Importance of a priori vertical ozone profiles for TEMPO air quality retrievals

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Ozone (O_3) is a toxic pollutant which plays a major role in air quality. Typically, monitoring of surface air quality and O_3 mixing ratios is conducted using in situ measurement networks. This is partially due to high-quality information related to air quality being limited from space-borne platforms due to coarse spatial resolution, limited temporal frequency, and minimal sensitivity to lower tropospheric and surface-level O_3. The Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite is designed to address the limitations of current space-based platforms and to improve our ability to monitor North American air quality. TEMPO will provide hourly data of total column and vertical profiles of O_3 with high spatial resolution to be used as a near-real-time air quality product.

TEMPO O_3 retrievals will apply the Smithsonian Astrophysical Observatory profile algorithm developed based on work from GOME, GOME-2, and OMI. This algorithm is suggested to use a priori O_3 profile information from a climatological data-base developed from long-term ozone-sonde measurements (tropopause-based (TB-Clim) O_3 climatology). This study evaluates the TB-Clim dataset and model simulated O_3 profiles, which could potentially serve as a priori O_3 profile information in TEMPO retrievals, from near-real-time data assimilation model products (NASA GMAO's operational GEOS-5 FP model and reanalysis data from MERRA2) and a full chemical transport model (CTM), GEOS-Chem. In this study, vertical profile products are evaluated with surface (0-2 km) and tropospheric (0-10 km) TOLNet observations and the theoretical impact of individual a priori profile sources on the accuracy of TEMPO O_3 retrievals in the troposphere and at the surface are presented. Results indicate that while the TB-Clim climatological dataset can replicate seasonally-averaged tropospheric O_3 profiles, model-simulated profiles from a full CTM resulted in more accurate tropospheric and surface-level O_3 retrievals from TEMPO when compared to hourly and daily-averaged TOLNet observations. Furthermore, it is shown that when large surface O_3 mixing ratios are observed, TEMPO retrieval values at the surface are most accurate when applying CTM a priori profile information compared to all other data products.