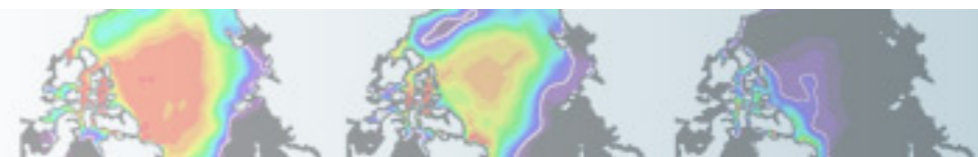


# Effects of the QBO on ENSO teleconnections

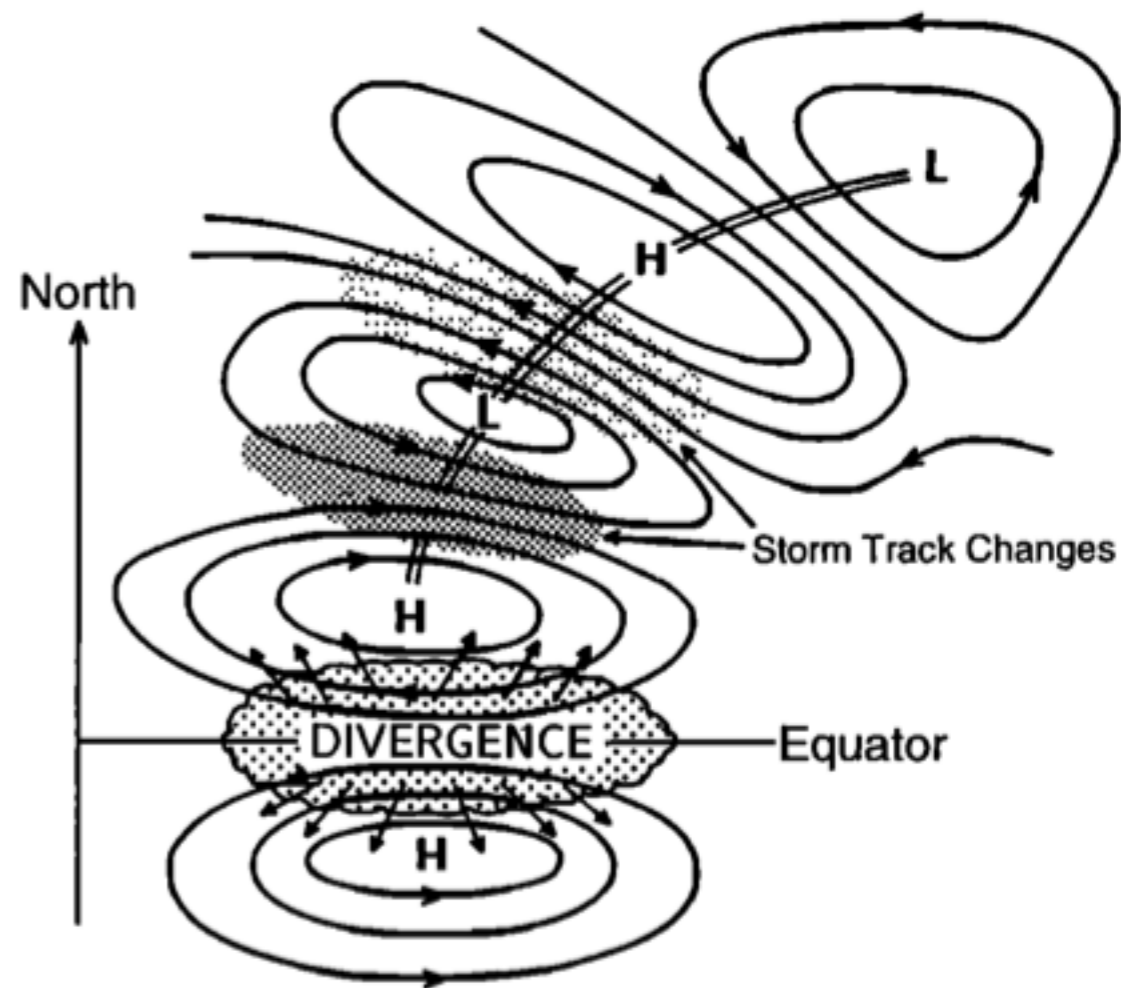
*Jadwiga (Yaga) Richter, Julio Bacmeister,  
Lantao Sun, and Clara Deser*



## ENSO teleconnection:

Observed for a long time

Mechanism: via Rossby waves



Trenberth et al. 1998

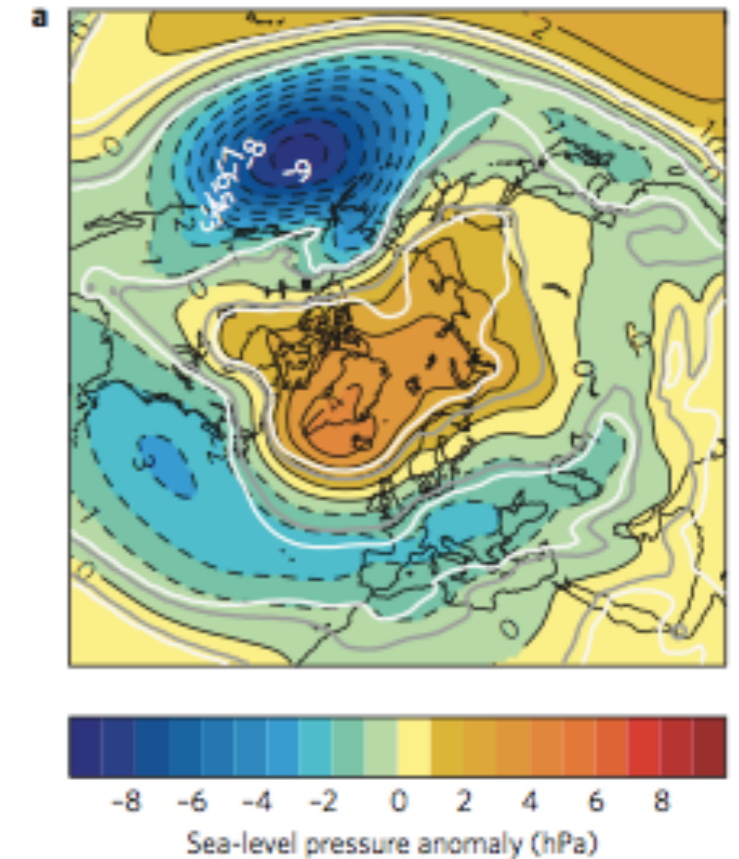
## Ineson and Scaife

**2008:**

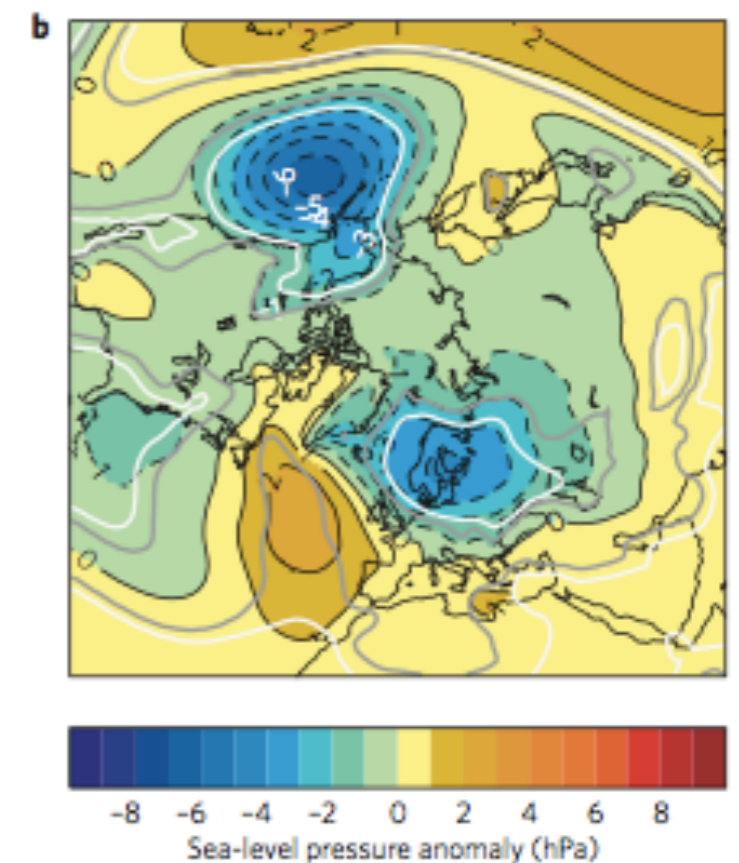
Showed amplified ENSO response during winters with SSWs as compared to winters without SSWs

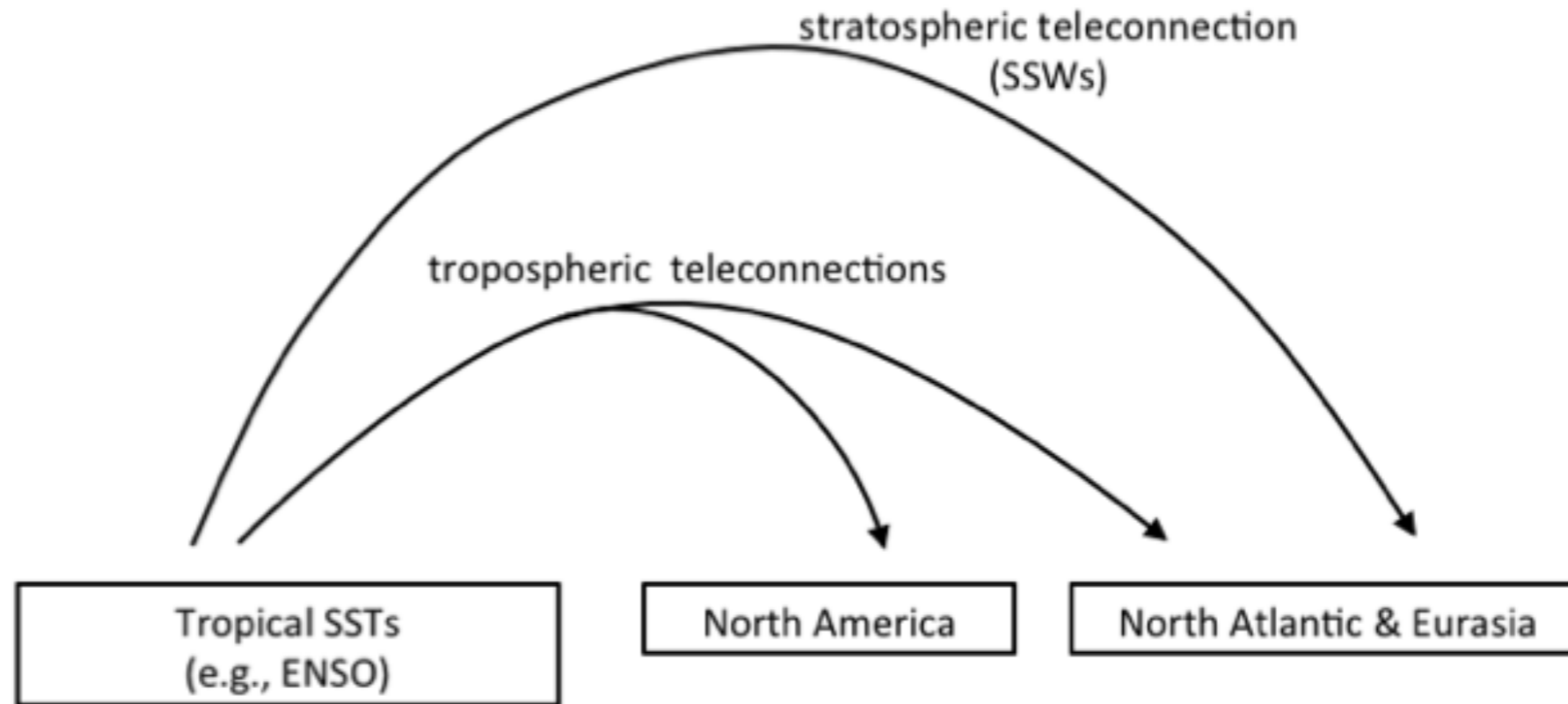
Suggesting role of stratosphere in the teleconnection pattern

With  
SSWs



Without  
SSWs





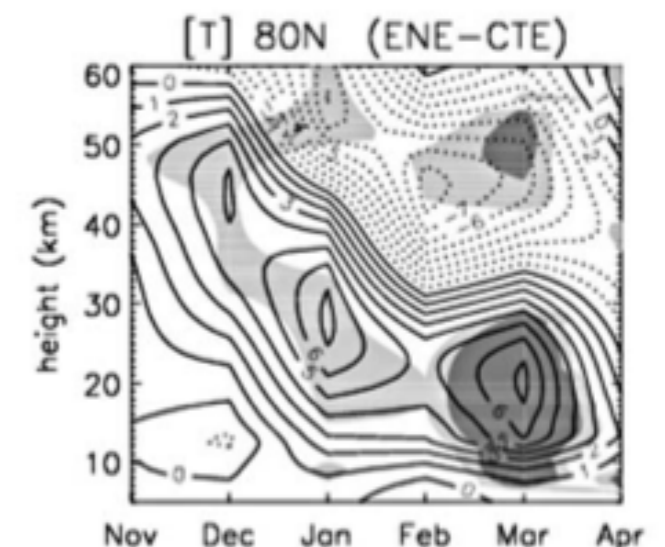
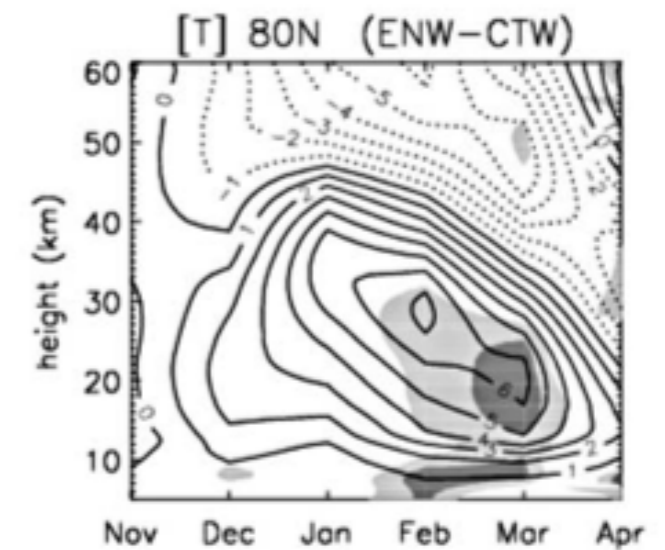
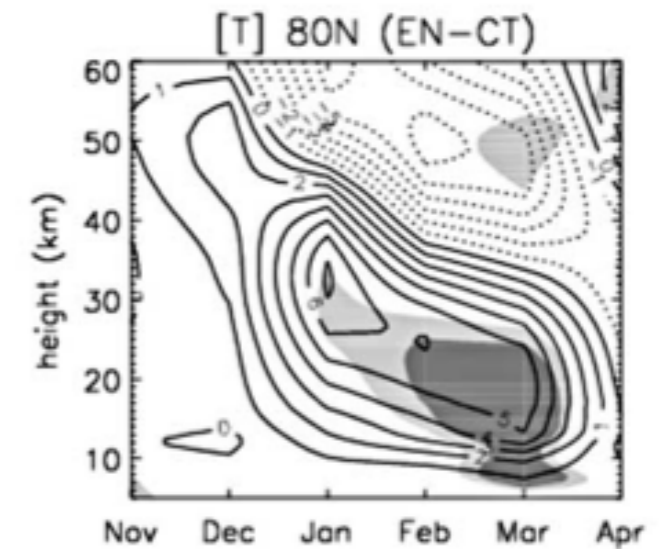
## **Butler et al 2014:**

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

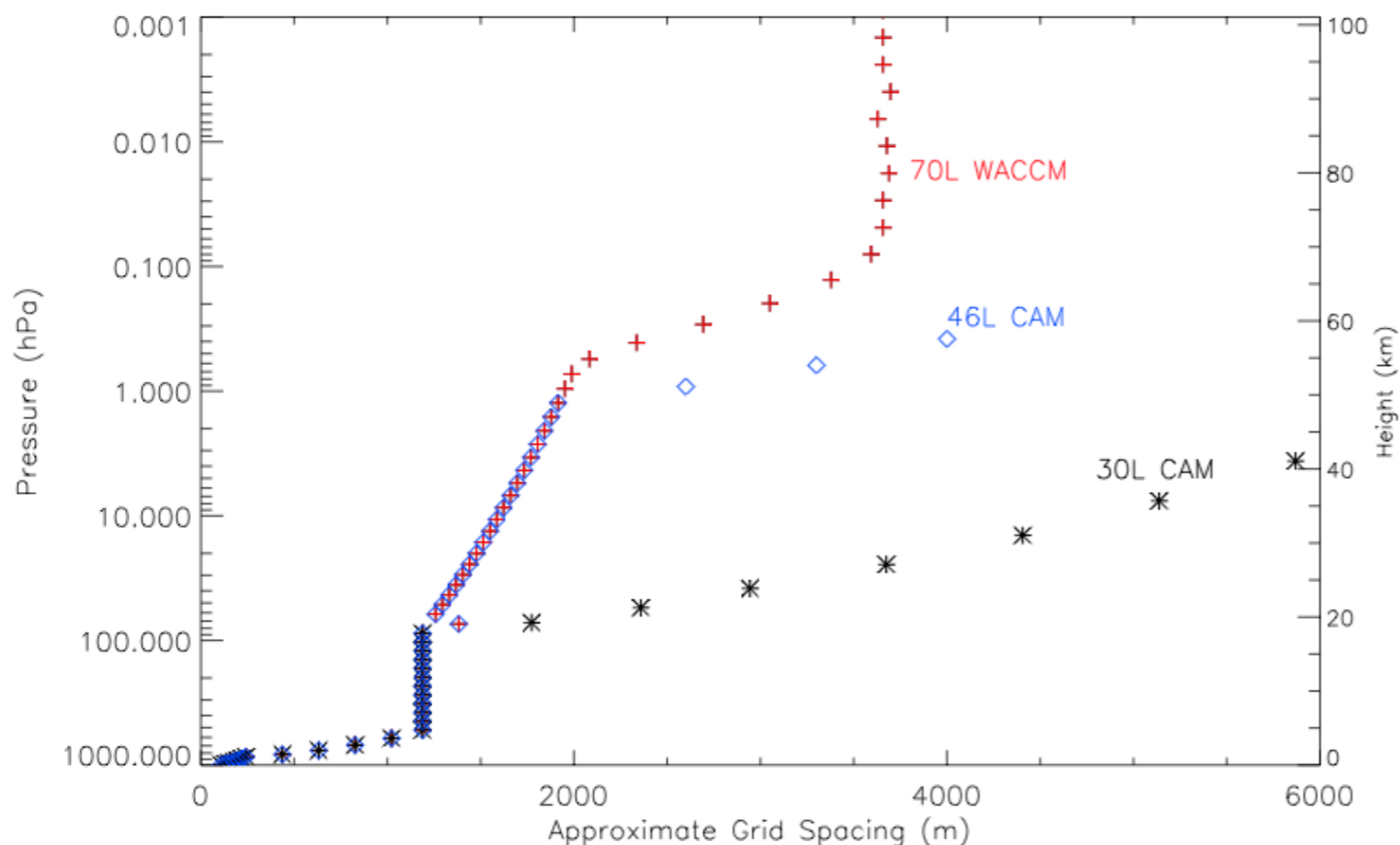
**Mechanism:**  
QBO affects PW propagation  
into the polar vortex

T80N



**Look at ENSO teleconnections**

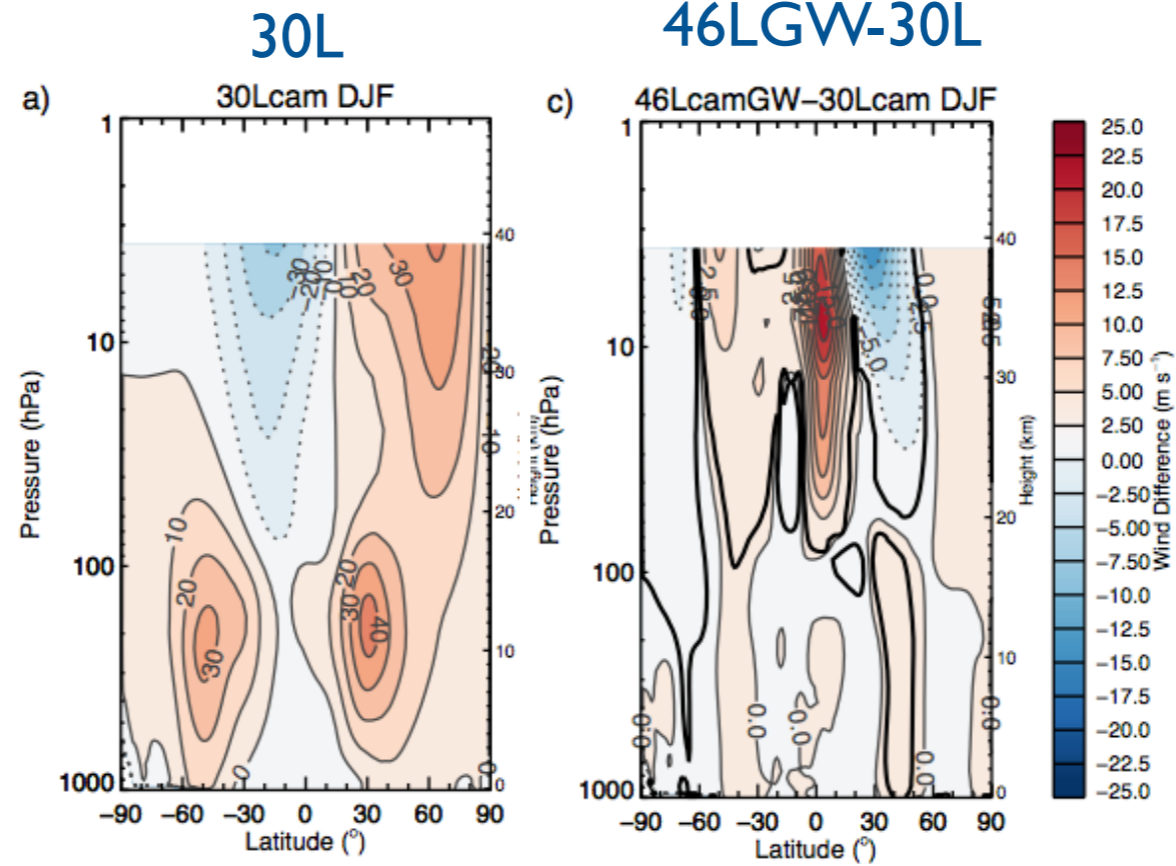
using 2 model configurations:  
with and without a QBO



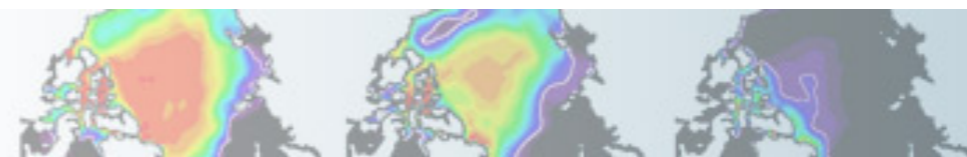
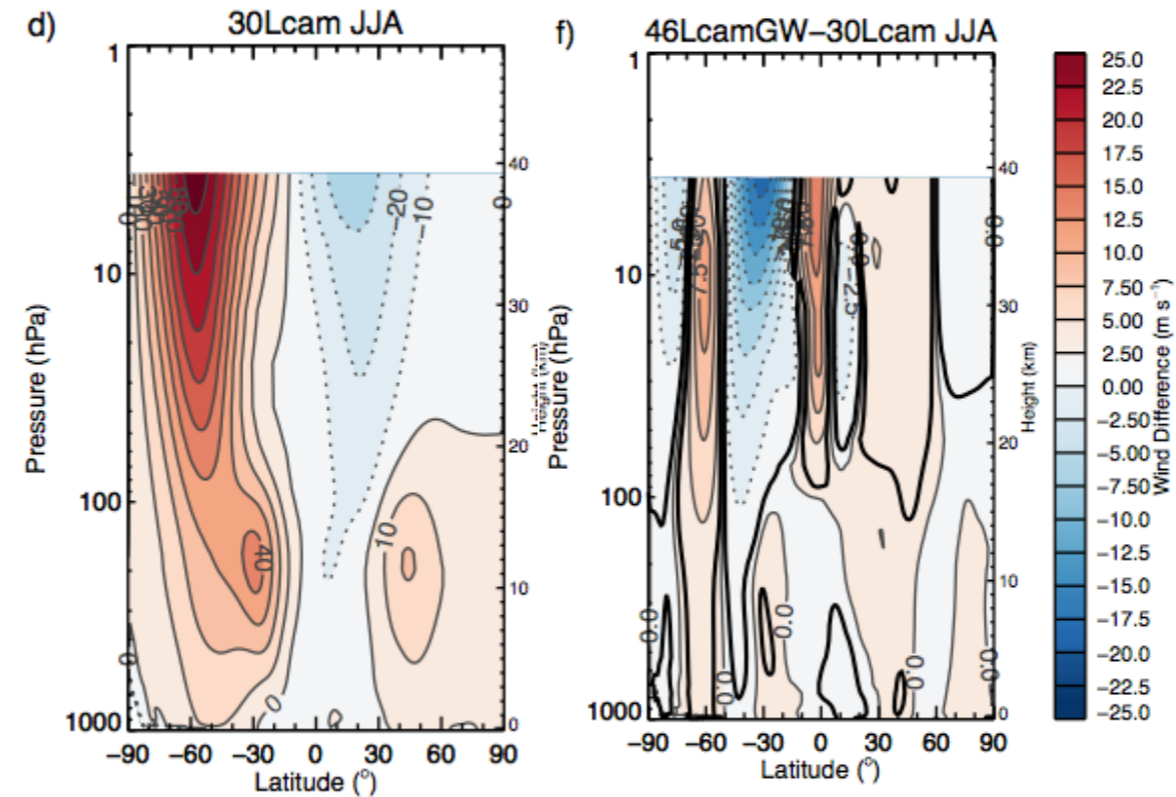
- 30L CAM5: 6 ensembles
- 46L CAM5: 10 ensembles
- SE dycore, ne30 (~ 100 km)
- AMIP Simulation
- 1952 - 2001 (50 yrs)
- Non-orographic GWs in 46L CAM

# Mean Climate: U

DJF



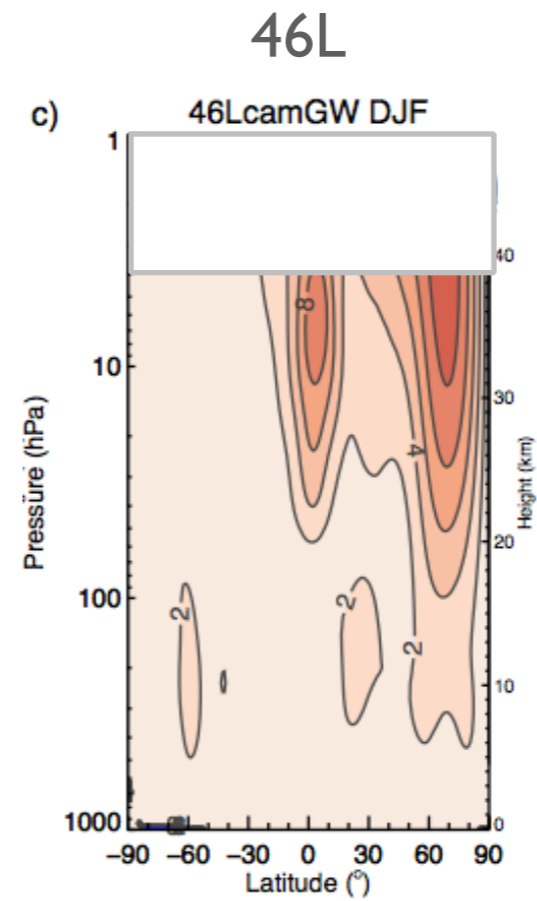
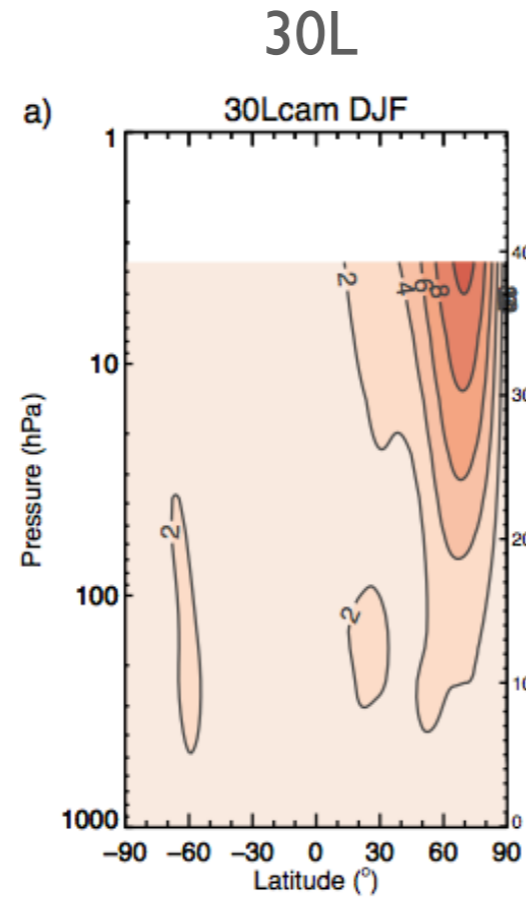
JJA



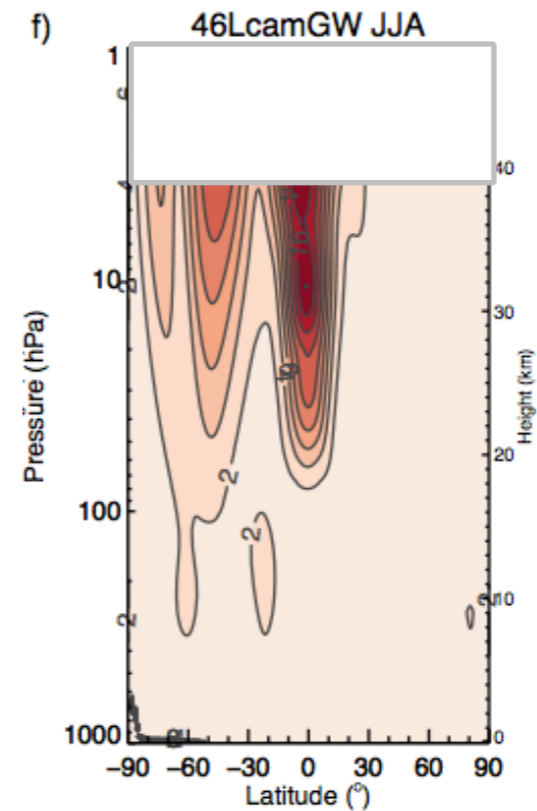
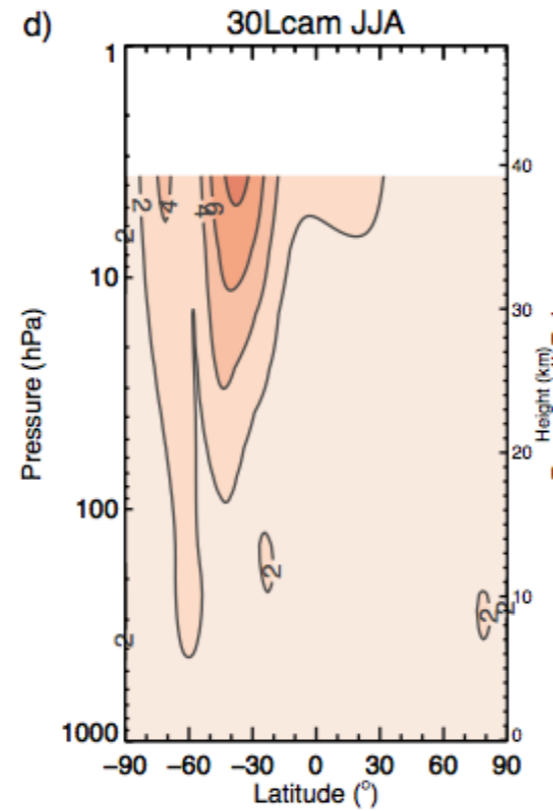


# Standard Deviation:

DJF

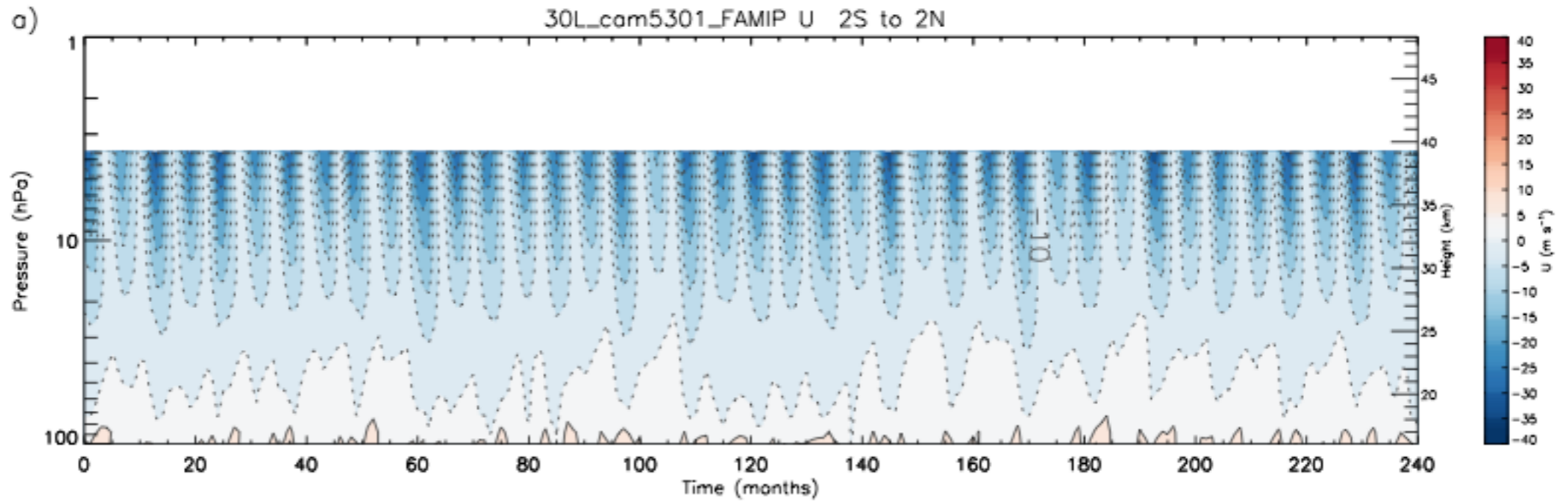


JJA

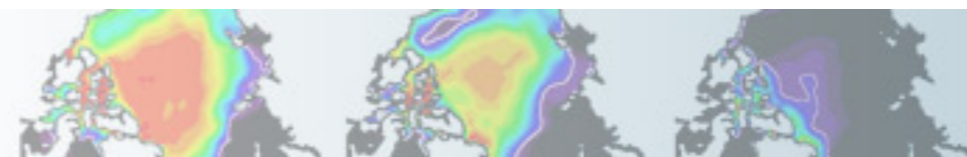
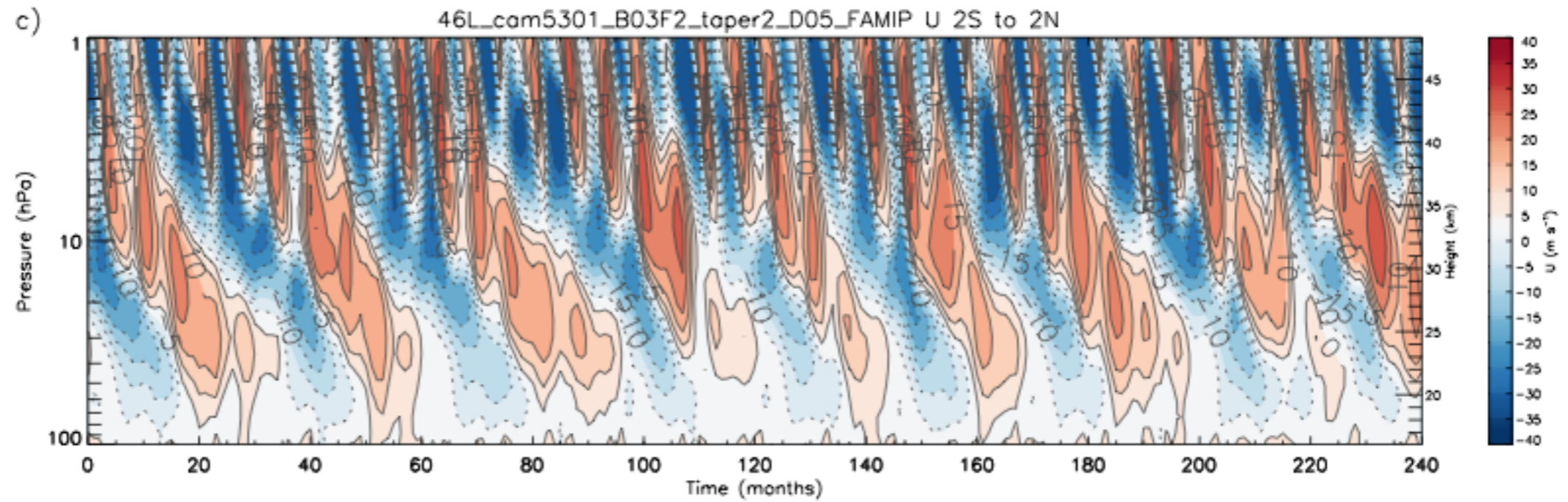


# Tropical Winds:

30L

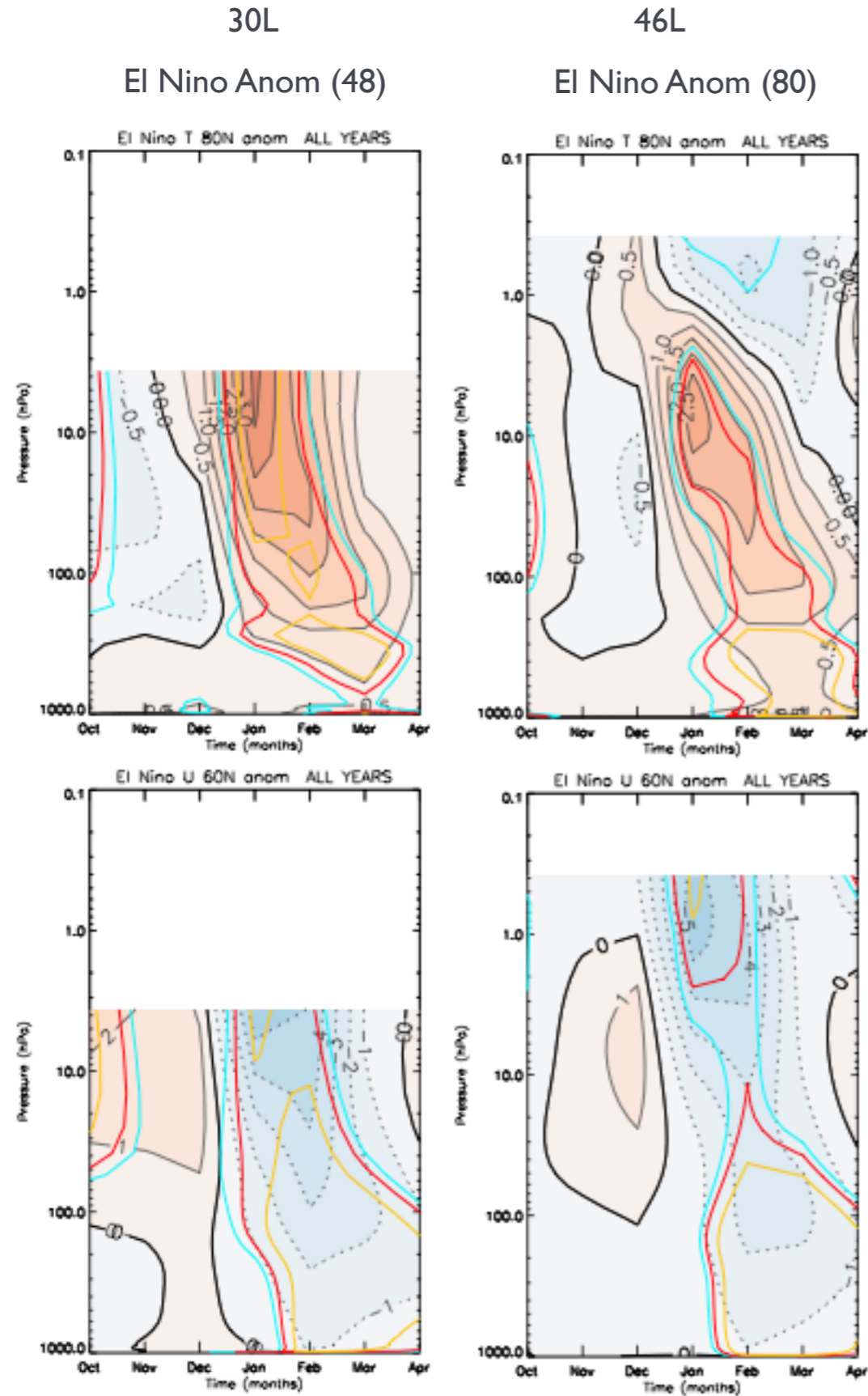


46L



T80N

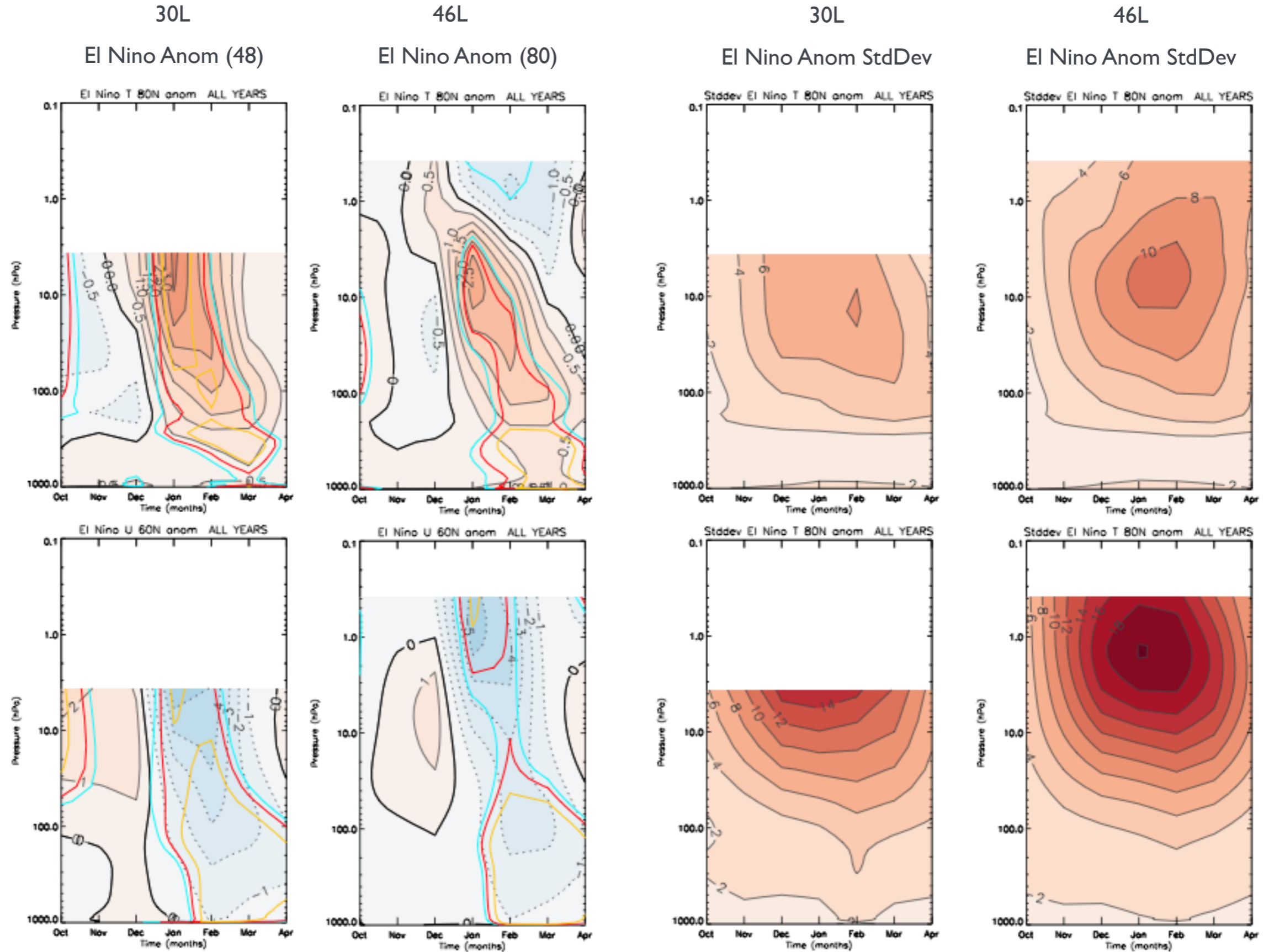
U60N



# El Nino Response

T80N

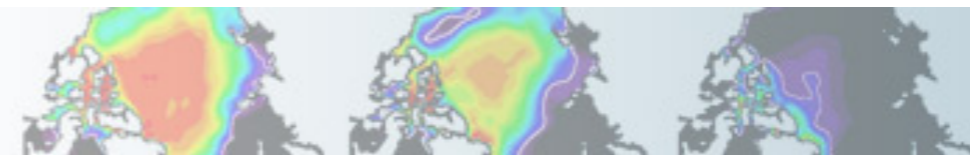
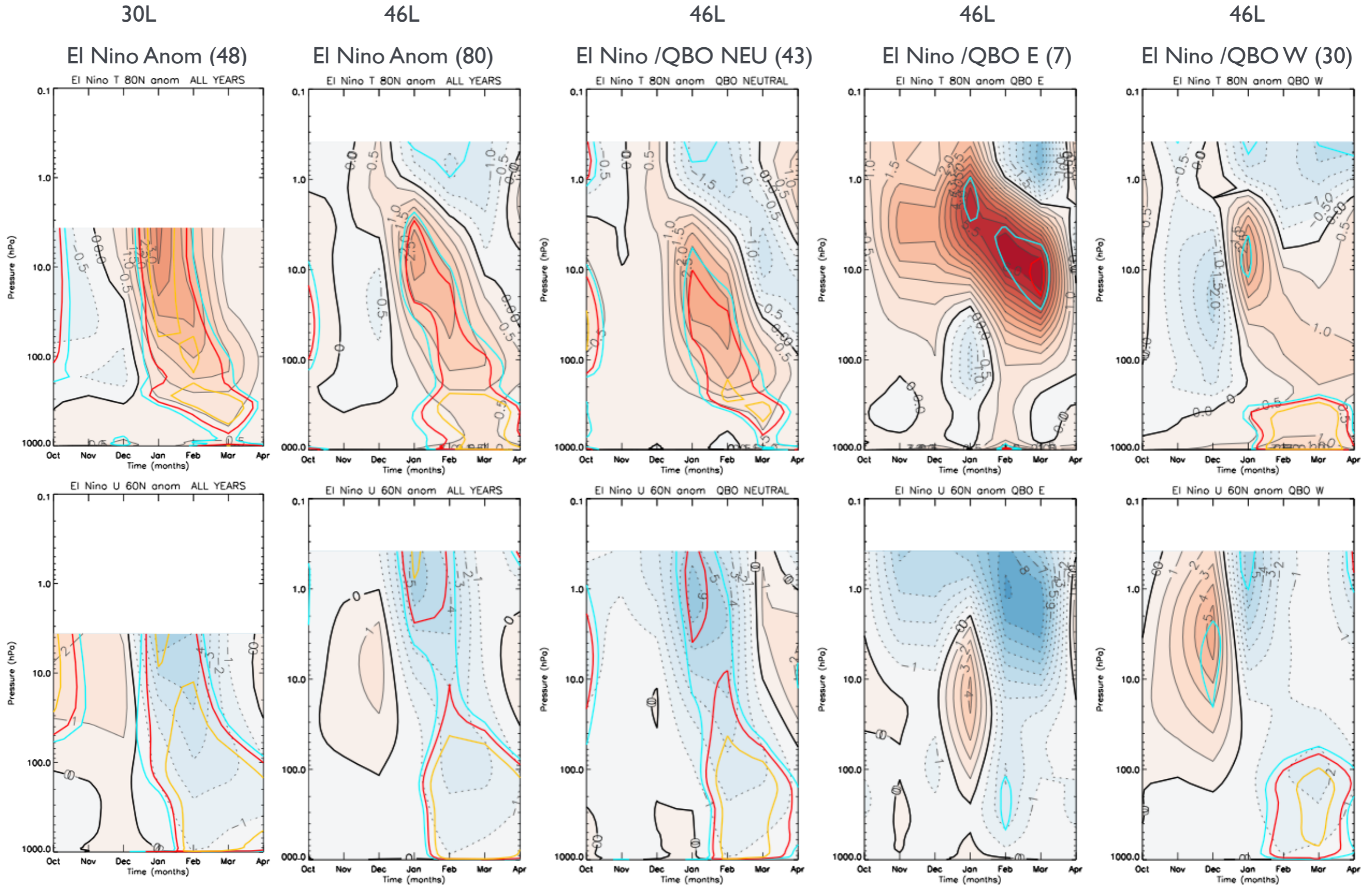
U60N



# El Nino Response

T80N

U60N



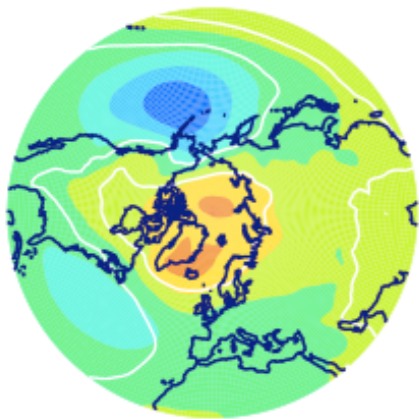
# El Nino Response: PSL

## Feb/Mar

30L

El Nino Anom (48)

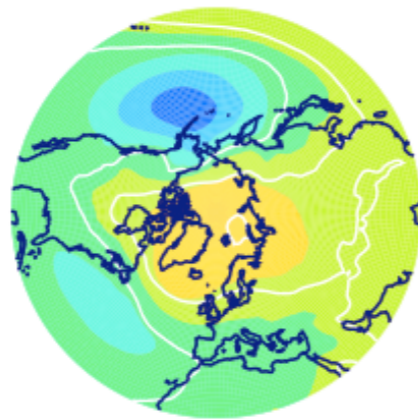
FM 30L El Nino



46L

El Nino Anom (80)

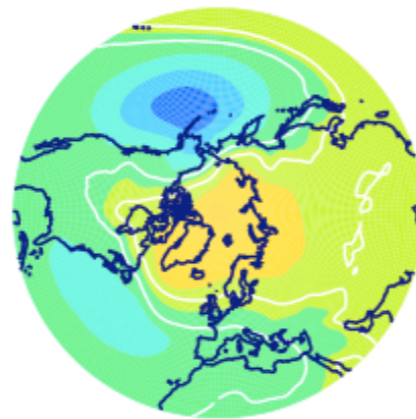
FM 46L El Nino



46L

El Nino /QBO NEU (43)

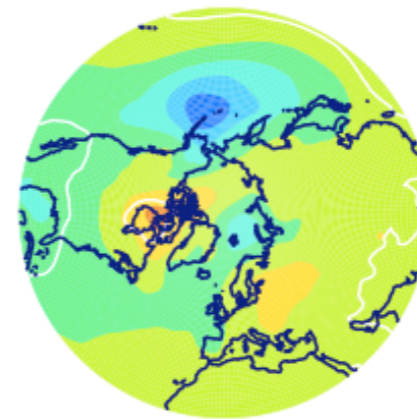
FM 46L El Nino QBO Neu



46L

El Nino /QBO E (7)

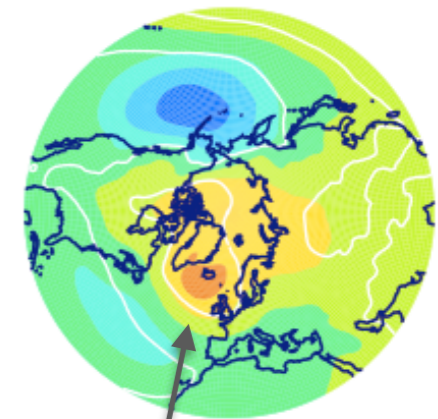
FM 46L El Nino QBO E



46L

El Nino /QBO W (30)

FM 46 El Nino QBO W



**Strongest response  
Over NP**

30L

46L

46L

46L

46L

El Nino Anom (48)

El Nino Anom (80)

El Nino /QBO NEU (43)

El Nino /QBO E (7)

El Nino /QBO W (30)

FM 30L El Nino

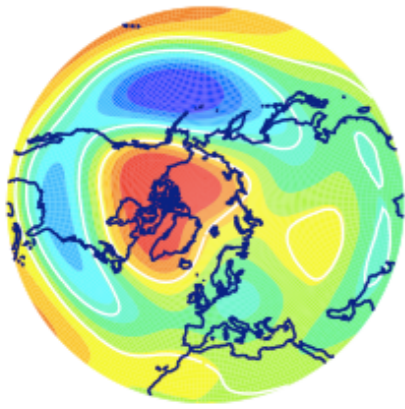
FM 46L El Nino

FM 46L El Nino QBO Neu

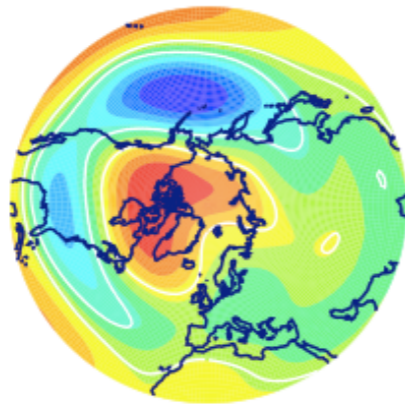
FM 46L El Nino QBO E

FM 46 El Nino QBO W

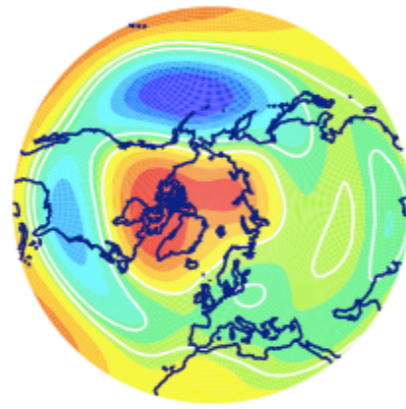
Z200



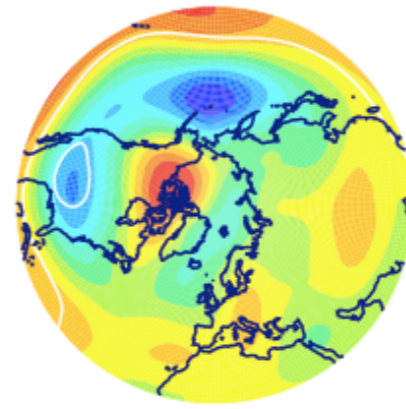
FM 30L El Nino



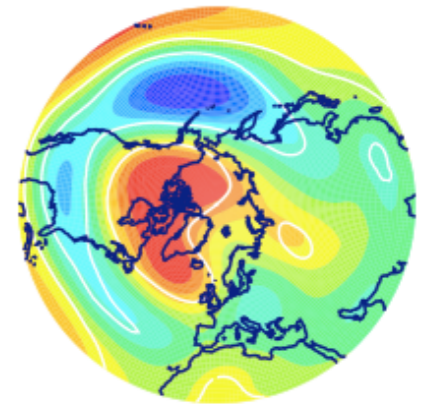
FM 46L El Nino



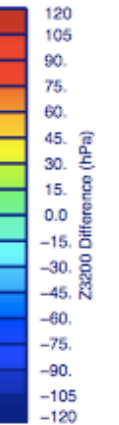
FM 46L El Nino QBO NEU



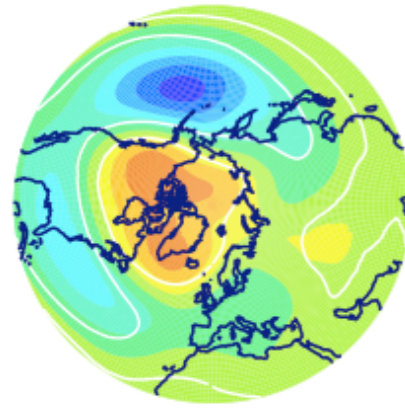
FM 46L El Nino QBO E



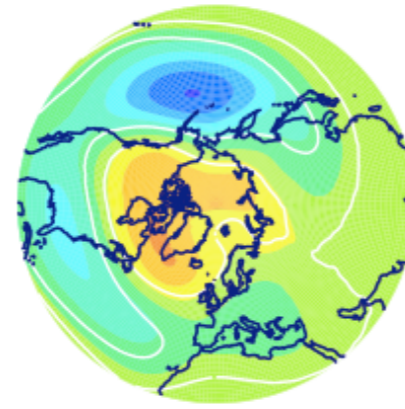
FM 46 El Nino QBO W



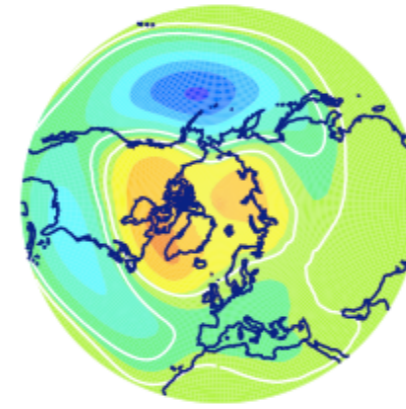
Z500



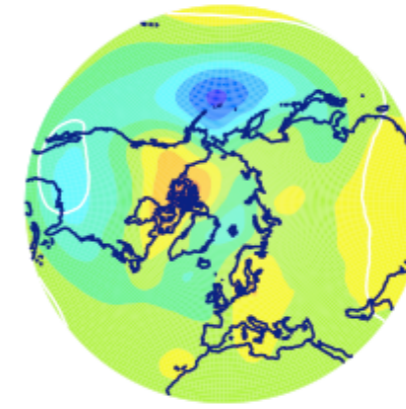
FM 30L El Nino



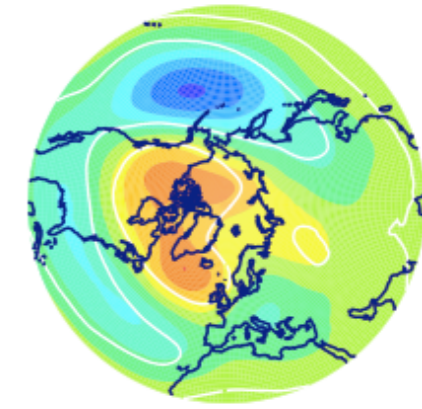
FM 46L El Nino



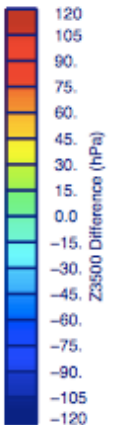
FM 46L El Nino QBO Neu



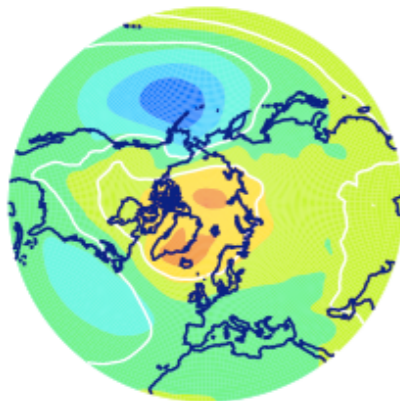
FM 46L El Nino QBO E



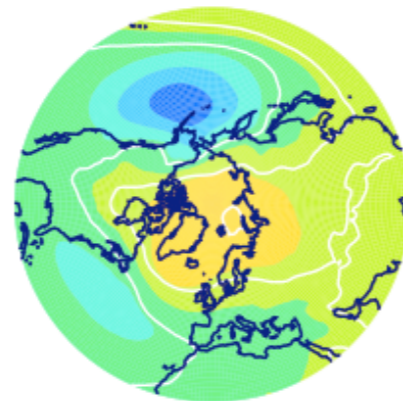
FM 46 El Nino QBO W



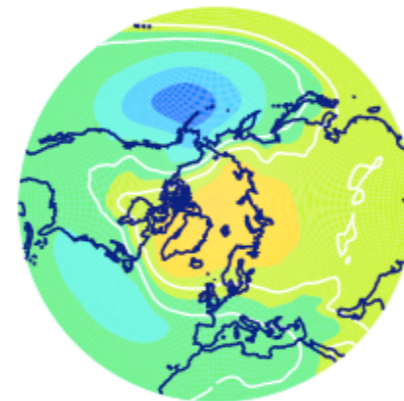
PSL



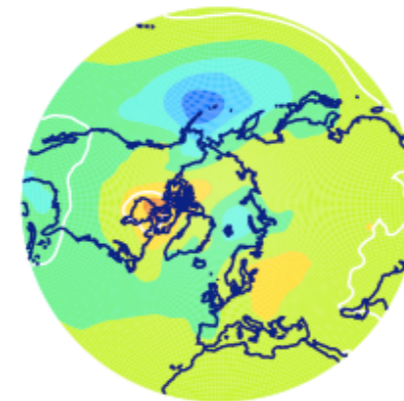
FM 30L El Nino



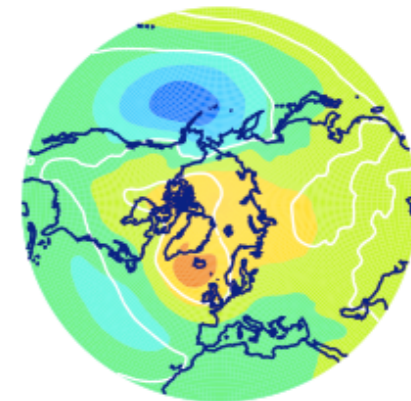
FM 46L El Nino



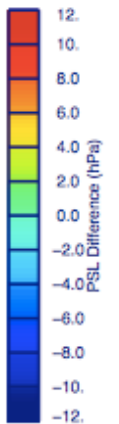
FM 46L El Nino QBO Neu



FM 46L El Nino QBO E



FM 46 El Nino QBO W



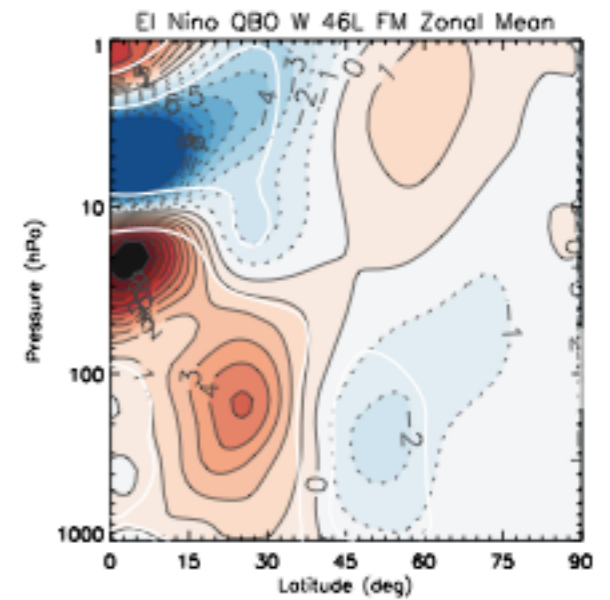
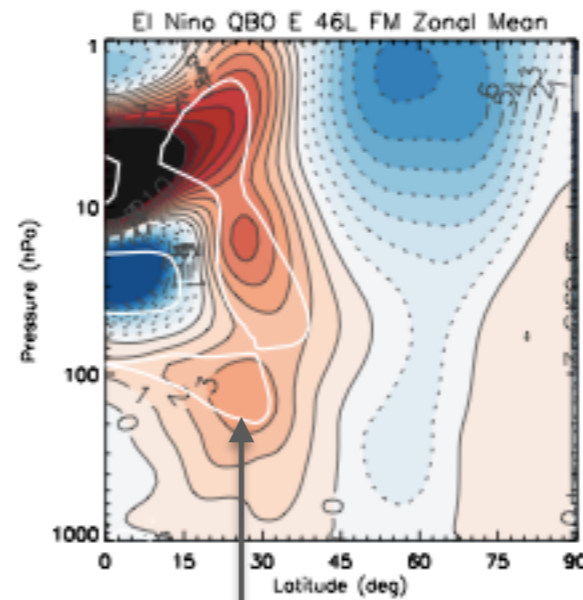
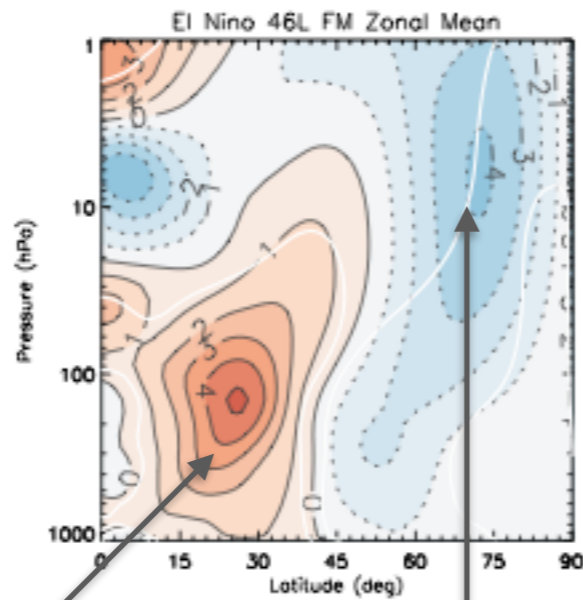
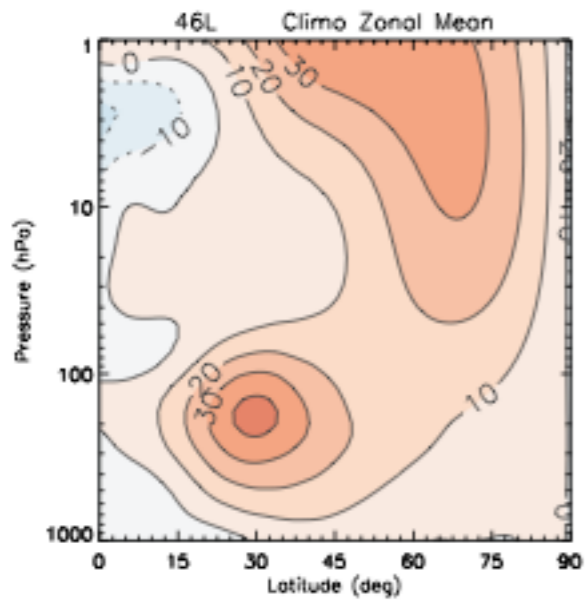
Feb/Mar

Climo

El Nino  
Anom

El Nino QBO E  
Anom

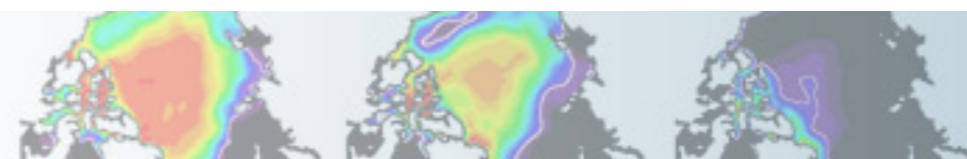
El Nino QBO W  
Anom



Strengthened  
Tropospheric Jet

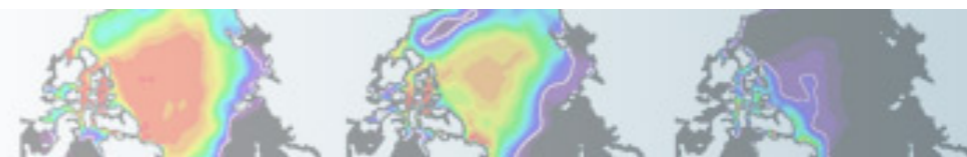
Weaker  
Polar vortex

Less  
strengthened





is the Stratospheric Pathway via SSWs?

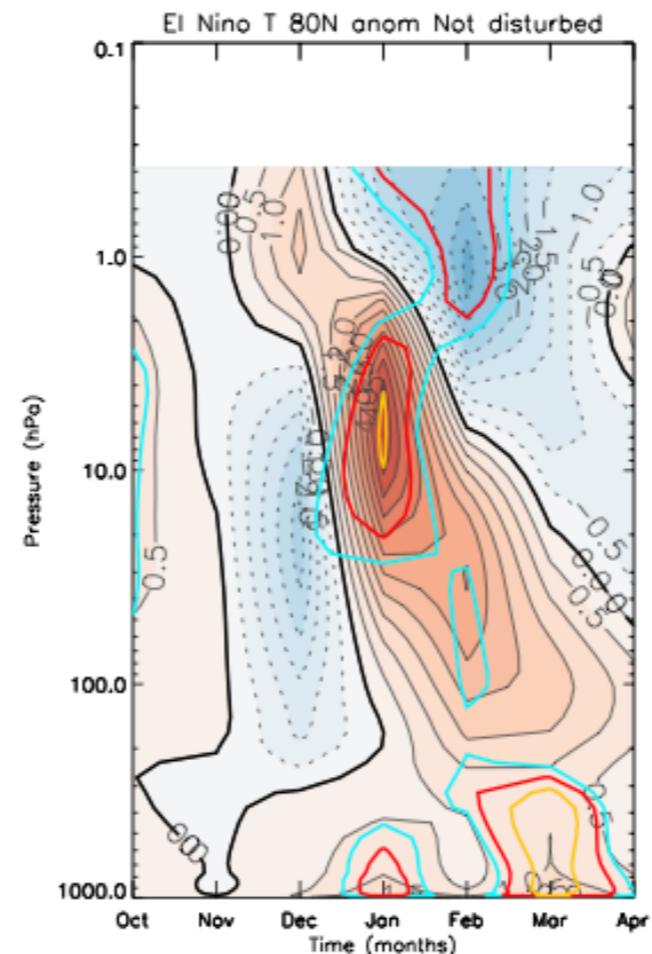
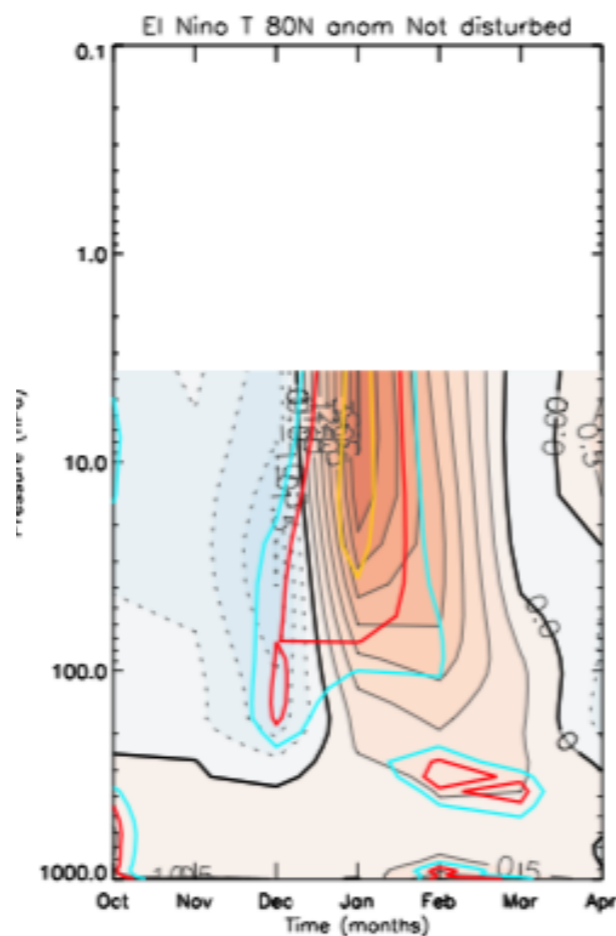


# Non-Disturbed years:

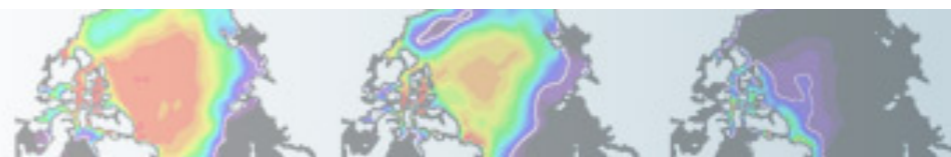
El Nino Years with No SSW Events:

T80N 30L

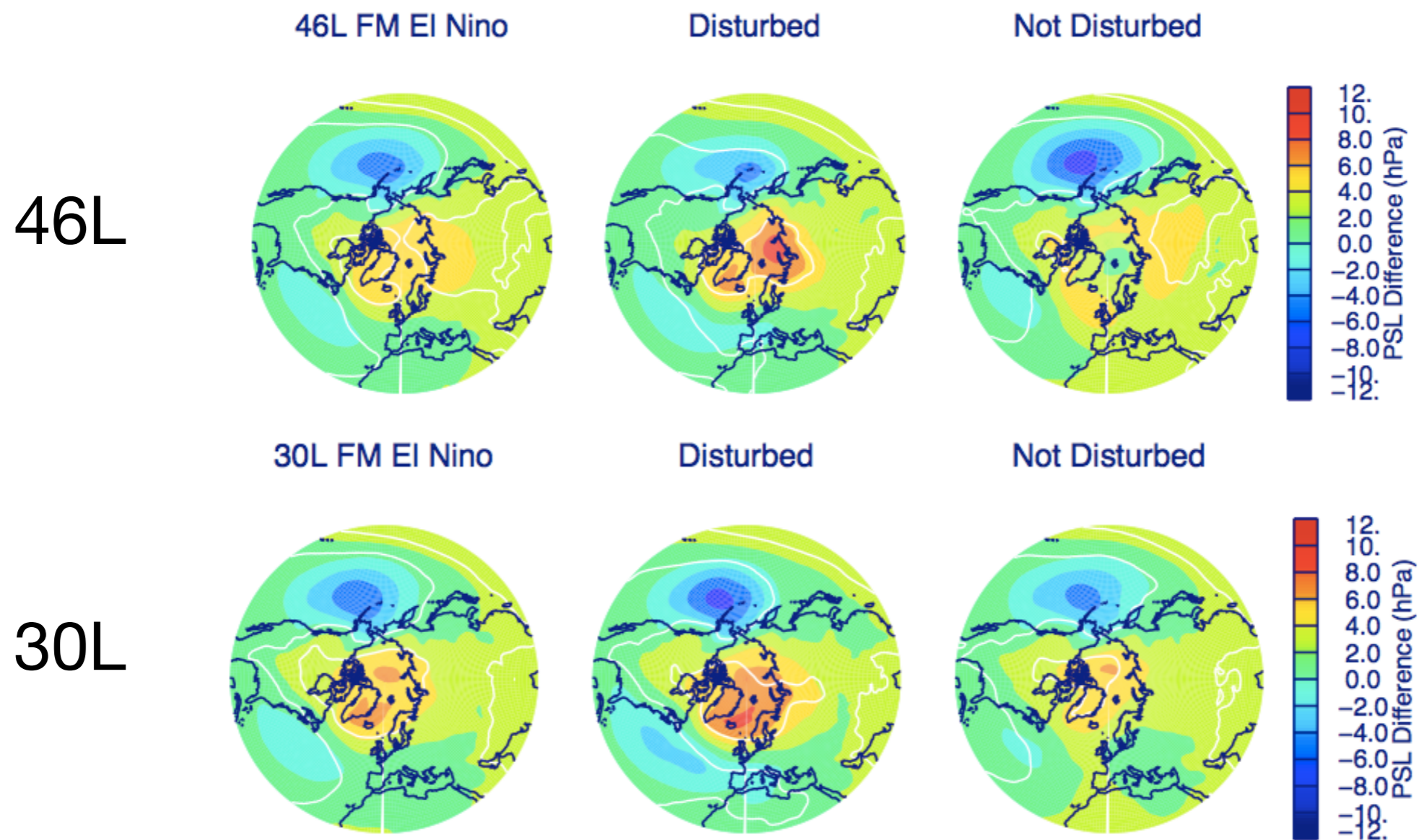
T80N 46L



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



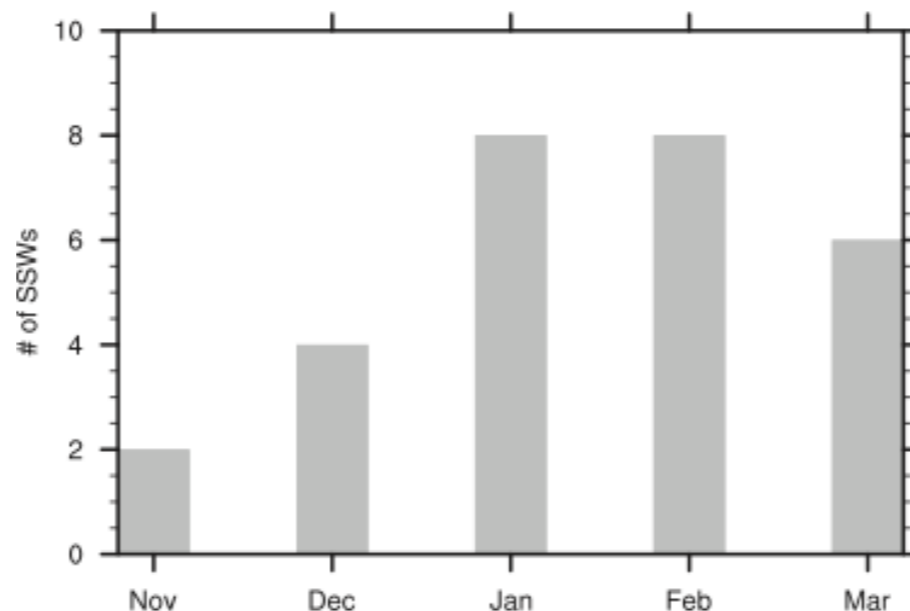
# However....



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

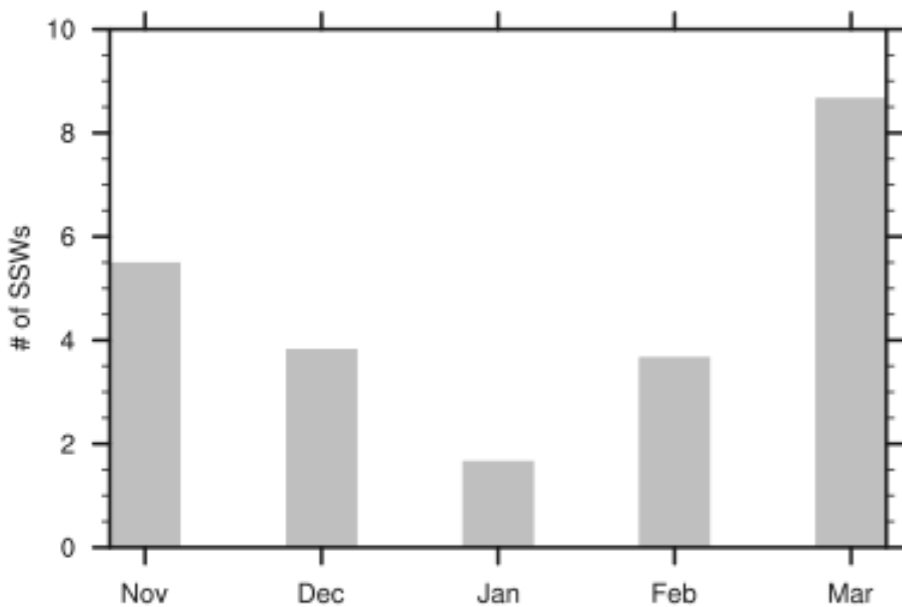
# SSWs:

## NCEP Reanalysis:



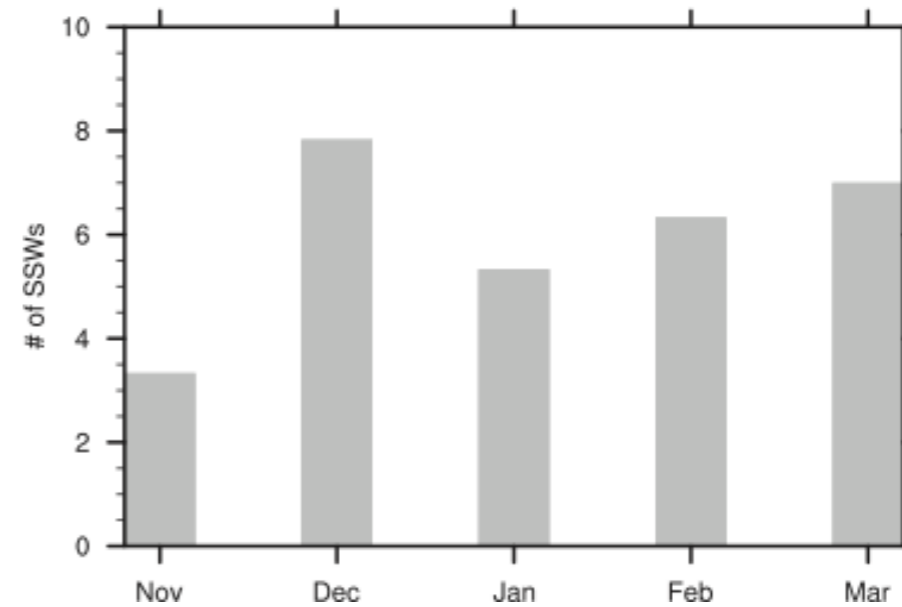
28 SSWs / 50 yrs  
0.6 SSWs/ yr

## 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?**

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$

QBOE years:  $f = 0.5$

QBOW years:  $f = 0.5$

NEU years:  $f = 0.7$

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$

EN years:  $f = 0.5$

LN years:  $f = 0.4$

NEU years:  $f = 0.7$

## I. QBO affects stratospheric SSW pathway?

**QBOE inhibits SSWs during El Nino?**

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$   
QBOE years:  $f = 0.5$   
QBOW years:  $f = 0.5$   
NEU years:  $f = 0.7$

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$   
EN years:  $f = 0.5$   
LN years:  $f = 0.4$   
NEU years:  $f = 0.7$

## II. QBO affects stratospheric Non-SSW pathway?

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

## I. QBO affects stratospheric SSW pathway?

**QBOE inhibits SSWs during El Nino?**

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$   
QBOE years:  $f = 0.5$   
QBOW years:  $f = 0.5$   
NEU years:  $f = 0.7$

**46L GW 6 ens:**

Total SSWs:  $f = 0.6$   
EN years:  $f = 0.5$   
LN years:  $f = 0.4$   
NEU years:  $f = 0.7$

## II. QBO affects stratospheric Non-SSW pathway?

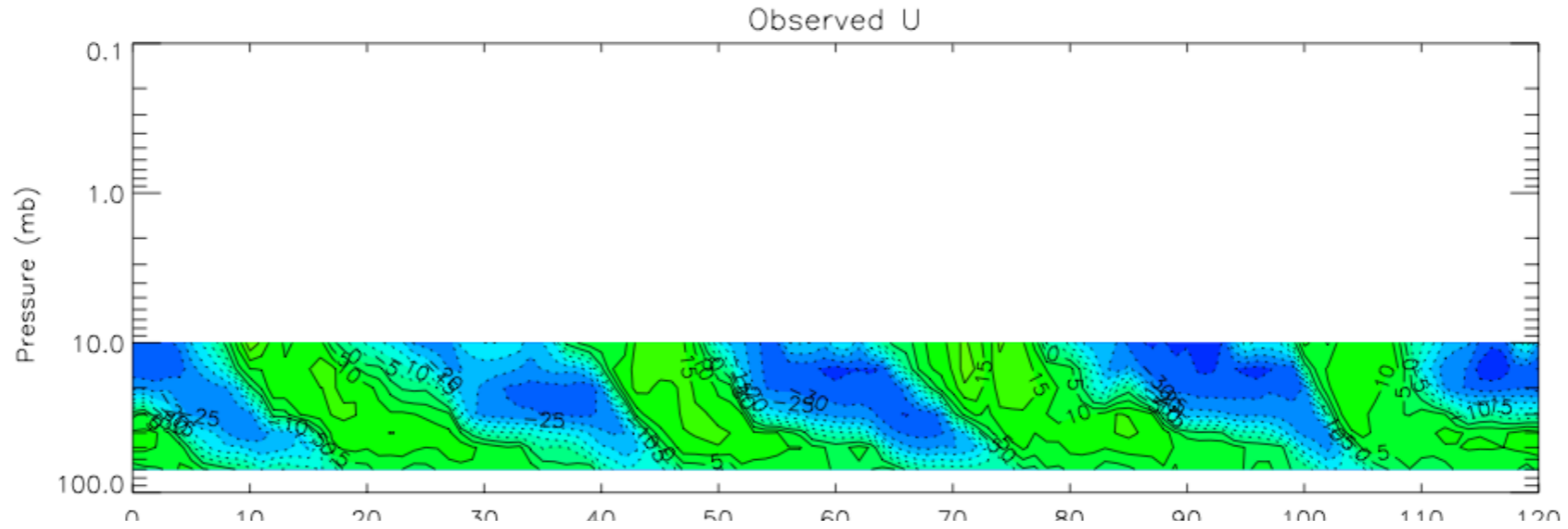
Need to look more closely at 'inactive winters' and looks at various QBO phases

## III. QBO affects tropospheric pathway?

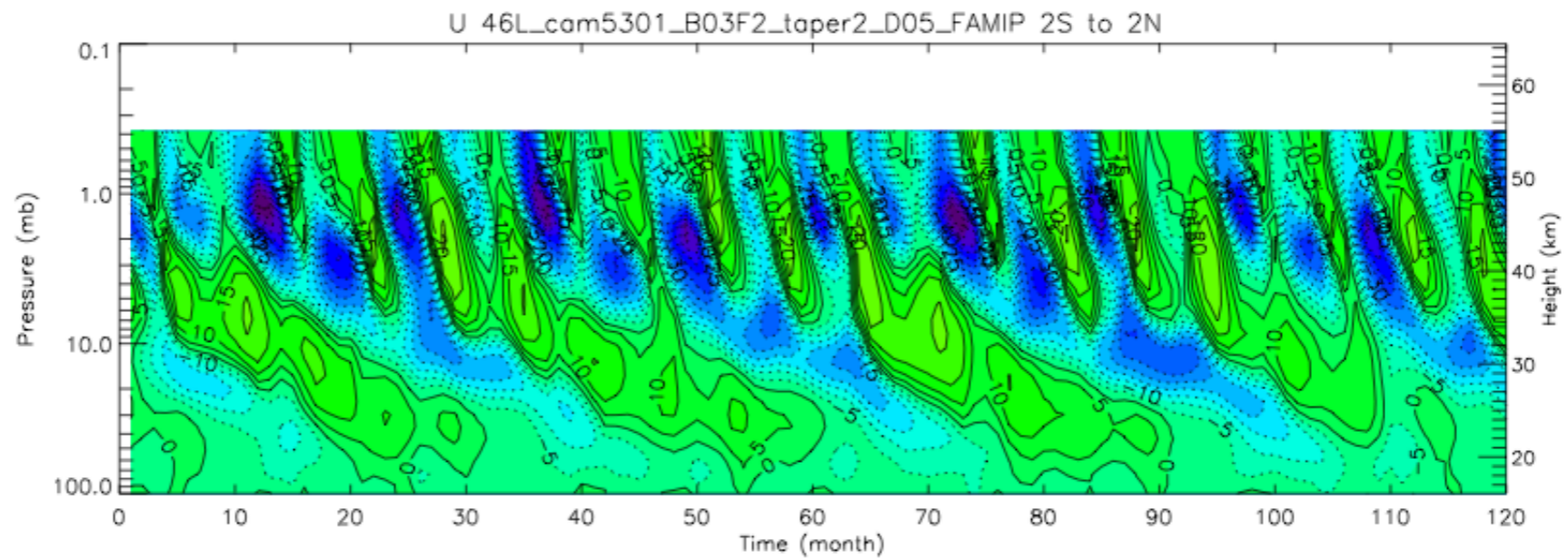
Does QBO affect Rossby wave propagation during ENSO events?

# Need to confirm results with better QBO:

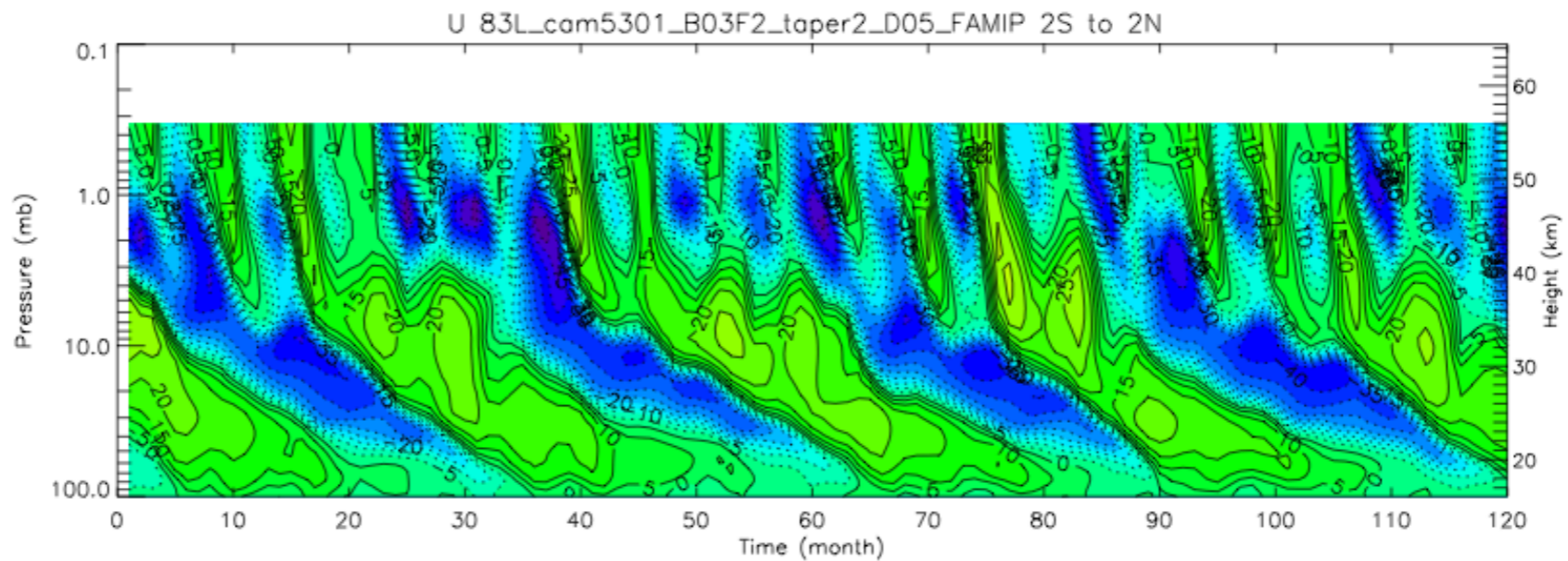
OBS



46L



83L



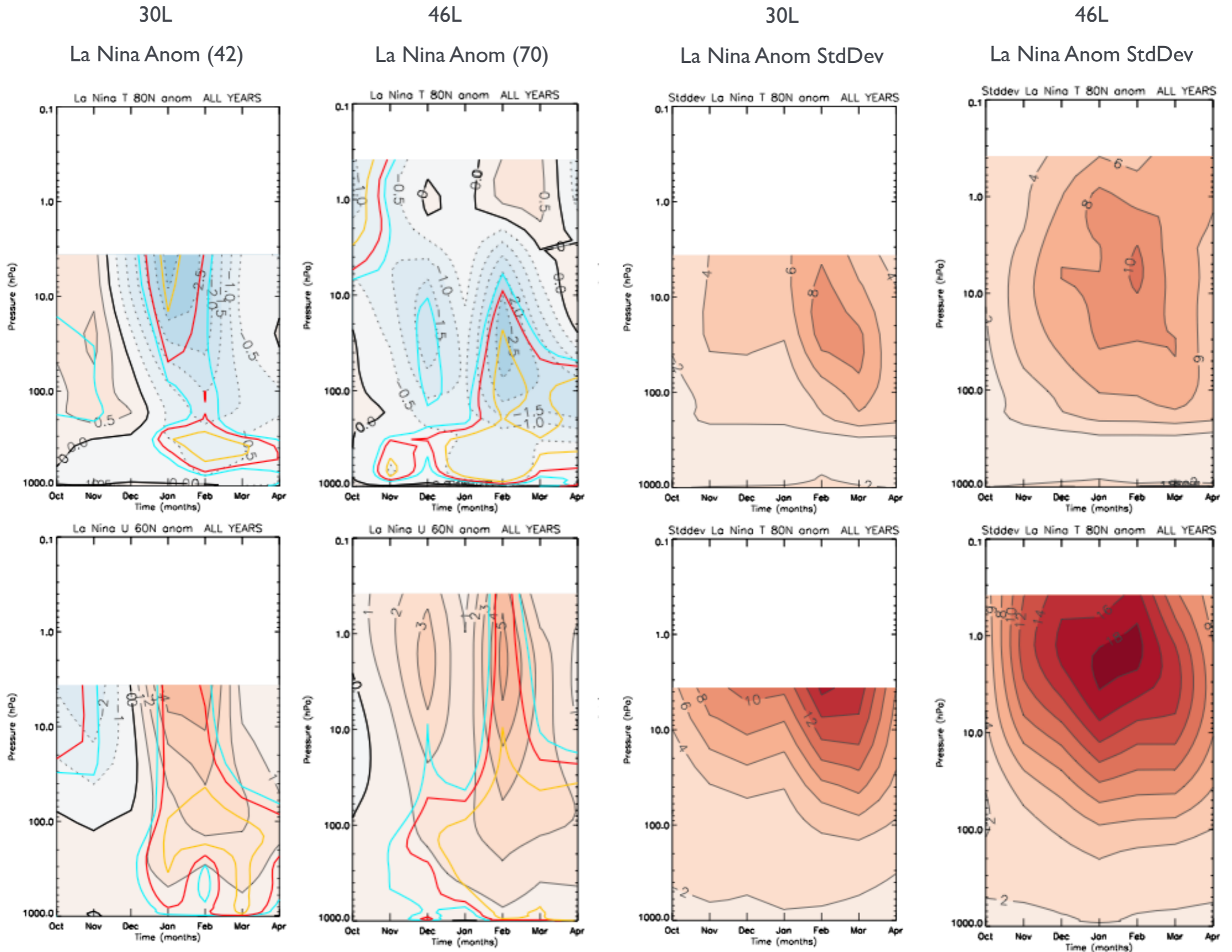


- The QBO increases the variability of the ENSO teleconnections
- Downward propagation of El Niño anomaly at 80N to the surface does not require presence of SSWs (non-SSW stratospheric pathway)
- The ‘stratospheric pathway’, however is stronger when SSWs are present

# La Nina Response

T80N

U60N



# La Nina Response

30L

La Nina Anom (48)

46L

La Nina Anom (70)

46L

La Nina /QBO NEU (36)

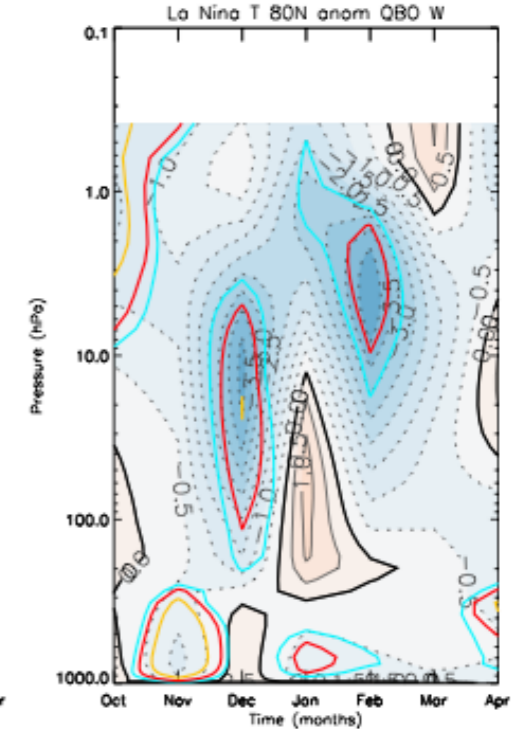
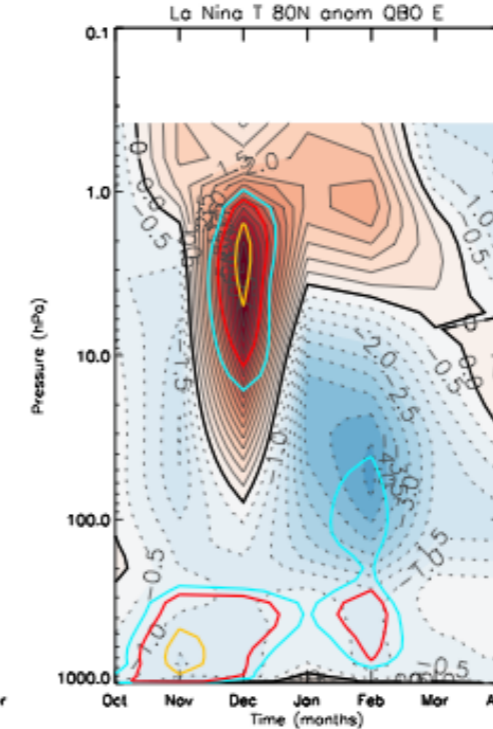
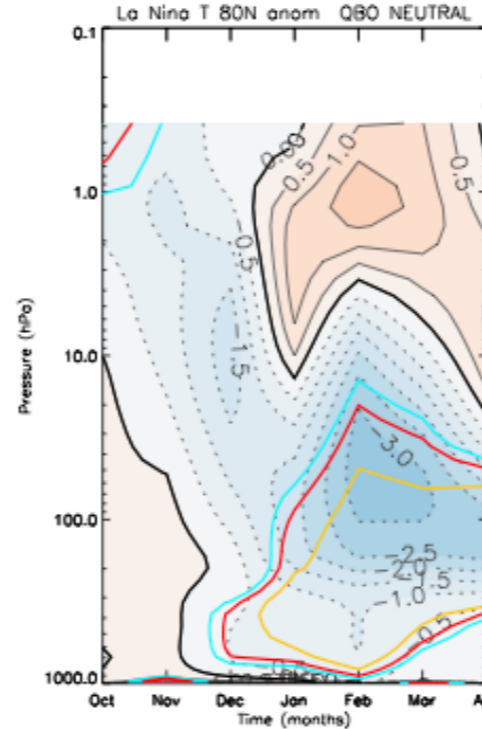
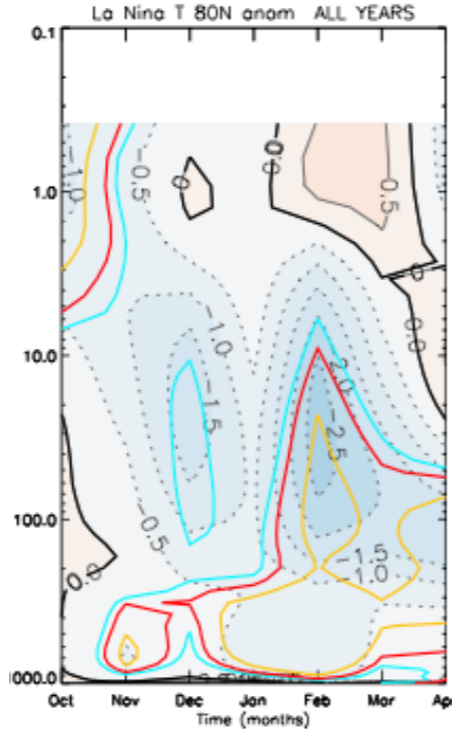
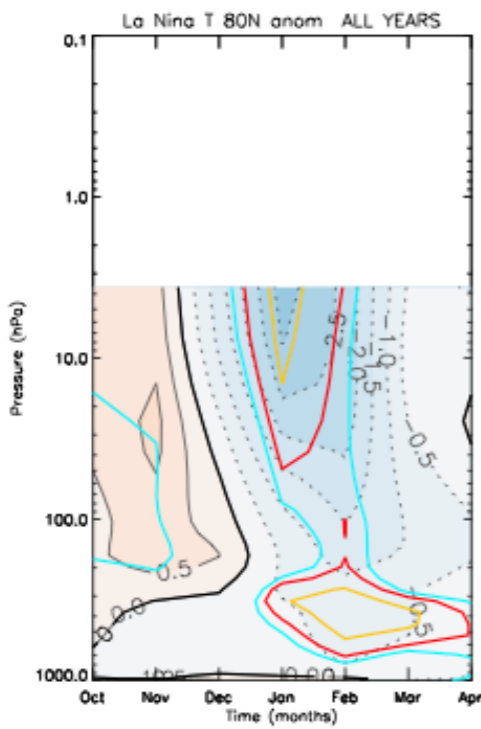
46L

La Nina/QBO E (8)

46L

La Nina/QBO W (26)

T80N



U60N

