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Retrievals of the Cloud and Boundary Layer Atmospheric Temperature and Moisture Profiles by Using the Atmospheric Emitted Radiance Interferometer (AERI) Measurements in Shouxian

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In the study, we retrieve the cloud and atmospheric profiles in the planetary boundary layer (PBL) based on the Atmospheric Emitted Radiance Interferometer (AERI). It includes two sections.

Firstly, we propose a new method of identifying the clear sky based on the AERI. Using the Atmospheric Radiation Measurement (ARM) Mobile Facility (AFM) dataset in Shouxian in 2008, the downwelling radiances on the surface in the 8$\sim$12 μm window region are simulated by using Line-By-Line Radiative Transfer Model (LBLRTM), and compared with the AERI radiances. The differences larger (smaller) than 3mw/(cm^2.sr.cm^{-1}) suggest a cloudy (clear) sky. Meanwhile, we develop the new algorithms for retrieving the zenith equivalent cloud base height (CBH$_e$) and the equivalent emissivity (ε_e), respectively. The retrieval methods are described as follows. 1) An infinitely thin and isothermal blackbody cloud is simulated by the LBLRTM. The blackbody base height (H) is adjusted iteratively to satisfy the situation that the contribution of the blackbody to the downwelling radiance is equal to that of realistic cloud. The final H is considered as CBH$_e$. The retrieval results indicate that the differences between the CBH$_e$ and observational cloud base height (CBH) are much smaller for thick low cloud, and increases with the increasing CBH. 2) The infinitely thin and isothermal gray body cloud is simulated by the LBLRTM, with the CBH specified as the observed value. The cloud base emissivity (ε_c) is adjusted iteratively until the contribution of the gray body to the downwelling radiance is same as that of realistic cloud. The corresponding ε_c is ε_e. The average ε_e for the low, middle and high cloud is 0.9670.781 and 0.616 for the 50 cases, respectively. It decreases with the CBH increasing. The new methods will be useful for studying the role of cloud in the radiation budget in the window region and cloud parameterizations in the climate model.

Secondly, we also propose a new strategy that exclusively uses NCEP-2, a global reanalysis data as a first-guess profile in an iterative recursive algorithm for atmospheric temperature and water vapor profiles retrieval from AERI. Compared with the corresponding radiosonde measurements, we find that AERI is able to obtain good temperature and water vapor profiles in the PBL, which can be used to monitor the PBL stability and evolution. Meanwhile, we note that the AERI retrievals have larger surface temperature biases, due to some environmental interference. The difference of surface temperature in the first guess has a remarkable impact on the AERI retrievals for both temperature and water vapor, and the impact varies with altitudes.