# ENSO Related Seasonal Range Prediction Over South America

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# Introduction

- Seasonal range forecasting up to two seasons ahead has been performed successfully in the Missouri USA region with skill better than climatology.

- The Midwest region winter conditions are highly dependent on the phase of El Niño and Southern Oscillation (ENSO), while the summer season can be shown to be dependent on the direction of the transition.  These associations can be found in other Northern Hemisphere regions as well.

# Introduction

- ENSO has been shown to have a strong impact on South American weather and climate as well, especially along the west coastal regions.

- The Pacific South American (PSA) pattern (analogous to it's North Pacific counterpart) has two primary modes which show different dependencies upon modes of ENSO.

# Motivation

- There is anecdotal evidence in the Bolivian Altiplano region that weather during the Winter Solstice season can be associated with the upcoming summer agricultural production.

- Understanding the upper air variability and the relationship to surface data may provide the statistical basis for generating seasonal range prediction for the region.

# Goals

- To examine the upper air variability (of height and winds) in the June period, versus January and February, which are the agriculturally sensitive seasons and seem to possess strong interannual variability. This study may be extended to other seasons.

- To relate the upper air variability with Pacific region SSTs as well as the surface information to create a statistical data base for geberating long range forecasts.

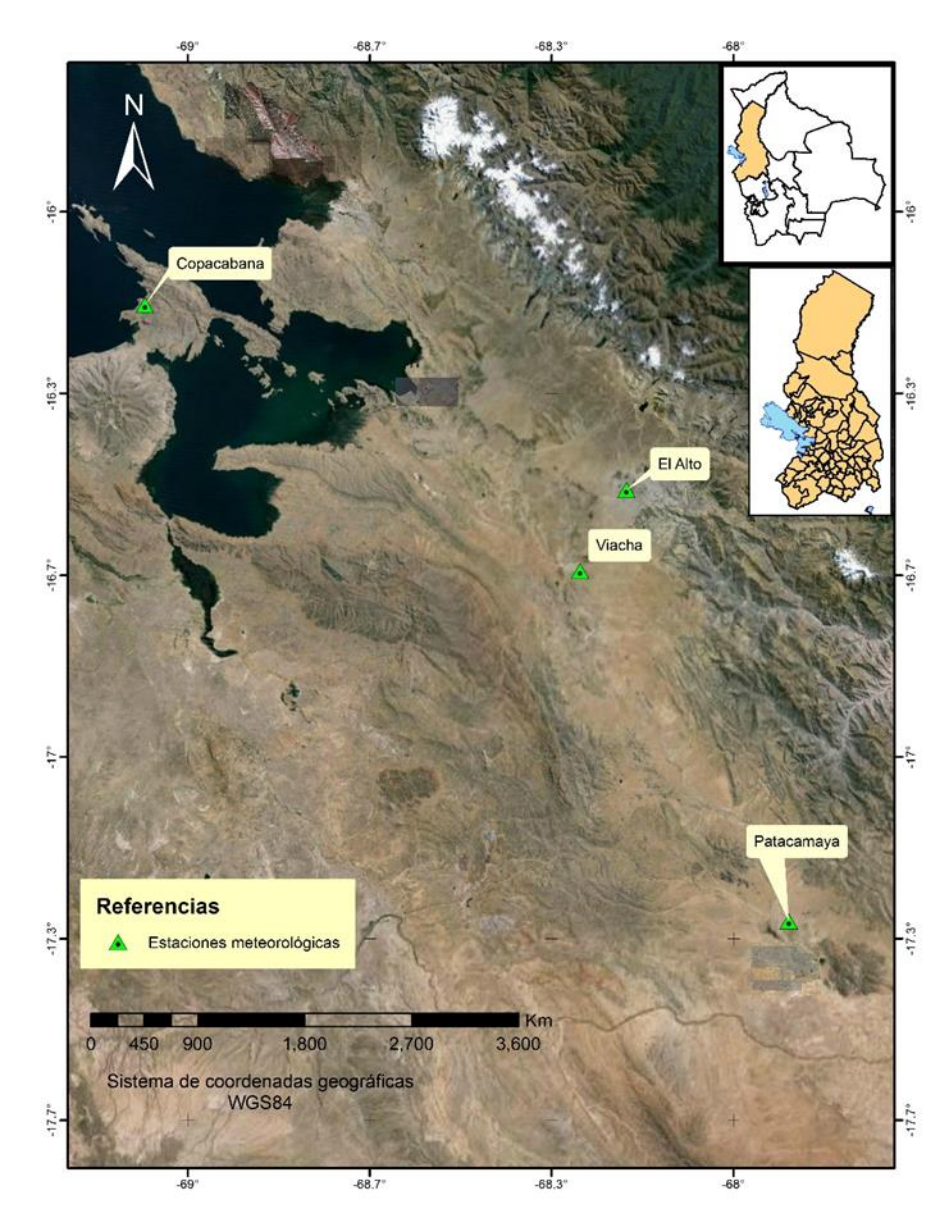
# Data

- The upper air data are provided by the National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalyses. There are available on a 2.5$^{o}$ x 2.5$^{o}$ latitude/longitude grid and are available at 6-h intervals from 1948 – present.

- Surface data will be gathered from stations across the Altiplano region of Bolivia.

# Map

- The Altiplano Region



# Methods

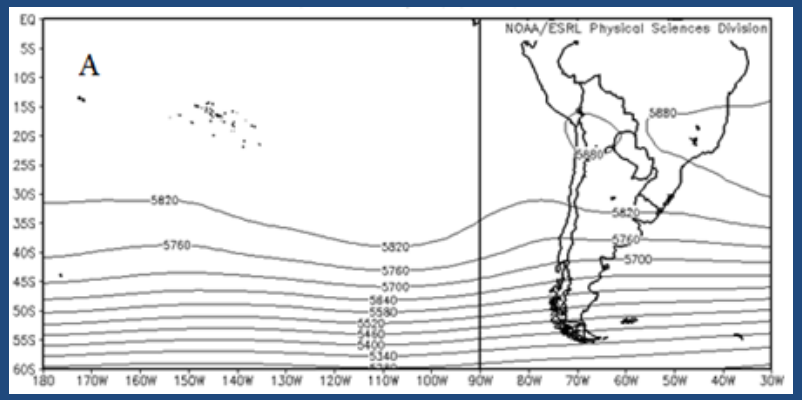
- Examine the monthly surface and upper air variables similar to the research done my the Global Climate Change Group (University of Missouri).

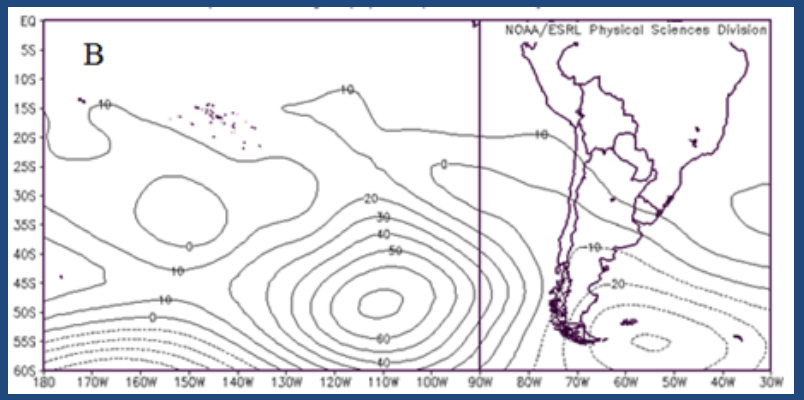
- ENSO definition is from the Japanese Meteorological Agency (JAM) and found at Center for Ocean and Atmosphere Prediction Studies (http://www.coaps.fsu.edu)

# Initial Analysis

- Analysis done first from 2000 – present since the phase of the Pacific Decadal Oscillation changed in 1999.

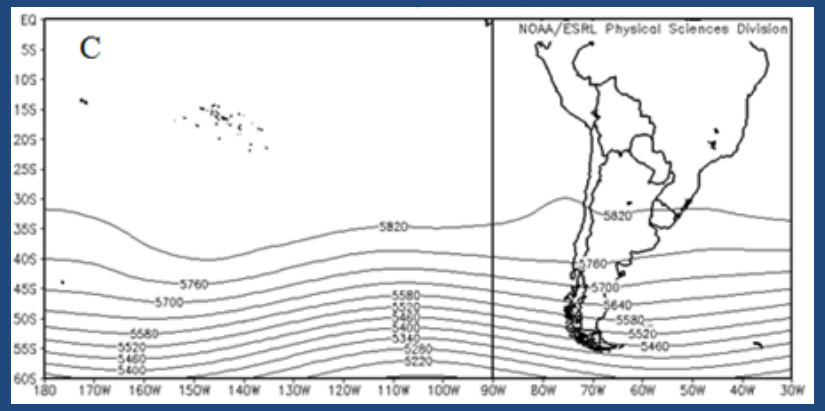
- EL Niño years (500 hPa) and anomalies (February – summer)

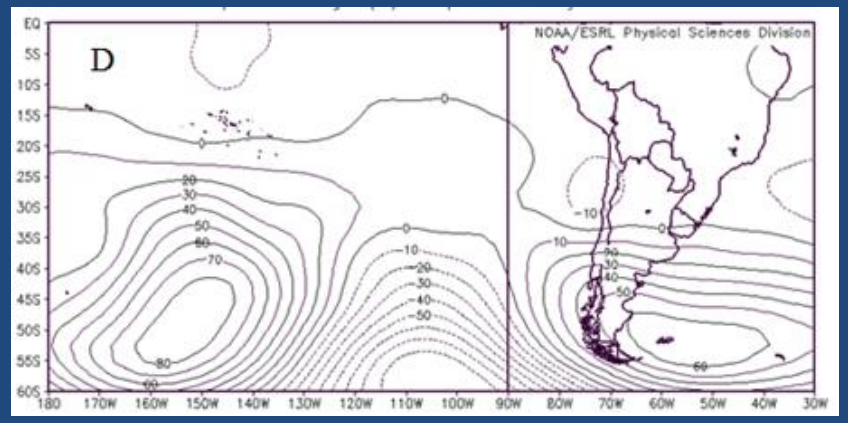


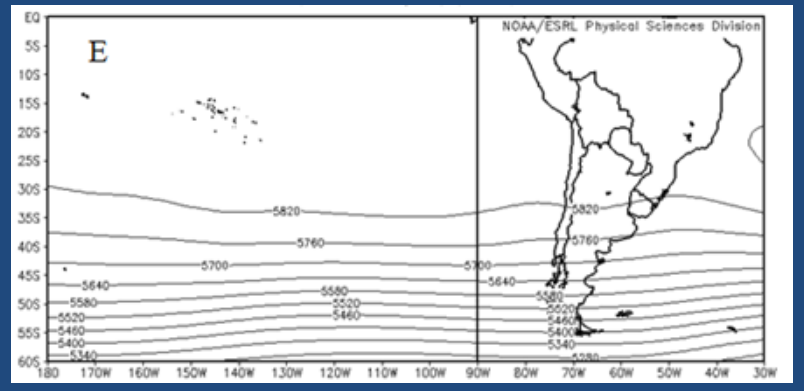
# Analysis

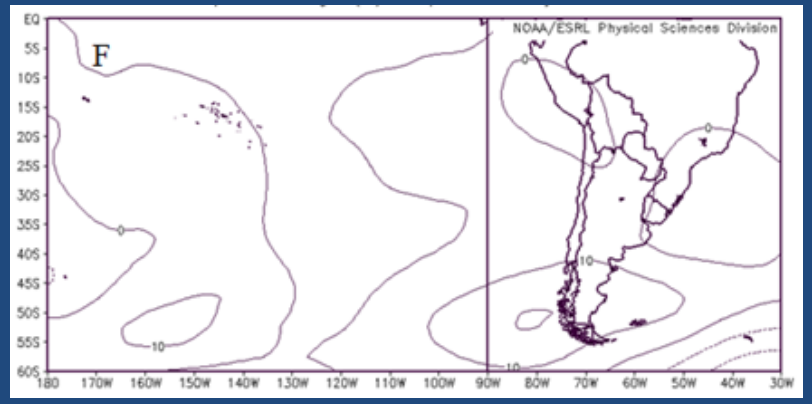
- La Niña years (500 hPa) and anomalies (February – summer)




- Neutral years (same)

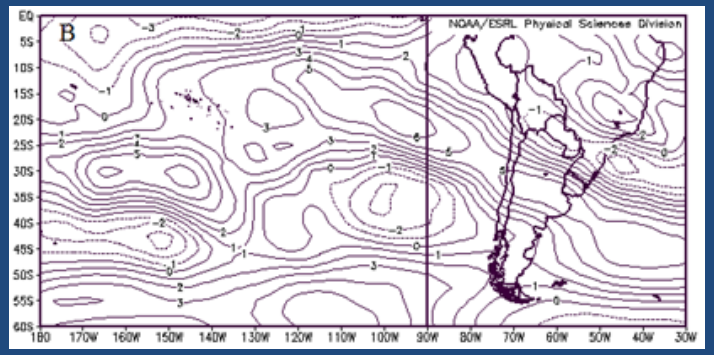


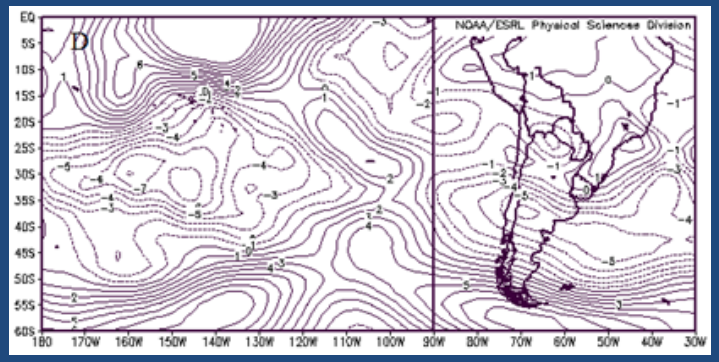
# Analysis

- El Niño and La Niña years produce 500 hPa height patterns over the Pacific South America region are nearly opposite in the February time period. Neutral years produce a weak signal.

- 200 hPa Wind Anomalies (February)
  - El Niño

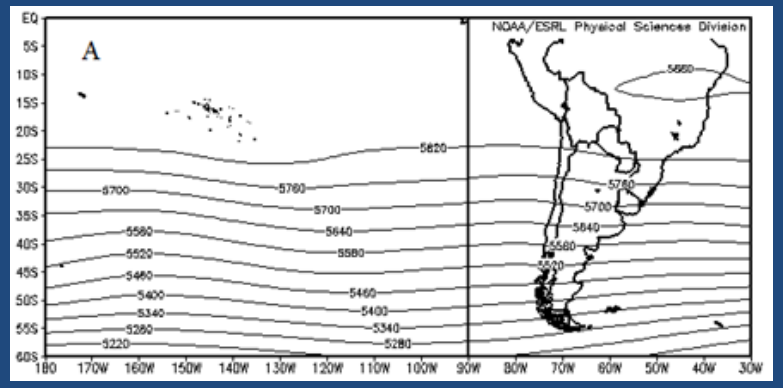


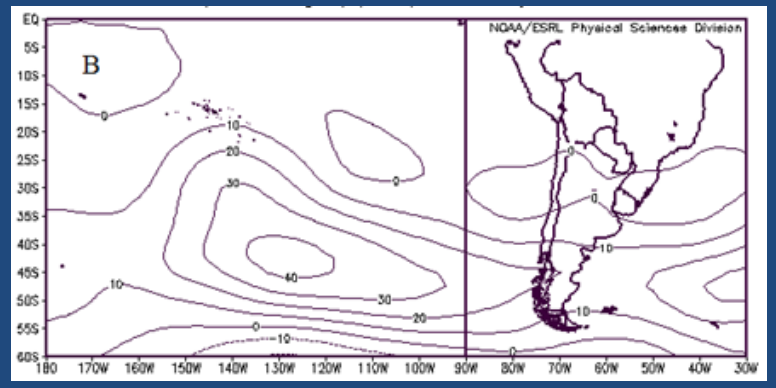

La Niña



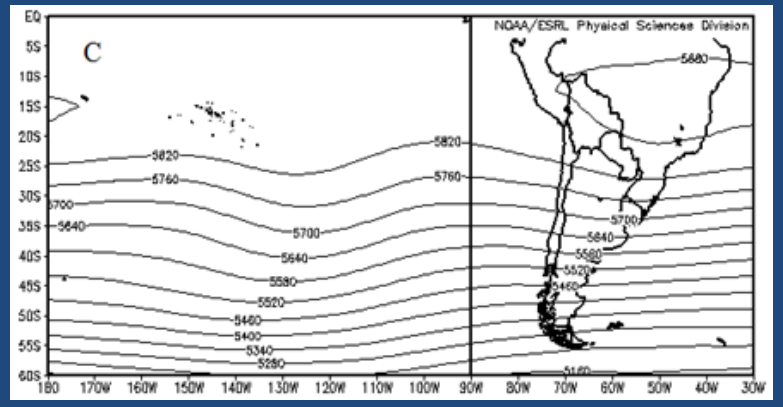
# Analysis

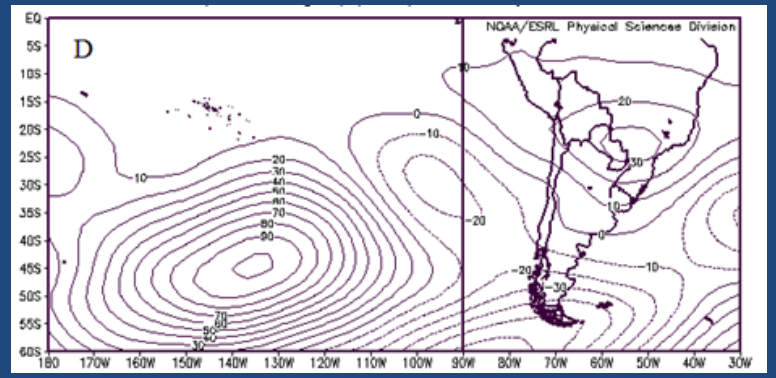
- El Niño years (500 hPa) winter season (June)



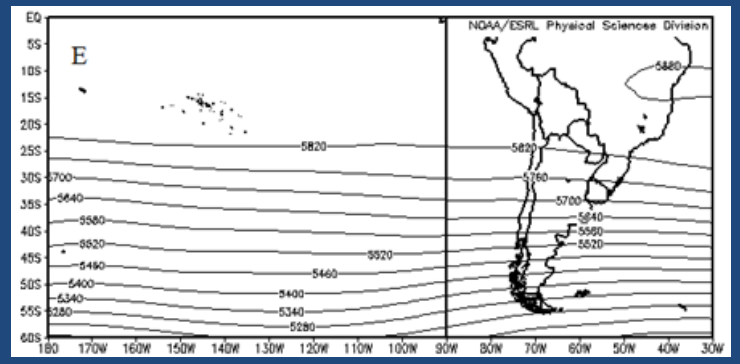

- La Niña years (500 hPa) winter season (June)

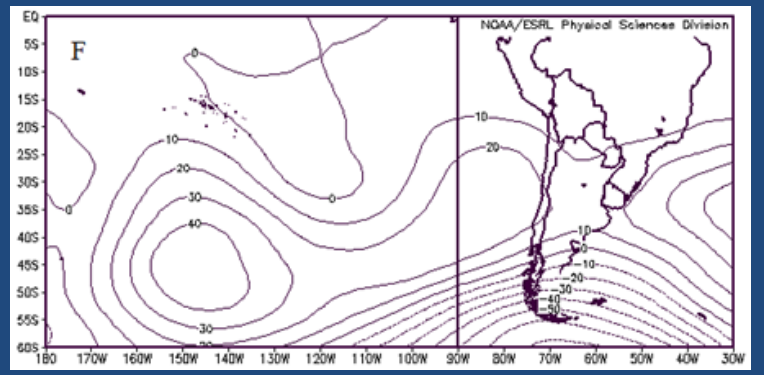


# Analysis

- Neutral years




- The June period also shows distinct differences in the 500 hPa circulation pattern as well as the 200 hPa winds (not shown).

# Southern Hemisphere Blocking

- After 2000 – a significant increase in block occurrences and durations Hemisphere-wide was noted in the SH. There was no change in the block intensity.

- There was little change in the Hemisphere-wide ENSO variability from 1970 – 1999 versus 2000 – present. However, the proportion of blocking occurring in the East Pacific just upstream of South America change substantially.

# Southern Hemisphere Blocking

- The changes in blocking have been found by others and could be associated with circulation changes in connection to the PDO.

- Table: Character of Southern Hemisphere blocking with respect to ENSO and PDO following the Weidenmann et al (2002) study.

| ENSO Phase | Occurrence | Duration | % East Pacific Events |
|---|---|---|---|
| Positive PDO | 1977-1998 | | |
| El Niño (5) | 9.0 | 7.0 | 28 |
| Neutral (15) | 9.5 | 7.1 | 36 |
| La Niña (2) | 6.0 | 6.7 | 45 |
| Total (22) | 9.0 | 7.1 | 34 |
| | | | |
| Negative PDO | 1970-6, 1999-p | | |
| El Niño (8) | 14.8 | 8.4 | 47 |
| Neutral (9) | 16.0 | 7.8 | 37 |
| La Niña (5) | 12.0 | 7.6 | 24 |
| Total (25) | 14.3 | 8.0 | 37 |

# Summary and Conclusions

- The study examined the interannual variability with respect to ENSO for the East Pacific and South American region with a focus on the Bolivian Altiplano region. There is interest in developing statistical techniques for generating long-range forecasts to aid the agricultural community.

- As part of the analysis Southern Hemisphere blocking, especially the event occurring in the Pacific region were examined. The NCEP/NCAR reanalyses as were used for the upper air analysis, blocking data was provided by the University of Missouri – Global Climate Change Group.

# Summary and Conclusions

- The initial analyses of the upper air data began with the period 2000 to 2016 since a change in the phase of the PDO occurred just before these years. The 500 hPa height fields and 200 hPa wind fields showed strong interannual variability that is linked to ENSO for the summer season.

- A similar approach was used here in order to examine the June variability since the local agricultural community looks to this period for indications of the upcoming seasons.

# Summary and Conclusions

- Changes in Southern Hemisphere blocking were found from 2000 – 2016 showing increases in all basins of block occurrence and duration, but no change in intensity. This study showed more east Pacific blocking in El Niño years compared to La Niña and Neutral years and this was particularly pronounced in the recent period (and 1970- 1976).

- Surface Data will be analyzed for a future paper.