

## ***Interactive comment on “Direct estimation of the rate constant of the reaction $\text{ClO} + \text{HO}_2 \rightarrow \text{HOCl} + \text{O}_2$ from SMILES atmospheric observations” by K. Kurabayashi et al.***

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General Comments: I felt that this was a very interesting paper, and I enjoyed reviewing it. The Authors describe an interesting approach to estimating rate constants from atmospheric measurements by isolating a spatial and temporal region where the photochemistry is dominated by a single reaction. They then estimate the rate constant using diurnal measurements of the abundance of all the reactants and one of the products. My only real concern is in the error analysis, and I describe my concern in more detail under specific comments.

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I strongly encourage the authors to revise the error analysis and resubmit, and I look forward to seeing the revised manuscript.

Specific Comments: I have two concerns with the discussion of uncertainties in this paper. The Authors have estimated the rate constant  $k_1$  using HOCl, ClO, and HO<sub>2</sub> ( $k_1$ ), and using only ClO and HO<sub>2</sub> ( $k_1'$ ). They look at  $dk = |k_1 - k_1'|$ , select a time period where the  $dk$  is small, then further select only data for which  $dk$  is less than a threshold value before looking at the distribution of remaining  $k_1$  values to estimate the statistical error. It is not clear to me that after already selecting for small  $dk$  one will not be biased towards a small spread in the remaining  $k_1$  and wind up underestimating the statistical uncertainty.

My bigger concern is that the authors have not considered other sources of bias in their estimate of  $k_1$ . Anything that causes a bias in the measurement of ClO, HOCl, or HO<sub>2</sub> number density will cause a bias in the estimate of  $k_1$ . Potential sources of bias include errors in the assumed atmospheric temperature profile, antenna elevation angle, line strength parameters, interfering species, and instrument calibration.

The total systematic uncertainty (bias) in the constituent profiles needs to be included in the analysis and added to the statistical uncertainty in  $k_1$  before the results presented here can be compared to previous work.

Technical Corrections: Page 12800, line 4: "Purity" should be "purity" Page 12803, line 10: change "by by" to "by" Page 12803, next to last paragraph: the authors talk about the variance being larger than the "1-sigma error precision" This statement is confusing, since the variance is the square of the standard deviation (usual meaning of 1-sigma precision.) Page 12806, Eq. 7: While I don't object to this being called the function chi, it is more commonly called the reduced chisquare. I also believe the sum should run from 1 to N, not 0 to N. Page 12807, Eq. 10 See comment above for Eq. 7.