The Coastal Jet in Future Climate Scenarios

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December 2006

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Thanks to H. Fuenzalida, M. Rojas and R. Sanchez

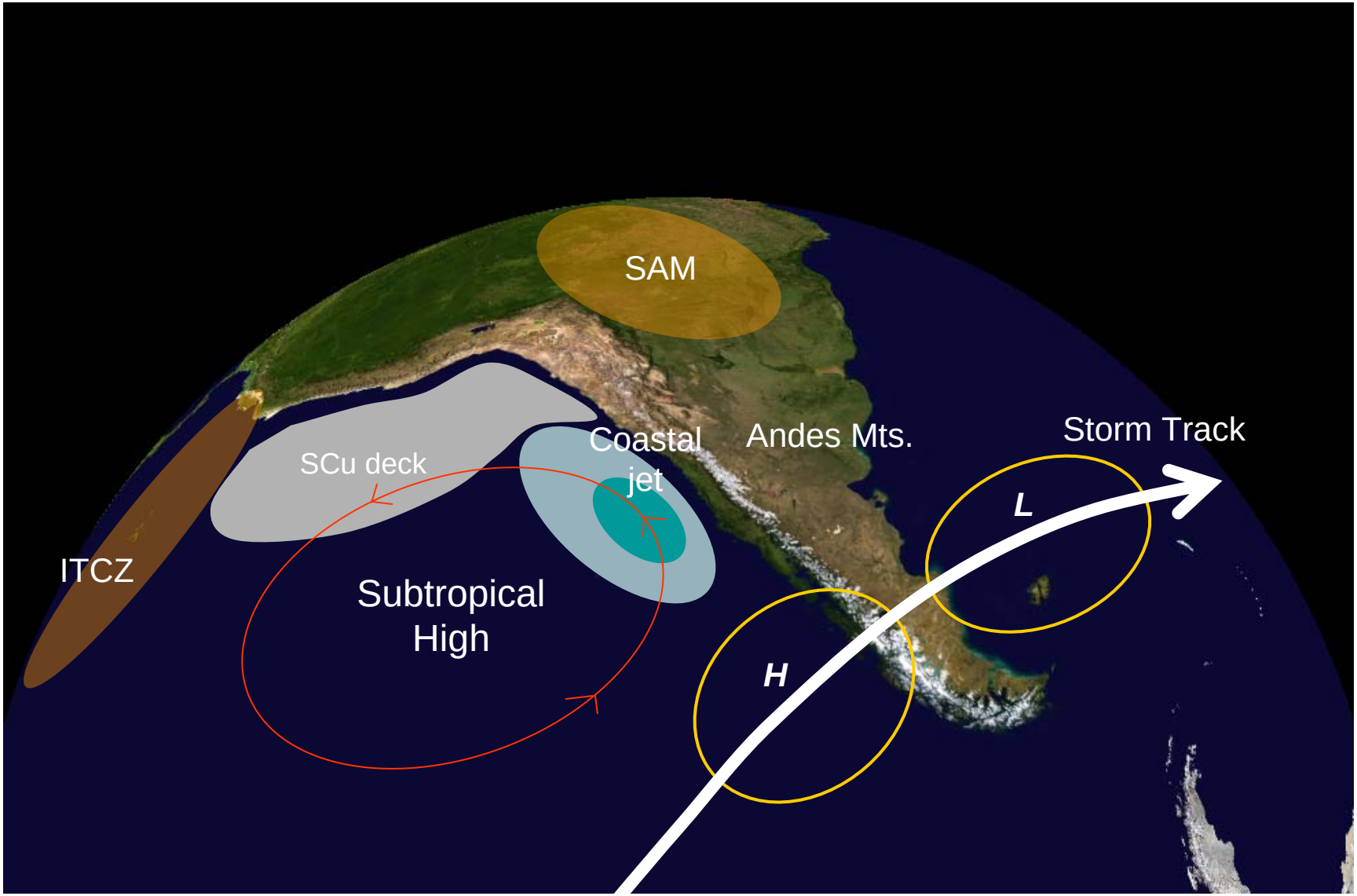
Outline

- Coastal jet basics:

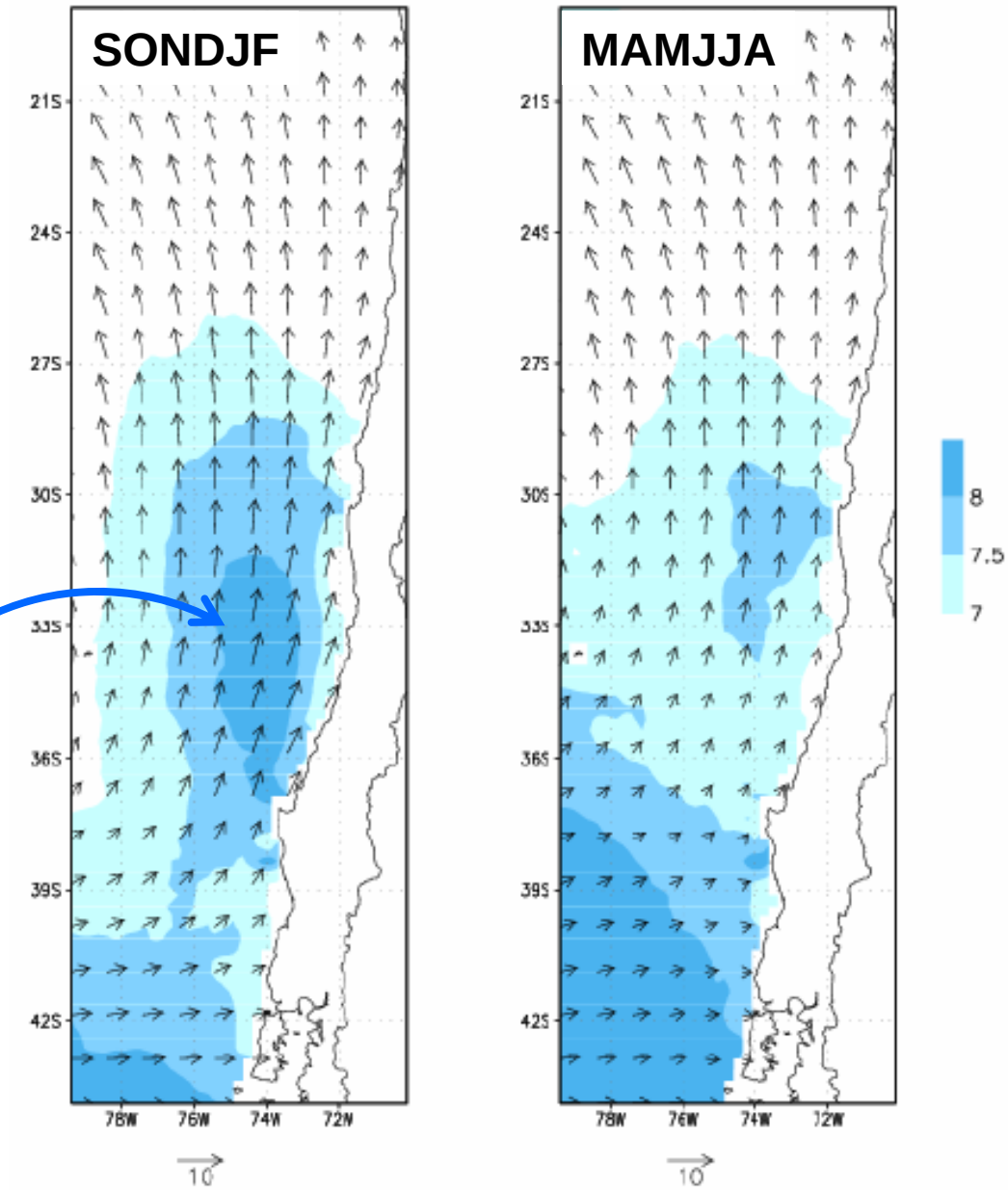
  climatology, impacts, interannual variability

- Future scenarios: insights from GCMs
- Future scenarios: insights from RCM

Key Atmospheric Features over the SEP



Surface wind climatology (u,v,ws): QSCAT 2000-2003 / 0.25°

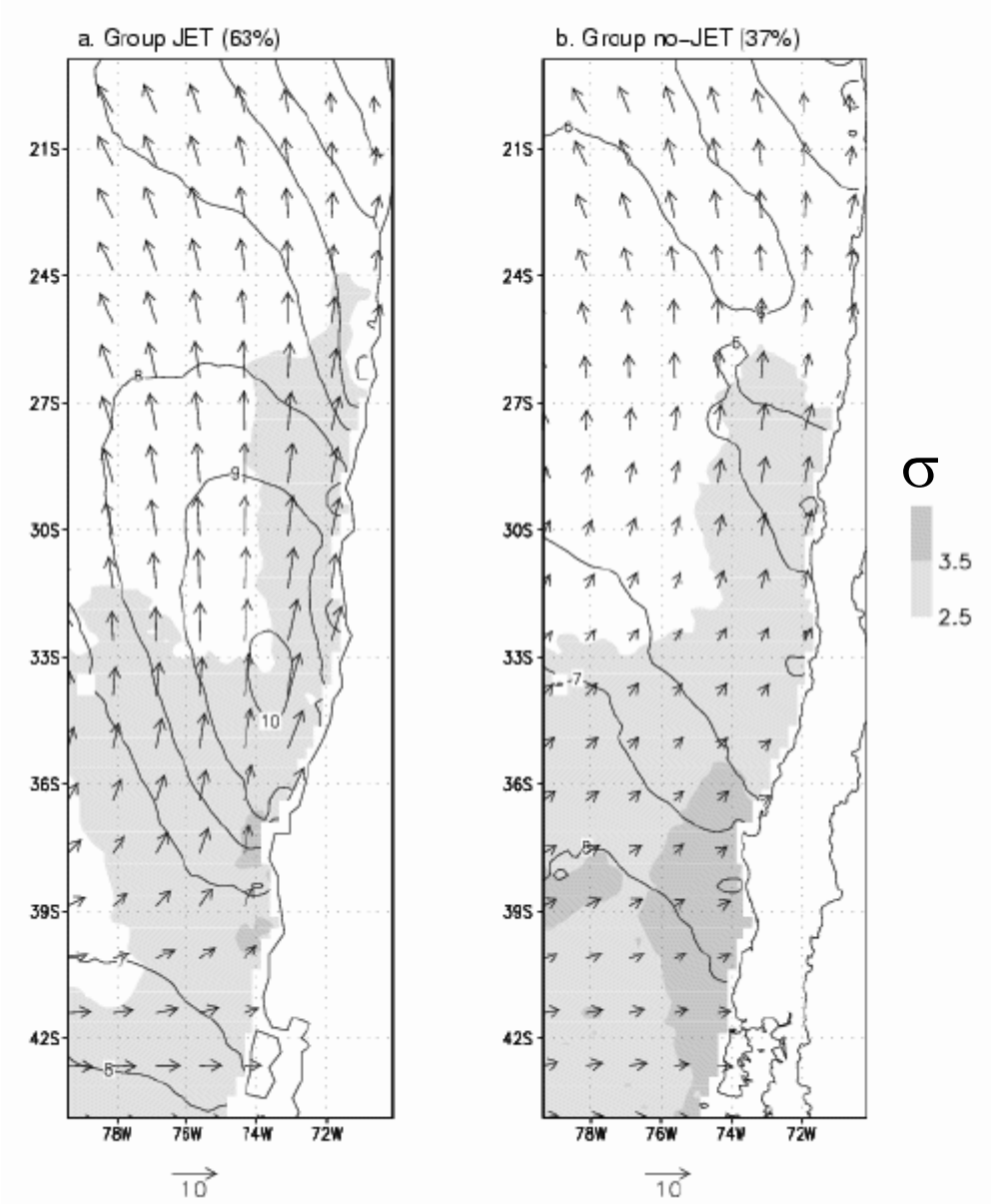


Coastal Jet

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

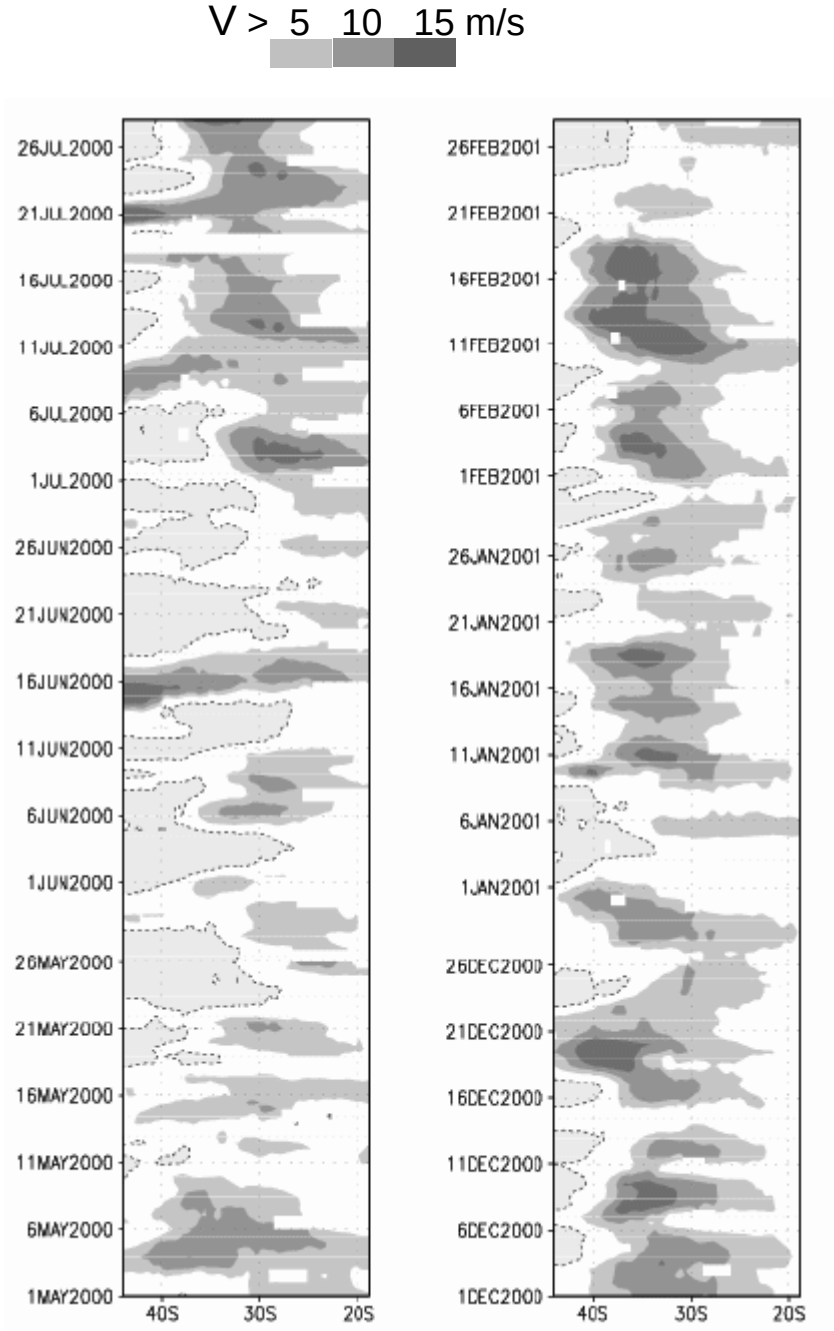
Cluster analysis using ws individual fields:

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



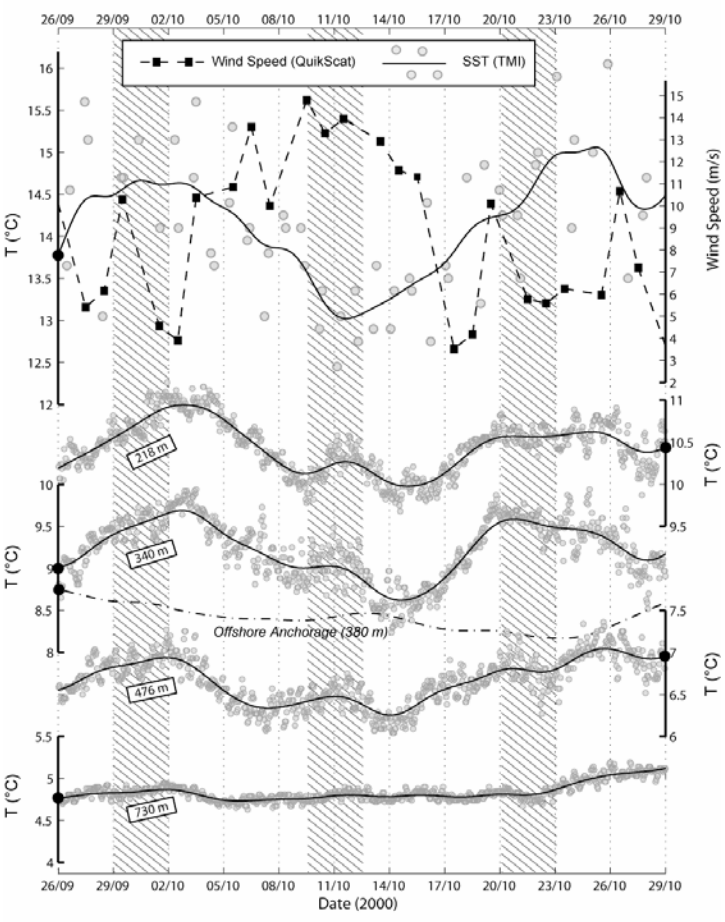
Jet-structure in mean field, but how often a jet occurs?

- V > 8 m/s off central Chile almost always associated with a southerly jet (dark shaded)
- Jet events typically a week long (3-15 days)
- More frequent, stronger and longer in summer.

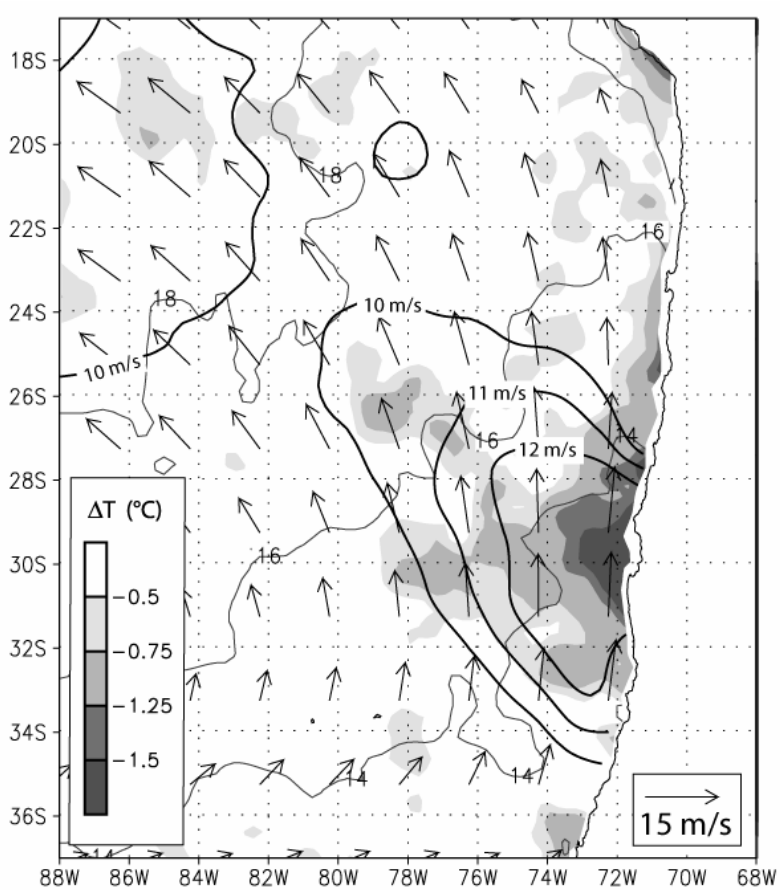


The october-2000 coastal jet event (well defined but not extreme)

SST, ocean Temp. and
Surface wind speed at 30ºS 73ºW

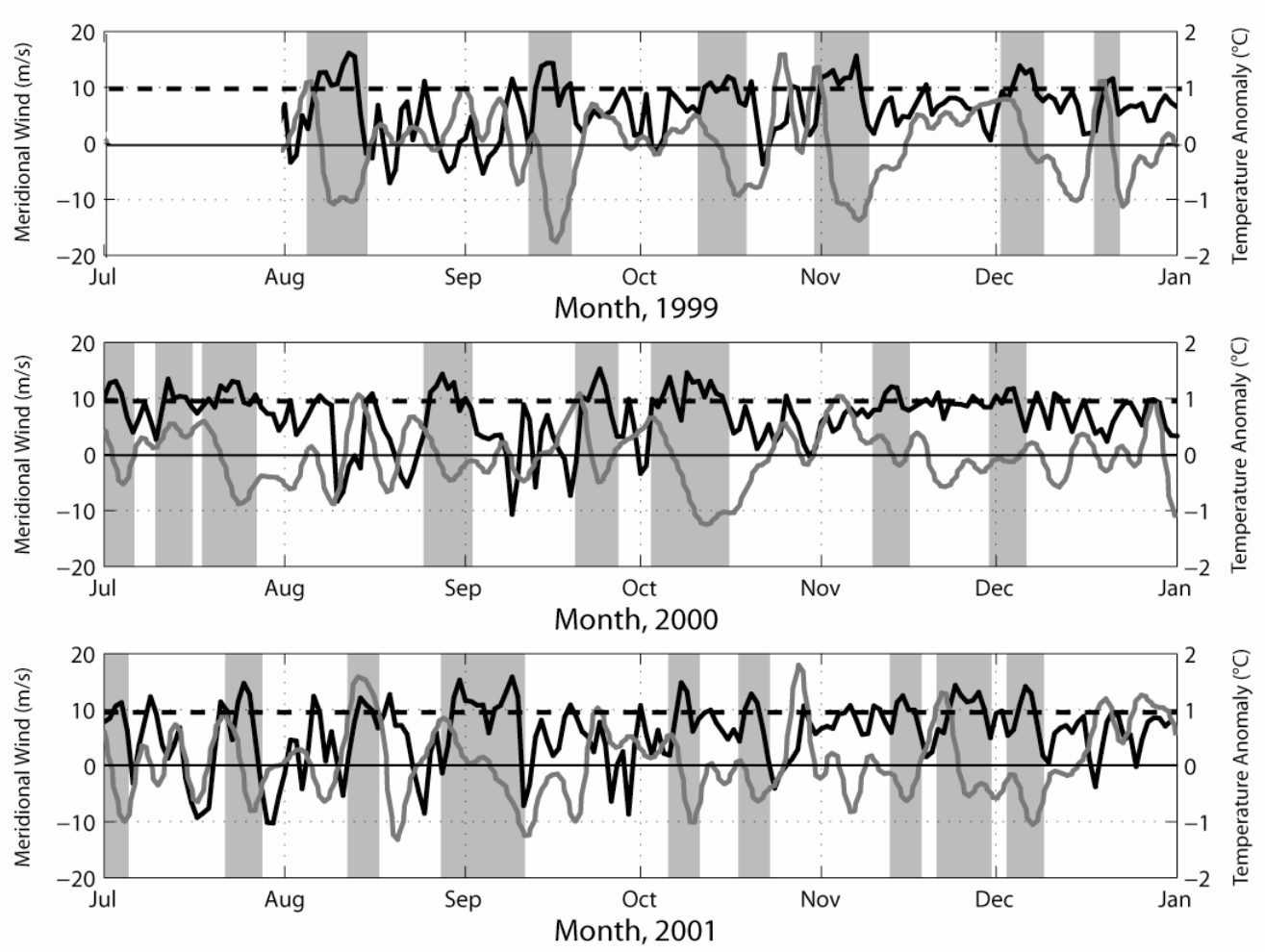


Wind, SST and SST anomalies



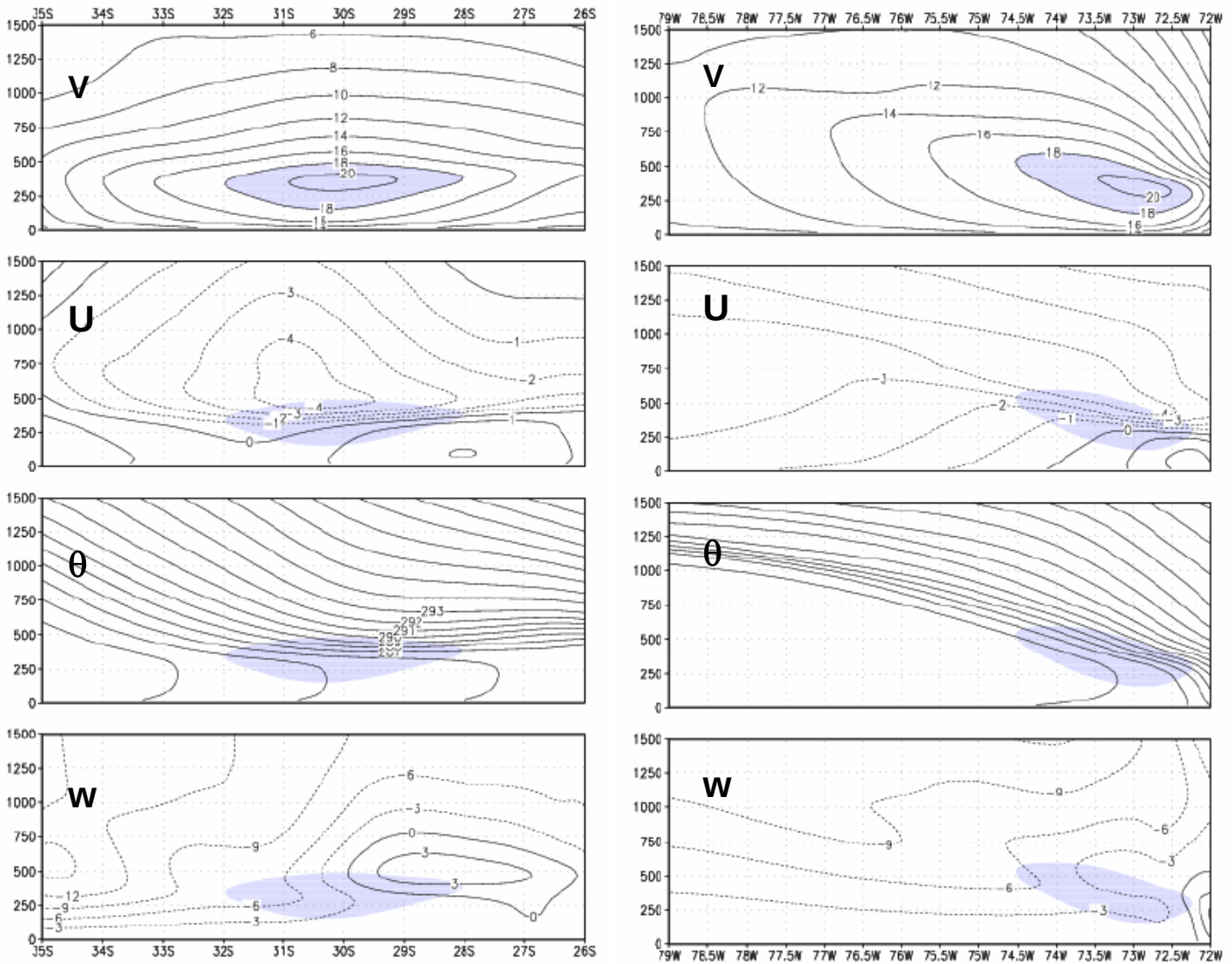
Renault et al. 2006

Time series of low-pass filtered SST (annual cycle removed) and meridional wind



Renault et al. 2006

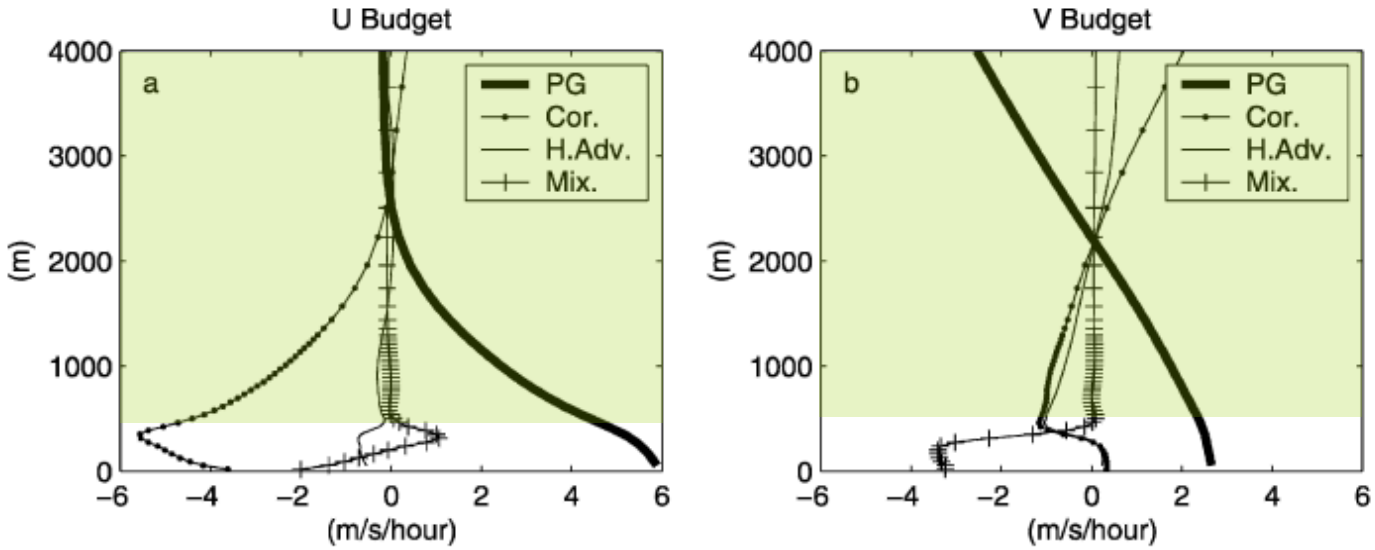
Simulated (MM5) structure of the coastal jet



V > 18 m/s

Garreaud and Muñoz 2005

Steady-state Dynamics



Mean (time average 11-13 Oct 2000) vertical profiles of terms in the zonal and meridional momentum budget for a point at 30.2°S 72.8°W. Within the lowest 0.5 km ***u*** ~ 0 (blocking effect of the coastal range?), thus:

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

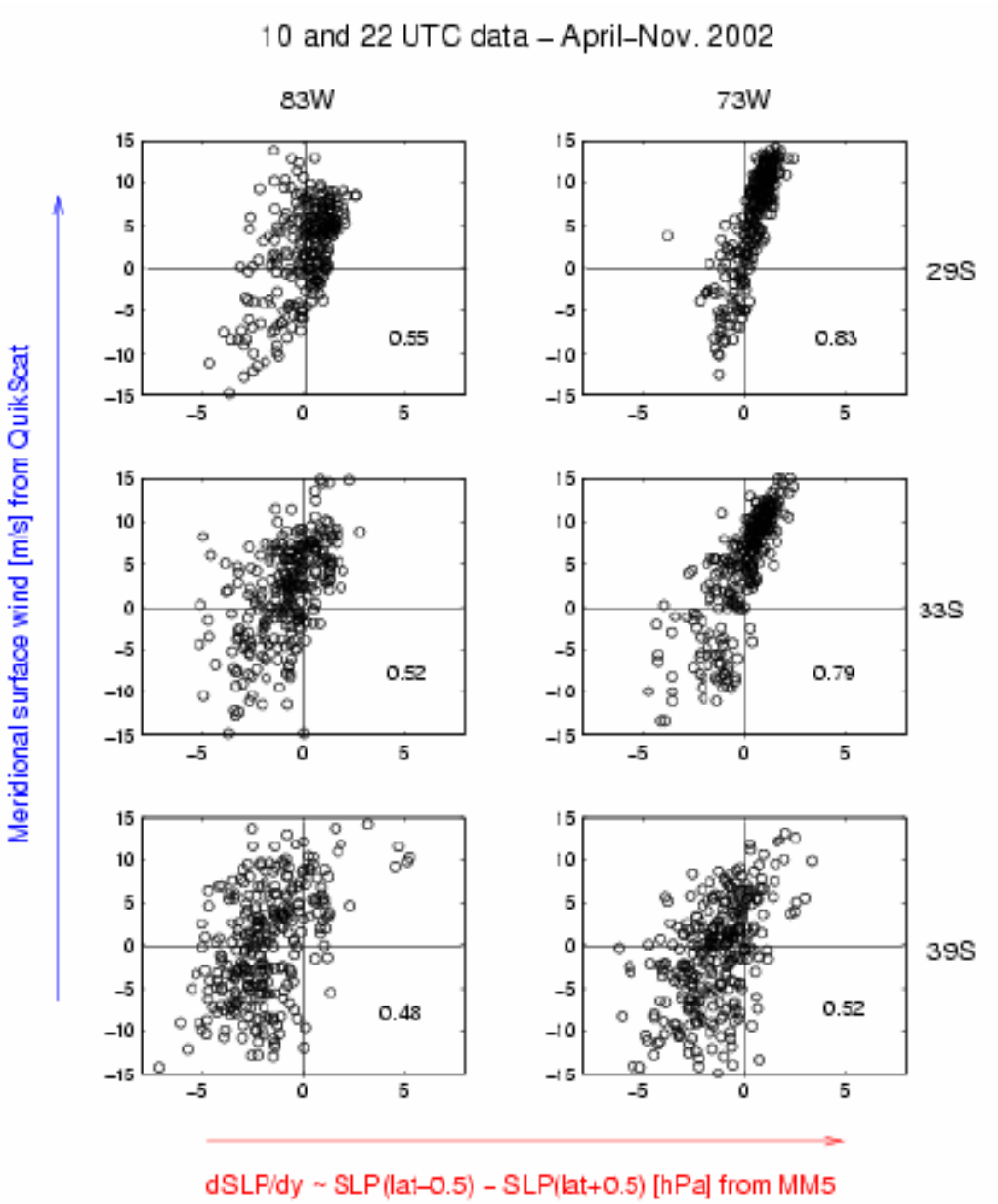
$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+fu-\frac{C_d}{H}v|\vec{v}|$$

Muñoz and Garreaud 2005

Steady-state dynamic

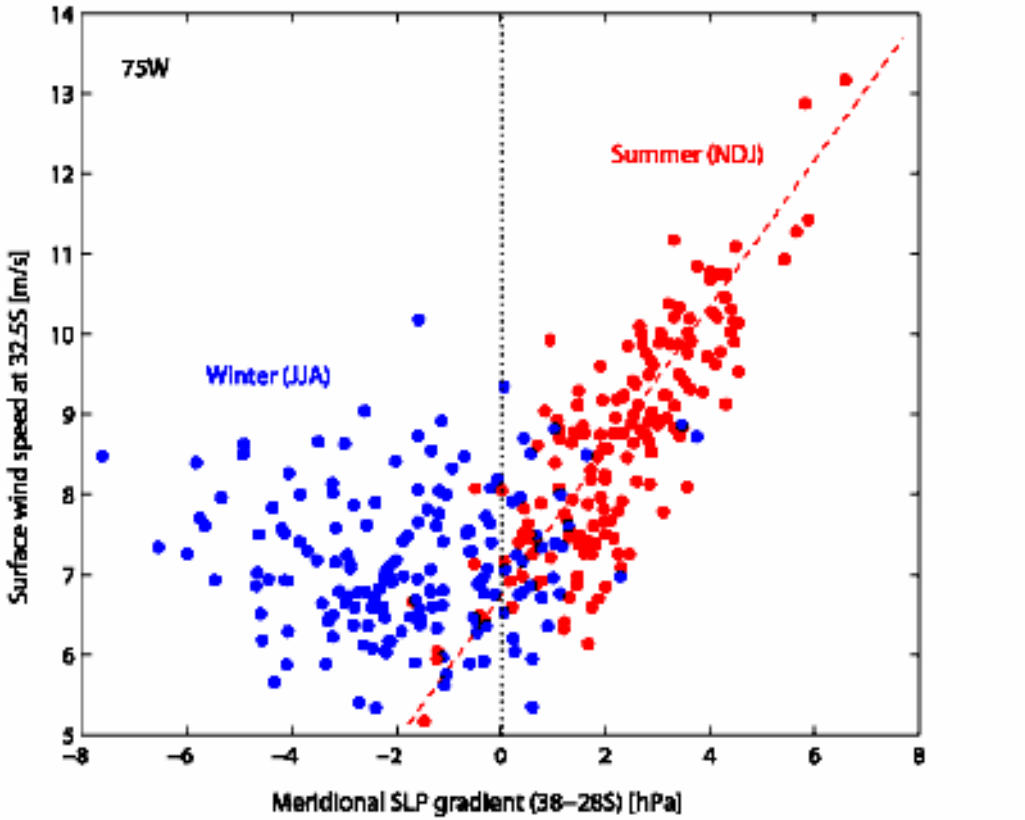
$$-\frac{1}{\rho}\frac{\partial p}{\partial y} = \frac{C_d}{H} v^2 \approx v$$

seems to hold for day-to-day changes

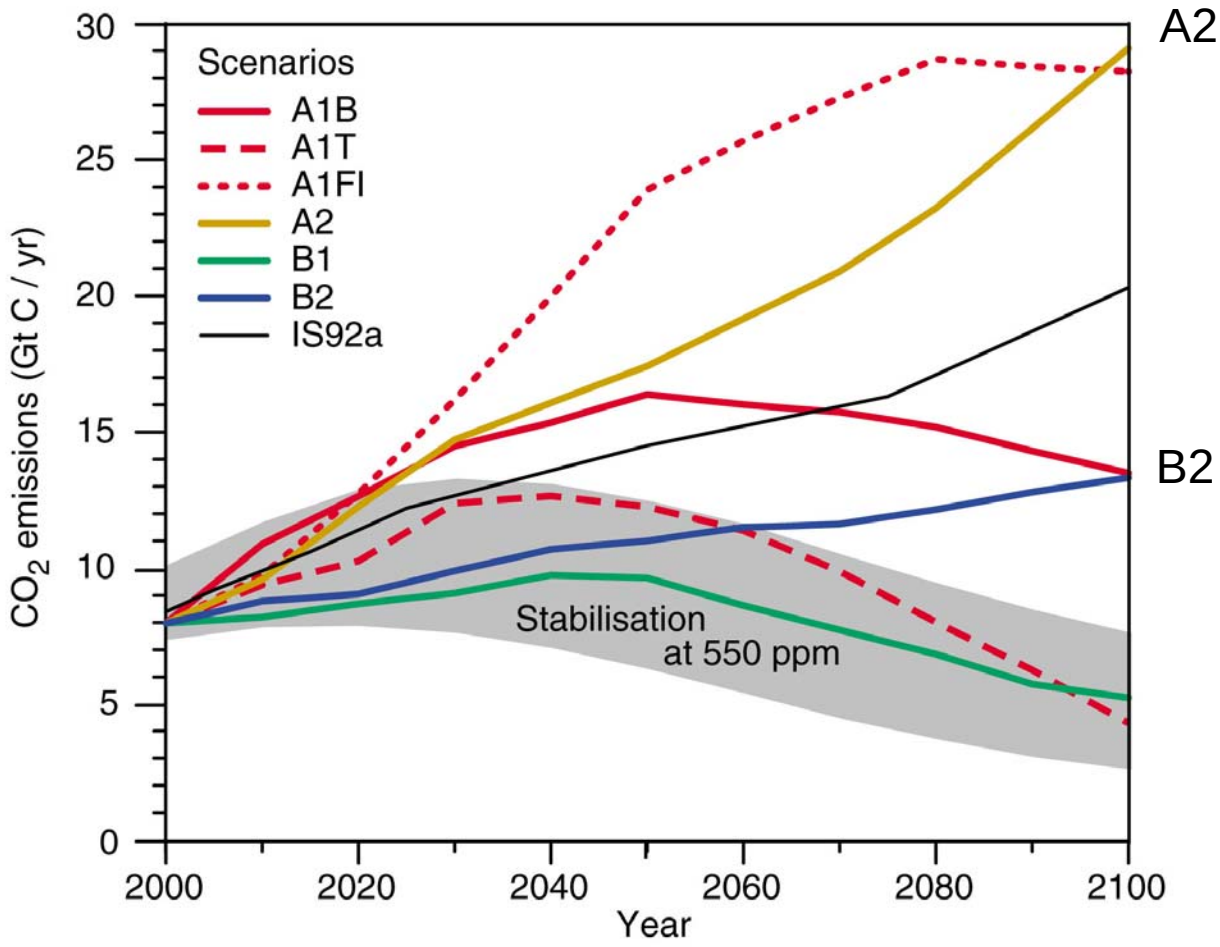


Steady-state dynamic seems to hold for Interannual variability

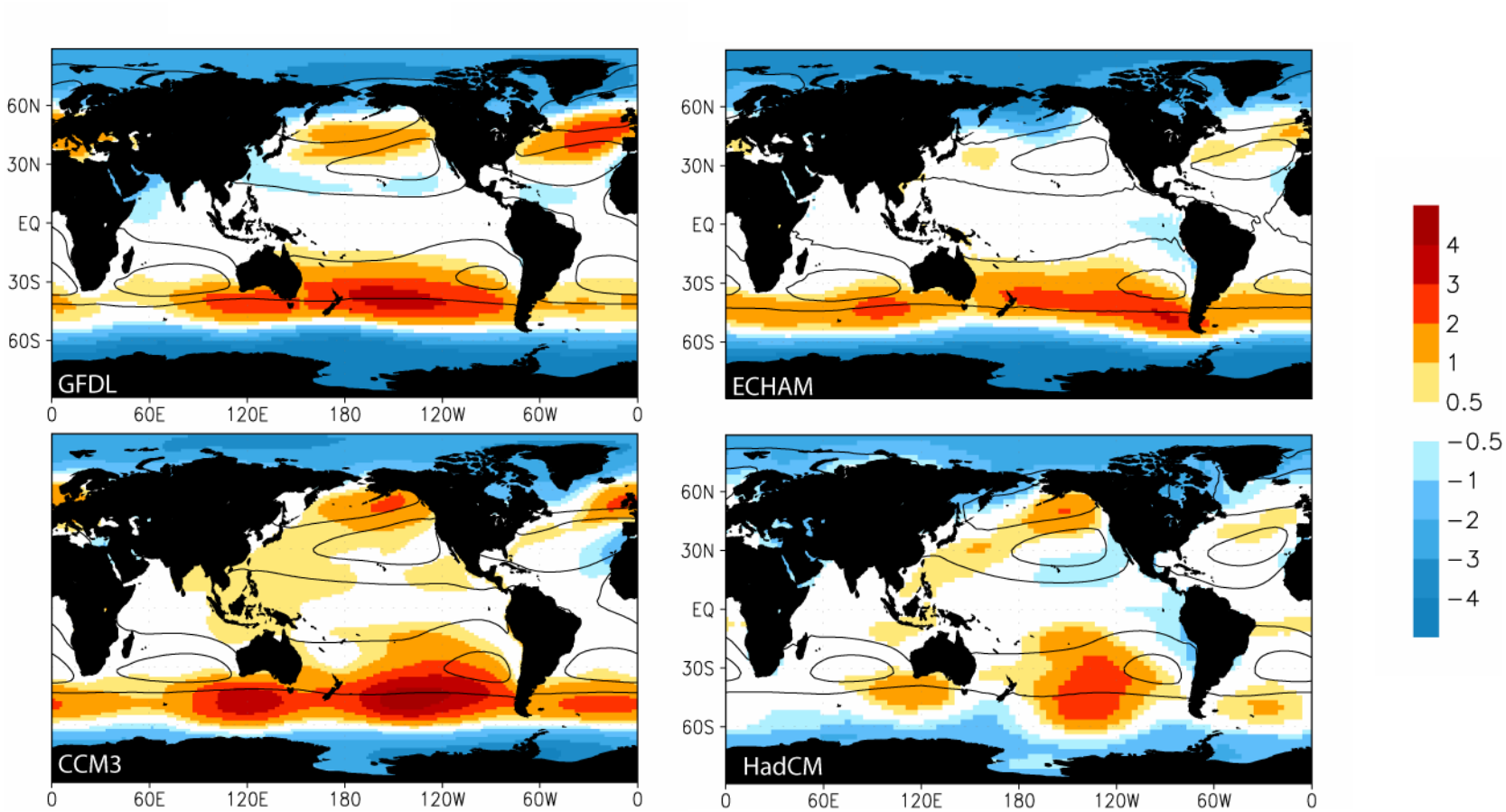
(NCEP-NCAR reanalysis data, 1960-2005)



Future Scenarios
CO_2 emissions projections + GCMs



BL SLP (1015, 1020 hPa) and A2-BL SLP difference



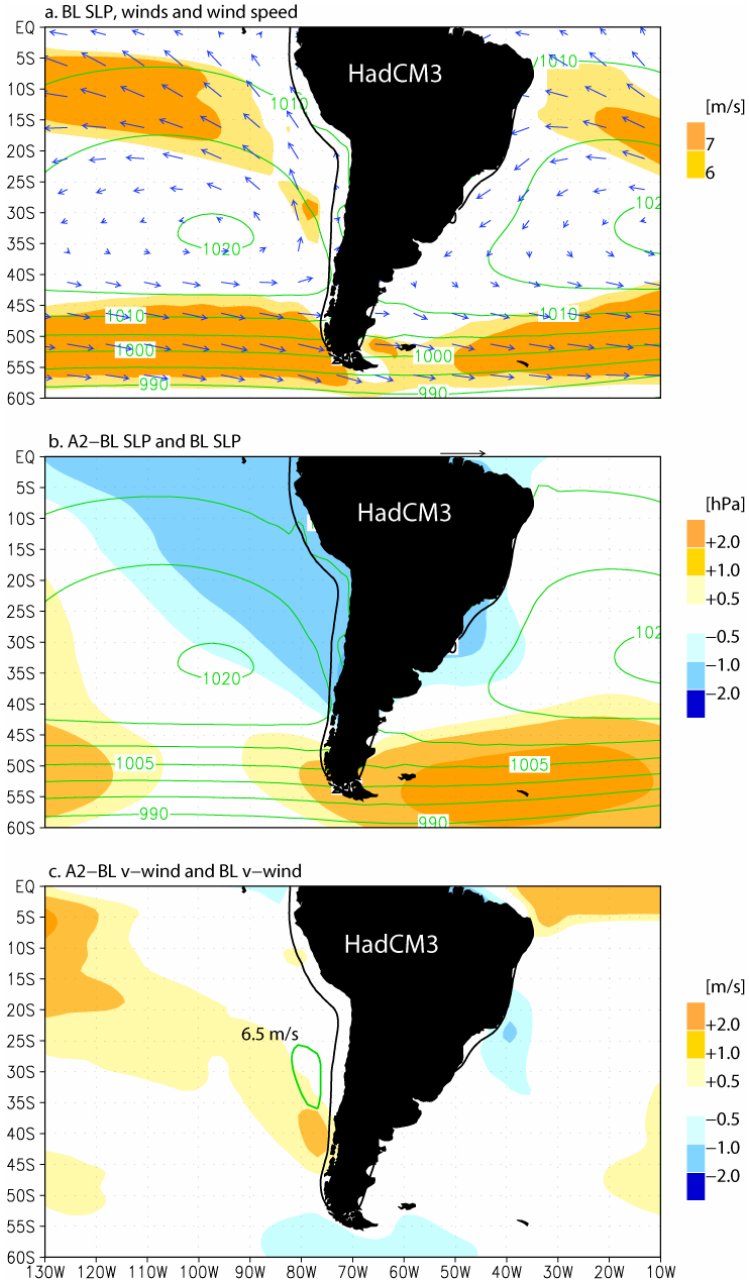
Strengthening of the poleward flank of subtropical anticyclones and poleward shift of the midlatitude storm track is very consistent among GCMs (?!?!)

More results from HadCM3:

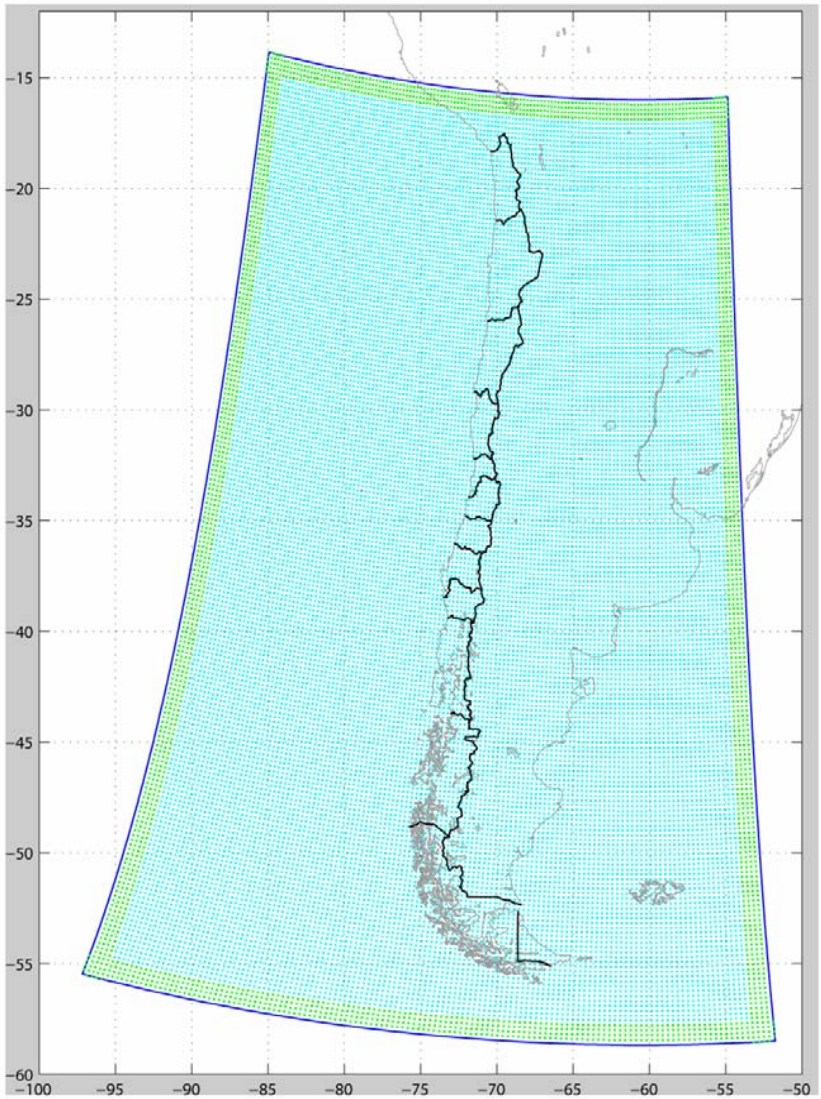
• Coastal jet is there but hard to see and misplaced (coarse resolution)

• Strengthening of the meridional pressure gradient along the coast

• Increased meridional wind to the south of the jet core



PRECIS (**P**roviding **RE**gional **C**limates for **I**mpact **S**tudies)
(Hadley Centre UK MetOffice RCM)



Single domain

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

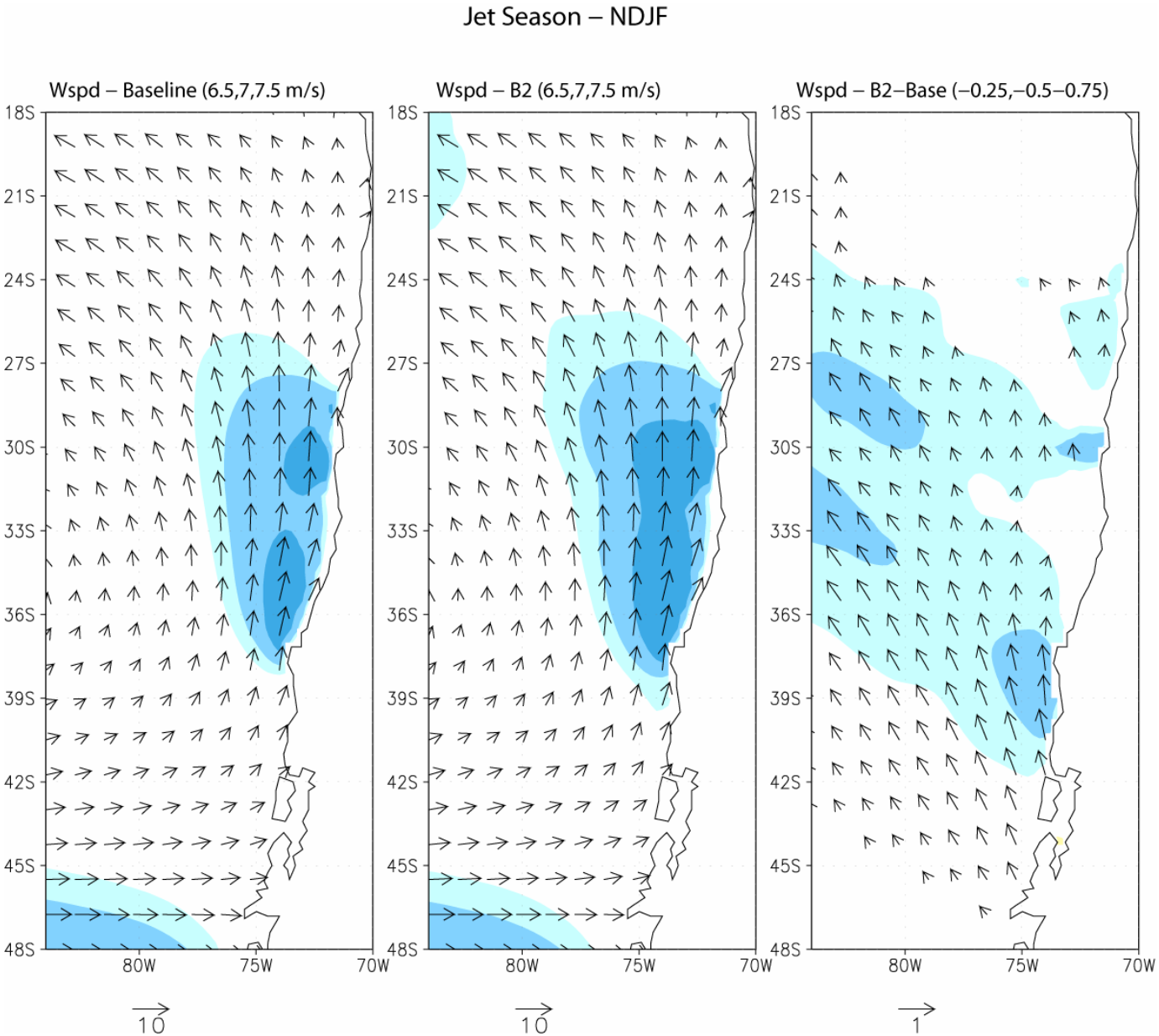
Simulations

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

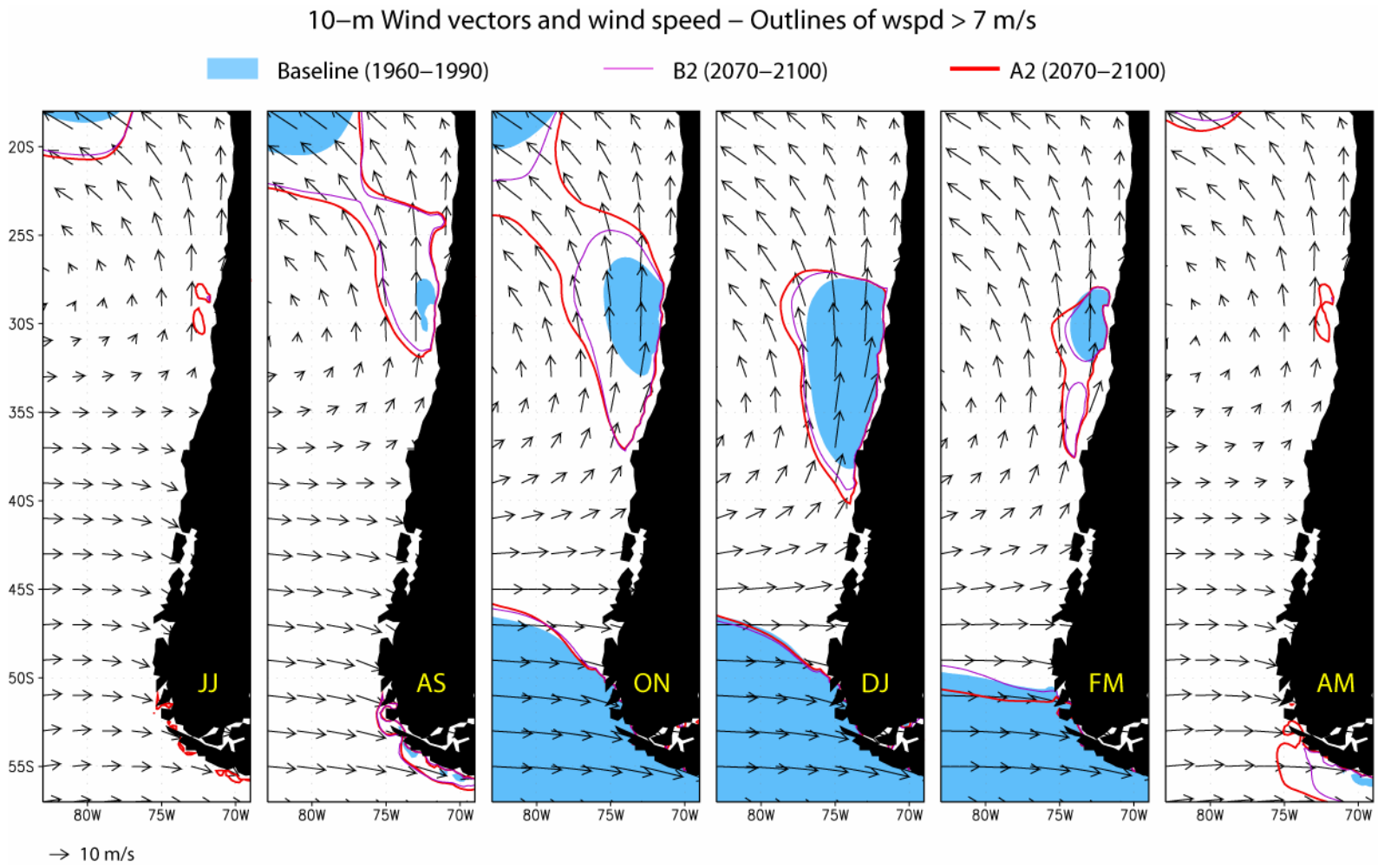
Why?

- CONAMA (Chile) needed results in 9 months

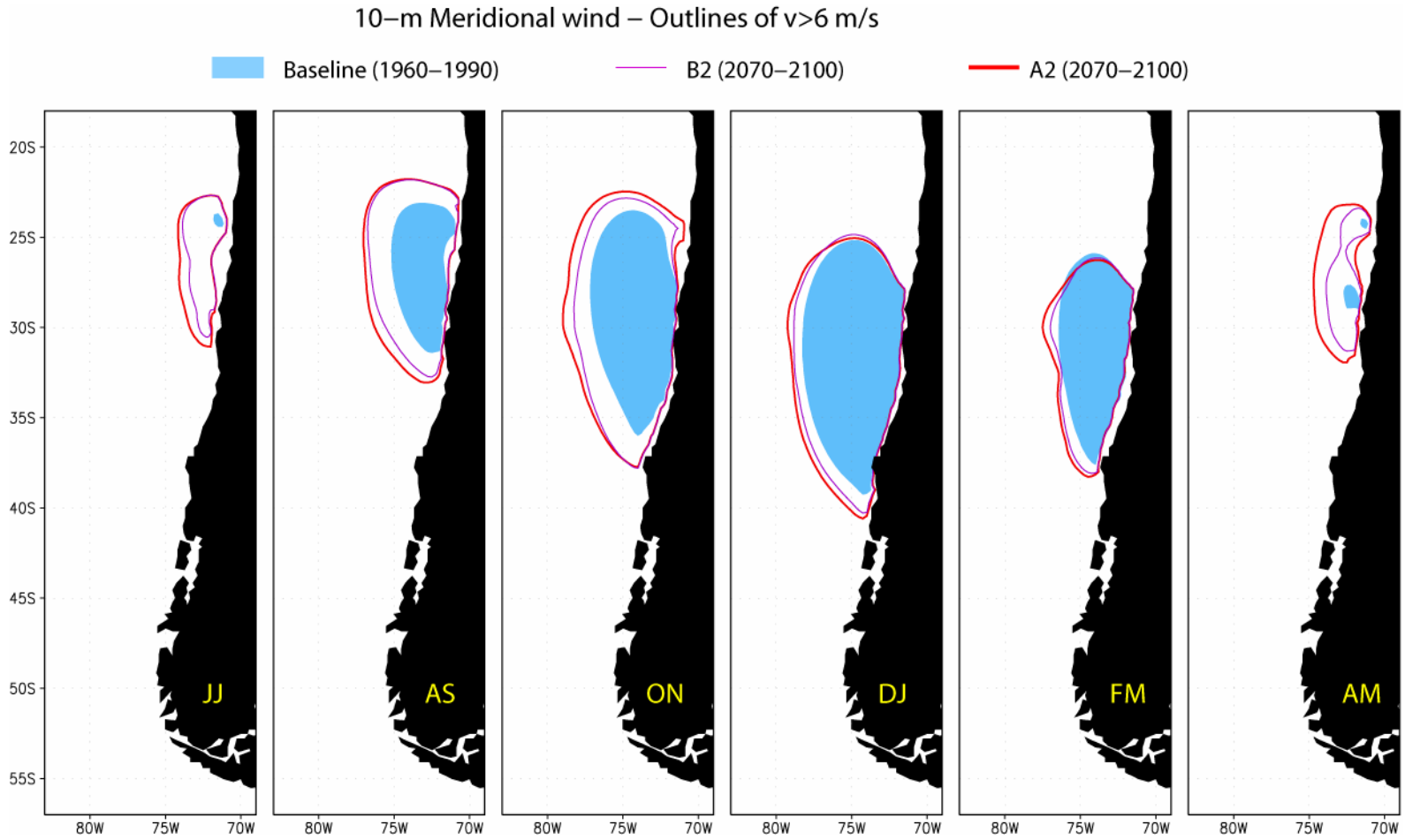
PRECIS Results



PRECIS Results



PRECIS Results



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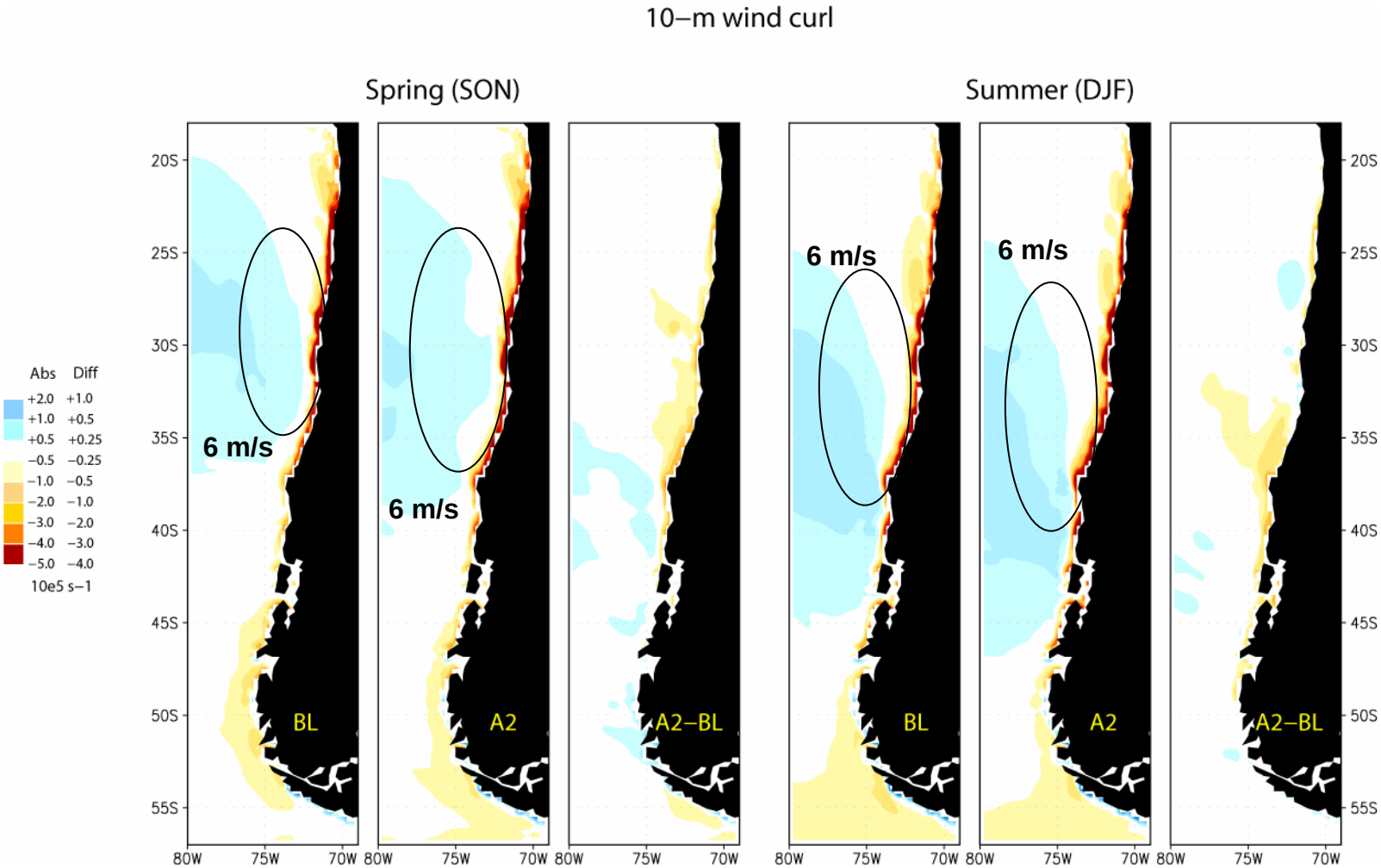
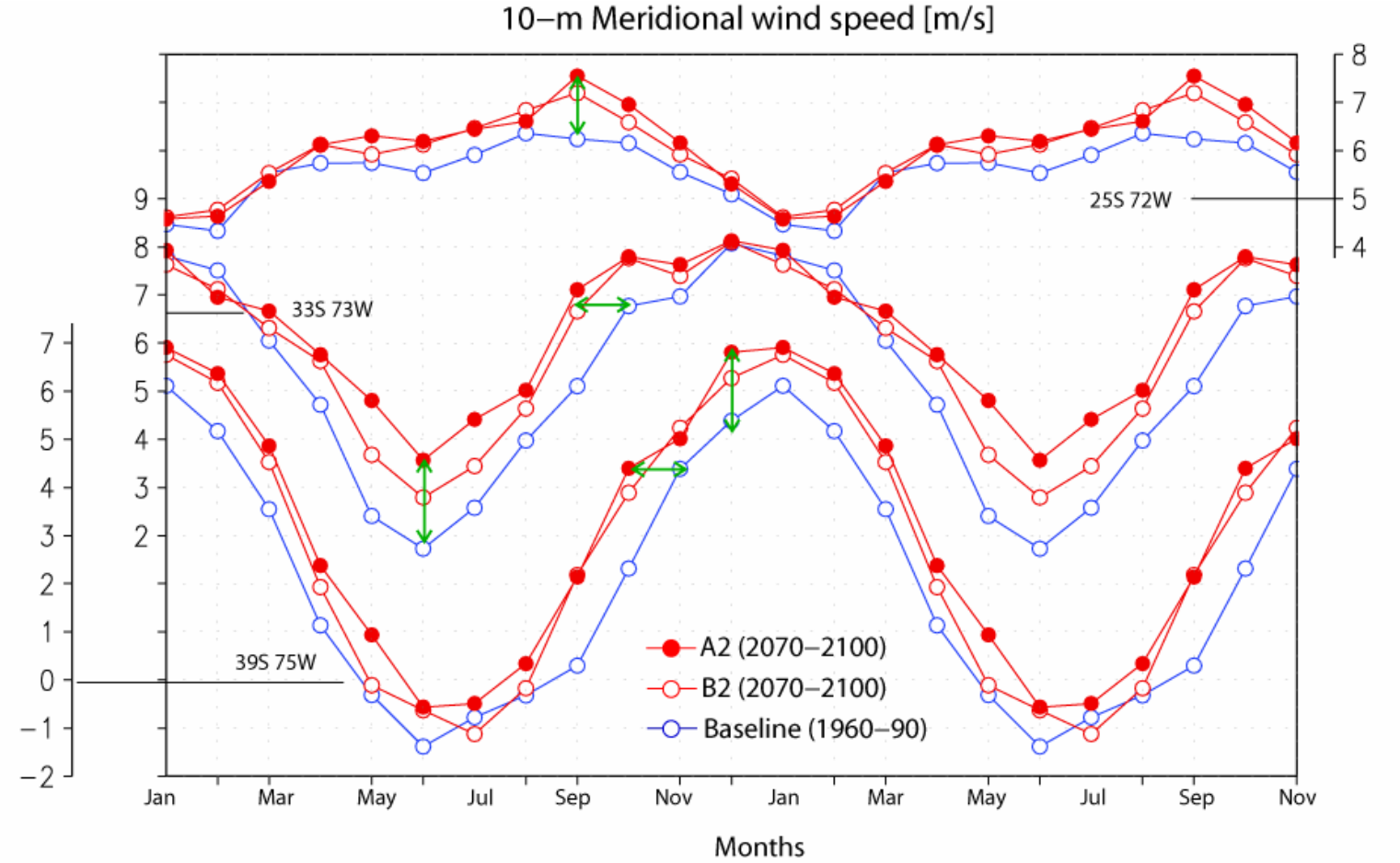
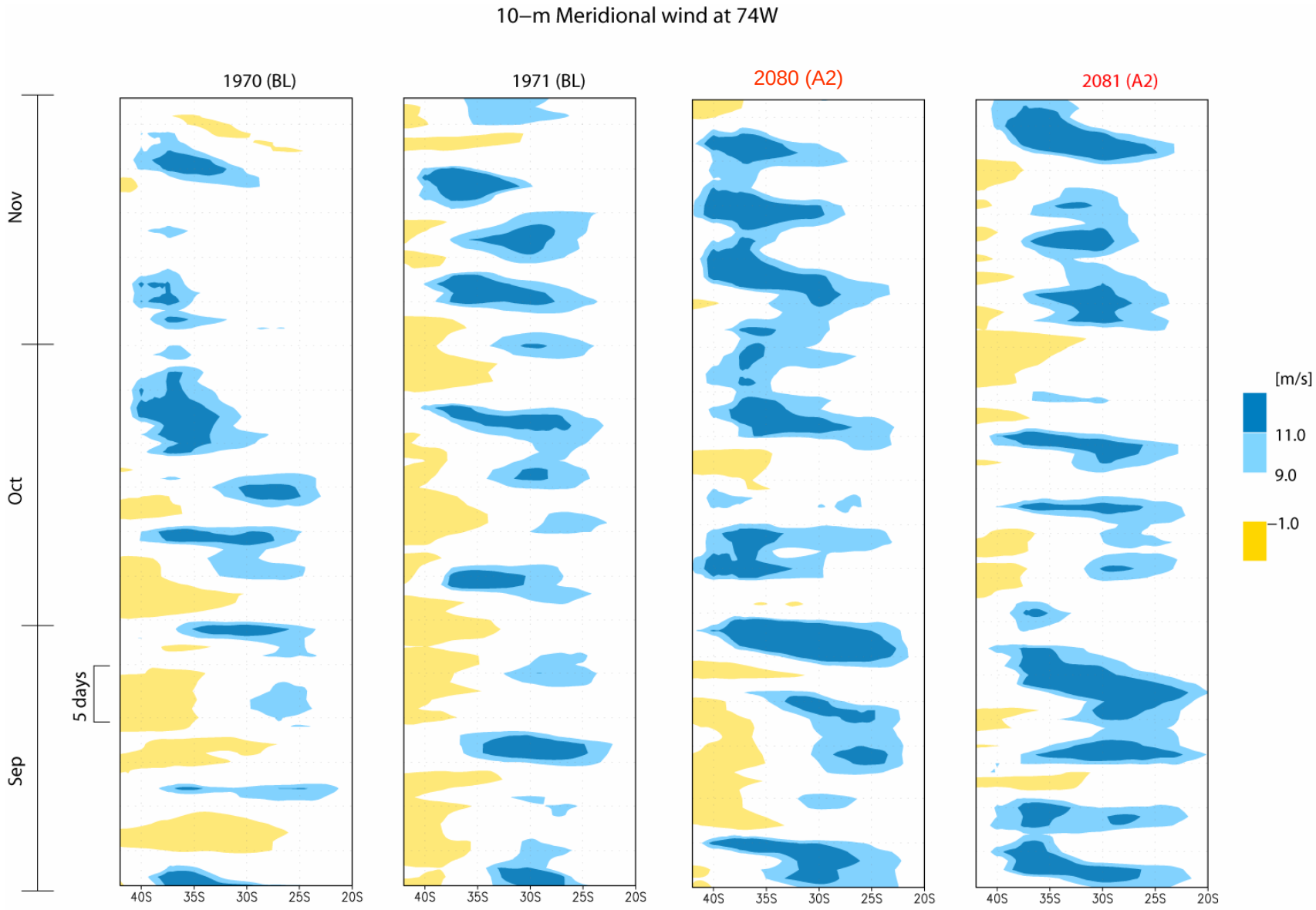


PRECIS Results

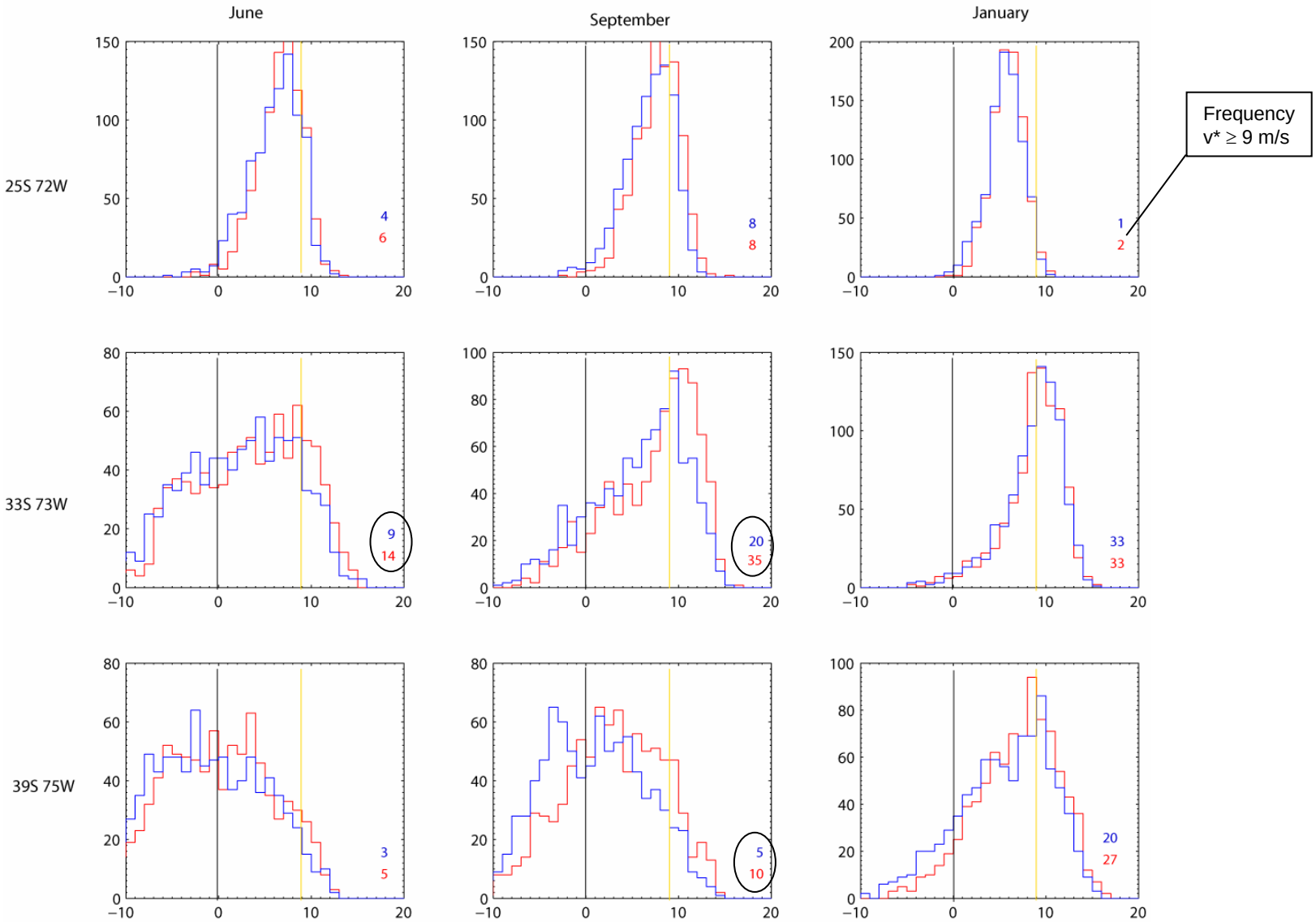


PRECIS Results



10-m Meridional wind – Daily means

PDFs for Baseline and B2



Summary / Ideas

- Southerly coastal winds strengthen in warmer climate. Δv is geographically and seasonally dependent.

- More frequent / stronger coastal jet events(?) Who cares?...is coastal upwelling a linear processes?

- Feel free to use PRECIS outputs to feed regional ocean model.

- 30-year of RCM simulation seems a waste of CPU-time…regional signals are too dependent of parent GCM. You better simulate 5 years and train a statistical model for downscaling. 30 years = 6 different scenarios x 5 years each