Modeling Convection of Water Vapor into the Mid-latitude Stratosphere

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Abstract

The direct injection of water vapor into the mid-latitude from the troposphere into the stratosphere by moist convection during the North American monsoon has been observed in isotopic data by in situ aircraft measurements (Hanisco et al. 2007). Convective injection has a strong seasonality occurring during the late spring and summer months and is associated with mesoscale convective systems (MCS). The consequent elevated levels of stratospheric water vapor may lead to catalytic destruction of stratospheric ozone in the mid-latitudes thereupon resulting in increased UV exposure at the Earth’s surface and increased risk to public health (Anderson et al. 2012). Climate models, however, do not directly inject water into the mid-latitude stratosphere by convection and so are not useful tools for predicting trends in mid-latitude water vapor. To address this issue, we undertook a modeling study to investigate the convective injection of water vapor from the troposphere into the stratosphere in the mid-latitudes. Models have been previously used to simulate convection from the troposphere to the stratosphere (Homeyer et al. 2014). We used the Advanced Research Weather and Research Forecasting (ARW-WRF) model at a 3-km resolution to resolve convection over the eastern United States during August of 2007. To assess the capability of ARW to simulate deep convection we plan to compare the morphology and the depth of stratospheric injection of the model output to NEXRAD data provided by Professor Ken Bowman.

Conclusions

Utilizing Advanced Research Weather and Research Forecasting (ARW-WRF) at high horizontal resolution allowed us to resolve local convection during the summer months over the mid-latitudes United States. In the model we saw several instances of convective injection and elevated water vapor concentrations up to 70 hPa. The high temporal and spatial resolution of ARW-WRF allowed us to visualize these events that MLS observations would miss due to averaging of the satellite’s footprint. Next we will investigate the ability of ARW to simulate deep convection by comparing the morphology and the depth of stratospheric injection of the model output to NEXRAD data provided by Professor Ken Bowman.