Global variations of Water Vapor Isotopologues from ACE-FTS satellite data

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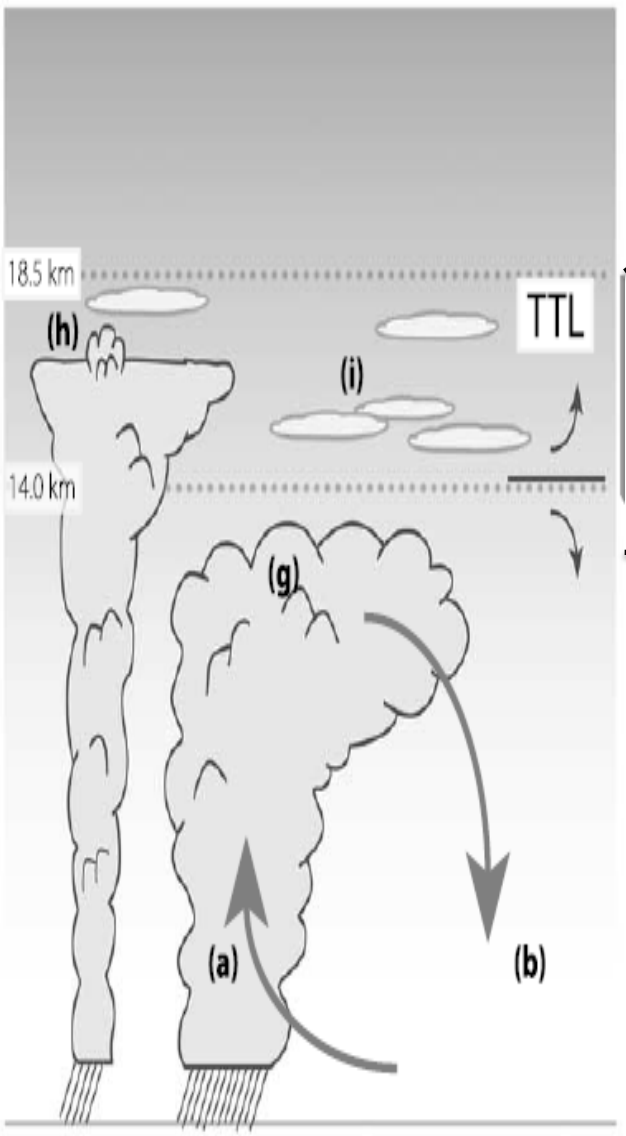
- *ACE/ Waterloo:* Peter Bernath, Kaley Walker, Chris Boone

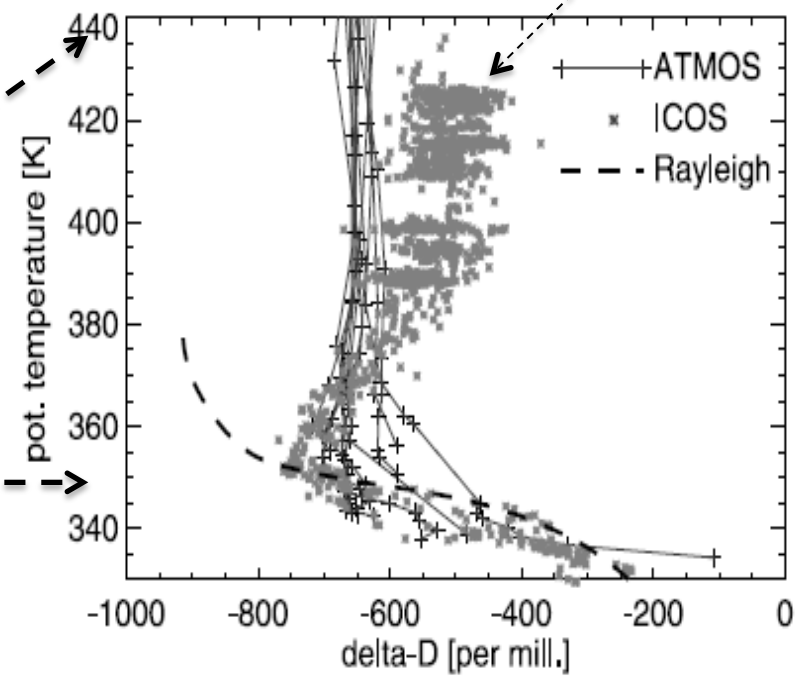
Aircraft measurements of water isotopologues

persistent increase in TTL region, heavy stratosphere



Fueglistaler et al, 2009

Hanisco et al, 2007



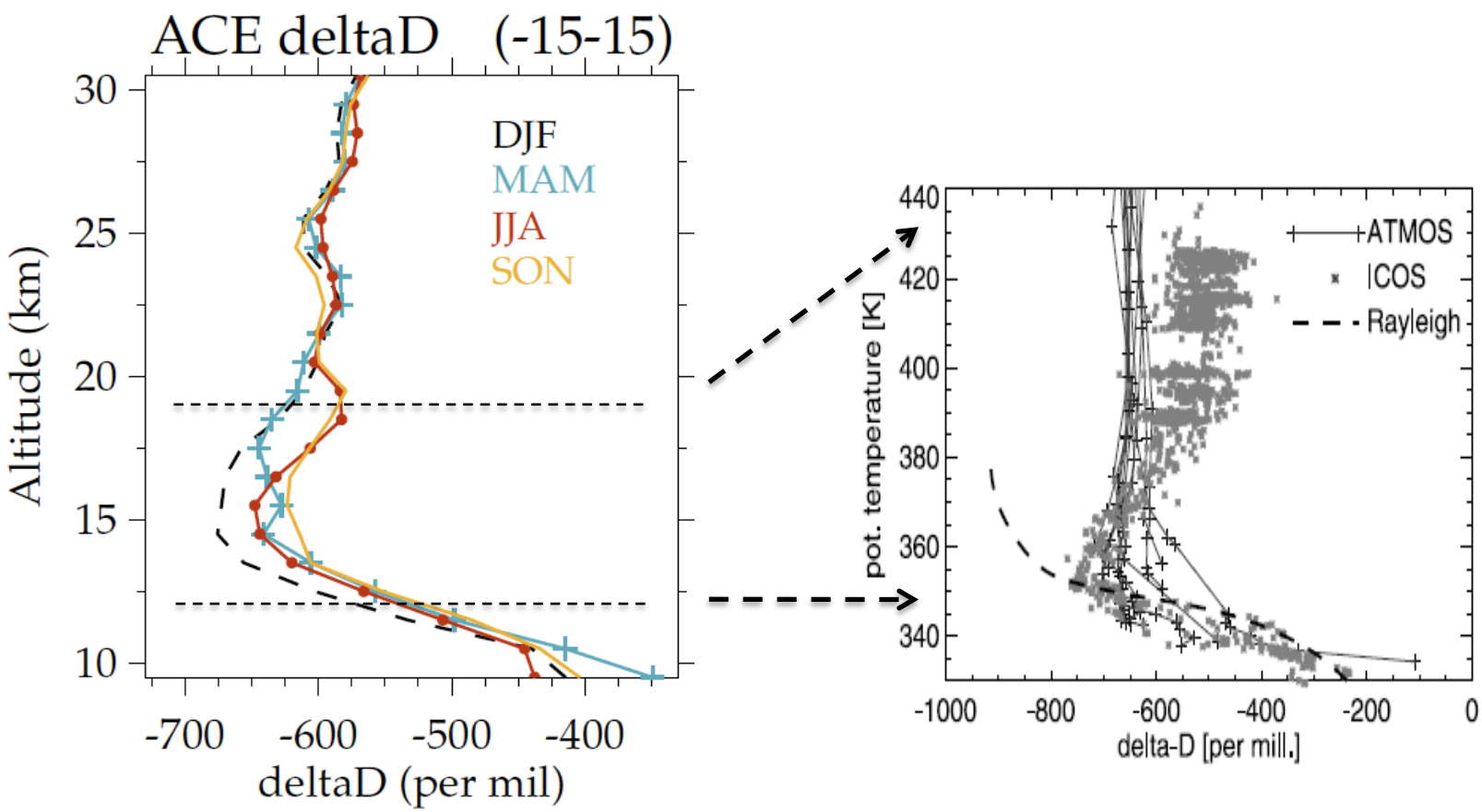
$$\delta D = 1000 \times \left[\frac{([HDO]/[H_2O])_{measurement}}{([HDO]/[H_2O])_{VSMOW}} - 1 \right]$$

ATMOS: 16 profiles across all tropics
(Kuang et al 2003 reanalysis)

ICOS: ca. 12 tropical profiles out of Costa Rica (CR-AVE mission). ICOS uncertainty up to 80 per mil,

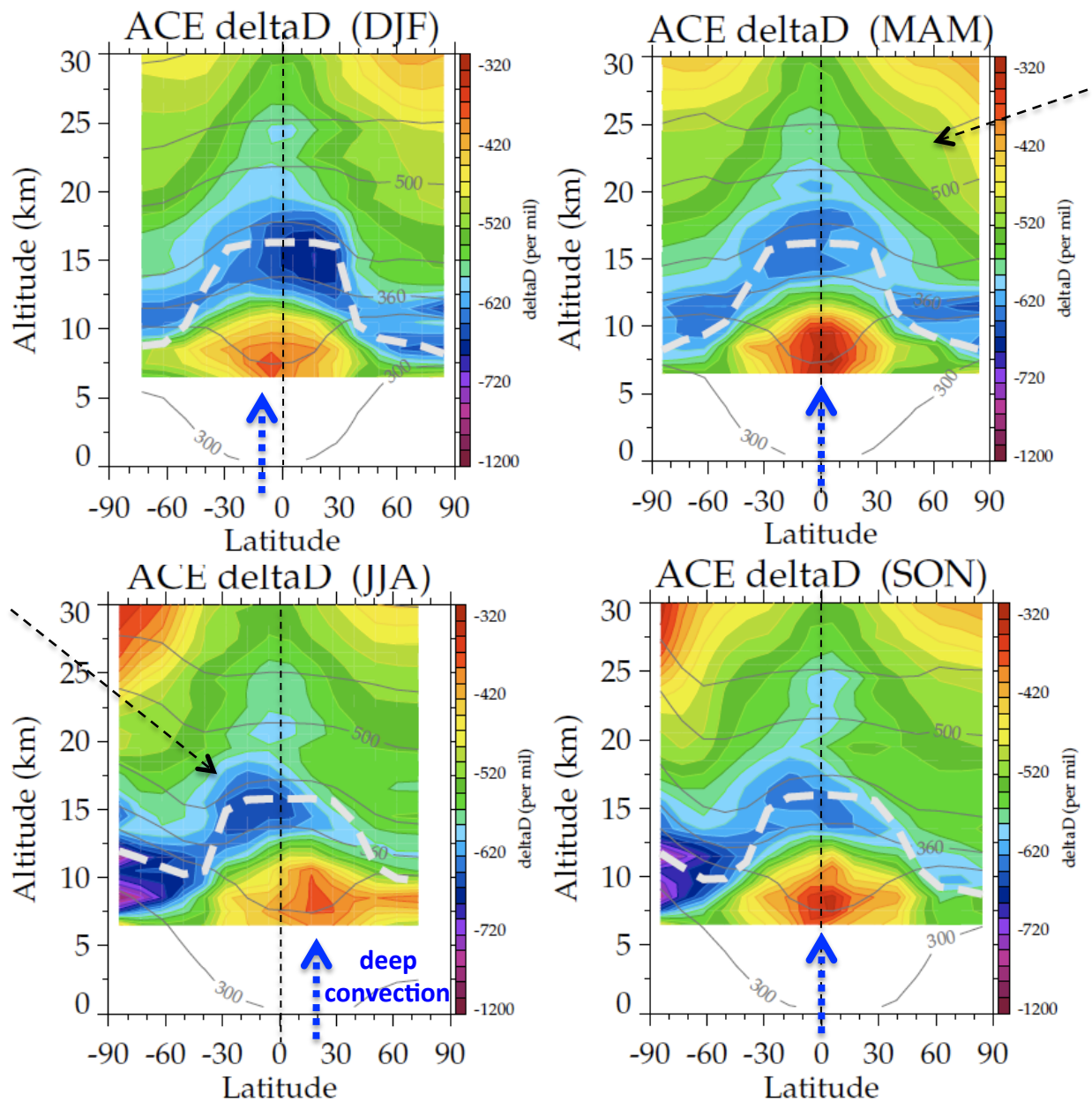
ACE profiles show many similarities

persistent increase in TTL region, heavy stratosphere



Nassar et al, 2008

deltaD seasonal cycle

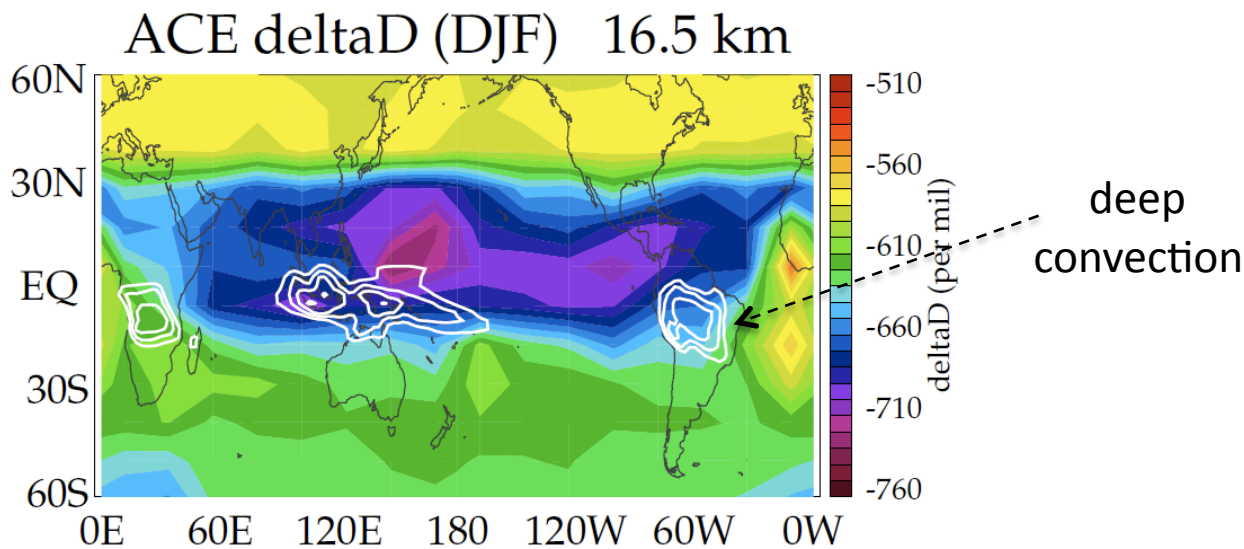


increase due to methane oxidation

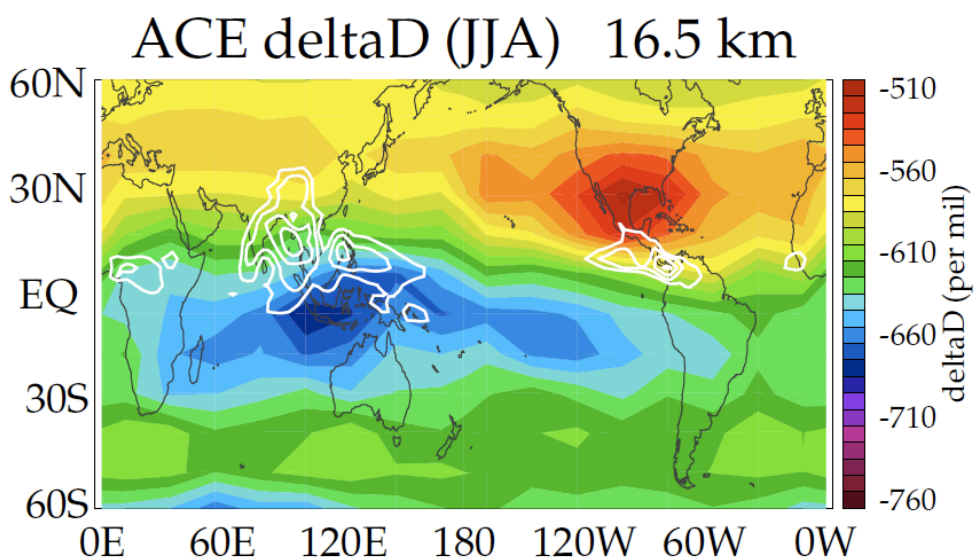
TTL minimum in <u>summer</u> hemisphere

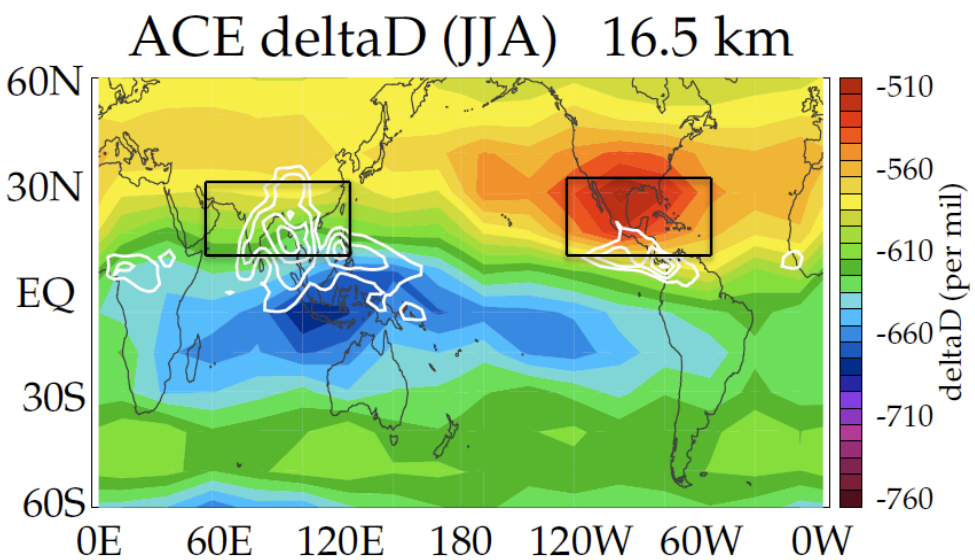
longitudinal structure

DJF

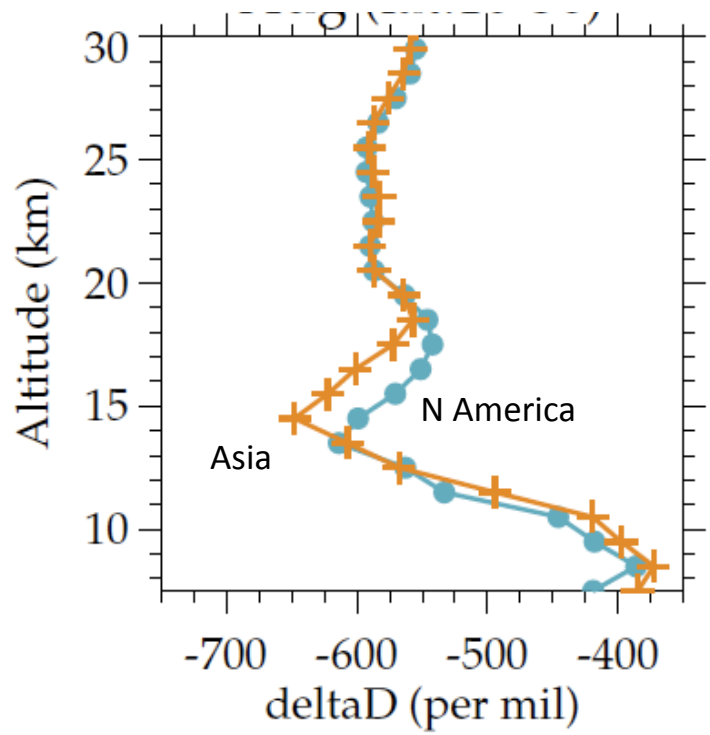


JJA



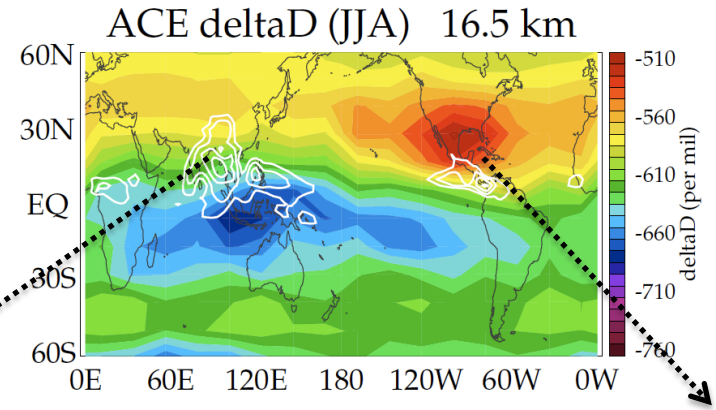


Vertical profiles over Asian, NA monsoons

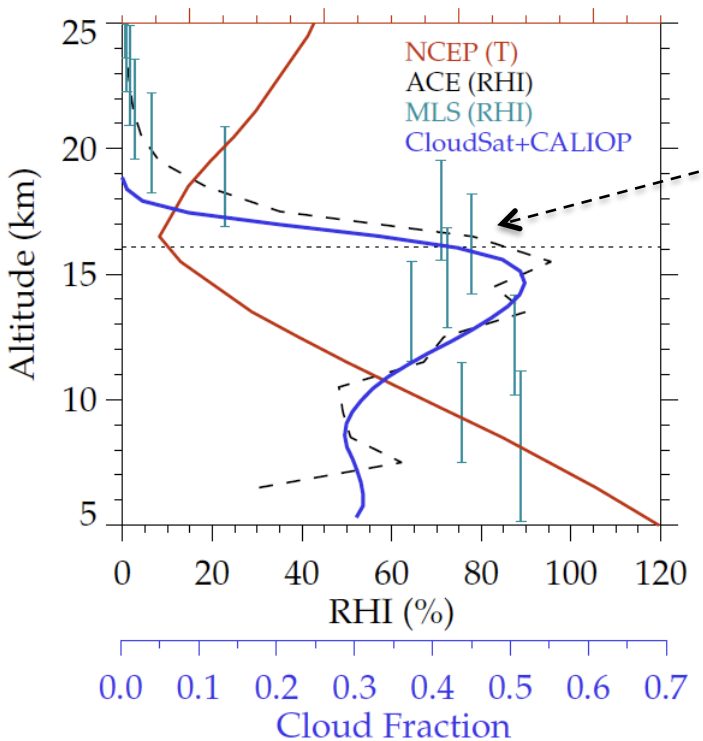


Relevant physics: depth of overshooting convection, into unsaturated stratosphere (e.g. Dessler and Sherwood, 2004)

Clouds and thermodynamic profiles over monsoons

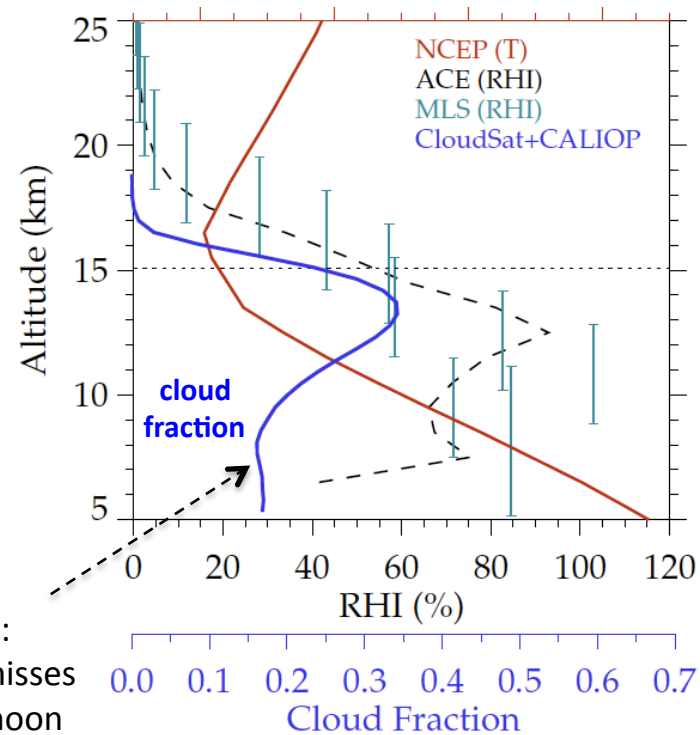


Asia monsoon



higher saturation over Asian monsoon

N. America monsoon



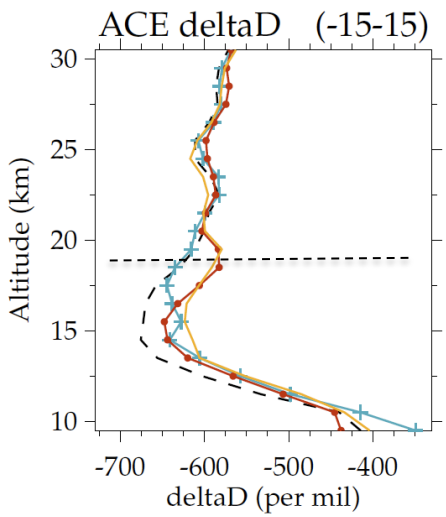
Caveat: sampling misses late afternoon deep convection

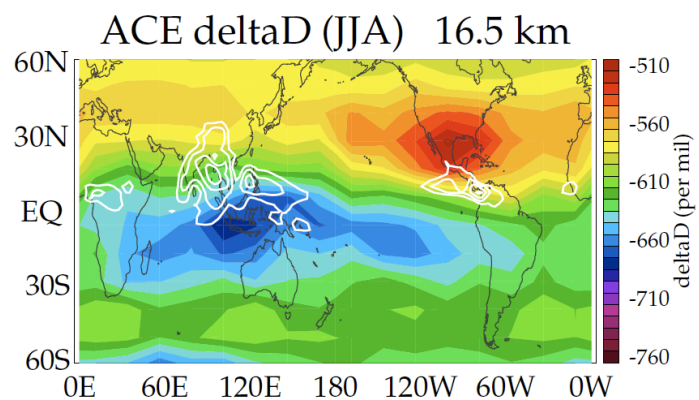
Key points:

- isotopic increase of water vapor above TTL is supported in ACE data
  - convective overshooting and/or mixing from extratropics ?

- significant spatial structure to global seasonal cycle of deltaD
  - caution for interpretation of aircraft data

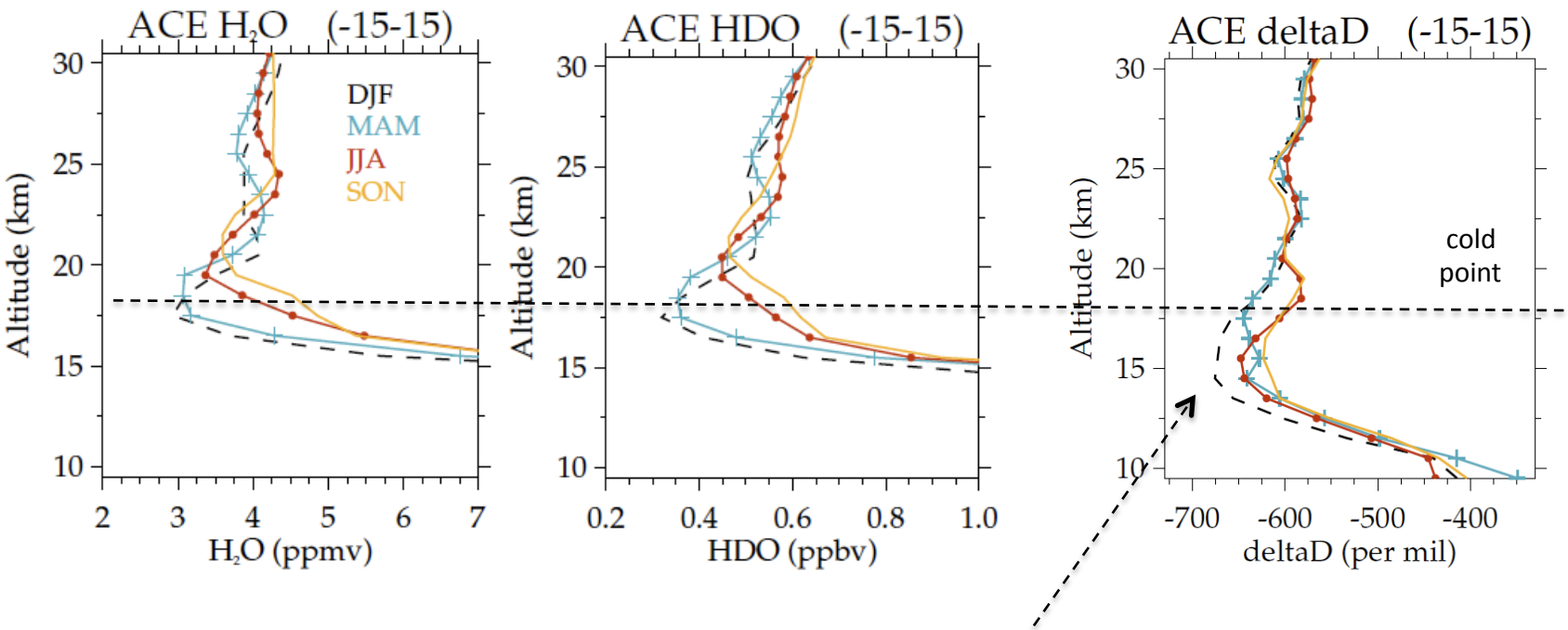
- strong enhancement associated with N America summer convection.
  - persistent signal, leads to hemispheric asymmetry in stratosphere





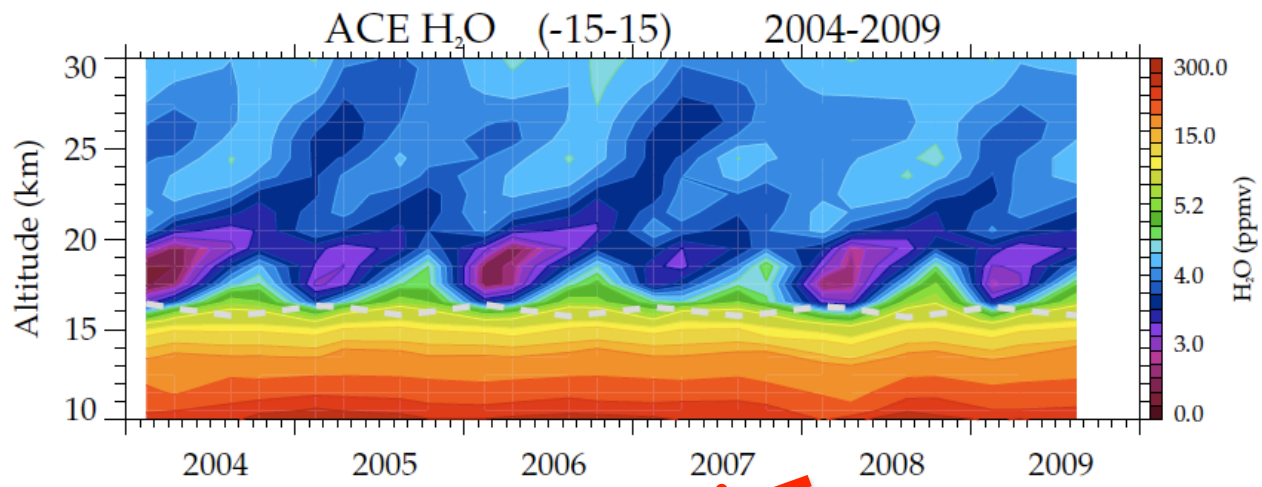
Extra slides

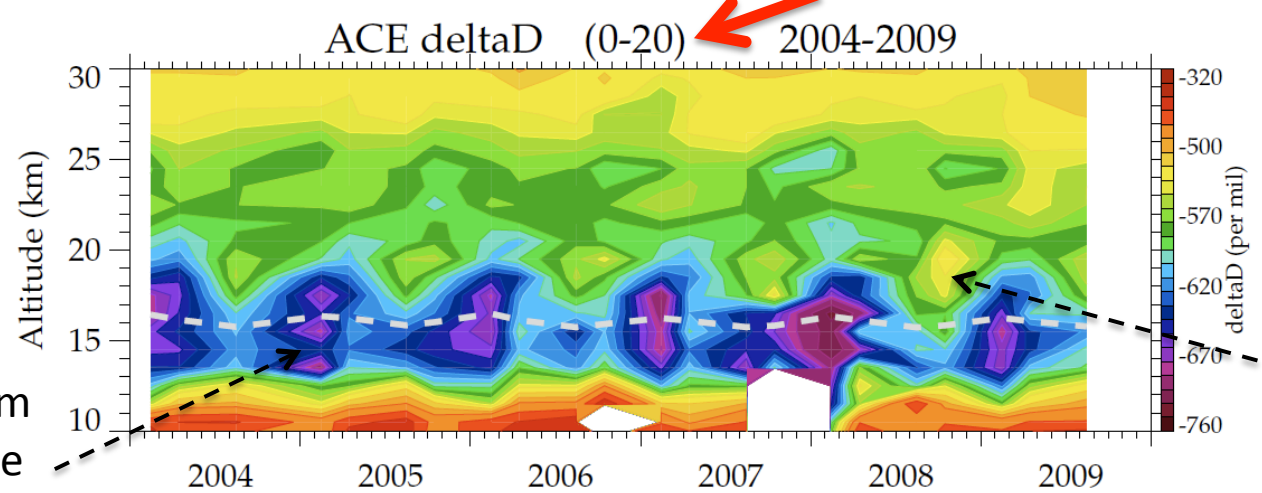
H_2O, HDO and deltaD



clear minimum below cold point
with increase above tropopause

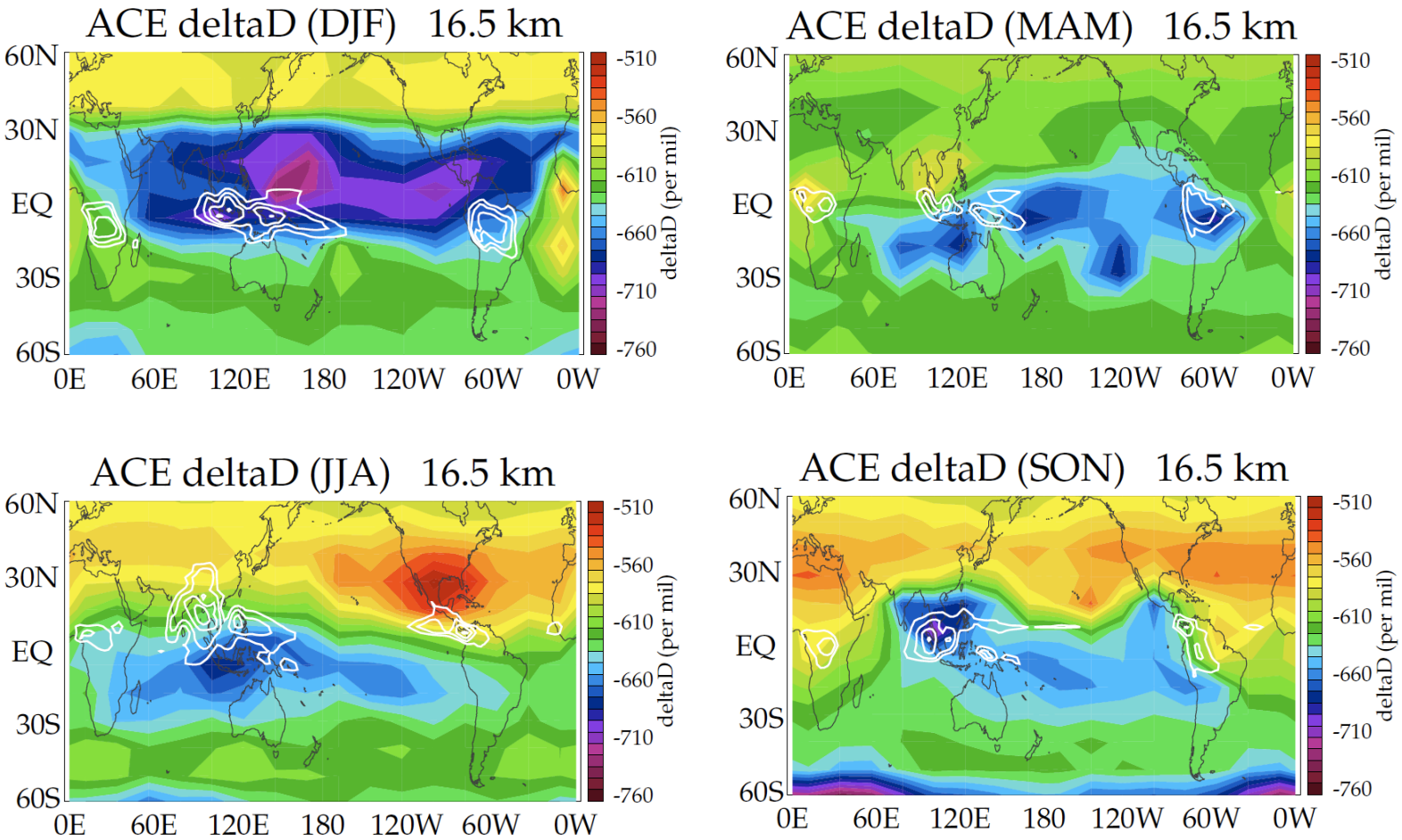
Tape recorder and seasonal cycle in deltaD



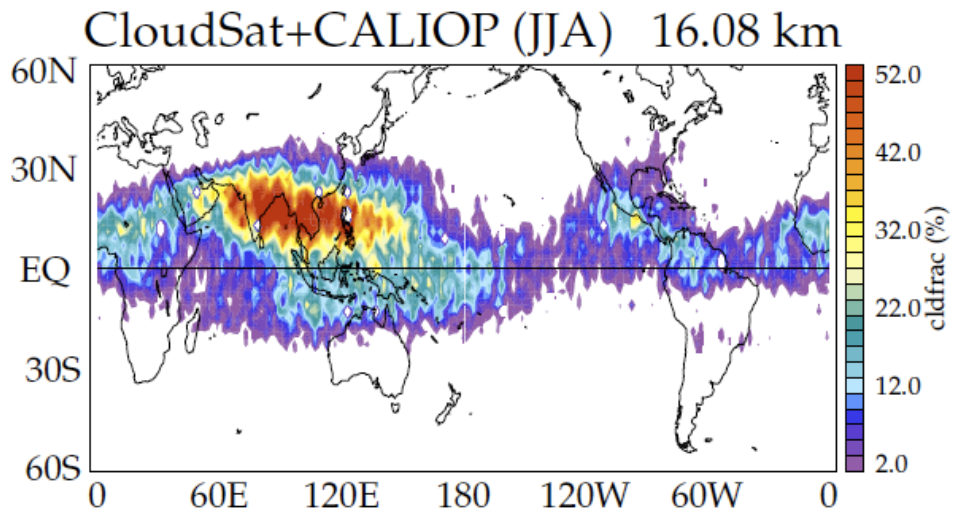


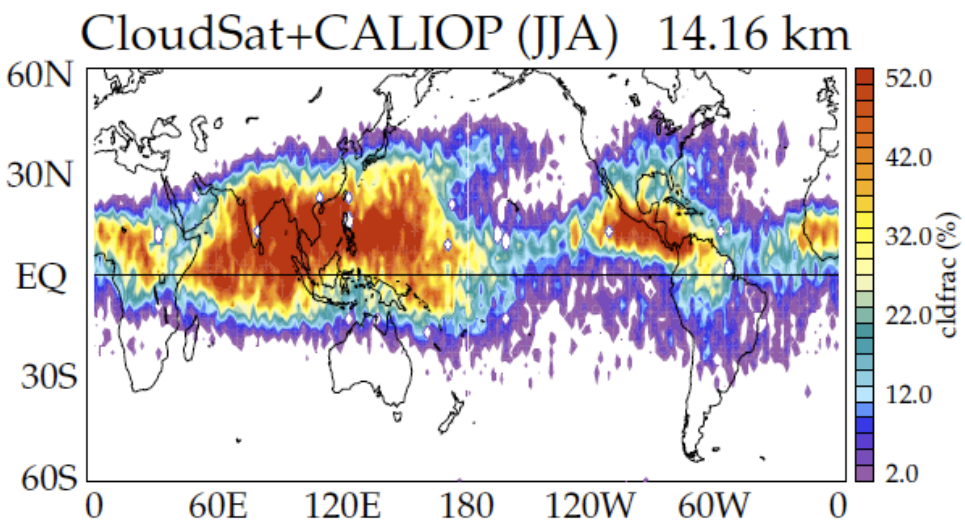
monsoon signal

seasonal minimum below tropopause (convection, not temperature)


ACE deltaD (DJF) 16.5 km
ACE deltaD (MAM) 16.5 km
ACE deltaD (JJA) 16.5 km
ACE deltaD (SON) 16.5 km
60N
30N
EQ
30S
60S
0E
60E
120E
180
120W
60W
0W
-510
-560
-610
-660
-710
-760
deltaD (per mil)

CloudSat+CALIOP

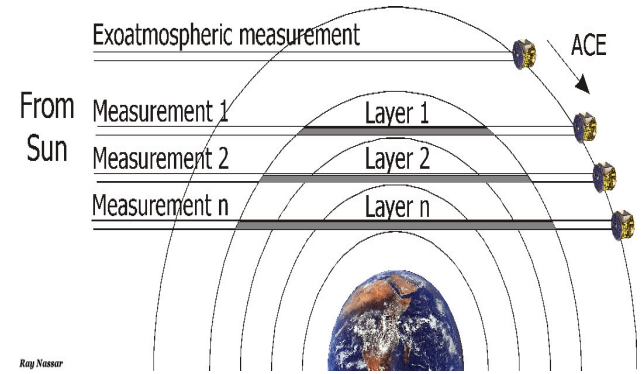




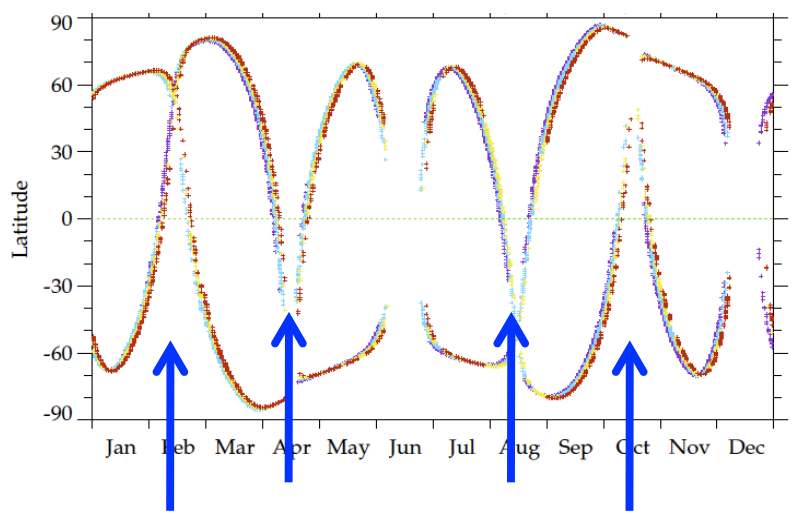
ACE-FTS water isotopologues

FTS measurements: *2.2 – 13.3 μm*
5+ years of data (Feb. 2004 – Aug. 2009)
~ 3,500 occultations /year
All major isotopologues of water and methane

Resolution: ~300 km horizontal, 3–4 km vertical



ACE occultations, 2004-2009



Low latitudes: 4 samples / year

Data presented in this talk:

~20,000 occultations (entire dataset 2004-2009)

Gridded data: seasonal average using Gaussian weighting