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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of HCl and ClO time series in the upper stratosphere using satellite data sets" *by* A. Jones et al.

Anonymous Referee #1

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The paper "Analysis of HCl and ClO time series in the upper stratosphere using satellite data sets" by A. Jones et al. fits well into ACP. The topic is scientifically significant, and scientific as well as presentation quality are, on the whole, good. Only Section 3.1 puzzles me; there are several ambiguities in the description of the method, so for the moment I do not feel able to finally judge the validity of the method (this means that a clearer description might well result in a better rating of the scientific quality). I recommend publication of this manuscript in ACP after consideration of the following specific comments, with emphasis on section 3.1:

Introduction: I like this introduction very much. It tackles a very general topic without being unspecific; it perfectly summarizes the motivation of the study, and presents a lot of well structured detailed information without any excessive length. Congratulations,

no actions required here.

Sect 2 p8626 l. 20/21: are the combined systematic and random uncertainties really relevant to trend estimation? 'systematic' usually means fully correlated in the time domain, so that they cancel out when the trend is derived. Possibly the confusion arises from an ambiguous definition of the term 'systematic uncertainty'.

Sect 3.1, general: I could not really follow here, i.e. I could not really figure out the data flow, the sequence of operations, and the rationale of each single step and how these steps interact. I suggest to rewrite this part in order to make the analysis strategy better traceable. My more detailed comments below are meant to help to spot these ambiguities; however, some of these comments may be driven by wrong understanding of the strategy as a whole and thus may become obsolete after general clarification.

Sect 3.1, p8631 l14/15: It should be mentioned that subtraction of the mean e.g. January value from each January data point in order to deseasonalize the data will affect the axis entercept b.

Sect 3.1, p8631 l16/17: what does "each data set" mean? HALOE vs. ACE-FTS etc.? Or January vs. February etc.? I did not quite get the point here.

Sect 3.1, p8631, Eq 1: This equation would be much easier to understand if [QBO] also had a time index, i.e. $[\mathrm{QBO}]_t$. This is because the generic term QBO cannot be represented as a scalar, and it is not quite clear how to add it to the other scalar terms. $[\mathrm{QBO}]_t$ would be one component of the QBO-vector and would better fit in the equation.

Sect 3.1, p8631, Eq 1: it is not quite clear what $[\mathrm{HCl}]_t$ really is. If it is the regression model, then why does in include the white noise terms and the autocorrelated error terms? A regression function only includes predictable components of the time series. Or is $[\mathrm{HCl}]_t$ actually the measured data? Clearer terminology is necessary here.

Sect 3.1, p8631, l24ff: Doesn't evaluation of a power spectrum need a stationary time

series, i.e. one with no trend? How did you solve this problem? By an iterative approach, where a first guess trend is subtracted prior to the FFT? Or are trend and amplitudes of the periodic function fitted in one step? Here it would be helpful to mathematically formulate the optimization problem (or, if applicable, the sequence of optimization problems), i.e. to report the cost function(s) to be minimized in order to make clear for each step which are the fit variables and which are the pre-fitted parameters.

Sect 3.1 p 8632 l1: Do you mean "Equation (1) can be solved for predetermined $[QBO]_t$ by ...", or are the amplitudes of the QBO-components of predetermined phases and period lengths retrieved also in this least squares analysis? Please make a clear statement on which the variables of the least squares problem are. Perhaps it might actually be helpful do include another equation which represents the object function of the least squares analysis (see above).

Sect 3.1 p 8632 l2: Are the residuals to be minimized weighted by the inverse variance of the related data point, or do they all have the same weight?

Sect 3.1 p 8632 l4: It is not easy to get the point here: Why has the seasonal component be removed again? Hasn't the time series already been deseasonalized?

Sect 3.1 p8632 l9: Since the Reinsel method seems to play a key-role in this paper, this method should be shortly summarized here. If necessary, even another equation could be included for this purpose. Particularly, it is not clear if the Reinsel method is applied after the least squaes fitting to get the trend, or if these methods interact somehow. Due to the importance of the Reinel method for this paper, a mere citation is not sufficient.

Sect 3.1 p8632 l11: I did not get the point why interpolation is necessary, and how these additional data points, which do not add any information but are fully dependent on the other data points affect the fitting procedure and the significance estimation.

Sect 3.1 p8632 l15: Again, it is not clear why extrapolation is necessary and how it

affects the data analysis.

Sect 3.1 p8632 l21: The removal of the offset certainly is valid but depending on the variability of the atmosphere and measurement noise - which both are reflected by the scatter in the time series - there will be a residual offset uncertainty. Is this small enough that it can be disregarded? If not, please note that this residual offset uncertainty contributes with a correlated error term to the error budget.

Sect 3.2 p8634 l 24: The term "scaled vertical profiles" is misleading. A scaled profile ususlly is understood to be a profile where each profile value is multiplied by the SAME scalar. I understand that the opposite is true here: The correction term is altitude-dependent. Instead of "scaled vertical profiles" I suggest to write "profiles corrected for diurnal variation according to Eq. (2)."

Sect 4.1 Fig 3: The discontinuity in the HALOE data in 2001 (the sharp increase) needs some explanation or discussion. Has the atmosphere abruptly changed or did the instrument characteristics or measurement mode change? Or is this an artefact because the Reinsel method might assume an abrupt change in trend while the actual trend changed rather continuously than abrupt?

Sect 4.2 p8637 l1 " diurnal correction factors" instead of "scaling factors" would be clearer, see above.

Sect 4.2. Fig 7, lowermost panel: same problem as with HCl: how is the 2000/2001 discontinuity explained?

Sect 5 p8637 l1: since the trends are negative, the term "lower trend" is somewhat ambiguous (is the number smaller or is the absolute value smaller?). "less negative" would be clearer.

Sect 5 p8638 l26: not quite clear what 'model errors' are. CMAM errors? Errors of the regression model? From the context I would guess this refers to the regression analysis; but is it really the model errors? I think 'regression parameter errors' would

be the correct term.

Sect 5 p8640 l4: “magnitudes found are typically smaller than those of the chlorine species reported here” would be clearer. Otherwise the reader might wonder where in this paper ozone trends are reported.

Technical comment:

Sect 3 p 8631, around Eq 1: The grammar looks funny to me: Either include Eq (1) in the sentence, like:

...takes the approach

$$[\mathrm{HCl}]_t = b + at + [\mathrm{QBO}]_t + N_t, \quad (1)$$

where ...

or start a new main clause, like

...takes the following approach:

$$[\mathrm{HCl}]_t = b + at + [\mathrm{QBO}]_t + N_t \quad (2)$$

Here ...

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