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The bibliometrics of atmospheric environment

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A B S T R A C T

Bibliometric analysis is an important tool in the management of a journal. *SCOPUS* output is used to assess the increase in the quantity of material in *Atmospheric Environment* and stylistic changes in the way authors choose words and punctuation in titles and assemble their reference lists. Citation analysis is used to consider the *impact factor* of the journal, but perhaps more importantly the way in which it reflects the importance authors give to papers published in *Atmospheric Environment*. The *impact factor* of *Atmospheric Environment* (2.549 for 2007) from the *Journal Citation Reports* suggests it performs well within the atmospheric sciences, but it conceals the long term value authors place on papers appearing in the journal. Reference lists show that a fifth come through citing papers more than a decade old.

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1. Introduction

The management of a scientific journal requires regular review of its position within scholarly literature. This is important in planning changes to its scope, advising referees and authors, inviting reviews and developing office procedures. Microfiched archive records (Brimblecombe and Sturges, 2008) reveal that bibliometric techniques were used by the mid 1980s and have been a consistent part of office procedure for more than a decade (Legouais et al., 2001). Although our bibliometric analysis aims to assist journal management, some of its output is likely to be of interest to authors and readers, and this aspect of our work is reported in the present paper.

2. Bibliometrics

Bibliometrics is a research methodology that the widening availability of electronic copy has increasingly created a feasible tool for understanding academic literature. The technique is found most often in library and information science, where it is seen as a tool for planning, evaluation and analysis. It is frequently able to provide quantitative information through citation or content analysis.

Potential problems with bibliometric analysis are much discussed (Hecht et al., 1998; Seglen, 1997) and often relate, particularly in citation counts to inadequate coverage (e.g. a bias towards English and a limited range of source types), issues of long citation half life, differences between disciplines and the non-linear distributions of citation frequency. While acknowledging these problems, we will use the technique because much of the analysis here is internal to the journal. This means that some of these objections are of reduced concern. Nevertheless these can still present problems, so they are alluded to within the text.

The analysis here uses output from *SCOPUS* although *Web of Science*, and to a lesser extent *Google Scholar*, provides some similar material. However, *SCOPUS* was convenient because of the easy output to an ASCII file that could subsequently be analysed. Here we adopted the programming language *awk*, which is quick to write and useful in analysing files of sequential data and incorporates regular expression operators that are useful in analysing textual fields. However, we need to recognise that such databases provide a snapshot and the data change frequently, but much of the analysis presented here took place in the late 2007–early 2008.

3. Volume

The journal has grown considerably from its origin in 1958 when its production was a difficult task and limited manuscripts were available on air pollution topics (Brimblecombe and Sturges, 2008). The journal has grown considerably since then as seen in Fig. 1, which illustrates a particularly rapid change from the late 1990s, the number of articles published in *Atmospheric Environment* has almost doubled over the last decade. Such rapid increases create problems in managing the journal, but also reflect the currency of its central theme of air pollution. At the same time, shifts in the field of atmospheric sciences, were also accompanied by a radical change in the nature of scientific publishing, particularly with the increased use of the Internet. These have necessitated new procedures within the editorial offices and

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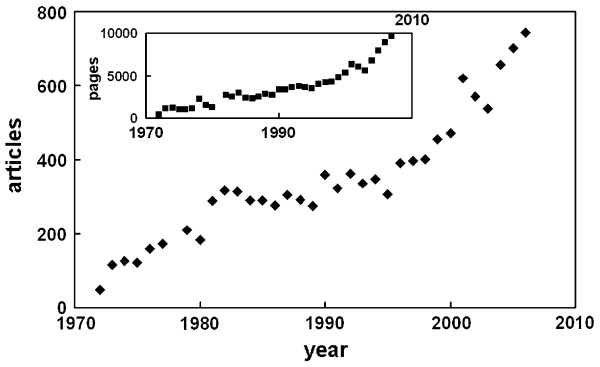

Fig. 1. Number of articles published each year in *Atmospheric Environment* with the total number of pages shown in the inset.

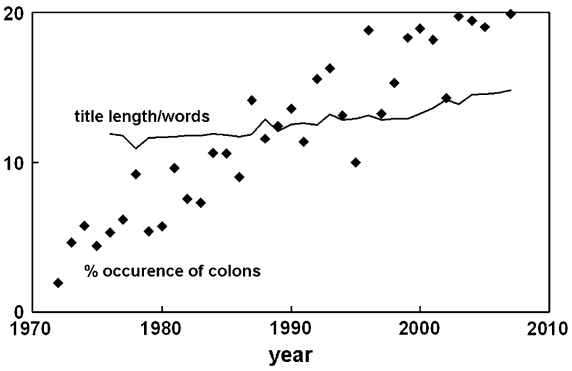

Fig. 3. The change in the number of words and colons in the title of papers published in *Atmospheric Environment*.

additional tools and staff to handle the processing of the increasing flow of manuscripts (Brimblecombe and Sturges, 2008).

More than 15,000 articles have appeared since the journal began and reflect the enormous effort of authors. The productivity of some authors (e.g. Carmichael, G.R., Derwent, R.G., Harrison, R.M., Hopke, P.K., Lindberg, S.E., Pandis, S.N., Puxbaum, H., Querol, X., Seinfeld, J.H., and Venkatram, A.) is remarkable in the very large numbers, at times close to a hundred, of important manuscripts they contribute. This does not mean the journal has only been used by a limited group active of authors. Most papers show multiple-authorship, with a relatively small fraction (about 2000) having just a single author. The number of authors contributing to individual manuscripts has risen gradually over time. The median number was two through the 1970s and 1980s, but from 1990–2001 it was three and since that time it has been four. This may indicate the growing importance of collaboration and the interdisciplinary nature of the atmospheric sciences. There has been a significant growth, perhaps not entirely welcomed by those who have to cite such works, in the number of papers with very long author lists. Before the late 1980s papers were not seen with more than ten authors, but since that time they can be found within excess of thirty authors, with some 5% of the papers having more than ten authors.

4. Style and content

The length of papers, concealed a little by changes in page size and typography (Fig. 2) increased relatively slowly from around eight to twelve. *Atmospheric Environment* encourages relatively short papers in its guide to authors and asks that manuscript are less than 6500 words, although extensions can be granted by the executive editors. There has been a parallel concern to keep the number of diagrams to a minimum, but the dominance of relatively simple software to generate diagrams has not always led to the highest quality output.

While there has been only a slow increase in the number of pages occupied by articles the increasing length of reference lists

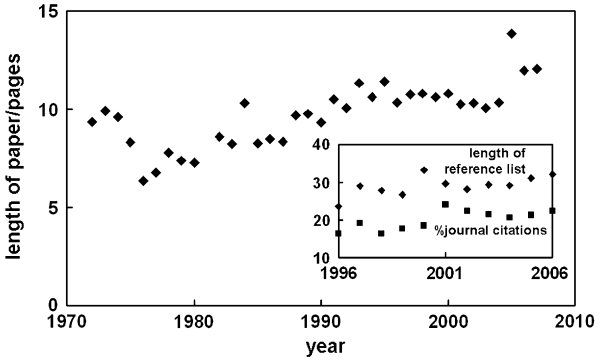

Fig. 2. The change in average page length of articles in *Atmospheric Environment*. The inset shows the length of reference lists and the percentage of papers cited in these lists that come from *Atmospheric Environment* (i.e. journal citations).

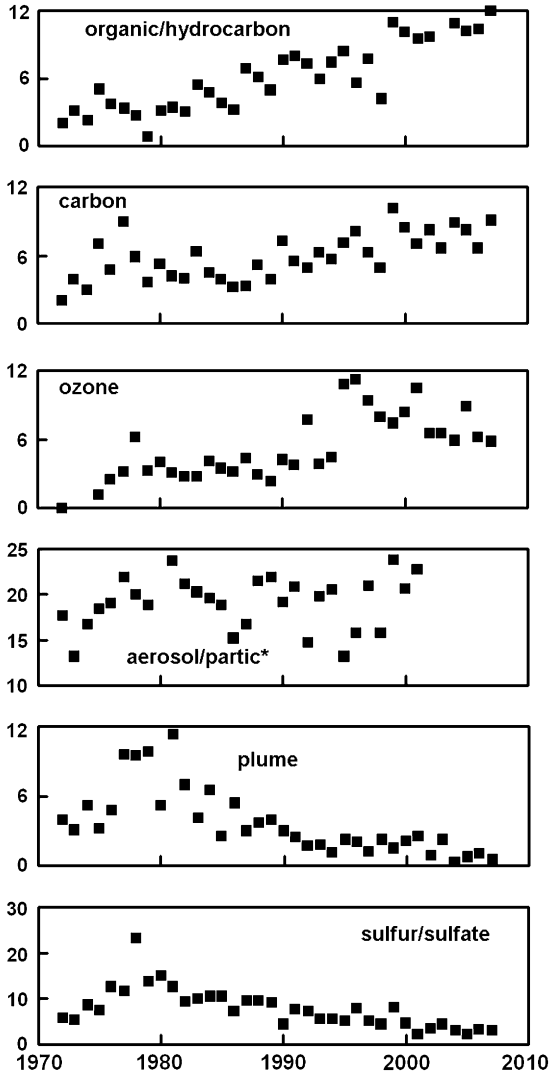

Fig. 4. The change in the relative frequency of word occurrence in the titles of papers published in *Atmospheric Environment*.

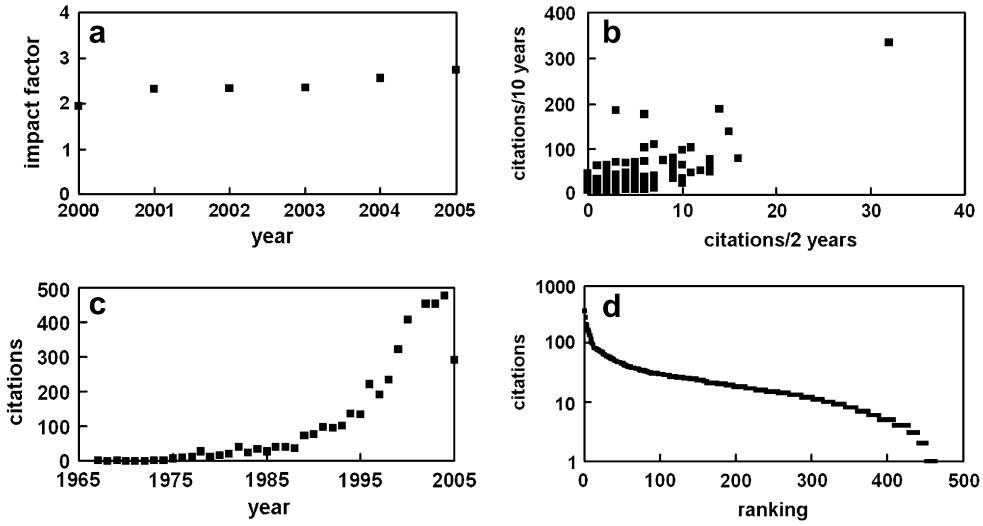

Fig. 5. (a) Change in *Atmospheric Environment's* impact factor (from *Journal Citation Reports*). (b) The number of citations to papers published in 1995 that accrued in the fist ten years as a function of the number in the first two years (c) The number of references to *Atmospheric Environment* papers of earlier publication dates made in the reference lists of the papers published in 2005. (d) The number of citations accruing to papers published in *Atmospheric Environment* in 2000 ranked by this number of citations.

has been more dramatic (Fig. 2 – inset). This stylistic change may simply be a function of the number of authors contributing to each paper or the complexity of the science. In the most recent decade it may also have been driven by the ease of availability of electronic databases. Many of the papers cited in the reference lists come from *Atmospheric Environment*. This is understandable, especially as a journal grows (i.e. initially the journal could not refer to itself), but there is often concern with high levels of journal self-citation. In extreme cases it can be in excess of 70%. This might suggest that a journal dominates a niche area, but it raises concerns that citations are being manipulated through editorial policy in an attempt to influence impact factors. However, self-citation in *Atmospheric Environment* is almost 30% (Fig. 2 – inset). This is not atypical in the sciences and probably reflects a healthy interest in the content of the journal by its authors.

An analysis of the reference lists also gives clues about other journals of importance to our authors. The *Journal of Geophysical Research* is not surprisingly the most important, but another American Geophysical Union journal, *Geophysical Research Letters* is also cited very frequently. The American Chemical Society journal, *Environmental Science and Technology* is especially relevant along with *Science* and *Nature* and two European journals: *Journal of Atmospheric Chemistry* and *Science of the Total Environment*. A newer journal, the European Geophysical Union's *Atmospheric Chemistry and Physics* will doubtless come to be cited frequently by *Atmospheric Environment's* authors. All told these key journals account for in excess of 40% of the citations made by articles published within *Atmospheric Environment*. The small number of journals that are responsible for most of the citations can be described in terms of Lotka's Law, a power function familiar to librarians and bibliometricians (e.g. Saam and Reiter, 1999).

Another change is seen in the length of the titles of articles. The increase shown by the line in Fig. 3 may again reflect an increasing complexity in the subject area. Perhaps a little more surprising is the increase in the use of punctuation in titles. The question mark and comma are found, but most notable is the changing occurrence of the colon (Fig. 3). In the early days of the journal very few titles contained colons and we find them especially associated with multipart papers where the colon separates a title and subtitle. However, the frequency has grown from $<2\%$ in the early 1970s to almost a quarter in 2007. This probably reflects a style change or a fashion rather than a distinct need, because if one examines titles there seems a preference among some contemporary authors to write in the form "Sulphur dioxide oxidation: an experimental study" rather than "An experimental study of sulphur dioxide oxidation".

A simple content analysis of the frequency of common words used in the titles reveals some distinct changes (see Fig. 4) The use of the words "plume" and "sulfate/sulfur" (including the "ph" spellings) have declined, although papers including sulfur in the title reached a maximum in 1978 at the height of scientific interest in acid rain and perhaps urban sulfur dioxide. Titles with aerosol or particulate in the title are relative constant across the period. In contrast, the journal has seen increases in "ozone" and "organic/hydrocarbon" over the decades. These changes do not come as a great surprise given the dominance of photochemical air pollution and the rising interest in organic substances in the atmosphere, most recently the secondary organic aerosol.

5. Citation and quality issues

Journal citation counts and *impact factor* now appear to worry everyone from authors to administrators. It sometimes appears that those who use impact factors make the assumption that an author's scientific reputation or the importance of their publications can be estimated on the basis of a journal impact factor (Hecht et al., 1998). This fails to recognise that the *impact factor* refers to a journal rather than an individual person or manuscript. Indeed Seglen (1997) has shown that highly and less cited authors maintain their differences across a wide range of journals and that citations appear to be largely independent of the journal in which articles are published.

Despite the flaws inherent in the *impact factor* it remain a key driver of the perception of journals, so there are understandable marketing pressures to enhance it (Hecht et al., 1998). As with many journals the *impact factor* of *Atmospheric Environment* has risen slowly over recent years as shown in Fig. 5a. It is important to realise that this does not give a sense of how individual papers might be cited. The *impact factor* is determined over a relative short period, counting citations received in 1 calendar year to the items published in the 2 preceding years. The citations for papers appearing in *Atmospheric Environment* continue to grow significantly well beyond this short duration. The inset Fig. 5b shows that there is a poor relationship between the citations

papers attract in their first two years compared to the decade, except for the most highly cited papers. Some papers are not cited at all in the first years, but subsequently attract interest; the delay can be lengthy in the case of articles that are ahead-of-their-time and such *sleeping beauties* can emerge to have considerable influence (Van Raan, 2004). The citations our authors make to publications from *Atmospheric Environment* indicate they are interested in older work as well as new. Fig. 5c shows that in 2005 the reference lists contained a substantial amount of cited materials from the journal that was more than a decade old. This older material formed 20% of *Atmospheric Environment* citations in the reference list and the decline indicates a citation half life of four to five years.

A further problem with relating impact factor to the quality of individual papers is that citations accrue to individual papers in an uneven way. Most citations are gained by a rather limited number of highly cited papers. The cumulative distribution of citations to papers in *Atmospheric Environment* is shown in Fig. 5d. We can see that almost a quarter of the citations are derived from the 20 most cited papers (i.e. less than 5% of the published papers) and this well-cited material accrues close to a hundred citations over seven years. This phenomenon is widely found and is another example of the Lotka-type relationships identified in bibliometric studies.

6. Conclusions

Atmospheric Environment has grown considerably since its parent journal began in 1958 and doubled its output over the most recent decade. The style of its titles, reference lists and diagrams have changed also, but bibliometric evidence would suggest that the articles published in *Atmospheric Environment* attract significant and long term interest from its own authors (journal self-citation ~ 30%) and scientists more generally (impact factor 2.549 for 2007 from *Journal Citation Reports* 2008).

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