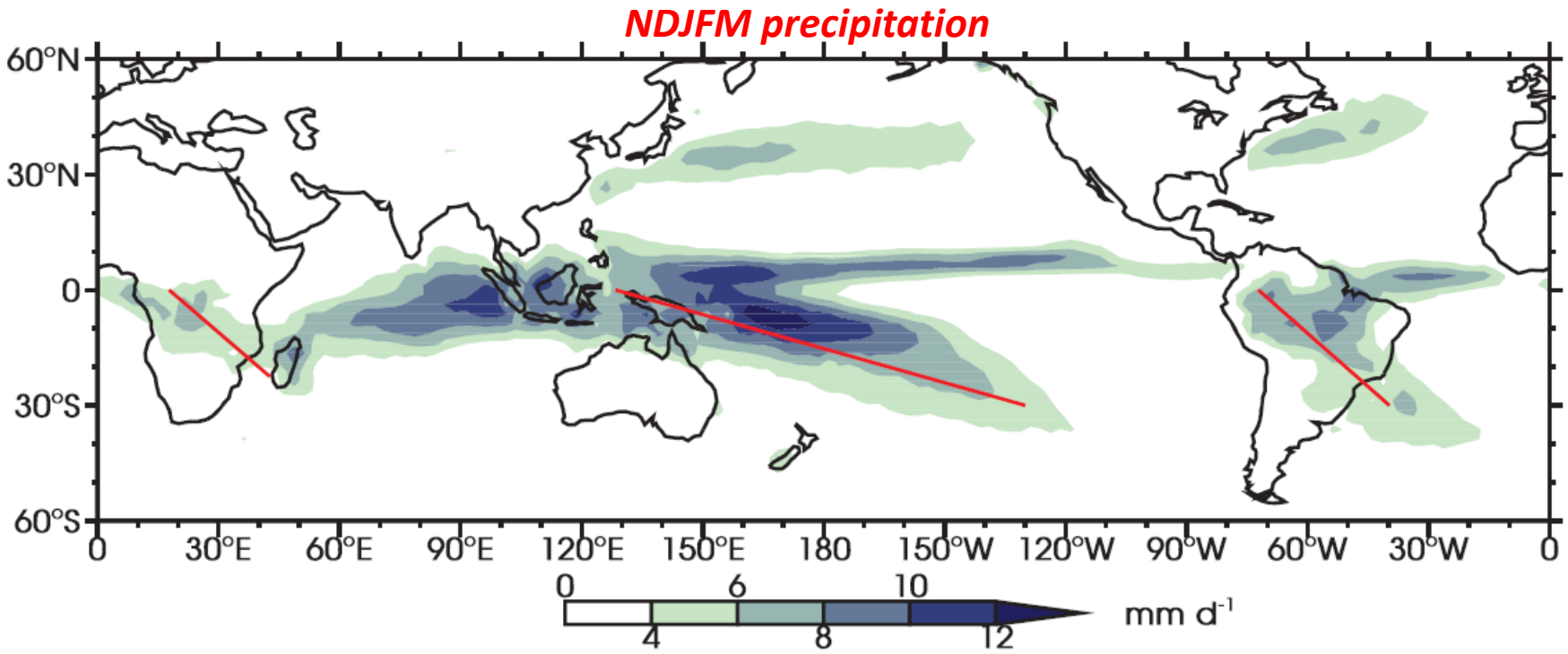
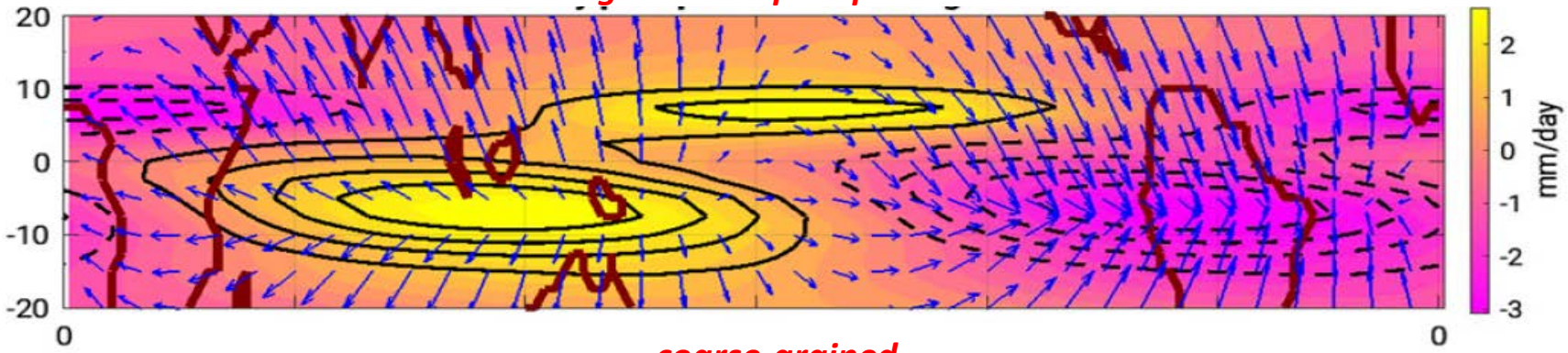
The interannual variability of the tropical divergence tilt

Pablo Zurita-Gotor (Universidad Complutense)

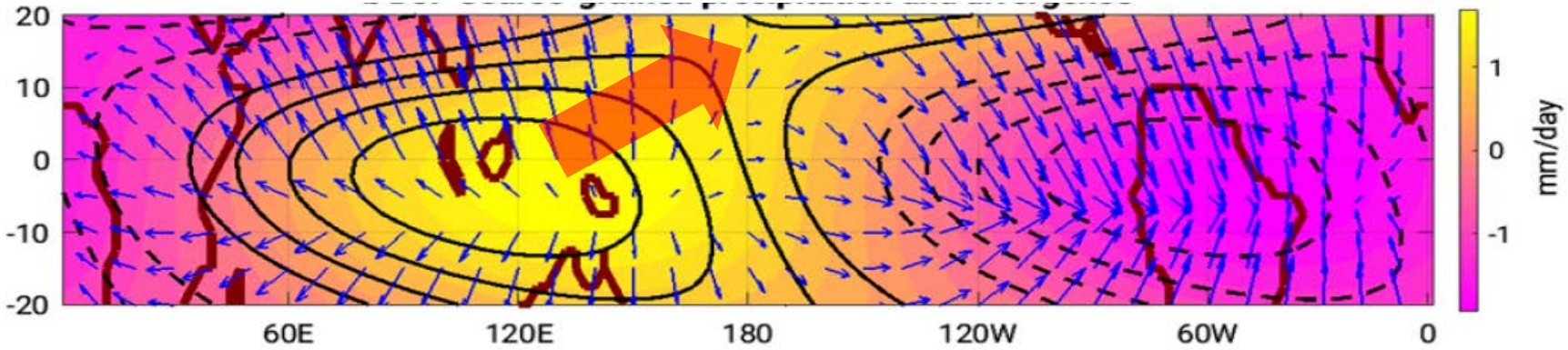


Van der Wiel et al. (2015)

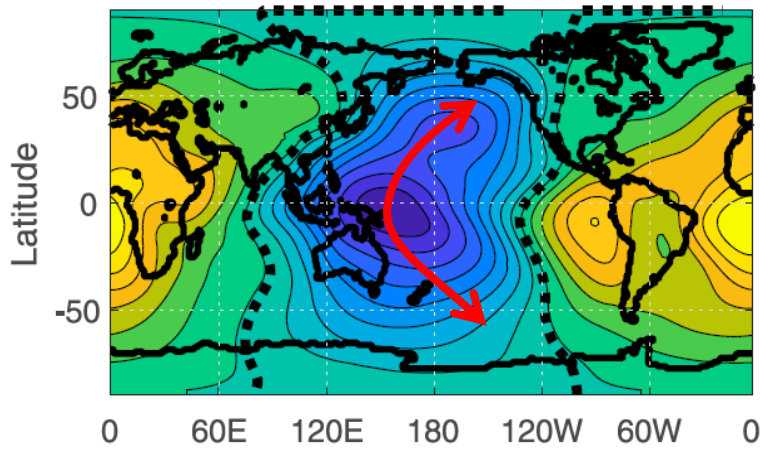
DJF k=1 divergence and precipitation



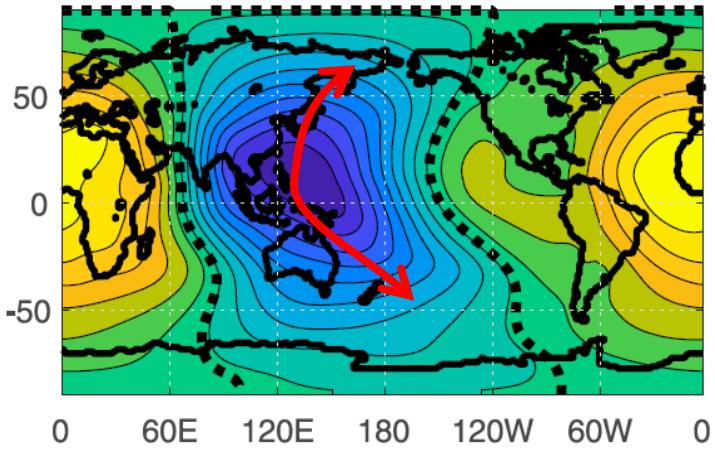
coarse-grained



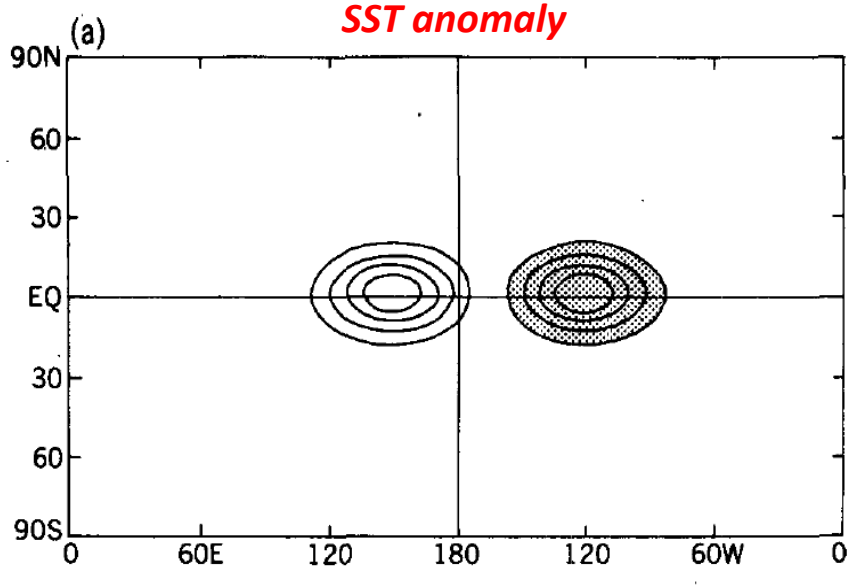
DJF Velocity potential



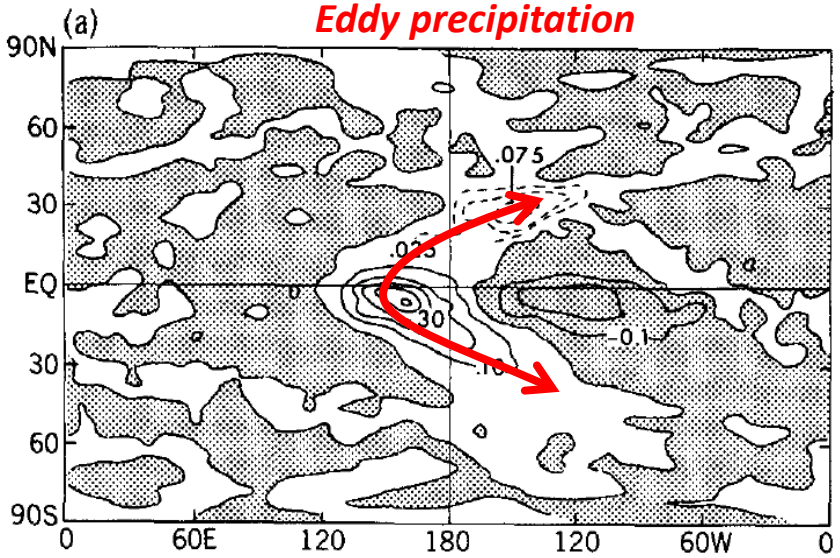
JJA Velocity potential



SST anomaly



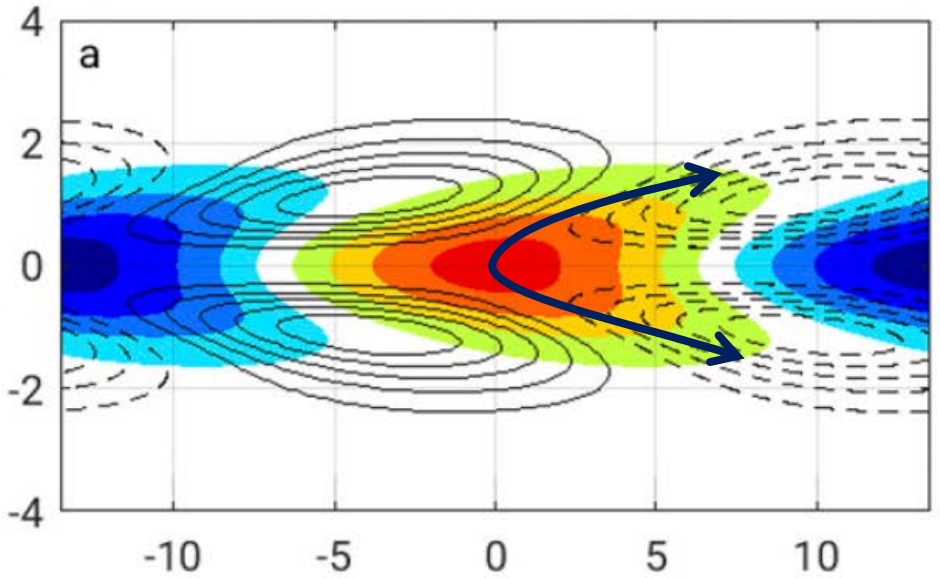
Eddy precipitation



Aquaplanet forced with untilted SST

Ting and Held (1990)

Divergence (shaded) and geopotential



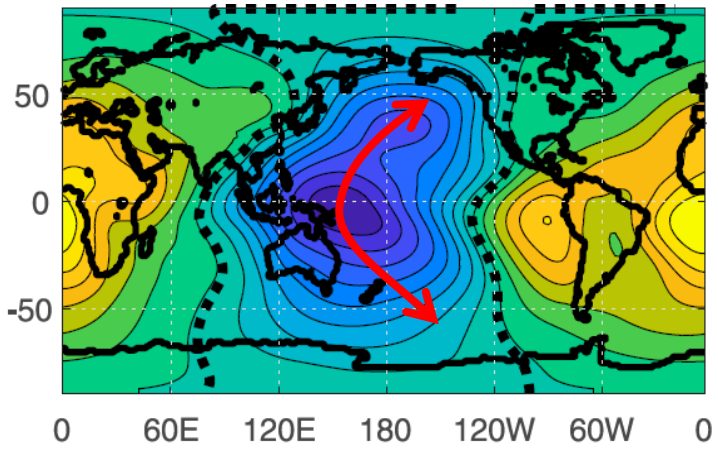
Gill problema (with no friction)

Zurita-Gotor (2020)

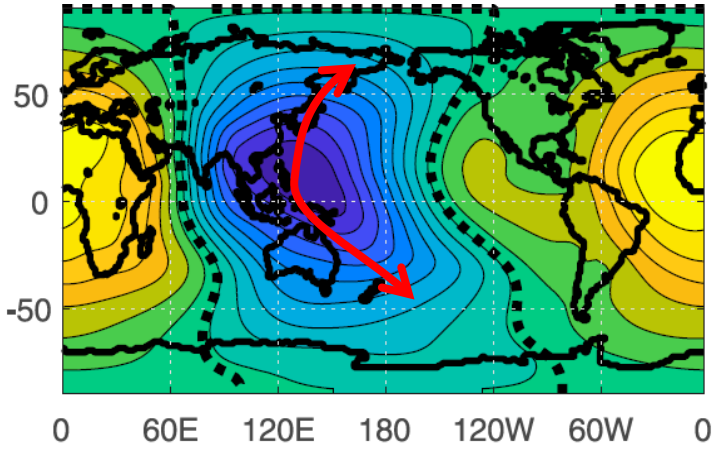
<u>Robust</u> eastward tilt of *large-scale* divergence:

- Both hemispheres and seasons
- Also without continents and SST tilt
- Also without moisture
- Also without extratropical eddies

DJF Velocity potential



JJA Velocity potential



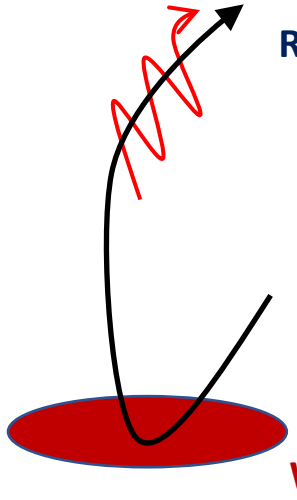
Recent work (Zurita-Gotor 2019, 2020) shows that ***tropical eddy momentum flux increases with divergence tilt***:

Inviscid, resting basic state $\langle \overline{u'_r v'_d}(k) \rangle = 2 \int_{-\infty}^{\infty} \frac{l}{k} \widehat{K}_d(k,l) dl$

v'_d: divergent meridional velocity (eddy Hadley cell/MRG)

u'_r: rotational zonal velocity (forced by the divergence)

$\widehat{K}_d(k,l)$: spectrum of divergent eddy kinetic energy



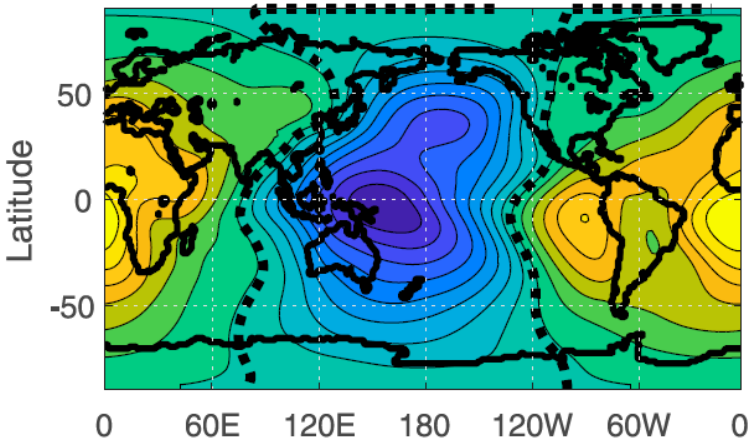
Sardeshmukh & Hoskins (1988)

Divergence tilt ⇔ wave activity flux

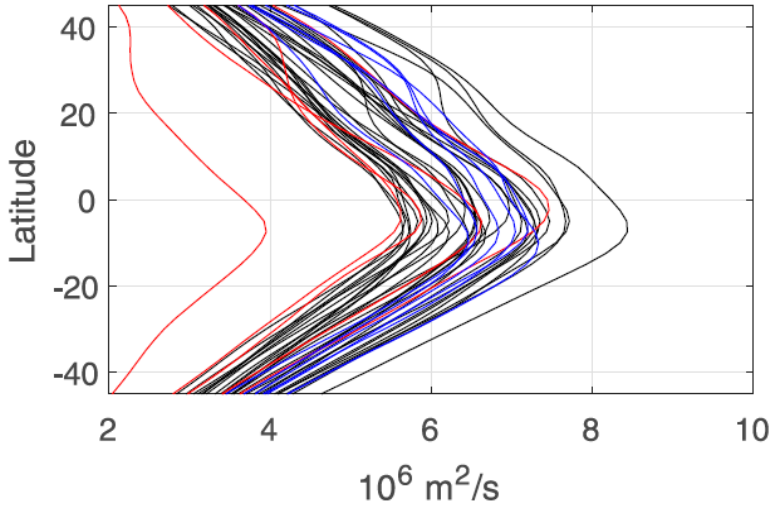
A signature of meridional propagation?

Impact of changes in divergence tilt (ERA-INTERIM 1979-2019)

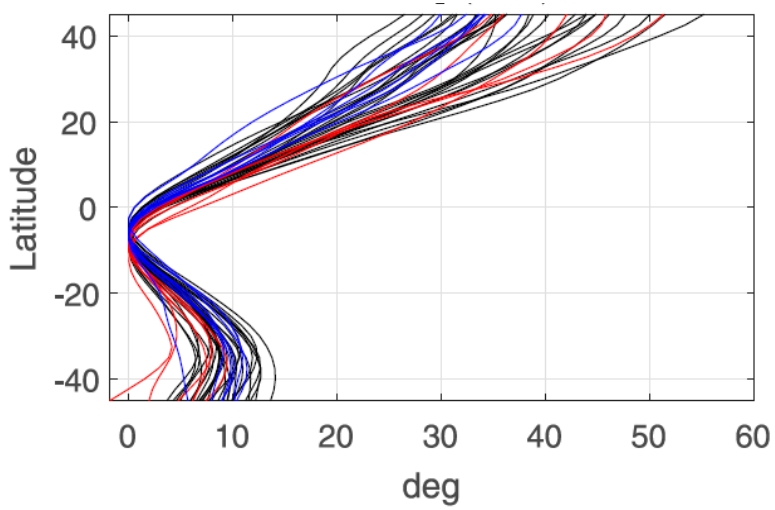
DJF velocity potential



k=1 amplitude for all years

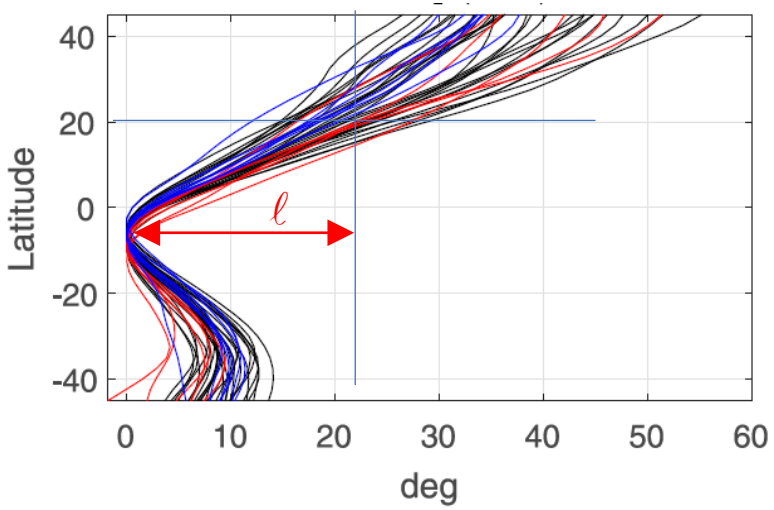


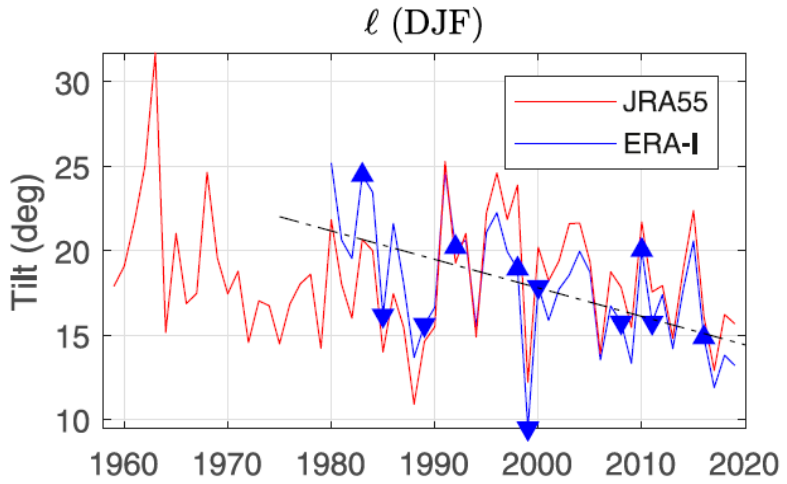
k=1 phase for all years



ℓ : metric for k=1 divergence tilt

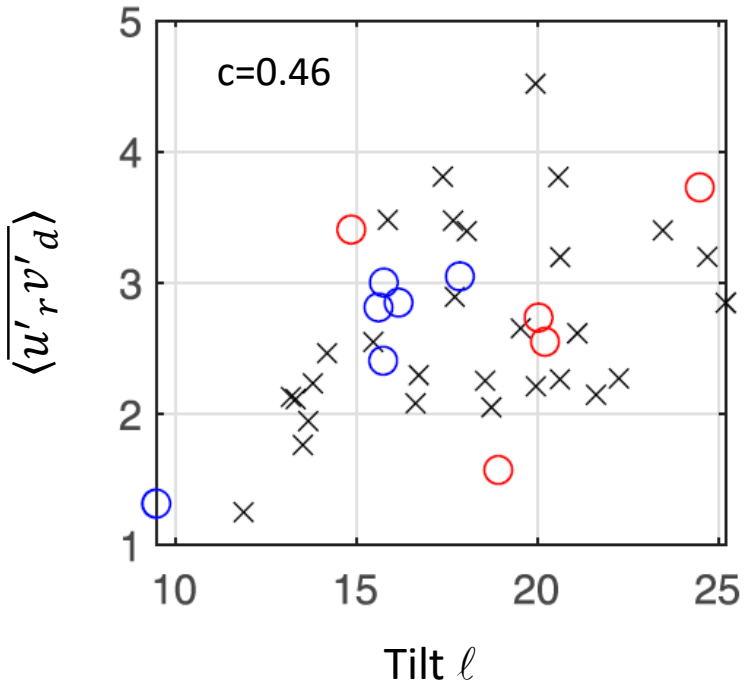
k=1 phase for all years





Do eddy momentum fluxes increase with ℓ?

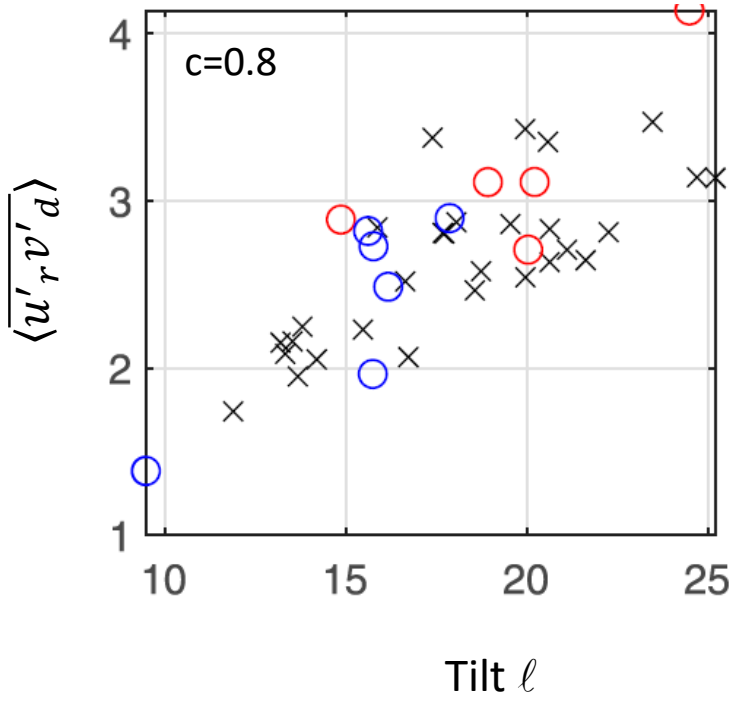
Scatterplot



o El Niño years
o La Niña years
x Neutral ENSO

Weak positive correlation

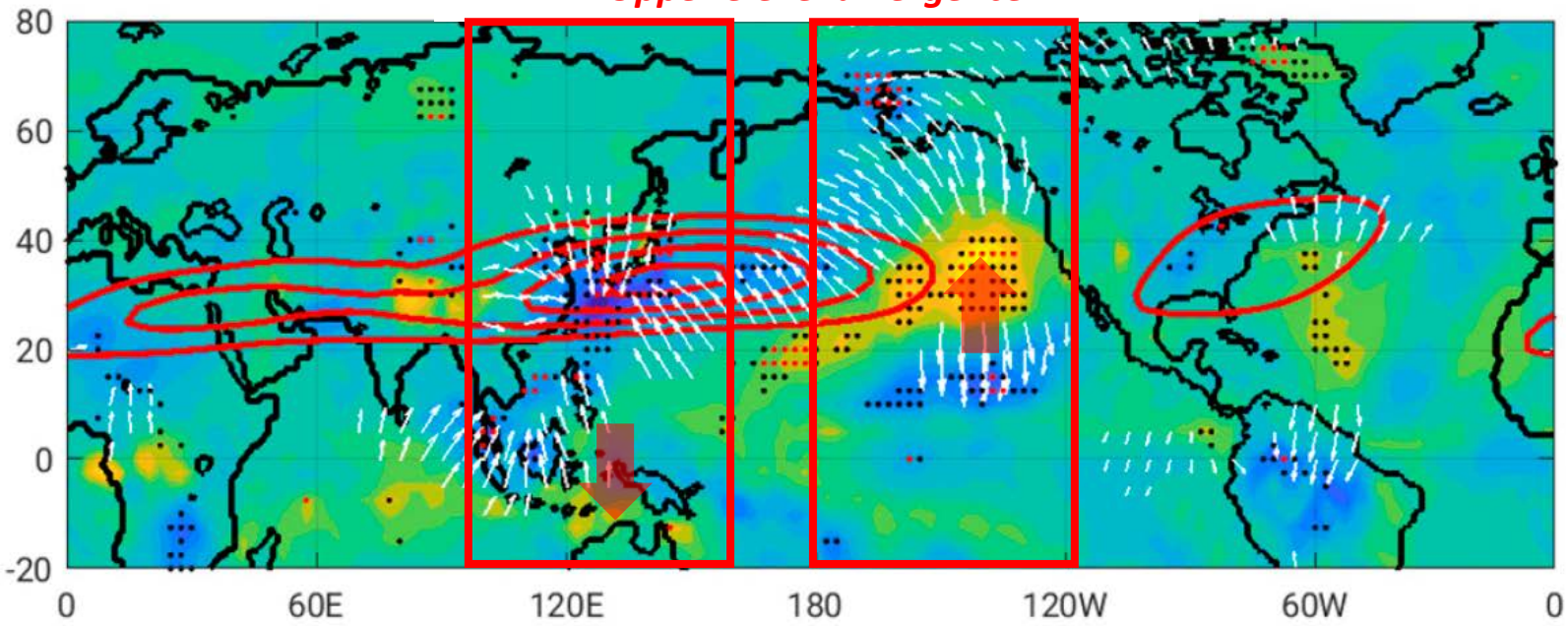
Adjusting for wave amplitude



Together with k=1 amplitude, ℓ explains 80% of the interannual changes in $\langle \overline{u'_r v'_d} \rangle$

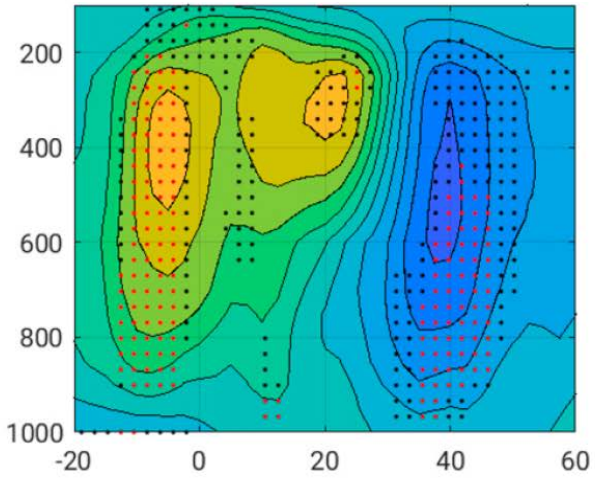
Regressions on ℓ

Upper elevel divergence



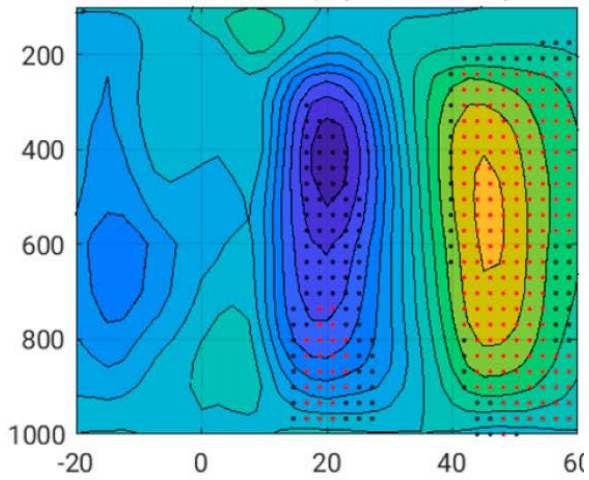
Divergence shifts southward over Maritime Continent, northward shift in East Pacific

MMC anomaly (100E-160E)



On the west, the Hadley cell strengthens and shifts into SH

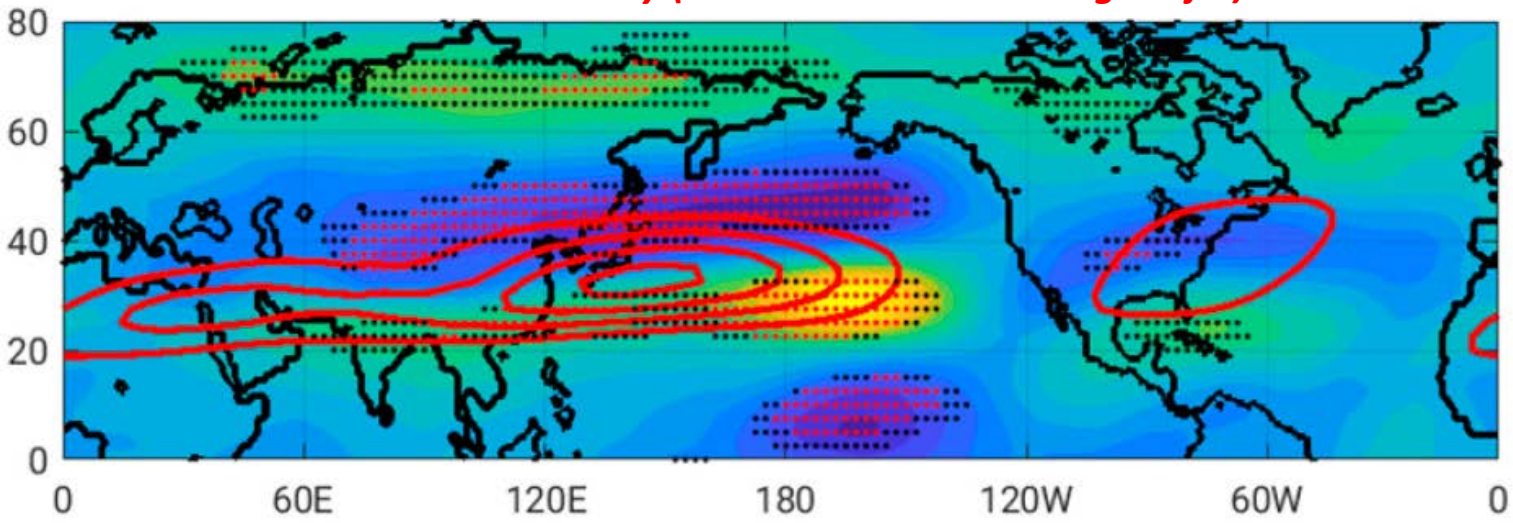
MMC anomaly (180-120W)



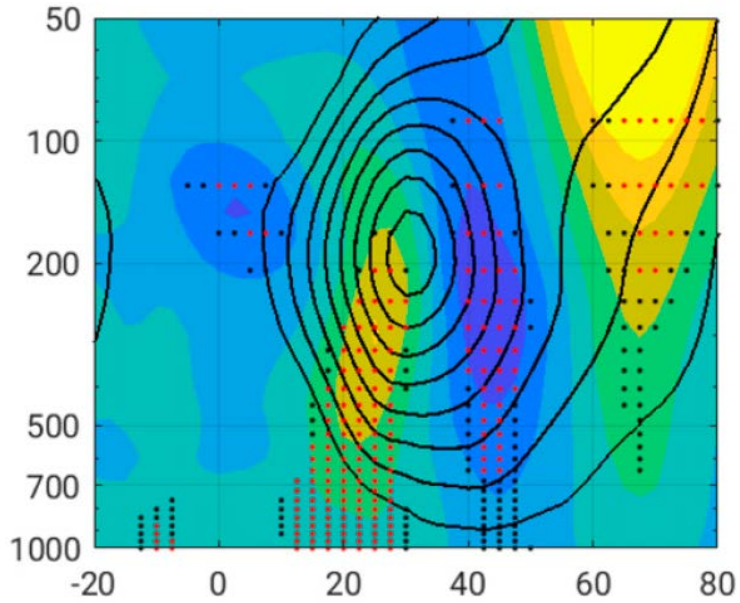
On the east, weaker Hadley and Ferrel cells over the jet exit region

Regressions on ℓ

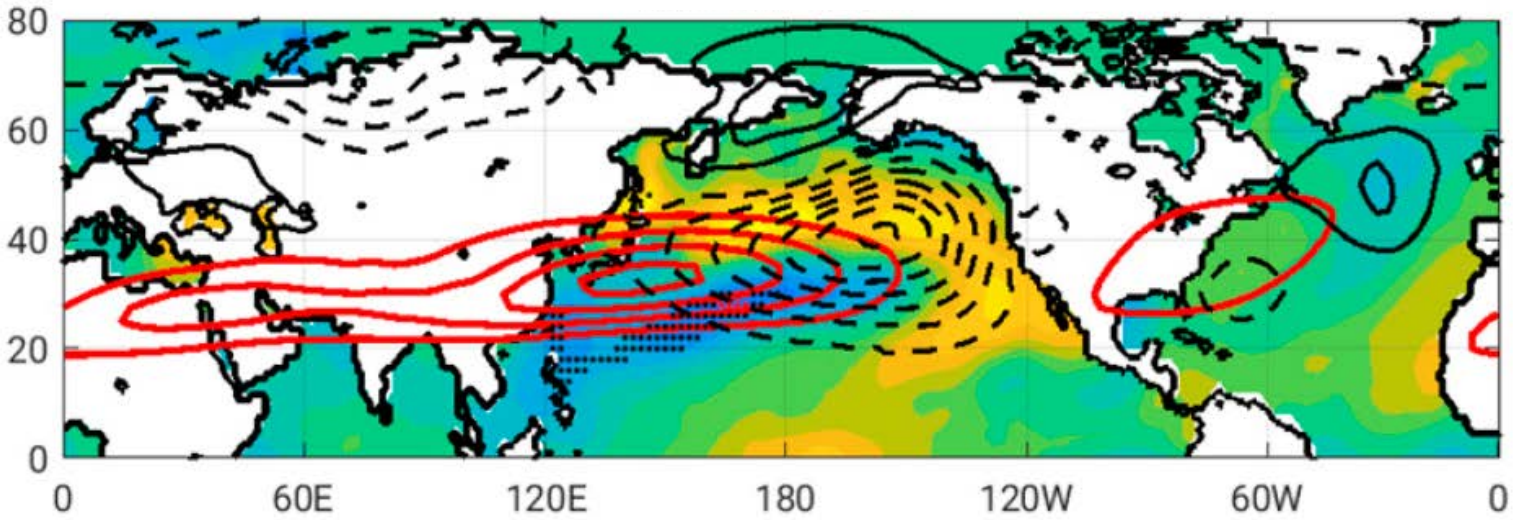
Zonal wind anomaly (red contours: climatological jet)



Zonal-mean zonal wind



SST (shading) and MSLP (contours)

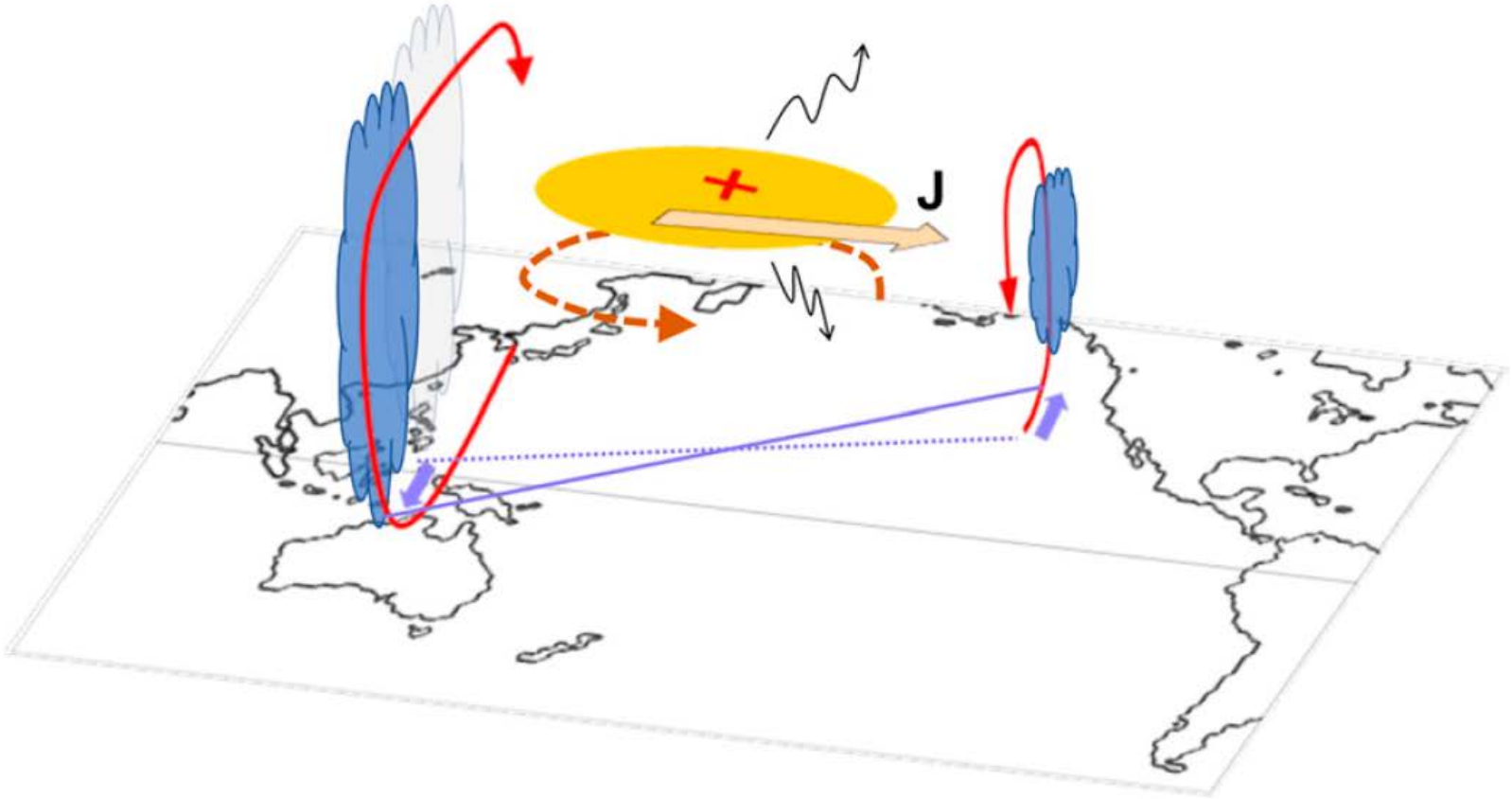


Strong similarity with negative phase of WPO

correlation: -0.62

- Opposite-signed divergence shifts in West and East Pacific are related
- Analysis of ω-equation shows East Pacific shift to be associated with termination of the jet anomaly

Proposed mechanism



1. Southward ITCZ shift over Maritime Continent. Hadley cell strengthens
2. Cyclonic vorticity anomaly downstream in the subtropics. Equatorward jet shift.
3. Anomalous East Pacific MMC associated with the termination of the jet anomaly

(But could also be driven from extratropics)

See Zurita-Gotor (2021, J. Climate) for more details