OCEANOGRAPHY:
THE DEVELOPMENT OF JOURNAL STRUCTURE AND INTERNATIONAL CO-AUTHORSHIP

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CONTENT

1. Introduction

In April 1986, on the occasion of her visit to the Science Dynamics Department of the University of Amsterdam, Dr. S. Cozzens of the National Science Foundation raised the question of whether it would be possible to use the instruments for the measurement of relations between journals as described in our article on 'The Development of Frames of References'[1], to explore the following questions in the area of oceanography:

1.Is there a specific journal structure for oceanography, and if so, can this structure be shown to change over time?

2.Is the growing international cooperation in the exploitation of deep sea resources reflected in these journals as an increase in joint scientific publications among research institutes in different countries?

The two questions are connected, because if the relevant journal set changes over the years, this should have implications for the relevant 'universes' to examine for international 'co- authorships'.

In this report, it will be argued that the pattern of aggregated journal-journal citations in 'oceanography' have changed, as measured with the data in the Science Citation Index, particularly in the 1970s. In the 1980s the journal structure has become almost completely stable.
However, since 1977 the (underlying) factor structure of inter-journal citations in this and related fields has been rather stable, and hence a core journal set can be identified in order to follow international co-authorship between France and California between 1974-1985. (California was chosen because of the location of the Scrips Institute in La Jolla.)
From the results of this analysis, we will conclude that this type of international co-authorship happens occasionally throughout the whole period at a frequency of about two times per year. These results are then compared with general frequencies of international co-authorship between France and California.

2. The journal-journal structure

2.1. Methods

The Journal Citation Reports of the Science Citation Index are used to determine the evolution of the journal structure. These contain between 2450 and 3300 journals for the relevant years (1974- 1984[2]), with an annual turn-over of approximately 7%. [3]

As core journal we selected the Journal of Physical Oceanography, because in more recent years this journal has become central to the field (see fig. 1 for the 1984 main journals citing this journal, and being cited by this journal). (Initially, the Journal of Geophysical Research was considered as a core journal for the analysis as well-- at the suggestion of dr. Cozzens-- but this journal was finally not selected because it is closely linked with journals in other areas as well.)
The analysis was performed as described in the above- mentioned article [4], namely as follows:

1.From the entry journal the three journals which cite that journal most heavily were listed, and then this procedure was reiterated for the new batch of journals either until the method converged or until we diverged more than two arrows from our entry. Subsequently, the same procedure was followed for 'citing' as well, and by combining the two lists a comprehensive journal list for that specific year was created.
2.For each year, a journal-journal citation matrix with numeric values was constructed. Correlation matrices were computed for each matrix and its transposition, and used for factor-analysis and Q-factoring respectively.
3.The sum-value of mutual citations between two journals was used for a multidimensional scaling representation. In these journal-maps the relevant structures were drawn in accordance with the results of the factor analyses.
4.Additionally, a dendogram was produced from the cluster analysis of the journals, using Wards' method of analysis on a Pearson correlation matrix[5]. The dendograms provide information about the level at which the journals belong together.

Qualitative analysis (ad 1.) was pursued for 1974, 1977, 1981, and 1984; Quantitative analyses (ad 2, 3, and 4) for 1974, 1977, and 1984 only.

2.2. Results

In 1974, the Journal of Physical Oceanography was not yet included in the Journal Citation Reports (although it is included in other sections of the Science Citation Index for that year.) Therefore, Deep-Sea Research, which in later years was closely linked to the Journal of Physical Oceanography, was taken as the entry journal.

The qualitative pictures for 1974 (fig. 2), show clearly that although Deep-Sea Research was among others directly linked to the leading journal in geophysical research (the Journal of Geophysical Research), its relations are much more scattered. The inclusion of the Journal of Physical Oceanography in 1977 only makes it possible to identify a definite cluster of journals on 'oceanography' from that year onwards.
Factor-analysis for 1977 (table 1) reveals 'geophysics' as a first factor accounting for 31.8% of the common variance. As a second factor (27.8%), 'atmospheric sciences' seem of major importance for this field, being linked to the 'geophysics' cluster by the Journal of Geophysical Research- Oceans and Atmospheres, a special section of this journal which in later years was not included separately in the Journal Citation Reports. These titles suggest a predominance of attention (and mutual citations) for what we might call 'surface-problems'.

Only the third and the fourth factor (16.7% and 12.3% respectively) consist of journals which have the word 'oceanography' in their titles. The third cluster is the biological part of the field, while the fourth is 'physical oceanography'. Finally, in 1977, a fifth cluster can be discerned corresponding to 'fluid mechanics' (11.4% of the common variance).
Figure 3 provides a multidimensional scaling representation of this journal-journal citation matrix. The stress is acceptable (dhat= 0.11). Figures 4 and 5 show the results of the cluster analysis over the 'being cited' patterns and the 'citing' patterns respectively, clearly indicating the changing position of the interdisciplinary character of GP7 (JGP- Oceans and Atmospheres) as the main difference between these two perspectives. For reasons explained in detail in 'The Development of Frames of References', we will focus on the perspective of regarding the volumes as cases and citations to them as variables[6].
In 1984, the number of relevant journals, according to the methods described above, has declined from 16 to 9. So has the number of factors, if we take as the cut-off criterion that a factor should explain more of the common variance than an average variable. Three instead of five factors emerge; hence the reduction in complexity is about the same, resp. 3/9 versus 5/16).
The factor matrix for 1984 is given in table 2.

Despite the fact that the Journal of Physical Oceanography (OC1) was taken as the entry, 'physical oceanography' is still a minor (third) factor in this matrix, explaining only 16.9% of the common variance.
Of greater significance are the other factors of 'oceanography' (with the biological journal Limnology and Oceanography correlating negatively with the Journal of Physical Oceanography) and 'geophysical research'. The dendogram and the MDS- map are given in figures 6 and 7[7].

2.3. Conclusions

Although differences appear in the journal-journal structures over the years, mainly in the degree of relatedness to other areas such as atmospheric sciences, there is also a great resemblance between the 1977 and 1984 structures.
Between 1974 and 1977 there are important differences, but these may in part be a consequence of the inclusion of the Journal of Physical Oceanography, which in itself, however, is a major fact.
Moreover, the impact-factors for the journals involved (table 3) are also rather stable. Therefore, it seems reasonable in this case to work with a constant journal set if one wants to measure another variable such as, in this case, international co-authorships.
Section 3 describes this constant journal set.

The important factors in the area as measured by journal-journal citations are:
1. geophysics
2. oceanography- biologically oriented
3. oceanography- physically oriented
4. atmospheric sciences
5.Science and Nature, which also play a role in some of the intervening years. .pa
3. The constant journal set

3.1. Methods

The constant journal set was constituted on the basis of the journals involved in the qualitative analyses of 1974, 1978, 1981 and 1984, on the one hand, and the results of the various factor-analyses on the other. Science and Nature were added because they do play a role in some years, and they provide a clear point of reference.
We think that the following list can be used for a longitudinal analysis of other variables in this field:

1. Journal of Physical Oceanography	OC1
2. Journal of Marine Research	OC2
3. Deep-Sea Research	OC3
4. Limnology and Oceanography	OC4
5. Marine Biology	OC5
6. Journal of Geophysical Research	GP1
7. Geophysical Journal of the Roy.Astr.Soci.	GP2
8. Planetary and Space Sciences	GP3
9. Geophysical Research Letters	GP4
10. Journal of Atmos. Terr. Physics	GP8
11. Journal of Atmospheric Sciences	AS1
12. Monthly Weather Review	AS2
13. Nature	
14. Science	

As we have noted, the Journal of Physical Oceanography was not yet included in 1974, and the same holds true for Geophysical Research Letters.

Matrices were composed for these 14 (12) journals, and all the analyses mentioned in section 2.1. were carried out.

3.2. Results

The journal-journal citation matrices between these years are highly comparable. Table 4 shows the Pearson correlations between these matrices for different years. The 1981- and the 1984-matrix correlate above .99.
Despite the much lower correlation between 1977 and 1984 (.69), the factor structure for these two years is almost identical, as is illustrated by tables 5 and 6. The only difference is that 'physical oceanography' in 1984 explains 12.2% of the common variance of this matrix (factor 4), as against 10.0% in 1977 (factor 5). This increase has been at the expense of 'atmospheric sciences', which explained about 3% less of the common variance in 1984 than in 1977.
However, these differences are extremely small.

Figure 8 displays the superposition of the multidimensional scaling solutions for 1977 and 1984, once more demonstrating their great stability. Finally, the dendograms for 1974, 1977, 1981, and 1984 are also provided (respectively figures 9, 10, 11, and 12).

3.3. Conclusion

A fixed journal set for the area can be defined for the years 1977-1984. Some reservations have to be made for the validity of this choice for the years 1974-1977 because it cannot be checked in the JCR. However, the high stability of the factor matrix in later years provides some support for the validity of the inference that the journal set may be stable over the whole period.

4. International co-authorship

In this section we address the question of whether the supposed internationalization of the field can be measured by the number of articles with addresses from different countries. The analysis has been limited to California, a US-state with major research facilities in the discipline, and to France as an exemplary advanced country with a share in economic activities.

4.1. Methods

The analysis was done straightforwardly on-line on DIALOG. The intersection of Californian AND French addresses for each year was combined with an AND for the relevant journals. This order in the search was chosen to enable us to compare the number of co- authored articles with general trends in co- authorship among researchers with Californian and French addresses.

For reasons of cost-effectiveness, only the following eight journals representing the core of the field were used:

1. Journal of Physical Oceanography (OC1)
2. Journal of Marine Research (OC2)
3. Deep-Sea Research (OC3)
4. Limnology and Oceanography (OC4)
5. Journal of Geophysical Research (GP1)
6. Geophysical J. of the Roy. Astr. Soci. (GP2)
7. Planetary and Space Sciences (GP3)
8. Geophysical Research Letters (GP4)

Hence Marine Biology (OC5), the Journal of Atmospheric and Terrestrial Physics (GP8), the two 'atmospheric sciences' journals, were left out, as were Science and Nature.

In this case the Journal of Physical Oceanography posed no problems, because it had been included in the 1974 Science Citation Index although not in the Journal Citation Reports of that year. The Geophysical Research Letters are only included from 1975 onwards.

It should be noted that these years relate not to "publication years" but to the dates-of-entry as indicated by ISI for the DIALOG-installation of the SCI.

4.2. Results

Co-authorship on institutional addresses in France and California does exist, but represents less than 1% of both French and Californian publications. Table 7 presents the total numbers and the respective percentages. However, the percentage is going up: for France, from 0.42% in 1974 to 0.93% in 1985, and for California from 0.31% to 0.84% in 1985.
The fifth column of this table lists the number of co-authorships with these two addresses for the eight journals involved. It is clear that these figures are extremely low, and there is no substantial increase over time. Moreover, all co- authored articles are in 'geophysical' journals, as can be seen from the latter column.
International co-authorship in this field seems rather to be something which happens from time to time, particularly in geophysics[8]. We found no such co-authorships in the oceanography-cluster at all, and hence also no increase.

The full bibliographic details of the articles (including the OATS-nrs for ordering) are given in Appendix B.

4.3. Conclusion

It is not possible to measure quantitatively the 'internationalization of oceanography' in terms of co-authorships from researchers with institutional addresses in different locations, in this case France and California (US).
However, an increasing French participation can be observed over the years in the universe of journal sets employed here (table 8). French participation nearly doubled between 1974 and 1985, against a more modest growth from almost 4 to almost 5% in the total French share of world publications.
Californian participation has always been high in this field (as compared to an overall share of world publications of about 5.2%), but tends to diminish somewhat in more recent years. (Of course, this effect could have other causes as well.)

5. Summary

With regard to the original questions raised in section 1 of this report, namely

1. whether a specific journal structure for oceanography can be identified, and if so, whether this structure can be shown to change over time? and
2.whether growing international cooperation in the field is reflected in a rise in scientific publications with addresses both in France and in California?

we can now conclude as follows:

1.A journal structure emerges more stable during the mid 1970s, partly because important journals in this field are taken up in the Science Citation Index, partly because the already present underlying citation structures become stronger. This process comes to an end by 1981.

However, already for 1974 a dendogram with the full structure could be produced as well (figure 8).

2.Because of the presence of a journal structure over the whole period, in this case it is possible to identify a fixed journal set, and hence to control for this variable while varying another. Such a fixed journal set has been determined, and has been found to be extremely stable over time in its structure, although some variance in other aspects can be found in the earlier years (1974- 1981).

3.Eight journals were chosen from this set to investigate in terms of internationalization as operationalized by sharing both a French and a Californian address in one record of the Science Citation Index.

This form of operationalization proved unworkable in this case.

However, internationalization can be measured if operationalized in a different way. French participation in the relevant journal set almost doubled in the course of a decade, against some decline of Californian participation (which is traditionally relatively high!) between 1982 and 1985.

Notes and References

1.L. Leydesdorff, 'The Development of Frames of References', Scientometrics, 9 (1986) 103- 125.

2. At the time of this analysis (April 1986) the JCR for 1985 has not yet been issued.

3.H. R. Coward, J. J. Franklin, L. Simon, ABRC Science Policy Study: Co-Citation Bibliometric Models, Center for Research Planning, Philadelphia, Penn., 1984, p. 4. For my critique of the use of a fixed journal set, see: L. Leydesdorff, 'Increases in British and Dutch Scientific Performance', Nature (forthcoming).

4. Leydesdorff, 1986.

5.L. Leydesdorff, 'Different Methods for the Mapping of Science' (in preparation).

6. Leydesdorff, 1986, p. 106.

7.When we transpose the matrix, the pattern of 'being cited' (as opposed to the 'citing') pattern reveals a remarkable-- negative!-- relation between Limnology and Oceanography and Nature, which may also be a result of other effects, such as being heavily cited. See also Leydesdorff, 1986, p. 106.

8.About geophysics see, e.g.: C. S. Gillmor and C. J. Terman, 'Communication Modes of Geophysics: The Case of Ionospheric Physics', EOS, 54 (1973) 900-08; C. S. Gillmor, 'Citation Characteristics of the JATP Literature', Journal of Atmospheric and Terrestrial Physics, 37 (1975) 1401-04.

APPENDIX A

FIGURES and TABLES

Legend_to_table_1

OC1 Journal of Physical Oceanography
OC2 Journal of Marine Research
OC3 Deep-Sea Research
OC4 Limnology and Oceanography
OC5 Marine Biology

GP1 Journal of Geophysical Research
GP2 Geophysical J. of the Royal Astron. Society
GP5 Geological Society of America Bulletin
GP6 Bulletin of the Seismological Society of America
GP7 Journal of Geophysical Research- Oceans and Atmospheres

FM1 Journal of Fluid Mechanics
FM2 Physics of Fluids
FM3 Proceeding of the Roy. Soci. of London Series A
FM4 AIAA Journal

AS1 Journal of Atmospheric Sciences

VAR1 Journal of the Acoustical Society of America

Legend to figures 3, 4 and 5

1.	Journal of Physical Oceanography	OC1
2.	Journal of Marine Research	OC2
3.	Deep-Sea Research	OC3
4.	Limnology and Oceanography	OC4
5.	Marine Biology	OC5
6.	Journal of Geophysical Research	GP1
7.	Geophysical J. of the Royal Astron. Society	GP2
8.	Geological Society of America Bulletin	GP5
9.	Bulletin of the Seismological Society of America	GP6
10.	Journal of Geophysical Research- Oceans and Atmospheres	GP7
11.	Journal of Fluid Mechanics	FM1
12.	Physics of Fluids	FM2
13.	Proceeding of the Roy. Soci. of London Series A	FM3
14.	AIAA Journal	FM4
15.	Journal of Atmospheric Sciences	AS1
16.	Journal of the Acoustical Society of America	VAR1

Legend_to_figure_1

OC1 Journal of Physical Oceanography

OC2 Journal of Marine Research

OC3 Deep-Sea Research

OC4 Limnology and Oceanography

GP1 Journal of Geophysical Research

GP2 Geophysical J. of the Royal Astron. Society

GP3 Planetary and Space Sciences

GP4 Geophysical Research Letters

NATURE

Legend_to_table_2

OC1 Journal of Physical Oceanography

OC2 Journal of Marine Research

OC3 Deep-Sea Research

OC4 Limnology and Oceanography

GP1 Journal of Geophysical Research

GP2 Geophysical J. of the Royal Astron. Society

GP3 Planetary and Space Sciences

GP4 Geophysical Research Letters

NATURE

Legend_to_figures_6_and_7

1. Journal of Physical Oceanography	OC1
2. Journal of Marine Research	OC2
3. Deep-Sea Research	OC3
4. Limnology and Oceanography	OC4
5. Journal of Geophysical Research	GP1
6. Geophysical J. of the Royal Astron. Society	GP2
7. Planetary and Space Sciences	GP3
8. Geophysical Research Letters	GP4
9. Nature	NATURE

Table_3

IMPACT FACTORS FOR RELEVANT JOURNALS IN DIFFERENT YEARS

		1974	1977	1984
OC1	Journal of Physical Oceanography	--	1.750	1.625
OC2	Journal of Marine Research	0.574	1.945	3.237
OC3	Deep-Sea Research	1.739	1.663	1.568
OC4	Limnology and Oceanography	1.487	1.937	2.628
OC5	Marine Biology	0.858	1.292	1.811
GP1	Journal of Geophysical Research	2.536	3.552	2.393
GP2	Geophysical J. of the Royal Astron. Society	1.691	2.003	1.668
GP3	Planetary and Space Sciences	1.645	1.381	1.388
GP4	Geophysical Research Letters	--	2.395	2.091
GP5	Geological Society of America Bulletin	1.674	1.192	2.554
GP6	Bulletin of the Seismological Society of America	1.150	0.787	1.744
GP7	Journal of Geophysical Research- Oceans and Atmospheres	--	0.263	--
GP8	Journal of Atmospheric and Terrestrial Physics	1.322	1.161	0.886
AS1	Journal of Atmospheric Sciences	2.051	2.049	2.192
AS2	Monthly Weather Review	0.873	1.020	1.741
	Nature	3.636	4.957	10.248
	Science	5.412	5.745	8.209

Legend to tables 5 and 6, and to figures 8, 9, 10, 11, and 12

Journal of Physical Oceanography	OC1	1	(not in 1974)
Journal of Marine Research	OC2	2	
Deep-Sea Research	OC3	3	
Limnology and Oceanography	OC4	4	
Marine Biology	OC5	5	
Journal of Geophysical Research	GP1	6	(not in 1974)
Geophysical Journal of the Roy.Astr.Soci.	GP2	7	
Planetary and Space Sciences	GP3	8	
Geophysical Research Letters	GP4	9	
Journal of Atmos. Terr. Physics	GP8	10	
Journal of Atmospheric Sciences	AS1	11	
Monthly Weather Review	AS2	12	
Nature		13	
Science		14	

Table_7

Co-authored articles with French and Californian adresses

	total (1)	% Fr. (2)	% Ca. (3)	in sample (4)	journals
1974	68	0.42%	0.31%	1	J. Geophys. Res.
1975	80	0.37	0.35	1	Geophysical J. of the Roy. Astr. Soci.
1976	112	0.43	0.38	4	J. Geophys. Res. (2x); Geophys. J. Roy. Astr. Soci. (1x); Geophys. Res. Letters (1x)
1977	131	0.50	0.46	2	J. Geophys. Res.; Planet. & Space Sci.
1978	150	0.61	0.50	3	J. Geophys. Res. (2x); Geophys. J. Roy. Astr. Soci.
1979	149	0.61	0.53	1	Geophys. Res. Letters
1980	180	0.59	0.57	2	J. Geophys. Res. (2x)
1981	206	0.73	0.64	3	J. Geophys. Res. (2x); Geophys. J. Roy. Astr. Soci.
1982	236	0.77	0.71	2	J. Geophys. Res. (2x)
1983	249	0.83	0.75	1	J. Geophys. Res.
1984	294	0.96	0.86	4	J. Geophys. Res (2x); Geophys. Res. Letters (2x)
1985	318	0.93	0.84	0	
				(24)	

1) total number of publications with a French and Californian address in that year (all of the SCI).
2) 1) as a percentage of the total number of publications with a French address
3) 1) as a percentage of the total number of publications with a Californian address
4) number of co-authored publications in the following journals:

Table_8

Publications with a French or Californian address

in the eight[1] central journals

	total in central journals	France N	France %	California N	California %
1974	1464	28	1.92%	233	15.91%
1975	1306	27	2.06%	223	17.07%
1976	2013	54	2.68%	394	19.57%
1977	1707	43	2.51%	289	16.93%
1978	1078	29	2.69%	311	28.85%
1979	1388	40	2.88%	242	17.44%
1980	1473	45	3.05%	271	18.40%
1981	1718	63	3.67%	324	18.86%
1982	1466	43	2.93%	286	19.51%
1983	1576	63	4.00%	259	16.43%
1984	1694	67	3.96%	222	13.10%
1985	1144	37	3.23%	155	13.55%

1.

1. Journal of Physical Oceanography (OC1)
2. Journal of Marine Research (OC2)
3. Deep-Sea Research (OC3)
4. Limnology and Oceanography (OC4)
5. Journal of Geophysical Research (GP1)
6. Geophysical J. of the Roy. Astr. Soci. (GP2)
7. Planetary and Space Sciences (GP3)
8. Geophysical Research Letters (GP4)

Legend_to_figure_2

OC2 Journal of Marine Research

OC3 Deep-Sea Research

OC4 Limnology and Oceanography

OC5 Marine Biology

MB1 Journal of Experimental Marine Biology and Ecology

MB2 Journal of the Marine Bilogical Association of the U.K.

JWPC Journal of the Water Pollution Control Federation

PHYC Journal of Phycology

FISH Journal of the Fisheries Research Board of Canada

GP1 Journal of Geophysical Research

GP3 Planetary and Space Sciences

GP8 Journal of Atmospheric and Terrestrial Physics

GP9 Reviews of Geophysics and Space Physics

SCI Science

PNAS Proceedings of the National Academy of Sciences USA

NATU Nature

JBC Journal of Biological Chemistry