Arctic Thermokarst Model Project Description: Phase 2

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# Introduction

The Arctic Thermokarst Model (ATM) models thermokarst disturbances in the Alaskan arctic and boreal forests, as discussed in more detail in the introduction to the report on [Phase 1](https://github.com/gina-alaska/arctic_thermokarst_model/blob/master/documents/Arctic_Thermokarst_Model_Phase_0_1.docx) [1]. While Phase 1 focused on the project management and the ability to extend the ATM to further regions, Phase 2 was intended to create better data structures to represent the grid-like data in the model.

# Phase 2: Grids, and Checks

There were two primary goals for phase 2: design objects to represent the various grid-like data in ATM, and to create a simplified check function (functions that determine the change in cohorts at each time step) that leverages the grid objects. A scheme for canon cohort names (name used internally by the model) was also determined. See the [Project board](https://github.com/gina-alaska/arctic_thermokarst_model/projects/2?)[2] or Issues [Issues List](https://github.com/gina-alaska/arctic_thermokarst_model/issues?utf8=✓&q=is%3Aissue%20project%3Agina-alaska%2Farctic_thermokarst_model%2F2%20)[3] for issues in this phase.

Initially the prescribed grids were: the fractional area of each cohort, the active layer depth (ALD), the protective layer (PL) at each cohort, and the probability of initiation (POI) for each cohort. These grids all vary over time. An ice grid was added that tracks ice quality and is static over time.

The new check function was created to take advantage of these new grids, and the fact the internal logic of most of the cohort checks was the same. The current checks mainly varied in the final step where the transition occurs. The information on how transitions occur could be passed to the new function.

The design of the class (GitHub issue 15) AreaGrid in atm/grids/area\_grid.py served as the main template for the other grid objects. It represents the fractional area for all cohorts present in all of the grid cells, as separate grids. These grids are flattened and stored as a 2D grid where the first dimension is a number that can be mapped to with the canon cohort names, and the second is the index into the flattened grid. The 2D grids were stored in a list with each index representing the time step of the model. Various getter and setter methods were implemented to access data, as was the ability to add a new time step to the grid.

The other grids all were based on this design with some differences. The ALD, and PL grids are represented as a single object where the ALD is constant for all cohorts but the PL is not at a given time step. The POI grid was implemented with more limited setting functions, and the Ice grid removes the temporal element. A final Model Grid object was created which has an instance of each of the other grids for ease of management. A suite of tests was also implemented for all of the grid objects.

When designing the area grid, a lot of extra IO functions for images and raster were created. The canon cohort name scheme was also implemented. During the clean up these were all moved to better locations.

# Issues Encountered

There were two main issues with the development of phase 2. The first was that Bob Bolton indicated that the model may need to track how long different parts of the fractional areas were in a specific cohort. Instead of waiting until further along in the project, this issue was addressed immediately by adding age buckets to each of the Area grid cohorts. The indexers can take care of accessing the sum of all the values by passing just the canon cohort name, or just the bit for an age range by giving the name followed by two dashes age.

The second problem was the integration of new model objects. It became apparent that it would create unnecessary work to integrate the new objects before a scheme for tracking the configuration values was devised. It was decided to move the integration, and create other output function tasks to a later phase (Phase 4) while the next phase (Phase 3) would tackle the configuration object.

Other issues were minor, but include the discovery that an Ice grid was needed, and whether time sensitive objects changes should be treated as current year values (last year + changes) or next year values (current year + changes). It was decided to use current year values as modified previous year values paradigm.

# Phase 3: Moving Forward

Phase 3 will tackle the configuration values, and Phase 4 will return to the integration of objects created here. Other issues that could be tackled in the future include standardizing the index format between grids (the ALD grid is different from the other objects) or refactoring all of the grids to inherit from a grid object that contains the common functionality. Documentation of the testing code could also be improved.

# References

[1] Phase 1 status report: <https://github.com/gina-alaska/arctic_thermokarst_model/blob/master/documents/Arctic_Thermokarst_Model_Phase_0_1.docx>

[2] Phase 2 project board: <https://github.com/gina-alaska/arctic_thermokarst_model/projects/2>?

[3] Issues https://github.com/gina-alaska/arctic\_thermokarst\_model/issues?utf8=✓&q=is%3Aissue%20project%3Agina-alaska%2Farctic\_thermokarst\_model%2F2%20