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Predictable Decadal Forcing of the North Atlantic Jet by the SPNA

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Preprint soon (today?) available in Weather and Climate Dynamics

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Past studies

Simpson et al. (2018)

Smith et al. (2019)

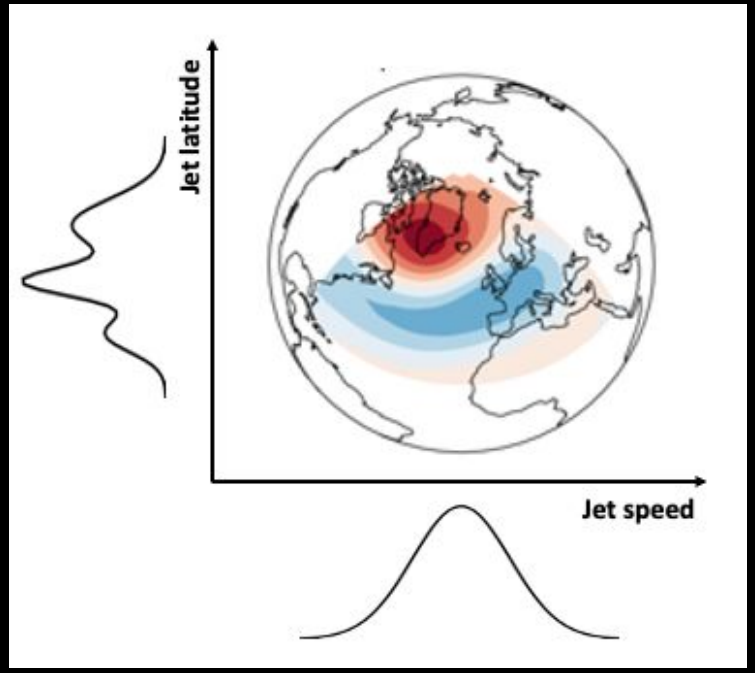
Athanasiadis et al. (2020)

Decadal variations in the winter NAO are predictable over period 1954-2015.

- AMV is suggested as possible source of skill.

Some outstanding questions

1. Is it really the AMV?
2. What exactly is being predicted?
3. Pathways/mechanisms?



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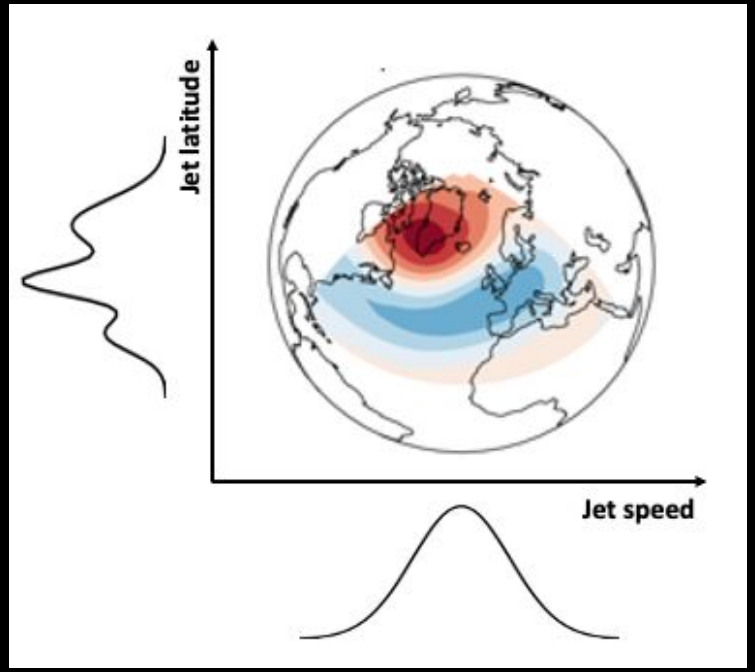
Jet latitude and jet speed:

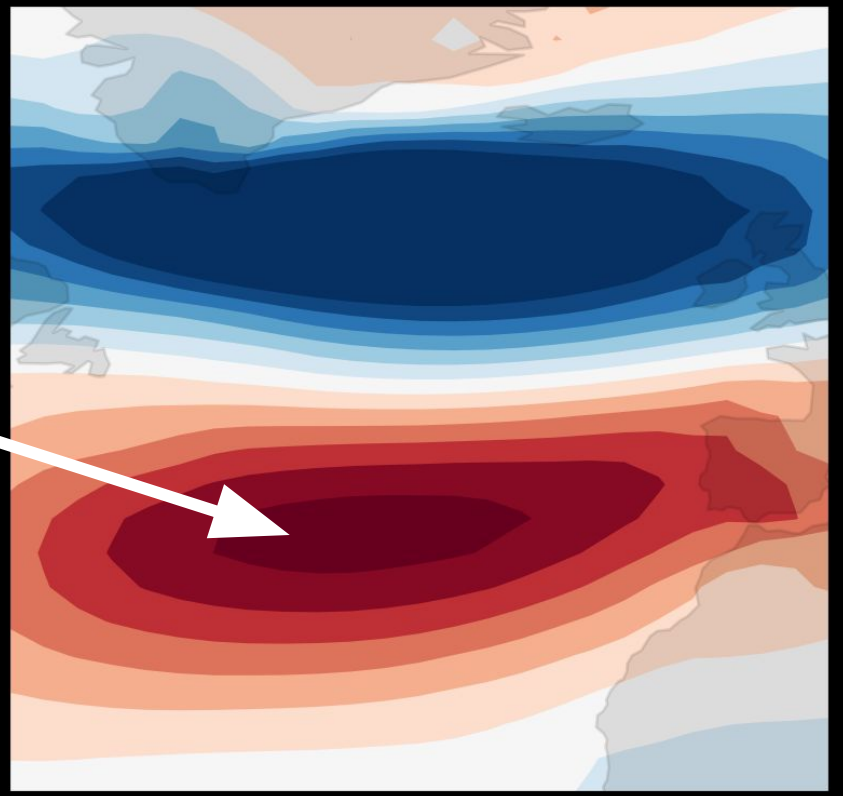
1. Different seasonal/decadal variability
2. Different responses to thermal forcing (!!)

 single index analysis can give wrong impression



How to compute latitude/speed

U850 anomaly on some day



This is where the jet “is”

Get the latitude and magnitude (= speed)

Repeat for every day.

Woollings et al.

DATA BEING USED

1. The Decadal Prediction Large Ensemble (DPLE) – covers 1954-2015

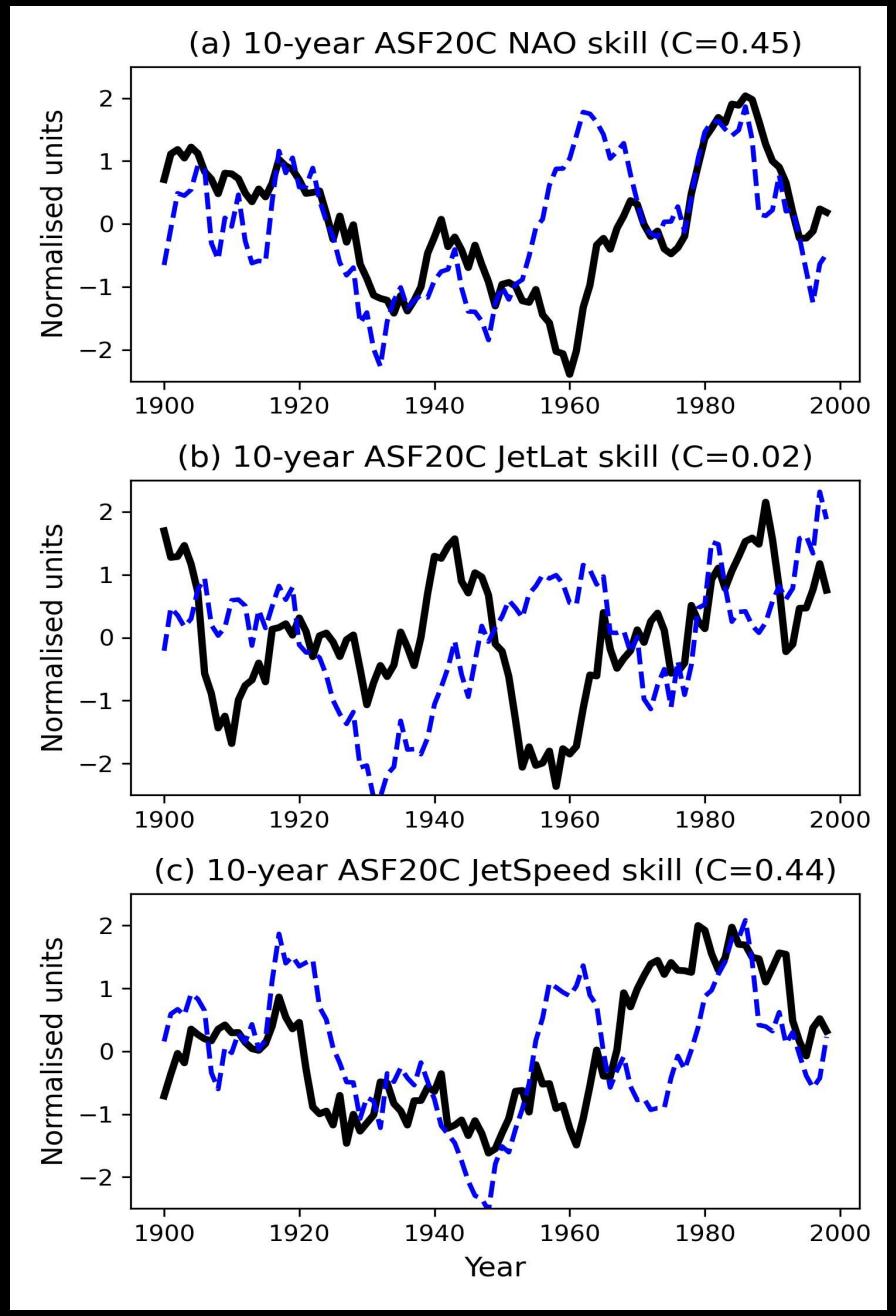
2. A seasonal IFS hindcast ensemble (ASF20C) – covers 1900-2010 (!)
   (uses prescribed SSTs from ERA20C) *(Weisheimer et al. 2017)*

3. ERA20C reanalysis

Focus is on 10/30-year running ensemble means

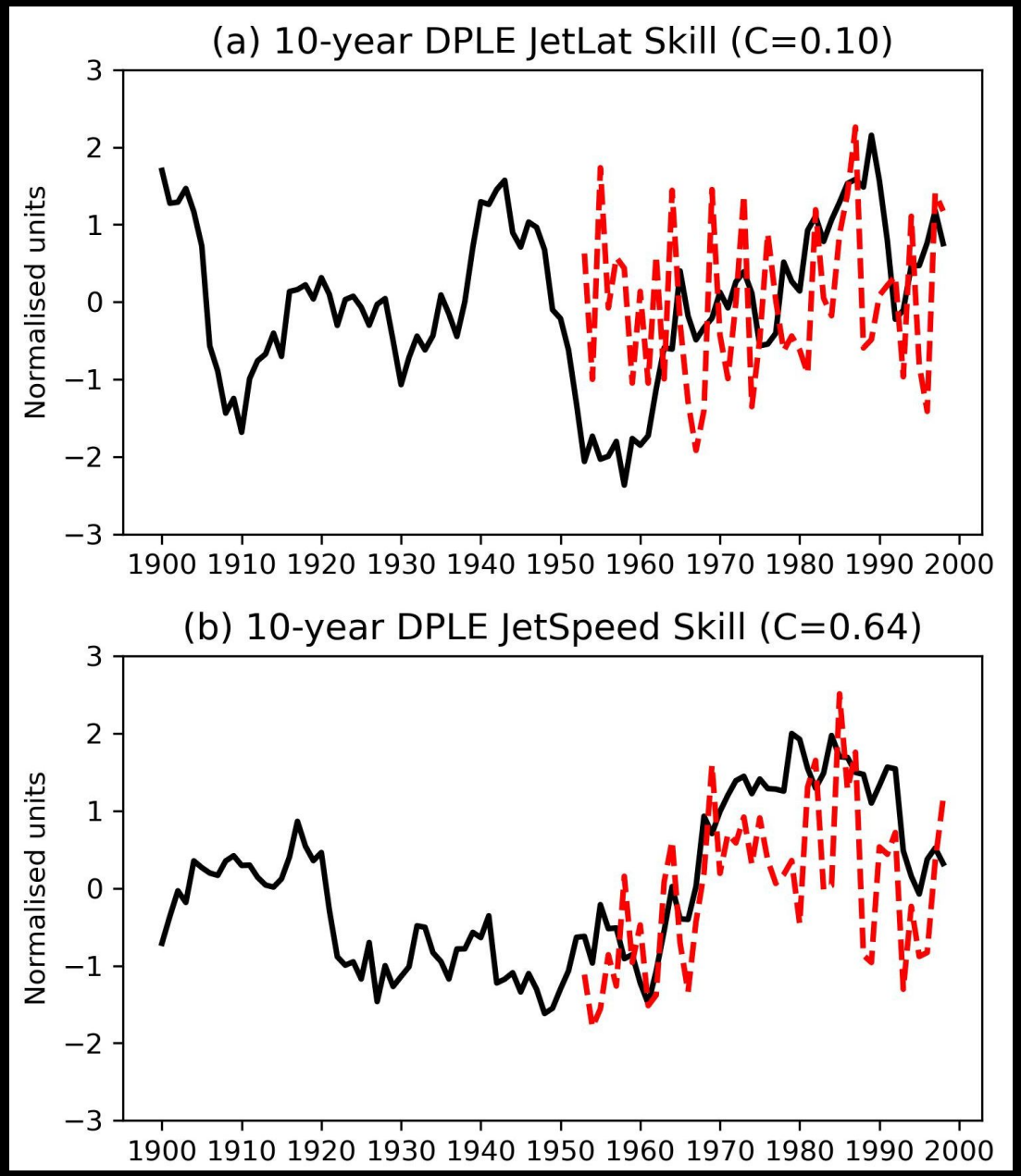
NB! Decadally averaged seasonal forecasts =/= a decadal forecast!

But useful to think of it as like a `nudged' decadal forecast
that we can use to study decadal signals



- ASF20C can skillfully reproduce decadal NAO variability over entire period 1900-2010
- It's all coming from the jet speed
- No predictability of the latitude!

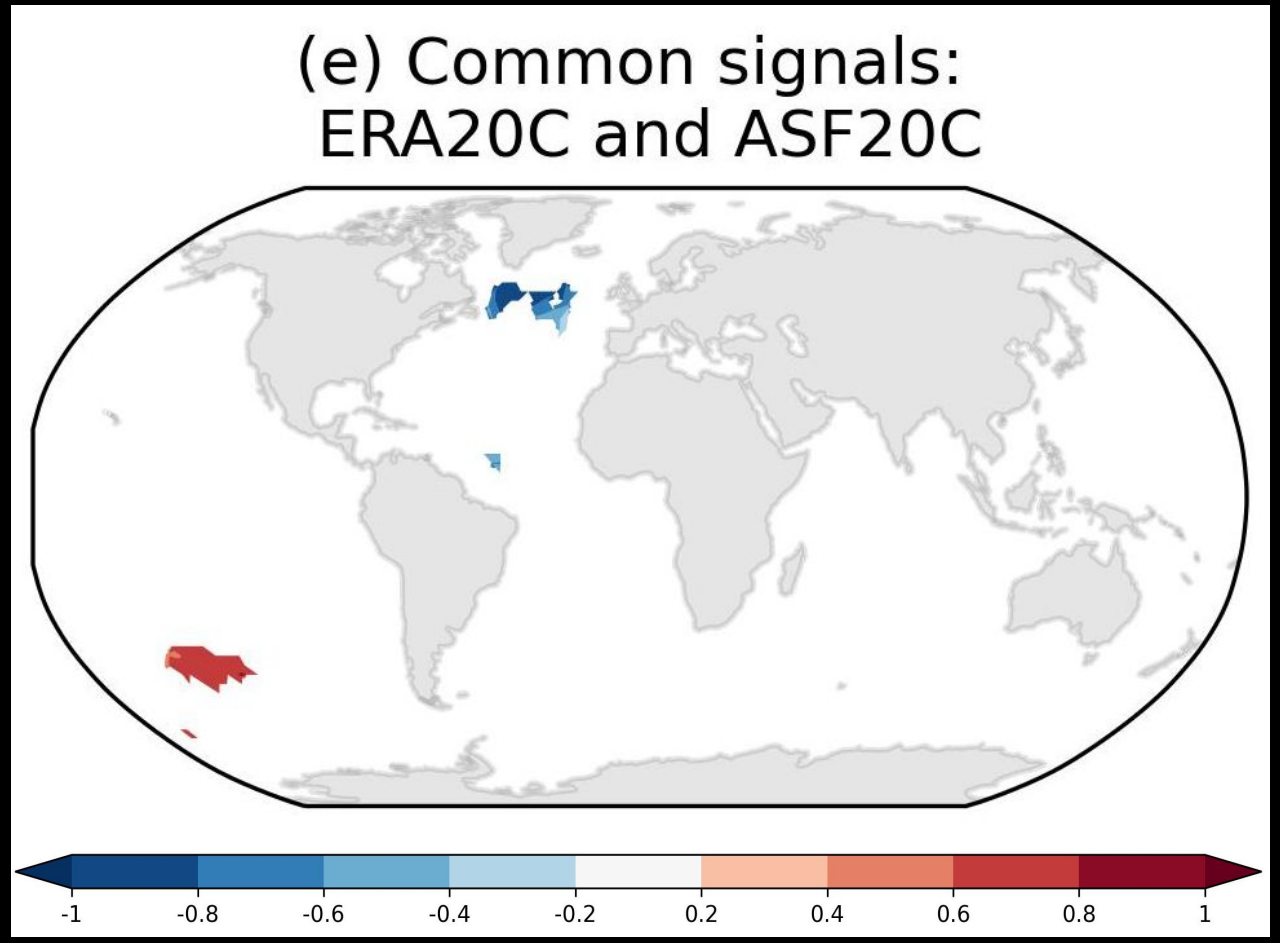
See also: Parker et al. (2019)



- Same picture for DPLE:
  only the speed is predictable

- Despite giving ASF20C the correct SSTs and correct Nov 1st (every year), it has similar `skill' to DPLE

  the signals in DPLE and ASF20C are probably the same
  (and visible within a single winter season)



correlations of jet speed vs SSTs at gridpoints (1900-2010, DJF)

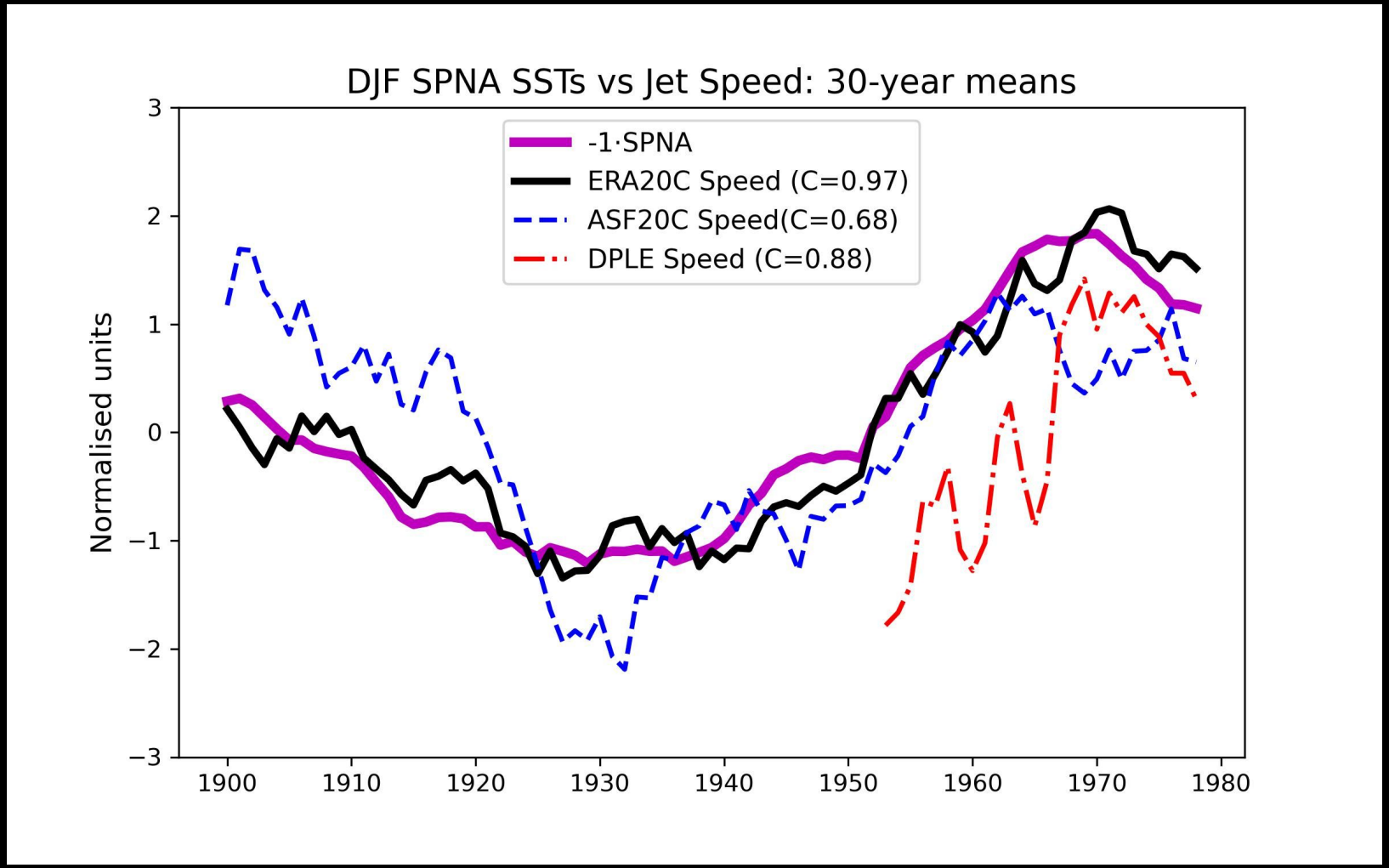
Look for any/all potential SST signals that satisfy:

1. Common to forecasts / ERA20C
2. Statistically significant
3. Visible on both seasonal and decadal timescales

 the SPNA is the only match

(SPNA is also there in DPLE: the blob in the south Pacific is not, so can be discounted)

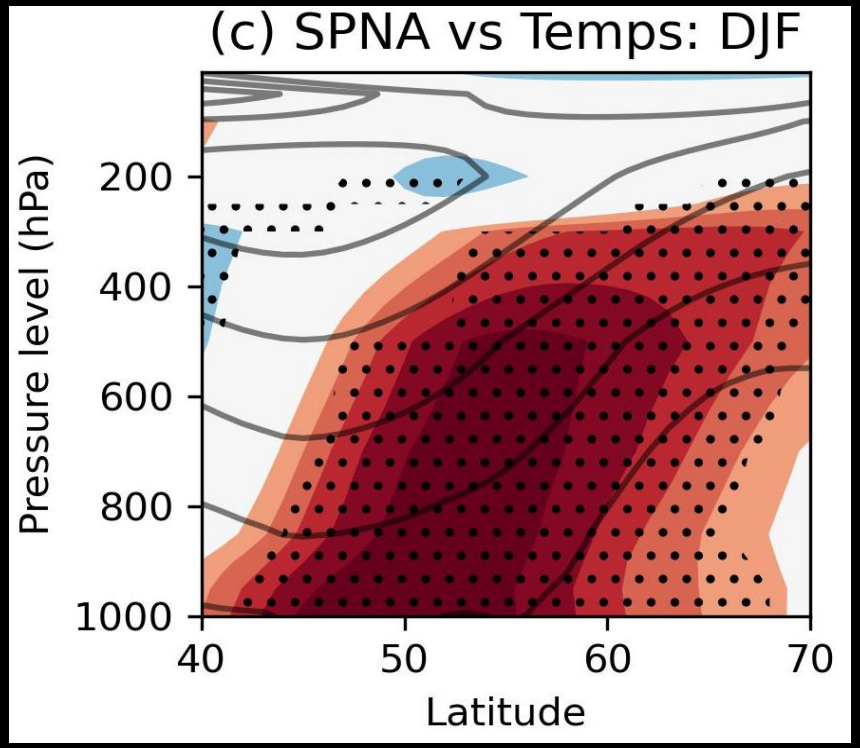
Large, significant correlations between SPNA SSTs and decadal jet speed



See also: Simpson et al. (2018)

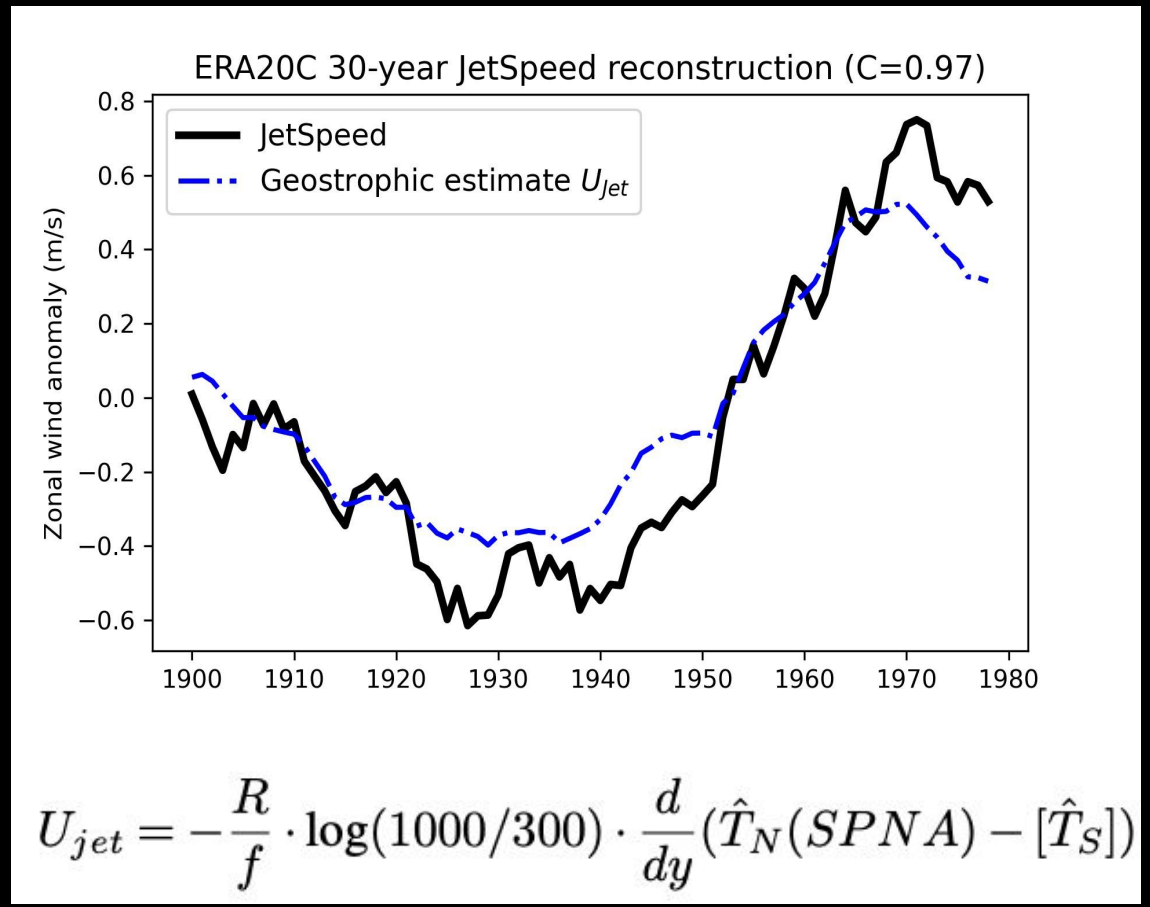
TROPOSPHERIC PATHWAY

1. SST-induced heating extends up to ~300 hPa



Filled contour = Corr(SPNA, Zonal Air Temp)
Line contour = Climatological zonal winds

2. Changes to tropospheric meridional temperature gradient
+
geostrophic balance
≈
all the observed decadal variability



$$U_{jet} = -\frac{R}{f} \cdot \log(1000/300) \cdot \frac{d}{dy}(\hat{T}_N(SPNA) - [\hat{T}_S])$$

IS IT REALLY OCEAN FORCING ATMOSPHERE?

(and not other way round?)

1. ASF20C hindcasts use prescribed SSTs:
   correlations can only arise due to forcing from the SSTs!

2. Heatfluxes and SSTs are positively correlated in the SPNA:
   indicative of forcing from SSTs

3. If it's all atmospheric forcing then where is the skill coming from?
   (Simpson et al. 2018 showed the stochastic winds are unpredictable)

4. Impact of `stochastic atmospheric forcing' component can be estimated:
   the effect is very small on decadal timescales

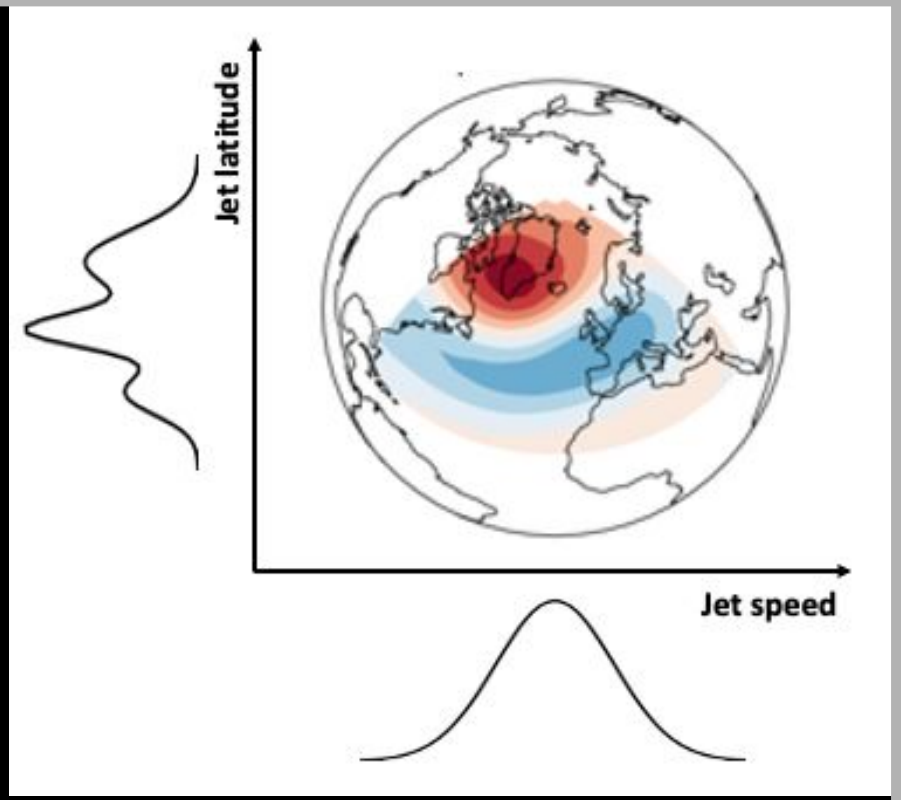
This seems to strongly suggest the SPNA forces the jet

SUGGESTED PICTURE OF DECADAL JET VARIABILITY

Eddies are varying around their mean latitude due to teleconnection effects that aren't predictable years ahead

↓

no decadal predictability of the jet latitude



Average *intensity* of eddies is varying slowly in response to the SPNA SSTs

→ decadal predictability of jet speed

(See also: Woollings et al. 2015)

Thanks owed to two key points:

1. The SPNA is optimally situated to shift the meridional gradient around jet core
2. The SPNA is predictable (Yeager et al.)

THE END

See preprint for more on the `signal-to-noise paradox', AMOC vs aerosols etc.