IRS2012-130-1
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Interaction between low-level temperature inversion and aerosols inferred from the ARM/SGP data

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Low-level atmospheric temperature inversion, where atmospheric temperature increases with altitude, occurred frequently at middle and high latitudes. They influence the depth of vertical mixing, surface radiation balance, pollutants dispersion, and cloud formation in the boundary layer. Through analysis of high-quality and continuous radiosonde, atmospheric emitted radiance interferometer (AERI), aerosols and radiation data collected at the ARM Southern Great Plains (SGP) site for the period of 2002 to 2010, we obtained statistical characteristics and seasonal variation of low-level atmospheric temperature inversion, and investigated the interaction between low-level inversion and surface aerosols in SGP under clear sky condition. Both surface-based inversion (SBI) and elevated inversion (EI) are included. The results indicate that 96.1% of inversion occurred less than 3000m, most of nighttime inversion tended to be surface-based inversion and daytime to be elevated. Inversion parameters, such as frequency, depth and temperature difference have obvious seasonal variations. More objective quantification of the effect of surface-based inversion on aerosol CN number concentration (CN) is conducted. It is seen that the presence of surface-based inversion led to mean CN increased by 11.0%, 37.5% and 45.1% in the evening (1800 LT), at night (0000 LT) and in the morning (0600 LT), respectively. Using high-temporal-resolution AERI temperature profile, we obtained more detailed characteristics of low-level temperature inversion evolution, and observed that formation, dissipation time and duration of temperature inversion have significant difference for different seasons, i.e, mean duration of SBI is 14.4 hours, 12.7 hours, 15.7 hours and 18.1 hours for spring, summer, autumn and winter, respectively. Due to the limitation of conventional observation technology, little attentions have been paid to the effect of aerosols on temperature inversions. We analyzed the relationships between temperature inversion, aerosols and downwelling shortwave radiation under clear sky condition, and the results show that: there is a negative correlative between inversion duration after sunrise and aerosol single scattering albedo (SSA), and a negative correlative between inversion formation time before sunset and aerosol SSA under clear sky. By comparing clear sky net downwelling shortwave radiation observed and calculated by Fu-Liou model, it is found that aerosol absorption diminish net downwelling shortwave radiation, hence decrease surface solar heating and increase duration of inversions.