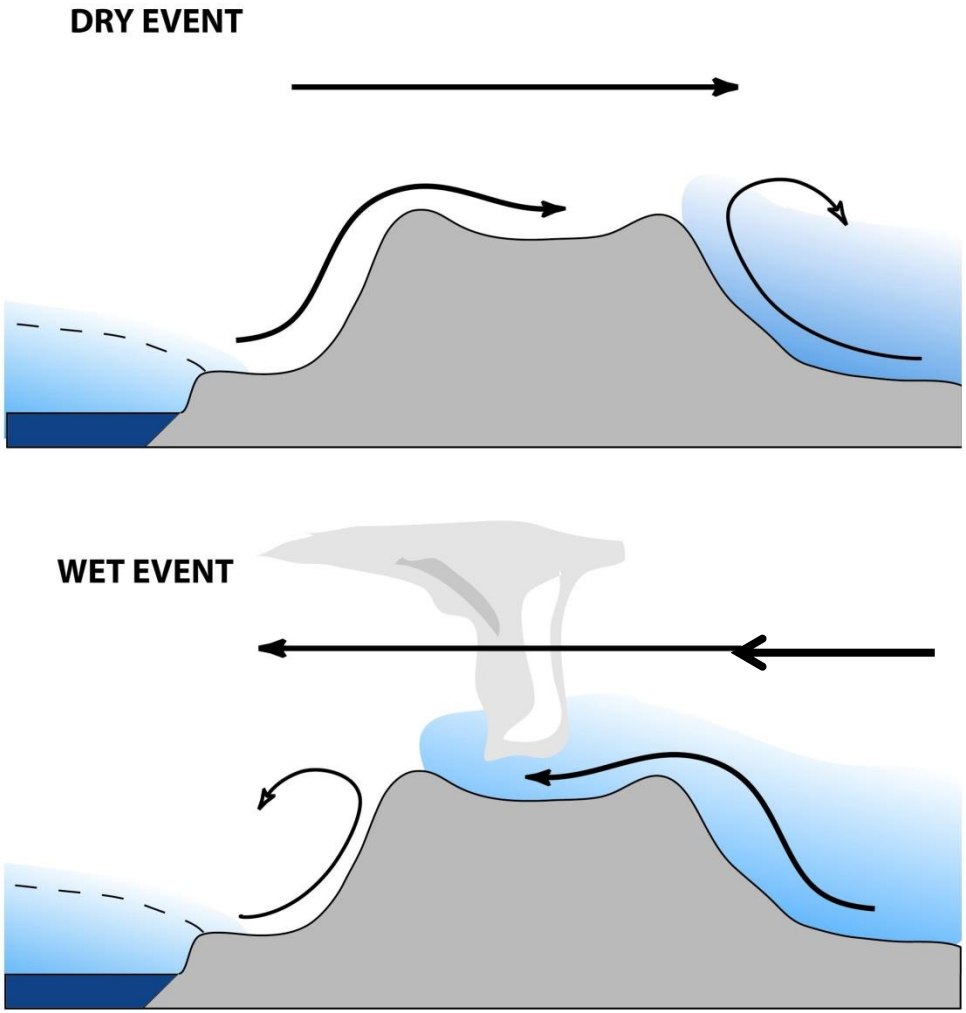


Altiplano Precipitation: intraseasonal variability



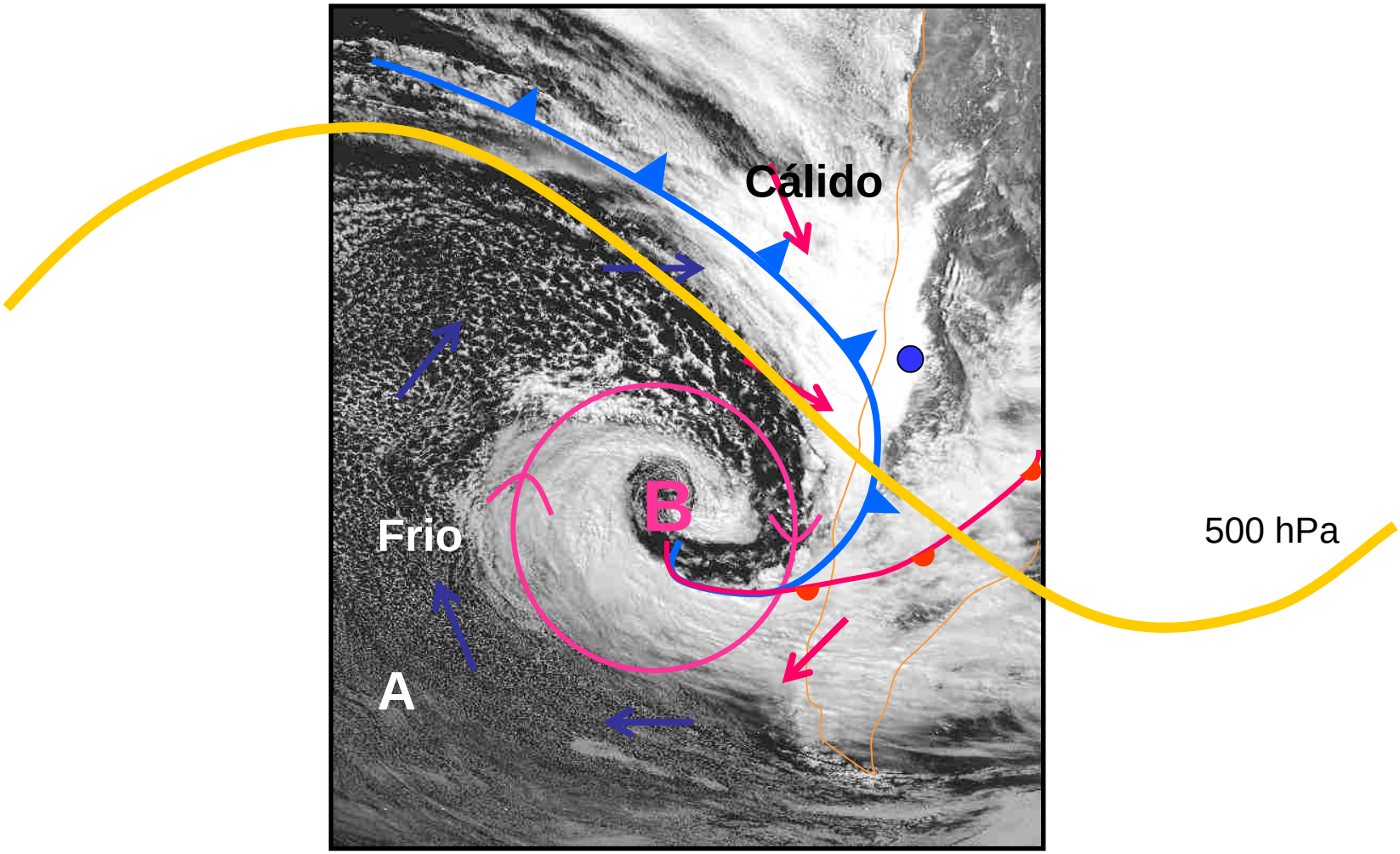
Altiplano Precipitation: conceptual model (summer)

Anomalies of wind aloft forced by extratropical disturbances
Wind aloft controls the transport of moisture towards the Altiplano



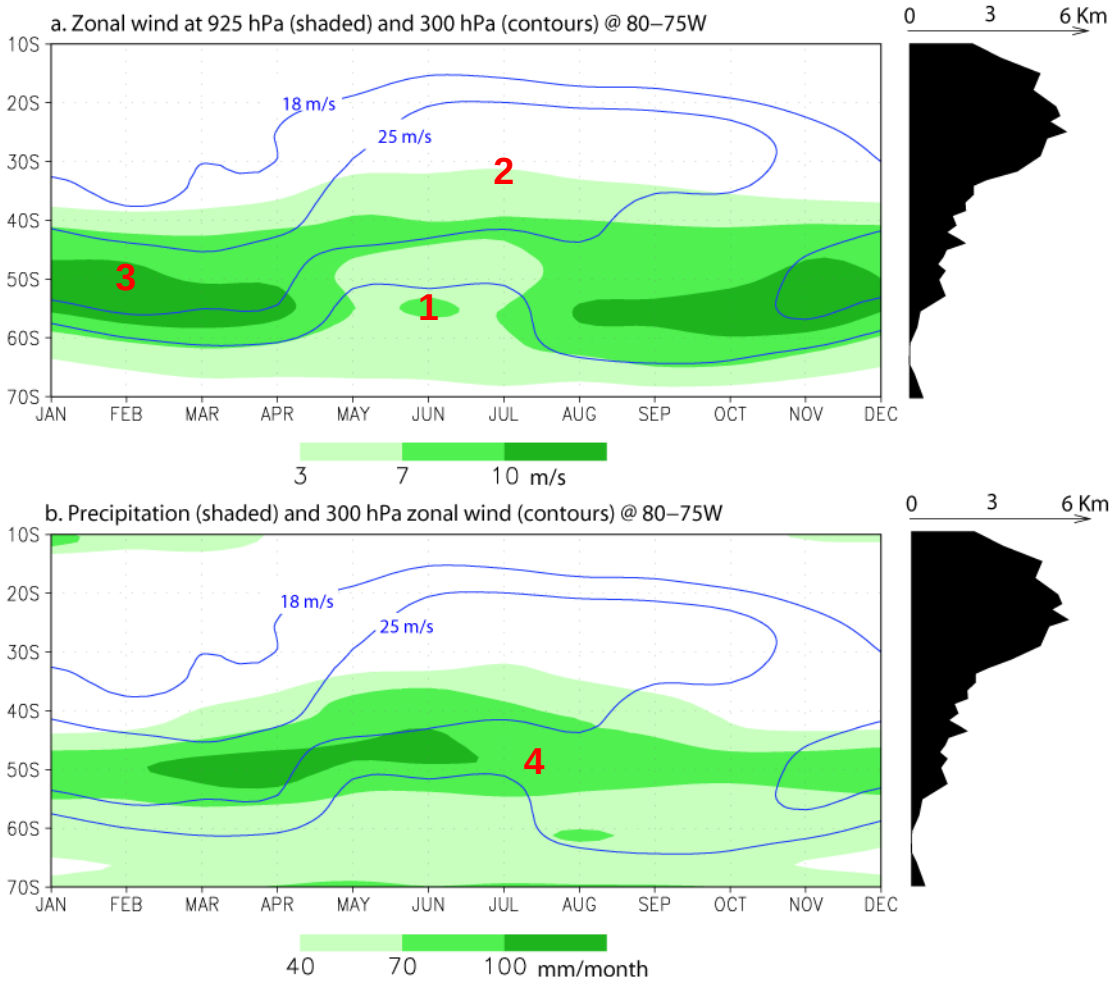
Precipitación en latitudes medias

Las perturbaciones de latitudes medias (ver clase anterior) también transportan calor hacia latitudes altas, continuando el proceso de transferencia de calor que realiza la atmósfera.



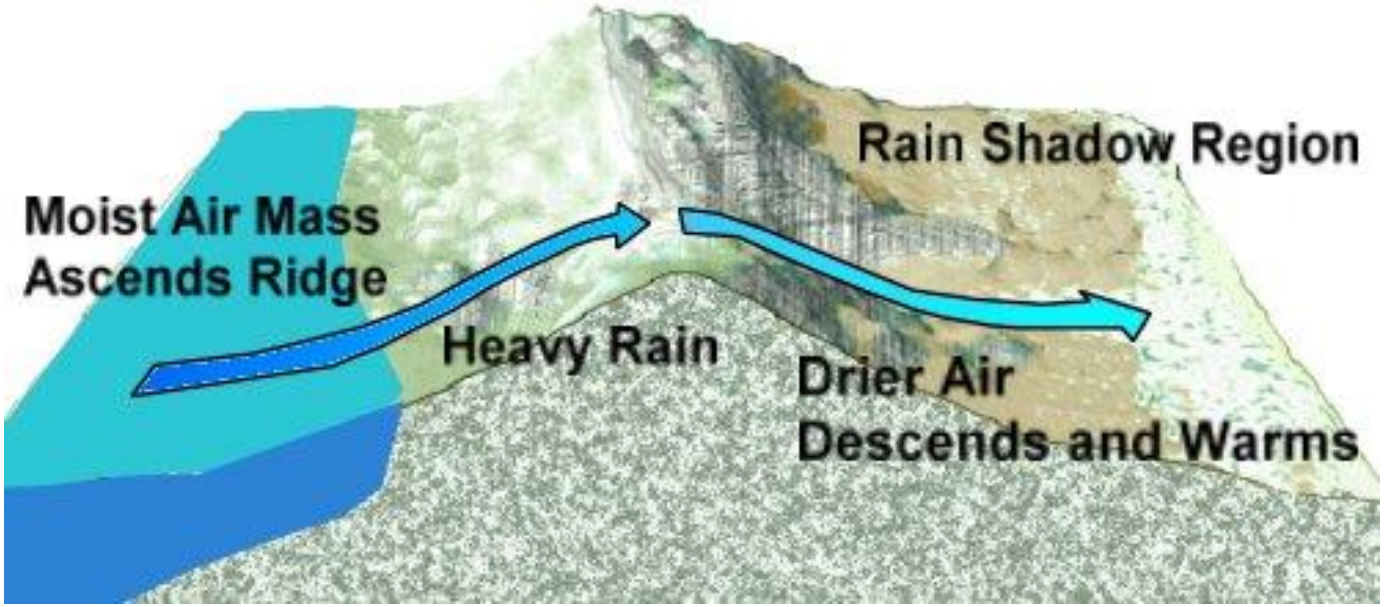
Precipitacion en Latitudes medias

Modest annual cycle in the extratropics



Precipitación Orografíca (latitudes medias)

El mecanismo más simple es la saturación de vapor de agua, y posterior formación de partículas de precipitación, en flujos estables ladera arriba al barlovento de la topografía.



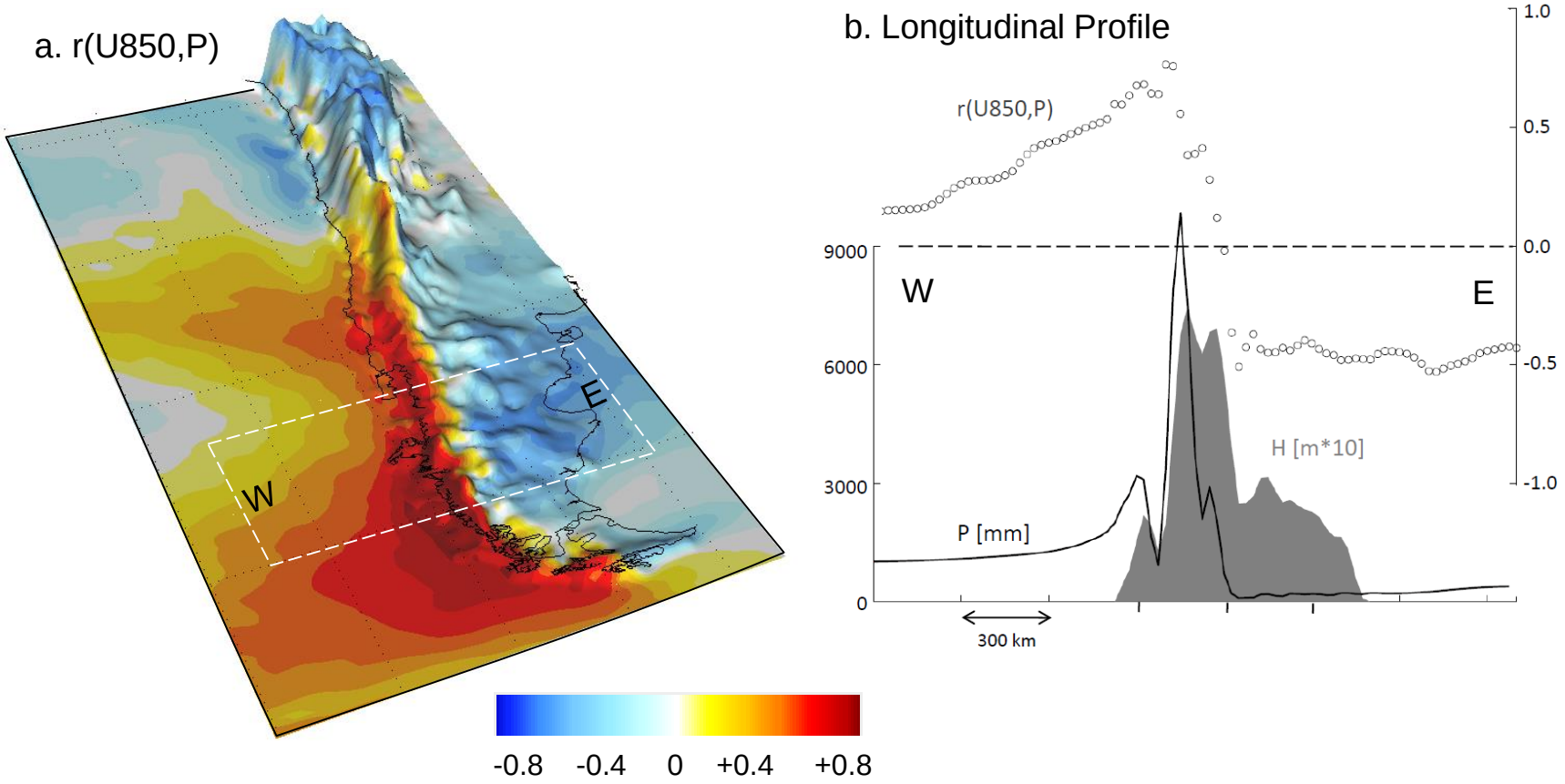


Figure 5. (a) Local (point-to-point) correlation between *annual mean* 850 hPa zonal wind and precipitation ($r(U_{850},P)$) using PRECIS-DGF results from 1978-2001. For display purposes the correlation values are shown over the model topography. (b) Longitudinal profile of terrain elevation (shaded area, scale at left), long-term-mean annual precipitation (black line, scale at left in mm/year) and the $r(U_{850},P)$ correlation, averaged between 42°-52°S. The profiles were constructed every 0.5° of latitude and then composited taken the longitude of highest elevation as a horizontal reference.