Science Goals Involving H_2O and HDO Measurements

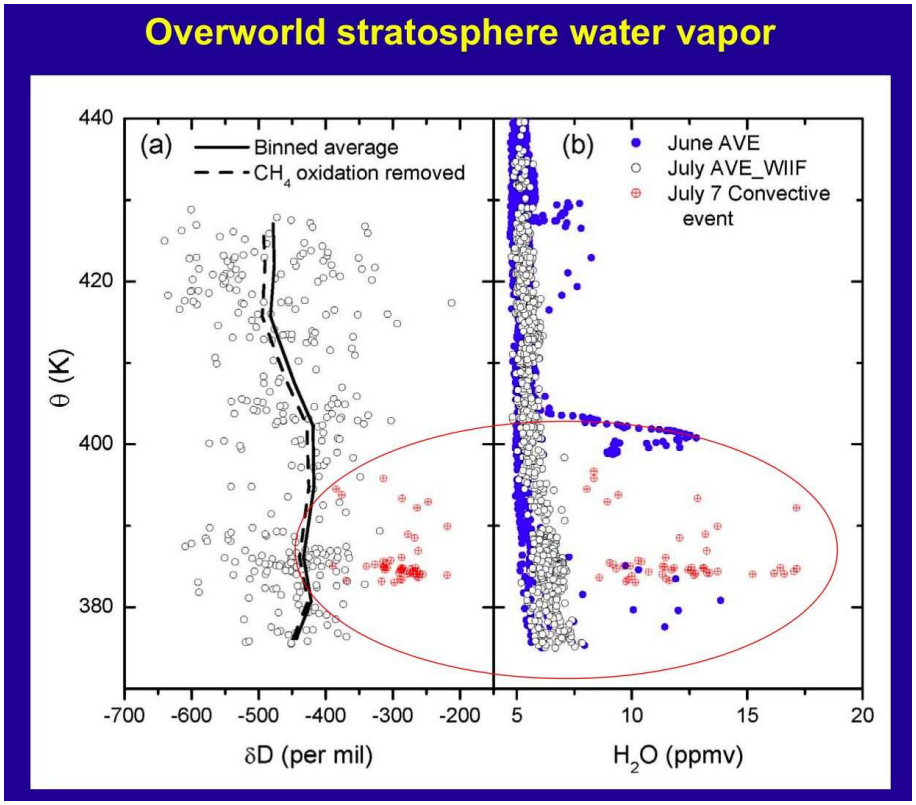
Measurements:

- Water vapor: Lyman-α, JLH, ICOS, Frostpoint, CLH, Maycomm
- Total water/ice water content: CSI, CLH, HOXotope
- HDO vapor: ICOS
- HDO total water: HOXotope
- HDO and DLH on the DC-8

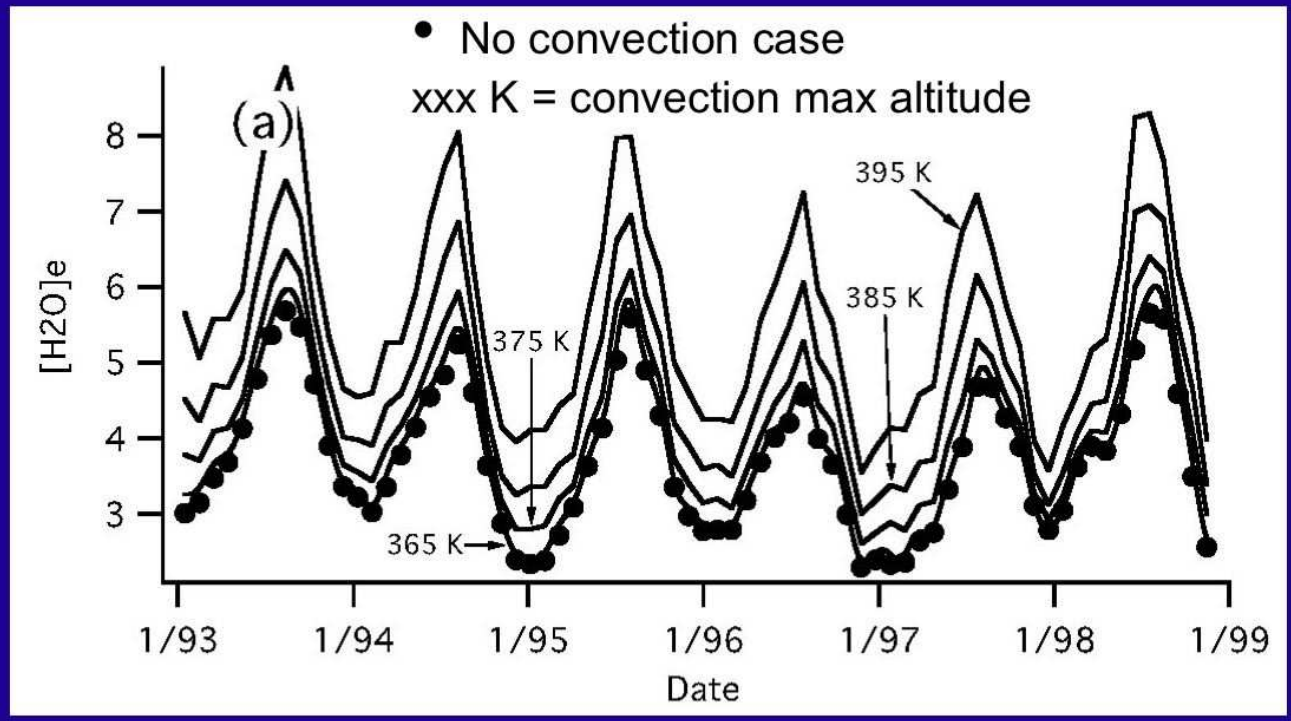
Thanks to Lenny Pfister, Tom Hanisco, Liz Moyer, and Jessica Smith for helpful input and figures.

1. How important is deep convection for regulating stratospheric humidity?

- Can convective injection of H_2O above the cold point decouple stratospheric humidity from tropopause temperature?
- Can isotope measurements be used to constrain convective input?

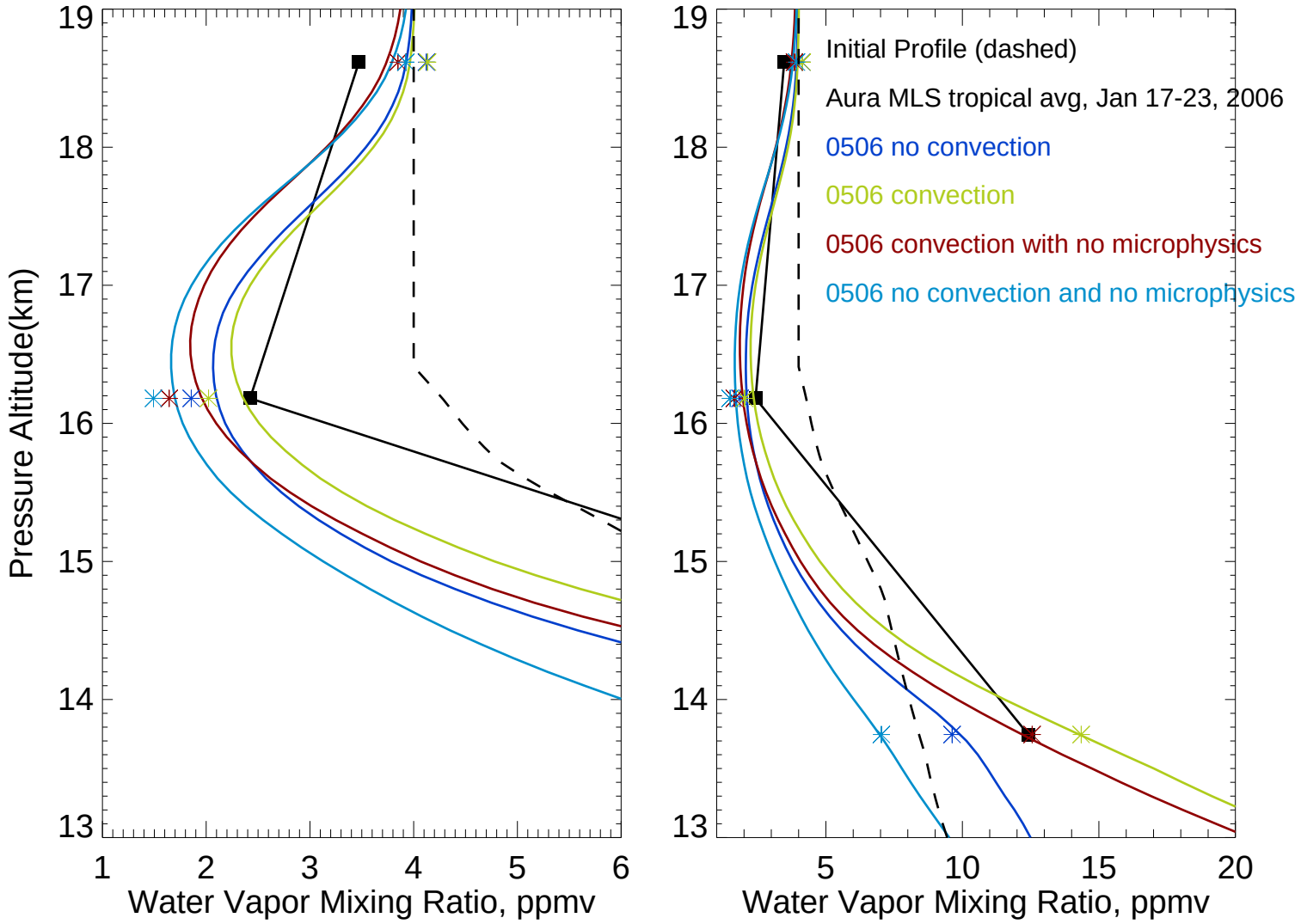


Calculated stratospheric H_2O



Monthly averaged H_2O at θ = 400 K. Capping convection below the tropopause (θ = 380 K) has a small effect on $[H_2O]_e$.

- Dessler/Fueglistaler calculations suggest 1.5–2.5 ppmv enhancement in H_2O_e resulting from convective input

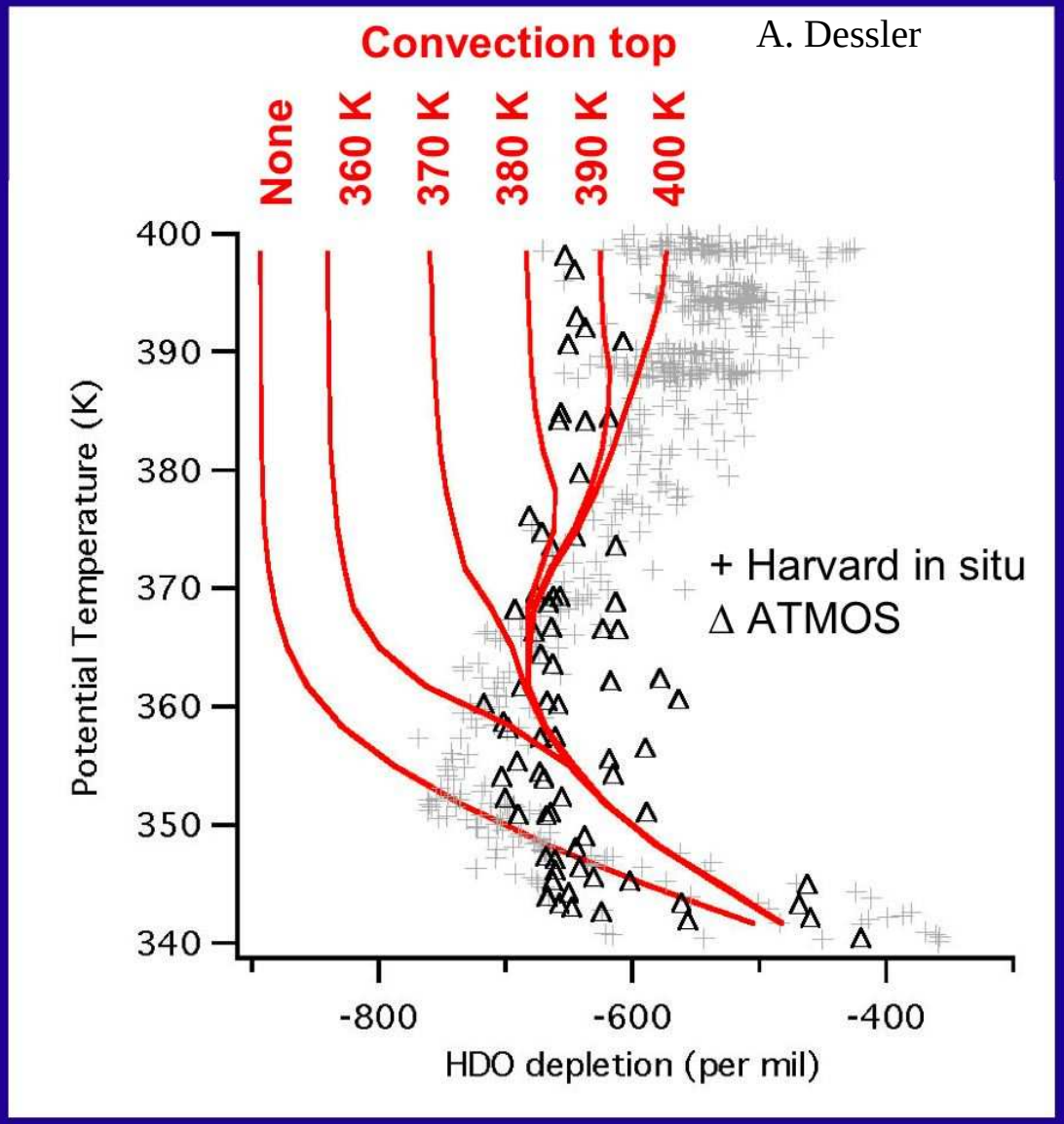


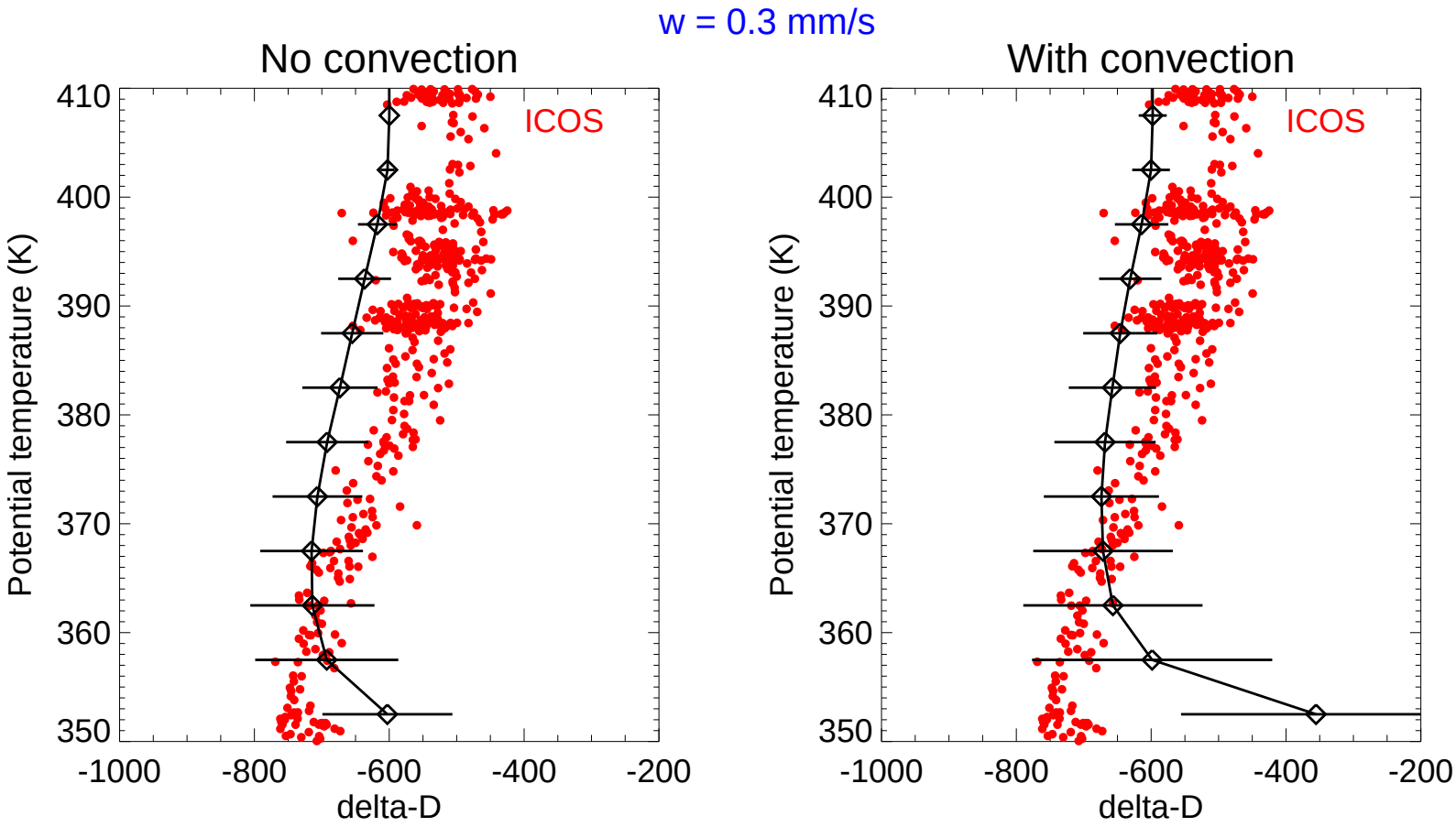
- Pfister approach produces very little convective enhancement of H_2O in the upper TTL.

Effect of Convection on HDO

ATMOS and Harvard data are consistent with convection up tp the tropopause.

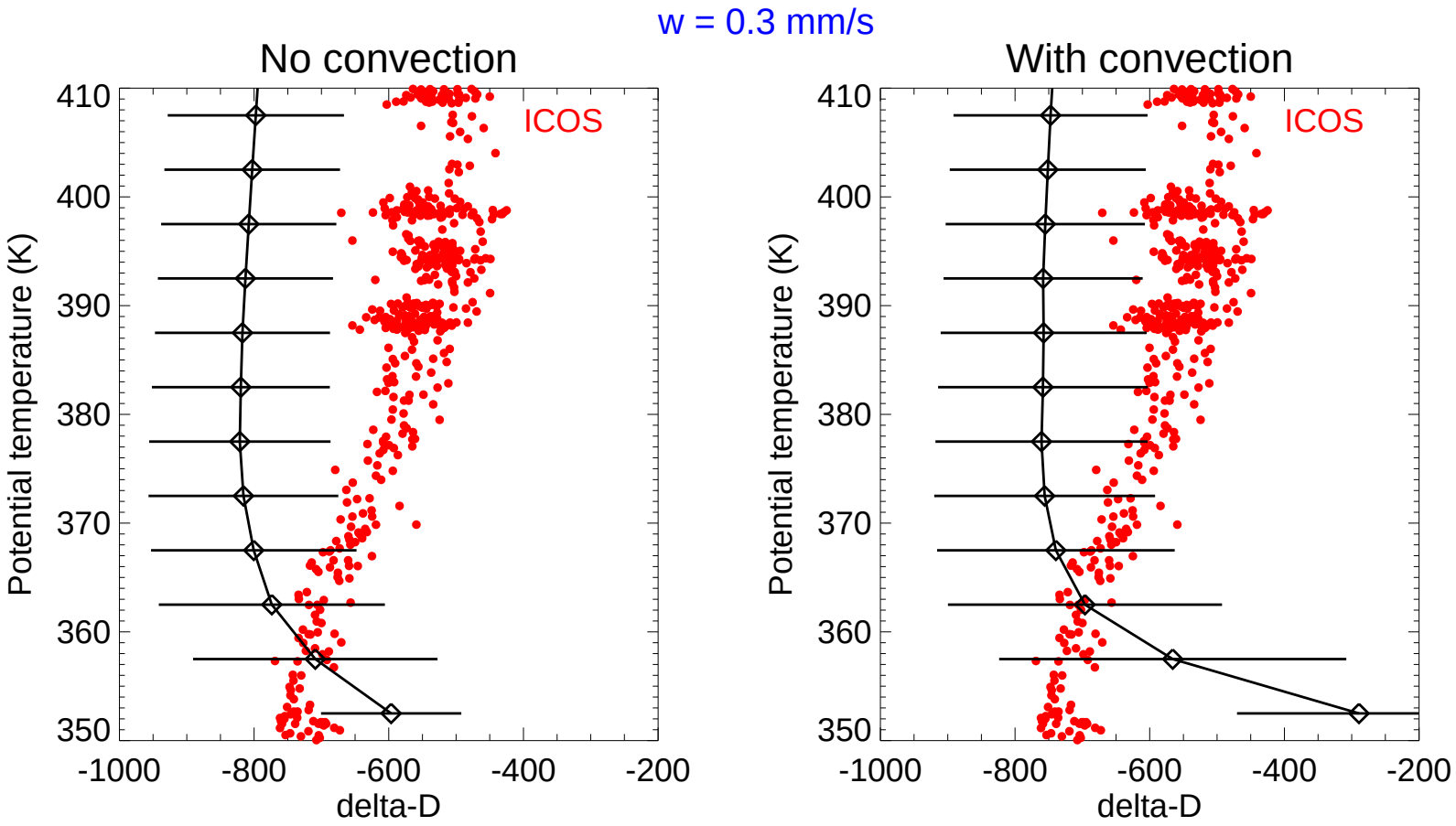
The in situ data suggests convective influence above the tropopause is significant.





- In curtain simulations with slow ascent, convective injection only slightly increases δ-D in the upper TTL.

- Parcels not reaching uppermost TTL



- In Pfister curtain simulations with fast ascent indicated by CO_2 clock, simulated δ-D is lower than indicated by measurements, even with convection.

- Regional variations need to be considered.

Mission strategy: determining convective origin

- Clear-sky profiles of H_2O and HDO in airmasses with varying degrees of convective influence.
- Attempt to sample air influenced by convection into both supersaturated and subsaturated regions.
- Measure the isotopic content of anvil ice.
- CALIPSO and CloudSat data should help quantify deep convection height distributions.

2. What fraction of tropical cirrus was generated directly (or indirectly) by deep convection?

- Does anvil cirrus sporadically reform downwind of convective systems?
- Are TTL cirrus typically formed in situ or related to deep convective systems?

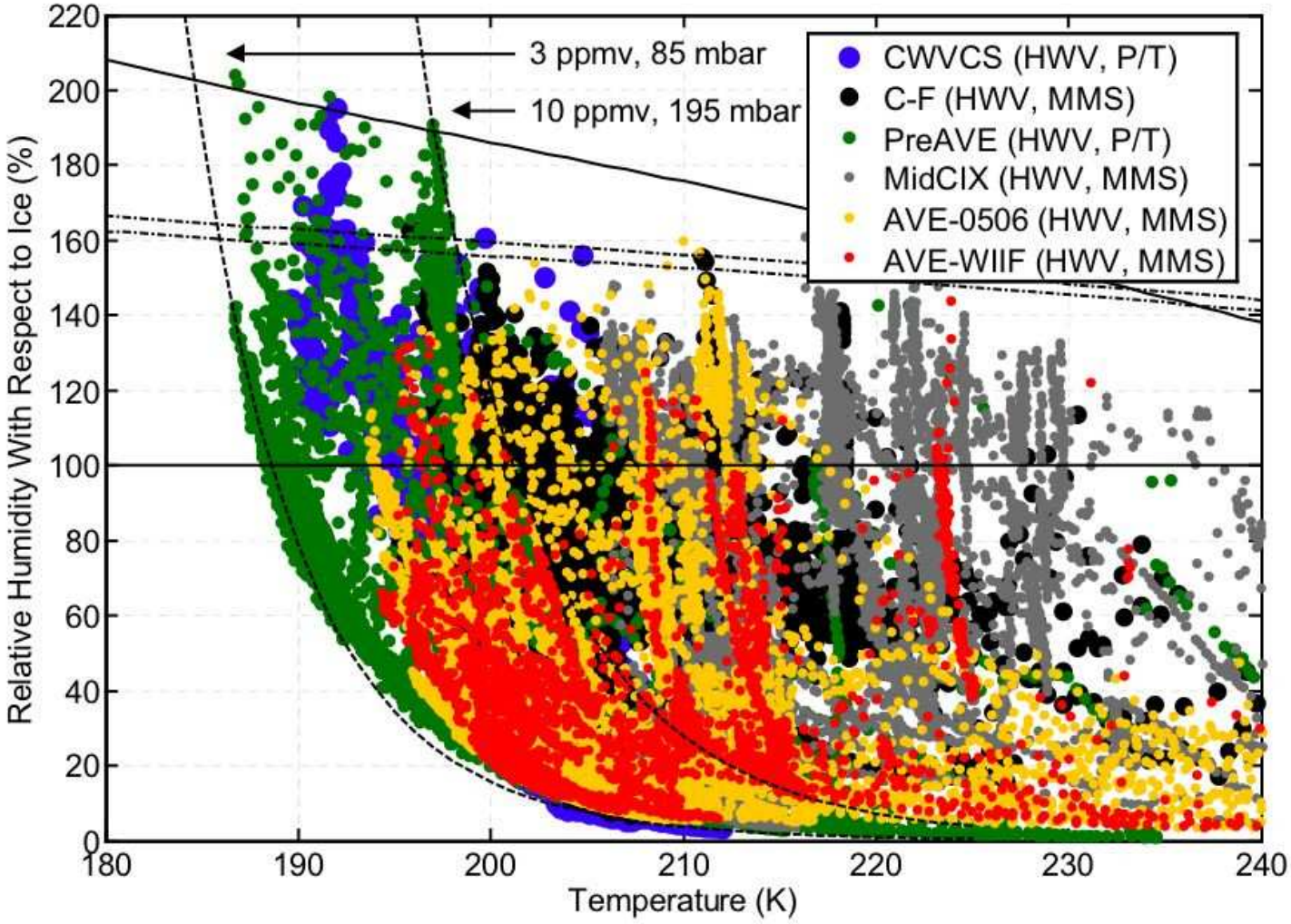
Mission strategy: supersaturation distributions

- Measure total water and vapor H_2O/HDO in TTL cirrus to distinguish convectively-generated, re-generated, and in-situ formed cirrus.
- Seek out TTL cirrus in air that had been influenced by convection hours–days before.

Vapor	Ice	Conclusion
Light	Heavy	Outflow
Light	Light	In-situ formed
Heavy	Heavy	Reformed outflow cirrus

How Prevalent are Supersaturations in the Tropopause Region?

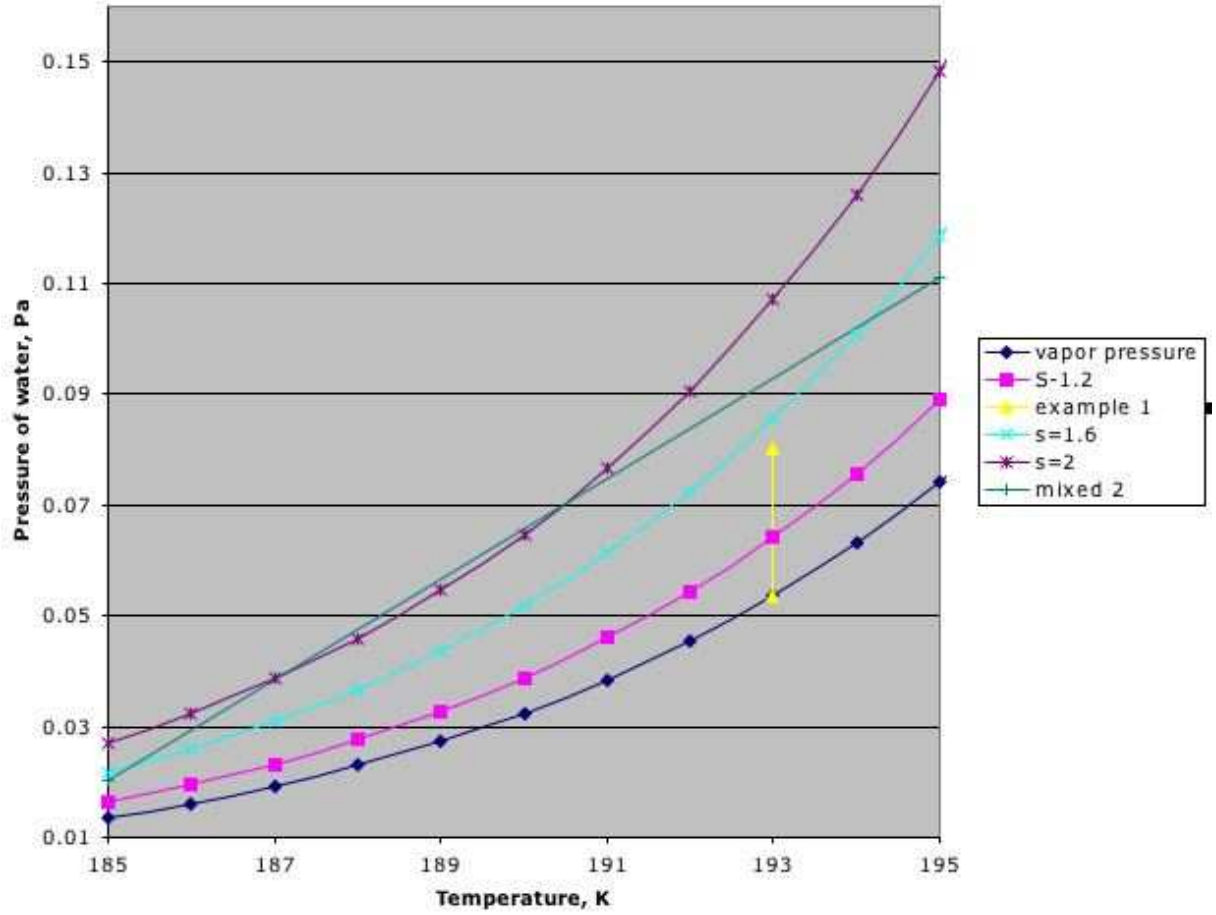
J. Smith et al.



Mission strategy

- Sampling clear and cloudy air in the tropopause region, particularly at low temperatures.

- Examine small-scale structure in RHI field using high-frequency (8-20 Hz) H_2O and temperature measurements.



What is the temporal and latitudinal variability in δ-D?

- How homogeneous is the stratospheric isotopic composition?
- How isolated is the stratosphere from the troposphere?
- What is the seasonal variability in UT/LS δ-D?

Mission strategy: variability in δ-D

- Head north on one of the test flights.
- Include stratospheric sampling on local flights and ferry flights.
- Obtain UT/LS profiles in air of different latitudinal origin based on trajectory analysis.
- Ascend to maximum altitude at the end of each flight.