CEOP Activities in Canada with a New High-Resolution Model for Global Medium-Range Weather Forecasting

Stéphane Bélair
Meteorological Service of Canada
Environment Canada

Environnement Canada

Main Features of the Next Canadian Medium-Range Weather Forecast Model

- **Global Environmental Multiscale (GEM) model**
- **Increased horizontal and vertical resolution**
    - *800x600x58L (33 km) compared to 400x200x28L (100 km)*
- **Numerical poles at geographic locations**
- **Representation of clouds and precipitation**
    - *Shallow convection with Kuo Transient*
    - *Deep convection with Kain-Fritsch*
    - *Modified Sundqvist scheme for grid-scale condensation*
- **Bougeault-Lacarrère for the turbulent mixing length**
- **ISBA land surface scheme with sequential assimilation of soil moisture (based on OI)**

This system is in the process of being transfered to the Canadian Meteorological Centre's operations – Should be fully operational by the end of June 2006

Optimum Interpolation Land Surface Analysis (Operational at CMC)

Optimum Interpolation of T_{2m} and RH_{2m} using SYNOP observations interpolated at the model grid-point (by a 2m analysis)

$$\Delta T_{2m} = T_{2m}^{a} - T_{2m}^{f} \qquad \Delta RH_{2m} = RH_{2m}^{a} - RH_{2m}^{f}$$

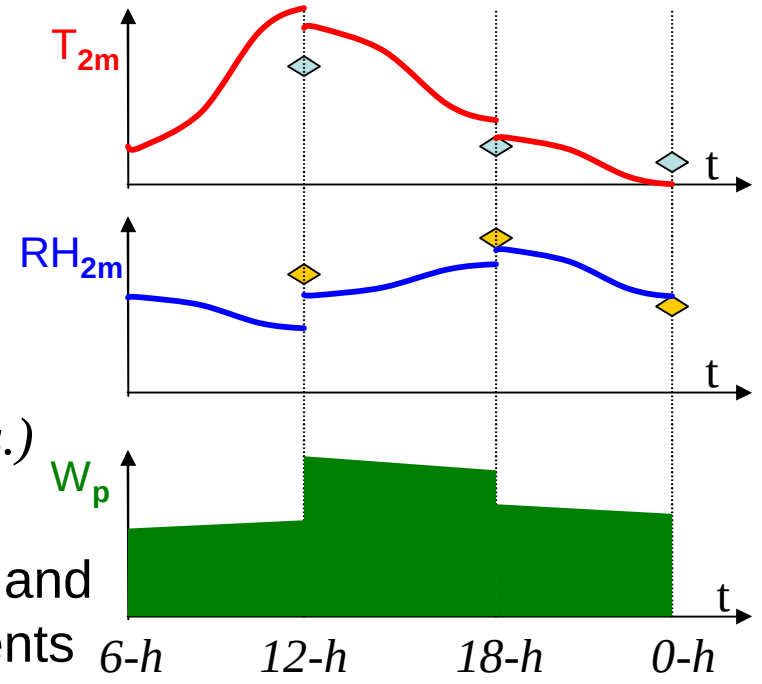
Correction of surface parameters (T_s, T_p, W_s, W_p) using 2m increments between analysed and forecasted values

$$T_s^a - T_s^f = \Delta T_{2m}$$
$$T_p^a - T_p^f = \Delta T_{2m} / 2p$$
$$W_s^a - W_s^f = \alpha_{WsT} \Delta T_{2m} + \alpha_{WsRH} \Delta RH_{2m}$$
$$W_p^a - W_p^f = \alpha_{WpT} \Delta T_{2m} + \alpha_{WpRH} \Delta RH_{2m}$$

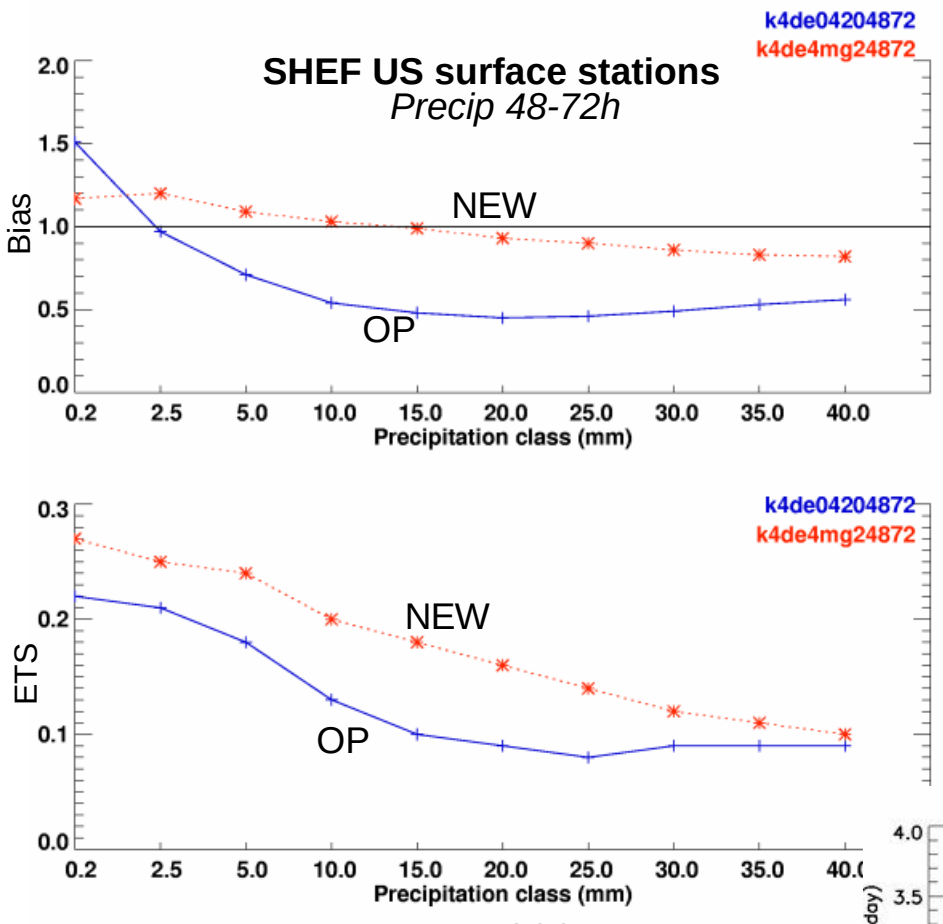
$\alpha_{Wp/sT/RH} = f\,(t, veg, LAI/Rs_{min}, texture, atm.cds.)$

Tuning of the OI statistics and regressions and accuracy of 2m analyses are key components

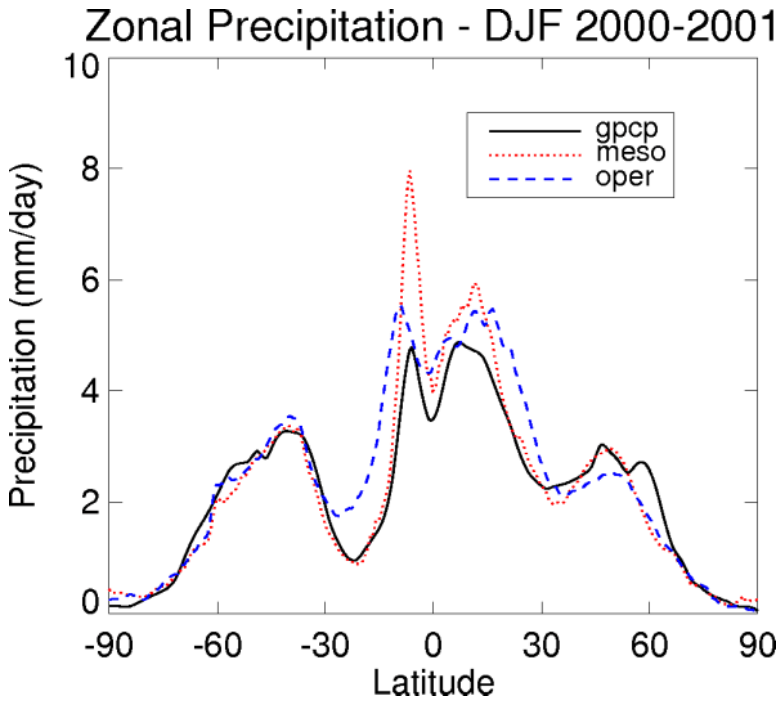
Sequential analysis (every 6h)

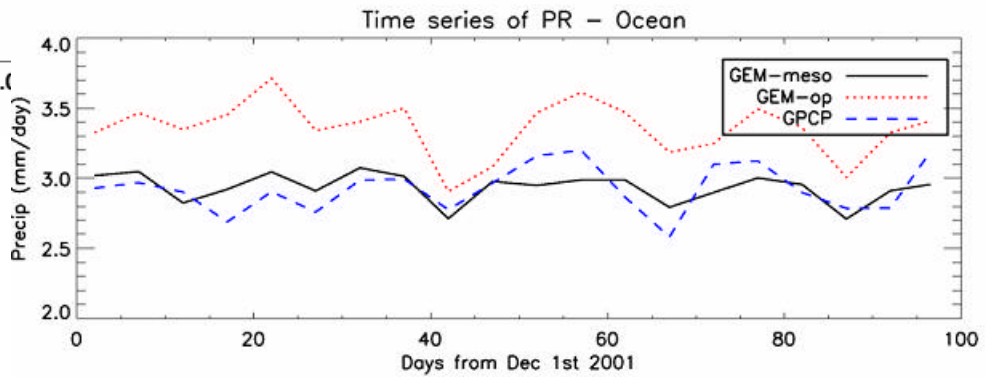


Objective Evaluation of Precipitation



55 summer 2004 cases





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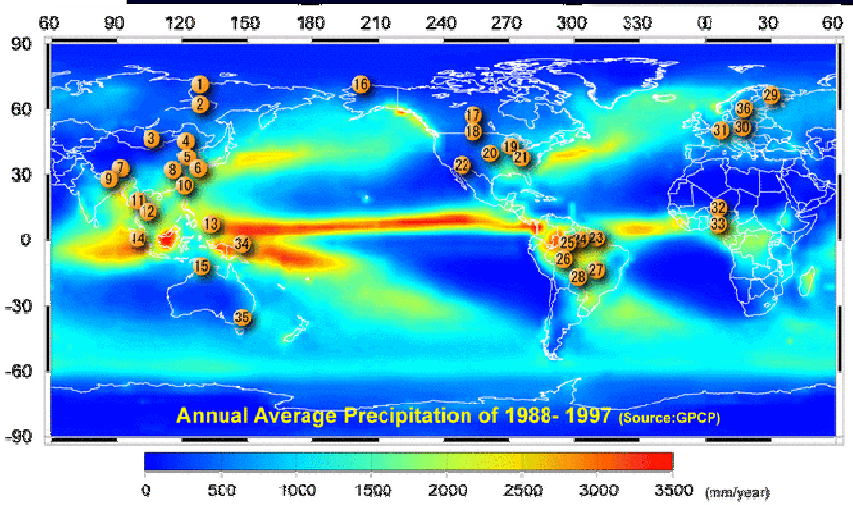
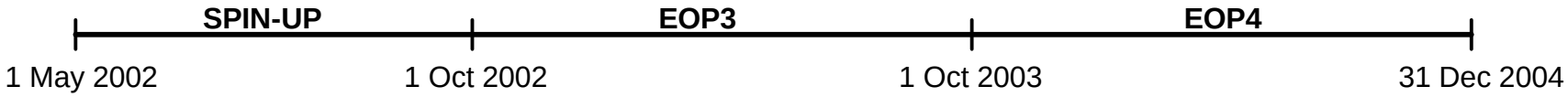
Coordinated Enhanced Observing Period (CEOP)



MSC's CEOP Experiment:
Based on the new mesoscale version of the Global Enrvironmental Multiscale (GEM) model that is currently being developed at MSC for medium-range weather forecasts

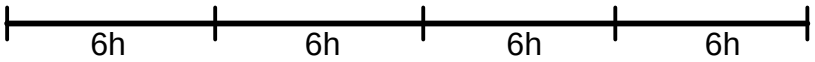
PERIOD of INTEGRATION:



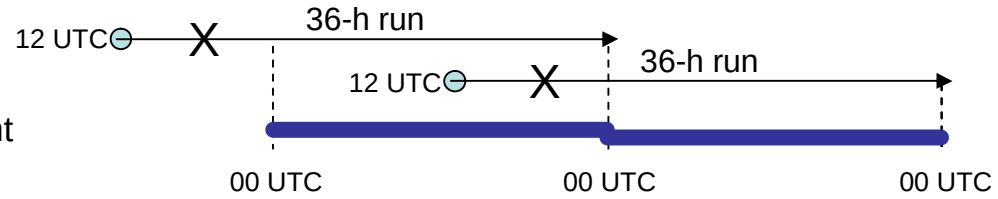
CYCLING and ASSIMILATION STRATEGY:

Upper-air component of the analyses is directly obtained from CMC's archive, i.e., no 4DVAR is performed for atmospheric observations

Surface component of the analyses is cycled from the previous 6-h forecast, with sequential assimilation of soil moisture, surface temperature, and snow



CONTINUOUS EVOLUTION of ATMOSPHERE and SURFACE:



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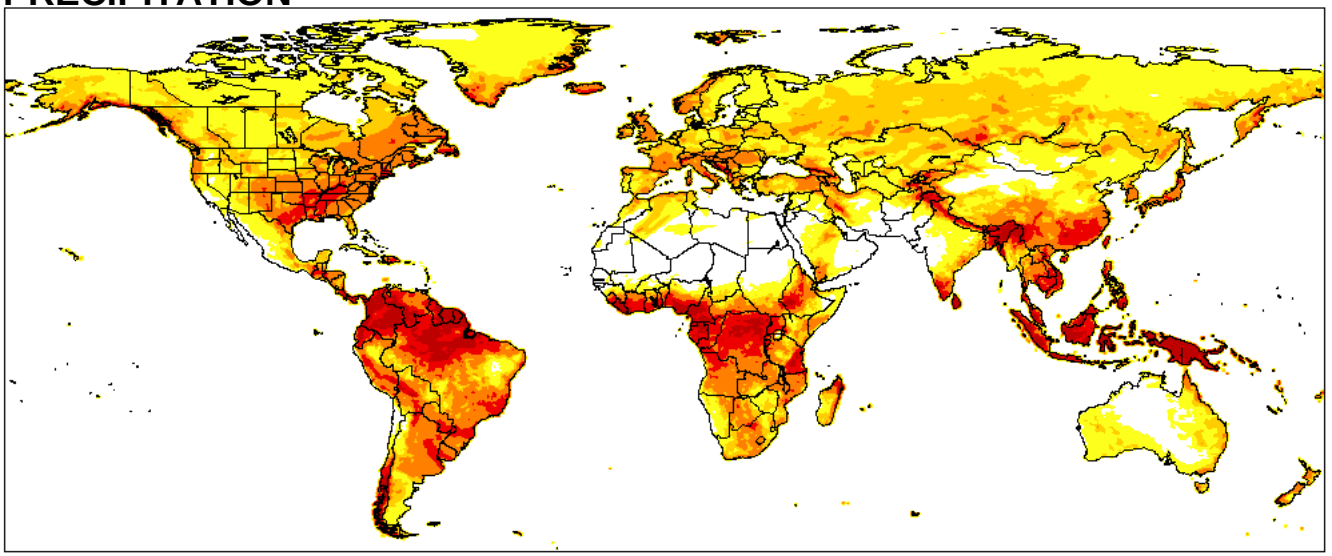
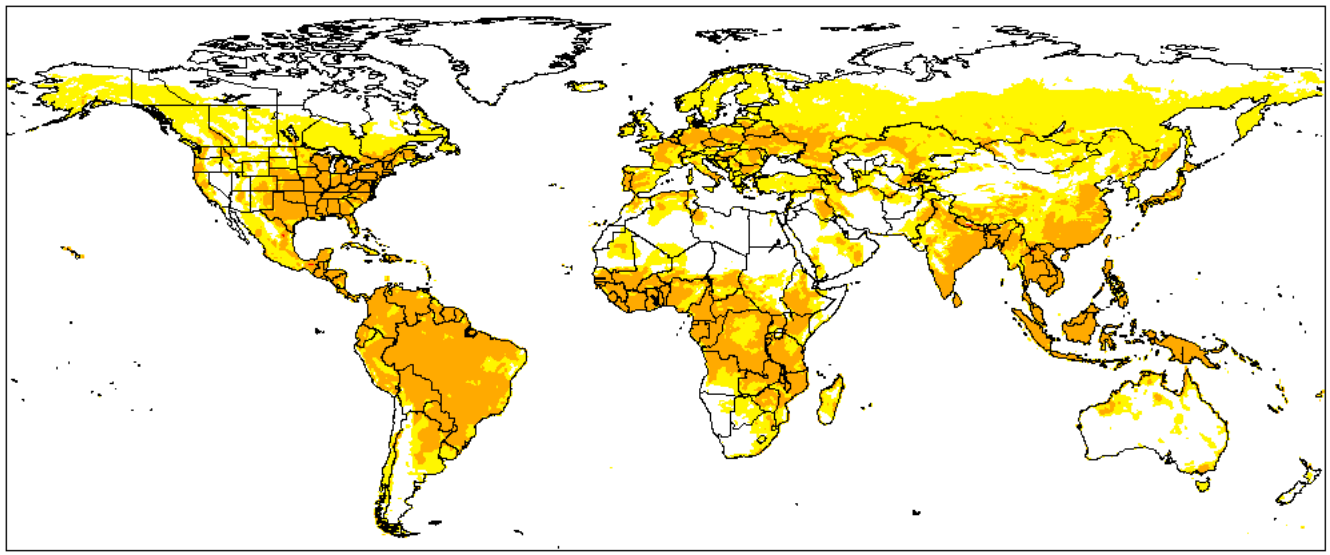
Precipitation and Evaporation – April 2004

PRECIPITATION



EVAPORATION

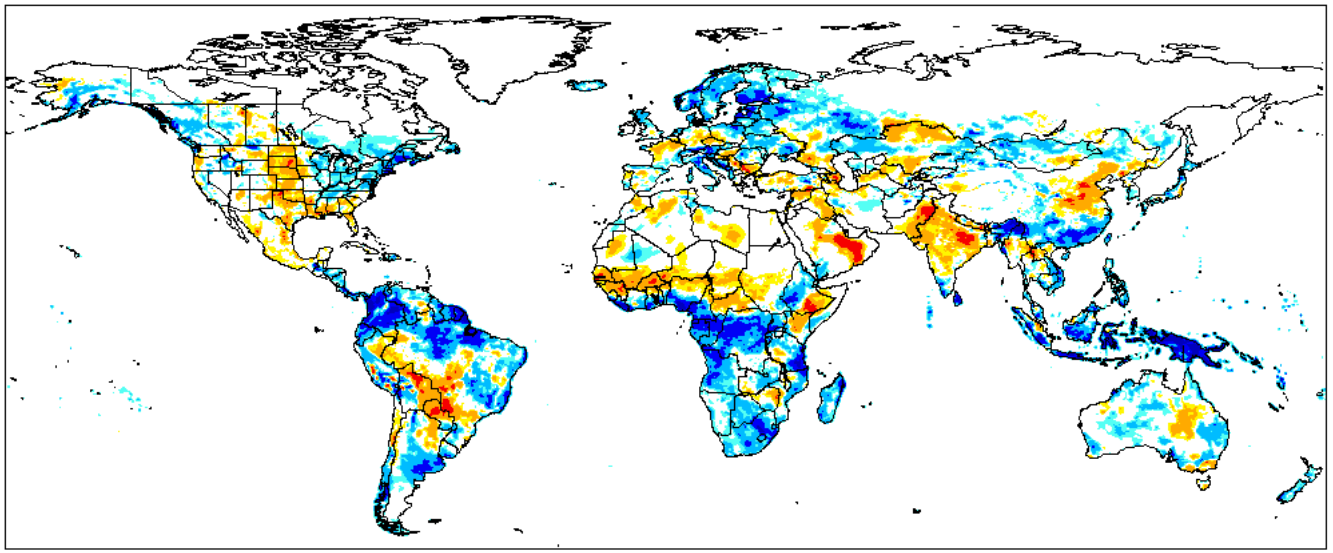


(kg $m^{-2}day^{-1}$)

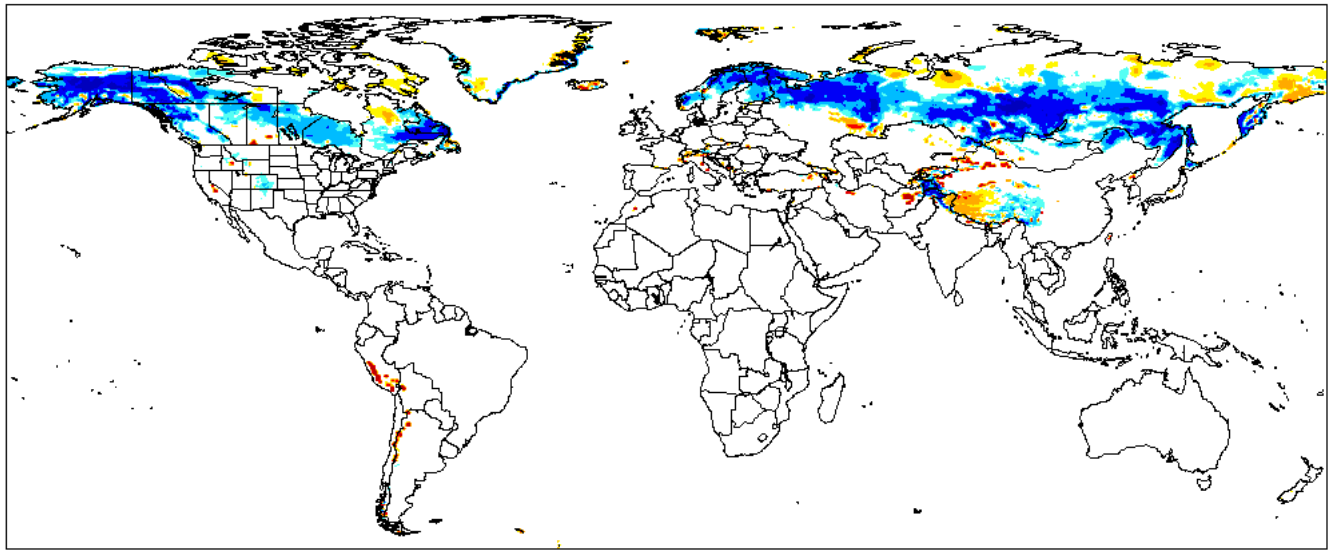
10
5
2
1
0.1
-0.1
-2
-5
-10

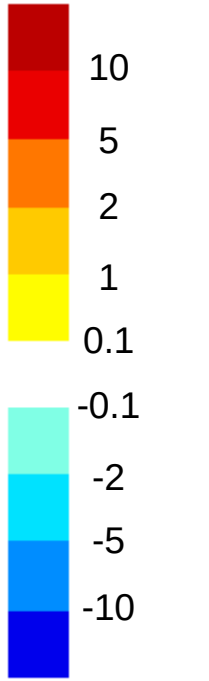
Assimilation Tendencies – April 2004

ASSIMILATION TENDENCIES for SOIL WATER



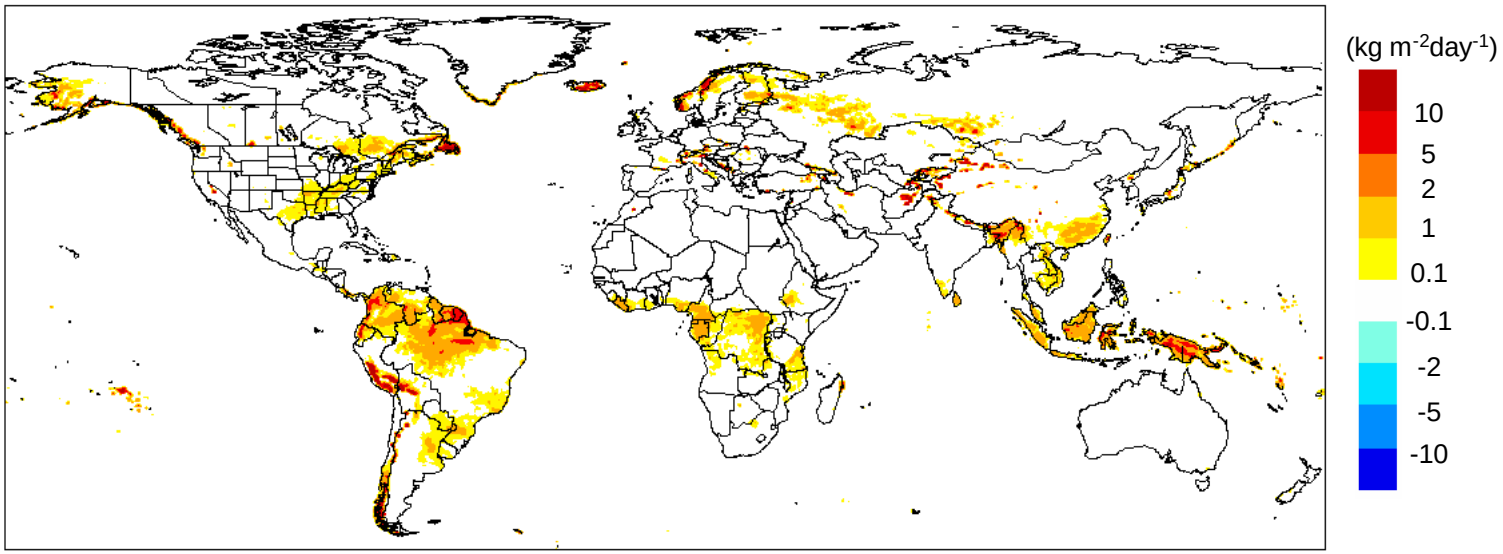
ASSIMILATION TENDENCIES for SNOW



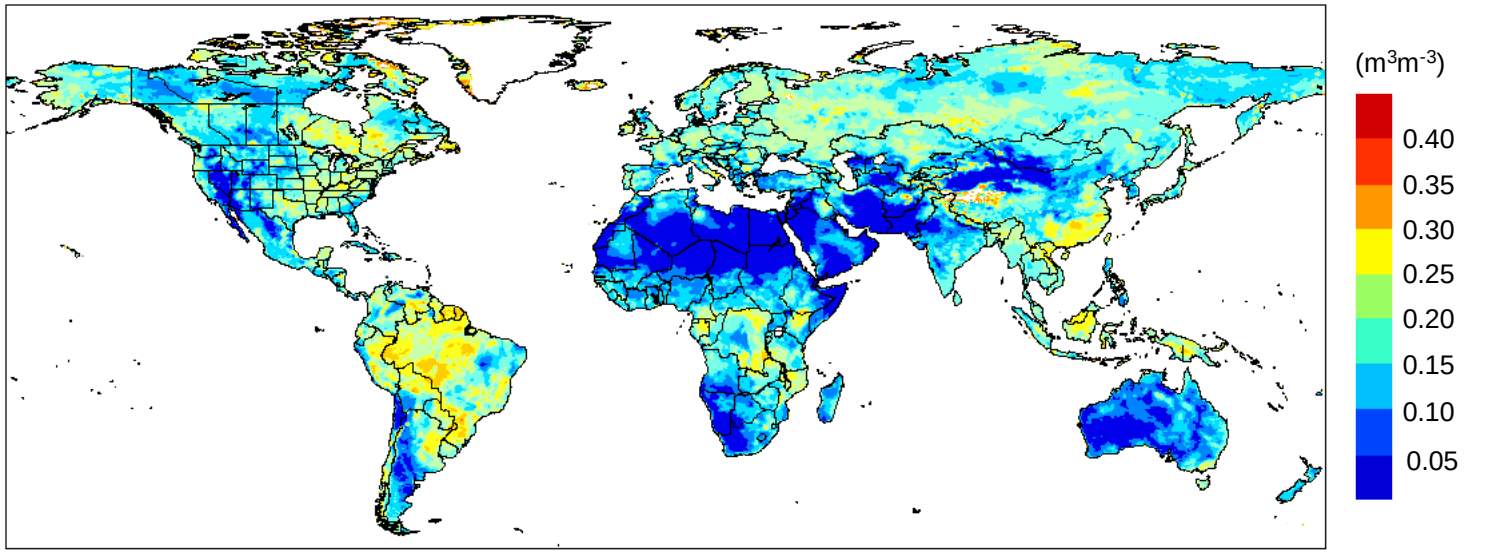


Soil Moisture and Runoff/Drainage – April 2004

RUNOFF and DRAINAGE



SOIL MOISTURE

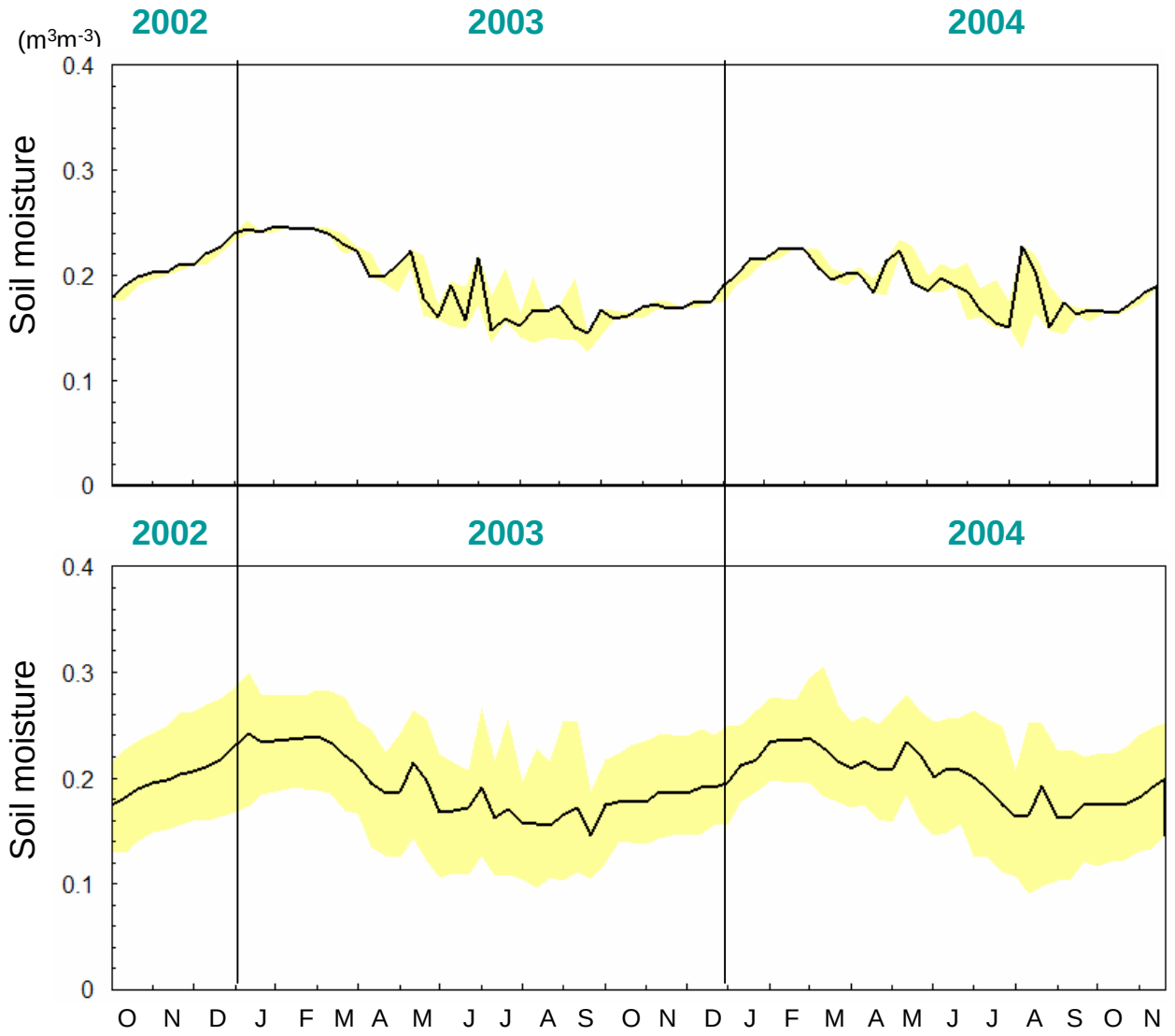


Soil Moisture at CEOP Reference Sites
Spatial and Temporal Variability

Time averages *over 10 days for the model closest point, with (min,max) during that period*

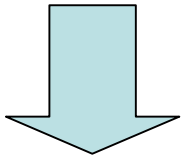
Evolution of soil moisture at **Lindenberg, Germany**

Time and spatial averages *over 10 days for a 5x5 box (25 points, ~160 km), with (min,max) during that period*



Our Plans with CEOP Data

- **Full water and energy budgets at the surface over the globe**
- **Variability**
  - *Scales and characteristics*
  - *Spatial vs temporal*
  - *Sources: forcing vs surface characteristics*
  - *Soil moisture vs surface fluxes*
- **Comparison between observations and model results**



- **Evaluation of the global configuration of the next land surface data assimilation system (CaLDAS)**

BACKUP CHARTS

Soil Moisture at CEOP Reference Sites
Spatial and Temporal Variability

Time averages *over 10 days for the model closest point, with (min,max) during that period*

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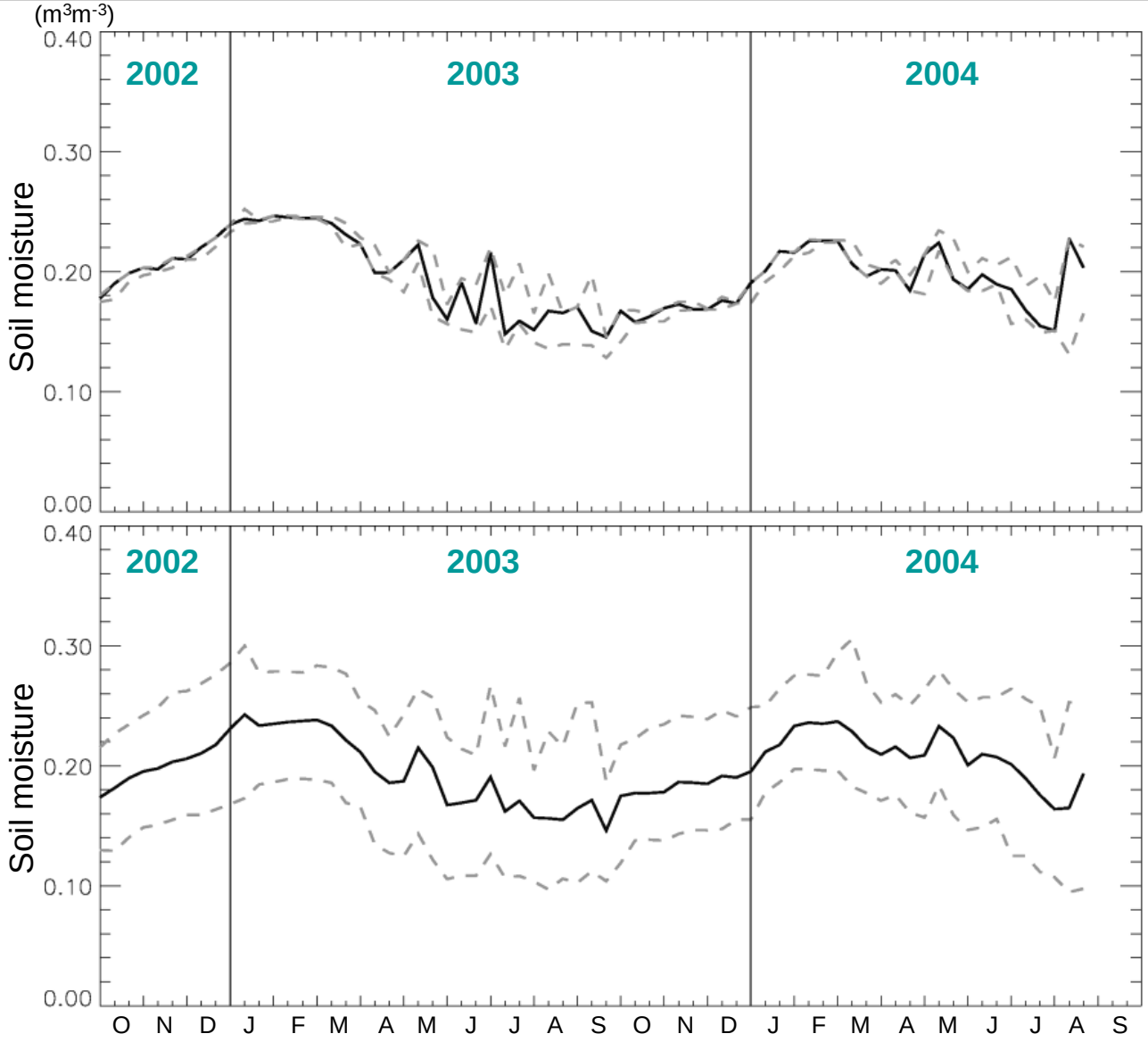
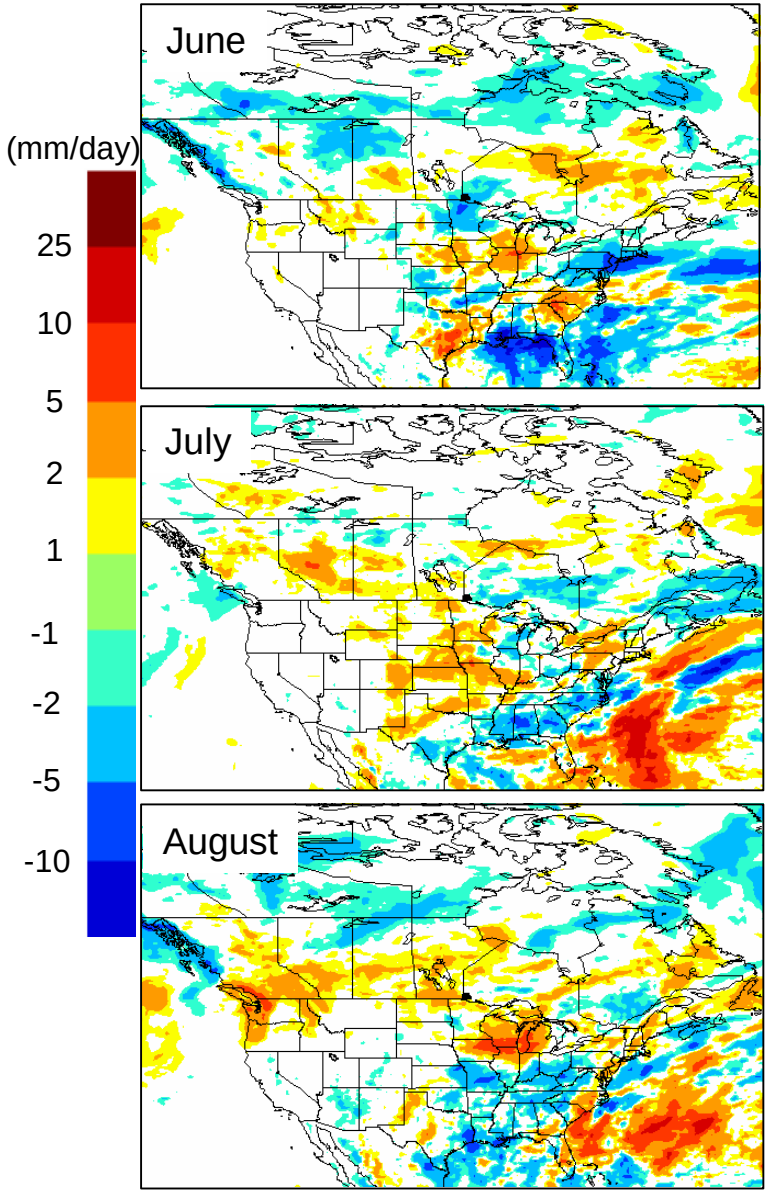
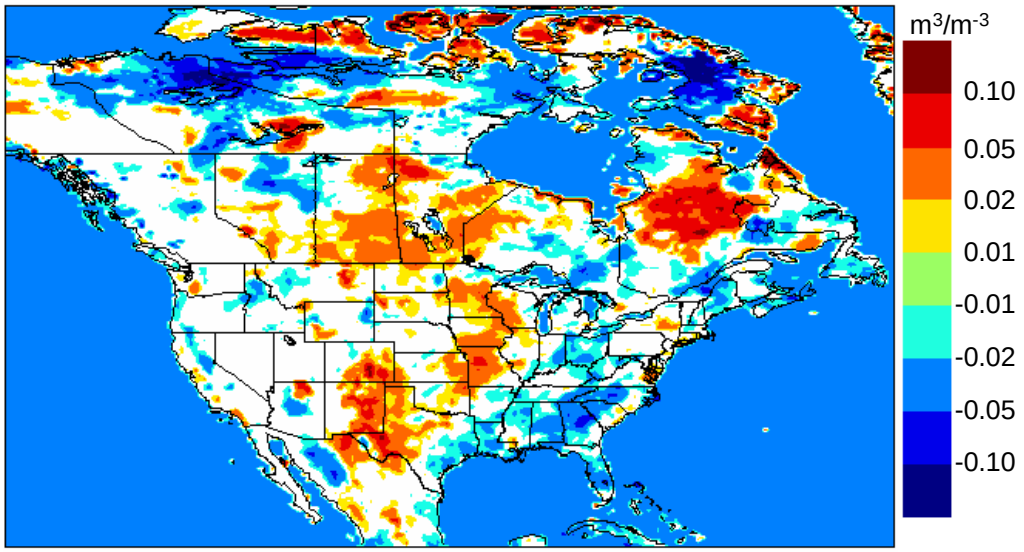


Soil Moisture over North America (2004-2003)

Precipitation



Soil Moisture



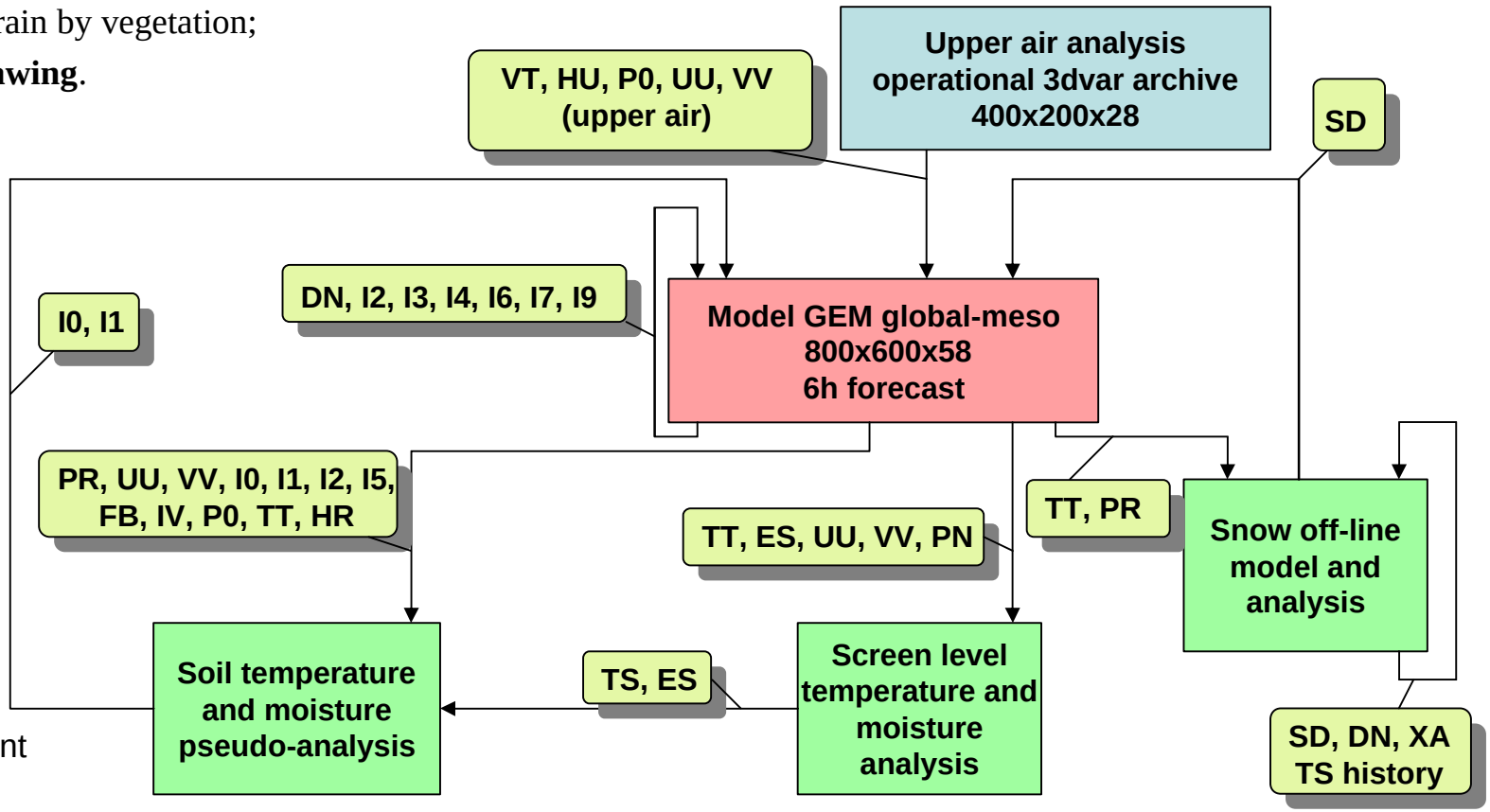
August

Land Surface Modeling and Assimilation System

ISBA: The Operational Land Surface Scheme

- Sophisticated **Force-Restore** scheme with more realistic treatment of vegetation and snow;
- **Aggregation** of characteristics over bare soil, vegetation, and snow (single energy budget);
- **Improved snow package** (liquid water reservoir in the snow, more physical processes influencing the snow density, impact of liquid precipitation on snow melting) Bélair et al. 2003b
- Includes models for **infiltration, runoff, drainage**;
- **Interception** of rain by vegetation;
- **Soil freezing/thawing**.

Surface Assimilation System



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