Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Spatial regression analysis on 32 years total column ozone data" *by* J. S. Knibbe et al.

Anonymous Referee #2

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GENERAL COMMENTS:

This work describes results from multiple regressions performed on 32 years of assim-ilated total ozone column data from satellites, intercalibrated with the use of ground-based data, and spatially gridded on a fine grid (1 by 1.5 degrees for lat. and long.). Local regressions are performed on a 2-dimensional grid in order to investigate spa-tial patterns of the regression coefficients and their explanatory power; this includes the seasonal dependence. The authors contrast and compare results from a more physically-based model (PHYS) and a more statistically-based model (STAT). The au-thors provide some interpretation of the explanatory power of the various regression coefficients, even though it seems that some aspects are not completely clear, or the significance is small (or possibly, some error sources are underestimated). Recovery

rates for ozone depend quite strongly on the choice of model, as well as on location. As a result, caution is suggested in the interpretation of such results, especially for the southern polar region (the ozone hole region).

This looks like a fairly comprehensive attempt at better understanding changes in to-tal ozone column, based on a mathematical construction for modeling these ozone changes. The work has some surprises, but not a lot of past work has been done in the same way, so it is hard to compare to previous results, and the authors, therefore, do not do a lot of this. This also means that it may be hard to judge how robust these results really are, and although I find this to be a useful exposition of methodologies and results, it makes one wonder whether such work can be improved in the near fu-ture or whether we mainly need more time to carefully gather, calibrate, and analyze the best continuing total column data one can obtain.

I favor publication of this work with some mostly minor changes, but I will also indicate which aspects bother me the most, in the specific comments below; some potential answers to the questions would be welcome in a revised version, even if some of this may not be easy to understand or explain right away for this paper. As it stands, the authors acknowledge that there is still a fair amount of work to do to clarify the interpretation of such analyses. I do not feel that a strong restriction regarding this publication is warranted, as long as the points about caveats and lack of robustness or understanding are made clearly and strongly enough. At the very least, this should help motivate more studies similar to these, and hopefully, an improved understanding in the end. Indeed, there may be better ways to define orthogonal variables to explain the time series (e.g., via empirical orthogonal functions), although one does not know the results until one tries this approach, and some of the meaning behind the coefficients is lost.

SPECIFIC COMMENTS:

- One of the most puzzling results has to do with the differences noted (see lines

522 and 523) for the EESC versus the PWLT results and the ozone recovery rates in the ozone hole region. Not only are the PWLT results not significant (based on the numbers given), but they tend to trend in a way that does not appear consistent with the results from the 3 different ages of air values from the EESC method (or do you see this differently?). Please clarify and comment more on these (apparent) discrepancies. Should one conclude from this that the recovery rate is most likely between 0.8 and 2 DU/year (roughly), a conclusion that the PWLT results are not in disagreement with? Or should one be suspicious enough (given such results) to not believe much of this at all?

- The results in Table 7 for the SH region are also puzzling in the same way. An other conclusion could be that the recovery rates can only be partially explained by the EESC-type model, so other factors play a role (and the actual recovery rate may be larger, as implied by the PWLT results), no? Please comment on this, as some readers may try to draw that conclusion. Also, this Table caption state "Maximum recovery rates" whereas the text states "average", so which is correct? And why not provide average results (rather than a maximum)?

- Line 149 (in MSR ozone section), is the "standard errors" really what you want to mention here, rather than the "standard deviations" (which is more of a spread indicator, given that the error gets weighted down by the square root of the number of values...so that can be very small if one has many measurements and the indication of spread is lost). I suggest changing this to "standard deviations".

- L280, as you indicate that you use data averaged along equivalent latitudes, but later show many plots with the y axis simply labeled as "Latitude" (or "Latitudes"), could you clarify why plots do not specify equivalent latitude or was this coordinate system used as a partial analysis which was then redone on geographic latitudes? Please clarify.

- L486, why did you not consider a piecewise linear model with two adjacent time periods (such as 1979 to 1997 and 1997-2010)? Why superpose the full time period

with a half period for the recovery only? Would it not help to also model the period when ozone is decreasing, or is this taken care of by other variables (more cleanly)? It would be useful to clarify this.

MINOR COMMENTS:

- L150, I suggest slight rewording to "measure of the spread of ozone values"

- L151, I would add "(2009 and 2010)" after "two years" to specify the actual dates.

- L158, change "correlated to" to "correlated with"; I also recommend deleting "the" before "halogens".

- L161, change "chloride" to "chlorine".

- L162, add a comma after "regressions".

- L175, change "regressions results" to "regression results".

- L176, no space needed in "straightforward".

- L183, "cycle" [dominates] rather than "cycles".

- L202, delete the period after "15-20 km".

- L203, why not use the plural for "polar vortices" here?

- L233, and elsewhere in the text, use lower case for "polar" [as opposed to "the North Pole"].

- L245, "the air mixing ratio between tropospheric and stratospheric air" could be clarified; maybe you should say "the mixing ratio of air between the troposphere and stratosphere".

- L319, you have two periods after "November".

- L329, change "Where" to "where".

- L344, change "which entries are" to "having entries that are"

- L350, change "statistical oriented" to "statistically-oriented".

- L358, not sure what you mean by "several reruns" (reruns of what?). Please clarify or explain with a better sentence.

- L373, "The occurrence of an ozone hole over Antarctica".

- L375, change "at" to "for" ["the Antarctic region" or "Antarctica"]

- L381, it would be good to find and cite past references (if any) that may have looked at interhemispheric differences for the solar influence. If this is correct, maybe the variations in the Southern Hemisphere is less "obstructed" by other variability (?).

- L385, change "show" to "shows".

- L387, do you mean that for both pressures, the correlation for total column is positive? As there is an out-of-phase relationship between the two pressures, please clarify how this correlation actually works. Is the total ozone column more in phase with one QBO pressure level's variations than the other?

- L398, the solar radiation and ozone formation relationship is more than a "notion"... I would just say the "fact that the amount" [rather than "the notion that in the amount".]

- L403, add "the" before "EP".

- L410, change "DAY en EP" to "DAY and EP" (?).

- L413, change "a 150 hPa" to "the 150 hPa".

- L416/417, the statement is not very convincing if not backed up by the reference cited (is it?) or by this manuscript's work. It is probably best to say "We believe that this dependency is related to..." of "They showed that...".

- L423, change "abundant" to "prevalent".

C795

- L426, I strongly suggest that the definition of R squared be provided here, to ensure that thsi is clear to all readers.

- L428, add "a" before "thorough".

- Also, I can understand the motivation for studying a site over Antarctica, but if you have a motivation for the other two sites, please indicate this (one in the tropics and one at high northern latitudes, is it as simple as that?). Stating how representative these site results are for their latitude region would be useful (although one can get this information from the lat/long plots).

- L435, add "than for the" before "PHYS model results".

- L436, change "is extended" to "extends".

- L439, delete "an" before "El Nino".

- L442, change "models" to "model".

- L447, do you mean "region north of 70N" or something else?

- L449, "PHYS model, 0.72, is nearly the same as the 0.79 value that is (on average) achieved by the STAT model".

- L450, change "yield" to "become".

- L471, add a comma after "EESC".

- L472, "In addition to the average ozone recovery, particular interest exists in the recovery over Antarctica...".

- L475, "All results shown here are significant at the 99% confidence interval." One significant issue is how one interprets results that are deemed significant and yet seem to be (and are!) in contradiction with each other.

- L493, add "the" before "Antarctic".

C796

- L498, change "poleward from" to "poleward of" [if you mean for latitudes from 10S to 90S or from 30N to 90N (?)].

- L504, add a period after "significant".

- L508, change "interested" to "interest"; also, I suggest "recovery of Antarctic ozone in Spetember-November, corresponding to the ozone hole period."

- L 511/512, make this simpler, like "First, estimates for the ozone recovery rate for the ozone hole region are generated..."

- L513, do you mean "after its minimum value" here?

- L526, change "analysis" to "analyses".

- L527/528, "However, none of the PWLT recovery rates are statistically significant."

- Section 4.1 is the only sub-section in section 4, so that numbering could be deleted (an editorial issue...).

- L541, change "support" to "supports".

- L543, change "extensively been" to "been extensively".

- L550, I think you mean "the Pinatubo eruption had a smaller impact on Southern Hemisphere..."?

- L557, change large other" to "other large".

- L559, "were poorly known (this started to be discussed after 2000)."

- L563, change "effective in" to "effective at".

- L572, "regression estimates show a positive effect...to the explanatory..."

- L575, change "notion" to "fact".

- L579, do you mean "South of 55S"?

- L587, do you mean "North of 70N"?

- L590, change "at northern" to "over northern".

- L591, change "regions" to "region".

- L595, change "show" to "shows".

- L598, delete the comma before "(2013)".

- L605, I would write "(poleward of 50N and 50S)".

- L606, change "achieve" to "achieves"; also "(equatorward of 50N and 50S)".

- L608, change "yield" to "yields".

- L609, change "in lower" to "at lower".

- L612, I suggest "in determining the ozone recovery rate."

- L621, "forms the basis of this study,"

- L622, delete "on" before "the detection".

- L634, do you mean "south of 70N" or something else?

- L643, change "has" to "have".

- L652, maybe write "perform other regression analyses".

- L654, change "forwards" to "forward" and "backwards" to "backward".

- L660, change "thanks" to "thank".

- Table 1, change "chloride" to "chlorine" and "bromide" to "bromine".

- In Tables 5 and 6, it would be better to use the same notation for "Standard Error", either "St. Error" or "Stand. Error". Also, the caption for Table 6 should read "standard errors" or something should be changed in the Table if these are standard deviations

and not standard errors.

- In general, I would say "at the 95% confidence level" rather than "on a 95%...", for all the Tables; also, please ensure that 99 should not be 95 or 90, as this does change from Table to Table...

- Fig. 5 caption, what does "south to -55 degrees" mean? Does this mean "from the Equator to 55S"? Please clarify everywhere.

- Fig. 8 caption, change "Bolivia" to "Columbia".

- Fig. 11 caption, delete "the" before "upper plots" and also before "lower plots". Also change "colorbar" to "color bar" and also in Fig. 12 caption).

- Fig. 13 caption, change "illustrates" to "illustrate". Change "similar comparison" to "similar comparisons". Change "With regions" to "White regions".

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 5323, 2014.