WACCM Studies at CU/LASP

Jeff France, Josh Pettit, Cora Randall, V. Lynn Harvey, Ethan Peck, Doug Kinnison, and Dan Marsh

Outline

Ongoing EPP work using 300 years of FR-WACCM
- Randall, Peck, France

The mesospheric polar vortices in FR-, SD-WACCM vs. Reanalyses
- Harvey

CU/LASP assisting with the “Sathist” capability
- Harvey, Pettit

RAISE - Response of the Atmosphere to Impulsive Solar Events

Simulation Specifications

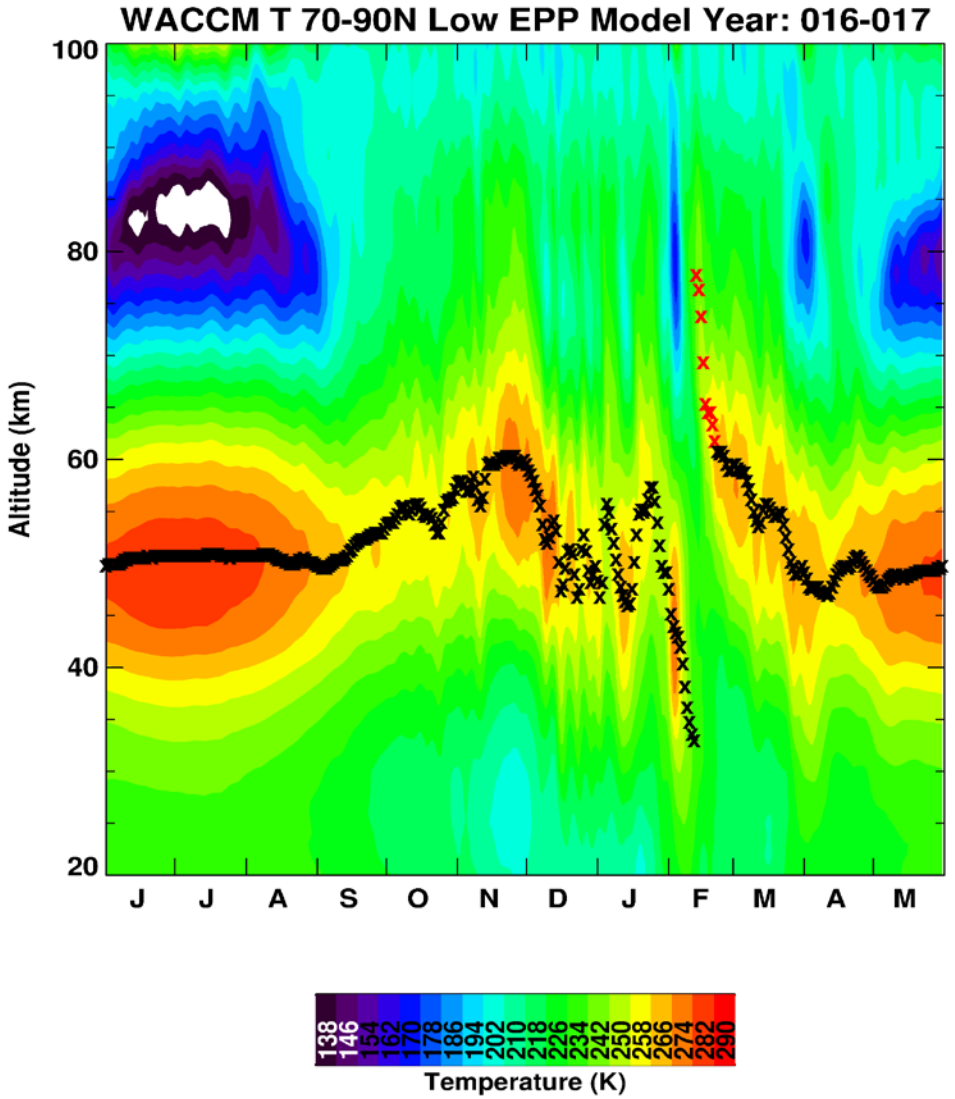
- CESM 1.2.2
- BWCN Compset
- 1.9° x 2.5° Horizontal Grid

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

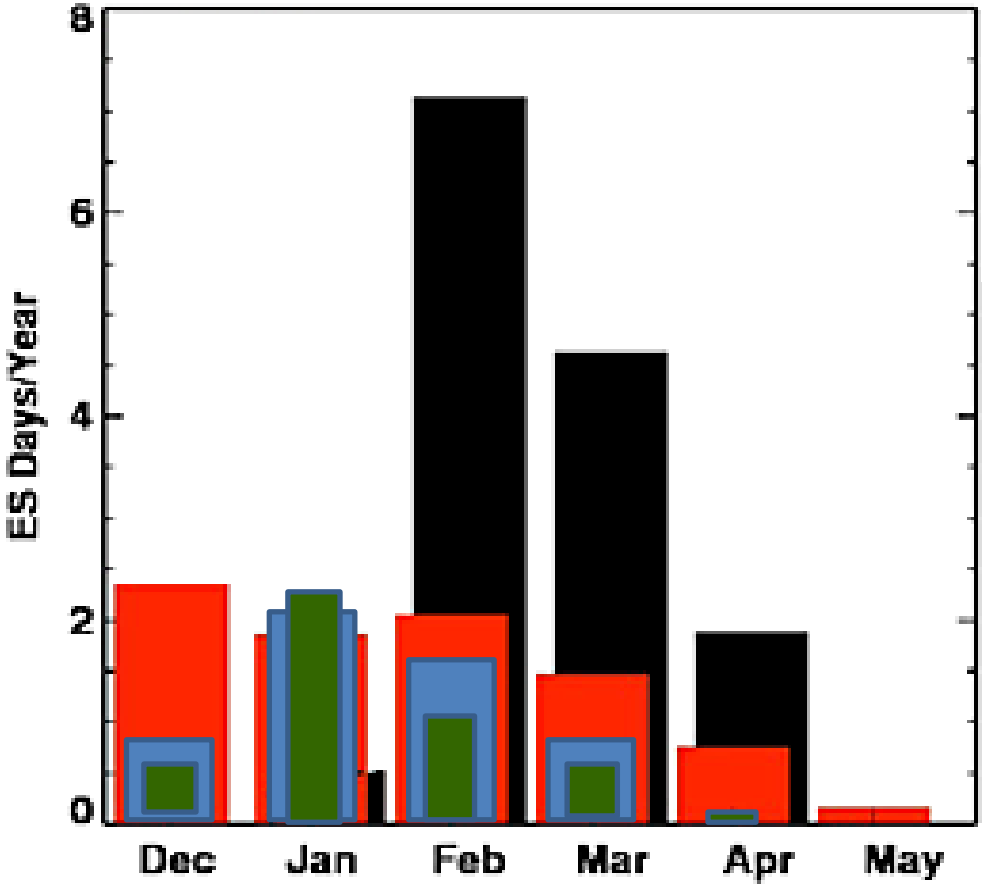
Elevated Stratopause Events in WACCM

Method for identifying ES events based on *France and Harvey* [2013].

1. Stratopause height at onset date must be at least 1 standard deviation above the climatological daily mean.
2. Must have "jump" of 25 km to onset height.



WACCM ES frequency



MLS
WACCM4 CESM 1.0.3
WACCM4 CESM 1.2.2 Low EEP
WACCM4 CESM 1.2.2 High EEP

ES/year:

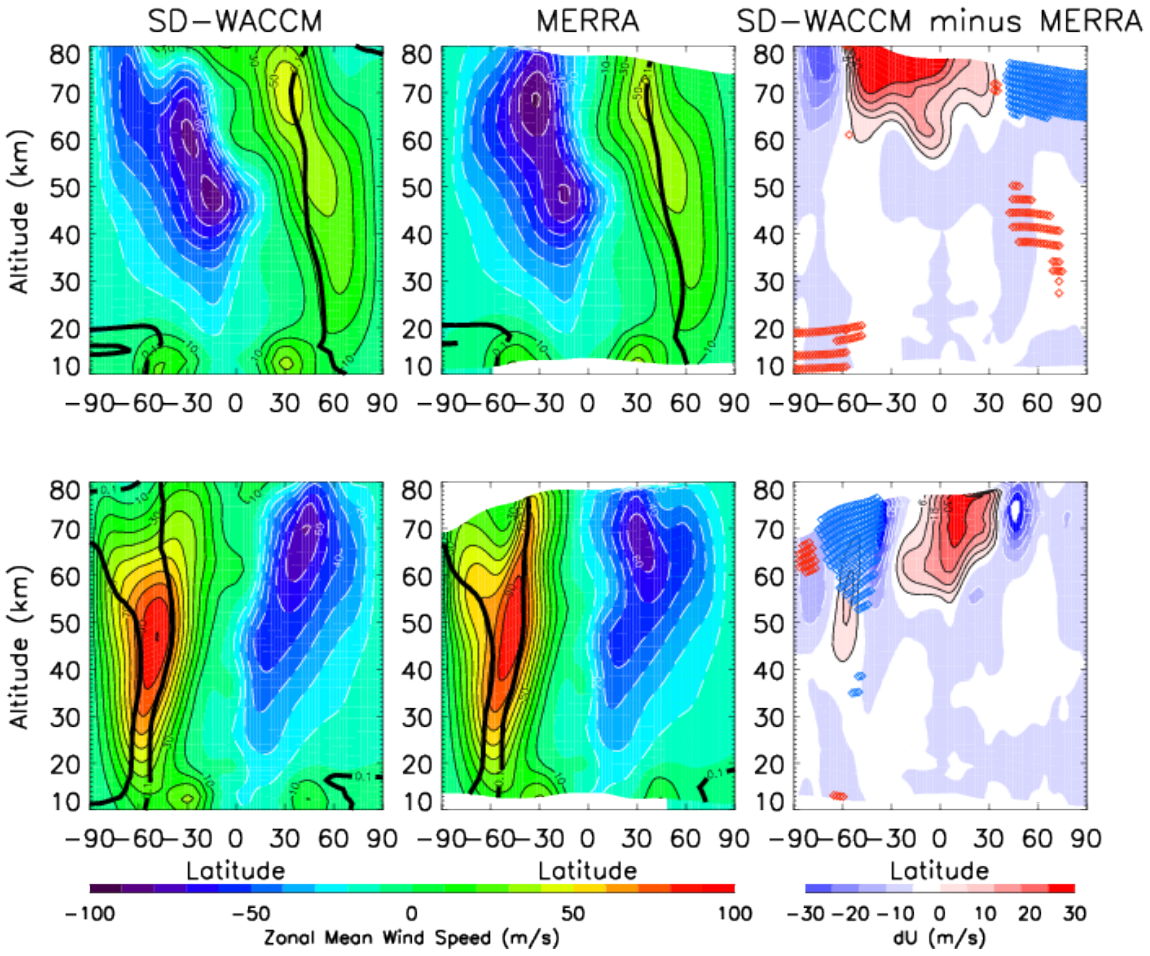
MLS	0.375
WACCM4	0.375
Low EEP	0.30
High EEP	0.25

France and Harvey [2013]

Largest Differences in $\bar{U}$ are in the Summer Mesosphere

JAN

JUL



SD-WACCM (REFC1SD) midwinter vortex occurs less frequently in the mesosphere compared to MERRA

Updated Instruments for "Sathist" Output Option

- WACCM is output at observation locations and times.
- Original functionality created by Matthias Brakebusch. Current archives and scripts maintained by Chuck Bardeen and CU/LASP.
- >38 observation sources from 1978-Present
- Create files containing geo-location and profile information: DATE, TIME, LATITUDE, LONGITUDE, ORBIT_NUMBER, PROFILE_NUMBER
- Ongoing observations need updating: ACE, SOFIE, EOS-MLS, SABER, SBUV/2
- **Update with newest data versions: MLS v4**
- **Add additional observations: SNOE**

Response of the Atmosphere to Impulsive Solar Events (RAISE)

Four main science questions:

(1) How well do models simulate effects of recent ISEs?

(2) What factors control the atmospheric response to ISEs?

(3) What is the range and sensitivity of the atmospheric response?

(4) Are there long-term, cumulative effects of ISEs on the atmosphere and climate, and with what certainty can these effects be modeled?

We will use WACCM, SD-WACCM, and WACCM-X to simulate recent ISEs (CMEs, SPEs, flares) and quantify the atmospheric response.

Josh Pettit is the LASP point-of-contact for WACCM simulations in support of RAISE

He is using SD-WACCM to answer the following 3 questions:

1. **What is the medium/high energy electron influence on middle atmosphere chemistry?**

2. **Can WACCM's middle atmosphere chemistry be improved by implementing medium and high energy electrons?**

3. **What electron data set would be the best for the implementation into WACCM? (contamination issues, etc.)**

ISE Time Period	Reasons to Study
14-16 July 2000	3rd largest solar proton event (SPE) in past 50 years, X5 flare. Southern Hemisphere winter.
19 Oct to 5 Nov 2003	4th largest SPE in past 50 years. X17 flare plus overall high flare activity. Many atmos. obs. Early Northern Hemisphere (NH) winter.
15-17 Jan 2005	13th largest SPE in past 50 years and hard spectrum. X2 flare. Many atmospheric observations. NH winter.
7-11 Sep 2005	Moderate SPE. X17 flare. ISR electron density data. Many atmospheric observations.
15 Feb to 9 Mar 2011	X1,X2 and many M-class flares. Very small (50 pfu) SPE. SDO data.
4-9 Aug 2011	X6 flare. Very small (<100 pfu) SPEs. SDO data.
7-13 Mar 2012	10th largest SPE in past 50 years. X5 flare. SDO data.

PhD Dissertation

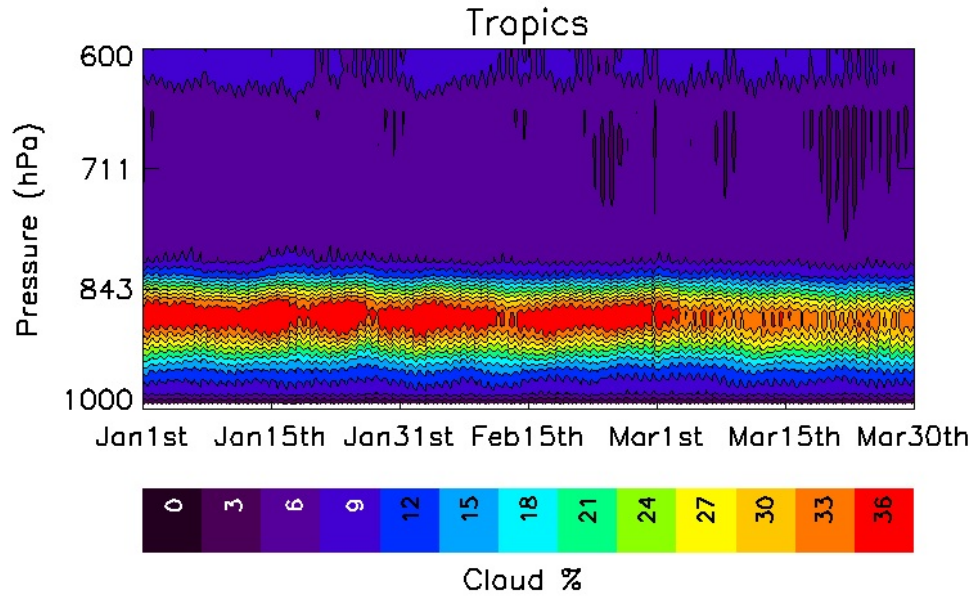
- Medium and higher energy electrons effects on the atmosphere in WACCM

Time-Step simulations for RAISE

Goal: Test the sensitivity of WACCM by decreasing the time-step

Purpose:

1) More accurately capture solar flare effects
2) Potential use in WACCM-X


Tropics
Pressure (hPa)
600
711
843
1000
Jan1st
Jan15th
Jan31st
Feb15th
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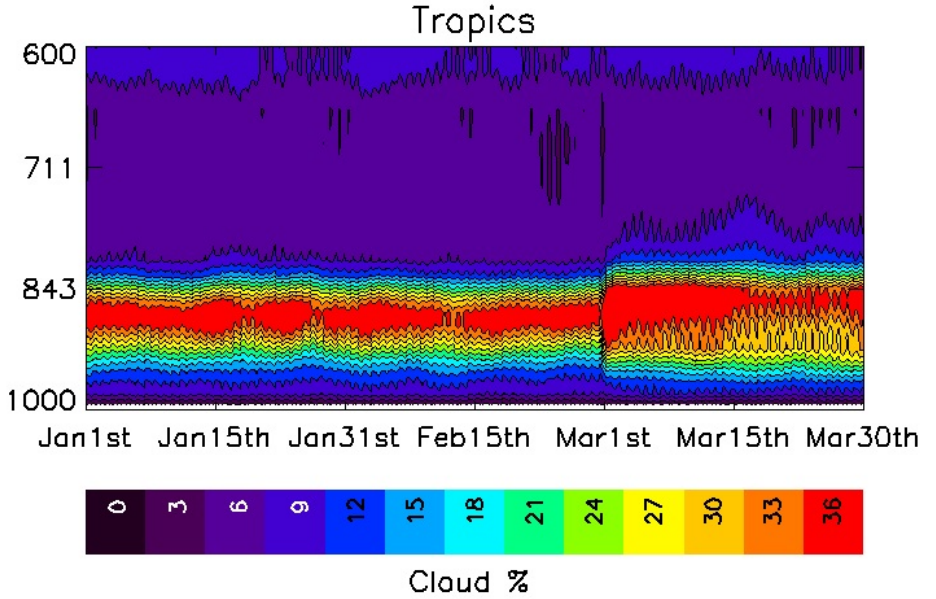
Cloud %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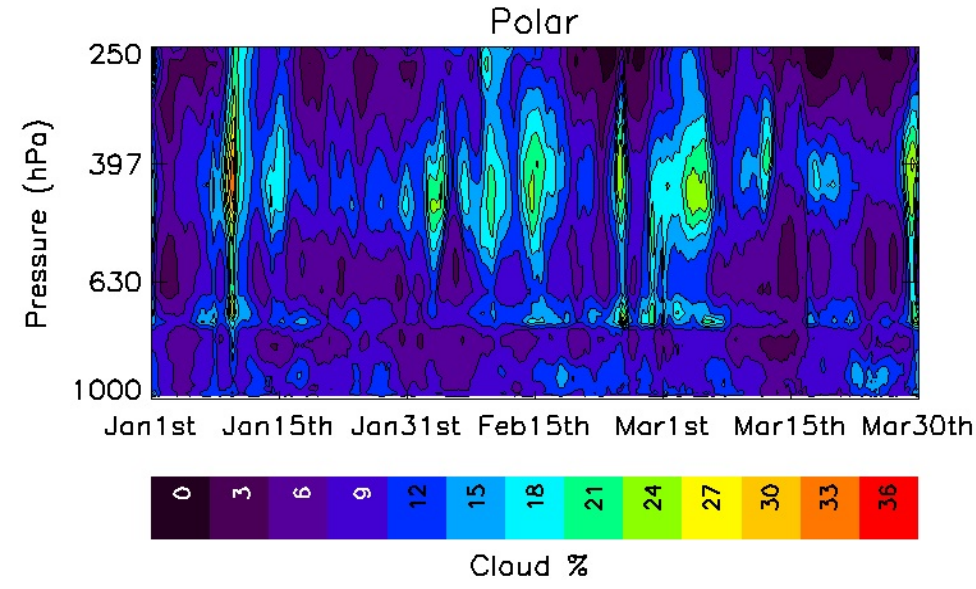
Polar
Pressure (hPa)
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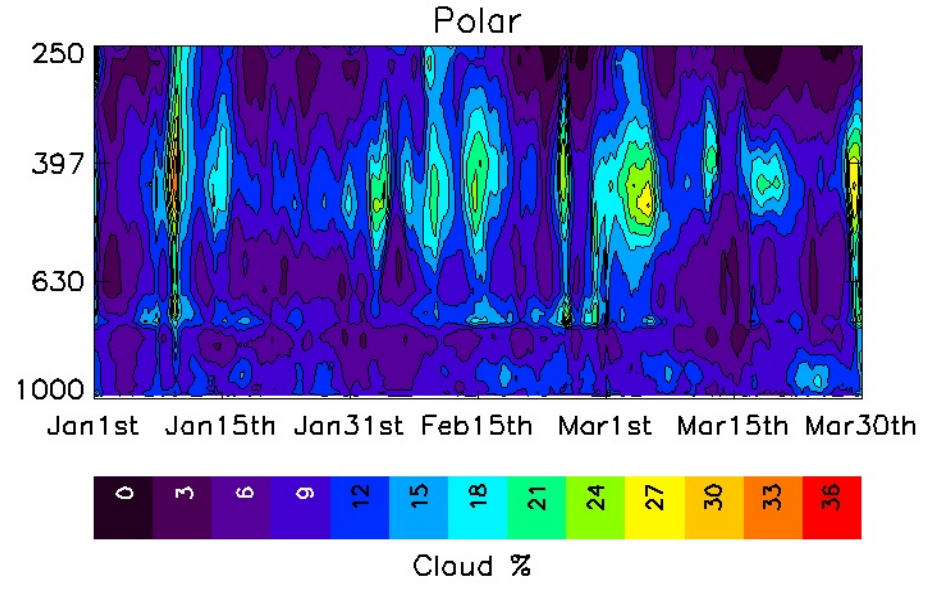
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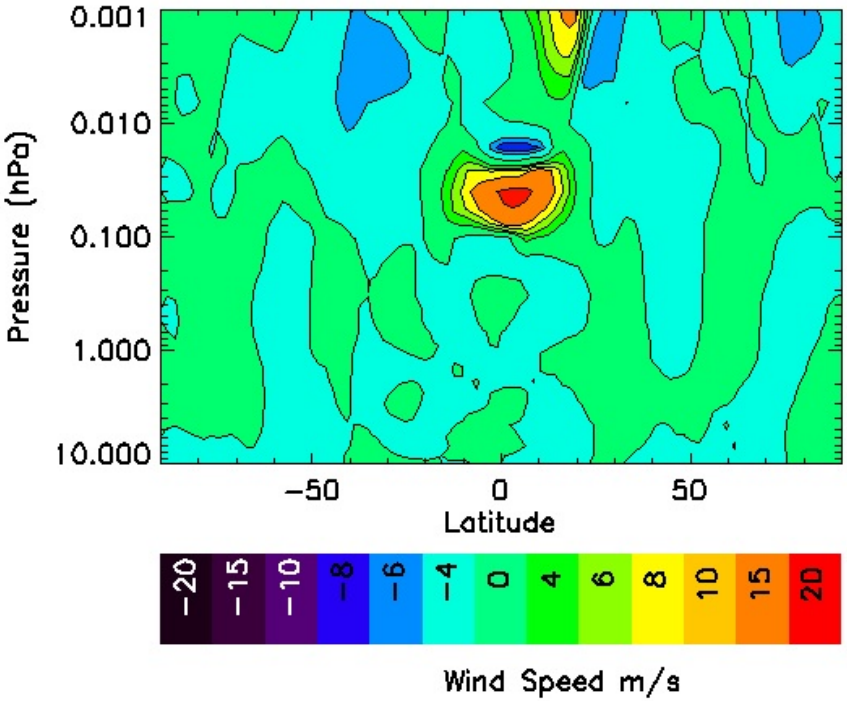

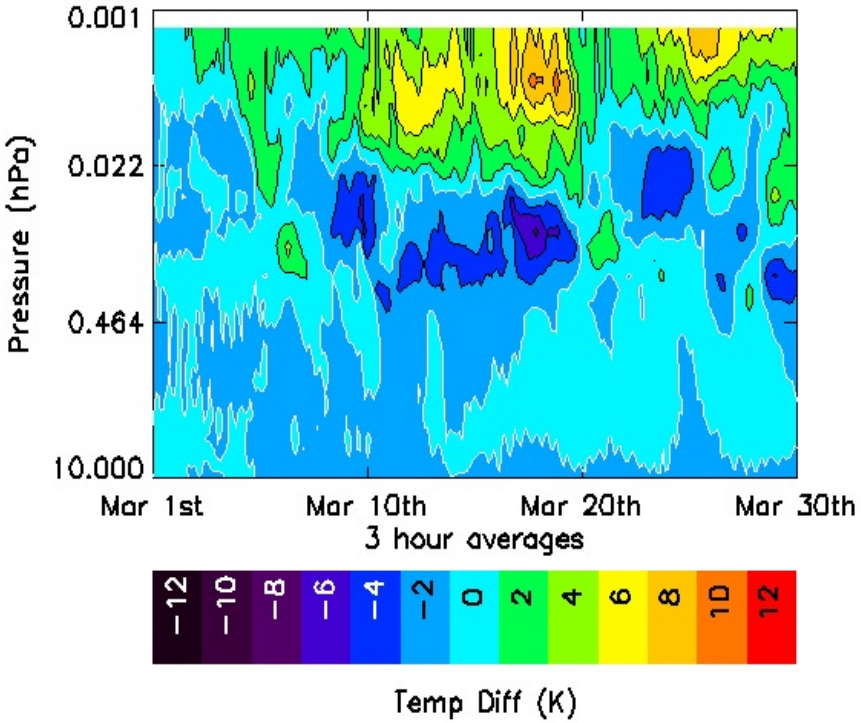

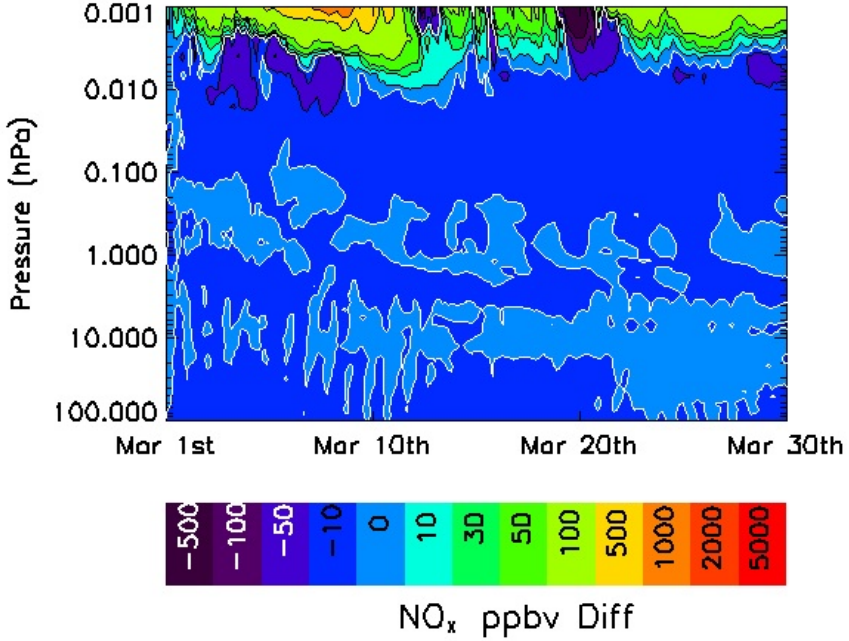

- Currently working on code modifications to ‘super-cycle’ the clouds at both 5 minute time-steps and 10 minute time-steps

Summary

Elevated Stratopause in 300 years of FR-WACCM
- Peck and France

Polar vortices in WACCM and Reanalyses
- Harvey

EPP – Randall

We will continue to keep the Sathist datasets and the SPE files up-to-date.

Stay tuned for more exciting results from Josh Pettit.

Thanks!

Energetic Particle Precipitation (EPP)

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Ionization & Dissociation

↓ ↓ ↓

NO_x and HO_x

NO_x and HO_x Destroy Ozone