Geophysical Research Abstracts,
Vol. 11, EGU2009-2942, 2009
EGU General Assembly 2009

Radiation transfer in stratus clouds at the BSRN Payerne site

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The effect of clouds on radiation is responsible for large uncertainties in climatology. A project was carried out for characterizing the effects of clouds on radiation using data collected at the Payerne station (Switzerland) of the Baseline Surface Radiation Network (BSRN). The effects of stratiform clouds on solar radiation were analyzed, focusing on the absorption, transmission and reflectance of the clouds.
Specific well defined single-layer stratus cloud cases observed at the Payerne station are presented. The corresponding shortwave atmospheric radiation transfer is calculated with MODTRAN^{TM} and compared with the observations. These stratus situations are selected in a data set covering the years from 2000 to 2005 with a method using data widely available at national meteorological observing stations. For 18 single layer stratus situations the shortwave radiation fluxes calculated with MODTRAN^{TM} are compared to surface observations from the Payerne BSRN site and top of atmosphere (TOA) observations from the Clouds and the Earth's Radiant Energy System (CERES) experiment. A median bias on the order of 20Wm^{-2} (<9%) was found for the differences between modeled and observed reflected solar radiation at TOA. At the surface, good agreement is obtained by adjusting the vertical extinction in the modeled cloud layer within reasonable limits for a stratus cloud: The median bias of modeled minus observed shortwave downward radiation is well within instrument precision (<1%). The simultaneous agreement of modeled and observed radiation fluxes at the surface and TOA confirmed that radiation transfer in the atmosphere including a single cloud layer can be well simulated with MODTRAN^{TM}. Based on the present results, the absorbance, transmittance and reflectance were calculated for the stratus cloud layer. For the 18 single stratus layer situations the median absorbance is 0.07 [minimum 0.04, maximum 0.1], the median transmittance is 0.29 [0.15 0.39], and the median cloud reflectance is 0.70 [0.63, 0.80].