We investigate the impact of CH$_3$O$_2$NO$_2$ chemistry on the interpretation of satellite observations of NO$_2$ and HNO$_3$ as a constraint on lightning NO$_x$ emissions.

Measurements of NO$_2$ and CH$_3$O$_2$NO$_2$ during DC-3 and SEAC4RS

Measurements of CH$_3$O$_2$NO$_2$ and NO$_2$ during DC-3 and SEAC4RS have been described elsewhere. Briefly, NO$_2$ is excited with a 585 nm tunable dye laser, and we measure the red shifted photons. CH$_3$O$_2$NO$_2$ is thermally dissociated at ~60°C to NO$_2$ and its parent radical, and the NO$_2$ is subsequently excited. The concentration of CH$_3$O$_2$NO$_2$ is the difference between the ambient NO$_2$ and the


during DC-3 and SEAC4RS. The black bars are the inter-quartile measurements and the line is the median measurements.

Effects of CH$_3$O$_2$NO$_2$ chemistry on lightning NO$_x$ and NO$_2$ Vertical

The model indicates that decreases in the NO$_2$ column due to including CH$_3$O$_2$NO$_2$ are as high as ~2×10$^{14}$ molecules/cm$^2$, values which are detectable by OMI.

Similar decreases in the NO$_2$ column density are calculated for the months of June and August. The largest changes in the NO$_2$ column density occur at high lightning NO emissions. This indicates that including CH$_3$O$_2$NO$_2$ chemistry has a noticeable impact in the interpretation of NO$_2$ columns near high lightning source regions (e.g., Southeast U.S.).

Impacts on Satellite Retrieved HNO$_3$

Satellite measurements of HNO$_3$ have also been used to constrain lightning NO$_x$ emissions. Browne et al. showed that including CH$_3$O$_2$NO$_2$ chemistry decreased HNO$_3$ concentrations by 15–40 pptv at pressure levels lower than 400 hPa.

We calculate decreases of HNO$_3$ as a result of CH$_3$O$_2$NO$_2$ chemistry of as much as 2×10$^{14}$ molecules/cm$^2$, which is on order 10–20% of the NO$_2$ column due to including CH$_3$O$_2$NO$_2$ are as high as ~2×10$^{14}$ molecules/cm$^2$, values which are detectable by OMI.

We calculate decreases of HNO$_3$ as a result of CH$_3$O$_2$NO$_2$ chemistry of as much as 2×10$^{14}$ molecules/cm$^2$, which is on order 10–20% of the NO$_2$ column due to including CH$_3$O$_2$NO$_2$ are as high as ~2×10$^{14}$ molecules/cm$^2$, values which are detectable by OMI.

In addition to the effects of CH$_3$O$_2$NO$_2$ recent work and our own analysis of DC-3 observations has shown that the HNO$_3$ production rate in current models is faster than in the atmosphere, especially in the upper troposphere. We expect larger decreases in the column density and concentrations of HNO$_3$ from this effect than from CH$_3$O$_2$NO$_2$ chemistry. Both changes to our understanding of the chemistry of the upper troposphere will reduce the amount of lightning NO$_x$ required for the models to be consistent with satellite based remote sensing of HNO$_3$.

Acknowledgements

The authors would like to acknowledge NASA Grant Numbers 81955 and NSF Grant No. DGE 1106400. We also acknowledge Jack Dibb for the use of HNO$_3$ measurements and Tom Ryerson for use of NO measurements.

References