Influence of convective regime migration on water vapor transport in the Asian monsoon lower stratosphere

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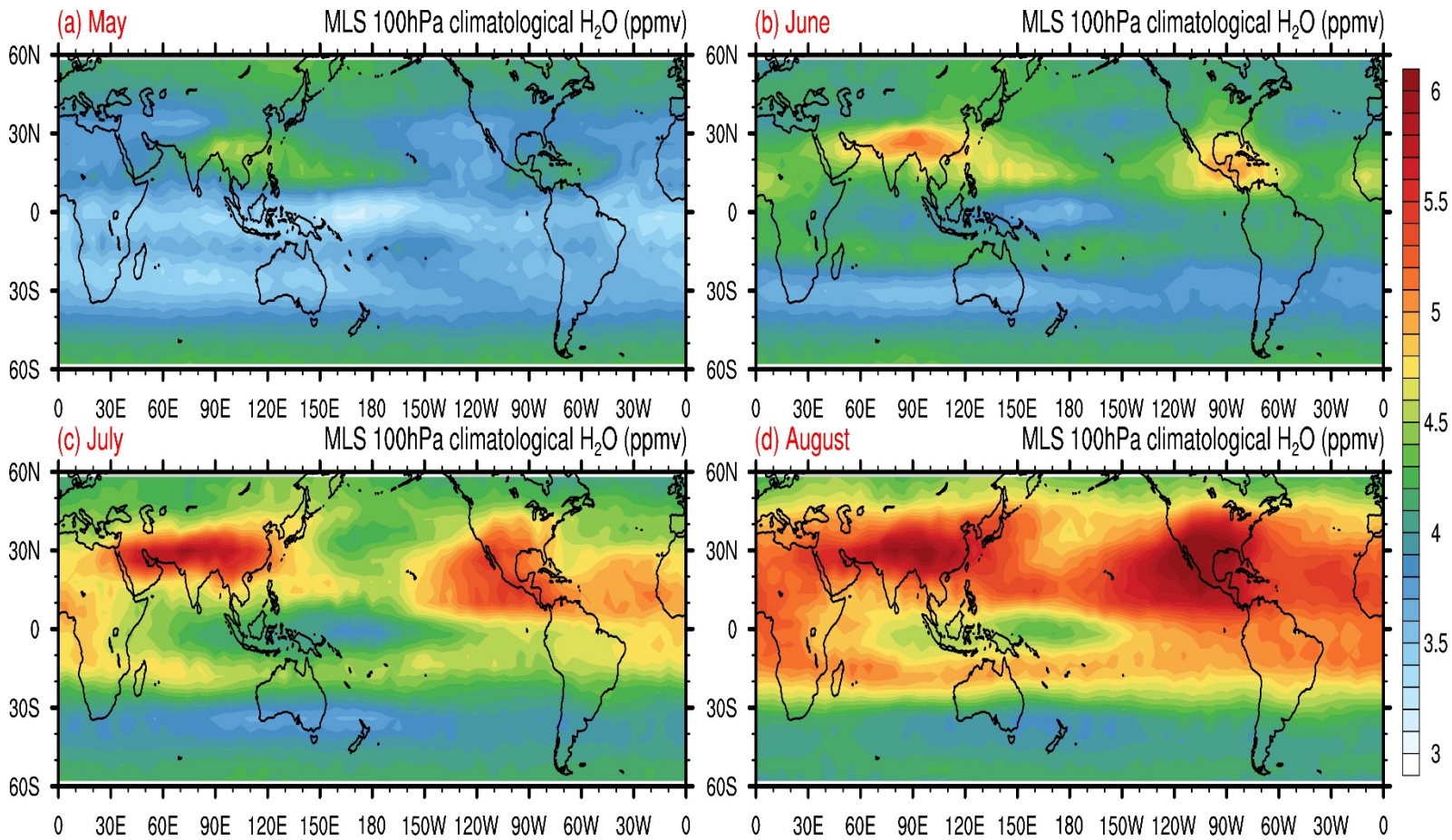
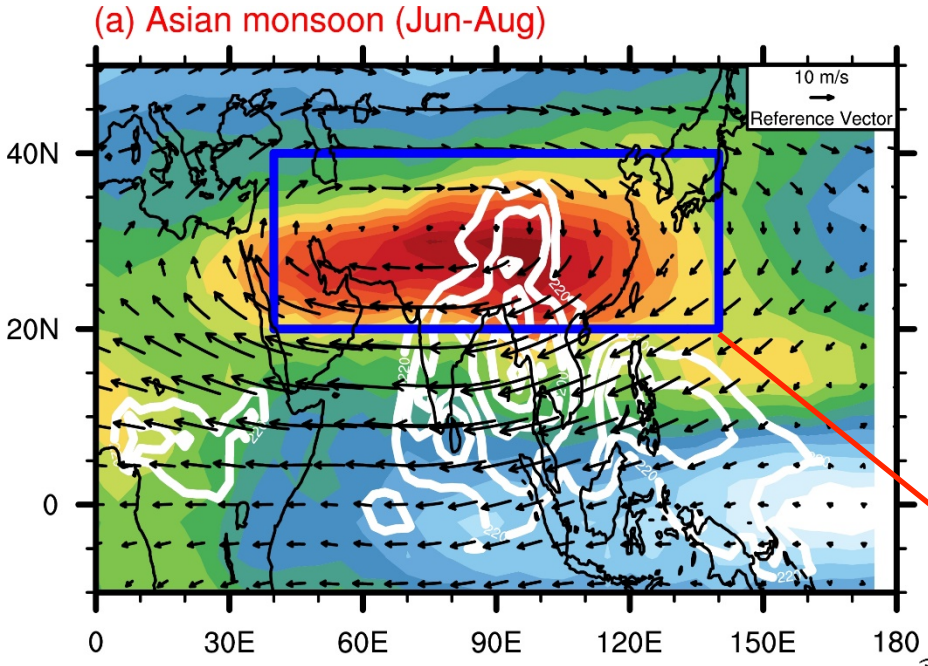
Climatological 100 hPa H_2O



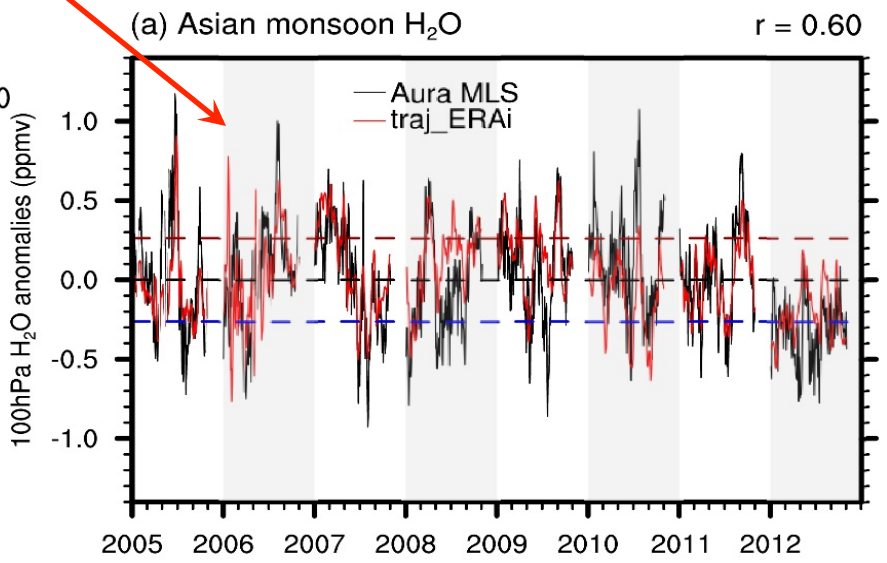
Q: What causes such a seasonal enhancement?

More convective injection?

Averaged 100 hPa H_2O over the Asian monsoon region



- **Aura MLS daily data (May-Sep, 2005-2013)**
- **Domain-filling forward trajectory model**

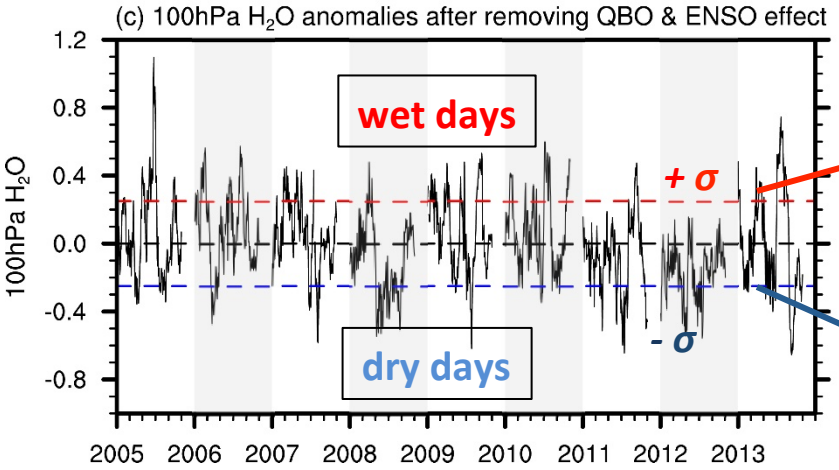


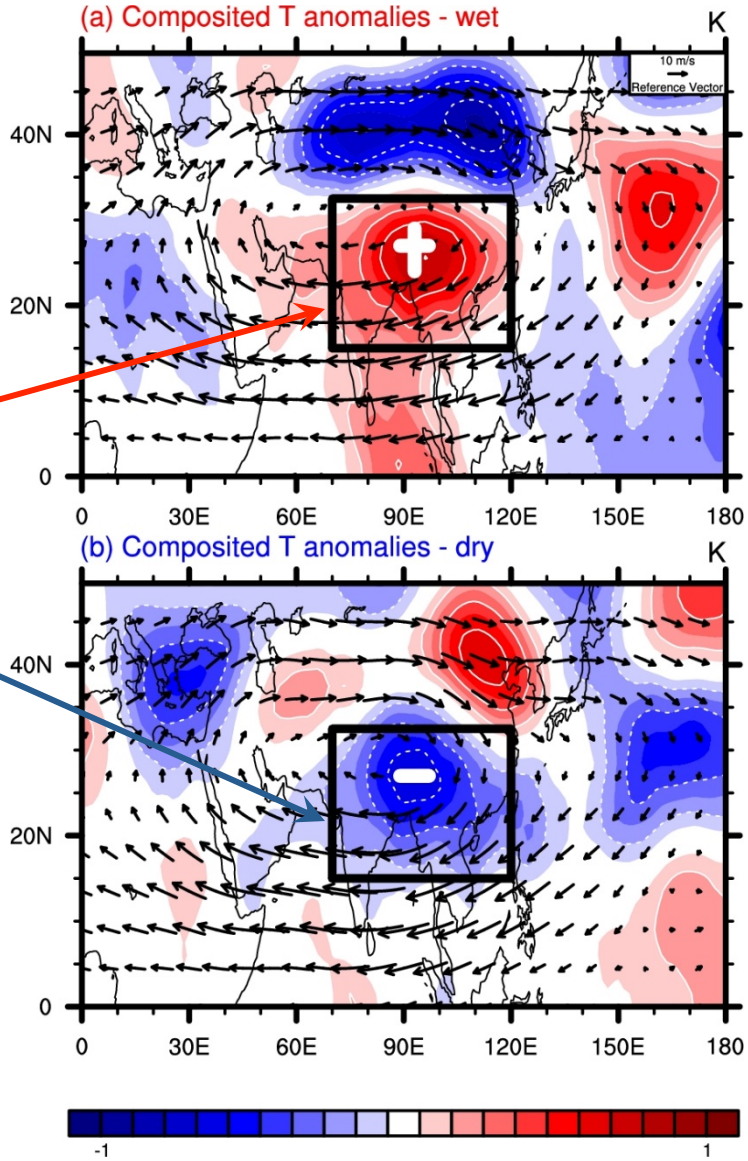
1. The good fit indicates that the variations of 100 hPa H_2O are primarily controlled by **temperature** and large-scale circulation, and convective injection plays a minor role.
2. The traj can also well simulate the seasonal enhancement.

Q: Why is there such a seasonal enhancement?

More convective injection ✗

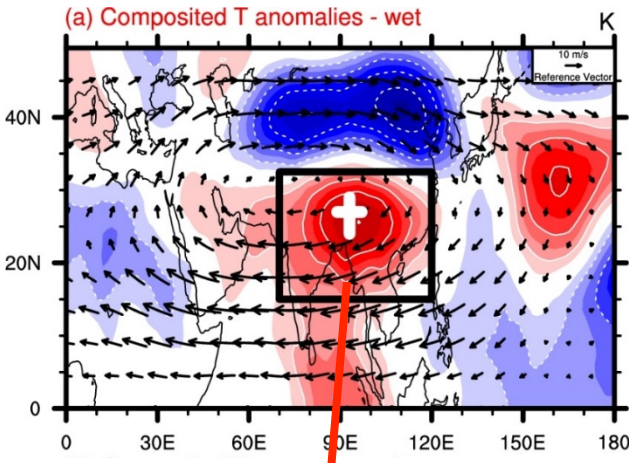
Variation of H_2O and its correlation with 100 hPa temp (*Randel et al., 2015*)

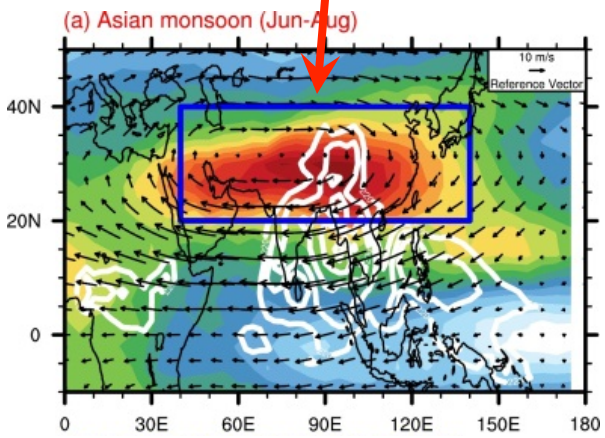




Randel et al. (2015), accepted by JGR

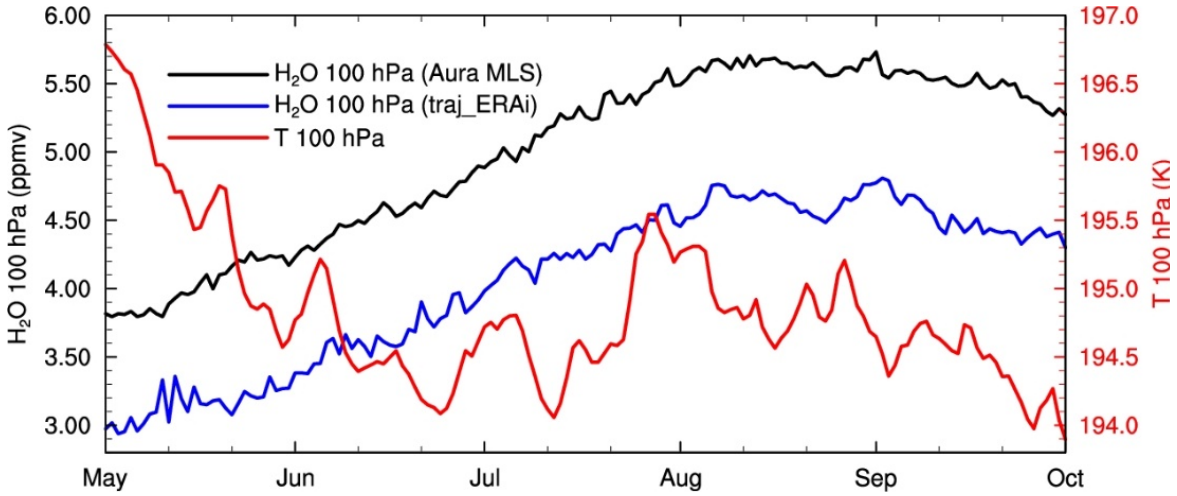
What controls stratospheric water vapor in the NH summer monsoon regions?



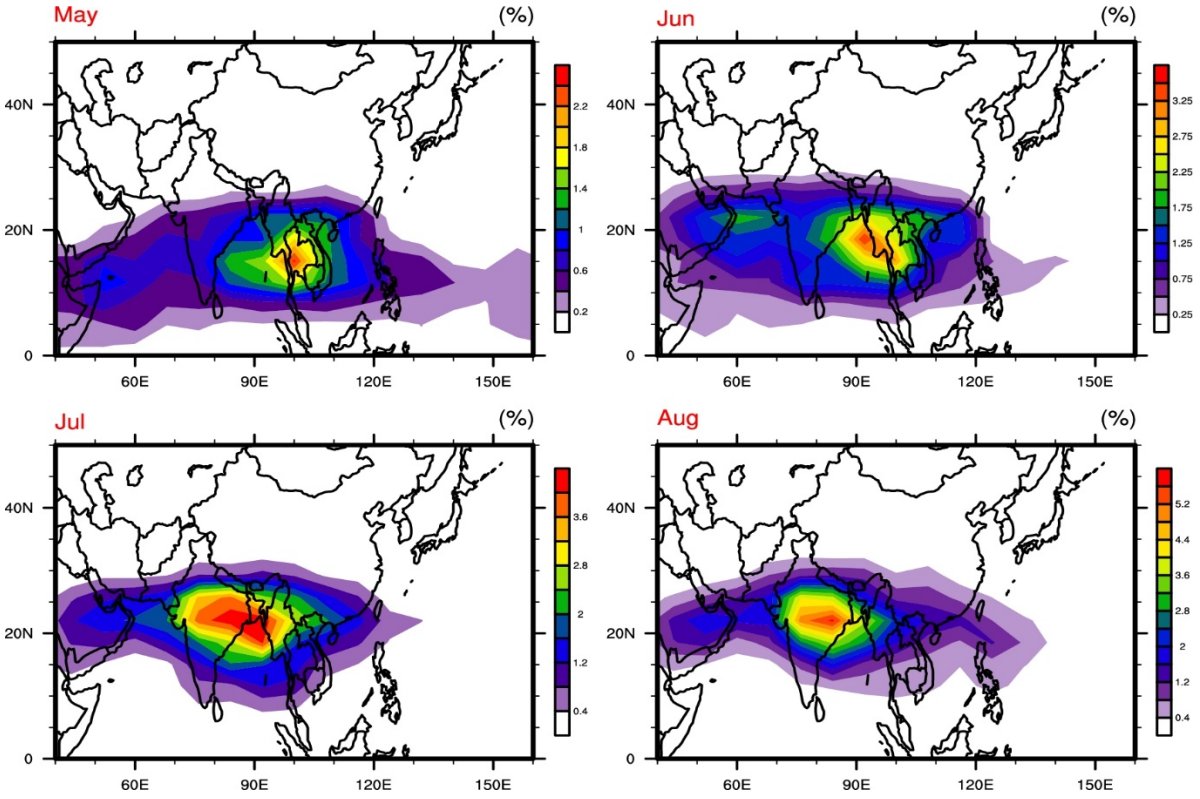


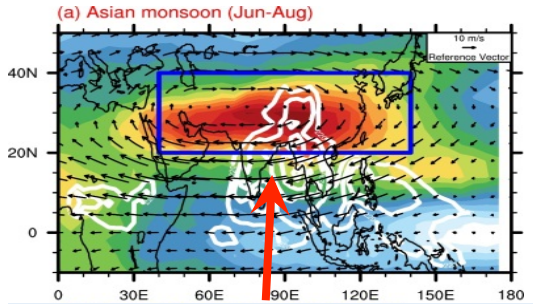
However, the temperature over this region cannot well explain the seasonal increase of LS water vapor in the Asian monsoon region.

But the traj model can also well capture the increase, and the water vapor in the model is determined by temperature.
How to explain the conflict?
>> One possibility is that dehydration occurs over different regions.



Westward migration of dehydration pattern





All the air parcels were selected at 100hPa over the Asian monsoon region during May-Sep 2005-2013.

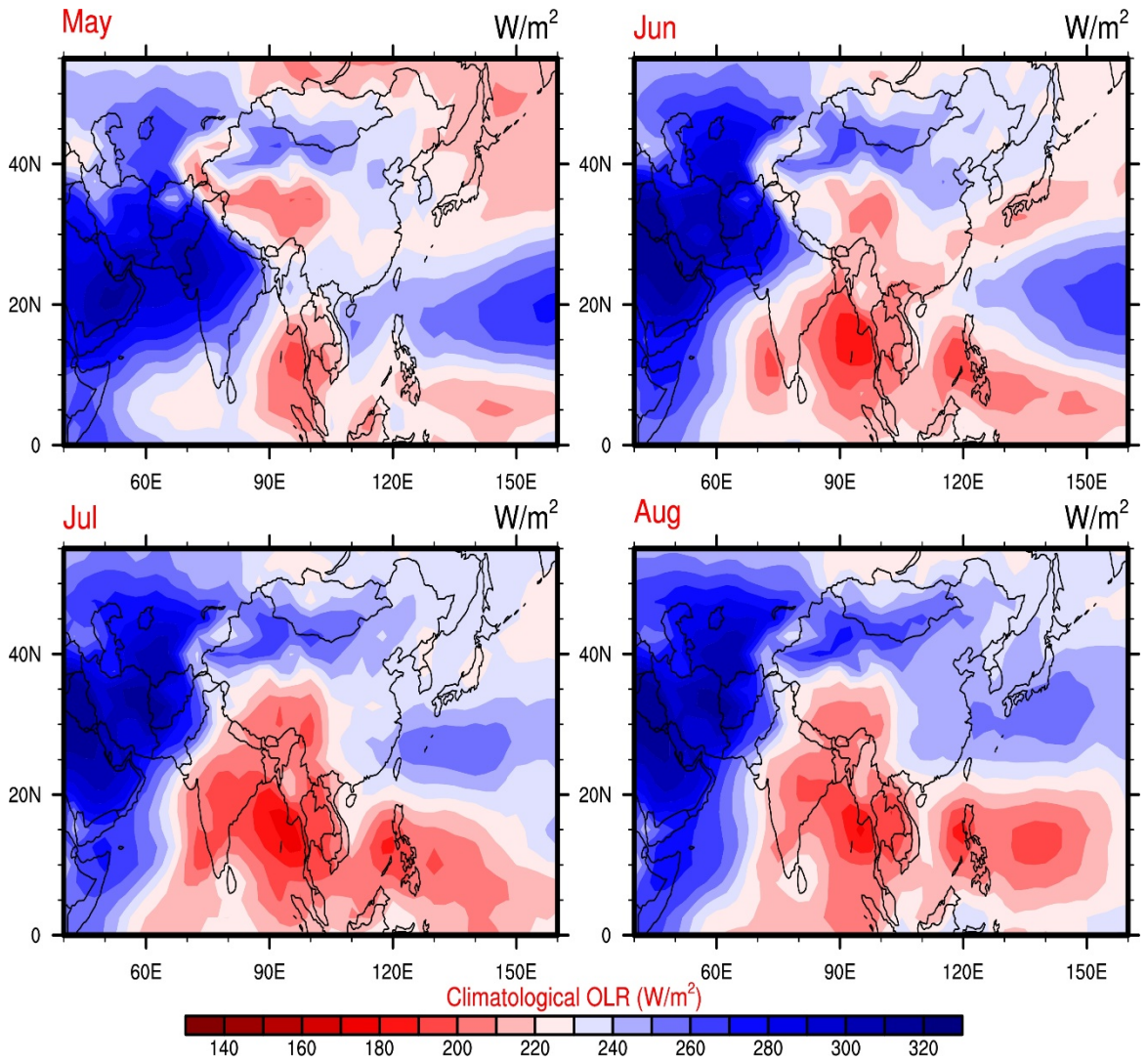
In trajectory model, water vapor content is determined by the final dehydration temperature.

>> The dehydration pattern shows a westward migration, which could well explain the increase during the monsoon season.

Climatological OLR

Red shadings (OLR<220W/m^2)

The convection pattern shows a westward migration during the monsoon season from May-July and retreat after August.

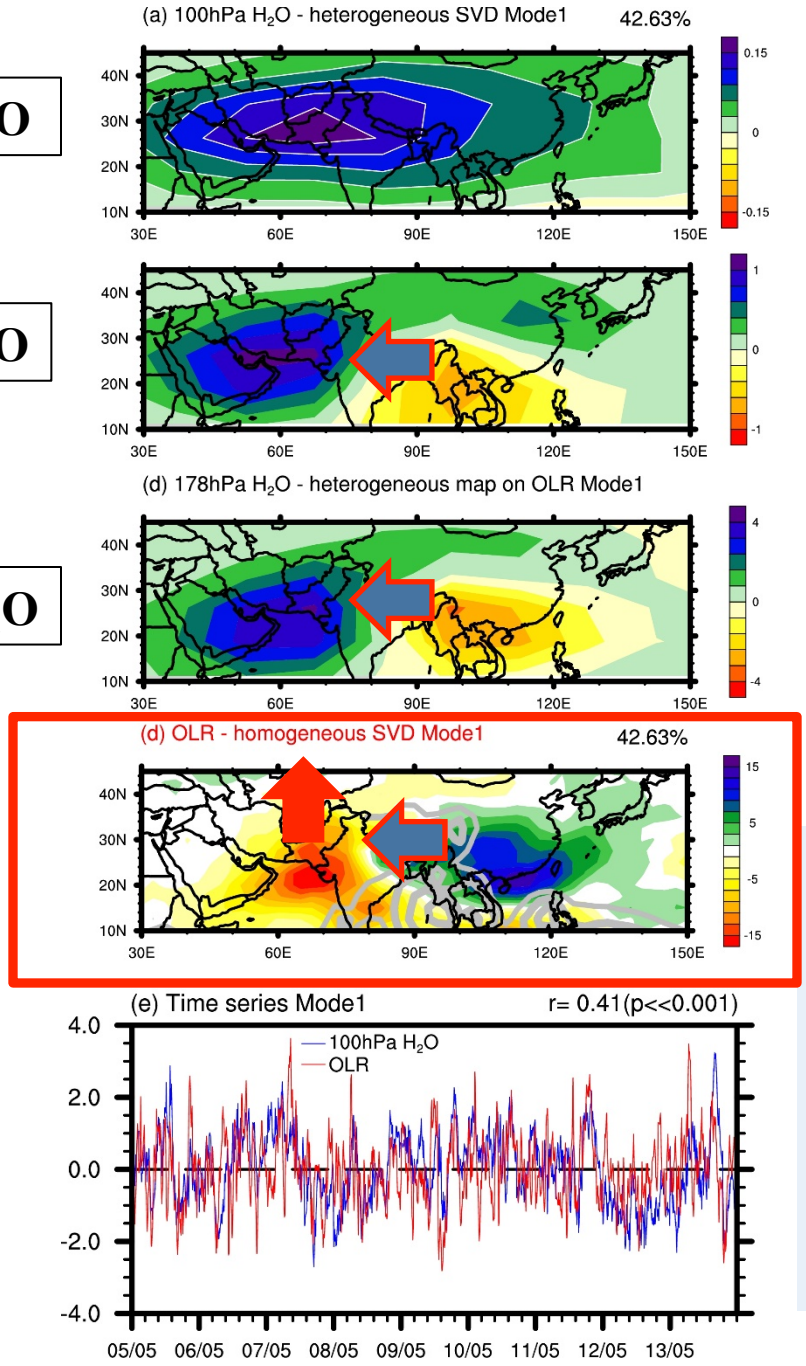


100hPa H_2O

147hPa H_2O

178hPa H_2O

OLR

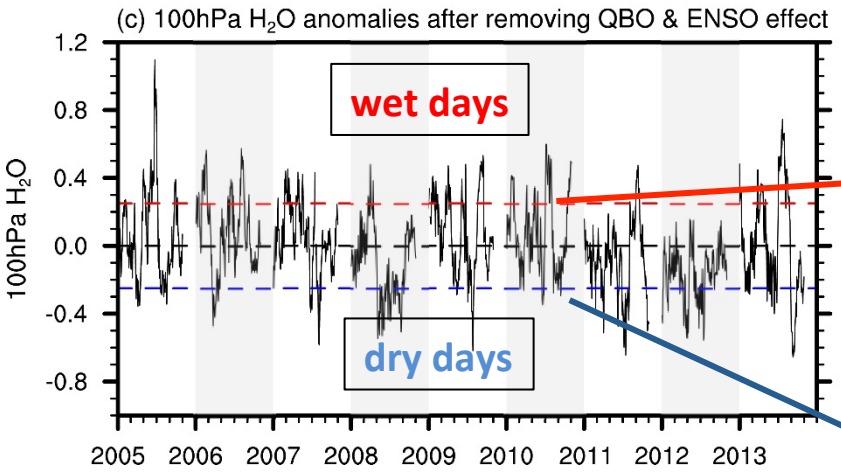


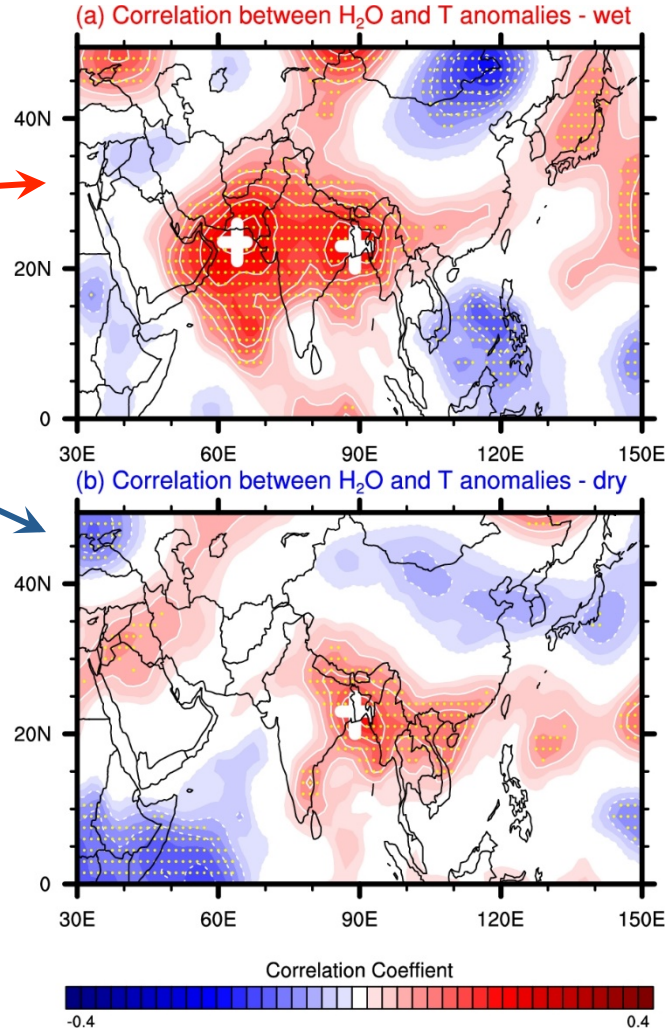
This figure shows the **SVD analysis** of 100hPa H_2O anomalies and OLR using Aura MLS daily observations. There is a significant correlation between H_2O and OLR.

>> Due to the **westward shift of convection**, humidity regime also shifts westward in the entire upper troposphere. As a result, more water vapor gets dehydrated and enters the LS over west side.

>> On the other hand, this convection pattern will lead to a warmer tropopause temperature on the east side, and thus more water vapor entering the LS over this region. (see *Randel et al., 2015, JGR*)

Different dehydration pattern during wet and dry days: *Observations*

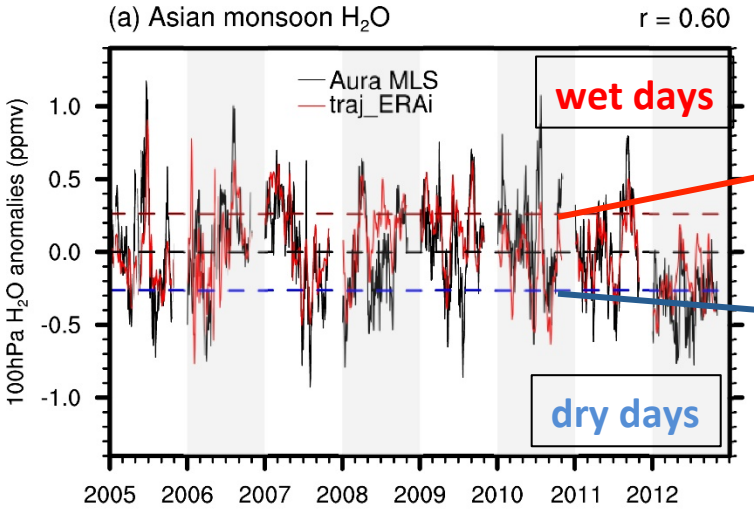




Hint:
Positive correlation → temperature controlling region → dehydration region

During wet days, H_2O variations are more correlated with temperature on the west side, which means that more H_2O parcels are dehydrated by this region.

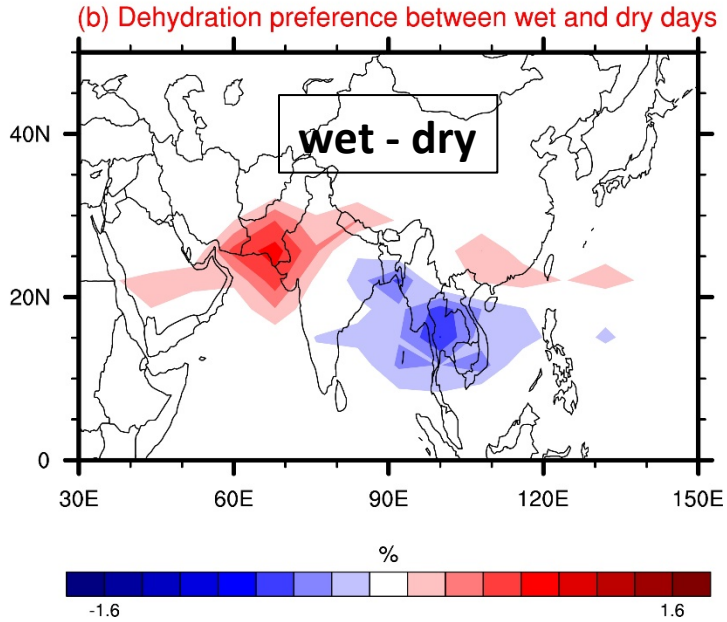
Different dehydration pattern during wet and dry days: *Traj Model*



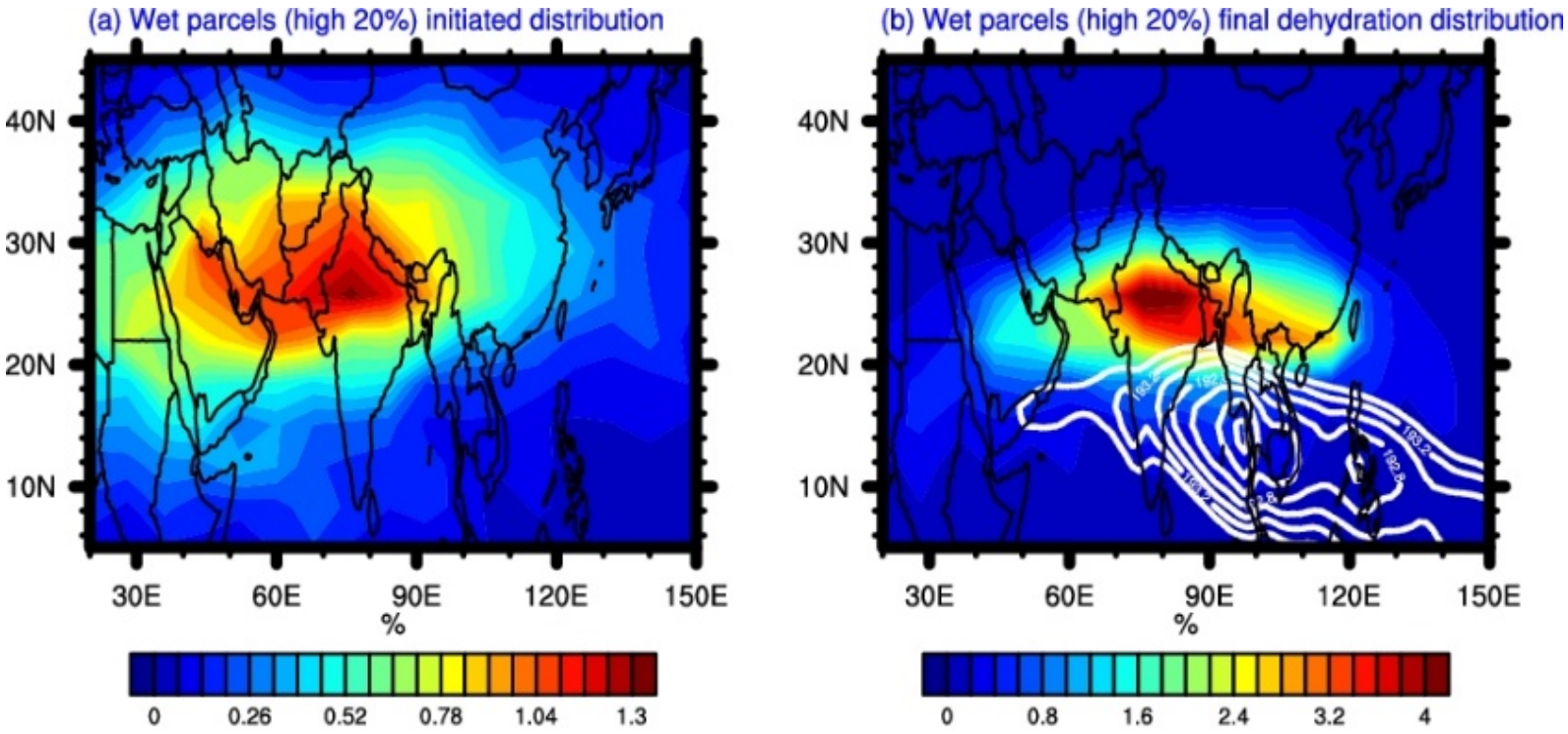
We trace back all the parcels in the Asian monsoon region at 100hPa from May-Sep 2005-2013.

We can get the final dehydration locations for wet and dry days, and check their differences.

In trajectory model, during wet days, more air parcels are finally dehydrated over the west side, which is consistent with the observational results.

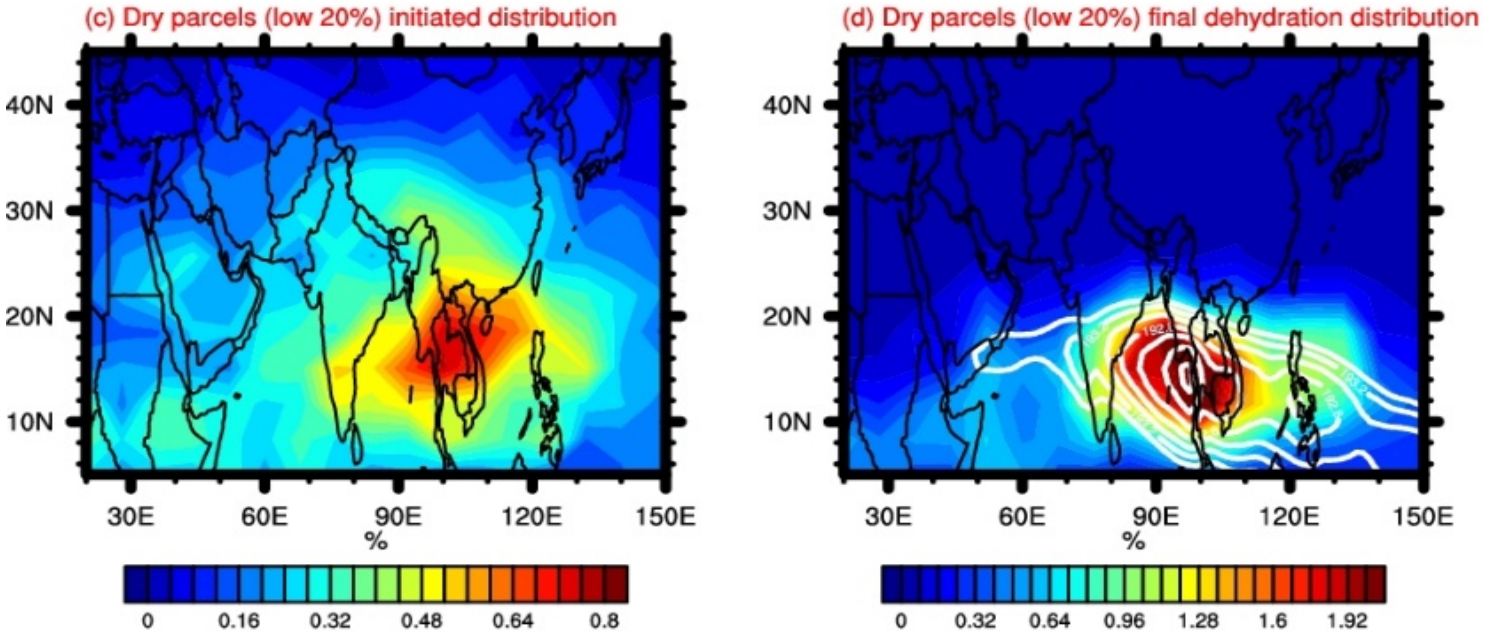


Wet parcels *(high 20% percentile)* in traj model



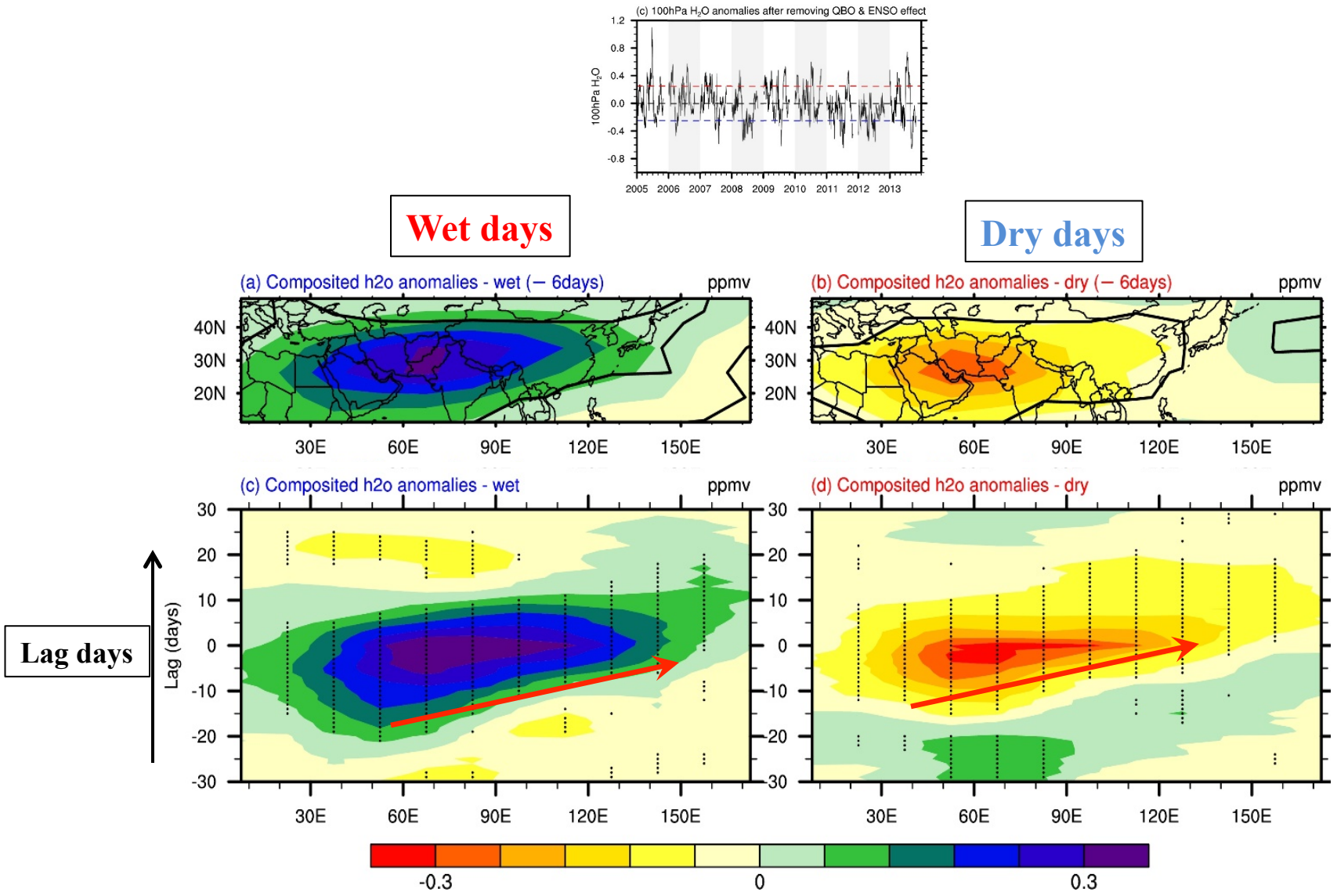
All the air parcels were selected at 100hPa over the Asian monsoon region during May-Sep 2005-2013.

Dry parcels *(low 20% percentile)* in traj model

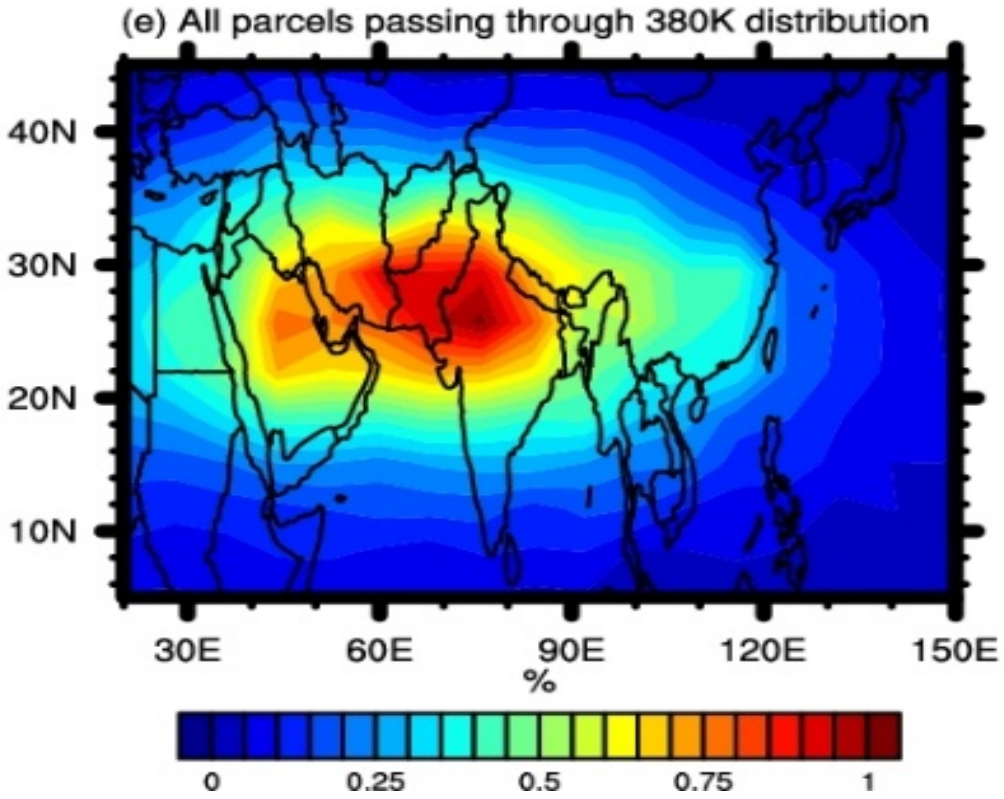


How do water vapor anomalies transport in the LS over the Asian monsoon region?

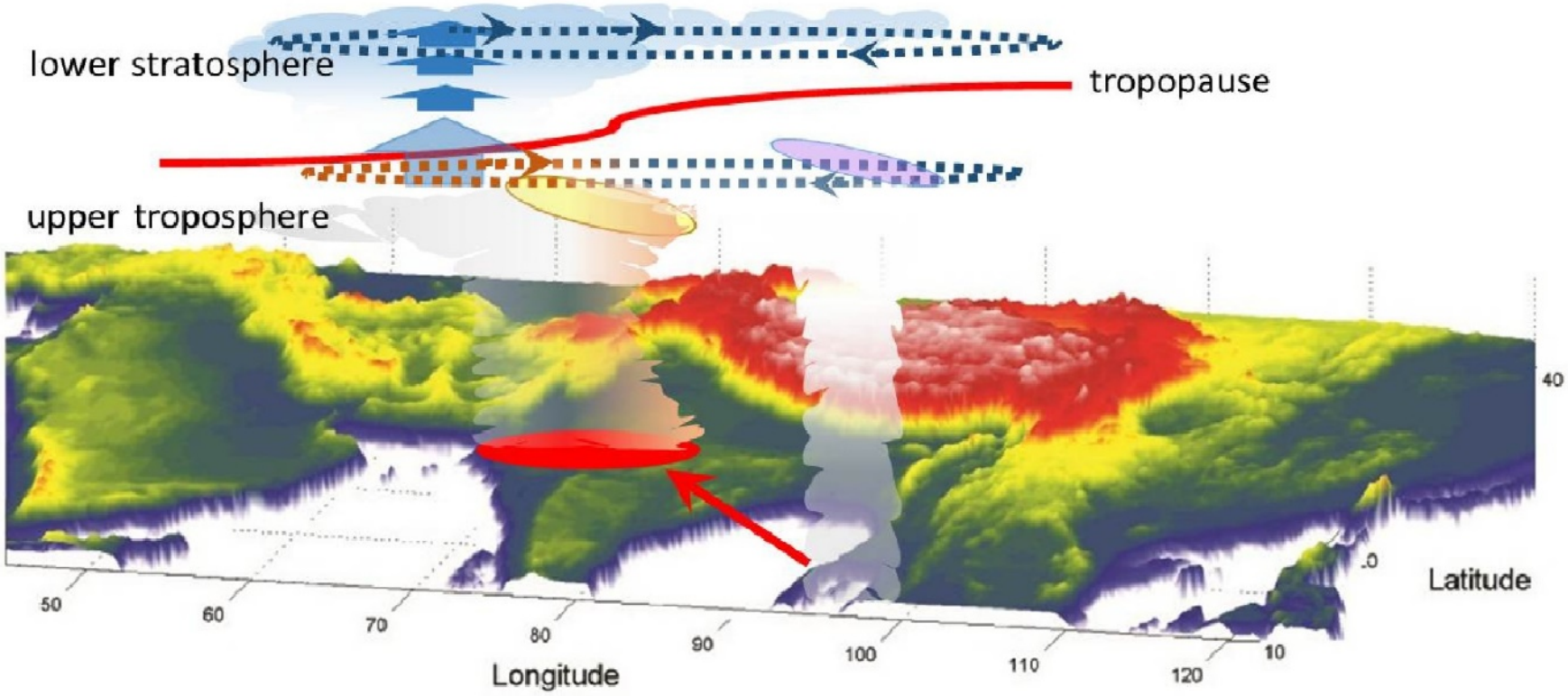
Composite H_2O anomalies using Aura MLS observations



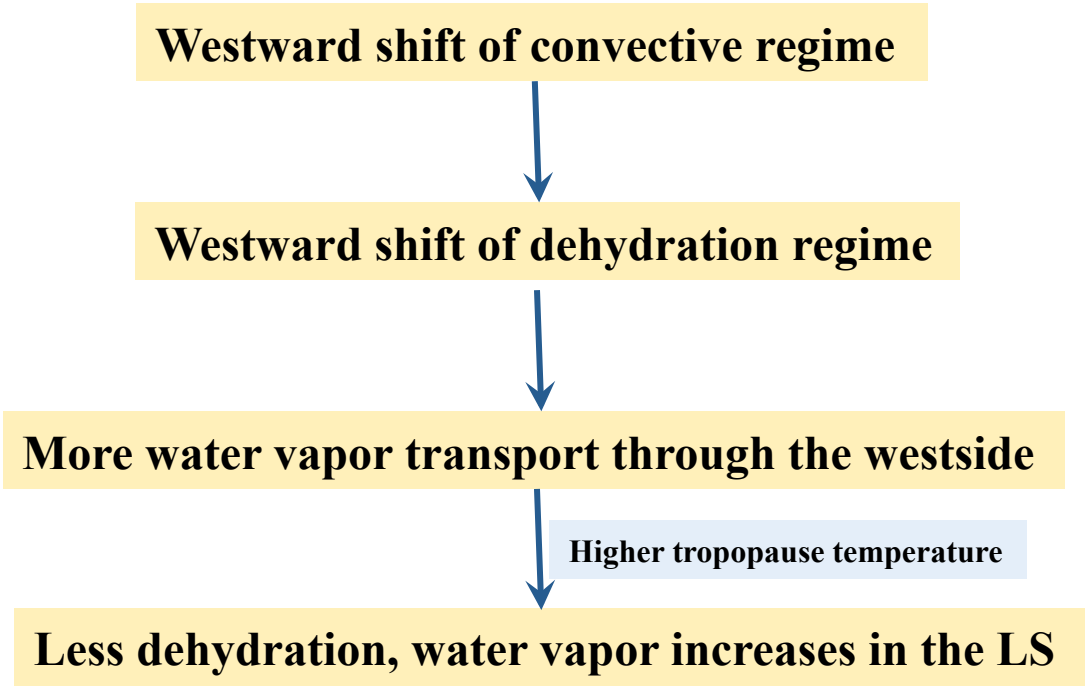
Where did all parcels pass through tropopause?



Conclusion


lower stratosphere
tropopause
upper troposphere
50
60
70
80
90
100
110
120
Longitude
10
40
Latitude

Conclusion



1. Water vapor variations over the Asian monsoon LS are primarily controlled by temperatures;
2. A westward migration of convection will moist the LS.

Thanks!

An example of 2011