Characterization of the variability of the South Pacific Convergence Zone (SPCZ) using satellite and reanalysis wind products

Autumn Kidwell¹, Tong Lee²*, Young-Heon Jo³, Xiao-Hai Yan¹
University of Delaware, USA
Jet Propulsion Laboratory/California Institute of Technology, USA
Pusan University, Korea

Material partially based on:
Background for SPCZ

- The largest rain band worldwide during austral summer.
- Important to atmos, ocean & their coupling., incl. cyclone genesis.
- Previous studies mostly based on OLR/precip, yet wind convergence is the dynamical cause.
- Extensive studies of SPCZ movements, but not strength.
- Lack of systematic investigation across different time scales is lacking.
- Consistency among different wind products – implications to TPOS2020.
Wind products used for analysis

- QuikSCAT (1999-2009)
- ASCAT (2007 onward)
- ERA-Interim (1980s onward)

This presentation focuses on QSCAT & ERA.
Focus more on convergence strength (lack of investigations).
Will discuss QSCAT-ASCAT consistency if time permits.
Diagnostic quantities

Divergence/convergence: \[ D = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \] (convergence when \( D < 0 \))

Convergence area: \[ A = \sum a(x, y) \] for grids with \( D < 0 \) within 130E-110W, 0-30S

Convergence strength: \[ S = \frac{\sum D(x,y) \times a(x,y)}{\sum a(x,y)} \] for the grids with \( D < 0 \) (same region)

Convergence centroid longitude & latitude:

\[ \bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \quad \bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i \] for the grids with \( D < 0 \) (same region)
QSCAT vs. ERA-Interim comparison of divergence (D) field (QSCAT period): good consistency for time mean & seasonal anomalies

Annual mean D

D<0 means convergence

January anomaly composite

July anomaly composite
Excellent agreement between QuikSCAT & ERA-Interim for various SPCZ diagnostic quantities (use ERA to examine longer period)

**Interannual swing > seasonal cycle**

**Dominant seasonal cycle**

**Strong intraseasonal fluctuations – MJO related**
Non-seasonal fluctuations of SPCZ strength: strong convergence anomalies associated with extreme El Nino

No obvious decadal change

Extreme El Nino events
SPCZ strength depends more on strength of El Nino (extreme vs. moderate/weak) rather than on central- vs. eastern-Pacific El Nino.

Blue circles: CP-El Nino

Yellow diamonds: EP-El Nino

DJF SPCZ strength as a function of year

DJF SPCZ strength vs Nino3 SST
Convergence structure during extreme & moderate/weak El Nino

82 & 97 events: “Zonal” SPCZ, basin-wide convergence/convection

Moderate/weak events: convergence confined to CP
PDO effects on SPCZ area & center (caution needed)

PDO index went from + to -
Decrease in mean SPCZ area

Westward shift of SPCZ center, smaller interannual fluctuations

Southward shift of SPCZ center
Summary

• Systematic study of SPCZ features (area, strength, centroid long & lat) for various time scales.
• QSCAT – ERA good consistency.
• Strong seasonal cycle, most dominant for SPCZ area.
• SPCZ strength: large interannual & intraseasonal variations associated with extreme El Nino, comparable to seasonal.
• SPCZ strength depends more on El Nino intensity than type.
• PDO change from + to –since 1999 caused:
  • decrease in SPCZ area;
  • southward/westward shift of SPCZ centroid with less interannual swings;
  • little effect on SPCZ strength.
• The diagnostics are useful for evaluating climate models.
QSCAT vs. ASCAT comparison

Time-mean divergence (D) (May 2007-Oct 2009) (D<0 is convergence)

Non-seasonal anomalies of convergence strength