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Discussions

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Interactive comment on "Cloud impacts on photochemistry: a new climatology of photolysis rates from the Atmospheric Tomography mission" *by* Samuel R. Hall et al.

Anonymous Referee #3

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This paper describes the novel use of observation-based photolysis rates derived from aircraft profile flux measurements to test global atmospheric chemistry models. It adopts an original and innovative approach, and provides a highly valuable first step in the evaluation of cloud impacts on photolysis rates in models, deriving some useful pointers to areas that need further exploration or model development. The study is well executed and thorough, exploring sensitivity to ozone column and albedo as well as to a central focus on cloud properties. The analysis approaches appear sound, the conclusions are useful, and as such the paper merits publication in ACP once some minor issues have been addressed.

C1

Specific comments

Data was provided from the models for a single day in August. How dependent are the model results on the specific day chosen? Are the regions large enough to provide a truly representative distribution of cloud coverage? This would be relatively simple to check. In addition, the number of observed samples per block is stated on page 5, but not the number of low-SZA model samples.

The coarse resolution of the models leads to an averaging of cloud cover and an under-estimation of clear sky conditions (explored in section 4.3). What would the distribution of rlnJ look like for the observations if these were averaged to the physical scale of the models?

To what extent does the noise inherent in the observation-based rlnJ values (evident in the broadening seen in Fig 4) wash out the vertical profile of cloud impacts on photolyis rates that is clearly seen in the models? Does the occasional enhancement of near-surface J-values and reduction at high altitudes reflect biases in model cloud distributions, 3-D effects, or just noise?

Is Fig 2 based on additional model runs without clouds (alluded to on page 4, line 23) or on clear-sky columns that are a subset of the all-sky data shown in Fig 1? This should be stated on page 6. If the clear-sky values are a subset, what bias does the different locations and SZAs of clear and cloudy columns introduce?

Fig 5 is an interesting and well thought out way of presenting the data, but is difficult for the reader to interpret, particularly where the bar indicating the proportion of reduced/enhanced J-values does not align with the cross indicating the mean magnitude.

Minor issues and Typos

Abstract, line 30: "more importantly" Please rephrase this or reorder the sentence appropriately.

Page 9, line 25: 3/2 should be a power

Page 10, line 23: section 4.3 is important, but the title of the section is awkward, please consider rephrasing "finding clear sky".

Page 11, line 6-7: this partly repeats information provided on page 5.

The caption to Figure 6 is too long. The information is valuable, but some of it should be included in the text on page 11. (Typo: please replace star with multiplication sign for consistency)

Caption to Fig S2, one line from bottom: "in the in the"

Caption to Fig S6, line 2: remove second occurence of "blocks"

Fig S6 needs to be cleaned up so that the titling is legible and the model legend is not superimposed on the axis labels.