A Thermal Wind Perspective of Driving Changes In Jet Stream Patterns

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Motivation

The jet stream plays a significant role in shaping global weather patterns and is expected to shift poleward and possible accelerate during the 21st century. We examine trends of jet stream position and speed in reanalyses of recent decades as well as CMIP6 simulations of future climates. We also compute thermal wind and trends and investigate the influence of meridional temperature gradient trends on jet stream trends.

Background

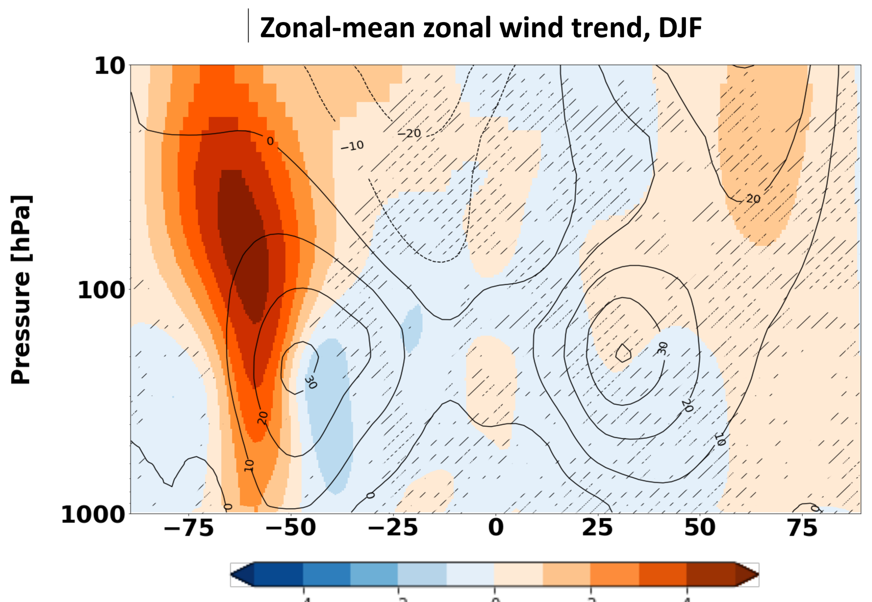


Figure 1.1: Climatology (contours) and trends (colours) of zonal-mean zonal wind at 300 hPa for AMIP6 simulations (1979-2014). Dashes indicate less that 80% model agreement.

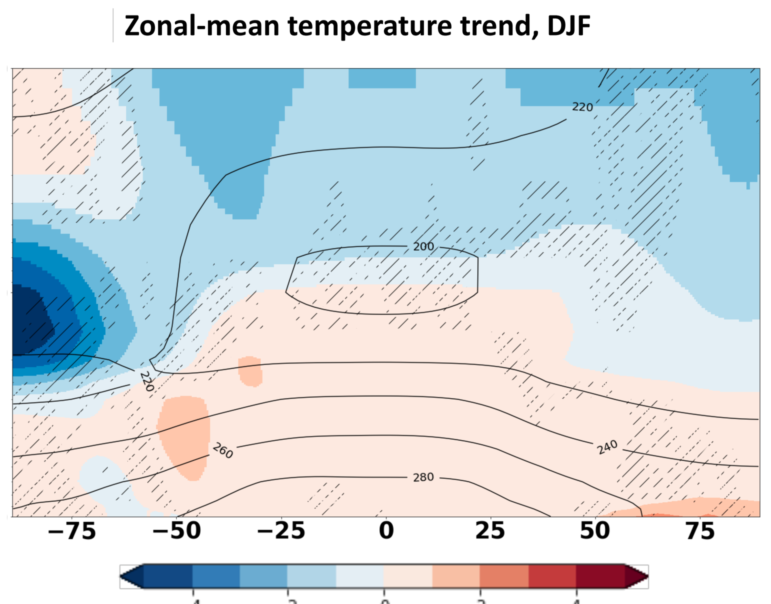


Figure 1.2: As Fig 1.1 but for zonal-mean temperature.

The Data – Readily available:

All data was spatially **regridded to 1˚**, focusing the period from **’79-’13**:

Experiment Type	#	Years
AMIP	31	33 x 31
piControl	38	~23000
piControl(FOCI-AMIP Runs)	3	9 x 22
1pctCO2	33	140 x 38
Reanalysis	10	33 x 10

note: Each chunks stands for a 33-year period.

Table 1.: The details about processed data.

Methodology

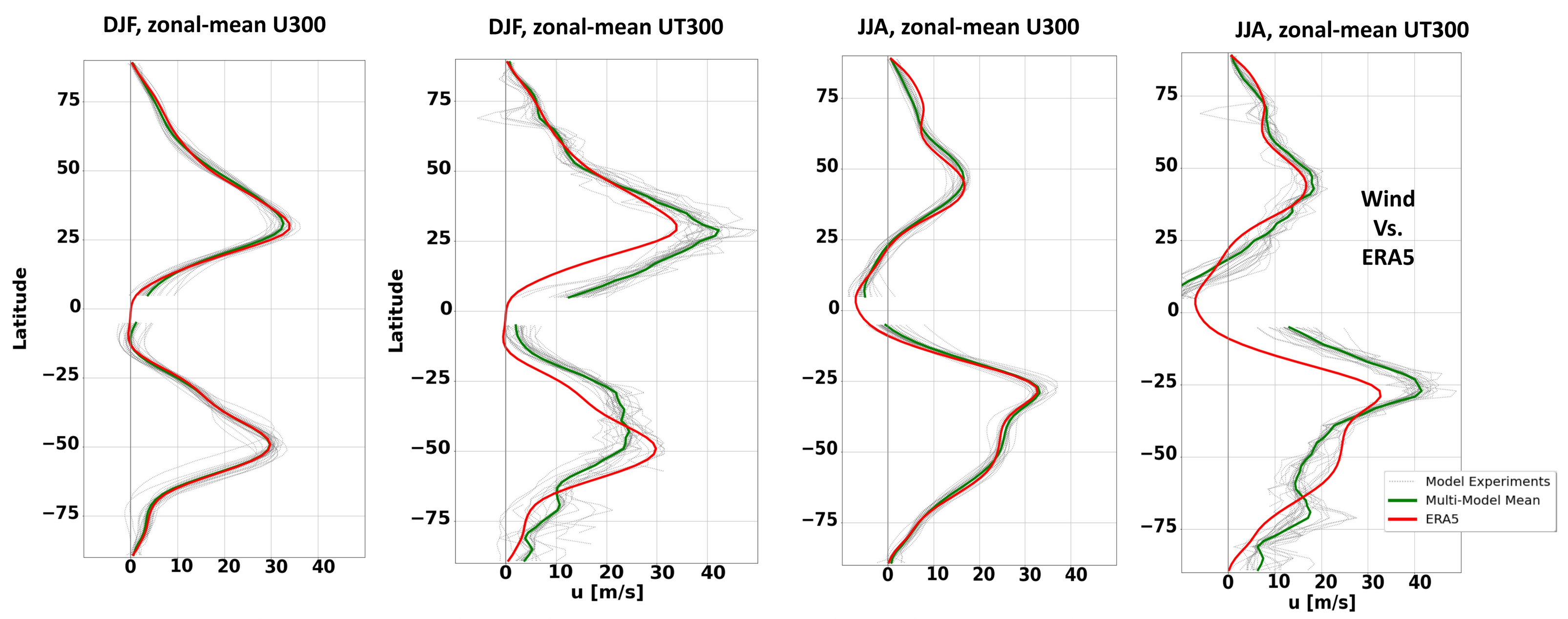


Figure 2.: Zonal-mean zonal wind at 300 hPa (U300) in AMIP6 models and ERA-5. Also shown is zonal-mean thermal wind for AMIP6 (UT300)

Reanalysis Study

Which renalysis dataset must be chosen as the ground truth?

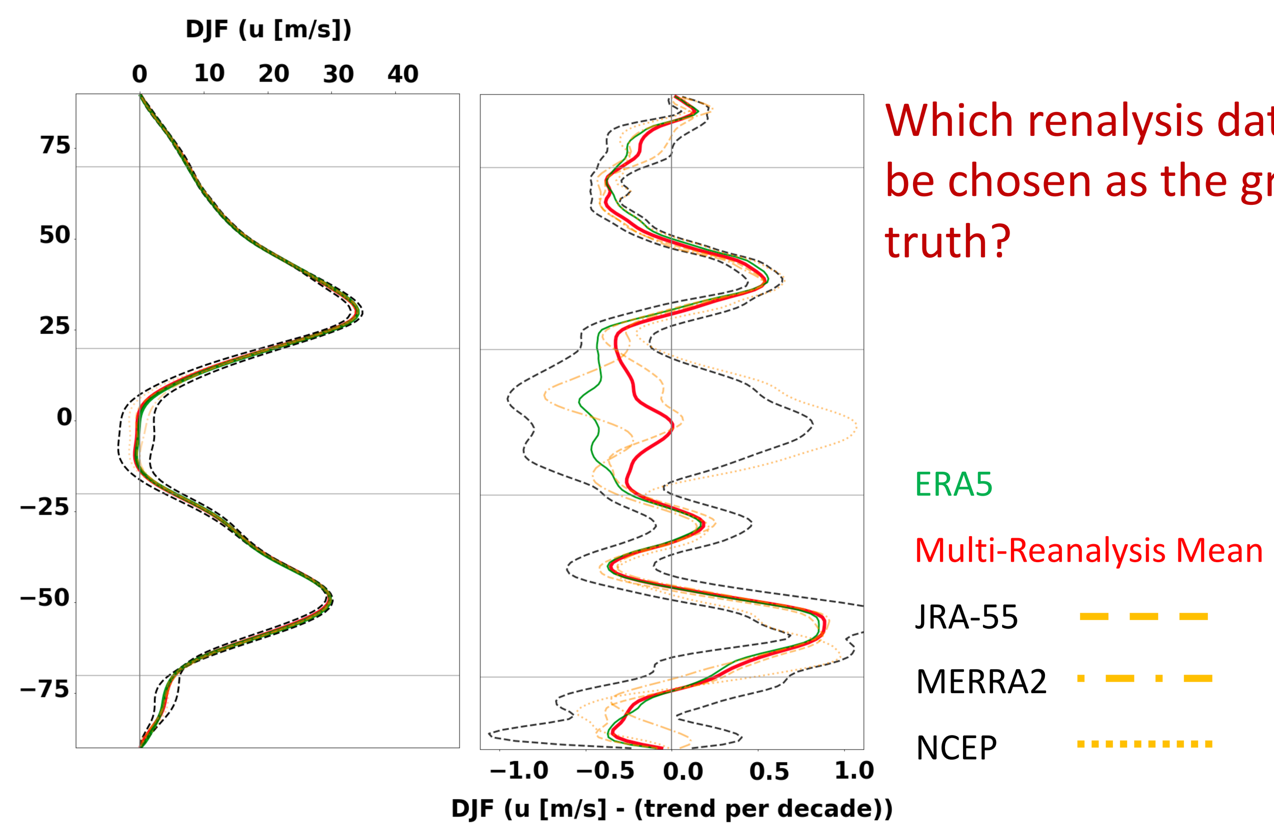
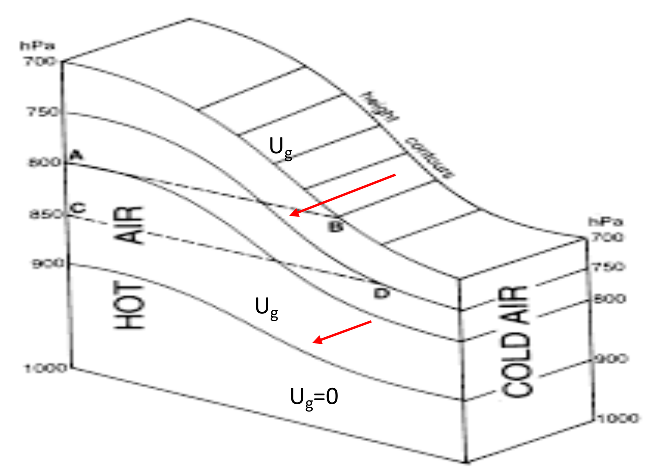


Figure 3.: The zonal mean and the trend plots of reanalysis datasets , ’79-’14.

Results – Thermal Wind



$$U_{TW} = \int_{1000hPa}^{300hPa} \frac{Rd}{aprf} \frac{\partial Tv}{\partial \theta}$$

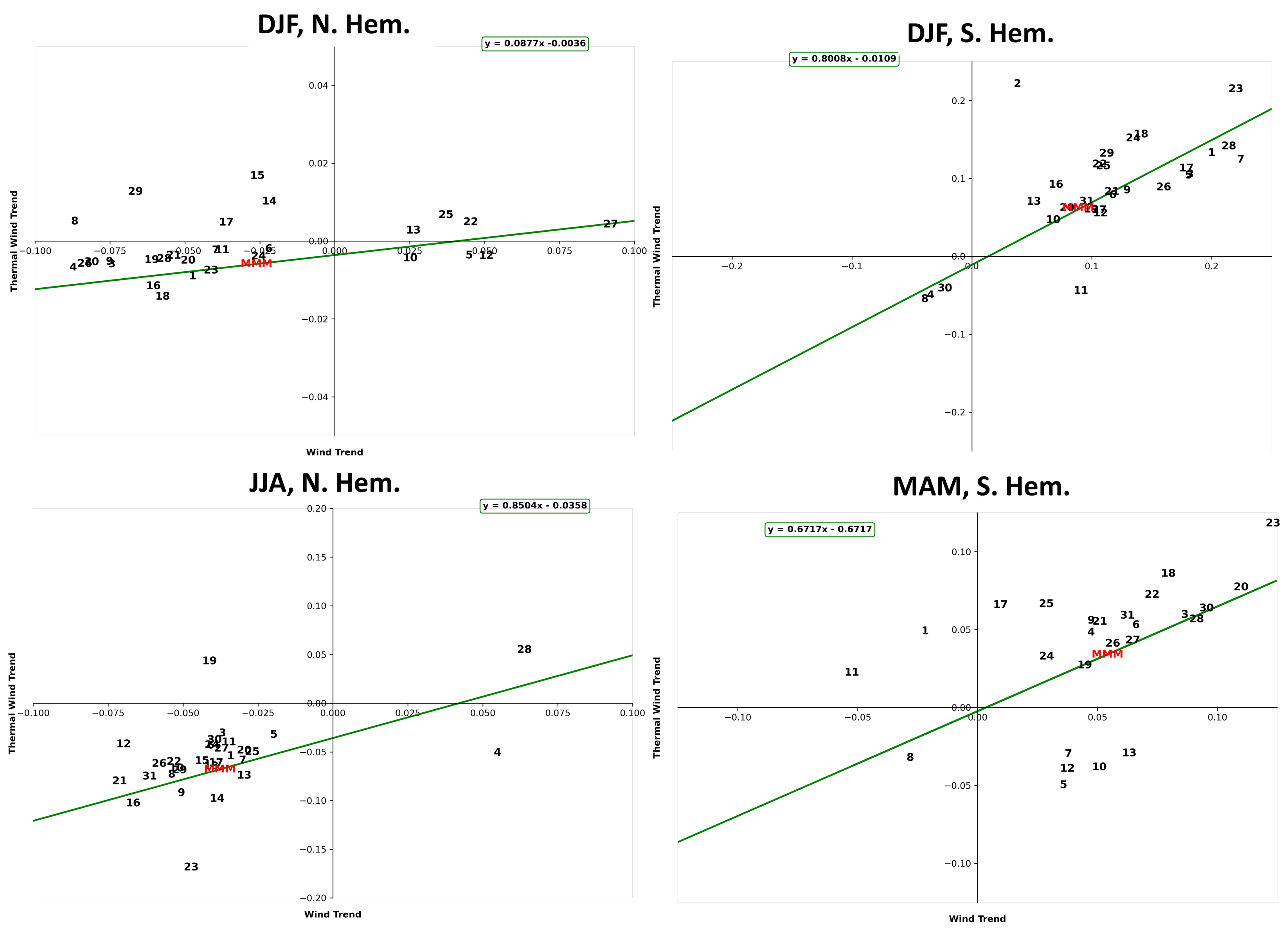


Figure 4.: The correlation plots for wind trends and thermal wind trends, for both hemispheres and all seasons.

Results – Natural Variability

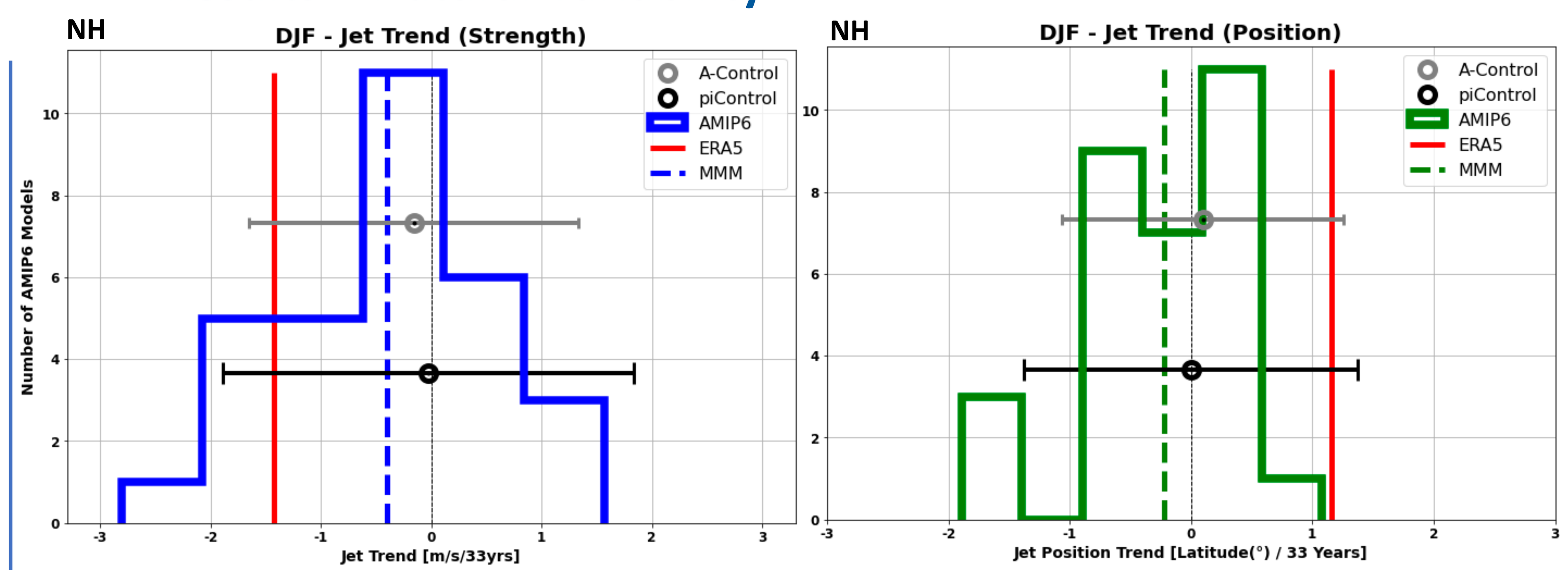


Figure 5.: The histograms for natural variability for DJF, ’79-’14. (95% confidence interval)

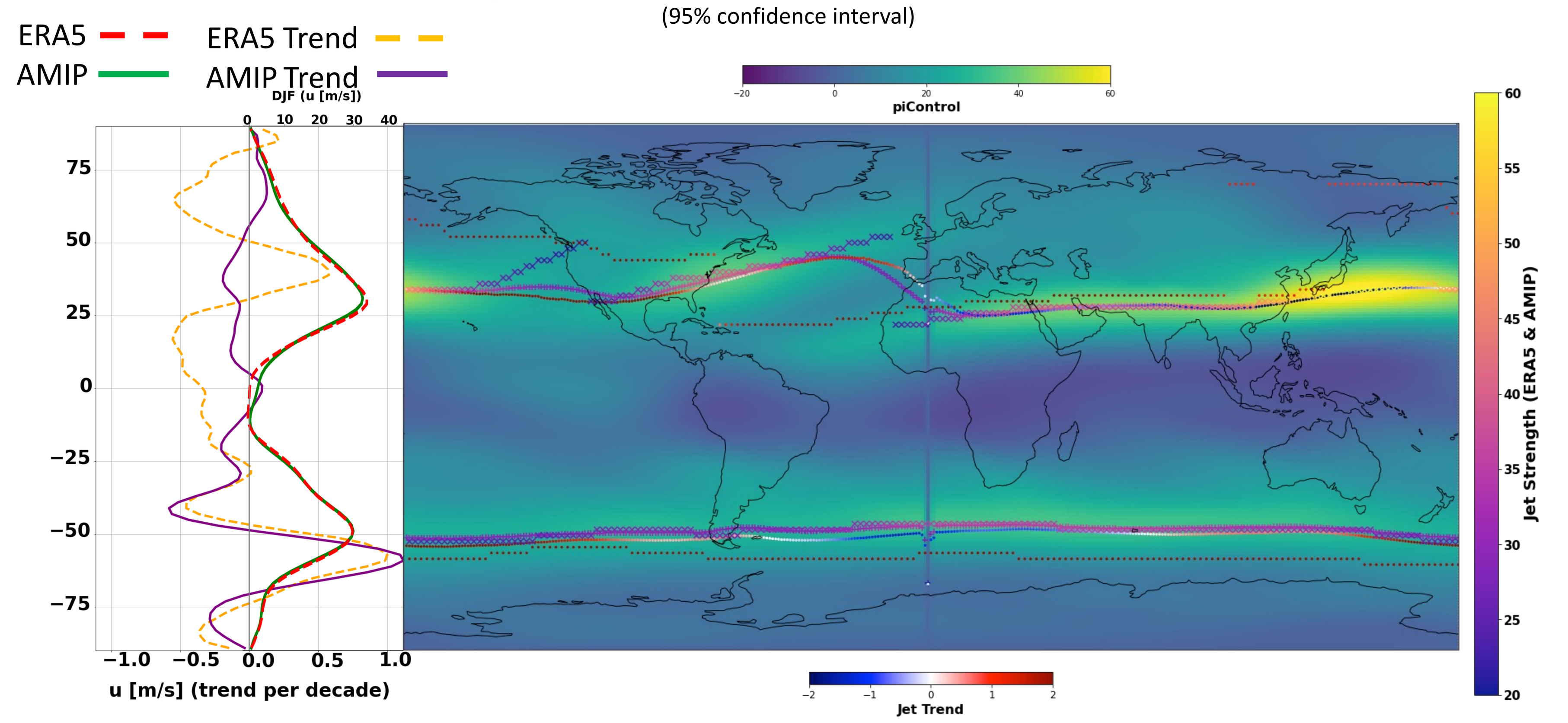


Figure 6.1: The zonal means and DJF U300 trend for ERA5 and AMIP, , ’79-’14.

Figure 6.2: The jet strength and position and their trends for ERA5 and AMIP, ’79-’14. As ‘X’ are standing for AMIP, ‘+’ are for ERA5. The colorbar in the right shows these two experiments intensity. The hollow and the full circles are located at the trend points for AMIP and ERA5 in return, and the degree of these trends are shown at the bottom of the figure. The base for the figure belongs to the piControl Runs, since it yields no trend, only zonal mean can be seen and its intensity can be read from the colorbar at the top.

Conclusions

- For the focused time period, AMIP multi-model mean reproduces jet stream trends on the Southern Hemisphere but not the Northern Hemisphere,
- piControl and OpenIFS-control runs proves that natural variability show no trend, yet yields to a large variance. Furthermore, even with limited total time-span, A-control produces comparable outcomes,
- Natural variability is estimated from piControl and OpenIFS-control. Most of the variability in coupled piControl can be reproduced by atmosphere-only control runs. Observed trends on Northern Hemisphere are within the estimated variability,
- Reanalysis products largely agree on midlatitude jet stream trends for 1979-2013, for the spatial focus of the work (±20th and ±70th latitudes).

What is next, soon?

- Checking is the **force** strong with the one…? If it is, the one might be:
  - 1pctCO2 analysis,
  - Thermal wind analysis

Scan for the rest of the work!

Scan for comm.- LinkedIn:

Sharing is encouraged

References:

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