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Sunnier than a Sunny Day: Recent Advances in Hyperspectral Image Simulation for Partly Cloudy Scenes

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ABSTRACT

A critical first step in the analysis of hyperspectral or multispectral imagery in the reflective domain (visible to SWIR) is atmospheric correction, or compensation, whereby atmospheric absorption and scattering effects are removed and the data are reduced to surface spectral reflectance. Broken cloud fields pose a problem for many atmospheric compensation and aerosol retrieval algorithms, as these algorithms typically assume uniform illumination, and ground illumination in the vicinity of clouds is inhomogeneous due to photons scattering from clouds into clear sunlit areas. In this work, illumination effects are simulated for a variety of broken cloud fields using the MCScene code, a high-fidelity model for full optical spectrum (UV through LWIR) multispectral image simulation. MCScene provides an accurate, robust, and efficient means to generate spectral scenes for algorithm validation. MCScene utilizes a Direct Simulation Monte Carlo approach for modeling 3D atmospheric radiative transfer, including full treatment of molecular absorption and Rayleigh scattering, aerosol absorption and scattering, and multiple scattering and adjacency effects, as well as scattering from spatially inhomogeneous surfaces. The model includes treatment of land and ocean surfaces, 3D terrain, 3D surface objects, and effects of finite clouds with surface shadowing. We will discuss the effects of broken cloud fields on solar illumination reaching the ground, and the consequence of solar scattered illumination from clouds on retrieved surface reflectance and target detection.