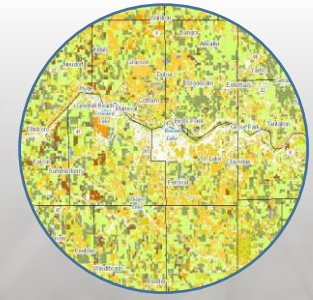
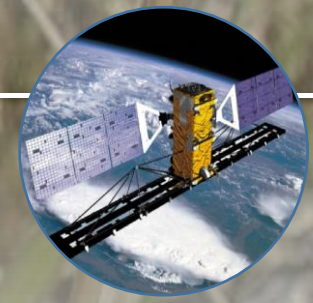
Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canada

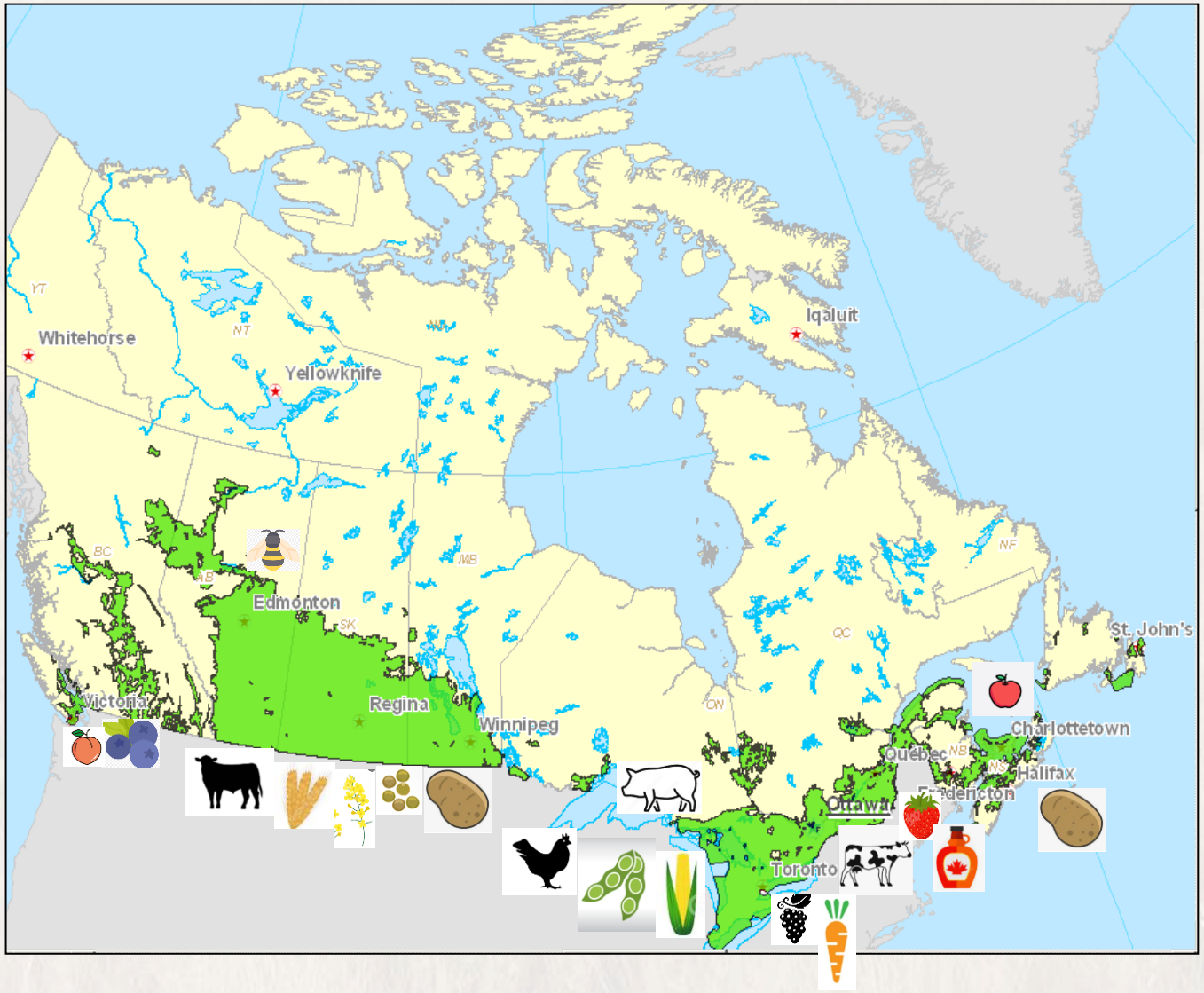




Application of Remote Sensing in Operational Agrometeorological Advisory Services

Catherine Champagne, Environmental Scientist
National Agroclimate Information Service
Science and Technology Branch
Agriculture and Agri-Food Canada

Agriculture and Agri-Food Sector in Canada



- Agriculture and Agri-Food sector employs 2.1 million people, accounts for 8% GDP
- Export focussed: $61.0 billion per year
- Canada's agricultural land mass large and sparsely populated with a wide diversity of crops
- Agriculture in Canada is largely weather and climate dependent and extremes result in billions of economic costs each year
- Climate change adaptation: vulnerability to changing climate normals could is leading to changes in where and what is grown but brings risks
- Climate change mitigation: reducing emissions from nitrous oxide, methane and sequestration of carbon in soils

National Agroclimate Information Service (NAIS)

Science and Innovation in Agroclimate

Development and Application of Geospatial Analytical Tools

Expert Interpretation and Analysis

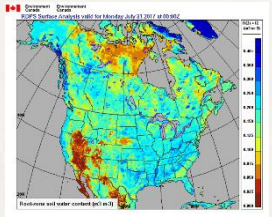
Building Partnerships and Collaborations

- Applied science & operational delivery of information and tools to monitor impact of climate on agriculture
- Monitoring, early warning using authoritative data and models are key to understanding climate risks and impacts
- NAIS activities focus on four main thematic areas:
  1. **Mitigating and Adapting to Climate Change**
  2. **Increasing the resilience of agro-ecosystems**
  3. **Accelerating Digital Transformation**
     - Building and maintaining cross-cutting agroclimate data sets
- All information made available via **Weather and drought** related to agriculture website:
  - https://agriculture.canada.ca/en/agricultural-production/weather

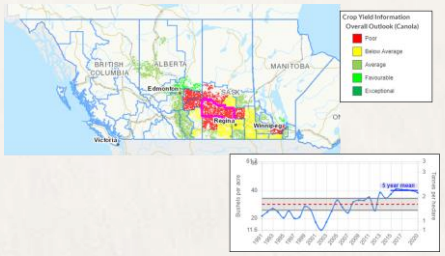
Some key activities…

Research & Development

Modelled Weather Data

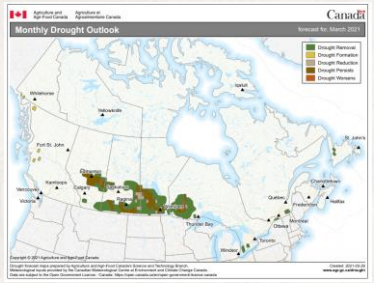


Sustainability & Crop Metrics



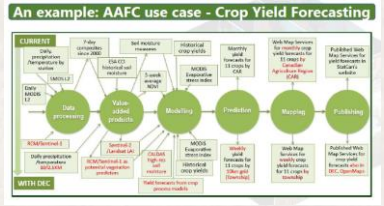
Blended Drought Indices

Drought Outlook



High Resolution Yield Modelling

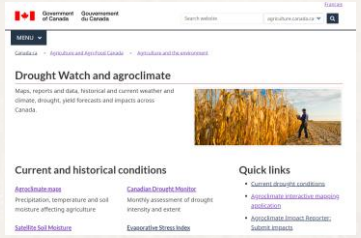
High Performance Computing tools For Big Data Exploitation



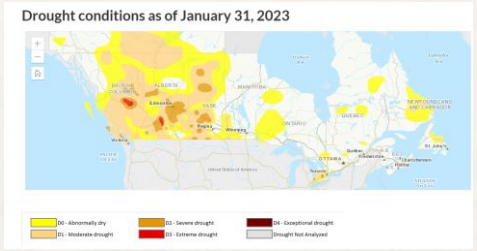
Operational

Near-Real Time Data

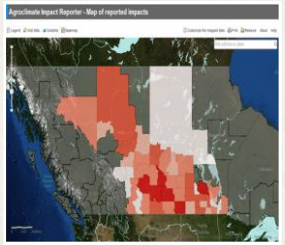
Weather and drought related to agriculture website



Canadian Drought Monitor

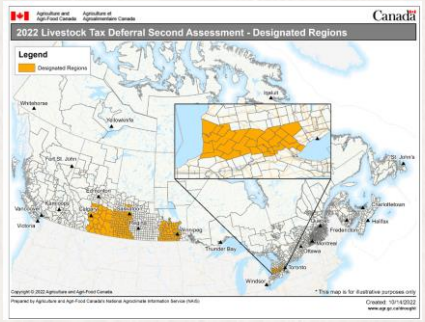


Agroclimate Impact Reporter

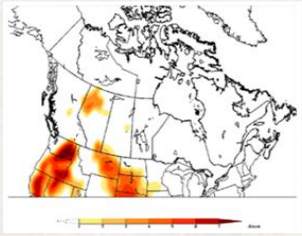


Climate-Related Risk Committee

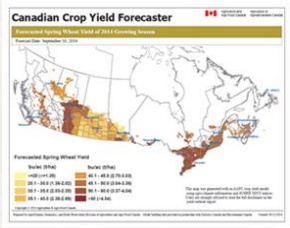
Livestock Tax Deferral



Extreme Weather Indices

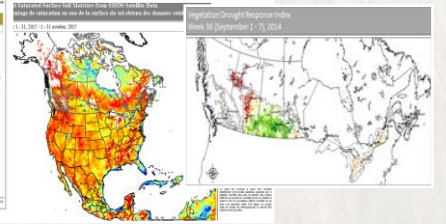


Crop Yield Forecaster



Satellite Soil Moisture

VegDRI, Evaporative Stress Index



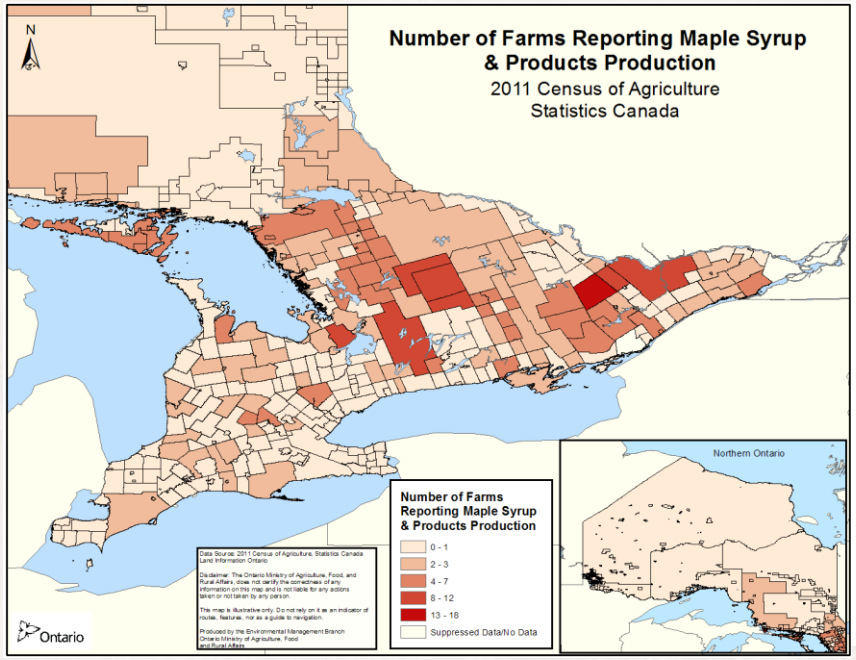
How Do We Collect Geospatial Information about Agricultural Sector?

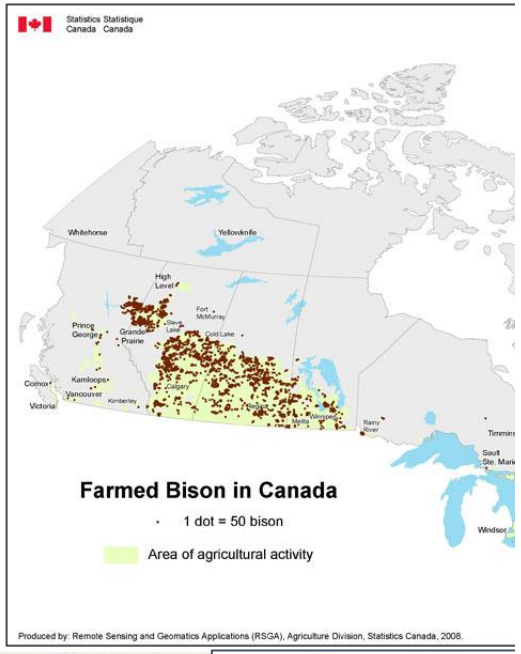
1. Surveys – Crowd Sourcing
   - Questionnaires (census, statistical surveys)
   - windshield surveys
   - Field data collection
2. Monitoring Stations
   - Automated Weather Stations
   - Doppler Radar
3. Satellite Remote Sensing
   - Optical, thermal, radar, microwave, gravity satellites
   - Polar orbiting or geostationary
   - Resolution from <1m to >10km
4. Models
   - Use statistical or physics based model to simulate information

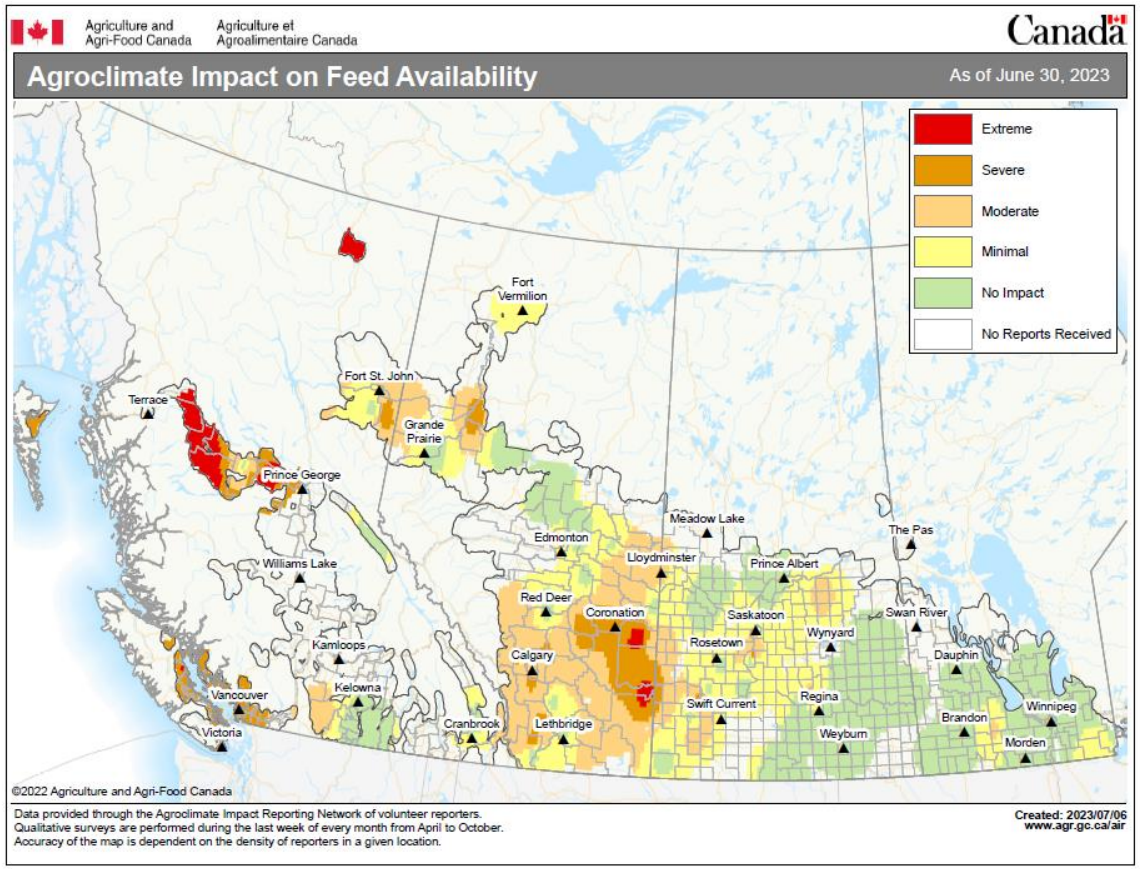
Many agroclimate services relay on using current data in combination with historical normals for determining risk

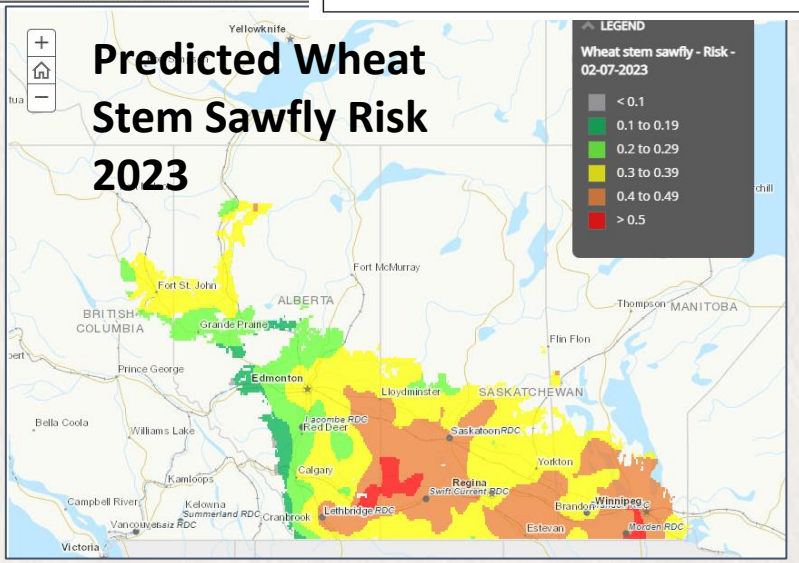
Long term, consistent data records are key for observing change

Surveys

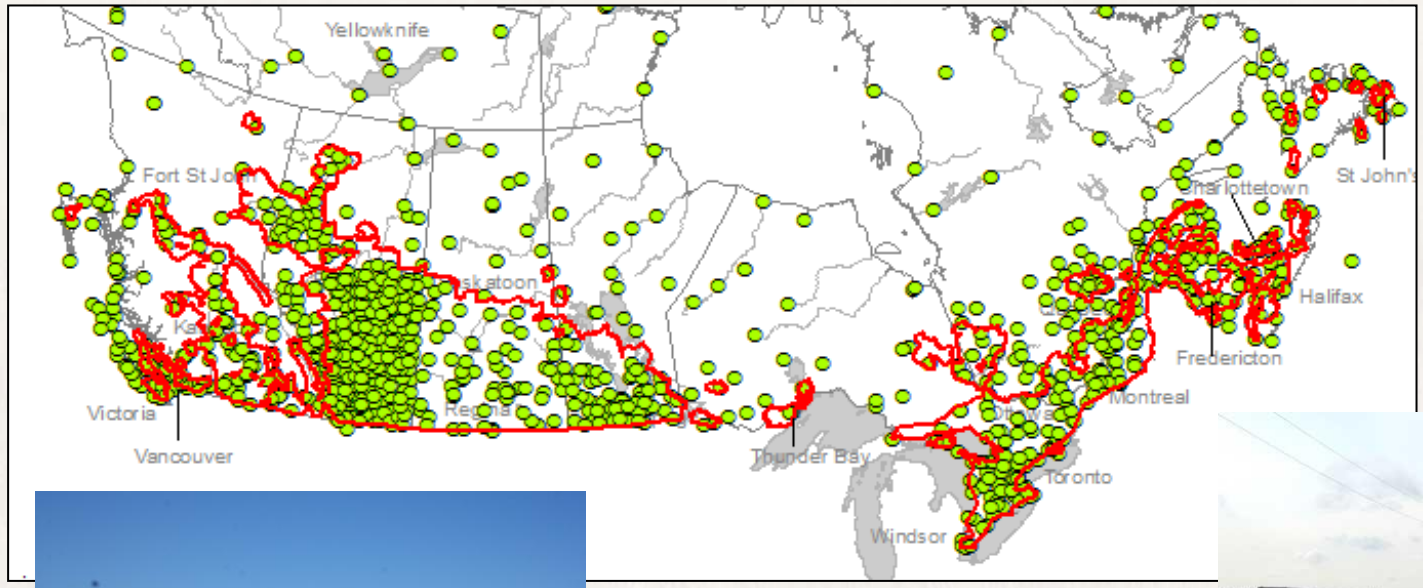

Number of Farms Reporting Maple Syrup & Products Production
2011 Census of Agriculture
Statistics Canada
Number of Farms Reporting Maple Syrup & Products Production
0 - 1
2 - 3
4 - 7
8 - 12
13 - 18
Suppressed Data/No Data
Northern Ontario
Ontario

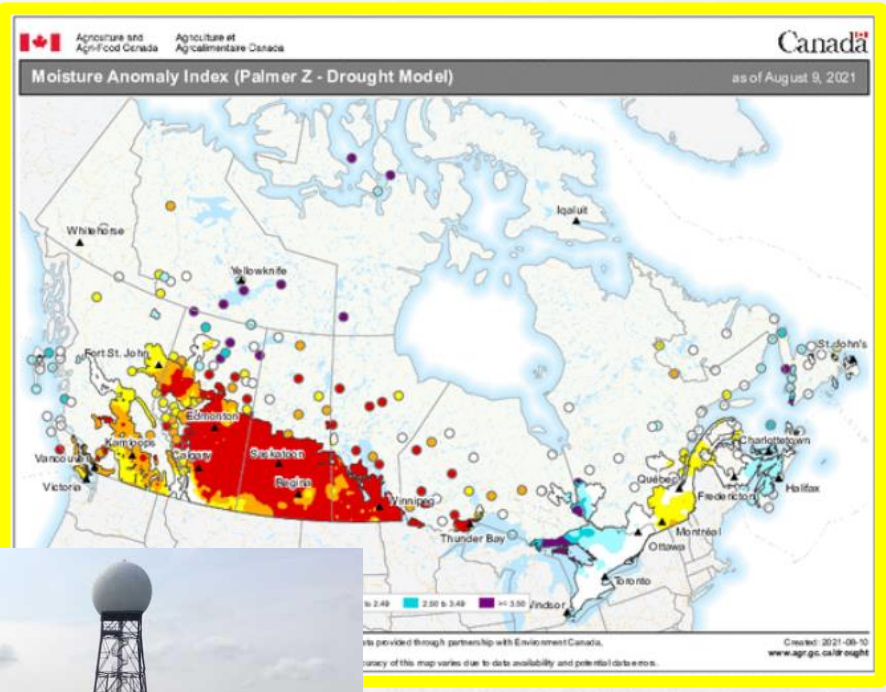

Statistics Statistique Canada Canada
Farmed Bison in Canada
1 dot = 50 bison
Area of agricultural activity
Produced by: Remote Sensing and Geomatics Applications (RSGA), Agriculture Division, Statistics Canada, 2008.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Agroclimate Impact on Feed Availability
As of June 30, 2023
Extreme
Severe
Moderate
Minimal
No Impact
No Reports Received
©2022 Agriculture and Agri-Food Canada
Data provided through the Agroclimate Impact Reporting Network of volunteer reporters.
Qualitative surveys are performed during the last week of every month from April to October.
Accuracy of the map is dependent on the density of reporters in a given location.
Created: 2023/07/06
www.agr.gc.ca/air


Predicted Wheat Stem Sawfly Risk 2023
LEGEND
Wheat stem sawfly - Risk - 02-07-2023
< 0.1
0.1 to 0.19
0.2 to 0.29
0.3 to 0.39
0.4 to 0.49
> 0.5
Yellowknife
Fort McMurray
Fort St. John
ALBERTA
BRITISH COLUMBIA
Grande Prairie
Prince George
Edmonton
Lloydminster
SASKATCHEWAN
MANITOBA
Thompson
Flin Flon
Bella Coola
Williams Lake
Kamloops
Calgary
Regina
Swift Current
Yorkton
Brandon
Winnipeg
Lethbridge
Cranbrook
Kelowna
Victoria

“Network of Networks” for Agroclimate Data: Station-Based Monitoring



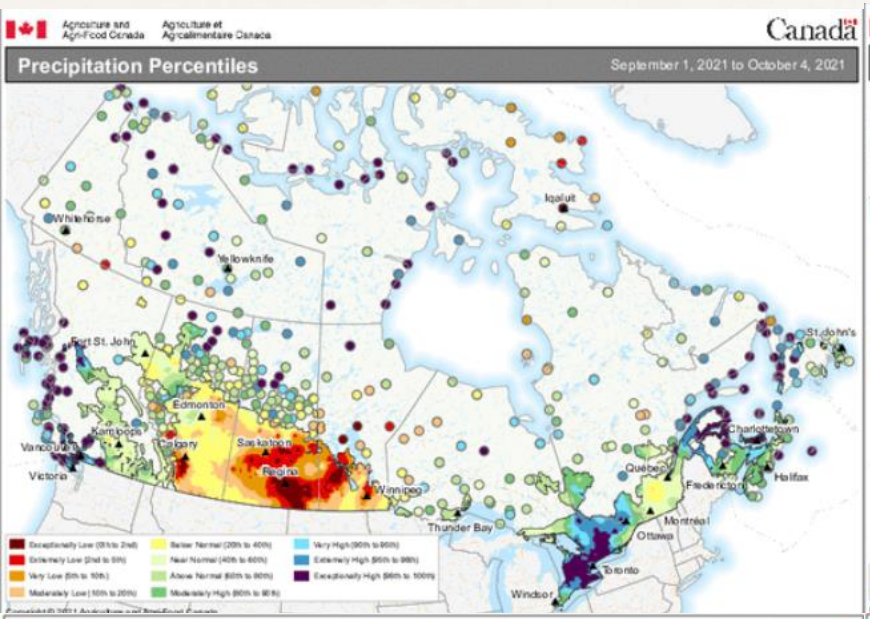


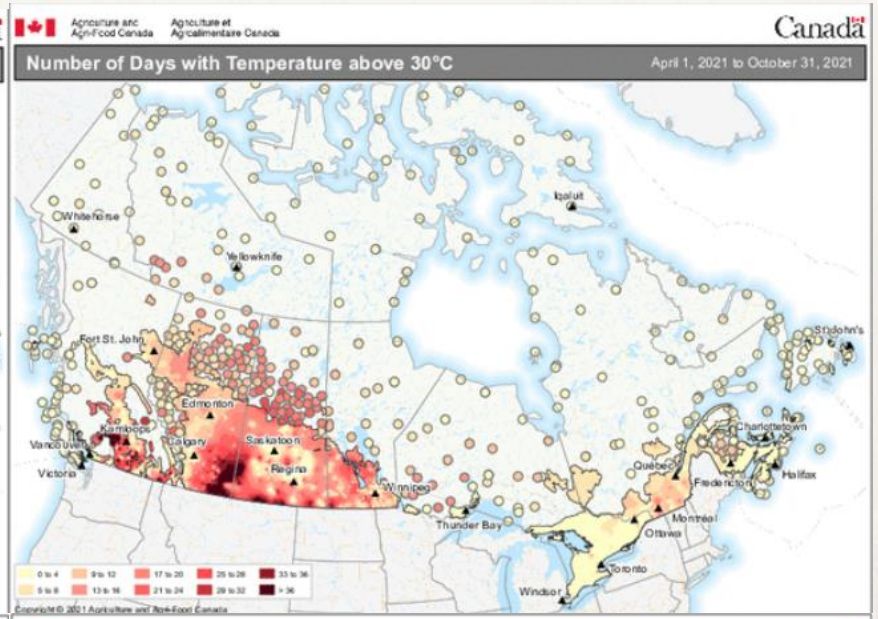
Agroclimate Data uses raw weather inputs to create indicators of heat and water accumulation relevant to crop growth

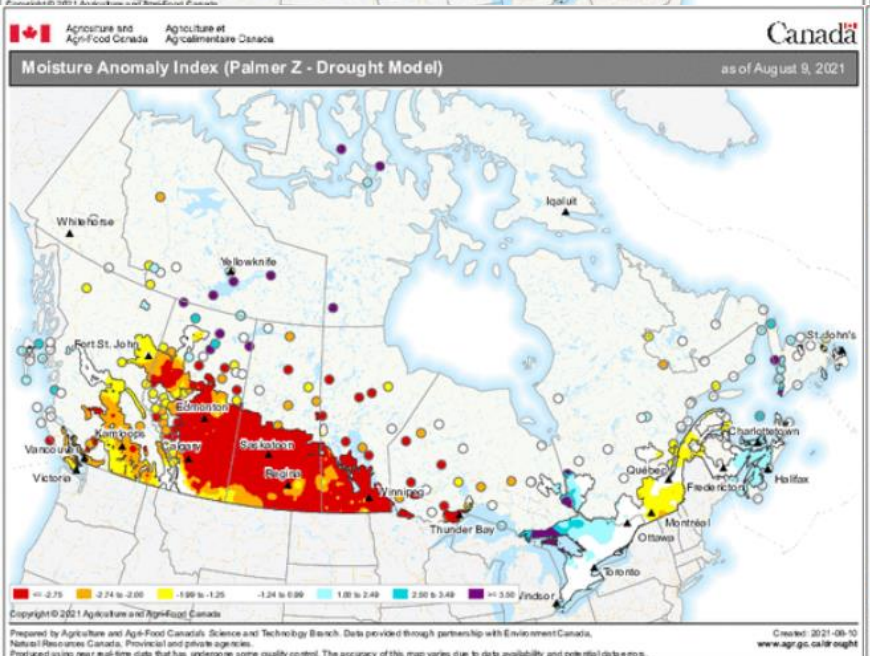
>2500 climate station locations

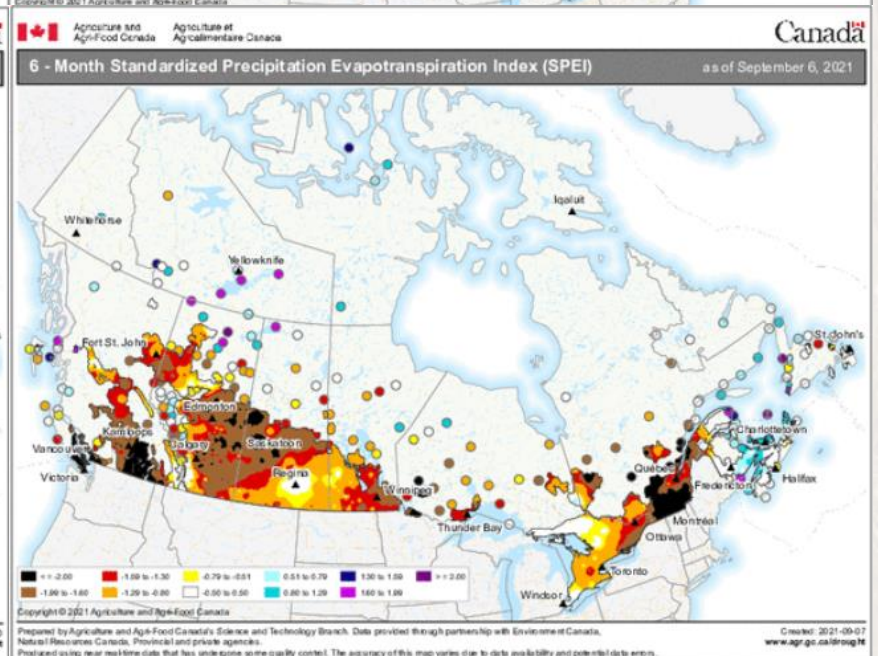
- **≈ 1000 ECCC**
- **≈ 420 CoCoRHaS**
- **≈ 450 Alberta Environment**
- **≈ 100 Manitoba Ag.**
- **≈ 80 PQ Mesonet**
- **≈ 10 New Brunswick DNR**

Near Real Time Monitoring System



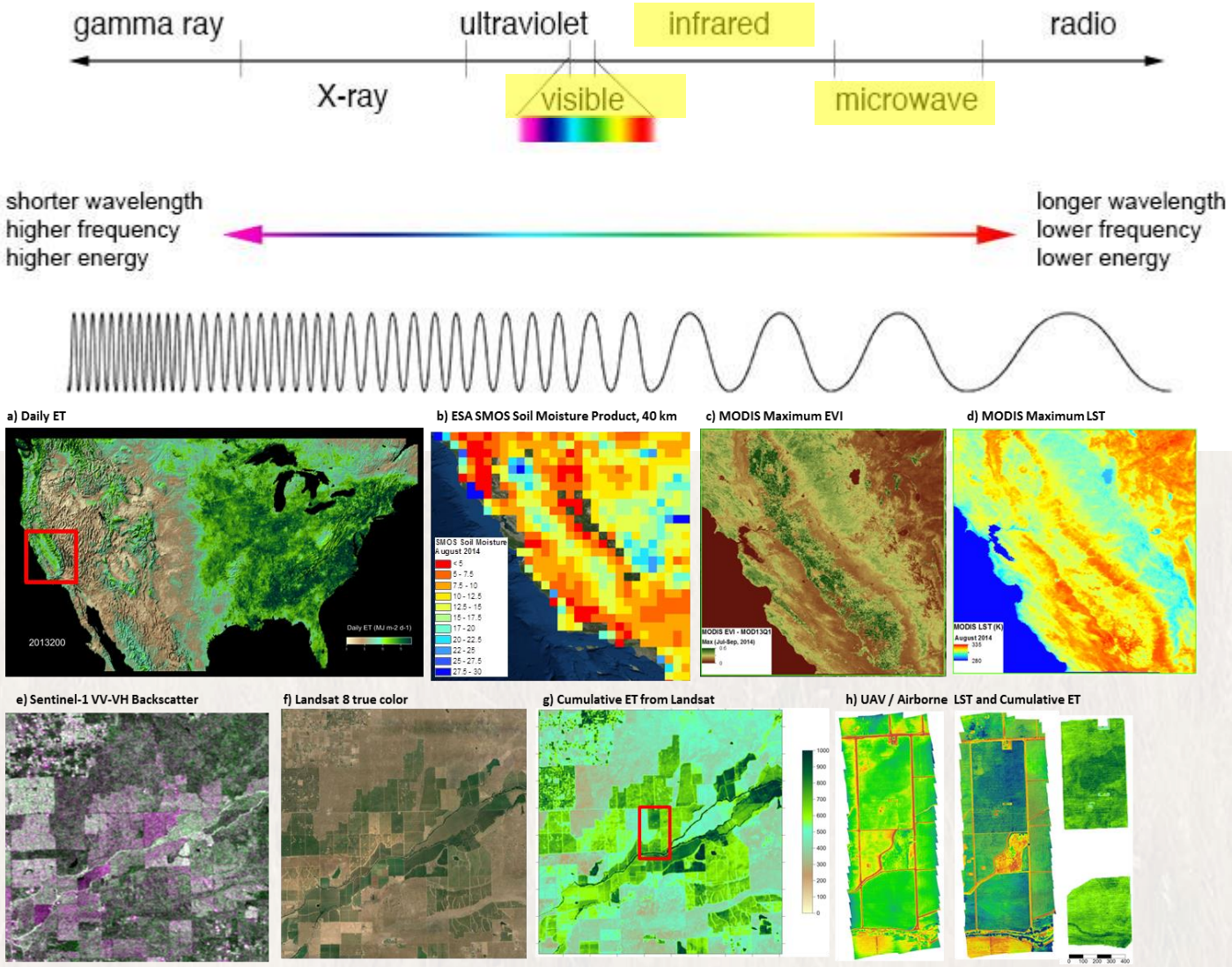






- Daily quality control of weather stations fully automated system)
- Use current data, station quality rankings and historical gridded data to produce gap-filled time series for estimation of large number of agroclimate measures:
- **Precipitation**
  - Percentiles (30, 60, 90, 180 day, Growing Season, Winter)
  - Accumulated (up to 1825 days)
  - Dry Spells
- **Temperature**
  - Max Temp
  - Min Temp
  - Heat Wave
  - Crop Heat Units
  - Temperature Anomalies
- **Drought Indicators:**
  - Palmer Z, Hydrological, Soil Moisture, SPEI, SPI

Satellite Remote Sensing



Different frequencies for different applications:

Optical Data

- Crop Health
- Leaf Area Index
- Biomass
- Crop Residue Cover
- Crop Types
- Crop Growth Stage

Radar Data (Active)

- Soil Moisture
- Surface Hydrology
- Plant Structure
- Crop Biomass
- Surface Roughness/Tillage

Passive Microwave Data

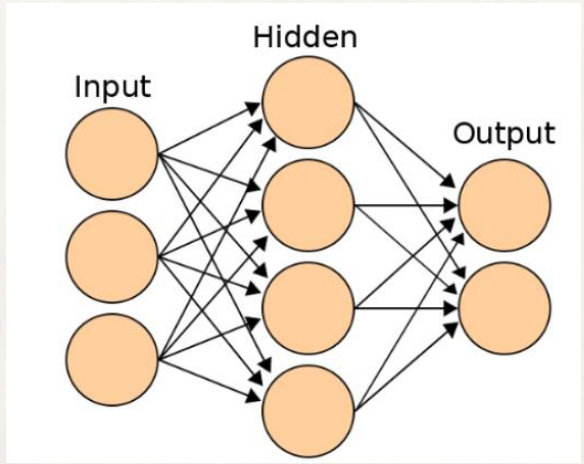
- Soil Moisture
- Vegetation Water Content

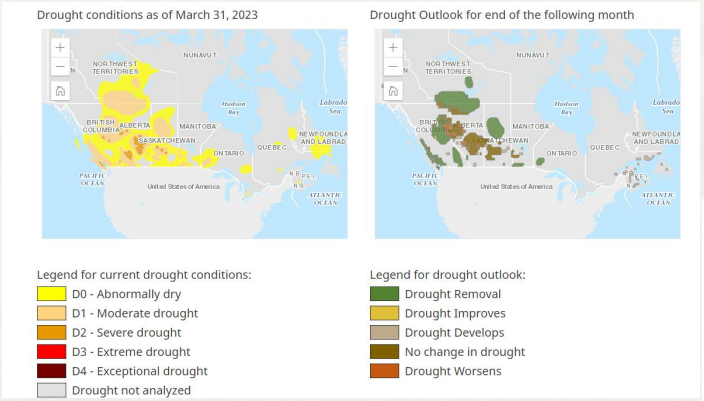
Thermal

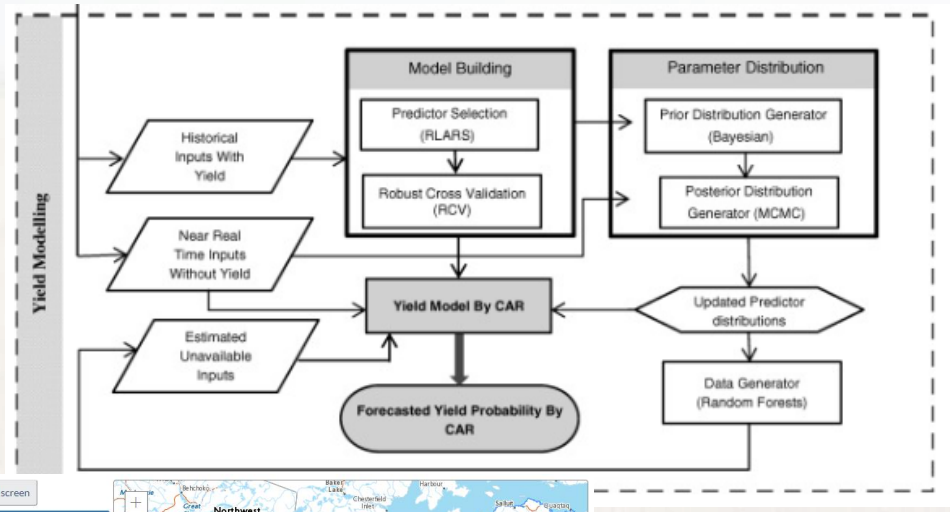
- Temperature
- Evapotranspiration

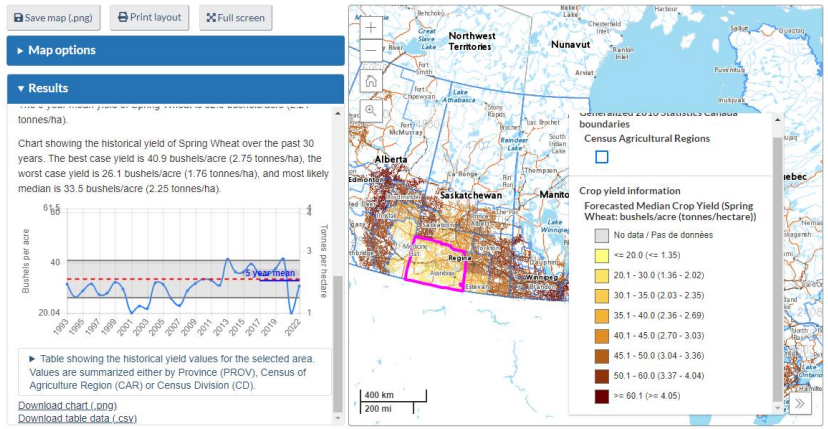
Models

1) Statistical / Empirical / Machine Learning / Artificial Intelligence

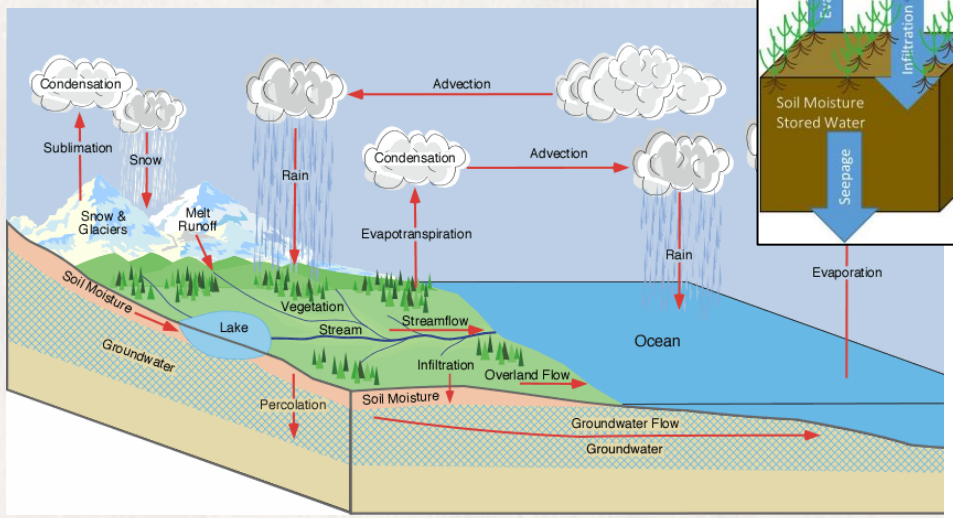


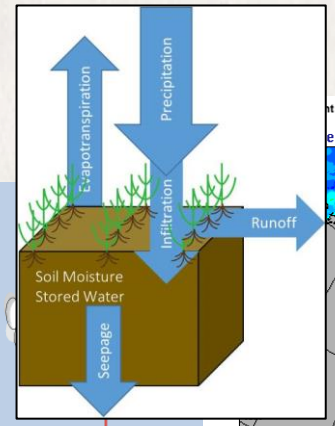


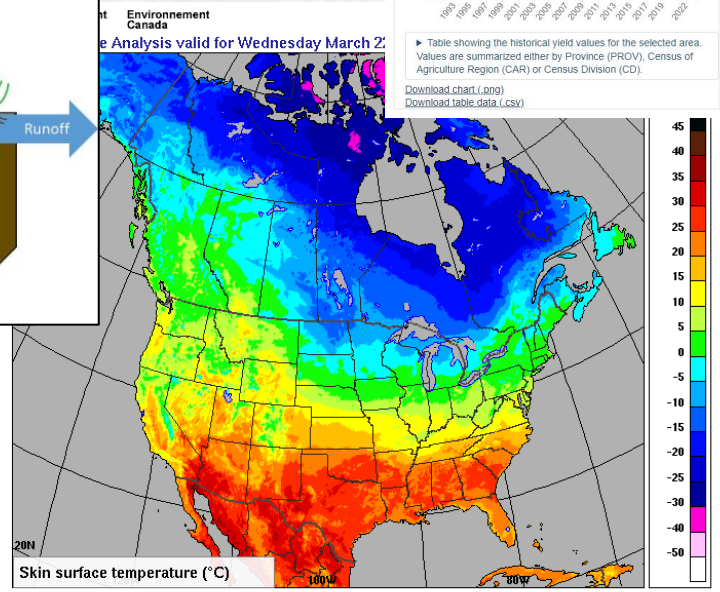


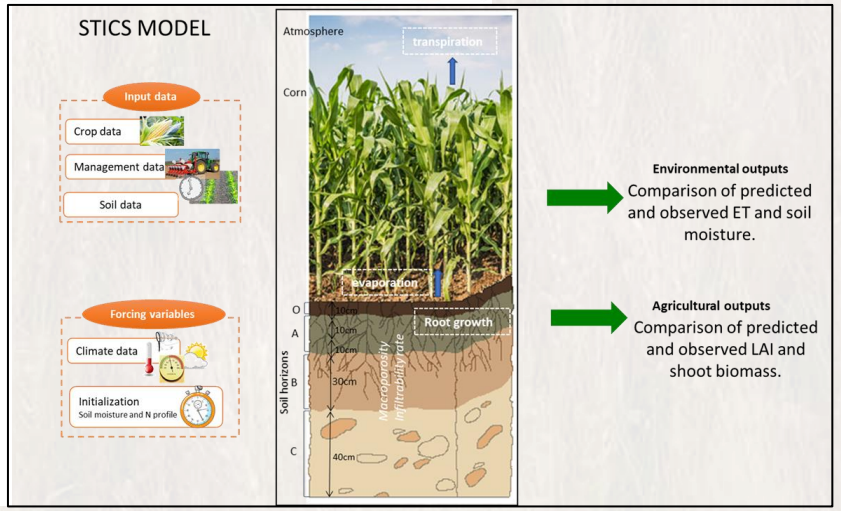


2) Physical/Process-Based

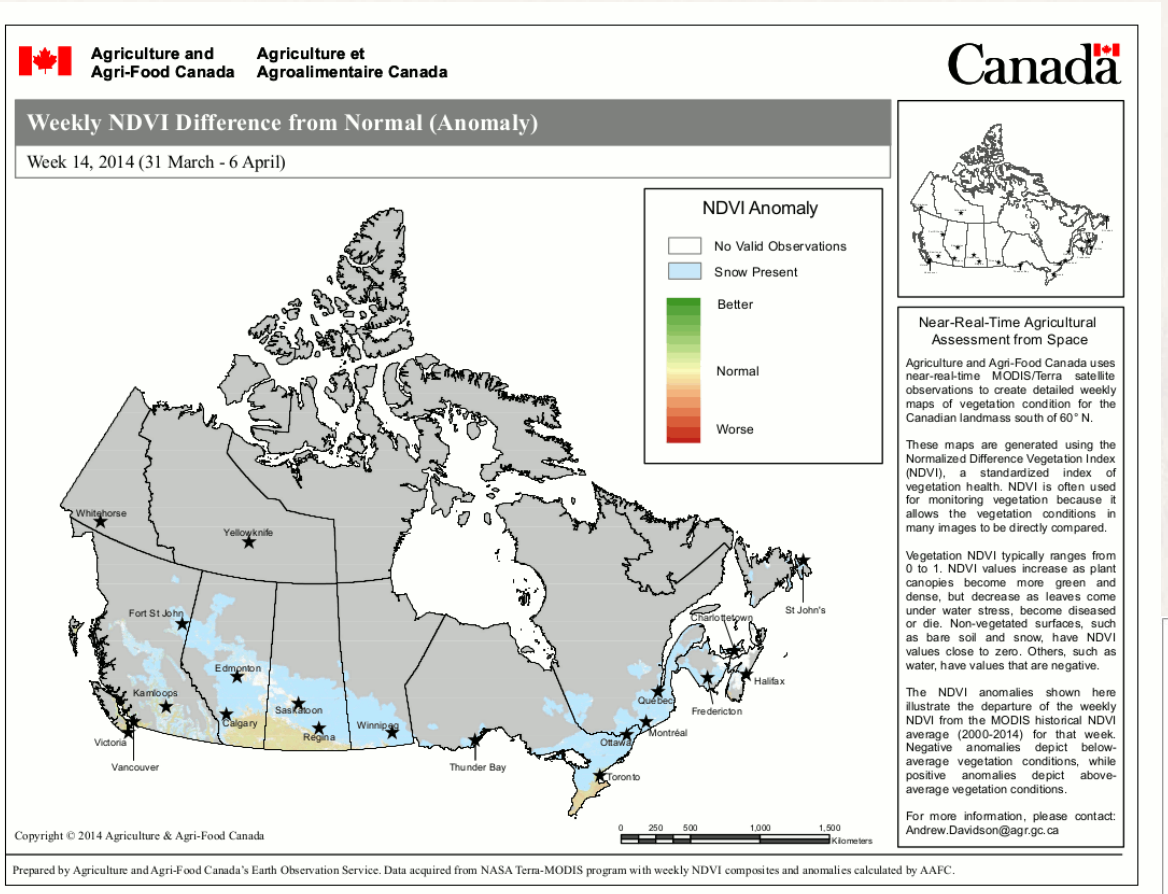






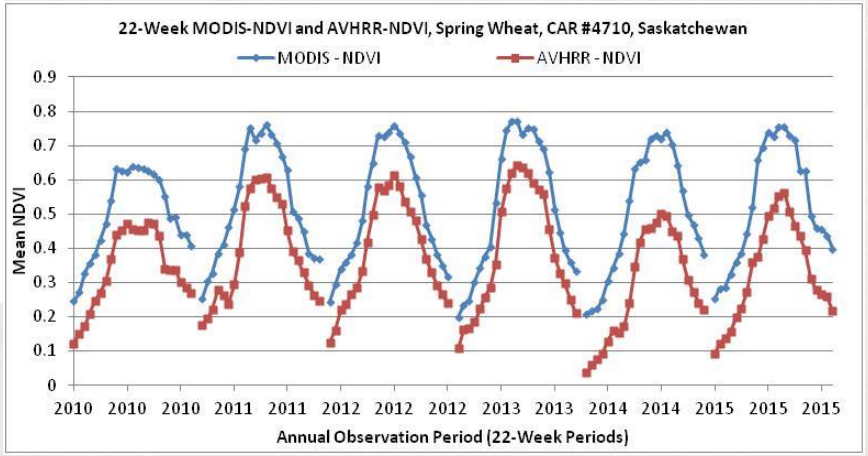


Earth Observation for Direct Monitoring of Agroclimate Conditions: **Vegetation Indices**

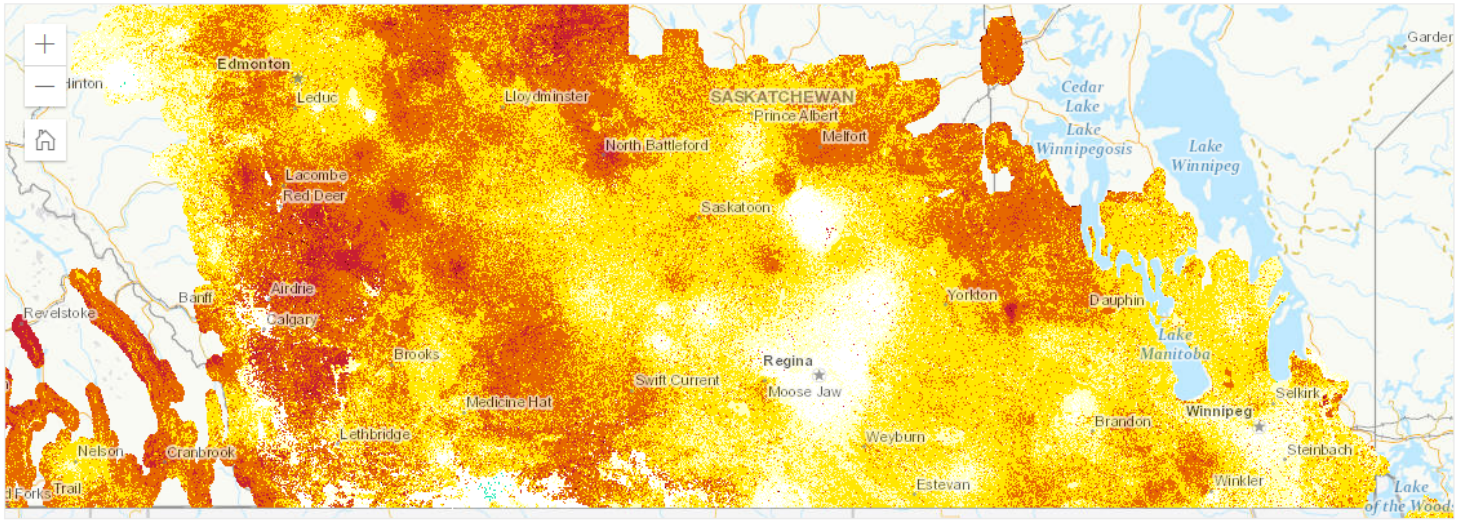


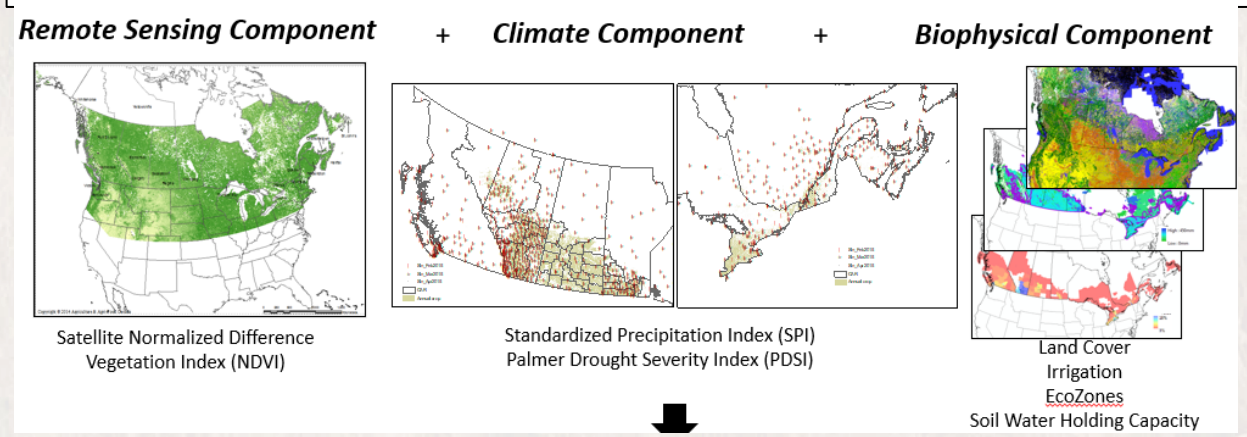
Maximum 7-day NDVI composites from MODIS comparing current conditions to long term average

- Normalize Differenced Vegetation Index (NDVI) and other similar indices use band ratios to quantify different between red/near infrared surface reflectance to monitor plant health at many scales
- Long term data records from “moderate” resolution sensors, such as AVHRR, MODIS and now VIIRS are key to these data sets



Vegetation Drought Response Index

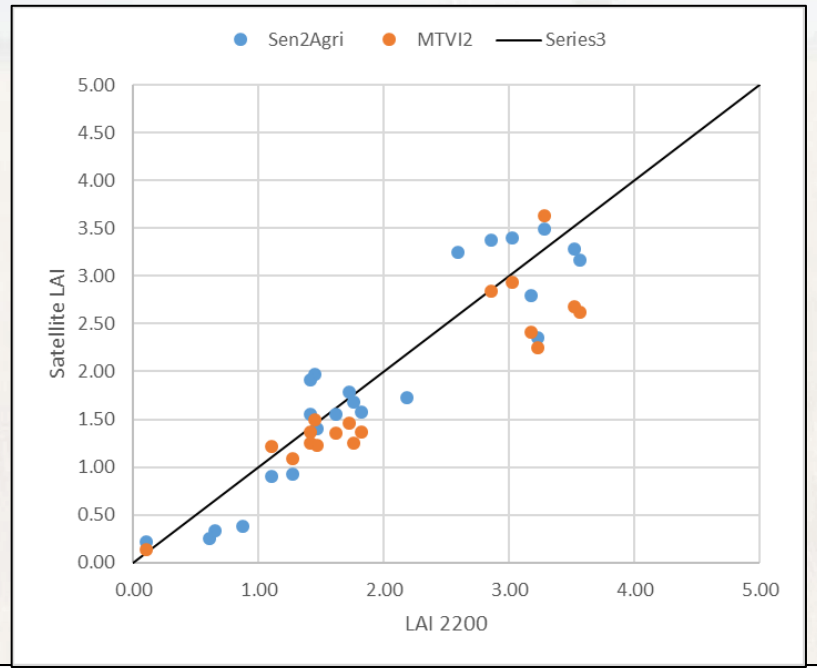




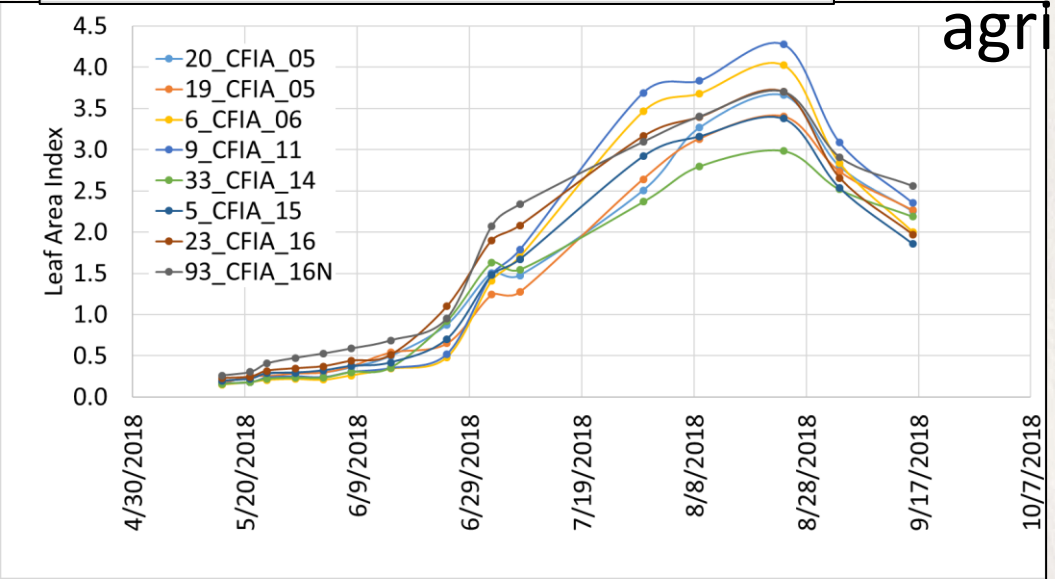
- Combines time series satellite NDVI (MODIS) and station-based drought indicators (Standardized Precipitation Index) and biophysical data (land cover, irrigation, ecozones) to model drought severity at pixel-scale

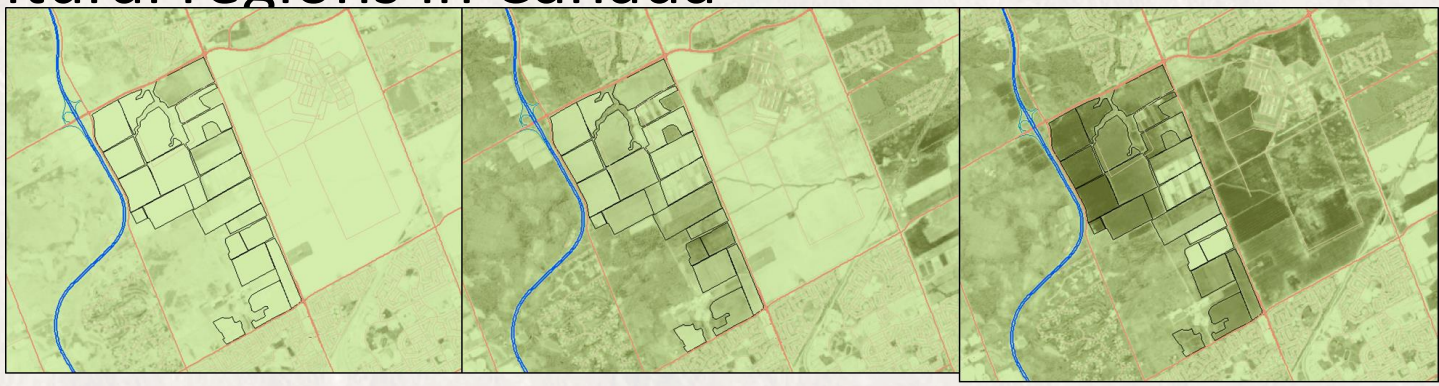
- *Tadesse, T., Champagne, C., Wardlow, B.D., Hadwen, T.A., Brown, J.F., Demisse, G.B., Bayissa, Y.A., Davidson, A.M. (2017). Building the vegetation drought response index for Canada (VegDRI-Canada) to monitor agricultural drought: first results. GIScience and Remote Sensing, [online] 54(2), 230-257. http://dx.doi.org/10.1080/15481603.2017.1286728*

Leaf Area Index



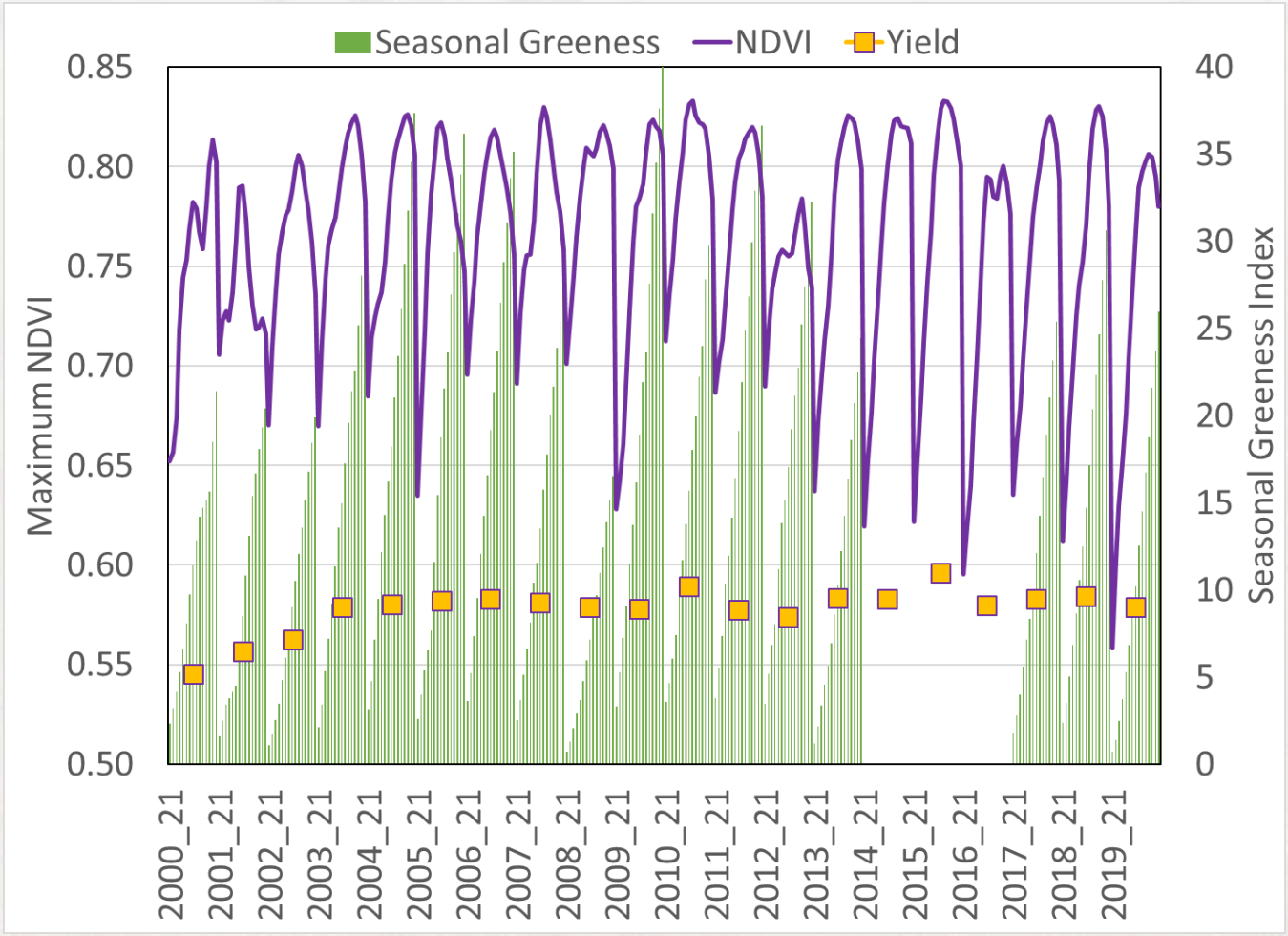
- LAI retrieval algorithm in Sentinel-2 Toolbox (SNAP) shows good correspondence with ground measurements (based on Neural Network Model) at 20m resolution
- Tool has been translated for Google Earth Engine into the LEAF Toolbox (https://github.com/rfernand387/LEAF-Toolbox) – can be run both as Java Script or using Python API
- Pilot is currently under way to run this for all agricultural regions in Canada

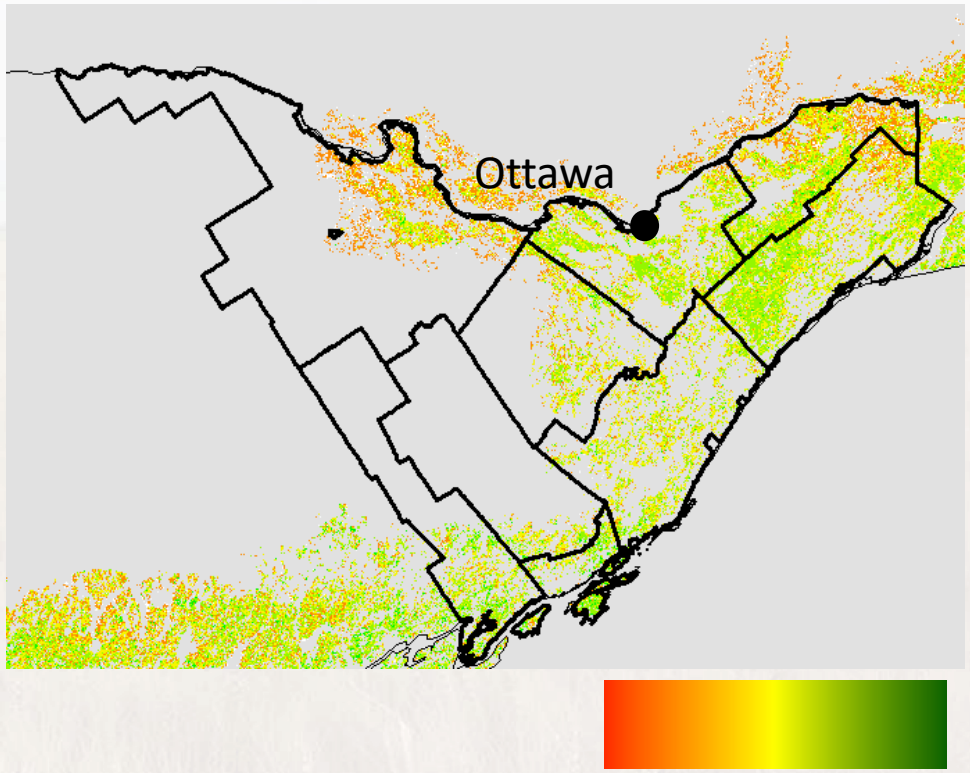


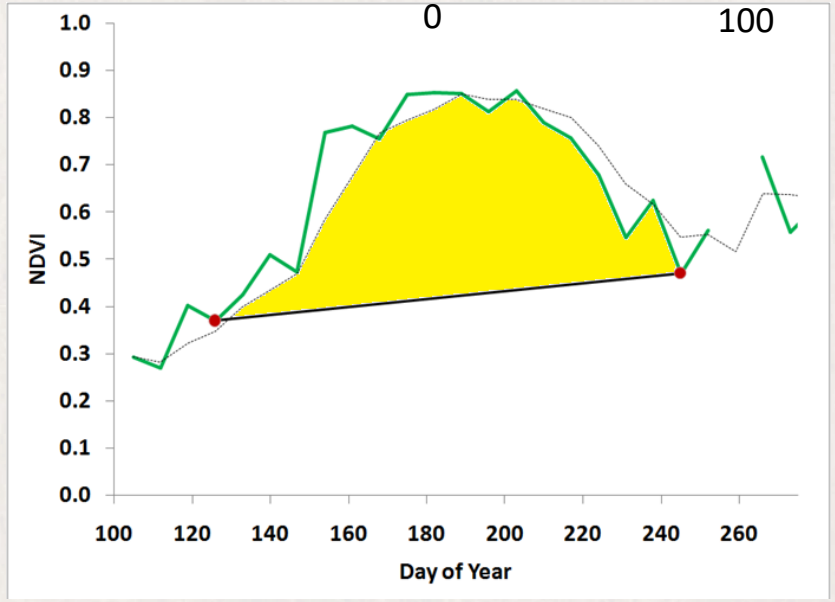


Leaf Area Index from Sentinel-2

Seasonal Greenness for Corn in Eastern Ontario

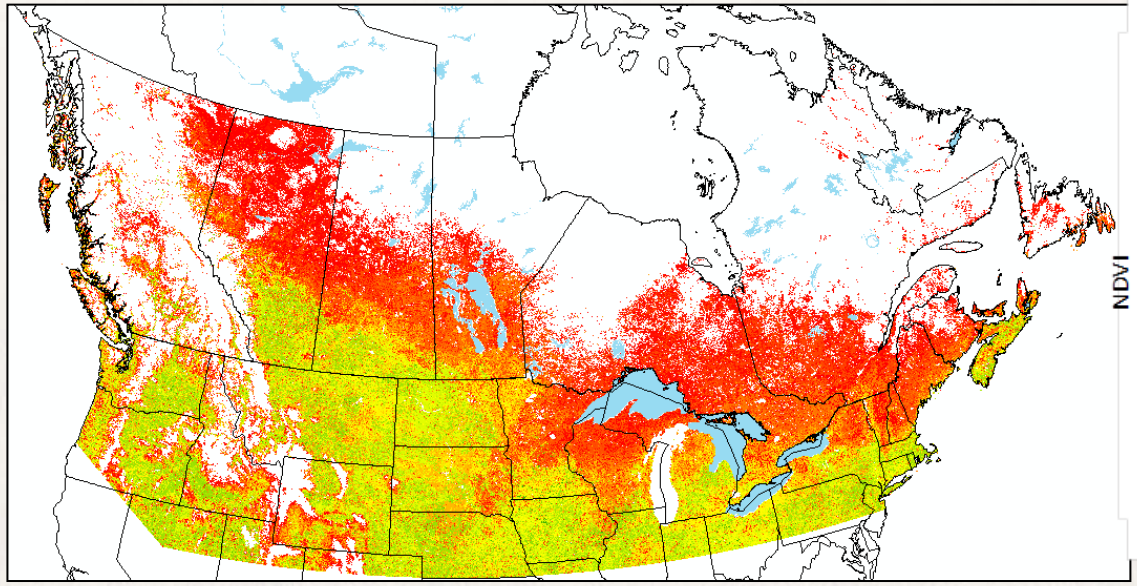




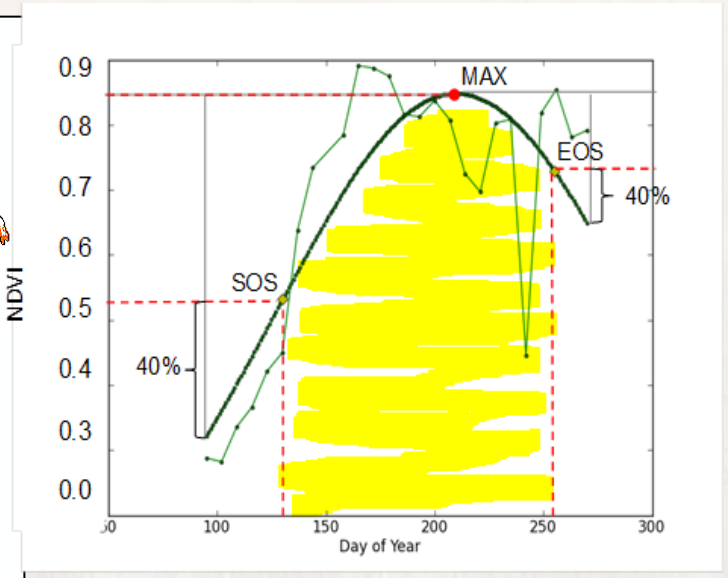


Seasonal Greenness shows potential as it is less cross correlated with other variables in capturing vegetation condition that leads to reductions in crop yield

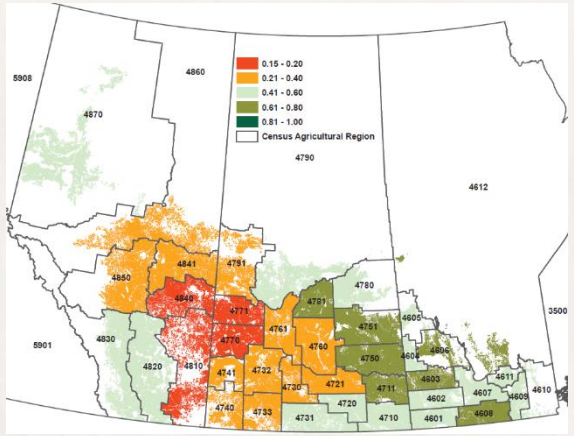
Estimating Growth Stage



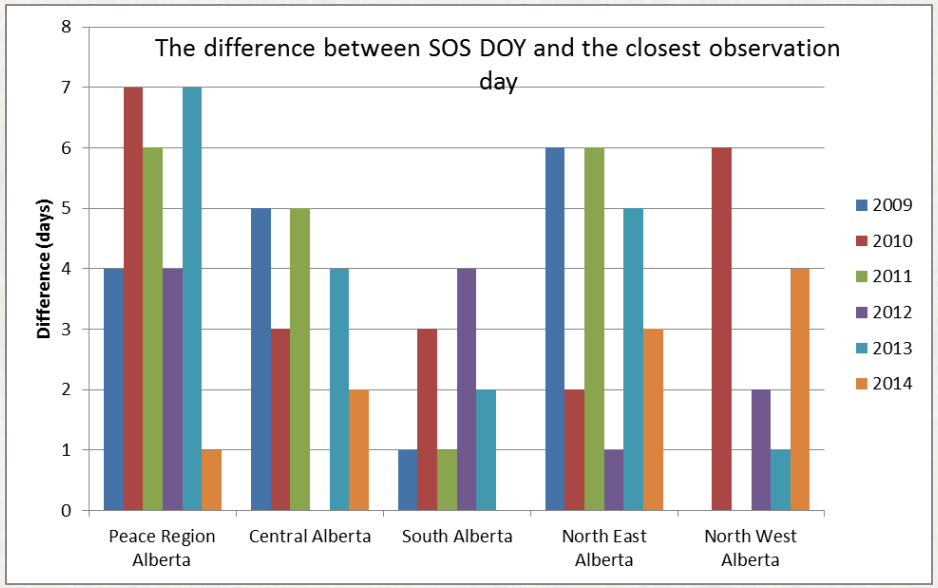
Start of Season estimate from MODIS NDVI Data



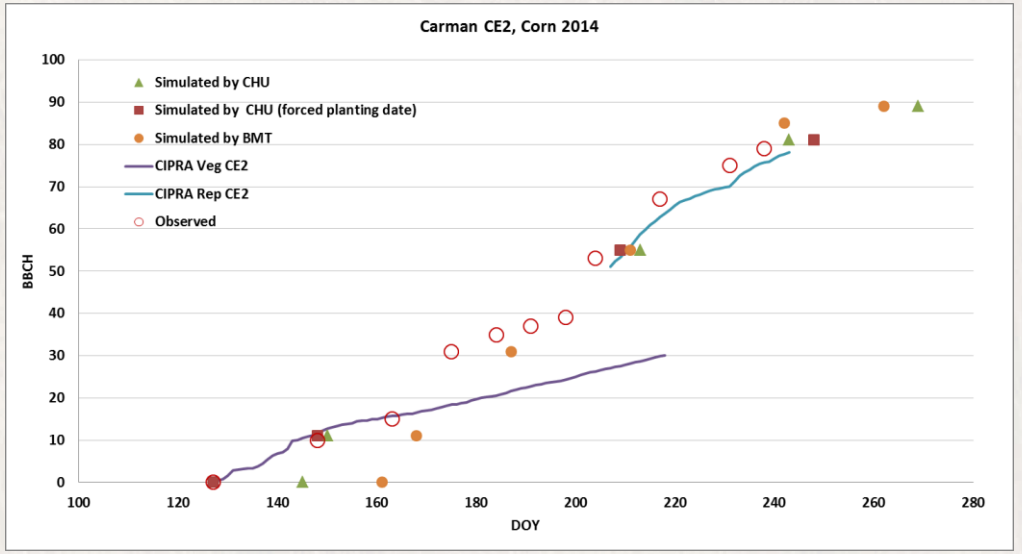
5 Year Correlation Between NDVI and BMT Start of Season



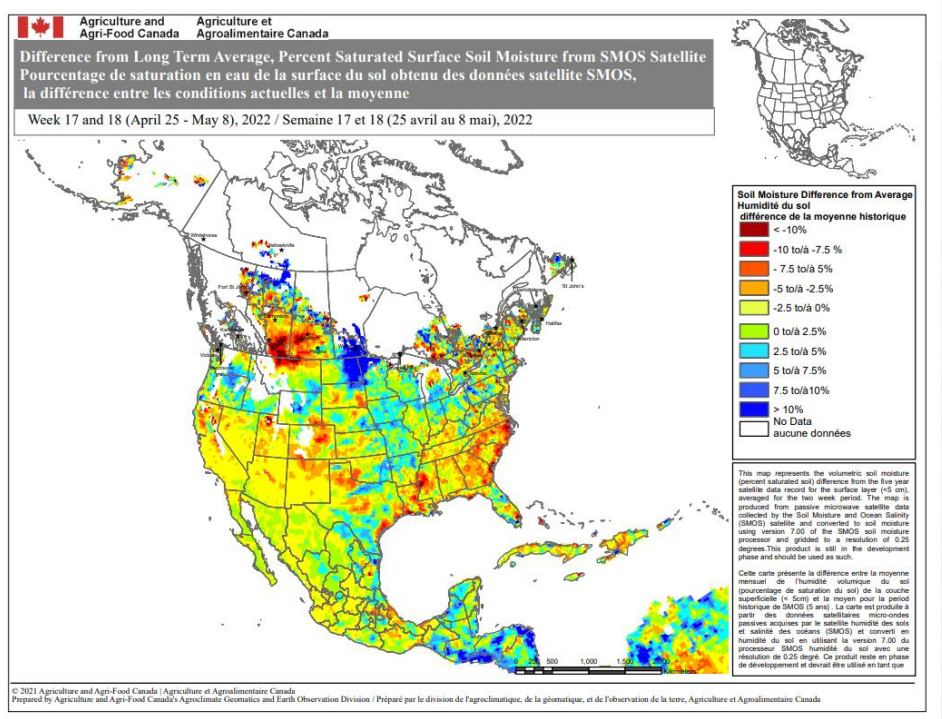
Vegetative Growth Stages from Bio-climatological models

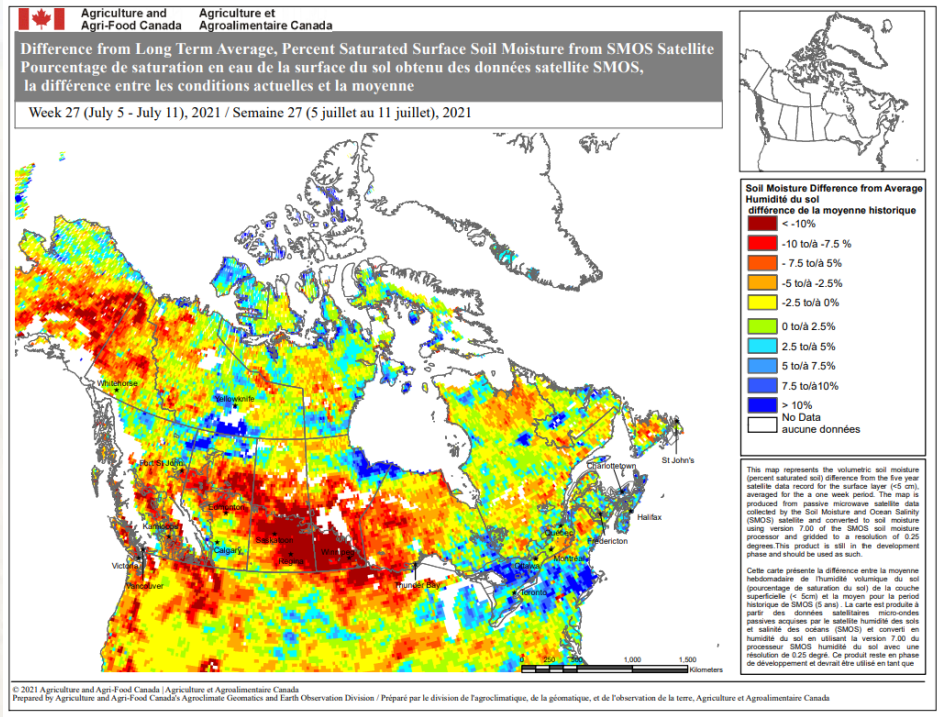


Most regions the seeding was estimated within 8 days or less by NDVI over a multi year period for Prairie Provinces



Satellite Soil Moisture from Passive Microwave

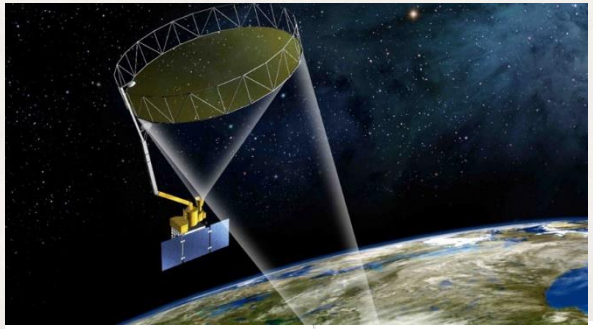




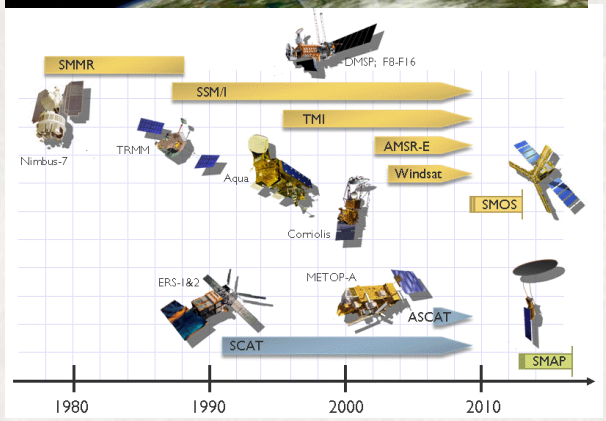
- From Soil Moisture Ocean Salinity Mission (European Space Agency), launched 2009
- Difference from average at weekly, biweekly, monthly accumulation periods
- Detects surface soil moisture but this corresponds with long term moisture deficits when accumulated over longer time periods

Emergence of Satellite Soil Moisture Data Sets

Soil Moisture and Ocean Salinity Mission (SMOS)
European Space Agency
Launched November 2009
L-Band Microwave Radiometer

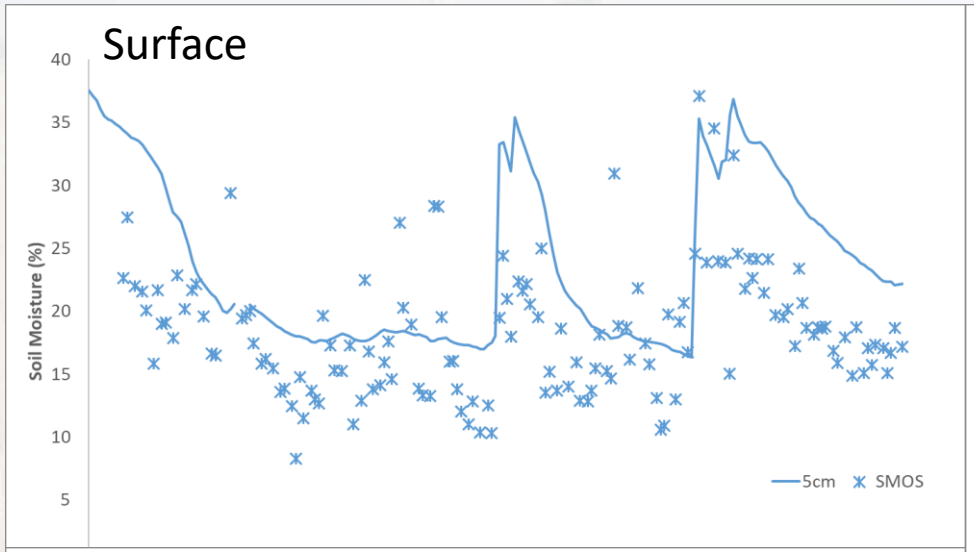


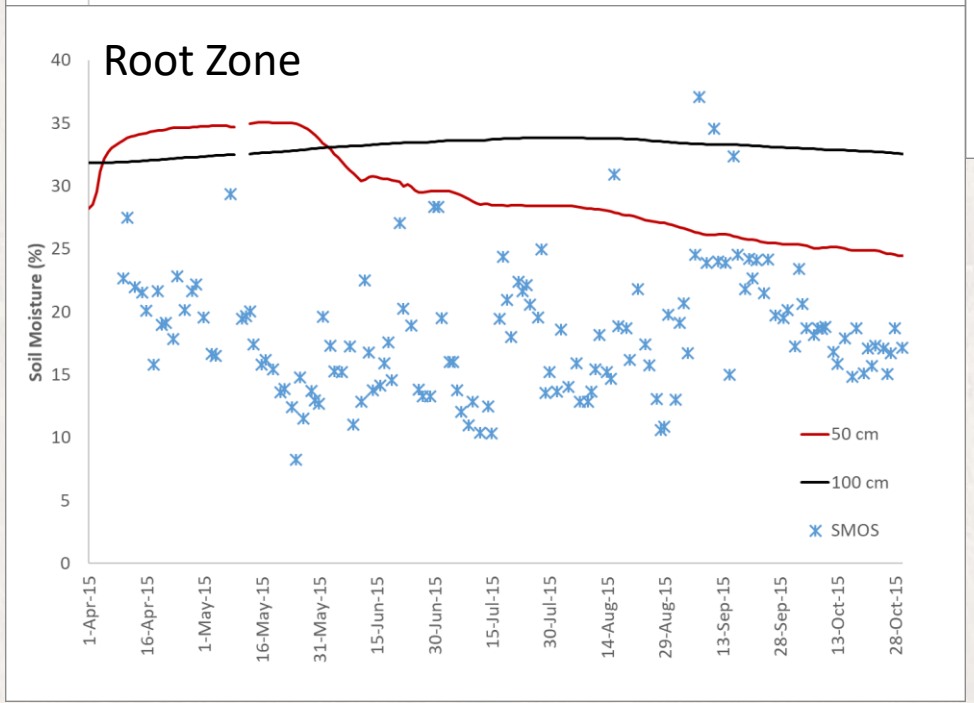
Soil Moisture Active Passive Mission (SMAP)
NASA
Launched January 2015
L-Band Microwave Radiometer /*L-Band RADAR*

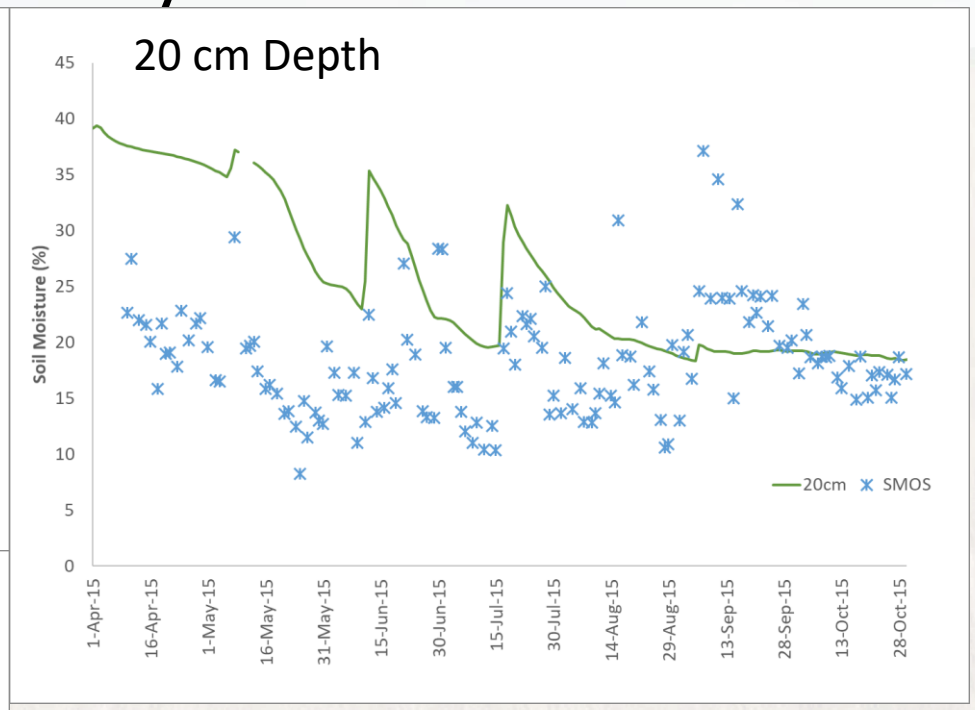


European Space Agency Climate Change Initiative (ESA-CCI)
Blend of Active/Passive Microwave soil moisture
1979-2017 **(1992-2018)**

Surface Soil Moisture Dynamics: Satellite vs In-Situ

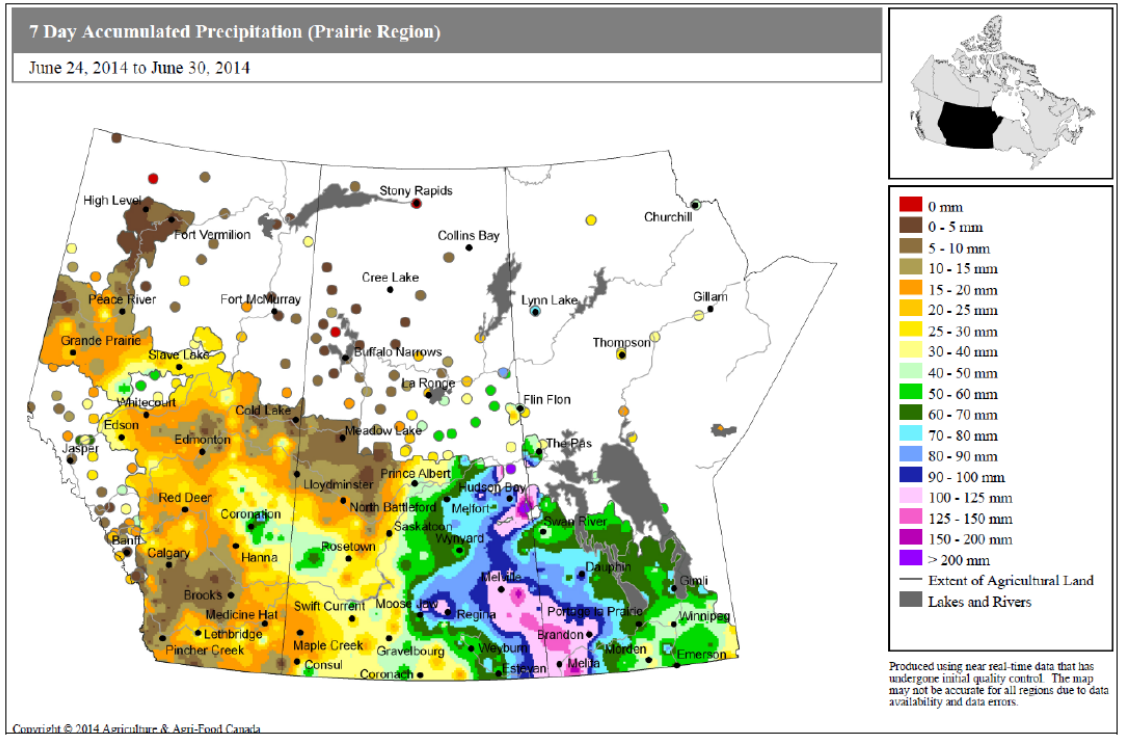


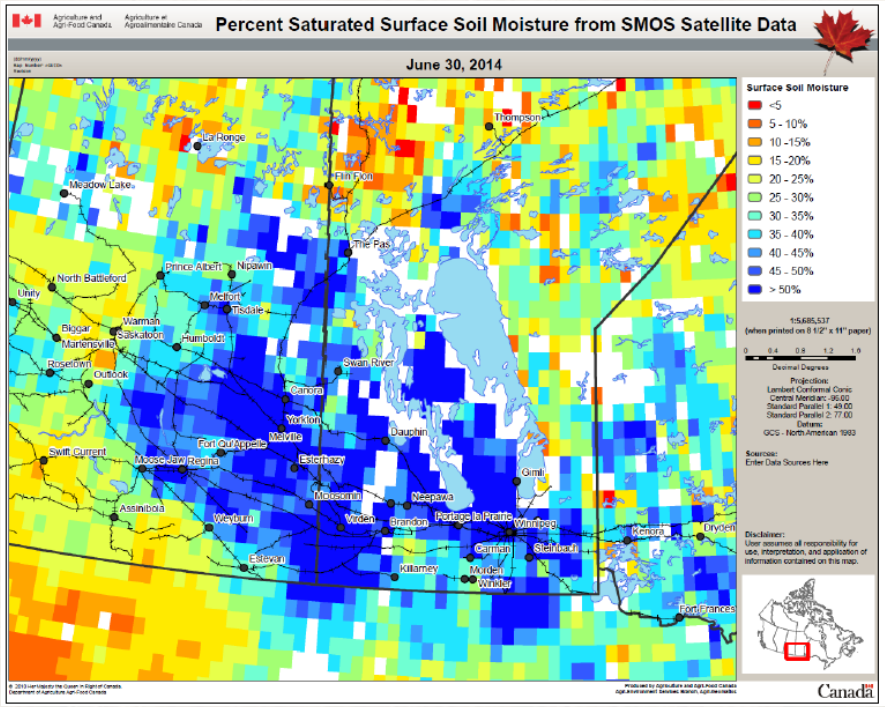




- Satellites capture moisture in top 5 cm with reasonably high accuracy; wetting and drying trends captured well
- Can’t directly infer water storage from surface measurements
- Use satellite soil moisture as a proxy for profile soil moisture dynamics

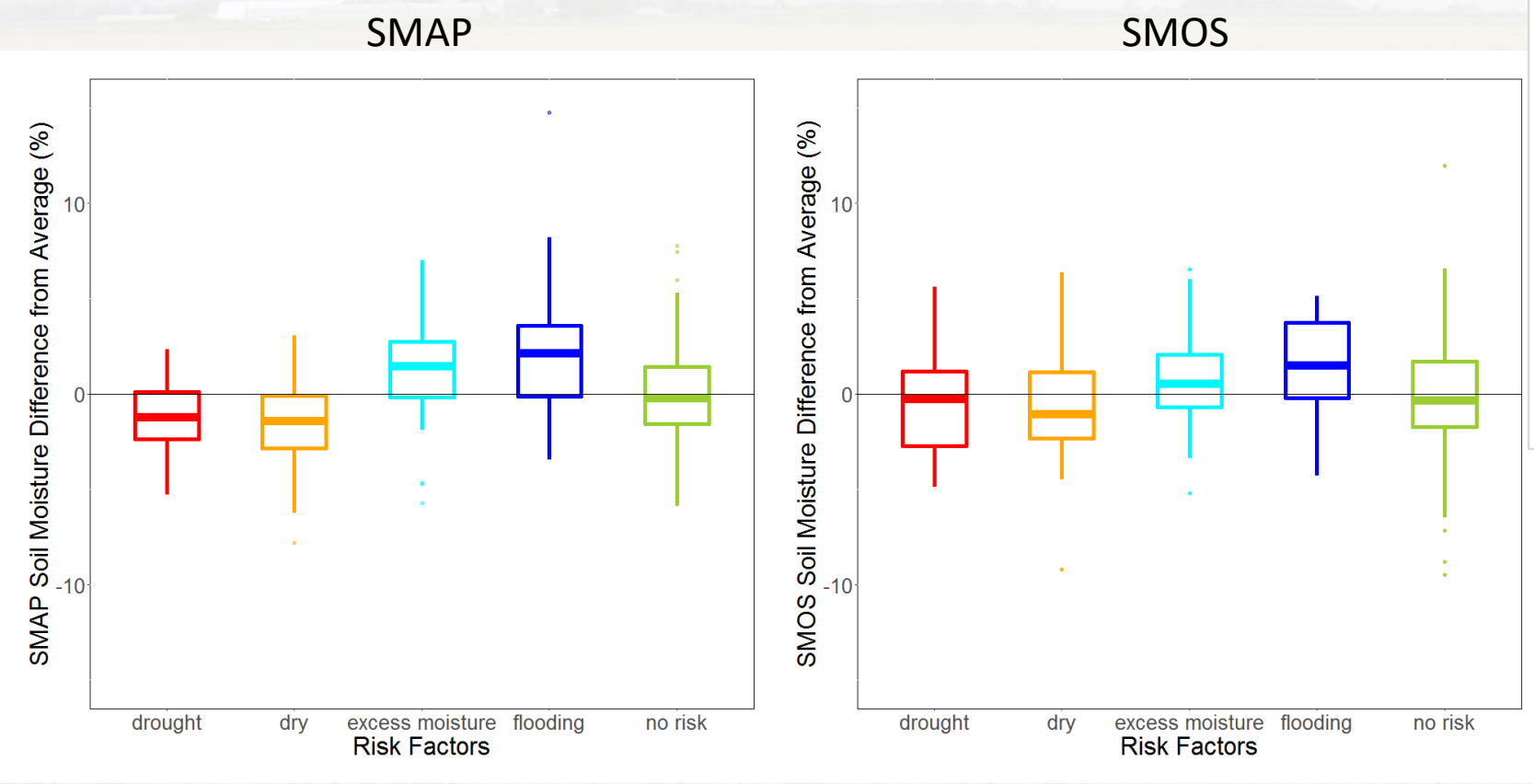
Climate Related Production Risk Monitoring

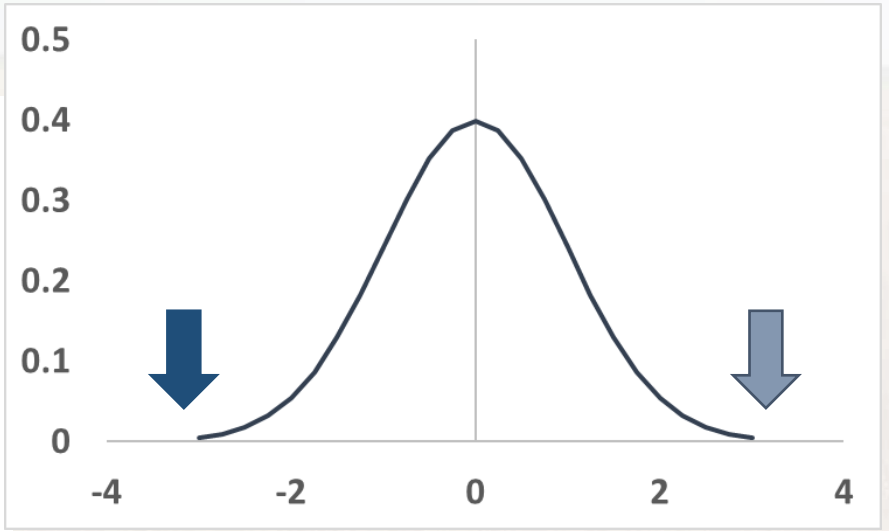




	BC	AB	SK	MB	ON	QC	ATL
Two-week forecast	stable	stable	improving	improving	worsening	stable	improving
July 8, 2014	low water supplies	drought	flooding	flooding	heat and lack of rain		rain, high winds
Last Report June 24, 2014	low water supplies	flooding	wet, low temps, unseeded	wet, unseeded			
June 10, 2014	low water supplies		wet	wet, delayed operations			
May 27, 2014		low soil moisture		wet, delayed operations			low temps, delayed operations
May 13, 2014		low temps, delayed operations	low temps, delayed operations	low temps, delayed operations	delayed operations	delayed operations	delayed operations
Apr 29, 2014		low soil moisture	low temps, low soil moisture	low temps, flooding	delayed operations	delayed operations	flooding, delayed operations

Quantifying Climate Related Risk





- Assessment of Extreme Events requires context
- Short record satellite data sets often have insufficient data to assess “normal” conditions

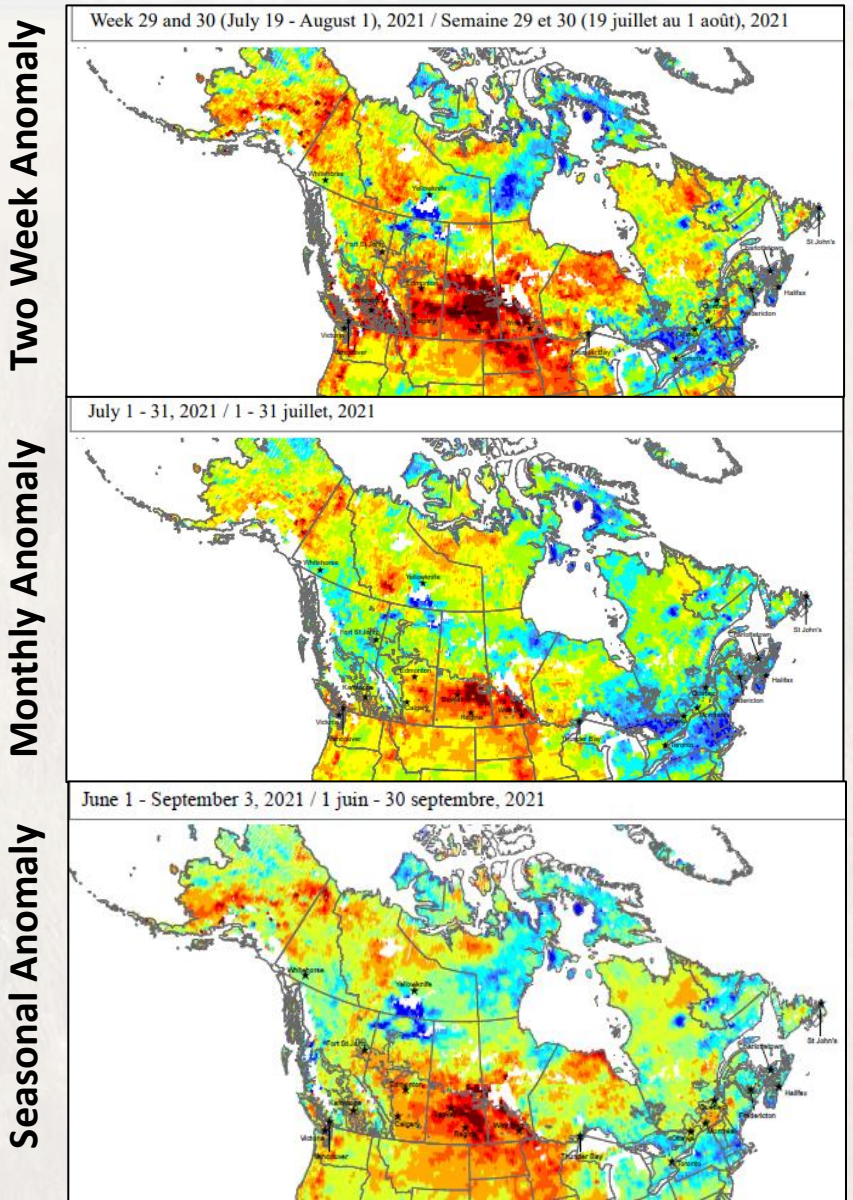
Champagne, C.; Zhang, Y.; Cherneski, P.; Hadwen, T. Estimating Regional Scale Hydroclimatic Risk Conditions from the Soil Moisture Active-Passive (SMAP) Satellite. Geosciences 2018, 8, 127.

Drought from L-Band Passive Microwave

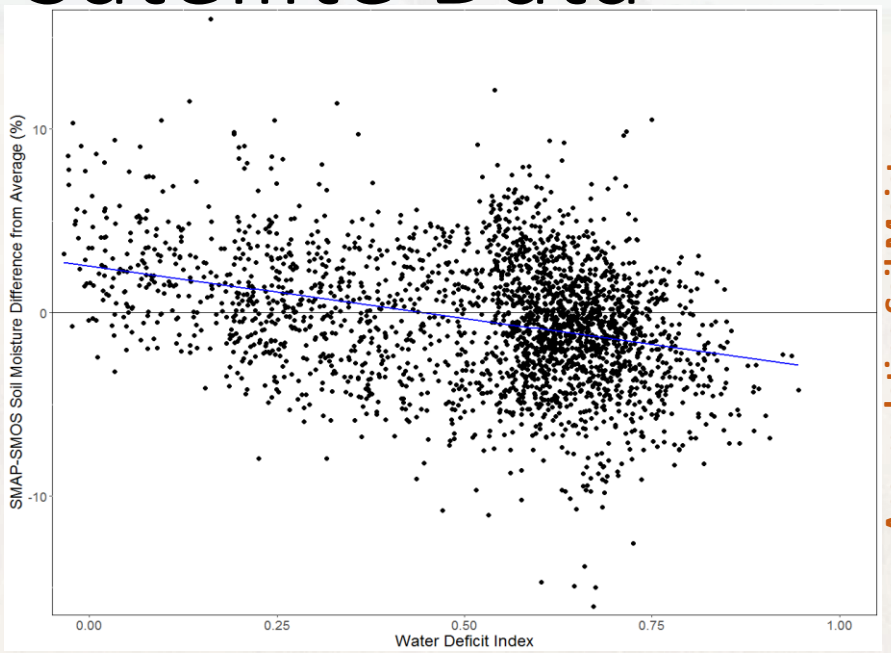
- Surface soil moisture is very responsive to fluctuating temperature/precipitation conditions and less indicative of long term water storage

- Assimilation of satellite soil moisture into land surface models can capture root zone soil moisture but these values are heavily dependent on other model parameters (primarily soil water holding capacity) which are not well characterized in many areas.

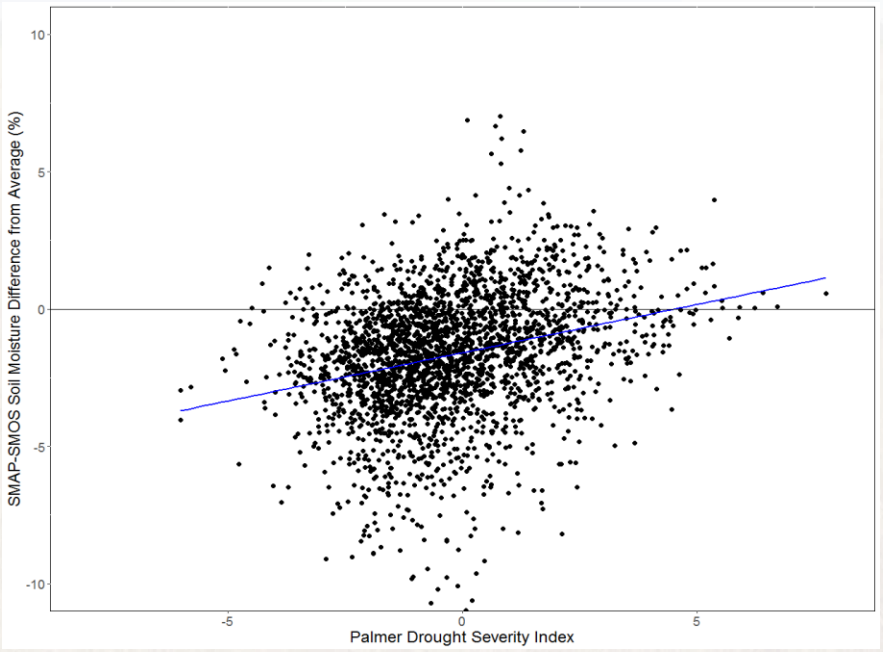
- Analysing soil moisture anomalies over different time scales can better capture agriculturally relevant water deficits (timing, intensity, persistence)



Scale and Severity of Drought Impacts Observed by Satellite Data

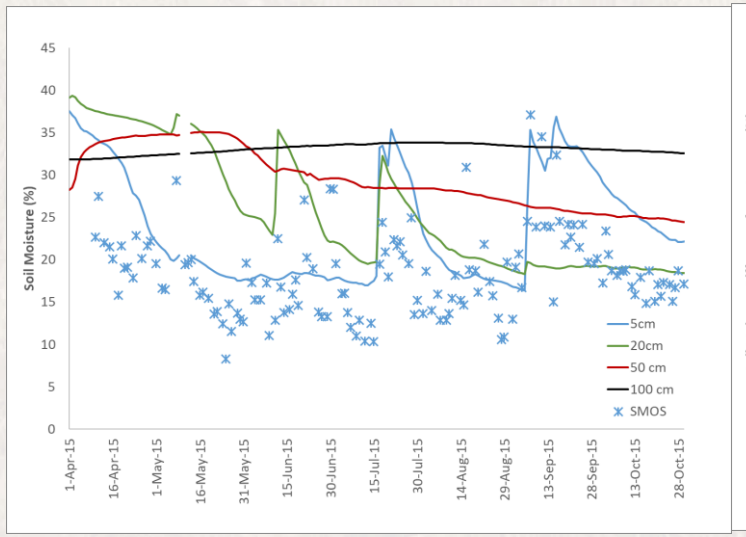


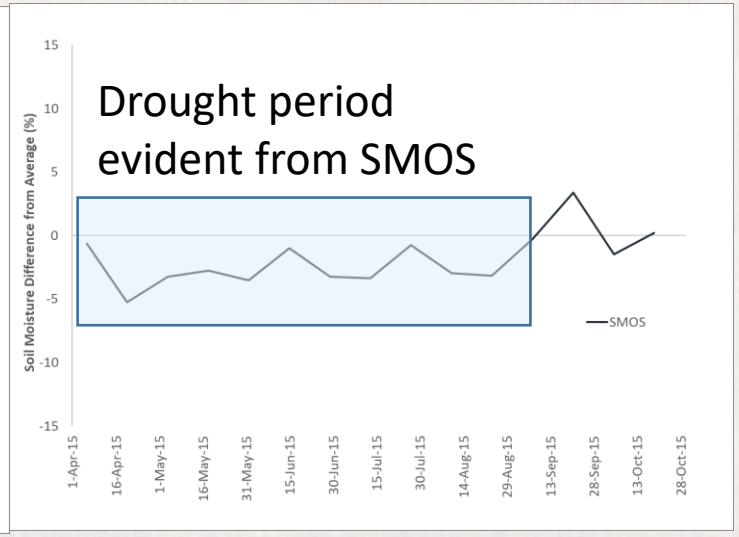
Accumulating Soil Moisture Anomaly vs Palmer Drought Severity Index



Soil Moisture Anomaly vs Crop Water Demand Index

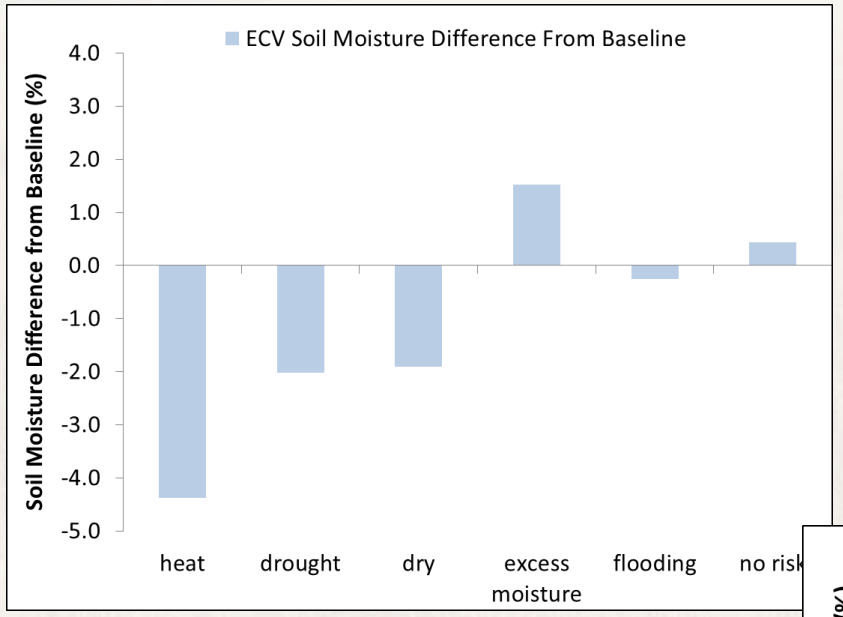
Satellite surface soil moisture most sensitive to drought processes driven by evaporative demand than long term soil moisture shortages



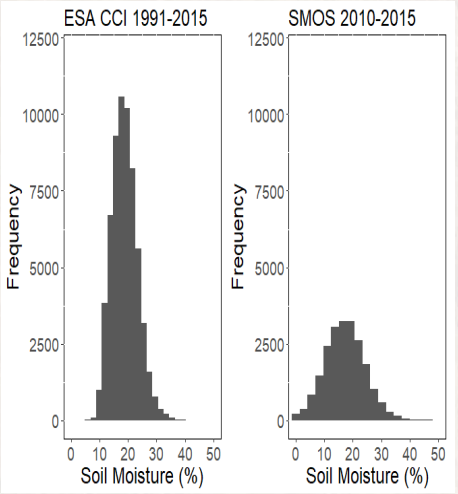


How Sensitive to Drought Conditions are Satellite Soil Moisture Anomalies?

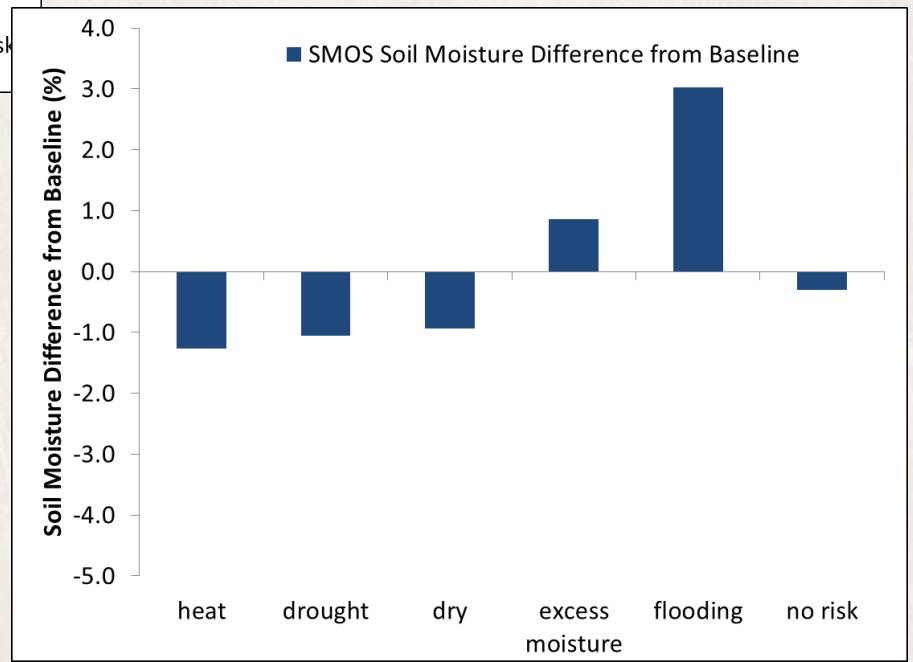
ESA – CCI Long Term Satellite Soil Moisture Data Set



27 Year Baseline

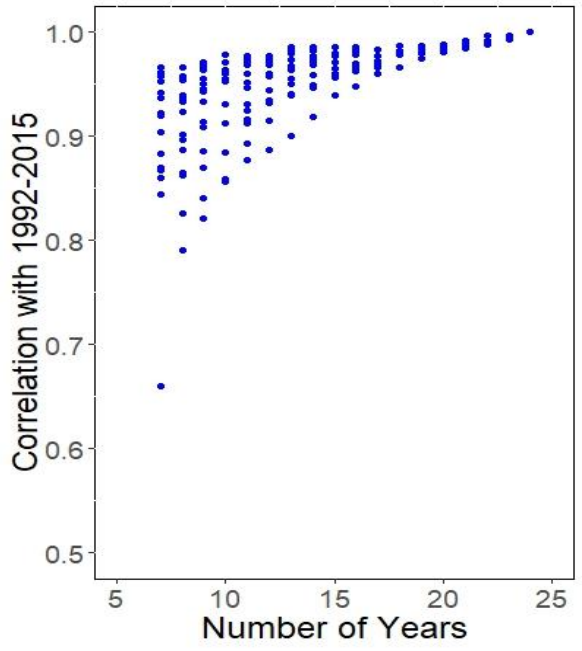


SMOS Soil Moisture Data Set



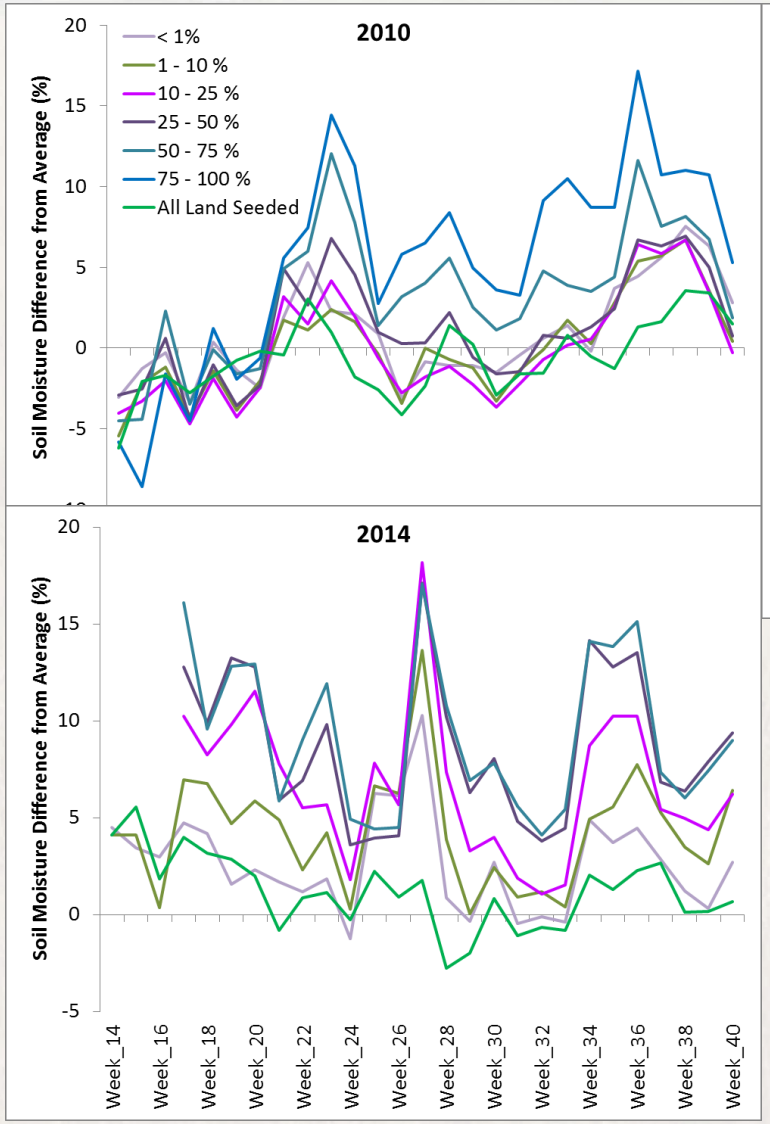
Length of baseline or normalizing period is important: Longer is better!

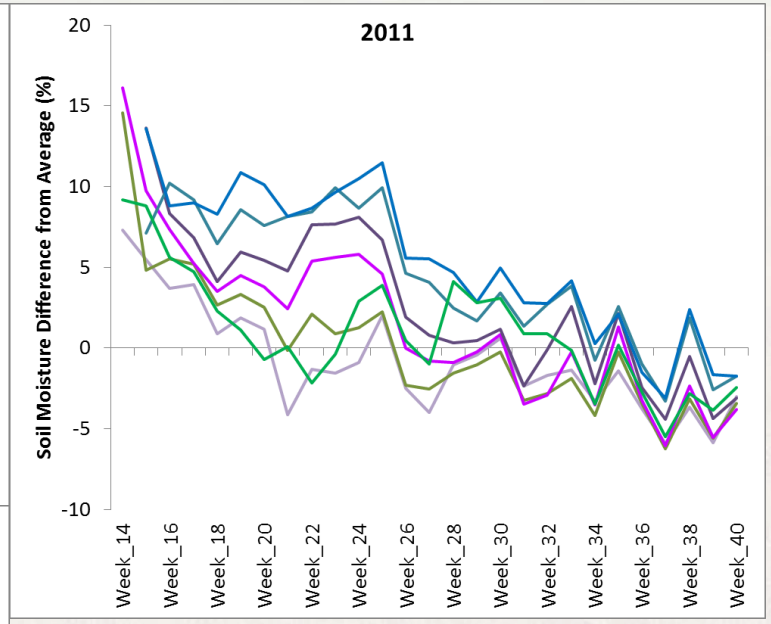
8 Year Baseline

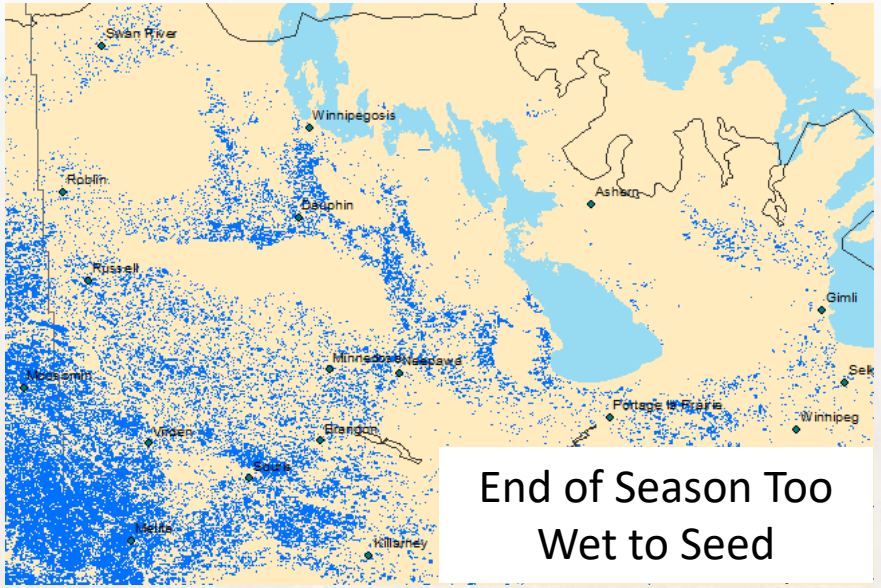


Need 12 years or more to robustly determining low yielding years from average , longer for determining high yielding years (18 years)

SMOS Soil Moisture Evolution During Wet Growing Seasons



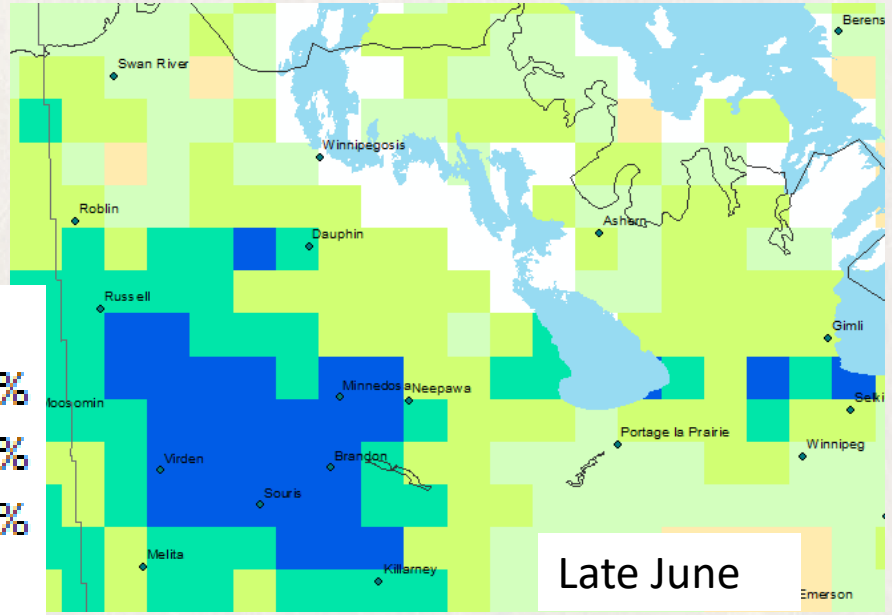




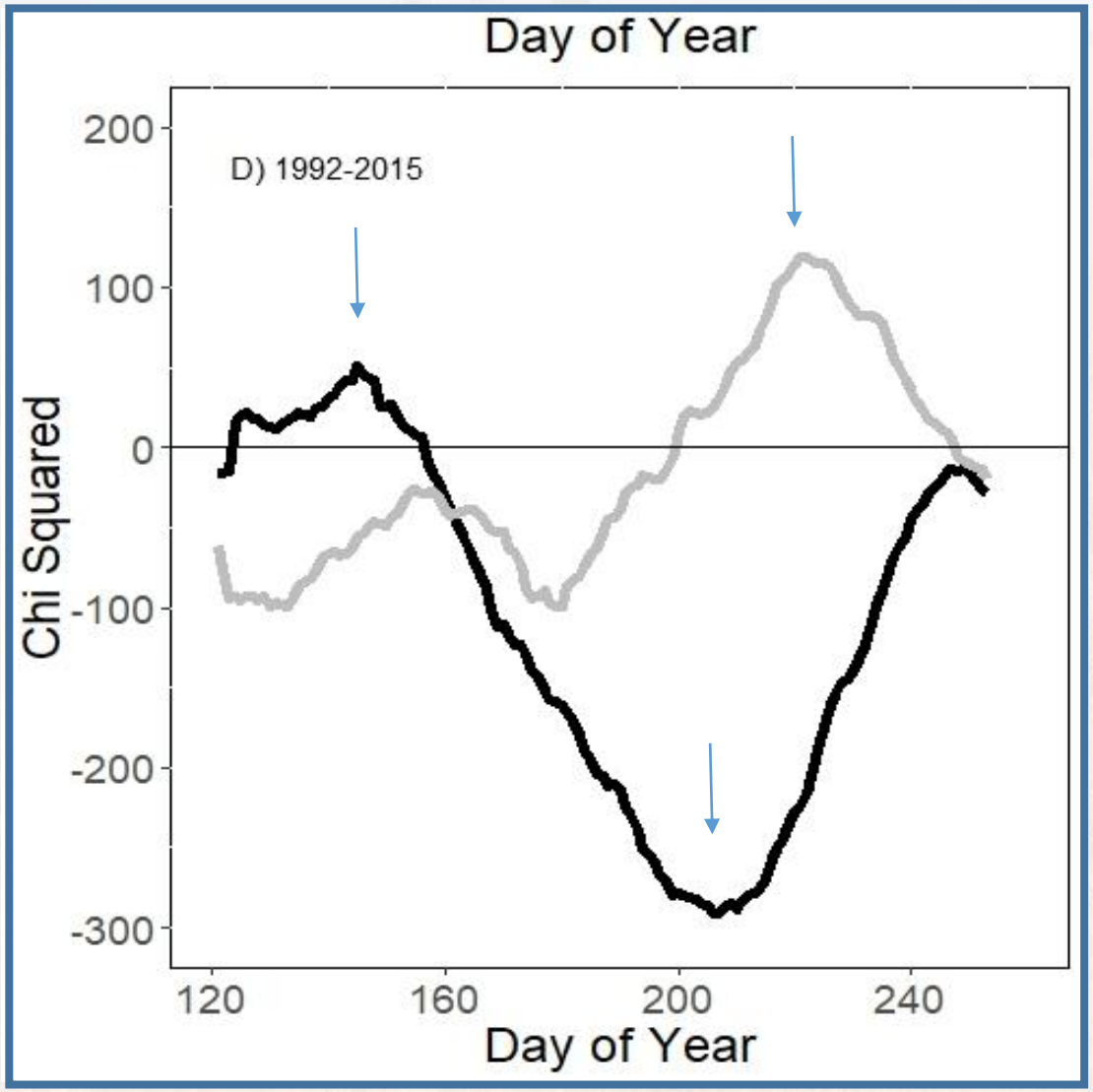
End of Season Too Wet to Seed

Satellite soil moisture conditions over areas classified as too wet to seed are variable from year to year

Regression tree model showed most predictive variable is Elevation, with slope, soil water holding capacity, land cover and ecoregion also

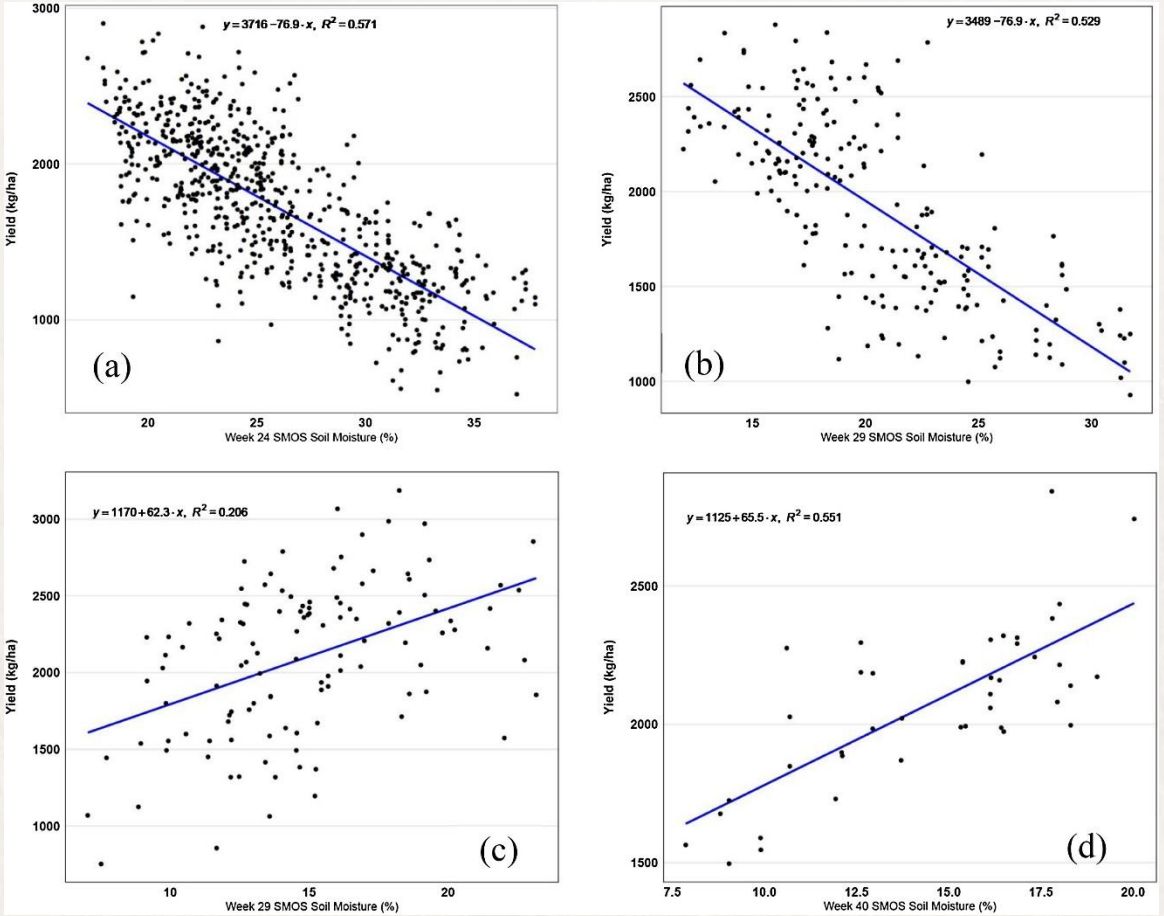


Sensitivity of Crop Yield to Soil Moisture



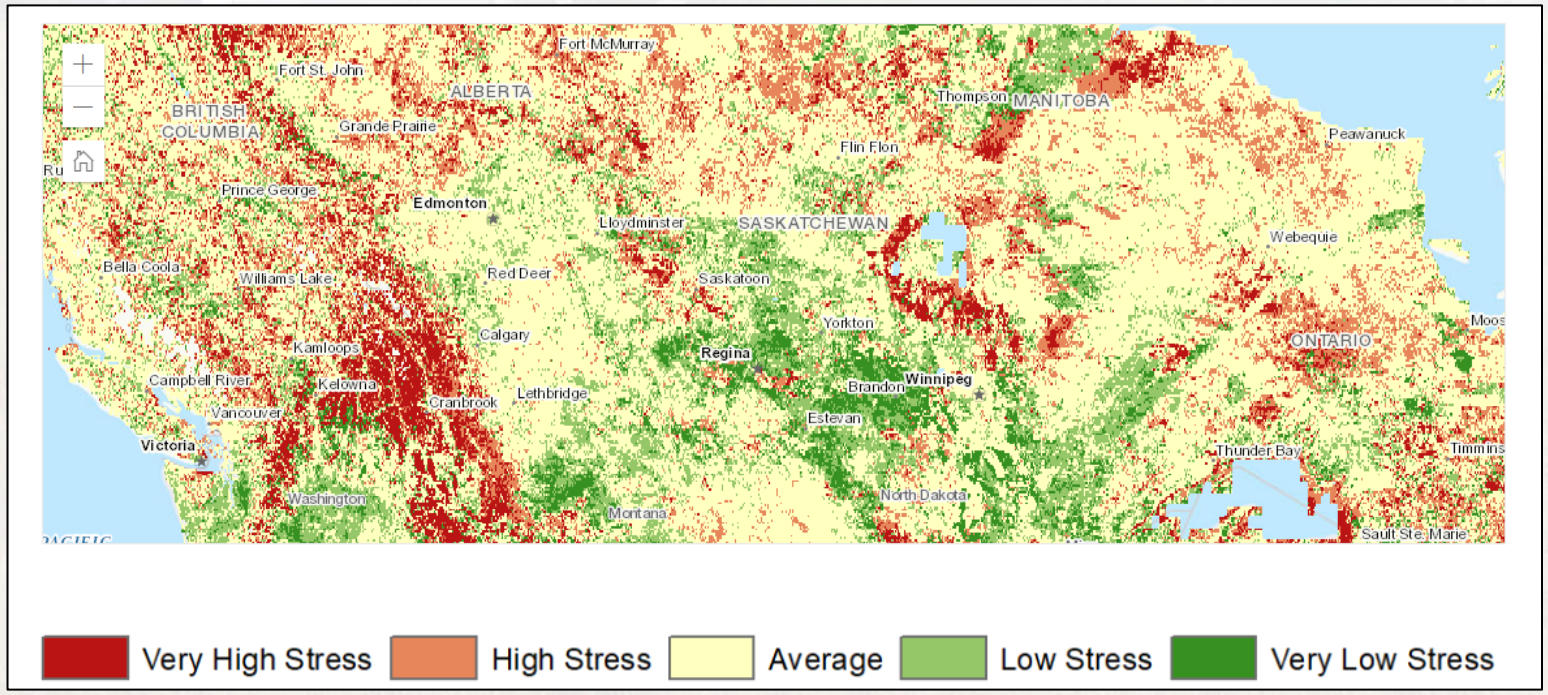
Champagne, C., White, J., Berg, A., Belair, S., Carrera, M. (2019). Impact of soil moisture data characteristics on the sensitivity to crop yields under drought and excess moisture conditions, 11(4), http://dx.doi.org/10.3390/rs11040372

Low yields associated with high spring soil moisture (excess) and low soil moisture in July (drought)



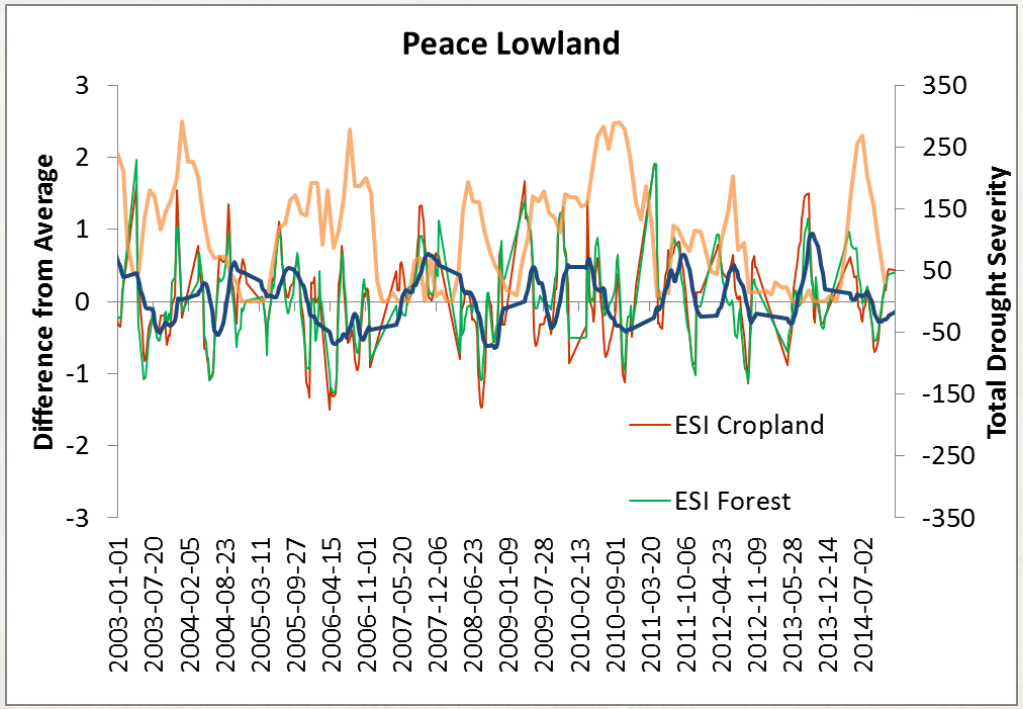
White, J., Berg, A.A., Champagne, C., Warland, J., Zhang, Y. (2019). Canola yield sensitivity to climate indicators and passive microwave-derived soil moisture estimates in Saskatchewan, Canada, 268 354-362. http://dx.doi.org/10.1016/j.agrformet.2019.01.004

Evaporative Stress Index (ESI)

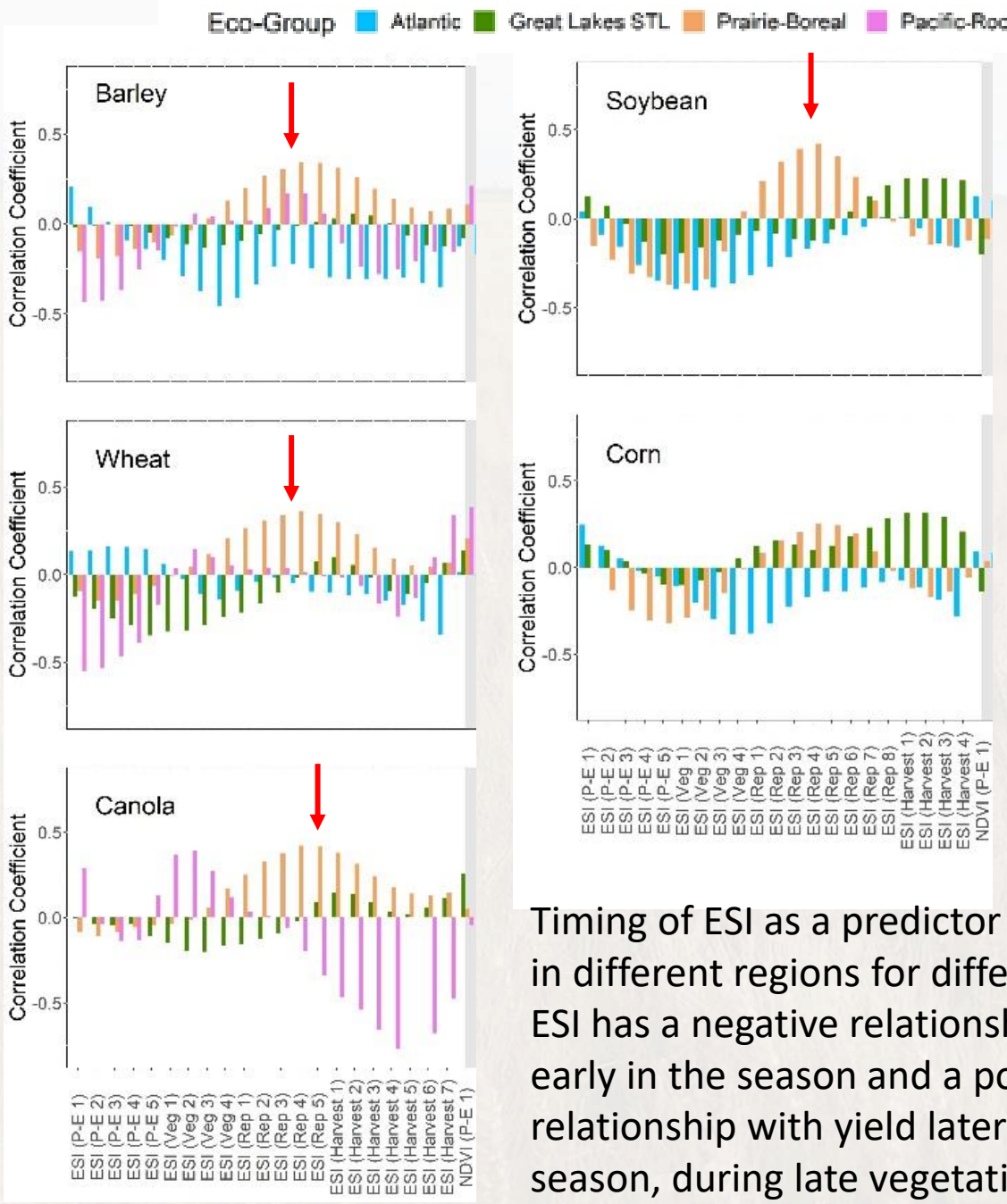


- Based on thermal/optical data from MODIS sensor quantifying rates of evapotranspiration at surface
- Data produced by NASA and distributed through SERVIR global
- *Mapping daily evapotranspiration at field to continental scales using geostationary and polar orbiting satellite imagery. Hydrology and Earth System Sciences, 15, 223-239 (2011). Anderson, M.C., Kustas, W.P., Norman, J.M., Hain, C.R., Mecikalski, J.R., Schultz, L., González-Dugo, M.P., Cammalleri, C., D'Urso, G., Pimstein, A., & Gao, F.*

Application of ESI



- Evaporative stress fluctuates in time with lows when high temperatures and low rainfall lead to dry periods; clearer trends are illustrated with temporal moving average
- Temporal trend shows higher evaporative stress during drought periods; in some cases high peaks in evaporative stress leading into more severe drought periods

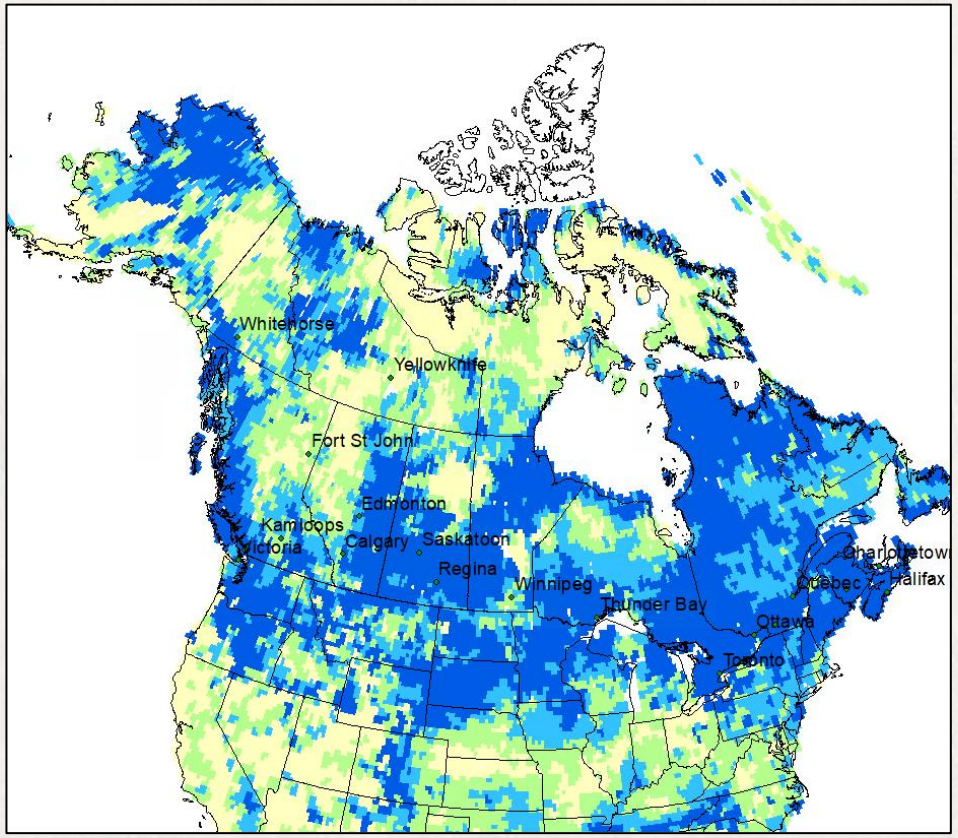


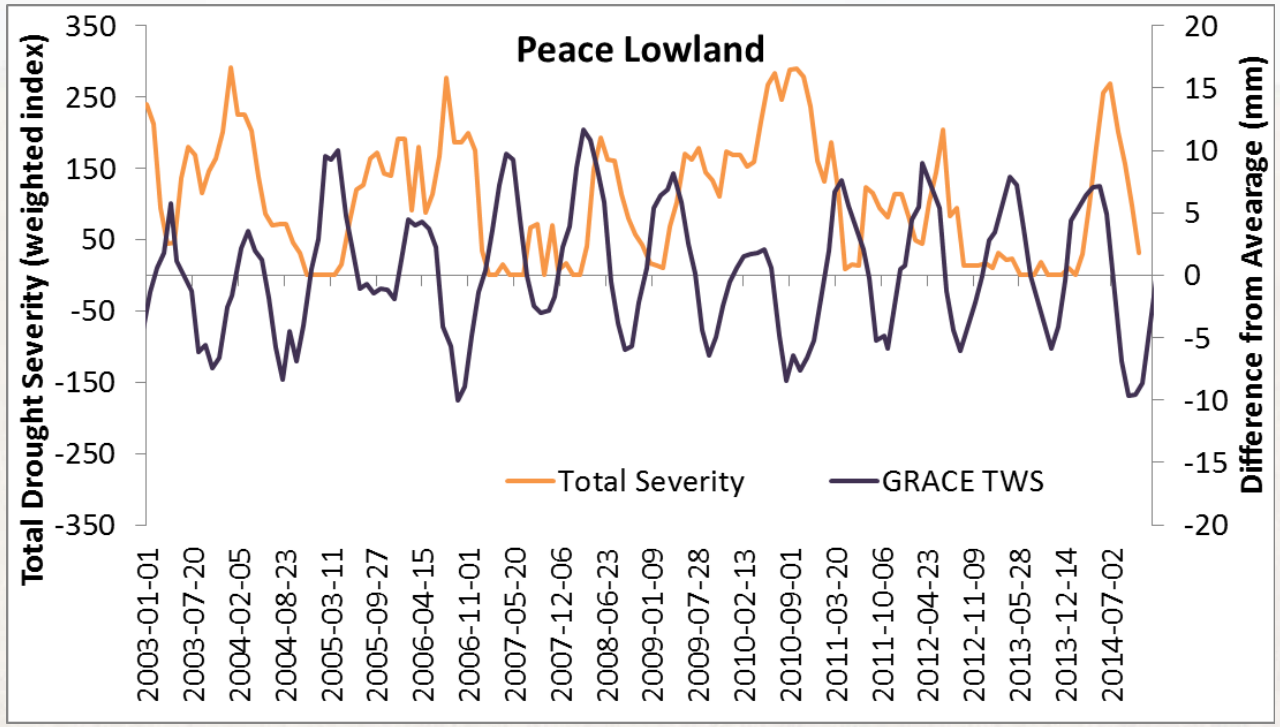
ESI is significant predictor in Prairies (more water limited environment and less relevant in coastal/maritime regions

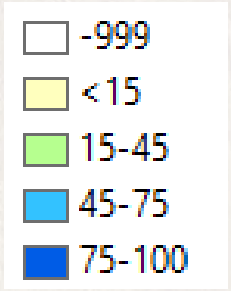
Timing of ESI as a predictor of crop yield in different regions for different crops. ESI has a negative relationship with yield early in the season and a positive relationship with yield later in the season, during late vegetative growth and seed reproduction.

GRACE: Gravity Recovery and Climate Experiment

- Total Water Storage Data set from NASA



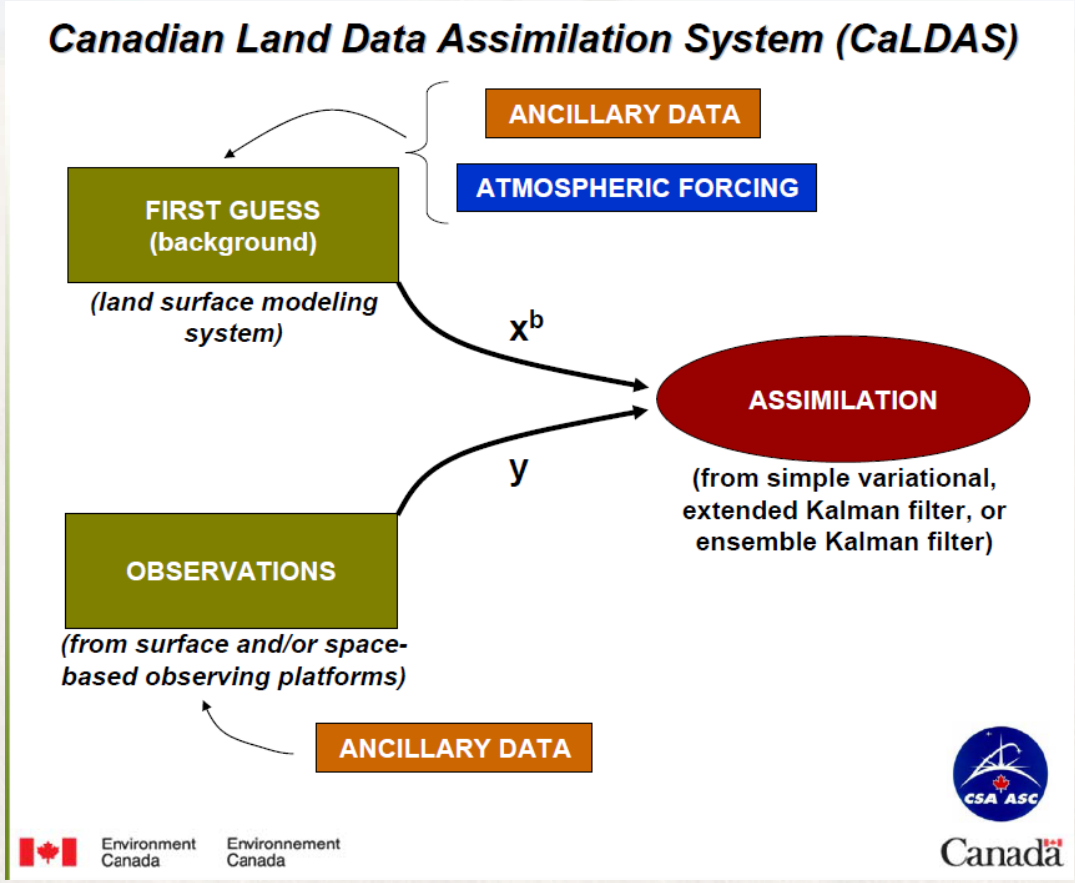


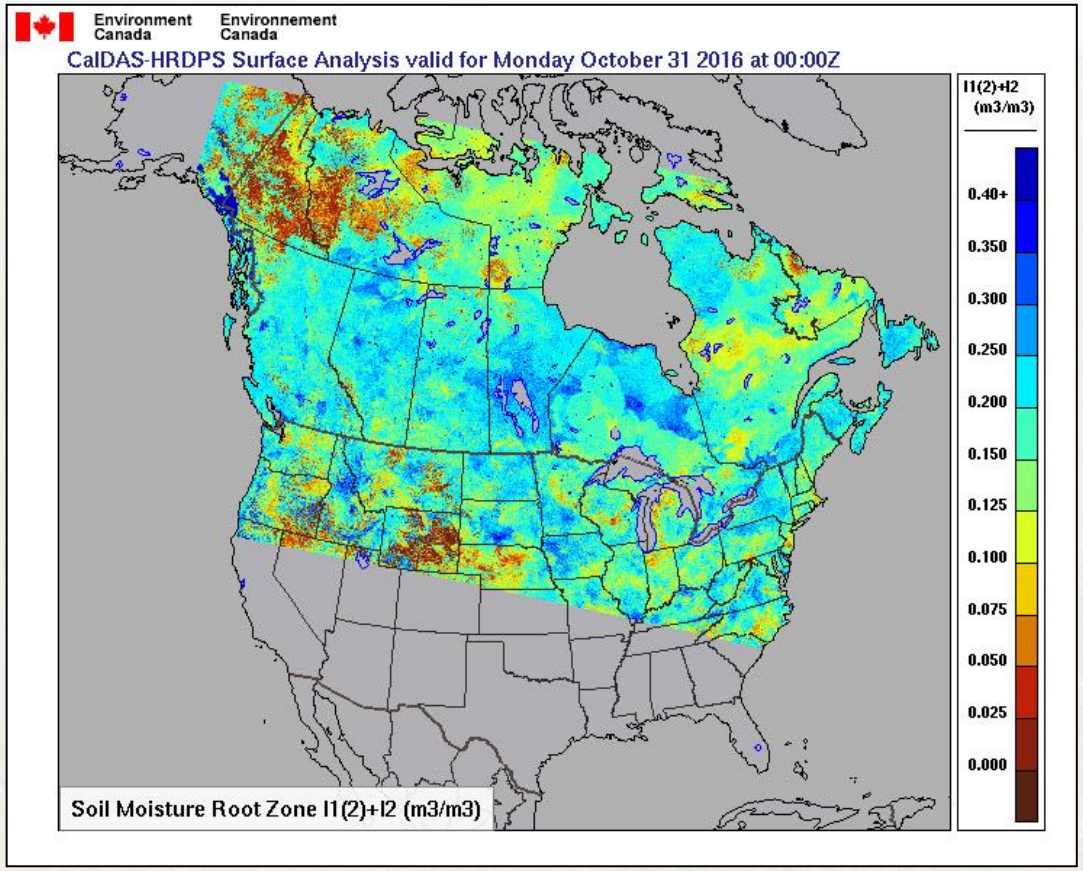


GRACE + GRACE FO has continuous data series from 2003 – present

Trends well with long term drought anomalies

Combining EO with Models: Land Data Assimilation

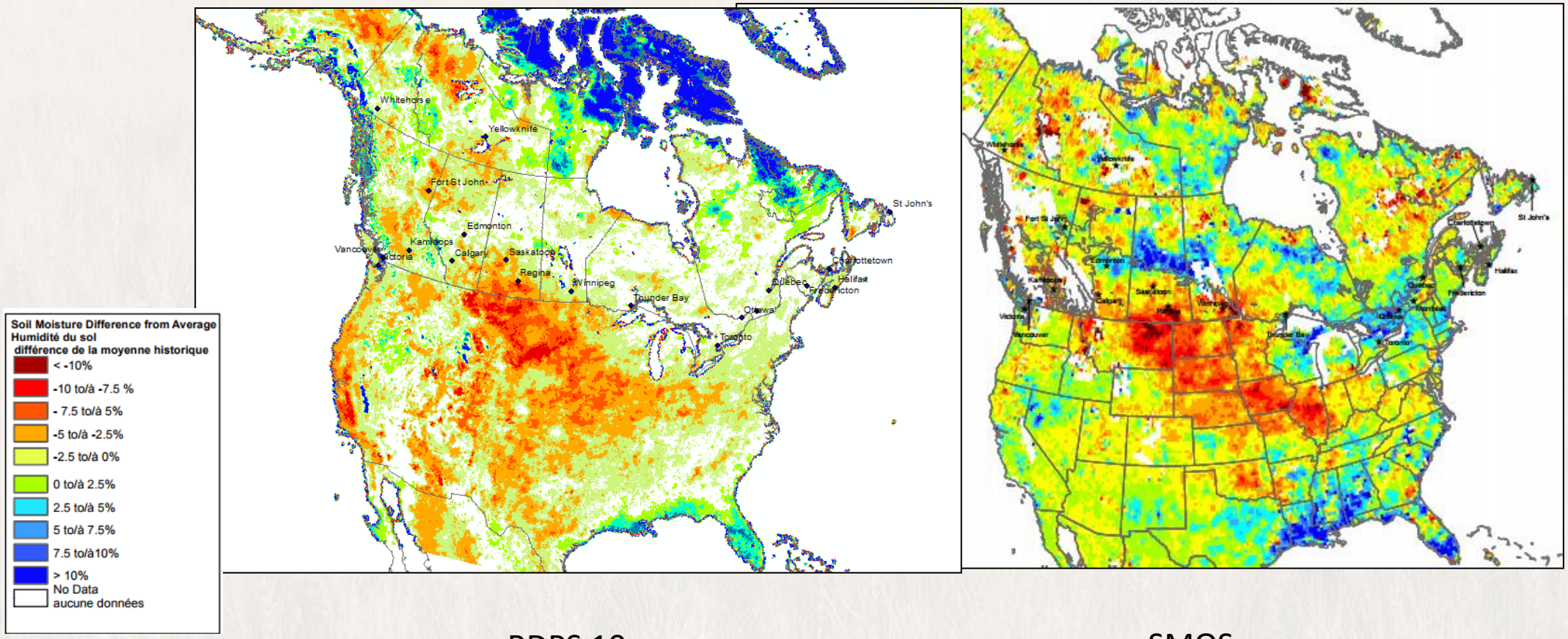




- Assimilation used to improve land surface characterization on global circulation models - provides improved meteorological data for climate services as alternative/supplement to station based data.

Soil Moisture for Drought Monitoring

Calculation of Drought indicators using CMC soil moisture data



RDPS 10 cm

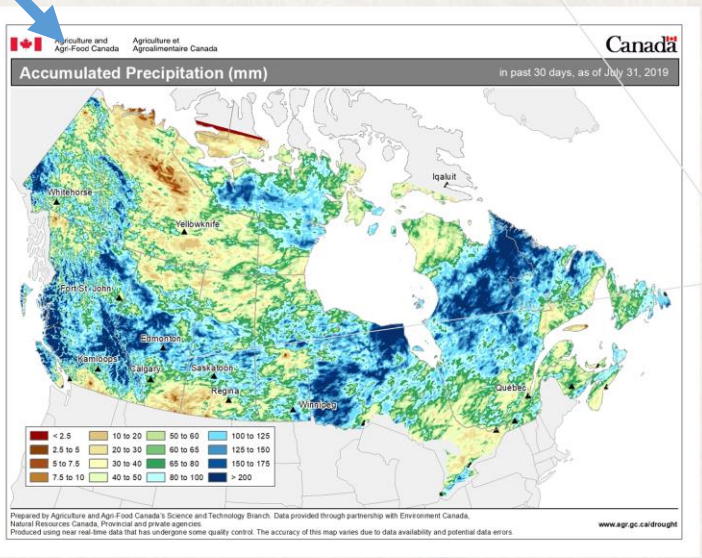
SMOS

Soil Moisture Difference from Average June 2017

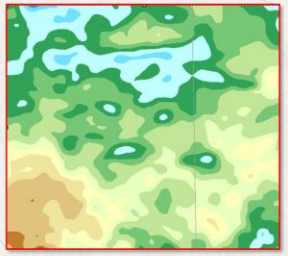
System to calculate drought indicators – build portal to view data sets

Numerical Weather Data: Near-term forecast, analysis and Re-Analysis Data

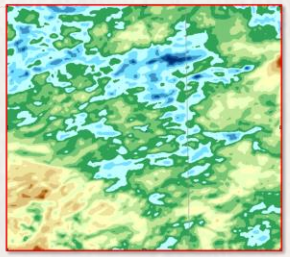
2.5 km High Resolution Deterministic Prediction System (HRDPS & HRDPA)



10 km Regional Deterministic Prediction System (RDPS & RDPA)

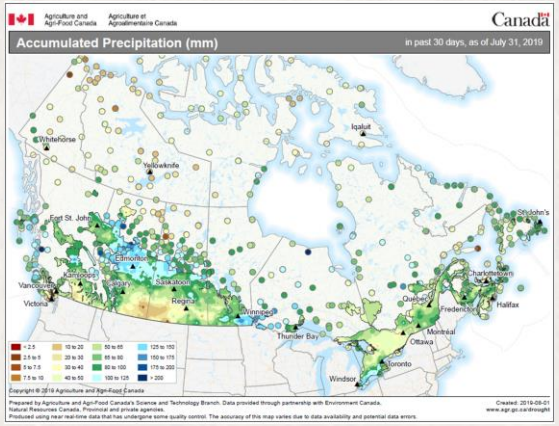


10km



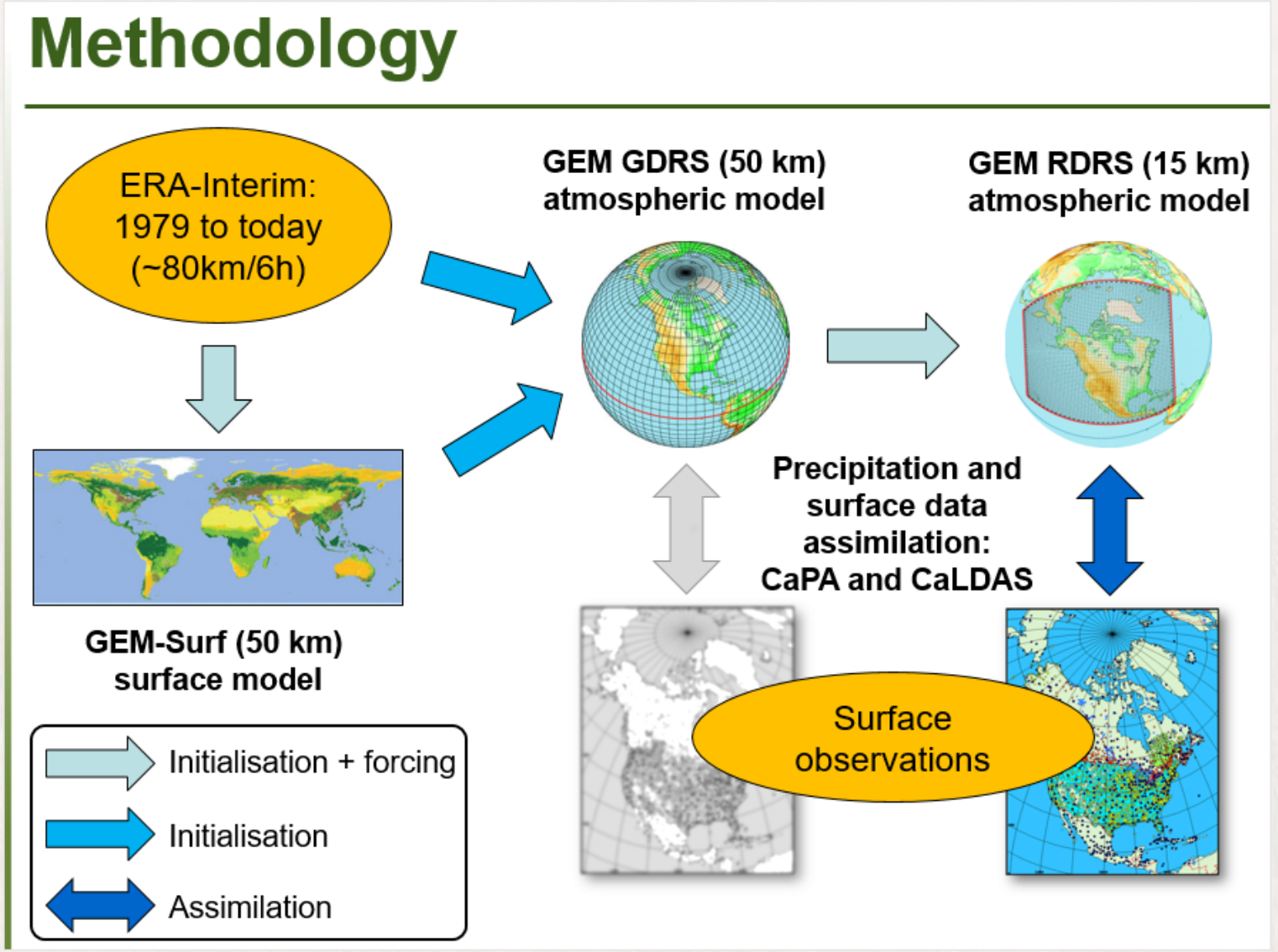
2.5km

- Initial conditions and near term forecasts from ECCC Numerical Weather Prediction system combine Global Environmental Multiscale Model (GEM) with land surface prediction systems
- Canadian Precipitation Analysis (CaPA) produces an optimal estimate of precipitation using deterministic models incorporating in situ gauges and Doppler radar estimates



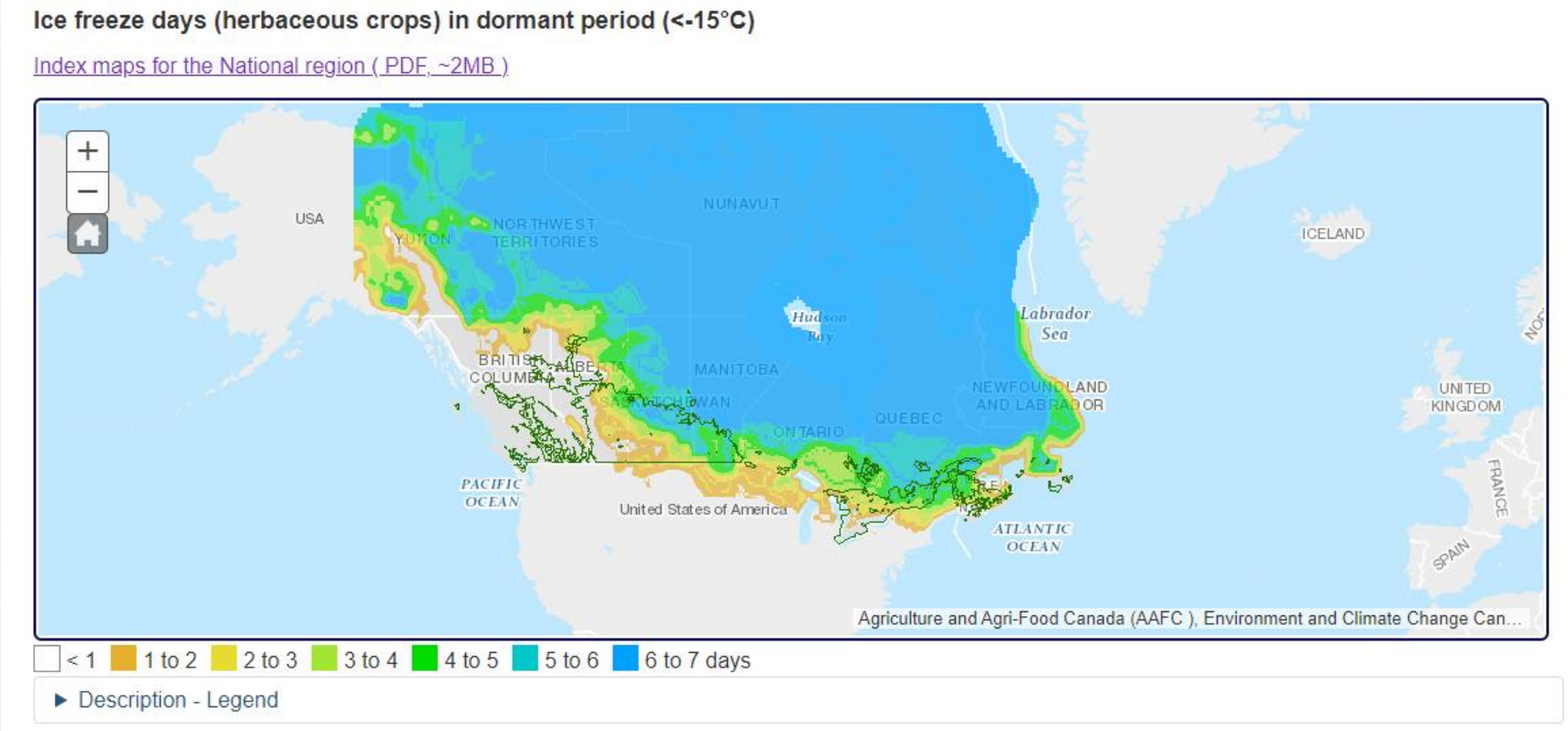
Regional Reanalylsis (RDRS)

- 39-Year Precipitation and Ground Surface Reanalysis
- Regional: RDRS
  - Modified REPS control member config. (cover Arctic Ocean)
  - GEM 4.8, LAM, 15-km
  - 12-h cycle/24-h reforecast
  - **Coupled with CaLDAS/CaPA**
- 1980-2018 Selected Variables Made Available and have been processed to 24 hour values
- Using as historical baseline for calculating drought indicators, agroclimate anomalies



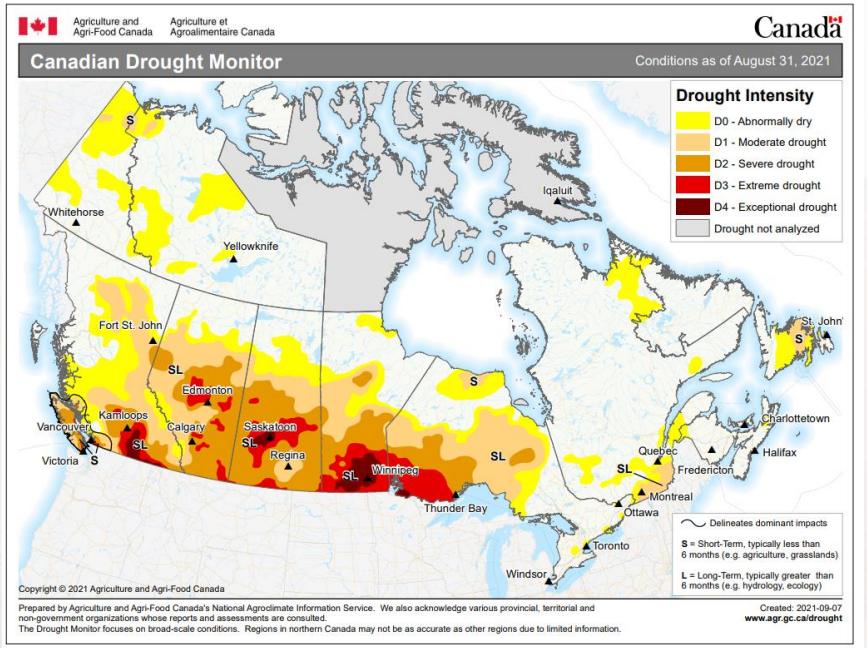
Agroclimate Forecasts

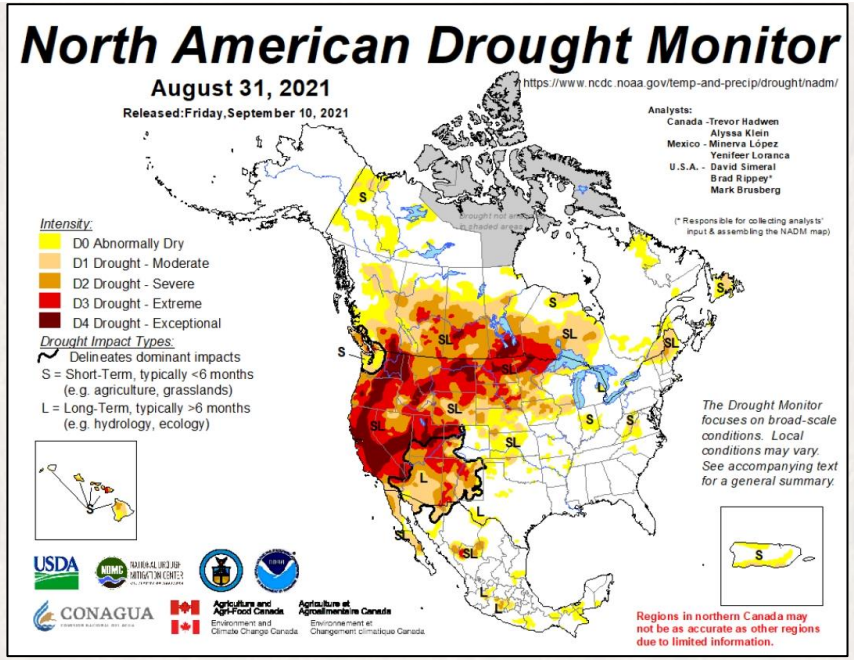
- Extreme Weather Indicators
  - Indicators of temperature, precipitation, heat & wind at forecasts from 1-4 weeks ahead (from Environment Canada 32 day forecasts), updated daily



Drought Monitoring in Canada

- AAFC is the lead for drought monitoring in Canada. Drought indicators are key to this activity and research and development are ongoing.
- Process is collective through the North America Drought Monitor, ongoing since 2003.
- Uses a convergence of evidence approach to analyse drought severity based on percentiles; inputs include agroclimate indices calculated using Versatile Soil Moisture Budget Model (Palmer, SPEI, SPI), satellite based indicators, modelled precipitation analysis data, regional expert reports



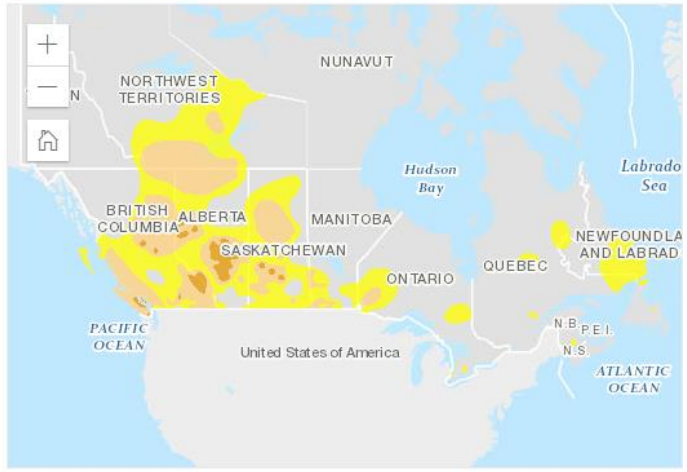


Drought categories are based on percentiles, which relate to the statistical return period.

D1- Moderate Drought	1 in 5 year event
D2 – Severe Drought	1 in 10 year event
D3 – Extreme Drought	1 in 20 year event
D4 – Exceptional Drought	1 in 50 year event

Drought Outlook Forecasts

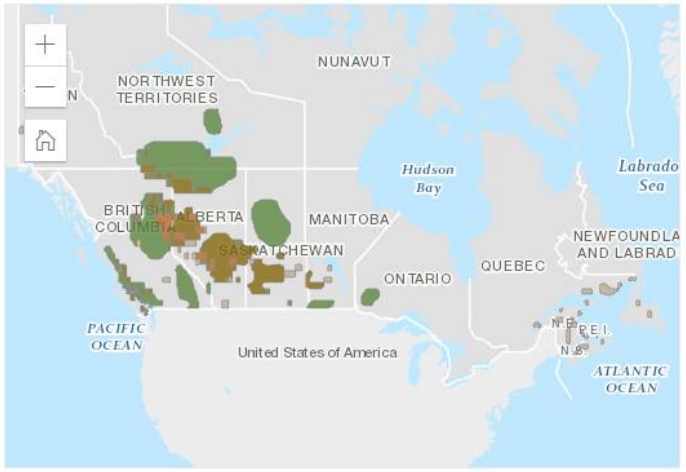
Drought conditions as of March 31, 2023



Legend for current drought conditions:

- D0 - Abnormally dry
- D1 - Moderate drought
- D2 - Severe drought
- D3 - Extreme drought
- D4 - Exceptional drought
- Drought not analyzed

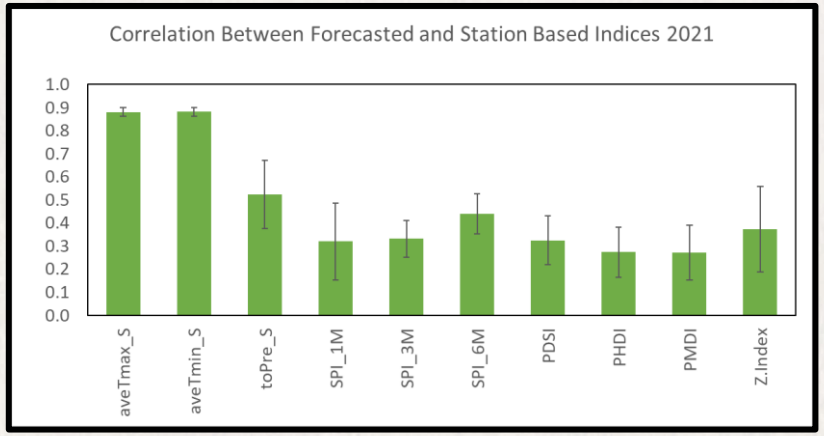
Drought Outlook for end of the following month



Legend for drought outlook:

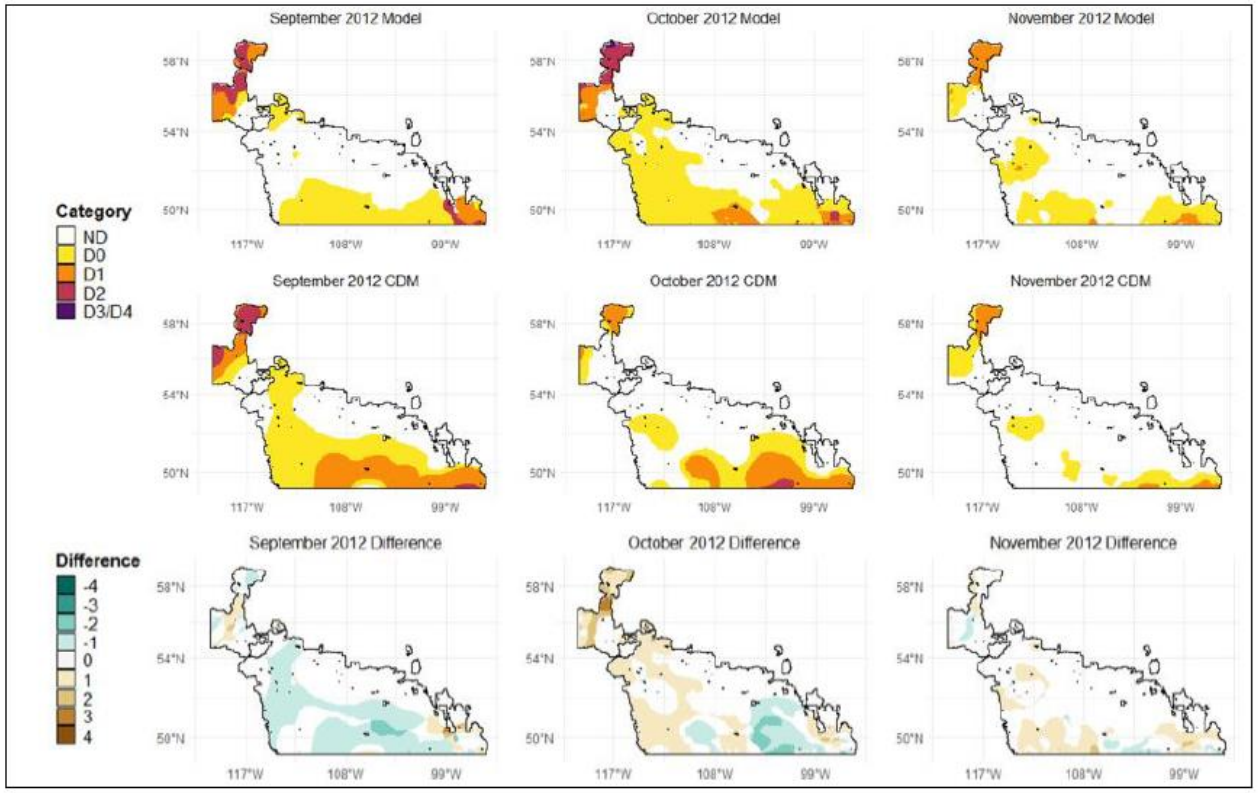
- Drought Removal
- Drought Improves
- Drought Develops
- No change in drought
- Drought Worsens

- Indicators used in drought forecast model as dominant predictors tend to be mid-term for separating drought/no drought (6 month range)
- Indicators for determining severity of each drought class are in the 9-12 month range



- Available on website https://agriculture.canada.ca/en/agricultural-production/weather/canadian-drought-outlook and at https://open.canada.ca/data/en/dataset/2c82daab-f6d9-4b19-96b5-238249e09fb9

Development of High Resolution Monitoring and Forecasting System – *Jacob Mardian (UofG)*



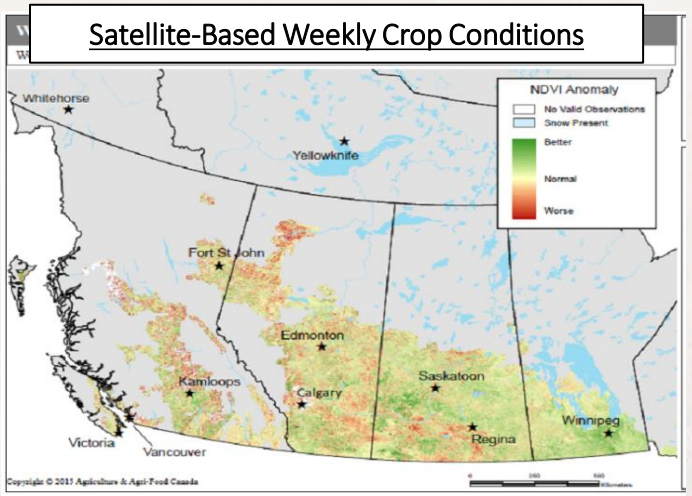
- Using an eXtreme Gradient Boosted Decision Tree model at 5km grid cells to predict Canadian Drought Monitor categories
- Model was trained over agricultural regions of 3 Prairie provinces for 2005 – 2009 and evaluated using data from 2010 to 2019.
- Used Shaley Additive Explanation variable importance metric to evaluate explanatory value of each input variable
- Includes spatial and temporal propagation metrics
- Can be expanded to include both real time and forecasted variables

From ***Mardian, J.****, C. Champagne, A. Berg and B. Bonsal (in review).* ***Machine Learning Framework for Predicting and Understanding the Canadian Drought Monitor*** *in Water Resources Research.*

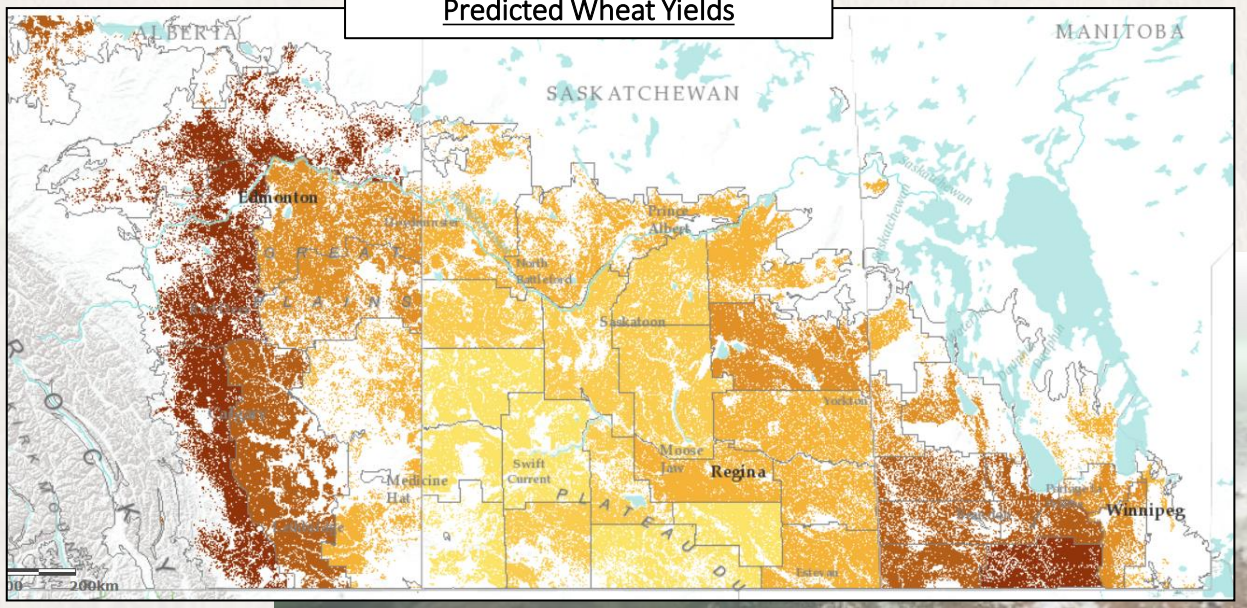
Canadian Crop Yield Forecasting System

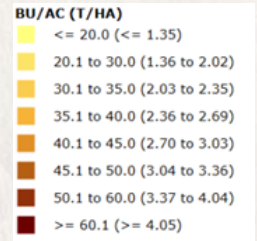
- National model used within AAFC to forecast end of season crop yields based on earth observation based Normalized Difference Vegetation Index (NDVI) and climate based indicators
- Climate based indicators come from ~450 weather stations in Canada. Heat and water accumulation and evapotranspiration are modelled using Versatile Soil Moisture Budget Model. These inputs and used as predictors in the yield forecast model
- The model uses a robust linear regression using top ranked predictors from a leave one out cross validation process
- Predictors identified from historical training data are used to predict current year's yield
- Model has been adapted by Statistics Canada to replace the July and September Farm Survey

Satellite-Based Weekly Crop Conditions

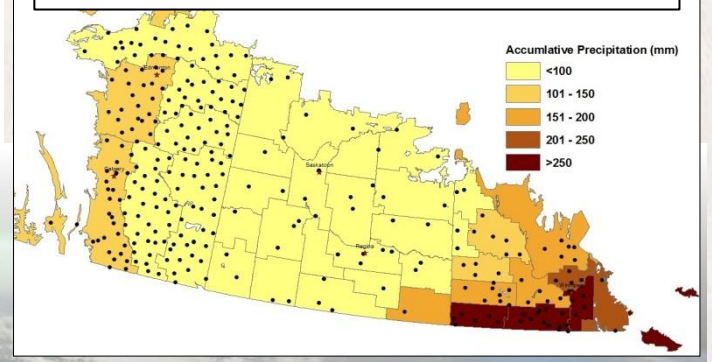


Predicted Wheat Yields

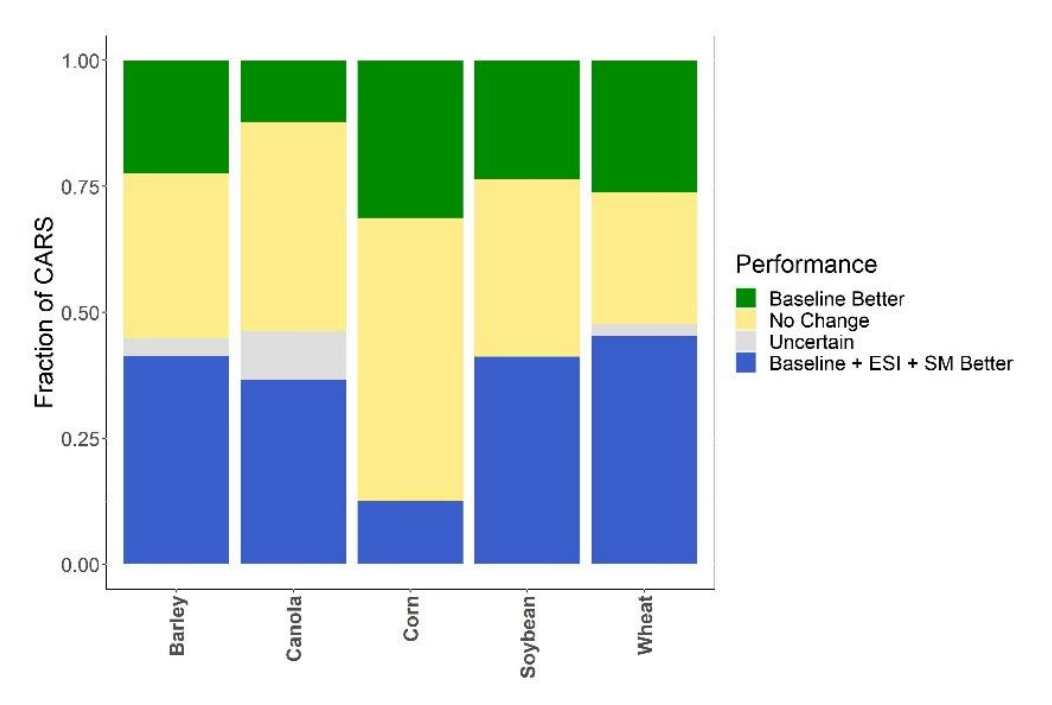


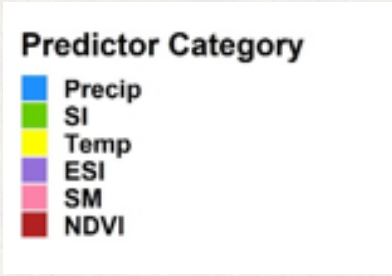


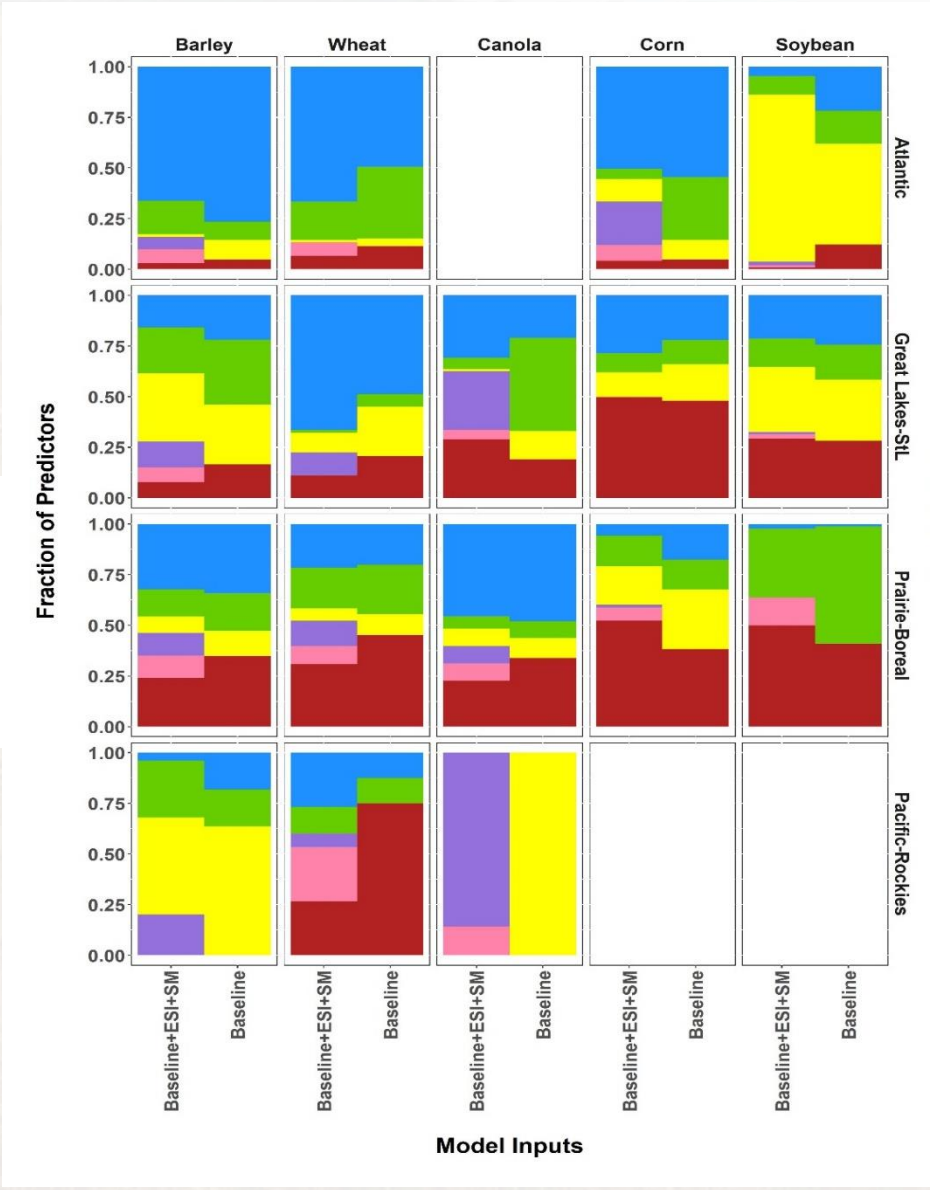
Agroclimate Interpretations e.g. Total Rainfall



Improving Yield Forecasts with Multifrequency EO



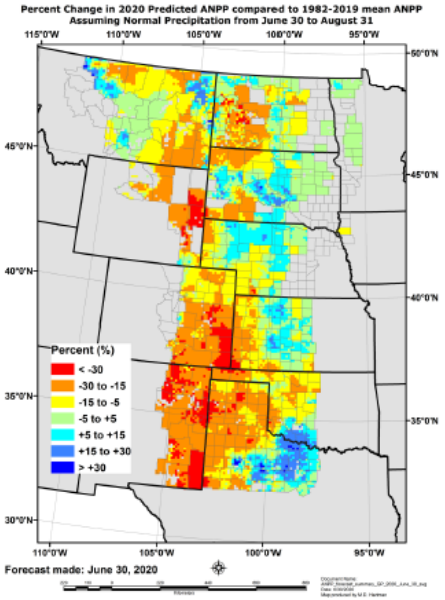




- Inclusion of satellite soil moisture and ESI improved crop yield prediction in many regions particularly for canola, barley and wheat
- SM was selected as a predictor in different regions for different crops, often displacing weather related variables or NDVI

Grass-Cast Canada

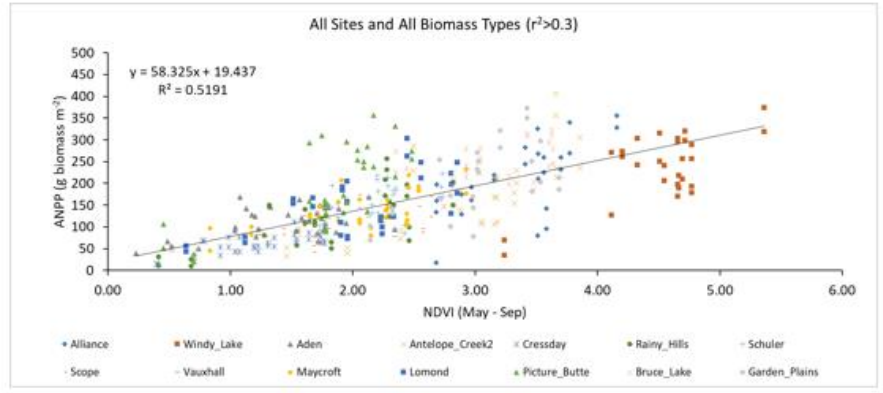
"Grass-Cast" – the Grassland Productivity Forecast



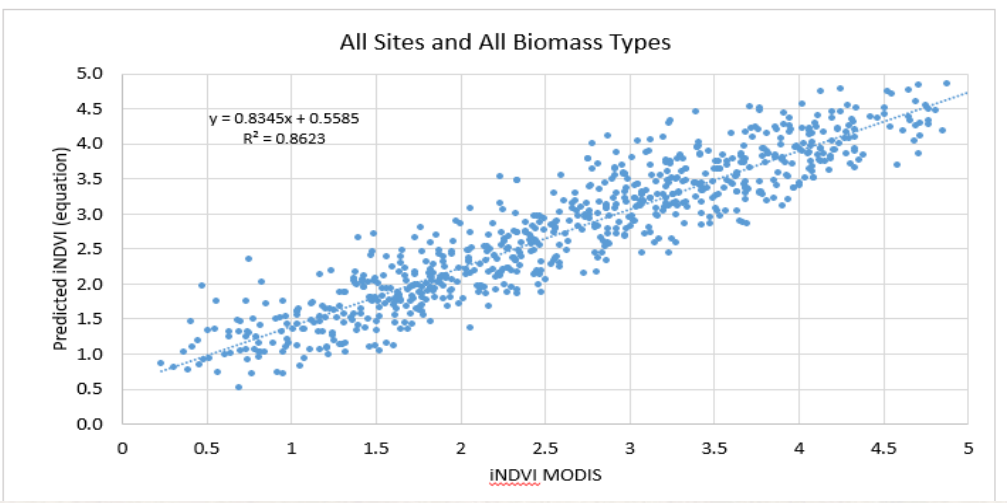
Based on **observed weather** to date
+ **future weather scenarios**...
we expect **grassland productivity**
in *your* area...
to be **X% higher** or **lower** than
your area's long-term average.

Dannele Peck, Bill Parton & Melannie Hartman
USDA Climate Hubs & Colorado State University

Observed Biomass with MODIS iNDVI

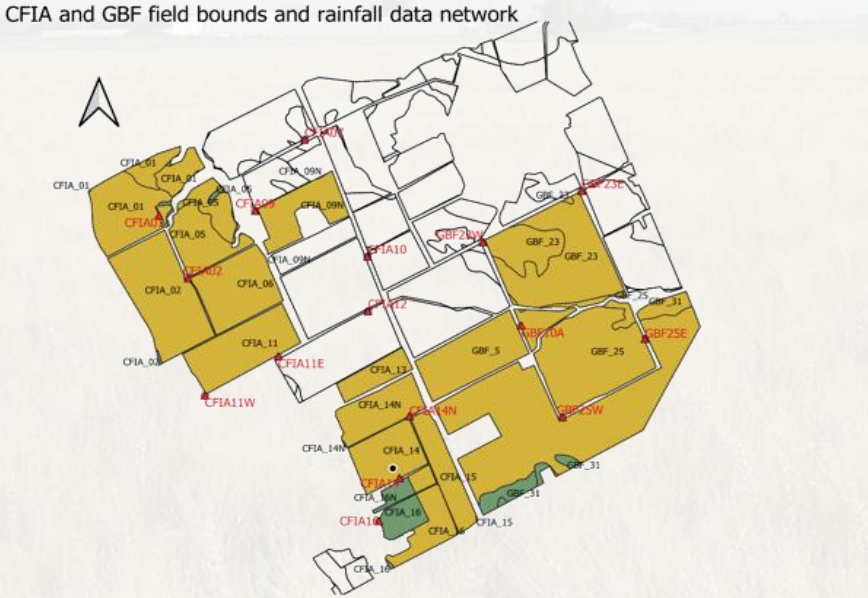


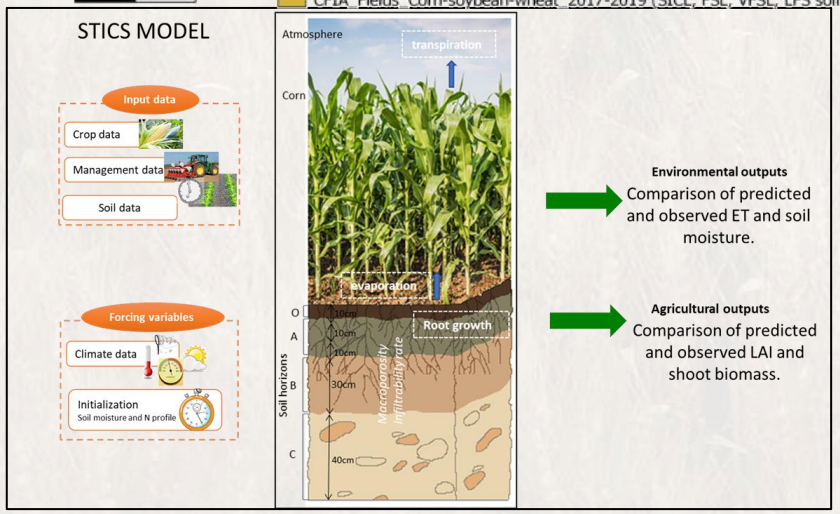
iNDVI vs. AET and MNDVI equation



- Developed relationship between grassland biomass, actual ET and NDVI to build an ensemble predictive model for grassland productivity in Canada

Optimization of Crop Models

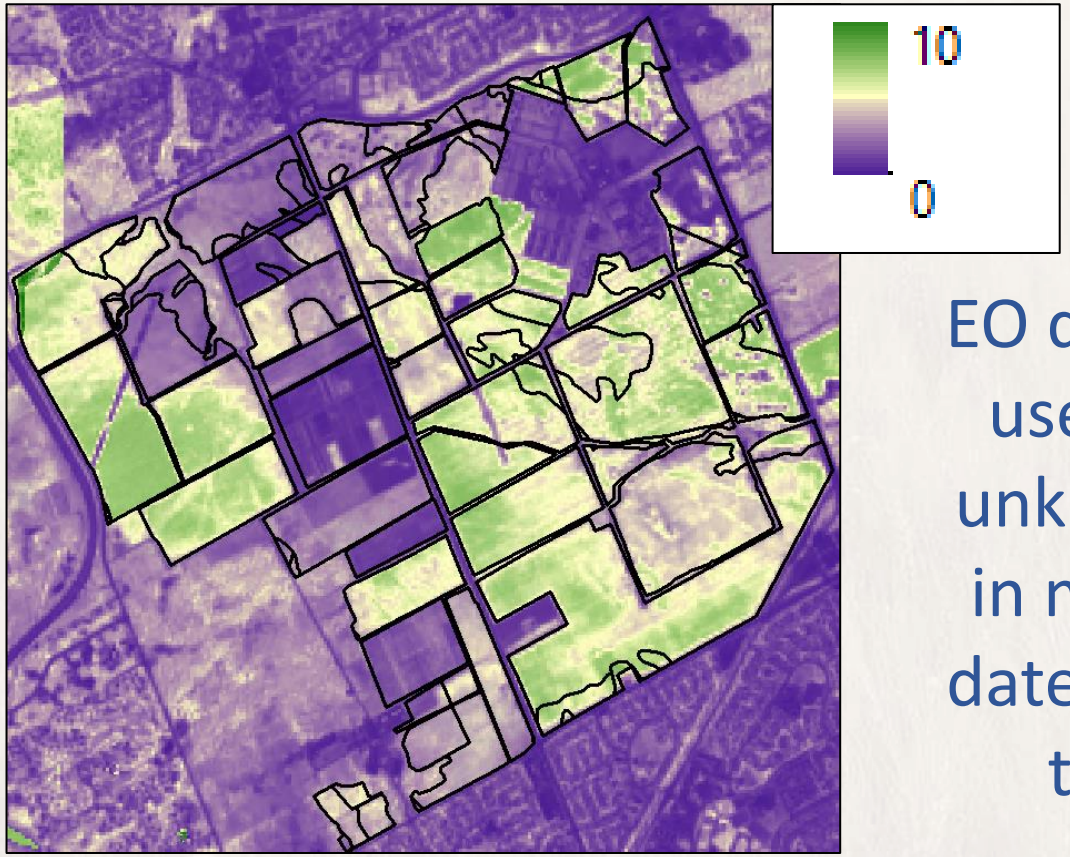




- Use gridded climate data, remotely sensed Leaf Area Index and Surface Soil Moisture to optimize crop models
- Optimize seeding date, seeding density, soil moisture initial conditions and soil water content at field capacity
- Initial work focused on adjusting crop models to estimate ET and soil moisture to accept remotely sensed estimates

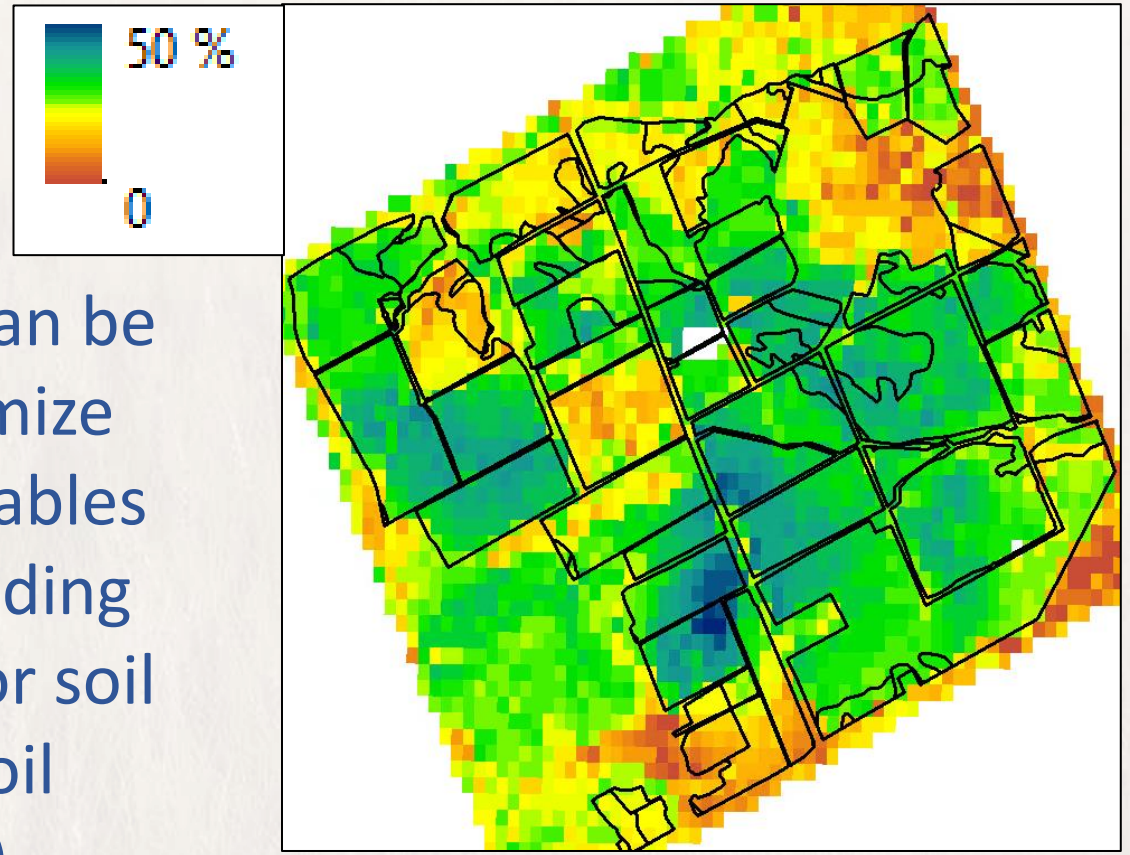
Saadi, Sameh & Pattey, Elizabeth & Jégo, Guillaume & Champagne, Catherine. (2022). Prediction of rainfed corn evapotranspiration and soil moisture using the STICS crop model in eastern Canada. Field Crops Research. 287. 108664. 10.1016/j.fcr.2022.108664.

Earth Observation Data for Model Optimization



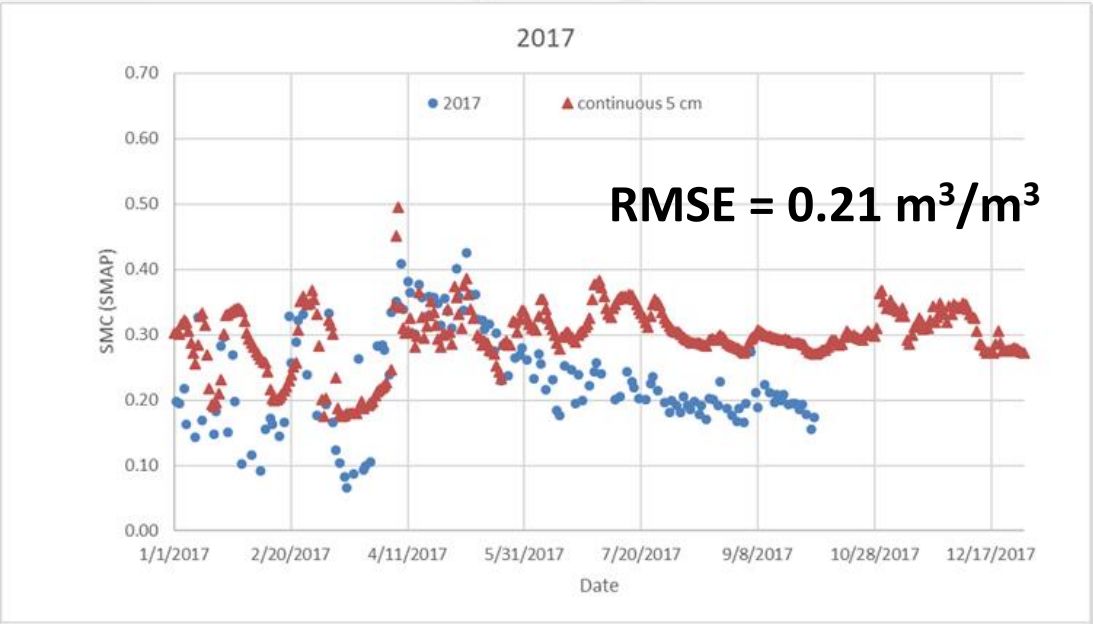
- **10m resolution Leaf Area Index derived from time series Sentinel-2 data**
- **Evaluated several methods: Index (MTVI-2), Sentinel-2 Agri/SNAP Toolbox and LEAF Toolbox (Google Earth Engine)**

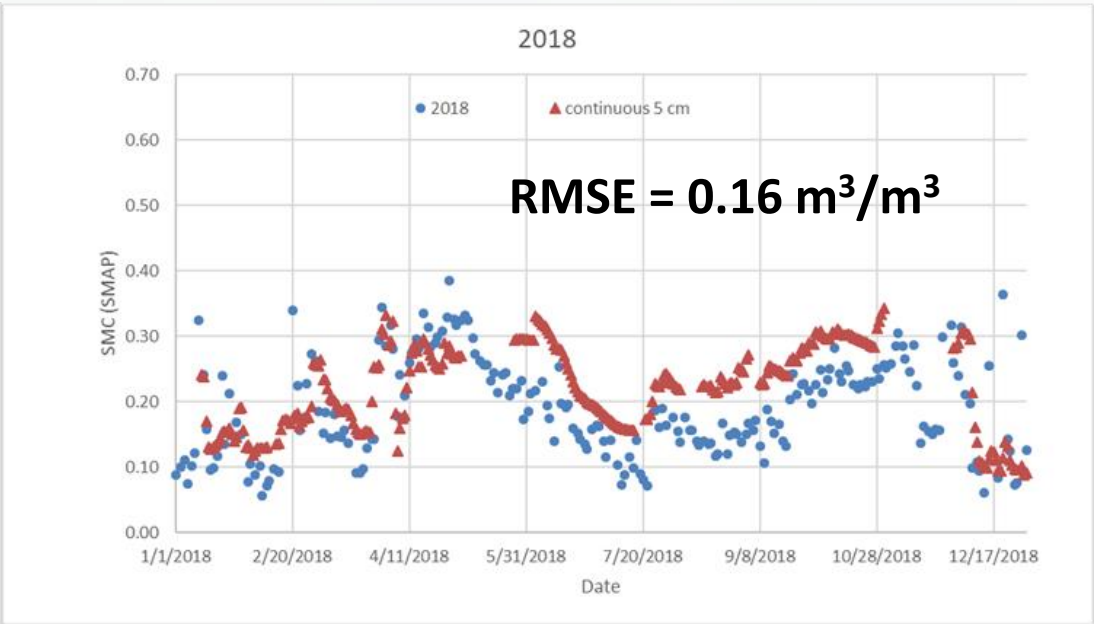
EO data sets can be used to optimize unknown variables in model (seeding date/density or soil texture / soil moisture) initialization (*Jégo et al 2012, Field Crops Research*)

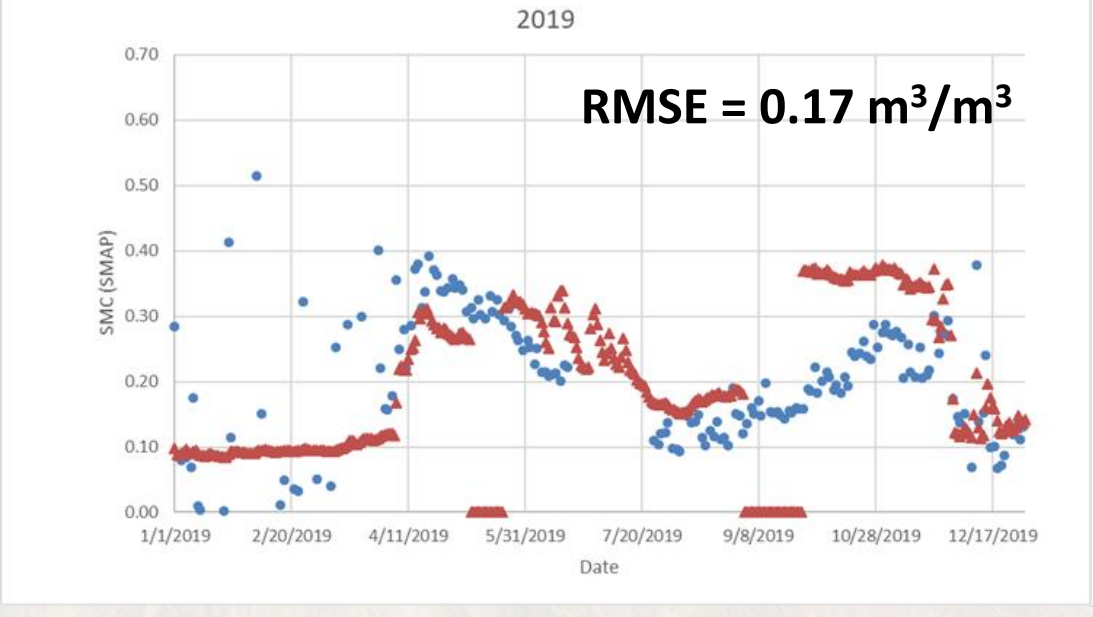


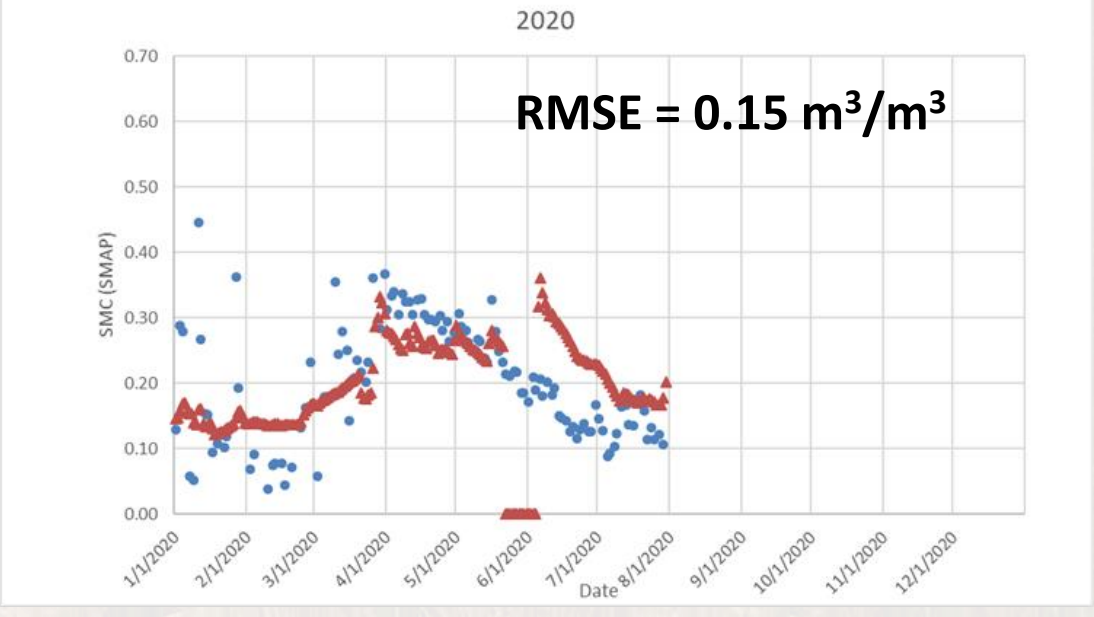
- **100m resolution surface soil moisture from Vandersat (SMAP + Sentinel-1)**
- **Compared against coarse resolution from SMOS/native SMAP & ground measurements**

Satellite Soil Moisture Data







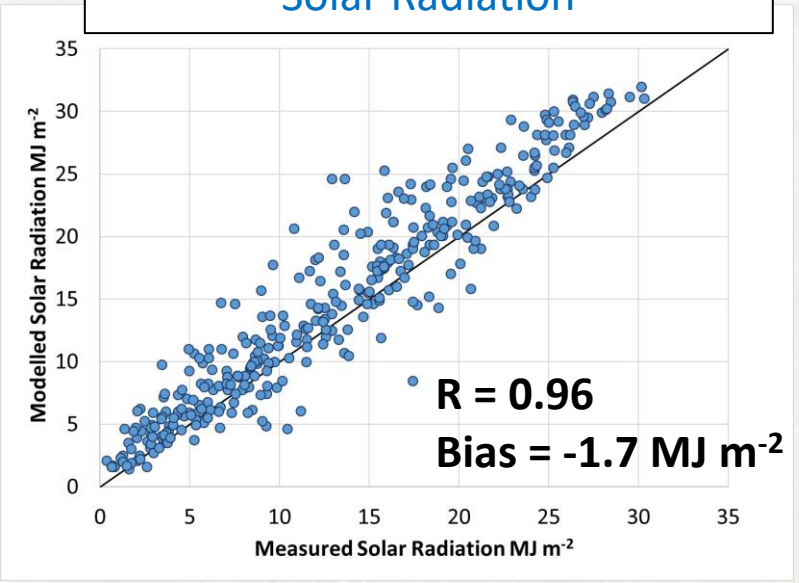


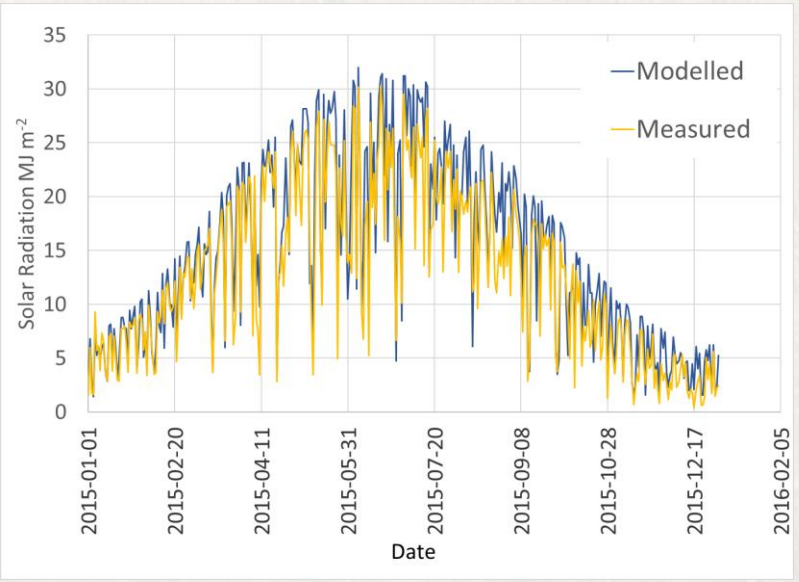
High resolution soil moisture for Vandersat shows good capturing of trends at local level

Biases are still too high to distinguish between soil properties in high pedodiversity regions

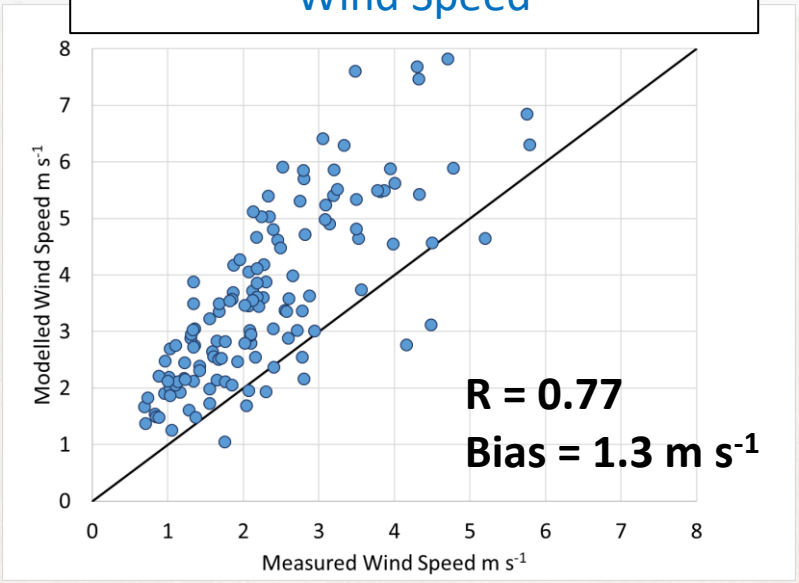
Other Key Gridded Meteorological Data Sets

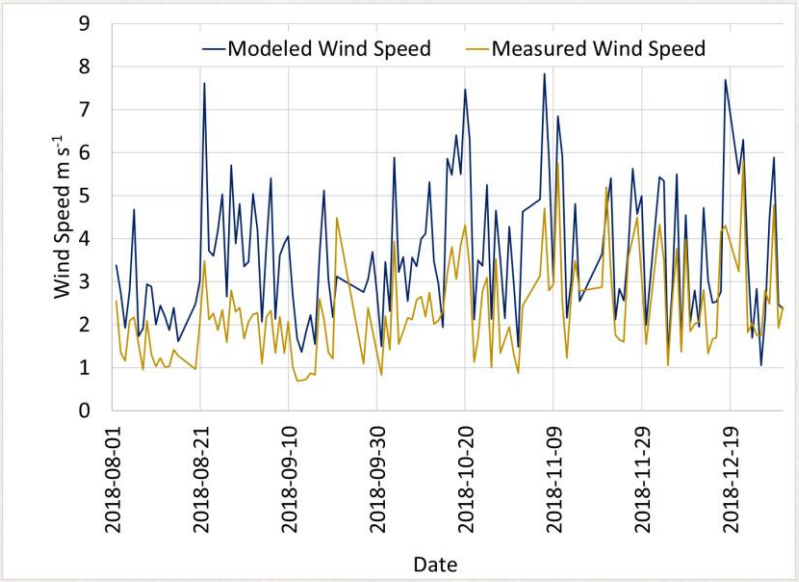
Solar Radiation



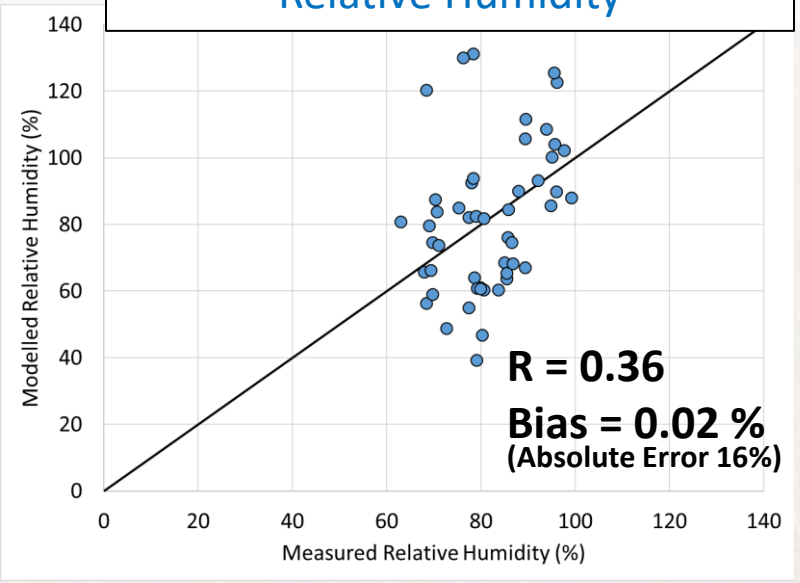


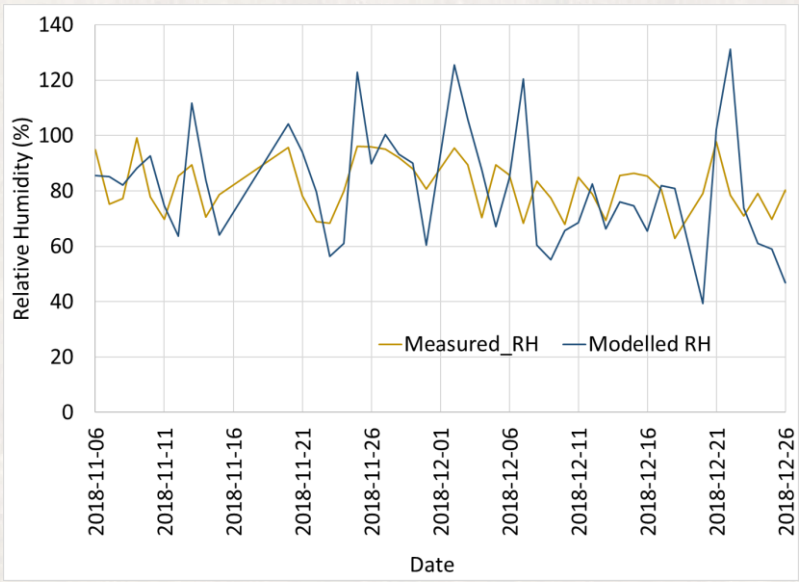
Wind Speed

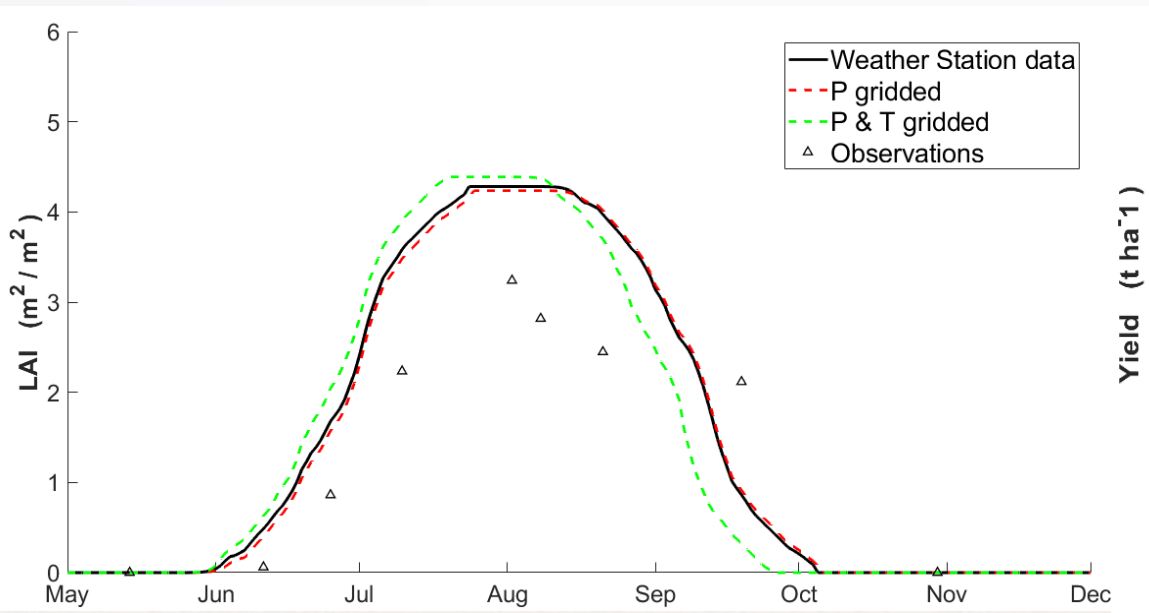


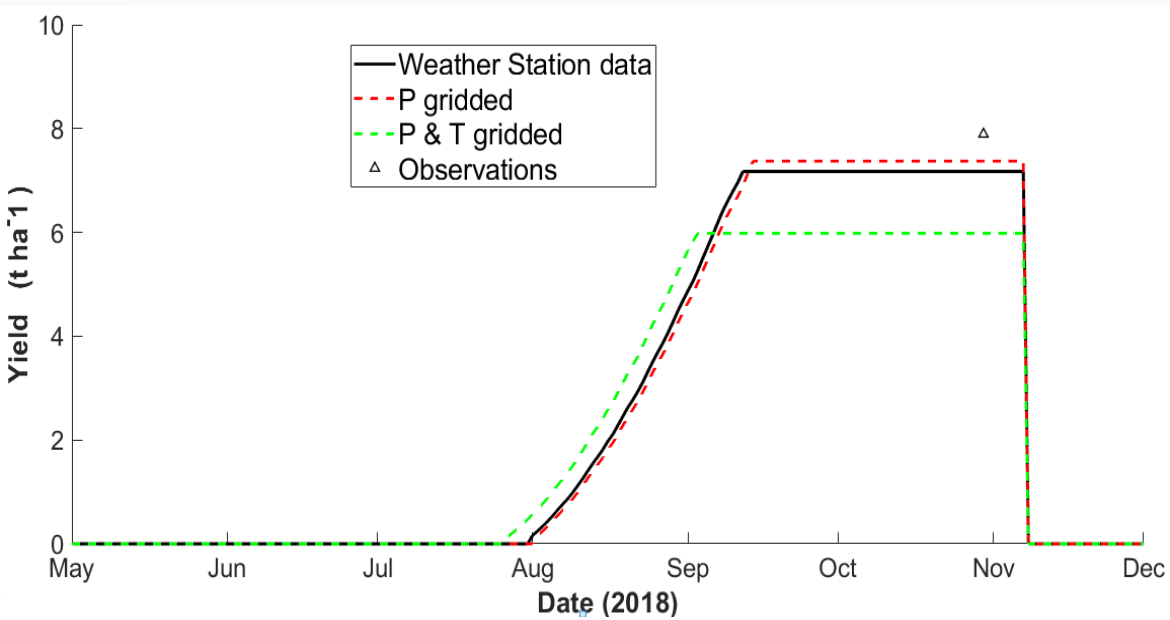


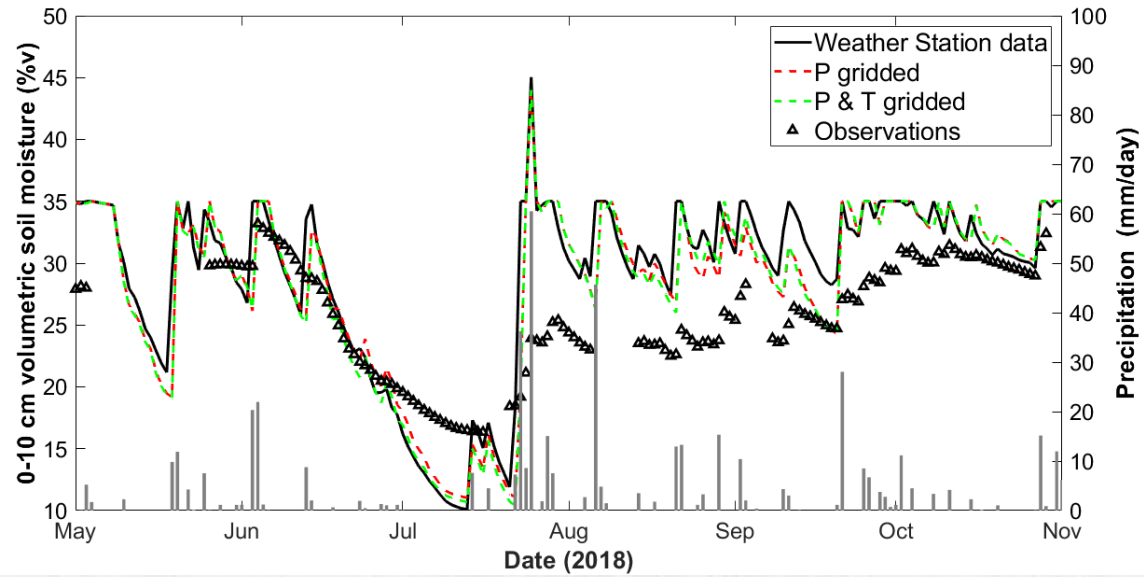
Relative Humidity

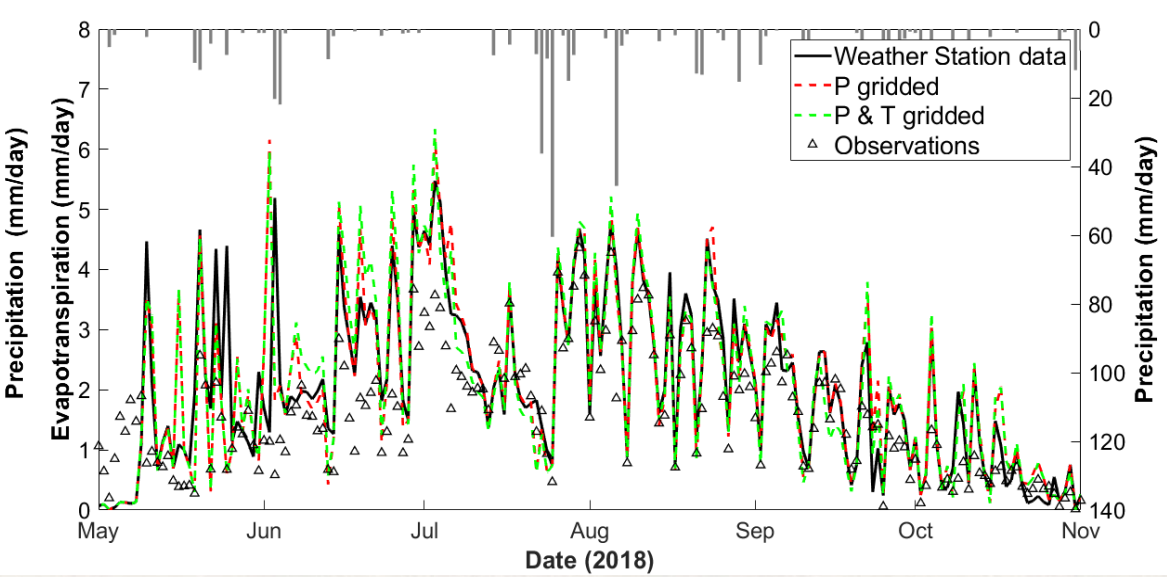










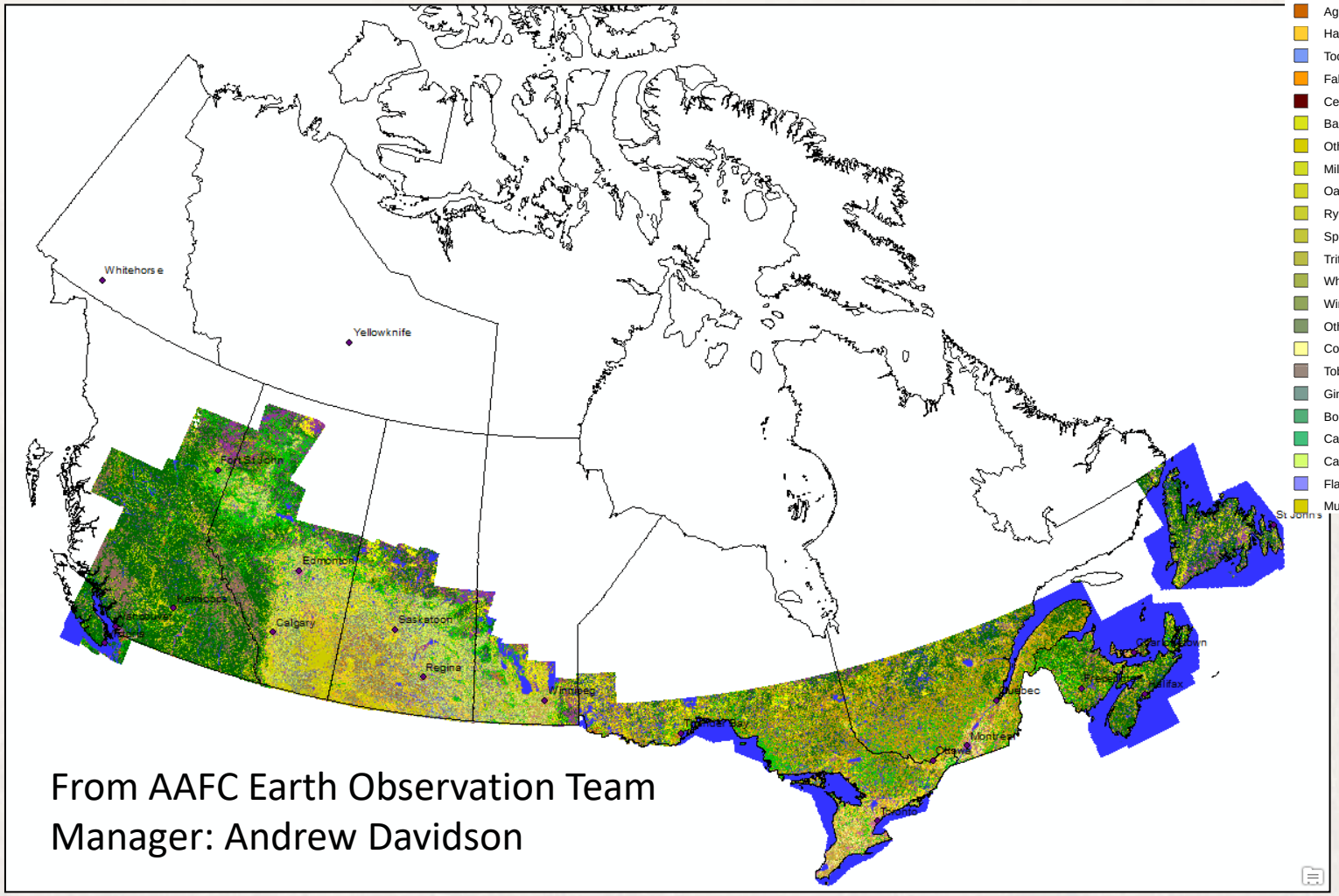


- Evaluated impact of using gridded precipitation and temperature data from HRDPS/HRDPA in STICs crop model for field site in Ottawa ON (results shown for 2018)

Impact on Crop Models

Other Key EO Data Sets: Crop Inventory

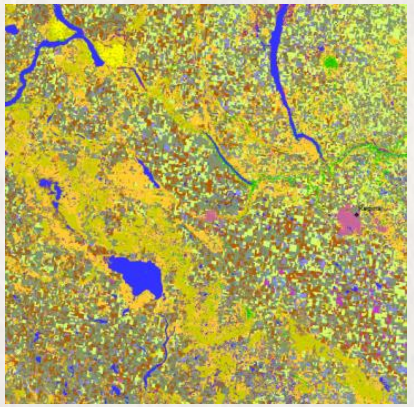
- Created annually using field observations, and multi-temporal optical remote sensing (Landsat) and radar remote sensing (Radarsat-2)



Legend

Water / Eau	Safflower / Carthame
Exposed Land / Sol nus	Sunflowers / Tournesols
Developed / Zones développées	Soybeans / Soja
Shrubland / Arbustes	Pulses / Légume à Gousse
Wetland / Terres humides	Peas / Pois
Grassland / Prairies	Beans / Fèves
Agriculture (undifferentiated) / Agriculture (indifférenciée)	Lentils / Lentilles
Hay / Pasture / Cultures pérennes et pâturages	Vegetables / Légumes
Too Wet to be Seeded / Trop humide pour le semis	Potatoes / Pomme de terres
Fallow / Jachère	Sugarbeets / Bettraves à sucre
Cereals / Céréales	Other Vegetables / Autres légumes
Barley / Orge	Fruits / Fruits
Other Grains / Autres céréales	Berries / Baies
Millet / Millet	Orchard / Vineyards / Vergers / Vignobles
Oats / Avoine	Other Fruits / Autre fruits
Rye / Seigle	Grape / Raisins
Spelt / Épeautre	Hops / Houblon
Triticale / Triticale	Sod / Gazonnière
Wheat / Blé	Herbs / Fines Herbes
Winter Wheat / Blé d'hiver	Nursery / Pépinière
Other Wheat / Autres blés	Buckwheat / Sarrasin
Corn / Maïs	Canary Seeds / Alpiste des Canaries
Tobacco / Tabac	Hemp / Chanvre
Ginseng / Ginseng	Other Crops / Autres cultures
Borage / Bourrache	Forest (undifferentiated) / Forêt (indifférenciée)
Camelina / Caméline	Coniferous Trees / Forêt de conifères
Canola / Rapeseed / Canola / Colza	Deciduous Trees / Forêt de feuillus
Flaxseed / Graines de lin	Mixed Trees / Forêt mixte
Mustard / Moutarde	

From AAFC Earth Observation Team
Manager: Andrew Davidson



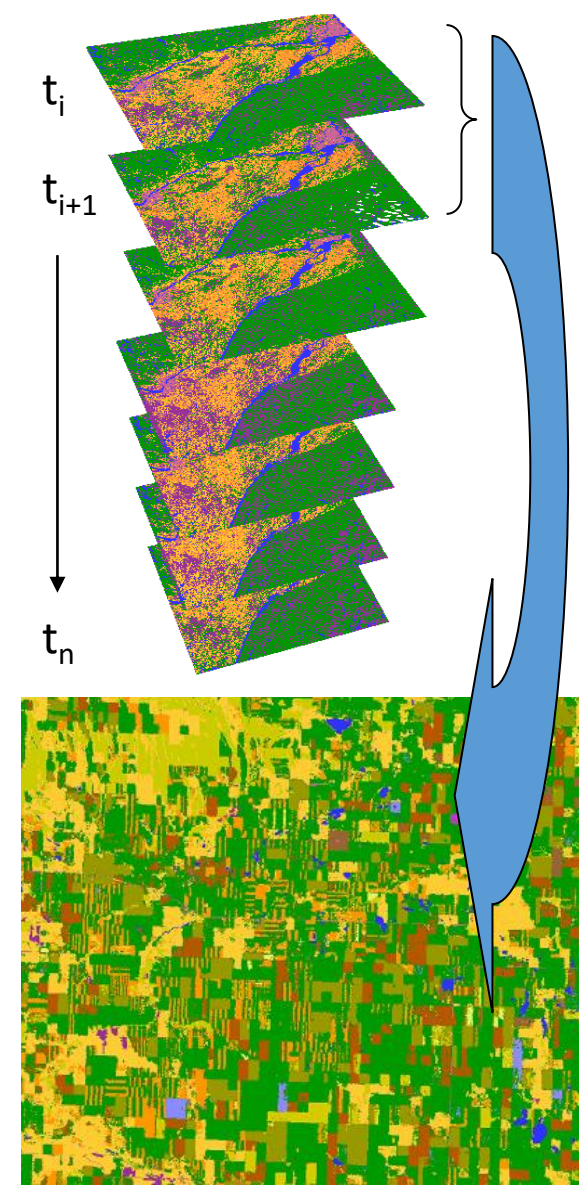
Working on cover crops, tillage, growth stage, grasslands, biomass

Agricultural Land Use Change

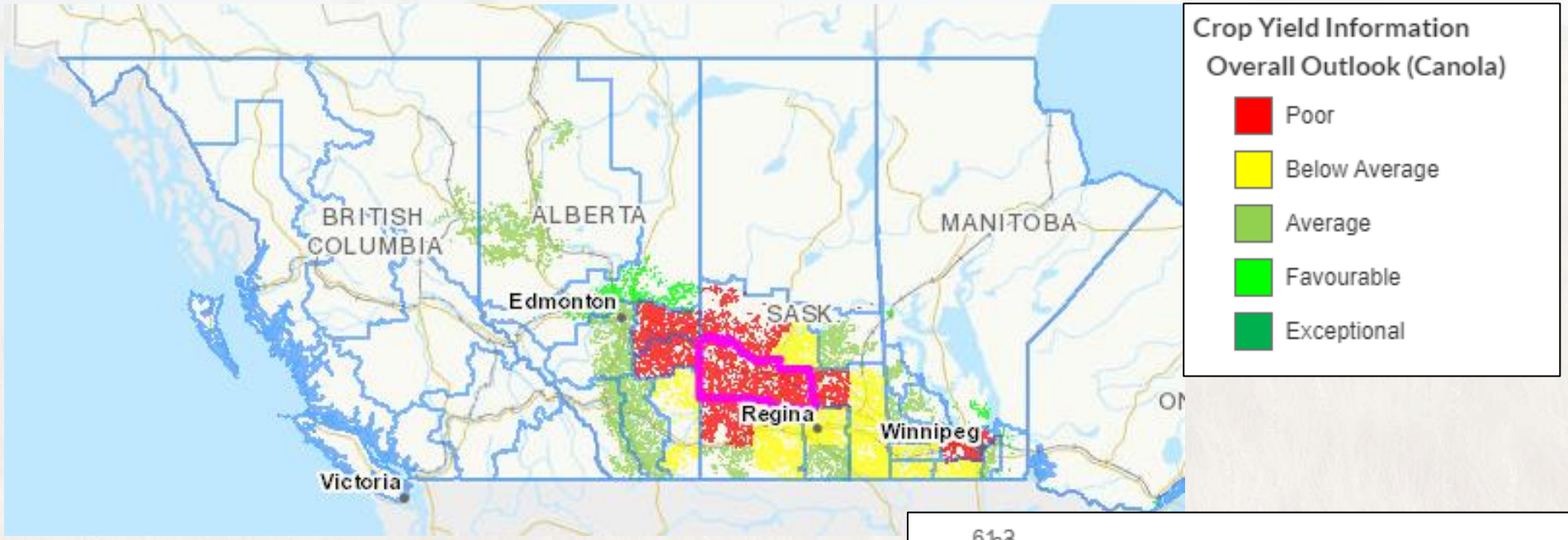
- Land use change indicators will indicate “where”, “how much” and “how” agricultural land use has changed.

Importance

- Allows annual land use changes to be tracked between important cover types.
  - Forest to agriculture,
  - Grassland to cropland,
  - Urbanization of agricultural land,
  - Perennial to annual crops.
- Such changes are key to estimating carbon sinks and sources in agricultural landscapes
- Allows spatially specific integration with other bio-physical data sets (i.e. detailed soils).

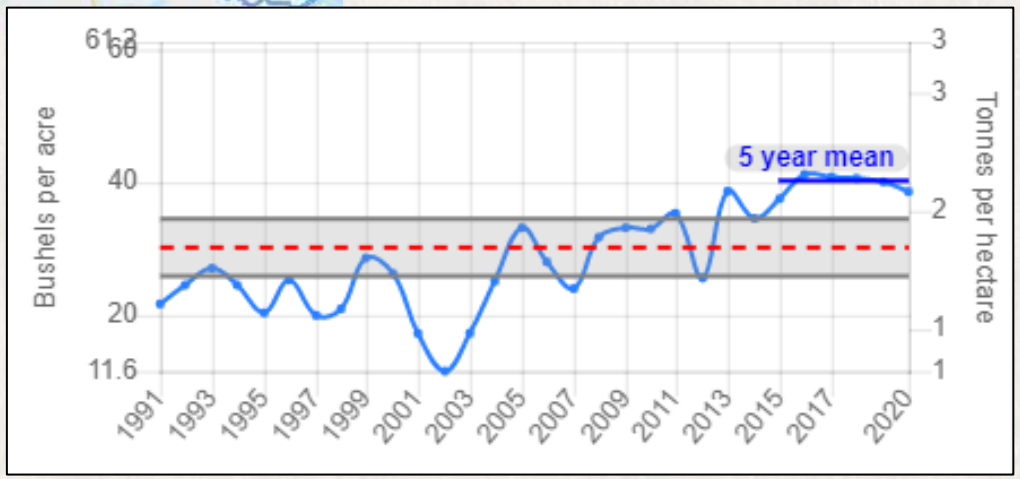


Tools: Canadian Crop Metrics Application



From AAFC Geomatics Team
Manager James Ashton

- Overall yield outlook, production forecasts, crop stress indicators, extreme weather indicators, drought, satellite data, historical analysis & graphing tools



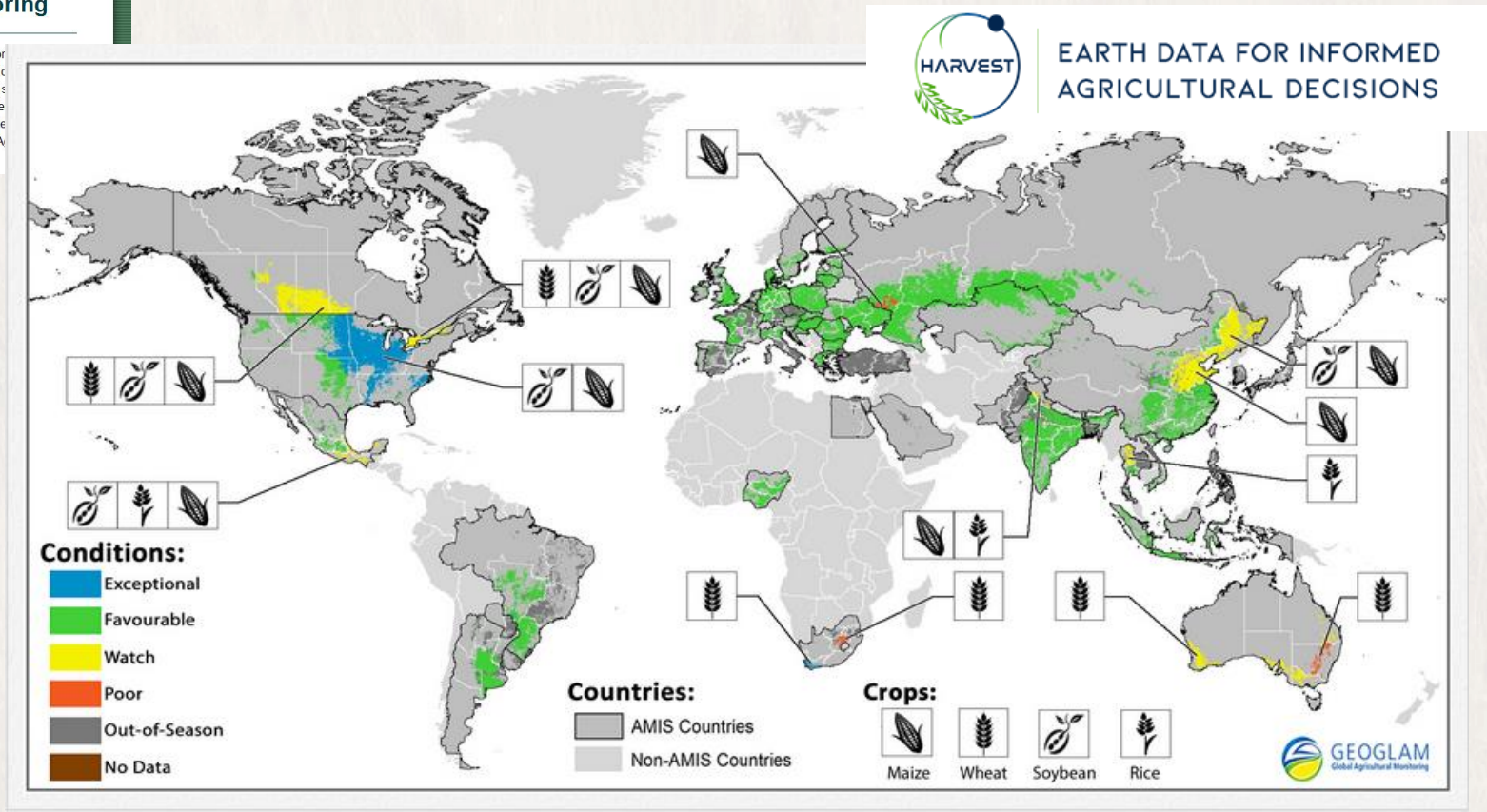
Estimated canola yield for Saskatoon Region

Canadian Crop Metrics Application:
www.agriculture.Canada.ca/atlas/cropmetrics

Global Crop Monitoring

Take successful national monitoring and improve methods to expand this globally

Produce crop forecasts based on scientifically sound, geospatial data to reduce spurious market speculation that follows environmental and political events



Take home messages

- The National Agroclimate Information Service leverages raw weather and climate data to translate this to information useful for assessing risks, monitoring production and analysing the sustainability of the agricultural sector in Canada – key tools for mitigating and adapting to climate change

- Station networks, satellites, modelled data, crowd sourcing all have a role to play in getting full picture of climate related impacts to agriculture and beyond

- Improving the spatial resolution and richness of indicators will strengthen our ability to respond to extreme weather as it happens; earth observation and integration of this data into models is critical to providing this information

- User-friendly tools, simplified data sets make these accessible to diverse user groups to interpretation and decision making

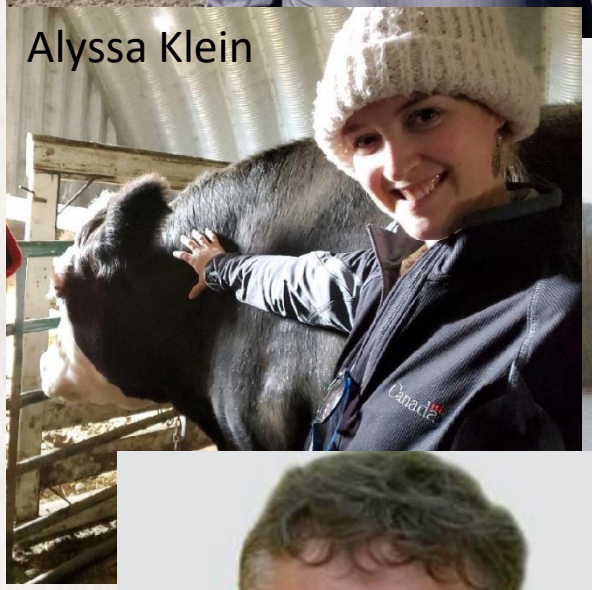
- Find everything at: https://agriculture.canada.ca/en/agricultural-production/weather

Trevor Hadwen

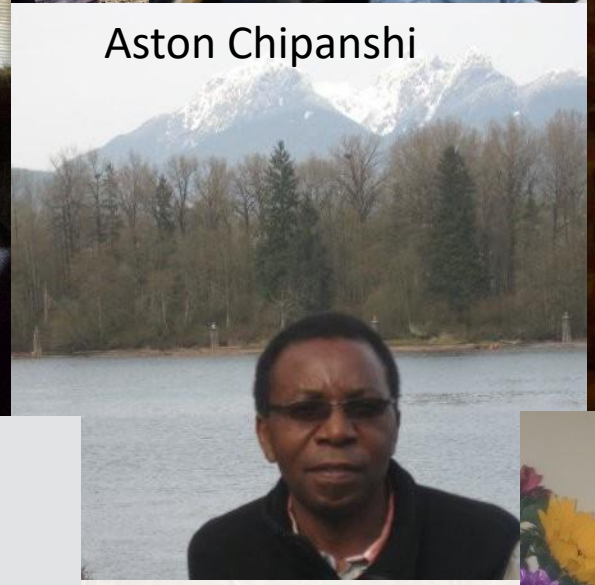
Yinsuo Zhang

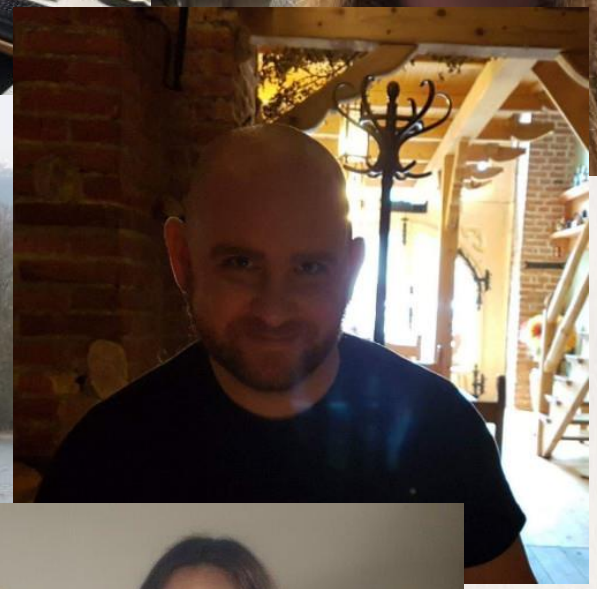
Laura Richard

Alyssa Klein



Aston Chipanshi





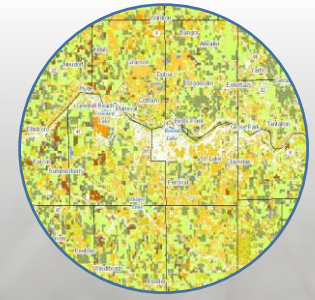
Tyler Black

Richard Warren

Marilee Pregitzer

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canada



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