Workshop:
Climate variability of the Western Tropical Pacific, Trieste, 12-16 Nov. 2012

Atlantic influence on Pacificmean state

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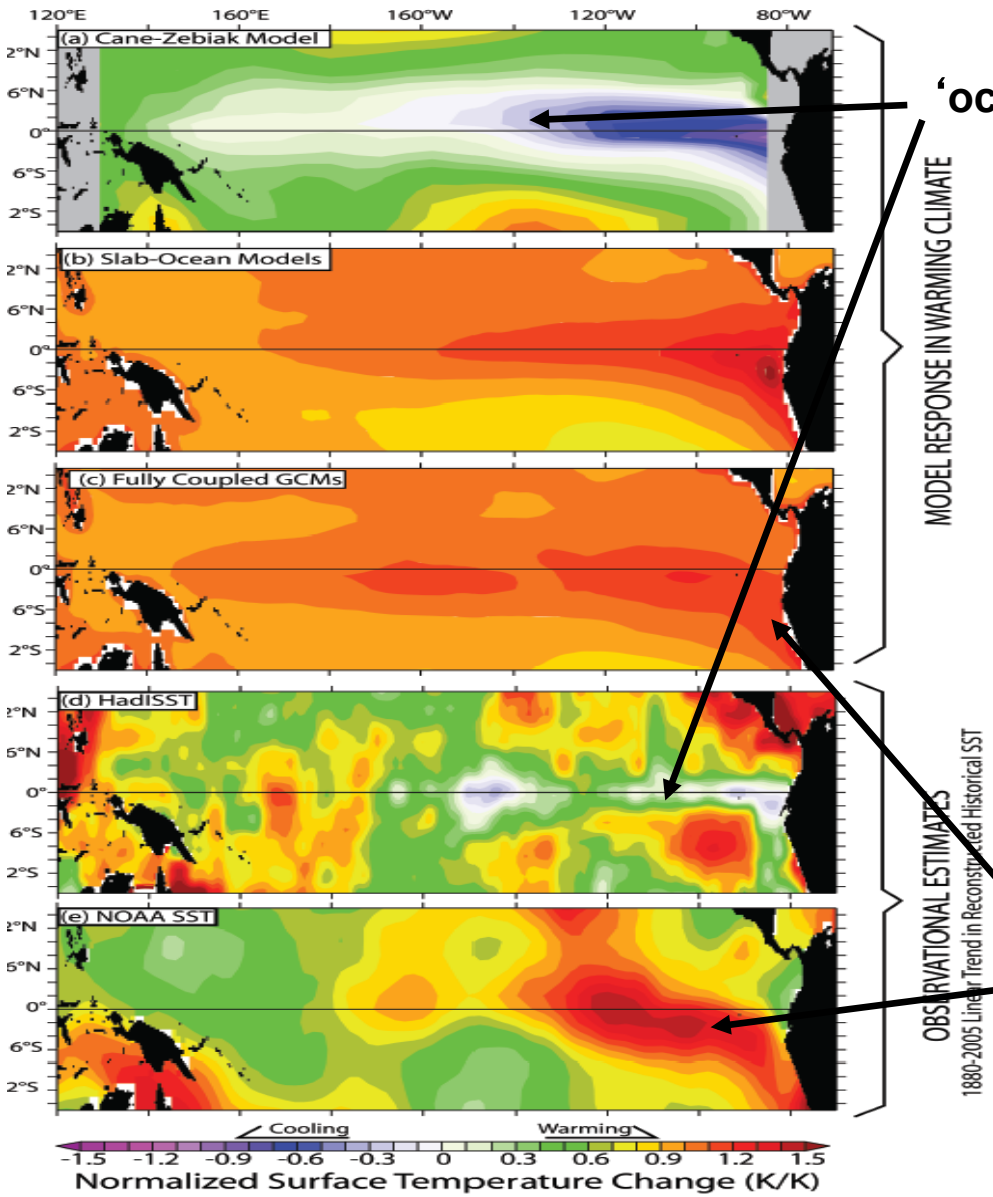
Motivation:

How will the Pacific mean-state change in global warming?



G. A. VECCHI, A. CLEMENT, AND B. J. SODEN

EOS, 2008

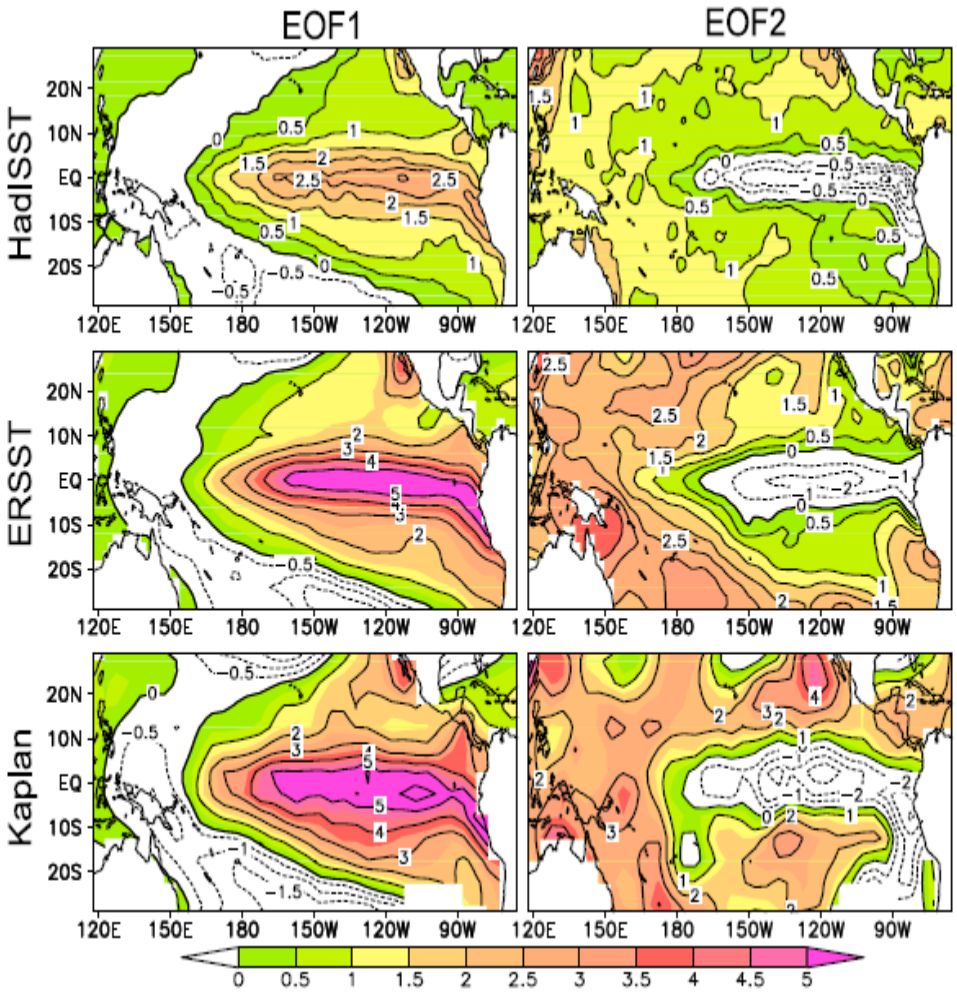
Fig. 1. Response of coupled models of varying complexity to a warming climate and observational estimates of the long-term trend in Pacific sea surface temperature (SST), normalized by tropical-mean SST change: (a) response of the Cane-Zebiak model to an imposed surface warming of 2 K, normalized by 2 K (adapted from Clement et al. [1996]); ensemble-average response of SST to CO_2 doubling from 13 global climate models (GCMs) from the CMIP3 model database in (b) a mixed-layer ocean GCM and (c) fully coupled GCM configurations; 1880–2005 trends from the reconstructions of observed SST are from (d) HadISST and (e) ERSST.

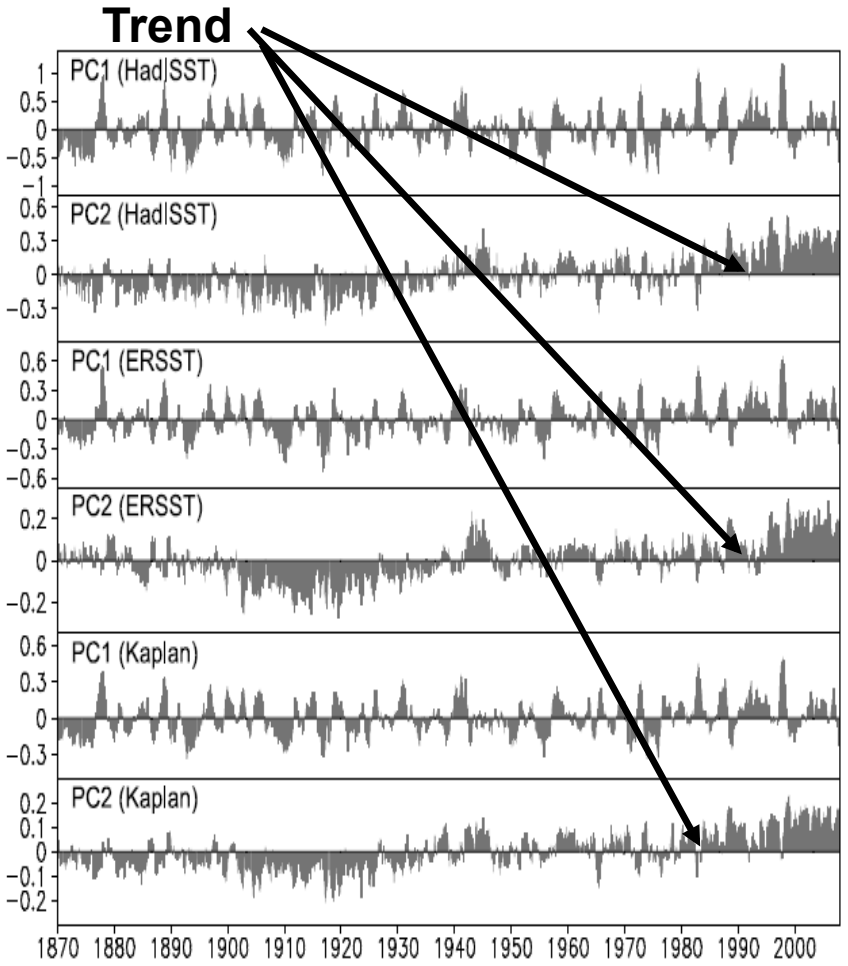
'ocean thermostat'

'weakening of Walker circulation'

Recent paper by Zhang et al. (2010) shows that EOFs of tropical Pacific SSTs from different datasets show consistent results

Zhang et al., 2010, J. GEOPH.RES., **115,** C12042, doi:10.1029/2010JC006501



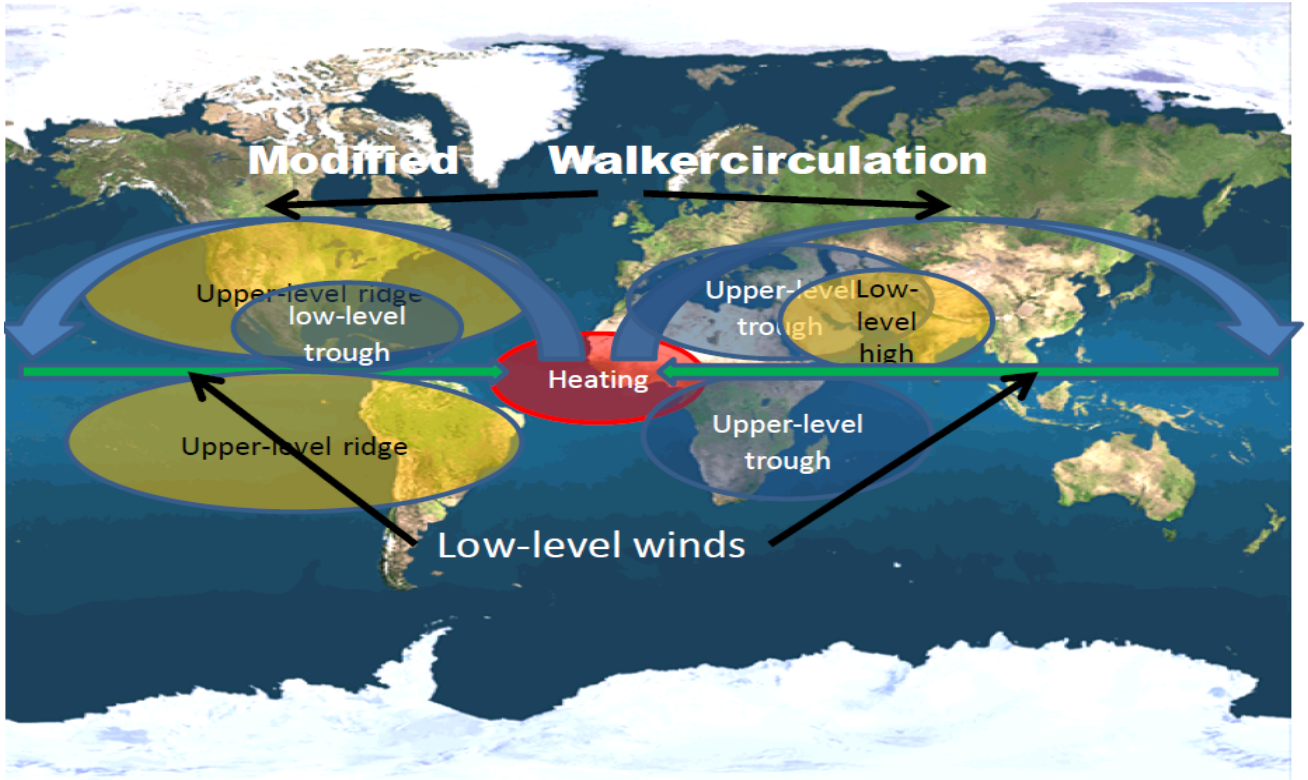


Similar results in recent Nature Climate Change paper: Solomon and Newman, NCLIMATE, 2012

Hypothesis: **Tropical Atlantic warming may have been be able to reduce eastern Pacific warming on decadal timescales (due to modifications of the walker circulation that induce increased eastern Pacific upwelling of colder waters).**

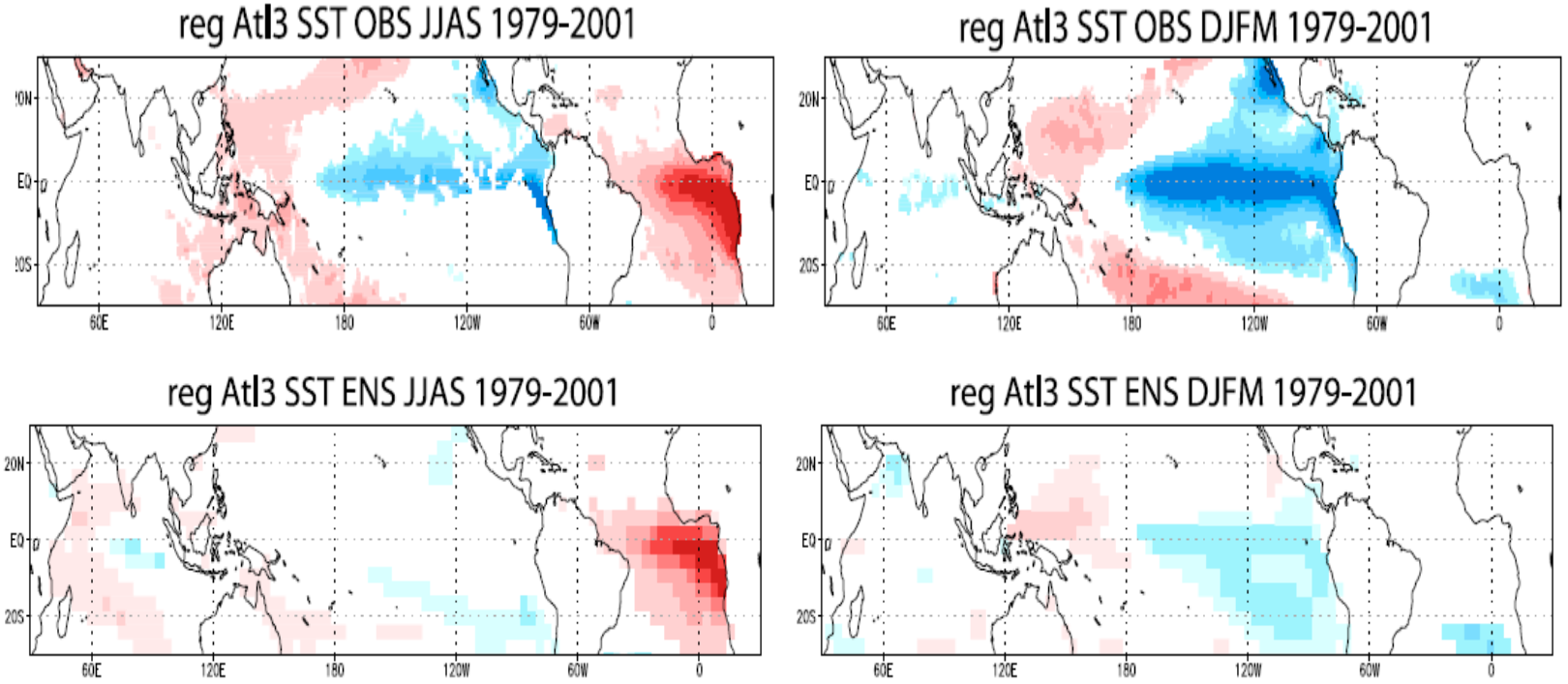
Previous studies have demonstrated the influence on the tropical Atlantic sea-surface temperature variations on interannual variability of the Indian and Pacific region (Kucharski et al., J Clim, 2007, Kucharski et al., GRL, 2008, Kucharski et al., QJRMS, 2009, Rodriguez-Fonseca et al., GRL, 2009, Wang, GRL, 2006, Wang et al., Meteorol. Zeitschrift, 2009, Jansen et al., 2009, Losada et al., 2010, Barimalala et al., Clim Dyn, 2011, Frauen and Dommenget, GRL, 2012).

A schematic of this influence is shown below (from Barimalala et al., Clim Dyn, 2011):



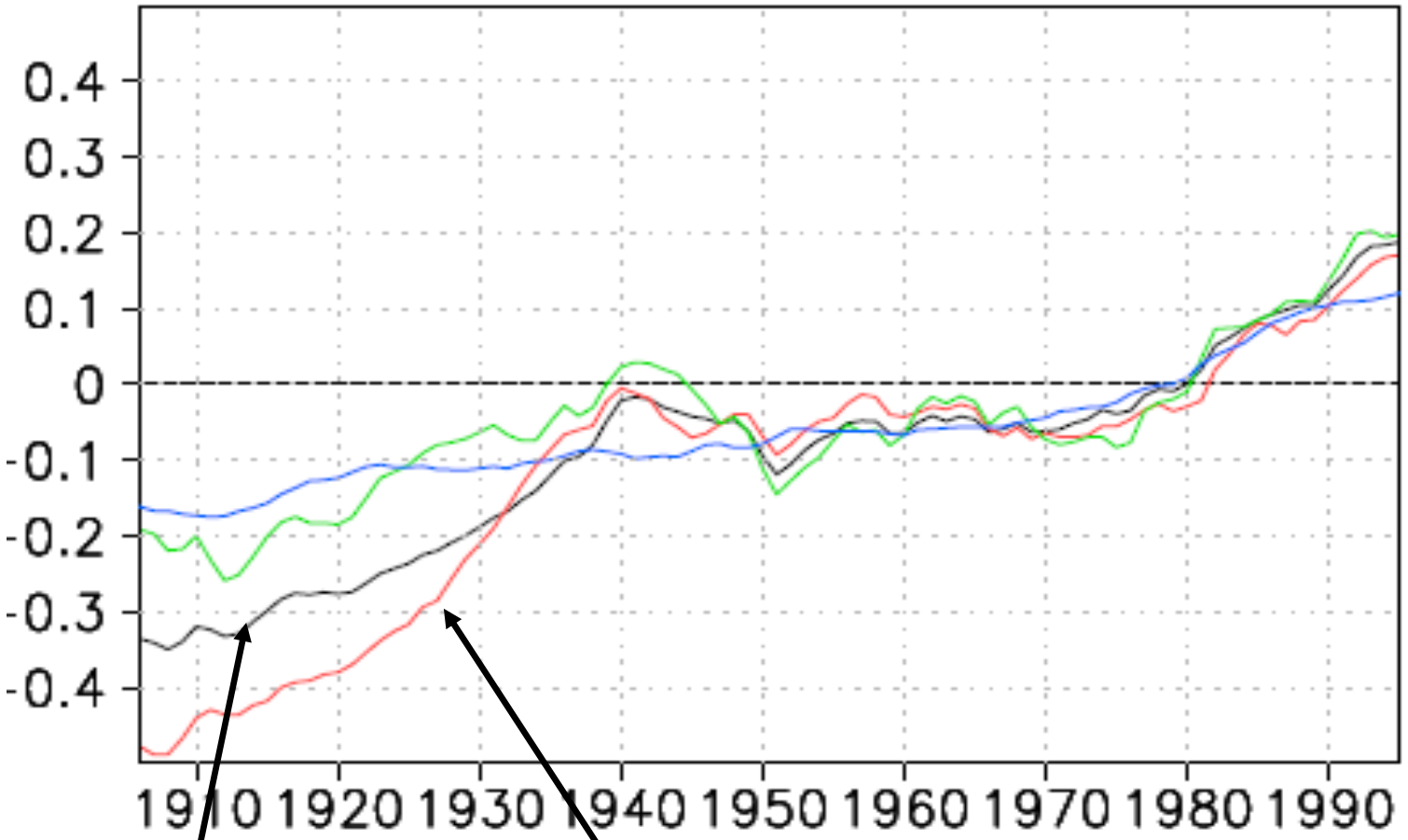
Some results from paper:

Rodriguez-Fonseca et al., 2009 GRL, **36**, L20705, doi:10.1029/2009GL040048



This results has been recently confirmed by Ding et al., Clim Dyn, 2011 with a state-of-the-art climate model

Time series of 11-year running mean, area averaged SSTs (globally and Atlantic basin)

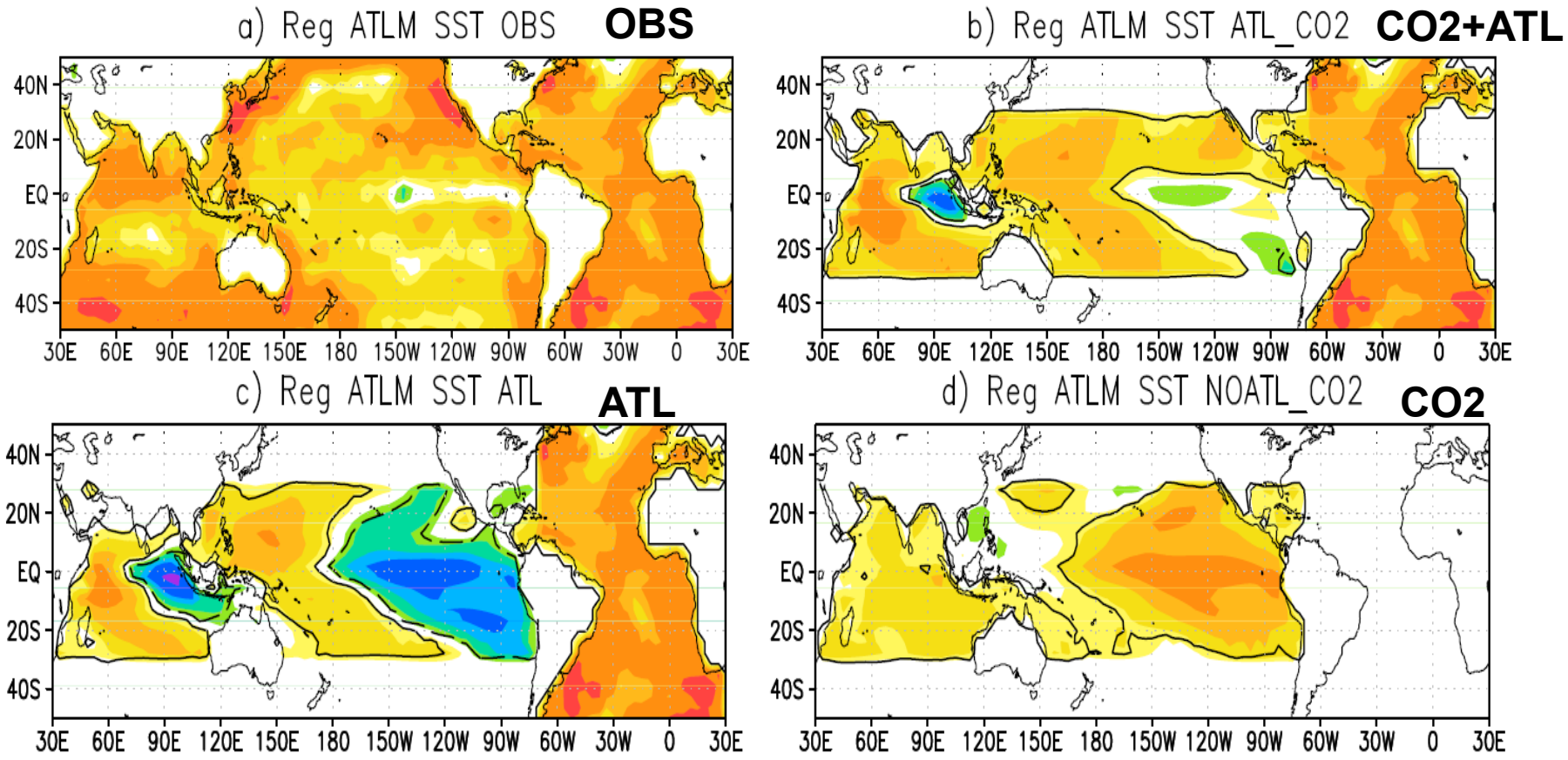


Globally mean SST

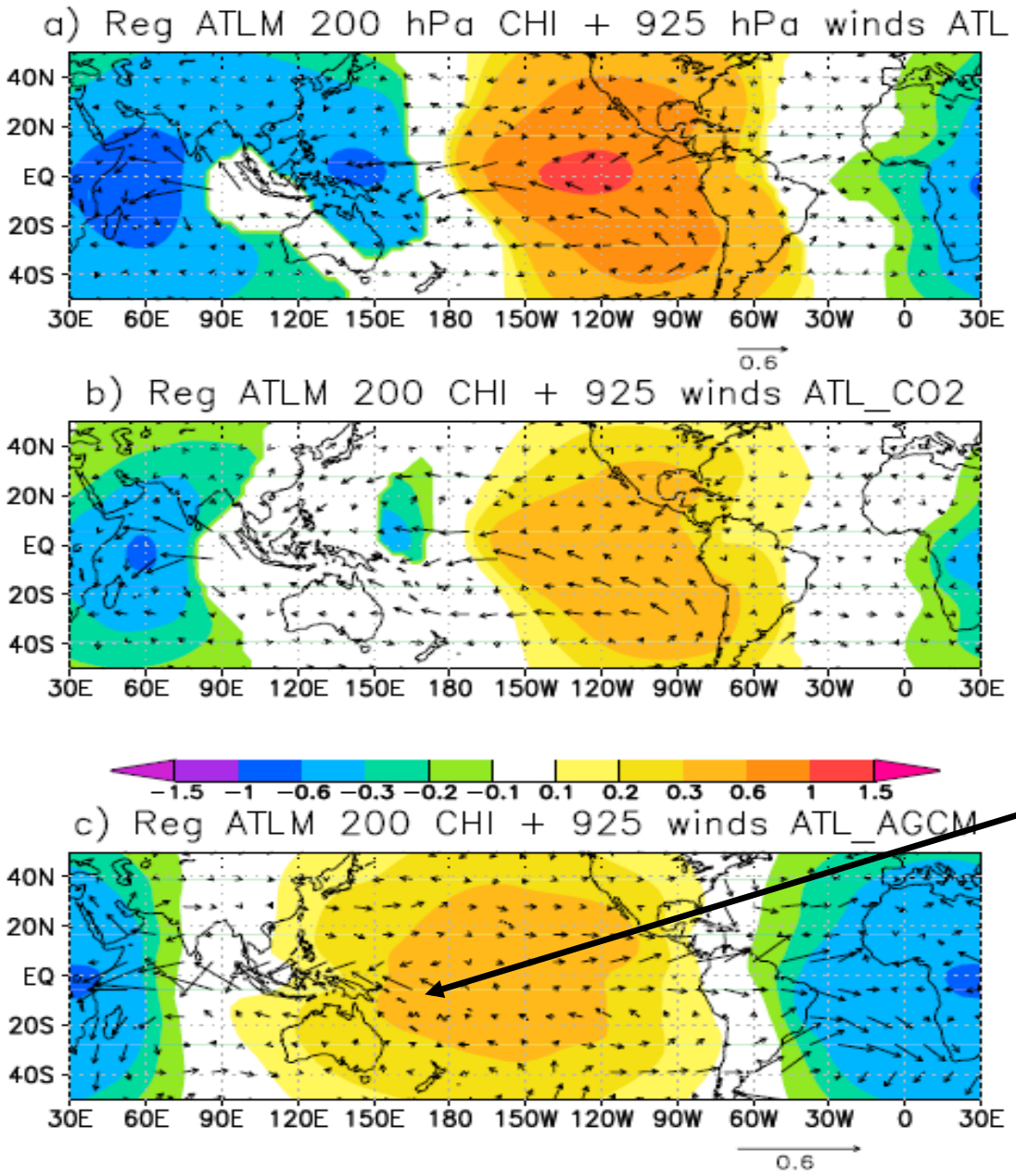
Atlantic mean SST

Make use of intermediate complexity global Climate model developed at ICTP (F Molteni, F Kucharski: http://users.ictp.it/~kucharsk/speedy-net.html), coupled to simple model (reduced gravity) of the tropical Pacific Ocean (Chang, 1994). Forcing in the model: Increased CO2 absorption and prescribed Atlantic Ocean sea surface temperatures. Shown are regressions of Atlantic mean SST onto SST.

Kucharski, F., I.-S. Kang, R. Farneti, and L. Feudale (2011), Tropical Pacific response to 20th century Atlantic warming, Geophys. Res. Lett., 38, L03702,doi:10.1029/2010GL046248



Upper-level velocity potential and low-level wind responses



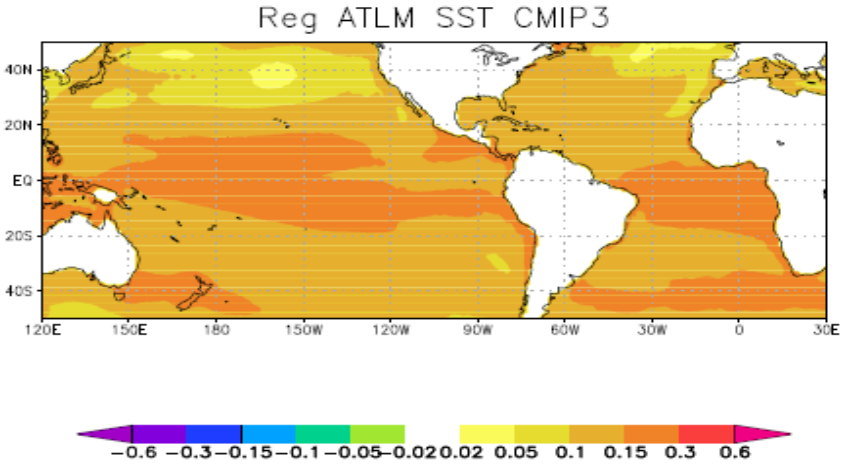
ATL

CO2+ATL

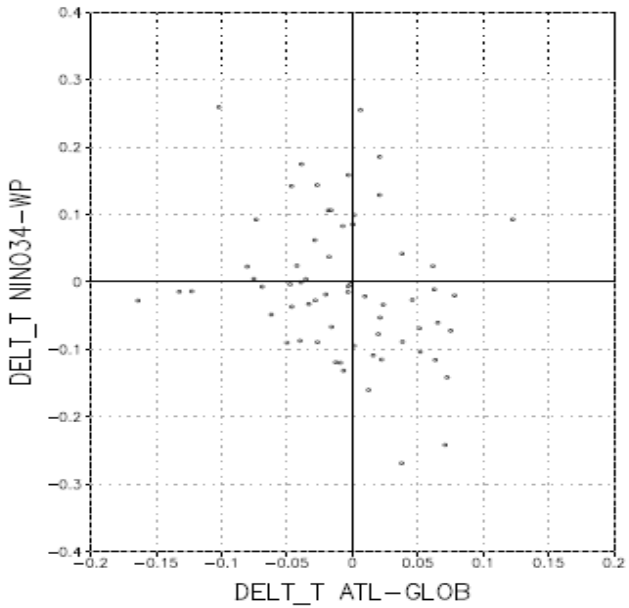
Easterly wind response in equatorial central-west Pacific ==> relevance of western Pacific

ATL AGCM

What do CMIP3 models show?



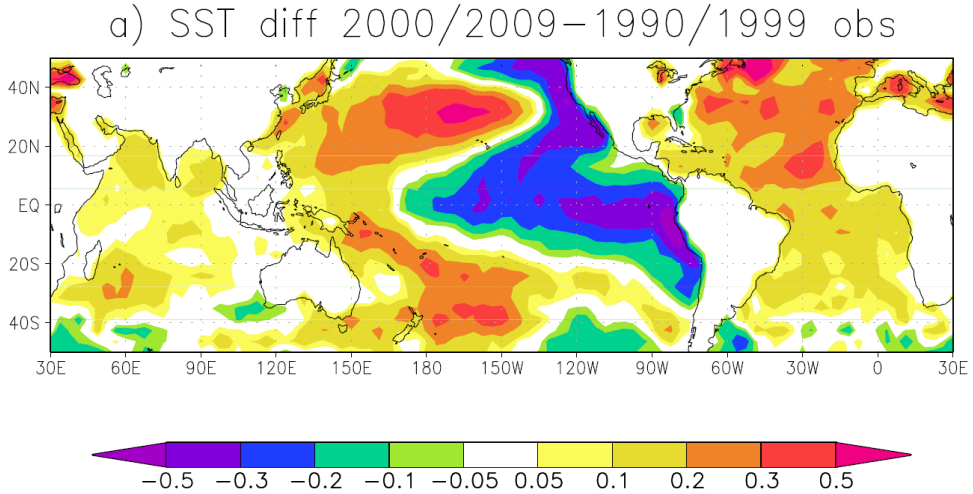
Regression of mean Atlantic SSTs onto Global SSTs for the ensemble mean of the CMIP3 C20 runs.



CMIP3 models show some anticorrelation (cc=-0.26) between the relative Atlantic warming and the tropical Pacific east-west SST gradient.

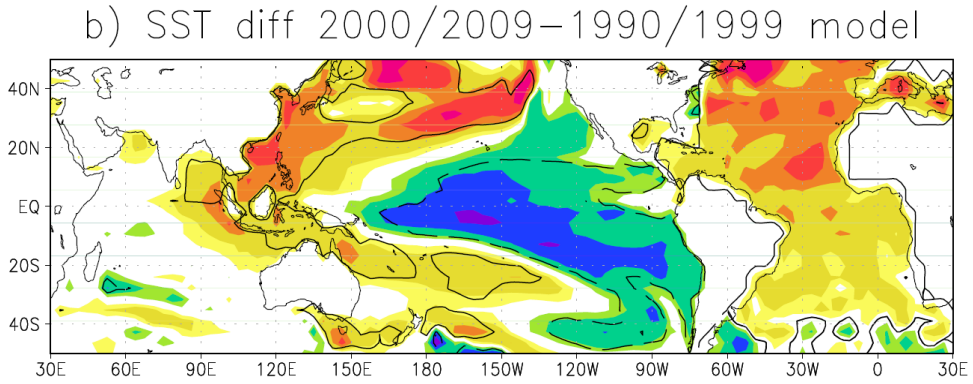
However, CMIP5 models do not show Such a relationship……

Very similar mechanism may be relevant also in the end-of-century climate shift (topic also of previous' talk)
E.g. Chikamoto, Kimoto, et al, GRL, 2012, in press, and In-Sik Kangs talk on Thursday



2000/2009 – 1990/1999 SST differences

OBS



Modeled with 8-member ensemble of the new ICTPAGCM(SPEEDY)/NEMO coupled model. SSTs prescribed in Atlantic region

Summary

❑The past and future mean state in the tropical Pacific remains a topic of active research.

❑ Different observational estimates of past changes support the ‘ocean thermostat’ as well as the ‘weakening of Walker circulation’ hypothesis.

❑ Our results suggest o possible crucial role of the Atlantic (and may be also Indian) Ocean in modifying the tropical Pacific response to increased GHG.

❑The ‘ocean thermostat’ may still be valid in our simulations, but must triggered by the tropical Atlantic warming that modifies the Walker circulation.

❑This mechanism is similar to the recently observed and modeled influence of the tropical Atlantic on ENSO events at interannual timescale.

❑The Walker circulation-weakening paradim could have more complex Details than previousely thought.

❑ Mechanism could also be relevant in decadal Pacific SST variations