Seasonal variability of the width of the tropical belt from GPS radio occultations and reanalyses

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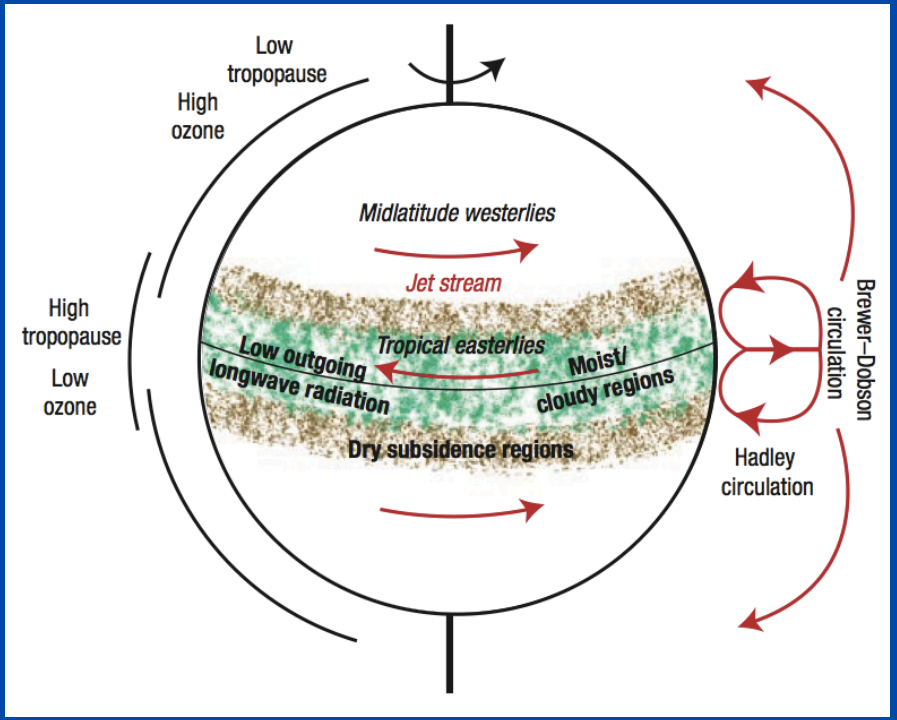
About Me

- Senior at SUNY Albany
  - Atmospheric Science major
  - Mathematics minor
- Research Interests:
  - Synoptic-dynamic meteorology
  - Numerical weather prediction
  - Tropical cyclone dynamics

What is the tropical belt?

- In the area of greatest descent in the Hadley cell, the net meridional (north-south) flow is zero.
- The area within the poleward boundaries of the Hadley cell is the **tropical belt.**



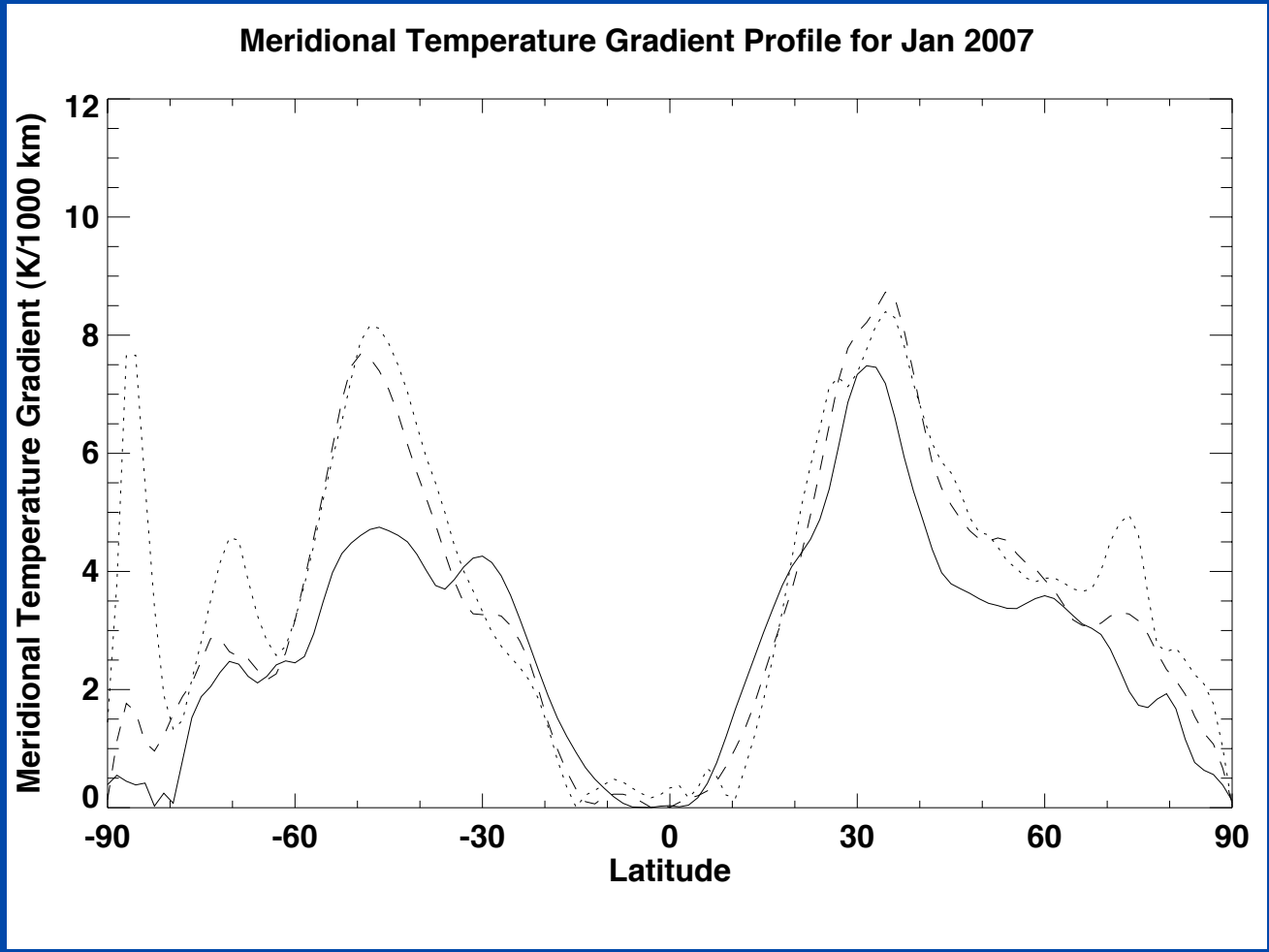
Seidel (2008) Fig. 1: Schematic of Hadley circulation

Introduction

- Evidence exists that the recent climate change trend is contributing to the widening of the tropical belt.
- Birner (2010) used tropopause statistical diagnostics to investigate this widening. He concluded that a seasonal cycle based on these diagnostics could be robust.
- The tropical belt can also be defined as the area between the Northern Hemisphere and Southern Hemisphere subtropical jet streams.

Objectives

- This study identifies the subtropical jet streams by a local maximum in meridional monthly mean temperature gradient between the equator and 60°.
- This study aims to find a seasonal cycle of tropical belt boundaries and widths comparable to that of Birner (2010).

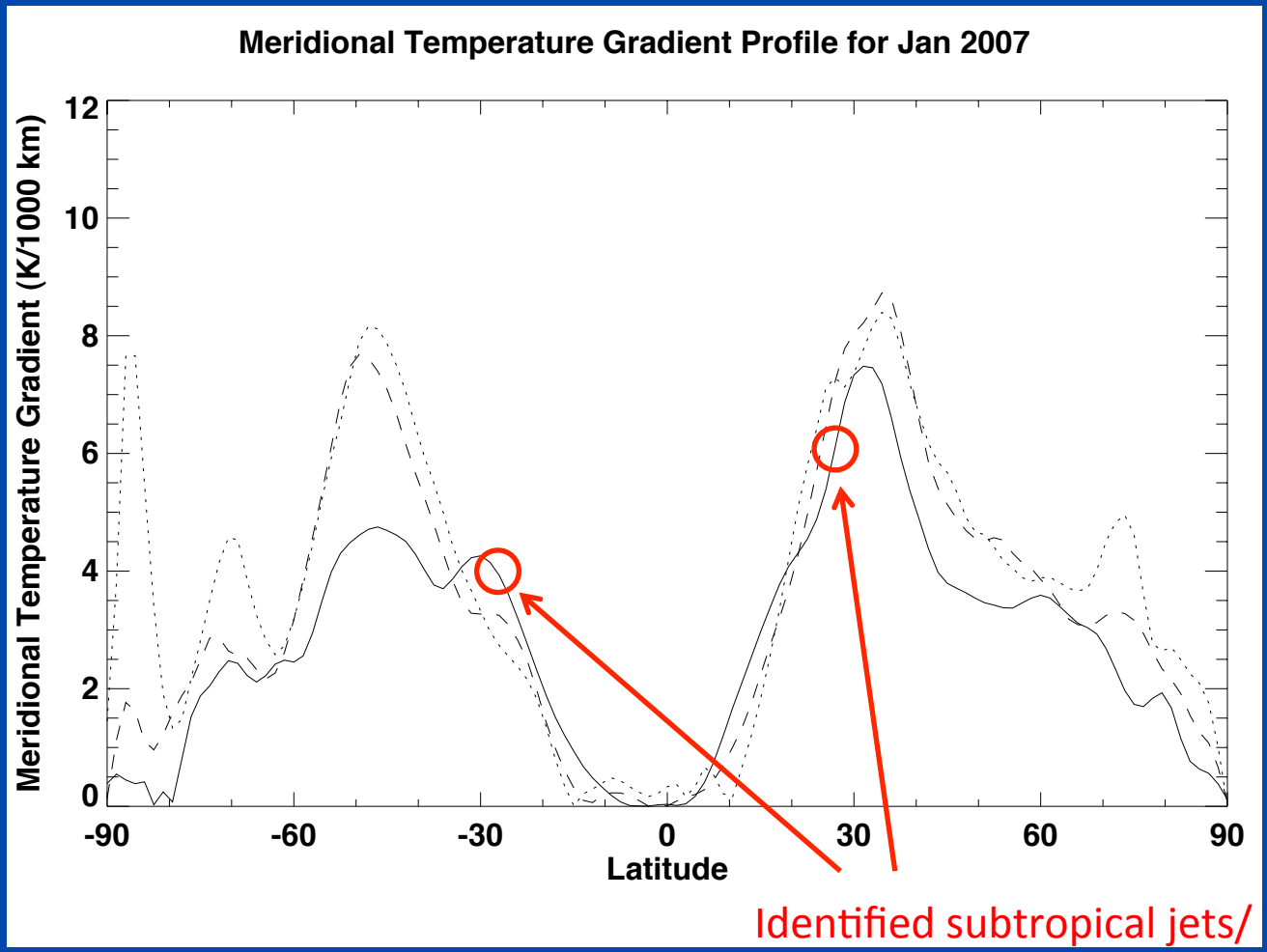


Meridional temperature gradient plot based on monthly mean temperature data from ECMWF reanalysis for Jan 2007.

Dotted line: at 700 mb; solid line: at 500 mb; dashed line: at 300 mb

Methods

- Generated temperature gradient data from raw data from GPS radio occultations.
- Reanalysis used:
  - ECMWF (ERA-INTERIM), NCEP, NCEP2, JRA25
- Data from Jan 2007 to Dec 2010 is used because of limitations in the GPS dataset.
- The latitude of the subtropical jet in a certain hemisphere in a certain month is defined as the latitude that falls at a 20% reduction threshold of the maximum meridional temperature gradient between 60° and 0° closest to the equator.
- Seasons are defined as DJF, MAM, JJA, SON.

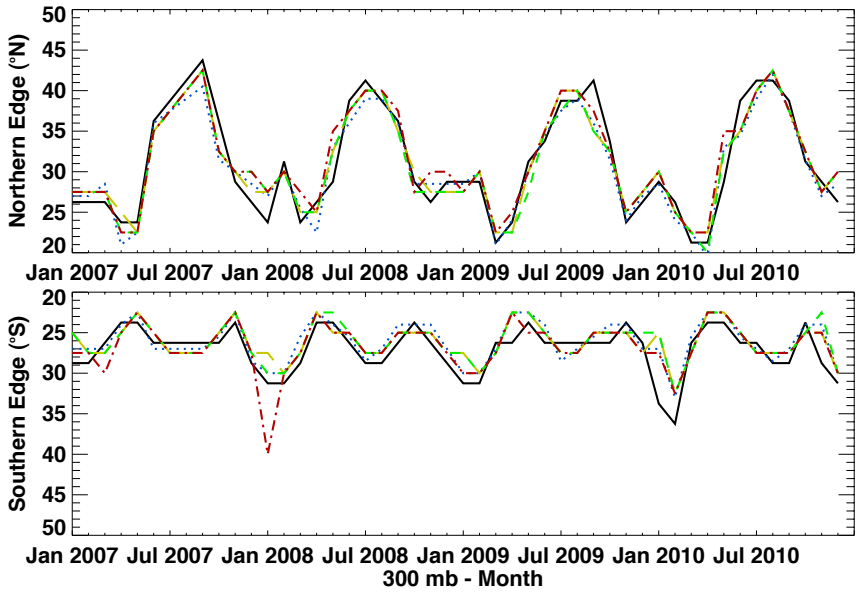


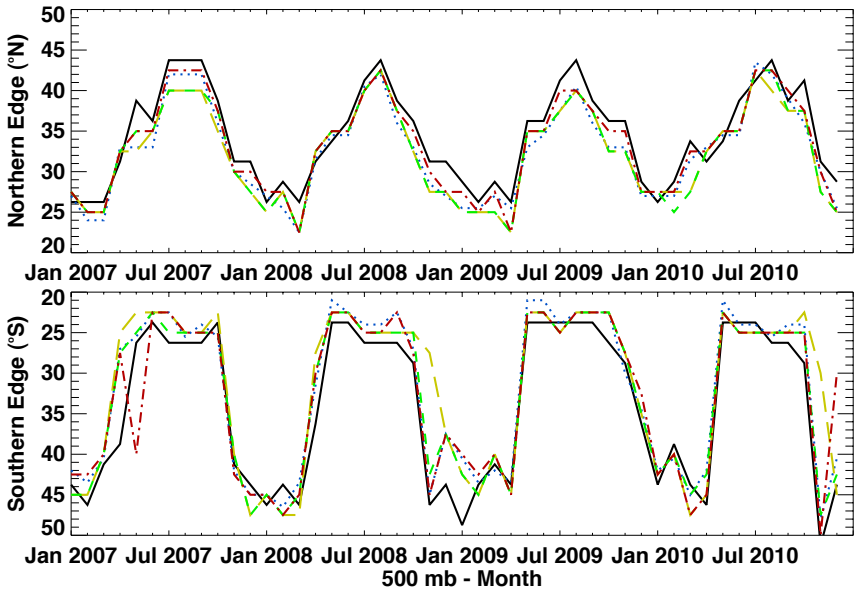
Meridional temperature gradient plot based on monthly mean temperature data from ECMWF reanalysis for Jan 2007.

Dotted line: at 700 mb; solid line: at 500 mb; dashed line: at 300 mb

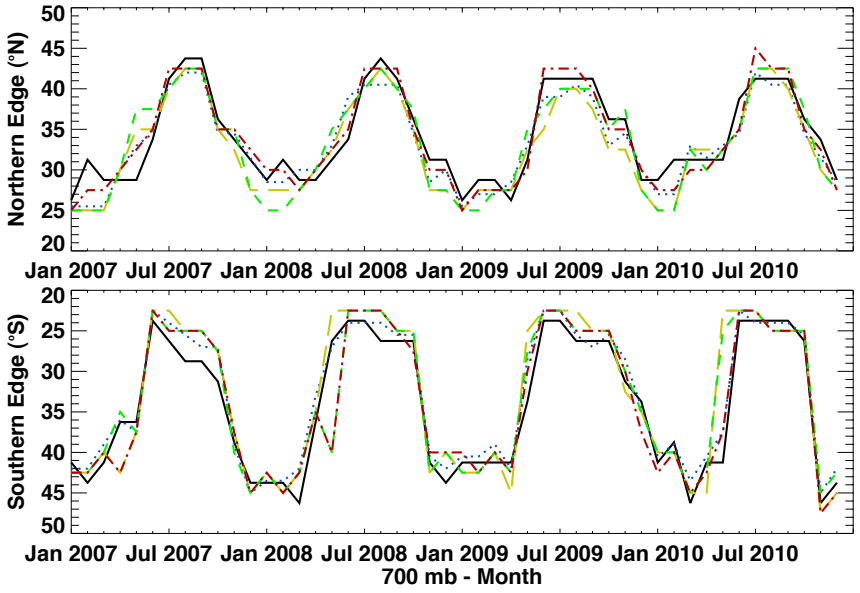
Preliminary Results

- The output from the dataset from the GPS radio is consistent with the output from the four reanalyses.
- The monthly cycle of northern tropical belt boundaries are consistent at 300 mb, 500 mb, and 700 mb.
- The monthly cycle of southern tropical belt boundaries vary between 300 mb and the lower levels (500 mb, 700 mb).



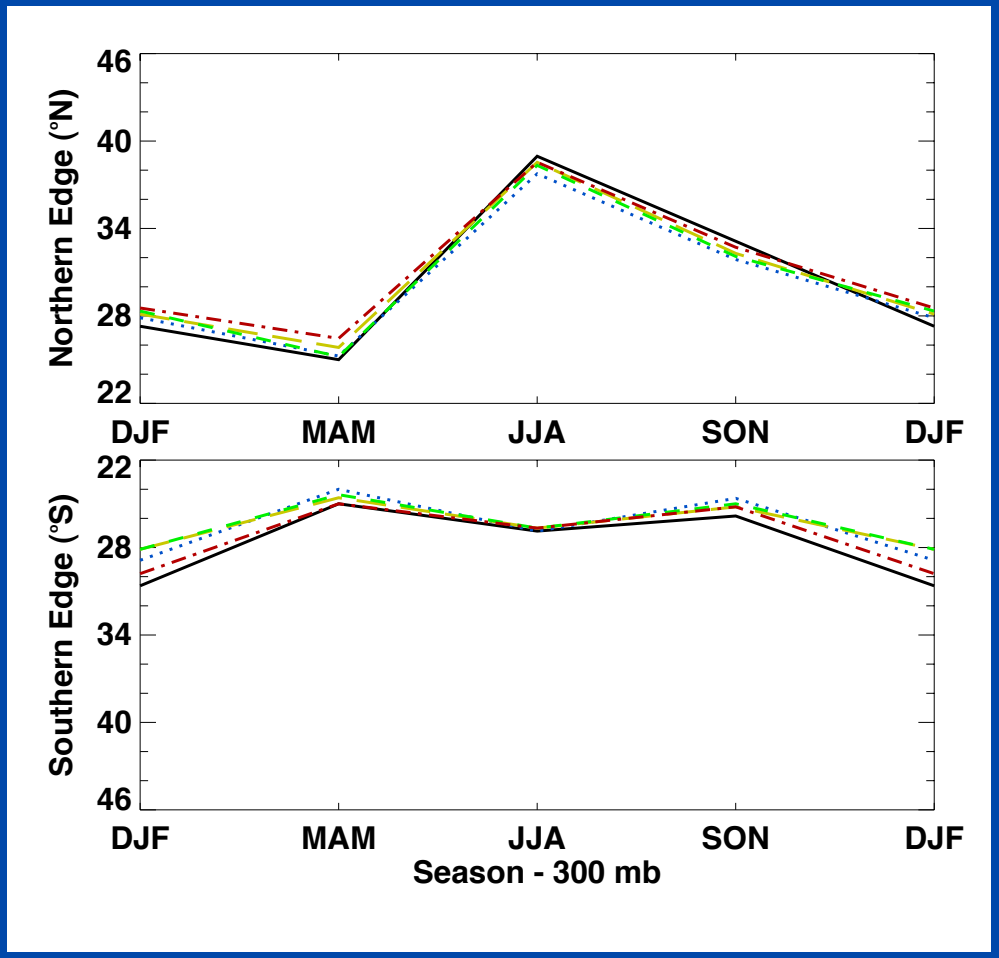


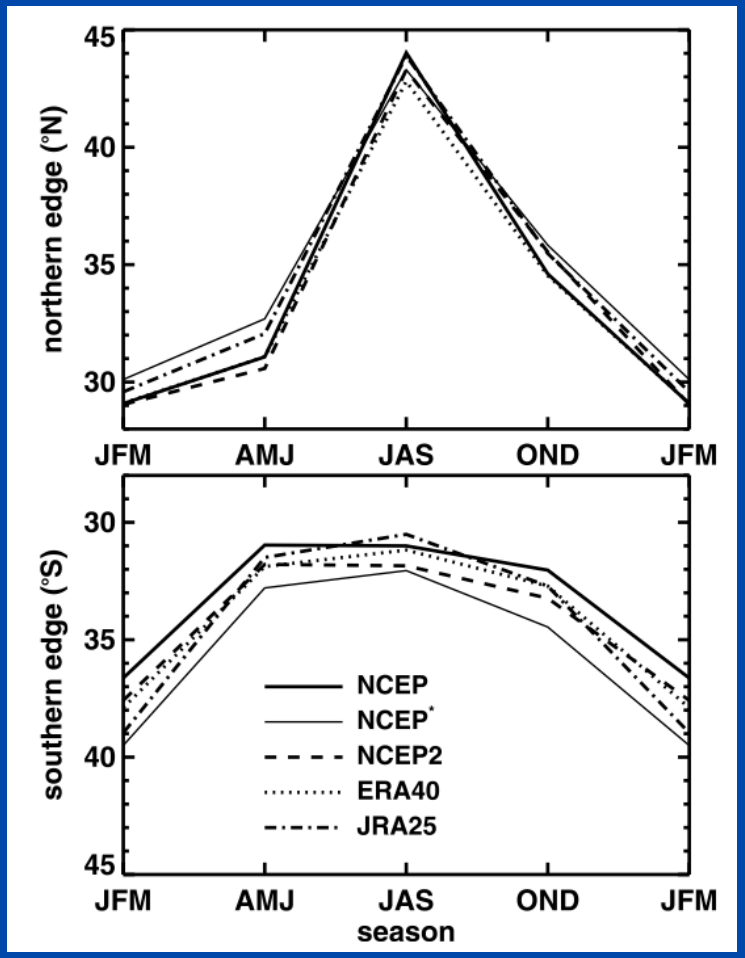
Monthly boundaries of the tropical belt at the northern (top) and southern (bottom) subtropical jets at 300 mb (above), 500 mb (upper-right), and 700 mb (right).



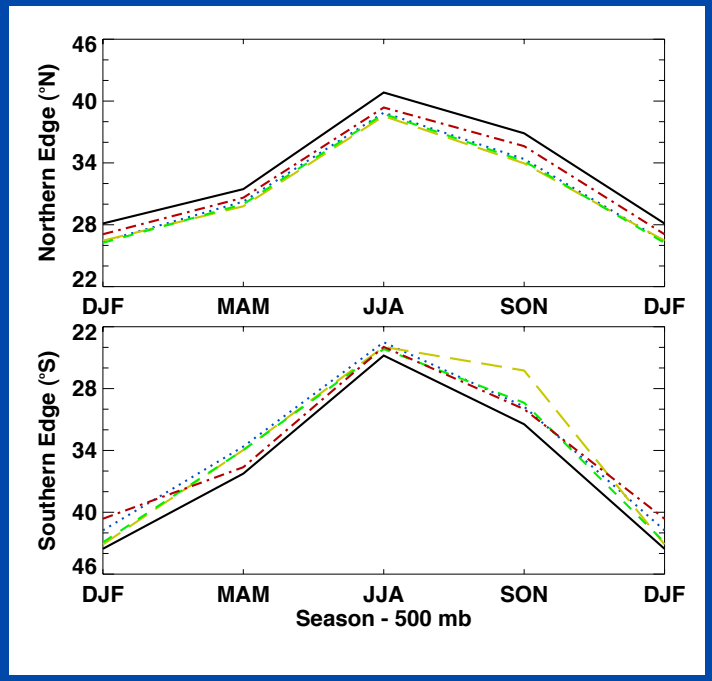
Preliminary Results

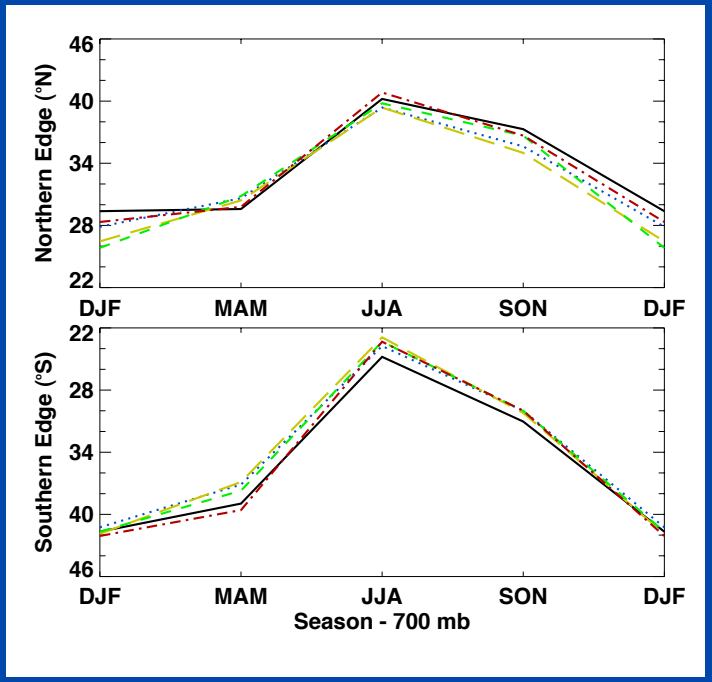
- At upper levels (300 mb) the seasonal mean patterns tend to resemble those of Birner (2010).
- At lower (700 mb) and mid-levels (500 mb), the patterns tend to diverge from those of Birner (2010).

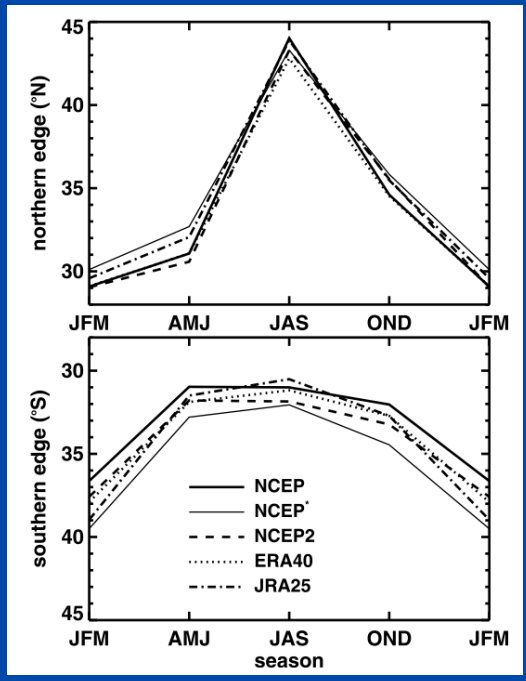




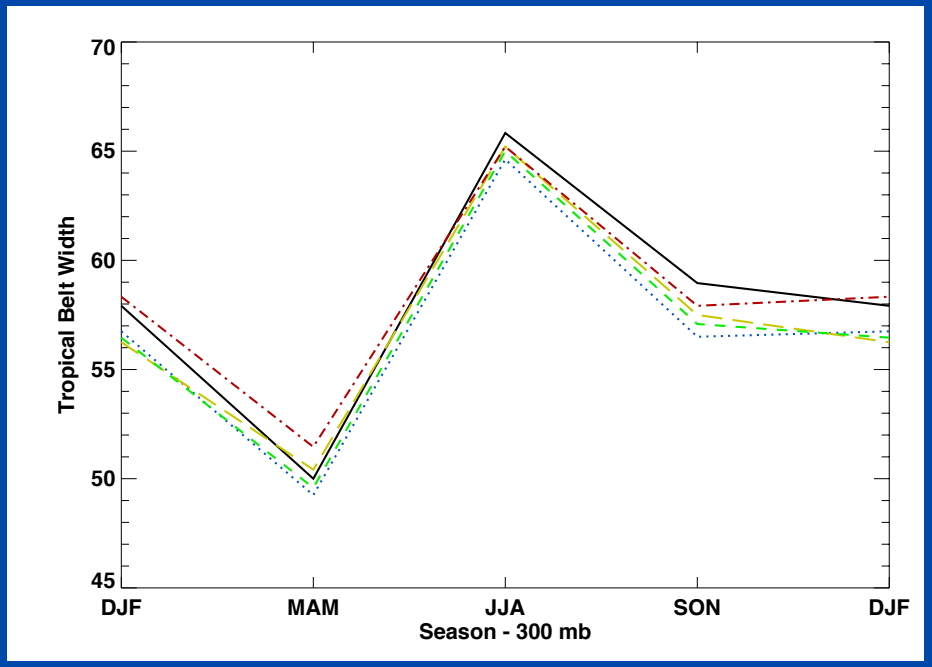
Seasonal boundaries of the tropical belt at the northern (top) and southern (bottom) subtropical jets at 300 mb (left) the tropopause (Birner (2010) Fig. 6; right).

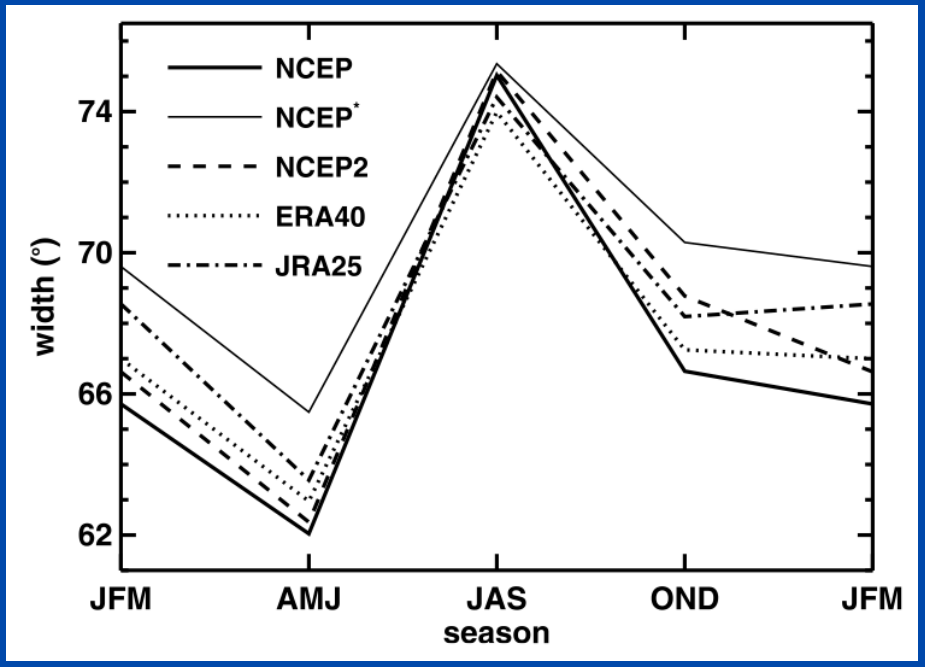




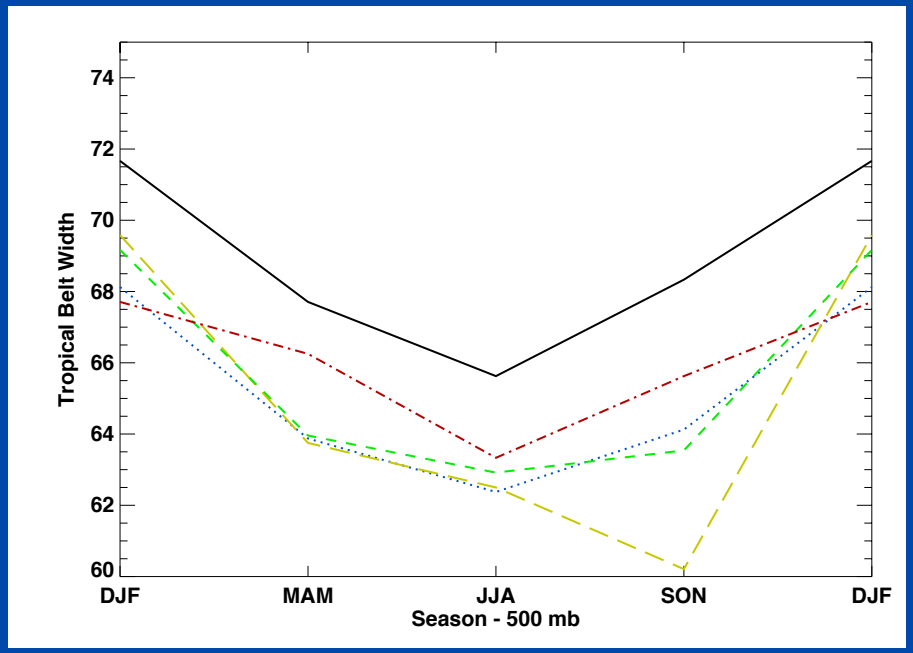


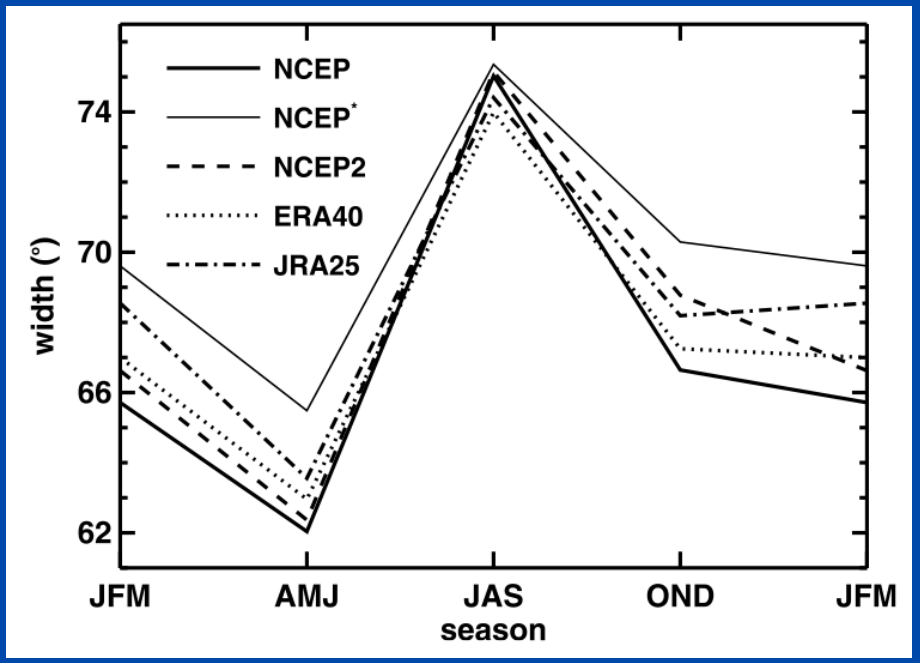
Seasonal boundaries of the tropical belt at the northern (top) and southern (bottom) subtropical jets at 500 mb (upper-left), 700 mb (lower-left), and the tropopause (Birner (2010) Fig. 6; right).

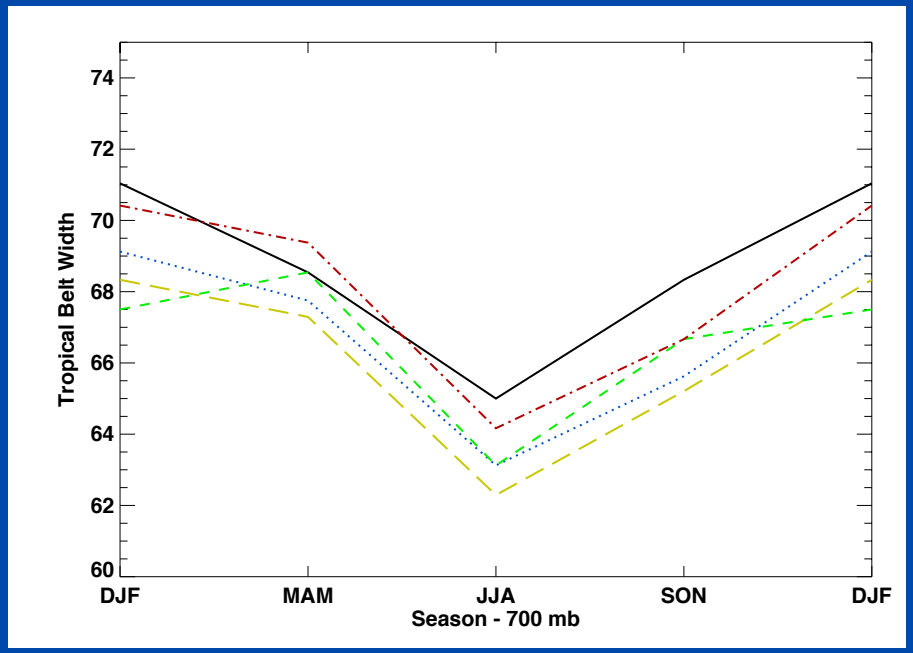




Width of the tropical belt at 300 mb (above) and the tropopause (Birner (2010 Fig. 6; right).







Width of the tropical belt at 500 mb (upper-left), 700 mb (lower-left), and the tropopause (Birner (2010) Fig. 7; right).

Preliminary Conclusions

- The methods and datasets used in this study exhibit seasonal variability at 300 mb that is consistent with the tropopause-based methods in Birner (2010).
- Seasonal variability patterns for the tropical belt width at lower levels (e.g. 700 mb, 500 mb) are notably different.
- Most notably, the variability pattern at the southern edge greatly differs from the pattern at the northern edge.

References

Birner, T. (2010), Recent widening of the tropical belt from global tropopause statistics: Sensitivities, *J. Geophys. Res.*, *115*, D23109, doi: 10.1029/2010JD014664.

Seidel, D.J., Q. Fu, W. J. Randel, and T. J. Reichler (2008), Widening of the tropical belt in a changing climate, *Nat. Geosci.*, *1*, 21-24.

Acknowledgements

This work has been supported by the National Science Foundation Science and Technology Center for Multi-Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement No. ATM-0425247.

Any Questions?