Reply to reviewer #1 and further comments

I thank the reviewer for the very supportive and helpful comments.

Here I respond to the comments, which I repeat at least partly in *italic*:

General comments:
• *"time integration and segment trajectories"*

During the course of the model development, I first tried the isentropic approach with J=0. The difference between the results for this isentropic version and the kinematic version based on vertical velocity derived from pressure changes was found to be minor in the sense that it did not essentially affect the mean statistics of the results, e.g. with respect to regional mean optical depth of contrails for many flights. Since I do not see a simple method to compute J correctly with computational effort comparable to the rest of the code, I did not follow this variant further.

Thank you for pointing out to the reference (Fueglistaler et al., 2009). I will think about this further.

• *"Radiative forcing"*

The RF concept was described before (Ramanathan, 1976; IPCC, 1990, 1999; Hansen et al., 1997). The RF is the difference between the net (upward-downward) radiances at a certain level for the Earth-atmosphere system with the disturbance (here from contrails) minus the net fluxes without this disturbance. The instantaneous RF at top of the atmosphere (TOA) is an often used approximation of the stratospherically adjusted RF commonly used in climate assessments. A full description of the RF computation is given in the paper Schumann et al. (2012), which is presently under review at J. Appl. Met. Climat. Depending on the outcome of that review I will add more explanations to the present paper in the revised version.

For analyses of the climate impact of contrails the radiative forcing issues are essential. Hence, this section is important for completeness of this paper. In particular it serves to identify where in CoCiP RF is computed and with which input.

Minor points:
• *L. 28*
"contrail outbreaks" sounds strange –
This technical term is used in the literature, e.g., in Duda et al. (2004). They refer to "widespread outbreaks of persistent contrails in otherwise clear skies". I will either avoid this term or define it more clearly in the revised text.

• *L. 132*
NWP - please explain this abbreviation
– is defined earlier in the text. See also list of abbreviations, Table 7

• *L 203*
We use the well-known Schmidt-Appleman Criterion (SAC)....
– The abbreviation is defined earlier in the text and in Table 7.

• *Fig. 4*
Maybe you should explain that every point is one aircraft.
- Yes

• *L 320*
I do not understand the contribution of the last 2 term. .
- The first term is the amount of emitted water vapor. The last two terms give the amount of water vapor exceeding ice saturation in the entrained air.

• *L 334*
...above expression (20) gives a negative...

- Yes

• *Fig 5*
every point is one aircraft ?

- Yes

• *Fig 10*
What is τ?*
Here 'τ*width", or better '$\tau \times$ width' or 'τ B' , is the product of optical depth and contrail width.

• *Fig 18*
I do not understand the red dotted curve on the right side (with many maxima).
- This is the difference of relative humidity over ice (RHi) between the true values (computed using a very fine vertical grid) and the RHi computed from absolute humidity q after linear interpolation of absolute humidity on the numerical weather prediction model grid.

As further comments, I want to point out the following corrections to the paper:

The indices "0" in Eq. (19) should be replaced by "1". (Thanks to John L. Ross for pointing this out to me).

P. 3245.line 9. A plus sign should be replaced by a minus sign. The correct version is:
$b = \alpha_S S_T^2 - \alpha_N N_{BV}^2$
(Thanks to Robert Sharman for pointing this out to me).

Two citations in the paper were missing in the list of references (Ponater, 2002; Gierens, 1994). The references are now given below.

Additional references

Fueglistaler, S., Legras, B., Beljaars, A., Morcrette, J.-J., Simmons, A., Tompkins, A. M., and Uppala, S.: The diabatic heat budget of the upper troposphere and lower/mid stratosphere in ECMWF reanalyses, Q. J. R. Meteorol. Soc., 135, 21-37, 10.1002/qj.361, 2009.

Gierens, K. M.: The influence of radiation on the diffusional growth of ice crystals, Beitr. Phys Atmos. (Contr. Atm. Phys.), 67, 181-193, 1994.

Hansen, J. E., Sato, M., and Ruedy, R.: Radiative forcing and climate response. J Geophys Res :, J. Geophys. Res., 102, 6831--6684, 1997.

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Ponater, M., S. Marquart and R. Sausen: Contrails in a comprehensive global climate model: Parameterization and radiative forcing results, J. Geophys. Res., 107, 10.1029/2001JD000429, 2002.

Ramanathan, V.: Radiative transfer within the Earth's troposphere and stratosphere: A simplified radiative-convective model, J. Atmos. Sci., 33, 1330--1346, 1976.