Proposing, Writing, & Defending an Honors Thesis in Atmospheric and Oceanic Sciences (ATOC): Student Guide

Table of Contents

I. Thesis Content and Formatting **2**
- *1. General Guidelines* *2*
- *2. Final Thesis (Defense Copy)* *4*
- *3. Archival Copy* *4*

II. Getting Started **4**
- *1. Developing a Research Question* *4*
- *2. Literature Searches* *5*
- *3. The Writing Process* *5*
- *4. Tips on Meeting Deadlines* *6*

III. Honors Thesis Defense Committee **6**
- *1. Working with your advisor* *6*
- *2. Choosing your committee members* *6*
- *3. Communication with your committee* *6*

IV. Defense Presentation **7**
- *1. Purpose* *7*
- *2. Guidelines and Formatting* *7*
- *3. Defense Agenda* *7*
- *4. Scheduling the defense* *8*

V. Honors Designations **8**
- *1. How the decision is made* *8*
- *2. Honors Council* *8*

Note: This guide is adapted from *Writing and Defending an Honors Thesis in IPHY: Student Guide* forwarded by Janet Jacobs from Dave Sherwood 11/1/2017.

I. Thesis Content and Formatting

1. General Guidelines

An Honors thesis should follow the general format of a peer-reviewed publication in your research area, but should contain a more extensive background and discussion section, as well as include justification for the formation of your hypotheses and predictions. This means that you should use (1) headers for sections and sub-headers for subsections, include an (2) abstract, (3) an introduction that ends with a clear hypothesis or question, (4) a materials and methods section, (5) a results section with figures, tables, and/or schemes, (6) a discussion section, (7) a brief conclusion section (optional), and (8) a reference list. In addition, you must include a (9) title page (see page 10 of this document). For more detailed descriptions of these sections,see below.

1) *Headers and Subheaders:* These include the names of sections (i.e., Abstract, Introduction, etc.), as well as natural subsections within those sections (e.g., Data Collection, Data Analysis, etc.)

2) *Abstract:* This is a brief summary of your research that includes 1-2 sentences of introduction, 1-3 sentences of methods, 1-3 sentences of results and conclusions, and 1-2 sentences for how the research impacts the field at large. This should not exceed one page (~250 words).

3) *Introduction:* Introduce the field that you are studying and clearly demonstrate a need for your research (i.e., an open gap or question), and tie this to a rationale for choosing your topic. The Introduction should be broader than it is in typical peer-reviewed empirical publications, and must be accessible to people who are not actively conducting research in this field, like your non-ATOC committee member and the members of the CU Honors council. You should introduce all concepts and define all technical terms and abbreviations for non-expert readers. The purpose of this section is to lead into your hypotheses and predictions, so that readers understand why you are asking certain questions, and why you are predicting certain results. Be sure to clearly state your research question including hypotheses and predictions, giving justification for why you think what you do. If you have a large amount of background information (i.e., more than 2-3 pages), provide a short general introduction ending with your hypotheses, and follow up with a Background section after this brief introduction.

4) *Materials and Methods:* This section is a detailed description of how you performed your study and how you analyzed your results. Using past tense, include everything necessary to completely replicate your experiment, from the statistical program you used to analyze your results, to the equipment used. For equipment and reagents provide the name of the company from which they were purchased and the location of the company's headquarters.

5) *Results:* Using past tense, succinctly report your results using text, figures, tables and schemes. Be sure to provide supporting statistics for the results you present. Do not discuss or analyze results further in this section! If you include figures, do not report results in legends of figures or tables or simply restate numbers and

data points. Figure captions should include a first sentence that clearly indicates what results are shown in the context of your research question, followed by a brief statement of any context for results (e.g., the treatment applied or the relationship displayed, etc.), the subjects (and sample size) studied in the experiment, a key to any abbreviations used, and statistical test annotations. Look at figures in peer-reviewed publications in your research area for examples to work from. Refer to all tables and figures in the text (e.g., see Table X), and also indicate the main "take home point" about the figures/tables in the text.

6) *Discussion:* In this section, summarize and interpret results, discuss potential strengths and weakness of the results in a constructive manner, talk about other studies that either contradict or corroborate your results, and present possible future research. Do not list your results in any detail again; you may refer to figures/tables to selected cases. Be sure to highlight how your data provides some novel insight. It is important to have a structure to your discussion; it often works well to discuss your overall findings first, and then individual findings in the same order as in the Results section.

7) *Conclusions*·. This is a brief, concise statement of the most important findings of your research and how they are immediately interesting to the audience. This section is optional, because you may be able to cover this in your discussion.

8) *Reference List.* List all previous literature/studies that you read, used and cited in your paper. You are highly encouraged to use referencing software such as Zotero, Endnote, or Mendeley from the very first draft of your thesis to facilitate this process. Do not wait to compile your reference list until the last draft! For every draft you submit, your reviewers will want to see the list of research and documents you are relying on. The purpose of the reference list is to demonstrate to your readers that you have read enough to be a credible researcher and lend credence to your study and findings. Follow the AGU format, and keep it consistent. See example below (this example shows the journal name written out. Bibliographic software may commonly abbreviate the titles, which is perfectly fine as well):

   Deng, A., and Stauffer, D. R. (2006), On improving 4-km mesoscale model simulations. *Journal of Applied Meteorology and Climatology*, 45(3), 361–381. doi:10.1175/JAM2341.1

9) *Title Page*: See the template later in this document (page 10).

You should strive to communicate information in a succinct professional writing style in your thesis, like in a peer-reviewed publication, and should not use colloquial or technical jargon. Be sure to check your grammar and punctuation! The thesis should flow from one section to another, with your introduction setting up the need for your project, your methods demonstrating how you sought to fill that gap, your results showing how said gap was addressed and/or filled, and your discussion expounding on the results and showing how your study leaves room for other studies and creates more gaps - questions - to be filled and answered. Every section should begin with "hints" that keep the reader informed about what is coming and why. For further help with your scientific writing

techniques, we recommend two specific books on the subject: "Writing Science" by Josh Schimel and "Eloquent Science" by David Schultz.

Avoid direct quotes from previous research. Instead, paraphrase ideas and give citations for all thoughts, ideas or results reported. Whenever you make a statement of fact, you must support this claim using previous research. Use in-text citations at the end of every sentence that references another scientist's work following the general AGU format; e.g., (Schmidt, 1974) or (Trenberth et al., 2009). *Et al.* (for *et alii*) means "and others" and should be used to reference papers that have more than two authors. For sentences that reference two or more papers, use semicolons to separate the references in alphabetical order; e.g., (Schmidt, 1974; Trenberth et al., 2009). Note that once you set up your referencing software correctly, this formatting task becomes trivial as you write up your drafts.

2. Final Thesis (Defense Copy)

This copy should include any and all revisions you have made, as this is the copy that will help determine your level of Honors. You will submit a hard copy of this document to the College of Arts and Sciences Honors Program, and offer a copy (electronic or paper) to each member of your committee to read thoroughly prior to your defense. Be sure to check the Honors Program deadlines for when this defense copy is due.

3. Archival Copy

This copy will be submitted *after* your defense (and includes any changes requested by your defense committee) but remember that your Honors designation is decided by your Honors defense committee based on your defense copy of thesis. Be sure to check the Honors Program deadlines for when this archival copy is due. Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm on the published date.

II. Getting Started

1. Developing a Research Question

Great research questions address gaps in the current literature, but are able to build on previous research. Some students will follow suggestions for a suitable research question/project from their chosen advisor, and later gain more independent steering of the project as they get deeper in the research. Other students may develop a research question more independently before starting their thesis research. These students should seek feedback from their advisor on the feasibility of successfully pursuing their idea as an Honors project with its limited time frame. In either scenario, several thorough literature searches (see the section below for more details) should be conducted, and attention paid to aspects of phenomena that warrant further investigation. This process will help to ascertain where the gaps are in the current literature, which ultimately makes for a more interesting and novel thesis topic. It usually takes quite a bit of reading to understand the "dialogue" that has been taking place in any sub-discipline of science, but it may help to begin your search by looking in topics that both interest you and pertain to your advisor's work. Reading recently published papers (including reviews) will show you how phenomena are currently investigated, but be sure to expand your reading frame to include classic papers in your field to understand how the scientific investigation has developed through the years. You may find a topic and read extensively about it, and find that there are a number of questions that have not been addressed. Alternatively, you may consider a phenomenon and number of questions that haven't even been explored yet. The

key to a good research question is that it attempts to describe and address a gap in the literature, but builds on previous research in a logical and creative way.

2. Literature Searches

Your literature searches may be one of the most important steps to crafting an interesting and novel study that will garner attention from your committee and the research community. After discussing possible projects with your advisor, utilize multiple online journal searches through databases (such as Web of Science or Google Scholar) to find relevant papers. It is especially helpful to find related reviews of the current literature to get a better handle on how research is being done, then focus in on relevant studies discussed in the review. Additionally, in the Web of Science, you can perform "forward" and "backward" searches for studies that are cited by, or cite, any given research article, which often helps to further direct your searches. Be sure to continually comb the literature for related papers to add to your understanding of the topic, even after you have started your work. Use the auto-update feature in the search engine to be informed about recent publications in the field. You must cite an appropriate number of references for your field, which bolster your credibility as a researcher. Strive to use both classic and newer studies to illustrate and authenticate your own research. All this will allow you to better understand your research area, grasp the meaning and importance of your own results, and compare your results with those of other authors.

3. The Writing Process

Start early! See Tables 2 and 3 for suggested timelines. Writing a thesis takes time, and should not be written in one sitting. You should begin by keeping "notes" and outlines of each section, especially of your methods, so that as you gain more information, you can then fill in your outlines with more detail. If you begin by building a logical structure of your study, with clear research questions and hypotheses, you will be able to identify those portions that "don't fit" or where further thought to fill gaps is needed. Be sure to note all assumptions or premises of your arguments, as these are of particular interest of your committee: you should have a well thought out reason for everything you do! The thesis is not just a summary of what you have seen previously, but a novel piece of your own work and ideas - these will be developed through your drafts.

It is also important to note that your thesis is typically not written about what you originally set out to find, but to describe the results you actually obtained (rather than what you might have hoped to find!). In your introduction, formulate the question you actually answered. Every section should prepare the reader to understand and appreciate the results and conclusions you discovered. If you find a non-significant result where you had expected something significant, prepare your readers in the introduction (and throughout the thesis) for the possibility that there is another phenomenon acting on the system. **Every section should contribute to a single, unified presentation of the actual findings from your study as an answer to your research question.**

You may find that working from an outline helps you develop your ideas, leads to a logical flow of those ideas, and ultimately carries your ideas towards a convincing argument. The thesis should tell one logical story, and everything in your thesis should support that story. Develop an outline of ideas that explicitly shows how your ideas are logically connected. Once you have your final outline, fill in sections as best suits you! For example, it may be best to write your Methods section as you carry out the research, such that no important details are left out. You will likely be surprised about how much time is devoted to describing how you conducted your experiment.

Additionally, before writing the Results section, remember that the goal of the thesis is to demonstrate one logical flow of information, and thus be sure to take time to carefully order all of your graphs and tables before you start writing this section.

4. Tips on Meeting Deadlines

Spend time making an initial in-depth schedule when you begin the thesis writing process, including the official deadlines from the Honors Program. Schedule personal deadlines with goals early in the semester to allow a time buffer in the event that problems are encountered, which occurs almost invariably. Try to meet with your advisor once a week, as well as consider meeting with the other defense committee members as needed for further feedback. The Writing Center in Norlin Library is also a good source for feedback on your writing. The more feedback you are able to get, the better your product will be. Record all your deadlines in a day planner at the beginning of the semester so you know what's due and when. You can revise these as needed as you go along. See Tables 2 and 3 for suggested timelines.

III. Honors Thesis Defense Committee

1. Working with your advisor

Your advisor should make himself/herself available for regular meetings with you, to answer questions and give you guidance about the proceedings of the scientific content of your thesis. Your advisor should play a key role in the revisions of your thesis and give suggestions of studies you should read to expand and broaden your understanding of the research topic. Since one of the biggest problems for Honors students is insufficient time allocated for the back-and- forth of thesis drafts between you and your advisor, be sure to check the sample time schedule found in Tables 2 and 3 (for Spring and Fall graduations, respectively).

2. Choosing your committee members

You need no less than three defense committee members: The Honors Council Representative for your department, your faculty advisor, and one outside (non-ATOC) member. You need to have your thesis advisor and your Honors Council Representative sign your Latin honors registration by the beginning of October for spring graduation or by the beginning of May for fall graduation. The outside non-ATOC member cannot be cross-listed as ATOC faculty. You may find someone with whom you've taken a class you enjoyed, or you may explore faculty members with related research interests to find someone who would find your research interesting. Your advisor may have some good suggestions. Keep in mind that your outside committee member will most likely not be familiar with your research area, and that you'll need to accommodate them in your oral defense and thesis writing by being transparent and defining all technical terms you use. You may choose to invite more than three committee members, but keep in mind that scheduling your defense may become more difficult.

3. Communication with your committee

Be respectful and punctual through email correspondence with your committee. Be sure to set up a time for your defense early in the semester, so that finding a time that works for your all your committee members is relatively easy. Give a range of dates (e.g., the last two weeks of March) and ask your committee what general time of day or days of the week would fit in their schedules. You

may want to send out a Doodle poll or use When2Meet to come up with the defense time. As the thesis defense gets closer, remind your committee of when and where your defense will be in the week of the presentation.
Remember to send your final defense copy to the whole committee *1-2 weeks prior to the defense*. Offer several different versions of your thesis (.doc, .docx, PDF, printed hard copy) and remember to request comments from your committee; the additional critique will likely help your thesis be even better!

IV. Defense Presentation

1. Purpose

The oral defense of your written thesis allows you to demonstrate familiarity with specific and broader aspects of your research area, and the ability to think critically and communicate effectively. This is not simply an overview of your thesis, but an opportunity to show the bigger picture into which your work fits, to engage in conversation about where your research could go, and reflect on research that has been done previously.

2. Guidelines and Formatting

Your overall presentation should take 30 to 45 minutes, and should generally be a synopsis of your thesis (typically using Powerpoint or equivalent). Introduce your study by giving a rationale of your work: why it matters, why you spent time researching this, what the bigger picture is. You should then give a brief summary of the methods, results and the conclusions of the study. Your methods should be described such that the audience can easily understand how you are answering your research question. Discuss any pitfall and limitations of your study, constructively - don't sell your research short, but be realistic. It is an excellent idea to practice your defense as much as possible. As you "talk it out", it is easier to identify holes in logic, reconstruct weak arguments, and doing this gives you more confidence when presenting the "real thing." You might even consider videotaping yourself to confirm that you are confident and composed while presenting. You should aim to be familiar enough with your presentation that you do not rely on slides or notes to give you the information.

3. Defense Agenda

You will set up your presentation, and greet committee members as they arrive. You will then give your 30-45 minute presentation, and subsequently engage in a period of questions and conversation about your presentation. This may take another 20 to 45 minutes. You will then be asked to leave once again, while the committee discusses, and after their discussion, you may return and pack up your laptop and belongings. The committee cannot reveal their honors recommendation to you, since the final decision is made by the natural sciences Honors Council.

Be prepared to answers questions about the following items: (1) any and all aspects of your research, especially what is mentioned in your presentation, written on your PowerPoint slides, and in your written thesis; (2) background knowledge of the main issues (found in the body of literature and sometimes textbooks); (3) relevant literature (e.g., what was known by the research community when you started, how do your results fit into the "big picture"); (4) things you may do differently if you could perform your experiment/project over again; and (5) future plans with your project or career. Previous students suggested writing a list of specific possible questions that you can prepare

to answer for your committee, to limit the number of questions that may take you by complete surprise.

4. Scheduling the defense

You are responsible for scheduling the defense with your committee members (as mentioned above), and booking a room early in the semester. Contact Laurie in the ATOC main office to schedule a room; book it for two hours to give yourself and the committee ample time. Previous Honors students recommend that you complete your defense before Spring Break (for Spring graduation), although you are free to schedule it any time before the Honors Program deadlines.

V. Honors Designations

1. How the decision is made

Your cumulative GPA suggests a specific honors designation (see Table 1 below), but the thesis and defense must earn these designations independently; written thesis, defense performance and GPA are all taken into consideration for the final honors designation. Therefore, depending on the quality of the thesis and thesis defense, a defense committee may recommend an honors designation other than what the guidelines suggest. Your committee will write a letter to the Honors Council recommending a particular level of honors, but the Honors Council has the final say on the level of honors awarded. If the recommendation is for two levels higher than the GPA, or for a split vote among your committee members, two letters must be submitted to the Honors council.

Table 1. Honors designations and corresponding cumulative GPAs.

Honors Level	**Latin Honors**	**GPA**
Honors	*Cum laude*	3.300-3.499
High Honors	*Magna cum laude*	3.500-3.799
Highest Honors	*Summa cum laude*	3.800-4.000

2. Honors Council

The Honors council is a group of faculty members representing all Arts & Sciences departments (50+, with many non-science disciplines). They make the final decision on your Honors designation. Their role is crucial when the defense committee's recommendation is not unanimous, or when the recommended designation is higher or lower than what the GPA suggests. In the latter cases, the archival copy of your thesis is circulated and leafed through by the Honors Council members.

Title of Thesis (Capitalized)

By
(Student name)
(Department), University of Colorado at Boulder

Defense Date (Month Day, Year)

Thesis Advisor (Advisor Name), Department or Program

Defense Committee: (Advisor Name with Department or Program), (2nd Committee Member with Department or Program), (3rd Committee member with Department or Program)

Table 2 Honors deadlines for Spring Graduation

Beginning of October (check Honors website for actual date)	Submit 2-page (hard copy) application to A&S Honors program (Room M400M in Norlin) with *all required signatures!* www.colorado.edu/honors/graduation
6 weeks before your defense*	Submit a working copy of your thesis to your advisor; by this time, you should have at least an outline of your thesis prepared
4 weeks before your defense*	Submit a first full draft of your thesis to your advisor, and expect there to be 2-4 renditions after this draft before your final defense copy can be submitted to the committee
At least 1 week before your defense (not including Spring Break)	Submit the final defense copy of your thesis to your whole committee.
Early April at 3:00 p.m. (this date may change from year to year. Check Honors site.)	Last day to defend thesis. Defense Copy of thesis due to Honors Program Office in Norlin (M400M) by 3:00 p.m.
About 5 days after defense at 3:00 pm (Specific date changes from year to year. Check Honors site.)	Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm.
* Recommended deadlines	

Table 3 Honors deadlines for Fall Graduation

Beginning of May (check Honors website for actual date)	Submit 2-page (hard copy) application to A&S Honors program (Room M400M in Norlin) with *all required signatures!* www.colorado.edu/honors/graduation
6 weeks before your defense*	Submit a working copy of your thesis to your advisor; by this time, you should have at least an outline of your thesis prepared
4 weeks before your defense*	Submit a first full draft of your thesis to your advisor, and expect there to be 2-4 renditions after this draft before your final defense copy can be submitted to the committee
At least 1 week before your defense (not including Spring Break)	Submit the final defense copy of your thesis to your whole committee.
Early November at 3:00 p.m. (date varies year to year. Check Honors site.)	Last day to defend thesis. Defense Copy of thesis due to Honors Program Office in Norlin (M400M) by 3:00 p.m.
About 5 days after defense (specific date changes from year to year. Check Honors site.)	Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm.
* Recommended deadlines	