Towards Increased Utilization of Weather Forecast Products in Agriculture

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Outline

• Motivation

• Methodology

• Sample products from the 2018 growing season

• The next steps
Motivation for forecast products

• Flooding and drainage impacts agriculture and other economic activities.
• Losing infrastructure is costly.
• The agricultural calendar is quite narrow across Canada (90 to 120 days).
• There are environmental implications from extreme weather events.
Damage to Infrastructure: Sideslope Failure

200 mm of rain in 48 hours
August 17-19, 2007 (near Saskatoon)
AAFC paid out at least $15 dollars per acre for 2.9 million acres of flooded ag land in 2006. (Total = $43 500 000): Red River MB
Rural Infrastructure failure (SK and BC)
Flooded Infrastructures have environmental implications

A flooded taxpayer is an unhappy taxpayer
High level features of the Global Ensemble Prediction System (source of data)

- GEM model as the dynamical core
- Yin-Yang grid 0.35 x 0.35 (about 39 km)
- 45 levels, top at 0.1 hPa
- Time step of 15 minutes
- 16 day integration (32 day integration every Thursday)
- Disturbed physical parameterizations
- Kalman Filter initialization
- In operation since 1996, with many upgrades
- Is part of North American Ensemble Forecast System (NAEFS)
Indices were developed for specific crop type

- Cool season crops -- wheat (*Triticum aestivum* and *Triticum durum*), barley (*Hordeum* ssp.), canola (*Brassica napus*), oat (*Avena* ssp.), rye (*Secale cereale*), etc.

- Warm season crops -- bean (*Phaseolus* spp.), corn (*Zea mays*), pea (*Pisum* spp.), potato (*Solanum tuberosum*) and soybean (*Glycine max*), etc.

- Over-wintering crops -- biennial and perennial herbaceous plants (strawberry, alfalfa, timothy, and other forage crops) and woody fruit trees (apple, pear, peach, cherry, plum, apricot, chestnut, pecan, grape, etc.).
Identified indices and indicators (1) ...

- **Temperature-based indices:**
  - Days of cool wave (DCW)- $f(\text{days}) < 5$ and $10^\circ\text{C}$,
  - Days of heat wave (DHW)- $f(\text{days}) > 30^\circ\text{C}$ and $35^\circ\text{C}$.

- **Precipitation-based indices:**
  - Greatest daily precipitation (P1D),
  - Greatest 10-day precipitation (P10D);
Identified indices and indicators (2) ...

- **Wind-based indices:**
  - Maximum daily wind speed (MDWS),
  - Number of strong wind days (NSWD),
    - \( f(\text{days}) \) with wind speed > 30km hr\(^{-1}\)
  - Number of Drying Days (NDD),
    - \( f(\text{days}) \) wind speed >30km hr\(^{-1}\) and \( T_{\text{max}} > 30^\circ\text{C} \)

- **Freeze-based indices:**
  - Number of frost-free days (NFFD),
    - \( f(\text{days}) > (-2^\circ\text{C and } 0^\circ\text{C})\)
  - Number of ice-freeze days (NIFD),
    - \( f(\text{days}) < (-2 \text{ and } 0^\circ\text{C})\)
• Moisture-based indices:
  – Standardized precipitation index (SPEI),
  – Crop water deficit (CWD, i.e., P-PE);

• Heat energy-based indices:
  – Effective growing degree days (EGDD) - Heat accumulation using 5° and 10° C T thresholds,
  – Cumulative crop heat unit (CCHU).
How skillful are these indices?

- GEMS 384-hours real forecast for 2009-2011
- Era-interim daily reanalysis data
- Major crop growing season (April-September)
Skill for heat, water and wind based indices
Index skill summary

- Energy and temperature-based indices are realistically forecast over Canada.
- Precipitation based indices exhibit a relatively high forecast skill in western Canada.
- Freeze-based indices are well forecast across Canada, except the Prairies.
- Wind-based indices had spatial differences: maximum daily wind speed is best forecast in western and eastern Canada, has low skill in central Canada; the number of strong wind days more skillful in eastern and central Canada, and low skill in western Canada.
Precipitation forecast and actual observations for Weeks 1 and 2 in September
The 2018 Growing Season EGDDs by mid September

Effective Growing Degree Day (warm season crops) August 31 - September 13, 2018

Effective Growing Degree Day (cool season crops) August 31 - September 13, 2018

Growing Degree Days: BASE 5 April 1, 2018 to September 30, 2018

Growing Degree Days: BASE 10 April 1, 2018 to September 30, 2018

Warm

Cool
The next steps

• Using the improved GEPS model, forecasts outputs will be provided at 1 to 4 week time steps.

• Forecast indices will be posted on a public website: http://www.agr.gc.ca/eng/programs-and-services/drought-watch.

• Additional indices based on multi-variable inputs from GEPS will be added.

• There will be an evaluation of indices with clients (users) that the selected indices are appropriate for agriculture.