Atmospheric
Chemistry
and Physics
Discussions

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 #2

Received and published: 19 October 2018

This paper presented a statistical analysis of the photolysis rates data obtained over the Pacific during the first deployment of the ATom mission (July 29-Aug.6, 2016) and evaluated the performance of nine global models with respect to how clouds affect photolysis rates (J-values). The ATom J-values are a unique data set for testing how well clouds are treated in terms of their impact on photochemistry in current global models. The model J-values presented in this study are from simulations with each model's own configuration without controlling input conditions among all nine models. Comparisons of the probability distributions of cloud impacts on J-values between the models and measurements provided original insights into model performance differences. The paper concludes with an interesting discussion on the difficulties and challenges involved

in simulating cloud impacts on J-values and comparing with measurements. The need for more effort to characterize the main factors contributing to the model differences are also acknowledged and discussed. The paper is overall well written and I recommend publication on ACP after some minor modifications.

Title: The title would suggest this paper is about the analysis of photolysis rates from all ATom campaigns, but in fact only the data from ATom-1 (July 29-Aug.6, 2016) is used to test nine global models. The title should reflect these. Also "climatology" (a term used throughout the text) cannot be derived from a single deployment. "Statistics" is probably a more appropriate term as part of the title for the kind of analysis presented, and is often used in the text.

Abstract: The abstract could be improved: 1). it doesn't flow that well. 2). P1, L28: "during the first deployment (ATom-1) in August 2016": it's actually July 29-August 6, 2016. 3). P1, L29: it would be useful to the reader to state that models provided hourly J-values for a single day of August for the domains measured in ATom-1. 4). L30: what is the statistical picture of the impact of clouds on J-values established by the ATom-1 measurements? 5). L31-32: "the models show largely disparate patterns", "there is some limited, broad agreement": what are the disparate patterns and broad agreement, specifically?

P4, L18: in Table 1

P5, L14-16: "It was not possible to have all the models simulate the flight paths and times" - why? Do most of these models use either assimilated or nudged meteorology? "we are trying to develop a climatology" - do you mean "statistics"? "the models were asked to pick a single day in August as representative of the cloud statistics over the large geographic blocks" - A single day of August 1-31, 2016, or near the end of the deployment (prior to Aug.6)? Figure S6 caption mentioned "one day in mid-August". Indicating the selected dates in the "Cloud data" column of Table 1 would help the readers who may want to reproduce or compare the results.

P6, 2nd paragraph: It's worth mentioning and explaining why the GC and GMI models, both driven by the MERRA-2 reanalysis, show large differences in JO1D over the tropical Pacific (upper left panels, Figs. 1-2).

P9, L11: the sharp peaks

P9, L25: superscript "3/2"

P13, L9, L14: "an observed climatology", "this CAFS climatology" - see above about "climatology".

P20, Table 1: GC "Cloud data" - the model uses liquid and ice cloud optical depths (not liquid and ice water) taken from MERRA-2. GC "Model references" - Gelaro et al. (2017) is the reference for MERRA-2. Cite Liu et al. (JGR 2006, 2009) for GC J-values and B-averaging.

P20, Table 1: 4th column, GFDL and GMI - what does C1 mean here? GMI "Cloud data" - the model uses liquid and ice cloud optical depths (not liquid and ice water) taken from MERRA-2.

Fig. S1 caption: low SZAs, not high SZAs

Fig. S2 caption: "in the in the"

Fig. S6 caption: Averaged in-cell cloud optical depth (COD, at 500-600 nm and .....); "blocks studies here blocks".