Erythemal Radiation, Column Ozone, and the North American Monsoon

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Abstract

Recently, Anderson et al. (2012, https://doi.org/10.1126/science.1222978, 2017, https://doi. org/10.1073/pnas.1619318114) and Anderson and Clapp (2018, https://doi.org/10.1039/C7CP08331A) proposed that summertime convectively injected water vapor over North America could lead to stratospheric ozone depletion through halogenic catalytic reactions. Such ozone loss would reduce the ozone column and increase erythemal daily dose (EDD). Using 10 years of observations over the North American monsoon region from the Aura Ozone Monitoring Instrument, we find that the column ozone and EDD has a ˜0.8–0.9 spatial correlation with lower stratospheric water vapor measured by the Aura Microwave Limb Sounder. We show that this correlation appears to be due to the elevation of the monsoonal tropopause and associated monsoonal convection. The increase in tropopause altitude reduces the ozone column and increases EDD. We see no apparent evidence of substantial heterogeneous chemical ozone loss in lower stratospheric ozone coincident with the stratospheric monsoonal water vapor enhancement.

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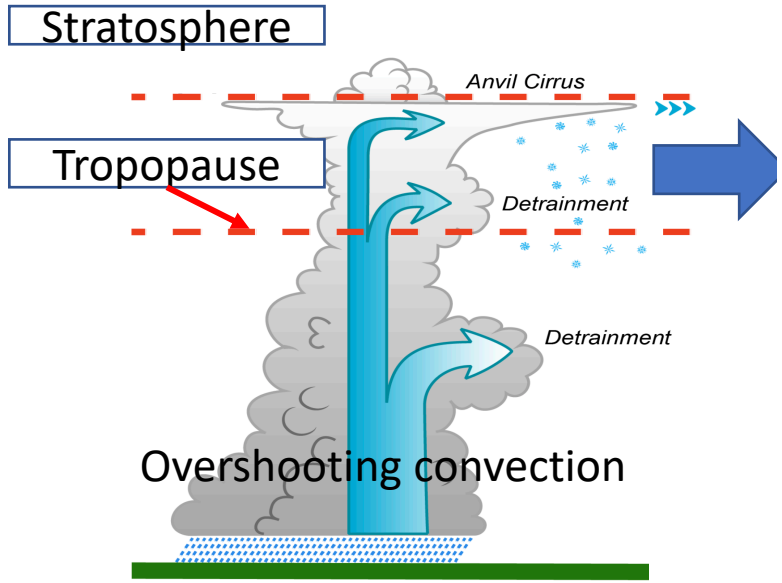
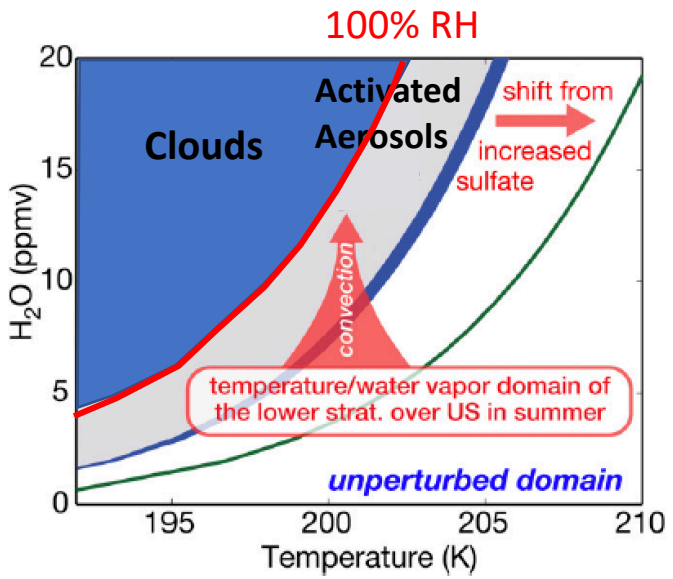
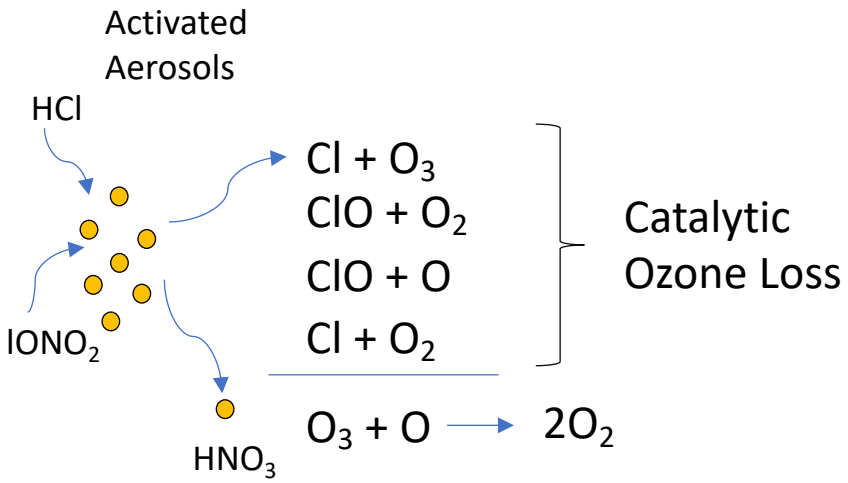
Overview

- Anderson and co workers (2012-2018) hypothesized that overshooting convection during the summer North American monsoon (NAM) might lead to lower stratospheric ozone loss through heterogeneous chemistry on activated aerosols. The result would be increase in surface UV radiation.
- We investigate the dynamics of the monsoon, changes in trace gases and convection during the NAM

Anderson [AC] hypothetical mechanism





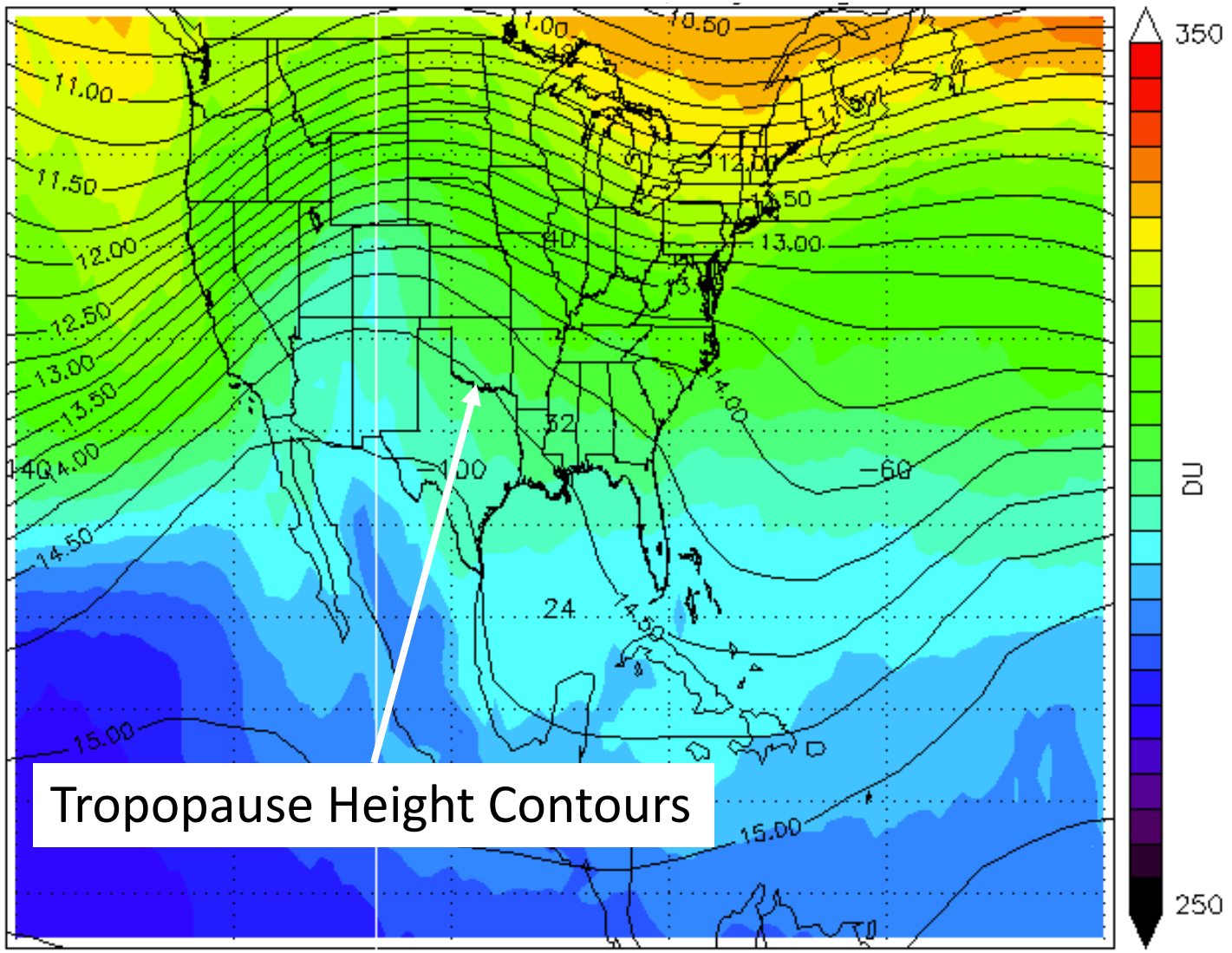


Less Ozone, More UV

Key Results

- We see a correlation between upper tropospheric/ lower stratospheric water vapor and decrease in column ozone
- This occurs because the monsoon lifts the tropopause reducing the ozone column and associated convection increases water vapor.
- The subsequent increase in surface UV radiation due to column lifting is 2x larger than any chemical depletion could produce.
- Little evidence of widespread chemical depletion through changes in column ozone

Column Ozone 2006-2015 July-August



Significance

- NAM tropopause lifting is a more plausible mechanism that explains increases in UV surface radiation during the summer monsoon and its correlation with lower stratospheric water vapor.
- Chemical processing may occur, but the impact on the column is much smaller than tropopause lifting.
- Future intensification of monsoons may lead to increases in UV radiation over monsoon regions.
- A similar process is likely occurring over the Asian Monsoon.
- NASA DCOTTS airborne mission will provide much more information on the chemical and dynamical environment of the NAM.

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