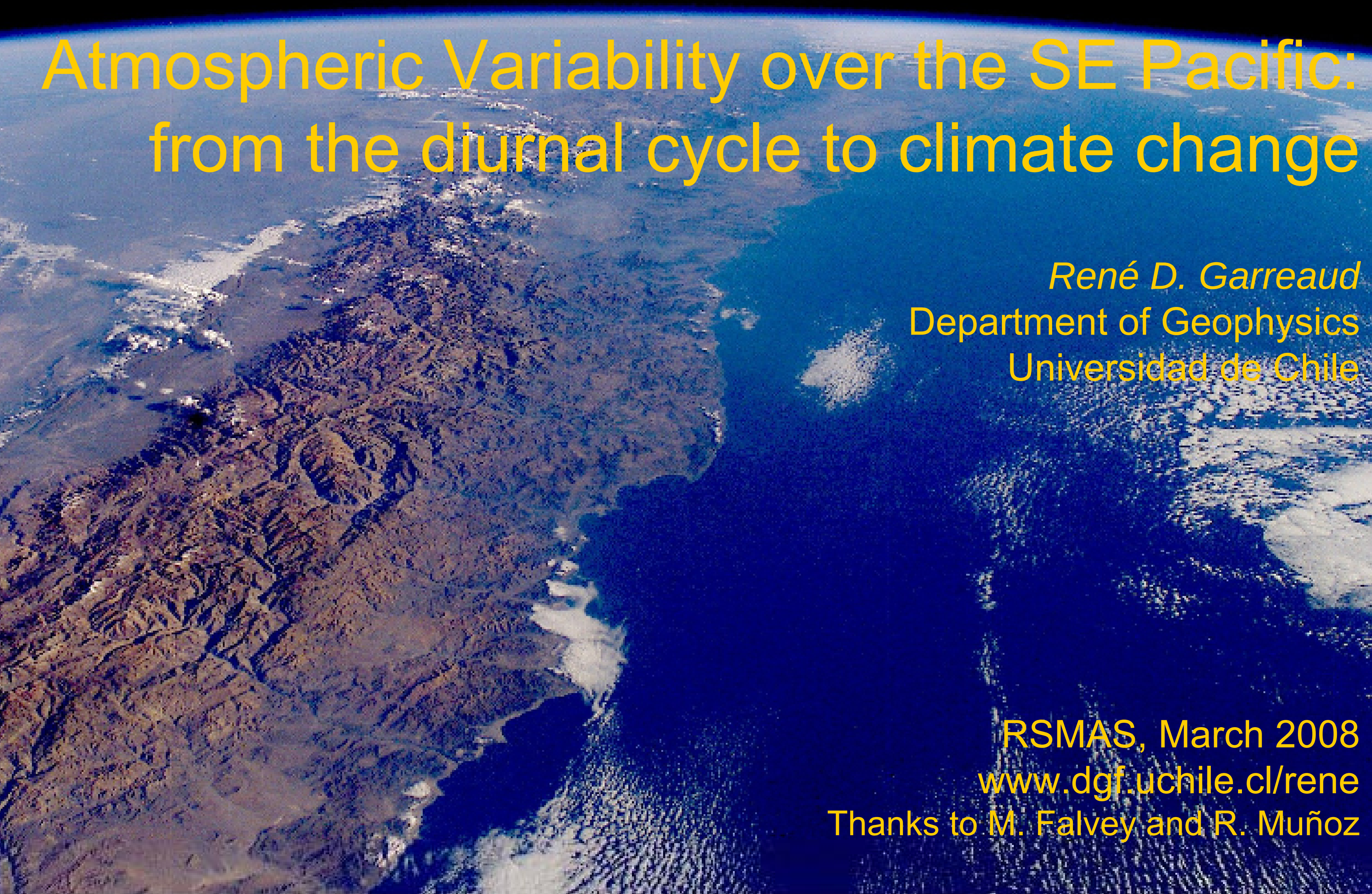

Atmospheric Variability over the SE Pacific: from the diurnal cycle to climate change

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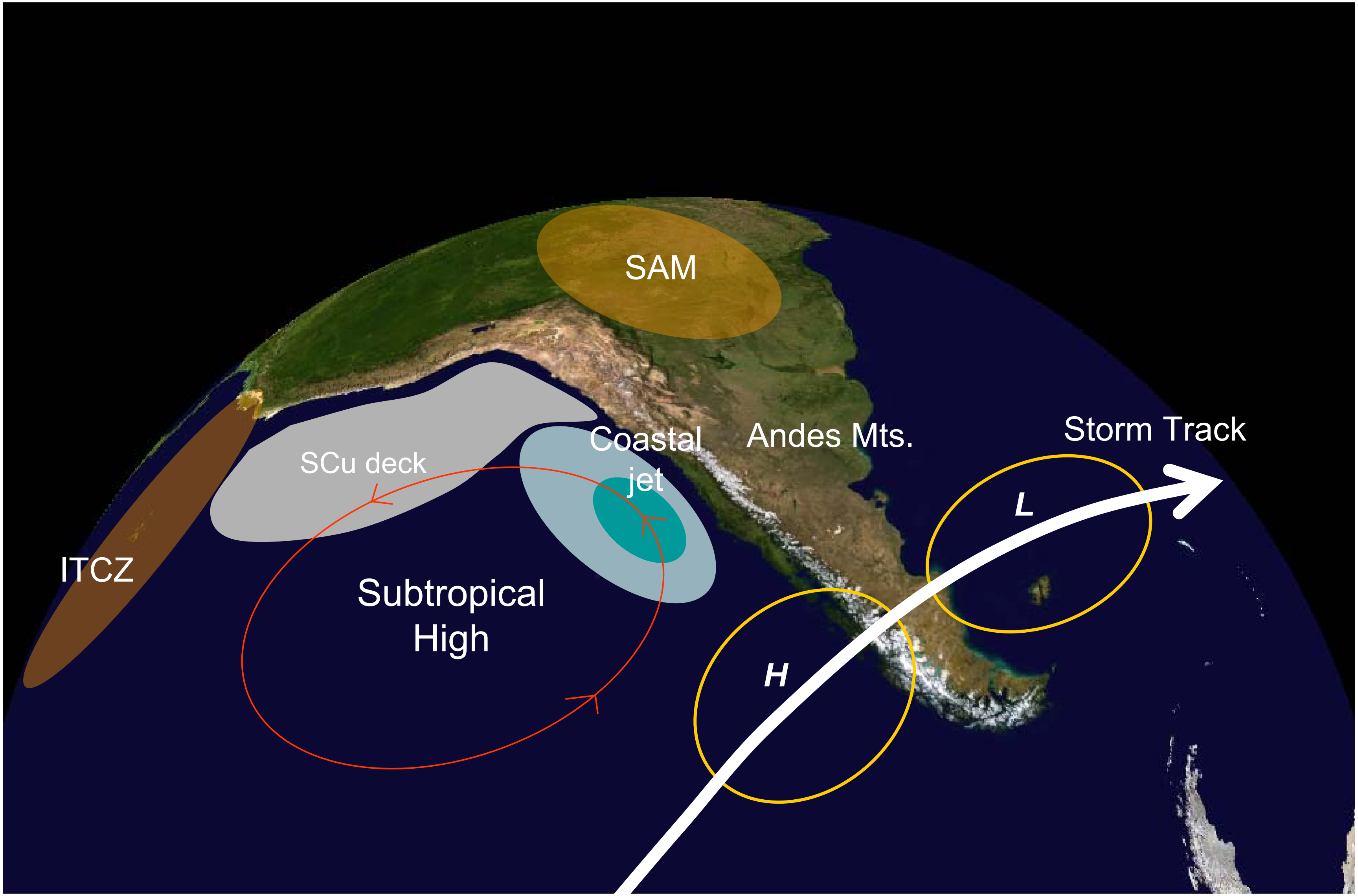
RSMAS, March 2008
www.dgf.uchile.cl/rene
Thanks to M. Falvey and R. Muñoz

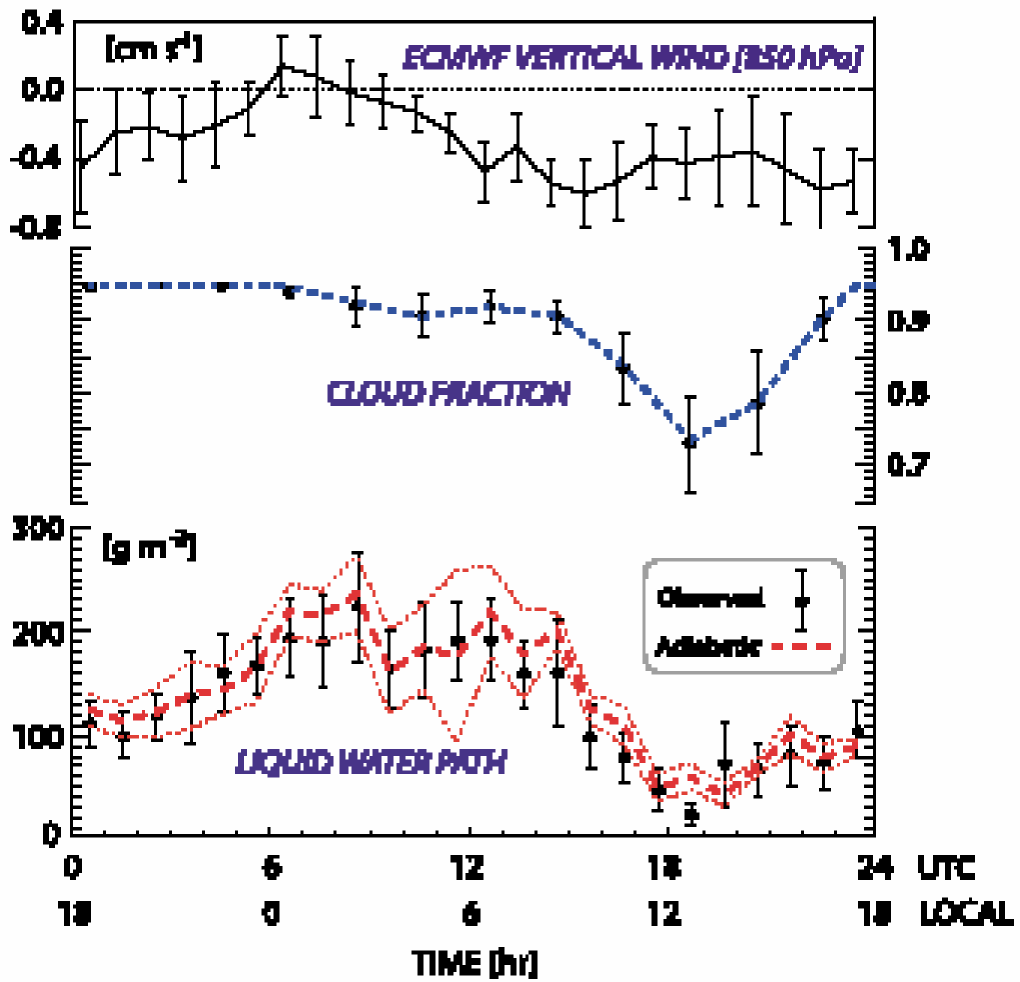
Outline

- The diurnal cycle of circulation and cloudiness
- The surface wind field (synoptic scale coastal jet)
- Recent trends of temperature and ACC predictions

Key Atmospheric Features over the SEP



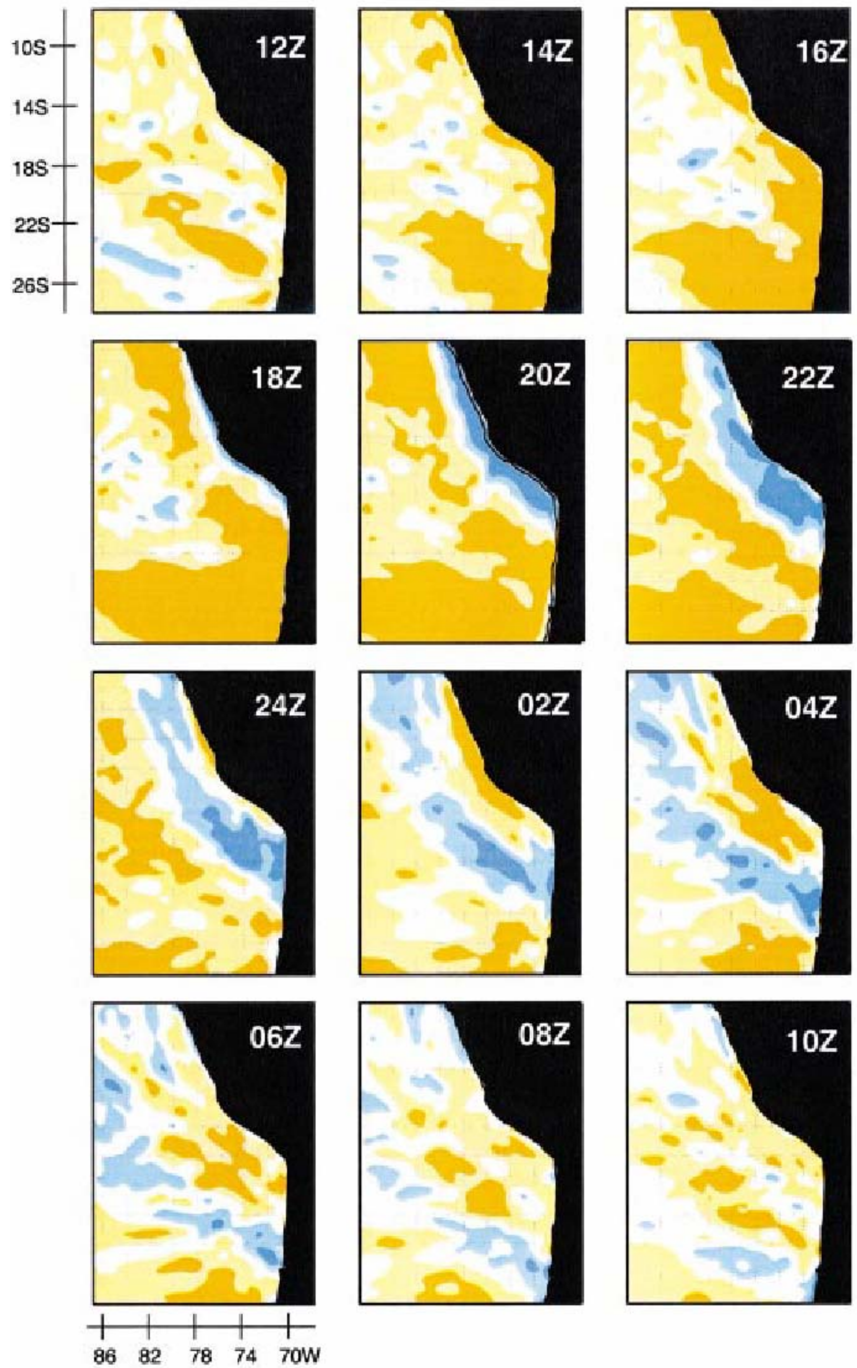
A distinctive feature of this Sc deck is its particularly pronounced diurnal cycle in cloud amount (Minnis and Harrison 1984; Rozendaal et al. 1995) and LWP (Bretherton et al. 2003; Wood et al. 2002), that is highly relevant to the quantification of the true impact of Sc on climate (Bergman and Salby 1997).

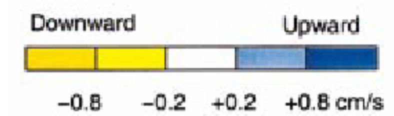


Bretherton et al. 1999

MM5 results
SON simulation

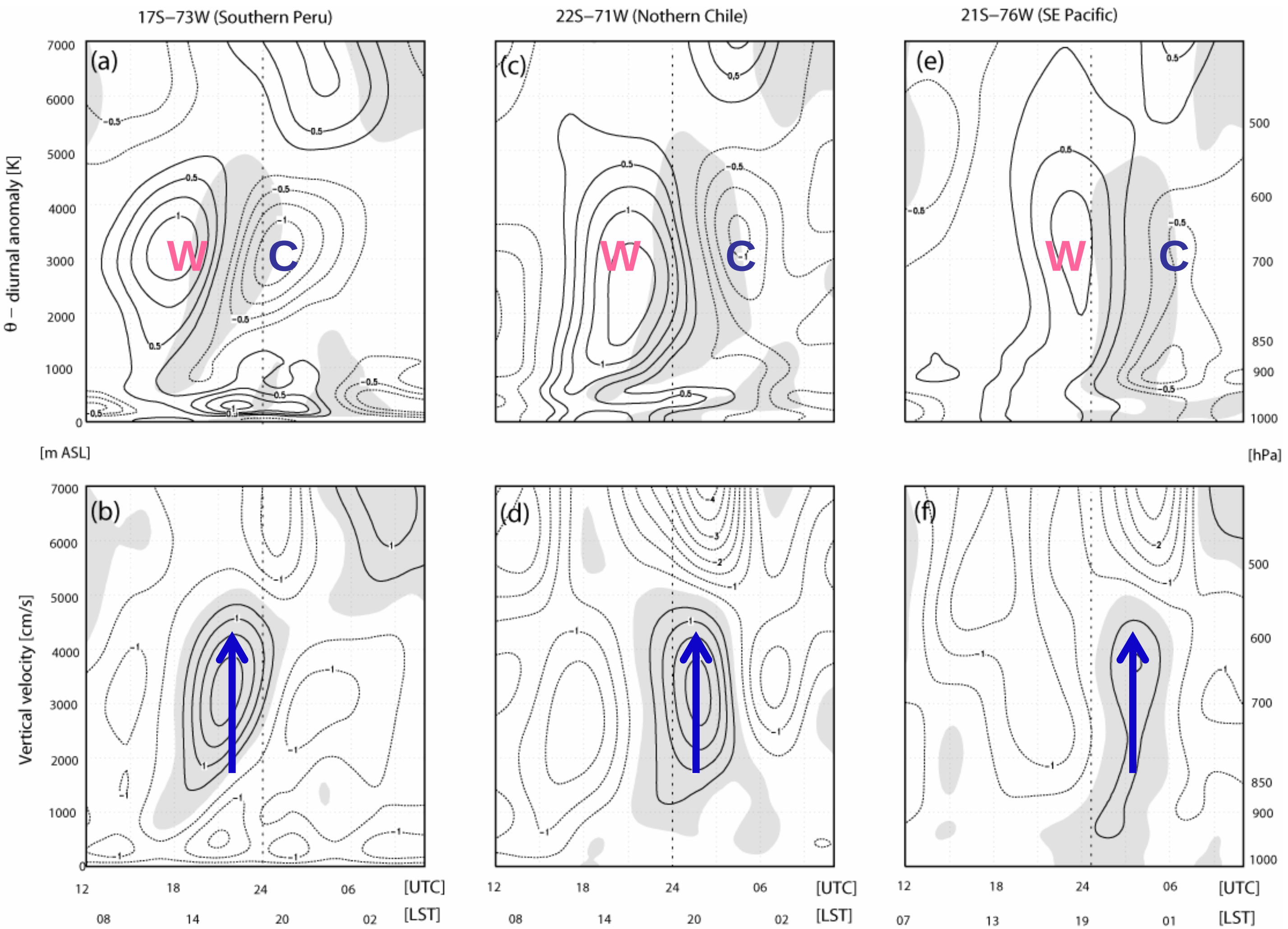
◄ **Mean diurnal cycle of vertical velocity at 800 hPa**





Garreaud and Muñoz 2004

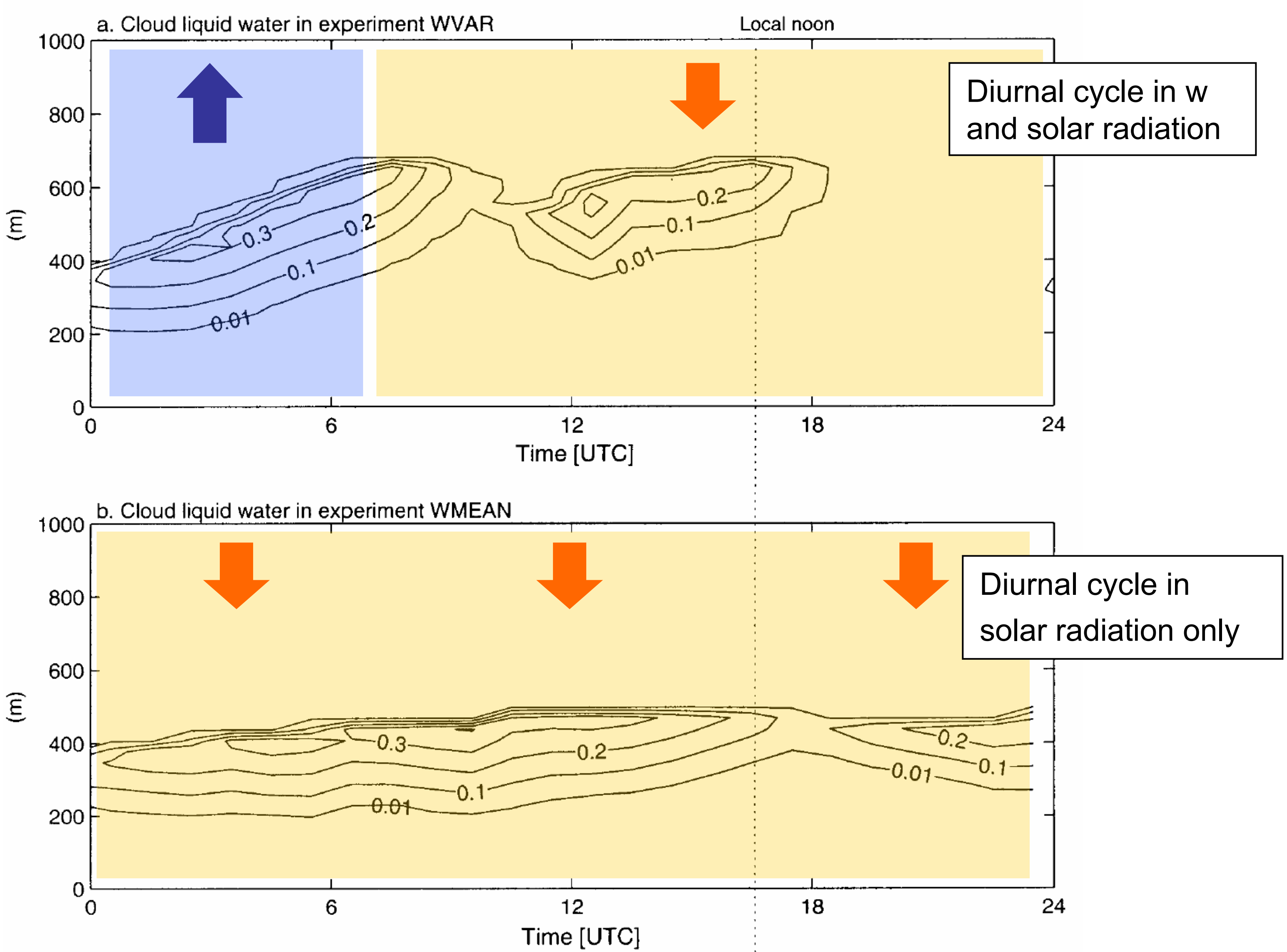
MM5 results. SON simulation.

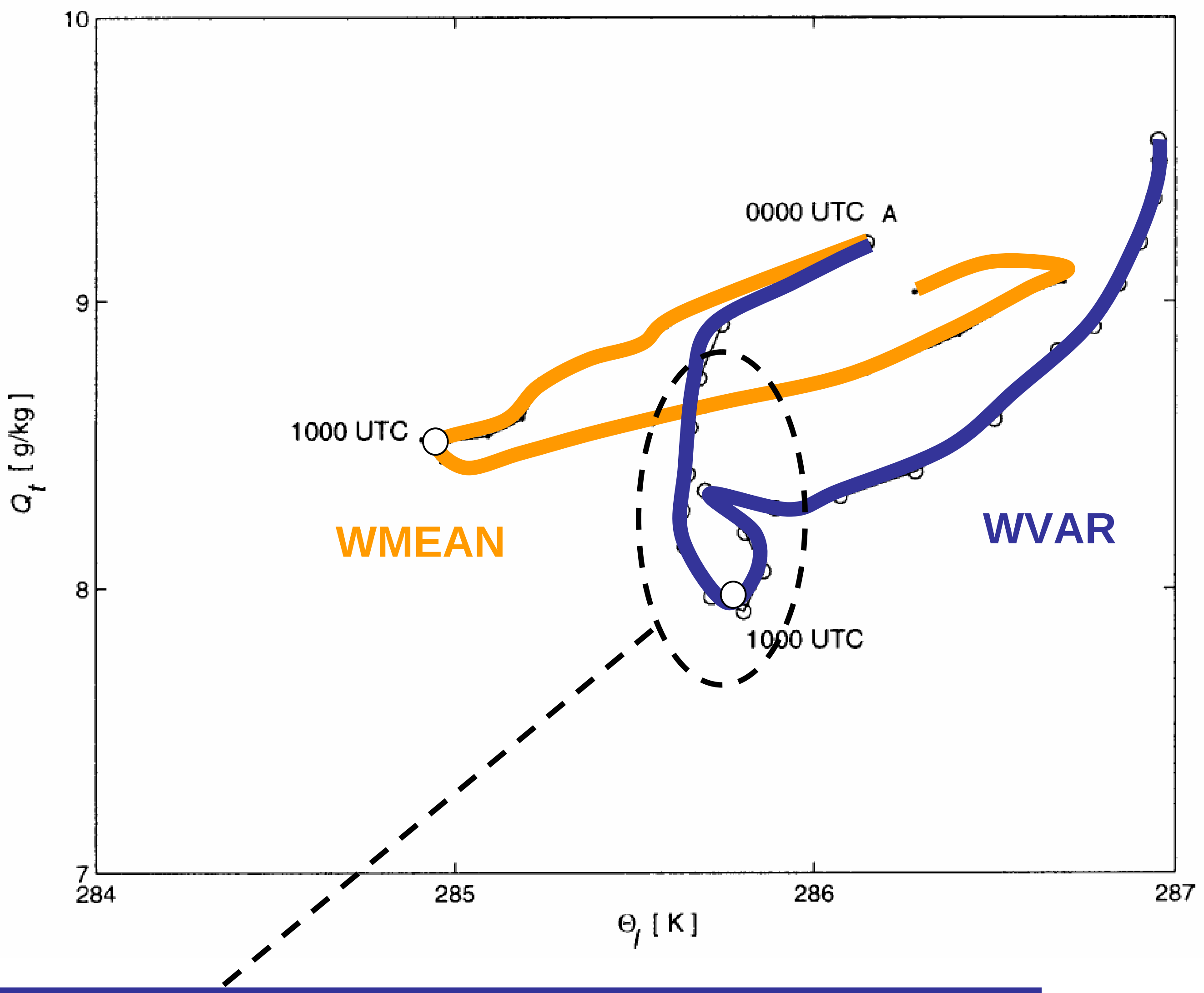


- Significant diurnal cycle in θ up to 5 km ASL
- Subsidence interrupted by period of upward motion
- Cooling largely produced by vertical advection

Garreaud and Muñoz 2004

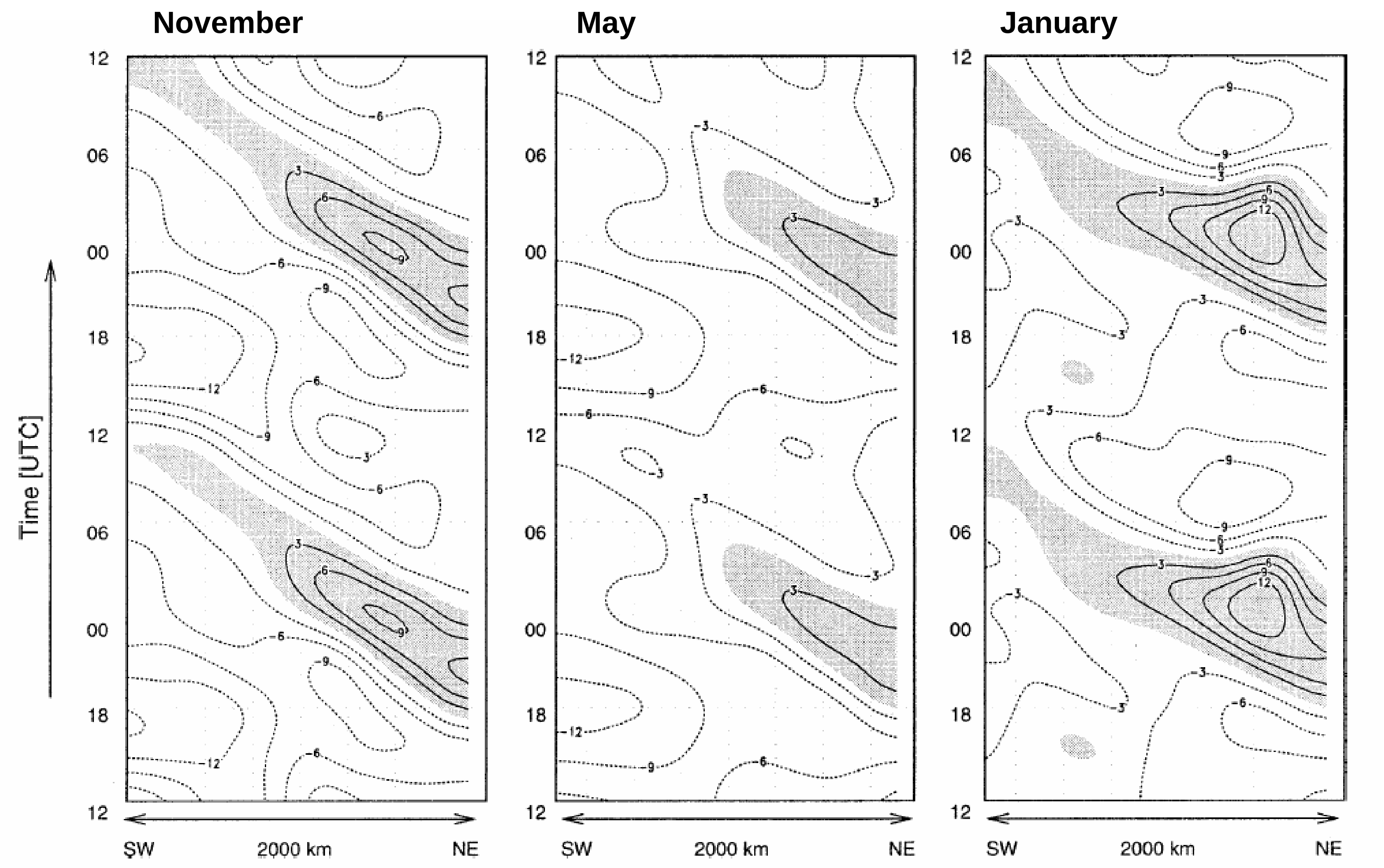
MM5-1D Experiments (no advection)
21ºS, 76ºW, 17 Nov 2001





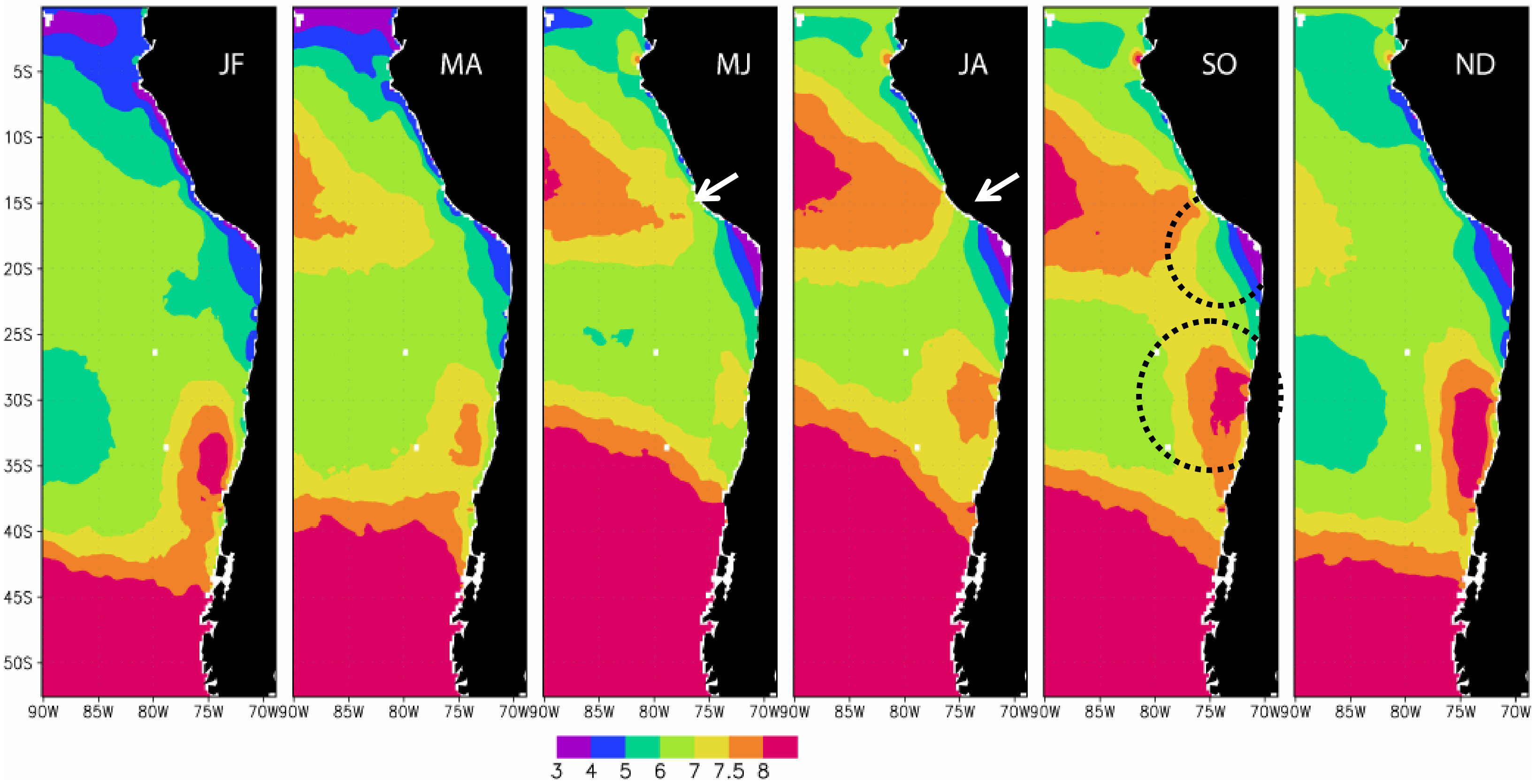
Significant drying (and little cooling) during nighttime hours when upsidence prevails. Larger entrainment at the top of a deeper MBL. (W_{LS} influence the size of the eddied).

MM5 results: w(800hPa).



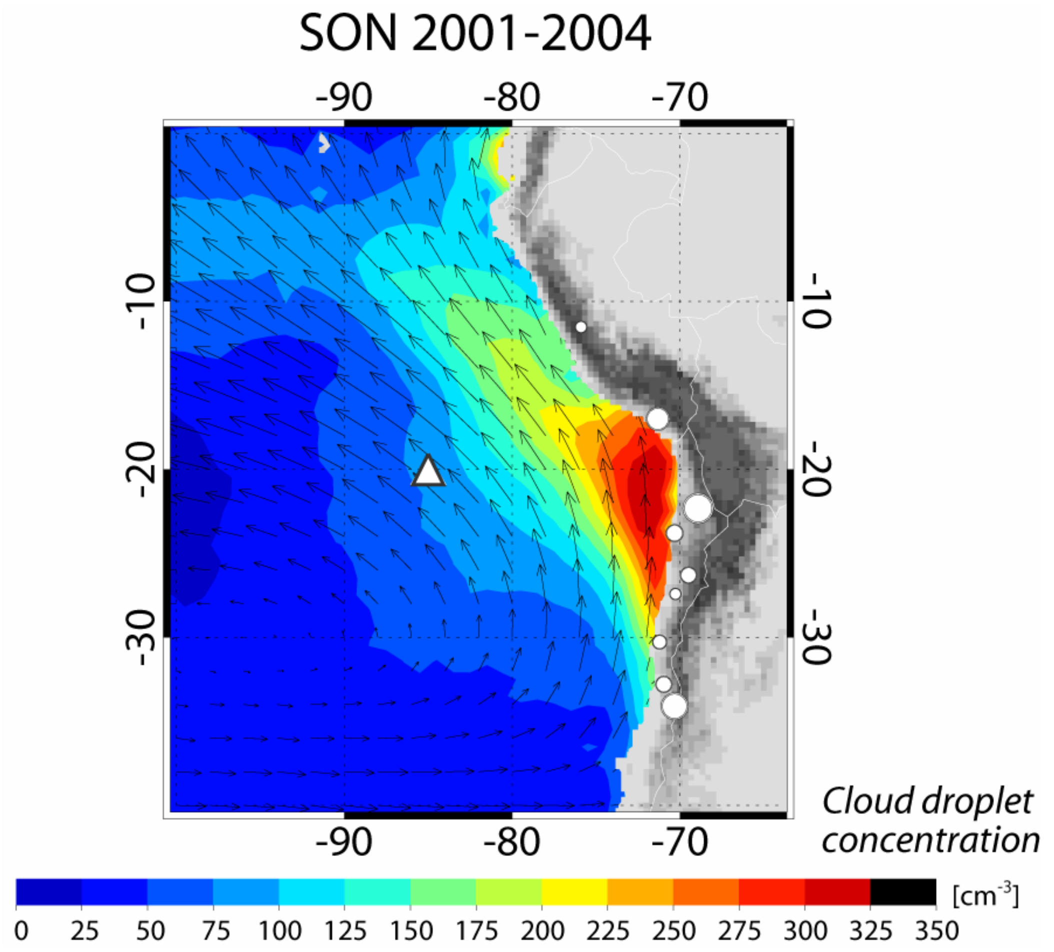
“Existence” of upsidence wave in “all” seasons suggest is not forced by convection over South America

QuikScat surface wind speed climatology (2000-2005)



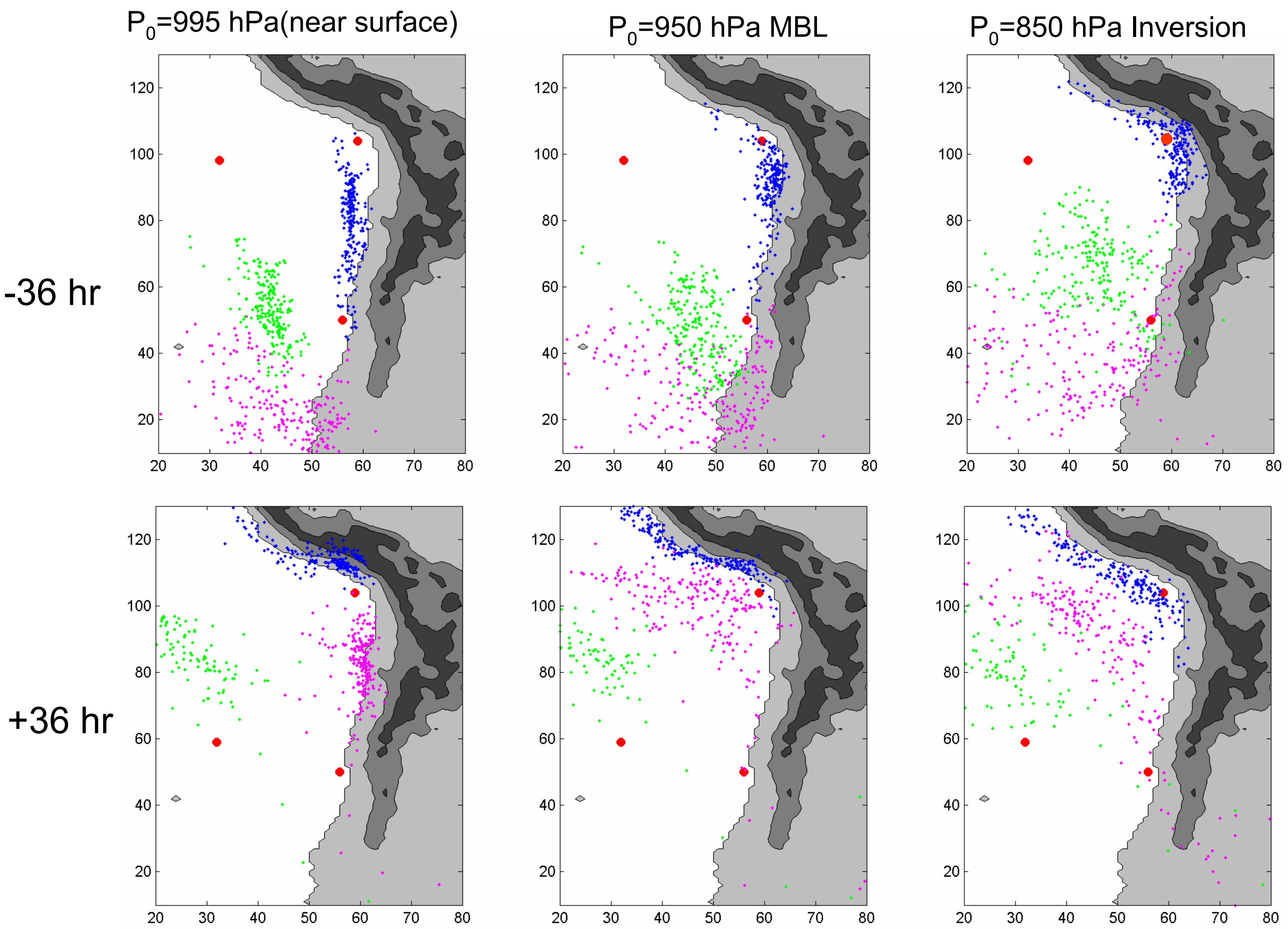
Among several interesting features of the sfc. ws field, we focus on the maximum off central Chile and the low-speed area around 18°S. Also notice the wind maximum @ 15°S only present during JJA

Near-stagnation zone collocated with maximum in CDC
Topographically induced? How deep? Sometime flush?



Rob Wood, 2006

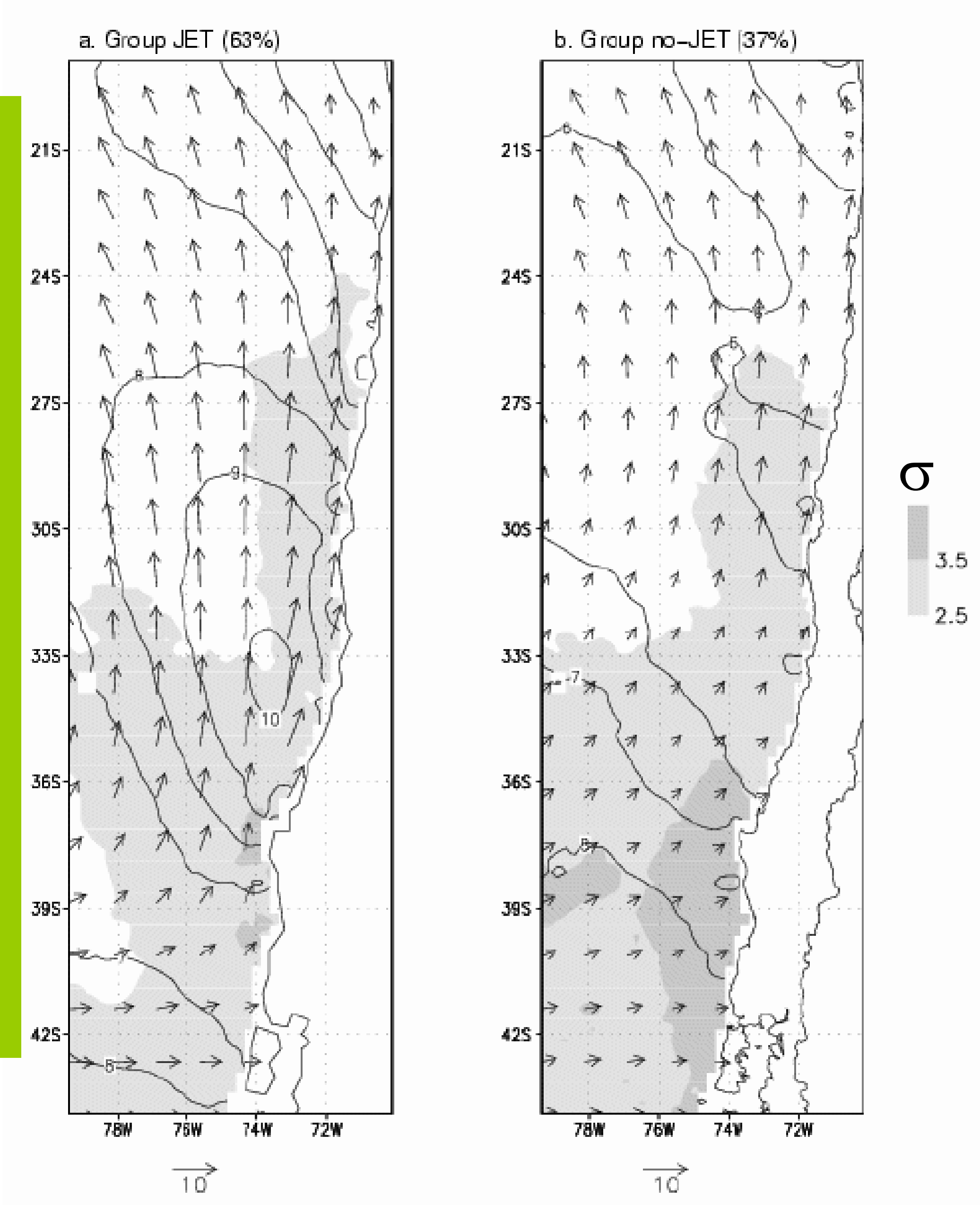
Model trajectory analysis (in progress)



Jet-structure in mean field, but how often a jet occurs?

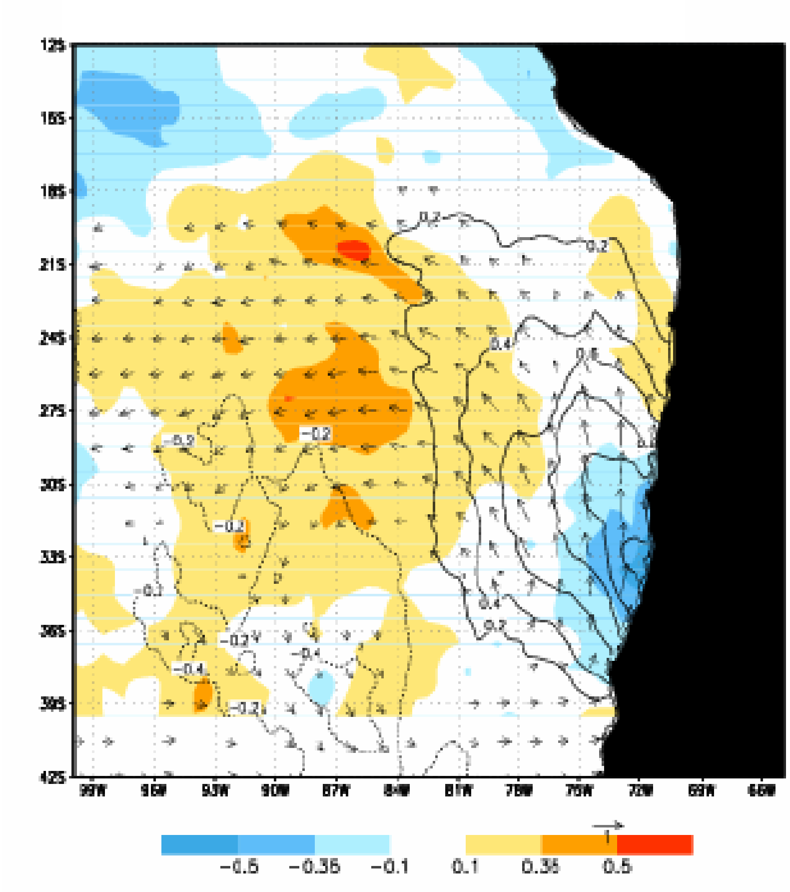
Cluster analysis using ws individual fields:

- Similarity measured by spatial correlation
- Ward method
- Two “best separated” clusters

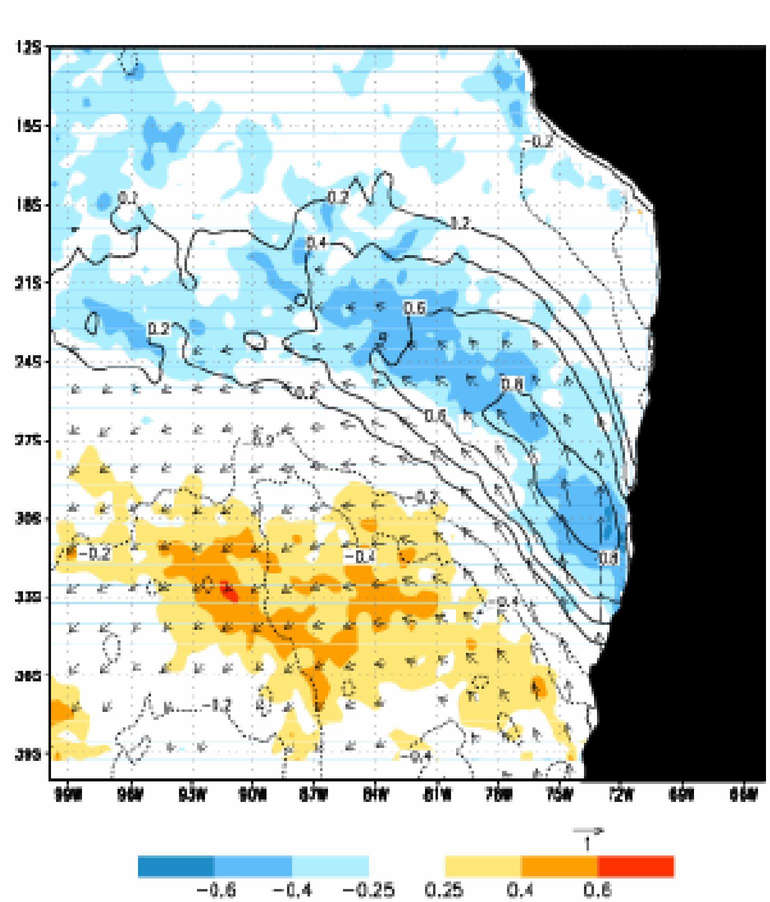


1-Point correlation map. V(33S/73W) regresed upon

U,V elsewhere (vectors)
WS elsewhere (contour)
Cloud elsewhere (colors)

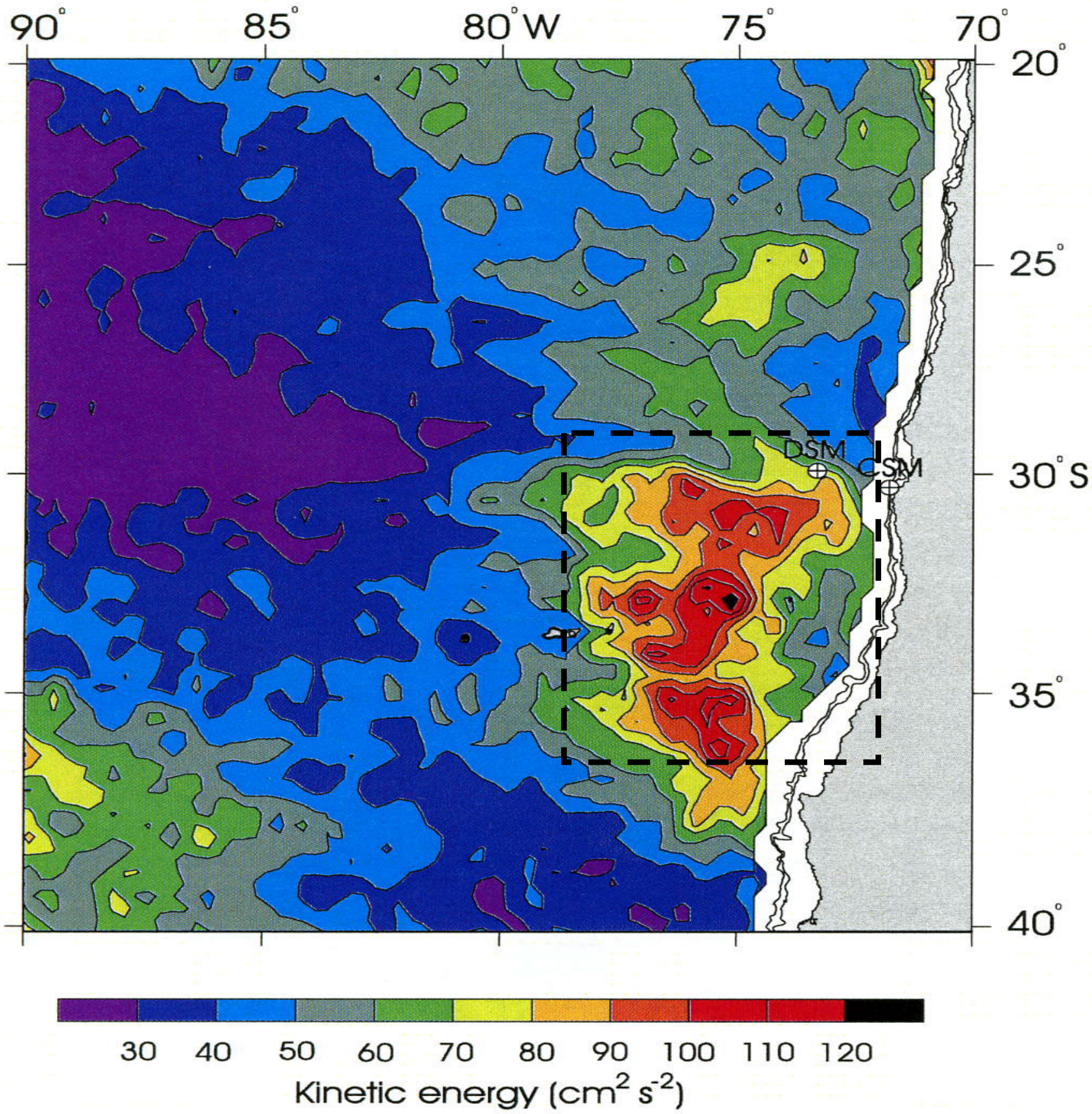


U,V elsewhere (vectors)
V elsewhere (contour)
SST elsewhere (colors)



Jet events associated with: Stronger anticyclone / Reduced Sc near the coast / Increased Sc off the coast / SST cooling downstream

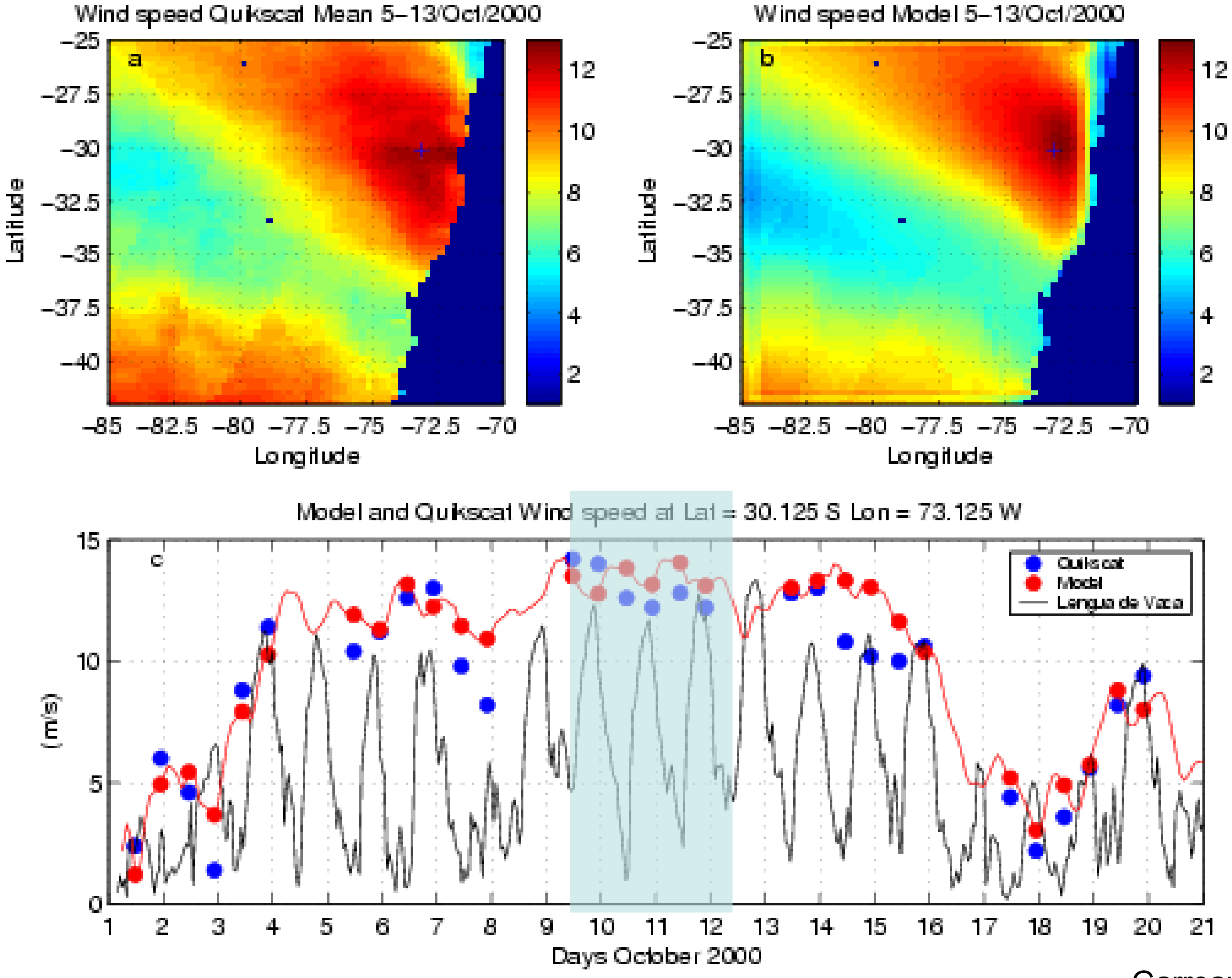
Further evidence of CJ impacts on ocean



Average kinetic energy from 7 years of altimetry data.

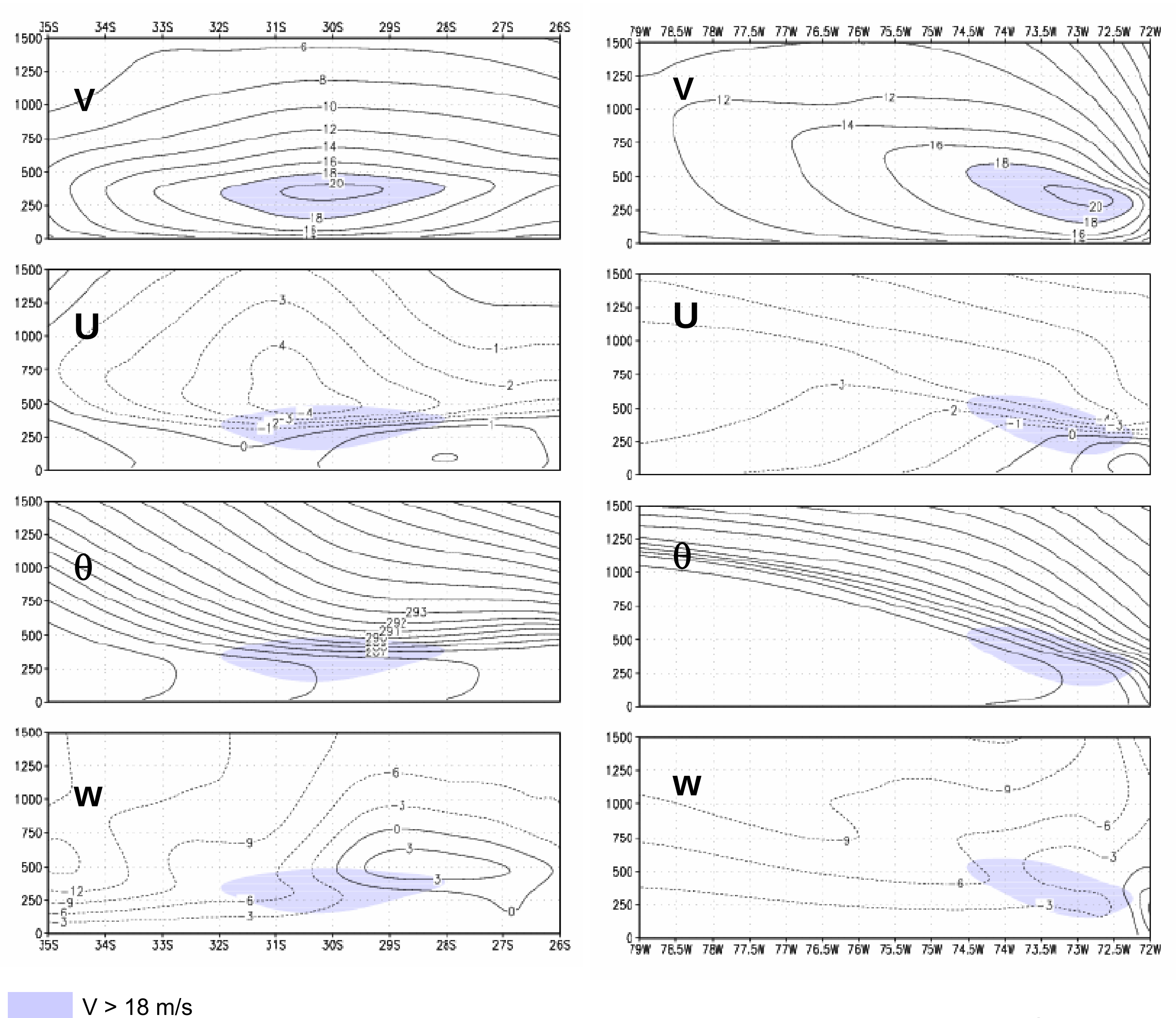
Image courtesy of Oscar Pizarro

MM5 results. October 2000 simulation of a well defined jet event



Garreaud and Muñoz 2005
Muñoz and Garreaud 2005

Simulated (MM5) structure of the coastal jet



Garreaud and Muñoz 2005

Steady-state Dynamics

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = \frac{1}{\rho}\frac{\partial p}{\partial x} + fv - \frac{C_d}{H}u|\vec{v}| \qquad \frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + fu - \frac{C_d}{H}v|\vec{v}|$$

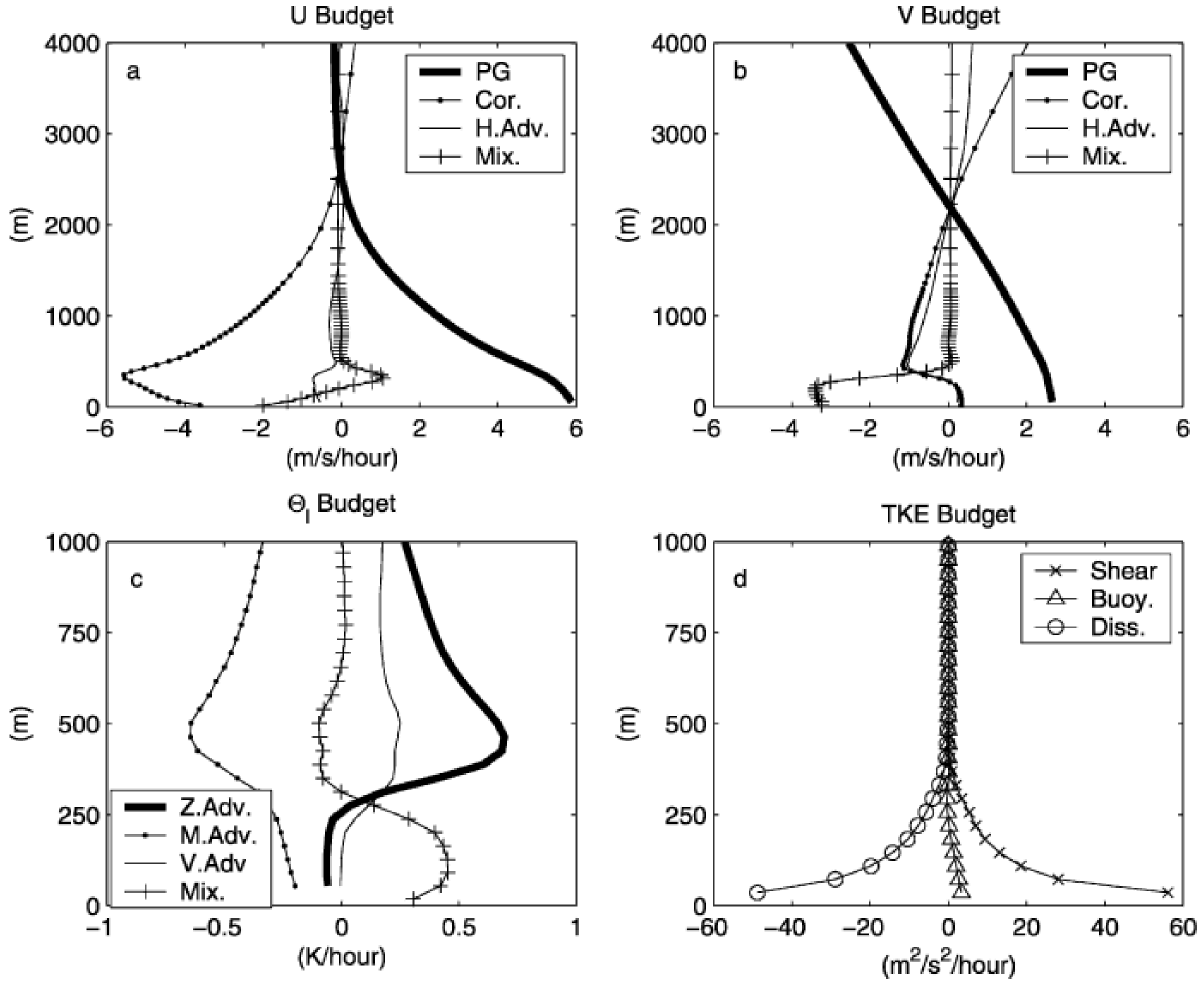
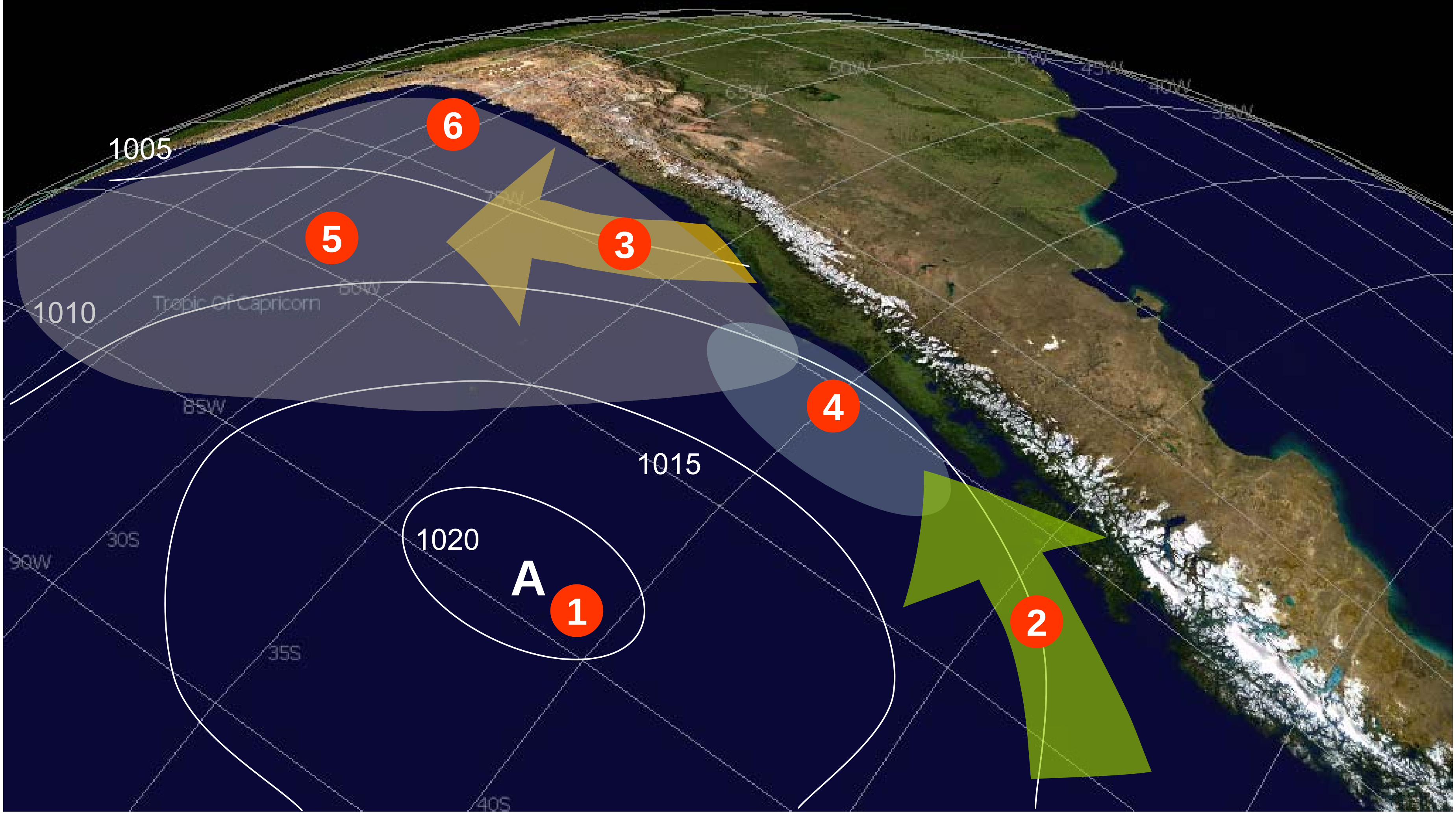
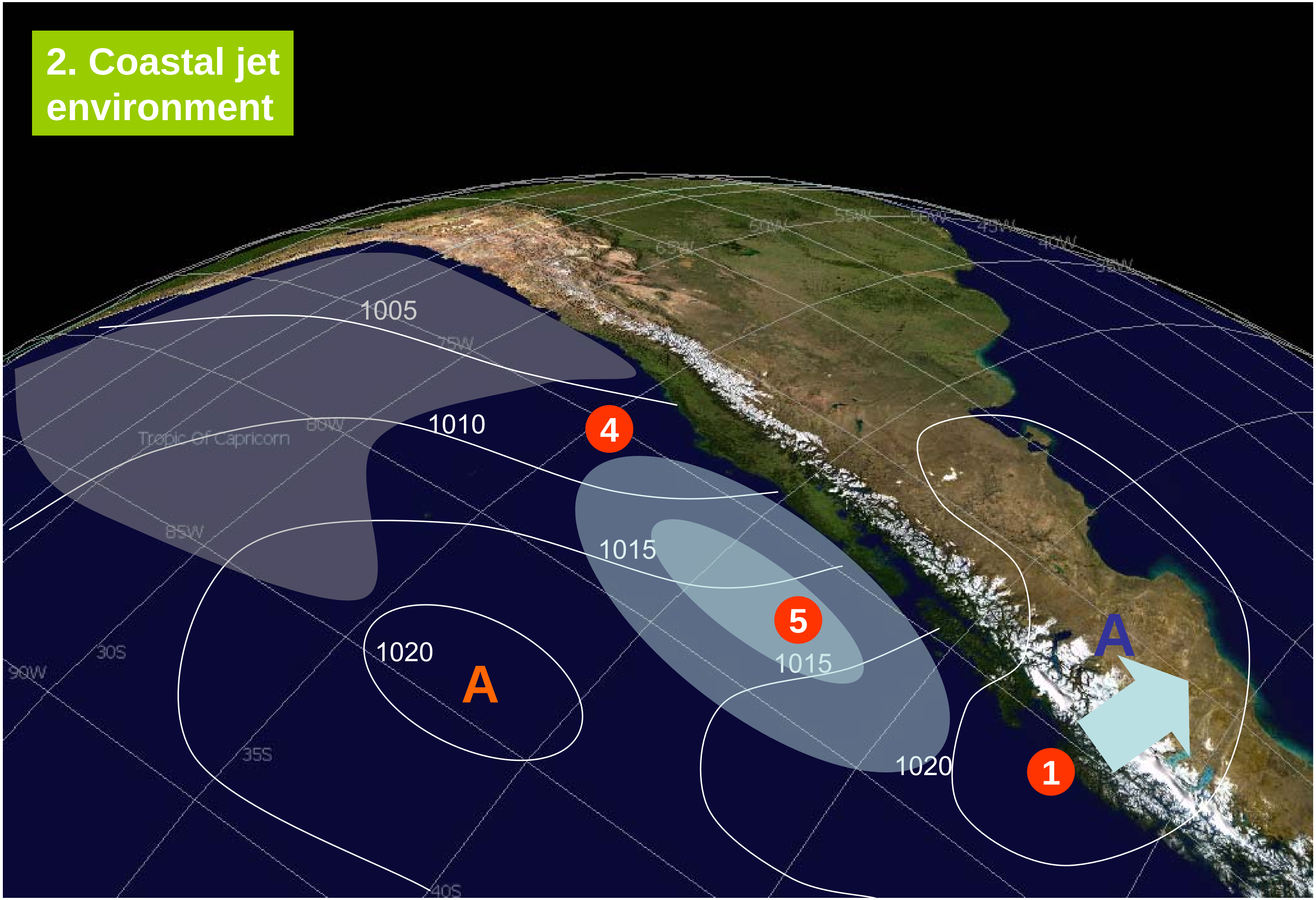


FIG. 8. Mean vertical profiles of terms in the budgets of (a) zonal momentum, (b) meridional momentum, (c) liquid water potential temperature, and (d) turbulent kinetic energy, for point at 30.2°S, 72.8°W.

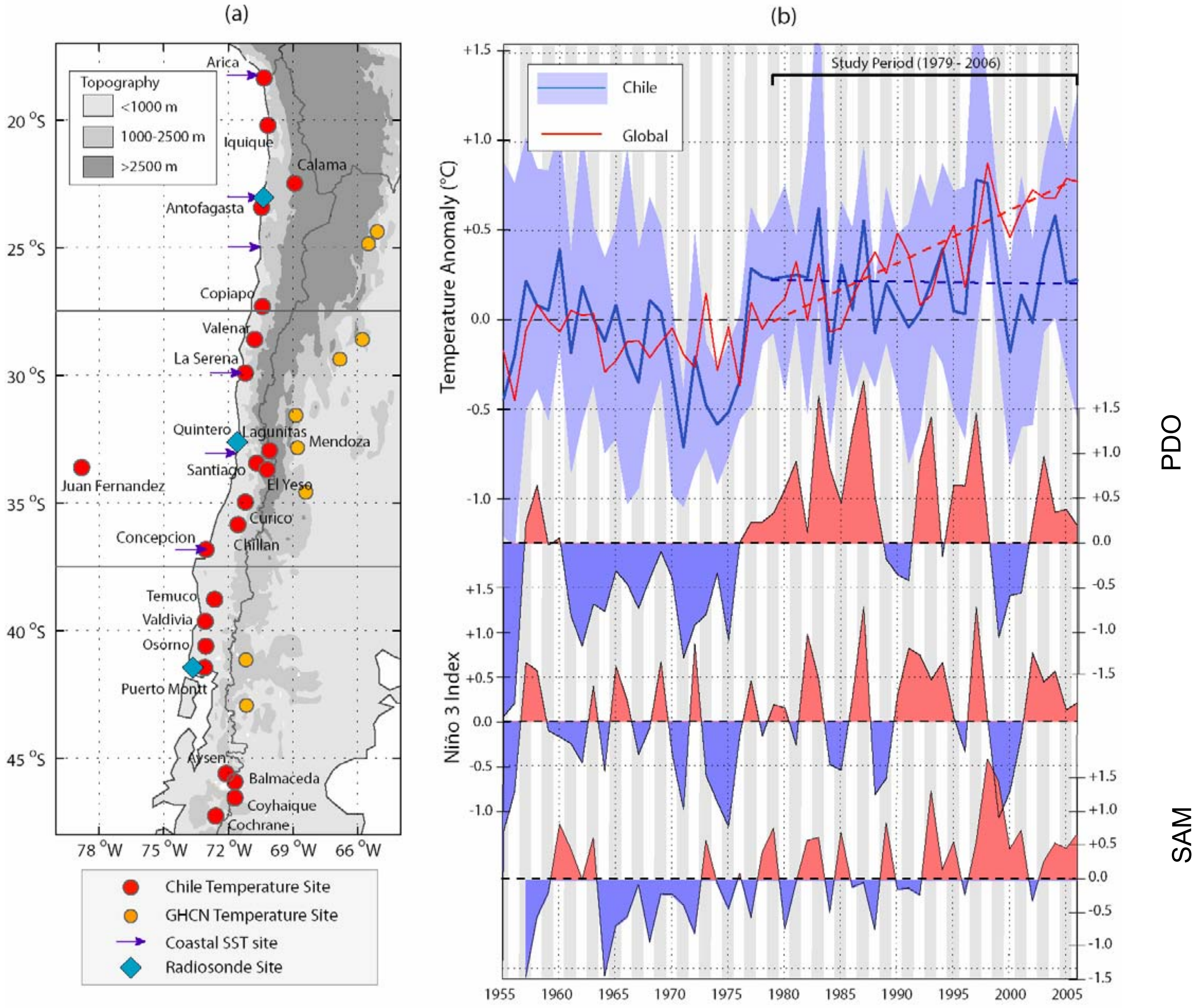
1. Condiciones climatologicas (no-perturbadas)



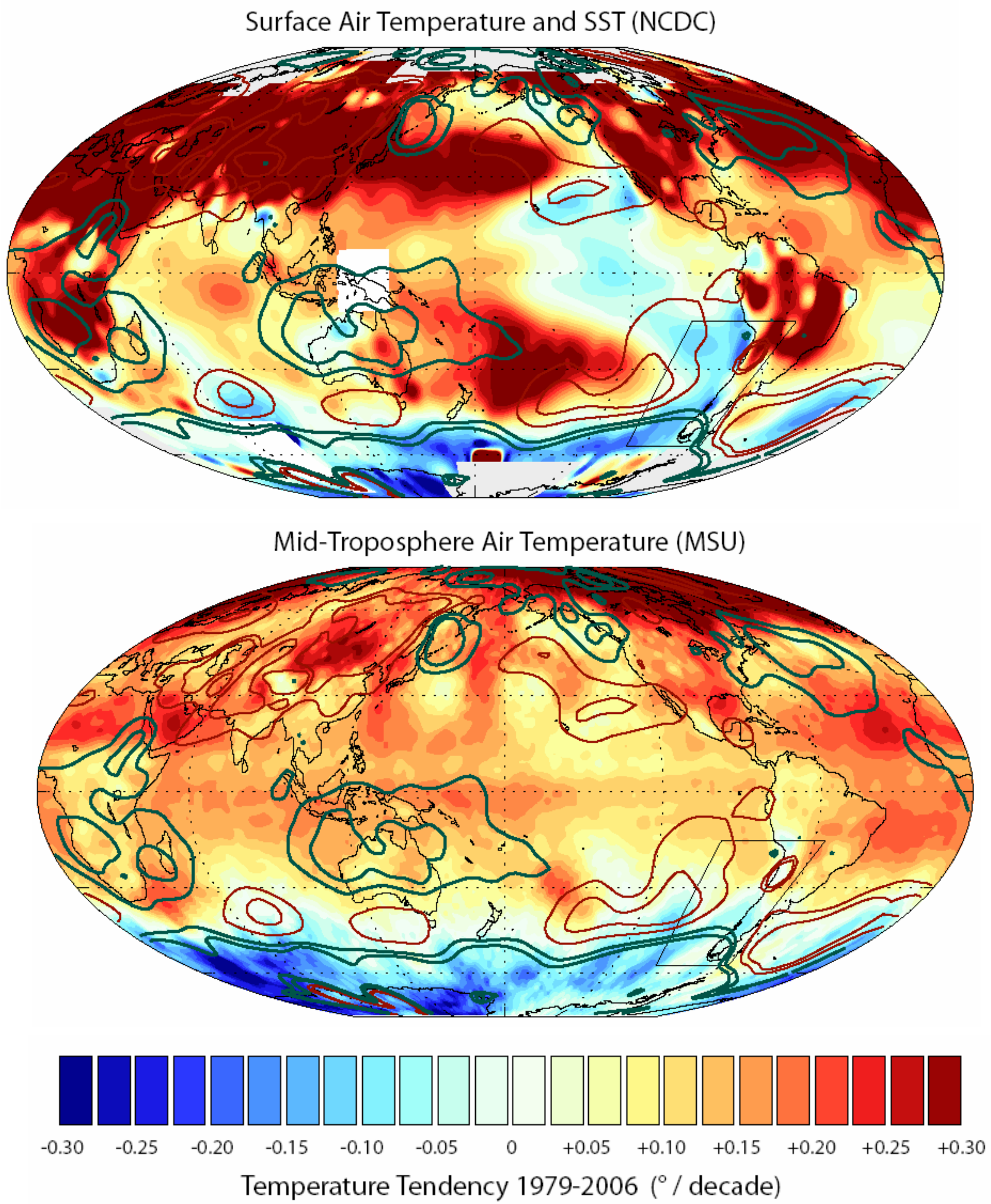
2. Coastal jet environment



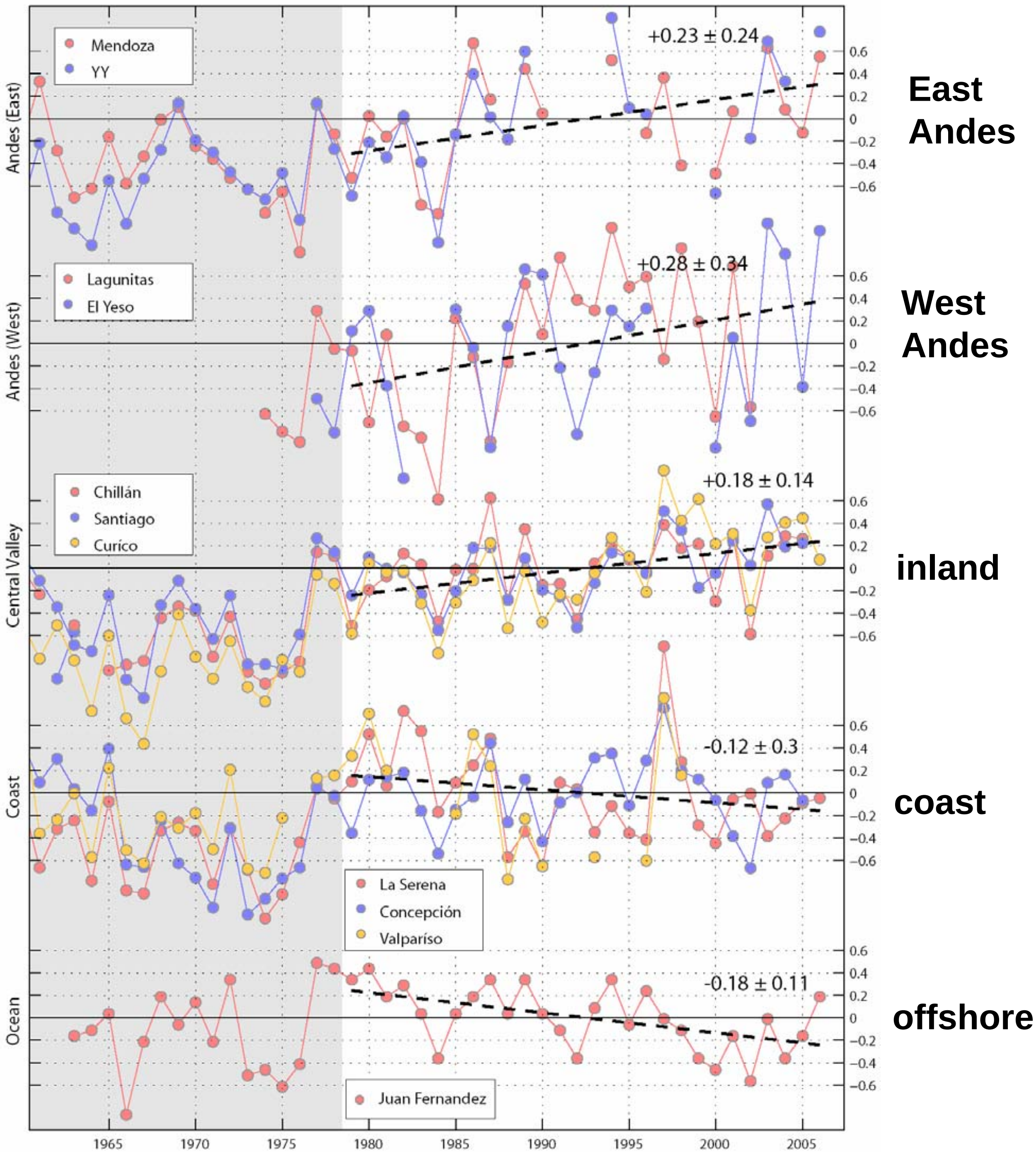
Geographical setting and global context



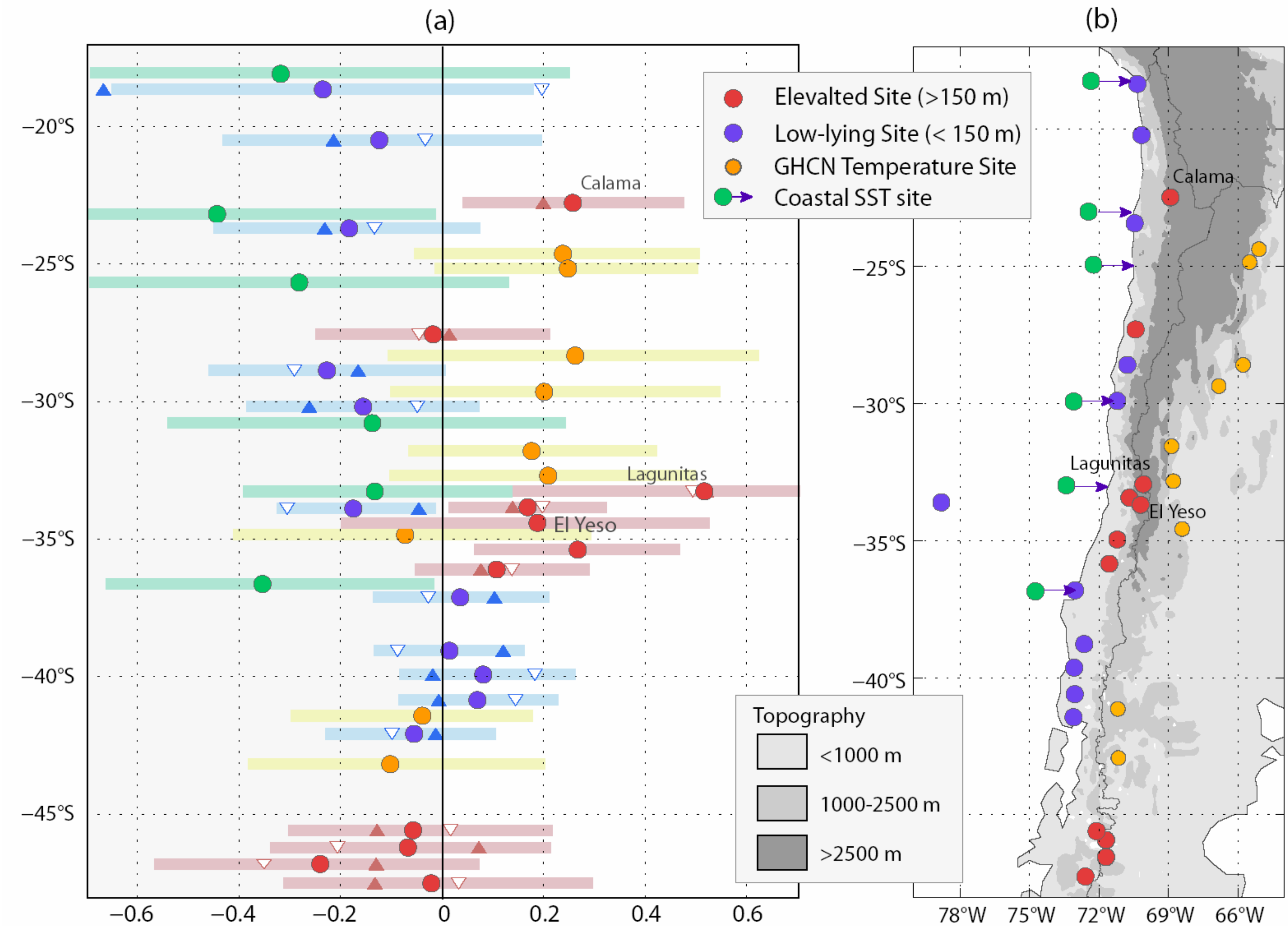
Global View SAT



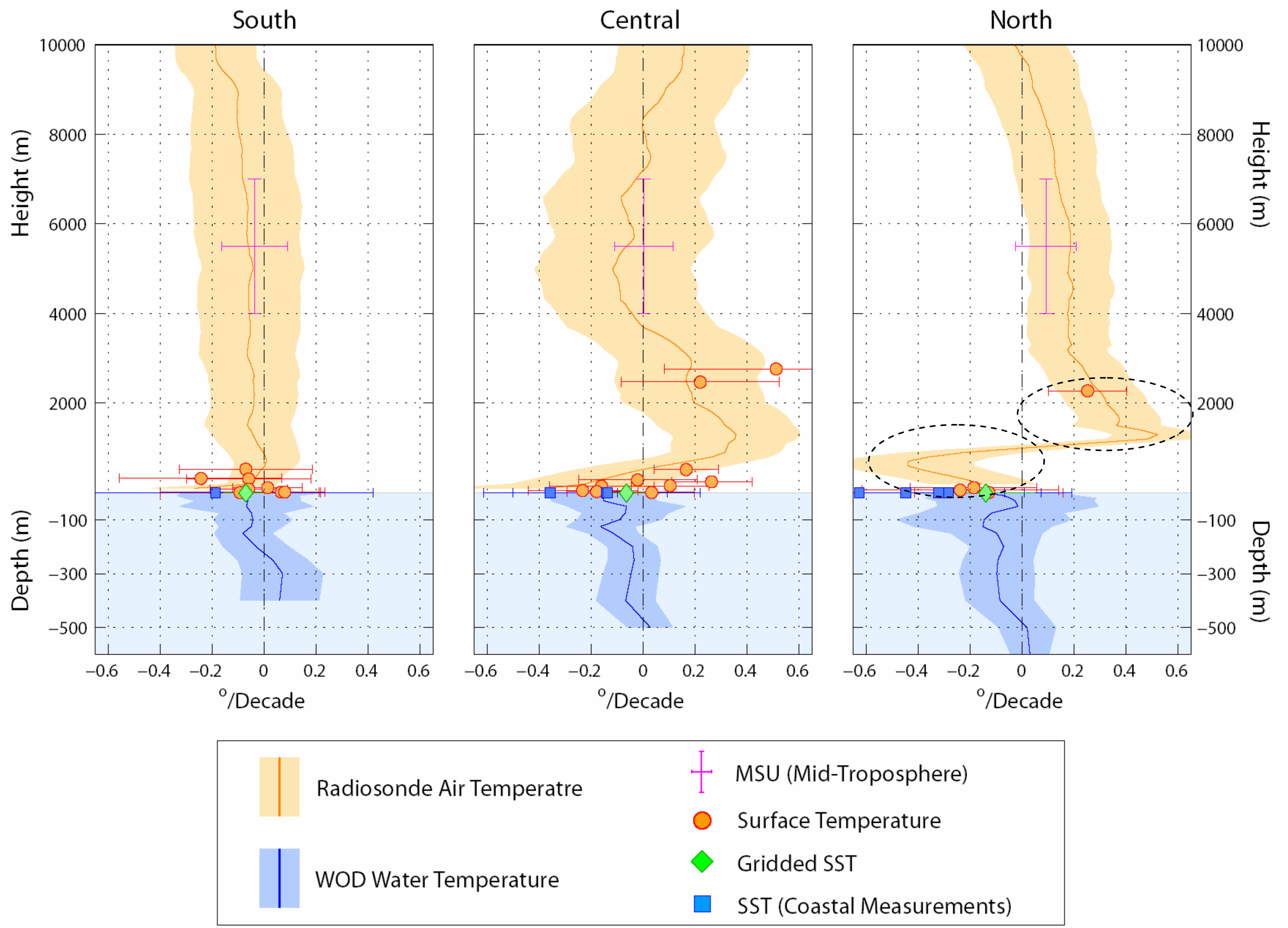
Regional view (SAT)



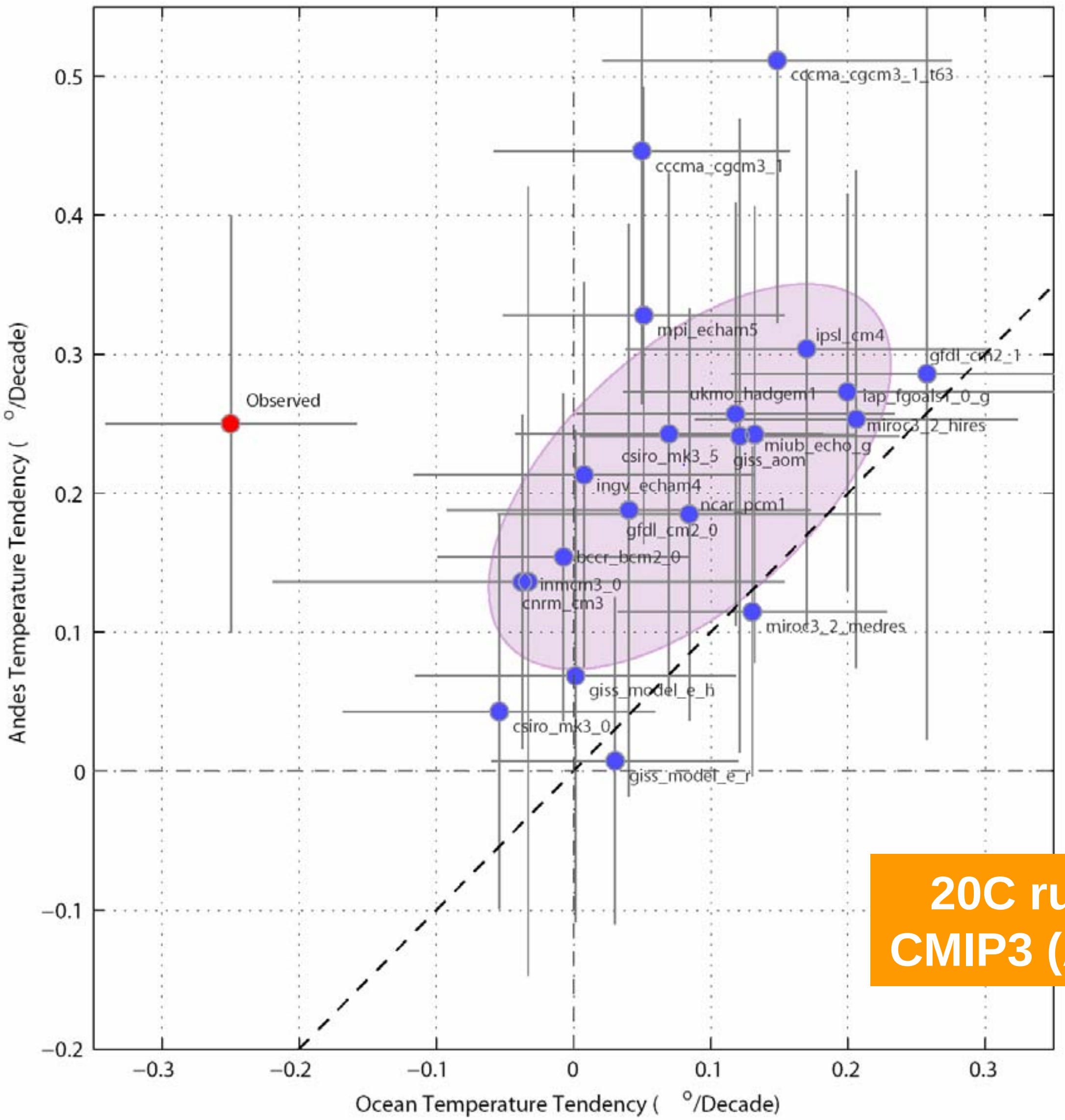
Ocean cooling – land warming along north-central Chile. Pattern reverses farther south



Cooling MBL / warming lower free troposphere → increased lower tropospheric stability …. Sc?

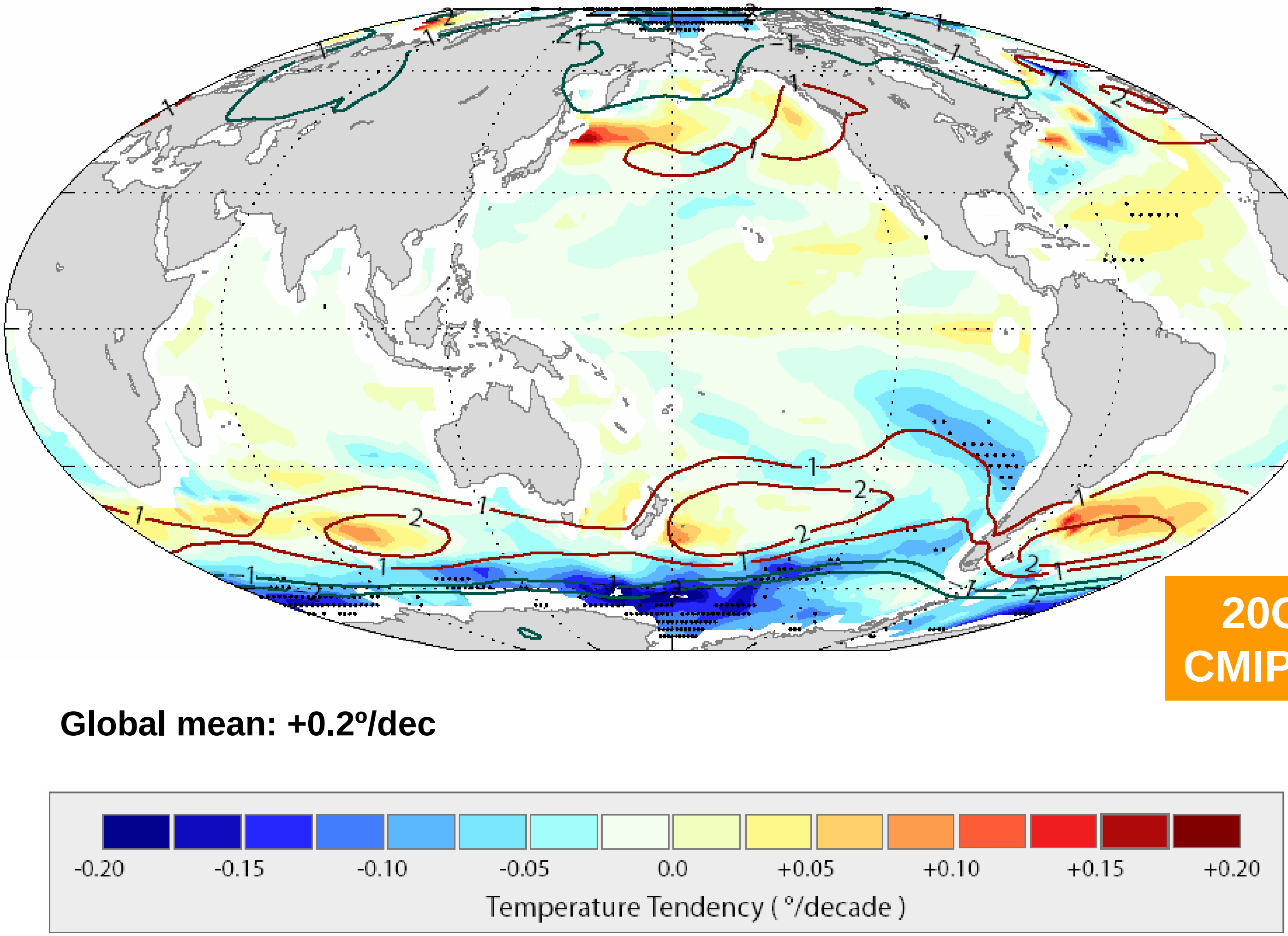


How are the models doing?
Not good but no so bad..



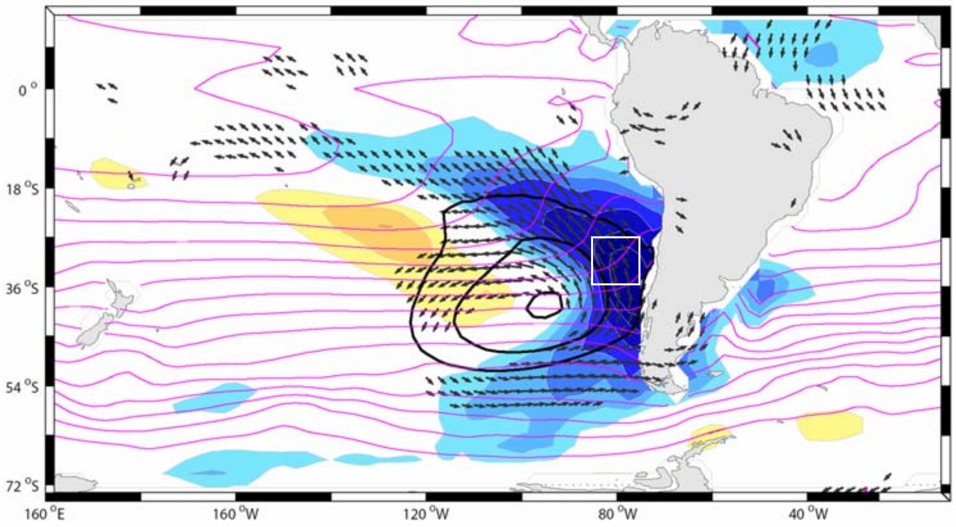
20C runs
CMIP3 (AR4)

Multimodel mean Regional warming 1970-2000 (SST anomaly). Also shown in contours SLP trend

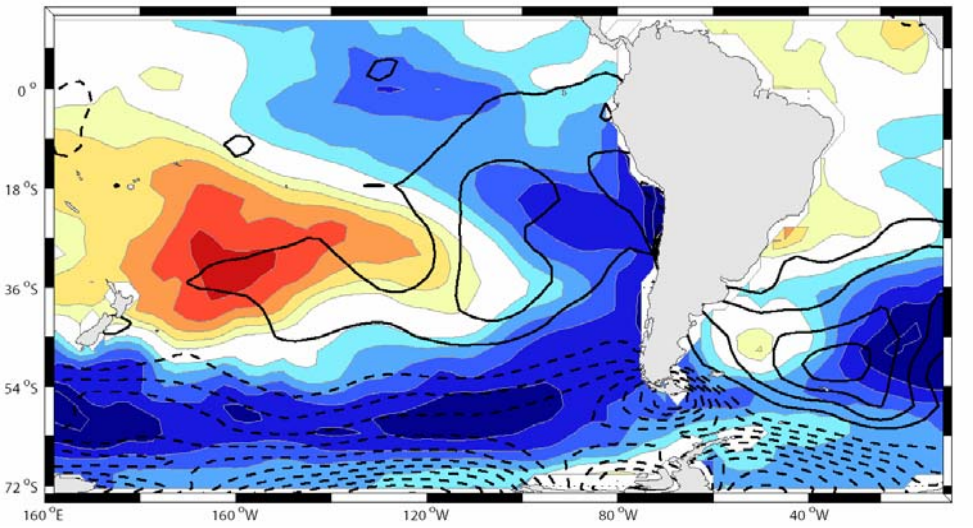


20C runs CMIP3 (AR4)

Global mean: +0.2º/dec



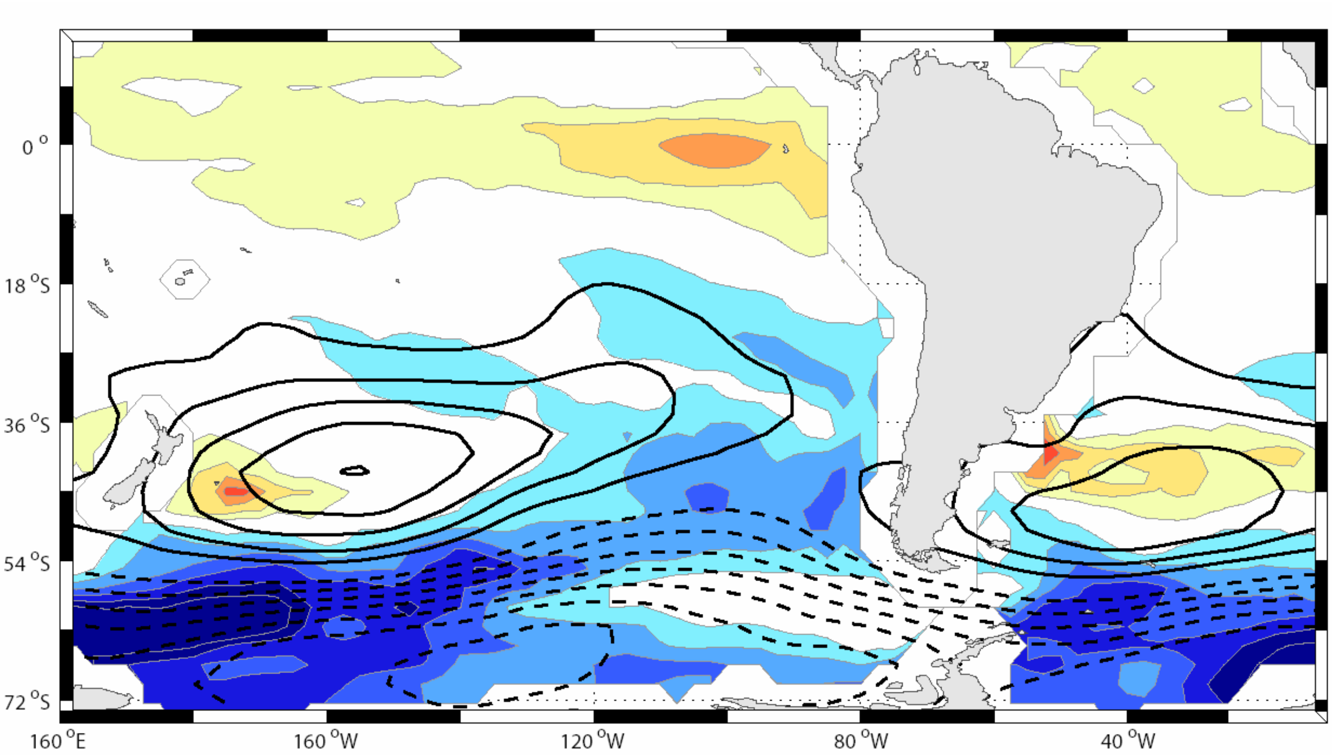
1-Point correlation map SST off central Chile, SST, SLP, sfc. winds.
Interannual variability only.



Observed ERSST and SLP changes, 1979-2005.
SLP from NCEP/NCAR reanalysis, supported by in-situ observations.

At interannual time scales, cooling off central Chile associated with spin-up of SEP anticyclone (increased cold advection, upwelling and heat fluxes). The same mechanism appears to operate in last decades to produce trends.

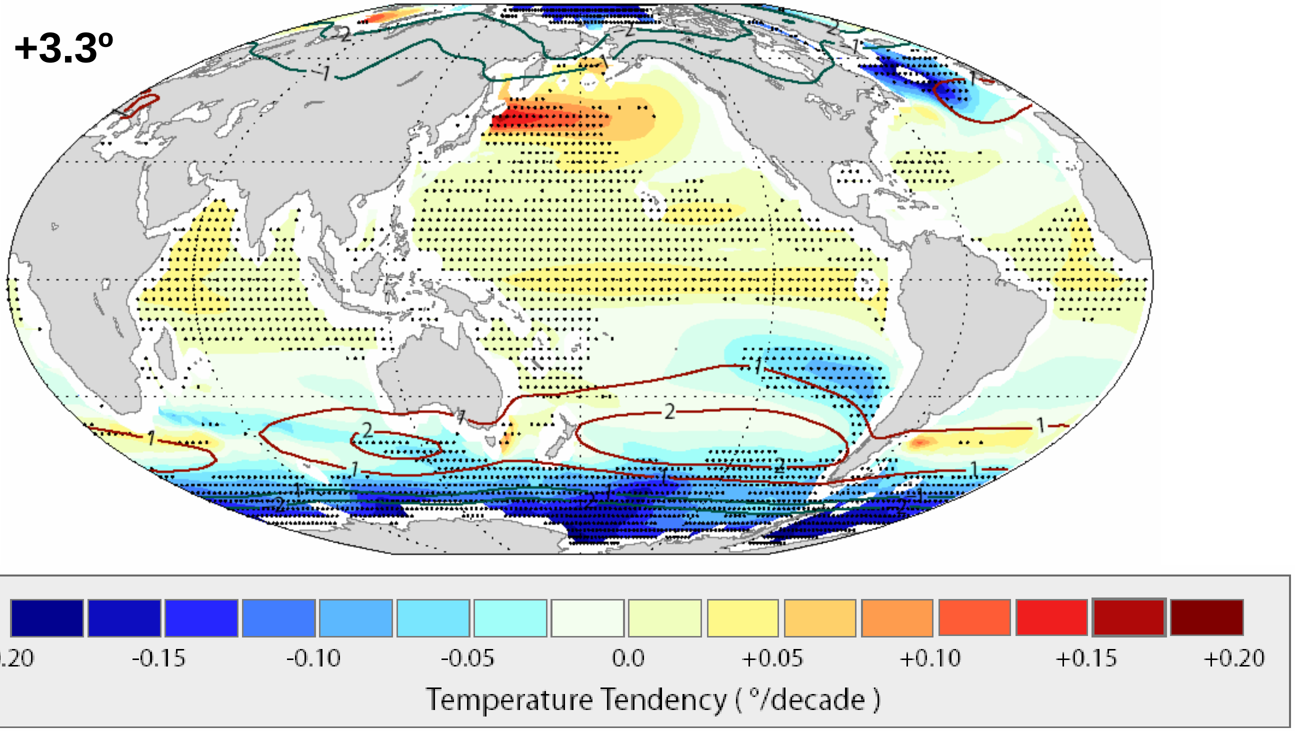
Multimodel mean SST* and SLP tendency, 1970-2000



The same mechanism appears to operate in the models during the last decades to produce trends. Thus, observed change is at least partially due to increased GHG (the only common ingredient in GCMs)

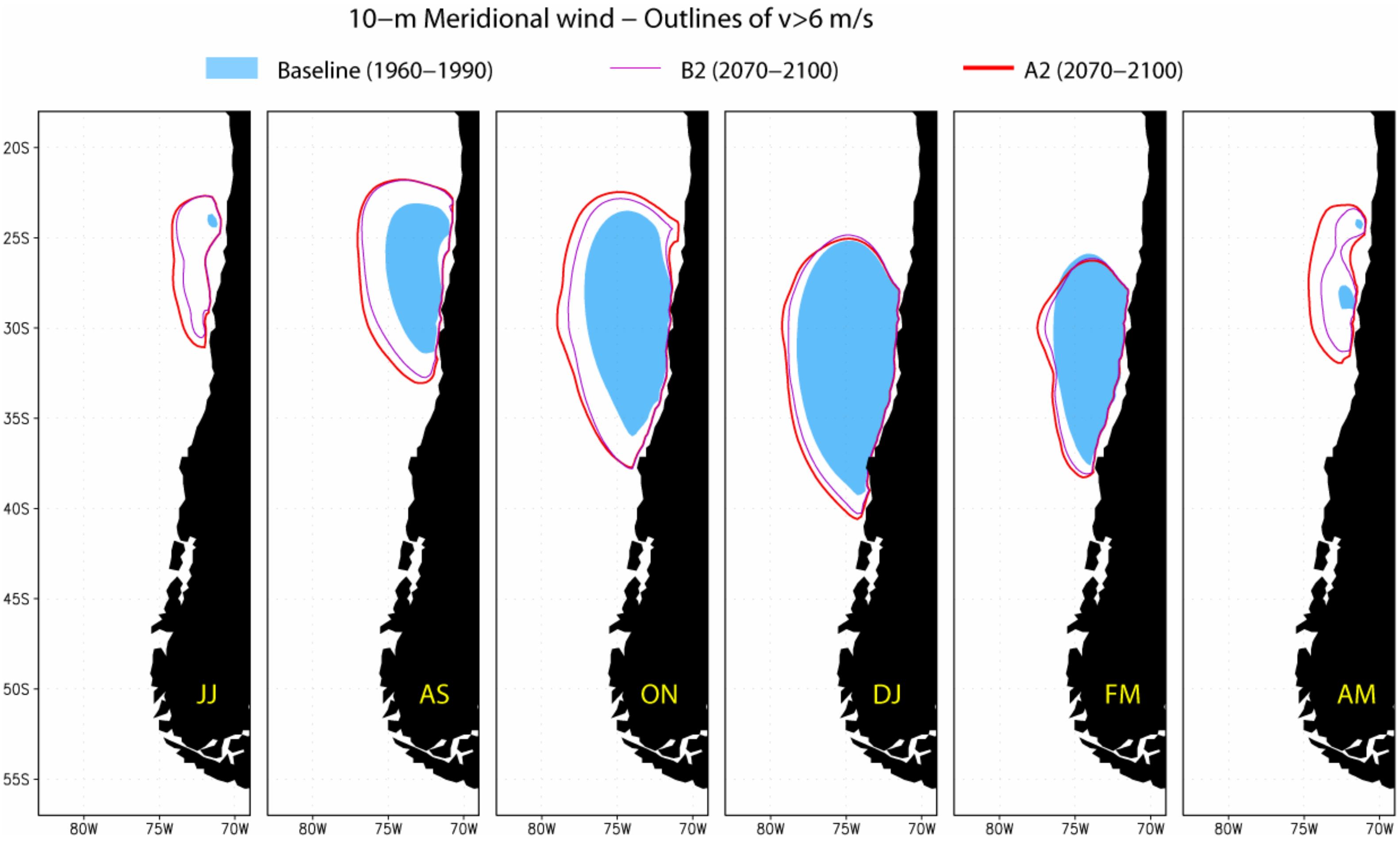
Multimodel mean Regional warming A2-BL (future-present). Also shown dSLP

Global mean: +3.3º



The future shows a consistent poleward expansion of the subtropical highs and poleward shift of the storm track. Thus, the same mechanism acting in recent decades appears to operate in the future and cause a regional cooling within a global warming context.

PRECIS Results



PRECIS Results