Continued Application and Development of a High-Resolution Land Data Assimilation System (HRLDAS)

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The Problem

- Atmospheric models running LSM physics require initial conditions of soil temperature and moisture
- No routine observations of soil conditions are performed on the large scale
  - Isolated mesonets
  - Satellite uncertainties
- Initializing soil conditions for one model from analyses generated in other modeling and assimilation systems can lead to serious imbalances in the soil fields, due to
  - Differing representations of soil textures, vegetation types, etc.
  - Horizontal interpolation
  - Differing representations of land-surface physical processes

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HRLDAS

Noah LSM run in a standalone, decoupled configuration (i.e., no atmospheric model), driven by hourly analyses of PCP, radiation, and atmospheric fields

- On the same model grids as an intended WRF or MM5 simulation
  - “Spun-up” initial soil conditions for coupled model
  - No mismatch in soil or vegetation categories or physical parameters between models
  - No horizontal interpolation necessary
  - Uses same LSM physics as WRF Noah in order to minimize imbalances at model initialization
- Spin-up on the order of a few months to a year may be necessary
  - Depends greatly on soil texture
  - CPU time really is not much – the bigger issue is simply managing the data

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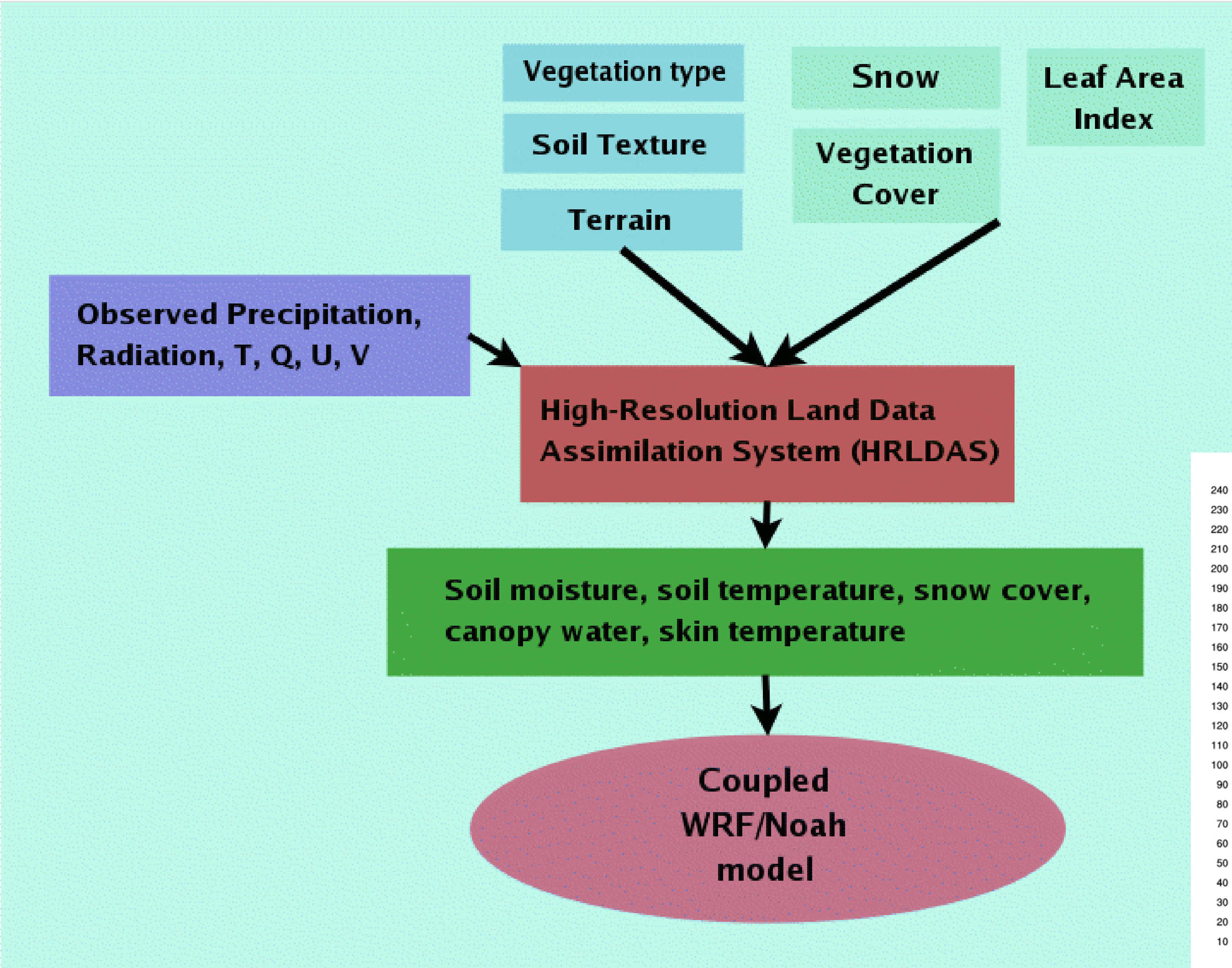
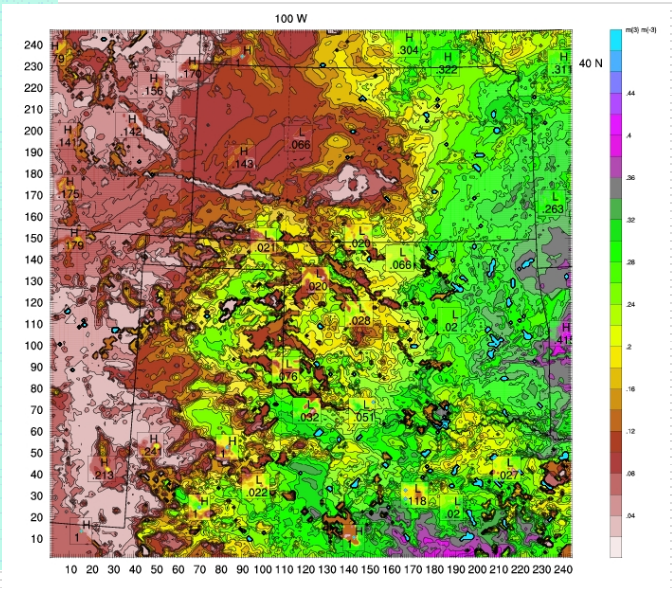
Goal: Assimilate observations into LSM to provide high-resolution land state variables for coupled models





4-km HRLDAS surface soil moisture

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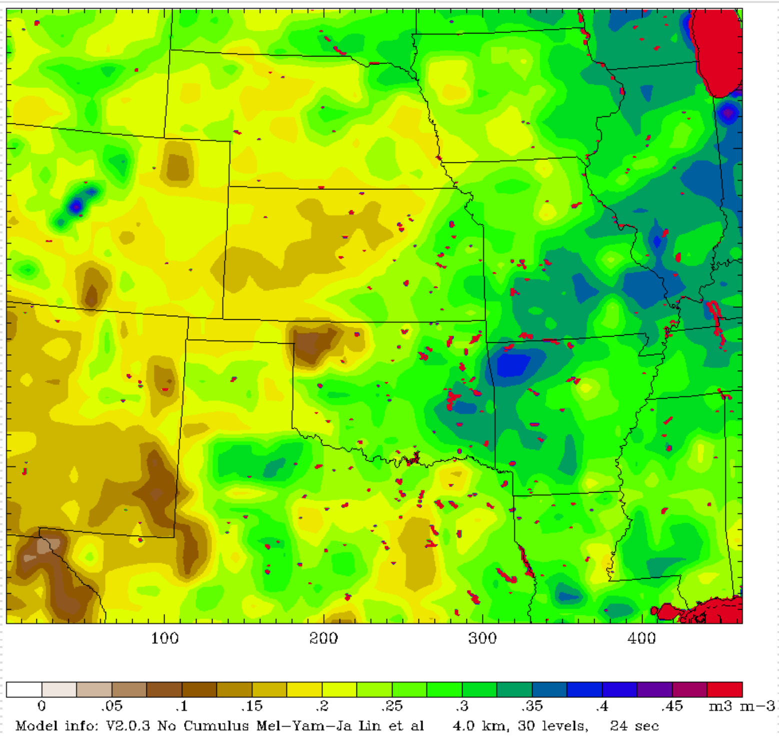
Recent applications

- IHOP studies
- DWFE
- Summer ARW-WRF experiments at NCAR
- ATEC RTFDDA

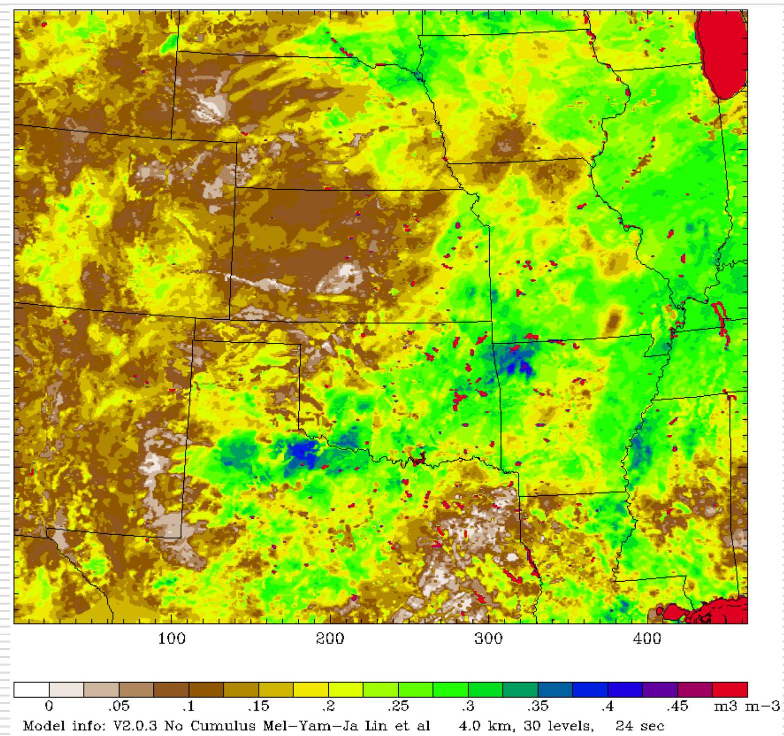
Recent applications

- IHOP convective studies

EDAS soil moisture 0 – 10 cm



HRLDAS soil moisture 0 – 10 cm



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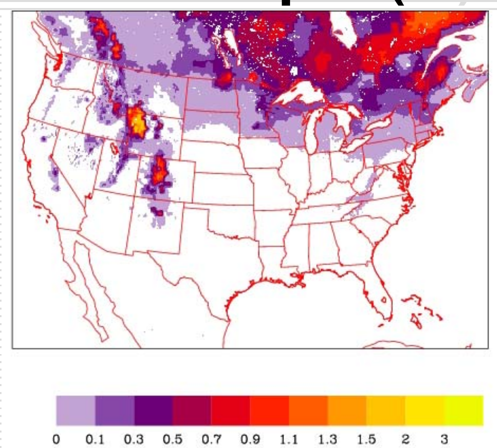
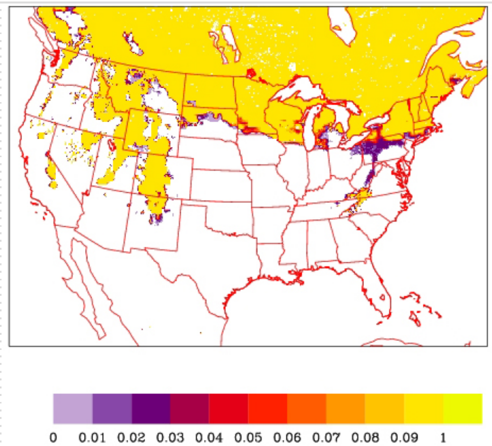
Recent applications

- DWFE – DTC Winter Forecast Experiment

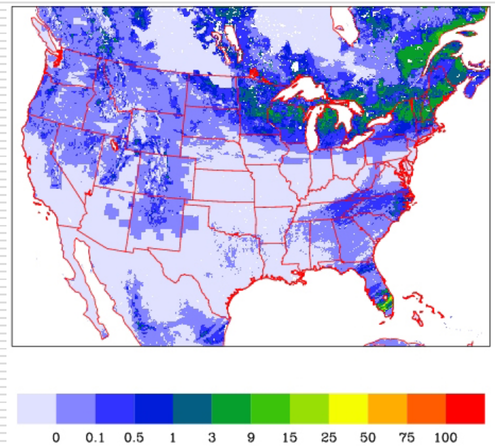
Snow depth (m)



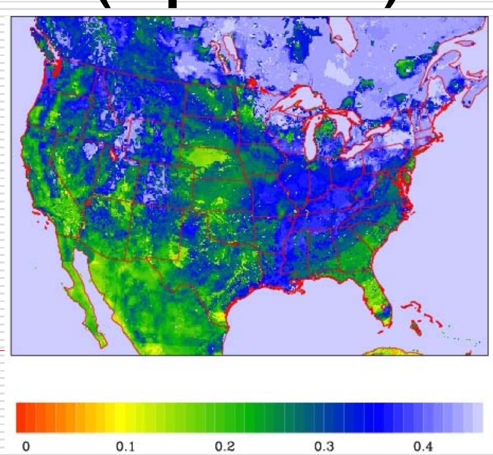
Snow cover



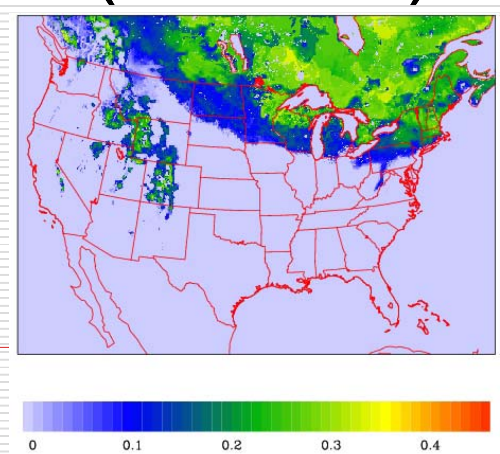
24-h accumulated runoff



Volumetric total soil moisture (liquid+ice)



Volumetric soil ice (frozen soil)



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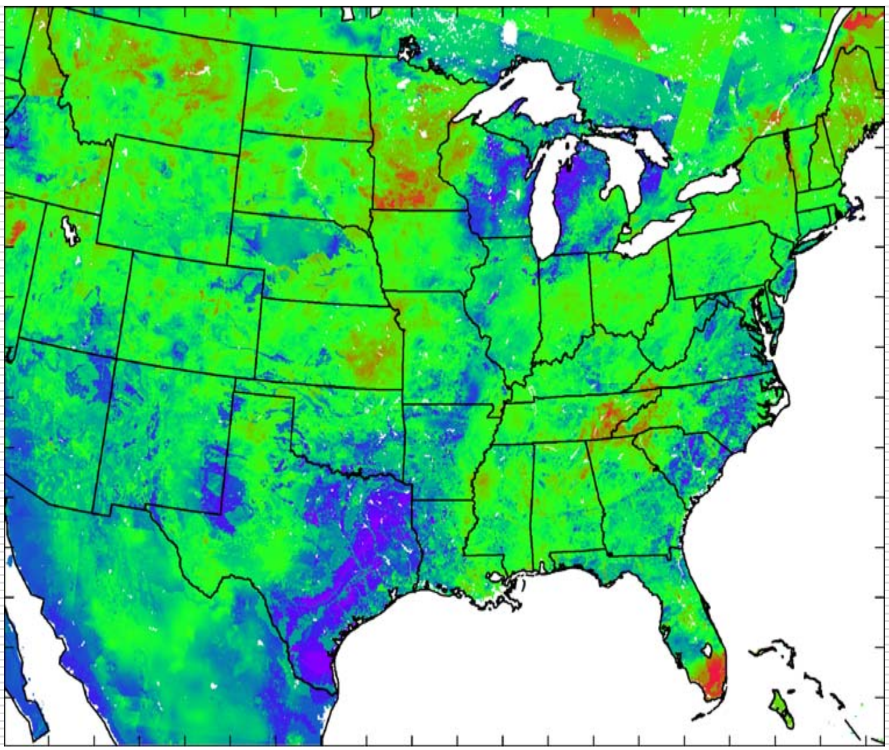
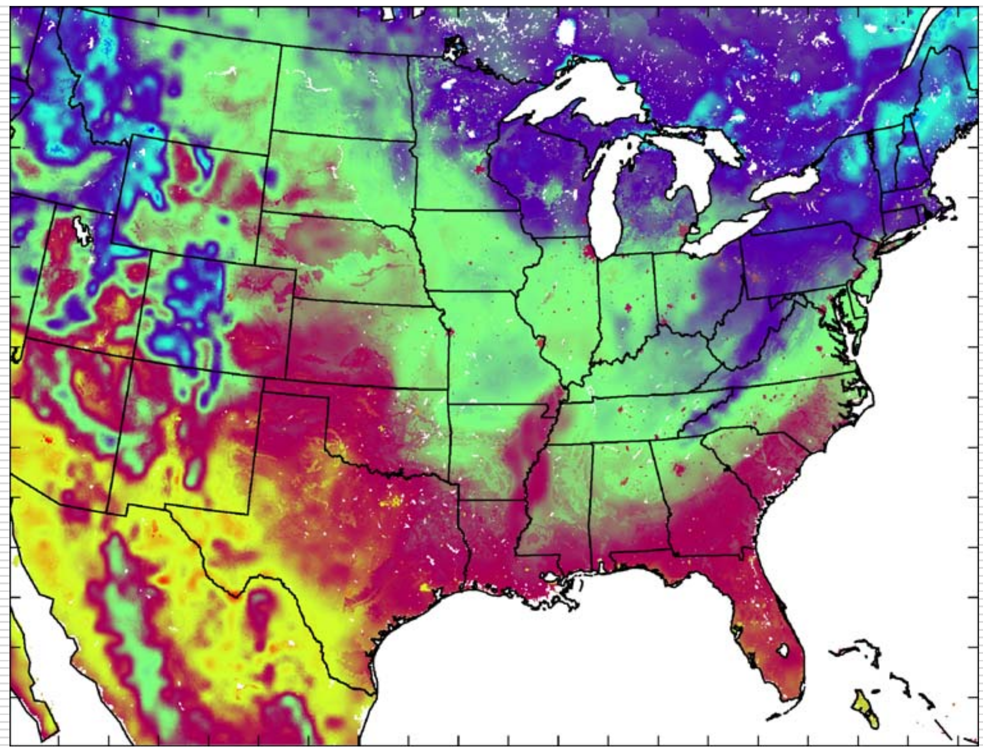
Recent applications

- Spring/Summer ARW-WRF experiments at NCAR/MMM

Soil Moisture 0 – 10 cm



Soil Temperature 10 – 40 cm



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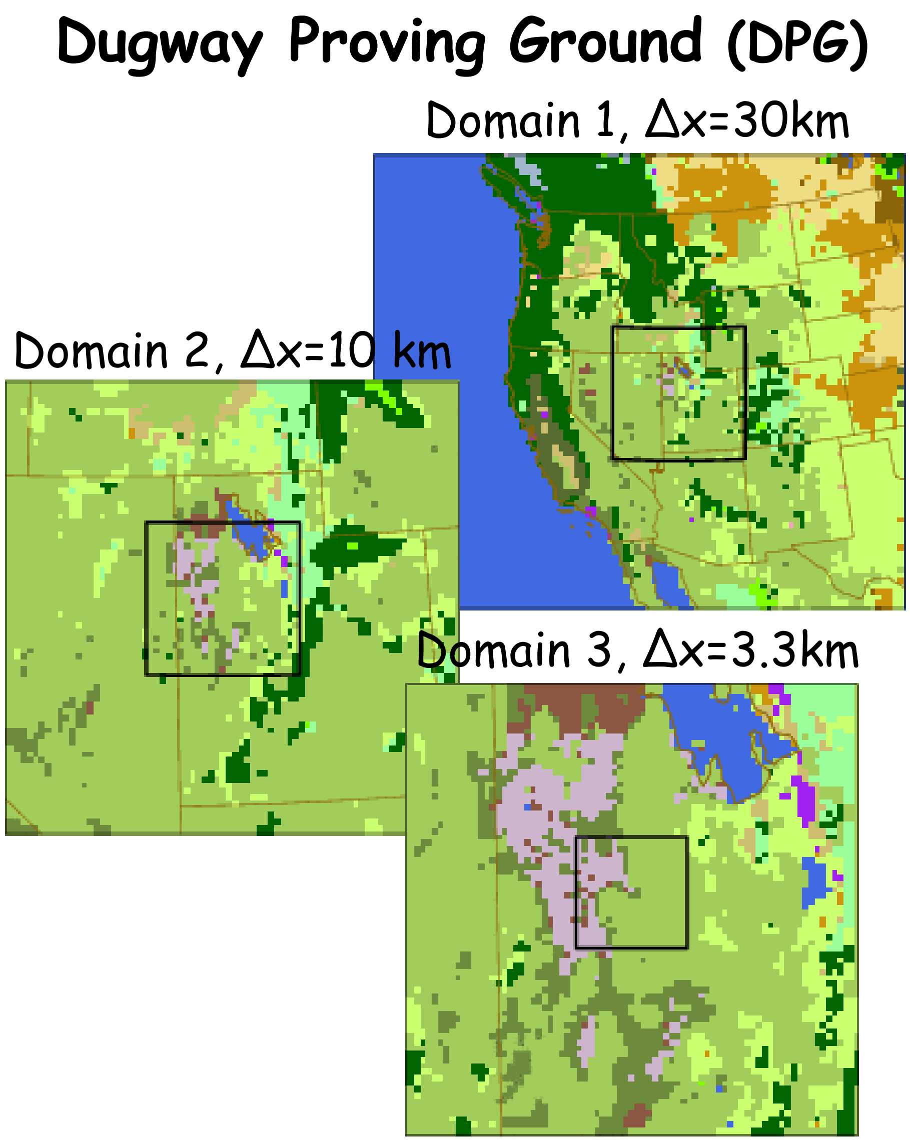
Recent Applications



- ATEC RTFDDA
  - Army Test and Evaluation Command
  - Real-Time Four-Dimensional Data Assimilation
- Example:
  - MM5/HRLDAS domain over ATEC Dugway Proving Ground (DPG) – centered over western Utah.

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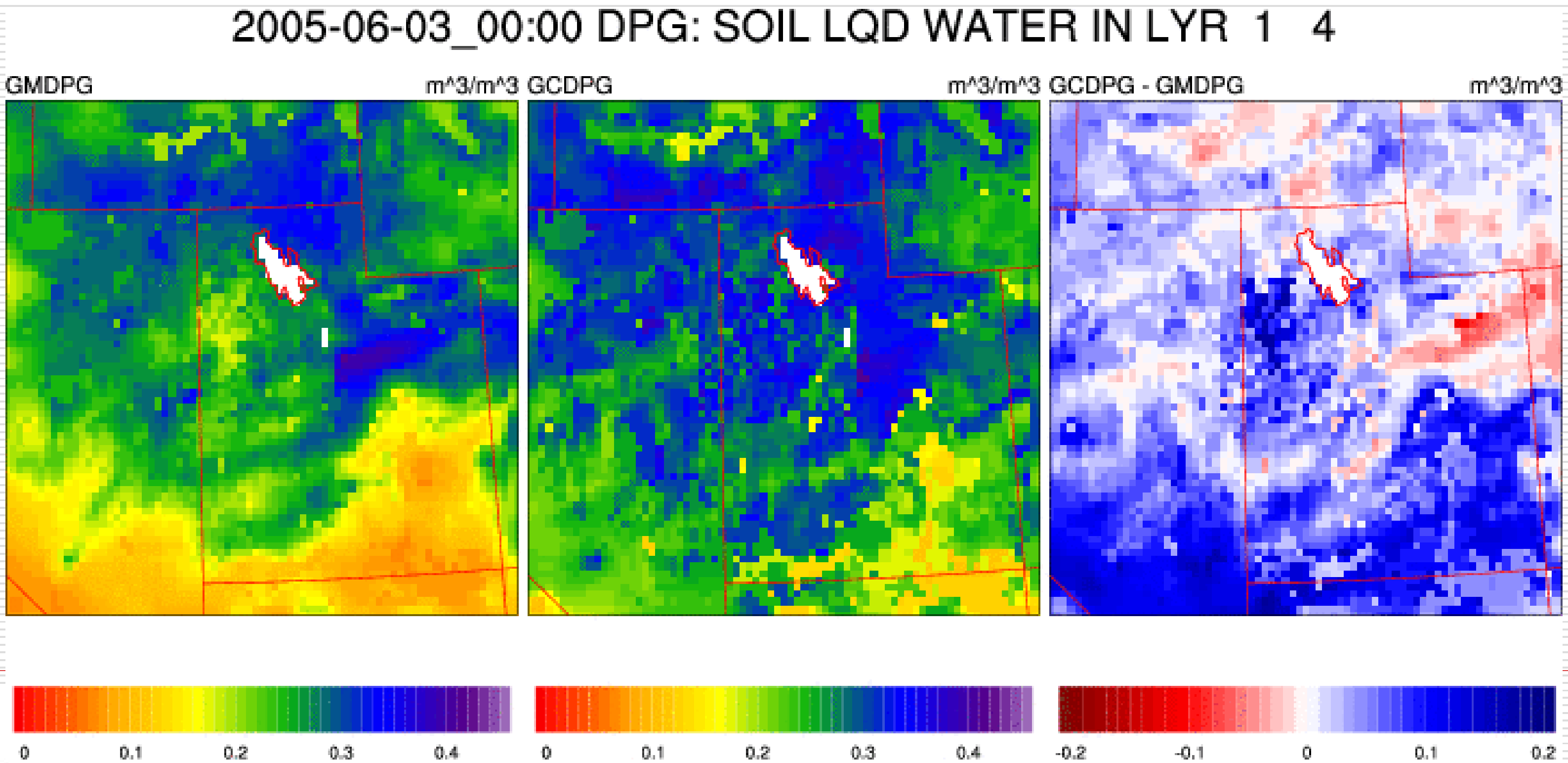
RTFDDA Experiments

- Two parallel RTFDDA and forecast experiments
- Two ranges: DPG, Utah and WSMR, New Mexico
- Identical initial and assimilated observations but of them is initialized with HRLDAS land surface fields



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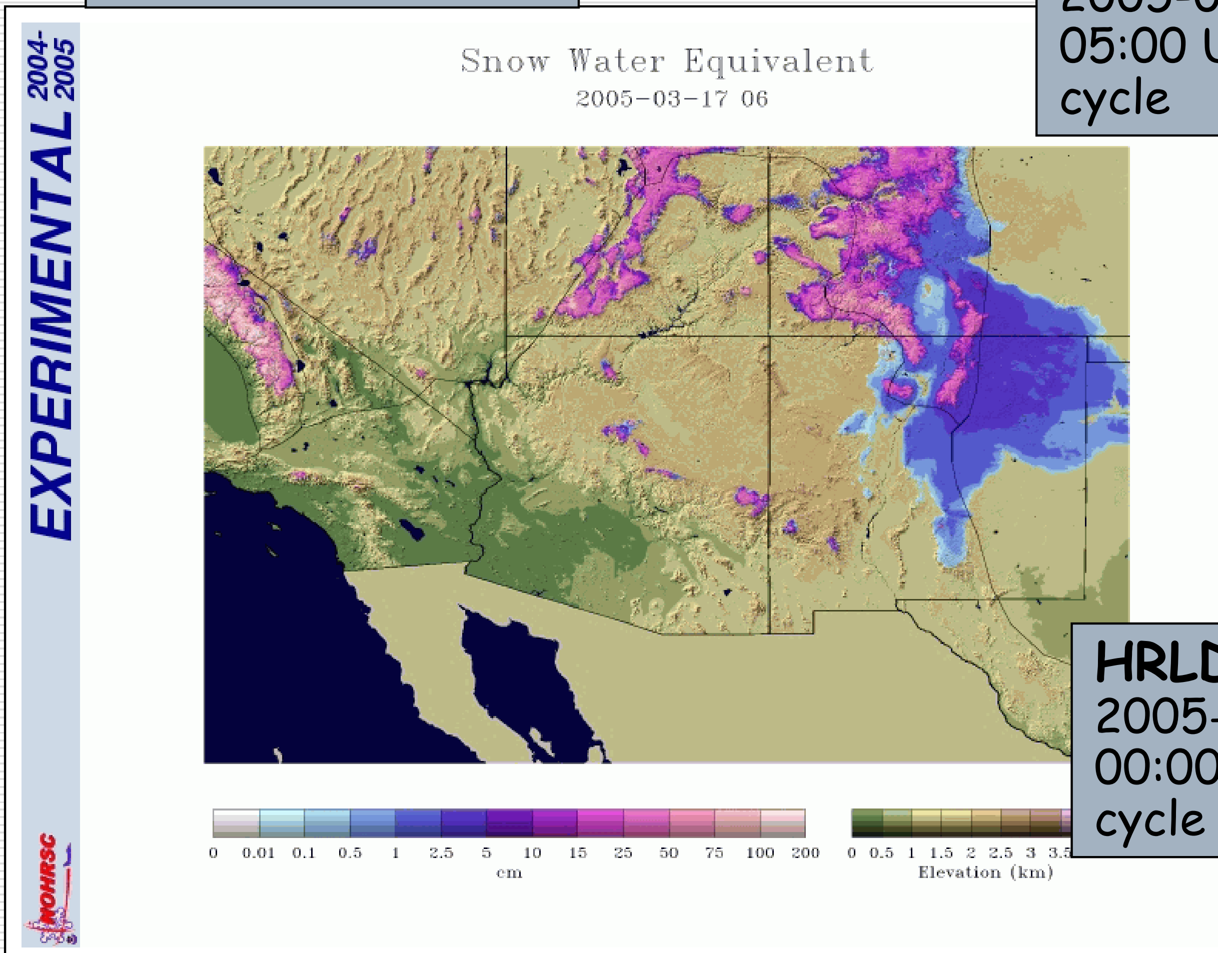
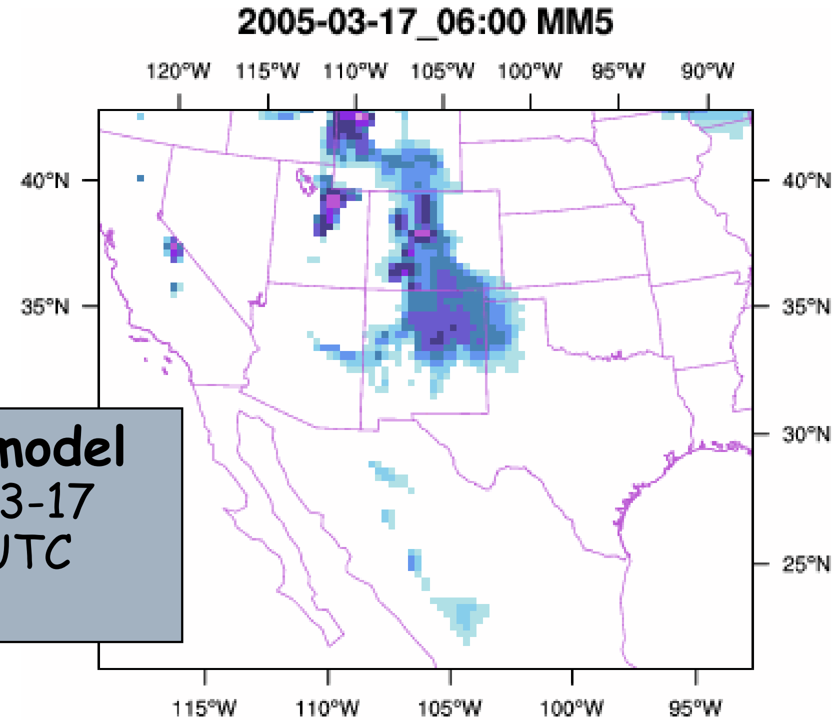
Comparison of water equivalent snow depth

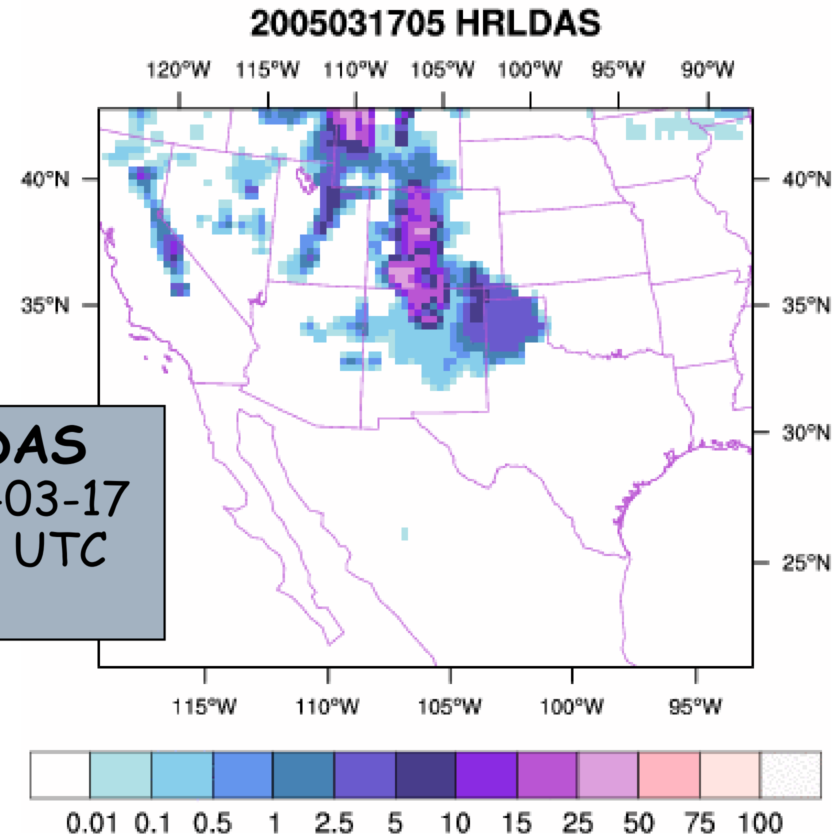
SNOW Analysis (NOHRSC)



MM5 model
2005-03-17
05:00 UTC
cycle



HRLDAS
2005-03-17
00:00 UTC
cycle



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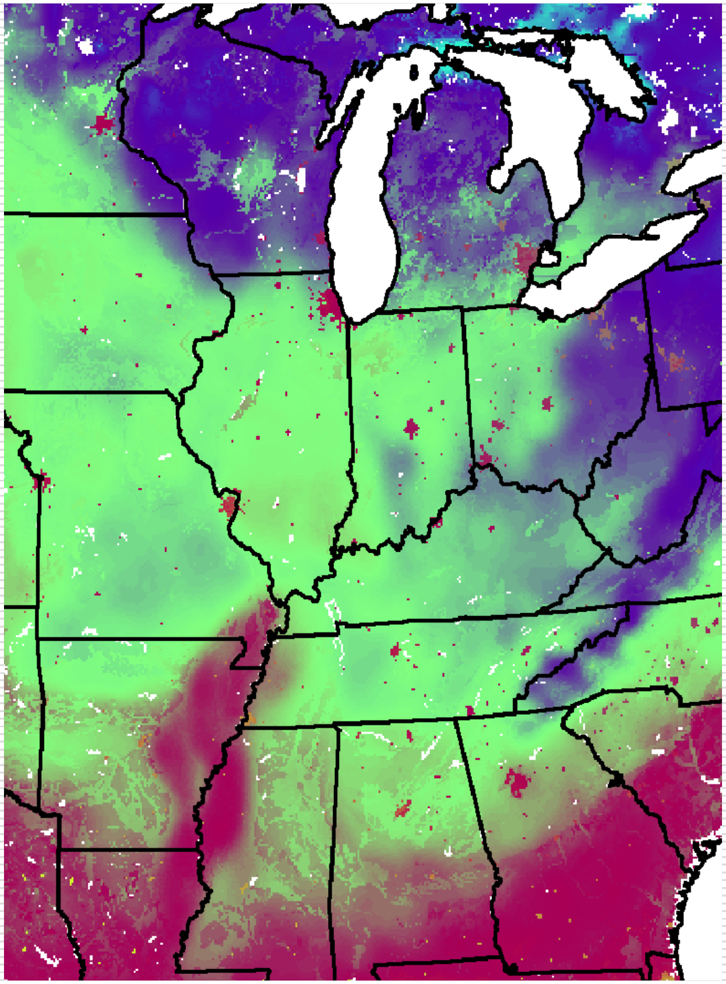
Recent and upcoming development

- Surface emissivity
  - Now a function of vegetation category
- Urban modifications
- Water routing scheme

Urban effects

- Increased roughness length
  - Drag due to buildings
- Reduced surface albedo
  - SW radiation trapping in urban canyons
- Increased volumetric heat capacity of surface
  - Concrete and asphalt roofs, walls, and roads
- Increased soil thermal conductivity
  - Storage of heat in and beneath urban surfaces
- Reduced green vegetation fraction

10-40 cm T



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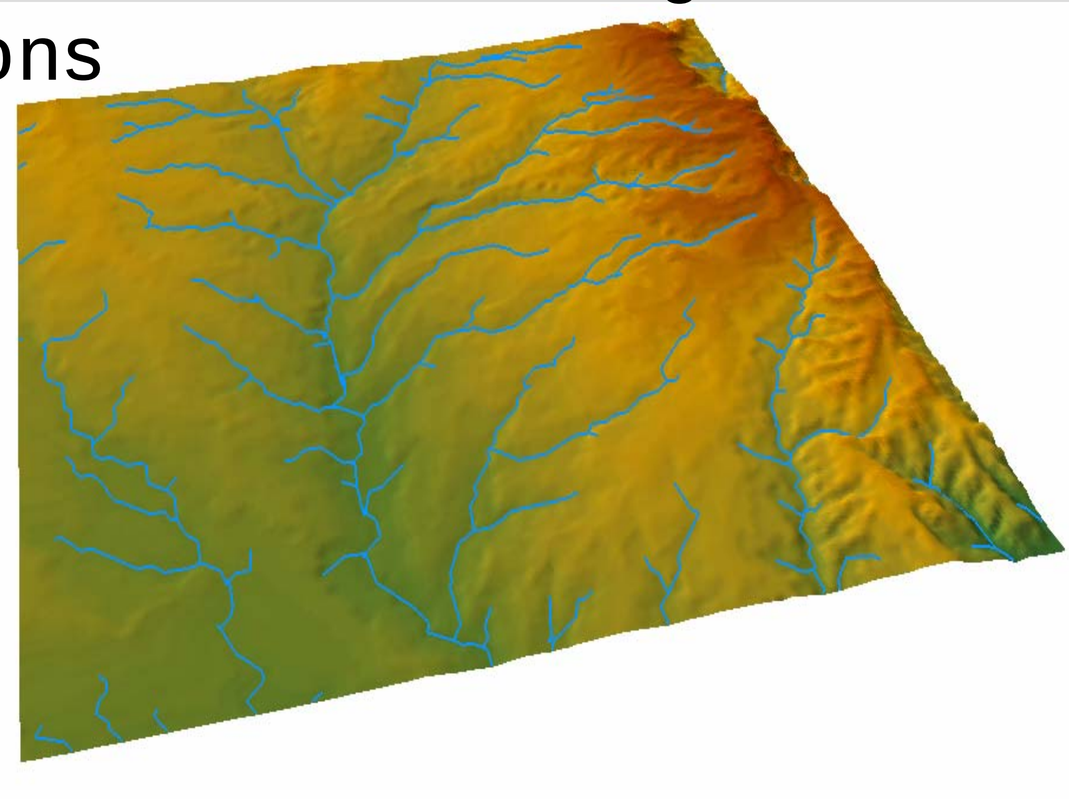
Water Routing

- Lateral transport of surface and subsurface water from one grid cell to another
  - E.g. flow of ground water from higher to lower elevations



• Important for areas of complex terrain
• Important for high resolution O(1-km) or smaller
• Important for long simulations

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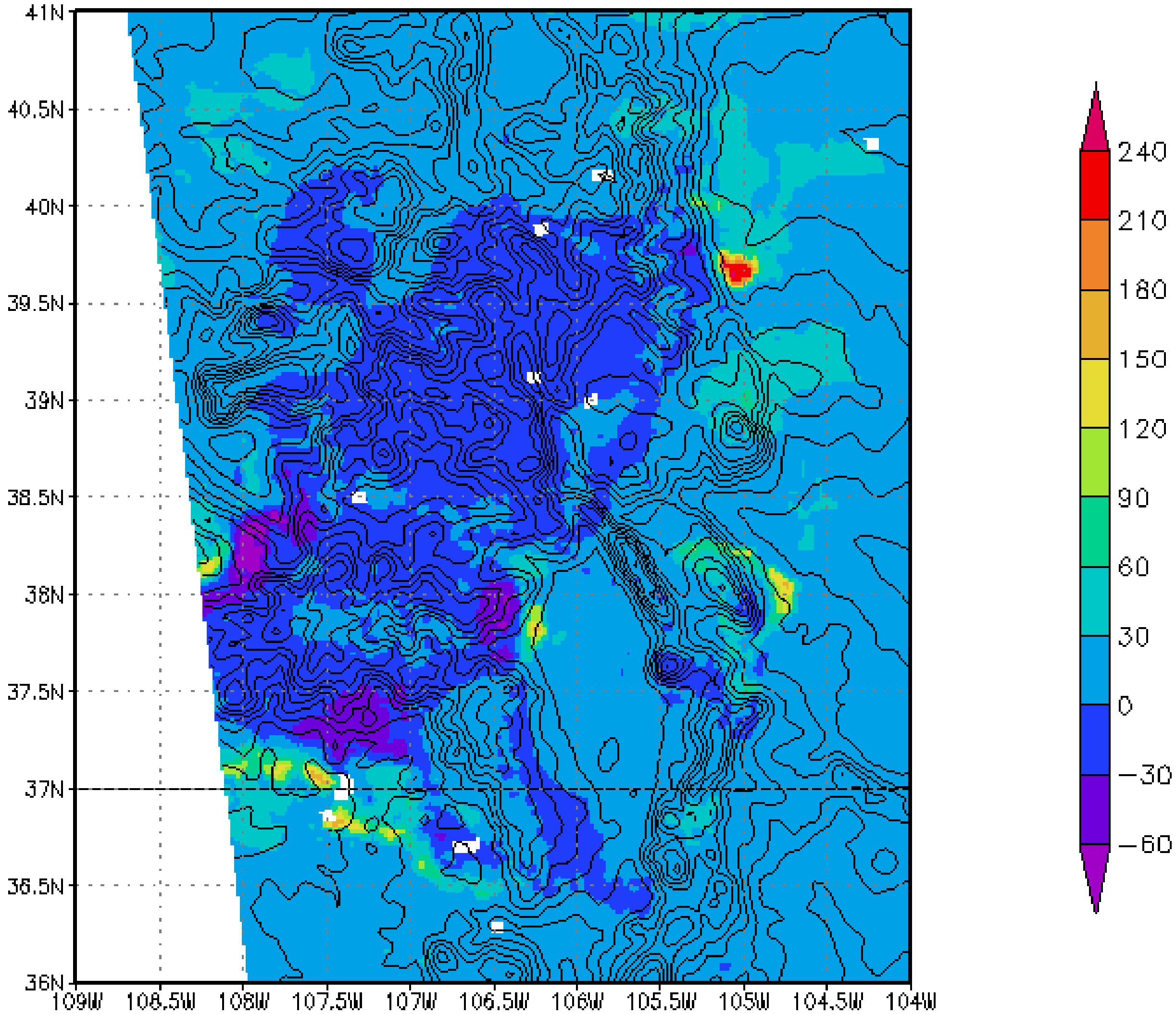
Water Routing



- Detail of difference in total evaporation (shaded) with and without dual routing shows terrain influence for the 5 month period (1 Jan-1 Jun, 2001)
- Broad decreases of 0-30 mm evident over most high topography
- Flat areas and topographic convergence zones within high terrain show modest increases
- Many, though not all, steep slopes show stronger decreases
- Southern and eastern peripheries show sizable localized increases
- Aggregation/disaggregation to/from 1km subgrid likely alters location of routing influence

Contours are topography

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Plans

- Plug-compatibility between Noah physics code in ARW-WRF and HRLDAS
- Offer HRLDAS for community use
- Support code in the context of ARW-WRF
- Sample shell scripts and programs