

The Ten Suggestions

For Better Scientific Term Papers

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Here are some tips on how to write a good, short¹ paper such as the one required for physical oceanography class. In writing this paper, you should read several primary sources in the scientific literature and use the information to summarize some part of the field at a level which your classmates should understand. The advice in this **Guide** focuses on this genre, but much of it will apply to any writing you do.

¹ 2500-5000 words, or about 5-10 single-spaced pages.

A. How to Create Good Structure

1. Know Why You are Writing

I don't mean your reason for going to school and taking this class, or the years of conditioning you received to seek good grades. I mean the goal of the paper, as defined by: me. The goal should be to explain something to someone. That is not the same as writing to

- Impress your reader with how much work you did or how hard the subject is.
- Compile a list of facts you have culled from your sources.

Do not explain something you yourself do not understand! Sometimes you can fake it, but often you will just write something that makes no sense. If something seems really important and you just can't figure it out, talking to the course instructor will often point you in the right direction.

2. Know What You Want To Say

In most cases, a term paper is conveying a **hierarchy** of information. It has a handful of main ideas, and each idea is associated with a few other ideas or facts. Those facts may then be associated with yet more detailed information, though that is less common in a 5-10 page paper. Many papers suffer—and make their readers suffer--when the author is unsure of the main ideas, or digresses from them, or omits information needed to understand them. A good way to

identify the ideas and their supporting information is to write an **outline**.

Students hate doing that. So does pretty much everyone else.

Shouldn't the outline be easier to write than the full paper? Why is there so much resistance to writing an outline? The reason is that figuring out what you want to say is often harder than simply writing facts that you encountered while researching the paper. You can fill the pages with many facts copied out of other papers. However, the value of your paper is not measured in how many pages it covers, but in how well it embodies a new way to present the information.

I find that writing one line per paragraph of text is a good top level for an outline. If another level is useful, indented and/or smaller-font lines can give more details for each paragraph.

3. Find Your Way Around Obstacles

Sometimes the author can't write an outline because s/he doesn't know enough about the topic. In that case, more research is called for. If you are stuck after that, you can try to summarize the information to yourself.

Sometimes the outline is so difficult that the writer really gets stuck and can't write anything even after doing research. There are a number of ways to deal with this problem, but in some cases the best strategy is to just start writing. Writing even a page or less may get you unstuck, and ideally once that happens you can go back to creating an outline.

It may turn out that by the time you are unstuck, you will notice that the paper is all written. In that case it may still be worth creating an outline, as if you are reading someone else's

paper and taking notes on it. Why write the outline after the paper is already written? When you re-read the outline, you may find major problems that you didn't notice in the heat of writing. Maybe paragraph 7 is a continuation of the explanation in paragraph 3 and needs to move. Maybe the second half of paragraph 8 repeats the first half of paragraph 6 and should be deleted. Maybe you forgot to include some information or a paragraph does not make sense. These problems may be hidden by the details in the full text of the paper.

If you do succeed in writing the outline first, you can turn each top-level line of the outline into the first sentence of its paragraph. This will help keep you on-target while writing the paragraph and will help the reader follow your train of thought.

4. Tell Your Reader A Story

Once you know what you want to say you need to tell it to the reader in a way that forms a coherent whole. In other words, the reader should see the connection between the ideas and between the facts and the main ideas.

A common writing problem is choppiness. If your outline is good, the ideas should follow in a logical sequence, so you don't jump around from (for example) salinity off the coast of Peru, temperature off the coast of California, and wind strength over the Benguela Current, unless there is some important connection between them. If there is a connection you need to make it clear to the reader, preferably at the beginning of the passage.

A more subtle form of choppiness is lack of motivation. By "motivation" I don't mean your desire to write the paper, I mean an explanation of why you are imparting some information. Often a paper plunges into some discussion which may be perfectly comprehensible, except that the reader is not paying enough attention to it because s/he is busy thinking, "Why is the author telling me this? What does this have to do with anything?" That is why this passage could easily induce sleep:

In the winter, the surface temperature is 13.5 degrees at the coast and 13.4 degrees 100 km off the coast. In the summer, the surface temperature is 12.5 degrees at the coast and 18.2 degrees 100 km off the coast. Ekman transport is offshore during the summer and onshore during the winter.

The reader has a much better chance of staying awake while reading the following passage instead:

Surface temperatures are good indicators of coastal upwelling. During the summer, when winds induce upwelling, relatively cold, subsurface water rises to the surface. The surface temperature near the coast then drops to 12.5 degrees, about 6 degrees colder than surface water 100 km offshore, where there is no upwelling. During the winter, when winds do not promote upwelling, the temperature near the coast remains at about the same temperature as the offshore water.

Notice that in the rewritten passage, I eliminated the fact that the winter temperature was about 13.5 degrees, because the point I was making was that the temperature was the same, not how cold it was. I could have dropped the reference to 12.5 degrees in the summer, but I thought that listing one

temperature would help the reader because it makes the situation a little less abstract.

B. How to Write Better Prose

It is imperative to have good information and a good overall paper structure, but these can be marred by bad sentences. Once you have checked the draft of your paper for overall content and structure, you should reread it to inspect the sentences.

It took me about 25 years to learn to enjoy sentence-editing, but you too can experience this pleasure by thinking of each sentence as a machine which may have some gears sticking out or banging against each other. Fixing the problem so that the machine becomes sleek and effective can be very satisfying. One way to check for badly-constructed sentences is to read them out of order (*e.g.* read the last sentence of the paragraph first, then the previous sentence, etc.). This will make you concentrate on the sentence itself rather than the overall idea of paper.

The classic reference on this topic is Strunk and White (1999) but I describe some points that frequently come up in student writing.

5. Repair Bad Sentences I: Scientificese

One way to induce sleep is "scientificese". In order to sound more scientific, people often put in extra, impersonal-sounding words, nounify their verbs, and use the passive voice. How do you do all that? Here's an example:

It was found that the temperature of the water was subject to an increase during the summer months.

What is this statement trying to say? Simply

The water warmed during the summer.

While it's easy to laugh at this example, this kind of writing creeps into people's prose all the time. The only way to get rid of it is to look carefully for it and fix it wherever it occurs.

6. Repair Bad Sentences II: Overloaded Sentences

Making your sentences very long will not guarantee that they are bad, but it sure will help. A period (".") alerts the reader that a thought is finished, and that they may want to pause before going on to the next. Long sentences ask the reader to juggle a bunch of different thoughts before absorbing any of them, which is intellectually more demanding.

Don't worry, if you are writing a paper about physical science, it will be intellectually demanding enough even with short sentences. Adding to the processing load makes hard reading harder.

Here is an example of an overloaded sentence:

The northward-flowing Gulf Stream, which is the western boundary current of the North Atlantic subtropical gyre, in contrast to the southward-flowing Labrador Current, which is the cold western boundary current for the North Atlantic Subpolar Gyre, is relatively warm, but shares the characteristic of high velocity with the Labrador Current.

That sentence is grammatically valid, but the core of the sentence, "The Gulf Stream... is relatively warm," has so many words between the subject and the verb that it is hard to even figure out that they go together. Reading a paper full of such

sentences feels like pushing a boulder up a large hill.

Rearranging the sentence and splitting it in two will make the path much easier.

In the North Atlantic, the high-velocity western boundary current is called the Gulf Stream in the subtropical gyre, and the Labrador Current in the subpolar gyre. The northward-flowing Gulf Stream is relatively warm and the southward-flowing Labrador Current is cold.

7. Repair Bad Sentences III: "What" Rather Than "Who"

Another way to waste paper is to spend a lot of time saying things like "Most scientists believe" or "There have been several studies of the effect of this on that." Everything in your paper is based on what scientists believe or on various studies. Try to get to the point instead. For instance, this long sentence hardly says anything:

According to Klinger (1996), there have been many studies of how the wind affects the general circulation of the oceans.

A shorter and more useful sentence is:

The large-scale ocean circulation is primarily driven by the wind (Klinger, 1996).

You can highlight the importance of individual scientists if you are discussing a debate about some aspect of your topic, and different scientists represent different opinions in the debate. Sometimes recounting the history of discoveries, which also tends to focus more on what different people did, is interesting. This can be overused and sometimes obscures what we know about the topic now. It's usually best to focus on what rather than who.

8. Rightsize Your Prose

There is a theme to many of these comments: be concise. Once I was writing a grant proposal that had to be 15 pages long. My draft was a few pages over the limit, so I had to cut it down by about 10%. This annoyed me greatly, but after I was done, I was surprised to find that the new version was actually better than the old one. Now I recommend doing the same thing to any rough draft. Get rid of words and sentences that are not ~~absolutely~~ needed to tell the reader something interesting and relevant. Usually the new version will not only be shorter, it will be better.

Then again, don't forget words and sentences that explain why your facts are interesting and relevant. Also, don't forget to tell enough details about your topic so that the reader sees a picture in his or her head. Thus, this is kind of vague:

The larvae are carried by an important current called the Labrador Current.

This is better:

The larvae are carried by the Labrador Current, a strong southward flow along the coast of Labrador. The Labrador Current is the Western Boundary Current of the subpolar gyre, which is the wind-driven, counterclockwise gyre in the northern North Atlantic. The term ``Labrador Current'' actually refers to three current regimes: flow above the continental shelf, a surface current flowing above the 1500 m isobath, and a more depth-independent current above the 2500 m isobath (Lazier and Wright, 1993). Typical current speeds are on the order of 50 cm/s.

You should not elaborate on every single fact you mention in your paper, but when your paper has a large number of

unconnected factoids, you may want to eliminate some and tell more about others.

C. How to Use Important Non-Prose Elements

9. Cite Sources

Any information that you did not create or collect yourself comes from a source, which you should cite near the text that states the information. This helps readers judge the quality of your evidence and learn more by going to your sources. It is also a serious matter because failure to cite sources is considered plagiarism and may result in disciplinary action which can include expulsion in the most serious cases. See <https://oai.gmu.edu/mason-honor-code/> for more information about Mason policies.

Do not write more than a few words in a row verbatim from a source without putting them in quotation marks and citing the source. Better yet, don't use direct quotes, even inside quotation marks, except for rare cases of a particularly colorful or wonderful passage that you want readers to see for themselves.

You can refer to a paper, report, or book, like this: (Klinger, 1995; Klinger *et al.*, 1995), or this: Klinger (1995) and Klinger *et al.* (1995). Note that *al.* has a period but *et* (Latin for ``and'') does not. The *al.* is an abbreviation of the Latin *alia*, which means ``others'' and is related to the root of the English word ``alien''. Two-author papers are cited like this: (Garuba and Klinger, 2018). Do not put the citation after the end of a sentence (like this). (Klinger, 1995). I prefer papers to not refer to sources with numbers, like this: [3]. Having author

and year in the text helps the reader keep track of which sources are being quoted in each part of the paper.

List references at the end of a paper in alphabetical order by author's last name. The accompanying file has an example of a reference list in an AMS (American Meteorological Society) journal, which is a good model for format.

10. Use Standard Tools of Scientific Writing

Section titles alert the reader to the theme of the following few paragraphs. For a 5--10 page paper, three to six sections are generally appropriate. Subsections are usually not necessary for such a short paper.

Figures are essential in a field like physical oceanography. It is often hard to picture the phenomena unless one sees a map or a graph, so most papers could use at least a couple of figures. Figures should be numbered. Pick your figures carefully. A map that merely shows the continents in the vicinity of your region of interest is not as good as one that shows velocity vectors, pressure variations, temperature, or some other feature that your text will be discussing. Only use figures that you refer to in the text---

Surface velocity is high in the winter and low in the summer (Figure 1).

--and each figure should have a caption. The caption should include enough information to interpret the data, such as explaining symbols or what variables the axes represent, and should include a citation if you did not create the graphic yourself. It should not include descriptions of results or interpretations of the data, which belong in the main text of the paper.

Figure 1. Surface velocity (cm/s) 50 km off the Labrador coast at 55° N, as a function of time (in months), from current meter observations (Lazier et al., 1991).

Page Numbers. Please use them. Also include a **title** (even on the rough draft), your **name**, the **date**, and the **class**.

Your Social Security Number is not required. In fact, you should try to protect your privacy; SS number is usually only required when taxes or other suitably serious financial transactions are involved.

Nonstandard Characters such as subscripts, superscripts, mathematical symbols, italics, and boldface, are easy to use with most wordprocessors. Mathematical or scientific papers are often written using LaTeX (<https://www.latex-project.org/about/>). The document is written in a normal textfile such as those created by Emacs, Notepad, or VI, and then processed with LaTeX software which turns commands such as “\beta”, “3^2”, “A_b”, “\pm” into corresponding symbols (in this case, the Greek letter beta, 3 squared, A with a subscript b, and the plus/minus sign).

Recent versions of Microsoft Word and Powerpoint use similar commands in **symbol mode**, which is entered and exited by typing “=” while holding down the “Alt” key. Doing that turns the examples in the previous paragraph into “ β , 3^2 , A_b , \pm ”.

Reference

Strunk, W. Jr., and E. B. White, 1999: *The Elements of Style*, 4th Ed., Pearson.