Westerly Wind Bursts: ENSO's Tail Rather than Dog?

OR

How do Westerly Wind Bursts Affect ENSO Characteristics?

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Westerly Wind Bursts Are ...

**In space:**

5 or more days with wind speed > 4 m/s and peak > 7 m/s

Defined to be the strong WWEs, i.e., 'mega-WWEs' of HV97

Defined relative to seasonal variations

Approx. 3 WWBs/yr

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**In time:**

Verbickas 1998, Yu et al. 2003

Harrison and Vecchi, 1997

Eisenman, pers. comm.

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A Link Between WWBs and the Ocean State

Vecchi and Harrison 2000, Yu et al. 2003, Eisenman et al. 2005
Objective:

Are the characteristics of ENSO (i.e., amplitude, frequency, irregularity) sensitive to the link between WWBs and SST?

Test: Use a hybrid coupled GCM with an explicit coupled representation of WWBs to determine the sensitivity of ENSO characteristics.

The Model:

Ocean model: GFDL MOM4
- Global domain
- ½ resolution in tropics

Statistical atmosphere:
- Linear regression of ERA40 monthly-mean wind stress onto SST (1979-2001)

Griffies et al. 2004, Wittenberg and Vecchi 2005
Modeling WWBs

1. Increase coupling coefficient.
2. Deterministic: When warm pool extends past 180, WWB occurs.

- WWBs applied 5 W of warm pool edge.
- No WWBs in boreal summer.
The model without WWBs:”Stable

NINO 3.4 SST

Zonal Windstress Anomaly

- coupling determined by ECMWF ERA40 reanalysis
- Decays to seasonal cycle
The model stability con't. "1.5x coupling coeff."

Wind anomalies are 1.5x larger than ECMWF regression values.

Dots represent warm events.

**Characteristics:**
- \( \text{std}(\text{NINO3}) = 0.8 \) °C
- 2.5 year ENSO recurrence time
- Periodic
Deterministic WWBs

If warm pool extends past date line, WWB occurs.

• $\text{std}(\text{NINO3}) = 0.6 \degree C$
• 2 yr period
• 3.5 WWBs/yr

Inclusion of WWBs gives interannual variability.

Black dots indicate WWBs.
Deterministic WWBs con't.

2 WWB representations:

40 day WWB lifecycle
std(NINO3) = 0.6 °C
2 year period

25 day WWB lifecycle
std(NINO3) = 0.7 °C
4 year period

The magnitude and period are sensitive to WWB formulation.
Purely Stochastic WWBs

WWBs occur independently of ocean state.

- $\text{std(NINO3.4)}=0.3 \, ^\circ C$
- 2-3 year recurrence interval
- Irregular
- 3.5 WWBs/yr

Weak interannual variability.
Semi-stochastic WWBs

WWBs more likely with extended warm pool.

- $\text{std}(\text{NINO3.4}) = 0.45$ C
- 2-5 year recurrence intervals
- Irregular
- 2.9 WWBs/yr

'Bunching' of WWBs. Stronger interannual variability than purely stochastic case.
Conclusions

**ENSO Amplitude:**

- Deterministic WWBs give interannual variability near observed levels without any other forcing.
- WWBs based upon a purely-stochastic atmosphere give weak variability.
- 'Semi-stochastic' WWBs are conceptually appealing and also give more variability than purely-stochastic WWBs.

**Warm event recurrence times:** Sensitive to particular WWB formulation.

**ENSO irregularity:** In this model, irregularity comes from the stochastic atmospheric variability.