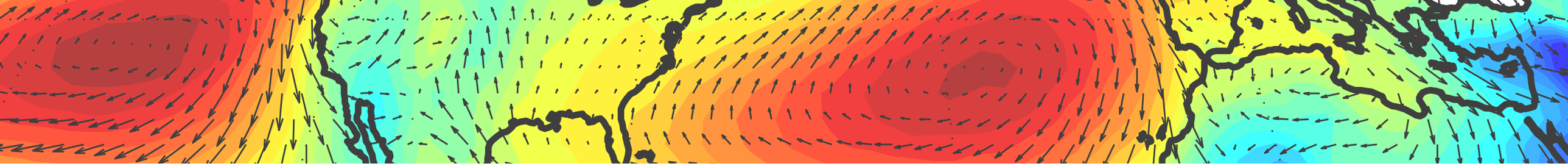


Climate Change & Coastal Upwelling Drivers

Marisol García-Reyes, William J. Sydeman, David S. Schoeman, Ryan R. Rykaczewski, Bryan A. Black, Sarah Ann Thompson, Arthur Miller, Andrew Bakun & Steven J. Bograd

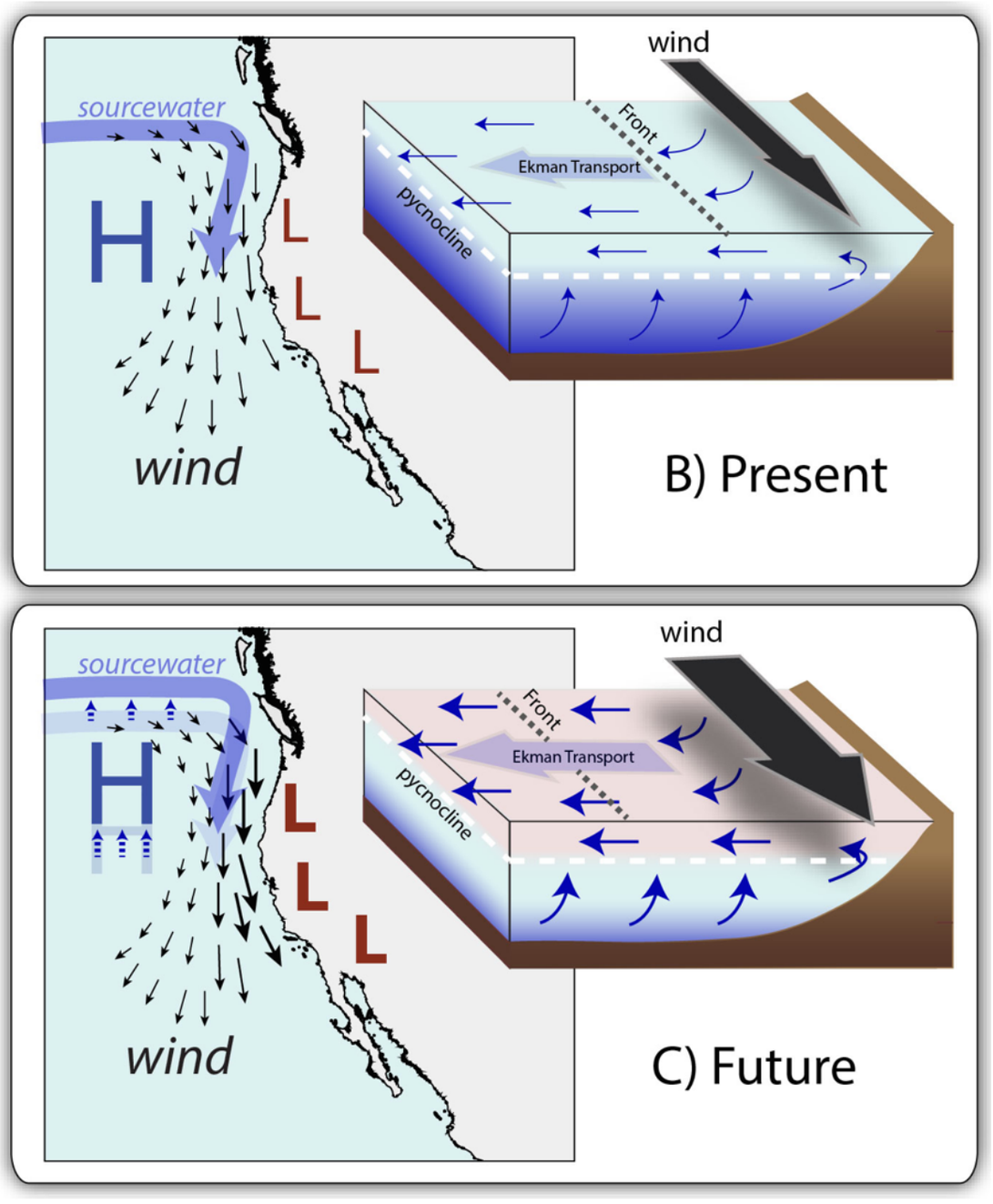
Third International Symposium
Effects of Climate change on the World's Ocean

\ Santos City, Brazil
\ March, 2015

climate change impact on upwelling drivers

- bakun hypothesis

- poleward migration of pressure systems

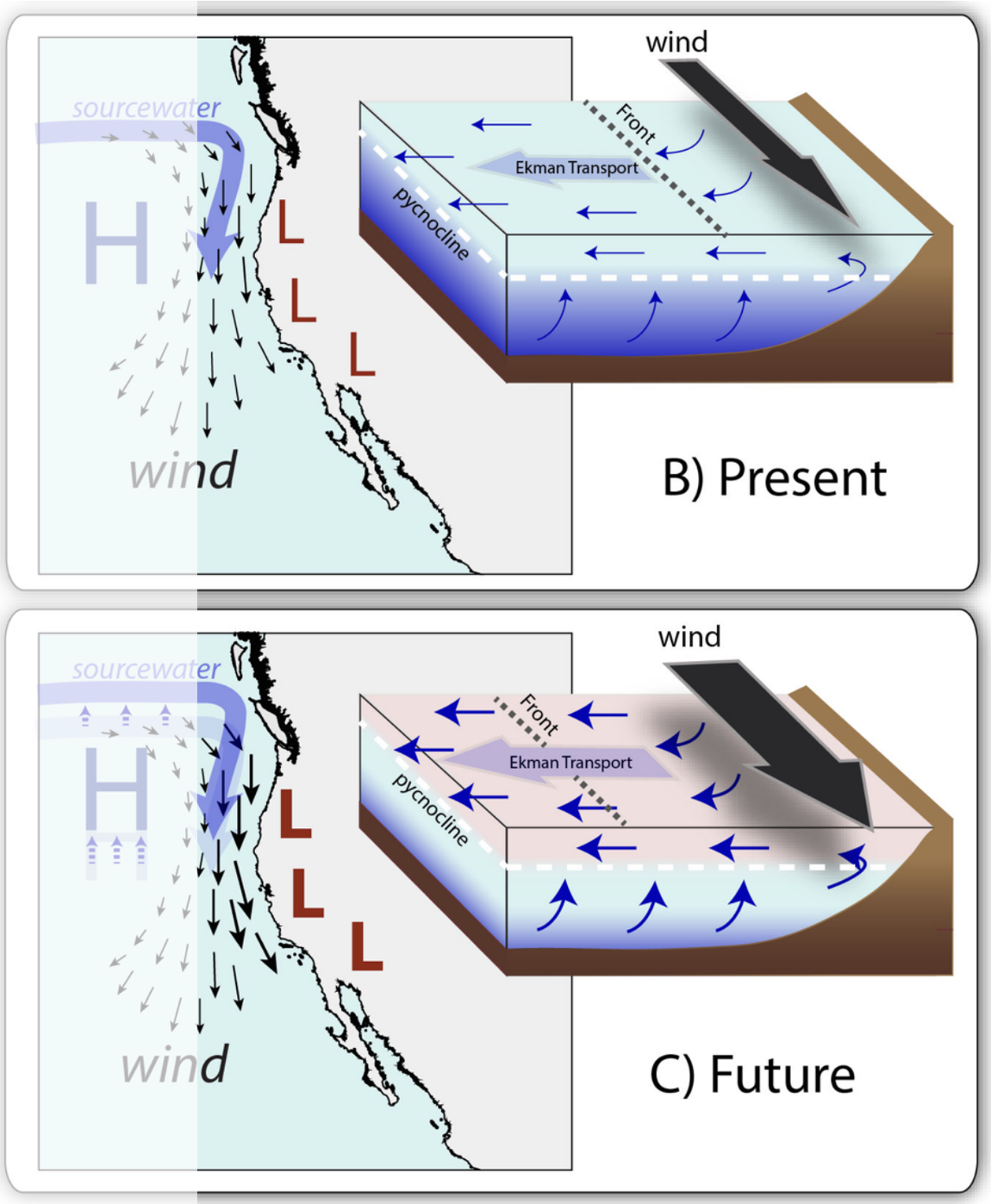


Bakun et al. 2015

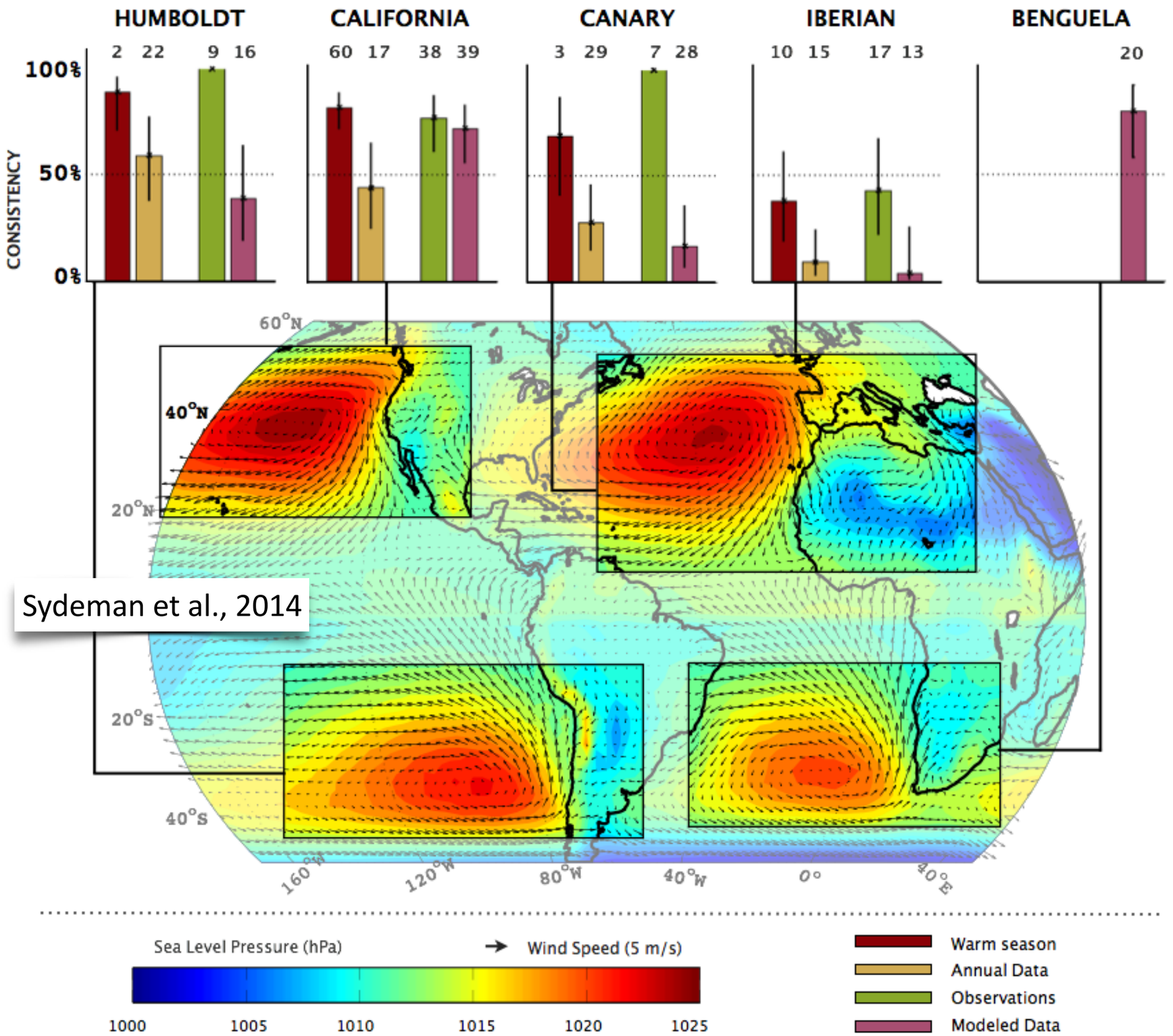
bakun hypothesis

Bakun, 1990

image by
Bakun et al. 2015



Meta-analysis of upwelling wind trends



Trends consistent with Bakun hypothesis of increasing upwelling favorable winds

18 studies
187 records (non-ind)

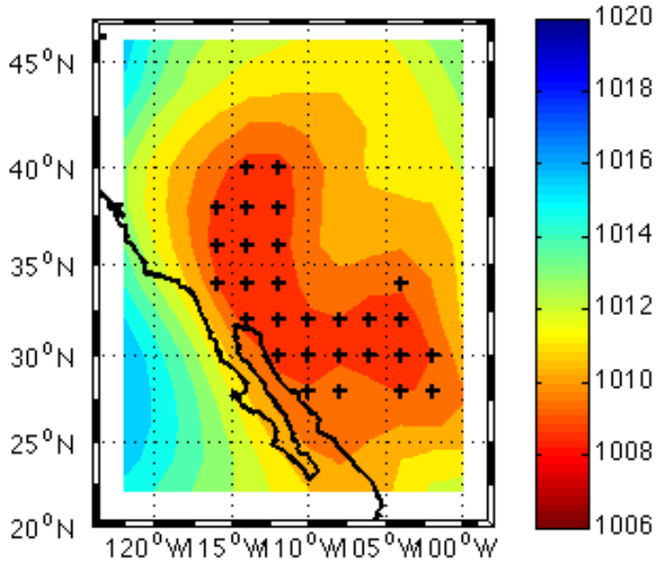
+ others that support it
  + Barton et al. 2014
  + Cropper et al. 2014
  + Alves et al. 2013
  + Bylhouwer et al. 2013
  + de Castro et al. 2014
  + Jacox et al. 2014
  + Stocker et al. 2013

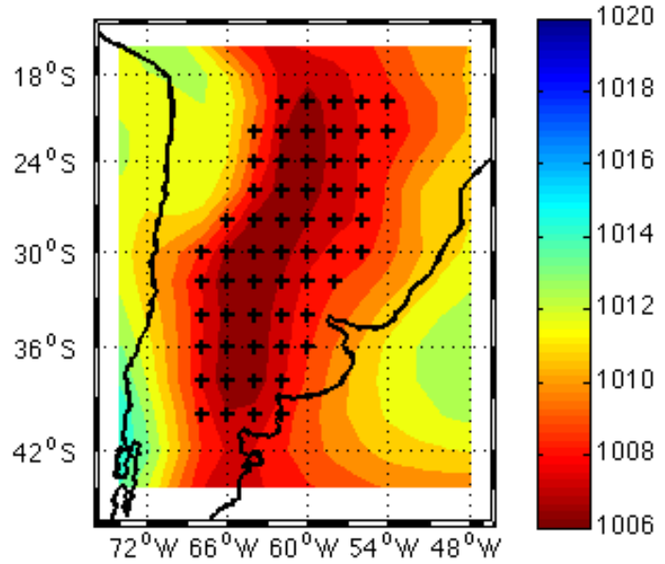
20th century reanalysis SLP climatologies

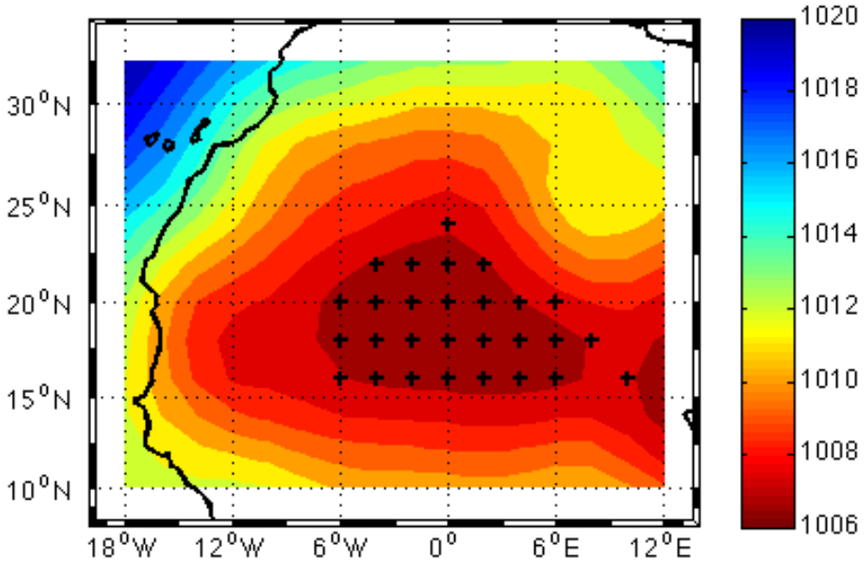
may-july

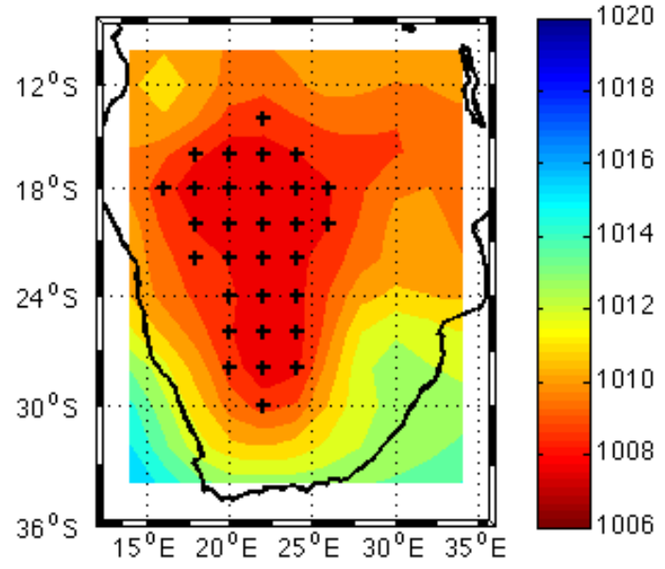
1940-2010

dec-feb



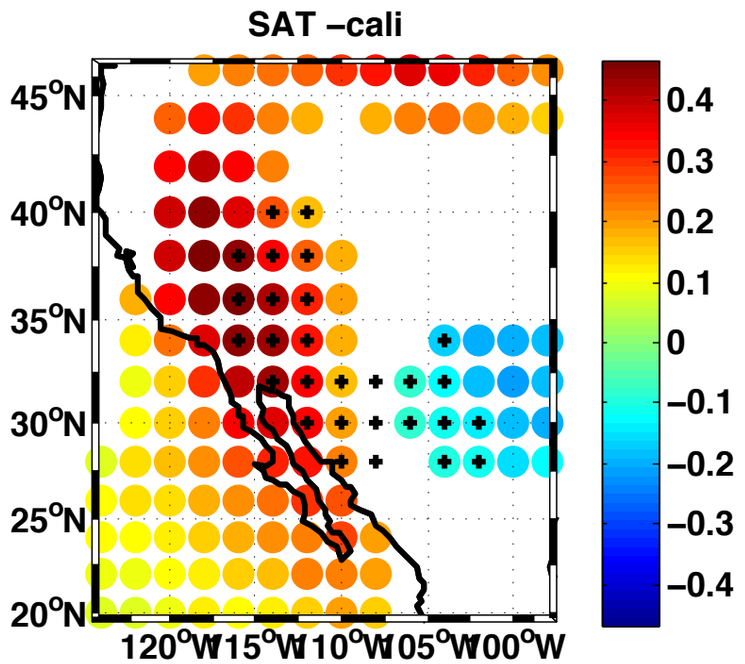


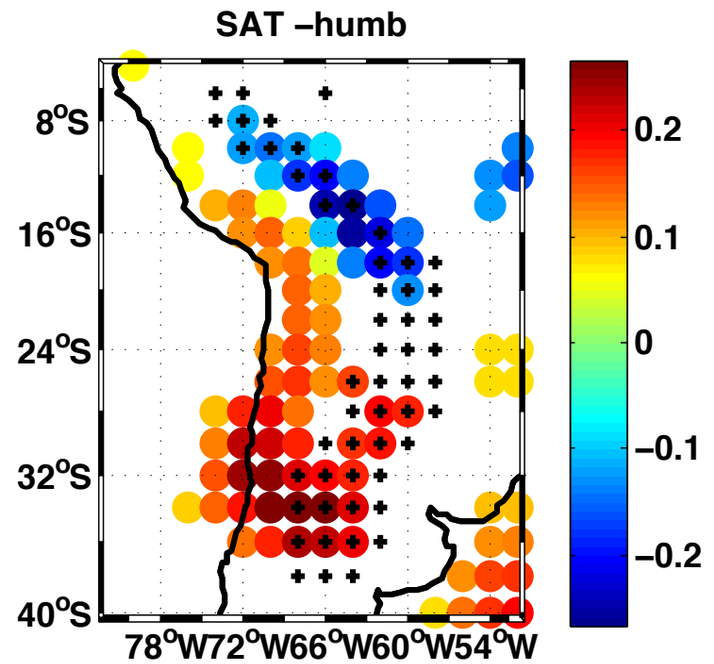




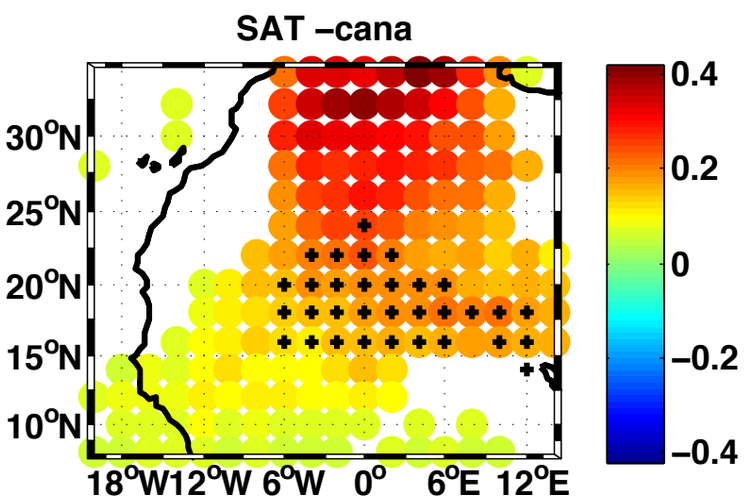
Surface Air Temperature trends, 1940-2010

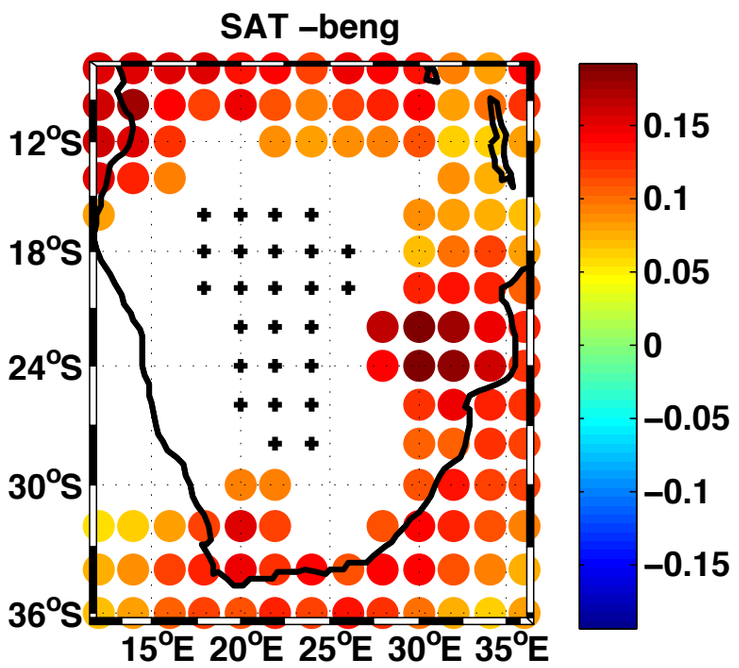
may-july





dec-feb

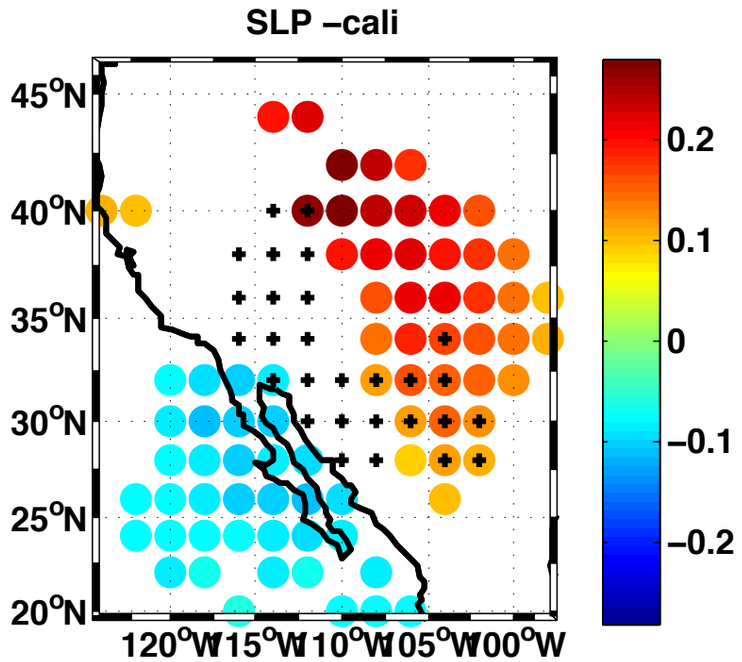


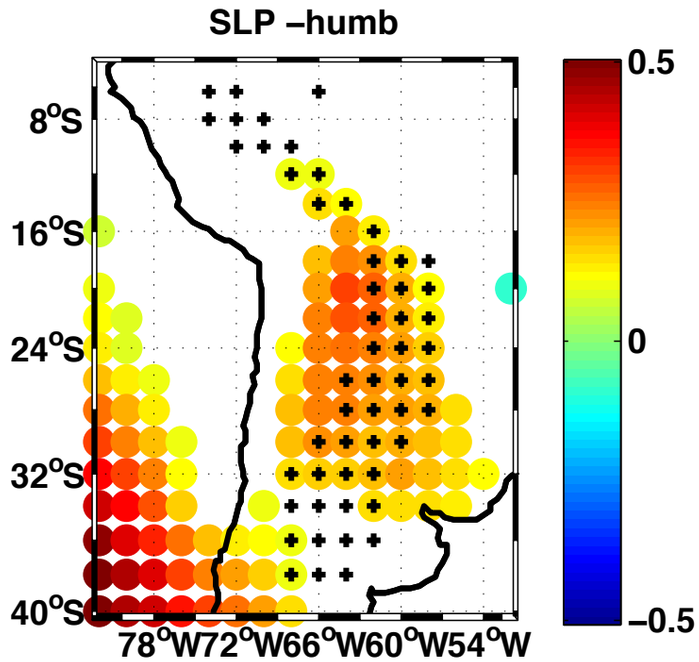


°C/decade

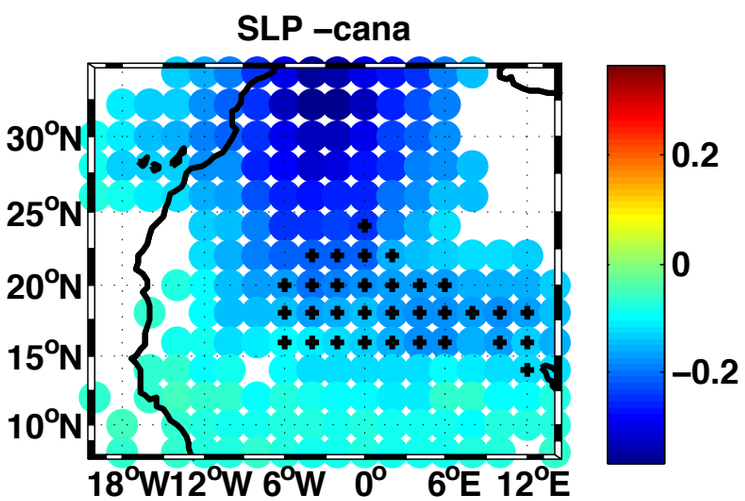
Sea Level Pressure trends, 1940-2010

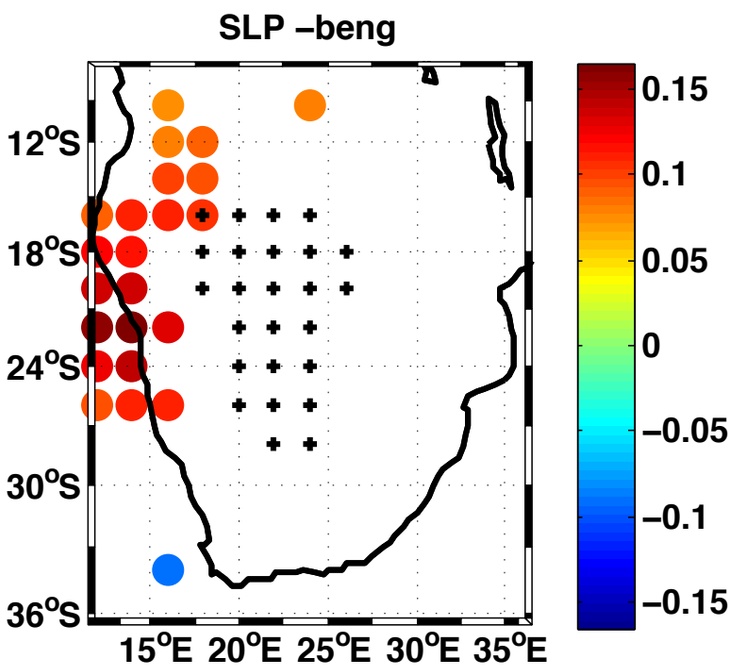
may-july





dec-feb

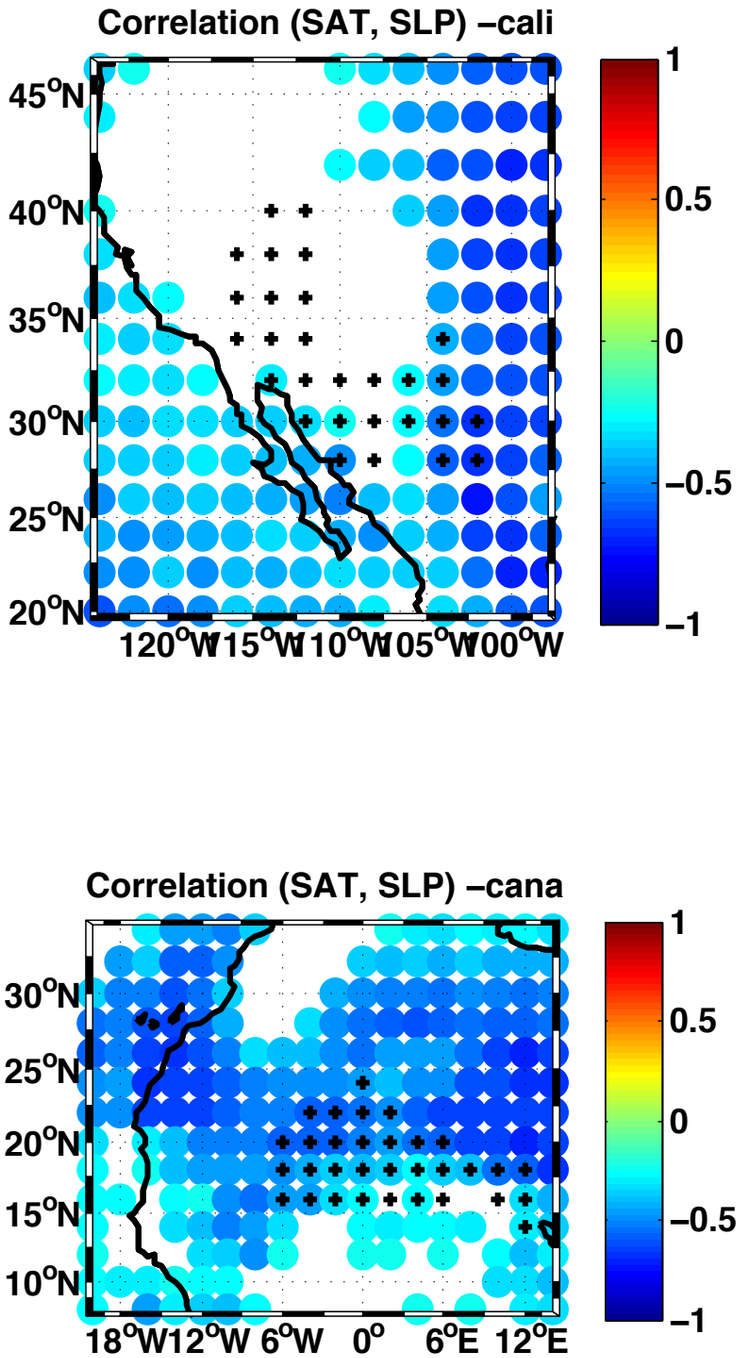


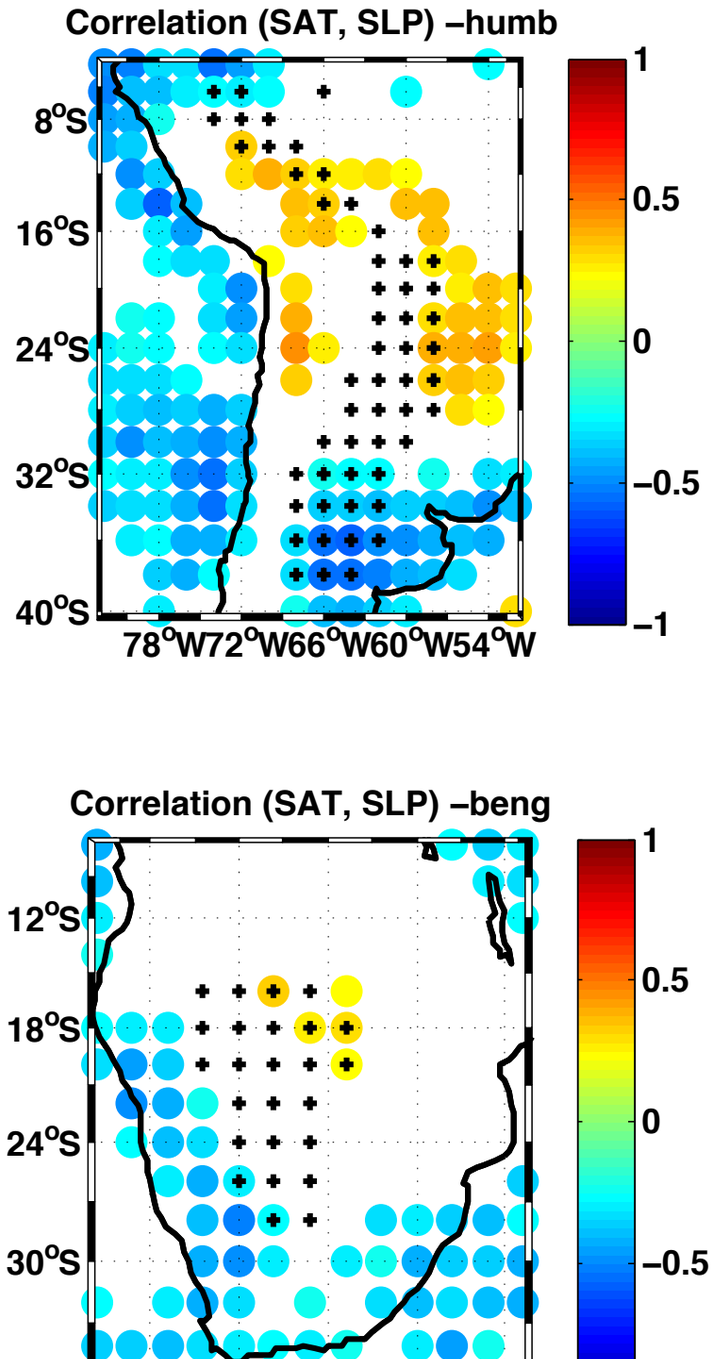


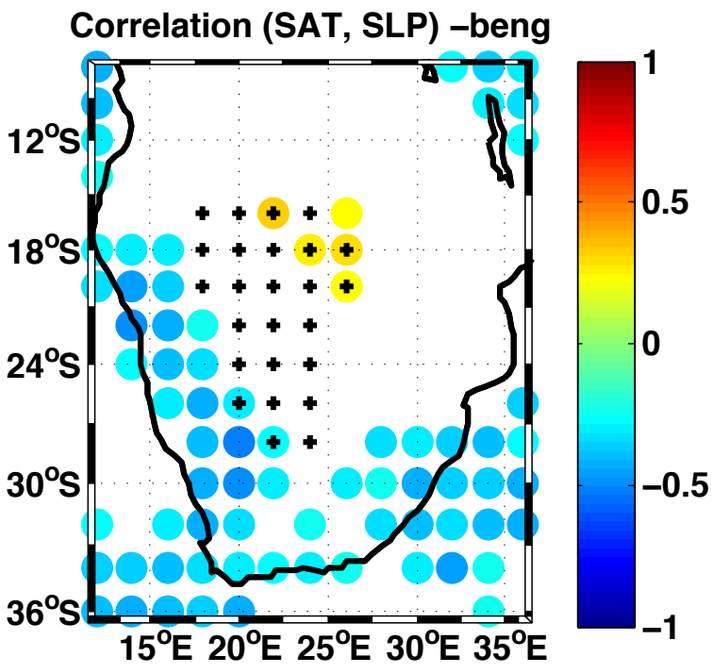
hPa/decade

correlation SAT-SLP, 1940-2010

may-july



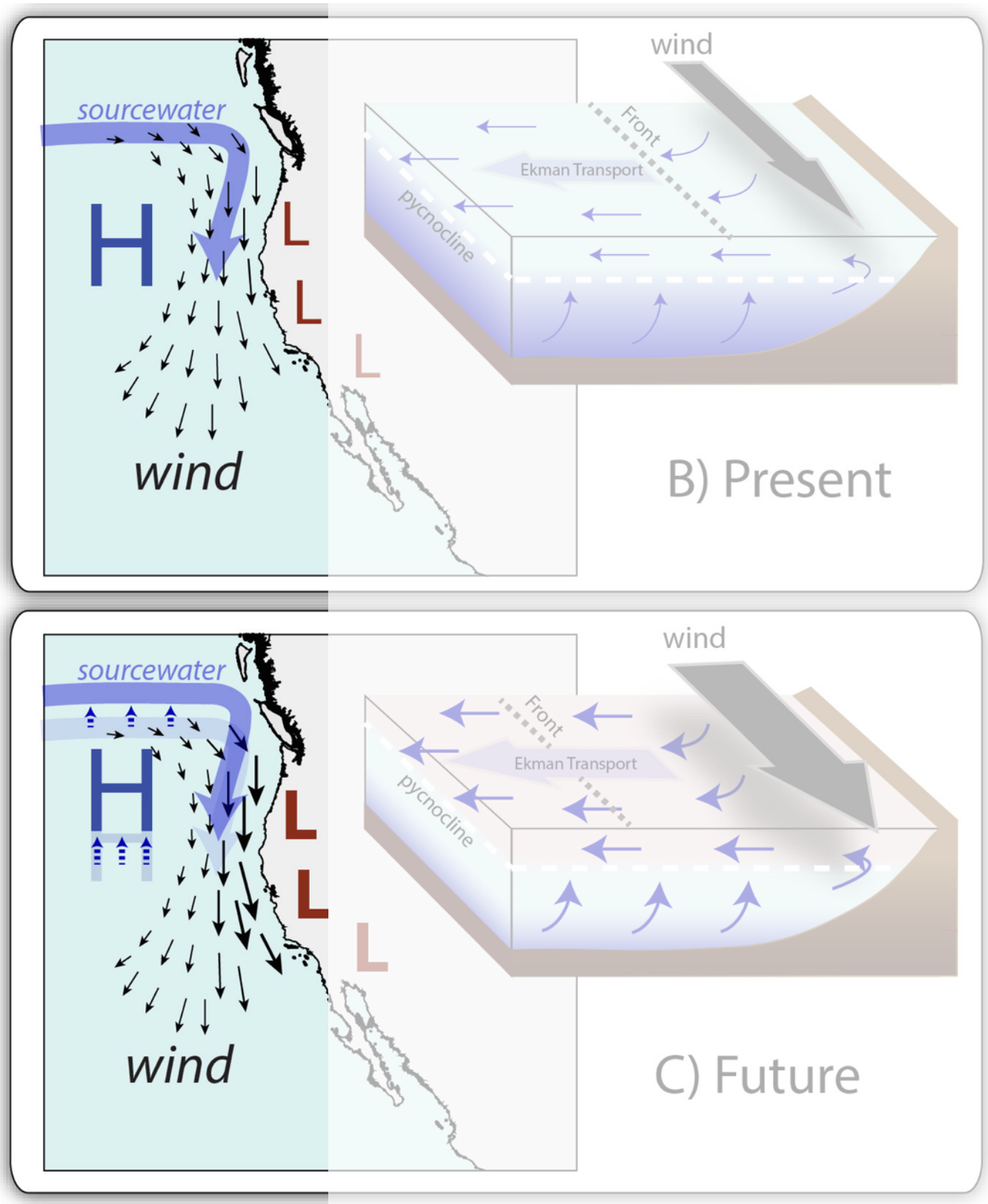




dec-feb

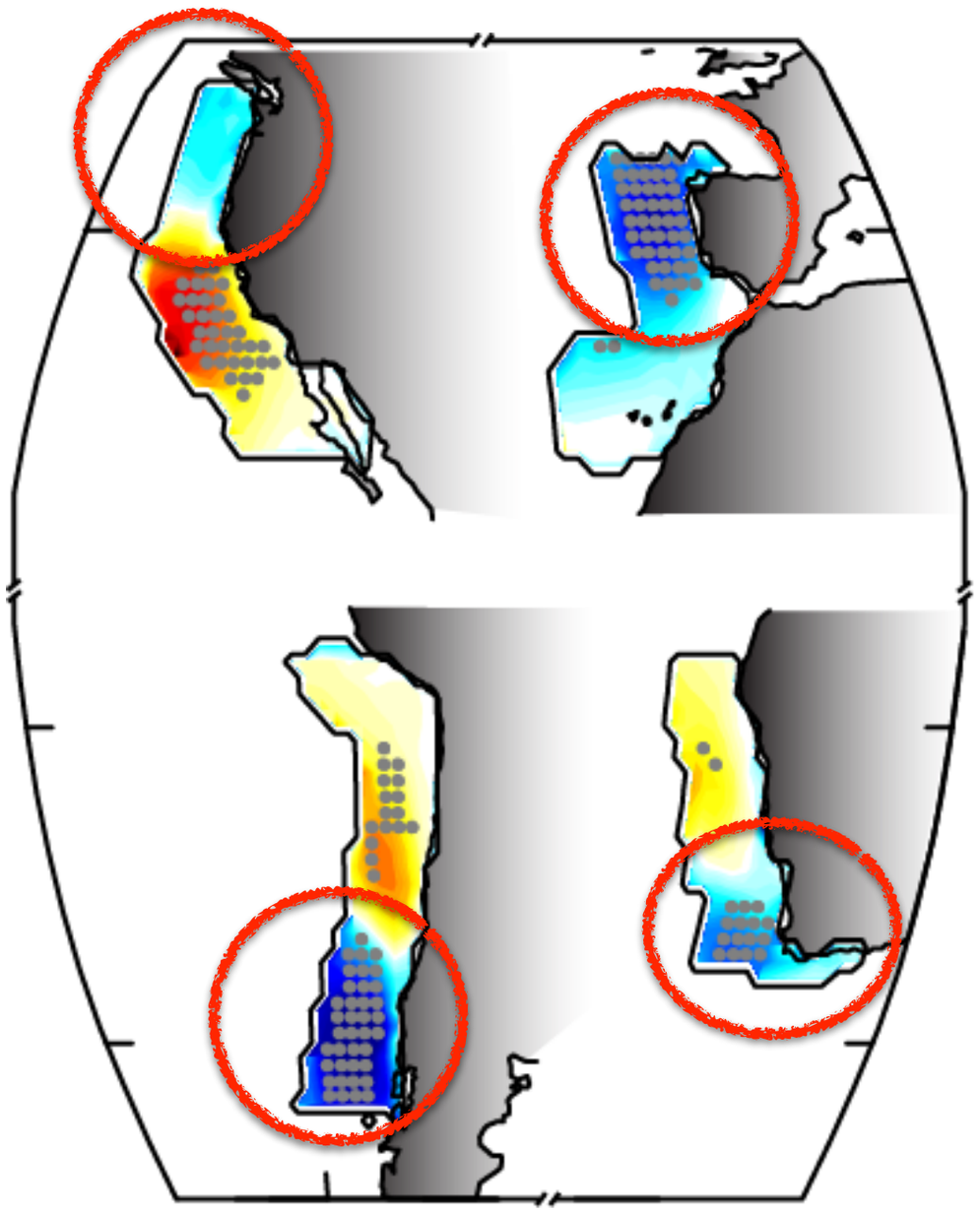
$p < 0.05$

poleward migration of pressure systems



Bakun et al., 2015

meridional gradient of wind trends in climate models



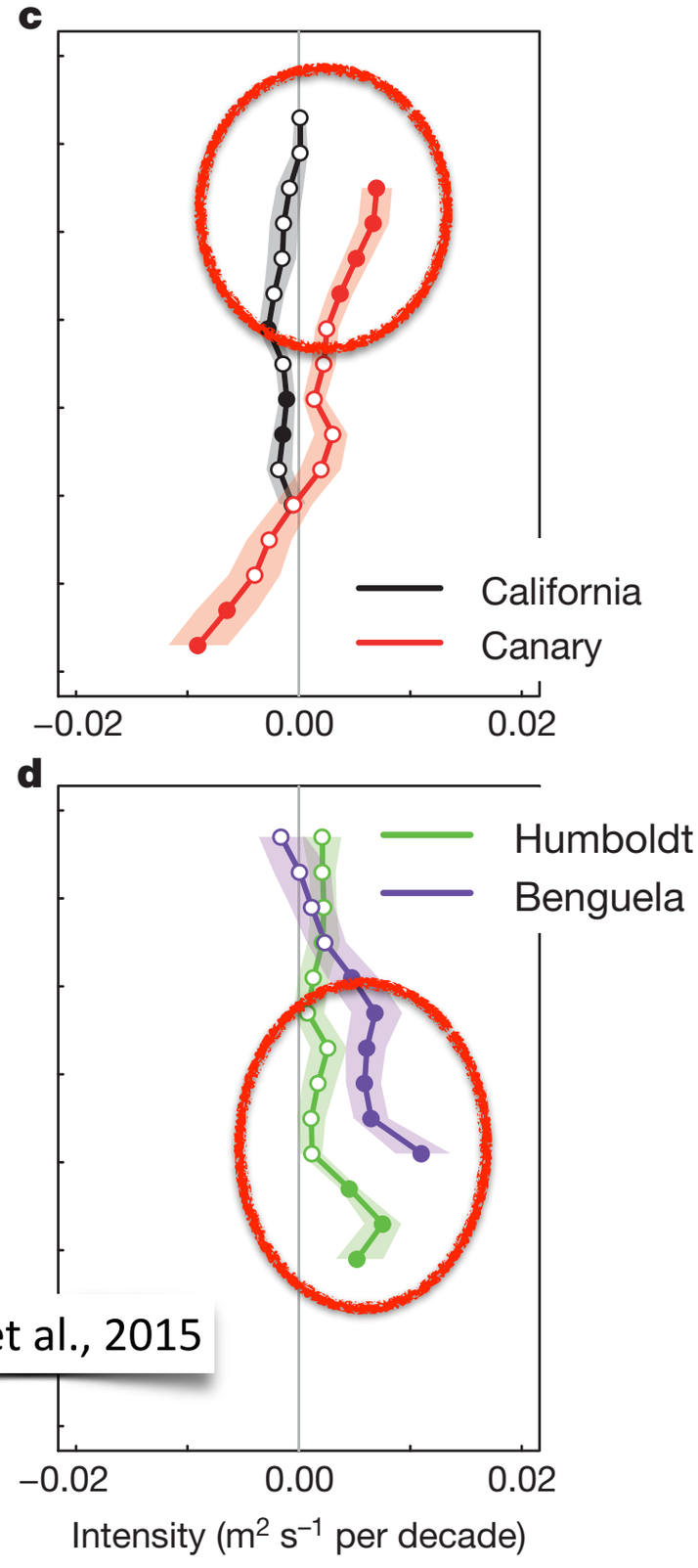
Change in τ_{upw} ($N\ m^{-2}$)

0.02

0

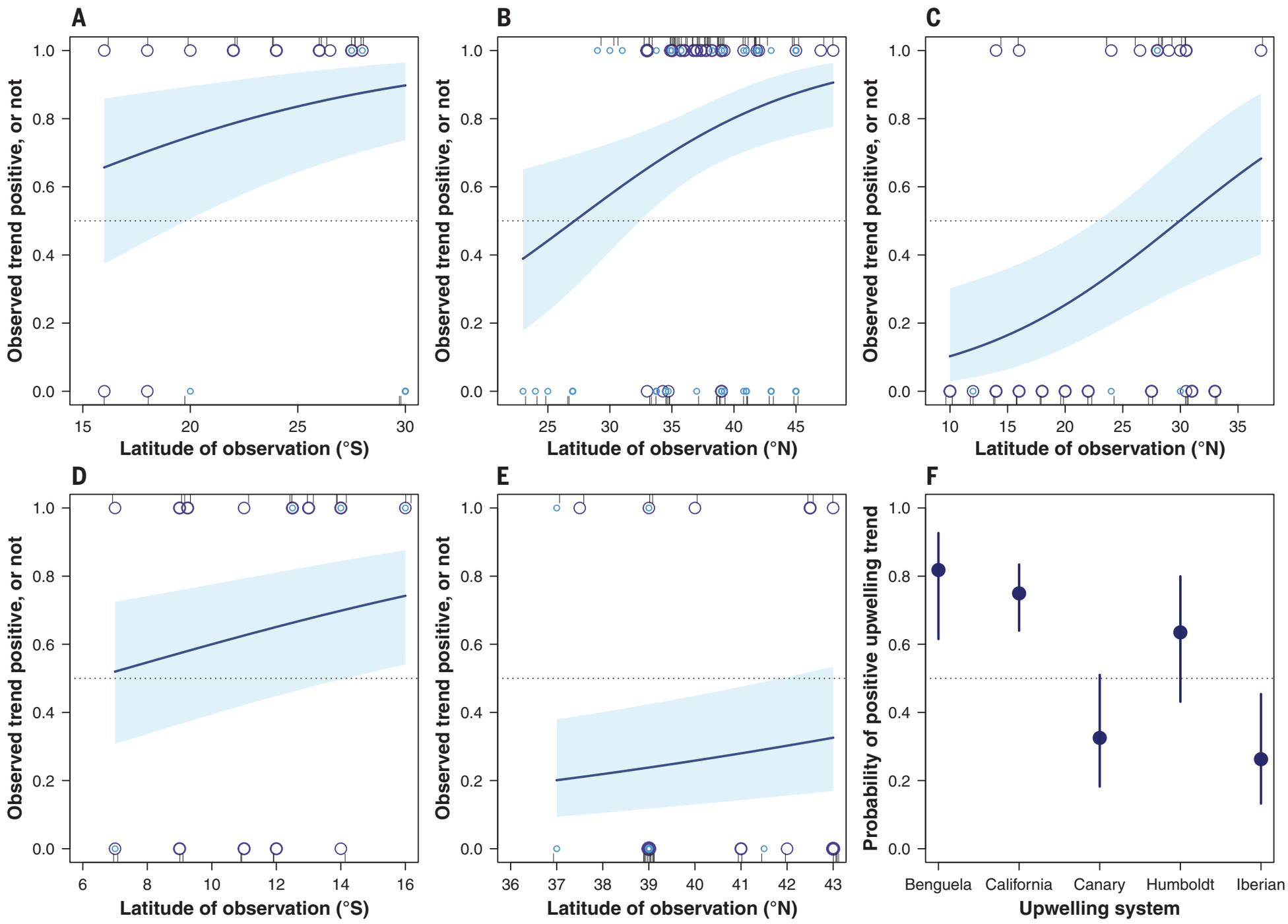
-0.02

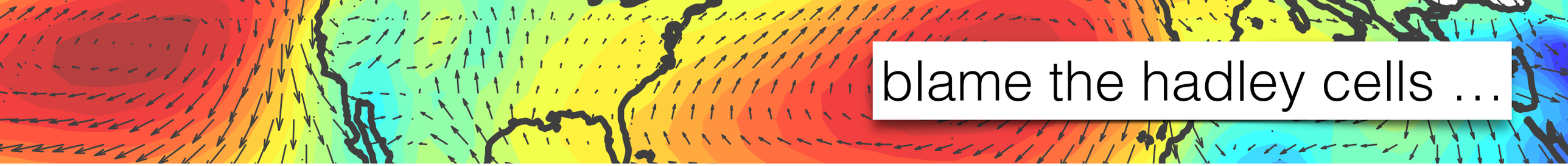
Rykaczweski et al., submitted



Wang et al., 2015

wind trends by latitude in meta-analysis





- IPCC AR4 models (3rd generation)
- poleward expansion of hadley cells:
- poleward displacement of subduction cells (ocean high pressure systems)
- poleward expansion of mid-latitude dry zones (thermal low pressure

Expansion of the Hadley cell under global warming

Jian Lu,[1,2] Gabriel A. Vecchi,[3] and Thomas Reichler[4]

GEOPHYSICAL RESEARCH LETTERS, VOL. 34, L06805, doi:10.1029/2006GL028443, 2007

JOURNAL OF CLIMATE VOLUME 23

Thermodynamic and Dynamic Mechanisms for Large-Scale Changes in the Hydrological Cycle in Response to Global Warming*

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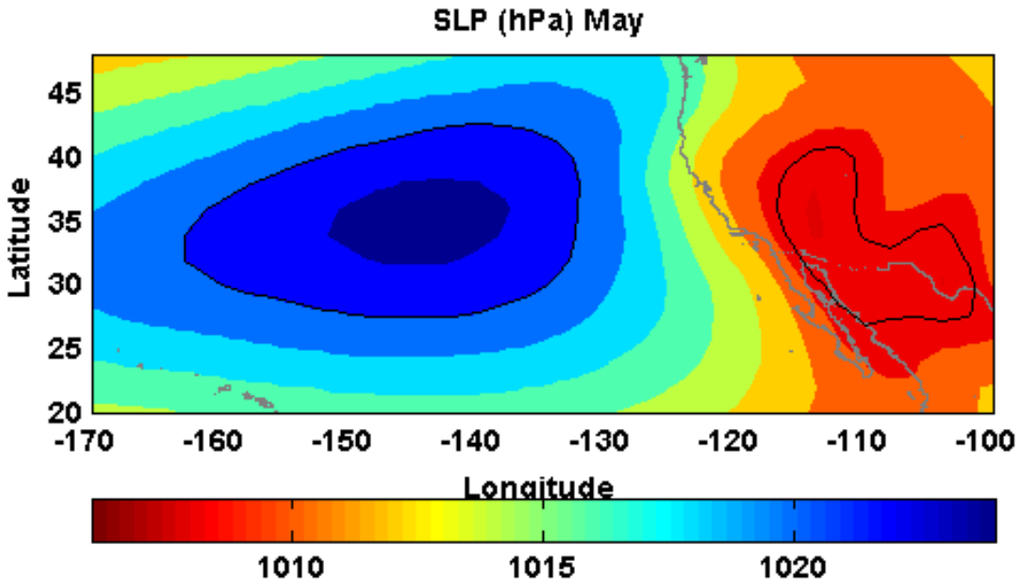
Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

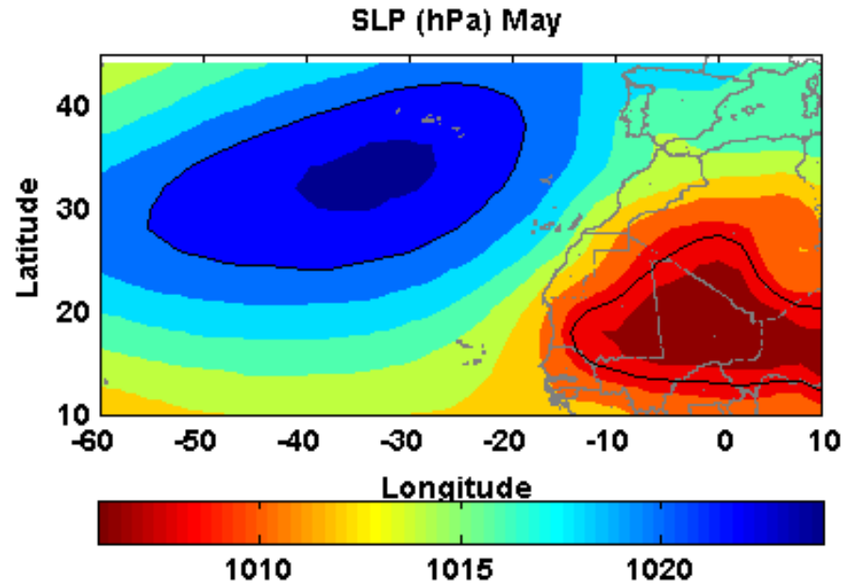
GABRIEL A. VECCHI

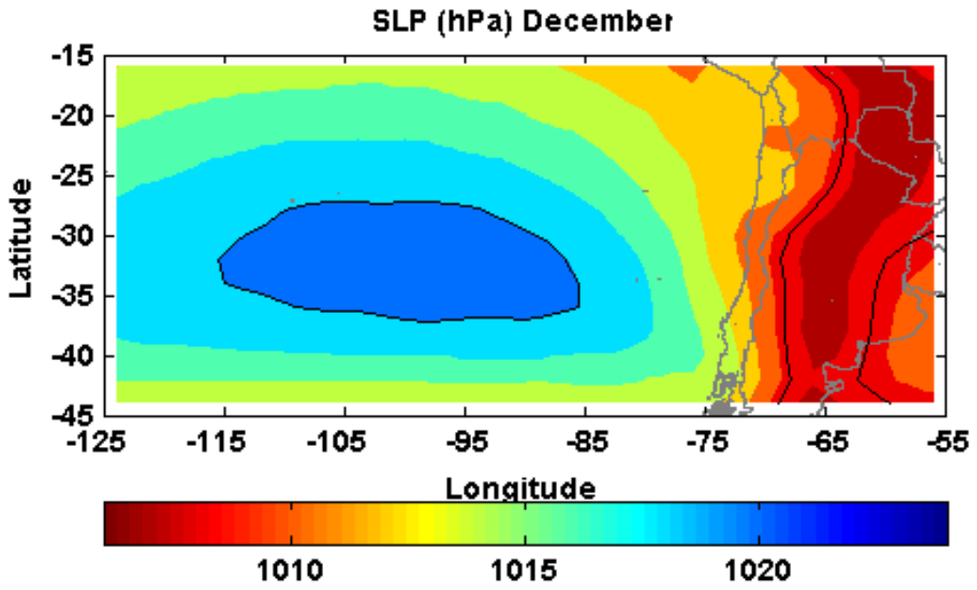
Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey

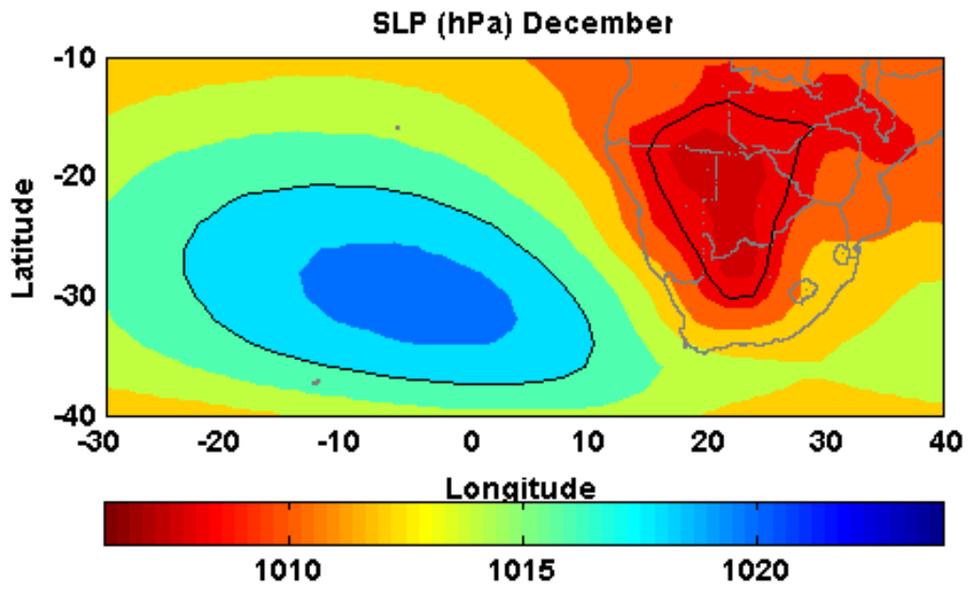
SLP climatologies for peak upwelling season

20th century reanalysis



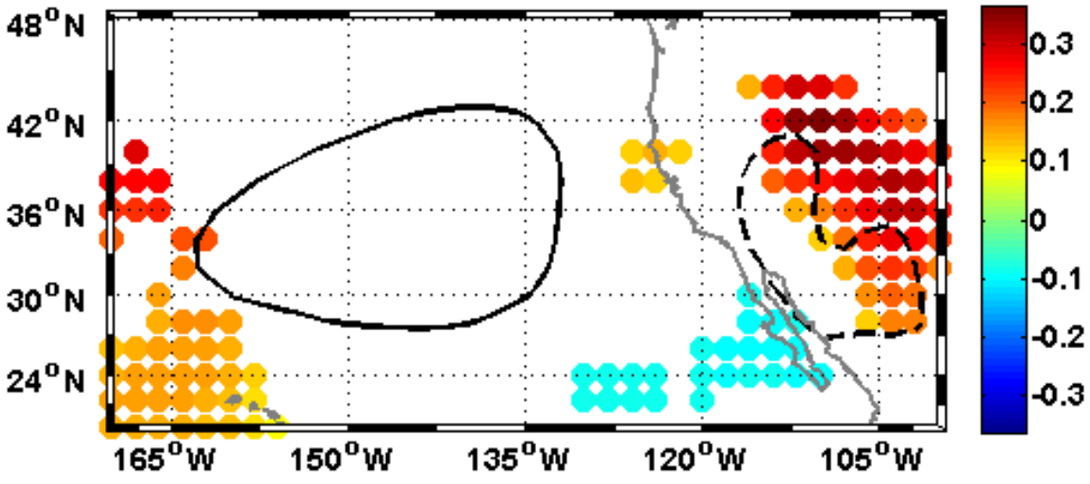




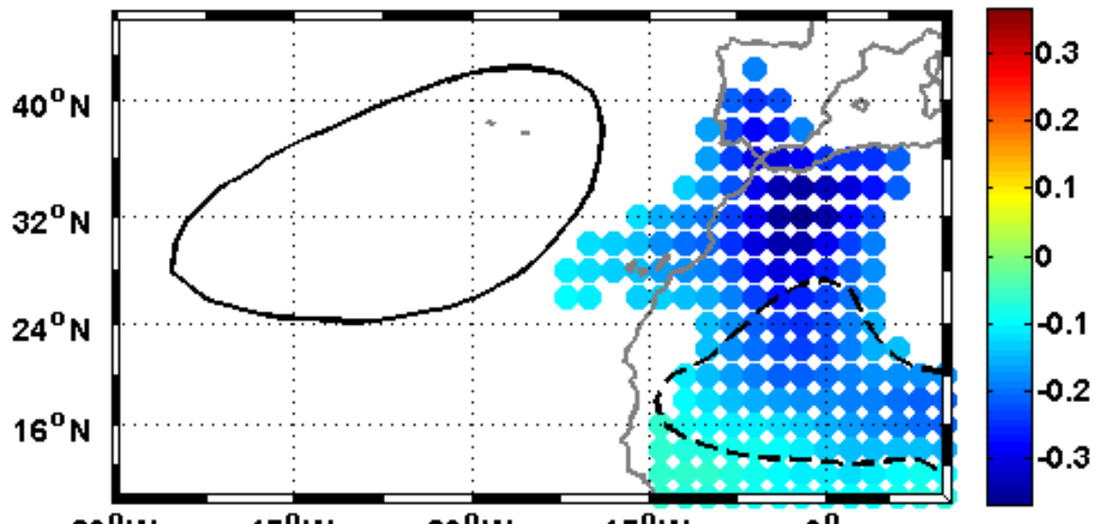


SLP linear trends: 1940-2013

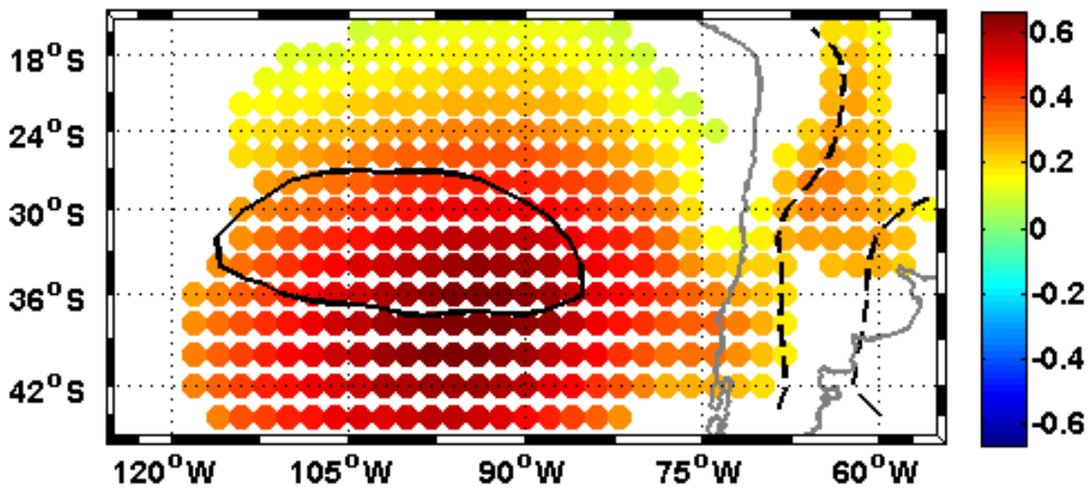
may



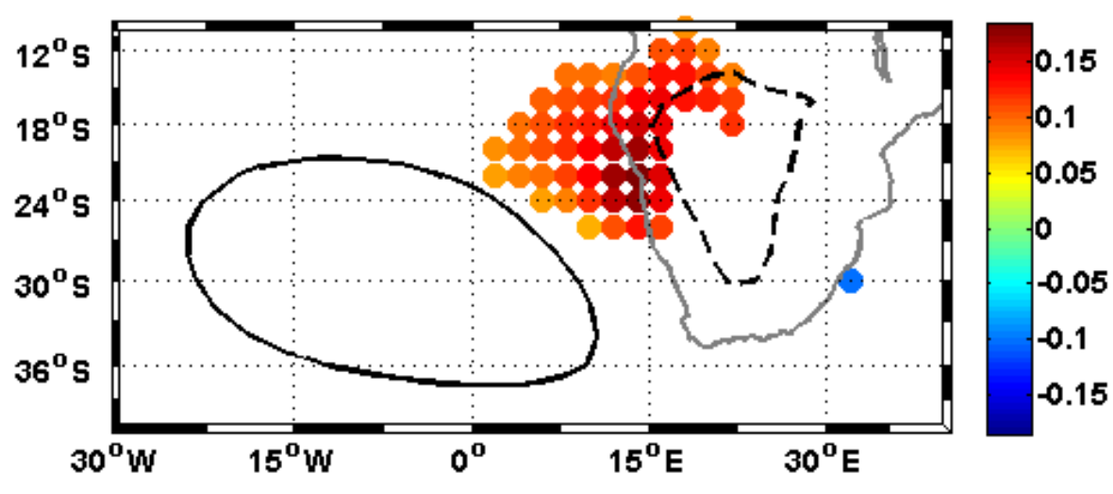
may



december

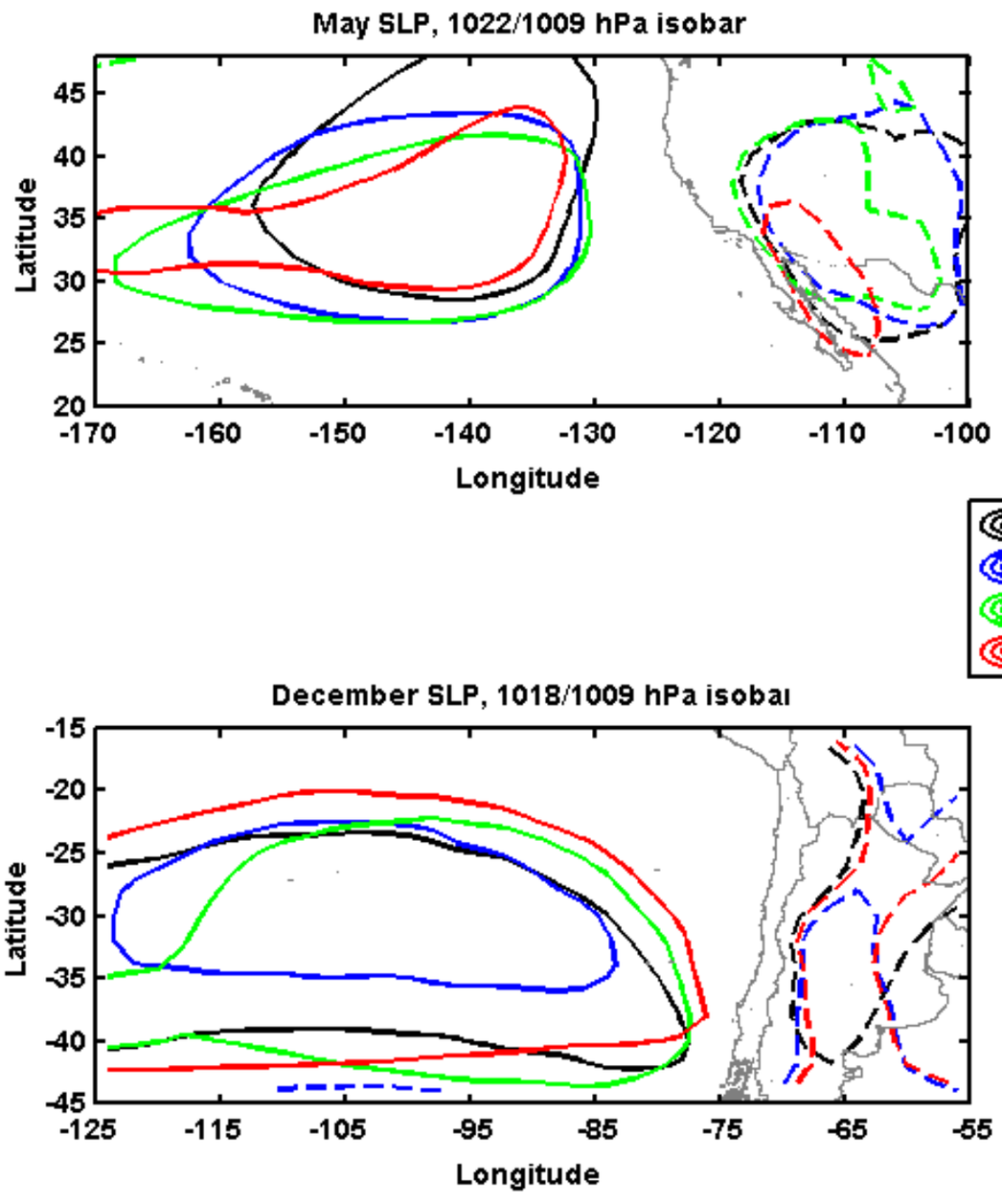


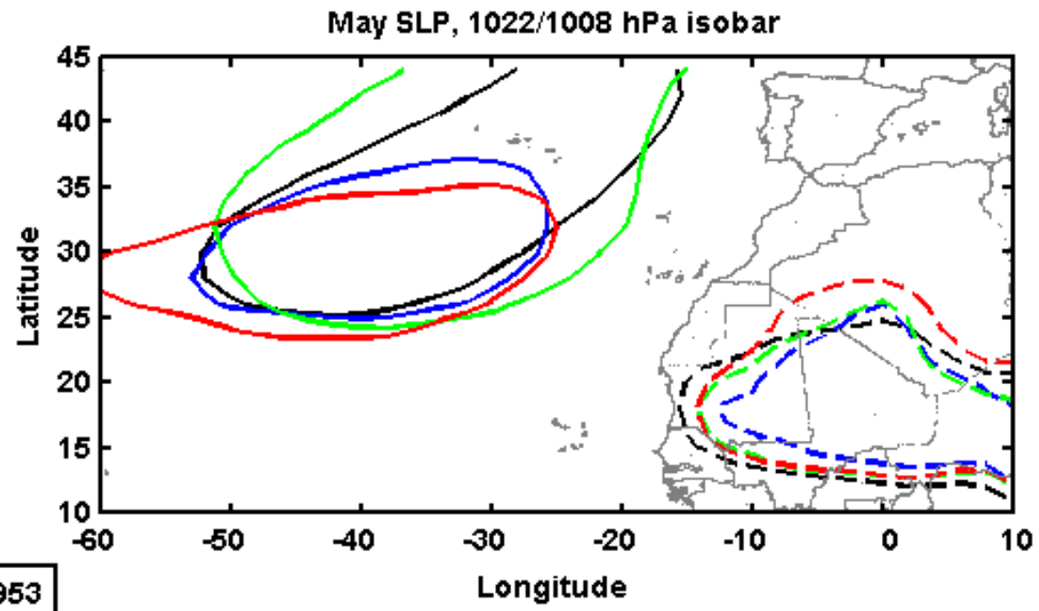
december

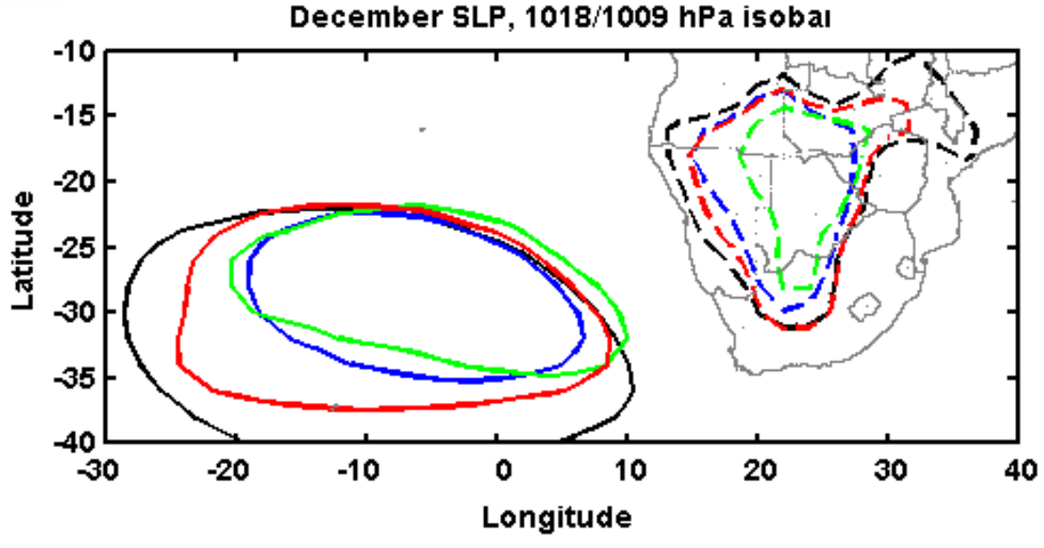


hPa/decade

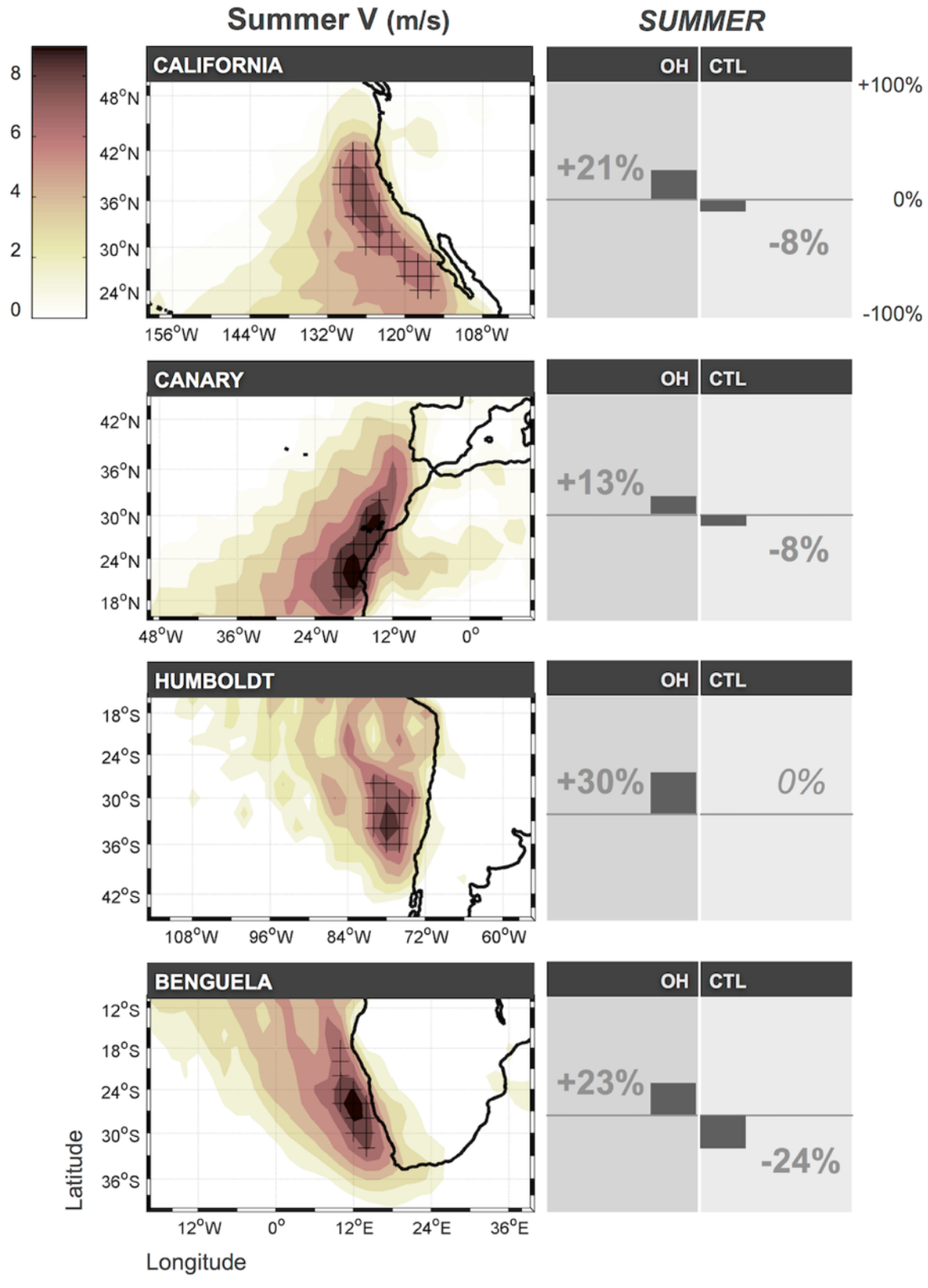
decadal variability in pressure systems







correlation between wind and pressure systems

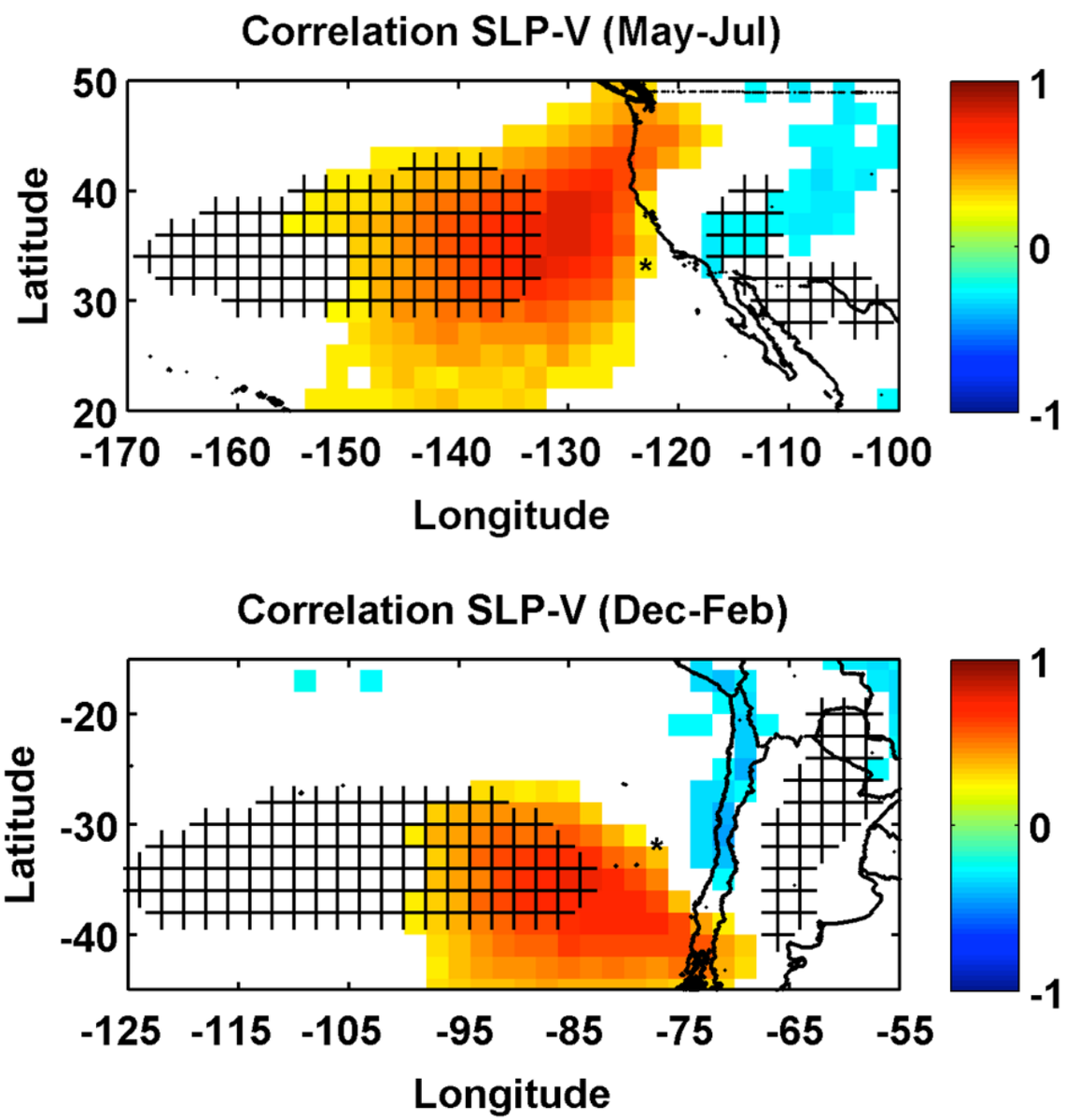


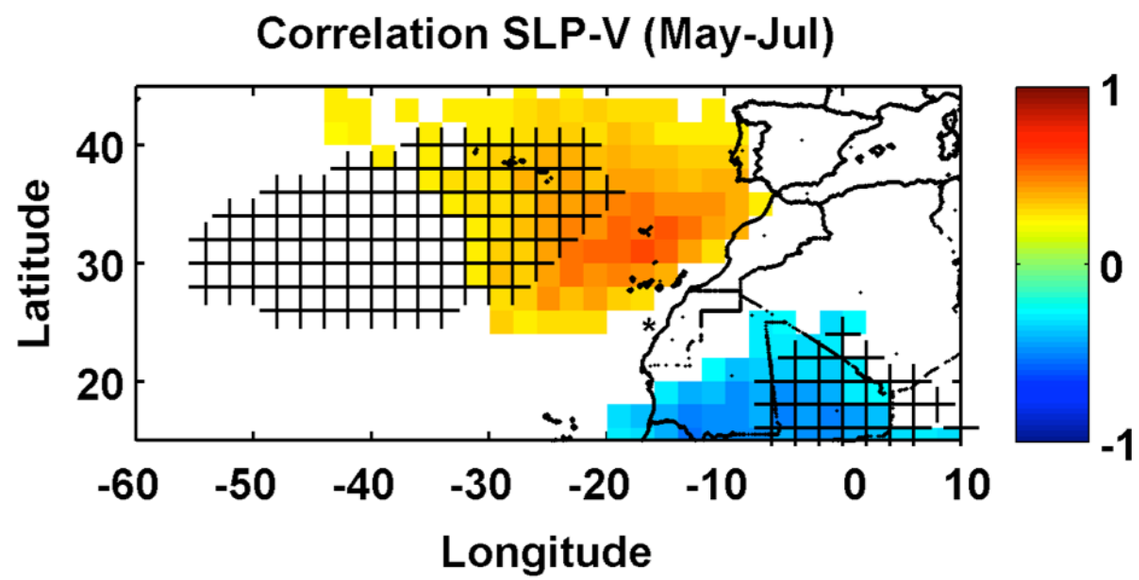
OH: ocean high pressure system

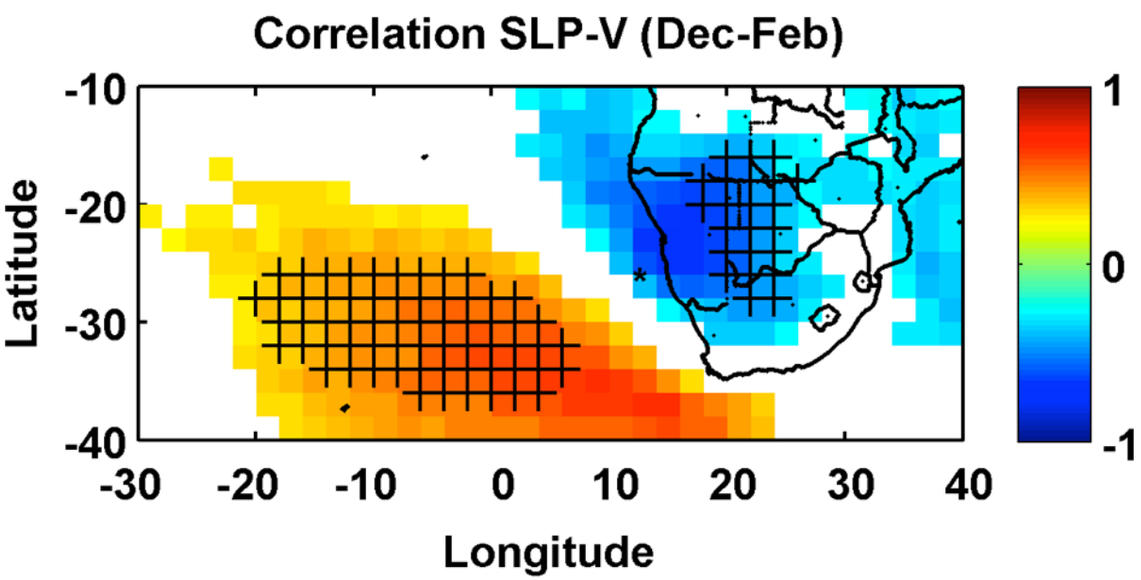
CTL: thermal low pressure system

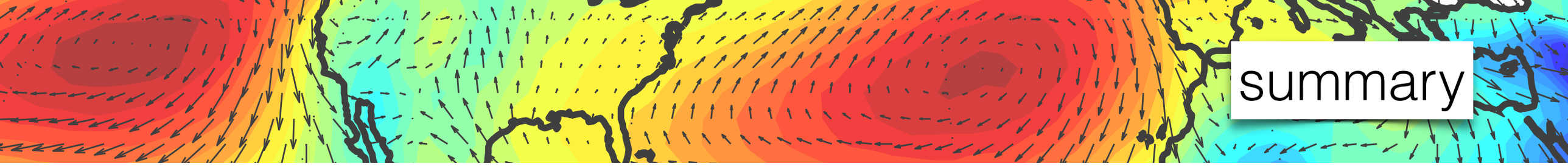
García-Reyes et al., 2014

correlation between wind and pressure systems



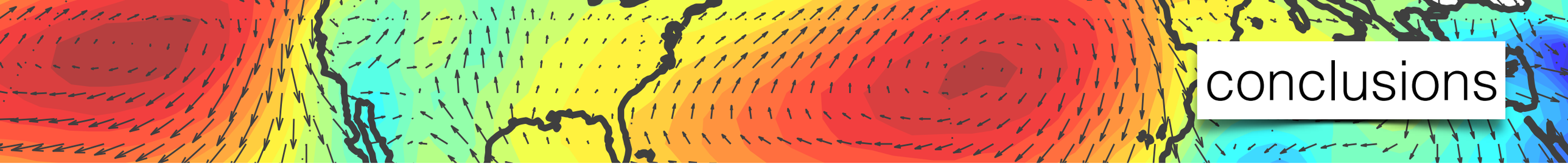






summary

- bakun hypothesis:
  - consistent with data in last decades, but mechanism not supported
- poleward migration of pressure systems:
  - not observed in past data
  - large multi-decadal variability
- higher impact of eastern side of ocean highs



conclusions

- bakun hypothesis:
  - consistent with data in last decades, but mechanism not supported
- poleward migration of pressure systems:
  - not observed in past data
  - large multi-decadal variability
- higher impact of eastern side of ocean highs
- **next step:** change on coastal pressure gradients in relation to both pressure systems