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Deriving Radiative Effects of Aerosol-Immersed Broken Cloud Fields from Multi-spectral Imagery

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Recently, significant progress has been made in the understanding of cloud inhomogeneity effects in shortwave passive remote sensing. Yet it has proven difficult to correct such effects on the pixel level using multi-spectral imagery alone, mainly because three-dimensional (3D) radiative transfer in cloud fields is a non-local phenomenon. As a result, estimates of irradiance – the fundamental climate variable – from space-or air-borne imagery continue to pose problems for complex cloud fields. The presence of aerosols in the vicinity of clouds exacerbates the problem. I will show evidence from field experiments and 3D radiative transfer calculations that biases may exceed 40% at the pixel level at the MODIS spatial resolution, and that some of these effects “survive” spatial averaging. A new way to cope with this problem is the discovery that 3D effects manifest themselves as spectral perturbation in reflected radiances and in the associated irradiance fields throughout an inhomogeneous cloud domain. In parameterized form, these correlations between spatial cloud distribution and spectral signature can be used to derive first-order inhomogeneity corrections for irradiance fields – not on a pixel basis, but for populations of pixels within a cloud domain represented by probability density functions. I will present the first practical approach for using these new findings in a future proxy-3D algorithm for deriving irradiances below and above cloud-aerosol fields from multi-spectral imagers, and discuss the accuracy that can be expected from this simplified method to account for 3D effects in mixed aerosol-cloud scenes.