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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Trends of solar ultraviolet irradiance at Barrow, Alaska, and the effect of measurement uncertainties on trend detection" *by* G. Bernhard

Anonymous Referee #1

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The manuscript provides a thorough analysis of long term changes and associated uncertainty factors from solar spectra measured at Barrow. The data set is unique as it represents the northernmost location of high quality, high resolution spectral measurement, spanning one of the longest timeseries of global spectral data. The methodology developed for QA/QC, analysis of measurement uncertainty and uncertainties from gaps in measurement series, and the combination of RT modelling in order to correct for systematic measuremetn errors is valuable tools for the user community. The work provides a significant scientific contribution in analysing long term changes.

General comments: The work is presented in a well structured way, with a number of

relevant references. However, some parts, e.g. the explanation of the four correction methods (which did not give any significant difference compared with CIs), periods that have been omitted due to anomalous data, presentation of results from figures and tables etc., appear to me too detailed and elaborate in the descriptions. I would recommend tightening up the text.

Specific comments:

Page 6, line 19-22: The method how UVI is calculated may be replaced by a reference to WHO/Intersun http://www.unep.org/pdf/Solar_Index_Guide.pdf

Page 8, equation 3: How is (db/dE(yi)) defined? The term is common in equations for u(b), uu(b) and ug(b).

Page 8, lines 10-14: The trend ananlysis is based on the assumption that the data set is not autocorrelated, referencing to the Durbin-Watson Test. However, looking at Figure 2 and Figure 4, the residuals appear to have cyclical components, most readily seen for the E345 June monthly means (two cycles, each 6 years period). With reference to the work of Weatherhead et al. 1998, autocorrelation would expand the uncertainty and reduce the significance of trend estimates. This is missing in the discussion.

Page 11, line 11-12. The q-ratios for correcting systematic errors in the calibration scales are based on selecting clear sky measurements, with a reference to Bernhard et al. 2008. Looking into this reference, page 4802, the requirement for flagging clear sky cases is that the temporal variability between 3 neighboring ratios E600/F600 are differing less than 1%. However, it seems this would also apply for stable overcast conditions. So how was the selection in order to avoid mixing overcast conditions with clear sky conditions made, which otherwise would have biased the q-ratios?

Page 11, line 5 : The data set was based on daily noon spectra. How many days were used, compared with the theoretical number of days for SZA <80 degree? And how many days were excluded due to improper quality and gaps, respectively? And was

the excluded days evenly distributed for each year? The information could be given in a figure, or Table 1 expanded.

Page 11, text referencing to the q-ratios in Figure 1: The differences between the q-ratios determined by methods 2-4 are small compared with no use of q-ratios (method 1), at least relative to the large CIs. To me, the text may be shortened, focusing on the finding that elaborate determinations of q-ratios did not significantly differ from the no-correction case.

Page 11-13: The description of q-ratios and influence from instrumental problems etc. appears too detailed. Information may be considered moved to an appendix, or reformulated in a more general way.

Page 14: The gap correction is based on the shift in monthly mean that would result if a number of days are missing, assuming the missing days follow the seasonal mean. However, the real situation may be differ from the seasonal mean and induce a bias not accounted for. E.g. for the case of early or late days in a month missing, and the weather situation being significantly different from the seasonal daily mean. Instead of assuming a rectangular probability distribution, I would suggest modelling the probability distribution with a bootstrap technique, calculating the distribution of monthly means for 1,2, 3 etc missing days arbitrarily chosen, using a data set with no gaps (which could be a pyranometer or multiband filterradiometer data set). This could be further discussed on page 17, lines 22-25 where the gap corrections apparently are overestimated for February (us(T) from eq. 7 being negative).

Page 16 lines 14-22: The text may be shortened, see the general comment above.

Page 17, line 5-6: 'Trends estimated with Method 2 are 1.7% larger on average'. I can't see this from the figure. To me there seems to be no significant difference within the groups of 4 bars. Page 28, Table 1: Why is n for ozone trend estimates different from n for E345 and UVI trend estimates (e.g. May, n is 19 and 17, and October n is 17 and 19)?

Page 33, Figure 3: Explanation of the four correction methods are missing. I suggest adding a line for short reference, e.g. Method 1 is without scale adjustements, whereas Methods 2-4 apply scale factors determined to fit clear sky measurements to model calculations, using annual, summerly and monthly mean ratios, respectively.

Page 33 (Figure 3) and page 35 (Figure 5): The figures are fairly similar. Consider if the two figures could be combined into one.

Minor comments:

Page 9 – 95.45% vs 95%. I suggest to use 95% throughout the text for better readability, since, at least for a user like me it has no practical implication. Rounded to integer values, the numbers are the same.

Page 9 – line 22, misprint "form" should be from.

Page 15, line 6, bracket] is missing.

Page 16, line 1: The trend uncertainty ranges between 3% (March and April): Replace March with February.

Page 16, line 19: '.. but trends determined by Method 2 are 1.7% larger on average': From figure 3 it looks like Method 3 (Cannual) is larger.

Page 18, line 6: replace '.. scattered downward by either air molecules (clear sky case) or cloud..' with '.. by air molecules (clear sky case) and cloud..'.

Page 18, line 14, add ' and overcast conditions' after 80%.

Page 28, Table 1: The 'n' factor is not explained. Add text n = number of years.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 26617, 2011.