Retrieving aerosol height over land via the O_2 A&B bands

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Aerosol vertical distribution is one of the most important but poorly observed variables that govern the aerosol's radiative impacts on climate and weather. Recently, the determination of aerosol height using passive satellite measurements in the oxygen (O_2) A band around 755–775 nm has been increasingly appreciated [1]. Its physical principle relies on the fact that the scattering of aerosol particles reduces the path length and the probability of light being absorbed by the underneath O_2, thus increasing the radiance in O_2 A band as observed by a satellite; this brightening is strongly sensitive to the altitude of the aerosol layer. However, such a retrieval over land is challenged by the high surface reflectance in the O_2 A band. Measurements in the O_2 B band at 685–695 nm, though engaging a relative weaker O_2 absorption signal, can complement aerosol height retrieval by taking advantage of the low reflectance of a vegetation surface [2,3].

In this study, we combined radiances in both the O_2 A and B bands measured by the Earth Polychromatic Imaging Camera (EPIC) to determine optical depth and layer height of biomass-burning aerosols over vegetated land surfaces. Carried by the Deep Space Climate Observatory satellite that orbits around the Earth–Sun Lagarange-1 point, EPIC observes the entire sun-lit Earth disk every 1 to 2 hours, providing Earth-reflected radiances in 10 narrow bands. In particular, our algorithm first determines the aerosol optical depth using EPIC's atmospheric window bands (443, 551, 680, and 780 nm), then uses its O_2 bands (688 and 763 nm) to derive the effective aerosol optical centroid altitude. The algorithm was applied to EPIC observations of several biomass burning activities over Canada and the United States in August 2017. Validations were performed against aerosol extinction profile scanned by the space-borne lidar, CALIOP, showing an average error of less than 0.6 km in the retrieved aerosol height.

References

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