Austin Abbott

Project Plan

I. Background

Melt pond development on Arctic sea ice is an observable, measurable consequence of a changing climate at high latitudes. Ponds change the biogeochemical and physical structure of the upper water column by allowing increased light and heat to penetrate beneath the ice. Given the inaccessible nature of the Arctic Ocean, observations of melt ponds are sparse in time and space. Worldview® satellites (commercially owned) have the necessary resolution to observe melt ponds from space, but cannot be relied on for consistent observation, as they are task-based. However, images of melt ponds from 10 days during the summer of 2018 in the Chukchi Sea are available and co-located with 2 autonomous buoys (WARM project) that measure a suite of environmental variables. Deriving meaningful relationships between melt pond abundance and more readily measured parameters provides a path forward in quantifying the impact of melt ponds over large spatial and temporal scales, where direct observation is unavailable. Machine learning opens a pathway for exploring these relationships.

II. Target Variable

The target variable for this study will be melt pond coverage, expressed as a proportion of a two-dimensional area. As previously stated, this variable is difficult to measure, as it requires direct observation from air or space (Worldview satellite), with the necessary resolution to discern meter-scale features. Environmental variables may be key drivers of melt pond coverage, and are more easily measured via buoys, moorings, etc. Building a melt pond model based on these environmental variables may improve our ability to predict pond coverage.

III. Predictor Variables

The following are a list of variables measured by the co-located WARM buoys that will be fed into a machine learning model:

1) Air Temperature (deg C)
2) Water Temperature at 2.5m (deg C)
3) Surface Photosynthetically Available Radiation (PAR) (umol photon/m^2/s)
4) Sub-Surface PAR (0.5m, 1m, & 2.5m) (umol photon/m^2/s)
5) Salinity at 2.5m (pss)
6) Latitude and Longitude
7) Wind Speed (either from remote sensing or models, if available)

Variables will be presented in different combinations in subsequent model runs to maximize model performance.

IV. Description of Datasets

As previously described, Worldview satellite imagery in tandem with the co-located WARM buoys will be used as the machine learning validation dataset. After validation, the model will be tested on data from Ice Camp SHEBA (1997-1998). The same predictor variables mentioned above were also measured as parts of various datasets, which can all be found on the Earth Observing Laboratory (EOL) data portal (https://data.eol.ucar.edu/). As a bonus, the SHEBA study also has measurements of melt pond coverage, which can be compared to the model output results for additional validation of model performance.

V. Implication on Thesis Research

The overarching goal of my research has always been to better understand melt ponds dynamics and improve our ability to model how they affect the underlying water column (increased photosynthesis, warming, etc). While Worldview satellite imagery has provided an amazing snapshot into melt pond propagation throughout the summer, it cannot be relied on for consistent observation, and access is proprietary and restricted (must have NSF or EPA grant that specifically provides imagery). Relationships derived between melt pond coverage from the imagery, and environmental parameters from the buoys may aid in developing a new melt pond coverage model, which can be passed along to physical and biogeochemical modelers for incorporation into larger scale models.