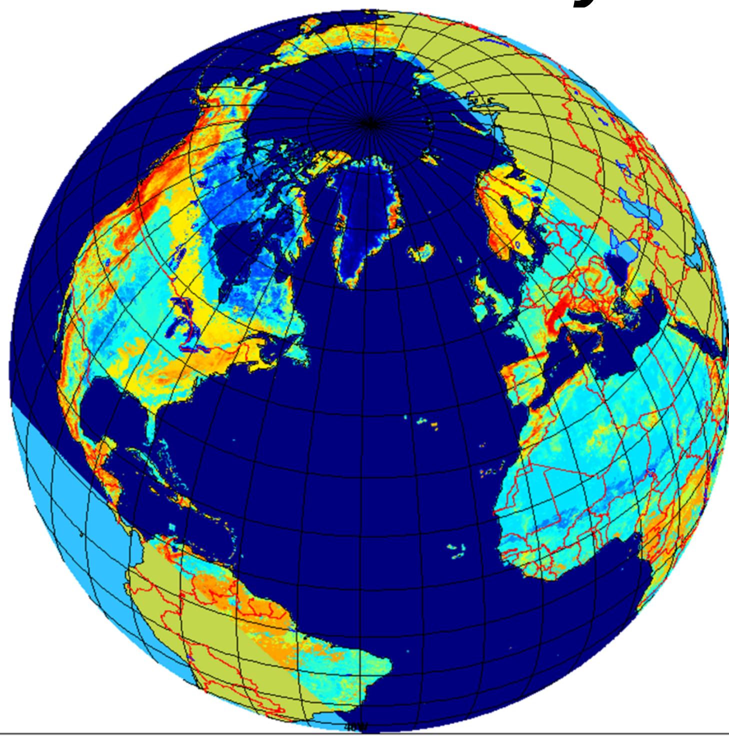
Environment Canada Environnement Canada

Canada

The Transition from Surface Observations to Space-Based Remote Sensing with the Canadian Land Data Assimilation System (CaLDAS)



Stéphane Bélair
Marco L. Carrera
Bernard Bilodeau
Maria Abrahamowicz
Sylvain Heilliette
Camille Garnaud
Chris Derksen

Environment and Climate Change Canada (ECCC)

International Surface Working Group, 18-19 July 2017, Monterey, CA, USA

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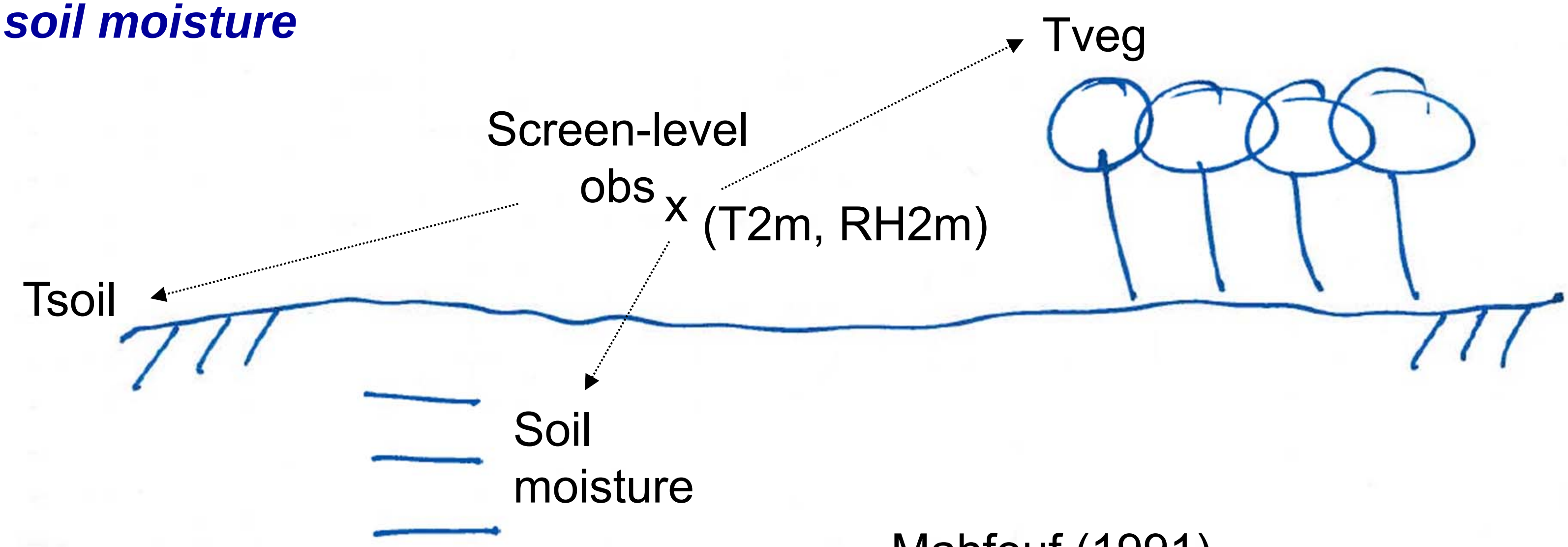
Land Data Assimilation for Numerical Weather Prediction (Now OP at ECCC)

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



Mahfouf (1991)
Douville et al. (2000)
Belair et al. (2003)

(case with no snow)

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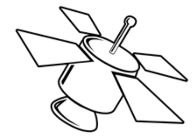
Land Data Assimilation for Numerical Environmental Prediction (in development)

L-band (SMOS / SMAP) for soil moisture

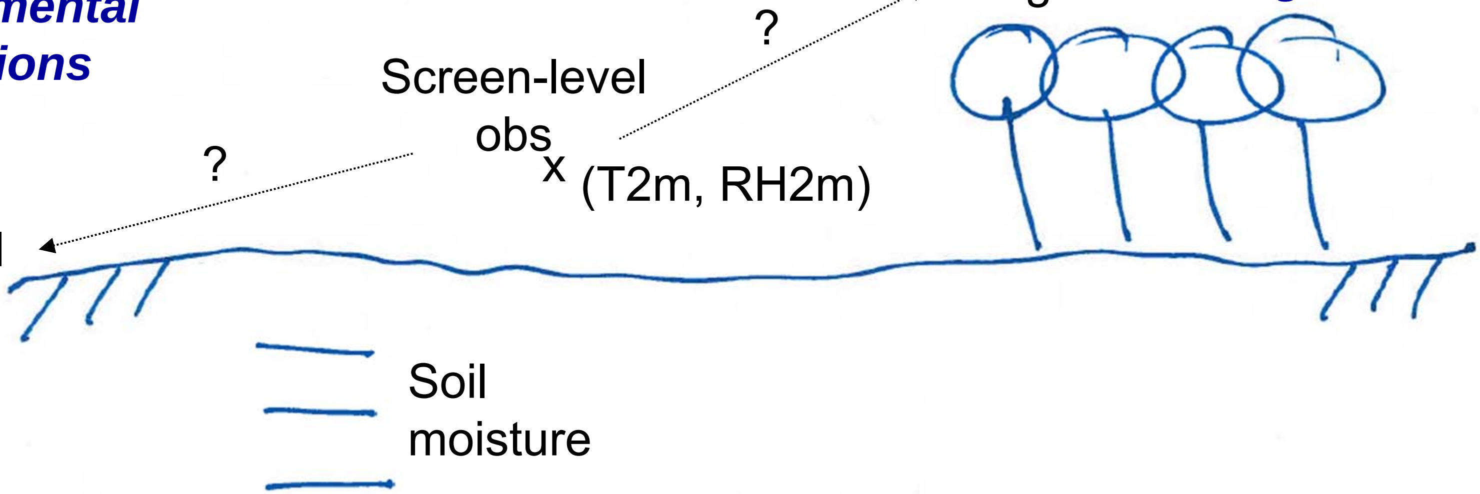
Use of space-based remote sensing data to enhance or replace near-surface observations



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



(case with no snow)

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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.*

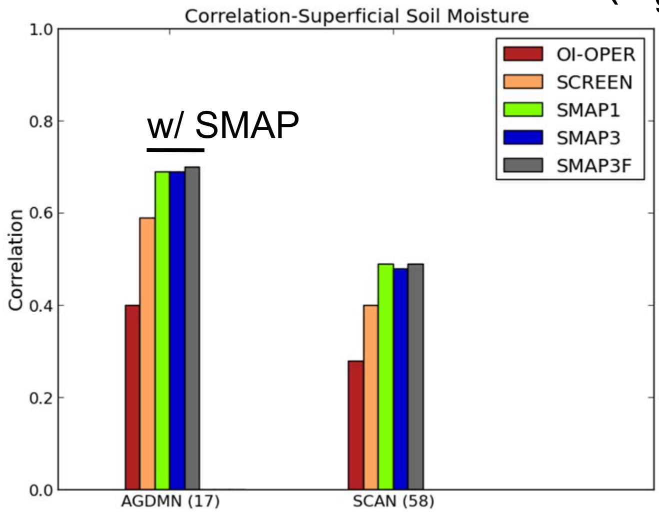
But, has to have a positive impact on numerical weather prediction (first / host client)

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

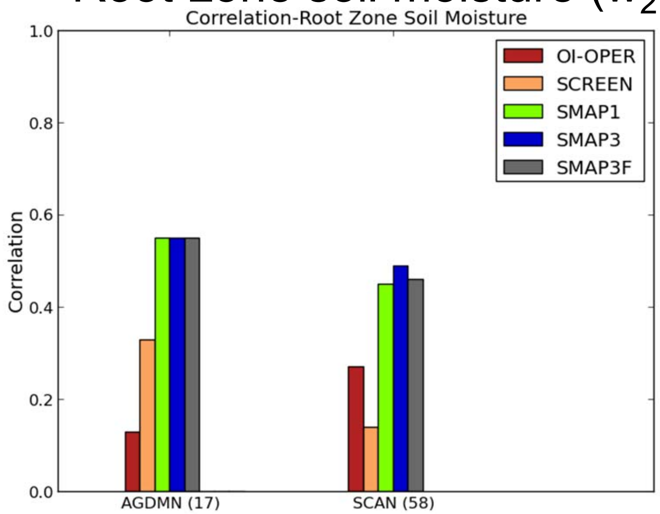
Weakly coupled with upper-air data assimilation systems (i.e., surface has its own operational process).

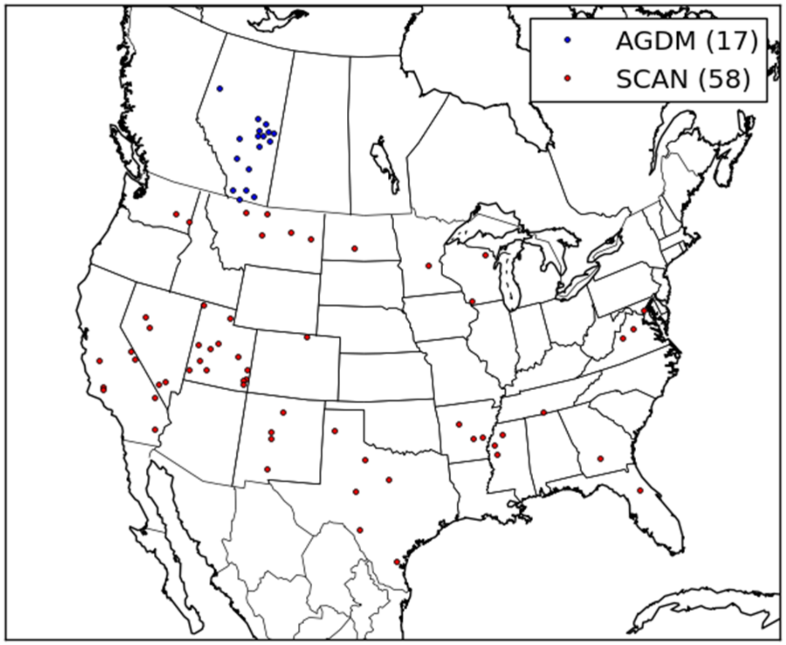
Impact of SMAP on Soil Moisture (corr)

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

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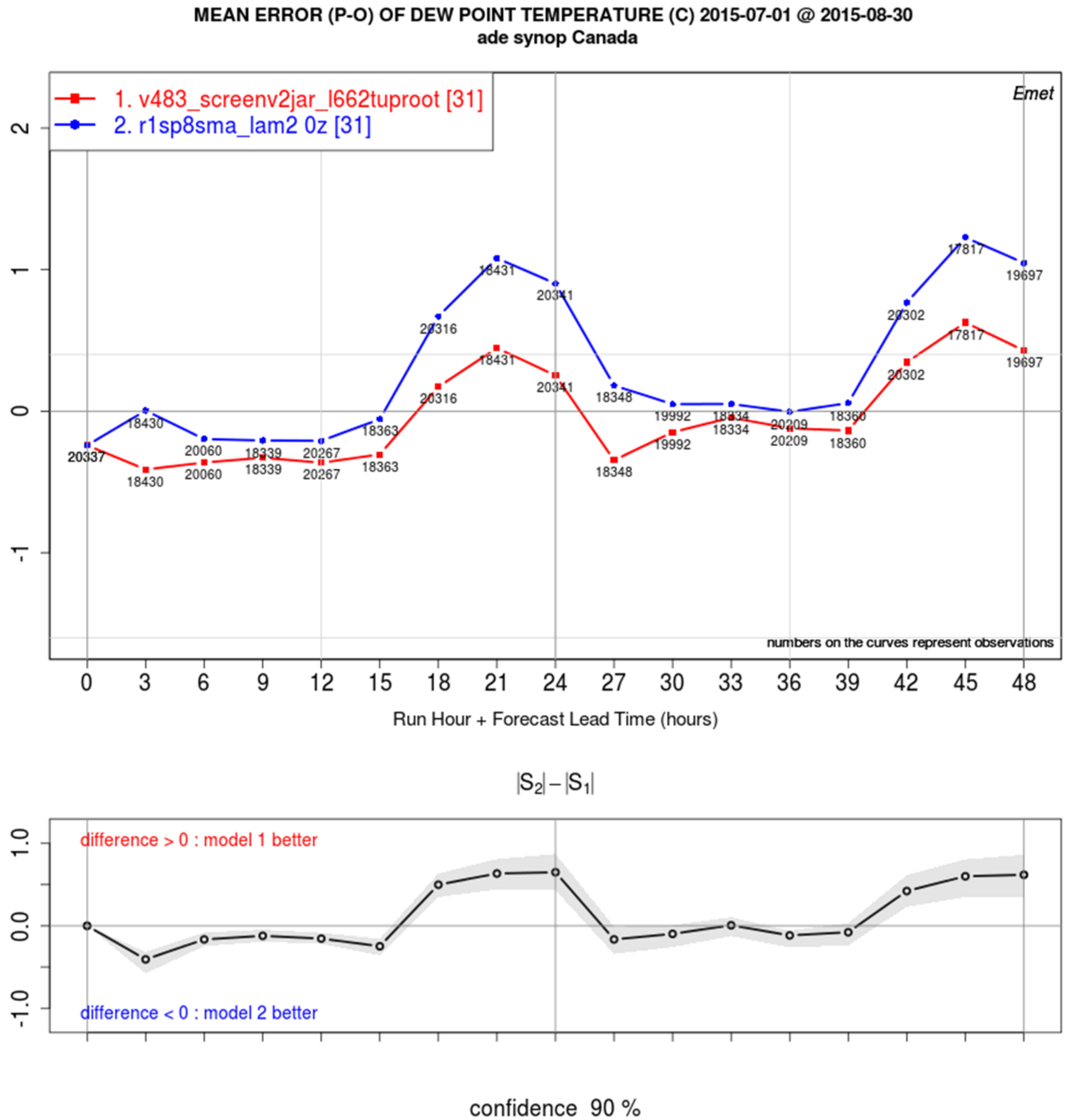
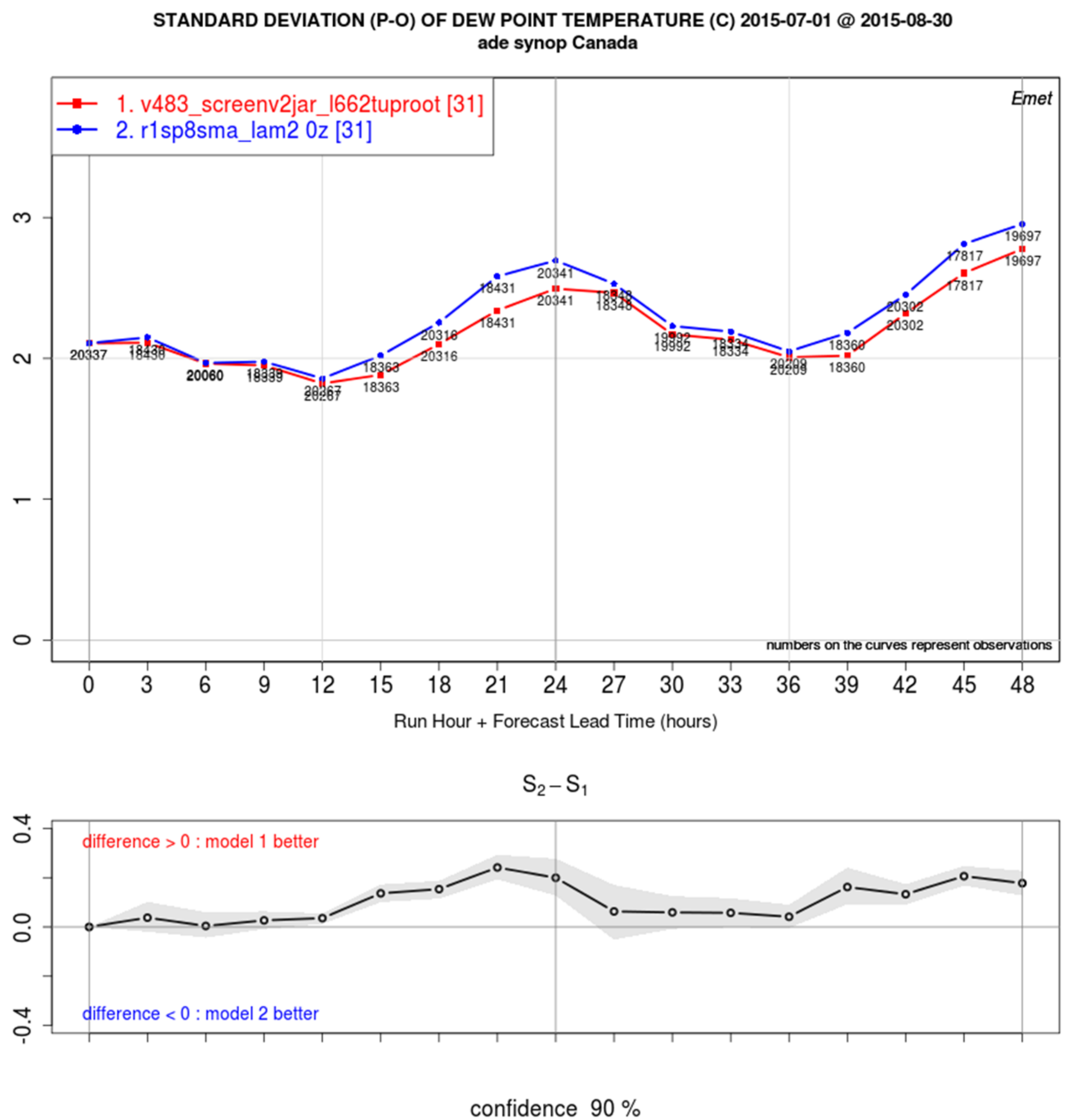
Soil Moisture Analyses with CaLDAS-SMAP
Dew point temperature – bias - Canada



CaLDAS-SMAP
CaLDAS-screen

Soil Moisture Analyses with CaLDAS-SMAP
Dew point temperature – STDE - Canada



CaLDAS-SMAP
CaLDAS-screen

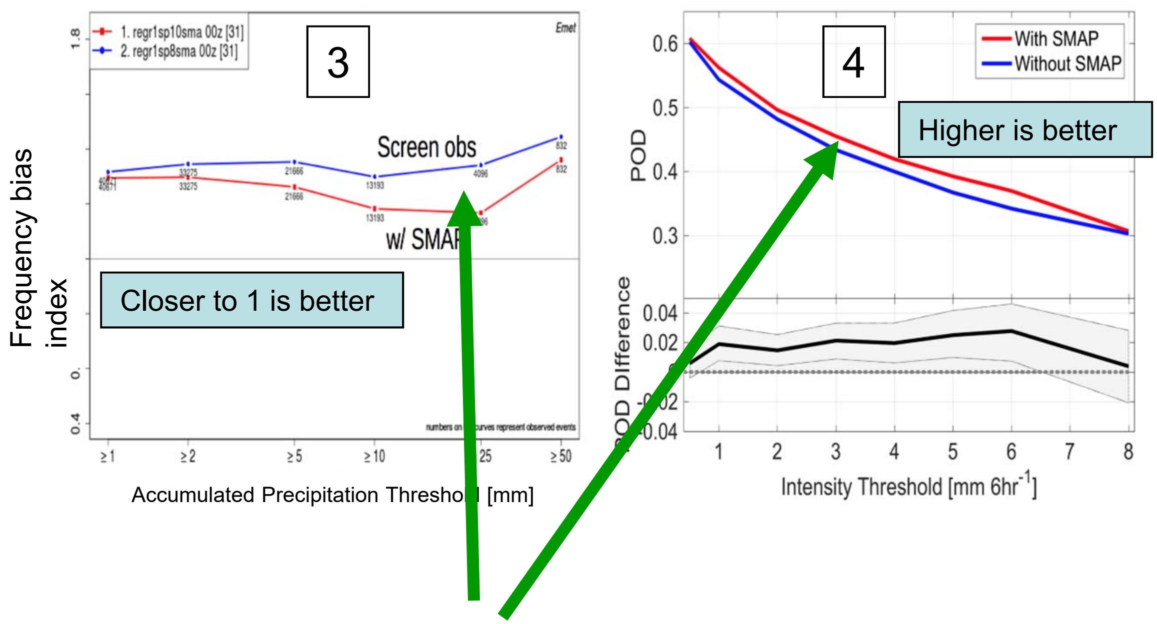
Optimizing Impact of SMAP for Weather Prediction in North America

SMAP Early Adopter: Environment and Climate Change Canada, Stephane Belair, Marco Carrera

Environment Canada

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.

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.

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.

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In addition to SMAP and SMOS…

Assimilate more space-based observations in CaLDAS for surface temperature and snow

e.g., surface temperature from geostationary IR (GOES, MSG, Himawari); snow from passive and active microwave

Better characterization of the land surface

(soils and LU/LC databases, satellite-based information for vegetation – roughness, fractional coverage, albedo, emissivity, LAI)

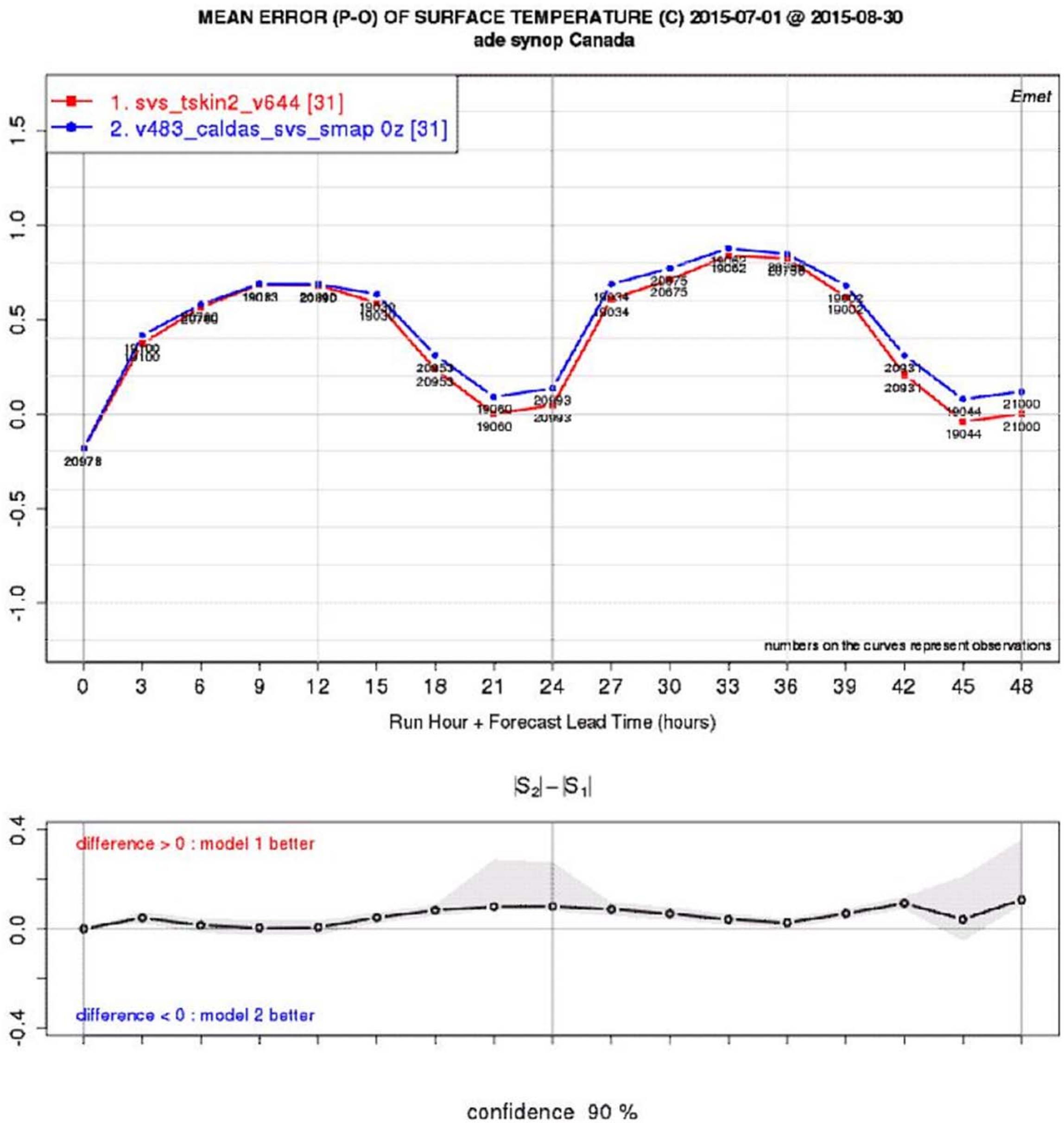
Better land surface modeling

New land surface scheme SVS Including photosynthesis; add TEB scheme for urban areas (km-scale and better)

Vegetation modeling and assimilation

Terrestrial ecosystem model for long-range forecasts

Assimilating Retrieved Tskin from GOES Impact on T2m forecasts (bias)



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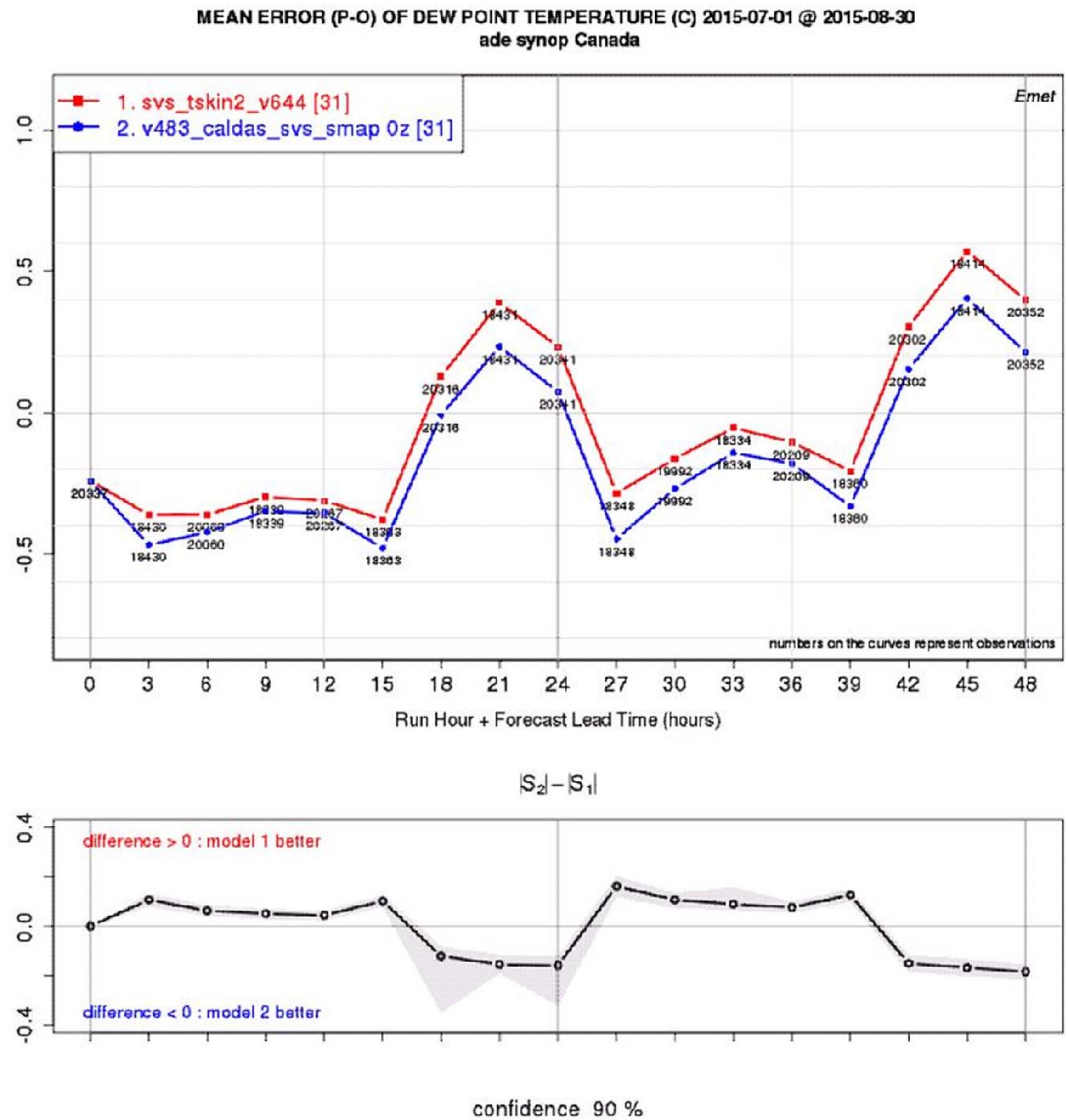
Assimilating Retrieved Tskin from GOES Impact on TD2m forecasts (bias)



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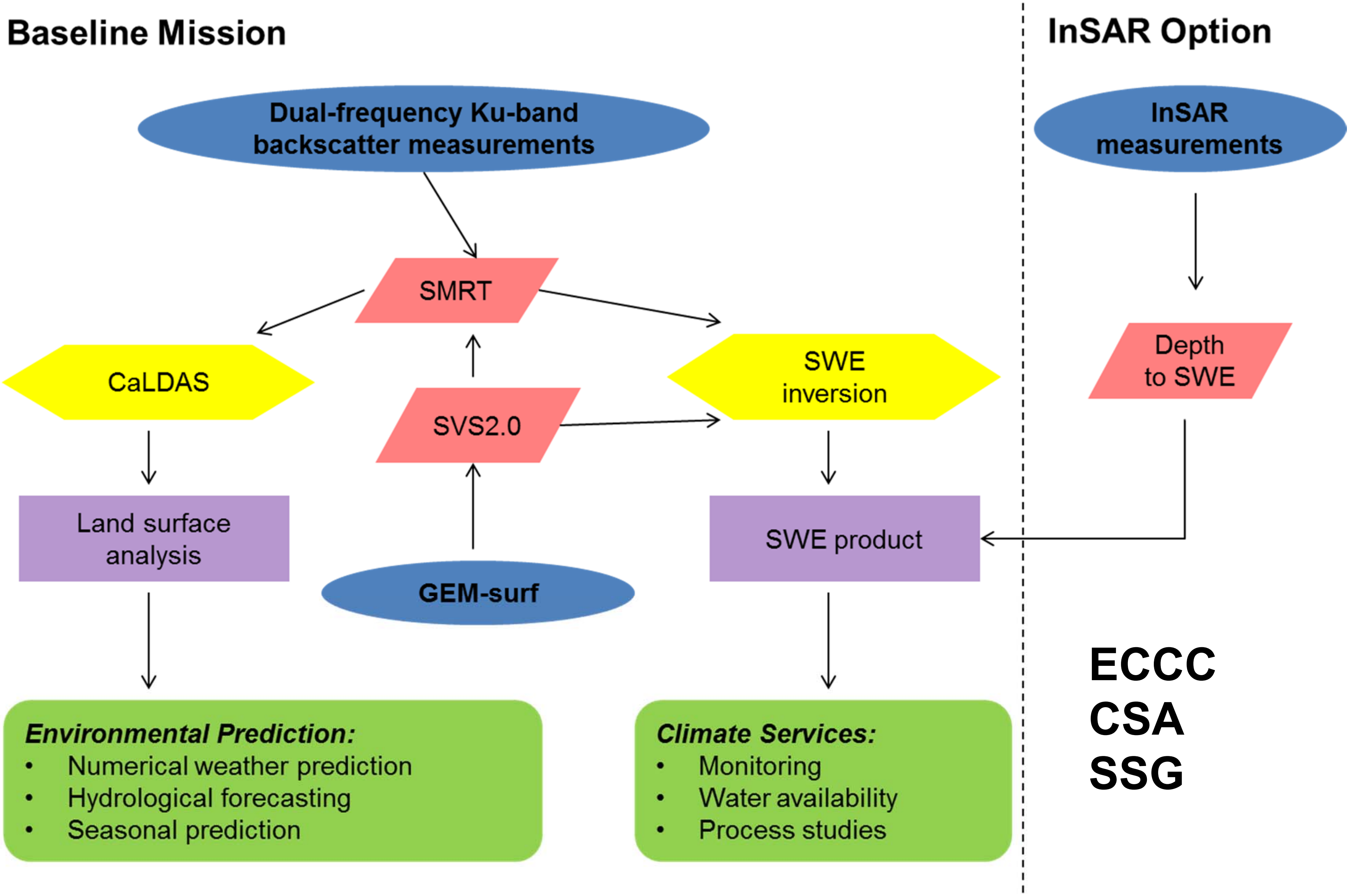
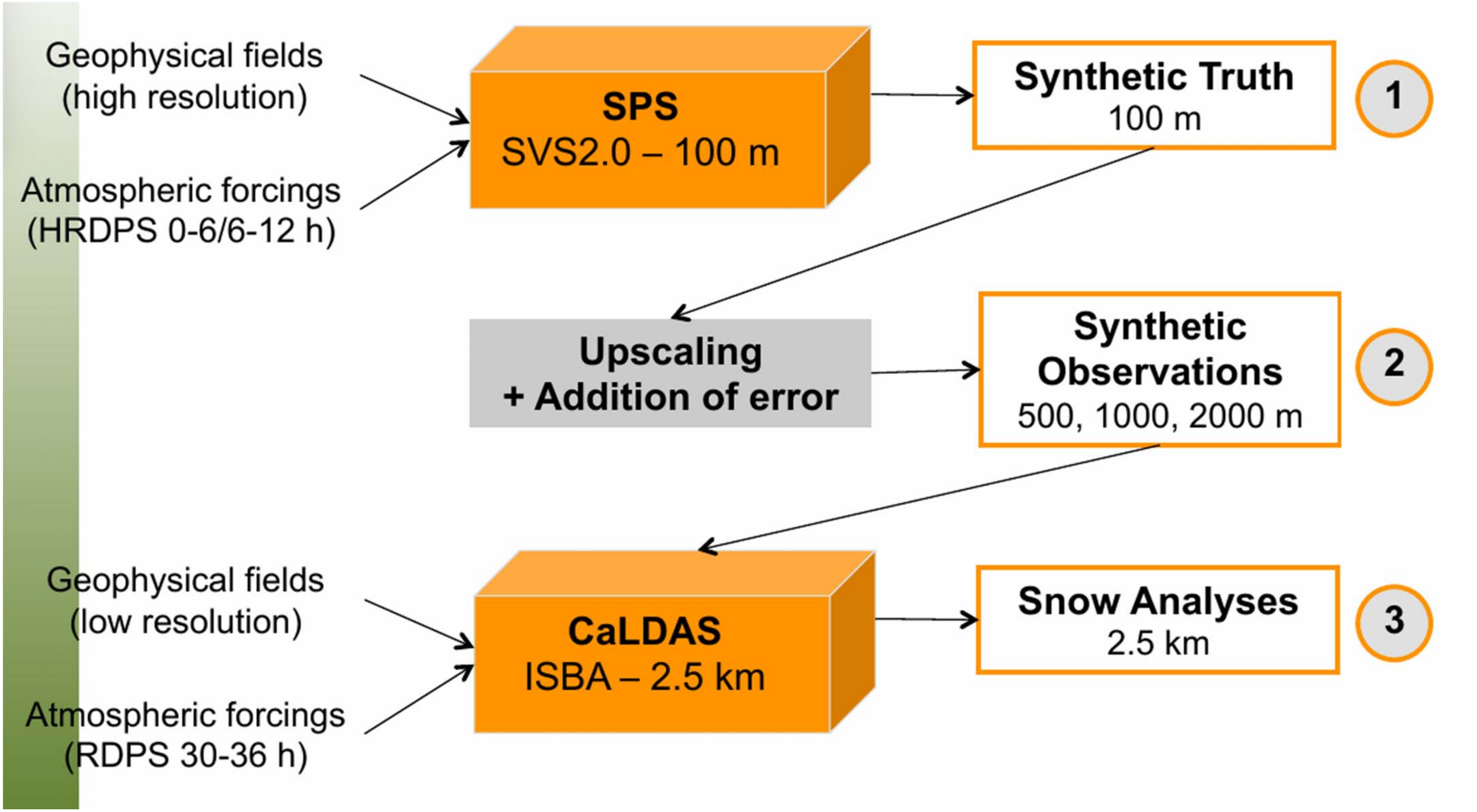
New snow mission concept



OSSE for new snow mission concept



(Garnaud et al., in preparation)

One of the OSSE's main results

Maps of temporal RMSE (SWE mm)

T vs G (threshold Vs goal accuracies)

2d vs 3d vs 4d revisit

500m vs 1000m vs 2000m grid spacing

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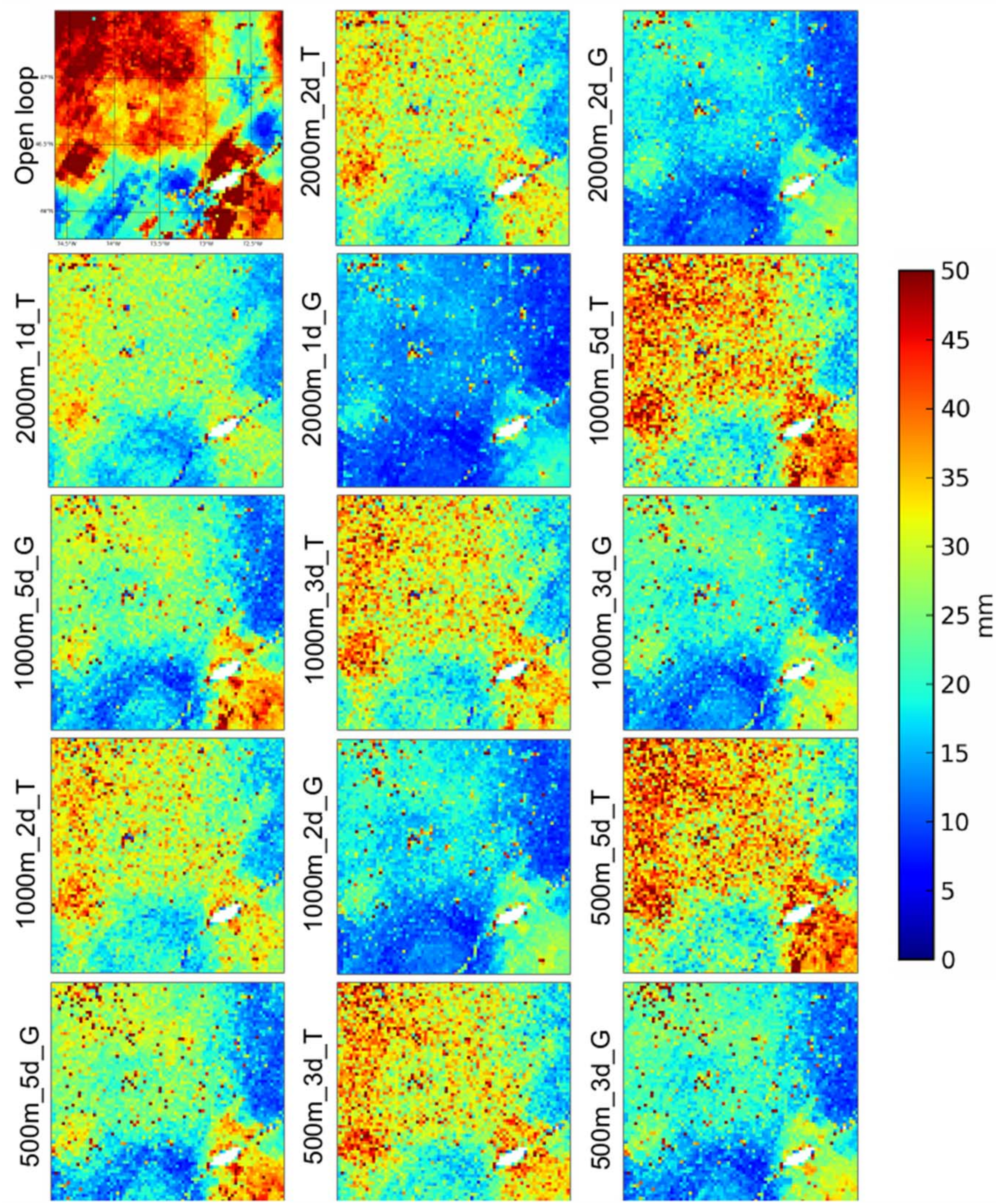

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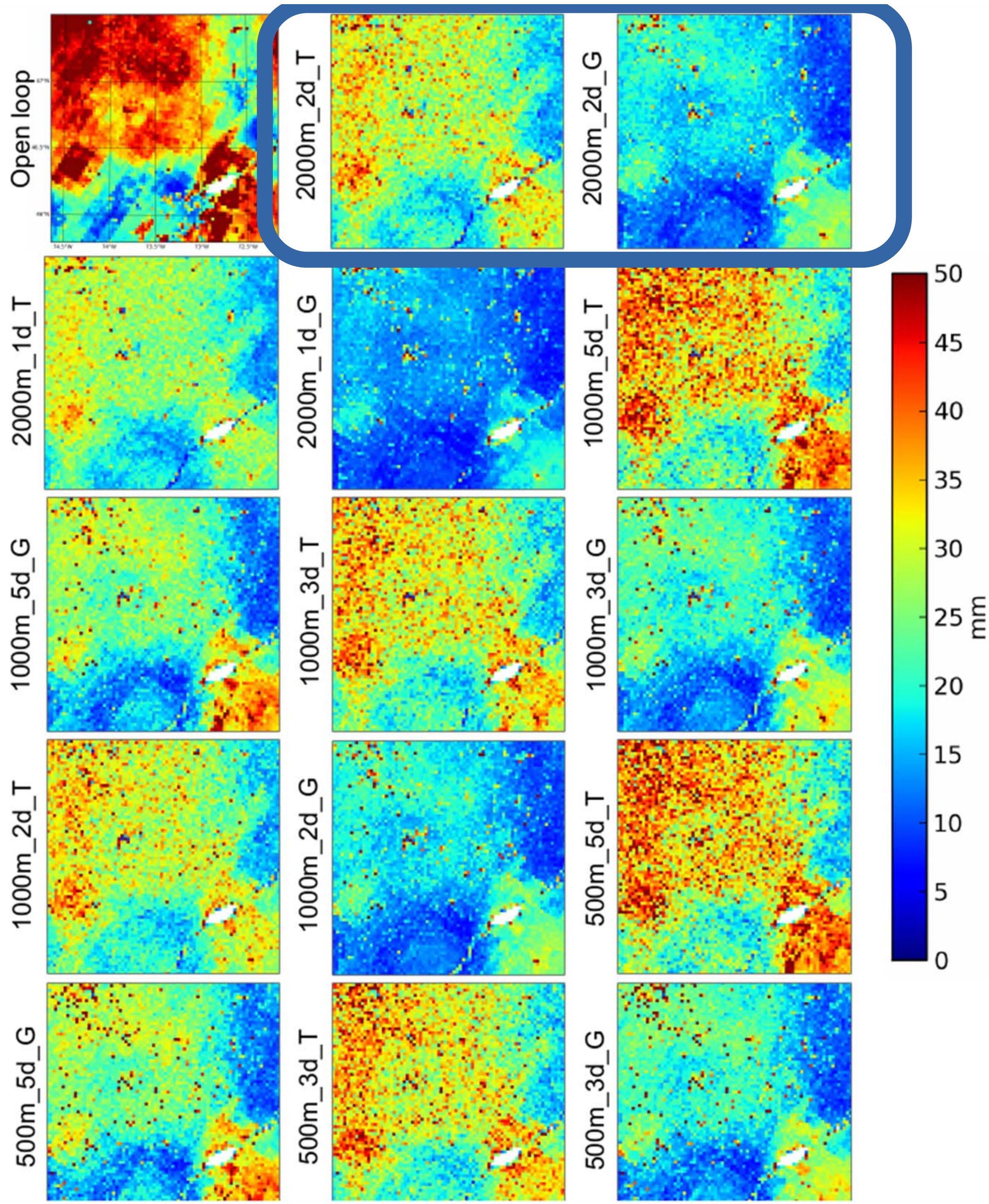

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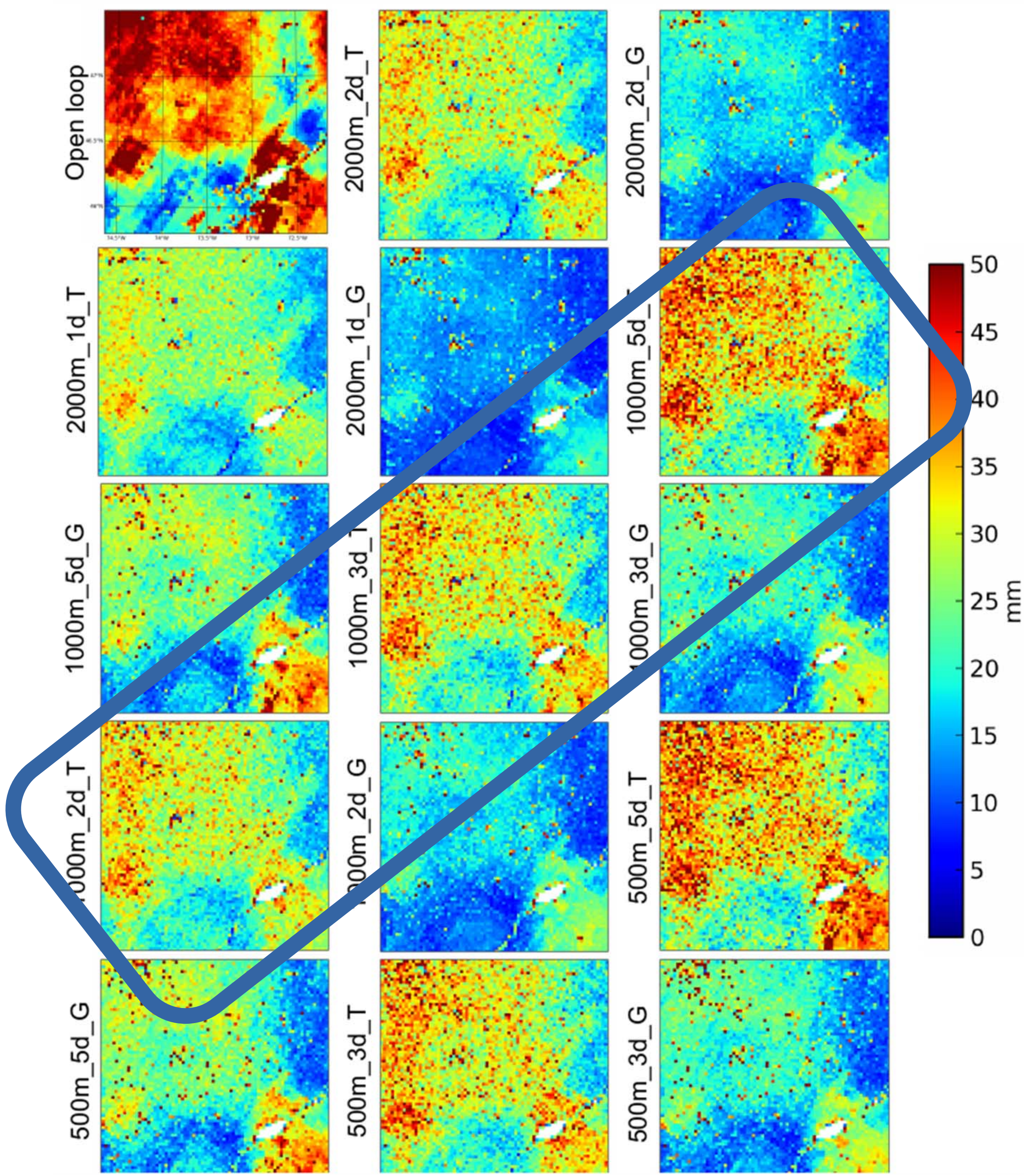

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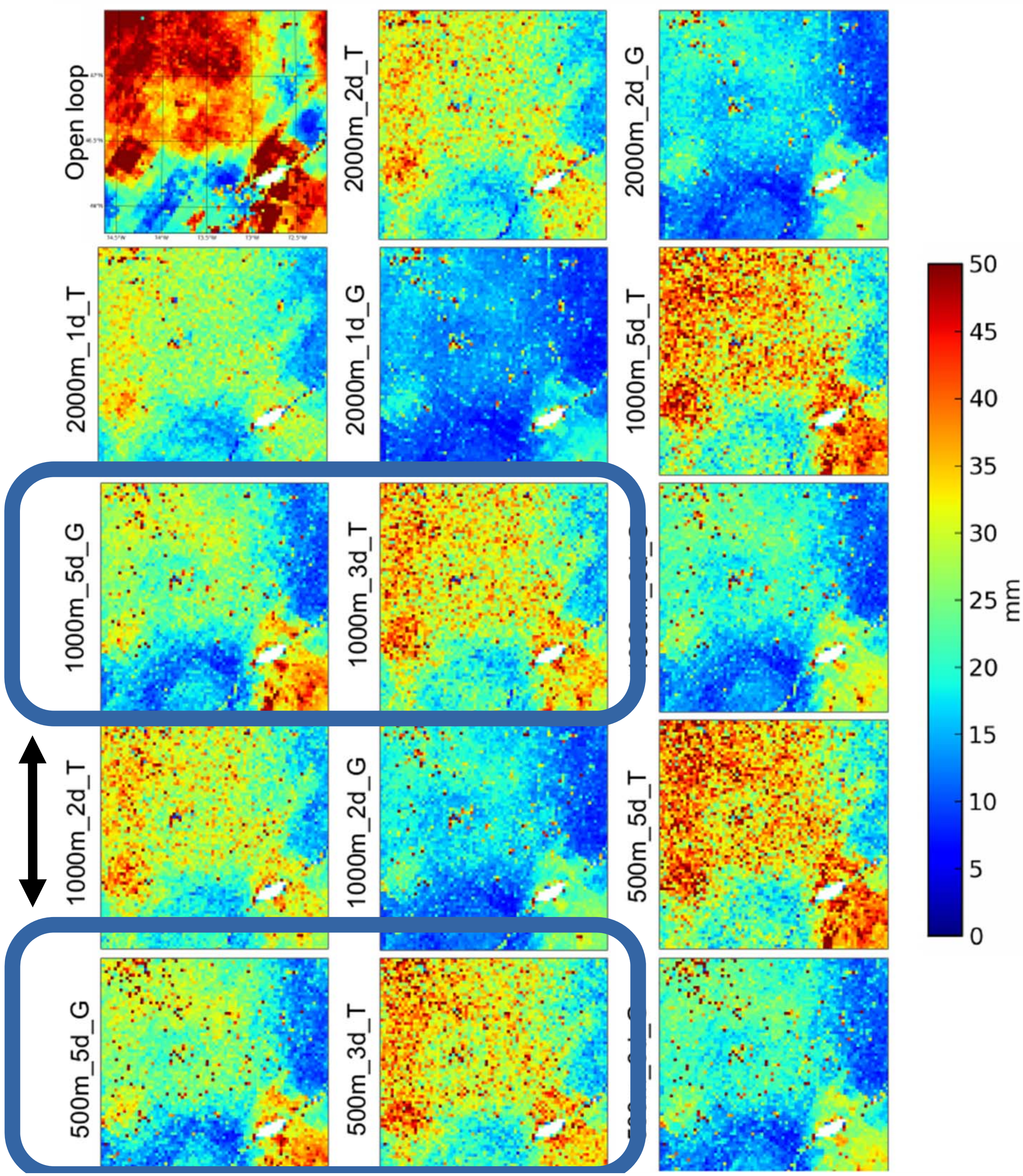

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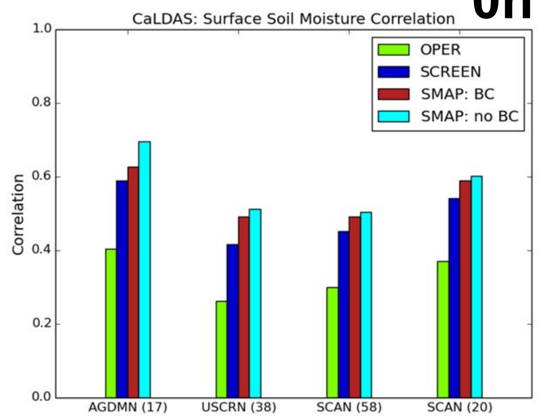
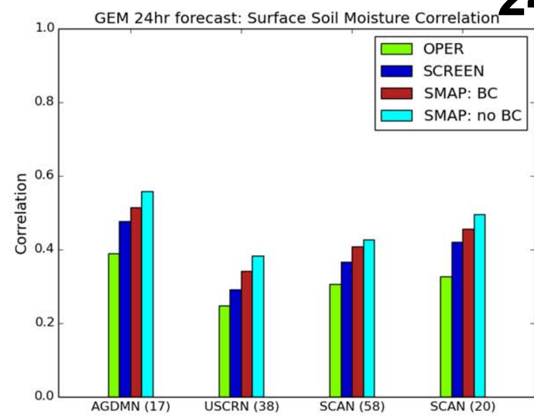
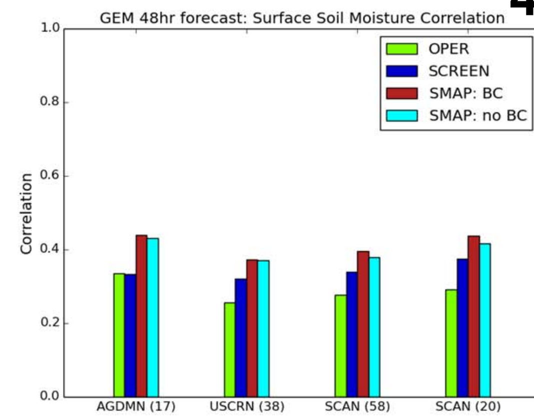
Evaluation of soil moisture forecast
Sparse networks, correlation

0h | 24h | 48h

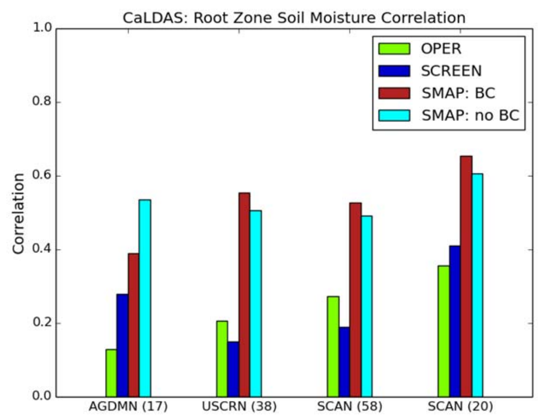
w_g

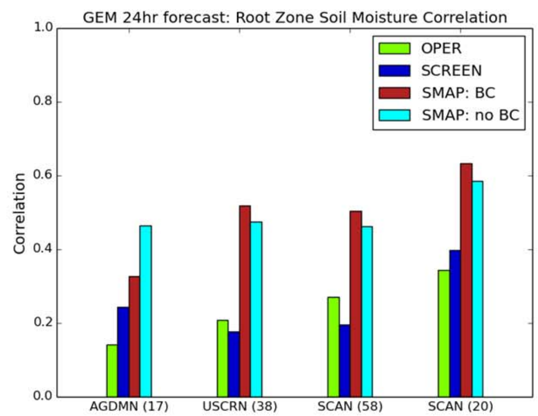


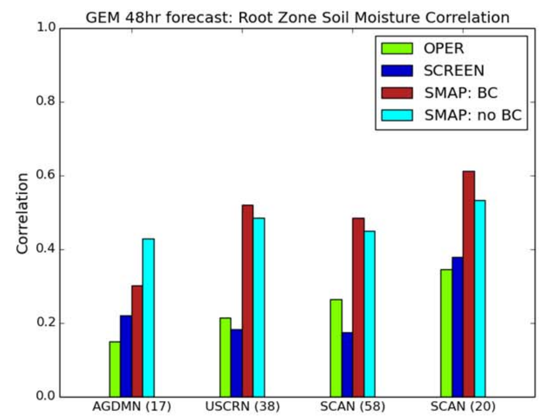




w_2







July and August 2015
North America

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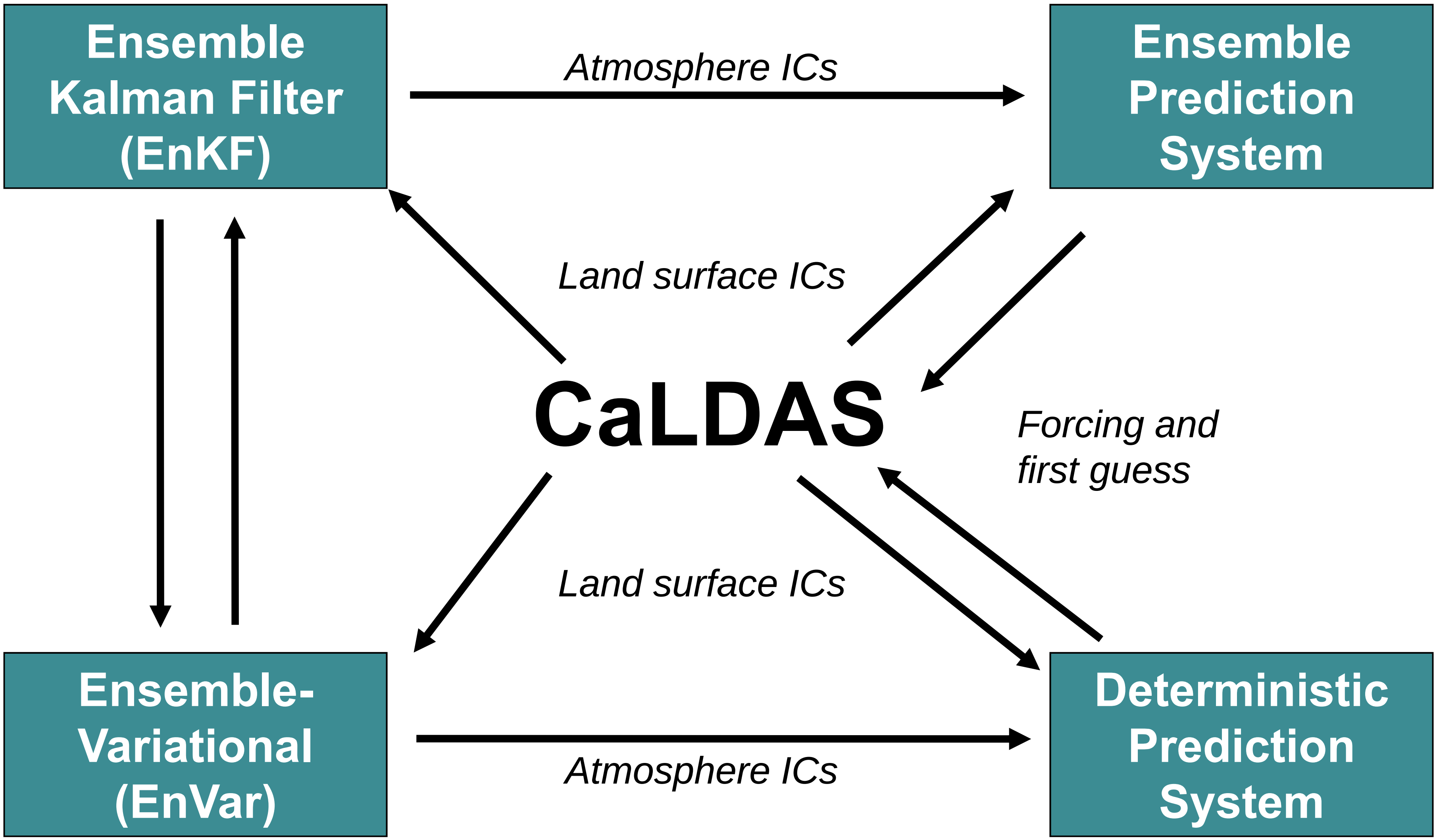
Coupling with atmospheric DA … or CaLDAS viewed as a "system", not a "module"



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Why we like modularity, flexibility, in contrast with complete integration...

Allow us to run the land surface data assimilation without needing to have...

- *same domain*
- *same resolution*
- *same time step*
- *same latency*
- *same assimilation approach*

… as the atmospheric assimilation systems

Also the question that the land data assimilation can be coupled with several upper-air assimilation systems at the same time (e.g., deterministic vs ensemble).

Are we there yet?

Finally able to beat the operational "screen" assimilation system

Still need to go global

Still need to investigate better coupling with atmospheric ensemble assimilation systems

Operational implementations expected for 2017 and 2018 (but who knows… the transfer process has become so slow these days, due to all the interdepencies)