Development of the Multilayer Cloudy Radiative Transfer Model for the GOES-R Advanced Baseline Imager

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Surface, aircraft and satellite observations show that many cloud types can appear simultaneously at the same location but at different altitudes. Furthermore, clouds may be continuous or broken at a given cloud level within a sensor's field of view. Therefore, it is desirable that a general radiative transfer model can deal with multilayer cloudy atmospheres for remote sensing applications. Multilayer cloudy systems can be complicated even for a non-scattering atmosphere. It can be shown that forming a two- and three-layer cloud system yields 10, and 218 combinations, respectively. The satellite cloud detection or cloud property retrieval algorithms (e.g. the CO2-slicing method, the N* methods) which have been widely used for a single-layer or a simple two-layer overcast cloud system are not applicable to more complicated multilayer cloudy systems. In support of GOES-R Advanced Baseline Imager (ABI) for remote sensing of cloudy atmospheres, we develop a generalized multilayer cloudy radiative transfer model. The model is not too complicated that it makes the cloudy retrieval problems unmanageable, while generalized enough to handle multilayer clouds with the definition of the effective cloud emissivity to include the multiple scattering effects. The clear-sky atmosphere is a special case of this model where the cloud fractions are reduced to zero.

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