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Atmospheric Measurement Techniques Discussions

Interactive comment on "kCARTA: A fast pseudo line-by-line radiative transfer algorithmwith analytic Jacobians, fluxes, Non-Local ThermodynamicEquilibrium and scattering for the infrared" *by* Sergio DeSouza-Machado et al.

Anonymous Referee #2

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This manuscript describes recent development of a pseudo-monochromatic radiative transfer package, kCARTA (the kCompressed Atmospheric Radiative Transfer Algorithm). The kCARTA improves computational speed relative to a line-by-line (LBL) radiative transfer model by using compressed optical depth lookup tables and by performing radiative transfer calculations at a pseudo-monochromatic grid. The main idea of the kCARTA algorithm is to compress molecular optical depth lookup tables into an Empirical Orthogonal Function (EOF) domain using a singular value decomposition method. The optical depth lookup tables, which are functions of atmospheric

molecules, wavelength (or frequencies), pressure, and temperatures, were generated using an UMBC-LBL model. Water vapor lookup table has an additional dependency on water vapor amount to account for self-broadening effect. The kCARTA approach reduces the optical depth lookup table size from hundreds of gigabytes to less than 900 megabytes. The generation of monochromatic transmittances from the compressed database is orders of magnitude faster than using a line by line model. The kCARTA package includes surface emission, atmospheric layer emission, solar reflection, and diffuse thermal emission reflected by the surface. The authors also described details on calculating non-local thermodynamic equilibrium in the CO2 4 micrometer band, the clear sky Jacobian calculation, a better approximation of calculating the background thermal radiations using an optical depth dependent single-stream effective diffusive angle, and the flux computation. The manuscript is well-written and the reviewer recommends publishing it with minor revisions. The specific comments are as follow:

1). What studies have the authors done to ensure that the 11 temperature grid points are adequate to represent the temperature dependency of optical depths of gases for each atmospheric layer. Please quantify the errors of interpolation due to 11 point grid and the choice of interpolation method (spline vs linear). 2). The kCARTA package is optimized for the thermal infrared spectral region. Though the authors claim it is trivial to extend the database out to span the far infrared to ultra-violet range, the package does not include Rayleigh scattering and an accurate multiple scattering radiative solver, which are important for the shortwave top of atmosphere radiation calculations. 3). On page 2 line 40, it will be useful to describe the relative errors between kCarta and the MNLBL. 4). Section 2.1 on page 4. Although the authors described the UMBC-LBL model line shape calculations and mentioned that extensive comparisons with LBLRTM and GENLIN2 have been performed, no quantitative results have been shown to illustrate differences among different LBL models. For some molecules, a sub-Lorentz line shape is used by LBLRTM, what about the UMBC-LBL? 5). The method used by kCARTA for calculating the downwelling background radiative is very efficient and much more accurate relative to a constant diffusive angle. However, for a non-Lambertian surface (e.g a specular reflection surface), this may not be a good approximation.

There are some minor errors in the manuscript:

1. In the figure caption for Figure 6, 0.005 cm-1 should be 0.0005 cm-1. 2. Not all the symbols used in this paper are defined. For example, Omega in equation (3), g under equation (C1)... 3. Some of the links given in Appendix A are not available. 4. Line 149, the symbols in the equation are not explained by the text or the appendix B. 5. Line 230, please correct typo “limemixing”

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