

Satellite observation of boreal land cover: methods, data sets and application

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Presenter:

Rasim Latifovic

Objectives

1. To develop an objective, robust, operational **method** for producing forest and other land cover information at the regional level.
2. To produce land cover **maps** over the 1993-2001 period using coarse resolution satellite data
3. To prepare a **database** of wetland distribution for Canada using a combination of remotely sensed and other data types
4. To develop **methods** for quantifying the content of coarse resolution land cover maps using high resolution satellite data or other information sources
5. To obtain **statistic** for land cover distribution at national, provincial and sub-provincial level using an optimum combination of coarse and high resolution data
6. To use the land cover information for deriving higher level **products** and to study surface-atmosphere interaction and the role of land cover in carbon and hydrological cycle

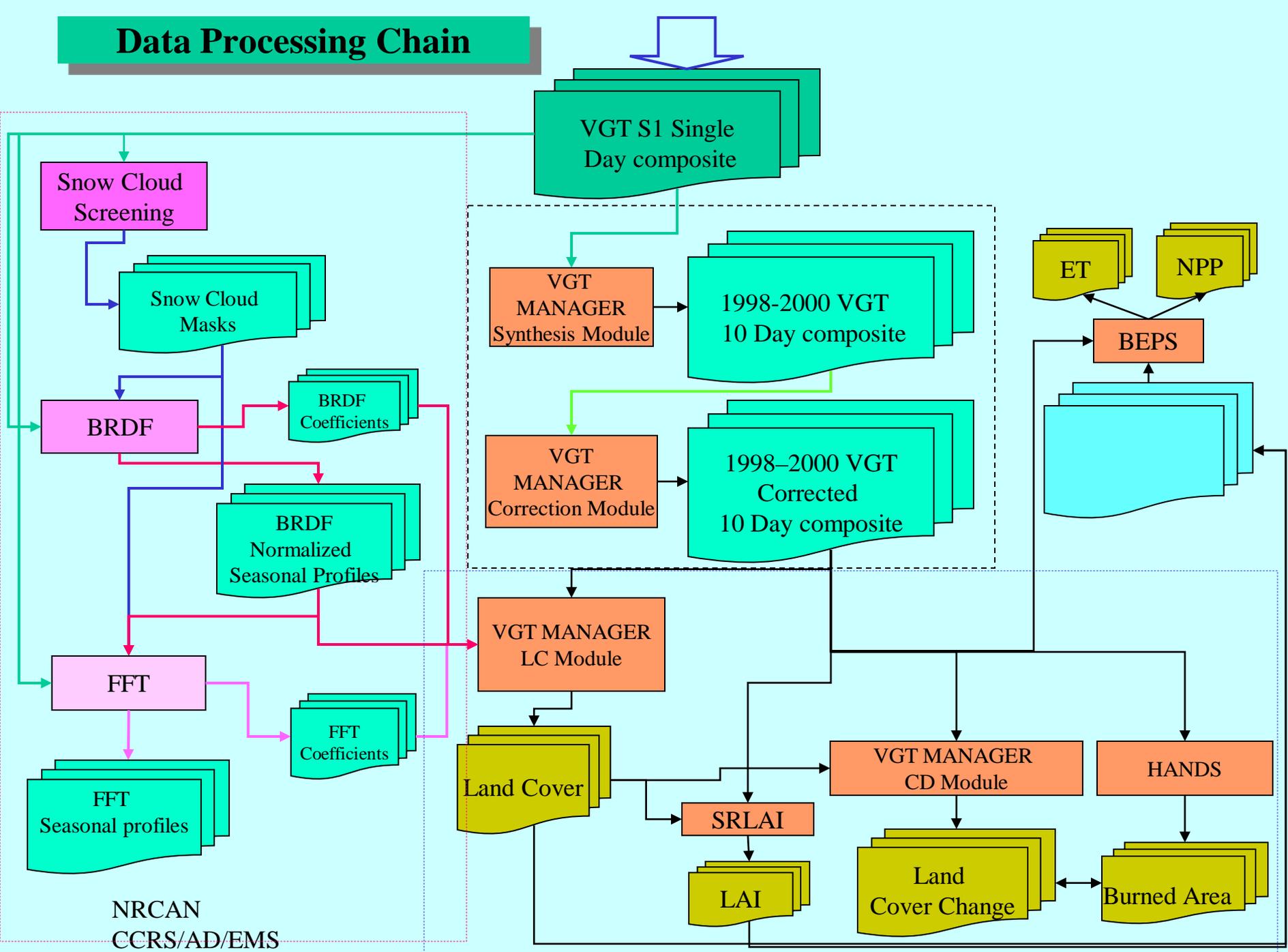
Objective 1, 2 and 5

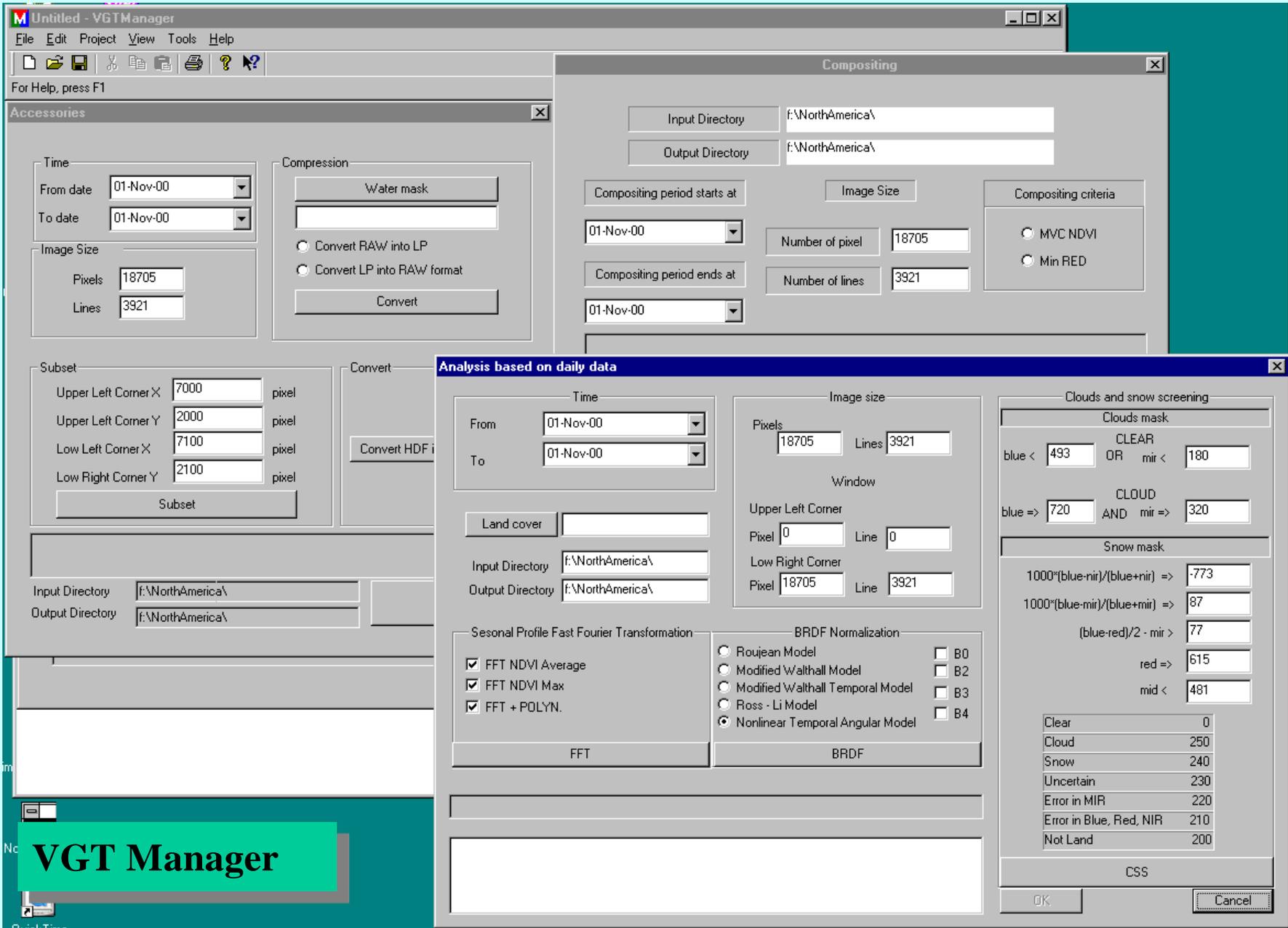
Systematic data correction procedure for temporal studies

Land cover classification

Land cover change detection

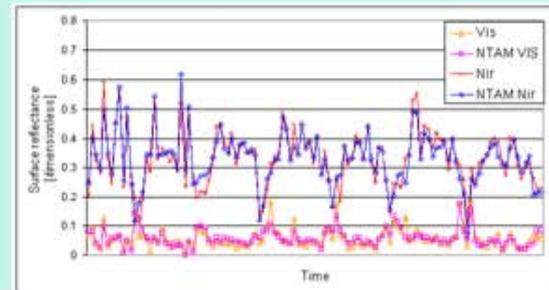
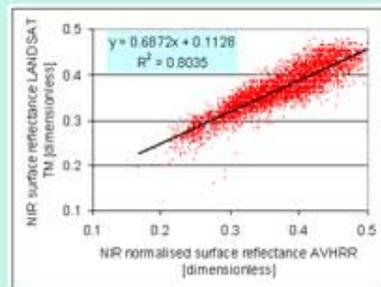
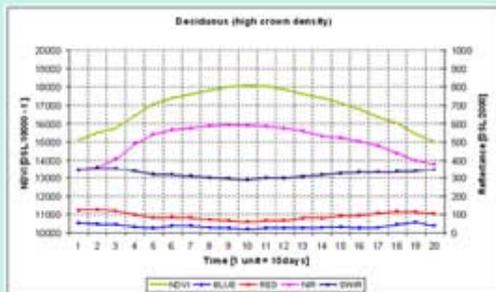
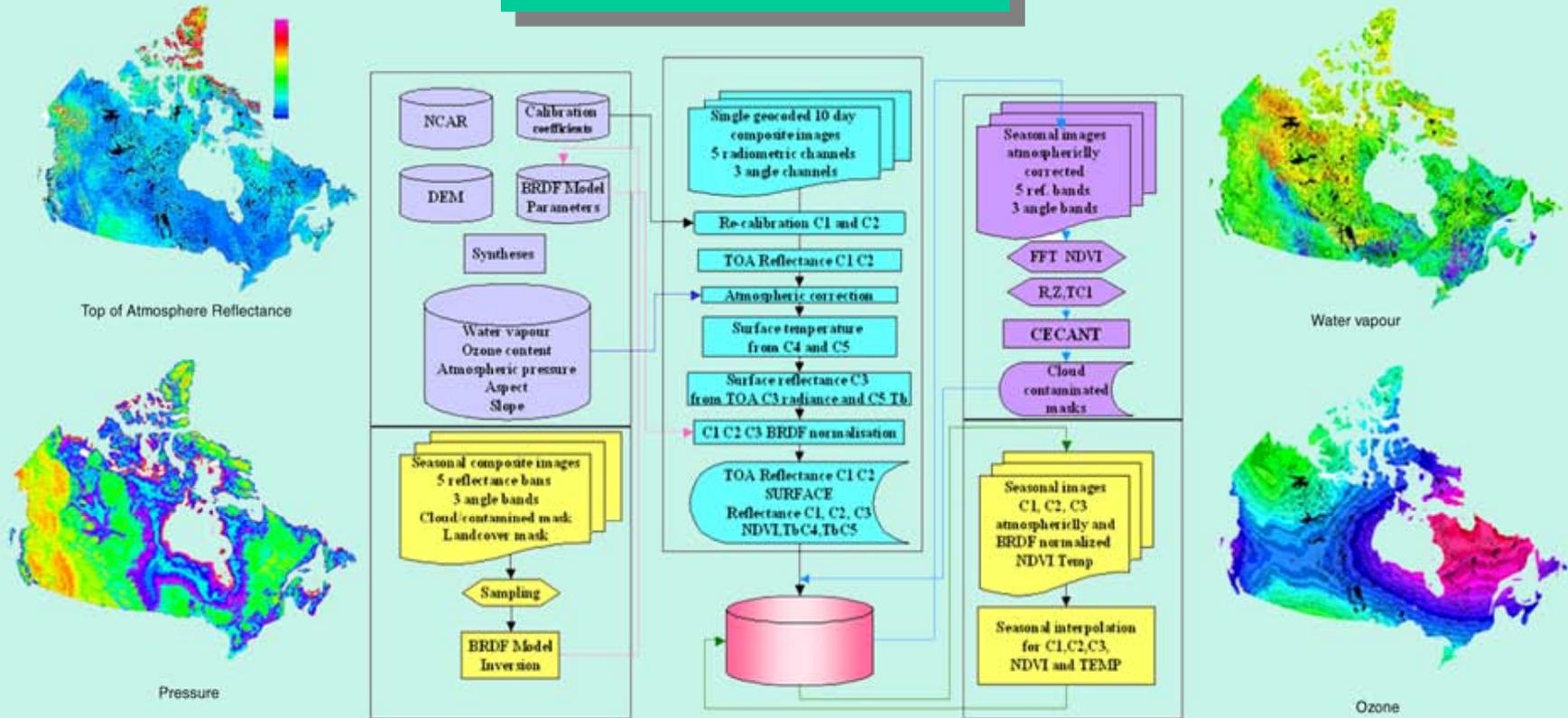
Data Processing Chain

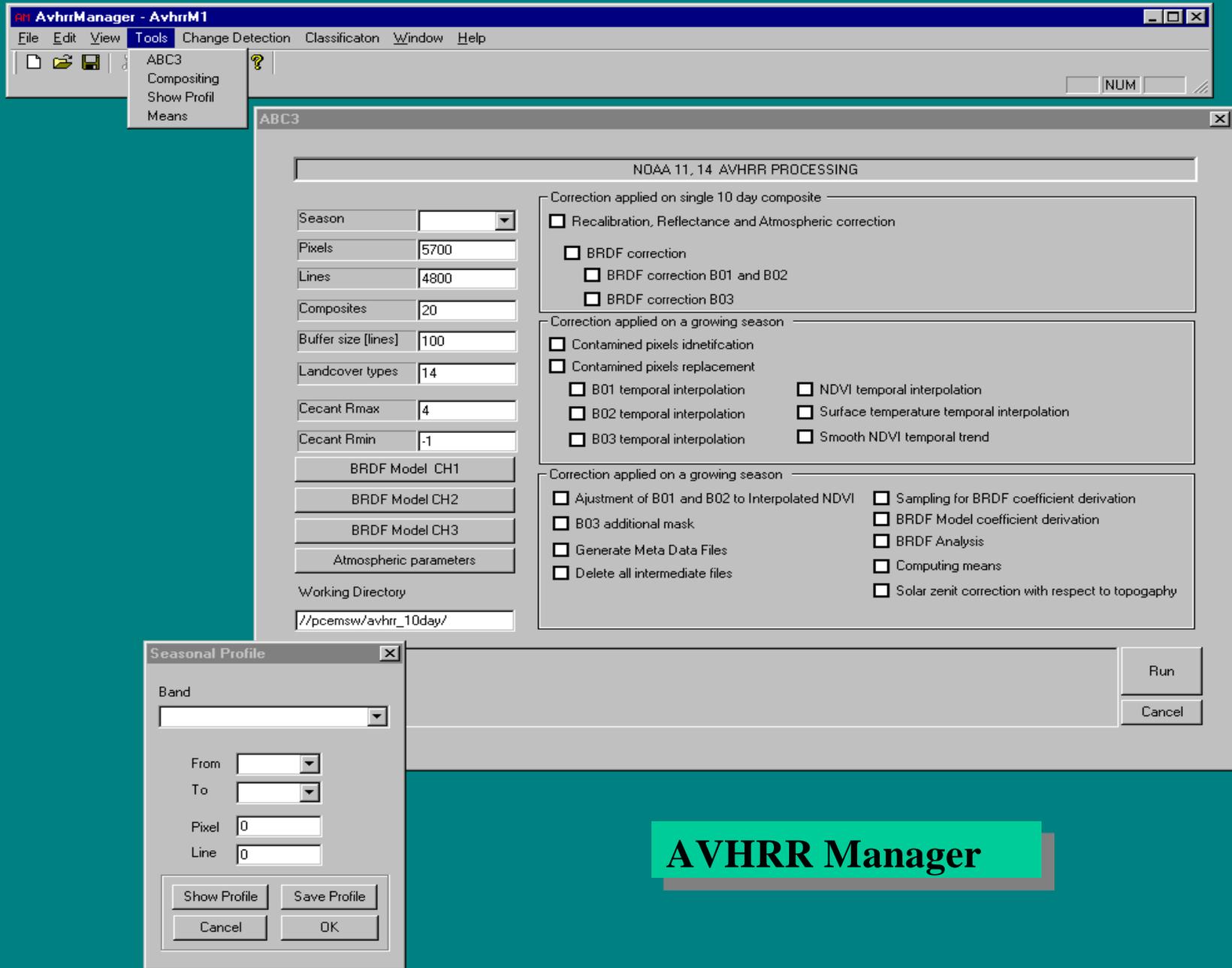




VGT Manager

ABC3V2 Methodology

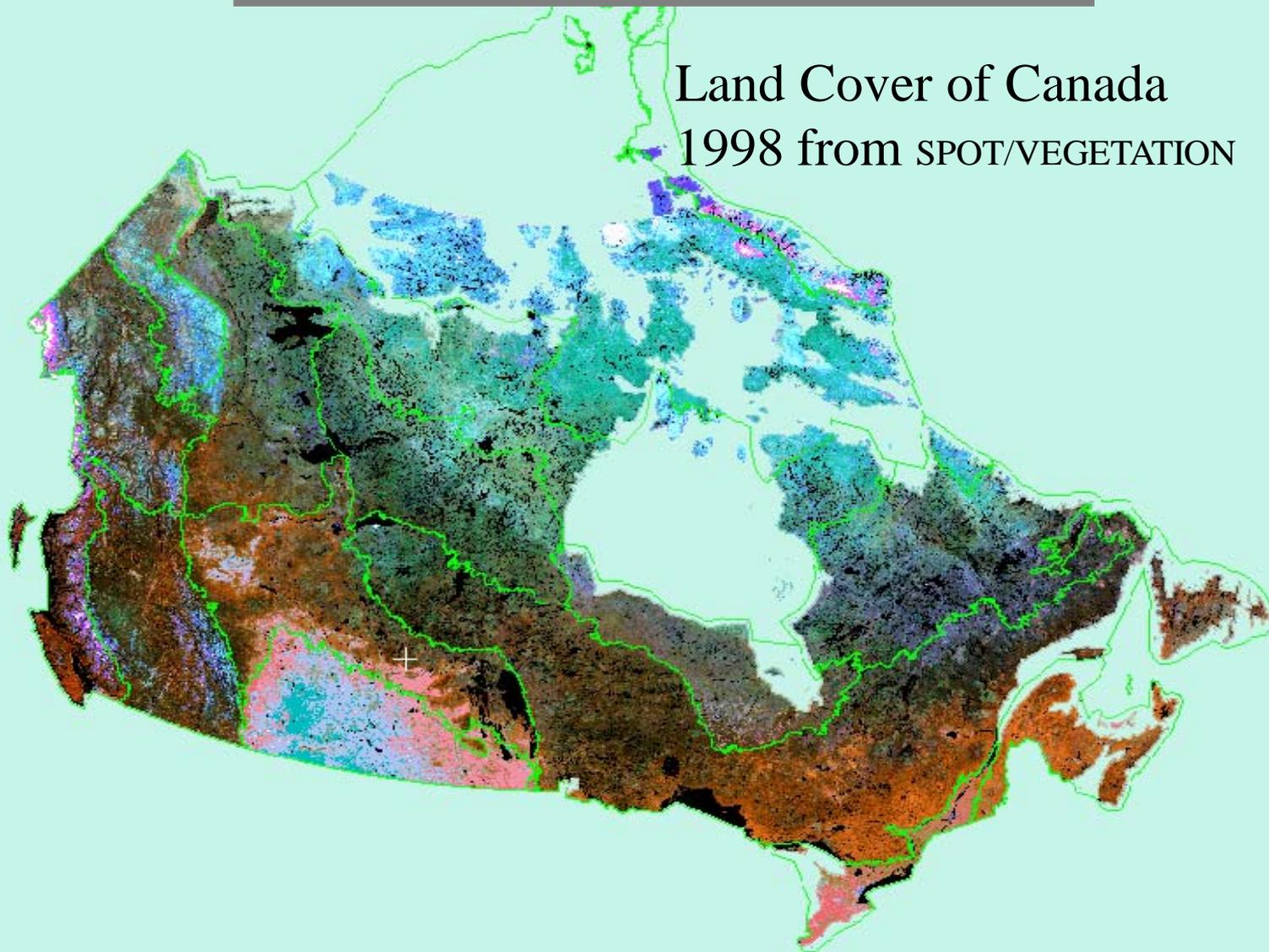




AVHRR Manager

Coarse resolution land cover classification

Land Cover of Canada
1998 from SPOT/VEGETATION

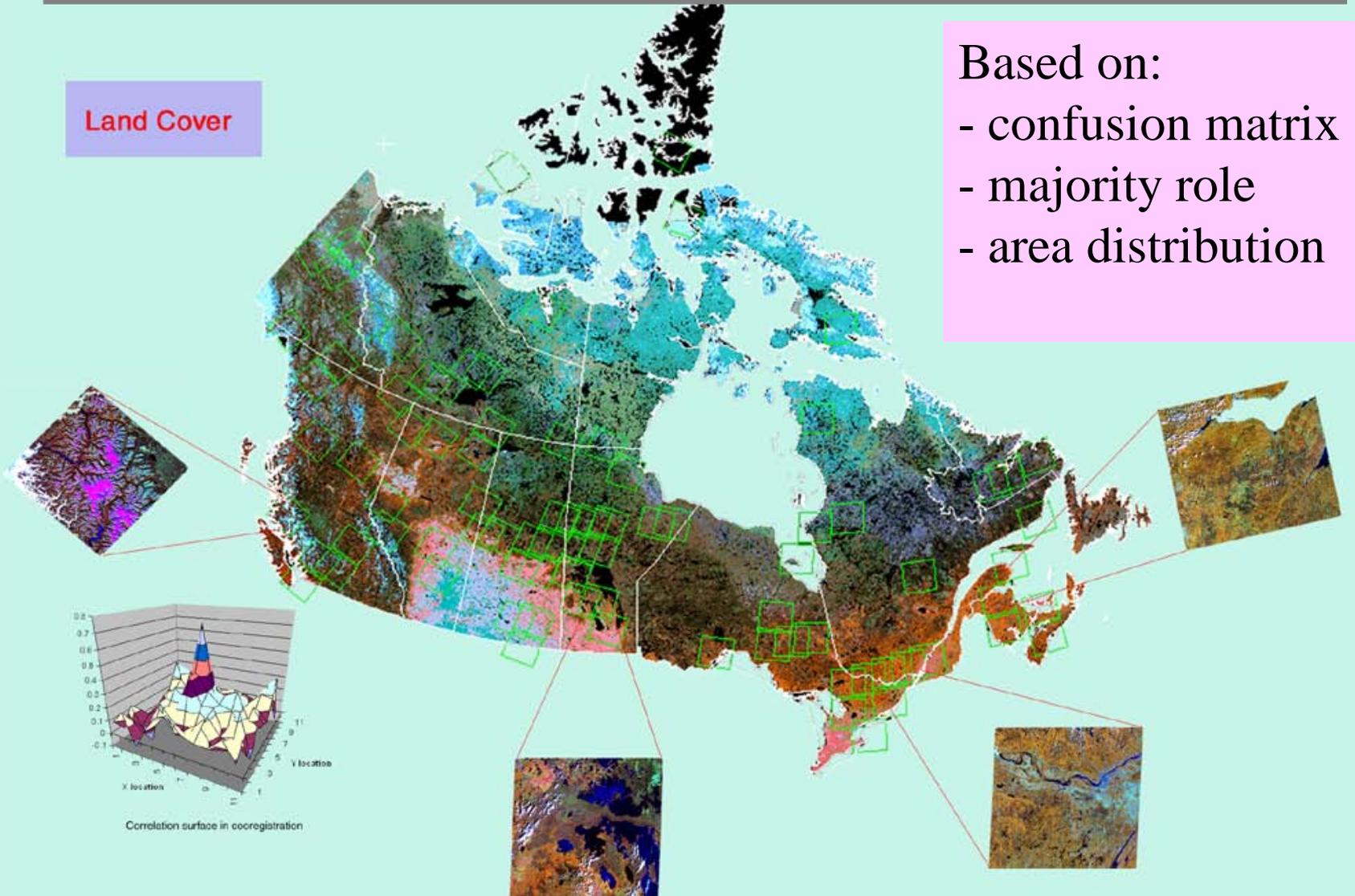


Accuracy assessment using fine resolution land cover classification

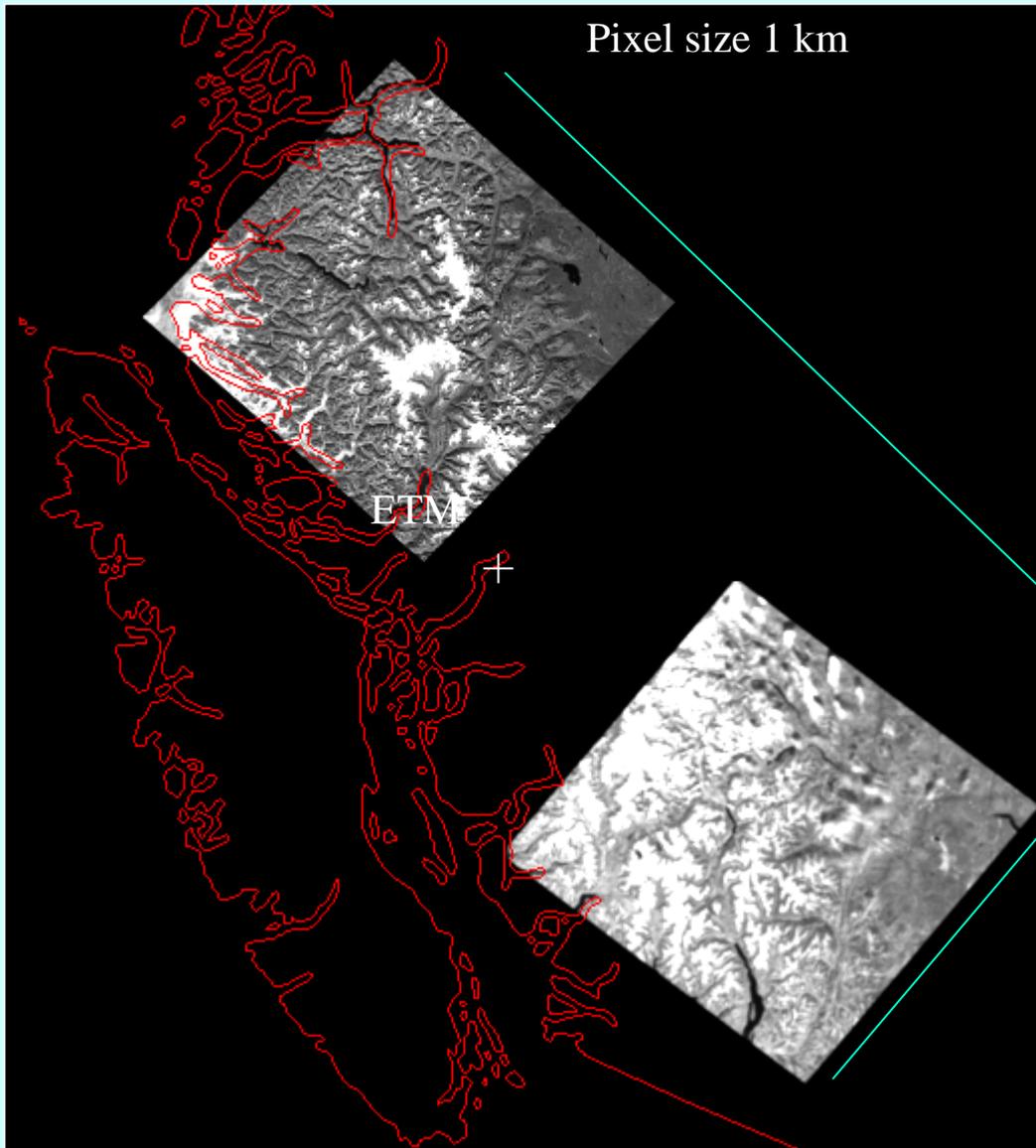
Land Cover

Based on:

- confusion matrix
- majority rule
- area distribution



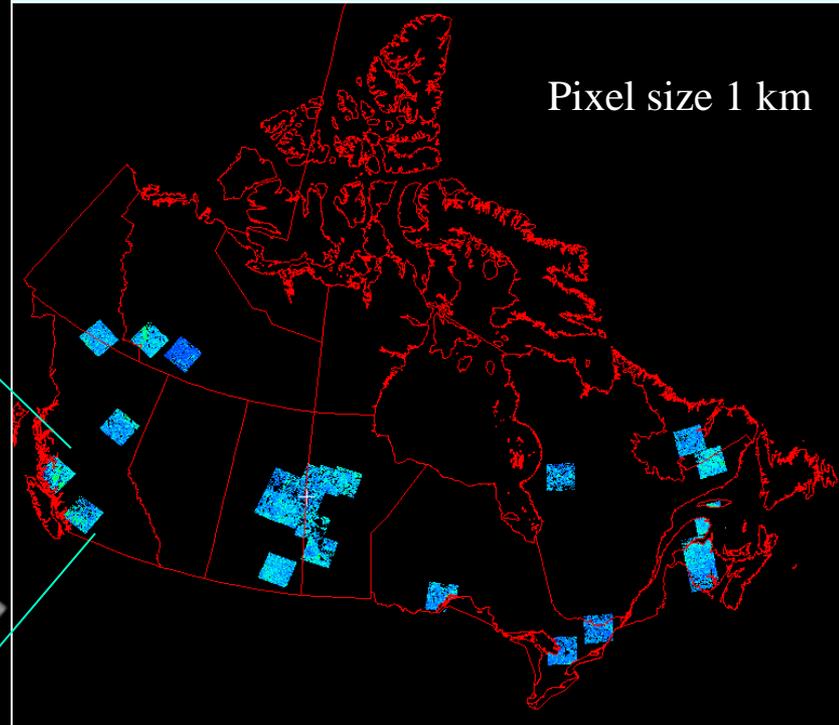
Preprocessing



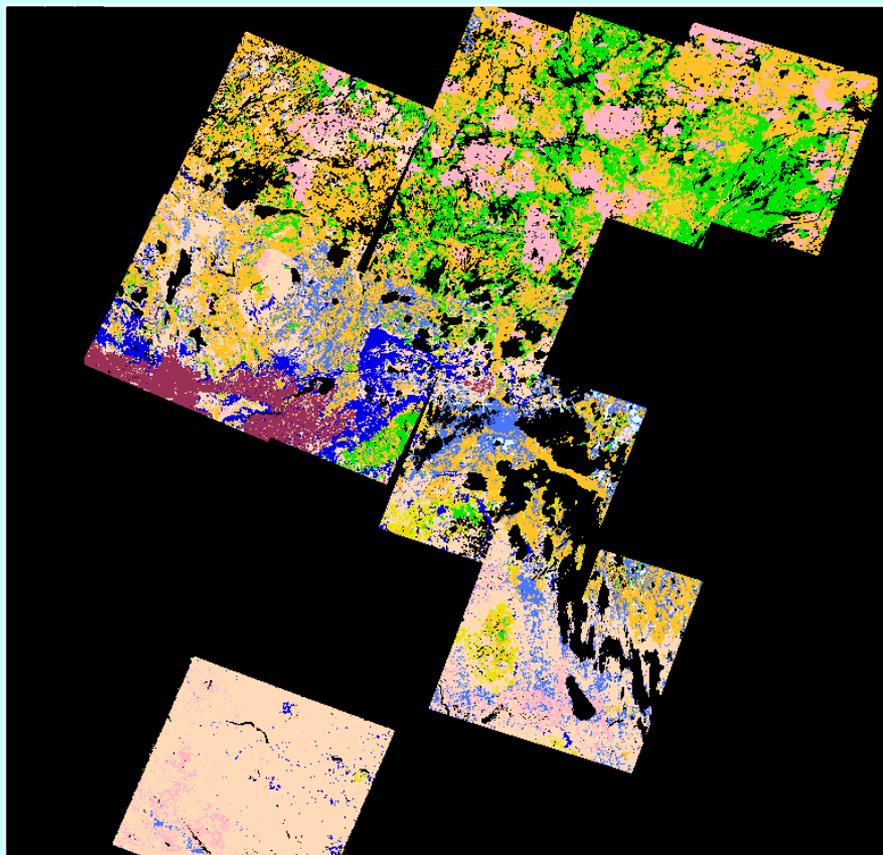
Georeferencing

Co-registration

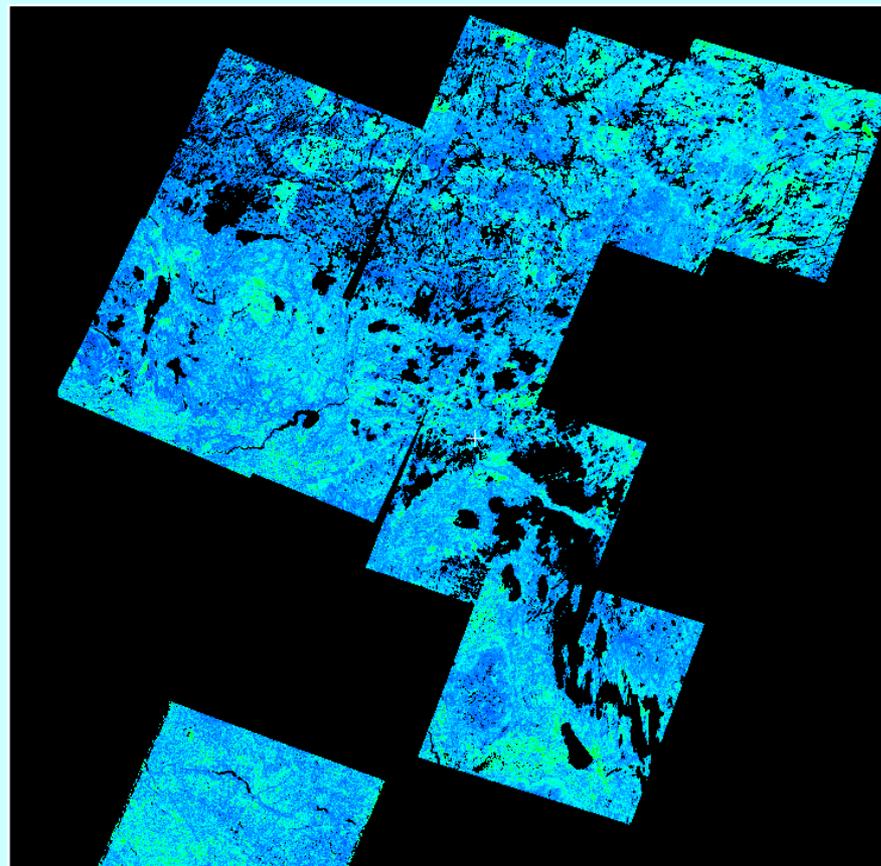
Re-sampling



Majority role

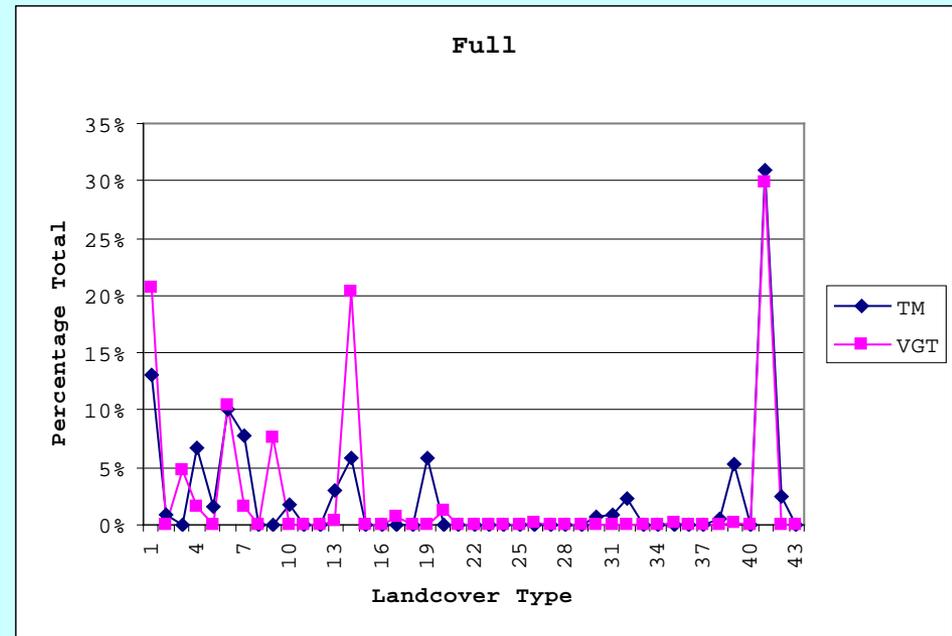
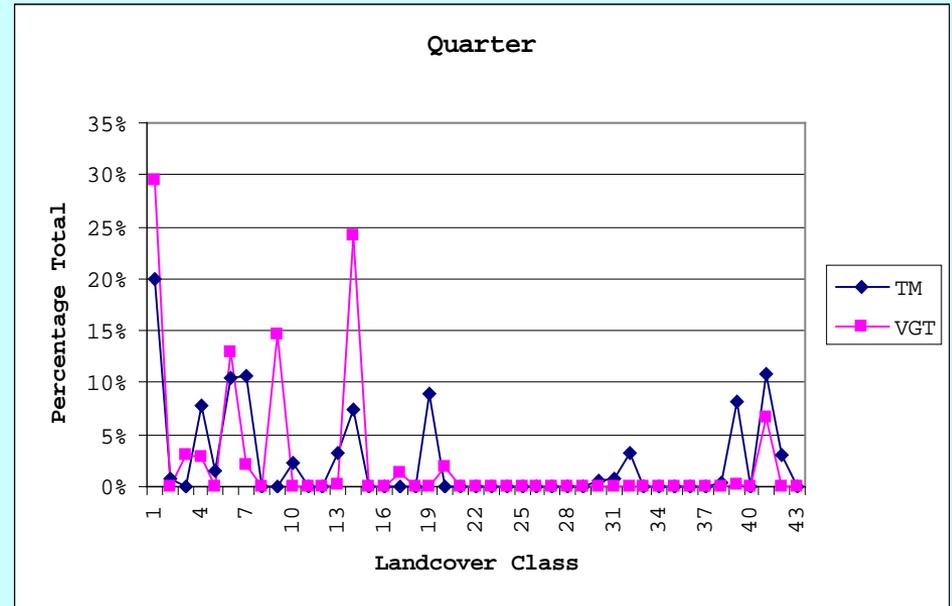
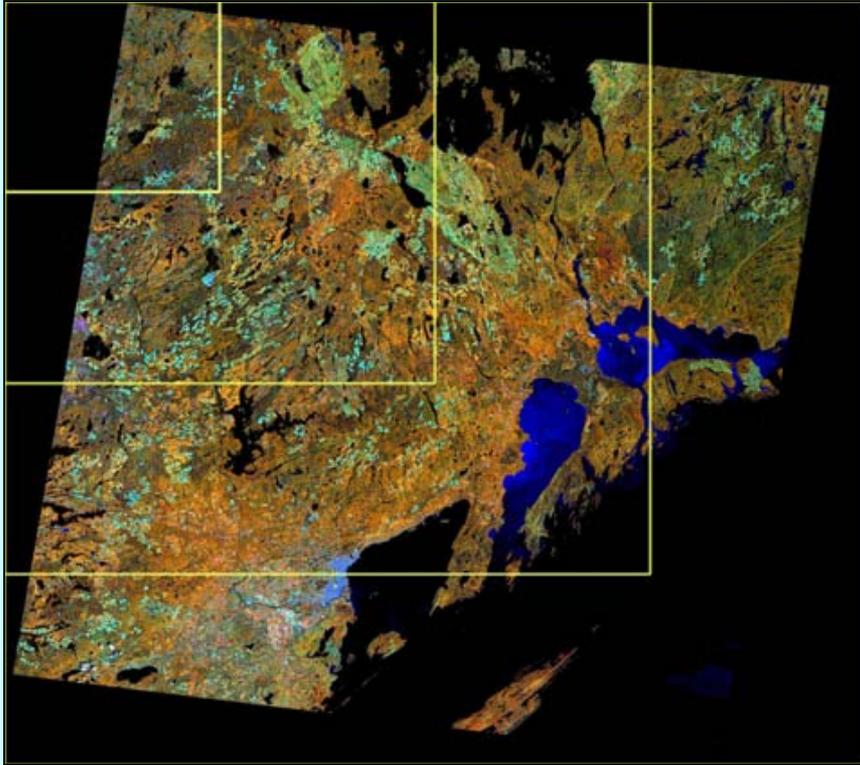


Most frequent type in 1 km pixel derived from Landsat TM



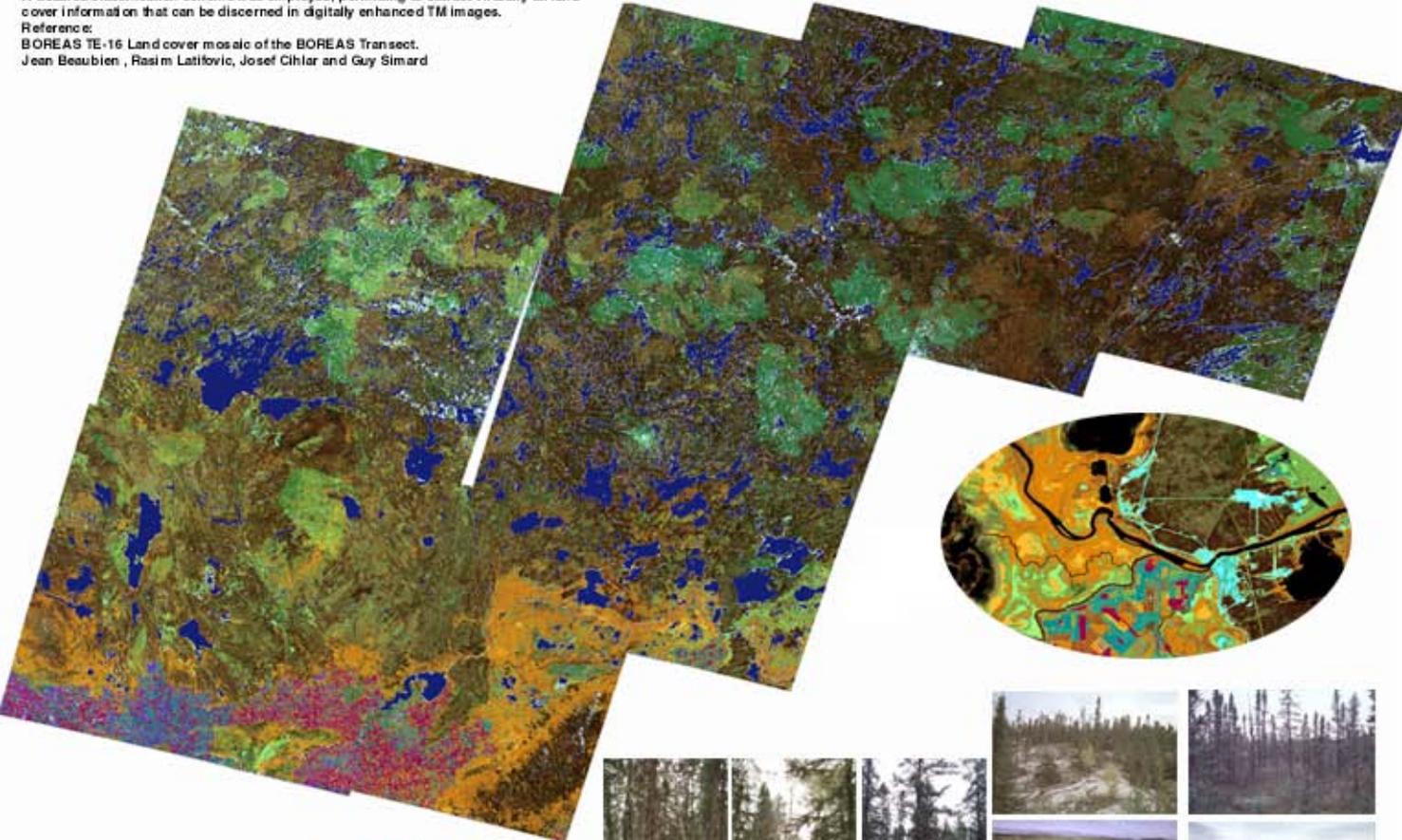
Percent of occupied area by the most frequent type in 1 km pixel

Area distribution



BOREAS LAND COVER MOSAIC

Boreas land cover mosaic, is a data product that characterizes the detailed land cover of a significant portion of the BOREAS Region. LANDSAT 5 TM images have been assembled completely covering the BOREAS Transect, and the entire images were used in this land cover map. A detailed classification scheme was employed, permitting to extract virtually all land cover information that can be discerned in digitally enhanced TM images.
 Reference:
 BOREAS TE-16 Land cover mosaic of the BOREAS Transect.
 Jean Beaubien, Rasim Lattifovic, Josef Cihlar and Guy Simard



- Coniferous**
 - High crown density (60%)**
 - Black spruce
 - Black spruce, Jack pine
 - Black spruce, younger
 - Medium crown density (40-60%)**
 - Jack pine
 - Black spruce, Jack pine
 - Black spruce
 - Low crown density (25-40%)**
 - Black spruce, Jack pine
 - Jack pine
 - Coniferous very low density
- Deciduous**
 - High crown density
 - Medium crown density
 - Low broadleaf cover
- Mixed forest**
 - Mixed coniferous (>60%)
 - High crown density (>60%)
 - Medium crown density
 - Mixed deciduous forest (>60%)
 - Mixed intermediate
- Open land**
 - Shrubs and grassland
- Burns**
 - Bare areas, recent burns
 - Rock outcrops
 - Recent burns, sparse vegetation cover
 - Older burns, shrub-grass cover
 - Older burns, mixed regeneration
 - Bare disturbed areas
 - Disturbed areas, sparse vegetation cover
- Cropland**
 - High biomass
 - Medium biomass
 - Low biomass
- Non-vegetated land**
 - Water bodies
 - Clouds

Canada
Natural Resources



ECM - Enhancement Classification Method
CPG - Classification by Progressive Generalisation
MFM-5-Scale - Multiple-Forward-Mode 5-Scale approach

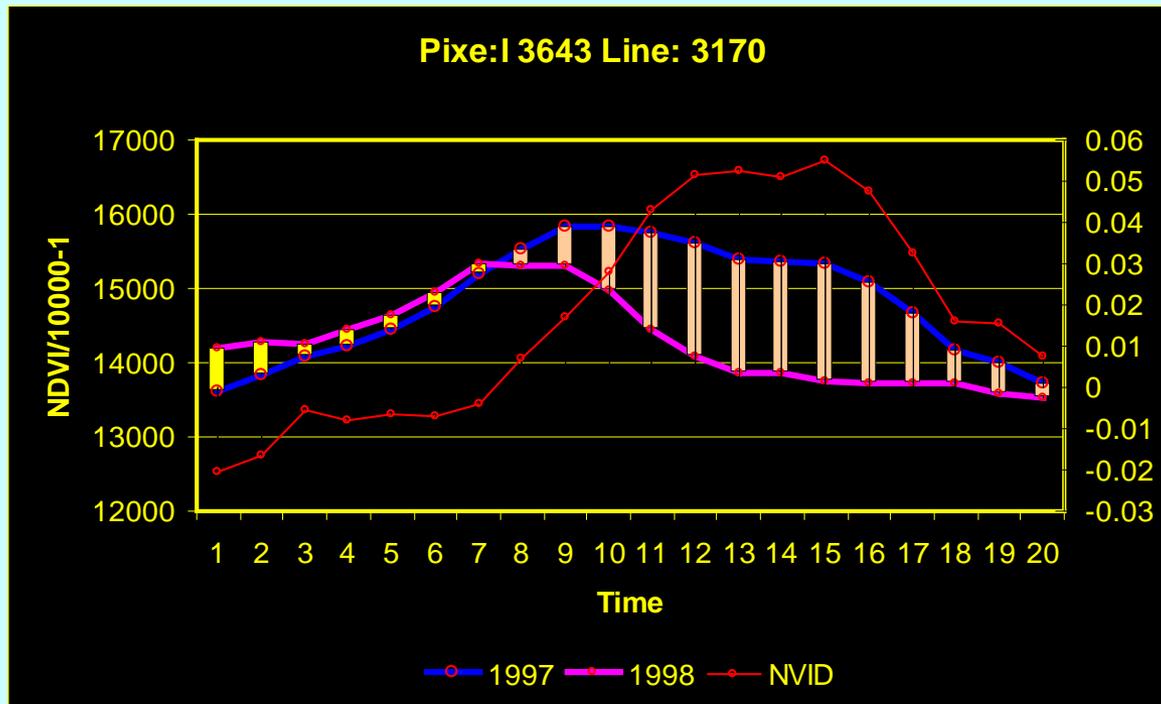
NRCAN
CCRS/AD/EMS

Spectral change detection methods

- *Multi Temporal Vector Change Detection Method*
- *Correlation Analysis Change Detection Method*
- *Texture Change Detection Method*
- *Pixel Fraction Change Detection Method*

Multi Temporal

Change detection algorithms based on temporal profiles assume that land cover type (spectral cluster) has relatively stable profile in VIS and NIR band over years. Change detection methods are implemented on the successive time trajectories represented as vector in multidimensional measurement spaces.



AVHRR Manager an analytical environment for change detection research

The screenshot displays the AVHRR Manager software interface with three dialog boxes open:

- Change Detection:** This dialog box allows for selecting bands (Band 1 to Band 6), a season, and a date range (From and To). It also includes fields for the number of bands (3) and the number of landcover types (29). The resolution is set to 5700 pixels and 4800 lines. Input and output filenames for LC Mask, Signature, Confidence, and Change are provided. Buttons for Signature, Change, Cancel, and OK are at the bottom.
- Change Vector Analysis:** This dialog box is for selecting the year (Year Tb and Year Tb+1), resolution (Pixels: 5700, Lines: 4800), start and end dates (Start Date: 5, End Date: 15), and a threshold (2). It also has an Output Filename field and a Working Directory field.
- Coefficient of Variation:** This dialog box is for selecting the data layer (B01_RRETOA.IMG), resolution (Pixels: 5700, Lines: 4800), and the first and last dates (both set to 0). It has OK and Cancel buttons at the bottom.

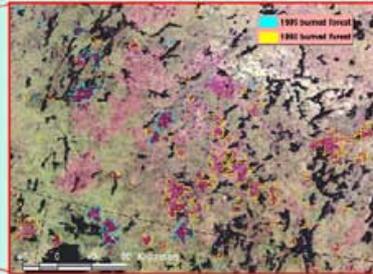
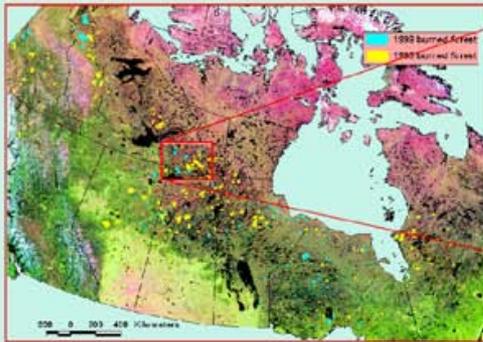
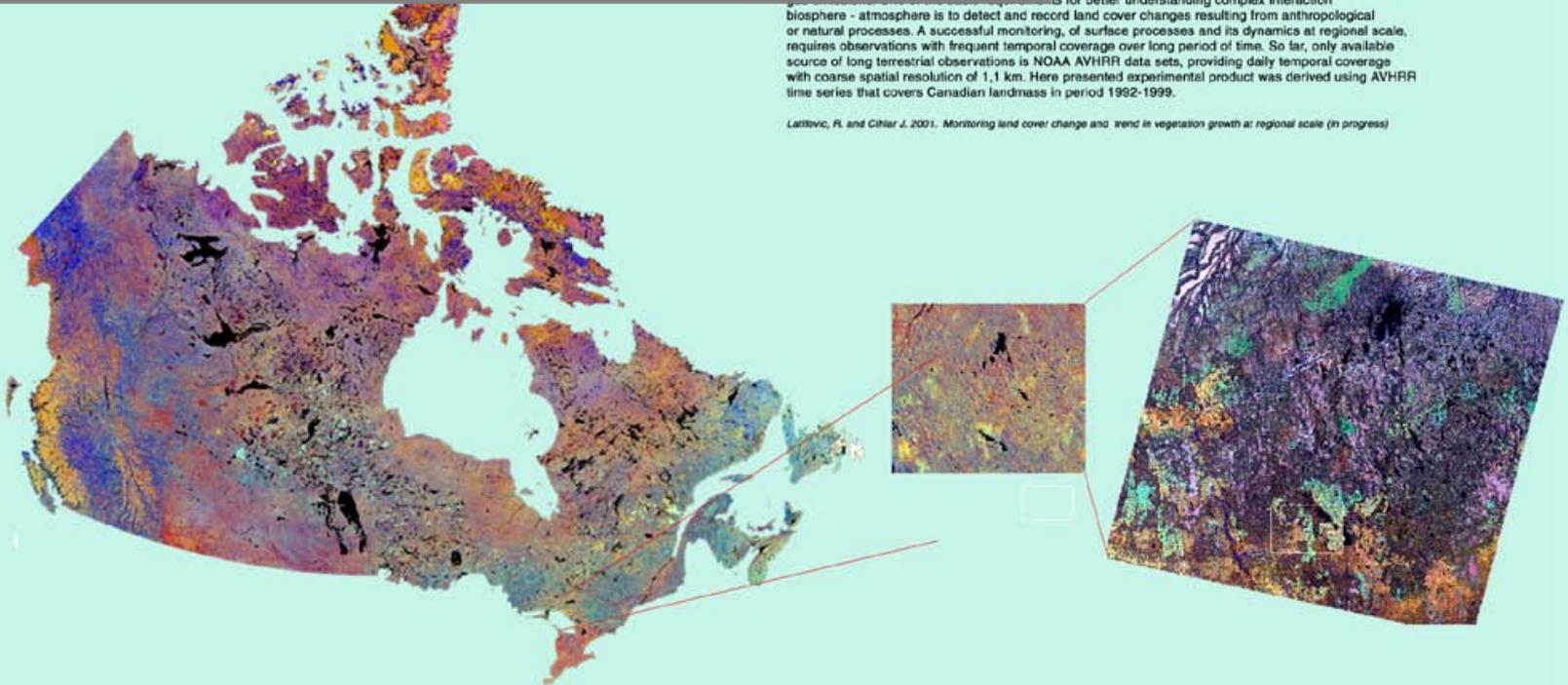
The main application window, titled "AvhrrManager - [AvhrrM1]", has a menu bar with File, Edit, View, Tools, Change Detection, Classification, Window, and Help. The "Change Detection" menu is open, showing options: Sequential Analysis, Normalization, Signature, Coefficient of Variation, Change Correlation Analysis, Change Vector Analysis, and Texture Change Detection.

Land cover change map of Canada 1993-1999

...ngly important for natural resource management,
...implementing international agreements on greenhouse
...ts for better understanding complex interaction

...biosphere - atmosphere is to detect and record land cover changes resulting from anthropological
...or natural processes. A successful monitoring, of surface processes and its dynamics at regional scale,
...requires observations with frequent temporal coverage over long period of time. So far, only available
...source of long terrestrial observations is NOAA AVHRR data sets, providing daily temporal coverage
...with coarse spatial resolution of 1,1 km. Here presented experimental product was derived using AVHRR
...time series that covers Canadian landmass in period 1992-1999.

Lattovic, P. and Chliar, J. 2001. Monitoring land cover change and trend in vegetation growth at regional scale (in progress)



Mapping of burned boreal forest across Canada for 1998 and 1999 was performed using a hybrid technique developed for annual, coarse resolution mapping of burned forest canopy (Fraser et al., 2000a). The method, dubbed Hotspot and NDVI Differencing Synergy (HANDS), combines active fire monitoring with multi-temporal change detection. Change detection and identification of new burned areas were accomplished by differencing of a pair of post-fire season vegetation indices derived from anniversary date SPOT VEGETATION composite imagery. The locations of actively burning fires, detected with daily NOAA-AVHRR satellite imagery, were used to derive a spatially adaptive, statistical threshold for differencing and separating burned areas.

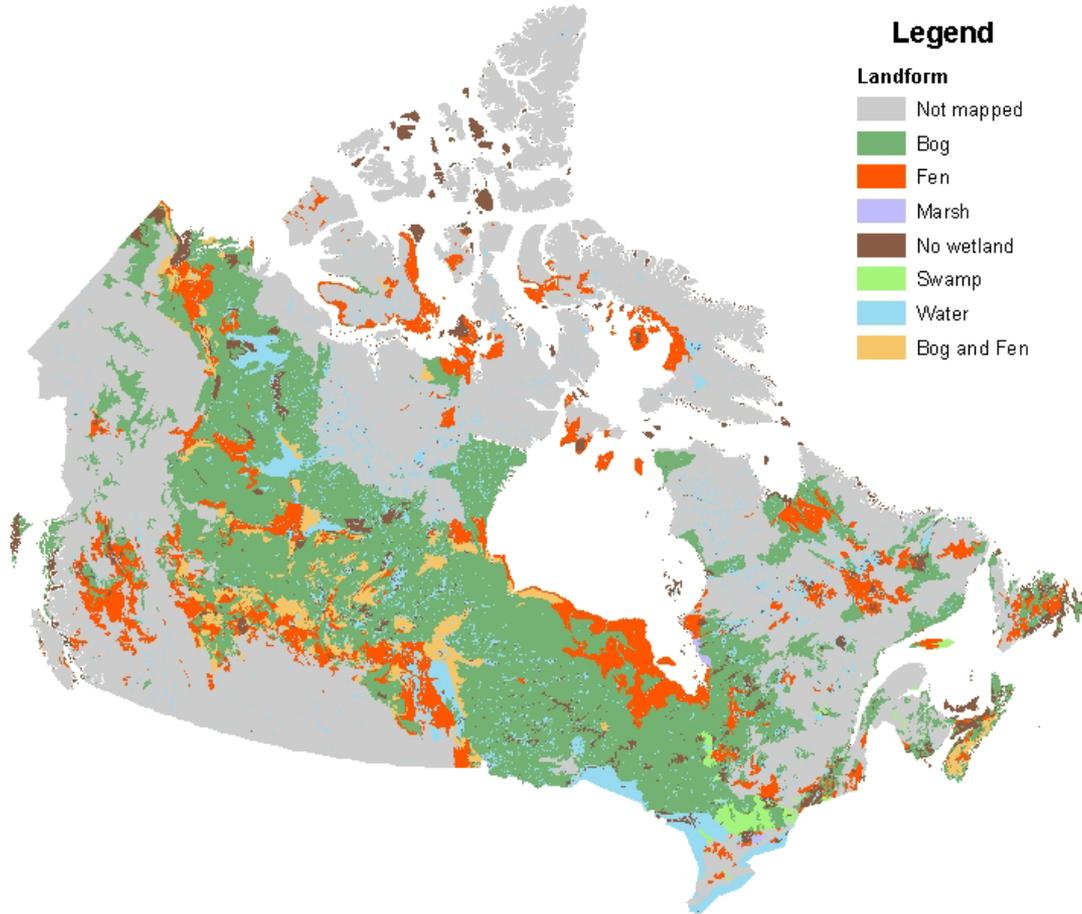
Fraser, R.H., Li, Z., and Chliar, J., 2000a. Hotspot and NDVI Differencing Synergy (HANDS): a new technique for burned area mapping over boreal forest. Remote Sens. Environ. 74:362-376.

Objective 3,4

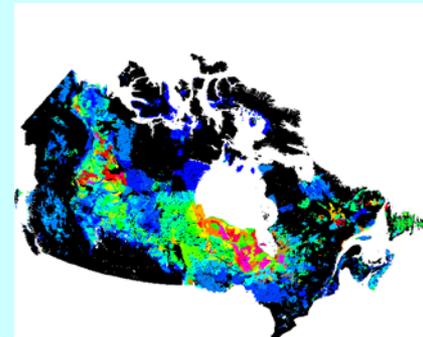
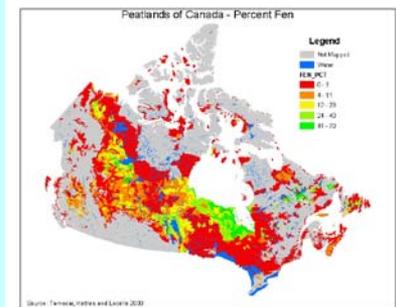
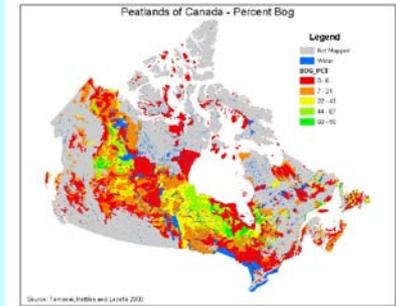
Wetland distribution data base for Canada
Fractional land cover and continuous mapping

Wetland distribution for Canada

Peatlands of Canada

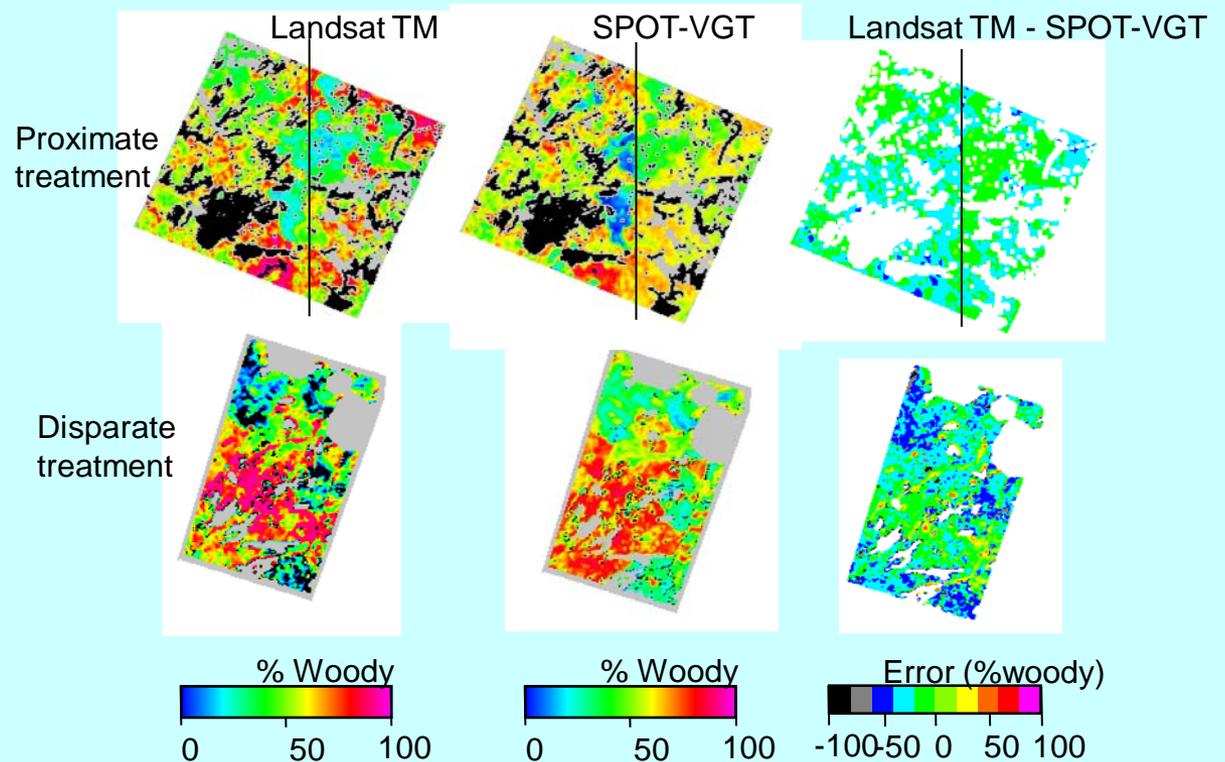


Source: Tamocai, Kettles and Lacelle 2000



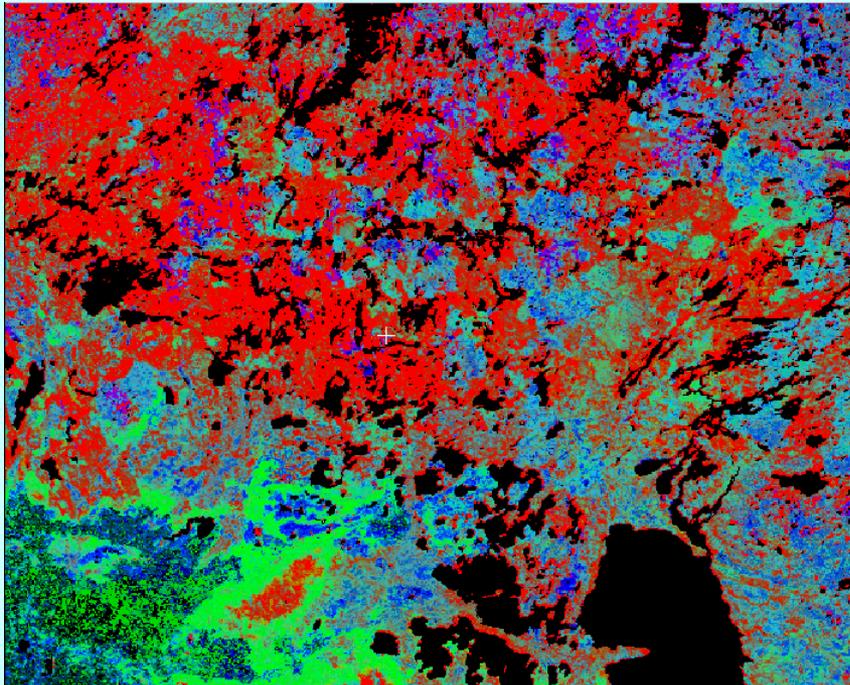
Approaches to fractional land cover and continuous mapping

1. Multivariate regression
2. Linear least squares inversion
3. Look-up table
4. Neural network
5. Hard' per pixel classifier

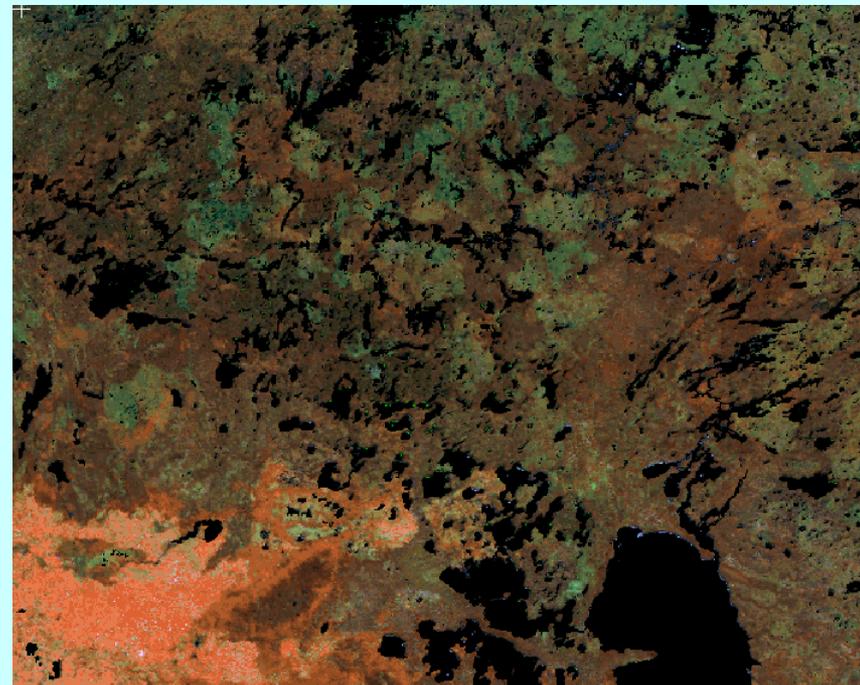


Land cover characterization carried out by estimating the proportions of major cover type within each 1 km pixel

Fractions



Classification



Coniferous

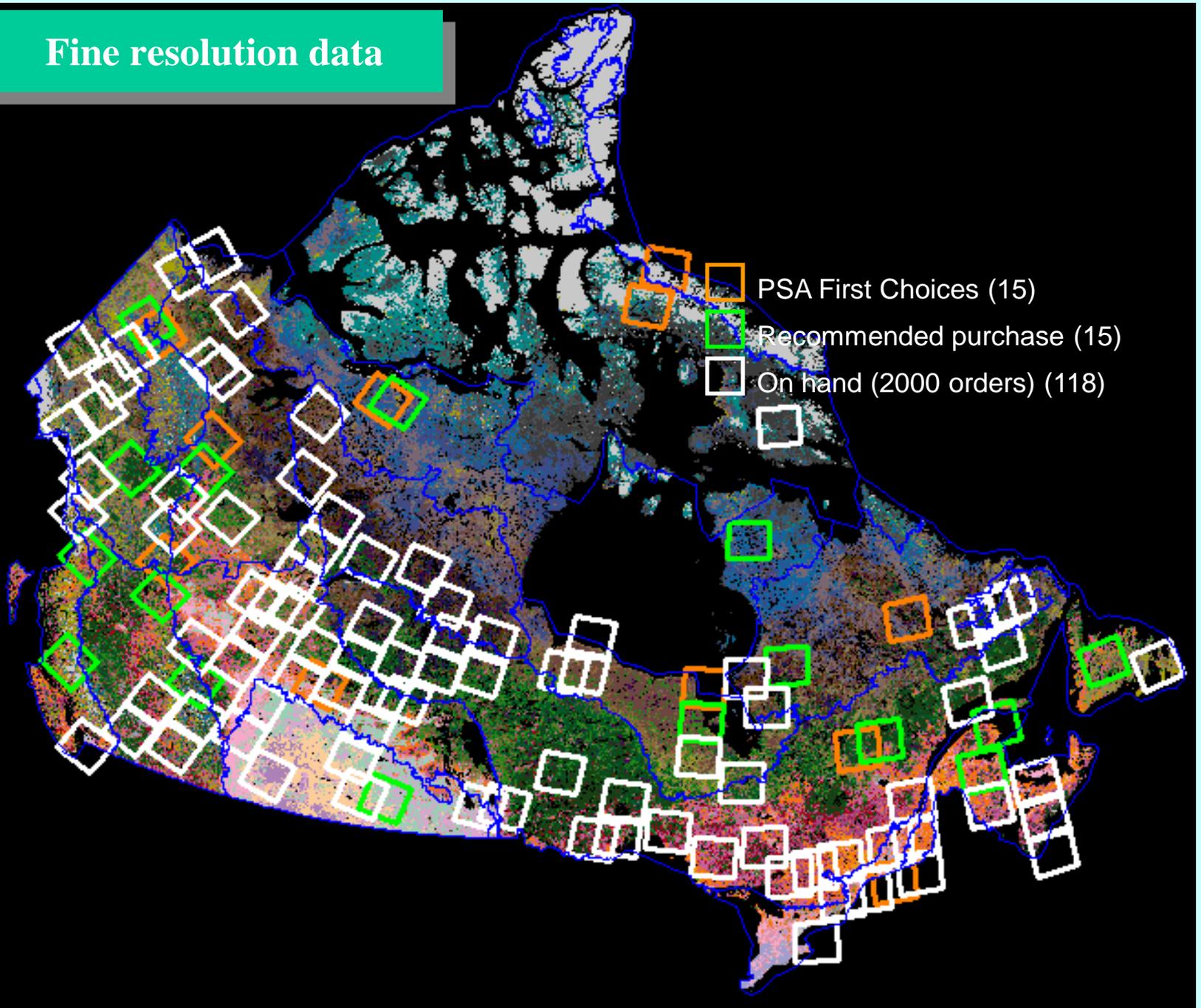


Shrub and grass

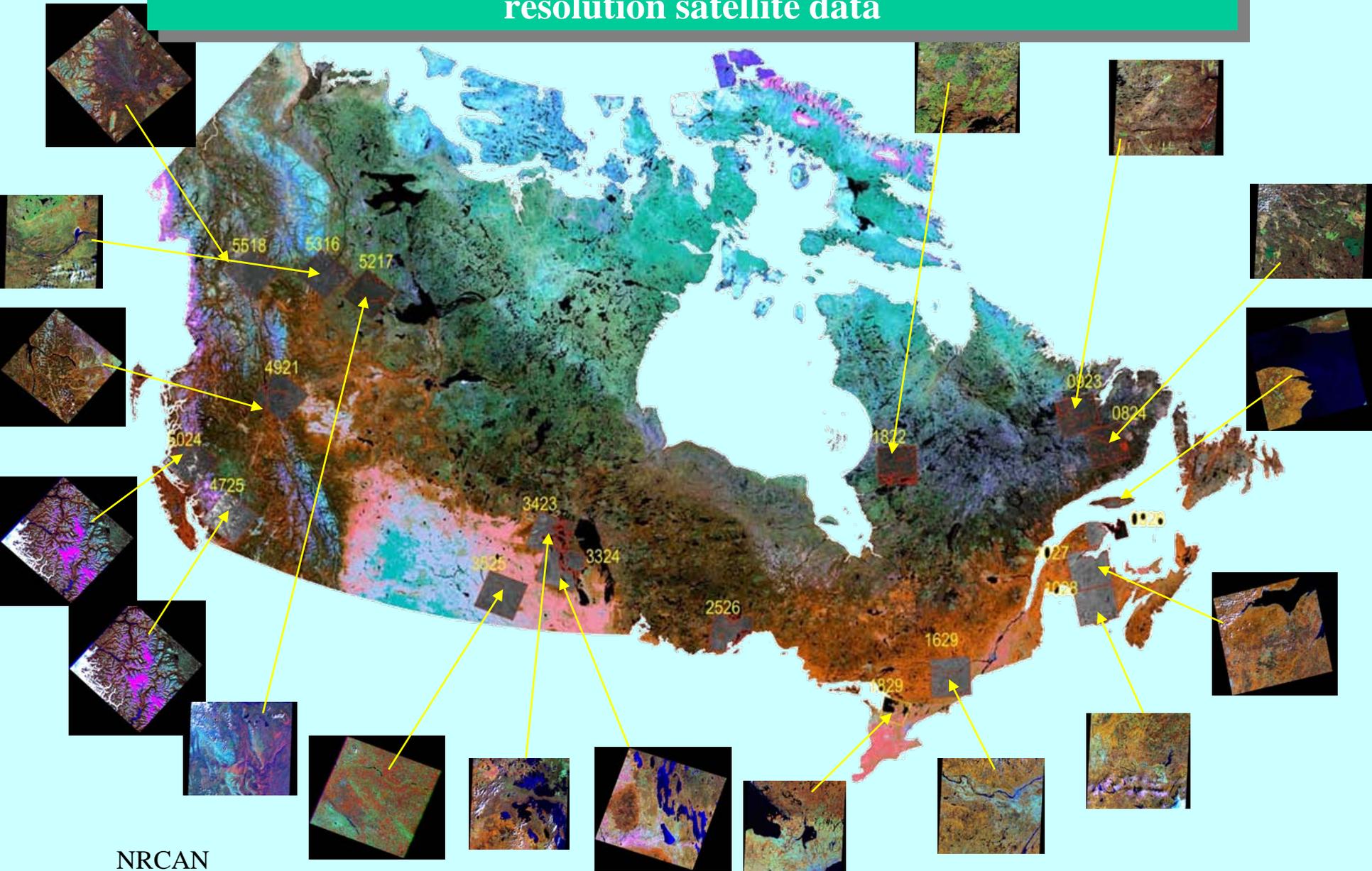


Deciduous

Fine resolution data



Land cover fractions in coarse resolution maps using high resolution satellite data



Summary of major products and their progress

Product	Classification Legend	Source Imagery	Pre-Processing System and Methodology	Classification strategy	Validation	Accomplishment
Coarse Land Cover Map	Classification System (hard)	SPOT/VGT 1998-(+2000)	VGT-Manager ABC3V2	ECM/CPGcs	TM	80%
Coarse Land Cover Map	Fraction	SPOT/VGT 1998-(+2000)	VGT-Manager ABC3V2	New	TM	50%
Coarse Land Cover Map	Fraction	MODIS 500+250		New	TM	20%
Coarse CD	Change detection	AVHRR/VGT 1993-2001	AVHRR-Manager	MTCV	TM, field	60%
Wetland	Wetlands	MODIS JERS-1	TBD	TBD (blended Product)	Airphotos TM, GIS	40%
Fine (scaling)	Hard/scale or continuous field	TM	Radiometric correction + intrascene normalisation	ECM/CPGcs MFM- 5 Scale	GIS maps field	70%
Fine (mosaic)	MRL/land cover change	MSS/TM	Radiometric correction + intrascene normalisation	TBD	GIS Maps field	

Summary

1. The project is on schedule at this point
2. Our current priorities
 - a. Completion of the TM sample set classifications
 - b. Generation and validation of fractions data for Canada
 - c. Continuation of land cover change detection
 - d. Testing methods for land cover change monitoring (various options, with coarse+fine resolution data)

In parallel:

- e. Continuing development of large volume TM classification methodology (focus on radiometric 'homogenisation' and labeling efficiency)
 - f. Development or related Canada-scale products at 1km (species, disturbances, site index,...)
3. Our feature priorities may be affected by program refocusing presently underway at CCRS