



A Guide to the Junior Paper and Senior Thesis

Department of Geosciences, 2018-2019

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1 Research in Geosciences

What has controlled the history of life on Earth, and why is Earth habitable? Why are some landscapes wetter, drier, higher, lower, smoother, or more jagged than others? How does Earth's deep interior control the surface landscape? What is climate change and how do you measure it? What makes water drinkable, soil contaminated, an ocean healthy, or an air mass polluted? How do climate and geography influence human civilization, and vice versa? What is the present and future of energy resources on Earth? Here is your chance to draw on all your classroom experiences in Earth science, biology, chemistry, physics, math, and computer science to tackle a piece of the fundamental question: How does Earth work?

Your research in Geosciences will involve studying the properties of rock, sediment, soil, water, air, fossils, and/or living microbes. Such studies recently have taken Princeton undergraduates on field expeditions to Australia, the Bahamas, Bermuda, Bolivia, Brazil, the Canadian Rockies, Cyprus, Egypt, England, Ethiopia, India, the Indian Ocean, Italy, Morocco, Namibia, the subtropical Pacific Ocean, Nevada, Panama, Spain, and Utah. As a Geosciences concentrator, you will have the opportunity to probe the samples you collect



using a variety of state-of-the-art laboratory techniques, from mass spectrometry to infra-red spectroscopy, from DNA probes to chemostats, from electron microscopes to serial grinder/imagers. You will have the chance to apply a range of quantitative approaches including new computational theory and super computing. Between the faculty:student ratio of 1:1 and the time spent together in the lab and/or field, you will have an unparalleled opportunity to interact with your adviser as you conduct your independent research.

1.1 An overview of independent work in Geosciences

As a concentrator in Geosciences, during your Junior year you will write a research proposal as your Fall Junior Paper (JP) and a research paper as your Spring JP. The Spring JP either can build on the Fall proposal with the same adviser, or be completely new with a different adviser. Each JP includes a written paper and a conference-style poster presentation. During Senior year, Geosciences concentrators write a single Senior Thesis (ST) research paper, with a number of proposals and drafts due along the way. The ST can build on one or both of your JPs, or it can be on a completely new topic. The written ST report (one hard bound copy due to the Geosciences Department) is accompanied by an oral presentation at the end of the Spring semester.

In each JP and ST, you are expected to apply your experience from coursework to the generation and presentation of new scientific knowledge. You will need to develop a cogent hypothesis, collect or compile data relevant to that hypothesis, and analyze the data in a way that serves to test your hypothesis and contribute new scientific knowledge. Independent work in the Geosciences will better your understanding of the natural world around you and also will teach you to research and write as a scientist. These skills will be valuable to you whether or not you continue with scientific research after you graduate from Princeton.

1.2 What to expect from the advising of your independent work

Each student will develop a unique working relationship with their **adviser**. Therefore, it is difficult to provide a generalized description of the advising process. A professor may work closely with undergraduate students and guide their research at all stages. In other cases, a professor may work closely during the planning phases of the project, but then expect students to work under the mentorship of a graduate student or postdoctoral investigator. Alternatively, the graduate student or postdoctoral investigator may be instrumental in developing the project and plan. In some cases, students will be given considerable freedom to design and develop a research project, while in other cases, the student will be given a project closely aligned with ongoing research. If you are seeking out a specific style of mentorship, you should be sure to ask a prospective **adviser** what they envision for the project under discussion. Likewise, you can communicate with your peers who have done independent work with different advisers and get a sense of what kind of research setup would best suit you.

Despite this range in advising arrangements, the goals of independent work are the same. Within the time frame of a single JP, and across the entirety of your Junior and Senior years, you will become increasingly independent as you gain self-confidence with respect to critically reading the literature, undertaking research, and expressing your own ideas. The responsibility of the **adviser** is to nurture this process, not to tell you what to do.

You also should take advantage of secondary advisers. For example, the professor with whom you work likely has an active group of post-doctoral fellows, graduate students, and even other undergraduates. They can be invaluable resources, whether they are going over lab techniques with you, reading your drafts, or giving you feedback on practice oral presentations. In most labs, all of the researchers give presentations of their work to the entire group on a regular basis, and undergraduates are no exception. Become part of the research group, get feedback, give feedback, and your independent work will be a more rewarding experience. The **second reader (Required for Fall Semester)** of your written work also can serve as an adviser. If you take the initiative to approach prospective **second readers** early and engage them in your research, you are more likely to receive valuable scientific feedback and mentoring.

The most important thing to realize about your independent work is that you, and no one else, are responsible for your JP/ST research. Your faculty adviser will have many students and responsibilities. Although they will try hard to keep an eye on you and your progress (and you should meet with them at regular intervals), they will not be able to chase after you to insure that you get your research done. Students who stay active and engaged will get a lot of help and attention. Students who do not put in the effort will get little help and have much less to show. Princeton is unique in its commitment to undergraduate research, so take this opportunity to work with some of the best scientists in the world and you will treasure this experience when you look back on your time at Princeton.

1.3 Expectations and responsibilities in a digital age

Whether working on a JP or ST, you will want to consult the archive of previous student work. You should take advantage of archived theses to explore research topics, gather ideas for possible faculty advisers, find references, gain familiarity with disciplinary writing styles, and develop methodologies for your own independent work.

The University keeps print copies of the most recent 3-4 years of natural sciences Senior Theses in the stacks in the Fine Hall Wing of Lewis Library (the first books shelved on the left, in alphabetical order by department, then by year and author). If you are looking for a specific ST and are having trouble, please contact **Scott Sibio** in **Lewis 204** or **Louise Deis** in **Lewis 211**.

Alternatively, you can access senior theses digitally. The [Mudd Library](#) archive holds more than 63,000 senior theses (ST) submitted on paper prior to 2013. Starting with the Class of 2013, the library also hosts original thesis PDFs and makes them available through Princeton's digital repository, [DataSpace](#).

1.3.1 Be aware that your work will be published online

In partial fulfillment of your ST, you will be required to submit a PDF of your complete senior thesis to the Department of Geosciences for inclusion in the Princeton Digital Senior Thesis Archive. The Princeton Digital Senior Thesis Archive is housed within the [DataSpace](#) database, just like Ph.D. theses. Your ST PDF will be downloadable by anyone with a Princeton login. Non-Princeton users must request and pay for Senior Thesis PDFs. The metadata that are publicly available from [DataSpace](#) and visible to online search engines include your name, ST title and abstract, class year, and ST adviser. The University does not archive digital JPs (yet).

The Department of Geosciences also will host a page listing your name, title & adviser of JP/ST, three keywords relevant to your JP/ST, and your faculty adviser's name. Each listing will be linked to the full PDF of your JP or ST. Therefore, the Geosciences webpage will make access to both your JPs and ST even easier for the general public. However, you may choose to opt out of posting the PDFs to the Geosciences website. If you do opt out, only the metadata common to [DataSpace](#) will be published online.

The primary purpose of these digital archives is to provide the Princeton University community with unprecedented access to your independent work. This increased accessibility brings useful and gratifying exposure to your research. Your work will provide subsequent generations of Princeton undergraduates with examples of research topics, writing style and thesis organization. Allowing students and faculty to search and examine your thesis may save someone the time of repeating your experiment and/or may inspire further research. The results of such sharing are in the spirit of scientific method and will benefit research on a potentially large scale. However, it is important for you to be aware of both the positives and negatives of online publishing. Because the Princeton community will have access to your thesis, it is entirely possible that the PDF of your ST ends up floating around the internet like a photo you posted on Facebook. Someone could find your ST and run it through a plagiarism checker like [turnitin](#). A future employer could examine your ST and judge you based on the quality of your work, or on the viewpoints you expressed in your thesis.

These warnings are not meant to scare you. Rather, this information is meant to better prepare you to write your JPs and ST with academic integrity. As you work on your JPs and ST, carefully consider the quality of your work and your use of previous publications in light of the fact that your JP or ST may find wider circulation than your faculty adviser and second reader. These are lessons that, whether you continue in science or not, are important

for any information you might put online.

2 Important Deadlines for Juniors and Seniors

Table 1: Important deadlines for Juniors (and Sophomores)

Sophomore Year	Due Date
Shop for a JP project [†] Apply for summer internship (PEI) [†] JP summer funding Proposal due to SAFE [†] optional	Throughout Spring semester January 2019 March 1-28, 2019
Junior Fall Meet with your assigned UWC adviser Fall JP mini-Proposal due to SAFE JP progress report PDF due BB * Designate Second Reader Final JP written report PDF due BB Junior Poster PDF due BB Junior Poster Presentation	On or before September 21, 2018 October 1, 2018 December 4, 11:50pm December 4, 11:50pm January 8, 2019, 11:50pm January 10, 2019, 11:50pm January 14, 9:00 AM, Great Hall
Junior Spring Meet with your assigned UWC adviser Spring JP mini-Proposal due to SAFE JP progress report PDF due BB Final JP written report PDF due BB Junior Poster PDF due BB Junior Poster Presentation	On or before February 8, 2019 February 22, 2019 April 2, 11:50pm May 7, 11:50pm May 9, 11:50pm May 13, 9:00am, Great Hall

2.1 Uploading your document as a PDF

In **Table 1 & 2** you will notice that for each JP or ST assignment (except for the **SAFE** proposals where you ask for money) you must submit a single PDF document (no secondary files or other file formats are accepted). ALL JP/ST mini-proposals must be submitted to **SAFE**, (if you do not require funding, put \$1.00) while all other JP **deliverables** (i.e., progress report (Fall and Spring), final written report (Fall and Spring), and Poster (Fall and Spring)) must be uploaded to the appropriate assignment on the **GeoJuniors Blackboard** organization page in which all Juniors are enrolled. The ST proposal must be submitted to **SAFE**, while all other ST **deliverable** (i.e., progress report (Fall), rough draft (Spring), final written report (Spring), and slide show

Table 2: Important deadlines for Seniors (and Juniors)

Junior Year	Due Date
Shop for a ST project [†] Apply for summer internship (PEI) [†] Apply for ST summer funding (SAFE) [†] optional	Throughout Spring semester January 2019 March 1-28, 2019
Senior Fall	
Meet with your assigned UWC adviser Attend ≥3 Departmental Seminars ST proposal due to SAFE & Designate Second Reader ST progress report PDF due - BB	On or before September 21 Tuesdays, 12:30–1:30pm October 1, 2018 December 14, 11:50pm
Senior Spring	
Attend ≥3 Departmental Seminars ST Rough Draft PDF due - BB ST final written report PDF due ST slide show PDF due ST oral presentation ST GEO Final Bound Copy	Tuesdays, 12:30–1:30pm April 01, 11:50pm April 19, 11:50pm May 8, 11:50pm May 10, 9:00am May 1, 2019

(Spring)) must be uploaded to the appropriate assignment on the **GeoSeniors Blackboard** organization page in which all Seniors are enrolled.

3 Junior Independent Work

3.1 How do you choose a topic to research?

The most important thing to remember is that this project may be longer and require more independence than anything you have worked on before – so choose a topic that excites you.

There are many ways you can discover a topic you are passionate about. While a sophomore, start attending the Junior Colloquium (Section 3.4) to meet Professors and find out what they are working on. You also should attend the JP oral presentations and Senior Thesis defenses of your peers, in part to get a sense of what will be expected of you. In a perfect world, by Spring semester of your sophomore year, you already will have taken at least one Geosciences course and will have a rough sense of what topics you might like to research during your junior year. Search the **Independent Work Shopping Guide (IWSG)** for projects that sound interesting, set up meetings with professors whose research looks appealing, and consult the faculty and graduate students teaching your courses. If you want to get a head start on research, you might find an opportunity as an intern or lab/field assistant during

the summer before junior year (see Section 6). These opportunities would allow you to learn skills and potentially to conduct research relevant to your JP.

3.2 Your Adviser

You will be assigned a curricular adviser who is a faculty member and part of the Undergraduate Work Committee (UWC) at the end of your sophomore year. For students who do not already have a JP adviser, your assigned UWC adviser is the first faculty member with whom you discuss JP ideas. You are required to schedule a meeting with your UWC adviser during the first two weeks of the Fall semester of junior year (Table 1), and you should come to that meeting having studied the Shopping Guide and taken some notes about the type of project you would like to do for your first JP (ideally you should begin this exploratory process before the start of the semester). Your UWC adviser will help recommend JP advisers whose research projects most closely align with your interests.

3.3 Your Second Reader

While your JP adviser will be your primary resource, **you must designate a second reader (Fall Semester Only)** who will help evaluate your JP. Normally, the second reader is another faculty member in Geosciences with overlapping interests. However, if some aspect of your project could benefit from the expertise of a faculty member in a different department, you may request permission from your JP and UWC advisers to engage them as a second reader. The sooner you engage a second reader in your project, the more useful and timely the feedback will be. You must have a confirmed second reader on or before the due date for the JP progress report (Table 1).

3.4 The Junior Fall Colloquium (JC)

A colloquium is organized during the Fall semester of the Junior year to introduce you to the department faculty members and their active areas of research in geosciences. Each week on Monday during lunch time (12:30–1:20pm), one faculty member gives an informal lecture on his/her research, invites questions and discussion, and suggests potential student projects for the Spring semester. Lunch is provided. A short reading assignment will be provided one week ahead of each meeting, and all juniors are required to attend the Junior Colloquium. This colloquium is your chance to get to know some professors, pepper them with questions, and brainstorm about potential JPs.

3.5 What are your research goals as a Junior?

(A) *Master the relevant background literature that sets the scene for and motivates your project*

Ask yourself, “how can I convince the reader that my research topic is important for them to understand?” Then, use information from the background literature to support your claims about why your research is relevant and important.

(B) *Develop a testable hypothesis*

As you read articles in your field of interest, you will be asking yourself questions constantly. Some of those questions will be easy to answer by reading the next paper. Some of the questions will be impossible to answer using only the data that you could collect during the short time span of a JP. And some of the questions will form compact, interesting, and testable hypotheses that you can support and refute with data you collect or compile yourself – these questions are the ones you will want to pursue and refine.

(C) *Learn how to collect data*

Your JP cannot be a literature review alone. One of your primary objectives should be to learn to work with data. Even for your Fall JP (a proposal), you’ll need to demonstrate that you can find appropriate data to test your hypothesis as a proof-of-concept. Data could be published by previous researchers and found online. Data could be collected during your own experimentation in the laboratory. Data could be generated by numerical models. Or data could be original observations you make in the field. Most importantly, the data needs to bear directly on your hypothesis and be in a form that can be analyzed quantitatively (i.e., the data should be numerical and digital).

(D) *Learn how to analyze data*

Whether you are writing a proposal with some bare-bones proof-of-concept data, dealing with a large quantity of data that you compiled from an external source, or you have just tens of hard-won data points from a challenging lab experiment, it is difficult to craft defensible arguments without some form of graphical data visualization and statistical analysis. You will want to familiarize yourself with software like Microsoft Excel, MatLab, R, and/or ArcGIS, depending on the nature of your data and the hypothesis you want to test. For at least some software (e.g., [MatLab](#), [R](#), [Excel](#), and [ArcGIS](#)), there are numerous online resources, classes, and campus workshops available to help you learn about techniques and software for data analysis.

(E) *Learn how to discuss your results*

For your Fall JP, your primary goal will be to discuss the strengths, uncertainties, and shortcomings of the data you are proposing to use to test your hypothesis. For your Spring JP, once you have spent a couple of months collecting and analyzing data, your challenge will be to distill your work into just a few key results that are most relevant to your hypothesis – less is more. Often, the greatest challenge is being willing to let go of some of the hard work you have done when an experiment does not work and a line of inquiry ends up being distracting or irrelevant.

(F) Learn to turn your prose into scientific writing

Scientific writing differs in style and form from the writing you may have learned in the Social Sciences or Humanities. Whether it is the structure of your paper, the use of figures, or the proper citation of peer reviewed work, you will learn to write a scientific paper by reading other scientific papers, using the JP/ST template, engaging in peer review with your classmates, and going over drafts with your adviser. You also should consult the specialists at the [Writing Center](#) housed in Whitman College (Baker Hall). The [Writing Center](#) offers one-on-one conferences with experienced fellow writers and special 80-minute conferences with Geosciences graduate students for JP writers.

(G) Learn to present your work in a poster to a broad audience

Perhaps as important as a scientist's written work is their ability to present the research visually and orally to a broad audience, from experts to interested lay people. As with your written discussion section, one of the most difficult tasks you will confront is being willing to set aside a large proportion of your hard work in order to focus on presenting just the most relevant information and salient results of your JP. For both your Fall and Spring JPs, your oral presentation will be in the form of a poster. As with your writing, you will have the chance to work closely with peers and your adviser's group to hone your poster presentation skills.

3.6 JP Deliverables

Each component of the JP is described below, and associated grading rubrics are provided in [Appendix B](#).

3.6.1 Mini-Proposal

In both Fall and Spring, your JP begins with a mini-proposal ([Table 1](#)). The primary goals of the mini-proposal are to (1) convince your JP adviser and the UWC that you have found a viable project to work on and (2) to secure funding for your research. Tips for writing

and submitting your mini-proposal can be found in [subsection 6.4](#). Unlike the other JP deliverables described below, the JP mini-proposals must be submitted to [SAFE](#).

3.6.2 Progress Report

The written JP continues with a progress report, due as a single PDF document **uploaded** to the [Blackboard](#) Organization called **GEOJUNIORS** by 11:50 pm on the first Tuesday of December for Fall JPs and first Tuesday of April for Spring JPs ([Table 1](#)). The progress report is a first draft, and should be rendered using the JP/ST template in either [L^AT_EX](#) or [MSWord](#) format. Just like the final draft of your JP, the progress report should include Title, Abstract, Acknowledgements, Table of Contents, List of Figures, List of Tables, Introduction, Methods, Results, Discussion, Conclusions and References sections. In the JP progress report, some of these sections may be incomplete. However, the Abstract should have a concise statement of your hypothesis, the Introduction should have accurate citations, and the body of your paper should demonstrate that you are well on your way to a final product. The progress report is your best chance to get detailed feedback from your adviser and second reader. Based on that feedback, you will be encouraged to make revisions (big or small) to your original hypothesis.

3.6.3 Final Written JP

The JP must be \leq 2500 words (not including figure captions or references) and is due as a single PDF document **uploaded** to the [Blackboard](#) Organization called **GEO JUNIORS** by 11:50 pm, please review [Table 1](#) for dates. While your grade will be reduced if you exceed the word limit, you will not be penalized for a shorter paper. In fact, a thoughtful, well-organized and concise JP that is short always will be better received than a verbose, poorly organized document in which the text is repetitive or you try to fit in everything. You must utilize the JP/ST template in either [L^AT_EX](#) or [MSWord](#) format. Read the template carefully as it contains useful hints and examples for the structure and contents of each section.

Tips for your Final Written JP:

- **Abstract:** Your abstract should be less than 250 words and contain no references. The abstract should summarize objectives, methods, results, and conclusions. Most importantly, the abstract should contain your statement of thesis as a single concise and exciting sentence.
- **Acknowledgements:** Whether it was a librarian, a funding source, a lab technician, a parent, a friend, or an adviser, make sure you acknowledge those who helped you along the way.

- **Introduction:** The introduction should convey the purpose and scope of your study. The introduction also is where you include relevant background text (bolstered by appropriate citations to peer-reviewed sources) and figures that give the reader the necessary context to understand the importance and meaning of your study. For example, the introduction might contain a map depicting the sample locations and/or a graph summarizing relevant data compiled from other publications that help to motivate your study.
- **Methods:** The methods section should describe how you conducted field work, how you collected samples, how you designed lab work, how you developed code, what analytical methods you employed, etc. For example, if you collected GPS data, you would describe what type of electronics you used, how you designed your sampling, and how you measured the accuracy of individual measurements. You would accompany this information with a table or graph depicting, for example, the reproducibility of GPS measurements from identical physical locations at different times. As another example, if you were modeling the strontium cycle in the ocean with a set of mass balance equations, you would explain how you chose to simplify the system (what variables are you treating as constant, etc.), and you would include a table that listed names and values for all the model variables. If you were conducting a lab project, you would describe the experiments in enough detail that other scientists could reproduce your work.
- **Results:** The Results section will contain the bulk of your tables and figures, describing and illustrating the data you collected for your project. It is impossible to overemphasize how important your illustrations are. Invest significant effort into making clear, intuitive, insightful figures with descriptive captions and easy-to-read axis labels and annotations. The reader should not have to decipher why you included a figure, and all figures must be referenced within the text of your paper.

Do not interpret your data in the Results section. For example, let's say you collected information about the minimum ejecta thickness around a ~ 2 km diameter bolide impact crater in India. You would collect these results in a figure (or two), and include text describing the nature and distribution of the data, but you would avoid discussing the significance and meaning of these results until the Discussion section.

- **Discussion:** The Discussion section is where you have the chance to interpret the results you just reported on. Additional figures to illustrate your interpretations are useful. For example, you might compile your data with data from other sources, fit a model to these data, and point to such figures to challenge existing hypotheses or generate new big-picture ideas.
- **Conclusions:** Unlike the Results, this section should be a clear statement of the major conclusions you have drawn from your work. The conclusions should follow clearly from the Results and Discussion sections.

- **References:** Include a complete list of references that you have cited within the sections above. Follow the [bibliography guidelines for Geophysical Journal International](#), or use the bibliography style file (gji.bst) included with the [L^AT_EX Senior Thesis template](#). It is very important that your references are relevant, appropriately cited, and from peer reviewed literature (not Wikipedia). It is not okay to have improperly formatted references.

3.7 How is the written Fall JP different from the Spring JP?

The Fall JP is a proposal, while the Spring JP is a research paper, but the two different reports have the same section headers listed in Section 3.6.3 and are not as different as they sound.

In the proposal (Fall), your goal is to convince the reader that you are (1) asking an important question and (2) can do the work. For (1), you will need to review the literature to contextualize and justify a strong and original hypothesis, in a similar way that you would for a research paper. For (2), you will need to lay out the methods you propose to use, generate proof-of-concept data, and discuss the uncertainties you expect to grapple with once you have your results. It is reasonable to expect that your Introduction section may be longer, and your Results section shorter for the Fall JP than for the Spring JP. But ultimately, the proposal will be your opportunity to explain to the reader how you will collect your data, and specifically how you will use those data to test your hypotheses. The feedback you receive on your Fall JP will shape your approach to the Spring JP. **Remember to designate a Fall Second Reader.**

In the Spring research report, your goal is to (1) analyze your data to tell a coherent geoscientific story and (2) discuss the uncertainties in your data and analysis. Some of you will choose to write their Spring JP on the project they proposed in the Fall, while others will choose to start a new project. Either approach is fine. The feedback you receive on your Spring JP will shape your approach to the Senior Thesis.

3.8 Poster Presentation

For each JP, you will give a poster presentation. Your poster should be 24" high by 36" wide. You will stand by your poster in the Great Hall, presenting your results to Geosciences faculty and students. Target your presentation to a broad audience of scientists, not just your adviser. You will be assigned faculty members (not including your adviser and second reader) who will be responsible for examining your poster, asking you questions, and evaluating your work. A PDF of your poster must be **uploaded** to the **Blackboard** Organization called **GEO JUNIORS** refer to Table 1 for the due date (**Table 1**); Late uploads will be reduced by one full letter grade or

will receive an incomplete, depending on whether the poster can be printed in time). Posters will be printed by Geosciences staff.

Tips for your Poster Presentation:

- Create your poster in Adobe Illustrator, MS Powerpoint, Apple Keynote, OpenOffice Impress, LaTeX, or any other software that allows you to export (or “print to pdf”) your poster as a single PDF document. Be sure to change the document size to 24”H x 36”W (landscape format) in the “document setup” or equivalent menu.
- Your poster should include Title, Introduction, Methods, Results, Discussion, Conclusions and References sections, very similar to your written JP. Likewise, your hypothesis should be concise and clearly stated on the poster. The big difference here is that text should be kept to an absolute minimum in your poster (no large blocks of text, and use large font sizes). For example, your Introduction should present the question you are asking and why it is important with just 2–3 sentences (just enough to get the reader interested). In the Results section, you should present only your most interesting data that you would like to focus on in your presentation. You will want to avoid trying to present too much material. You will want your audience to walk away from the poster having understood and gotten excited about just one or two key ideas.
- You should feel free to adopt any [layout](#) that you find effective. Be sure that the information flows, from panel to panel, in an obvious order that your reader can follow.
- Practice presenting your poster beforehand (many times). You will want to be able to be clear and concise as you discuss your JP. You do not want to just read your poster to the audience, nor do you want to stumble over verbose explanations. Practice with your peers, your research group, and your adviser, and as you do so, prepare for the questions you might receive.

4 Senior Independent Work

In many ways, the Senior Thesis (ST) is a more in-depth, more substantial and more polished Spring JP, spread out over an entire year. The deliverables are similar: A mini-proposal, a progress report, a final written report (≤ 6000 words (If the nature of your project is such that it requires an extension to the word count, permission must be sought from the UWC three weeks in advance of the submission deadline), and an oral presentation ([Table 2](#)). The rough draft is the only required part of the ST that is not part of the JP. As with your JPs, all ST deliverables must be [uploaded](#) to the appropriate assignment on the [GEO SENIORS Blackboard](#) page as a single PDF document. Basically, the idea is for you to draw on your experience from both JPs to help you craft a spectacular ST project. Grading rubrics for the ST are available in [Appendix B](#).

4.1 Oral Presentation

At the end of the Spring semester (Table 2) you will give an oral presentation on your ST. The presentation will be delivered to the faculty and students in the Geosciences Department and should be targeted at a broad audience (not just your adviser). Your presentation will be considered the defense of your Senior Thesis. A PDF of the slide show must be **uploaded** to the **Blackboard** Organization called **GEO Seniors** by 11:50 pm on the day before the presentations (Table 2; Late uploads will be reduced by one full letter grade or will receive an incomplete, depending on whether the PDF can be setup on the departmental laptop without delaying the other presentations). The Undergraduate Coordinator will upload the PDF files to the departmental laptop in time for the presentations the following morning.

Tips for your Oral Presentation:

- Create your presentation in MS Powerpoint, Apple Keynote, OpenOffice Impress, L^AT_EX, or any other software that allows you to export your slide show as a single PDF document.
- Remember that your audience is composed of specialists, geosciences faculty and students, non-scientists and parents. Your talk needs to be accessible and interesting to everyone.
- Avoid the temptation to include too much material. Concentrate on getting your main points across (this is all your audience will remember after they listen to a half-day of presentations). A good rule of thumb is 8–10 slides for a 10-minute talk, but this number will vary (some slides may require 2–3 minutes; others 20–30 seconds).
- Think about what you would like to say as you prepare your figures, and use your figures as a guide to help you through your talk. You want to minimize the amount of rote memorization or “note cards” required. If you have to say a lot that is not directly related to the figure on the screen, then you have not done a good job preparing your slides.
- Make text readable from the back of the room, even on axis labels and figure legends.
- Normally font sizes of ≥ 16 are recommended. Figures originally formatted for a written paper often are not readable when projected, so reformat accordingly.
- Avoid an abundance of “text-only” slides. Such slides put the audience in the position of having to decide whether to read them or to listen to you read them.
- Present your adviser with an anticipated outline for your presentation. He/she has many years of experience in giving short talks, and probably has a good view of the “big picture” context surrounding your work (hopefully by this point you do as well).

- Attend as many Departmental Seminars as you can to pick up oral presentation tips and broaden your geosciences knowledge.
- Practice your talk beforehand (many times). In a 10-minute talk there is little margin for hemming and hawing. Practice with your peers, your research group, and your adviser. This point cannot be emphasized enough. Even the faculty at Princeton, having given umpteen oral presentations, still benefit from practicing their talks a few times before standing in front of an audience. These practice talks also will prepare you for the types of questions you likely will receive. The authors of this guide have given more than one-hundred 10–15 minute talks, and they still practice each talk 2–5 times prior to delivery.
- A clear distinction should be made between the background material and the work you have conducted (for the benefit of those not directly involved in advising). Feel free to use figures from relevant publications, as long as you cite them appropriately.
- Include a “conclusions” slide at the end of your talk in order to ensure that the audience is clear about your take-away message.

4.2 Senior Thesis Writing Support

The Senior Thesis Writing Group is an important additional resource that supports seniors writing their ST. Composed of three [graduate student representatives](#), the Senior Thesis Writing Group meets throughout the year and is designed to complement the individual guidance students receive from their advisers. The group helps thesis writers learn the methods and expectations of research and writing in the geosciences, conducts skill workshops for software like L^AT_EX and MatLab, provides practical guidance for tackling big research projects, and establishes communities of writers for support and feedback.

The [Princeton Writing Center](#) offers free one-on-one conferences with experienced fellow writers trained to consult on assignments at any stage of the writing process. Special 80-minute conferences are available for JP and ST writers, who may sign up to work with a graduate student fellow in their department or neighboring discipline. Schedule online [here](#).

In collaboration with the Director of Undergraduate Research, the Residential Colleges, and departments across campus, the [Writing Center](#) also offers a variety of workshops, events, and peer review groups for juniors and seniors throughout the year, including the popular boot camp series. These programs help JP and ST writers learn the methods and skills they need for projects in their field; provide practical guidance for tackling big research projects; and establish communities of writers for support and feedback. Starting in September, the latest information on upcoming events will be found [here](#).

5 Top ten things you should know before you start your ST (or JP)

A few graduated seniors have provided a retrospective on the top ten things they wish they knew before they started their independent work. Perhaps you already figured out many of these things while working on your JPs. When working on your Senior Thesis, you should follow the same tips and guidelines presented in this guidebook for JP work, while at the same time keeping these additional tips in mind.

1. Meet with prospective advisers as early as possible (you can start Freshman year, but no later than Spring term Junior year). Do not be afraid to ask questions. Pepper prospective advisers with questions about projects and expectations until you zero in on a topic you want to devote yourself to. But do not pick a thesis topic just because the peripheral bits are interesting (cool field work, good adviser, etc.). You have to love the core topic, or it will be a long nine months. Good for you if the extra stuff is fun too, but it's hard to get motivated to work when the actual science is not interesting to you.

When picking a JP or ST topic, find out what kinds of tasks will be the bread and butter of the project, and what background is necessary. Will you be doing lots of chemistry in a lab, programming on a computer, and/or gathering data from the literature? Then, ask yourself if you think you might enjoy this kind of work and if you have the skills to do such a project. For instance, if the project requires a great deal of programming, but you do not have any experience writing code, will somebody (a professor, postdoctoral fellow, or graduate student) be available to teach you?

2. Make a commitment. Research takes time. You need to be sure that you can set aside a couple of hours on a daily or every-other-day basis for independent work. A good test to see if you'll be overcommitted – see how busy you are at the beginning of the semester, before your coursework has really ramped up. If you are sitting around feeling like you could comfortably take another class or two, you probably have enough time to dedicate to independent work. Otherwise, you might want to cut back while you still can. Ever heard “Do a little work each day and you'll finish on deadline?” It turns out you actually have to do a lot of work each day – it is easy to lull yourself into a false sense of productivity if you've only completed a little work in a day. It's better to set long-term deadlines and break down the steps to meet those deadlines. That way, you'll know in advance if you're ahead or behind.
3. Stay motivated. Research is the study of the unknown, and as such, the path to success is not always clear. You'll make many, many false starts before getting anywhere. But false starts are not time wasted, because you always learn something, and hopefully your frustrations will be tempered by some successes too.

4. Make friends with the people in your lab group – graduate students, postdoctoral fellows, lab technicians, other undergraduates, etc. Since you likely will be spending many hours with this lab group, a good way to make those hours more enjoyable is if you are friends with the people around you.
5. Ask for help. Don't know how to use that expensive-looking, delicate piece of equipment? Ask. Your fellow lab members hold a wealth of information and experience you should take advantage of. A nice perk of being an undergraduate is that you can ask basic questions and not feel dumb, as you're the least trained in the lab in terms of formal education. You may feel like a leech at times – that's okay. More often than not, your lab mates are happy to help. Also, people in academia usually are more helpful than you expect. If you are having trouble tracking down the source code for something, or a digital data set described in the paper, try contacting the author. They may be happy to help. That said, people in academia also are more busy than you expect. Do not waste anyone's time if you just did not read the paper thoroughly enough.
6. Respect those around you. Remember that people are taking time and energy away from their own work to help you out. Always come prepared to meetings with your adviser with questions ready and any results presentable for discussion. Feel free to ask questions about things that you don't know and have not been told – no one in the Geosciences department will bite your head off for asking a question! However, don't ask the same question multiple times of the same person. If someone explains a procedure to you, write it down.
7. It is almost always worth spending time upfront to make a process simple and automated so that it is quick and accurate every time you need it in the future. Often, the learning curve is steep at first and you will question the time investment. However, if it is a task you will be repeating, or one you think you will do again in the future, the upfront investment usually is well worth the time. Here are just a few examples:
 - Invest time in bibliography management. Store all the documents you read as PDFs on your computer. Keep a [BibTeX](#) or [EndNote](#) database of each bibliographic entry for the articles you read. Know how to call this database from your text editor so that your citations always are properly formatted and complete. Keep digital notes about each article ([Papers](#) is an expensive but nice option; [Mendeley](#) is free solution).
 - A thesis has many sections and often grows to monumental size. Typesetting software such as [L^AT_EX](#) will make your life harder at first, and then hopefully much easier later when you are compiling a large collection of text, figures, tables, and references into one big document. Geosciences even provides you with a [L^AT_EX thesis template](#) to get you started.
 - Figures, figures, figures. Many scientists prepare the figures first and then write the paper around them (one big thing that differentiates science writing from other

writing styles). Whether the figure is setting the scene for your project, plotting your data in an interesting way, or depicting the results of a model, how well you execute the figures may make or break your thesis. To generate publication quality figures, you will need to invest time in software. First, to model and plot your data, software such as [MatLab](#), [R](#), and [GMT](#) will provide you an infinite array of improvements and additional plotting/analysis options over [MS Excel](#). Next, when you are building figures with multiple graphs, images, and annotations, you will want to employ software like [Adobe Illustrator and Photoshop](#) (or their open source equivalents, [Inkscape](#) and [Gimp](#)).

- Keep a lab notebook that chronicles your experiments, thoughts, and even daily activities. There may come a point when you realize that something's gone wrong and you need to retrace your steps back through a code or a lab experiment to a midway point. Also, your notebook is like a science diary. You might be surprised how a few remarks about a lunchtime discussion with peers might inspire a new line of inquiry weeks later when you are going through your notebook. Furthermore, when you write down things you learn, you will not need to ask about them again.
 - Keep your data organized. Whether you are slowly collecting your own lab results, or compiling thousands of data from an online repository, it pays to put the time into creating a consistent and well organized spreadsheet.
 - **BACKUP.** By the time you are reading this guide, no professor will take "my hard drive crashed" as an excuse for lost data or writing. So from the start, invest the time in setting up a foolproof backup system. Each day, photograph new pages in your lab notebook and compile the images as a single lab-notebook-PDF. Save all your files (data, code, analysis, writing, figures, etc...) not only to your laptop, but also to all of the following: a lab computer, a cloud service like [WebSpace](#), [DropBox](#) or [Google Drive](#), and at least one external hard drive that you store in your room or somewhere that you do not normally store your laptop.
8. Have confidence in your own ideas. Just because something is published in a peer-reviewed paper does not mean that it is true. I have read many papers that convincingly argue both sides of a topic. Do not be afraid to pose a new idea or dispute an old one. You might be right or you might be wrong. That is science.
 9. Budget more time than you think you'll need. Almost always, lab procedures, code writing, figure making, etc. will take longer than you think they will. Something will go wrong and you'll need to start over. If you don't want to be constantly scrambling to race the clock, take the time you think the task will take, multiply by 2, and you should have a safer and likely more accurate estimate.
 10. Have fun. Don't get too caught up in experiments or code that don't work or the hours and hours you spend in lab. Relax, remember the broader view, and enjoy the ride. Your senior thesis at Princeton is a once in a lifetime opportunity.

6 Funding Opportunities

Three types of funding can benefit you during your independent research at Princeton:

6.1 Summer Internships

Summer internships are not designed explicitly to fund JP/ST work. In fact, while nearly all internships will provide training and experience that will be useful for your future research, they may not give you the opportunity to collect/analyze your own data for use in a JP or ST. However, some internships will provide you the opportunity to conduct JP or ST research, so be on the look out for those opportunities.

The [PEI/Grand Challenges Internship program](#) is open to all Princeton freshmen, sophomores and juniors with interests in topics broadly related to the environment, regardless of academic concentration. Frequently, Geosciences concentrators find JP and ST summer research opportunities as PEI interns.

The Princeton Environmental Institute hosts an informational session in December and/or January. The deadline for priority applications for established internships is in January ([Table 1 & 2](#)), and admissions are rolling. The final deadline for a PEI internship application is March.

6.2 Summer Independent Research

Whether you are just finishing Sophomore year and looking for a first JP research experience, or you are looking to fund an ST project, all summer independent research funding requests must be submitted through the Student Activities Funding Engine ([SAFE](#)). Funding proposals for the Department of Geosciences must be uploaded through [SAFE](#) in March ([Table 1 & 2](#)). In general, funding rarely exceeds a total of \$5,000, so be sure that your proposal is realistic. You are encouraged to talk to your JP/ST adviser about what would be a suitable amount. Nearly all Geosciences concentrators apply for summer funding for their ST, and many write proposals for their Fall JP.

6.3 Academic Year Independent Research

You have two opportunities to apply for funds to support research during the academic year. Proposals for ST and Fall JP work are due to [SAFE](#) by October, and proposals for Spring JP work are due to [SAFE](#) in February ([Table 1 & 2](#)). These mini-proposals

(Table 1 & 2) are not optional (even if you are not applying for any money), and they will be evaluated by your JP/ST adviser and the UWC as the first component of your written grade.

6.4 Tips for writing a proposal and submitting it to SAFE

Regardless of whether or not you already have funding or do not need funding, you must write a mini-proposal. It is impossible to emphasize enough how important it is to craft a well-organized, clearly written, thoughtful, and appropriately structured mini-proposal. Your proposal should include an abstract that is 1-2 sentences of motivation, 1 sentence of hypothesis (what question are you asking? what might you see given your new approach and/or new data). 1 sentence of how you will test your hypothesis (i.e. what are you going to do for your JP?). For you, the proposal helps get you started on your project, solidify your hypothesis, and identify any weak ideas and poor strategies. For your adviser, the proposal helps him/her determine if you are ready to embark on your independent research. Your proposal cannot just convince someone to give you a good grade, it has to convince someone, who is balancing the needs of every other student, that they should give you money. When preparing a mini-proposal, you want to make it easy for your adviser, the undergraduate work committee, the Office of the Dean of the College, and/or Princeton Environmental Institute to decide in your favor.

6.4.1 Project Details

- *Activity:* Here you write ‘Independent Projects’ if you are applying for JP funding, or ‘Senior Thesis Research’ if you are applying for ST funding.
- *Title of Project / Thesis Topic:* Your title should be catchy and informative, accurately describing your proposed project.
- *Start Date / End Date:* Always make your **Start Date** is after the proposal deadline. For example, if you are applying for ST funding on October 15, you could make your **Start Date** October 24. If you input a **Start Date** that occurs before your proposal has been evaluated, offices like ODOC will not be able to fund you.

6.4.2 Recommenders / Advisers

Enter the name of your primary faculty JP or ST **adviser**. If you already have **second reader** and they are willing, you can enter them as a second adviser.

6.4.3 Funding Request(s)

Once you have filled out all the **Applicant Information**, you will be matched automatically to opportunities that you are eligible for. You will want to check the “Choose this

opportunity” box for all the funding opportunities available. For example, as a Geosciences concentrator, you likely will be eligible for some combination of Office of the Dean of the College (ODOC), [Princeton Environmental Institute \(PEI\)](#) and [Grand Challenges](#), and Department of Geosciences funding to support your JP or ST. Make sure you select all of these funding opportunities so that you have a better chance to fully fund your proposed research (even if you do not need any money). Additional opportunities such as those that are “published” (viewable), but not yet open when you begin your application can be added later from within your existing application (do not create a second application).

6.4.4 Anticipated Expenses

This section is one of the most important parts of your proposal. Budgets are where you demonstrate that you have a thorough and well-conceived research plan that you can accomplish at reasonable cost. Be specific, and be sure that each line item is clearly described and competitively priced. In your ‘Project Statement’ (coming up), you will have a ‘Budget Justification’ section where you will have the opportunity to further justify each of the expenses you list here. If you already have money or do not need any money, just explain that here (as one item for \$0) – you must convince your reader that you do not need money. Your Budget Justification must exactly match the budget line items you included here. Below is a list of allowable expenses:

Allowable Expenses

- Travel to research sites (to be eligible for this funding, you must register your trip in the [Travel Database](#). Note that funding for research travel is not allowable if the site is within 25 miles of your home town or country and/or on the [State Department warning list](#). If you intend to apply for a travel exemption in order to travel to destinations on the [State Department warning list](#), please first consult the [University Travel website](#) and provide [Dean Nancy Kanach](#) with the information necessary to investigate your request.)
- Weekly living expenses: food (meal budget is limited to \$25 per day), accommodation and local transportation
- If you have an awesome JP/ST, talk to your adviser about submitting an abstract to a conference. If your abstract is accepted, then conference fees (up to \$500) are an acceptable expense.
- Books not available at Princeton University
- Consumable laboratory supplies not covered by any of your adviser’s existing grant
- Off-campus data acquisition

- Software specific to your research project not available through Geosciences or Princeton University

Expenses Not Allowed

- Purchase of capital equipment such as recording or electronic machinery (rental costs may be covered)
- General laboratory equipment
- Transcription services
- Payment to individuals for services rendered
- Travel to home town or home country
- Entertainment and/or personal expenses
- Tuition for instructional programs
- Vaccinations

6.4.5 Documents

In your **Project Statement** (see below), you will include information about the context for your proposed project and relevant previous results. Frequently, these sections are supported by 1-4 figures illustrating the problem you are addressing and/or some of your previous results. While optional, you should consider uploading a single PDF document containing numbered figures and tables, all with captions, that are specifically referenced within the text of your 'Project Statement.'

6.4.6 Independent Project / Senior Thesis Research Questions

The **Overnight Travel**, **IRB**, and **IACUC** questions should be self explanatory. The **Project Statement** question is the core of your proposal. The structure of this **Project Statement** follows that of a funding proposal to the National Science Foundation and will help prepare you for a career in the natural sciences. Please follow closely the length and structure guidelines described below. You should prepare this statement in your favorite text editor, and then paste it into the **SAFE** application. It is hard to emphasize enough how important a well-crafted and polished proposal is for getting funded and for getting useful feedback from your adviser.

Project Statement

- (A) **Abstract (3–6 lines):** This section should be one short paragraph that contains your statement of thesis as a single emboldened sentence. Make your hypothesis clear, and ask yourself: “Is the question I am asking interesting and relevant, and am I capable of testing my hypothesis using the time and resources available?”
- (B) **Introduction (10–25 lines):** In this section, you should place your thesis in context. Who has worked on this problem before (be sure to cite the relevant primary literature)? What big questions remain? Conclude your introduction with a one sentence restatement of your thesis that is now in the context of some of the previous studies others have conducted on your topic.
- (C) **Previous Results (0–40 lines):** Many of you will have completed JP and/or summer independent work related to this JP or ST proposal. Use this section to describe the results most relevant to this project. In many cases, your previous results will form an important part of the justification for this proposal. How well you can explain and make relevant your previous results is a direct measure of how prepared you are to embark on the project you are proposing.
- (D) **Objectives & Methods (15–25 lines):** Describe the major field/lab/computational methods you will use in your research. Additionally, explain the specific objectives for each set of techniques you will employ. In other words, instead of just listing the methods you plan to use, explain why each of these methods is relevant to your work. If you make it clear that you can test your hypothesis by acquiring data (be sure to demonstrate that you have or can get the data) and that you have the tools and expertise to perform the requisite analyses on this data, then you have made a great start.
- (E) **Budget Justification (15–30 lines):** Here you should explain clearly why you need the funds you requested in the ‘Anticipated Expenses’ Section 6.4.4. Justify, justify, justify. You will not receive any funding unless it is clear why each expense is crucial for a specific part (do not be vague) of your independent work. For example, it is not enough to say: “I need \$500 for travel to Brookhaven to run two samples on the synchrotron.” You would need to explain what two samples you want to run, why they are important, what data the synchrotron will generate, how you will use those data to test your hypothesis, what proportion of the funds is for travel expenses, and what the actual costs are to run the samples. If you already have money or do not think you need money, take the space to elaborate on why your project will be successful without any additional funds.
- (F) **References (2–20 entries):** Include a complete list of references that you have cited within the sections above. Follow the [bibliography guidelines for Geophysical Journal International](#), or use the bibliography style file (gji.bst) included with the [L^AT_EX Senior Thesis template](#). It is very important that your references are relevant, appropriately

cited, and from peer reviewed literature (not Wikipedia). It is not kay to have improperly formatted references.

Whether traveling or not for your independent work, the **Planned Itinerary** section (5–15 lines) is your work plan. Support your text with a table or itemized list, explaining when you plan to accomplish each task, and what tools/methods you will employ to meet your goals. Your adviser may choose to use this table to set goals and schedule review meetings with you. You also will use this section to make it clear that you have the logistics for your project under control. How/when will you get to and from your research site? Where will you be living? Who else will be with you, and have you been in contact with them?

The **Qualifications** section (4–10 lines) is your chance to explain why you are qualified to undertake this independent work. What previous course work, lab/field/computer experience, etc... do you have that prepare you for this project?

7 Assessment & Grading

7.1 Junior Paper

The final grade for a JP is determined based on the mini-proposal, progress report, the written final report, and the poster presentation as outlined. A penalty of one full letter grade will be assessed for each day that the submission of the JP progress report, JP written final report or JP poster is late. All criteria presented in the **grading rubrics** will be compiled and discussed in a Department Faculty Meeting, during which scores will be normalized to ensure uniform and equitable grading across the department.

7.2 Senior Thesis

The final grade for the Senior Thesis is determined based on the ST proposal, the written rough draft, the written final report, and the oral presentation. A penalty of one full letter grade will be assessed for each day that the submission of the ST Proposal, ST Rough Draft, ST final written report, or ST oral presentation PDF is late. All criteria presented in the **grading rubrics** will be compiled and discussed in a Department Faculty Meeting, during which scores will be normalized to ensure equitable grading across the department.

8 Departmental Awards

8.1 Awards for Juniors

- **Benjamin F. Howell, Class of 1913 Prize:** Awarded, by vote of the Geosciences faculty, to a Junior for excellence in independent research (i.e., the JP) in Geosciences. Established in 1975 to honor Professor Howell in his 85th year.

8.2 Awards for Seniors

- **Arthur F. Buddington Award – \$250.00:** Awarded, by vote of the Geosciences faculty, to the graduating Senior who has demonstrated overall excellence in Earth sciences. Established in 1975 to honor Professor Buddington in his 85th year.
- **Edward Sampson, Class of 1914, Prize in Environmental Geosciences – \$250.00:** Awarded, by vote of the Geosciences faculty, to graduating Senior for distinguished work in the field of environmental geosciences. Established in 1975 to honor Professor Sampson in his 85th year.
- **Sheldon Judson (*40) / William E. Bonini (*48) Teaching Award – \$100.00:** Awarded, by vote of the Geosciences faculty, to a graduating Senior for dedicated, quality service in support of the teaching mission of the Department.
- **Chairmans Award – \$100.00:** Awarded at the discretion of the Chair to recognize special achievement by a graduating Senior.
- **Sigma Xi Book Award – Nomination in Society & Inscribed Book:** Awarded for excellence in science research (i.e., the Senior Thesis).
- **Sigma Xi Associate Memberships – Nomination in Society only:** Awarded to graduating Seniors with a GPA of B+ or better.
- **ENV Senior Thesis Prize – \$500:** Awarded by PEI and ENV to the Senior who has written the best thesis in the broad area of Environmental Studies, especially for theses that address both the technical or scientific and human aspects of environmental issues. This competition only is open to students receiving a Certificate in the Environmental Studies Program.
- **Peter W. Stroh '51 Environmental Senior Thesis Prize – \$500:** Awarded by PEI and ENV to outstanding Seniors receiving a Certificate in the Environmental Studies Program.

9 Useful Links

- [Department of Geosciences Undergraduate Home Page](#)
- [Geosciences Undergraduate Brochure](#)
- [Geosciences JP/ST Shopping Guide](#)
- [Student Activities Funding Engine \(SAFE\)](#)
- [Example SAFE ST Funding Proposal Form](#)
- [Princeton Environmental Institute \(PEI\) Summer Internships](#)
- [The Princeton Writing Center](#)
- [Data and Statistical Services at Princeton](#)
- [GIS at Princeton](#)

10 Student Feedback

Please let us know what you think of this guide! Your feedback will help us improve the information and advice we supply to future generations of Geosciences undergraduates. Please email your recommendations and edits to the Undergraduate Coordinator, [Sheryl Robas](#).

A Example titles of JP/STs from the last three years

- Updates to Leaf Respiration Parameterization: Assessing the Impact of Light Inhibition, Leaf Expansion, and a Warming Scenario for Carbon Budget Modeling
- Aerosols, Change Points, and the Evolving Land Carbon Sink
- Precision and Accuracy of Low-Cost Global Positioning Augmentation Systems
- Distribution of Relative Humidity Observed by the VCSEL Hygrometer in the Tropical Troposphere, Interpreted Through Tracers
- Lake Bonneville's Tilted Shorelines Revisited: Implications for Late Pleistocene Climate
- A Regionalized Maximum-Likelihood Estimation of the Spatial Structure of Venusian Topography

- Examining Benthic Nitrogen Dynamics Using a Whole Core Squeezer
- What Caused the Abrupt Increase in Net Global Land Carbon Uptake in 1989?
- The Nature of Reactive Thiols on Bacterial Cell Envelopes And their Reactivity with Aqueous Hg^{2+}
- Isotopic Evidence for Source Changes in Aerosol Nitrate Deposition in the North Atlantic
- Permafrost and Global Climate Change: Novel Models and Policy Implications
- The Implications of Mafic Enclaves on Magmatic Differentiation and Pluton Emplacement: Geochronological And Geochemical Insights from the Bergell Intrusion, N. Italy
- The Effects of Elevated Soil CO_2 on Plant Uptake of Metals
- Calcite-Graphite Thermometry in the Southwestern most Central Metasedimentary Belt, Grenville Province, Southern Ontario
- Constrained Parameterization of the Dual Arrhenius and Michaelis-Menton Model of Soil Carbon Respiration for a Central Amazonian Terra Firme Rainforest Site
- Testing the N Isotopes of Marine Particles as a Tool to Study Nitrogen Sources to Flow Cytometrically Sorted Phytoplankton in the Subtropical Ocean
- U-Pb Geochronology from the Pimple Hills near Ogdensburg, NJ: Implications for the Tectonic History of the Losee-Wanaque Composite Arc
- A Novel Apatite-Based Sorbent for Defluoridation: Synthesis and Sorption Characteristics of Nano-Micro Crystalline Apatite on Limestone
- Pushing the 123 ka Barrier in Greenland: A Revisitation in the Reconstruction of the Disturbed Section of GISP2/GRIP
- Global Effects of Seismic Wave Propagation from the Chicxulub Asteroid Impact
- Geophysics: Imaging a Salt Dome in West Africa Based on Spectral-Element and Adjoint Methods
- Bio-optical Properties and Mixed Layer Net Community Production of Southern Ocean Phytoplankton
- The Cretaceous–Tertiary (K–T) Boundary at Wadi Nukhul, Egypt: Planktic Foraminiferal Turnover and Environmental Changes
- Dynamic vs. Static Triggering: An Evaluation of Aftershock Decay with Distance

- Reinterpretation of the Elatina Rhythmite Fold Structures: Evidence for a Seasonal Slushball and Giant Impact Lunar Formation ~ 4.4 Ga.
- Trichodesmium Response to Ocean Acidification
- Methanobacterium sp. MK4 Under Conditions of Simulated Martian Regolith and Atmosphere
- Evaluating the Haynesville Black Shale Resource Play
- A New Record of Environmental Change in the Late Cretaceous from Brazil
- Environmentally-Sustainable Poverty Reduction: Rural Road Development in Liberia
- Utilizing Ground Penetrating Radar and the Hough Transform to Investigate Spatial Patterns of Tree Root Systems
- The Risks and Behavior of Carbon Dioxide Leakage From Geologic Reservoirs
- Redevelopment of Iraqi Hydrocarbon Resources and Infrastructure, A GIS Investigation into the Interplay Between Resources and Insurgency
- Phosphorus Limitation and the Reduction of the Carbon Fertilization Effect in Tropical Ecosystems
- Temperature-Dependent Methanotrophy in High Arctic Permafrost: Implications for Global Warming
- High-Stress Conditions in Early Paleocene Benthic Foraminifera: Evidence from NW Atlantic ODP Site 1050C

B Grading Rubrics

In all the grading rubrics below, evaluation is based on a scale of 1–5 (1 is highest, 5 is lowest) where a '3' is considered an adequate score. You are advised to repeat your hypothesis either before or after the abstract, in order to make it clear to those reading your work. Penalties will be applied to those proposals or reports which exceed the length requirements. You are reminded that overall grades are not calculated by summing scores, but by considering the piece of work as a whole.

B.1 Grading Rubric: JP mini-Proposal/ST Proposal

Hypothesis (one sentence) – The student’s hypothesis

- 1 – is clear, original, testable and has the perfect scope for an JP/ST.
- 2 – is concise, testable, and should form the basis of a nice JP/ST.
- 3 – is moderately interesting and broadly testable, and, with a bit of tweaking, will make for a good JP/ST.
- 4 – is interesting but not really testable, or not particularly interesting but reasonably testable.
- 5 – is not properly stated or tested, and/or is not appropriate for a JP/ST.

Abstract (≤ 6 lines) – The student’s abstract

- 1 – elegantly summarizes their hypothesis and objectives in 3-6 lines.
- 2 – is a clear and concise statement of their objectives.
- 3 – is an adequate summary of the proposed JP/ST.
- 4 – roughly summarizes the JP/ST to be conducted.
- 5 – is not a good summary of the proposed JP/ST.

Introduction ($10 \leq 25$ lines) – The student’s Introduction

- 1 – contains an impressive review of the relevant literature and shows that their hypothesis is timely and important within the space permitted.
- 2 – demonstrates that the student has conducted a survey of the literature and has done a nice job motivating the work.
- 3 – indicates an adequate appreciation of the background context for their proposed work.
- 4 – mentions a few relevant papers, but is not an elegant motivation for their proposed work.
- 5 – does not properly review the literature or motivate their proposed work.

Previous Results (≤ 40 lines) – If the student has conducted Independent Work on the topic (note, a student will not be penalized if he/she did not conduct a JP that produced results relevant to his/her ST), he/she

- 1 – showcases previous results with text and figures that do a superb job motivating the proposed JP/ST work.
- 2 – depicts previous results with text and figures that help make their proposed JP/ST work relevant.
- 3 – present previous results that are somewhat relevant to the proposed JP/ST work.

- 4 – presents relevant previous results but does not explain them adequately or relate them to the proposed JP/ST work.
- 5 – does not present or does not seem to fully understand previous JP results that are relevant to the proposed JP/ST work.

Methods (≤ 25) –The student

- 1 – clearly describes his/her objectives and the methods to be used to achieve those objectives so that even a general science reader could understand.
- 2 – presents his/her objectives and an excellent summary of the methods to be used to achieve those objectives.
- 3 – describes the methods fairly clearly. However, the rationales and/or objectives for some approaches were not clear.
- 4 – provides a good summary of the methods used. However, the objectives and/or some relevant details were either inappropriate or missing.
- 5 – presents a poor description of the objectives and the methods.

Planning & Budget Justification (≤ 30 lines)

- 1 – All anticipated expenses are justified and indicate thoughtful and realistic planning of the proposed JP/ST work.
- 2 – Most of the anticipated expenses are justified and are part of a reasonable plan for the proposed JP/ST work.
- 3 – Most of the anticipated expenses are discussed, but are not completely integrated into a realistic proposed plan for JP/ST work.
- 4 – Only about half of the anticipated expenses are justified, and the proposed JP/ST plan needs significant revision.
- 5 – Anticipated expenses are not justified or appropriate.

References & use of literature (≤ 20 entries) – The references are

- 1 – impeccably formatted and complete. The references cited represent an authoritative survey of the most relevant primary literature.
- 2 – formatted properly at least 75% of the time. The references cited show careful scholarship and an adequate use of the primary literature.
- 3 – formatted properly at least 50% of the time. The references show average scholarship, but the student relied heavily on reviews rather than primary sources.
- 4 – formatted properly at least 25% of the time. The references cited indicate that the student has mastered only part of the relevant literature, and significant parts of the paper are not supported by appropriately cited material.

- 5 – improperly formatted and incomplete. The references cited demonstrate poor scholarship and suggest that the student understands little of the primary literature and/or has made major errors interpreting and citing sources.

Overall Evaluation: – This JP/ST

- 1 – proposal is one of the best I have seen (as a general guide, within the top 5%).
- 2 – proposal is excellent (as a general guide, within the top 25%).
- 3 – proposal is good.
- 4 – proposal is weak in one or more significant respects.
- 5 – proposal suffers from several major flaws.

B.2 Grading Rubric: Fall JP progress report & final report

Progress reports will be graded using the same criteria as final reports, with the understanding that the some sections, particularly the data analysis, will not be completed. Progress reports should nonetheless be presented as professional pieces of scientific writing.

Hypothesis – The student’s hypothesis

- 1 – is uniquely clear, original, testable and provocative.
- 2 – is concise, testable, and interesting.
- 3 – is moderately interesting and broadly testable.
- 4 – is interesting but not really testable, or not particularly interesting but reasonably testable.
- 5 – is not properly stated, nor is it testable.

Abstract – The student’s abstract

- 1 – elegantly summarizes their hypothesis, objectives, methods, results and conclusions in <250 words.
- 2 – is a clear statement of their hypothesis, objectives, methods, results and conclusions, but too verbose.
- 3 – is an adequate summary of the JP, but may be partly unclear or too long.
- 4 – is only a partial summary the JP.
- 5 – does not acceptably summarize the JP.

Context – The student’s introduction

- 1 – demonstrates a deep understanding of the big picture and an exciting motivation for their work.
- 2 – demonstrates a good grasp of the background and a strong motivation for their work.
- 3 – indicates an adequate appreciation of the background context for their work.
- 4 – includes a vague or incomplete understanding of the big picture.
- 5 – shows no, or very little, understanding of the setting for their work.

Literature review – The student’s review of literature

- 1 – is an authoritative survey and analysis of the relevant primary literature.
- 2 – shows a broad survey of the primary literature, with an appreciation of the relationships between previous studies.
- 3 – indicates an competent survey of the most relevant literature and goes beyond simply reporting previous publications’ results. It may rely too heavily on review papers.
- 4 – includes a summary of a few relevant papers, but does not go beyond this.
- 5 – does not properly review or show understanding of the literature.

Research design & methods – Whether a lab experiment, a new computer model, a field project, or a data-mining project the student

- 1 – clearly describes all methods and their rationales so that even a general science reader could understand.
- 2 – presents an excellent summary of the methods. A knowledgeable reader could repeat the project without too much difficulty.
- 3 – describes the methods fairly clearly. However, the rationales for some approaches were not clear and there were some instances where the student assumed knowledge on the part of the reader, or used too much jargon.
- 4 – provides a good summary of the methods used. However, some relevant details were either inappropriate or missing. The work would be difficult to repeat based on the material presented, and is difficult to understand for a general science reader.
- 5 – presents a poor description of the methods. It would be impossible for even a knowledgeable reader to completely understand the methods used.

Preliminary results & analysis –

- 1 – Results were presented in a logical, effective and creative manner. Data was presented accurately and clearly with text, figures and tables, and could be easily understood by a general reader.

- 2 – The data are described accurately and completely with relevant text, figures and tables, but may not be completely accessible to a general audience.
- 3 – Data were presented with reasonable figures and tables, and adequate text.
- 4 – The Results section is a collection of data with little information to explain their significance or where they came from. Some portions are unclear or missing, and/or data were presented in a confusing or incomplete fashion.
- 5 – The student paid little attention to the data beyond a cursory statement of the results. The student did not demonstrate that he/she understood the data.

Writing – The paper is

- 1 – a pleasure to read. It is crisp, clear and concise, needs no editing, and reads as though it has been written by a professional in the field.
- 2 – is easy to read, needs only minor editing, represents excellence in student writing, and appears to be the end product of multiple drafts.
- 3 – is well written and reads like a good, proof-read draft, but requires revisions and editing. The paper often is clear, but some sections need to be reread to get at the meaning.
- 4 – is poorly written and reads like a rough draft. Significant portions of the paper are sloppy or unclear. There are many misspellings and ambiguities.
- 5 – is very difficult to read and appears rushed and not proof-read. Most sections are unclear, grammatically incorrect and convoluted.

Figures – The figures

- 1 – spectacularly depict the most relevant background information, data and analyses with impeccable presentation and a high degree of originality.
- 2 – do an excellent job presenting the relevant background information, data and analyses, with very good presentation.
- 3 – do a good job depicting data and analyses, and presentation generally is adequate. However, the figures are not a significant improvement over the types of figures available in the primary literature.
- 4 – depict only a subset of the relevant data and analyses, with generally fair presentation that sometimes lacks adequate axis labels, annotations or other details.
- 5 – do not clearly present the data, and are poorly formatted without adequate axis labels, annotations or other details.

Formatting & References – The references are

- 1 – impeccably formatted and complete. The report is formatted appropriately, with careful attention paid to the structure and layout.

- 2 – formatted properly at least 75% of the time. The report is, for the most part appropriately formatted and structured.
- 3 – formatted properly at least 50% of the time. The formatting and structure are adequate.
- 4 – formatted properly at least 25% of the time. Some attention has been paid to the formatting and structure of the report, but more work is needed.
- 5 – improperly formatted and incomplete. The structure and layout of the paper is inappropriate

Completion – This JP

- 1 – is a comprehensive and persuasive research proposal. It presents the perfect springboard for a successful piece of independent work.
- 2 – is a competent research proposal. With one or two small additions, it will make a good springboard for a successful piece of independent work.
- 3 – contains many of the elements needed to carry out an adequate piece of independent research.
- 4 – suggests that a piece of independent work might be possible on a topic, but does not provide a convincing foundation for independent work.
- 5 – is obviously incomplete.

Originality – This student's overall JP

- 1 – demonstrated exceptional originality.
- 2 – clearly went beyond the basic ideas laid out by the adviser.
- 3 – contained one or more good ideas that extended current thinking a bit.
- 4 – stayed within the bounds of the adviser's ideas.
- 5 – contributed little to science.

Overall Evaluation: – This fall JP

- 1 – is one of the best I have seen (as a general guide, within the top 5%).
- 2 – is excellent (as a general guide, within the top 25%).
- 3 – is good.
- 4 – is weak in one or more significant respects.
- 5 – suffers from several major flaws.

B.3 Grading Rubric: Spring JP and ST progress reports & final reports

Progress reports will be graded using the same criteria as final reports, with the understanding that the some sections, particularly the results and discussion, will not be completed. Progress reports should nonetheless be presented as professional pieces of scientific writing.

Hypothesis – The student’s hypothesis

- 1 – is uniquely clear, original, testable and provocative.
- 2 – is concise, testable, and interesting.
- 3 – is moderately interesting and broadly testable.
- 4 – is interesting but not really testable, or not particularly interesting but reasonably testable.
- 5 – is not properly stated, nor is it testable.

Abstract – The student’s abstract

- 1 – elegantly summarizes their hypothesis, objectives, methods, results and conclusions in < 250 words.
- 2 – is a clear statement of their hypothesis, objectives, methods, results and conclusions, but too verbose.
- 3 – is an adequate summary of the JP/ST, but may be partly unclear or too long.
- 4 – is only a partial summary the JP/ST.
- 5 – does not acceptably summarize the JP/ST.

Context – The student’s introduction

- 1 – demonstrates a deep understanding of the big picture, a thorough reading of the relevant literature, and an exciting motivation for their work.
- 2 – shows a good survey of the literature and a good motivation of the big question they set out to address.
- 3 – indicates an adequate appreciation of the background context for their work.
- 4 – includes a review of a few relevant papers, but is not an elegant motivation for their work.
- 5 – does not properly review the literature or motivate their work.

Methods – Whether a lab experiment, a new computer model, or a field project, the student

- 1 – clearly describes all methods and their rationales so that even a general science reader could understand.
- 2 – presents an excellent summary of the methods. A knowledgeable reader could repeat the project without too much difficulty.
- 3 – describes the methods fairly clearly. However, the rationales for some approaches were not clear and there were some instances where the student assumed knowledge on the part of the reader, or used too much jargon.
- 4 – provides a good summary of the methods used. However, some relevant details were either inappropriate or missing. The work would be difficult to repeat based on the material presented, and is difficult to understand for a general science reader.
- 5 – presents a poor description of the methods. It would be impossible for even a knowledgeable reader to completely understand the methods used.

Results –

- 1 – Results were presented in a logical, effective and creative manner. Data were presented accurately and clearly with text, figures and tables, and could be easily understood by a general reader.
- 2 – The data are described accurately and completely with relevant text, figures and tables, but may not be completely accessible to a general audience.
- 3 – Data were presented with reasonable figures and tables, and adequate text.
- 4 – The Results section is a collection of data with little information to explain their significance or where they came from. Some portions were unclear or missing, and/or data were presented in a confusing or incomplete fashion.
- 5 – The student paid little attention to the data beyond a cursory statement of the results. The student did not demonstrate that he/she understood the data.

Discussion & Analysis –

- 1 – The student provided an in-depth quantitative analysis of the results, supported by relevant figures and tables, and demonstrating exceptional insight into the broader implications.
- 2 – The student provided an excellent quantitative analysis of the data with useful figures and tables. Interpretation went beyond the simplest interpretation, but the implications and broader impacts are not clearly stated.
- 3 – The student provided a good discussion of the results with at least partly quantitative analysis and adequate figures and tables, but stayed mostly within the bounds of current thinking.

- 4 – The student provided a limited, fairly qualitative analysis of the data supported by decent figures and tables. However, the author mostly reiterated the results without further expansion.
- 5 – The student failed to provide a thorough critique of the results and/or their analysis was only qualitative.

Writing – The paper is

- 1 – a pleasure to read. It is crisp, clear and concise, needs no editing, and reads as though it has been written by a professional in the field.
- 2 – is easy to read, needs only minor editing, represents excellence in student writing, and appears to be the end product of multiple drafts.
- 3 – is well written and reads like a good, proof-read draft, but requires revisions and editing. The paper often is clear, but some sections need to be reread to get at the meaning.
- 4 – is poorly written and reads like a rough draft. Significant portions of the paper are sloppy or unclear. There are many misspellings and ambiguities.
- 5 – is very difficult to read and appears rushed and not proof-read. Most sections are unclear, grammatically incorrect and convoluted.

Figures – The figures

- 1 – spectacularly depict the most relevant background information, data and analyses with impeccable presentation and a high degree of originality.
- 2 – do an excellent job presenting the relevant background information, data and analyses, with very good presentation.
- 3 – do a good job depicting data and analyses, and presentation generally is adequate. However, the figures are not a significant improvement over the types of figures available in the primary literature.
- 4 – depict only a subset of the relevant data and analyses, with generally fair presentation that sometimes lacks adequate axis labels, annotations or other details.
- 5 – do not clearly present the data, and are poorly formatted without adequate axis labels, annotations or other details.

References & use of literature – The references are

- 1 – impeccably formatted and complete. The references cited represent an authoritative survey of the relevant primary literature.
- 2 – formatted properly at least 75% of the time. The references cited show careful scholarship and an adequate use of the primary literature.

- 3 – formatted properly at least 50% of the time. The references show average scholarship, but the student relied heavily on reviews rather than primary sources.
- 4 – formatted properly at least 25% of the time. The references cited indicate that the student has mastered only part of the relevant literature, and significant parts of the paper are not supported by appropriately cited material.
- 5 – improperly formatted and incomplete. The references cited demonstrate poor scholarship and suggest that the student understands little of the primary literature and/or has made major errors interpreting and citing sources.

Completion – This JP/ST

- 1 – is a complete story containing new science. If it is an ST, the paper will be ready to reformat for publication in a peer-reviewed journal.
- 2 – needs just one or two additional experiments or analyses to make a complete story containing new science.
- 3 – contains most of the elements of a nice result that someone should follow-up on.
- 4 – is not complete enough to decide whether there is a result or not.
- 5 – is obviously incomplete.

Originality – This student's overall JP/ST

- 1 – demonstrated exceptional originality.
- 2 – clearly went beyond the basic ideas laid out by the adviser.
- 3 – contained one or more good ideas that extended current thinking a bit.
- 4 – stayed within the bounds of the adviser's ideas.
- 5 – contributed little to science.

Overall Evaluation – This JP/ST

- 1 – is one of the best I have seen (as a general guide, within the top 5%).
- 2 – is excellent (as a general guide, within the top 25%).
- 3 – is good.
- 4 – is weak in one or more significant respects.
- 5 – suffers from several major flaws.

B.4 Grading Rubric: ST Oral Presentation

Hypothesis – The student's hypothesis

- 1 – is uniquely clear, original, testable and provocative. The student elucidated clearly right from the start of their presentation.
- 2 – is concise, testable, and interesting. The student is able to describe the hypothesis verbally.
- 3 – is moderately interesting and broadly testable. The student is able to state the hypothesis verbally, but not in particularly succinct terms.
- 4 – is interesting but not really testable, or not particularly interesting but reasonably testable.
- 5 – is not properly stated and/or is not testable. The student cannot communicate the hypothesis verbally or in writing.

Context – The student's introduction to the audience

- 1 – demonstrates a deep understanding of the big picture, a thorough reading of the relevant literature, and an exciting motivation for their work.
- 2 – shows a good survey of the literature and a good motivation of the big question they set out to address.
- 3 – indicates an adequate appreciation of the background context for their work.
- 4 – includes the review of a few relevant papers, but is not an elegant motivation for their work.
- 5 – does not properly review the literature or motivate their work.

Graphics – The presentation graphics

- 1 – spectacularly depict the most relevant background information, data and analyses with impeccable presentation and flow, and a high degree of originality.
- 2 – do an excellent job presenting the relevant background information, data and analyses, with very good presentation and flow.
- 3 – do a good job depicting data and analyses, and presentation generally is adequate. However, the figures are not a significant improvement over the types of figures available in the primary literature, and the presentation may not be organized clearly.
- 4 – depict only a subset of the relevant data and analyses, with generally fair presentation that sometimes lacks adequate axis labels, annotations or other details.
- 5 – do not clearly present the data, and are poorly formatted without adequate axis labels, annotations or other details.

Discussion & Analysis – The student

- 1 – provided an in-depth quantitative analysis of the results, supported by relevant figures and tables, and demonstrating exceptional insight into the broader implications.
- 2 – provided an excellent quantitative analysis of the data with useful figures and tables. Interpretation went beyond the simplest interpretation, but the implications and broader impacts are not clearly stated.
- 3 – provided a good discussion of the results with at least partly quantitative analysis and adequate figures and tables, but stayed mostly within the bounds of current thinking.
- 4 – provided a limited, fairly qualitative analysis of the data supported by decent figures and tables. However, the author mostly reiterated the results without further expansion.
- 5 – failed to provide a thorough critique of the experiments and results and/or their analysis was only qualitative.

Completion – This oral presentation

- 1 – tells a coherent and substantial story.
- 2 – needs just one or two additional experiments, observations or analyses to make it whole
- 3 – contains most of the elements of a nice result that someone should follow-up on.
- 4 – tells a story that is not complete enough to decide whether there is an interesting result or not.
- 5 – contains few new results or ideas.

Questions – The student

- 1 – did an exceptional job answering audience questions, clearly demonstrating his/her deep grasp both of the subject and his/her data.
- 2 – did a very good job answering audience questions, demonstrating an good understanding of the subject and his/her data.
- 3 – was able to answer audience questions, but displayed somewhat superficial understanding of the subject and/or his/her data.
- 4 – tried to answer the audience questions, but was out of his/her depth as soon as the question strayed from their specific project.
- 5 – could not understand the questions being asked, nor could he/she answer them.

Style – The student

- 1 – presented with a clear delivery, an engaging tone, and without memorization or notes. The talk was nicely targeted to the broad audience.
- 2 – presented his/her slides in a comprehensible manner and was adequately engaging. While some jargon may have crept in, the talk was accessible to the general audience.
- 3 – made the primary gist of the talk comprehensible, but not all the supporting details were well-presented. Pacing, visuals, and/or word choice can be improved.
- 4 – presented the material in a way that was not particularly clear, concise or engaging and/or relied too heavily on notes, but at least the presentation was understandable to the experts in the room.
- 5 – presented an incomprehensible talk.

Overall Evaluation: This JP/ST oral presentation

- 1 – is one of the best I have seen (as a general guide, within the top 5%).
- 2 – is excellent (as a general guide, within the top 25%).
- 3 – is good.
- 4 – is weak in one or more significant respects.
- 5 – suffers from several major flaws.

B.5 Grading Rubric: JP Poster Presentations

Hypothesis – The student’s hypothesis

- 1 – is uniquely clear, original, testable and provocative. The student is able to elucidate the hypothesis verbally and in print.
- 2 – is concise, testable, and interesting. The student is able to describe the hypothesis verbally.
- 3 – is moderately interesting and broadly testable. The student is able to state the hypothesis verbally, but not in particularly succinct terms.
- 4 – is interesting but not really testable, or not particularly interesting but reasonably testable.
- 5 – is not properly stated and/or is not testable. The student cannot communicate the hypothesis verbally or in writing.

Context – The student’s Introduction

- 1 – demonstrates a deep understanding of the big picture, a thorough reading of the relevant literature, and an exciting motivation for their work.

- 2 – shows a good survey of the literature and a nice setup of the big question they set out to address.
- 3 – indicates an adequate appreciation of the background context for their work.
- 4 – includes the review of a few relevant papers, but is not an elegant motivation for their work.
- 5 – does not properly review the literature or motivate their work.

Graphics – The poster graphics

- 1 – spectacularly depict the most relevant background information, data and analyses with impeccable presentation and flow, and a high degree of originality.
- 2 – do an excellent job presenting the relevant background information, data and analyses, with very good presentation and flow.
- 3 – do a good job depicting data and analyses, and presentation generally is adequate. However, the figures are not a significant improvement over the types of figures available in the primary literature, and the poster may not be organized clearly.
- 4 – depict only a subset of the relevant data and analyses, with generally fair presentation that sometimes lacks adequate axis labels, annotations or other details.
- 5 – do not clearly present the data, and are poorly formatted without adequate axis labels, annotation or other details.

Discussion & Analysis – The student

- 1 – provided an in-depth quantitative analysis of the results, supported by relevant figures and tables, and demonstrating exceptional insight into the broader implications.
- 2 – provided an excellent quantitative analysis of the data with useful figures and tables. Interpretation went beyond the simplest interpretation, but the implications and broader impacts are not clearly stated.
- 3 – provided a good discussion of the results with at least partly quantitative analysis and adequate figures and tables, but stayed mostly within the bounds of current thinking.
- 4 – provided a limited, fairly qualitative analysis of the data supported by decent figures and tables. However, the author mostly reiterated the results without further expansion.
- 5 – failed to provide a thorough critique of the experiments and results and/or their analysis was only qualitative.

Completion – This poster

- 1 – tells a coherent and substantial story.
- 2 – needs just one or two additional experiments, observations or analyses to make it whole
- 3 – contains most of the elements of a nice result that someone should follow-up on.
- 4 – tells a story that is not complete enough to decide whether there is an interesting result or not.
- 5 – contains few or no new results or ideas.

Questions – The student

- 1 – did an exceptional job answering visitor questions, clearly demonstrating their deep grasp both of the subject and their data.
- 2 – did a very good job answering visitor questions, demonstrating an good understanding of the subject and their data.
- 3 – was able to answer visitor questions, but displayed somewhat superficial understanding of the subject and/or their data.
- 4 – tried to answer the visitor questions, but was out of their depth as soon as the question strayed from their specific project.
- 5 – could not understand the questions being asked, nor could he/she answer them.

Overall Evaluation: – This JP poster

- 1 – is one of the best I have seen (as a general guide, within the top 5%).
- 2 – is excellent (as a general guide, within the top 25%).
- 3 – is good.
- 4 – is weak in one or more significant respects.
- 5 – suffers from several major flaws.

