Creating Remote Imaging Pyramids for the Permafrost Discovery Gateway

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The Arctic is changing rapidly through permafrost thaw.

We are unable to keep up monitoring via traditional science approaches.
Human Impact
Developing permafrost big imagery products & making them discoverable for knowledge-generation
Mapping Application for Arctic Permafrost Land Environment [MAPLE]

- **BIG imagery**
  - Pre-processing
  - Automated analysis
  - HPC
  - Science-ready products
  - Knowledge Discovery

Al-based automated ice-wedge polygon detection from sub-meter resolution satellite imagery

Tundra Vegetation map (CAVM 2019) and Ground ice probability map (high category) are shown in the background

- **RUSSIA**
  - 9,000 images [63 TB]

- **ALASKA**
  - 3,000 images [14 TB]

- **CANADA**
  - 14,000 images [107 TB]

- Remaining 14,000 images [107 TB]

‘Big’ imagery

- Entire Arctic (above 60°N) has been imaged by DigitalGlobe Inc. commercial satellites in 0.5m resolution four times in the last 6 years.
- > 4 petabytes of imagery (> 1 million image scenes)
- Image data is available at the Polar Geospatial Center (PGC), University of Minnesota
MAPLE Clowder Extractor

**Input**

- lake_change_grid_3000_grossloss.tif

**Submit**

Submit dataset for extraction

- Extractor's Name: NCSA Radiant (OpenStack)
- Description: geoprocessing stack, zip file
- Parameters: geoprocessing stack, all input files to communicate with Clowder to retrieve HPC submissions
- Submit

**Output**

- WV03_2018083210107_10400100402E7100_18 AUG03210107-M1BS-502531227030_01_P003_u16rf3413_pansh.zip

**NCSA Radiant (OpenStack)**

- SSH
  - MAPLE
  - HPC SLURM Submission

**XSEDE Bridges2 (GPUs)**

- Kubernetes

FuncX for Submission to XSEDE Bridges2

- Use funcX to achieve better portability beyond Bridges2
- Do you need special permissions to run FuncX on head node?
  - Long running process?
This biophysical permafrost zonation map was produced using a rule-based GIS model that integrated a new permafrost extent, climate conditions, vegetation structure, soil and topographic conditions, as well as a wetness map. Permafrost in this map is classified into five types: climate-driven, climate-driven/erosion-modified, climate-driven/erosion-protected, ecosystem-driven, and ecosystem-protected. 81% of the permafrost regions in the Northern Hemisphere are modified, driven, or protected by ecosystems, indicating the dominant role of ecosystems in permafrost stability in the Northern Hemisphere. Permafrost driven solely by climate occupies 19% of permafrost regions, mainly in high Arctic and high mountains areas, such as the Qinghai-Tibet Plateau.


Lauren Walker, Chris Jones, Robyn Thiessen-Bock, Matt Jones, Amber Budden
The first pan-Arctic map of ice-wedge polygons. An ice wedge is a crack in the ground formed by a narrow or thin piece of ice that measures 3 to 4 meters in length at ground level and extends downwards into the ground up to several meters. Ice wedges are degrading with climate change, affecting watershed hydrology, and amplifying the loss of permafrost.
Tile Job Dispatcher

- Graph we are trying to build is not aligned with the tile structure
- Ideal: launch jobs as enough tiles stream in
- Realistic: Wait for all files to become available
- Parsl **pattern** for triggering jobs based on requirements?
Creating Raster and 3D Tiles at Scale
Clowder Parsl Extractor

• Prototyped a Clowder extractor to Launch Parsl jobs on local Kubernetes cluster
• Plan to generalize to make it easier to create Clowder extractors leveraging Parsl (Simple Clowder Extractors)
• Improvement: Ability to load incluster config in `parsl.providers.kubernetes.kube.py:107`:
  – `config.load_kube_config()` vs `config.load_incluster_config()`
Thank you!

https://permafrost.arcticdata.io

Navigating the New Arctic
Awards #
1927872, 1927723,
1927729, 1927720,
1927920, & 2052107