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Earth Sciences Summer Research Assistantship

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Research PHASE 1 Write-up: Arctic Water Tracks

Introduction: Problem & Intentions

One of the projects we are working on in Professor Marisa Palucis's lab is understanding the effects of warming global temperatures on Arctic landscapes and geological systems. Water tracks are small streams of water, running parallely in groups off of hillslopes, as opposed to typical rivers that are meandering, braided, or “veiny”. Their small size makes them difficult to distinguish and map out, leaving them underlooked. Both a database of mapped water tracks, and an understanding of the common characteristics and geological consequences of water tracks, would allow us to incorporate this important, underlooked Arctic feature into research on water runoff. Water runoff is an essential metric in climate change studies because it is increased by warming global temperatures and can have major impacts on infrastructure, surrounding ecosystems, and human livelihood. Even better than this database would be a neural network we train to map water tracks on its own. This first consists of making “training data” by manually tracing water tracks over satellite imagery of our areas of interest: Alaska, Russia, Northern Canada, and other Arctic locations. We used Doodler, a “web application for image segmentation”. We will soon begin the process of machine learning with Segmentation Gym, an application that feeds the neural network training data. With an AI that can identify water tracks,

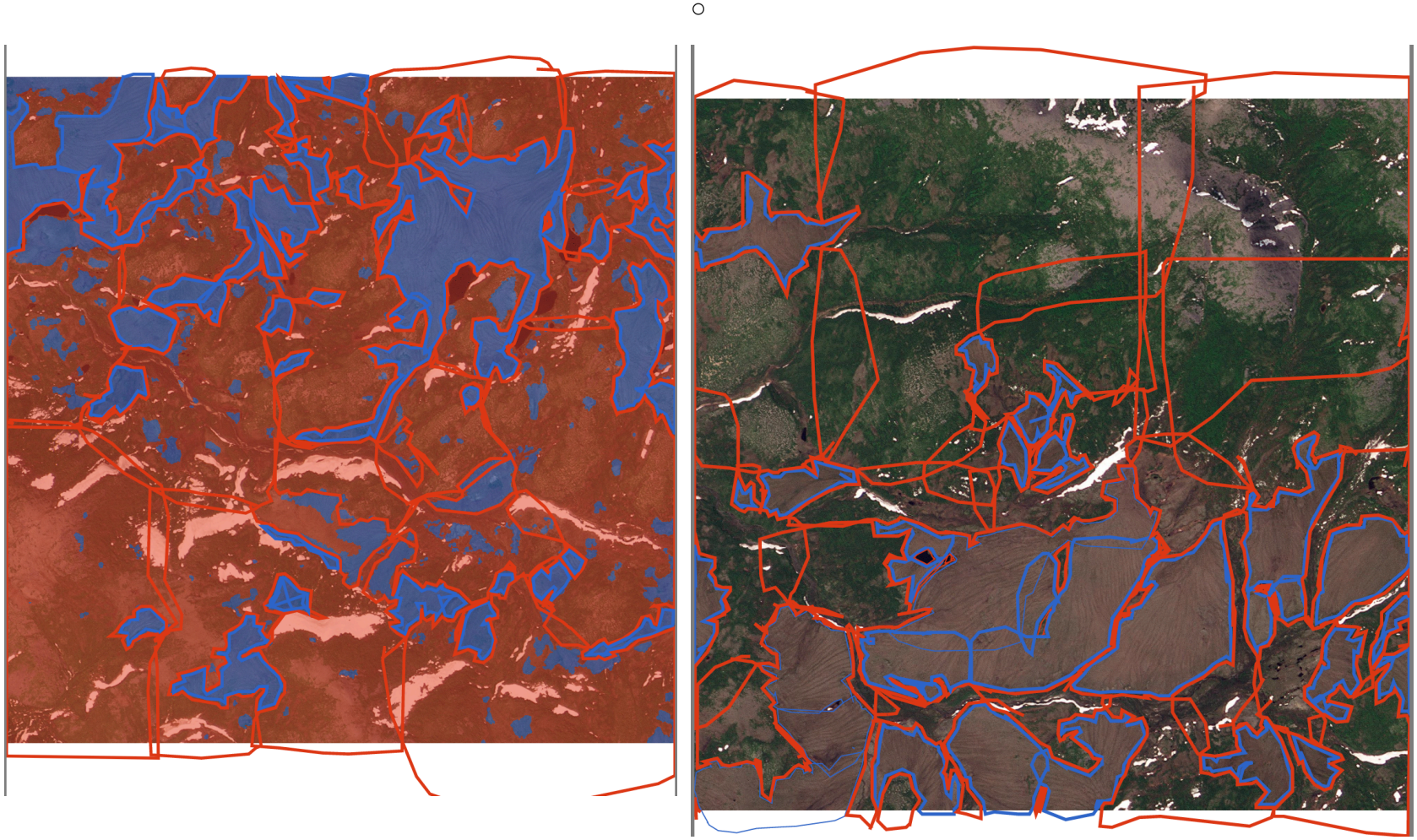
researchers can do observational experiments on how water track location, size, and density are affected by increased permafrost thaw and changes water runoff.

What are water tracks? How to identify them? (Literature Review)

Joanmarie and I had some “science” days (as opposed to coding/doodling days) where we discussed what water tracks are, and how to identify them- both in the field and through satellite imagery. We started off with a few articles, specifically, Evans’s “Water Tracks Enhance Water Flow Above Permafrost in Upland Arctic Alaska Hillslopes”, Levy’s “Water tracks and permafrost in Taylor Valley, Antarctica: Extensive and shallow groundwater connectivity in a cold desert ecosystem”, Trochim’s “Remote sensing of water tracks”, and Trochim’s companion article “Geomorphic and biophysical factors affecting water tracks in northern Alaska”. We distilled these articles down in a jamboard to determine what each author actually had to say about the distinct characteristics and functions of water tracks. In terms of visual appearance, water tracks cause darker soil and greener (earlier budding) vegetation due to the added moisture. In contrast, the soils around water tracks are dry and lighter in color. They typically stem from the snow melt of snowdrifts. Levy also specified the types of nematodes that prefer and avoid water tracks, based on their environmental preferences of salinity and moisture. Trochim gives an informative guide on the different types of water tracks, based on the shape of and plants growing in and around the track. Each author explained that the soil texture of water tracks can be both composed of larger, coarse, unsorted particles, but also sometimes of silt and clays. Lastly, the articles detail the additive role that water tracks play in the water budget, but, more significantly, act as super-highways for solutes and chemicals, changing lake geochemistry.

With all of these characteristics in mind, we were able to narrow down what we were looking for, and improve my standards in doodling.

Methods: Workflow, Tips, and Obstacles

After getting all of the necessary accounts, and completing setup and installations (Macbook perspective):

- Sourcing files to doodle on
    - Used: Google Earth Engine, Planet Explorer
    - Data filtering:
        - Area coverage: 95-100%
        - Cloud cover: 0-5%
        - Date ranges:
            - May 1st to June 30th, 2022
            - July 1st to July 31st, 2022
            - May 1st to June 30th, 2021
            - July 1st to July 31st, 2021
            - May 1st to June 30th, 2020
            - July 1st to July 31st, 2020
            - And if none of those give you good scenes, add
                - May 1st to June 30th, 2019
                - July 1st to July 31st, 2019
- Making jpegs
- Doodling
    - In general, it is better to lean on the conservative side when deciding if a section should be marked as having water tracks.
    - “Compute/Show segmentation”
    - The more consistent your doodles are (marking water tracks as accurately as possible), the faster your segmentation will go.
    - Here’s an example of one of my doodles and an example of an unrelated segmentation.