**First, some nuts and bolts**

Starting in Fall 2007, the following is now an official policy of our research group. If you are moving here from another state, read carefully and make sure that you understand the implications!

**Our grants will cover out-of-state tuition for graduate students for one year: your first year.** We cover out-of-state tuition for your first year specifically because it is impossible for you to achieve in-state status right after you have moved here. The university will only grant you in-state status if you have lived here for one year, and have satisfied a host of other criteria for the duration of that year.

You need to establish a residence, pay for utility bills, get a NC driver’s license, register your vehicle, and register to vote. File your income tax returns as a NC resident, and do not allow your parents to pay your fees for you (at least not directly). Note that some of the above items take time! For example, in North Carolina, you cannot register your vehicle until you have obtained a NC driver’s license… and, there is a test required to obtain the NC driver’s license (i.e. you may need to study). Get started soon, and allow yourself plenty of time! It will be very useful to arrive in August a week or two ahead of when orientation and classes actually begin.

You will need to apply for in-state status before the fall semester of your second year. At the time you are applying, you have to have the full year of the above items "under your belt". Waiting to do any of the above will almost always result in the university declining your application for in-state status. **If you are declined (i.e. if you are still considered a non-resident after one year), then you must pay out of pocket for the difference between in-state and out-of-state tuition.** This has caused quite a few headaches in the group during our first couple of years, so please take the obligation seriously. The state mandates a 12 month qualification period. **As soon as you arrive in North Carolina, sever all ties to your former state of residence.**

For more valuable information, please see NC State’s web site on residency:

http://www.ncsu.edu/legal/legal_topics/residency.php

*This is your responsibility. Neither NCSU, MEAS, nor Dr. Parker are able to do it for you!*
Welcome to Graduate School! Now what?

I have a list of required reading in my research group. You have some time to read all of the key scientific papers in our subdiscipline… so, first things first. You absolutely must read the following excellent paper by Dr. Chuck Doswell. It talks in both direct and indirect terms about what you should be doing as a grad student in our field.

http://www.flame.org/~cdoswell/publications/Student_Book_II.pdf

In my own words… Graduate school is a time during which you are an apprenticed scientist. You are no longer seeking merely to follow in the footsteps of others… you are seeking to create new knowledge! In order to do this, you need:

- to have a sound knowledge base
- to think critically and scientifically about everything
- to expend considerable effort, never settling for the quick or easy answer

Your curiosity should drive you to apply these tenets and learn independently! I think of science as being similar to the infinite regression of “why” questions that a 3-year old might ask. We get to the heart of a matter when we continue to ask “why” until we’ve worked our way back to first principles. Now that you are a scientist in training, the difference is that you must answer these “why” questions using your own means!

I consider the proper motivation and mindset to be absolutely essential to success as a graduate student. I strongly believe that knowing the expectations up-front will make your studies more rewarding and the quality of your work higher. It will also ensure that you will please your advisors and instructors!

Keep in mind that, as a scientist in training, your ideas will be subject to review and critique by your advisors, instructors, and peers. This mirrors the path that any scientific idea must walk. It is not enough to make a claim: you must support it and defend it! Criticism may seem harsh but, ultimately, you must use it in a positive way to improve your work. Firstly, it is better to be corrected now than to make an embarrassing error later in your career (in a published article, while teaching a course, etc). And secondly, scientists must react to ideas objectively: a demonstrably incorrect idea must be rejected, and there is nothing personal about it. It’s the nature of the scientific method. A thick skin and the proper attitude will be a great asset. Better still, focus on applying the three tenets above and anticipating and pre-empting (valid) criticisms. That is a mature scientific work ethic.

The remainder of this document is devoted to our philosophy of work, and to some of the mechanics of writing (especially your thesis). Although you may not begin writing for some months, completing a research thesis is often the most intimidating part of the M.S. program for incoming students. So, it is well to put into perspective from the beginning.
Philosophy for the use of models and observations in our research:

From Hoskins (1983):

"The pressure for the production of a forecast and the advent of the electronic computer have… conspired to push the organization of research into the situation depicted in Figure 1. Observations of the atmosphere and output from sophisticated numerical models are diagnosed and conveyed to others using conceptual models that have not changed in decades. Theoretical modeling frequently proceeds with little contact with data from the real atmosphere or with the complex numerical model and contributes little to diagnosis."

Instead, our group’s philosophy is to strive for the system described by Figure 2.

"Here, the sophisticated numerical model is at one end of a spectrum of dynamical models of different complexity. All levels of modeling interact well with each other and with observations of the atmosphere to produce an evolving conceptual background. In turn this is used to aid in diagnosis of atmospheric and complex model behavior."

In other words, research is not merely “doing something”. It is an attempt to advance the knowledge base through the scientific method (i.e. hypothesis-driven investigation), by integrating multiple techniques and tools. Again: this is hard work! But, it’s well worth the effort!
Most theses will include the following components, in roughly this order:

0. Abstract
   - Defines the problem, the basic approach of the study, and key results (<1 page).

1. Introduction
   - Briefly sets up the problem and outlines the structure of the document

2. Review of literature relevant to the study
   - Not a core dump, but a focused, interpretive review of literature that specifically bears upon the study: thorough, but not “everything and the kitchen sink”
   - Brings the study into the context of a current gap in the knowledge base

3. Data and methods utilized in the study
   - Describes datasets, computations, and foundations for their use (either theoretical or from the literature), but not trivial things (i.e. “I did this with FORTRAN”)

4. Results
   - Conceivably multiple chapters’ worth, depending upon the nature of the study
   - Includes both presentation and interpretation of data

5. Discussion/synthesis of the results
   - Building upon the results section, paints a consolidated picture of the studied phenomena and compares this consolidated picture to what is known in the literature… not all papers will have this section: “Conclusions” may suffice.

6. Concluding remarks
   A. Summary
   B. Ideas for future work to follow up the study

You should write an outline first and submit it to your advisor. This outline should be detailed down to the paragraph level (i.e. one outline item per paragraph). This will provide a very concrete plan for what your thesis will look like, will make the writing flow more easily, and will help your advisor to head off problems before you’ve spent weeks writing text that you may have to redo.

A good scientific paper addresses: What’s new? How does it work? Who cares?

My expectations for your thesis:
1. Work is of sufficient quality, rigor, and novelty that it is publishable in an AMS (or other peer-reviewed) journal
2. Is somewhat conceptual (not entirely mechanical). In other words, it is not enough to have done something; you have to interpret it!
3. Writing is clear, concise, grammatically correct, and follows AMS style and format.
General comments on scientific writing that I’ve assembled over time
*(Subtitle: comments that I’ve written on papers over and over again!)*

**Content and science**

1. If you find yourself stating facts (describing numerous observations, etc.) without interpreting them, then there is a problem. Good scientific writing puts the data into an interpretive “story” about the phenomenon being studied. A sentence like “The CIN was 400 J/kg.” immediately raises the question, “So what?” Your writing should always be answering all of the “so what”s. Description of data is what figures and tables are for. Your job as a scientist is to interpret. If you are making an argument, you need to include all viable data to support that argument (check every source available and get the best that are out there). If a piece of information is not important to your argument, you may not even need to include it.

2. Remember that the reader cannot hear your thoughts. So, you need to explicitly make connections between the information you’re presenting and the argument that you’re making. A sentence such as, “The large scale environment was favorable for the development of convection” is insufficient. Why was it favorable? Large scale ascent? Ok then! And now what about this large scale environment specifically led to ascent? Answer these questions and you’ll have rich, detailed writing that fully explains the processes you’re studying. Particularly in a thesis, which is a means for your committee to assess your knowledge base, you need to make the physical links clear. If point 1 is about answering the “so what”s, then point 2 is about answering the “how so”s.

3. You don’t generally need to detail what software you used and what FORTRAN codes you wrote to manipulate data unless in doing so you modified the data (e.g. unfolding radar velocities). Otherwise, just describing the dataset and showing the plots is sufficient. Along with this, you don’t need to explain the day-by-day evolution of your thought process during your two year program: you should focus on presenting and supporting your final interpretations.

4. This error seems repeatedly to arise in various forms… there are no such things as “storm-relative vorticity” or “storm-relative vertical wind shear”. Vorticity and shear are computed by taking spatial derivatives. Adding or subtracting a constant storm motion from the wind field does not change its spatial derivatives! So, the storm-relative vorticity is simply the vorticity. The storm-relative vertical shear is simply the vertical shear.

5. Continuing with shear, we often wish to refer to the magnitude of the vector wind difference over a layer (for example, the 0-6 km shear is often represented this way). Keep in mind, however, that the units of shear are s\(^{-1}\) (i.e. a velocity divided by a layer’s depth). We should refer to the total change over a layer as the “shear vector magnitude”. So, for example, a 0-6 km “shear vector magnitude” of 18 m s\(^{-1}\) corresponds to a “shear” value of 0.003 s\(^{-1}\).

6. Motion, advection, and propagation are not the same thing. Motion is simply change in position over time. Advection is a specific process whereby the wind is acting on a gradient in order to move a feature downwind. Propagation is a specific process whereby dynamic forcing moves a feature by causing it to be
reformed or continually created in some preferred direction. A storm could be advected eastward, and at the same time be propagating southward, such that its overall motion was southeastward. The terms are not interchangeable.

7. Be clear about what you have direct evidence for, as opposed to what you infer to be occurring. If you have evidence for a process/explanation, you need to show it. If you do not have evidence, then you need to detail the concepts or prior references that support your interpretation.

**Grammar, style, and mechanics**

8. The passive voice is not required in scientific writing. In some situations, passive writing makes for nearly incomprehensible sentences. I’m all for saying things in the clearest way possible, and that often means using the active voice.

9. Along with the previous point: avoid nominalizations. A nominalization takes a verb and weakens it by turning it into a noun; you can often sniff these out because they usually also include a passive linking verb. As an example, for the simple phrase “I wrote,” a nominalization is “writing was undertaken.” Many people think this sounds “scientific”, but it’s just plain bad writing. The best approach is to express the main action in your sentence with the verb in the sentence. So, don’t use phrases like “Analysis was conducted to determine the locations of fronts”. Instead try something like “The locations of fronts were analyzed.” Or even better, if you’re not afraid of using the first person voice, try “We analyzed frontal locations.” Clear and concise!

10. We’re not interested in beliefs. Don’t use phrases like “It is believed that…” or “The author thinks that…” or any relatives thereof. Instead try something like “The data suggest that…” or “It appears that…” or “This is consistent with the idea that…” or “This supports the hypothesis that…”.

11. Don’t give commands to the reader or address the reader in the second person. In other words, avoid sentences like “Notice that the front has moved rapidly eastward (Figure 3).” or “You can see the front’s rapid eastward motion in Figure 3.” Simply present the data. Try something like “The front moved eastward rapidly (Figure 3).”

12. I prefer a scientifically rigorous style for most writing: map room lingo should be avoided. After all, we aren’t just looking for forecasting rules of thumb… we’re seeking understanding of the phenomena we’re studying.

13. “Data” is the plural for “datum”. It should receive the plural forms of verbs (“data were”… not “data was”, etc.).

14. Pet peeve(s) of mine: “Initiated” requires a direct object (what’s being initiated). For example, “storms initiated in Nebraska” is improperly formed. Either “a cold front initiated storms in Nebraska…” or “storms initiated panic among Nebraskans…” or whatever. An alternative is simply to avoid using “initiated” altogether, and to use a word like “developed instead, i.e. “storms developed in Nebraska.” The same goes for “advected”. For example, “moisture advected into Nebraska” is improperly formed. By definition, only the wind field can advect anything. The quantity of interest (what’s being advected) is the direct object. So, the normal way to form such sentences is: “moisture was advected into Nebraska…” It is implicit that the advection was by the wind.
15. Directions require suffixes when used as adjectives or adverbs. For example, “northeast” is a direction (a noun), storms are located in the “northeastern” part of a state (an adjective), and the storms move “northeastward” (an adverb). Finally, remember that an “easterly” wind is from the east. It’s generally best not to use this convention when discussing the motion of a feature. For example, I frequently see people refer to a squall line that is moving toward the east as a squall line with “easterly motion”. This is not consistent with the definition of easterly (i.e. “from the east”)… it would make more sense to use “westerly”, but many people would find this confusing. It’s clearest and best to just say that the line is moving “eastward”.

16. Use the past tense for things that happened in the past (e.g. a storm that occurred on 15 April 1997). The 15 April 1997 storm “intensified between 0000 and 0100 UTC” many years ago, so avoid using the present tense (i.e. “the storm intensifies between 0000 and 0100 UTC”).

17. Avoid personifying weather phenomena. The atmosphere doesn’t “want” to be in geostrophic balance, etc.

18. Capitalization should follow basic sentence-style, even in captions and figure titles. In other words, capitalize the first word and any proper nouns… that’s it!

19. Try to avoid long sequences of nouns. They tend to be hard to interpret. So, for example… instead of a phrase like “our MCS structure determination procedure” (that’s four consecutive nouns!), consider using a phrase like “our procedure to determine the structure of MCSs”.

AMS formatting

20. AMS style includes: a) writing out all state names (don’t use their postal abbreviations); b) using only SI units (m/s, not knots; degrees C, not Fahrenheit; hPa, not millibars); c) expressing times in UTC (the standard format would be “1900 UTC”, not “19 UTC” or “1900Z” or “19Z”). Define all acronyms at their first appearance in a paper.

21. This comes up occasionally and there may be some disagreement over it. My favorite style manual says than the indefinite article (i.e. “a” vs. “an”) before an acronym should match with the pronounced sound of that acronym when it’s read aloud. In other words, we refer to “an MCS”, not “a MCS” (the key is M=”em”). We would refer to “a TS system” (T=”tee”) but “an LS system” (L=”ell”). I believe that this is how it is always done in AMS journals.

22. For citations, a few style suggestions: a) always cite the figure/table/source within a sentence (e.g. “Clouds are cool (Parker 2006).”); not “Clouds are cool. (Parker 2006)”; b) these are people’s names you are using, so I prefer to cite them as if the information came from the authors, not the document (e.g. “Clouds are cool, as discussed by Parker (2006)”); not “Clouds are cool as found in Parker (2006)”).

Figures

23. Avoid describing the content of your figures. Use the captions to explain what is plotted, and do not restate data that appear in the figures and tables when possible. Your figures should help you to tell an interpretive story. If you spend a paragraph on things such as “The temperature at 1800 UTC was 24 C at Lincoln whereas it was 26 C at Omaha and 28 C at Topeka (Figure 7)”, you will not have
the space to discuss important processes, and you are providing the reader with information that is already available to them in your figure. Resist the temptation to use this technique to fill space!

24. Refer to figures in order. In other words, arrange your figures so that they appear in the same order that you cite them.

25. Images downloaded off the web are okay for quick and dirty analysis and class presentations, but should not be used for production figures in papers.

26. If you refer to a place name whose location is not obvious (i.e. a city or county), it absolutely must be shown and labeled in a figure so that the reader knows what you’re talking about. Do not assume that readers know where major cities are situated, or what the names of minor mountain ranges/peninsulas/etc. might be. Label them!

27. The figure’s caption absolutely must make clear a) what the figure is from (which observational dataset or which model run); b) what fields are plotted, what their units are, and what their line-styles are; c) what time the plot is valid for; and, d) the height/pressure level that is plotted or, if it’s a cross-section, what is the location of the cross-section. These are basic requirements for a usable figure!

28. In the long run, it will save you much time and effort if you have a script to create each figure in your thesis or article. Almost all figures require revision at some point along the way, and with a script it is easy to make a small change (to the caption, the shading scale, or whatever) and then remake and re-insert the figure.

29. Color is prohibitively expensive in the AMS journals, so it is a good idea to plan ahead and use an attractive grayscale for shading in figures. Keep in mind that you cannot use as many gradations of shading when you are limited to grayscale. You will need to think strategically about the key points that you want to be evident in your shaded fields.

30. If you are plotting wind barbs, the standard convention is flag=25 m/s, barb=5 m/s, half-barb=2.5 m/s. This conforms to the AMS requirement for SI units, and yet still produces something that looks like knots.

31. All words in figure titles/headers should be lowercase, with the exception of proper nouns and acronyms.

Dr. Chuck Doswell has many more good things to say. See his excellent tips for good scientific communication at:

http://www.cimms.ou.edu/~doswell/communication.html
Timeline for an M.S. thesis in 21 months:

*It can be done, but it’s not easy!*

Year 1: (heavier classwork)
- Early spring: Topic identified and explored in sufficient detail that student can give (and does give) Tuesday lunchtime seminar proposal. Appoint supervisory committee and file memorandum of courses.
- End of spring classes: Relevant literature identified and acquired for the chosen topic.
- Mid-summer: Literature reading complete (all papers understood and summarized).
  - Rough draft of literature review section for thesis. Data sources identified and methods outlined.
- End of summer: Data crunching (or modeling) has begun, and methods are refined to near-final form. Rough draft of data and methods section for thesis.

Year 2: (lighter classwork)
- Mid-fall: Data processing (or model runs) almost entirely complete, save for additional computations that may become of interest during writing. Analysis and plotting software in hand, compatible with datasets, and operating. Intensive data analysis begins.
- End of fall classes: Sufficient data analysis has occurred to identify any additional needed computations/simulations and any additional needed literature. Results section of thesis is now being drafted.
- End of January: Data analysis complete (first round). Rough draft of results section of thesis is complete.
- End of February: Additional reading and work suggested by advisor/committee upon reviewing rough draft of results section are completed. Overall interpretations mentally formed and discussed with advisor.
- Mid-March: Rough draft of synthesis/discussion section completed.
- End of March: Advisor reviews first draft of entire thesis, including abstract, introduction, and conclusions.
- Early April: Thesis goes to committee and defense is scheduled. Preparations for defense seminar commence.

In closing, a favorite quotation: “*Writing is like compounding interest.*” If you invest a little bit every day during your graduate career, you will have so much more to show for your time at the end than if you wait until you are up against a deadline and use the same amount of time to pound something out last minute. Writing now (instead of waiting) will help you to structure your thoughts as you work, often leading to new avenues of research that you might not otherwise have discovered. Indeed, it seems to me that we can’t really critique an idea until we have actually expressed it. You probably won’t keep all of the text that you’re writing as is, and that’s okay! But, you can’t move beyond it and improve upon it until you’ve actually written it in the first place. Even if (for now) it’s only a research diary in Word, get the juices flowing and get something down. *Start now!*