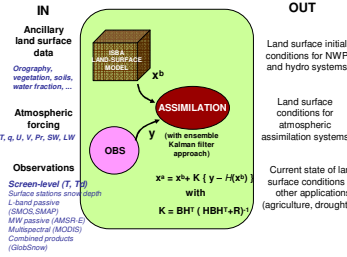


Assimilation of Screen-Level Observations in the Canadian Land Data Assimilation System

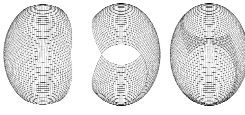
Bernard Bilodeau¹, Marco L. Carrera¹, Sarah Dyck², Nathalie Gauthier²,
 Maria Abrahamowicz² and Stéphane Bélair¹
¹Meteorological Research Division, Environment Canada
²Canadian Meteorological Centre

CaLDAS in a nutshell

- The Canadian Land Data Assimilation System (CaLDAS) aims at improving the land surface modeling in environmental prediction systems
- The high efficiency of the offline modeling system allows the use of the Ensemble Kalman Filter (EnKF) technique
- The goal of the current project is to replace the current operational pseudo-analysis of soil moisture and soil temperature
- Instead of statistically correcting soil moisture and soil temperature based on screen level forecast errors, the EnKF does so dynamically

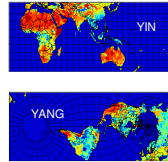


Configuration of the system



YIN-YANG computational grids

- Global coverage
- Yin and Yang independent grids, with minimal overlap
- 901x301 grid points for each grid
- 0.3° resolution
- Global analysis is recomposed by interpolation



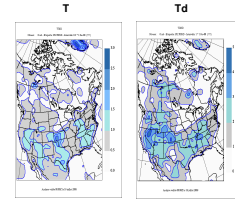
- Global domain, 33 km for Global Deterministic Prediction System (GDPS)
- Observations: ensemble of screen-level temperature and dewpoint temperature analyses, generated by Optimal Interpolation
- Control variables: deep soil moisture (w_2) and temperature (T_2)
- 24 members
- Each member produces a snow depth analysis using Optimal Interpolation
- Assimilation step: 3 hours
- From April 2008 to February 2009

Perturbations to the ensemble members

- Precipitation forcing: an ensemble of CaPA precipitation analyses is obtained by perturbing observations and by adding a random phase shift to the first guess (which is also applied to the radiative forcing).
- Temperature (T) and dewpoint temperature (T_d) innovations are randomly perturbed (constant value for whole domain).
- Soil moisture and soil temperature analyses are randomly perturbed (again with constant value).
- These perturbed forcing, innovations and analyses generate the ensemble spread.

Observation error

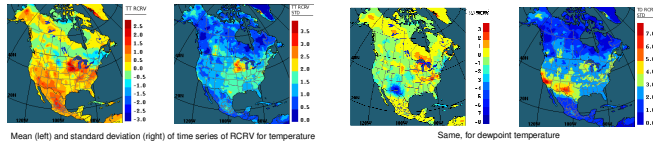
- Taken from the spread of the ensemble of screen level analyses
- Example shown for 00 UTC 18 July 2008



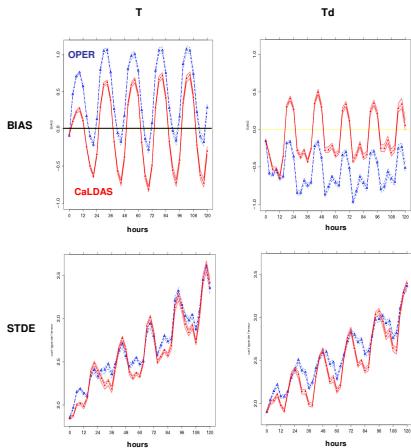
Some diagnostics of the system

- For a perfectly representative ensemble, the Reduced Centered Random Variable (RCRV) will have a standard normal distribution $N(0,1)$.
- $$RCRV = \frac{O - H(x)}{\sqrt{\text{var}(O) + \text{var}(H(x))}}$$
- The RCRV can be thought of as the mean innovation normalized by its expected variance.

Cordillat, G., C. Chik, P.L. Huskauer and G. Pellerin, 2007: Verification of an Ensemble Prediction System against Observations. *WEA*, 135, 2688-2699.

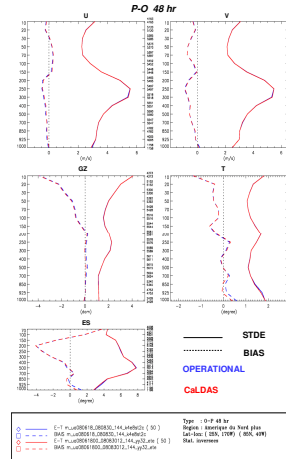


Surface scores over Canada



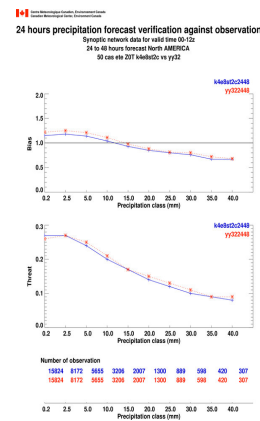
Impact of CaLDAS soil moisture and soil temperature analyses on screen-level forecasts scores (0-120h) of temperature (left) and dewpoint temperature (right) produced by the GDPS for summer 2008 (25 runs starting at 00 UTC). Operational in blue, CaLDAS in red. Warm and dry biases are reduced, and nighttime errors are smaller.

Upper air scores over North America



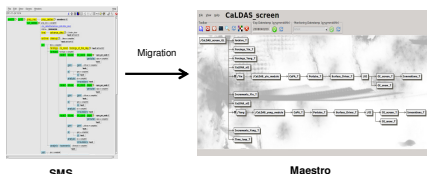
Impact of CaLDAS soil moisture and soil temperature analyses on upper air 48-hour forecasts produced by the GEM global model for summer 2008 (25 runs starting at 00 UTC). Scores show cooler and wetter forecasts are generated with CaLDAS analyses from surface up to 700 hPa.

Precipitation scores over North America



Impact of CaLDAS soil moisture and soil temperature analyses on precipitation bias and threat scores produced by the GDPS for summer 2008 (25 runs starting at 00 UTC). Verified against synoptic stations.

Sequencing



The CaLDAS site is being converted from SMS to the new CMC operational sequencer, Maestro, in preparation for the upcoming implementation to CMC operations (2013).

Coupling with the Global Deterministic Prediction System

- CaLDAS is being coupled with the atmospheric En-Var data assimilation system
- Experiments at intermediate 25-km resolution on global uniform lat- lon grid will soon be conducted for year 2011
- En-Var will provide forcings every hour
- In return, CaLDAS will generate w_2 , T_2 and snow depth analyses every 3 hours
- The system will be two-way coupled, as opposed to the one-way coupling tests results shown here
- Final tests (early 2013) to be done on 15-km Yin-Yang global grid