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Interactive Comment

Interactive comment on "Simulated radiative forcing from contrails and contrail cirrus" *by* C.-C. Chen and A. Gettelman

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The paper discusses an important and difficult issue; the radiative forcing (RF) from contrails and in particular for contrail cirrus.

Based on a model study, the paper gives quite specific and rather low numbers for these RF contributions: RF from linear contrails: 2.9+-1.25 mW/m2 RF from contrail cirrus: 12+- 10 mW/m2.

These RF values are significantly lower than the range of values cited in the recent overview by Lee et al. [Lee et al., 2009] for the year 2005: RF from linear contrails: 11.8 (5.4-25.6) mW/m2 RF from contrail cirrus or aviation induced cirrus: 33 (12.5-86.7) mW/m2.

I agree that independent model studies are needed. But, I ask whether the model used is sufficiently validated to justify the conclusions given.

In recent years, several papers at least tried to use experimental evidence to validate contrail and contrail-cirrus properties, e.g. [Burkhardt and Kärcher, 2009; Kärcher et al., 2009; Lee et al., 2010; Naiman et al., 2011; Rap et al., 2010; Schumann, 2012; Schumann and Graf, 2013; Schumann et al., 2012]. Others at least discussed reasons for uncertainties, e.g. [Frömming et al., 2011; Frömming et al., 2012; Kärcher et al., 2010; Voigt et al., 2011]. This list of references is certainly not complete.

Several of these and other recent studies report the RF from contrails and contrail cirrus.

A table with listing of RF results and shortwave to longwave ratios from other studies (for contrails and for a homogeneous cirrus case) can be found, e.g., in [Schumann and Graf, 2013]

The present paper uses a method in which the particle size is prescribed independent of emissions, temperature and humidity. More advanced models or at least concepts are available, e.g. [Kärcher et al., 1996; Kärcher and Yu, 2009; Schumann et al., 2013; Unterstrasser and Gierens, 2010]

The discussion of the diurnal cycle on global scale could be misleading. Even if traffic varies during day, its diurnal cycle may vanish in the global mean simply because the local diurnal traffic cycles depend on local time and not on UTC.

The paper mentioned existing satellite observations [Graf et al., 2012] for the contrail cirrus variability in correlation with traffic over the North Atlantic. It would be interesting to see a plot of the mean diurnal cycle of computed cover and LW-RF [Schumann and Graf, 2013] in the North Atlantic region as specified in the cited papers for direct comparison with the satellite observations of cirrus cover and outgoing longwave radiation. It would be interesting to see whether the present model agrees on the time scales and amplitudes of the observed signals, or gives arguments why the model results are correct.

Also a comparison to the observations of Iwabuchi et al. (2012) [Iwabuchi et al., 2012], e.g. in terms of a pdf of optical depth values, would help to assess the validity of the results or to identify possible uncertainties.

Several recent GRL papers by the NASA Langley team of Pat Minnis present estimates of cover, RF, particle sizes and optical depth values, e.g. versus temperature [Bedka et al., 2013]. These results may be helpful to check this model.

References

Bedka, S. T., P. Minnis, D. P. Duda, T. L. Chee, and R. Palikonda (2013), Properties of linear contrails in the Northern Hemisphere derived from 2006 Aqua MODIS observations, Geophys. Res. Lett., 40, 772-777.

Burkhardt, U., and B. Kärcher (2009), Process-based simulation of contrail cirrus in a global climate model, J. Geophys. Res., 114, 1-13, doi:10.1029/2008JD011491.

Frömming, C., M. Ponater, U. Burkhardt, A. Stenke, S. Pechtl, and R. Sausen (2011), Sensitivity of contrail coverage and contrail radiative forcing to selected key parameters, Atmos. Env., 45, 1483-1490, doi:10.1016/j.atmosenv.2010.11.033.

Frömming, C., M. Ponater, K. Dahlmann, V. Grewe, D. S. Lee, and R. Sausen (2012), Aviation-induced radiative forcing and surface temperature change in dependency of the emission altitude, J. Geophys. Res., 117, D19104, doi: 10.1029/2012JD018204.

Graf, K., U. Schumann, H. Mannstein, and B. Mayer (2012), Aviation induced diurnal North Atlantic cirrus cover cycle, Geophys. Res. Lett., 39, L16804, doi: 10.1029/2012GL052590.

Iwabuchi, H., P. Yang, K. N. Liou, and P. Minnis (2012), Physical and optical properties of persistent contrails: Climatology and interpretation, J. Geophys. Res., 117, D06215,

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13, C4384–C4388, 2013

doi:10.1029/2011JD017020.

Kärcher, B., T. Peter, U. M. Biermann, and U. Schumann (1996), The initial composition of jet condensation trails, J. Atmos. Sci. , 53, 3066-3083.

Kärcher, B., U. Burkhardt, S. Unterstrasser, and P. Minnis (2009), Factors controlling contrail cirrus optical depth, Atmos. Chem. Phys., 9, 6229-6254, SRef-ID: 1680-7324/acp/2009-9-6229.

Kärcher, B., and F. Yu (2009), Role of aircraft soot emissions in contrail formation, Geophys. Res. Lett., 36, L01804, doi:10.1029/2008GL036649.

Kärcher, B., U. Burkhardt, M. Ponater, and C. Frömming (2010), Importance of representing optical depth variability for estimates of global line-shaped contrail radiative forcing, PNAS, 19181-19184, doi:10.1073/pnas.1005555107.

Lee, D. S., D. W. Fahey, P. M. Forster, P. J. Newton, R. C. N. Wit, L. L. Lim, B. Owen, and R. Sausen (2009), Aviation and global climate change in the 21st century, Atmos. Env., 43, 3520-3537, doi:10.1016/j.atmosenv.2009.04.024.

Lee, D. S., G. Pitari, V. Grewe, K. Gierens, J. E. Penner, A. Petzold, M. J. Prather, U. Schumann, A. Bais, T. Berntsen, D. Iachetti, L. L. Lim, and R. Sausen (2010), Transport impacts on atmosphere and climate: Aviation, Atmos. Env., 44, 4678-4734, doi:10.1016/j.atmosenv.2009.06.005.

Naiman, A. D., S. K. Lele, and M. Z. Jacobson (2011), Large eddy simulations of contrail development: Sensitivity to initial and ambient conditions over first twenty minutes, J. Geophys. Res., 116, D21208, doi:10.1029/2011JD015806.

Rap, A., P. M. Forster, A. Jones, O. Boucher, J. M. Haywood, N. Bellouin, and R. R. D. Leon (2010), Parameterization of contrails in the UK Met Office Climate Model, J. Geophys. Res., 115, D10205, doi:10.1029/2009JD012443.

Schumann, U. (2012), A contrail cirrus prediction model, Geosci. Model Dev., 5, 543–

580, doi: 10.5194/gmd-5-543-2012.

Schumann, U., B. Mayer, K. Graf, and H. Mannstein (2012), A parametric radiative forcing model for contrail cirrus, J. Appl. Meteorol. Clim., 51, 1391-1406, doi: 10.1175/JAMC-D-11-0242.1.

Schumann, U., and K. Graf (2013), Aviation-induced cirrus and radiation changes at diurnal timescales J. Geophys. Res., 118, 2404-2421, doi: 10.1002/jgrd.50184.

Schumann, U., P. Jeßberger, and C. Voigt (2013), Contrail ice particles in aircraft wakes and their climatic importance, Geophys. Res. Lett., 40, 6, doi: 10.1002/grl.50539.

Unterstrasser, S., and K. Gierens (2010), Numerical simulations of contrail-to-cirrus transition - Part 2: Impact of initial ice crystal number, radiation, stratification, secondary nucleation and layer depth, Atmos. Chem. Phys., 10, 2037-2051, doi:10.5194/acp-10-2037-2010.

Voigt, C., U. Schumann, P. Jessberger, T. Jurkat, A. Petzold, J.-F. Gayet, M. Krämer, T. Thornberry, and D. W. Fahey (2011), Extinction and optical depth of contrails, Geophys. Res. Lett., 38, L11806 doi:10.1029/2011GL047189.

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