Record warming in the South Pacific & western Antarctica associated with the 2009-10 El Nino: will it get worse in the future?

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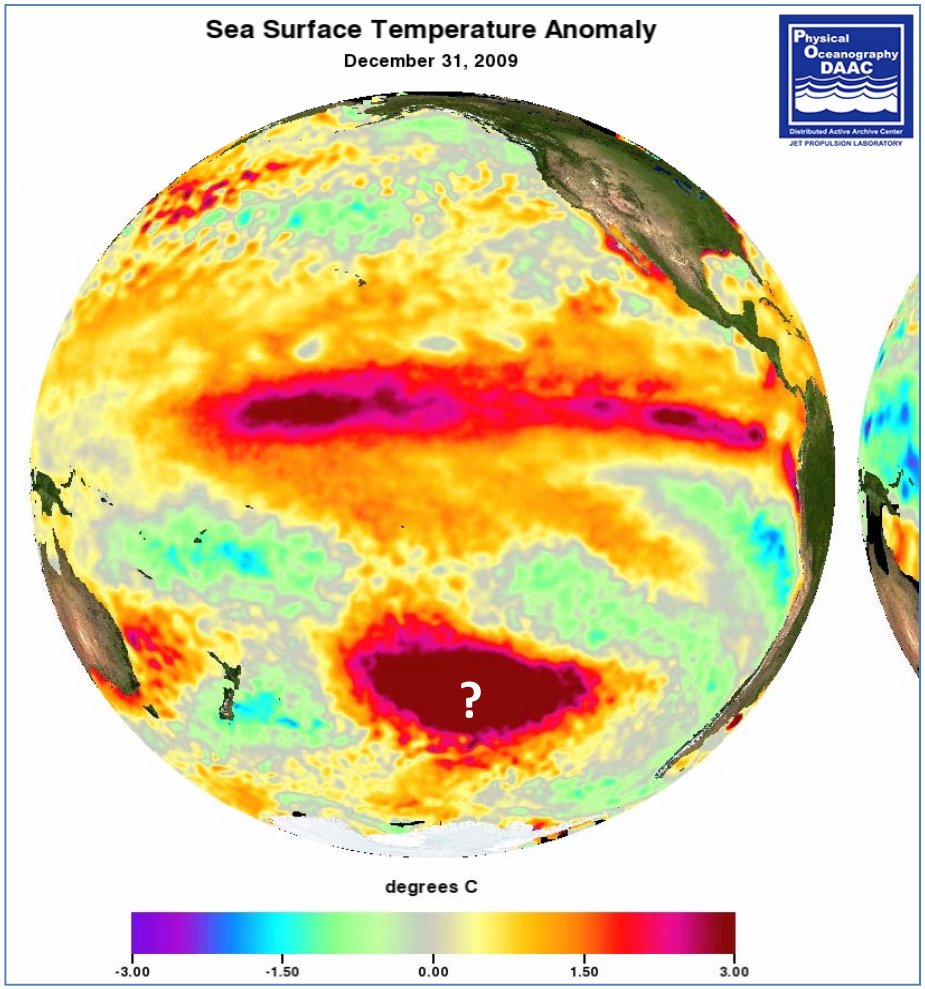


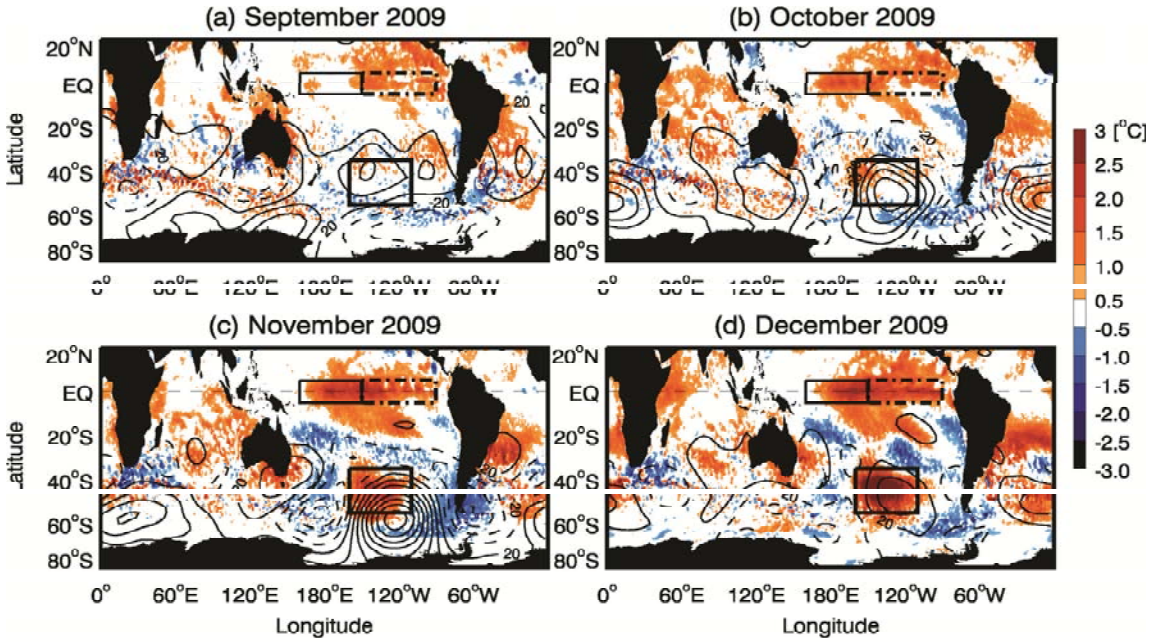
A partial frame from an El Nino animation of AMSR-E data in PO.DAAC home page (produced by Charles Thompson)

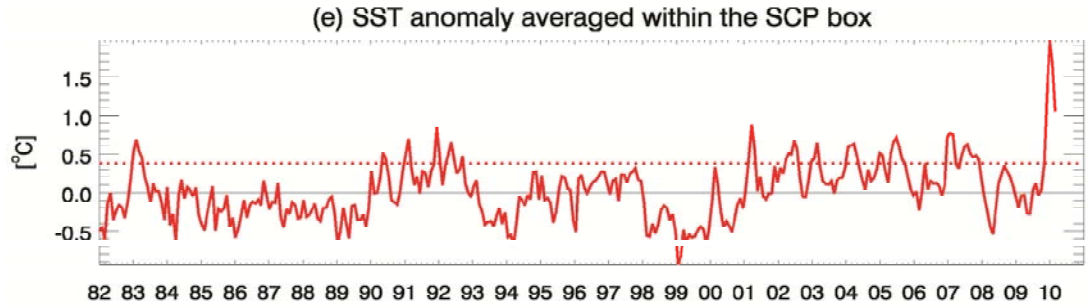
Record SSTA associated with extreme atmos. high-pressure (HP) system

Colors: SSTA from Reynolds ¼-deg daily OI L4 GHRSST

Contours: 500-hPa geopotential height anomaly from NCEP/DOE reanalysis II

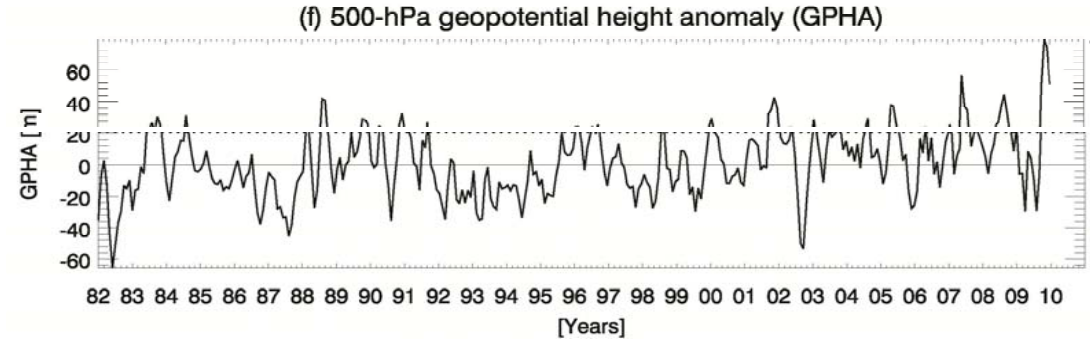
Anomalies referenced to 1982-2008 seasonal climatology





5 std. dev.

1 std. dev.



4 std. dev.

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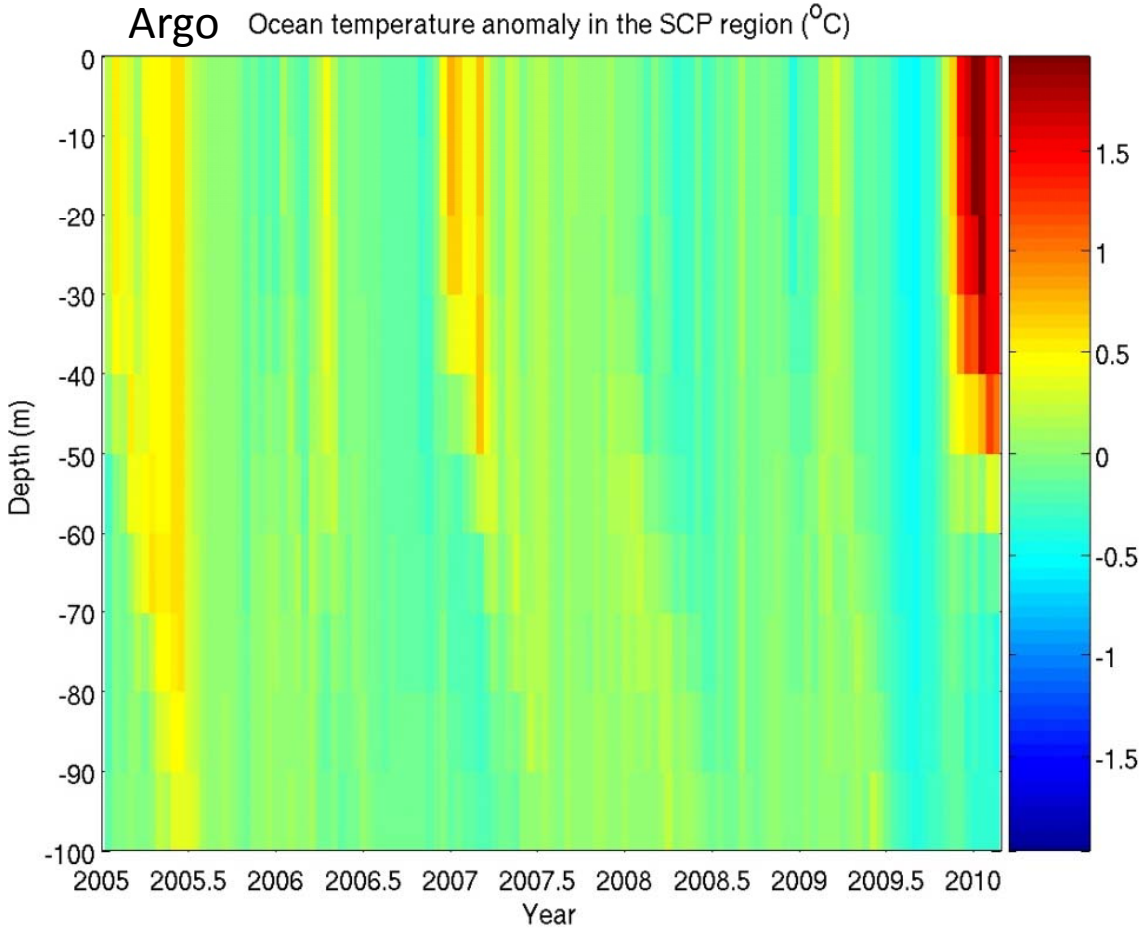
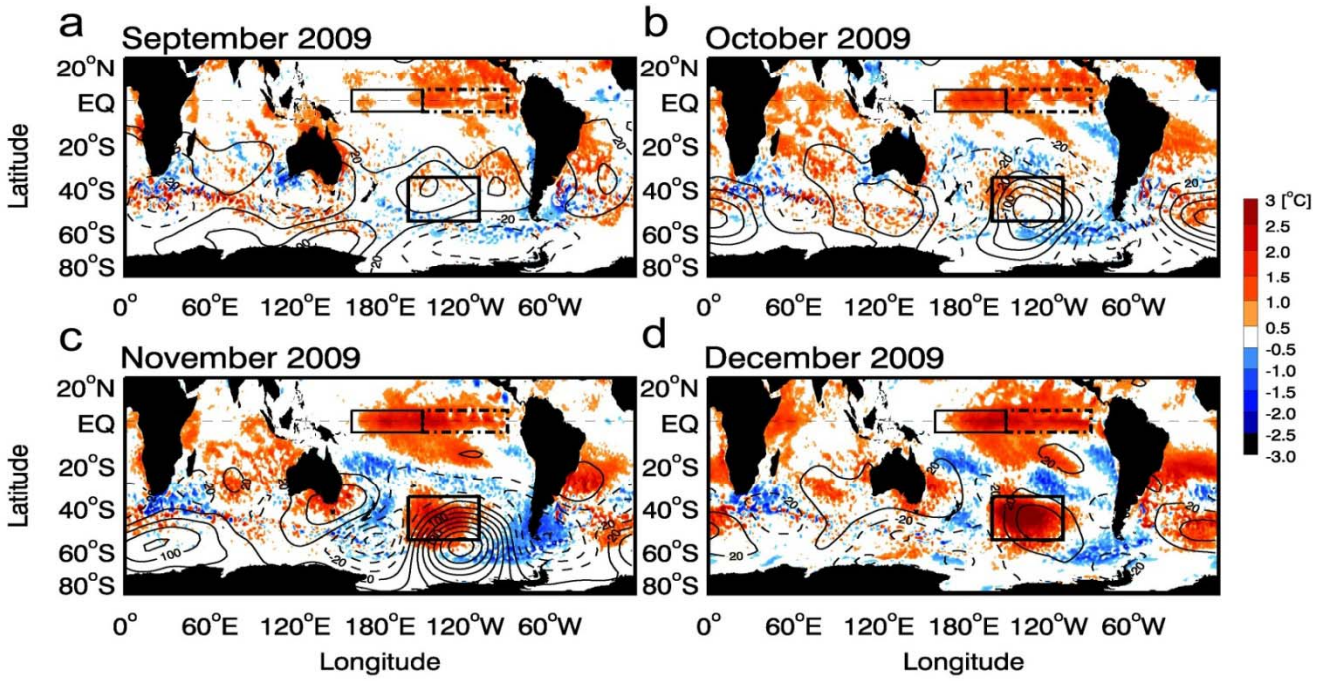
Vertical structure of the warming in the south-central Pacific (SCP): confined to top 50 m (austral spring-summer mixed-layer depth)



Anomalies referenced to July 2004-June 2009 seasonal climatology

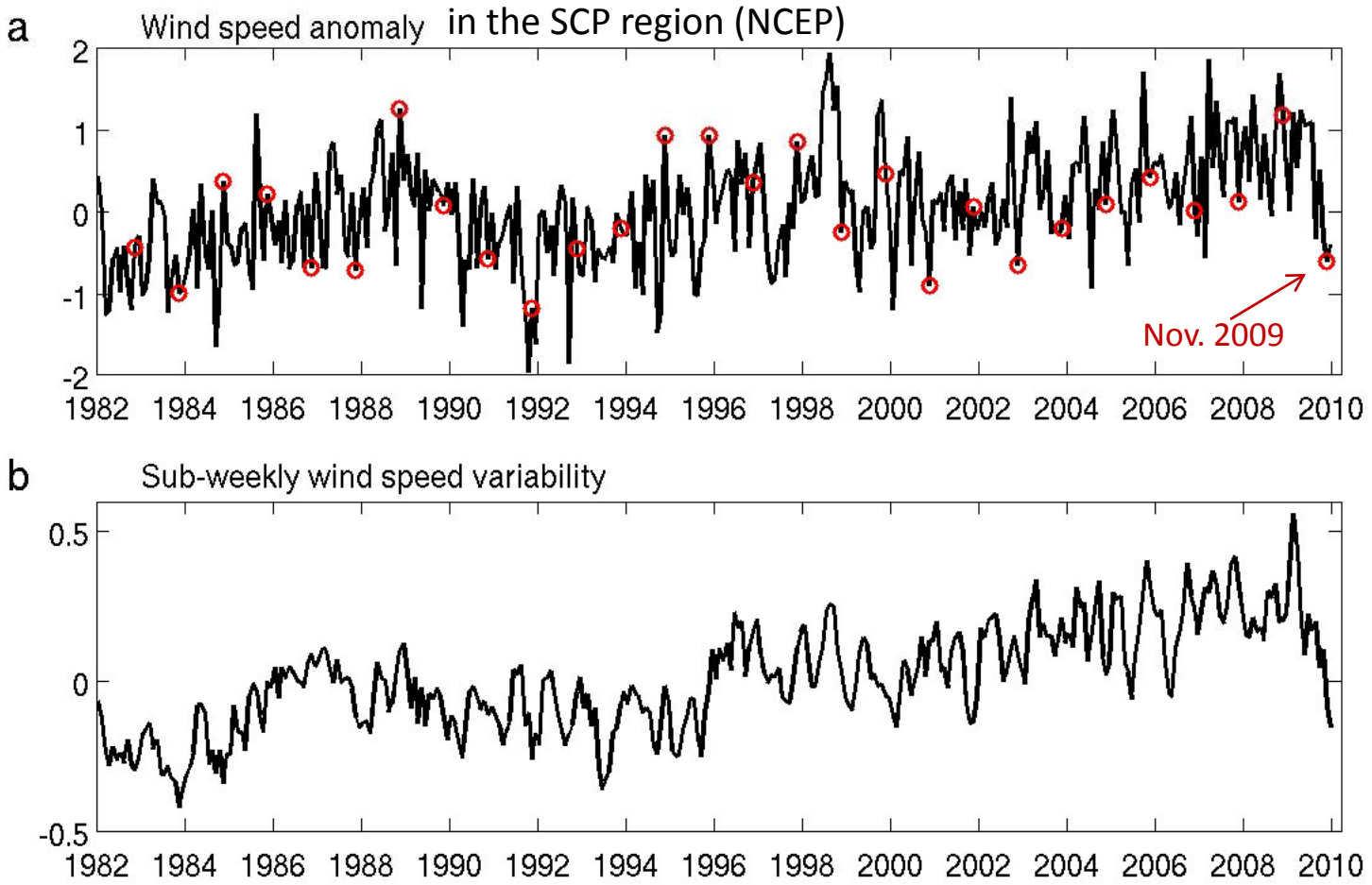
What processes in the SCP region caused the oceanic warming?



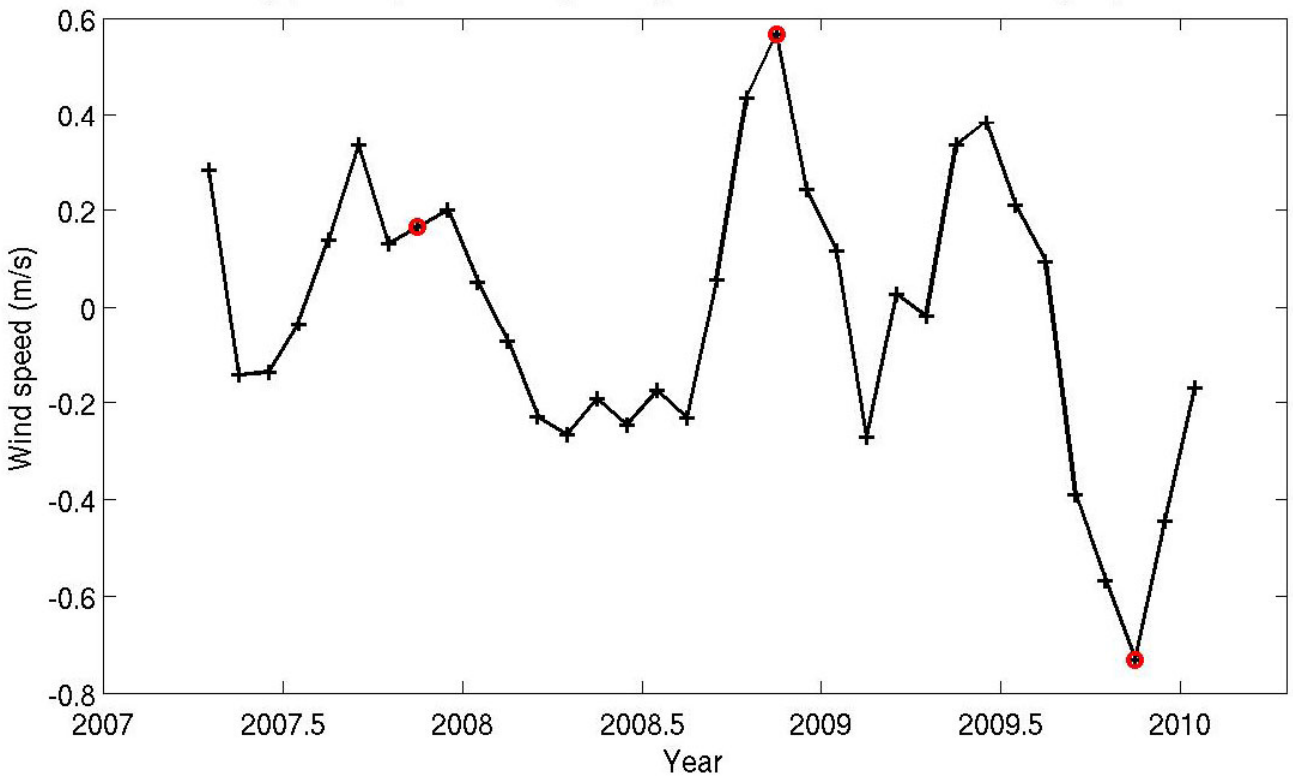
- Enhanced solar radiation? — No
- Reduced heat loss? — Yes
- Ocean processes? — Yes

} Has to do with wind changes (esp. vector wind)

The HP system blocked off synoptic weathers & reduced wind speed (an abrupt drop in late 2009)

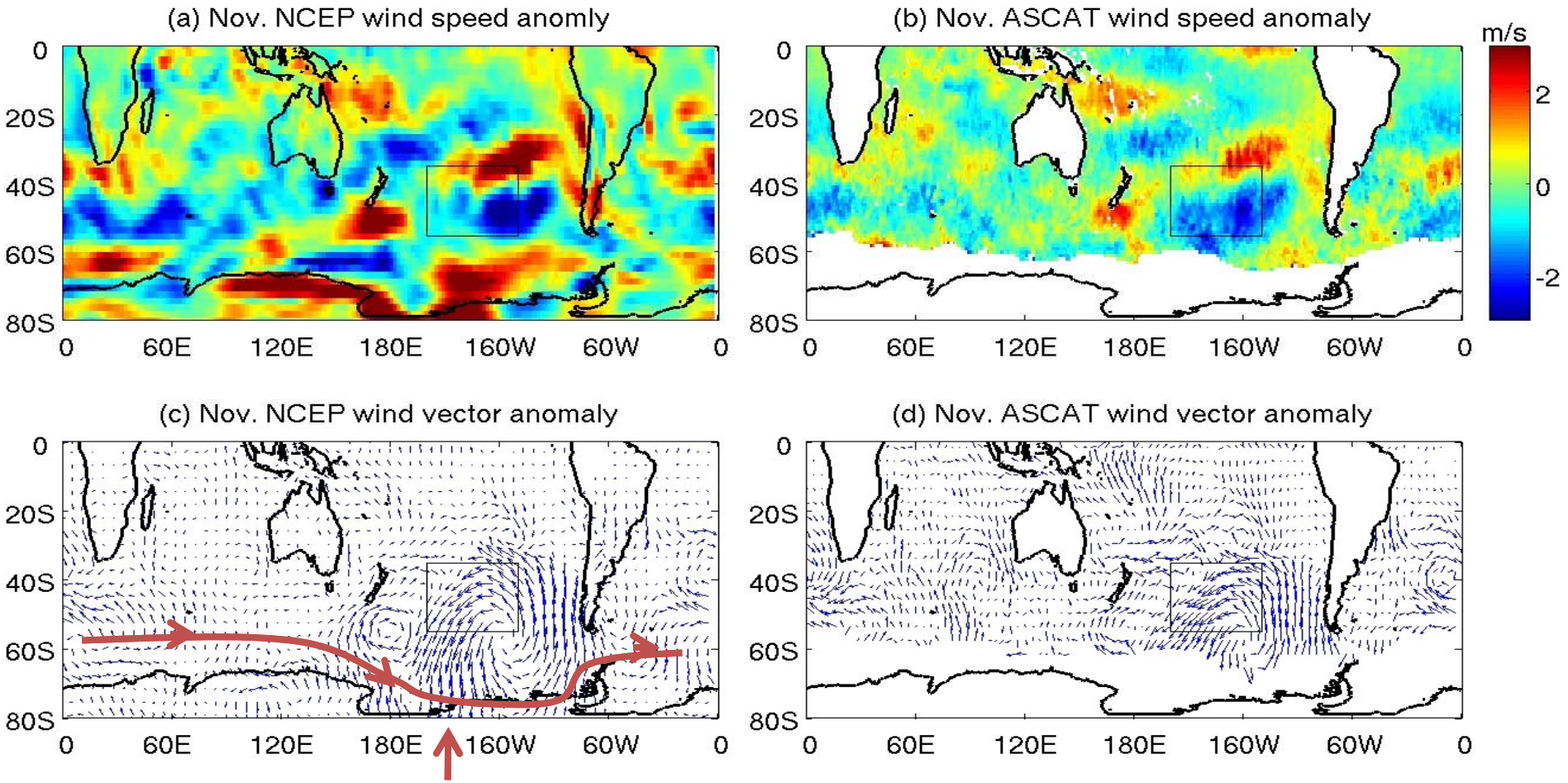


ASCAT wind speed anomaly show a similar reduction in late 2009



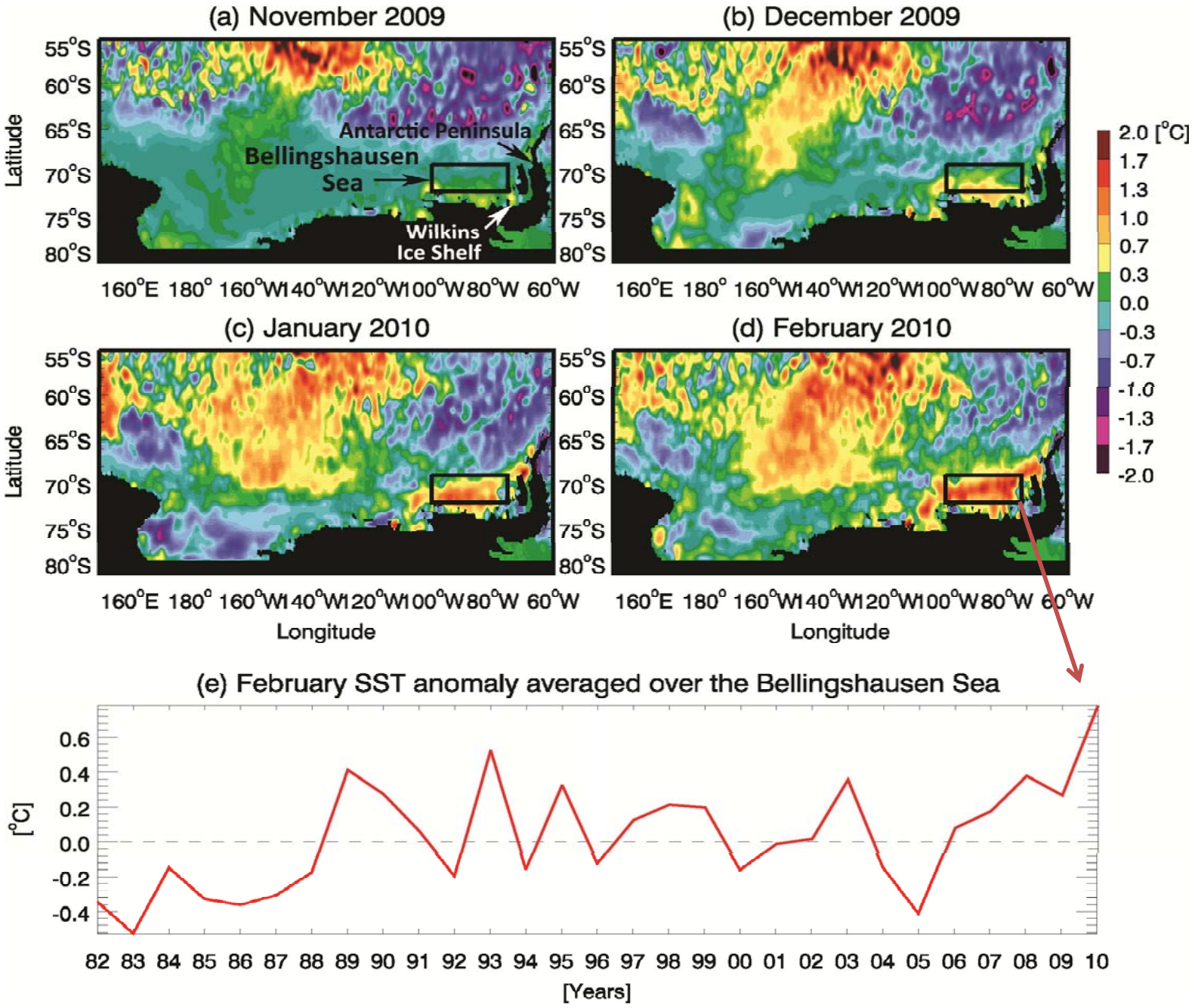
Wind changes associated with the HP system caused oceanic warming

- Weaker wind reduced latent & sensible (oceanic) heat loss (~ 40% of the warming)
- Easterly anomaly of zonal wind caused southward intrusion of warm waters (~ 40%)



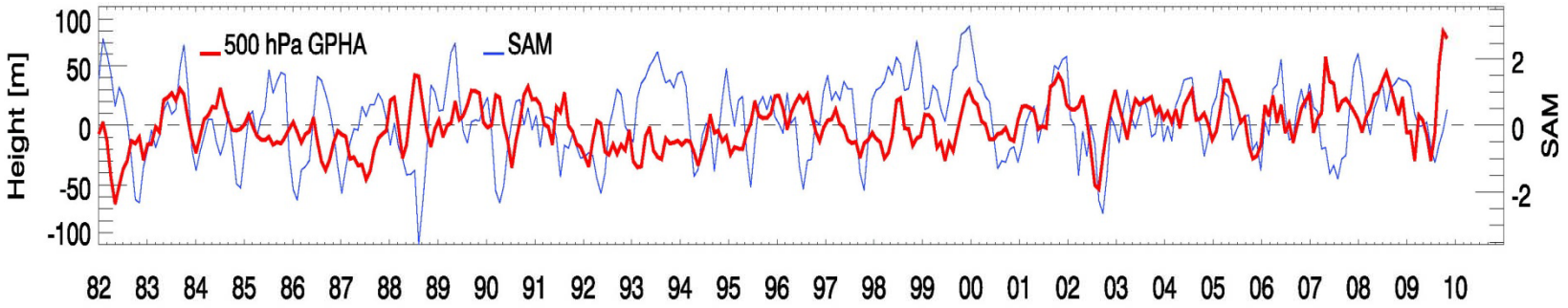
The HP system diverted circumpolar westerlies and warm air to Antarctica.

Record austral-summer warming off the western Antarctic Peninsula



What climate variability caused the extreme atmos. & oceanic anomalies in the SCP region?

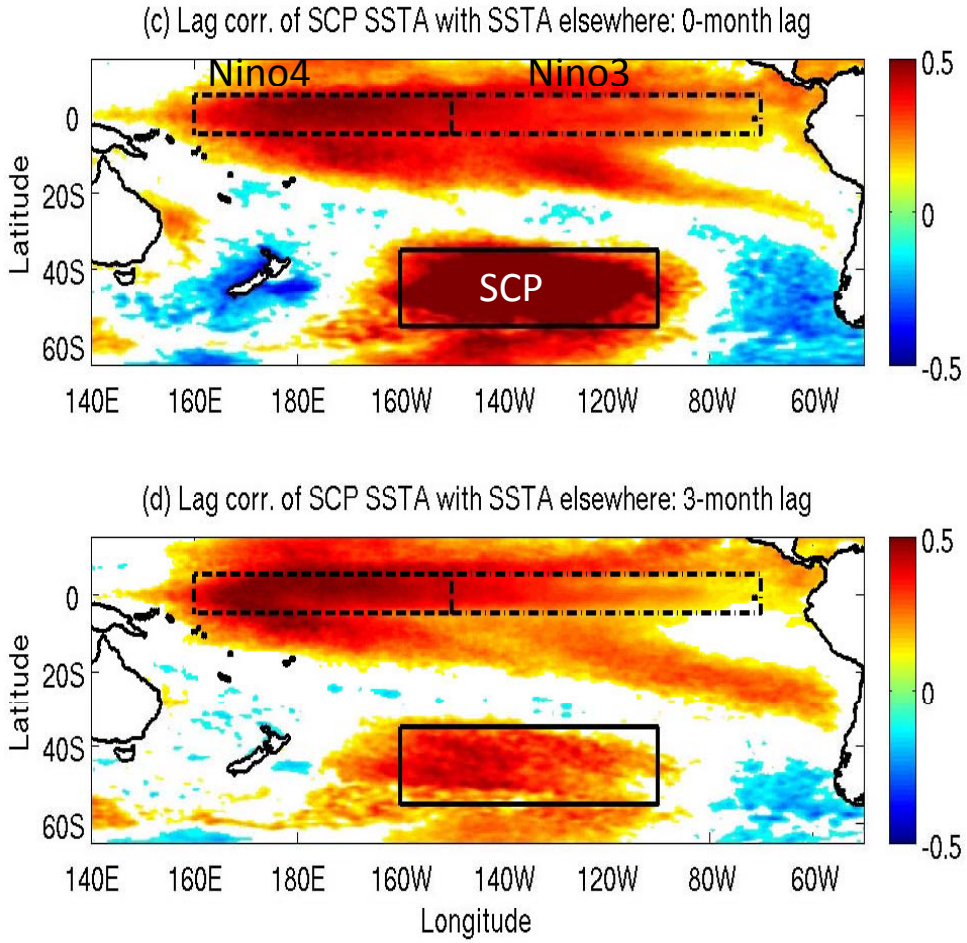
- The Southern Annular Mode (SAM) did not (SAM index is nearly zero in late 2009)

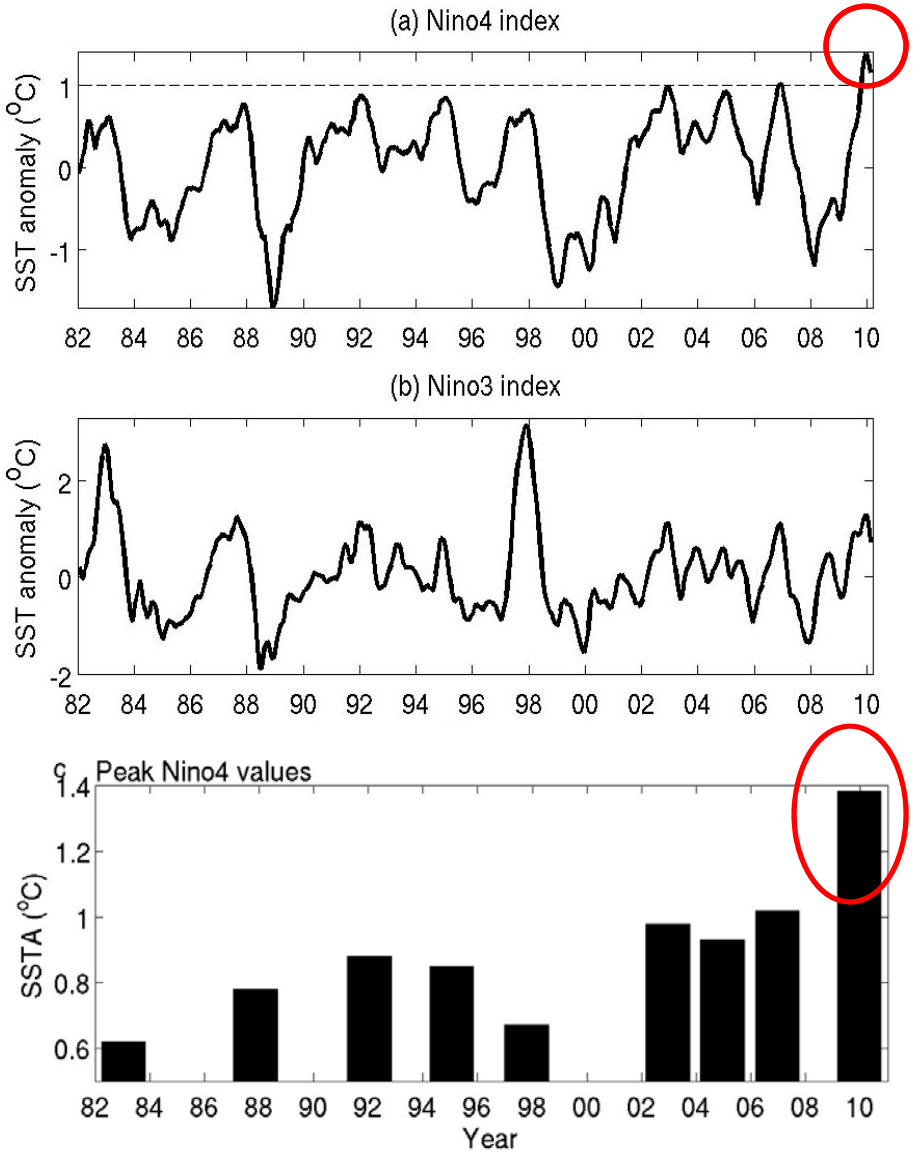


- What about the 2009-10 El Nino?

SCP warming appeared to be fueled by the 2009-10 El Nino

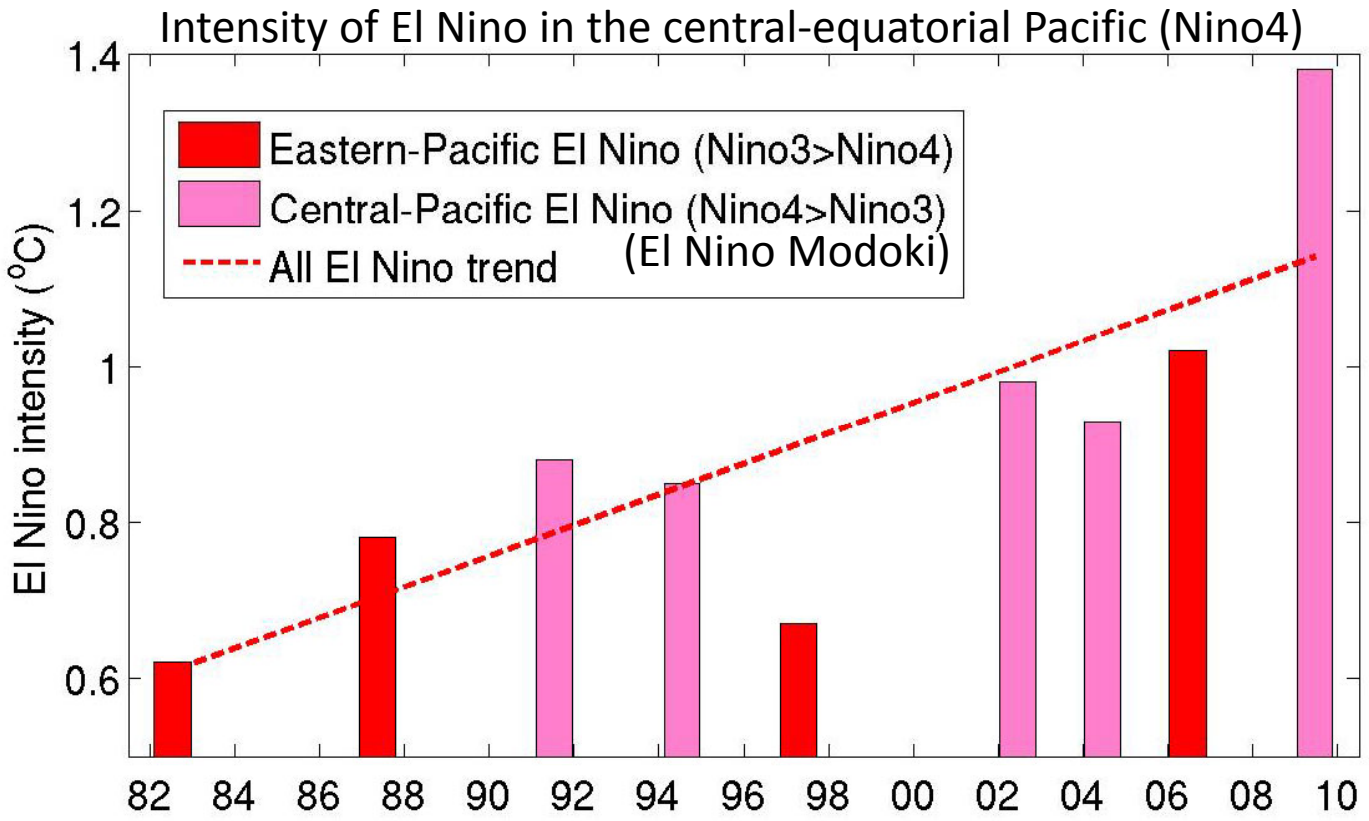
- SCP SSTA best correlated with Nino4 SSTA (up to a few months of lags).
- Nino4 SSTA for the 2009-10 El Nino reached a record high.





Atmos. processes: meridional Rossby waves (PSA), Ferrel cell

Increasing intensity of El Nino in the central-equatorial Pacific (CP): due to more frequent & more intense CP-El Nino (Lee & McPhaden 2010)



- Central-Pacific El Nino events have occurred more frequently in recent decades (Ashok et al. 2007, Kao & Yu 2009, Kug et al. 2009).
- May occur much more frequently under projected global warming scenarios (Yeh et al. 2009).

- Will that cause more extreme warming events in the SCP & western Antarctica in the future?

Summary

- Record warming in SCP & w. Antarctica during 2009-10 austral spring-summer.
- Warming confined to the mixed layer (about 50 m).
- Associated with an extreme & persistent HP system.
- Related wind changes caused the oceanic warming:
  comparable roles of reduced latent/sensible heat loss & southward Ekman advection of warm waters.
- SAM did not play a major role.
- The 2009-10 El Nino appeared to be the cause: the strongest CP-El Nino observed to date.
- Extreme events like this may adversely affect the Antarctic environment, esp. if they become more frequent & intense in the future associated with CP-El Nino.

	Sept.	**Oct.**	**Nov.**	**Dec.**
Net heat flux	**16.9**	**21.6**	**9.5**	**-10.4**
Latent	8.7	14.6	13.6	-3.2
Sensible	8.0	8.3	4.7	-2.1
Net shortwave	-1.0	-2.6	-15.0	-6.8
Net longwave	1.3	1.3	6.2	1.6