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Bibliometric Analysis of Papers on Topics Related to Global Change

This is a revised bibliometric analysis of the papers prepared by intramural and extramural researchers of the U.S. Environmental Protection Agency (EPA) on topics related to global change (GC). This analysis was revised in June 2007 because the journals were initially categorized into the fields used by Thomson Scientific's *Essential Science Indicators (ESI)* using information provided in Thomson's *Journal Citation Reports (JCR)*; for this revised analysis, the journals were categorized into *ESI* fields using the journal category list by *ESI* that is available on the Internet at <http://in-cites.com/journal-list/index.html>. The Journal List for *ESI* was made available in 2006 and the current list contains all of the 12,734 journals covered for *ESI* up to December 31, 2006. This list is updated bimonthly by Thomson. This revised bibliometric analysis will allow comparison of the results of this 2005 analysis to those of the analysis performed in 2007.

This is a bibliometric analysis of the papers prepared by intramural and extramural researchers of on topics related to global change. For this analysis, 341 papers, reports, and books were reviewed, and they were published from 1998 to 2005. These publications were cited 3,694 times in the journals covered by Thomson's *Web of Science*.¹ Of these 341 publications, 293 (86%) have been cited at least once in a journal.

Searches of Thomson's *Web of Science*, Scopus², and Google were conducted to obtain times cited data for the global change journal publications. The analysis was completed using Thomson's *ESI* and *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 influence and impact measures, *ESI* employs both total citation counts by field and cites per paper scores. The former reveals gross influence while the latter shows weighted influence, also called impact. *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 Immediacy Index and the Impact Factor. 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. 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

¹ Thomson's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,700 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.

evaluate a journal's relative importance, especially when compared to other journals in the same field.

The report is divided into three sections. The first section presents an analysis of all 341 global change papers analyzed by *ESI* field (e.g., Environment/Ecology, Geosciences, Plant & Animal Science, Engineering). The second section presents an analysis of the global change papers by year of publication. The third section presents an analysis of the global change papers by focus area (e.g., air quality, regional assessment, ecosystems). In each section, a summary of the results is provided as well as the data evaluated and a description of the analysis.

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

SUMMARY OF RESULTS

1. **About one-fifth of the global change publications are highly cited papers.** A review of the citations indicates that 67 (19.6%) of the global change papers qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is nearly twice the number expected for a typical program. Eight (2.3%) of the global change papers qualify as highly cited when using the criteria for the top 1%, which is more than twice the number expected. One (0.3%) of these papers qualifies as very highly cited (in the top 0.1%), which is 3 times the number expected. It is not surprising that no papers actually meet the 0.01% threshold for the most highly cited papers because the expected number for this program is 0.03 papers in the most highly cited category.
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 9 of the 14 fields in which the 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 (3,694 to 2103.25) is 1.8, indicating that the global change papers are more highly cited than the average paper.
3. **Nearly one-third of the global change papers are published in very high impact journals.** Ninety-nine (99) of the 341 papers were published in the top 10% of journals ranked by *JCR* Impact Factor, representing 29% of EPA's global change papers. This number is about 3 times higher than expected. One-hundred seven (107) of the 341 papers appear in the top 10% of journals ranked by *JCR* Immediacy Factor, representing 31% of EPA's global change papers. This number is more than 3 times higher than expected.
4. **Eight of the global change papers qualify as hot papers.** Using the hot paper thresholds established by *ESI* as a benchmark, 8 hot papers, representing 2.4% 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 is 24 times higher than expected.
5. **The authors of the global change papers cite themselves much less than the average author.** Two-hundred fifteen (215) of the 3,694 cites are author self-cites. This 5.8% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.
6. **Twenty-seven of the authors of the global change papers are included in *ISI Highly Cited.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.

Highly Cited Global Change Publications

The 341 global change papers reviewed for this analysis covered 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

<i>ESI</i> Field	No. of Citations	No. of EPA GC Papers	Average Cites/Paper
Environment/Ecology	1,521	148	10.28
Geosciences	680	54	12.59
Plant & Animal Science	462	48	9.62
Multidisciplinary	419	7	59.86
Clinical Medicine	211	19	7.00
Engineering	203	41	4.95
Microbiology	85	4	21.25
Biology & Biochemistry	60	8	7.50
Immunology	20	2	10.0
Social Sciences, general	14	5	2.80
Economics & Business	11	2	5.50
Agricultural Sciences	6	1	1.00
Physics	2	1	2.00
Computer Science	0	1	0.00
	Total = 3,694	Total = 341	10.83

There are 67 (19.65% of the papers analyzed) highly cited EPA global change papers in 7 of the 14 fields—Environment/Ecology, Geosciences, Multidisciplinary, Plant & Animal Science, Engineering, Clinical Medicine, and Economics & Business—when using the *ESI* criteria for the **top 10% of papers**. Table 2 shows the number of EPA papers in those 7 fields that meet the **top 10% threshold in *ESI***. Eight (2.35%) of the papers analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These papers cover five fields—Multidisciplinary, Environment/Ecology, Geosciences, Plant & Animal Science, and Engineering. Table 3 shows the 8 papers by field that meet the **top 1% threshold in *ESI***. The citations for these 10 papers are provided in Tables 4 through 8. There was 1 (0.3%) very highly cited global change paper in the Multidisciplinary field. This paper, which met the **top 0.1% threshold in *ESI***, is listed in Table 9. None of the global change papers actually met the **top 0.01% threshold in *ESI***, which is to be expected.

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

<i>ESI</i> Field	Citations	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
Environment/Ecology	773	27	28.63	18.24%
Geosciences	485	13	37.31	24.07%
Multidisciplinary	405	5	81.00	71.43%
Plant & Animal Science	262	11	23.82	22.92%
Engineering	128	7	18.26	17.07%
Clinical Medicine	126	3	42.00	15.79%
Economics & Business	10	1	10.00	50.00%
	Total = 2,189	Total = 67	32.67	19.65%

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

<i>ESI</i> Field	Citations	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
Multidisciplinary	304	2	152.0	28.57%
Environment/Ecology	215	2	107.5	1.35%
Geosciences	134	2	67.00	3.70%
Plant & Animal Science	79	1	79.00	2.08%
Engineering	52	1	52.00	2.44%
	Total = 784	Total = 8	98.0	2.35%

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

No. of Cites	First Author	Paper
236	Root TL	Fingerprints of global warming on wild animals and plants. <i>Nature</i> 2003;421(6918):57-60.
68	Pascual M	Cholera dynamics and El Nino-Southern Oscillation. <i>Science</i> 2000;289(5485):1766-1769.

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

No. of Cites	First Author	Paper
141	National Assessment Team	Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change (Overview and Foundation reports), 2001.
74	Marsh DM	Metapopulation dynamics and amphibian conservation. <i>Conservation Biology</i> 2001;15(1):40-49.

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

No. of Cites	First Author	Paper
61	Pielke RA	Influence of the spatial distribution of vegetation and soils on the prediction of cumulus convective rainfall. <i>Reviews of Geophysics</i> 2001;39(2):151-177.
73	Chase TN	Simulated impacts of historical land cover changes on global climate in northern winter. <i>Climate Dynamics</i> 2000;16(2-3):93-105.

Table 7. Highly Cited Global Change Paper in the Field of Plant & Animal Science (top 1%)

No. of Cites	First Author	Paper
79	Moran MA	Carbon loss and optical property changes during long-term photochemical and biological degradation of estuarine dissolved organic matter. <i>Limnology and Oceanography</i> 2000;45(6):1254-1264.

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

No. of Cites	First Author	Paper
52	Douglas EM	Trends in floods and low flows in the United States: impact of spatial correlation. <i>Journal of Hydrology</i> 2000;240(1-2):90-105.

Table 9. Very Highly Cited Global Change Paper in the Field of Multidisciplinary (top 0.1%)

No. of Cites	First Author	Paper
236	Root TL	Fingerprints of global warming on wild animals and plants. <i>Nature</i> 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 9 of the 14 fields in which the 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 (see Table 10).

Table 10. Ratio of Actual Cites to Expected Cites for Global Change Papers by Field

<i>ESI</i> Field	Total Cites	Expected Cite Rate	Ratio
Agricultural Sciences	6	6.98	0.86
Biology & Biochemistry	60	64.12	0.94
Clinical Medicine	211	148.50	1.42
Computer Science	0	0.63	0.00
Economics & Business	11	2.36	4.66
Engineering	203	112.83	1.80
Environment/Ecology	1,521	1,041.40	1.46
Geosciences	680	354.04	1.92
Immunology	20	28.94	0.69
Microbiology	85	53.17	1.60
Multidisciplinary	419	28.97	14.46
Physics	2	3.96	0.50
Plant & Animal Science	462	247.31	1.87
Social Sciences, general	14	10.07	1.39

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 11 indicates the number of global change papers published in the top 10% of journals, based on the *JCR* Impact Factor. Ninety-nine (99) of 341 papers were published in the top 10% of journals, representing 29.0% of EPA’s global change papers. This indicates that nearly one-third of the global change papers are published in the highest quality journals as determined by the *JCR* impact factor, which is nearly 3 times the expected percentage.

Table 11. Global Change Papers in Top 10% of Journals by *JCR* Impact Factor

EPA Global Change Papers in that Journal	Journal	Impact Factor (IF)	<i>JCR</i> IF Rank
10	Environmental Health Perspectives	3.929	439
9	Journal of Geophysical Research–Atmospheres	2.839	831
7	Ecological Applications	3.287	623
7	Ecosystems	3.241	642
6	Global Change Biology	4.333	358
6	Journal of Climate	3.500	558
5	Epidemiology	3.840	459
5	Conservation Biology	3.672	504
5	Environmental Science & Technology	3.557	540
4	Lancet	21.713	20
4	Proceedings of the National Academy of Sciences of the United States of America	10.452	88
4	Limnology and Oceanography	3.024	737
3	Applied and Environmental Microbiology	3.810	470
2	Nature	32.182	9
2	Ecology	4.104	394
2	Plant Cell and Environment	3.634	517
2	New Phytologist	3.355	603

EPA Global Change Papers in that Journal	Journal	Impact Factor (IF)	JCR IF Rank
2	American Journal of Public Health	3.241	642
2	Bioscience	3.041	730
1	Science	31.853	10
1	JAMA—Journal of the American Medical Association	24.831	15
1	Reviews of Geophysics	8.667	114
1	British Medical Journal	7.038	169
1	Emerging Infectious Diseases	5.643	230
1	Trends in Parasitology	5.497	239
1	Journal of Infectious Diseases	4.943	287
1	American Journal of Epidemiology	4.933	290
1	Microbes and Infection	3.753	480
1	Climate Dynamics	3.497	561
1	Oecologia	2.899	800
1	Agricultural and Forest Meteorology	2.811	844
Total = 99			

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 12 indicates the number of global change papers published in the top 10% of journals, based on the JCR Immediacy Index. One-hundred seven (107) of the 341 papers appear in the top 10% of journals, representing 31.4% of the global change papers. This indicates that approximately one-third of the global change papers are published in the highest quality journals as determined by the JCR immediacy index, which is more than 3 times higher than the expected percentage.

Table 12. Global Change Papers in Top 10% of Journals by JCR Immediacy Index

EPA Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
17	Climatic Change	1.235	195

EPA Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
10	Environmental Health Perspectives	1.202	202
9	Journal of Geophysical Research–Atmospheres	0.617	630
7	Ecosystems	2.048	76
7	Ecological Applications	0.747	466
6	Journal of Climate	0.528	795
5	Epidemiology	0.864	354
5	Conservation Biology	0.744	468
5	Environmental Science & Technology	0.623	617
4	Lancet	5.017	12
4	Proceedings of the National Academy of Sciences of the United States of America	1.923	89
3	Journal of Biogeography	0.514	827
2	Nature	6.089	5
2	New Phytologist	0.876	349
2	Bioscience	0.863	356
2	American Journal of Public Health	0.723	489
2	Plant Cell and Environment	0.605	653
2	Ecology	0.590	676
1	Science	7.379	3
1	JAMA–Journal of the American Medical Association	5.499	9
1	British Medical Journal	3.039	35
1	Reviews of Geophysics	1.714	110
1	Ambio	1.435	156
1	Emerging Infectious Diseases	1.350	169
1	Journal of Infectious Diseases	1.105	229
1	American Journal of Epidemiology	0.842	373
1	Trends in Parasitology	0.819	393
1	Aquatic Sciences	0.800	413
1	Hydrobiologia	0.681	532

EPA Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
1	Tellus Series B-Chemical and Physical Meteorology	0.610	646
1	Theoretical and Applied Climatology	0.564	720
Total = 107			

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. There were no hot papers identified for the current 2-month period (i.e., January–February 2006), but there were a number of hot papers identified from previous periods.

Using the hot paper thresholds established by *ESI* as a benchmark, 8 hot papers, representing 2.4% of the global change papers, were identified in five fields—Environment/Ecology, Engineering, Multidisciplinary, Plant & Animal Science, and Geosciences. The hot papers are listed in Table 13.

Table 13. Hot Papers Identified Using *ESI* Thresholds

Field	<i>ESI</i> Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	4	8 cites in May 2000	Polsky C, et al. The Mid-Atlantic Region and its climate: past, present, and future. <i>Climate Research</i> 2000;14(3):161-173.
	4	5 cites in May 2000	Rose A, et al. Simulating the economic impacts of climate change in the Mid-Atlantic Region. <i>Climate Research</i> 2000;14(3):175-183.
	4	5 cites in May 2000	Fisher A, et al. The Mid-Atlantic Regional Assessment: motivation and approach. <i>Climate Research</i> 2000;14(3):153-159.
	4	4 cites in October–November 2001	Patz JA, et al. The potential health impacts of climate variability and change for the United States: executive summary of the health sector of the US National Assessment. <i>Environmental Health Perspectives</i> 2000;108(4):367-376.

Field	ESI Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Engineering	5	7 cites in June-July 2002	Douglas EM, et al. Trends in floods and low flows in the United States: impact of spatial correlation. <i>Journal of Hydrology</i> 2000;240(1-2):90-105.
Multidisciplinary	9	9 cites in September-October 2003	Root TL, et al. Fingerprints of global warming on wild animals and plants. <i>Nature</i> 2003;421(6918):57-60.
Plant & Animal Science	4	5 cites in December 2002	Sousounis PJ, Grover EK. Potential future weather patterns over the Great Lakes region. <i>Journal of Great Lakes Research</i> 2002;28(4):496-520.
Geosciences	4	4 cites in October-November 2001	Hogrefe C, et al. Simulating regional-scale ozone climatology over the eastern United States: model evaluation. <i>Atmospheric Environment</i> 2004;38(17):2627-2638.

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 3,694 total cites, 215 are author self-cites—a 5.8% author self-citation rate. Garfield and Sher³ found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts⁴ claim that approximately 10% to 30% of all the citations listed fall into the category of author self-citation. Kovacic and Misak⁵ recently reported a 20% author self-citation rate for medical literature. Therefore, the 5.8% self-cite rate for the global change papers is well below the range for author self-citation.

Highly Cited Researchers

A search of Thomson's *ISIHighlyCited.com* revealed that 27 (3.5%) of the 773 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

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.

during the period from 1981 to 1999. The highly cited researchers identified during this analysis of the global change publications are presented in Table 14.

Table 14. 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
Giorgi, Filippo	Abdus Salam International Centre for Theoretical Physics	Geosciences
Goldberg, Richard	Columbia University	Plant & Animal Science
Jacob, Daniel J	Harvard University	Geosciences
Lauenroth, William K	Colorado State University	Environment/Ecology
Lugo, Ariel E	USDA	Environment/Ecology
Ojima, Dennis S	Colorado State University	Environment/Ecology
Pacala, Stephen	Princeton University	Ecology/Environment
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
Schwartz, Joel D	Harvard University	Environment/Ecology
Shugart, Herman H	University of Virginia	Environment/Ecology
Teramura, Alan H	University of Hawaii	Plant & Animal Science
Zeger, Scott L	Johns Hopkins University	Mathematics
Zepp, Richard G	U.S. EPA	Environment/Ecology
Total = 27		

II. Analysis of Global Change Publications by Year of Publication

This section of the report presents an analysis of the global change papers by year of publication from 1998 to 2005. The data are presented by year in Table 15, which includes eight key bibliometric parameters.

SUMMARY OF RESULTS

1. **About one-fifth of the global change publications are highly cited papers (this is twice the number expected for a typical program).** From 1998 to 2005, the percentage of global change papers that qualified as highly cited when using the *ES*/criteria for the top 10% of highly cited publications ranges from a low of 7.4% to a high of 30.9%. From 2000 to 2003, there were 8 papers that qualified as very highly cited when using the *ES*/criteria for the top 1%, with the percentages ranging from 2.4% to 7.7%. These percentages are, on average, about 2.6 times higher than would be expected for a typical program. One paper published in 2003 meets the *ES*/criteria for the top 0.1%, which is about 3 times higher than would be expected for a typical program. None of the global change papers meet the *ES*/criteria for the most highly cited papers (top 0.01%). The expected number of papers in this top category for a program of this size would be 0.03 papers, so the absence of papers in this top category is not surprising.
2. **The global papers are more highly cited than the average paper.** Using the *ES*/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 years analyzed (i.e., 2004). This indicates that the global change papers are more highly cited than the average papers published in these fields.
3. **Nearly one-third of the global change papers are published in high impact journals** as determined by the *JCR* Impact Factor of the journals in which the papers are published. For every year analyzed 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) ranges from 14.3% to 45.2%, which is 1.4 to 4.5 times higher than expected. The percentage of papers in high impact journals (by Immediacy Index) ranges from 14.3% to 38.1%, which is 1.4 to 3.8 times higher than expected.
4. **The percentage of publications cited one or more times is consistently high from 1998 to 2003.** The number declines as expected in the more recent years (i.e., 2004 and 2005) because most publications are not cited until a year or longer after they are published.
5. **The authors of the global change papers cite themselves less than the average self-citation rate.** The author self-citation rate for most years is well below the accepted range of 10-30% author self-citation rate. The only exception is in 2005, which is expected because most publications are not cited by other researchers until a year or longer after they are published.
6. **There were hot papers published in 2000, 2002, 2003, and 2004.** The absence of hot papers in 2005 is not surprising given the fact that the period during which the citations analyzed for determining hot paper status was incomplete.

The results of the analysis are presented below and the numbers link the findings with the corresponding data in Table 15.

1. **No. of Global Change Papers Analyzed**—The number of global change publications has ranged from 27 to 56 per year over the period analyzed (i.e., 1998 to 2005).
2. **Total No. of Highly Cited Publications**—*ESI* identifies four thresholds of highly cited papers—those in the top 10%, 1%, 0.1%, and 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 for the top 10% cited papers, about 20% of the global change publications are highly cited papers (this is twice the number expected for a typical program). From 1998 to 2005, 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 a low of 7.4% to a high of 30.9%. From 2000 to 2003, there were 8 papers that qualify as very highly cited when using the *ESI* criteria for the top 1%, with the percentage ranging from 0% to 7.7%. These percentages are, on average, about 3.5 times higher than would be expected for a typical program. One paper published in 2003 meets the *ESI* criteria for the top 0.1%, which is about 3 times higher than would be expected for a typical program. None of the global change papers meet the *ESI* criteria for the most highly cited papers (top 0.01%). The expected number of papers in this top category for a typical program of this size would be 0.03 papers, so the absence of papers in this top category is not surprising.
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 two of the years analyzed (i.e., 2004 and 2005). 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 one-third of the global change papers are published in high impact journals as determined by the *JCR* Impact Factor of the journals in which the papers are published. For every year analyzed, 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 of the journals. The percentage of papers in high impact journals (by Impact Factor) ranges from 14.3% to 45.2%, which is 1.4 to 4.5 times higher than expected.
5. **No. of Papers in High Impact Journals by Immediacy Index**— Nearly one-third of the global change papers are published in high impact journals as determined by the *JCR* Immediacy Index of the journals in which the papers are published. For every year analyzed, 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* Immediacy Index of the journals. The percentage of papers in high impact journals (by Immediacy Index) ranges from 14.3% to 38.1%, which is 1.4 to 3.8 times higher than expected.
6. **Total No. of Publications Cited One or More Times**—The percentage of publications cited one or more times is consistently high (88% or greater) from 1998 to 2003. The number declines as expected in the more recent years (i.e., 2004 and 2005) because most publications are not cited until a year or longer after they are published.

7. **Total No. of Author Self Cites**—The authors of the global change papers cite themselves less than the average self-citation rate. The author self-citation rates in Table 15 are well below the accepted range of 10-30% author self-citation rate. The only exception is in 2005, which is expected because most publications are not cited by other researchers until a year or longer after they are published.
8. **No. of Hot Papers**—Using the hot paper thresholds established by *ESI* as a benchmark, there were hot papers published in 2000, 2002, 2003, and 2004. Because only the top 0.1% of papers are selected as hot papers for each *ESI* field, the percentages of global change hot papers identified in Table 15 are 18 to 96 times higher than expected for these years. The percentage of hot papers in 2004 and 2005 is probably low because this analysis was conducted before the 2 year period in which hot papers must be cited was completed. *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. For papers published in 2004, the 2-year period of consideration would not conclude until 2006. Similarly, for papers published in 2005, the 2-year period of consideration would not conclude until 2007. The original bibliometric analysis was completed in March 2006; therefore, the number of hot papers among those published in 2004 and 2005 would be expected to be lower than if the analysis was completed in January 2008.

Table 15. Key Bibliometric Parameters for Global Change Papers By Year (1998 to 2005)

ANALYSIS PARAMETERS	1998	1999	2000	2001	2002	2003	2004	2005
1. No. of Global Change Papers Analyzed	35	42	52	42	56	41	46	27
2. No. of Highly Cited Publications That Met the Top 10% Threshold (Percentage)	9 (25.7%)	9 (21.4%)	9 (17.3%)	13 (30.9%)	12 (21.4%)	9 (21.9%)	4 (8.7%)	2 (7.4%)
No. of Highly Cited Publications That Met the Top 1% Threshold (Percentage)	0 (0%)	0 (0%)	4 (7.7%)	3 (7.1%)	0 (0%)	1 (2.4%)	0 (0%)	0 (0%)
No. of Highly Cited Publications That Met the Top 0.1% Threshold (Percentage)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2.4%)	0 (0%)	0 (0%)
No. of Highly Cited Publications That Met the Top 0.01% Threshold (Percentage)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

ANALYSIS PARAMETERS	1998	1999	2000	2001	2002	2003	2004	2005
3. Expected No. of Citations Calculated Using the Average Citation Rate	376.59	382.38	489.43	328.86	295.71	144.18	78.10	8.00
Total No. of Times Cited for All Publications	630	528	817	791	434	419	67	8
Ratio of Actual Cites to Expected Cites	1.67	1.38	1.67	2.41	1.47	2.91	0.86	1.00
4. No. of Papers in High Impact Journals by Impact Factor (Percentage)	5 (14.3%)	7 (16.7%)	17 (32.7%)	19 (45.2%)	20 (35.7%)	8 (19.5%)	14 (30.4%)	9 (33.3%)
5. No. of Papers in High Impact Journals by Immediacy Index (Percentage)	6 (17.1%)	6 (14.3%)	14 (26.9%)	16 (38.1%)	19 (33.9%)	13 (31.7%)	15 (32.6%)	9 (33.3%)
6. No. of Publications Cited One or More Times (Percentage)	34 (97.1%)	40 (95.2%)	51 (98.1%)	41 (97.6%)	54 (96.4%)	36 (87.8%)	31 (67.4%)	6 (22.2%)
7. Total No. of Author Self Cites (Percentage)	61 (9.7%)	49 (9.3%)	35 (4.3%)	26 (3.3%)	25 (5.8%)	10 (2.4%)	5 (7.5%)	4 (50.0%)
8. No. of Hot Papers (Percentage)	0 (0%)	0 (0%)	5 (9.6%)	0 (0%)	1 (1.8%)	1 (2.4%)	1 (2.2%)	0 (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, ecosystems, human health, regional assessment, and water quality). The data are presented by focus area in Table 16, which includes eight key bibliometric parameters.

SUMMARY OF RESULTS

1. **About one-fifth of the global change publications are highly cited papers (this is twice the number expected for a typical program).** 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 2.4% for the air quality papers to 35.0% for the water quality papers. The water quality and human health 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 3.5 to 2.9 times higher than expected. The ecosystems and water quality focus areas 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 2.9 to 2.5 times higher than expected. Only one paper in the ecosystems focus area meets the *ESI* criteria for the top 0.1% of papers, which is 6 times higher than the expected number for this focus area. None of the global change papers meet the *ESI* criteria for the most highly cited papers (top 0.01%), which is expected.
2. **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 the air quality focus area. This indicates that the global change papers are more highly cited than the average papers published in these fields.
3. **Nearly one-third of the global change 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.** For every year analyzed, 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 air quality, ecosystems, and human health ranges from 21.4% to 75.6%, which is 2 to 8 times higher than expected. The percentage of water quality papers published in high impact journals (by Impact Factor) is the same as that expected (i.e., 10%). None of the regional assessment papers are published in high impact journals, but this could be attributed to the fact that this focus area had more non-journal publications than the other focus areas. The percentage of papers in high impact journals (by Immediacy Index) for all five focus areas is higher than expected, ranging from 11.4% to 65.8%, which is 1.1 to 7 times higher than expected.
4. **In four of the five focus areas (i.e., ecosystems, human health, regional assessment, and water quality) the percentage of publications cited one or more times is very high (i.e., 88% to 95%).** For the air quality focus area the percentage drops to approximately 60%, but this is attributed to high percentage of air quality papers published after 2003.
5. **The authors of the global change papers cite themselves less than the average self-citation rate.** The author self-citation rates range from 3.4% to 23.4%. The rates for the ecosystems, human health, regional assessment, and water quality focus areas are well below the accepted range of 10-30% author self-citation rate, and the rate for the air quality papers is 23.4%, which is within the accepted range.
6. **There were hot papers published in each of the five focus areas.** The highest percentage of hot papers (i.e., 9.1%) is in the regional assessment focus area, and the percentage of hot papers in the three of the other focus areas is consistent (i.e., approximately 2.4%). These percentages are 24 to 91 times higher than expected.

The results of the analysis are presented below and the numbers link the findings with the corresponding data in Table 16.

1. **No. of Global Change Papers Analyzed**—More than half of the global change publications fall under the ecosystems focus area. The number of global change publications for the remaining focus areas is approximately the same.
2. **Total No. of Highly Cited Publications**—*ESI* identifies four thresholds of 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 20% of the global change publications are highly cited papers (this is 2 times the number expected for a typical program). 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 2.4% for the air quality papers to 35.0% for the water quality papers. The water quality and human health 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 3.5 and 2.9 times higher than expected. The ecosystems and water quality focus areas 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 2.9 and 2.5 times higher than expected. Only one paper in the ecosystems focus area meets the *ESI* criteria for the top 0.1% of papers, which is 6 times higher than the expected number for this area. None of the global change papers meet the *ESI* criteria for the most highly cited papers (top 0.01%). The expected number of papers in this top category for a typical program of this size would be 0.03 papers, so the absence of papers in this category is not surprising.
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., air quality). 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 one-third of the global change 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 air quality, ecosystems, and human health ranges from 21.4% to 75.6%, which is 2 to 8 times higher than expected for these three focus areas. The percentage of water quality papers published in high impact journals is the same as that expected (i.e., 10%). None of the regional assessment papers are published in high impact journals, but this could be attributed to the fact that this focus area had more non-journal publications than the other focus areas.
5. **No. of Papers in High Impact Journals by Immediacy Index**—Nearly one-third of the global change 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 11.4% to 65.8%, which is 1.1 to 7 times higher than expected for these five focus areas.

6. **Total No. of Publications Cited One or More Times**—In four of the five focus areas (i.e., ecosystems, human health, regional assessment, and water quality) the percentage of publications cited one or more times is very high (i.e., 88% to 95%). For the air quality focus area, the percentage drops to approximately 60%, but this can be attributed to the fact that 74% of the air quality papers are published after 2003 compared to 4% of the regional assessment papers. In fact, 20% of the air quality papers were published in 2005, and only 6 of the 27 (22%) global change papers published in 2005 (all focus areas combined) have been cited one or more times.
7. **Total No. of Author Self Cites**—The authors of the global change papers cite themselves less than the average self-citation rate. The author self-citation rates range from 3.4% to 23.4%. The rates for the ecosystems, human health, regional assessment, and water quality focus areas are well below the accepted range of 10-30% author self-citation rate, and the rate for the air quality papers is 23.4%, which is within the accepted range.
8. **No. of Hot Papers**—Using the hot paper thresholds established by *ESI* as a benchmark, there were hot papers published in each of the five focus areas. The highest percentage of hot papers (i.e., 9.1%) is in the regional assessment focus area, and the percentage of hot papers in three of the other focus areas is consistent (i.e., approximately 2.4%). Because only the top 0.1% of papers are selected as hot papers for each *ESI* field, the percentages of global change hot papers identified in Table 16 are 24 to 91 times higher than expected.

Table 16. Key Bibliometric Parameters for Global Change Papers by Focus Area

ANALYSIS PARAMETERS	Focus Areas				
	Air Quality	Ecosystems	Human Health	Regional Assessment	Water Quality
1. No. of Global Change Papers Analyzed	42	174	41	44	40
2. No. of Highly Cited Publications That Met the Top 10% Threshold (Percentage)	1 (2.4%)	35 (20.1%)	12 (29.3%)	5 (11.4%)	14 (35.0%)
No. of Highly Cited Publications That Met the Top 1% Threshold (Percentage)	0 (0%)	5 (2.9%)	1 (2.4%)	1 (2.3%)	1 (2.5%)
No. of Highly Cited Publications That Met the Top 0.1% Threshold (Percentage)	0 (0%)	1 (0.6%)	0 (0%)	0 (0%)	0 (0%)
No. of Highly Cited Publications That Met the Top 0.01% Threshold (Percentage)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

ANALYSIS PARAMETERS	Focus Areas				
	Air Quality	Ecosystems	Human Health	Regional Assessment	Water Quality
3. Expected No. of Citations Calculated Using the Average Citation Rate	94.18	1,082.61	332.93	284.56	308.97
Total No. of Times Cited for All Publications	64	2,034	655	356	585
Ratio of Actual Cites to Expected Cites	0.68	1.88	1.97	1.25	1.89
4. No. of Papers in High Impact Journals by Impact Factor (Percentage)	9 (21.4%)	55 (31.6%)	31 (75.6%)	0 (0%)	4 (10.0%)
5. No. of Papers in High Impact Journals by Immediacy Index (Percentage)	11 (26.2%)	58 (33.3%)	27 (65.8%)	5 (11.4%)	6 (15.0%)
6. No. of Publications Cited One or More Times (Percentage)	25 (59.5%)	154 (88.5%)	36 (87.8%)	42 (95.4%)	36 (90.0%)
7. Total No. of Author Self Cites (Percentage)	15 (23.4%)	115 (5.6%)	29 (4.4%)	12 (3.4%)	44 (7.5%)
8. No. of Hot Papers (Percentage)	1 (2.4%)	1 (0.57%)	1 (2.4%)	4 (9.1%)	1 (2.5%)

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