The Development of an Algorithm to Measure Aerosols in Clouds Using MODIS Satellite Data

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Absorbing aerosols represent significant uncertainties in environmental science and pose serious environmental issues worldwide, especially in urban and arid regions like the Middle East North Africa (MENA) region. Enhancing the accuracy of aerosol impact estimates on clouds and reducing the associated uncertainties are crucial for projecting future climate scenarios. Remote sensing technology, particularly high temporal resolution satellites like MODIS, plays a pivotal role in monitoring changing weather and terrestrial phenomena. However, the retrieval of aerosol data is complicated by the presence of clouds, as detecting particles within them can lead to improved aerosol estimates, thereby enhancing the spatial coverage in climate models This study addresses the complex task of retrieving absorbing aerosols within cloud formations by differentiating between cloud and absorbing aerosol particles, aiming to bridge the knowledge gap regarding cloud-aerosol interactions. It concentrates on analyzing clouds along the borders of the MENA region from January 1, 2018, to December 31, 2023. The process for extracting aerosols from space-based observations involved multiple stages. It began with a visual comparison and the conversion of digital values to actual radiance measurements. Then, using a radiative transfer model to eliminate unwanted radiances from MODIS top-of-atmosphere (TOA) reflectance. The newly developed algorithm, which uses radiance data from MODIS bands 31 and 29, performs a subtraction operation to single out the radiance values attributable to absorbing aerosols. This approach promises to be a valuable tool for aerosol research as it increased spatial coverage and efficiency by 68%, thereby enhancing our understanding of the Earth's atmospheric dynamics.