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A study of clouds over snow and ice and their effect on ozone retrievals using A-Train sensors

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We examine how clouds over snow and ice affect ozone absorption and how these effects may be accounted for in satellite retrieval algorithms. Over snow and ice, the Aura/OMI Raman cloud pressure algorithm derives an effective scene pressure. When this scene pressure differs appreciably from the surface pressure, the difference is assumed to be caused by a cloud that is shielding atmospheric absorption and scattering below cloud-top from satellite view. A pressure difference of 100 hPa is used as a crude threshold for the detection of clouds that significantly shield tropospheric ozone absorption. Combining the OMI effective scene pressure and the Aqua/MODIS cloud top pressure, we can distinguish between shielding and non-shielding clouds. To evaluate this approach, we performed radiative transfer simulations under various observing conditions. Using cloud vertical extinction profiles from the CloudSat Cloud Profiling Radar, we find that clouds over a bright surface can produce significant shielding (i.e., a reduction in the sensitivity of the top-of-the-atmosphere radiance to ozone absorption below the clouds). The amount of shielding provided by clouds depends upon the geometry (solar and satellite zenith angles) and the surface albedo as well as cloud optical thickness. We also use CloudSat observations to qualitatively evaluate our approach. The current OMI total column ozone algorithm assumes no clouds over snow and ice. This assumption leads to errors in the retrieved ozone column. We show that the use of OMI effective scene pressures over snow and ice reduces these errors and leads to a more homogeneous spatial distribution of the retrieved total ozone.