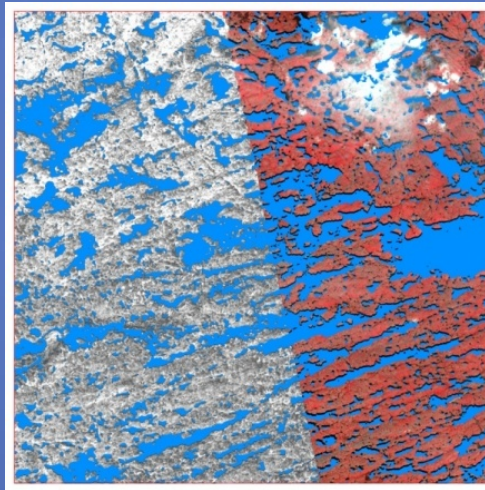


Lakes sediments and carbon

Jamie MacGregor



School of Earth and Ocean Science
University of Victoria

- Introduction & context
- Thesis objective
- Data processing:
 1. PALSAR vs CanVec
 2. CanVec and carbon estimates
 3. Local coring perspective



Introduction

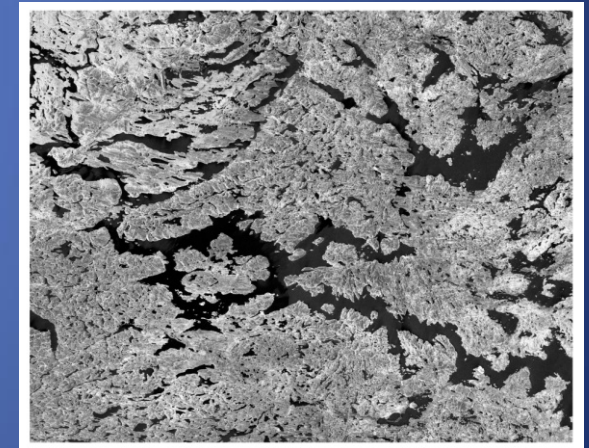
- Quantifying lake interactions with the environment
 - Carbon accumulation in lake sediments:
 - Many things influence carbon accumulation rates in lake sediments
 - Catchment characteristics
 - Geomorphology
 - Water chemistry
 - **Lake size**
 - Several studies have found a strong relationship between lake size and carbon accumulation (Kortelainen et al. 2004, Pajunen 2004)
 - Estimates of carbon accumulation at regional scales

Objective

- Construct a lake database
 - A database describing lake size distribution (count, area and shape) can be used to investigate lake functions (carbon accumulation) at regional scales
- There are several hydrographic databases already (E.g. CanVec, GLWB)
- Limited spatially and/or temporally
- Compiled from multiple sources

Synthetic Aperture RADAR (SAR)

- PALSAR sensor on the ALOS satellite
 - Launched by JAXA in 2006
 - L-band SAR sensor
 - All weather night and day acquisition capability
 - Favorable target interaction qualities
- Continuous coverage
- Single source
- Single time period
- Allows for the construction of a lakes database at both high spatial and temporal resolution
 - Canada wide coverage as part of the K&C initiative



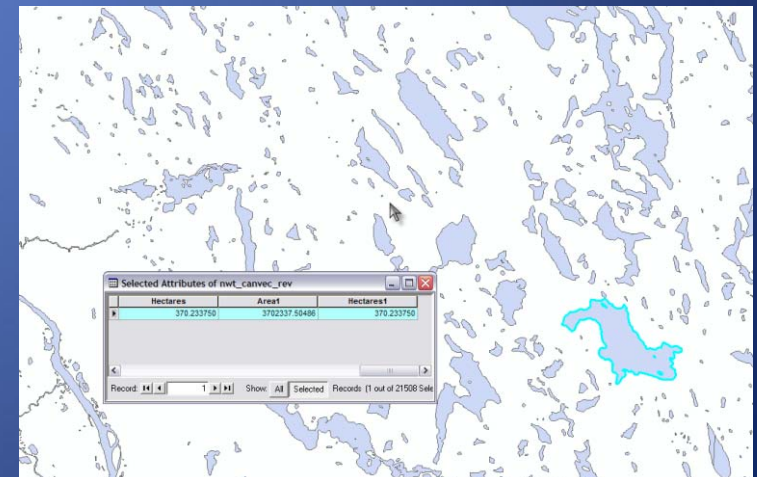
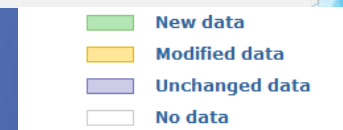
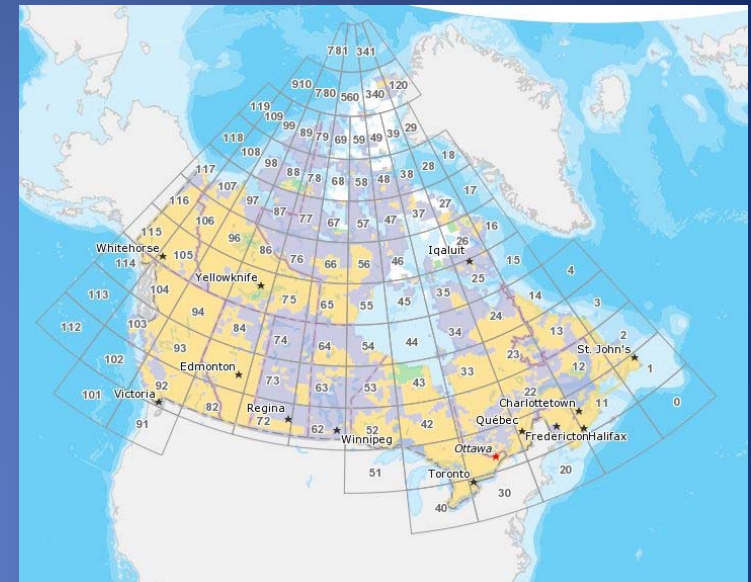
Images: The ALOS Kyoto & Carbon Initiative Science Plan (v.3.0)

PALSAR

- PALSAR data delivery delayed
- No 50m mosaic coverage for Canada in time for masters completion.
- New plan: Comparison of PALSAR and CanVec datasets
- Pros/cons of:
 - Data resolution temporal/spatial
 - Accuracy
- CanVec seems to be the next best choice

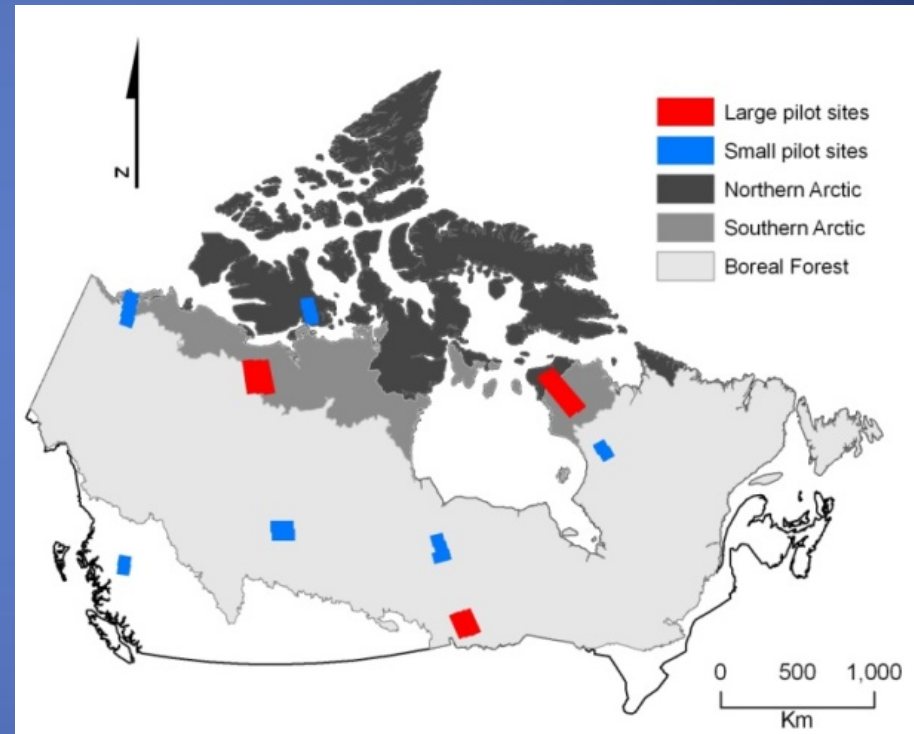
What is CanVec?

- Free cartographic reference product produced by NRCan
- 11 distribution themes including hydrographic data
- Very good spatial resolution
 - lakes on the order of $\sim .25$ Ha
- Limited by temporal resolution
 - Can span up to 50 years



PALSAR Vs CanVec

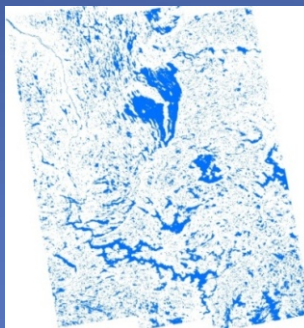
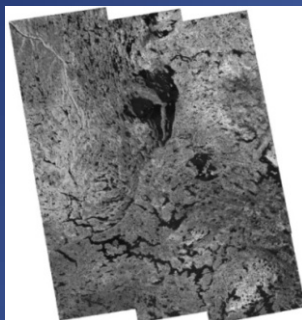
- Analysis restricted to several pilot sites across Canada
- Three large focus sites:
 - NWT
 - Northern Quebec
 - ELA
- Expand CanVec coverage to regional scales



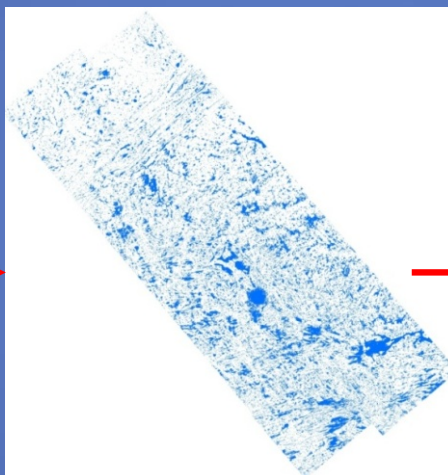
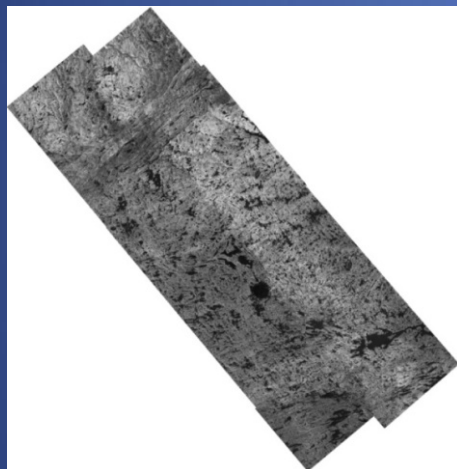
PALSAR Imagery

PALSAR Lake Classification/ CanVec

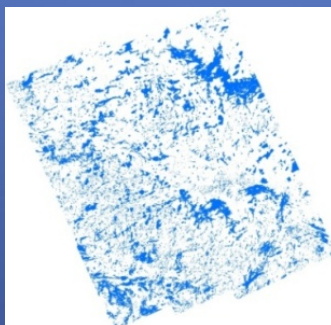
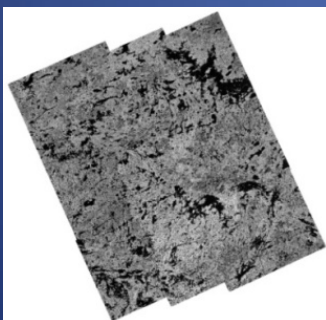
NWT



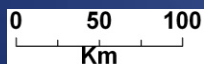
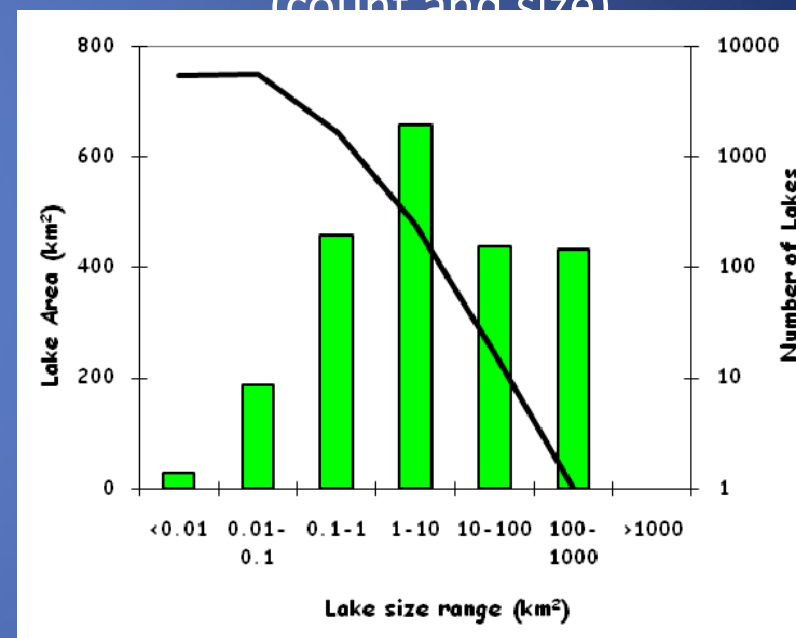
Northern
Quebec



ELA

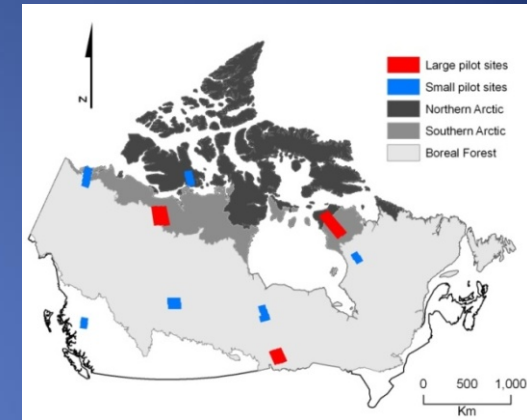


Lake size
distribution
(count and size)



CanVec and Carbon estimates:

- Lake size distribution (count and size) allows us to estimate carbon accumulation in Canadian lake sediments at regional scales
- Here we use Finnish data*
 - Vary as a function of size
 - Large census (140 lakes)
- Incorporation of Canadian accumulation rates
- Goal is to get regional estimates of carbon accumulation in lake sediments



Carbon accumulation rates

Lake Size (Km ²)	g/m ² /yr
<0.1	2.4
0.1-1	4
1-10	3.1
10-100	1.8
>100	0.96

(Pajunen 2004)

PALSAR derived carbon accumulation in Canadian lakes per 100,000 km² per year

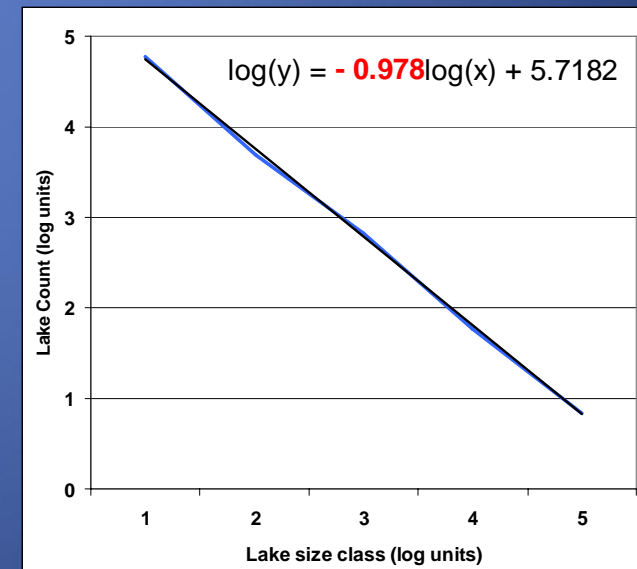
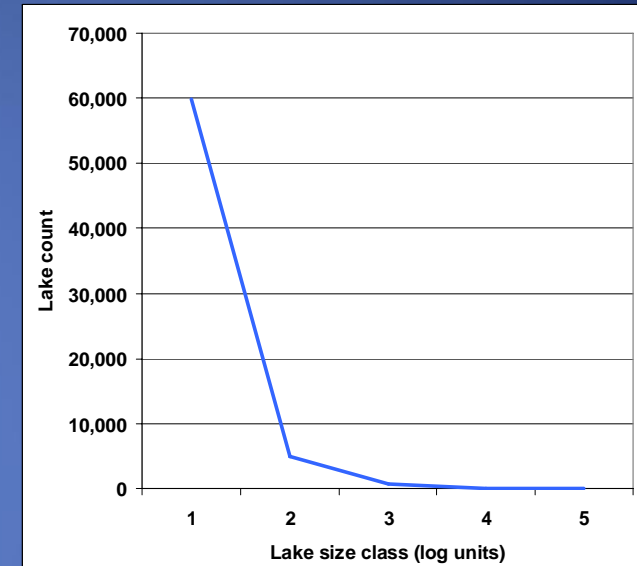
Lake size (km ²)	Boreal	South Arctic	North Arctic
<0.1	0.15	0.24	0.08
0.1-1	1.07	0.94	0.20
1-10	1.10	0.79	0.10
10-100	0.76	0.28	0.11
>100	0.57	0.20	0.00
Total Carbon in megatonnes (Mt)	3.65	2.45	0.48
Mt CO ₂ Equivalent	13.39	9.00	1.77
Number of Cars ¹	2,579,000	1,733,000	342,000

¹Based on EPA average annual emissions for passenger cars, April 2000. (<http://www.epa.gov/oms/consumer/f00013.pdf>)

Other uses of the data:

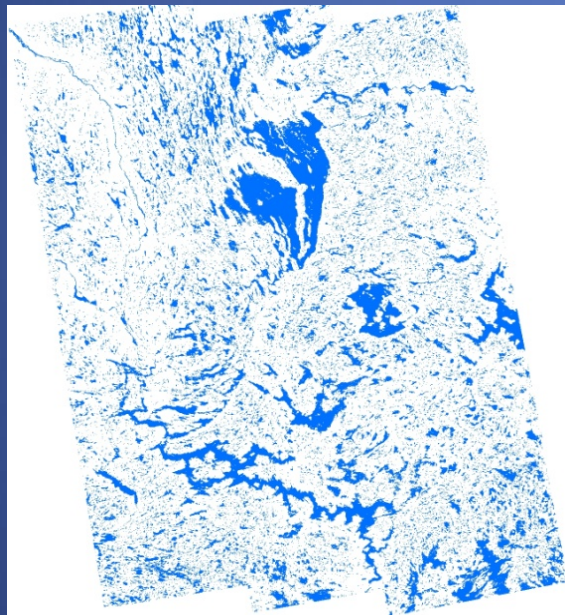
Thematic lake map

- The density of lakes increases going from large lakes to small lakes (Maybeck 1995)
- I.e. there are usually many more small lakes than large
- Can be described by a simple log-linear regression:
 $\log(\text{lake density}) = m \log(\text{lake size}) + b$
- Slope (m) will vary as a function of the underlying lake size distribution
- We can utilize this to thematically express how the lake distribution changes across the landscape



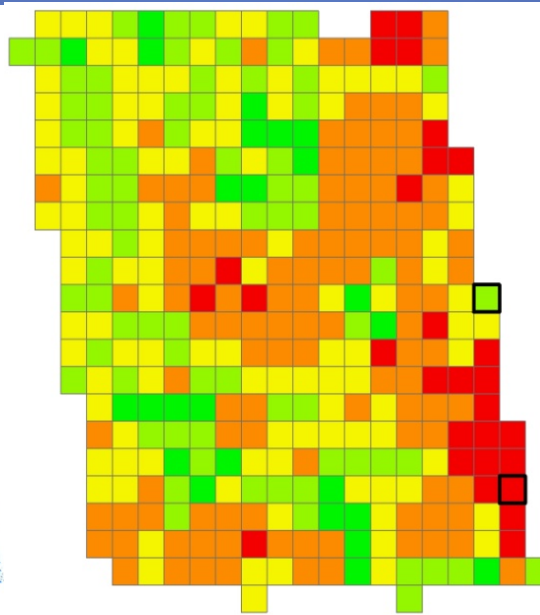
Thematic lake maps

Lake polygons

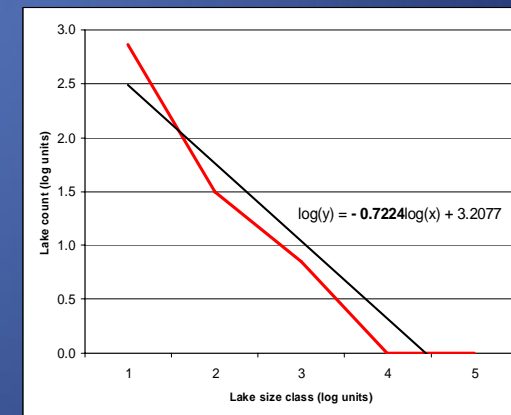
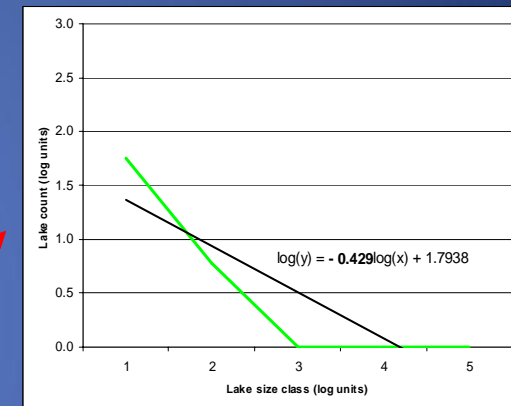


0 50 100
Km

Lake size distribution
“slope map”

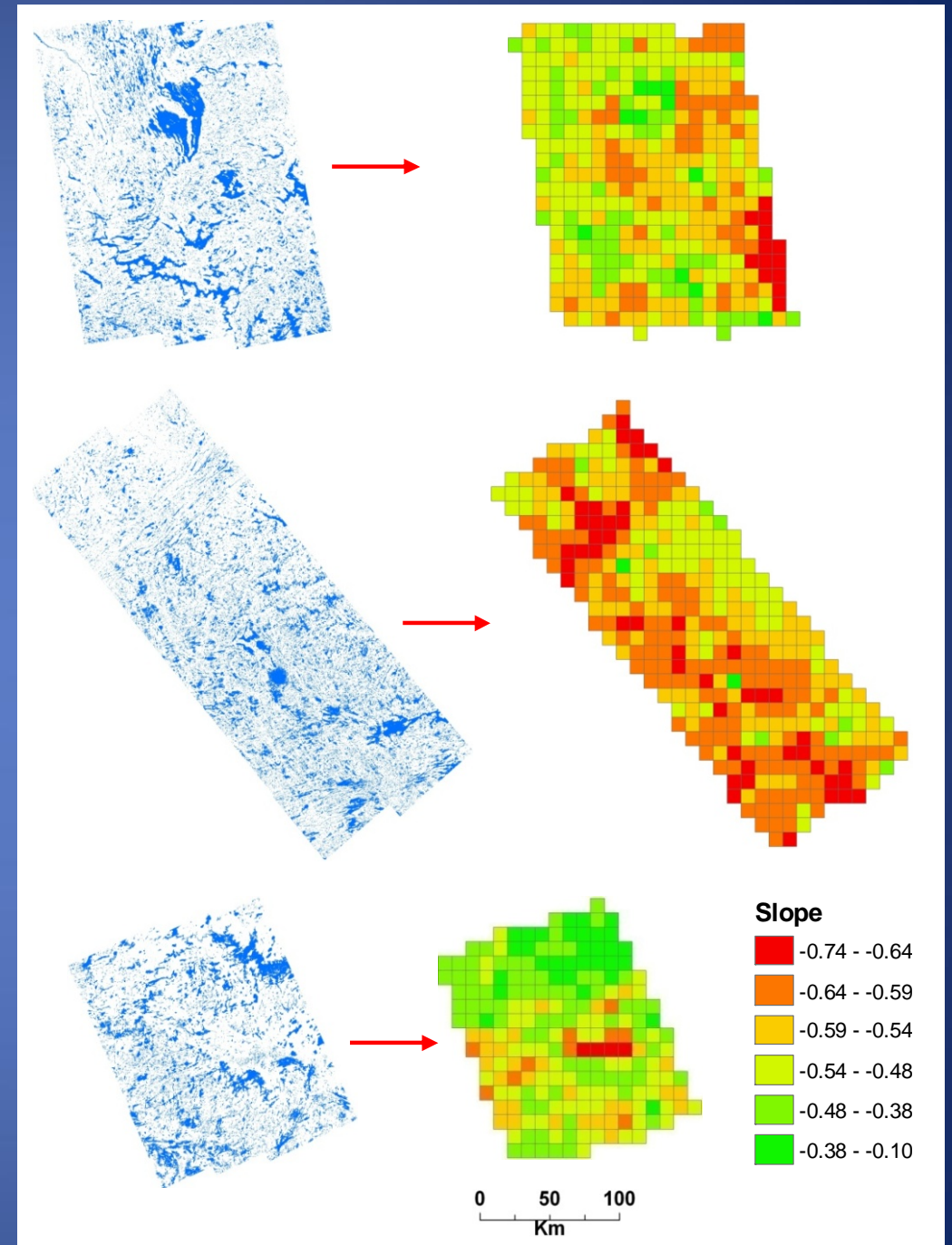


ALOS K&C © JAXA/METI.



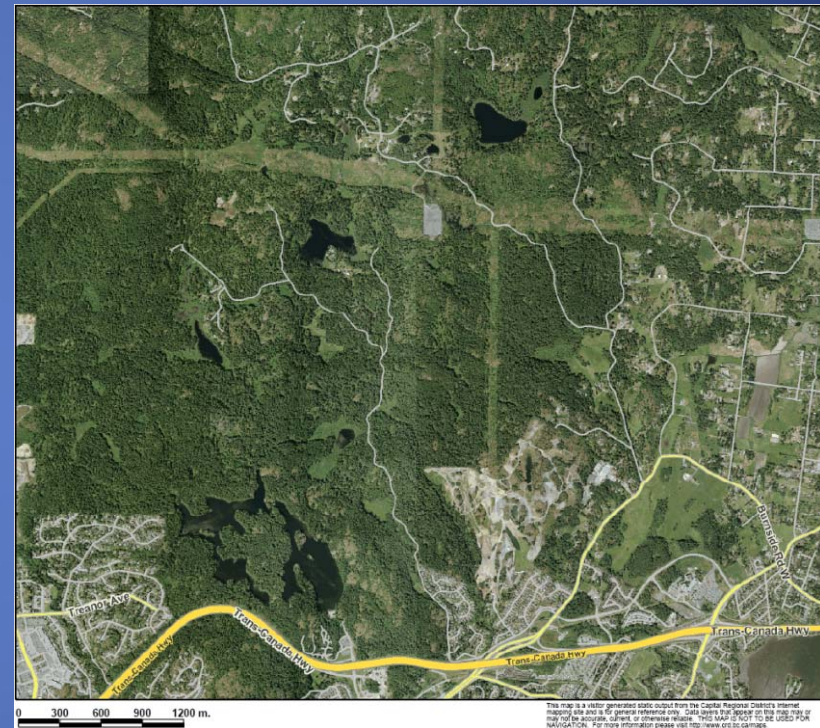
Slope map applications:

- Help to extrapolate lake sediment carbon accumulation measurements across Canada
- A parameterization of the land surface for use in climate modeling studies?
 - Currently lakes, which are known to have strong feedbacks on the atmosphere, are not adequately represented in models.



Coring data:

- Supplement thesis main objective
- Local lakes:
 - Maltby and Prior lake
 - Collected in 2000 by T. James (GSC)
- Estimates of OC content
 - Present \longleftrightarrow Holocene



Acknowledgments

- Special thanks to:
 - JAXA and the K&C Initiative
http://www.eorc.jaxa.jp/ALOS/en/kyoto/kyoto_index.htm
 - Kevin Telmer and Maycira Costa
 - UVic aqueous geochemistry lab group peers
(Daniel, Ricardo, Pete)