

A routine 24-hour measurement of total column NO₂ using direct solar and lunar spectra over Table Mountain Facilities, California

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The first 24-hour measurement of total column NO₂ has been made over the Jet Propulsion Laboratory's Table Mountain Facilities (TMF) located in a suburban area of Los Angeles, California, USA (2.286 km above mean sea level, 34.38°N, 117.68°W) during a 1-week campaign in October, 2018 using a grating spectrometer that measures the telluric NO₂ absorptions in the direct solar and lunar spectra. The measured 24-hour cycle of total column NO₂ on clean days agrees well with a 1-D photochemical model calculation, including the monotonic changes during daytime and nighttime due to the exchange with the N₂O₅ reservoir and the abrupt changes at sunrise and sunset due to the activation or deactivation of the NO₂ photodissociation. In our photochemical model, we find that the Arrhenius constant $A = 6.7 \times 10^{-11} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ and the activation energy $E/R = 0.0$ for the bimolecular reaction $\text{N}_2\text{O} + \text{O}(^1D) \rightarrow 2\text{O}$ from previous recommendation are adequate to well simulate the observed 24-hour cycle of the total column NO₂. The resulting rate constant is ~15% less than that obtained using more recent recommended values of A and E/R , and it lies in the lower end of the suggested uncertainty. While the model is able to reproduce the observed rate of increase of daytime total column NO₂, it overestimates the rate of decrease of nighttime total column NO₂, implying that a lower nighttime temperature is required for a more accurate simulation. The total column NO₂ in one of the afternoons during the campaign was much higher than the model simulation, implying the influence of urban pollution from nearby cities. A 24-hour back-trajectory analysis shows that the wind first came from inland in the northeast and reached the southern Los Angeles before it turned northeast and finally arrived TMF, allowing it to pick up pollutants from Riverside County, Orange County, and Downtown Los Angeles.

Keywords: grating spectrometer, modified Langley method, back-trajectory, urban pollution

