Use of Soil Moisture in NOAA/NWS Hydrologic Modeling

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Overview

- Simulation of soil moisture
- Uses of soil moisture
  - Model calibration
  - Assimilation
  - New products
- Future Needs

NOAA's Water Resources Objectives: Integrated Products & Services

Partners

NOAA

Federal Agencies

Tribal Agencies

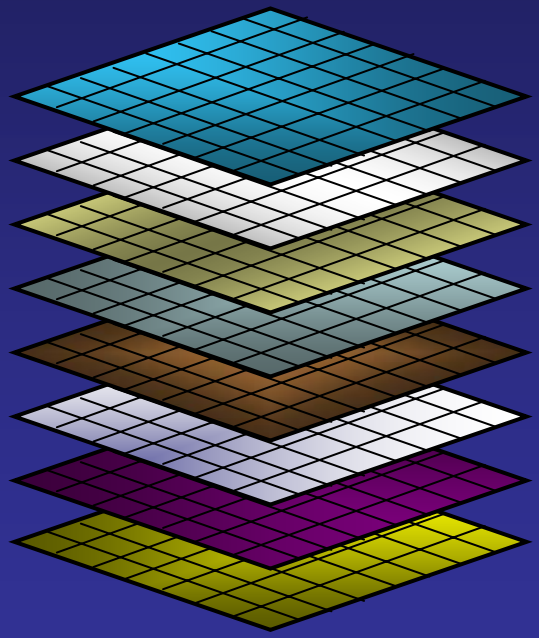
State Agencies

Local Agencies

Academia

Private Sector

High-resolution Gridded Water Resources Product Suite



- Precipitation
- Snowpack Properties
- **Soil Moisture**
- Evaporation
- Groundwater
- River Flow
- Surface Storage
- Runoff
- Water Quality

Applications

Drought Mitigation

Flood Potential

Flood Management

Water Allocation

Transportation

Emergency Management

Agriculture

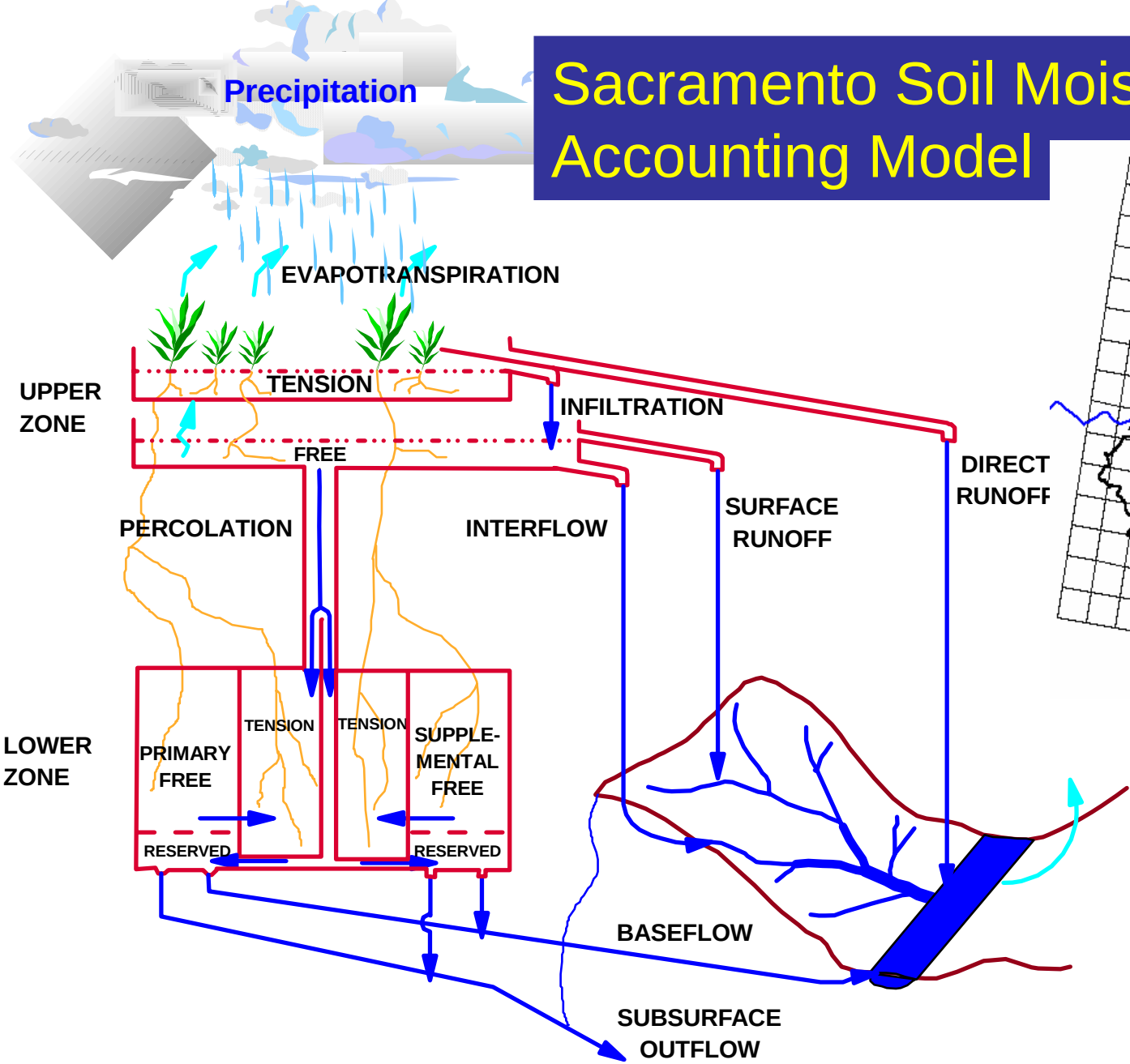
Debris Flows

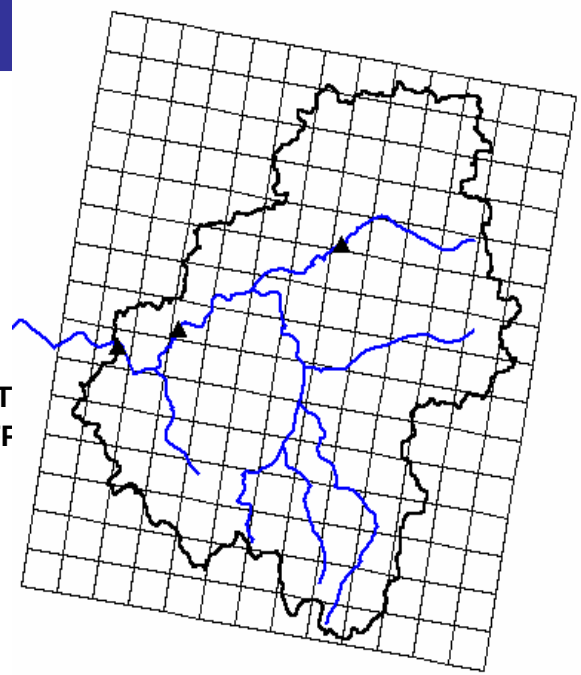
Ecosystems Management

Research

Uses of Soil Moisture Data: New Products

Sacramento Soil Moisture Accounting Model

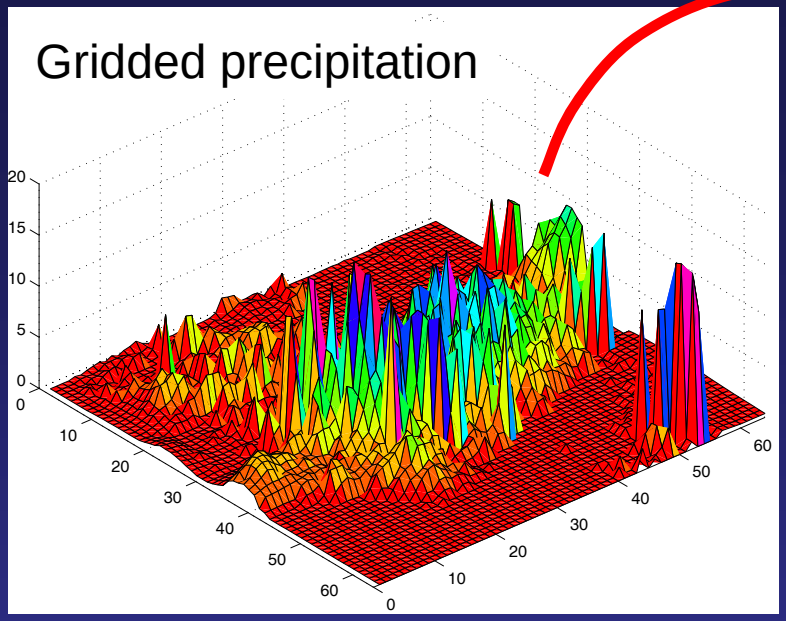


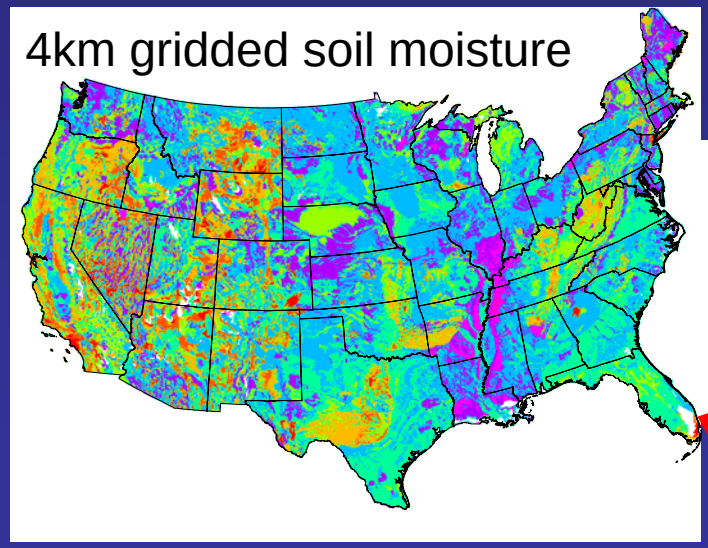


Source: U. Arizona

Simulation of Soil Moisture

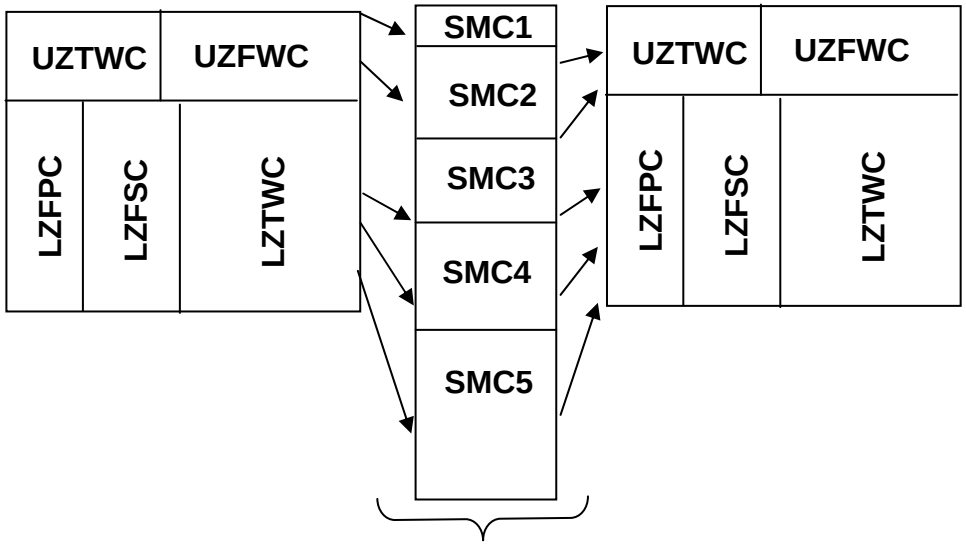
Simulation of Soil Moisture
Modified Sacramento Soil Moisture Accounting Model





SAC-HT

In each grid and in each time step, transform *conceptual* soil water content to *physically-based* water content



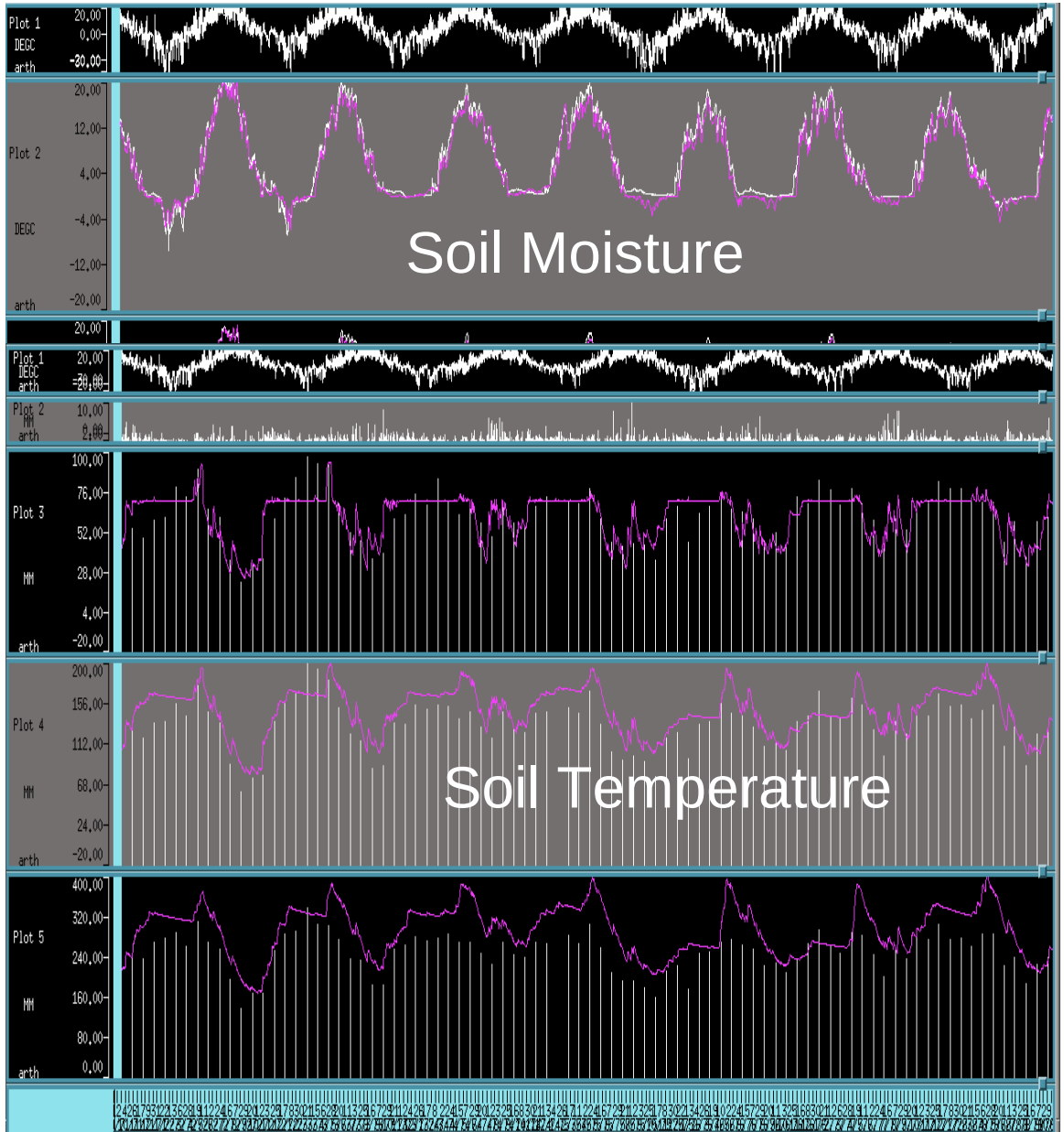
Reference

Koren et al., JGR, 104, 1999

SAC-HT Background

- Originally developed for the Noah Land Surface Model
  - Documented improvements
    - Koren, V., others, 1999. A parameterization of snowpack and frozen ground intended for NCEP weather and climate models. J Geo. Research, Vol. 104,
- Designed as replacement of the existing conceptual SAC-SMA frozen ground option.
  - The HT component uses physically-observable parameters: does not need calibration
  - Generates soil moisture and temperature versus depth
  - Can be used with local soil properties to adjust soil moisture to local conditions.

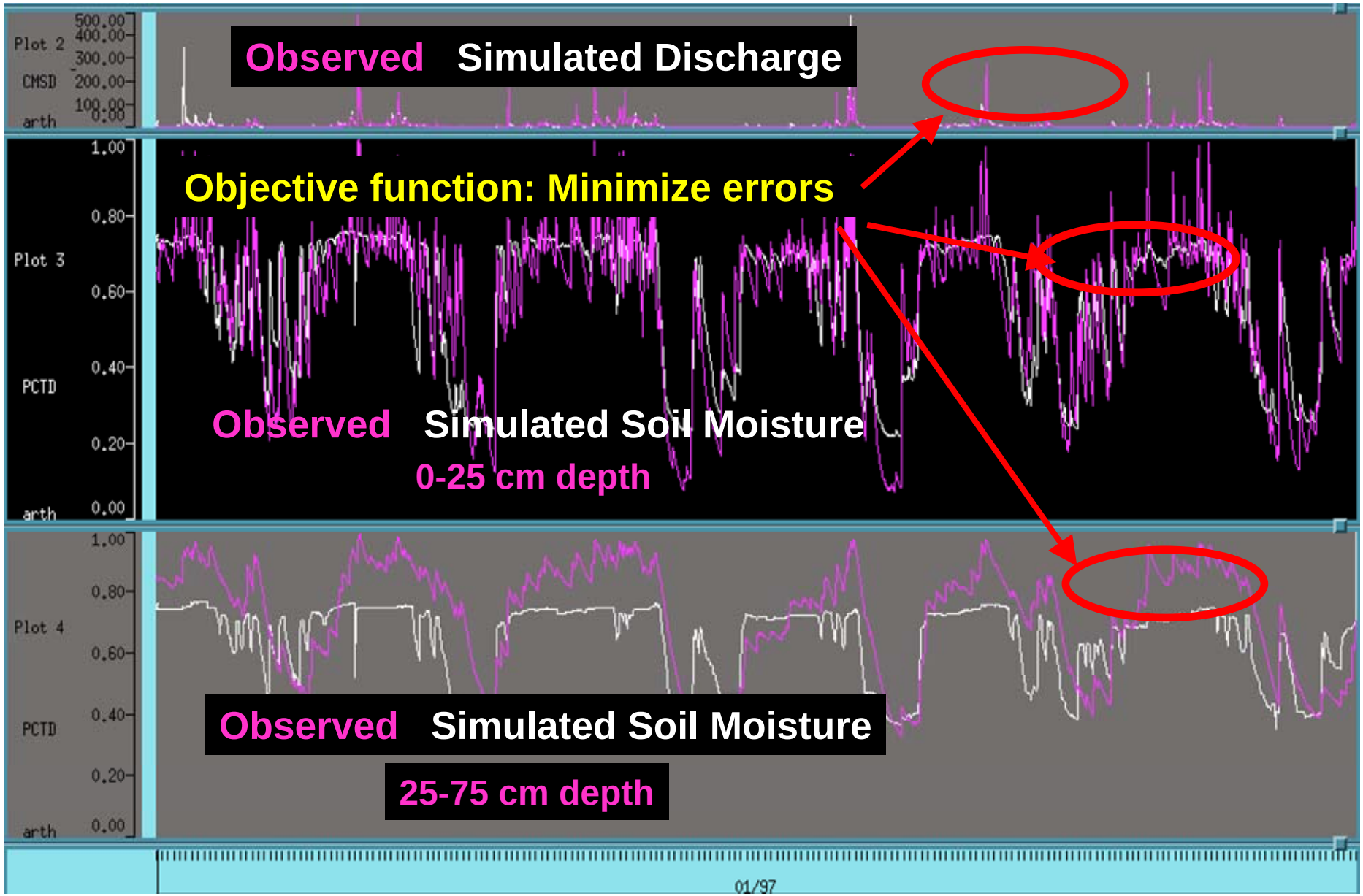
Observed (white) and simulated (red) soil temperature and moisture at 20cm, 40cm, and 80cm depths. Valdai, Russia, 1971-1978.



Validation of SAC-HT

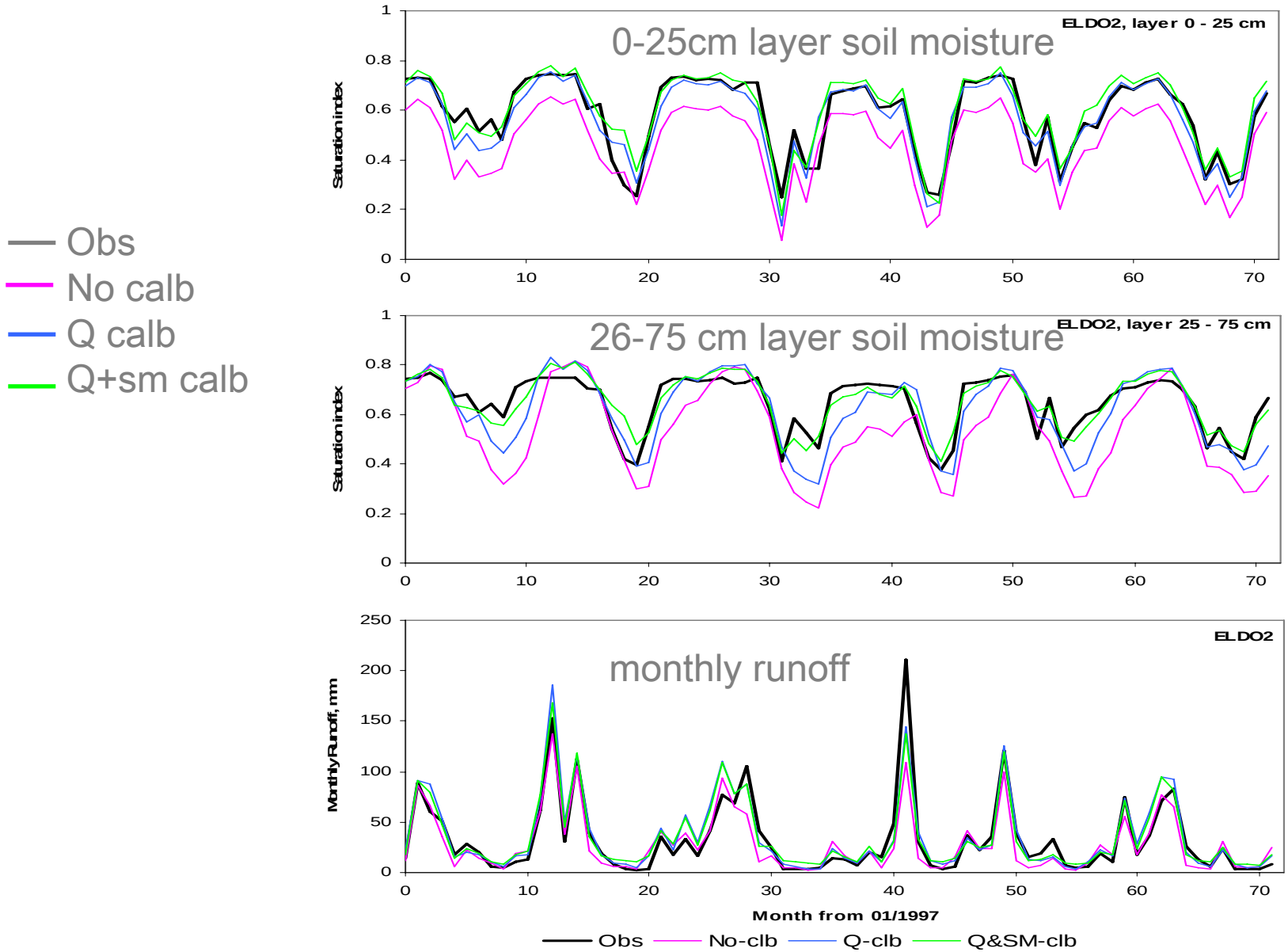
Simulation of Soil Moisture

Use of Soil Moisture: Model Calibration



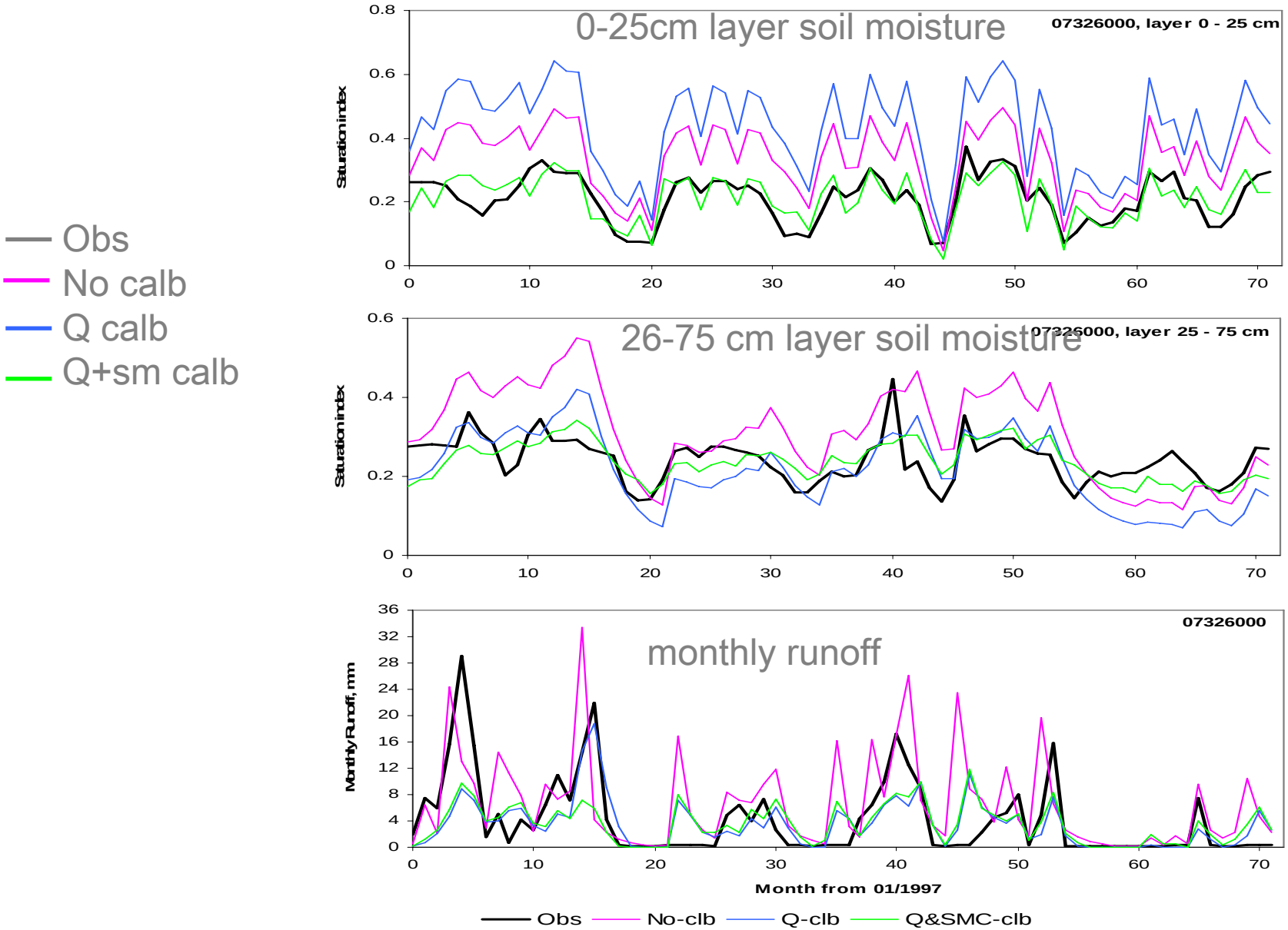
Calibration Results: Monthly soil moisture and runoff estimated from a priori and calibrated parameters with/without use of soil moisture measurements

Case 1. Not much difference in simulated soil moisture between two calibration approaches



Calibration Results: Monthly soil moisture and runoff estimated from a priori and calibrated parameters with/without use of soil moisture measurements

Case 2. Considerable difference in simulated soil moisture between two calibration approaches



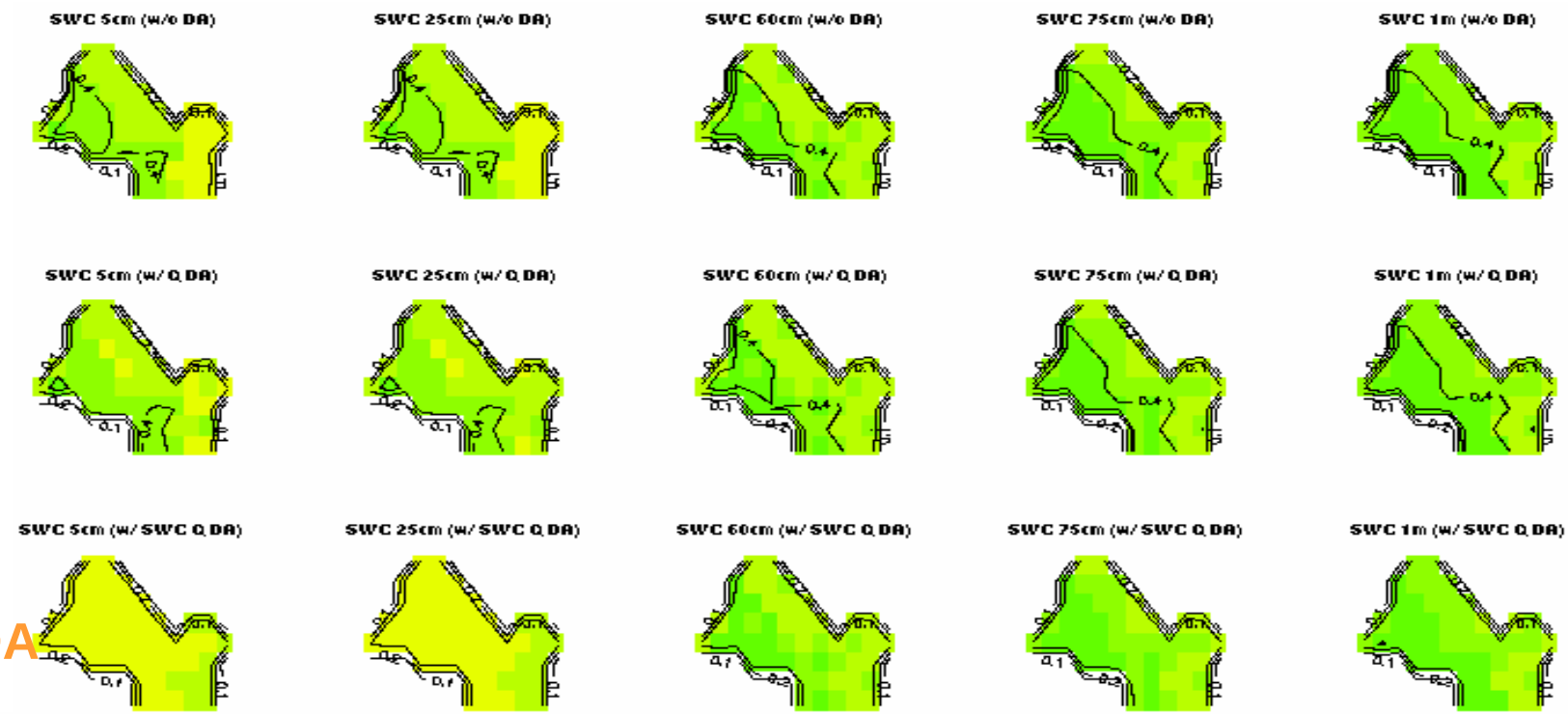
Assimilation of Streamflow (Q) and Soil Moisture (SWC)

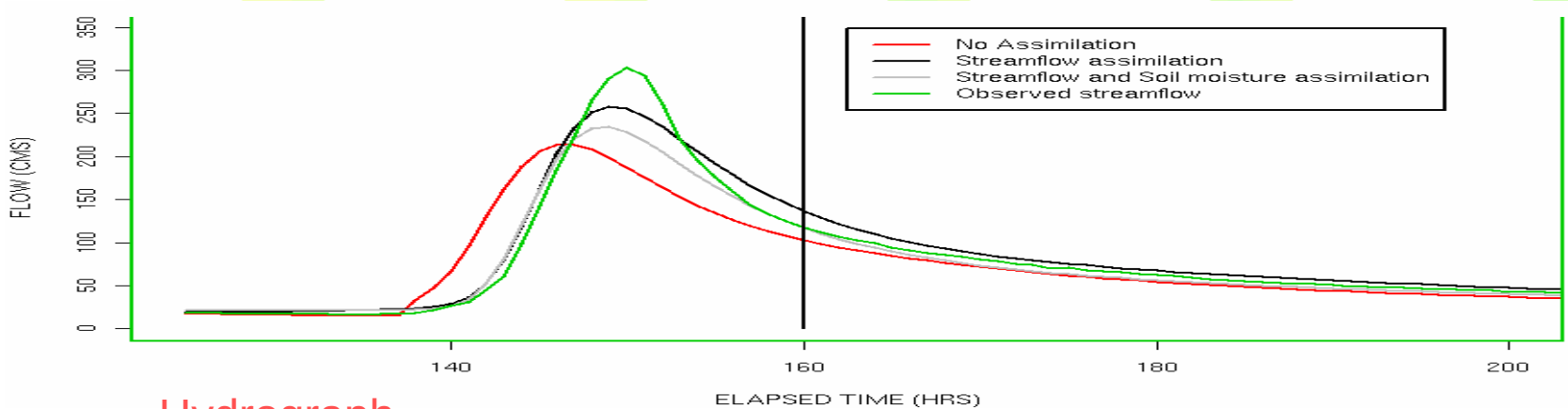
Soil moisture map at 5/25/60/75/100 cm depth for Baron Fork, OK

No DA

Q DA

Q & SWC DA



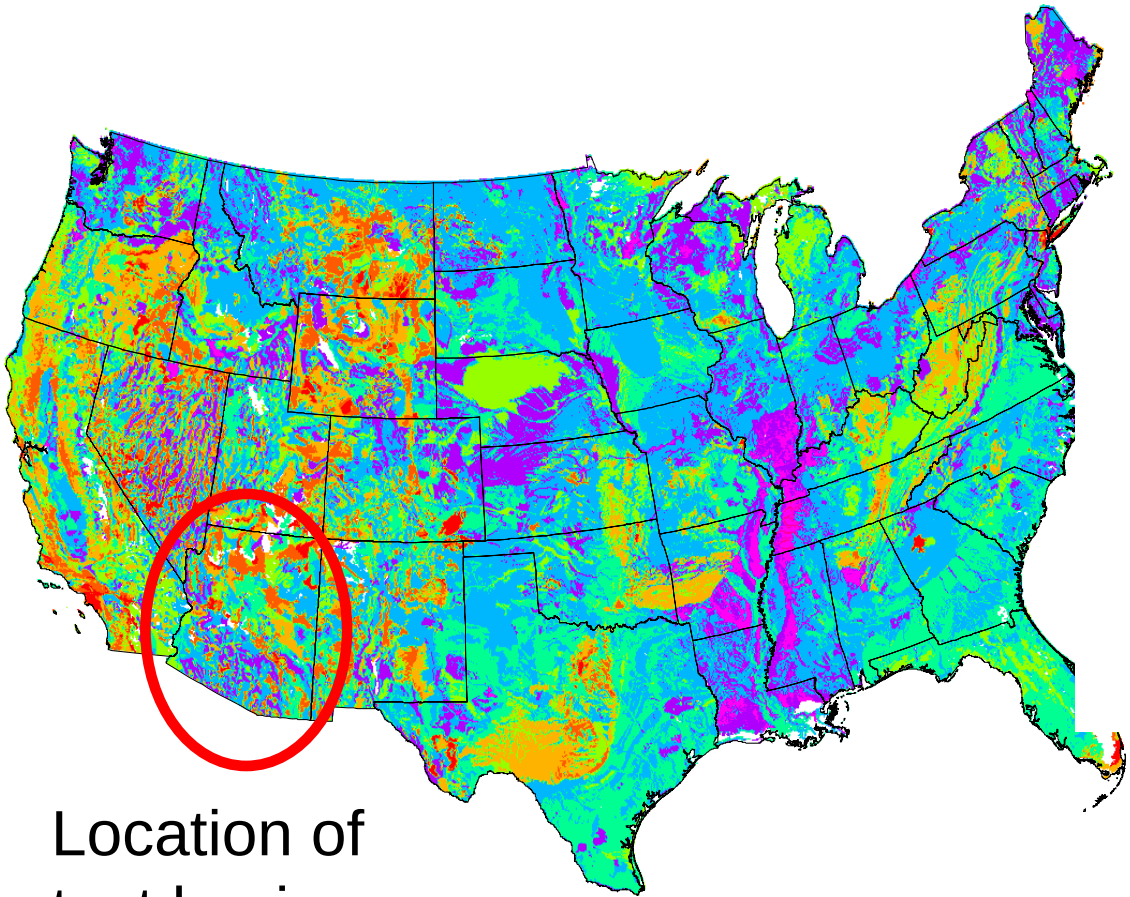


Hydrograph

Uses of Soil Moisture: Data Assimilation

NWS-CBRFC NIDIS Pilot Project

- Soil moisture estimates for drought decision making
- Uses sparse observations

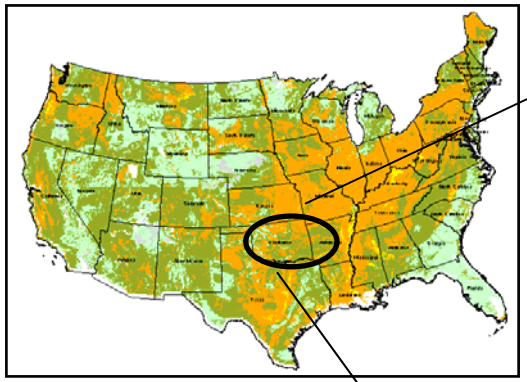


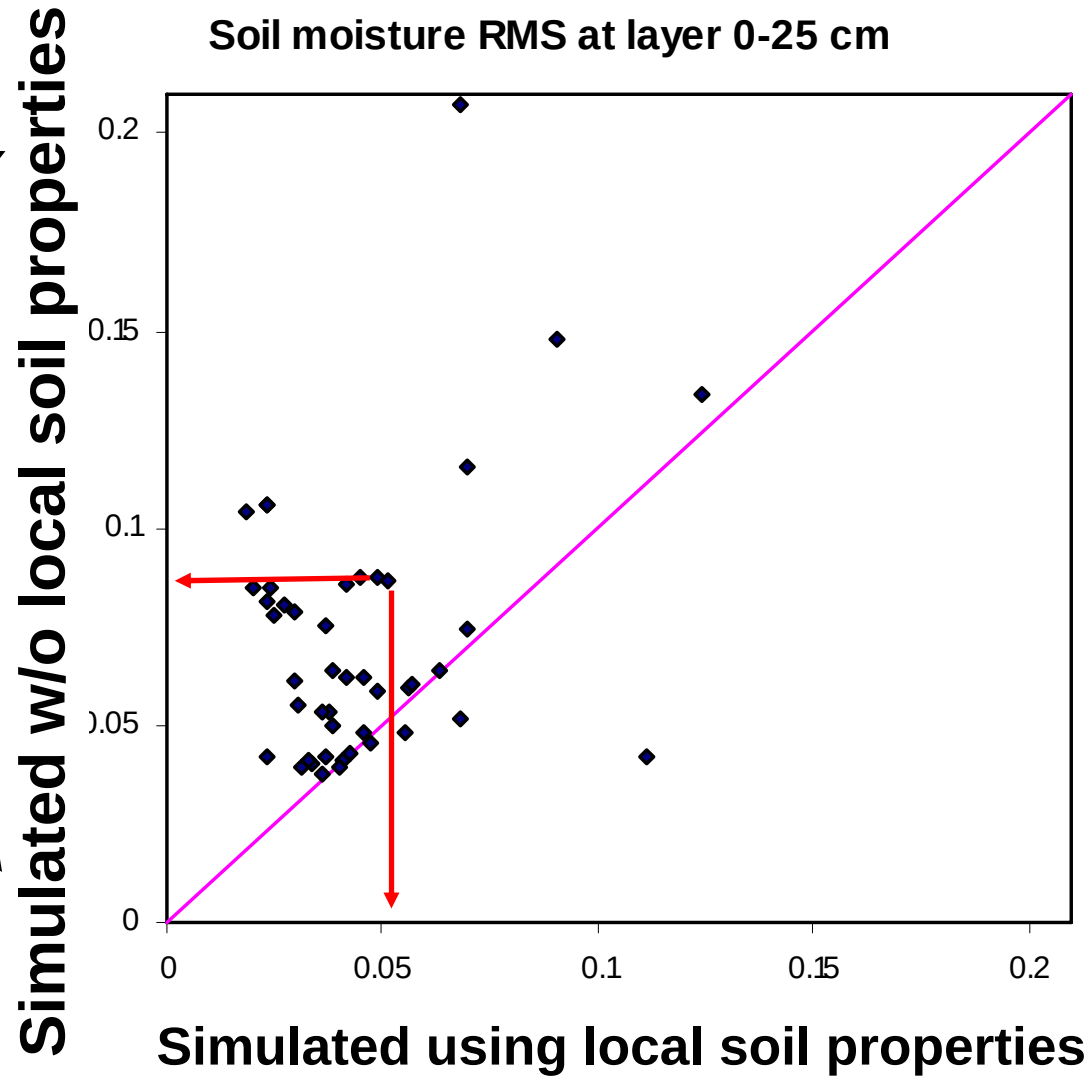
Location of test basins

Uses of Soil Moisture Data: New Products

Use of Soil Moisture Data: New Products

Tailor Soil Moisture Simulations for Local Soil types





Technique being developed for operational implementation

Future Needs

- Soil moisture observations with:
  - Spatially-averaged soil moisture observations at resolutions compatible with the Distributed Model
  - High accuracy
  - Observations at depths in excess of a few centimeters