Satellite SVW in Climate Studies:

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

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([1] also at NCAR)

van Loon, H. and D.J. Shea, 1985: "The Southern Oscillation Part IV: The Precursors South of 15°S to the Extremes of the Oscillation", *Mon. Wea. Rev.,* **113**, 2063-2074.

van Loon, H. and D.J. Shea, 1987: "The Southern Oscillation Part VI: Anomalies of Sea-Level Pressure on the Southern Hemisphere and of Pacific Sea Surface Temperature during the Development of a Warm Event", *Mon. Wea. Rev.,* **115**, 370-379.

van Loon, H., G.A. Meehl, R.F. Milliff, 2003: "The Southern Oscillation in the Early 1990s", *Geophys. Res. Lett.,* **30**(9), 1478, doi: 10.1029/2002GL016307.

Stephens, D.J., M.J. Meuleners, **H. van Loon**, M.H. Lamond and N.P. Telcik, 2007: "Differences in Atmospheric Circulation between the Development of Weak and Strong Warm Events in the Southern Oscillation", *J. Climate,* **20**, 2191-2209.

van Loon, H. and R.F. Milliff, 2009: "The Southern Oscillation Part X: Successful and Failed Precursors to Warm Events", *in prep.*

OUTLINE

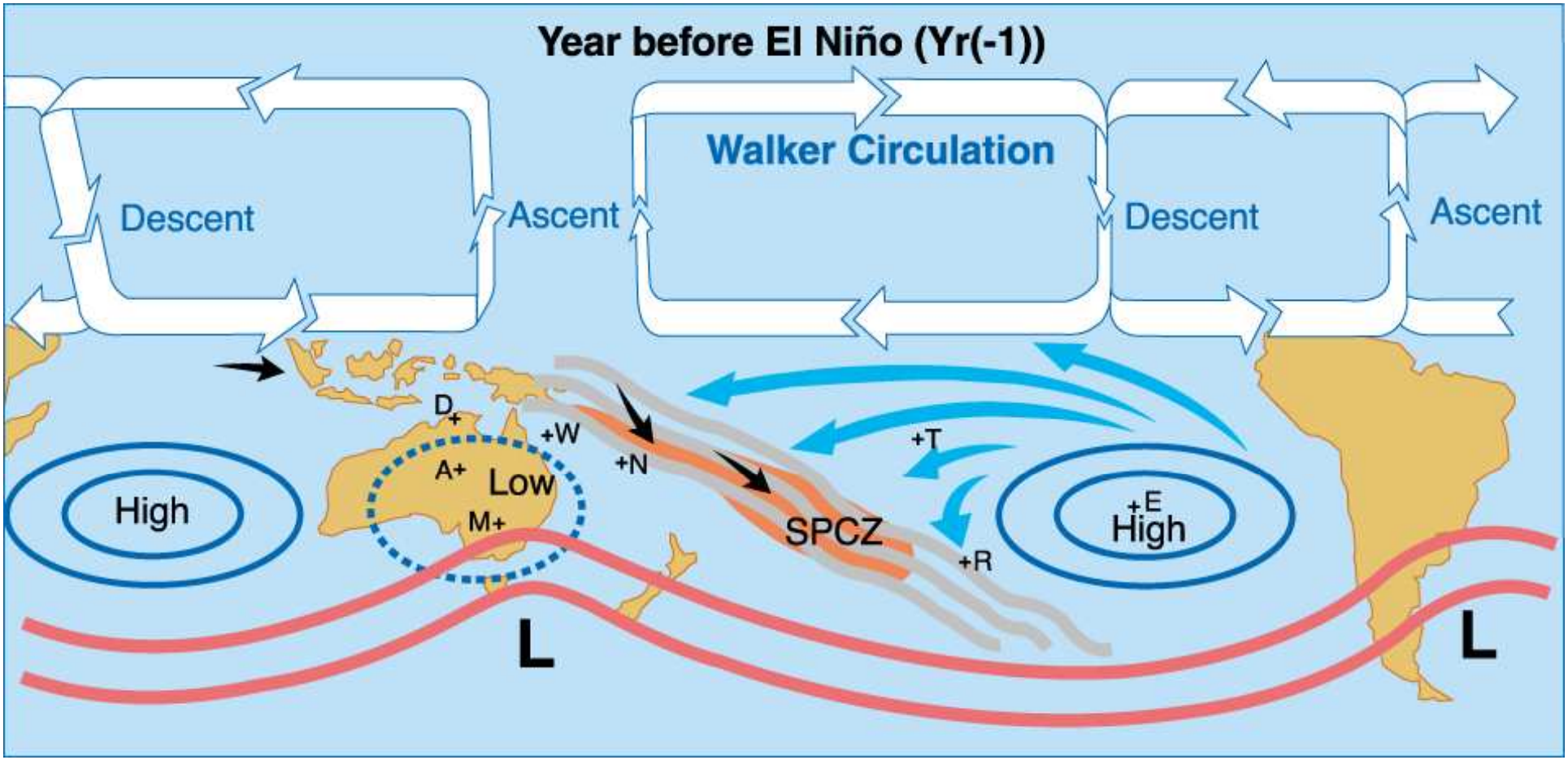
- *Surface signals on the Southern Oscillation during Warm Event Onset following van Loon and co-workers (descriptive)*

- *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)*

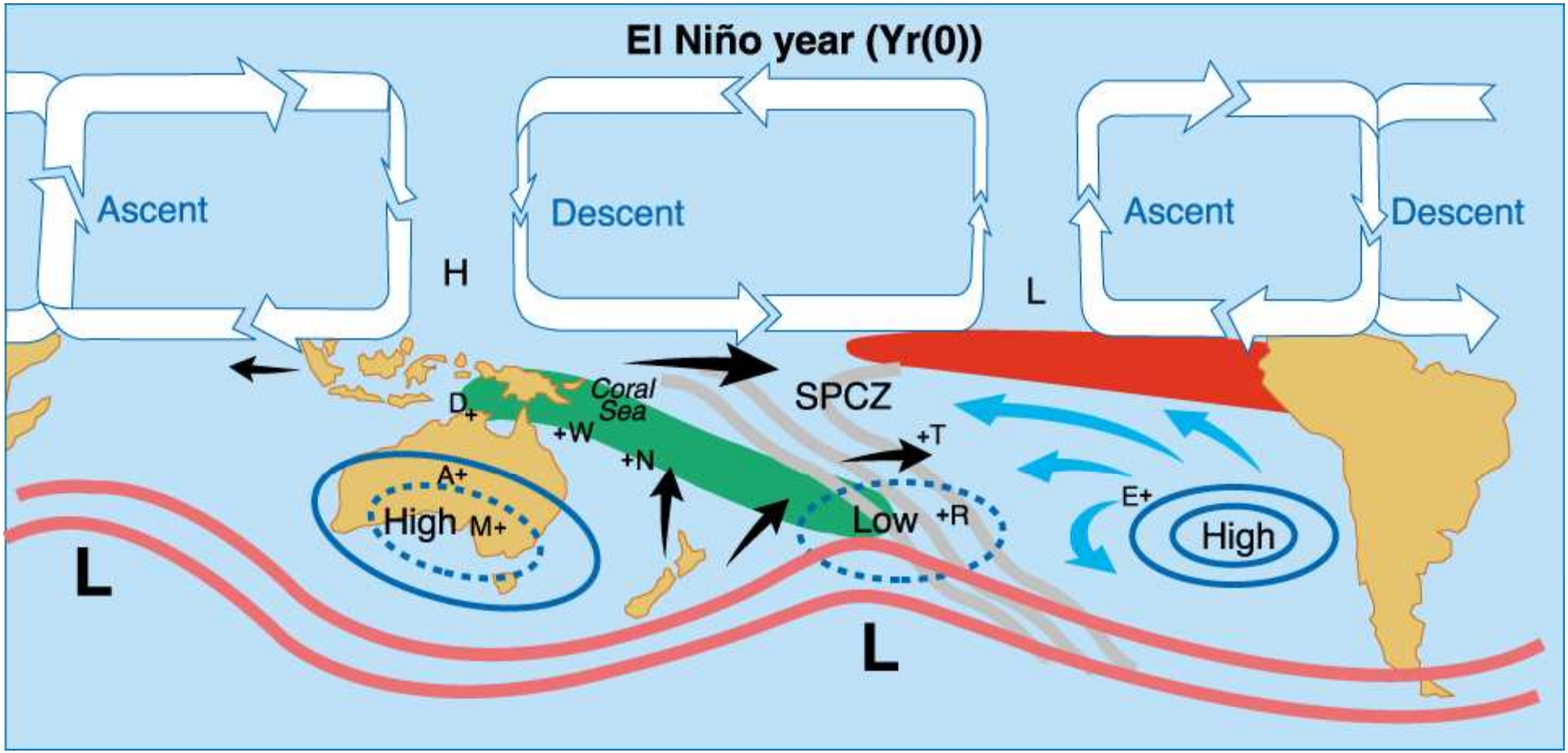
Anomalies on the SH in Year(-1) consistent with Warm Event development in Year(0)



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

Stephens et al.(2007)

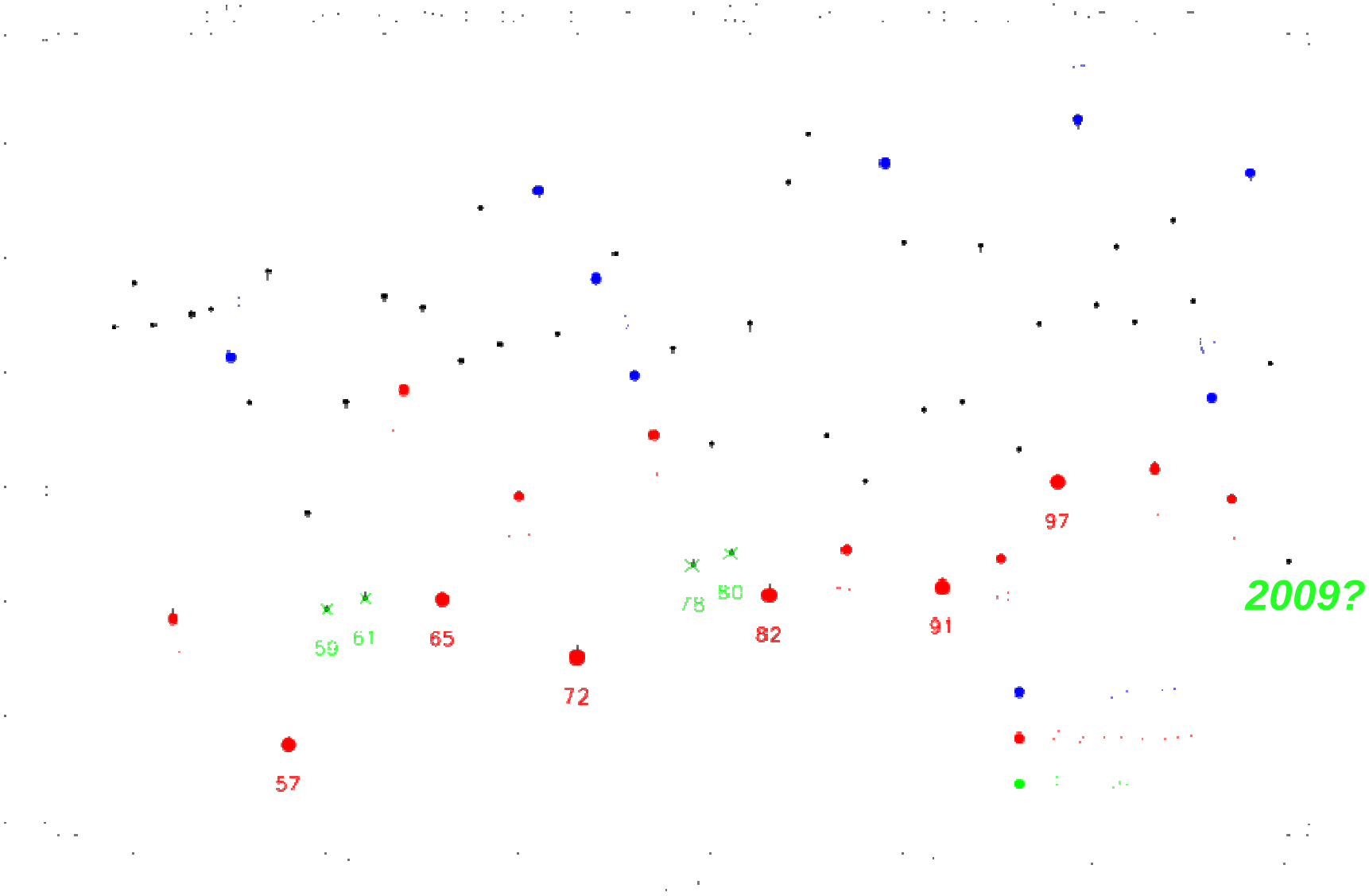
Anomalies on the SH in Year(0) consistent with a mature Warm Event in DJF



- 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)

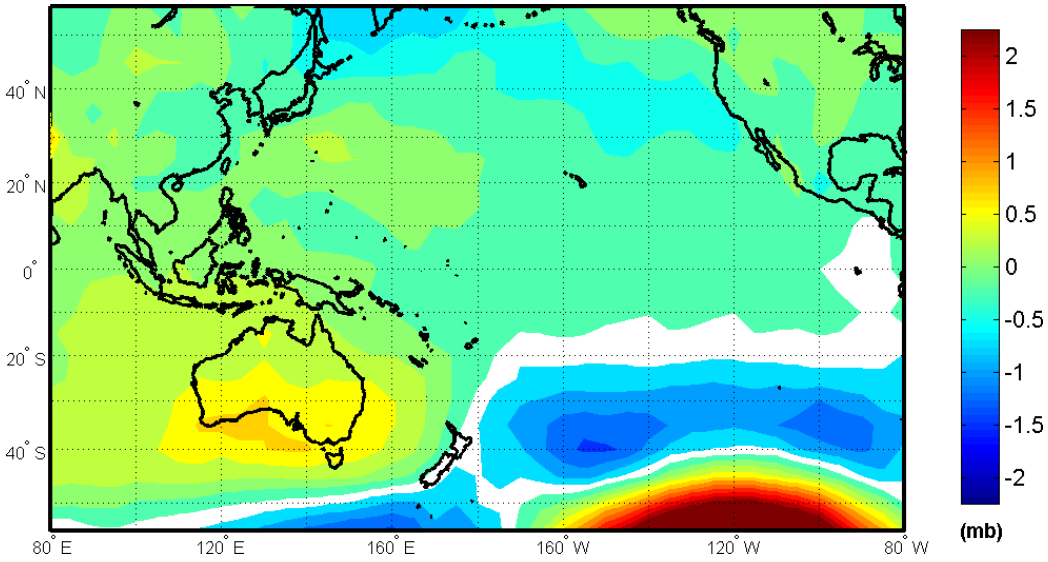
Stephens et al.(2007)

Area-Average SLP (hPa) in the region of the S. Pacific High Pressure System



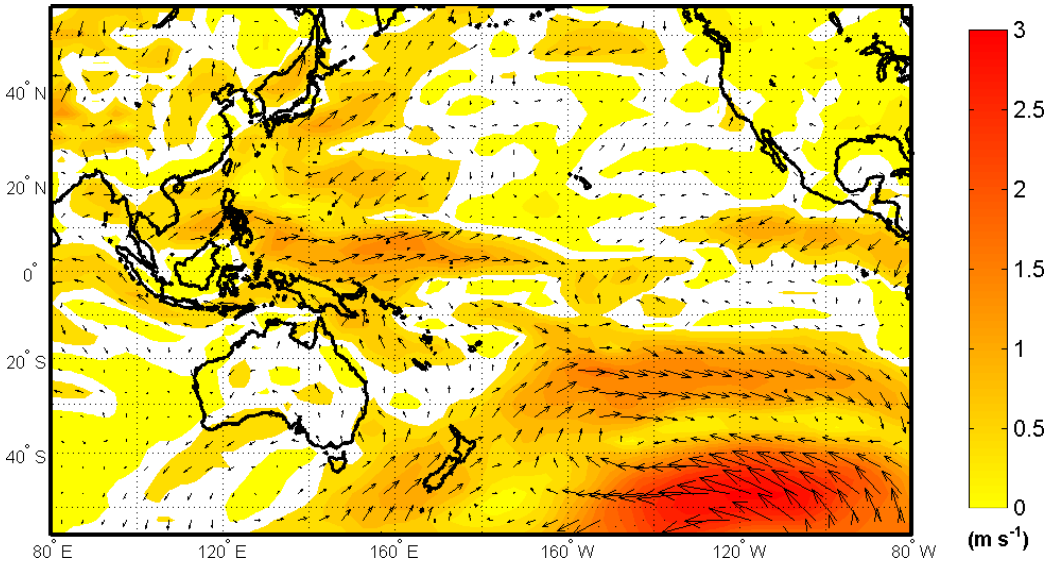
14 Warm Events ("modern era")

MJJ Sea-Level Pressure Anomalies

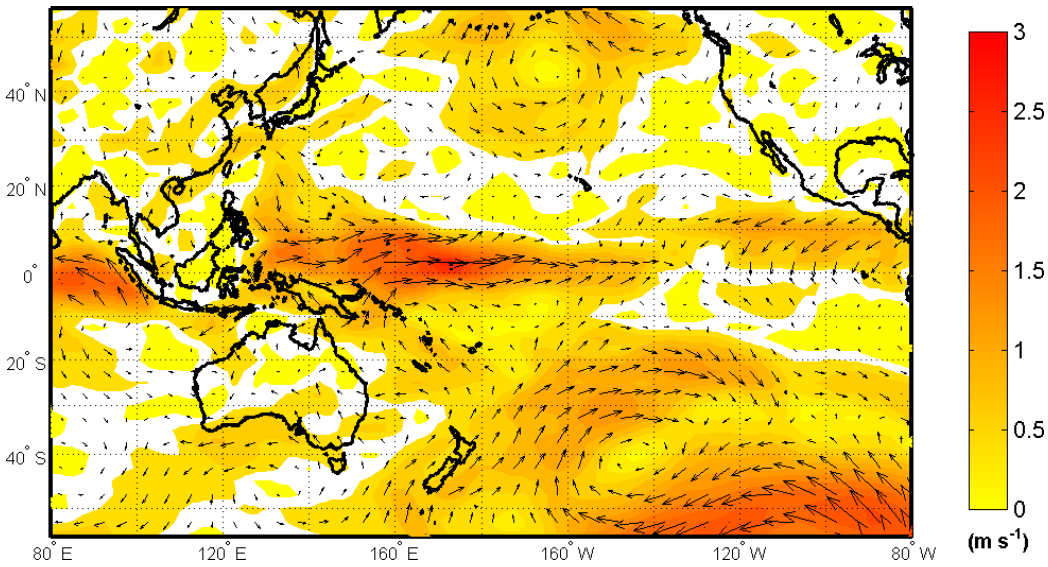


Hadley-2 SLP

MJJ Surface Wind Anomalies



ASO

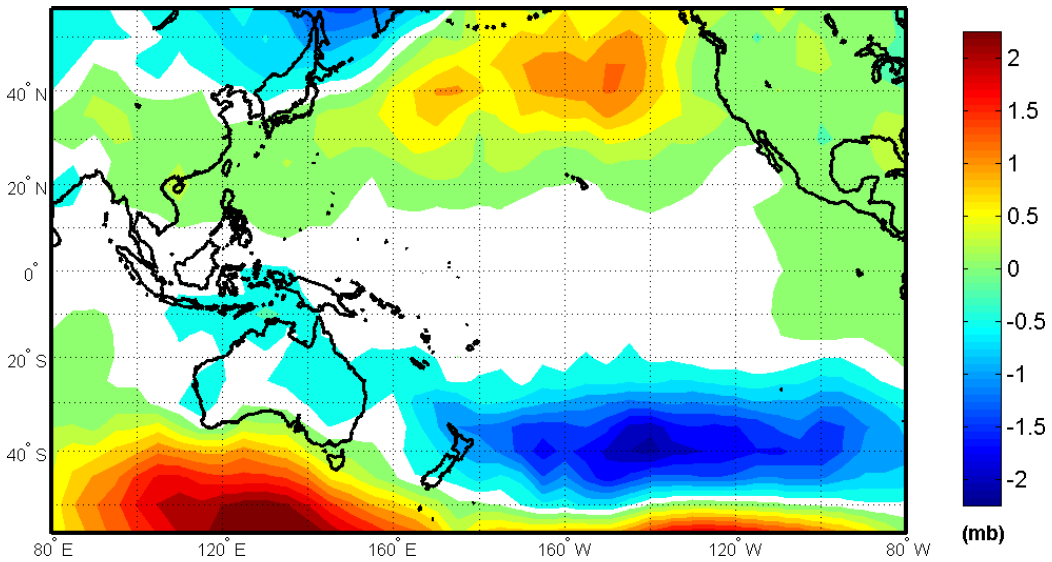


NCEP/NCAR Reanalysis Surface Wind

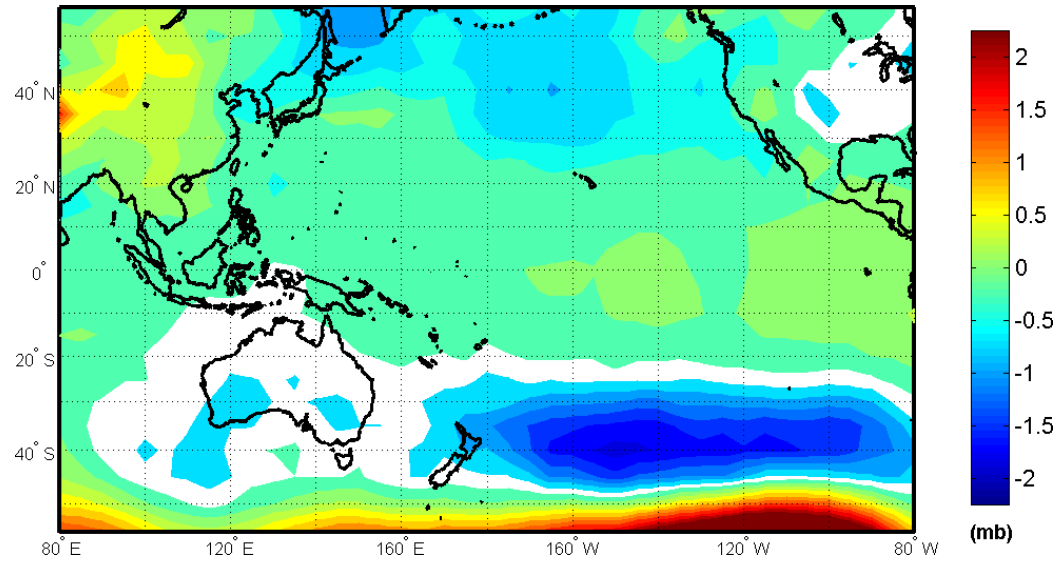
E. Pacific SST anomaly in DJF > 0.5℃

(1951, 1957, 1963, 1965, 1969, 1972, 1976, 1976, 1982, 1991, 1994, 1997, 2002, 2006)

Failed Precursors: MJJ SLP Anomalies (Hadley-2)



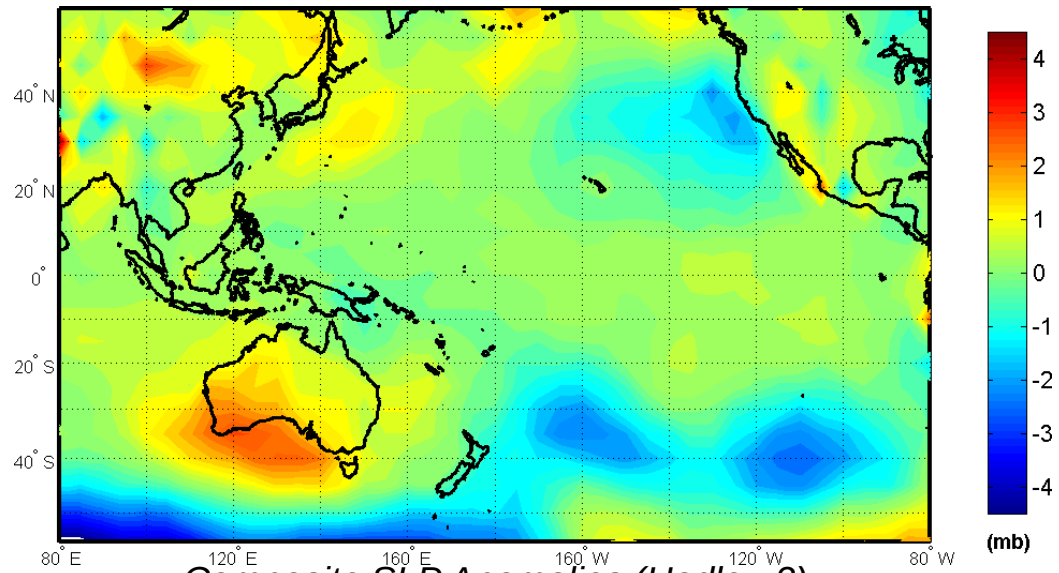
Modern record:
1959,1961,1978,1980



Historical record:
1898,1900,1907,1915,
1928,1932,1935,1943

Using the QuikSCAT CDR to Validate SLP Anomalies in the SO

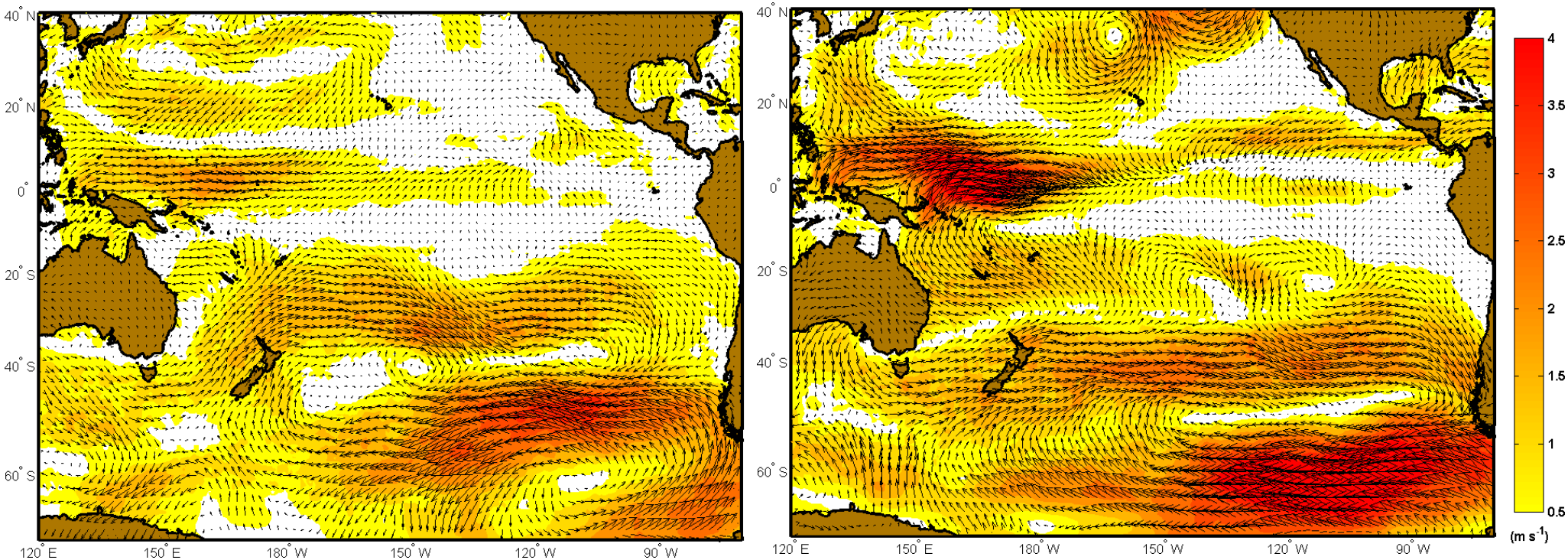
MJJ



Composite SLP Anomalies (Hadley-2)

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

ASO



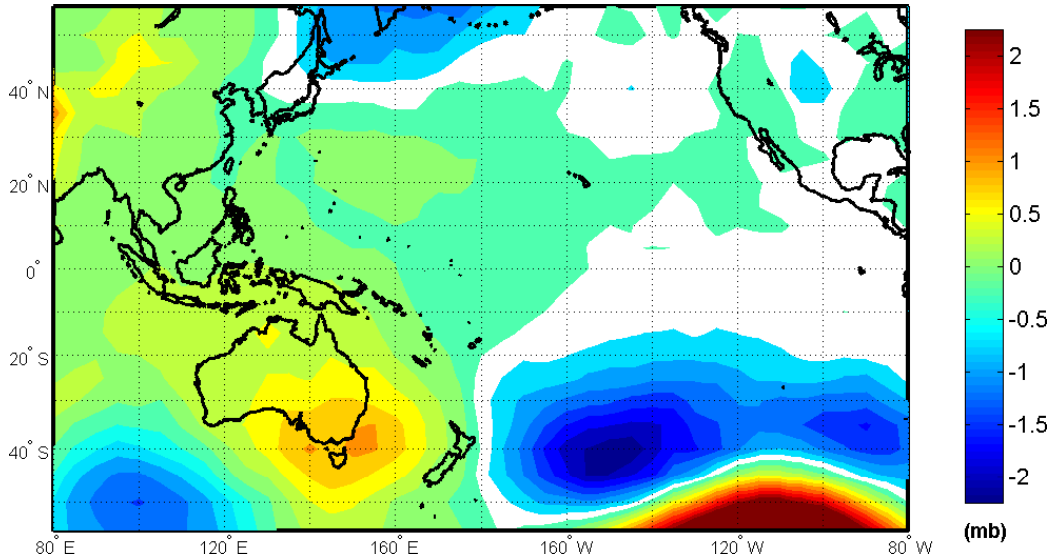
Composite SVW Anomalies (QuikSCAT CDR)

Weak vs. Strong Warm Events based on MJJ Anomalies ("historical record")

Strong: SST anomaly in DJF of Yr(0) > 1℃ Weak: 0.5℃ < SST anomaly in DJF < 1℃

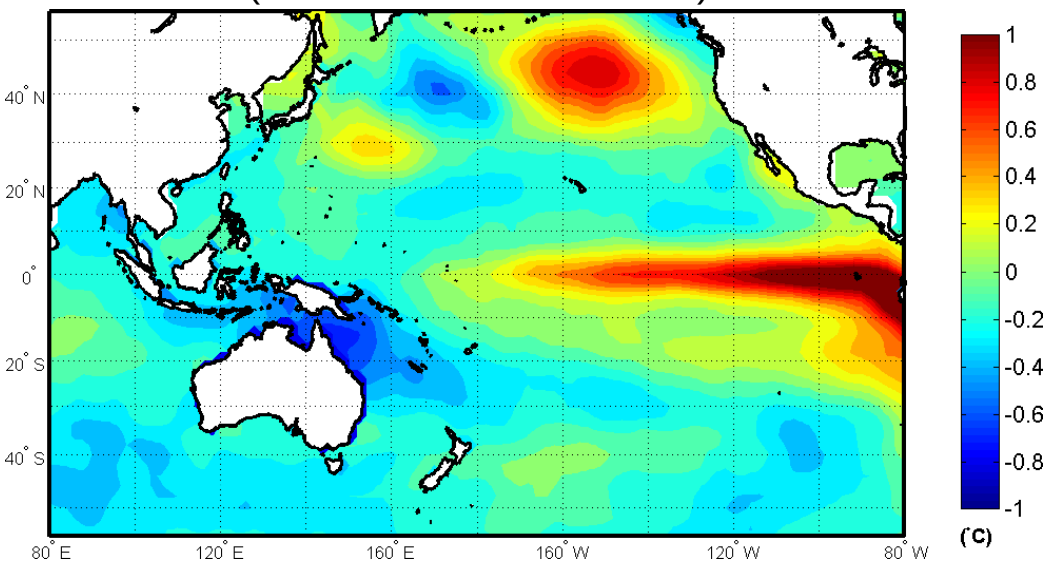
MJJ SLP Anomalies

(Hadley-2 SLP)

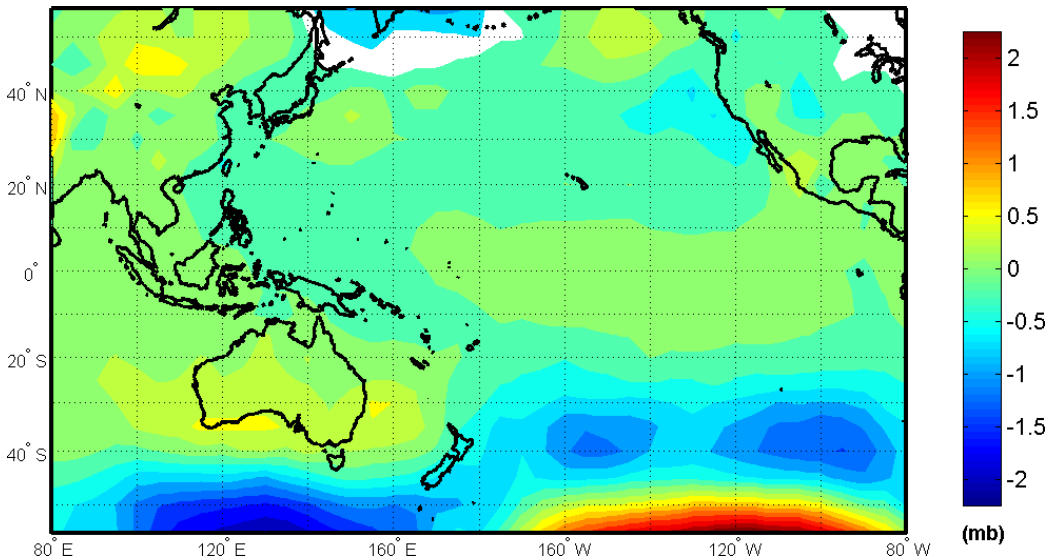


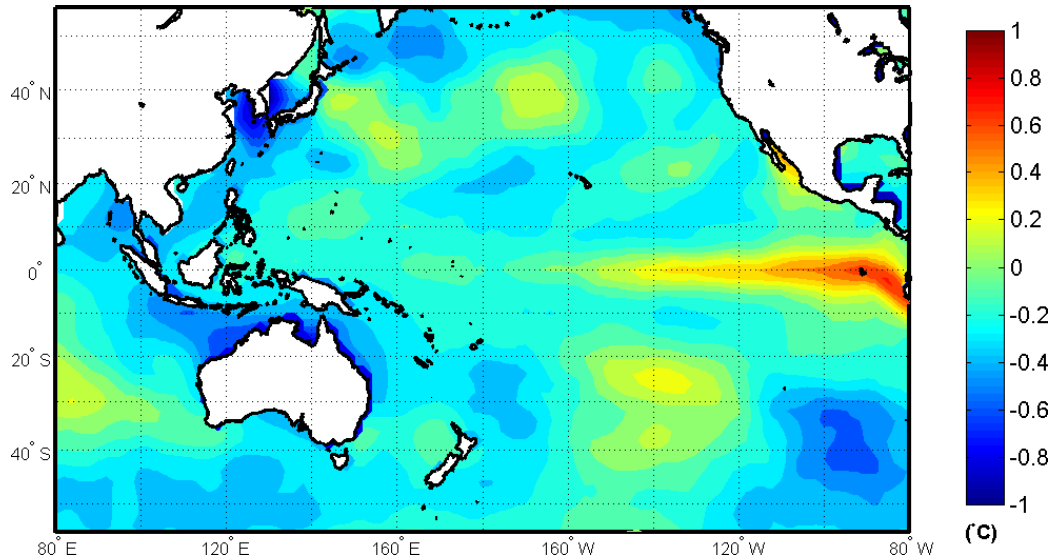
MJJ SST Anomalies

(NOAA Reconstructed SST)



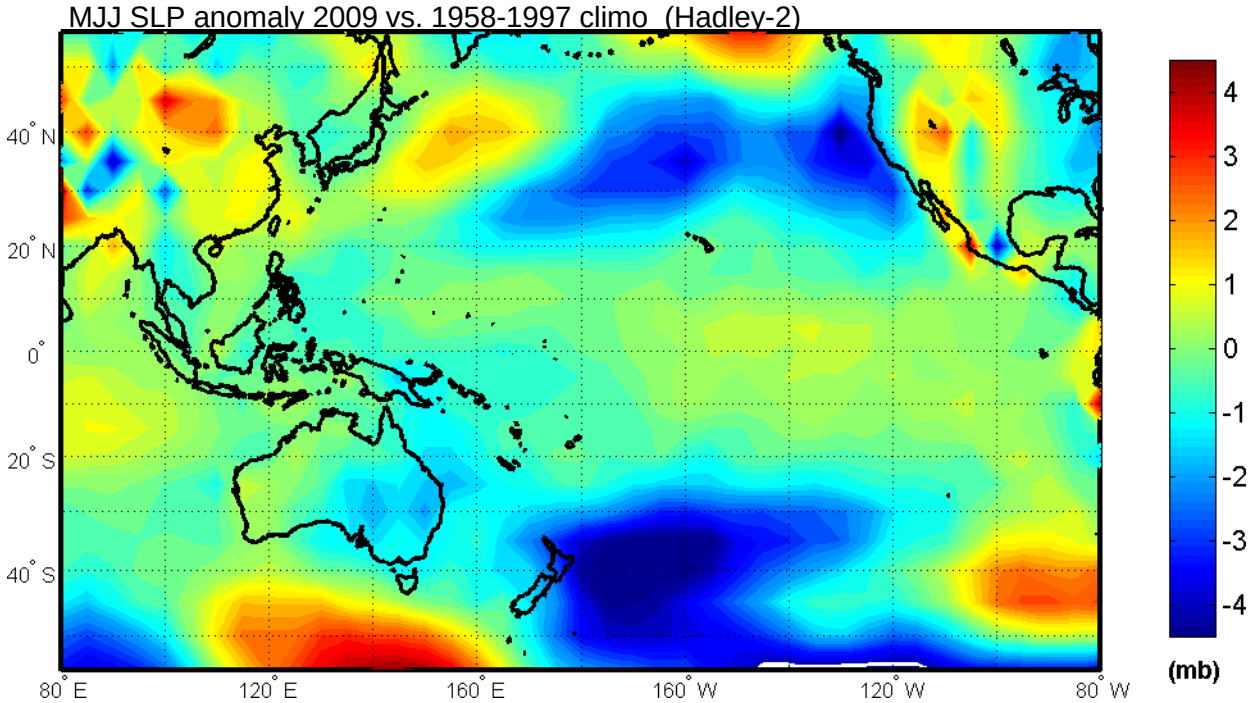
11 strong Warm Events (1877,1888,1896,1899,1930,1957,1965,1972,1982,1991,1997)

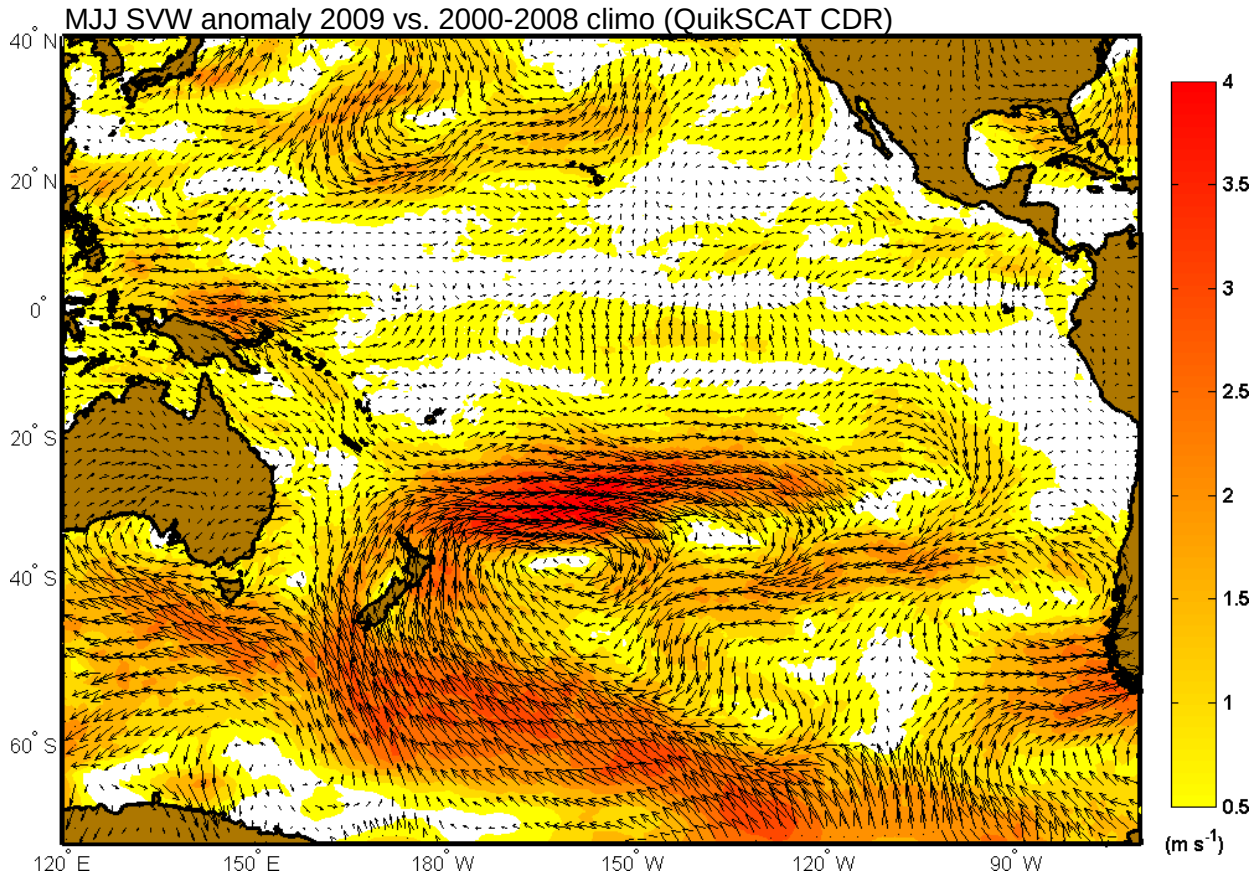




16 weak WE (1884,1902,1904,1911,1913,1918,1925,1939,1951,1963,1969,1976,1986,1994,2002,2006)

Anomalies with respect to climatologies for the period 1958-1997





What about 2009?

- *MJJ SLP anomalies <u>do not</u> 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

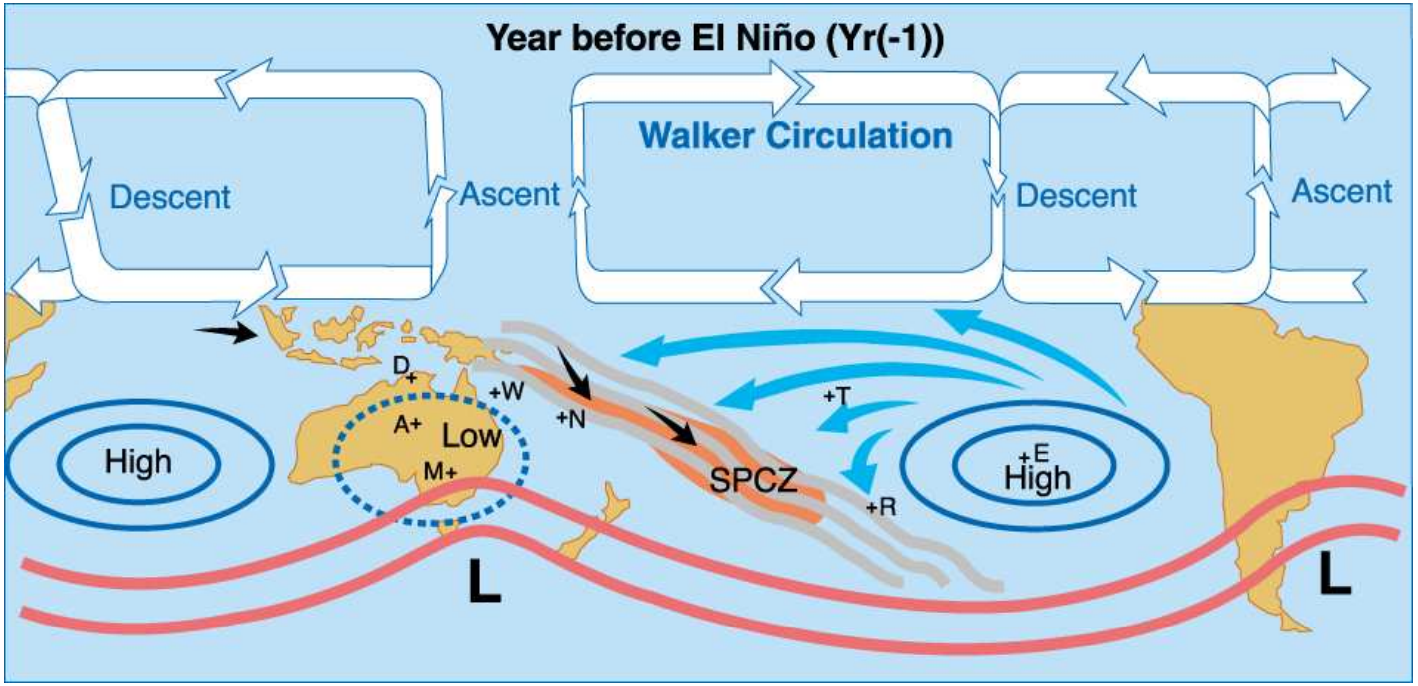
- *<u>Danger!</u> interpreting single-year anomalies (i.e. vs. composites)*

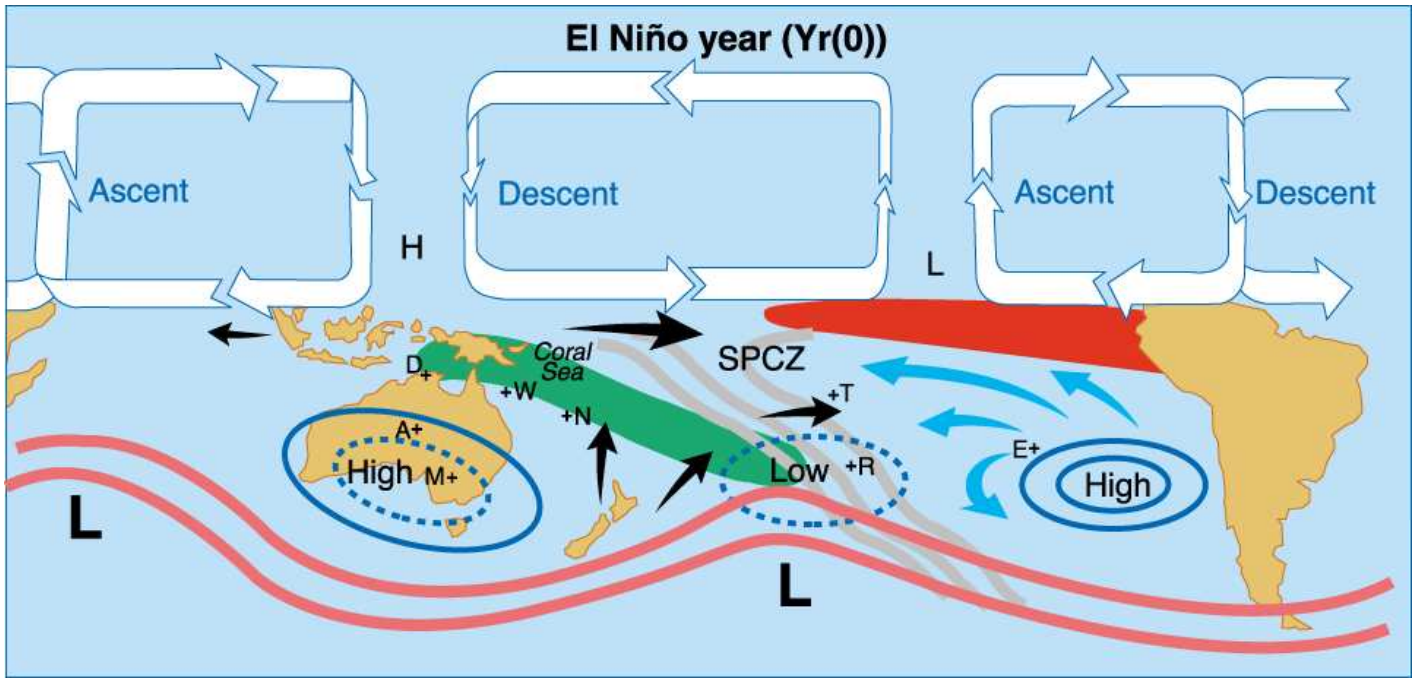
"one should be very careful about predicting anything ... especially the future" *HvL personal communications too numerous to recount.*

Aspects of the SO to be Validated by Higher Temporal and Spatial Resolution Data from Multiple Sensors

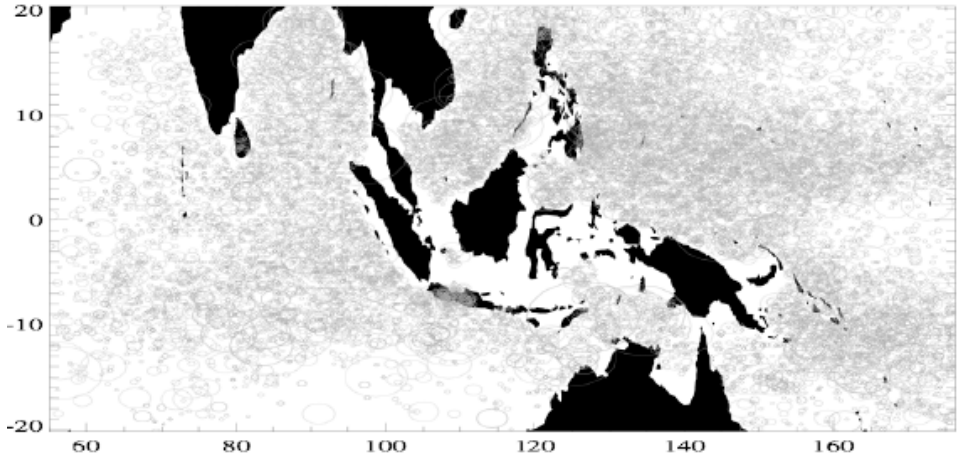
- *Mesoscale convergence and divergence*
- *SST and SST gradient extrema*
- *Moisture convergence*
- *2-layer temperature and/or moisture*

MCS!

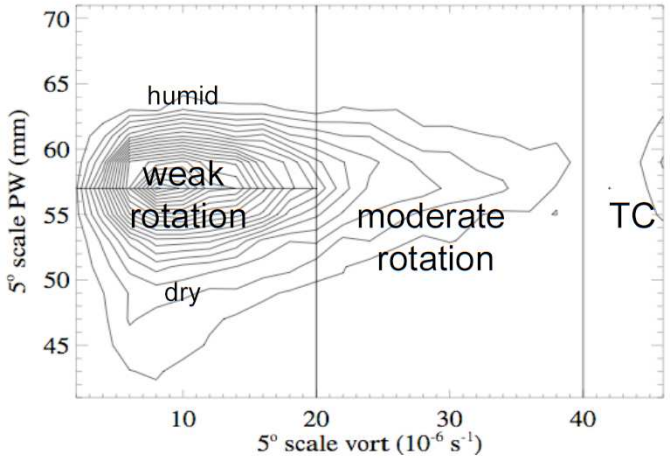




Mesoscale Convective System Composites: Multi-Sensor



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

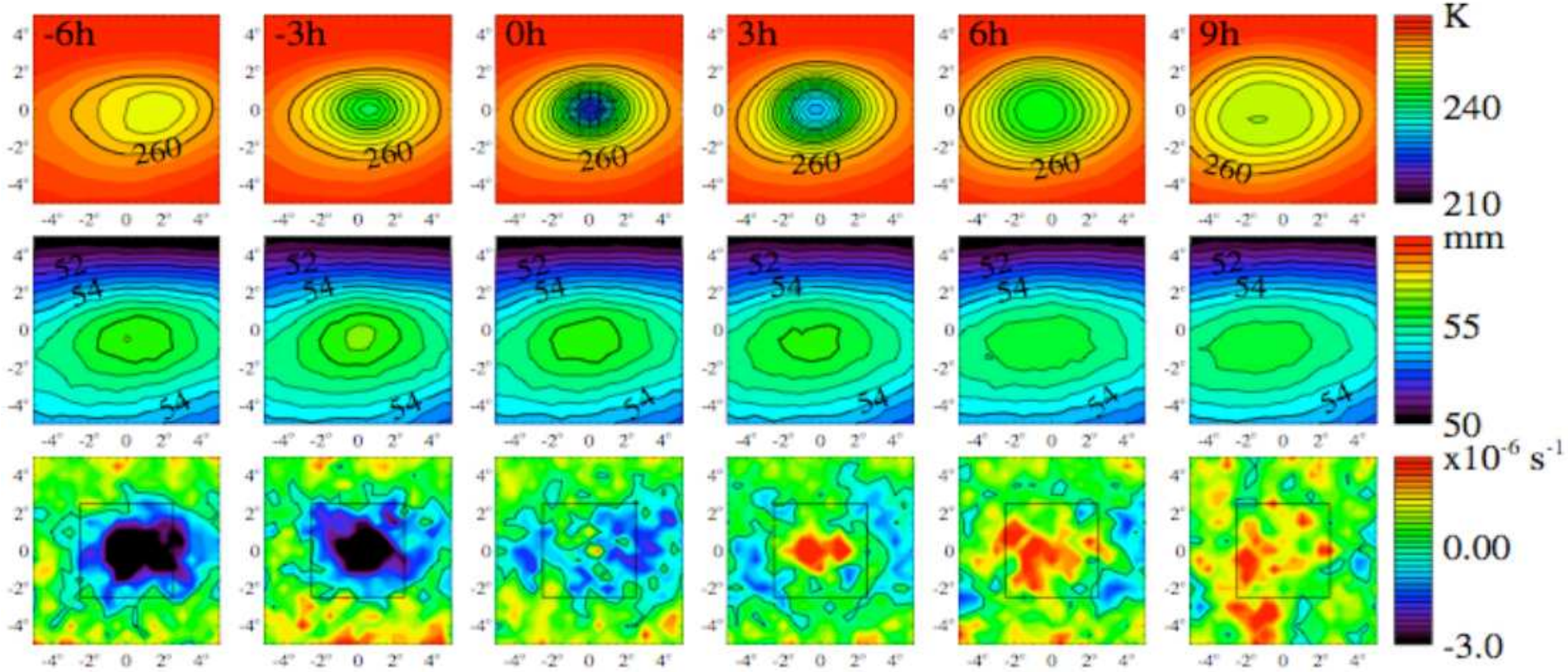


Number density of identified cloud systems in Vorticity-precipitable water space

IR
CLAUS

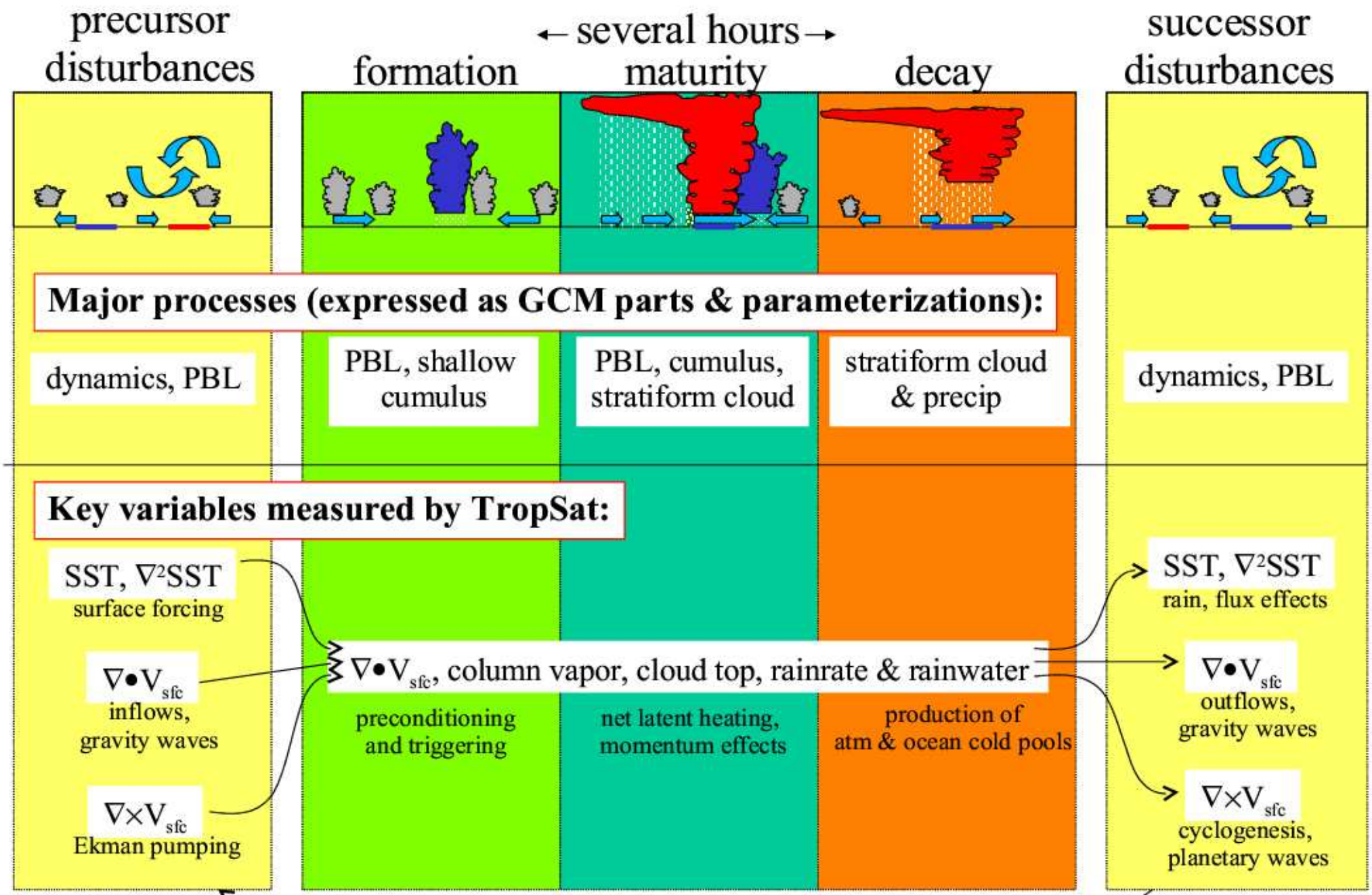
PW
RSS
Composite
(alpha)

Conv
QuikSCAT
BHM



Mapes B.E., R.F. Milliff and J. Morzel, 2009: “Composite life cycle of maritime tropical MCS in scatterometer and MW satellite obs”, *J. Atmos. Sci.*, **66**, 199-208

The Mesoscale Convective System (MCS) life cycle



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)

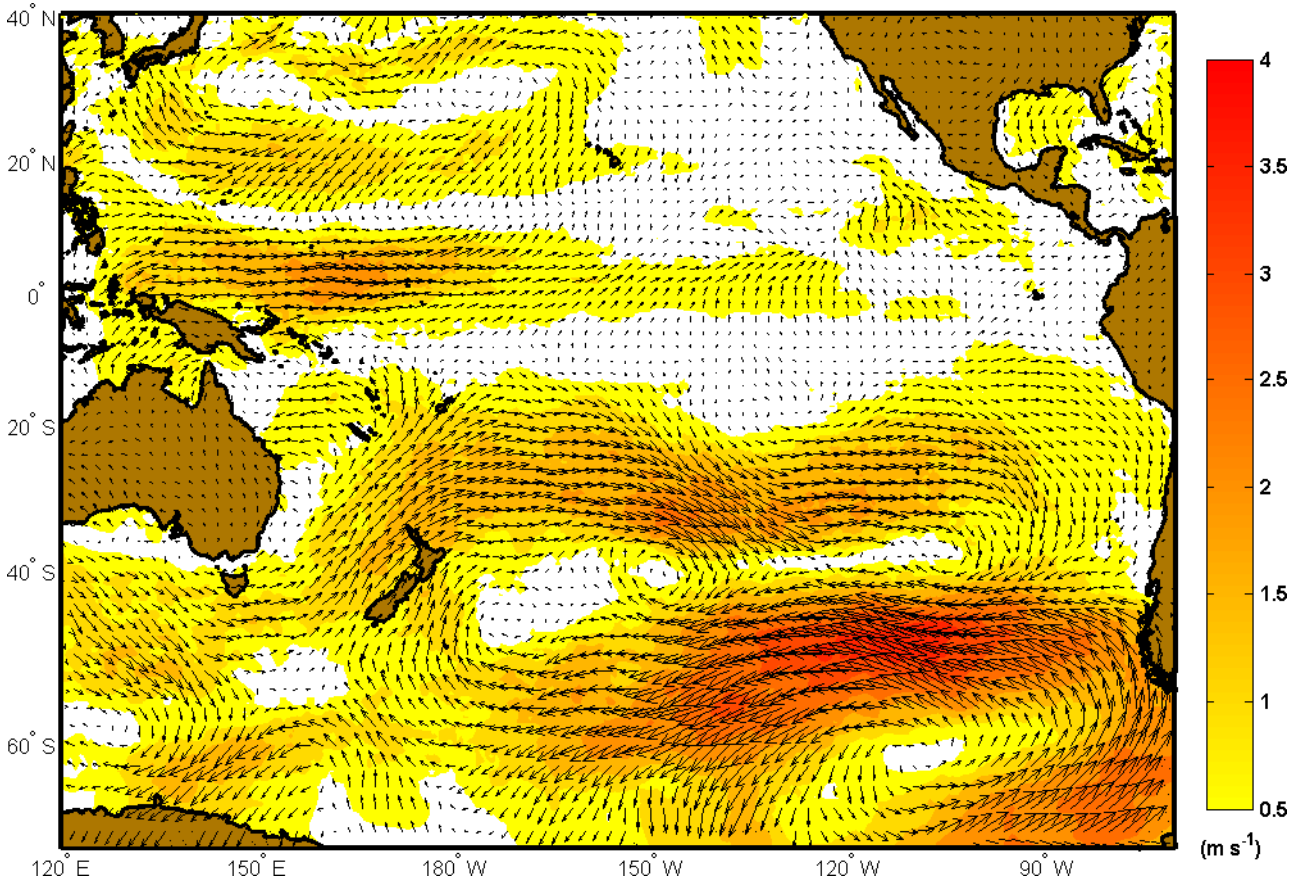
- *Implications for Warm Event (or not!) in 2009*
  MJJ SLP suggests not; MJJ SVW from QuikSCAT ambiguous

- *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

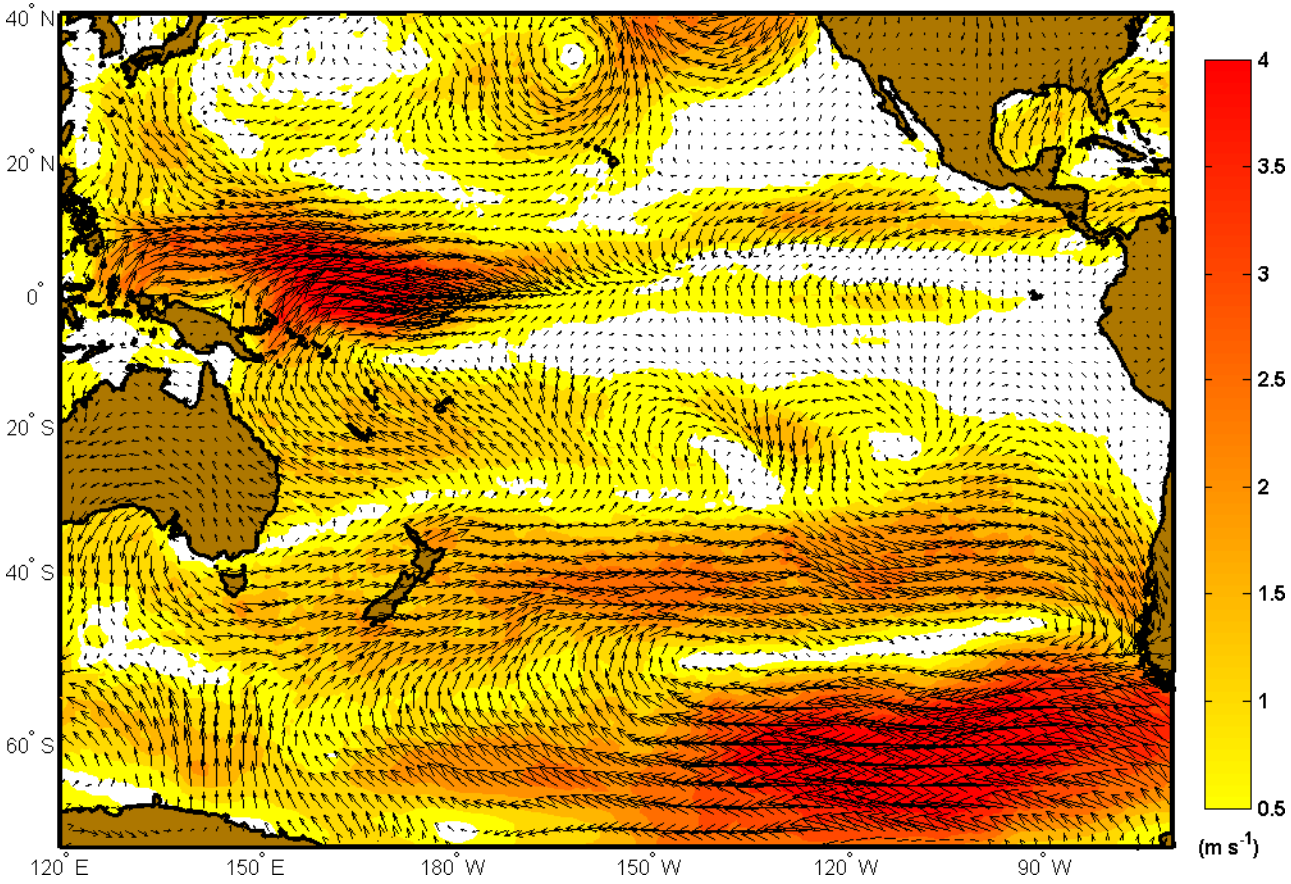
2002, 2006 average *vs.* 2000-2009 climatology



• QuikSCAT CDR confirms (quantifies) SVW implied by SLP

ASO Anomaly SVW from the QuikSCAT CDR

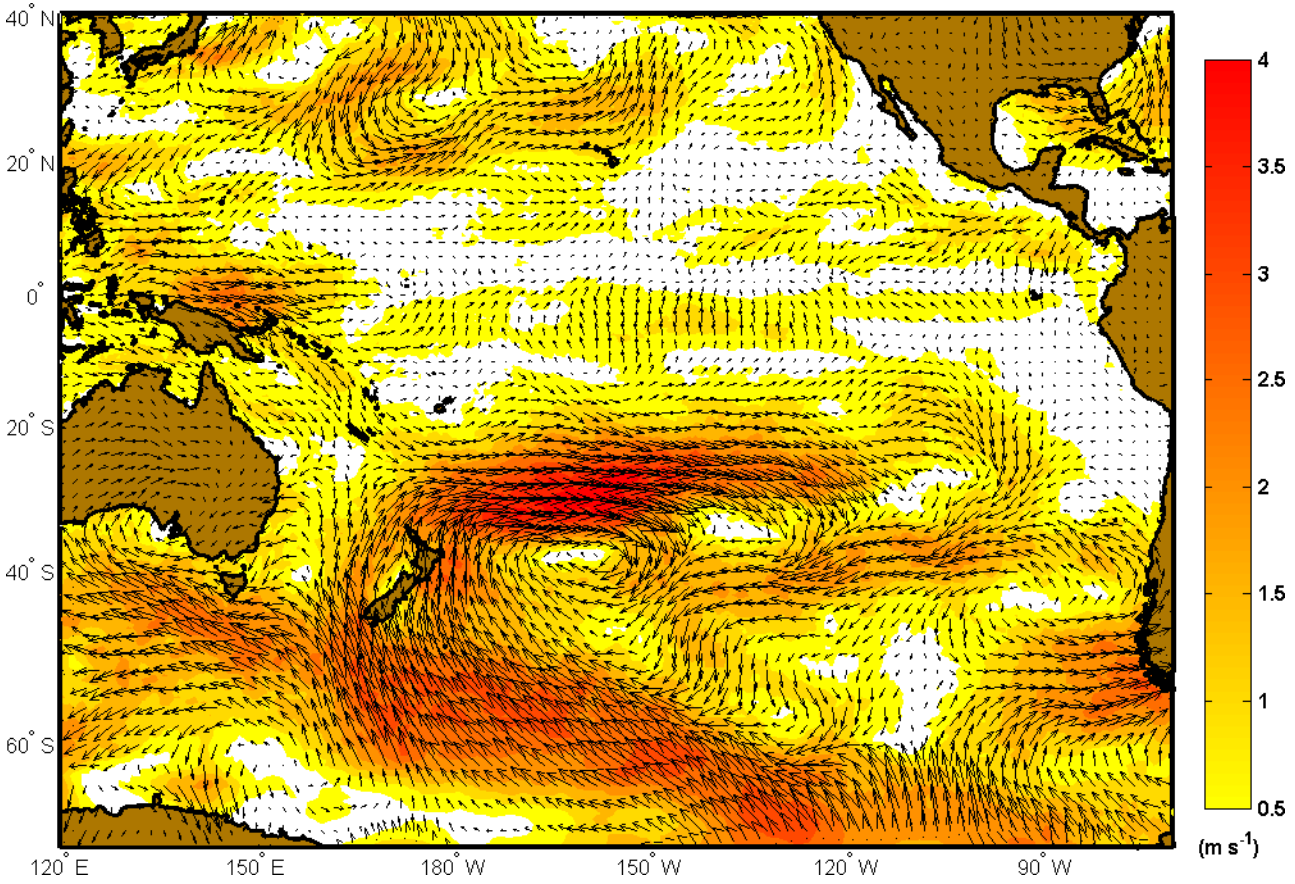
2002, 2006 average *vs.* 2000-2009 climatology



- Westerly wind anomaly in W. Pacific signals WE onset

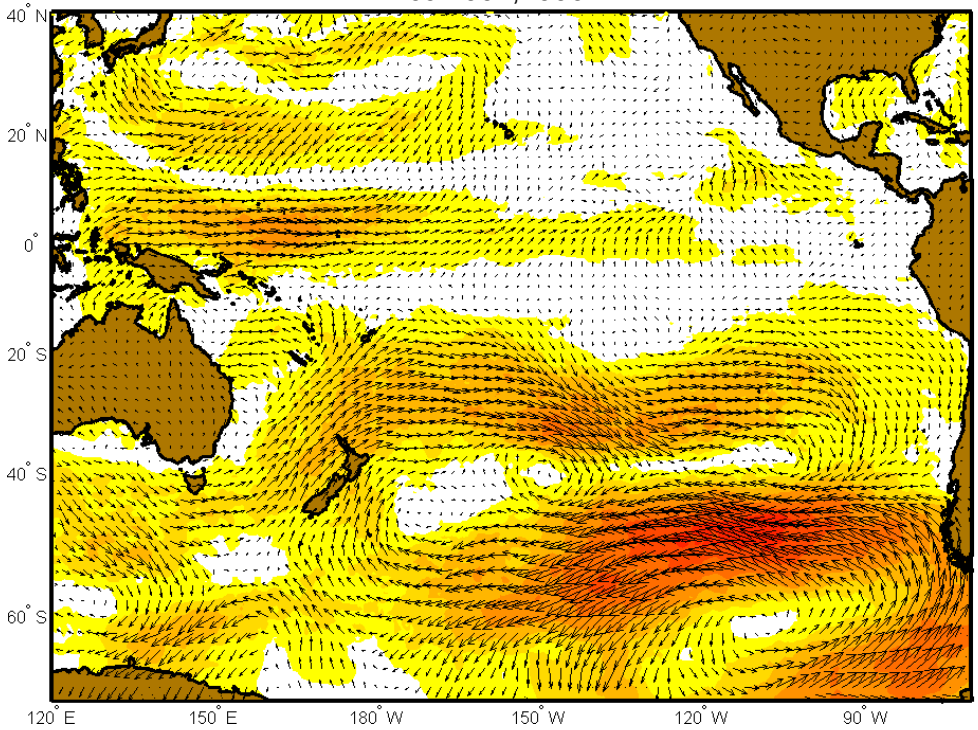
2009 MJJ Anomaly SVW from the QuikSCAT CDR

2009 average *vs.* 2000-2009 climatology

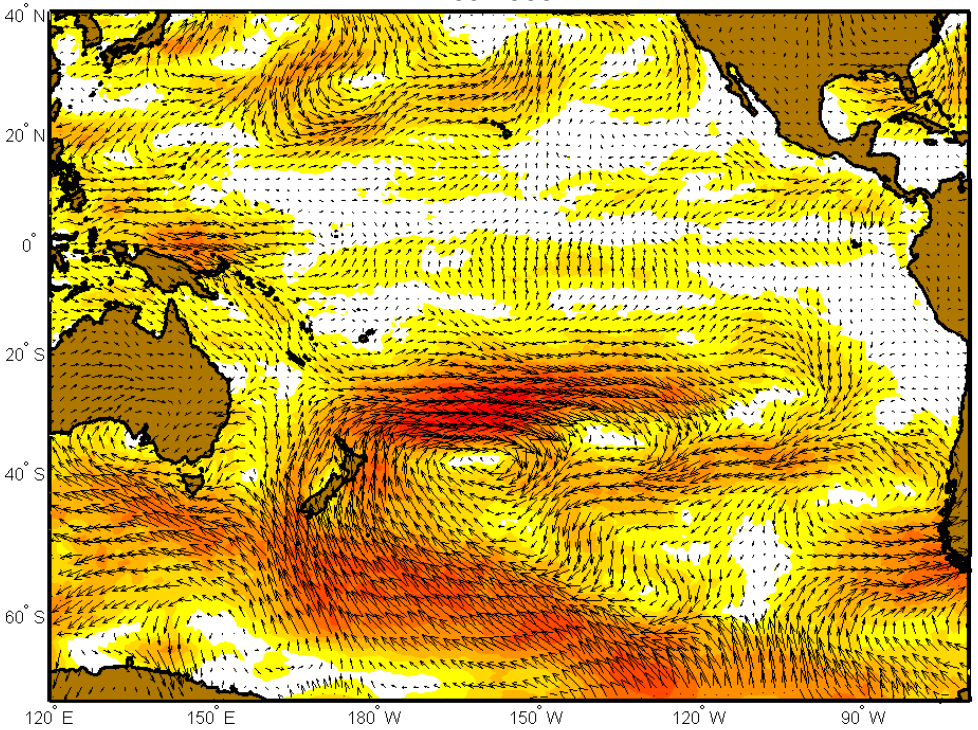


- Supportive of weak Warm Event this year?
- Danger of single year anomaly maps comparison (“beauty contest”)

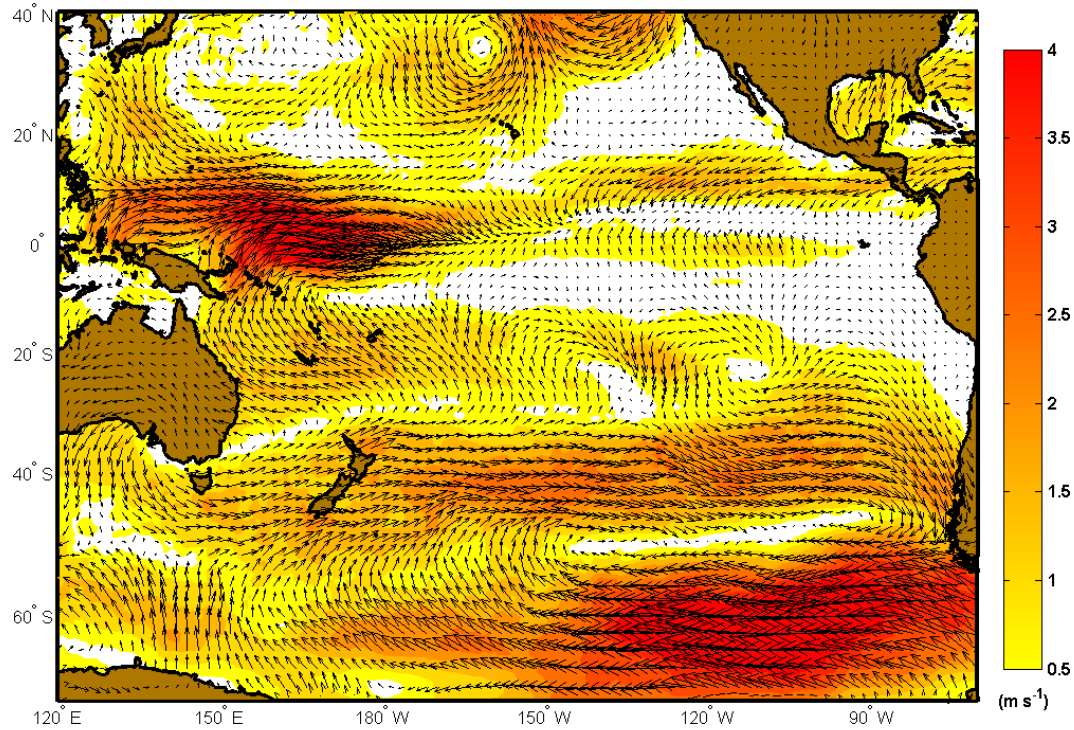
MJJ 2002,2006



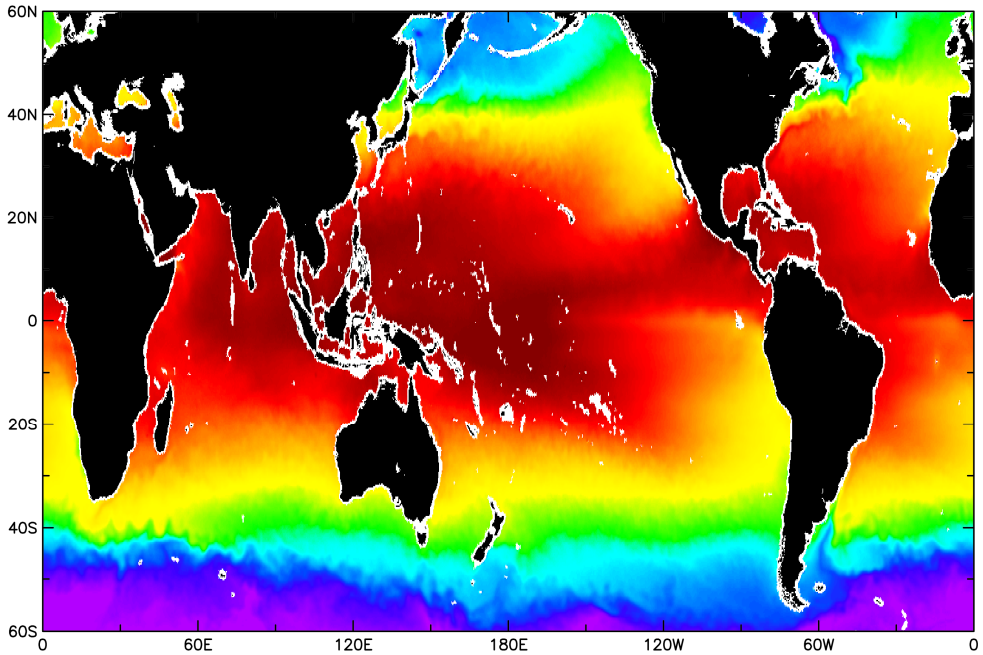
MJJ 2009



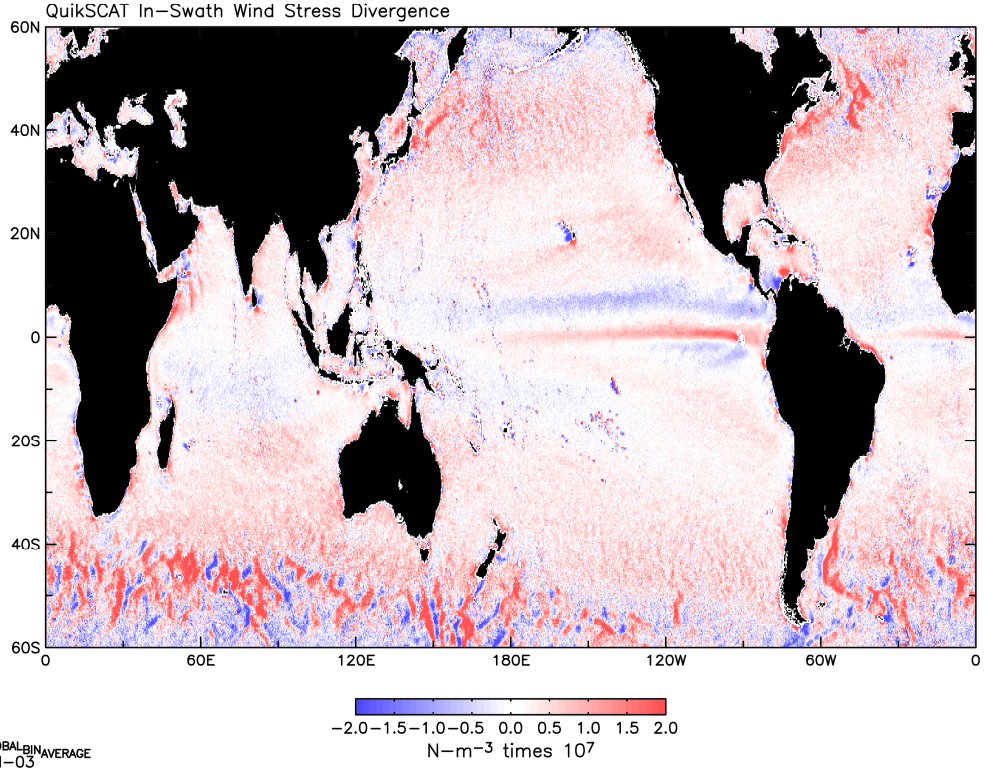
ASO 2002,2006



June 2002–December 2002 AMSR



QuikSCAT In–Swath Wind Stress Divergence



PLOT GLOBAL BIN AVERAGE
22–JAN–03

Images courtesy of D. Chelton, M. Schlax