

POLAR MIDLATITUDE TELECONNECTIONS IN A SIMPLE CLIMATE

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cmcc
Centro Euro-Mediterraneo
sui Cambiamenti Climatici

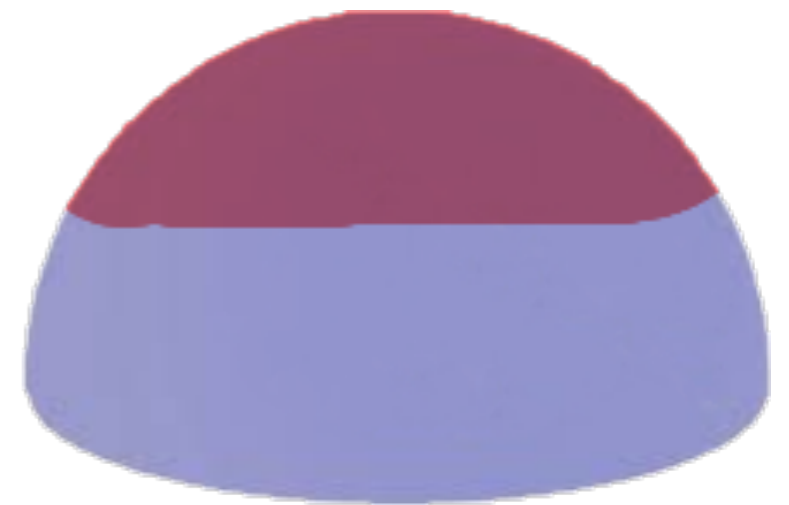
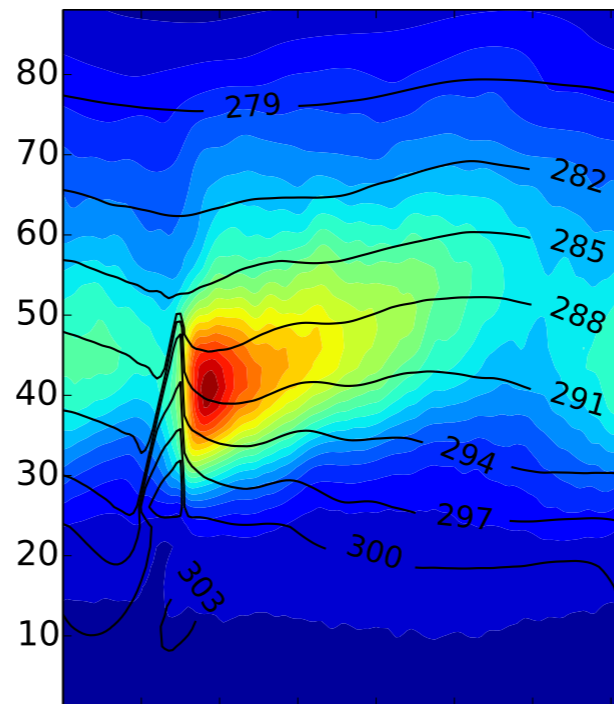
OVERVIEW

SPEEDY
ICTP-AGCM + SLAB
OCEAN

AQUAPLANET

STORM TRACK

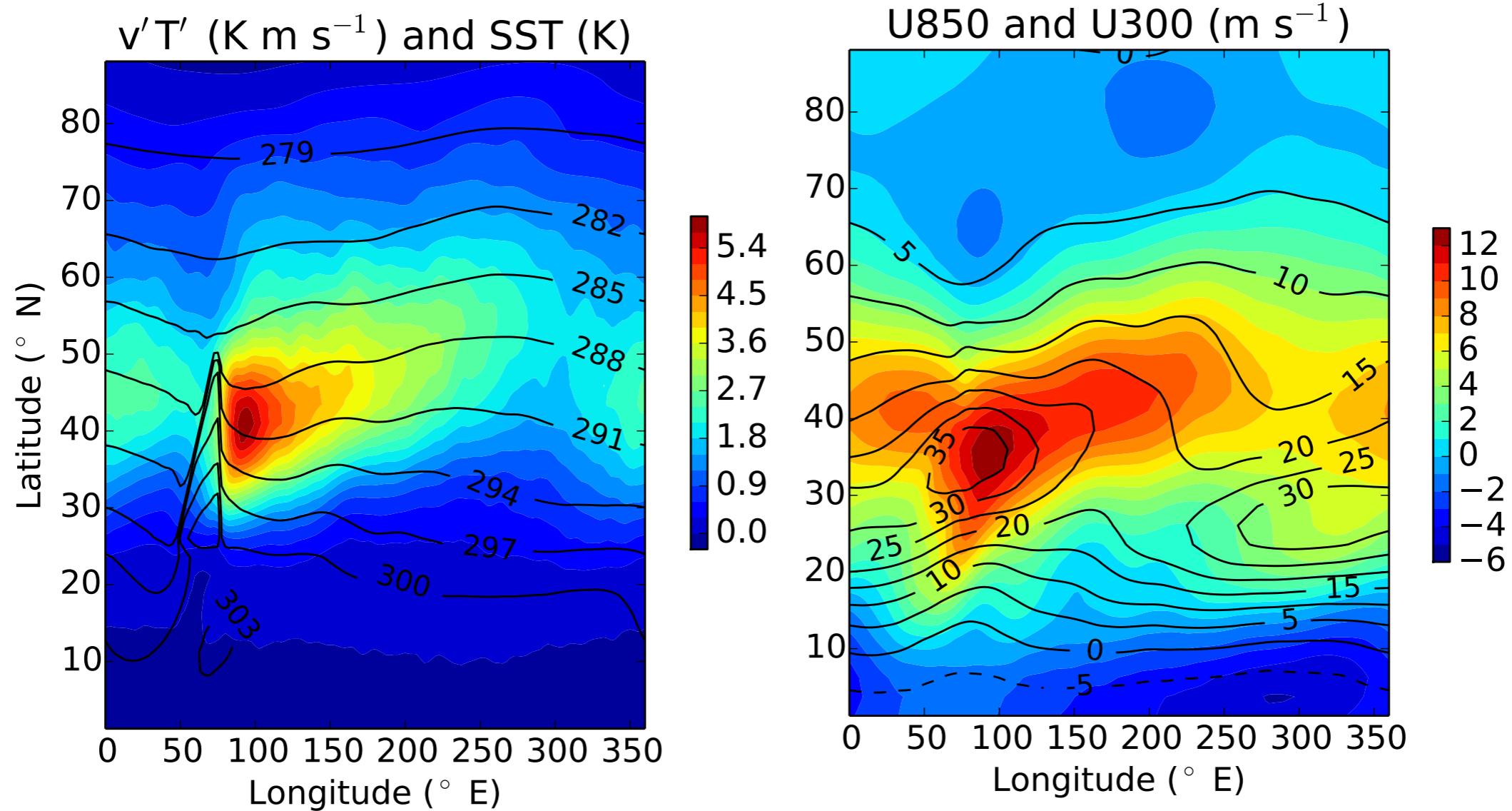
POLAR SURFACE
HEATING



SIMPLE FLOW AND SIMPLE SURFACE

LOCALISED MID-LATITUDE STORM TRACK

WN1 STATIONARY WAVE PATTERN

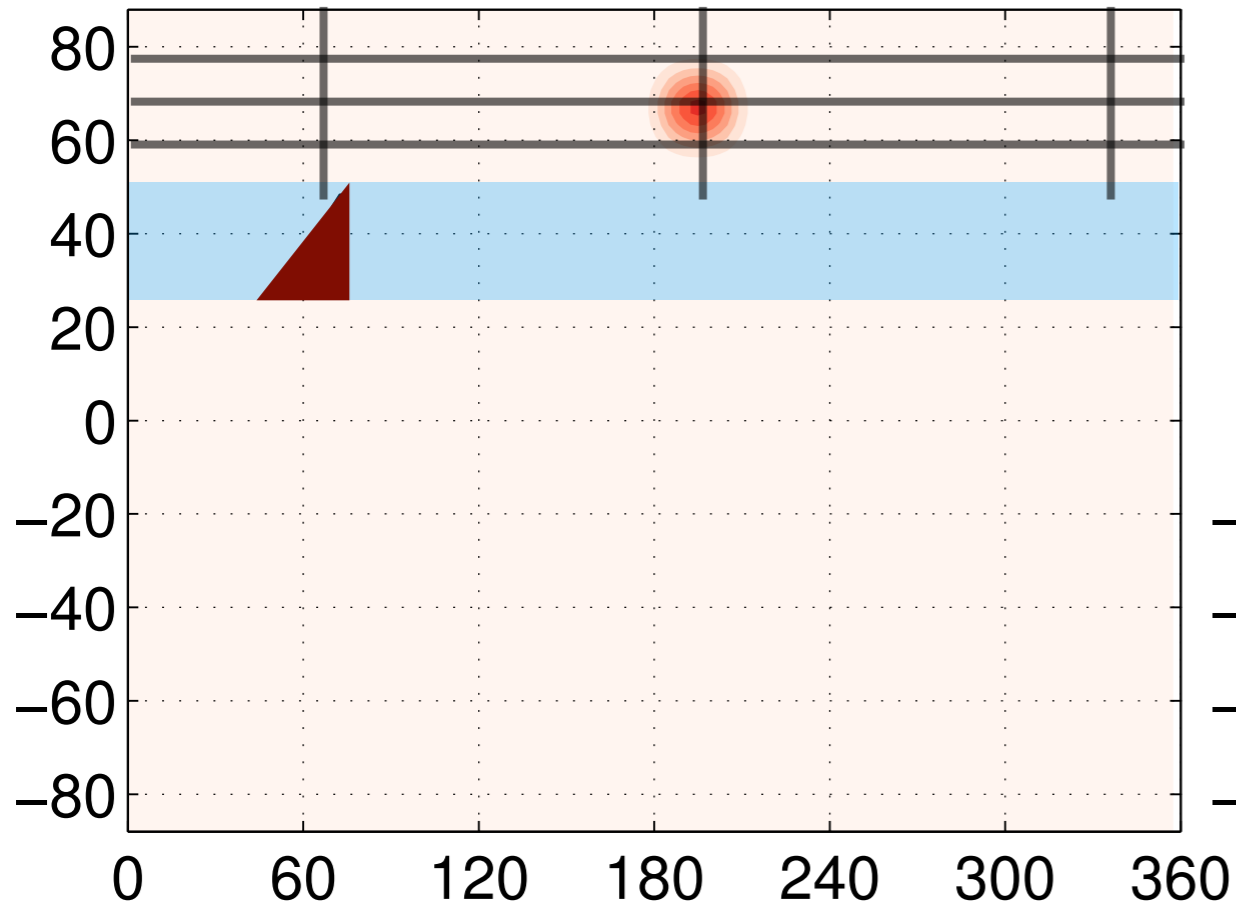


Introduced by Kaspi and Schneider 2013 JAS

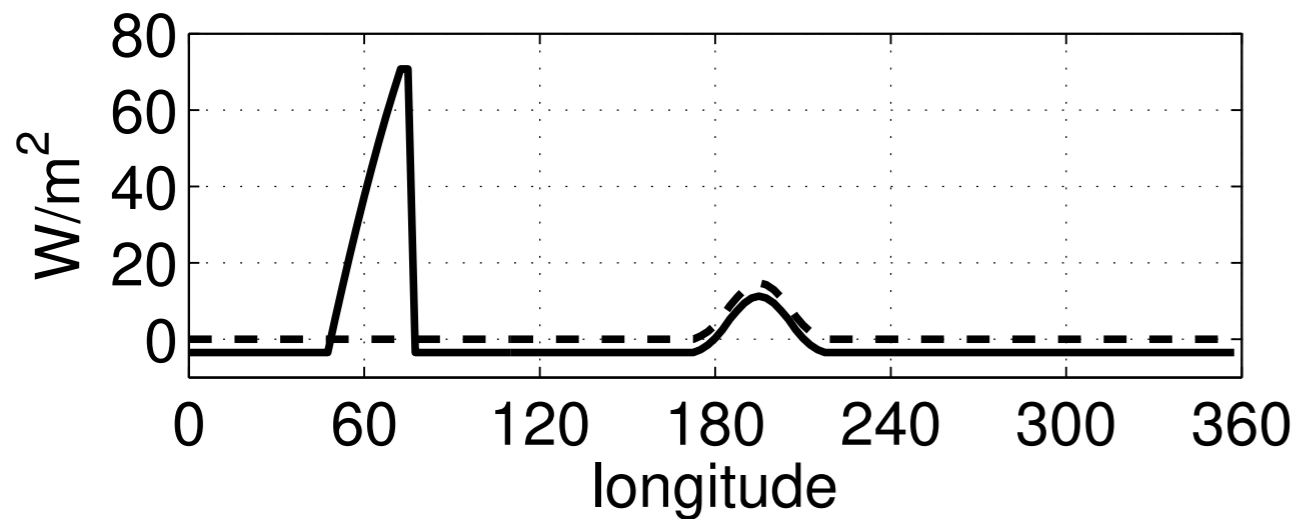
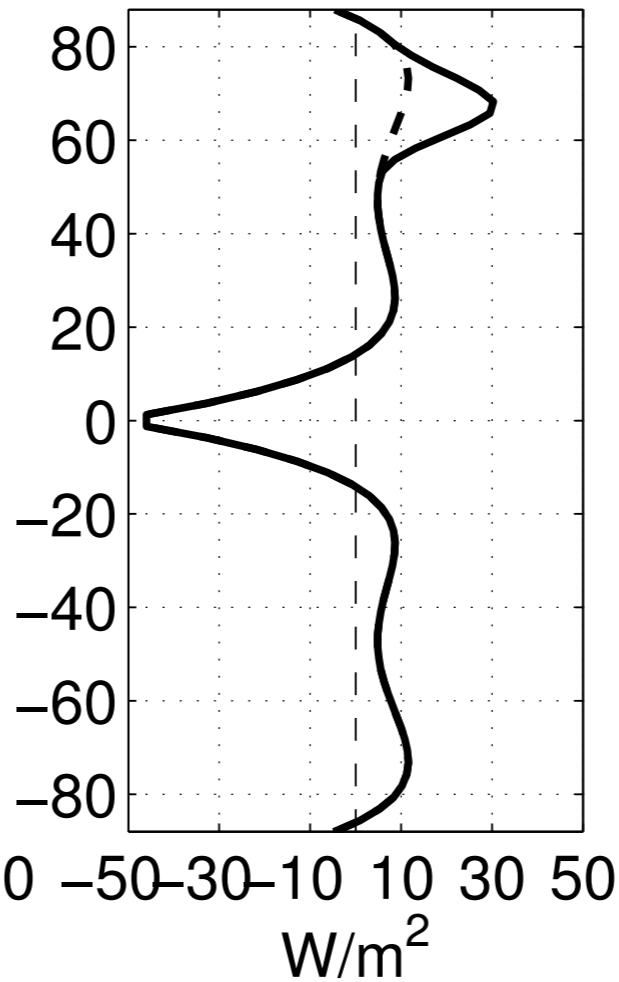


POLAR TELECONNECTIONS

Ocean Qflux



zonal mean

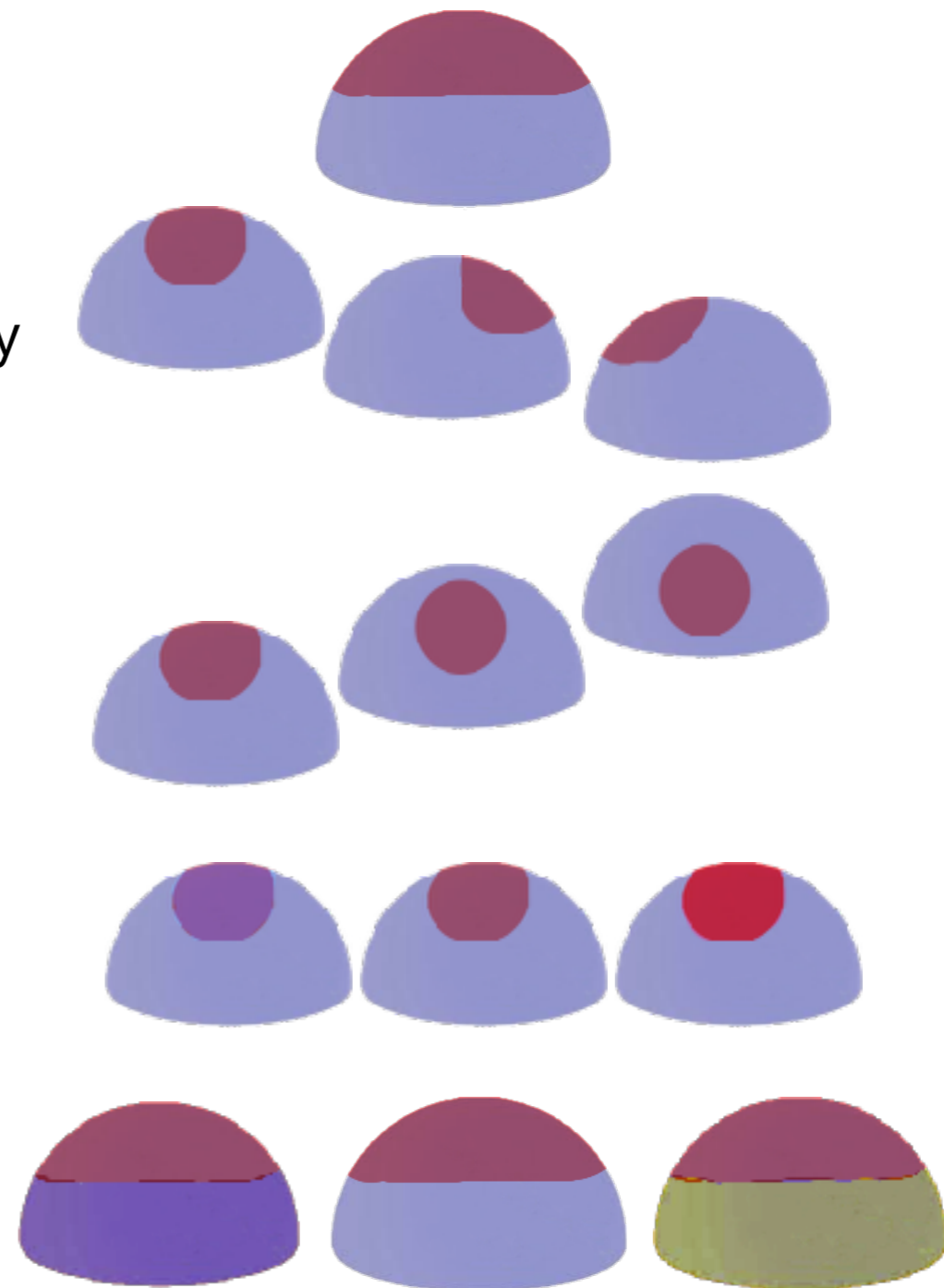


- ◆ 1 year integrations
- ◆ 50 members
- ◆ Additional Heating in polar regions
- ◆ Total power conserved
- ◆ Angular extent conserved
- ◆ Perpetual equinox



EXPERIMENTS

- **Spin Up** with idealised storm track
- **Zonally symmetric forcing**
60-90 °N
- **Sectorial Heating:** longitudinal sensitivity
8 longitudes at 65/67.5/70 °N
- **Sectorial Heating:** latitudinal sensitivity
6 latitudes in 3 sectors
upstream, downstream, storm track
- **Magnitude sensitivity**
60-90 °N
- **Mean state sensitivity**
60-90 °N



EXPERIMENTS

- **Spin Up** with idealised storm track

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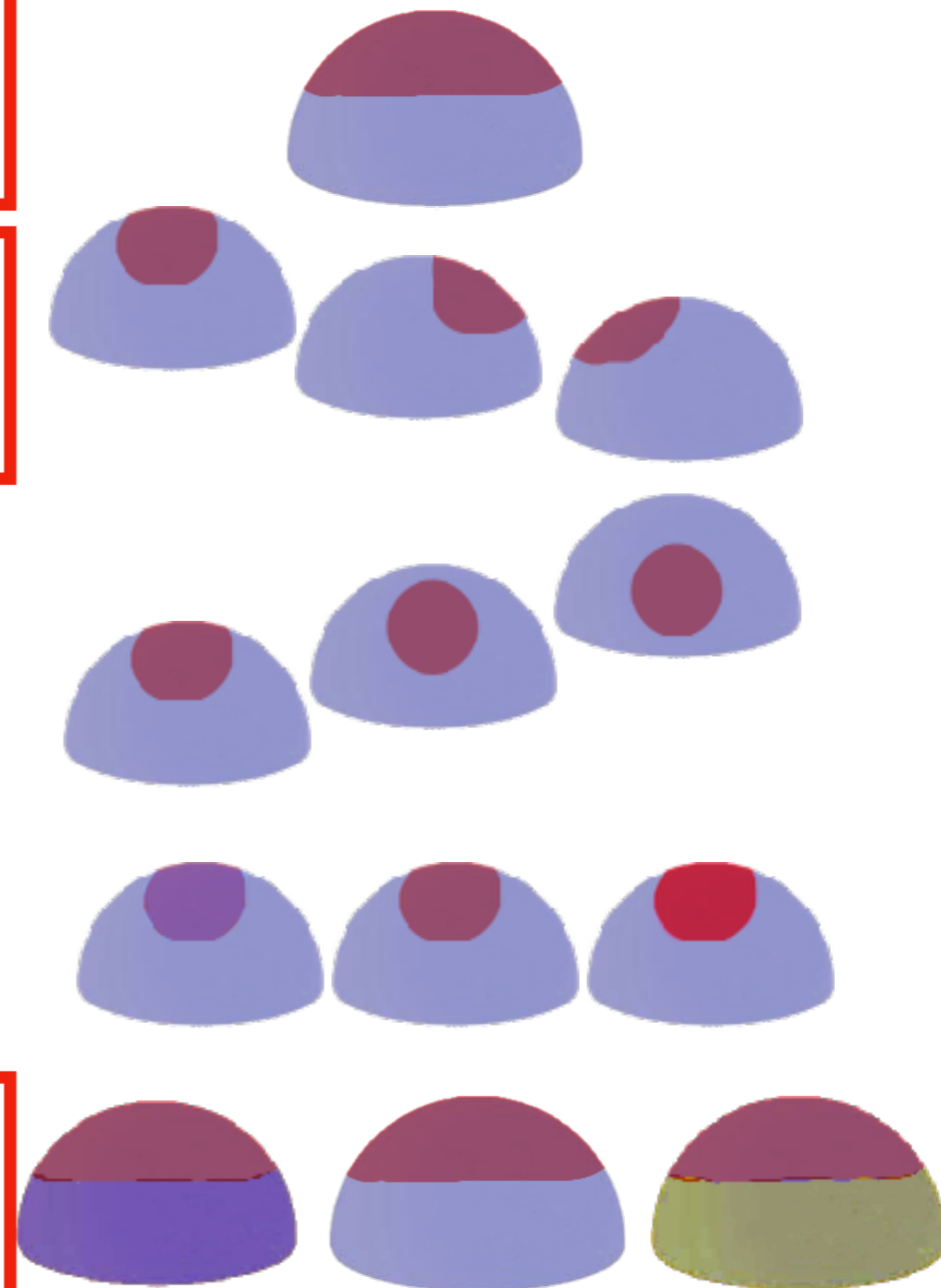
upstream, downstream, storm track

- **Magnitude sensitivity**

60-90 °N

- **Mean state sensitivity**

60-90 °N



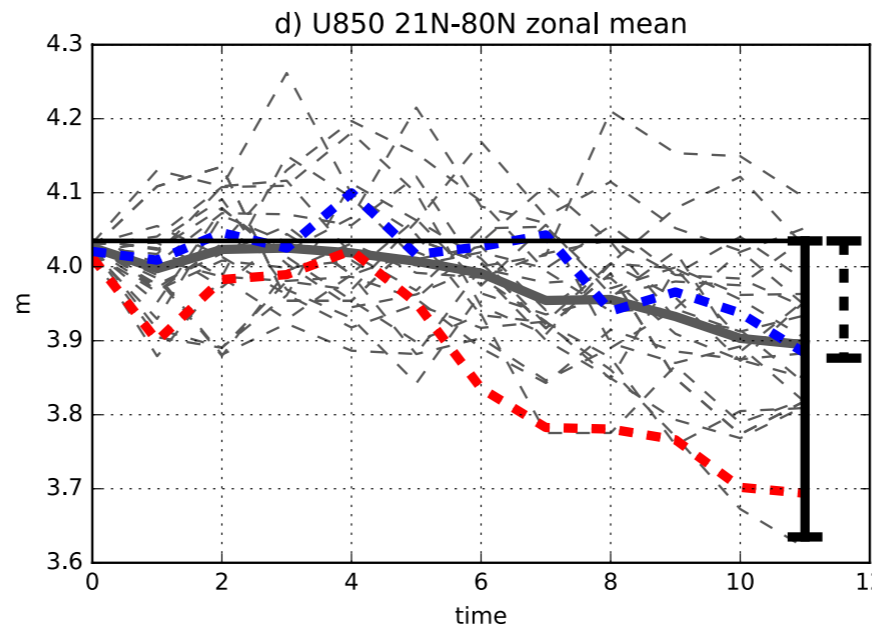
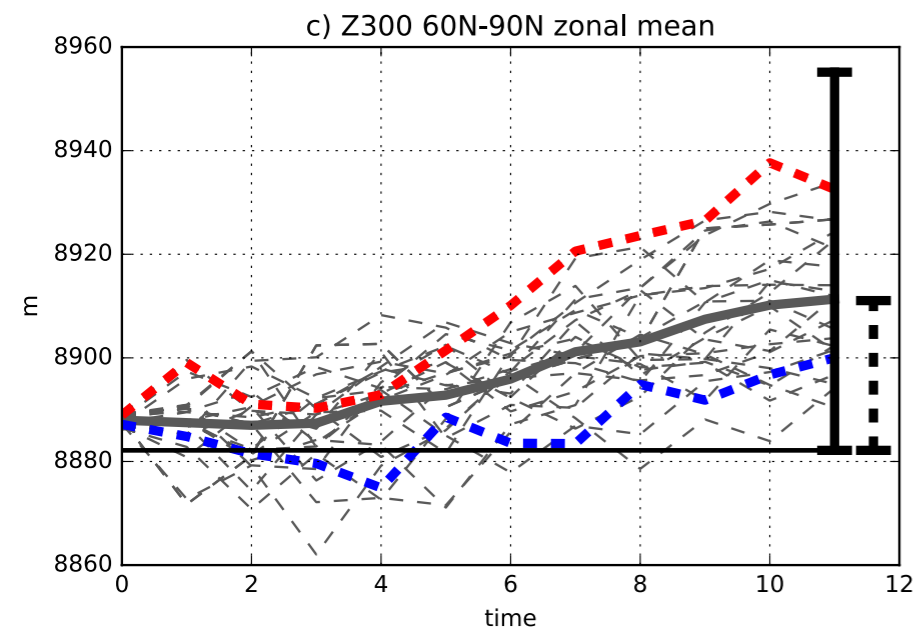
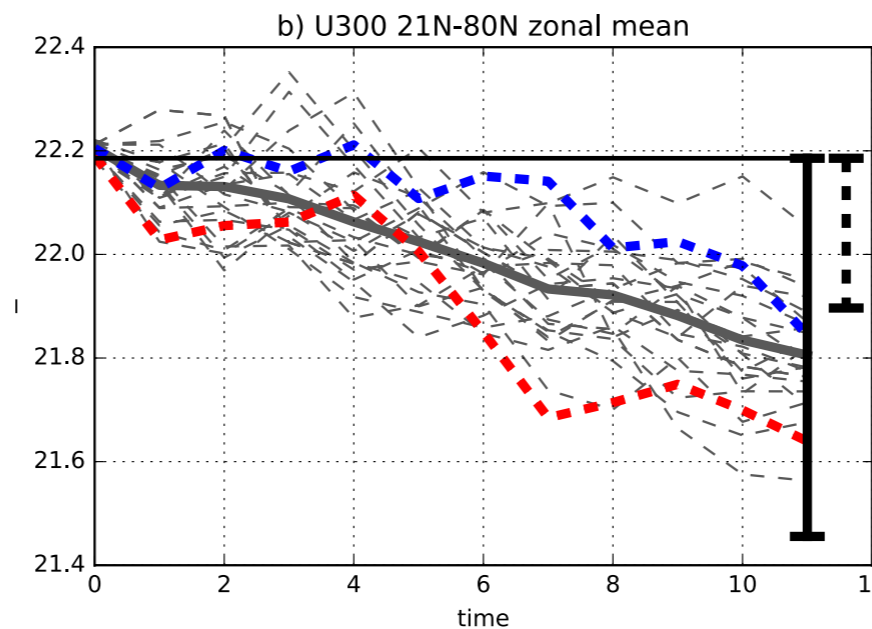
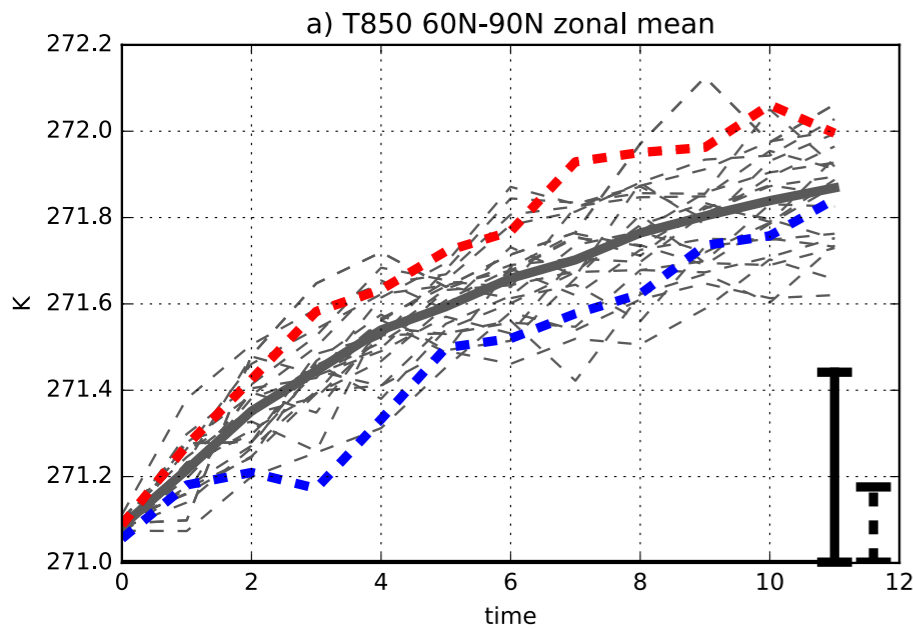
OVERVIEW: ATMOSPHERIC RESPONSE

Multi exp. mean

Single exp. mean

1 exp

Zonally sym. forcing



Polar Cap about 0.5 K warmer at 850 hPa

Upper troposphere flow weaker 0.2 m/s

+15 m 300 hPa Polar Cap height

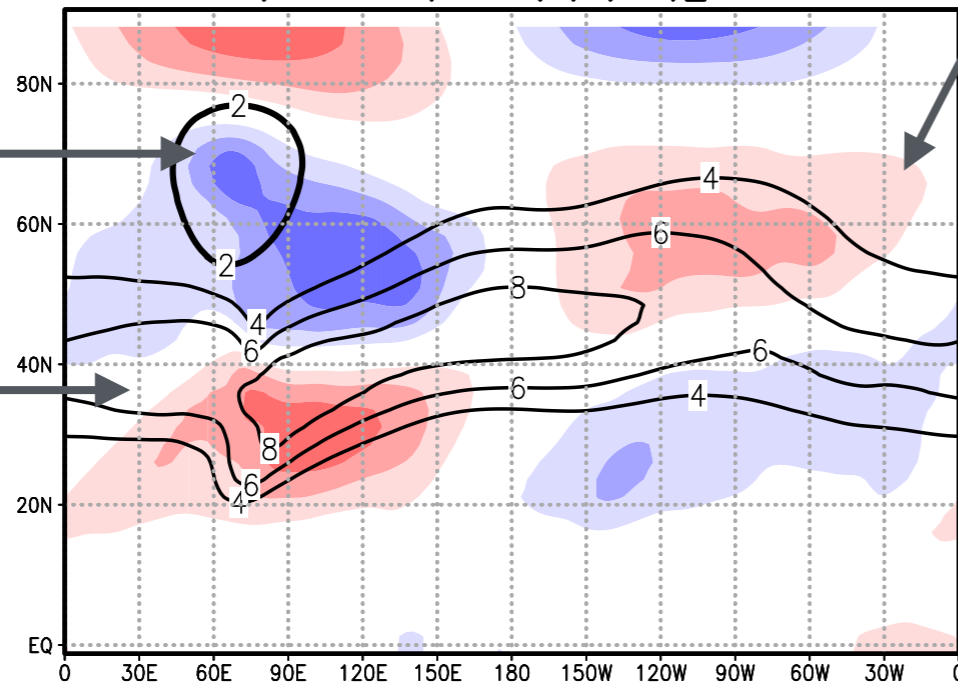
Equatorward shift Low level wind



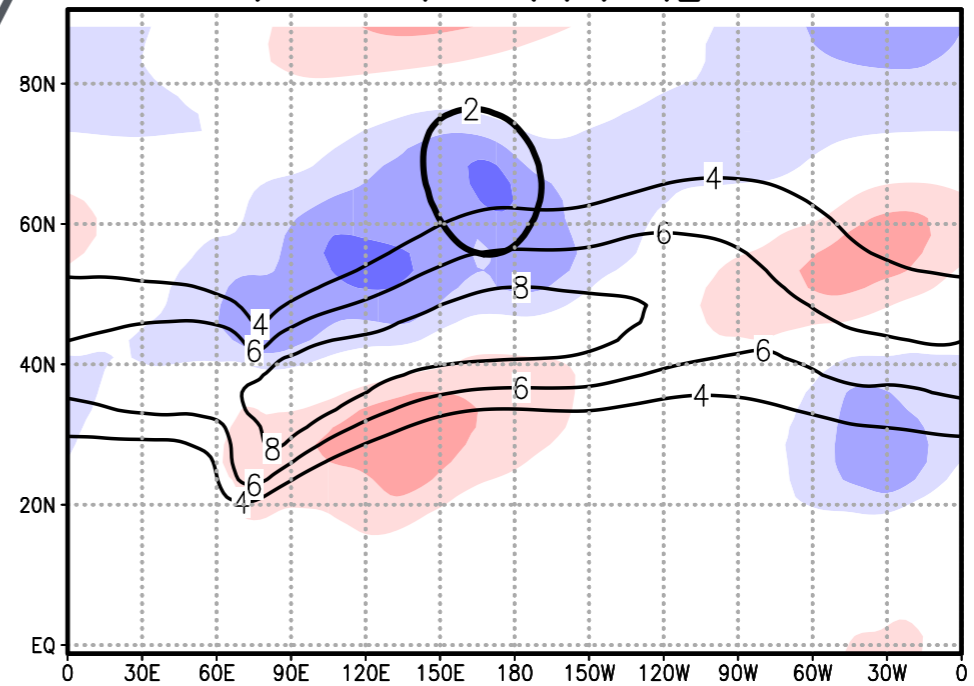
LONGITUDINAL DEPENDENCE

U850
response

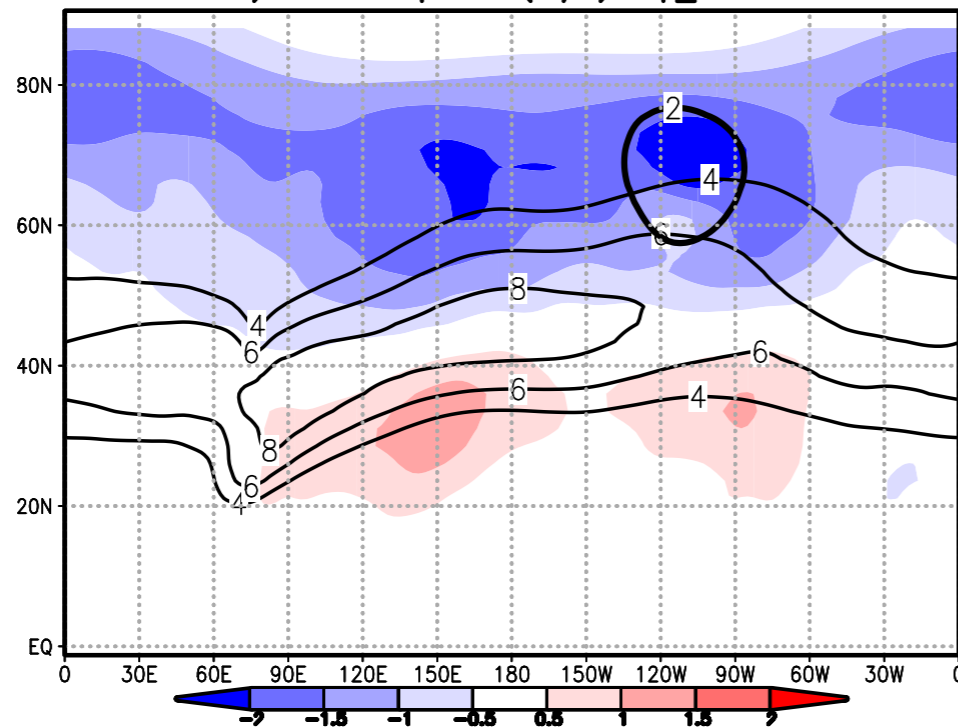
a) U850 response (m/s) exp_N62



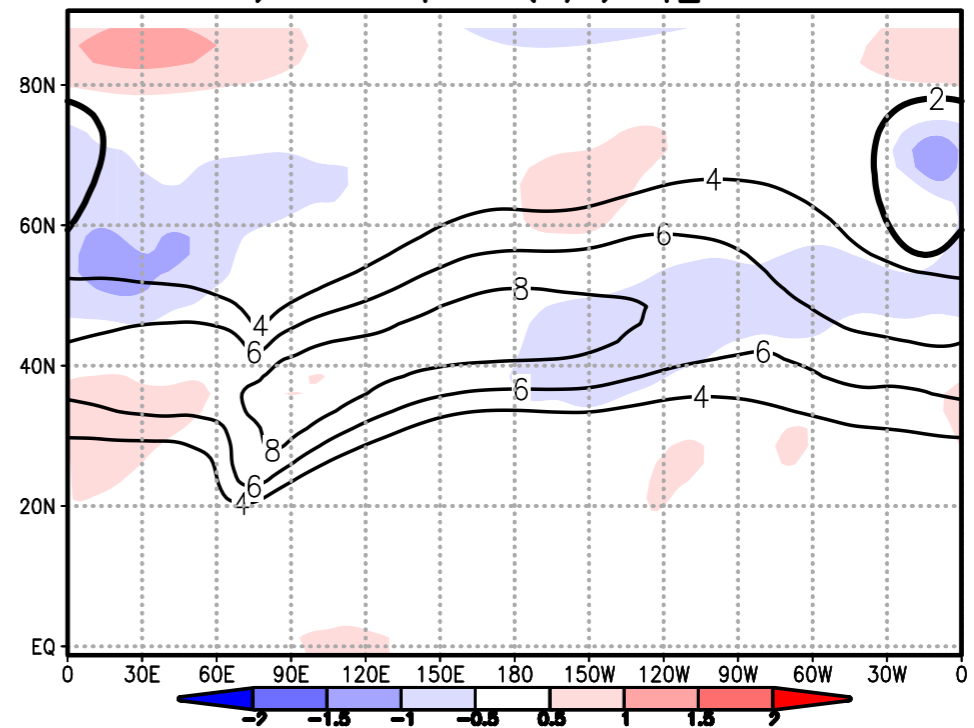
b) U850 response (m/s) exp_N156



c) U850 response (m/s) exp_N250



d) U850 response (m/s) exp_N344



T850
response

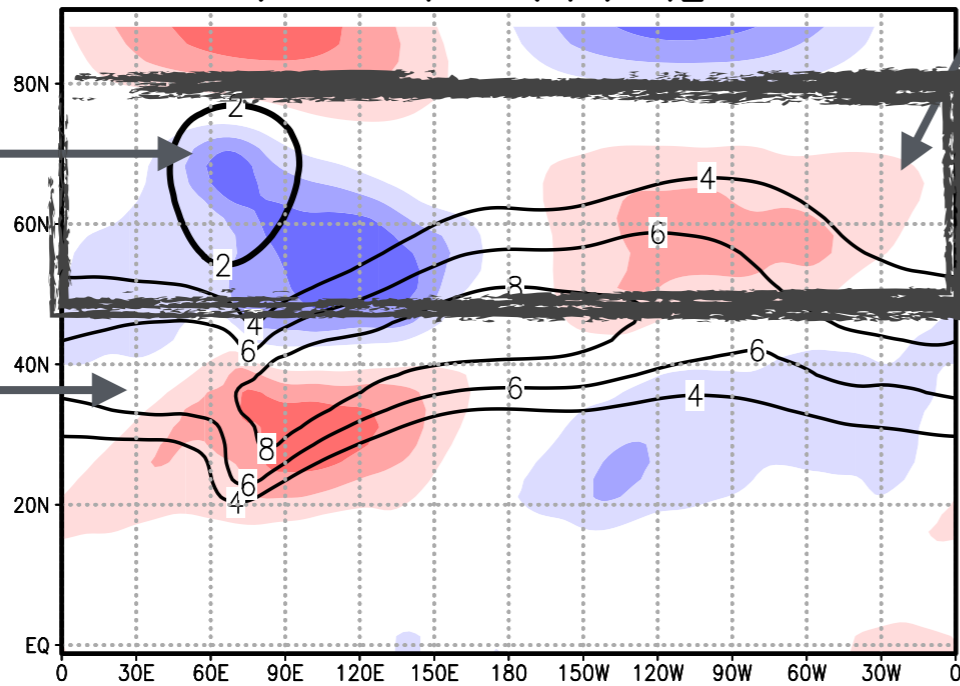
U850
Climatology



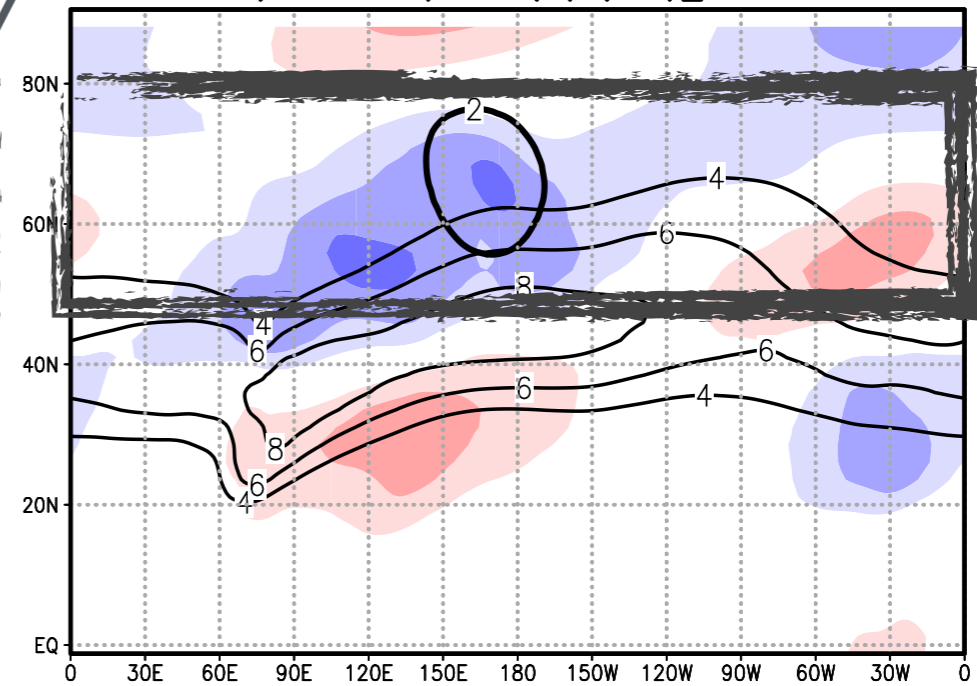
LONGITUDINAL DEPENDENCE

U850
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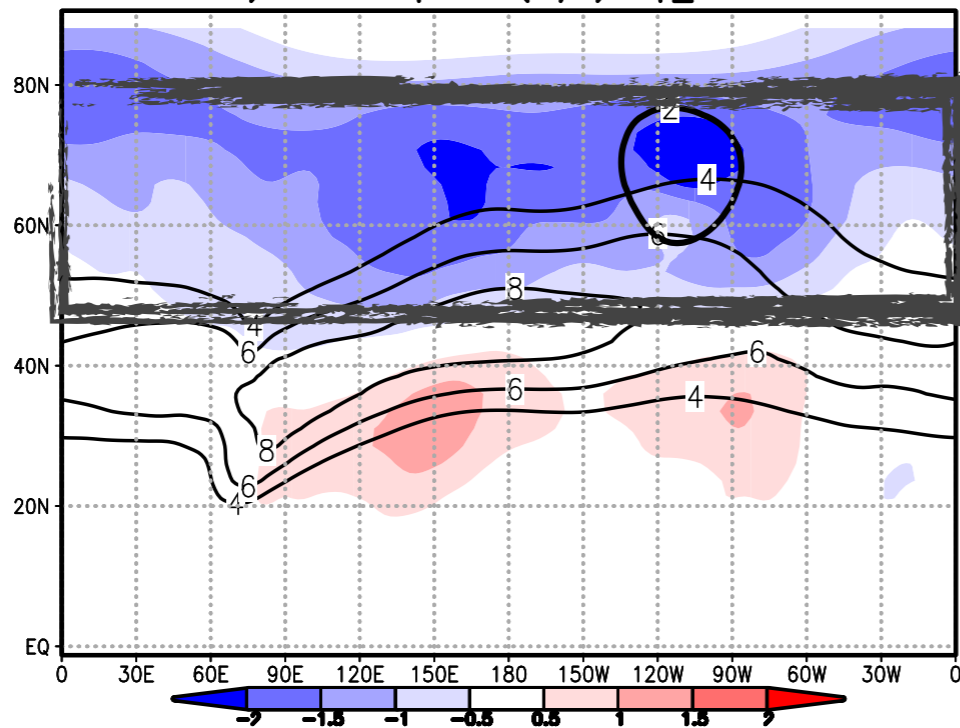
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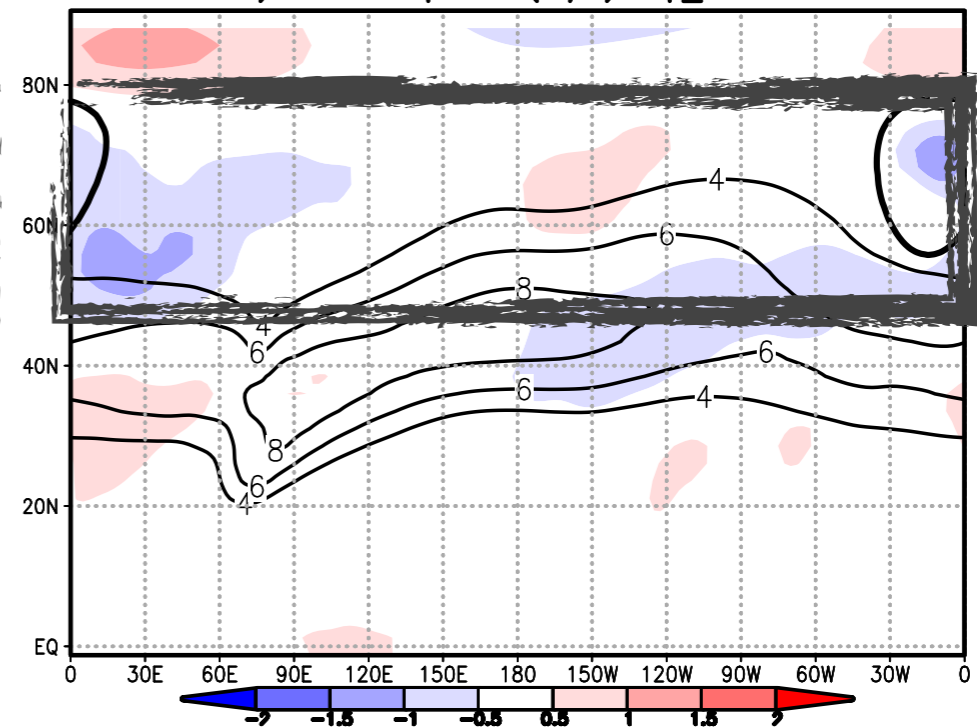
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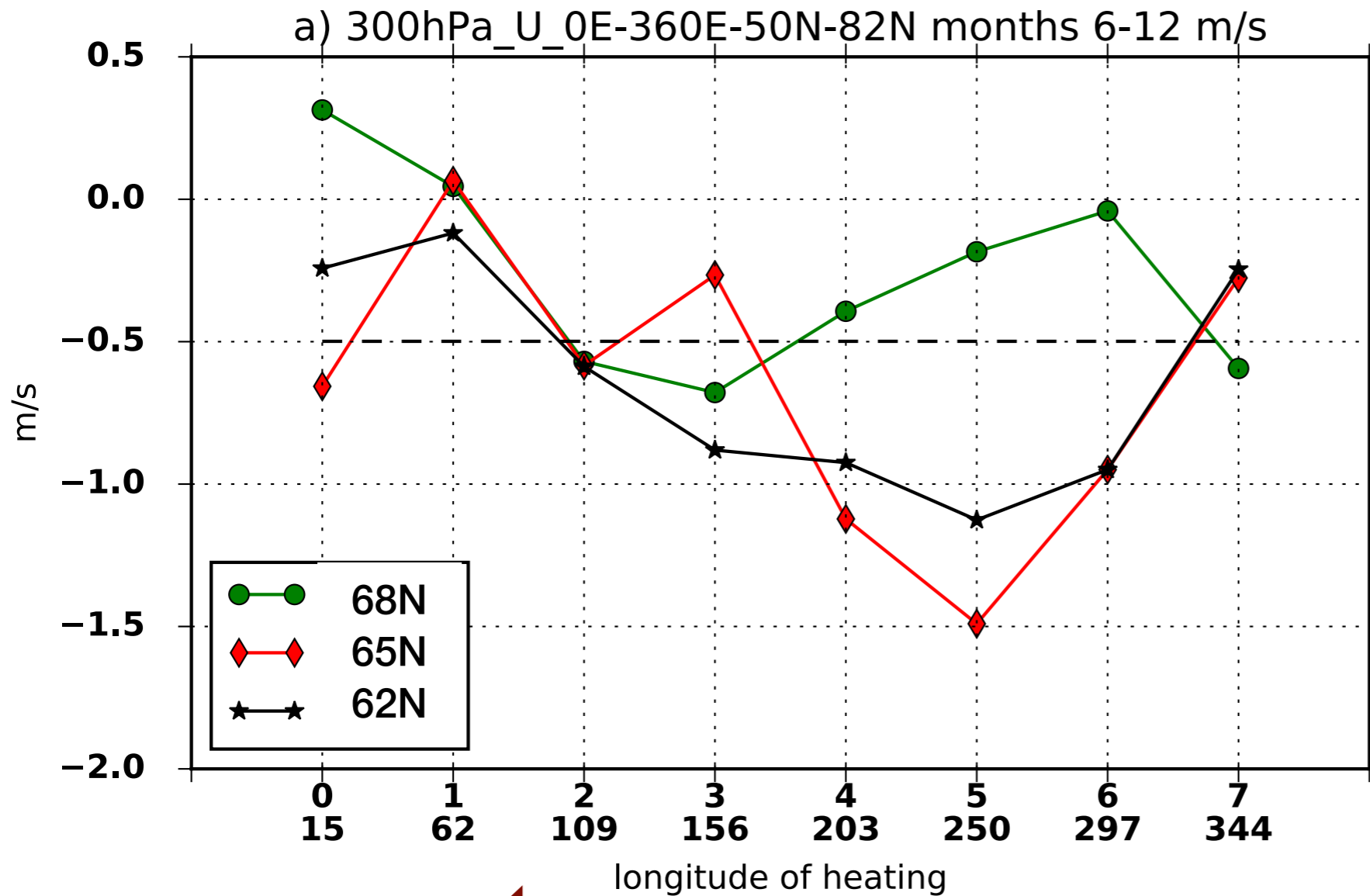


T850
response

U850
Climatology



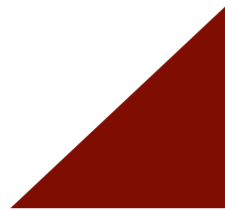
UPPER TROPOSPHERE



Strong longitudinal dependence

Latitudinal dependence only in downstream region

Fluctuations around response to zonal mean forcing



MIDLAT PERTURBATION

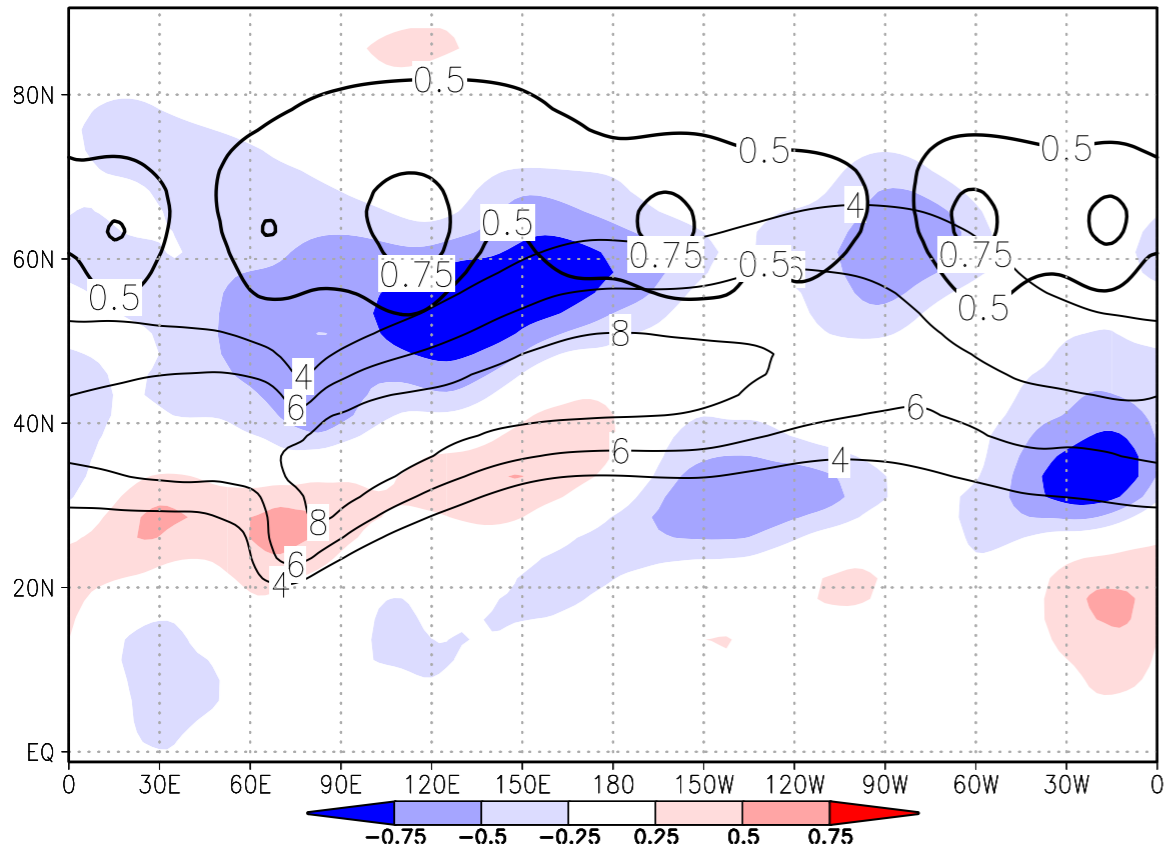


MAXIMUM JET LAT

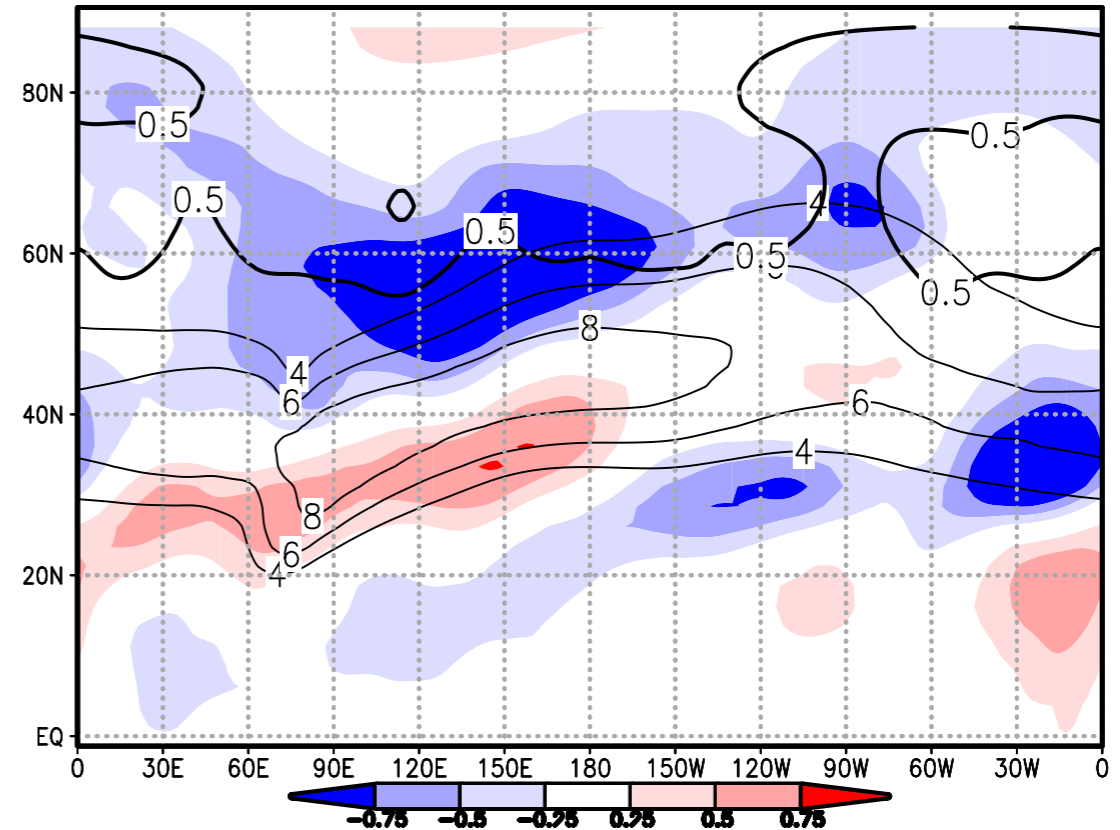


MEAN RESPONSE IN THE UPPER TROPOSPHERE

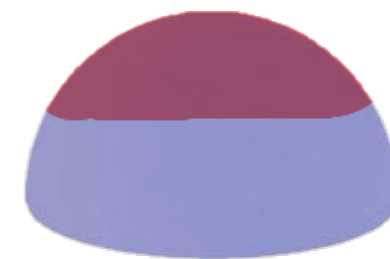
a) U300 response (m/s) N-C-S



b) U300 response (m/s) exp_Z0



N



STORM TRACK - WAVE PROPAGATION



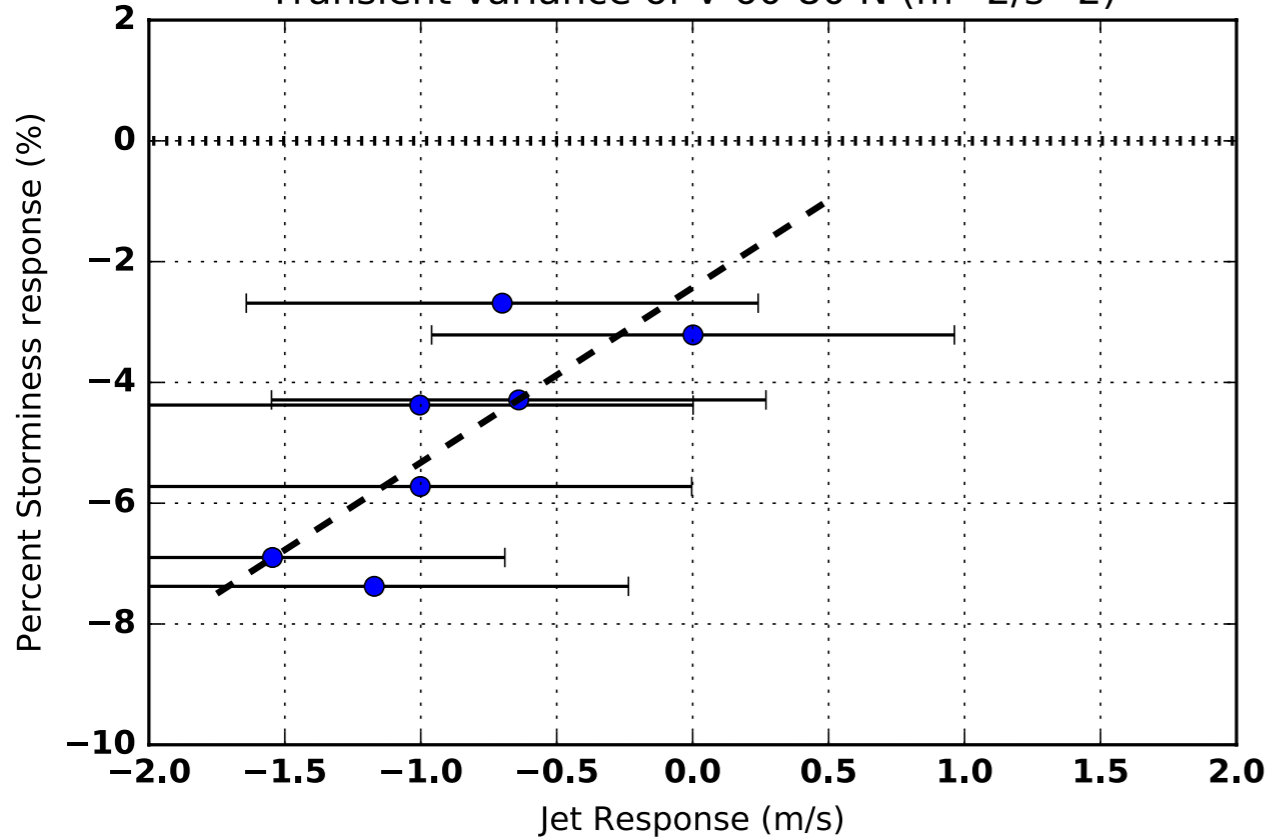
STORM TRACK

Reduction of global transient eddy activity (TEKE)

Reduction of poleward propagation correlated with response

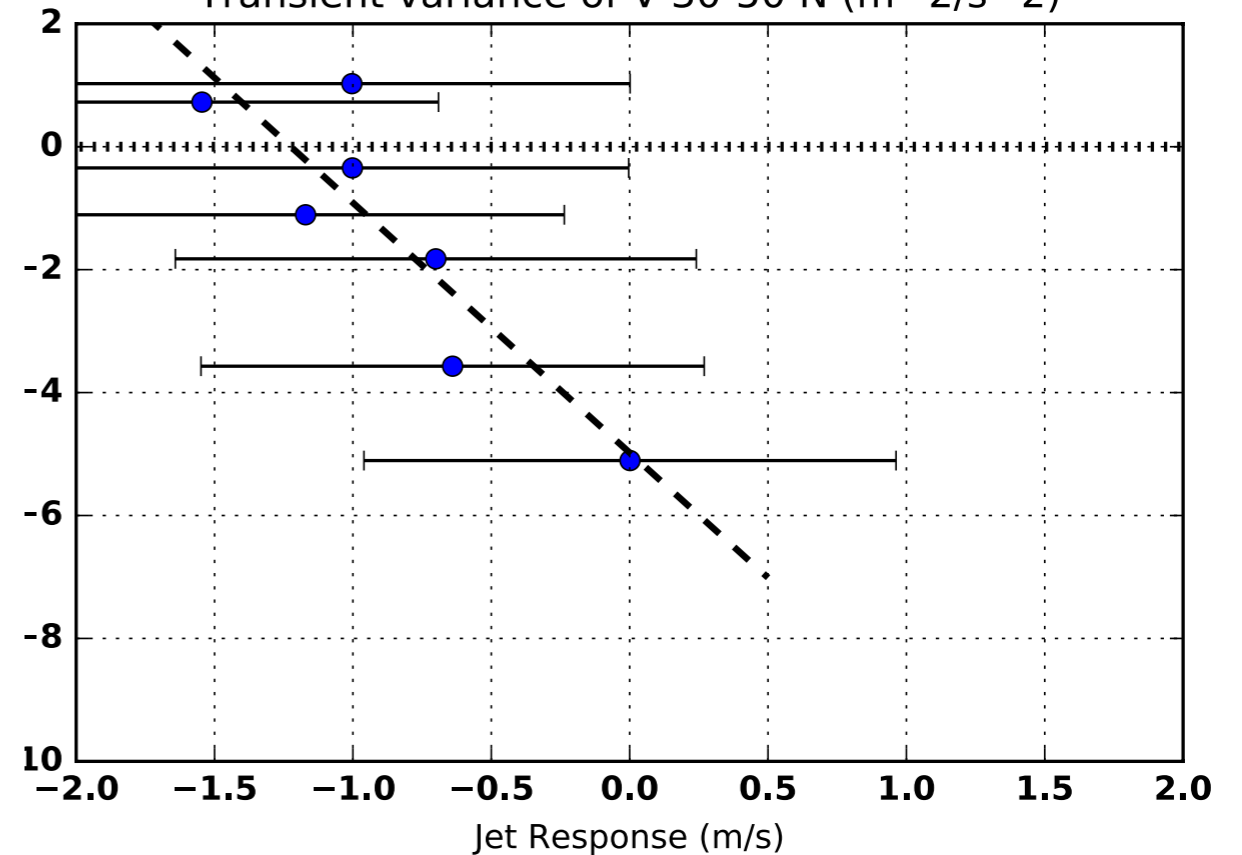
HIGH LAT V'^2

Transient variance of V 60-80 N (m^2/s^2)

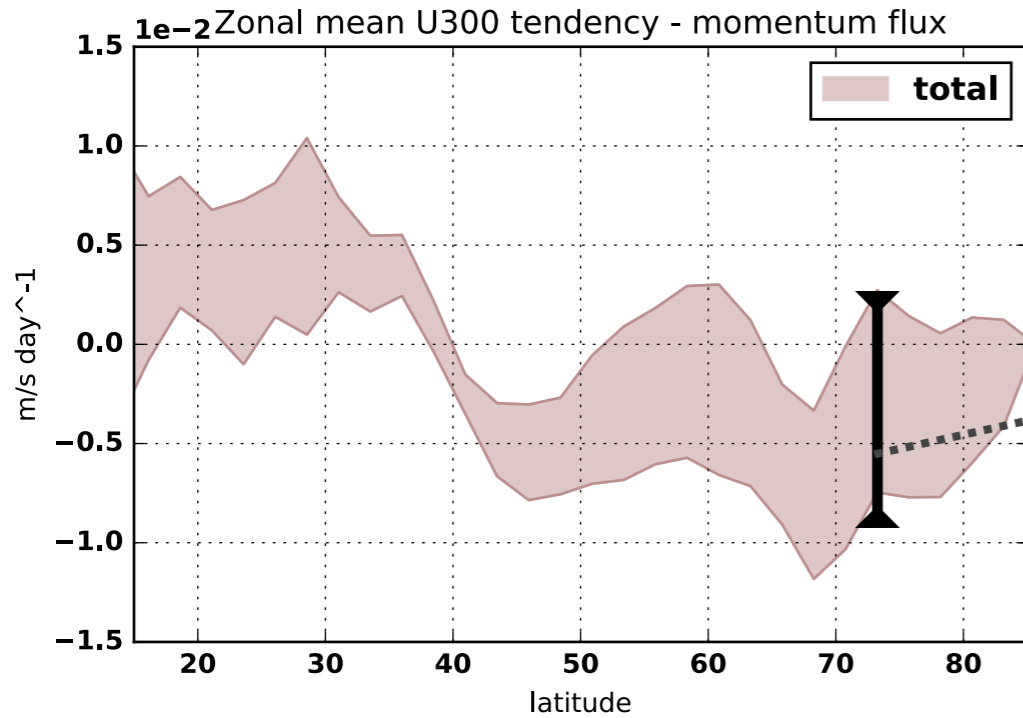


MIDLAT V'^2

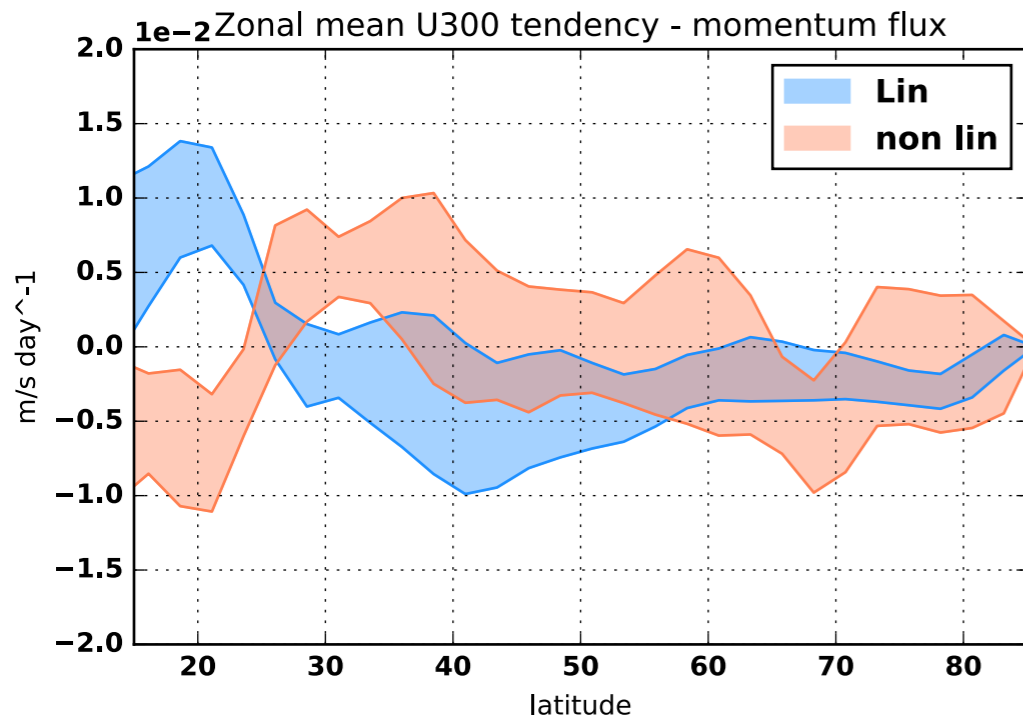
Transient variance of V 30-50 N (m^2/s^2)



WAVES AND INTERFERENCE



Max-Min values in experiments with heating centered at 68 N



$$\overline{\langle u_{PF}^* v_{PF}^* \rangle} = \langle U_c^* V_c^* \rangle + \langle \Delta U^* V_c^* + U_c^* \Delta V^* \rangle + \langle u_{PF}^*(t) v_{PF}^*(t) \rangle$$

$$\overline{\langle u_{Ctl}^* v_{Ctl}^* \rangle} = \langle U_c^* V_c^* \rangle + \overline{\langle u_{Ctl}^*(t) v_{Ctl}^*(t) \rangle}$$

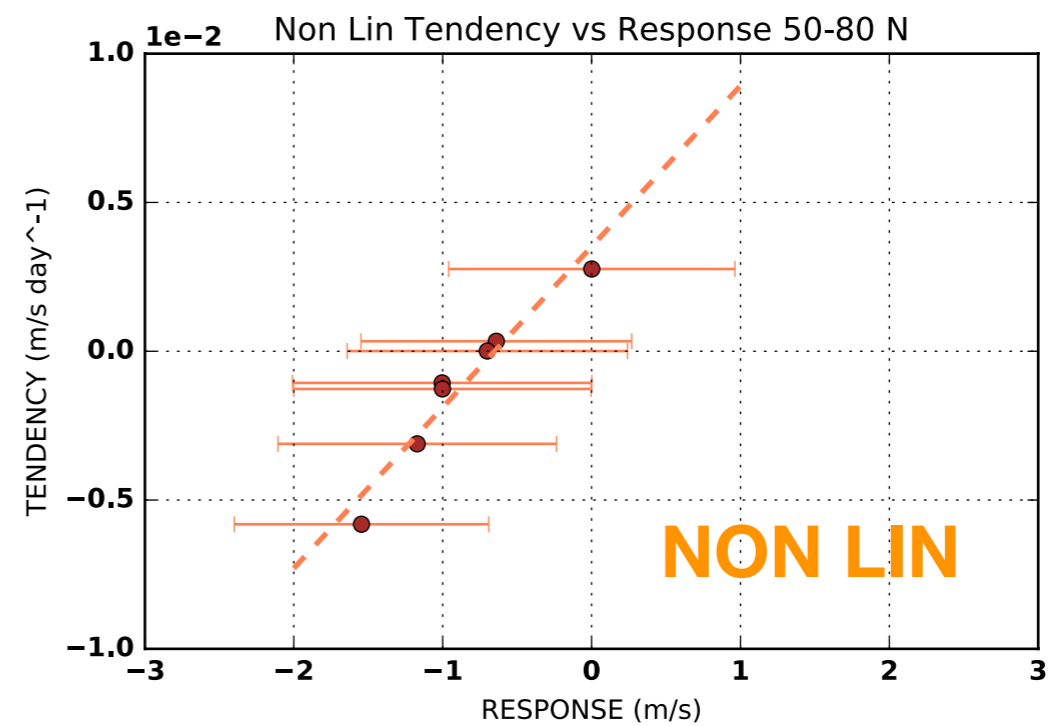
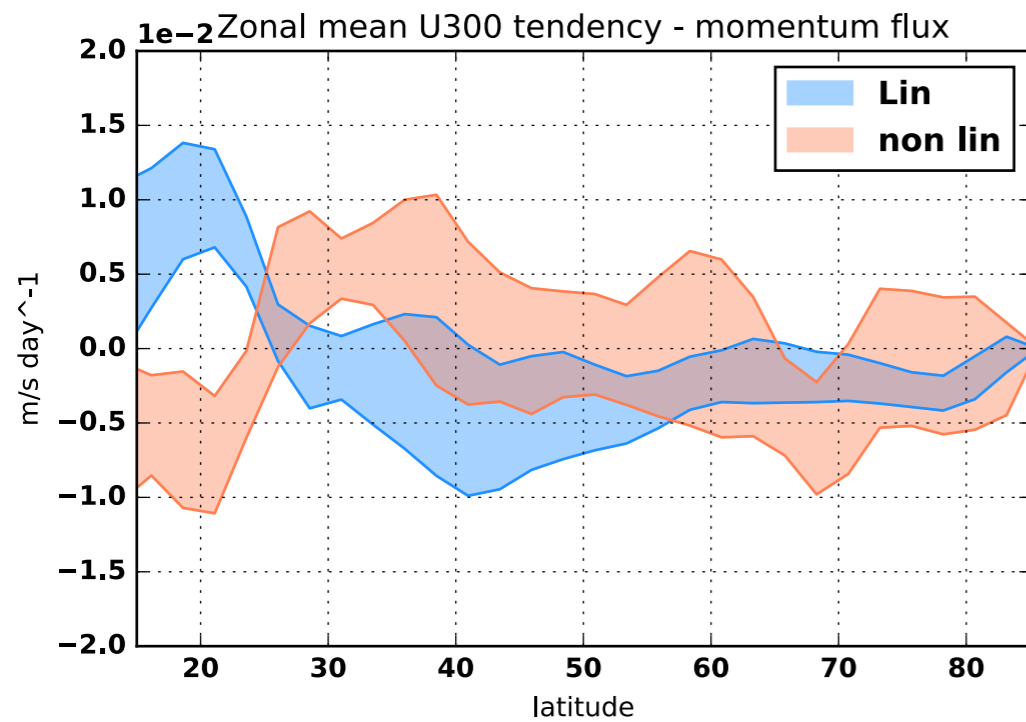
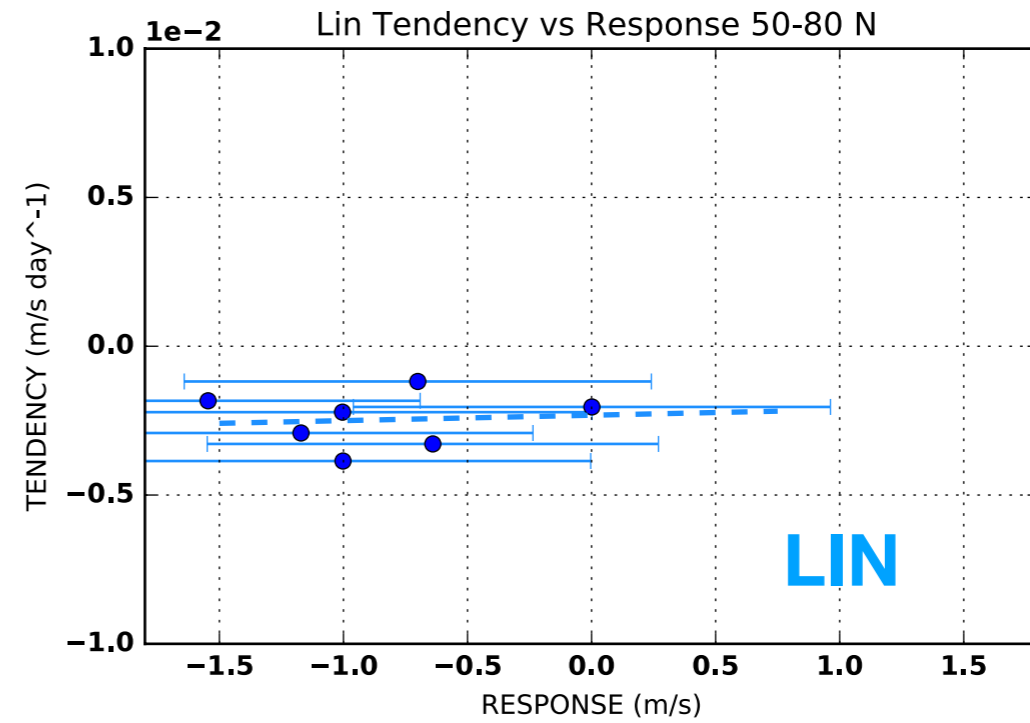
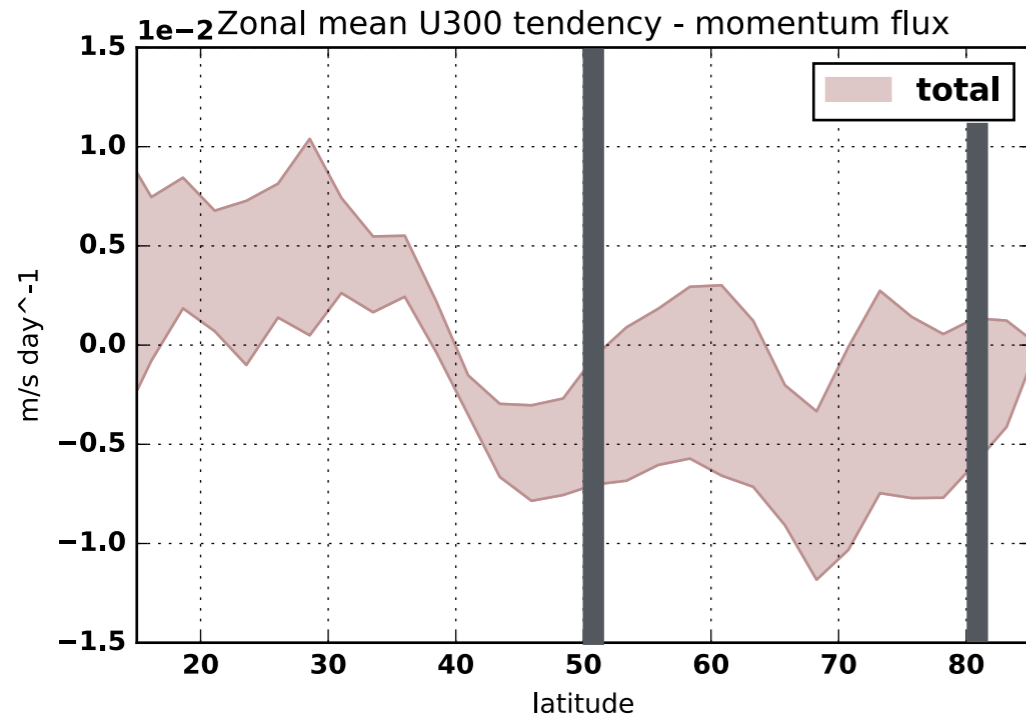
$$\Delta \overline{\langle u_{PF}^* v_{PF}^* \rangle} = \overline{\langle u_{PF}^* v_{PF}^* \rangle} - \overline{\langle u_{Ctl}^* v_{Ctl}^* \rangle} =$$

$$\underbrace{\langle \Delta U^* V_c^* + U_c^* \Delta V^* \rangle}_{\text{INTERFERENCE TERM}} + \underbrace{(\overline{\langle u_{PF}^*(t) v_{PF}^*(t) \rangle} - \overline{\langle u_{Ctl}^*(t) v_{Ctl}^*(t) \rangle})}_{\text{NON LINEAR TERM}}$$

$$\underbrace{\hspace{15em}}_{\text{TOTAL}}$$



LINK WITH ZONAL MEAN RESPONSE



POINTWISE REGRESSION

LINEAR

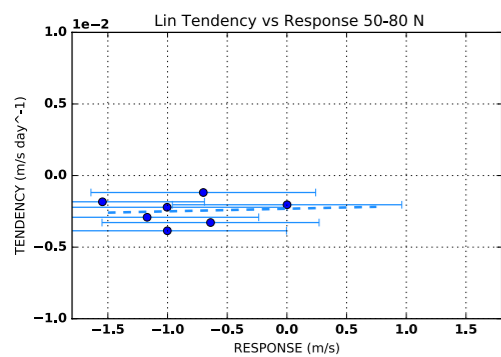
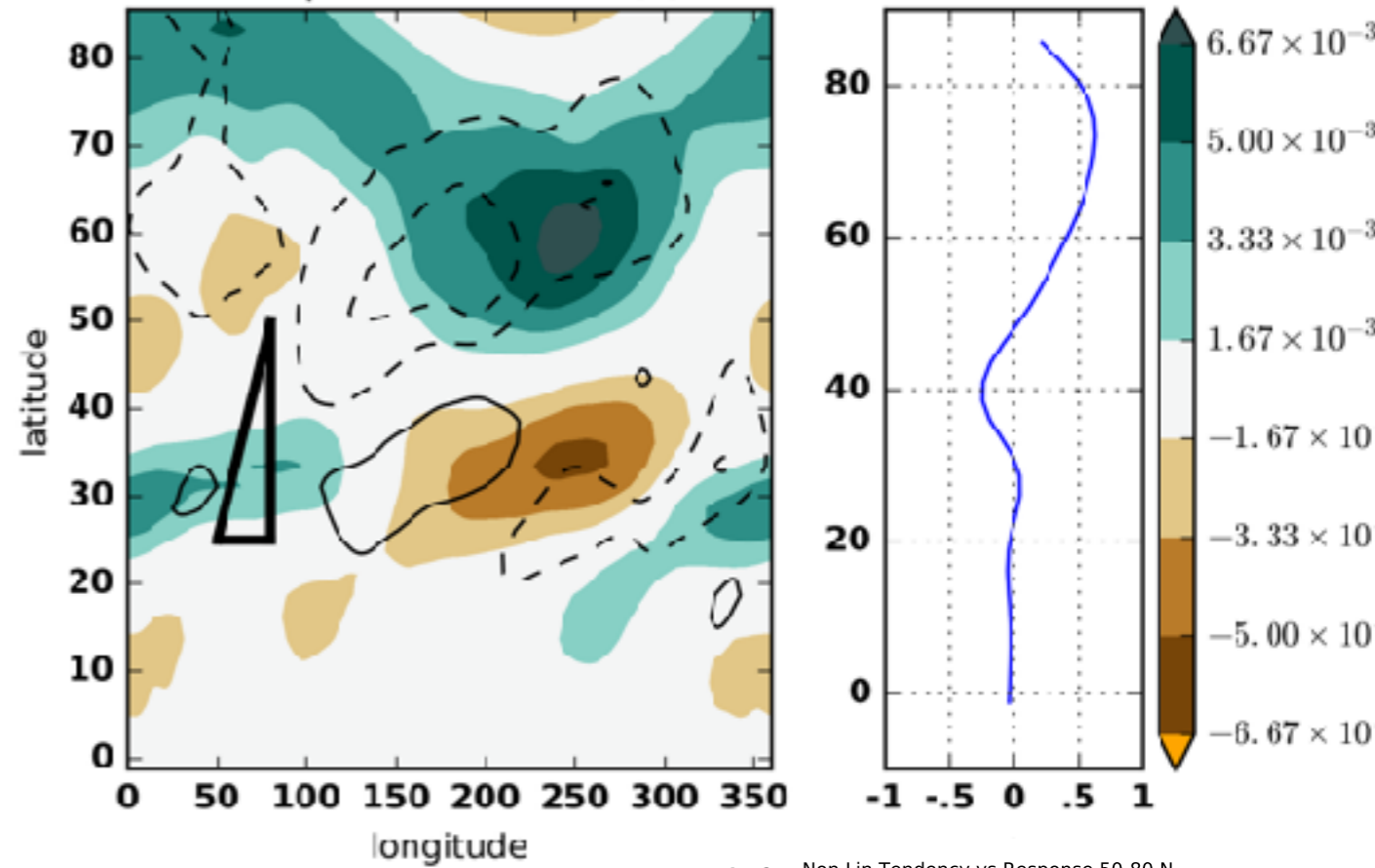
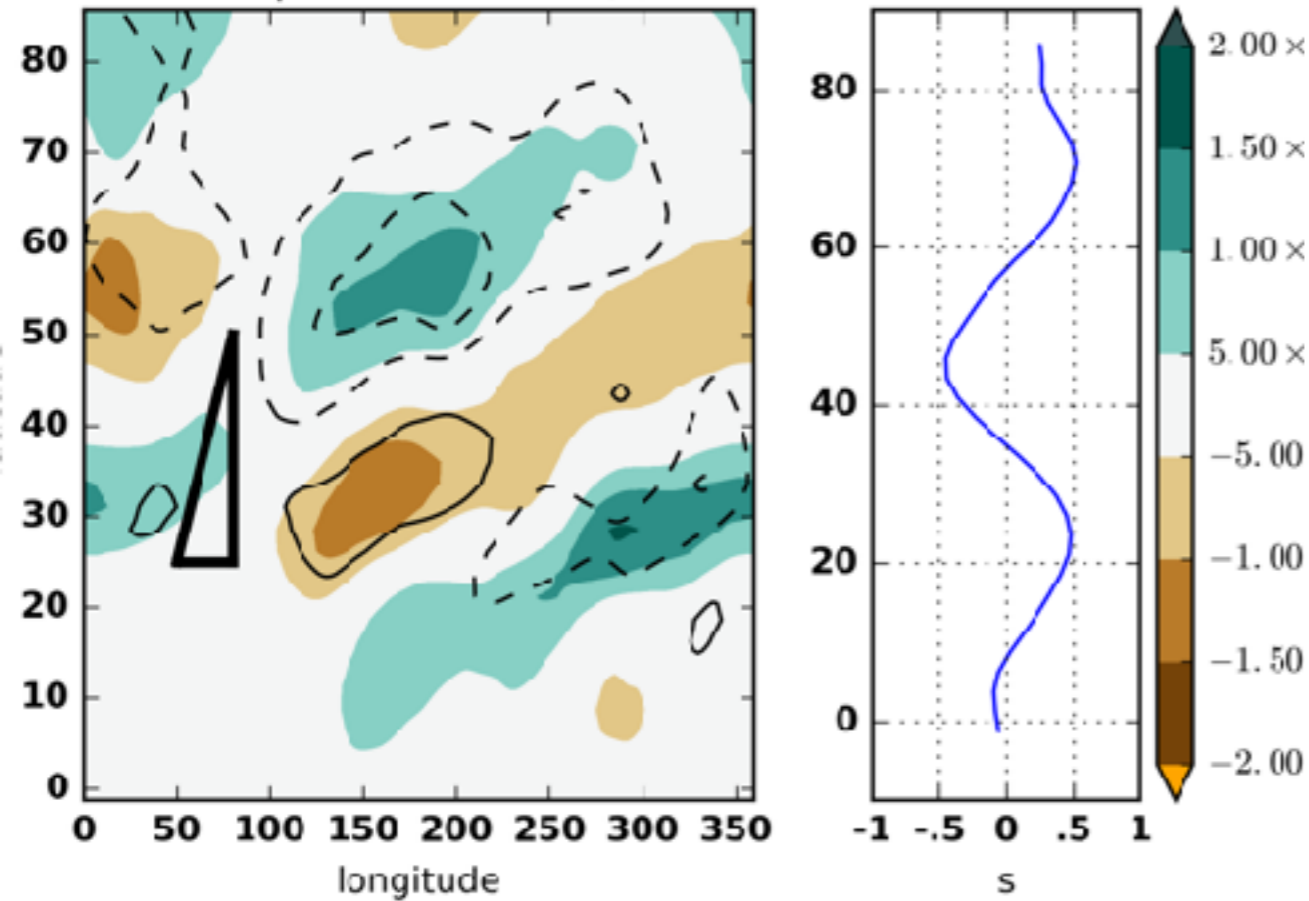
NON LINEAR

Resp. vs Tend. LIN (s)

Zonal mean

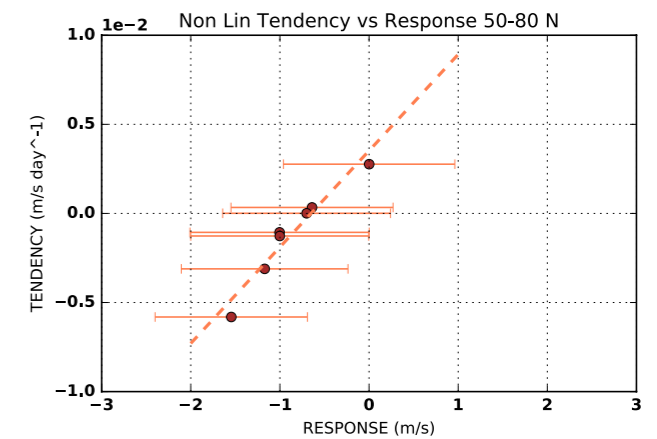
Resp. vs Tend. LIN. (s)

Zonal mean

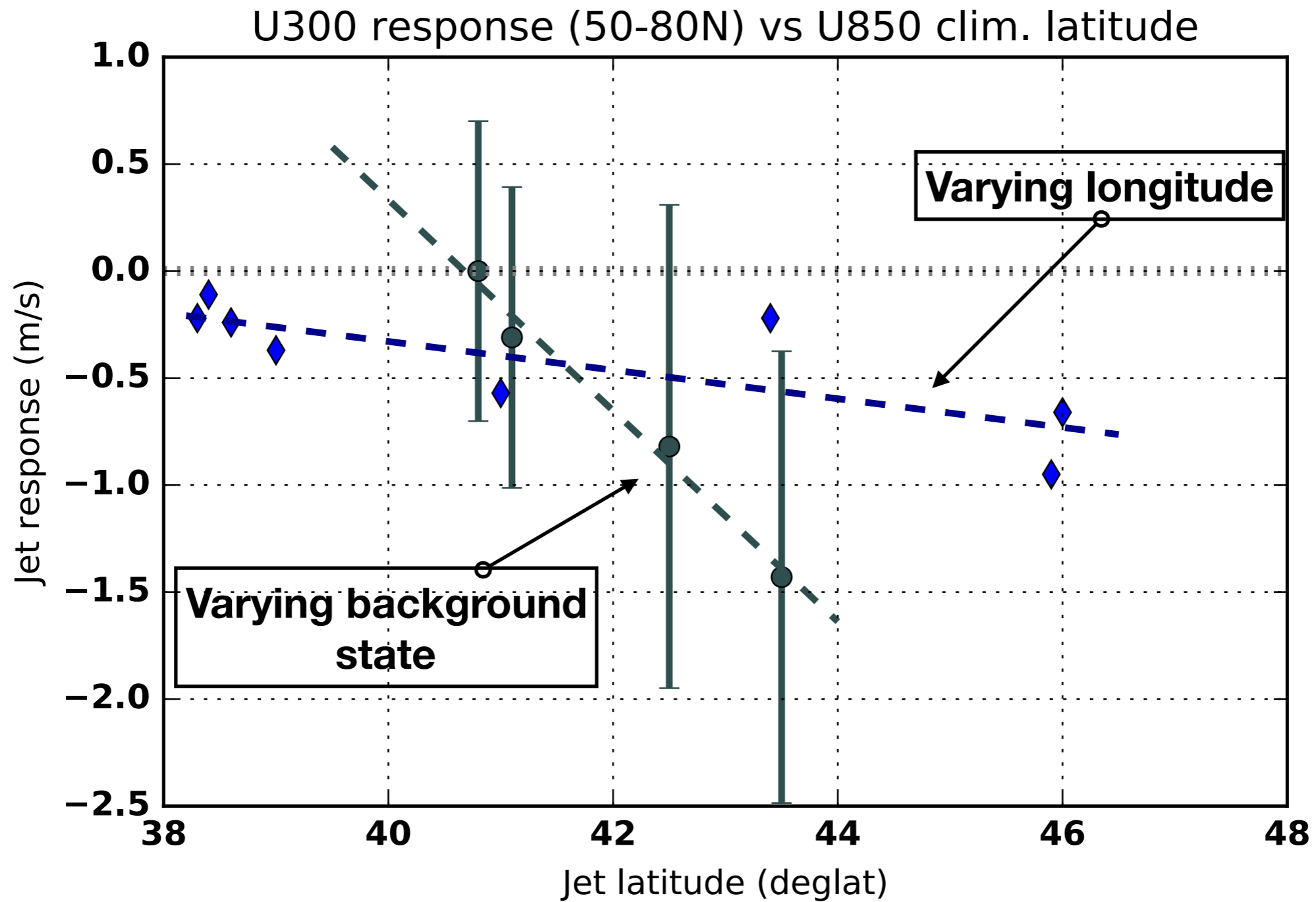


**EXPLAINS
MEAN
RESPONSE**

**EXPLAINS
'SPREAD'
OF RESPONSE**

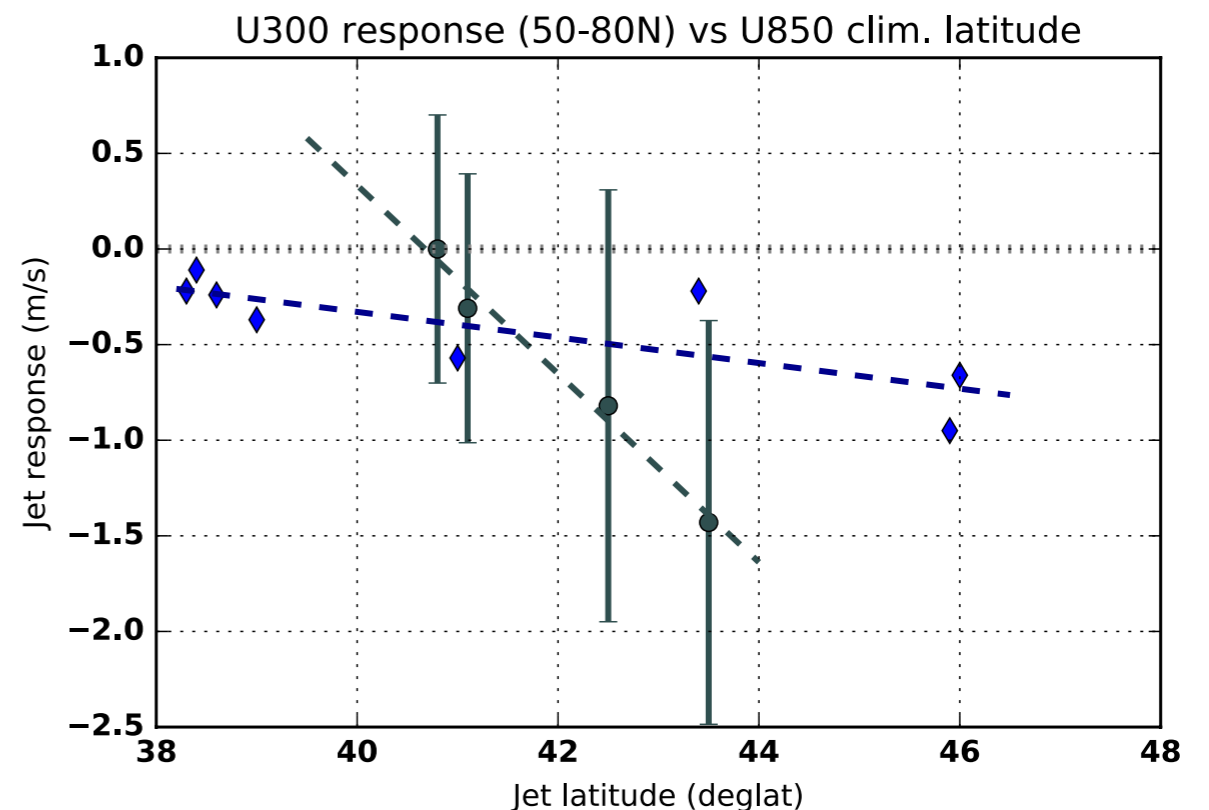
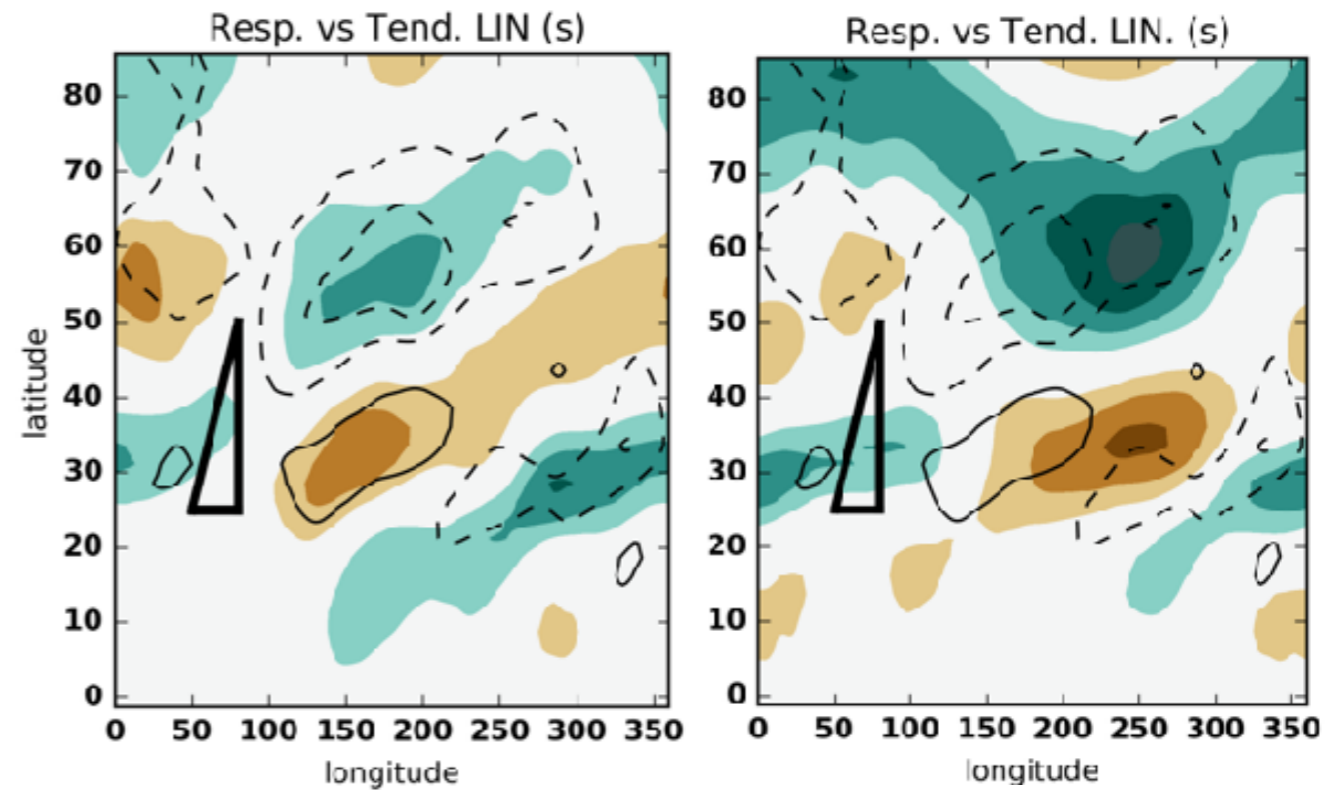


MEAN STATE SENSITIVITY



SUMMARY

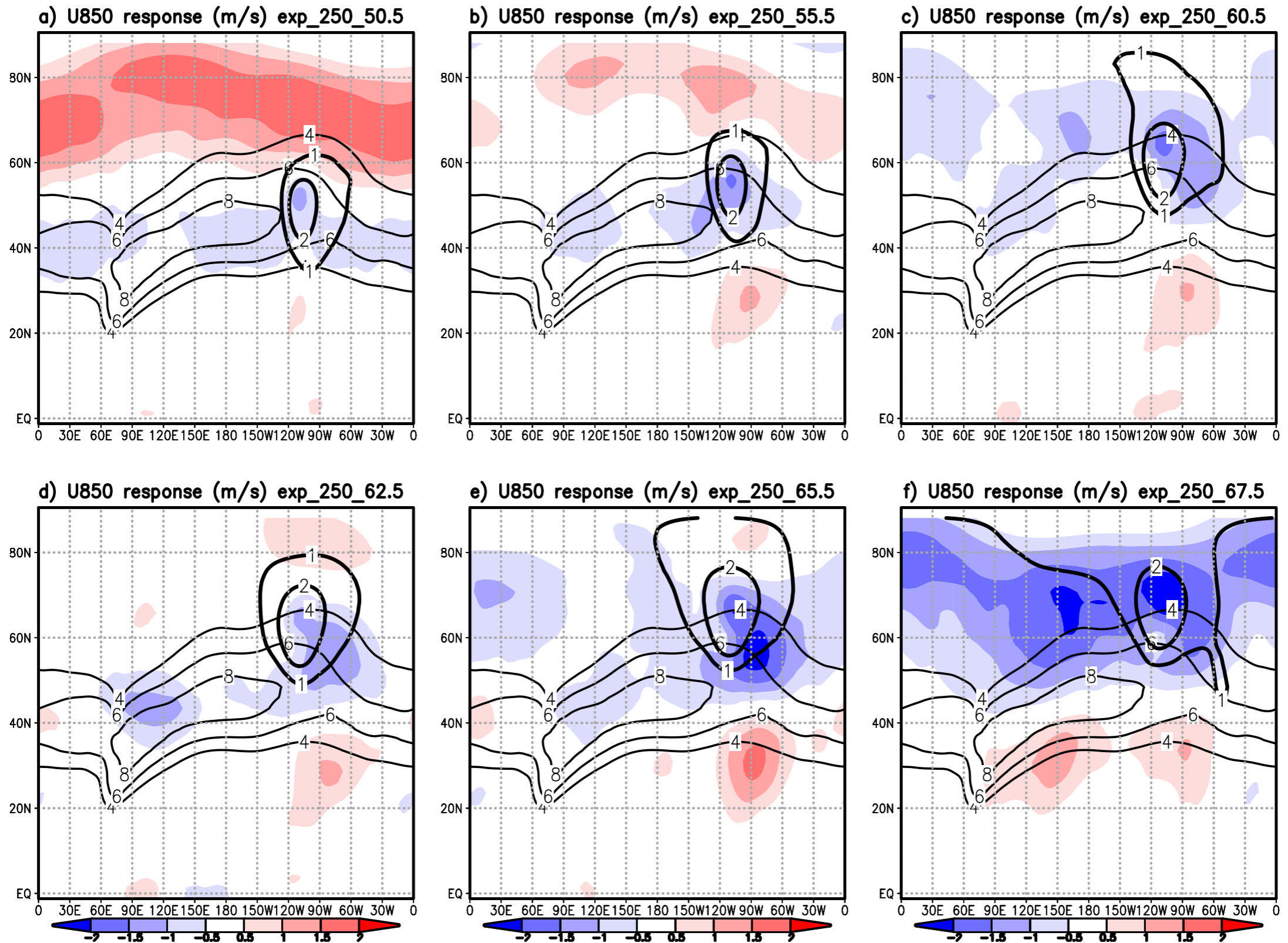
- Mean response: equatorward shift reduction of high lat zonal wind
- Less transient activity modulated by weaker poleward storm propagation
- Strong zonal mean response comes with strong sensitivity to small shifts in lon-lat
- Linear interference is a robust feature but lon-lat differences are explained by non linear terms
- Strong sensitivity to mean state of the atmosphere



Thanks

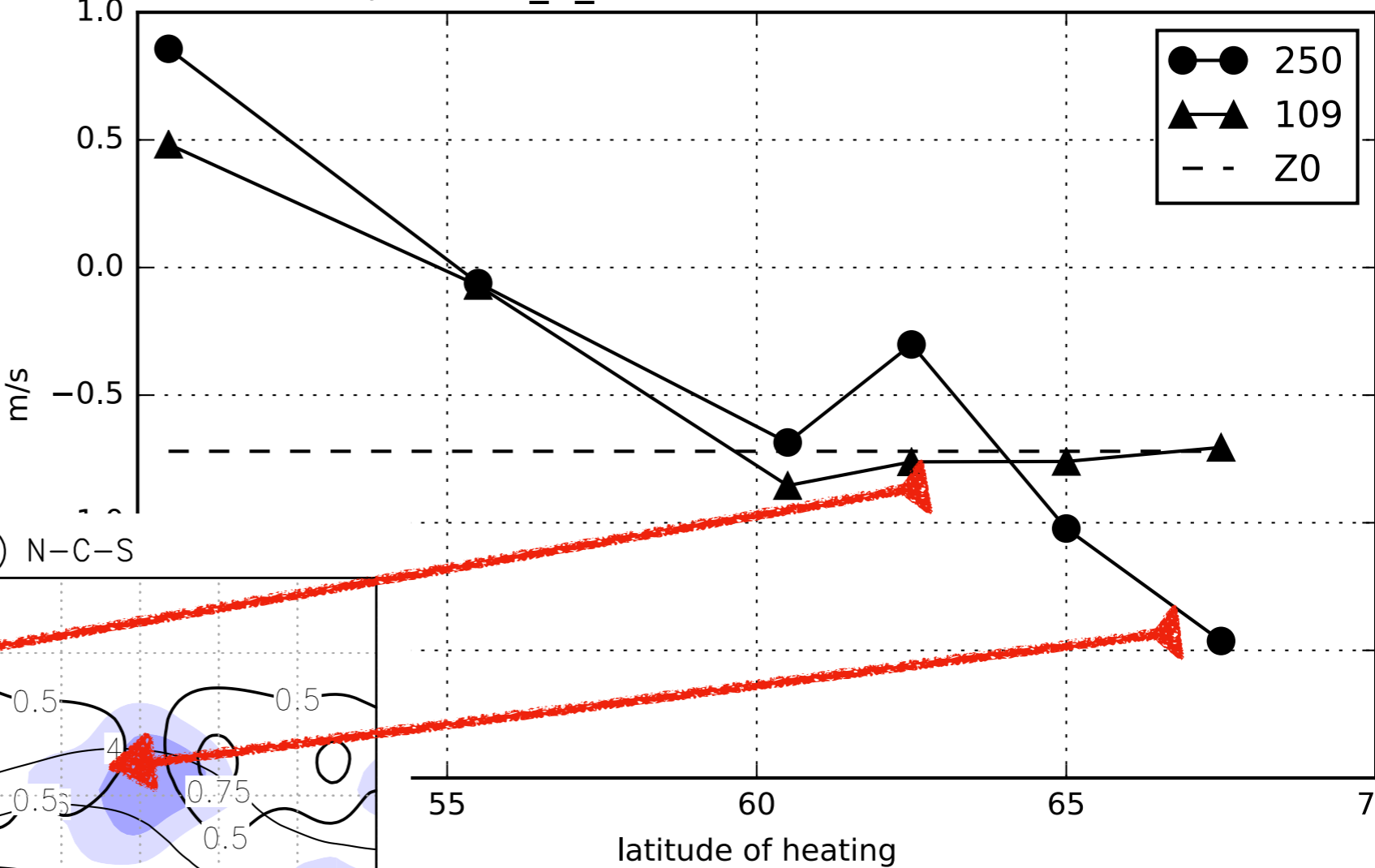


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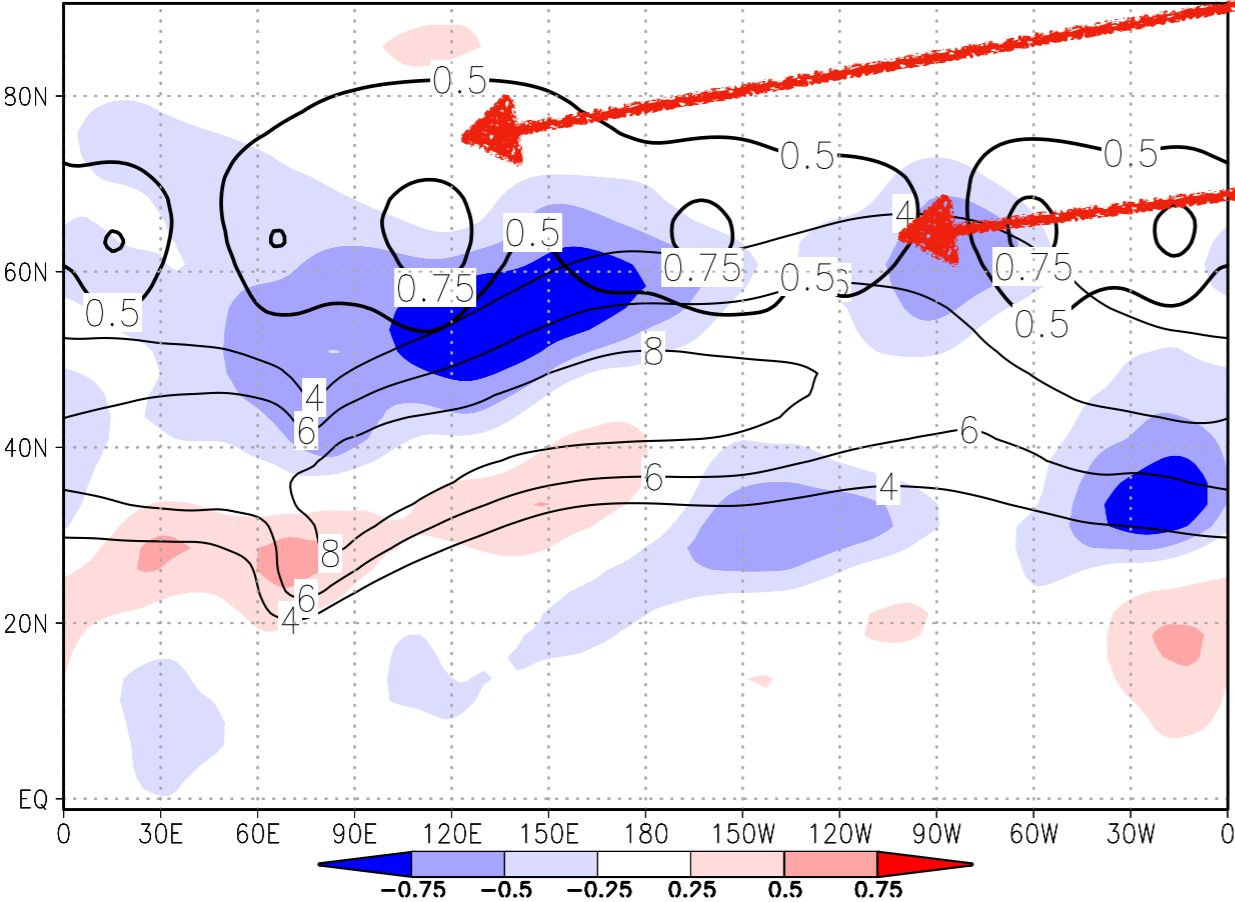


ADD. 2

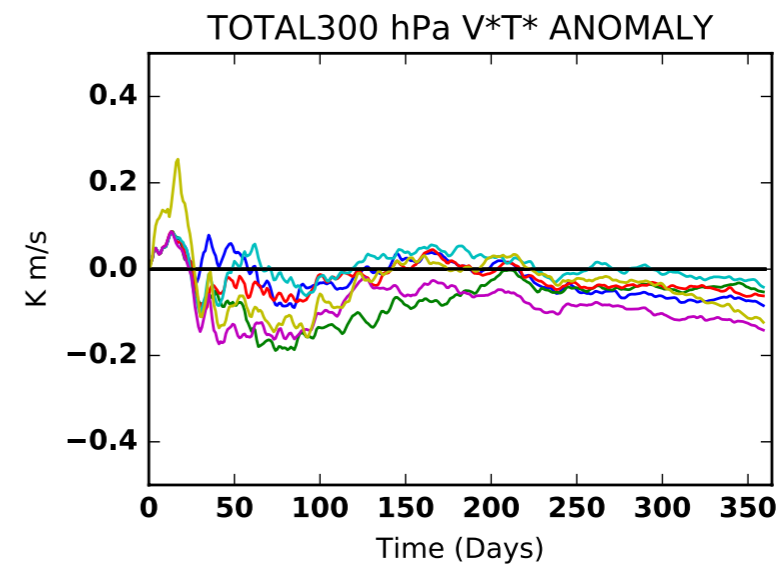
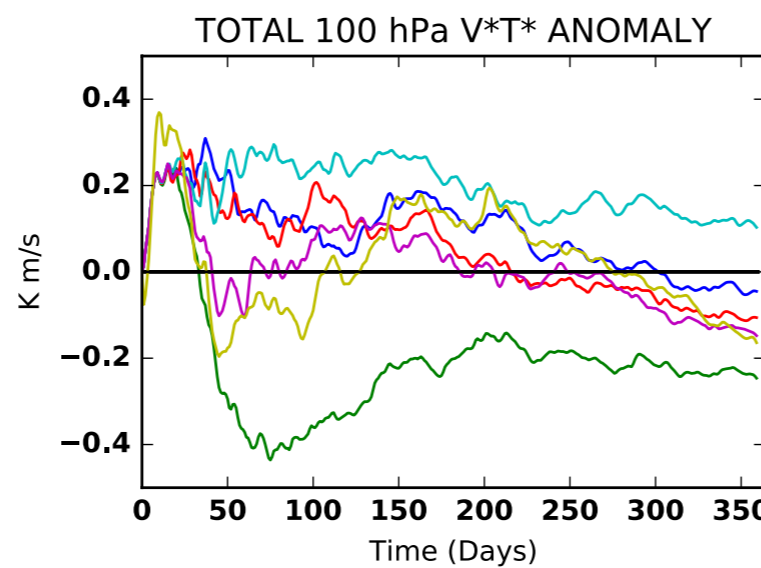
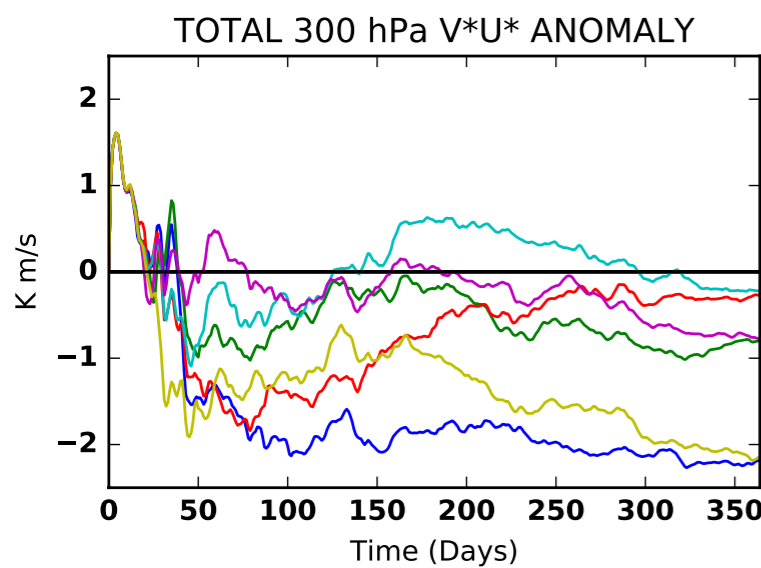
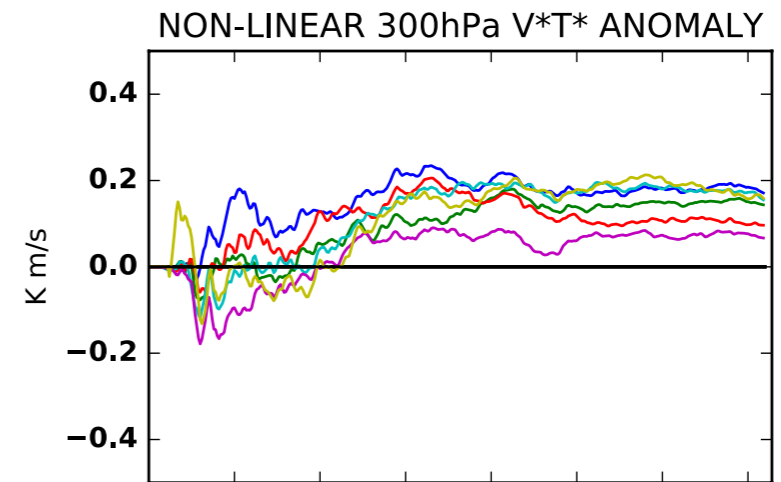
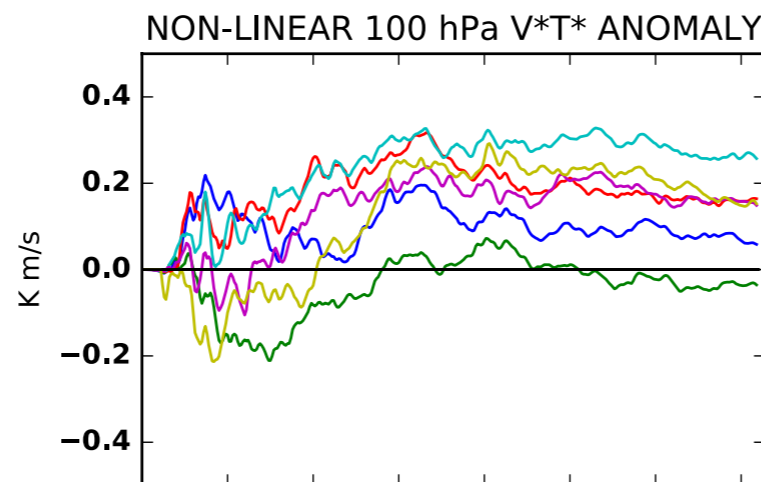
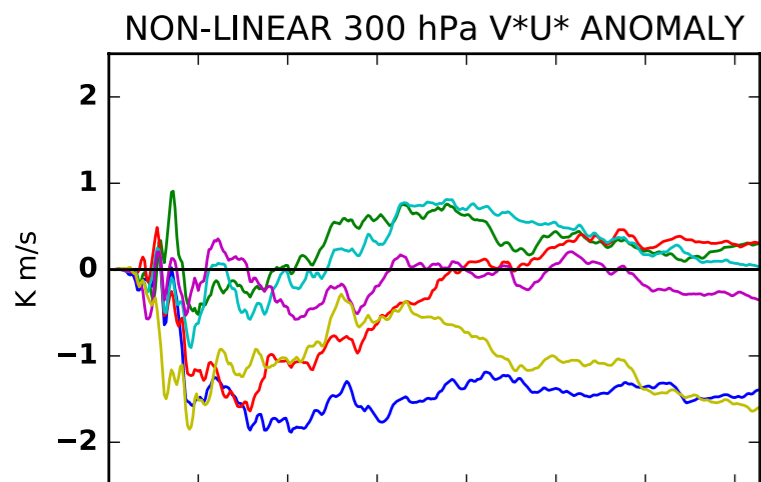
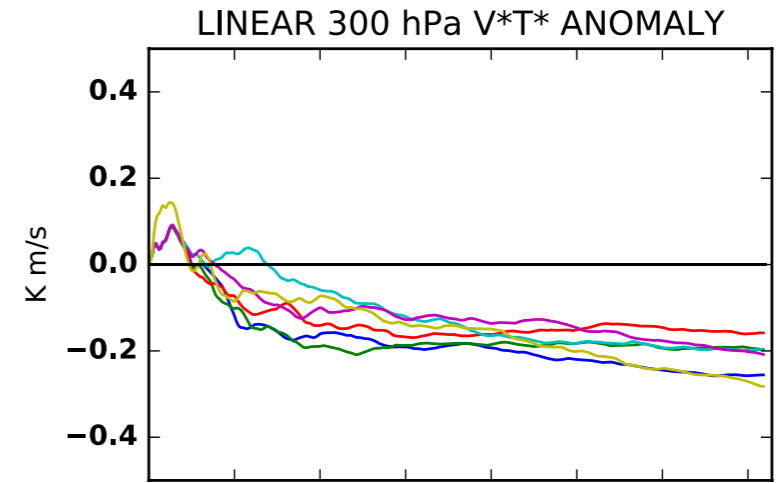
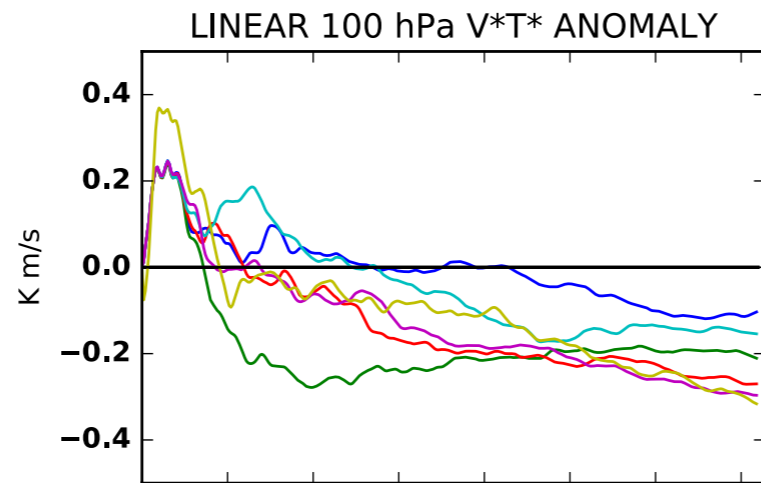
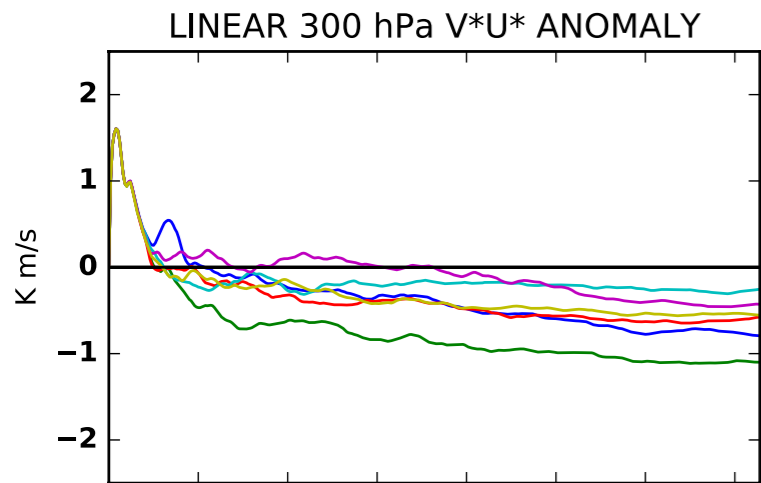
d) 850hPa_U_0E-360E50-80 months 6-12 m/s



a) U300 response (m/s) N-C-S



ADD. 3



ADD. 4

a) Z300 response (m) exp_N210,_N110

