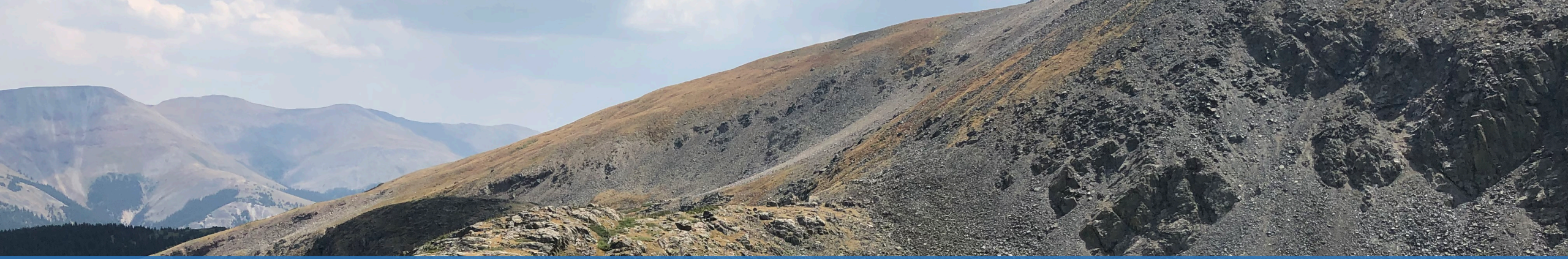


Near-global Variability of Stratospheric Water Vapor observed by SAGE III/ISS

Mijeong Park, Bill Randel, Robert Damedeo, David Flittner, Sean Davis and Karen Rosenlof

SAGE III/ISS Science Team Meeting, October 19-20, 2020

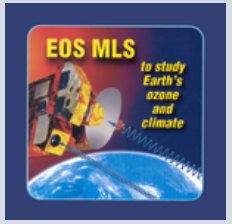
Mohawk lake, Colorado

SAGE III/ISS and MLS H_2O

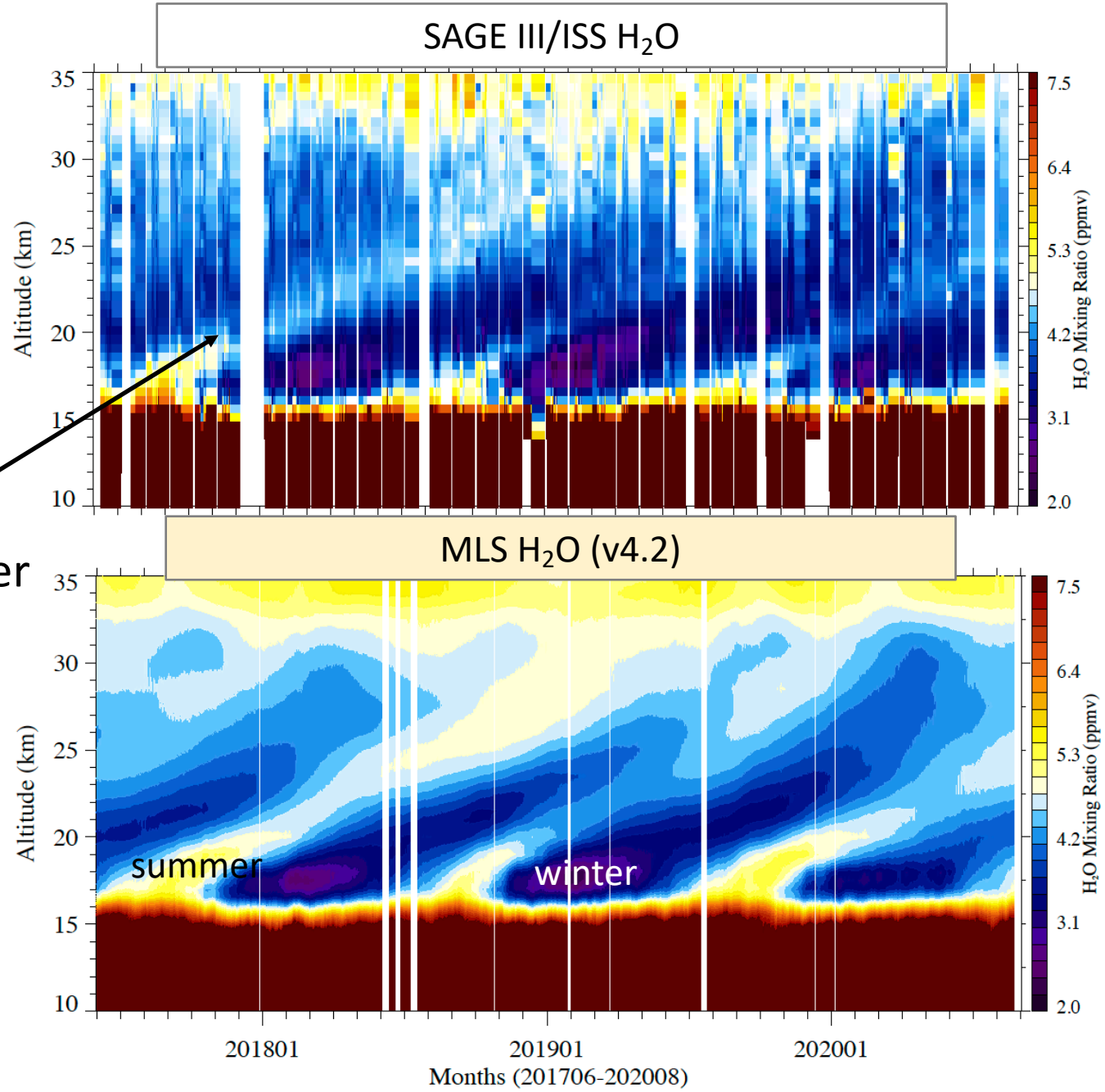
1. H_2O Tape Recorder in the Tropical Stratosphere
2. Data Screening and Aerosol Sensitivity
3. Relative Humidity (RH)
4. Seasonal Variability

Data - SAGE III/ISS v5.1 H_2O (Jun 2017-May 2020)

MLS H_2O v4.2 and v5.0 (interpolated to an altitude grid)



H_2O tape recorder (15S-15N) Jun 2017-Aug 2020



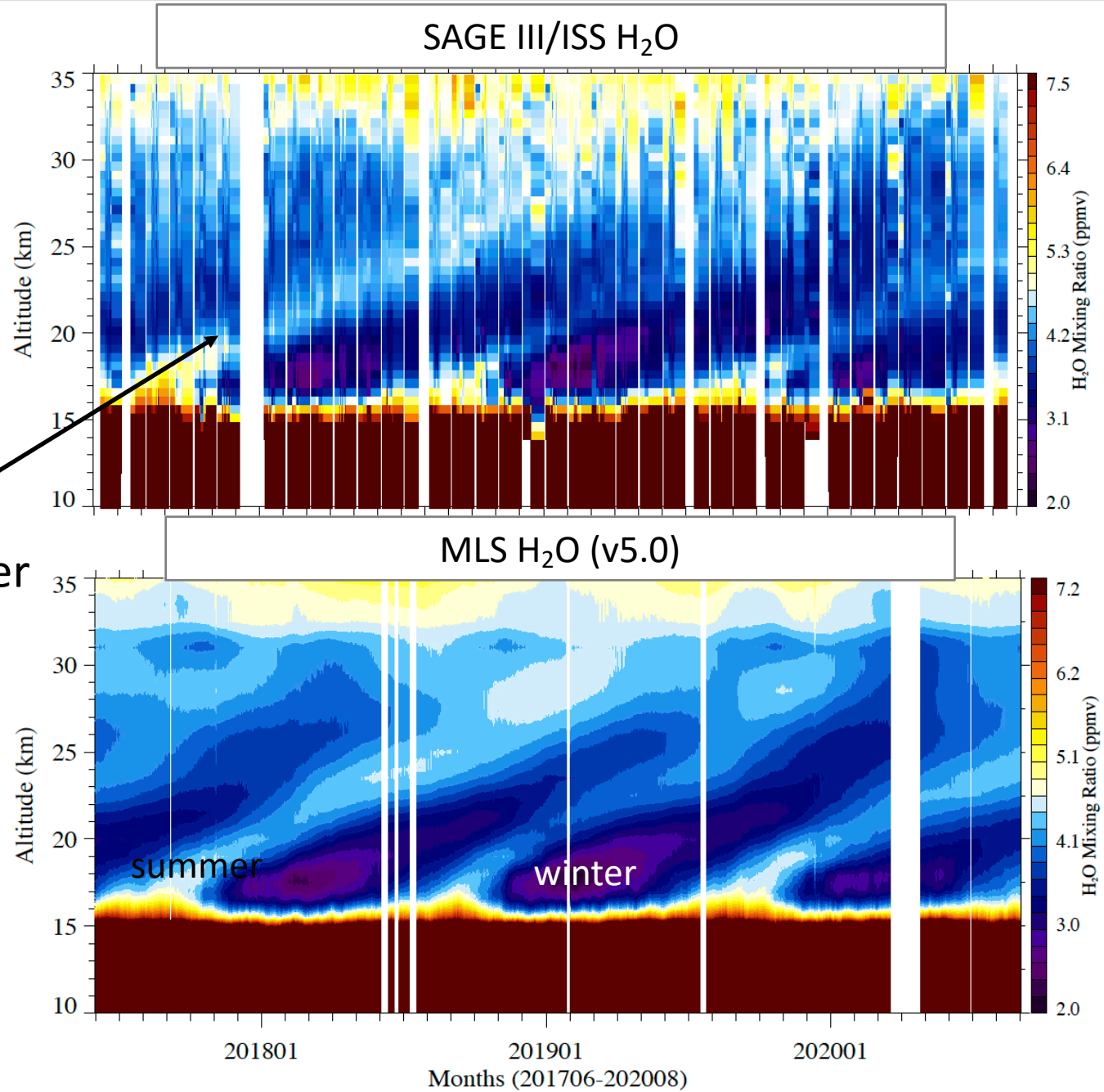
H_2O tape recorder (wet phase/ dry phase)

SAGE III/ISS and MLS H_2O agree in phase and amplitude (16-30 km).

SAGE III/ISS ~ 10 % drier than MLS v4.2 H_2O in the stratosphere (Davis et al., 2020).

H_2O tape recorder (15S-15N) Jun 2017-Aug 2020

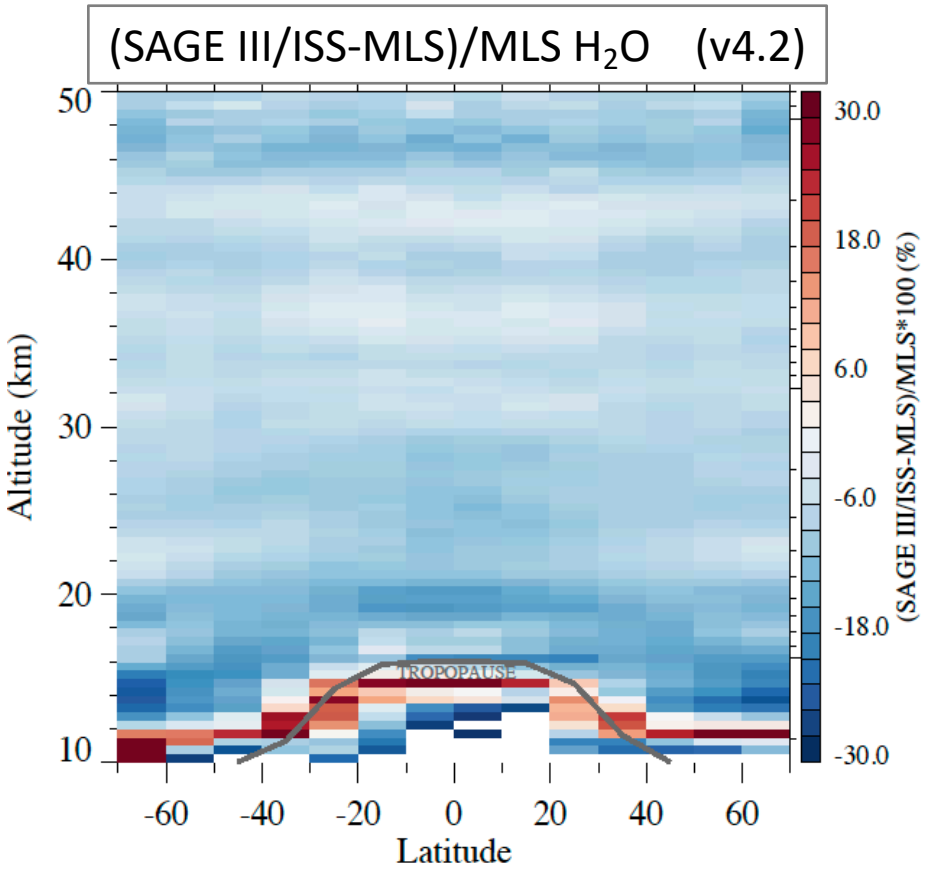
H_2O tape recorder (wet phase/ dry phase)



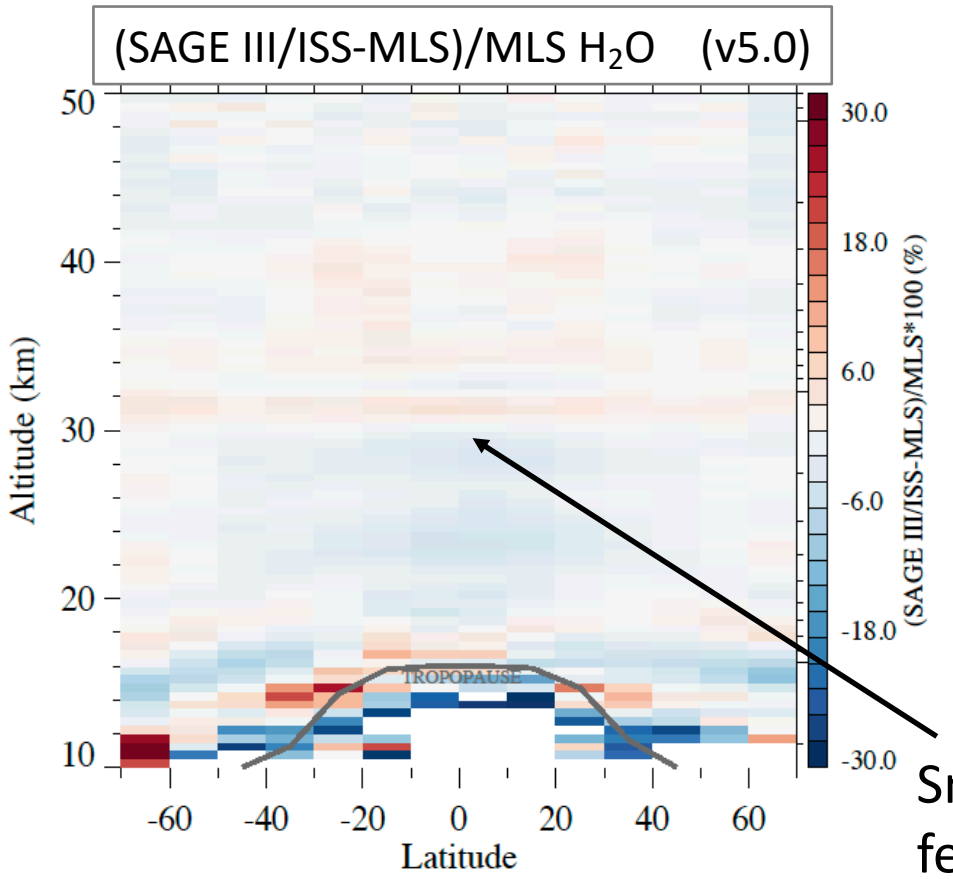
SAGE III/ISS agrees with MLS v5.0 H_2O in the stratosphere.

MLS v5.0 is ~5-10 drier than v4.2 (instrument drift issues).

SAGE III/ISS & MLS H_2O Differences (v4.2 & v5.0)



SAGE III/ISS ~ 10 % drier than MLS v4.2 H_2O in the stratosphere.

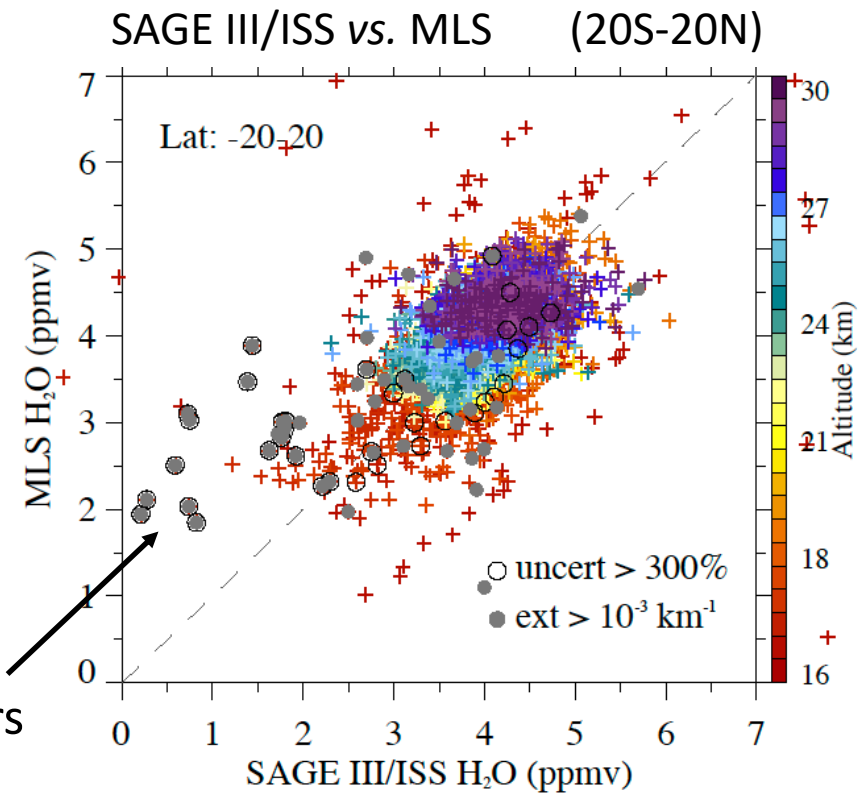


Small scale features remain.

SAGE III/ISS agrees with MLS v5.0 H_2O in the stratosphere.

SAGE III/ISS – H_2O Screening (example - Nov. 2017)

Before Screening

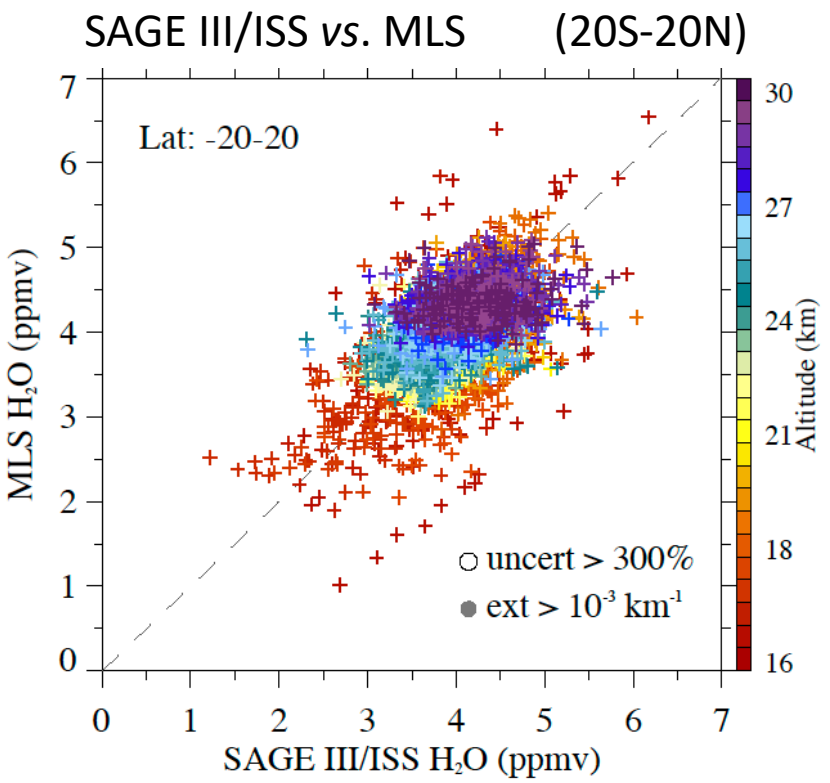


outliers

Uncertainty (300 %)

Aerosol Ext. at 1022 nm (10^{-3} km^{-1})

After Screening



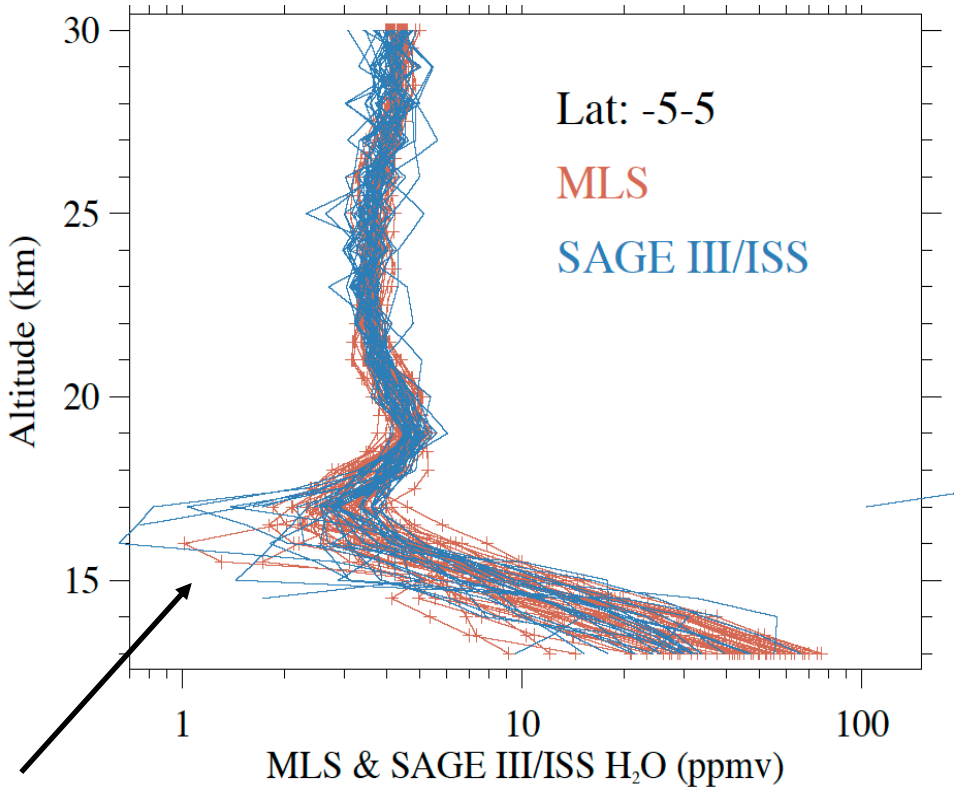
The screening filters out obvious outliers but not all (~1.2 % of total profiles).

<u>Screening Criteria</u>
(Davis et al. 2020)

Anomalous events
Keel over
Color ratio (B1022/B520)

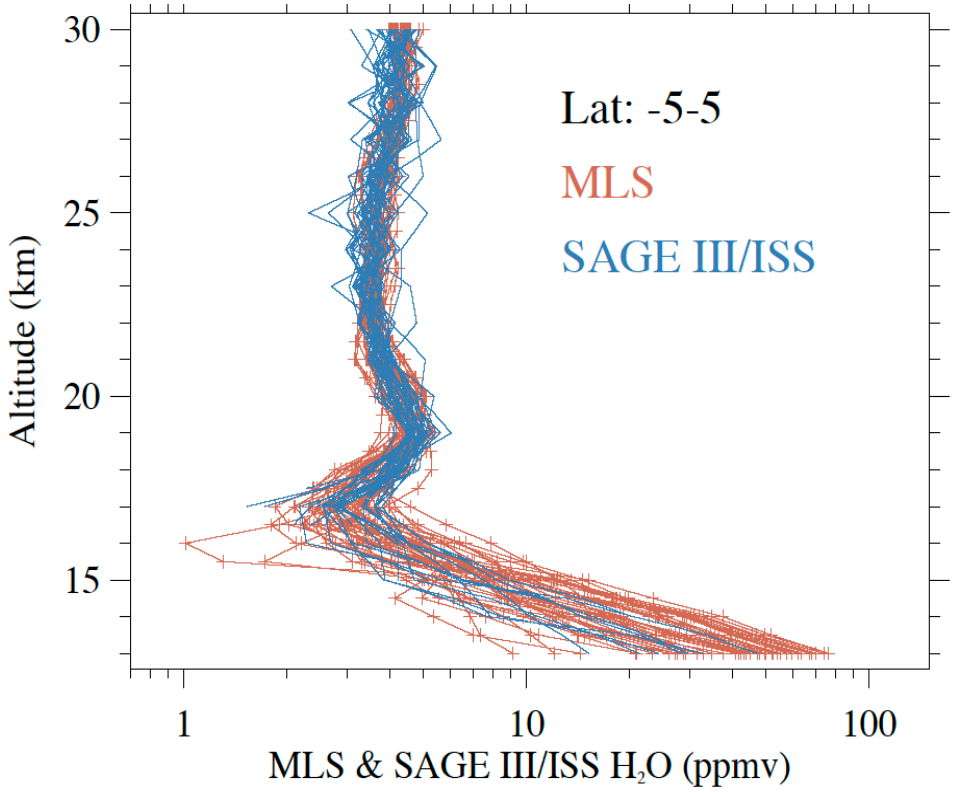
SAGE III/ISS – H_2O Screening 5S-5N (example - Nov. 2017)

Before Screening



outliers & very low H_2O

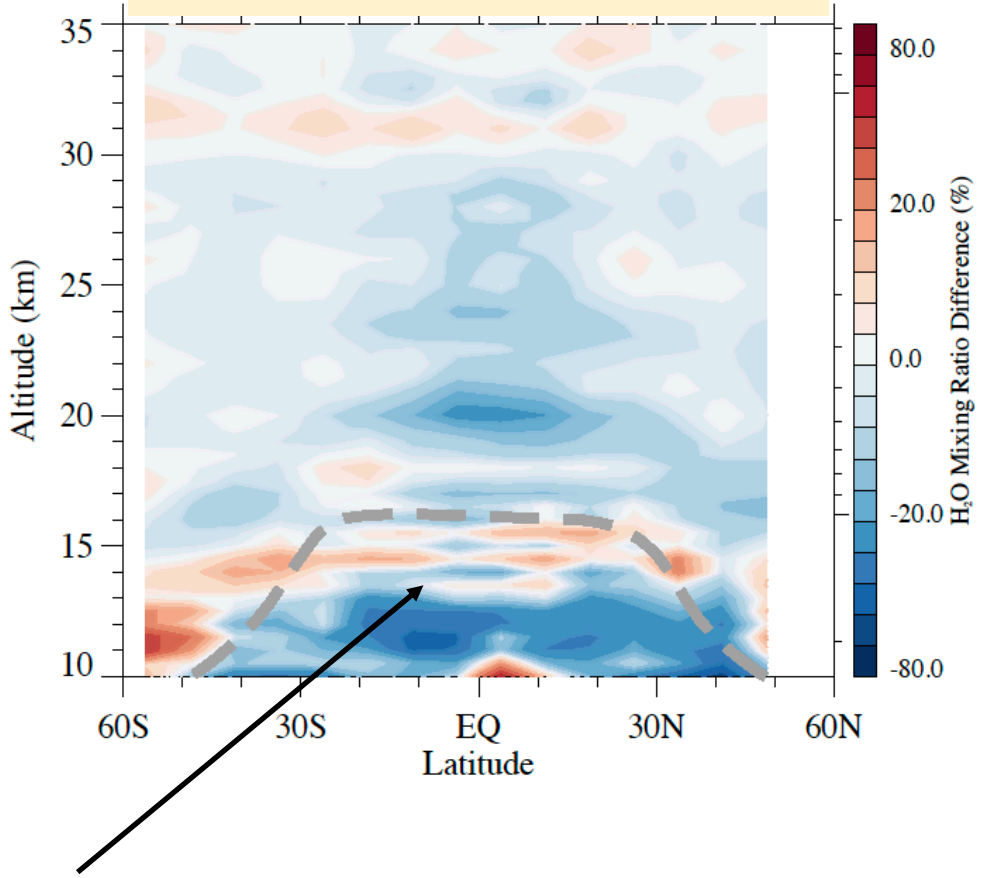
After Screening



SAGE III/ISS *vs*. MLS H_2O + Aerosol Sensitivity (Nov 2019)

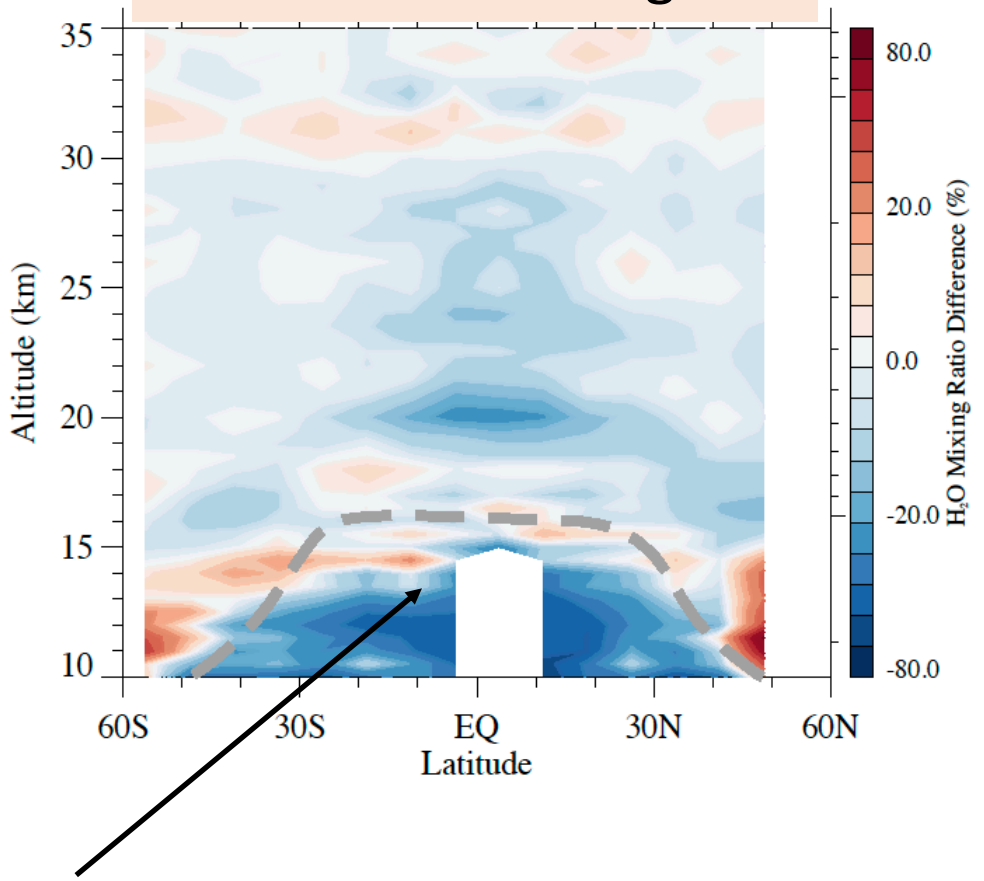
(SAGE III/ISS-MLS)/MLS

Before Screening



Noise

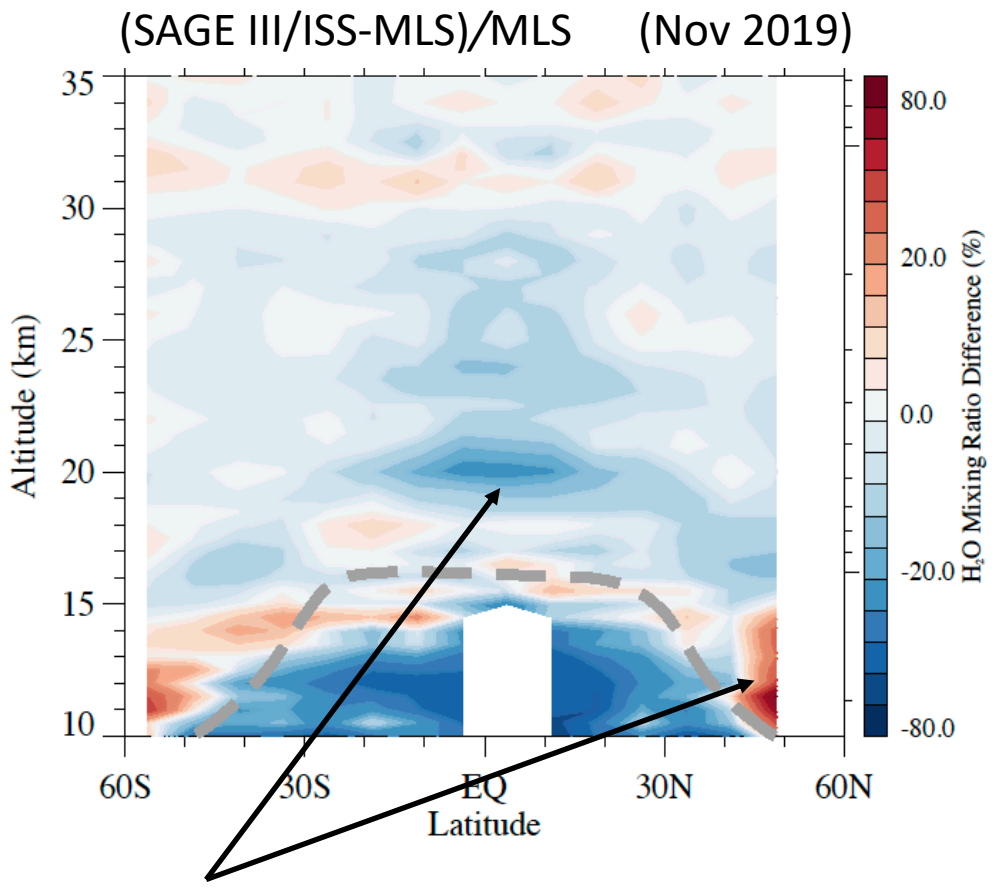
After Screening



Filtered

Filtering affects low altitudes.

SAGE III/ISS *vs*. MLS H_2O + Aerosol Sensitivity (Nov 2019)



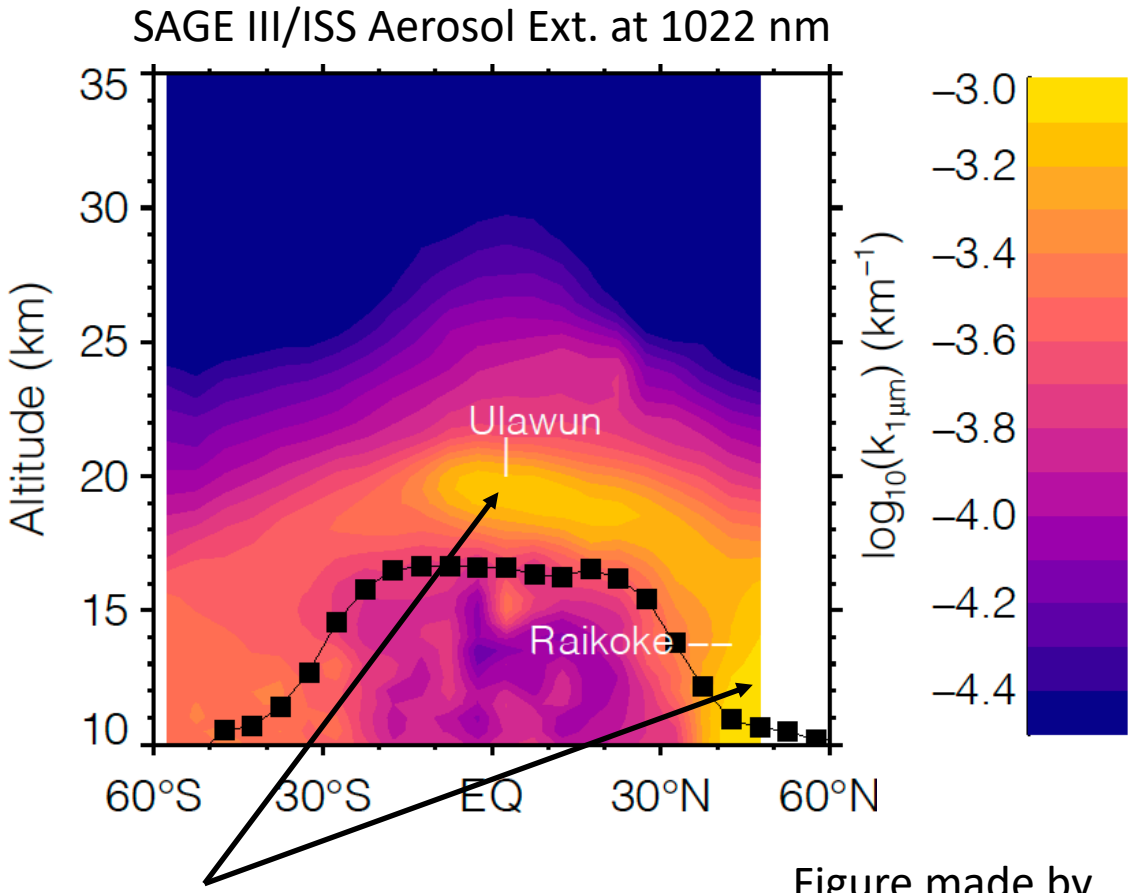
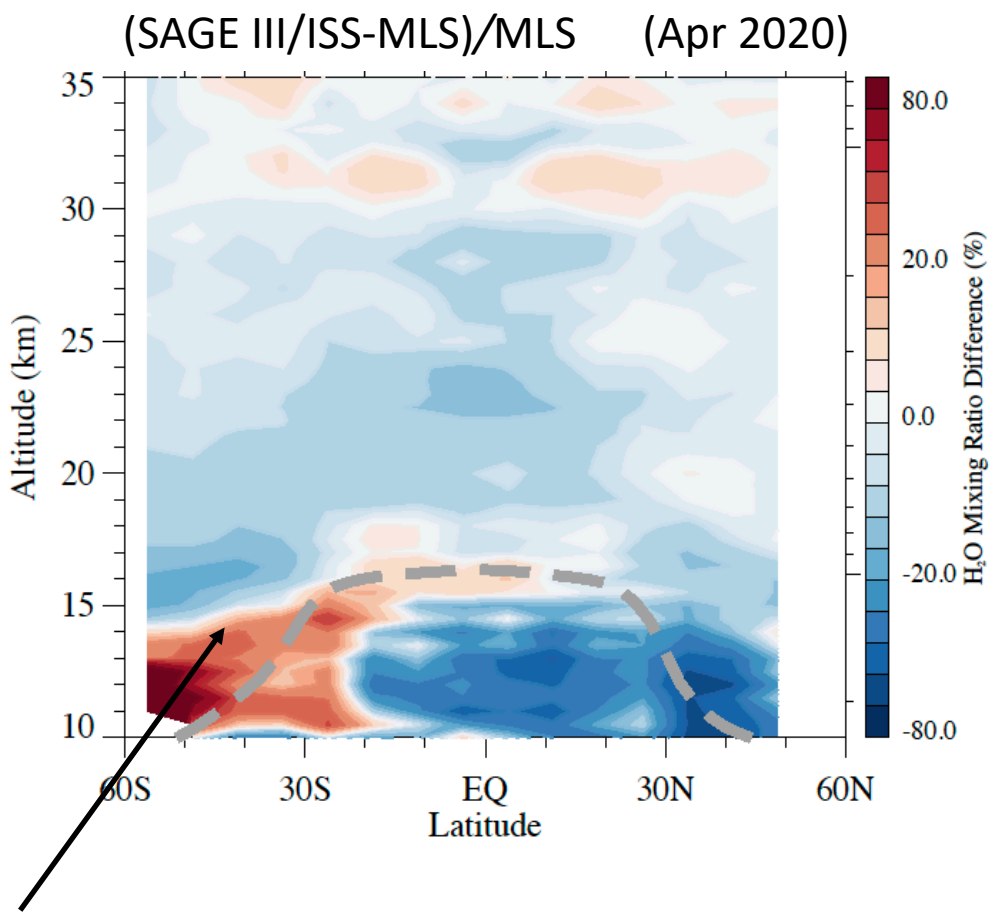


Figure made by Rob Damadeo

Larger difference coincides with high aerosol loadings related to volcanic eruptions.

SAGE III/ISS *vs*. MLS H_2O + Aerosol Sensitivity (Apr 2020)



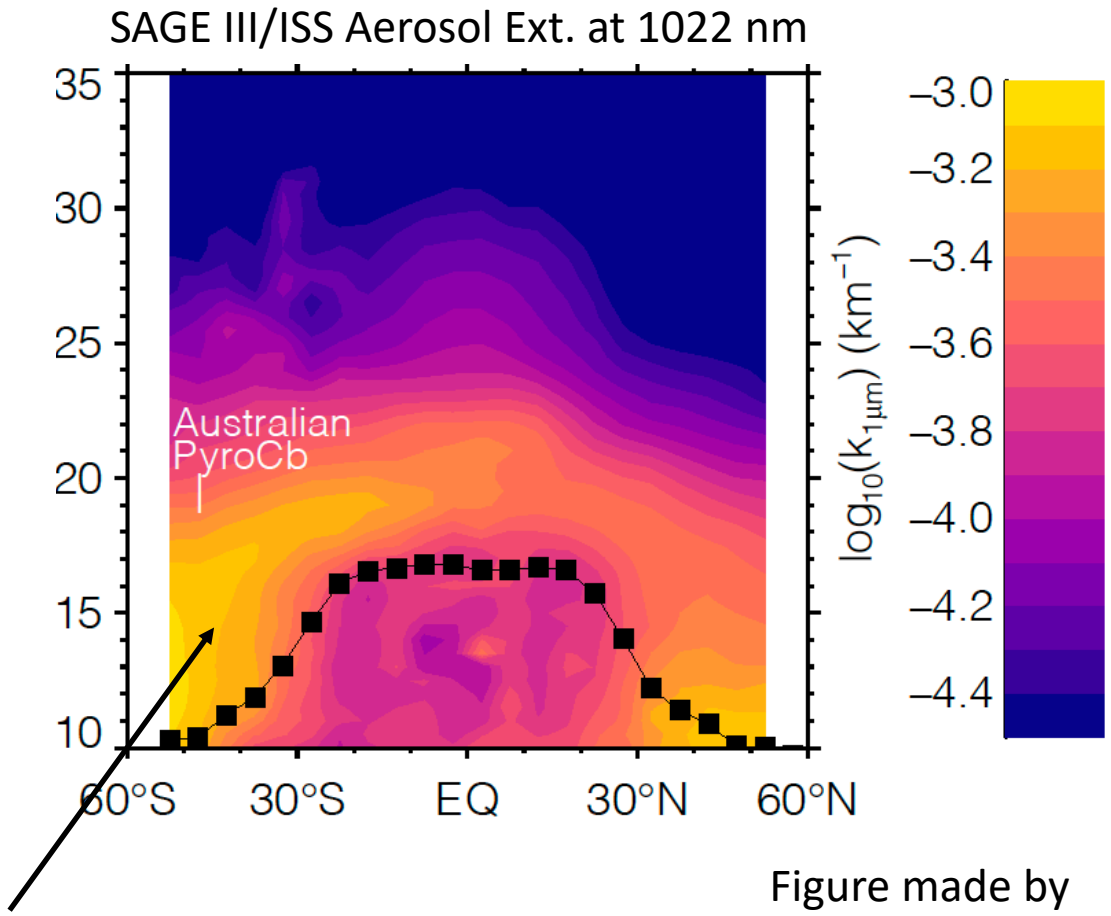
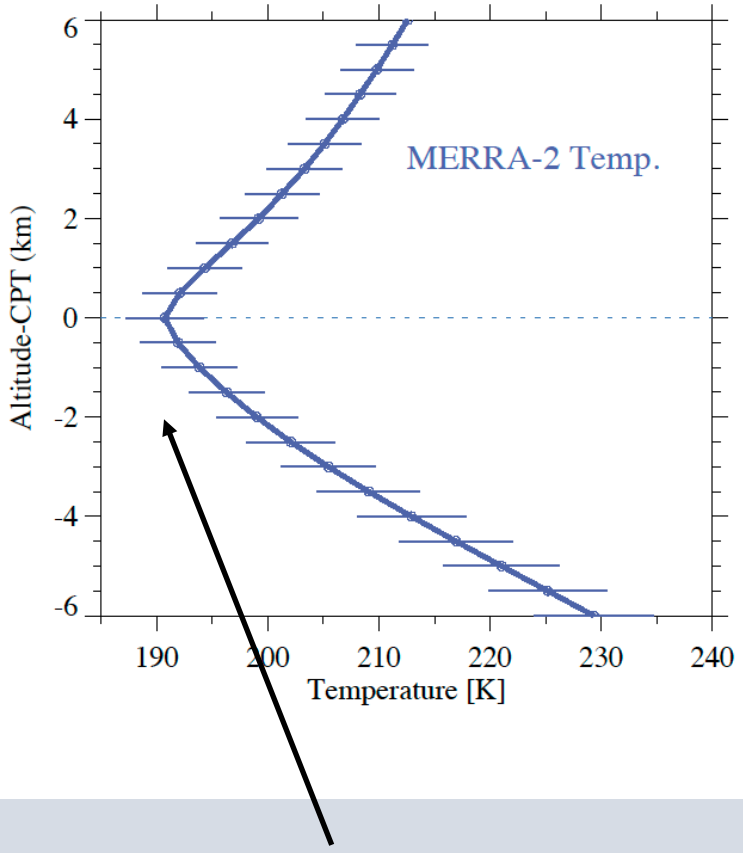


Figure made by
Rob Damadeo

Larger difference coincides with high aerosol loadings related to volcanic eruptions.

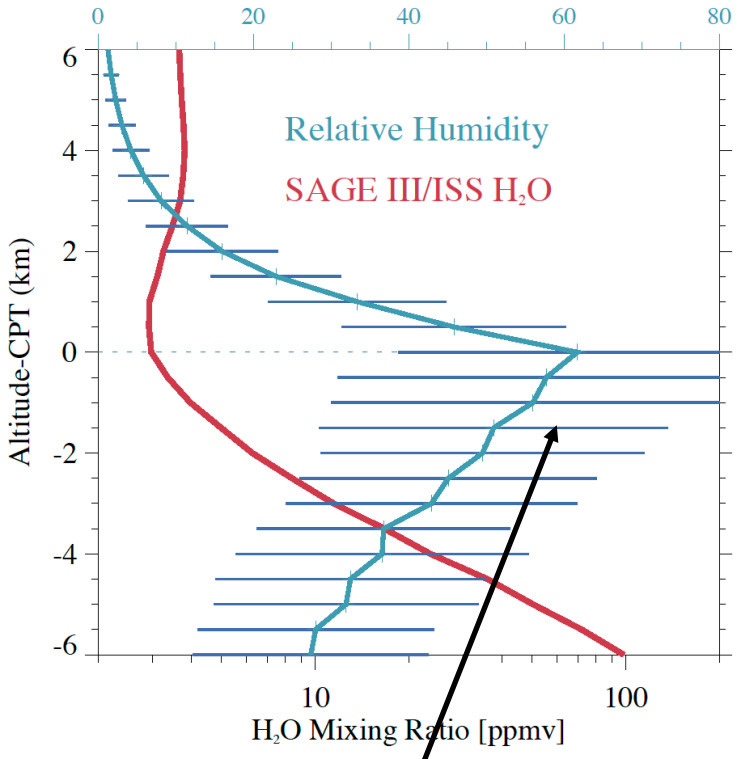
SAGE III/ISS H_2O – Temperature - Relative Humidity (RH)

Temperature 15S-15N (Jan-Mar)



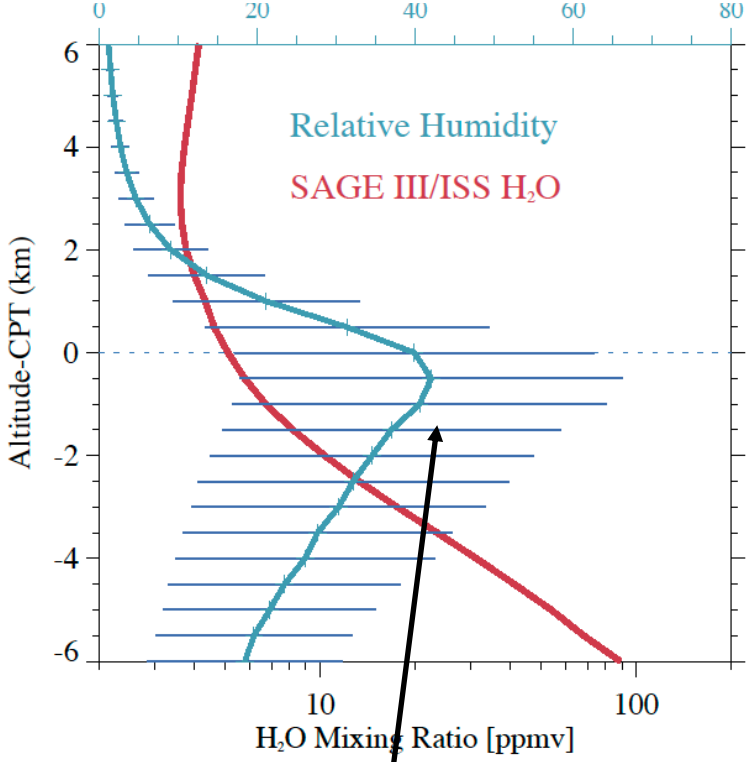
CPT
(Tropics, winter)

RH & H_2O 15S-15N (Jan-Mar)



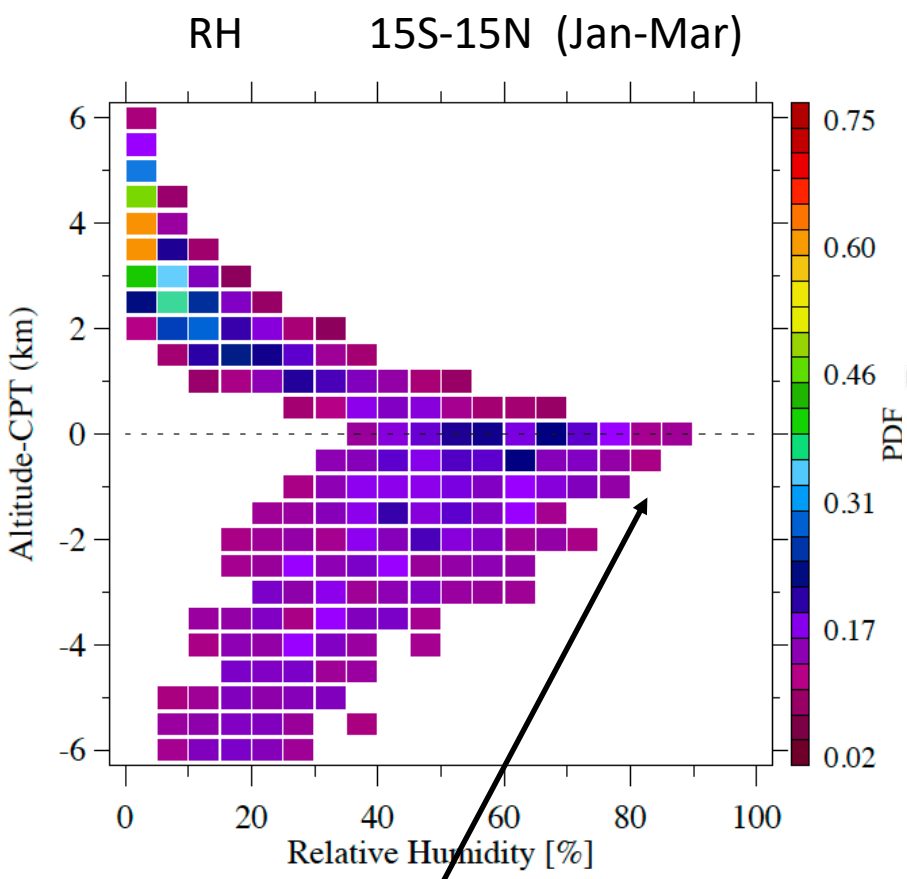
High RH
(Tropics, winter)

RH & H_2O 15-35N (Jun-Aug)



Drier
(Subtropics, summer)

SAGE III/ISS RH PDF (Winter vs. Summer)



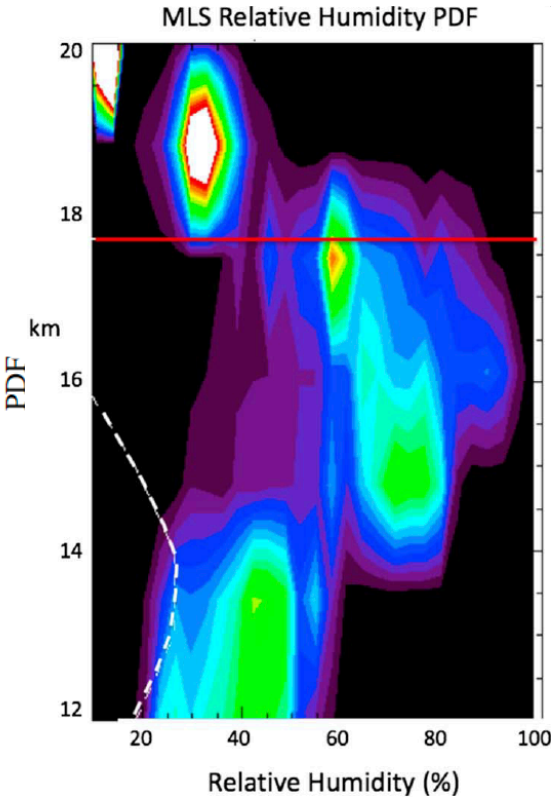
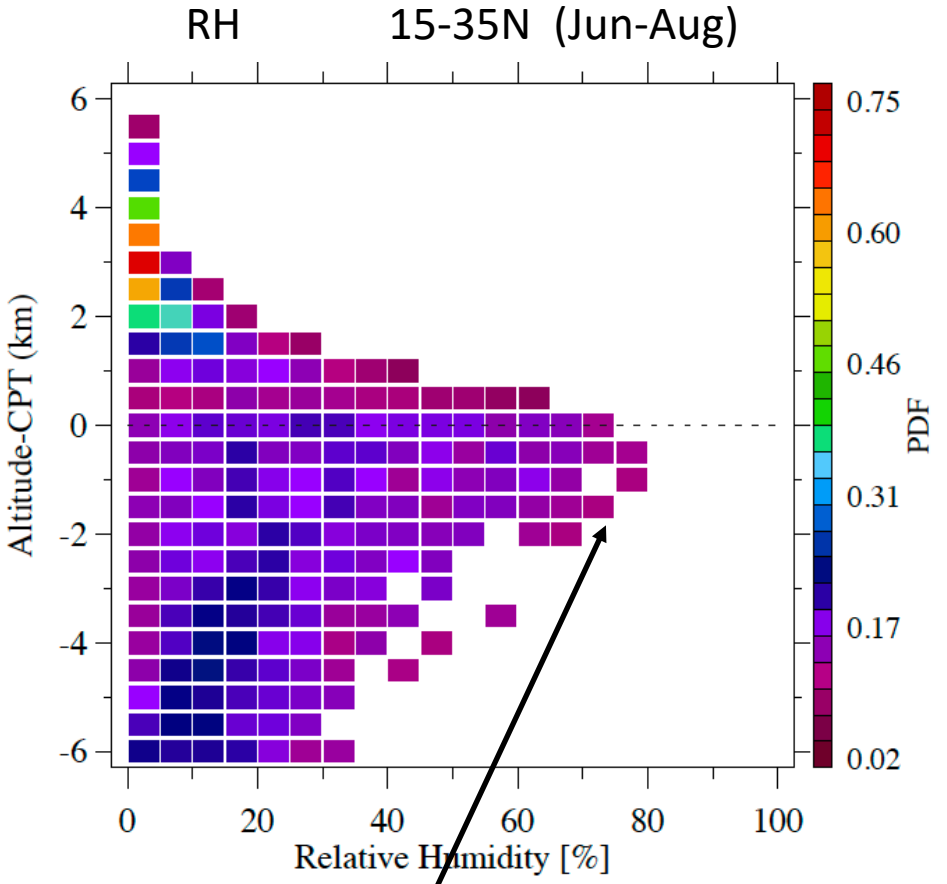


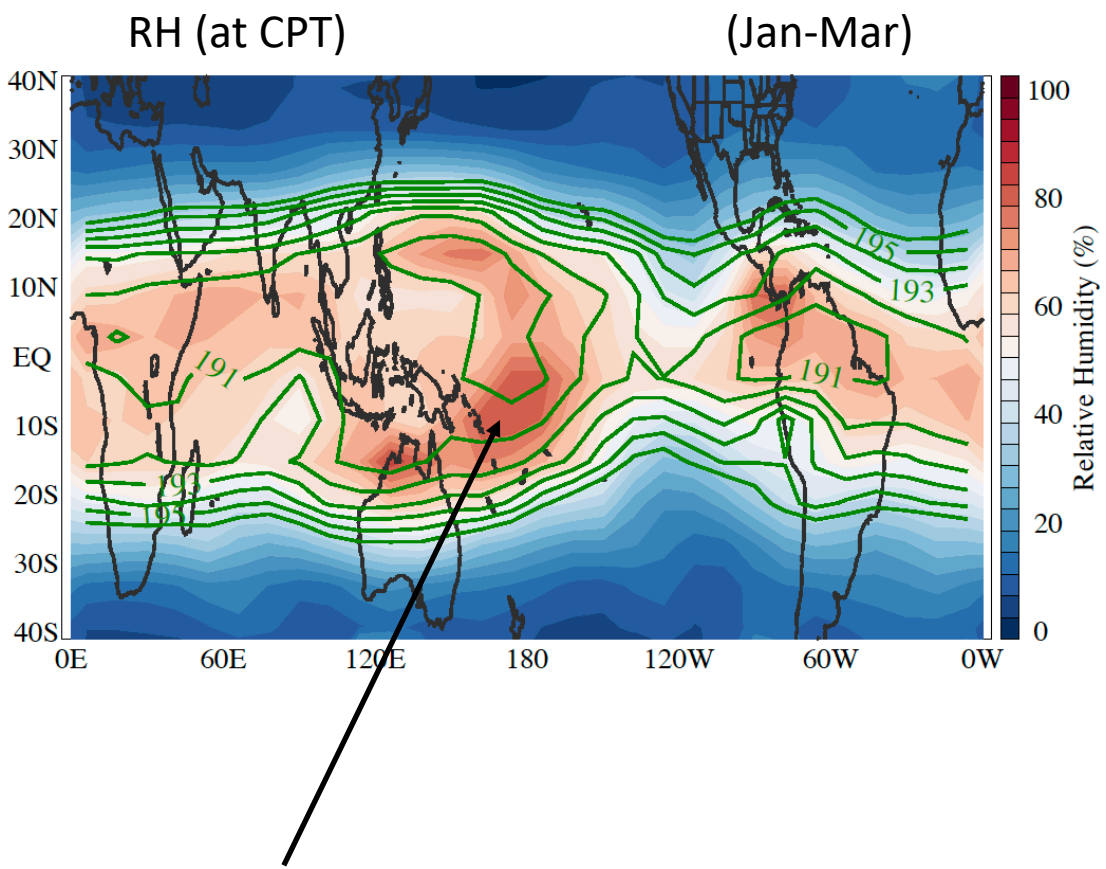
Fig. 4 - Schoeberl et al. (2019)

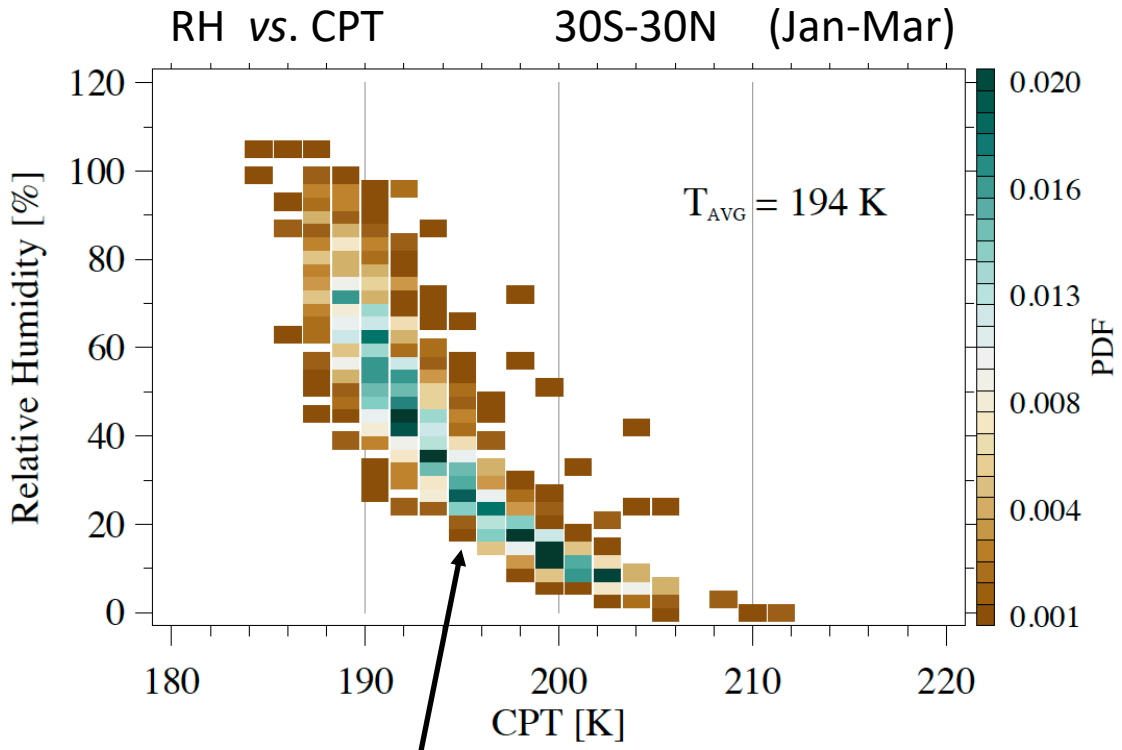


Max RH at CPT then sharp decrease above the CPT.

Drier than tropics. Max RH below the CPT. CPT is not well defined.

SAGE III/ISS RH PDF (at CPT) (Jan-Mar)

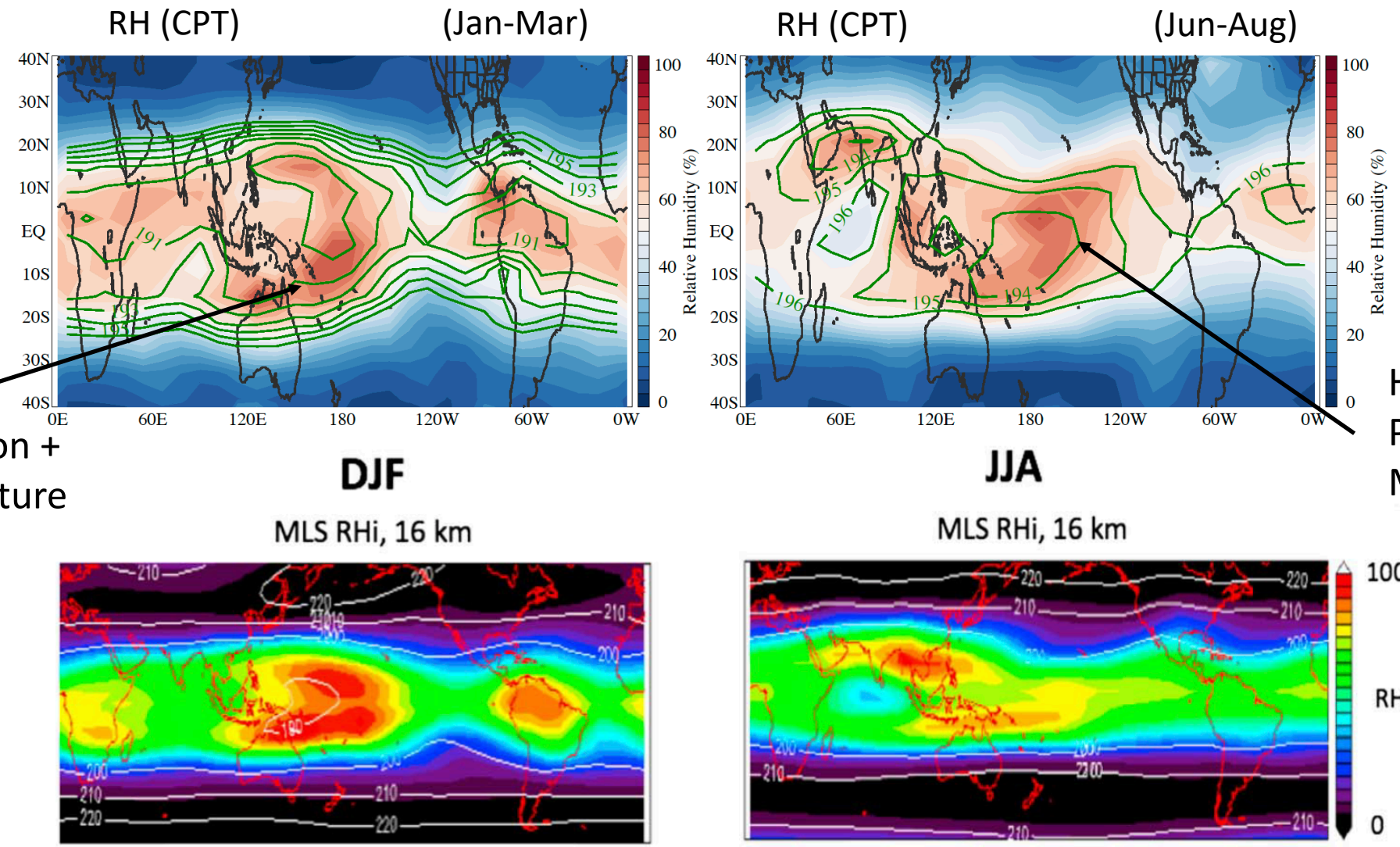




Max RH over Western Pacific, South America and Africa where CPT is cold.

CPT – 190-200 K (average=194K)
RH – 0-60 %

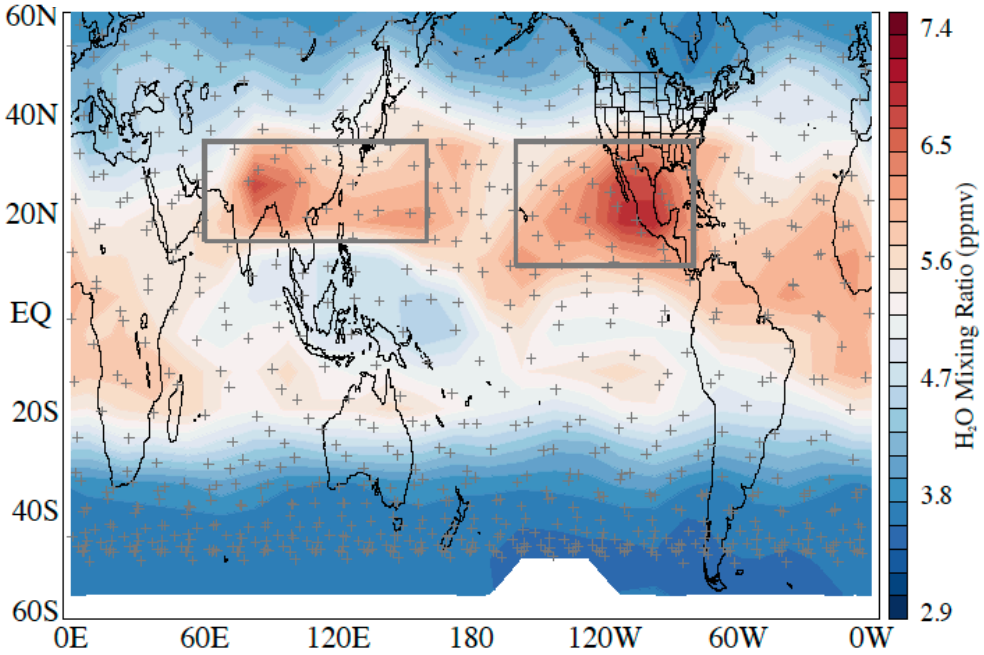
SAGE III/ISS RH PDF (at CPT) Winter/Summer



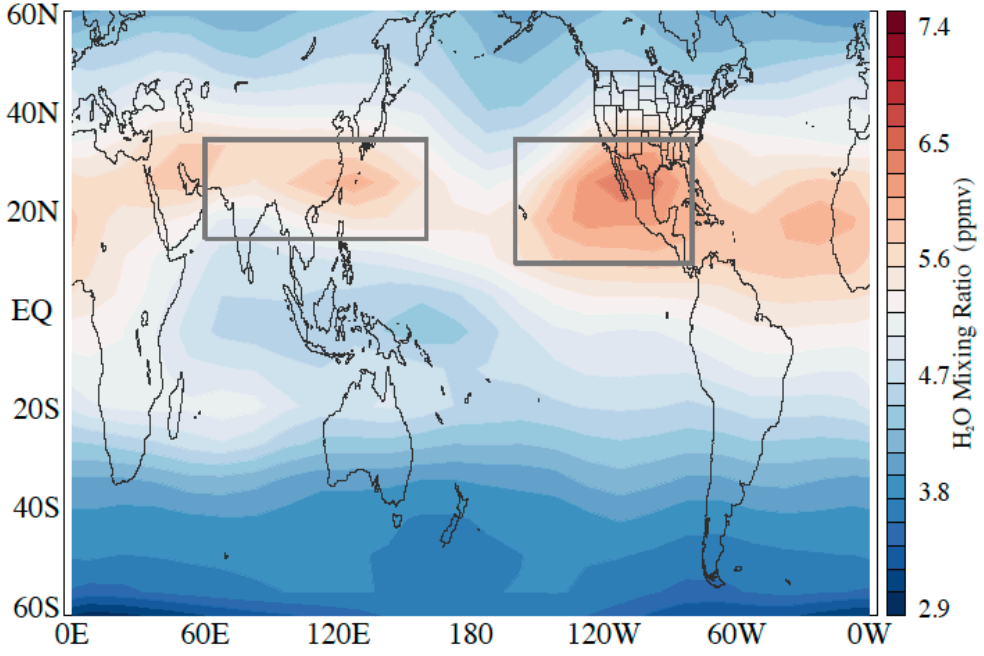
Schoeberl et al. (2019) – Figure 2 (8-year average RHI from MLS H_2O + MERRA-2 Temperature)

SAGE III/ISS and MLS H_2O 16.5 km August 2017

SAGE III/ISS H_2O 16 .5 km (Aug 2017)



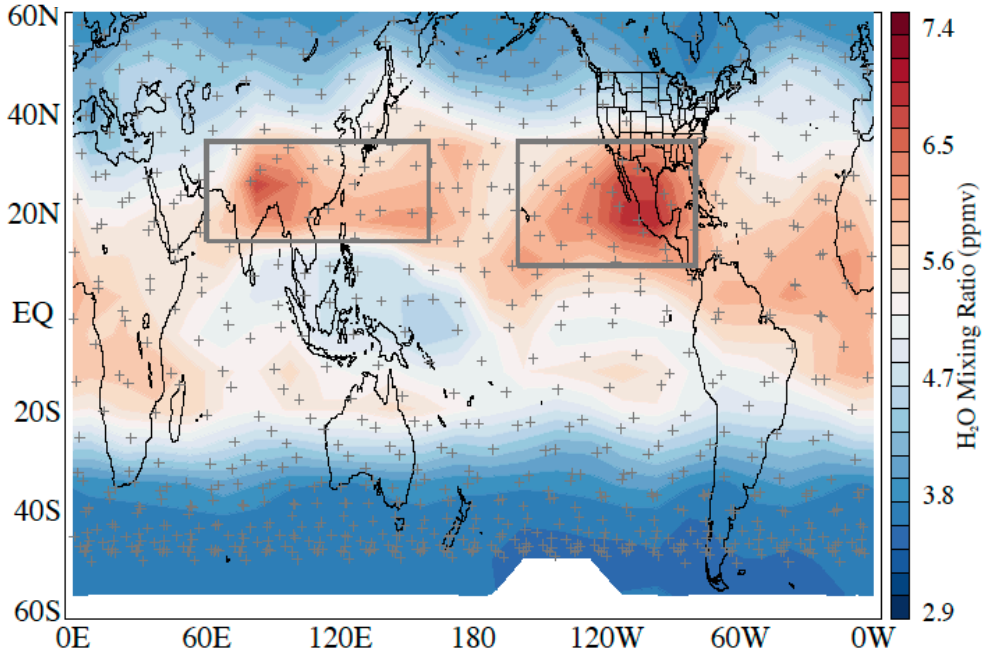
MLS H_2O 16 .5 km (Aug 2017)



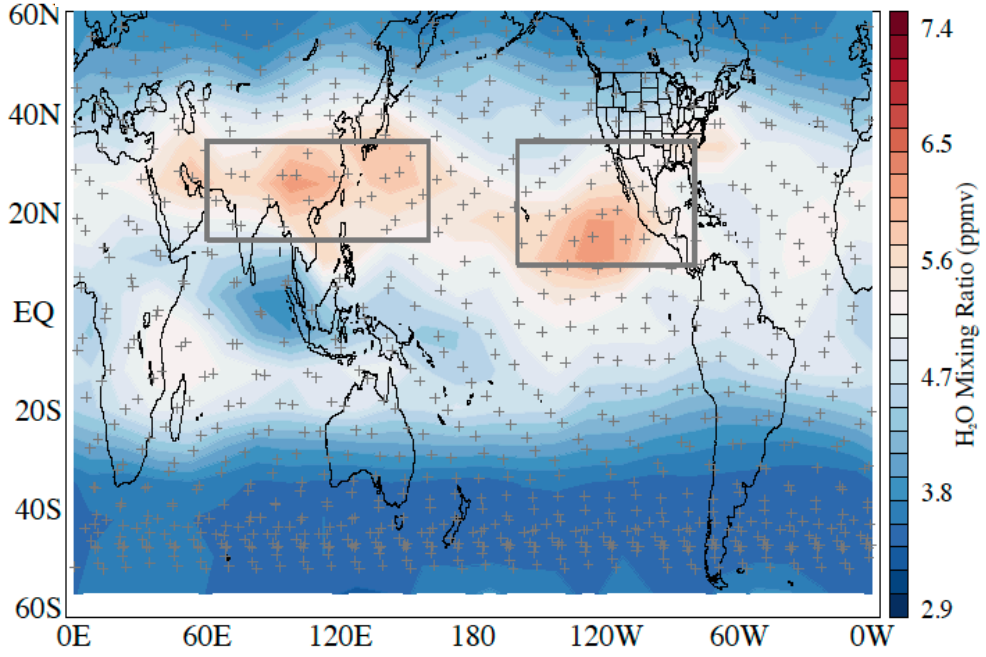
Max H_2O over Asian and North American monsoons.
Max over N. America is larger than one over Asia (SAGE III/ISS and MLS).

SAGE III/ISS H_2O 16.5 km August 2017/2018

SAGE III/ISS H_2O 16 .5 km (Aug 2017)

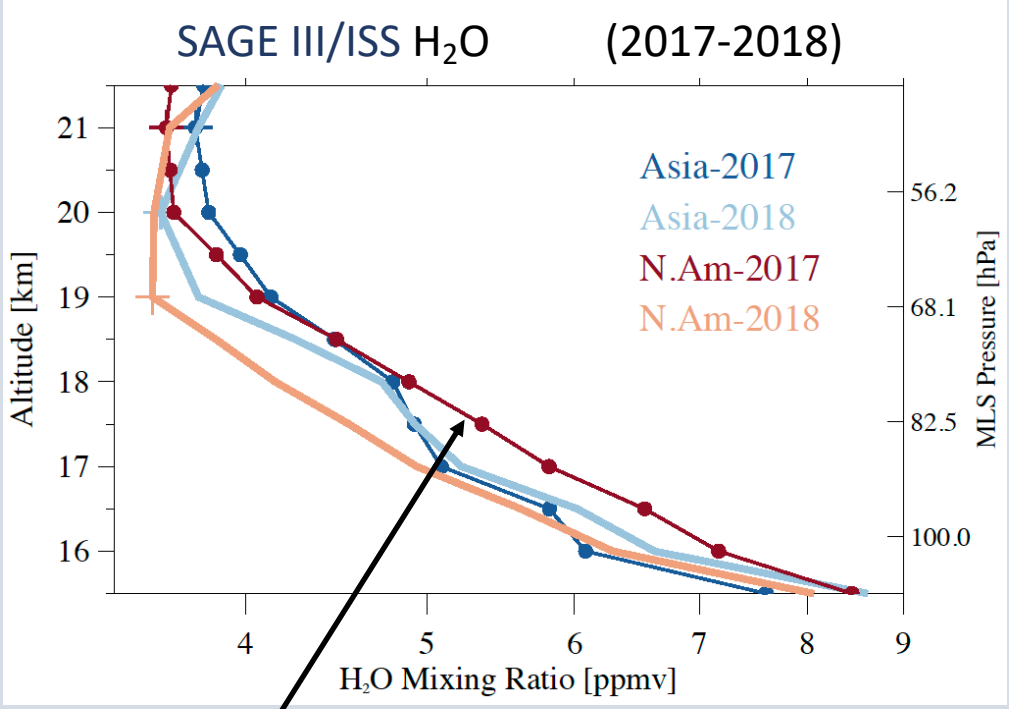


SAGE III/ISS H_2O 16 .5 km (Aug 2018)

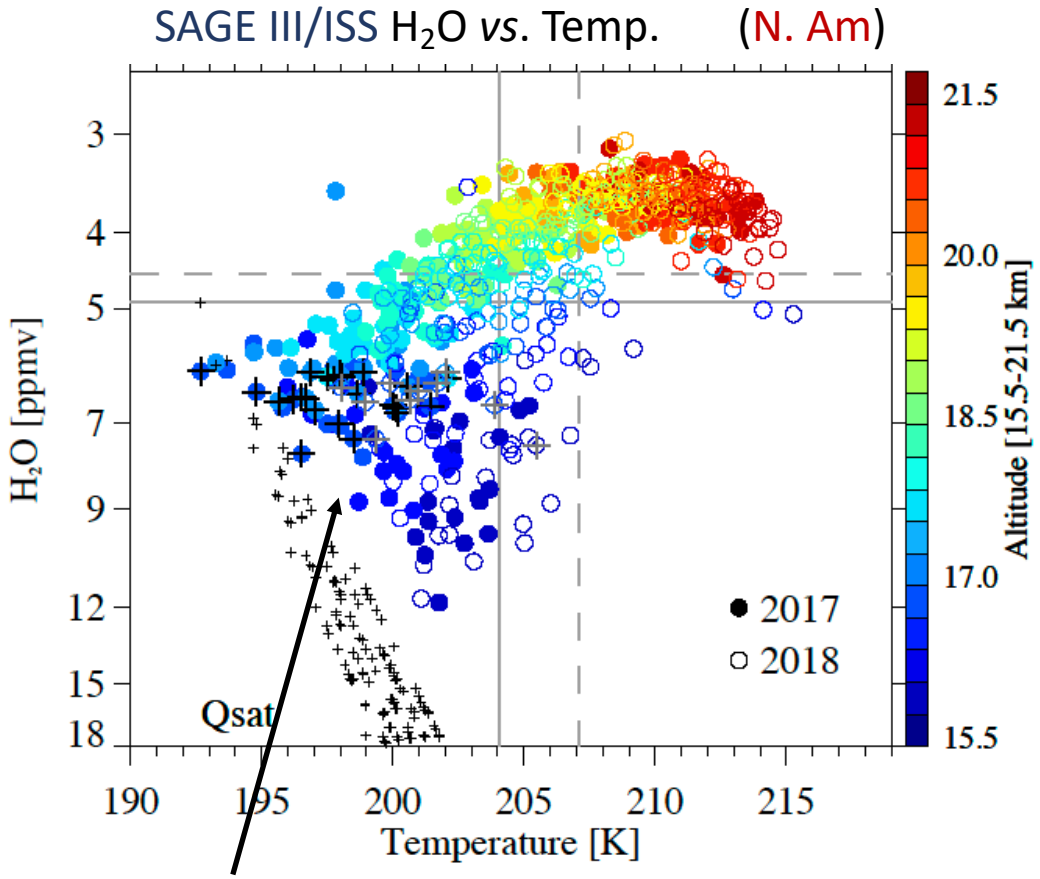


Max H_2O over Asian and North American monsoons.
Max over North America is larger in 2017 than 2018.

SAGE III/ISS H_2O N. America August 2017/2018

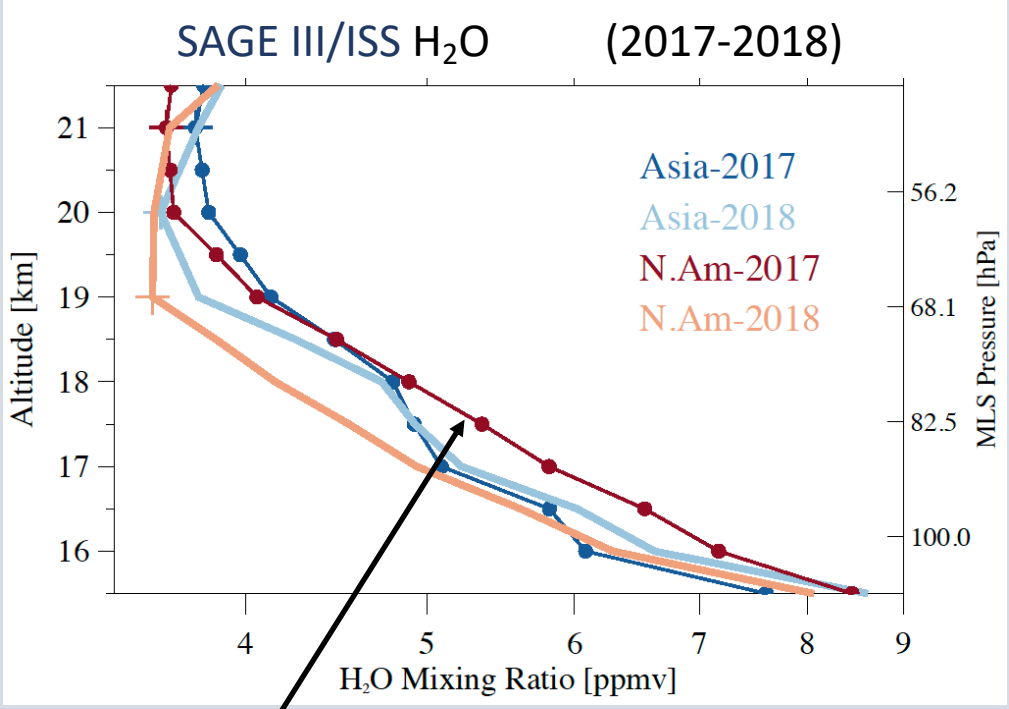


N. America (2017) – Highest H_2O (16-18.5 km)

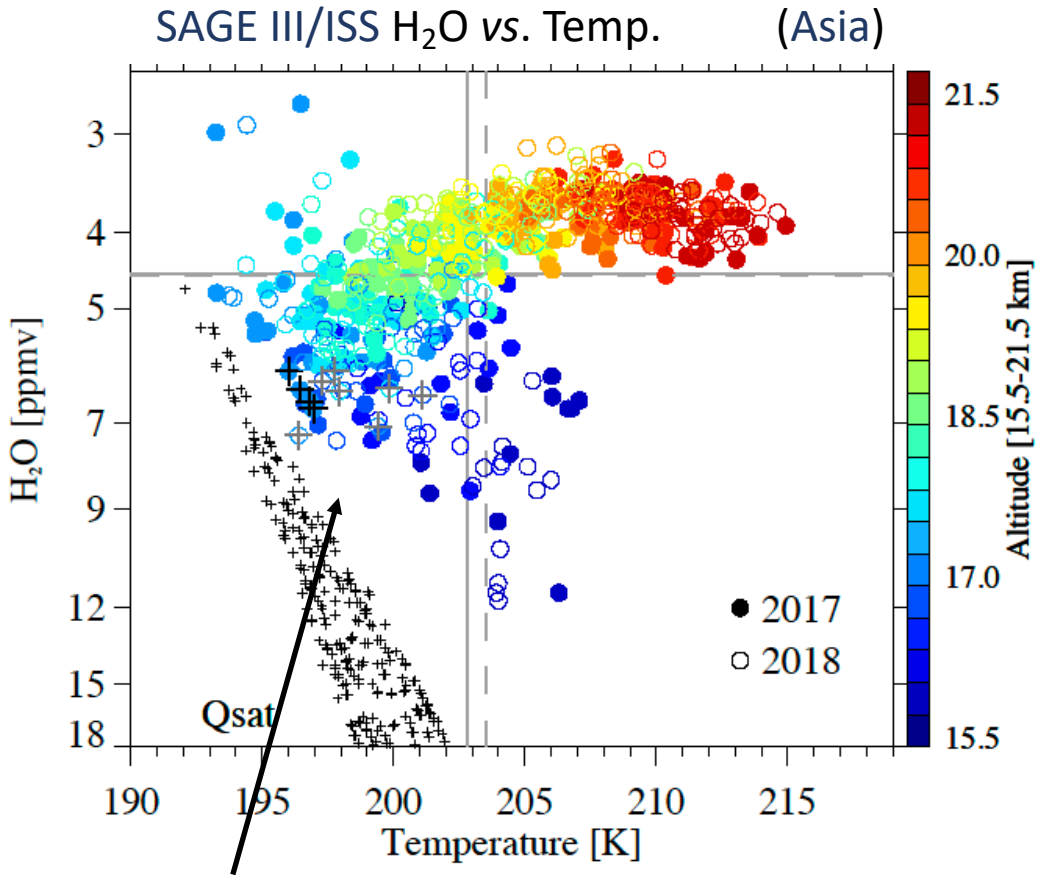


North America (2017)
- High H_2O & Low Temperature
- H_2O > 6 ppm (above CPT)

SAGE III/ISS H_2O Asia August 2017/2018



N. America (2017) – Highest H_2O (16-18.5 km)



Asia (2017 & 2018)

- Low H_2O & Low Temperature
- Very few H_2O > 6 ppm exists above CPT

Summary

- SAGE III/ISS agrees with MLS H_2O version 5 in terms of spatial and temporal variability in the stratosphere for June 2017-May 2020.

- Relative humidity (RH) calculated from SAGE III/ISS H_2O at CPT show seasonal maxima over the Western Pacific and Africa in NH winter and central Pacific and Asian monsoon region in NH summer.

- SAGE III/ISS H_2O retrieval sensitivity to stratospheric aerosol loadings needs further evaluation. Looking forward to version 5.2 release!