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# The satellite and chemical transport model tandem: constraining TM5 with AURA observations

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Satellite-based studies focusing on tropospheric ozone ($O_3$) and nitrogen dioxide ($NO_2$) have the potential to close the gap left by previous studies on air quality. After all, satellites can provide large-scale robust observational evidence that both $O_3$ precursor concentrations and tropospheric $O_3$ levels are rapidly changing over source receptor areas.
Chemical transport models (CTM) significantly contribute to our understanding on transport patterns, production and destruction of tropospheric air constituents, but the infrequently update of emission inventories and the slow implementation of updates on chemical reactions and reaction rates slow down the widespread use.
Satellite observations of tropospheric $NO_2$ have the potential to improve and update anthropogenic $NO_x$ emissions in a near-continuous way and may provide information on the life time of $NO_x$, impacting the production and destruction of many air constituents including $O_3$.

Here we show the increased ability of the CTM TM5 to reproduce the 2005-2010 observed strong and rapid rise in free tropospheric ozone of 0.8% per year over China from TES (Tropospheric Emission Spectrometer, onboard AURA), once OMI (Ozone Monitoring Instrument, onboard AURA) $NO_2$ measurements were implemented in TM5 to update $NO_x$ emissions. What is more, MLS observations (Microwave Limb Sounder, onboard AURA) on stratospheric ozone demonstrate its potential to constrain the stratosphere-troposphere exchange (STE) in TM5 which is mainly driven by ECMWF meteorological fields. The use of MLS observations of stratospheric $O_3$ improved the TM5 modelled trends in tropospheric $O_3$ significantly. Thanks to the TM5 input updates from satellite observations, the impact of Asian $O_3$ and its precursors on the western United States could be quantified showing a large import from China to the West. Here we also show that deriving $NO_x$ life times from OMI $NO_2$ observations to evaluate new rate constants of the reaction $NO_2$ + OH => $HNO_3$ in TM5 is a promising tool for obtaining better $NO_2$ columns and $O_3$ production rates.