November 15, 2006

Bibliometric Analysis for Papers on Topics Related to Global Change (GC)

This is a 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). For this analysis, 252 papers were reviewed (132 papers by extramural researchers and 120 papers by intramural researchers). These 252 papers, published from 1994 to 2005, were cited 4,142 times in the journals covered by Thomson's Web of Science.[1] Of these 252 papers, 212 (84%) have been cited at least once in a journal.

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. The chief indicators of output, or productivity, are journal article publication counts. For influence and impact measures, ESI employs both total citation counts and cites per paper scores. The former reveals gross influence while the latter shows weighted influence, also called impact. JCR 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.

Summary of Analysis

Nearly one-quarter of the GC publications are highly cited papers. A review of the citations indicates that 53 (21.0%) of the GC papers qualify as highly cited when using the ESI criteria for the top 10% of highly cited publications. Nine (3.6%) of the GC papers qualify as highly cited when using the criteria for the top 1%. Two (0.8%) of these papers qualify as very highly cited (in the top 0.1%), and one paper actually meets the top 0.01% threshold.

The GC 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 13 fields in which the EPA GC papers were published, the ratio of actual to expected cites is greater than 1, indicating that the GC papers are more highly cited than the average papers in those fields.

About one-quarter of the GC papers are published in very high impact journals. Fifty-seven (57) of 252 papers were published in the top 10% of journals ranked by JCR Impact Factor, representing 22.6 % of EPA's GC papers. Nearly one-third of the GC papers are published in the top 10% of journals ranked by JCR Immediacy Factor. Seventy-one (71) of the 252 papers appear in the top 10% of journals, representing 28.2% of EPA's GC papers.

One of the GC publications qualified as a hot paper. 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. Using the hot paper thresholds

[1] Thomson's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,500 of the most prestigious, high impact research journals in the world. *Web of Science* also provides cited reference searching.

established by ESI as a benchmark, one of the GC papers, representing 0.4% of the GC publications, was identified in the analysis.

The author self-citation rate is well below average. One hundred sixty-four (164) of the 4,142 cites are author self-cites. This 3.96% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.

Highly Cited GC Publications

The 252 GC papers reviewed for this analysis covered 13 of the 22 ESI fields of research. The distribution of the papers among these 13 fields and the number of citations by field are presented in Table 1.

Table 1. GC Papers by ESI Fields

No. of Citations	ESI Field	No. of EPA GC Papers	Average Cites/Paper
1,470	Environment/Ecology	143	10.28
962	Geosciences	20	48.10
778	Multidisciplinary	6	129.67
311	Agricultural Sciences	26	11.96
188	Biology & Biochemistry	5	37.60
146	Engineering	26	5.62
108	Plant & Animal Science	14	7.71
86	Clinical Medicine	4	21.50
59	Microbiology	3	19.67
21	Immunology	1	21.00
7	Social Sciences	1	7.00
4	Economics & Business	1	4.00
2	Computer Science	2	1.00
Total = 4,142		**Total = 252**	

There were 53 (21.0% of the papers analyzed) highly cited EPA GC papers in 8 of the 13 fields—Geosciences, Environment/Ecology, Multidisciplinary, Agricultural Sciences, Biology & Biochemistry, Engineering, Clinical Medicine, and Plant & Animal Science—when using the

ESI criteria for the **top 10% of papers**. Table 2 shows the number of EPA papers in those 8 fields that met the **top 10% threshold in ESI**.

Nine (3.6%) of the papers analyzed qualified as highly cited when using the ESI criteria for the **top 1% of papers**. These papers were categorized in four fields—Environment/Ecology, Multidisciplinary, Geosciences, and Engineering. Table 3 shows the nine papers by field that met the **top 1% threshold in ESI**. There were two (0.8% of the papers analyzed) very highly cited EPA GC papers in two fields—Geosciences and Multidisciplinary. These two papers met the **top 0.1% threshold in ESI**. One of these two GC papers actually met the **top 0.01% threshold in ESI** (i.e., the paper by RK Dixon).

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

Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
864	Geosciences	5	172.80	25.00%
825	Environment/Ecology	25	33.00	17.48%
735	Multidisciplinary	4	183.75	66.67%
162	Agricultural Sciences	7	23.14	26.92%
151	Biology & Biochemistry	1	151.00	20.00%
97	Engineering	8	12.12	30.77%
69	Clinical Medicine	1	69.00	25.00%
45	Plant & Animal Science	2	22.50	14.29%

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

Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
771	Geosciences	2	385.50	10.00%
699	Multidisciplinary	3	233.00	50.00%
230	Environment/Ecology	3	76.67	2.10%
35	Engineering	1	35.00	3.85%

The citations for the highly cited papers in the top 1% are presented in Tables 4 through 7. The citations for the very highly cited papers are listed in Table 8.

Table 4. Highly Cited GC Papers in the Field of Geosciences (top 1%)

No. of Cites	First Author	Paper
721	Guenther A	A global model of natural volatile organic compound emissions. *Journal of Geophysical Research-Atmospheres* 1995;100(D5):8873-8892.
50	Pielke RA	Influence of the spatial distribution of vegetation and soils on the prediction of cumulus convective rainfall. *Reviews of Geophysics* 2001;39(2):151-177.

Table 5. Highly Cited GC Papers in the Field of Multidisciplinary (top 1%)

No. of Cites	First Author	Paper
510	Dixon RK	Carbon pools and flux of global forest ecosystems. *Science* 1994;263(5144):185-190.
102	Rygiewicz PT	Mycorrhizae alter quality and quantity of carbon allocated below ground. *Nature* 1994;369(6475):58-60.
87	Pitelka LF	Plant migration and climate change. *American Scientist* 1997;85(5):464-473.

Table 6. Highly Cited GC Papers in the Field of Environment/Ecology (top 1%)

No. of Cites	First Author	Paper
95	Stockwell W	Biogenic hydrocarbons in the atmospheric boundary layer: a review. *Bulletin of the American Meteorological Society* 2000;81(7):1537-1575.
63	Chase TN	Simulated impacts of historical land cover changes on global climate in northern winter. *Climate Dynamics* 2000;16;(2-3):93-105.
72	McCarty JP	Ecological consequences of recent climate change. *Conservation Biology* 2001;15(2):320-331.

Table 7. Highly Cited GC Papers in the Field of Engineering (top 1%)

No. of Cites	First Author	Paper
35	Hamlet AF	Effects of climate change on hydrology and water resources in the Columbia River basin. *Journal of the American Water Resources Association* 1999;35(6):1597-1623.

Table 8. Very Highly Cited GC Papers (Top 0.1%)

Field	No. of Cites	First Author	Paper
Geosciences	721	Guenther A	A global model of natural volatile organic compound emissions. *Journal of Geophysical Research-Atmospheres* 1995;100(D5):8873-8892.
Multidisciplinary	510	Dixon RK	Carbon pools and flux of global forest ecosystems. *Science* 1994;263(5144):185-190.

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 13 fields in which the EPA GC papers were published, the ratio of actual to expected cites is greater than 1, indicating that the EPA papers are more highly cited than the average papers in those fields (see Table 9).

Table 9. Ratio of Average Cites to Expected Cites for GC Papers by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Environment/Ecology	1,470	1,103.62	1.33
Geosciences	962	134.46	7.15
Multidisciplinary	778	18.58	41.87
Agricultural Sciences	311	147.33	2.11
Biology & Biochemistry	188	59.81	3.14
Engineering	146	70.43	2.07
Plant & Animal Science	108	73.76	1.46
Clinical Medicine	86	49.92	1.72
Microbiology	59	35.47	1.66
Immunology	21	21.11	0.99
Social Sciences	7	4.91	1.42
Economics & Business	4	4.06	0.98
Computer Science	2	4.73	0.42

JCR Benchmarks

The 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 10 indicates the number of GC papers published in the top 10% of journals, based on the JCR Impact Factor. Fifty-seven (57) of 252 papers were published in the top 10% of journals, representing 22.6% of EPA's GC papers.

Table 10. GC Papers in Top 10% of Journals by JCR Impact Factor

EPA GC Papers in that Journal	Journal	Impact Factor (IF)	JCR IF Rank
7	Environmental Health Perspectives	3.929	439
6	Journal of Climate	3.500	558
5	Global Change Biology	4.333	358
4	Ecological Applications	3.287	623
4	Limnology and Oceanography	3.024	737
3	Applied and Environmental Microbiology	3.810	470
3	Conservation Biology	3.672	504
3	Bioscience	3.041	730
2	Nature	32.182	9
2	Lancet	21.713	20
2	Ecology	4.104	394
2	Plant Cell and Environment	3.634	517
2	Environmental Science & Technology	3.557	540
2	New Phytologist	3.355	603
1	Science	31.853	10
1	JAMA-Journal of the American Medical Association	24.831	15
1	Proceedings of the National Academy of Sciences of the United States of America	10.452	88
1	Reviews of Geophysics	8.667	114
1	Emerging Infectious Diseases	5.643	230

EPA GC Papers in that Journal	Journal	Impact Factor (IF)	JCR IF Rank
1	Epidemiology	3.840	459
1	Climate Dynamics	3.497	561
1	Ecosystems	3.283	624
1	Global Ecology and Biogeography Letters	3.242	641
1	American Journal of Public Health	3.241	642
Total = 57			

Immediacy Index

The journal 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 11 indicates the number of EPA papers published in the top 10% of journals, based on the JCR Immediacy Index. Seventy-one (71) of the 252 papers appear in the top 10% of journals, representing 28.2% of EPA's GC papers.

Table 11. GC Papers in Top 10% of Journals by JCR Immediacy Index

EPA Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
19	Climatic Change	1.235	195
8	Journal of Geophysical Research-Atmospheres	0.617	630
7	Environmental Health Perspectives	1.202	202
4	Ecological Applications	0.747	466
3	Bioscience	0.863	356
3	Conservation Biology	0.744	468
2	Nature	6.089	5
2	Lancet	5.017	12
2	AMBIO	1.435	156
2	New Phytologist	0.876	349
2	Environmental Science & Technology	0.623	617

EPA Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
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	Ecosystems	2.048	76
1	Proceedings of the National Academy of Sciences of the United States of America	1.923	89
1	Reviews of Geophysics	1.714	110
1	Emerging Infectious Diseases	1.350	169
1	American Journal of International Law	1.260	188
1	Hydrology and Earth System Sciences	1.069	242
1	Bulletin of the American Meteorological Society	0.895	341
1	Epidemiology	0.864	354
1	American Journal of Public Health	0.723	489
1	Aerosol Science and Technology	0.595	668
1	Theoretical and Applied Climatology	0.564	720
Total = 71			

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., August-September 2005), but there was one hot paper identified from previous periods.

Using the hot paper thresholds established by ESI as a benchmark, 1 hot paper, representing 0.4% of the GC papers, was identified in the field of Geosciences. The hot paper is listed in Table 12.

Table 12. Hot Papers Identified Using ESI Thresholds

Field	ESI Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Geosciences	6	7 cites in September-October 1996	Guenther A. A global model of natural volatile organic compound emissions. *Journal of Geophysical Research-Atmospheres* 1995;100(D5):8873-8892.

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 GC papers. Of the 4,142 total cites, 164 are author self-cites—a 3.96% author self-citation rate. Garfield and Sher[2] found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts[3] claim that approximately 10% to 30% of all the citations listed fall into the category of author self-citation. Therefore, the 3.96% self-cite rate for the GC papers is well below the range for author self-citation.

[2] Garfield E, Sher IH. New factors in the evaluation of scientific literature through citation indexing. *American Documentation* 1963;18(July):195-201.

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