

Yale



耶鲁大学-南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

# A discussion on the book **“Writing Science”** by Joshua Schimel

Wei Xiao

Video conference of YNCenter

2012-6-15

# Contents

1. Writing in science
2. Science writing as storytelling
3. Making a story sticky



## A: Scientific writing versus Storytelling

4. Story structure
5. The opening
6. The funnel: connecting O & C
7. The Challenge
8. Action
9. The resolution
10. Internal structure



## B: How to build effective story arcs

11. Paragraphs
12. Sentences
13. Flow
14. Energizing writing
15. Words

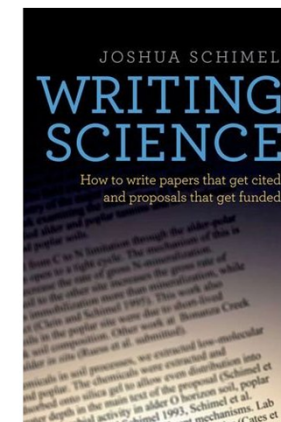


## C: Subsections and finer scale

16. Condensing
17. Putting it all together: real editing
18. Dealing with limitations
19. Writing global science
20. Writing for the public
21. Resolution



2012-6-15



## **A. SCIENTIFIC WRITING VERSUS STORYTELLING**

# 1. Writing in Science

- As a scientist, you are a professional writer.
- Success as a scientist is not simply a function of the quality of the ideas we hold in our heads, or of the data we hold in our hands, but also of the language we use to describe them.
- “publish or perish” is about surviving, not succeeding.
- You don’t succeed as a scientist by getting papers *published*. You succeed as a scientist by getting them *cited*.
- H-factor: if you have 10 publications that have each been cited 10 if you have times, you have an H of 10. If you have published 100 papers and none have been cited, H-factor -0.
- It is the author’s job to make the reader’s job easy.

# Evaluation of SHAW Model in Simulating Energy Balance, Leaf Temperature, and Micrometeorological Variables within a Maize Canopy

Wei Xiao, Qiang Yu, Gerald N. Flerchinger,\* and Youfei Zheng

## ABSTRACT

Understanding and simulating plant canopy conditions can assist in better acknowledgment of plant microclimate characteristics, its effect on plant processes, and the influence of management and climate scenarios. The ability of the Simultaneous Heat and Water (SHAW) model to simulate the surface energy balance and profiles of leaf temperature and micrometeorological variables within a maize canopy and the underlying soil temperatures was tested using data collected during 1999 and 2003 at Yucheng in the North China Plain. The SHAW model simulates the near-surface heat and water movement driven by input micrometeorological variables and observed plant characteristics (leaf area index [LAI], height, and rooting depth). For 1999, the model accurately simulated air temperature and relative humidity in the upper one-third of the canopy, but overpredicted midday temperature in the lower canopy. For 2003, although the surface energy balance was simulated quite well, radiometric canopy surface temperature and midday leaf temperature in the upper portion of the canopy were overpredicted, by approximately 5°C. Model efficiency (the fraction of variation in observed values explained by the model) for leaf temperature in the lower two-thirds of the canopy ranged from 0.82 to 0.98, but fell to 0.30 for the uppermost canopy layer. Weaknesses in the model were identified and potentially include: the use of a theory to simulate turbulent transfer within the canopy; and simplifying assumptions with regard to long-wave radiation transfer within the canopy. Model modifications are planned to address these weaknesses.

Knowledge of conditions near the soil-atmosphere interface is of key interest to many areas of research. The near-surface microclimate controls vital plant biological processes such as photosynthesis, respiration, transpiration, and crop damage from extreme temperatures. Canopy temperature reflects plant physiological conditions, not only by relating to air temperature, but also to stomatal opening, vapor diffusion resistance, and overall plant stress. Understanding processes of heat and water transfer within the plant canopy can assist in better acknowledgment of microclimate characteristics and their influence on plant processes. The ability to predict microclimatic conditions within the soil-plant-atmosphere system enhances our ability to predict plant response to microclimatic conditions and to evaluate management and climate scenarios (Gottschalk et al., 2001; Pachepsky and Acock, 2002; Yu et al., 2002, 2004).

W. Xiao and Y. Zheng, Dep. of Environmental Sciences, Nanjing Univ. of Information Science & Technology, Nanjing 210044, China; Q. Yu, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China; G.N. Flerchinger, USDA-ARS, Northwest Watershed Research Center, 600 Park Blvd., Suite 105, Boise, ID 83712. Received 2 May 2005. \*Corresponding author (gflerch@nwr.ars.usda.gov).

Published in Agron. J. 98:722-729 (2006).  
Agroclimatology  
doi:10.2134/agron2005.0126  
© American Society of Agronomy  
677 S. Segoe Rd., Madison, WI 53711 USA

The surface energy balance describes the partitioning of net short and long wave radiation into latent, sensible, and soil heat fluxes which form the basis for simulating water and heat transfer and are the driving factors for C and N circulation. Transport of mass and energy between the land and atmosphere is an increasing area of interest as the need to better represent surface-atmosphere interactions in climate and atmospheric circulation models increases.

Researchers have struggled with describing heat and mass transfer between the atmosphere and vegetated surfaces for more than 35 yr (Waggoner and Reifsnnyder, 1968) and have developed several models ranging widely in complexity (Goudriaan and Waggoner, 1972; Norman, 1979; Shuttleworth and Wallace, 1985; Kustas, 1990; Massman and Weil, 1999). Comprehensive models capable of simulating microclimate within the canopy typically employ one of two theories: Gradient (or K-theory) models (Norman, 1979; Flerchinger et al., 1998; Mihalović et al., 2002) define heat and mass fluxes within the canopy as the product of a concentration gradient and the eddy diffusivity,  $K$ . Considerable effort has been expended to estimate eddy diffusivities within the canopy (Ham and Heilman, 1991; Jacobs et al., 1992; Huntingford et al., 1995; Sauer et al., 1995; Sauer and Norman, 1995). The K-theory has come under criticism for not predicting counter-gradient fluxes (Denmead and Bradley, 1985). Lagrangian trajectory theory (L-theory; Raupach, 1989) has been proposed as an alternate to K-theory, and recently several L-theory models have been developed (van den Hurk and McNaughton, 1995; Massman and Weil, 1999; Warland and Thurtell, 2000; Wilson et al. (2003) compared K-theory and L-theory approaches and concluded that both approaches performed equally in simulating surface energy components.

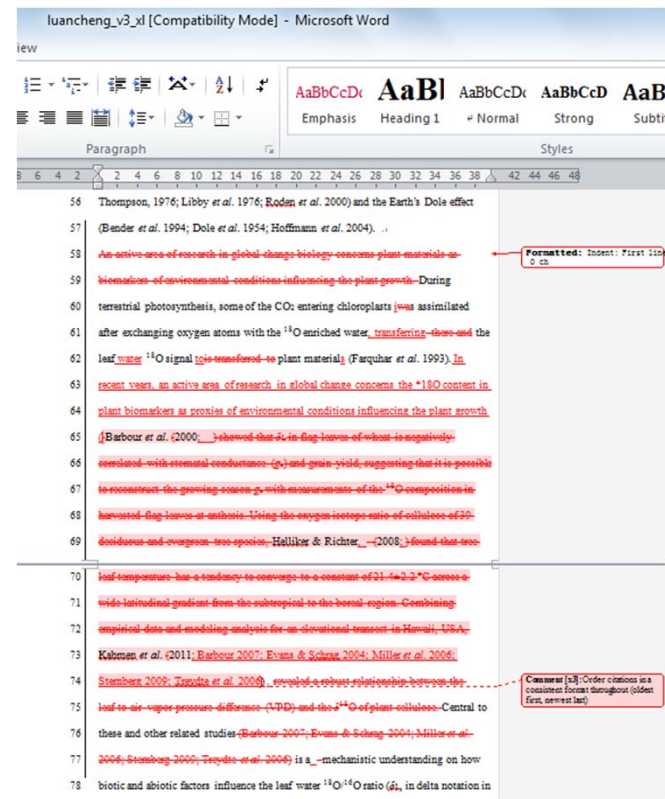
The SHAW model, which is based on K-theory, was originally developed by Flerchinger and Saxton (1989b) and modified by Flerchinger and Peterson (1991) to include transpiring plants and a plant canopy. Its ability to simulate heat, water, and chemical movement through plant cover, snow, residue, and soil for predicting climate and management effects on soil freezing, snowmelt, soil temperature, soil water, evaporation, transpiration, energy flux, and surface temperature has been demonstrated (Flerchinger and Hanson, 1989a; Flerchinger and Peterson, 1991; Xu et al., 1991; Flerchinger et al., 1994, 1996a,b, 1998; Hayhoe, 1994; Flerchinger and Seyfried, 1997; Kennedy and Sharratt, 1998; Duffin,

Abbreviations: IRGA, infrared gas analyzer; IRT, infrared temperature sensor; IRTS, infrared thermocouple sensor; LAI, leaf area index; MBE, mean bias error; ME, model efficiency; NCP, North China Plain; RMSD, root mean square deviation; SHAW, Simultaneous Heat and Water.

722

My first SCI paper

2012-6-15



My fourth SCI paper at its third version

5

## My NSFC proposal...

2010.3



2010.7



2010.9



2011.3



2011.9

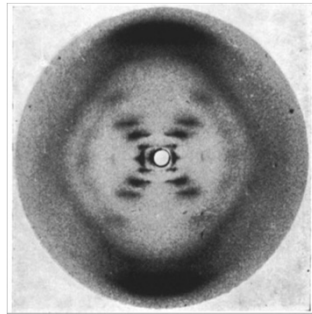


## 2. Science writing as storytelling

### Finding the story

The role of scientists is to collect data and transform them into understanding.

A. Photo 51



B. Model of DNA



(Photo 51, Rosalind Franklin's critical X-ray diffraction image of crystallized DNA and the simple model of its structure developed by James Watson and Francis Crick)



(The flow of science, from data to understanding)

### 3. Making a story sticky

- SUCCES
  - S: Simple
    - A simple idea contains the core essence of an important idea in a clear compact way. Simple ideas have power.
    - “it’s the economy, stupid” – Bill Clinton
  - U: Unexpected
    - Incremental science can be important, but really good papers go beyond incremental to *novel* – they say something new and unexpected.
  - C: Concrete
    - “If those who have studied the art of writing are in accord on any one point, it is this: the surest way to arouse and hold the reader’s attention is by being specific, definite, and concrete.”



# 3. Making a story sticky

- SUCCES
  - C: Credible
    - Science writing that isn't credible is science fiction.
    - Credibility goes hand in hand with being concrete.
  - E: Emotional
    - Curious
    - Excitement
    - “what information do I have to offer?” to “what knowledge do I have to offer?”
  - S: Stories
    - Stories are modular; a single large story is crafted from a collection of smaller story units, threaded together.
    - To write a good paper, you need to think about internal structure and how to integrate story modules.

## **B: HOW TO BUILD EFFECTIVE STORY ARCS**

## 4. Story structure

- OCAR: Slowest – take your tie working into the story.
  - ABDCE: Faster – get right into the action.
  - LDR: Faster yet – but people will read to the end.
  - LD: Fastest – the whole story is up front.
- 
- LDR (Lead-development-resolution)
  - LD (Lead-development)

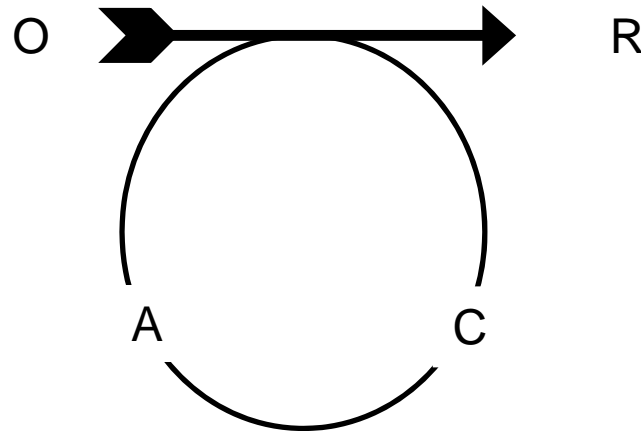
# OCAR Structure

- **Opening (O):** Whom is the story about? Who are the characters?  
Where does it take place: What do you need to understand about the situation to follow the story? What is the larger problem you are addressing?
- **Challenge (C):** What do your characters need to accomplish? What specific question do you propose to answer?
- **Action (A):** What happens to address the challenge? In a paper, this describes the work you did; in a proposal, it describes the work you hope to do.
- **Resolution (R):** How have the characters and their world changed as a result of the action? This is your conclusion – what did you learn from your work?

# ABDCE Structure

- **Action (A):** Start with a dramatic action to immediately engage readers and entice them to keep reading.
- **Background (B):** Fill the readers in on the characters and setting so they can understand the story as it develops.
- **Development (D):** Follow the action as the story development to the climax.
- **Climax (C):** Bring all the threads of the story together and address them.
- **Ending (E):** What happened to the characters after the climax? (This is the same as resolution.)

One aspect to both the OCAR and ABDCE structures is that they have a resolution that shows how overcoming the challenge has changed the characters and their world.



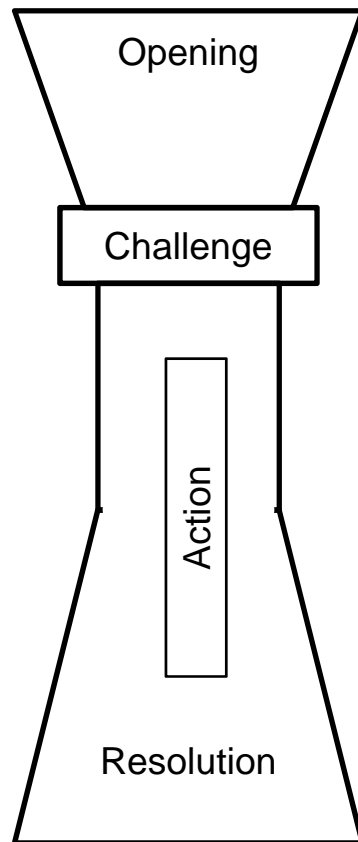
*How an OCAR story makes a spiral: the story comes back to its starting point, but that point has moved.*

Highlighting this spiral structure is key to making an OCAR or ABDCE story powerful.

# Physical structure for science papers -- IMRaD

- Introduction:
  - *Opening*: the first paragraph that introduces the larger problem the paper is targeting. What is the context?  
What are the characters we are studying?
  - *Background*: What information does the reader need? Why it is important, what it will contribute to the larger issue?
  - *Challenge*: What are the specific hypotheses/questions/goals of the current work?
- Materials and Methods: What did you do?
- Results: Your findings.
- Discussion: the climax and the resolution. What did it all mean, and what have you learned? It often ends with a conclusions subsection that is the resolution.

# Mapping OCAR onto IMRaD



*Introduction: introduce characters and question. Narrow down to your specific questions*

*M&M and Results: What you did and what you found*

*Discussion: What it means*

*Conclusions: Take home message*

*The hourglass structure of a paper. It starts wide with the opening, narrows with the challenge and action, and widens back out again at the resolution.*

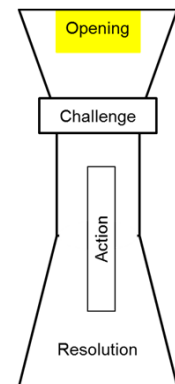


# 5. The opening

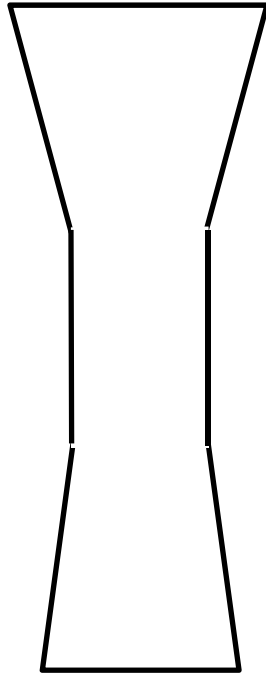
*The most important sentence in any article is the first one.*

--William Zinsser, *On writing Well*

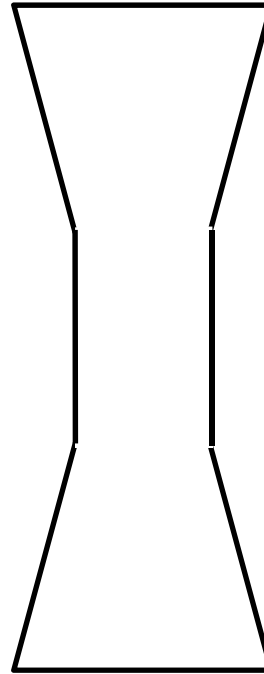
- Good openings:
  - Identify the problem that drives the research;
  - Introduce the characters;
  - Target an audience.
  - Example:
    - Since the late 1800s, N mineralization has been the perceived center point of the soil N cycle and the process that controls N availability to plants.
- Bad openings:
  - Misdirection
  - No Direction
  - Example:



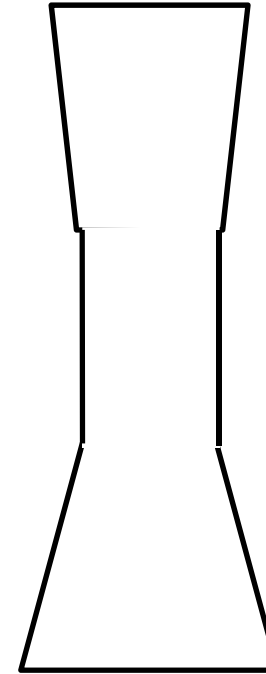
How wide should your opening be?  
Matching the opening to the resolution.



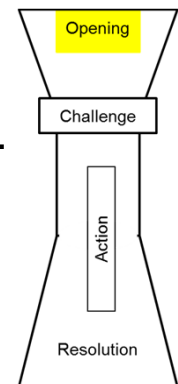
A. Opening wider than resolution: overpromising. Your readers will feel cheated.



B. On target. Your readers will be satisfied.

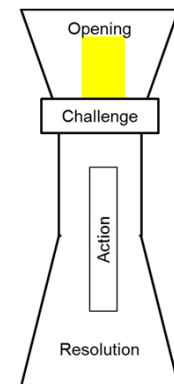


C. Resolution wider than opening: underpromising. Your readers won't ever see that you are telling a story that would interest them.



## 6. The funnel: Connecting O and C

- A large problem (Opening) → A specific question (Challenge)
- The main body of the Introduction must connect these elements. It forms the funnel in the hourglass; it narrows the focus and leads readers from the general to the specific, drawing them along the story and framing in the knowledge gap.
- Example:
  - To understand the global climate system
  - To study bacteria in the frozen soils of the arctic tundra during winter
- Bad introduction
  - Failing to identify the problem
  - Offering solution before defining a problem



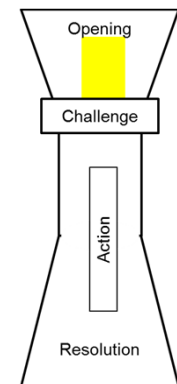
# Introduction versus literature review

- **Review:**

- Synopsise what we know about a topic.
- Build a solid wall -- describing *knowledge*.
- When you describe something we know, do you use it to identify the boundaries of that knowledge? If so, introduction, **if not, literature review**.
- “Smith (2003) found X”

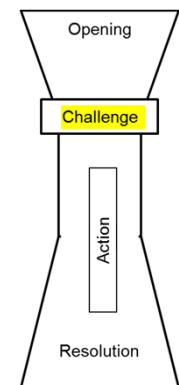
- **introduction**

- Show us what we *don't* know and why it is important.
- Focus on the hole in that wall -- describing *ignorance*.
- **If so, introduction**, if not, literature review.
- “X occurs (Smith 2003)”



# 7. Challenge

- In the challenge, you describe the specific knowledge you hope to gain.
- This starts with the question that drove you to do the research. You did the work to discover the answer.
- Hypothesis
- Specific objectives
- Questions



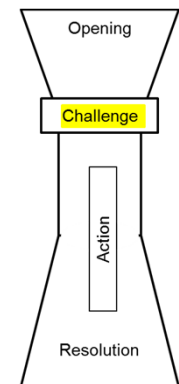
# Questions versus objectives

## Objectives

- “Our objectives were”
- Focus on the information they will collect.
- Weak science and weak storytelling.
- Doesn’t engage SUCCES
- Doesn’t create unexpectedness or curiosity.

## Questions

- “Our question was”
- Focus on the knowledge they hope to gain.
- You have a question that drove your work.
- Make it clear.
- Then you can tell us how you answer it.



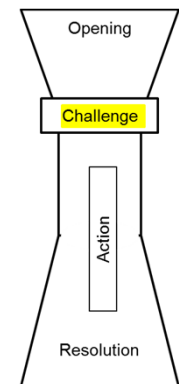
# Good challenge versus bad challenge

## Good challenge

- “to learn X, we did Y.”
- Present the question
- Lay out an approach to answering it.

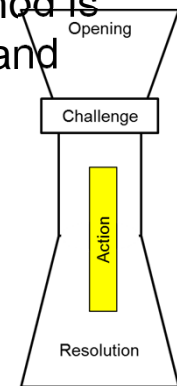
## Bad challenge

- “to learn X...”
- Or “we did Y...”



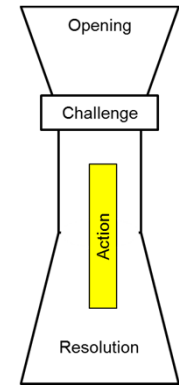
# 8. Action

- In OCAR, action makes up the main body of the story and includes everything between the challenge and the resolution.
- Two distinct parts:
  - Describing what you did (Materials and Methods)
  - What came of it (Results and Discussion)
- Methods:
  - To serve the needs of all possible readers, the best way to describe a method is use a lead/development (LD) structure, providing an initial overview for all and then the details for those who need them.





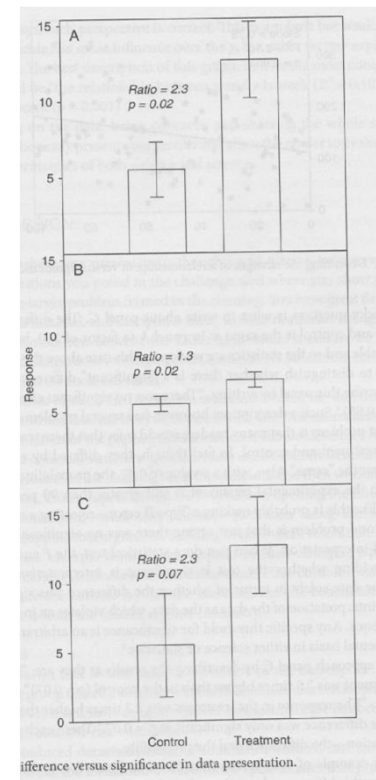
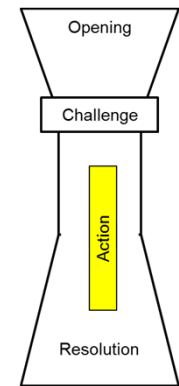
# Results and discussion



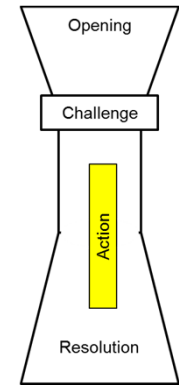
- To separate, or not to separate: that is the question
- Make the reader's job easy (our principle no.1): present results and interpretations in a way that best develops the story.
- Readers must be able to distinguish what you found from what you think.

# Results

- Choosing data to present
  - The most important decision in describing results is not *how* to present your data but *which* data to present.
- Presenting data
  - To make it easy for the reader to understand your results, you need give us more than the raw data.
  - You need to synthesize them into a pattern and fit them into the larger story to provide context.
  - Most results call for an LD structure: first frame the major point or pattern, then flesh out the detail.
- Statistics and stories
  - The story is not in the statistics – it is in the data themselves.



# Discussion

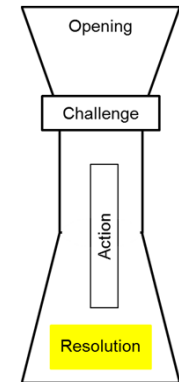


- Discussion is
  - Where you present your thoughts and interpretations,
  - Where you answer the questions you posed in the challenge,
  - Where you show your contribution to the larger problem frames in the opening.
- Writing a good Discussion is *the* critical act of creativity in science that no book can teach.
- Both OCAR and LDR work well for the Discussion – they each provide a coherent structure that allows you to develop a clear and compelling story.

# 9. The resolution

## Good resolutions

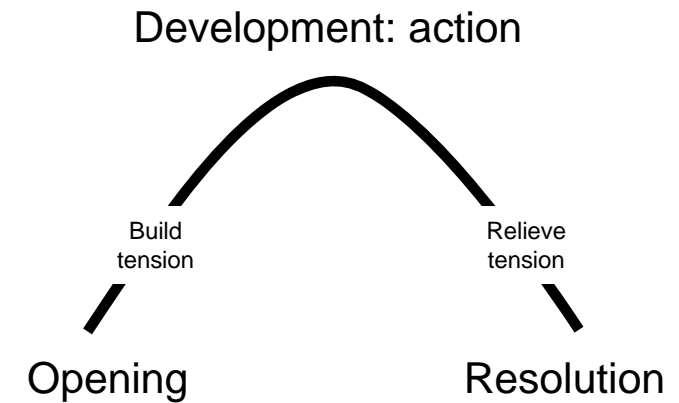
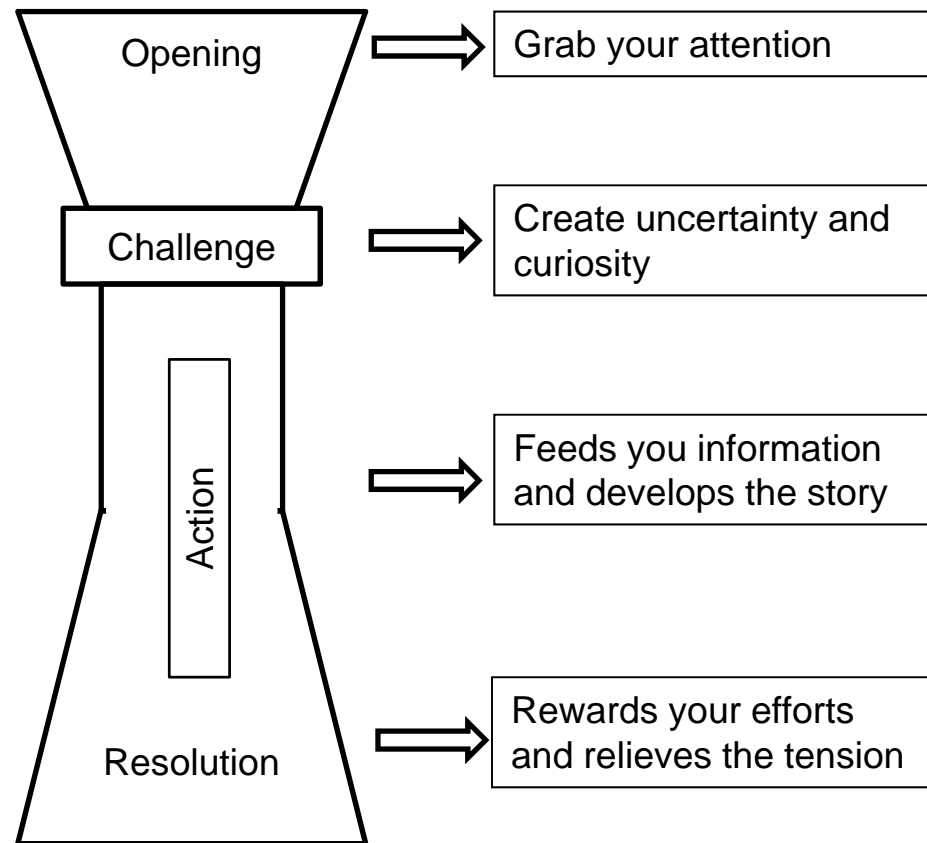
- Shows us how our understanding of nature has advanced, and by offering new insights into the problem identified in the opening, **it wraps up the story**.
- Reiterates the action, answers the questions raised in the challenge, demonstrates how those answers contribute to the larger problem.



## Bad resolutions

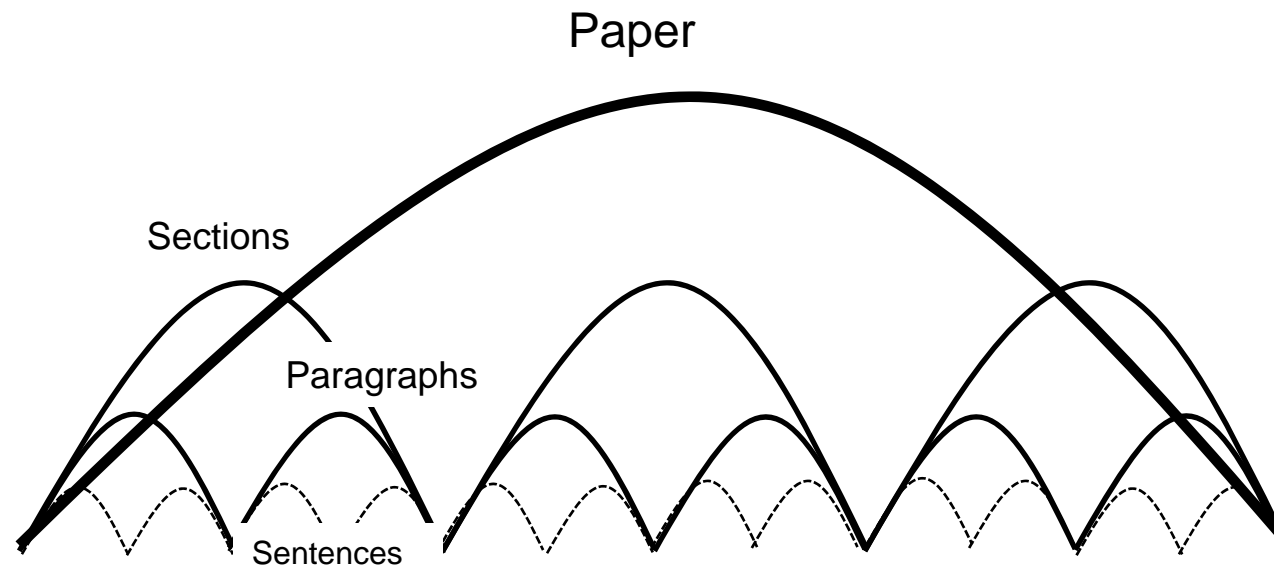
- Weak
  - Usually synopsizes their results and then tell you that they are important, but don't clarify how –they don't answer the questions they were asking and don't synthesize their information into knowledge.
- Distracting
  - Conclude with material that is distracting– ideas that should be in the Introduction or is already in textbooks and that neither synopsizes nor synthesizes the results.
- Undermining your conclusions
  - “more research is needed to clarify our findings.”

# 10. Internal structure

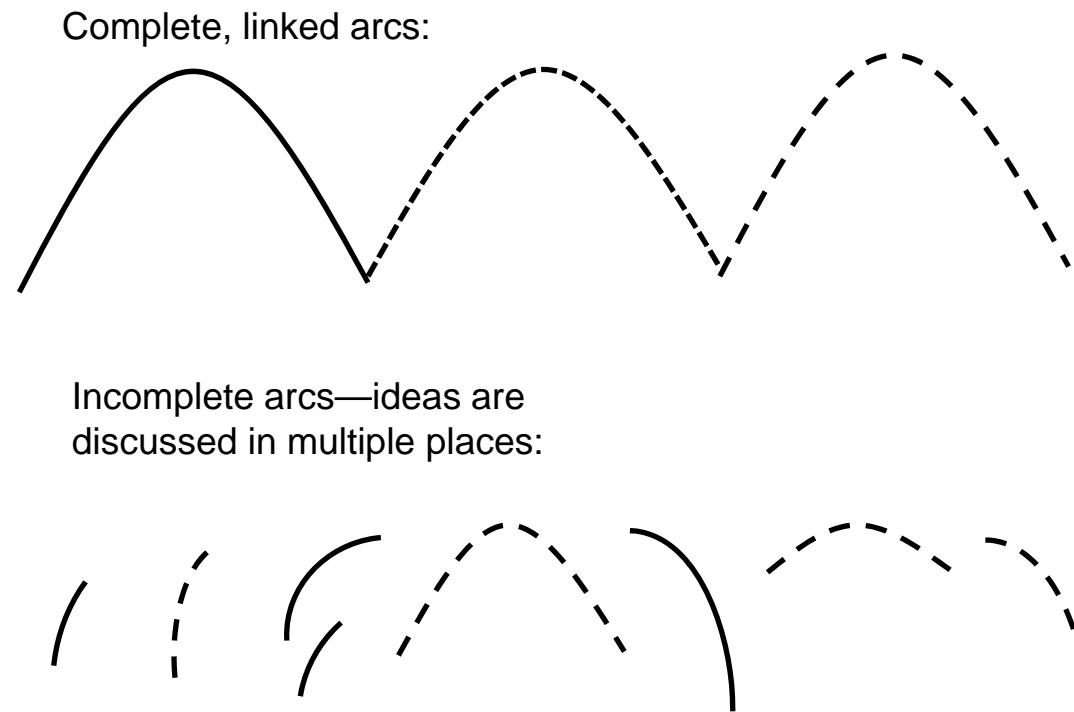


**Figure 10.1.** A story arc.

- **Introduction:** why you did the work—it opens, narrows, and resolves with the paper's overall challenge.
- **Materials and Methods:** starts with the study system, then the measurements, and wraps up with how you analyzed the data.
- **Discussion:** opens by restating the issue, discusses the evidence, and resolves with the paper's conclusion.



**Figure 10.2.** A story is a set of nested arcs.



**Figure 10.3.** Complete versus broken story arcs: beginnings and endings are power positions.

- Creating arcs compartmentalizes your thoughts and makes them manageable.
- Effective arcs make it easier for readers to deal with multiple ideas in a single paper.
- Arc structure is effective as well because beginnings and endings are power positions.

# Arcless writing

- California supports rich fisheries off its coast. The high productivity of fish is supported by high rates of algal production. Algal growth in the ocean is typically limited by nitrogen supply, but this is high off California because N-rich deep water wells up to the surface along the coast. This upwelling is driven by winds that push the south-flowing surface water away from the shore, allowing deep water to rise to the surface. These off-shore winds are driven by regional climate patterns, including El Nino, that are being intensified by the greenhouse effect, which results from increased CO<sub>2</sub> in the atmosphere. Increased CO<sub>2</sub> in the atmosphere also increases the amount of O<sub>2</sub> dissolved in the ocean, which reacts with water to form carbonic acid (H<sub>2</sub>CO<sub>2</sub>), reducing the ocean's pH. This reduced pH makes it hard for shell-forming organisms to make calcium carbonate shells, and so may reduce the productivity of important marine species such as abalone, oysters, and even sea urchins. Thus, increasing atmospheric CO<sub>2</sub> is going to have many important effects on marine ecosystems.
- California...fisheries
- Fish...algae
- Algae...nitrogen...upwelling
- Upwelling...winds
- Winds...climate
- Climate...greenhouse effect...CO<sub>2</sub>
- CO<sub>2</sub>...acid...reduced pH
- Reduced pH...damage to shell-forming organisms
- Thus, ...CO<sub>2</sub> will affect marine ecosystems.



Thank you!