

What controls stratospheric water vapor?

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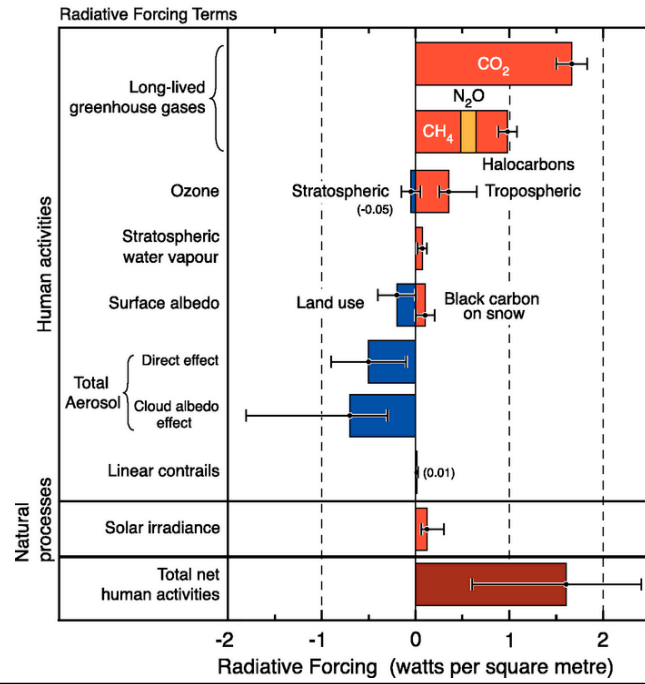


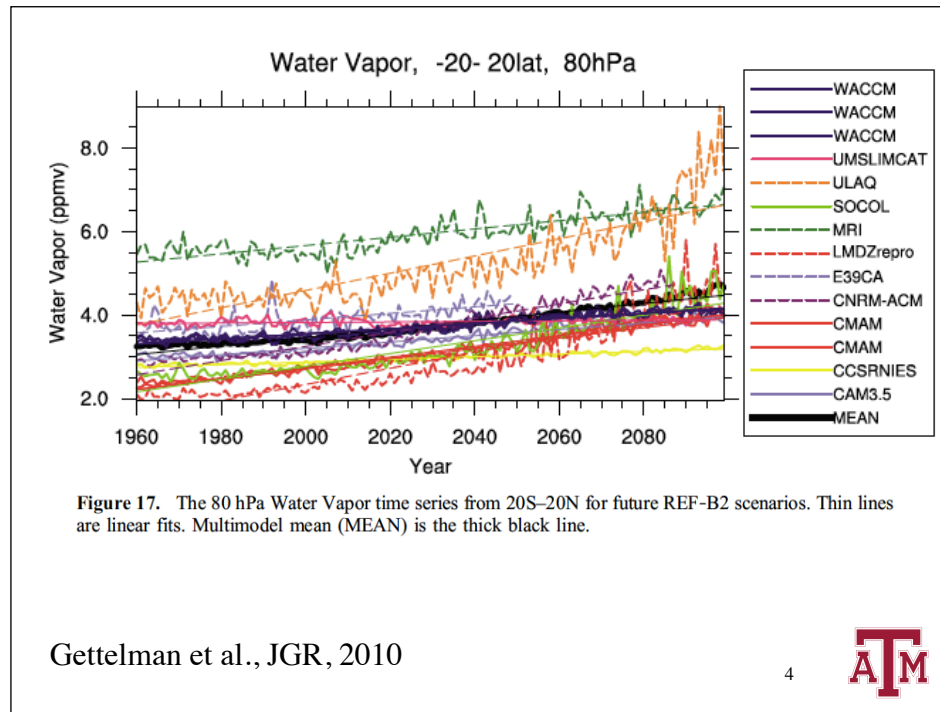
Maria asked me to talk about the use of science in the policy debate

Introduction

- SWV_e = water vapor entering the stratosphere
- Greenhouse gas, possibly important for interannual variations (e.g., Solomon et al. 2010)
- What drives interannual variations in SWV_e ?
- Is there a stratospheric water vapor feedback?

Radiative forcing of climate between 1750 and 2005

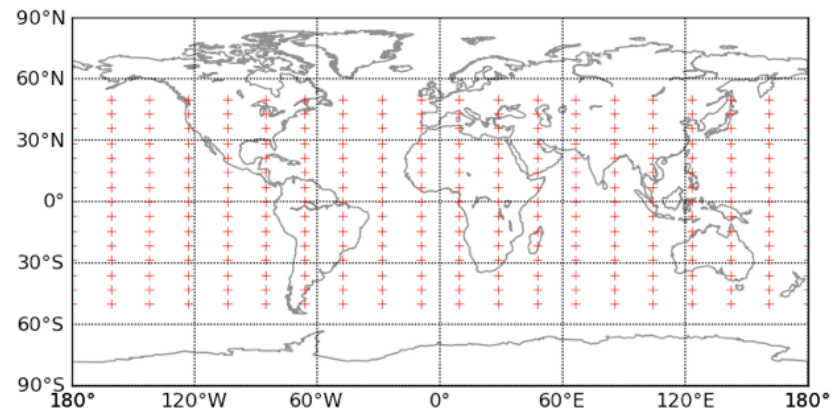




Models show increases in CPT, which leads to about 25% increases in WVe over the next century

The model

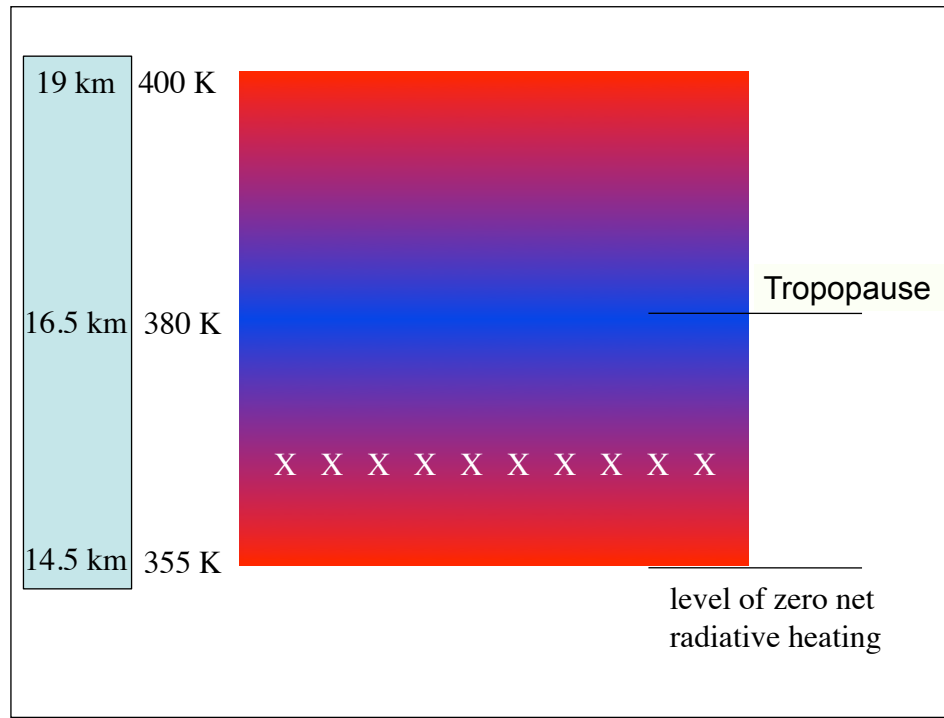
- Bowman trajectory model
- Uses horizontal winds and heating rates from MERRA and ERA-interim
- grid of parcels initialized every day



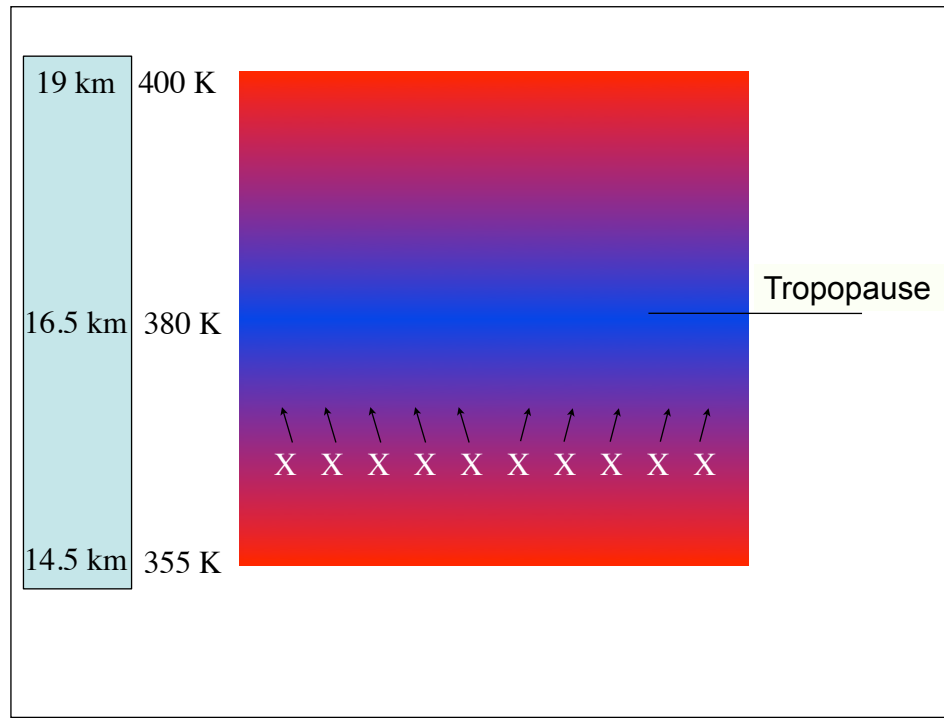
Parcels initialized at 370-K potential temperature

The model

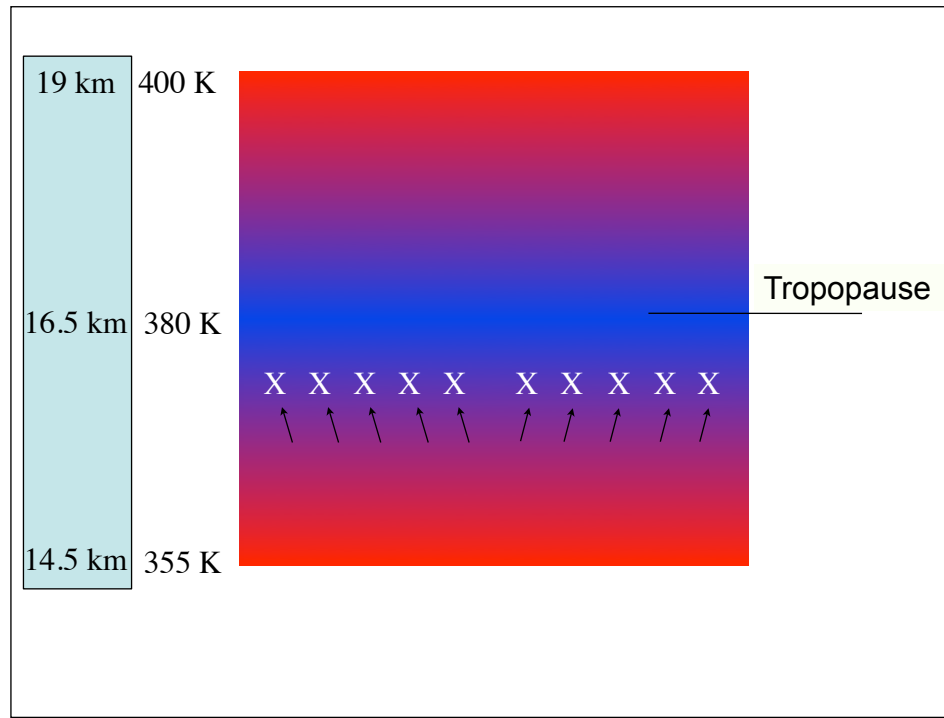
- Bowman trajectory model
- Uses horizontal winds and heating rates from MERRA and ERA-interim
- grid of parcels initialized every day
- parcels advected forward in time; most head into the stratosphere
- removed when they reenter the troposphere or age > 10 years



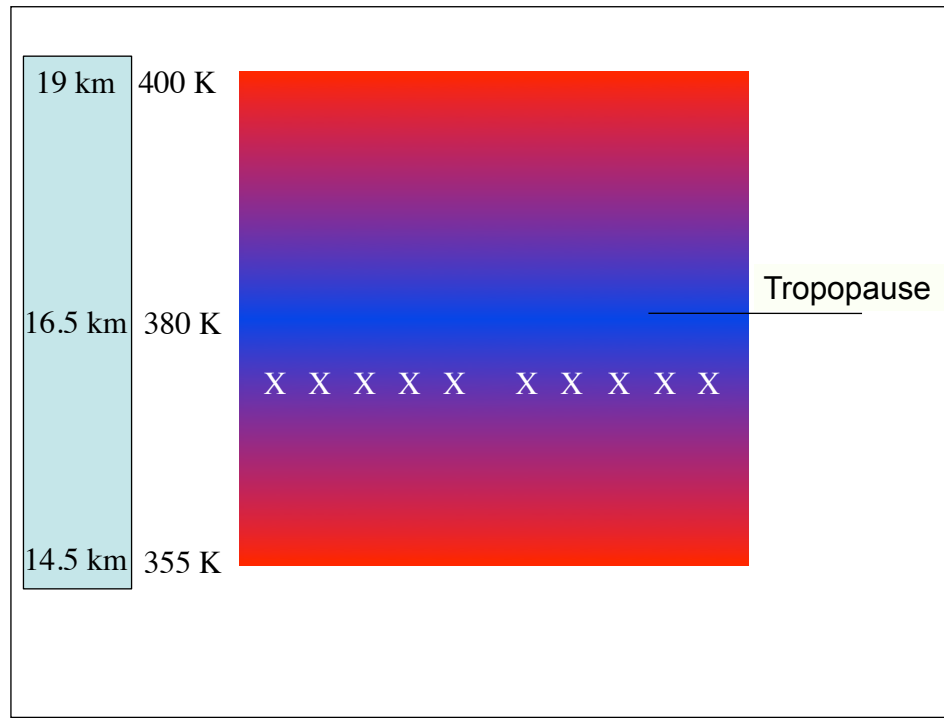
Let's consider the TTL. Note we'll be predominantly using potential temperature coordinates ... define theta ... 355 K is the bottom, tropopause is around 375 K, top is around 400 K.



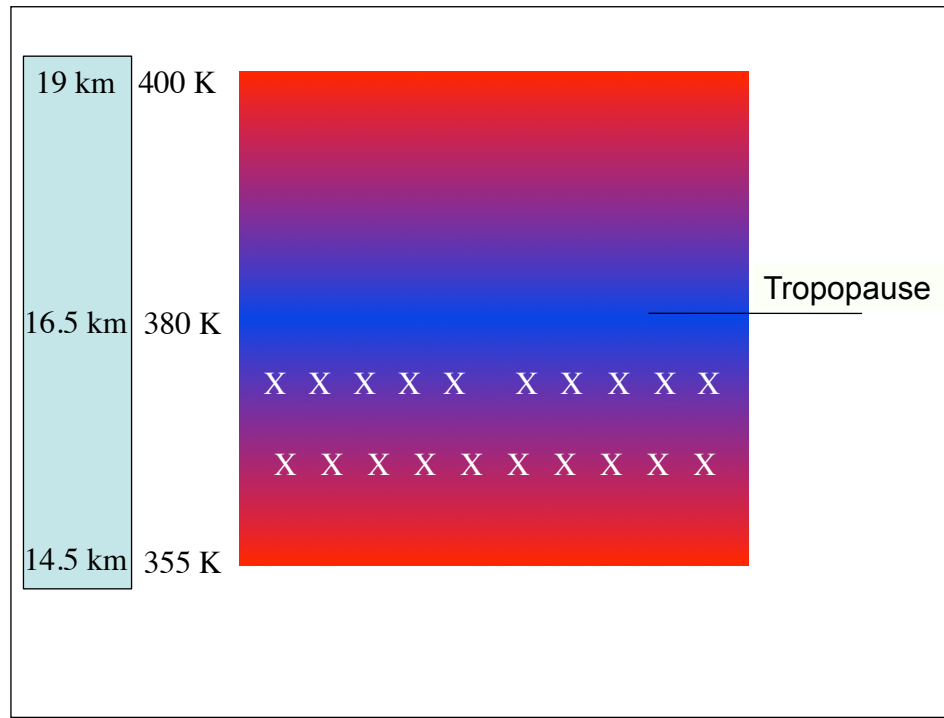
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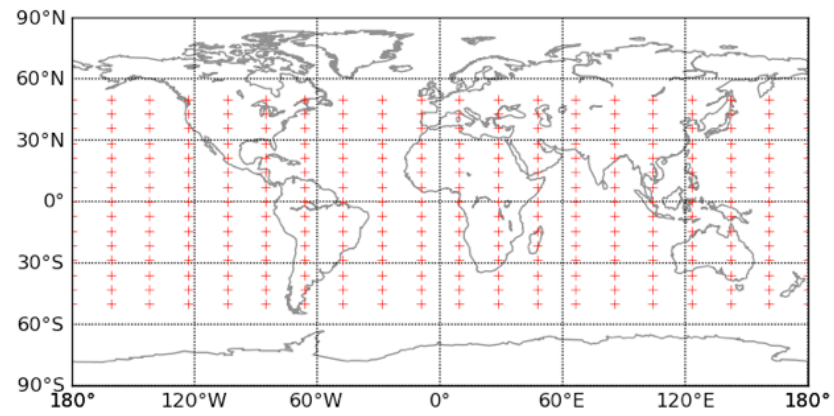
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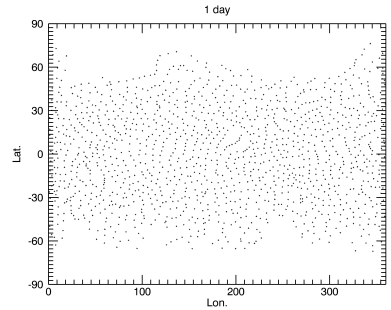


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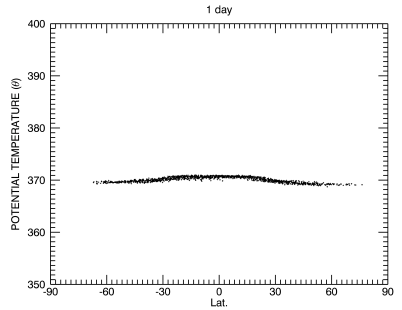


Parcels initialized at 370-K potential temperature

1 day

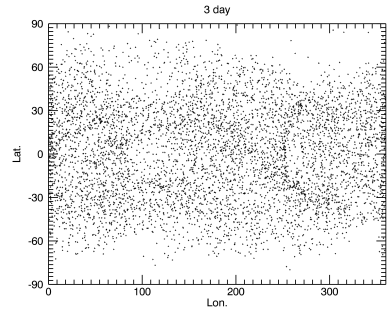


Horizontal view

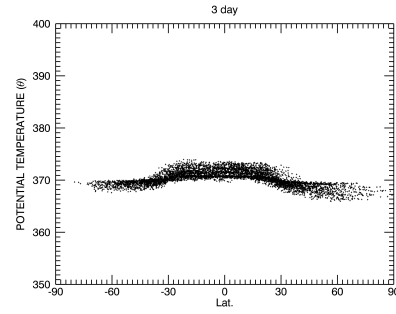


Vertical view

3 days

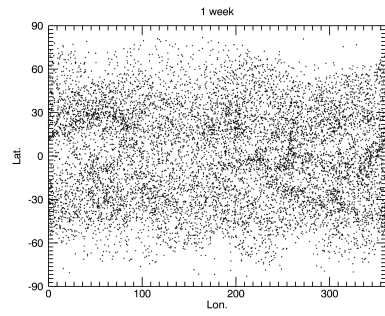


Horizontal view

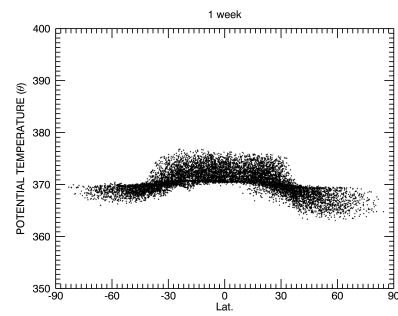


Vertical view

1 week

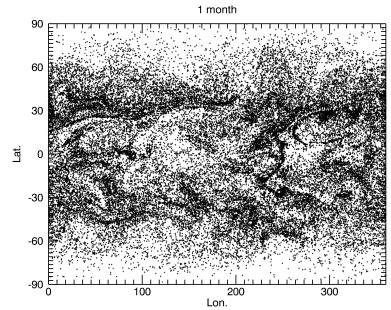


Horizontal view

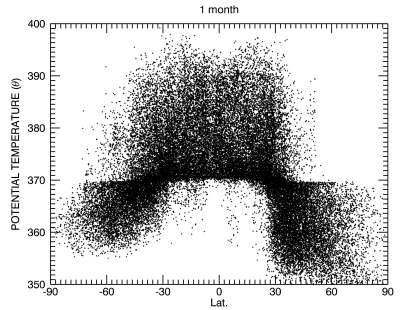


Vertical view

1 month

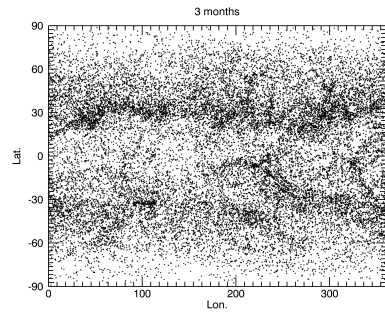


Horizontal view

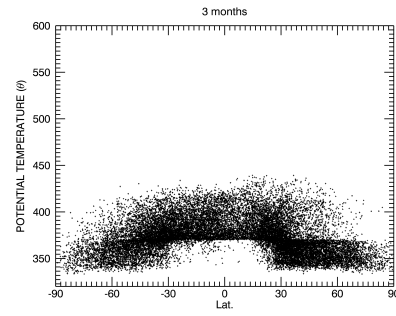


Vertical view

3 months



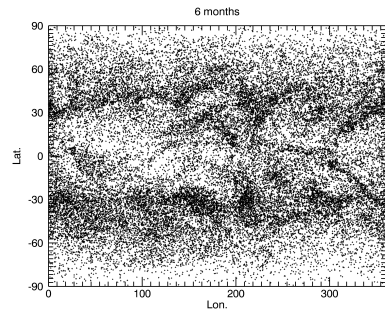
Horizontal view



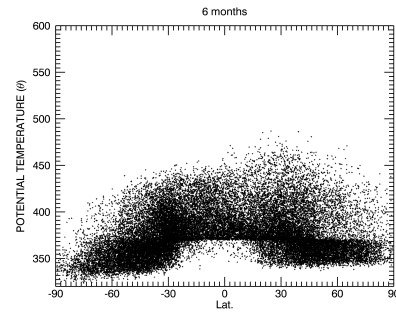
Vertical view

Parcels have been thinned out by a factor of 10

6 months



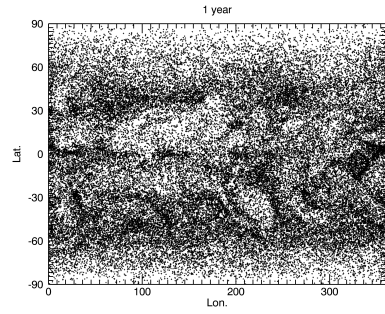
Horizontal view



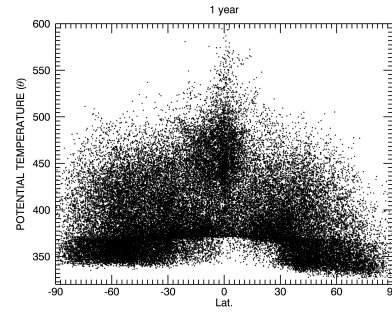
Vertical view

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1 year



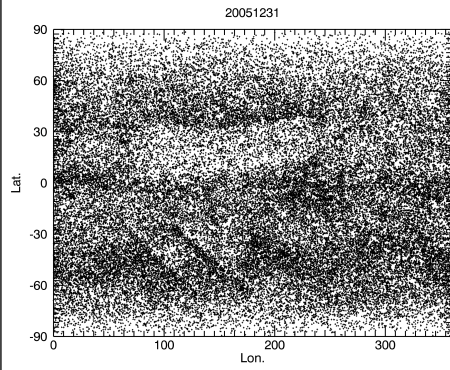
Horizontal view



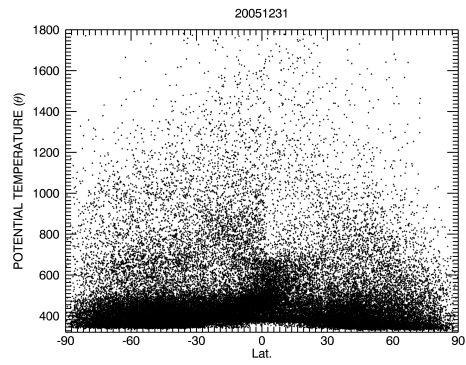
Vertical view

Parcels have been thinned out by a factor of 10

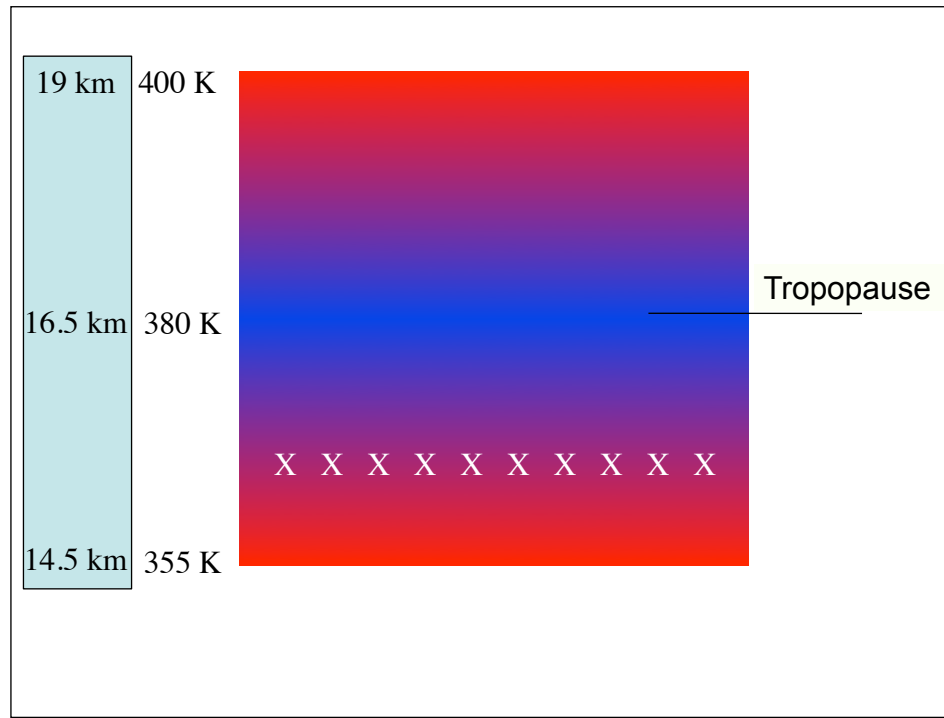
12/31/2005



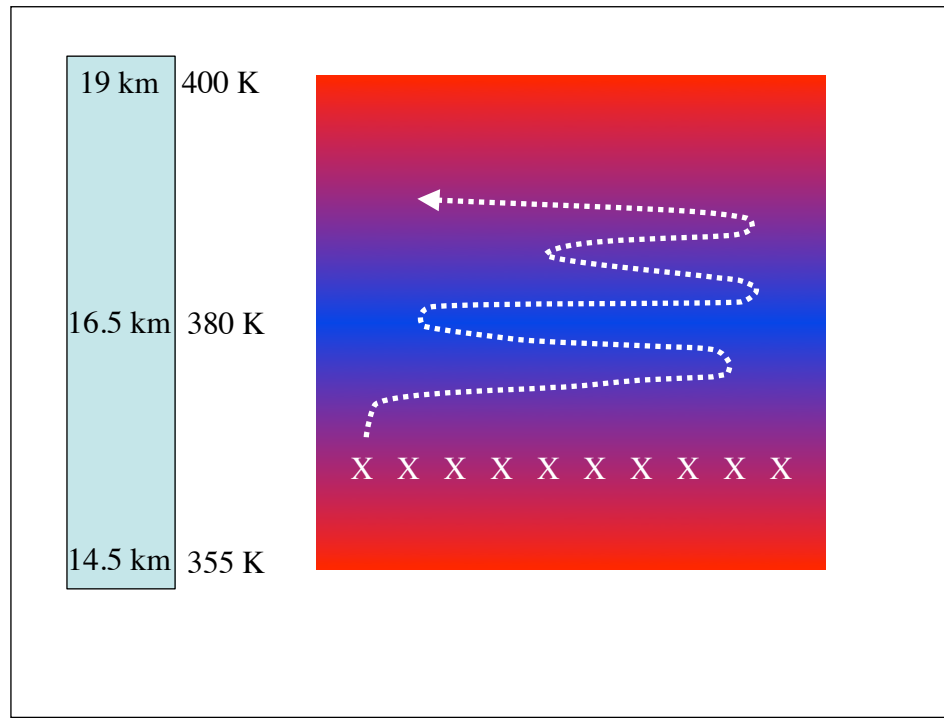
Horizontal view



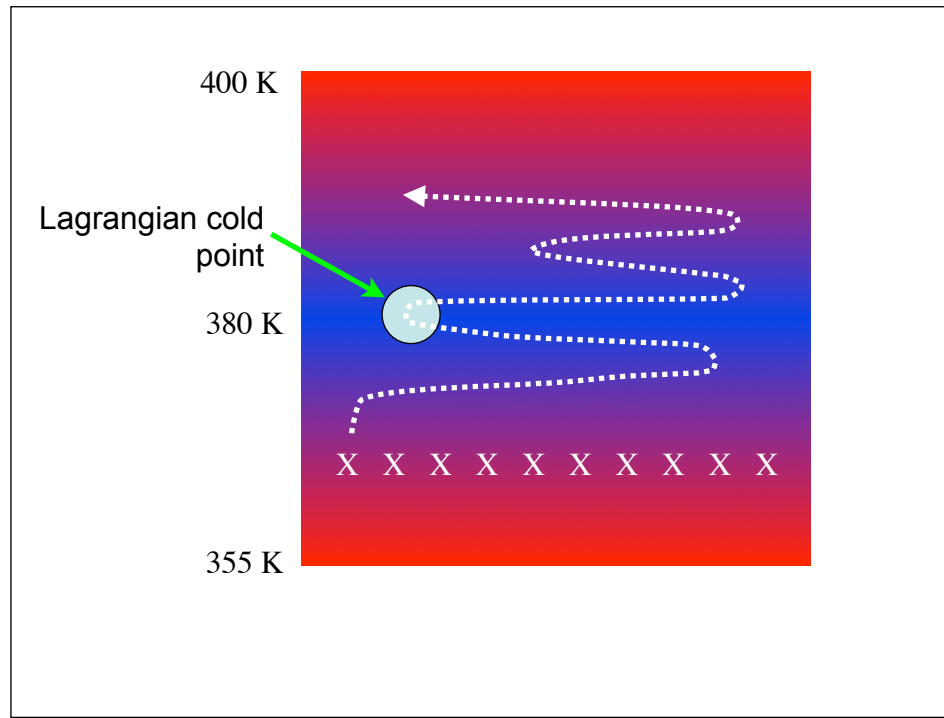
Parcels have been thinned out by a factor of 10



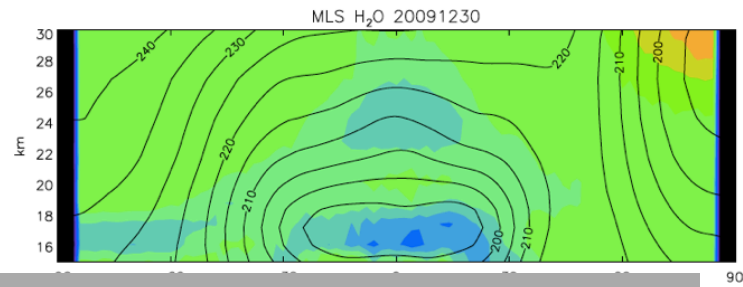
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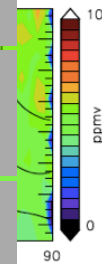
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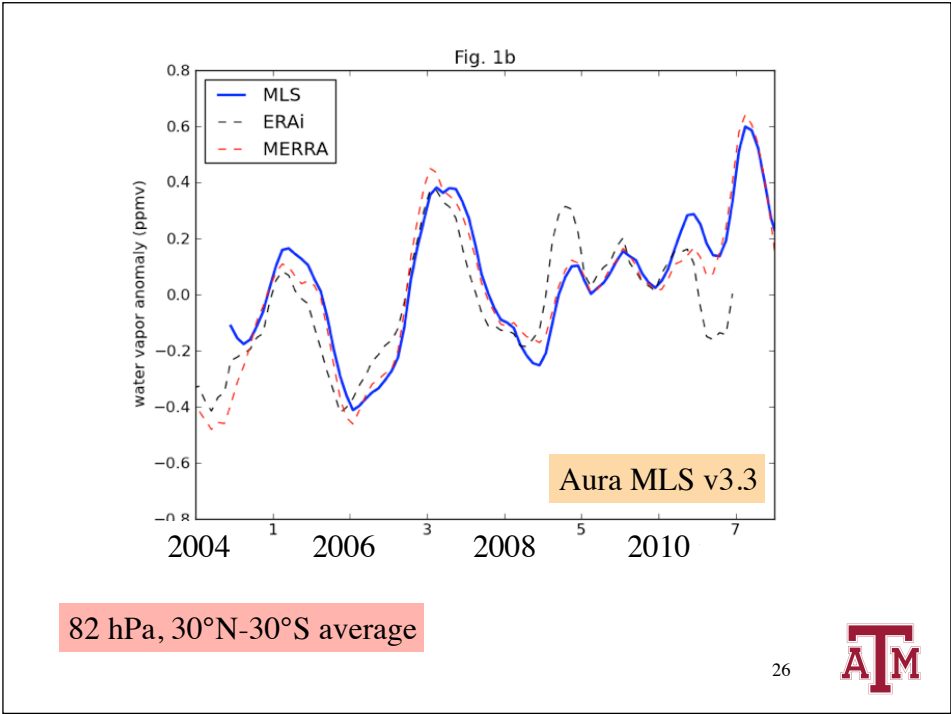


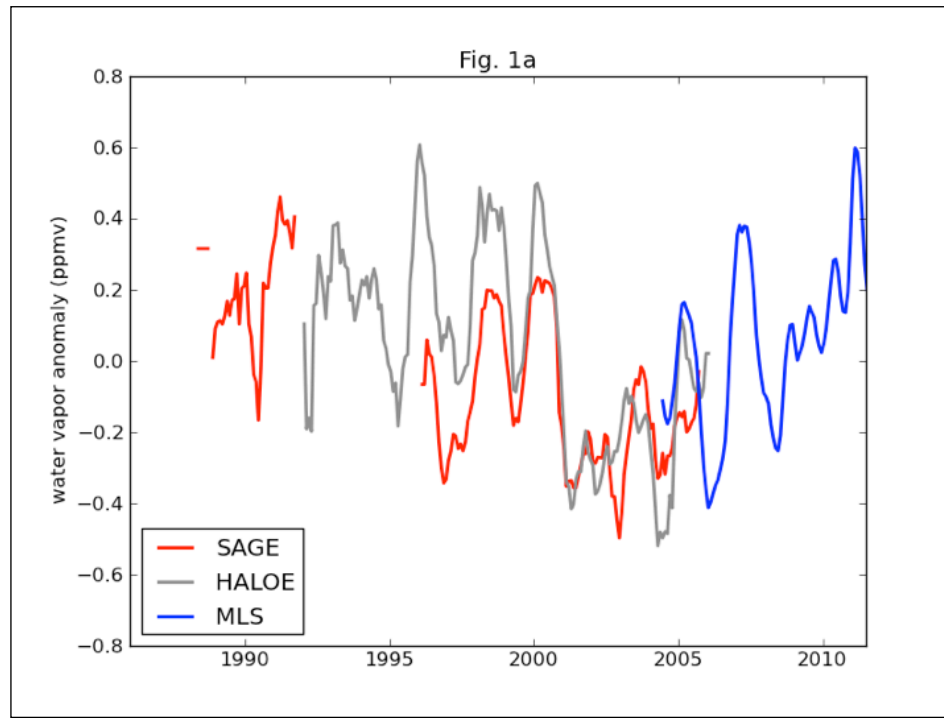
Schoeberl, M. R., and A. E. Dessler, Dehydration of the stratosphere, *Atmos. Chem. Phys.*, 11, doi: 10.5194/acp-11-8433-2011, 8433-8446

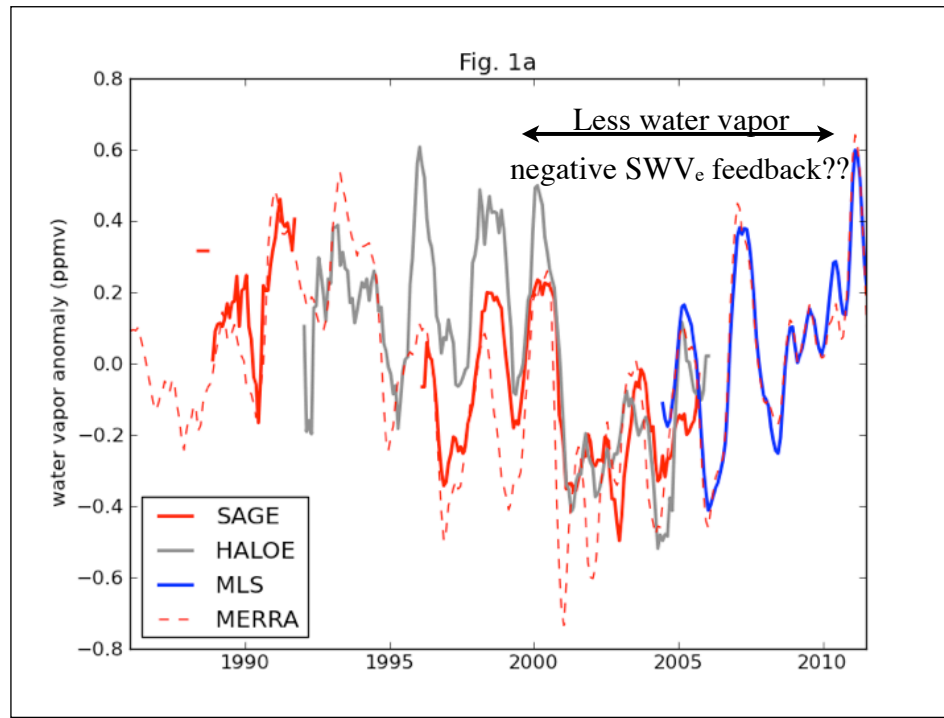
Schoeberl, M. R., A. E. Dessler, and T. Wang, Simulation of stratospheric water vapor and trends using three reanalyses, *ACPD*, soon

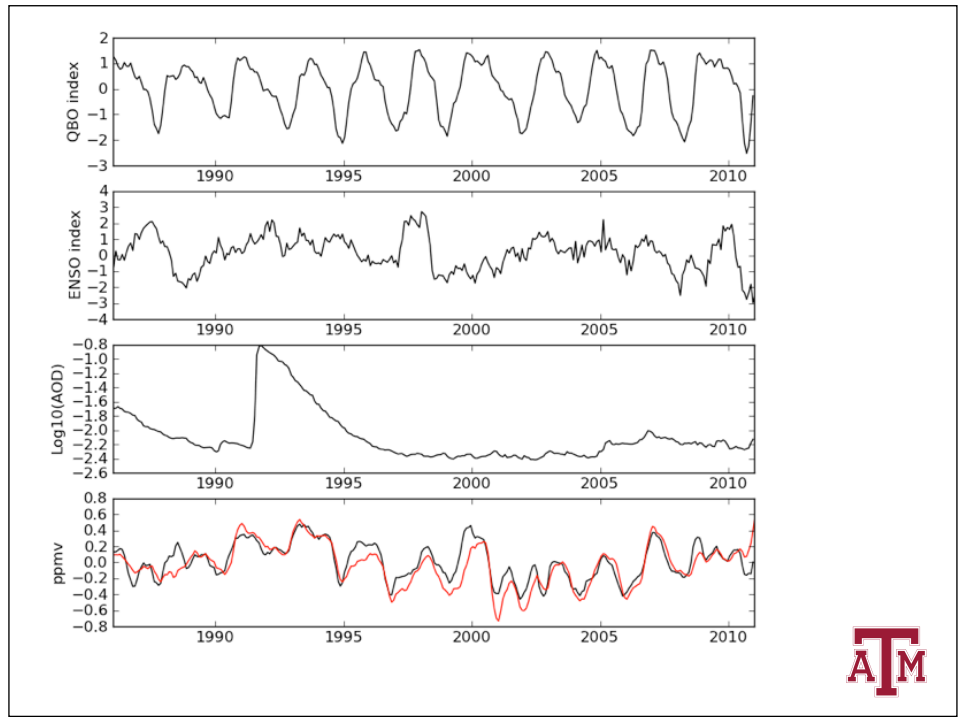
A. Christenberry, A. E. Dessler, and M. R. Schoeberl, Seasonal and Regional Variations in Stratospheric Dehydration, submitted to *JGR*

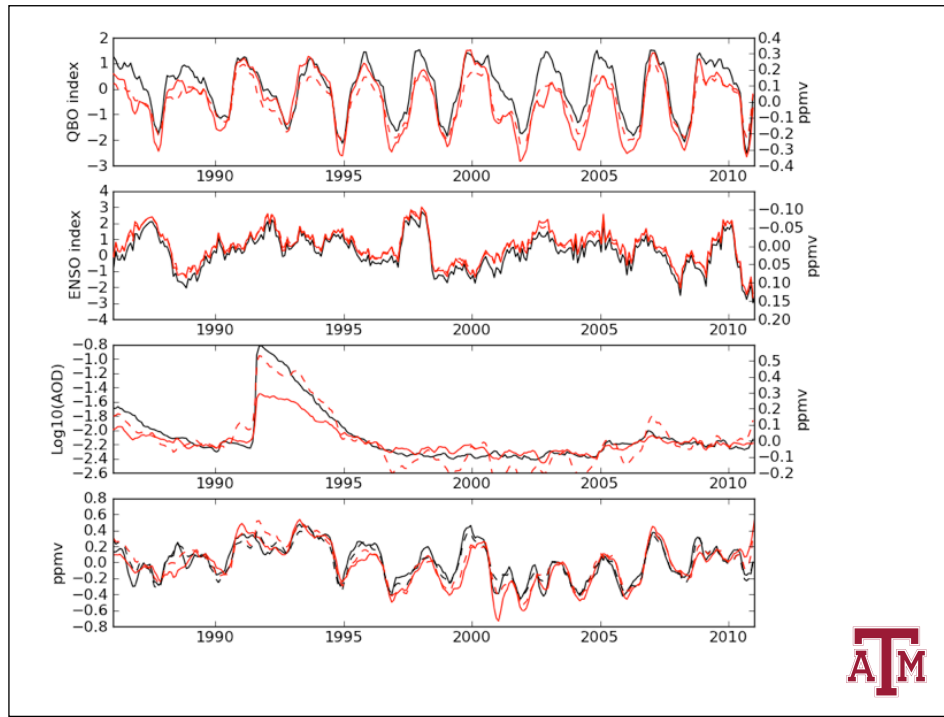


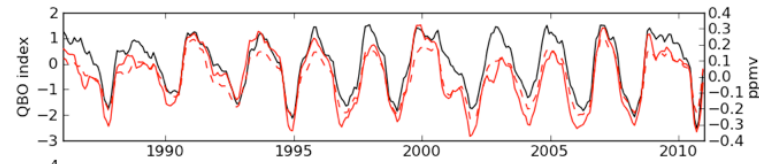






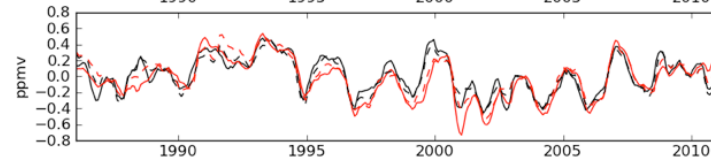
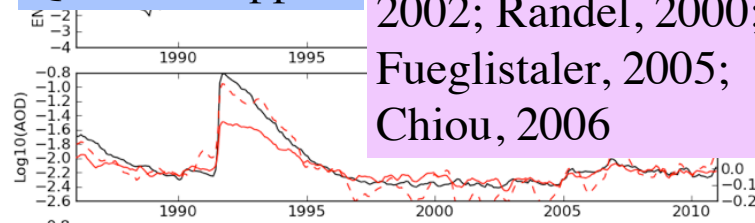


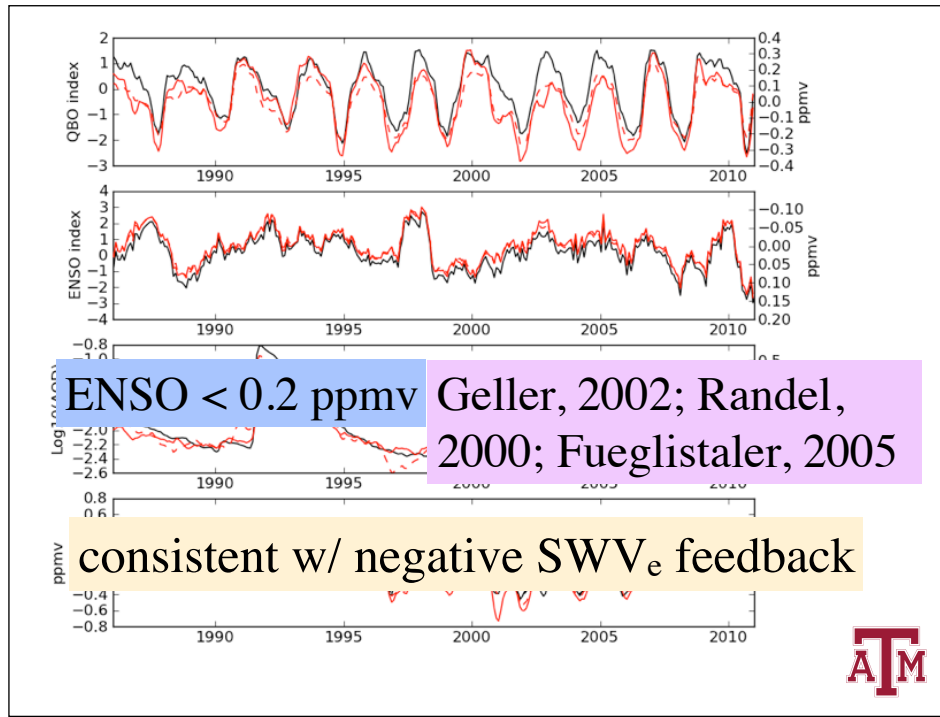


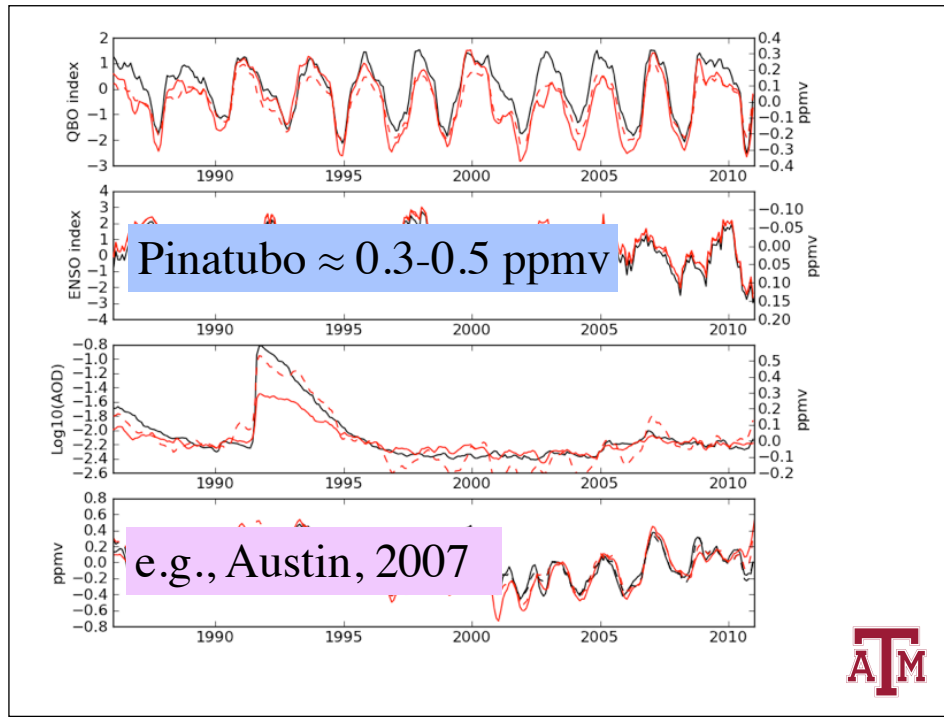


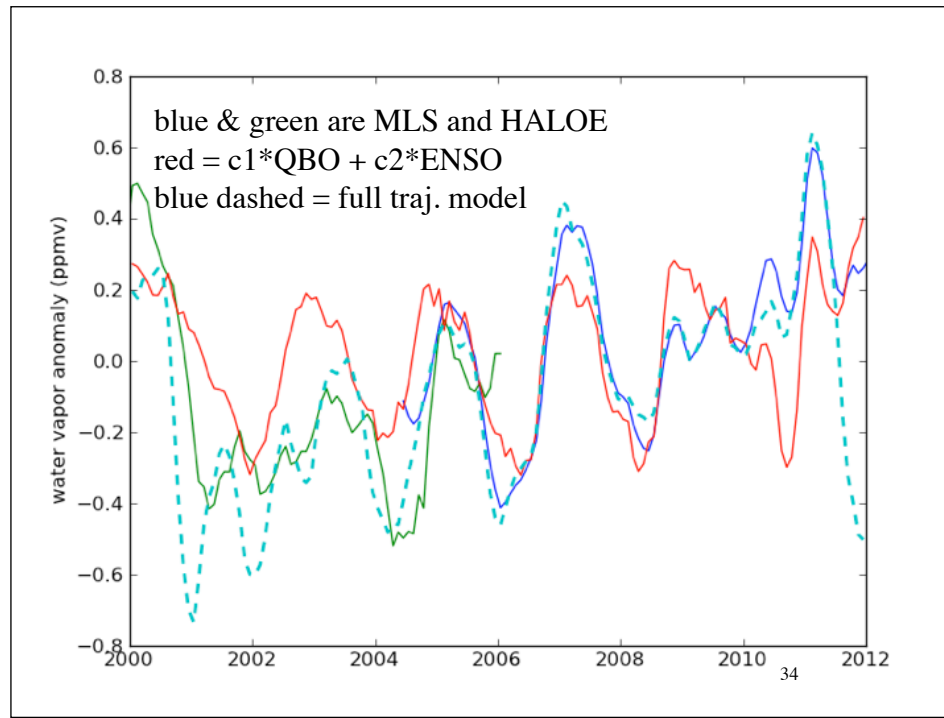
QBO \approx 0.5 ppmv

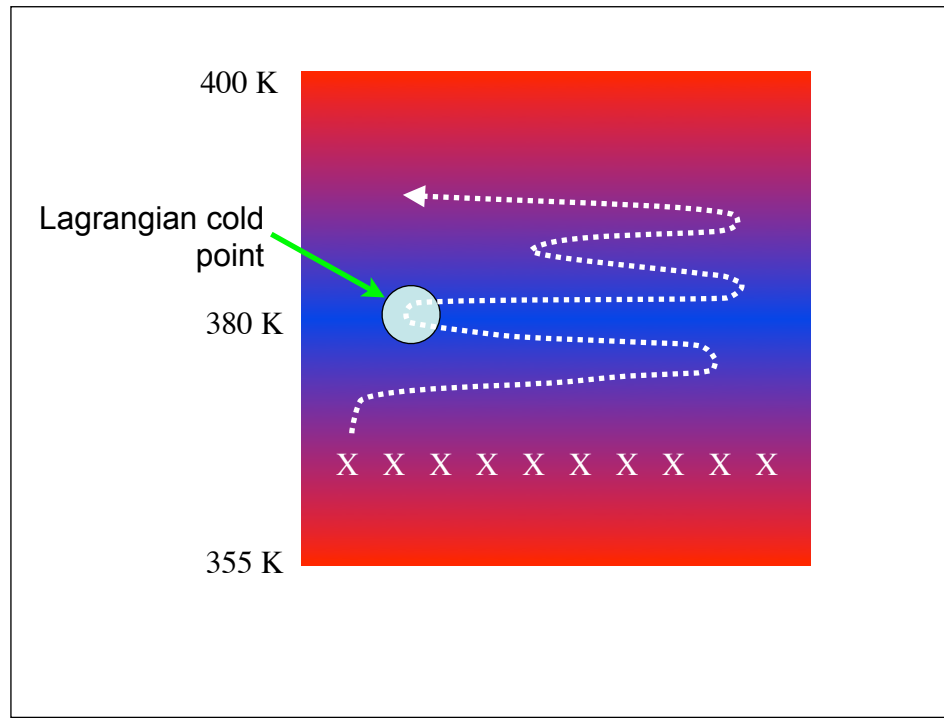
Giorgetta, 1999; Geller, 2002; Randel, 2000; Fueglistaler, 2005; Chiou, 2006











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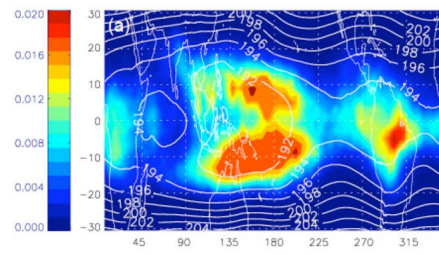
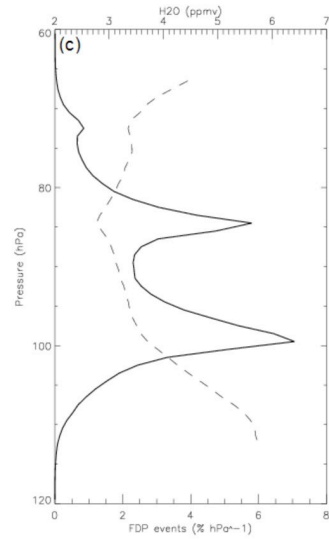


Fig. 2 of Christenberry et al.
submitted to JGR



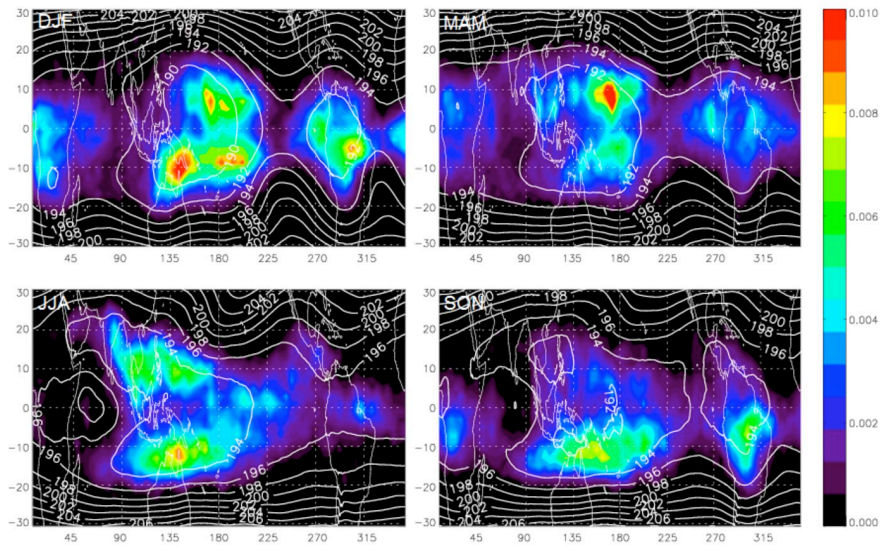


Fig. 3 of Christenberry et al.
submitted to JGR

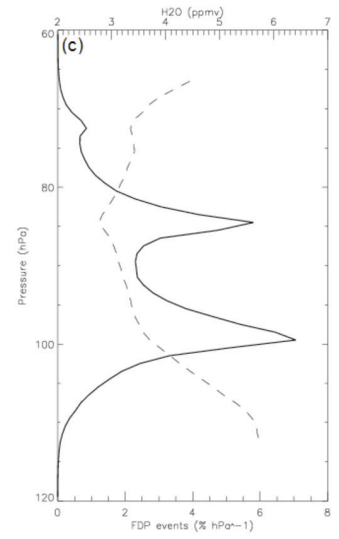
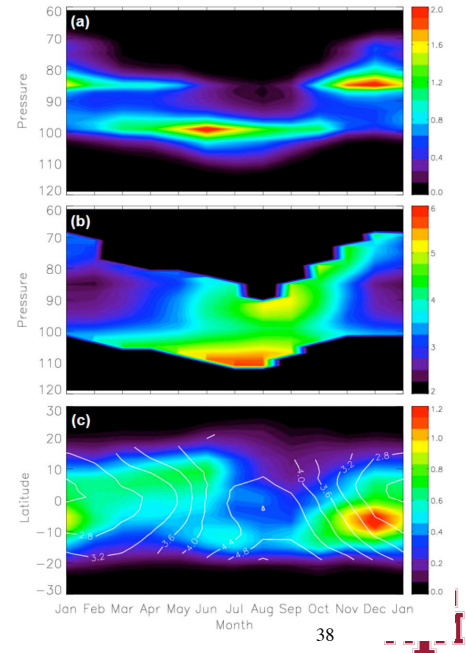


Fig. 4 of Christenberry et al.
submitted to JGR



Conclusions

- SWV_e can be accurately simulated over the last 25 years with a trajectory model using a simple microphysical assumption
- Analysis shows no increase in SWV_e for either long-term warming or ENSO warming
- Provides no support for a SWV_e feedback
- Longer-term (decadal) variations are presently unattributed