

Correlated variations of MLS stratospheric water vapor and GPS cold point tropopause temperatures

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Objective: study correlated behavior of stratospheric water vapor and cold point tropopause temps on daily to annual time scales

- Can we understand the large-scale behavior of H₂O in a simple way from accurate temperatures?
- Empirical complement to trajectory studies

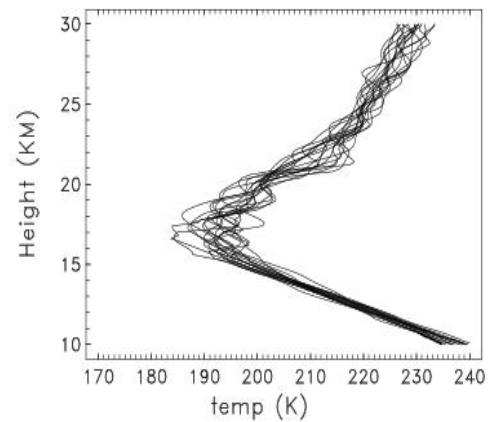
Data:

MLS water vapor:

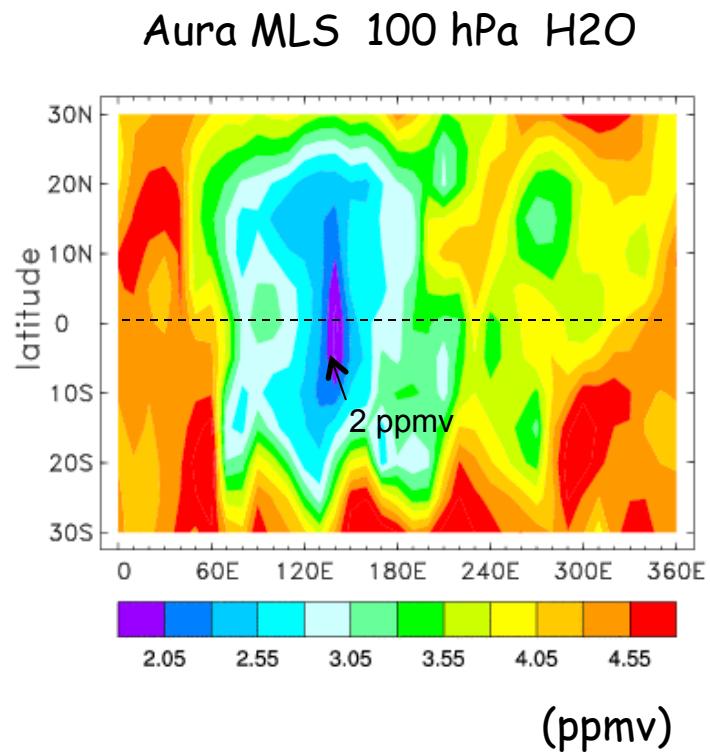
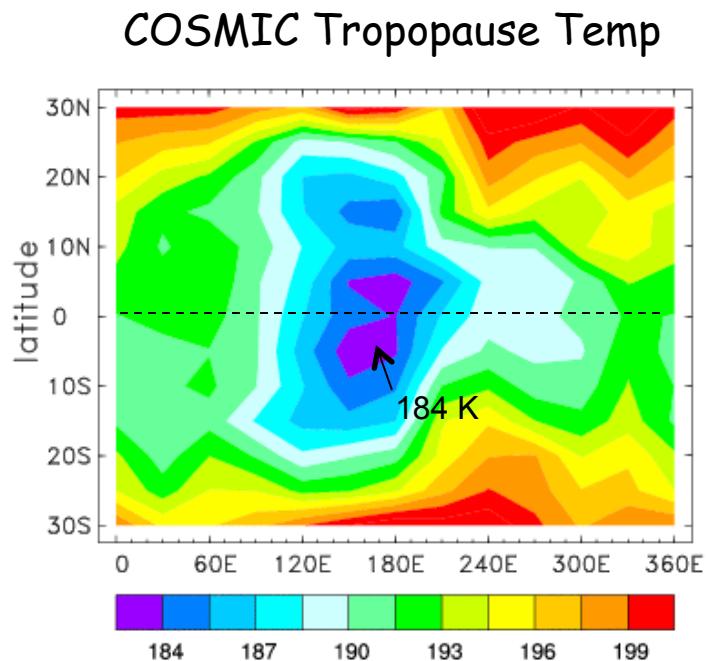
- daily gridded fields at 100, 83, 68, ... hPa; late 2004 - 2012
- mostly interested in lower stratosphere levels 100, 83 hPa

GPS radio occultation temps:

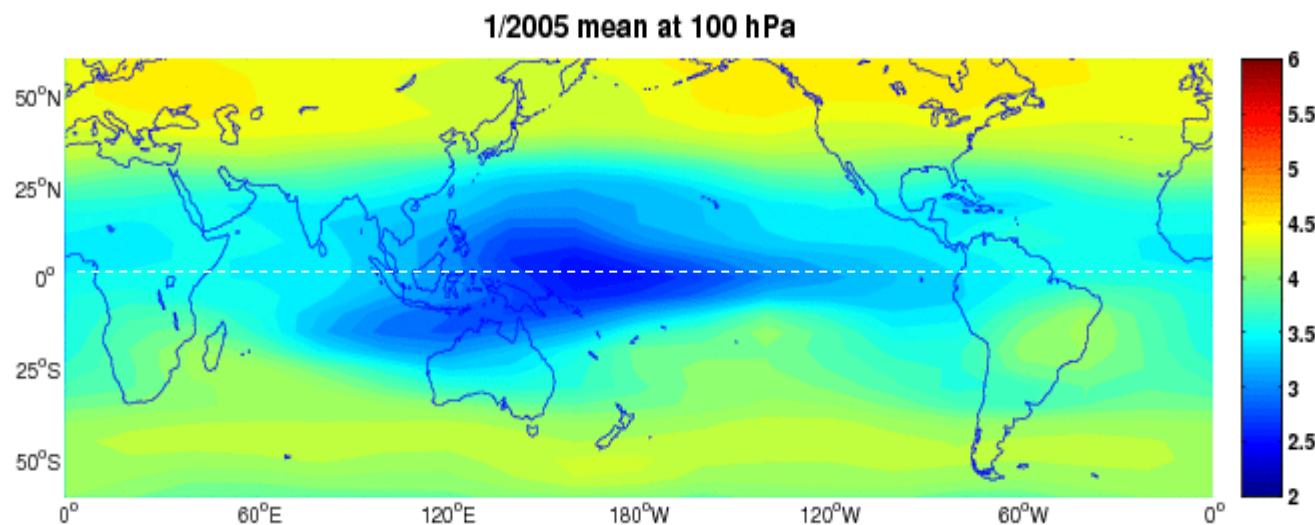
- Gridded daily data combining CHAMP, COSMIC, others
~3000 obs/day for middle 2006-present
- High vertical resolution (< 1 km), well-resolved cold point



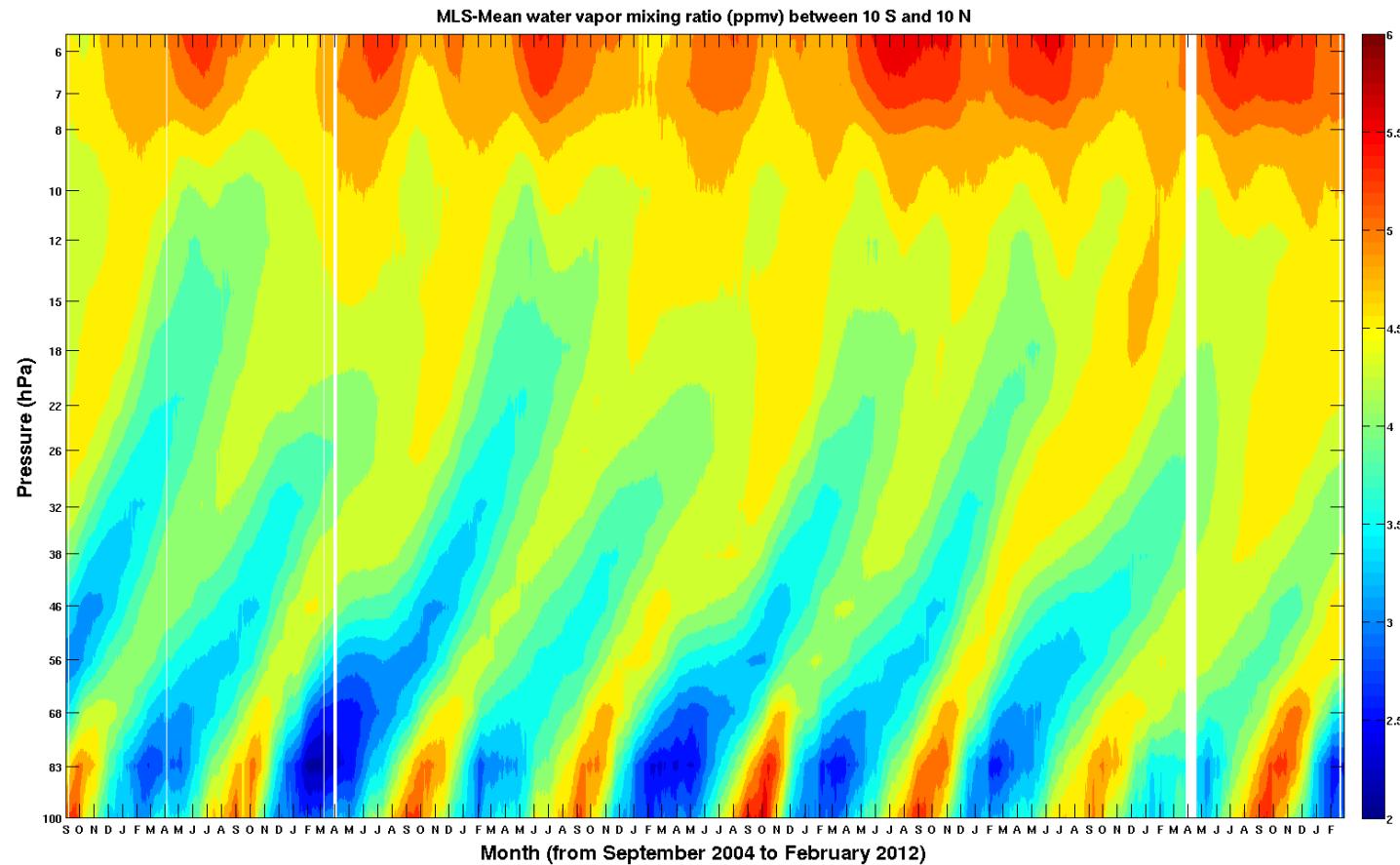
Example: Jan 2, 2007



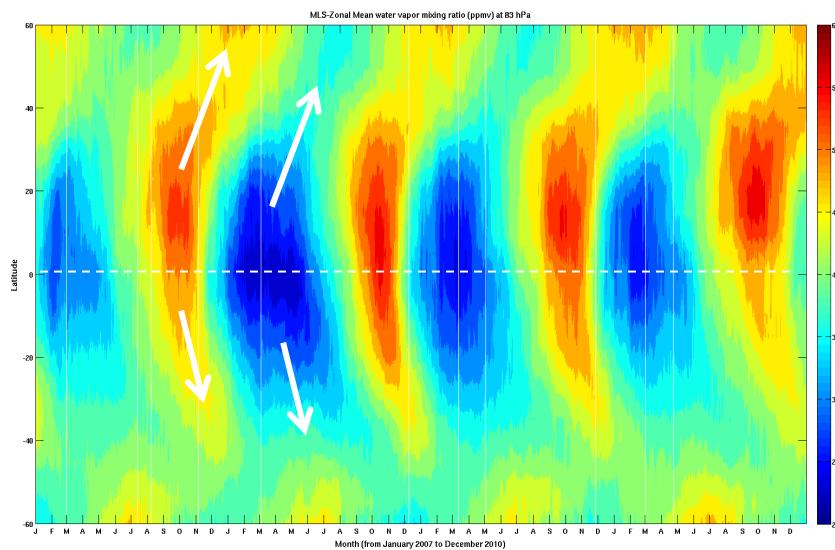
MLS monthly mean water vapor



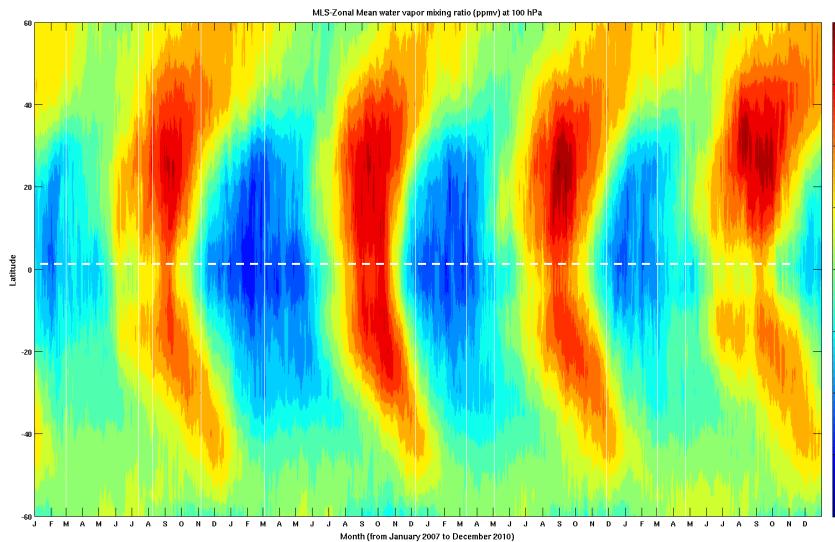
Tropical tape recorder 15 N-S



Lower stratosphere horizontal tape recorder



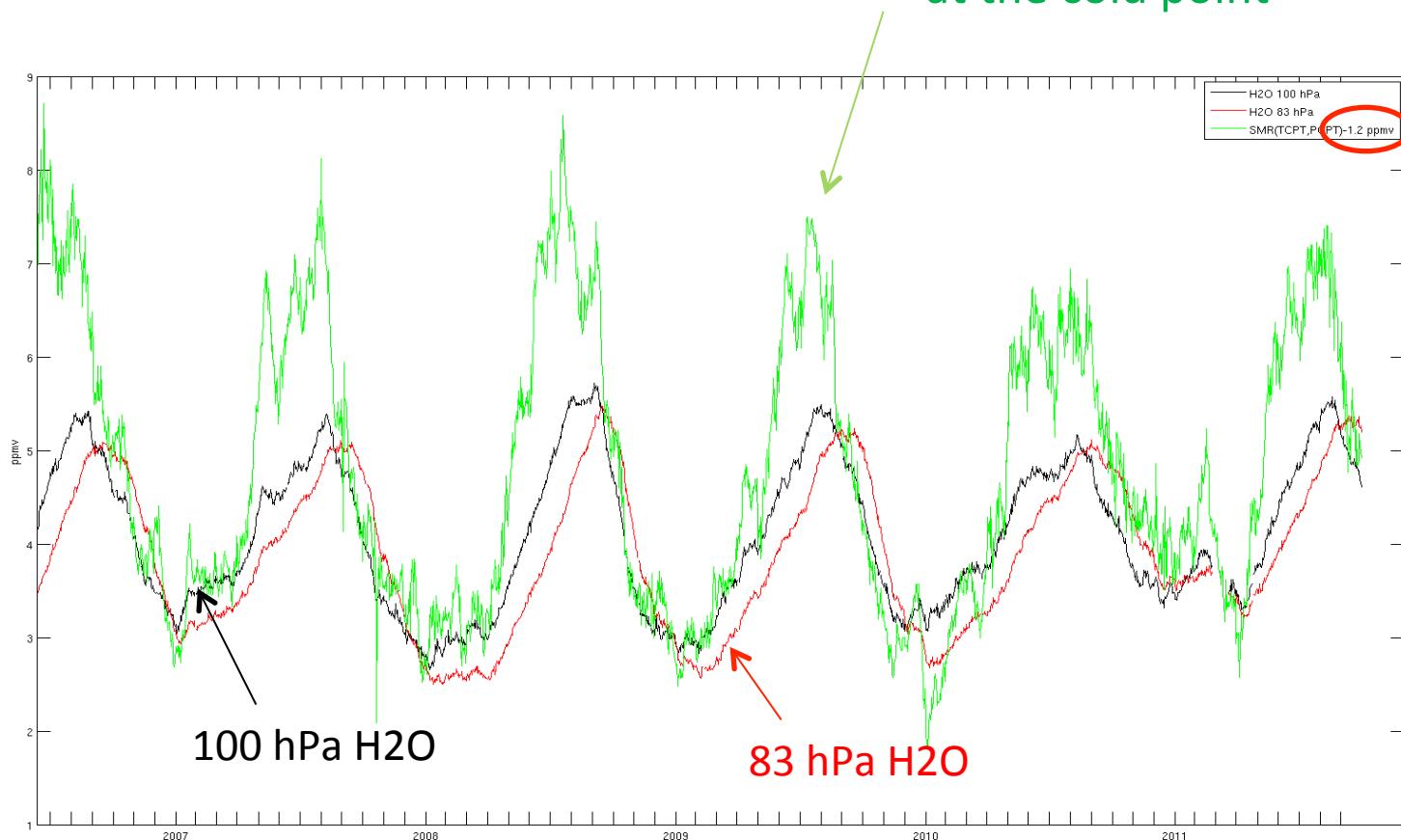
83 hPa



100 hPa

Zonal means 15° N-S

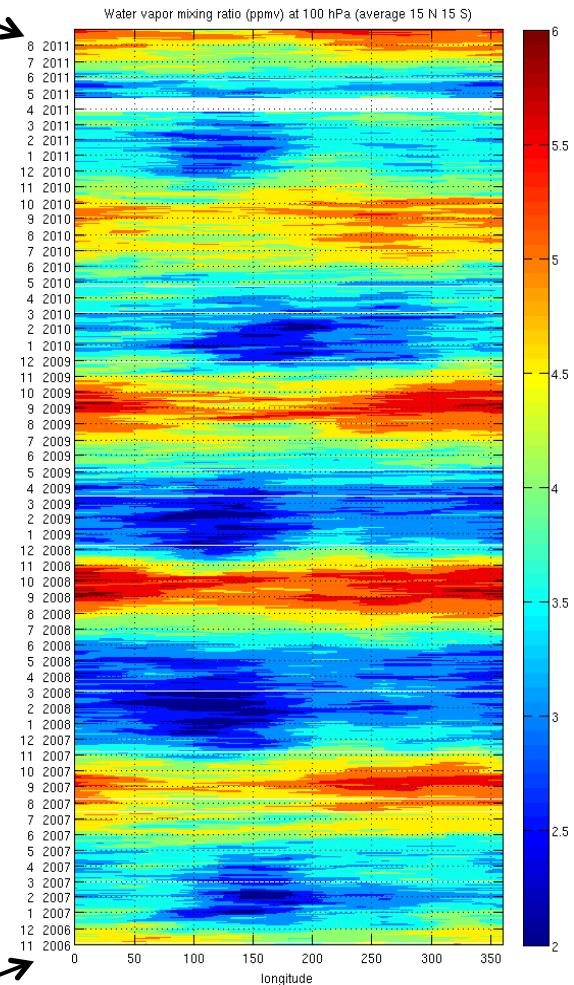
GPS saturation mixing ratio
at the cold point



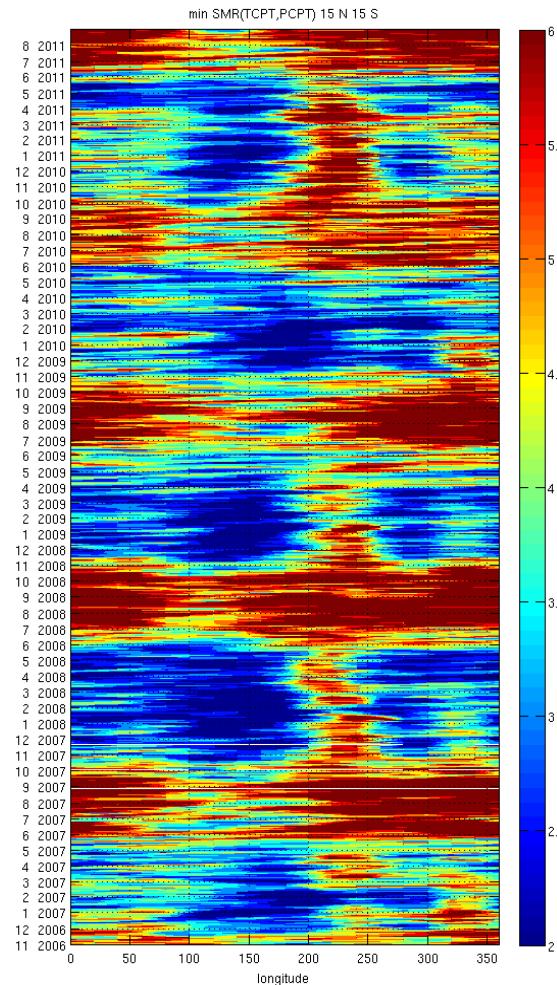
Hovmoller diagrams at 15° N-S (longitude vs. time):

100 hPa H₂O

Aug 2011



GPS cold point SMR

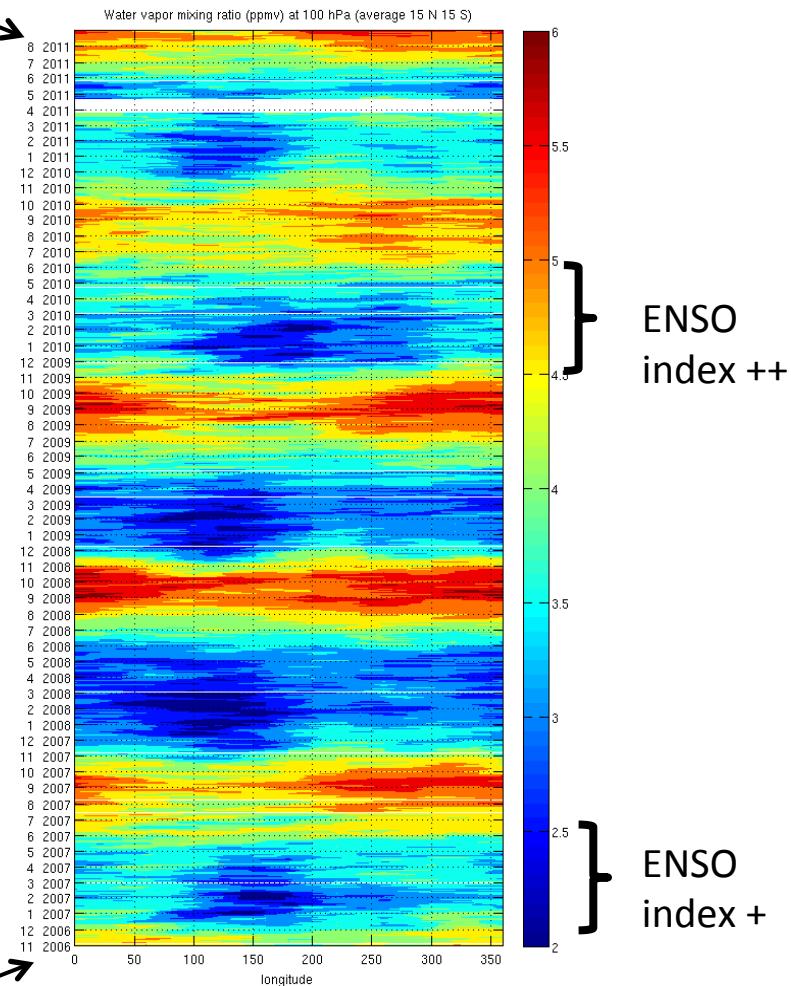


Nov 2006

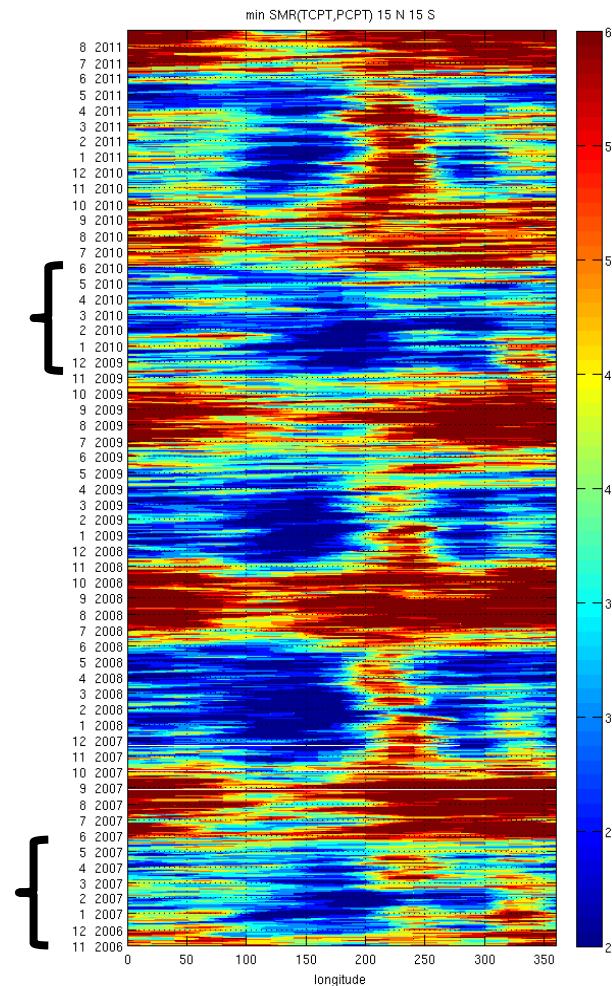
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Aug 2011



GPS cold point SMR

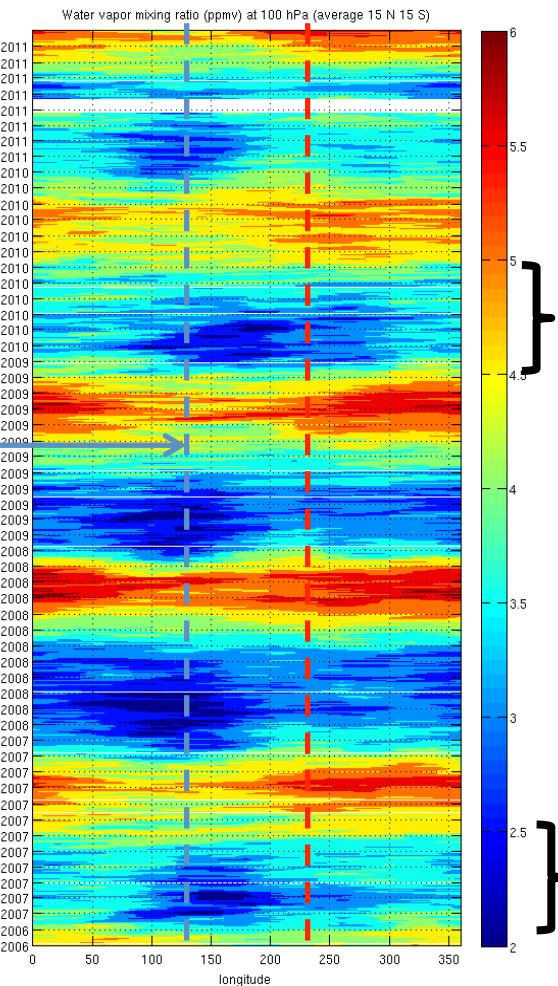


Nov 2006

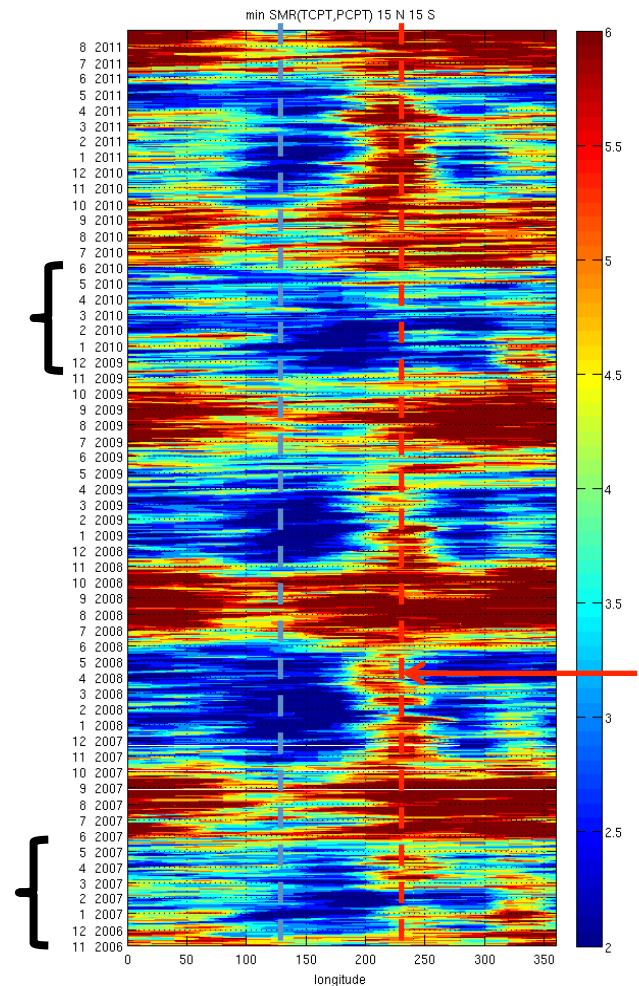
Hovmoller diagrams at 15° N-S (longitude vs. time):

100 hPa H₂O

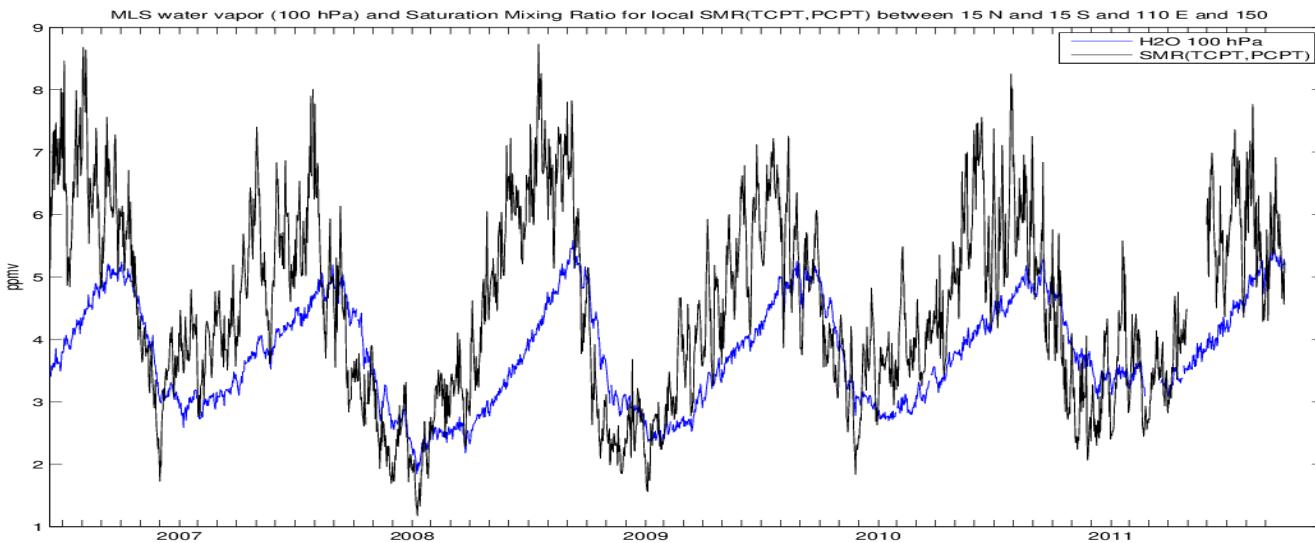
Aug 2011



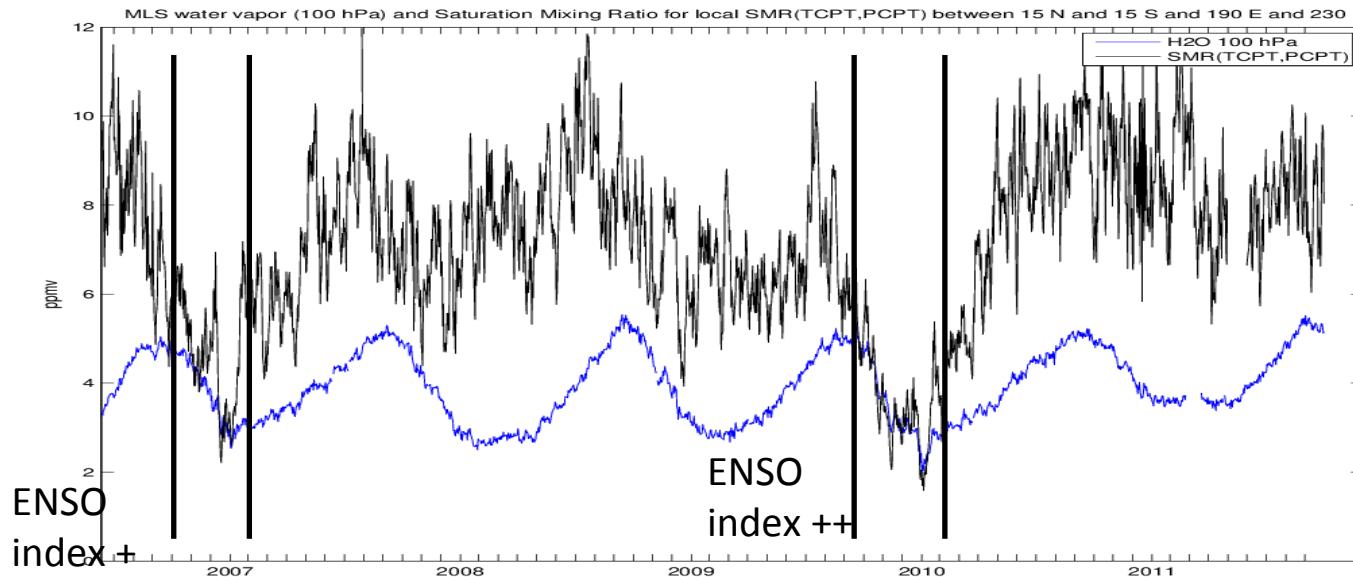
GPS cold point SMR



1:Cold trap
(Western Pacific)
Mainly active

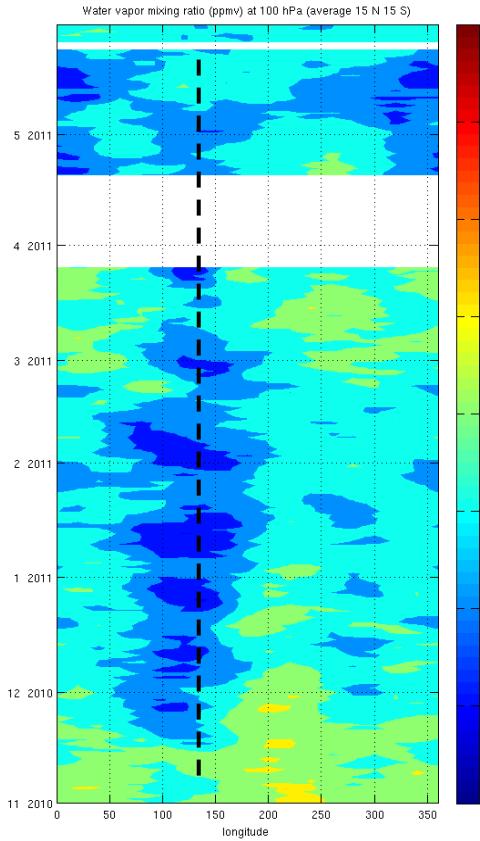


2:Central Pacific
Mainly passive

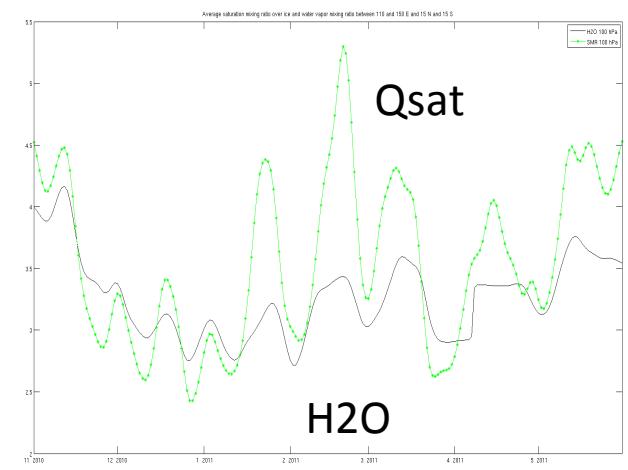
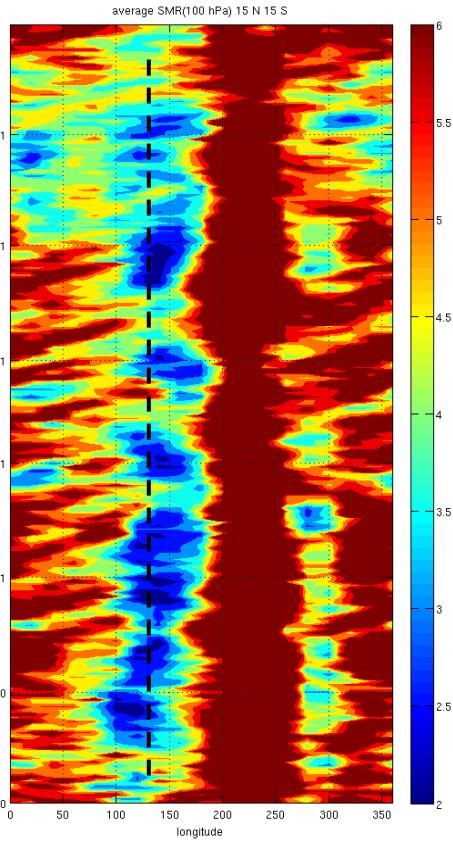


Boreal winter 2010-2011

100 hPa H₂O

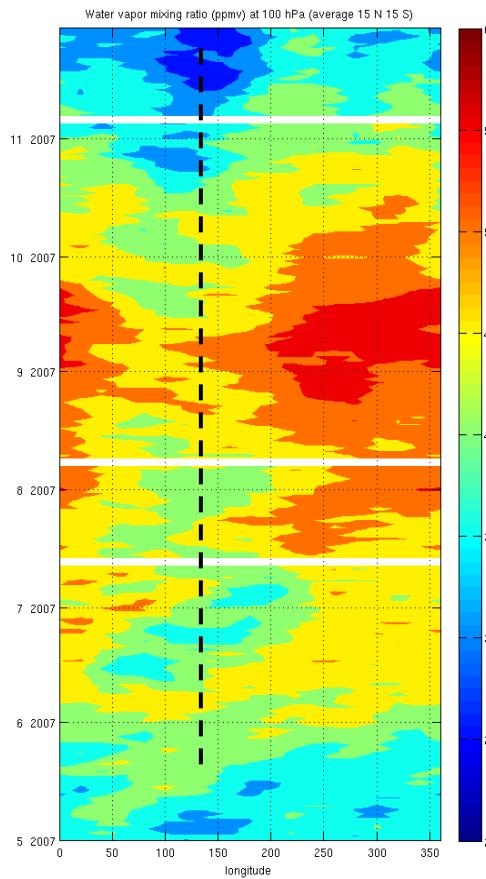


GPS cold point SMR

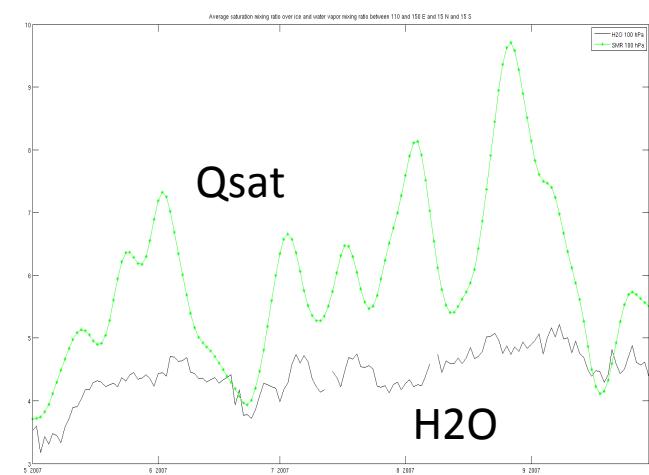
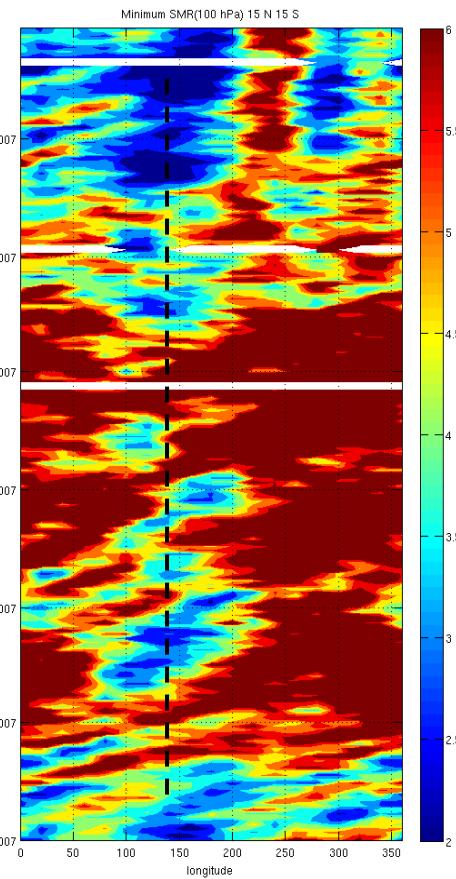


Boreal summer 2007

100 hPa H₂O



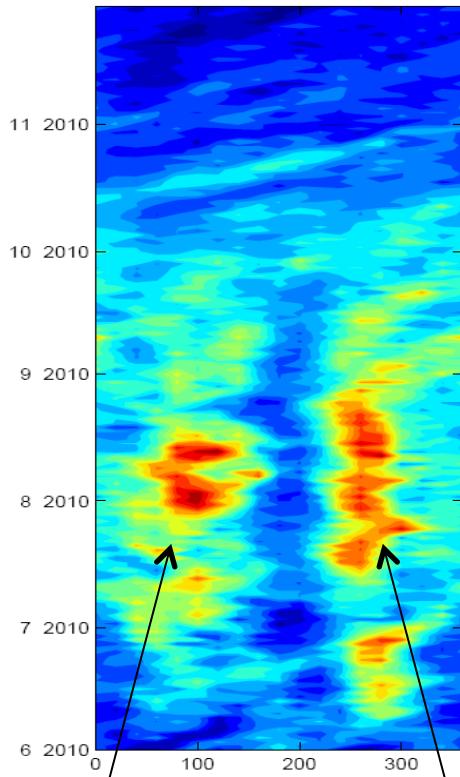
GPS cold point SMR



NH summer monsoon regions (25° - 40° N) 2010

H_2O 121 hPa

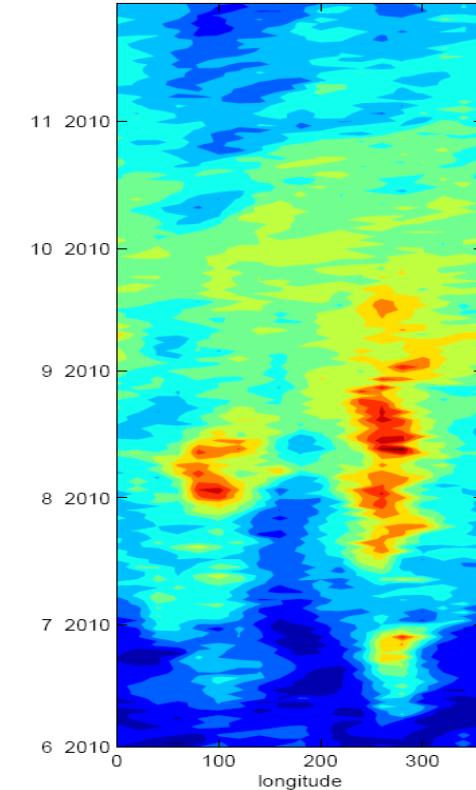
Water vapor mixing ratio (ppmv) at 121 hPa (average 25 N 40 N)



Asian
monsoon

100 hPa

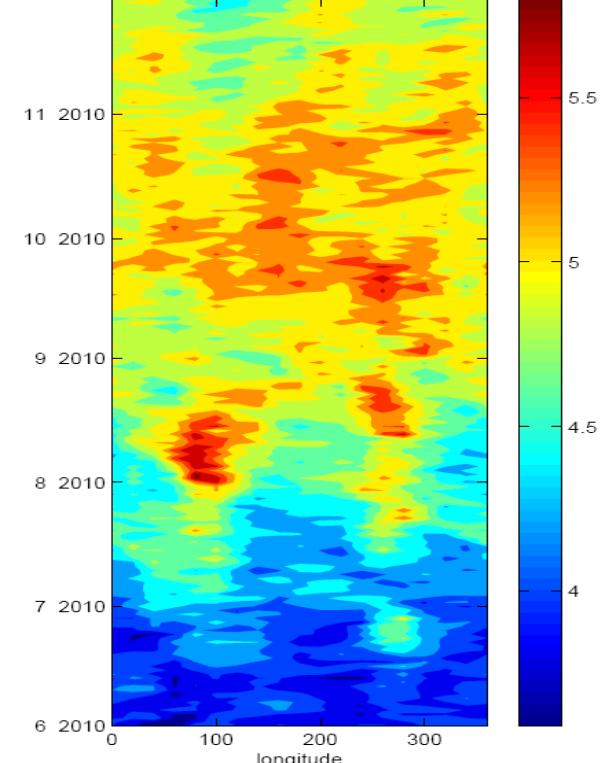
Water vapor mixing ratio (ppmv) at 100 hPa (average 25 N 40 N)



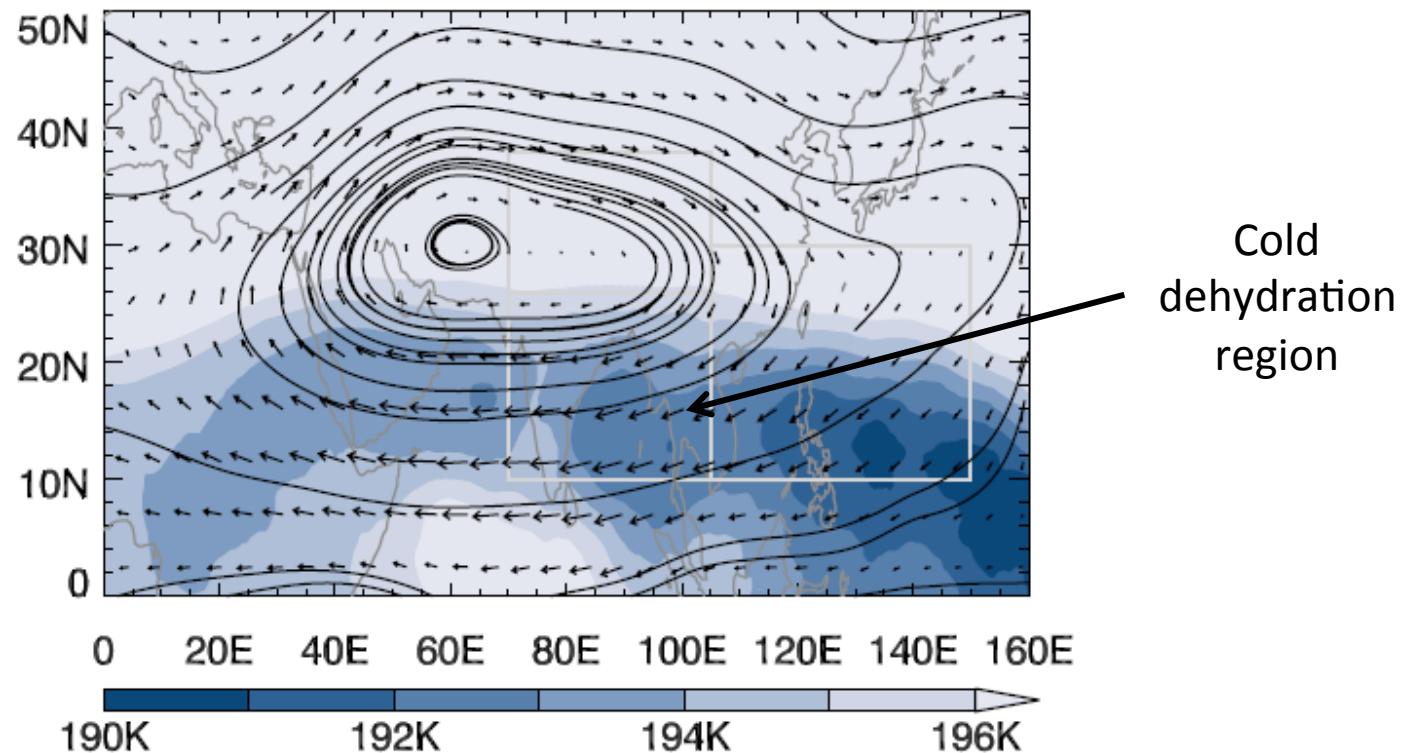
N American
monsoon

83 hPa

Water vapor mixing ratio (ppmv) at 83 hPa (average 25 N 40 N)

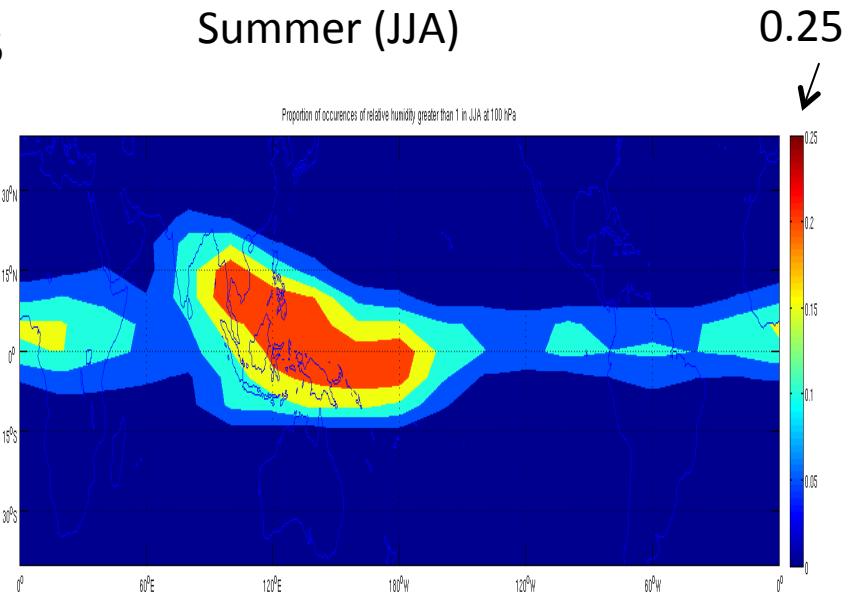
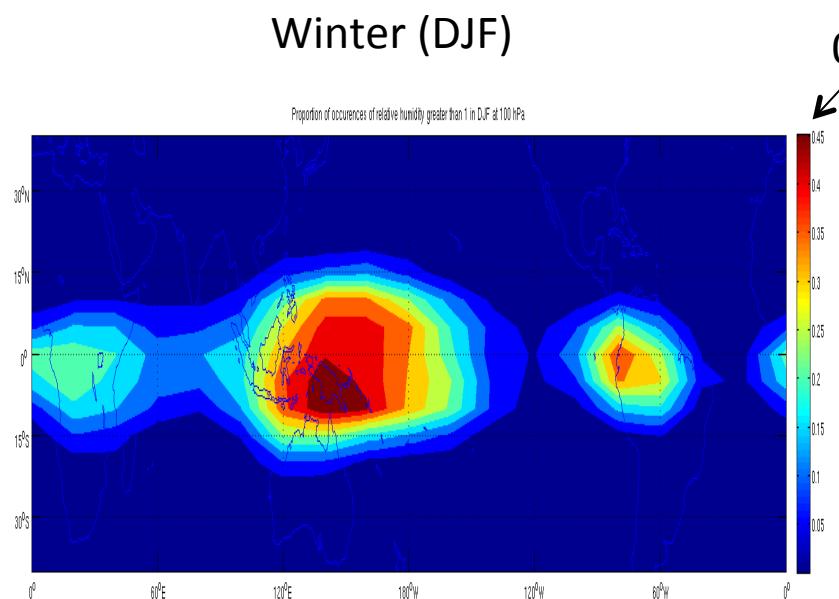


Trajectory simulation of dehydration in Asian monsoon



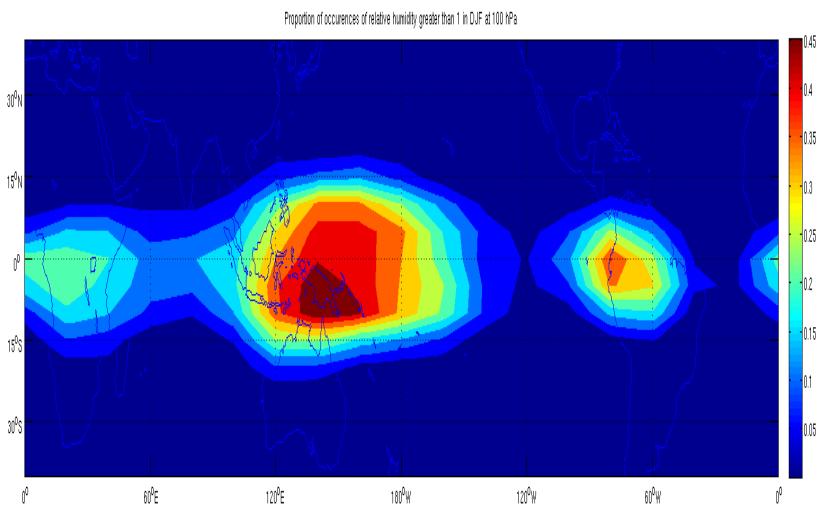
Wright et al 2011

Fraction of RH > 1.0 at 100 hPa (locations where dehydration may occur)

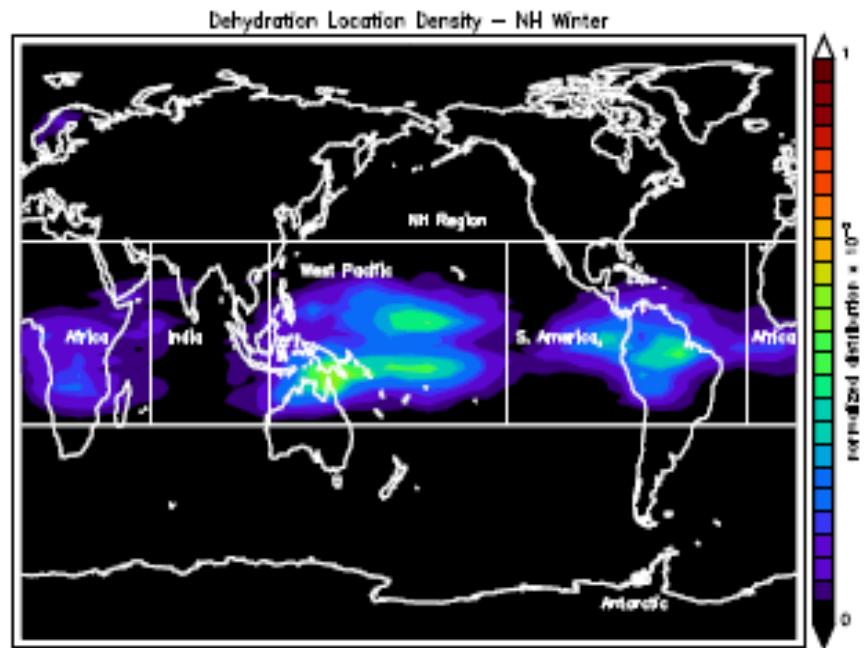


Fraction of RH > 1.0 at 100 hPa (locations where dehydration may occur)

Winter (DJF)



Trajectory dehydration location

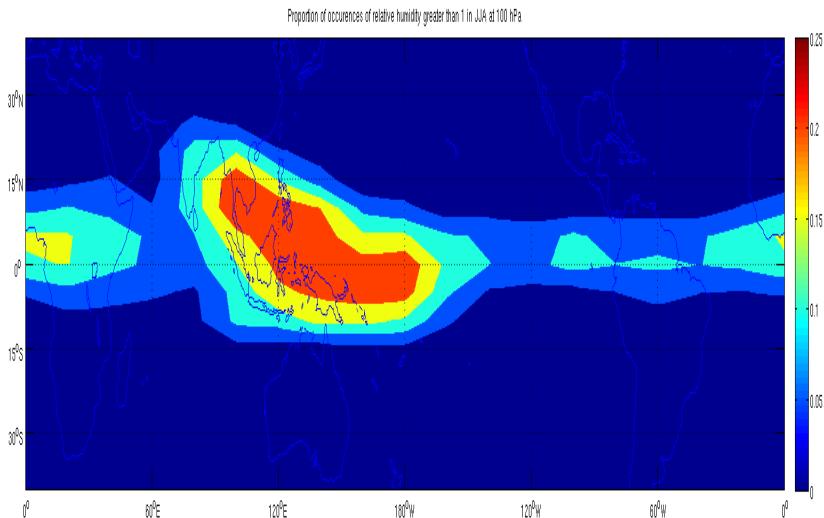


(a)

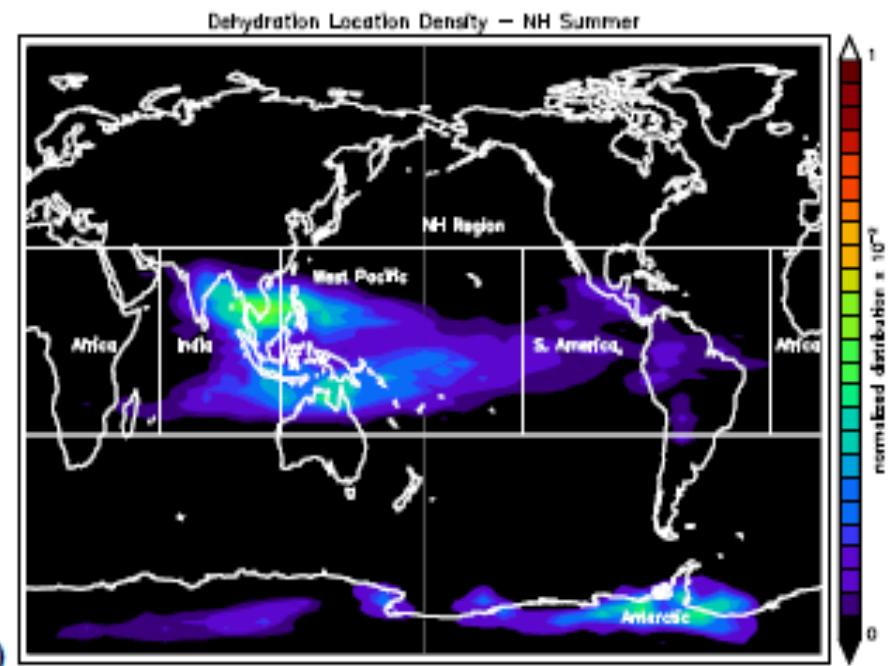
Schoeberl and Dessler 2011

Fraction of RH > 1.0 at 100 hPa (locations where dehydration may occur)

Summer (JJA)

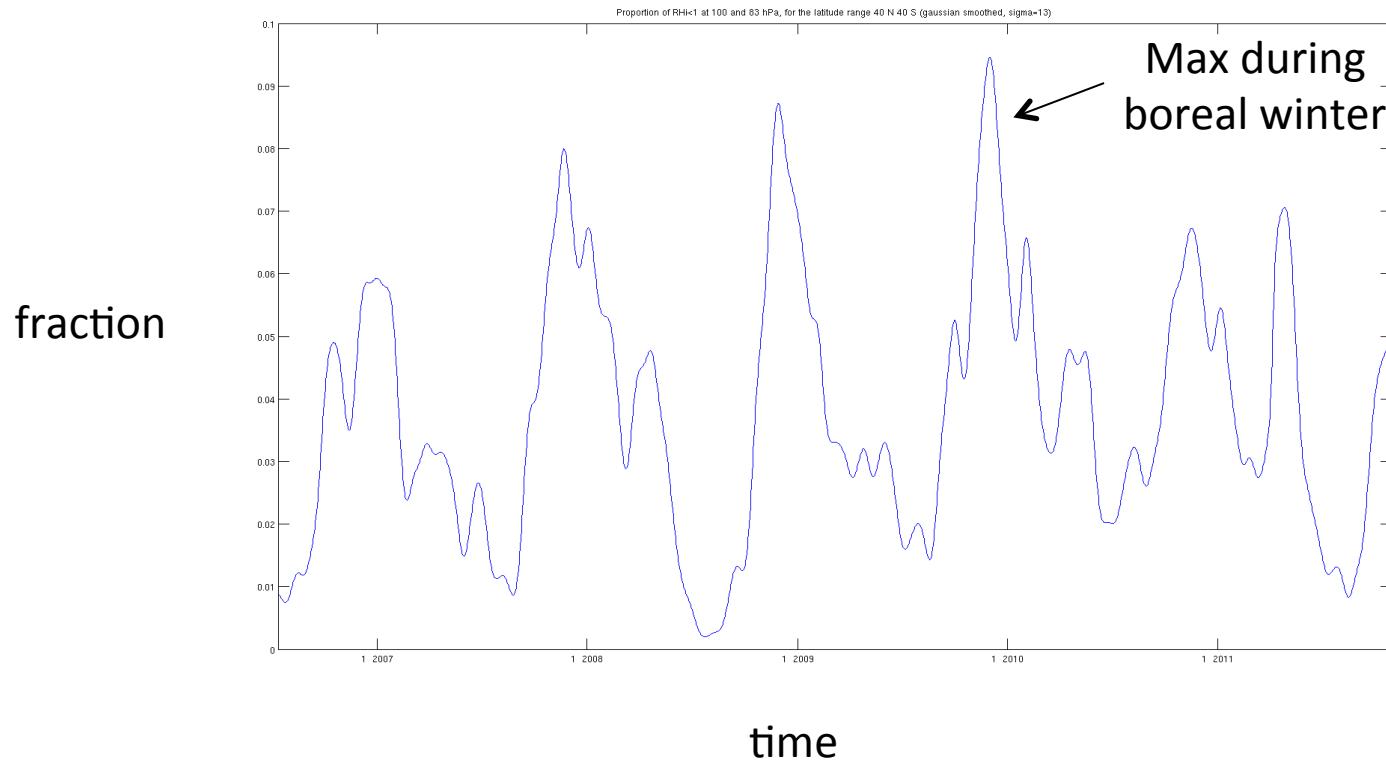


Trajectory dehydration location



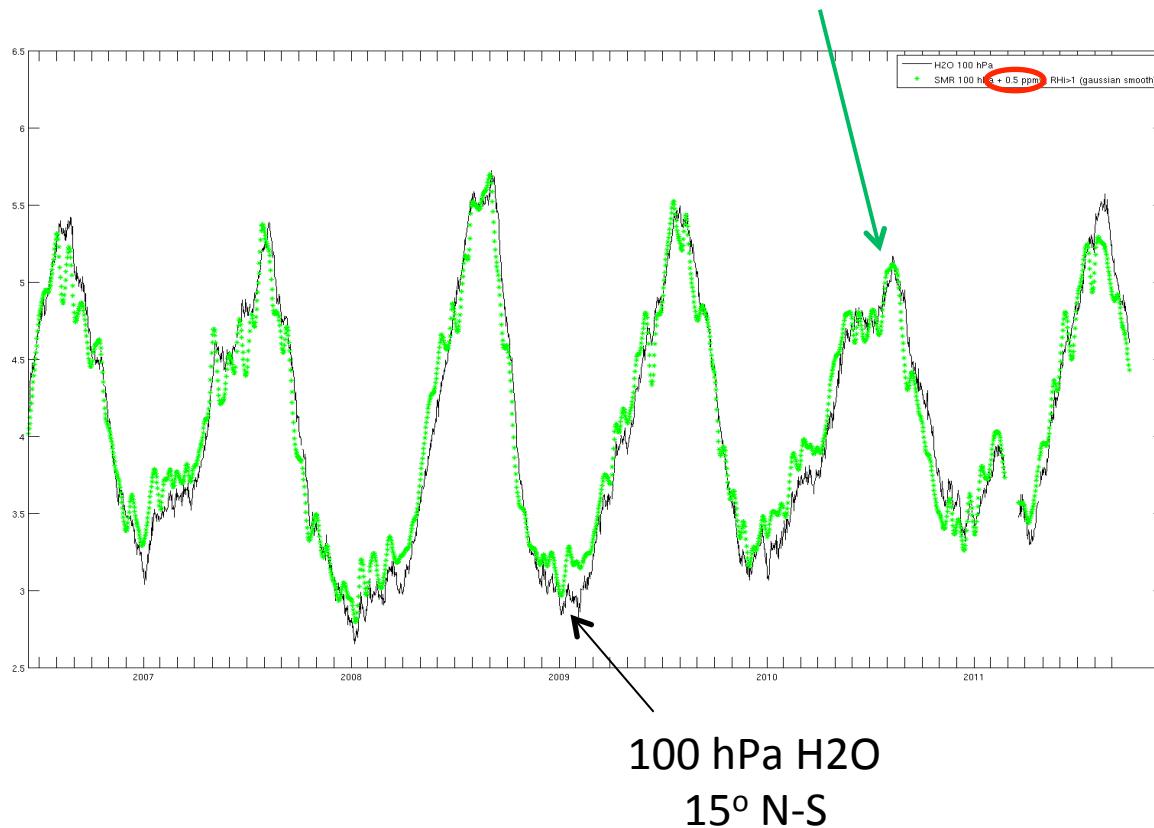
Schoeberl and Dessler 2011

Fraction of RH>1, for 40 S 40 N and 100 and 83 hPa



H_2O vs. Q_{sat}

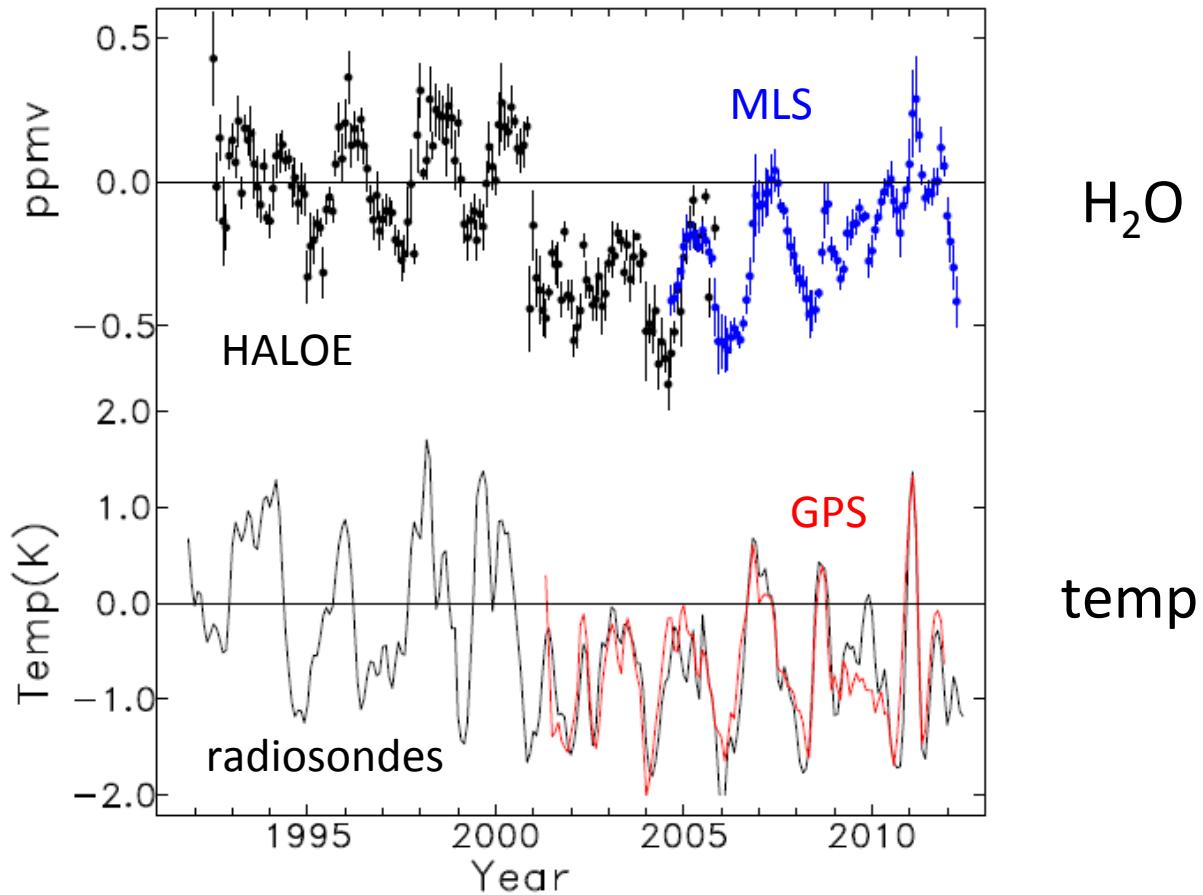
GPS saturation mixing ratio
at locations where $RH > 1.0$



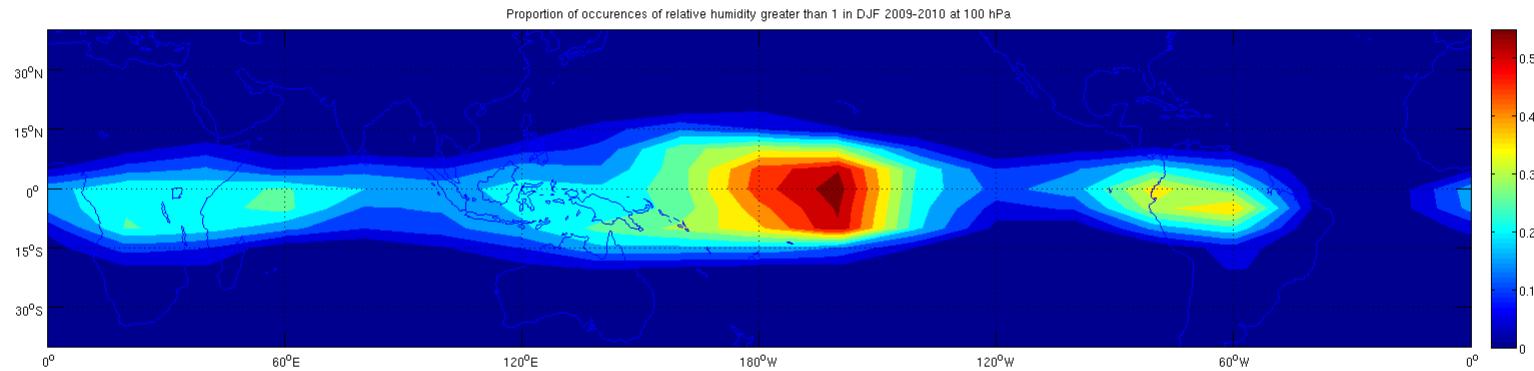
Key points:

- Work in progress
- MLS and GPS data sets provide opportunity to understand $H_2O - T$ coupling on daily to interannual time scales
- Localized dehydration regions ($RH > 1.0$) consistent with trajectory modeling results

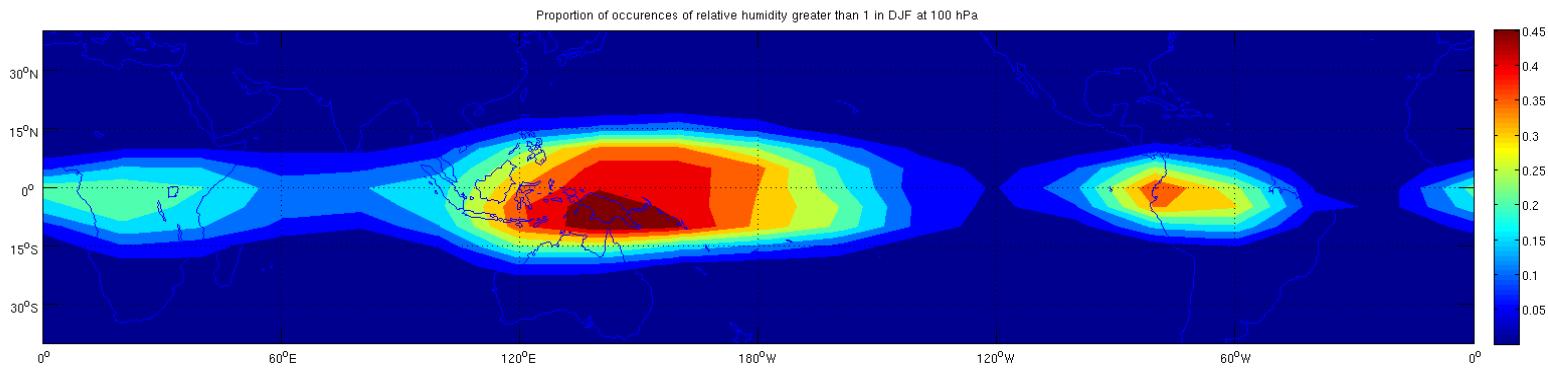
Longer record of stratospheric H₂O and cold point temp anomalies



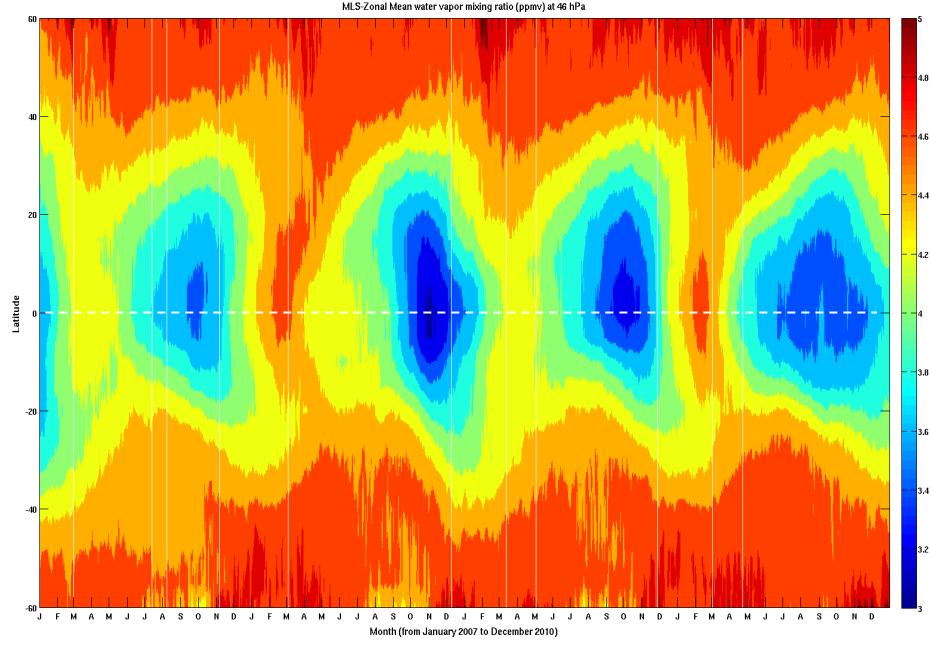
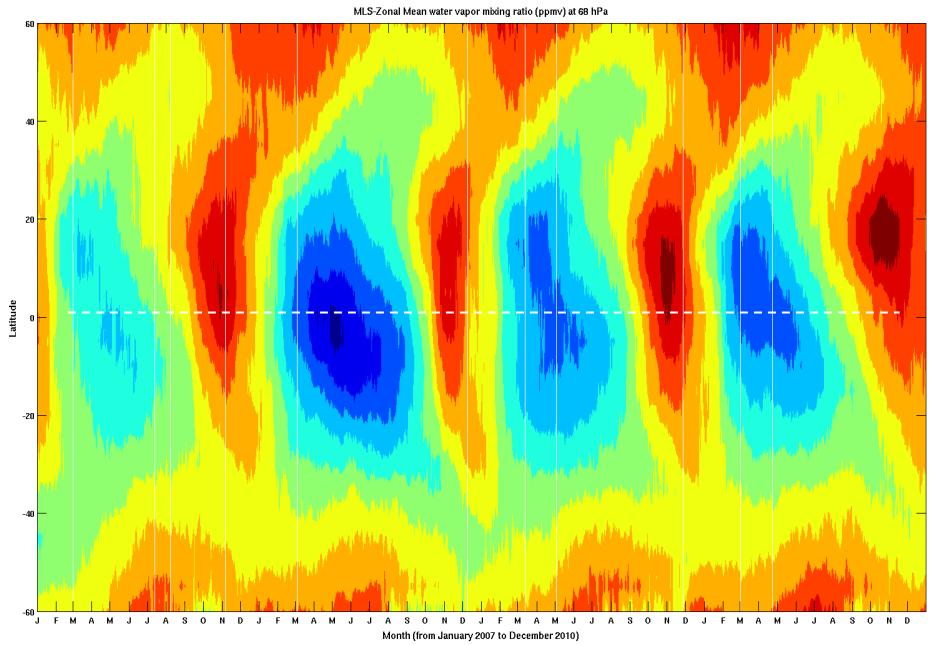
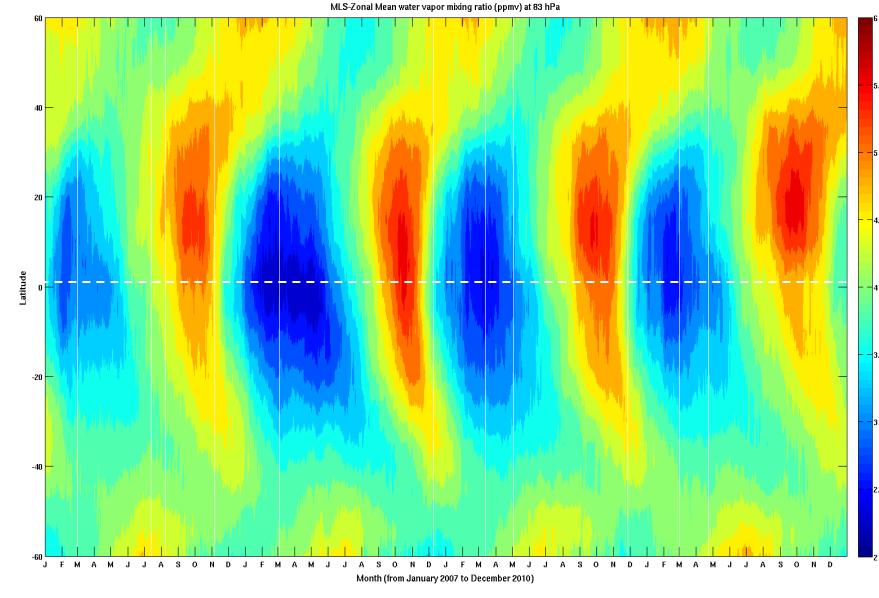
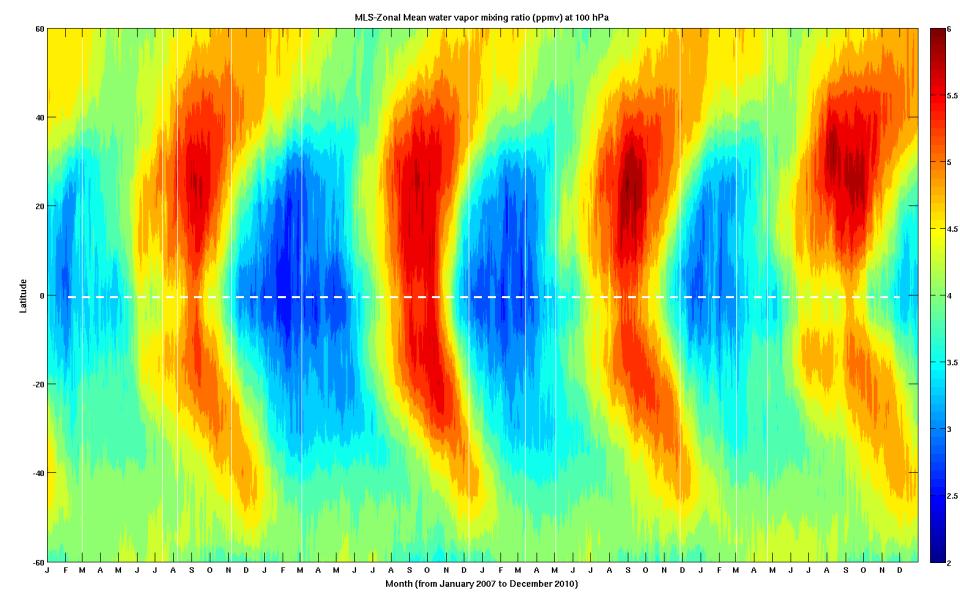
Fraction of relative humidity superior to 1



ENSO+ DJF

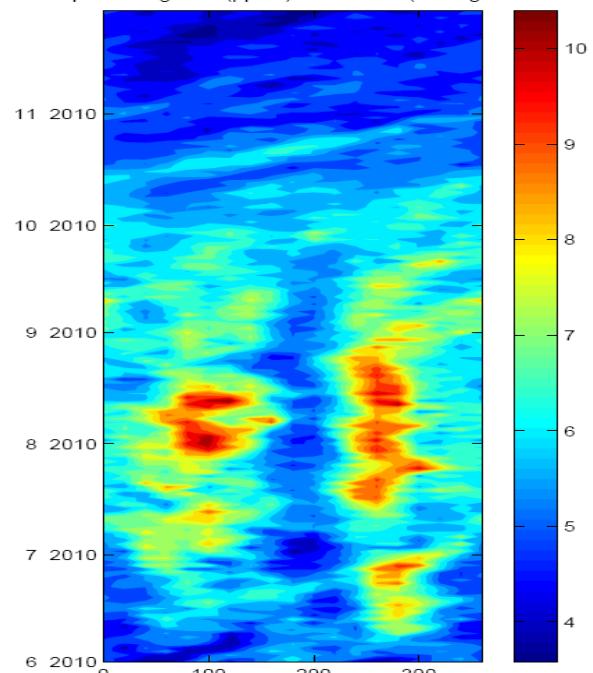


Average all DJF

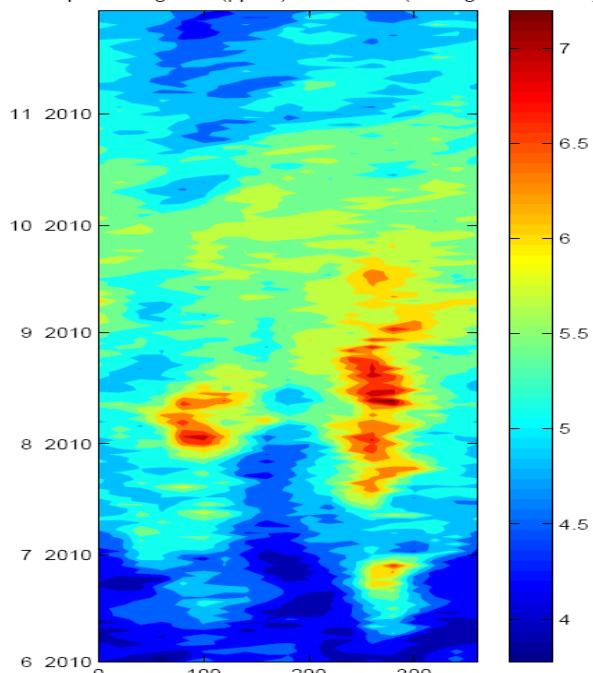


Monsoon region

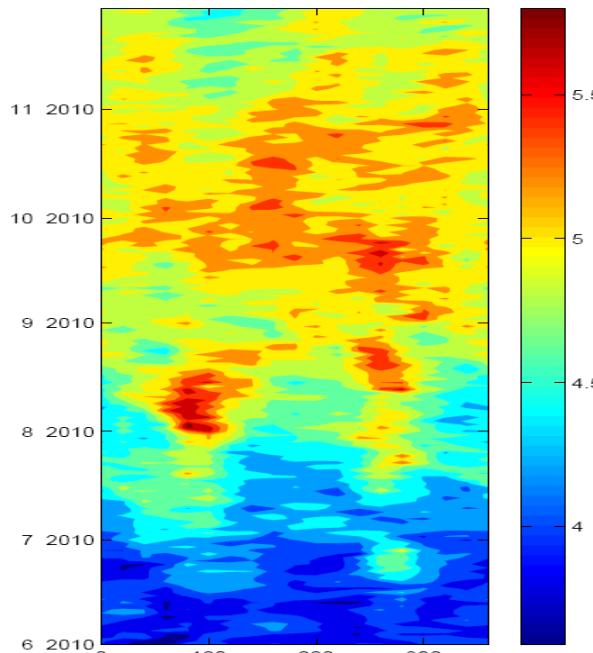
Water vapor mixing ratio (ppmv) at 121 hPa (average 25 N 40 N)



Water vapor mixing ratio (ppmv) at 100 hPa (average 25 N 40 N)



Water vapor mixing ratio (ppmv) at 83 hPa (average 25 N 40 N)



Water vapor mixing ratio (ppmv) at 68 hPa (average 25 N 40 N)

