CAM MT/WACCM comparison

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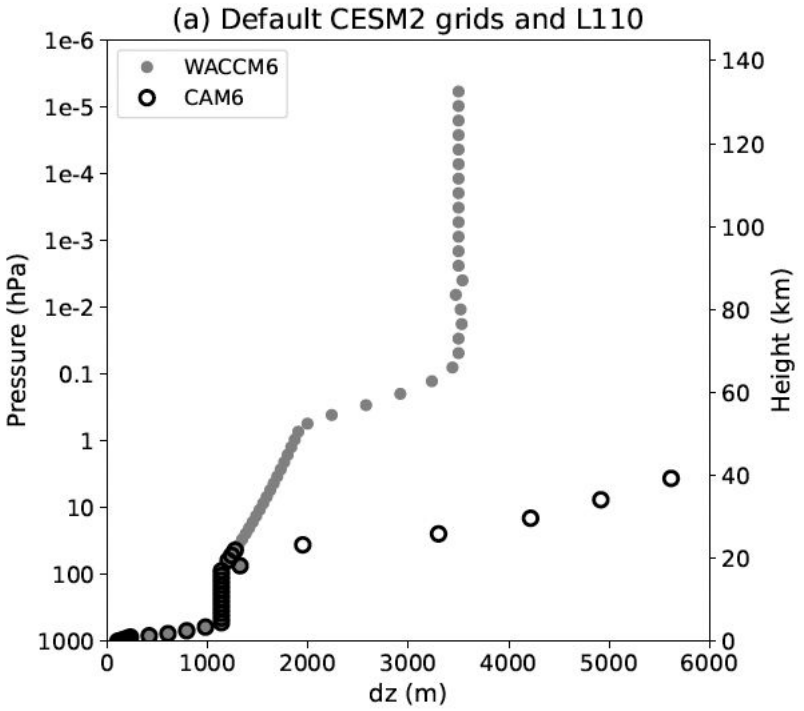
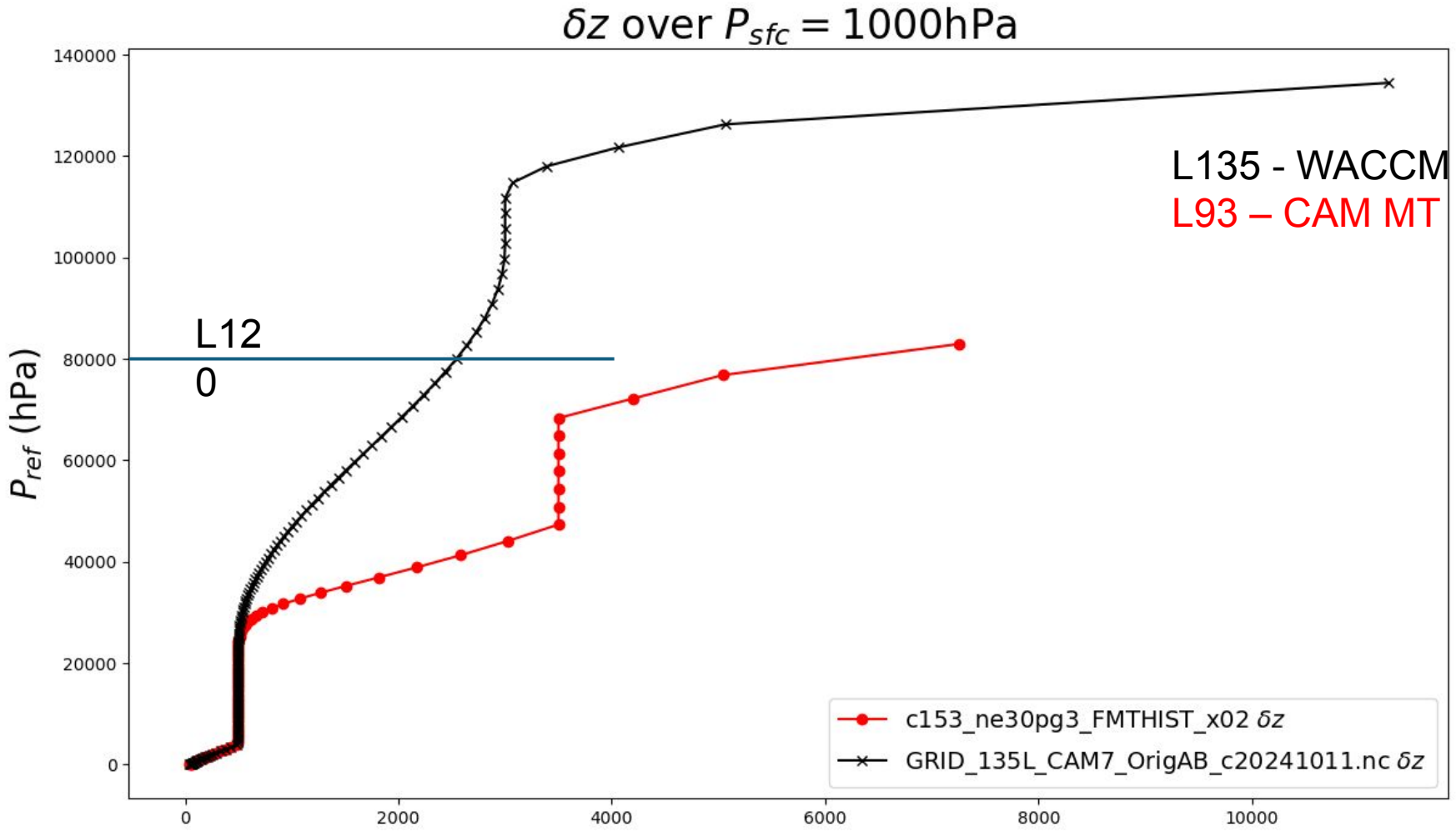
Background

- Before CESM3, CAM and WACCM were clearly distinct regarding the stratosphere
- New CAM development with model top at 80km,
- Now CAM and WACCM overlap in the stratosphere, but have different vertical grids



What is the impact of model top height and vertical grid spacing on representation of stratospheric circulation?

Vertical levels – L135 vs L93 grid



Setup – Overview

L135 and L93 vertical grids are very different, therefore we need to disentangle the effect of vertical resolution and model top.

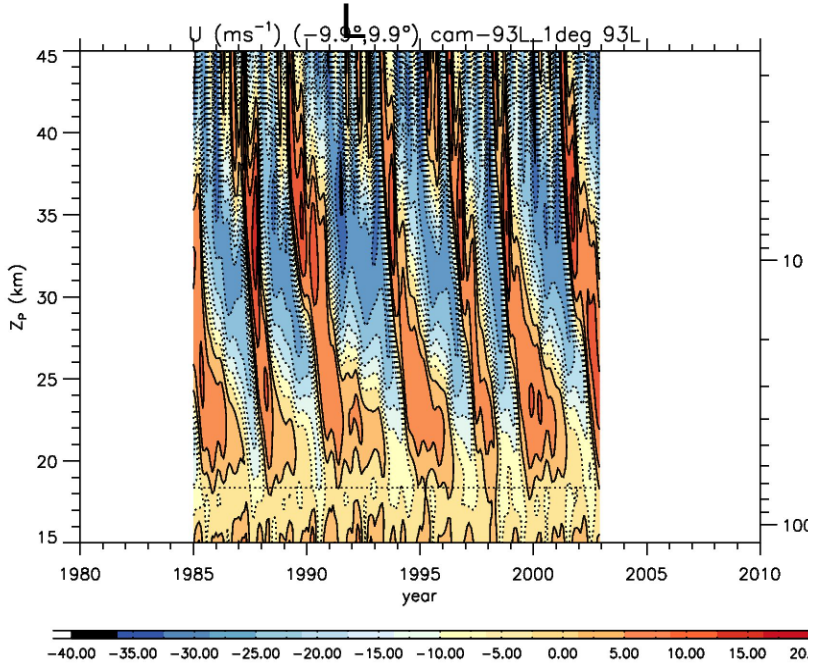
Simulations span 18.5 years

1. L93: Mid-top CAM with 93 vertical levels
2. L120: Mid-top CAM with 120 vertical levels, corresponding to the current WACCM L135 vertical grid.
3. L135: WACCM with 135 vertical levels

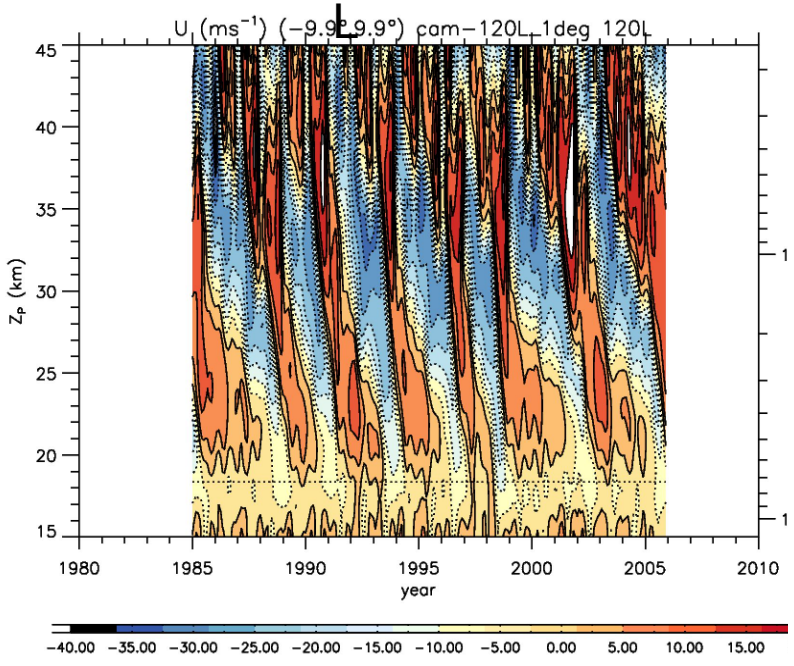
No specific tuning was performed for any of the model runs

Impact on QBO

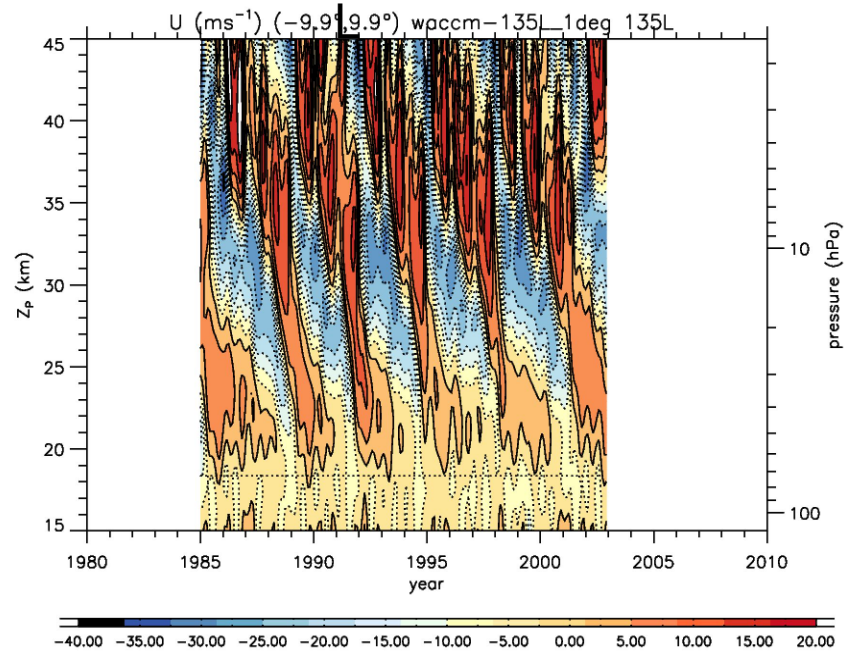
CAM93



CAM120



CAM135



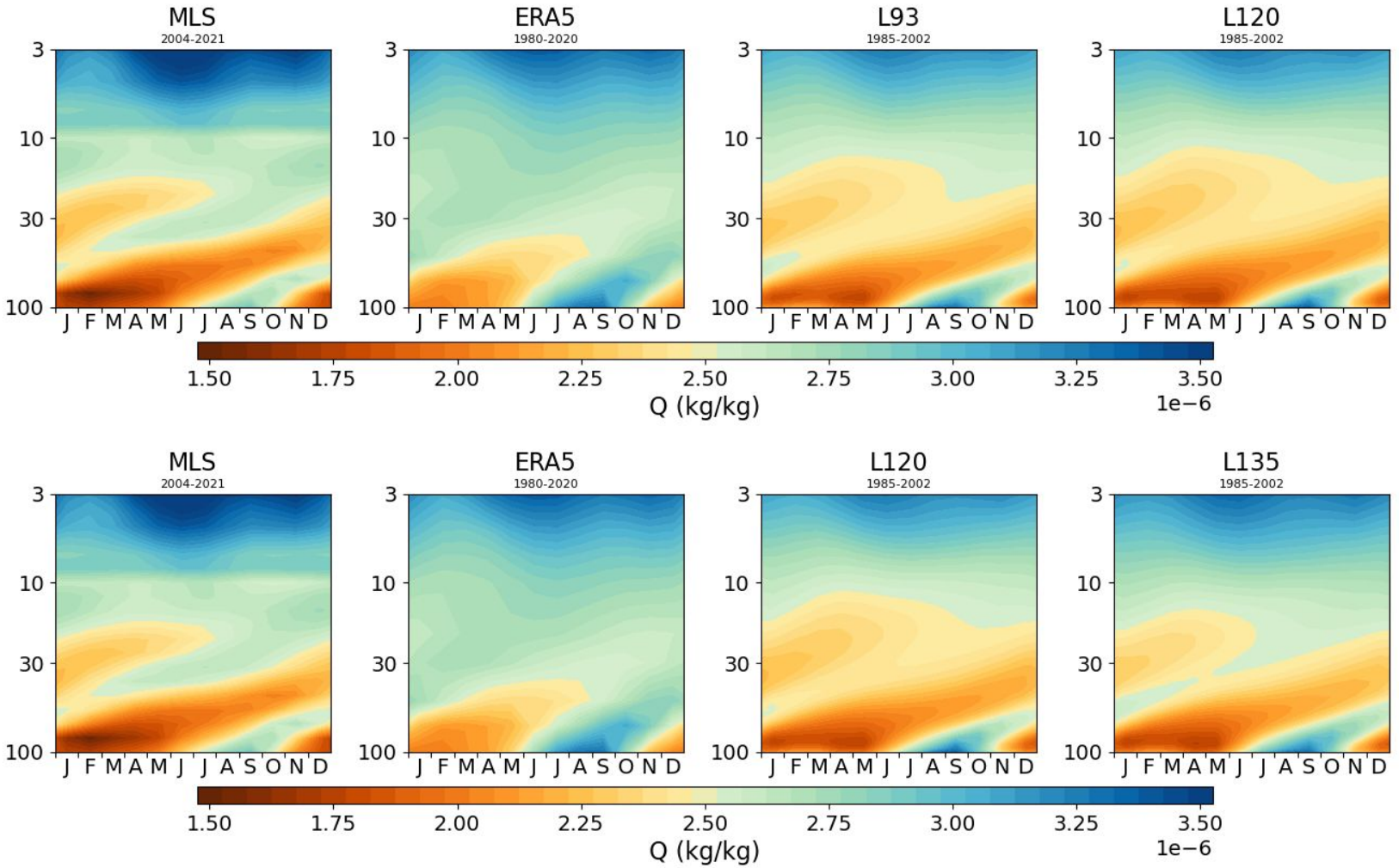
Notes: all runs used eff_gw_beres = 0.4, no specific tuning has been done on these runs

QBO Period very similar between the different runs

Impact on QBO

- Periods are very similar in the runs
- Influence of model mostly on the QBO amplitudes

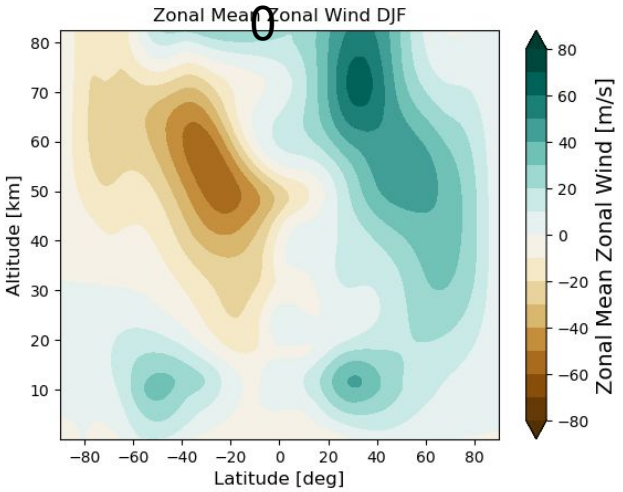
Impact on Tape Recorder



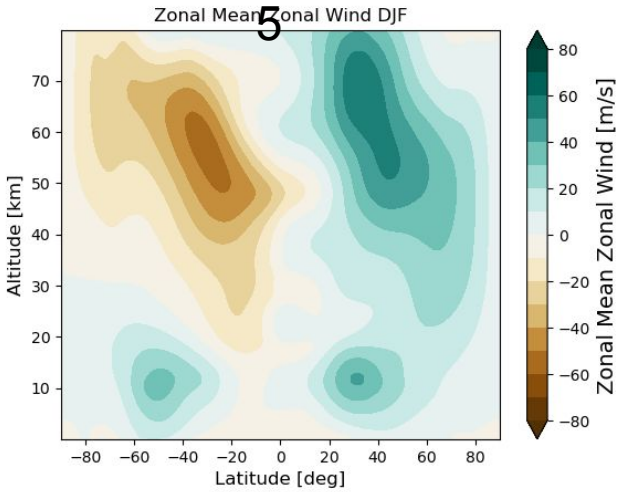
- CAM MT (L93 and L120) are both drier compared to observations
- WACCM (L135) better reproduces Tape recorder

Impact on Polar Vortex - DJF

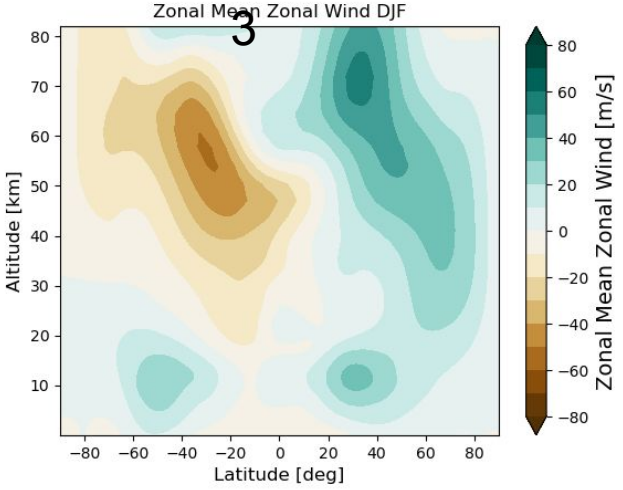
L12



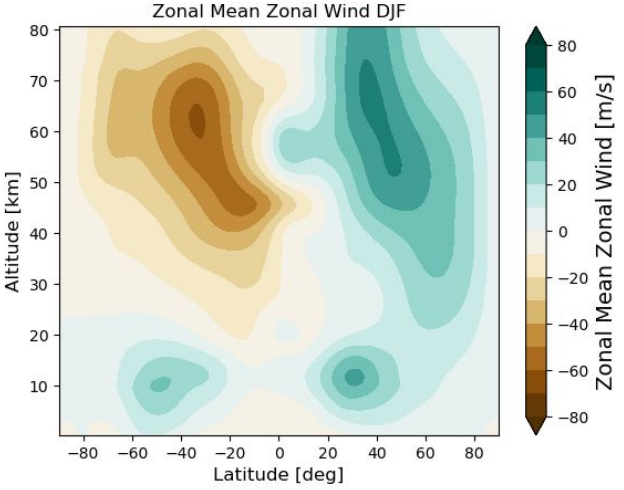
L13



L9



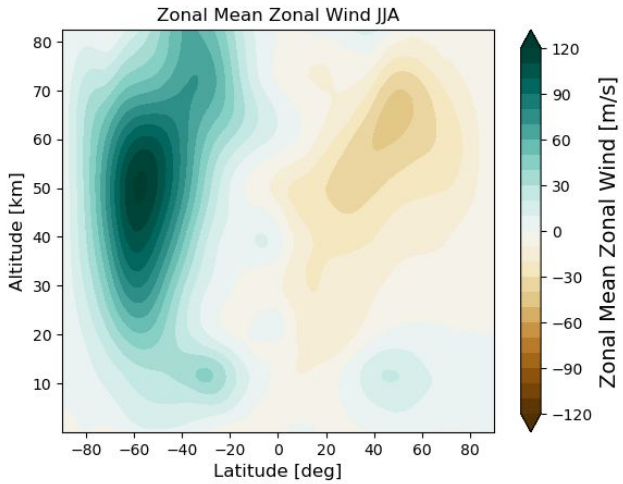
ERA



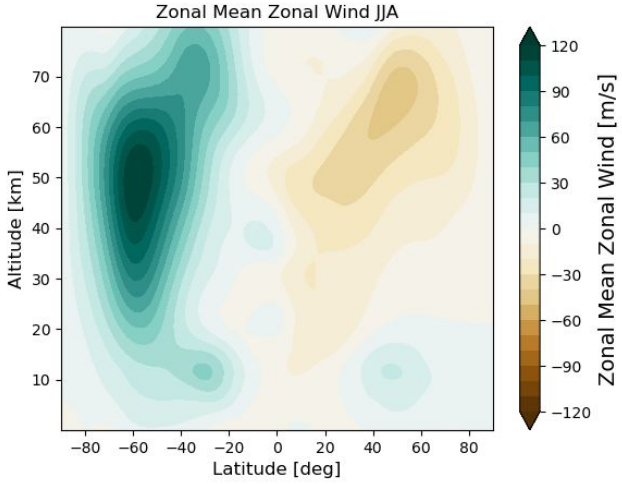
- Increased vertical resolution leads to stronger winds in the stratopause region
- Higher model top brings wind speeds down in the stratopause region

Impact on Polar Vortex - JJA

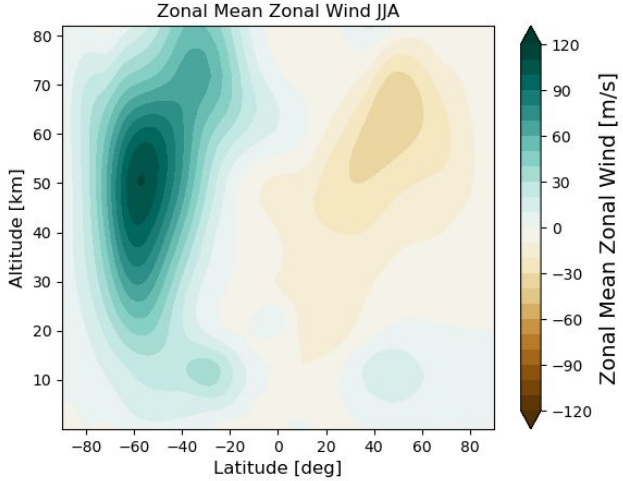
L12



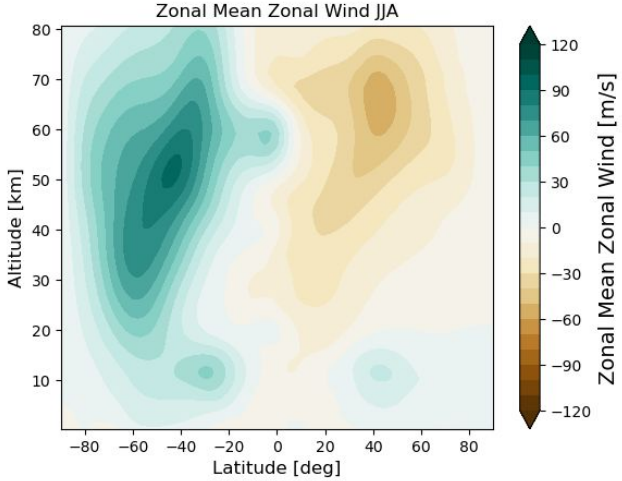
L13



L9



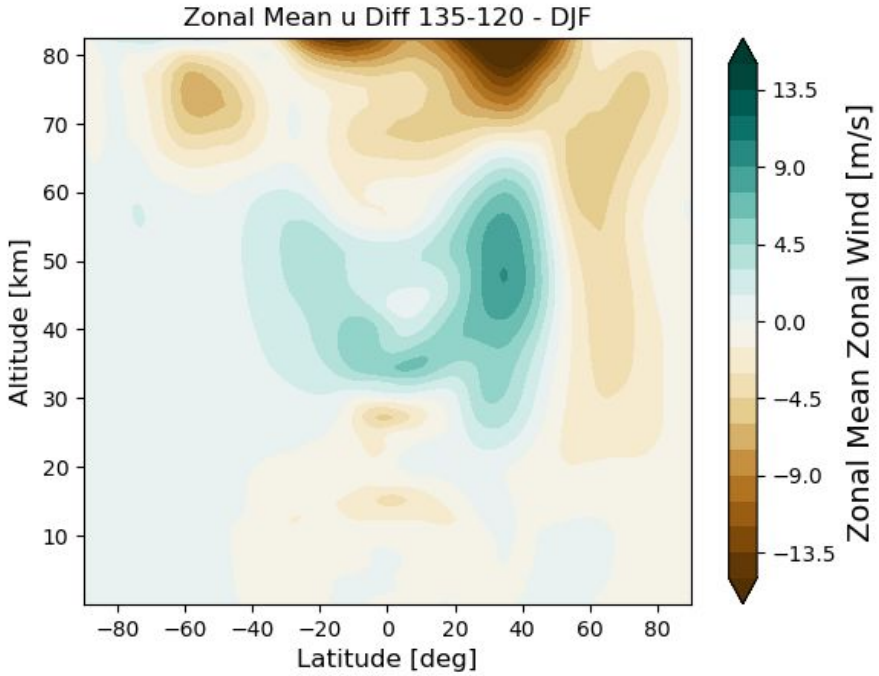
ERA

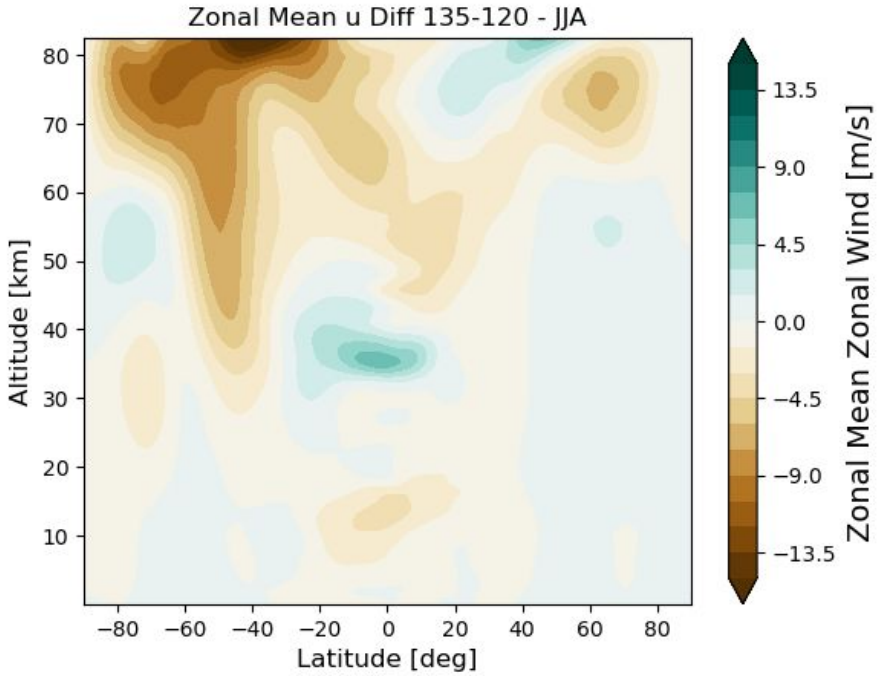


As in DJF:

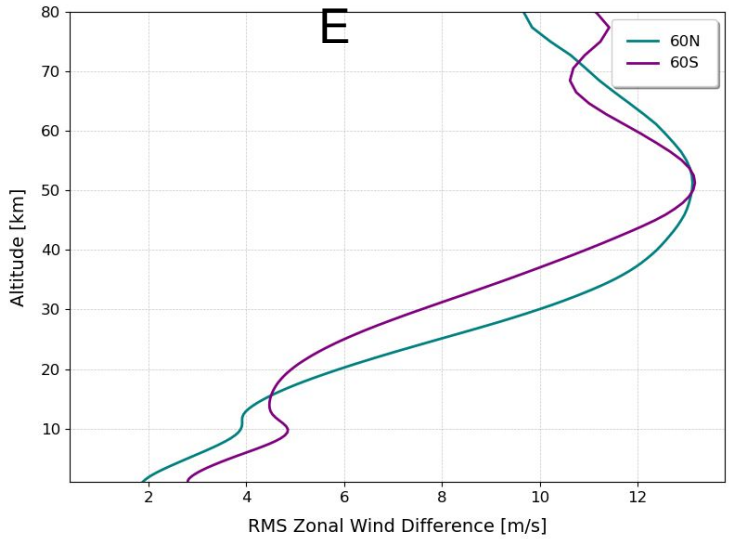
- Increased vertical resolution leads to stronger winds in the stratopause region
- Higher model top brings wind speeds down in the stratopause region

Impact on Polar Vortex – L120/L135



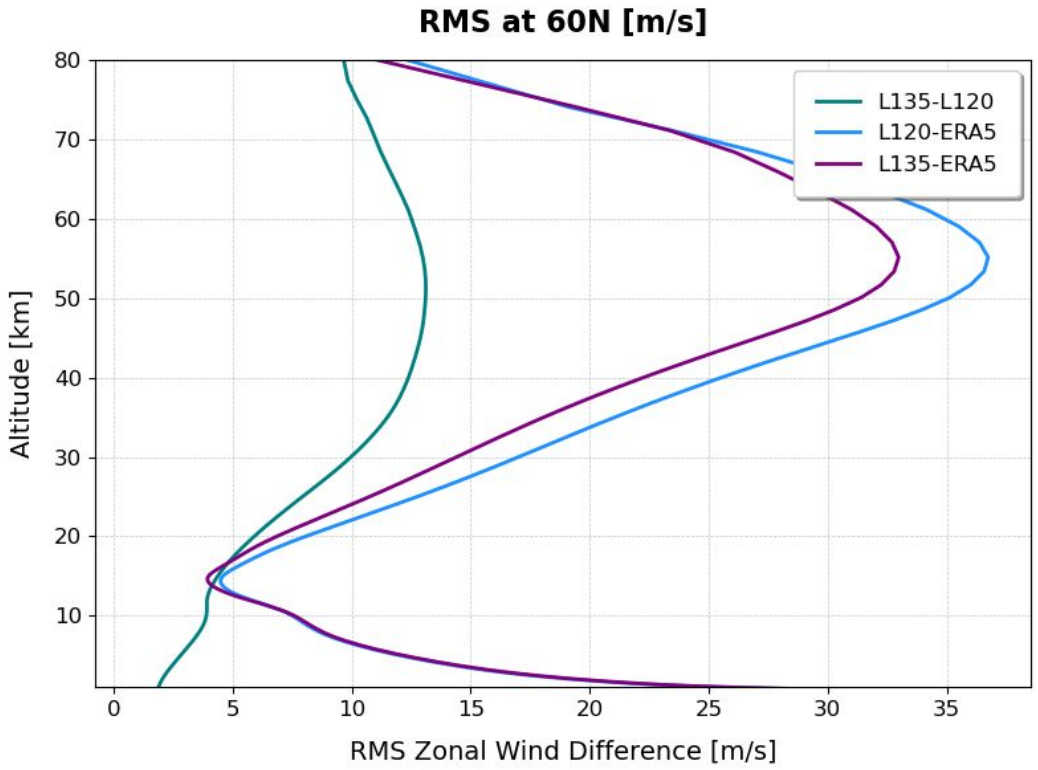


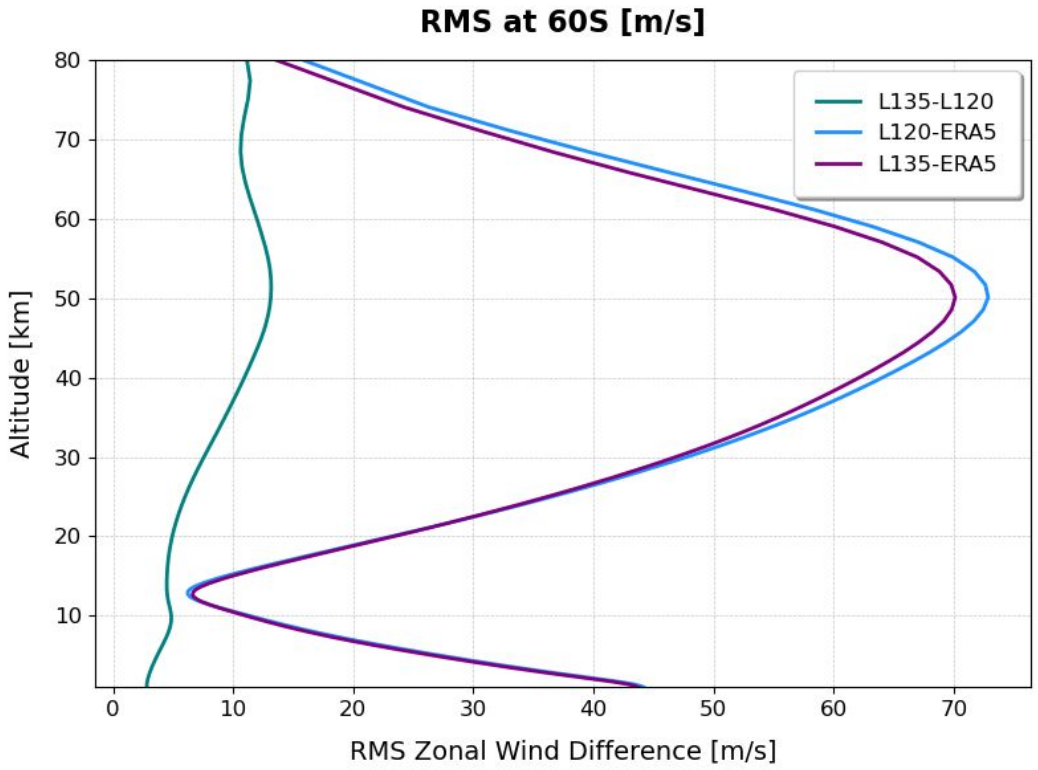
RMS E



- Largest differences in the winter hemispheres between 50N/S and 80N/S
- Differences increase with altitude especially in the upper stratosphere
- RMSE of differences peak at about 50km (core of polar vortex)

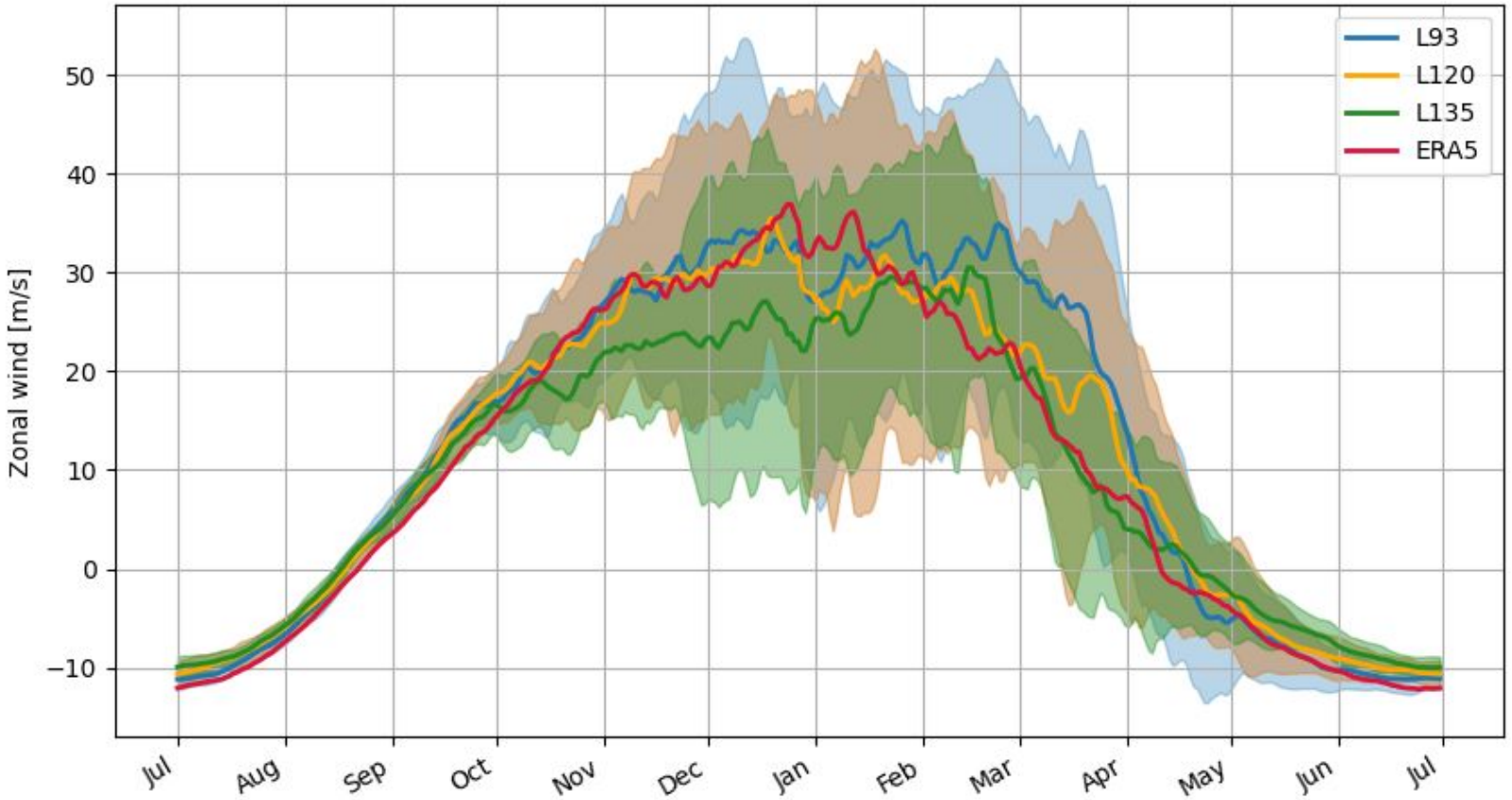
Impact on Polar Vortex – L120-L135





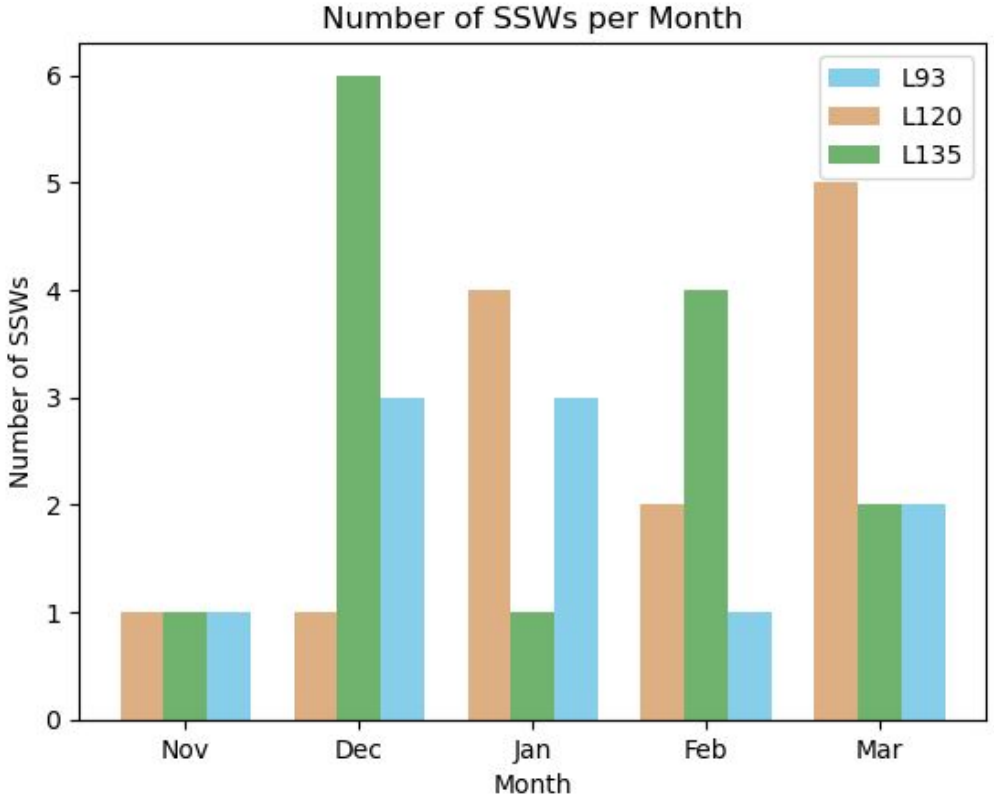
- L135 and L120 runs have similar RMS to ERA5, L135 bias is smaller in NH and above 50km
- Both models have largest biases compared to ERA5 between 50km and 60km
- Biases in the SH almost double compared NH

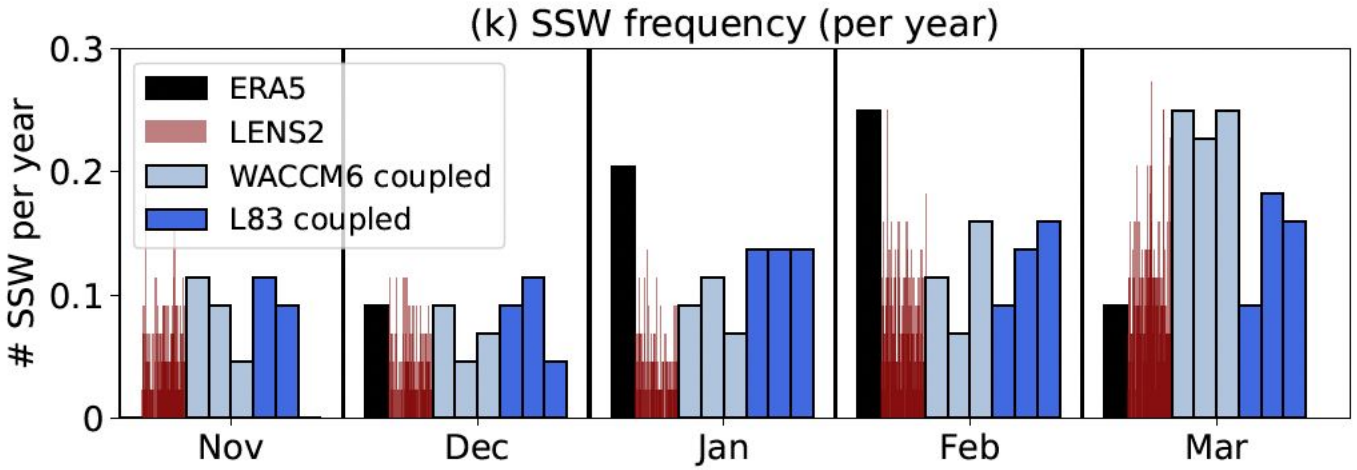
Impact on Seasonal Cycle, 60N 10hPa



- Similar seasonality throughout the difference model runs
- All model runs compare similarly to ERA5

Impact on SSW frequency and distribution

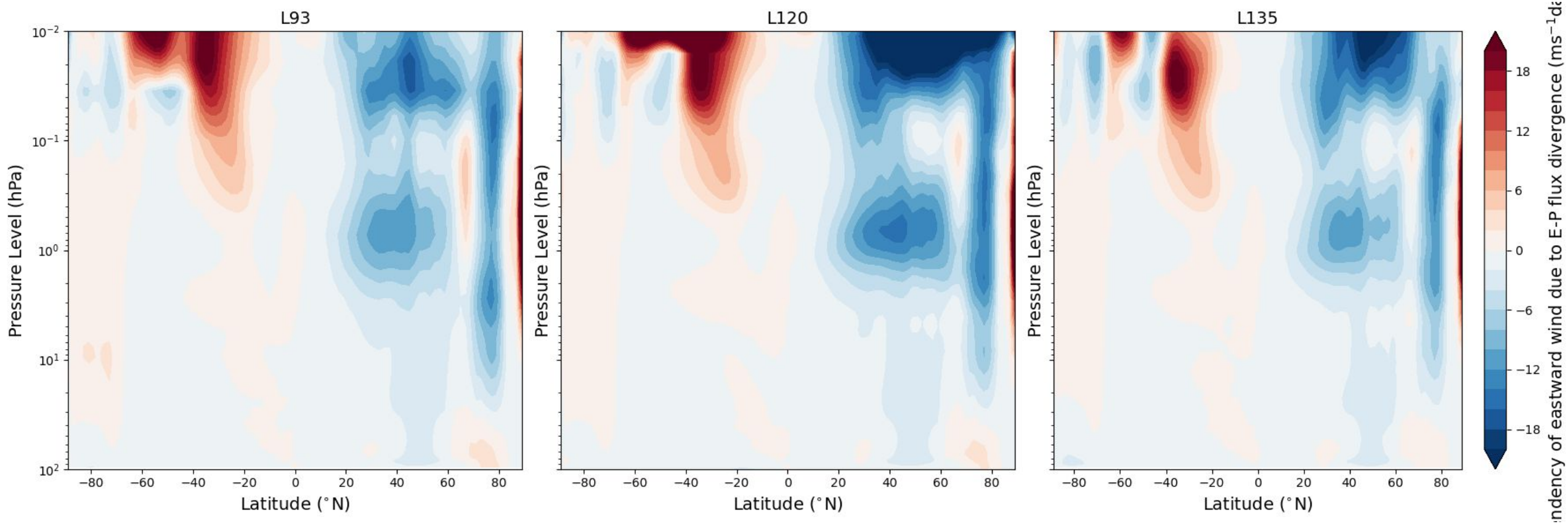




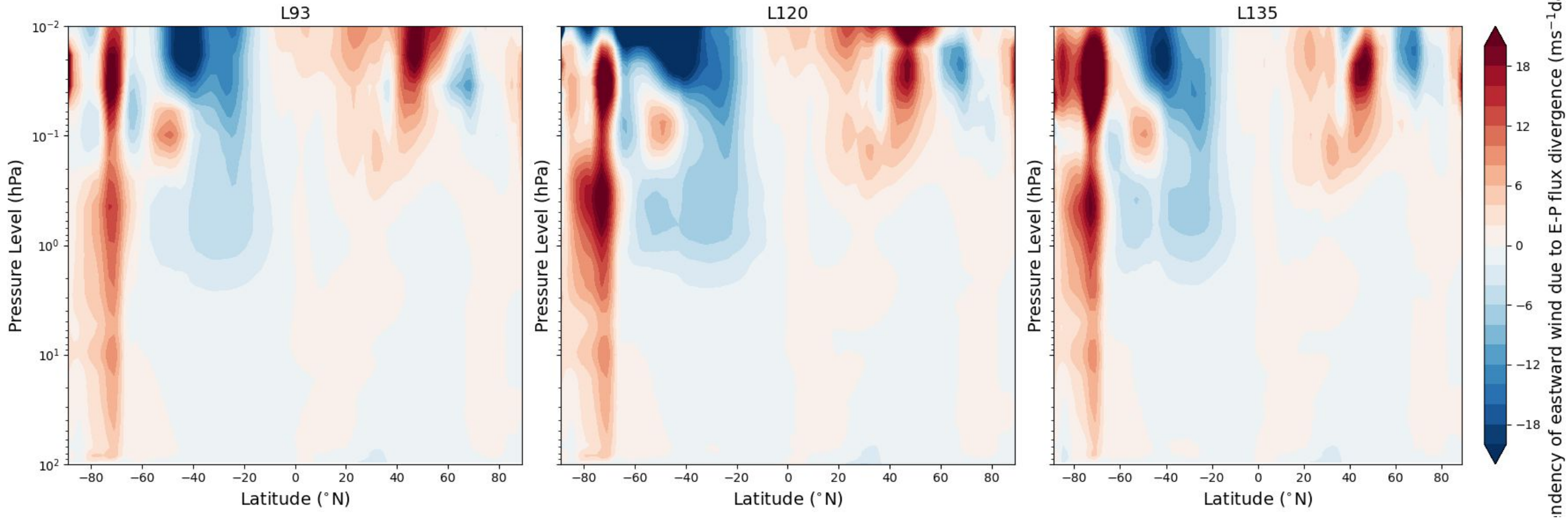
Simpson et al. submitted

- No systematic difference between the different model runs
- For longer runs, different model versions have similar SSW frequency

Tendency of eastward wind due to E-P flux divergenc - DJF

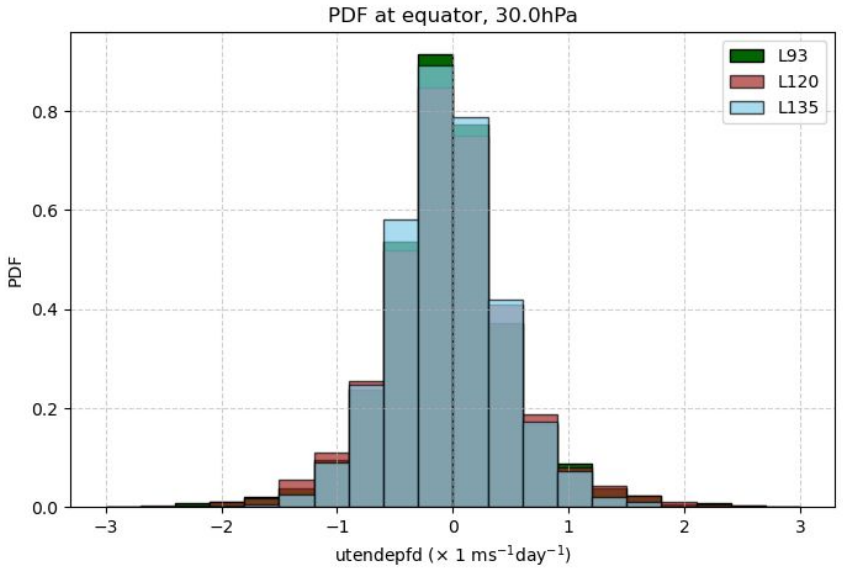


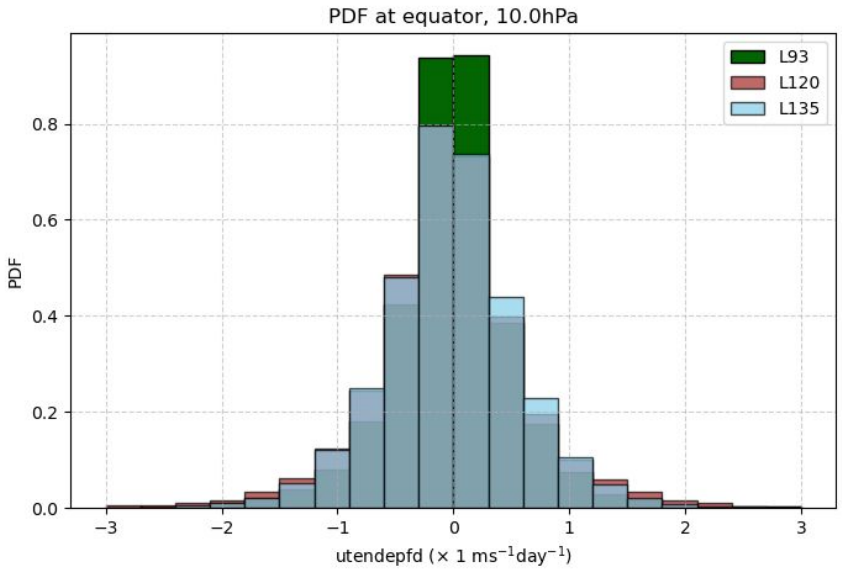
Tendency of eastward wind due to E-P flux divergenc - JJA

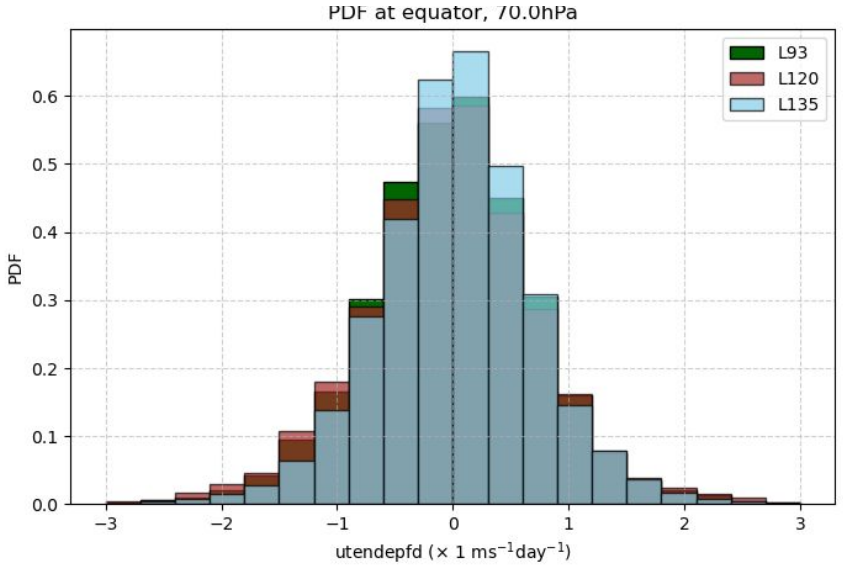


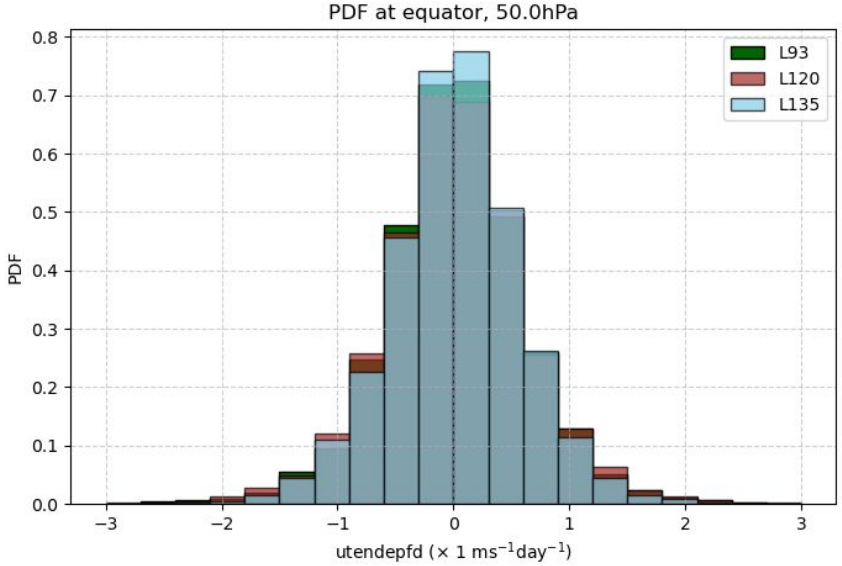
- For both DJF and JJA differences are most pronounced above 1hPa

Tendency of eastward wind due to E-P flux divergenc at equator



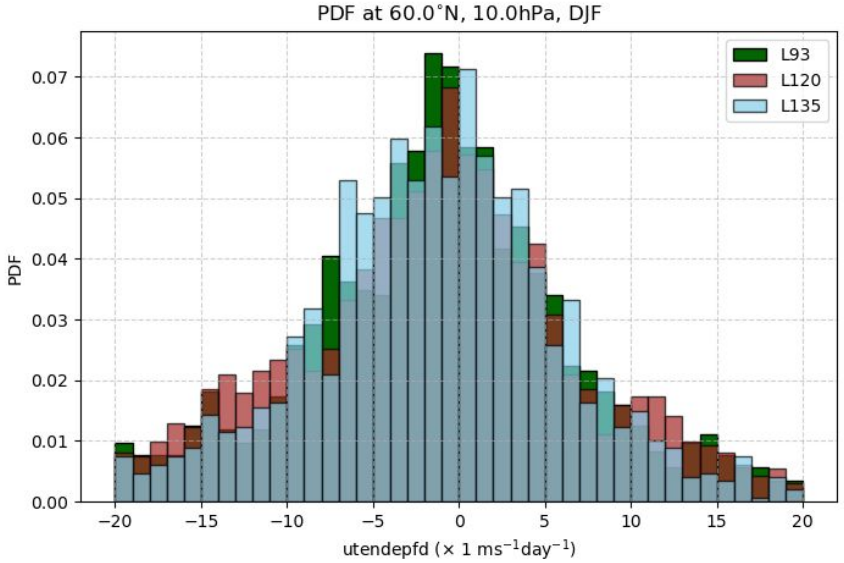


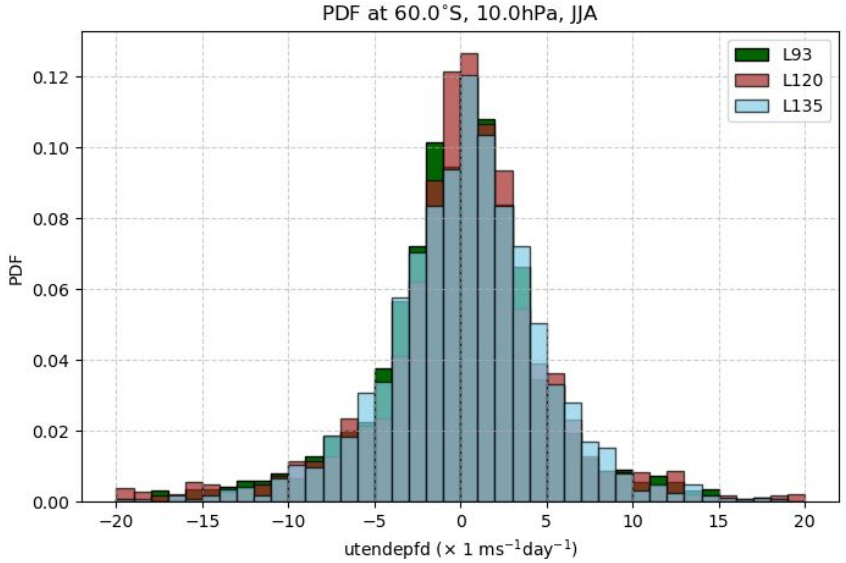


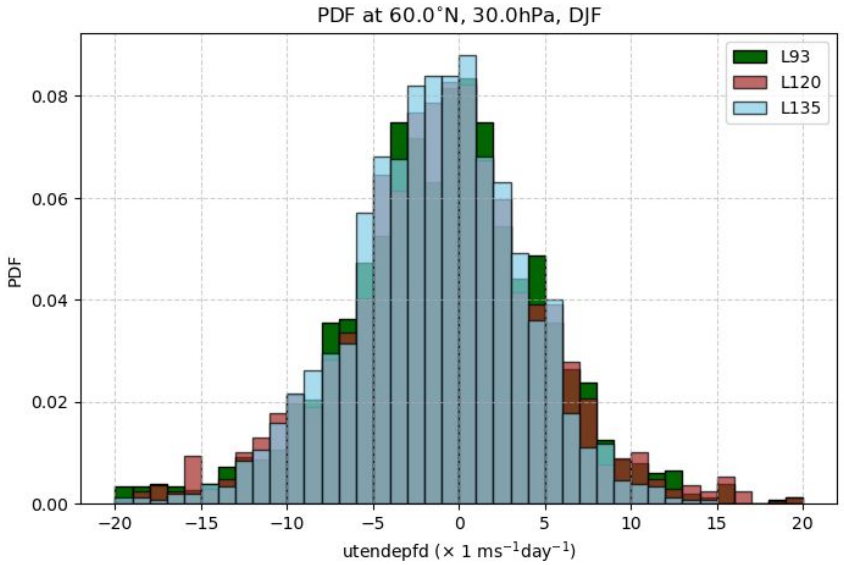


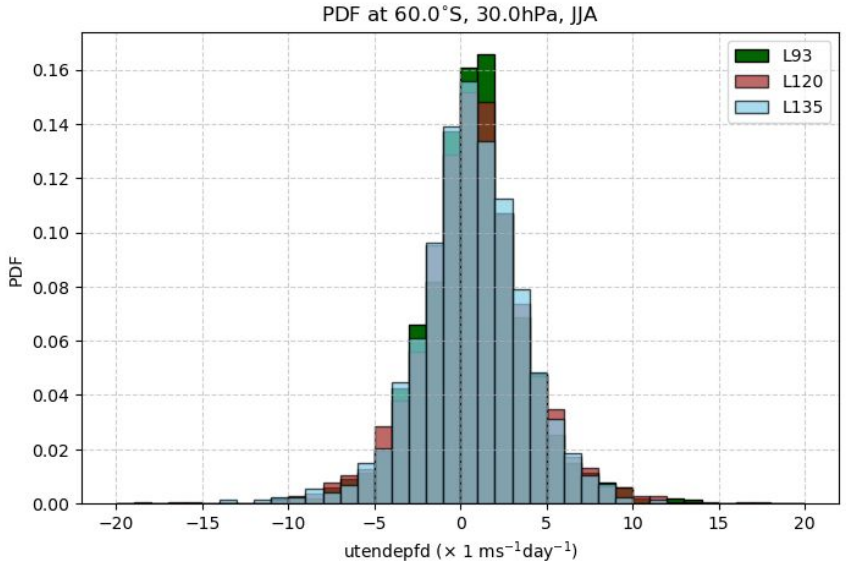
- Utendency between 70hPa and 10hPa is similar between different model versions

Tendency of eastward wind due to E-P flux divergenc at equator









- Utendency at 30hPa and 10hPa is similar between different model versions
- No systematic differences based on vertical grid or model top
- At 10hPa slightly higher utend in L120 which might explain larger wind speeds in this run

Conclusions

We compared different stratospheric circulation patterns for CAM MT and WACCM

- Based on current model runs no systematic difference was found below the stratopause region
- Analysis suggests that CAM MT can be used for stratospheric analyses up to the stratopause region
- Starting at stratopause and above WACCM has smaller differences compared to ERA5 in the polar vortex

Further steps

- Study impact of model top on representation of elevated stratopause after SSWs
- More statistical analysis (bootstrapping and t-tests) for differences between model versions
- Analyze the cause of differences in the tape recorder

Mountain Waves above Lake Como