Integration of Weather, Soil and Remote Sensing Data for Soil Profile Moisture Modeling

RoTimi Ojo
Paul Bullock
Limitations and Opportunities

👍 Continuous soil moisture monitoring network is limited in Western Canada

👎 Soil moisture sensors that provide continuous real time data are expensive and often require soil-specific calibration

👍 Increase in the number of automated weather stations on the Prairies that report weather data in real time

👍 Great potential in using models to estimate soil moisture content from the information provided by these weather stations
Why models?

- Models are used to predict the outcomes or to fill the gap between the known and the unknown.

- They are cheaper and less laborious when compared to the cost of instrumentation for direct measurement.

- Soil moisture sensors are often useful for making point measurements.
The VSMB

- The Versatile Soil Moisture Budget (VSMB) was developed to simulate vertical, one-dimensional soil moisture flux.

- VSMB source code was written in Fortran language and it works on a daily time-step with the soil profile divided into user-defined number of layers.

- The model uses water balance method to quantitatively determine soil moisture.
The VSMB has been widely applied in agrometeorology and hydrology applications such as:

- Estimation of evaporation from grassland (Hayashi et al, 2010)
- Impact of water use on crop yields (Qian et al, 2009)
- Number of field work days for manure application (Sheppard et al 2007)
- Impact of climate change scenarios on the agro-climate of the Canadian prairies (McGinn and Sheppard, 2003)
VSMB Input Data

VSMB

Weather
- Precipitation
- Maximum Temperature
- Minimum Temperature
- Wind Speed
- Maximum RH
- Minimum RH
- Solar Radiation

Soil/Plant
- Field Capacity (mm)
- Saturation (mm)
- Permanent Wilting Point (mm)
- Initial Water Content (mm)
- Plant Growth Coefficients
- Site Elevation
- Plant Type
- # and Depth of Soil Layer

Integration of weather, soil and remote sensing data for soil profile moisture modeling
Objective

Create a soil-vegetation-weather integration (e.g. map) with changes in weather and vegetation affecting soil moisture status over the growing season.
Observed Soil Moisture

- Specific point measurement, small sensing volume
- Great results with proper calibration
- High temporal measurement

- Great spatial measurement
- Sensing depth ~5 cm
Integration of weather, soil and remote sensing data for soil profile moisture modeling
Soil Profile Applications

Integration of weather, soil and remote sensing data for soil profile moisture modeling
Gathering Inputs

Soil Information

Soil Mapping by Municipality

Soil Series

Crop Inventory

Seeding Date: Use of thermo-time
Crop Identification: Optical and SAR imagery
Crop Growth: Biometeorological time scale

Weather Data

Air Temperature
Precipitation
Humidity
Wind Speed

Integration of weather, soil and remote sensing data for soil profile moisture modeling
Integration of weather, soil and remote sensing data for soil profile moisture modeling.
Integration of weather, soil and remote sensing data for soil profile moisture modeling

Weather Data

SMAPVEX12 Temperature and Precipitation

Temperature (°C)  Precipitation (mm)

Integration of weather, soil and remote sensing data for soil profile moisture modeling
Expected Outcome

Weather: Daily weather update based on data from weather stations

Vegetation: Growth updated weekly

Soil layer: Static, populate attribute table with daily soil moisture update driven by weather and vegetation data
Thank you

Thoughts & Questions?