



# Cambio climático en los Andes subtropicales (25-45°S): Evidencias y proyecciones

Taller Internacional Cambio Climático en los Andes  
Lima 24-26 Septiembre 2009

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<http://www.dgf.uchile.cl/rene>

# Temario

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El Proyecto ACT-19 (2006-2008)

Tendencias Observadas

Proyecciones regionales siglo XXI

# Proyecto ACT19. Variabilidad Climática en Chile: Evaluación, Interpretación y Proyecciones

## Main scientific questions

- Is the Chilean climate changing?
- Which are the characteristics of this change in the global context? Is there evidence of anthropogenic impacts?
- Which are the leading mechanisms behind regional climate variability?
- What is the role of the ocean in driving atmospheric variability?

# ACT-19 Project. Climate Variability in Chile: Evaluation, interpretation and projections

## PIs

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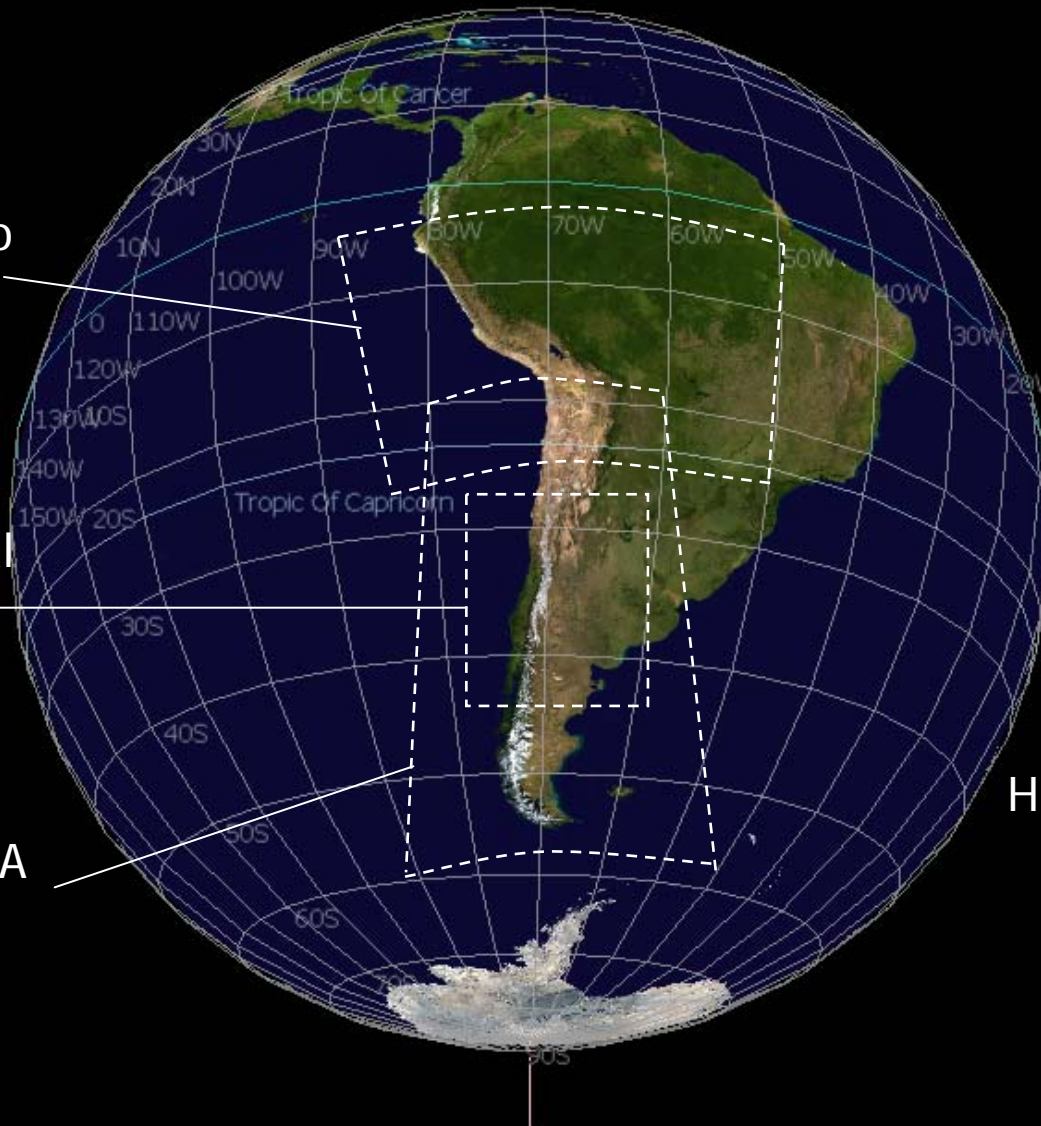
# Regional Climate Simulations during ACT-19

All output available via DODs: [www.dgf.uchile.cl/ACT19](http://www.dgf.uchile.cl/ACT19)

PRECIS-Altiplano  
25 km hor res.

WRF-ChileCentral  
15 km hor.res.

PRECIS-CONAMA  
25 km hor. Res.



Scenarios:

BL (1960-1990)  
A2 (2070-200)  
B2 (2070-2100)

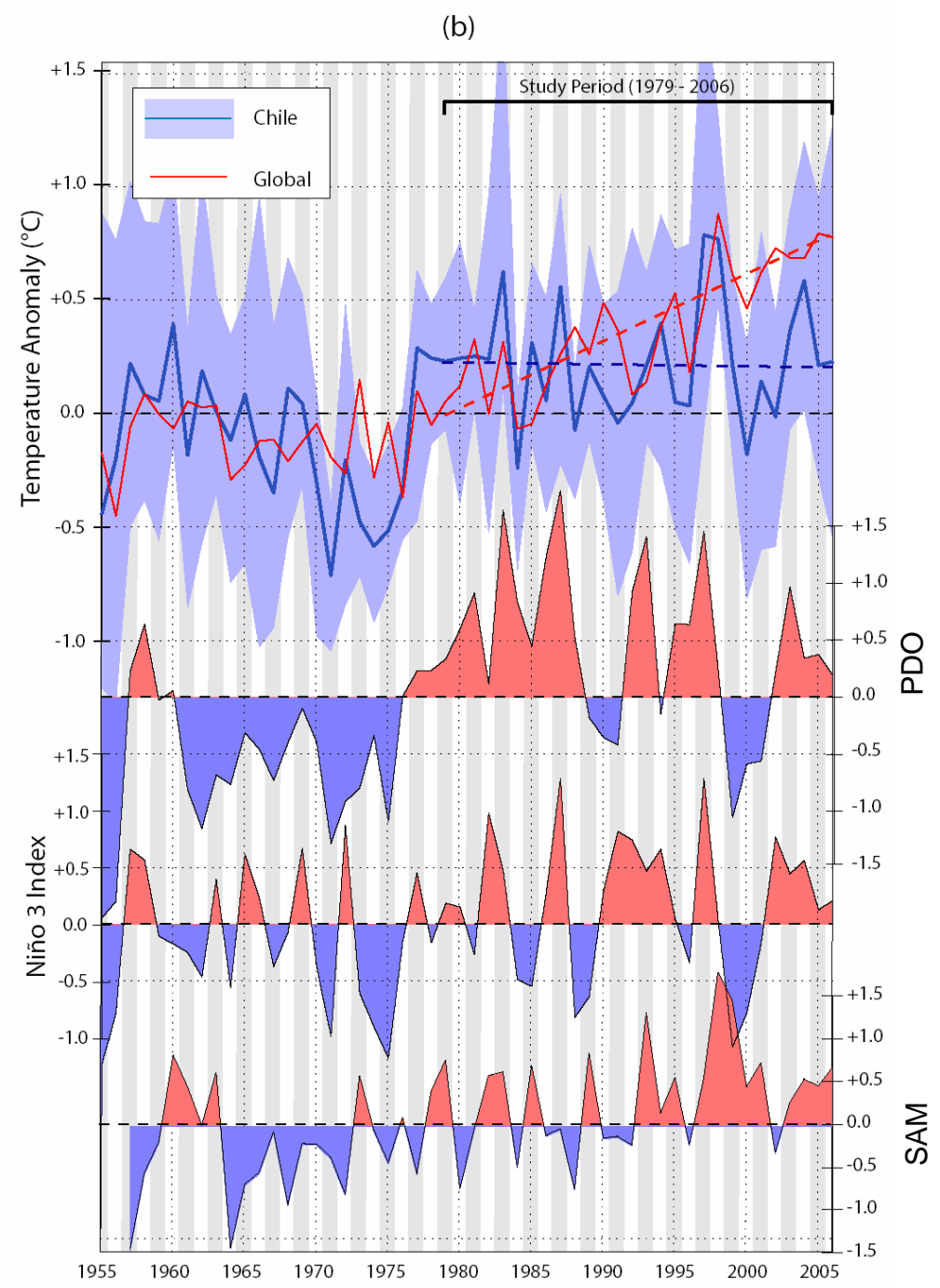
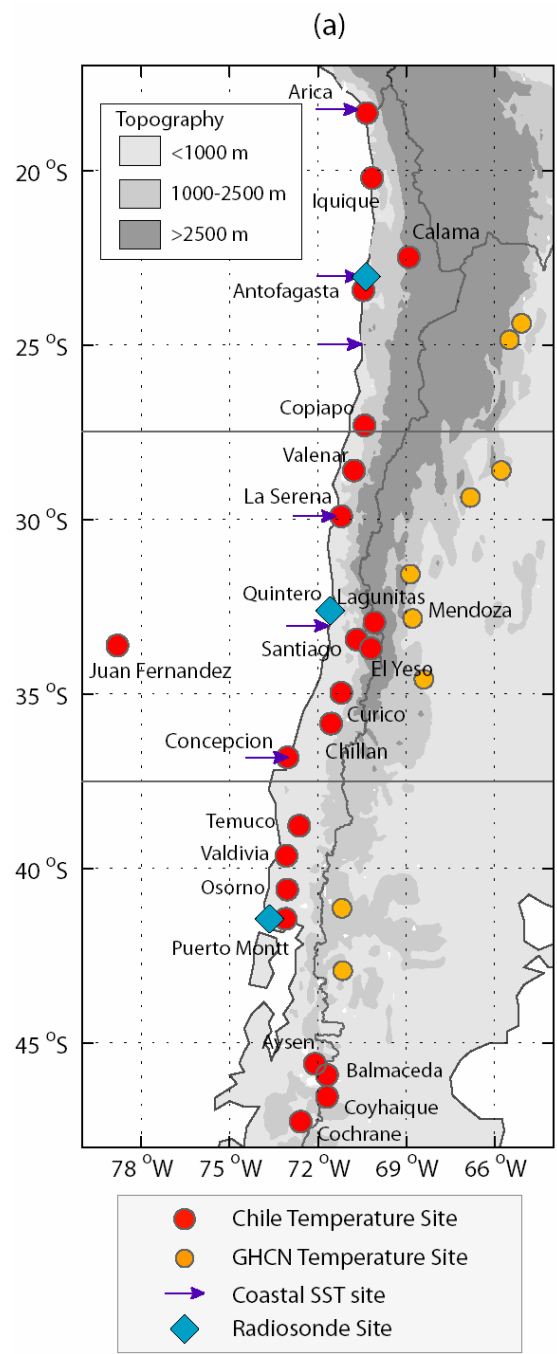
Lateral BC:  
HadAM

Surface BC:  
HadISST + HadCM3

# Outreach Brochure



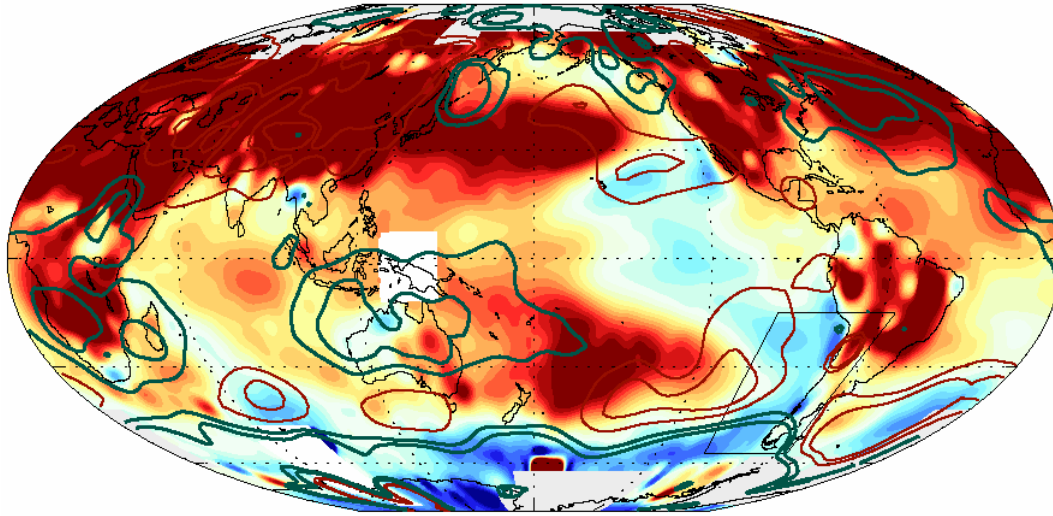
# Geographical setting and global context



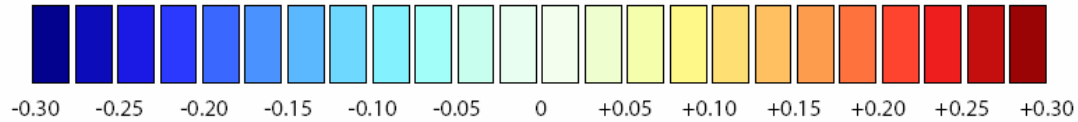
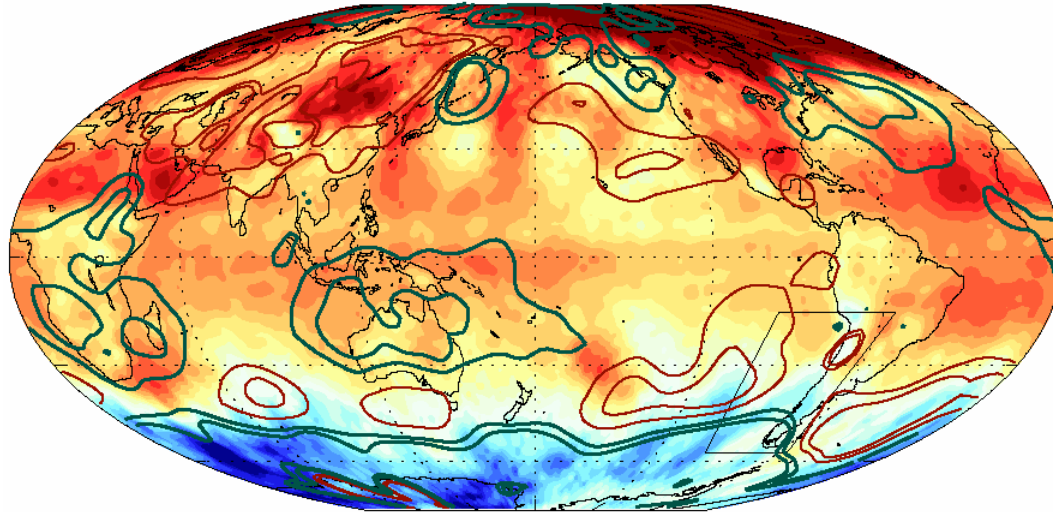


# Global Temperature Change 1979-2006

Surface Air Temperature and SST (NCDC)



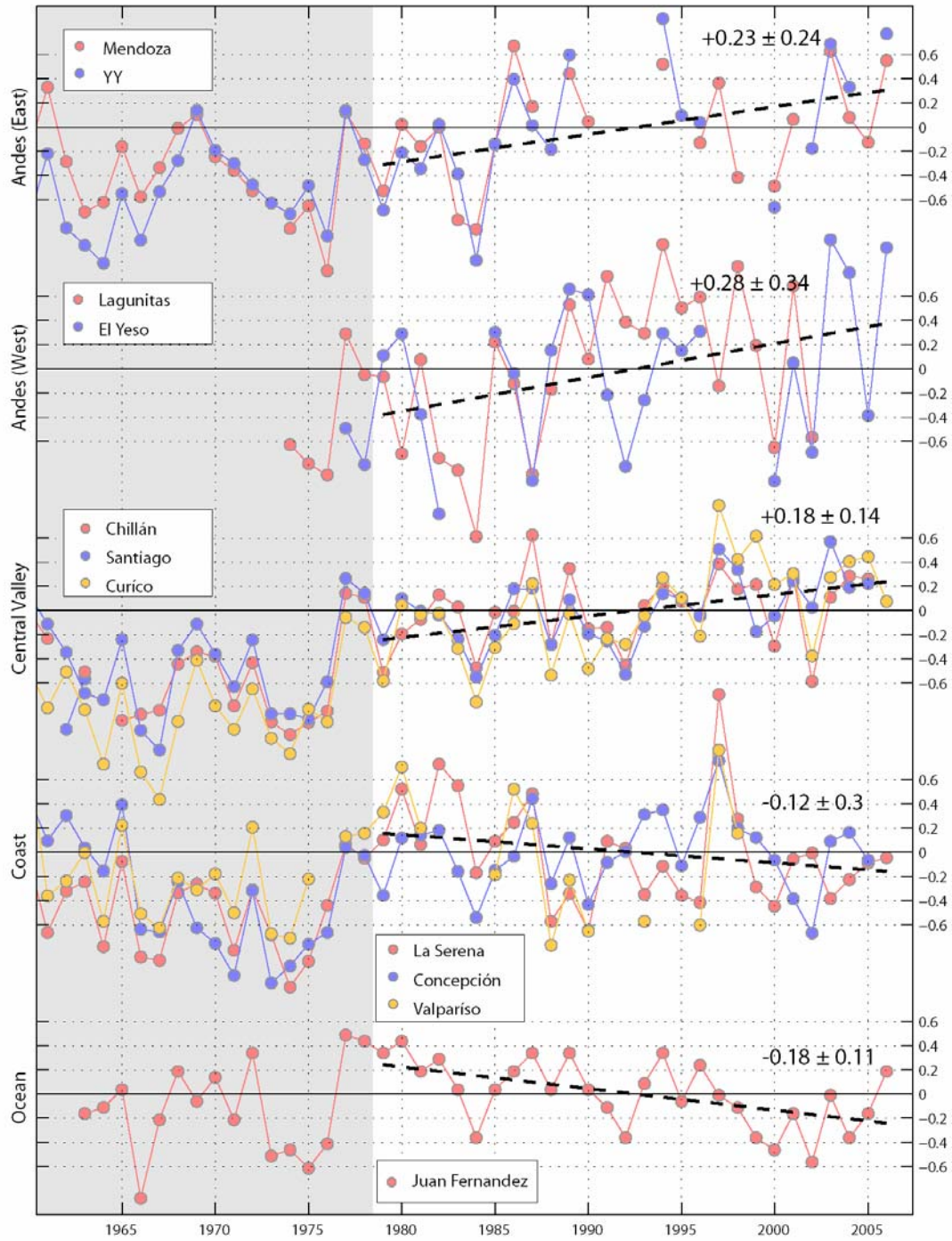
Mid-Troposphere Air Temperature (MSU)



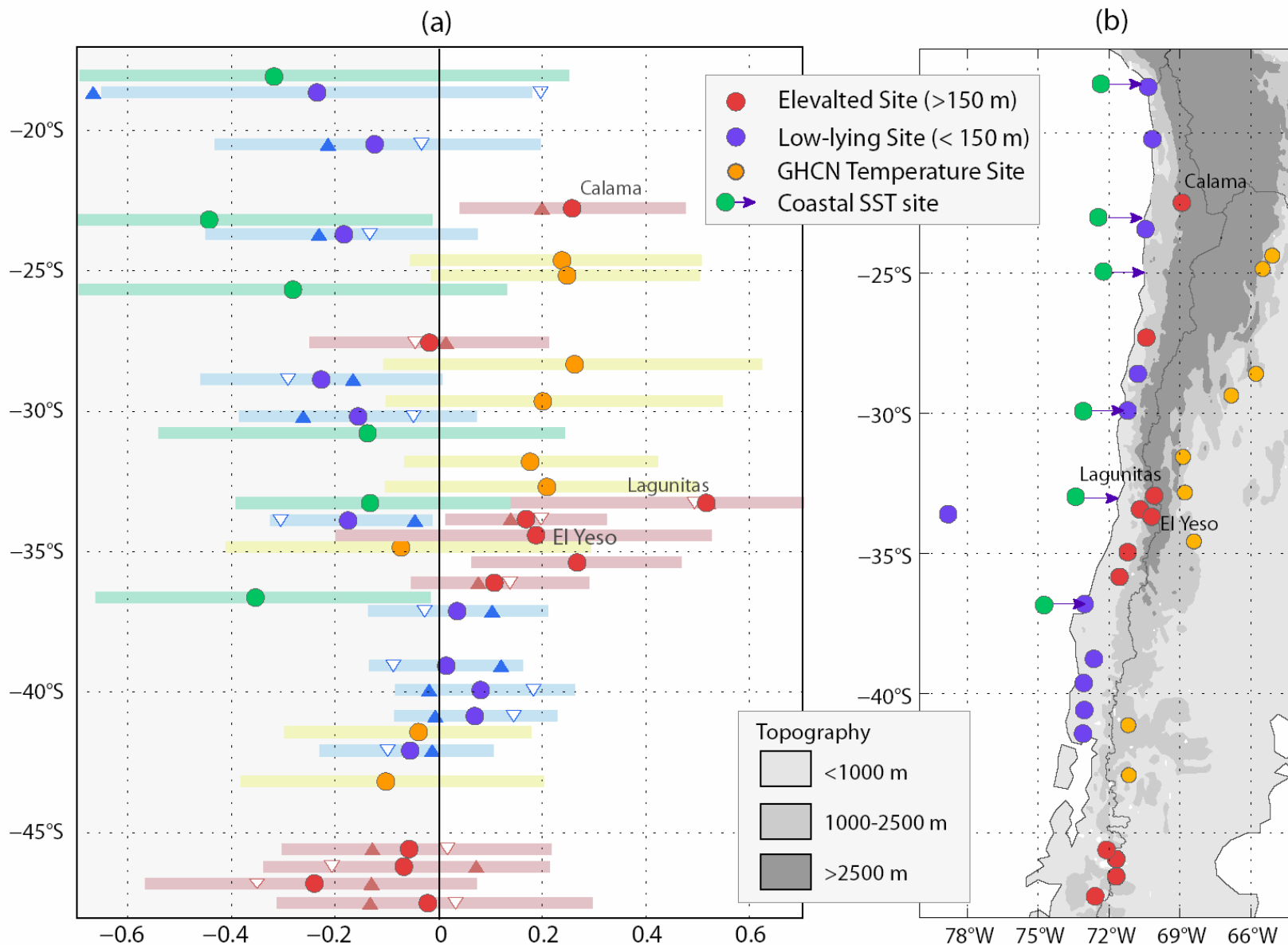
Temperature Tendency 1979-2006 ( $^{\circ}$  / decade)



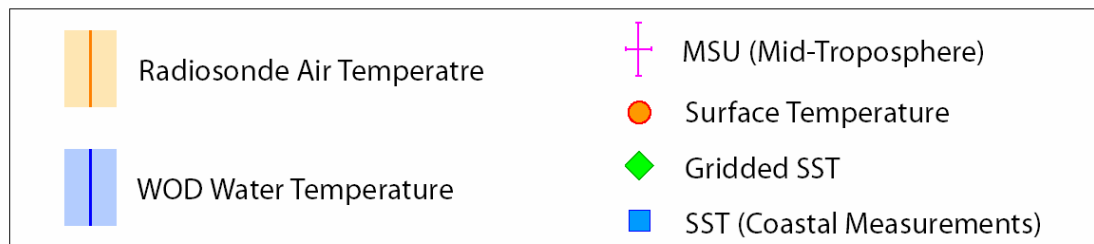
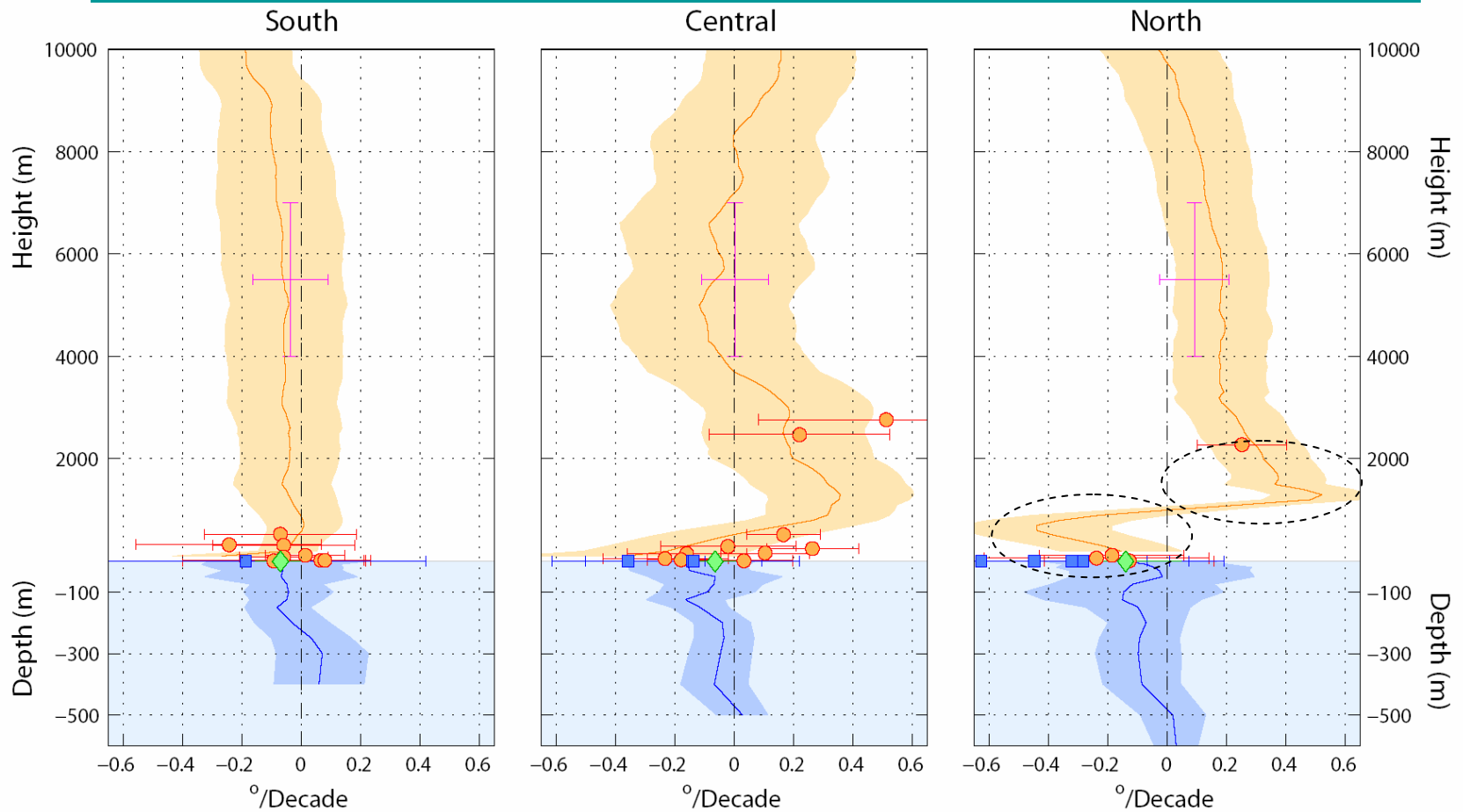
# Temperature Changes in Central Chile



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

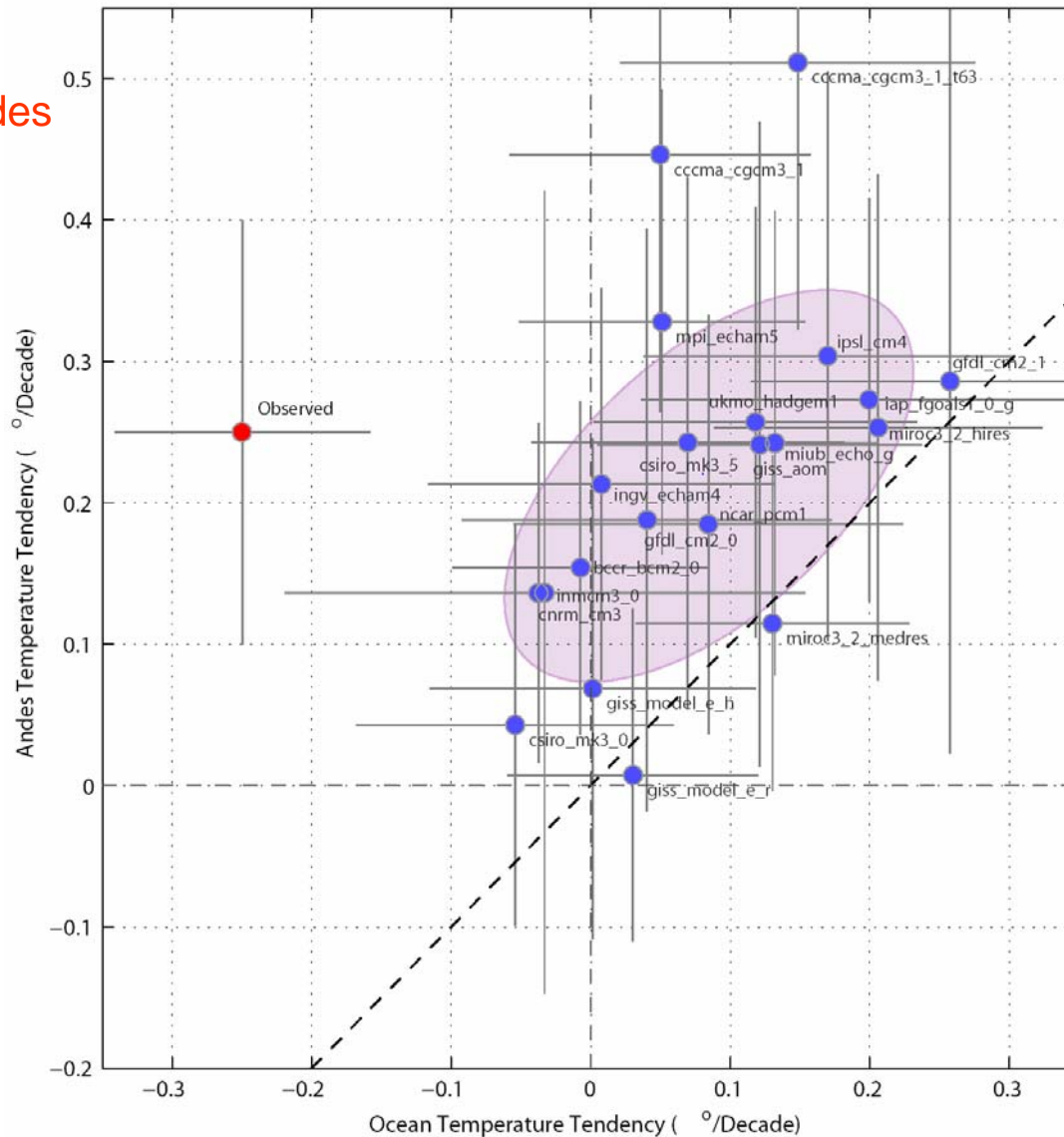


# Cooling MBL / warming lower free troposphere → increased lower tropospheric stability ... Sc?



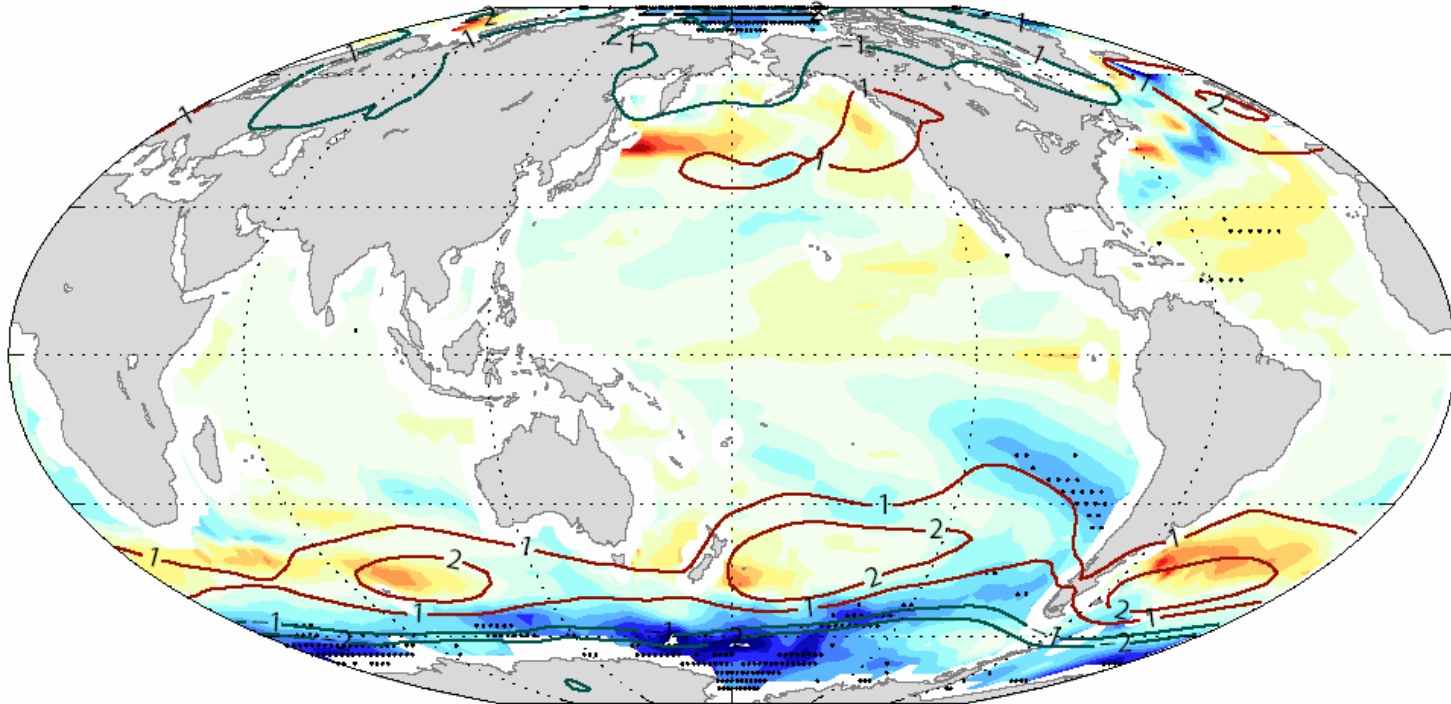
# How are the models doing? Not good but no so bad..

$\partial T/\partial t$   
central Andes

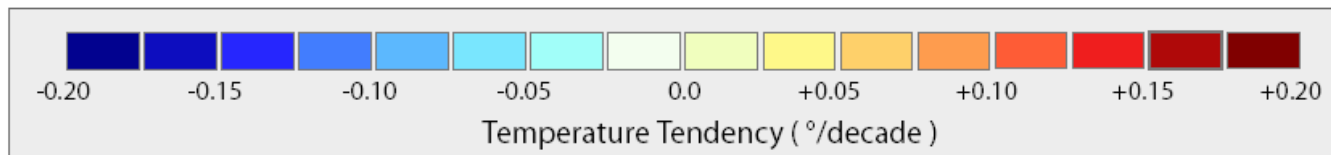


$\partial T/\partial t$   
off Central Chile

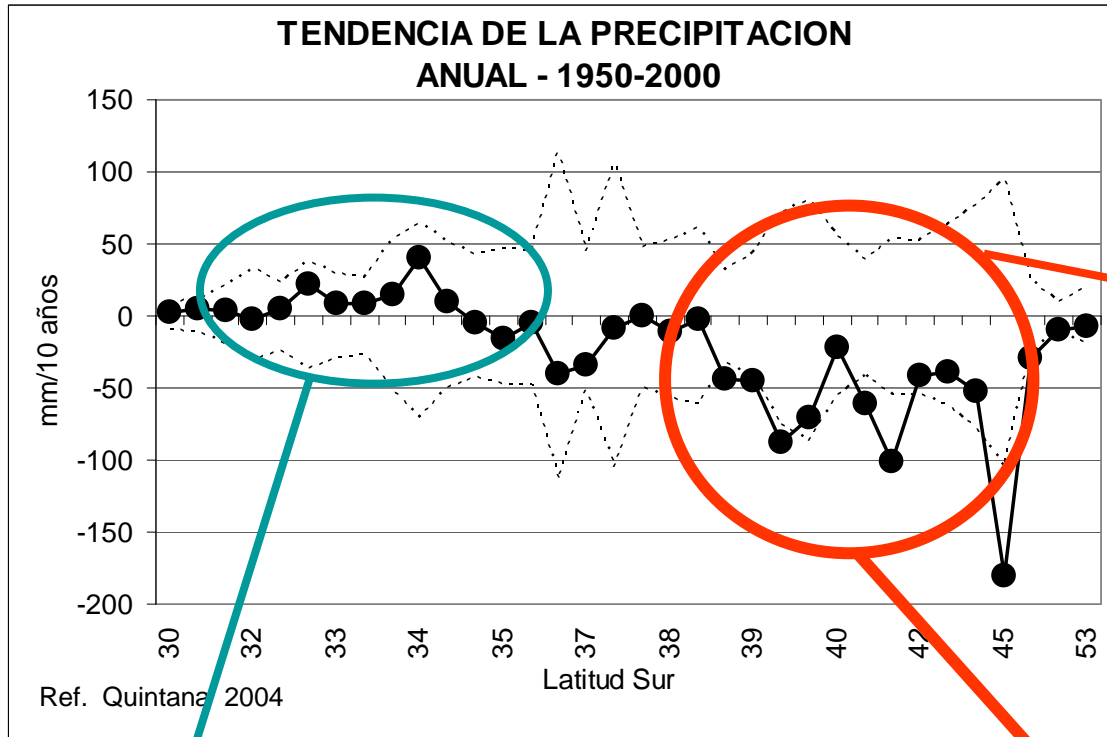
# Multimodel mean Regional warming 1970-2000 (SST\*). Also shown in contours SLP\* trend



**Global mean: +0.2°/dec**

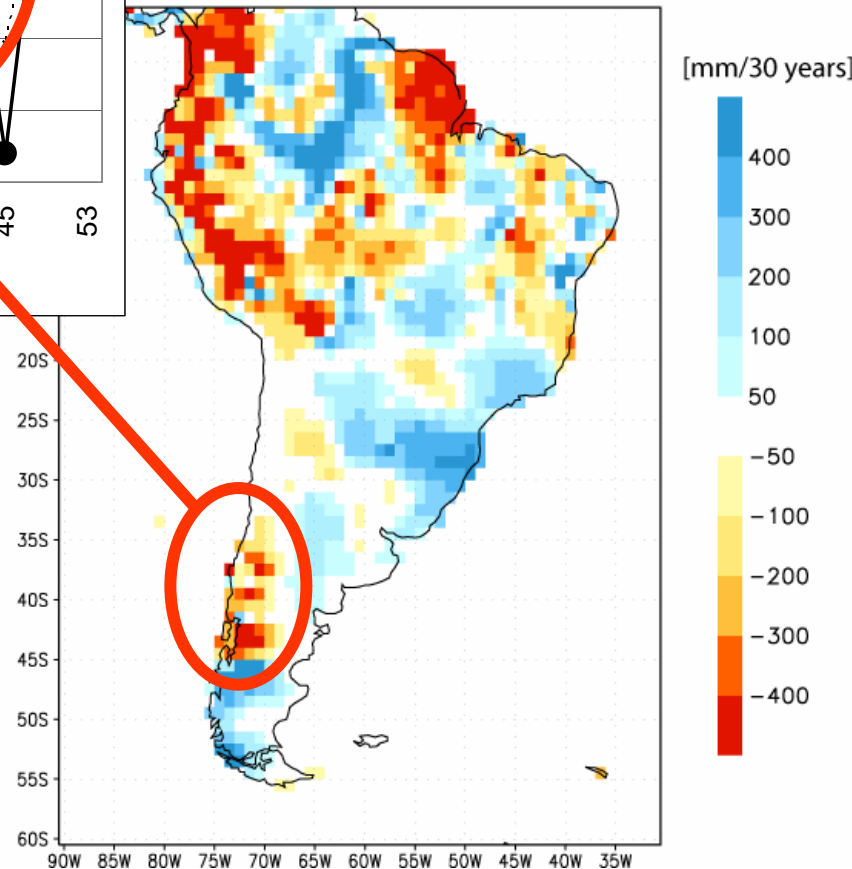


# Precipitation Changes...warming, drying south

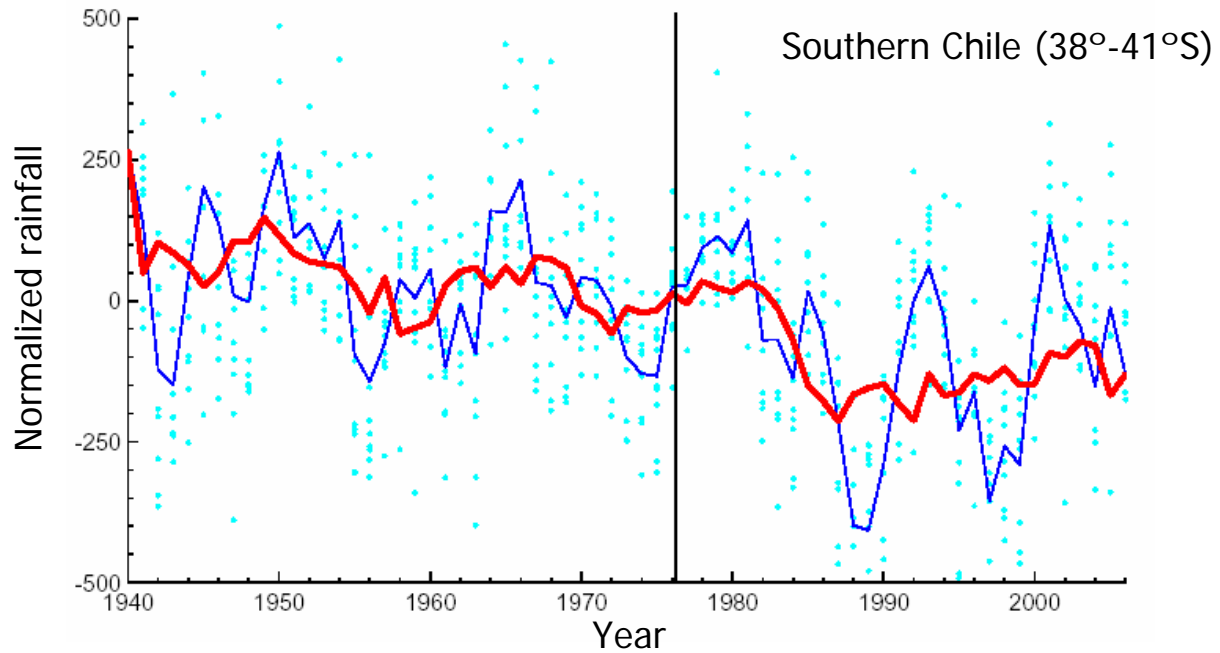
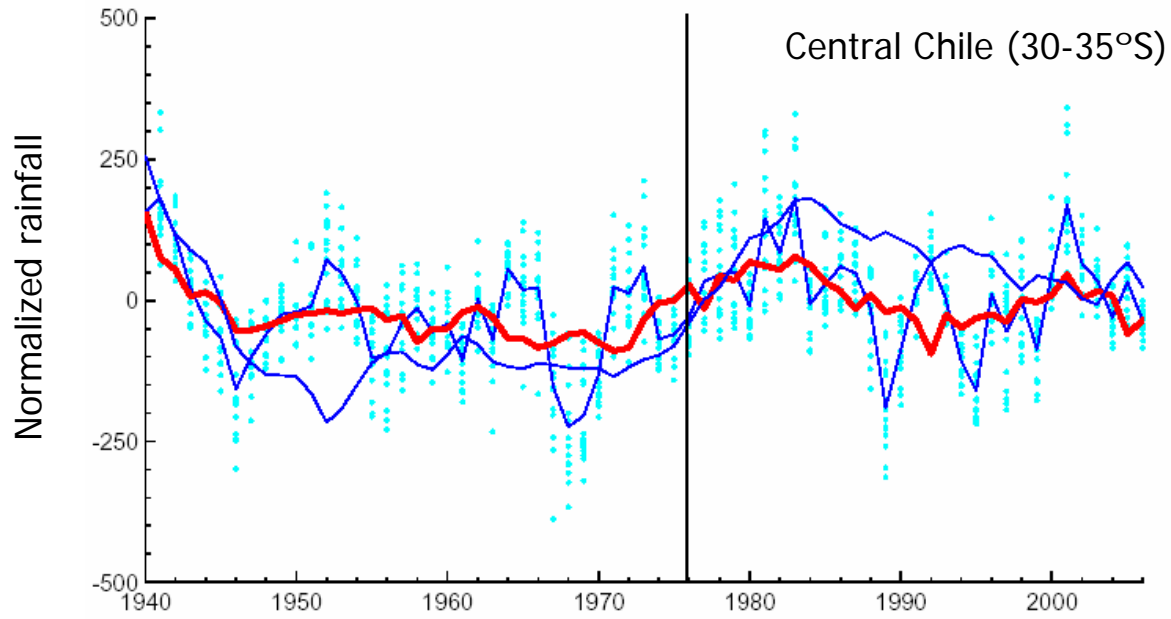


- Rainy climate
- MAP ~ 1000-3000 mm
- $\sigma(IA)/MAP \sim 0.1$
- Weak ENSO Impact
- Significant drying trend

- Semiarid climate
- MAP ~ 30-500 mm
- $\sigma(IA)/MAP \sim 0.3 - 0.5$
- Strong ENSO Impact
- No significant trend

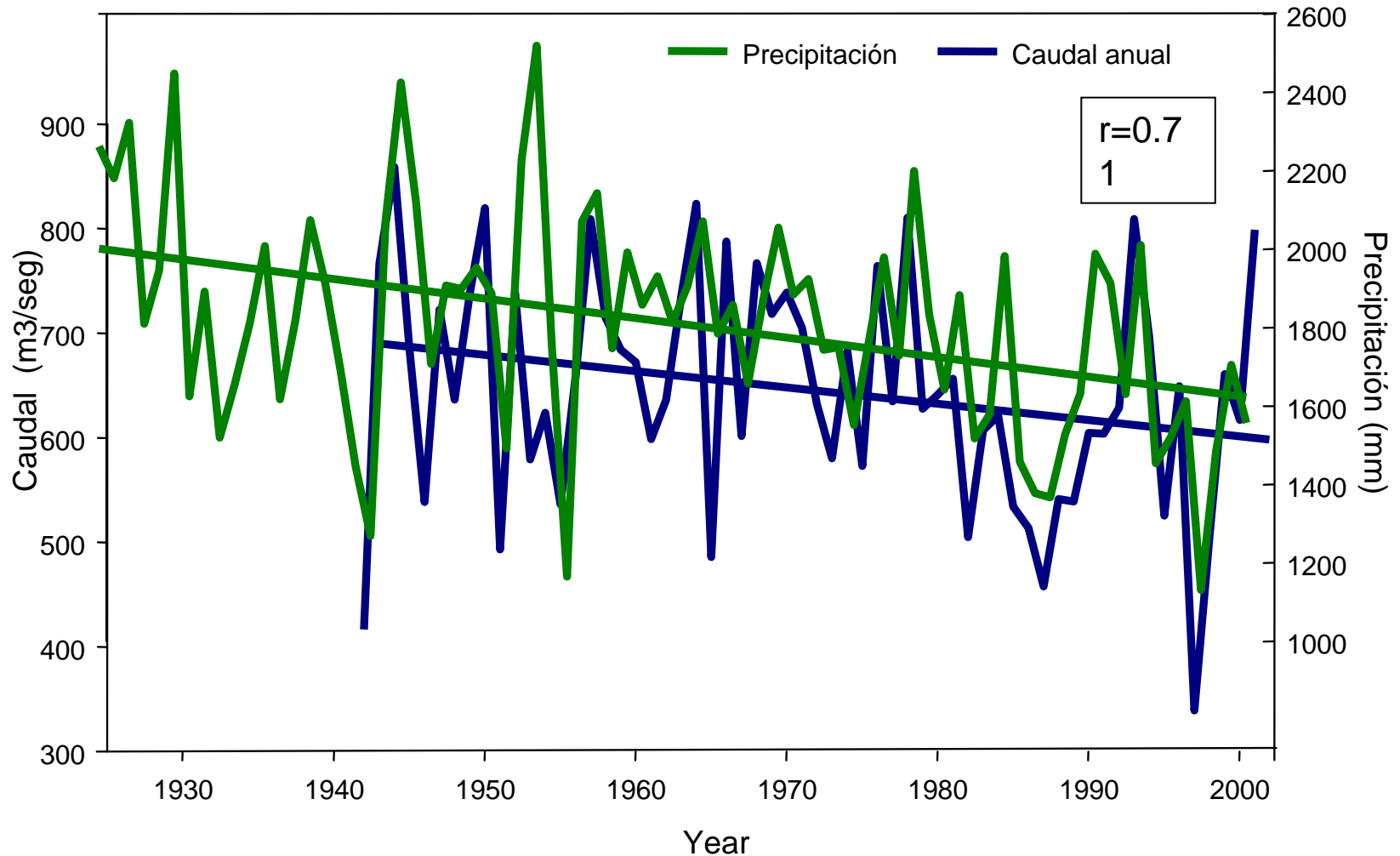


# Evolución de las Precipitaciones

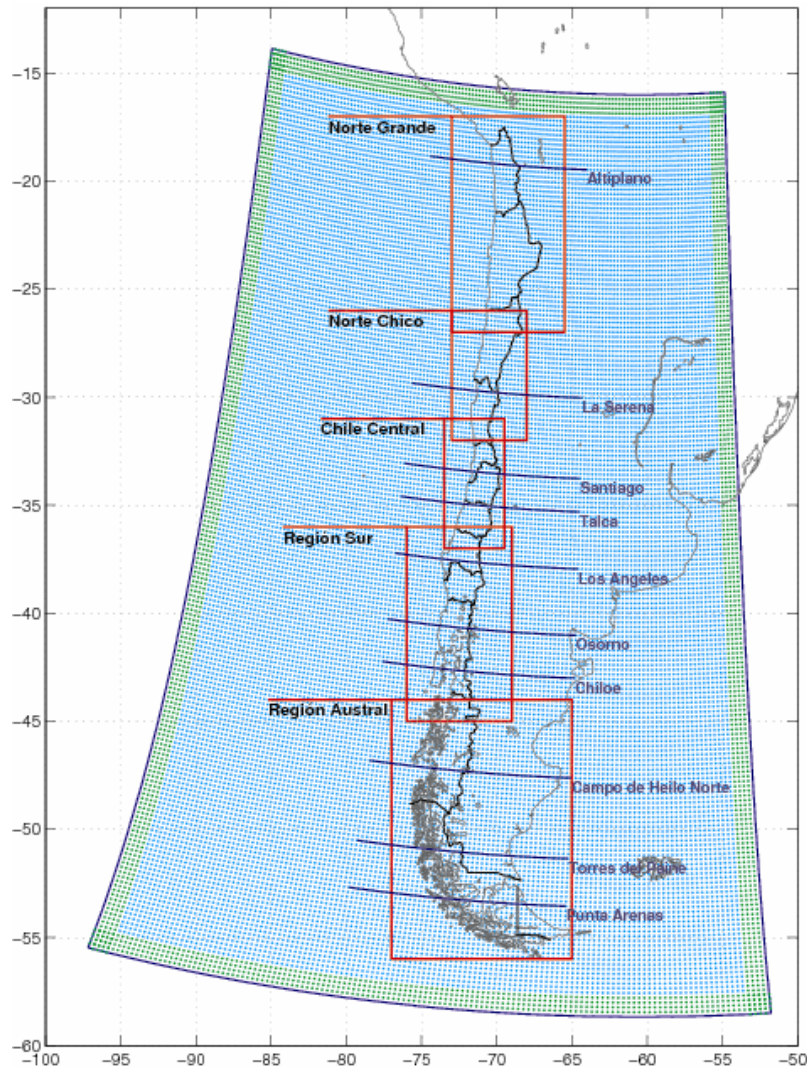




# Comparación entre la precipitación de Pto. Montt y el caudal del Río Puelo (Fuente: Antonio Lara, UACH)



# Regional Simulations of the Future



## Model:

- PRECIS – UK

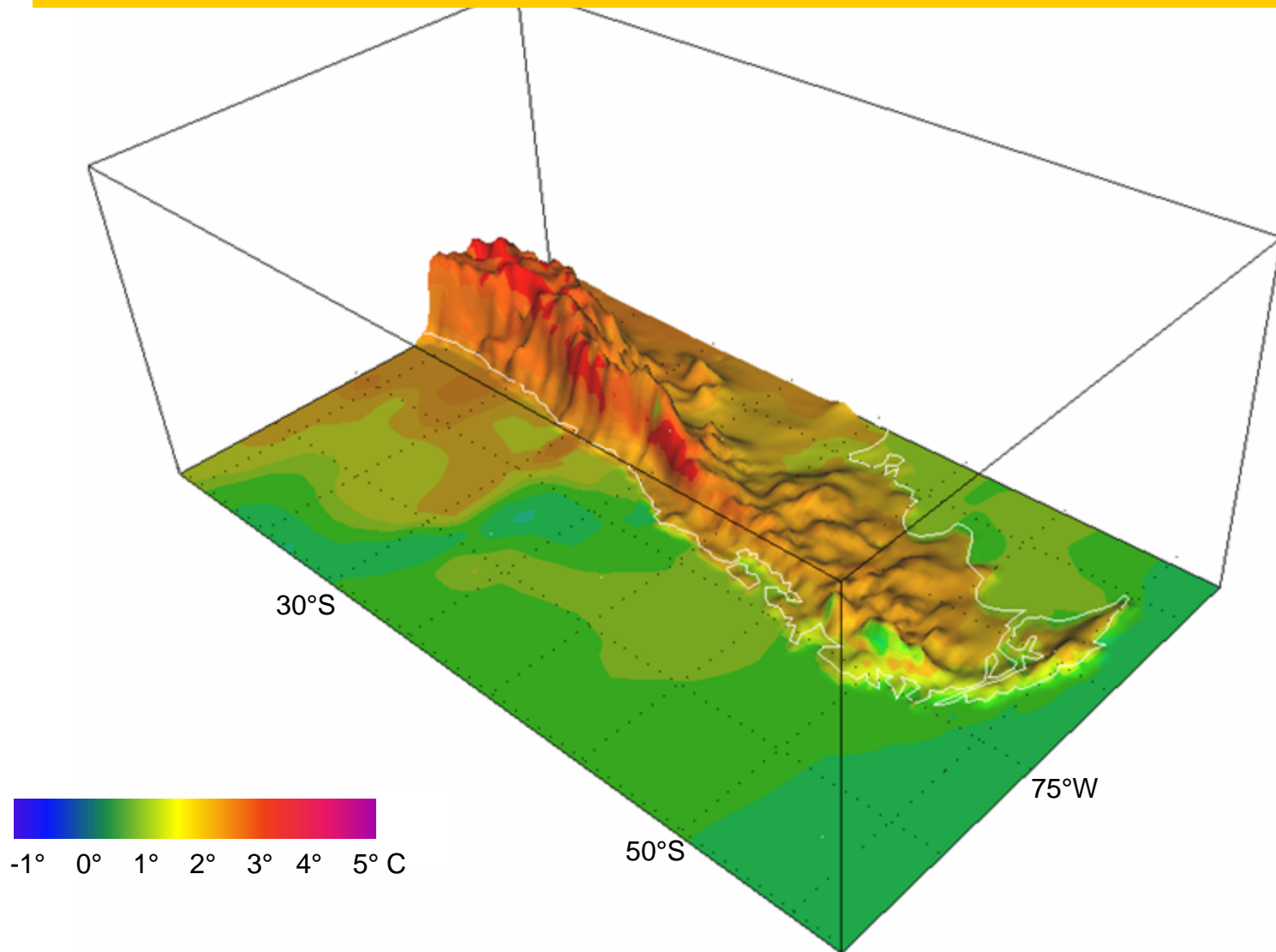
## Single domain

- Horiz. grid spacing. 25 km
- 19 vertical levels
- Lateral BC: HadAM every 6h
- Sfc. BC: HadISST1 + Linear trend

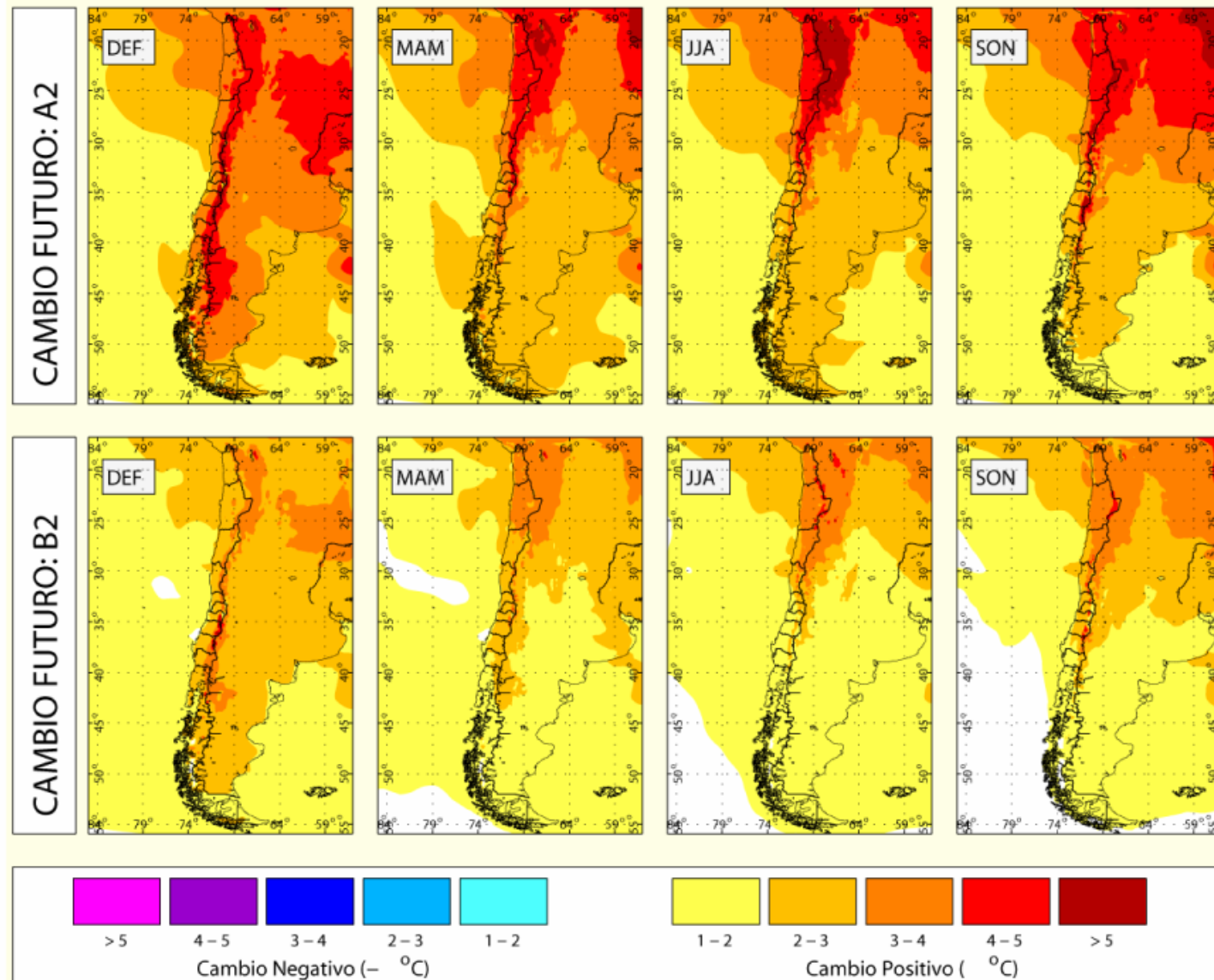
## Simulations

- **1961-1990 Baseline**
- **2071-2100 SRES A2 y B2**
- 30 years @ 3 min → 4 months per simulation in fast PC

# Surface Temperature Difference A2-BL

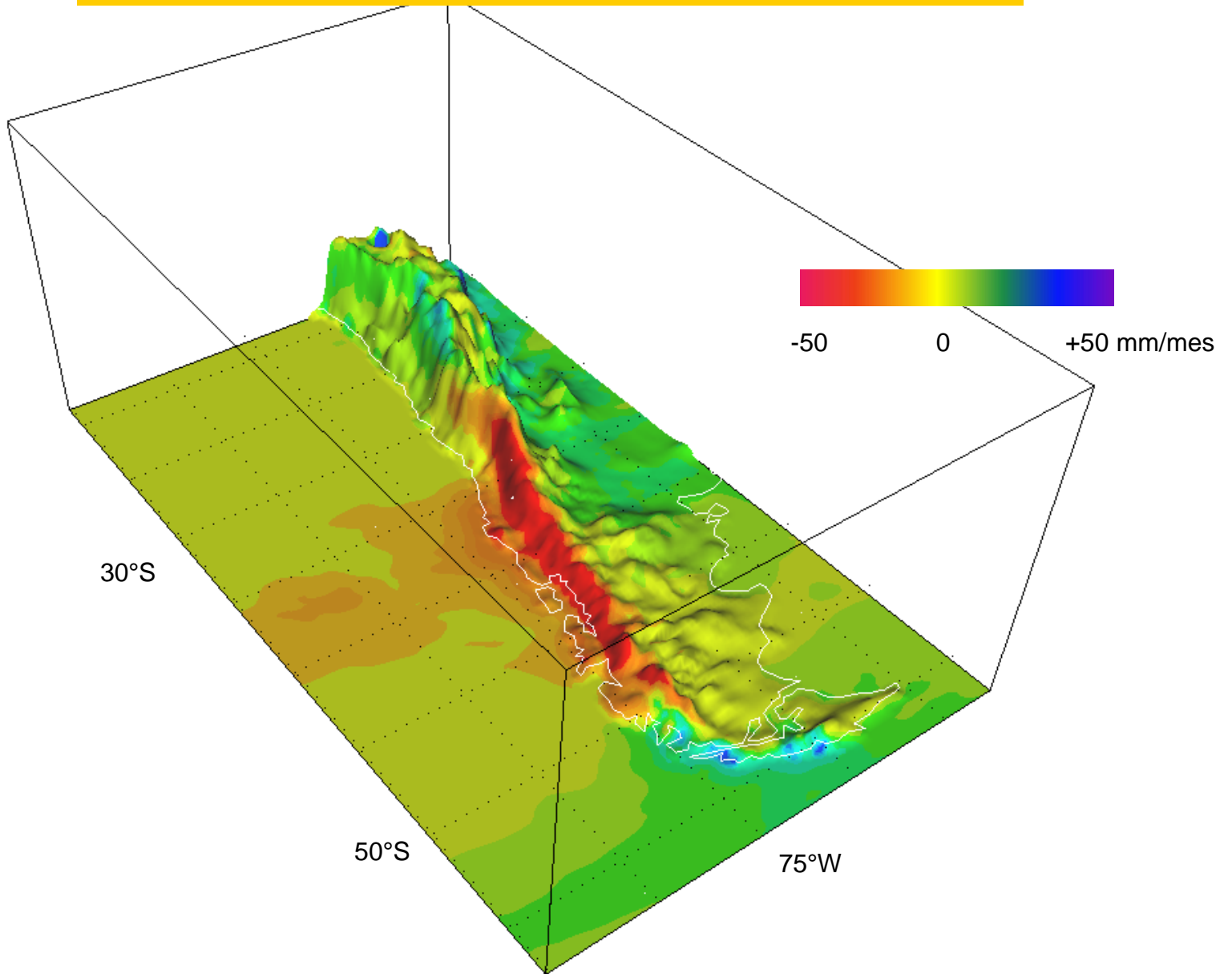


# PRECIS-DGF $T_{\text{futuro}} - T_{\text{presente}}$



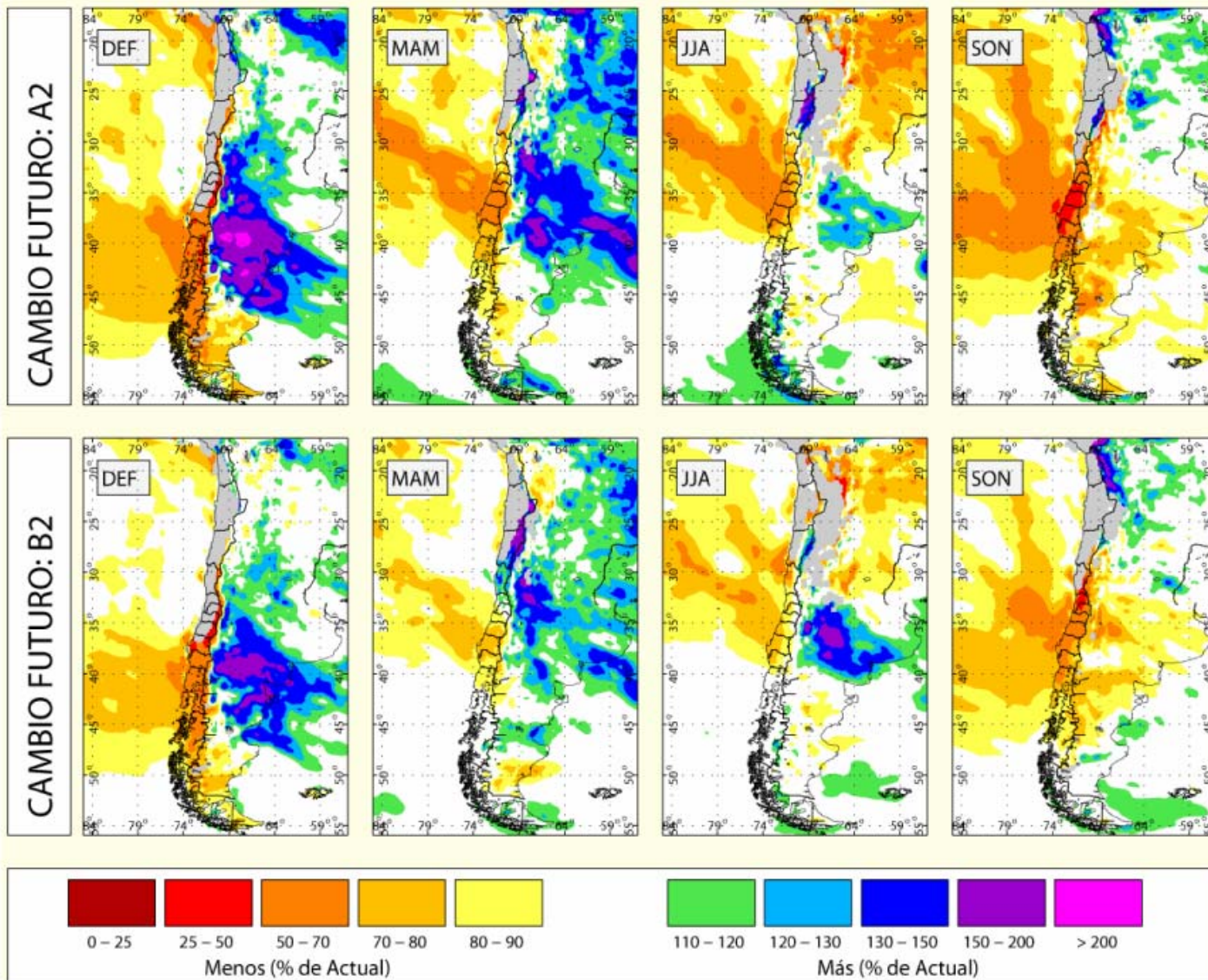
Futuro: 2071-2100 / Presente: 1960-1990

# Precipitation Difference A2-BL



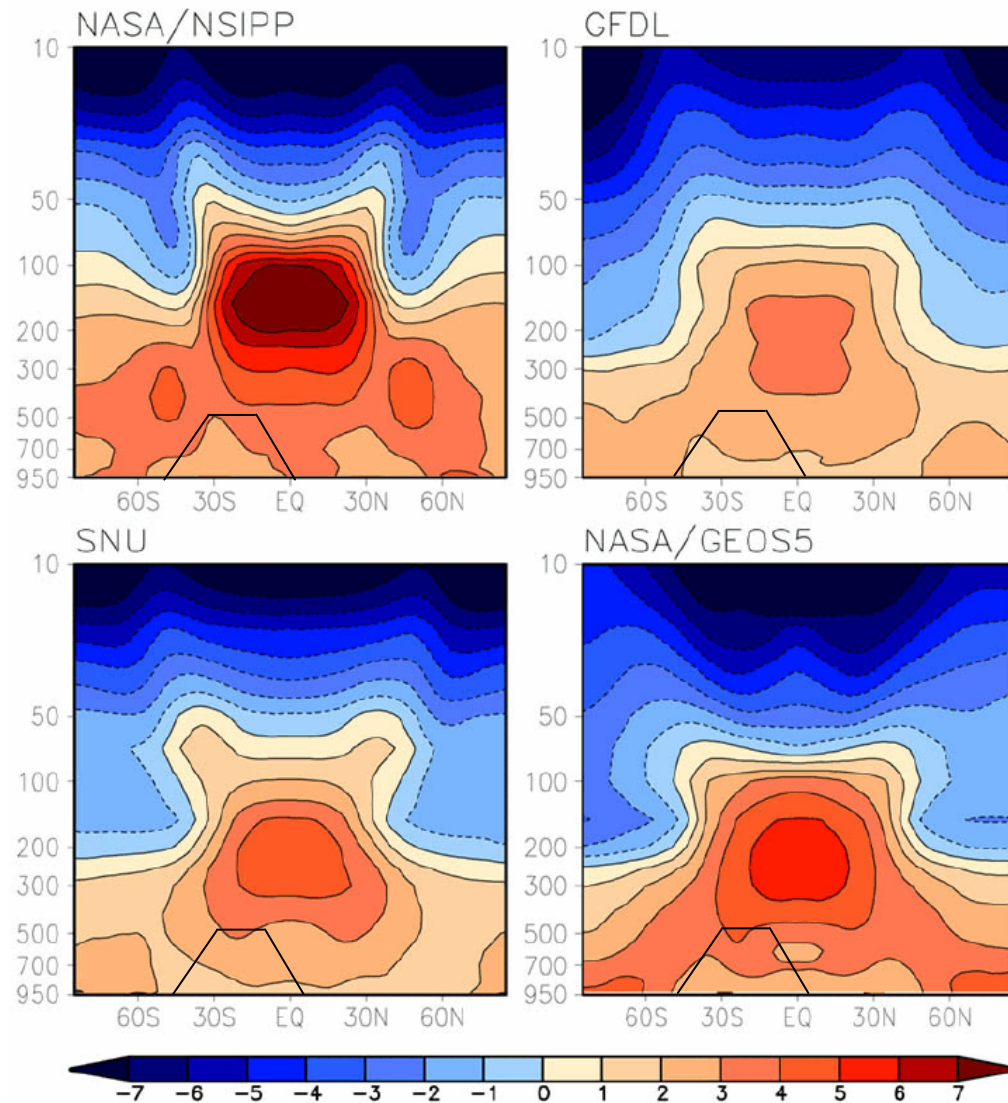


# PRECIS-DGF $R_{\text{futuro}} / R_{\text{presente}}$



Futuro: 2071-2100 / Presente: 2071-2100

# Zonal mean distribution of temperature change (2xCO<sub>2</sub>-Ctr)

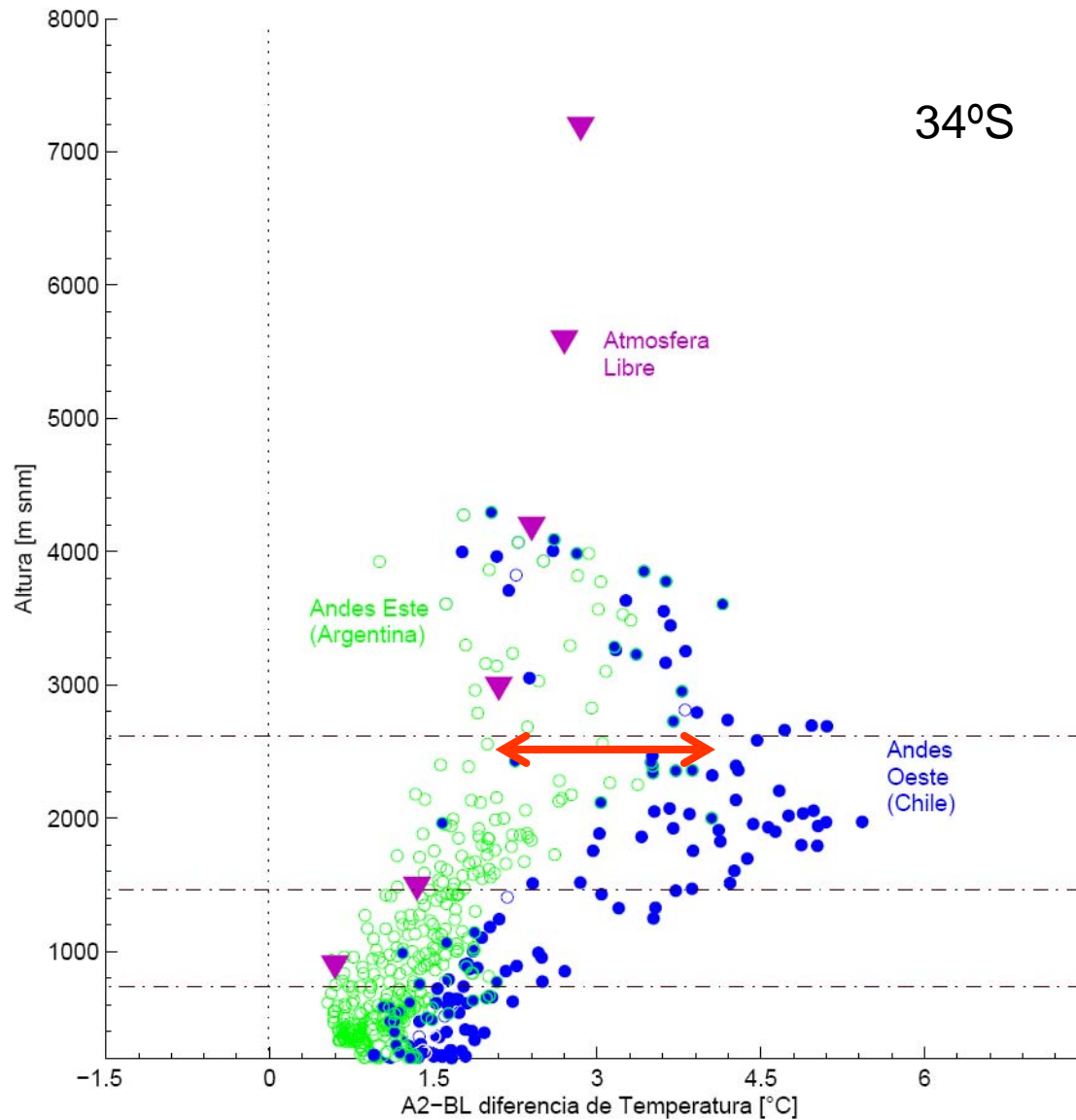


Zonal mean distributions of temperature change (2xCO<sub>2</sub>-Control). Units are Kelvin.

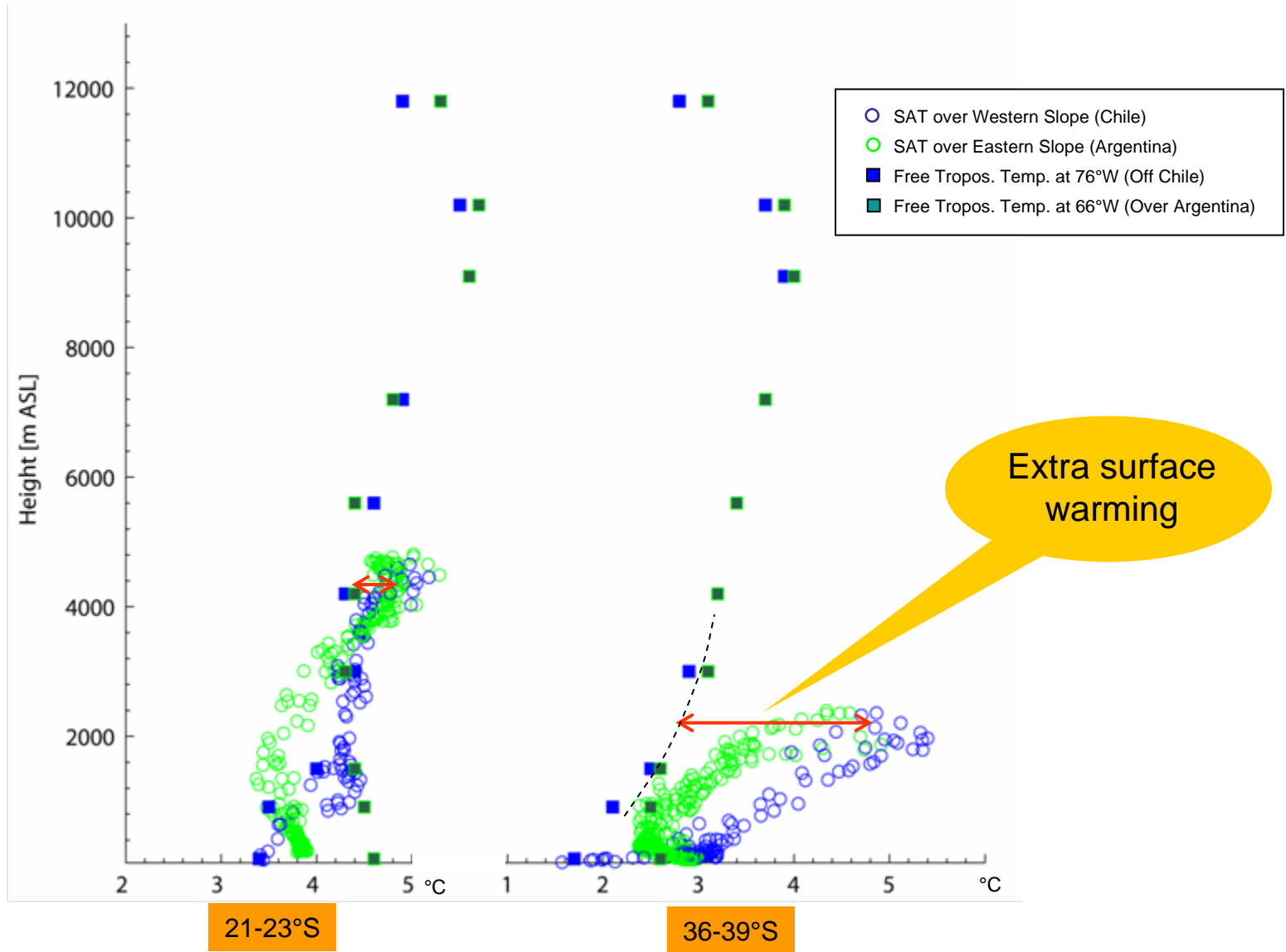
**Figure 4:** Zonally averaged, equilibrated temperature change associated with doubling CO<sub>2</sub> as a function of latitude and pressure for four different GCMs. From Lee et al, 2007.



# $\Delta T$ (A2-BL) versus Height

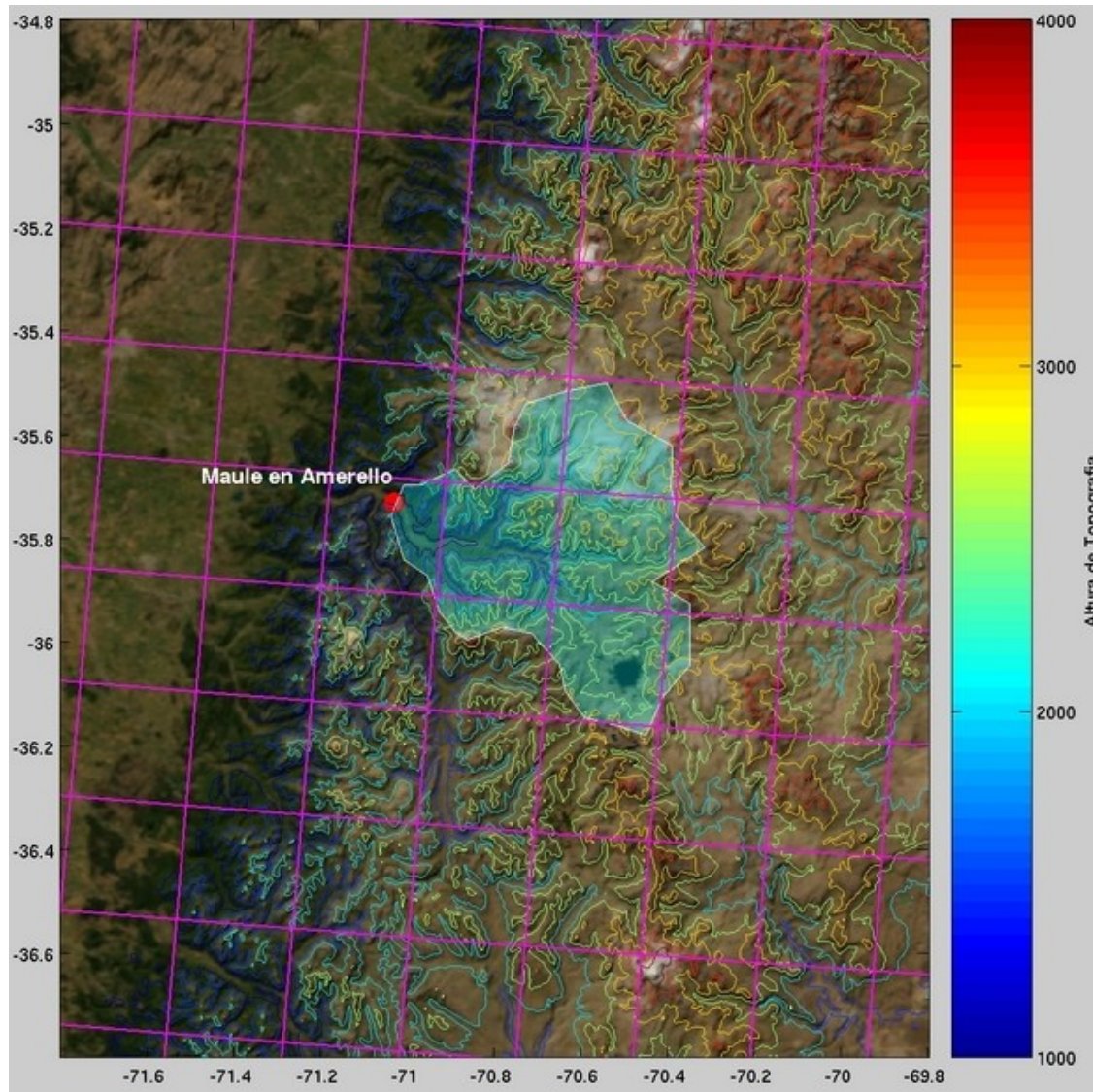


# $\Delta T$ (A2-BL) versus Height



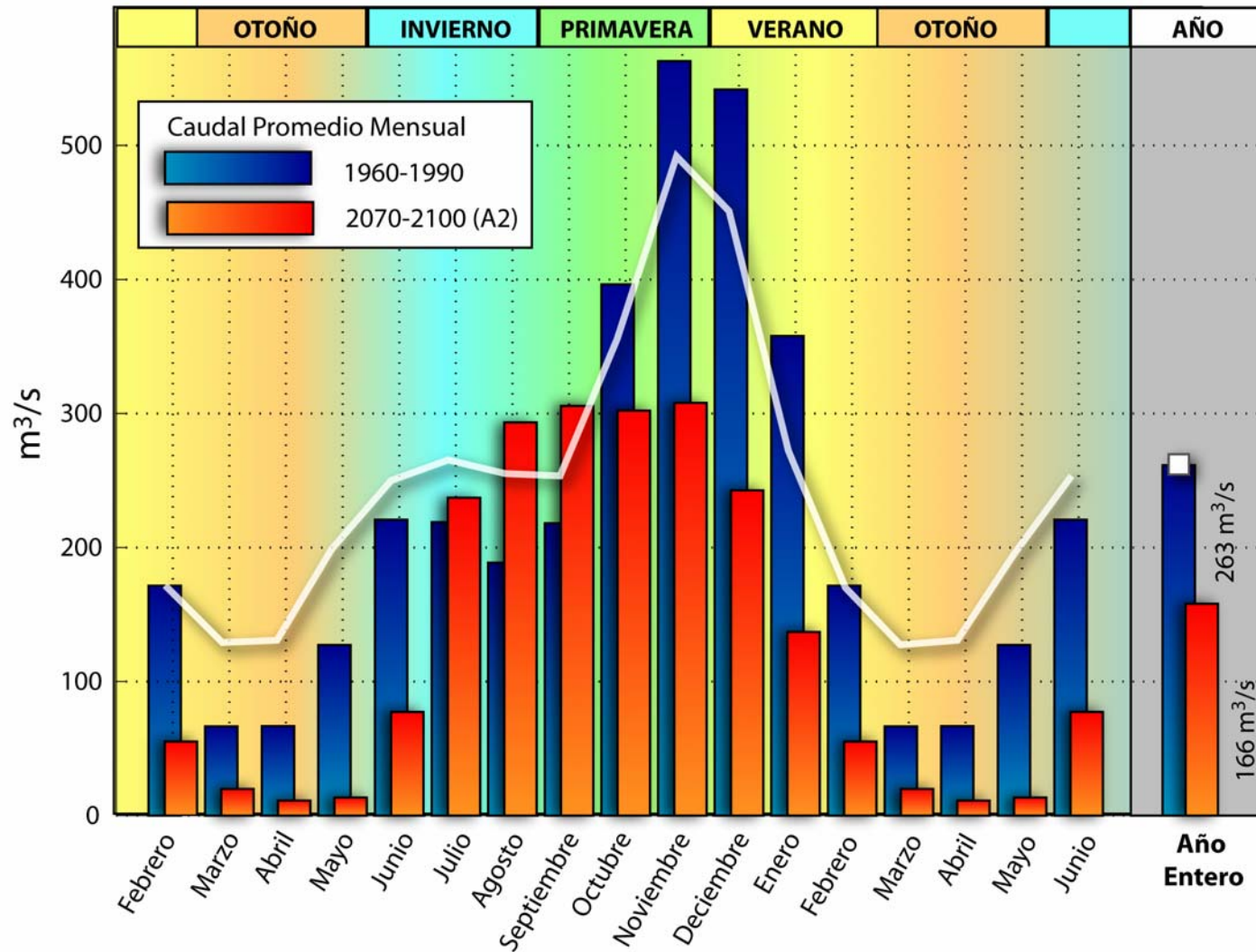
# PRECIS-DGF

Acomplamiento con modelos hidrológicos.



# PRECIS-DGF Acomplamiento con modelos hidrológicos.

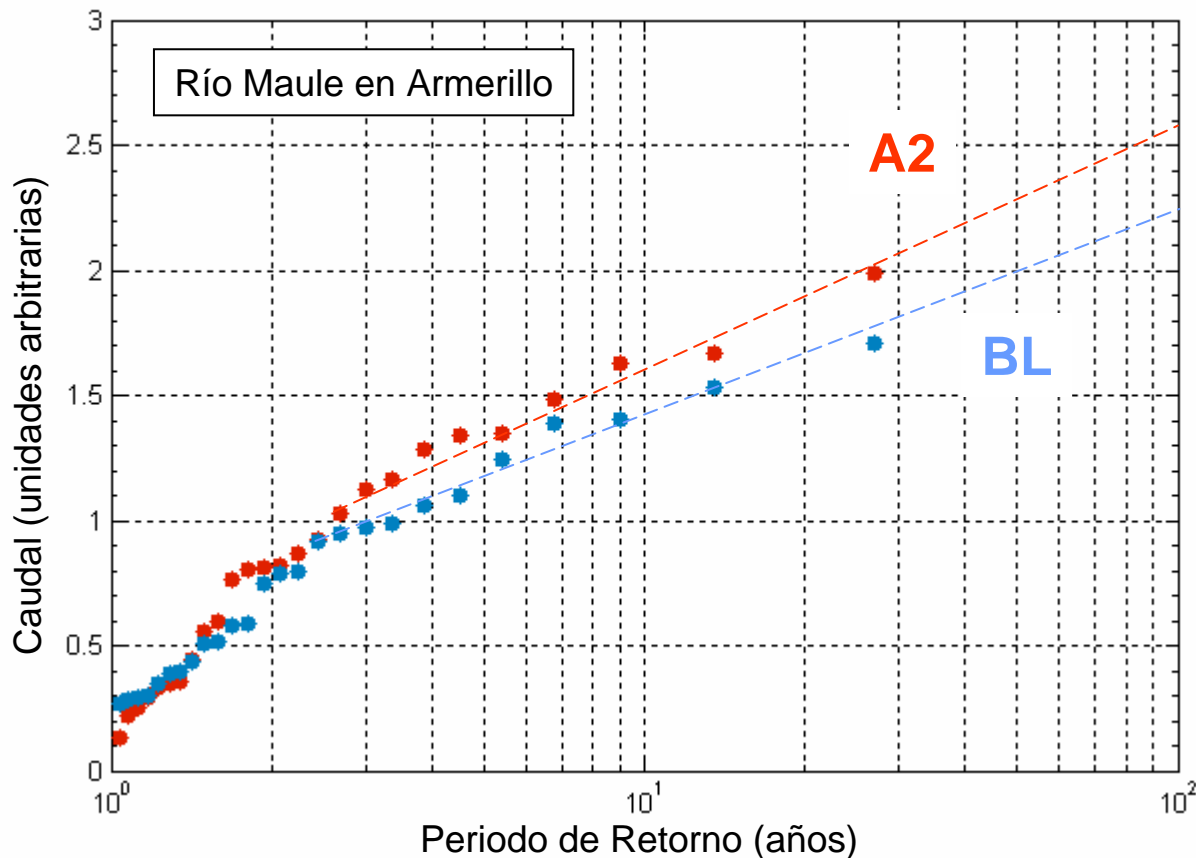
## CAUDAL SIMULADO DEL RIO MAULE\* - PRESENTE y FUTURO (A2)



\* Rio Maule en Armerillo - Pre-Cordillera

# PRECIS-DGF - Eventos Extremos

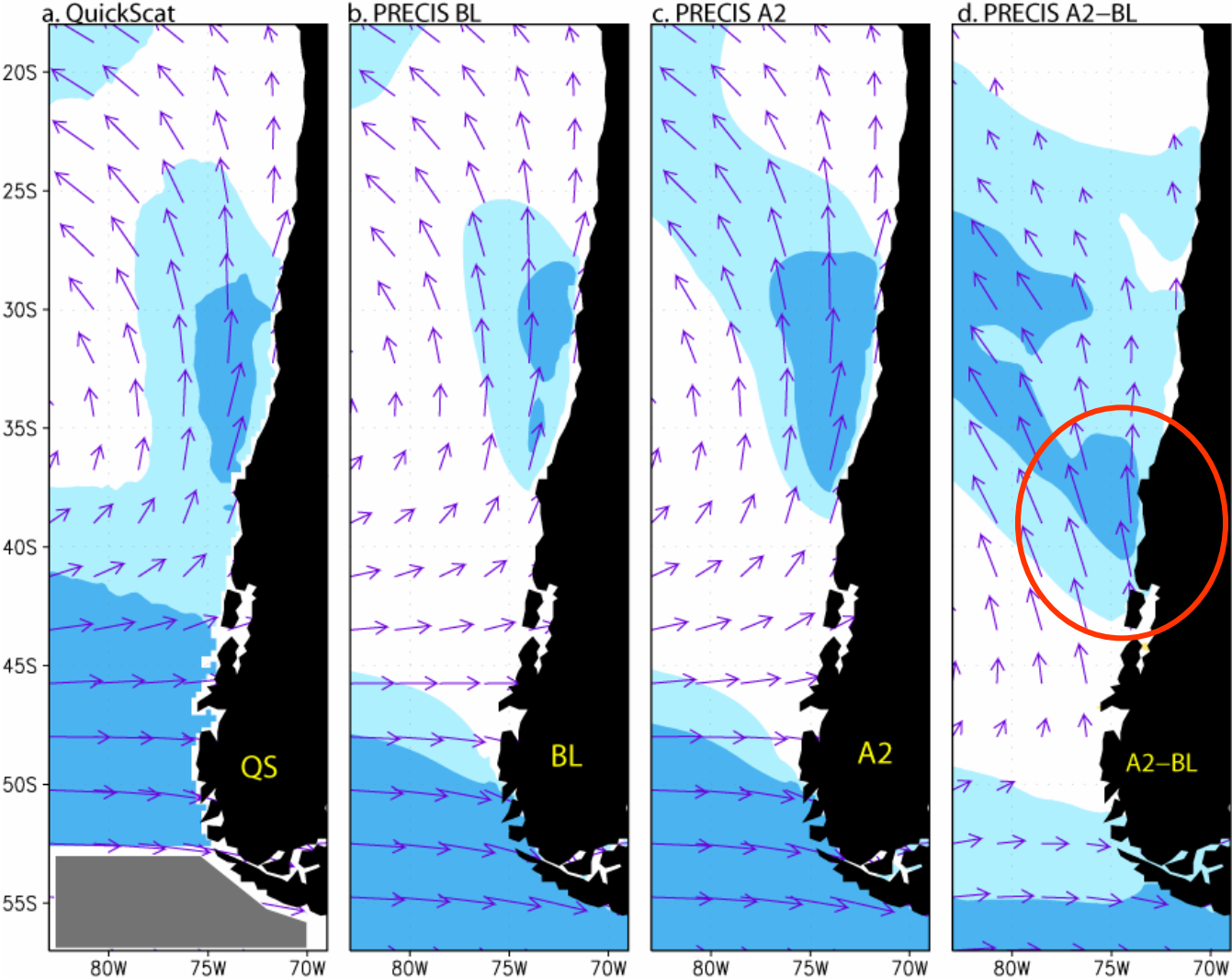
Modelo hidrológico simple indica cierta disminución de **caudales extremos diarios** con bajo periodo de retorno pero un aumento de caudales extremos diarios con alto periodo de retorno





# Resultados PRECIS: Viento Superficial

Surface Wind – SONDJ



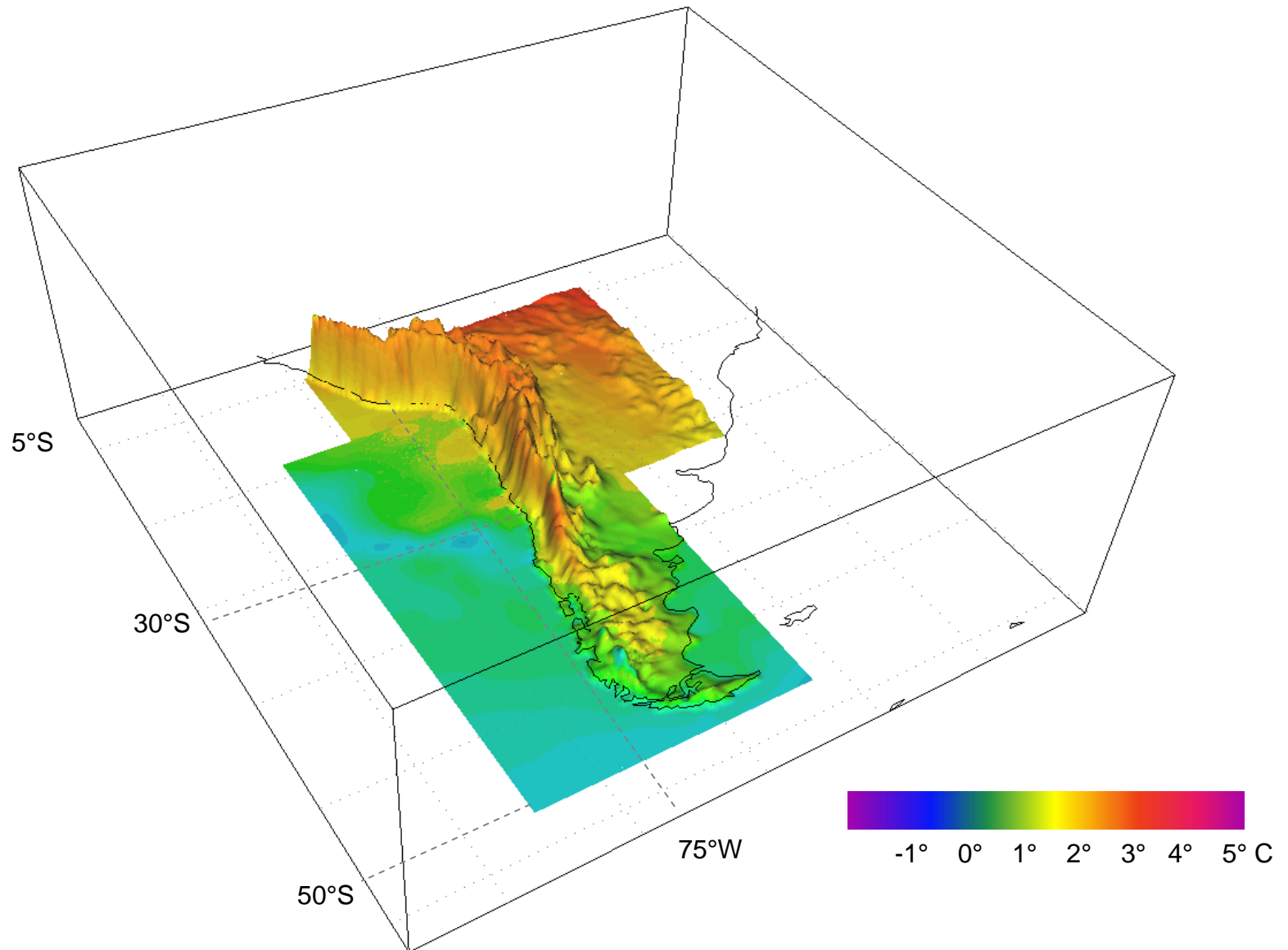
Consecuencias biológicas a través de cambio en la surgencia costera y turbulencia

# Conclusiones

- \* Existen manifestaciones del cambio climático asociado a los GI en las últimas décadas a lo largo del país.
- \* Cambios proyectados son en algunos casos similares en magnitud y signo a los observados en las últimas décadas.
- \* Zona centro sur afectada por disminución de precipitación (especialmente en primavera,  $\sim 1/2-3/4$  actual), aumento de temperatura (especialmente Tx,  $\sim + 2-4^{\circ}\text{C}$ ) y vientos del sur mas intensos durante verano
- \* Es tiempo de moverse a predicciones ambientales y construir una estrategia de adaptación regional / sectorial



# Surface Temperature Difference A2-BL



# Precipitation Difference A2-BL

