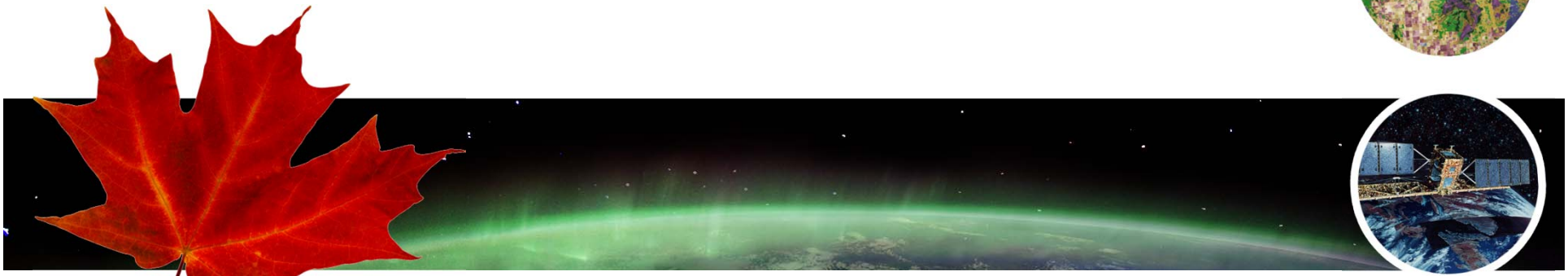
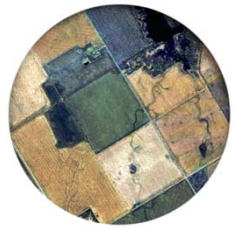
Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada



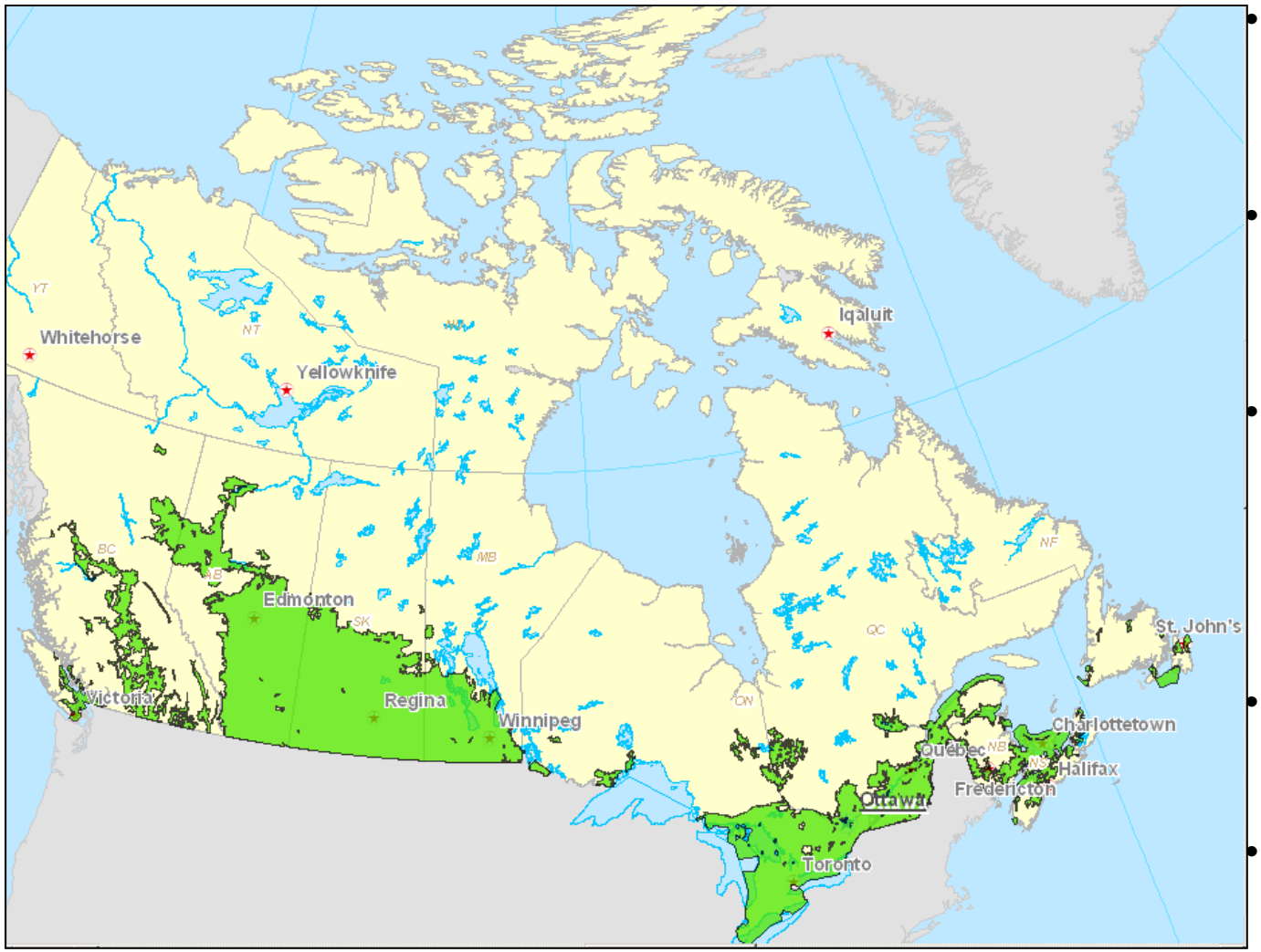


Soil Moisture Monitoring for Agricultural Risk Assessment in Canada

Catherine Champagne, Patrick Cherneski, Trevor Hadwen, Antoun El Khoury
National Agroclimate Information Service
Science and Technology Branch

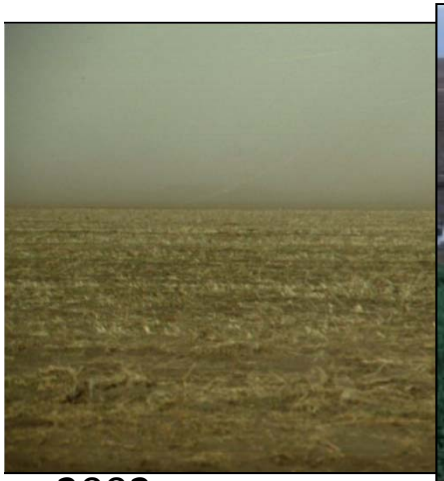
Canada

Agricultural Production in Canada



- 65 million hectares of land concentrated mainly along the US border
- 55% of land is crop land (primarily oilseeds and grains), 30% pasture
- Climate risk is significant – large land area, sparse monitoring and primarily rain-fed cropping system
- Single growing season: April to October
- Business risk management support is a major role of government

Soil Moisture and Extremes



2002
Saskatchewan

2006 Manitoba

2011
Saskatchewan

2009 Alberta

Canada's large size and geographic diversity means parts of the country are impacted by climate risk most growing seasons.

2014 Saskatchewan

2012 Ontario

National Climate Production Risk Assessment

NATIONAL DASHBOARD

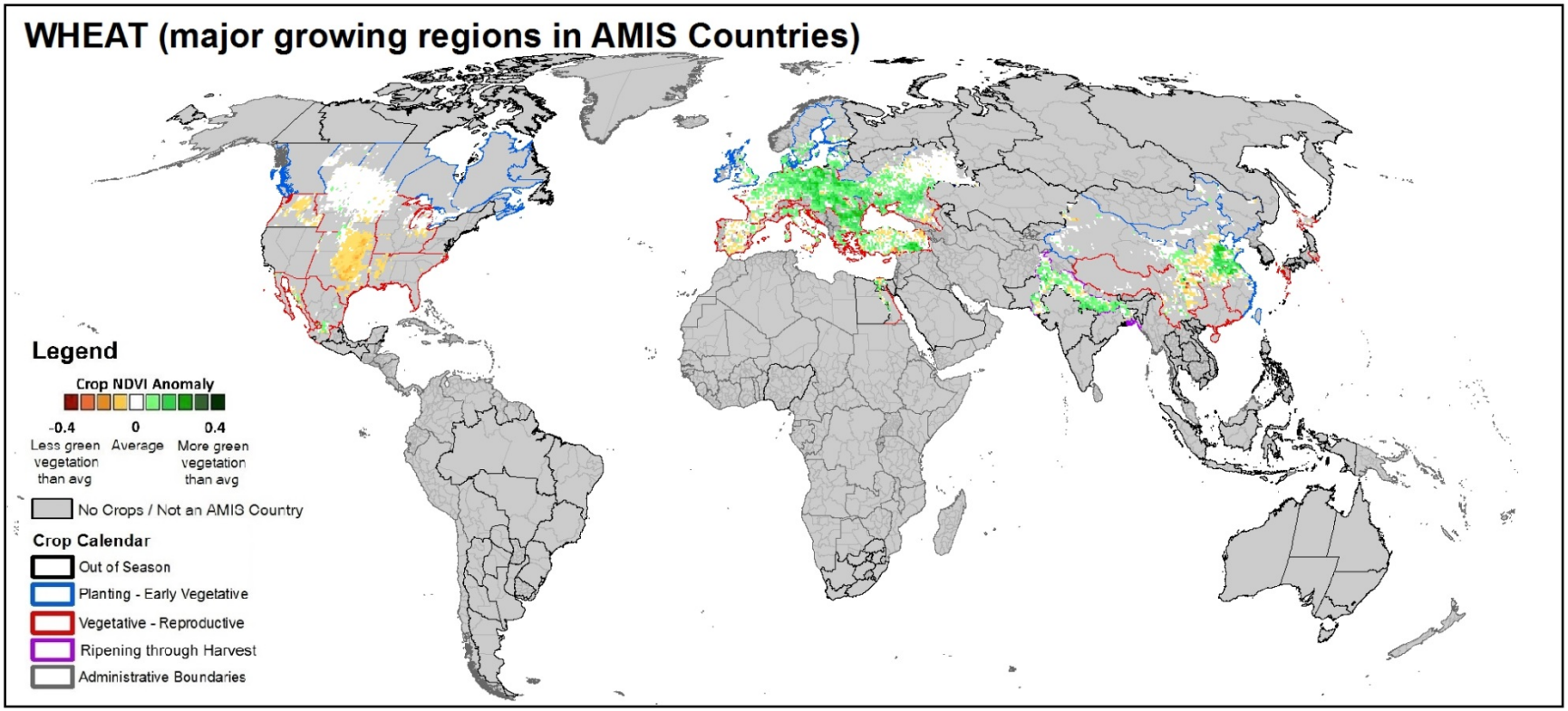
	BC	AB	SK	MB	ON	QC	ATL
2-week forecast	stable	stable	stable	stable	improving	improving	improving
Sept. 5	dry, impacts from hail			drought and disease	no report	dry	dry areas
Aug. 21	dry		excess moisture	dry	heat, drought	drought	dry
Aug. 8	dry	hail	hail, excess moisture	excess moisture, dry	heat, drought	heat, drought	heat, dry
July 24	flooding		excess moisture	excess moisture, flooding, heat	heat, drought	heat, dry	heat, dry
July 10			excess moisture	excess moisture, flooding	heat, dry, drought	heat, hail	dry in PE and NL
June 26	flooding	hail	excess moisture	excess moisture, flooding	heat, dry, drought	no report	heat
June 12			excess moisture	excess moisture	drought		dry
May 29			excess moisture		dry, drought		dry
May 15		frost	excess moisture	dry, drought	impacts from frost		
May 1		low soil moisture	drought, excess moisture	dry, drought	frost		
Apr. 17		dry, drought	dry, drought	dry, drought	frost	no report	heat
Apr. 3			dry, drought	dry, drought	heat	heat	heat
Mar. 6		dry, drought	dry, drought	dry		no report	

Green – no significant climate-related risks; minimal impacts.
Yellow – one significant climate-related risk; minimal to moderate impacts.
Orange – one or more significant climate-related risks; moderate impacts.
Red – one or more significant climate-related risks; large, urgent, disaster or record impacts.

Inputs:

- climate station based maps
- Drought indicators (PDSI, SPI)
- Soil moisture from water budget models
- Satellite based surface soil moisture, NDVI
- Media reports
- Crowd sourcing (Agroclimate Impact Reporter)

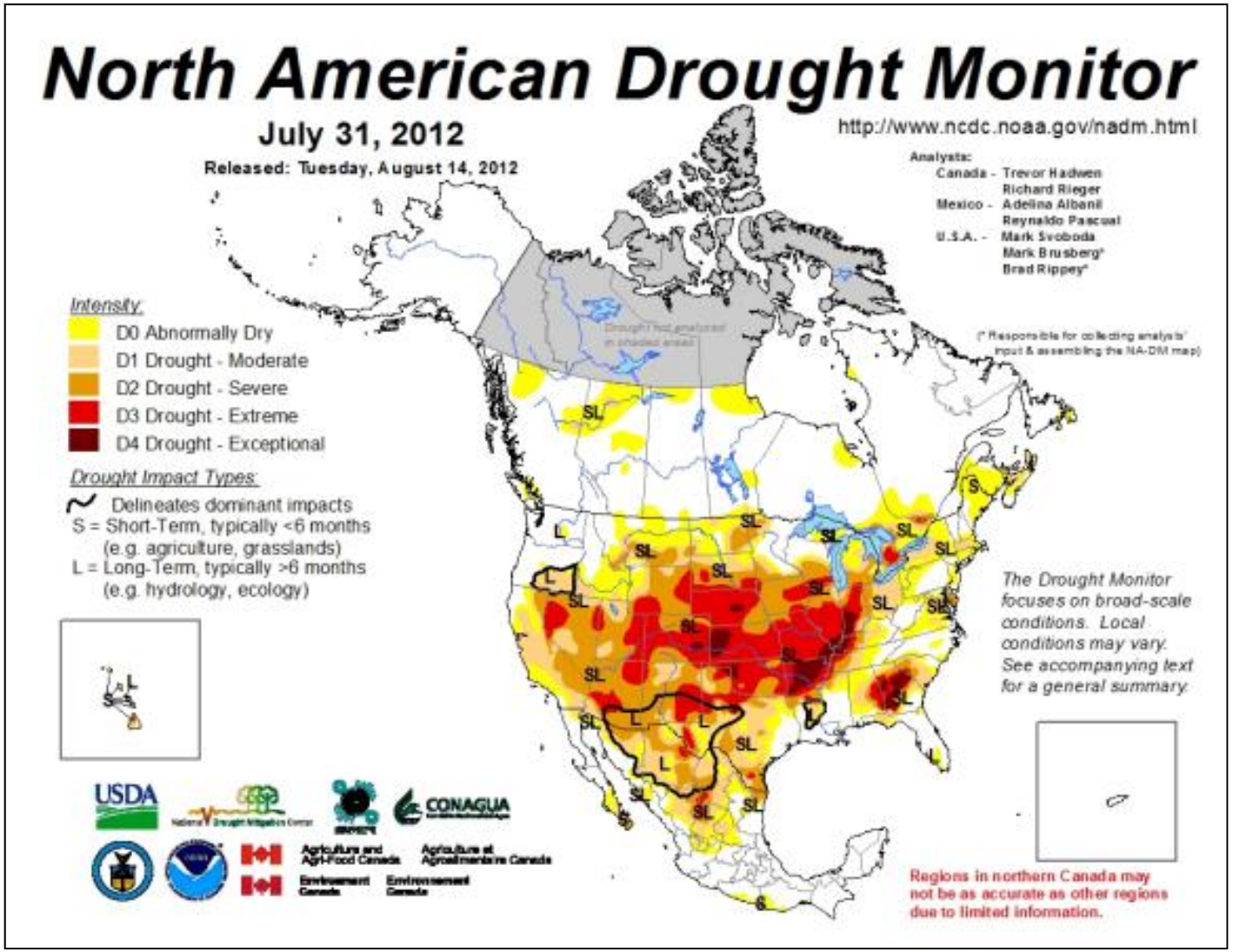
Global Monitoring: GEOGLAM



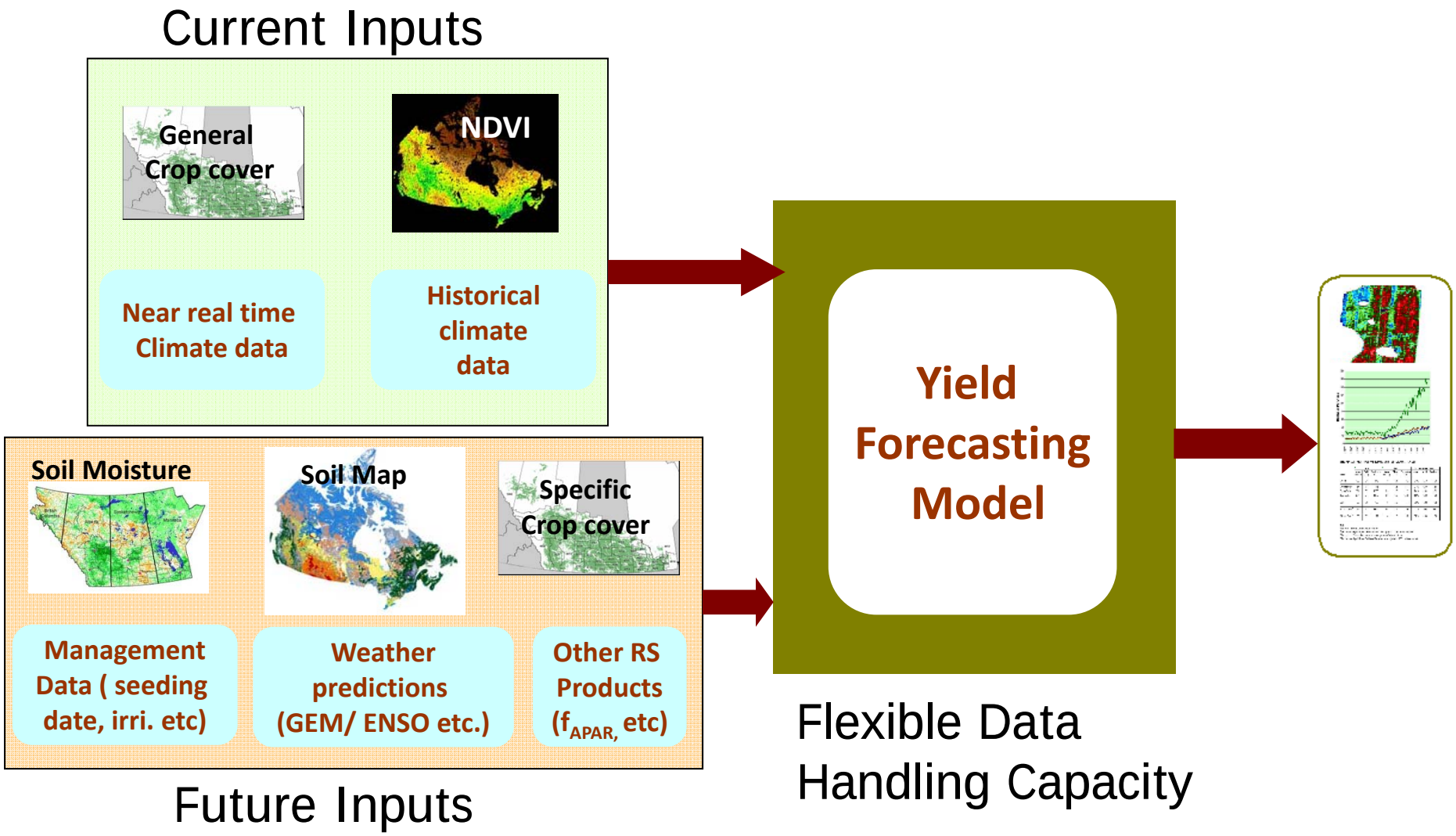
G20 Ministers of Agriculture initiative to reduce food price volatility by providing transparent, consistent information on global crop outlooks

Joint Experiment for Crop Assessment and Monitoring (JECAM) – develop best practices for remote sensing of key agricultural indicators

Drought Monitoring

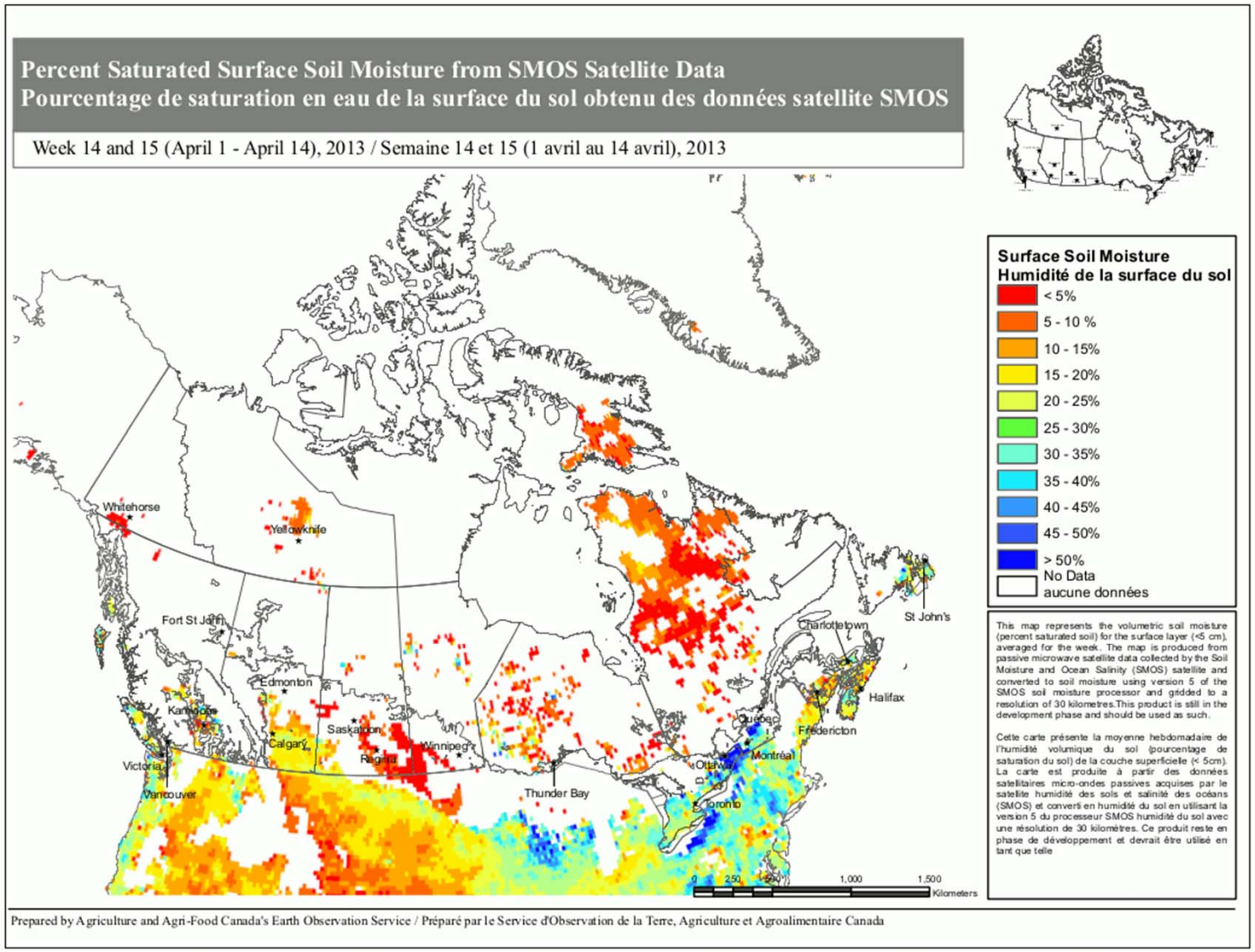


Integrated Canadian Crop Yield Forecaster



SMOS Surface Soil Moisture

(animated time series 2013)



- Produce Weekly, Bi-weekly and Monthly estimates April 1 to November 30 in NRT
- Operationally produced data set to support programs and services

Near Real Time Monitoring

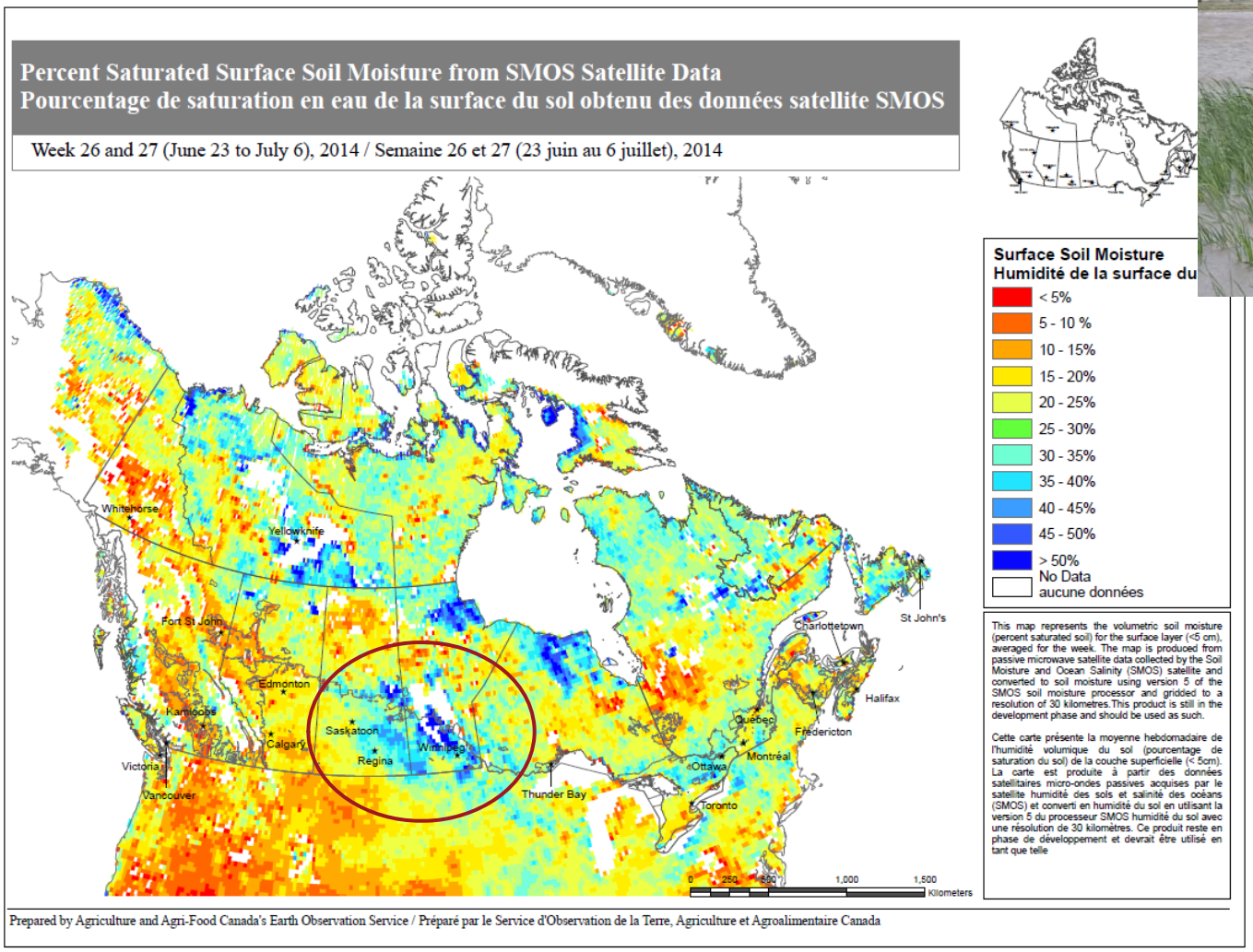
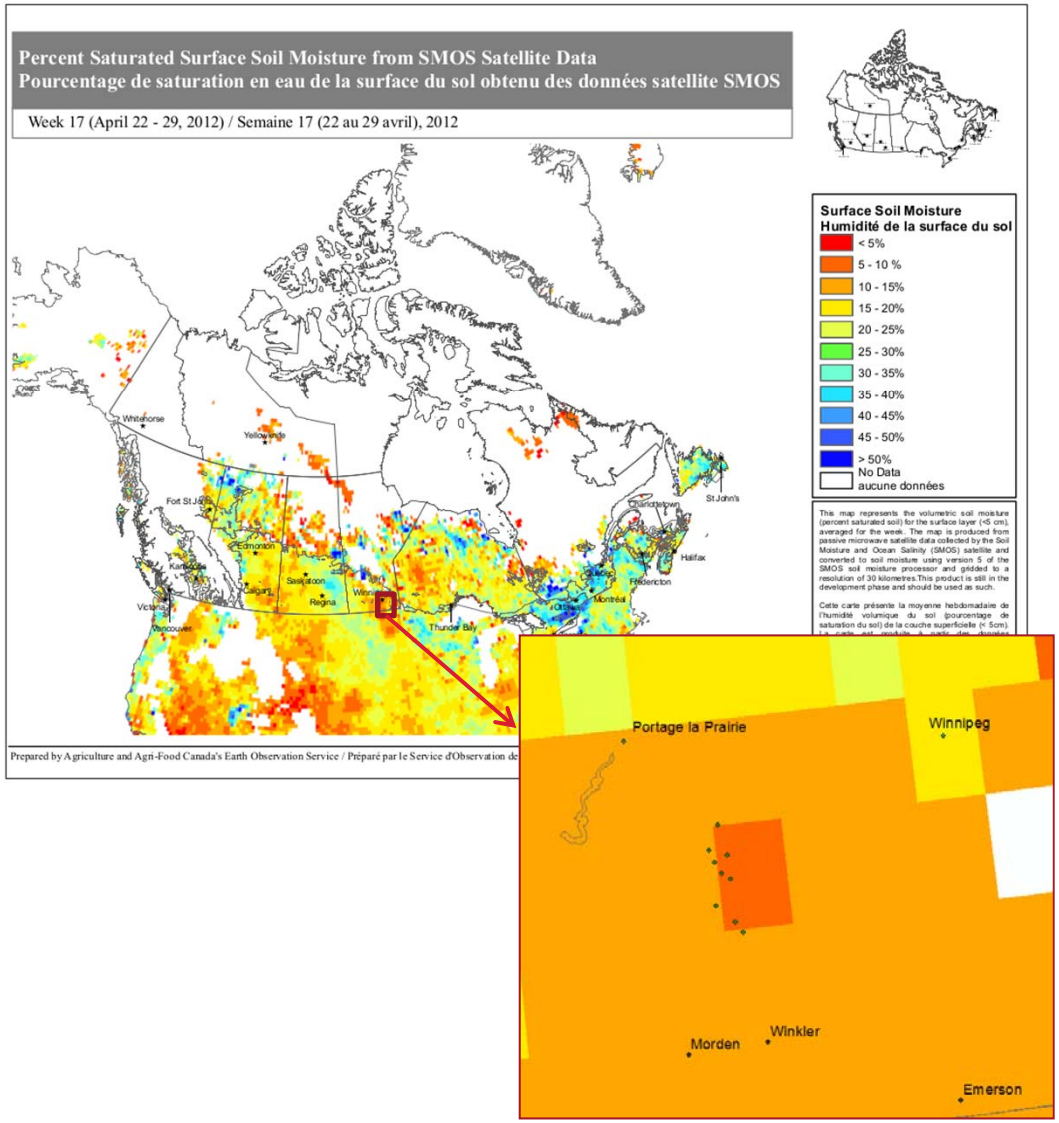
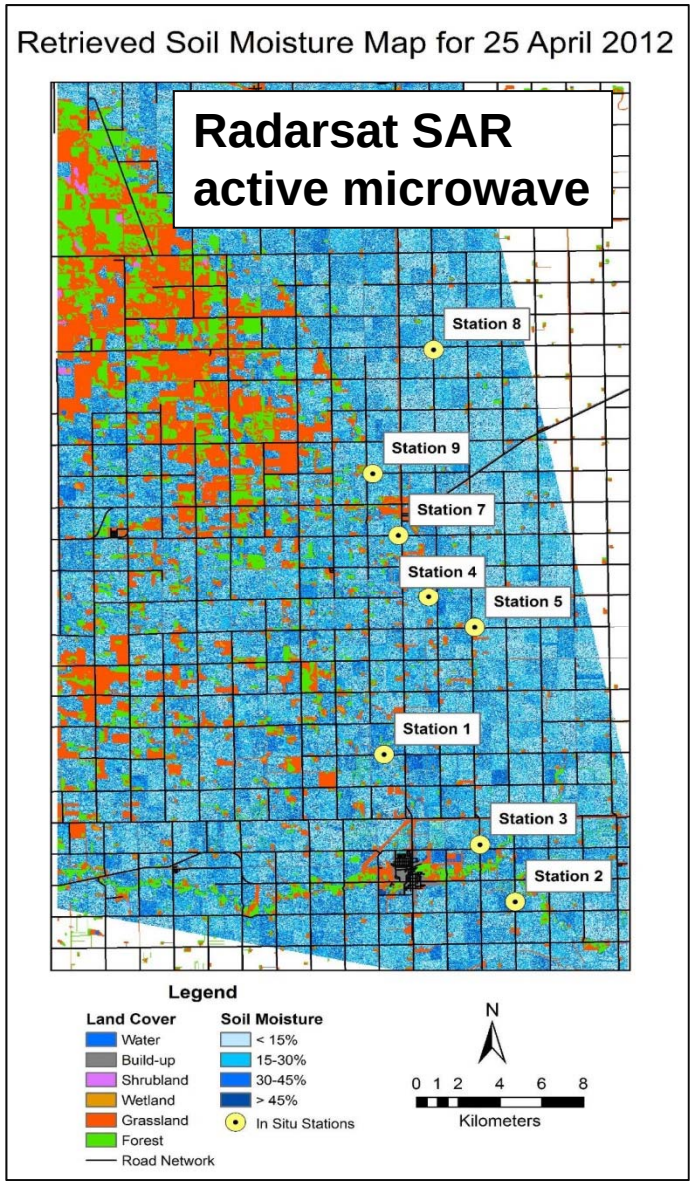


Image courtesy Portage Online

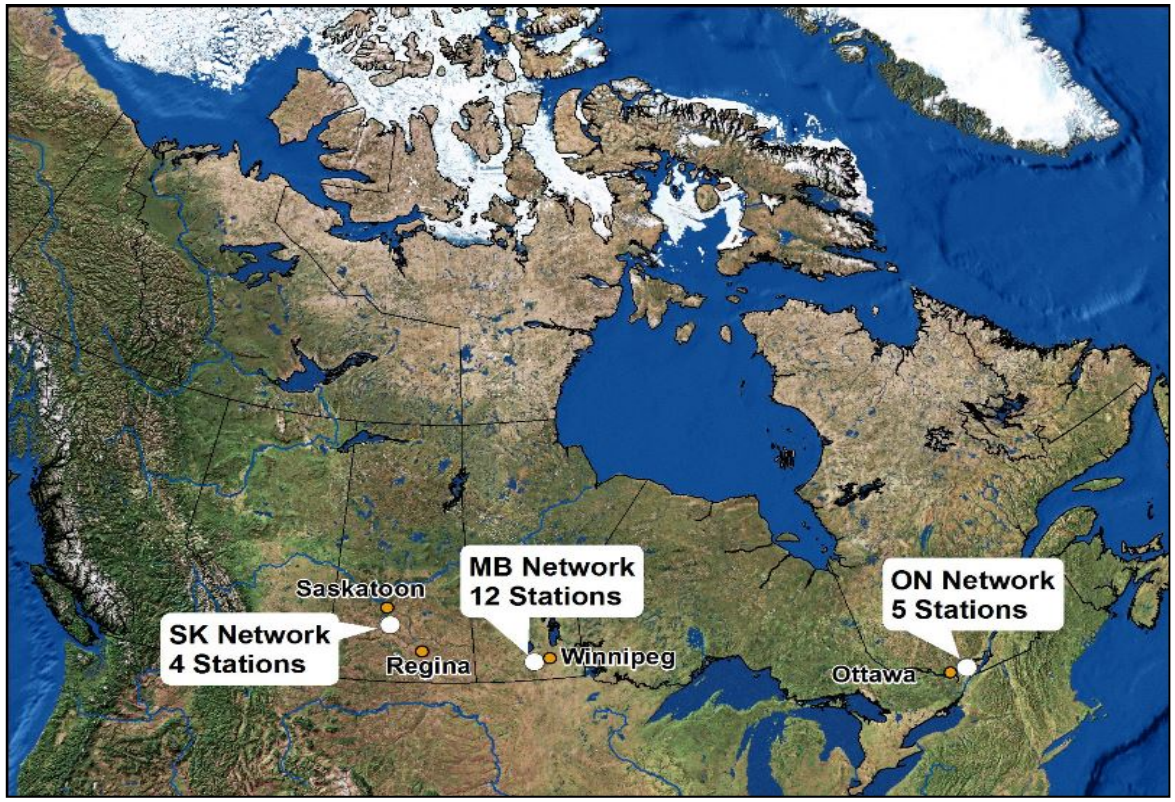
Multi-Scale Satellite Surface Soil Moisture Monitoring



Courtesy Heather McNairn



RISMA In Situ Validation Network



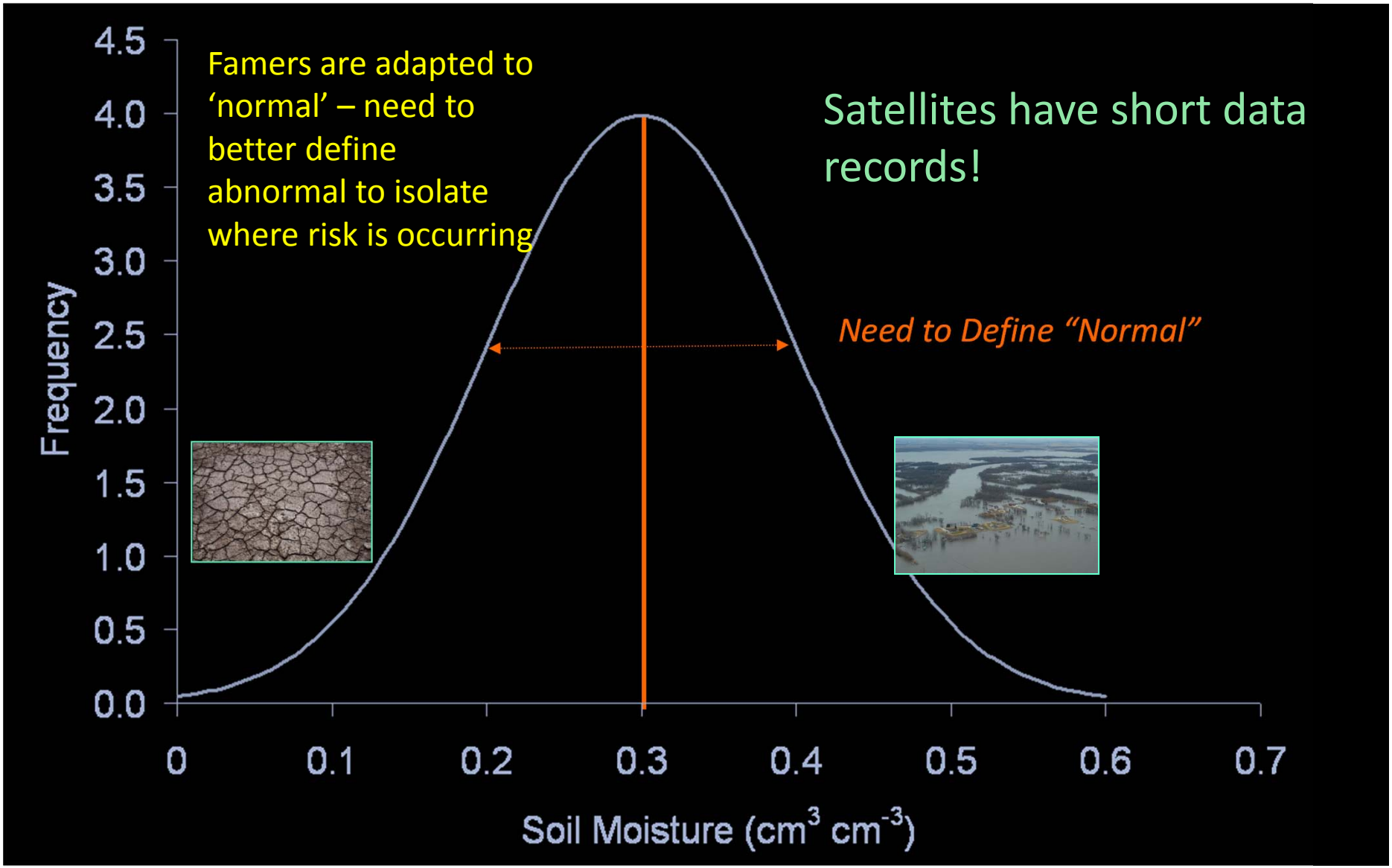
Data available in Near Real Time

3 Hydra probes each installed at multiple depths:

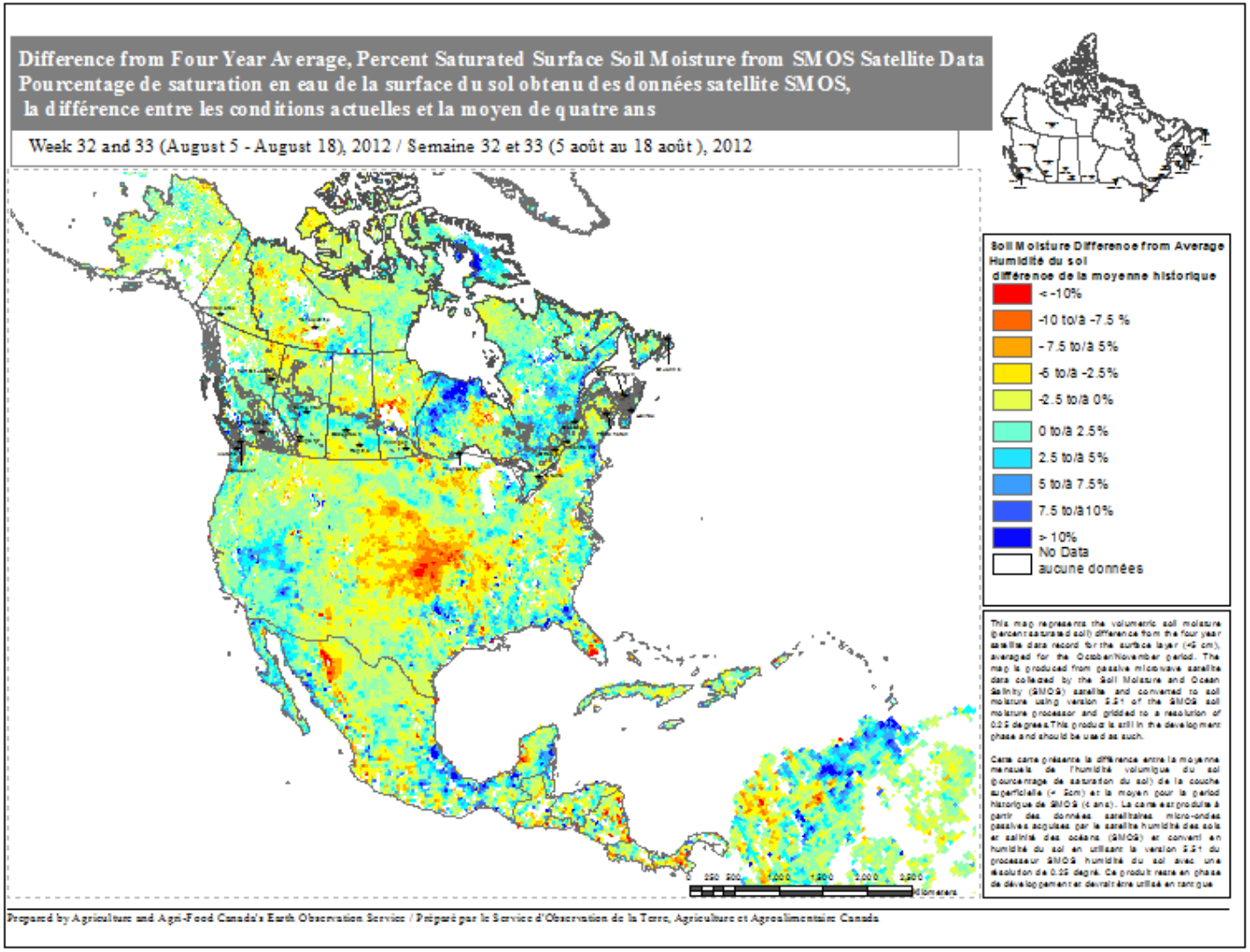
- 0-5cm 5cm
- 20cm 50cm
- 100cm 150cm (Sask Pasture)

- Maps, information products are communication tools for decision making at a national scale, not for individual farmers
- Tools for precision agriculture, producer decision support are largely provided by private sector

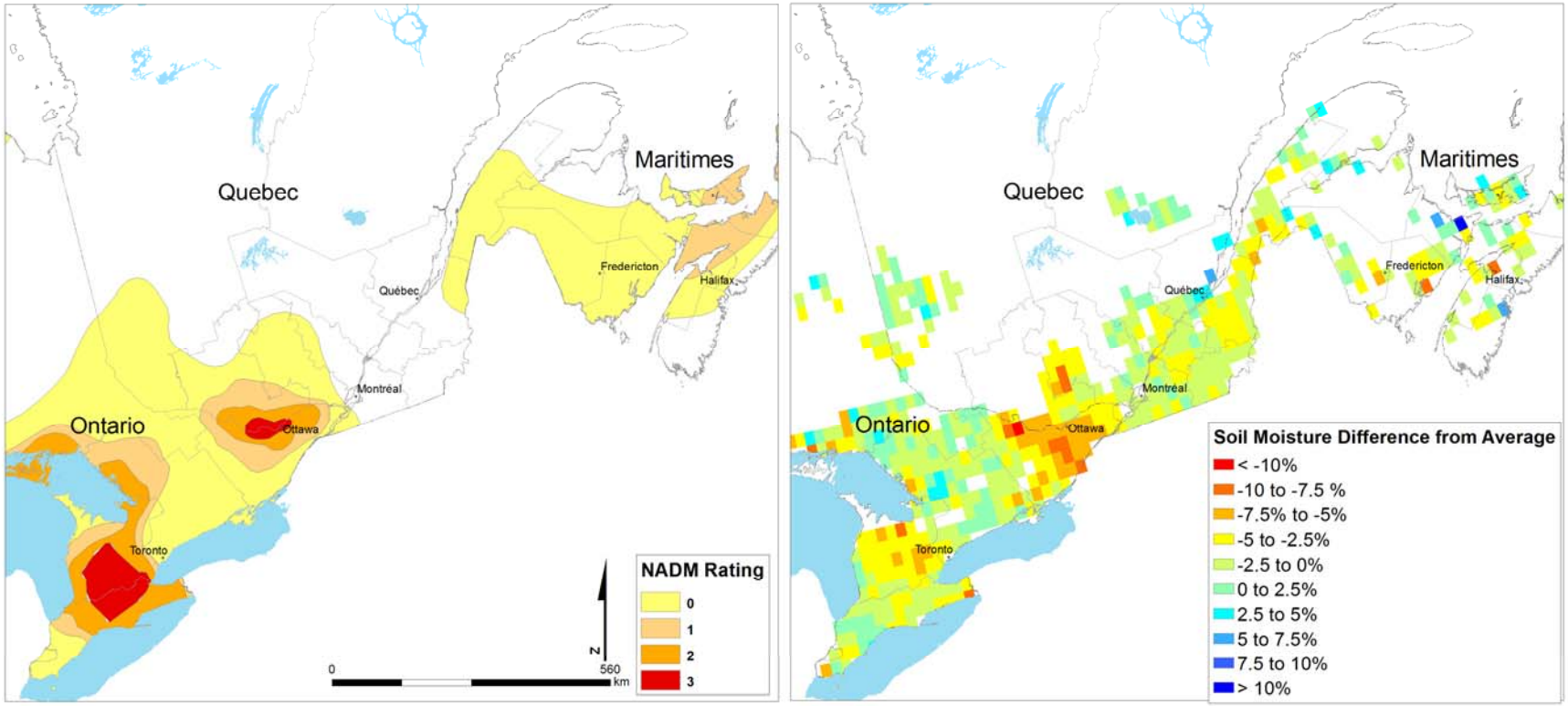
Defining Risk Conditions: Soil Moisture Anomalies



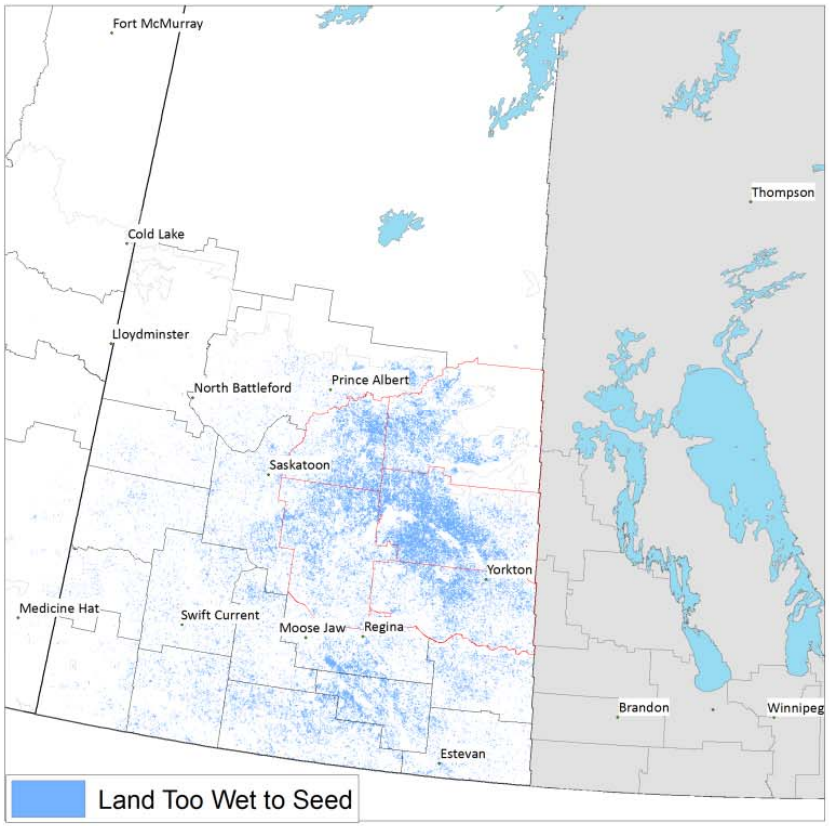
Soil Moisture Anomalies from SMOS 4 year Baseline

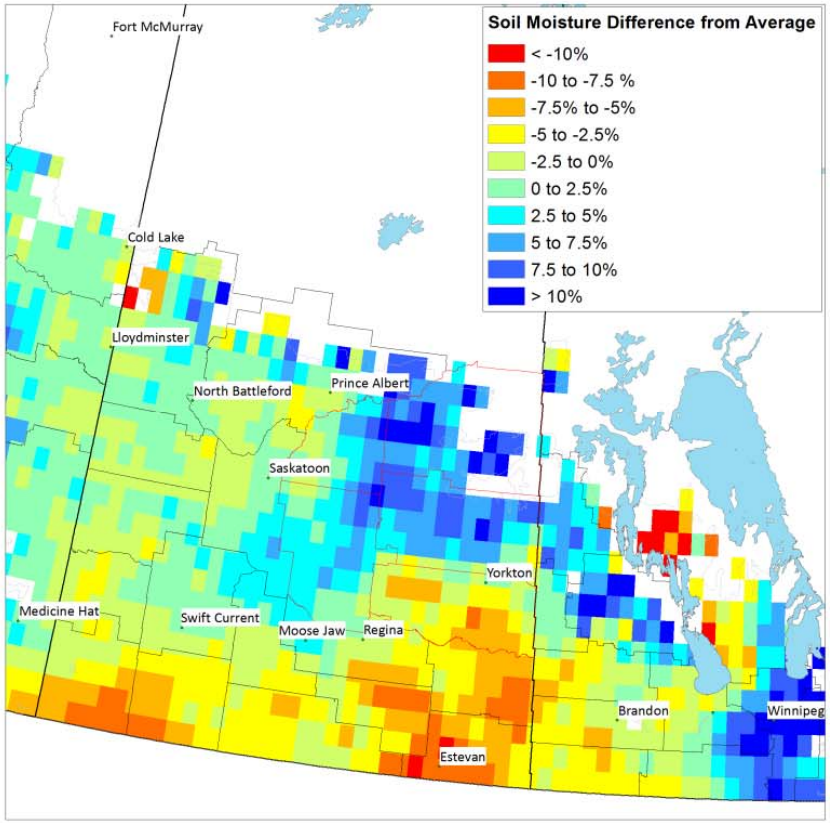


2012 Drought in Southern Ontario

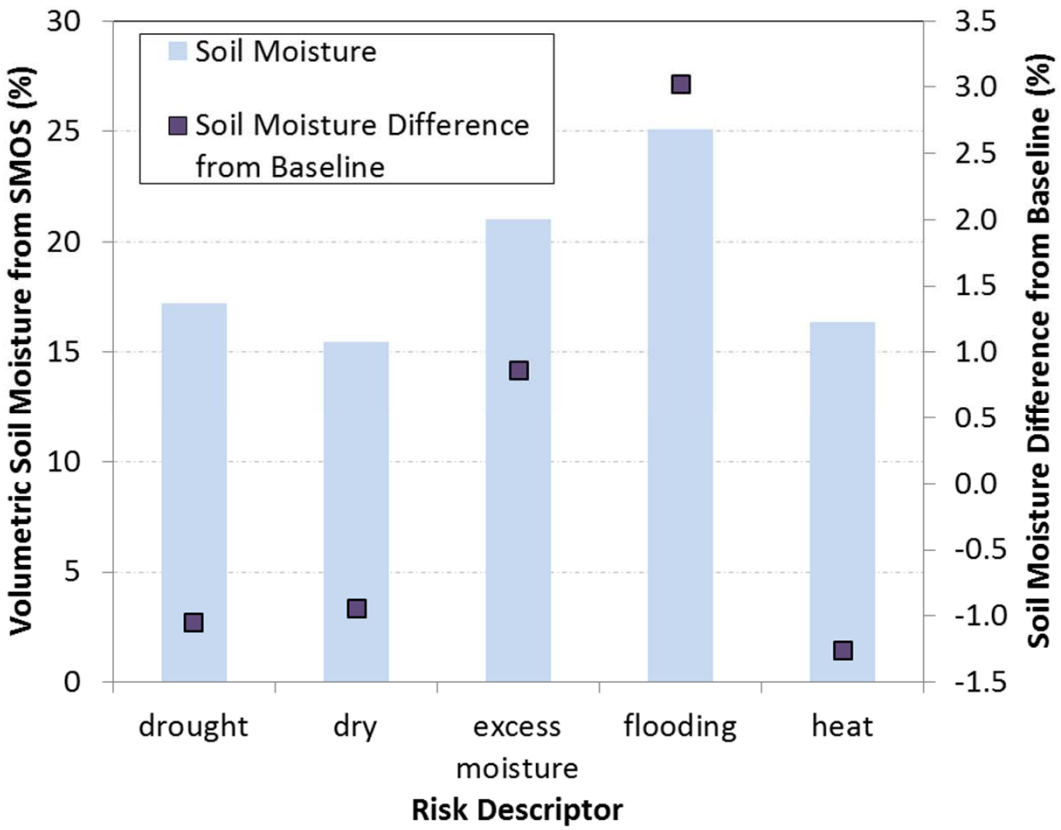


Too Wet To Seed 2010 and SMOS Soil Moisture Anomalies





How does SMOS capture risk events?



- Soil moisture anomalies (from four year baseline) capture regional scale risk events well
- Can inter-calibrate data sets to get a longer time series for forecasting, risk assessment?

Multi-Sensor History of Soil Moisture

SMMR
1979 - 1987

C/X – Band 150 km Res

K – Band
15km Res

SSM/I
F8: 1987- - present

C – Band, 50km Res

ERS/ASCAT Scatterometers
1991-1996; 1996-2001; 2006 - present

C/X – Band, 60km Res

AMSR-E
2002 - 2011

L – Band, 30km Res

SMOS
2009- present

C/X – Band, 50 km Res

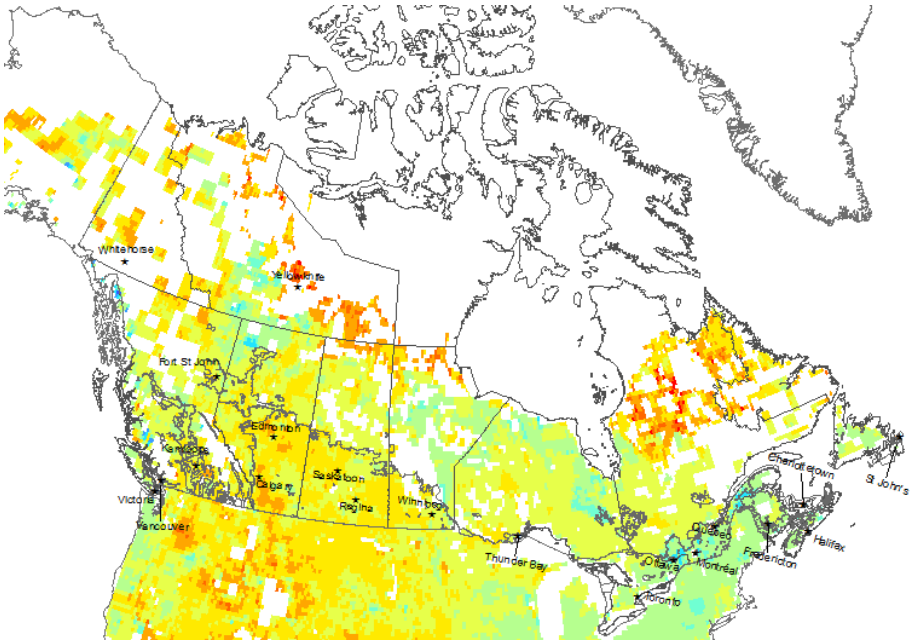
AMSR2
2012 - present

L – Band, 40km Res

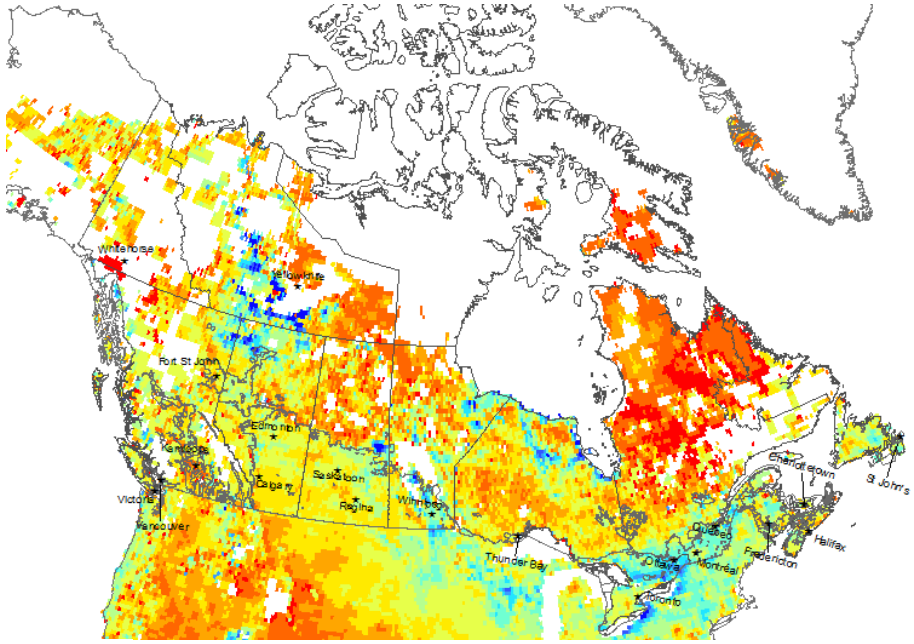
SMAP
2014 -

Essential Climate Variable Data Set from ESA: 1979 to 2010 soil moisture data set

Satellite Soil Moisture ‘Normals’



32 years of ECV Soil Moisture
April Monthly Average

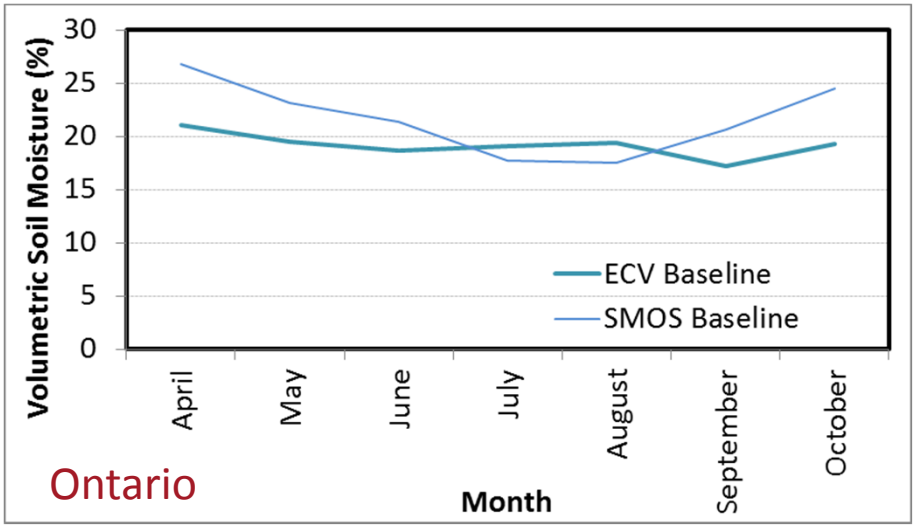


4 years of SMOS Soil Moisture
April Monthly Average

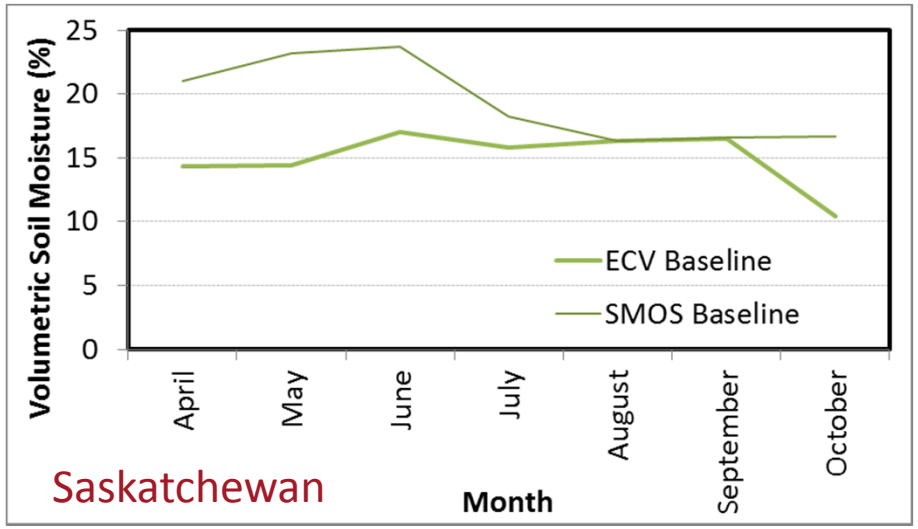
Surface Soil Moisture
Humidité de la surface du sol

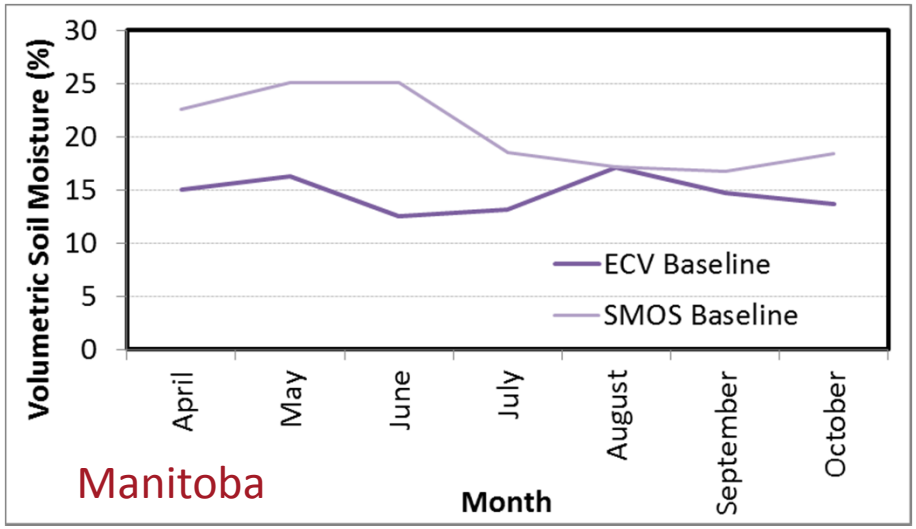
- < 5%
- 5 - 10 %
- 10 - 15%
- 15 - 20%
- 20 - 25%
- 25 - 30%
- 30 - 35%
- 35 - 40%
- 40 - 45%
- 45 - 50%
- > 50%
- No Data
  aucune données

Difference between Baselines

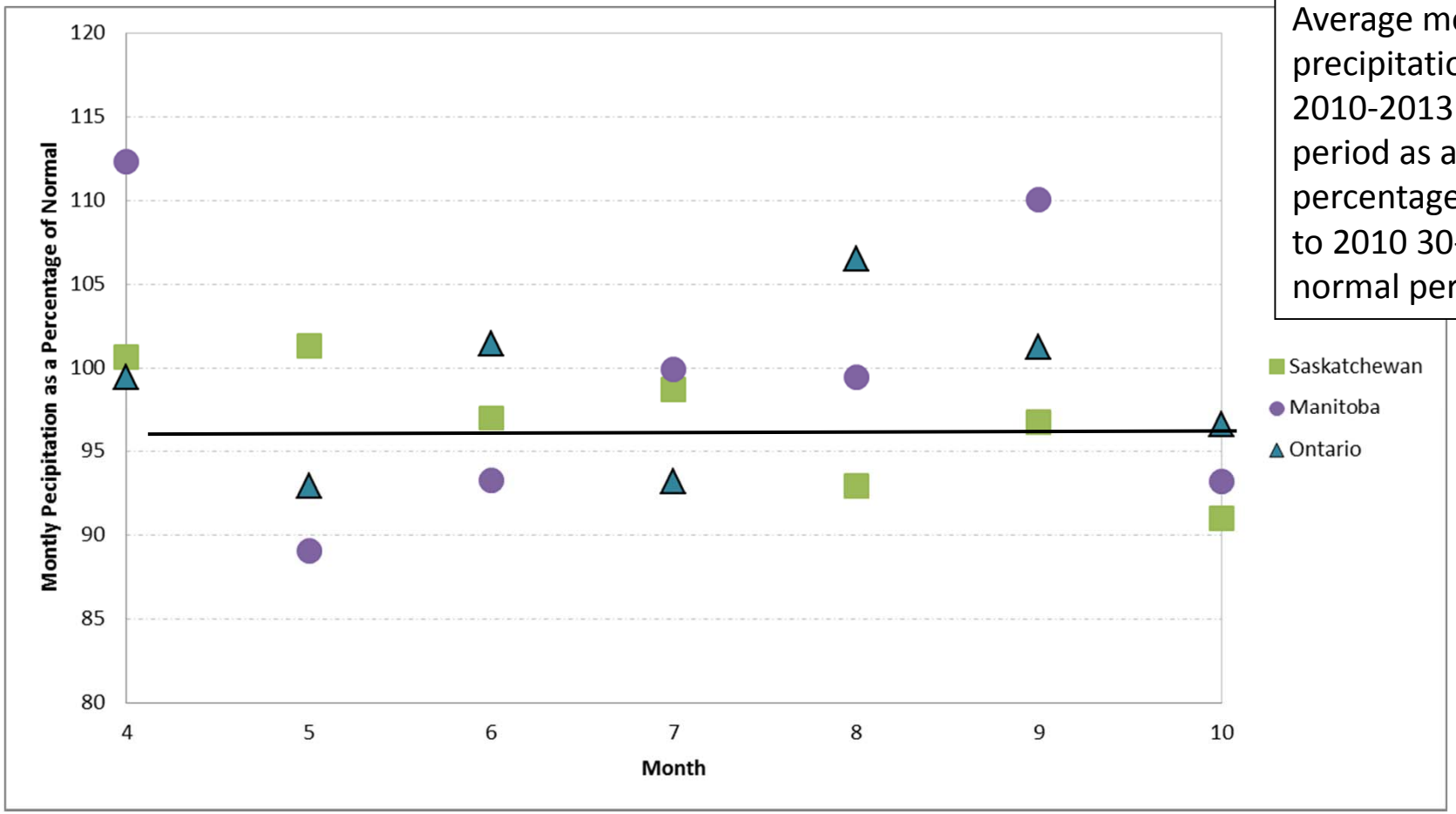


- *Spring and fall soil moisture are particularly divergent from 32 year baseline*
- *The differences are of a larger magnitude for the semi-arid Saskatchewan versus temperate Ontario*





Baseline time periods



Average monthly precipitation for 2010-2013 baseline period as a percentage of 1981 to 2010 30-year normal period

- How much of the difference between the baselines is due to differences in errors of the two data sets, and how much is due to differences in the length of the time period?

Application User Needs

- Root zone soil moisture
- Consistent time series
- Reliable near real time data access
- Cal/val – how does error in data impact the applications?
- Processing of data at source
  - Inter-calibration
  - Meaningful product development

Conclusions & Future Directions

- Timing is everything!
  - Data needs to be available in NRT to support risk assessment
  - Longer term, high accuracy and confidence can be used for longer term evaluation such as statistical forecasting
- Evaluation of ECV reference data set
  - Can this be a robust baseline?
  - What are the errors in using a multi-sensor data set
  - Can the dataset be used for statistical yield forecasting?
- Blended agricultural risk indicators – NDVI, Evapotranspiration – snapshot of risk