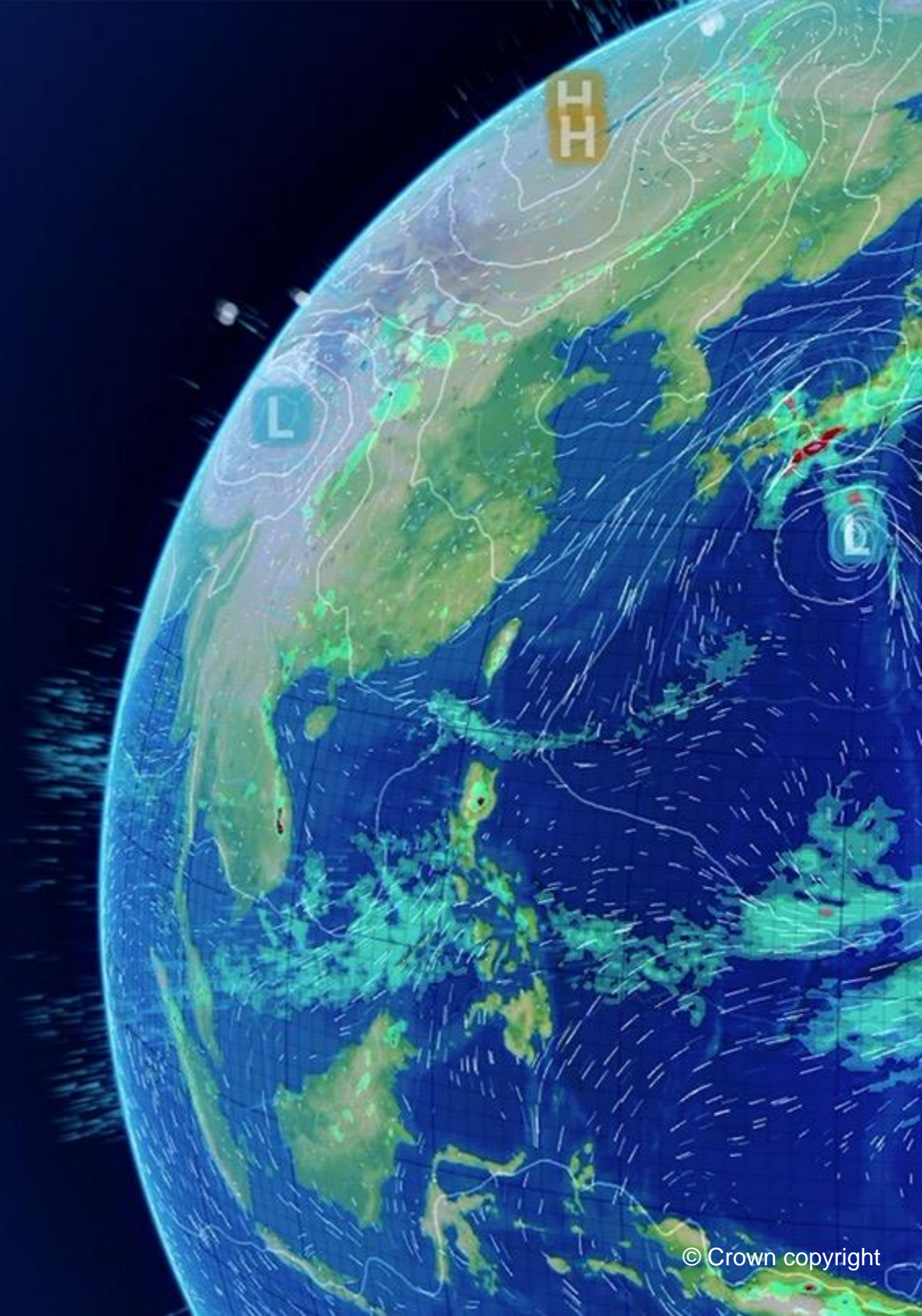


The impact of strong El Niño and La Niña events on the north Atlantic

**Steven Hardiman, Nick Dunstone,
Adam Scaife, Doug Smith,
Sarah Ineson, Juyoun Lim, and
David Fereday**

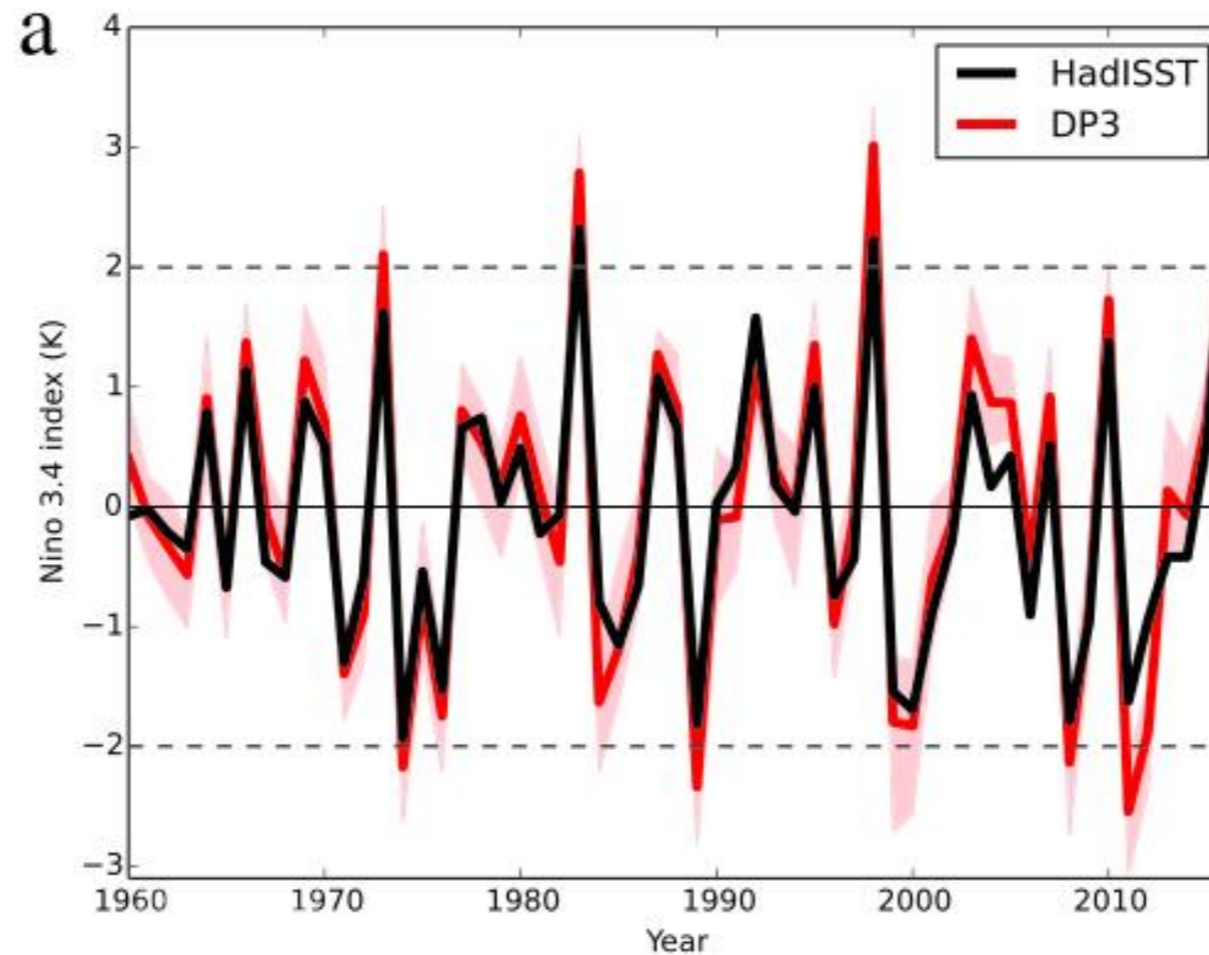
ASC, July 2019



Motivation

- ENSO impacts winter north Atlantic MSLP
- This has implications for European winter temperature / precipitation
- Would like to understand the teleconnections leading to this impact
- Impact of moderate El Niño is negative NAO, and impact of moderate La Niña is positive NAO – symmetric response
- Specific question: what is the impact of strong La Niña events (not yet observed) on Jan—Feb north Atlantic MSLP, and is it the opposite of strong El Niño?

Niño 3.4 index

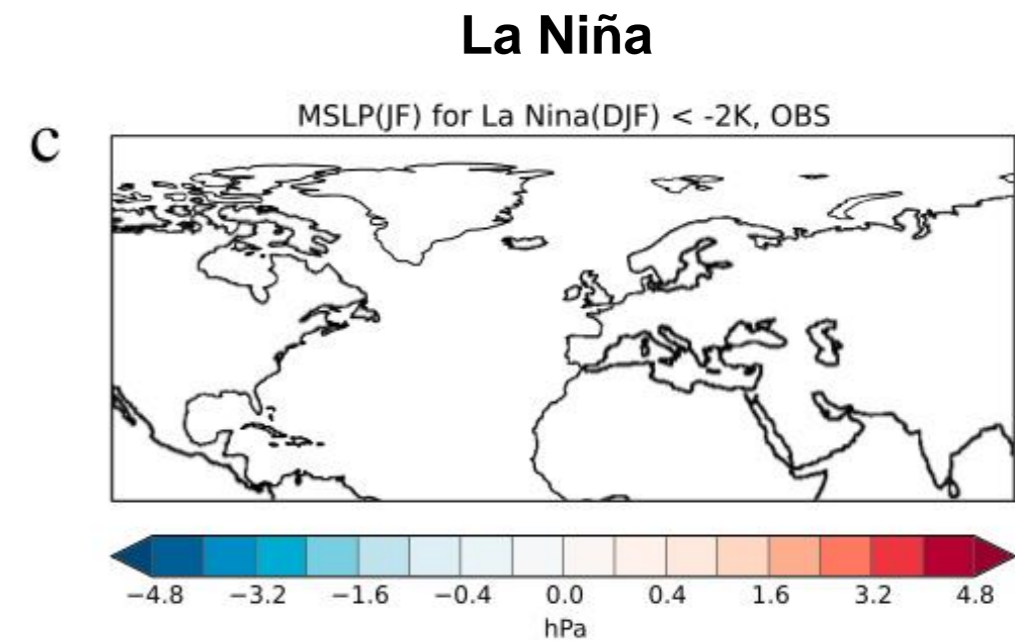
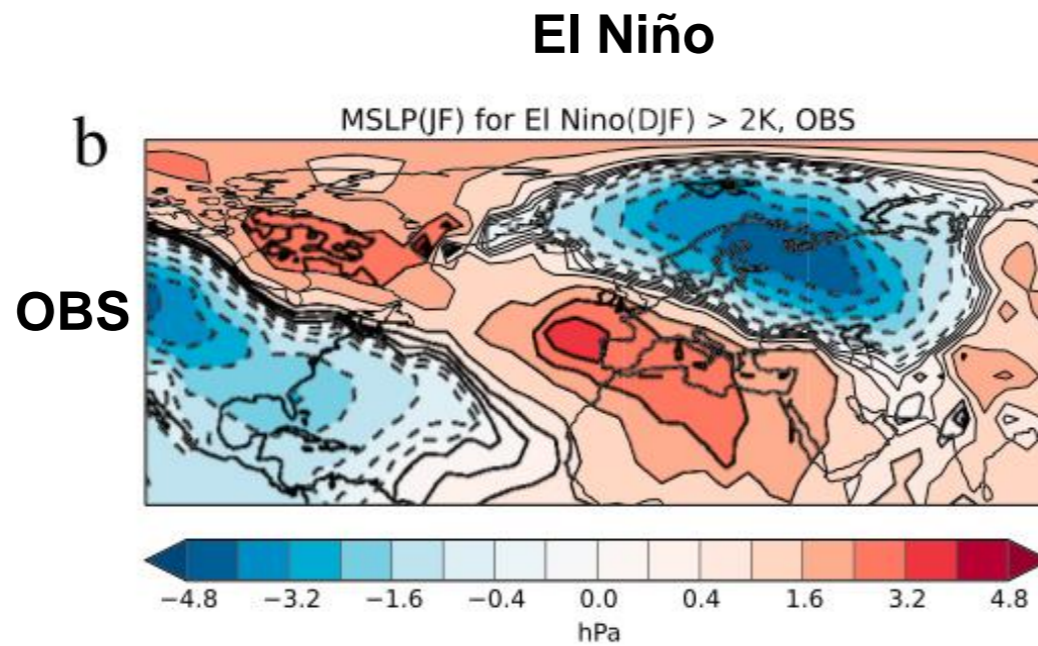


Met Office decadal prediction system (DP3) simulates strong La Niña events ($< -2K$).

40 member ensembles for each year, initialised 1st Nov

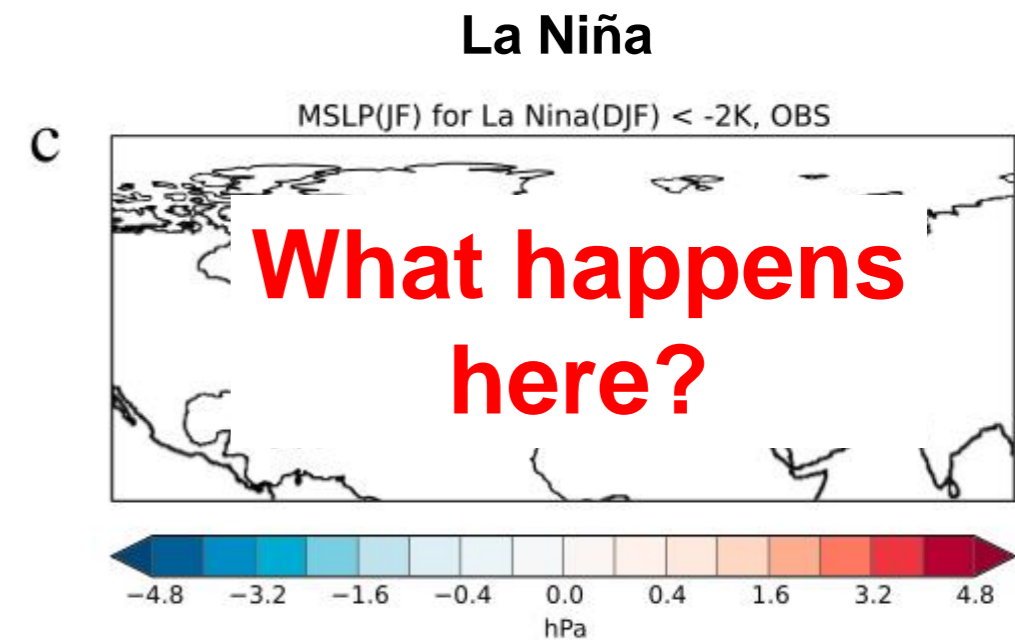
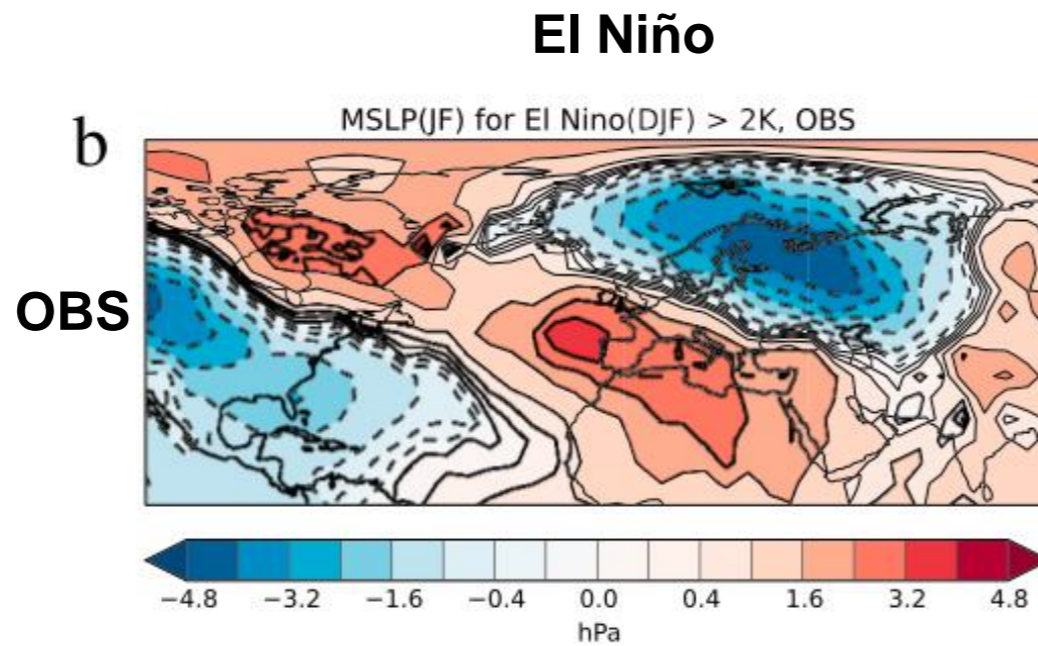
The impact of strong events on north Atlantic Jan—Feb MSLP

Impact of strong El Niño on north Atlantic MSLP is wavelike (Toniazzo and Scaife, 2006)



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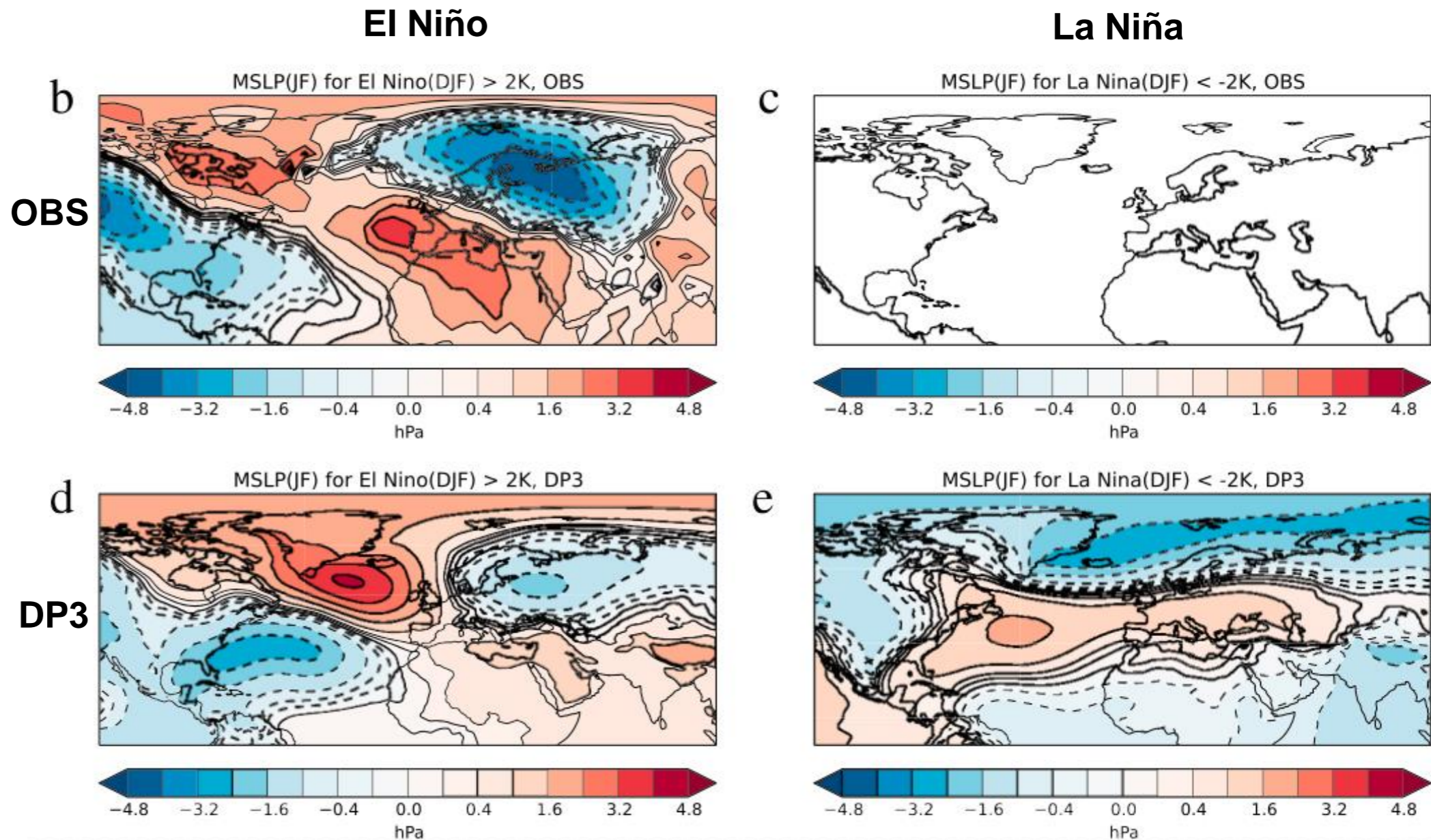


The impact of strong events on north Atlantic Jan—Feb MSLP

Impact of strong El Niño on north Atlantic MSLP is wavelike (Toniazzo and Scaife, 2006)

Modelled impact of strong La Niña (not yet observed) on north Atlantic MSLP is positive NAO

Why this asymmetry?

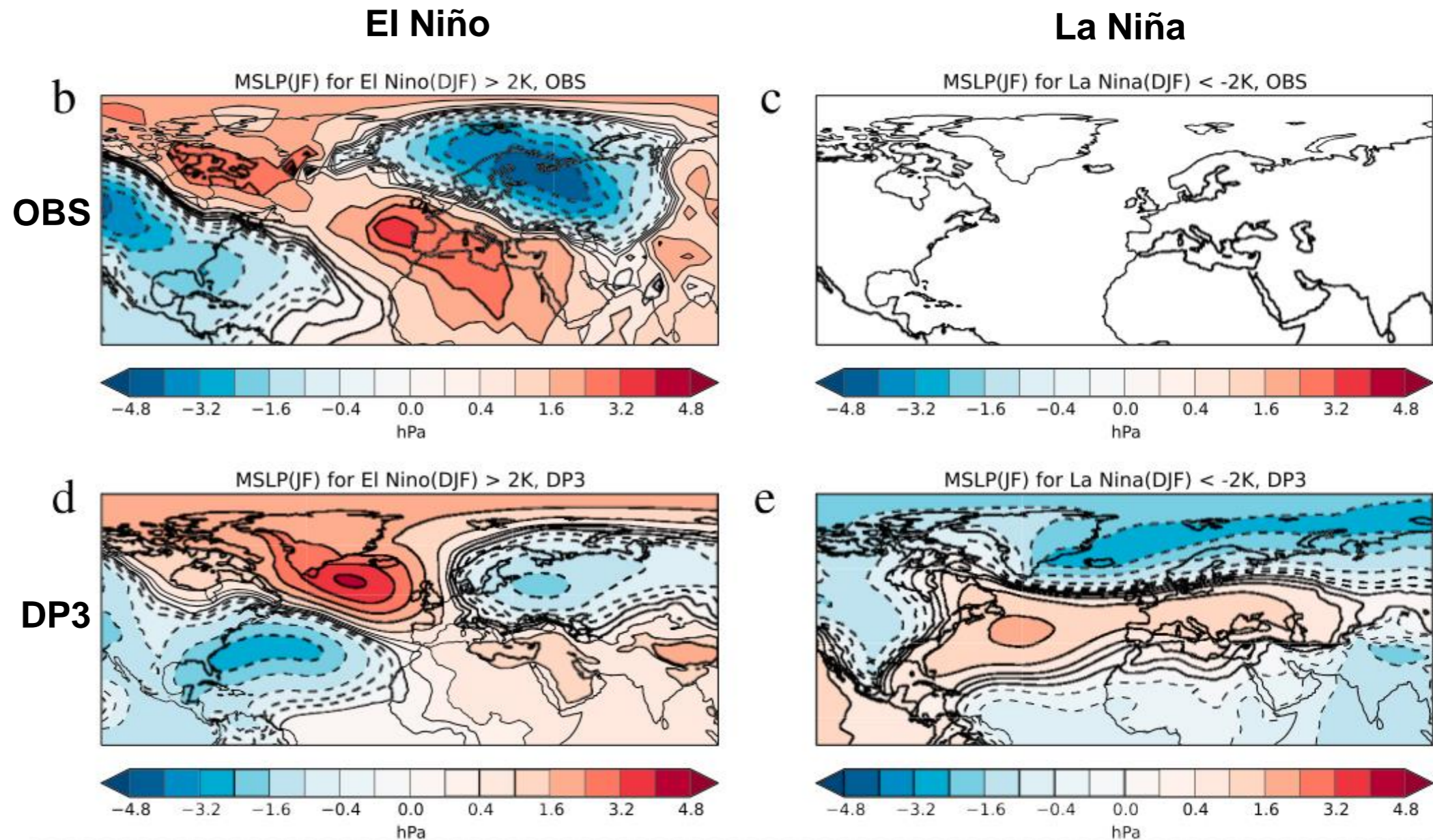


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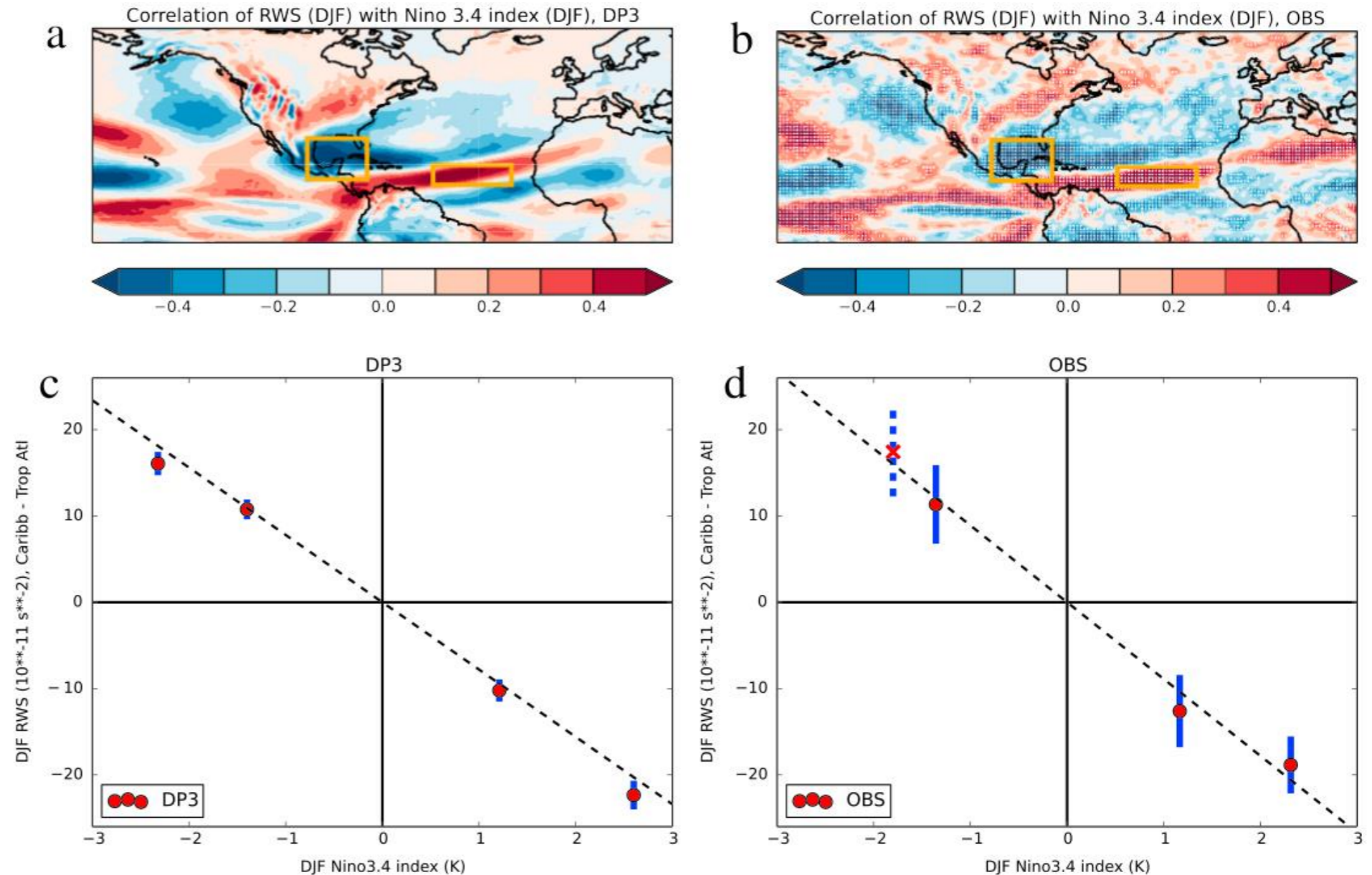
ENSO impacts north Atlantic via tropospheric and stratospheric pathways

Tropospheric teleconnection pathway

Tropospheric pathway

Tropospheric pathway (RWS in Caribbean / tropical Atlantic) is symmetric in response to El Niño / La Niña and grows linearly with size of ENSO event

Projects onto NAO *and wavelike* MSLP patterns



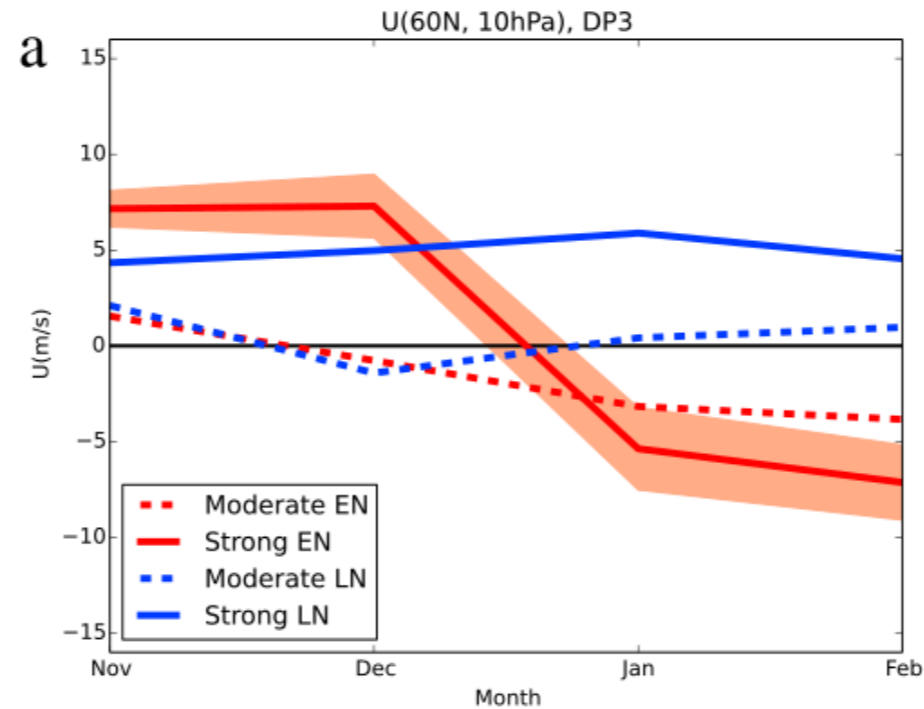
Stratospheric teleconnection pathway

Stratospheric pathway

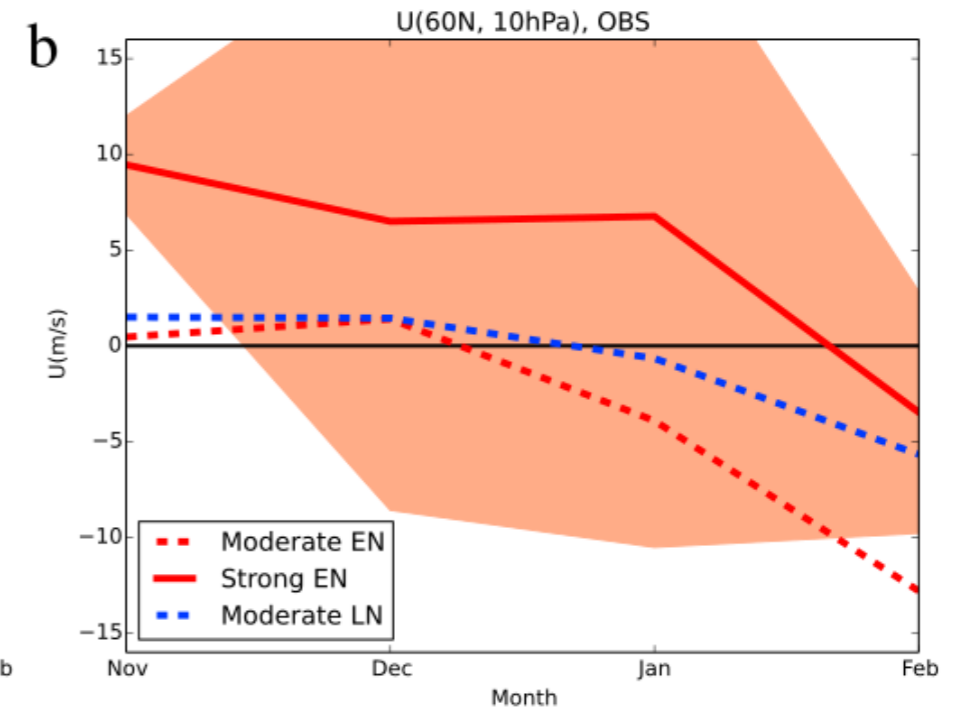
Stratospheric pathway is via Aleutian low and stratospheric polar vortex (diagnosed using $U(60N, 10hPa)$)

Projects onto the NAO

DP3



OBS

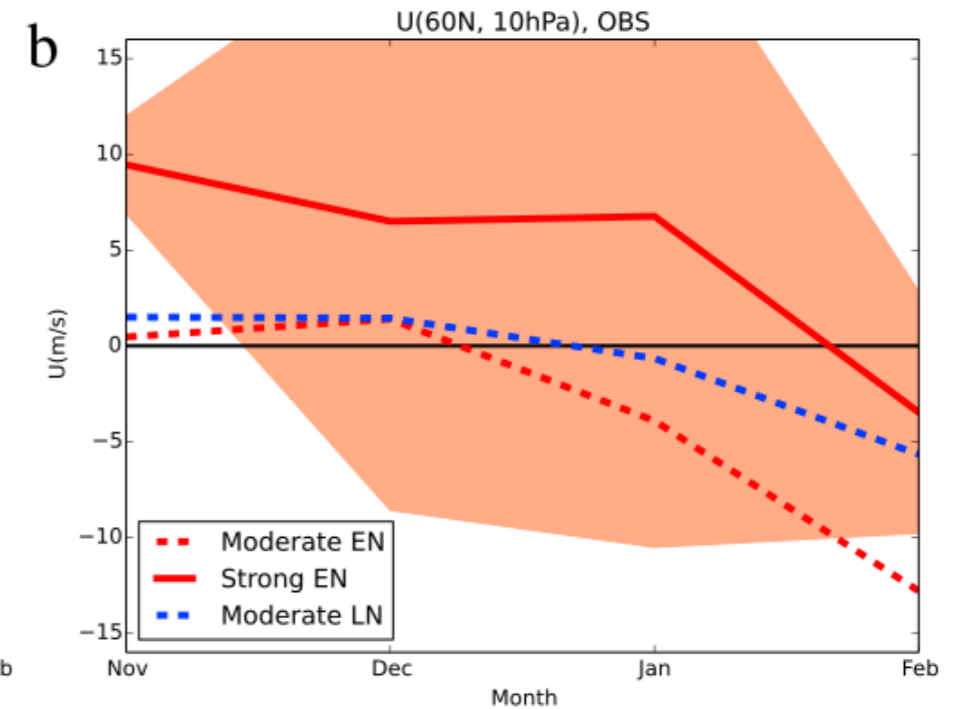
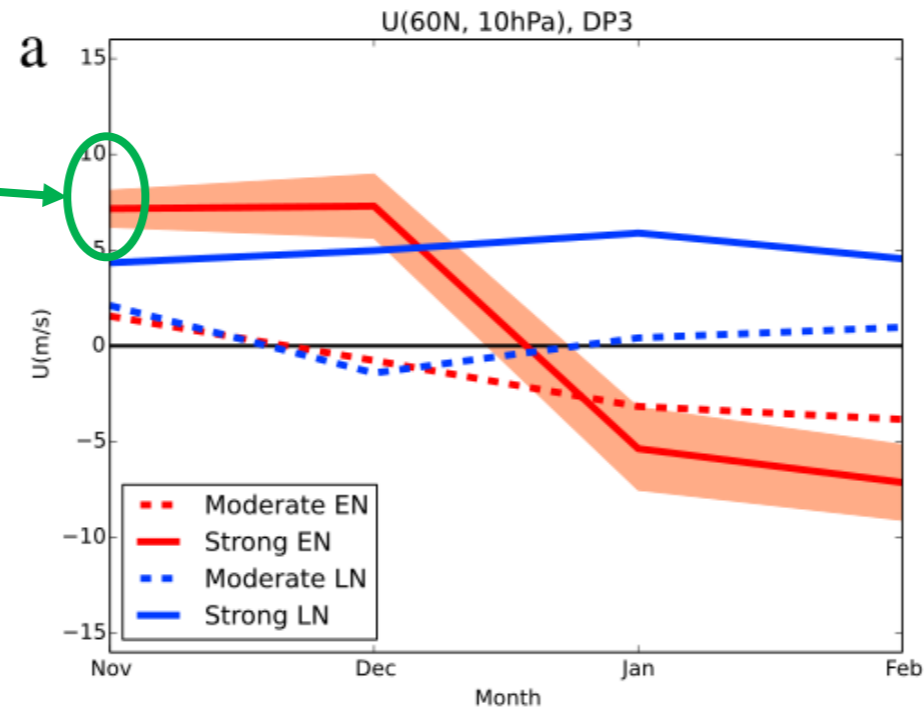


Stratospheric teleconnection pathway

November
vortex
anomalously
strong for strong
El Niño events

DP3

OBS



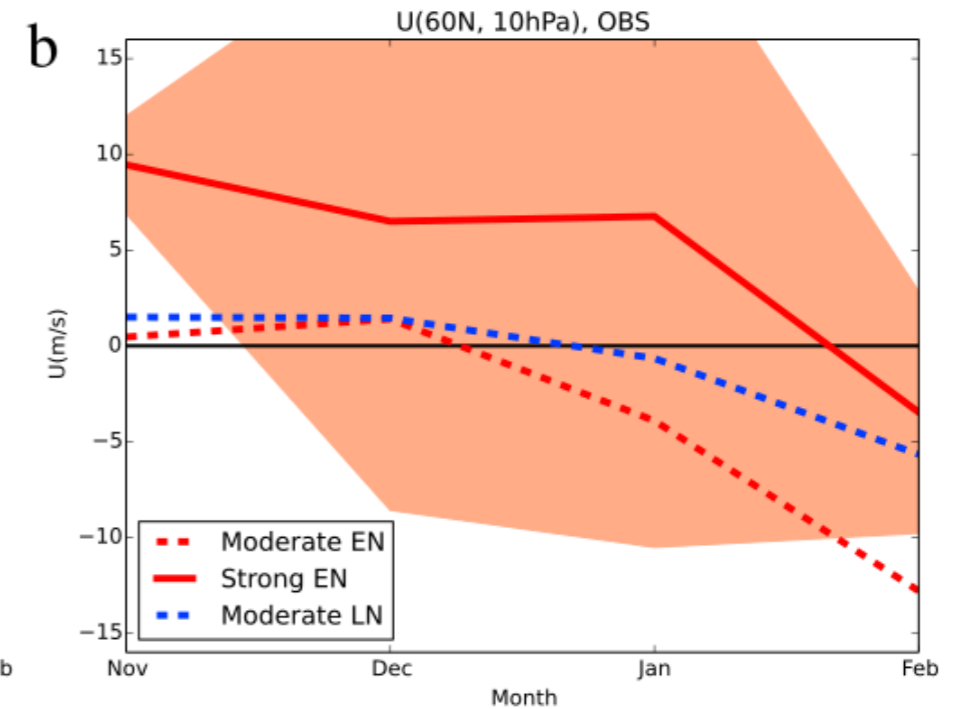
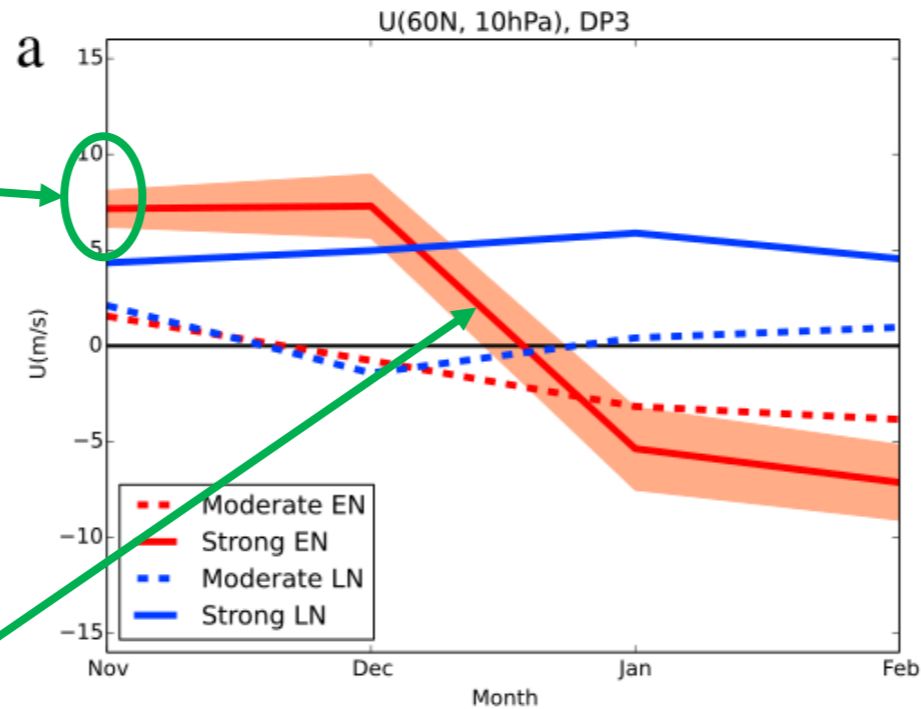
Stratospheric teleconnection pathway

DP3

OBS

November vortex anomalously strong for strong El Niño events

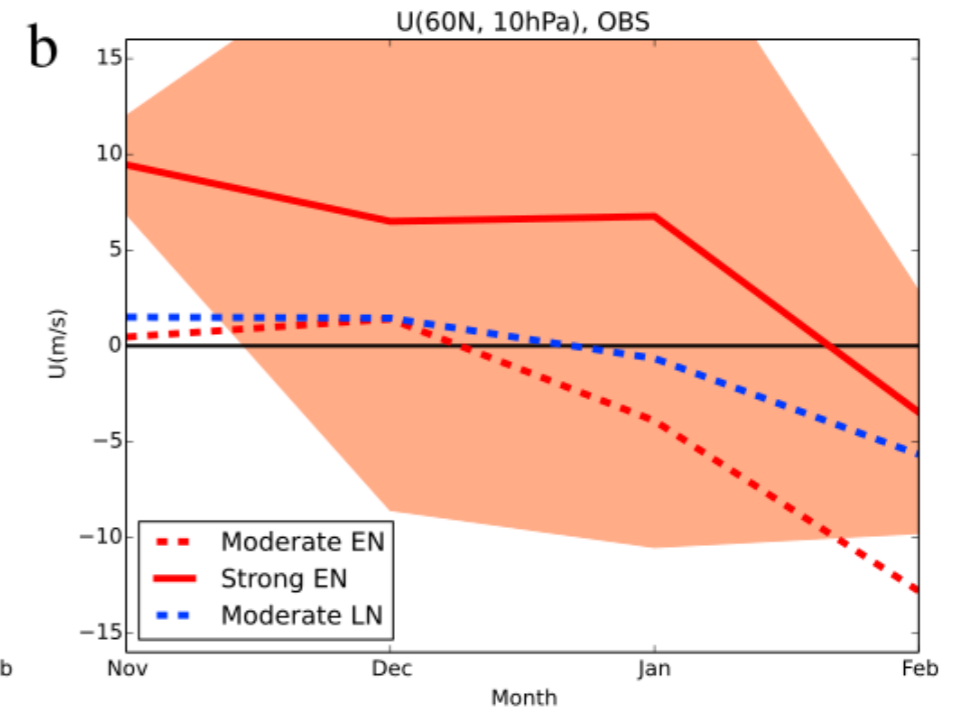
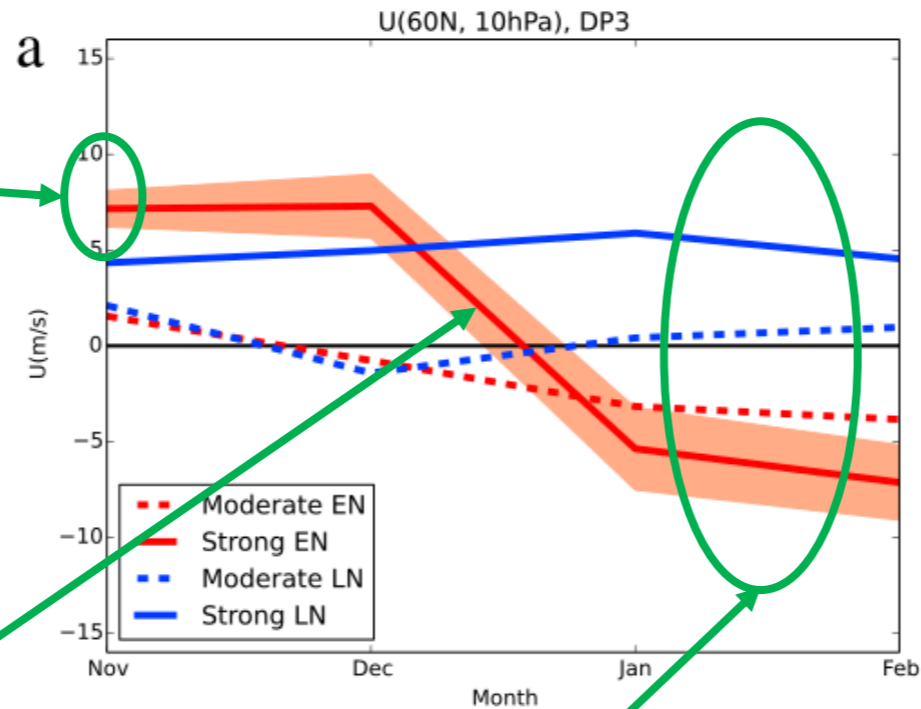
Vortex warms (weakens) rapidly during winter for large El Niño, but strong anomaly remains constant through winter for large La Niña



Stratospheric teleconnection pathway

DP3

OBS



November vortex anomalously strong for strong El Niño events

Vortex warms (weakens) rapidly during winter for large El Niño, but strong anomaly remains constant through winter for large La Niña

Vortex strengths in Jan—Mar are monotonic in the Niño 3.4 index.

Stratospheric teleconnection pathway

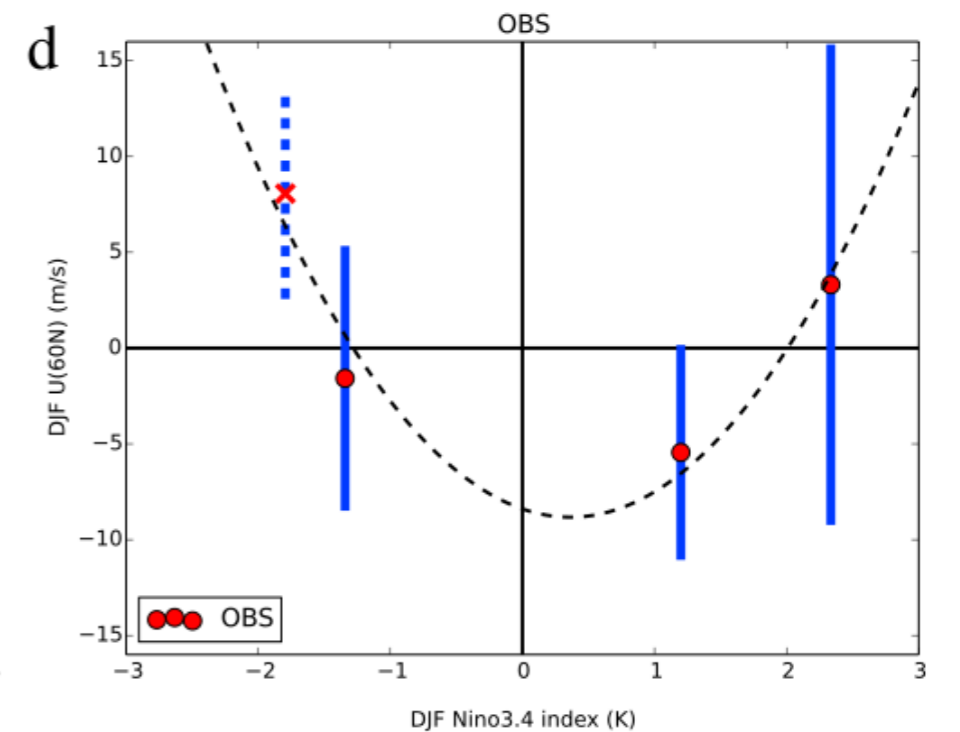
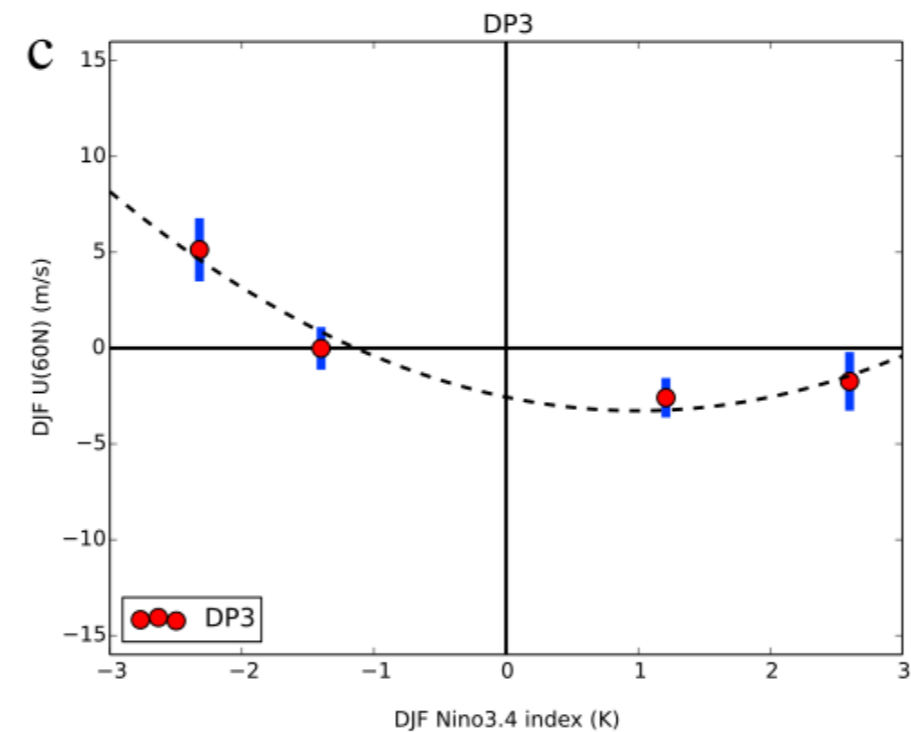
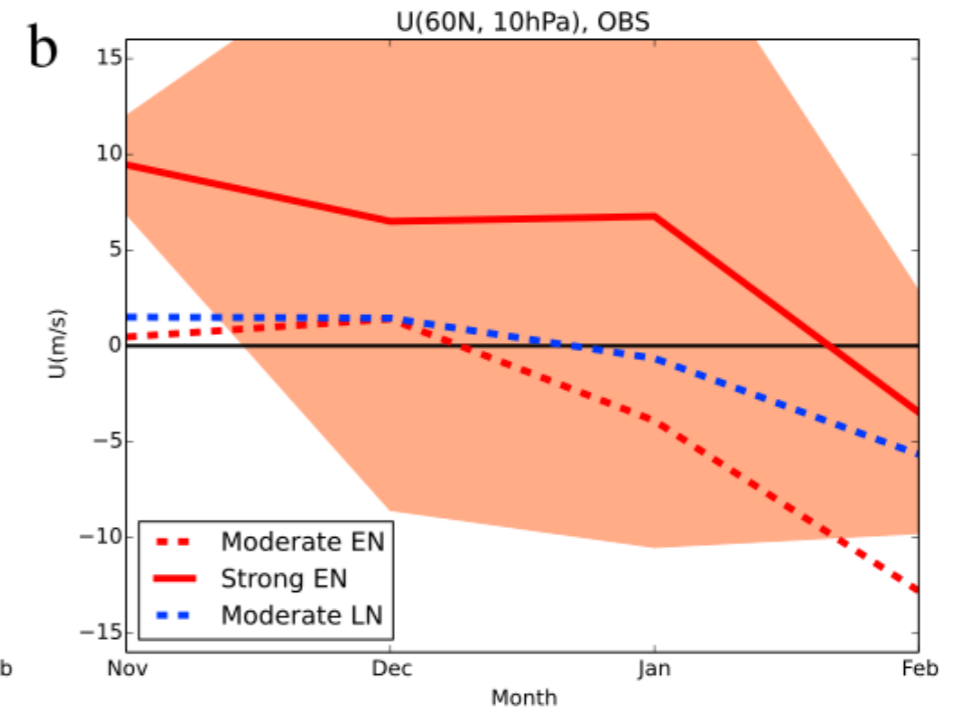
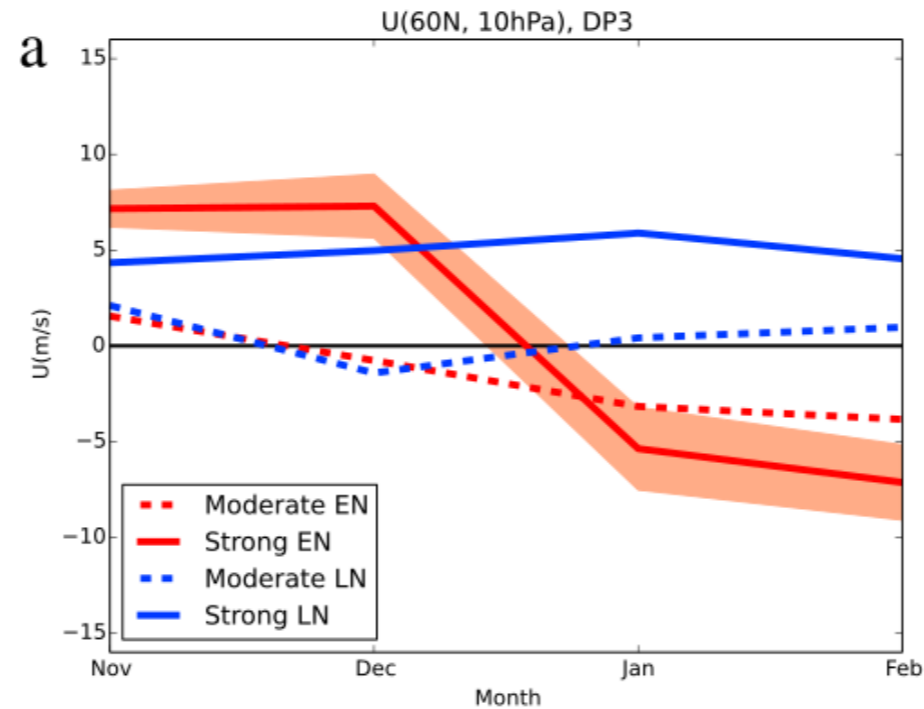
Stratospheric pathway

Thus DJF mean polar vortex strength (impacting JF MSLP) is strong for strong La Niña but *not* weak for strong El Niño.

Obs are similar but no strong La Niñas and very few strong El Niños (so large error bars).

DP3

OBS





Conclusions

Using 40 member DP3 ensembles, it is found that:

- North Atlantic MSLP in *Jan-Feb* shows a wavelike response following strong El Niño events but positive NAO following strong La Niña events.
- This is due to the tropospheric pathway dominating for El Niño, and the stratospheric pathway dominating for La Niña.
- Asymmetry is due to the stratospheric pathway.
- If strong La Niña ever occurs, northwest Europe might well experience enhanced westerly flow and substantial rainfall during that winter, with increased risk of flooding.

Hardiman, S. C., N. J. Dunstone, A. A. Scaife, D. M. Smith, S. Ineson, J. Lim, and D. Fereday (2019), The impact of strong El Niño and La Niña events on the North Atlantic, *Geophys. Res. Lett.*, 46, 2874-2883, doi:10.1029/2018GL081776