Motivation
• During 3–4 May 2010, heavy rainfall resulted in devastating flooding:
  • 26 fatalities
  • $2–$3 billion in damages throughout Tennessee and Kentucky
  • 48-h precipitation totals exceeded 400mm in some locations
  • All-time record levels and discharges were observed at several river gauging sites

Goals and questions:
• Identify most prominent moisture sources; isolate roles of Pacific, Atlantic (Caribbean) moisture
• What was the role of terrain in favorable dynamics and thermodynamics, focusing of precipitation?
• How does sensitivity to key features relate to forecast success, challenges?
• How does sensitivity realized through atmospheric model changes relate to sensitivity in surface hydrologic quantities?
• Can we identify components of the hydrologic routing and modeling that can be improved for improved impacts forecasts?

The impact of model physics and upstream moisture sources on the May 2010 Tennessee flooding event: An examination of precipitation and surface hydrology

Kelly Mahoney
CIRES/NOAA/University of Colorado

Objectives and scientific questions
• Linkage to the NOAA Hydrometeorology Testbed – Southeast Pilot Study (HMT-SEPS):
• HMT-SEPS aims to improve quantitative precipitation forecast (QPF) and flood forecast skill through the following objectives:
  i. clarify processes/environmental parameters affecting extreme precipitation;
  ii. identify human and model QPF challenges;
  iii. identify new or improved tools, definitions and classifications to connect relevant research findings to benefit operational forecasting.

New WRF tools and capabilities: Using MMET and WRF-Hydro to evaluate physics, resolution, hydrologic sensitivity
The Mesoscale Model Evaluation Testbed (MMET) was established by the Developmental Testbed Center (DTC) to assist the research community in efficiently demonstrating the merits of a new technique by providing datasets to utilize for testing in a common framework in order to effectively transition promising new advances into operations (see Wolff et al. poster, P77)

Summary
• The Nashville, TN flooding event of 2010 was a very high-impact event that motivates and serves as an ideal case to explore many sources of model sensitivity
• Moisture transport to flooded region has strong synoptic-scale dynamical forcing; even when a main tropical moisture conduit is interrupted, synoptic dynamics still produce considerable rainfall.
• Sensitivity to NWP model resolution, physics packages relatively lower when initialized with CFSR; more noticeable with more dramatic MBB-based/NAM-initialized testing
• For MET simulations, over-forecast of precip in LA and TN in all runs; timing error vs. location error? (Need longer simulation to test.)
• KF CP scheme generates NW–SE-oriented precip banding not seen in explicit convection (no CP) runs
• Increased horizontal resolution increases precipitation maxima; does not strongly affect MCS motion

Next steps
• Perform verification of all simulations with MET
• Compare operational model errors to WRF forecast and simulation errors
• Pursue improved simulations with WRF-Hydro
• Compare rain rate vs. streamflow distributions in simulations versus observations

Sensitivity testing: Upstream moisture and terrain
1. Total (72-h) precipitation

2. Two main MCS events & Evolution of integrated water vapor transport (IVT)

3. Connection to HMT-SE Extreme Precipitation Climatology

Model scenario
- WRF: version 3.5.1
- Simulation duration: 48 hours (UTC 1200 on 1 May–1800 UTC 3 May 2010)
- Model output frequency: 3-hourly
- Model physics:
  - physics package: no CP scheme, Thompson microphysics, YSU PBL scheme, NOAH land-surface model, Dudhia, RRTM radiation
  - Initial conditions:
    - Model simulations: Eta physics
    - NCEP Climate Forecast System Reanalysis (CFSR) data (Saha et al. 2010)
  - Resolution:
    - 4-km horizontal grid spacing; 54 vertical levels
  - Model simulations:
    - Sensitivity to upstream moisture: up to 30 km above

Model output:
- Simulated reflectivity (CTRL)
- DryCarib
- Sensitivity to upstream moisture (CTRL)
- DryCarib

1. 48-h Total Precip Accumulation

2. Simulated reflectivity: 2 main MCSs

3. WRF-Hydro
The WRF-Hydro system is now available with WRF version 3.5. WRF-Hydro was designed as a model coupling framework to facilitate easier coupling between the WRF model and components of terrestrial hydrological models (see Goich et al. oral presentation #21). Here, we explore its basic utility as a proof-of-concept with the ultimate goal of relating WRF precipitation to surface hydrology, river flood stage, and flood impacts.

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• The color bar is used to indicate the intensity of precipitation, with different colors representing different levels of precipitation. The color bar is an important tool in meteorology for understanding the intensity and distribution of precipitation.

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