Citations and impact of Dutch astronomy

P. Kamphuis and P.C. van der Kruit

February 5, 2010

1 Introduction

The aim of this study is to make a bibliometric comparison of the performance of research astronomers in the *Netherlands Research School for Astronomy* (NOVA) with astronomers elsewhere. This is complementary to similar studies as undertaken by the *Center for Science and Technology Studies* (CWTS), but has the specific feature of using the *NASA Astrophysics Data System* (ADS)[1] and possibilities offered by it. We will use various indices for bibliometric performance for a sample of Dutch (NOVA) astronomers to compare to samples of astronomers worldwide, from the United States in general and from American top-institutes.

Secondly, we will consider the results of the *'Nederlands Observatorium van Wetenschap en Technologie'* (NOWT), the Netherlands Observatory of Science and Technology, which regularly publishes a report *'Science and Technology Indicators'*[2]. We will try and reproduce those results using publication lists from institutions in the Netherlands, again using ADS, and examine and discuss the conclusions and indications from these reports.

2 NASA Abstract Database Service

We investigate here first the reliability of the NASA *Astrophysics Data System* (ADS) for citation analysis in order to address questions about bibliometric performance. Briefly, the ADS is a database for astronomical publications; it provides scanned versions of articles in astronomy and astrophysics in almost all relevant journals, going back to the earliest volumes (in relevant cases well into the nineteenth century), and of papers in proceedings and observatory annals. For papers published since journals started electronic subscriptions the user is linked to the journal sites. Also ADS provides for each article a list of papers that have been cited and of papers that cite that particular publication. In principle ADS is a complementary database to the *Science Citation Index* used for NOWT. Also it can easily order papers of a particular author or group of authors by the number of citations and normalised counts or normalised citations[3], etc. The ADS is a unique facility, available free of charge, made available and maintained by NASA with public funds.

There have been a few investigations into the use of ADS for bibliometric studies. Helmut Abt[4] concludes that the correspondence is good. His abstract reads: *"From a comparison of*

[1] The American and European websites of ADS are `http://adsabs.harvard.edu` and `http://esoads.eso.org`.

[2] This study is commissioned by the *Ministery of Education, Culture and Science* (OCW) and performed jointly by the *Center for Science and Technology Studies* (CWTS) of Leiden University and the *Maastricht Economic and social Research and training centre on Innovation and Technoly* (MERIT) of Maastricht University.

[3] Normalised counts/citations are numbers of publications/citations where each paper is counted with a weight that is the inverse of the number of authors.

[4] A Comparison of the citation counts in the Science Citation Index and the Nasa Astronomical Data System (2004); `http://www.garfield.library.upenn.edu/papers/helmutabtorgstratastronv6y2004.html`.

1000+ references to 20 papers in four fields of astronomy (solar, stellar, nebular, galaxy), we found that the citation counts in Science Citation Index (SCI) and Astronomical Data System (ADS) agree for 85% of the citations. ADS gives 15% more citation counts than SCI. SCI has more citations among physics and chemistry journals, while ADS includes more from conferences. Each one misses less than 1% of the citations." More specific to the determination of impact ratios, van der Kruit[5] found that studies based on ADS reproduce the results of studies by the CWTS very well and ADS reliably provides information to perform bibliometric studies.

3 The performance of NOVA astronomers

We use the ADS to investigate the distribution of various publication and citation scores of NOVA astronomers. To this end we used a sample comprising all staff members of the NOVA institutes in the 2003 – 2009 periodand three comparison samples. A list of NOVA researchers was provided by Wilfried Boland, executive director of NOVA; this is the same list as has been used by the CWTS in its recent bibliometric study of NOVA. We will designate this list as the 'NOVA-list'. We also used a list of 'key-researchers' of NOVA, which is of course a selection from the NOVA list itself.

The first random comparison sample has been taken from the membership directory of the International Astronomical Union (IAU)[6]. Only 'active members' were considered. After every selected member his/her membership number n was updated by adding 25. If no name was found the next number was taken, etc. This resulted in a list of order 400 astronomers. We then ignored names that had major difficulties in unique identification in the ADS, such as 'Li' among Chinese astronomers; this applied to about half the sample we had selected. The procedure was repeated for the American Astronomical Society (AAS; taking every 50th member)[7] to produce the second comparison sample. Here we only selected 'full members'. As a final sample a sub-selection of the AAS was constructed by considering only the faculty of the top 15 institutes of the US. These institutes follow from a study by A.L. Kinney[8]. Note that this selection uses citation scores and therefore this sample contains astronomers with high citation scores that often work in areas of astrophysics with high citation rates. The samples comprised 79 (NOVA), 177 (TopUS), 172 (AAS) and 193 (IAU) astronomers (the list of key-researchers has 26 persons).

From the ADS we found for each person the number of publications (in a refereed journal), first-author publications, normalised[9] publications and first-author papers, and to all these sets of publications a sorted list of the number of citations and normalised citations. We also noted the year of the first (refereed) publication. From this we calculated various properties such as (normalised) citations per paper, Hirsch-index[10], (normalised) citations and (normalised) publication per paper and per year (since that of the first publication).

It is well-known that the h-index of a person increases with time, and for comparison between individuals therefore sometimes the index is divided by the number of years that the person concerned has been active in research. This assumes (usually incorrectly) that one's h-index

[5] Citation analysis and the NASA Astrophysics Data System (2005), `http://www.astro.rug.nl/~vdkruit/jea3/homepage/ads.pdf`.

[6] Starting with www.iau.org/administration/membership/individual/186; membership numbers run from 186 to 9605.

[7] Starting at members.aas.org/directory/public_directory/member_details.cfm?ID=10000; AAS membership numbers run from 10,000 to 36,000.

[8] The institutes are listed in Appendix A.

[9] This normalisation is done by dividing the score for each paper by the number of authors. For example, a paper with five authors would contribute 0.2 to the normalised number of papers of each author. The same is done for normalised citations.

[10] J.E. Hirsch, Proc. Nat. Acad. Sci. 102(46), 16569 (2005); the value h of the h-index is defined such that the person involved is a (co-)author of h papers that have been cited more than h times.

	NOVA	TopUS	AAS	IAU	NOVA-kr
Number of people in sample	79	177	172	193	26
Number of papers	90	94	26	58	123
Number of first-author papers	21	22	8	19	23
Normalised number of papers	26	25	7	20	33
Number of normalised first-author papers	11	10	3	9	13
Number of citations	3325	4175	544	1042	4558
Number of first-author citation	795	971	112	256	1166
Number of normalised citations	704	929	86	271	1213
h-index	31	34	12	17	39
First-author h-index	13	14	4	8	14
Normalised h-index	14	16	5	9	16
First-author normalised h-index	9	10	3	6	10
Citations per paper	36	43	21	18	38
Citations per first-author paper	39	39	13	15	45
Normalised citations per normalised paper	33	35	17	14	37
Papers per year	3.9	3.3	1.6	1.9	5.6
Citations per year	131	141	34	34	229
Normalised papers per year	1.1	0.9	0.4	0.7	1.5
Normalised citations per year	34	33	6	10	57
First-author papers per year	0.9	0.9	0.5	0.6	1.2
First-author citations per year	40	33	8	9	59
Number of publishing years	25	30	18	30	22

Table 1: Medians of the various distributions of publication and citation scores for the samples of NOVA, topUS (15 top US institutions) tenured staff , AAS and IAU members and NOVA 'key-researchers. The distributions (except for NOVA-kr) are shown as histograms in Figures 1-21.

increases linearly with time. A more serious shortcoming is that it is not always calibrated between disciplines or (sub-)fields of scientific research, where very different publication and citation cultures may prevail. We will in this report use samples that give an idea of what a typical h-index is for an astronomical researcher. Another important effect is that of the number of authors on a paper. E.g. persons contributing to highly cited papers presenting a new instrument or survey all get the credit of an additional point on their h-index.[11] Therefore we also calculated h-indices using normalised citations. Furthermore, we also produced statistics using only papers on which the researchers involved are first author.

Figures 1–21 show representations of the performance of astronomers. Every figure shows in the bottom panels the histogram of astronomers of the TopUS, AAS and IAU samples. The second panel from the top shows the same property for the Dutch (NOVA) staff members and the top panel compares the distributions of all samples (NOVA – solid line, TopUS – dashed line, AAS – dashed-dotted line. IAU – dashed-three dotted line). We collect the median values of the various distributions in Table 1.

Before discussion the results we want to stress that in comparing the various samples it should be kept in mind that the selections are different for different samples. The NOVA and TopUS samples are active, tenured staff members and are selected in a comparable manner. But the AAS and IAU samples have been chosen at random from membership lists and will contain in addition postdocs and other non-tenured astronomers, retired astronomers and persons that are associated with astronomical research but to a large extent perform technical or other support functions. So, although the NOVA and TopUS samples are suitable for a direct comparison, the AAS and IAU samples can be expected on the grounds of their composition to score lower

[11] E.g., the Sloan Digital Sky Survey data release papers have well over a hundred authors and receive hundreds of citations. Such a paper will contribute one extra point to the h-index of all authors.

in bibliometric studies. They are useful, however, in finding out average (typical) values for astronomers of parameters such as the h-index.

It is easily seen from Figures 1 and 2 that the number of papers produced by NOVA astronomers is clearly higher than that of astronomers in the random samples and comparable to the astronomers in the top US institutions. However, it could be that that NOVA and TopUS astronomers have on average a different number of co-authors to their papers. This can be estimated from the ratio between the total and normalised number of papers. For NOVA, TopUS and AAS this is between 3.5 and 4, but for the IAU it is more like 2.9. In Figures 3 and 4 we see that the normalised number of papers for the IAU sample is more similar to NOVA and TopUS, but the AAS sample is not. IAU astronomers publish fewer papers, apparently with fewer co-authors than in the US and the Netherlands.

The AAS sample gives surprising results. This sample performs at a similar or lower level than that for IAU membership. The cause must be that there apparently are among the 'active' AAS members many astronomers that have not published very many papers. In fig. 2 we see that for the AAS astronomers about 45% have fewer than 20 refereed papers. This may seem surprising. However, a random check by hand, selecting only those members whose names start with 'Blo..', 'Men..' en 'Scha..' resulted in 14 out of 36 (39%) having 20 refereed papers or less and 9 (25%) more having between 21 and 40 papers. The number of papers per year is similar to that of the IAU sample. It is an effect of age (see Table 1): AAS astronomers have published on average for fewer years than the other samples. There appears no such difference between the NOVA and AAS samples; the NOVA astronomer on average publishes more papers per year. In fact, the average number of years that an astronomer has been publishing is 29 for NOVA and TopUS and 30 for IAU, but only 18 for the AAS sample (Figure 21). It does not have much to do with people publishing papers with many authors on them. The number of normalised papers per year is 0.9 (NOVA), 0.9 (TopUS), 0.4 (AAS) and 0.7 (IAU), so there appears to be less production in the AAS sample per astronomer. This was not found in a related older paper[12].

From Figures 5-7 we see that the number of citations and related parameters for NOVA astronomers is much higher than that of the IAU and AAS samples. One can also imagine that the distribution of citations per paper differs between the samples. We therefore show the the citations per paper in Figures 12-14 and the h-index (Figures 8-11). We also compare the citations received per year (Figures 15-20). All these figures show that the number of citations to papers by NOVA astronomers is significantly higher than that in the samples randomly selected randomly from the IAU and AAS membership lists. We noted already that this comparison is not entirely fair, as the NOVA-sample consists exclusively of tenured, active researchers.

The comparsion of NOVA researchers to the faculty of the top-15 institutes in the USA, however, is between two samples that are selected similarly and the two samples are directly suited to look for differences in bibliometric performance. It is obvious from Table 1 that the NOVA sample performs as good or almost as good as the TopUS astronomers. Note that the number of publishing years is less for the NOVA sample than for the TopUS astronomers, indicating a smaller average age of Dutch tenured staff. Indeed recently (to a large extent due to the NOVA funding from the Bonus-incentives Scheme) a large number of new hires have been made, often replacing retiring staff on so-called 'overlap' positions. The set of key-researchers does even better, but these are of course selected from the most senior astronomers (none of them has an h-index below 20) and this sample should not be compared directly with the TopUS staff.

[12] *"A comparison of astronomy in fifteen member countries of the Organisation for Economic Co-operation and Development"*, P.C. van der Kruit, Scientometrics 31, 155-172 (1994), and *" The astronomical community in the Netherlands"* Quart. J. R.A.S. 35, 409 (1995). Available at www.astro.rug.nl/∼vdkruit/jea3/homepage/oecd.pdf and www.rug.nl/∼vdkruit/jea3/homepage/qjras.pdf.

Summarising:
We find that the NOVA researchers perform much better among bibliometric measures than samples drawn from IAU or AAS membership lists. More suitable for a comparison is with the (tenured) staff of the top-15 US institutions and there the outcokme is that NOVA staff performs in these respects as good or almost as good as that of American top instiutes.

4 The published NOWT results

Every three years the level of Dutch research and development is compared to that of other OESO countries. This is done in the *Nederlands Observatorium van Wetenschap en Technologie* (NOWT), the *Netherlands Observatory of Science and Technology*, which regularly publishes a report *Science and Technology Indicators*. This study is commissioned by the *Ministery of Education, Culture and Science* (OCW) and performed jointly by the *Center for Science and Technology Studies* (CWTS) of Leiden University and the *Maastricht Economic and social Research and training centre on Innovation and Technoly* (MERIT) of Maastricht University.

The NOWT makes use of several indicators. One of the most important ones is the number of citations to papers in refereed journals normalised by the number of citations that the average articles from the same years receive. This parameter is called the *impact ratio* and it indicates whether an article receives more citations (impact ratio > 1) or less (impact ratio < 1) than the average paper worldwide in the same discipline and published in the same year. This is used as an important indication of the quality, visibility and impact of scientific disciplines and the years preceding the report. Usually the window of the years of publication of the papers and the citations is 3 or 4 years prior to that of the NOWT study.

Between the reports of 2005 and 2008 the impact ratio of Dutch astronomy as a whole dropped from 1.25[13] to 1.19 according to NOWT. In the following we will investigate the reasons of this drop and whether this conclusion is robust. This will be done by analysing the citation patterns of articles with authors from the institutes that make up the *Netherlands Research School for Astronomy* (NOVA), using as a tool the *NASA Astrophysics Data System* (ADS).

We will examine first the results published by NOWT. We note first that between the reports there is an important difference in the focus of the studies; the 2005 report paid special attention to the workforce in R&D, whereas the focus of 2008 was budgets. Within the area of bibliometric parameters there is also a difference in emphasis between subsequent NOWT reports.

When we look at the impact ratios, we see that in the 2008 NOWT this is presented as the *total impact ratio* of the universities[14] as well as separate scores for the five universities and of the institutes of ASTRON and SRON.[15] The contributions of ASTRON and SRON are not all purely astronomical, but it is not a priori clear how NOWT treats this. Another thing that is striking in the 2008 report is that NIKHEF (NWO/FOM institute for high energy physics), Rijnhuizen (NWO/FOM institute for plasma physics) and KNMI (meteorology) are considered to produce astronomical publications. This may very well be unjustified; in any case we usually do not regard the staff of these institutes as part of the Dutch astronomical community. Certainly they are not part of the NOVA federation of institutes. Where the Rijnhuizen and KNMI effects

[13] Or 1.27; NOWT gives different results in their tables 4.6 and 4.7 of the 2005 report

[14] This is the impact ratio of 1.19 mentioned as the result for astronomy 2008.

[15] The *Netherlands Foundation for Research in Astronomy* ASTRON and the *Foundation for Space Research in the Netherlands* SRON are funded by the *Netherlands Organisation for Scientific Research* (NWO) primarily as technological organisations; they have institutes in respectively Dwingeloo and Utrecht/Groningen primarily for the design and construction of scientific instruments and the operation of observing facilities. Although there definitely is also related astronomical research, the staff of these institutes are not part of NOVA, which is a federation of astronomical institutes at universities. On the other hand, most astronomers employed by ASTRON and SRON have additional parttime or unpaid affiliations with NOVA institutes.

year	impact	Univ.
2008	1.19	Y
2005	1.25	
2003	1.29	
2000	1.30	Y
1998	1.07	

Table 2: Impact ratios for Dutch astronomy from NOWT reports. The last column indicates whether or not the number applies solely for the institutes at the universities

are small and probably negligible (19 and 10 papers respectively), the NIKHEF contribution is considerable (118 articles or of order 10%).

In the 2005 report the only number reported is an impact ratio for Dutch astronomy as a whole, being either 1.25 (Table 4.6) or 1.27 (Table 4.7). This raises some uncertainties. It is for example not clear whether or not this includes publications from the ASTRON and SRON institutes[16]. And the question is if it also includes NIKHEF, Rijnhuizen and the KNMI?

Going back further in time to the 2003 report, we see that in that report the total impact ratio of Dutch astronomy is 1.29. This 2003 NOWT also provides the impact ratios of the different institutions separately. In this report the impact ratio of astronomy at the universities is equal to the total impact ratio (1.29). It is interesting to see that in 2003 the contributions from ASTRON and SRON are not split into different disciplines and therefore one would assume that they are considered to be completely astronomical.

Table 2 shows the results retrieved from the NOWT reports back to 1998. From this table we see that the impact ratio in 1998 is lower than the current one; however, only two years later the highest impact ratio of the last decade is reported. So there are fluctuations on very short timescales that are unlikely to reflect significant variations in productivity, quality or relevance of Dutch astronomal research. Also, in 2000 and 2008 a total number for the universities only (essentially the NOVA federation) is given, e.g. not including ASTRON, SRON and other possible non-academic institutes.

The astronomy group at the Radboud Universiteit Nijmegen (RU) is new and included in the NOWT report for the first time in 2008. If we look at the impact ratio cited in the report of 2008 we see that their impact according to the NOWT is low (impact ratio = 1.03) compared to the other universities. They produce a much lower quantity of articles which reduces their contribution to the total number. In fact the impact ratio for the universities excluding RU would be 1.20.

These results produced in the NOWT reports suggest that the difference in impact ratio between 2005 and 2008 is within the normal scatter caused by natural fluctuations as well as inconsist methods of calculating the actual number for the whole of Dutch astronomy; the same must hold for the impact ratios of individual institutes.

5 The NOWT studies repeated using ADS

ADS has a query form where articles can be selected according to author, set of authors, words in title or abstract, journal, year of publication, etc. It also has an unsupported query form to search by affiliation, which we will use below. Since this is an unsupported feature of the database services, it is important to establish the trustworthiness of this type of query. To investigate the reliability of ADS we have obtained all the articles of the Kapteyn Astronomical Institute as well as those of the Sterrewacht Leiden and compared them to the Annual reports

[16] It is true that separate results are given for ASTRON as an institute.

of these institutes for the years 1998, 2000, 2003, 2004, 2005 and 2006. From this we find that ADS can be used as a reliable source back to the year 2000. Before 2000 entries for the major journals *Astrophysical Journal* and *Astronomical Journal* do not list affiliation consistently in ADS.

From the comparison of the Kapteyn Institute it became clear that persons with a cross-affiliation are often identified with their main affiliation only. Therefore in ADS roughly 15% of articles listed in the Annual reports are not attributed to the Kapteyn Institute since their authors have an unpaid-appointment with Groningen University in addition to their main affiliation (often ASTRON or SRON) and are solely affiliated with their main institutions in ADS. This problem should also affect the ratios presented in the NOWT reports, but is irrelevant for the impact ratio of Dutch astronomy as a whole. Another mismatch between the lists retrieved from ADS and the Annual Reports is caused by authors who recently have been relocated to a different institute. These authors are often affiliated with their new institutes while much of the work for the article concerned was done at their previous location. Fortunately, this behaviour seems to produce a similar number of additional articles as missing ones when compared to the annual reports. Of course, the actual affiliation mentioned on the papers corresponds to that found in the ADS listing and not to the Annual Reports. Even though there are cases where the affiliation mentioned on the paper is incorrect, these cases seem to be rare and they would most likely not be corrected by CWTS.

We therefore conclude that back until the year 2000, the affiliation search of ADS can be used to construct correct publication lists of the Dutch institutes. This period (2000-2008) also covers the period of the so-called *Dieptestrategie*[17]

We have obtained from ADS lists of all refereed articles, which are affiliated to one of the Dutch institutes, plus the number of citations to that article received up to December 2008. The number of citations of a paper here is the number of references to that article in *all* bibliographic publications, refereed as well as the unrefereed. We have calculated the impact ratios of the institutes by normalising these counts by average citation rates of papers in the same years of publication and with the same citation window. We have done that in several ways.

First, we determined impact ratios by taking only those Dutch publications that appeared in one of the four major astronomical journals and normalised these with the average number of citations of all papers in these journals published in the same years. The journals are *Astrophysical Journal, Astronomical Journal, Monthly Notices of the Royal Astronomical Society* and *Astronomy and Astrophysics*. Secondly, we did the same excercise, but now included in addition the astronomical publications in *Science* and *Nature*. Even though the number of articles in these latter journals is low, their impact is generally extremely high. Thirdly, we include two smaller journals (namely *Astronomische Nachrichten* and *New Astronomy Reviews*) in order to see whether the addition of such journals severely affects the impact ratios. Fourthly, we calculated the citation rates for the total of all refereed Journals in ADS as listed in `http://adsabs.harvard.edu/abs_doc/refereed.html`. In this case of 'all journals' the numbers involved are so large that ADS can only handle one month at the time. Therefore it is very time-consuming to calculate the normalisation factor. We have solved this by taking only the first and last two months into consideration. This assumes that the number of citations per article declines linearly throughout the period considered.

To make a comparison to the NOWT results, we finally used a citation window equal to that of the publication years, as is done in the CWTS and NOWT studies. We used again all refereed journals. Such a citation window is uncomfortably small since a publication on the last day of the window would never obtain citations no matter what its eventual impact is. However, the

[17]The *'Bonus-incentives Scheme'*, in which NOVA has been recognized as a top-research school in 1998 and receives additional funding since then.

Method	2000-2002	2000-2003	2003-2005	2003-2006
4 Major journals	1.22(873)	1.21(1193)	1.27(970)	1.27(1399)
6 Major journals	1.23(889)	1.24(1219)	1.31(1182)	1.31(1428)
8 Journals	1.27(893)	1.27(1238)	1.31(1024)	1.31(1490)
All refereed journals	1.87(986)	1.89(1376)	2.00(1182)	2.00(1721)
Citation window	1.81(986)	1.78(1376)	1.93(1182)	1.87(1721)
All NL	1.74(1285)	1.71(1830)	1.86(1578)	1.80(2261)
NOWT		1.27(1807)		1.19(1311/1407*))

Table 3: Impact ratios (Number of publications) for the different methods described in the text for the periods 2000-2002, 2000-2003, 2003-2005, 2003-2006 (always last year inclusive). In the top part, the impact ratios are the summed results of the Dutch universities together and the citation window extends to (and including) 2008. In the bottom part the publication and citation windows are the same. The first row is for the universities together and the second one all Dutch publications. The NOWT impact ratios in the bottom line are for all Dutch publications for 2000-2003 and for the universities only for 2003-2006.
*)The publication output is given as a percentage of the total output in table 4.6 of the 2008 NOWT report. The individual results of the universities amount to a higher total than the percentage of total output given in this table.

normalisation should be affected in the same way and thus differences should be small as long as the sample is large. In ADS such a window must be set by hand.

We determined all these results for a two 3-year periods (2000-2002 and 2003-2005) as well as two 4-year periods (2000-2003 and 2003-2006) to see whether such changes in the time window are of any influence on the impact ratios.

Detailed results as obtained from the ADS are presented in Tables 6-9 at the end of the report. These tables present the impact ratios for all institutes as well as the overall results for the universities and for all astronomical institutes. Table 6 shows the results as obtained from the NOWT reports and Tables 5-9 the results as obtained from ADS.

The impact ratios and total numbers of publications found using the various normalisations described above are collected in Table 3. It shows that, according to the data obtained with ADS, the impact of the Dutch articles is *increasing* instead of decreasing. This trend is seen in all the different methods that were used to process the ADS data. This is different from the NOWT results and we will try to find out why this is so.

First note that for the period 2003-2006 the number of publications that NOWT uses is already comparable to those in the four major journals. In total ADS has found many more publications from authors at the Dutch universities (1721) than NOWT has for all of Dutch astronomy (1311 or 1407). The situation is is different for the period 2000-2003, where NOWT and ADS find comparable numbers (1807 versus 1830). In any case, the results for 2003-2006 in the NOWT is derived from fewer publications than in reality have been published by all Dutch astronomers. Note that inclusion of the non-academic institutes in the sample would only have an effect if their workers would pre-dominantly publish outside the four major journals. However, this is not the case, which can be seen by comparing the number of publications for ASTRON and SRON in Tables 5 and 8. This shows that also these institutes publish mostly in the four major journals.

Another remarkable feature in Table 3 is the high impact ratios obtained when considering all refereed journals in ADS. This is purely caused by the fact that the bulk of the Dutch astronomical publications are in the major journals, in papers which receive many more citations than publications in other journals. Since the Dutch astronomical publications mostly appear in the major journals the average number of citations per article does not change much when one includes less important journals, while the average number of citations per article of the field is severely lowered by the inclusion of smaller journals. The CWTS solves this in their studies by also calculating the impact ratio with respect to the actual journal citation rates rather than that of the field. This could be done in ADS also, but is less straightforwared to implement.

When we consider the number of publications of NIKHEF we find a large difference between NOWT and the number of articles found in ADS. The 2008 NOWT states 118 articles whereas ADS produces 11 articles for all refereed journals. This is caused by the fact that articles in the journal *Physical Review D* are always considered to be astrophysical by the ISI *Web of Knowledge* (WoK) whereas ADS splits articles in this journal into astronomy articles and physics articles. Interestingly the WoK considers all these articles also to be physics articles. A quick glance at the articles in question shows that the majority of these articles are related to the decay or branching of elementary particles. It is questionable whether such articles should be considered astrophysical.

ADS finds more publications (in 2003-2006) than NOWT. We also found that comparing to annual reports even ADS is still missing publications from the university institutes due to double affiliations. This should not be a problem when all Dutch insttiutes are considered since in general such publications then would be found. Still, there appears a clear underrepresentation of papers in refereed journals in the NOWT data. At the same time all impact scores are higher when determined with the use of ADS. We believe that the ADS results (both the values of the impact ratios themselves as the trend with time) are robust and a better determination of the actual situation than the NOWT results.

It is also interesting to see that the choice of citations window does not affect the trend observed in the impact ratio. However, a citation window that coincides with the publication window does significantly lower the impact ratio, as would be expected.

When comparing the number of citations found per article, we find that articles in ADS consistently gain more citations with respect to the same articles in the WoK. This is caused by the fact that the WoK does not count citations to the article when the reference is made with a pre-print identifier. In a society where the use of pre-print archives becomes more and more common, one can expect this lack of citations in the WoK to become increasingly important. Also this effect is most likely more pronounced in the NOWT reports because of the short citation windows.

Summarizing:

From a citation analysis through the use of ADS we conclude that the impact ratio of Dutch astronomical publications is actually rising. This trend seems to be firm over several methods of calculating the impact ratio and is opposite to what is reported in the NOWT reports. This difference is most likely caused by a better separation of astronomy and physics in ADS than in the WoK. ADS probably finds more citations in conference proceedings, while the inclusion of citations to articles with their pre-print identifier could also help explain the difference (especially since the citation windows in the reports are short). Differences in the actual selection process between the different NOWT reports seem to be present and contributing to the differences between ADS and the NOWT report.

6 Figures and tables

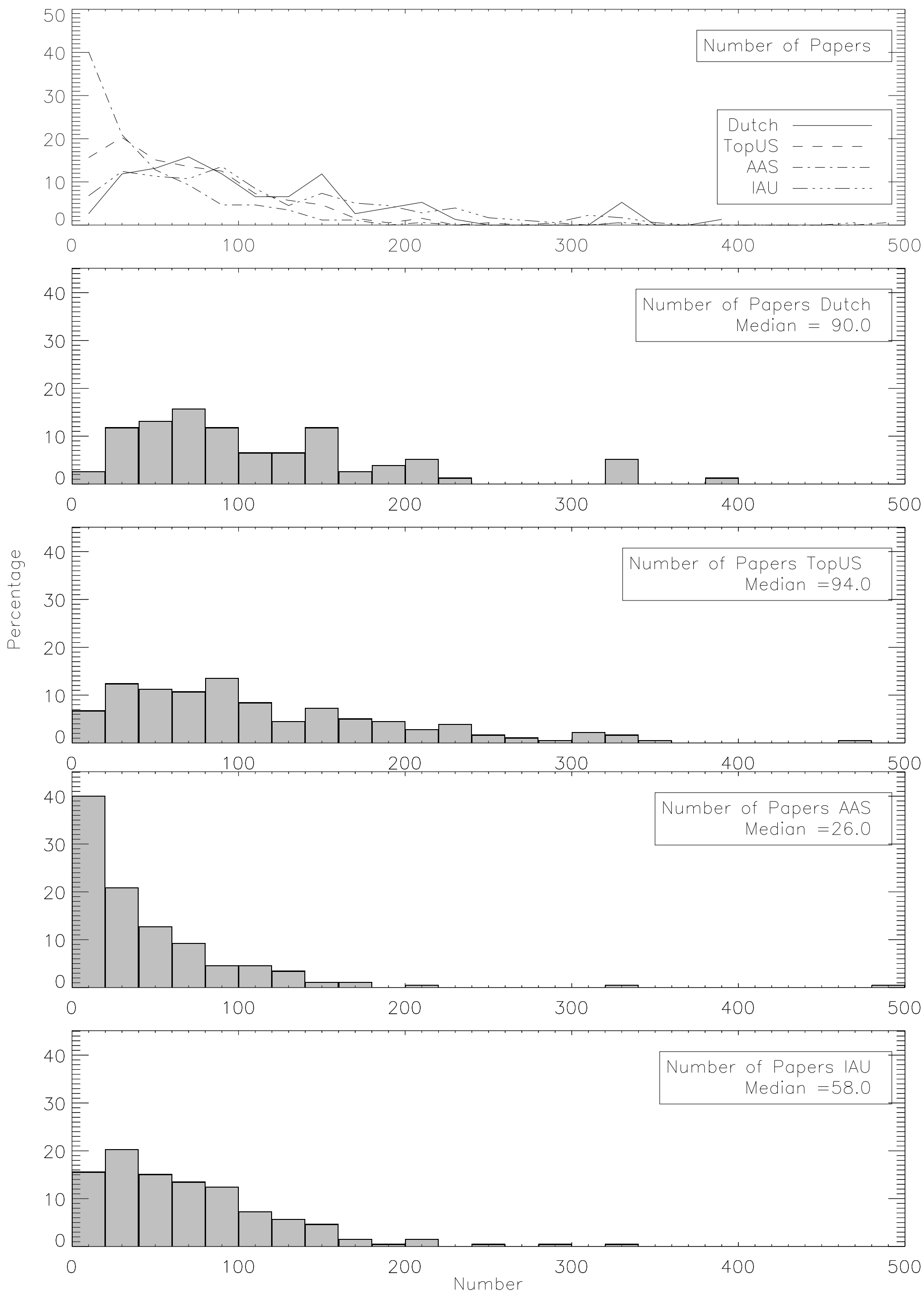

Figure 1: Histograms and a plot of the percentage of authors (y-axis) that has a certain number of papers (x-axis). From top to bottom: (1) The Dutch (solid line) ,the TopUS (dashed line), random AAS (dot-dashed line) and random IAU (three-dotted-dashed line) samples. (2) Histogram of the distribution of the Dutch sample. (2) Histogram of the distribution of the TopUS sample. (3) Histogram of the distribution of the AAS sample. (4) Histogram of the distribution of the IAU sample.

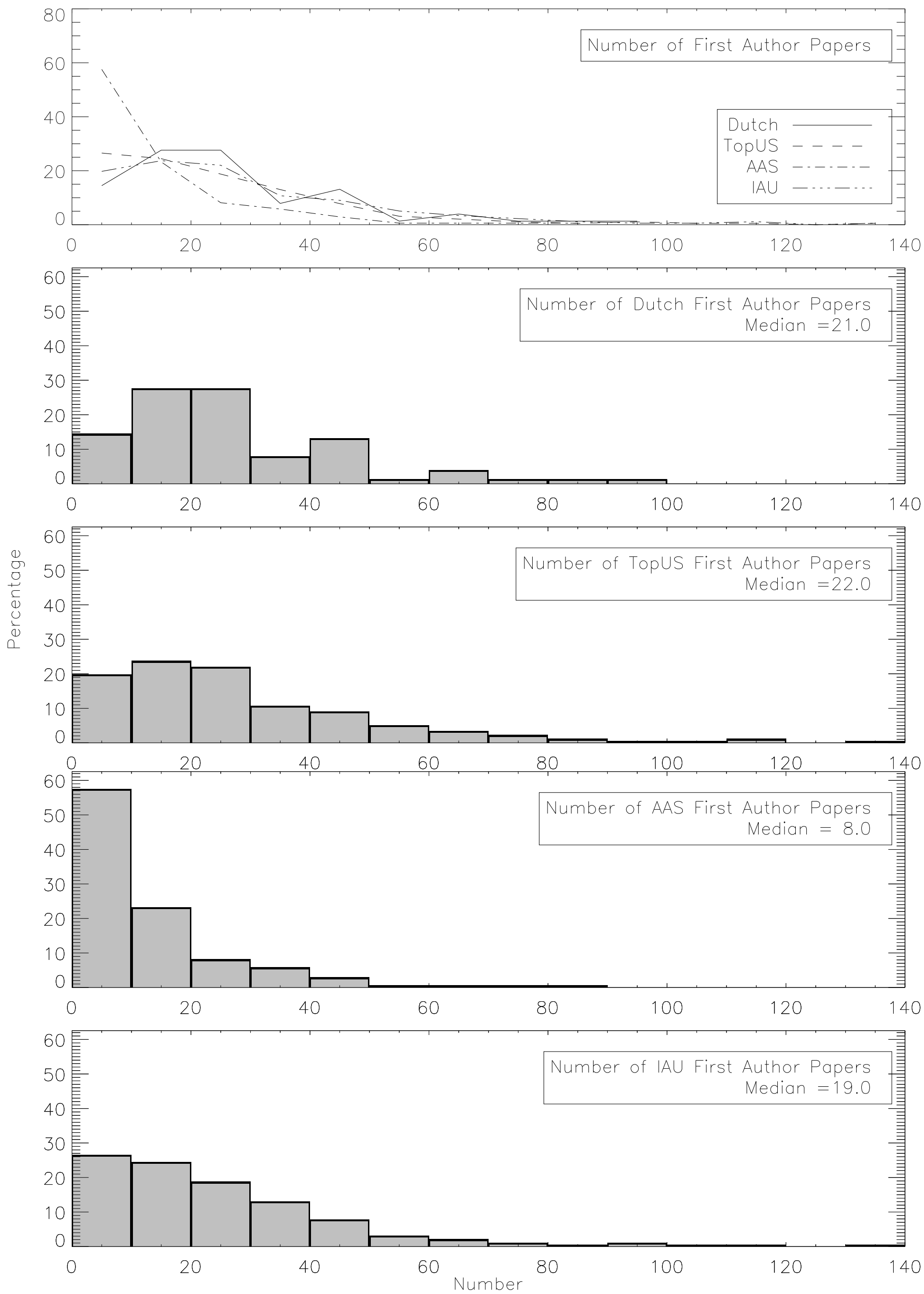

Figure 2: As Figure 1 but now only first author papers are considered.

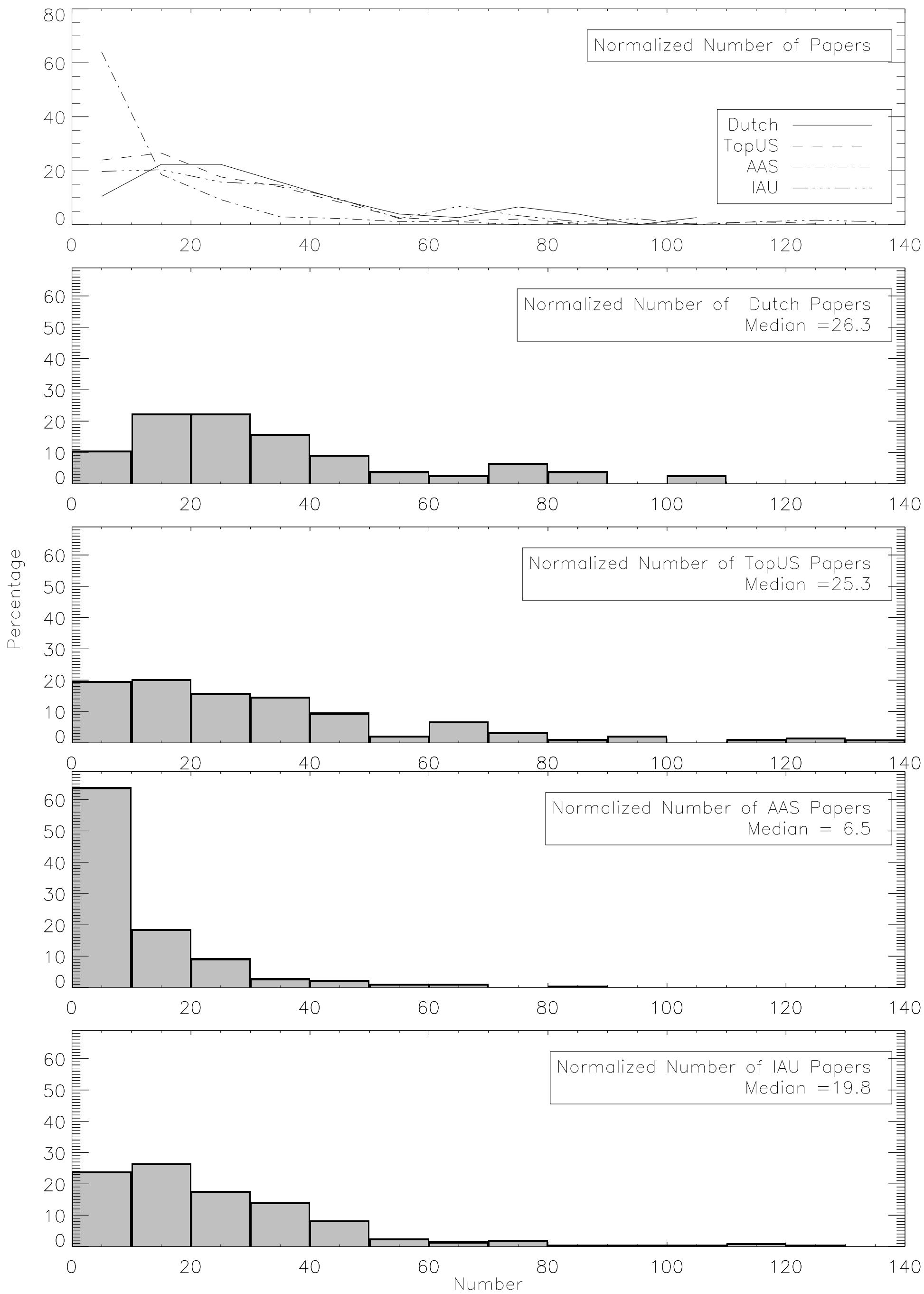

Figure 3: As Figure 1 but now the papers are normalised to the number of authors.

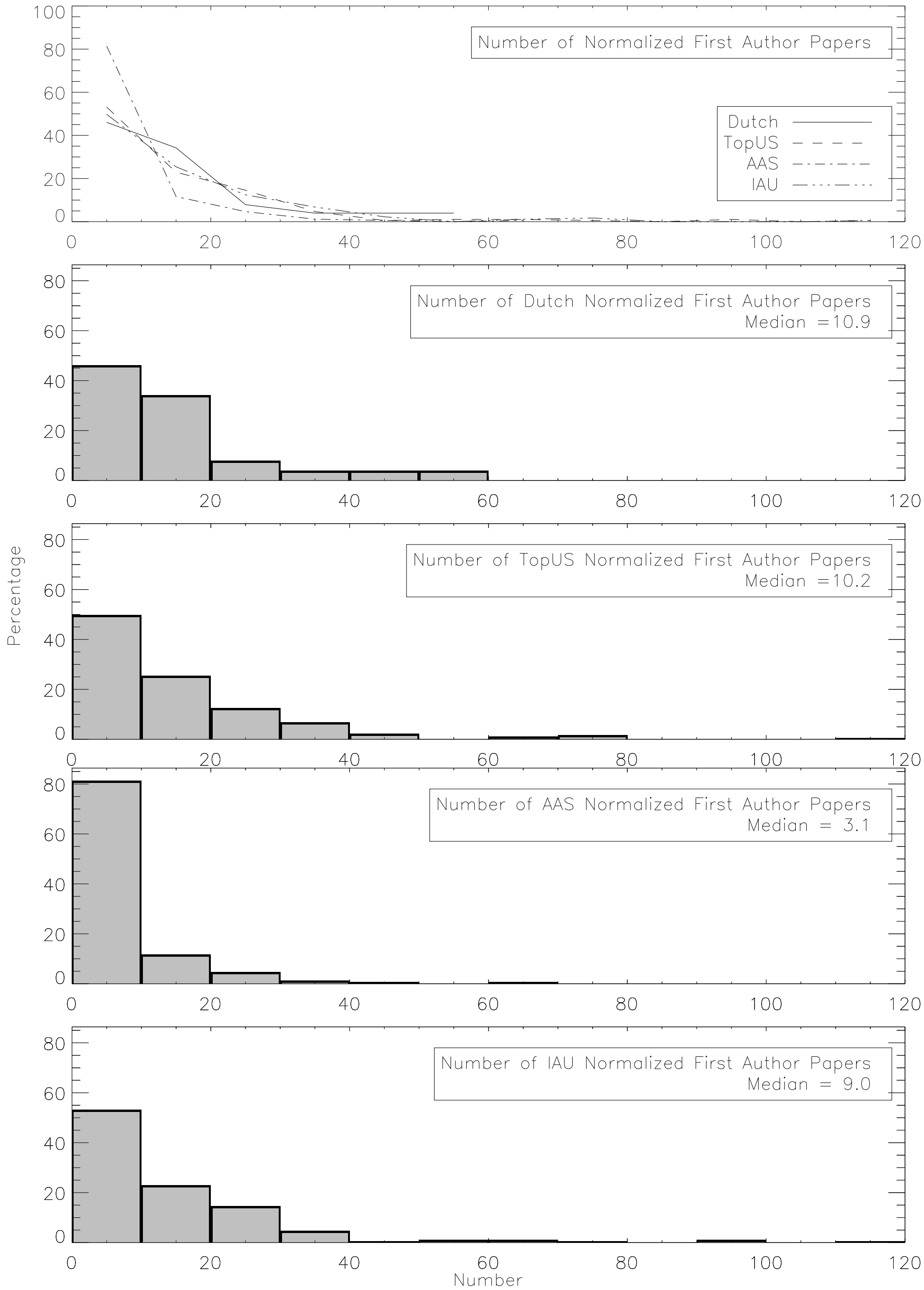

Figure 4: As Figure 2 but now the papers are normalised to the number of authors.

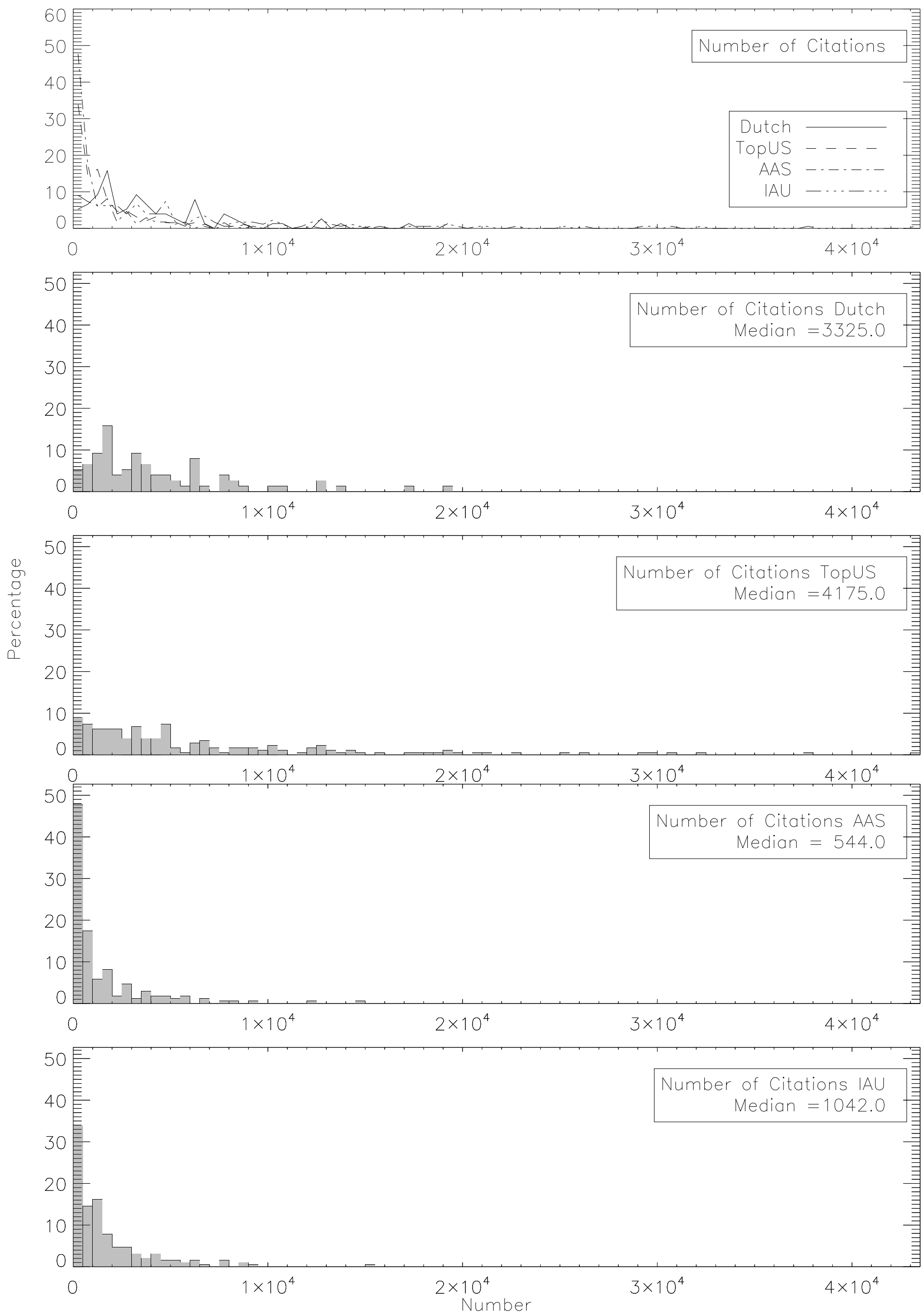

Figure 5: As Figure 1 but now for the citations received.

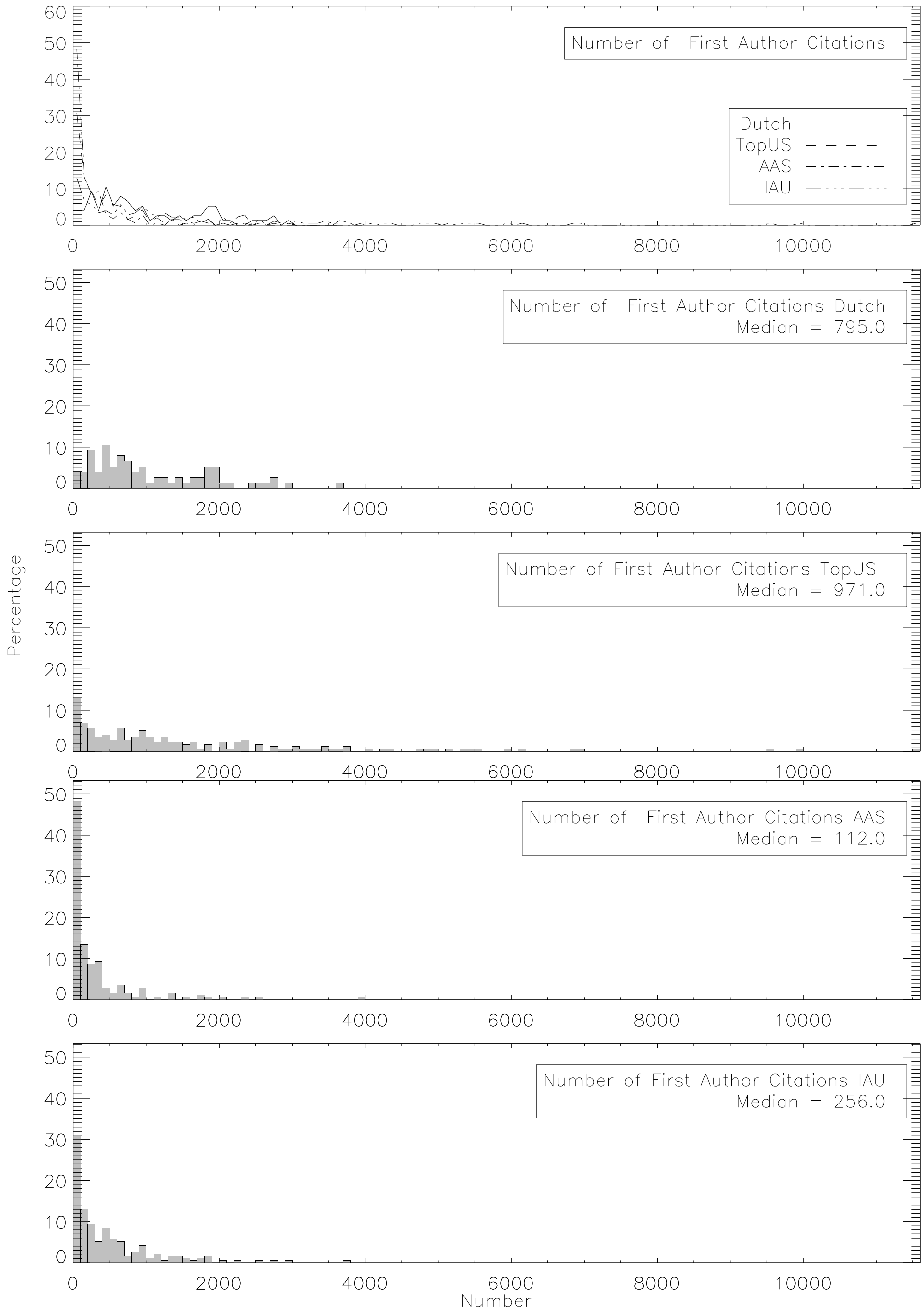

Figure 6: As Figure 5 but now only first author papers are considered.

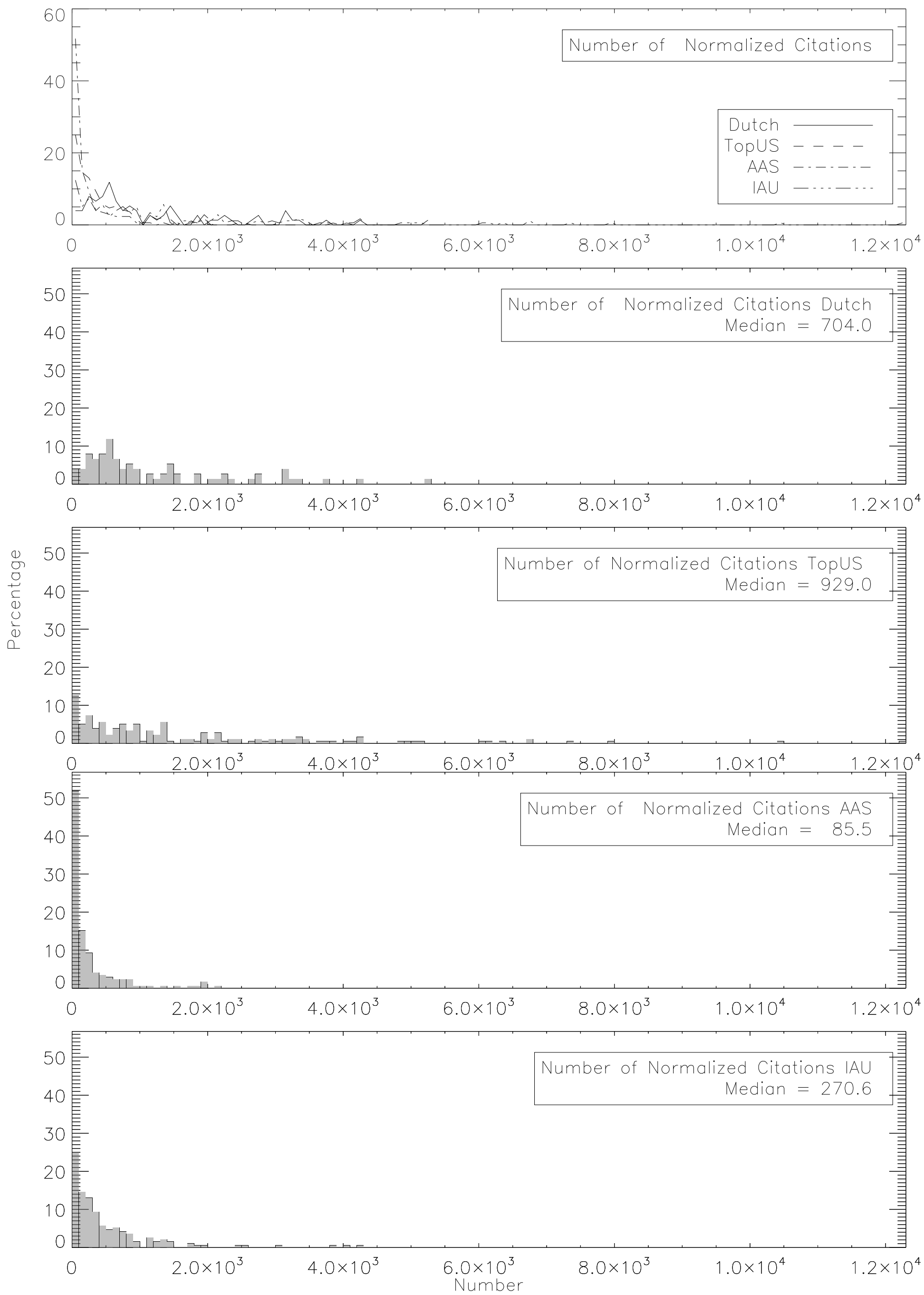

Figure 7: As Figure 5 but now the citations are normalised to the number of authors.

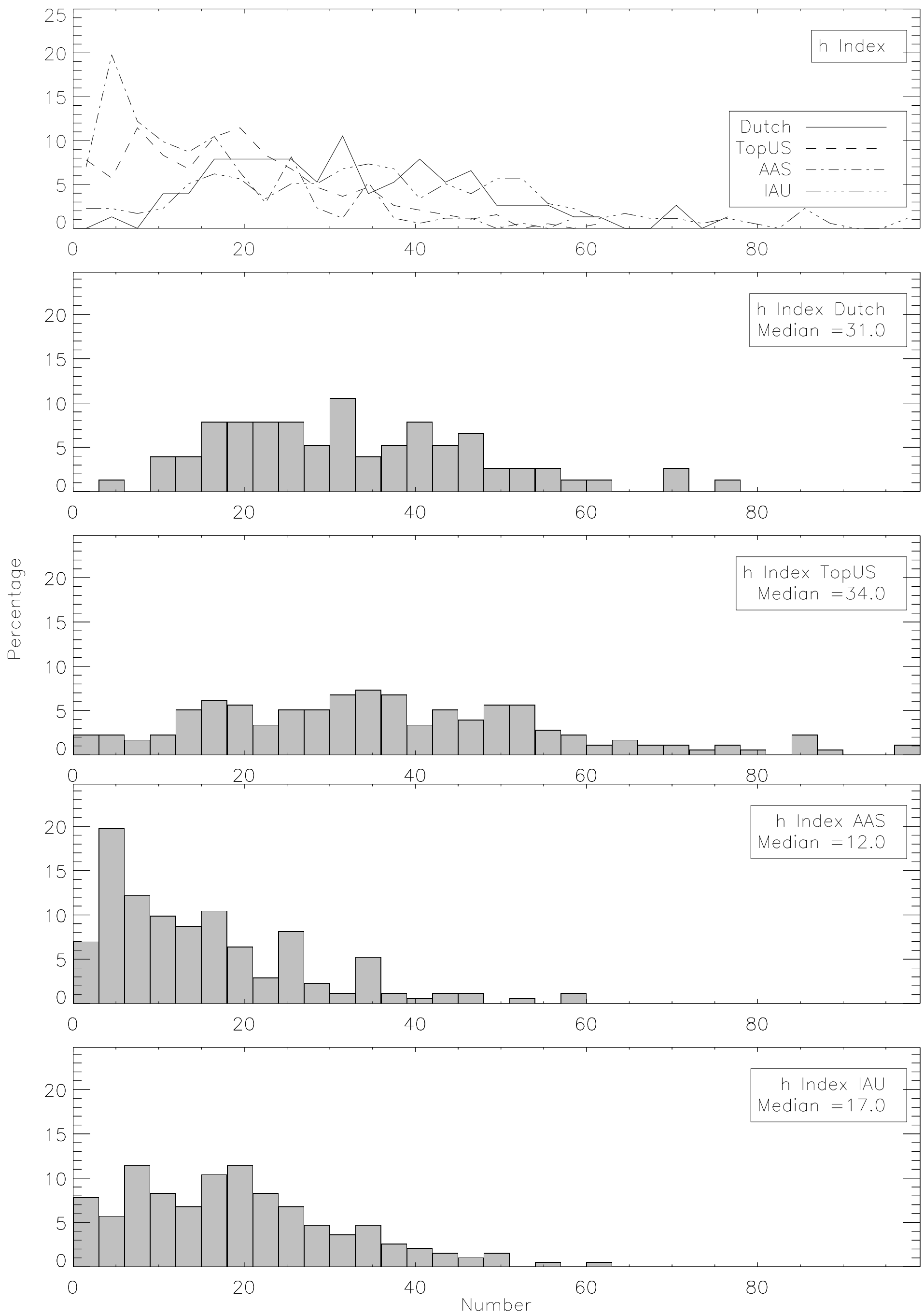

Figure 8: As Figure 1 but now for the h-index.

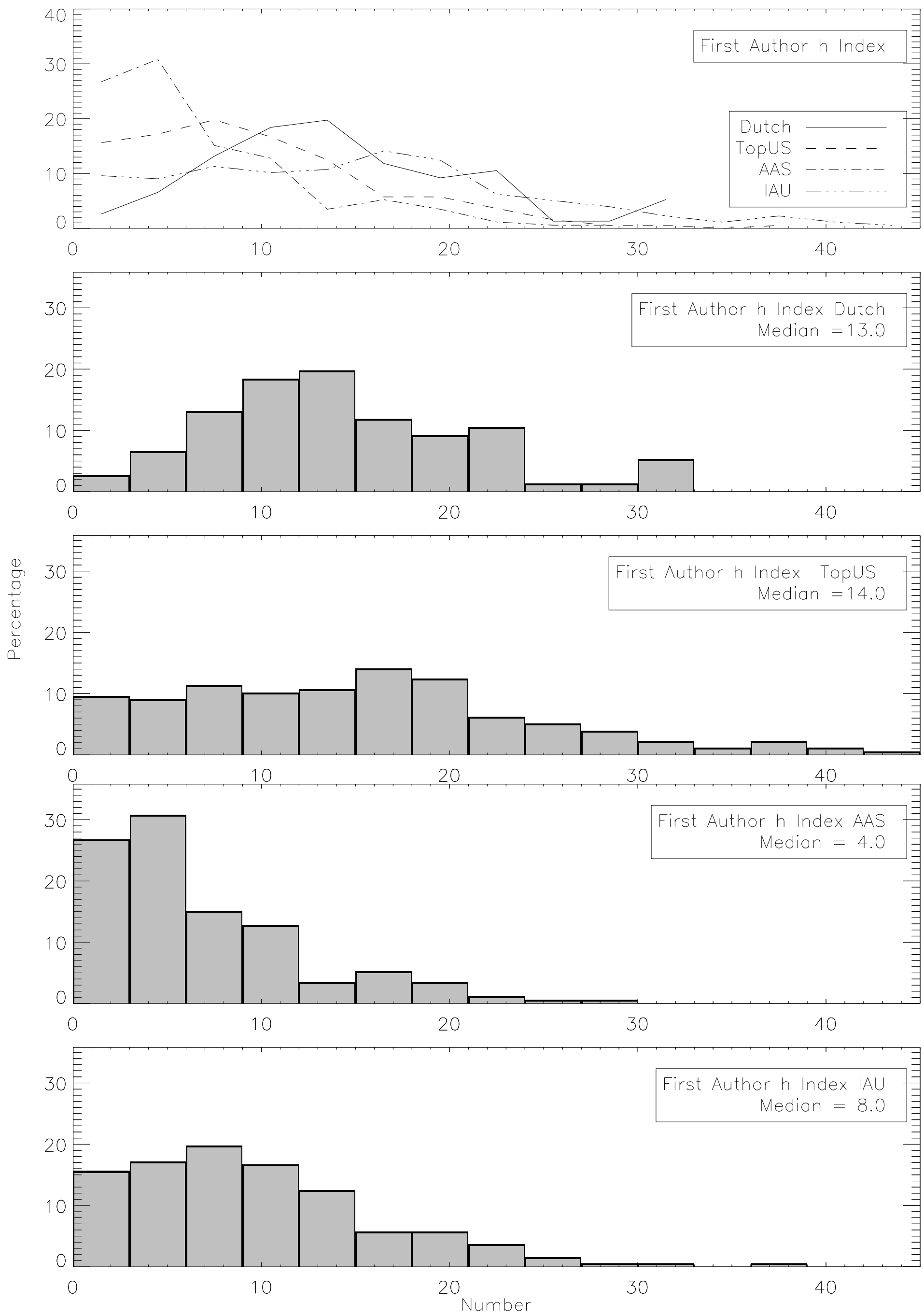

Figure 9: As Figure 8 but now only first author papers are considered.

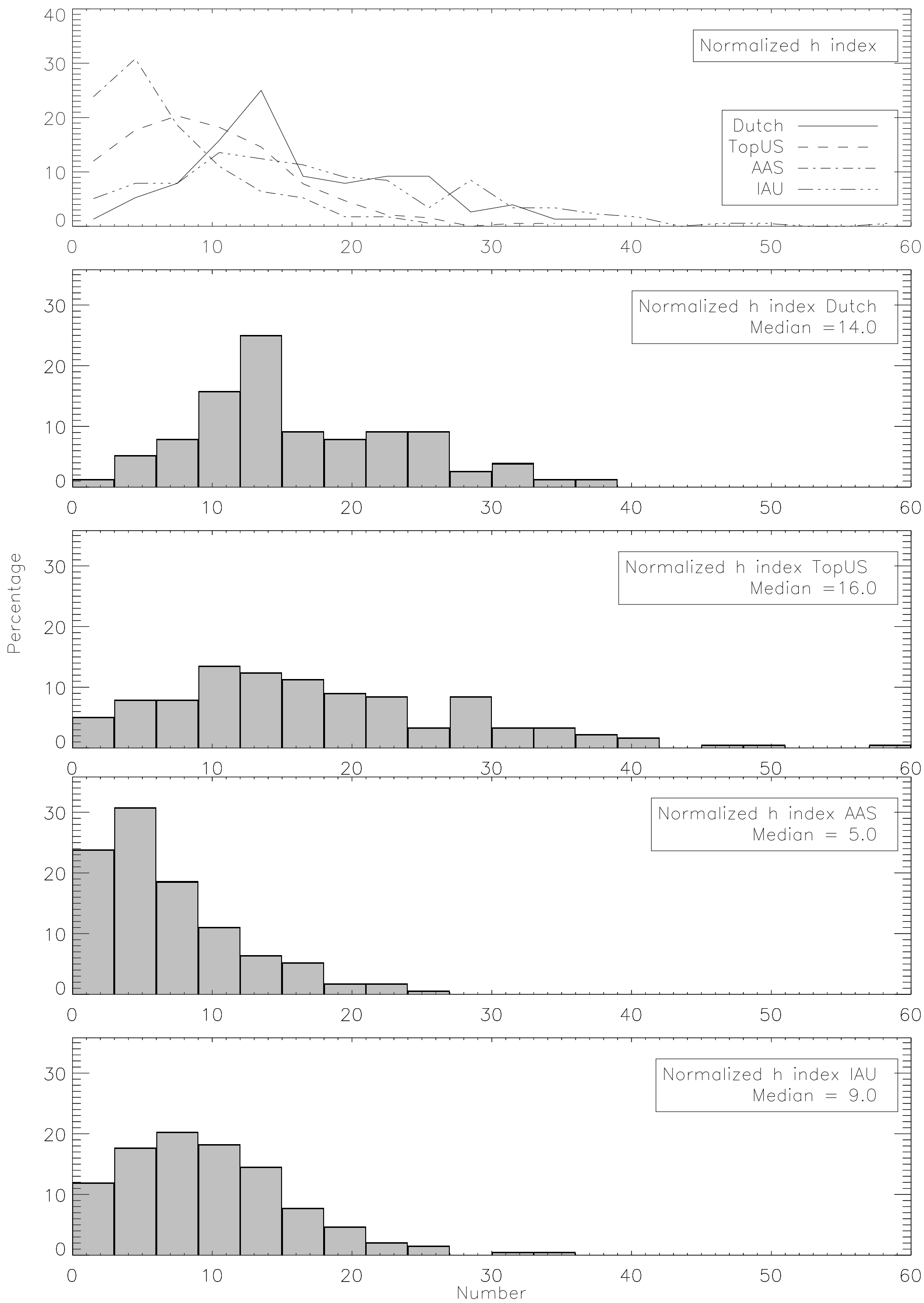

Figure 10: As Figure 8 but based on normalised citations.

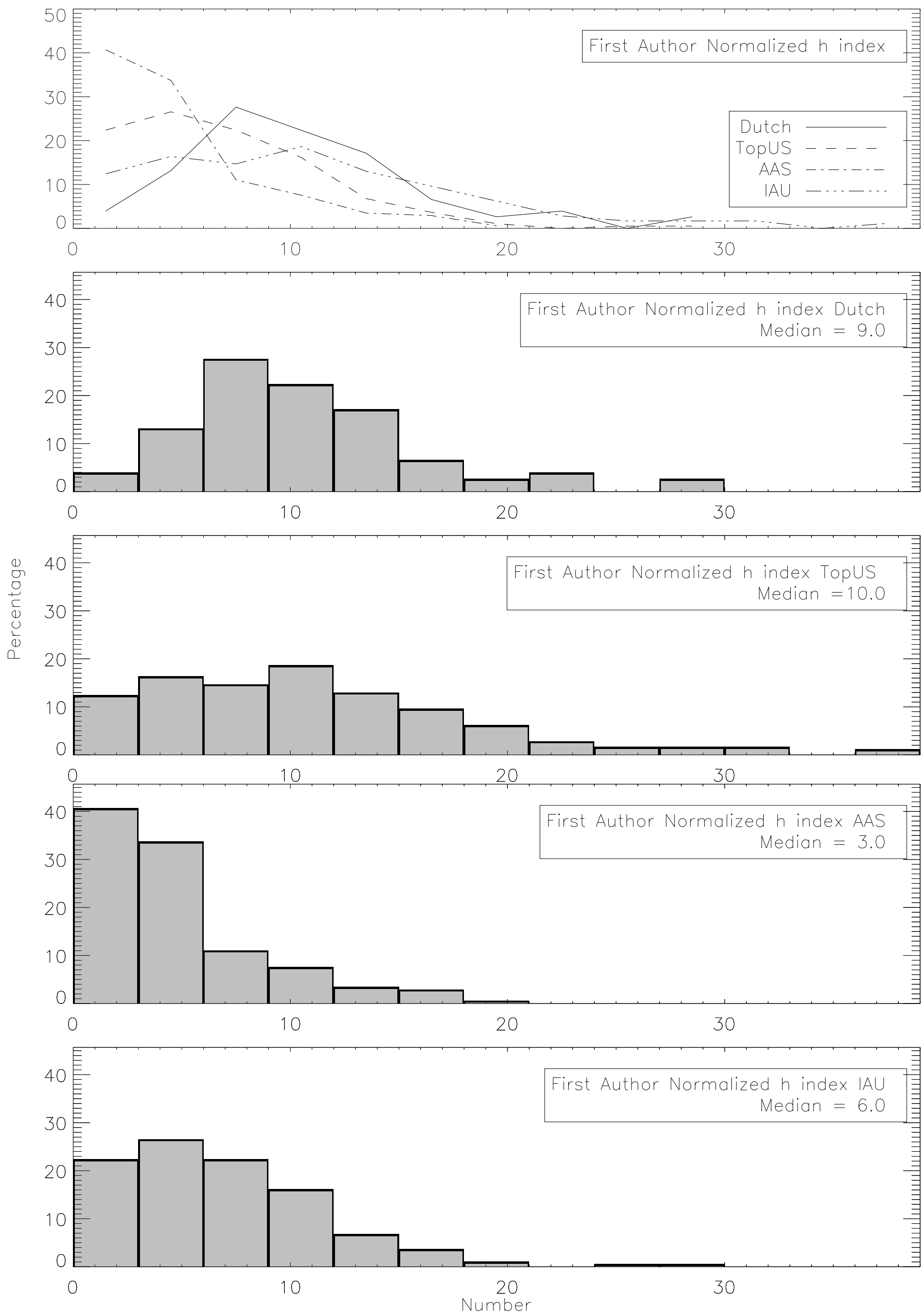

Figure 11: As Figure 9 but based on normalised citations.

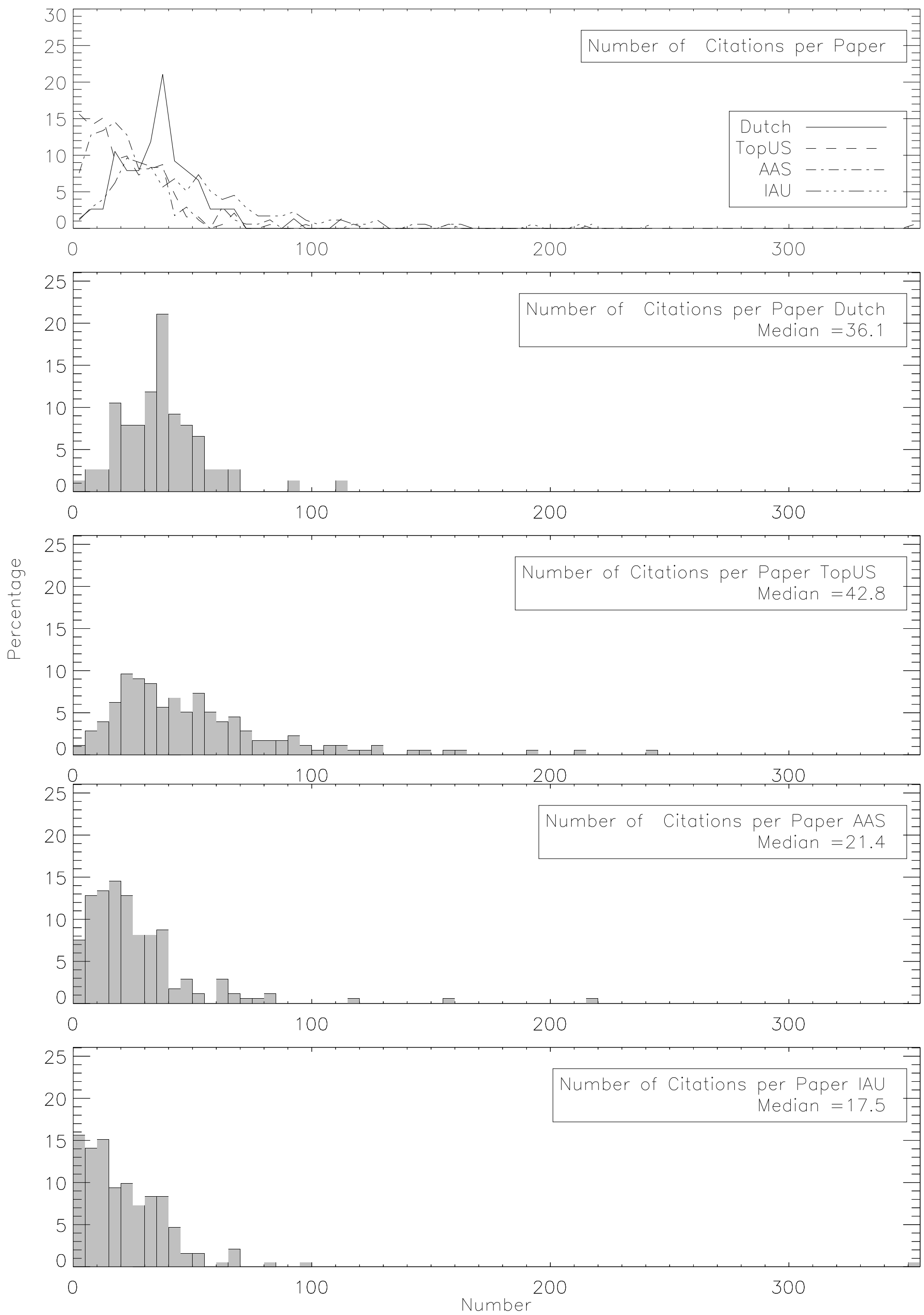

Figure 12: As Figure 1 but based on citations per paper.

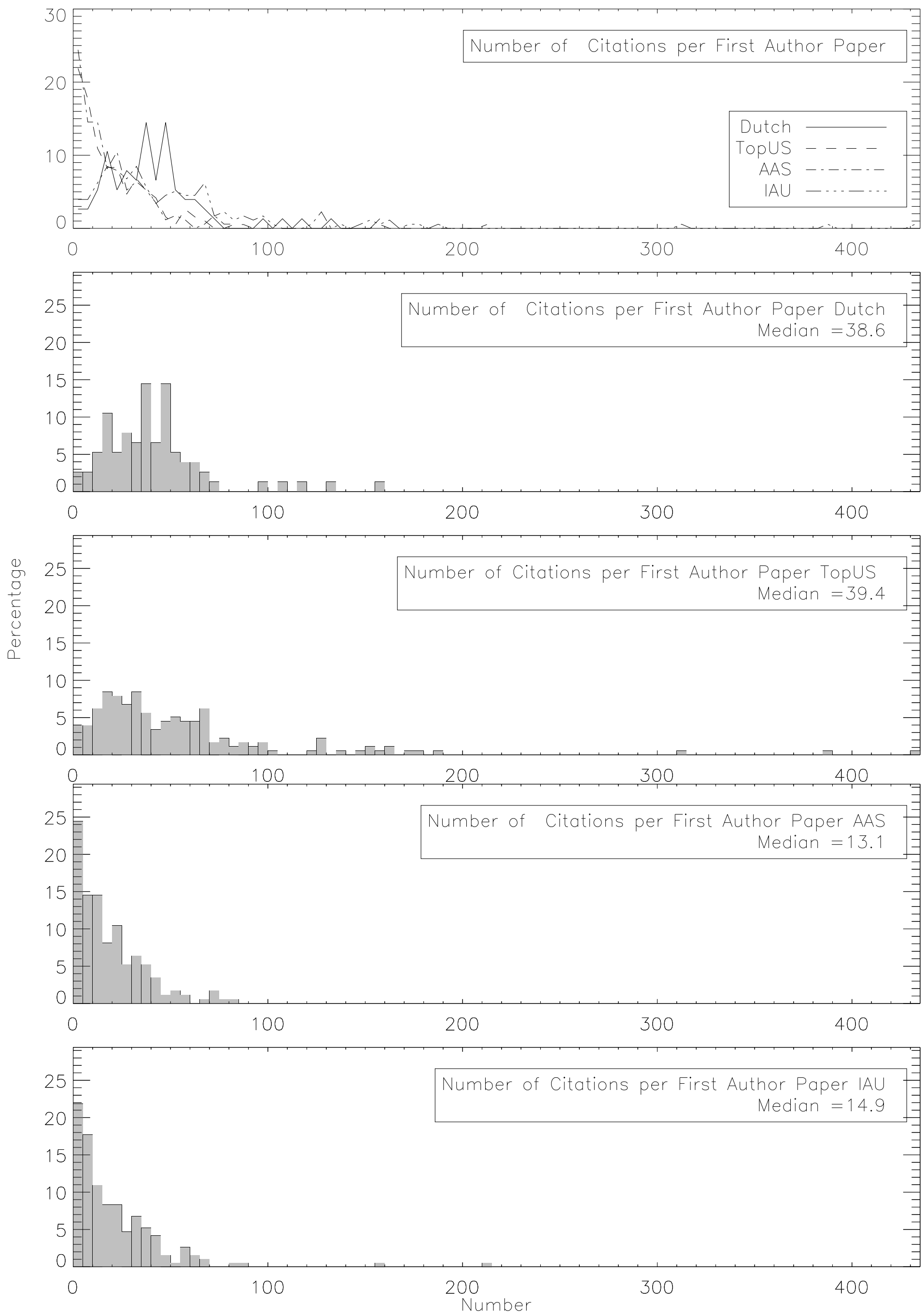

Figure 13: As Figure 12 but only considering first author papers.

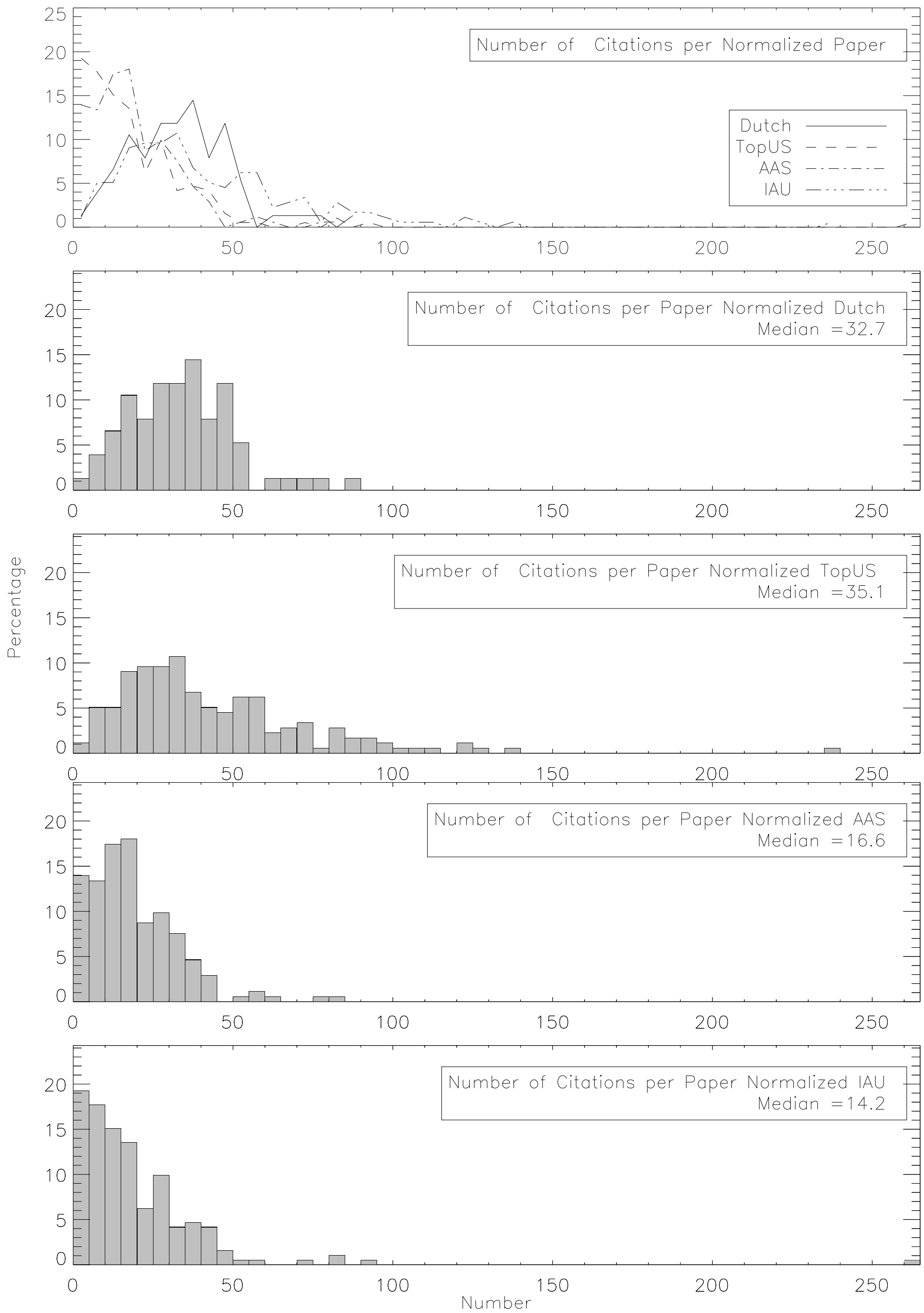

Figure 14: As Figure 12 but with citations and papers normalised to the number of contributing authors.

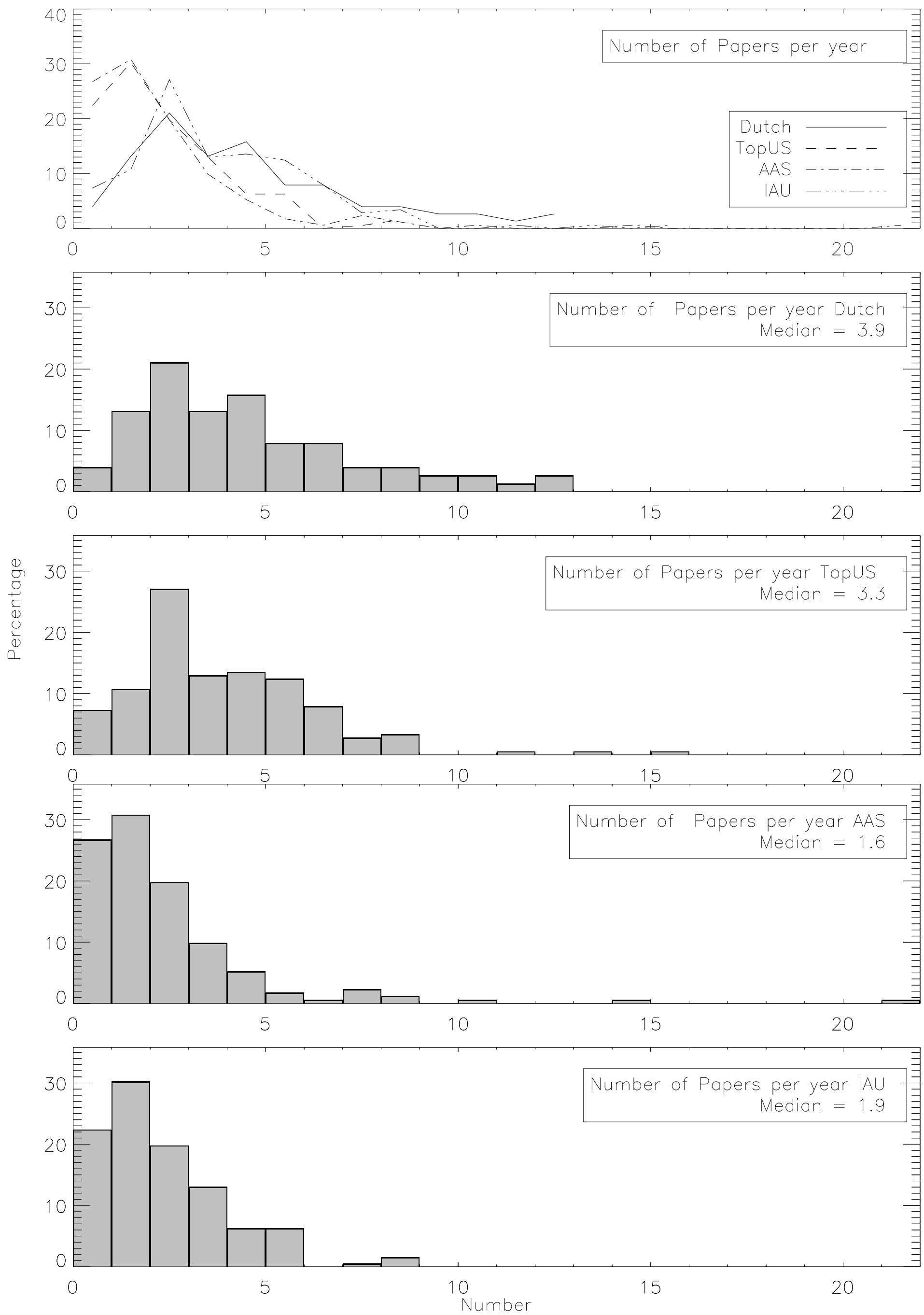

Figure 15: As Figure 1 but based on articles per year.

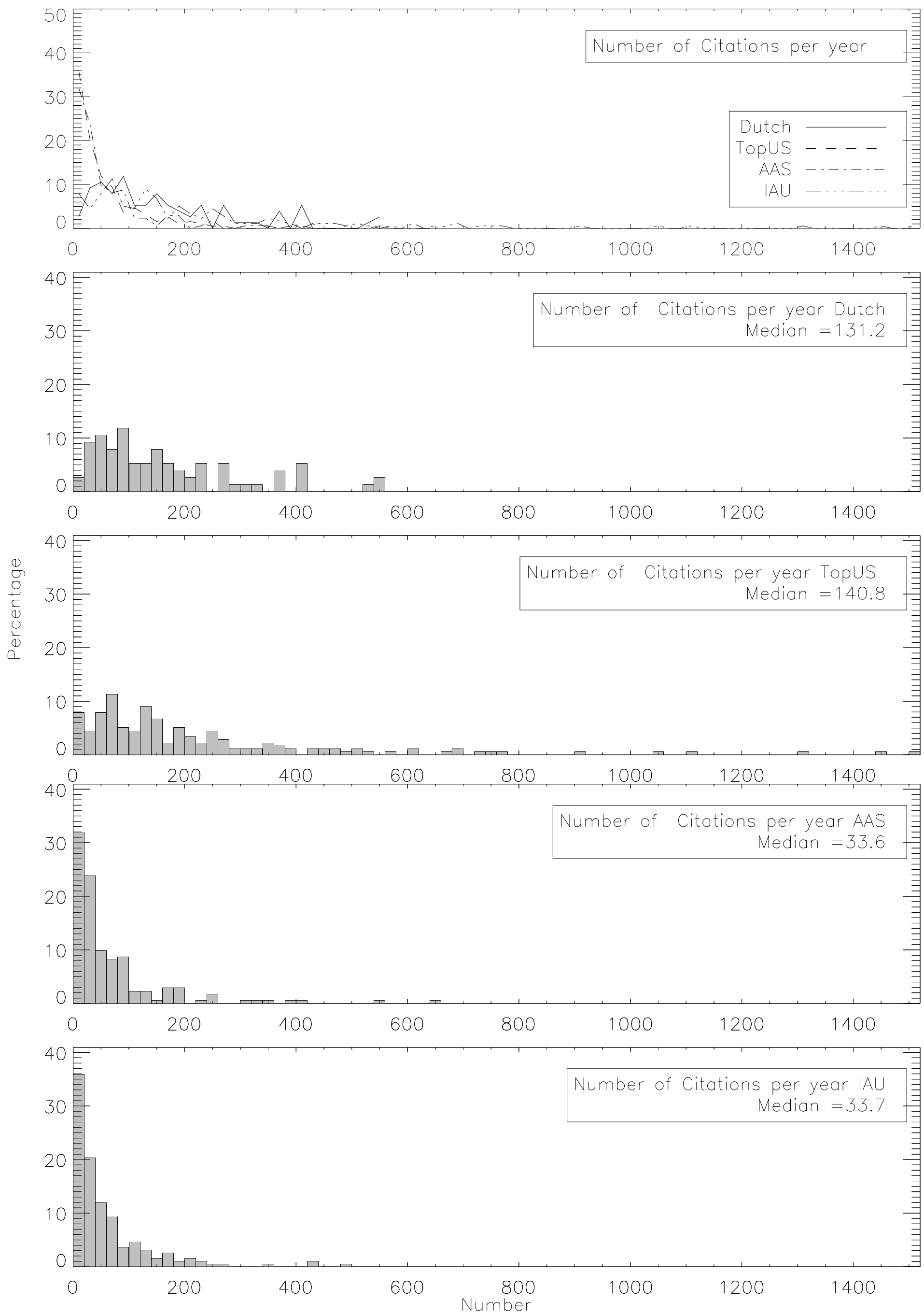

Figure 16: As Figure 1 but based on citations per year.

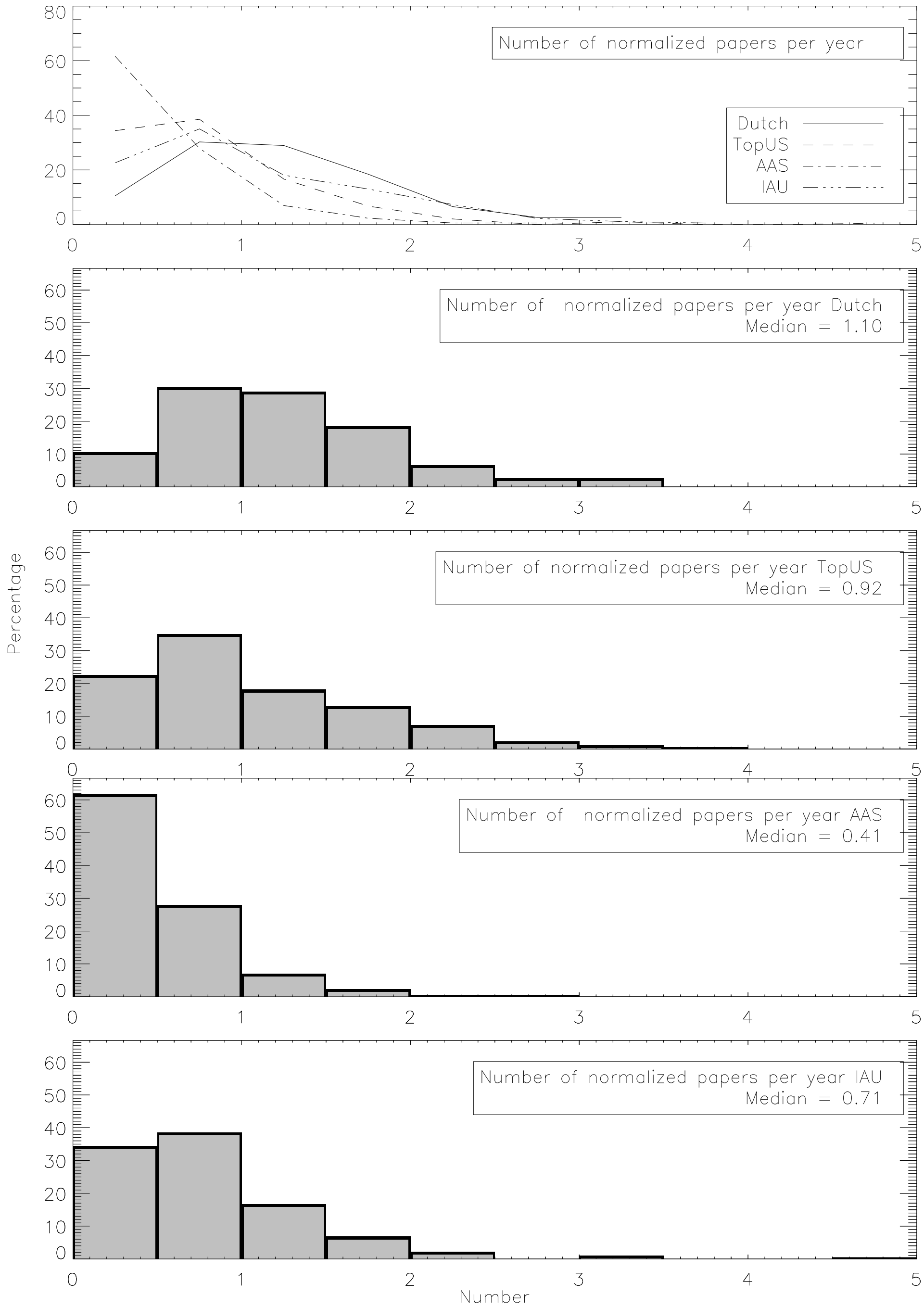

Figure 17: As Figure 1 but based on normalised articles per year.

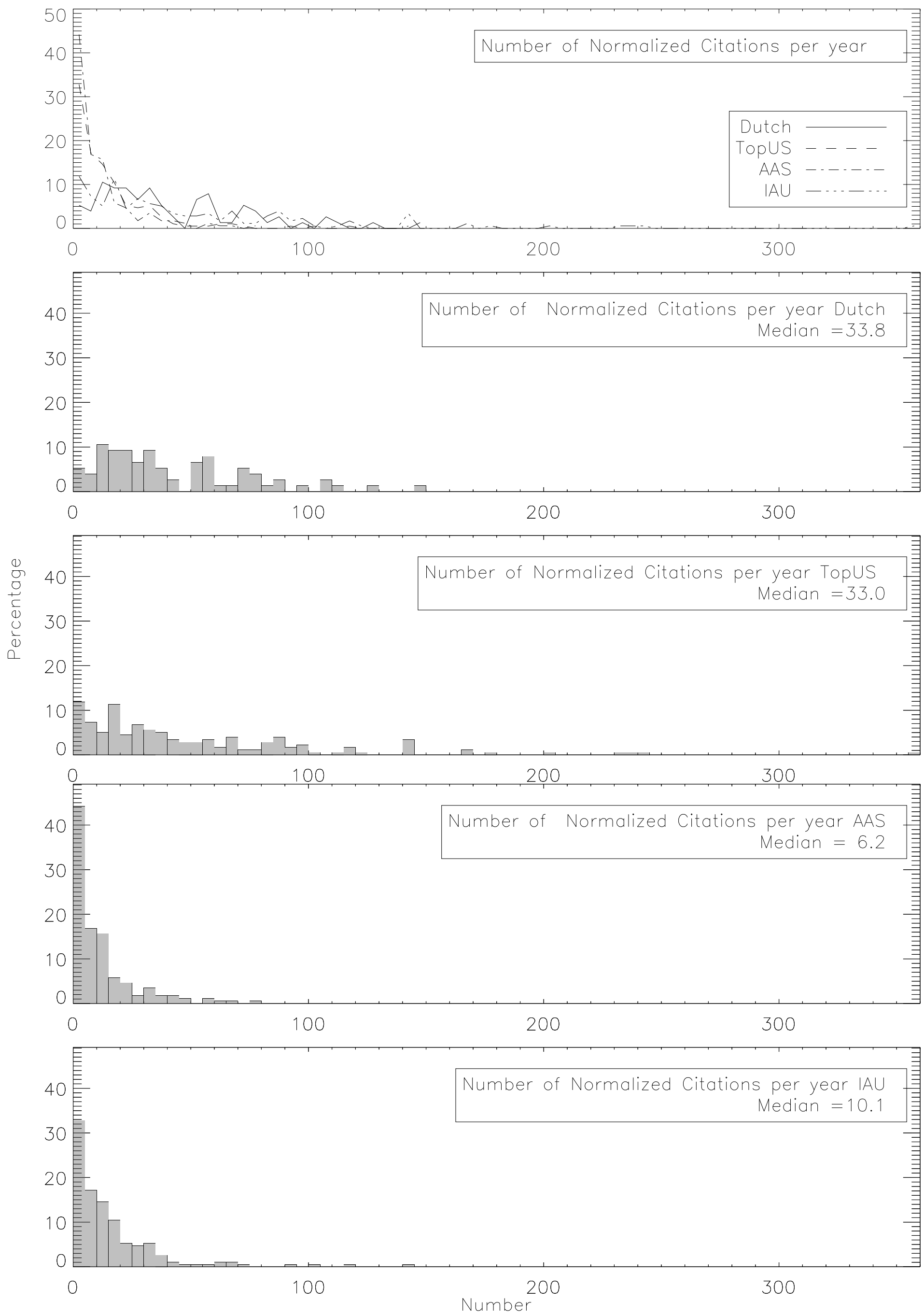

Figure 18: As Figure 1 but based on normalised citations per year.

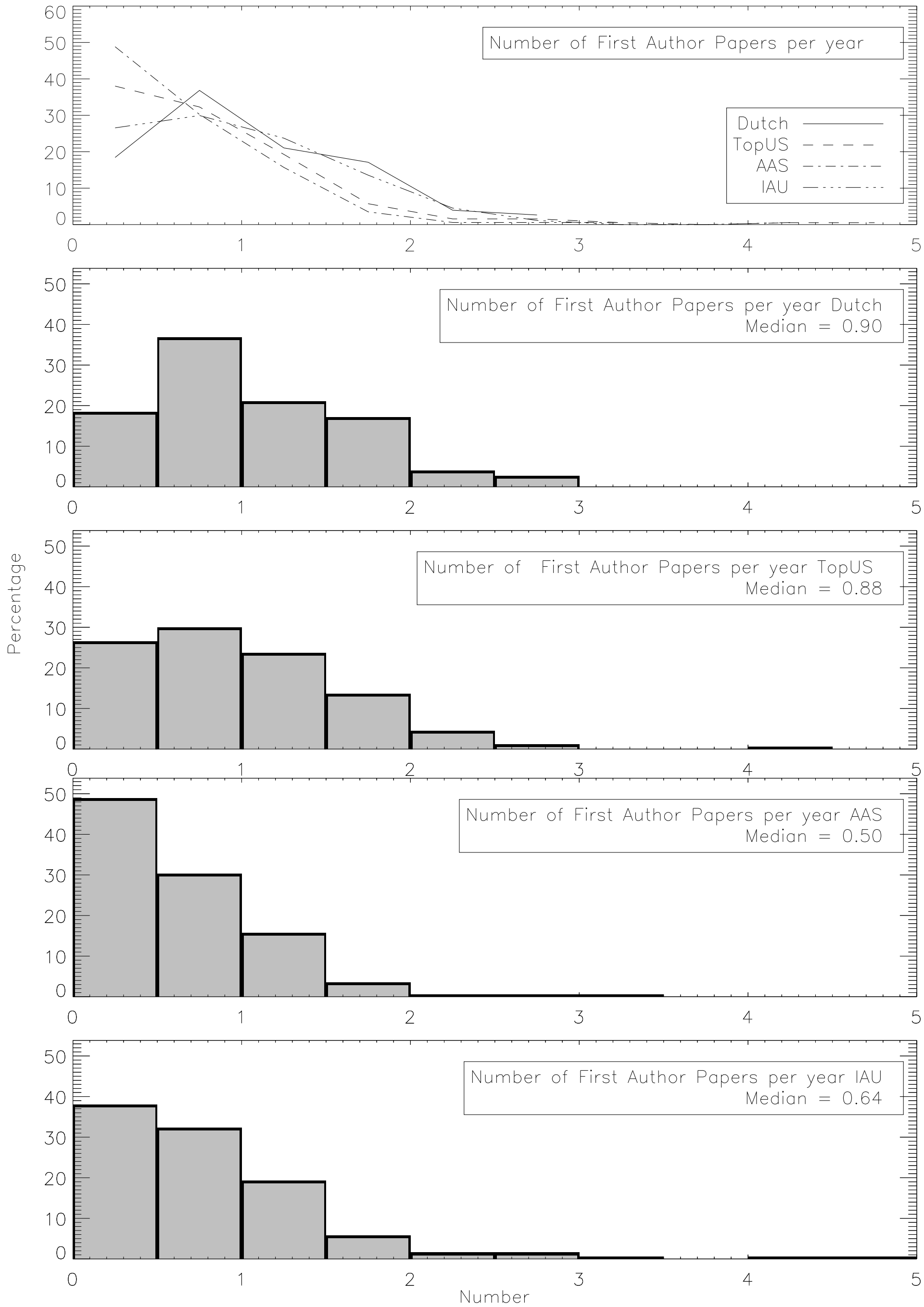

Figure 19: As Figure 15 but based on first author articles only.

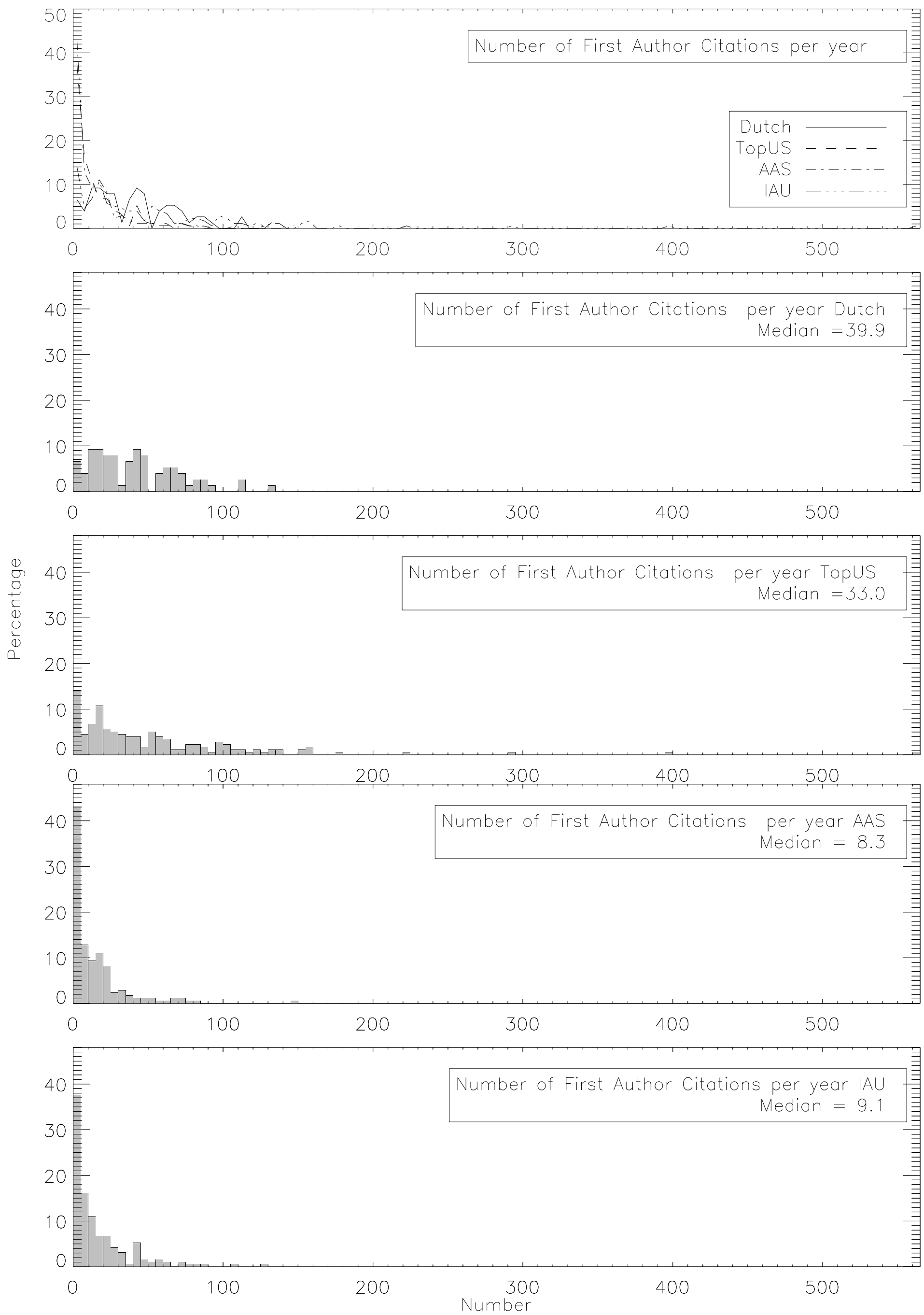

Figure 20: As Figure 19 but based on citations per year.

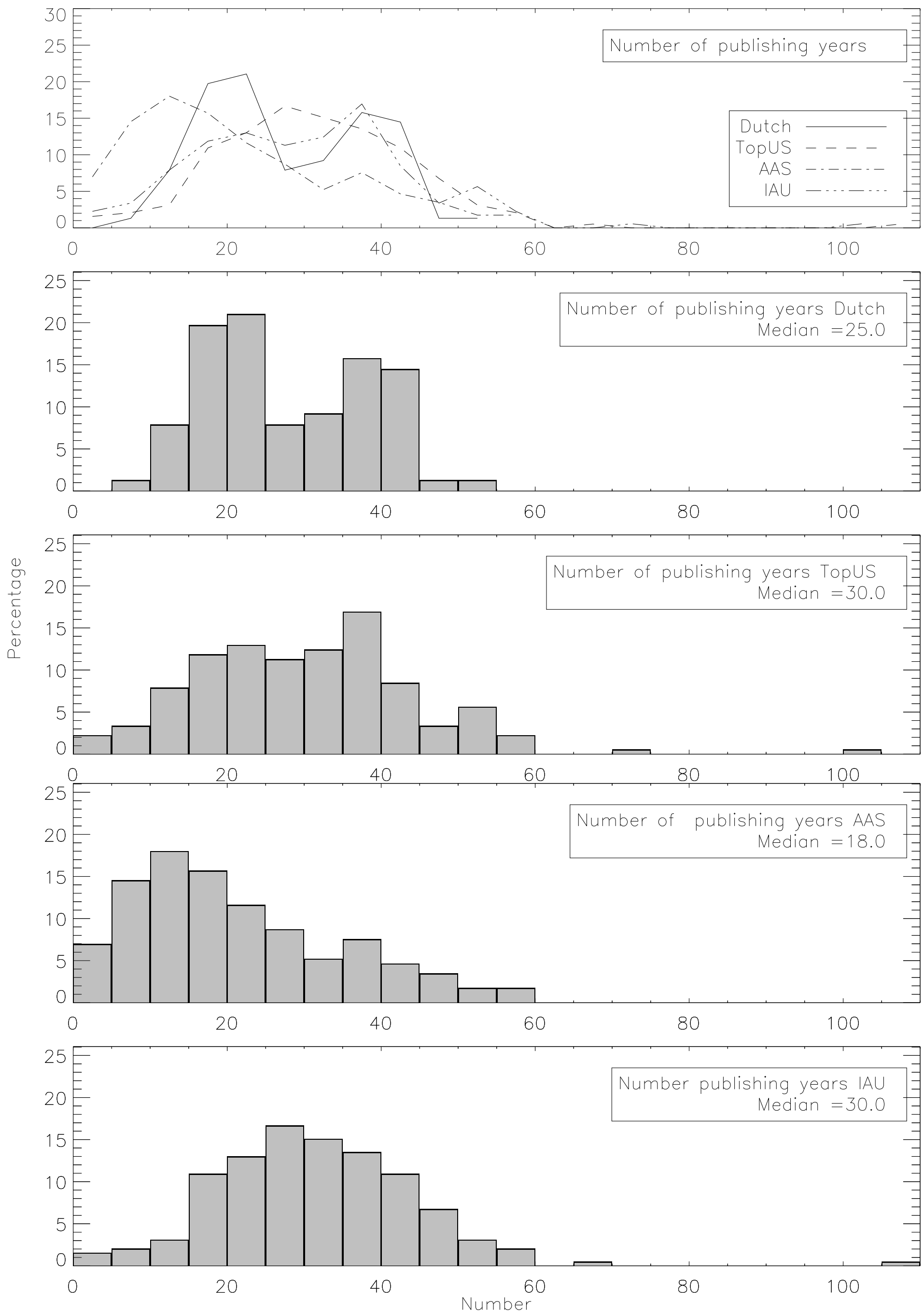

Figure 21: As Figure 1 but based on the number of years an author has been publishing (e.g. number of years between the first and last article).

Impact ratio												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)		1.19	1.19	1.18	1.03	1.26	1.13	0.84(s)	1.27(s)	1.13	0.85	0.22
2005(2000-2003)	1.27											
2003(1998-2001)	1.29	1.29	1.43	1.35		1.22	1.2	1.66(a)	1.04(a)			
2000(1994-1998)		1.3										
1998(1992-1996)	1.07	1.11										
Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)		1311	276	470	94	390	177	233(s)	300(s)	118	19	10
2005(2000-2003)	1807											
2003(1998-2001)								114(a)	463(a)			
2000(1997-1998)												
1998(1995-1996)	390											

Table 4: Impact ratios of astronomy from the NOWT reports.

(a) All institute publications (technical and astronomical). (s) Solely astronomy publications.

Impact ratio												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1.23	1.27	1.28	1.46	0.79	1.20	1.13	1.07	1.14	0.20	0.86	0.37
2008(2003-2005)	1.22	1.27	1.23	1.44	0.88	1.20	1.18	1.05	1.14	0.18	0.84	
2005(2000-2003)	1.18	1.21	1.17	1.29	0.46	1.25	1.12	0.87	1.22		0.78	
2005(2000-2002)	1.21	1.22	1.14	1.35	0.37	1.26	1.09	0.90	1.30		0.79	
Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1812	1399	292	475	95	365	172	163	228	1	18	3
2008(2003-2005)	1273	970	212	325	52	264	117	119	167	1	16	0
2005(2000-2003)	1570	1193	279	365	15	338	196	128	239	0	10	0
2005(2000-2002)	1125	873	211	260	6	245	151	80	165	0	7	0

Table 5: Impact ratios calculated from ADS solely based on the the 4 major journals (Astronomy & Astrophysics, Monthly Notices of the Royal Astronomical Society, Astrophysical Journal, Astronomical Journal). Citation window up to december 2008. Each range of years includes the last year.

Impact ratio												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1.26	1.31	1.29	1.47	0.84	1.34	1.10	1.09	1.11	2.07	0.84	0.36
2008(2003-2005)	1.26	1.31	1.24	1.46	0.95	1.31	1.15	1.08	1.11	1.86	0.82	
2005(2000-2003)	1.20	1.24	1.20	1.30	0.63	1.31	1.13	0.86	1.23		0.90	
2005(2000-2002)	1.21	1.23	1.16	1.34	0.75	1.25	1.11	0.89	1.31		0.94	
Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1848	1428	296	483	98	379	172	169	228	2	18	3
2008(2003-2005)	1300	1182	215	332	55	272	117	124	167	2	16	0
2005(2000-2003)	1603	1219	284	371	17	348	199	131	242	0	11	0
2005(2000-2002)	1146	889	214	263	8	250	154	81	168	0	8	0

Table 6: Impact ratios calculated from ADS solely based on the 6 major journals (Astronomy & Astrophysics, Monthly Notices of the Royal Astronomical Society, Astrophysical Journal, Astronomical Journal, Science, Nature). Citation window up to december 2008. Each range of years includes the last year. ¿From Nature and Science only articles listed as astronomical are included.

Impact ratio												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1.26	1.31	1.29	1.47	0.84	1.34	1.10	1.09	1.11	2.07	0.84	0.36
2008(2003-2005)	1.26	1.31	1.24	1.46	0.95	1.31	1.15	1.08	1.11	1.86	0.82	
2005(2000-2003)	1.20	1.24	1.20	1.30	0.63	1.31	1.13	0.86	1.23		0.90	
2005(2000-2002)	1.21	1.23	1.16	1.34	0.75	1.25	1.11	0.89	1.31		0.94	
Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1931	1490	321	514	98	382	175	187	231	2	18	3
2008(2003-2005)	1344	1024	228	349	55	274	118	134	168	2	16	0
2005(2000-2003)	1627	1238	289	384	17	349	199	135	243	0	11	0
2005(2000-2002)	1150	893	216	264	8	251	154	81	168	0	8	0

Table 7: Impact ratios calculated from ADS solely based on the 6 major journals (Astronomy & Astrophysics, Monthly Notices of the Royal Astronomical Society, Astrophysical Journal, Astronomical Journal, Nature, Science) plus two smaller journals (Astronomische Nachrichten and New Astronomy Reviews). Citation window up to december 2008. Each range of years includes the last year.

Impact ratio											
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1.89	2.00	1.99	2.19	1.32	2.11	1.70	2.45	1.67	1.29	0.93	0.34
2008(2003-2005)	1.90	2.00	1.92	2.17	1.56	2.07	1.71	2.54	1.62	1.29	0.93	0.20
2005(2000-2003)	1.85	1.89	1.83	1.91	1.02	2.08	1.76	1.90	1.82	0.39	1.36	0.14
2005(2000-2002)	1.81	1.87	1.76	2.01	1.12	1.96	1.71	1.32	1.93	0.27	1.53	0.13
Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	2261	1721	349	593	113	430	236	215	273	11	31	10
2008(2003-2005)	1578	1182	252	406	60	308	156	152	203	8	26	7
2005(2000-2003)	1830	1376	315	438	20	371	232	155	280	5	12	2
2005(2000-2002)	1285	986	233	298	11	266	178	91	195	3	8	2

Table 8: Impact ratios calculated from ADS based on all refereed journals as listed by ADS. Citation window up to december 2008. Each range of years includes the last year.

Impact ratio											
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	1.80	1.87	1.83	1.99	1.15	2.09	1.56	1.60	1.61	1.48	0.99	0.17
2008(2003-2005)	1.86	1.93	1.87	1.97	1.18	2.17	1.74	1.69	1.74	1.60	0.92	0.08
2005(2000-2003)	1.71	1.78	1.72	1.76	0.92	1.90	1.77	1.08	1.74	0.26	1.20	0.32
2005(2000-2002)	1.74	1.81	1.77	1.91	1.33	1.89	1.64	1.23	1.64	0.37	1.37	0.14

Total number of publications												
year report (calc)	Total	univ.	RUG	UL	RU	UvA	UU	ASTRON	SRON	NIKHEF	Rijnhuizen	KNMI
2008(2003-2006)	2261	1721	349	593	113	430	236	215	273	11	31	10
2008(2003-2005)	1578	1182	252	406	60	308	156	152	203	8	26	7
2005(2000-2003)	1830	1376	315	438	20	371	232	155	280	5	12	2
2005(2000-2002)	1285	986	233	298	11	266	178	91	195	3	8	2

Table 9: Impact ratios calculated from ADS based on all refereed journals as listed by ADS . Citation window is equal to the publication period. Each range of years includes the last year.

7 Appendix A

The 15 instutes that were considered as top in US are listed below. This list was constructed by taking the astronomy departments of the first 13 instutes as listed in Table 1 of A.L. Kinney's "The Science Impact of Astronomy PhD Granting Departments in the United States"[18] and supplemented with UCLA and the University of Texas at Austin. For our analysis only faculty that is listed as active and part of astronomy are considered. Faculty that is listed as physicist is excluded from our sample.

1 Caltech
2 UC Santa Cruz
3 Princeton University
4 Harvard University
5 Colorado
6 SUNY Stony Brook
7 Johns Hopkins University
8 Penn. State Univ.
9 Univ. Michigan
10 Univ. Hawaii
11 Univ. Wisconsin
12 UC Berkeley
13 Michigan State Univ.
14 UCLA
15 Univ. Texas

[18]arXiv:0811.0311