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# Surface Longwave Cloud Radiative Forcing of Stratus Clouds at the BSRN site Payerne, Switzerland

S. Wacker (1), J. Gröbner (1), D. Nowak (2,3), L. Vuilleumier (3), and N. Kämpfer (4)

(1) Physikalisch-Meteorologisches Observatorium Davos/ World Radiation Center PMOD/WRC, Davos Dorf, Switzerland (stefan.wacker@pmodwrc.ch), (2) Federal Office of Civil Aviation FOCA, Bern, Switzerland, (3) Federal Office of Meteorology and Climatology MeteoSwiss, Aerological Station Payerne, Switzerland , (4) Institute of Applied Physics IAP, University of Bern, Bern, Switzerland

This study presents surface longwave downward radiation fluxes and surface longwave cloud radiative forcing results for single-layered overcast stratus situations at the BSRN site Payerne, Switzerland, obtained by using high quality BSRN surface observations and the Radiative Transfer Model (RTM) MODTRAN. The stratus cases were selected using synoptic observations, radiosonde profiles and ceilometer data. A total of 31 atmospheric profiles of pressure, temperature and humidity derived from radiosondes launched at Payerne have been applied to the MODTRAN model for the selected stratus cases during the winter periods 2000 to 2005. Results show a very good agreement of 0.2 $\mathrm{Wm}^{-2}$mean difference between model and observations with a standard deviation of 1.2 $\mathrm{Wm}^{-2}$. Outliers caused by overestimated computed surface longwave downward fluxes can be observed only if the stratus layer does not completely cover the sky.

The validated results were then applied to derive the surface longwave cloud radiative forcing $\mathrm{CRF}_{LW}$. As used in this study, $\mathrm{CRF}_{LW}$ is the difference between the longwave downward radiation flux at the surface for the stratus situation, $\mathrm{F}_{LWstr}$, and the corresponding expected clear-sky flux, $\mathrm{F}_{LWcs}$:

$$CRF_{LW} = F_{LWstr} - F_{LWcs} \quad (1)$$

We used model results for both, clear-sky and cloudy longwave downward fluxes to derive $\mathrm{CRF}_{LW}$. Results revealed a mean $\mathrm{CRF}_{LW}$ of 80.6 $\mathrm{Wm}^{-2}$ with a standard deviation of 2.4 $\mathrm{Wm}^{-2}$. Using the modeled clear-sky and stratus surface longwave downward fluxes with uncertainties of 2 $\mathrm{Wm}^{-2}$ for each, we estimate an expected $\mathrm{CRF}_{LW}$ uncertainty in the order of 3 $\mathrm{Wm}^{-2}$. However, second-order effects due to different temperature and especially humidity profiles for clear-sky fluxes are not taken into account: according to equation [1], $\mathrm{CRF}_{LW}$ is the difference between the surface fluxes under a stratus cloud and clear-sky conditions during the stratus period. Since cloudy and clear-sky conditions do not appear at the same time, the determination of the clear-sky fluxes are an additional source of uncertainty in deriving $\mathrm{CRF}_{LW}$.