New Method for $PM_{2.5}$ Air Quality Retrievals Combining CATS Spaceborne Lidar and the NASA GEOS-5 Model

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Abstract

Accurately monitoring fine particulate matter ($PM_{2.5}$) from space remains challenging due to limitations in measuring the vertical distribution of aerosols. This study presents a new approach overcoming this limitation to retrieve $PM_{2.5}$ concentrations by combining high-resolution spaceborne lidar observations with a global aerosol transport model. The NASA Cloud-Aerosol Transport System (CATS) is an elastic backscatter lidar system operational aboard the International Space Station from 2015-2017. Using CATS 1064-nm backscatter data and model priors from the NASA Goddard Earth Observing System (GEOS) global aerosol transport model, we developed a 1-D ensemble-based variational technique (1-D EnsVar) to retrieve vertically-resolved estimates of speciated aerosol extinction and surface $PM_{2.5}$. Improving upon previous studies that rely on empirical relationships between $PM_{2.5}$ and aerosol optical depth, this approach overcomes traditional limitations by leveraging the strengths of complementary vertical aerosol information from CATS and GEOS to better resolve speciated aerosol optical properties and mass. Furthermore, with the advantage of active remote sensing, this approach has the capability of performing aerosol retrievals during both daytime and nighttime scenes. In this study, we evaluate the performance of 1-D EnsVar retrievals through validation with independent measurements from spaceborne and ground-based platforms. Preliminary results show enhanced aerosol extinction of dust at higher altitudes, suggesting aerosol observations over these areas may be larger than previously reported. Given the unique capability of CATS to process vertical profile data in near real-time, this work demonstrates the utility of future spaceborne lidar platforms for improving air quality forecasts. Results from this study may be useful in other applications, including establishing constraints for atmospheric chemistry modeling, improving passive satellite retrievals of $PM_{2.5}$, and developing data assimilation techniques for future spaceborne lidar platforms.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

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