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Interactive comment on "ARTS, the atmospheric radiative transfer simulator – version 2.2, the planetary toolbox edition" *by* Stefan A. Buehler et al.

Anonymous Referee #1

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Summary:

The article describes the current version of the ARTS package, which is a widely used line-by-line radiative transfer model for the thermal spectral range. The paper is not a complete model description but focuses on new features that have been included after the last ARTS reference publication in 2011. The major extension is a planetary toolbox which enables simulations for the planets Venus, Mars and Jupiter in addition to Earth.

The paper is interesting to read, and, as also mentioned in the abstract, it focuses on the major extension, the planetary toolbox, in particular, on how the line-by-line

calculations need to be adapted for other planets. My major concern is, that the reader, a potential ARTS user, could think, that this is the main application of ARTS. The introduction summarizes the history of the ARTS development, but afterwards I miss an overview of the features included in ARTS, version 2.2. I think that for example an overview table including the most important ARTS features (not only the new ones) should be added. Further it would be nice to include examples of use of the new features, if possible including example input files as supplementary data. The first section should also include something like "basic usage", how the program is installed, how it is executed, etc ...

I have several more specific comments and recommend to publish the paper after the revisions.

General Comments:

Regarding the planetary toolbox extension, I have general questions: I understood that in detail the absorption lines look different for planetary atmospheres other than Earth because one has to take into account different line broadening parameters and also isotopic ratios are different. It is not clear from the paper how large the resulting differences in the absorption lines actually are.

A further question is, whether it is possible to estimate the error, which would be obtained for broad-band simulations, when the radiance is integrated over a large number of spectral lines. In particular IR instruments often measure broader bands. Does the error for integrated radiance become larger or smaller than for individual lines? Can ARTS without adaptions for other planets be used to simulate IR broad-band observations of other planets?

Specific comments:

- Abstract: Please motivate, why you have included Faraday rotation and Zeeman splitting. Why are these features needed for atmospheric radiative transfer?

p.1., l.16: "computer codes for energy flux computations and remote sensing simulations have been developed in parallel..." - Is this really true? Traditional solution methods like the discrete ordinate method (theory by Chandrasekhar 1950, included e.g. in DISORT code) compute radiance and irradiance simultaneously. I guess that there are more codes that calculate both, e.g. also libRadtran gives radiances, and can also compute (spectrally integrated) irradiances.

p.5, Eq. 2: Why has this equation been chosen to calculate the pressure shift in ARTS. Where do the constants 0.25 and 1.5 come from?

Sec. 2.1: Could you include an example plot showing the difference between the two approaches to calculate line broadening and line shift for a spectral line in the Earth atmosphere? How significant is the difference? Here it would also be nice to include ARTS input files (as supplement), showing how to set up the classical absorption calculation and what is changed for the new approach.

p7, l14ff: The line catalogue generated for planetary atmospheres includes data up to 3THz. Are there plans to extend it to the full IR region and possibly also to visible spectral region?

p.7 l.21: The sources of data for the planetary database are given in Mendrok et al. 2014. The reference is a technical report for ESA, thus it might be difficult to access it. Please include the data sources in the paper (a table would be nice, perhaps references could be included in Table 2).

p.11, Sec. 2.3, Refractivity: A plot showing refractive index profiles of all planets in the planetary toolbox would be interesting.

p.11, l. 26. Refer to section 3.1 so that reader knows that radio link simulations are actually possible with ARTS and thus the electron contribution to the refractivity is important to include in the model.

Sec. 2.4: Can you show an example (e.g. a specific water vapor line) and demonstrate

how this line changes with different isotopic ratios? I.e. plot the same line for Venus, Earth, Mars and Jupiter.

Sec. 2.5: "Doppler shifts" are mentioned here but at this point the reader does not know about this feature in ARTS. Please refer to Sec. 3.3.4.

Sec. 3.1: Please provide one example for a radio link budget simulation.

p. 14, l. 10: "considers effects covered by geometrical optics ..." - which effects, please describe more precisely. Do you mean Snell's law of refraction or something else? What is meant with "multi-pathing", please explain briefly.

p. 14, l.15/16: Is it correct that in one of the equations for the "free space loss" the denominator includes 4*pi and in the other (4*pi)^2?

p. 14, l.29: Please explain in a few words what is "Faraday rotation" and why it has to be considered for radio link budget simulations.

Sec. 3.2: Please provide one example for a radar simulation.

p. 15, l.9: Please give an example when T_h and T_a are not equal. How relevant is this inequality for radar simulations?

Sec. 3.1: Please provide an example for non-particle polarization. It would be very interesting to show the circular polarisation by Zeeman splitting. How large is the degree of circular polarisation? For which remote sensing applications is this important?

Sec. 3.3.6: I do not understand this section: Absence of attenuation means vacuum, right? In vacuum there is no refraction. How can the radiance change in absence of attenuation? Please explain.

p. 19, l.9: The "vacuum speed" is the "speed of light", right?

Sec.4. The summary and conclusions section is very short. It should include once more a general overview of what is ARTS, including LBL-absorption calculations, RT in thermal range (microwave, IR), scattering by cloud droplets and (oriented) ice crystals, surface reflection ...

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