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Satellite-based photolysis rates of NO_2 and O_3: applications to air quality and secondary pollution formation

Anu-Maija Sundström, Jukka Kujanpää, and Johanna Tamminen
Finnish Meteorological Institute, Space and Earth Observation Centre , Finland (anu-maija.sundstrom@fmi.fi)

Ultraviolet (UV) radiation is the key driver of the chemistry in the troposphere. UV-radiation reaching Earth's surface dissociates molecules into reactive species that enter atmospheric chemical cycles and controls their photolysis rates. Examples of species that photodissociate include many important trace constituents of the troposphere, such as NO_2 and O_3. The photolysis rates of these species, denoted as $J(NO_2)$ and $J(O_3)$, are tightly connected to the formation of secondary air pollution. One of the main pathways for surface-level ozone formation is the photolysis of NO_2. On the other hand, the photolysis of O_3 is related to the formation of radicals, e.g. hydroxyl radical (OH), that plays an important role in secondary new particle formation since it is involved in the formation of sulphuric acid. OH can also be viewed as atmosphere's own detergent as it removes gases such as carbon monoxide and methane from the atmosphere.

One of the applications of the UV-type satellite instruments, such as GOME-2, OMI, and most recently TROPOMI, has been to monitor UV radiation reaching the Earth's surface. The operational surface UV- algorithms provide e.g. estimates of noontime erythemal and vitamin-D UV dose rates. The satellite-based surface UV data has been successfully used in various studies considering the health effects on humans, but overall much less attention has been given to the potential of using satellite data to study atmospheric chemistry and the formation of secondary pollution. Photolysis rates for different gases can be retrieved from UV satellite observations, and currently $J(NO_2)$ and $J(O_3)$ are available from GOME-2 instrument within the EUMETSAT Satellite Application Facility on Atmospheric Composition Monitoring (AC SAF). These photolysis rates can give valuable information on global conditions favourable for formation of secondary pollution as well as how these conditions vary spatially and temporally. Combined with other satellite observations proxies for estimating e.g. OH concentrations can be derived. In this work we will analyse satellite-based photolysis rates of NO_2 and O_3 from GOME-2 and also discuss the potential of using TROPOMI observations for such applications.