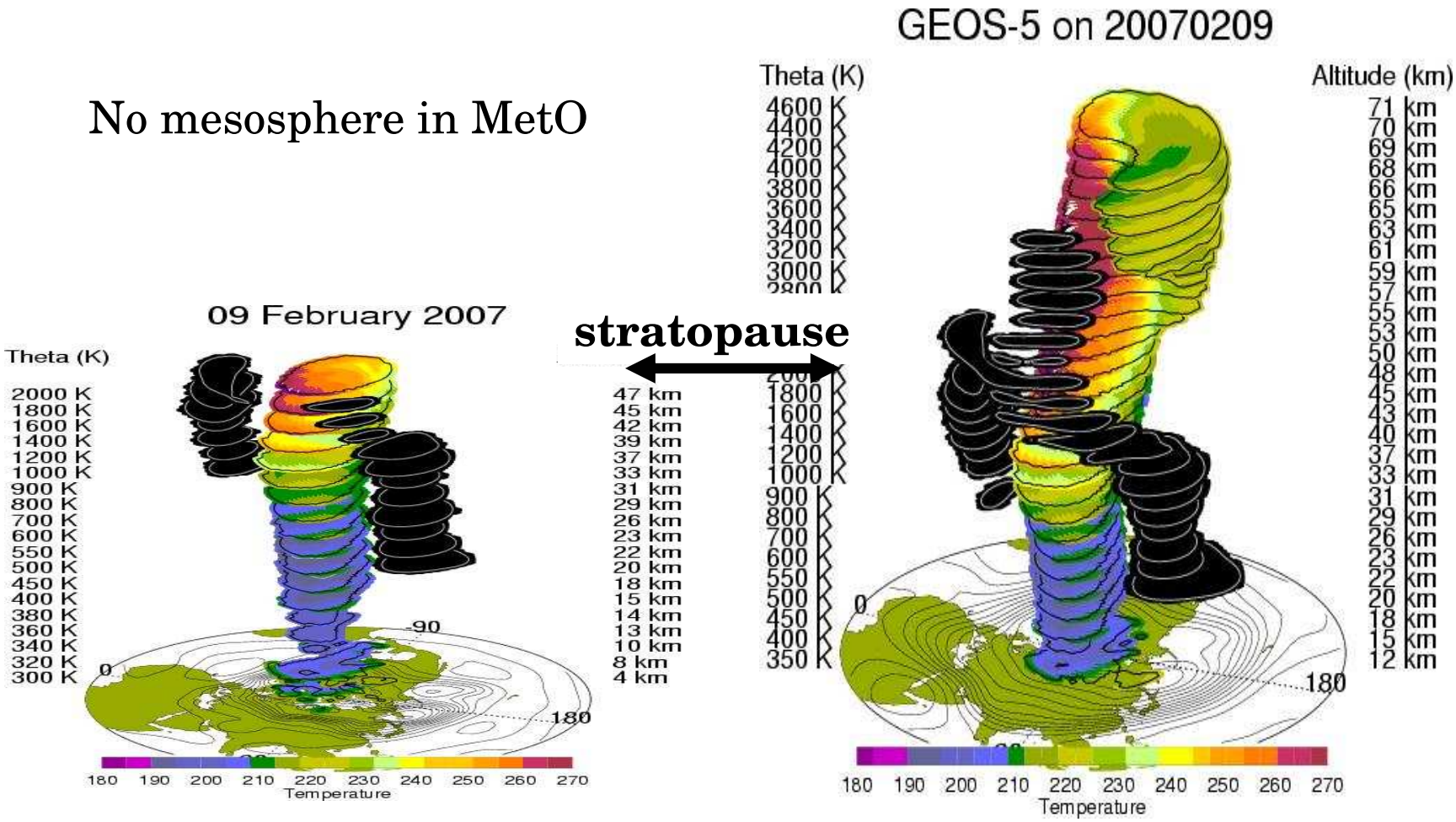
The Mesospheric Polar Vortices

V. Lynn Harvey, C. Randall, S. Pawson, R. Garcia, R. Lieberman, and G. Manney

No mesosphere in MetO



Outline

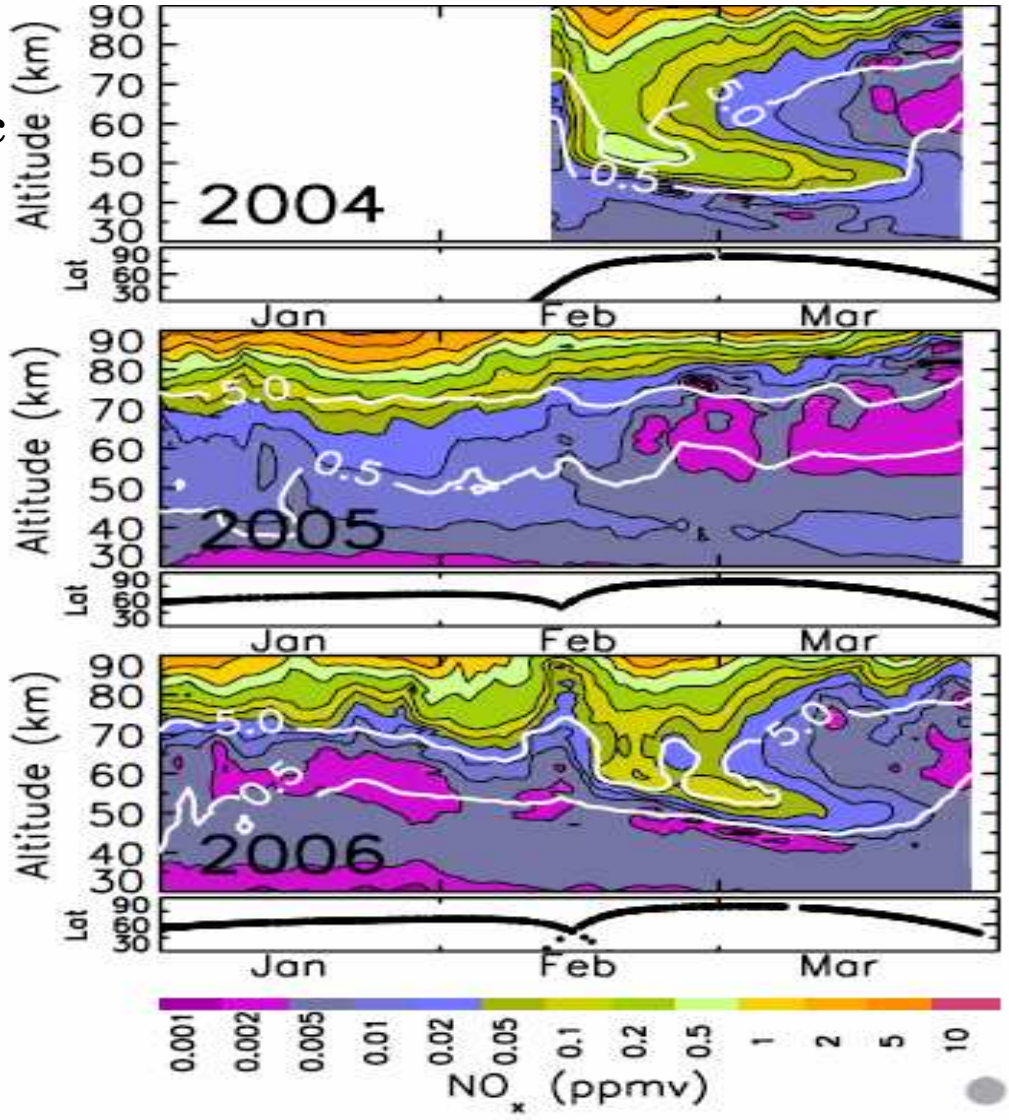
- Motivation
- Models and Data: MetO, GEOS-4/5, WACCM, SABER, and EOS-MLS
- Vortex edge definition based on Q
- Polar vortex zonal mean climatologies in MetO, GEOS-4, WACCM
- SABER vs. GEOS USLM winds
- 3-D vortex structure
- Vortex edge validation exercise using MLS CO
- Future work

Enhanced NO_x in 2006 linked to strong upper stratospheric Arctic vortex

C. E. Randall,[1,2] V. L. Harvey,[1] C. S. Singleton,[1] P. F. Bernath,[1] C. D. Boone,[3] and J. U. Kozyra[4]

High Geomagnetic Activity Oct 2003

Strong Vortex



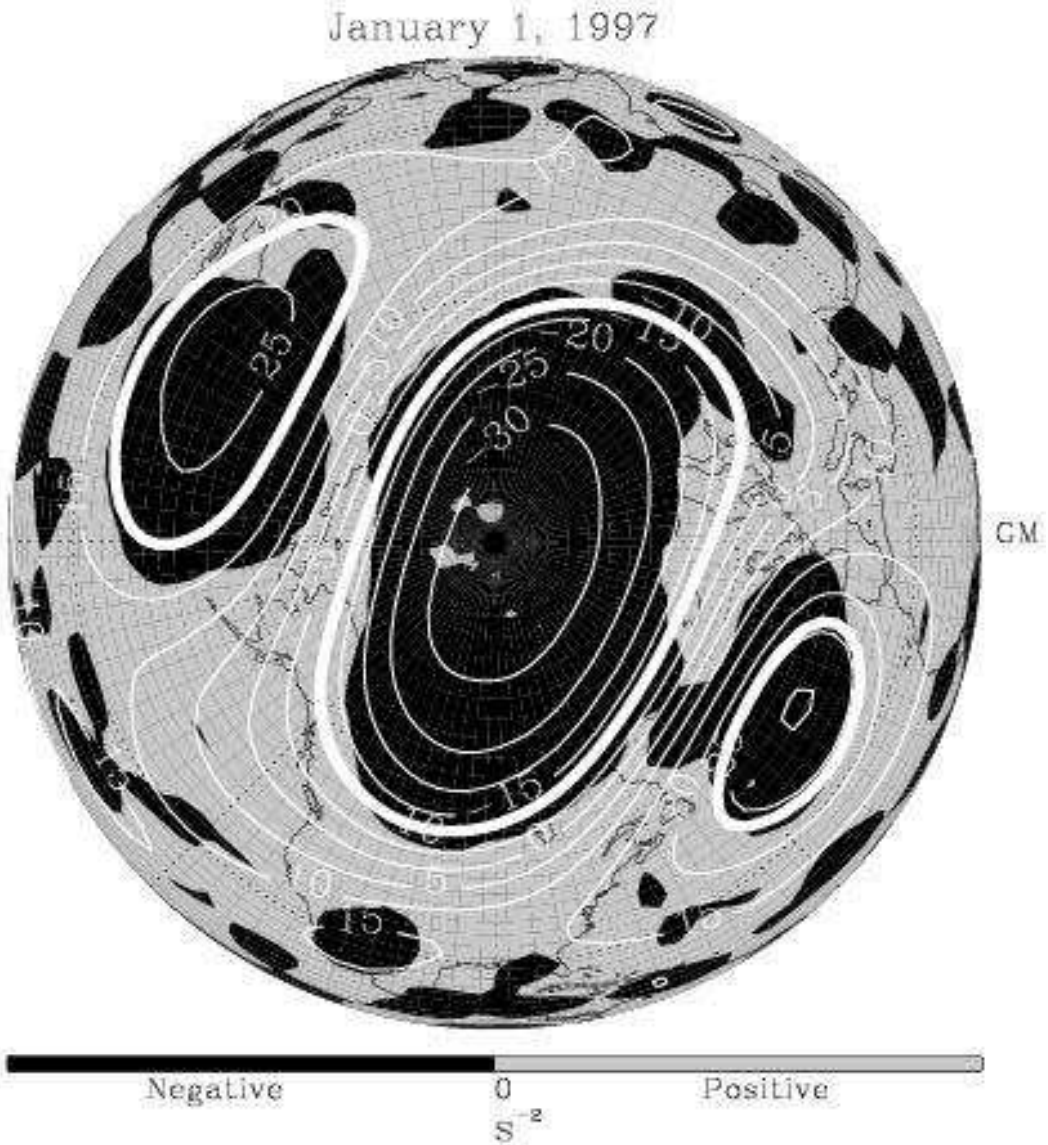
Low Geomagnetic Activity

Strong Vortex

Motivation (for this talk)

- Compare polar vortices in GEOS and WACCM to observations to assess need for data assimilation above the stratopause.

Q, Streamfunction, Arctic Vortex

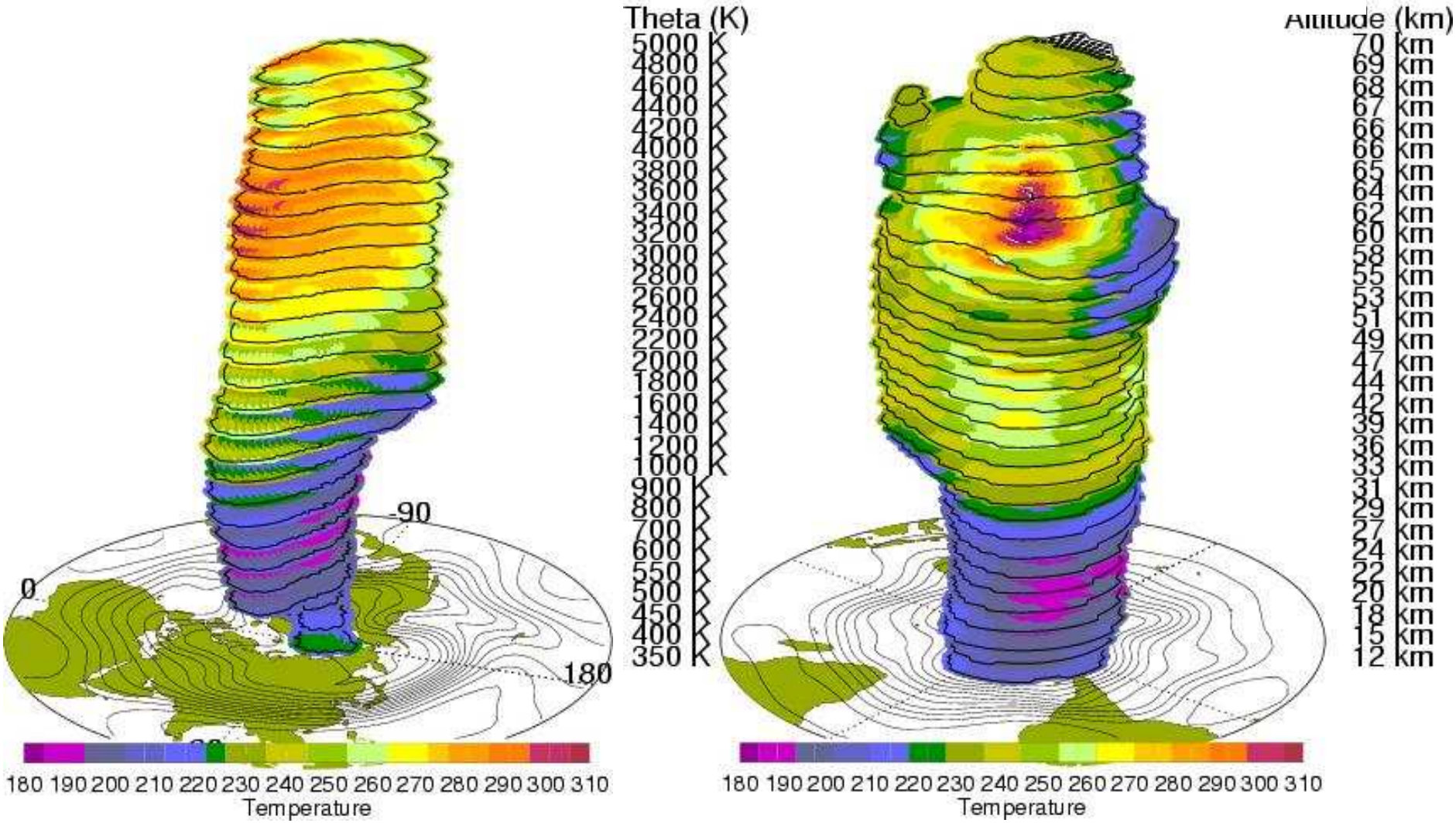


Q is negative where rotation dominates shear. See Tatyana's poster.

GEOS-4 Daily 3D Structure

Arctic 20051207

Antarctic 20040710

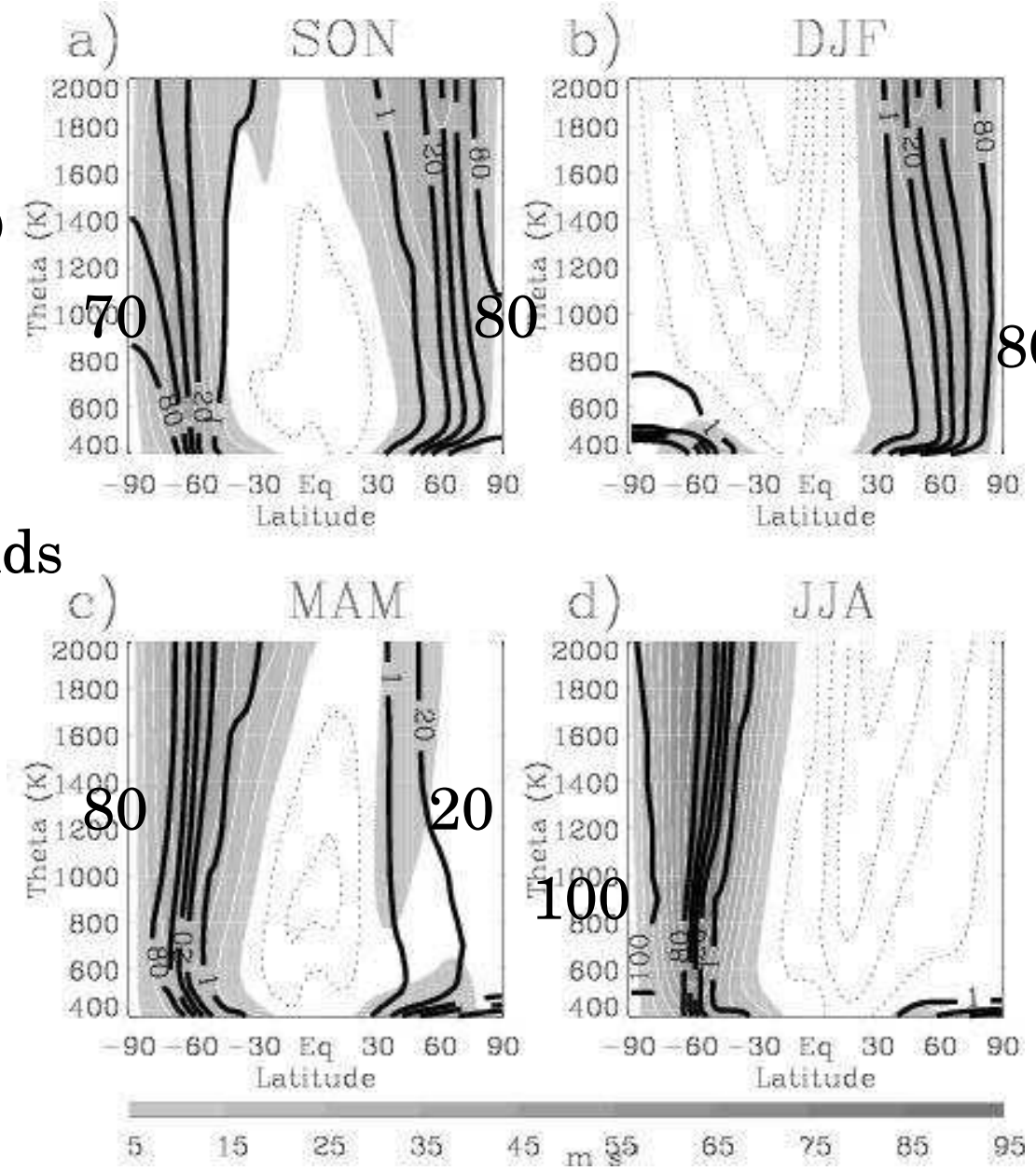


Extends to ~72 km but need ~10 more km to fully resolve polar vortices

MetO Zonal Mean Vortex Frequency

Seasonal
(10-year mean)

Zonal mean
Westerly winds
shaded



70 80 80

80 20 100

Solstice

Antarctic Vortex

July

January

Arctic Vortex

GEOS-4
(3-year mean)

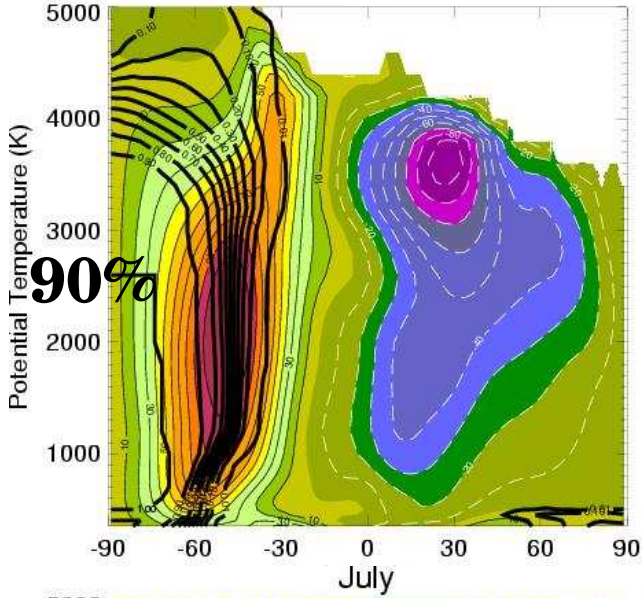
90%

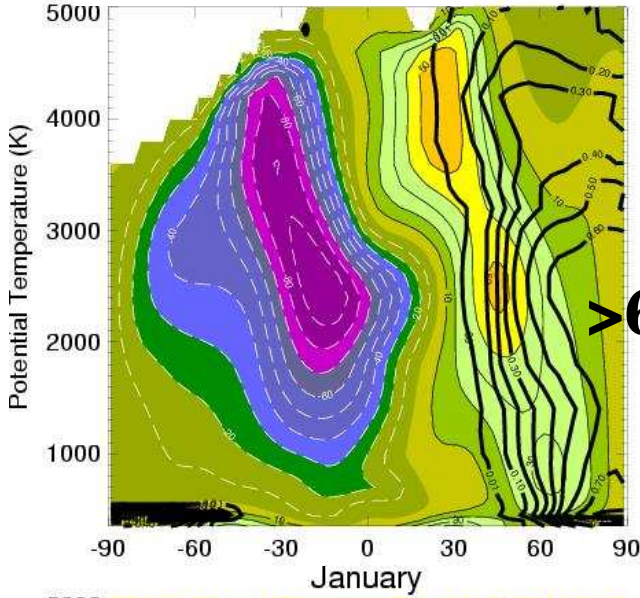
>60%

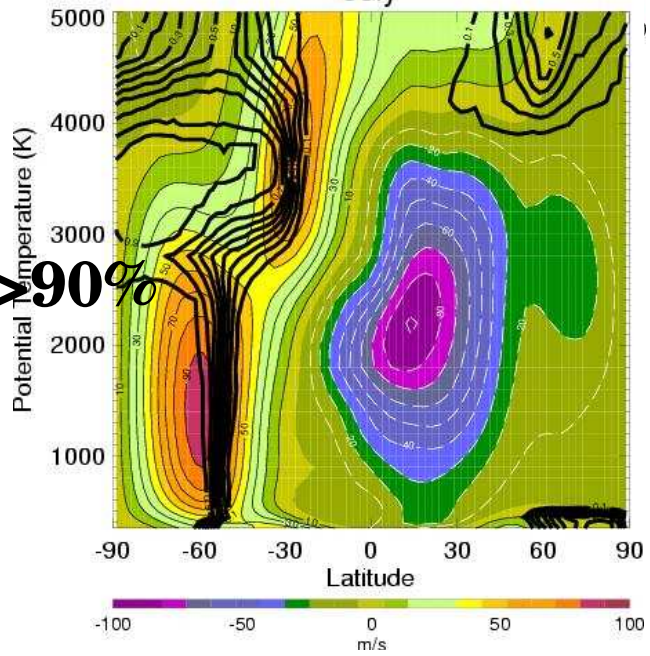
WACCM
(15-year mean)

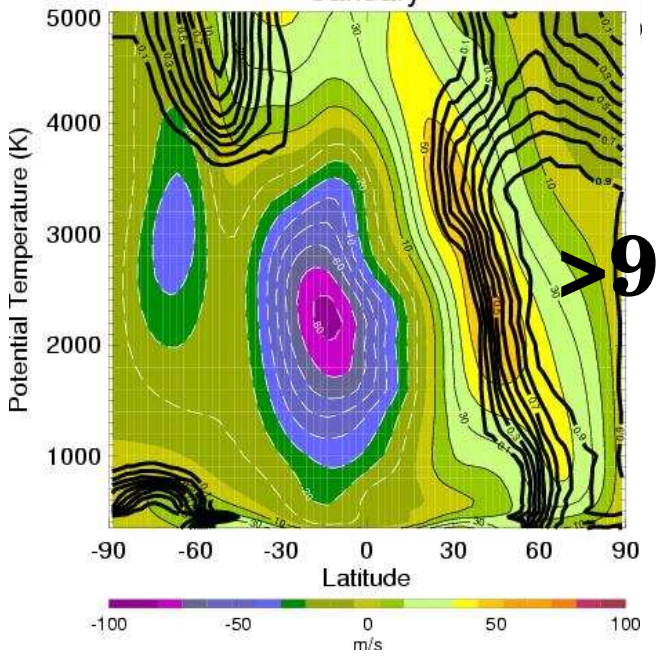
>90%

>90%





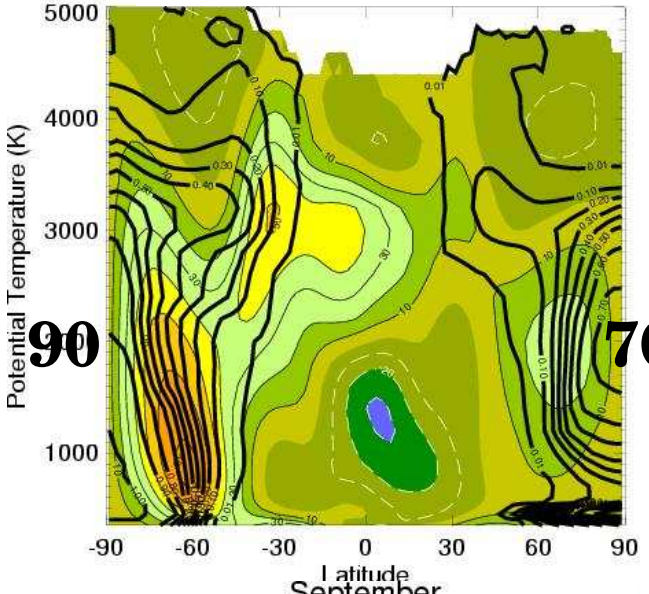




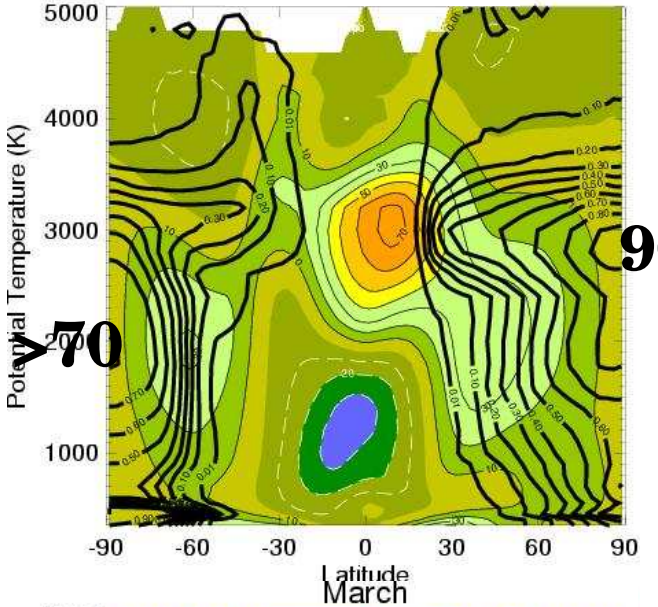
September

March

GEOS-4

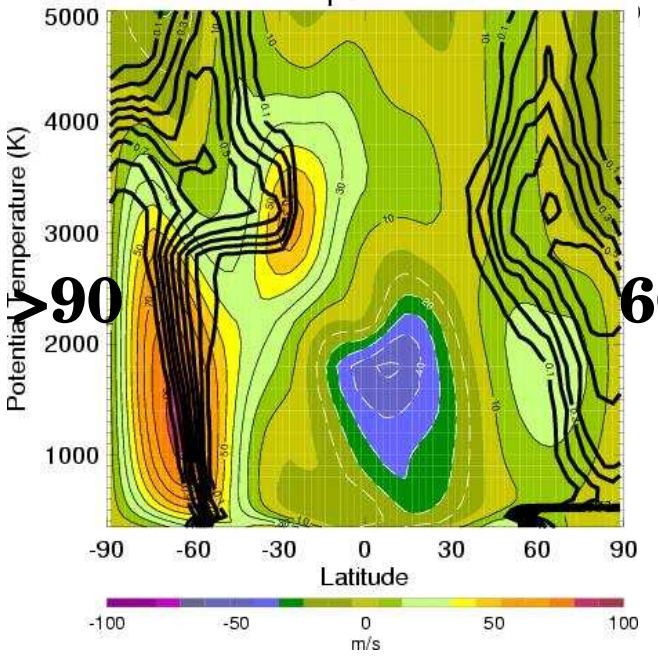


90 **70**

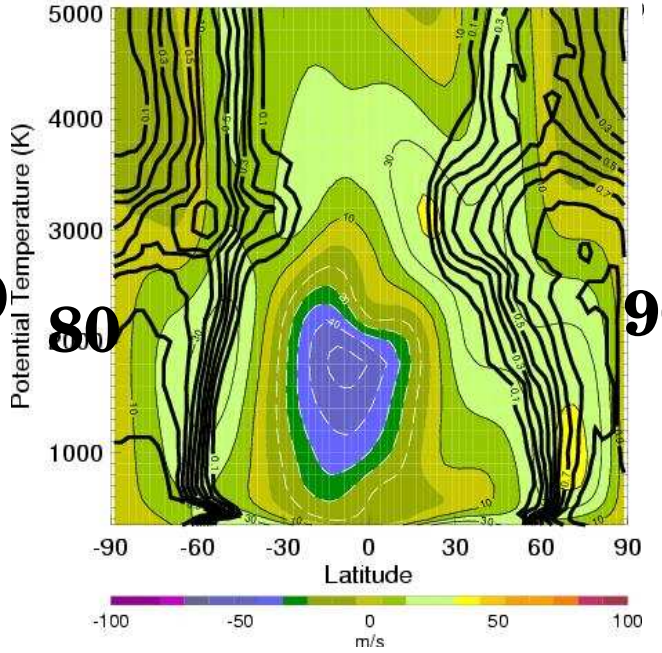


>70 **90**

WACCM

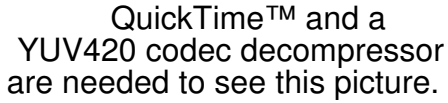


>90 **60**



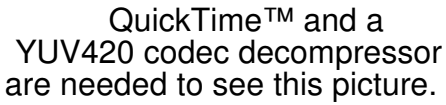
80 **90**

Equinox is more prone to vortex contamination by SAO

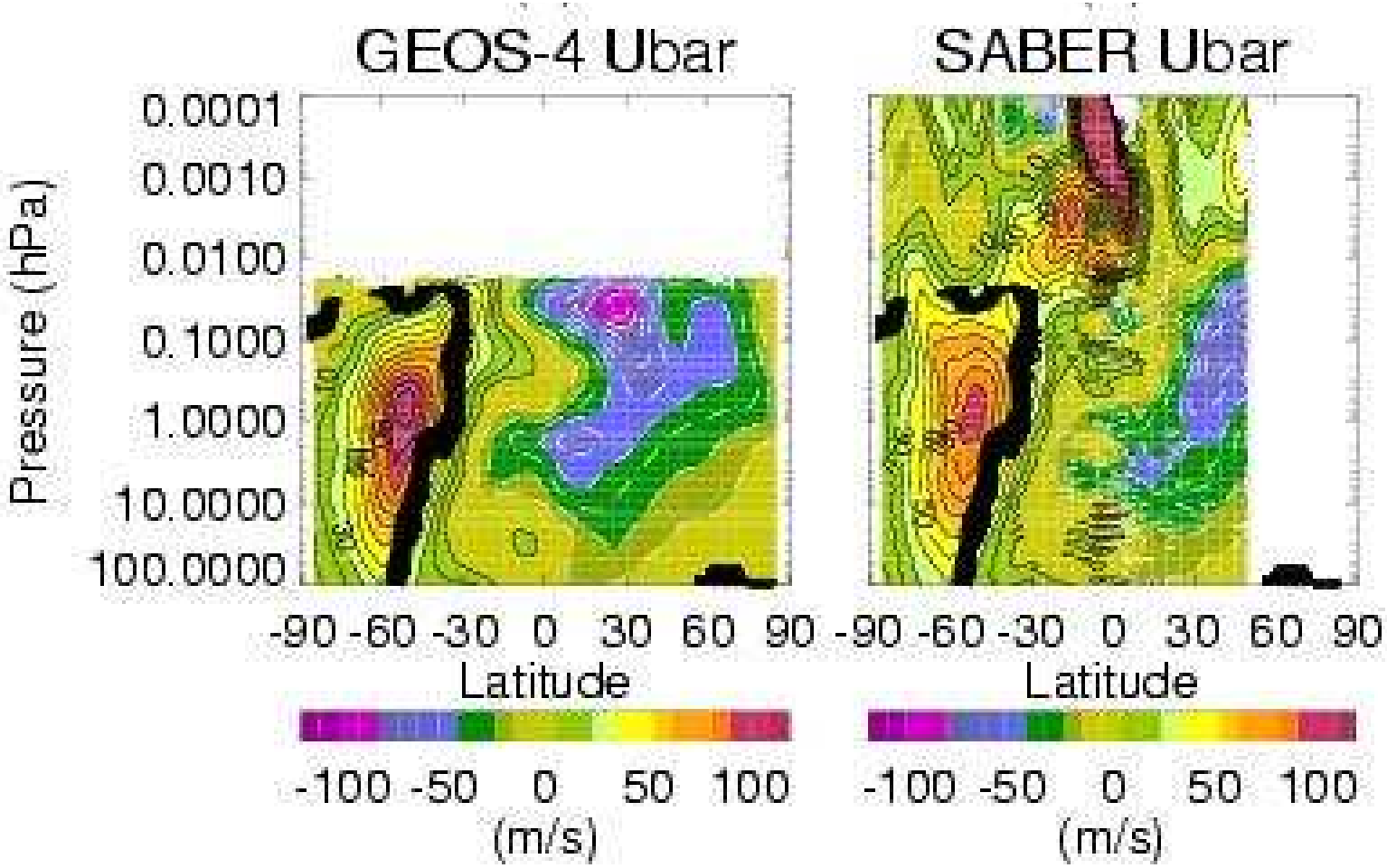

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

SABER vs. GEOS USLM winds

- Daily zonal mean zonal wind + vortex edge movie
- Contamination of vortex edge by the SAO similar to in the UTLS by the subtropical jet. Is this feature accurately represented here?
- Should the vortex “close off” above the separated polar stratopause instead of bulge out to low latitudes? Probably.


QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

“Double jet” in USLM

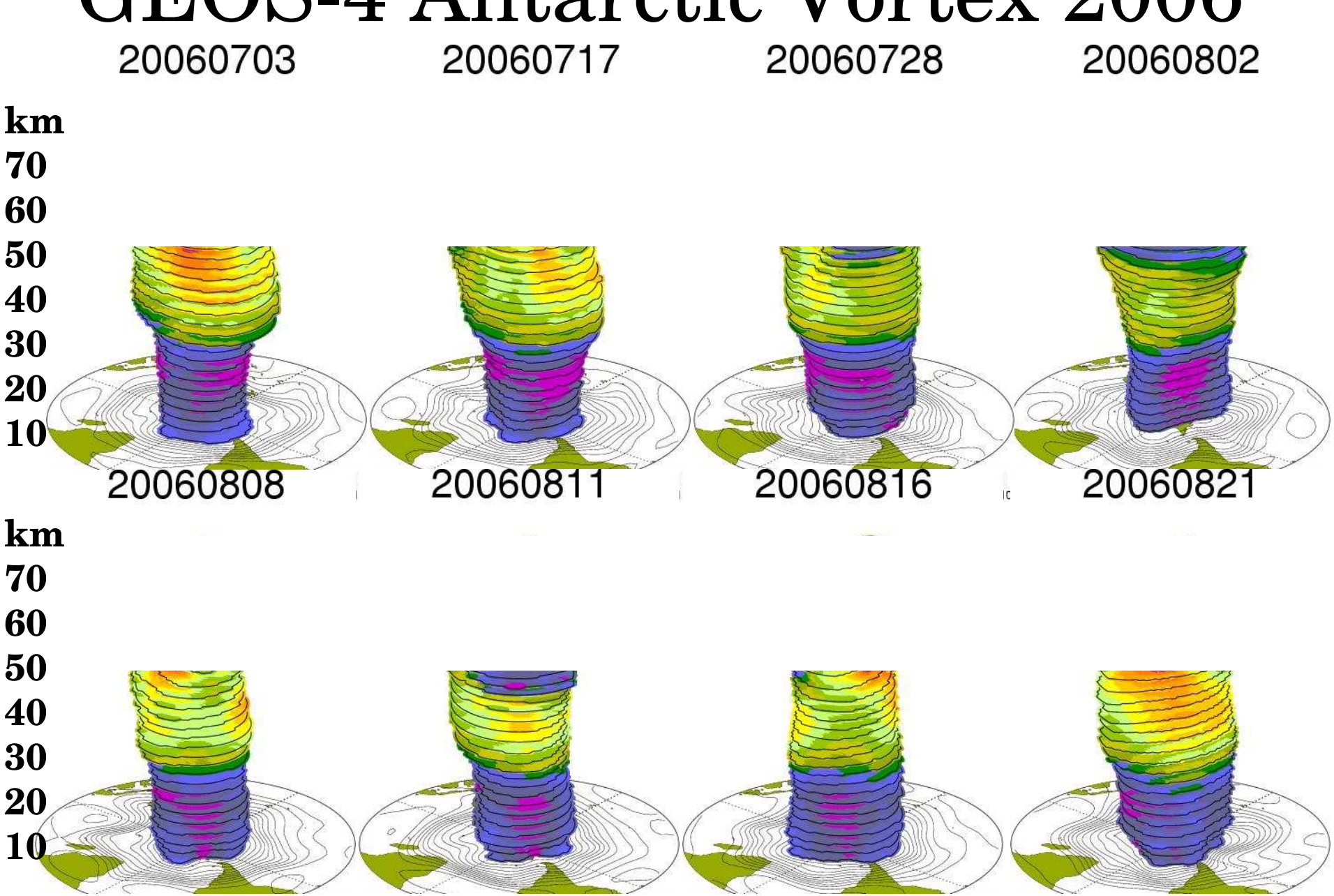


Should the vortex edge follow the jet axis toward the pole?

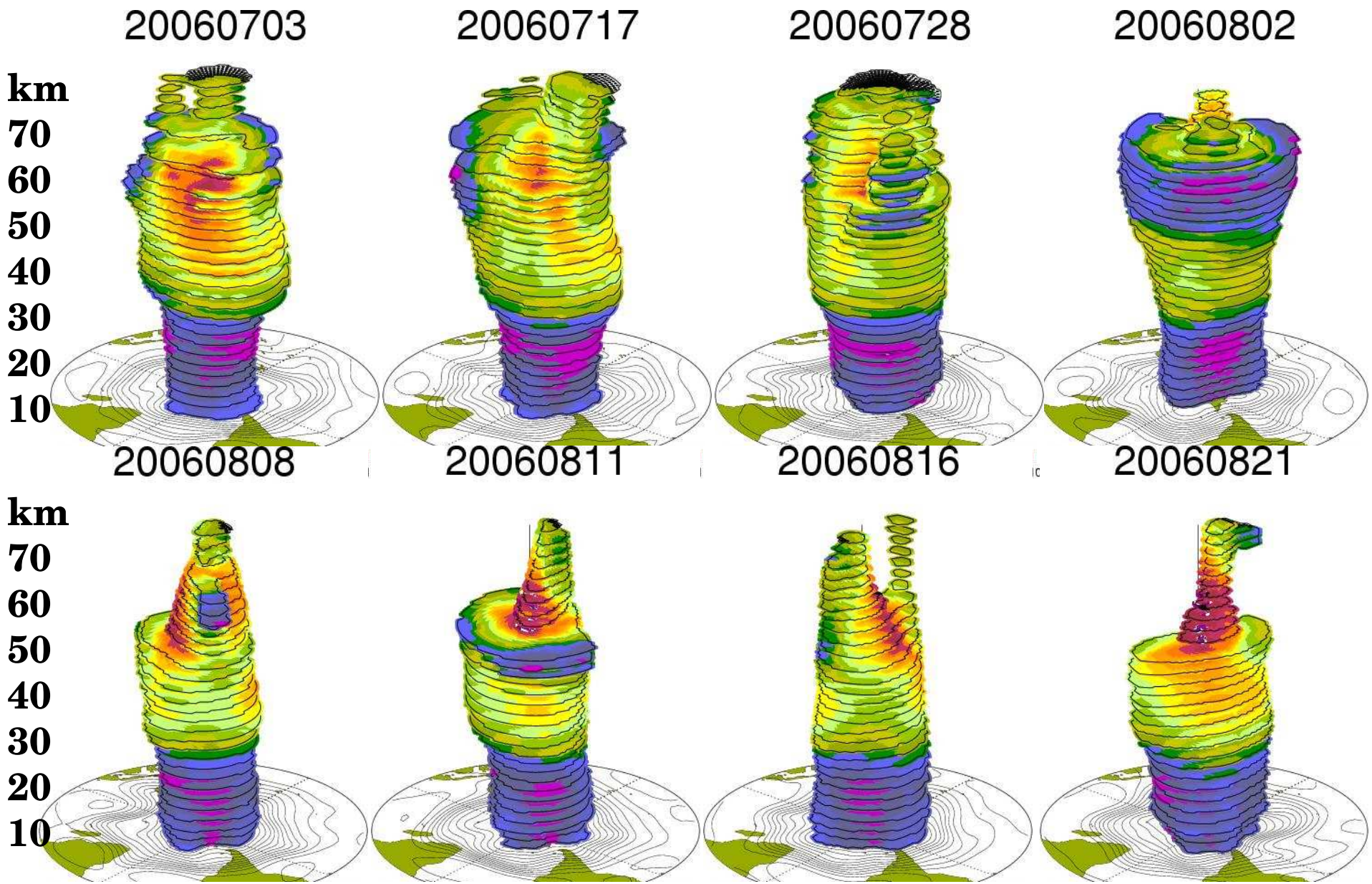
Vortex Edge vs. MLS CO

- Quick 3D case study in each hemisphere
- Cross-Polar CO Swaths + Vortex Edge
- This is a vortex edge validation exercise.

GEOS-4 Antarctic Vortex 2006

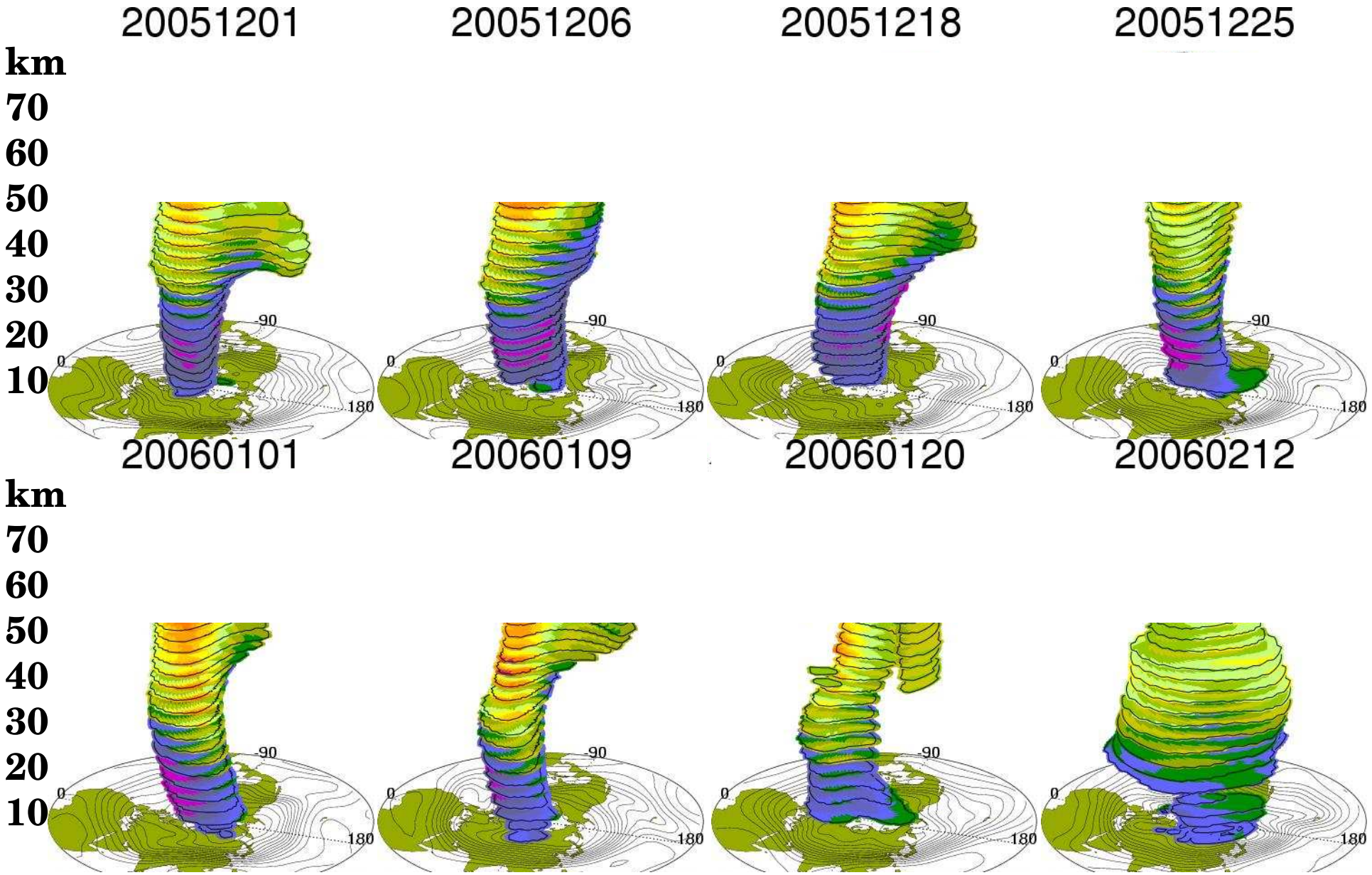


GEOS-4 Antarctic Vortex 2006

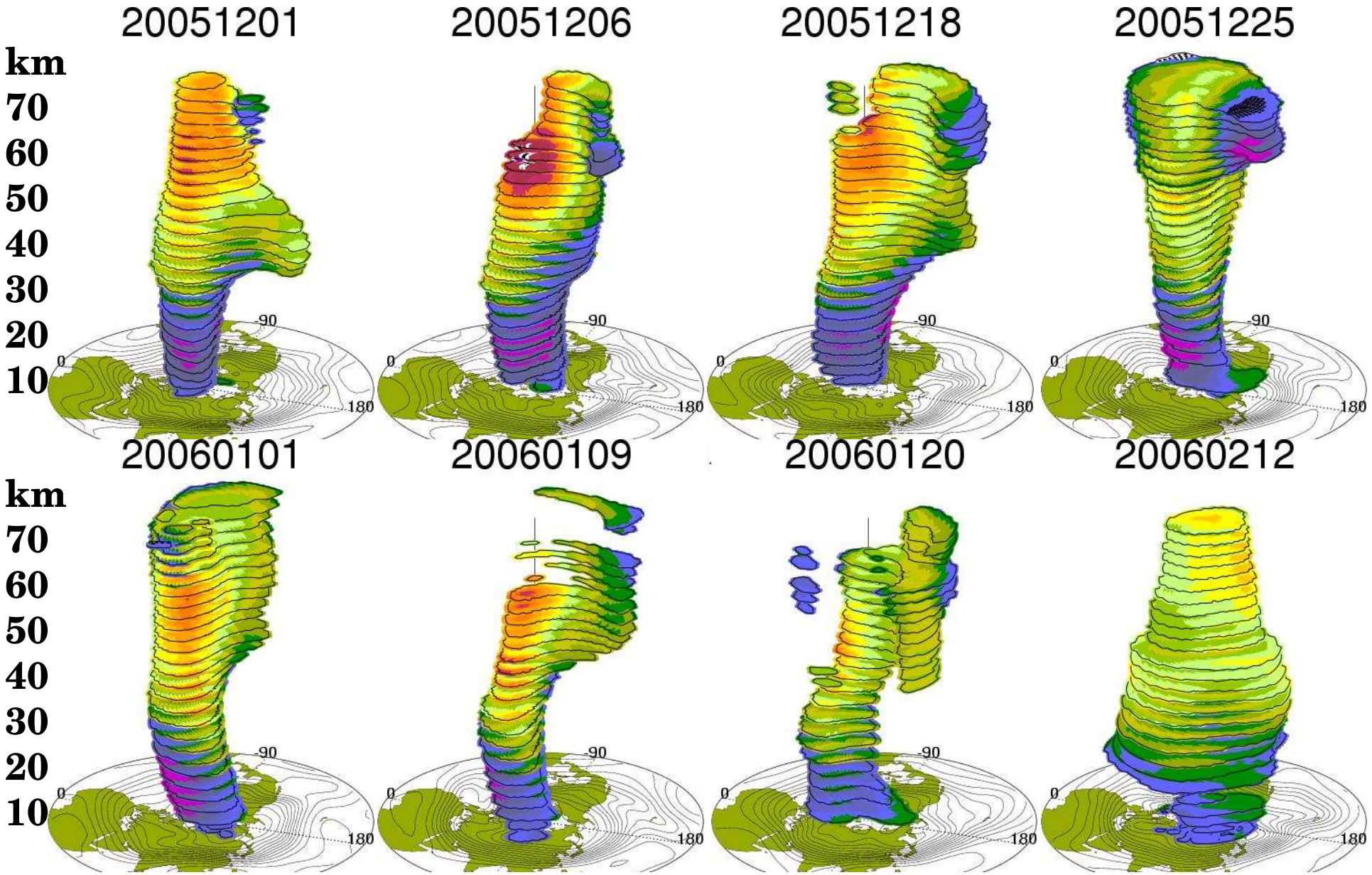


QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

GEOS-4 Arctic Vortex 2005/06



GEOS-4 Arctic Vortex 2005/06



QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

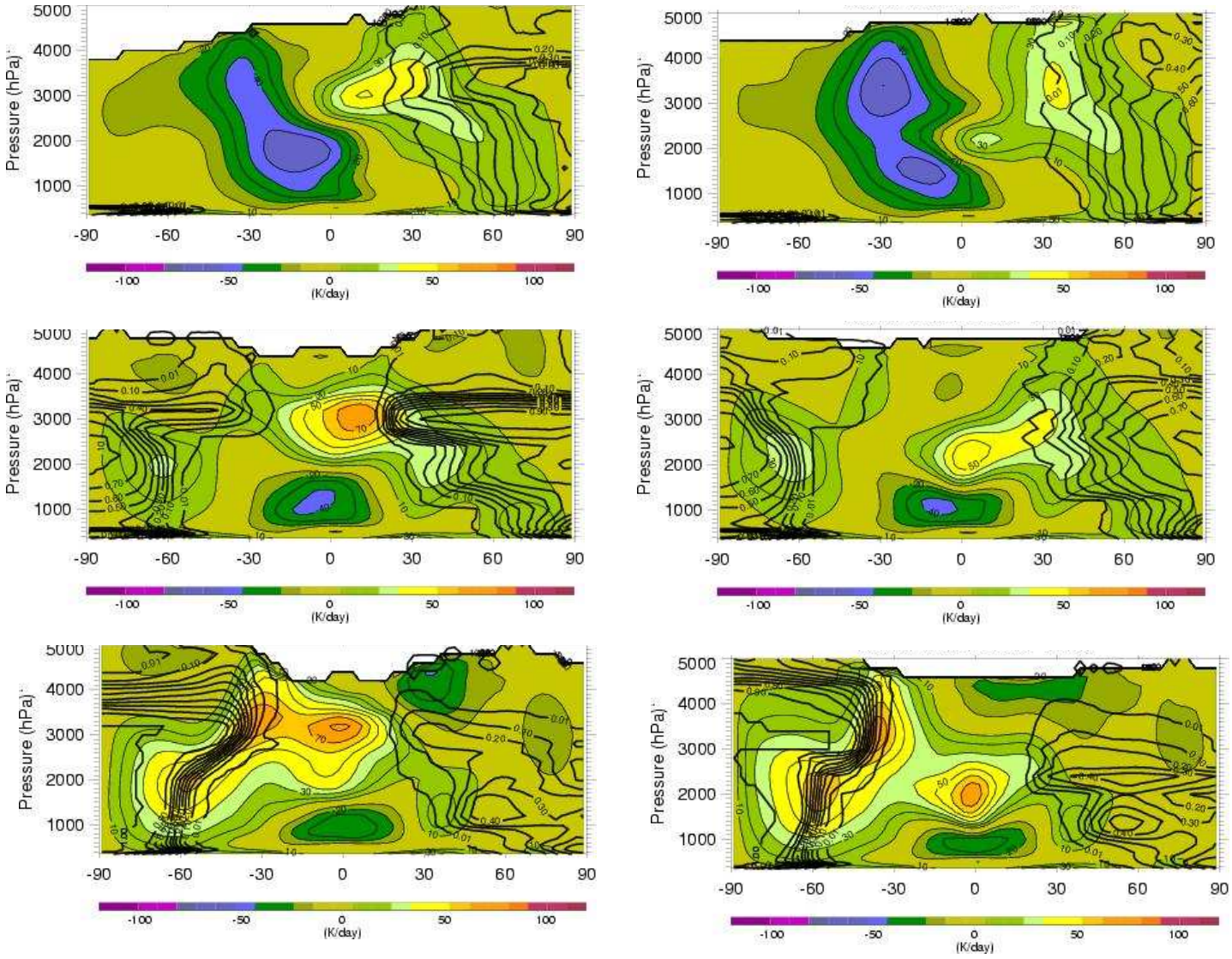
GEOS-4 vs. GEOS-5

2007

Feb

Mar

Apr



Less contamination by SAO in GEOS-5?

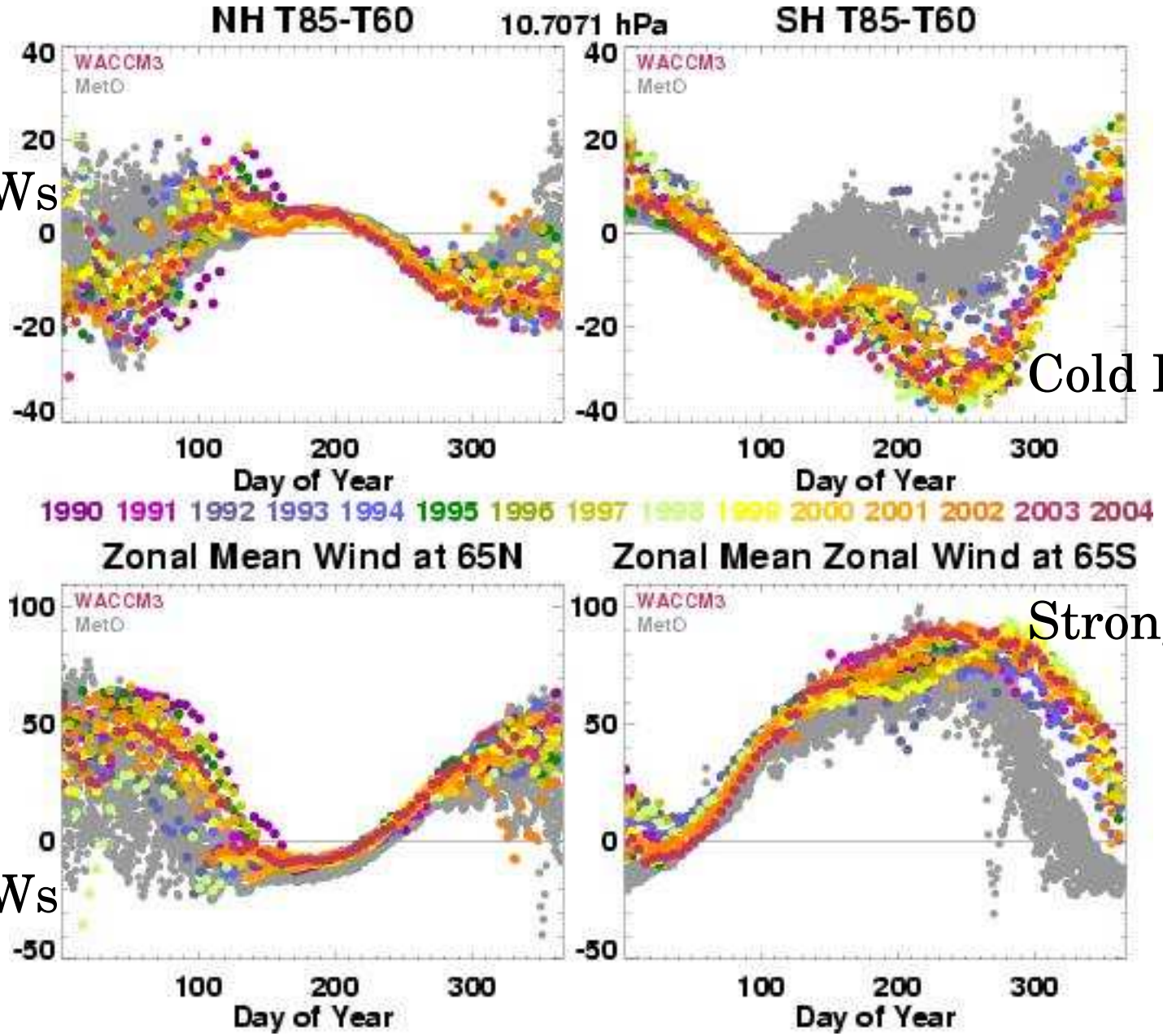
Summary

- MetO -> GEOS -> WACCM vortex climatologies
- Used SABER winds and MLS CO to validate edge definition
- Contamination of vortex edge by SAO
- Top of the polar vortices are some distance above the separated polar winter stratopause.

Future Work

- Improve UTLS and USLM vortex definition to accommodate SAO.
- Compare GEOS and SABER winds to TIDI.
- JGR paper and AGU Special Session

WACCM vs MetO



SSWs

Cold Pole

Strong Jet

SSWs