

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) measurements of aerosols and trace gases and evaluation of corresponding satellite data products over three locations in India

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Abstract:

Aerosols and trace gases such as NO₂ and SO₂ are some of the most important atmospheric constituents. Although several observations of these species have been reported, understanding their vertical distribution is still limited, especially in India. This study reports observations of aerosols, nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) using the Multi-Axis Differential Absorption Spectroscopy (MAX-DOAS) technique over Pune, Delhi and Mahabaleshwar. We retrieved the vertical profiles of aerosols and trace gases over these locations using MAX-DOAS observations in conjunction with the radiative transfer model (RTM). Additionally, we investigate the monthly diurnal variation in AOD and columnar density of trace gases. The AOD results from MAX-DOAS observations are compared with total aerosol optical depth observations from the AERONET station at Pune, and overall good agreement is found. We used MODIS and OMI satellite observations to validate their data products of AOD and trace gases, respectively. The correlation between retrieved AOD in UV range and MODIS is strong and significant for all three study sites. Compared to the UV range, the correlation in the visible range is weaker for Pune and Delhi; however, the correlation is significantly strong in Mahabaleshwar. At both urban locations, Pune and Delhi, the OMI satellite seems to underestimate NO₂ VCD. Whereas for the unpolluted remote region, Mahabaleshwar, the OMI satellite estimates the NO₂ within the range of MAX-DOAS observations with a weak correlation. Over Pune, NO₂ observations from MAX-DOAS are weakly correlated with OMI, and over Delhi, they show a slightly better correlation. Compared to NO₂ validation results, SO₂ results agree well with satellite products. A very weak correlation for SO₂ over Pune and strong correlation over Delhi and Mahabaleshwar is observed. Although the correlation values between MAX-DOAS SO₂ VCDs and OMI VCDs over Pune and Mahabaleshwar are not significant, OMI estimated SO₂ values are within the range of MAX-DOAS measured SO₂ VCDs.