How Can TOLNet Help to Better Understand Tropospheric Ozone? A Satellite Perspective.

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Potential sources of a priori ozone (O_3) profiles for use in Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite tropospheric O_3 retrievals are evaluated with observations from multiple Tropospheric Ozone Lidar Network (TOLNet) systems in North America. An O_3 profile climatology (tropopause-based O_3 climatology (TB-Clim), currently proposed for use in the TEMPO O_3 retrieval algorithm) derived from ozonesonde observations and O_3 profiles from three separate models (operational Goddard Earth Observing System (GEOS-5) Forward Processing (FP) product, reanalysis product from Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA2), and the GEOS-Chem chemical transport model (CTM)) were: 1) evaluated with TOLNet measurements on various temporal scales (seasonally, daily, hourly) and 2) implemented as a priori information in theoretical TEMPO tropospheric O_3 retrievals in order to determine how each a priori impacts the accuracy of retrieved tropospheric (0-10 km) and lowermost tropospheric (LMT, 0-2 km) O_3 columns. We found that all sources of a priori O_3 profiles evaluated in this study generally reproduced the vertical structure of summer-averaged observations. However, larger differences between the a priori profiles and lidar observations were observed when evaluating inter-daily and diurnal variability of tropospheric O_3. The TB-Clim O_3 profile climatology was unable to replicate observed inter-daily and diurnal variability of O_3 while model products, in particular GEOS-Chem simulations, displayed more skill in reproducing these features. Due to the ability of models, primarily the CTM used in this study, on average to capture the inter-daily and diurnal variability of tropospheric and LMT O_3 columns, using a priori profiles from CTM simulations resulted in TEMPO retrievals with the best statistical comparison with lidar observations. Furthermore, important from an air quality perspective, when high LMT O_3 values were observed, using CTM a priori profiles resulted in TEMPO LMT O_3 retrievals with the least bias. The application of time-specific (non-climatological) hourly/daily model predictions as the a priori profile in TEMPO O_3 retrievals will be best suited when applying this data to study air quality or event-based processes as the standard retrieval algorithm will still need to use a climatology product. Follow-on studies to this work are currently being conducted to investigate the application of different CTM-predicted O_3 climatology products in the standard TEMPO retrieval algorithm. Finally, similar methods to those used in this study can be easily applied by TEMPO data users to recalculate tropospheric O_3 profiles provided from the standard retrieval using a different source of a priori.