

**2018 Environmental Monitoring, Evaluation, and  
Protection (EMEP) Citation Analysis**

*Final Report*

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## Notice

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# 1 Introduction

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## 1.1 Program Description

Since 2006, Research Into Action, Inc. has contracted with Clarivate Analytics (Clarivate) to update the Institutional Citation Report (ICR) produced for the Environmental Monitoring, Evaluation, and Protection program (EMEP) in 2018. Research Into Action completed four updates of the ICR since 2006, and during each update, they analyze all the EMEP funded research since program inception in 1998.

**Table 1-1. Summary of Citation Analysis Updates**

Update Year	Years of EMEP Research Covered	Matched papers in Clarivate Database
2006	1998-2006	98
2009	1998-2009	154
2013	1998-2013	247
2018	1998-2018	364

Using its *Web of Science*<sup>®</sup> bibliographic database, Clarivate algorithmically matches the records of authors with articles in the *Web of Science*. Thomson does not guarantee a 100% match rate. For this ICR update, citation counts were created for matched projects from program inception in 1998 up to June 2018.

Obtaining an ICR allows EMEP to document if and how the research findings supported by the program are being communicated. EMEP staff would like to confirm that program-sponsored projects are being cited in academic journals as a way to: 1) document the performance of research through citation metrics; 2) evaluate the outcomes of funding decisions; and 3) identify opportunities for future collaboration or information transfer. In response to this request, Clarivate provided customized databases created for Research Into Action on behalf of NYSERDA. These databases document the results of the *Web of Science* analysis.

In addition to the *Web of Science* analysis, and different than in previous citation analysis reports, Research Into Action used Google Scholar to further understand how often EMEP funded work is cited by others - the “intellectual reach” of the program. Google Scholar reports how many citations each paper has received on the web. However, it does not provide the same customized

analysis for a select group of papers like Clarivate provides. For example, Google Scholar does not offer an H-index or C-index score.<sup>1</sup>

## 1.2 Summary of Evaluation Objectives and Methods

In June 2018, Research Into Action provided a list of 590 EMEP papers to Clarivate. Of these papers, 539 were categorized into one of four topical areas: air quality, ecosystems, climate change, and crosscutting research. The remaining 51 publications were not categorized.

Ultimately, Clarivate was able to match 364 of the 590 (62%) records in their *Web of Science* database. This rate was similar to the 61% match rate achieved in 2009 and 2013 (Figure 1-1).

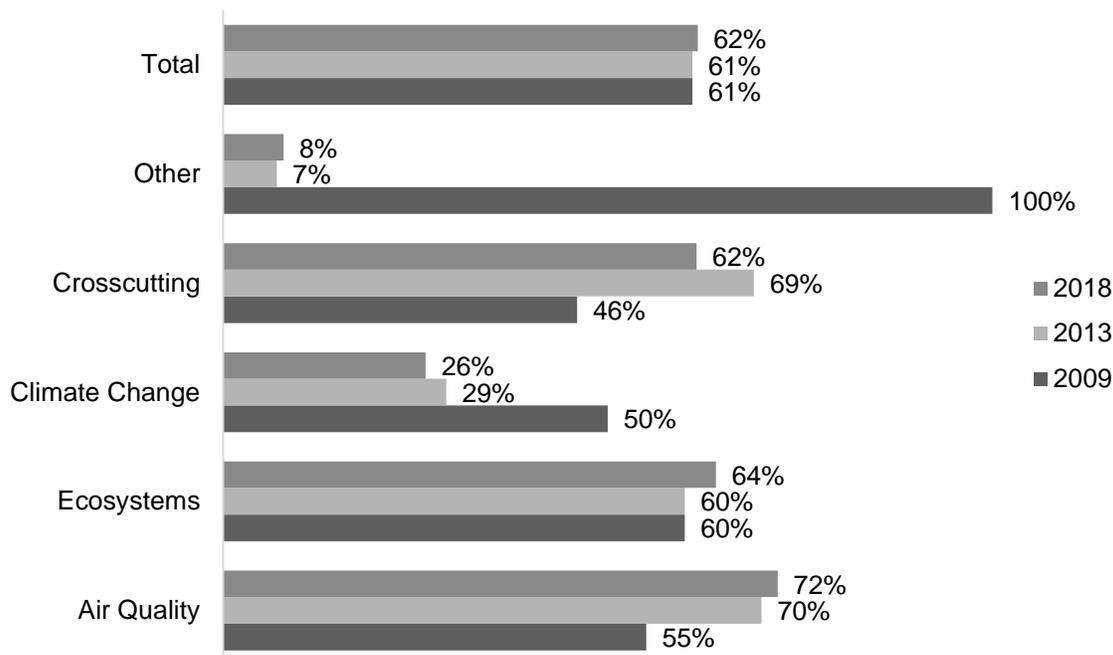
Why did 233 of the products submitted to Clarivate not match their database? Articles are likely to be either not published yet (under review), appear in a non-peer-reviewed publication (graduate theses, conference proceedings, websites), or were published in a journal outside of Clarivate's scope.

As a result of matching about three-fifths of the articles, the analysis in Figure 1-1 demonstrates the *minimum* number EMEP-sponsored research cited by others.

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<sup>1</sup> Google Scholar does offer individual authors analysis beyond total citations including the H-index and C-index metrics. However, these metrics are not available for a group of papers like Clarivate offers. For definitions of these indices, see page 2-1.

**Figure 1-1. Comparison of EMEP Records to Clarivate/Thomson Results Over Time**



To further increase the distribution and availability of research projects funded by EMEP, program staff have begun to encourage researchers that receive EMEP funding to publish their articles in open access journals. Open access journals provide access to published scientific work, typically without subscription requirements. In some cases, EMEP funds have helped make articles published in subscription-based journals publicly available.

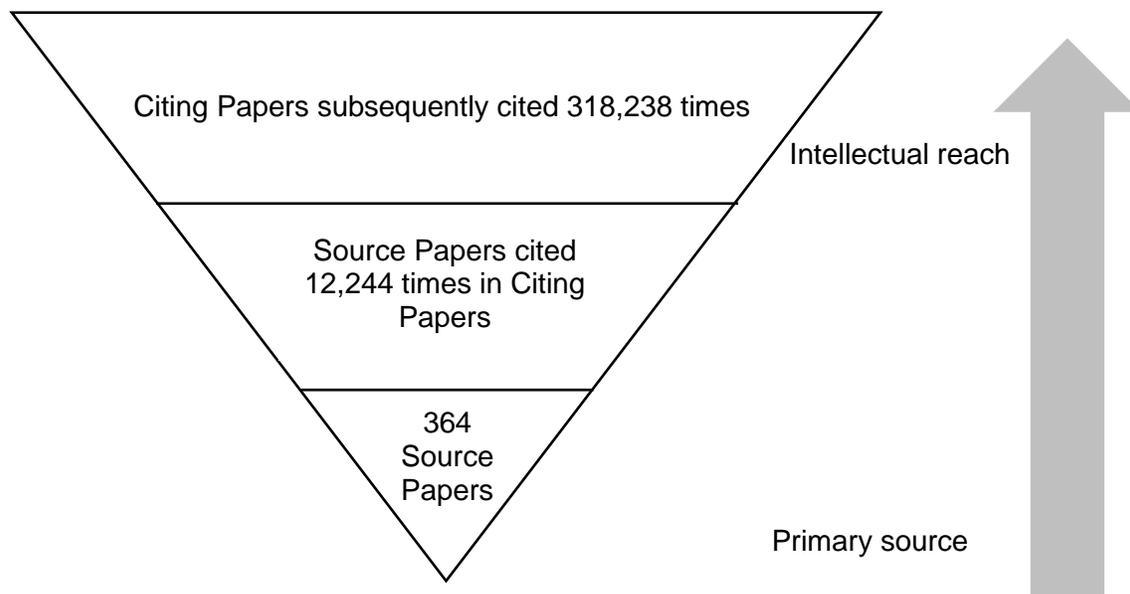
In September 2018, Research Into Action searched for each EMEP-funded document in the Google Scholar database and recorded the number of citations associated with that work in a spreadsheet. Using the spreadsheet, Research Into Action calculated the total and average number of citations of EMEP funded papers in Google Scholar and compared Google Scholar’s match rate – the percentage of all EMEP work – to Clarivate’s match rate.

## 2 Results

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**The EMEP funded papers continue to be cited and referenced in many journal articles.** The 364 EMEP-funded and categorized papers matched in the *Web of Science* database search are called *source papers*. These *source papers*, attributed to 949 authors, were cited 12,244 times between 1998 and 2018 in citing papers. These *citing papers* were in turn cited 318,238 times (Figure 2-1). These 2018 numbers show the intellectual reach increased more than four-fold since 2013 when only 76,384 citations resulted from 5,833 citing papers.

**Figure 2-1. Intellectual Reach of EMEP Funding as Matched to *Web of Science*® in 2018**



**The intellectual reach of EMEP funded papers continues to expand.** An ICR results in several other measures of reach or success. The first measure is called a C-Index. A C-Index communicates the actual citations relative to expected citations. A value of 1.0 would indicate that the EMEP funded papers were cited at the same rate as other papers in the *Web of Science* database and a score over one indicates the papers are cited more than other papers in the database. EMEP-funded papers appear to be cited at a higher rate than expected, as demonstrated by the mean C-Index value of 1.2. This value is consistent with the 2013 C-index score of 1.3. Furthermore, the two main subject areas with the largest number of papers, Air Quality and Ecosystems have C-index scores higher than one. As of 2018, 93% of EMEP funded papers have

been cited at least once and this value is consistent with the 2009 percentage of 92% and the 2013 percentage of 94%.

The second measure of intellectual reach is an H-Index. An H-Index is a statistic that reflects the number of papers cited at least that many times. In 2018, the 364 matched EMEP source papers earned an H-Index of 52 – meaning that 52 of the source papers were cited at least 52 times each. The increasing H-index from 2009 to 2018 is another sign that the program is continuing to expand its reach (Table 2-1).

**Table 2-1. Summary Analytics**

NYSERDA Topic	Number of Papers	Average Cites <sup>a</sup>	Median Citations <sup>b</sup>	H-Index <sup>c</sup>	C-Index <sup>d</sup>	Percentage Cited <sup>e</sup>
Air Quality	199	36.2	15	41	1.3	92%
Climate Change	5	10.2	2	2	.7	80%
Crosscutting	8	79.0	68	8	.9	100%
Ecosystem	148	29.4	16	36	1.1	94%
Other	4	1	1	n/a	n/a	75%
<b>2018 Overall Results</b>	<b>364</b>	<b>33.6</b>	<b>15</b>	<b>52</b>	<b>1.2</b>	<b>93%</b>
<b>2013 Overall Results</b>	<b>245</b>	<b>23.8</b>	<b>12</b>	<b>39</b>	<b>1.3</b>	<b>94%</b>
<b>2009 Overall Results</b>	<b>154</b>	<b>18.0</b>	<b>12.5</b>	<b>29</b>	<b>1.7</b>	<b>92%</b>

<sup>a</sup> Total number of citations divided by number of source papers

<sup>b</sup> Half of the source papers received fewer citations, half received more

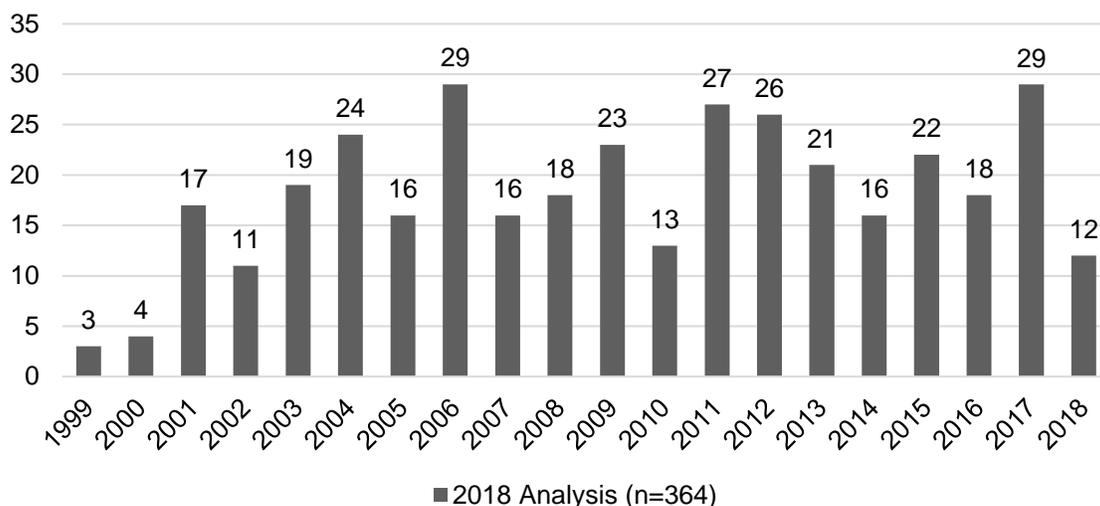
<sup>c</sup> The number of papers (N) in a given dataset having N or more citations.

<sup>d</sup> The sum of all actual citations divided by the sum of expected citations

<sup>e</sup> The portion of source papers cited at least one time

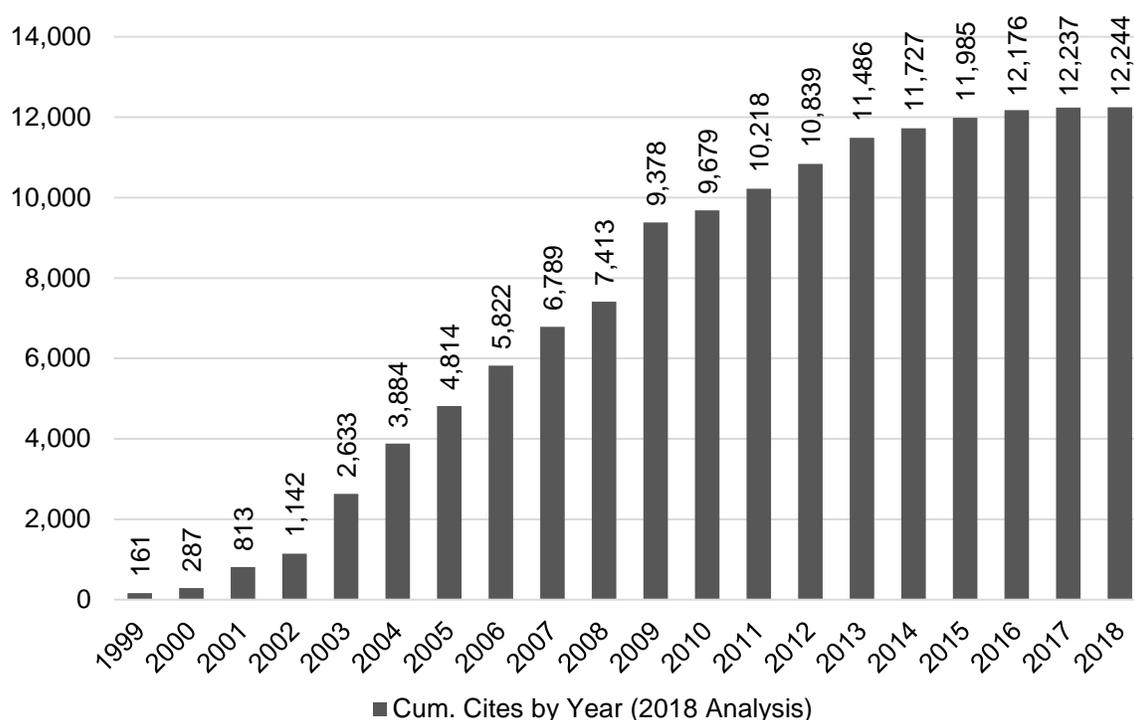
**The number of articles cited by publication year varies.** The ICR also shows the number of articles published each year. Figure 2-2 shows that EMEP articles were cited most frequently in 2006 and 2017, with 29 articles being cited in each of those years. The relatively small number of citations in 2018 is a reflection of the time required for published work to be cited elsewhere (Figure 2-2).

**Figure 2-2. Number of Articles Cited by Publication Year**



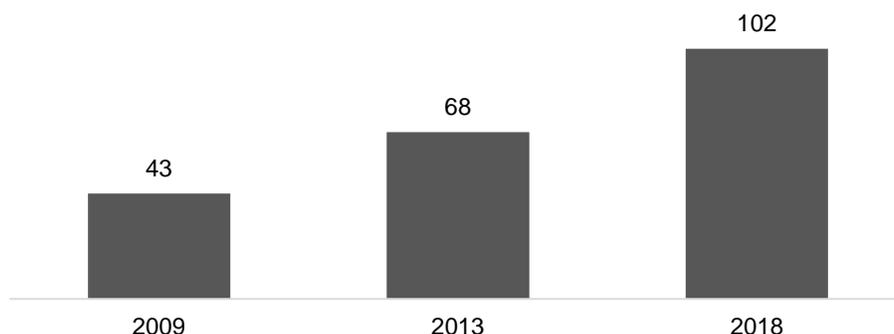
The cumulative number of citations increases each year following a similar trend seen in the 2009 and 2013 reports. From 1998-2018, EMEP articles were cited over 12,000 times in the *Web of Science* database with the largest increases occurring from 2008 to 2009. While there are fewer citations in recent years, this should be expected – the more recent the publication date, the less time there has been for citations to occur (Figure 2-3).

**Figure 2-3. Cumulative Number of Citations by Publication Year**



**EMEP funded research is reaching more journals than ever.** Since the 2009 analysis, the number of journals that include funded papers has increased 137% from 43 journals in 2009 to 102 in 2018 (Figure 2-4.).

**Figure 2-4. Number of Journals Including Funded Research**



**More journals are representing the bulk of citations further suggesting greater diffusion of EMEP funded papers in the literature.** In 2009, nine journals represented two-thirds of all citations, in 2013 it increased to 15 journals, and in 2018 it increased to 21 journals. Table 2-2 shows the 16 journals most used by EMEP funded research.

**Table 2-2. Journals Publishing EMEP-Funded Project Citations by Frequency – 1998-2018**

Journal	Papers	Cumulative Papers	Cumulative Percent
Atmospheric Environment	54	54	15%
Environmental Science and Technology	29	83	23%
Journal of Air and Waste Management Associations	19	102	28%
Energy and Fuels	13	115	32%
Journal of Geophysical Research-Atmospheres	13	128	35%
Environmental Pollution	11	139	38%
Aerosol Science and Technology	10	149	41%
Hydrological Processes	10	159	44%
The International Journal of Aerosol and Air Quality Research	9	168	46%
Atmospheric Chemistry and Physics	8	176	48%

Journal	Papers	Cumulative Papers	Cumulative Percent
Science of the Total Environment	8	184	51%
Ecological Applications	8	192	53%
Ecotoxicology	8	200	55%
Environmental Fluid Mechanics	7	207	57%
Biogeochemistry	6	213	59%
Journal of Geophysical Research - Biogeosciences	5	218	60%
All other Journals (n=86)	-	146	40%

**A large portion of EMEP funded papers continue to appear in the *Web of Science's* environmental sciences topic field.** EMEP research focuses on environmental issues related to energy production and use, and this is evidenced in the papers published in environmental science and ecological fields. The field associated with the largest number of papers is *Environmental Sciences* followed by *Meteorology and Atmospheric Sciences* (Table 2-3).

**Table 2-3. Articles by Clarivate Topic**

Field	Papers	Rank
Environmental Sciences	130	1
Meteorology and Atmospheric Sciences	65	2
Water Resources	20	3
Engineering Mechanical	15	4
Toxicology	14	5
Geosciences, multidisciplinary	11	6
Engineering, chemical	10	7
Engineering, environmental	9	8
Public, environmental and occupational health	9	8
Mechanics	7	10
Ecology	7	10
Other categories (n=27)	67	-

**Google Scholar indicates an even greater intellectual reach than Clarivate’s *Web of Science* analysis.** Of the 590 EMEP funded items, 483 (82%) received at least one citation in Google Scholar compared to the aforementioned 364 – Clarivate’s “source papers” - found in *Web of Science*. Additionally, the 483 items found in Google Scholar received about twice the number of citations (24,282) compared to Web of Science’s calculation of number of citations (12,244) (Table 2-4).

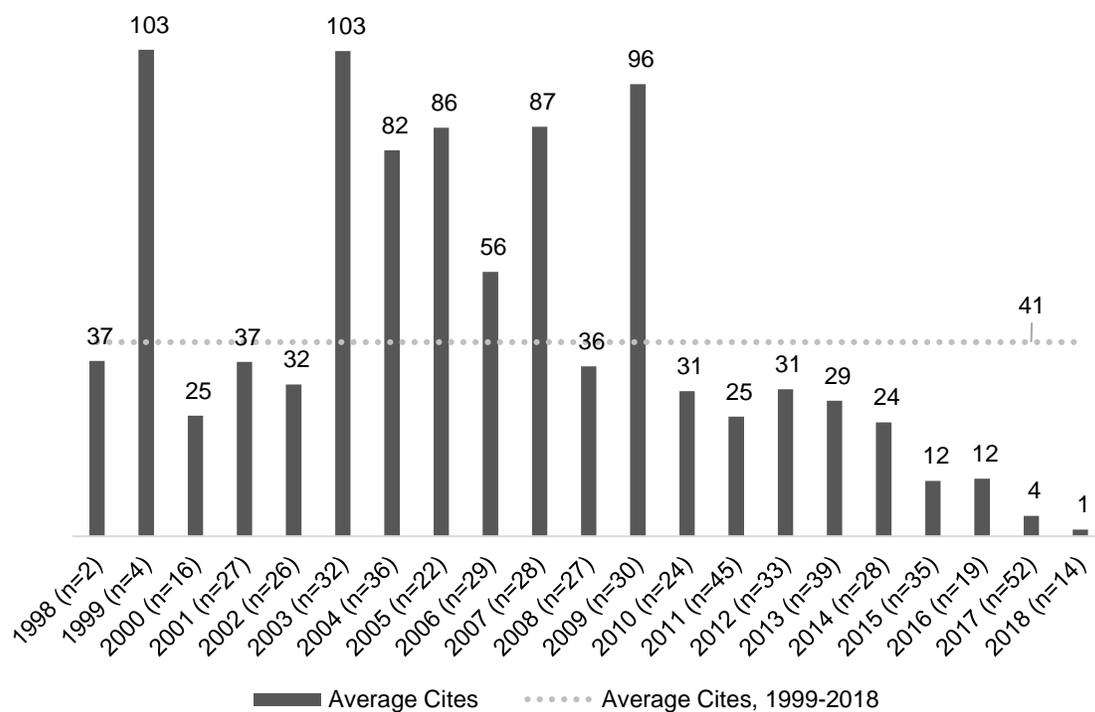
**Table 2-4: Comparison of Clarivate Citations to Google Scholar**

Source	Clarivate – <i>Web of Science</i>	Google Scholar
Source papers	364	483
Match rate	62%	82%
<b>Total citations</b>	<b>12,244</b>	<b>24,282</b>

The higher match rate and higher total number of citations in Google Scholar is likely a result that Google Scholar captures more non-peer reviewed journals compared to *Web of Science*.

**Google Scholar analysis indicates that EMEP work published between 2003 and 2009 received more citations on average than other years.** Papers funded between 2003 and 2009 received, on average, about twice the number of citations per item than all years, save 1999 (Figure 2-5). It is unclear why there is this spike in average citations. It is to be expected that older papers would receive more citations than newer papers – older papers have more time to be referenced by others – but the spike in citations from 2003 to 2009 is noticeable.

**Figure 2-5. Average Number of Citations by Publication Year, Google Scholar**



### 3 Conclusions and Recommendations

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EMEP funding supports research that is being widely disseminated in the academic literature and beyond. This analysis captures only part of the academic reach of EMEP, and these results indicate that the research is being utilized by academics at a greater rate than other literature in the field. The trend over time shows that the intellectual reach continues to expand, reaching more journals and scientists than ever before. Furthermore, the Google Scholar analysis shows that EMEP funded work is even more utilized than previously understood in past citation analysis reports that looked only at *Web of Science*.

Conducting a similar citation analysis with another vendor such as Scopus would provide additional insights into the intellectual reach of the EMEP funded papers. However, it is unclear that the cost of pursuing this – it costs \$20,000 for the data and additional time to analyze the data – would be worth the extra effort.