Effects of the QBO on ENSO teleconnections

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**ENSO teleconnection:**

Observed for a long time

Mechanism: via Rossby waves

Trenberth et al. 1998
Ineson and Scaife 2008:
Showed amplified ENSO response during winters with SSWs as compared to winters without SSWs

Suggesting role of stratosphere in the teleconnection pattern
Butler et al 2014:
Suggests that there is a tropospheric AND a stratospheric pathway by which ENSO can influence the northern extra tropics
Calvo et al 2009: looked at QBO/ENSO effects on the polar vortex, but not on surface

Mechanism: QBO affects PW propagation into the polar vortex
This Study:

Look at ENSO teleconnections using 2 model configurations: with and without a QBO
Model Set-up

- 30L CAM5: 6 ensembles
- 46L CAM5: 10 ensembles
- SE dycore, ne30 (~ 100 km)
- AMIP Simulation
- 1952 - 2001 (50 yrs)
- Non-orographic GWs in 46L CAM
Mean Climate: U

DJF

JJA
Standard Deviation:

DJF

JJA
Tropical Winds:

30L

46L
El Nino Response: PSL

Feb/Mar

30L
El Nino Anom (48)

46L
El Nino Anom (80)

46L
El Nino /QBO NEU (43)

46L
El Nino /QBO E (7)

46L
El Nino /QBO W (30)

Strongest response
Over NP
Zonal Wind Response

Feb/Mar

- **Climo**
  - Strengthened Tropospheric Jet

- **El Nino Anom**
  - Weaker Polar vortex

- **El Nino QBO E Anom**
  - Less strengthened

- **El Nino QBO W Anom**
Mechanism?

is the Stratospheric Pathway via SSWs?
Non-Disturbed years:

El Nino Years with No SSW Events:

T80N 30L

T80N 46L

El Nino response reaches the surface in Spring even when there are no SSWs suggesting that stratospheric pathway exists with or without SSWs
However….

Stronger PSL response over NP during winters with SSWs suggesting STRONGER stratospheric pathway when SSWs are present.
SSWs:

NCEP Reanalysis:

28 SSWs / 50 yrs
0.6 SSWs/ yr

30L 6-ensembles:

23 SSWs / 50 yrs
0.5 SSWs/ yr

46L GW 6-ensembles:

29 SSWs / 50 yrs
0.6 SSWs/ yr
I. QBO affects stratospheric SSW pathway?

QBOE inhibits SSWs during El Nino?

46LGW 6 ens:
Total SSWs: \( f = 0.6 \)
QBOE years: \( f = 0.5 \)
QBOW years: \( f = 0.5 \)
NEU years: \( f = 0.7 \)

46LGW 6 ens:
Total SSWs: \( f = 0.6 \)
EN years: \( f = 0.5 \)
LN years: \( f = 0.4 \)
NEU years: \( f = 0.7 \)
How does QBO influence ENSO response?

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46LGW 6 ens:
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- QBOE years: \( f = 0.5 \)
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II. QBO affects stratospheric Non-SSW pathway?

Need to look more closely at ‘inactive winters’ and looks at various QBO phases

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II. QBO affects stratospheric Non-SSW pathway?
Need to look more closely at ‘inactive winters’ and looks at various QBO phases

III. QBO affects tropospheric pathway?
Does QBO affect Rossby wave propagation during ENSO events?
Need to confirm results with better QBO:

- OBS
- 46L
- 83L
Conclusions:

• The QBO increases the variability of the ENSO teleconnections

• Downward propagation of El Nino anomaly at 80N to the surface does not require presence of SSWs (non-SSW stratospheric pathway)

• The ‘stratospheric pathway’, however is stronger when SSWs are present