

# THE SURFACE IMPACTS OF EEP AS SIMULATED IN WACCM

Ethan D. Peck

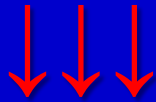
Lorenzo Polvani

# OUTLINE

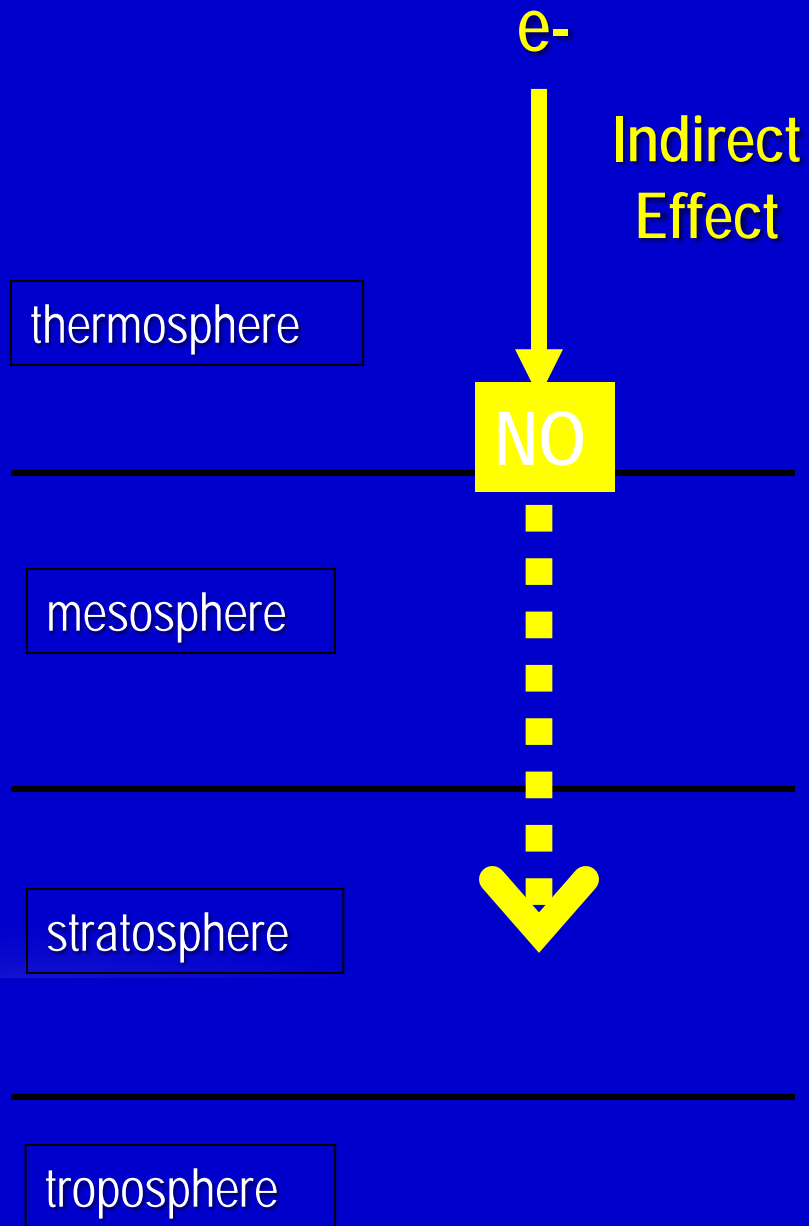
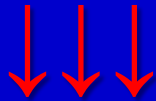
- Energetic Electron Precipitation (EEP)
- Question & Motivation
- Whole Atmosphere Community Climate Model (WACCM)
- Results
- Conclusions

# EEP Impacts on Atmosphere

Energetic  
Electron Precipitation  
(EEP)



Ionization &  
Dissociation

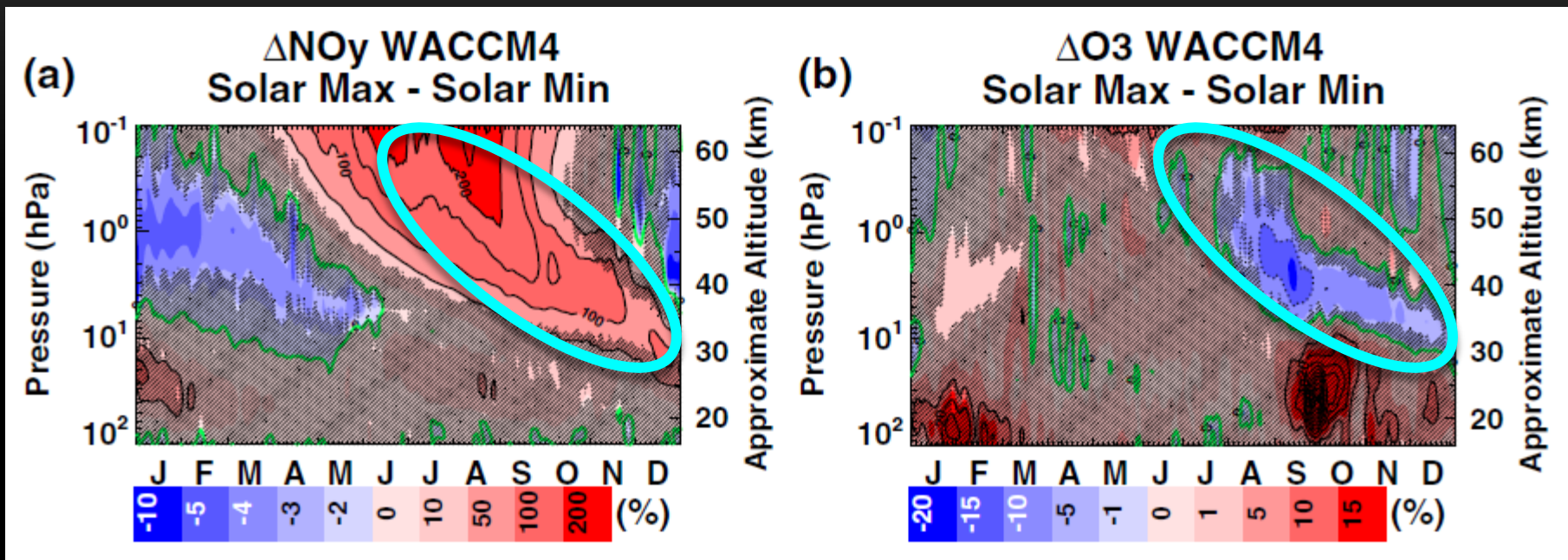


Slide courtesy of Cora E. Randall

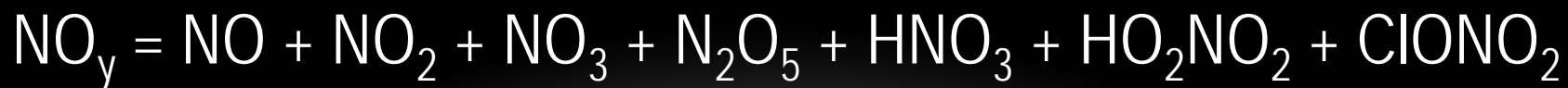
WAWG 2/9/16

# What are the surface impacts of auroral EEP?

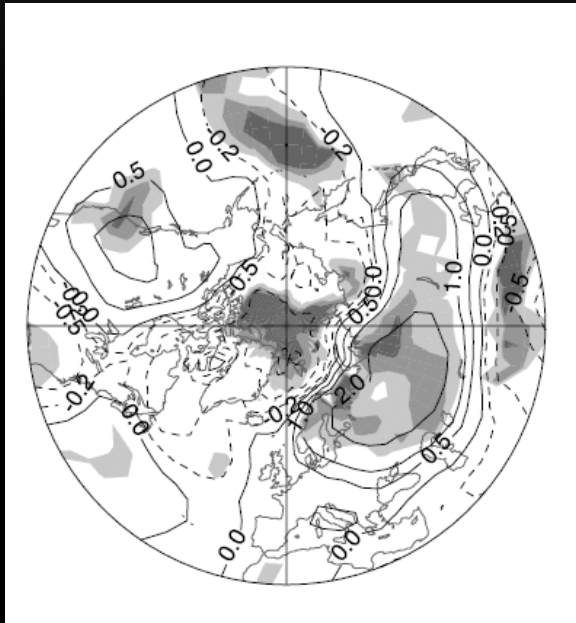
# KNOWN EEP IMPACTS IN WACCM4 (CESM 1.0.4)



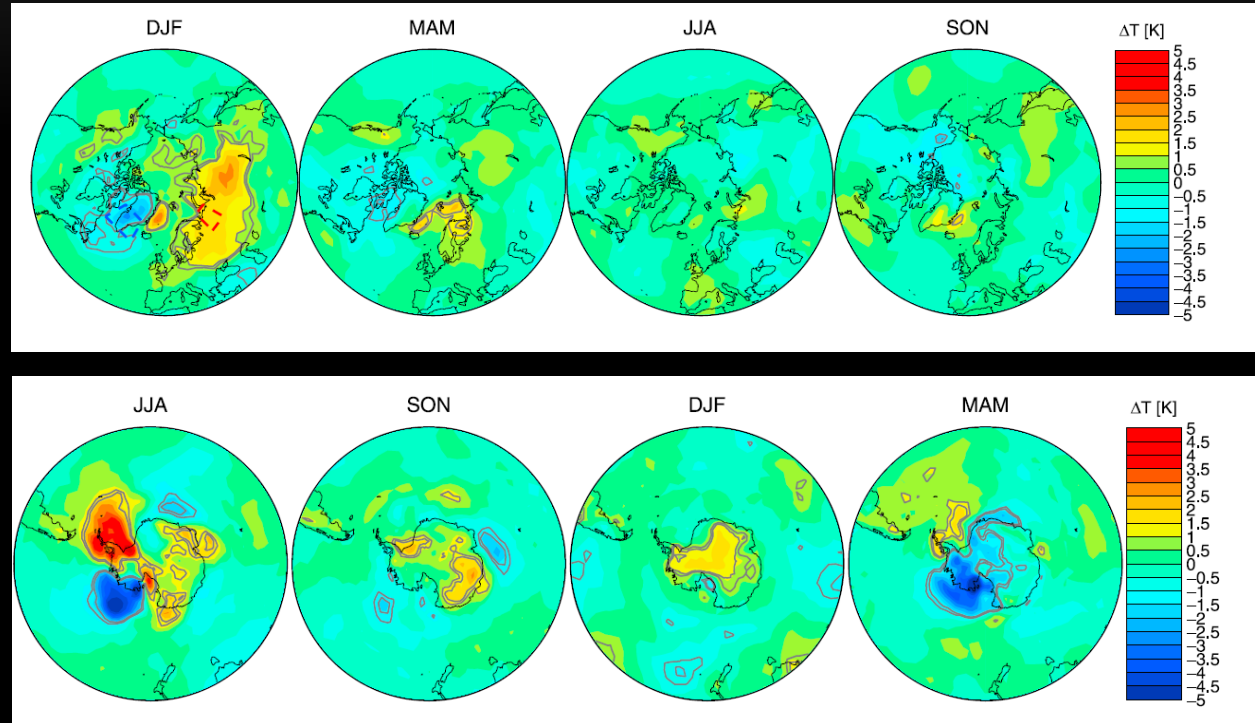
Change with and without auroral EEP in WACCM (*Peck et al. 2015*).



# STUDIES OF EPP AT THE SURFACE



Surface temperature change using a model with versus without auroral EEP.  
(*Rozanov et al. 2005*)



Surface Temperature changes in ERA-40 from High Ap – Low Ap years. (*Seppälä et al. 2009*)

# THIS IS WHAT WE DO DIFFERENT

- 1) Isolate EEP from solar spectral irradiance changes.
- 2) Use coupled ocean model, allowing us to study the troposphere and surface.
- 3) Kill noise with a long (300 years) integration.

# SIMULATION SPECIFICATIONS

- CESM 1.2.2
- BWCN Compset
- 1.9° x 2.5° Horizontal Grid

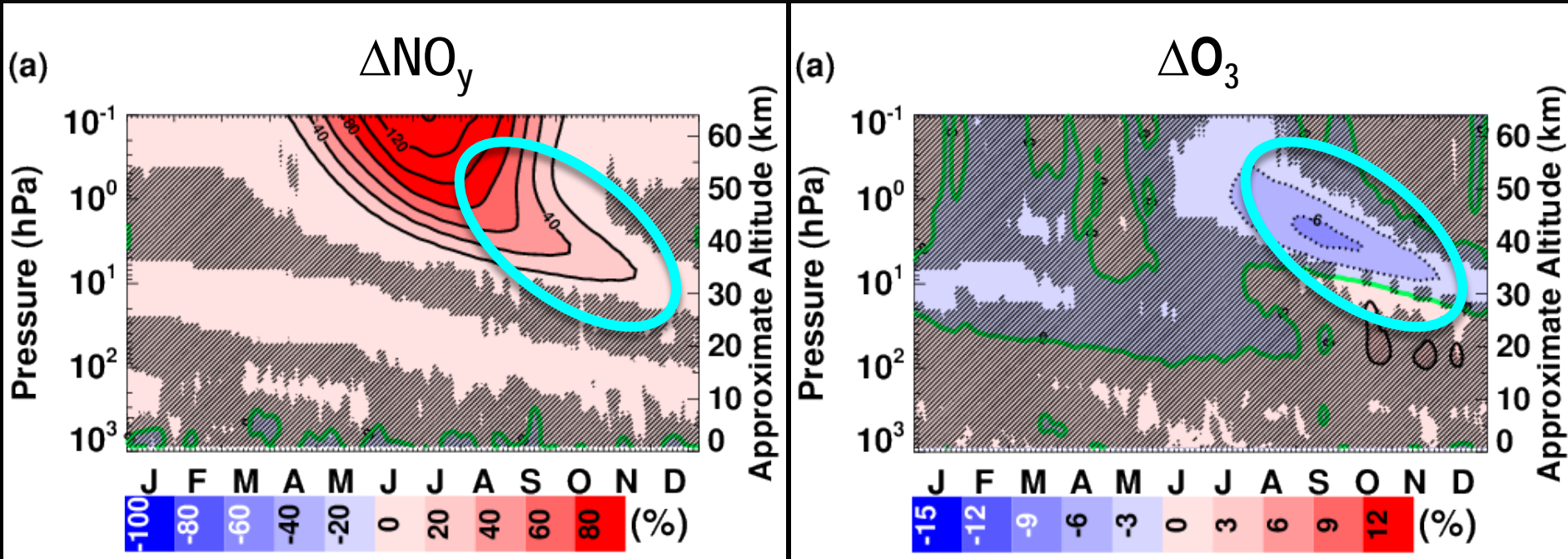
Name	Run Length (spinup)	Solar Flux (f10.7)	Ap Index
Low EEP	300 years (10 years)	128	3
High EEP	300 years (10 years)	128	27



# RESULTS

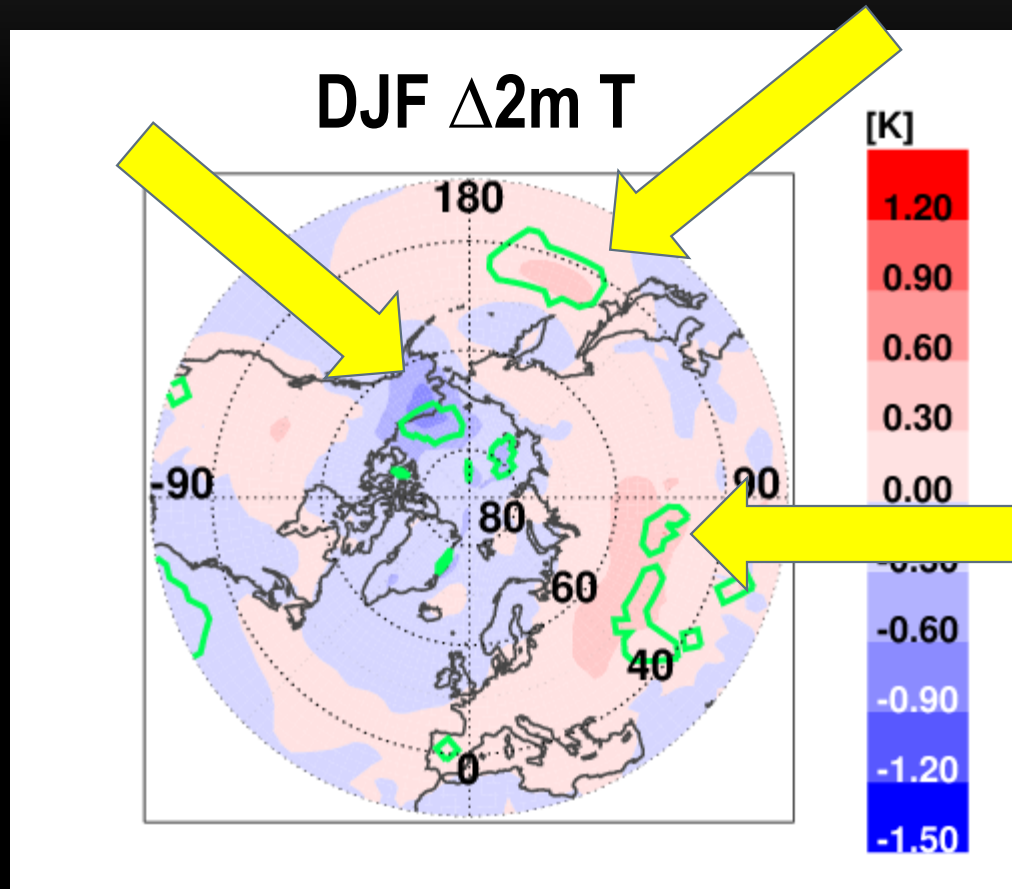
- All plots are differences between the two simulations (High – Low).
- Statistical significance at 95% using the Student's T-test.

# STRATOSPHERIC CHEMICAL SPECIES IN AGREEMENT WITH OTHER STUDIES



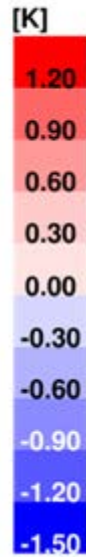
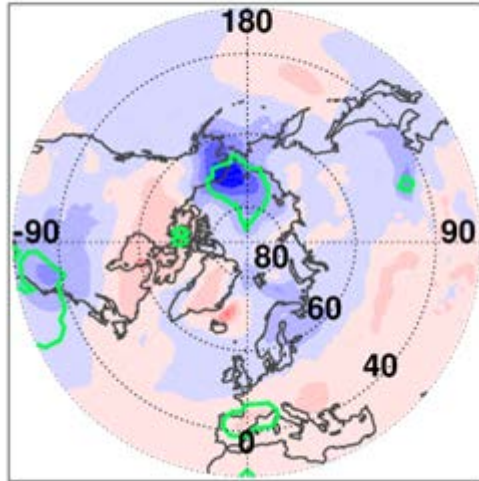
Plots are polar cap averages from geographic  $60^\circ$  to  $90^\circ\text{S}$ .

# THERE ARE SOME SURFACE IMPACTS

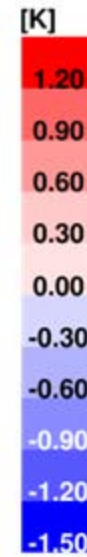
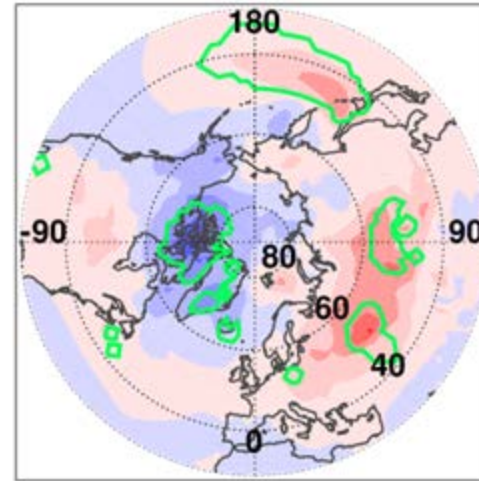


...OR ARE THERE?

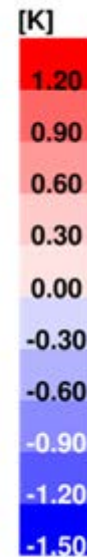
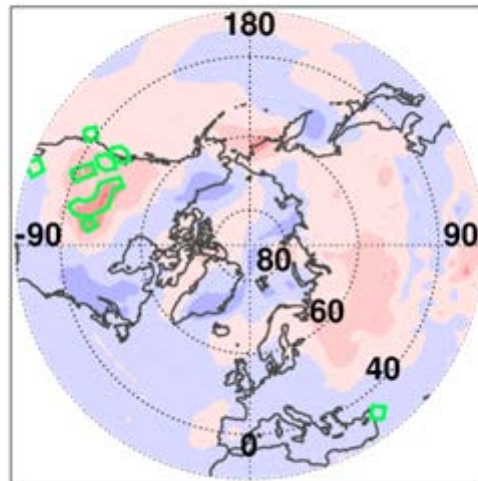
First Century



Second Century

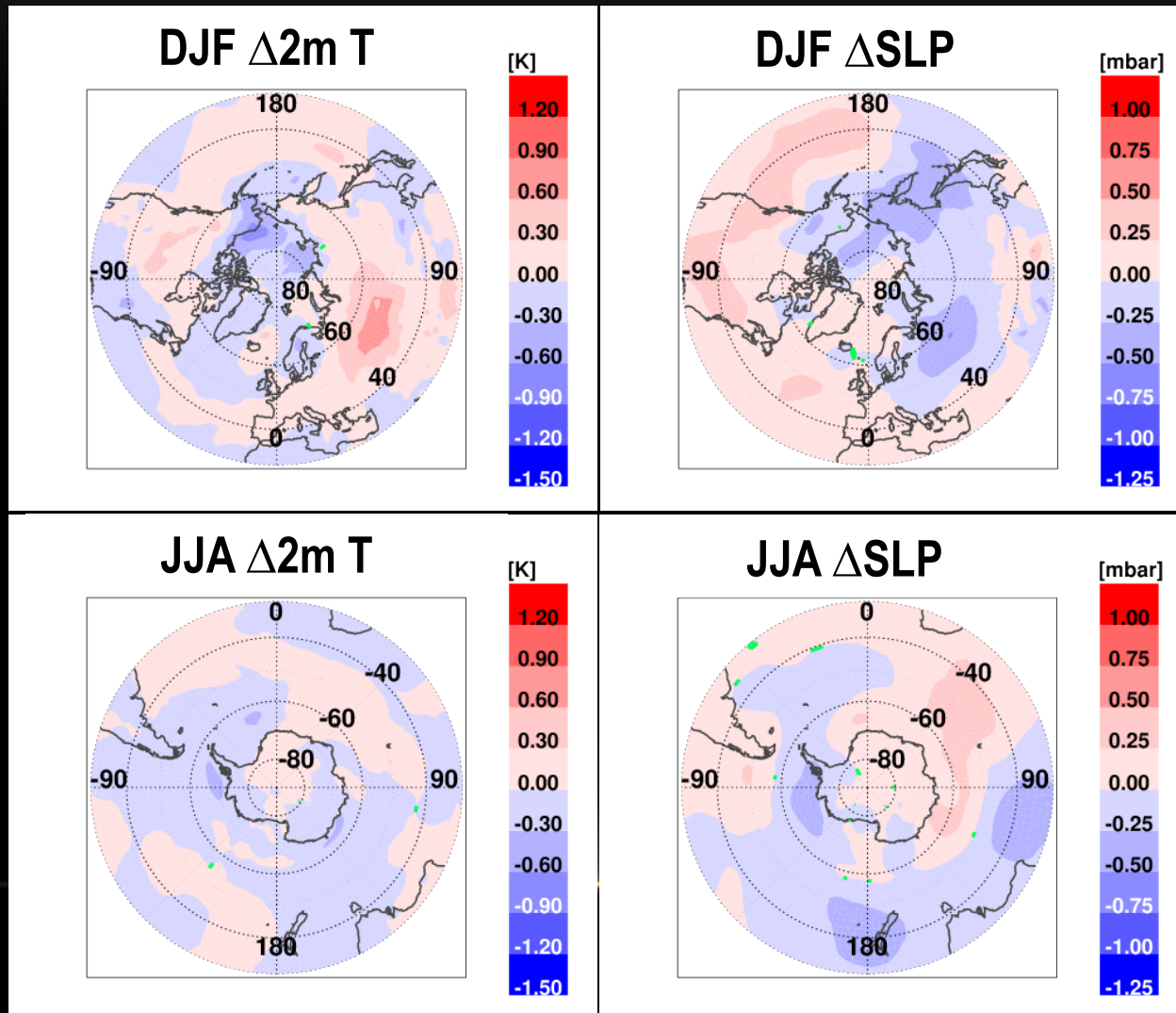


Third Century

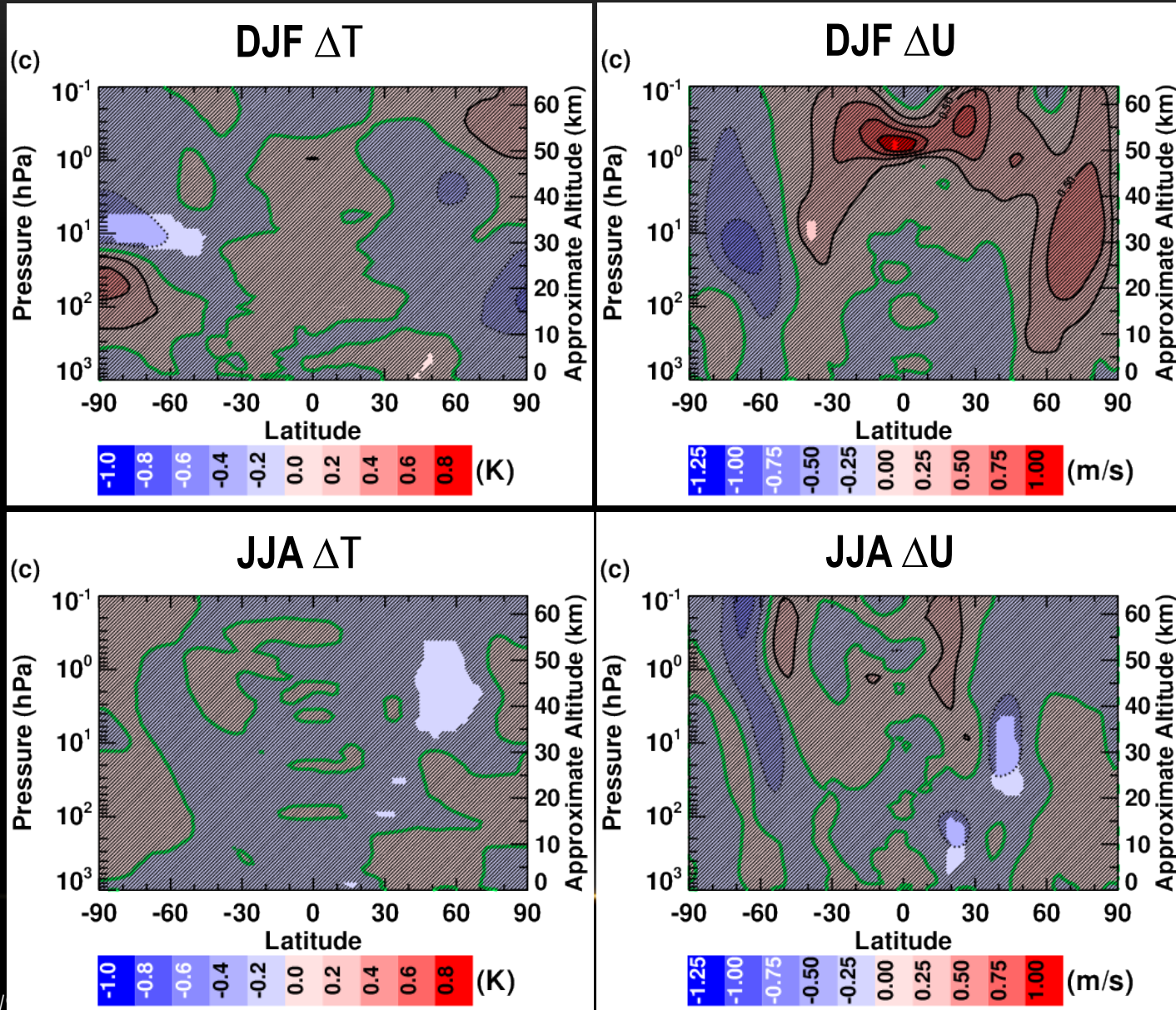


All three plots  
are DJF  $\Delta 2m T$ .

# MONTE CARLO SIMULATION RESULTS



# NO OBVIOUS SIGNAL TO THE SURFACE



# CONCLUSIONS

- Stratospheric signal in  $O_3$  and  $NO_y$  are large, robust, and confirm previous findings.
- Surface signal is not robust.
  - Signal is miniscule, even with long simulations.
  - Auroral EEP surface signal may be heavily confounded by internal variability.
- Stratospheric signal does not obviously go to the surface at the poles (or any other latitude).

# FUTURE WORK

- Continue investigations into “interesting” EEP impacts.
  - Middle and upper atmosphere changes
- Examine possible mechanisms that could tie the stratosphere to the troposphere (e.g., events).
- Examine surface response in long simulations using varying solar conditions (i.e., not just EEP).



THANK YOU!