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Relationship between the NO_2 photolysis frequency and the global broadband irradiance

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Direct measurements of the nitrogen dioxide (NO_2) photolysis rate ($j(NO_2)$) at ground level are often not available from field experiments. Modeling approaches are mainly used to estimate $j(NO_2)$ for air chemistry studies, involving complex radiative transfer algorithms based on e.g., actinic flux, absorption cross sections, solar zenith angle, aerosol optical thickness, ozone column concentration and cloud cover. Bahe et al., 1980 empirically found a near-linear relationship between global broadband irradiance (G) and $j(NO_2)$ on top of a laboratory building in Germany, which has been applied to estimate $j(NO_2)$ from G. We have measured incoming $j(NO_2)$ using spectral/filterradiometers and G using pyranometers side-by-side at several field sites. In this study, we will show that a second-order polynomial function can be used to accurately estimate $j(NO_2)$ solely from G, independent of latitude and longitude, solar zenith angle, aerosol optical thickness and cloud cover. Our results include solar zenith angels smaller than 30° and are based on nine field observations in temperate, subtropical and tropical environments. This approach can be applied to calculate chemical timescales of the NO-NO_2-O_3 triad in order to evaluate the potential influence of chemical reactions on surface-atmosphere exchange fluxes. Furthermore, the relationship represents a simple tool to evaluate the photochemical steady state (PSS) assumption of NO_x in the absence of $j(NO_2)$ measurements, subsequently being useful for examining the local photochemistry.

Bahe, F.C., Schurath, U. and Becker, K.H., 1980. The Frequency of NO_2 Photolysis at Ground-Level, as Recorded by a Continuous Actinometer. Atmospheric Environment, 14(6): 711-718.