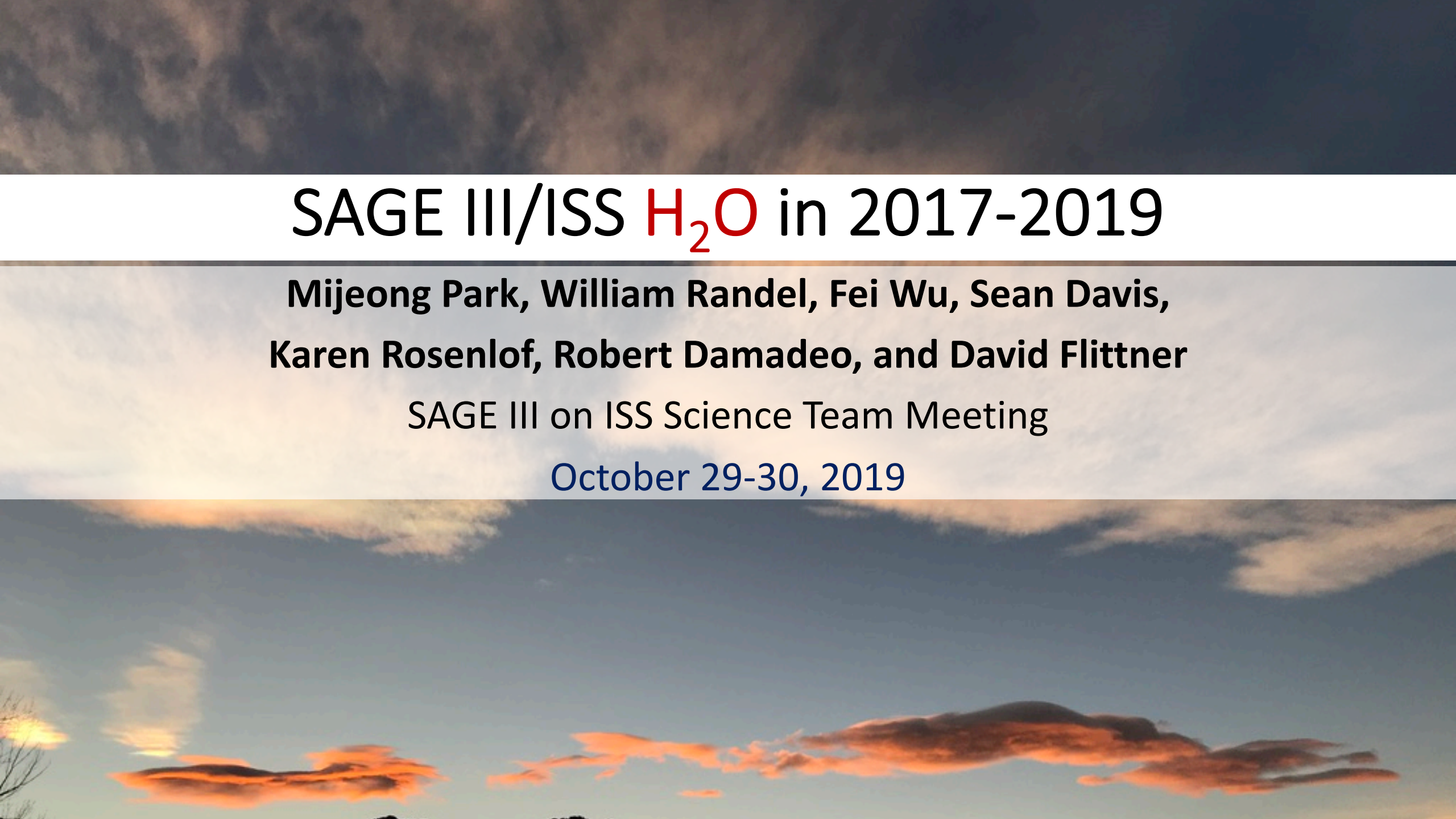




SAGE III/ISS H_2O in 2017-2019

**Mijeong Park, William Randel, Fei Wu, Sean Davis,
Karen Rosenlof, Robert Damadeo, and David Flittner**

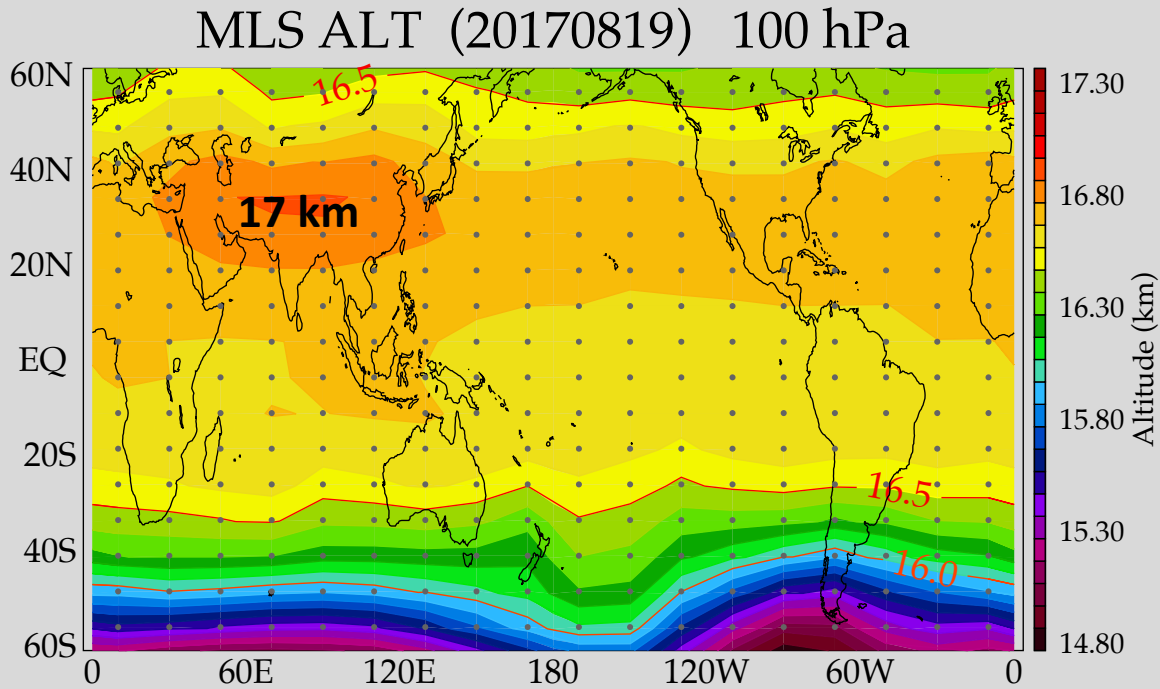
SAGE III on ISS Science Team Meeting

October 29-30, 2019

Contents

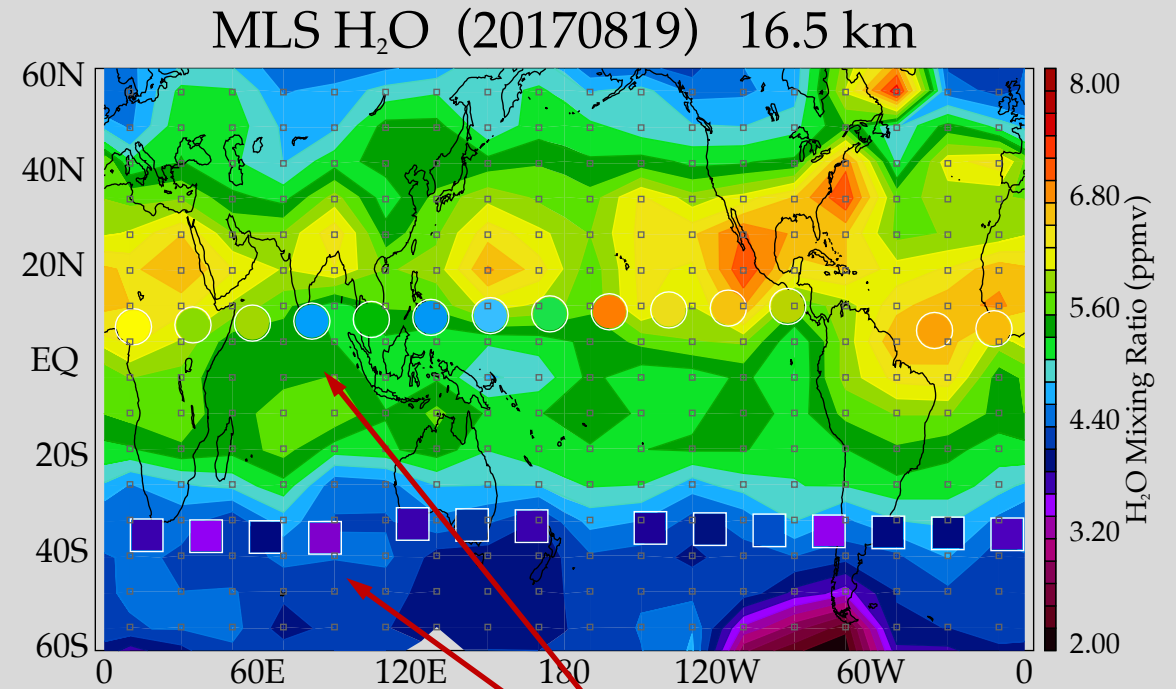
1. SAGE III/ISS vs. MLS H₂O comparison
 - Uncertainty and aerosol ext. 1022
2. SAGE III/ISS H₂O variability in 2017 vs. 2018

SAGE III/ISS vs. MLS H₂O Comparison (20170819)



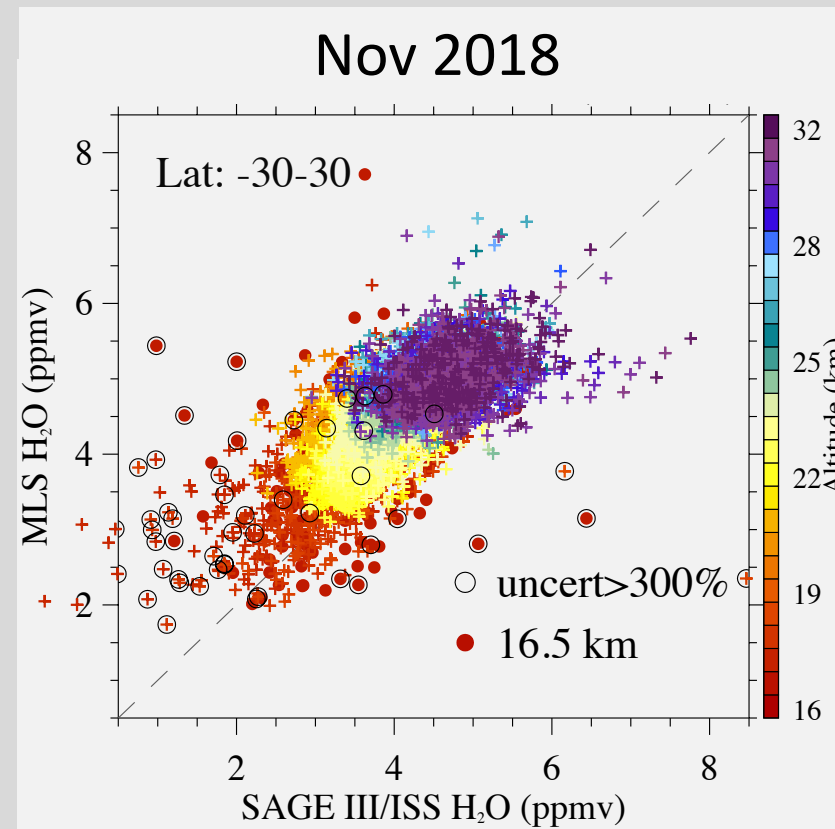
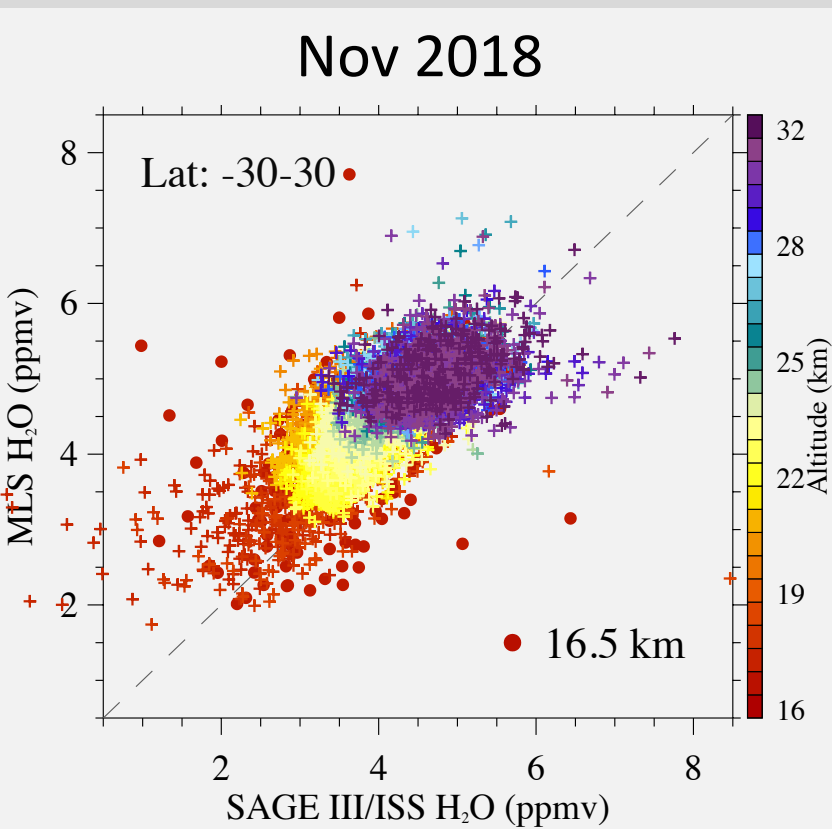
MERRA-2 altitude on 100 hPa

Pressure <- -> Altitude

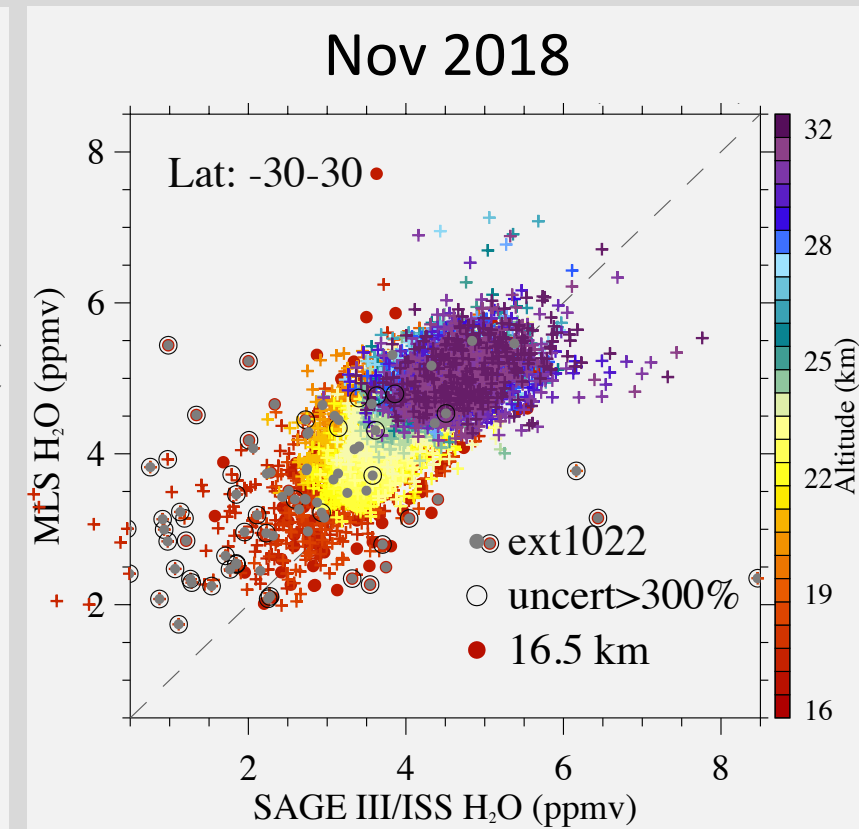


Spatial/temporal sampling

SAGE III/ISS vs. MLS H₂O (Uncertainty & Aero. Ext 1022)



uncertainty > 300 %

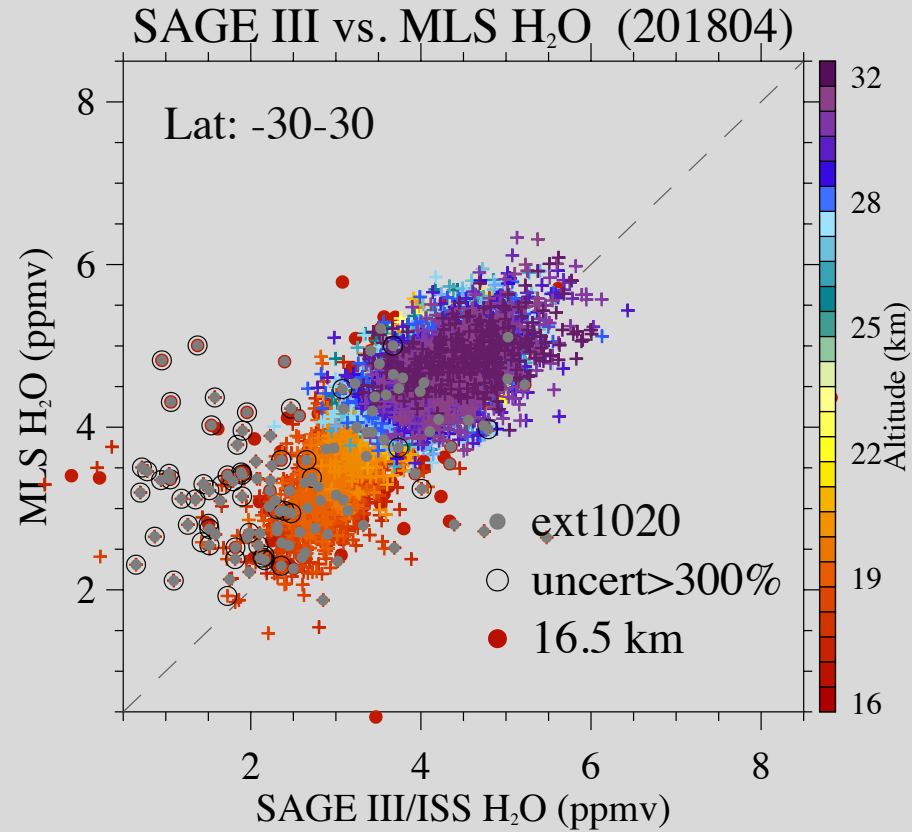


aero ext. 1022 > 10⁻³ km⁻¹

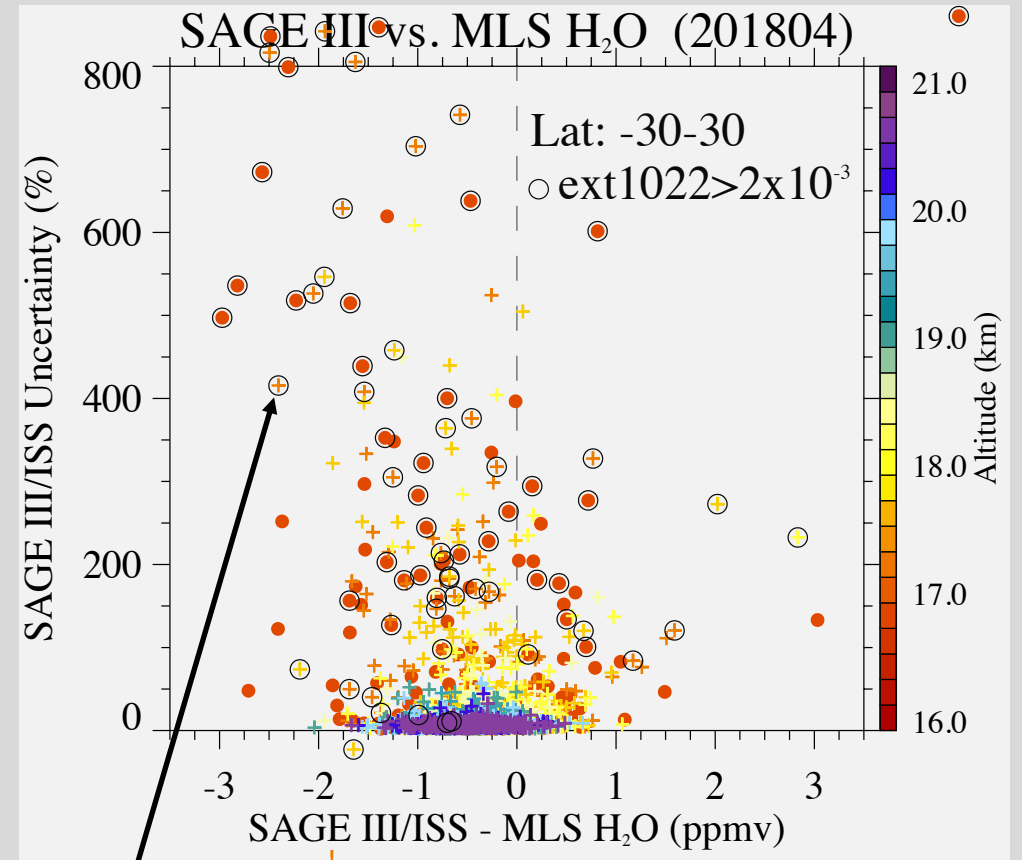
Altitude = 16-32 km

SAGE III/ISS vs. MLS H₂O (Differences)

30S-30N



uncertainty



Altitude = 16-21 km

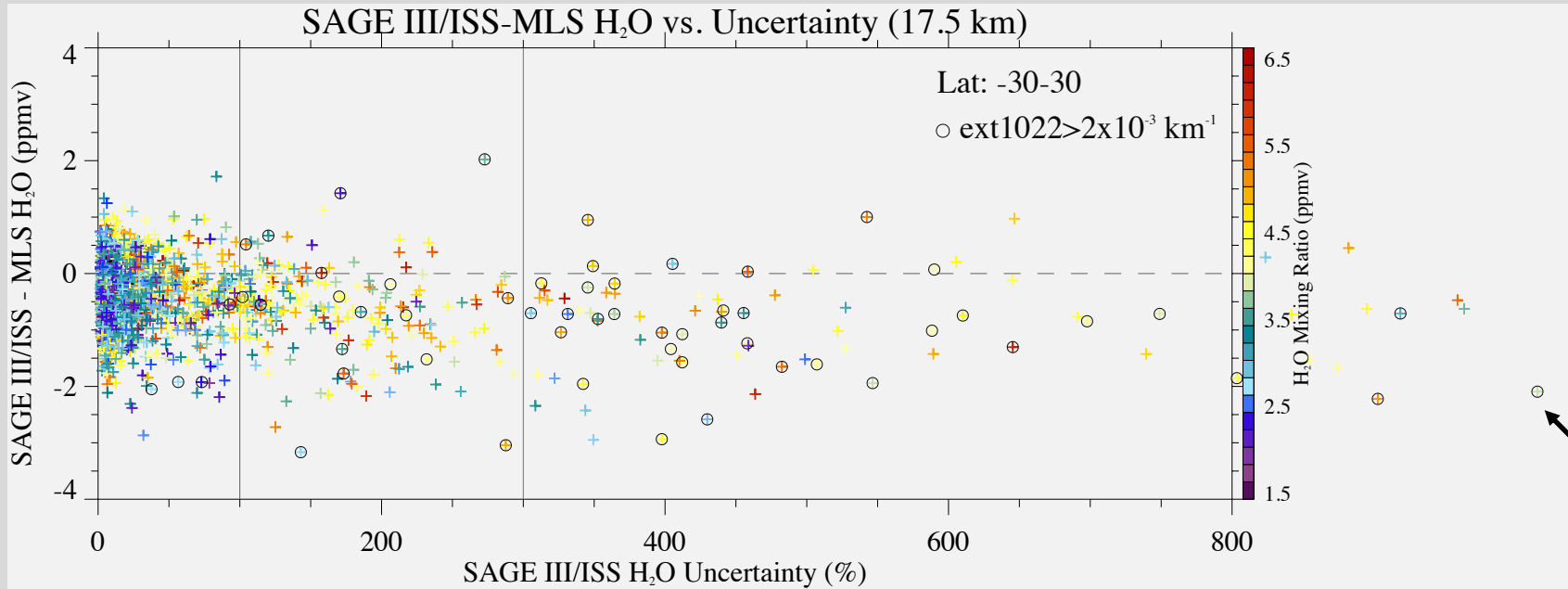
aero ext. 1022 > 2x10⁻³ km⁻¹

SAGE III/ISS-MLS H₂O (Uncertainty)

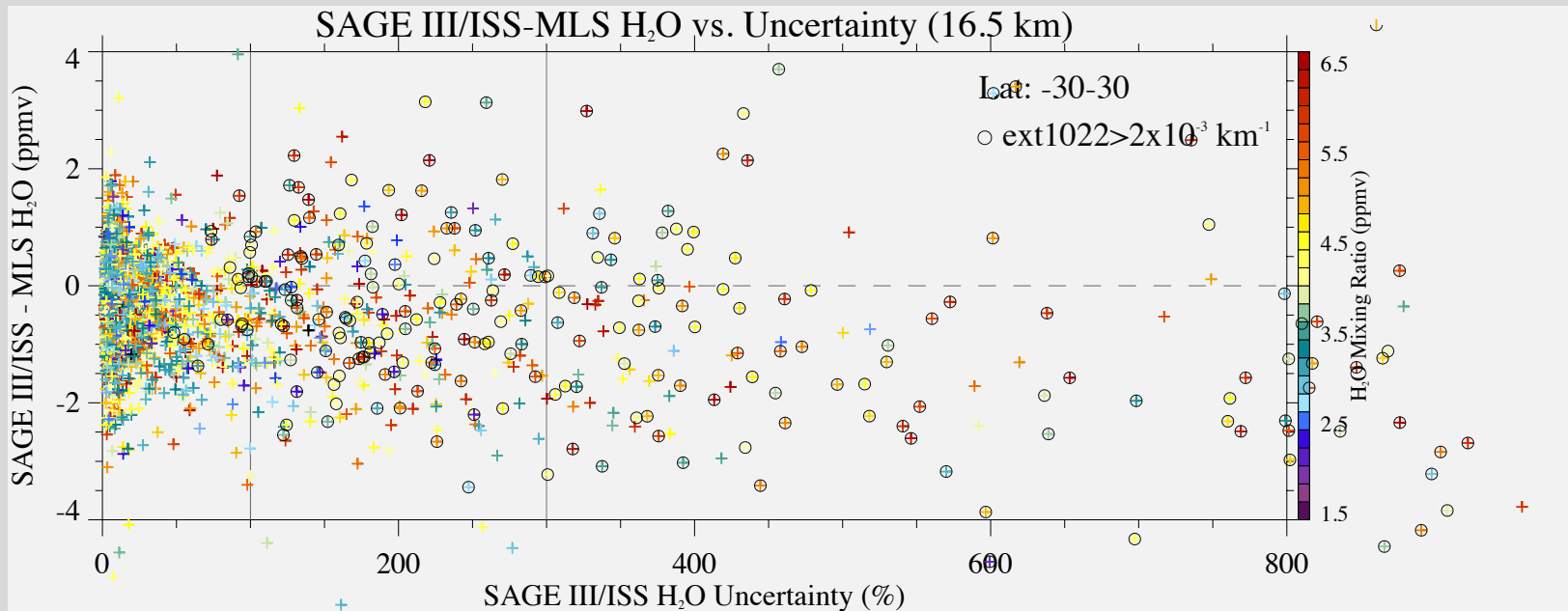
201706-201905

17.5 km

30S-30N



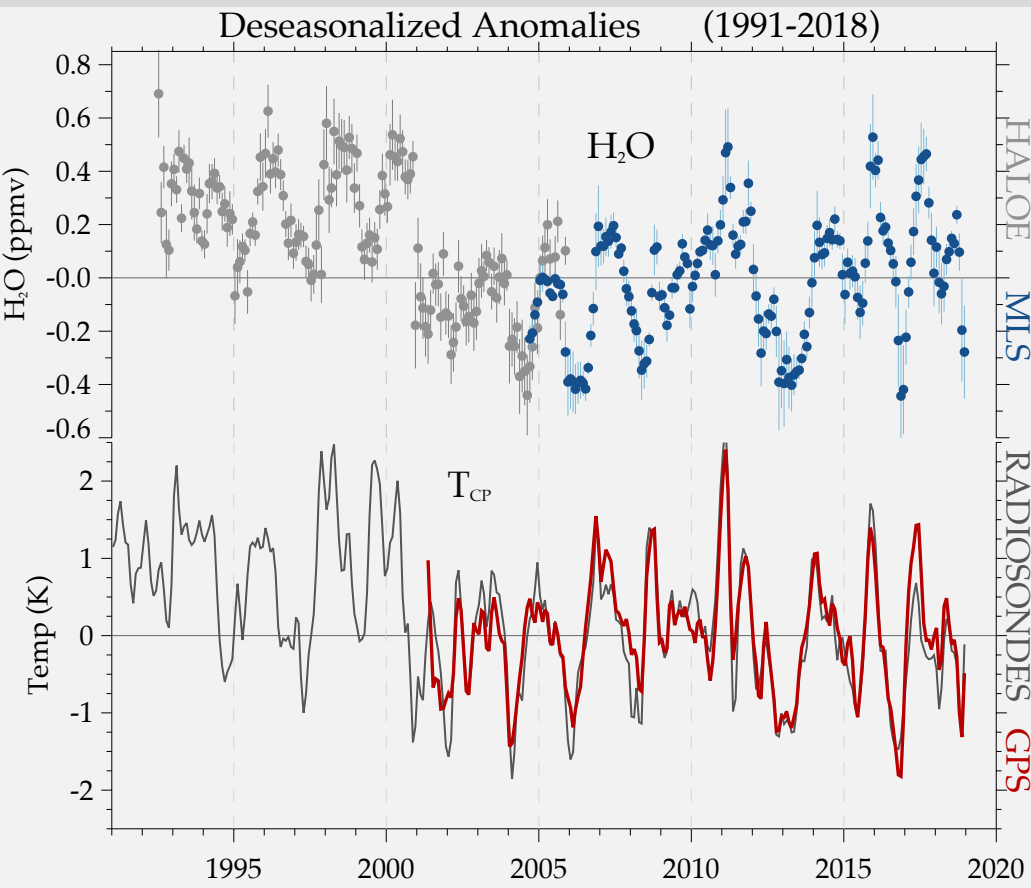
16.5 km



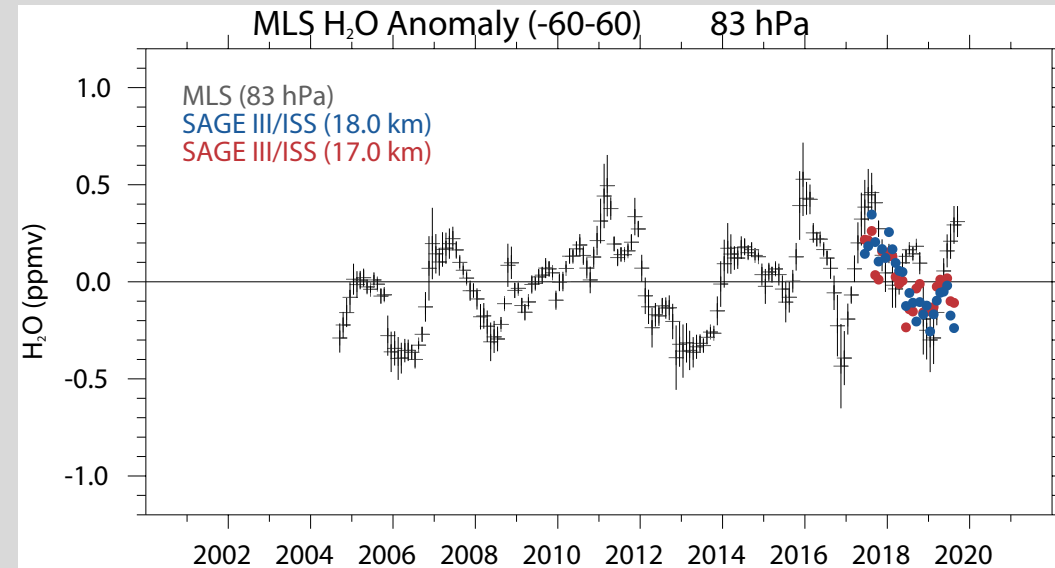
large uncertainty +
high aero. Ext. 1022

H₂O Time Series (HALOE + MLS + SAGE III/ISS)

H₂O (global average) vs. CPT

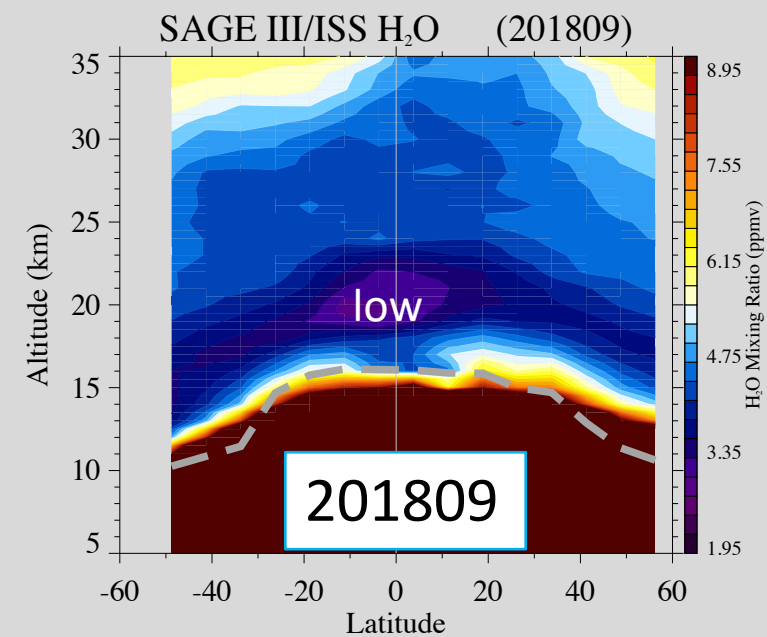
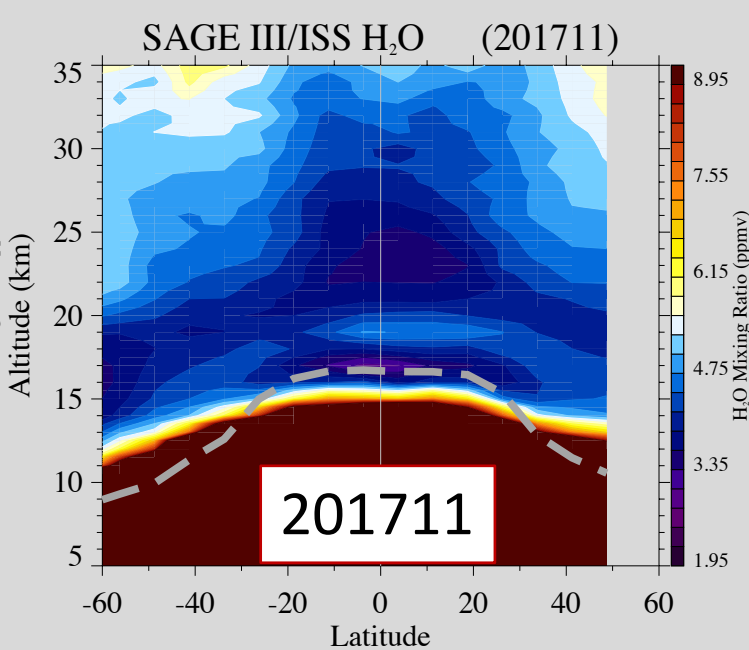
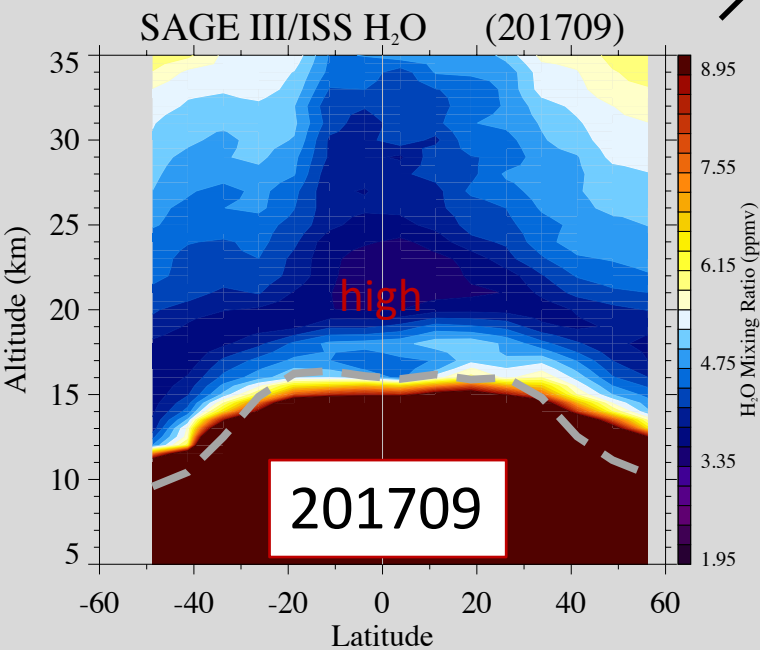
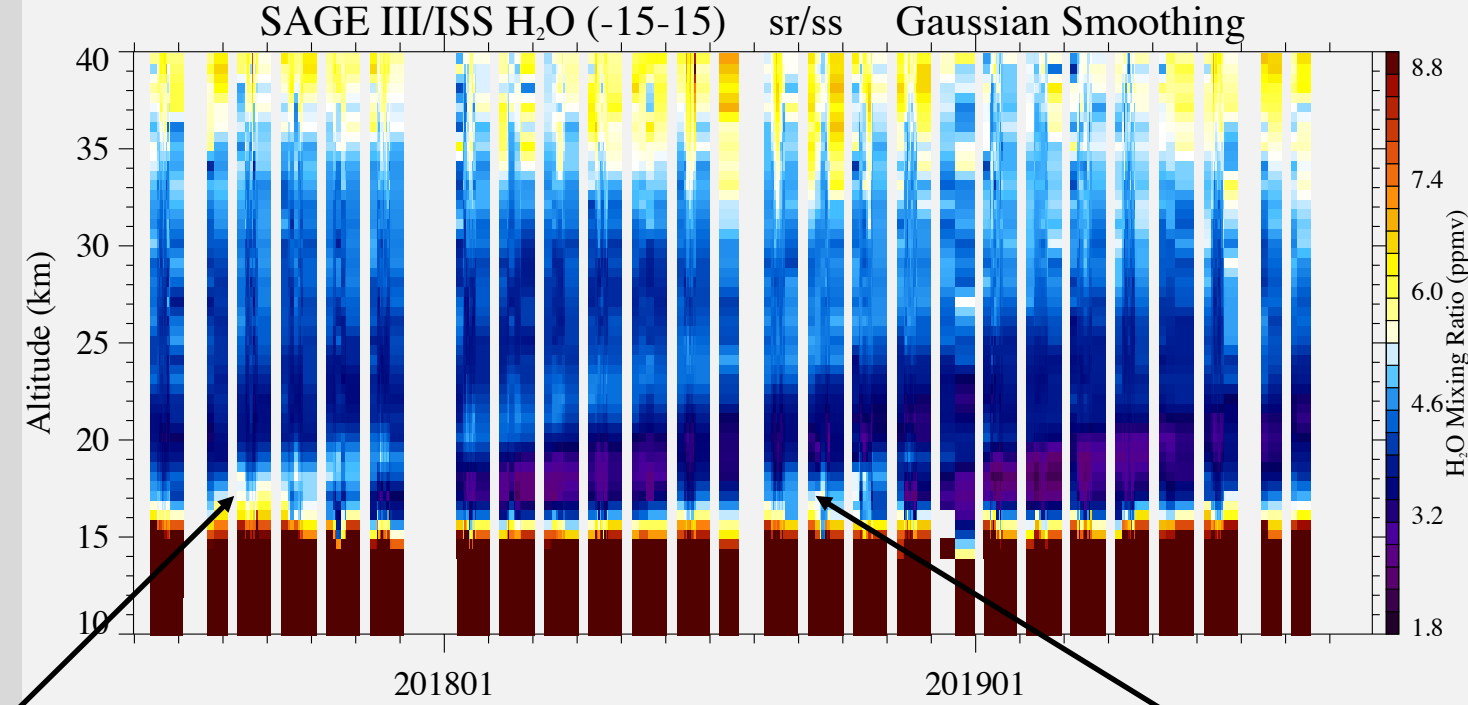


Randel and Park (2019)



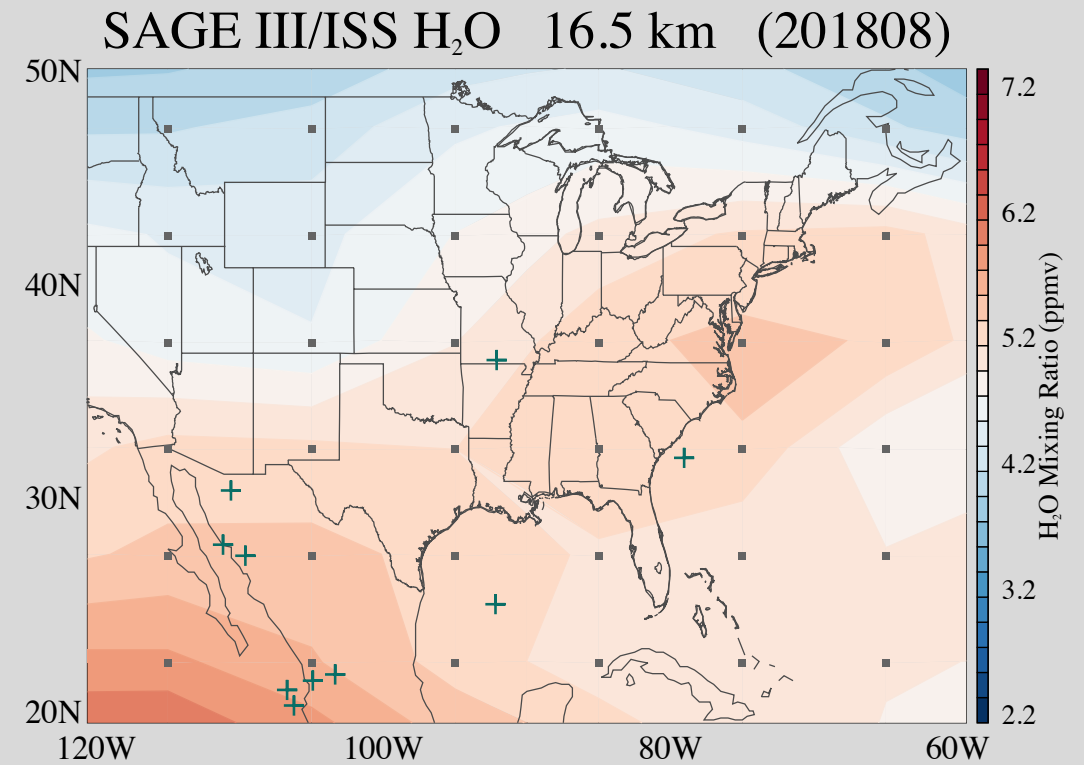
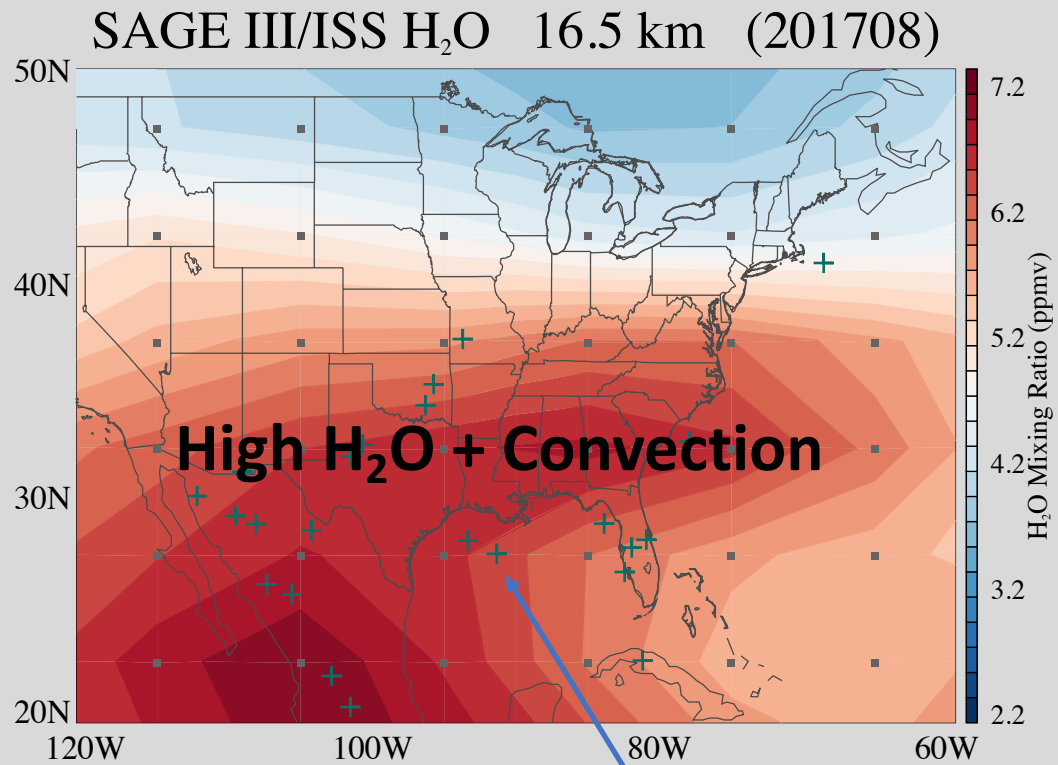
H₂O – global average
(MLS & SAGE III/ISS)

SAGE III/ISS H₂O (2017 vs. 2018)



SAGE III/ISS H₂O (16.5 km)

2017 vs. 2018

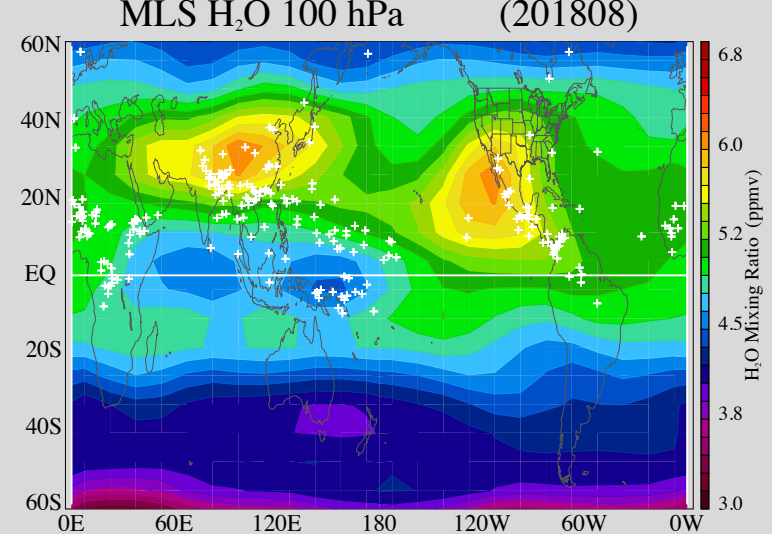
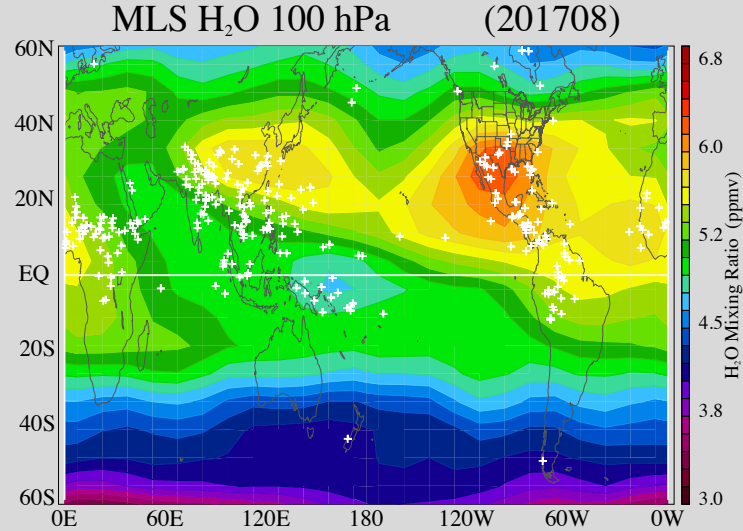
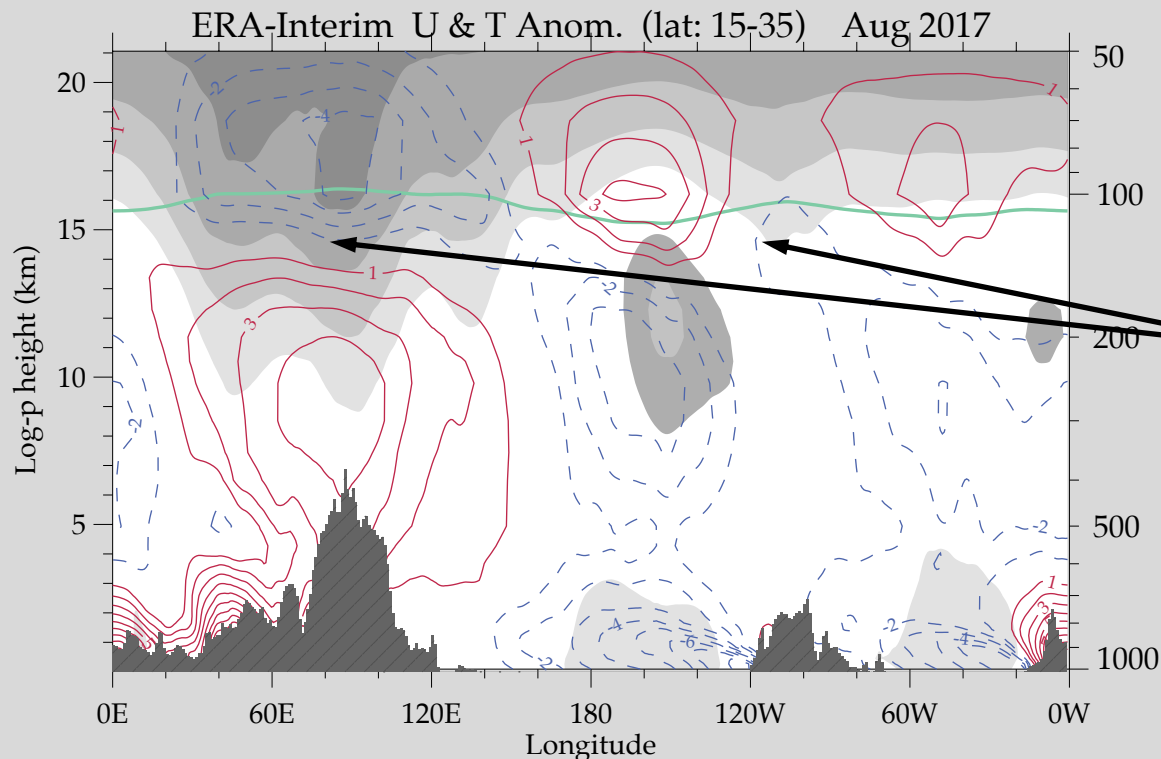


GPM (20 dBZ > 16 km)
(Global Precipitation Measurement)

GPM data from Nana Liu

Asian vs. American monsoons

ERA-Interim
Temperature
Zonal Wind
(Aug 2017)

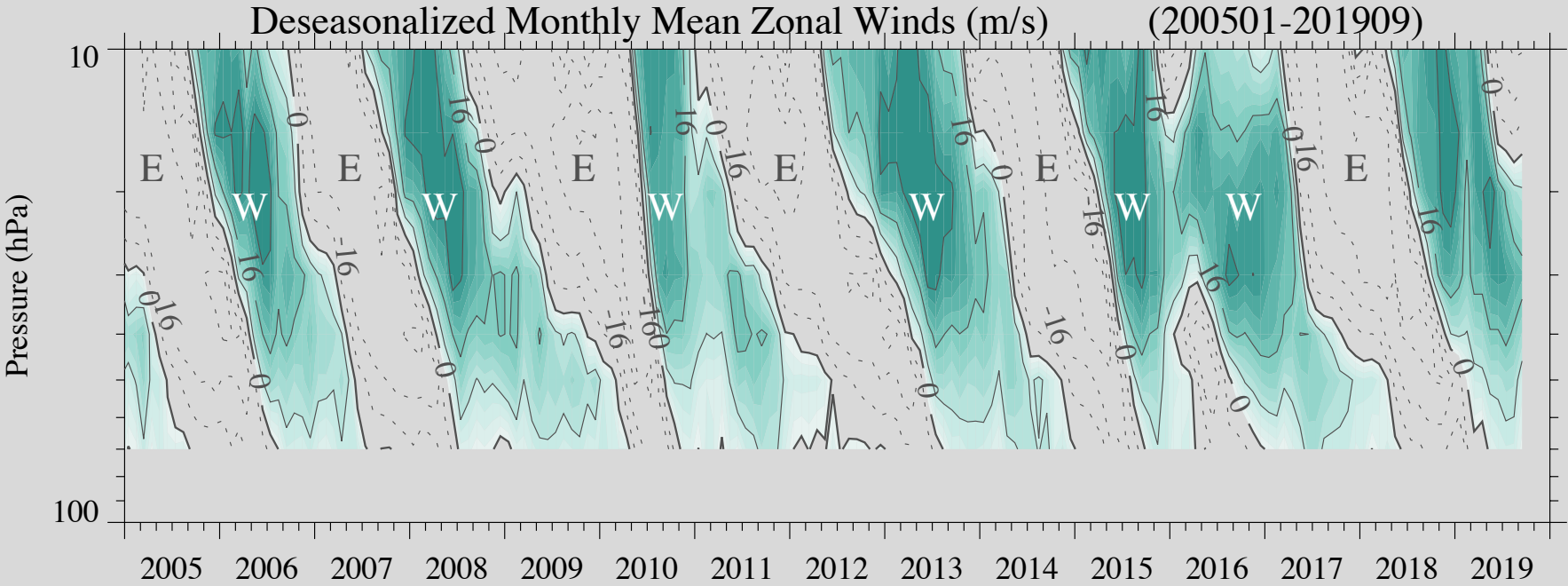


GPM data from Nana Liu

Thermal structure (hence RH) is different over Asian vs. American monsoon regions.

Extreme convection strongly influences near and above the tropopause over NA but not over Asia.

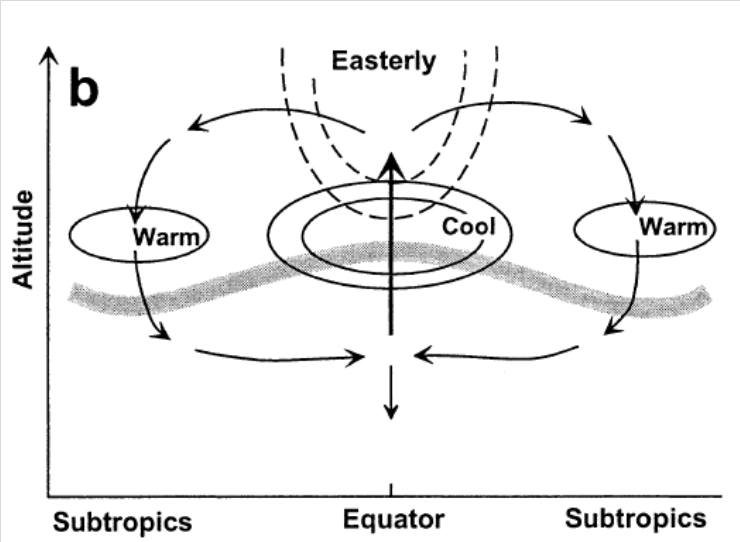
Stratospheric QBO



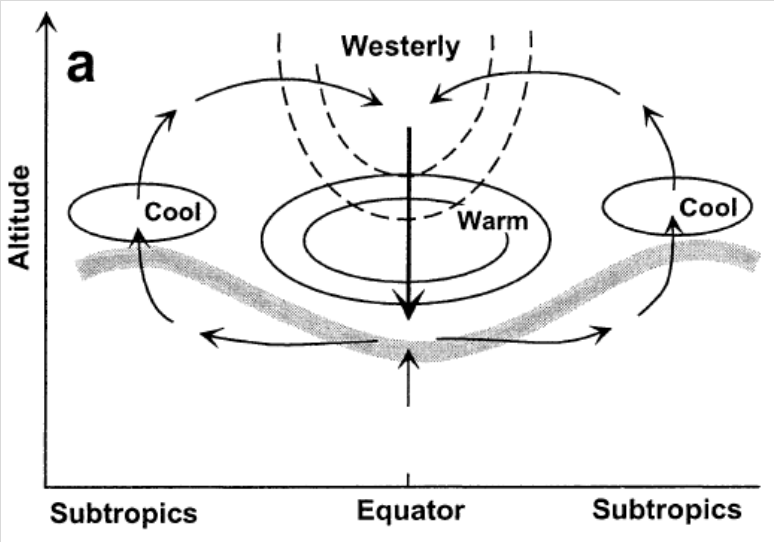
QBO wind shear was different for 2017 & 2018

FIG. 1. Schematic representation of the mean meridional circulation driven by the QBO, after Trepte (1993). Dashed contours indicate isopleths of zonal velocity; solid contours represent anomaly isotherms. The thick, gray lines represent the tropopause. (a) Warm anomaly during descending zonal mean westerly shear; (b) cold anomaly during descending zonal mean easterly shear.

Collimore et al. (2003)



2017



2018

Summary

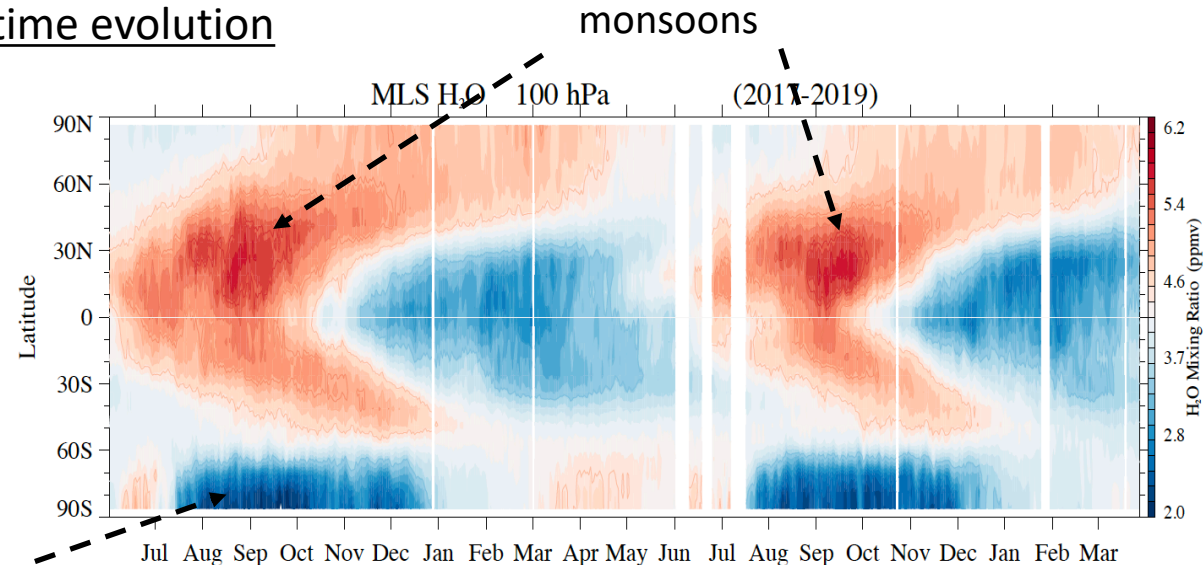
1. SAGE III/ISS vs. MLS H₂O comparison
 - Continue work on quality control (uncertainty + aero ext. 1022)
2. SAGE III/ISS H₂O variability in 2017 vs. 2018
 - Interannual variability in H₂O (NH summer : 2017 > 2018)

Exploring SAGE III/ISS data near the tropopause

- 1) Using ozone – H₂O tracer correlations to identify tropopause structure
- 2) Deriving relative humidity from SAGE III/ISS H₂O retrievals

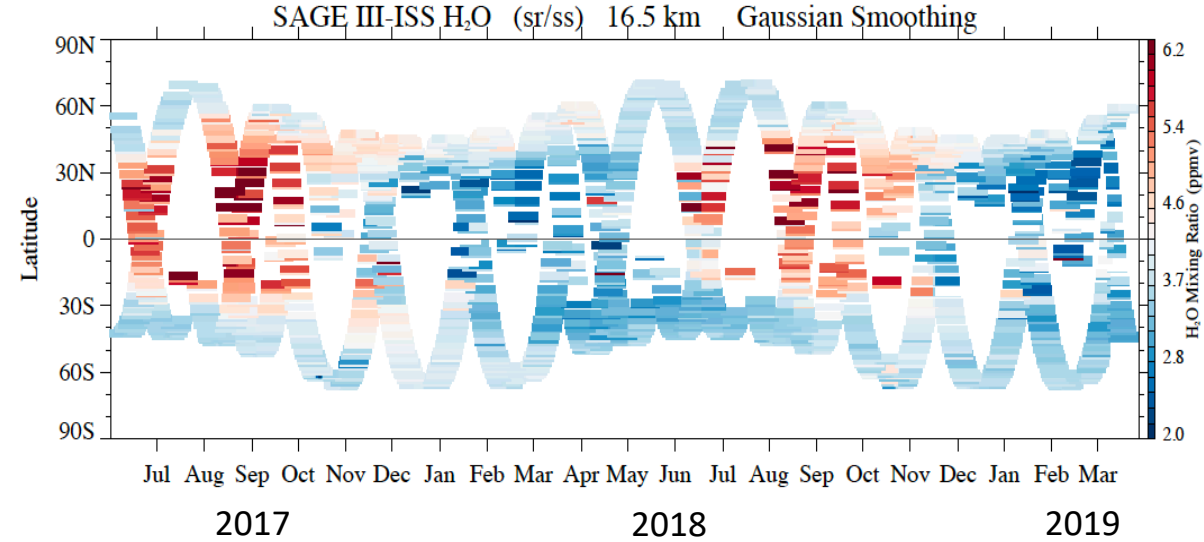
What novel information can be derived from the high quality,
high vertical resolution SAGE III/ISS observations?

Latitude vs. time evolution



MLS H₂O at 100 hPa

Antarctic
dehydration

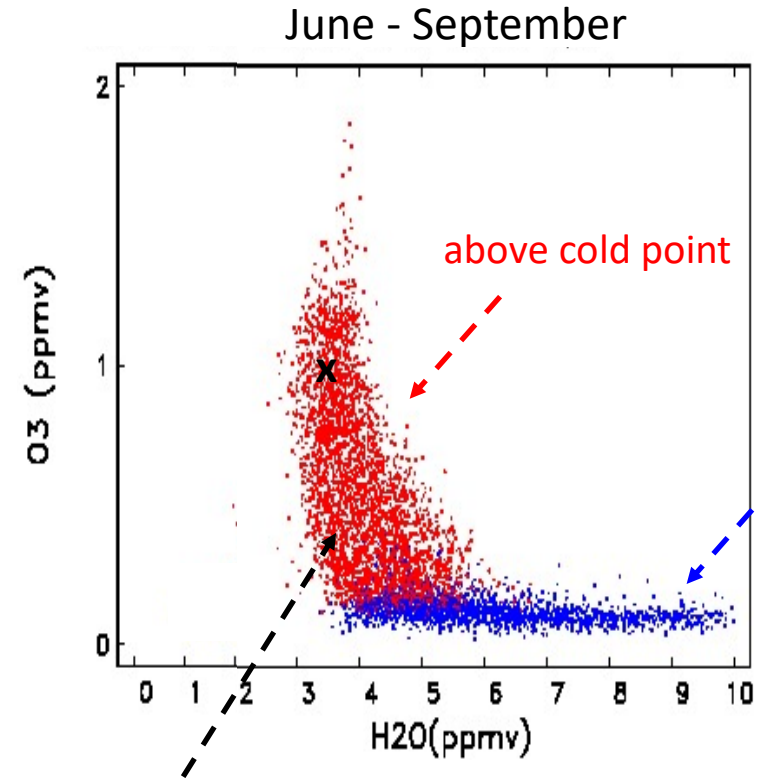
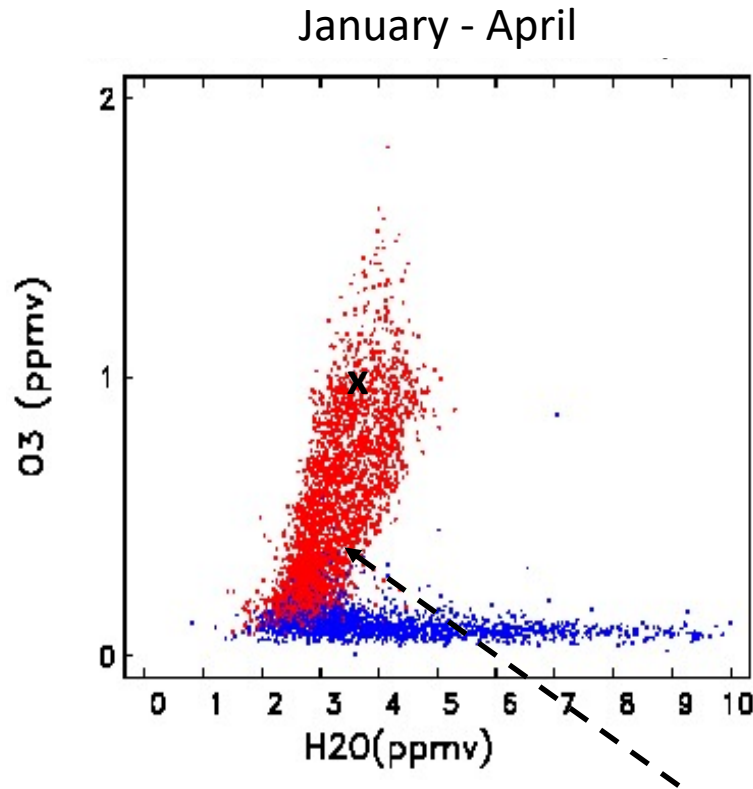


SAGE III/ISS H₂O at 16.5 km

Tropical tropopause layer ozone – H₂O correlations

*high vertical resolution
diagnostics of the TTL*

15-20 km 20° N-S



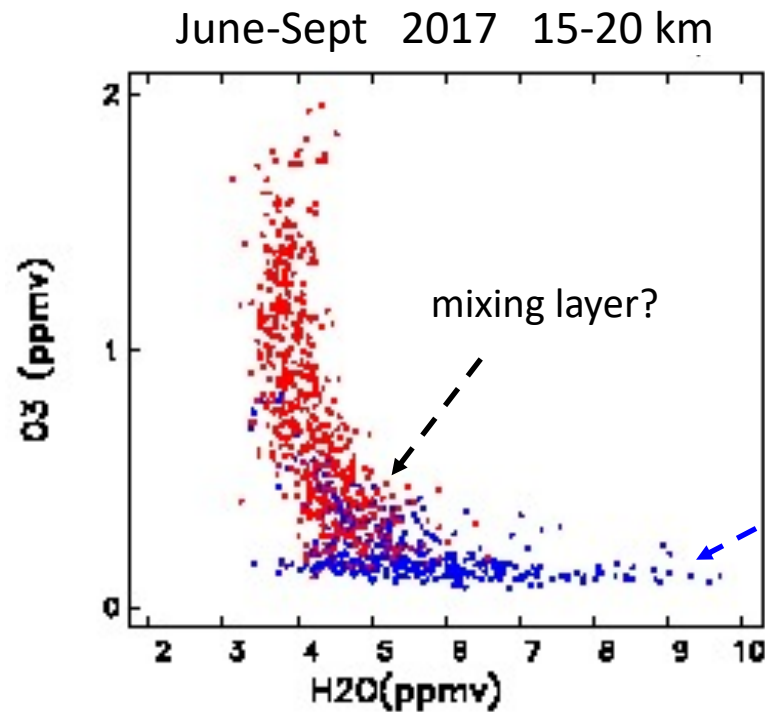
data separated
according to
cold point tropopause

seasonal cycles in ozone and H₂O

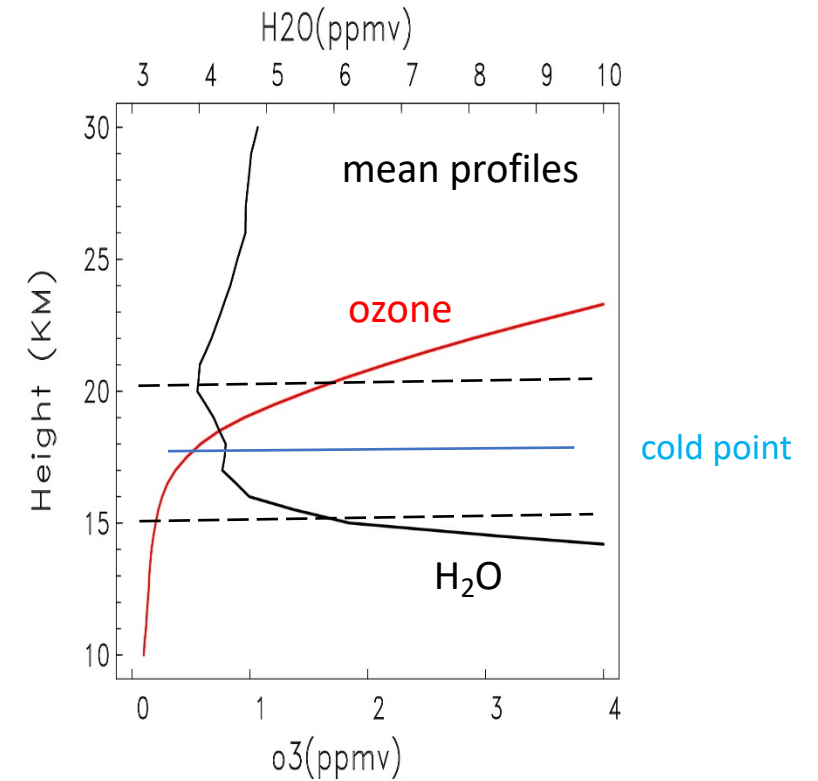
Ozone – H₂O correlations

Asian monsoon region

what do ozone-H₂O-tropopause relationships reveal about monsoon structure?



below cold point



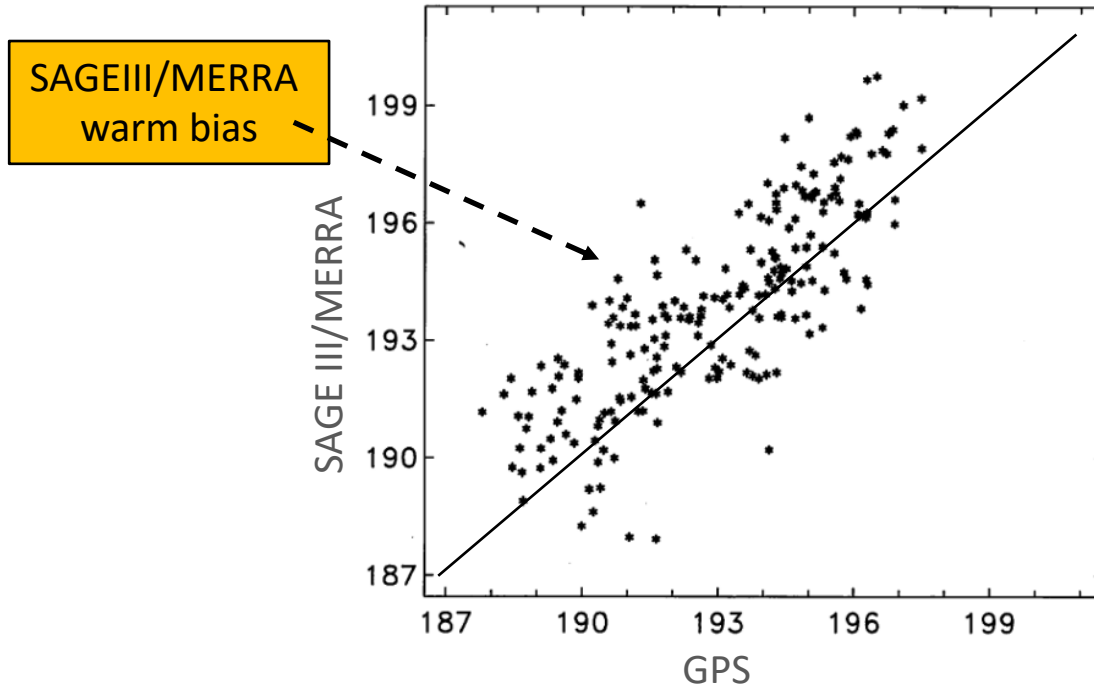
Relative humidity near the tropopause from SAGE III/ISS data:

Near the tropopause, H_2O may closely follow local temperature, if dehydration occurs locally.

- How does observed H_2O compare to saturated H_2O profile from $T(z)$?
- Calculate $Q_{\text{sat}} = 100\%$ relative humidity from observed $T(z)$ (Clausius-Clapeyron)
- Exploratory calculations - *how meaningful is a 200 km integrated H_2O measurement?*

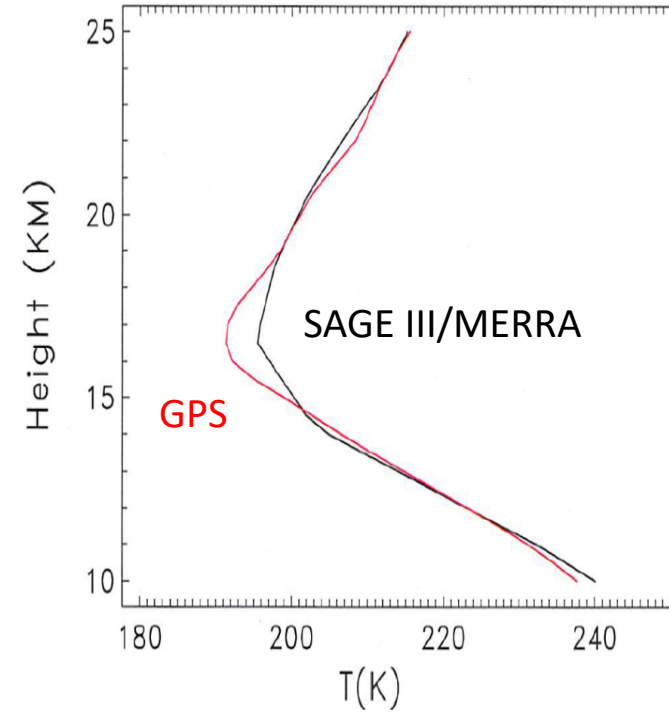
Using high vertical resolution GPS temperatures co-located with SAGE III/ISS retrievals

Cold point temperature



SAGE III/ISS occultations,
10° N-S, Jan-April 2018

example

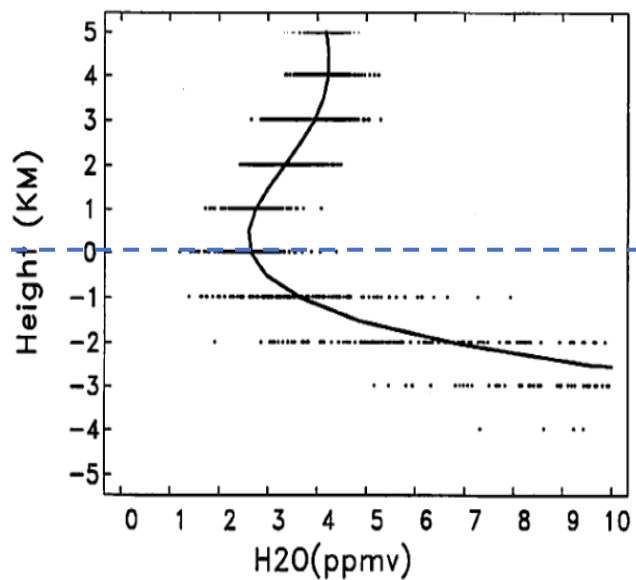


Statistics over 10^0 N-S during 'cold phase' (January-April 2018)

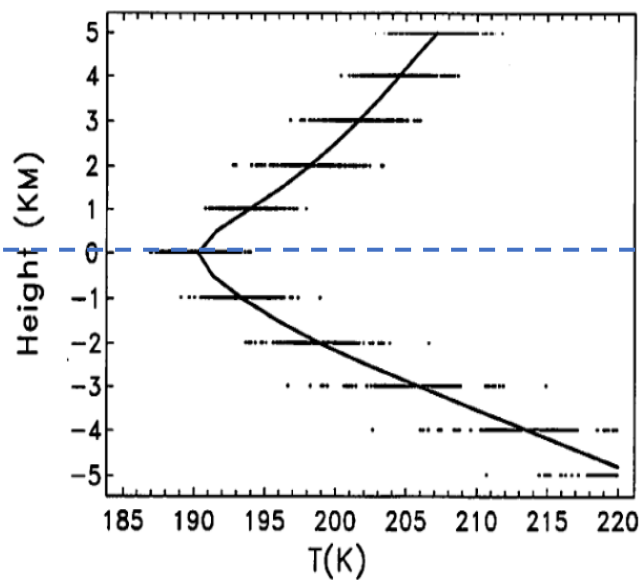
profiles organized wrt
cold point tropopause

cold point
tropopause

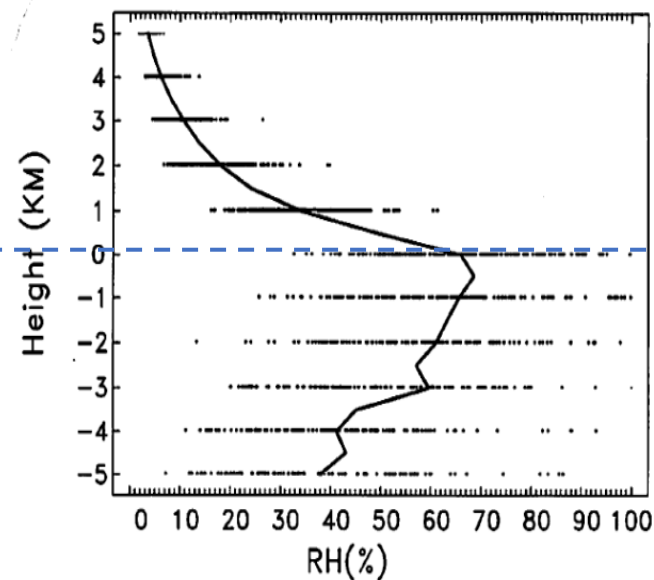
SAGE III/ISS H₂O



GPS temperature



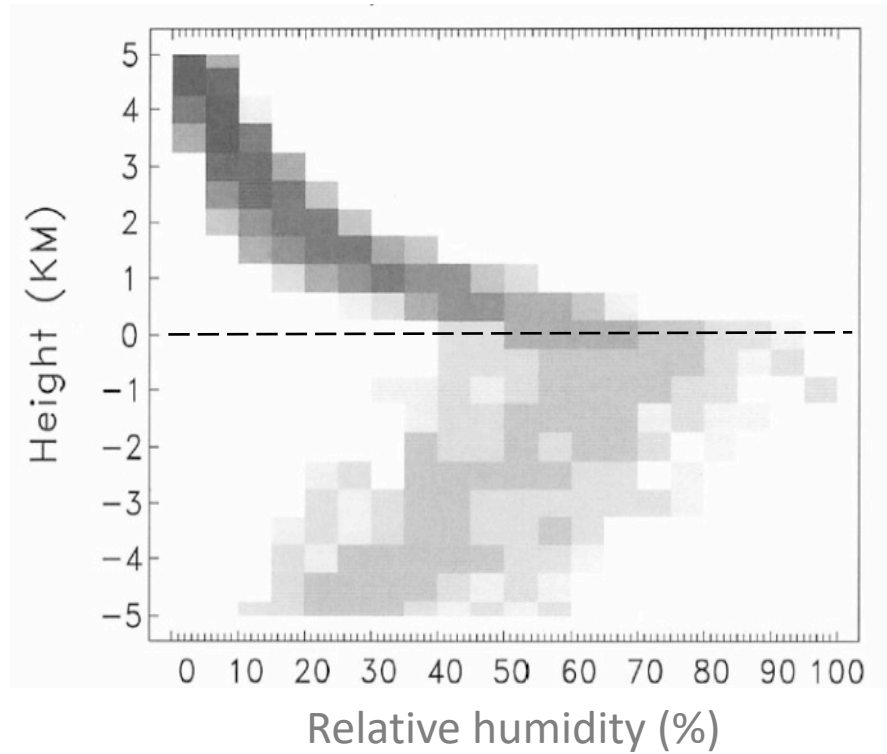
relative humidity



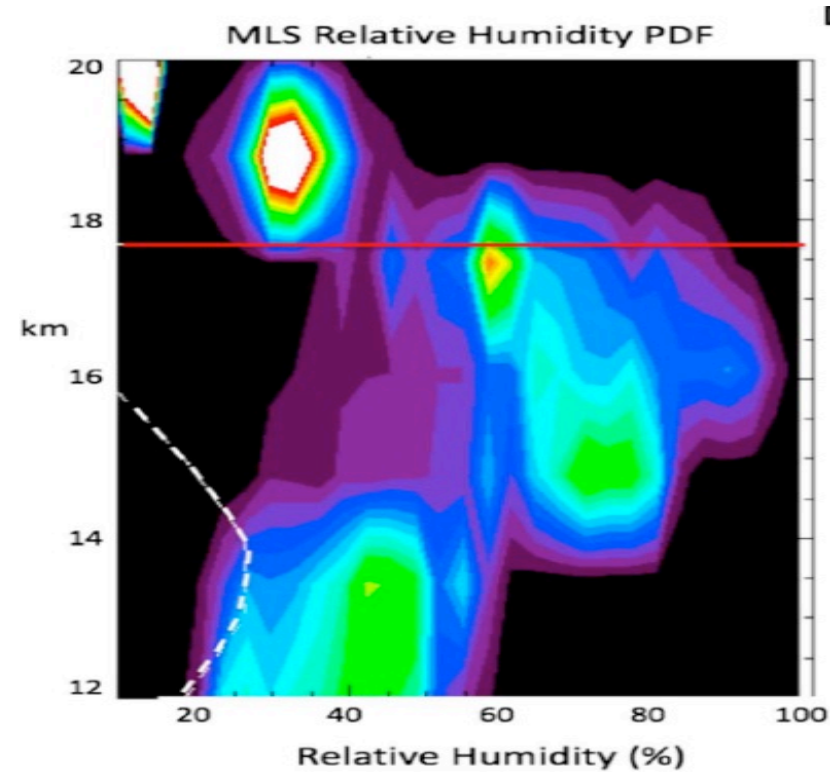
PDF of relative humidity vs. altitude (wrt. cold point)

SAGE III/ISS + GPS

cold point
tropopause



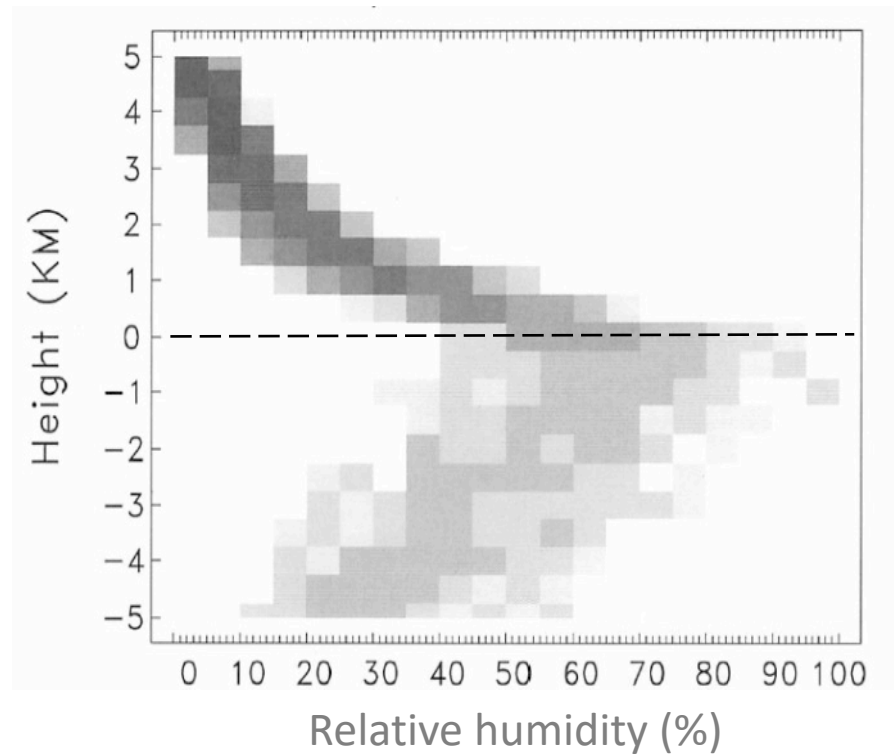
MLS results
Schoeberl et al. 2019 JGR



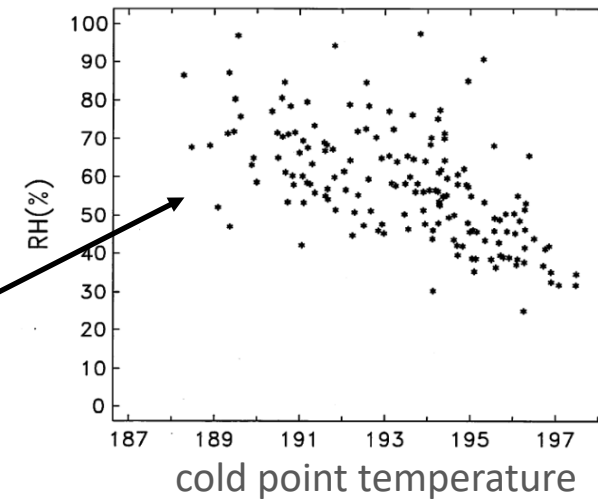
Higher RH for colder temperatures,
but very few saturated values

PDF of relative humidity vs. altitude (wrt cold point)

SAGE III/ISS + GPS



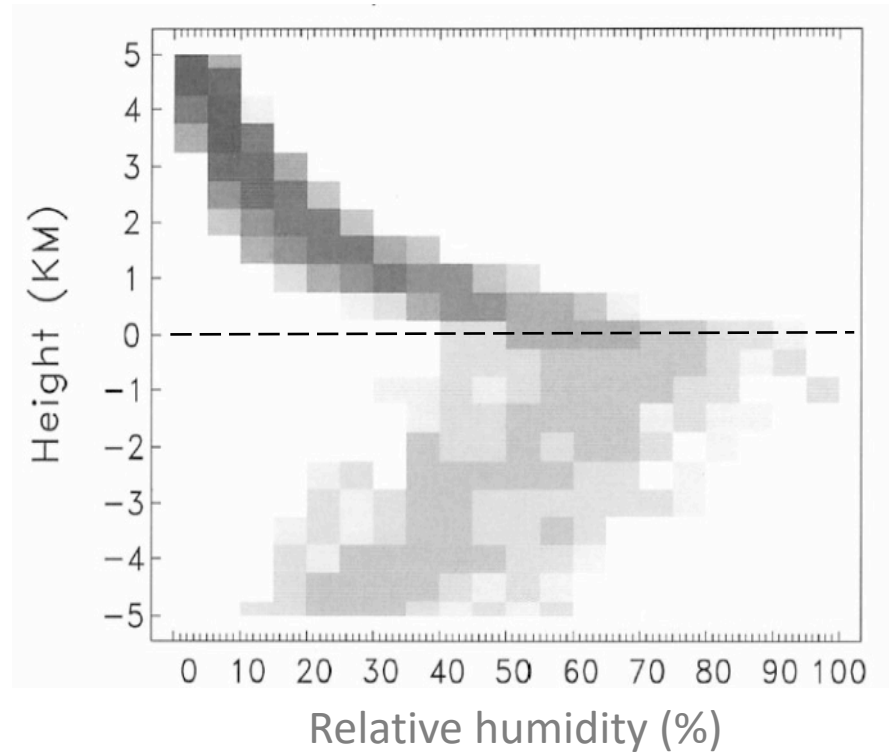
RH vs. temperature



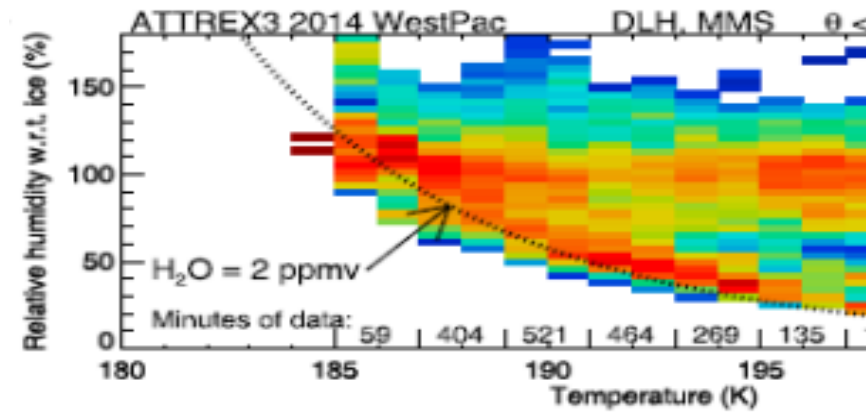
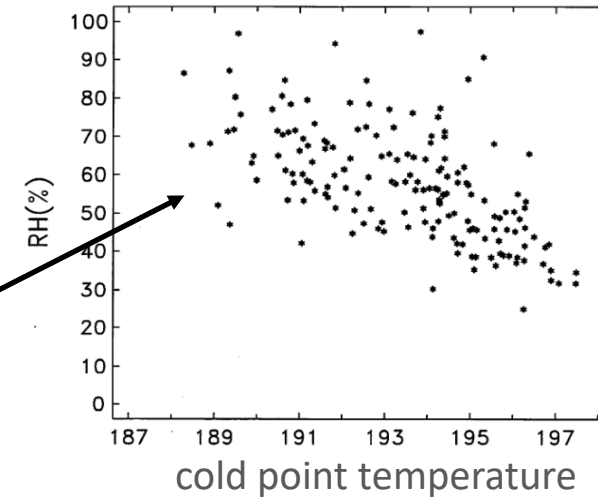
Higher RH for colder temperatures,
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PDF of relative humidity vs. altitude (wrt cold point)

SAGE III/ISS + GPS



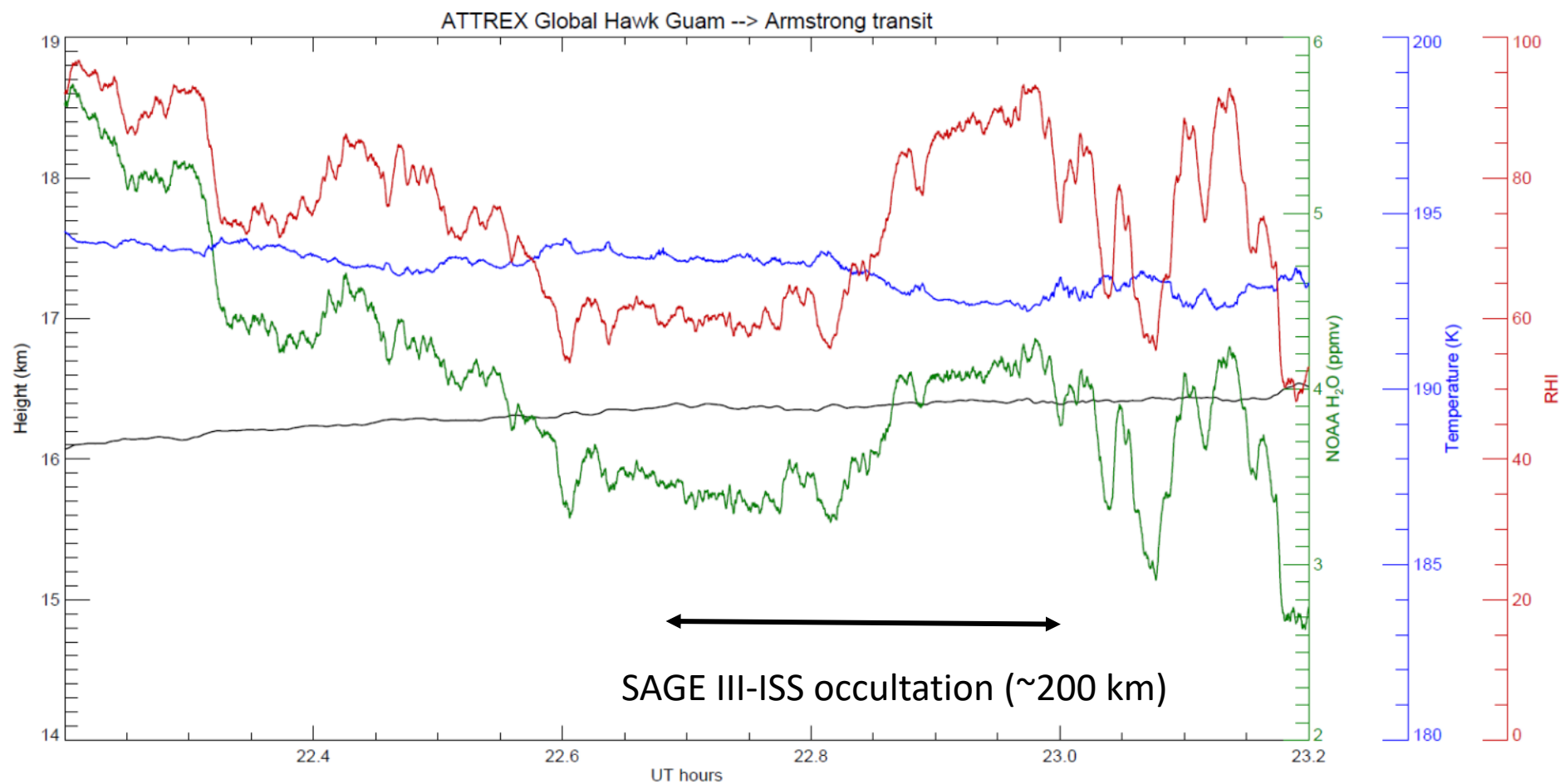
RH vs. temperature



ATTREX aircraft
data from
Western Pacific
Jensen et al 2017

ATTREX aircraft measurements from a near-level transit flight

courtesy Eric Jensen





Ongoing work:

- Using ozone-H₂O correlations to quantify tropopause structure. What is the information content on large- and small-scales?
- Evaluating H₂O and relative humidity distributions derived from SAGE III/ISS to understand tropopause transition layers.