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Intensification of Pacific Walker Circulation During Last Quarter Century

Frank J. Wentz, Carl Mears, and Lucrezia Ricciardulli

Remote Sensing Systems, Santa Rosa CA

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Underlying Physics of Radiative Cooling Constraint

“Simple Physics”

1. A warming troposphere radiates more energy into space: 2 W/m^2 for 1 K warming

2. This extra energy comes for increase latent heat release: precipitation increases by 2% for 1 K warming

3. A warming troposphere holds more water vapor (Clausius-Clapeyron) : vapor increases by 7% for 1 K warming

4. To sustain a 2% increase in precipitation accompanied by a 7% increase in total water, mass flux balance requires a decrease in global circulation.

Questions:

1. Can this simple physics really be applied to the very complex Earth system?

2. What are the effect of aerosols, clouds, stratosphere, etc. on assumption #1 ?

3. Strictly speaking the above statements only apply to a global average.
   What type of departures are expected regionally?
   Also how does the above manifest itself over oceans versus over continents?

Experimental Evidence

- Several long-term (pre-satellite) studies have indicated a decrease in Pacific atmospheric circulation (Vecchi, Soden et al., Nature, 2006, and others)

On the other hand

- Wentz et al., Science, 2007 found global evaporation and precipitation increasing at about the same rate of 7%/K (Clausius-Clapeyron, CC).
  Caveats:
  1. Relatively short 19 year period (1987-2006)
  2. Land evaporation (14%) assumed unchanged
  3. Trends very small and signal-to-noise (SNR) was only 2.

- Wild et al., BAMS, 2012, suggested enhanced precipitation during 1980-2000 increases may be due to 'atmospheric brightening'

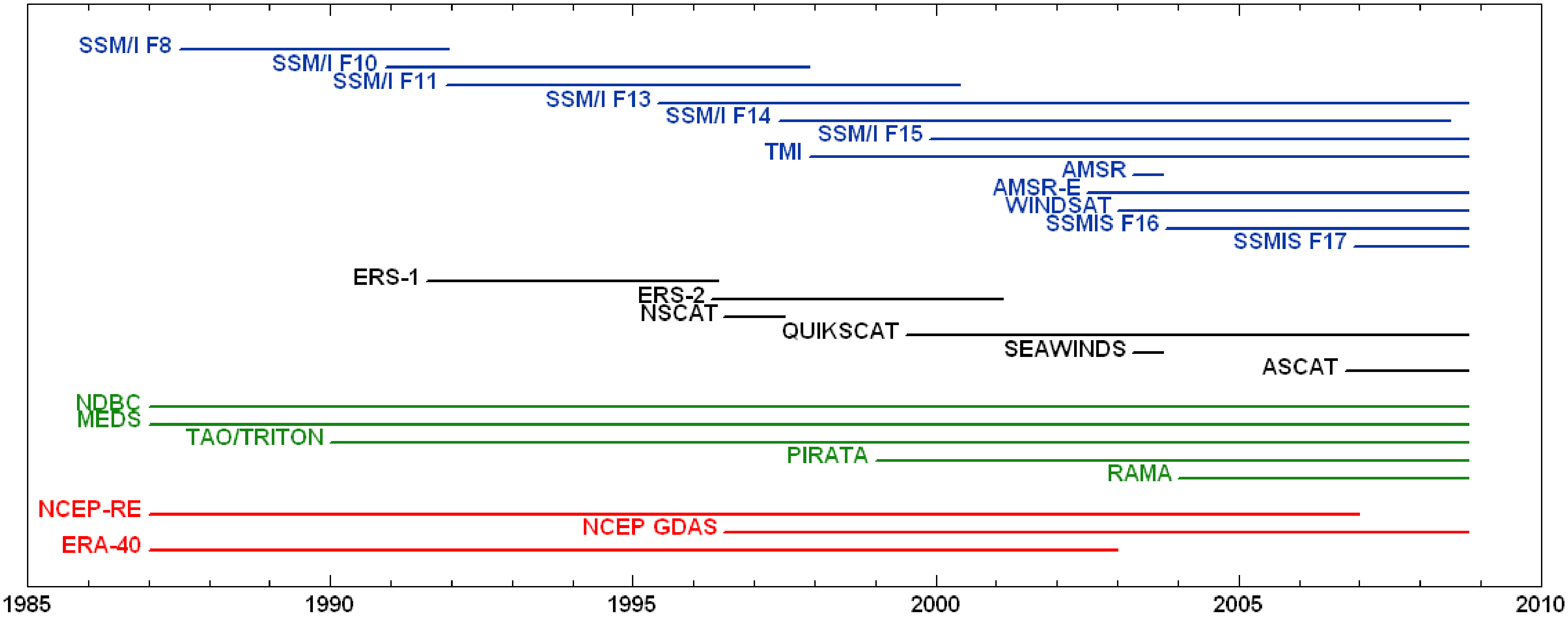
- Recent paper by Durack et a.l, Science, 2012, also found CC-type increases in precipitation over the last 30 years using ocean salinity as a proxy.

Here we look at a very robust l (SNR > 5) 25-year climate signal that clearly shows a substantial increase in the Pacific Walker Circulation

Version 7 Ocean Wind Climatology

Various Sources Providing Ocean Wind Speed

MW radiometer; MW Scatterometers; Ocean Buoys; Analyses



Currently there are 10 satellites at Version-7 Calibration Standard

- **All 6 SSM/I: F08, F10, F11, F13, F14, and F15**
- **One SSMIS: F17**
- **WindSat and AMSR-E**
- **QuikScat**

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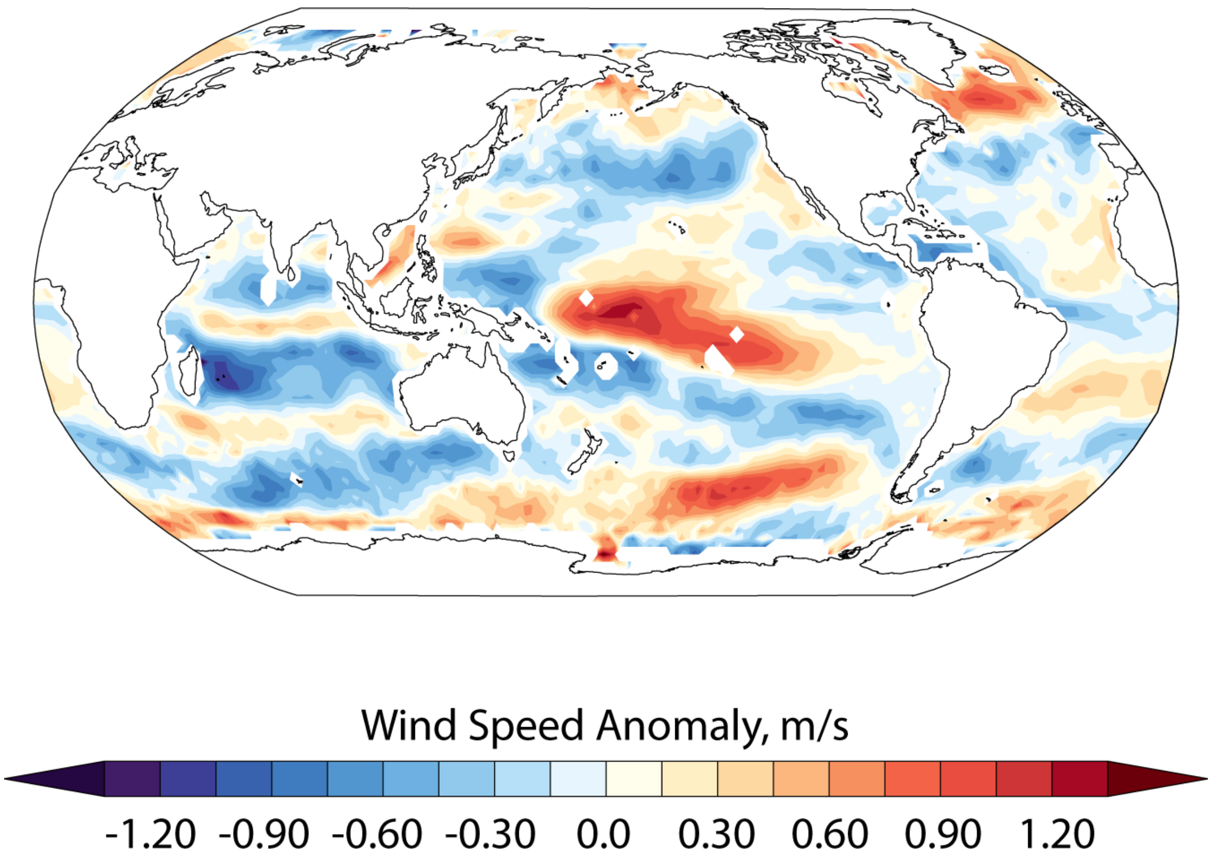
2011 Wind Speed Anomaly

2011 Wind Speed Anomalies, V7
Data from WindSat, SSMIS F17, and AMSR-E



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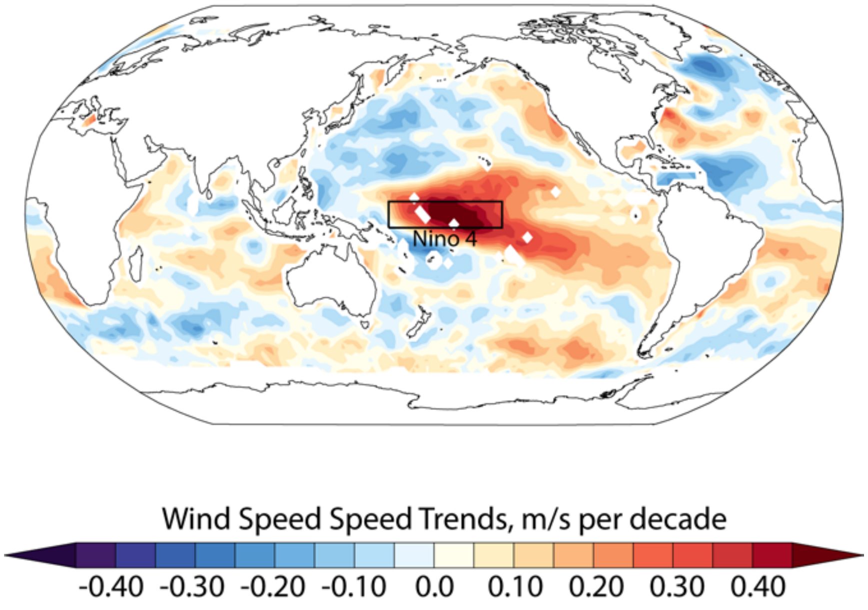
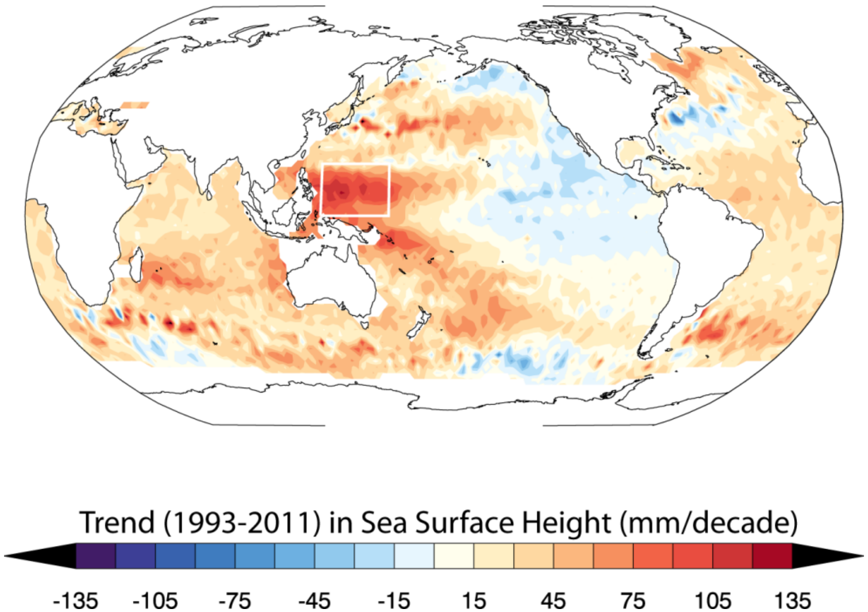
Intensification of Walker Circulation as Evidence by Increasing Surface Winds in Tropical Pacific

Wind Speed Trends, 1988-2011, V7
Data from SSM/I, SSMIS, AMSRE and WindSat



Sea-Surface Height, 1993-2011



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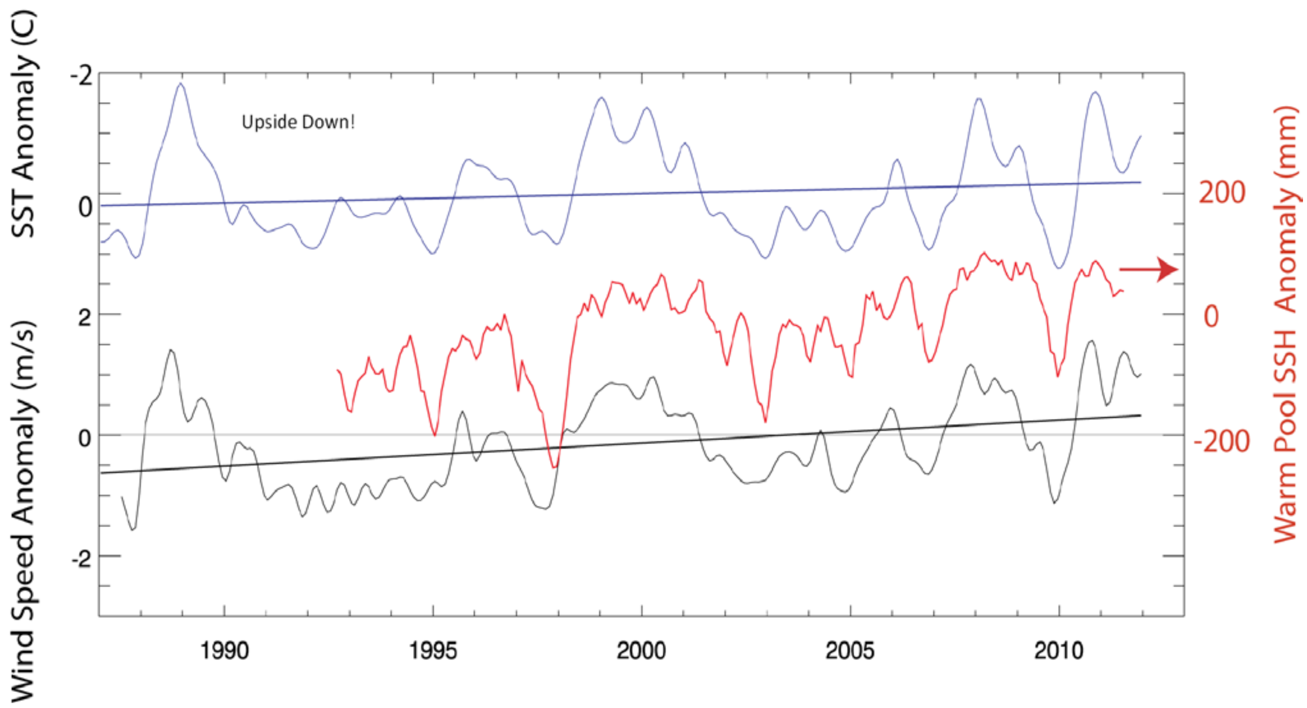
Time Series of SST, Wind, and SSH



SST Trend = -0.155 K per decade
Wind Trend = 0.387 m/s per decade

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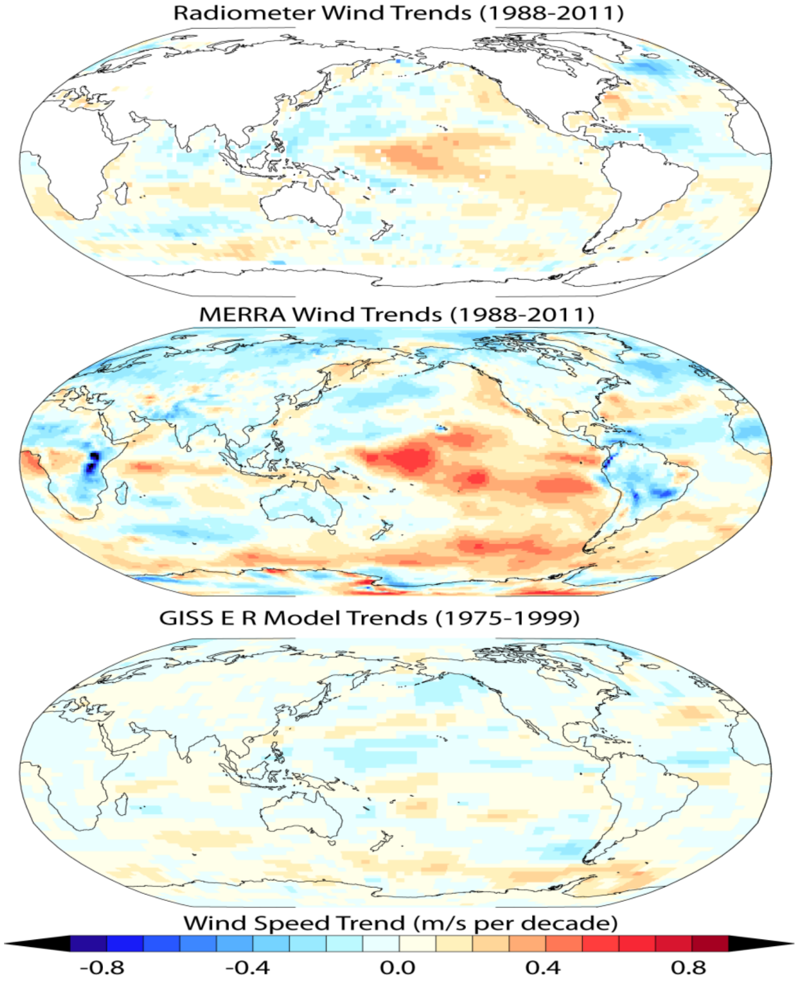
Satellite Wind Trends Versus Assimilation Models and Climate Models



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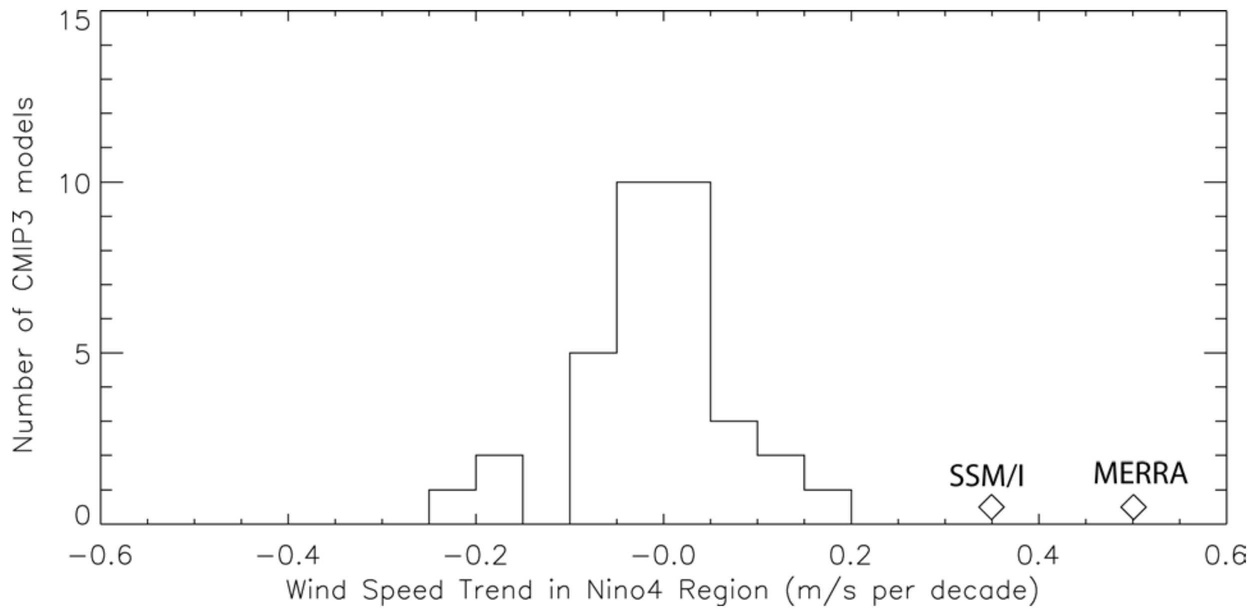
Climate Models Do Not Produce True Large-Scale, Quarter-Century Climate Features



Conclusions

- Is Intensification due to Global Warming or Pacific Decadal Oscillation (PDO),
- Or, the 1998 El Nino brought on a different climate state, similar to the “1977 climate shift”
- Begs the question: When do oscillations effectively (societally) become trends
- Climate models do a poor job at representing these quarter-century climate wind features