A. Berk will be the presenting author.

Recent Developments in the MODTRAN® Atmospheric Model and Implications for Hyperspectral Compensation

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MODTRAN® Version 5.1 [1] includes many new capabilities introduced specifically to enhance and facilitate atmospheric compensation. For the thermal region, the new 0.1 cm^{-1} statistical band model provides the finer spectral resolution required for analysis of state-of-the-art long-wave and mid-wave hyper- and ultra-spectral imagers (e.g. AIRS). The 0.1 cm^{-1} molecular transmittances are computed by partitioning absorption into line center, line tail and continua (distant line) contributions. The line center absorption is determined by combining the Plass transmittance expression for N randomly distribution identical lines in an interval [2] with a newly derived exact expansion for the finite bin Voigt equivalent width [3]. Temperature and pressure dependent Voigt line tails are fit to simple Padé approximates in spectral frequency to accurately model the absorption from the molecular lines centered outside of but near to each spectral bin [3].

A new MODTRAN®5.1 atmospheric correction data (*.acd*) output file includes the specific radiative transfer quantities employed in the atmospheric compensation of solar region hyperspectral imager (e.g. MODIS, MAS) measurements. The five spectral outputs in an *.acd* file are the spherical albedo from the ground, the sun-to-ground direct and diffuse transmittances, and the observer-to-ground direct and *atmosphere embedded* diffuse transmittances. Properly coupled observer-to-ground-to-sun path diffuse and direct transmittances are computed by using the MODTRAN® statistical correlated-*k* model [4] to generate the *.acd* output. By combining this *.acd* data with the MODTRAN®5.1-generated observer-to-ground path radiance from a non-reflecting ground surface, one can retrieve ground reflectance maps directly from hyperspectral radiance image data fully including the affects of adjacency [5]. The spherical albedo and diffuse transmittance data are computed by the DISORT multiple scattering algorithm [6, 7] within MODTRAN®5.1. Diffuse transmittance is defined as the fraction of collimated radiation that passes through a medium after being scattered at least once [8, 9]. If the collimated source is embedded within the medium, then some radiation can be reflected behind the source and reflected again so that it eventually passes through the medium. This *atmosphere embedded* observer-to-ground diffuse transmittance is the quantity required for short-wave atmospheric correction of low altitude sensors, and DISORT has been specifically modified to provide this output.

Other MODTRAN®5.1 features impacting both multi- and hyper-spectral atmospheric correction include the regeneration of molecular databases using HITRAN2004 with updates through January 2007 [10, 11], introduction of the $O_2 - O_2$ visible absorption continuum [12], output of spectral channel brightness temperatures [13], and input options facilitating perturbation of atmospheric profiles. The HITRAN updates include more accurate water lines in the 1.35 μm H_2O band, which can significantly impact H_2O retrievals. The introduction of the $O_2 - O_2$ visible absorption continuum leads to improvements in retrieved spectral reflectivities near 0.58 and 0.63 μm. In the thermal infrared, broad multi-spectral imager band channel radiances cannot be accurate converted to brightness temperatures simply using the channel center wavelength; MODTRAN®5.1 invokes a new analytically derived procedure to easily obtain these temperatures.

Details of these capabilities are presented in the forward *simulation* mode along with applications in the reverse *remote sensing* mode to current satellite and aircraft sensors.

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