SMAP and its Importance for the Next Generation of ECCC’s Land Data Assimilation System

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Near-surface observations are now assimilated to increment surface temperatures and soil moisture.

The primary objective is to optimize the impact of land surface initial conditions (ICs) on atmospheric forecasts.

(T2m, RH2m)

Mahfouf (1991)
Douville et al. (2000)
Belair et al. (2003)
Land Data Assimilation for Numerical **Environmental** Prediction (in development)

L-band (SMOS / SMAP) for soil moisture

Use of space-based remote sensing data to enhance or replace near-surface observations

IR imagery for surface temperature

Weakly coupled with upper-air assimilation system, i.e., land surface has its own configuration

The main objective is to produce land surface ICs for all environmental applications

L-band (SMOS / SMAP) for soil moisture

Screen-level obs \( x \) (T2m, RH2m)

Tveg

Tsoil

Soil moisture

(cased with no snow)
Requirements for the next operational land data assimilation system at ECCC

Setup and optimized **first** to minimize errors against surface observations of control variables, i.e., surface temperatures, soil moisture, snow, vegetation

**One** system for all applications: weather, hydrology, and other clients such as agriculture, forest fires, ecosystems.

But, has to have a positive impact on numerical weather prediction (first / host client)

Km-scale over North America, 5-10 km grid spacing worldwide

Weakly coupled with upper-air data assimilation systems (i.e., surface has its own operational process).
Impact of SMAP on Soil Moisture (corr)

Near-surface soil moisture ($w_g$)

Root-zone soil moisture ($w_2$)

AGDMN = Alberta Ground Drought Monitoring Network
(5, 20, 50, 100 cm)

SCAN = Soil Climate Analysis Network
(5, 10, 20, 50, 100 cm)

For July-August 2015
Assimilation of SMAP brightness temperature leads to significant improvement in surface and root-zone soil moisture estimates vs. the current operational system of Environment and Climate Change Canada (ECCC). This improvement further leads to a positive impact of SMAP on Numerical Weather Prediction (NWP) as shown in the quantitative precipitation forecasts in ECCC’s North America NWP systems.

Positive impact of SMAP on Precipitation forecasts

a. Reducing frequency bias  
b. Better detection of convective events

Improvements obtained through the use of SMAP data may appear small, but in the forecasting game, any true, significant increase in skill is considered a major accomplishment. Seemingly small increases in skill can have significant economic benefits.

ECCC is continuing to work on the optimal incorporation of SMAP products into the Canadian Land Data Assimilation System (CaLDAS). The operational implementation of CaLDAS-SMAP is targeted for Spring 2018.
**SMAP Alone not Sufficient… More is Needed**

<table>
<thead>
<tr>
<th>Assimilate more observations in CaLDAS</th>
<th>e.g., surface temperature from geostationary IR (GOES, MSG, Himawari)</th>
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<tbody>
<tr>
<td>Better characterization of the land surface</td>
<td>(soils and LU/LC databases, satellite-based information for vegetation – roughness, fractional coverage, albedo, emissivity, LAI)</td>
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<tr>
<td>Better land surface modeling</td>
<td>New land surface scheme SVS Including photosynthesis</td>
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<tr>
<td>“Assimilation” of “calibration” of the surface stomatal resistance</td>
<td>Possible, or desirable?</td>
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Assimilating Retrieved Tskin from GOES Impact on T2m forecasts

From Garand’s presentation that was cancelled

**Tskin assim - 2-m obs assim**

**STD**

**BIAS**

July and August 2015
North America
Assimilating Retrieved Tskin from GOES
Impact on TD2m forecasts

Tskin assim - 2-m obs assim

From Garand’s presentation that was cancelled

July and August 2015
North America
SVS vs ISBA for NWP Forecasts

2-m Air Temperature STDE

Based on 31 forecasts (48h) in July and August 2015

CANADA
SVS vs ISBA for NWP Forecasts

STANDARD DEVIATION (P-O) OF SURFACE TEMPERATURE (C) 2015-07-01 @ 2015-08-30
ade synop United States of America

2-m Air Temperature STDE

Based on 31 forecasts (48h) in July and August 2015

USA
SVS vs ISBA for NWP Forecasts

2-m Dew point temp Bias

Based on 31 forecasts (48h) in July and August 2015 USA
Vegetation characteristics from MODIS

Air temperature (2m)

Dew point temp. (2m)

New surface characteristics

Bias

July and August 2015
USA East
CaLDAS-SMAP Cycle with SVS (vs OP)

STANDARD DEVIATION (P-O) OF DEW POINT TEMPERATURE (C) 2015-07-01 @ 2015-07-25
dei synop North America

2-m Dew point temp
STDE

Based on (only) 13 forecasts (48h) in
July 2015

North America
CaLDAS-SMAP Cycle with SVS (vs OP)

2-m Dew point temp Bias

Based on (only) 13 forecasts (48h) in July 2015

North America
Are we there yet?

SMAP essential for new generation of CaLDAS

Only one test away from completing tests with the light 10-km North America configuration (i.e., with photosynthesis)

The configuration: CaLDAS w/ SMAP/SMOS, screen-level obs for Tsurf, no changes to snow assimilation, SVS w/ photosynthesis

The two target configurations:

a) 2.5-km North America

b) 15-km global (or 10-km)

Timeline for operational implementation still uncertain (early 2018 seems most likely)

Data distribution via CMC-Operations (geomet, datamart) + other less official means (rpn-wms, collaboration web page)
Backup Slides
Land surface modeling... SVS vs ISBA

From an open loop cycle, evaluation over North America for June, July, and August 2012

From Husain et al. (2016)
Land surface modeling... SVS vs ISBA

From an open loop cycle, evaluation over North America for June, July, and August 2012

From Husain et al. (2016)