OBSERVED WIND ANOMALIES IN THE SOUTHERN PACIFIC AND THEIR IMPACT ON TROPICAL SSTs DURING LA NINA

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• Studies on ENSO dynamics in the tropics and the NH greatly outnumber those in the SH
• Before the advent of satellites, observations in the SH were limited to few cruise ships and some buoys.

• The availability of 20 years of satellite data provides the opportunity to study the interplay of wind and temperature anomalies in the Southern Hemisphere.
Satellite data: SSM/I
- Special Sensor Microwave Imager, processed at Remote Sensing Systems
- Global ocean, regridded 2 deg resolution; rain and ice mask applied
- Additional SSM/I data: monthly precipitation (PREC), water vapor (WV), cloud liquid water (CLW).

Reanalysis data
- NCEP/NCAR, NCEP/DOE, ERA40
- 1988-2007, monthly average surface wind speeds derived from daily or sub-daily wind components.
- Regridded 2 deg resolution, ocean only (for comparison)
- Additional reanalysis data: Sea Level Pressure (SLP), 500hPa Geopotential height (Z500), 300 mb winds (U300).
SSM/I WIND SPEED ANOMALY, August 2007

• Monthly climatology derived from 1988-2007 data
• Monthly wind anomalies determined as monthly average minus monthly climatology.

Note: Overimposed are the average wind vectors from Quickscat for the same month.
Eastern Pacific wind anomaly (1988-2007), zonal average

La Nina years

SSM/I

NCEP/DOE

60N

EQ

60S
EOF ANALYSIS

• We extracted the main modes of wind variability using EOF decomposition of the monthly anomaly timeseries.

• EOF analysis applied to satellite and reanalysis ocean-only wind data, for global Southern Hemisphere.

• Additional EOF decomposition of additional SSM/I (PREC, CLW, WV) and reanalysis fields (SLP, Z500, U300).
SSM/I Wind EOF-1

SSMI WIND EOF1, variance (%) = 8.4

SSMI WIND PC1 TIMESERIES

LA NINA
SSM/I Wind EOF-1

Note: in the reanalyses, the EOF-1 represents the Southern Annular Mode, absent in SSM/I because no reliable data at the ice edge.
Sea Level Pressure EOFs

- **EOF-1**: SOUTHERN ANNULAR MODE
- **EOF-2**: PACIFIC SOUTH AMERICAN PATTERN (PSA-1)
- **EOF-3**: PACIFIC SOUTH AMERICAN PATTERN (PSA-2)
CORRELATION OF WIND AND TROPICAL SST ANOMALIES

Wind-SST Lag-Correlation: 0.74, 4 months lead time  
(0.47 for the unsmoothed timeseries)

The Cold Tongue Index is the SST anomaly in the boxed area.
Correlation **tropical** wind anomaly component: 0.64  (3-4 months lead)
Correlation **extratropical** wind anomaly component: 0.77  (5 months lead)
Correlation of SST Anomaly with other variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cross Correlation</th>
<th>Time lag compared to SST</th>
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</thead>
<tbody>
<tr>
<td>SSMI wind</td>
<td>0.73</td>
<td>Lead 4 months</td>
</tr>
<tr>
<td>NCEP/DOE wind</td>
<td>0.54</td>
<td>Lead 4 months</td>
</tr>
<tr>
<td>NCEP/NCAR wind (*)</td>
<td>0.64</td>
<td>Lead 3 months</td>
</tr>
<tr>
<td>ERA40 wind (*)</td>
<td>0.67</td>
<td>Lead 5 months</td>
</tr>
<tr>
<td>NCEP/DOE SLP</td>
<td>0.75</td>
<td>Lead 5 months</td>
</tr>
<tr>
<td>NCEP/DOE Z500</td>
<td>0.75</td>
<td>Lead 4-5 months</td>
</tr>
<tr>
<td>NCEP/DOE U300</td>
<td>0.85</td>
<td>Lead 2 months</td>
</tr>
<tr>
<td>SSMI (tropics) PREC</td>
<td>0.96</td>
<td>No lag</td>
</tr>
<tr>
<td>SSMI (tropics) WVAP</td>
<td>0.90</td>
<td>Lag 0-1 months</td>
</tr>
<tr>
<td>SSMI (tropics) CLW</td>
<td>0.89</td>
<td>Lag 0-1 months</td>
</tr>
</tbody>
</table>
SUMMARY

- Using satellite observation of surface winds we extracted the leading mode of wind variability in the S. Hemisphere (EQ-60S).
- Double dipole pattern in the Pacific, associated with the PSA.
- Good correlation to SST anomalies in the equatorial cold tongue.

CONCLUSIONS

- Intensified winds in SH lead cold equatorial SST anomalies by 4 months.
- Extratropical wind anomaly is as relevant as the tropical one. Together, they form a pattern that affects the cold phase of ENSO.
- Wind anomaly pattern in the SH can be easily identified using satellite observations.
- Potential for La Nina predictability.