Atmos. Chem. Phys. Discuss., 9, C1113–C1117, 2009
www.atmos-chem-phys-discuss.net/9/C1113/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A simple model for cloud radiative forcing" *by* T. Corti and T. Peter

U. Schumann

ulrich.schumann@dlr.de

Received and published: 23 May 2009

Besides its educational values, the simple cloud-radiative forcing model presented by Corti and Peter (the CP-model) may be useful for quick calculations of the short-wave and long-wave radiative forcing contributions from thin cirrus and plane contrail cirrus layers.

Figures 1 and 2 show comparisons of the CP-model results with the result presented in Meerkötter et al. (1999) [R. Meerkötter, U. Schumann, D. R. Doelling, P. Minnis, T. Nakajima, Y. Tsushima: Radiative forcing by contrails, Ann. Geophysicae 17, 1080-1094 (1999)].

Figure 1 shows the daily mean instantaneous short-wave (SW, short dashed), long-wave (LW, long dashed), and net forcing (full thin curve) versus 0.55 μm solar optical depth at top of the atmosphere for 100% contrail cover for a mid-latitude summer con-

tinent reference case, at 45° latitude, with surface albedo of 0.2, surface temperature of 20.8°C, and standard summer atmosphere. Cirrus layer between 10.8 and 11 km altitude. Black curves, Results of Meerkötter et al. (1999) for spherical ice particles. The two circles denote the short-wave forcing values for spherical particles (upper) and hexagons (lower value) at an optical depth of 0.52. Red curves: the same result for the CP model. It should be noted that these are daily mean values. The short wave mean value has been computed averaging over the day with one minute time step.

Figure 2 shows the instantaneous SW (short dashed) and LW (long dashed) and net forcing (full thin curve) versus solar zenith angle for a thin cirrus layer with an solar optical depth of 0.52 for otherwise the same parameters as in Figure 1.

The figures show that the CP-model results agree to first order with the model results pre-sented in Meerkötter et al., in particular when one compares with the hexagon re-sults, see Figure 1.

However, the dependence on the solar zenith angle is not so pronounced as in that older study, see Figure 2. In particular the CP-model seems to underestimate the peak in short-wave forcing at high SZA values.

It would be interesting to learn whether the difference is a property of the underlying Fu and Liou model or a consequence of the CP-model fits. The radiative forcing of thin cirrus obviously depends rather strongly on the assumed particle shapes.

With respect to the remark by Kärcher [Atmos. Chem. Phys. Discuss., 9, C833–C833, 2009] it is noted here that Twomey's expression

r+(1-r)ˆ2 A/(1-rA) – A

is the same as

r (1-A)ˆ2 /(1-3A),

which goes back to Paltridge and Platt (1976), p. 235, as cited in Meerkötter et al.

(1999). This expression agrees with Corti and Peter, eq. (13) if the reflectances of the cloud layer for direct and diffuse solar radiation, R_c and R'_c, are equal, which is not the case in general.

It should be noted that fits to the results of radiative transfer calculations, such as used to determine the model parameters with the Fu-Liou code for the CP-model, depend on the range of parameters used in the forward calculations (e.g. range of values used for albedo, surface temperature, zenith angles, temperature profiles, ice water or liquid water paths, altitudes and geometrical thickness of the cloud layers, particle shapes and particle size distributions, and presence or non-presence of lower level clouds etc.). Information on these parameters should be given by Corti and Peter. It would be interesting to learn how far the model fit parameters change, when the particle shapes vary.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 8541, 2009.

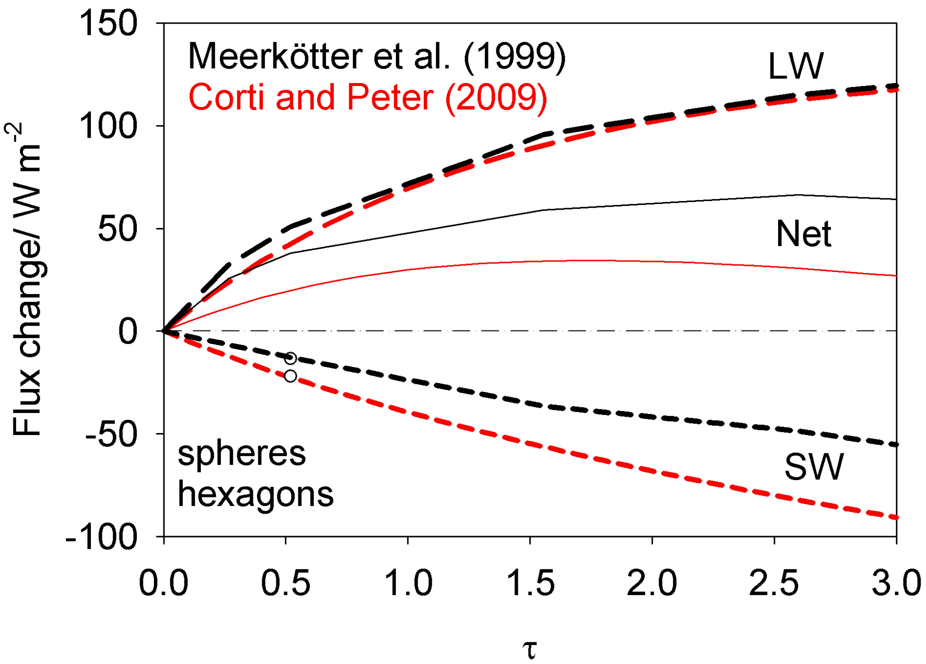

Fig. 1. Daily mean radiative forcing versus optical depth

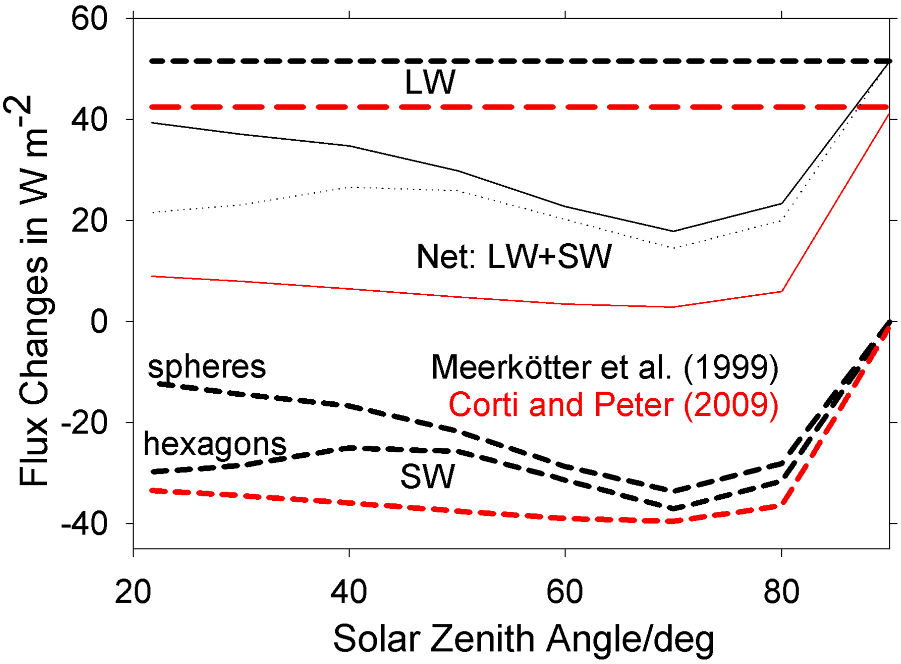

Fig. 2. Radiative forcing versus solar zenith angle.