AMS AND PEER REVIEW

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1. INTRODUCTION

We have all been taught at one time of another about the so-called "scientific method," which involves asking a question, searching the literature, framing a hypothesis, testing that hypothesis from data, experiment, or (now) computer simulation, and then reporting the results. This "classical" definition is absurdly simple and not realistic. Science is not linear. The question and the hypothesis can change during the course of an investigation, as one does more experiments or collects more data, or learns something through informal comments of colleagues (e.g., at a conference or seminar). But, most telling, there is no statement about the importance of peer review of the final conclusions. Any of these steps can lead scientists scurrying back to any step in the process.

In the wake of the "climategate" emails, peer review has come under some criticism. What prevents a few unreasonable reviewers or dishonest authors from subverting the process? Here, we describe the process of editorial decision by the AMS, highlighting points at which the process is protected, and discussing other points at which peer review takes place.

Peer review is simply review of the work by one scientist or group of scientists by another scientist or group of scientists. It's a control mechanism to keep "mistakes" out of the formal literature. Or to prevent as much as possible one paper leading scientists down a blind alley. Or to prevent scientists from going "too far" with too little to support their conclusions. Constructive peer review is helpful to scientists; typically it improves not only the paper that is being reviewed, but also the work itself. Peer review has more than once prevented embarrassment for a scientist or organization.

When one speaks of peer review, one typically refers to the peer-reviewed literature. However, this is only the first step in a process that involves peer review at several stages. After discussing the entire process, we will focus on publishing. At each stage, we will focus on the role of the AMS as appropriate.

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2. PRE-PUBLICATION PEER REVIEW

There are several opportunities for peer review before a scientist submits work to a journal for publication. Scientists planning a piece of research will often have to write a formal proposal to get funded to do the work, take the required measurements, or do the required computer runs. In this proposal, they put the work in context, try to convince the funding agency that the work is important, and outline how they plan to do the work.

Each agency handles proposals differently, but typically a proposal has three or more anonymous reviewers, who are asked to comment on the work itself, the ability of the scientist(s) to do the work, and the relevance and greater impact of the work on the body of science, society, the training of new scientists, education, and diversity. Program officers can then fund (or not) the proposals based on the reviews. Often, a panel of peers is convened to help in the review process. In this case, unreasonable reviews are typically ignored. However, it is recognized that this process can weed out non-mainstream or extremely innovative proposals, especially if the scientist is not known to the community. In response to this, the National Science Foundation (NSF) has Small Grants for Exploratory Research (SGER) grants, designed for innovative but untested ideas, with review taking place within NSF (http://www.nsf.gov/od/lpa/news/publicat/nsf0203/cross/ocpa.html)

Once the scientist begins the investigation, informal peer review often occurs at the workplace. Our scientist might run down the hall to check to see if he or she is using the best data or method. When the work is well underway, scientists will typically prepare a talk for their colleagues at their home institution. This provides valuable feedback in a friendly environment.

The next step is typically to present the work at a conference. The AMS runs about two-dozen scientific conferences a year. The organizing committee is usually pretty generous about accepting presentations from the scientific

community; the real peer review takes place during the talk – and afterwards in the hallways.

Armed with feedback from the conference, the scientists can improve on what has already been done (a new data-analysis technique, a new data set is suggested), and either takes the research in another direction, expands on the work, or, if far enough along, incorporates the feedback while preparing a paper for publication. It is here that the formal review process starts.

3. PUBLISHING IN PEER-REVIEWED JOURNALS

Atmospheric scientists typically publish in ~63 peer-reviewed journals (Schultz 2010a), of which the AMS publishes 10 and co-publishes an eleventh (Table 1). A more complete description and history of AMS journals is found in Jorgensen et al. (2007).

Table 1. AMS Journals and their area of focus copied or paraphrased from http://www.ametsoc.org/pubs/journals/

Journal	Type of Articles
Journal of the Atmospheric Sciences	Quantitative: physics, dynamics, and chemistry of the atmosphere of the Earth and other planets
Journal of Applied Meteorology and Climatology	Applications of weather/climate data and numerical models,
Journal of Physical Oceanography	Physics of the ocean; interaction of ocean with boundaries, other parts of earth system.
Monthly Weather Review	Analysis or prediction of atmospheric phenomena on seasonal or shorter time scale, using observations or models. Also includes technique development, review articles, reviews of high-impact weather events.
Journal of Atmospheric and Oceanic Technology	In-situ and remote-sensing instruments for atmospheric and oceanic research, Data acquisition, analysis, and interpretation algorithms or techniques.
Weather and Forecasting	New operational techniques for forecasting and verification, societal value of forecasts.
Journal of Climate	Large-scale variability of the atmosphere, oceans, land surface, and cryosphere; past, present, and projected future climate-system changes; climate simulation and prediction. Review articles.
Journal of Hydrometeorology	Water and energy exchanges from the subsurface to the boundary layer and related lower atmosphere; precipitation, radiation, etc.
Weather, Climate, and Society	Interactions of weather and climate with society. Deals with economics, policy, institutional, social, behavioral, and international research; mitigation/adaptation.
Bulletin of the American Meteorological Society	Articles on atmospheric and related sciences, the AMS, etc., of interest to all AMS members in user-friendly language.
Earth Interactions	Interactions among the physical, biological, and human components of the earth system. Publ. with American Geophysical Union and American Association of Geographers.

3.1 The AMS Review Process

The peer-review editorial process of the AMS can best be visualized by the flowchart shown in Figure 1 and the description in Jorgensen et al. (2007).

After a cursory check by AMS Headquarters to ensure that format meets some minimum standards, each paper submitted to an AMS journal is assigned by its Chief Editor to one of the Editors (or the Chief Editor), matching the subject of the paper to the expertise of the editor. If the Chief Editor or Editor feels the paper would be more suitable in another AMS journal, they will try to persuade the author to transfer it.

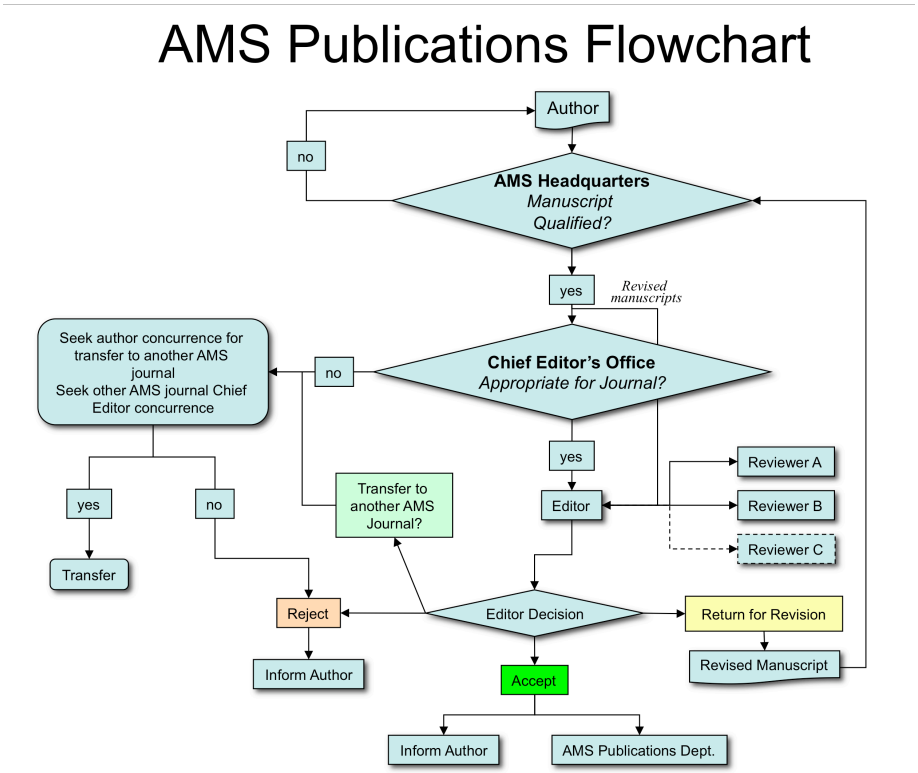

Figure 1. The AMS peer-review process

The editor in turn sends out the paper to three reviewers after ensuring they are willing and able to review the manuscript within about four weeks (two weeks for "Expedited Contributions," a special category recently initiated by the AMS for shorter, focused manuscripts).

Each reviewer is asked to judge the paper on its merits (whether the paper is novel, logically consistent, conclusions are consistent with the data and well supported, clearly-written, etc.). Reviewers are anonymous unless they choose to sign their reviews. Typically, each review will discuss major and minor concerns, suggest specific changes for clarification or firming up the conclusions, and make a recommendation to accept with no revisions, return for minor revisions, return for major revisions, or reject.

The Editor reads the reviews (and sometimes the paper) and writes a letter along with the reviewer comments to the corresponding author, selecting one of the above options. The Editor requests that the author respond to both Editor and reviewer concerns and revise accordingly; or provide good reasons for instances when the authors feel revision is not warranted. This process usually takes another four weeks depending on how much work the author has to do to satisfy the reviewer comments.

When the authors' responses are in, the Editor may send out the revised manuscript and the authors' responses to the reviewers' concerns to the reviewers who had major concerns. If the Editor feels the author has adequately responded to the reviewer concerns, the paper is accepted.

In the case of a second review, upon receiving the second set of reviews, the Editor decides whether to accept the paper, send it out for still another round of reviews, or reject it; and writes a letter to the author, accepting or rejecting the paper, or outlining further need for revision. Papers are not actually accepted until all of he reviewers' concerns are addressed.

Most often, only one round of major revisions is needed for papers that are accepted. If the needed revisions simply aren't taking place, the paper is rejected.

The percentage of first-round editorial decisions across all AMS journals for "Major" revisions, "Minor" revisions, and "Rejection" are shown in Table 2. Note that an editorial decision for "Major" revisions means that the Editor intends at

the time of decision to return the revised paper to one or more reviewers for a second round of reviews. Nearly half of all initial editorial decisions are in the Major category; i.e., the reviewers' comments are serious enough to warrant another round of review.

Table 2. 2009 1st editorial decisions by all AMS Editors across all AMS journals. The acceptance and rejection rates at final decision can be considerably different.

Total initial decisions	2486
Accept	0.2
Major Revisions	49.8%
Minor Revisions	23.0%
Rejection	27.0%

The editorial process isn't always smooth; and can indeed lead to an infinite loop if the author and reviewers can't come to a conclusion about reviewer concerns. In the vast majority of cases a final editorial decision is made with one or two revision iterations. If a reviewer is unreasonably harsh, however, the Editor might ask the reviewer to tone it down. If a reviewer makes threats ("I will no longer publish in this journal if you publish this manuscript.") the tendency for a good editor is to ignore such threats and possibly not use the reviewer in the future. If there is no consensus, the Editor might do a fourth review, send the paper to an additional reviewer, or enlist the help of an Associate Editor to adjudicate the disparate reviews.

Clearly, the integrity of the peer-review system depends on volunteer efforts of the Editors and Reviewers. Editors are chosen carefully for their expertise and their duties are clearly articulated in an Editors Guide. Editors are chosen to cover the breadth of papers expected by a given journal. Necessary attributes include not only scientific excellence in a needed area, but also breadth, and a reputation for being fair, conscientious, and open-minded. Editors need to be thick-skinned to stay in the job very long: authors don't like their papers rejected.

If a manuscript is rejected, the authors have several options

(1) Do further work based on editor and reviewer comments, and re-submit the paper at a later date.
(2) Submit the paper to another journal,
(3) Drop the work altogether

If the authors feel the review process was somehow flawed and want to get their rejection reconsidered (Schultz, 2010b), they can register their complaint with the AMS Journal Chief Editor or the Publications Commissioner. This happens a few times a year. If they contend that an editor was biased in the decision, the Commissioner or Chief Editor will check the correspondence involved. If he/she sees evidence of bias (e.g., mild negative reviews but a rejection), he/she will ask the authors to re-submit and make sure another editor handles the manuscript. This happens once every two-three years. For comparison, over 2500 manuscripts are submitted to AMS journals each year.

3.2 Other Approaches

Double-Blind Reviews. One practice that has been advocated is the "double-blind" approach, in which the author(s) as well as the reviewer(s) remain anonymous. This has the benefit of leveling the playing field between young scientists and those better established, and leads to less opportunity for bias based on gender, ethnic group, etc. However, many authors keep their papers compact by referring to earlier papers for documentation of a dataset, model, or experiment; making "double-blind" papers harder to review, or the author(s) easier to identify. Indeed, reviewers often find they can identify the authors from either references or familiarity with the authors' previous work. In a small field like atmospheric sciences, with even smaller subfields, it is often quite easy to identify either the authors or reviewers. Indeed, a several-year test of double-blind review for *Weather and Forecasting* manuscripts back in the 1990s found through surveys of authors and reviewers that most were ambivalent about the double-blind process and that the amount of work required to prepare a manuscript for a double-blind review was not worth it. The double-blind procedure was thus not adopted by the AMS.

Editor pre-screening. According to Schultz (2010a), Editors screen papers according to whether they fit the journal (typically recommending sending papers elsewhere), interest to the readers, impact, or quality of the manuscript. For example, the very small (<10%) percentage of submitted papers that appear in the more general scientific journals *Nature* or *Science* go through a pre-screening by an editorial panel that rejects paper not deemed scientifically significant and of interest to the readership, before they are sent out to outside reviewers. Thus the rejection rates for these journals are very high (>60%). Several years ago, the AMS *Journal of Climate* (JCLI) experimented with a category of submission called "Letters." The JCLI Editors would screen manuscripts in the Letter category for their perceived "significance" and if the submission wasn't deemed sufficiently significant, the manuscript was rejected. After a few years, the

JCLI editors dropped the idea of Letters because of author complaints about the subjectivity involved in determining what was significant.

Within more specialized journals such as the AMS journals, the author success rate is much higher (order 65%, Schultz 2010a). Sometimes editors recommend the authors submit the paper to another journal; but this is rare, since (1) the journal focus is published on the AMS web site (see Table 1), (2) the paper doesn't have to be "breakthrough" science, and (3) "popularity" of the subject is not an issue.

Smaller number of reviewers. Some journals use fewer reviewers. For example, the *Astrophysical Journal* only uses one reviewer. In the case of an unfavorable reviewer, the author(s) can ask for a second review. However, two unfavorable reviews will likely result in a rejection.

3.3 Some challenges for peer review

Editor Expertise and Identifying Reviewers. Although papers in AMS and other scholarly journals are typically sent to Editors with expertise in the general subject of the paper, sometimes the Editor is less familiar with the subject matter than optimum. In this case, the Editor will often pick out reviewers from the reference list. Many organizations (AMS included) provide an opportunity for the authors to suggest reviewers for their paper, but the Editor is not obligated to use this list. In either case, the Editor will choose reviewers they know at least by reputation. Nevertheless, this is a potential "weak point" in the system (Redman 1989).

Data and Methods. Peer review is based on trust that the scientists writing a manuscript are being honest with themselves and with their audience about their data, analysis techniques and so on. Discussions of the scientific method typically mention that a new result should be replicable by an independent group of scientists. But meteorological datasets can be quite large, and falsified data or flawed analysis techniques can be hard to pick up in peer review. When misconduct is found, one typically finds the discovery months or even years after a paper was published.

The solution to this problem requires that methods and data be accessible. In recent years, data preservation and access have received increased attention, some even asserting that the *data can have equal or greater value compared to publications* (Nelson 2010*).* Not only must data be transferred to newer storage devices as old ones become obsolete, but decisions need to be made about what versions of the data to save: early versions often are noisy, but data that are too thoroughly edited can have useful information removed. Objective data flagging can miss useful information, while subjective data editing varies with the interest of the person doing the flagging. On the other hand, scientists not collecting the data might not understand the shortcomings of the instruments used or the environmental conditions affecting the readings, or even what the data are. T*hus the data, processing and analysis need to be thoroughly documented.*

Fortunately, the atmospheric-science community has a culture that encourages saving and sharing data, and many of the datasets are processed at centers with well-documented data-processing techniques. Public data access and sharing are part of most field-program operational plans, for example. As far back as 1974, NCAR was designated a data repository for GATE. As a result, GATE data (including aircraft data) are still available on the NCAR Mass Store and films in the NCAR Archives. While there are significant gaps after that, NCAR has field-program data available back to 1990 (see http://www.eol.ucar.edu/data). NASA maintains data from present and past field campaigns at http://eosweb.larc.nasa.gov/ and elsewhere. DOE maintains a data archive at http://www.archive.arm.gov/armlogin/login.jsp and so on. NOAA has climate data and images available at http://www.climate.gov/#dataServices/dataLibrary . Such efforts are more difficult for groups at individual universities. To see how we can address data issues further, the AMS has convened an Ad Hoc Committee on Data Stewardship.

Similar arguments can be made for numerical models and methods. For community models, documentation is straightforward, but the author (and reviewer) needs to be conscientious about documenting the information (model name, version, parameterization schemes used, input data) needed to replicate the result.

The AMS is currently working on publishing its "expectations for authors" that will include specific language that all authors should be prepared to make available all datasets, analysis software, and model code to support published work upon request. This statement will reiterate the importance of scientific integrity and provide detail about the documentation needed to enable meaningful peer review as well as replication of results.

Publications. Not all publications are created equal. Scientists choosing a journal go on

reputation among their peers and impact factor (number of citations per paper). AMS journals tend to rank high on both counts. (For impact factor, see http://www.ametsoc.org/pubs/journals/impactfactor2008.html; for a list and discussion of scholarly journals publishing in the atmospheric sciences, see Schultz 2010a). There are journals that are not peer-reviewed. One such journal, *Medical Hypotheses*, may be converted to a peer-review journal, in the wake of an article that hypothesized that HIV does cause AIDS (*Science 2010)*. Also, one needs to watch out for non-atmospheric science journals publishing atmospheric-science papers (e.g., the *Journal of Physicians and Surgeons*). Likewise, the default position for blogs is skepticism: few of them are peer-reviewed.

4. DISCUSSION

Building on the work of others is how science progresses. Peer review is designed to ensure that that the results scientists build on are reasonably robust and free of errors in methodology and analysis that affect conclusions. How do revolutionary ideas survive peer review? According to Kuhn (1962), scientific revolutions, or "paradigm shifts" occur when evidence piles up against conventional wisdom, and a new candidate paradigm is consistent with the new evidence, but can still explain most of the central problems of the discipline. The evidence accumulates through the peer-review process. When the evidence against a current paradigm becomes overwhelming, the time is ripe for papers proposing an alternative way of looking at things to be taken seriously. Anecdotal evidence suggests that authors with more novel or unconventional results have a tougher time getting through the review process for either proposals or papers. However, the results do seem to break through, particularly when backed up by a battery of more "routine" papers shedding doubt on the current paradigm.

For example, continental drift, proposed by Alfred Wegener (a meteorologist) in the early 1900s, was not taken seriously by many scientists for another 50-70 years. However, evidence for continental drift was able to make it through the peer-review process – continents that fit together like pieces of a puzzle, matching rock strata and fossils where the continents fit together, and much more. By the 1960s, when the relationship between the separating continents and new rock with alternating magnetic orientation forming along the mid-Atlantic Ridge and spreading out in both directions, the evidence became so overwhelming that most scientists accepted continental drift. See Oreskes (1980) for a fascinating discussion of this process.

Today, our ideas about climate change are going through a similar evolution. The Baby-Boomer generation went to school learning about a static climate and the notion that our impact on the environment was limited to changing the landscape. The idea of humans modifying Earth's climate goes back at least 100 years (Fleming 1998, Weart 2004), when scientists started looking at the role of carbon dioxide in trapping more heat in the earth system. Such changes were initially hard to detect, but the recent meta-analysis of hundreds of papers by the IPCC provides strong evidence for an association between increased greenhouse gases and heating up of the earth system (warmer oceans, warmer air, warmer land, increasing air temperature). The paradigm is shifting toward human-induced climate change, including not only greenhouse gases, but particulates, and for local and regional climates, the impact of land use. At the same time, a small subset of scientists continues to question some of the basic results (e.g., the surface temperature trend) or the emphasis (e.g., greenhouse gases as opposed to the emphasis on other forcings or natural variability); and the some of the personal emails revealed by the hacking into the Hadley Climate Research Unit's emails shed doubt on the objectivity of scientists.

When science has policy relevance – as in the case of climate change – the government sometimes requests peer review of results or publications that are considered important or controversial. The National Academies, founded in 1863, under President Lincoln to offer advice to the government on matters related to science, takes this role. In such a case, the Academies convene a panel of experts to look at the work.

The peer-review system is designed to contain human flaws shared by scientists, and to keep science moving forward, even during times of controversy. The small number of truly offensive emails involved in climategate, and the overwhelming number of positive contributions made by the climate-research community led to the AMS decision to continue to support its statement on climate change. At the same time, however, the AMS supports ethical behavior, and we consider the "climategate" incident a "teachable moment" and an excuse to focus on taking steps to improve our behavior, with a focus on making a robust peer-review system even stronger.

5. CONCLUSIONS

The peer-review process is designed to ensure that published results are reliable stepping stones on the path to progress. Failures can occur; thus publishers of scholarly journals need to be vigilant in shoring up all steps of the process. The AMS is currently working on a statement of expectations for authors and editors that upholds scientific integrity and provides detail about needed documentation that enables meaningful peer review as well as replication of results.

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