HOW TO WRITE AN EFFECTIVE SCIENTIFIC PAPER
…and how to deal with the review process

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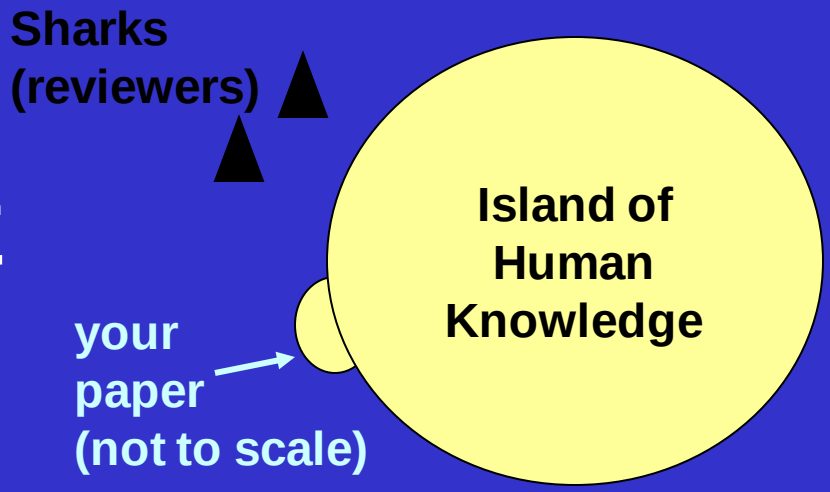
WHAT IS A SCIENTIFIC PAPER?

- It is an addition to human knowledge.



- A scientific paper is <u>not:</u>
  - a technical report or term paper
    - a paper is worth writing only if it has general implications for knowledge
  - a gospel
    - paper should be scholarly but you're not writing for the ages – others will come after you with newer data and better models.
    - being occasionally wrong is forgiven, being boring is not.
  - fine literature
    - important is to be clear and concise – expo writing rules be damned.

WHY WRITE SCIENTIFIC PAPERS?

"Scientists are motivated by two things: (1) to understand the world, (2) to get credit for it"

- **A scientific career is all about expansion of human knowledge**
- **In the academic and public sectors, scientific papers ARE the means for this expansion.**
- **Quantity doesn't matter beyond an expected number – quality is what matters**
- **What determines the perceived quality of a scientific paper? (now routinely- perhaps unfortunately – measured by the citation index)**
  - **Originality and importance of ideas**
  - **Effectiveness of communication**
  - **Usefulness as a source of information**

"The paper is not a description ot the work, it IS the work" – Richard Feynman said something like this

FEW WILL READ YOUR PAPER FROM BEGINNING TO END

Think of how scientists (e.g., you!) read papers !

- Title and abstract are for the search engines…most readers will not go beyond the abstract.
- Figures + captions and Tables + footnotes must be self-contained…a lot of readers go through those w/out reading the text. Some may look for quick explanation in text, so discussion of figures/tables in text should jump at reader (start paragraphs with "Figure X shows…")
- Make your figures attractive for use in presentations, both by you and others. If you wouldn't use a figure in a presentation, then fix or delete the figure!
- Many readers are interested in your paper mainly because they want some specific numbers, or a synthesis or references to previous work; oblige them by being scholarly.
- The take-home messages of the paper should be "in your face", I.e., in abstract, in intro, in conclusions, to make sure the "diagonal reader" gets the message.

THE INTRODUCTION

write it first – do it early, revisit often; use it to think about what your paper is about, to test your command of the literature

- Classical approach: begin with a mini-review and finish the intro by saying what your paper is about
- Better (I think), more direct approach:
  - First paragraph: state succinctly the problem – don't encumber with too many refs
  - At end of first paragraph or beginning of second: tell us in one sentence what your paper is about
  - Second and following paragraphs: now that you told us what your paper is about, give us the background information, what people have done before, the limitations, etc. (copious referencing)
  - Last paragraph: elaborate on what you'll be doing in your paper.

A few words about references…

- Showing command of the literature is extremely important. You need to describe the foundation on which your contribution to human knowledge is based. Thorough referencing is the scholarly and ethical thing to do, it's also useful to readers and it makes your paper more accessible by search engines!
- So be serious about literature search and reading papers – comb the literature using search engines.
- Never cite a paper for which you haven't read at least the relevant part.
- Cite papers in a context that makes it clear what the paper did – otherwise the reference is useless. If you're not clear on what the paper you're citing actualy did, go back and (re-)read the paper – it's the intellectually honest thing to do and you may learn something.
- Don't cite textbooks – they may be difficult for reader to access, information may be buried.
- There's nothing wrong with citing yourself extensively – in fact that's normal since that's the work you typically build on, and that's part of advertising. But don't ignore what others have done!
- References should be helpful to the reader, not of historical interest (unless you're writing a review)

Methods section following the Intro

- Write this as soon as you think that your methods are mature – the writing process will make you check whether they really are
- Often you'll be working with a complicated model or using a messy data set. Focus your methods section solely on what is important for your paper. Reference other papers for peripheral information.
- Read papers from the group to see how we generally handle model description. No point in reinventing the wheel.
- Provide useful numbers for readers to use (budgets, etc.)
- Make sure all math is clean (next slide)

A few words about math…

- Equations are often necessary to describe methods, but can also be an excellent way to set the stage – sometimes your arguments can be encapsulated neatly in an equation. Peripheral equations should be avoided or moved to an Appendix – don't force the reader to understand something that's not crucial to the paper
- There is no excuse for math errors, yet they happen to the best of us – check and double-check.
- Define all terms in your equations.
- Your notation should be textbook-quality. Don't use words or multi-letter variables in equations. Always try to make your equations more compact and reduce their number (but don't skip steps in derivation).
- Use standard notation and terminology as much as possible – it makes it easier for the reader to follow.

Results sections

- Use section headers descriptive of the science: “Model comparison to observations”, “Results and discussion” are generally not good.
- If not clear from the header, start the section with a brief statement of what it’s about
- Start by presenting your results (Figure X shows…) and then discuss what they mean including comparisons to prior work
- Logical, linear flow of thought is essential – you’ve thought a lot about your results and what they mean, share this progression with reader
- One theme per paragraph – first sentence lays out the theme, last sentence provides link to next paragraph. Few paragraphs need to be longer than ½ page – longer than 1 page is sure sign of confused thinking.
- Don’t wring your hands about lack of confidence in your results! The reader expects you to focus on what you can say with confidence.

A few words about comparing model with observations

"Nobody believes a modeling paper except the author, everybody believes an observational paper – except the author"

- **Comparisons with observations should have a clear purpose in terms of learning about the atmosphere. You should tell us what features you're looking for**
- **No one cares that the model "does a good job", "is in reasonable agreement", etc. What are you actually testing in the model? What increased confidence in terms of processes are you getting from the comparison? Can you usefully make the comparison quantitative?**

Abstract and Conclusions

…can wait to be written until rest of paper is mature

- Abstract is the most important part of the paper – many readers will read just that. Focus on what is new - essential ideas, essential numbers. One fact/idea per sentence. Everything that you would like the casual reader to remember should be there.
- The Conclusions section gives the take-home messages of your paper in a way that's not as severely limited in space as the Abstract. Readers who want to go beyond the Abstract may read your paper diagonally and then zoom in on the Conclusions. Here's an easy recipe for writing an effective Conclusions section:
  - First paragraph: quick summary of what you did and why you did it.
  - Successive paragraphs: one paragraph per section, following the flow of the paper and extracting the take-home messages.

Some general editorial remarks…

- "Dr. X, your presentation was just superfluous! When will it be published?"
- "It will be published posthumously"
- "Wonderful! I can't wait!"

- Read your draft from the perspective of a critical reader. Are you satisfied?
- Be as short as possible. "Every word must hurt". Use short words (e.g., "use" vs. "utiilize") and strong effective words with precise meaning.
- Try to use short sentences. Try using active present form.
- Remove value judgments: "Surprising", "interesting", "unfortunately" have no place in a scientific paper.
- Beware of words with different scientific vs. lay meanings, such as "significant", "ideal". Use them in their scientific meaning.
- Be consistent in notation and terminology. "Ozone" or "O_3"?
- Communication is better if you write as you would speak. Which means for example "ozone", but "CO", "SO_2", but "sulfate", etc.
- In the same vein, if you experience writer's block think about how you would express yourself orally …and then write it that way.

WHERE SHOULD I SUBMIT MY PAPER?

- **A good indicator is where most of the papers that you cite have been published. Standard atmchem journals are *ACP, JGR, AE, GBC, GRL*. This is where people looking at your CV would expect you to have published. There is no real difference in quality between these journals. Ease of access (crucial!) is comparable. They accept ~50% of submitted papers.**
- **ACP is the only open-access journal and also "publishes" papers when they're submitted (ACPD). This has proven to be a very successful model. On the other hand, it's very expensive to publish in (all costs are borne by the author). At the other extreme, AE is free to authors but expensive for libraries – so far libraries are biting the bullet...**

THE REVIEW PROCESS

"This paper isn't even wrong!" – my dad, former editor of Physics Letters

- **By scientific community rules, peer-reviewed literature represents the body of scientific knowledge – and all scientists are expected to be familiar with it.**
- **…which makes reviewing papers an important responsibility! As a reviewer, you're the gatekeeper to the trove of human knowledge. And yet you're doing it on a volunteer anonymous basis! Isn't it amazing that the system works?**
- **The trove of human knowledge will be polluted if papers are published that are (1) wrong, (2) don't add significant knowledge. You must can those papers, for the sake of the scientific community.**
- **At the same time, don't set your standards too high. Consider that the authors generally need to publish to satisfy their sponsors. A paper doesn't have to be *great* to be publishable.**
- **The review process must be anonymous. Else it cannot be candid – scientists are amazingly thin-skinned against criticism.**
- **Decision on publishing the paper is made by the Editor. Your role as reviewer is only to advise the Editor. Which means that (1) you don't need to comment on stuff where you don't have expertise; (2) you shouldn't get furious if the Editor doesn't follow your advice.**

SOME SUGGESTIONS FOR WRITING A REVIEW

- Try not to create more work for the authors.
  - Surely the work could be improved – but you're not a co-author, so that's not your job. Surely additional work could be done – but that's generally not feasible, the student may have graduated or the funding run out. Does the work as it stand provide a useful contribution to human knowledge? That should be your yardstick.
  - Remember that the authors are not interested in you making their paper better. They're interested in publishing. You're just standing in their way.
- The authors have thought about the content of their paper a lot more than you have. On the other hand, you're a more sophisticated reader than most. This calls for a combination of humility and forthrightness.
  - If you don't understand some aspect of the paper it's the authors' problem, not yours.
  - Rather than assume that the authors are wrong, ask them to 'clarify'?
  - Authors will view any criticism of their work as an aggression. Express it in personal terms to make it less aggressive: 'In my opinion,…', 'I couldn't understand…' , 'I wasn't convinced…', 'I don't see how…'
  - Sometimes the English is atrocious. You're not in the ESL business – it's not your problem to fix. Just tell the Editor that the English needs to be improved.

HOW I REVIEW A PAPER

1. Read the paper and jot down notes in the margin wherever I have a problem.
2. Go for a walk or bike ride to think about the paper as a whole.
3. Separate review into an ‘Overall Assessment’ and ‘Specific Comments’.
4. In the ‘Overall Assessment’, state what I think of the paper – this is mainly for the Editor.
5. In the ‘Specific Comments’, go line-by-line through the paper, following my jotted notes.

HOW TO RESPOND TO A REVIEW

- Criticism from an anonymous reviewer is hard to take, (1) Give the criticism a chance – could the reviewer be right? Think about it for a while. (2) Generally the reviewer is wrong (see previous lesson about humility) but it's your problem that s/he was mistaken – so fix it! Even when the inescapable conclusion is that the reviewer is just an idiot, keep in mind that s/he is a more sophisticated reader than most.
- Respond to the comments in the text of your paper. Don't engage in a private dialog with the reviewer, that's not the point of the review process. It's best to respond to comments by saying that you've actually changed something in the paper to accommodate the reviewer's comments.
- Don't try to guess who the reviewer is. It's pointless.