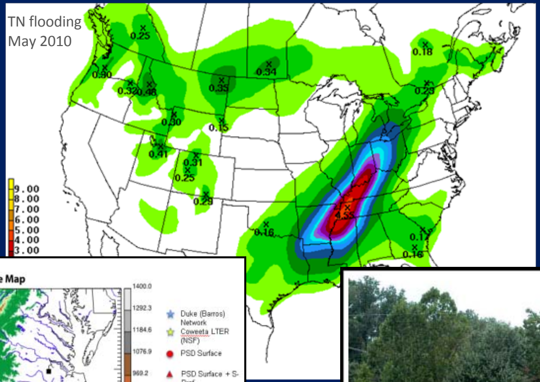
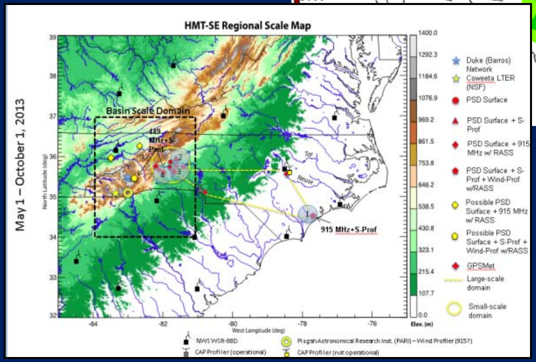
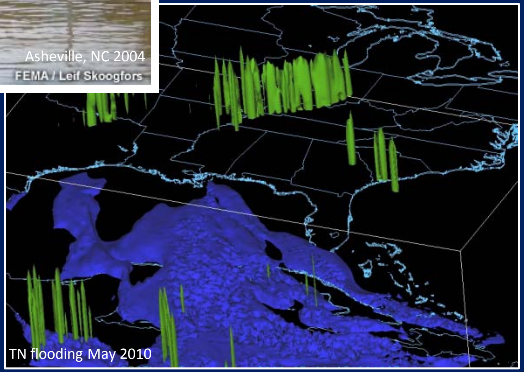
HMT-Southeast Pilot Study







Community Update
June/July 2012

Outline

1. HMT-SE history
2. HMT-SE Science Plan overview
3. HMT-SEPS Deployment
4. Preliminary climatology & QPF verification work
5. Next steps and potential future directions

History of HMT-SE

- Pre 2011
  - Goal to establish long term testbed in southeast
    - Workshop(s) to identify needs and requirements
  - Tar-Neuse identified as possible area of focus
- 2011-2012
  - Budget cuts force HMT to "re-think" plans for southeast
  - NASA desire to do a ground validation field campaign for Global Precipitation Measurement (GPM) mission in N.C. with NOAA HMT
  - NOAA HMT-Southeast Pilot Study (HMT-SEPS) and NASA GPM Convective and Orographic Precipitation-Hydrology Experiment (COPrHEX) near Asheville, NC
  - Originally planned for 5 months in 2013
  - Revised to 16 months (May 2013 – September 2014) due to pushback in GPM satellite launch

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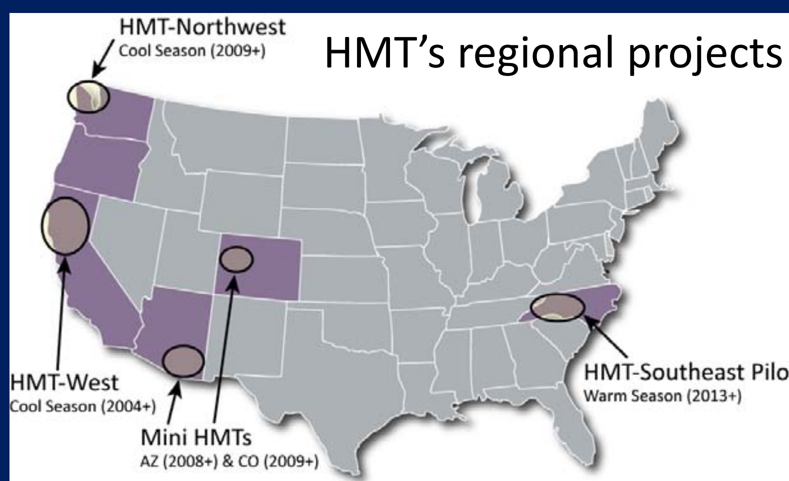
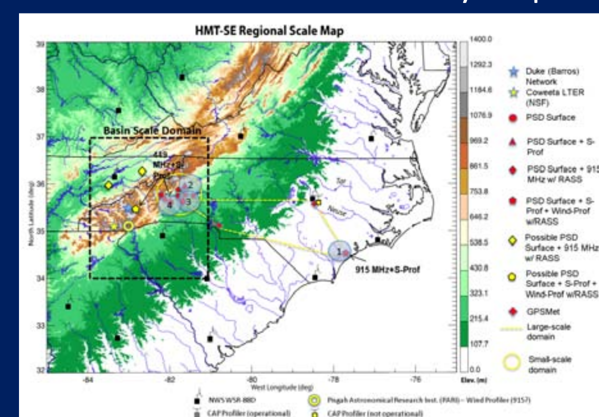
NOAA's Hydrometeorology Testbed (HMT)

- HMT conducts research on precipitation and weather conditions that can lead to flooding
- Fosters transition of scientific advances and new tools into forecasting operations
- Accelerates development , prototyping of advanced hydrometeorological observations, models, and physical process understanding
- HMT-Southeast: 2 parts
  1. Pilot Study in western North Carolina (Spring 2013 – Fall 2014)
  2. Operationally-oriented research on extreme precipitation and forecast challenge identification

Mobile atmospheric river observatory (as used in HMT-West and HMT-Northwest)

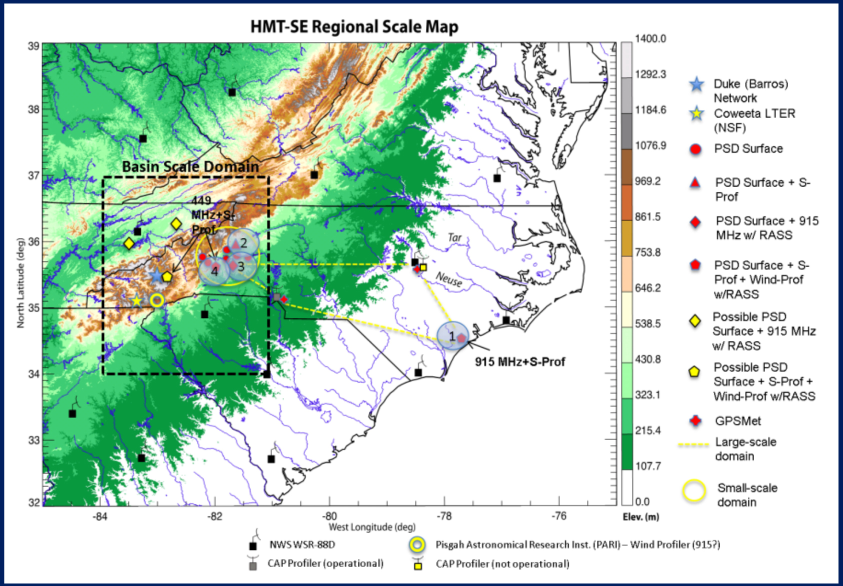


HMT-Southeast Pilot Study map



HMT-Southeast Pilot Study (“HMT-SEPS”)

- Planned for May 2013 – September 2014 in western North Carolina
- Largely focused on QPE in western NC (but some instrumentation in central and eastern NC)
- NOAA will bring instrumentation and also leverage additional assets from NASA ground validation campaign
- Exact deployment plan still in development (Rob to discuss next)
- Science Plan will continue to document Pilot Study details, and updates will be posted to HMT website and distributed through email list



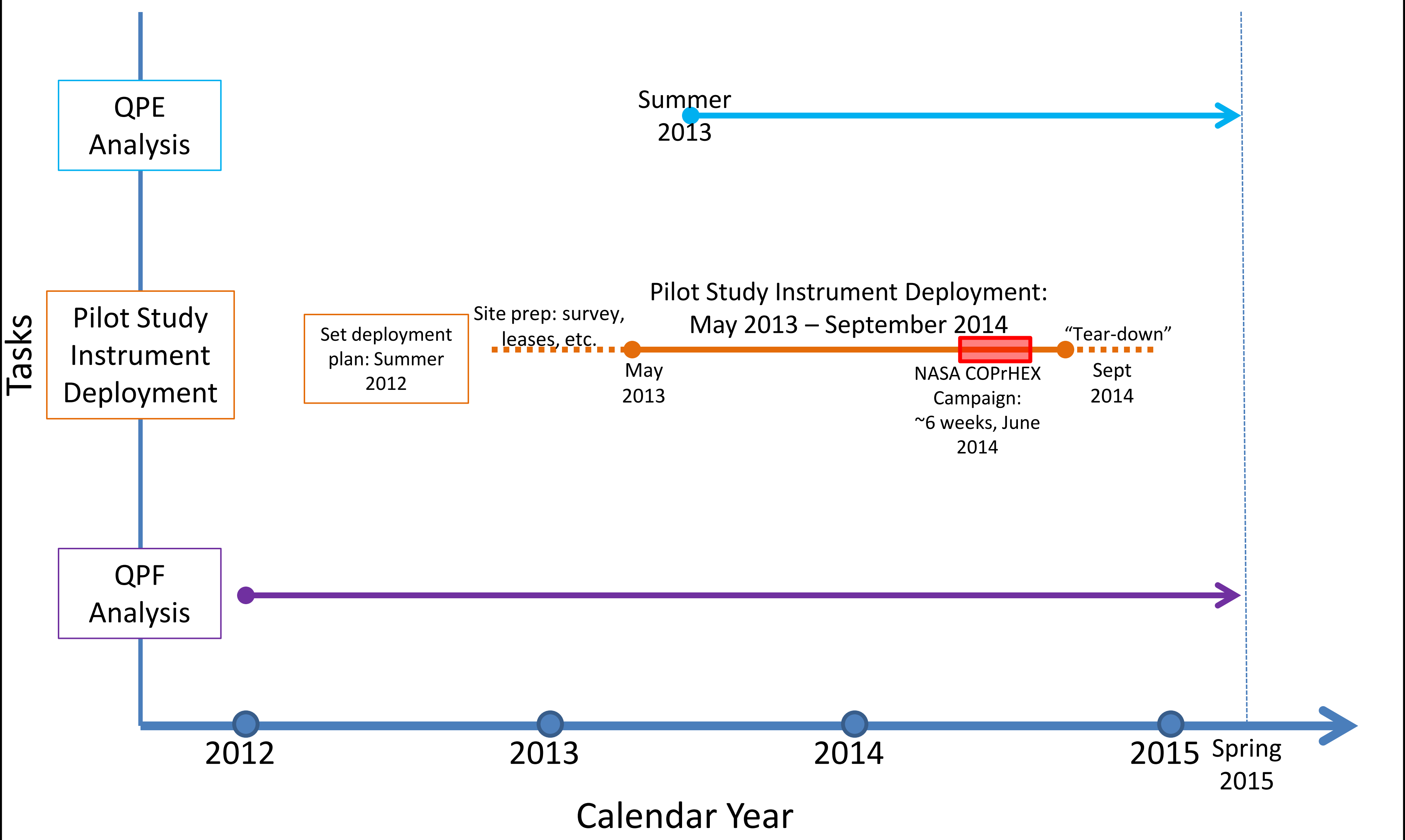
Main tasks as described in Science Plan

- Quantitative precipitation estimation (QPE)
  - Deployment
  - Data management
  - QC radar data
  - Calibration of profiler/disdrometer data
  - Profiler drop size distribution (DSD) retrievals/partition profiler data
  - NEXRAD DSD retrieval/rainfall rate comparisons
  - Integration/evaluation of QPE in NMQ/MPE
  - Manuscript preparation

- Quantitative precipitation forecasts (QPF)
  - Extreme precipitation climatology
  - QPF verification of extreme precipitation, error identification
  - Process studies
  - Case study analysis
  - Manuscript preparation

- QPE and QPF tasks directed toward "research-to-operations" (R2O) – critical to find/strengthen key partnerships now

Timeline



Tasks
QPE Analysis
Summer 2013
Pilot Study Instrument Deployment
Set deployment plan: Summer 2012
Site prep: survey, leases, etc.
Pilot Study Instrument Deployment: May 2013 – September 2014
May 2013
NASA COPrHEX Campaign: ~6 weeks, June 2014
"Tear-down"
Sept 2014
QPF Analysis
2012
2013
2014
2015
Spring 2015
Calendar Year

HMT-Southeast: QPE Research Objectives

- Evaluate the NWS radar-rainfall algorithms
- Evaluate and improve QPE systems (MPE,MRMS, and others as appropriate) in regions extending from the Appalachian mountains to the piedmont to coastal plain, including
  - impact of additional sensor information on QPE systems (e.g., VPR correction);
  - intelligent integration of multi-sensor QPE information for gauges, radars, and satellite;
  - infrared (IR) and microwave satellite QPE products (CMORPH, SCaMPR, Hydro-Estimator, TRMM 2A25 and 3B42) with ground-based QPE;
  - 4-D structure of precipitation and variability of the drop size distribution (DSD) with resulting impact on QPE systems (e.g., radar-rainfall estimators)
- Evaluate impact of gap-filling radars on QPE systems

HMT-Southeast: QPF Research Questions

- What is the climatology of extreme precipitation events in the southeast U.S.?
- How do QPF errors relate to the largest observed precipitation events?
- What are the primary moisture sources and moisture transport mechanisms for extreme rainfall in the southeast U.S.?

Research approach:

1. Climatology of observed extreme events and associated environments
2. Climatology of QPF successes, errors
3. Case studies of observed extreme events: Diagnostic observational analysis, numerical model-based experiments

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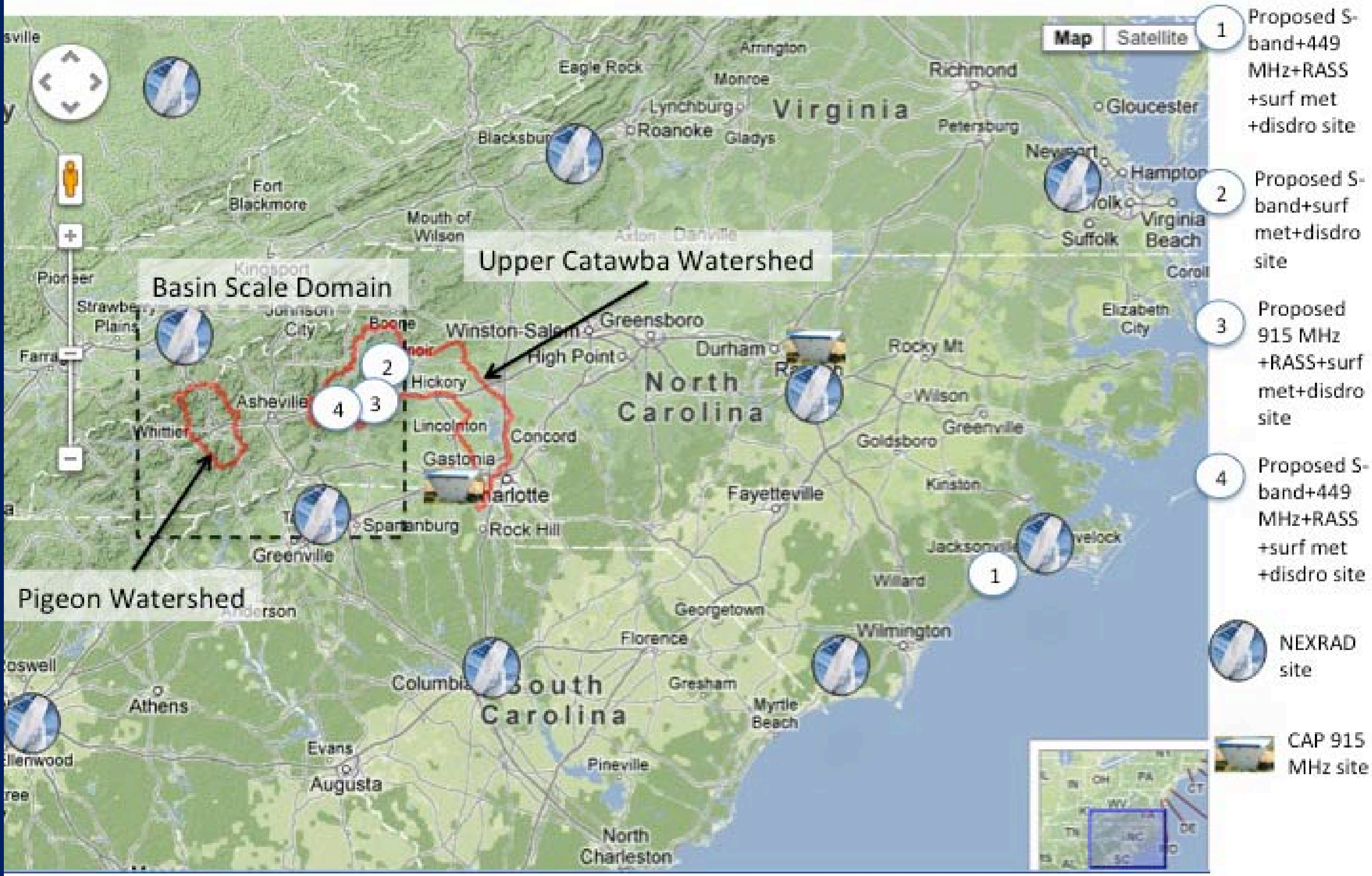
HMT-SE Pilot Study (HMT-SEPS)

- HMT-SEPS is pilot project in western NC
  - Primary focus is Upper Catawba watershed near Asheville
  - 2ndary focus is coastal region
- Project duration is May 2013 – April 2015
  - Instrument deployments May 2013-Spetmeber 2014
- Involve close coordination with NASA GPM GV
  - QPE is big driver for both GPM GV and HMT-SEPS
  - GPM GV will have intensive field campaign May-June 2014 in same region
- Principal focus of HMT-SEPS is QPE and QPF
  - Hydrology and surface process activities also identified

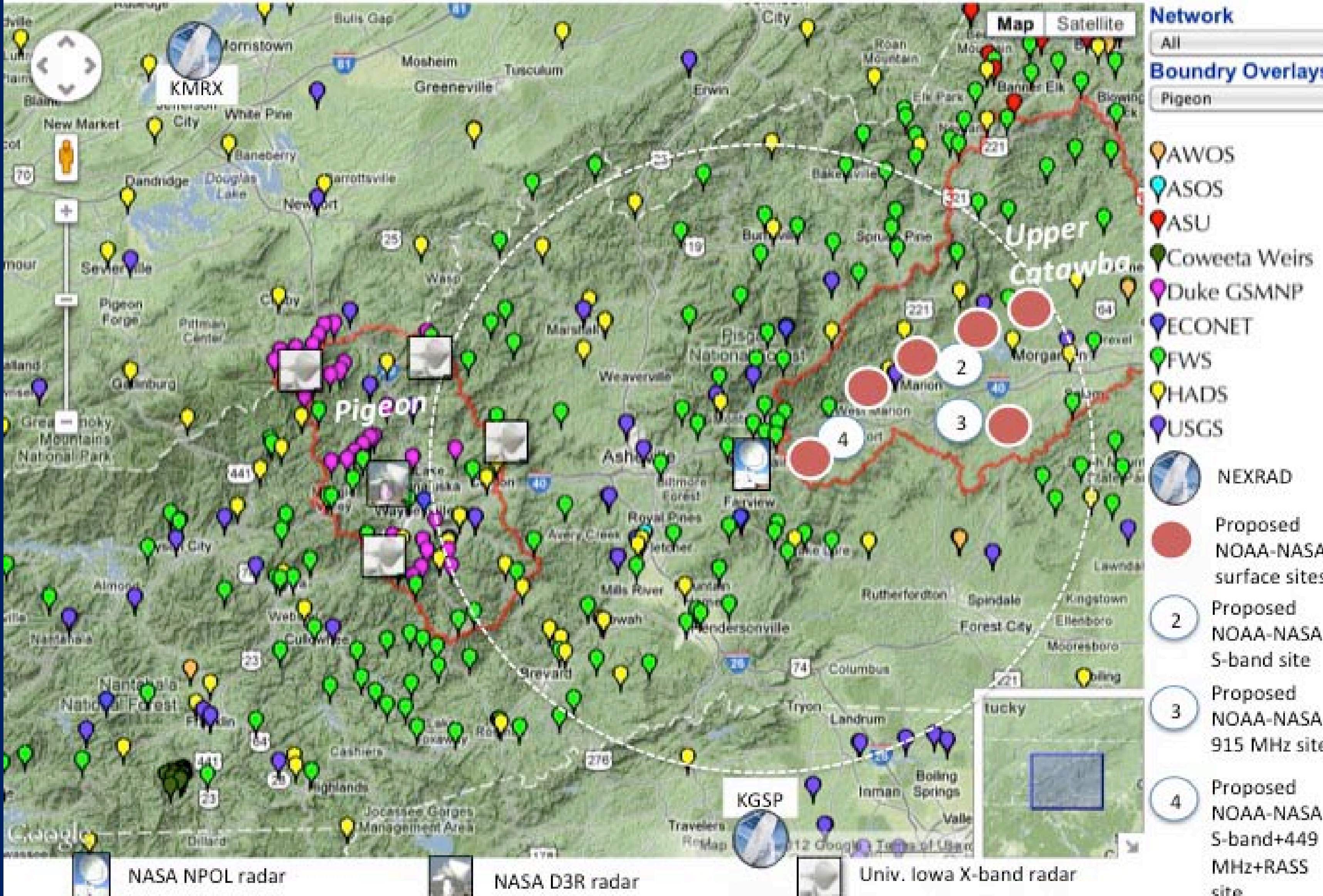
Tentative Deployment for HMT-SEPS

- May 2013 - September 2014
- Instrument deployment to be supported by NOAA and NASA (exact details TBD)
- Current plan includes:
  - 4 profiler sites
  - 6 separate surface sites (gauges, disdrometers, soil moisture)
- Focus on QPE

Proposed NOAA-NASA Deployment Plan (Regional Scale)



Proposed NOAA-NASA Deployment Plan (Basin-Scale)



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1. Climatology of extreme precipitation events in the Southeast: Data and methods

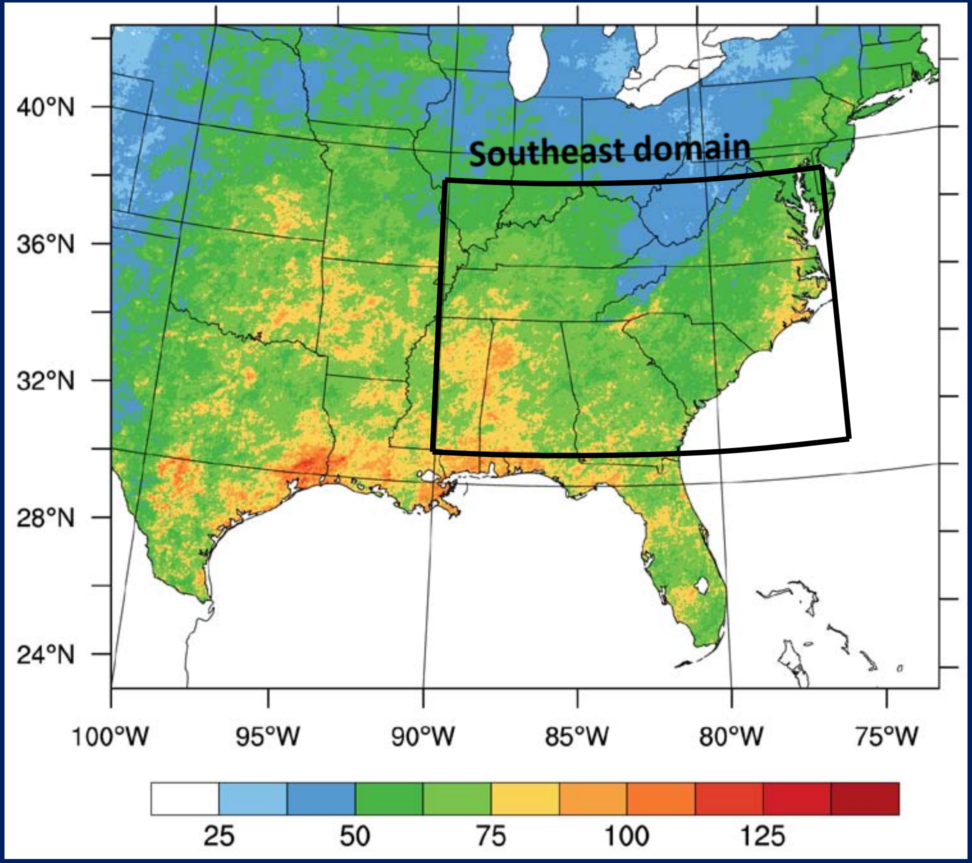
Data sources:

- Daily (12Z–12Z) precipitation accumulations for 2002–2011 NCEP Stage-IV QPE product at 4-km resolution
- NARR and CFSR used to examine environmental characteristics of events
- Previous climatologies exist: many use gauge/station data
- Gridded dataset facilitates better coverage, diagnosis of event spatial characteristics; flexible approach

Method of event identification:

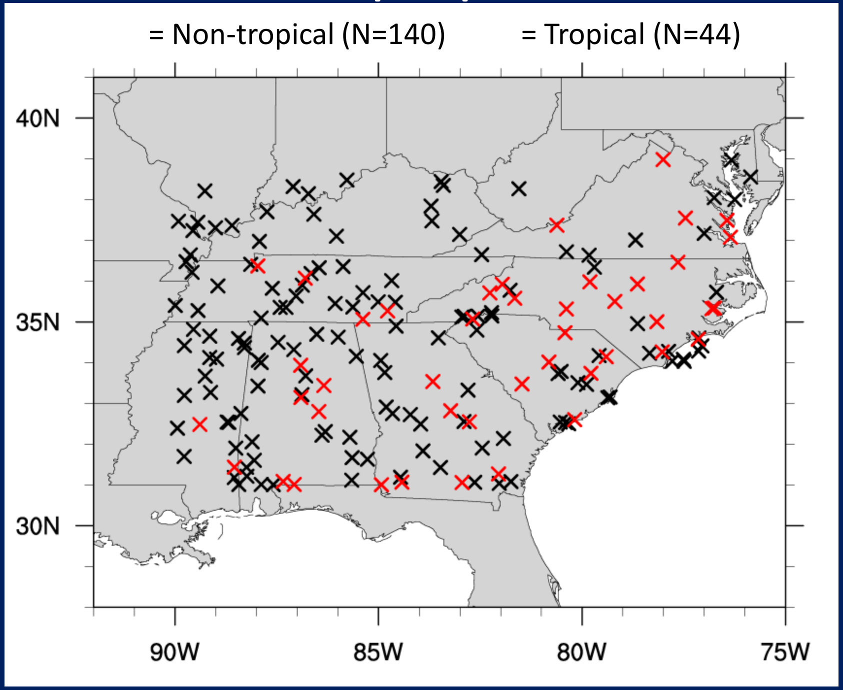
- 99th percentile of 24-h precipitation calculated at each grid point for all days with precipitation >0
- Extreme precipitation “events”: 24-h periods for which the 99th percentile threshold was exceeded at >1000 grid points (~16000 km^2) within “southeast” domain
- Tropical/non-tropical classification using National Hurricane Center Best Track information + national radar mosaic imagery
- **This presentation focuses primarily on non-tropical events**

99th percentile of 24-h precipitation (mm)

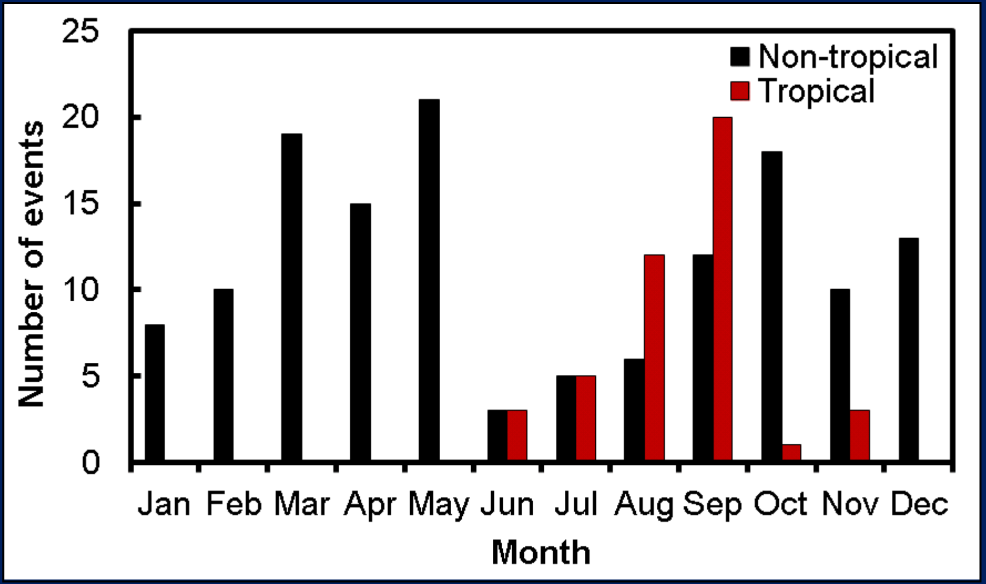


Climatology of extreme precipitation events in the Southeast

Locations of maximum 24-h precipitation for each extreme precipitation event



Monthly frequency distribution of non-tropical and tropical events



Salient climatological characteristics:

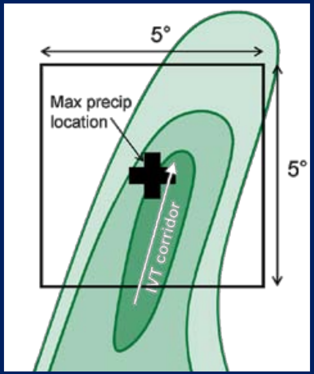
- Non-tropical events most common in interior southeast; tropical events most common along east coast
- Extreme precipitation events occur in all months in southeast; least common in summer months
- Non-tropical events most frequent in May; tropical events most frequent in Sept
- West of Appalachians and in Gulf Coast states, non-tropical events most frequent in DJF and MAM
- East of Appalachians, non-tropical events most frequent in SON

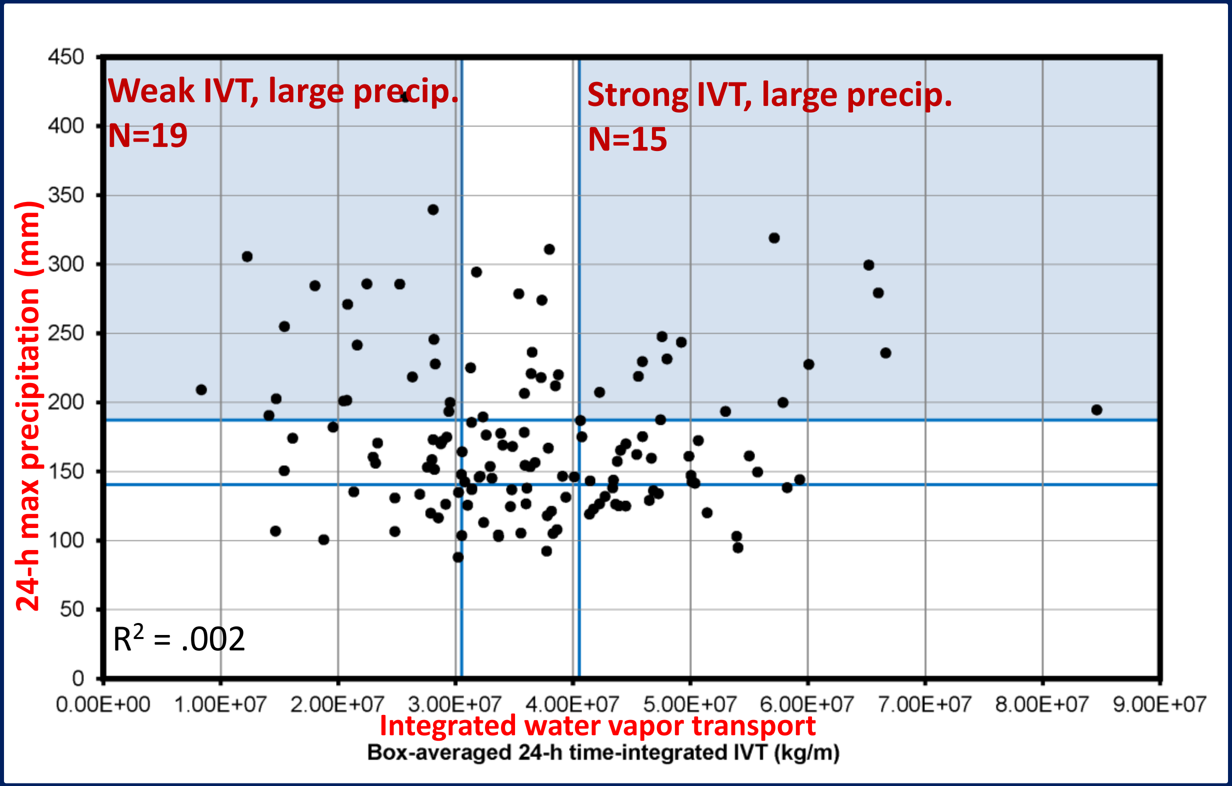
Classification of non-tropical events

Key question: How does magnitude of water vapor transport relate to precipitation amount?

Approach:

1. Quantify water vapor transport: vertically integrated water vapor transport (IVT)
2. For each event, average the 24-h time-integrated IVT from NARR within 5° lat × 5° lon box centered on maximum precipitation location
3. Examine correlation between maximum precipitation amount and IVT value





Results and additional questions:

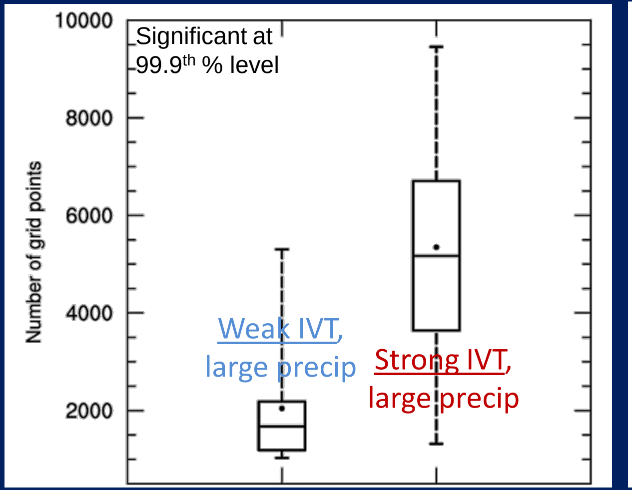
- Nearly zero correlation observed between max precipitation and IVT– this is in marked contrast to west coast heavy rainfall events, which are predominantly associated with "atmospheric rivers"

→ How are large precipitation events with weak IVT distinguished from those with strong IVT?

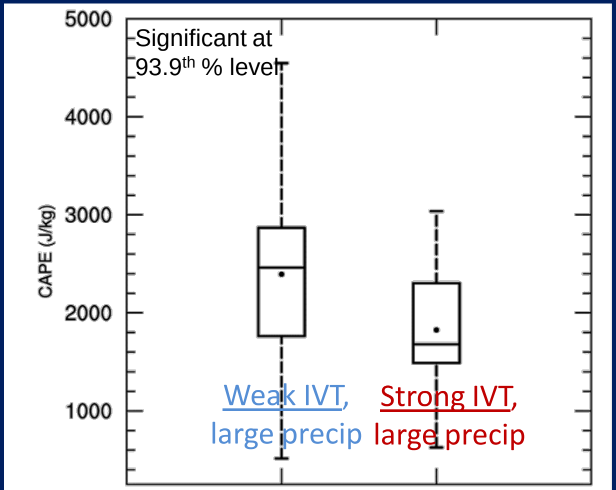
→ Compare largest events in the strongest, weakest IVT terciles

Extreme precipitation climatology: Key properties of events

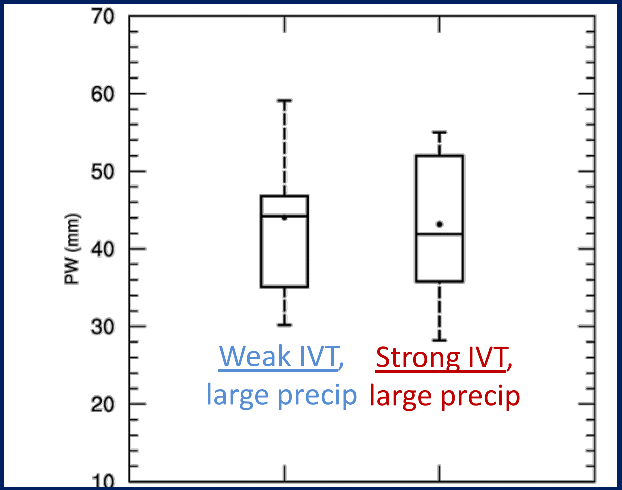
Areal coverage



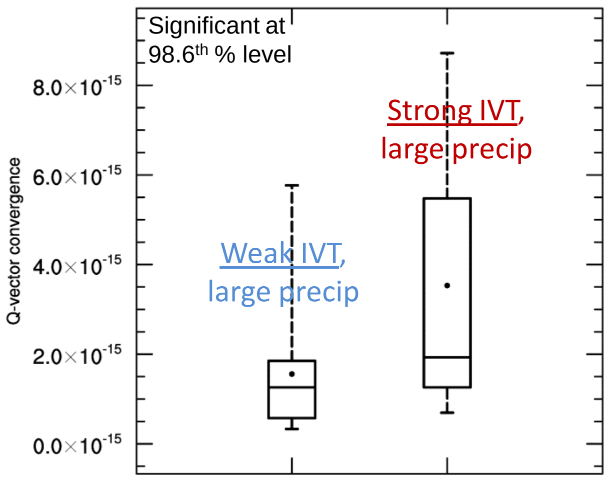
CAPE



Precipitable water



850–700-hPa layer-averaged Q-vector convergence



Weak IVT, large precipitation events:

- More localized/small-scale
- Larger CAPE
- Weaker QG forcing for ascent

Strong IVT, large precipitation events:

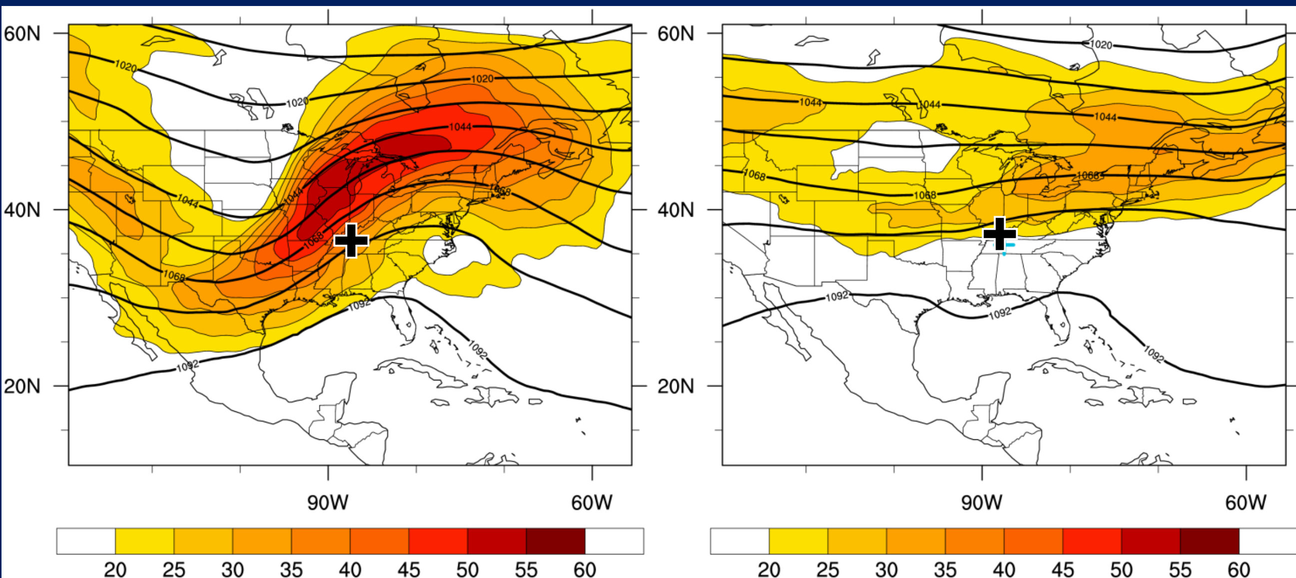
- More widespread/larger-scale
- Weaker CAPE
- Stronger QG forcing for ascent

Analysis uses CFSR dataset for 6-h largest precipitation period using maximum value (of PW, CAPE, Q-vect conv) within 5° lat × 5° lon area centered on event

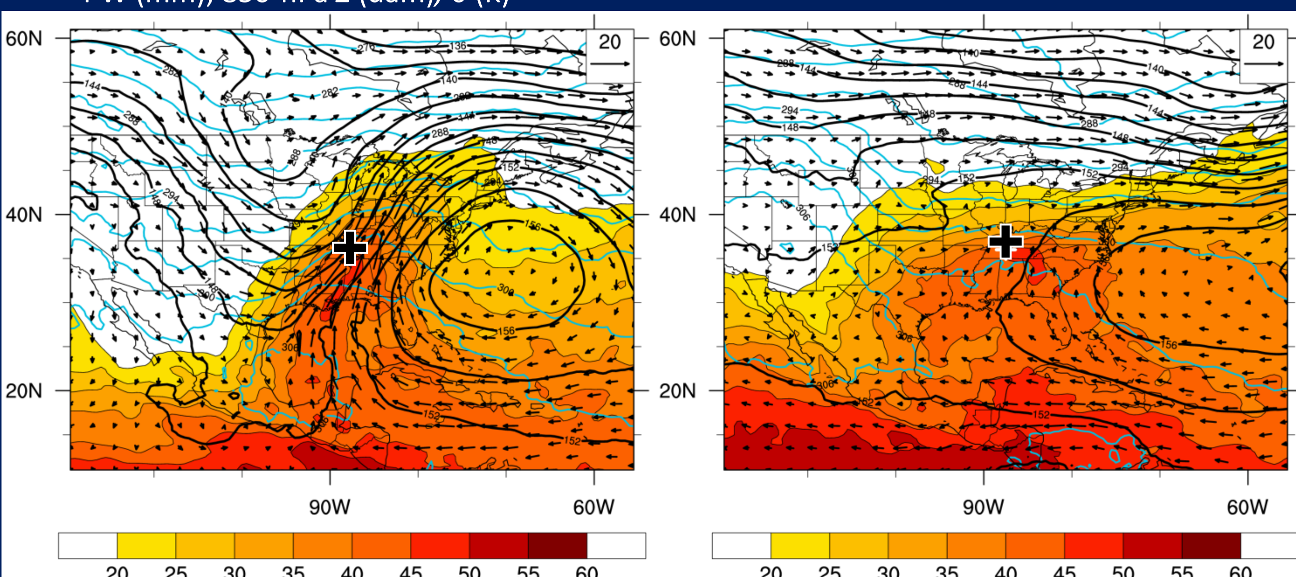
Event-relative composite synoptic-scale environments

Strong IVT, large precipitation (N=15) | Weak IVT, large precipitation (N=19)

250-hPa *Z* (dam), wind speed (m s^{-1})



PW (mm); 850-hPa *Z* (dam), θ (K)



Key characteristics

- Amplified upper-level trough-ridge couplet, strong jet streak for “strong IVT” events
- Intense corridor of water vapor transport from low latitudes for “strong IVT” cases; gradual poleward flow of moist air around subtropical high for “weak IVT” cases
- Large PW values for both categories; larger CAPE for “weak IVT” cases
- Stronger low-level warm advection in precipitation region for “strong IVT” cases -> stronger QG forcing for ascent than “weak IVT” cases

* Composites are event-relative; geography shown for spatial reference and distance scaling only. Computed using CFSR at beginning of 6h period of largest precip

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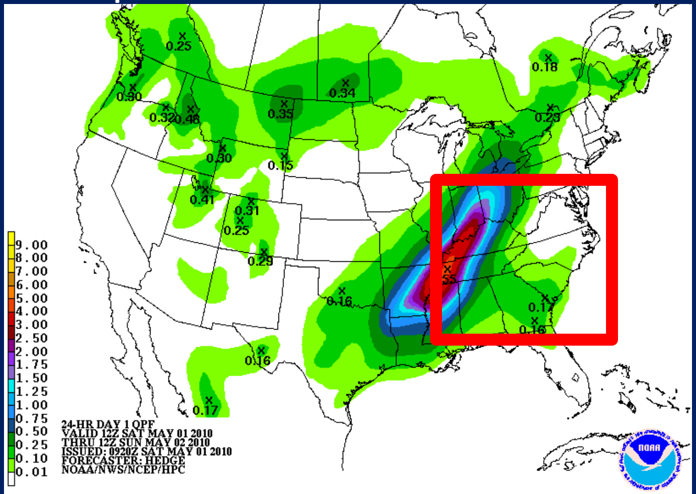
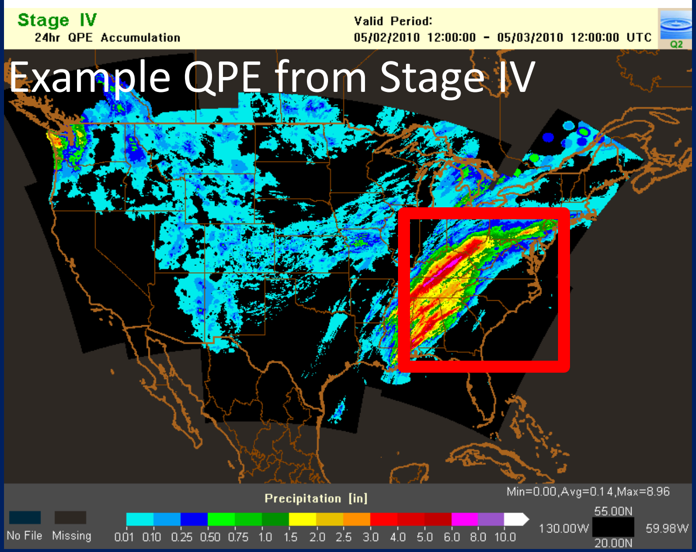
Forecast skill for extreme precipitation events: : Forecast and Evaluation Data

Example QPF from HPC



Example QPE from Stage IV



Data Period:

1 January 2002 - 31 December 2011

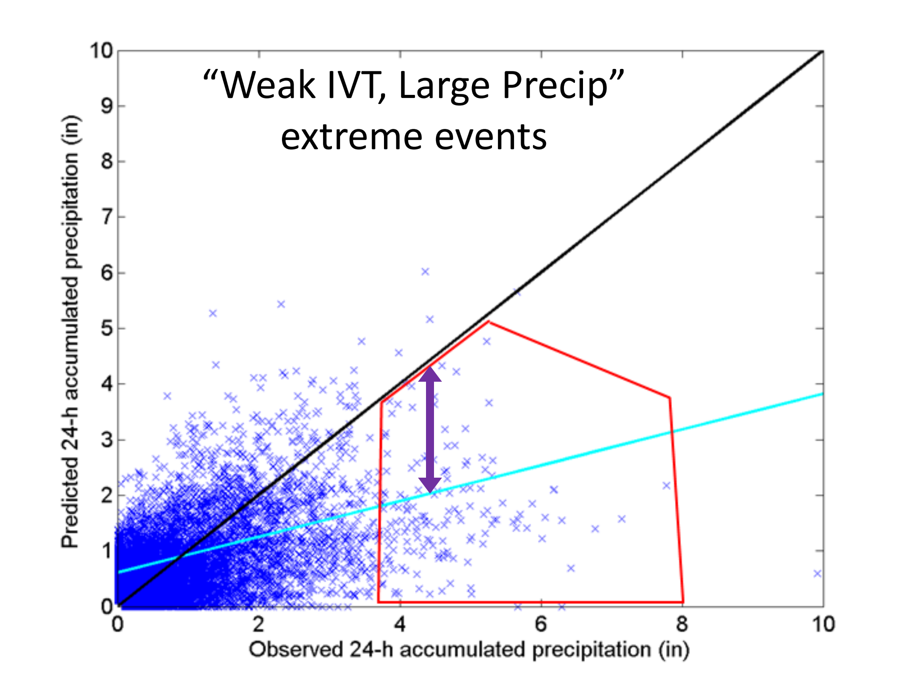
Forecasts:

- HPC CONUS Quantitative Precipitation Forecasts (QPF)
- 32-km resolution
- Forecasts valid 12Z to 12Z
- Day 1 (24 h) forecasts evaluated here

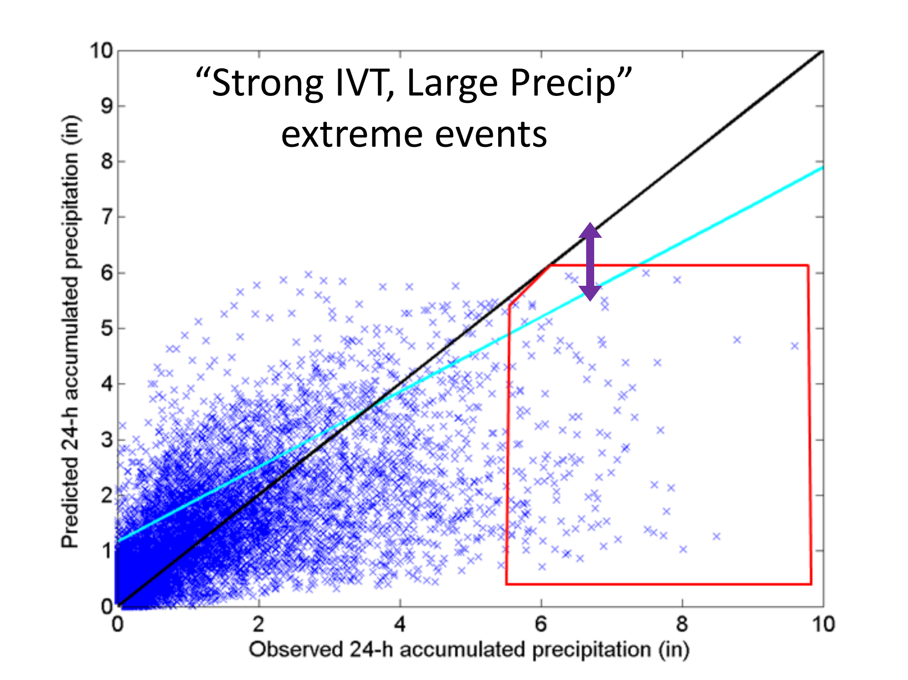
Verification/quantitative precipitation estimates (QPE)

- Stage IV data
- 32-km resolution (upscaled from 4-km)
- Accumulated precipitation from 12Z to 12Z

QPE vs. QPF:
Strong IVT vs. Weak IVT cases



Weak IVT cases: underforecast at higher precipitation amounts

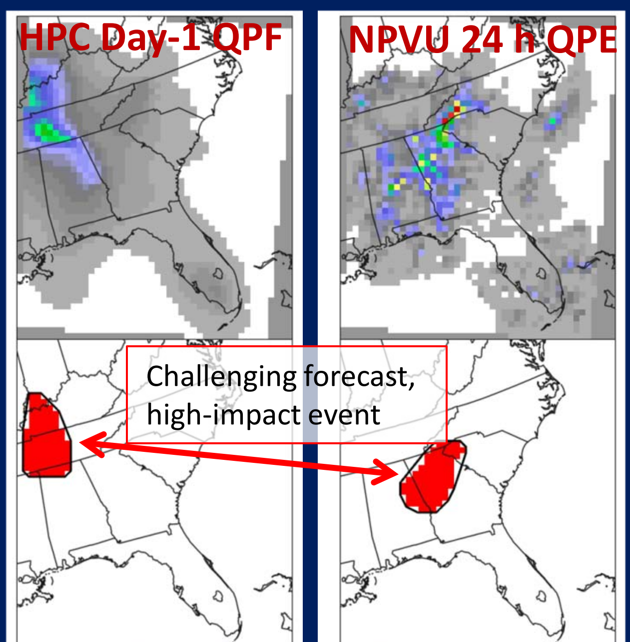


Strong IVT cases: also underforecast at higher precipitation amounts, but not by as much

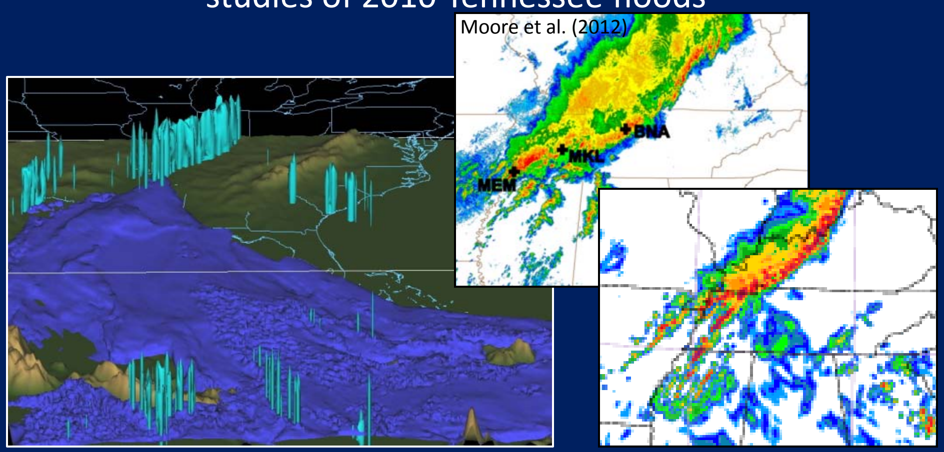
QPF research: Ongoing work and future directions

- Climatology: More compositing, sub-regional event types, focus on event subsets associated with largest QPF errors
- QPF: QPF error assessments using traditional verification metrics <u>and</u> spatial verification, expand to additional forecast datasets (NWP and human-generated)
- Case studies, process studies: diagnostic assessments, NWP experiments
- R2O: Connecting with operational community

Object-based spatial QPF verification example: Atlanta floods: 20 September 2009



Case study example: WRF model diagnostic/sensitivity studies of 2010 Tennessee floods



WRF simulated water vapor (purple) and rain (cyan) mixing ratio surfaces

Observed vs. WRF-simulated radar reflectivity

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Next steps for HMT-SE at large

1. HMT-SEPS deployment planning: Summer/Fall 2012
2. QPF/climatology work: ongoing
3. Southeast community engagement
   1. Growth through regional partnerships
   2. Establishing simple communication strategies (e.g., e-mail list, HMT website, Facebook)

Summary

- Since 2009, HMT-SE has been a moving target due to federal budget cuts
- Current funding support is far less than once envisioned, but the Pilot Study seeks to make the most of resources in hand through key partnerships -- and hard work!
- Capitalizing on specific regional interests and capabilities in a collaborative fashion will be key to upscale growth (and perhaps in turn greater and longer-term funding support?)
- Please feel free to contact us with specific collaboration/project ideas or questions:

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