

Understanding Climate Variability and Change in the Altiplano

Anji Seth, Jeanne Thibeault (UConn)
Magali Garcia (UMSA, La Paz)

SANREM CRSP

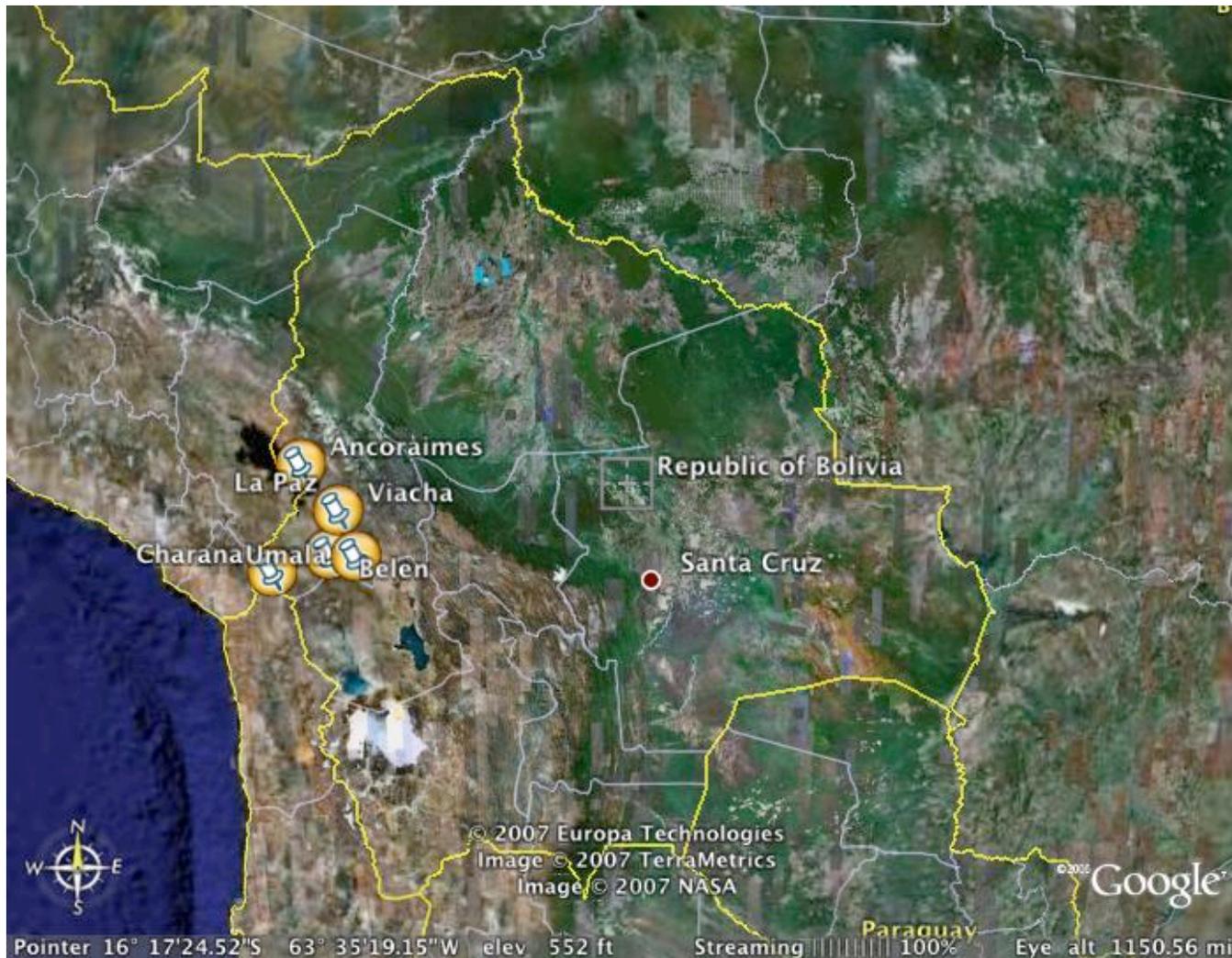
Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program

Adapting to Change in the Andean Highlands: Practices and Strategies
to Address Climate and Market Risks in Vulnerable Agro-Eco Systems

- promotes stakeholder empowerment and improved livelihoods through knowledge - based sustainable agriculture and natural resource management systems.
- emphasis on developing economies

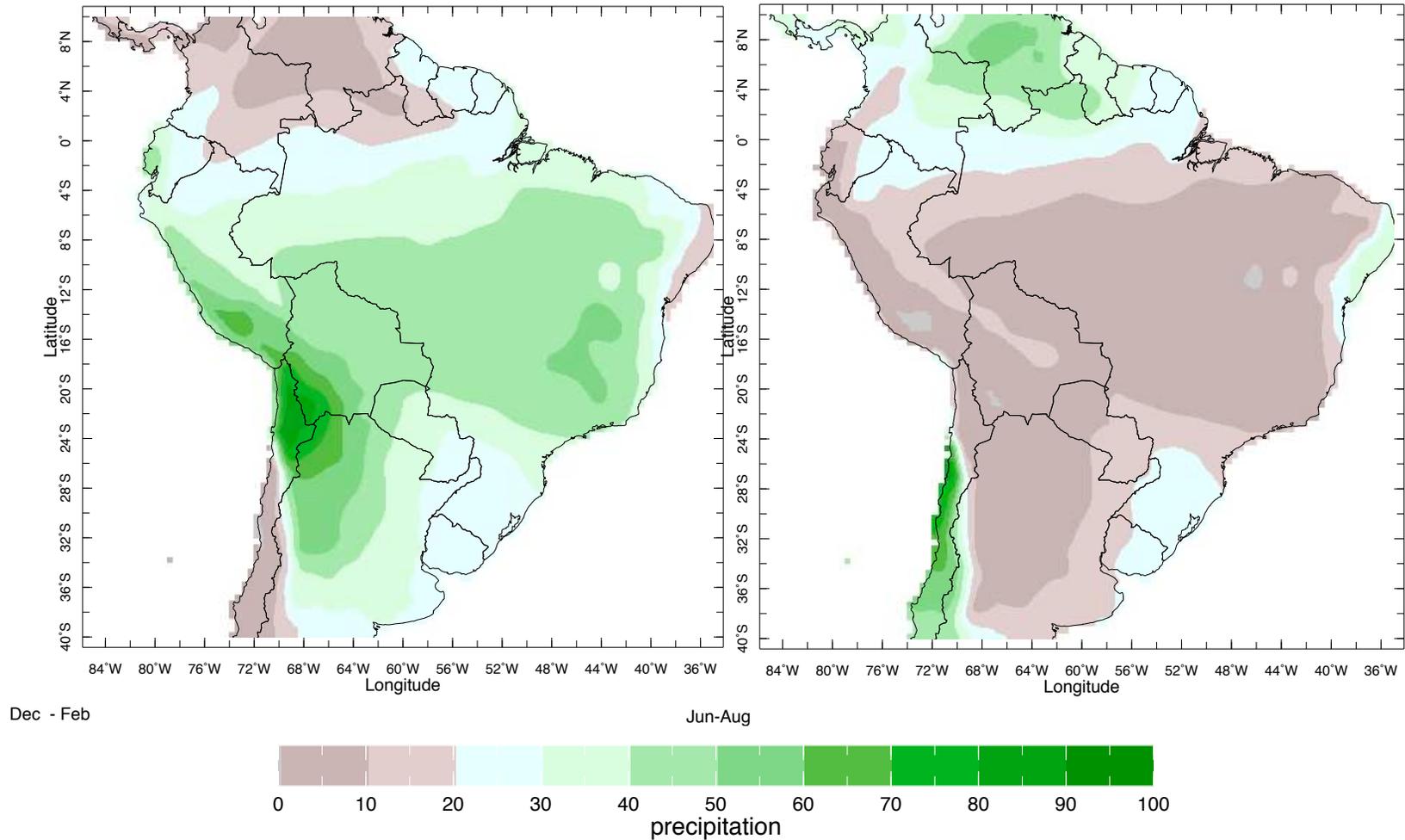


Andean Highlands



Altiplano Climate

Fraction of annual precipitation: DJF, JJA

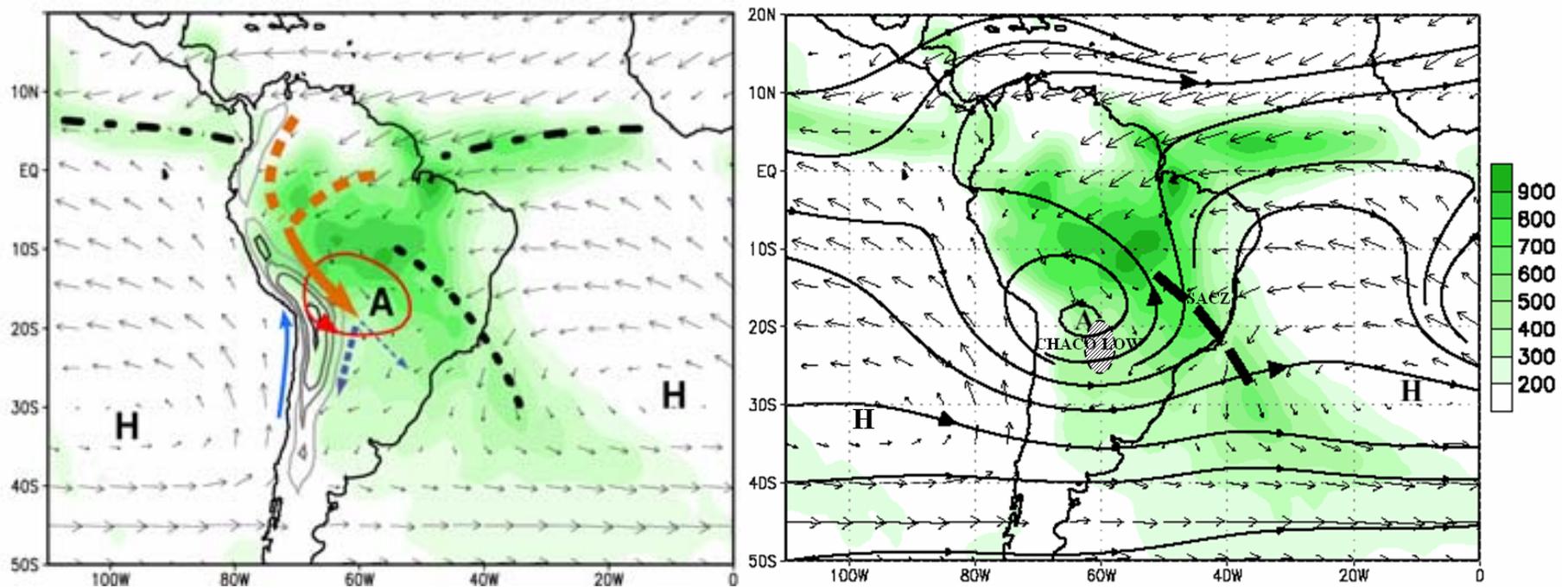


Overview

- 20th Century Observations and Global Models
 - Mean climate
 - Present day variability
 - Recent trends
- Projections for the 21st century
 - Mean climate
 - Variability

Altiplano Climate

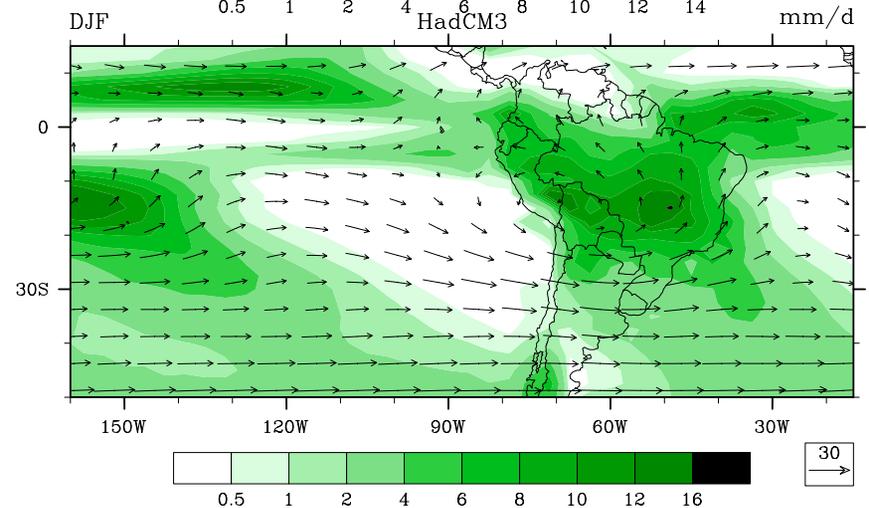
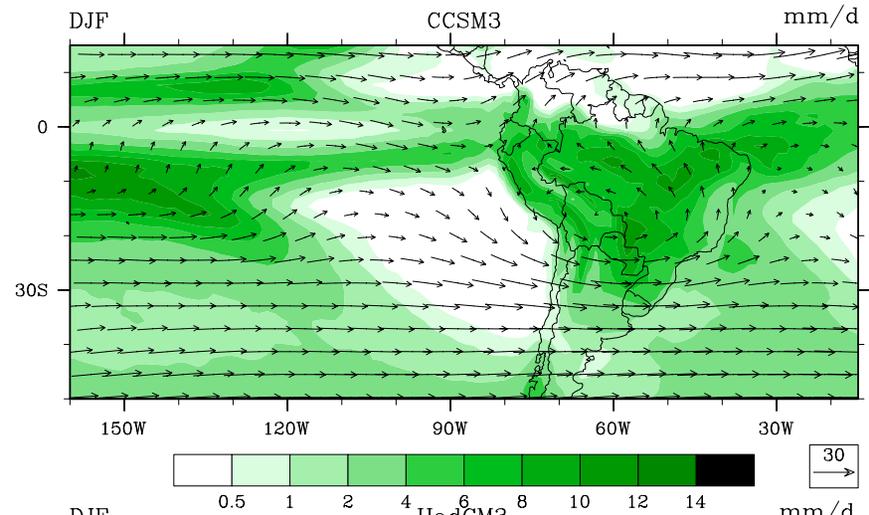
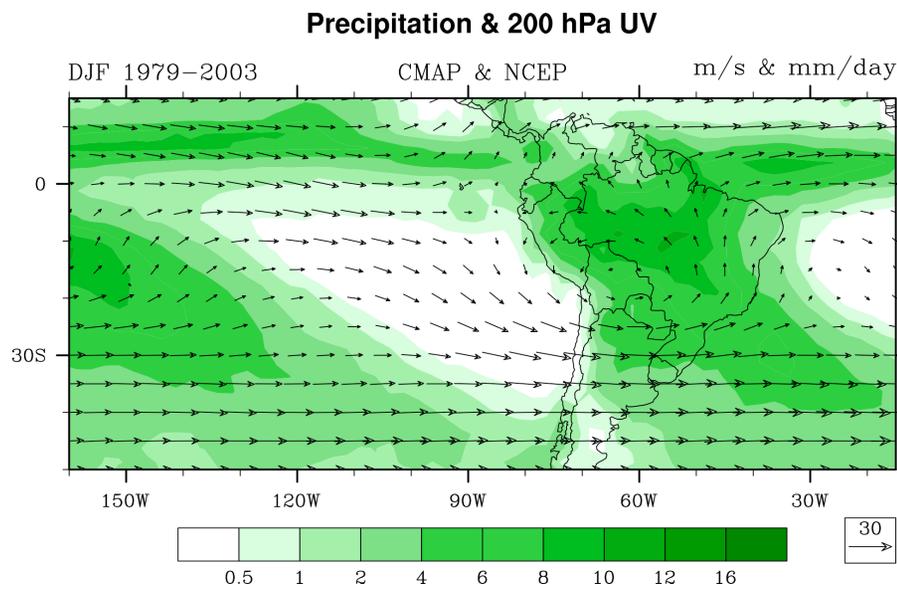
Features of South American Warm Season Rains



Altiplano Climate

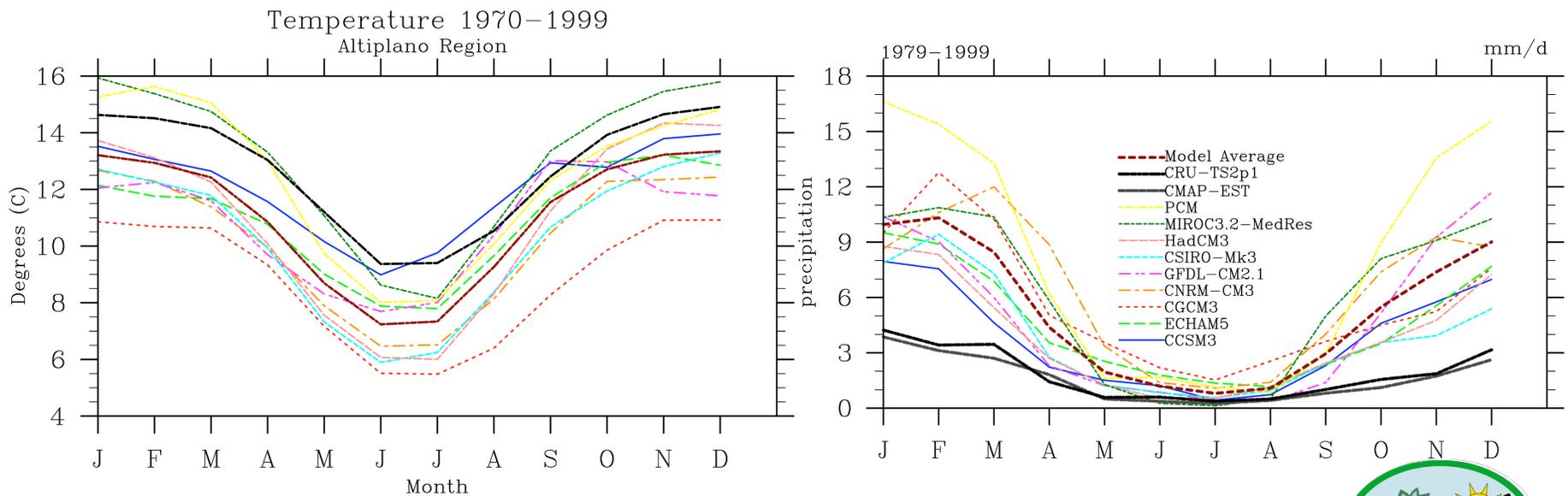
Precipitation & 200 hPa Wind - AR4 Models

Precipitation & 200 HPa Winds 1970-1999



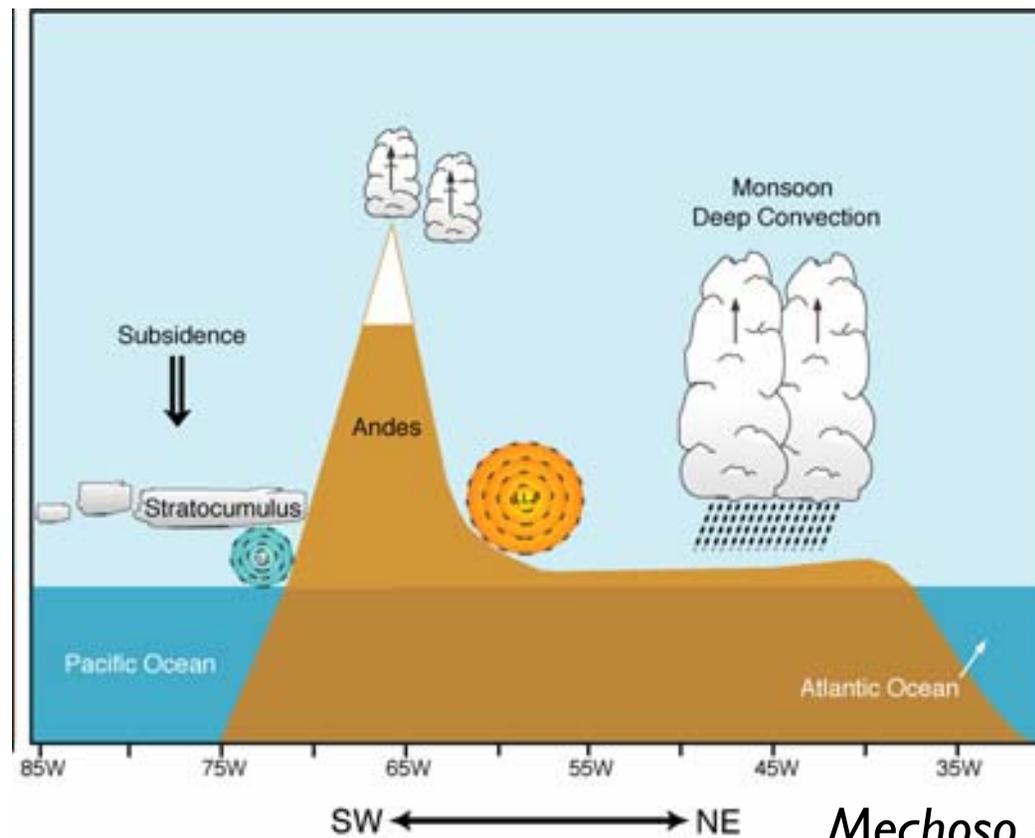
Climate Models: 20th Century

Altiplano Mean Annual Cycle



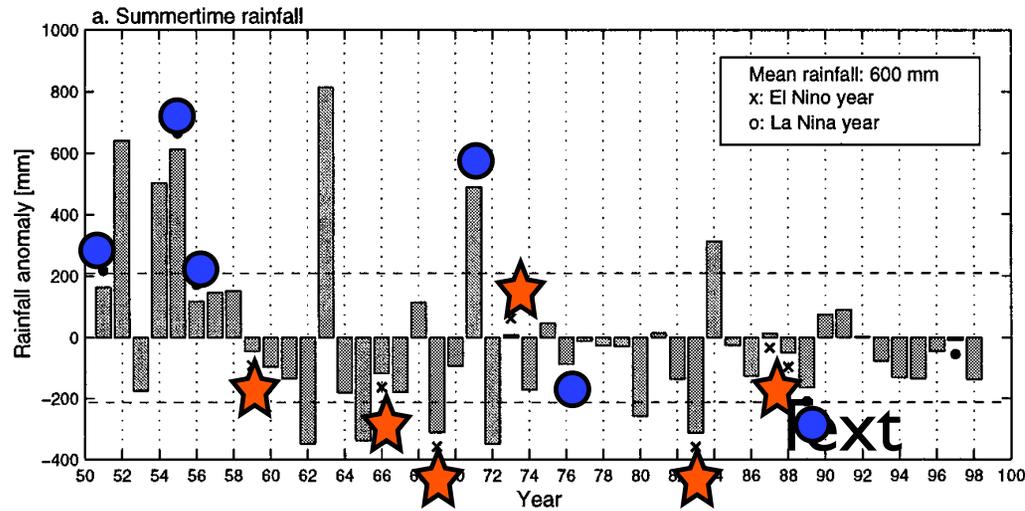
Altiplano Climate

Features of South American Warm Season Rains



Mechoso et al., 2006

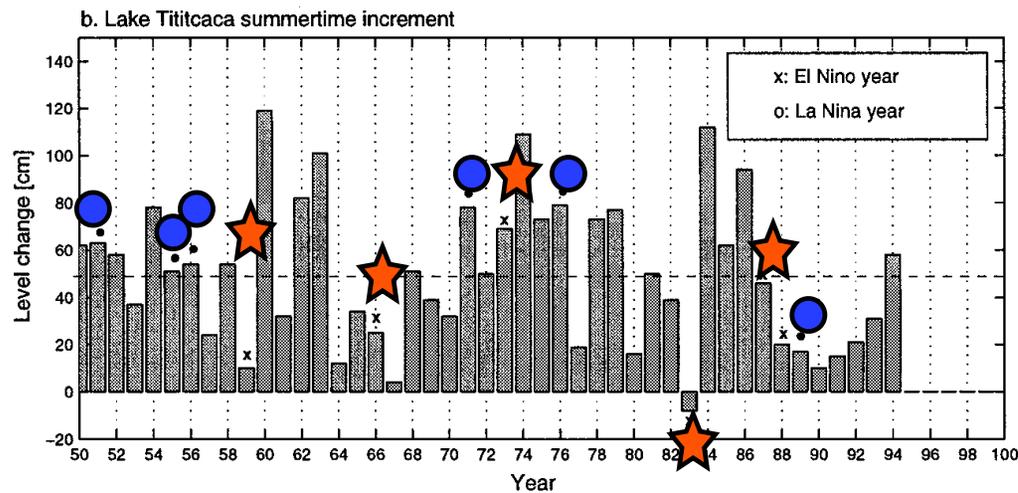
Altiplano Variability



Garreaud & Aceituno, 2001

Summer Rainfall Anomalies
Gridded precipitation from
CRU/Dai

El Nino - Dry?
La Nina - Wet?



Lake Titicaca summertime
increment

Altiplano Variability

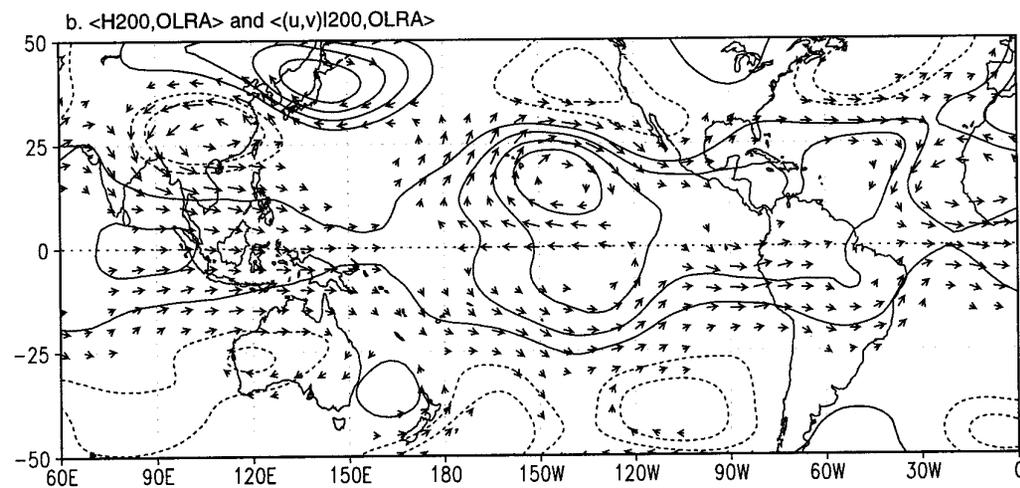
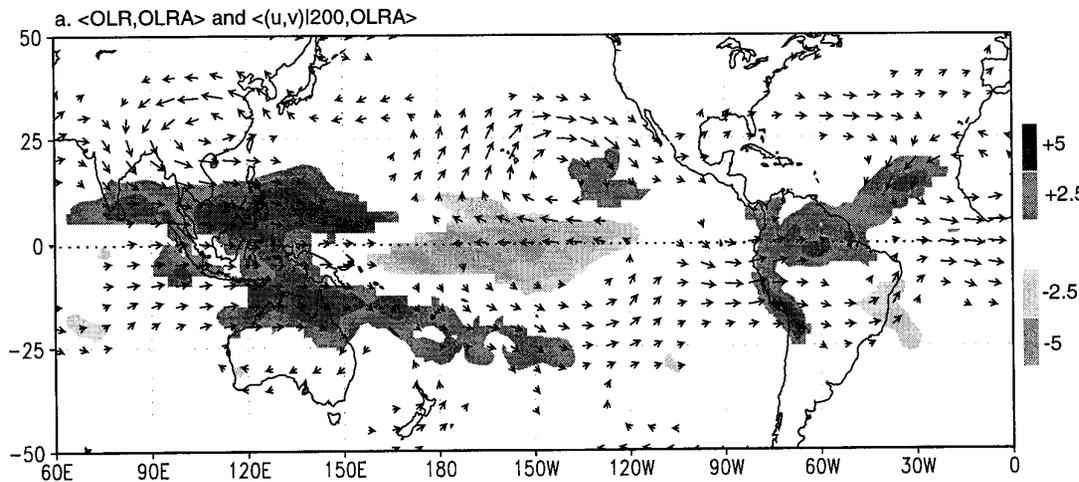
Garreaud & Aceituno, 2001

Summer rainfall anomalies
upper tropospheric winds
and tropospheric
temperatures

Dry - upper level westerlies
and warm troposphere

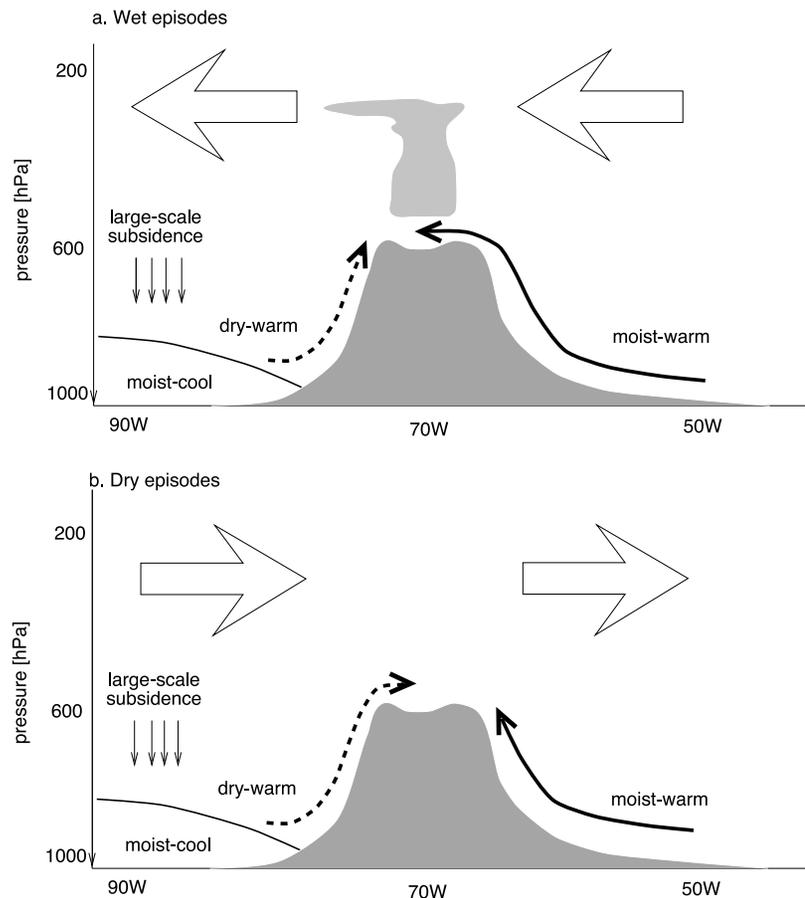
Wet - easterlies and cooler
troposphere

Sensitive to latitude of
enhanced westerlies



Altiplano Variability

R. Garreaud et al. / *Palaeogeography, Palaeoclimatology, Palaeoecology* 194 (2003) 5–22



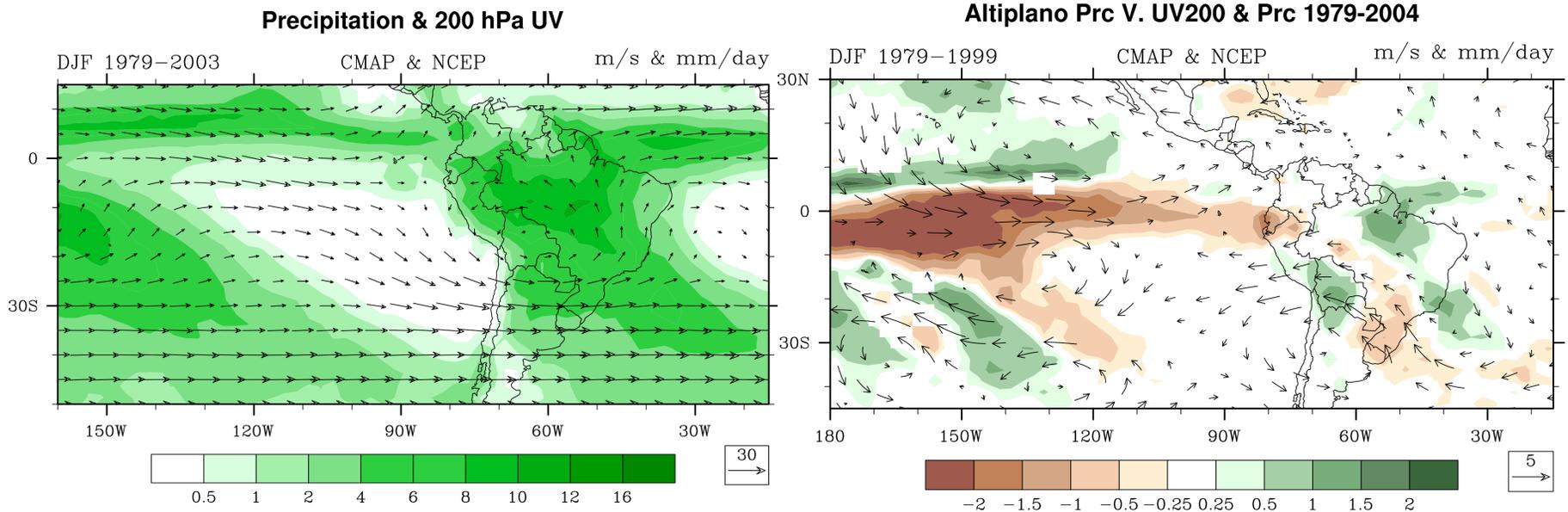
Garreaud et al., 2003

Summer rainfall related to direction of upper tropospheric winds at

- intraseasonal
 - annual cycle
 - interannual
 - interglacial?
- timescales.

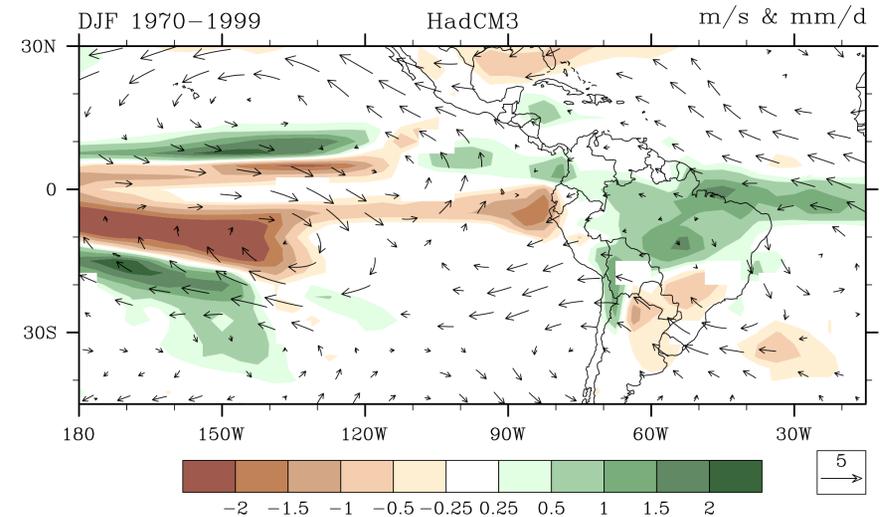
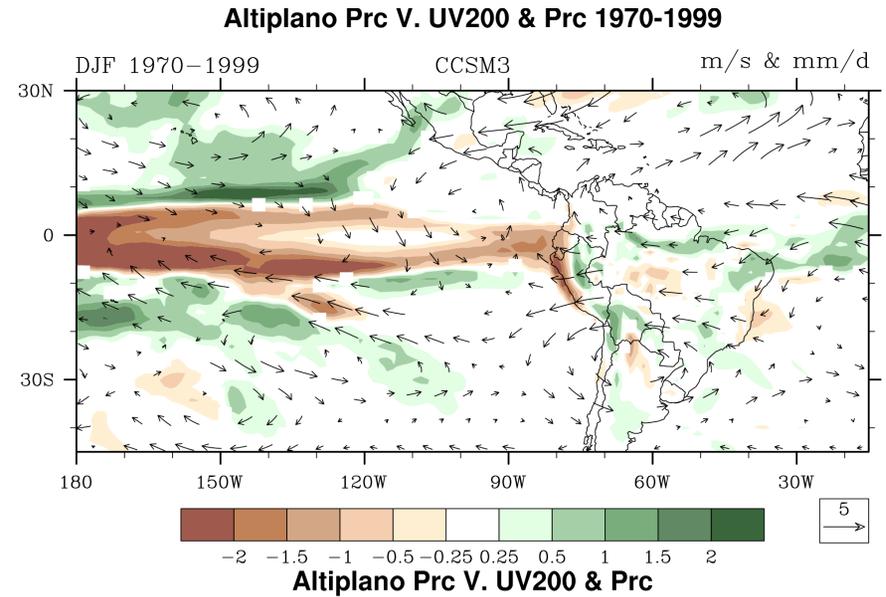
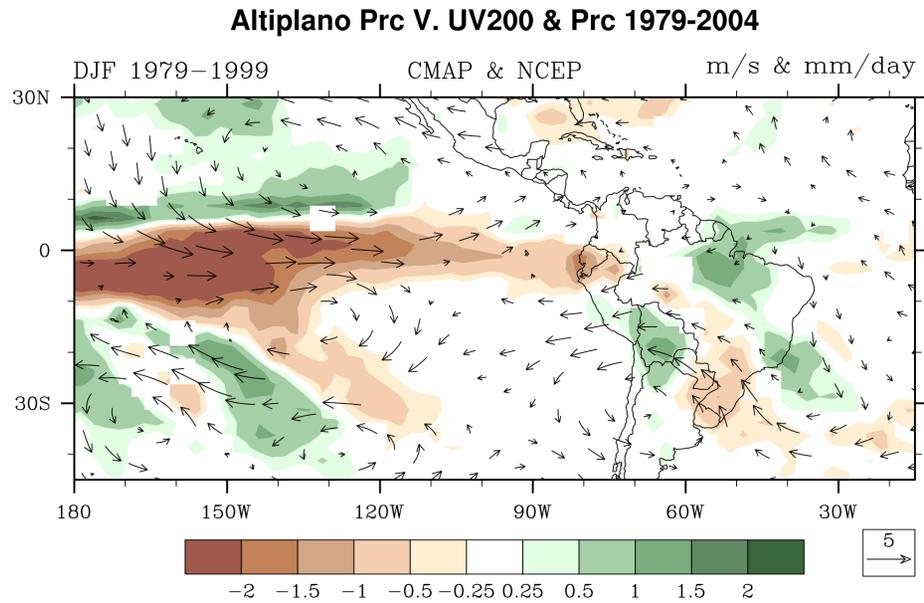
Altiplano Climate

Present Day Variability: Observations

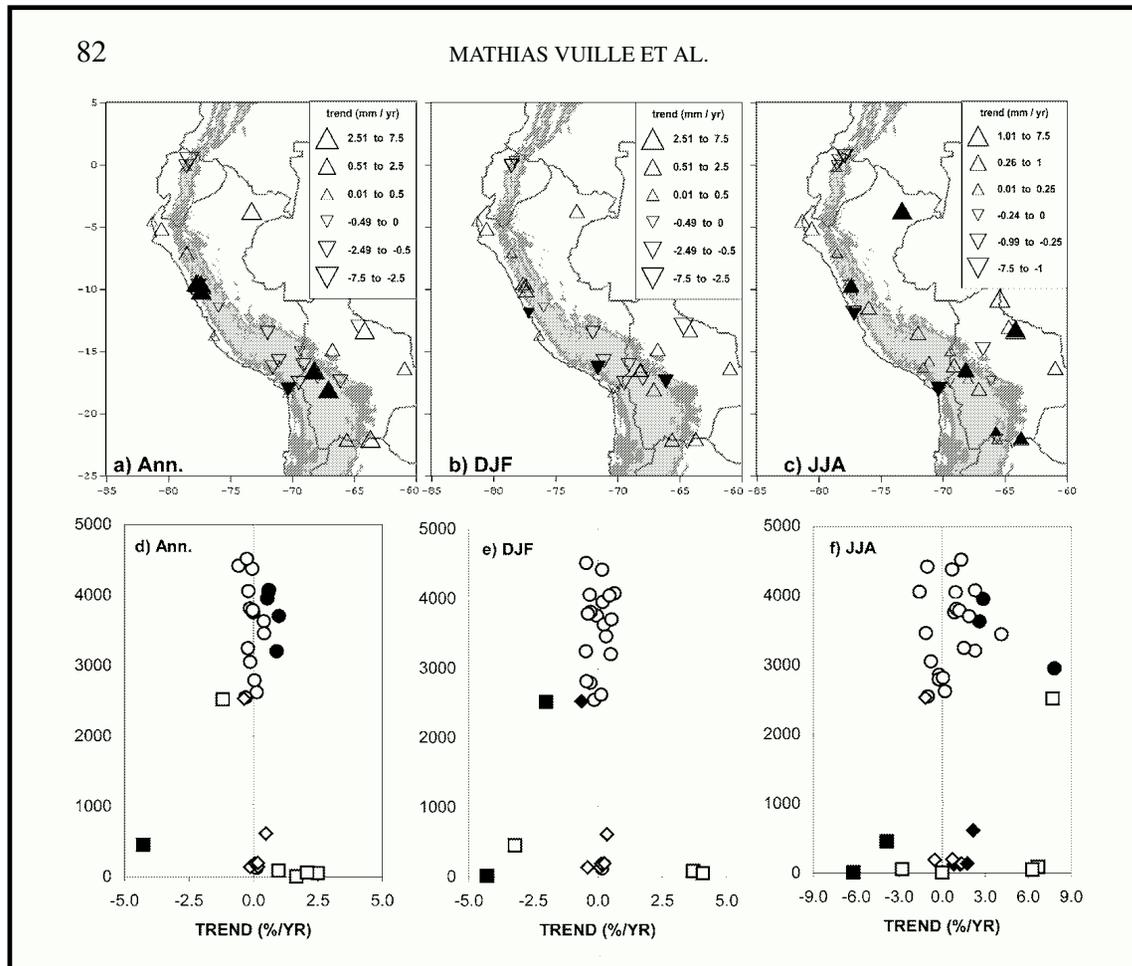


Climate Models: 20th Century

Present Day Variability



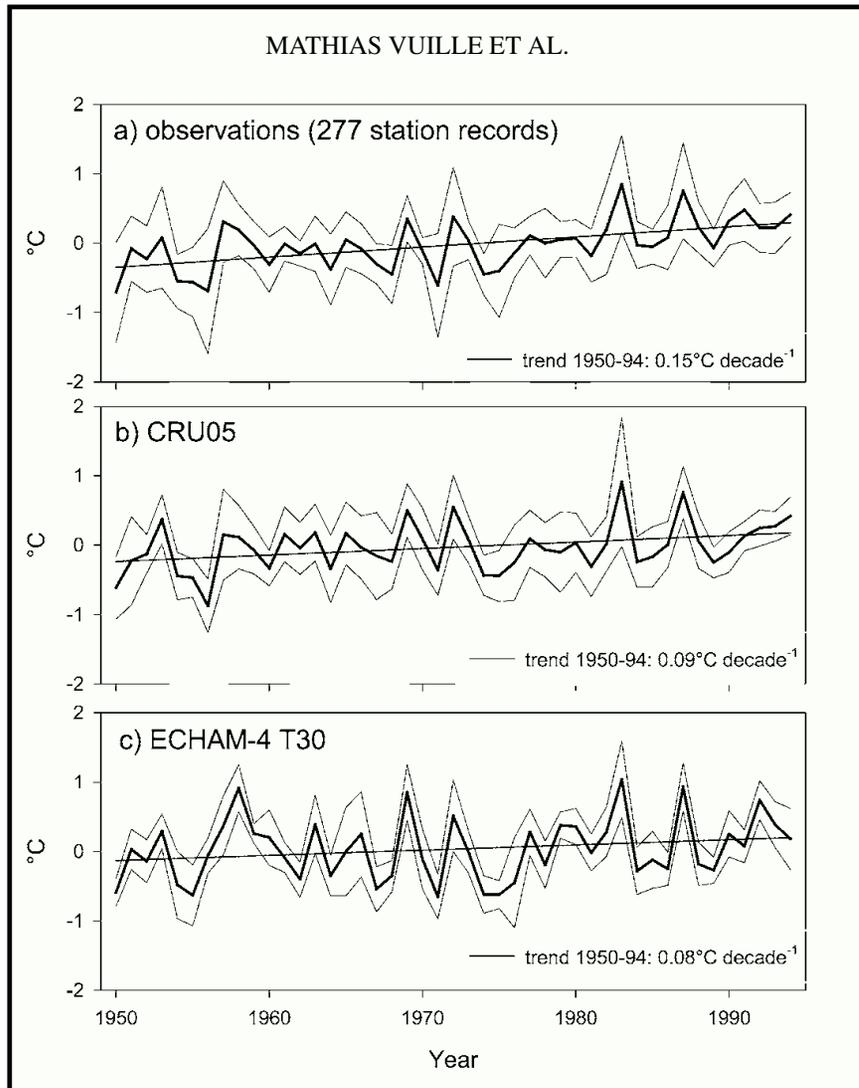
20th Century Trends



Vuille et al., 2003

Precipitation trends are minor and cannot explain observed retreat of glaciers.

Altiplano Trends

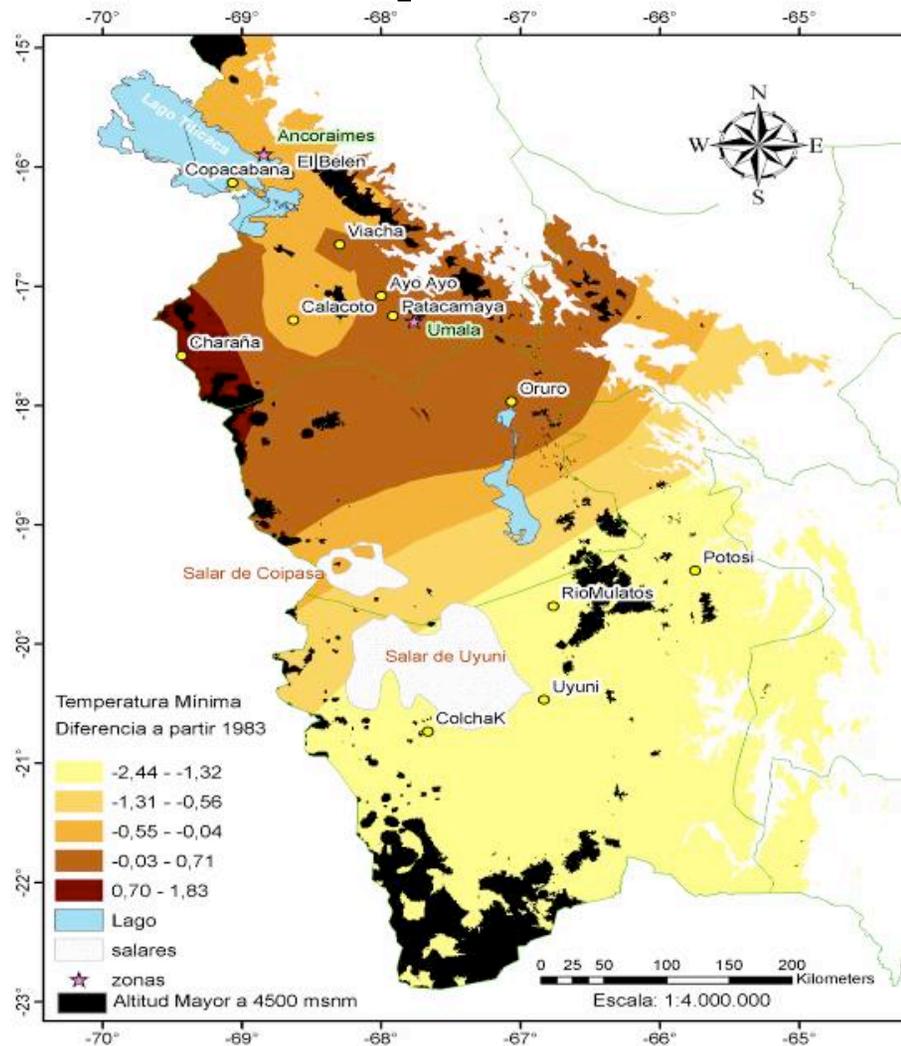


Vuille et al., 2003

Temperature trends are substantial, and are a likely cause of glacial retreat.

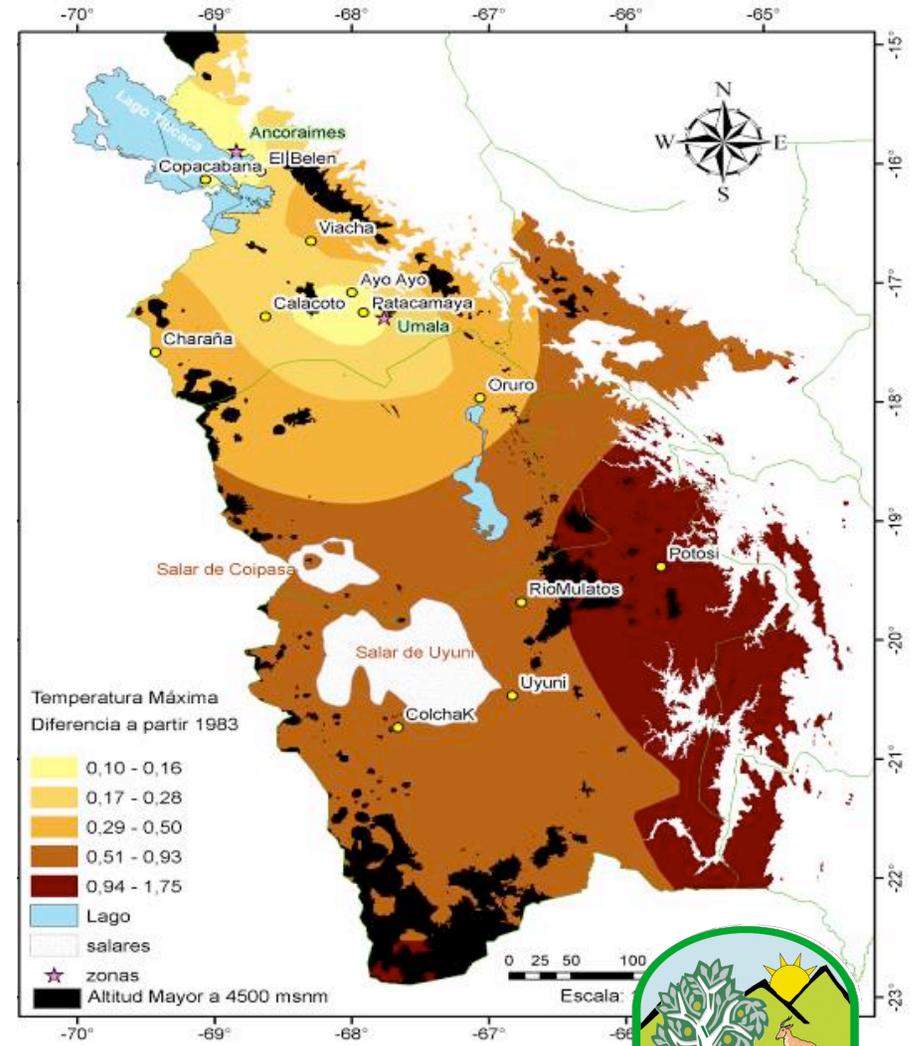
Trend is larger on the western slope of the Andes.

Altiplano Climate Trends



^ Min Temperature

Difference since 1983

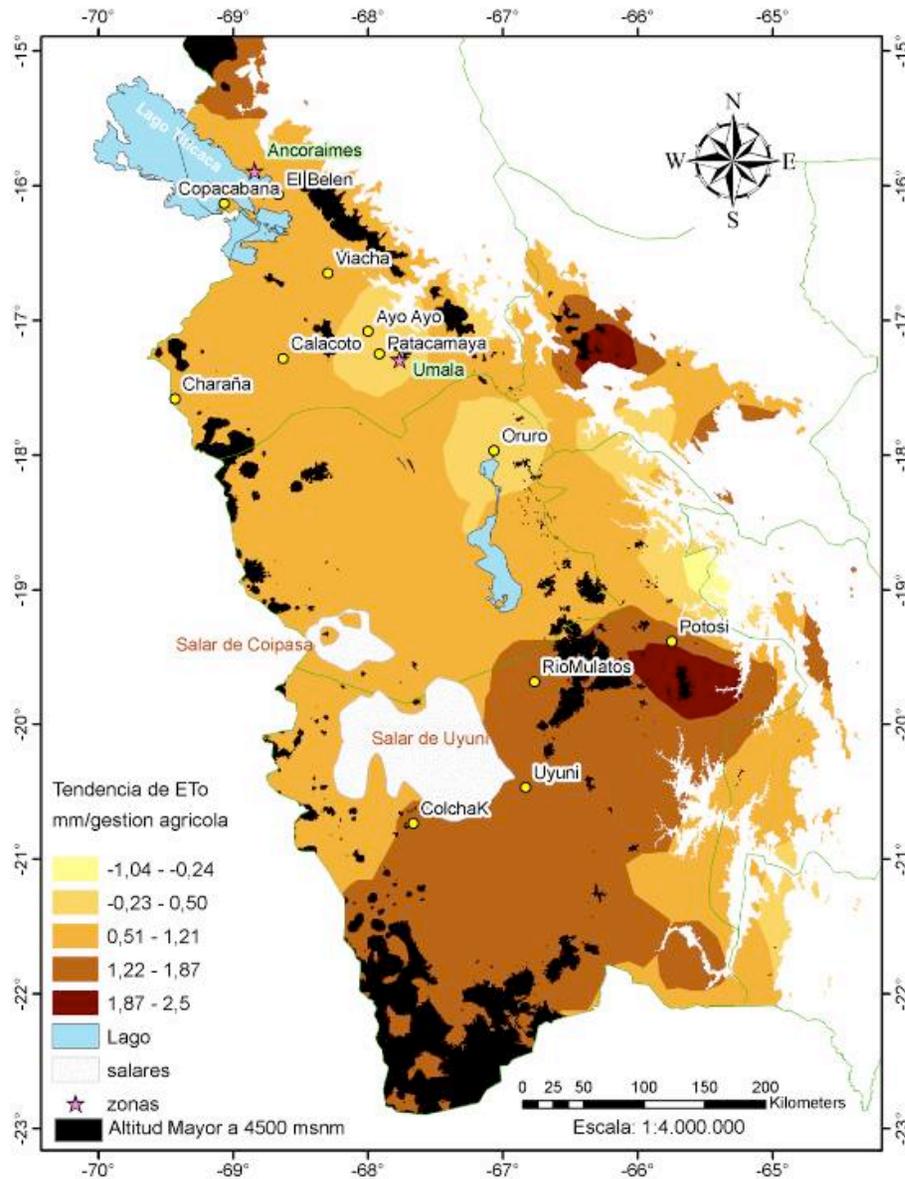


^ Max Temperature



SANREM CRSP

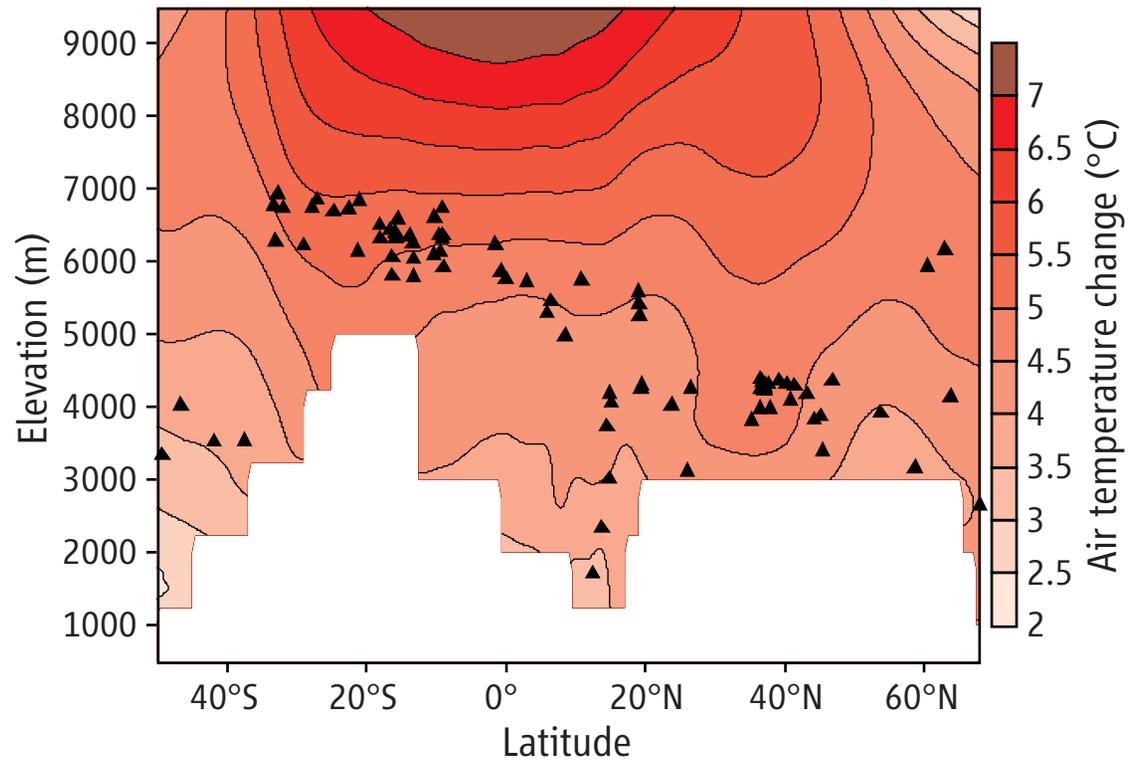
Evapotranspiration Trend



< Evapotranspiration trend



Altiplano Projections



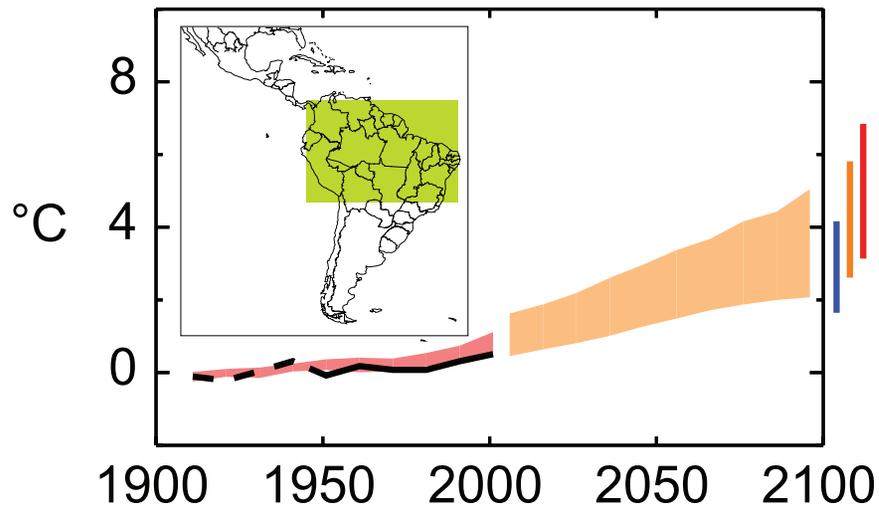
Threats to Water Supplies in the Tropical Andes

Raymond S. Bradley, Mathias Vuille, Henry F. Diaz, Walter Vergara

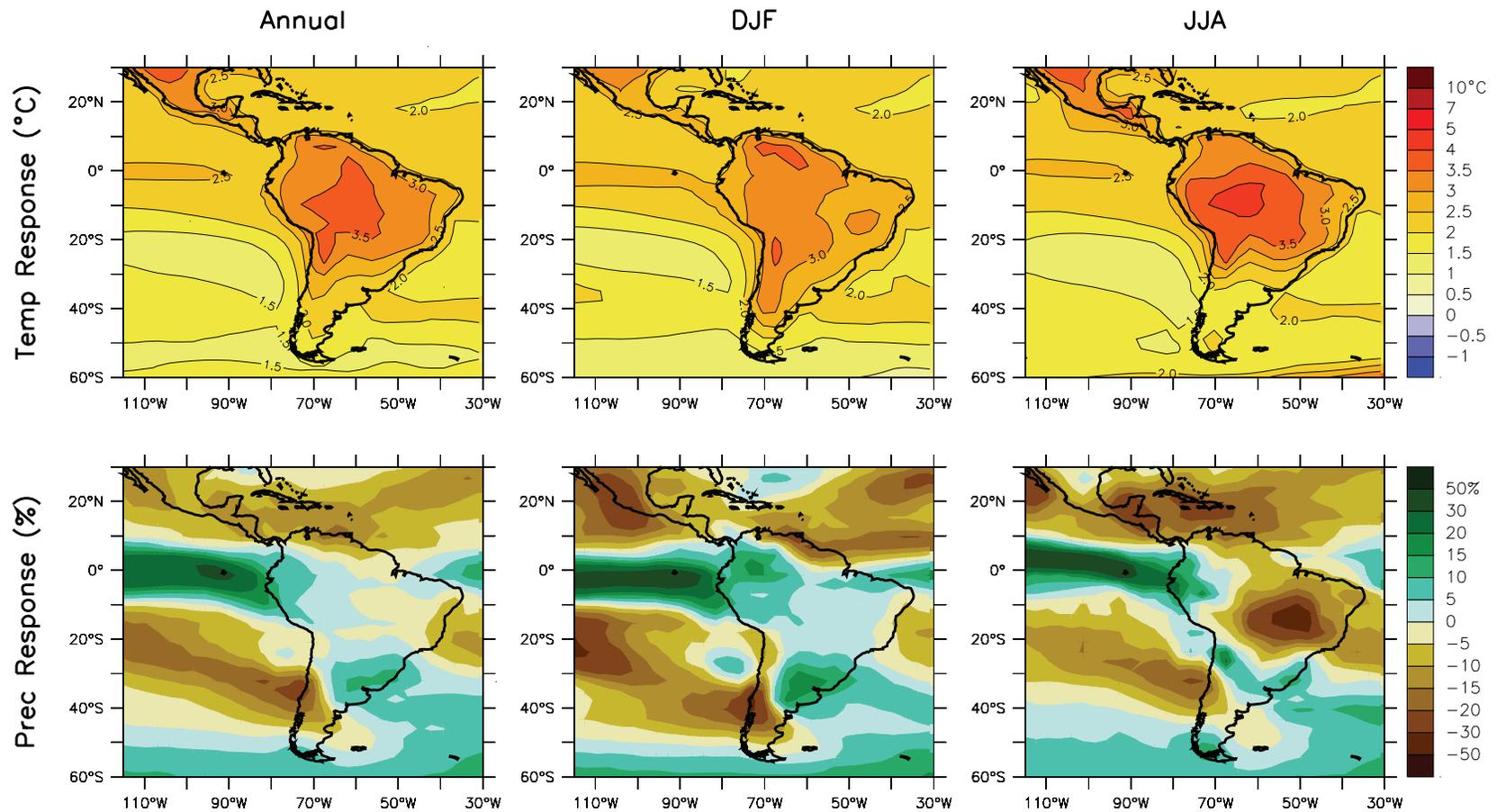
IPCC AR4 Projections

Temperature Changes

AMZ

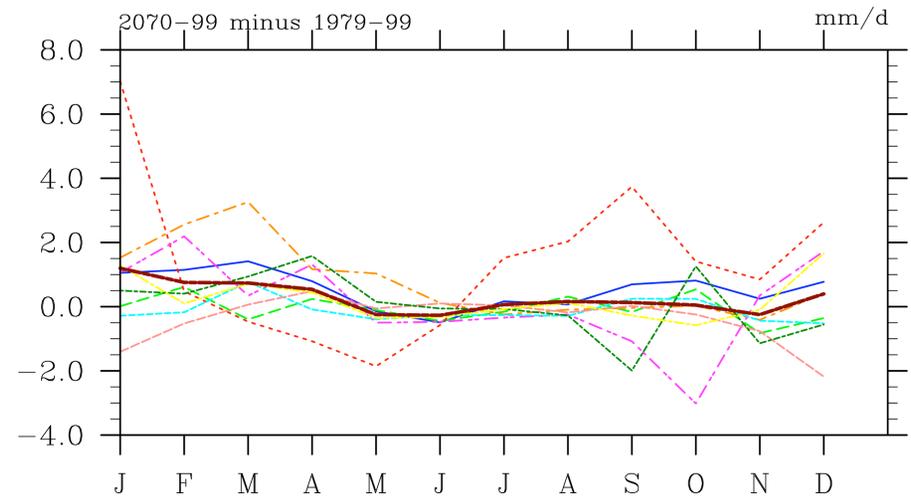
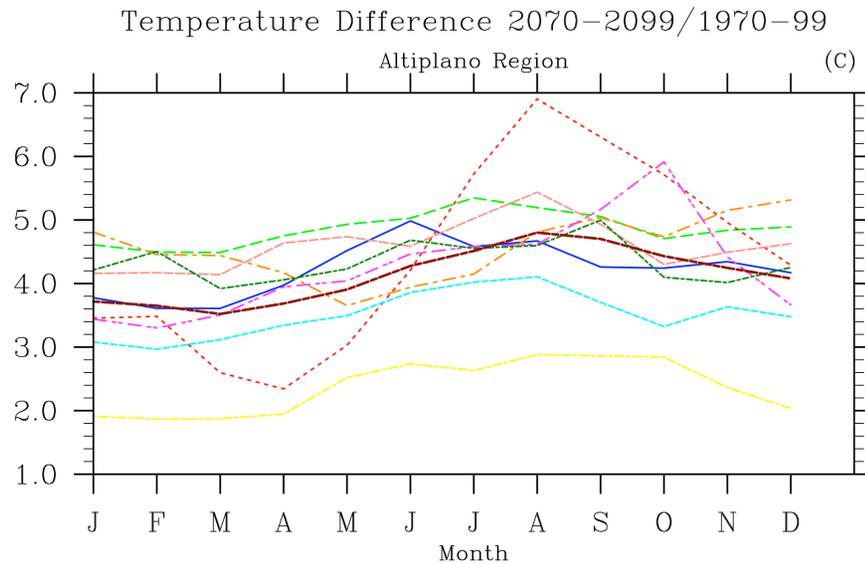


IPCC Projections (2080-2099) - (1980-1999)

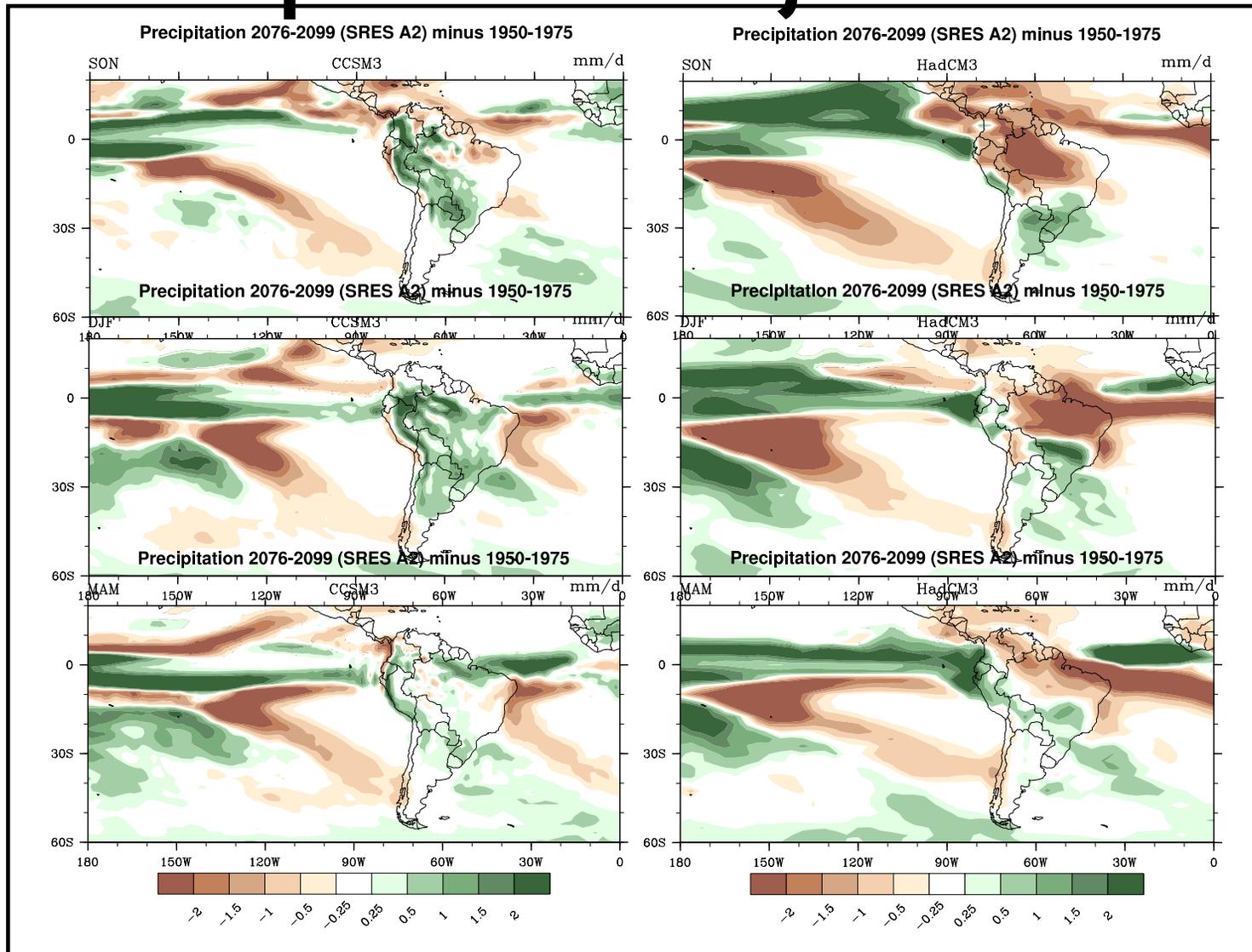


Climate Models: 21st Century

Altiplano Monthly anomalies w.r.t. 20th Century



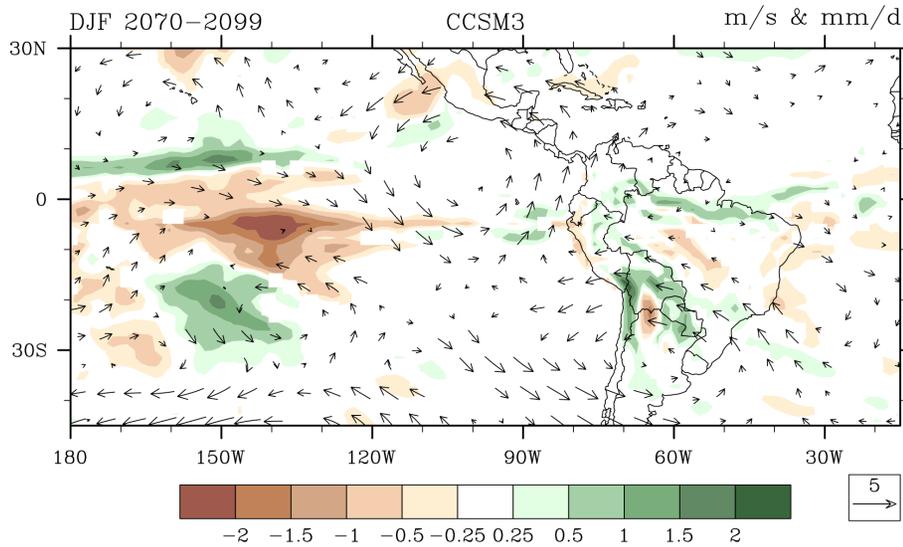
Altiplano Projections



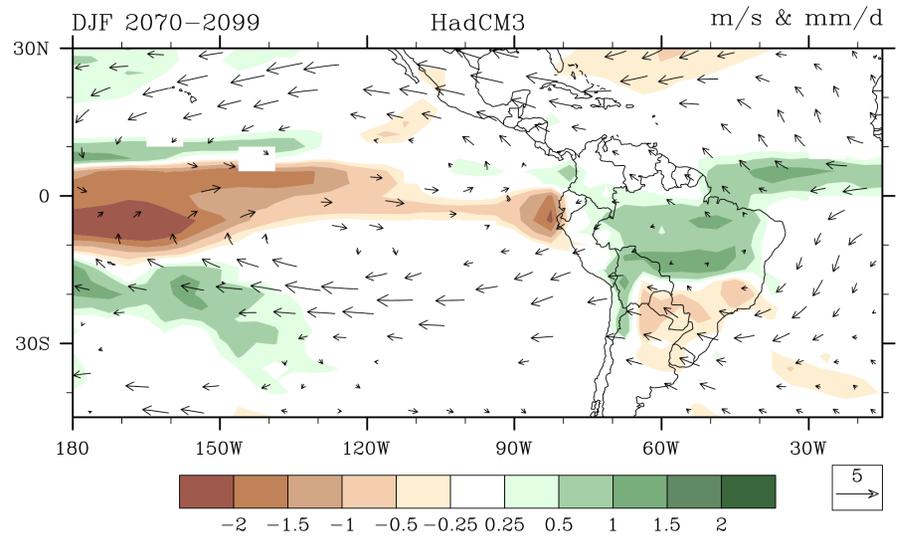
Climate Models: 21st Century

Interannual Variability

Altiplano Prc V. UV200 & Prc



Altiplano Prc V. UV200 & Prc

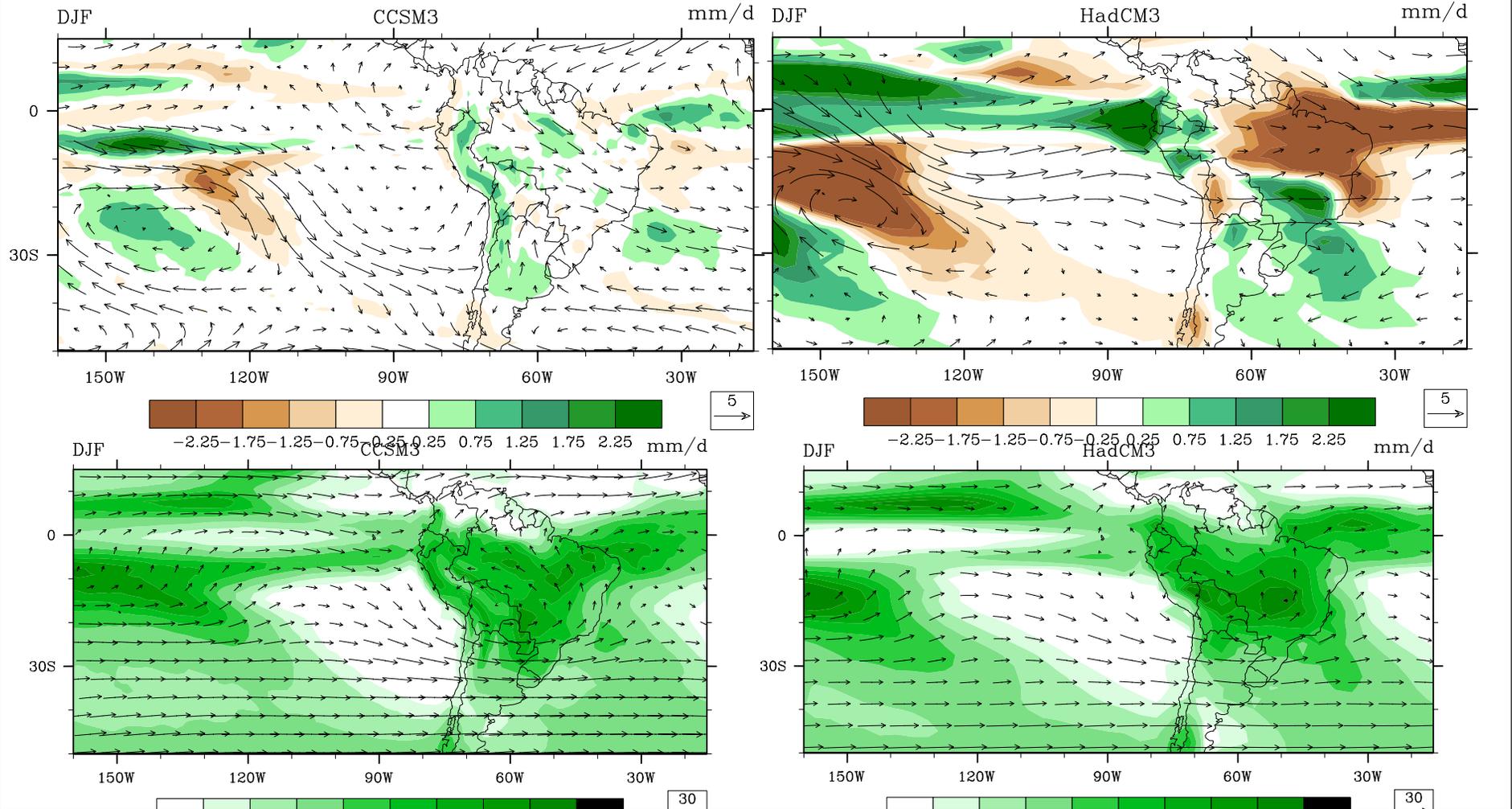


Altiplano Variability

Precipitation & 200 hPa Wind - AR4 Models

Precip & 200 HPa UA 2070-2099 - 1970-1999

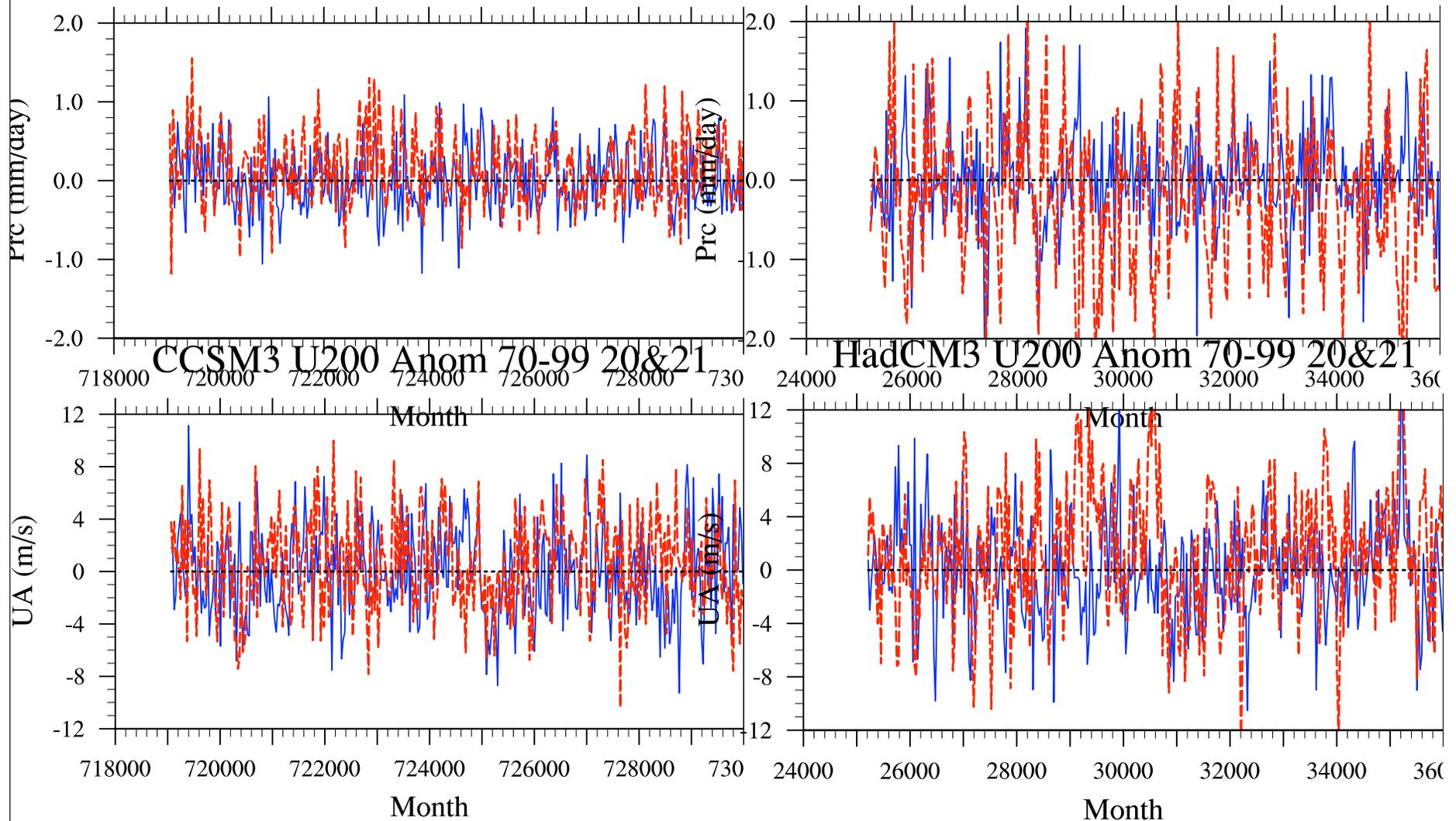
Precip & 200 HPa UA 2070-2099 - 1970-1999



Altiplano Variability

CCSM3 Prec Anom 70-99 **20** & **21**

HadCM3 Prec Anom 70-99 **20** & **21**



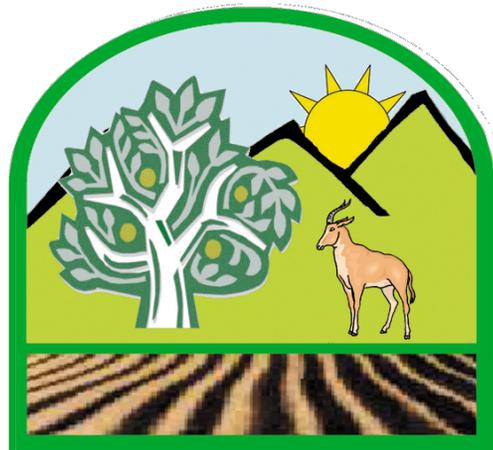
Discussion

- The upper tropospheric zonal wind hypothesis...
- The models appear to simulate this mechanism in the present
- The models respond quite differently in 21st Century climate - is this related to differences in the evolution of ocean temperatures in the coupled ocean atmosphere models?

Acknowledgments



University of Connecticut



SANREM CRSP



University of Missouri-Columbia



USAID
FROM THE AMERICAN PEOPLE