The Water Forecast: Predictions of all things water with the WRF-Hydro System

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Impacts from the September 2013 Colorado Floods

• 9 fatalities
• Flooding less than 1.0% probability widespread across several counties
• Communities completely evacuated
• > 450 mi road destroyed
• Water/wastewater infrastructure destroyed
• Measurement infrastructure destroyed
• No flood watch was issues on 9/11
Current operational streamflow forecasts

- Hydrologic predictions...
  (lumped, point-forecast depictions...)

- Lacks physical treatment of:
  - Landform
  - Vegetation
  - Groundwater
  - Inundation
  - Infrastructure and Management
Operational point streamflow forecasts during the Sept. 2013 Colorado Floods

Advanced flood warning was not available on smaller river systems
Forecasting all components of the Water Cycle:
Physics components:

- physics-based runoff processes
Simultaneous forecasts of water cycle components:
Simultaneous forecasts of water cycle components:

Channel Flows at spatial resolutions of 10s to 100s of meters
Emerging capabilities...

- **Full water cycle depictions**...
  - Groundwater
  - Wetlands
  - River baseflows

Implemented by B. Fersch, KIT-Garmisch, Germany
Emerging capabilities...

• Full water cycle depiction...
• Water management....
  • Reservoirs
  • Diversions
  • Transfers
  • Irrigation
Emerging capabilities:

- Dynamic landscapes...
- Rapidly integrate land cover change information:
  - Wildland fire
  - Urbanization
  - Forest mortality
  - Agricultural production

2009 Aerial Detection Survey, Courtesy: USFS
Colorado Headwaters Project...

- Full water cycle depiction...
  - Spatially-explicit hydrologic information
  - Flow rate and depth
  - Resolving streamflow processes down to tributary headwater basins
Fully-coupled Hydrometeorological Prediction

- WRF-Hydro Model setup for hydrometeorological research into the 2013 Colorado Floods

- Conducting a variety model hindcast experiments to discover opportunities to improve flood forecast information
WRF-Hydro simulated streamflow using NOAA radar-gauge observed rainfall

Streamflow in cms
Simulated peakflow values from the WRF-Hydro model

Initialization: 9/11 00z
Forecasted accumulated rainfall:

Uncoupled NOAA-ESRL HRRR:
15-hr Initialized:
9/11 23z (1700 LT)

Coupled WRF/WRF-Hydro model
Initialization:
9/11 00z
Valid: 9/12 07z
Forecasted streamflow coupled WRF/WRF-Hydro model

Initialization: 9/11 00z

Valid: 9/12 07z

Streamflow in cms
Summary:

• The need for more impacts-oriented hydrometeorological forecast information is driving a host of prediction system innovations

• NCAR resides at an intellectual cross-road for integration of atmospheric, hydrologic and computing sciences and prediction system engineering

• The WRF-Hydro system offers an extensible, scalable architecture for hydrometeorological research and predictions

• WRF-Hydro v2 released last week with updated code, expanded parallel computing capabilities and training materials
Thank you!

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WRF-Hydro: http://www.ral.ucar.edu/projects/wrf_hydro/

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