Change of water vapor in UTLS caused by deep convections

Ying Sun and Yi Huang
Department of Atmospheric and Oceanic Sciences, McGill University

MOTIVATION AND OBJECTIVES

Water vapor is an important constituents of stratosphere for its radiative and chemical effects. The amount of water vapor in stratosphere is small, but that small amount can make a big difference to energy budget and loss of ozone. The distribution of water vapor is quite uniform in stratosphere, but recently it is proposed that some big values observed in specific regions are caused by deep convections. My main objective is to find robust evidence to show if deep convection can influence water vapor distribution in stratosphere and how.

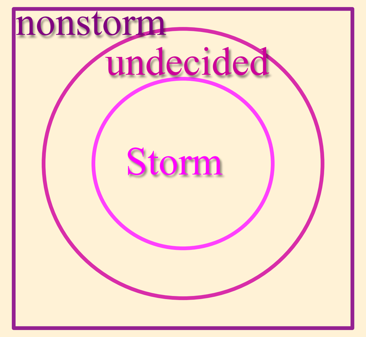
DATA AND METHOD

- International Satellite Cloud Climatology Project (ISCCP) was used to identify deep convections.

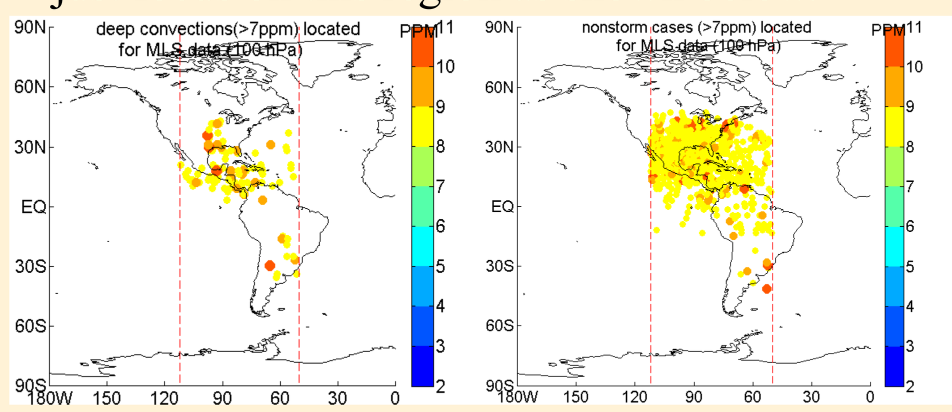
cloud top temperature definition	< 245K convective systems	<220K convective clusters

- Satellite data are divided into three groups

Standard	Center	Space range	Time range
Storm (inside)	Average center	Average radius of CS	Start - end
Nonstorm (ourside)	Average center	Biggest radius of CS	Start – 3 hr ~~ End +3 hr

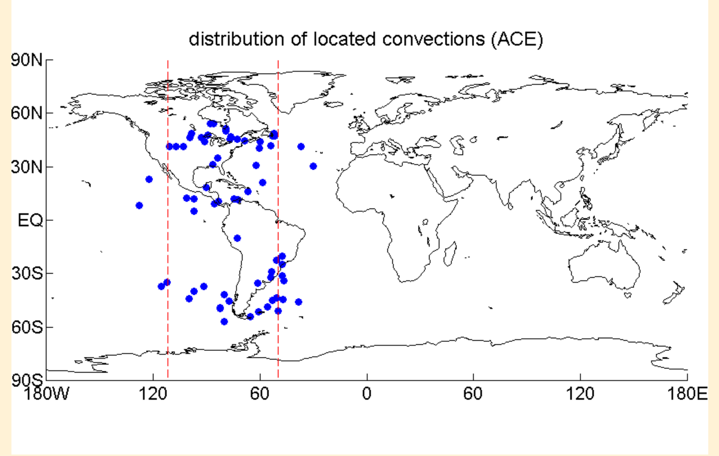


- EOS-MLS data is used to analyze water vapor change in stratosphere. Since the valid longitude of GOE is 112W-50W, we just focus on this region as shown below.

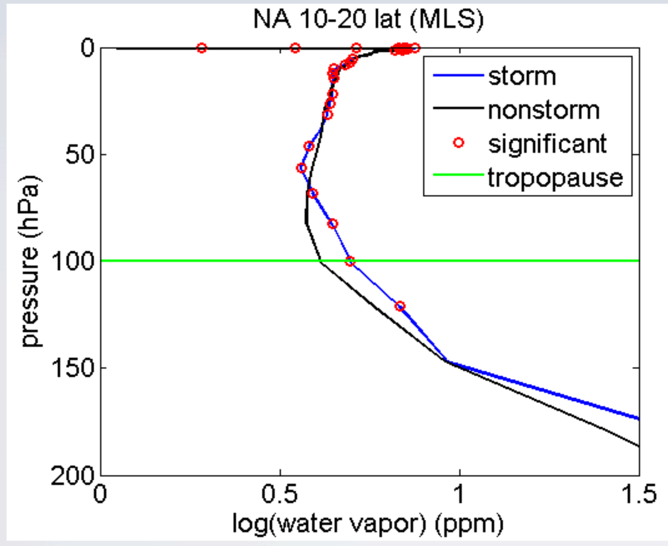


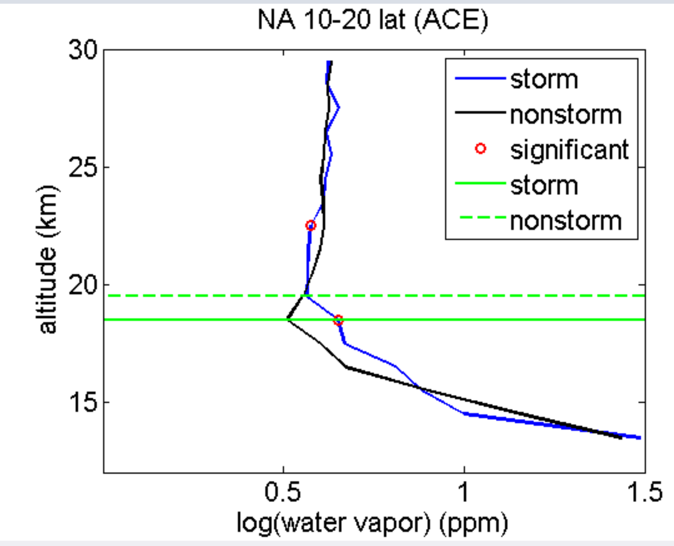
The amount of water vapor at each point is shown in different colors

- ACE-FTS version 3 is also used to compare with the result derived by using MLS data. One disadvantage of this dataset is the limited number of data.



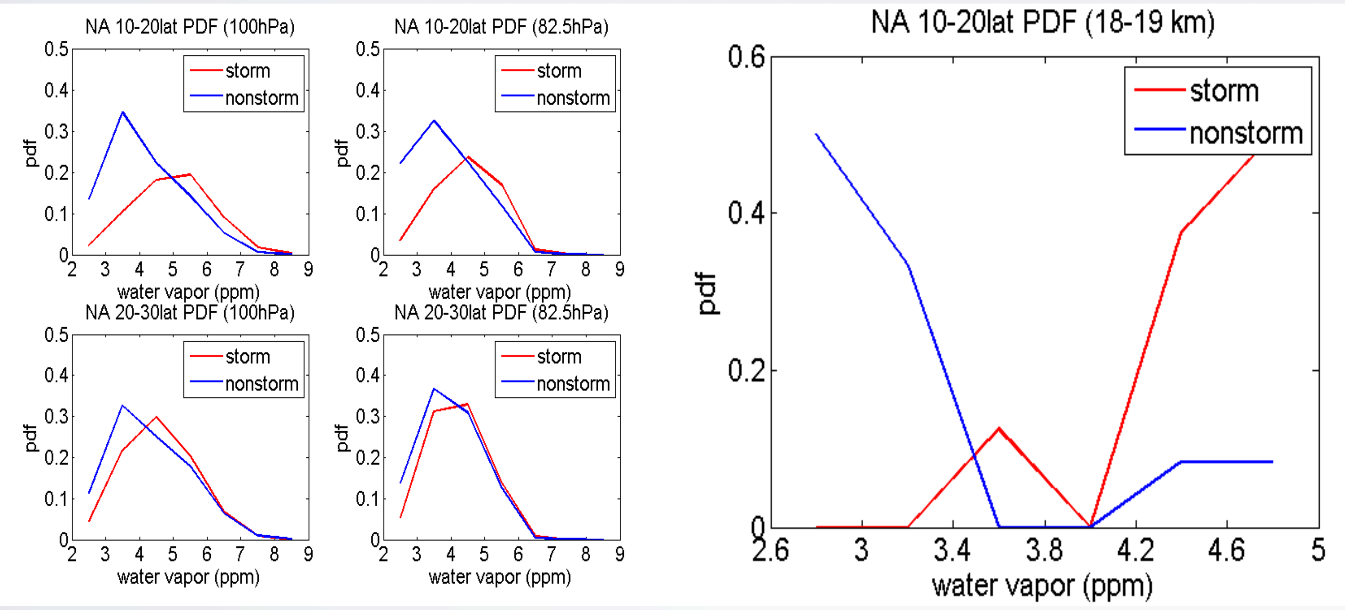
RESULTS





Vertical distribution of water vapor in 10-20N box is shown here. This latitude box Red dots mark the significant difference.

In this latitude box, MLS result shows that the increase level is around 100 hPa while for ACE result the level is 18-19 km which correspond to 80 hPa.



PDF of water vapor at levels where the increase is most obvious are shown.

Deep convections can explain a part of big values, but for nonstorm cases there are still some extreme values.

Water vapor (ppm)	2-3	3-4	4-5	5-6	6-7	7-8	8-9
Number of data	4731	12467	8882	6217	2457	336	29
Percentage of nonstorm	0.9639	0.9402	0.8500	0.7748	0.7265	0.6577	0.5172
Percentage of strom	0.0131	0.0229	0.0566	0.0864	0.1018	0.1458	0.2414

(A)

Water vapor (ppm)	2-3	3-4	4-5	5-6	6-7	7-8	8-9
Number of data	7812	12188	9323	5227	309	9	1
Percentage of nonstorm	0.9656	0.9052	0.8173	0.7668	0.6828	0.8889	0
Percentage of strom	0.0124	0.0360	0.0704	0.0895	0.1100	0.1111	0

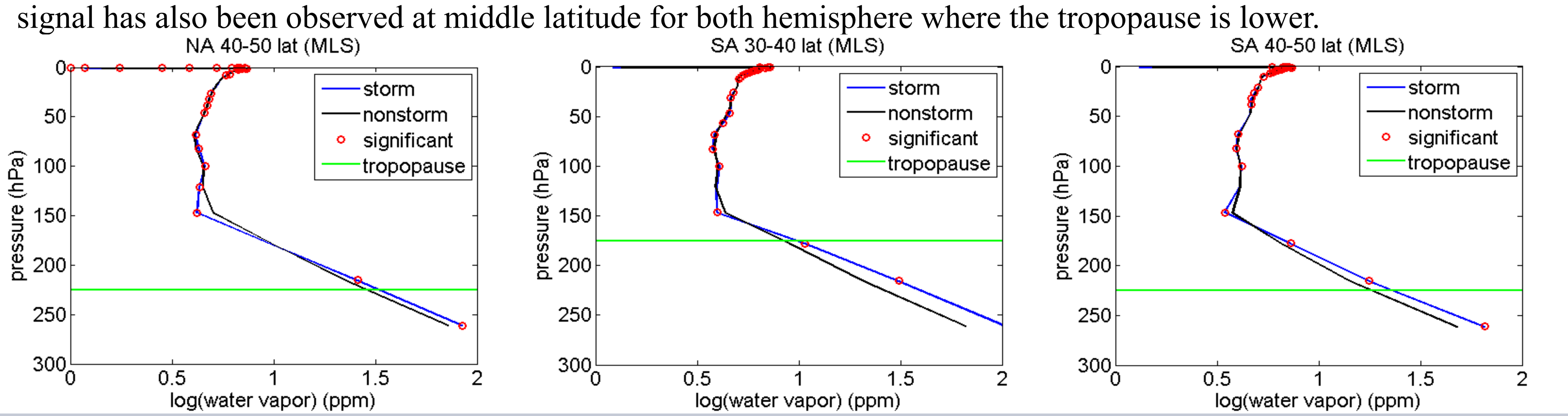
(B)

Water vapor (ppm)	2.6-3	3-3.4	3.4-3.8	3.8-4.2	4.2-4.6	4.6-5
Number of data	6	4	1	0	5	5
Percentage of nonstorm	1	1	0	0	0.2	0.2
Percentage of storm	0	0	1	0	0.6	0.8

(C)

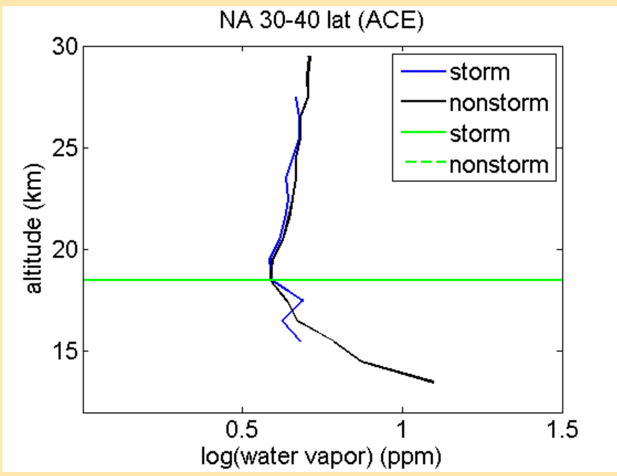
Percentage of storm and nonstorm cases in 10-20N latitude box at (A) 100hPa; (B) 82.5 hPa and (C) 18-19km (ACE)

More evidence are shown below. Although 10-20N is the latitude box where the signal is most obvious, the similar signal has also been observed at middle latitude for both hemisphere where the tropopause is lower.



CONCLUSIONS AND DISCUSSION

- **Both results derived by using MLS and ACE data suggest that deep convections will increase the amount of water vapor in UTLS. At the same time, a decrease signal is observed at a little higher level in stratosphere.**
- **We have proved that deep convections (storms) will definitely influence the water vapor distribution (storms), but still there are a number of big values belonging to nonstorm cases that cannot be explained yet.**
- **By using ACE temperature profile it is also found the tropopause will be brought down at lower latitudes when deep convections happen while it will be no change or even raised up at middle latitudes. Similar result has also been seen by using TES data.**



For 30-40N the tropopause of storm and nonstorm cases are at the same height compared with that of 10-20N.

- **Furture work**
  1) **Use trajectory model to locate the source of big values of water vapor that cannot be explained by deep convections; predict the transport range of one deep convection case**
  2) **Use hurricane model to study the dynamic process of water vapor transport from troposphere to stratosphere**

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