Phragmites Mapping with SAR

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Annual Meeting Society of Wetland Scientists

Duluth, Minnesota, June 2-6, 2013

Outline

- Project Description
- Background
- Polarimetry and Compact Polarimetry
- SAR Data and Processing
- Preliminary Results
- Summary
- Future Work

Project Description

- Investigate polarimetric RADARSAT-2 Synthetic Aperture Radar (SAR) data to map the extent of *Phragmites* in the Georgian Bay Islands National Park, Ontario.
- Data is used for polarimetric analyses and to simulate compact polarimetry data in preparation for the RADARSAT Constellation Mission (RCM)
- Identify future R&D for RCM

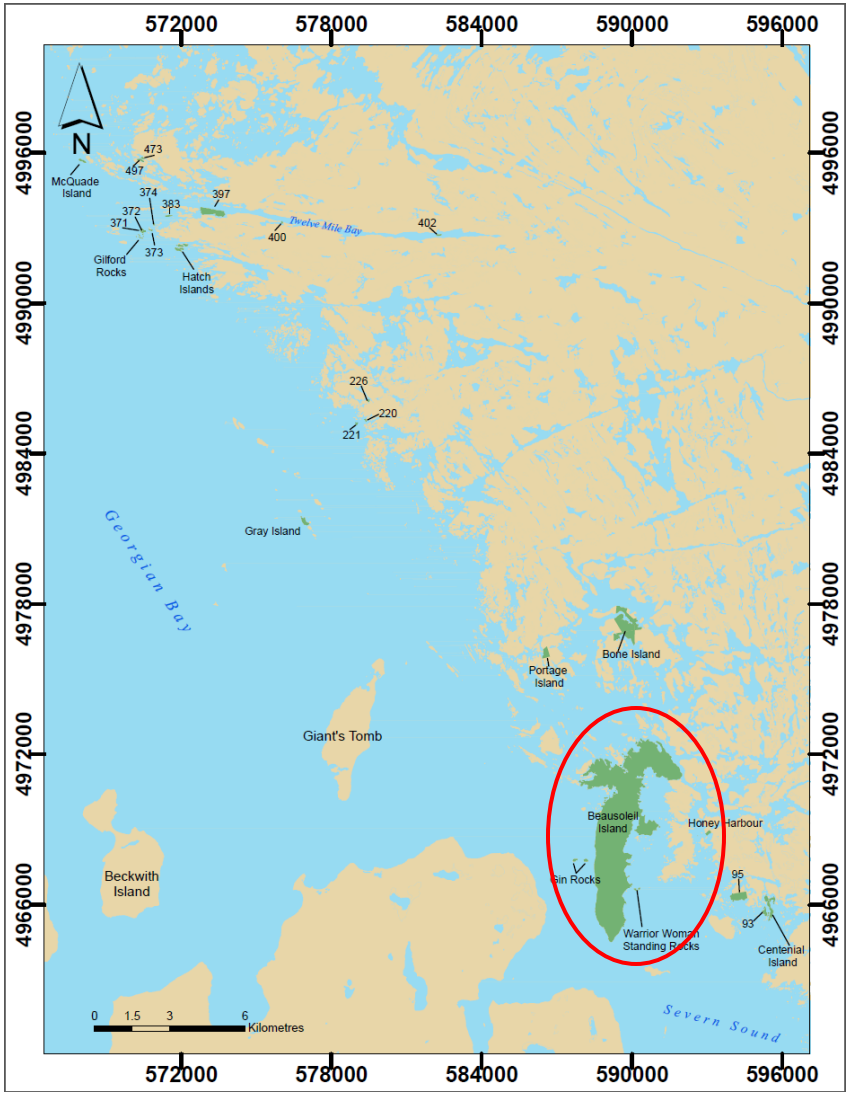
Georgian Bay Islands National Park

Partners:

- Prabir Roy and Jean Poitevin, Parks Canada

Site:

- Georgian Bay National Islands Park
  - Beausoleil Island



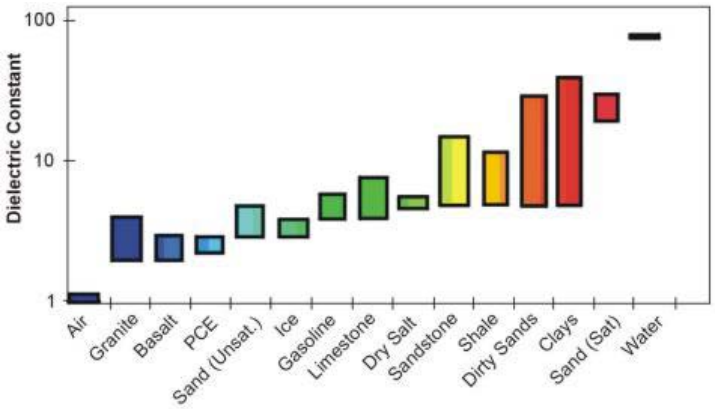
Background

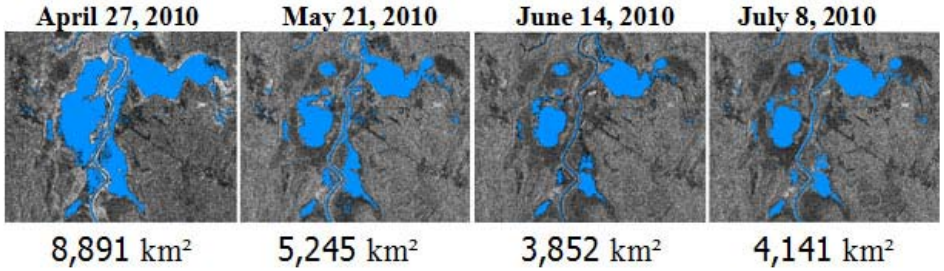
- *Phragmites australis* has become an invasive species in the Great Lakes region
- Largely due to changing climate conditions that expose large areas of fertile ground around wetlands
- Tall grassland species, native flora and fauna face significantly reduced habitats

SAR & Water Rational

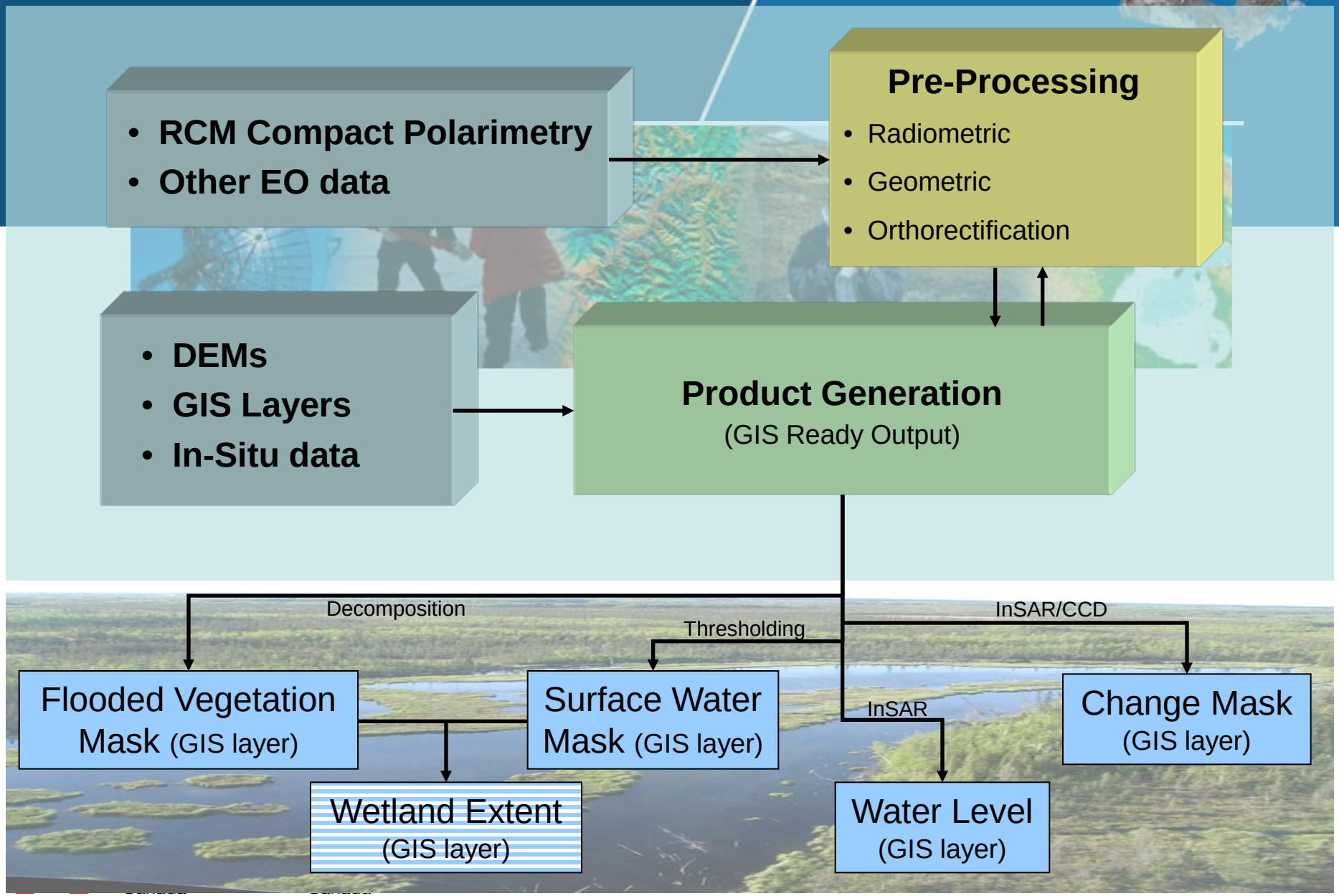
- Dielectric Constant – major target parameter

  Water ~ 70 Ice ~ 2-5
  Air ~ 1
- RADAR – Water Seeker
- Standing Water – Specular
- “Bound” Water – in general backscatter magnitude increases as water increases while penetration depth decreases





SAR Surface Water Monitoring



Polarimetry provides…

$$E^S = \frac{e^{jk_0 r}}{r}\begin{pmatrix} S_{vv} & S_{vh} \\ S_{hv} & S_{hh} \end{pmatrix} E^i$$

Scattering matrix
(complex)

$$\sigma^\circ \cong \sigma^\circ_{ground} + \sigma^\circ_{vegetation-ground} + \sigma^\circ_{vegetation}$$

5 independent measures

3 Backscatter coefficients $\sigma°$

amplitudes: *Svv, Shh, Shv*

2 Phases differences $\Delta\phi$

$$\phi_{like} = \phi_{hh} - \phi_{vv}$$

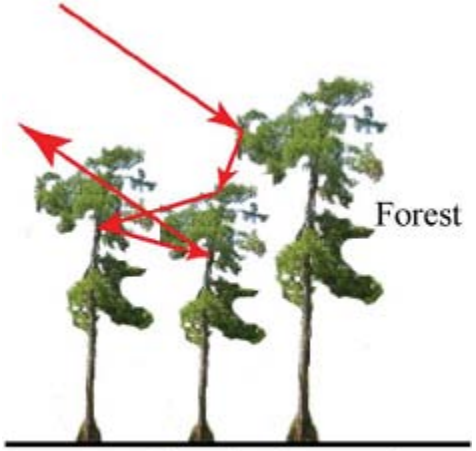
$$\phi_{cross} = \phi_{hh} - \phi_{hv}$$

Freeman-Durden Decomposition

$$|S_{HH}|^2 + |S_{HV}|^2 + |S_{VH}|^2 + |S_{VV}|^2 =$$

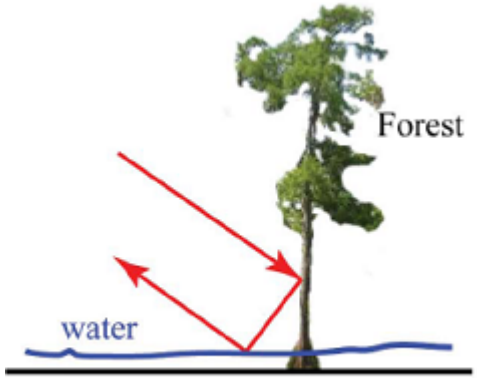
Surface backscattering

+



Volume backscattering

+

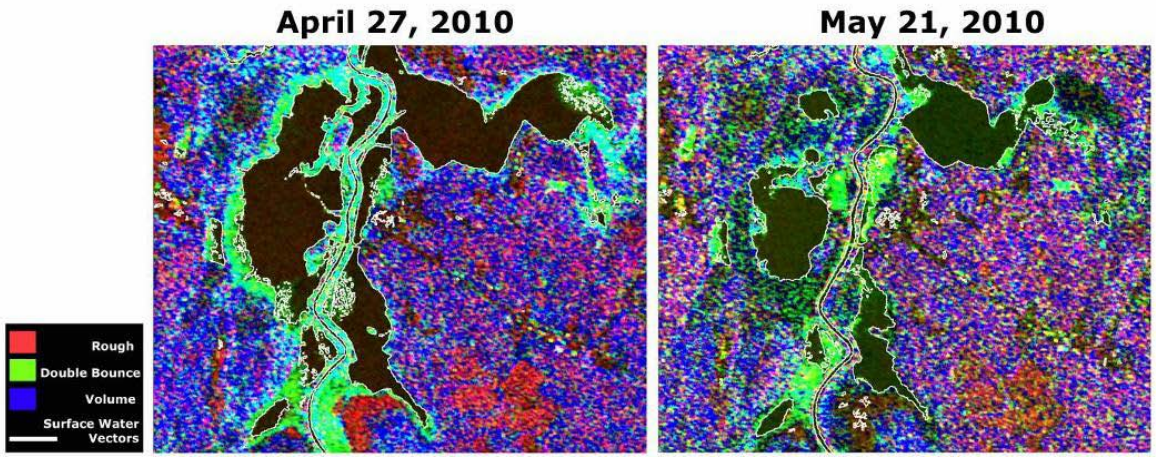


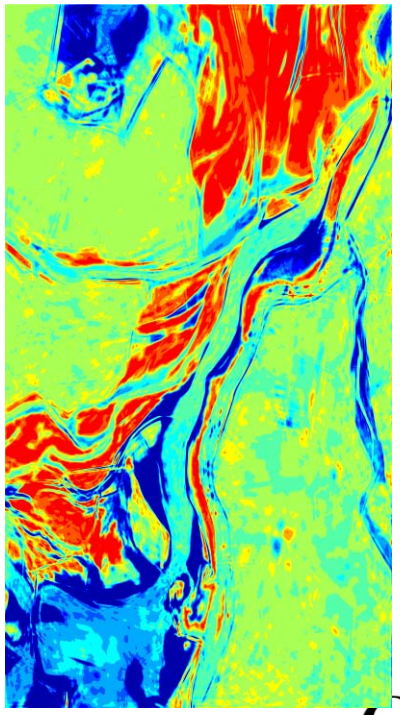
Double-bounce backscattering

$$= \text{Total Intensity}$$

SAR and Flooded Vegetation

- Prototype techniques and approaches have been developed for the application of satellite SAR to the mapping of flooded vegetation
- Flooded vegetation has dominant double bounce scattering
- Polarimetric decomposition can be used to highlight flooded veg



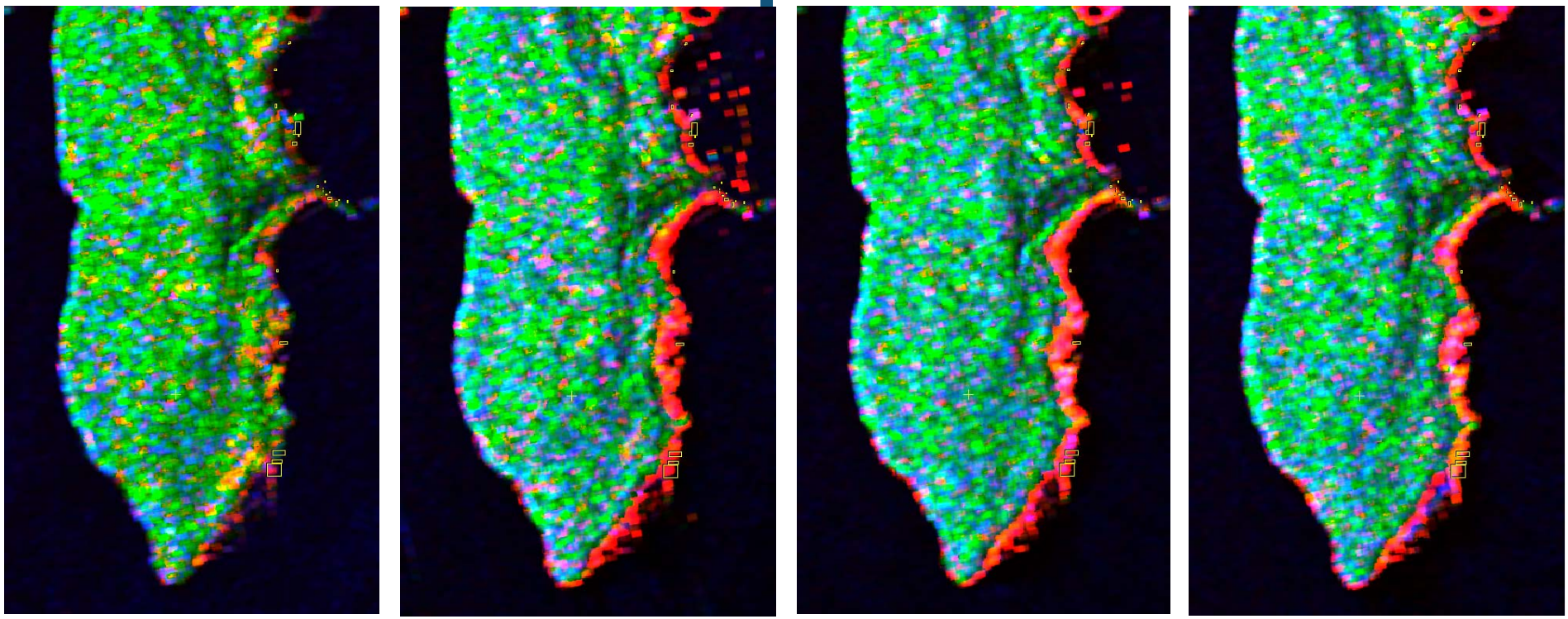


Dong Ting Lake
Δ Double Bounce

SAR DATA

2009		2012		2013	
Date	Beam Mode	Date	Beam Mode	Date	Beam Mode
20-May-09	FQ16	25-Mar-12	FQ28	26-Feb-13	FQ25
13-Jun-09	FQ16	20-Apr-12	FQ25	15-Apr-13	FQ25
24-Aug-09	FQ16	14-May-12	FQ25	02-May-13	SLA25
17-Sep-09	FQ16	07-Jun-12	FQ25	09-May-13	FQ25
		01-Jul-12	FQ25	02-Jun-13	FQ25
		18-Jul-12	SLA25	19-Jun-13	SLA25
		25-Jul-12	FQ25	26-Jun-13	FQ25
		11-Aug-12	SLA25	20-Jul-13	FQ25
		18-Aug-12	FQ25	20-Jul-13	SLA25
		11-Sep-12	FQ25	13-Aug-13	FQ25
		28-Sep-12	SLA25	30-Aug-13	SLA25
				06-Sep-13	FQ25
				30-Sep-13	FQ25

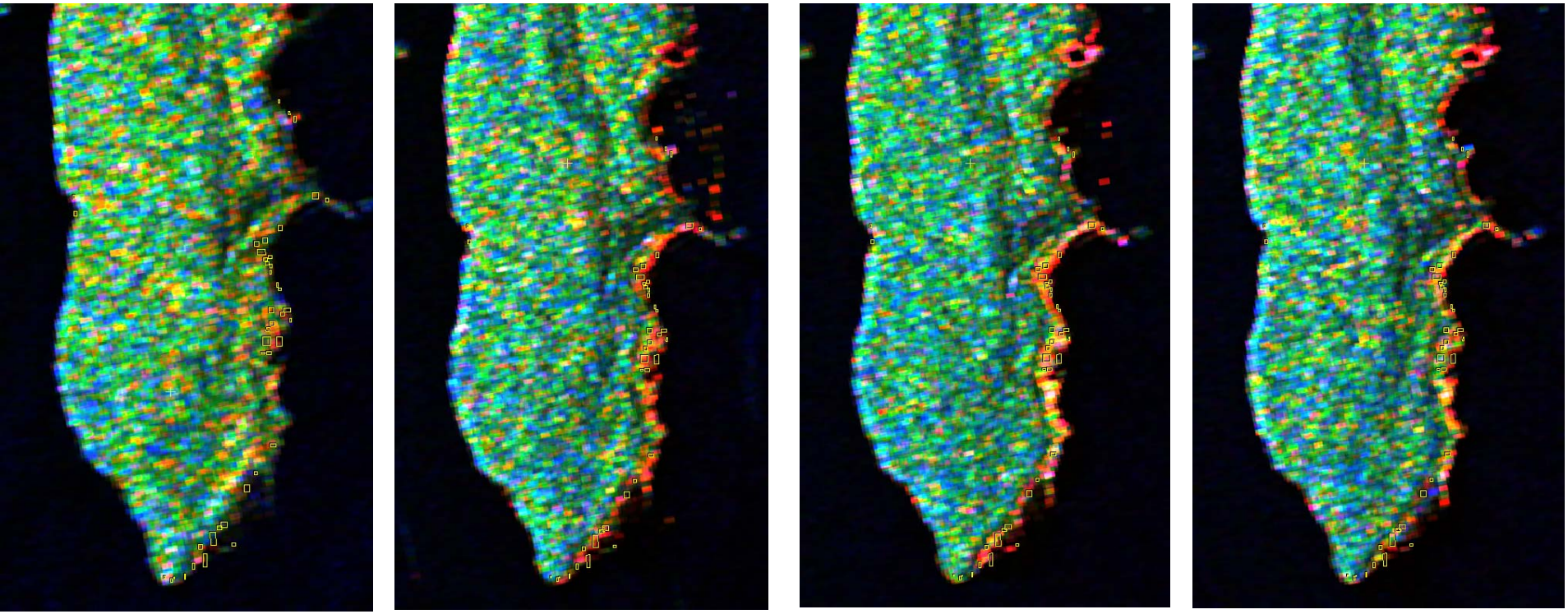
2009 Results: Freeman-Durden Decomposition



May 20, 2009 June 06, 2009 Aug. 24, 2009 Sept. 17, 2009

Red = Double Bounce, Green = Volume, Blue = Rough Surface

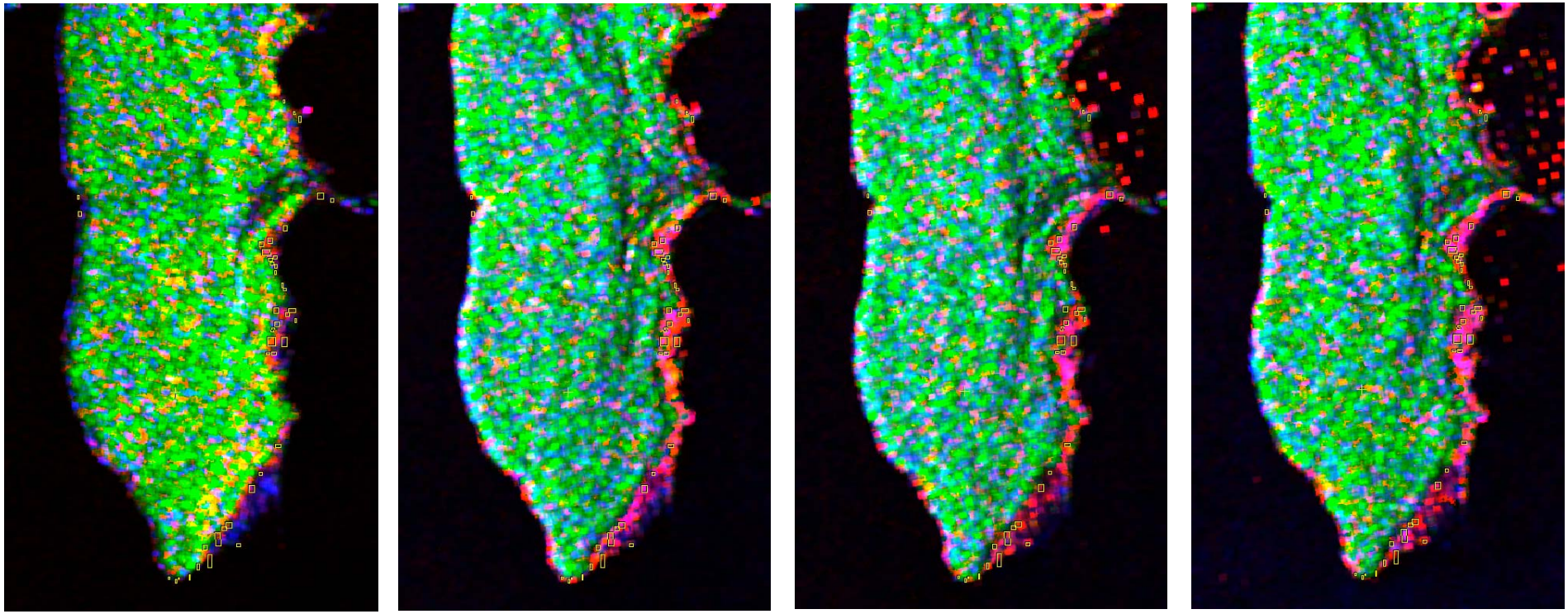
2009 Results: *M-Chi* Decomposition



May 20, 2009 June 06, 2009 Aug. 24, 2009 Sept. 17, 2009

Red = Double Bounce, Green = Volume, Blue = Rough Surface

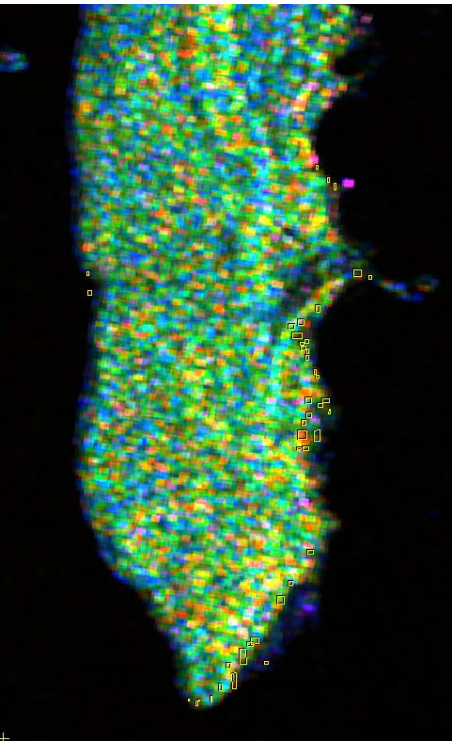
2012 Results: Freeman-Durden Decomposition



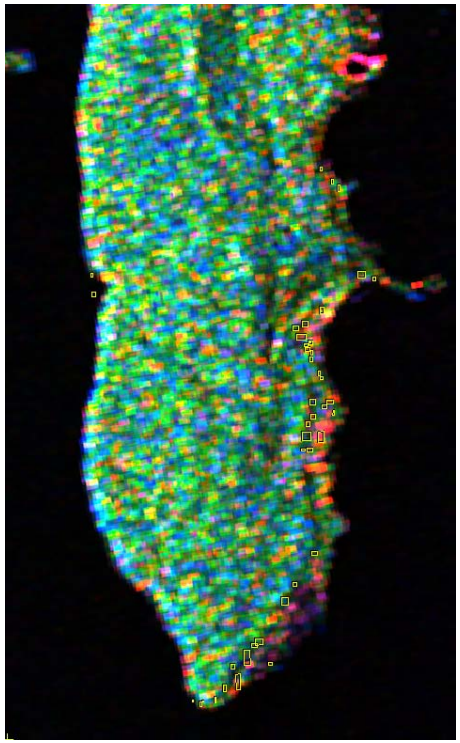
March 25, 2012 June 7, 2012 July 25, 2012 Aug. 18, 2012

Red = Double Bounce, Green = Volume, Blue = Rough Surface

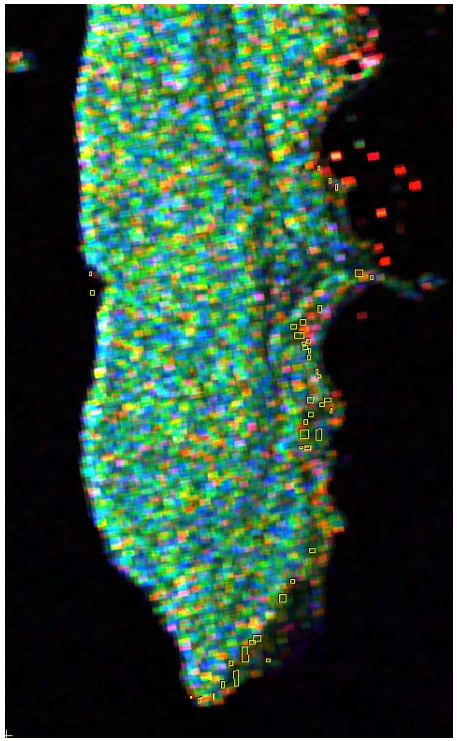
2012 Results: *M-Chi* Decomposition



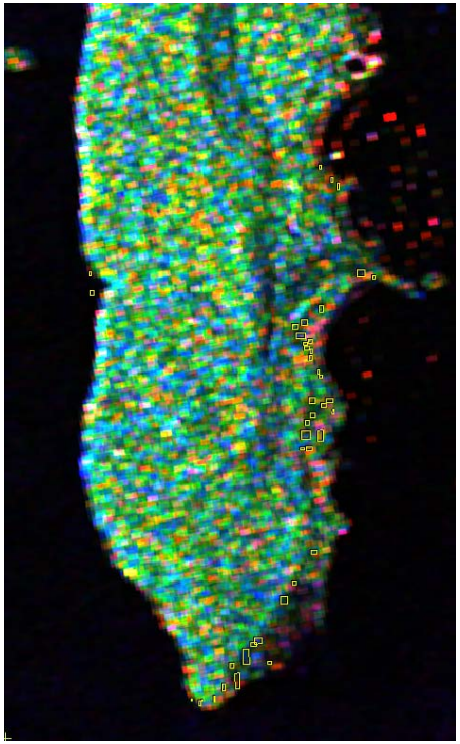
March 25, 2012



June 7, 2012



July 25, 2012



Aug. 18, 2012

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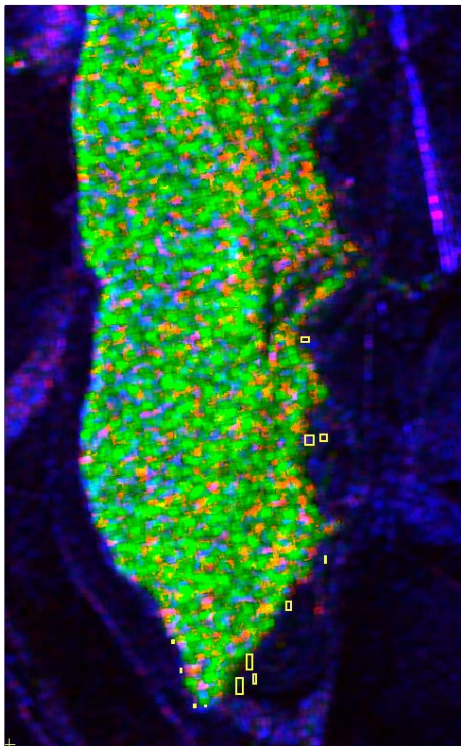
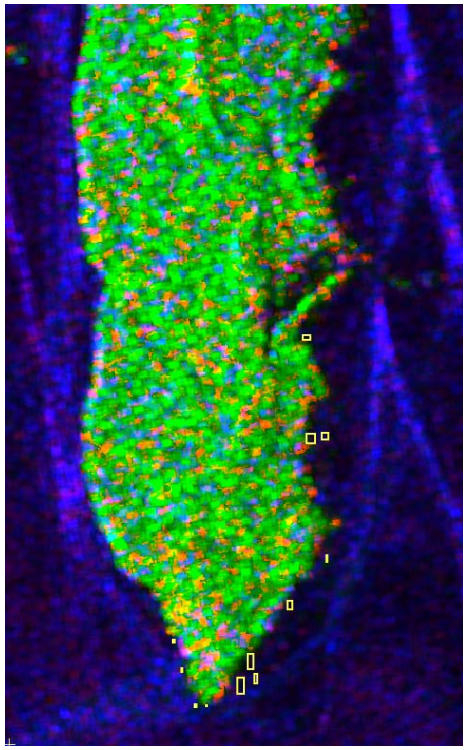
2013 Results: Freeman-Durden Decomposition



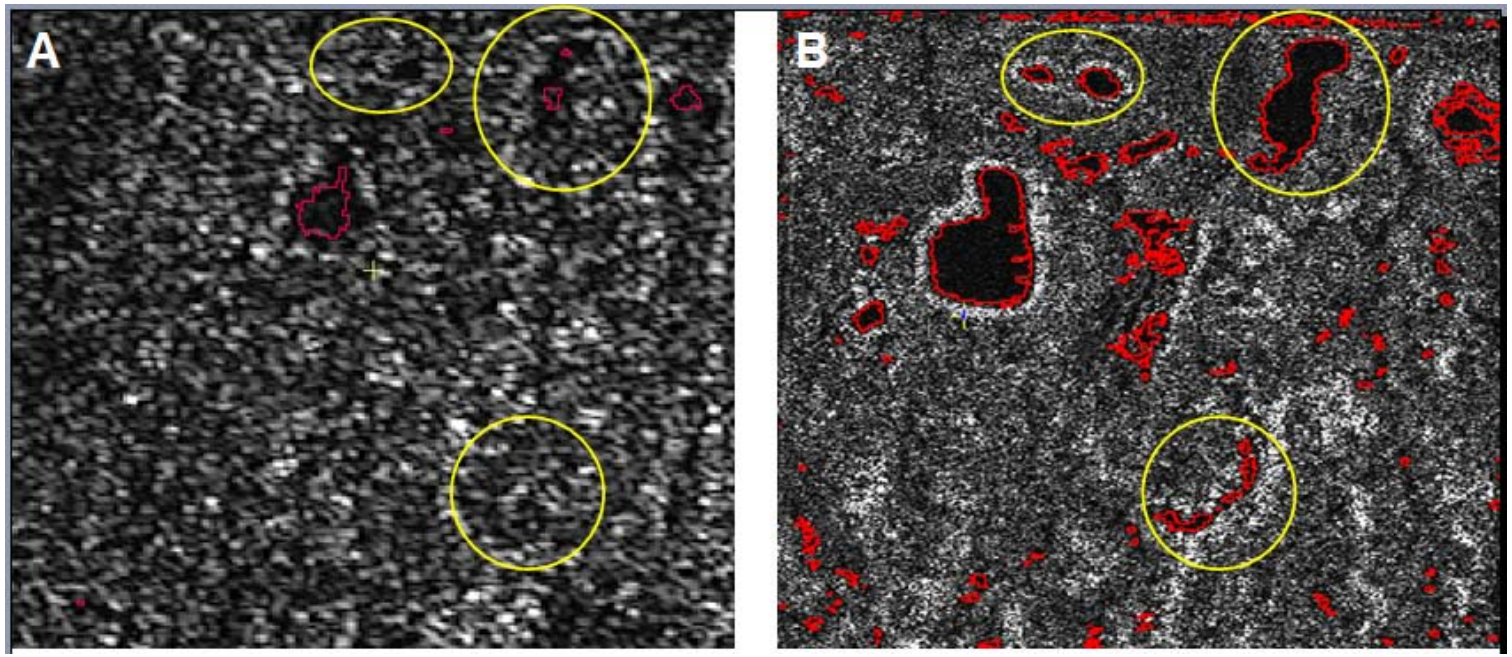
Jan. 09, 2013



Feb. 26, 2013

Red = Double Bounce, Green = Volume, Blue = Rough Surface

Spotlight and Fine Quad Imagery Comparison



June 8th, Fine Quad Image

June 9th, Spotlight Image

Smith Creek Watershed

Summary

- *Phragmites* returns a strong double-bounce response in the summer imagery, but it cannot be separated from marsh or swamp using C-band
- To accurately map small patches of *Phragmites* high resolution imagery is needed
- Wetland classification and threshold values for *Phragmites* is still being established
- The phase in fully polarimetric SAR data helps with *Phragmites* classification
- Other researchers found winter to be useful for detecting *Phragmites* patches. May be due to the frequency of L-band.

Future Work

- RADARSAT-2 Fine-Quad and Spotlight data for another summer and winter season
- Investigate Spotlight data in the winter season
- Acquire ALOS imagery and work with Laura Bourgeau-Chavez to investigate L-band