Communicating Scientific Research Effectively

VALLIAPPA LAKSHMANAN
NATIONAL WEATHER CENTER REU PROGRAM
LAKSHMAN@OU.EDU
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Uncommunicated research is not worth doing

- If you discover a cure for cancer and describe it in an obscure way, will any lives be saved?
  - Scientific research is a service to society
  - Need to describe your work to those who can apply it
- Research becomes useful to society only if you disseminate it
Disseminate research in multiple ways

- Use as many of these methods as possible:
  - Presentations
    - Hallway conversations, Conference talks, Seminars
  - Publications
    - Conference papers, Journal papers, Books, Technical reports
  - End-products
    - Example: Models, software, analyses, predictions, datasets

- Research adds to scientific knowledge only when the scientific community takes note
Communication keeps you in business

• Scientific research is a competitive enterprise
  ▪ Need to continue being funded to carry out your research
  ▪ Disseminate your research so that your work is recognized
Communication makes research possible

- Scientific research is a collaborative enterprise
  - Not enough hours in the day to do everything
  - May not have all the expertise needed

- Develop partnerships
Communicating Scientific Research Effectively

- Communication is essential
- **Takes preparation and practice**
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Do Now: 1 minute summary

- Pair up: we’ll assume that the person next to you is a potential collaborator
  - Give your partner a 1-minute synopsis of your project
  - Swap roles
  - Listen as your partner gives you a 1-minute synopsis of her project
Do Now: Comment

- For your partner’s project
  - Jot down:
    - What is the project?
    - Why is it being done? Why is it important?
    - What are the impacts of the project?
    - How is the project going to be accomplished?
    - How could you could help him?
  - Hand the note over to your partner

- Look at what your partner wrote about your project
  - Is it an accurate description of your project?
    - If not, whose fault is it? (in a US cultural context)
Effective communication takes preparation & practice

- One minute is a long time
  - You can speak 3-4 sentences in a minute
  - Enough time to get all those details across

- But only if you are clear and brief
Effective communication is accurate, clear & brief

• Descriptions should be technically accurate
  ○ Make sure you know what you’re talking about
  ○ Reasoning and use of statistics should be sound

• Use simple, direct, unambiguous language
  ○ Write/speak to the audience’s level of knowledge
  ○ But make sure to place your statements in the right context
  ○ Accuracy vs. clarity: choose accuracy

• Be concise
  ○ Focus on a problem and its resolution
  ○ Use diagrams and charts to cut down on prose
  ○ Edit mercilessly
Checklist for Talks and Papers

- What is my purpose?
  - Do I want to inform or to persuade?

- Who is my audience?
  - What do I want of them?
  - What do they already know?
  - What should they know after they listen to me?

- What am I talking about?
  - What is the problem?
  - What is my approach to solve the problem?
  - What do my results mean?
  - What is the utility of my research? Where can it be used?
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Scientific papers have a standard storyline

- Follow the “standard” scientific storyline
  - Introduction
    - Motivation: what problem are you trying to solve? Why is it important?
    - Literature review: what has been done to address this problem? Why is it not enough?
  - Method
    - What is your approach? Is it better than what’s been done?
  - Results
    - What happened when you did what you did?
  - Conclusions
    - What are the limitations of your work? What do the results mean?

- The standard storyline adds structure to papers
  - Deviate from this storyline only with very good reason
Think about the audience’s interests

• Provide just enough context for the audience’s level of knowledge
  o Similar data sets, techniques, current state of knowledge
  o What makes your dataset/technique different? Better?
    ▪ Be prepared for push-back: scientists are skeptical, reviewers may be biased

• Avoid the temptation to focus on where you spent the most amount of time
  o No one needs to know how hard “S-plus” is to learn
  o Or that you needed to reprocess all your data after a hard disk failed
Focus on what’s novel about your work

- Emphasize what you did that’s new and interesting
  - Did you discover something about a known data set?
    - Focus on the results
  - Did you collect new data?
    - Focus on the method of acquiring the data
  - Is your technique new?
    - Focus on the algorithm
  - Did you find some new phenomenon? Have a new explanation for a process?
    - Focus on persuasion
Summarize your work twice

- Summarize your work at the beginning (abstract)
  - Motivation, Method, Results
  - This is your “mini-paper” and provides a road-map
    - No point in putting up an “outline” slide
    - Tell them what the outline is

- Summarize your work at the end
  - Stick to focus of paper
  - No need to recap introduction, etc.

- Skip one of the summaries on very short talks
  - You should be able to hold their attention for 10 minutes, right?

Introduction
Methodology
Results
Conclusions

Hard to forecast tornadic storms in California
Studied XX California Storms XX-YY
Found that buoyancy and shear values useful
in forecasting tornadoes
Looked for optimal thresholds
CSI=XYZ obtained on historical data set
Do Now: 1-minute summary

- Take 5 minutes to prepare what you’ll say
  - Remember the standard storyline
  - Feel free to draw a cartoon to illustrate some point
- Try the exercise again
  - Is your partner’s recollection any better?
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- **Pointers to write a statistical report**
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
In statistical studies, focus on interpreting your results

- Be careful about reporting statistics
  - Is your sample size large enough?
  - Are there implicit restrictions that arise from your dataset selection?
  - Are your results meaningful?

- Interpret your results for your audience
  - Do not just throw up some charts or tables
  - What do they mean?
  - What is the implication?

- Emphasis should be on what you discovered
  - Resist the temptation to drone on about what you did
  - Unless your method is innovative, keep Methods concise
Choose a specific and clear title

- Don’t overpromise
- Don’t mislead
- Be clear and specific

NOTES AND CORRESPONDENCE

Shear Parameter Thresholds for Forecasting Tornadic Thunderstorms in Northern and Central California

JOHN P. MONTEVERDI
San Francisco State University, San Francisco, California

CHARLES A. DOSWELL III*
National Severe Storms Laboratory, Norman, Oklahoma

GARY S. LIPARI
San Francisco State University, San Francisco, California

14 March 2001 and 20 June 2002

Forecasting Tornadic Thunderstorms
A Technique to Choose Shear Parameter Thresholds
Predicting California Tornadoes Using Shear

lakshman@ou.edu
Summarize your major findings in the abstract

Including the reason to undertake study would have been nice to include, but it is obvious

Half-sentence on method!

Key negative finding

Quality of result: actual numbers would have been better

Qualification of findings

Key result in first paragraph

ABSTRACT
A study of 39 nontornadic and 30 tornadic thunderstorms (composing 25 tornado “events,” as defined in the text) that occurred in northern and central California during the period 1990–94 shows that stratification of the stronger tornadic events (associated with F1 or greater tornadoes) on the basis of 0–1- and 0–6-km positive

Shear values for the weaker F0 events could not be distin-

Shear magnitudes calculated for the F1/F2 events suggest that these tornadoes had

Hindcasting the tornado events based upon

Although the current sample size is limited and the conclusions drawn from it should be considered preliminary, it appears that California forecasters may be able to use shear profiles to distinguish days on which there is a higher threat of storms producing moderate and significant tornadoes. Buoyancy, as indicated by surface-based convective available potential energy (SBCAPE), was weak for each of the categories, and there were no statistically significant differences between SBCAPE values for each of the categories. Thus, as is true elsewhere, buoyancy magnitude alone appears to be of no value in forecasting whether California thunderstorms will be tornadic.
Start off with the reason to undertake study

1. Introduction

California tornadic thunderstorms\(^1\) and their counterparts in other parts of the world in similar climatological environments (e.g., Hanstrum et al. 1998) have only recently been subjected to systematic documentation. Indeed, preconceived notions persist that tornadic storms either are not a forecasting problem in California or are “freak” events (see Monteverdi and Quadros 1994).

Although the processes that interact to produce tornadic storms in California are not unique, topographic effects in the Central Valley and the coastal valleys act to increase the magnitude of the vertical wind shear locally. This has been noted in previous studies, but only for a limited number of cases (e.g., Monteverdi and Quadros 1994).

In order to document the shear and buoyancy environment in this portion of the state more systematically, the detailed analysis of 30 tornadic thunderstorm cases in northern and central California during the period 1990–94 presented in Lipari and Monteverdi (2000, hereafter referred to as LM) was augmented with a study of the 41 nontornadic thunderstorm cases (hereinafter referred to as “null” cases) that occurred during the same period...
Explain the context of the study

Conceptual diagrams can replace acres of text

Concise descriptions, with extensive citations for interested readers

pause heights of the winter and spring months in patterns that are conducive to convective storms rooted in the boundary layer. In such buoyant environments, the warm season, inversion-topped surface marine layer is absent and lapse rates are steep in the boundary layer. Soundings correspond to the Miller “type III” sounding [for description see Bluestein (1993, p. 453)] and are characterized by steep lapse rates in a relatively shallow

mento or San Joaquin valleys are associated with a synoptic pattern (Fig. 2) that acts to create a buoyancy and shear environment favorable for supercell storms. The pattern favoring supercell tornado events in the Central Valley (and, to some extent, in the coastal valleys) initially was described in Monteverdi et al. (1988) and subsequently found to be associated with other cases of tornado thunderstorms in the state (Braun and Mon-
Concisely describe methodology

3. Methodology

During the 5-yr period 1990–94, 30 tornadoes were documented in northern and central California. The total sample included 16 tornadoes rated F0, 13 F1 tornadoes, and 1 F2 tornado (see Fig. 1 and Table 1). The 30 tornado cases (numbered consecutively in Fig. 1 and Table 1) were grouped into “tornado events” on the basis of the proximity sounding/hodograph used in the subsequent analysis. Multiple tornado cases analyzed on the basis of the same proximity sounding/hodograph shear and bulk shear. Positive shear is defined as the sum of the shear magnitudes for segments of the hodograph in which wind veers or is unidirectional with height (Johns et al. 1990, 1993). Positive shear is greatest for hodographs in which both the wind shear magnitude is great and the wind shear vector veers with height (the hodograph is anticyclonically curved), in the Northern Hemisphere. Bulk shear is defined as the vector difference between top and bottom of the specific layers (0–1, 0–2, 0–3, and 0–6 km AGL) updated with surface observations.
Show level of uncertainty in graphs

- Labeled axes
- SI units
- Caption explains: min, max, 25th, 75th percentile
- Labeled axes even if axis is not conventional
- Actual numbers shown
The point of a graph is to justify the interpretation

- Interpretation of results
- Implication of results

Is it statistically significant? How do we know?

Fig. 4. Maximum, 75th, and 25th percentiles and minimum values of SBCAPE of
null, F0, and F1/F2 data grouping, hereafter referred to as bins (Fig. 4), the median value (near the center of the box in the plot) is less than 500 J kg⁻¹ for each of the bins. Since the data were not normally distributed, the authors used the Mann–Whitney test (Johnson 2000, 314–317) to compare the median values for each of the bins. The test failed to show any statistically significant differences in the median values between any pair of the bins. Thus, there appears to be no statistical justification for stratifying the cases on the basis of SBCAPE; there is simply no relationship between buoyancy magnitude alone and the potential for thunderstorms to become tornadic. Observe that the greatest mean and maximum buoyancy occurred in the null bin. This result is inconsistent with the notions of those forecasters who persist in believing that threat of tornadoes increases when the SBCAPE increases.
What’s the POD and FAR that you’d get if you used these low-level and mid-level shear thresholds?

The impact of using a certain threshold on historical tornadoes

Avoid color until online publications become the norm
7. Conclusions

This study of 25 tornadic and 39 nontornadic thunderstorm events in California shows that buoyancy alone could not be used to distinguish between tornadic and nontornadic events. Statistically significant differences in values of 0–1- and 0–6-km shear for the F1/F2 cases compared to the other bins suggest thresholds that could be used in assessing the risk for convection associated with California. This study also performs bulk shear as a detecting the F1 and stronger events. This is consistent with observational and modeling results that show the association of anticyclonically curved hodographs with stronger tornado events in other parts of the United States. A forecaster in California using the shear thresholds developed in this study would have had considerable success in forecasting the potential for thunderstorms producing the stronger tornadoes (F0–F2), at least for the storms represented in the data set. There is a statistically significant drop in the shear values for F0 storms. Our data do not include the tornadic storms that occurred in California from 1950 to 1989 and from 1995 to the present. Even so, the success of the thresholds in hindcasting the potential for tornadic convection in general, and for the stronger tornadoes (possibly supercellular) events in particular, suggests that California forecasters can use shear thresholds to achieve success in forecasting tornadoes.

We recognize the dangers of inferring too much from the limited data sample considered here. Because of this, the study is being expanded to include all tornadic cases from 1950 to 1989 and from 1995 to the present time. Even so, the success of the thresholds in hindcasting the potential for tornadic convection in general, and for the stronger tornadoes (possibly supercellular) events in particular, suggests that California forecasters can use shear thresholds to achieve success in forecasting tornadoes.

Summary

Key results

Why should you care?

Qualification: “FAR may be lower than what we say because we made conservative assumptions”

Qualification: “our sample size was limited; our conclusions are preliminary; this is how we are going to address this in the future”
Acknowledge Help and Grants

- Acknowledge help that does not rise to co-authorship
- Funding agencies like to be recognized; put grant number if it exists
- Common to acknowledge reviewers

*Acknowledgments. This research was partially funded by the Department of Geosciences, San Francisco State University, and the National Severe Storms Laboratory. Lipari and Monteverde are partially composed of work in progress by the third author as part of his M.S. thesis in applied geosciences at San Francisco State University. The authors gratefully acknowledge the diligence of three anonymous reviewers and Josh Korotky in guiding them in the revisions of this manuscript.*
Follow Citation Formats Scrupulously

Cite related work; every reviewer first looks to see if he is cited ...

Standard abbreviations for common journals

Address for tech reports (online address okay)

Newer conferences may not have page numbers

Different journals have different styles; tools like BibTeX and EndNote help
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Use others’ presentations as examples

- What did you like about my presentation style?

- What would you do better?
Less is More

• Every talk should have a focus
  ○ Outline your talk, then cut anything that is irrelevant

• Time your talk
  ○ 3-min/slide for text-heavy slides
  ○ 1-min/slide for graphics-heavy slides

• Leave time for questions
  ○ 25% of “lecture” time for questions
  ○ Some conferences have formal time limits
Explain things in an approachable way

• You are the expert: act like one
  o The audience looks to you to explain things
  o Try your talk out on a colleague
  o Fuzzy language and jargon are signs of a flustered speaker

• Don’t “read” a paper
  o Use normal speech patterns
  o Walk about a little

• Interact with your audience
  o Vary your pace, line of sight and tone of voice
  o Feel free to point, draw and ask questions
Grab attention, and then keep it

Sounds interesting!

What does that term mean?

OK, now I’m lost!

What was that all about?

I didn’t get all that, but ok ...
Animations and clip art get annoying

- Did you enjoy the animation on the previous slide?
  - The first time or all the time?

- A session full of fluff gets very annoying
- Progressive disclosure hides your storyline
  - Many people read “ahead” to see where the presenter is going
Use graphs, equations & diagrams only as visual aids

- Interpret all visual aids for the audience
  - The audience is there to listen to you, not to squint at your slides
  - The visual aids must be big enough to be seen by back benchers

Null cases have higher CAPE than F1/F2 cases!

If these numbers are important, is the font size big enough?

If this is the take-away from this diagram, is the 75th percentile the right statistic to show?
The normal storyline does not work for talks

Some people are curious about your field

Motivation, method, results all tied together in one place

Interpret ...

Source for presentation outline: EFCATS talking tips
http://www.efcats.org/Give+Successful+Presentations/Give+Successful+Oral+Presentation.html
Don’t go crazy with backgrounds and fonts

Don’t use photos as background either

Better in a brighter room; Prints better

Better in a darker room

Source: EFCATS talking tips
http://www.efcats.org/Give+Successful+Presentations/Give+Successful+Oral+Presentation.html

lakshman@ou.edu
Use your title space to emphasize the key point

- Should have one key point per slide
  - Everything on the slide should support that key point

Buoyancy is not useful by itself

Null cases have higher CAPE than F1/F2

CAPE

Null cases have higher CAPE than F1/F2

CAPE (J kg⁻¹)

0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0

Null FO F1/F2

136.0 1.0

871.0

104.0 425.0

113.0 525.0

0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0

Null FO F1/F2

136.0 1.0

871.0

104.0 425.0

113.0 525.0

lakshman@ou.edu
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Reasonable people differ on posters’ purpose

a) Posters are meant for work that is not of wide interest
   - Target poster towards the niche audience for solitary study
   - The poster should be understandable even if you are not present

b) Posters are meant for one-on-one discussion
   - Satisfy the “glancers” with the big picture
     - The 1-minute synopsis should guide overall structure of poster
     - Have the most novel part of your work be the central element
     - Leave out anything that you can’t explain in 3-5 minutes
   - Be prepared at the poster session to expand on work orally
Posters are interactive; talks reach more people

- Some scientists prefer posters
  - Allow for deeper, more meaningful, more personal interactions
  - Help scientists who have language difficulties
  - But ... don’t try to “hide” behind posters because you’re nervous

- Oral presentations reach wider audiences
  - Inertia: people stick around from previous talk
  - Be careful to provide solid introduction
  - Difficult to gain feedback after oral presentation

- If you can, choose the right mode of presentation
  - Posters are not graveyards for sub-par work
  - And oral presentations are not necessarily “better”
Make solitary study posters self-contained

Organized like a typical paper

Call out information to explain diagrams

Too much text? Fonts too small? Too few graphics?

Contact information

Title is too broad; is the subtitle really needed?

The central element has the appropriate emphasis: the poster is about the software for drought monitoring

Color scheme (dark text on light background) allows extended reading
Critique this poster

(Jot down a few things that you like about this poster. What would you improve?)
Posters should emphasize a few key points

- Make sure to print poster number
- Save space by using logos for affiliations
- A photograph can make you easier to find
- Intro, method, results
- Central part of poster: system that was built
- Full affiliations as footnotes
- 1-minute storyline prominent
- Images illustrate steps
- Website of project is prominent
- Acknowledge grants and helpers in footnotes

(Note: modifications by V. Lakshmanan: original & modified are in your electronic packet)
Communicating Scientific Research Effectively

- Communication is essential
- Takes preparation and practice
- The standard storyline
- Pointers to write a statistical report
- Presenting scientific work clearly
- Creating effective posters
- Organize your thinking
Plan your papers/talks as you do your work

- Use abstract as a plan for scientific project
  - Gives you a goal
  - Fill in the blanks as you go along

- Break large projects down into smaller chunks
  - Consider what you will need to proceed from one stage to the next
  - Write abstracts for each stage
  - Conceptualize what results will prompt you to take which approach

- Keep a scientific journal for projects
  - Take notes, capture screenshots, log problems
  - Write/edit paper as you go along
You don’t have to do it all by yourself

• Seek help if you find that you are not clear on something
  o Utilize collaborators and mentors throughout project
• If you ask good questions, you’ll do better work
  o Listen to terminology and nuance when experts talk
  o Will help you be accurate in the questions that you ask
Communicating effectively makes you a better scientist

- Communication is essential
  - Science is collaborative and competitive
  - Use the outline of papers/talks as ways to organize your thinking

- Communicate effectively so that your work is recognized
  - Scientific communication follows a standard storyline
    - Different papers have different emphases: choose your focus
  - Be accurate, brief and clear
  - Papers are for solitary study: describe only what’s new in your work
  - Posters are meant for interaction: grab attention and keep it
  - Talks are meant to explain: what should your audience learn?
Suggested resources

- Communication is part of what makes science rewarding
- To be good at it takes preparation and practice
  - Shultz, David: Eloquent Science. American Meteorological Society
  - Scientifically Speaking: http://tos.org/pdfs/sci_speaking.pdf
  - How to give a successful oral presentation:
  - The art of scientific communication: Using PowerPoint effectively:
    http://ian.umces.edu/pdfs/science_comm_powerpoint.pdf
  - Tips for Giving a Scientific Presentation:
  - Guidelines for writing scientific papers:
    http://www.bms.bc.ca/library/Guidelines%20for%20writing%20Scientific%20papers.pdf
- Questions? Comments?
Assignment 1

- Download the zip-file at
  http://cimms.ou.edu/~lakshman/reu2009_scientific_communication.zip

- Read the following from the examples folder of the zip file; we will critique these in class
  - shear_parameter_thresholds.pdf
  - P-WE1.12_Shafer.pdf
  - 2008AMS24thIIPS_2.13_OnDemand.png
Eloquent Science: Assignment 2

- Read chapters 3 and 4 of Eloquent Science
  - Be prepared to come and discuss in class
  - Go to http://journals.ametsoc.org/
  - Pick any 3 articles from any of the journals
    - Critique the title
      - Suggest an improved title
    - Similarly critique the organization of the paper
      - Would you have organized it differently?
      - Increase or decrease emphasis on some sections?
Eloquent Science: Assignment 3

• Read chapter 11 of Eloquent Science
  o Be prepared to come and discuss in class
  o Go to http://journals.ametsoc.org/
  o Pick any 3 articles from any of the journals
    ✷ Critique the figures
    ✷ What can be improved?
• Before your first presentation in REU:
  o Read chapter 24-26 of Eloquent Science
  o Do not want to see:
    ▪ unlabeled images
    ▪ crowded slides
    ▪ tacky backgrounds
    ▪ unnecessary verbiage

• Before creating poster for the AMS student conference:
  o Read chapter 27 of Eloquent Science
  o Create clear, concise and accessible posters