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

OR

How do Westerly Wind Bursts Affect ENSO Characteristics?

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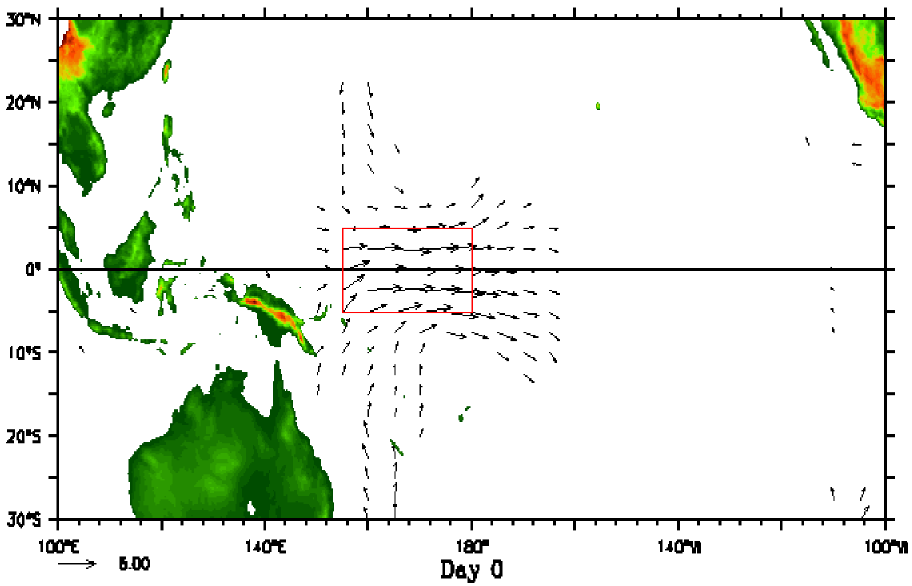
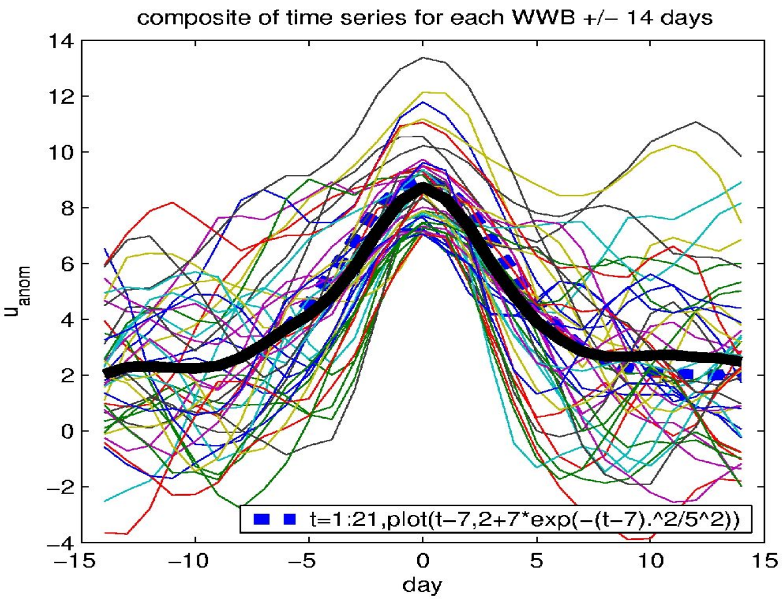
Westerly Wind Bursts Are ...

In space:



Harrison and Vecchi, 1997

In time:



Eisenman, pers. comm.

- 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

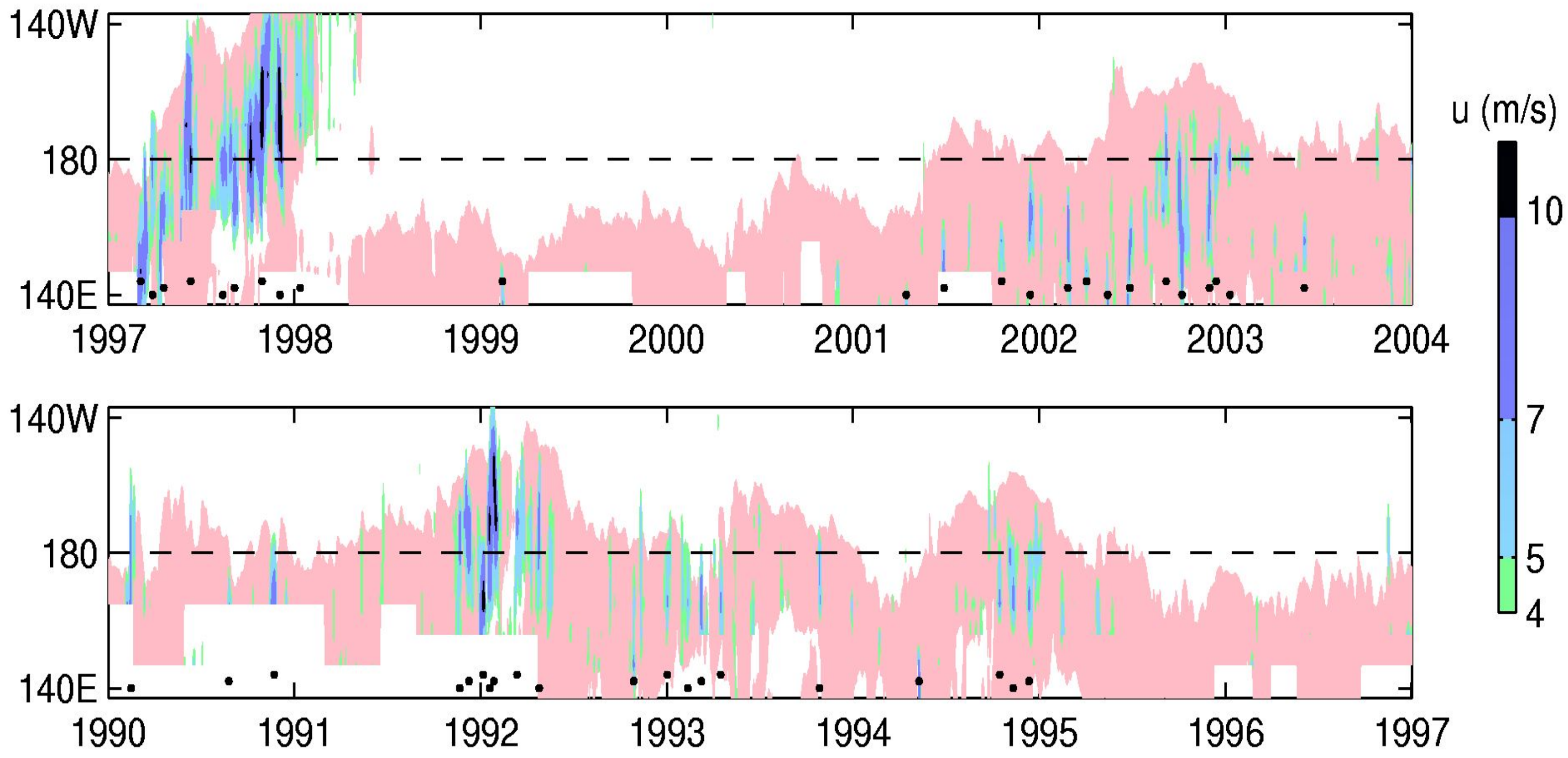
Verbickas 1998, Yu et al. 2003

A Link Between WWBs and the Ocean State

The TAO Array

Pink: >29 C

Wind speed is overlaid.



WWBs are 3x more common when warm pool extends past date line

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:

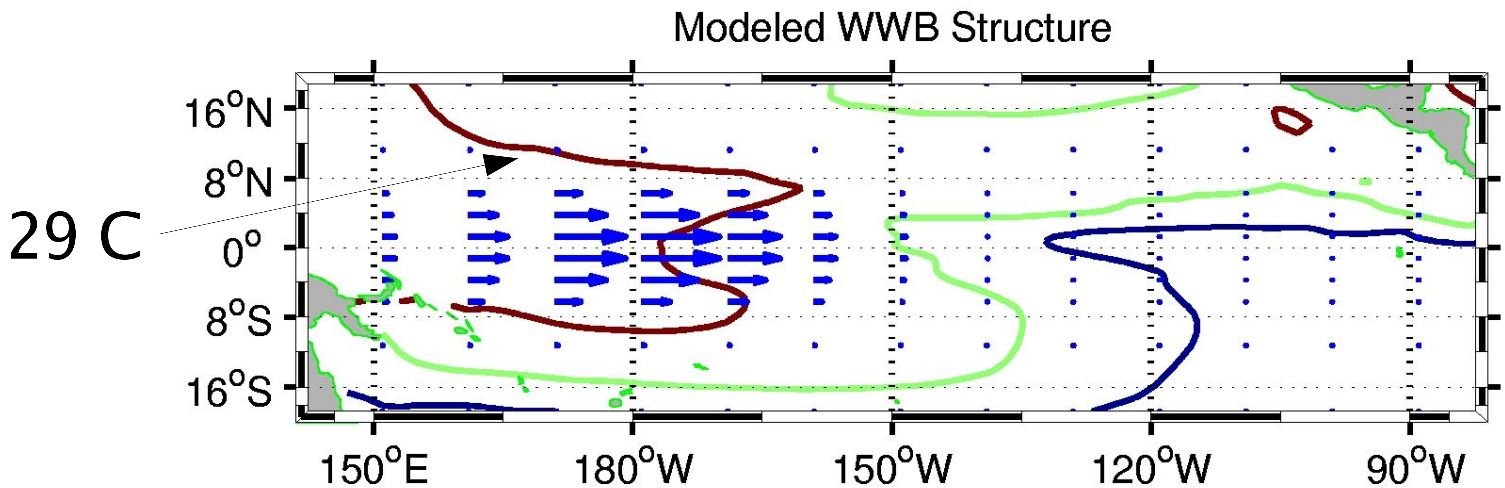
Ocean model: GFDL MOM4
- Global domain
- ½ resolution in tropics

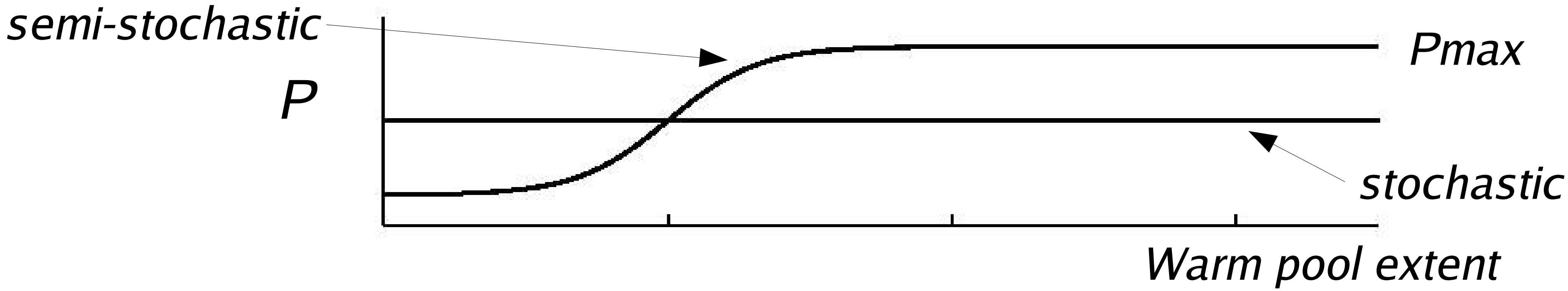
Statistical atmosphere:
- Linear regression of ERA40 monthly-mean wind stress onto SST (1979-2001)

Griffies et al. 2004, Wittenberg and Vecchi 2005

Modeling WWBs

1. Increase coupling coefficient.
2. Deterministic: When warm pool extends past 180 , WWB occurs.
3. Stochastic. No dependence on warm pool.
4. Semi-stochastic. Probability of WWB increases with warm pool extent.

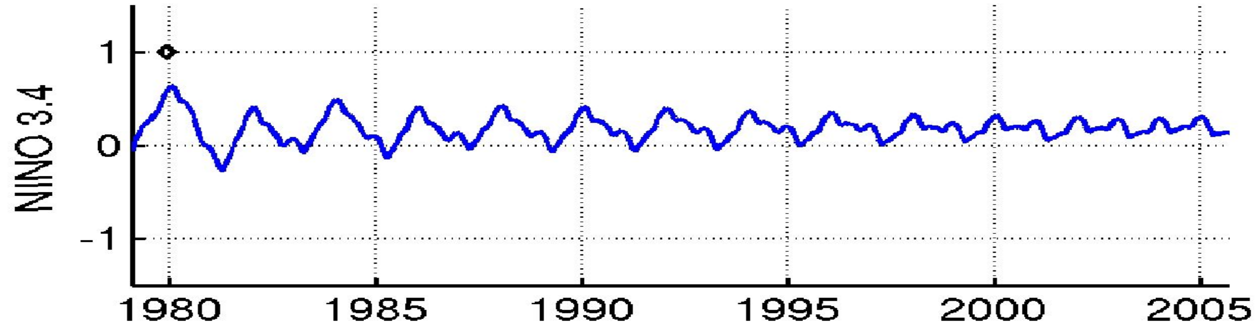




- WWBs applied 5 W of warm pool edge.
- No WWBs in boreal summer.

The model without WWBs:"Stable

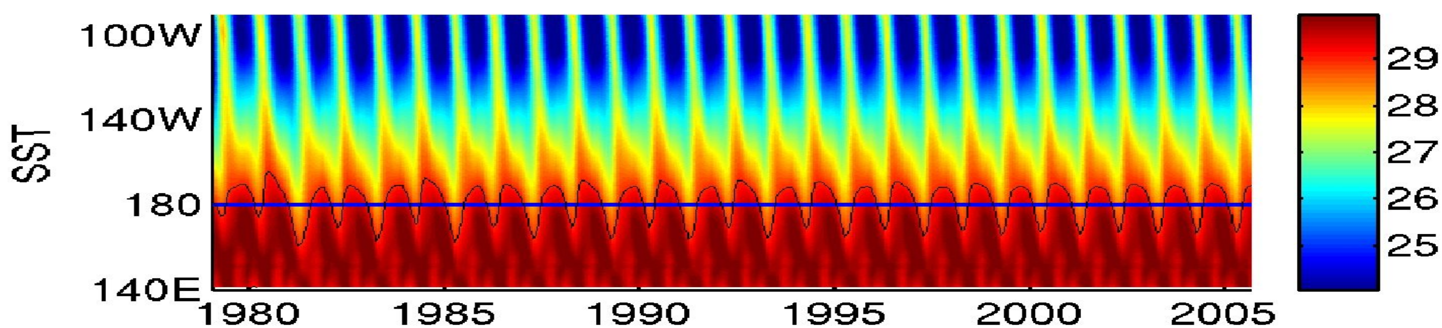
NINO 3.4



C

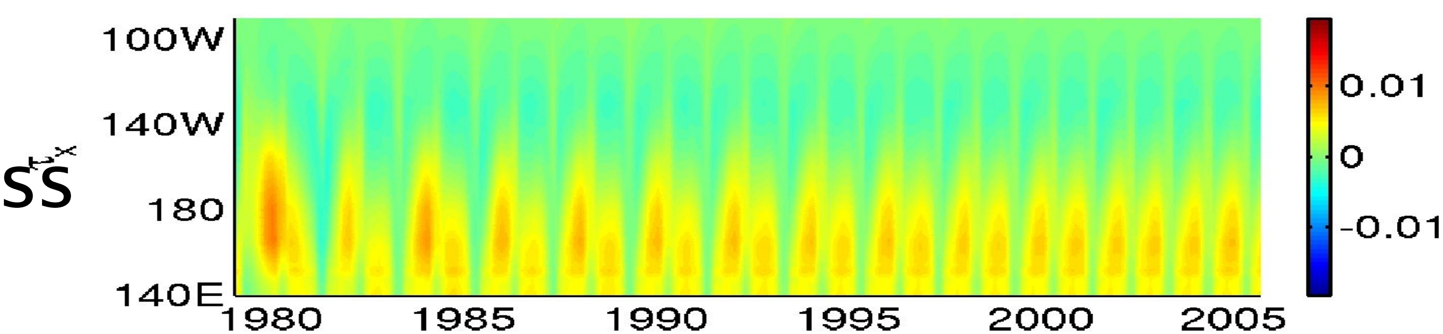
SST

Blue: dateline
Black: 29



C

Zonal Windstress Anomaly



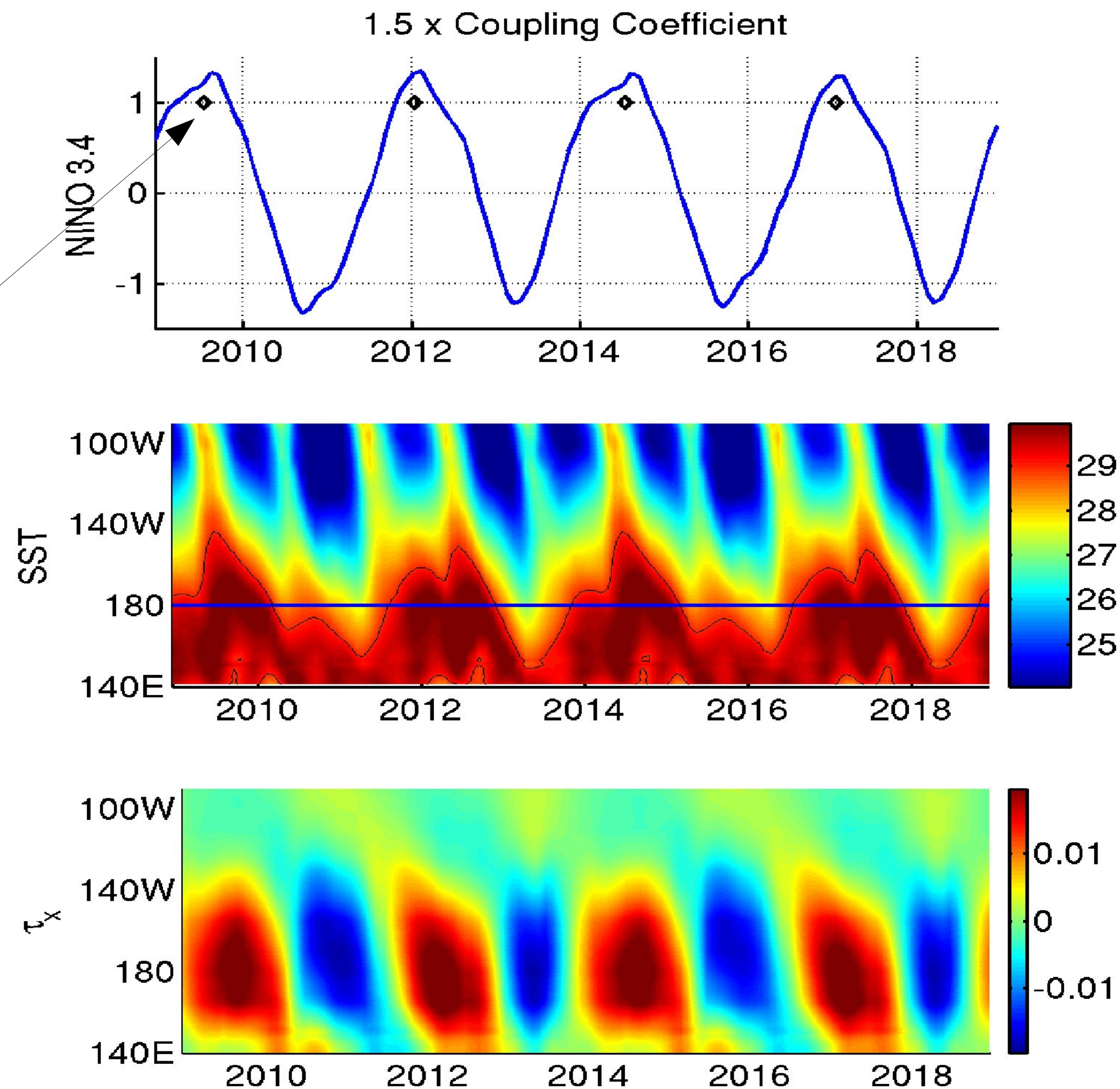
N/m

- 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.



<u>*Characteristics:*</u>

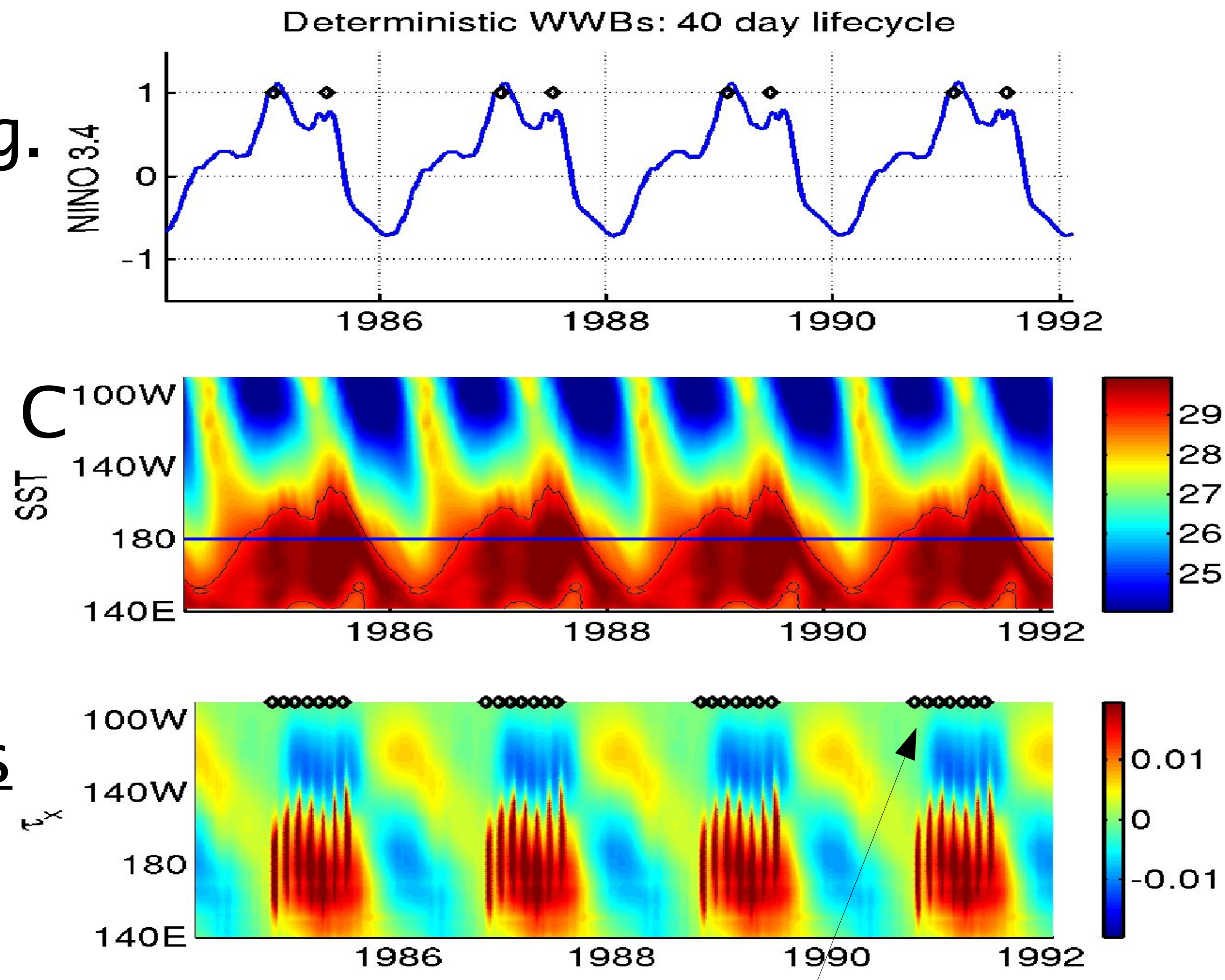
- std(NINO3) = 0.8 C
- 2.5 year ENSO recurrence time
- Periodic

Deterministic WWBs

If warm pool extends past date line, WWB occurs.

No external forcing.

- std(NINO3) = 0.6 C
- 2 yr period
- 3.5 WWBs/yr



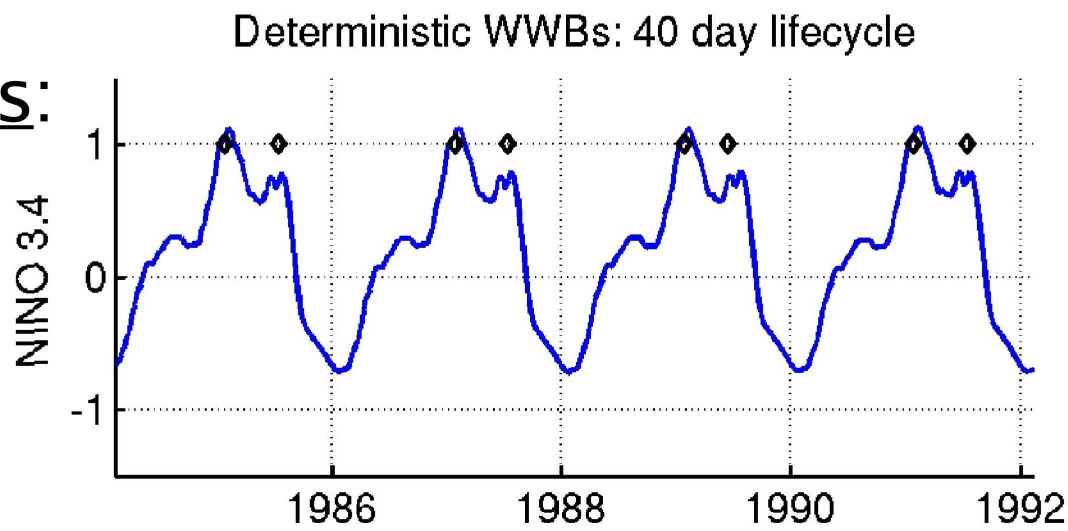
<u>Inclusion of WWBs gives interannual variability.</u>

Black dots indicate WWBs.

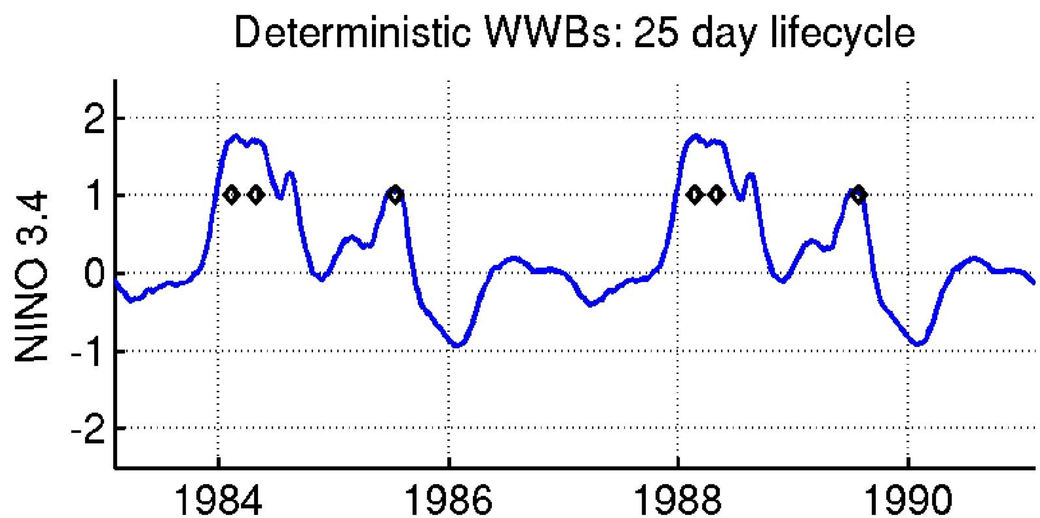
Deterministic WWBs con't.

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



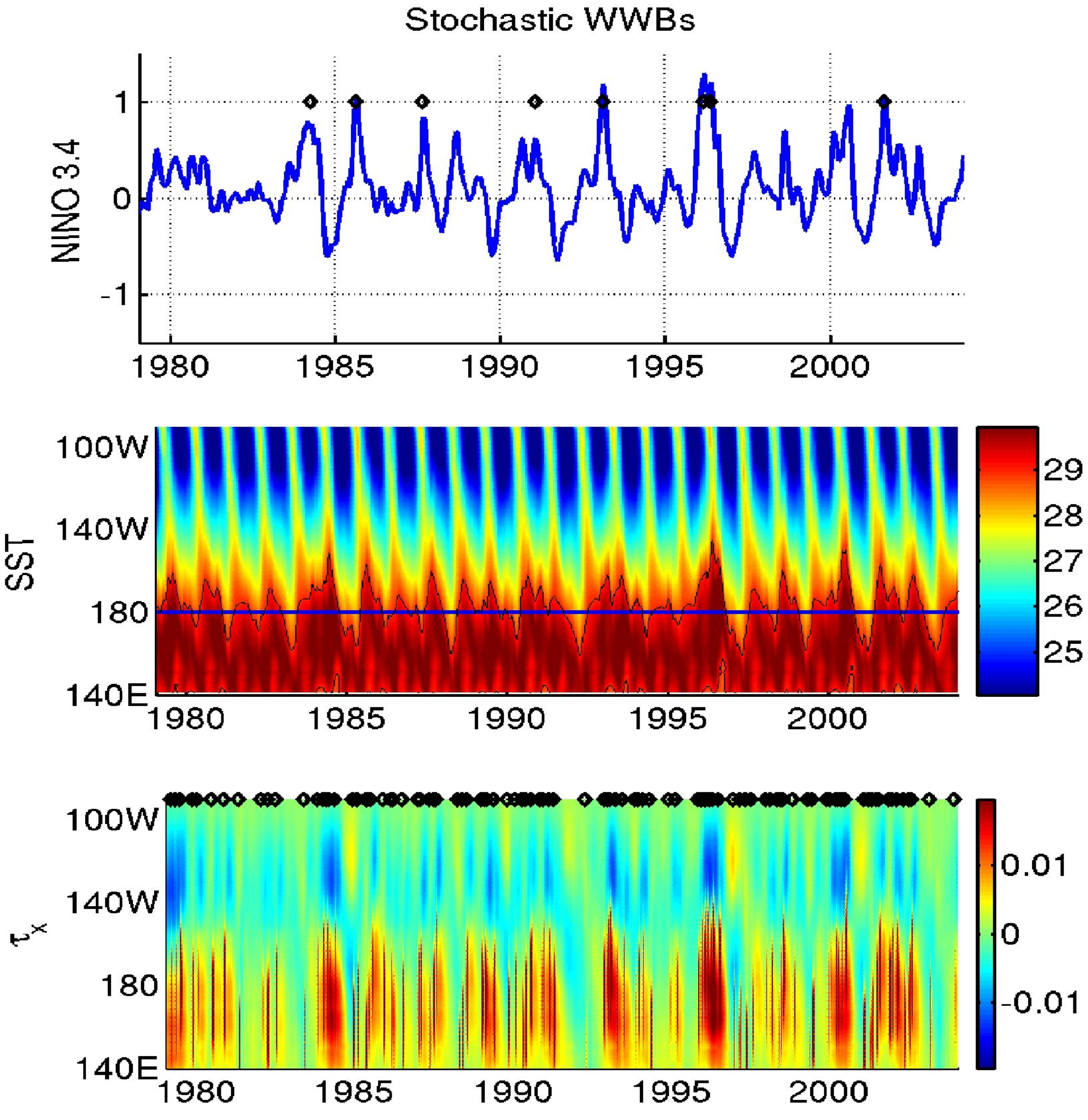
The magnitude and period are sensitive to WWB formulation.

Purely Stochastic WWBs

WWBs occur independently of ocean state.

- std(NINO3.4)=0.3 C
- 2-3 year recurrence interval
- Irregular
- 3.5 WWBs/yr

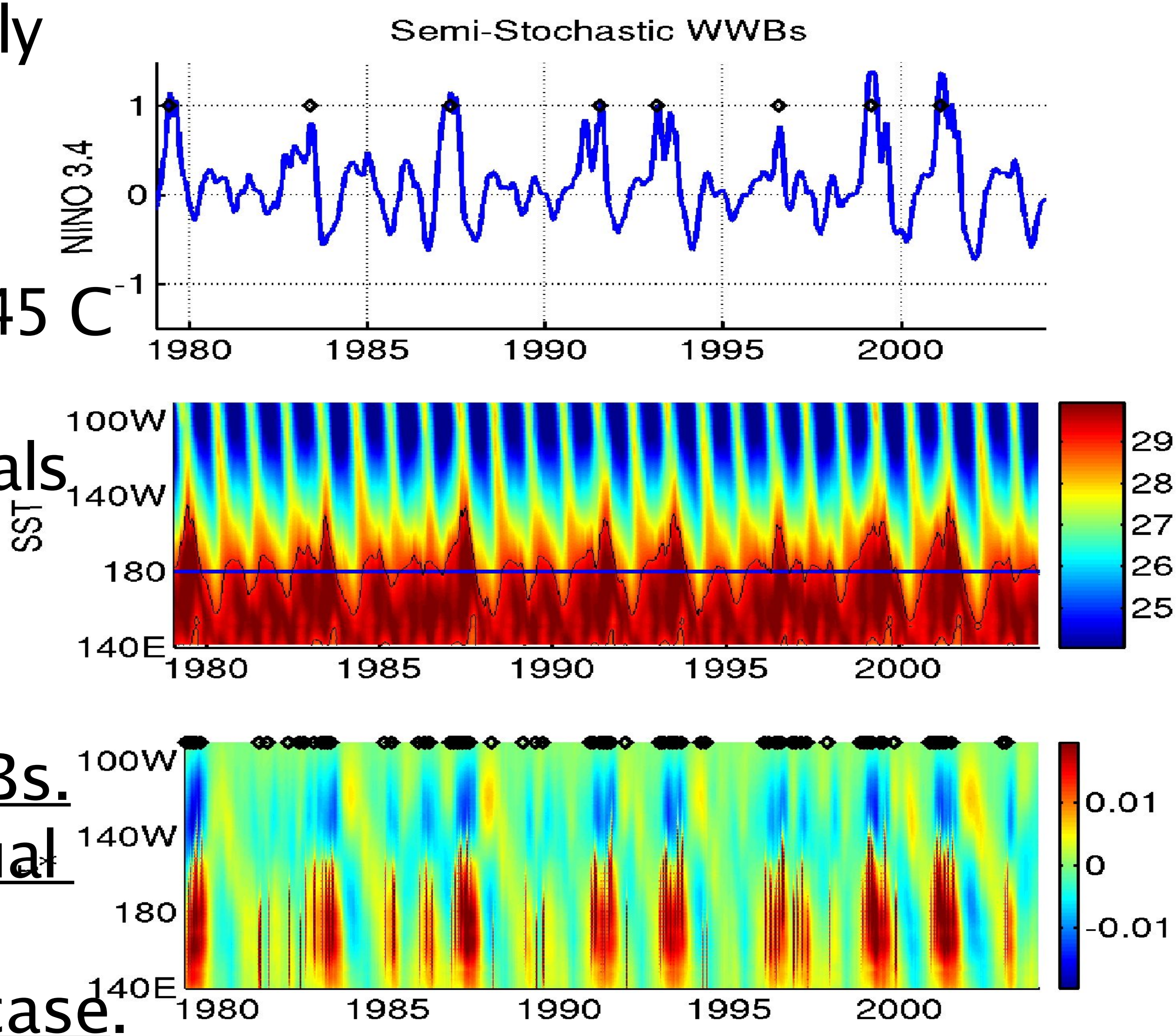
<u>Weak interannual variability</u>.



Semi-stochastic WWBs

WWBs more likely with extended warm pool.

- std(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.