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Atmospheric Chemistry and Physics Discussions

Interactive comment on "60 years of UK visibility measurements: impact of meteorology and atmospheric pollutants on visibility" *by* Ajit Singh et al.

Anonymous Referee #2

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General comments The study explores UK horizontal visibility, using observations from a number of stations of different characteristics. Actually the study extends the work by Doyle & Dorling (2002) who reported UK visibility improvement from 1950-1997 due to antipollution measures. The extension alone is not so useful as regards estimation of long term trends, since a very strong step change occurred after changes in observational methods. However, authors perform detailed analyses regarding meteorological influence, the role of RH, and develop a light extinction model which make the study interesting. Many points however need to be reconsidered, corrected and clarified.

Major comments The study updates the work by Doyle & Dorling 2002, who study UK visibility from 1950-1997. The same stations and the same visibility hour (12Z) have

been used in both studies. So, one would expect to see exactly the same values of visibility for the common period which is not true. In contrast, the authors estimate lower values almost in all stations. Is it because of different filters? Or averaging procedure? Following Sloane (1982), Doyle & Dorling exclude visibility values when RH >90% . The authors use another filter (99%) which means that they use more high RH days . I can suppose that this is the reason for the observed differences in the two studies. Some clarifications are required however. How was determined the filter 99%? The authors relate visibility with meteorology, however, precipitation is a fundamental parameter which is missing from this analysis. Precipitation increases RH, but also is related to scavenging of particles in the atmosphere, possibly improving visibility. Precipitation frequency than amount is more important indicator and consequent cleanup of the atmosphere is more important in these cases. So I am wondering if any relevant data are available from nearby stations. Averaging procedure of visibility is not mentioned. Which code/protocol has been used for human visibility observations? Since uncertainties are much higher in high visibility ranges (as you also mention in Page 5, line 5), visibility follows a rather geometric distribution. Did you use simple mean or a geometric mean for visibility? The method of measuring visibility changed from human observations to electronic visiometers. This was done at different times for each station. The impact of this change is dramatic as easily seen in Fig. 2. I would say that it is impossible under these circumstances to draw a conclusion for the long term trend of visibility. Are the two methods compared at any station? Is there any parallel period with human + electronic observations? This is a common procedure to evaluate and compare the two methods. If such parallel measurements are available, then authors need to make proper comparisons/calibration and provide a better transition from the first to the second period. The authors use wind roses from surface wind data and perform an extended analysis on visibility variation with respect to wind speed/direction. This is related to air mass origin and associated air pollution or RH sources. Although they perform a reasonable analysis, I think that additional information is required regarding local or long transport pollution from distant sources.

Frequently, surface winds reflect very local phenomena (breezes, circulations due to UHI effect, chanelling phenomena etc). Although authors refer to long range transport of air pollution from central Europe (for eastern sector) there is no information on long range transport (trajectories, frequencies etc). European emissions increased after the 1950s and decreased after the 1980s. Is UK unaffected from these changes? Is it all local pollution? A discussion on this is necessary. In general, information on local pollution sources and reasons for improving per sector is not adequate. Relative to this, in page 14, line 9, the authors seem to speculate.

How do you define good or poor visibility? In Fig 2 authors present long-term trends of the annual/seasonal visibility averages and find an overall positive trend in most stations. However, this cannot provide information on the relative improvement in different visibility ranges. Is the improvement higher in low, average or higher visibilities? I would like to see a frequency distribution of different visibility ranges for different sub-periods, which would be much more informative on visibility improvement.

In Fig. 5 the authors provide long term records of annual visibility and annual averages of different meteorological parameters. A comparison is attempted between variation of visibility and meteorological variables. I have some questions here. Annual visibility was calculated using daily measurements at 12Z. How other variables were averaged? Do averages refer to 24-hour periods? From the figure it comes out (visually) that visibility is anticorrelated (in low frequencies) with RH. However, RH changes do not refer to 12Z (I think) and also these changes are small enough (in the range of very few units of %, for instance from 75% to 78% or something like that). In the analysis of Fig. 4 such changes fall into the same RH category. What mean annual WD refers to? Is it prevailing wind direction? How was calculated? In the same figure, wind speed variability does not seem to be positively correlated (as expected) with visibility. Decreasing trends of wind speed in some stations are accompanied with increasing trends in visibility. Does it mean that wind speed is less influential? Perhaps a running correlation coefficient between visibility and other meteorological variables would be

more informative on the influence of such variables and possible temporal changes of this influence. The relationship with air temperature is tentative. At urban area in particular, air temperature increase could refer to nocturnal increases due to urban heat island effect (but visibility refers to noon). Some clarifications are required.

Model: The authors present a model for light extinction, making a number of assumptions and simplifications. Which could be the cost (uncertainty arising from these assumptions)? Despite assumptions, the model has an absolutely perfect performance with observations. Any explanation? What about the other stations?

Page 4, line 5: The aim of the study is implemented? what do you means UK projections of meteorology (climate change? it is not clear). And what do you mean with pollution projections? Local or regional? What kind of projections? For which pollutants?

Minor comments Abstract, line 1: This is not always true, add meteorology factor. Abstract, Line 2. It can be removed from abstract Page 2, line 16: rearrange using chronological order In the analysis of week day variations of visibility , the information provided in Page 12, line 14 is confusing and I also think wrong (regarding the calculations). I do understand the meaning of this analysis. In Figures 3 (right side), it is better to use normalized values. For instance you can normalize values with the maximum visibility value for a direct estimation of % differences. Page 5, line 25: do you mean the sensor was not cleaned? How can you be sure that all other stations are cleaned properly?

Technical comments

Although English is in general good, some syntax errors exist in the paper. Missing comma in many cases make the text hard to understand. Figures quality needs to be improved. Use legends in Fig. 3 or use analogous (with variables) colors in the axis Fig3. Indicate in the legends what dashed lines represent (left side) and bars (right side).

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