Satellite SVW in Climate Studies:

Using the SVW Climate Data Record to Validate Aspects of The Southern Oscillation

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OUTLINE

• Surface signals on the Southern Oscillation during Warm Event Onset following van Loon and co-workers (descriptive)

• Independent confirmation from QuikSCAT Climate Data Record (weak WE in 2002, 2006)

• Other aspects of SO susceptible to confirmation given higher temporal and spatial resolution and multi-sensor datasets

• Current state of SO and potential for (weak) Warm Event in 2009 (from QuikSCAT)
Anomalies on the SH in Year(-1) consistent with Warm Event development in Year(0)

- Convection energized in SPCZ
- Anomaly Low SLP over SE Australia (trough in long waves)

Stephens et al. (2007)
Anomalies on the SH in Year(0) consistent with a mature Warm Event in DJF

- Convection in SPCZ erodes sub-tropical High SLP in S. Pacific
- Trade wind circulation weakens in E. Pacific
- Anomaly High SLP over SE Australia
- SLP gradient in SW Pacific supplies mass to tropics in W Pacific (MJJ)
- See-saw response in equatorial Pacific; onset of WE (ASO)

Stephens et al.(2007)
Area-Average SLP (hPa) in the region of the S. Pacific High Pressure System
14 Warm Events ("modern era")

MJJ Sea-Level Pressure Anomalies

Hadley-2 SLP

E. Pacific SST anomaly in DJF > 0.5°C

MJJ Surface Wind Anomalies

NCEP/NCAR Reanalysis Surface Wind

ASO
Failed Precursors: MJJ SLP Anomalies (Hadley-2)


Historical record: 1898, 1900, 1907, 1915, 1928, 1932, 1935, 1943
Using the QuikSCAT CDR to Validate SLP Anomalies in the SO

MJJ

- Weak Warm Events in 2002, 2006
- Composite SVW minus QuikSCAT Climatology (2000-2008)

ASO

Composite SLP Anomalies (Hadley-2)

Composite SVW Anomalies (QuikSCAT CDR)
**Weak vs. Strong Warm Events based on MJJ Anomalies**

**Historical record**

**Strong:** SST anomaly in DJF of Yr(0) > 1°C

**Weak:** 0.5°C < SST anomaly in DJF < 1°C

### MJJ SLP Anomalies
(Hadley-2 SLP)


### MJJ SST Anomalies
(NOAA Reconstructed SST)

Anomalies with respect to climatologies for the period 1958-1997
What about 2009?

- MJJ SLP anomalies do not support the development of a mature Warm Event by DJF
  - anomalous H missing from Oz
- MJJ SVW anomalies from QuikSCAT are more ambiguous
  - Equatorward flow in Tasman Sea
  - no clear connection to equatorial W Pac
- Danger! interpreting single-year anomalies (i.e. vs. composites)

“one should be very careful about predicting anything ... especially the future” HvL personal communications too numerous to recount.
Aspects of the SO to be Validated by Higher Temporal and Spatial Resolution Data from Multiple Sensors

- Mesoscale convergence and divergence
- SST and SST gradient extrema
- Moisture convergence
- 2-layer temperature and/or moisture

MCS!
Circles indicate mean size of 13206 cloud systems identified by cold cloud top temp (< 210°K) and connectivity in lat/lon/time

Number density of identified cloud systems in Vorticity-precipitable water space

The Mesoscale Convective System (MCS) life cycle

precursor disturbances

formation

→ several hours →
maturity

decay

successor disturbances

**Major processes (expressed as GCM parts & parameterizations):**
- dynamics, PBL
- PBL, shallow cumulus
- PBL, cumulus, stratiform cloud
- stratiform cloud & precip

**Key variables measured by TropSat:**
- SST, $\nabla^2$SST
- $\nabla \cdot V_{sfc}$, column vapor, cloud top, rainrate & rainwater
- $\nabla \times V_{sfc}$, preconditioning and triggering
- net latent heating, momentum effects
- production of atm & ocean cold pools

- SST, $\nabla^2$SST
- $\nabla \cdot V_{sfc}$, outflows, gravity waves
- $\nabla \times V_{sfc}$, cyclogenesis, planetary waves

**Other processes:**
- Ekman pumping

Surface forcing
SUMMARY

- **SO signals in MJJ SLP anomalies** (van Loon and co-workers)

- **Independent confirmation of physical description from QuikSCAT CDR**
  QuikSCAT precision, spatial resolution, coverage critical to validation of regional anomaly signals 2002, 2006.

- **Extend analysis to historical record**
  refine MJJ SLP anomaly connection to DJF SST anomaly amplitude in equatorial E. Pacific (i.e. strong vs. weak Warm Events)

- **Implications for Warm Event (or not!) in 2009**
  MJJ SLP suggests not; MJJ SVW from QuikSCAT ambiguous

- **Other aspects of SO (ENSO onset) susceptible to confirmation given multi-sensor satellite datasets with frequent repeats (sub-daily resolution)**
  MCS processes (temporal resolution is key)
  implications for many tropical/sub-tropical climate processes (MJO, TC, monsoon, ....)
EXTRAS
MJJ Anomaly SVW from the QuikSCAT CDR

- QuikSCAT CDR confirms (quantifies) SVW implied by SLP
Westerly wind anomaly in W. Pacific signals WE onset
Supportive of weak Warm Event this year?
Danger of single year anomaly maps comparison ("beauty contest")