Westerly Wind Bursts (WWB) revisited: Implications for Central Pacific (CP), Eastern Pacific (EP) and extreme El Niño events

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Westerly Wind Burst (WWB) in Feb-Mar 1997, preceding El Niño

Five-Day Zonal Wind and SST 2°S to 2°N Average

Zonal Wind Anomalies (m s\(^{-1}\))

SST Anomalies (°C)

1997

1998

140°E 160°E 180° 160°W 140°W 120°W 100°W

140°E 160°E 180° 160°W 140°W 120°W 100°W

-8 -4 0 4 8

-4 -2 0 2 4

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The response of the coupled tropical ocean–atmosphere to westerly wind bursts

By ALEXEY V. FEDOROV
Niño3 in two suites of experiments – with and without WWB

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Triggering of El Niño by westerly wind events in a coupled general circulation model

The HadOPA coupled model

The OGCM used in this study is the OPA model (Madec et al. 1998, see documentation at http://www.lodyc.jussieu.fr/opa/) in its global configuration, known as ORCA2. The horizontal mesh is based on a 2° by 2° Mercator grid (i.e., the same zonal and meridional grid spacing). However, a local transformation is applied to the model grid in the tropics to refine the meridional resolution to up to 0.5° at the equator. The
Experiments

Following Lengaigne et al. 2005, we will impose a Westerly Wind Burst observed in Feb-Mar 1997; 1-month duration.
Experimental set-up:

Two sets of ensemble experiments:

Set 1. Recharged. Ocean Heat Content (OHC) initially recharged
Set 2: Neutral. Ocean Heat Content (OHC) initially neutral

Each set has

10 control experiments
(the same initial ocean; atmospheric state shifted by a few days)
and
10 perturbed experiments
(a WWB is superimposed in Feb-Mar)

40 experiments total. Each lasts for 2 years. Model HadOPA.
Variations in Ocean Heat Content

Set 1. Recharged (Control)

Set 2. Neutral (Control)

OHC = temperature (°C) averaged 5N-5S, East-West, 0 – 300m
Each thin line – one experiment
Blue line – ensemble mean
Set 1 (Recharged):
*The Warm pool is extended farther eastward;*
*The Cold tongue is warmer!*

Set 2 (Neutral):
*Generally colder!*
Set 1. Recharged

Niño3:

Niño4:

(a) Control (Nino 3) Set 1
(b) Perturbed (Nino 3) Set 1

Control

EP El Niño

WWB

Perturbed

(a) Control (Nino 4) Set 1
(b) Perturbed (Nino 4) Set 1

Control

CP El Niño

Perturbed
Set 2. Neutral

Niño3:

Weak La Niña

Perturbed WWB

Niño4:

Weak CP El Niño
Events at their peak:

SST along the equator in December

CP El Niño

EP El Niño

La Niña

CP El Niño
SST indices at the peak of events (Oct-Dec)

Left: separate events
Right: ensemble mean and STD
Anomalies: SST

Set 1. Control

Set 1. Perturbed

Wind stress

Zonal current
Set 2. Control

Set 2. Perturbed
Month-by-month development of events (ensemble-mean)
Conclusions

- For recharge states: a timely occurrence of WWBs can transform an upcoming CP El Niño into a strong EP El Niño (even extreme)

- For neutral states: a WWB can transform a weak La Niña into a weak CP El Niño

- Whether a CP El Niño evolves into an EP El Niño depends on how far the Warm Pool edge can move eastward (facilitated by WWB) before the growth of the Niño3 SST anomaly can start

- Thermocline depth anomalies in the central Pacific are indeed important for CP El Niño events

- Evolution of the neutral state is much more uncertain (with or without WWBs)
Why Set 1 (Control) and Set 2 (Perturbed) are so similar?
Extreme events
Is distribution of events unimodal or bimodal?
Model warm and cold events (200 years) + perturbation experiments