How to Get Started if You Hate to Write

Part II—Writing Paragraphs

Celia M. Elliott
Department of Physics
cmelliot@illinois.edu

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Reminder:
Successful science writing is

- Logically constructed—think "linear"
- Clearly and succinctly expressed
- Precisely and simply worded
- Written to inform and persuade
- Written with the *reader* in mind

Any piece of scientific writing must present a coherent, cohesive, persuasive logical argument—that's axiomatic.

Today, we're going to write the introduction for a paper about the special mirrors built for NASA's Solar Dynamics Observatory

Courtesy NASA

Avoid the novice writer's "core dump" method…

(and the paralysis induced by a blank piece of paper or a blank screen)

First, write down main points you want to make in the introduction section

- The atmospheric imaging assembly (AIA) is composed of highly reflective multi-layer mirrors.
- Mirrors image Sun at all seven euv wavelengths.
- The NASA Solar Dynamics Observatory (SDO) was launched in 2010 to study the solar corona.
- One component of SDO is the AIA, a suite of four telescopes.
- The Sun is the source of all space weather, but its physical processes are poorly understood.

*Write a complete sentence for each point, in any order now—we'll arrange the points logically in the next step

Start by writing down the main points you want to make in the paper. Don't worry about details—just concentrate on the main ideas now.

Next, arrange the points so they provide a logical narrative arc*

*Show a linear progression from premise to conclusions

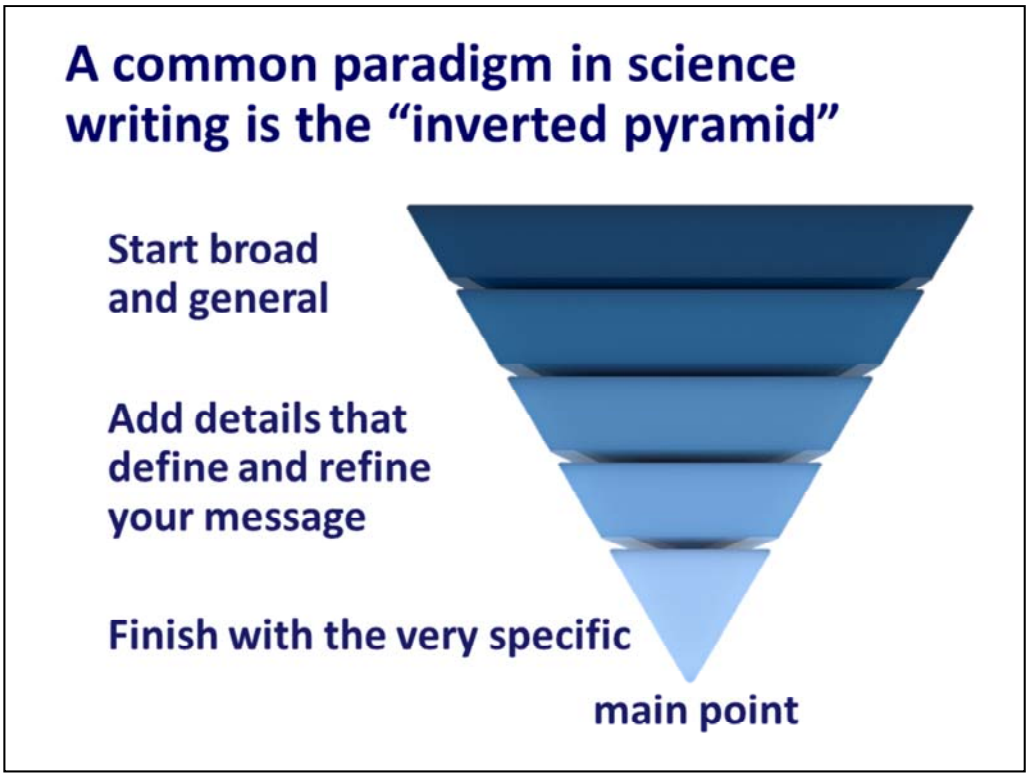
*No digressions or discursive material

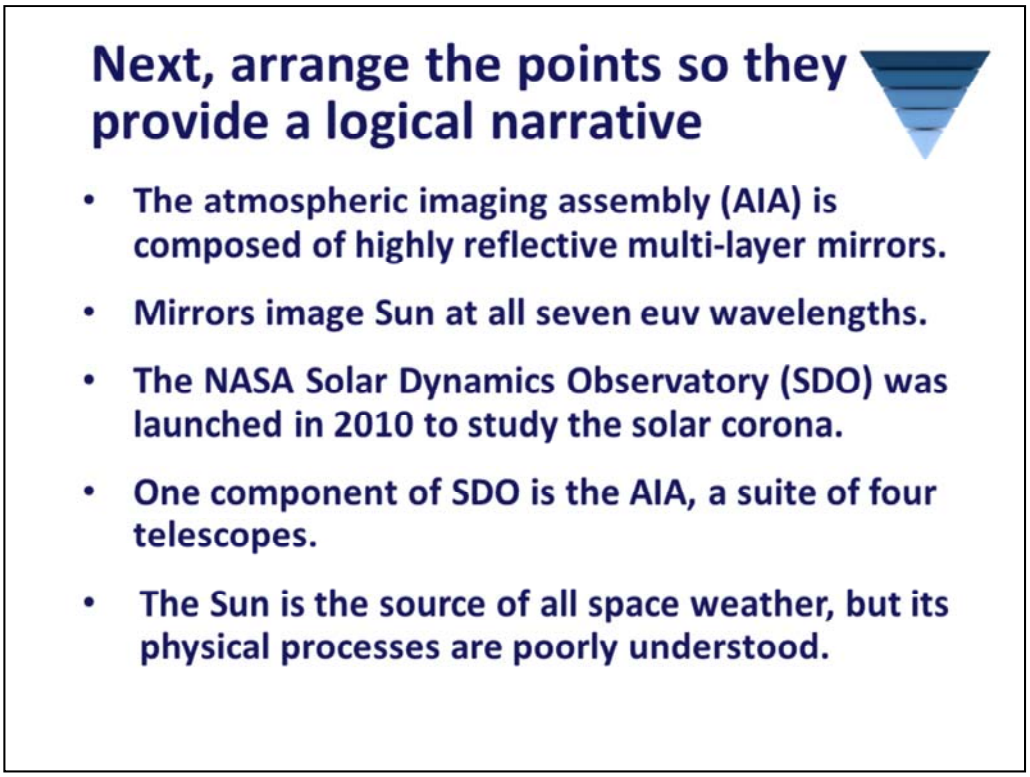
Next, arrange the points in a logical order so they provide a coherent storyline.

Think of this step as creating a map to guide your reader through your talk, paper, or proposal.

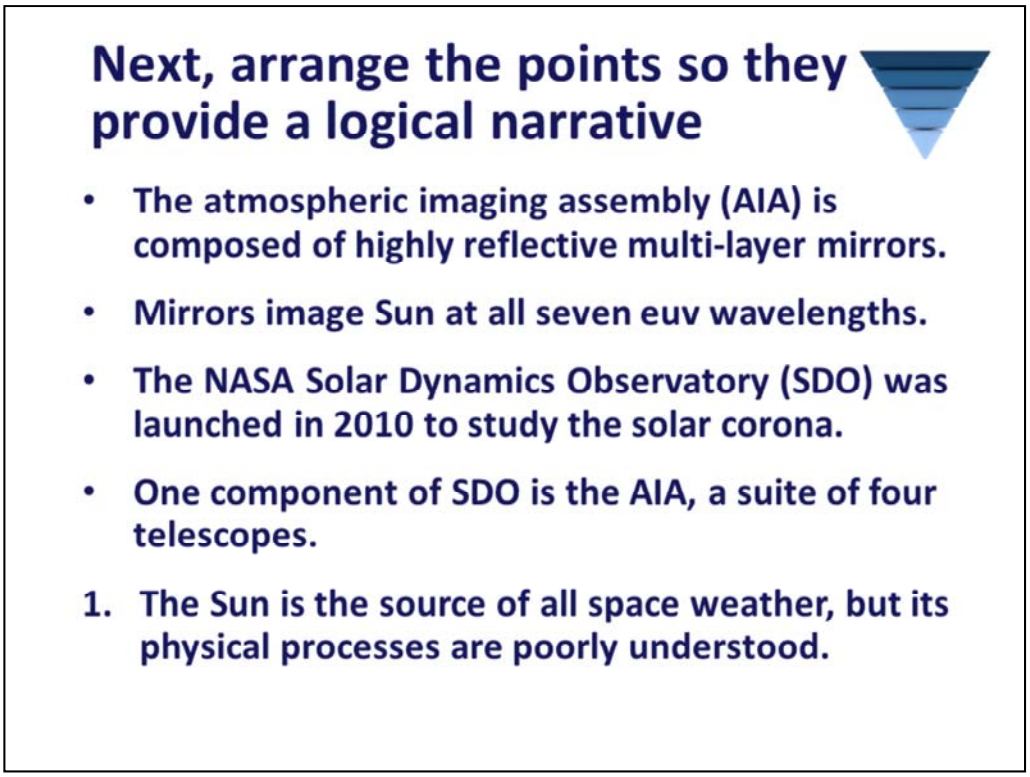
Each one of these points is going to be a signpost along the journey.

A common paradigm in science writing is the "inverted pyramid"





Using the inverted-pyramid structure as a guide, we next arrange the points we want to make in a coherent, logical order.



Start with the “big picture” statement.

Next, arrange the points so they provide a logical narrative

- The atmospheric imaging assembly (AIA) is composed of highly reflective multi-layer mirrors.
- Mirrors image Sun at all seven euv wavelengths.

2. The NASA Solar Dynamics Observatory (SDO) was launched in 2010 to study the solar corona.

- One component of SDO is the AIA, a suite of four telescopes.

1. The Sun is the source of all space weather, but its physical processes are poorly understood.

Next, arrange the points so they provide a logical narrative

- The atmospheric imaging assembly (AIA) is composed of highly reflective multi-layer mirrors.
- Mirrors image Sun at all seven euv wavelengths.

2. The NASA Solar Dynamics Observatory (SDO) was launched in 2010 to study the solar corona.
3. One component of SDO is the AIA, a suite of four telescopes.
1. The Sun is the source of all space weather, but its physical processes are poorly understood.

Next, arrange the points so they provide a logical narrative

4. The atmospheric imaging assembly (AIA) is composed of highly reflective multi-layer mirrors.
   - Mirrors image Sun at all seven euv wavelengths.
2. The NASA Solar Dynamics Observatory (SDO) was launched in 2010 to study the solar corona.
3. One component of SDO is the AIA, a suite of four telescopes.
1. The Sun is the source of all space weather, but its physical processes are poorly understood.

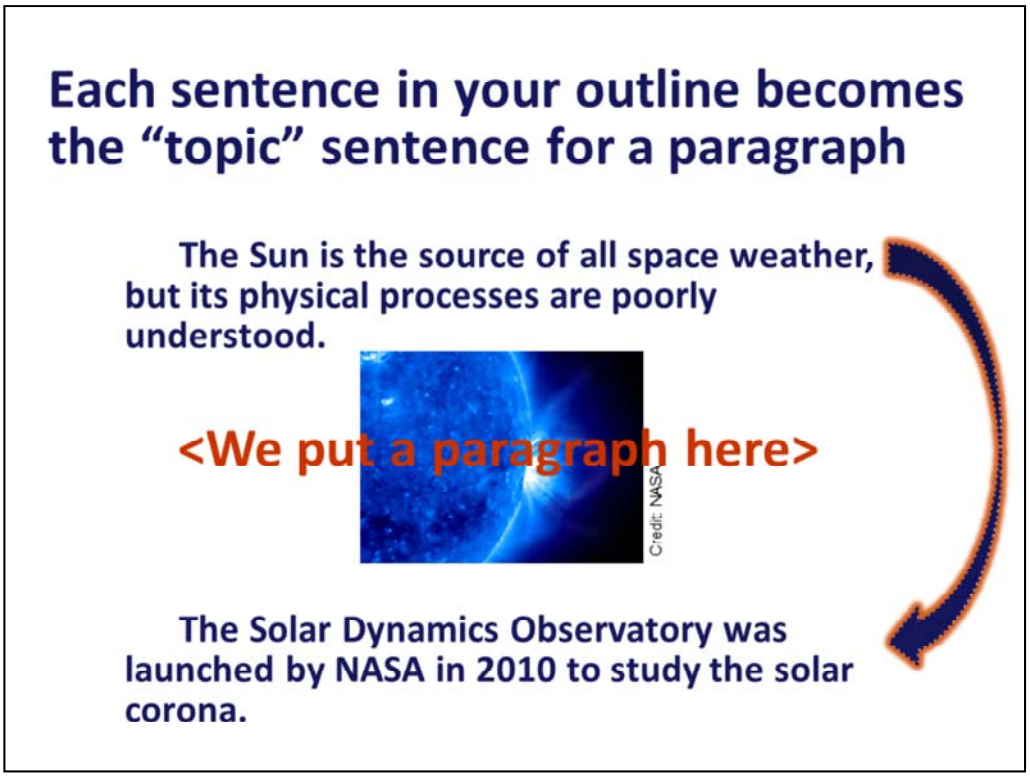
Next, arrange the points so they provide a logical narrative

4. The atmospheric imaging assembly (AIA) is composed of highly reflective multi-layer mirrors.
5. Mirrors image Sun at all seven euv wavelengths.
2. The NASA Solar Dynamics Observatory (SDO) was launched in 2010 to study the solar corona.
3. One component of SDO is the AIA, a suite of four telescopes.
1. The Sun is the source of all space weather, but its physical processes are poorly understood.

Check to see if you've left anything out, or if you have superfluous statements that lead the reader off the trail that you've laid out for him or her to follow.

Make adjustments (additions or deletions) now. It's much easier to write from a structure than to try to go back after you've already written something and try to impose a logical order on it.

It's also much less painful to cut things now than after you've struggled to get them written and are tempted to leave in superfluous information out of pride of authorship.



Your main points—your topic sentences—provide a framework for your narrative.

The purpose of ***every additional word*** that you put in a paragraph should be to support and explain the topic statement and move the reader logically and incrementally to the next topic statement.

Celia's foolproof, four-step SEES* method to crank out science writing:

1. Put the topic sentence first
2. Explain it
3. Give an example of it
4. Summarize it in a way that leads logically to the next topic sentence

*State → Explain / Expand → Exemplify / Evidence → Summarize

Tip: Use the same construction paradigm for paragraphs, subsections, and sections of your paper

One of the key advantages of this method is its scalability—you can use it for short papers, theses, talks, posters—for any audience.

Do the math: one topic sentence = one paragraph
one figure = one paragraph
four paragraphs = one page

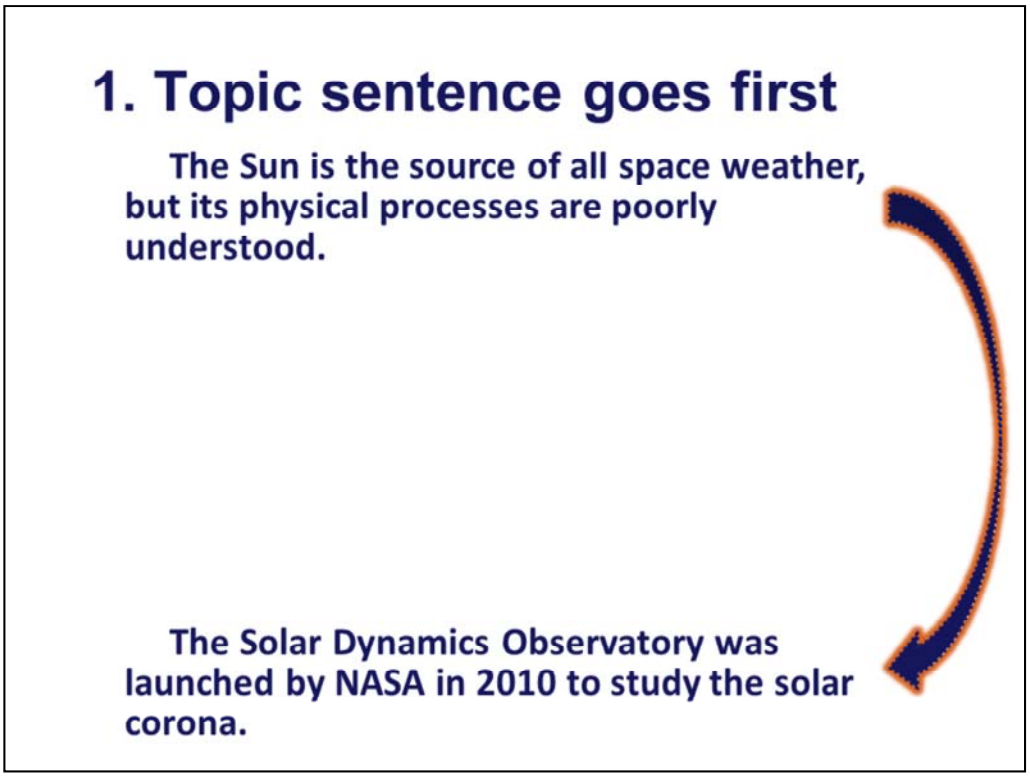
Suppose you're writing a paper for *Science* and you have 21 sentences and three figures. You know right NOW, before you write another word, that you've got too much material for one paper. Make your adjustments now—it's much less painful than trying to cut later.

Use the formula to create logical, coherent paragraphs.

So let's go back to our first two topic sentences from our outline:

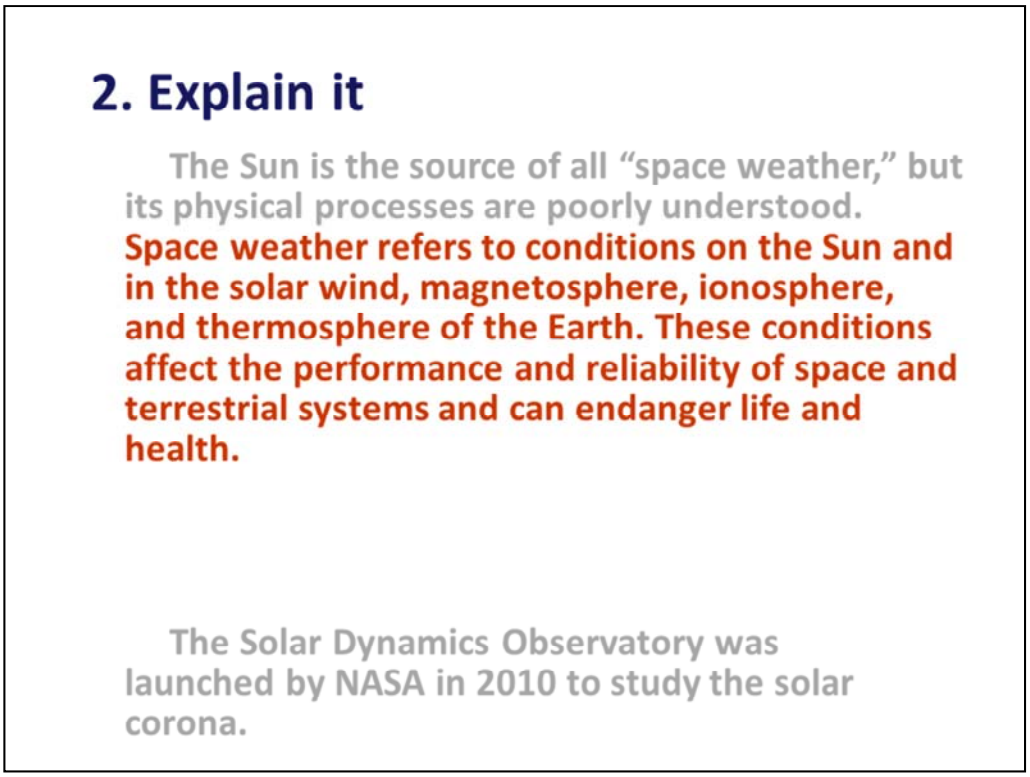
"The Sun is the source of all space weather…"
and
"The Solar Dynamics Observatory was launched by NASA in 2010…"

and run them through the paragraph cranker-outer...



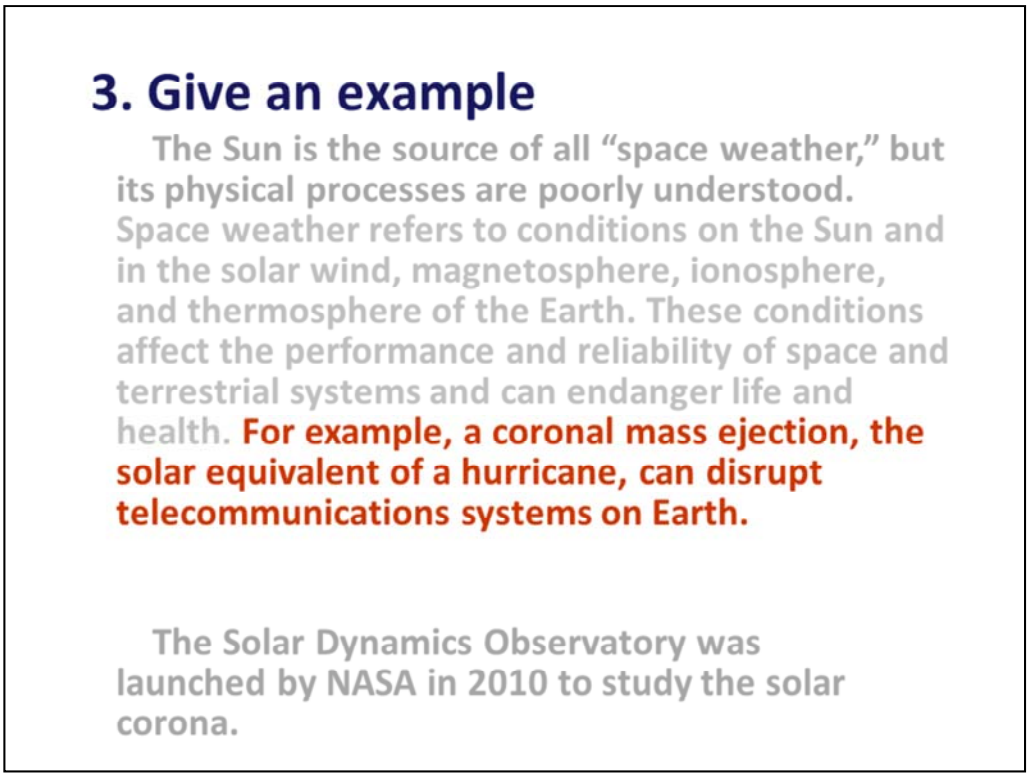
In science writing, the topic sentence is almost always the first sentence of the paragraph. While literary writing might put the topic sentence last, to build suspense, or in the middle, to redirect a reader's attention, put the topic sentence first in your paragraphs to emphasize your important points and reinforce the logical structure of your arguments.

Readers pay the most attention at the beginning of chunks of text. Exploit this natural human tendency by putting your topic sentences in the places where people are most likely to recognize and remember them—as the first sentence of each new paragraph.



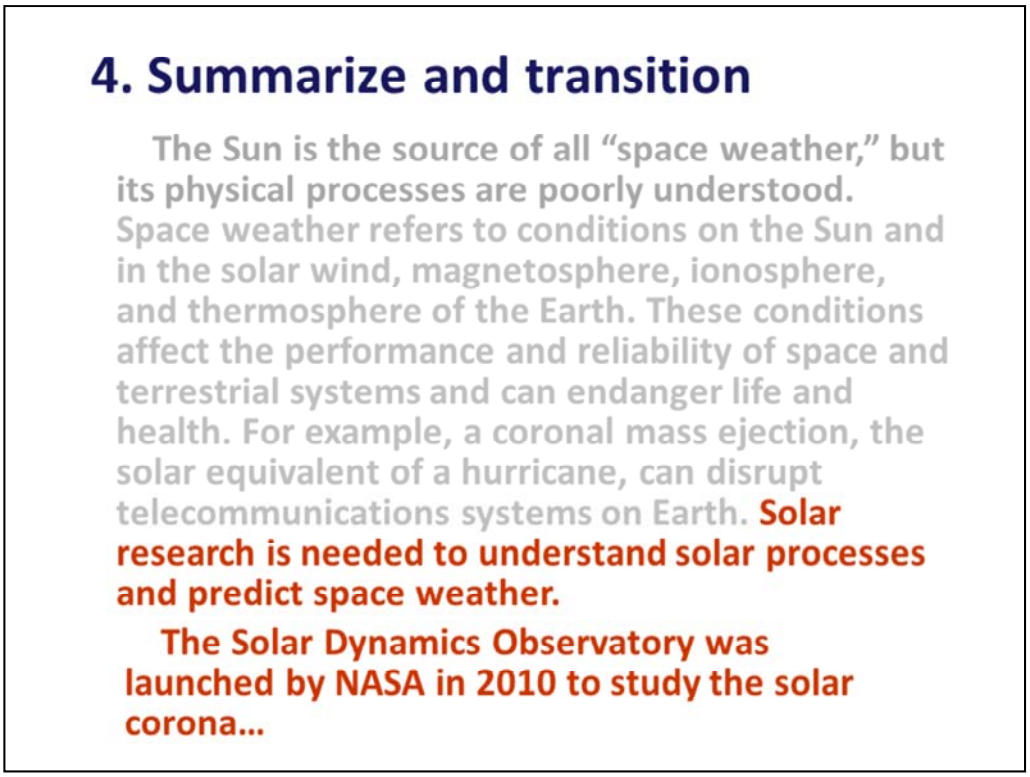
In the next sentence(s), explain, expand on, or provide supporting evidence for the ideas conveyed in the topic sentence.

In the SEES method, this first *E* can stand for three things: explanation, expansion, evidence.



Your explanation will often include illustrative examples. Put them next.

Note how the writer has used a familiar example from terrestrial weather, a hurricane, to explain the unfamiliar concept of "coronal mass ejection."



Finally, add a transitional sentence that sums up this paragraph and leads the reader logically to the next topic sentence.

In this example, the fourth sentence repeats the ideas of "space weather" and "not currently understood" that are introduced in the topic sentence and sets the stage for the next paragraph, which explains what the SDO is, what kind of research it is designed to do, and how it is addressing the problem of space weather. ***Thus the two paragraphs are linked structurally by the evolution of the ideas and explanations that they present.***

Paragraph equation:

$$1\ S_t = 1\ ¶, \qquad [1]$$

where S_t is a topic sentence, and ¶ is a paragraph

Don't put more than one topic sentence in a paragraph

Don't put anything in a paragraph that doesn't support, explain, exemplify, or summarize the topic sentence

Write shorter paragraphs (<8 sentences)

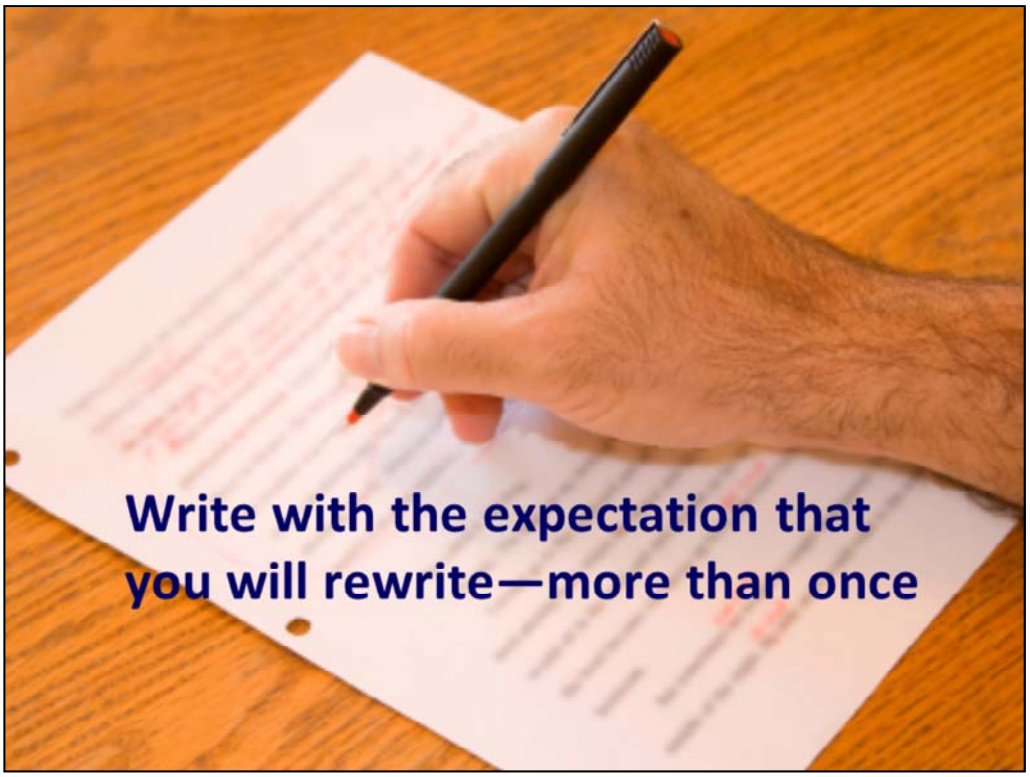
Write from an outline!

No superfluous "stuff" in a paragraph. If it is not directly related to the topic sentence, delete it or move it to its own paragraph.

In fact, no superfluous stuff anywhere!
(q.v. http://people.physics.illinois.edu/Celia/Lectures/Fluff.pdf)

To learn more about the Solar Dynamics Observatory (SDO), see http://sdo.gsfc.nasa.gov/.

To learn more about how the SDO's extreme ultraviolet (euv) telescopes were constructed, see https://str.llnl.gov/JanFeb11/soufli.html.



Brevity is a key goal. Use your revisions to clarify and simplify.

Give yourself adequate time to reflect and rewrite.

Writing well is a learned skill—train yourself to recognize good writing; emulate good examples, and practice, practice, practice.

To recap...

Think first

Make an outline and follow it

Use the SEES method for paragraphs and sections

Get words on paper/screen

Revise, revise, revise, revise, revise, revise, revise...

FINISH!!!*

*Tip: Don't use too many exclamation points in scientific writing!!
People will think you're a crackpot!!!!

cmelliot@illinois.edu
http://physics.illinois.edu/people/Celia/

NOTES: