Bibliometric Analysis

for the U.S. Environmental Protection Agency/Office of Research and Development's Air (Particulate Matter, Ozone, Air Toxics, and Indoor Air) 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) Air Research Program. For this analysis, 2,064 papers were reviewed, and they were published from 1998 to 2007. These publications were cited 34,562 times in the journals covered by Thomson Scientific's *Web of Science*[1] and Elsevier's Scopus[2]. Of these 2,064 publications, 1,827 (88.5%) have been cited at least once in a journal.

Searches of *Web of Science* and Scopus were conducted to obtain times cited data for the Air Research Program 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 air 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 air 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.

The report includes a summary of the results of the bibliometric analysis, an analysis of the 2,064 air research papers analyzed by *ESI* field (e.g., Clinical Medicine, Environment/Ecology, and Geosciences), an analysis of the journals in which the air papers were published, a table of the highly cited researchers in the Air Research Program, a list of patents that have resulted from the program, and other parameters reported by *ESI*.

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.

SUMMARY OF RESULTS

1. **One-third of the air publications are highly cited papers.** 679 (32.9%) of the air papers qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is 3.3 times the 10% of papers expected to be highly cited. 107 (5.2%) of the air papers qualify as highly cited when using the *ESI* criteria for the top 1%, which is 5.2 times the number expected. 14 (0.7%) of these papers qualify as very highly cited when using the criteria for the top 0.1%, which is 7 times the number anticipated. None of the papers actually meets the 0.01% threshold for the most highly cited papers, which is not surprising given that the expected number for this program is 0.2 papers.

2. **The air papers are more highly cited than the average paper.** Using the *ESI* average citation rates for papers published by field as the benchmark, in 15 of the 19 fields in which the 2,064 EPA air papers were published, the ratio of actual to expected cites is greater than 1, indicating that the air papers are more highly cited than the average papers in those fields. For all 19 fields combined, the ratio of total number of cites to the total number of expected cites (34,562 to 15,305.25) is 2.2, indicating that the air papers are more highly cited than the average paper.

3. **More than one-third of the air papers are published in high impact journals.** 696 of the 2,064 papers were published in the top 10% of journals ranked by *JCR* Impact Factor, representing 33.7% of EPA's air papers. This number is 3.4 times higher than the expected 206 papers. 966 of the 2,064 papers appear in the top 10% of journals ranked by *JCR* Immediacy Index, representing 46.8% of EPA's air papers. This number is 4.7 times higher than the expected 206 papers.

4. **Fifty-two of the air papers qualify as hot papers.** Using the hot paper thresholds established by *ESI* as a benchmark, 52 hot papers, representing 2.5% of the air papers, were identified in the analysis. Hot papers are papers that were highly cited shortly after they were published. The number of air hot papers identified is 25 times higher than the expected 2 hot papers.

5. **The authors of the air papers cite themselves much less than the average author.** 1,605 of the 34,562 cites are author self-cites. This 4.6% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.

6. **Fifty-nine of the 3,452 authors of the air 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 6 patents issued** to investigators from 1998 to 2007 for research that was conducted under EPA's Air Research Program. Two of these patents were cited by a total of 9 other patents.

8. **EPA's Air Research Program includes 4 of the top 20 air pollution papers** (published from January 2003 to April 2005) and **18 of the top 20 air pollution authors** (from 1995 to 2005) authored papers for EPA's Air Research Program.

SUMMARY OF RESULTS (Continued)

10. **The United States ranks first among the top 20 countries** publishing on air pollution.

11. **More than one-half of the EPA air papers are published in *ESI*'s top 20 journals** in air pollution.

12. **Harvard University (one of EPA's grantees) ranks number one and EPA ranks number two on *ESI*'s top 20 institutions** publishing on air pollution.

13. **The number of air pollution papers published in journals covered by *ESI* from 2001 to 2005 has declined compared to the number published from 2000 to 2004. The number of cites and cites/paper for papers published from 2001 to 2005 also have declined.** The number of EPA Air Research Program publications, however, has increased slightly from 2001 to 2005 (1,257 publications) when compared to the number published from 2000 to 2004 (1,240 publications). Like the overall air pollution paper trends identified by *ESI*, the number of cites and the cites per paper have declined.

Highly Cited Air 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 younger papers for each field.

The 2,064 air research papers reviewed for this analysis were published in journals that were assigned to 19 of the 22 *ESI* fields. The distribution of the papers among these 19 fields and the number of citations by field are presented in Table 1.

Table 1. Air Papers by *ESI* Fields

ESI Field	No. of Citations	No. of Air Papers	Average Cites/Paper
Biology & Biochemistry	546	41	13.3
Chemistry	2,375	150	15.8
Clinical Medicine	6,479	260	24.9
Computer Science	15	4	3.8
Economics & Business	25	3	8.3
Engineering	4,259	360	11.8
Environment/Ecology	7,910	435	18.2
Geosciences	8,477	490	17.3

ESI Field	No. of Citations	No. of Air Papers	Average Cites/Paper
Immunology	377	14	26.9
Materials Science	1	2	0.5
Mathematics	35	7	5.0
Microbiology	22	1	22.0
Molecular Biology & Genetics	62	8	7.8
Multidisciplinary	421	10	42.1
Neuroscience & Behavior	227	20	11.4
Pharmacology & Toxicology	2,951	220	13.4
Physics	194	15	12.9
Plant & Animal Science	124	11	11.3
Social Sciences, general	62	13	4.8
	Total = 34,562	**Total = 2,064**	**16.7**

There are 679 (32.9% of the papers analyzed) highly cited EPA air papers in 14 of the 19 fields—Biology & Biochemistry, Chemistry, Clinical Medicine, Economics & Business, Engineering, Environment/Ecology, Geosciences, Immunology, Mathematics, Multidisciplinary, Pharmacology & Toxicology, Physics, Plant & Animal Science, and Social Sciences—when using the *ESI* criteria for the **top 10% of papers**. Table 2 shows the number of EPA air papers in those 14 fields that meet the **top 10% threshold in *ESI***. One hundred-seven (5.2%) of the papers analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These papers cover 9 fields— Biology & Biochemistry, Chemistry, Clinical Medicine, Economics & Business, Engineering, Environment/ Ecology, Geosciences, Multidisciplinary, and Pharmacology & Toxicology. Table 3 shows the 107 (5.2% of the papers analyzed) papers by field that meet the **top 1% threshold in *ESI*.** The citations for these 107 papers are provided in Tables 4 through 12. Table 13 shows the 14 (0.7%) papers by field that meet the **top 0.1% threshold in *ESI***. These 14 very highly cited air papers in the fields of Chemistry, Clinical Medicine, Economics & Business, Engineering, Environment/Ecology, and Geosciences are listed in Table 14. None of the air papers meet the **top 0.01% threshold in *ESI***, which is not surprising because the expected number of papers that should meet this threshold for this analysis is 0.2. The highly cited papers in Tables 4 through 13 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 2. Number of Highly Cited Air Papers by Field (top 10%)

ESI Field	No. of Citations	No. of Papers	Average Cites/Paper	% of Papers in Field
Biology & Biochemistry	216	6	36.0	14.6%
Chemistry	1,156	34	34.0	22.7%
Clinical Medicine	4,970	91	54.6	35.0%

ESI Field	No. of Citations	No. of Papers	Average Cites/Paper	% of Papers in Field
Economics & Business	7	1	7.0	33.3%
Engineering	3,525	144	24.5	40.0%
Environment/Ecology	5,655	170	33.3	39.1%
Geosciences	5,737	164	35.0	33.5%
Immunology	303	5	60.6	35.7%
Mathematics	25	2	12.5	28.6%
Multidisciplinary	398	6	66.3	60.0%
Pharmacology & Toxicology	1,692	47	36.0	21.4%
Physics	117	3	39.0	20.0%
Plant & Animal Science	64	2	32.0	18.2%
Social Sciences, general	20	4	5.0	30.8%
	Total = 23,885	**Total = 679**	**35.2**	**32.9%**

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

ESI Field	No. of Citations	No. of Papers	Average Cites/Paper	% of Air Papers in Field
Biology & Biochemistry	37	1	37.0	2.4%
Chemistry	62	2	31.0	1.3%
Clinical Medicine	1,513	8	189.1	3.1%
Economics & Business	7	1	7.0	33.3%
Engineering	1,768	32	55.2	8.9%
Environment/Ecology	1,549	31	50.0	7.1%
Geosciences	2,255	28	80.5	5.7%
Multidisciplinary	272	2	136.0	20.0%
Pharmacology & Toxicology	259	2	129.5	0.9%
	Total = 7,722	**Total = 107**	**72.2**	**5.2%**

Table 4. Highly Cited Air Papers in the Field of Biology & Biochemistry (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
37	33	Kadiiska MB	Biomarkers of Oxidative Stress Study II: are oxidation products of lipids, proteins, and DNA markers of CCl_4 poisoning? *Free Radical Biology & Medicine* 2005;38(6):698-710.

Table 5. Highly Cited Air Papers in the Field of Chemistry (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
59	43	Gao S	Low-molecular-weight and oligomeric components in secondary organic aerosol from the ozonolysis of cycloalkenes and alpha-pinene. *Journal of Physical Chemistry A* 2004;108(46):10147-10164.
3	2	Rudich Y	Aging of organic aerosol: bridging the gap between laboratory and field studies. *Annual Review of Physical Chemistry* 2007;58:321-352.

Table 6. Highly Cited Air Papers in the Field of Clinical Medicine (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
187	144	Abbey DE	Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. *American Journal of Respiratory and Critical Care Medicine* 1999;159(2):373-382.
216	133	Gold DR	Ambient pollution and heart rate variability. *Circulation* 2000;101(11):1267-1273.
249	115	Peters A	Increased particulate air pollution and the triggering of myocardial infarction. *Circulation* 2001;103(23):2810-2815.
634	99	Pope CA	Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate air pollution. *Journal of the American Medical Association* 2002;287(9):1132-1141.
89	54	Peters A	Exposure to traffic and the onset of myocardial infarction. *New England Journal of Medicine* 2004;351(17):1721-1730.
131	54	Pope CA	Cardiovascular mortality and long-term exposure to particulate air pollution: epidemiological evidence of general pathophysiological pathways of disease. *Circulation* 2004;109(1):71-77.
2	2	Baccarelli A	Effects of exposure to air pollution on blood coagulation. *Journal of Thrombosis and Haemostasis* 2007;5(2):252-260.
5	2	Miller KA	Long-term exposure to air pollution and incidence of cardiovascular events in women. *New England Journal of Medicine* 2007;356(5):447-458.

Table 7. Highly Cited Air Papers in the Field of Economics & Business (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
7	4	Peng RD	Model choice in time series studies of air pollution and mortality. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 2006;169(2):179-203.

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

No. of Cites	*ESI* Threshold	First Author	Paper
54	46	Zhang Y	Simulation of aerosol dynamics: a comparative review of algorithms used in air quality models. *Aerosol Science and Technology* 1999;31(6):487-514.
45	44	Wilson WE	Estimating separately personal exposure to ambient and non-ambient particulate matter for epidemiology and risk assessment; why and how. *Journal of the Air & Waste Management Association* 2000;50(7):1167-1183.
52	44	Tobias HJ	Real-time chemical analysis of organic aerosols using a thermal desorption particle beam mass spectrometer. *Aerosol Science and Technology* 2000;33(1-2):170-190.
75	44	Sarnat JA	Assessing the relationship between personal particulate and gaseous exposures of senior citizens living in Baltimore. *Journal of the Air & Waste Management Association* 2000;50(7):1184-1198.
78	44	Long CM	Characterization of indoor particle sources using continuous mass and size monitors. *Journal of the Air & Waste Management Association* 2000;50(7):1236-1250.
207	44	Jayne JT	Development of an aerosol mass spectrometer for size and composition analysis of submicron particles. *Aerosol Science and Technology* 2000;33(1-2):49-70.
209	44	Richter H	Formation of polycyclic aromatic hydrocarbons and their growth to soot – a review of chemical reaction pathways. *Progress in Energy and Combustion Science* 2000;26(4-6):565-608.
38	37	Vette AF	Characterization of indoor-outdoor aerosol concentration relationships during the Fresno PM exposure studies. *Aerosol Science and Technology* 2001;34(1):118-126.
42	37	Lewtas J	Comparison of sampling methods for semi-volatile organic carbon associated with $PM_{2.5}$. *Aerosol Science and Technology* 2001;34(1):9-22.
57	37	Tolocka MP	East versus West in the US: chemical characteristics of $PM_{2.5}$ during the winter of 1999. *Aerosol Science and Technology* 2001;34(1):88-96.

No. of Cites	*ESI* Threshold	First Author	Paper
92	37	Woo KS	Measurement of Atlanta aerosol size distributions: Observations of ultrafine particle events. *Aerosol Science and Technology* 2001;34(1):75-87.
105	37	Weber RJ	A particle-into-liquid collector for rapid measurement of aerosol bulk chemical composition. *Aerosol Science and Technology* 2001;35(3):718-727.
31	31	Cabada JC	Sources of atmospheric carbonaceous particulate matter in Pittsburgh, Pennsylvania. *Journal of the Air & Waste Management Association* 2002;52(6):732-741.
34	31	Zhang Z	Cyclic micron-size particle inhalation and deposition in a triple bifurcation lung airway model. *Aerosol Science and Technology* 2002;33(2):257-281.
37	31	Kim S	Size distribution and diurnal and seasonal trends of ultrafine particles in source and receptor sites of the Los Angeles basin. *Journal of the Air & Waste Management Association* 2002;52(3):297-307.
40	31	Zhang X	A numerical characterization of particle beam collimation by an aerodynamic lens-nozzle system: Part I. an individual lens or nozzle. *Aerosol Science and Technology* 2002;36(5):617-631.
63	31	McMurray PH	The relationship between mass and mobility for atmospheric particles: A new technique for measuring particle density. *Aerosol Science and Technology* 2002;36(2):227-238.
130	31	Zhu YF	Concentration and size distribution of ultrafine particles near a major highway. *Journal of the Air & Waste Management Association* 2002;52(9):1032-1042.
31	25	Lewis CW	Source apportionment of Phoenix PM2.5 aerosol with the Unmix receptor model. *Journal of the Air & Waste Management Association* 2003;53(3):325-338.
22	18	Lemieux PM	Emissions of organic air toxics from open burning: a comprehensive review. *Progress in Energy and Combustion Science* 2004;30(1):1-32.
23	18	Zhang XF	Numerical characterization of particle beam collimation: Part II integrated aerodynamic-lens-nozzle system. *Aerosol Science and Technology* 2004;38(6):619-638.
23	18	Zhu Y	Seasonal trends of concentration and size distribution of ultrafine particles near major highways in Los Angeles. *Aerosol Science and Technology* 2004;38(S1):5-13.
24	18	Cabada JC	Estimating the secondary organic aerosol contribution to $PM_{2.5}$ using the EC tracer method. *Aerosol Science and Technology* 2004;38(S1):140-155.

No. of Cites	*ESI* Threshold	First Author	Paper
25	18	Drewnick F	Measurement of ambient aerosol composition during the PMTACS-NY 2001 campaign using an aerosol mass spectrometer. Part II: Chemically speciated mass distribution. *Aerosol Science and Technology* 2004;38(S1):104-117.
26	18	Cho A	Determination of four quinones in diesel exhaust particles, SRM 1649a and atmospheric $PM_{2.5}$. *Aerosol Science and Technology* 2004;38(S1):68-81.
33	18	Stanier CO	Nucleation events during the Pittsburgh Air Quality Study: description and relation to key meteorological, gas phase, and aerosol parameters. *Aerosol Science and Technology* 2004;38(S1):253-264.
34	18	Drewnick F	Measurement of ambient aerosol composition during the PMTACS-NY 2001 campaign using an aerosol mass spectrometer. Part I: Mass concentrations. *Aerosol Science and Technology* 2004;38(S1):92-103.
39	18	Subramanian R	Positive and negative artifacts in particulate organic carbon measurements with denuded and undenuded sampler configurations. *Aerosol Science and Technology* 2004;38(S1):27-48.
55	18	Canagaratna M	Chase studies of particulate emissions from in-use New York City vehicles. *Aerosol Science and Technology* 2004;38(6):555-573.
13	10	Kim E	Estimation of organic carbon blank values and error structures of the speciation trends network data for source apportionment. *Journal of the Air & Waste Management Association* 2005;55(8):1190-1199.
14	4	Byun D	Review of the governing equations, computational algorithms, and other components of the Models-3 Community Multiscale Air Quality (CMAQ) modeling system. *Applied Mechanics Reviews* 2006;59:51-77.
17	4	Bond TC	Light absorption by carbonaceous particles: an investigative review. *Aerosol Science and Technology* 2006;40(1):27-67.

Table 9. Highly Cited Air Papers in the Field of Environment/Ecology (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
175	103	Liao D	Daily variation of particulate air pollution and poor cardiac autonomic control in the elderly. *Environmental Health Perspectives* 1999;107(7):521-525.
208	88	Laden F	Association of fine particulate matter from different sources with daily mortality in six U.S. cities. *Environmental Health Perspectives* 2000;108(10):941-947.
83	77	Fine PM	Chemical characterization of fine particle emissions from the fireplace combustion of woods grown in the northeastern United States. *Environmental Science & Technology* 2001;35(13):2665-2675.

No. of Cites	*ESI* Threshold	First Author	Paper
83	77	Jang M	Atmospheric secondary aerosol formation by heterogeneous reactions of aldehydes in the presence of a sulfuric acid aerosol catalyst. *Environmental Science & Technology* 2001;35(24):4758-4766.
94	77	Dockery DW	Epidemiologic evidence of cardiovascular effects of particulate air pollution. *Environmental Health Perspectives* 2001;109(S4):483-486.
67	48	Park K	Relationship between particle mass and mobility for diesel exhaust particles. *Environmental Science & Technology* 2003;37(3):577-583.
144	48	Li N	Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage. *Environmental Health Perspectives* 2003;111(4):455-460.
34	34	Landrigan PJ	Health and environmental consequences of the World Trade Center disaster. *Environmental Health Perspectives* 2004;112(6):731-739.
40	34	Chow JC	Equivalence of elemental carbon by thermal/optical reflectance and transmittance with different temperature protocols. *Environmental Science & Technology* 2004;38(16):4414-4422.
44	34	Xia T	Quinones and aromatic chemical compounds in particulate matter induce mitochondrial dysfunction: implications for ultrafine particle toxicity. *Environmental Health Perspectives* 2004;112(14):1347-1358.
45	34	Zhang Q	Insights into the chemistry of new particle formation and growth events in Pittsburgh based on aerosol mass spectrometry. *Environmental Science & Technology* 2004;38(18):4797-4809.
58	34	Pope CA	Ambient particulate air pollution, heart rate variability, and blood markers of inflammation in a panel of elderly subjects. *Environmental Health Perspectives* 2004;112(3):339-345.
59	34	Gao S	Particle phase acidity and oligomer formation in secondary organic aerosol. *Environmental Science & Technology* 2004;38(24):6582-6589.
17	17	Reisen F	Atmospheric reactions influence seasonal PAH and nitro-PAH concentrations in the Los Angeles Basin. *Environmental Science & Technology* 2005;39(1):64-73.
18	17	Delfino RJ	Potential role of ultrafine particles in associations between airborne particle mass and cardiovascular health. *Environmental Health Perspectives* 2005;113(8):934-946.
19	17	Dockery DW	Association of air pollution with increased incidence of ventricular tachyarrhythmias recorded by implanted cardioverter defibrillators. *Environmental Health Perspectives* 2005;113(6):670-674.
22	17	Zanobetti A	The effect of particulate air pollution on emergency admissions for myocardial infarction: a multicity case-crossover analysis. *Environmental Health Perspectives* 2005;113(8):978-982.
23	17	Lim H	Isoprene forms secondary organic aerosol through cloud processing: model simulations. *Environmental Science & Technology* 2005;39(12):4441-4446.

No. of Cites	*ESI* Threshold	First Author	Paper
25	17	Park SK	Effects of Air Pollution on Heart Rate Variability: The VA Normative Aging Study. *Environmental Health Perspectives* 2005;113(3):304-309.
26	17	Bahreini R	Measurements of secondary organic aerosol from oxidation of cycloalkenes, terpenes, and m-xylene using an Aerodyne aerosol mass spectrometer. *Environmental Science & Technology* 2005;39(15):5674-5688.
27	17	Lough GC	Emissions of metals associated with motor vehicle roadways. *Environmental Science & Technology* 2005;39(3):826-836.
40	17	Zhang Q	Deconvolution and quantification of hydrocarbon-like and oxygenated organic aerosols based on aerosol mass spectrometry. *Environmental Science & Technology* 2005;39(13):4938-4952.
133	17	Oberdorster G	Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. *Environmental Health Perspectives* 2005;113(7):823-839.
6	6	Selgrade MK	Induction of asthma and the environment: what we know and need to know. *Environmental Health Perspectives* 2006;114(4):615-619.
7	6	Dubowsky SD	Diabetes, obesity, and hypertension may enhance associations between air pollution and markers of systematic inflammation. *Environmental Health Perspectives* 2006;114(7):992-998.
7	6	Elder A	Translocation of inhaled ultrafine manganese oxide particles to the central nervous system. *Environmental Health Perspectives* 2006;114(8):1172-1178.
7	6	Okin GS	Multi-scale controls on and consequences of aeolian processes in landscape change in arid and semi-arid environments. *Journal of Arid Environments* 2006;65(2):253-275.
8	6	Shrivastava MK	Modeling semivolatile organic aerosol mass emissions from combustion systems. *Environmental Science & Technology* 2006;40(8):2671-2677.
8	6	Donahue NM	Coupled partitioning, dilution, and chemical aging of semivolatile organics. *Environmental Science & Technology* 2006;40(8):2635-2643.
9	6	Presto AA	Investigation of α-pinene + ozone secondary organic aerosol formation at low total aerosol mass. *Environmental Science & Technology* 2006;40(11):3536-3543.
13	6	McConnell R	Traffic, susceptibility, and childhood asthma. *Environmental Health Perspectives* 2006;114(5):766-772.

Table 10. Highly Cited Air Papers in the Field of Geosciences (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
116	114	Wang YH	Global simulation of tropospheric O_3-NO_x-hydrocarbon chemistry, 2. Model evaluation. *Journal of Geophysical Research–Atmospheres* 1998;103(D9):10727-10756.
148	114	Wang YH	Global simulation of tropospheric O_3-NO_x-hydrocarbon chemistry, 1. Model formulation. *Journal of Geophysical Research–Atmospheres* 1998;103(D9):10713-10726.
149	114	Nenes A	ISORROPIA: a new thermodynamic equilibrium model for multiphase multicomponent inorganic aerosols. *Aquatic Geochemistry* 1998;4:123-152.
121	98	Simpson D	Inventorying emissions from nature in Europe. *Journal of Geophysical Research–Atmospheres* 1999;104(D7):8113-8152.
166	98	Griffin RJ	Organic aerosol formation from the oxidation of biogenic hydrocarbons. *Journal of Geophysical Research–Atmospheres* 1999;104(D3):3555-3567.
170	98	Yu J	Gas-Phase ozone oxidation of monoterpenes: gaseous and particulate products. *Journal of Atmospheric Chemistry* 1999;34(2):207-258.
188	98	Simoneit BRT	Levoglucosan, a tracer for cellulose in biomass burning and atmospheric particles. *Atmospheric Environment* 1999;33(2):173-182.
112	85	Russell A	NARSTO critical review of photochemical models and modeling. *Atmospheric Environment* 2000;34(12-14):2283-2324.
130	85	Fuentes JD	Biogenic hydrocarbons in the atmospheric boundary layer: a review. *Bulletin of the American Meteorological Society* 2000;81(7):1537-1575.
174	85	Guenther A	Natural emissions of non-methane volatile organic compounds, carbon monoxide, and oxides of nitrogen from North America. *Atmospheric Environment* 2000;34(12-14):2205-2230.
92	69	Sokolik IN	Introduction to special section: outstanding problems in quantifying the radiative impact of mineral dust. *Journal of Geophysical Research–Atmospheres* 2001;106(D16):18015-18027.
178	69	Huser RB	Asian dust events of April 1998. *Journal of Geophysical Research–Atmospheres* 2001;106(D16):18317-18330.
121	54	Zhu Y	Study of ultrafine particles near a major highway with heavy-duty diesel traffic. *Atmospheric Environment* 2002;36(27):4323-4335.
42	41	Binkowski FS	Models-3 Community Multiscale Air Quality (CMAQ) model aerosol component. 1. Model description. *Journal of Geophysical Research–Atmospheres* 2003;108(D6):4183.
53	41	Orsini DA	Refinements to the particle-into-liquid sampler (PILS) for ground and airborne measurements of water soluble aerosol composition. *Atmospheric Environment* 2003;37(9-10):243-1259.

No. of Cites	*ESI* Threshold	First Author	Paper
85	41	Jiminez JL	Ambient aerosol sampling using the Aerodyne Aerosol Mass Spectrometer. *Journal of Geophysical Research–Atmospheres* 2003;108(D7):8425.
29	29	Zhang KM	Evolution of particle number distribution near roadways: Part II: The “road-to-ambient” process. *Atmospheric Environment* 2004;38(38):6655-6665.
31	29	Wittig AE	Pittsburgh Air Quality Study overview. *Atmospheric Environment* 2004;38(20):3107-3125.
31	29	Kim E	Improving source identification of Atlanta aerosol using temperature resolved carbon fractions in positive matrix factorization. *Atmospheric Environment* 2004;38(20):3349-3362.
18	18	McKeen S	Assessment of an ensemble of seven real-time ozone forecasts over eastern North America during the summer of 2004. *Journal of Geophysical Research–Atmospheres* 2005;110(D21307).
27	18	Edney EO	Formation of 2-methyl tetrols and 2-methylglyceric acid in secondary organic aerosol from laboratory irradiated isoprene/NO_x/SO_2/air mixtures and their detection in ambient $PM_{2.5}$ samples collected in the eastern United States. *Atmospheric Environment* 2005;39(29):5281-5289.
32	18	Zhang Q	Hydrocarbon-like and oxygenated organic aerosols in Pittsburgh: insights into sources and processes or organic aerosols. *Atmospheric Chemistry and Physics* 2005;5(12):3289-3311.
8	7	Hallock-Waters KA	Carbon monoxide in the U. S. Mid-Atlantic troposphere: evidence for a decreasing trend. *Geophysical Research Letters* 2006;26(18):2861-2864.
8	7	Offenberg JH	Thermal properties of secondary organic aerosols. *Geophysical Research Letters* 2006;33(3):L03816.
8	7	Takegawa N	Seasonal and diurnal variations of submicron organic aerosol in Tokyo observed using the Aerodyne aerosol mass spectrometer. *Journal of Geophysical Research–Atmospheres* 2006;111(D11206).
12	7	Guenther A	Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature). *Journal of Geophysical Research–Atmospheres* 2006;6:3181-3210.
3	3	Kondo Y	Oxygenated and water-soluble organic aerosols in Tokyo. *Journal of Geophysical Research–Atmospheres* 2007;112(D1):D01203.
3	3	Pathak RK	Ozonolysis of a-pinene at atmospherically relevant concentrations: Temperature dependence of aerosol mass fractions (yields). *Journal of Geophysical Research–Atmospheres* 2007;112(D3):D03201.

Table 11. Highly Cited Air Papers in the Field of Multidisciplinary (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
117	55	Gard EE	Direct Observation of Heterogeneous Chemistry in the Atmosphere. *Science* 1998;279(5354):1184-1187.
155	93	Jang M	Heterogeneous Atmospheric Aerosol Production by Acid-Catalyzed Particle-Phase Reactions. *Science* 2002;298(5594):814-817.

Table 12. Highly Cited Air Papers in the Field of Pharmacology & Toxicology (top 1%)

No. of Cites	*ESI* Threshold	First Author	Paper
157	99	Oberdorster G	Pulmonary effects of inhaled ultrafine particles. *International Archives of Occupational and Environmental Health* 2001;74(1):1-8.
102	44	Oberdorster G	Translocation of inhaled ultrafine particles to the brain. *Inhalation Toxicology* 2004;16(6-7):437-445.

Table 13. Number of Very Highly Cited Papers by Field (Top 0.1%)

ESI Field	No. of Citations	No. of Papers	Average Cites/Paper	% of Air Papers in Field
Chemistry	3	1	3.0	0.7%
Clinical Medicine	639	2	319.5	0.8%
Economics & Business	7	1	7.0	33.3%
Engineering	671	7	95.8	1.9%
Environment/Ecology	277	2	138.5	0.5%
Geosciences	178	1	178.0	0.2%
	Total = 1,775	**Total = 14**	**126.8**	**0.7%**

Table 14. Very Highly Cited Air Papers (top 0.1%)

ESI Field	*ESI* Threshold	No. of Cites	First Author	Paper
Chemistry	3	3	Rudich Y	Aging of organic aerosol: bridging the gap between laboratory and field studies. *Annual Review of Physical Chemistry* 2007;58:321-352.

ESI Field	*ESI* Threshold	No. of Cites	First Author	Paper
Clinical Medicine	288	634	Pope CA	Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate air pollution. *Journal of the American Medical Association* 2002;287(9):1132-1141.
	4	5	Miller KA	Long-term exposure to air pollution and incidence of cardiovascular events in women. *New England Journal of Medicine* 2007;356(5):447-458.
Economics & Business	7	7	Peng RD	Model choice in time series studies of air pollution and mortality. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 2006;169(2):179-203.
Engineering	116	207	Jayne JT	Development of an aerosol mass spectrometer for size and composition analysis of submicron particles. *Aerosol Science and Technology* 2000;33(1-2):49-70.
	116	209	Richter H	Formation of polycyclic aromatic hydrocarbons and their growth to soot – a review of chemical reaction pathways. *Progress in Energy and Combustion Science* 2000;26(4-6):565-608.
	76	130	Zhu YF	Concentration and size distribution of ultrafine particles near a major highway. *Journal of the Air & Waste Management Association* 2002;52(9):1032-1042.
	39	39	Subramanian R	Positive and negative artifacts in particulate organic carbon measurements with denuded and undenuded sampler configurations. *Aerosol Science and Technology* 2004;38(S1):27-48.
	39	55	Canagaratna M	Chase studies of particulate emissions from in-use New York City vehicles. *Aerosol Science and Technology* 2004;38(6):555-573.
	9	14	Byun D	Review of the governing equations, computational algorithms, and other components of the Models-3 Community Multiscale Air Quality (CMAQ) modeling system. *Applied Mechanics Reviews* 2006;59:51-77.
	9	17	Bond TC	Light absorption by carbonaceous particles: an investigative review. *Aerosol Science and Technology* 2006;40(1):27-67.
Environment/ Ecology	116	144	Li N	Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage. *Environmental Health Perspectives* 2003;111(4):455-460.
	43	133	Oberdorster G	Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. *Environmental Health Perspectives* 2005;113(7):823-839.

***ESI* Field**	***ESI* Threshold**	**No. of Cites**	**First Author**	**Paper**
Geosciences	176	178	Huser RB	Asian dust events of April 1998. *Journal of Geophysical Research–Atmospheres* 2001;106(D16):18317-18330.

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 15 of the 19 fields in which the EPA air papers were published, the ratio of actual to expected cites is greater than 1, indicating that the air papers are more highly cited than the average papers in those fields (see Table 15). For one field, the ratio is equal to 1, indicating that the papers in that *ESI* field are cited the same as the average paper. For all 19 fields combined, the ratio of total number of cites to the total number of expected cites (34,562 to 15,305.25) is 2.2, indicating that the air papers are more highly cited than the average paper.

Table 15. Ratio of Actual Cites to Expected Cites for Air Papers by Field

***ESI* Field**	**Total Cites**	**Expected Cite Rate**	**Ratio**
Biology & Biochemistry	546	570.96	1.0
Chemistry	2,375	1,476.02	1.6
Clinical Medicine	6,479	2,404.04	2.7
Computer Science	15	14.06	1.1
Economics & Business	25	7.29	3.4
Engineering	4,259	1,178.88	3.6
Environment/Ecology	7,910	3,299.45	2.4
Geosciences	8,477	3,378.05	2.5
Immunology	377	225.52	1.7
Materials Science	1	9.72	0.1
Mathematics	35	15.00	2.3
Microbiology	22	20.07	1.1
Molecular Biology & Genetics	62	202.11	0.3
Multidisciplinary	421	42.32	9.9
Neuroscience & Behavior	227	330.78	0.7
Pharmacology & Toxicology	2,951	1,868.21	1.6

ESI Field	Total Cites	Expected Cite Rate	Ratio
Physics	194	138.43	1.4
Plant & Animal Science	124	88.47	1.4
Social Sciences, general	62	35.87	1.7
TOTAL	**34,562**	**15,305.25**	**2.2**

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 16 indicates the number of air papers published in the top 10% of journals, based on the *JCR* Impact Factor. Six hundred ninety-six (696) of 2,064 papers were published in the top 10% of journals, representing 33.7% of EPA's air papers. This indicates that more than one-third of the air papers are published in the highest quality journals as determined by the *JCR* Impact Factor, which is 3.4 times higher than the expected percentage.

Table 16. Air Papers in Top 10% of Journals by *JCR* Impact Factor

EPA Air Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
2	New England Journal of Medicine	51.296	2
7	Science	30.028	9
3	Lancet	25.800	18
5	JAMA—Journal of the American Medical Association	23.175	23
1	Journal of Clinical Investigation	15.754	42
1	Annual Review of Physical Chemistry	11.250	83
10	Circulation	10.940	88
1	Nano Letters	9.960	110
2	Proceedings of the National Academy of Sciences of the United States of America	9.643	116
27	American Journal of Respiratory and Critical Care Medicine	9.091	131
7	Journal of Allergy and Clinical Immunology	8.829	136

EPA Air Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	Neuroscience & Biobehavioral Reviews	8.293	149
1	Advanced Drug Delivery Reviews	7.977	156
1	Journal of the American Chemical Society	7.696	168
2	Cancer Research	7.656	172
1	Mutation Research–Reviews in Mutation Research	7.579	175
1	Journal of Neuroscience	7.453	177
1	FASEB Journal	6.721	206
1	Critical Care Medicine	6.599	211
5	Journal of Immunology	6.293	223
1	Plant Physiology	6.125	232
5	Thorax	6.064	237
1	American Journal of Pathology	5.917	249
130	Environmental Health Perspectives	5.861	255
4	Journal of Biological Chemistry	5.808	260
14	Analytical Chemistry	5.646	276
6	Free Radical Biology & Medicine	5.440	289
1	Stroke	5.391	293
12	American Journal of Epidemiology	5.241	308
1	Journal of Thrombosis and Haemostasis	5.138	325
4	European Respiratory Journal	5.076	335
2	TrAC - Trends in Analytical Chemistry	5.068	337
1	Cellular Signaling	4.887	363
1	Faraday Discussions	4.731	393
27	Toxicology and Applied Pharmacology	4.722	397
1	Environmental Microbiology	4.630	406
18	American Journal of Respiratory Cell and Molecular Biology	4.593	412
1	Journal of Leukocyte Biology	4.572	415
5	Journal of Catalysis	4.533	418
1	International Journal of Epidemiology	4.517	424

EPA Air Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	Antioxidants & Redox Signaling	4.491	431
2	Atmospheric Chemistry and Physics	4.362	449
24	Epidemiology	4.339	452
2	American Journal of Physiology - Cell Physiology	4.334	455
3	Progress in Energy and Combustion Science	4.333	456
1	Cancer Epidemiology Biomarkers & Prevention	4.289	463
36	American Journal of Physiology - Lung Cellular and Molecular Physiology	4.250	472
4	Journal of Physical Chemistry B	4.115	501
2	Mutation Research–Fundamental and Molecular Mechanisms of Mutagenesis	4.111	505
167	Environmental Science & Technology	4.040	518
1	Journal of Pharmacology and Experimental Therapeutics	3.956	545
2	Applied Catalysis B: Environmental	3.942	548
3	Chest	3.924	552
1	Carbon	3.884	562
1	Experimental Cell Research	3.777	596
1	Human Reproduction	3.769	599
5	Bulletin of the American Meteorological Society	3.728	614
1	American Journal of Physiology - Heart and Circulatory Physiology	3.724	616
1	American Journal of Public Health	3.698	626
1	Journal of Cellular Physiology	3.638	646
3	Clinical Immunology	3.606	659
1	Optics Letters	3.598	662
41	Toxicological Sciences	3.598	662
1	Biochemical Pharmacology	3.581	667
1	Genomics	3.558	676
4	Journal of Chromatography A	3.554	678
3	Journal of Neuroscience Research	3.476	704

EPA Air Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	Ecological Applications	3.470	708
1	Cancer Letters	3.277	777
15	Journal of Applied Physiology	3.178	807
2	Journal of Chemical Physics	3.166	814
8	Chemical Research in Toxicology	3.162	818
1	Remote Sensing of Environment	3.064	855
38	Journal of Physical Chemistry A	3.047	863
1	American Journal of Cardiology	3.015	876
Total = 696			

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 17 indicates the number of air papers published in the top 10% of journals, based on the *JCR* Immediacy Index. Nine hundred sixty-six (966) of the 2,064 papers appear in the top 10% of journals, representing 46.8% of the air papers. This indicates that nearly one-half of the air papers are published in the highest quality journals as determined by the *JCR* Immediacy Index, which is 4.7 times higher than the expected percentage.

Table 17. Air Papers in Top 10% of Journals by *JCR* Immediacy Index

EPA Air Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
2	New England Journal of Medicine	12.743	2
5	JAMA - Journal of the American Medical Association	7.781	4
3	Lancet	7.419	6
7	Science	5.555	16
1	Journal of Clinical Investigation	3.911	29
1	Faraday Discussions	2.766	59
10	Circulation	2.674	63
1	International Journal of Epidemiology	2.200	84

EPA Air Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
27	American Journal of Respiratory and Critical Care Medicine	2.006	98
7	Journal of Allergy and Clinical Immunology	1.790	118
1	Annual Review of Physical Chemistry	1.762	124
2	Proceedings of the National Academy of Sciences of the United States of America	1.758	126
1	Critical Care Medicine	1.641	146
4	Philosophical Transactions of the Royal Society of London Series A: Mathematical and Physical Sciences	1.534	166
1	Journal of the American Chemical Society	1.510	168
1	Nano Letters	1.485	177
5	Thorax	1.460	184
24	Epidemiology	1.437	187
1	Journal of Thrombosis and Haemostasis	1.397	194
1	Journal of Neuroscience	1.319	216
1	Stroke	1.242	237
1	FASEB Journal	1.241	238
1	Neuroscience & Biobehavioral Reviews	1.222	243
2	Cancer Research	1.220	246
1	Cellular Signaling	1.213	249
1	Antioxidants & Redox Signaling	1.131	281
4	Journal of Biological Chemistry	1.110	291
3	Chest	1.110	291
4	European Respiratory Journal	1.108	294
12	American Journal of Epidemiology	1.091	306
1	Mutation Research–Reviews in Mutation Research	1.050	331
15	Journal of Applied Physiology	1.026	343
2	Atmospheric Chemistry and Physics	1.015	350
130	Environmental Health Perspectives	0.994	373
1	Environmental Science and Pollution Research	0.982	376

EPA Air Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
18	American Journal of Respiratory Cell and Molecular Biology	0.925	404
2	American Journal of Physiology - Cell Physiology	0.906	417
1	Plant Physiology	0.900	423
5	Journal of Immunology	0.886	435
1	Journal of Cellular Physiology	0.867	453
1	Physical Chemistry Chemical Physics	0.866	454
1	Environmental Microbiology	0.850	469
1	Computer Physics Communications	0.845	478
1	American Journal of Pathology	0.833	487
36	American Journal of Physiology - Lung Cellular and Molecular Physiology	0.832	493
2	Annals of Occupational Hygiene	0.808	513
14	Analytical Chemistry	0.795	524
2	Journal of Pharmacology and Experimental Therapeutics	0.791	531
1	Optics Letters	0.778	543
1	American Journal of Physiology - Heart and Circulatory Physiology	0.777	547
2	TrAC - Trends in Analytical Chemistry	0.752	578
6	Free Radical Biology & Medicine	0.751	580
5	Journal of Catalysis	0.751	580
1	American Journal of Public Health	0.740	588
1	Human Reproduction	0.734	597
41	Toxicological Sciences	0.734	597
38	Journal of Physical Chemistry A	0.730	602
2	Journal of Chemical Physics	0.721	616
4	Journal of the Atmospheric Sciences	0.712	631
1	Biochemical Pharmacology	0.705	641
1	Carbon	0.690	664
145	Journal of Geophysical Research	0.684	673

EPA Air Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	Agricultural and Forest Meteorology	0.669	690
1	Journal of Leukocyte Biology	0.668	691
8	Chemical Research in Toxicology	0.663	703
1	Genomics	0.659	706
1	Cancer Letters	0.658	707
1	Monthly Weather Review	0.654	716
167	Environmental Science & Technology	0.646	729
5	Bulletin of the American Meteorological Society	0.646	729
1	Journal of Environmental Pathology, Toxicology and Oncology	0.639	742
4	Journal of Physical Chemistry B	0.637	746
5	Boundary-Layer Meteorology	0.629	758
1	American Journal of Cardiology	0.615	781
1	Equine Veterinary Journal	0.611	790
3	Clinical Immunology	0.604	804
6	Journal of Exposure Science and Environmental Epidemiology	0.596	821
7	Environmental Research	0.583	844
135	Aerosol Science and Technology	0.571	872
Total = 966			

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., March-April 2007), but there were a number of hot papers identified from previous periods.

Using the hot paper thresholds established by *ESI* as a benchmark, 52 hot papers, representing 2.5% of the air papers, were identified in six fields—Clinical Medicine, Engineering, Environment/Ecology, Geosciences, Multidisciplinary, and Pharmacology & Toxicology. The number of air hot papers is 25 times higher than expected. The hot papers are listed in Table 18.

Table 18. Hot Papers Identified Using *ESI* Thresholds

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Clinical Medicine	7	7 cites in March-April 2002	Peters A, et al. Increased particulate air pollution and the triggering of myocardial infarction. *Circulation* 2001;103(23):2810-2815.
	12	21 cites in August-September 2003	Pope CA, et al. Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate air pollution. *Journal of the American Medical Association* 2002;287(9):1132-1141.
	10	11 cites in November-December 2005	Peters A, et al. Exposure to traffic and the onset of myocardial infarction. *New England Journal of Medicine* 2004;351(17):1721-1730.
	13	19 cites in November-December 2005	Pope CA, et al. Cardiovascular mortality and long-term exposure to particulate air pollution: epidemiological evidence of general pathophysiological pathways of disease. *Circulation* 2004;109(1):71-77.
	3	3 cites in July 2005	Ito K, et al. Associations between ozone and daily mortality: analysis and meta-analysis. *Epidemiology* 2005;16(4):446-457.
Engineering	4	4 cites in October-November 2001	Christoforou CS, et al. Trends in fine particle concentration and chemical composition in southern California. *Journal of the Air & Waste Management Association* 2000;50(1):43-53.
	4	4 cites in July 2001	Richter H, Howard JB. Formation of polycyclic aromatic hydrocarbons and their growth to soot - a review of chemical reaction pathways. *Progress in Energy and Combustion Science* 2000;26(4-6):565-608.
	3	3 cites in May 2001	Vanderpool RW, et al. Evaluation of the loading characteristics of the EPA WINSPM 2.5 separator. *Aerosol Science and Technology* 2001;34(5):444-456.
	3	5 cites in May 2001	Peters TM, et al. Design and calibration of the EPA $PM_{2.5}$ well impactor ninety-six (WINS). *Aerosol Science and Technology* 2001;34(5):389-397.
	5	5 cites in March- April 2003	Weber RJ, et al. A particle-into-liquid collector for rapid measurement of aerosol bulk chemical composition. *Aerosol Science and Technology* 2001;35(3):718-727.
	4	4 cites in November-December 2005	McMurry PH, et al. The relationship between mass and mobility for atmospheric particles: A new technique for measuring particle density. *Aerosol Science and Technology* 2002;36(2):227-238.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Engineering	2	3 cites in March- April 2003	Weber R, et al. Short-term temporal variation in $PM_{2.5}$ mass and chemical composition during the Atlanta Supersite Experiment, 1999. *Journal of the Air & Waste Management Association* 2003;53(1):84-91.
	3	4 cites in July 2003	Fujita, et al. Diurnal and weekday variations in source contributions of ozone precursors in California's South Coast Air Basin. *Journal of the Air & Waste Management Association* 2003;53(7):844-863.
	3	3 cites in November-December 2003	Lewis CW, et al. Source apportionment of Phoenix $PM_{2.5}$ aerosol with the Unmix receptor model. *Journal of the Air & Waste Management Association* 2003;53(3):325-338.
	3	3 cites in February 2004	Vette A, et al. Environmental research in response to 9/11 and homeland security. *EM: Air & Waste Management Association's Magazine for Environmental Managers* 2004;Feb:14-22.
	4	4 cites in March-April 2005	Russell M, et al. Daily, seasonal, and spatial trends in $PM_{2.5}$ mass and composition in Southeast Texas. *Aerosol Science and Technology* 2004;38(S1):14-26.
	4	4 cites in March-April 2005	Zhu YF, et al. Seasonal trends of concentration and size distribution of ultrafine particles near major highways in Los Angeles. *Aerosol Science and Technology* 2004;38(S1):5-13.
	3	3 cites in September-October 2004	Cho AK, et al. Determination of four quinones in diesel exhaust particles, SRM 1649a and atmospheric $PM_{2.5}$. *Aerosol Science and Technology* 2004;38(S1):68-81.
	4	4 cites in November-December 2004	Drewnick F, et al. Measurement of ambient aerosol composition during the PMTACS-NY 2001 campaign using an aerosol mass spectrometer. Part I: Mass concentrations. *Aerosol Science and Technology* 2004;38(S1):92-103.
	3	4 cites in November-December 2005	Canagaratna MR, et al. Chase studies of particulate emissions from in-use New York City vehicles. *Aerosol Science and Technology* 2004;38(6):555-573.
Environment/ Ecology	3	3 cites in March-April 2001	Lumley T, Levy D. Bias in the case-crossover design: implications for studies of air pollution. *Environmetrics* 2000;11(6):689-704.
	3	3 cites in August 2000	Stolzenburg MR, Hering SV. Method for the automated measurement of fine particle nitrate in the atmosphere. *Environmental Science & Technology* 2000;34(5):907-914.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	6	6 cites in September-October 2001	Schwartz J. Assessing Confounding, Effect modification, and thresholds in the association between ambient particles and daily deaths. *Environmental Health Perspectives* 2000;108(6):563-568.
	5	5 cites in August 2001	Seila RL, et al. Atmospheric volatile organic compound measurements during the 1996 Paso Del Norte Ozone Study. *Science of the Total Environment* 2001;276(1-3):153-169.
	5	6 cites in August 2001	Fujita EM. Hydrocarbon source apportionment for the 1996 Paso del Norte Ozone Study. *Science of the Total Environment* 2001;276(1-3):171-184.
	6	6 cites in September-October 2003	Jang MS, et al. Atmospheric secondary aerosol formation by heterogeneous reactions of aldehydes in the presence of a sulfuric acid aerosol catalyst. *Environmental Science & Technology* 2001;35(24):4758-4766.
	5	5 cites in November-December 2004	Jang MS, et al. Particle growth by acid-catalyzed heterogeneous reactions of organic carbonyls on pre-existing aerosols. *Environmental Science & Technology* 2003;37(17):3828-3837.
	5	7 cites in May-June 2004	Li N, et al. Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage. *Environmental Health Perspectives* 2003 ;111(4) :455-460.
	3	3 cites in April-May 2004	Sexton K, et al. Comparison of personal, indoor, and outdoor exposures to hazardous air pollutants in three urban communities. *Environmental Science & Technology* 2004;38(2):423-430.
	2	2 cites in August 2004	Landrigan PJ, et al. Health and environmental consequences of the World Trade Center Disaster. *Environmental Health Perspectives* 2004;112(6):731-739.
	5	9 cites in June-July 2006	Gao S, et al. Particle Phase Acidity and Oligomer Formation in Secondary Organic Aerosol. *Environmental Science & Technology* 2004;38(24):6582-6589.
	3	4 cites in May-June 2006	Thurston GD, et al. Workgroup report: workshop on source apportionment of particulate matter health effects—intercomparison of results and implications. *Environmental Health Perspectives* 2005;113(12):1768-1774.
	3	3 cites in September 2005	Koenig JQ, et al. Pulmonary effects of indoor- and outdoor-generated particles in children with asthma. *Environmental Health Perspectives* 2005;113(4):499-503.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	3	4 cites in March-April 2006	Presto AA, et al. Secondary organic aerosol production from terpene ozonolysis. 1. Effect of UV radiation. *Environmental Science & Technology* 2005;39(18):7036-7045.
	6	6 cites in August-September 2006	Dockery DW, et al. Association of air pollution with increased incidence of ventricular tachyarrhythmias recorded by implanted cardioverter defibrillators. *Environmental Health Perspectives* 2005;113(6):670-674.
	6	7 cites in December 2005-January 2006	Zanobetti A, Schwartz J. The effect of particulate air pollution on emergency admissions for myocardial infarction: a multicity case-crossover analysis. *Environmental Health Perspectives* 2005;113(8):978-982.
	6	6 cites in July-August 2006	Park SK, et al. Effects of air pollution on heart rate variability: The VA Normative Aging Study. *Environmental Health Perspectives* 2005;113(3):304-309.
	4	6 cites in March-April 2006	Bahreini R, et al. Measurements of secondary organic aerosol from oxidation of cycloalkenes, terpenes, and m-xylene using an Aerodyne Aerosol Mass Spectrometer. *Environmental Science & Technology* 2005;39(15):5674-5688.
	5	5 cites in March-April 2006	Lough GC, et al. Emissions of metals associated with motor vehicle roadways. *Environmental Science & Technology* 2005;39(3):826-836.
	6	12 cites in December-2006-January 2007	Zhang Q, et al. Deconvolution and quantification of hydrocarbon-like and oxygenated organic aerosols based on aerosol mass spectrometry. *Environmental Science & Technology* 2005;39(13):4938-4952.
	10	24 cites in March-April 2007	Oberdorster G, et al. Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. *Environmental Health Perspectives* 2005;113(7):823-839.
	4	4 cites in February-March 2007	Elder A. Translocation of inhaled ultrafine manganese oxide particles to the central nervous system. *Environmental Health Perspectives* 2006;114(8):1172-1178.
Geosciences	5	5 cites in June-July 2003	Huser RB, et al. Asian dust events of April 1998. *Journal of Geophysical Research-Atmospheres* 2001;106(D16):18317-18330.
	10	10 cites in June-July 2004	Orsini DA, et al. Refinements to the particle-into-liquid sampler (PILS) for ground and airborne measurements of water soluble aerosol composition. *Atmospheric Environment* 2003;37(9-10):1243-1259.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Geosciences	4	4 cites in June-July 2006	Grell GA, et al. Fully coupled "online" chemistry within the WRF model. *Atmospheric Environment* 2005;39(37):6957-6975.
	6	6 cites in November-December 2006	McKeen S, et al. Assessment of an ensemble of seven real-time ozone forecasts over eastern North America during the summer of 2004. *Journal of Geophysical Research–Atmospheres* 2005;110(D21):Art. No. D21307.
	5	5 cites in February-March 2007	Guenther A. Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature). *Atmospheric Chemistry and Physics* 2006;6:3181-3210.
Multidisciplinary	6	10 cites in May-June 2004	Jang MS, et al. Heterogeneous atmospheric aerosol production by acid-catalyzed particle-phase reactions. *Science* 2002;298(5594):814-817.
Pharmacology & Toxicology	5	6 cites in April 2005	Lippmann M, et al. Effects of subchronic exposures to concentrated ambient particles (CAPs) in mice: I. Introduction, objectives, and experimental plan. *Inhalation Toxicology* 2005;17(4-5):177-187.
	5	7 cites in April 2005	Maciejczyk P, et al. Effects of subchronic exposures to concentrated ambient particles (CAPs) in mice: II. The design of a CAPs exposure system for biometric telemetry monitoring. *Inhalation Toxicology* 2005;17(4-5):189-197.
	2	2 cites in September-October 2006	Costa DL, et al. Comparative pulmonary toxicological assessment of oil combustion particles following inhalation or instillation exposure. *Toxicological Sciences* 2006;91(1):237-246.
	2	2 cites in July 2003	Kodavanti UP, et al. Inhaled environmental combustion particles cause myocardial injury in the Wistar Kyoto rat. *Toxicological Sciences* 2003;71(2):237-245.

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 air papers. Of the 34,562 total cites, 1,605 are author self-cites—a 4.6% author self-citation rate. Garfield and Sher[3] found that authors working in research-based disciplines tend to

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

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 4.6% self-cite rate for the air papers is well below the range for author self-citation.

Highly Cited Researchers

A search of Thomson's *ISIHighlyCited.com* revealed that 59 (1.7%) of the 3,452 authors of the air 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 air publications are presented in Table 19.

Table 19. Highly Cited Researchers Authoring Air Publications

Highly Cited Researcher	Affiliation	*ESI* Field
Ames, Bruce N.	Children's Hospital Oakland Research Institute	Biology & Biochemistry Molecular Biology & Genetics
Andersen, Melvin E.	CIIT Centers for Health Research	Pharmacology
Anderson, James G.	Harvard University	Geosciences
Arey, Janet	University of California–Riverside	Environment/Ecology
Atkinson, Roger	University of California–Riverside	Environment/Ecology
Calvert, Jack G.	National Center for Atmospheric Research	Geosciences
Carter, William P.L.	University of California–Riverside	Environment/Ecology
Cass, Glen R.	Georgia Institute of Technology	Environment/Ecology
Corey, Lawrence	University of Washington	Clinical Medicine
Dickey, David A.	North Carolina State University	Mathematics Economics & Business
Dockery, Douglas W.	Harvard University	Environment/Ecology
Driscoll, Charles T.	Syracuse University	Environment/Ecology
Fehsenfeld, Fred C.	National Oceanic and Atmospheric Administration	Geosciences
Folsom, Aaron R.	University of Minnesota	Clinical Medicine
Fuster, Valentin	Mount Sinai Medical Center	Clinical Medicine

[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.

Highly Cited Researcher	Affiliation	*ESI* Field
Garcia, Rolando R.	National Center for Atmospheric Research	Geosciences
Giorgi, Filippo	Abdus Salam International Centre for Theoretical Physics (Trieste, Italy)	Geosciences
Hites, Ronald A.	Indiana University School of Public and Environmental Affairs	Environment/Ecology
Holben, Brent N.	National Air and Space Administration Goddard Space Flight Center	Geosciences
Houk, Kendall N.	University of California–Los Angeles	Chemistry
Hubler, Gerhard F.	National Oceanic and Atmospheric Administration	Geosciences
Jacob, Daniel J.	Harvard University	Geosciences
Karl, Thomas R.	National Oceanic and Atmospheric Administration	Geosciences
Kaufman, Yoram J.	National Air and Space Administration Goddard Space Flight Center	Geosciences
Kawachi, Ichiro	Harvard School of Public Health	Social Sciences, general
Khalil, Mohammed A.K.	Portland State University	Environment/Ecology
Kloner, Robert A.	Good Samaritan Hospital	Clinical Medicine
Koutrakis, Petros	Harvard School of Public Health	Environment/Ecology
Lay, Thorne	University of California–Santa Cruz	Geosciences
Likens, Gene E.	Institute of Ecosystem Studies	Environment/Ecology
Lindberg, Steven E.	Oak Ridge National Laboratory	Environment/Ecology
Liotta, Lance A.	National Cancer Institute	Clinical Medicine
Lioy, Paul J.	University of Medicine & Dentistry of New Jersey	Environment/Ecology
Lippmann, Morton	New York University School of Medicine	Environment/Ecology
Logan, Jennifer A.	Harvard University	Geosciences
Madronich, Sasha	National Center for Atmospheric Research	Geosciences
Mannucci, Pier M.	Università degli Studi di Milano	Clinical Medicine
Mazurek, Monica A.	Rutgers University	Environment/Ecology
Pankow, James F.	Oregon Health and Science University	Environment/Ecology

Highly Cited Researcher	Affiliation	*ESI* Field
Parker, John (Jack) C.	University of Tennessee	Environment/Ecology Engineering
Rasmussen, Reinhold A.	Oregon Health and Science University	Environment/Ecology Geosciences
Richards, James H.	University of California–Davis	Environment/Ecology
Rogge, Wolfgang F.	Florida International University	Environment/Ecology
Salawitch, Ross J.	California Institute of Technology	Geosciences
Schwartz, Joel D.	Harvard School of Public Health	Environment/Ecology Pharmacology
Schwartz, Stephen E.	Brookhaven National Laboratory	Geosciences
Seinfeld, John H.	California Institute of Technology	Geosciences Environment/Ecology Engineering
Simoneit, Bernd R.T.	Oregon State University	Environment/Ecology Engineering
Speizer, Frank E.	Harvard Medical School	Clinical Medicine
Spengler, John D.	Harvard University	Environment/Ecology
Trainer, Michael	National Oceanic and Atmospheric Administration	Geosciences
Turco, Richard P.	University of California–Los Angeles	Geosciences
Van Thiel, David H.	Loyola University Medical Center	Clinical Medicine
Wang, J.	National Centers for Environmental Prediction	Geosciences
Watson, John G.	Desert Research Institute	Environment/Ecology
Winer, Arthur M.	University of California–Los Angeles	Environment/Ecology
Wofsy, Steven C.	Harvard University	Geosciences
Wolff, George T.	General Motors Corporation	Environment/Ecology
Zeger, Scott L.	Johns Hopkins University	Mathematics
Total = 59		

Patents

There were 6 patents issued by investigators from 1998 to 2007 for research that was conducted under EPA's air research program. The patents are listed in Table 20. Two of the 6 patents (33.3%) were referenced by a total of 9 other patents.

Table 20. Patents from the Air Research Program (1998-2007)

Patent or Patent Application No.	Inventor(s)	Title	Patent/Patent Application Date	Patents that Referenced This Patent
U.S. Patent No. 6,890,372	Dasgupta PK Morris KJ Li J	Denuder assembly for collection and removal of soluble atmospheric gases	May 2005	None
U.S. Patent No. 5,763,360	Gundel L Daisey JM Stevens RK	Quantitative organic vapor-particle sampler	June 1998	Referenced by 6 patents: (1) 7,122,065 Adapter for low volume air sampler (2) 6,604,406 Human portable preconcentrator system (3) 6,523,393 Human portable preconcentrator system (4) 6,502,450 Single detector differential particulate mass monitor with intrinsic correction for volatilization losses (5) 6,403,384 Device and method for analyzing a biologic sample (6) 6,035,701 Method and system to locate leaks in subsurface containment structures using tracer gases
U.S. Patent No. 6,226,852	Gundel L Daisey JM Stevens RK	Method for fabricating a quantitative integrated diffusion vapor-particle sampler for sampling, detection and quantitation of semi-volatile organic gases, vapors and particulate components	May 2001	Referenced by 3 patents: (1) 7,159,475 Apparatus and method of sampling semivolatile compounds (2) 7,122,065 Adapter for low volume air sampler (3) 7,089,747 Pressure reduction apparatus and method
U.S. Patent No. 6,780,818	Gundel L Daisey JM Stevens RK	Quantitative organic vapor-particle sampler	August 2004	None
U.S. Patent No. 7,168,292	Gundel LA Apte MG Hansen AD Black DR	Apparatus for particulate matter analysis	January 2007	None

Patent or Patent Application No.	Inventor(s)	Title	Patent/Patent Application Date	Patents that Referenced This Patent
U.S. Patent No. 7,168,292	Gundel LA Apte MG Hansen AD Black DR	Apparatus for particulate matter analysis	January 2007	None

<u>Additional *ESI* Parameters for Air Pollution Publications</u>

Since the last bibliometric analysis for the Particulate Matter/Ozone Research Program, which was conducted in 2005, *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 Air Pollution. The parameters reported by *ESI* for the special topic of Air Pollution are compared with the results of the analysis of the EPA Air Research Program publications below.

<u>Top 20 Papers in Air Pollution</u>—A review of *ESI*'s top 20 papers on the topic of air pollution (published from January 1, 2003 to April 30, 2005), indicates that 4 (20.0% of the top 20 papers) are papers from EPA's Air Research Program. These papers are listed in Table 21.

<u>Top 20 Authors in Air Pollution</u>—Eighteen of *ESI*'s top 20 authors (90.0% of the top 20 authors) in air pollution (ranked by total cites from 1995-2005) authored papers for EPA's Air Research Program. These authors are listed in Table 22.

Table 21. EPA Air Papers in *ESI*'s Top 20 Air Pollution Papers Overall (Published from January 1, 2003 to April 30, 2005)

ESI Rank	EPA Air Program Publication
3	Pope CA, et al. Cardiovascular mortality and long-term exposure to particulate air pollution—epidemiological evidence of general pathophysiological pathways of disease. *Circulation* 2004;109(1):71-77.
4	Binkowski FS, Roselle SJ. Models-3 Community Multiscale Air Quality (CMAQ) model aerosol component. 1. Model description. *Journal of Geophysical Research–Atmospheres* 2003;108(D6):4183.
9	Becker S, et al. Response of human alveolar macrophages to ultrafine, fine, and coarse urban air pollution particles. *Experimental Lung Research* 2003;29(1):29-44.
13	McConnell R, et al. Prospective Study of Air Pollution and Bronchitic Symptoms in Children with Asthma. *American Journal of Respiratory and Critical Care Medicine* 2003;168(7):790-797.

Table 22. *ESI*'s Top 20 Overall Authors in Air Pollution (Ranked by Total Cites, 1995-2005)

***ESI* Rank**	**Author**	**Total Cites**	**Number of Papers**	**Cites Per Paper**	**EPA Air Research Paper Author**
1	Schwartz, J.	2,537	93	27.28	Yes
2	Dockery, DW	2,473	35	70.66	Yes
3	Pope, CA	1,973	29	68.03	Yes
4	Samet, JM	1,255	28	44.82	Yes
5	Speizer, FE	1,193	11	108.45	Yes
6	Brunkekreef, B	967	55	17.58	Yes
7	Thun, MJ	952	4	238.00	Yes
8	Anderson, HR	906	31	29.23	No
9	Cass, GR	869	27	32.19	Yes
10	Peters, A	770	39	19.74	Yes
11	Burnett, RT	668	39	17.13	Yes
12	Zeger, SL	653	15	43.53	Yes
13	Katsouyanni, K	640	35	18.29	Yes
14	Wichmann HE	606	27	22.44	Yes
15	Donaldson, K	598	7	85.43	Yes
16	Macnee, W	598	7	85.43	Yes
17	Ghio, AJ	577	12	48.08	Yes
18	Dominici, F	556	16	34.75	Yes
19	Spix, C	546	13	42.00	No
20	Touloumi, G	539	18	29.94	Yes

Top 20 Countries Publishing in Air Pollution—The United States ranks number one among the top 20 countries publishing on air pollution. From 1995-2005, the United States published 1,608 papers that were cited 16,899 times. The second ranking country, England, published 421 papers that were cited 3,295 times.

Top 20 Journals in Air Pollution—1,038 (50.2%) of the EPA Air Research Program papers were published in *ESI*'s top 20 journals in air pollution (ranked by total cites from 1995-2005). The top 20 journals and the number of EPA air papers published in these journals are provided in Table 23.

Table 23. *ESI*'s Top 20 Journals in Air Pollution (Ranked by Total Cites, 1995-2005)

***ESI* Rank**	**Journal**	**Total Cites**	**Number of Papers**	**Cites Per Paper**	**Number of EPA Air Papers in Journal**
1	Atmospheric Environment	2,869	344	8.34	266
2	Environmental Health Perspectives	2,735	148	18.48	130
3	American Journal of Respiratory and Critical Care Medicine	2,486	66	37.67	27
4	Epidemiology	1,715	544	3.15	24
5	Environmental Science & Technology	1,122	93	12.06	167
6	Lancet	995	28	35.54	3
7	American Journal of Epidemiology	986	55	17.93	12
8	Inhalation Toxicology	907	56	16.20	103
9	European Respiratory Journal	809	52	15.56	4
10	Journal of the Air & Waste Management Association	800	110	7.27	120
11	Thorax	702	25	28.08	5
12	Science	697	27	25.81	7
13	Occupational and Environmental Medicine	632	54	11.70	7
14	Journal of Geophysical Research–Atmospheres	612	74	8.27	143
15	Journal of Epidemiology and Community Health	576	38	15.16	1
16	Archives of Environmental Health	538	48	11.21	4
17	Environmental Pollution	492	71	6.93	6
18	Water, Air, and Soil Pollution	412	75	5.49	2
19	Indoor Air	356	48	7.42	2
20	JAMA-Journal of the American Medical Association	342	11	31.09	5
Total					**1,038**

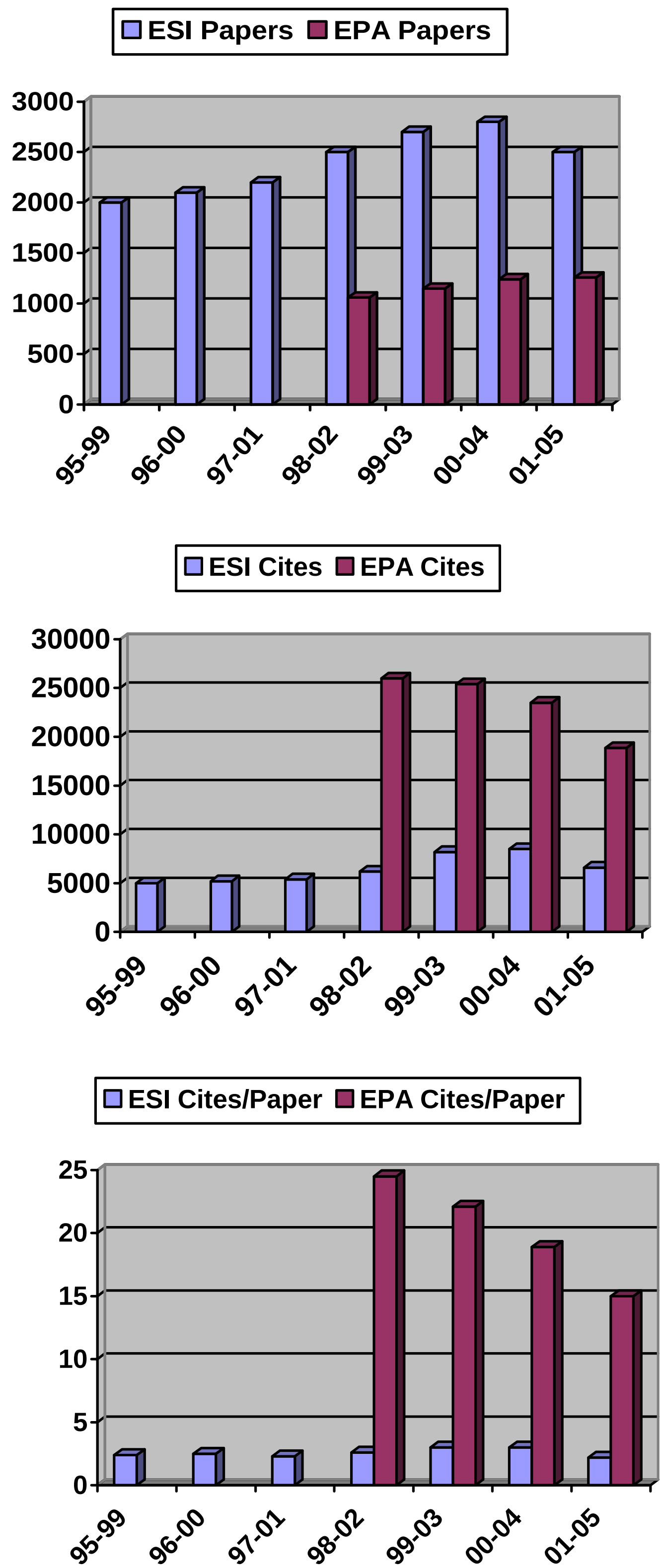
<u>Top 20 Institutions Publishing on Air Pollution</u>—Harvard University ranks number one on *ESI*'s top 20 overall institutions publishing on air pollution with 192 papers (published from 1995-2005) that were cited 4,771 times. Harvard University is one of the recipients of EPA grants that publishes under the Air Research Program. The U.S. Environmental Protection Agency ranks number two with 175 publications that were cited 2,543 times. The top 20 institutions are listed in Table 24.

Table 24. *ESI*'s Top 20 Institutions Publishing on Air Pollution (Ranked by Total Cites, 1995-2005)

ESI Rank	Institution	Total Cites	Number of Papers	Cites Per Paper
1	Harvard University	4,771	192	24.85
2	U.S. EPA	2,543	175	14.53
3	University of North Carolina	1,316	72	14.53
4	Brigham Young University	1,311	2	46.82
5	GSF Forschungszentrum Umwelt & Gesundheit	1,268	62	20.45
6	Johns Hopkins University	1,227	45	27.27
7	Health Canada	1,067	57	18.72
8	American Cancer Society	952	4	238.00
9	Wageningen University	830	38	21.84
10	Caltech	821	36	22.81
11	University of Athens	777	58	13.40
12	University of Groningen	633	19	33.32
13	St. George's Hospital	621	24	25.88
14	University of California–Berkeley	615	72	8.54
15	University of British Columbia	604	51	11.84
16	University of California–Irvine	603	24	25.13
17	University of Rochester	599	13	46.08
18	Napier University	591	8	73.88
19	Municipal Institute of Medical Research (IMIM–Barcelona)	584	18	32.44
20	University of Maryland	564	19	29.68

Air Pollution Publication Trends—According to *ESI*, the number of air pollution papers rose slightly each year from 2000 to 2004; however, the number of cites and the number of cites/paper have been declining since 1999. The number of air pollution papers published from 2001 to 2005 has declined from the number published from 2000 to 2004, and the number of cites and cites/paper from 2001 to 2005 have declined as well. These trends are depicted in Figure 1. The number of EPA Air Research Program publications, however, has increased slightly from 2001 to 2005 (1,257 publications) when compared to the number published from 2000 to 2004 (1,240 publications). Like the overall air pollution paper trends identified by *ESI*, the number of cites and the cites per paper have declined.

Figure 1. Comparison of *ESI* Air Pollution Publication Trends with EPA Air Research Program Publication Trends



ESI Field Distribution of Air Pollution Papers—The majority of air pollution papers from 1995 to 2005 were published in journals that fall within the *ESI* field of Clinical Medicine, followed by the fields of Environment/Ecology, Geosciences, Engineering, and Chemistry. For the EPA air papers included in this analysis, the majority of the papers were published in the *ESI* field of Geosciences, followed by Environment/Ecology, Engineering, Clinical Medicine, and Pharmacology & Toxicology. The distribution of air pollution papers among the 22 *ESI* fields and the distribution of the EPA air papers for comparison are presented in Table 25.

Table 25. Comparison of Field Distribution of Air Pollution Papers (Ranked by Number of Papers, 1995-2005) to Field Distribution of EPA Air Research Program Papers (Published from 1998-2007)

ESI Rank	*ESI* Field	Air Pollution Papers Overall				EPA Air Papers			
		Total Cites	Number of Papers	Cites Per Paper	% of Papers	Total Cites	Number of Papers	Cites Per Paper	% of Papers
1	Clinical Medicine	12,689	1,376	9.22	27.6%	6,479	260	24.9	12.6%
2	Environment/ Ecology	7,534	1,196	6.30	24.0%	7,910	435	18.2	21.1%
3	Geosciences	4,144	594	6.98	11.9%	8,478	490	17.3	23.7%
4	Engineering	1,921	566	3.39	11.3%	4,259	360	11.8	17.4%
5	Chemistry	450	301	1.50	6.0%	2,375	150	15.8	7.3%
6	Social Sciences	598	224	2.67	4.5%	62	13	4.8	0.6%
7	Pharmacology & Toxicology	1,572	139	11.31	2.8%	2,951	220	13.4	10.7%
8	Plant & Animal Science	433	116	3.73	2.3%	124	11	11.3	0.5%
9	Economics & Business	440	80	5.50	1.6%	25	3	8.3	0.1%
10	Immunology	357	75	4.76	1.5%	377	14	26.9	0.7%
11	Computer Science	91	66	1.38	1.3%	15	4	3.8	0.2%
12	Multidisciplinary	829	60	13.82	1.2%	421	10	42.1	0.5%
13	Materials Science	48	44	1.09	0.9%	1	2	0.5	0.1%
14	Biology & Biochemistry	74	41	1.8	0.8%	546	41	13.3	2.0%
15	Physics	126	34	3.71	0.7%	194	15	12.9	0.7%
16	Molecular Biology & Genetics	279	27	10.33	0.5%	62	8	7.8	0.4%
17	Agricultural Sciences	72	24	3	0.5%	—	—	—	—
18	Mathematics	60	15	4	0.3%	35	7	5.0	0.3%
19	Microbiology	23	4	5.75	0.1%	22	1	22.0	0.05%
20	Neuroscience & Behavior	8	4	2.00	0.1%	227	20	11.4	1.0%
21	Psychiatry/Psychology	3	4	0.75	0.1%	—	—	—	—
22	Space Science	1	4	0.25	0.1%	—	—	—	—
Total		32,422	4,994	6.49		34,562	2,064	16.7	