Intensified El Nino Teleconnection Under the Greenhouse Warming

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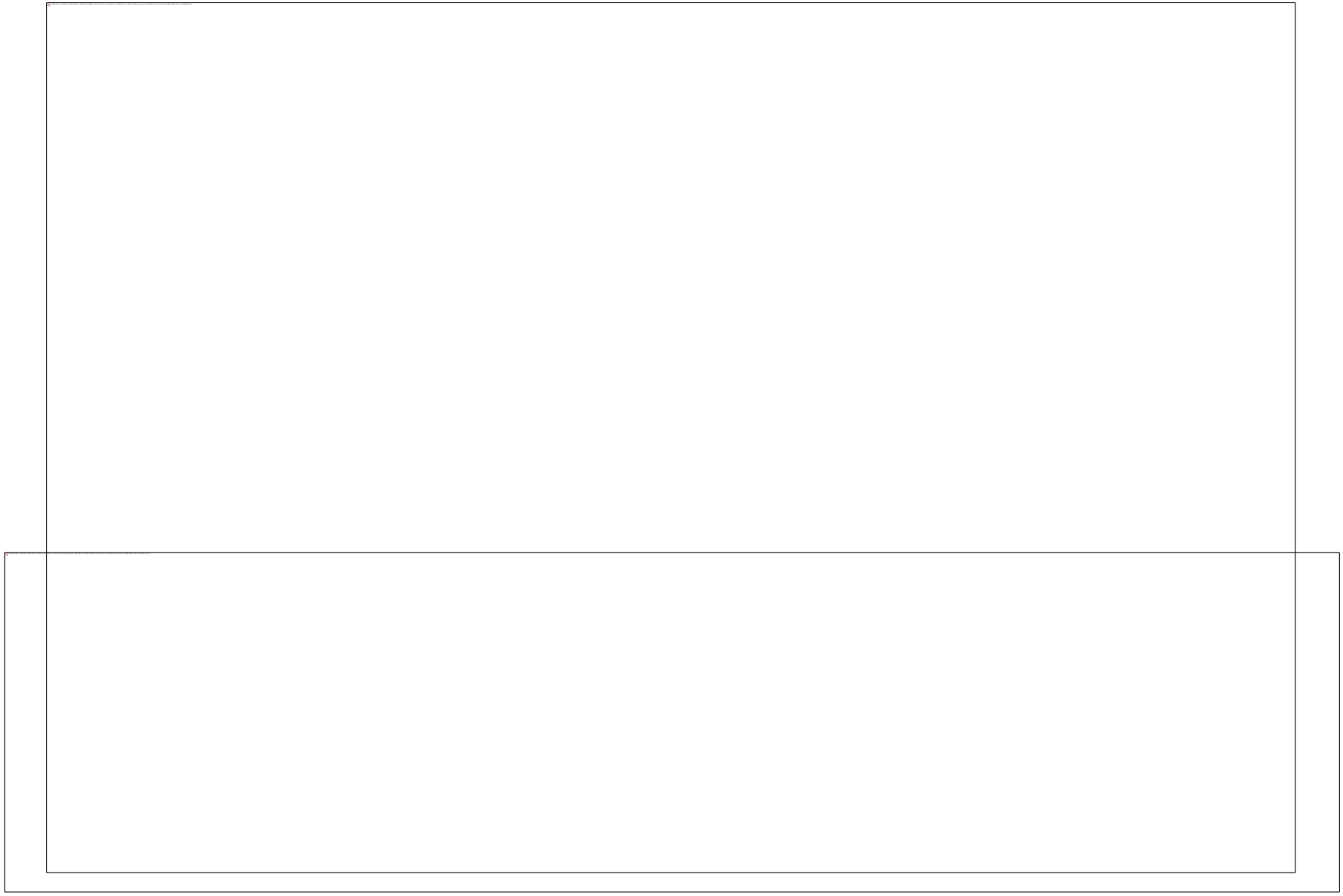
SST: Individual El Nino events (SONDJFM)



New Type of El Nino

- Dateline El Nino (Larkin and Harrison 2005)
- El Nino Modoki (Ashok et al. 2007)
- Central Pacific (CP) El Nino (Kao and Yu 2009)
- Warm Pool (WP) El Nino (Kug et al. 2009a)

  : Strong SST variability over the central Pacific
  : Different teleconnection
  : Recent frequent occurrence
  : Climate Change Responses?

Occurrence Frequency ?
CT El Nino vs WP El Nino

Will the WP El Nino events occur more frequently in the future warm climate?

Yeh, S.-W., **J.-S. Kug,** B. Dewitte, M.-H. Kwon, B. Kirtman, and F.-F. Jin 2009: El Niño in a changing climate. *Nature*,**461**, 511-514.

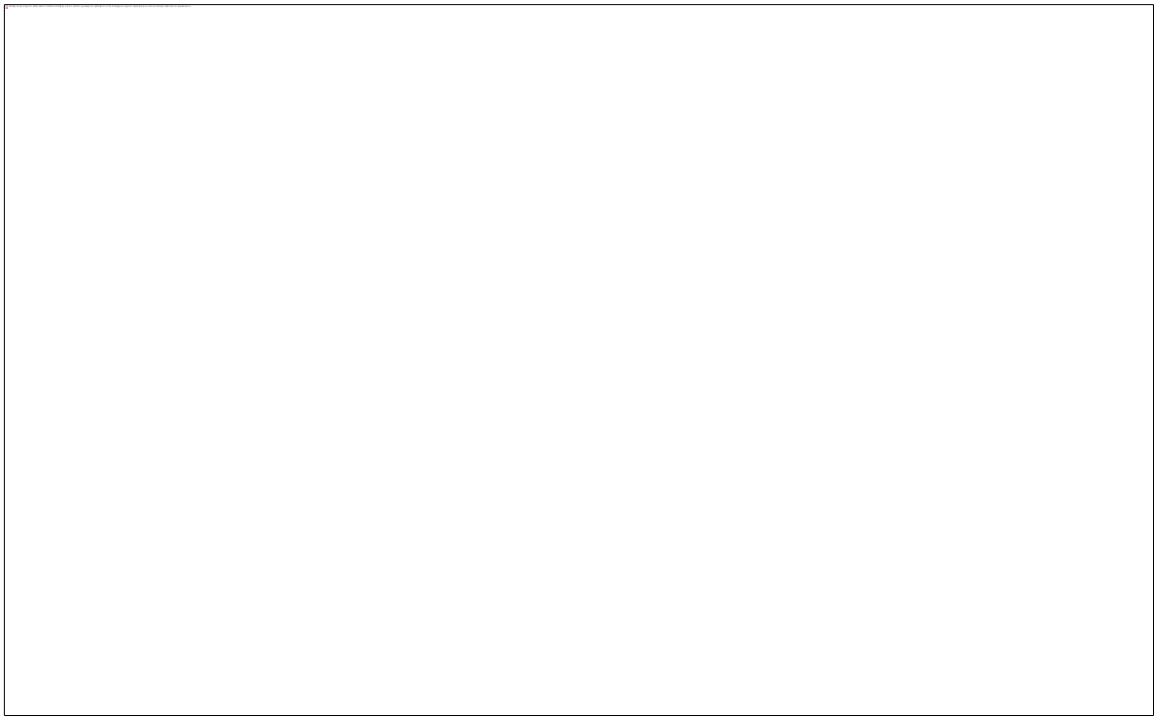
Frequency Changes in WP vs CT El Nino Events

	Raw SST		Detrended SST	
	CT El Niño	WP El Niño	CT El Niño	WP El Niño
1870s	**1876, 1877**		**1876, 1877**	
1880s	**1888**		**1888**	
1890s	**1896, 1899**		**1896, 1899**	
1990s	**1902,1904,1905**		**1902,1904,1905**	
1910s	**1911,1913,1914**		**1911,1913,1914,1918**	
1920s	**1925**		**1925**	
1930s	**1930, 1939**		**1930, 1939**	
1940s	**1940,1941**		**1940,1941**	
1950s	**1951,1957**		**1951,1957**	
1960s	**1963,1965,1969**	**1968**	**1963,1965,1969**	**1968**
1970s	**1972,1976,1979**	**1977**	**1972,1976,1979**	**1977**
1980s	**1982,1986,1987**		**1982,1986,1987**	
1990s	**1991,1997**	**1990,1992,1994**	**1991,1997**	**1990, 1994**
2000s	**2002,2003,2006**	**2001,2004**	**2003,2006**	**2001,2002,2004**

Changes in Occurrence Frequency ; WP vs CT El Nino Events

IPCC AR4 Models

Ratio : # of WP El Nino / # of CT El Nino



Possible Explanation I: Mean Thermocline Change

Equatorial Thermocline Depth

Possible Explanation II: ENSO-WWB Interaction

Lag Correlation between NINO3.4 SST and MJO/WWEs Activity

1950-1975

1980-2005

Using NCEP reanalysis data

Contour: Regression, Shading: Correlation

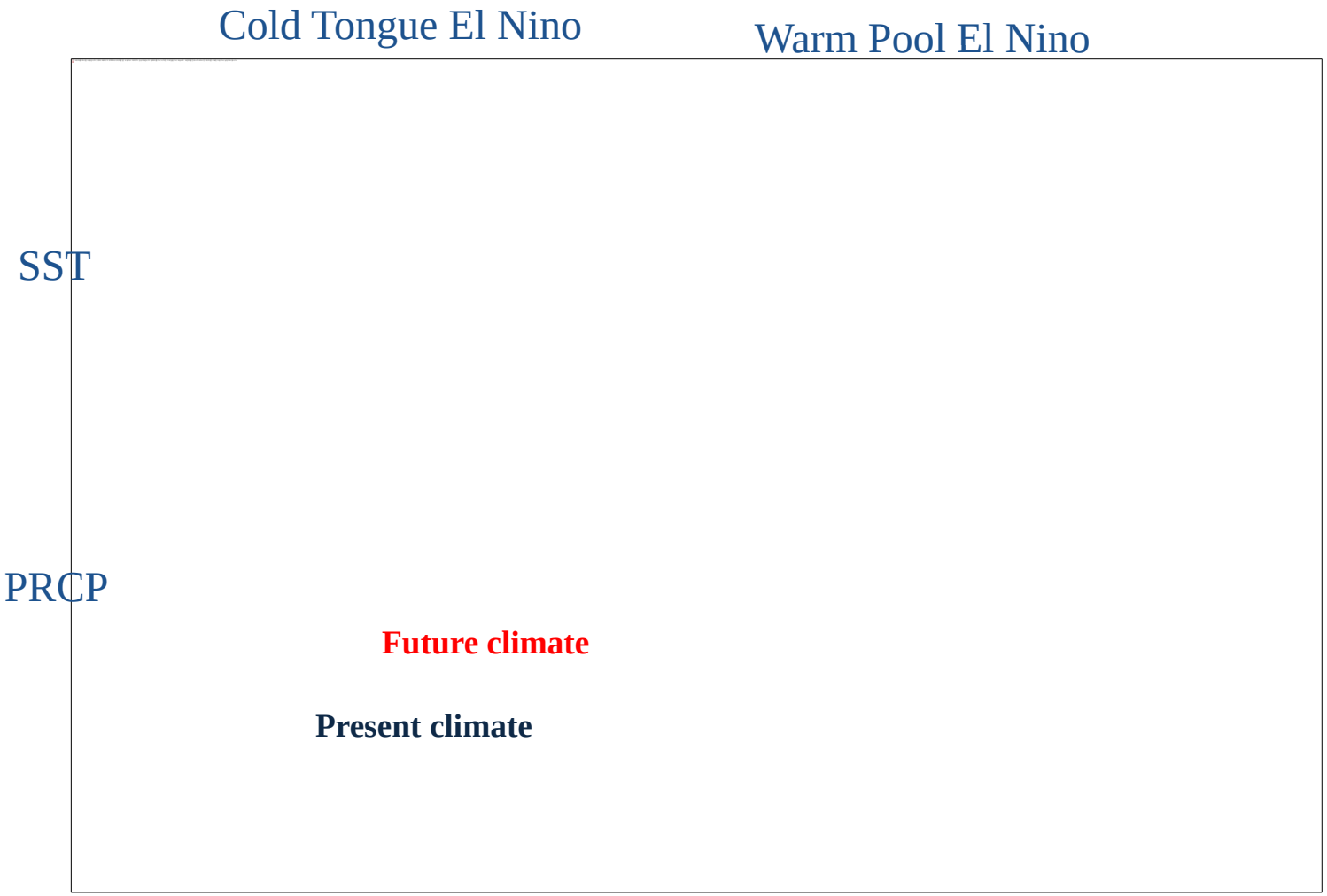
Kug et al. (2008a)

Teleconnection

How about El Nino-induce Teleconnection in the future warm climate?

Kug et al. 2010 (To be submitted)

SST and Precipitation Anomalies



Extratropical Teleconnections

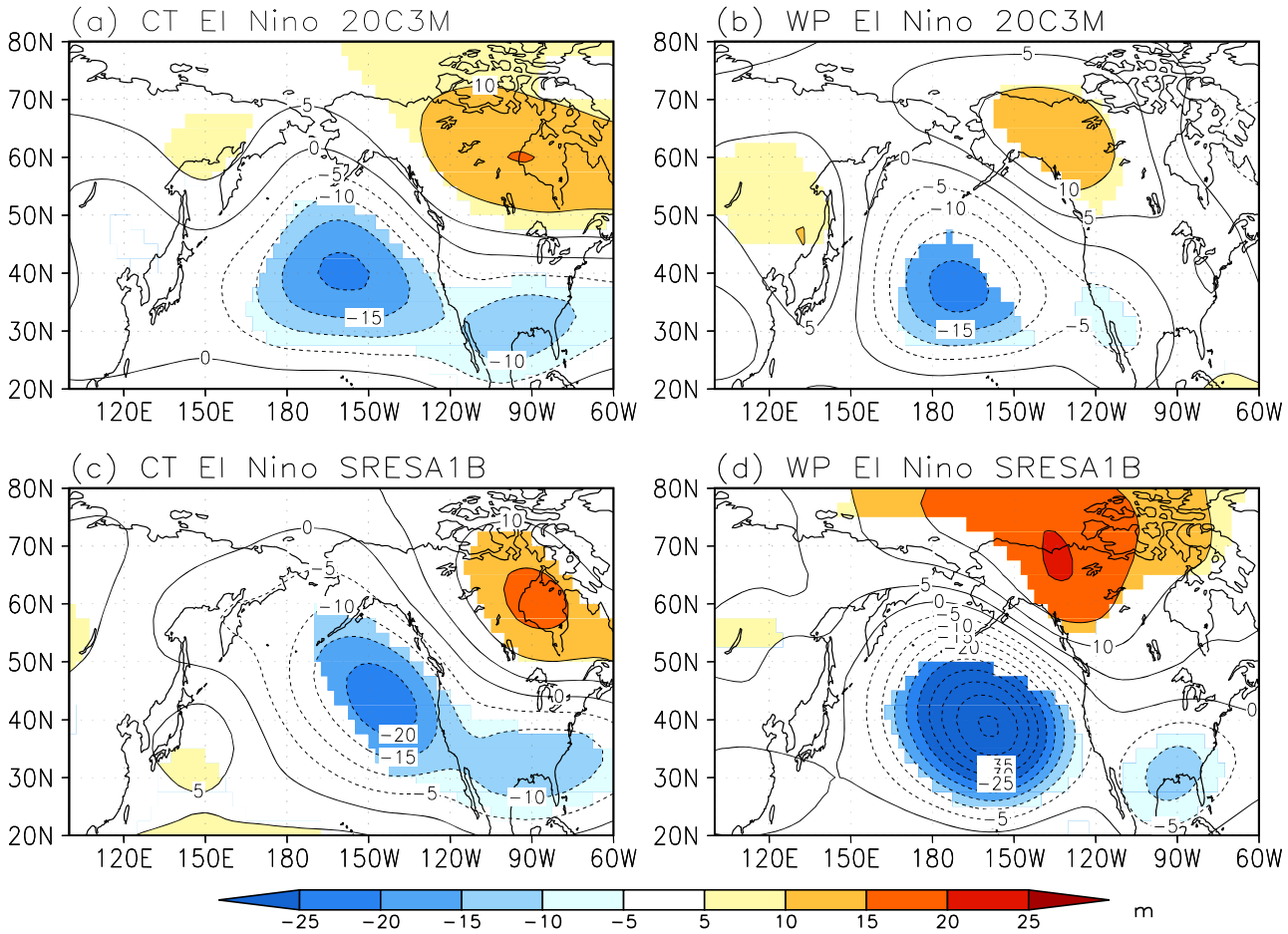
500hPa Geopotential Height

Cold Tongue El Nino

Warm Pool El Nino

Present Climate

Future Climate



ENSO Amplitude vs Teleconnection Amplitude

7 Models: Intensified.

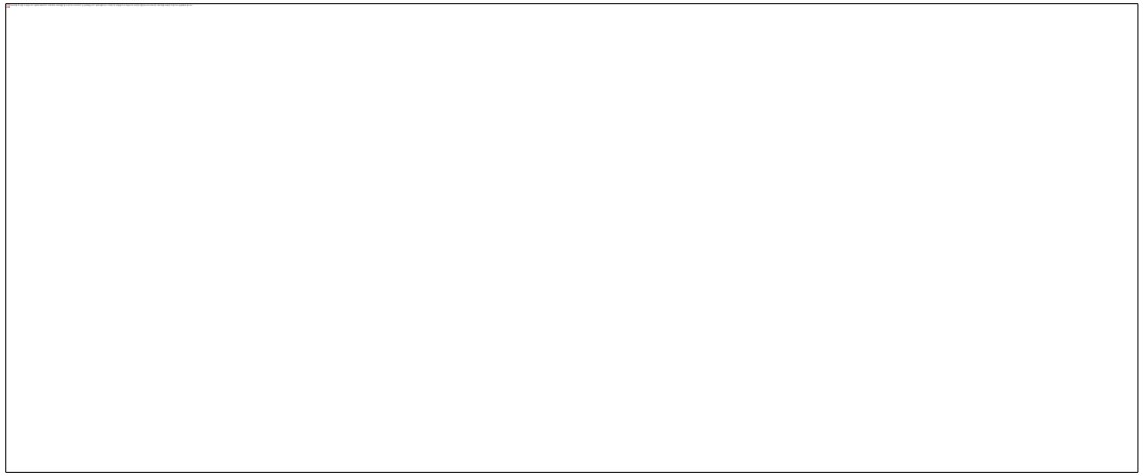
2 Models: Weakened

Climate Impacts of WP El Nino

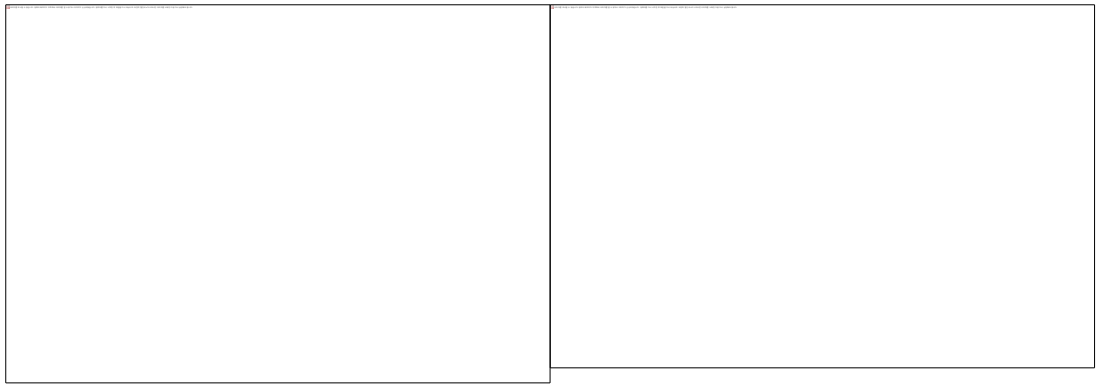
Present Climate

Future Climate

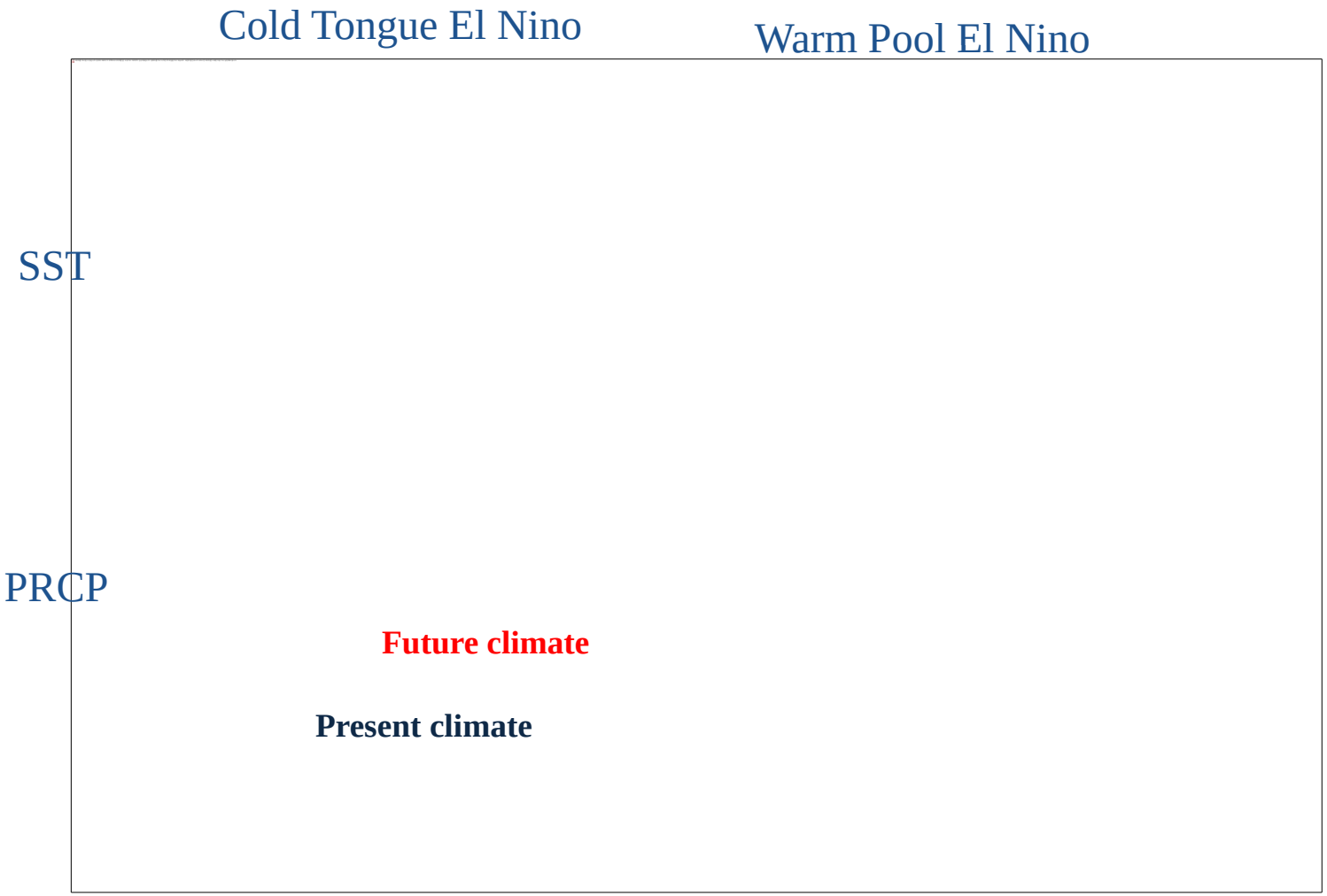
Surface Temperature



Precipitation



SST and Precipitation Anomalies



Why is WP El Nino teleconnection amplified?

Jet Stream Changes

Jet Stream Eastward Expansion -> Stronger Storm Activity -> Stronger Eddy Feedback

Conclusion Remarks

❖ There is large uncertainty on ENSO magnitude changes under greenhouse warming.

❖ However, there are robust ENSO characteristics changes simulated by climate models.

- **More Frequent WP El Nino**
- **Stronger WP El Nino Teleconnection**

❖ Our results suggest that **the WP El Nino will be more prominent climate driver in strongly affecting global climate variability.**

Thank You

Relevant References

Kug, J.-S., F.-F. Jin and S.-I. An 2009: Two-types of El Nino events: Cold Tongue El Nino and Warm Pool El Nino. J. Climate, 22, 1499-1515.

Yeh, S.-W., **J.-S. Kug**, B. Dewitte, M.-H. Kwon, B. Kirtman, and F.-F. Jin 2009: El Niño in a changing climate. Nature, 461, 511-514.

Kug, J.-S., J. Choi, S.-I. An, F.-F. Jin, and A. T. Wittenberg 2010: Warm Pool and Cold Tongue El Nino events as simulated by the GFDL 2.1 coupled GCM. J. Climate. 23, 1226-1239.

Yoon J., S.-W. Yeh, Y.-H. Kim, **J.-S. Kug**, and H.-S. Min 2010: Understanding the responses of the sea surface temperature to the two different type of El Nino in the western North Pacific. *Progress in Oceanography*. (submitted)

Boucharel J., B. Dewitte, Y. du Penhoat, B. Garel, S.-W. Yeh, and **J.-S. Kug** 2010: ENSO nonlinearity in a warming climate. *Clim. Dyn*. (submitted)

Kug, J.-S., M.-S. Ahn, M.-K. Sung, S.-W. Yeh, H.-S. Min, and Y.-H. Kim 2010: Statistical relationship between Two-types of El Nino and Korean climate variation. To be submitted APJAS

Kug, J.-S., M.-H. Kwon, T. Li, F.-F. Jin 2010, Intensified El Nino teleconnection under global warming. To be submitted to Science.

Choi, J., S.-I. An, **J.-S. Kug**, Role of climate state changes on El Nino's Flavor. To be submitted to J. Climate.

Jin, K, **J.-S. Kug**, F.-F. Jin 2010: Predictability of Two-Types of El Nino. In preparation.

Correlation between NINO3 and NINO4 SSTs