Bibliometric Analysis

for the U.S. Environmental Protection Agency/Office of Research and Development's Global Change Research Program

This is a bibliometric analysis of the papers prepared by intramural and extramural researchers of the U.S. Environmental Protection Agency's (EPA) Global Change Research Program. For this analysis, 432 journal publications and 12 non-journal publications were reviewed, and they were published from 1998 to 2007 (the program's first papers were published in 1998). The journal publications were cited 5,925 times in the journals covered by Thomson Scientific's *Web of Science*[1] and Elsevier's Scopus[2]. The non-journal publications were cited 720 times in journals and books. Of the 444 publications global change publications, 397 (89.4%) have been cited at least once in a journal or book.

Searches of *Web of Science* and Scopus were conducted to obtain times cited data for the Global Change Research Program journal publications and searches of *Web of Science* and Google Scholar were conducted to obtain times cited data for the non-journal publications. The analysis was completed using Thomson's *Essential Science Indicators (ESI)* and *Journal Citation Reports (JCR)* as benchmarks. *ESI* provides access to a unique and comprehensive compilation of essential science performance statistics and science trends data derived from Thomson's databases. For this analysis, the *ESI* highly cited papers thresholds as well as the hot papers thresholds were used to assess the influence and impact of the global change papers. *JCR* is a recognized authority for evaluating journals. It presents quantifiable statistical data that provide a systematic, objective way to evaluate the world's leading journals and their impact and influence in the global research community. The two key measures used in this analysis to assess the journals in which the EPA global change papers are published are the Impact Factor and Immediacy Index. The Impact Factor is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to other journals in the same field. The Immediacy Index is a measure of how quickly the "average article" in a journal is cited. This index indicates how often articles published in a journal are cited within the same year and it is useful in comparing how quickly journals are cited.

This report is divided into four sections. The first section presents an analysis of the 432 global change journal publications analyzed by *ESI* field (e.g., Geosciences,

[1] Thomson Scientific's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,830 of the most prestigious, high impact research journals in the world. *Web of Science* also provides cited reference searching.

[2] Scopus is a large abstract and citation database of research literature and quality Web sources designed to support the literature research process. Scopus offers access to 15,000 titles from 4,000 different publishers, more than 12,850 academic journals (including coverage of 535 Open Access journals, 750 conference proceedings, and 600 trade publications), 27 million abstracts, 245 million references, 200 million scientific Web pages, and 13 million patent records.

Environment/Ecology, and Engineering). The second section presents an analysis of the 12 non-journal publications analyzed by *ESI* field. The third section provides an analysis of the 432 global change journal publications by focus area (e.g., Air Quality, Water Quality/Aquatic Ecosystem). The fourth section of this report includes some additional parameters on global warming publications that are reported by *ESI*. A summary of the results of the entire bibliometric analysis precedes the four sections.

SUMMARY OF RESULTS

I. Analysis of Global Change Journal Publications

1. One-fourth of the global change publications are highly cited papers. 108 (25.0%) of the global change papers qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is 2.5 times higher than the 10% of papers expected to be highly cited. 12 (2.8%) of the global change papers qualify as highly cited when using the *ESI* criteria for the top 1%, which is 2.8 times higher than the number expected. 2 (0.5%) of these papers qualify as very highly cited when using the criteria for the top 0.1%, which is 5 times higher than the number anticipated. 1 (0.2%) of the papers actually meets the 0.01% threshold for the most highly cited papers, which is surprising given that the expected number for this program is 0.04 papers.

2. The global change papers are more highly cited than the average paper. Using the *ESI* average citation rates for papers published by field as the benchmark, in 10 of the 14 fields in which the 432 EPA global change papers were published, the ratio of actual to expected cites is greater than 1, indicating that the global change papers are more highly cited than the average papers in those fields. For all 14 fields combined, the ratio of total number of cites to the total number of expected cites (5,925 to 3,332.72) is 1.8, indicating that the global change papers are more highly cited than the average paper.

3. One-fourth of the global change papers are published in high impact journals. 104 of the 432 papers were published in the top 10% of journals ranked by *JCR* Impact Factor, representing 24.1% of EPA's global change papers. This number is 2.4 times higher than the expected 43 papers. 123 of the 432 papers appear in the top 10% of journals ranked by *JCR* Immediacy Index, representing 28.5% of EPA's global change papers. This number is 2.8 times higher than the expected 43 papers.

4. Eleven of the global change papers qualify as hot papers. Using the hot paper thresholds established by *ESI* as a benchmark, 11 hot papers, representing 2.6% of the global change papers, were identified in the analysis. Hot papers are papers that were highly cited shortly after they were published. The number of global change hot papers identified is 26 times higher than the expected 0.4 hot papers.

SUMMARY OF RESULTS (Continued)

5. **The authors of the global change papers cite themselves less than the average author.** 424 of the 5,925 cites are author self-cites. This 7.2% author self-citation rate is below the accepted range of 10-30% author self-citation rate.

6. **Thirty-four of the 1,006 authors of the global change papers are included in** *ISIHighlyCited.com*, which is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999.

7. **There were no patents issued** to investigators from 1998 to 2007 for research that was conducted under EPA's Global Change Research Program.

II. Analysis of the Non-Journal Global Change Publications

8. **Nearly one-half of the non-journal publications were cited at least once in a journal or book.** 5 (41.7%) of the 12 publications were cited at least once in a journal or book covered by Thomson's *Web of Science* and Google Scholar.

9. **The 12 non-journal publications were cited 720 times.** The 5 books were cited 497 times, the 2 book chapters were cited 172 times, the 4 reports were cited 31 times, and the technical paper was cited 20 times.

10. **Nearly one-half of the non-journal global change publications are highly cited using the top 10% threshold in *ESI*.** 5 (41.7%) of the global change non-journal publications qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited papers. This is 4.2 times the number of publications expected to be highly cited.

11. **One-fourth of the non-journal publications are highly cited using the top 1% threshold in *ESI*.** 3 (25.0%) of the global change publications qualify as highly cited when using the *ESI* criteria for the top 1%, which is 25 times the number expected. 2 (16.7%) of these publications qualify as very highly cited when using the criteria for the top 0.1% and 1 (8.3%) of the papers qualify as extremely highly cited when using the criteria for the top 0.01%. These results are extraordinary given that the expected numbers are 0.012 publications and 0.0012 publications, respectively, for these two highest thresholds.

12. **The non-journal global change publications are cited more than the average paper.** Using the *ESI* average citation rates for papers published by field as the benchmark, the ratio of actual to expected cites for every field to which the publications were assigned was greater than 1, indicating that the global change publications are cited more than the average papers in those fields. For all 4 fields combined, the ratio of total number of cites to the total number of expected cites (720 to 90.09) is 8.0, indicating that the global change publications are cited more than the average paper.

SUMMARY OF RESULTS (Continued)

III. Analysis of Global Change Journal Publications by Focus Area

13. More than one-third of the Human Health and one-fourth of the Air Quality and Water Quality/Aquatic Ecosystem focus area publications are highly cited papers (this is 2.4 to 3.8 times the number expected). The percentage of global change papers that qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications ranges from 4.8% for the Regional- and Place-Based Assessment papers to 38.1% for the Human Health papers. The Human Health and Water Quality/Aquatic Ecosystem focus areas have the highest percentages of highly cited publications when using the *ESI* criteria for the top 10%, and the number of highly cited papers in these areas is 3.8 to 2.6 times higher than expected. These two focus areas also hold the lead positions when using the *ESI* criteria for the top 1% of papers, and the number of very highly cited papers in these areas is 4.8 to 3.2 times higher than expected. Two (0.7%) papers in the Water Quality/Aquatic Ecosystem focus area meet the *ESI* criteria for the top 0.1% of papers, which is 7 times higher than the expected number for this focus area. One (0.4%) of the Water Quality/Aquatic Ecosystem papers meets the *ESI* criteria for the most highly cited papers (top 0.01%), which is 40 times the number expected for this focus area.

14. The global papers are more highly cited than the average paper in three of the four focus areas. Using the *ESI* average citation rates for papers published by field as the benchmark, the ratio of actual to expected cites is greater than 1 for all but the Regional- and Place-Based Assessment focus area. This indicates that for three of the four focus areas, the global change papers are more highly cited than the average paper.

15. Nearly three-fourths of the Human Health papers, one-fourth of the Water Quality/Aquatic Ecosystem papers, and one-sixth of the Air Quality papers are published in high impact journals as determined by the *JCR* Impact Factor and Immediacy Index of the journals in which the papers are published. The number of global change papers published in high impact journals (the top 10% of journals) exceeds the expected 10% as determined by the *JCR* Impact Factor and Immediacy Index of the journals. The percentage of papers in high impact journals (by Impact Factor) for Human Health, Water Quality/Aquatic Ecosystem, and Air Quality ranges from 73.8% to 22.3% to 15.2%, which is 7.4, 2.2, and 1.5 times higher than expected, respectively. None of the Regional- and Place-Based Assessment papers are published in high impact journals determined by Impact Factor. The percentage of papers in high impact journals (by Immediacy Index) for three of the four focus areas is higher than expected, ranging from 73.8% for the Human Health papers to 30.3% for the Air Quality papers to 25.2% for the Water Quality/Aquatic Ecosystem papers. These percentages are 7.4, 3.0, and 2.5 times higher than expected, respectively. Only 1 (2.4%) of the Regional- and Place-Based Assessment papers was published in a high impact journal determined by Immediacy Index.

16. In all four of the focus areas, the percentage of publications cited one or more times is very high (i.e., 84.8% to 95.2%).

SUMMARY OF RESULTS (Continued)

17. **The authors of the global change papers cite themselves less than the average self-citation rate.** The author self-citation rates range from 4.0% to 14.3%. The rates for the Human Health, Regional- and Place-Based Assessment, and Water Quality/Aquatic Ecosystem focus areas are well below the accepted range of 10-30% author self-citation rate, and the rate for the Air Quality papers is 14.3%, which is within the accepted range.

18. **There were hot papers published in three of the four focus areas.** The highest percentage of hot papers (i.e., 9.5%) is in the Regional- and Place-Based Assessment focus area, followed by the Air Quality focus area at 3.0% and the Water Quality/Aquatic Ecosystem focus area at 1.8%. These percentages are 95, 30, and 18 times higher than expected for these focus areas, respectively. There were no hot papers in the Human Health focus area.

IV. Comparison of EPA's Global Change Publications to ESI's Top Global Warming Publication Parameters

19. **EPA's Global Change Research Program includes 1 (5.0%) of *ESI*'s top 20 global warming papers** (published from January 1996 to April 2006).

20. **The United States ranks first among the top 20 countries** publishing on global warming.

21. **Nearly one-fourth of the EPA global change papers were published in *ESI*'s top 20 journals** in global warming.

22. **Thirteen (65%) of the top 20 institutions publishing on global warming participate in EPA's Global Change Research Program.**

23. **The number of cites and cites per paper for global warming papers have begun to decline in recent years and this trend holds true for the EPA global change papers.**

I. Analysis of Global Change Journal Publications by *ESI* Field

Highly Cited Global Change Journal Publications

All of the journals covered by *ESI* are assigned a field, and to compensate for varying citation rates across scientific fields, different thresholds are applied to each field. Thresholds are set to select highly cited papers to be listed in *ESI*. Different thresholds are set for both field and year of publication. Setting different thresholds for each year allows comparable representation for older and more recent papers for each field.

The 432 global change research papers reviewed for this analysis were published in journals that were assigned to 14 of the 22 *ESI* fields. The distribution of the papers among these 14 fields and the number of citations by field are presented in Table 1.

Table 1. Global Change Papers by *ESI* Fields

***ESI* Field**	**No. of Citations**	**No. of Global Change Papers**	**Average Cites/Paper**
Agricultural Sciences	8	1	8.0
Biology & Biochemistry	108	10	10.8
Clinical Medicine	352	16	22.0
Computer Science	7	1	7.0
Economics & Business	25	2	12.5
Engineering	374	47	8.0
Environment/Ecology	2,103	175	12.0
Geosciences	1,372	87	15.8
Immunology	30	2	15.0
Microbiology	113	6	18.8
Multidisciplinary	820	12	68.3
Physics	4	1	4.0
Plant & Animal Science	568	65	8.7
Social Sciences, general	41	7	5.8
	Total = 5,925	**Total = 432**	**13.7**

There are 108 (25.0% of the papers analyzed) highly cited EPA global change papers in 10 of the 14 fields—Clinical Medicine, Computer Science, Economics & Business, Engineering, Environment/ Ecology, Geosciences, Microbiology, Multidisciplinary, Plant & Animal Science, and Social Sciences—when using the *ESI* criteria for the **top 10% of papers**. Table 2 shows the number of global change papers in those 10 fields that meet the **top 10% threshold in *ESI***. These publications are listed in the Appendix.

Twelve (2.8%) of the papers analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These papers cover six fields—Engineering, Environment/ Ecology, Geosciences, Microbiology, Multidisciplinary, and Plant & Animal Science. Table 3 shows the 12 (2.8% of the papers analyzed) papers by field that meet the **top 1% threshold in *ESI*.** The citations for these 12 papers are provided in Tables 4 through 9. The highly cited papers in Tables 4 through 9 are presented in order of year of publication with the oldest papers appearing first. Within the year of publication, the papers are ordered by increasing number of times cited. Table 10 shows the number of papers by field that meet the **top 0.1% threshold in *ESI***. These 2 (0.5%) very highly cited global change papers in the fields of Multidisciplinary and Plant &

Animal Science are listed in Table 11. One (0.2%) of the global change papers meets the **top 0.01% threshold in *ESI***, which is 20 times higher than expected. This is extraordinary because the expected number of papers that should meet this threshold for this analysis is 0.04. The paper that meets the **top 0.01% threshold in ESI** is presented in Table 12.

Table 2. Number of Highly Cited Global Change Papers by Field (top 10%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of Papers in Field**
Clinical Medicine	213	3	71.0	18.8%
Computer Science	7	1	7.0	100.0%
Economics & Business	23	1	23.0	50.0%
Engineering	235	9	26.1	19.1%
Environment/Ecology	955	32	29.8	18.3%
Geosciences	1,047	34	30.8	39.1%
Microbiology	113	4	28.2	66.7%
Multidisciplinary	820	9	91.1	75.0%
Plant & Animal Science	258	14	18.4	21.5%
Social Sciences, general	11	1	11.0	14.3%
	Total = 3,682	**Total = 108**	**34.1**	**25.0%**

Table 3. Number of Highly Cited Global Change Papers by Field (top 1%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of Global Change Papers in Field**
Engineering	75	1	75.0	2.1%
Environment/Ecology	125	1	125.0	0.6%
Geosciences	227	4	56.8	4.6%
Microbiology	41	1	41.0	16.7%
Multidisciplinary	640	4	160.0	33.3%
Plant & Animal Science	6	1	6.0	1.5%
	Total = 1,114	**Total = 12**	**92.8**	**2.8%**

Table 4. Highly Cited Global Change Papers in the Field of Engineering (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
75	46	Douglas EM	Trends in floods and low flows in the United States: impact of spatial correlation. *Journal of Hydrology* 2000;240(1-2):90-105.

Table 5. Highly Cited Global Change Papers in the Field of Environment/Ecology (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
125	82	Marsh DM	Metapopulation dynamics and amphibian conservation. *Conservation Biology* 2001;15(1):40-49.

Table 6. Highly Cited Global Change Papers in the Field of Geosciences (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
96	89	Chase TN	Simulated impacts of historical land cover changes on global climate in northern winter. *Climate Dynamics* 2000;16(2-3):93-105.
113	89	Moran MA	Carbon loss and optical property changes during long-term photochemical and biological degradation of estuarine dissolved organic matter. *Limnology and Oceanography* 2000;45(6):1254-1264.
12	10	Howarth RW	Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: evolving views over three decades. *Limnology and Oceanography* 2006;51(1):364-376.
6	4	Wu SL	Why are there large differences between models in global budgets of tropospheric ozone? *Journal of Geophysical Research-Atmospheres* 2007;112(D5):Art. No. D05302.

Table 7. Highly Cited Global Change Papers in the Field of Microbiology (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
41	34	Jiang SC	Genetic diversity of clinical and environmental isolates of *Vibrio cholerae* determined by amplified fragment length polymorphism fingerprinting. *Applied and Environmental Microbiology* 2000;66(1):148-153.

Table 8. Highly Cited Global Change Papers in the Field of Multidisciplinary (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
57	51	Brutsaert W	Hydrologic cycle explains the evaporation paradox. *Nature* 1998;396(6706):30-30.
94	57	Pascual M	Cholera dynamics and El Nino-Southern Oscillation. *Science* 2000;289(5485):1766-1769.
448	82	Root TL	Fingerprints of global warming on wild animals and plants. *Nature* 2003;421(6918):57-60.
41	27	Worm B	Impacts of biodiversity loss on ocean ecosystem services. *Science* 2006;314(5800):787-790.

Table 9. Highly Cited Global Change Papers in the Field of Plant & Animal Science (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
6	3	Bullard SG	The colonial ascidian *Didemnum* sp A: current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. *Journal of Experimental Marine Biology and Ecology* 2007;342(1):99-108.

Table 10. Number of Very Highly Cited Papers by Field (top 0.1%)

ESI Field	No. of Citations	No. of Papers	Average Cites/Paper	% of Global Change Papers in Field
Multidisciplinary	448	1	448.0	8.3%
Plant & Animal Science	6	1	6.0	1.5%
	Total = 454	**Total = 2**	**227.0**	**0.5%**

Table 11. Very Highly Cited Global Change Papers (top 0.1%)

ESI Field	*ESI* Threshold	No. of Cites	First Author	Paper
Multidisciplinary	339	448	Root TL	Fingerprints of global warming on wild animals and plants. *Nature* 2003;421(6918):57-60.
Plant & Animal Science	3	6	Bullard SG	The colonial ascidian *Didemnum* sp A: current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. *Journal of Experimental Marine Biology and Ecology* 2007;342(1):99-108.

Table 12. Extremely Highly Cited Global Change Papers (top 0.01%)

ESI Field	*ESI* Threshold	No. of Cites	First Author	Paper
Multidisciplinary	339	448	Root TL	Fingerprints of global warming on wild animals and plants. *Nature* 2003;421(6918):57-60.

Ratio of Actual Cites to Expected Citation Rates

The expected citation rate is the average number of cites that a paper published in the same journal in the same year and of the same document type (article, review, editorial, etc.) has received from the year of publication to the present. Using the *ESI* average citation rates for papers published by field as the benchmark, in 10 of the 14 fields in which the global change papers were published, the ratio of actual to expected cites is greater than 1, indicating that the global change papers are more highly cited than the average papers in those fields (see Table 13). For all 14 fields combined, the ratio of total number of cites to the total number of expected cites (5,925 to 3,332.72) is 1.8, indicating that the global change papers are more highly cited than the average paper.

Table 13. Ratio of Actual Cites to Expected Cites for Global Change Papers by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Agricultural Sciences	8	9.13	0.9
Biology & Biochemistry	108	114.85	0.9
Clinical Medicine	352	207.45	1.7
Computer Science	7	1.65	4.2
Economics & Business	25	6.01	4.2
Engineering	374	197.85	1.9
Environment/Ecology	2,103	1,616.28	1.3

ESI Field	Total Cites	Expected Cite Rate	Ratio
Geosciences	1,372	598.58	2.3
Immunology	30	42.60	0.7
Microbiology	113	103.22	1.1
Multidisciplinary	820	41.87	19.6
Physics	4	6.83	0.6
Plant & Animal Science	568	362.94	1.6
Social Sciences, general	41	23.46	1.7
TOTAL	**5,925**	**3,332.72**	**1.8**

JCR Benchmarks

Impact Factor. The *JCR* Impact Factor is a well known metric in citation analysis. It is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to others in the same field. The Impact Factor is calculated by dividing the number of citations in the current year to articles published in the 2 previous years by the total number of articles published in the 2 previous years.

Table 14 indicates the number of global change papers published in the top 10% of journals, based on the *JCR* Impact Factor. One hundred four (104) of 432 papers were published in the top 10% of journals, representing 24.1% of the global change journal publications. This indicates that nearly one-quarter of the global change papers are published in the highest quality journals as determined by the *JCR* Impact Factor, which is 2.4 times higher than the expected percentage.

Table 14. Global Change Papers in Top 10% of Journals by *JCR* Impact Factor

Global Change Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
4	Science	30.028	9
3	Nature	26.681	15
4	Lancet	25.800	18
1	JAMA-Journal of the American Medical Association	23.175	23
4	Proceedings of the National Academy of Sciences of the United States of America	9.643	116
1	British Medical Journal	9.245	128

Global Change Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	Reviews of Geophysics	8.375	144
10	Environmental Health Perspectives	5.861	255
2	Bioscience	5.424	291
1	Journal of Infectious Diseases	5.363	298
1	American Journal of Epidemiology	5.241	308
1	Emerging Infectious Diseases	5.094	332
1	Trends in Parasitology	4.907	356
1	Frontiers in Ecology and the Environment	4.842	371
2	Ecology	4.782	381
1	Atmospheric Chemistry and Physics	4.362	449
2	Epidemiology	4.339	452
6	Global Change Biology	4.339	452
2	New Phytologist	4.245	474
2	Plant Cell and Environment	4.135	495
6	Environmental Science & Technology	4.040	518
2	Global Biogeochemical Cycles	3.796	587
8	Conservation Biology	3.762	601
1	Bulletin of the American Meteorological Society	3.728	614
2	American Journal of Public Health	3.698	626
3	Applied and Environmental Microbiology	3.532	682
1	Journal of Power Sources	3.521	686
9	Ecological Applications	3.470	708
9	Journal of Climate	3.419	728
1	Climate Dynamics	3.344	747
1	Oecologia	3.333	753
1	Global Ecology and Biogeography	3.314	764
8	Limnology and Oceanography	3.287	774
1	Microbes and Infection	3.127	833

Global Change Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	Remote Sensing of Environment	3.064	855
Total = 104			

Immediacy Index. The *JCR* Immediacy Index is a measure of how quickly the *average article* in a journal is cited. It indicates how often articles published in a journal are cited within the year they are published. The Immediacy Index is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year.

Table 15 indicates the number of global change papers published in the top 10% of journals, based on the *JCR* Immediacy Index. One hundred twenty-three (123) of the 432 papers appear in the top 10% of journals, representing 28.5% of the global change papers. This indicates that more than one-quarter of the global change papers are published in the highest quality journals as determined by the *JCR* Immediacy Index, which is 2.8 times higher than the expected percentage.

Table 15. Global Change Papers in Top 10% of Journals by *JCR* Immediacy Index

Global Change Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	JAMA-Journal of the American Medical Association	7.781	4
4	Lancet	7.419	6
3	Nature	6.789	9
4	Science	5.555	16
1	British Medical Journal	4.412	25
4	Proceedings of the National Academy of Sciences of the United States of America	1.758	126
2	Ambio	1.695	136
2	Journal of the North American Benthological Society	1.568	158
2	Epidemiology	1.437	187
9	Journal of Climate	1.343	206
1	Journal of Infectious Diseases	1.300	221
1	Emerging Infectious Diseases	1.222	243
1	Reviews of Geophysics	1.100	300

Global Change Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	American Journal of Epidemiology	1.091	306
1	Atmospheric Chemistry and Physics	1.015	350
10	Environmental Health Perspectives	0.994	373
2	New Phytologist	0.970	381
3	Journal of Biogeography	0.958	391
2	Marine Chemistry	0.958	391
1	Trends in Parasitology	0.906	417
1	Global Ecology and Biogeography	0.793	529
8	Limnology and Oceanography	0.784	537
8	Conservation Biology	0.778	543
2	Plant Cell and Environment	0.777	547
1	Climate Dynamics	0.760	569
2	American Journal of Public Health	0.740	588
2	Ecology	0.724	610
2	Global and Planetary Change	0.709	635
18	Journal of Geophysical Research-Atmospheres	0.684	673
1	Agricultural and Forest Meteorology	0.669	690
6	Global Change Biology	0.660	705
2	Monthly Weather Review	0.654	716
2	Global Biogeochemical Cycles	0.652	720
6	Environmental Science & Technology	0.646	729
1	Bulletin of the American Meteorological Society	0.646	729
3	Applied and Environmental Microbiology	0.634	751
1	Environmental Research	0.583	844
2	Bioscience	0.582	848
Total = 123			

Hot Papers

ESI establishes citation thresholds for hot papers, which are selected from the highly cited papers in different fields, but the time frame for citing and cited papers is much shorter—papers must be cited within 2 years of publication and the citations must occur in a 2-month time period. Papers are assigned to 2-month periods and thresholds are set for each period and field to select 0.1% of papers.

Using the hot paper thresholds established by *ESI* as a benchmark, 11 hot papers, representing 2.6% of the global change papers, were identified in five fields—Engineering, Environment/ Ecology, Geosciences, Multidisciplinary, and Plant & Animal Science. The number of global change hot papers is 26 times higher than expected. The hot papers are listed in Table 16.

Table 16. Hot Papers Identified Using *ESI* Thresholds

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Engineering	4	6 cites in July-August 2002	Douglas EM, et al. Trends in flood and low flows in the United States: impact of spatial correlation. *Journal of Hydrology* 2000;240(1-2):90-105.
Environment/ Ecology	5	5 cites in May 2000	Rose A, et al. Simulating the economic impacts of climate change in the Mid-Atlantic Region. *Climate Research* 2000;14(3):175-183.
	5	5 cites in May 2000	Fisher A, et al. The Mid-Atlantic Regional Assessment: motivation and approach. *Climate Research* 2000;14(3):153-159.
	5	8 cites in May 2000	Polsky C, et al. The Mid-Atlantic Region and its climate: past, present, and future. *Climate Research* 2000;14(3):161-173.
Environment/ Ecology	3	3 cites in January-February 2003	Ankley GT, et al. Assessment of the risk of solar ultraviolet radiation to amphibians. I. Dose-dependent induction of hindlimb malformations in the Northern leopard frog (*Rana pipiens*). *Environmental Science & Technology* 2002;36(13):2853-2858.
Geosciences	3	4 cites in November-December 2004	Hogrefe C, et al. Simulating regional-scale ozone climatology over the eastern United States: model evaluation results. *Atmospheric Environment* 2004;38(17):2627-2638.
	3	3 cites in May 2007	Wu SL, et al. Why are there large differences between models in global budgets of tropospheric ozone? *Journal of Geophysical Research-Atmospheres* 2007;112(D5):Art No. D05302.
Multidisciplinary	10	19 cites in September-October 2004	Root TL, et al. Fingerprints of global warming on wild animals and plants. *Nature* 2003;421(6918):57-60.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Multidisciplinary	6	15 cites in June-July 2007	Worm B, et al. Impacts of biodiversity loss on ocean ecosystem services. *Science* 2006;314(5800):787-790.
Plant & Animal Science	4	5 cites in December 2002	Sousounis PJ, Grover EK. Potential future weather patterns over the Great Lakes region. *Journal of Great Lakes Research* 2002;28(4):496-520.
	4	6 cites in March 2007	Bullard SG, et al. The colonial ascidian Didemnum sp A: Current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. *Journal of Experimental Marine Biology and Ecology* 2007;342(1):99-108.

Author Self-Citation

Self-citations are journal article references to articles from that same author (i.e., the first author). Because higher author self-citation rates can inflate the number of citations, the author self-citation rate was calculated for the global change papers. Of the 5,925 total cites, 424 are author self-cites—a 7.2% author self-citation rate. Garfield and Sher[3] found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts[4] claim that approximately 10% to 30% of all the citations listed fall into the category of author self-citation. Kovacic and Misak[5] recently reported a 20% author self-citation rate for medical literature. Therefore, the 7.2% self-cite rate for the global change papers is below the range for author self-citation.

Highly Cited Researchers

A search of Thomson's *ISIHighlyCited.com* revealed that 34 (3.4%) of the 1,006 authors of the global change papers are highly cited researchers. *ISIHighlyCited.com* is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999. The highly cited researchers identified during this analysis of the global change publications are presented in Table 17.

[3] Garfield E, Sher IH. New factors in the evaluation of scientific literature through citation indexing. *American Documentation* 1963;18(July):195-210.

[4] MacRoberts MH, MacRoberts BR. Problems of citation analysis: a critical review. *Journal of the American Society of Information Science* 1989;40(5):342-349.

[5] Kavaci N, Misak A. Author self-citation in medical literature. *Canadian Medical Association Journal* 2004;170(13):1929-1930.

Table 17. Highly Cited Researchers Authoring Global Change Publications

Highly Cited Researcher	Affiliation	*ESI* Field
Ankley, Gerald T	U.S. EPA	Environment/Ecology
Brown, Sandra L	Winrock International	Environment/Ecology
Caldwell, Martyn M	Utah State University	Environment/Ecology
Callaghan, Terry V	University of Sheffield	Environment/Ecology
Chase, Thomas N	NINDS	Neuroscience
Colwell, Rita R	Canon U.S. Life Sciences	Microbiology
Ehleringer, James	University of Utah	Environment/Ecology
Elliott, Edward T	University of Nebraska	Environment/Ecology
Galloway, James Neville	University of Virginia	Environment/Ecology Geosciences Engineering
Giorgi, Filippo	Abdus Salam International Centre for Theoretical Physics	Geosciences
Goldberg, Richard	Columbia University	Plant & Animal Science
Howarth, Robert W	Cornell University	Environment/Ecology
Jacob, Daniel J	Harvard University	Geosciences
Lauenroth, William K	Colorado State University	Environment/Ecology
Levin Simon A	Princeton University	Environment/Ecology
Logan Jennifer A	Harvard University	Geosciences
Lugo, Ariel E	USDA	Environment/Ecology
McKenzie Dan	University of Cambridge	Geosciences
Ojima, Dennis S	Colorado State University	Environment/Ecology
Palmer, T.N.	European Center for Medium Range Weather Forecasts	Geosciences
Parton, William J	Colorado State University	Environment/Ecology
Pielke, Roger A	Colorado State University	Geosciences
Rind, David H	NASA Goddard	Geosciences
Running, Steven W	University of Montana	Environment/Ecology
Sala, Osvaldo E	Brown University	Environment/Ecology
Schimel, David S	National Center for Atmospheric Research	Environment/Ecology
Schindler David W	University of Alberta	Environment/Ecology
Schwartz, Joel D	Harvard University	Environment/Ecology
Seinfeld John H	California Institute of Technology	Engineering Geosciences
Shugart, Herman H	University of Virginia	Environment/Ecology
Teramura, Alan H	University of Hawaii	Plant & Animal Science

Highly Cited Researcher	Affiliation	*ESI* Field
Wang J	U.S. National Weather Service, National Centers for Environmental Prediction	Geosciences
Zeger, Scott L	Johns Hopkins University	Mathematics
Zepp, Richard G	U.S. EPA	Environment/Ecology
Total = 34		

Patents

There were no patents issued to investigators from 1998 to 2007 for research that was conducted under EPA's Global Change Research Program.

II. Analysis of Global Change Non-Journal Publications by *ESI* Field

This section contains a bibliometric analysis of the non-journal publications prepared by intramural and extramural researchers of EPA's Global Change Research Program. For this analysis, 12 non-journal publications—4 reports, 5 books, 2 book chapters, and 1 technical paper—were reviewed. These publications were published from 2000 to 2007, and they were cited 720 times in the journals and books covered by Thomson Scientific's *Web of Science* and Google Scholar. All 12 (100%) of these publications have been cited at least once in a journal or book. The 4 reports were cited 31 times, the 5 books were cited 497 times, the 2 book chapters were cited 172 times, and the technical paper was cited 20 times.

Searches of *Web of Science* and Google Scholar were conducted to obtain times cited data for the Global Change Research Program non-journal publications. The analysis was completed using Thomson's *Essential Science Indicators (ESI)* as benchmarks. *ESI* provides access to a unique and comprehensive compilation of essential science performance statistics and science trends data derived from Thomson's databases. For this analysis, the *ESI* highly cited papers thresholds were used to assess the influence and impact of the global change non-journal publications.

Distribution of Non-Journal Publications Among *ESI* Fields

For this analysis, each publication was assigned to one of the 22 *ESI* fields so that the *ESI* thresholds for highly cited journal papers could be used to determine how many of the non-journal publications were highly cited. The 12 non-journal publications reviewed for this analysis were assigned to 4 of the 22 *ESI* fields. The distribution of the publications among these four fields and the number of citations by field are provided in Table 18.

Table 18. Non-Journal Global Change Publications by *ESI* Fields

***ESI* Field**	**No. of Citations**	**No. of EPA Publications**	**Average Cites/ Publication**
Clinical Medicine	36	2	18.0
Environment/Ecology	523	7	74.7
Geosciences	151	2	75.5
Plant & Animal Science	10	1	10.0
	Total = 720	**Total = 12**	**60.0**

Highly Cited Non-Journal Publications

There are 5 (41.7% of the publications analyzed) highly cited non-journal global change publications in three of the four *ESI* fields—Clinical Medicine, Environment/Ecology, and Geosciences—when using the *ESI* criteria for the **top 10% of papers**. Table 19 shows the number of global change publications in those three fields that meet the **top 10% threshold in *ESI***. The citations of the publications that met the criteria for the top 10% of papers are presented in Table 20.

Three (25.0%) of the publications analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These publications cover two fields—Environment/Ecology and Geosciences—and these publications are listed in Table 21. Two (16.7%) of the non-journal publications met the **top 0.1% threshold in *ESI,*** and one (8.3%) actually met the criteria for the **top 0.01% of papers**, which is impressive given that the expected numbers of very highly cited non-journal publications for this program are 0.12 and 0.012, respectively, for these thresholds. The citations of the publications that met the criteria for the top 0.1% and 0.01% of papers are presented in Tables 22 and 23.

Table 19. Number of Highly Cited Non-Journal Global Change Publications by Field (top 10%)

***ESI* Field**	**No. of Citations**	**No. of Publications**	**Average Cites/Publication**	**% of Publications in Field**
Clinical Medicine	13	1	13.0	50.0%
Environment/Ecology	487	3	162.3	42.9%
Geosciences	150	1	150.0	50.0%
	Total = 650	**Total = 5**	**130.0**	**41.7%**

Table 20. Highly Cited Non-Journal Global Change Publications (top 10%)

ESI Field	No. of Cites	Author(s)	Publication
Clinical Medicine	13	Corvalan C, Hales S, McMichael A, Butler C, Campbell-Lendrum D, Confalonieri U, Letiner K, Lewis N, Patz J, Polson K, Scheraga JD, Woodward A, Younes M	Ecosystems and human well-being: health synthesis. Report of the World Health Organization, 2005.
Environment/ Ecology	400	McCarthy JJ, Canziani OF, Leary NA, Dokken DJ, White KS, eds.	Climate Change 2001: Impacts, Adaptation, and Vulnerability. Report of the Intergovernmental Panel on Climate Change, World Meteorological Organization and United Nations Environment Programme. Cambridge, United Kingdom: Cambridge University Press, 2001, 1032 pp.
	22	Zepp RG	Solar ultraviolet radiation and aquatic carbon, nitrogen, sulfur and metals cycles (Chapter 5). In: Helbling EW, Zagarese H, eds. Ultraviolet Effects in Aquatic Organisms and Ecosystems. United Kingdom: Royal Society of Chemistry, 2003, pp. 137-184.
	65	Marshall P, Schuttenberg H, eds.	A Reef Manager's Guide to Coral Bleaching. Townsville, Australia: Great Barrier Reef Marine Park Authority, 2006, 163 pp.
Geosciences	150	Giorgi F, Hewitson B, Christensen J, Hulme M	Regional climate information – evaluation and projections (Chapter 10). In: Houghton JT, Ding Y, Griggs DJ, Noguer M, van der Linden PJ, Dai X, Maskell K, Johnson CA, eds. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom: Cambridge University Press, 2001, pp. 583-638.

Table 21. Highly Cited Non-Journal Global Change Publications (top 1%)

ESI Field	No. of Cites	Author(s)	Publication
Environment/ Ecology	400	McCarthy JJ, Canziani OF, Leary NA, Dokken DJ, White KS, eds.	Climate Change 2001: Impacts, Adaptation, and Vulnerability. Report of the Intergovernmental Panel on Climate Change, World Meteorological Organization and United Nations Environment Programme. Cambridge, United Kingdom: Cambridge University Press, 2001, 1032 pp.

ESI Field	No. of Cites	Author(s)	Publication
Environment/ Ecology	65	Marshall P, Schuttenberg H, eds.	A Reef Manager's Guide to Coral Bleaching. Townsville, Australia: Great Barrier Reef Marine Park Authority, 2006, 163 pp.
Geosciences	150	Giorgi F, Hewitson B, Christensen J, Hulme M	Regional climate information – evaluation and projections (Chapter 10). In: Houghton JT, Ding Y, Griggs DJ, Noguer M, van der Linden PJ, Dai X, Maskell K, Johnson CA, eds. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom: Cambridge University Press, 2001, pp. 583-638.

Table 22. Very Highly Cited Non-Journal Global Change Publications (top 0.1%)

ESI Field	No. of Cites	Author(s)	Publication
Environment/ Ecology	400	McCarthy JJ, Canziani OF, Leary NA, Dokken DJ, White KS, eds.	Climate Change 2001: Impacts, Adaptation, and Vulnerability. Report of the Intergovernmental Panel on Climate Change, World Meteorological Organization and United Nations Environment Programme. Cambridge, United Kingdom: Cambridge University Press, 2001, 1032 pp.
	65	Marshall P, Schuttenberg H, eds.	A Reef Manager's Guide to Coral Bleaching. Townsville, Australia: Great Barrier Reef Marine Park Authority, 2006, 163 pp.

Table 23. Extremely Highly Cited Non-Journal Global Change Publication (top 0.01%)

ESI Field	No. of Cites	Author(s)	Publication
Environment/ Ecology	65	Marshall P, Schuttenberg H, eds.	A Reef Manager's Guide to Coral Bleaching. Townsville, Australia: Great Barrier Reef Marine Park Authority, 2006, 163 pp.

Ratio of Actual Cites to Expected Citation Rates

The expected citation rate is the average number of cites that a paper published in the same journal in the same year and of the same document type (article, review, editorial, etc.) has received from the year of publication to the present. Using the *ESI* average citation rates for papers published by field as the benchmark, the non-journal global change publications were

cited more than the average paper in all 4 fields to which the non-journal global change publications were assigned, i.e., the ratio of actual to expected cites is greater than 1 (see Table 24). For all 4 fields combined, the ratio of total number of cites to the total number of expected cites (720 to 90.09) is 8.0, indicating that the non-journal global change publications are cited more than the average journal paper.

Table 24. Ratio of Actual Cites to Expected Cites for Non-Journal Global Change Publications by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Clinical Medicine	36	14.72	2.4
Environment/Ecology	523	48.53	10.8
Geosciences	151	17.30	8.7
Plant & Animal Science	10	9.54	1.0
TOTAL	**720**	**90.09**	**8.0**

III. Analysis of Global Change Publications by Focus Area

This section of the report presents an analysis of the global change papers by focus area (i.e., Air Quality, Human Health, Regional- and Place-Based Assessment, and Water Quality/Aquatic Ecosystem). The data are presented by focus area in Table 25, which includes eight key bibliometric parameters.

The results of the analysis are presented below and the numbers link the findings with the corresponding data in Table 25.

1. **No. of Global Change Papers Analyzed**—There were 66 Air Quality, 42 Human Health, 42 Regional- and Place-Based Assessment, and 282 Water Quality/Aquatic Ecosystem publications analyzed. Sixty-five percent of the global change publications fall under the Water Quality/Aquatic Ecosystem focus area.

2. **Total No. of Highly Cited Publications**—This analysis used four of the *ESI* thresholds for highly cited papers—those in the top 10%, top 1%, top 0.1%, and top 0.01%. It is extraordinary for a publication to meet the threshold for the top 0.01%; these publications are rare and should not be expected in every program. Using the *ESI* thresholds, about 25% of the global change publications are highly cited papers (this is 2.5 times the number expected). The percentage of global change papers that qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications ranges from 4.8% for the Regional- and Place-Based Assessment papers to 38.1% for the Human Health papers. The Human Health and Water Quality/Aquatic Ecosystem focus areas have the highest percentages of highly cited publications when using the *ESI* criteria for the top 10%, and the number of highly cited papers in these areas is 3.8 and 2.6 times higher than expected. The Human Health and Water Quality/Aquatic Ecosystem focus areas also hold the lead positions

when using the *ESI* criteria for the top 1% of papers, and the number of very highly cited papers in these areas is 4.8 and 3.2 times higher than expected. Two (0.7%) papers in the Water Quality/Aquatic Ecosystem focus area meet the *ESI* criteria for the top 0.1% of papers, which is 7 times higher than the expected number. One (0.4%) of the Water Quality/Aquatic Ecosystem papers meets the *ESI* criteria for the most highly cited papers (top 0.01%), which is extraordinary because the expected number of papers in this top category for a typical program of this size would be 0.03 papers.

3. **Ratio of Actual to Expected Cites**—The global papers are more highly cited than the average paper. Using the *ESI* average citation rates for papers published by field as the benchmark, the ratio of actual to expected cites is greater than 1 for all but one of the focus areas (i.e., Regional- and Place-Based Assessment). This indicates that the global change papers are more highly cited than the average papers published in these fields.

4. **No. of Papers in High Impact Journals by Impact Factor**—Nearly three-fourths of the Human Health, one-fourth of the Water Quality/Aquatic Ecosystem, and one-sixth of the Air Quality papers are published in high impact journals as determined by the Impact Factor of the journals in which the papers are published. The percentage of papers in high impact journals for the Air Quality, Human Health, and Water Quality/Aquatic Ecosystem focus areas ranges from 15.2% to 73.8% to 22.3%, which is 1.5, 7.4, and 2.2 times higher than expected for these three focus areas, respectively. None of the Regional- and Place-Based Assessment papers are published in high impact journals.

5. **No. of Papers in High Impact Journals by Immediacy Index**—Nearly three-fourths of the Human Health, one-third of the Air Quality, and one-fourth of the Water Quality/Aquatic Ecosystem papers are published in high impact journals as determined by the Immediacy Index of the journals in which the papers are published. The percentage of papers published in high impact journals ranges from 73.8% for Human Health, 30.3% for Air Quality, and 25.2% for Water Quality/Aquatic Ecosystem, which is 7.4, 3.0, and 2.5 times higher than expected for these three focus areas, respectively. Only 2.4% of the Regional- and Place-Based Assessment papers are published in high impact journals as determined by Immediacy Index, which is less than the expected 10%.

6. **Total No. of Publications Cited One or More Times**—In all four focus areas, the percentage of publications cited one or more times is very high (i.e., 84.8% to 95.2%).

7. **Total No. of Author Self Cites**—For three of the four focus areas, the authors of the global change papers cite themselves less than the average self-citation rate. The author self-citation rates for these three focus areas range from 4.0% for Human Health, 4.5% for Regional- and Place-Based Assessment and 4.9% for Water Quality/Aquatic Ecosystem. The rates for these three focus areas are well below the accepted range of 10-30% author self-citation rate, and the rate for the Air Quality papers is 14.3%, which is within the average range.

8. **No. of Hot Papers**—Using the hot paper thresholds established by *ESI* as a benchmark, there were hot papers published in three of the four focus areas. The highest percentage of hot papers (i.e., 9.5%) is in the Regional- and Place-Based Assessment focus area, followed by the Air Quality focus area at 3.0% and the Water Quality/Aquatic Ecosystem focus area at

1.8%. These percentages are 95, 30, and 18 times higher than expected for these three focus areas, respectively. None of the Human Health papers qualified as hot papers.

Table 25. Key Bibliometric Parameters for Global Change Papers by Focus Area

ANALYSIS PARAMETERS	Focus Areas			
	Air Quality	**Human Health**	**Regional- and Place-Based Assessment**	**Water Quality/ Aquatic Ecosystem**
1. No. of Global Change Papers Analyzed	66	42	42	282
2. No. of Highly Cited Publications That Met the Top 10% Threshold (Percentage)	16 (24.2%)	16 (38.1%)	2 (4.8%)	74 (26.2%)
No. of Highly Cited Publications That Met the Top 1% Threshold (Percentage)	1 (1.5%)	2 (4.8%)	0 (0%)	9 (3.2%)
No. of Highly Cited Publications That Met the Top 0.1% Threshold (Percentage)	0 (0%)	0 (0%)	0 (0%)	2 (0.7%)
No. of Highly Cited Publications That Met the Top 0.01% Threshold (Percentage)	0 (0%)	0 (0%)	0 (0%)	1 (0.4%)
3. Expected No. of Citations Calculated Using the Average Citation Rate	201.68	501.04	390.68	2,239.32
Total No. of Times Cited for All Publications	273	980	288	4,384
Ratio of Actual Cites to Expected Cites	1.4	2.0	0.7	2.0
4. No. of Papers in High Impact Journals by Impact Factor (Percentage)	10 (15.2%)	31(73.8%)	0 (0%)	63 (22.3%)
5. No. of Papers in High Impact Journals by Immediacy Index (Percentage)	20 (30.3%)	31 (73.8%)	1 (2.4%)	71 (25.2%)
6. No. of Publications Cited One or More Times (Percentage)	56 (84.8%)	40 (95.2%)	39 (92.9%)	250 (88.6%)
7. Total No. of Author Self Cites (Percentage)	39 (14.3%)	39 (4.0%)	13 (4.5%)	214 (4.9%)
8. No. of Hot Papers (Percentage)	2 (3.0%)	0 (0%)	4 (9.5%)	5 (1.8%)

IV. Additional *ESI* Parameters for Global Warming Publications

Since the last bibliometric analysis for the Global Change Research Program, which was conducted in 2006, *ESI* has begun analyzing special topics and reporting information such as the top 20 papers, top 20 authors, top 20 institutions, and top 20 countries for these special topics. One of the of *ESI* special topics is global warming. The parameters reported by *ESI* for the special topic of global warming are compared with the results of the analysis of the EPA Global Change Research Program publications below.

Top 20 Papers in Global Warming—A review of *ESI*'s top 20 papers on the topic of global warming (published from January 1, 1996 to April 30, 2006), indicates that 1 (5.0% of the top 20 papers) are papers from EPA's Global Change Research Program. This paper is listed in Table 26.

Top 20 Authors in Global Warming—None of *ESI*'s top 20 authors in global warming (ranked by total cites from 1996-2006) authored papers for EPA's Global Change Research Program.

Table 26. EPA Global Change Paper in *ESI*'s Top 20 Global Warming Papers Overall (Published from January 1, 1996 to April 30, 2006)

***ESI* Rank**	**EPA Global Change Program Publication**
5	Root TL, et al. Fingerprints of global warming on wild animals and plants. *Nature* 2003;421(6918):57-60.

Top 20 Countries Publishing in Global Warming—The United States ranks number one among the top 20 countries publishing on global warming. From 1996-2006, the United States published 1,362 papers that were cited 16,682 times. The second ranking country, England, published 447 papers that were cited 6,259 times.

Top 20 Journals in Global Warming—100 (23.2%) of the EPA Global Change Research Program papers were published in *ESI*'s top 20 journals in global warming (ranked by total cites from 1996-2006). The top 20 journals and the number of EPA global change published in these journals are provided in Table 27.

Table 27. *ESI*'s Top 20 Journals in Global Warming (Ranked by Total Cites, 1996-2006)

***ESI* Rank**	**Journal**	**Total Cites**	**Number of Papers**	**Cites Per Paper**	**Number of EPA Global Change Papers in Journal**
1	Nature	3,409	49	69.57	3
2	Science	2,047	33	62.03	4
3	Geophysical Research Letters	1,210	116	10.43	6
4	Journal of Climate	1,099	70	15.70	9

***ESI* Rank**	**Journal**	**Total Cites**	**Number of Papers**	**Cites Per Paper**	**Number of EPA Global Change Papers in Journal**
5	Climatic Change	1,050	90	11.67	20
6	Journal of Geophysical Research-Atmospheres	886	70	12.66	18
7	Proceedings of the National Academy of Sciences of the United States of America	735	28	26.25	4
8	Climate Dynamics	600	35	17.14	1
9	Global Change Biology	440	58	7.59	6
10	Forest Ecology and Management	380	20	19.00	5
11	Global Biogeochemical Cycles	356	27	13.19	2
12	Trends in Ecology & Evolution	344	5	68.80	0
13	Tellus Series B-Chemical and Physical Meteorology	342	16	21.38	1
14	Ambio	328	29	11.31	2
15	Ecology	328	21	15.62	2
16	Environmental Health Perspectives	320	13	24.62	10
17	Quaternary Science Reviews	318	8	39.75	0
18	Geology	282	15	18.80	0
19	Global Change Biology	280	10	28.00	6
20	Bulletin of the American Meteorological Society	259	12	21.58	1
Total					**100**

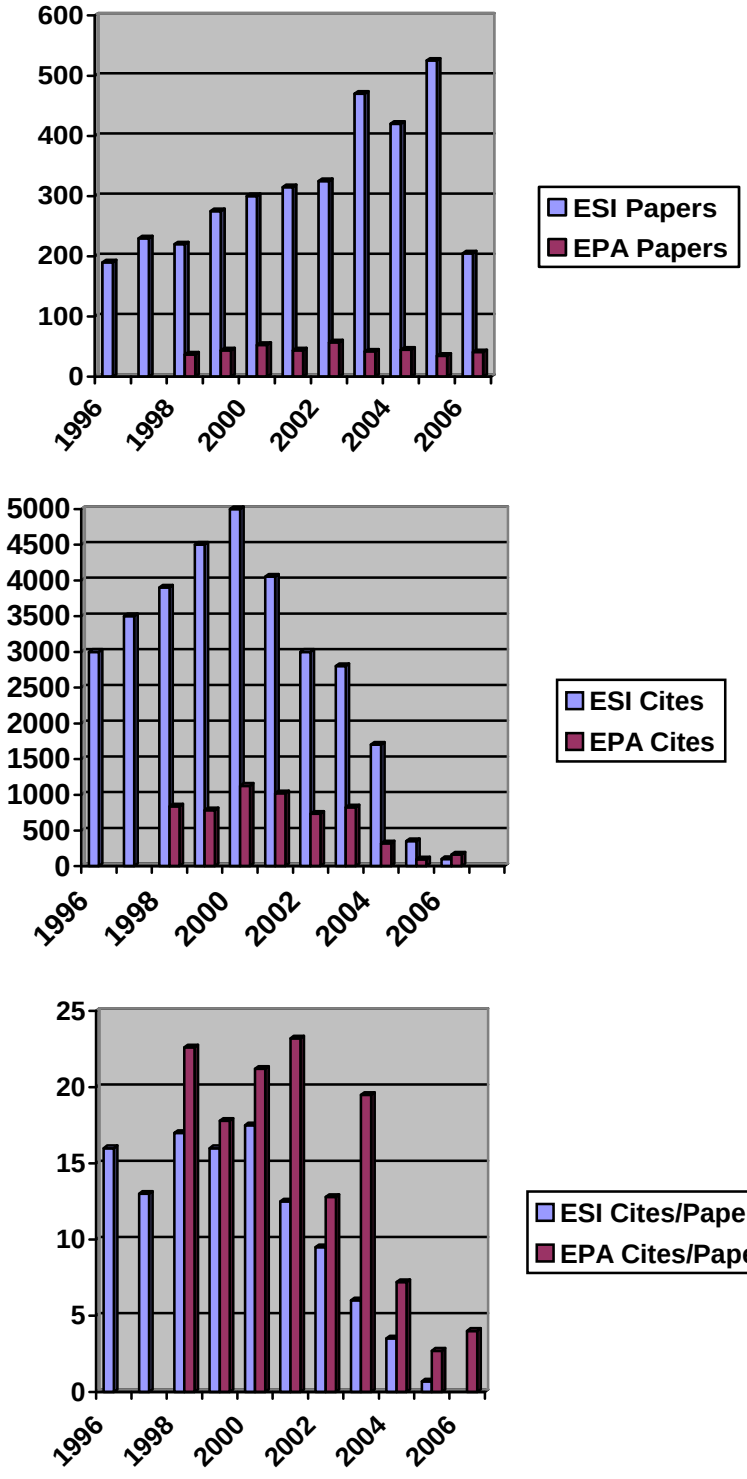
Top 20 Institutions Publishing on Global Warming—The National Aeronautics and Space Administration (NASA) ranks number one on *ESI*'s top 20 overall institutions publishing on global warming with 48 papers (published from 1996-2006) that were cited 1,559 times. NASA is one of the partners on EPA grants that publish under the Global Change Research Program. Thirteen (65.0%) of the top 20 institutions publishing global warming papers are participants in EPA's Global Change Research Program. The top 20 institutions are listed in Table 28.

Table 28. *ESI*'s Top 20 Institutions Publishing on Global Warming (Ranked by Total Cites, 1996-2006)

ESI Rank	Institution	Total Cites	Number of Papers	Cites Per Paper	Participant in EPA's Global Change Research Program
1	NASA	1,559	48	32.48	Yes
2	NOAA	1,471	49	30.02	No
3	Stanford University	1,014	40	25.35	Yes
4	National Center for Atmospheric Research	927	32	28.97	Yes
5	Pennsylvania State University	884	39	22.67	Yes
6	Columbia University	870	40	21.75	Yes
7	Meteorology Office, Hadley Centre for Climate Change	742	19	39.05	No
8	Rutgers State University	732	25	29.28	Yes
9	MIT	710	51	13.92	Yes
10	University of California-Berkeley	685	50	13.70	Yes
11	Princeton University	674	41	16.44	Yes
12	University of California-San Diego	650	25	26.00	No
13	University of Queensland	633	14	45.21	No
14	University of Maryland	565	24	23.54	Yes
15	U.S. Forest Service	563	20	28.15	Yes
16	Michigan State University	556	16	34.75	No
17	University of Illinois	524	26	20.15	Yes
18	University of East Anglia	504	34	14.82	No
19	Harvard University	488	22	22.18	Yes
20	University of Victoria	487	27	18.04	No

Global Warming Publication Trends—According to *ESI*, the number of global warming papers generally rose from 1996 to 2003; the number of papers declined slightly in 2004 and then increased in 2005 (because the data for 2006 are incomplete, no conclusion can be drawn concerning the trend in 2006). The number of cites of global warming papers published from 1996 to 2000 increased steadily, but has declined for papers published from 2001 to 2005. The trends are depicted in Figure 1. The number of EPA Global Change Research Program publications, however, increased from 1998 to 2000, declined in 2001, peaked in 2002, and leveled off from 2003 to 2006 at an average of 41 publications per year. Like the overall global warming paper trends identified by *ESI*, the number of cites and the cites per paper for the EPA Global Change Research Program publications have declined significantly in recent years.

Figure 1. Comparison of *ESI* Global Warming Publication Trends with EPA Global Change Research Program Publication Trends



ESI Field Distribution of Global Warming Papers—The majority of global warming papers from 1996 to 2006 were published in journals that fall within the *ESI* field of Geosciences, followed by the fields of Environment/Ecology, Engineering, Multidisciplinary, and Social Sciences. For the EPA global change papers included in this analysis, the majority of the papers were published in the *ESI* field of Environment/Ecology, followed by Geosciences, Multidisciplinary, Plant & Animal Science, and Engineering. The distribution of global warming papers among the 22 *ESI* fields and the distribution of the EPA global change papers for comparison are presented in Table 29.

Table 29. Comparison of Field Distribution of Global Warming Papers (Ranked by Number of Papers, 1991-2001) to Field Distribution of EPA Global Change Research Program Papers (Published from 1998-2007)

ESI Rank	*ESI* Field	Global Warming Papers Overall				EPA Global Change Papers			
		Total Cites	Number of Papers	Cites Per Paper	% of Papers	Total Cites	Number of Papers	Cites Per Paper	% of Papers
1	Geosciences	6,047	516	11.72	18.3%	1,372	87	15.8	20.1%
2	Environment/ Ecology	3,881	485	8.00	17.2%	2,103	175	12.0	40.5%
3	Engineering	649	302	2.15	10.7%	374	47	8.0	10.9%
4	Multidisciplinary	3,371	274	12.30	9.7%	820	12	68.3	2.8%
5	Social Sciences	891	259	3.44	9.2%	41	7	5.8	1.6%
6	Chemistry	399	199	2.01	7.0%	—	—	—	—
7	Plant & Animal Science	1,834	180	10.19	6.4%	568	65	8.7	15.0%
8	NO CATEGORY	0	169	0	6.0%	—	—	—	—
9	Economics & Business	730	139	5.25	4.9%	25	2	12.5	0.5%
10	Agricultural Sciences	295	66	4.47	2.3%	8	1	8.0	0.2%
11	Clinical Medicine	159	58	2.74	2.0%	352	16	22.0	3.7%
12	Materials Science	84	49	1.71	1.7%	—	—	—	—
13	Biology & Biochemistry	318	44	7.23	1.6%	108	10	10.8	2.3%
14	Physics	229	42	5.45	1.5%	4	1	4.0	0.2%
15	Microbiology	62	10	6.20	0.4%	113	6	18.8	1.4%
16	Space Science	16	10	1.60	0.4%	—	—	—	—
17	Computer Science	25	7	3.57	0.2%	7	1	7.0	0.2%
18	Psychiatry/Psychology	20	6	3.33	0.2%	—	—	—	—
19	Immunology	0	3	0	0.1%	30	2	15.0	0.5%
20	Molecular Biology & Genetics	14	2	7.00	0.1%	—	—	—	—
21	Pharmacology & Toxicology	2	2	1.00	0.1%	—	—	—	—
22	Neuroscience & Behavior	0	1	0	0.0%	—	—	—	—
Total		19,026	2,823	6.74	100%	5,925	432	13.7	100%

This bibliometric analysis was prepared by
Beverly Campbell, The Scientific Consulting Group, Inc.
under EPA Contract No. EP-C-05-015