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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ultraviolet actinic flux in clear and cloudy atmospheres: model calculations and aircraft-based measurements" *by* G. G. Palancar et al.

Anonymous Referee #2

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General Comments:

The manuscript compares spectral actinic flux (see specific comments) measurements made from an aircraft platform over a range of conditions with a radiative transfer model simulating the same conditions. The agreement is good in clear sky conditions, especially for the down welling component of the total actinic flux, as one might expect for this model which has been widely tested and used.

Once clouds are included the situation becomes far more complex and the resulting actinic flux depends on where the clouds are in relation to the aircraft, and whether the direct beam is obscured or not, as well as the macro- and micro-physical properties of

the clouds which determine the reflection and transmission of radiation. This makes for a complex set of possible changes from the clear sky situation. Observations from the aircraft provide the spatial distribution of clouds, but cloud properties are generally not available.

The model can only deal with one dimensional clouds and then use a cloud fraction to deal with broken clouds. Typical values were used for cloud properties. While for a single observation the absolute discrepancy between model and measurement increases enormously in the presence of clouds, the model does manage to reproduce the general pattern of observations, and for a large set of data provides some statistical correlation with the observations.

As the authors point out, chemistry-transport models are in need of better understanding of cloud-radiative interactions to increase confidence in their ability to predict photolysis processes when clouds are present, and this work begins to address that need, producing a simplified analytical model as a start to disentangling the complexities involved. The paper is well written and suitable for ACP, but requires some minor corrections.

Specific comments:

The term “Actinic flux” is widely used in atmospheric science for what is the radiant fluence rate (W(or photons s-1)m-2), also sometimes called spherical irradiance or scalar irradiance. Radiant flux (W, or photons s-1) is the power emitted, transmitted or received in the form of radiation, while actinic simply means capable of producing a photochemical effect. It is clear how the term actinic flux developed as a shorthand for “radiation arriving at a molecule in the atmosphere and capable of causing a photochemical effect” when atmospheric chemistry is the interest. However the term is at odds with its mathematical definition (as given in equation 2) and with accepted lighting / radiation terminology. While the authors cannot be criticised for using the accepted, albeit incorrect, terminology in their field, perhaps they can start a move to use a more

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widely understood and technically correct term e.g. actinic fluence rate retains the sense that this quantity is appropriate to photochemistry, but is also clearly understood in general radiation terms.

Abstract – this gives the impression that the model and measurements agree almost perfectly. The level of enhancement or reduction in the observations, and captured by the model, should be quantified.

P3326 How well do the input optics represent the theoretical directionally independent response to radiation? How are the SAFS calibrated, and how well do they compare with each other? What is the overall uncertainty in the measurements? This is alluded to later (p3329 line 17), but is never actually stated.

P3328 /P3333 What is the effective albedo of the cloud in the TUV model / its contribution to the total albedo in the analytical model? Measurements of cloud and surface albedo in the UV can be found in Webb, A.R., Kylling, A., Wendisch, M and Jakel,E. (2004) Airborne measurements of ground and cloud spectral albedos. J. Geophys. Res. 109, doi:10.1029/2004JD004768.

P3328 What is the uncertainty in the model output for clear skies (based on the uncertainty of inputs)? Again this is mentioned later, but only in terms of "within the uncertainties". Please state what these are.

P3332 Section 4.2 provides a very simple approach to understanding a complex problem. However, it is almost divorced from the rest of the paper in that the simple analytical model is not systematically compared with either the measurements or the TUV model. If the same input parameters were used as for the TUV model then it would show whether the conceptual ideas in the simple model are realistic enough to be useful. For example, Rayleigh scattering is ignored – is this viable in the UV where Rayleigh scattering is especially strong?

Technical:

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P3325 line 19/20 Sect. should be Section

Time should be expressed as UTC throughout.

Figure 7 caption states correlation of cloudy model to clear sky model, yet the axes are labelled observation/model. They should state model (cloud)/model (clear).

Figures 3-7 are inconsistent in the notation used (Q up, or just UP) and both these are different to the text. Please use one notation throughout.

Fig 6 and 7. Why are the scales, and the number of points (observations) different on these two figures? There are more grey spots in Fig 7 than are represented in Fig 6.

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