Decadal Variability of Tropical Pacific Temperature in Relation to Solar Cycles

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Forcing of Earth’s Climate Change

Global

-- ‘global warming’, ‘global forcing’

Deviations from Global

-- appear as spatial patterns naturally generated by non-linear, noisy atmosphere-ocean system

Structural Stability of Climate Patterns

-- against external forcing (anthropogenic, volcanic, solar)
Climate Patterns

Northern and Southern Annular Modes (NAM and SAM)

Quasi Biennial Oscillation (QBO)

El Nino & Southern Oscillation (ENSO)
ENSO

[Diagram showing ocean and atmospheric circulation patterns associated with ENSO events.]

- Convective loop
- Atmospheric Circulation
- Equator
- Australia
- South America
- Upwelling

Sea-surface temperatures:
- Cooler than normal
- Warmer than normal

[Map indicating regions of interest for ENSO, such as Niño 3.4, Niño 1+2, Niño 3, and Niño 4, with corresponding coordinates.]
Solar Variability (SSN) & Nino 3.4 SST (13 cycles, 1871-2010)

No correlation between SSN and Nino34. No trend in Nino3.4 SST.
Response of Pacific to Solar Cycle

Cool response of Tropical Pacific SST to max of solar activity
van Loon and Meehl, 2008

Warm response of Tropical Pacific SST to max-min of solar activity
White et al, 1997; Roy & Haigh, 2010
Solar UV and Observed SST Record

- 4-year rise
- 7-year fall
Rising Phase of Solar Cycles
Falling Phase of Solar Cycles

- Cycle 19
  - \( \Delta T(\text{°C}) \)
  - Trend: \(-0.07°/\text{year}\)

- Cycle 20
  - \( \Delta T(\text{°C}) \)
  - Trend: \(-0.16°/\text{year}\)

- Cycle 21
  - \( \Delta T(\text{°C}) \)
  - Trend: \(-0.15°/\text{year}\)

- Cycle 22
  - \( \Delta T(\text{°C}) \)
  - Trend: \(-0.27°/\text{year}\)

- Cycle 23
  - \( \Delta T(\text{°C}) \)
  - Trend: \(-0.2°/\text{year}\)
Cycle 23, AIRS data

T

q
Visible heats clear parts of trop ocean bringing evaporated moisture by trade winds to convergence zone where it strengthen Hadley circulation and trade winds (G. Meehl & H. van Loon)

UV enhances $O_3$ in trop stratosphere creating $\nabla T$ that affects Hadley circulation (J. Haigh)
Coupled Mechanism

Meehl et al., 2009
Conclusions

- Solar variability influences the ENSO pattern
- Best seen in the falling phase of solar cycle
- Emerging understanding of the mechanism