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| --- | --- | --- | --- | --- | --- |
|  | **Score** | | | | |
| **5** | **4** | **3** | **2** | **1** |
| **Model** | The model(s) contain the necessary stocks, flows, and converters to accurately represent the system(s). Units cancel and/or track through the model correctly. Equations are correct. The dt is appropriate to the system. \***SEE BELOW** | The model(s) contain the necessary stocks, flows, and converters to accurately represent the system(s). Equations are correct. Units and/or dt may be missing or incorrect. | The model(s) contain the necessary stocks, flows, and converters to accurately represent the system(s). There may be a minor error in the equations that prevents the model from working correctly. | The model(s) is missing some necessary stocks, flows, or converters. There are numerous errors in the model equations. | The model is missing several key components. There are numerous errors in equations used to describe the system. |
| **Main text** | The text is factually correct and complete. It thoroughly addresses all five sections described in the assignment. It contains no spelling or grammatical errors. | The text is factually correct and mostly complete. It thoroughly addresses all five sections described in the assignment. It contains few/no spelling or grammatical errors. | The text is mostly factually correct and mostly complete. It does not address all five sections described in the assignment. It contains multiple spelling or grammatical errors. | The text is only partially complete and contains several factual errors. It does not address all five sections described in the assignment. It contains frequent spelling or grammatical errors. | The text is full of factual errors. It addresses only one or two sections described in the assignment. It contains multiple spelling or grammatical errors. |
| **Graphs and figures** | All graphs have titles and axis labels, including units. Axes are scaled in a logical way, i.e. different variables are plotted on the same scale where appropriate, the scale shows the full range of variability, etc. | All graphs have titles and axis labels. Some units may be missing. Axes are scaled in a logical way. | Most graphs have titles and axis labels, including units. Axes may be left on the “auto” settings from STELLA, which may not be appropriate to the exercise. | A few graphs have titles and axis labels, including units. Axes may be left on the “auto” settings from STELLA, which may not be appropriate to the exercise. | Most graphs do not have titles and axis labels, including units. Axes may be left on the “auto” settings from STELLA, which may not be appropriate to the exercise. |
| **Meta-cognition** | This portion of the paper is complete and thoughtful. The student reflects in a meaningful way on both topics outlined in the assignment. |  | This portion of the paper shows moderate effort. The student briefly addresses both topics from the assignment, but does not offer specific examples. |  | This portion of the paper is cursory and surficial. The student may not address both topics, or may describe them in a way that does not directly address the question(s). |

**\***A note on evaluating students’ models: In order to allow students to master geoscientific methods and develop geoscientific habits of mind, we strongly believe that students should approach this project independently and decide for themselves which system to model. Obviously, it is helpful for the instructor to steer students away from problems that are truly impossible, but it is possible that, even with good instructional support, a student will choose a system that turns out to be beyond his or her ability to model correctly or completely. When “real” scientists reach this point in their own work, they analyze what went wrong, regroup, try a new approach, or learn new skills (or collaborate with an expert). Realistically, by the time a student potentially reaches this point, the semester is over. However, we do not feel that failure to create a complete, fully functional model is, in fact, failure, nor do we think it should be graded as such. We therefore allow for the possibility that a student can earn full credit on the modeling portion of the rubric despite an incomplete or non-functional model under the following conditions:

* The student has put forth a sustained and genuine effort throughout the course of the project.
* The portions of the model that exist are based on credible sources of data and/or literature, and the student has searched extensively for additional sources of information.
* The student conducts a through analysis in the accompanying paper of why the model did not work. This should include a scientific or technical analysis (e.g. “I could never find a function that accurately related two reservoirs”) as well as self-reflection on how the student attempted to solve the problem, and how he or she might approach the problem differently if given more time.

Finally, to prevent students from being unnecessarily risk-averse with their choice of projects, it is essential that they are made aware of this caveat from the very beginning. The assignment description reflects this, but does not go into detail. It is important that students to know the circumstances under which a non-working model can still get full credit, as well as when it cannot (i.e. last-minute projects with little analysis or reflection).