Global Water Futures 2021 Operations Team Meeting – Project Reporting Template

Instructions: All GWF projects are asked to provide a summary update on their activities and accomplishments in preparation for the upcoming Operations Team meeting. **Please submit these by email to chris.debeer@usask.ca by no later than December 2.** These will be used to help guide discussions and breakout synthesis activities and will be made generally accessible on our website in advance of the meeting.

Project Name:	Remotely Sensed Monitoring of Northern Lake Ice Using RADARSAT Constellation Mission and Cloud Computing Processing

Our major accomplishments to date are:

- Development of uncertainty quantification for retrieval of remotely sensed ice cover using bayesian neural networks tested on sea ice concentration
- Coding and initial testing of threshold algorithms using Sentinel-1 SAR data on Google Earth Engine.
- Development of an algorithm to derive satellite lake surface temperature on 500 lakes at Northwest Territories (1984 – 2021).
- Development of spatially distributed lake ice model coupled with satellite observations.

Our current activities are:

- Conducting literature review for bias correction methods for ice concentration
- Retrieval of ice cover on Northern Lakes using Synthetic Aperture Radar data and Convolutional Neural Networks (CNNs).
- Writing review paper of polarimetric decomposition algorithms for freshwater ice (lake, river, glacial) - to be submitted in early December to Remote Sensing of Environment.
- Algorithm testing for threshold-based intra-lake and North America-scale ice phenology on Google Earth Engine (Figs 4 & 5).
    - Development of algorithm validation using thermodynamic ice model with ERA-5 data as input.
- Building database of RCM data – troubleshooting opening SLC data (RCM user forum discussed difficulty opening Single-Look-Complex RCM data products using industry standard remote sensing software).
- Collecting in-situ data of lake surface temperature and ice thickness on selected lakes in Northwest Territories (in progress - Figs 1, -3).
- Collecting in-situ data of lake surface temperature and ice thickness on selected lakes in Northwest Territories.
- Validation and trend analysis of lake surface temperature on 500 lakes at Northwest Territories (1984 – 2021).
- Calibration of developed spatially distributed lake ice model coupled with satellite observations.

The main accomplishments expected by the end of the project are:

- Retrieval of lake ice cover from SAR using CNNs with uncertainty estimates
- Comparison of methods for bias correction of climate data (Bayesian approach vs quantile mapping)
- Retrieval of lake-ice phenology using Google Earth Engine on hemisphere-scale

- Retrieval of lake-ice phenology from SAR (GEE) within a lake (freeze-onset, melt-onset, and water clear of ice).
- Improved understanding of microwave interaction with freshwater lake ice (what physical structure of the ice is driving returned backscatter?
- Retrieval of ice thickness changes during the winter season through interferometry.
- Development of a validated and calibrated ice thickness model and lake surface temperature and ice thickness data (NetCDF format) for verification of spatial details of ice phenology and thickness (1984 – 2021).
- Improve understanding of the processes that regulate the changes in ice cover, extent and thickness in cold regions in a warming climate

Here is a key visual from the project (figure, photo, table, graph, etc.)

Fig.1: Collecting snow depth and ice thickness using magnaprobe and ground penetrating radar (GPR) on Vee Lake, Northwest territories, November 29, 2021.

Fig.2: Collecting ice thickness on Landing Lake, Northwest territories, November 28, 2021.

Fig.3: Using RPAS to map snow depth and distribution on Finger Lake, Northwest territories, November 29, 2021.

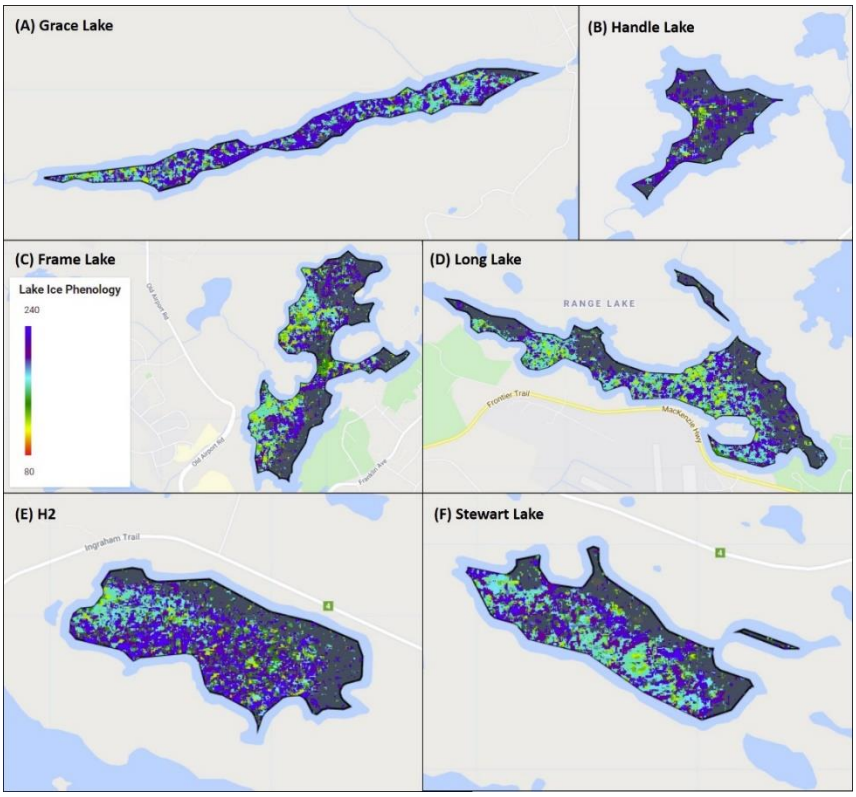

Fig.4: Intra-lake ice phenology for lakes of interest in the North Slave Region for 2020-21 derived using Google Earth Engine

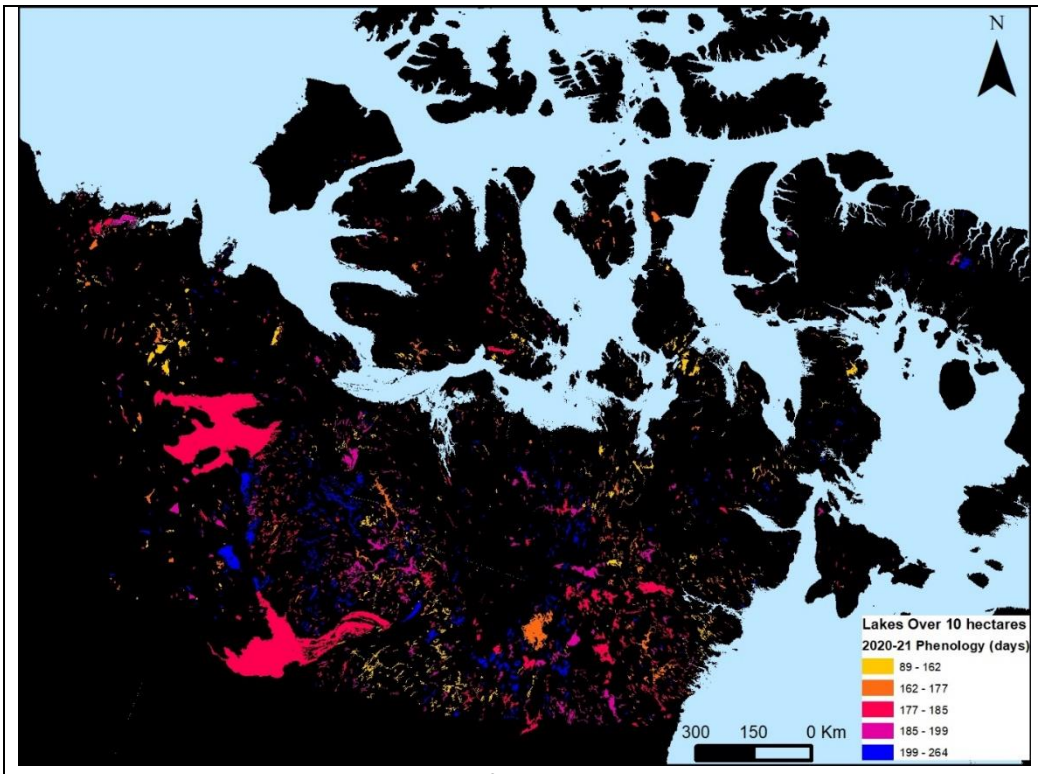

Fig.5: Lake-wide median ice phenology for Canadian lakes greater than 10 hectares above 60° N derived from Google Earth Engine threshold algorithm.