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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Radiative effects of tropospheric ionisation" *by* K. L. Aplin

Anonymous Referee #1

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Determining the source of the IR continuum in the 10 micron wavelength window region is an important problem. In the past, it has been believed that it may be due to the water vapour (wv) wings originating from the far IR. More currently dimers have been suggested. This paper suggests that the continuum may originate from hydrated molecular cluster-ions. This work is important for remote sensing, and through the link with cosmic rays (cr) it also has importance for climate change studies.

The paper is interesting and plausible, however, it lacks enough rigour in order to make a compelling case. I have listed some points below in support of this statement.

Main Comments

When I read the paper, I felt that it had two main thrusts of work. The first is a use of observations to estimate the downwelling IR radiation and show that this correlates with the cosmic ray flux. The second is a calculation to estimate the radiative influence from theory with some parameters from laboratory measurements and observations.

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I think this two areas are both important aspects to be covered, but the paper very weakly connects the two. A more lengthy in-depth study on each of these topics is needed.

The study of observational results is too limited. There needs to be more comparisons of CR fluxes and downwelling IR fluxes in order to make the arguments convincing. Figure 2 looks interesting but needs a much more substantial timeseries.

I am dubious of the radiative transfer calculations. Equation 7 is in error (see specific points) and the simplicity of some of the calculations puts the calculated impact in question.

I get the impression that many details in this study were ignored due to the assumption that it wouldn't have an impact on the correlation between CRs and Ld.

Specific points

Line page 20 - 3207 How do they know that they exist in sufficient numbers when the cross sections for these molecules are not well known. (also see 20-3208)

14 - 3208 Little is mentioned after this point about negative ions.

12 - 3209 Were Carlon's measurements were in a saturated or unsaturated environment or both (see 12-3209 and 19-3212)?

7 - 3210 How do you know your aerosol concentrations are low? With such a small time series for comparison with observations, aerosols may have an important role.

Eq(2) 3210 Why is Sd the upward flux? For consistency shouldn't it be Su (consistent with Lu)? Shouldn't the equation be Rn = Sd - Su + Ld - Lu Why the bracket around Ld - Lu in your equation?

19 - 3210 I don't see any account made of instrument effects on the spectrum in your calculations. Instruments measuring over limited spectral ranges will have filters of a certain shape.

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Eq.(3) 3210 The surface isn't a blackbody. What error do you expect and shouldn't this be included in the determination of Ld? (Other influences may affect your surface emissivity beyond just temp).

12 - 3211 It would be useful to have also shown CR observations for the Sahel latitude. Wouldn't it be possible for CR observations to show different trends in different regions? For example, perhaps a very aerosol polluted airmass passing over Finland but a clear airmass over the Sahel, or the opposite.

13 - 3211 What is the spectral range?

22 - 3211 Can you support this claim that scattered cumulus will not have much of an effect on the daily averaged downwelling IR flux? Can you rule out subvisible cirrus at upper altitudes increasing Ld?

7 - 3212 Did you look at correlations of CR with Sg and Sd? It might be interesting to see if there was a possible indirect effect at work too (scattered cumulus).

8 - 3212 You should state the temp, pressure range that Carlon made his measurements to show that they are applicable for the range in this study.

18 - 3213 A plot of the N+ profile would be useful here.

Eq(7) - 3214 The transmissivity in eq(6) is okay as long as the density and the absorption coefficient is independent of the path. Eq(7), however, shows explicit z dependence in these terms and so the equation is incorrect. There should be an integral over the density times the absorption coefficient. Figure 3 should be recalculated if it was really derived from eq(7), as in the paper.

3 - 3214 You state that equation(7) was obtained by combining eqs (5) and (6). Equation (6) would follow from eq(7) (with the integral added) by assuming a small path.

Eq(7) - 3214 This only calculates the transmissivity, the extracted radiation from the beam through a path. To better link to the observational results from the Sahel, you

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should really compute the downward flux for the modelled atmosphere. This IR source term has been neglected here and also in the very simplistic isothermal slab calculation in the last paragraph of section 5. I expect that the 2 W/m2 in 20-3214 is a very, very rough estimate.

17 - 3214 Ta is used as an atmospheric temp and a surface temp variable (see 20-3210 and 17-3214).

19 - 3214 There is a significant O3 absorption band near 10 micron. What sort of variation in O3 concentration would be needed to give a trend in Ld that is observed?

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3205, 2003.