Data Analytic Approaches and Algorithmic Development for Pollutant Retrievals based on Satellite and Modeled Datasets

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ABSTRACT

Conducting environmental retrieval at sufficiently high spatial and temporal resolutions, especially for ground concentration and column sum of trace gases and pollutants within the lower troposphere, have become a critical global environmental concern nowadays. Due to the insufficiency of ground monitoring stations within a prescribed spatial area, it is crucial to develop accurate retrieval algorithms and numerical models for conducting these environmental retrieval tasks, so that the temporal and spatial maps of these constituents can be acquired for air quality monitoring and pollutant trajectory analyses. This talk explores how one can synergize various available environmental measurement datasets, raw satellite-based datasets and respective L2 products, as well as the forecasted outputs acquired from numerical weather prediction and chemistry transport models, and ingest these attributes as inputs into a data analytic framework for pollutant retrieval and prediction. Such framework has taken into account physical parameters and meteorological conditions within the selected spatial regions, the altering of satellite-based datasets that can describe surrounding environmental features and terrain in a better manner, as well as the potential statistical adjustments needed during model training processes. Machine learning approaches are also incorporated into the retrieval framework of selected gaseous pollutants like NO_2, and all retrieved outputs are validated against available raw measurements, with the aim of ensuring the accuracies of respective established retrieval techniques for selected pollutants. Case studies within China will be adopted for illustrating the pros and cons, and the dependent factors within each retrieval algorithm. Further, the recently launched Geostationary Environmental Monitoring Spectrometer (GEMS), which is one of the three air quality monitoring missions over Asia, together with NASA's TEMPO and ESA's Sentinel-4, is capable of capturing and describing vertical profiles of pollutants. In particular, it has adopted the advanced version of TOMS V8 algorithm in retrieving total ozone column, providing ozone profile and information of relevant errors in retrieval. With the aid of vertical profiles provided by GEMS, we discuss its effectiveness in retrieving near-surface ozone concentrations at different areas of China, and assess the Aerosol Optical Depth (AOD) product of GEMS, which is an important ingredient for conducting large-scale ground $PM_{2.5}$ and ozone retrievals, especially in places with higher relative humidity or with stronger light extinction efficiency. The spatial discrepancies identified based on all proper validations can provide insights for researchers to enhance respective retrieval mechanisms, as a result strengthen the use of different satellite datasets and remotely sensed instruments for environmental monitoring in the future.