

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-325

Anonymous Referee #1

Referee comment on "Computation of longwave radiative flux and vertical heating rate with 4A-Flux v1.0 as an integral part of the radiative transfer code 4A/OP v1.5" by Yoann Tellier et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-325-RC1>, 2021

The paper describes an extension of the radiative transfer model Automated Atmospheric Absorption Atlas OPERational (4A/OP). The original version of the model enables line-by-line simulations of radiances in the thermal spectral region. The extension 4A-Flux performs an angular integration of the radiances to obtain irradiances (fluxes) and heating rates, either vertically resolved or only at top of atmosphere (outgoing longwave radiation OLR). For the angular integration exponential integral functions are applied. The model has already participated in the Radiative Forcing Model Intercomparison Project (RFMIP) and performed well. As an application, OLR and heating rate profiles are calculated using the Thermodynamic Initial Guess Retrieval (TIGR) atmospheric database as model input. The paper is generally well written and as a model description paper, it fits the scope of GMD, although it does not include substantial new concepts. I have some comments regarding the methodology which should be clarified before publication.

General comments:

- There are several publications about the calculation of line-by-line irradiances (fluxes), heating rates etc. in the thermal region (e.g. Buehler et al. 2006 and references therein) More scientific context including references to relevant publications should be included in the introduction.

- The most commonly used methods to compute irradiances (fluxes) and heating rates are two-stream methods, which provide accurate results (e.g., Zdunkowski, W., Trautmann, T., & Bott, A. (2007). Radiation in the Atmosphere: A Course in Theoretical Meteorology. Cambridge: Cambridge University Press.). Please explain and justify why you used the exponential integral functions to perform the angular integration.

- The role of clouds and aerosols is not discussed. Can clouds/aerosols be handled by the 4A model? Can the model handle scattering at all? If not are there any plans to extend the model in this direction?

- Is specular reflection a good approximation for natural surfaces? I suppose Lambertian surface reflection is a much more realistic assumption. Please justify why you included specular reflection.

Minor comments:

l. 53: "The spectral integration was performed with either a Gaussian quadrature or at a single angle under the diffuse approximation"- I assume you mean angular integration?

l. 107: "solution of the radiative transfer equation ..." -> here you may add that this solution is called Schwarzschild equation

Eq. 16: Please define g and c_p

Table 1: I did not understand why the computational time for the vertical profiles is so much higher, could you explain this? For the calculation of OLR you need to step through all layers. Couldn't you save the results at all layer boundaries to get the vertical flux profiles?

l. 387ff.: Which are the main processes responsible for the "kink"? Isn't this mainly due to absorption by the ozone layer? This would also explain why it appears at different altitudes for the different scenarios,

Fig. 7: (c1) and (f1) do not show heating rate difference but heating rate. (c2) and (f2) show exactly the same as (b2) and (e2), the same scale on the x-axis.

References:

Buehler, SA, A von Engel, E Brocard, VO John, T Kuhn, and P Eriksson (2006), Recent developments in the line-by-line modeling of outgoing longwave radiation, *JQSRT*, 98(3), 446-457

Zdunkowski, W., Trautmann, T., & Bott, A. (2007). *Radiation in the Atmosphere: A Course in Theoretical Meteorology*. Cambridge: Cambridge University Press