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Aerosol influence on polarization and intensity in near-infrared O2 and CO2 absorption bands observed from space

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We study the intensity and degree of linear polarization of reflected solar radiation at the top of the atmosphere within two carbon dioxide bands and one oxygen absorption band in the near-infrared. In particular, we are interested in the sensitivity of the degree of linear polarization and intensity to changes of aerosol and cirrus cloud layer heights, microphysical properties, and surface albedo. For the simulations we use spectral response functions representative of the Orbiting Carbon Observatory (OCO). Inside the O2A band at 760 nm and strong CO2 band at 2060 nm we find a strong influence of the aerosol and cirrus cloud layer height on the degree of linear polarization. An increase of the aerosol or cirrus cloud layer height can lead either to a decrease or increase of the polarization within the band, depending on the microphysical and optical properties of the scatterers, surface albedo, and absorption strength in the bands. The results for the O2A band also indicate that even over land OCO enables an estimation of the height of an aerosol or cirrus cloud layer. Inside the weak CO2 band at 1610 nm the influence of aerosol or cirrus cloud layer heights is lower as compared to the O2A band and CO2 band at 2060 nm, due to the relatively stronger surface influence. Here an increase of aerosol or cirrus cloud layer height leads to an increase of the degree of linear polarization even in case of low surface albedo and for weakly polarizing scatterers. For the weak CO2 band at 1610 nm we also study the influence of the aerosol or cirrus cloud layer height on the column CO2 estimate and the errors resulting from ignoring polarization in simulations of backscatter measurements by space-based instruments such as OCO. Depending on the surface albedo, misinterpretations of the height of atmospheric scatterers might strongly affect the column CO2 estimates.