Quantifying the sensitivity of North Atlantic cyclone development to atmospheric precursor fields

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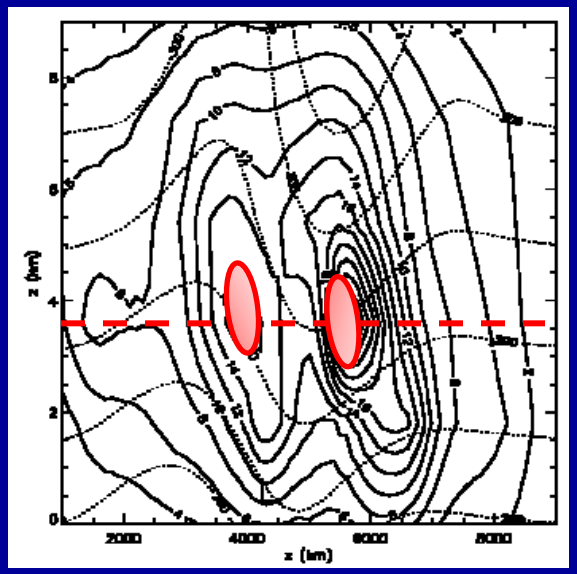
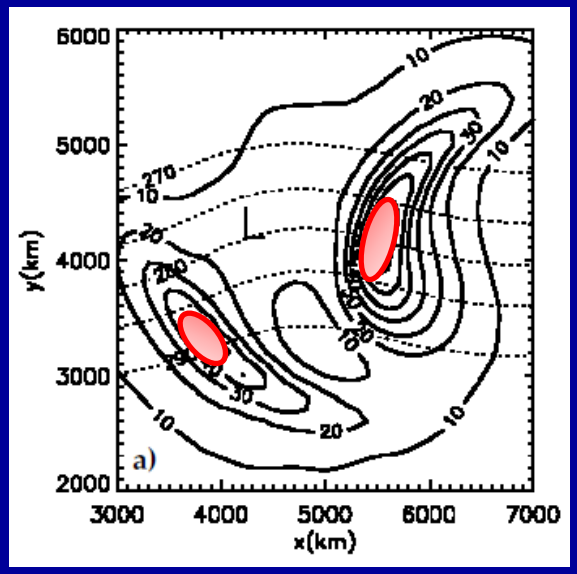
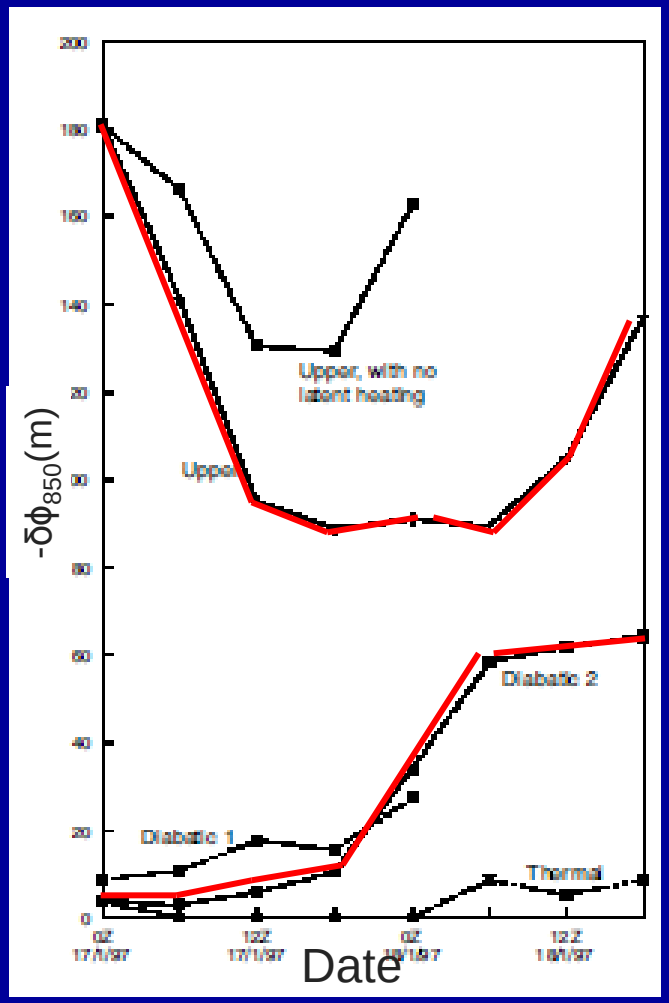
Lorena Garcies, Marc Stringer
Kevin Hodges

Motivation: Cyclone sensitivity to PV





Beare et al. (2003)



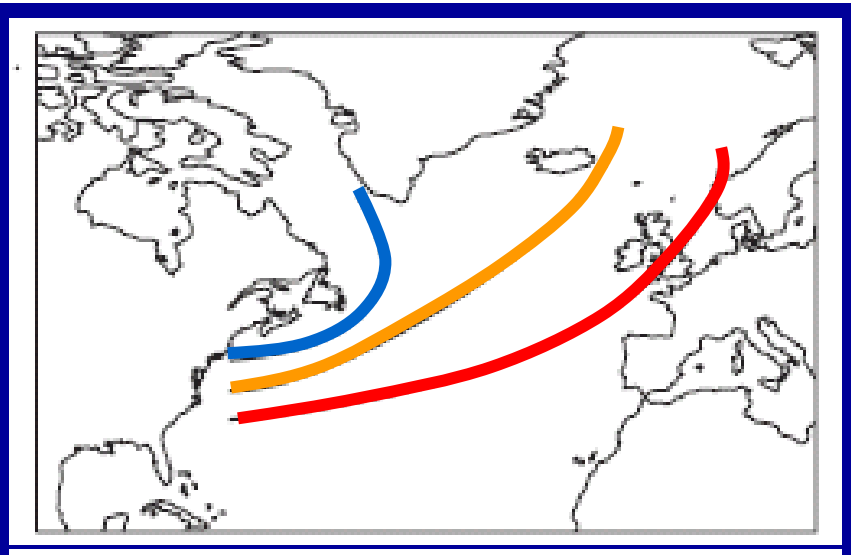
Plant et al. (2003)

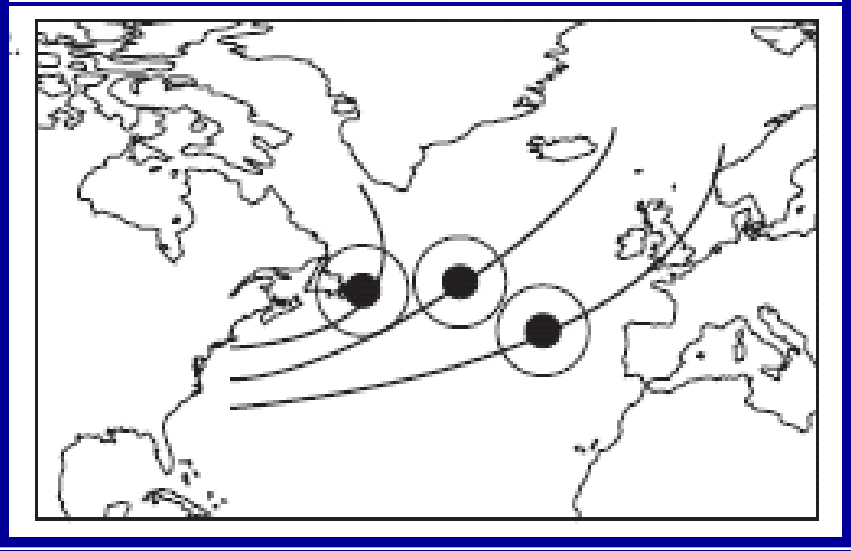
Talk Outline

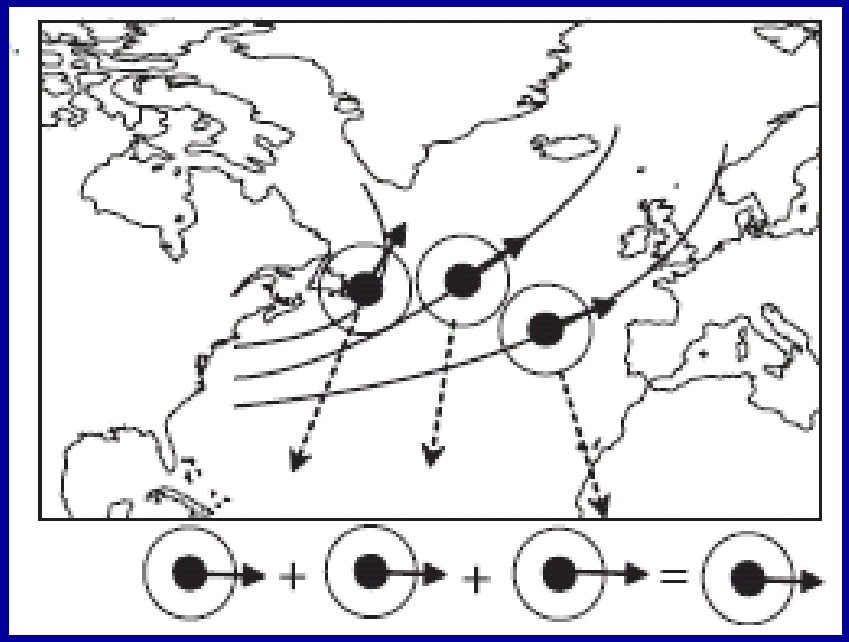
AIM: to determine the relative role of mid-level PV in the development of a climatology of east and west Atlantic cyclones

- Creating the cyclone climatology
- West and east Atlantic cyclone structure
- Relationship between atmospheric precursor fields and cyclone development

3D Cyclone Compositing Technique

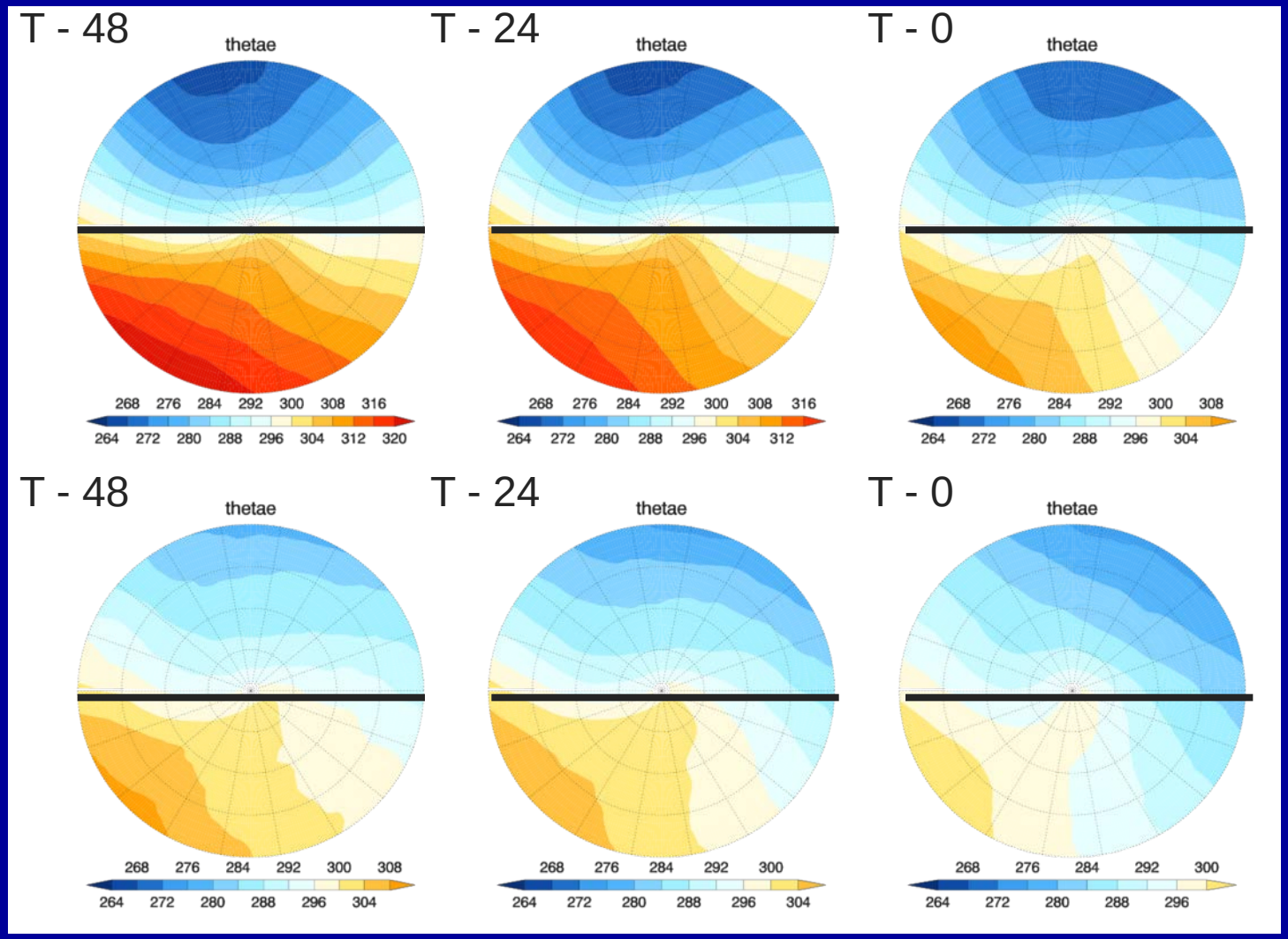






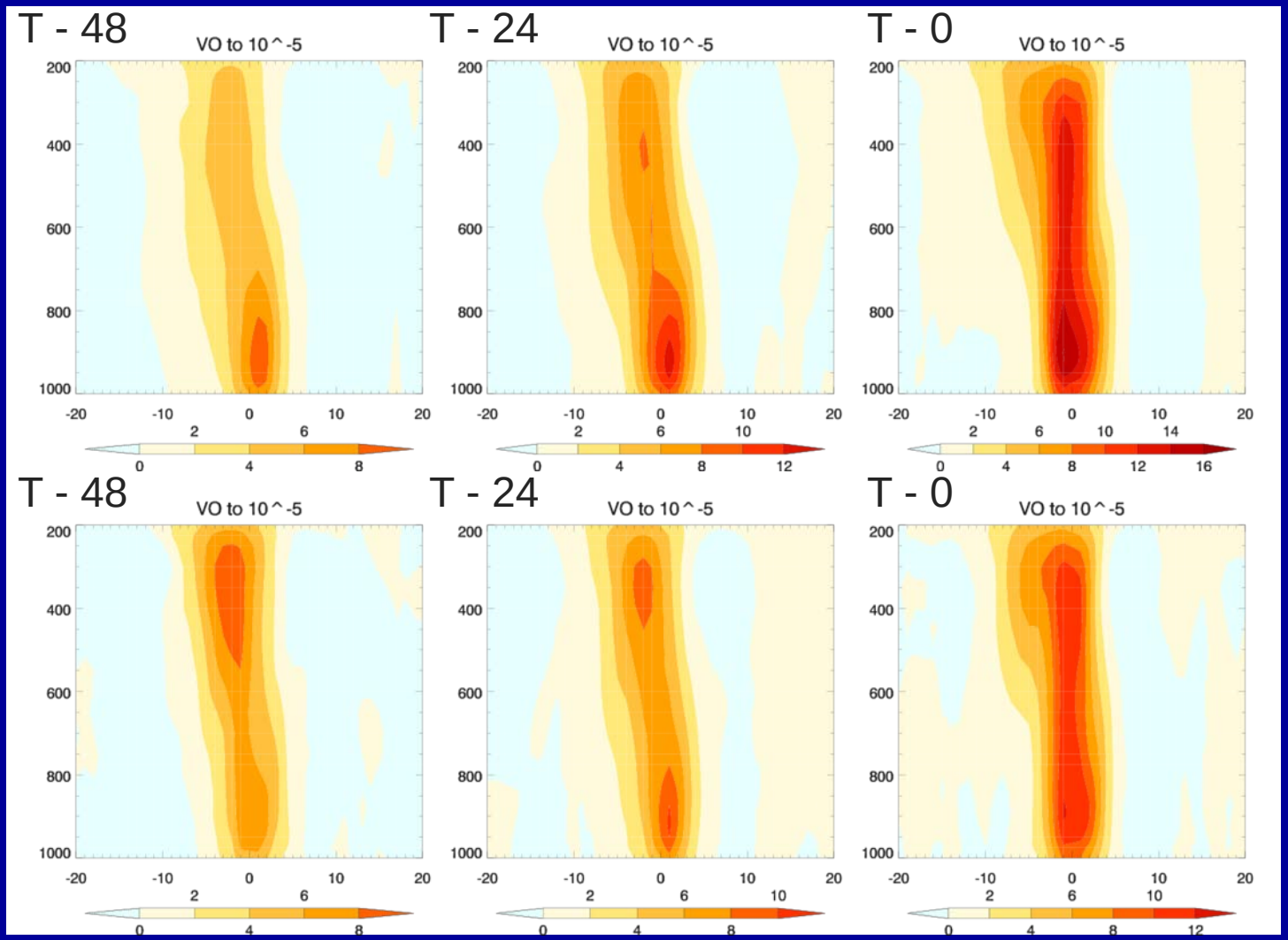
Catto et al. 2010

West (top) and East (bottom) Atl. Cyclones θ_e at 950hPa (DJF 1989-2008)



Direction of travel

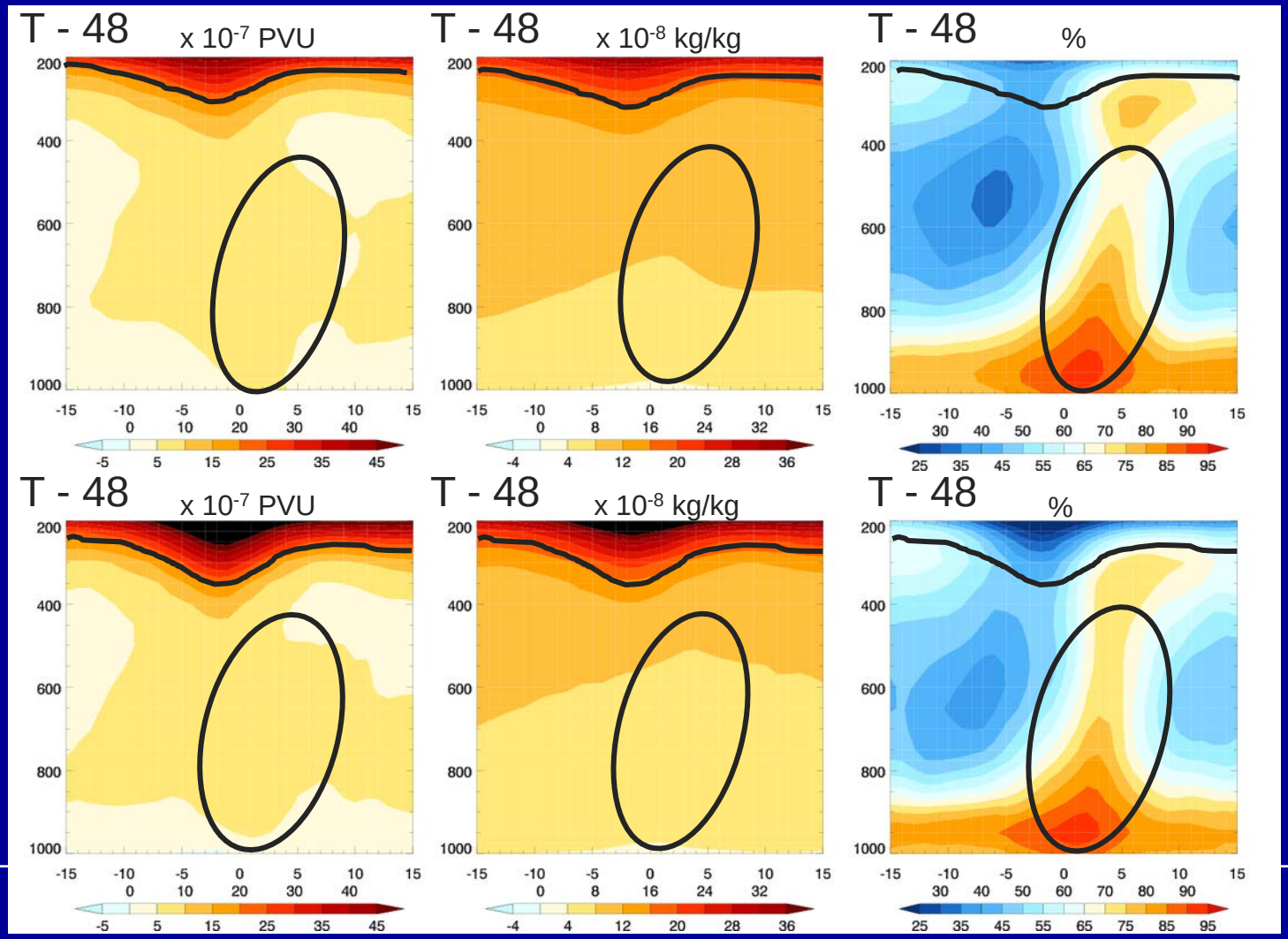
West (top) and East (bottom) Atl. Cyclones Vorticity Cross-Section (DJF 1989-2008)



Direction of travel

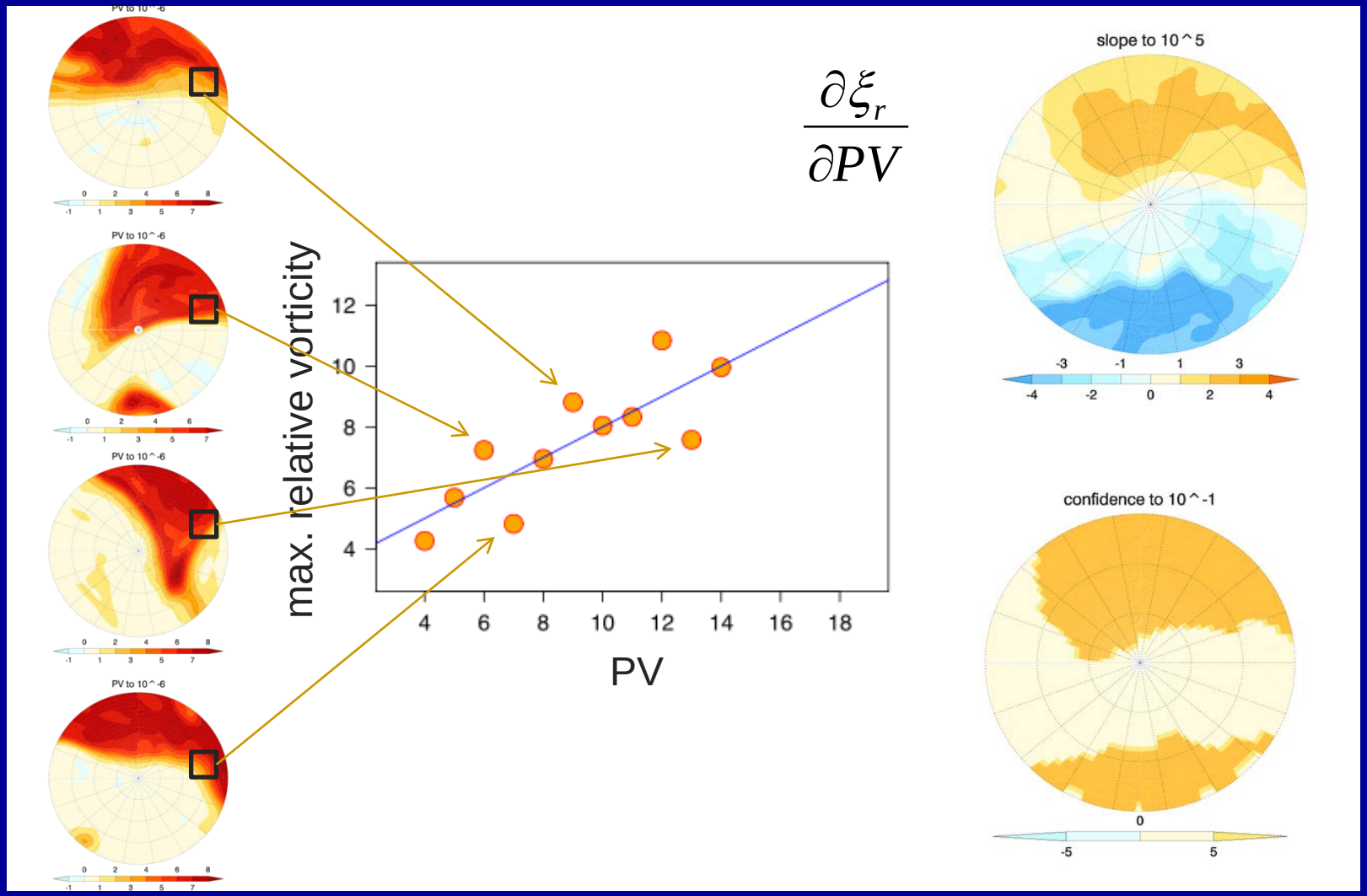
West (top) and East (bottom) Atl. Cyclones T-48 Cross-Section (1989-2008)

PV O_3 RH

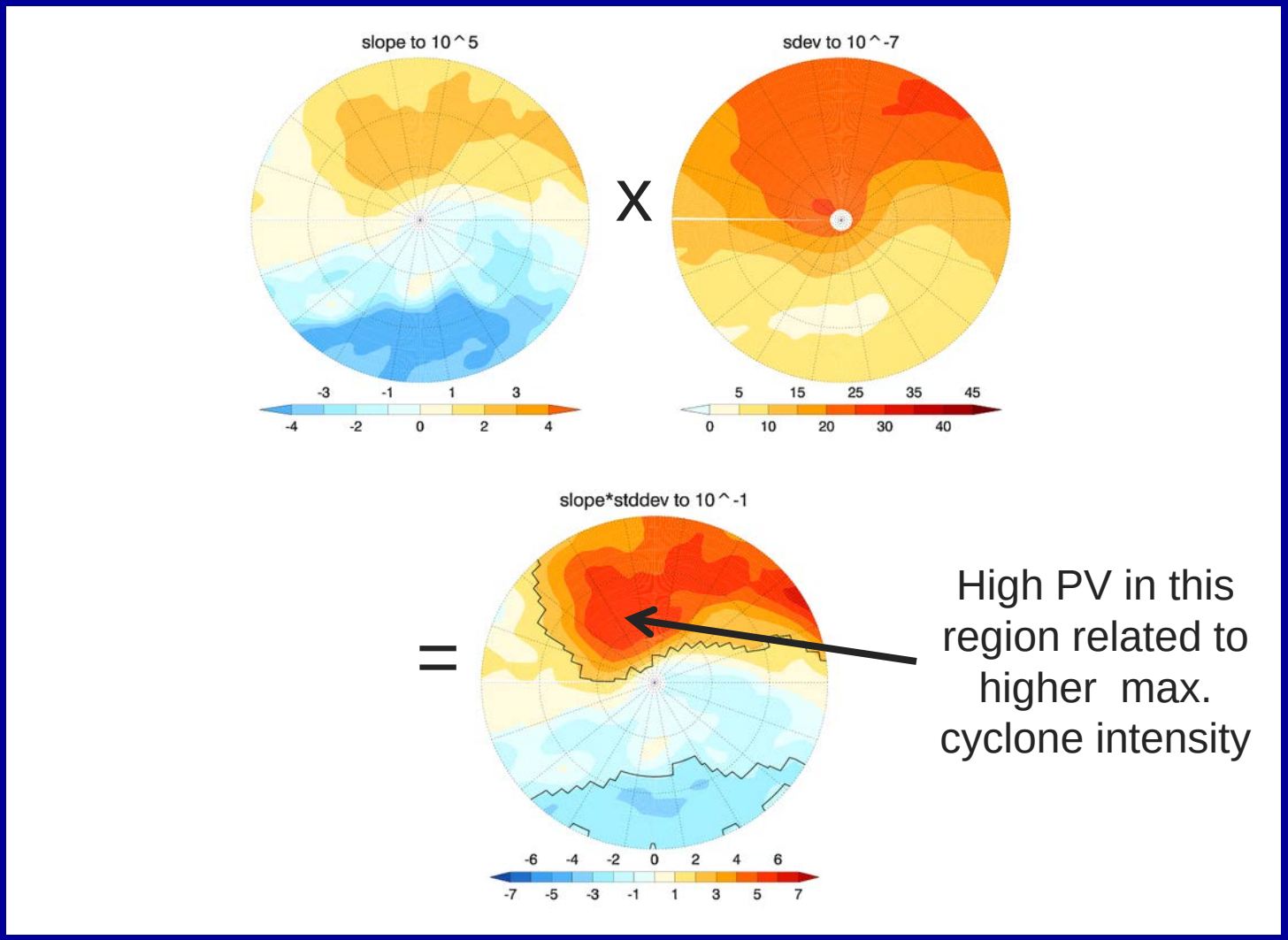


Direction of travel

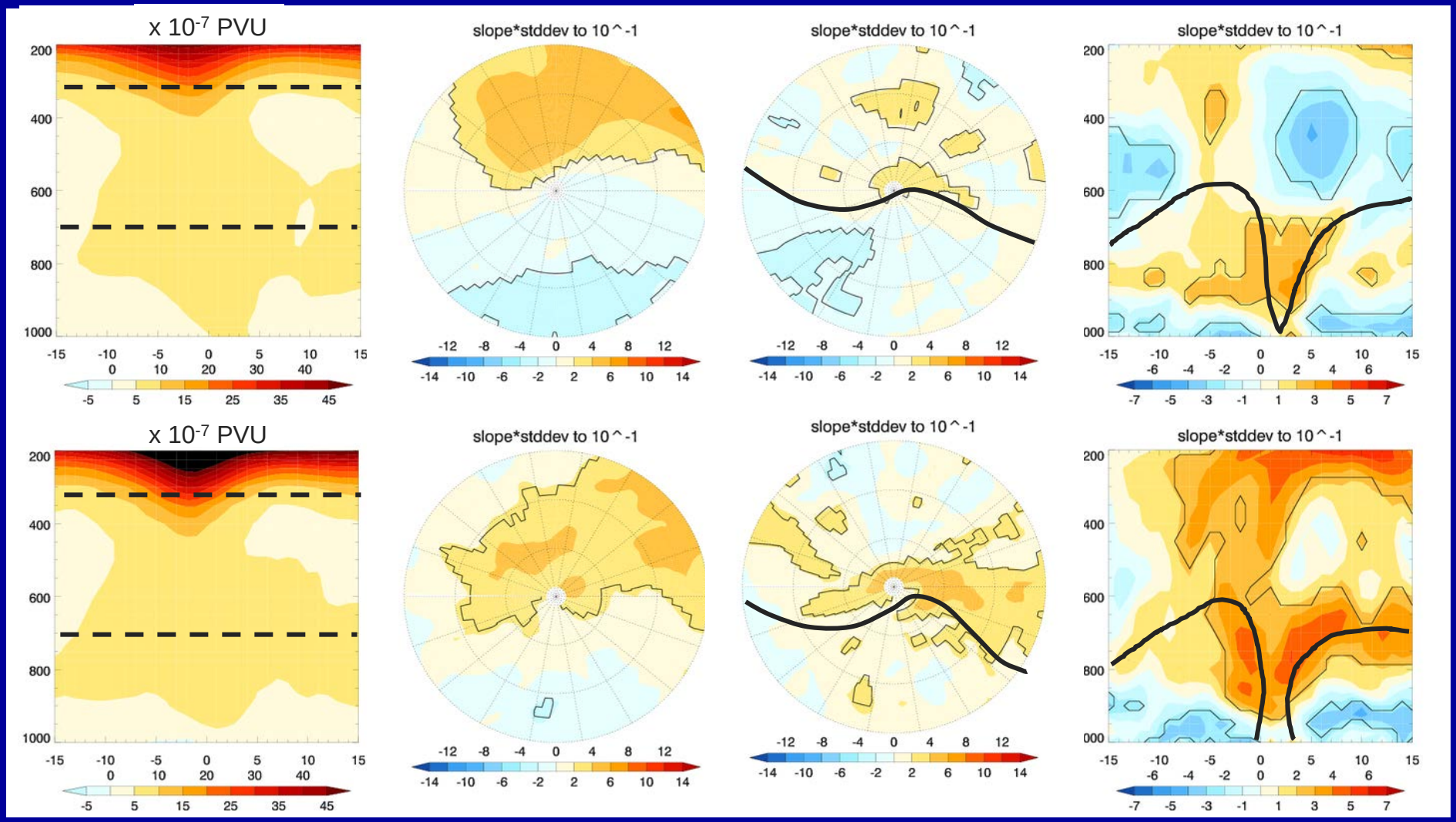
Linear regression of ξ_{max} and 300hPa PV (West Atl. cyclones)



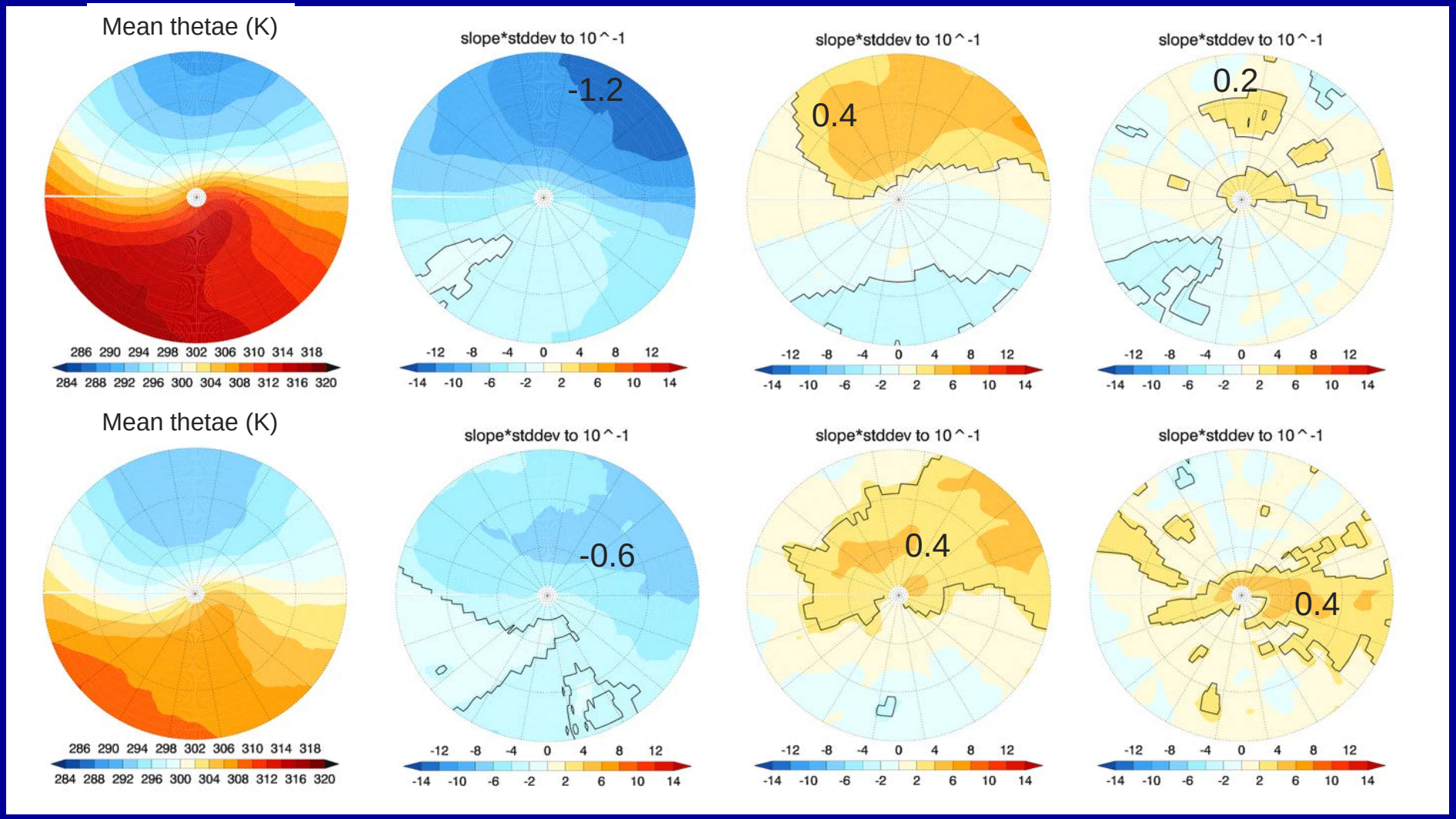
Relation of ξ_{max} to PV precursor at 300hPa (West Atl. 1989-2008)



West (top) and East (bottom) Atl. Cyclones Relation of PV at 300hPa and 700hPa to ξ_{max}



West (top) and East (bottom) Atl. Cyclones Relation of Thetae at 800hPa to ξ_{max}

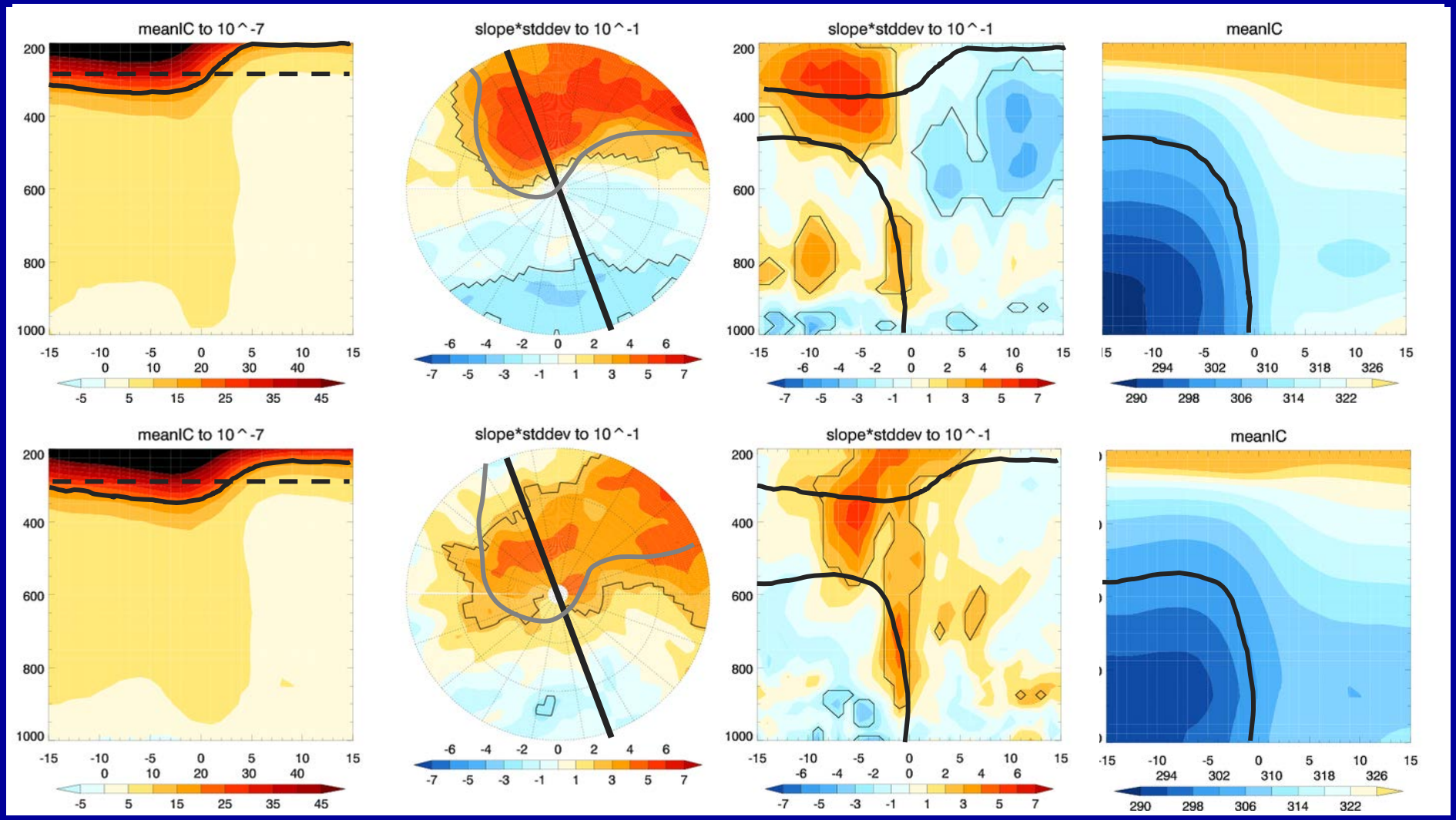


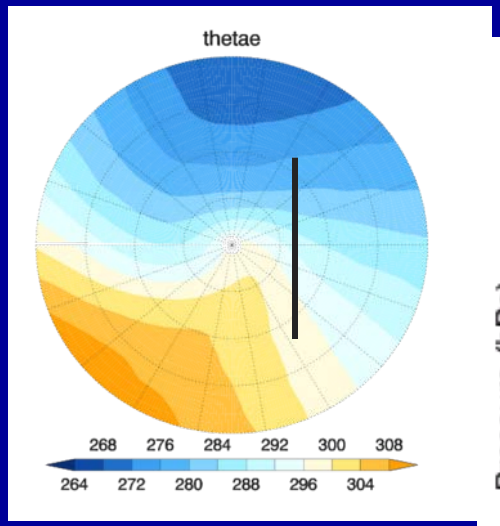
Summary

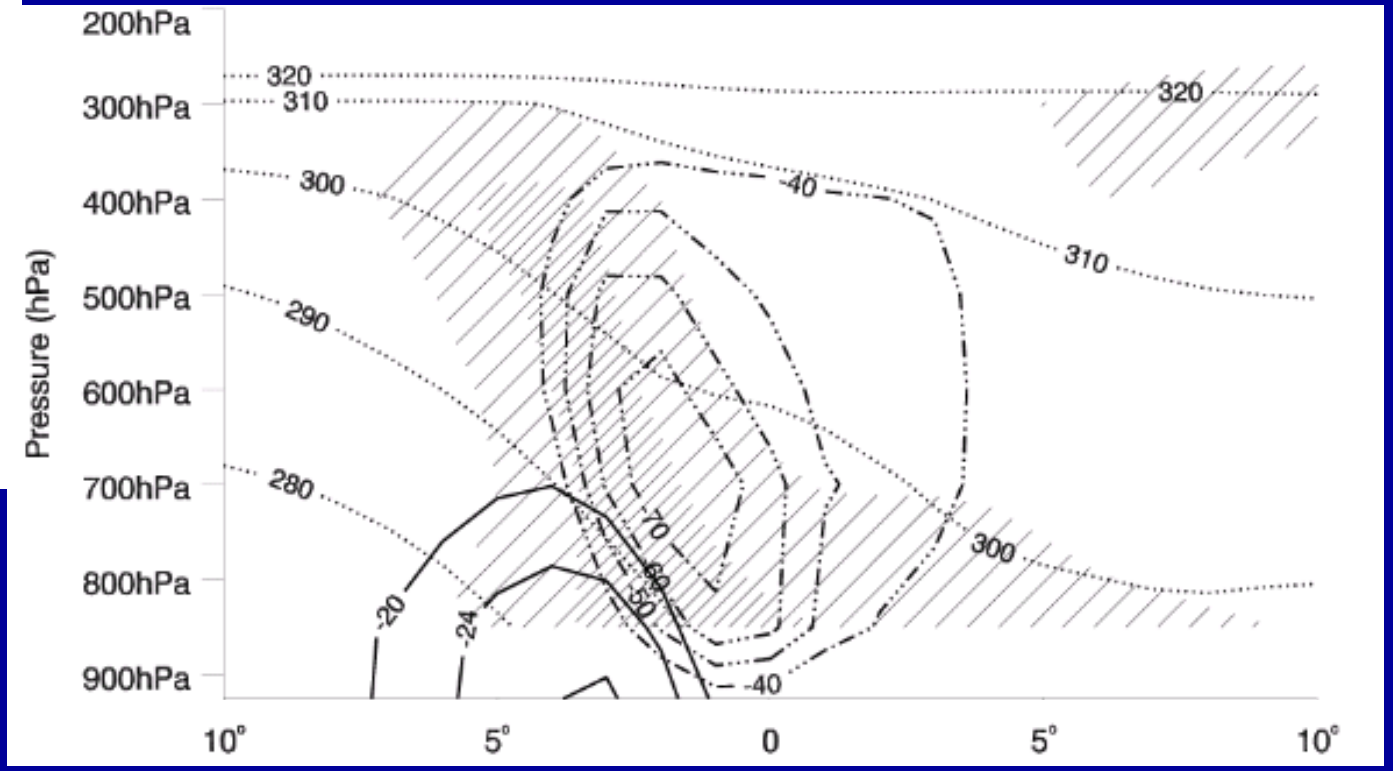
- Cyclones are sensitive to PV at two distinct heights
  - the tropopause (~300hPa)
  - the steering level (~700hPa)
- More intense west and east Atl. cyclones are associated with stronger precursor tropopause depressions
- Mid-level latent heating contributes more positively to the development of east Atl. cyclones than west Atl. cyclones
- Lower tropospheric temperature gradient contributes more positively to the development of west Atl. cyclones

EXTRA SLIDES

West (top) and East (bottom) Atl. Cyclones Sensitivity to PV at 300hPa

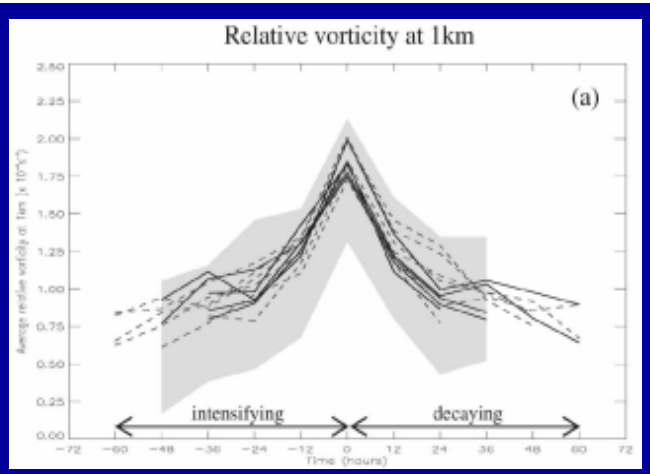


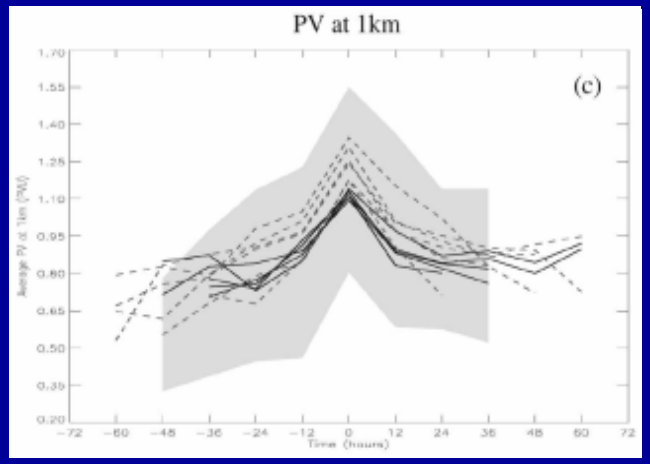


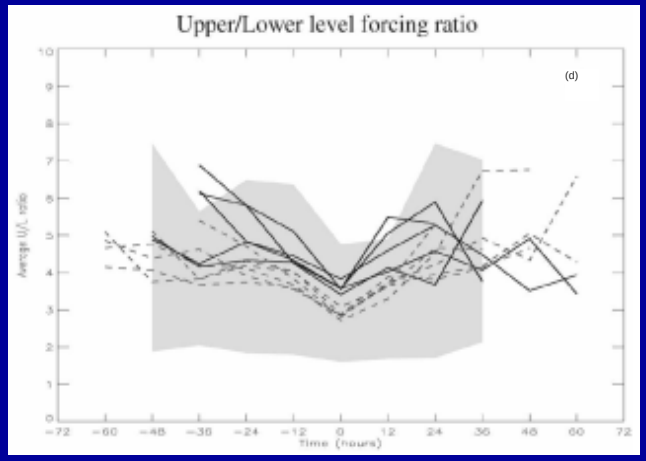


Matt Hawcroft (see poster)

Evolution of Cyclone Characteristics

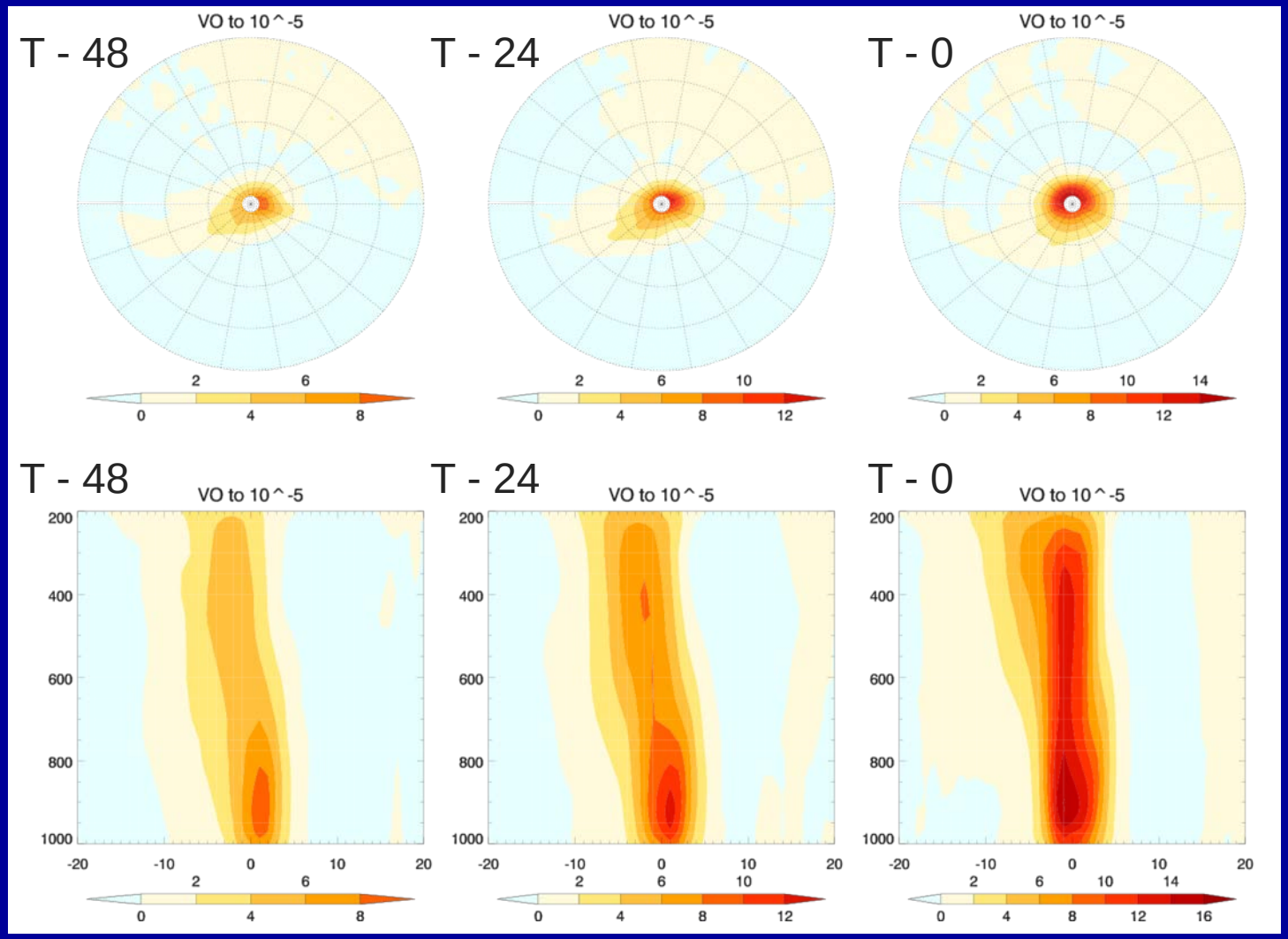




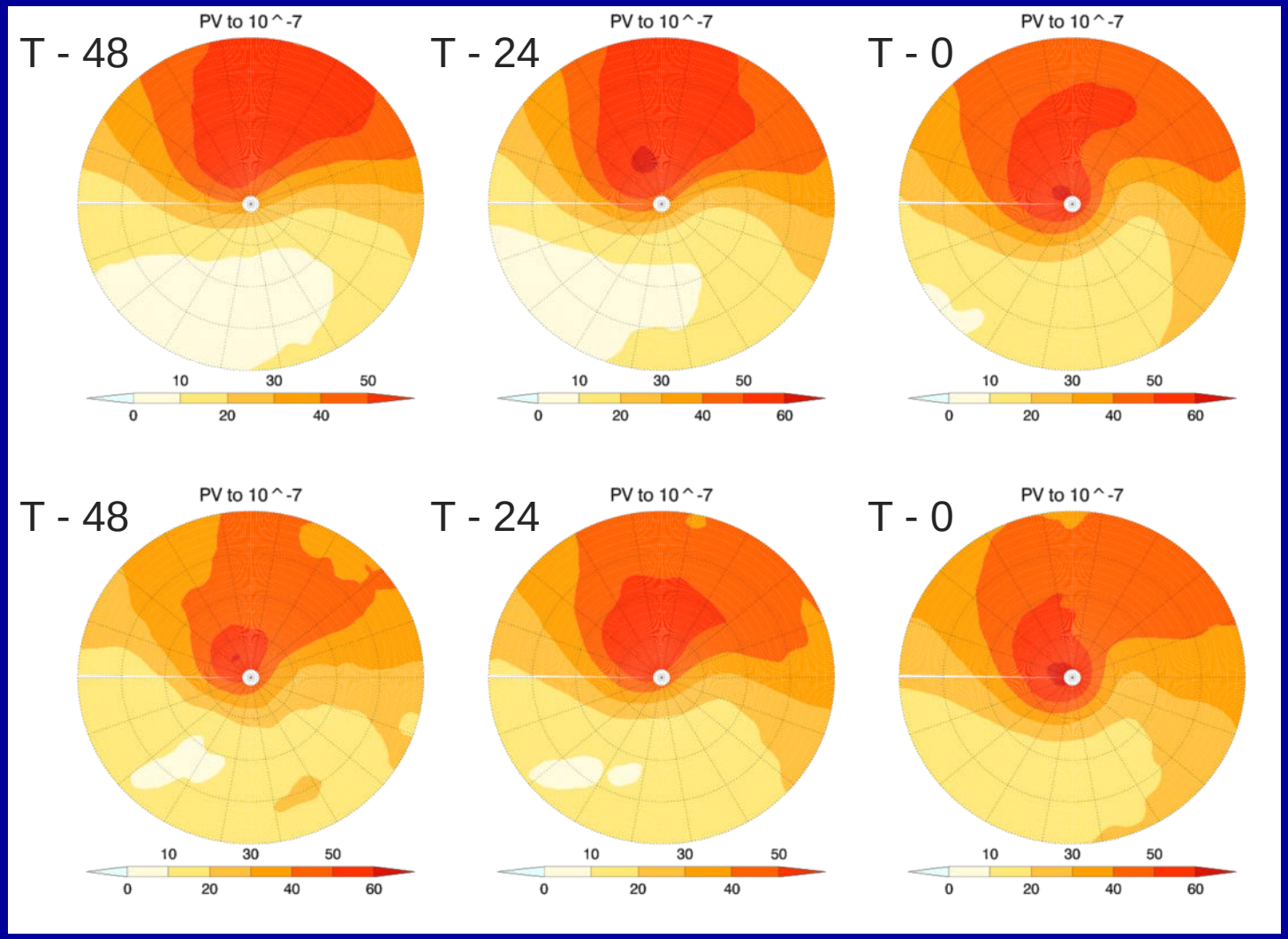


West Atl. cyclones (dashed) and east Atl. cyclones (solid) with lifetimes of 36-96h. Shading represents 1 sd from mean for 48h west Atl. cyclones.

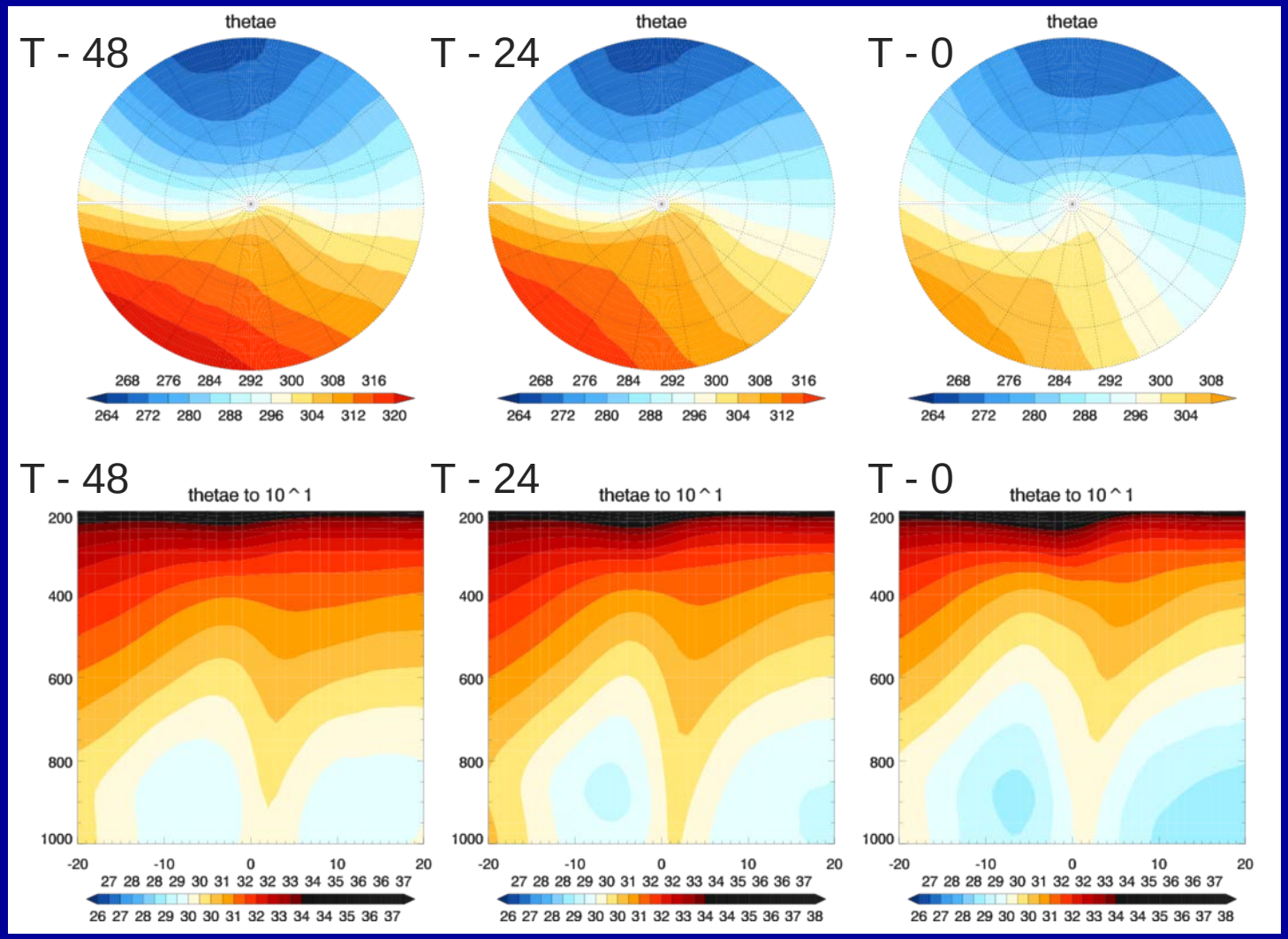
West Atl. Cyclones
Relative Vorticity at 950 hPa



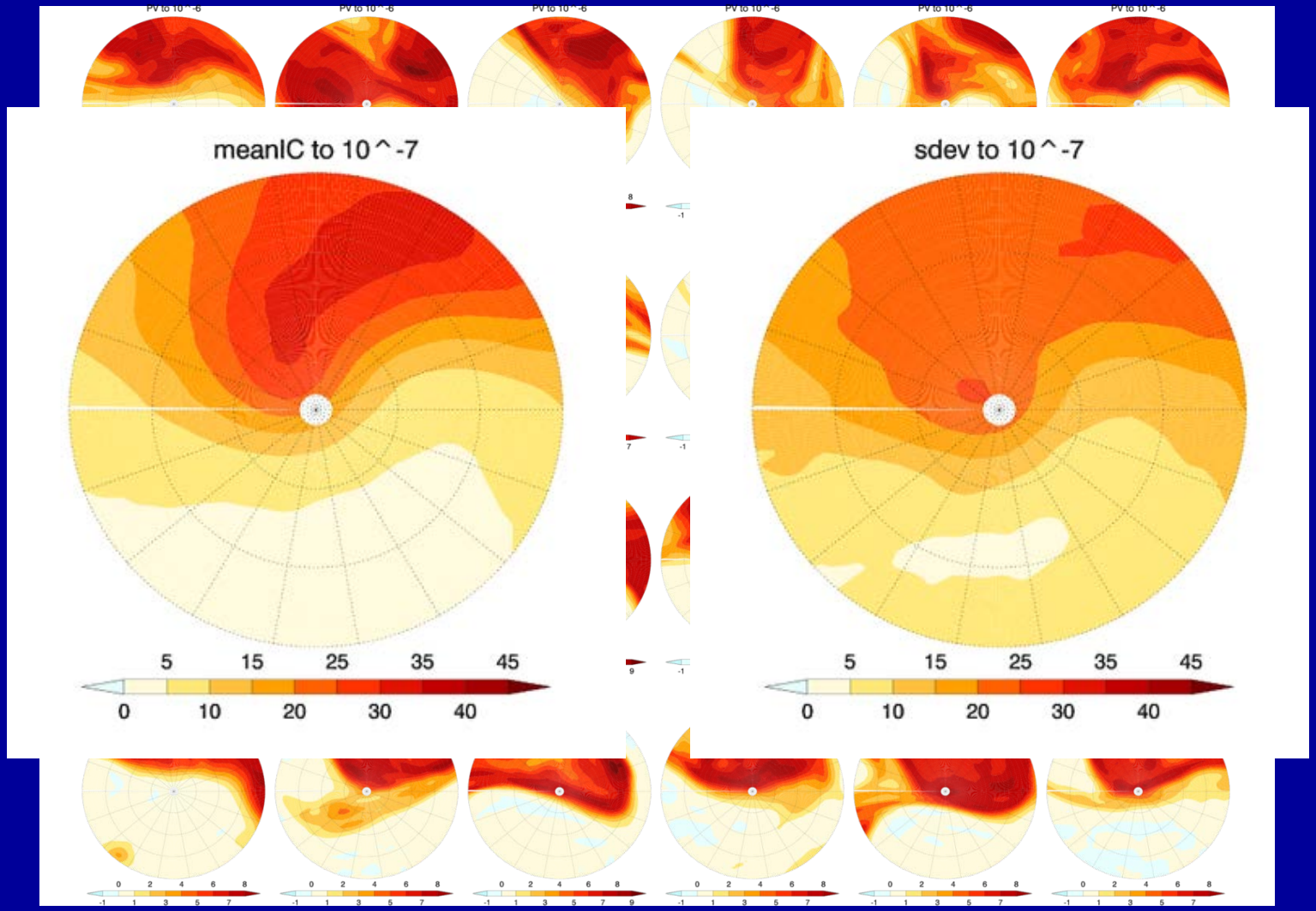
West (top) and East (bottom) Atl. Cyclones Potential Vorticity at 250hPa



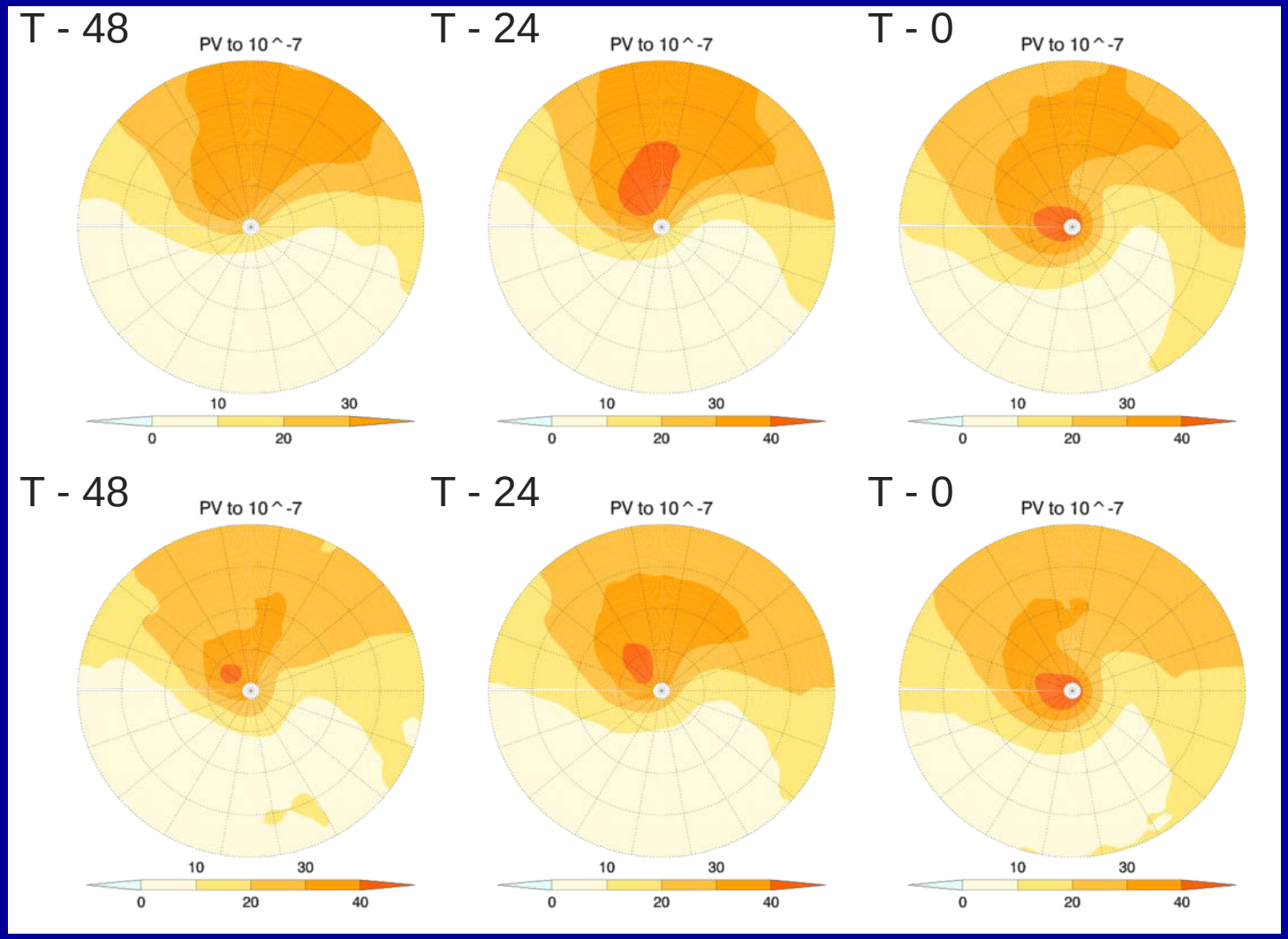
West Atl. Cyclones
Equivalent Potential Temperature at 950 hPa



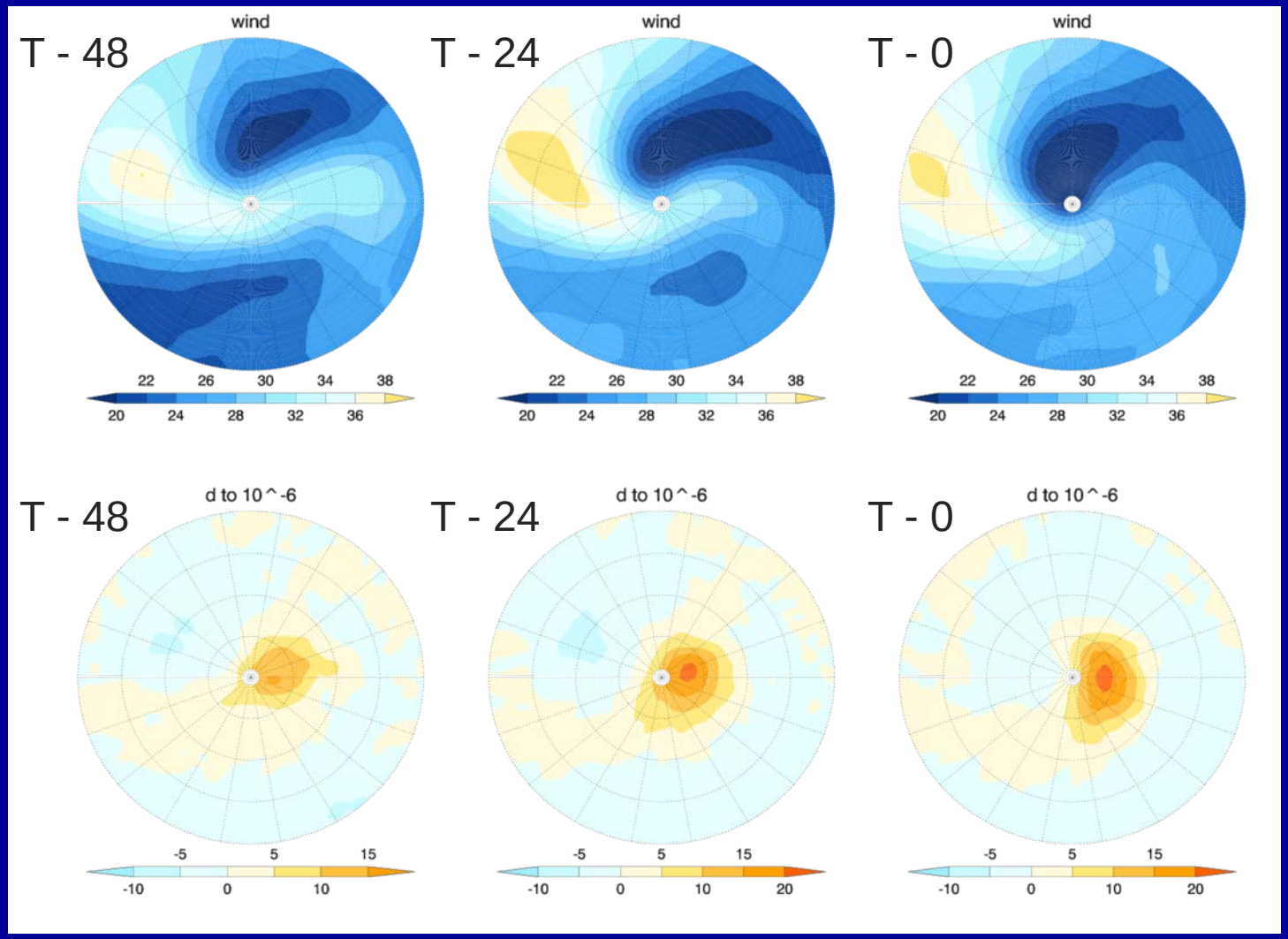
300 hPa PV for each west Atlantic cyclone



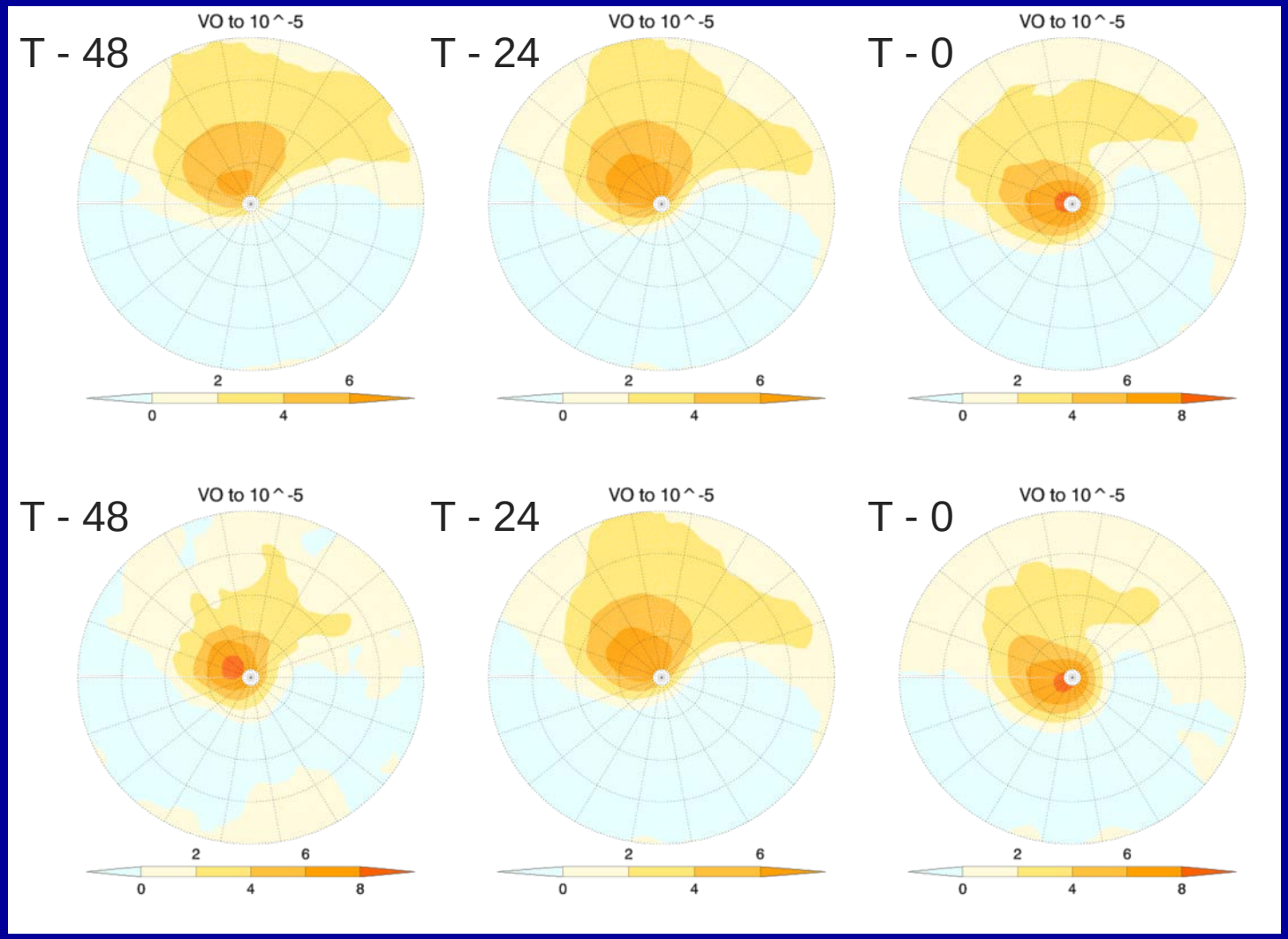
West (top) and East (bottom) Atl. Cyclones PV at 300hPa (DJF 1989-2008)



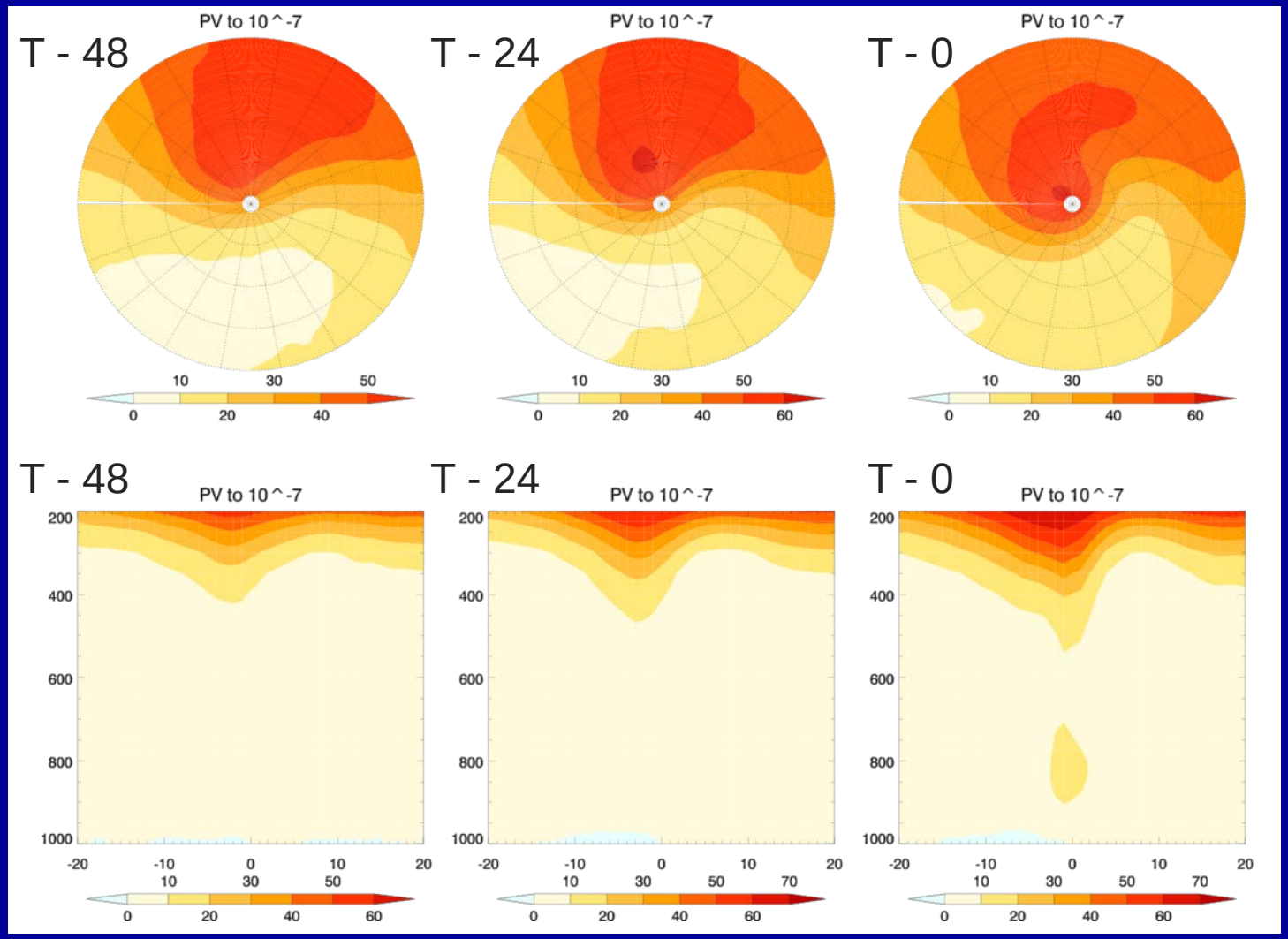
West Atl. Cyclones
Wind Speed and Divergence at 250 hPa



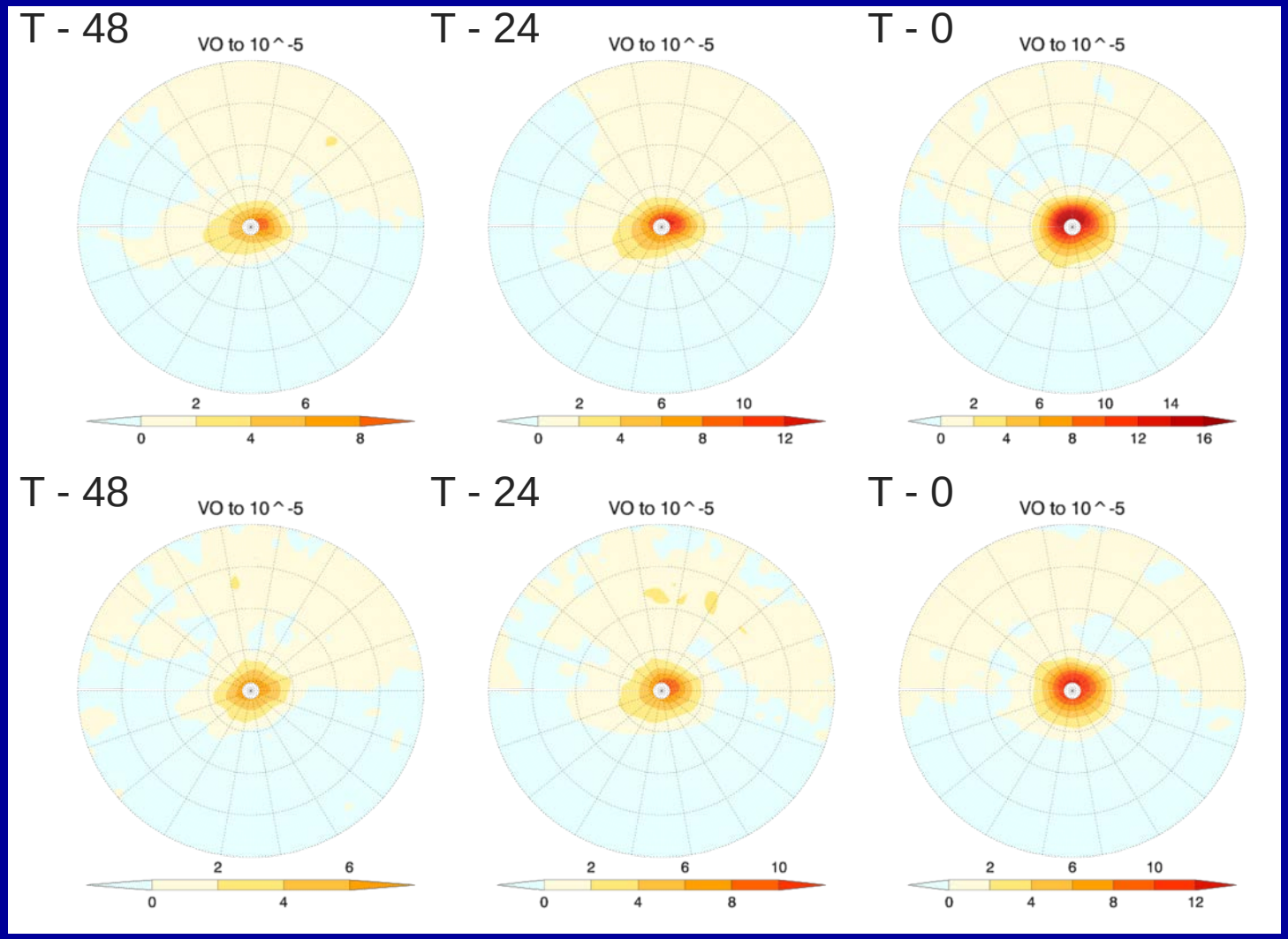
West (top) and East (bottom) Atl. Cyclones Relative Vorticity at 250hPa



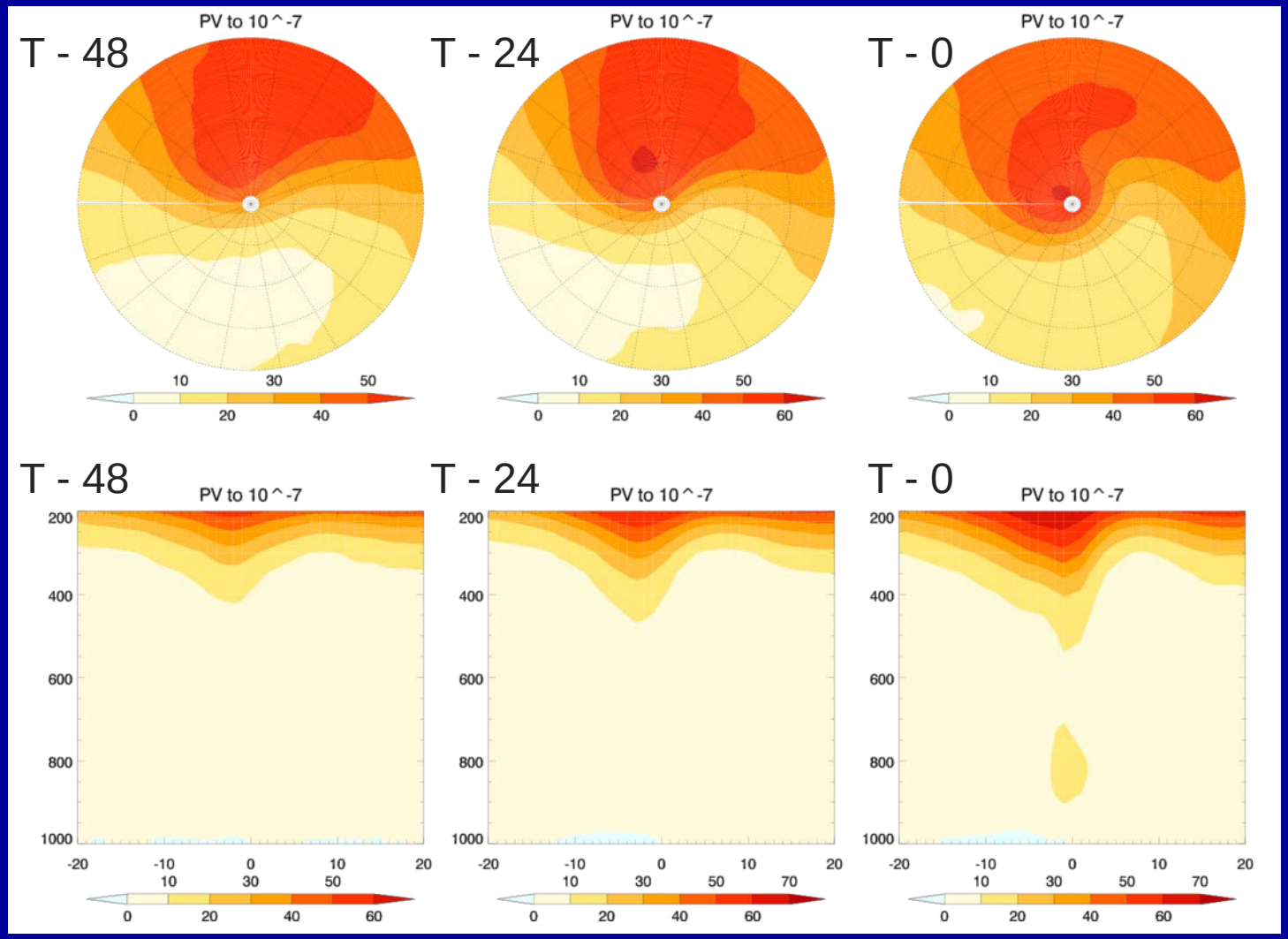
East Atl. Cyclones
Potential Vorticity at 250 hPa



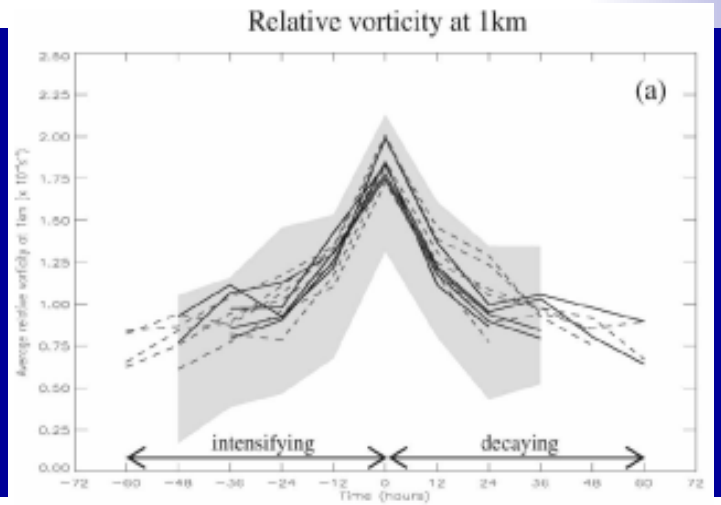
West (top) and East (bottom) Atl. Cyclones θ_e at 950hPa (DJF 1989-2008)

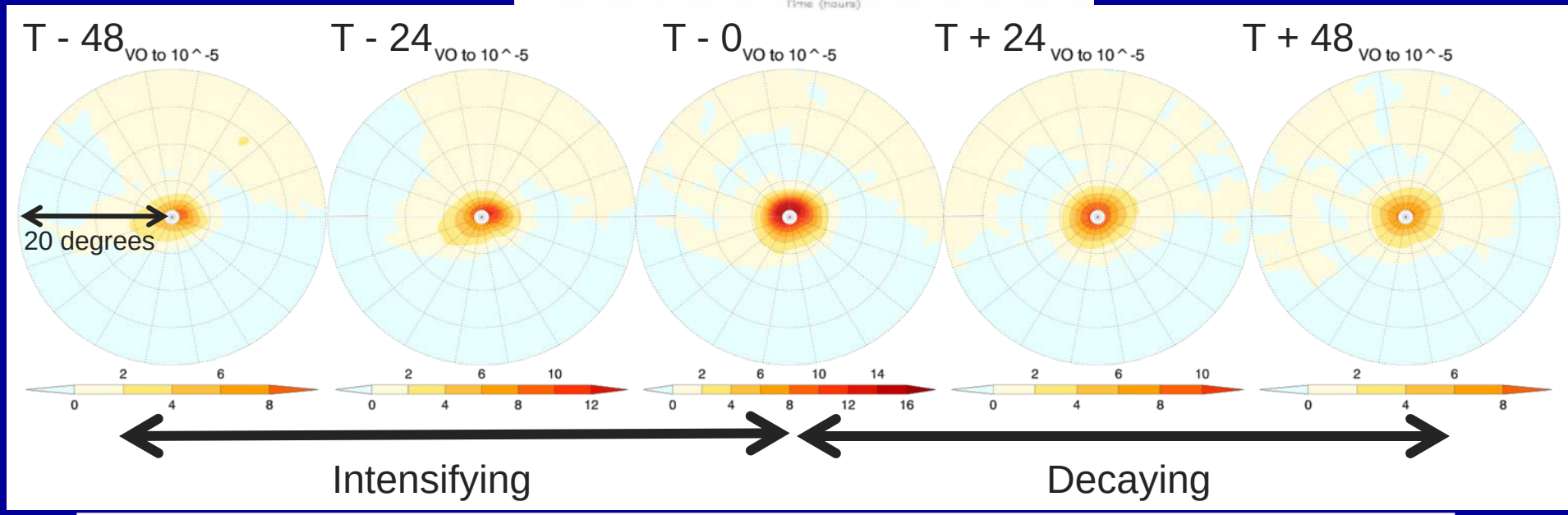


West Atl. Cyclones
Potential Vorticity at 250 hPa

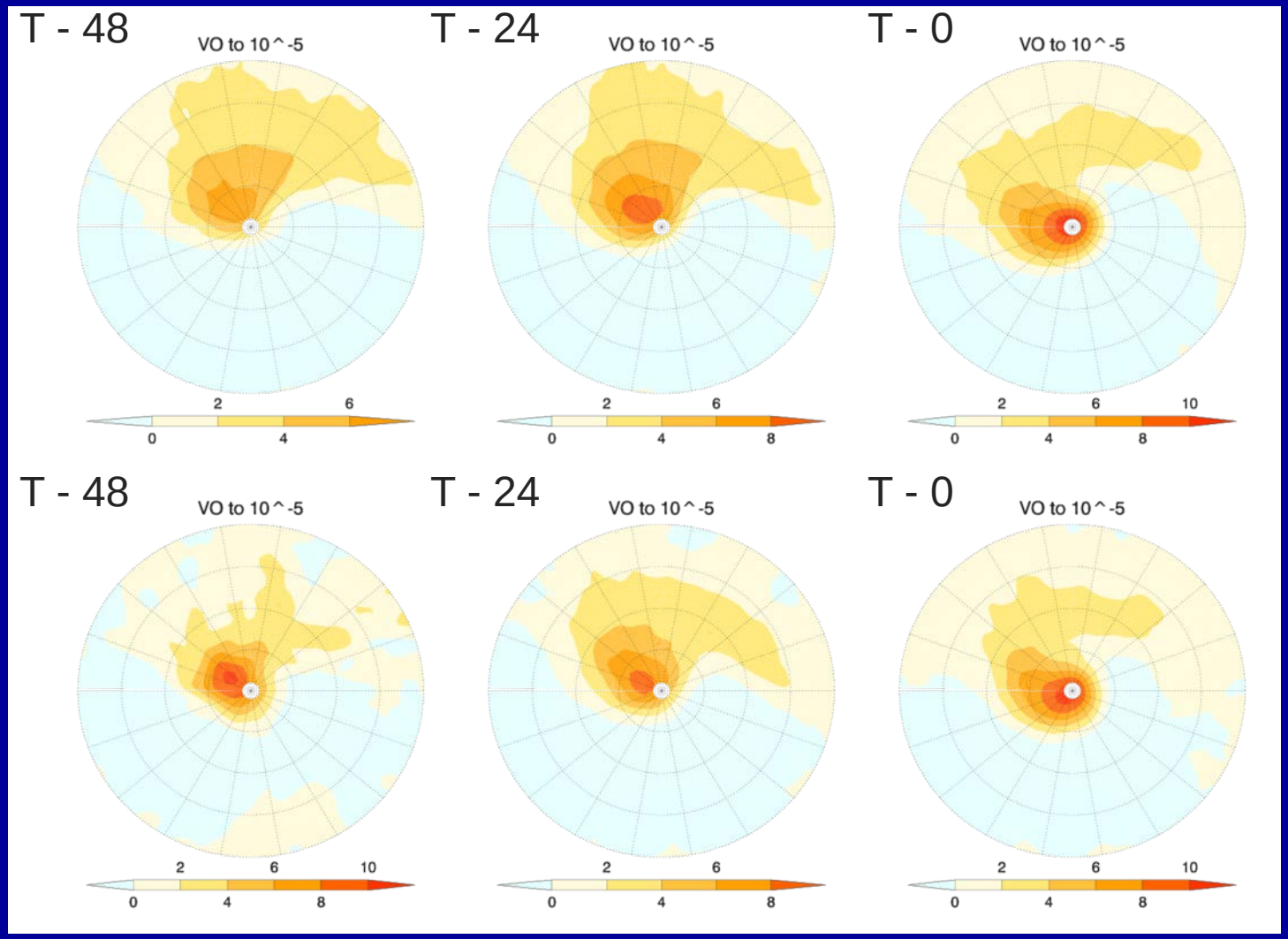


West Atl. Cyclones
Relative Vorticity at 850hPa

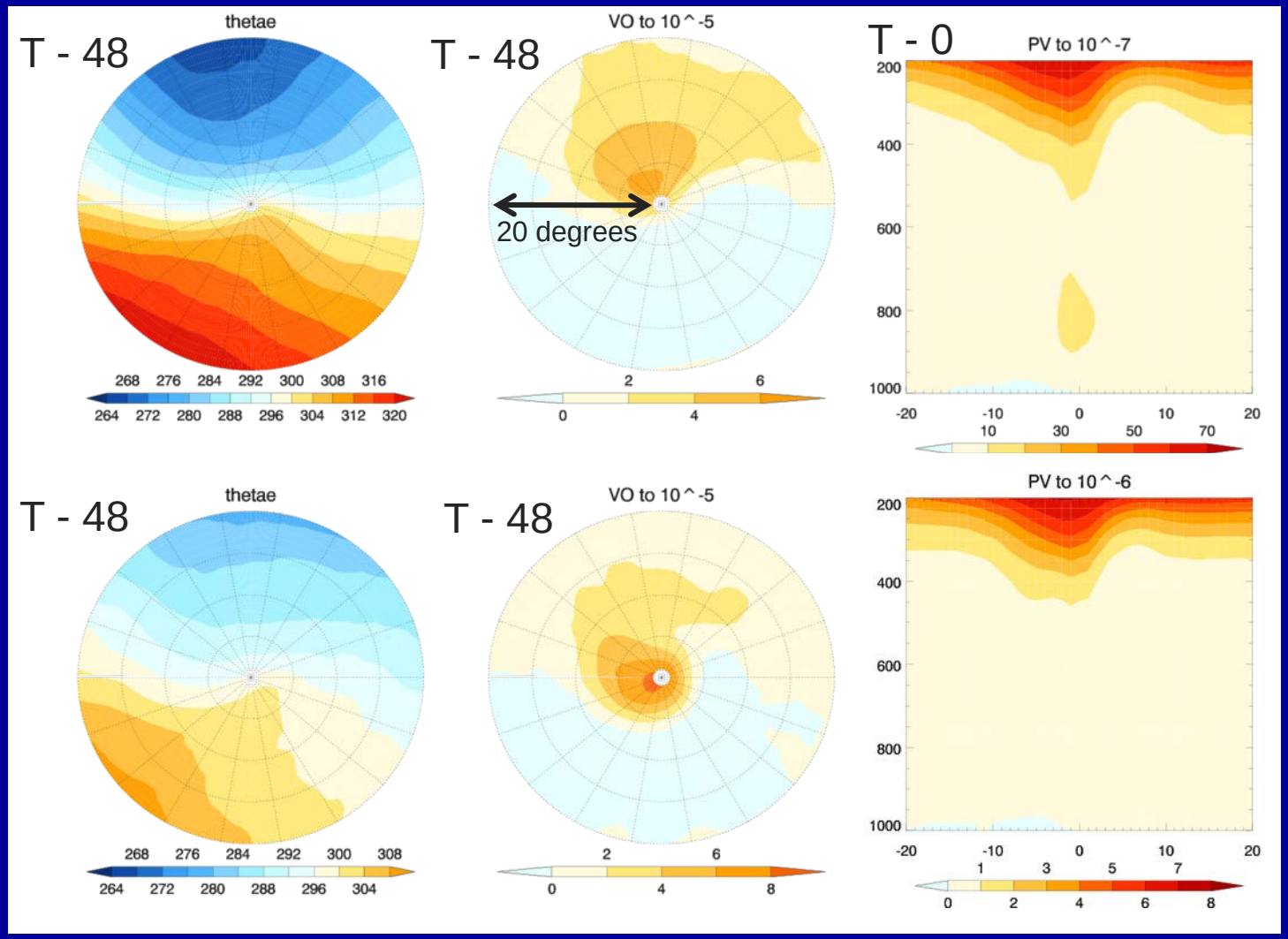




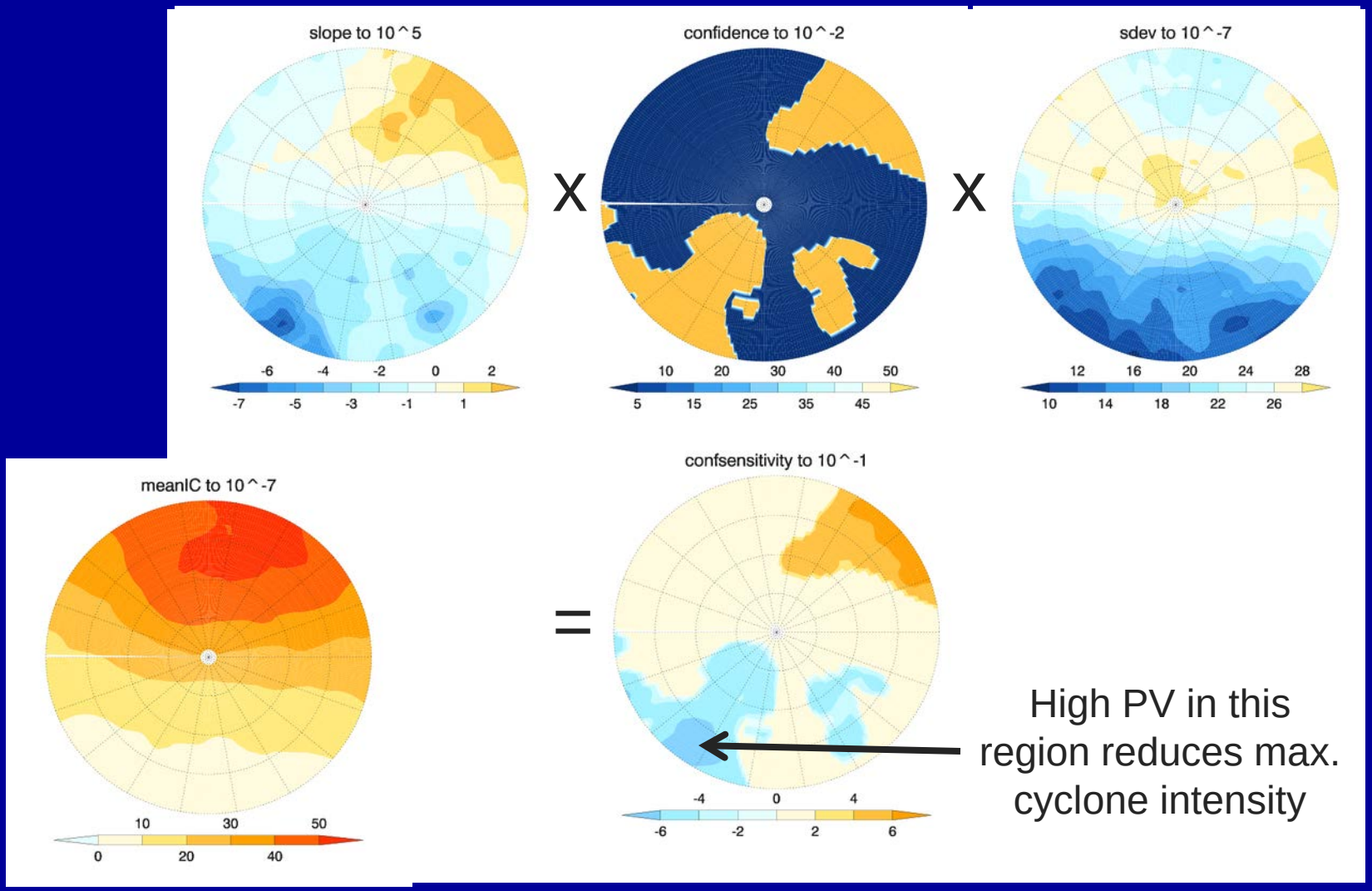
West (top) and East (bottom) Atl. Cyclones Vorticity at 300hPa (DJF 1989-2008)



West (top) and East (bottom) Atl. Cyclones θ_e at 950hPa, ξ_r at 250 hPa, PV at 250 hPa

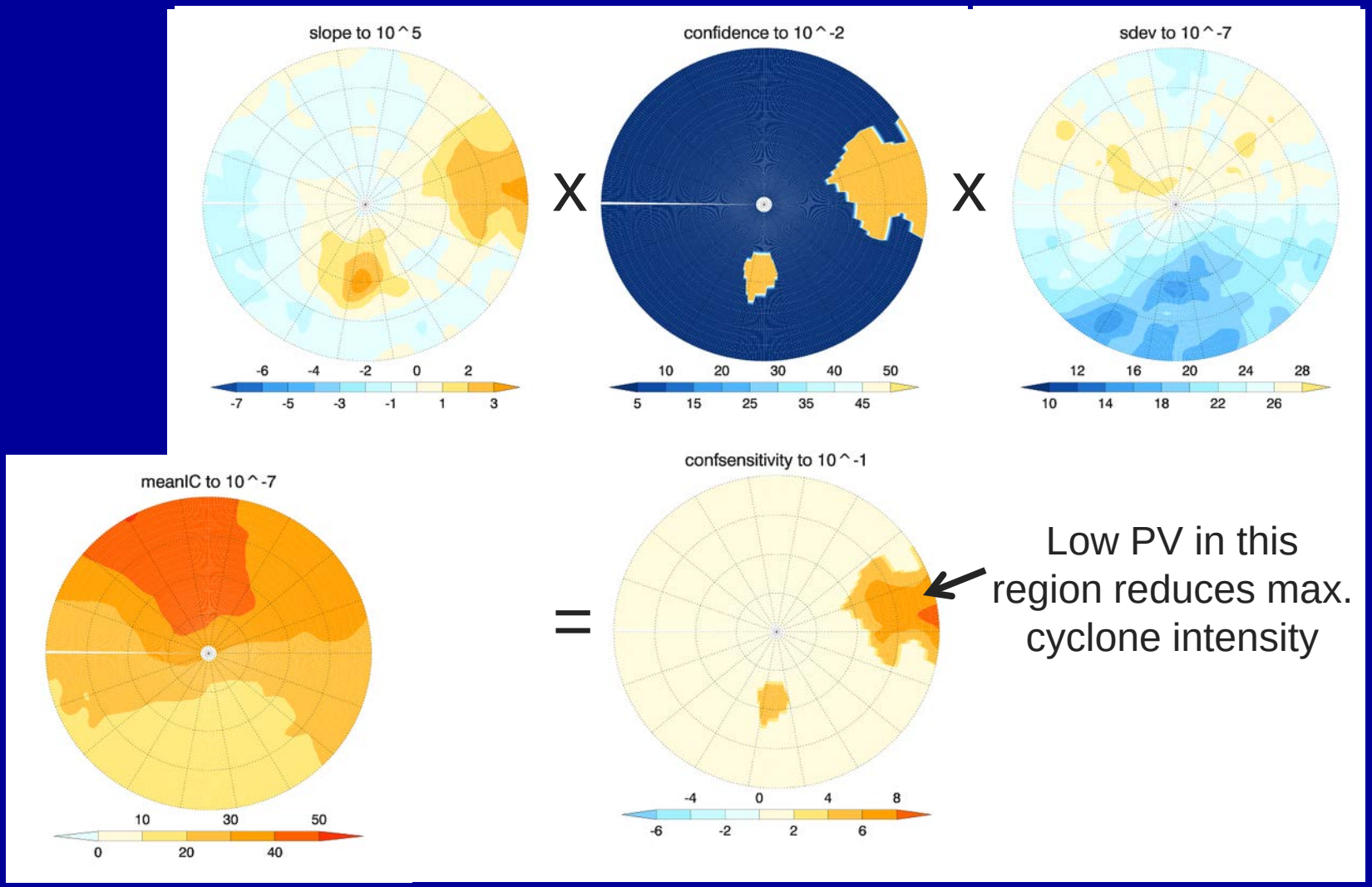


Sensitivity (west Atl. 1989-2008)



High PV in this region reduces max. cyclone intensity

Sensitivity (east Atl. 1989-2008)



Low PV in this region reduces max. cyclone intensity