Hydrometeorological Prediction Center 2012 Review and R2O Activities

Wallace Hogsett
Science and Operations Officer

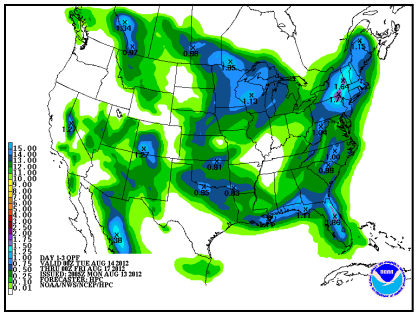
with contributions from HPC: Jim Hoke, David Novak, Mark Klein, Keith Brill, Chris Bailey, Dan Petersen, Faye Barthold, Tom Workoff, Patrick Burke, Mike Bodner, Tony Fracasso, Jim Cisco

2012 Research in Transition Team (RITT) – December 2012

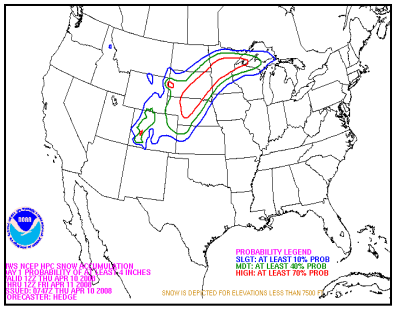
Outline

- Overview of HPC Product Suite
- Review of FY12 performance metrics (GPRA)
- Use of EMC guidance in support of HPC operations
  - QPF, Winter weather, Medium Range, MetWatch
- R2O activities via the Hydrometeorological Testbed at HPC

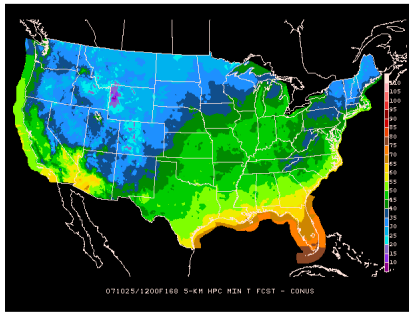
HPC Operational Desks



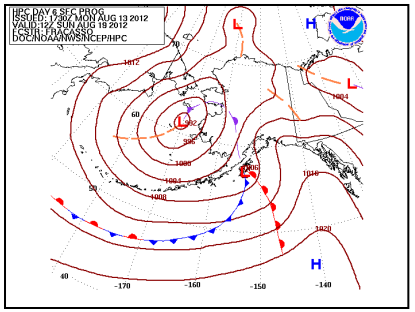
QPF



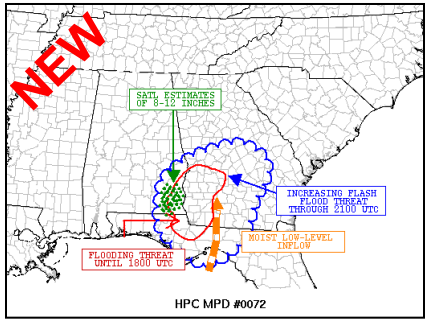
Winter Weather



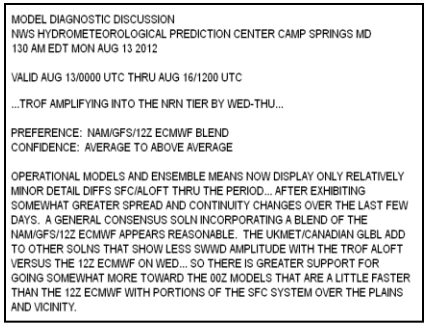
Medium Range



Alaska Med. Range



Met Watch


MODEL DIAGNOSTIC DISCUSSION
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
130 AM EDT MON AUG 13 2012

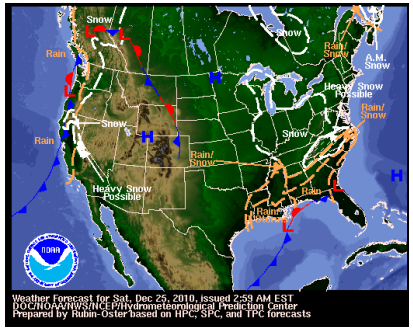
VALID AUG 13/0000 UTC THRU AUG 16/1200 UTC

...TROF AMPLIFYING INTO THE NRN TIER BY WED-THU...

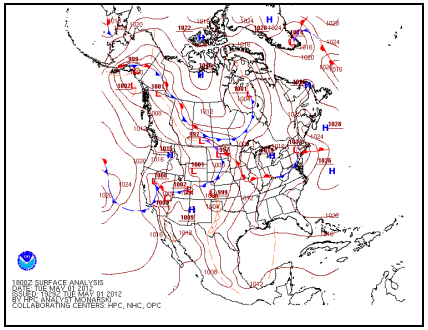
PREFERENCE: NAM/GFS/12Z ECMWF BLEND
CONFIDENCE: AVERAGE TO ABOVE AVERAGE

OPERATIONAL MODELS AND ENSEMBLE MEANS NOW DISPLAY ONLY RELATIVELY MINOR DETAIL DIFFS SFC/ALOFT THRU THE PERIOD... AFTER EXHIBITING SOMEWHAT GREATER SPREAD AND CONTINUITY CHANGES OVER THE LAST FEW DAYS. A GENERAL CONSENSUS SOLN INCORPORATING A BLEND OF THE NAM/GFS/12Z ECMWF APPEARS REASONABLE. THE UKMET/CANADIAN GLBL ADD TO OTHER SOLNS THAT SHOW LESS SWWD AMPLITUDE WITH THE TROF ALOFT VERSUS THE 12Z ECMWF ON WED... SO THERE IS GREATER SUPPORT FOR GOING SOMEWHAT MORE TOWARD THE 00Z MODELS THAT ARE A LITTLE FASTER THAN THE 12Z ECMWF WITH PORTIONS OF THE SFC SYSTEM OVER THE PLAINS AND VICINITY.

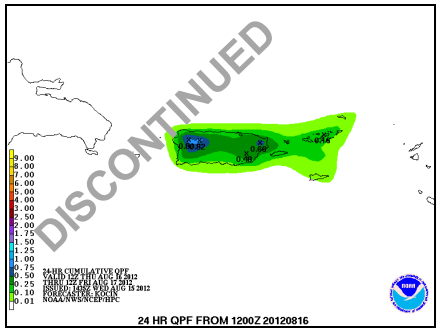
Model Diagnostics



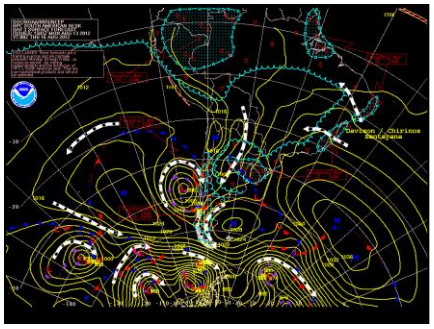
Short Range



Surface Analysis



Puerto Rico QPF



International

Tropical

NAM AIR QUALITY DIAGNOSTIC DISCUSSION
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
1024 AM EDT FRI AUG 03 2012

...INTERIOR VALLEYS OF CALIFORNIA...

THE NAM INITIALIZED TEMPERATURES ON THE ORDER OF 10 TO 15 DEGREES TOO LOW IN THE SOUTHERN VALLEYS...ESPECIALLY NEAR MOJAVE AND PALM SPRINGS.

...NORTHERN TENNESSEE VALLEY...

THE RAINFALL ASSOCIATED WITH THE DECAYING MCS WAS NOT INITIALIZED WELL BY THE NAM ACROSS CENTRAL AND EASTERN TENNESSEE...AS THE MODEL WAS TOO LIGHT WITH THE RAINFALL COMPARED TO THE OBSERVED RADAR IMAGERY AND PRECIPITATION ESTIMATES.

Air Quality

HPC Forecast Process

PAST

- Forecaster in the loop
- Subjective "model of the day"
- Manual product generation
- Extensive manual edits

Forecaster evaluation of ensemble guidance
(ex., NCEP, MDL, CMC, NAEFS, ECMWF, UKMET, FNMOC)

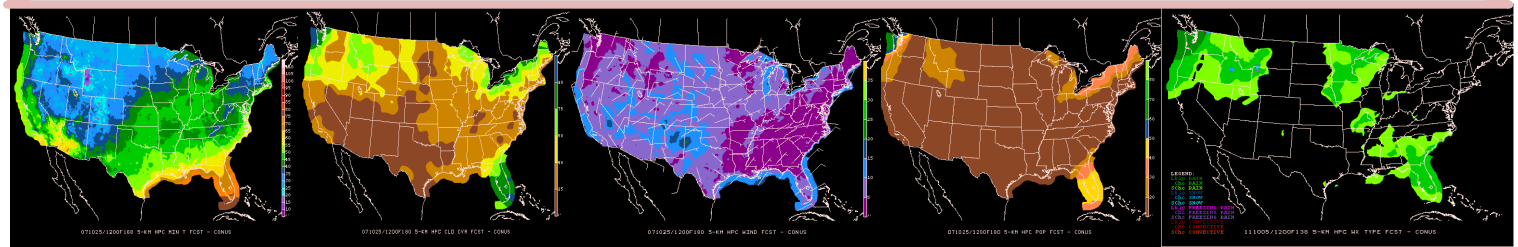
Forecaster weighting of ensemble guidance

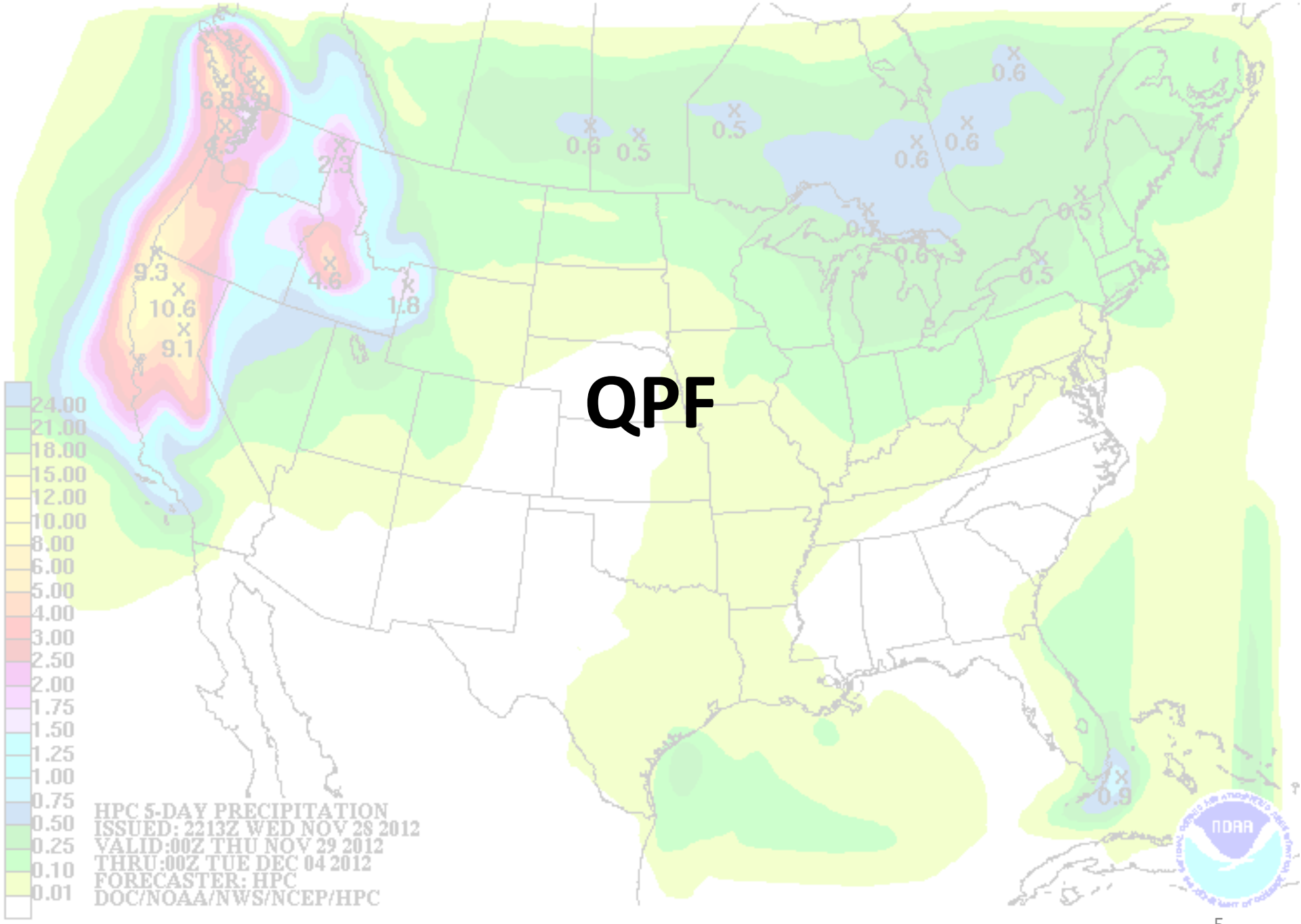
Automated grid generation

Forecaster adjustment of grids

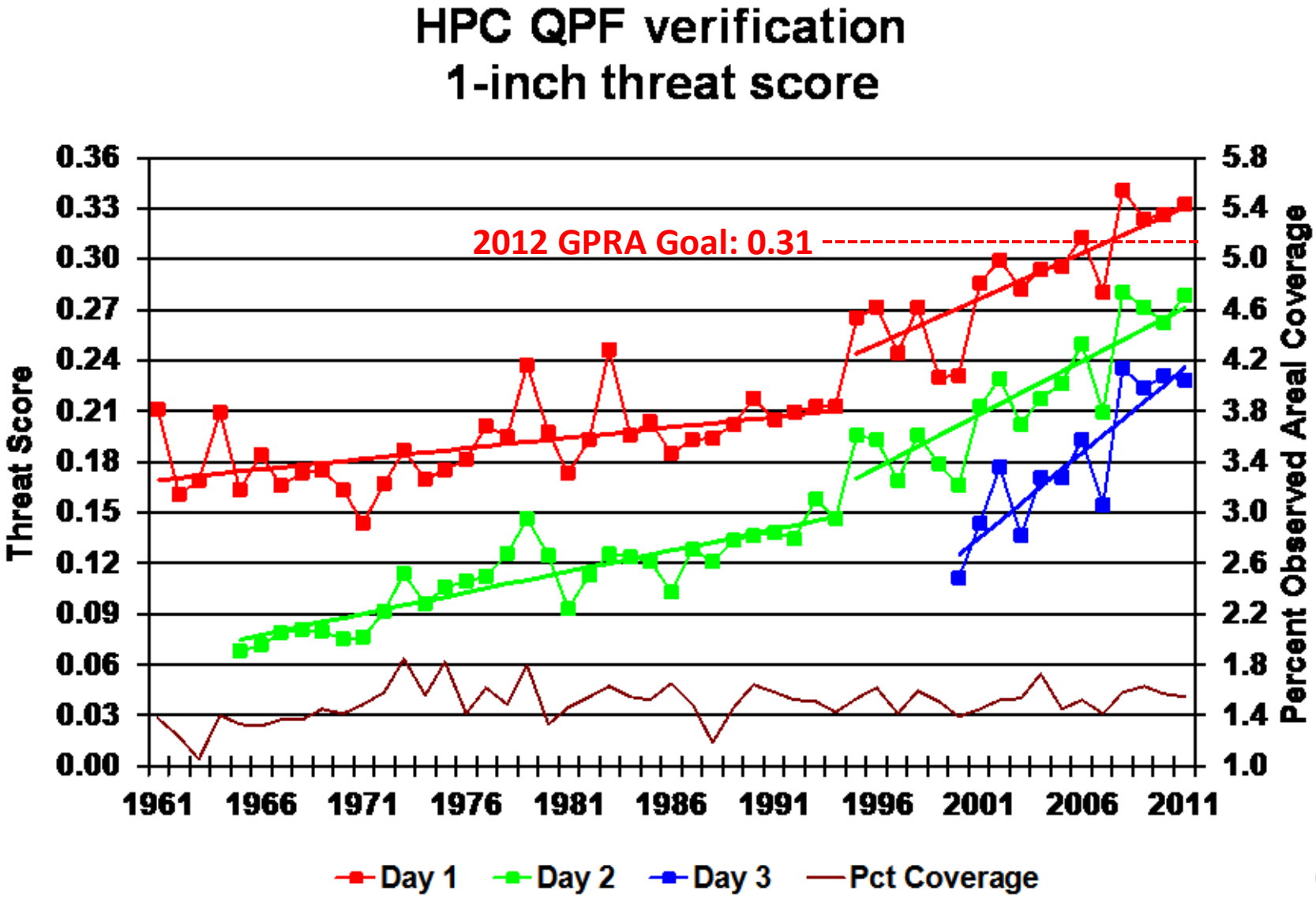
TARGET

- Forecaster over the loop
- Subjective "most likely outcome"
- Automated grid generation (spatial consistency)
- Limited manual edits



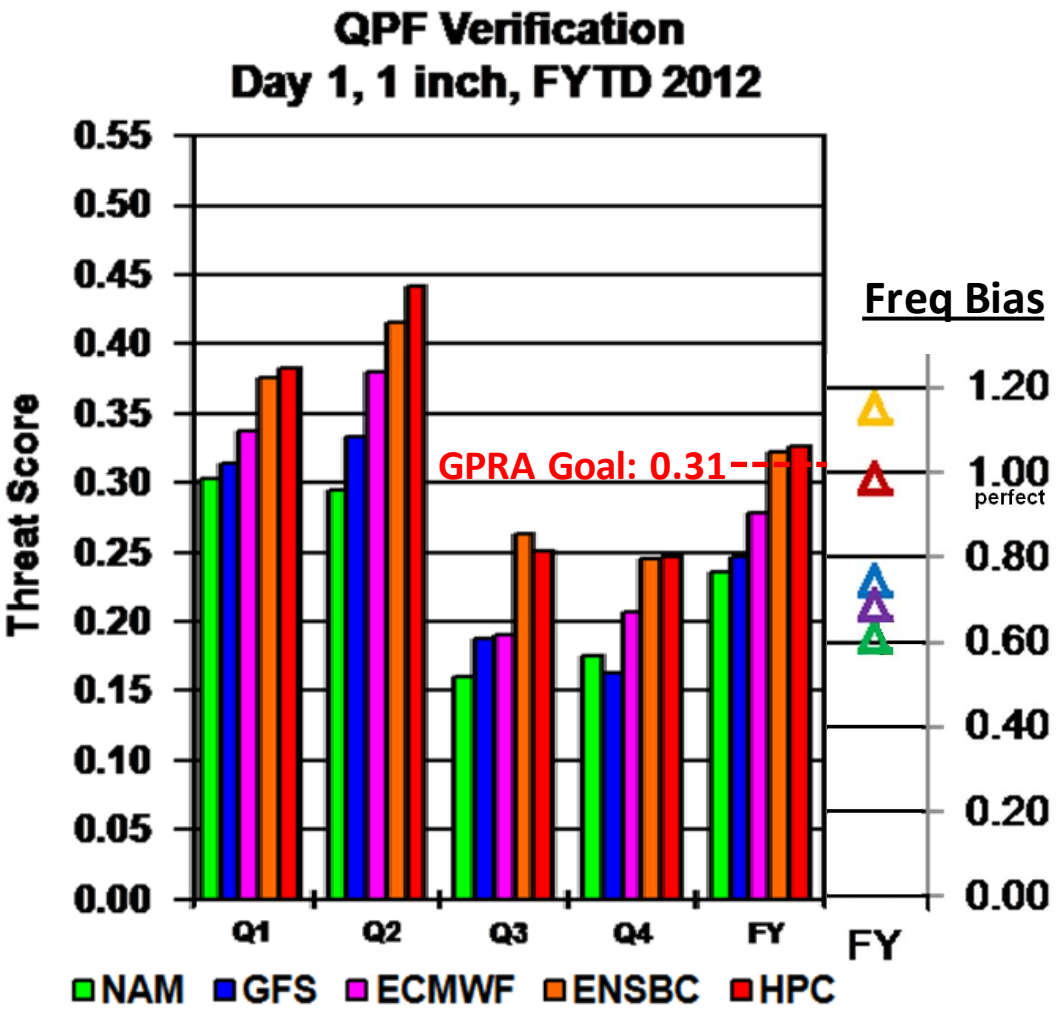

QPF
24.00
21.00
18.00
15.00
12.00
10.00
8.00
6.00
5.00
4.00
3.00
2.50
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.10
0.01
HPC 5-DAY PRECIPITATION
ISSUED: 2213Z WED NOV 28 2012
VALID:00Z THU NOV 29 2012
THRU:00Z TUE DEC 04 2012
FORECASTER: HPC
DOC/NOAA/NWS/NCEP/HPC
NOAA

Long-Term Verification



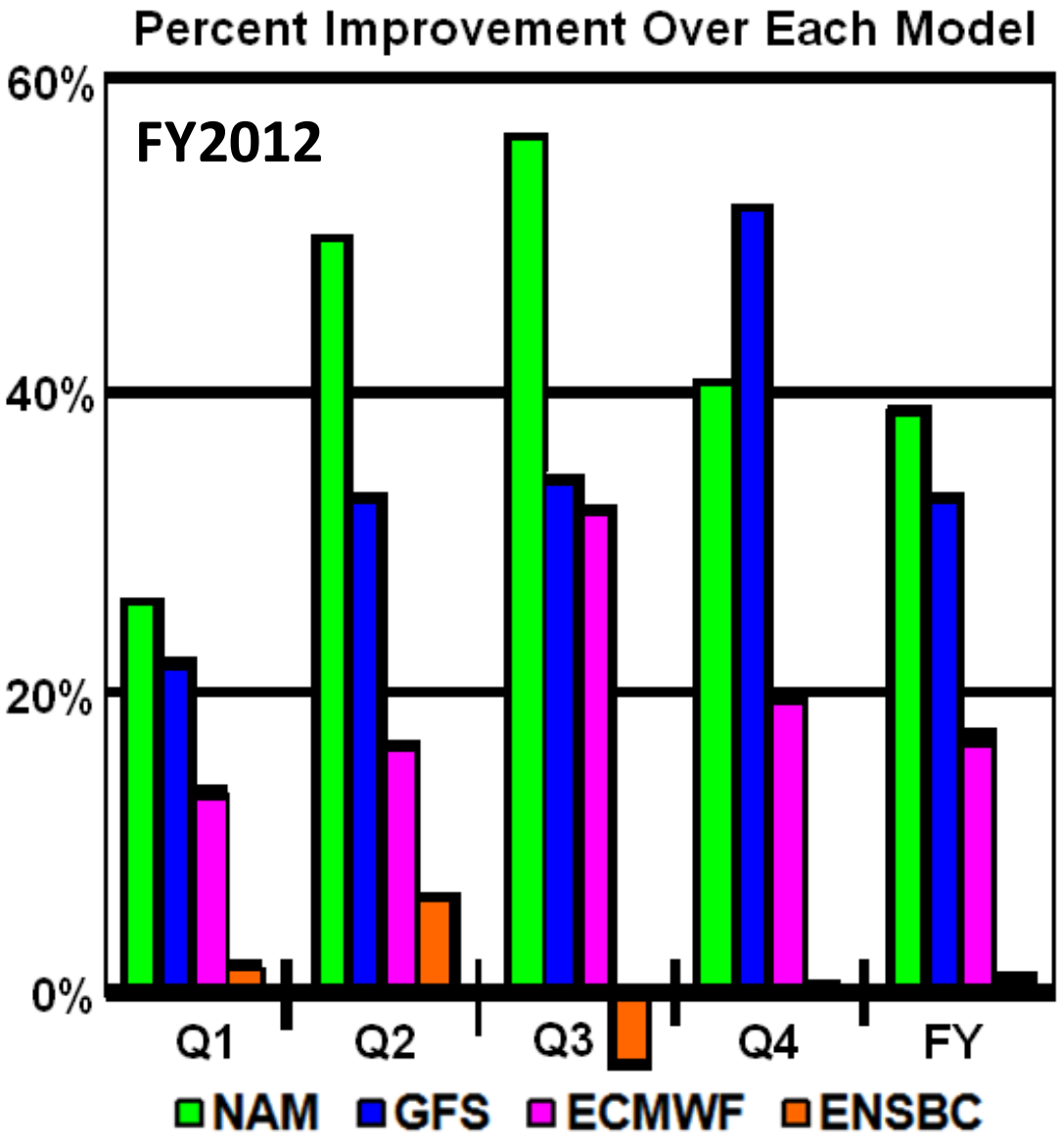
2012 HPC Verification

- Achieved 2012 GPRA goal
- HPC's internal bias-corrected ensemble (ENSBC) technique performs well at Day 1.
- In general, ECMWF>GFS>NAM
- Cool season skill (Q1 - Q2) is notably better than the warm season skill (Q3 – Q4)



Day 1: Percent Improvement

- HPC adds value to the NAM, GFS, and ECMWF
- More value is added during the more difficult warm season
- ENSBC is based on EMC guidance suite



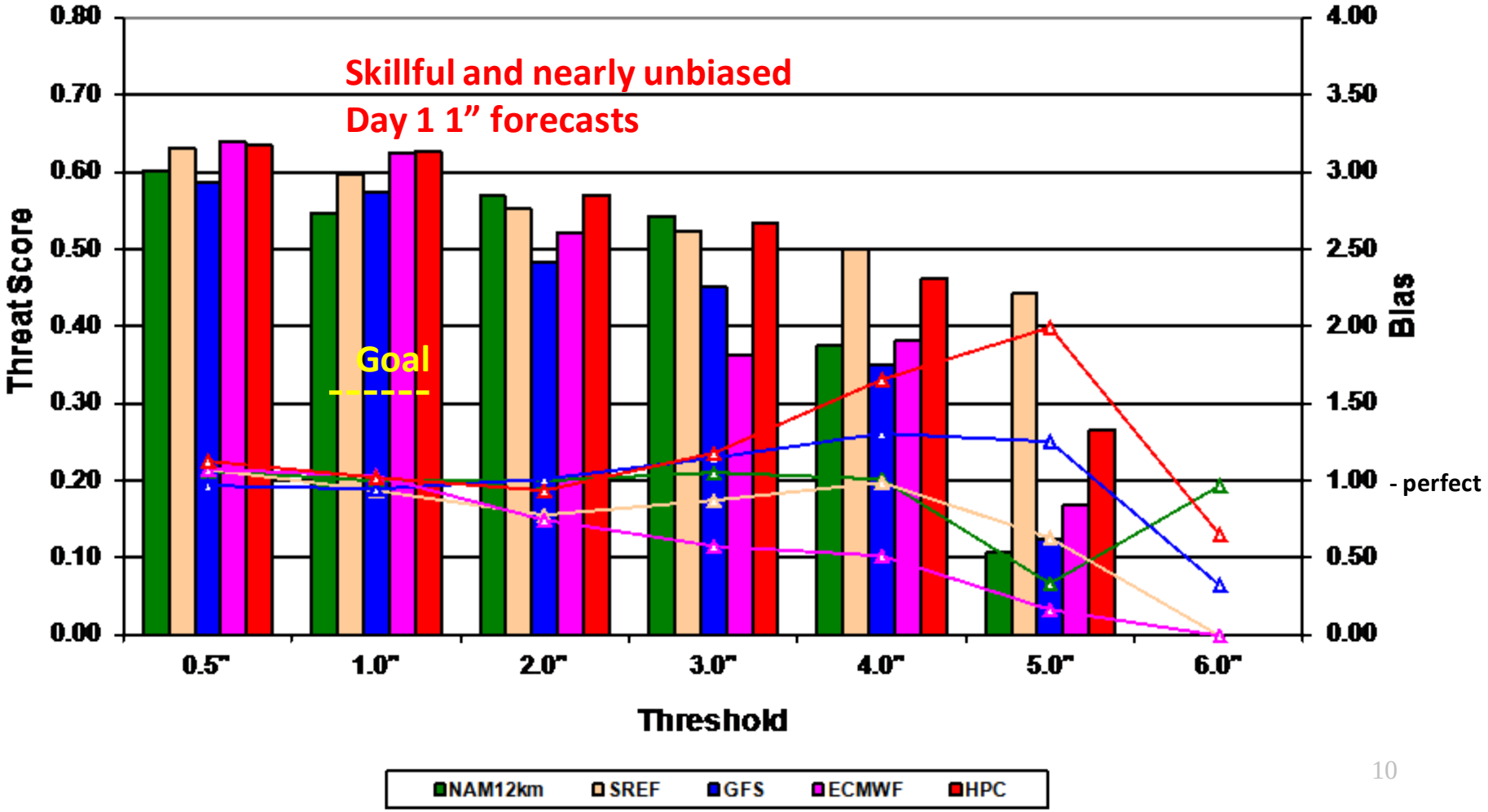
High-Impact Events

- Landfalling “TCs” presented two of the most visible QPF hazards of 2012.
  - Sandy
  - Isaac
- HPC contributions:
  - Skillful and value-added QPFs
  - Decision Support Services (DSS)
    - Media, NOAA coordination

High-Impact Events: Sandy

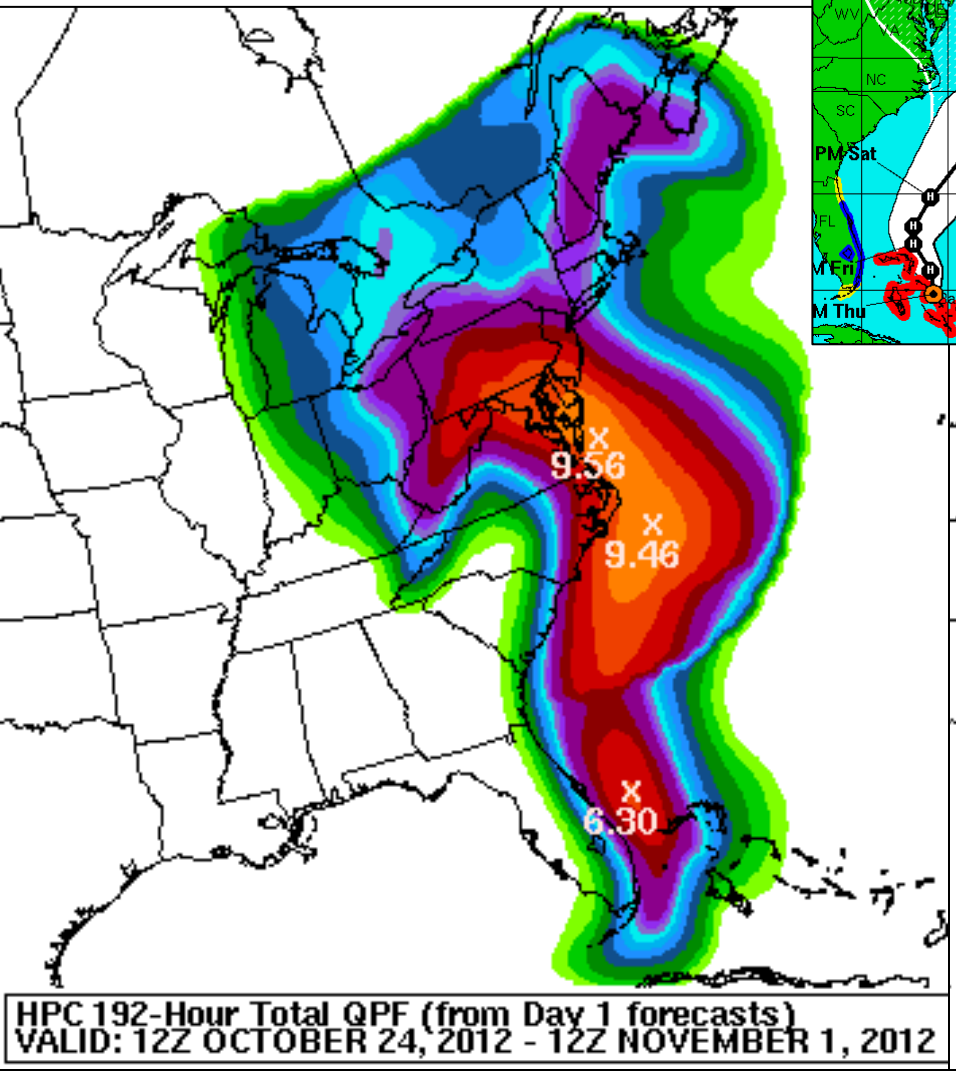
Day 1 Verification

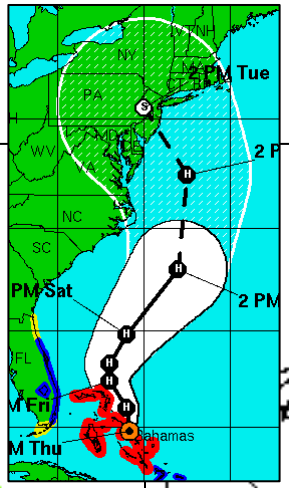
Day 1 QPF Threat Scores, October 28 - 31, 2012



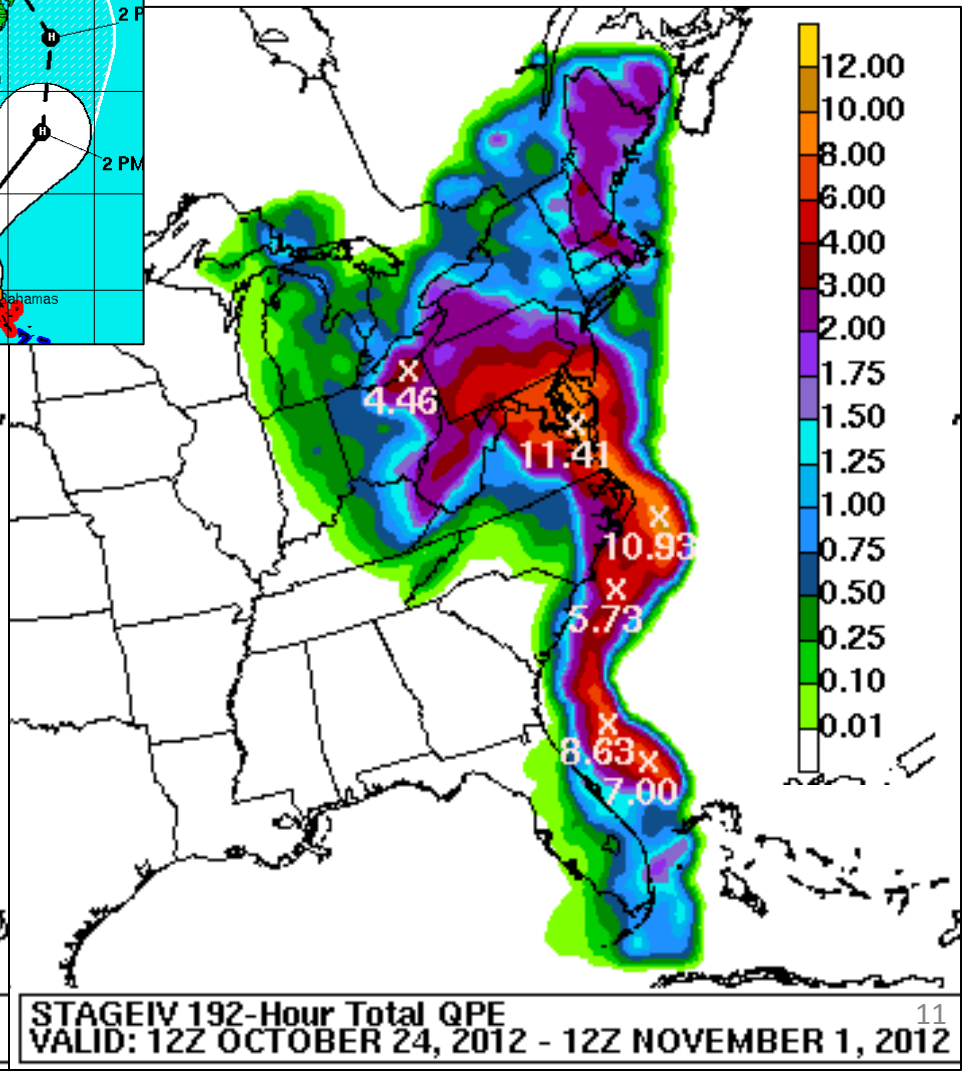
Day 1 QPFs - Sandy

Forecast



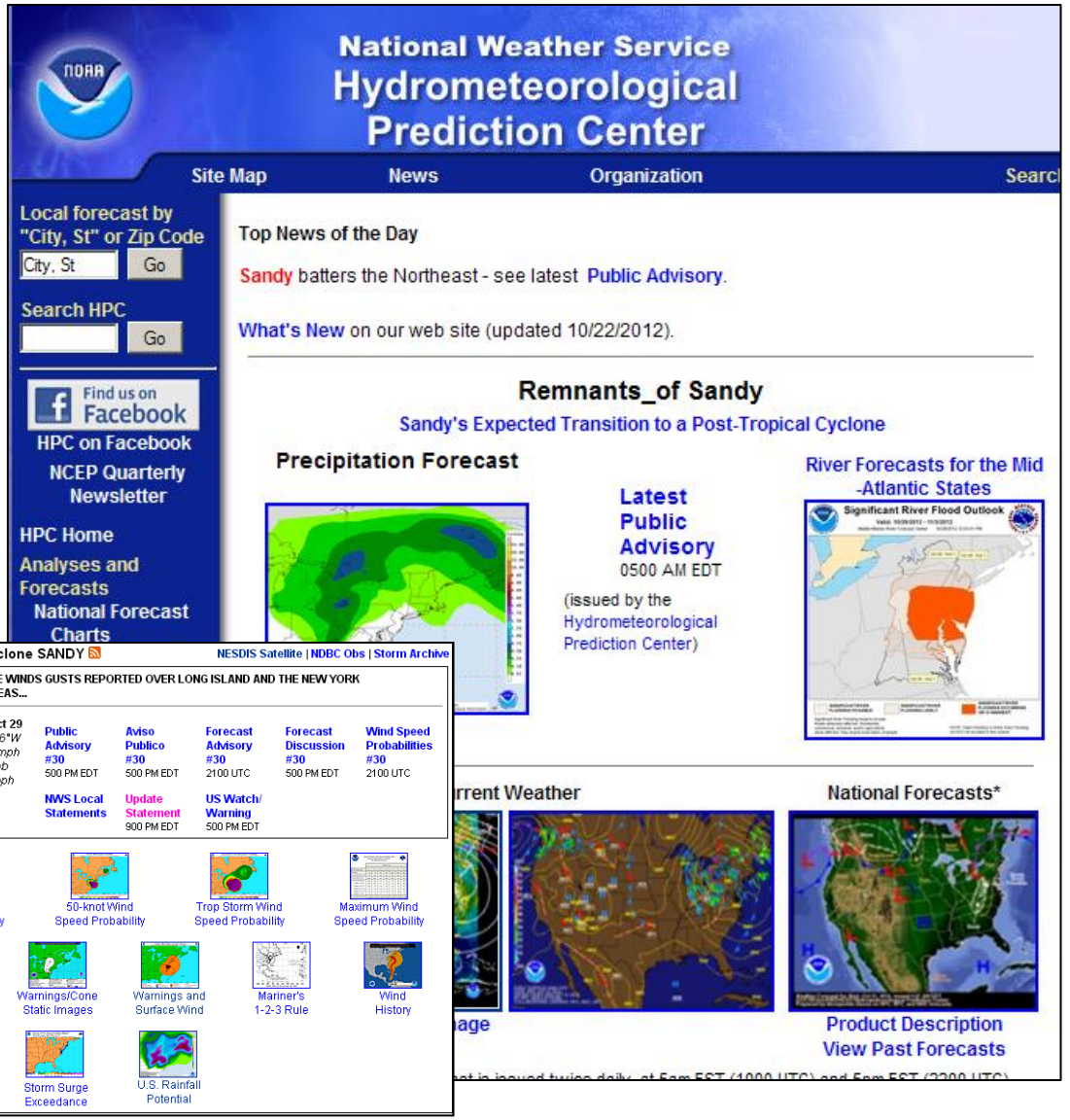


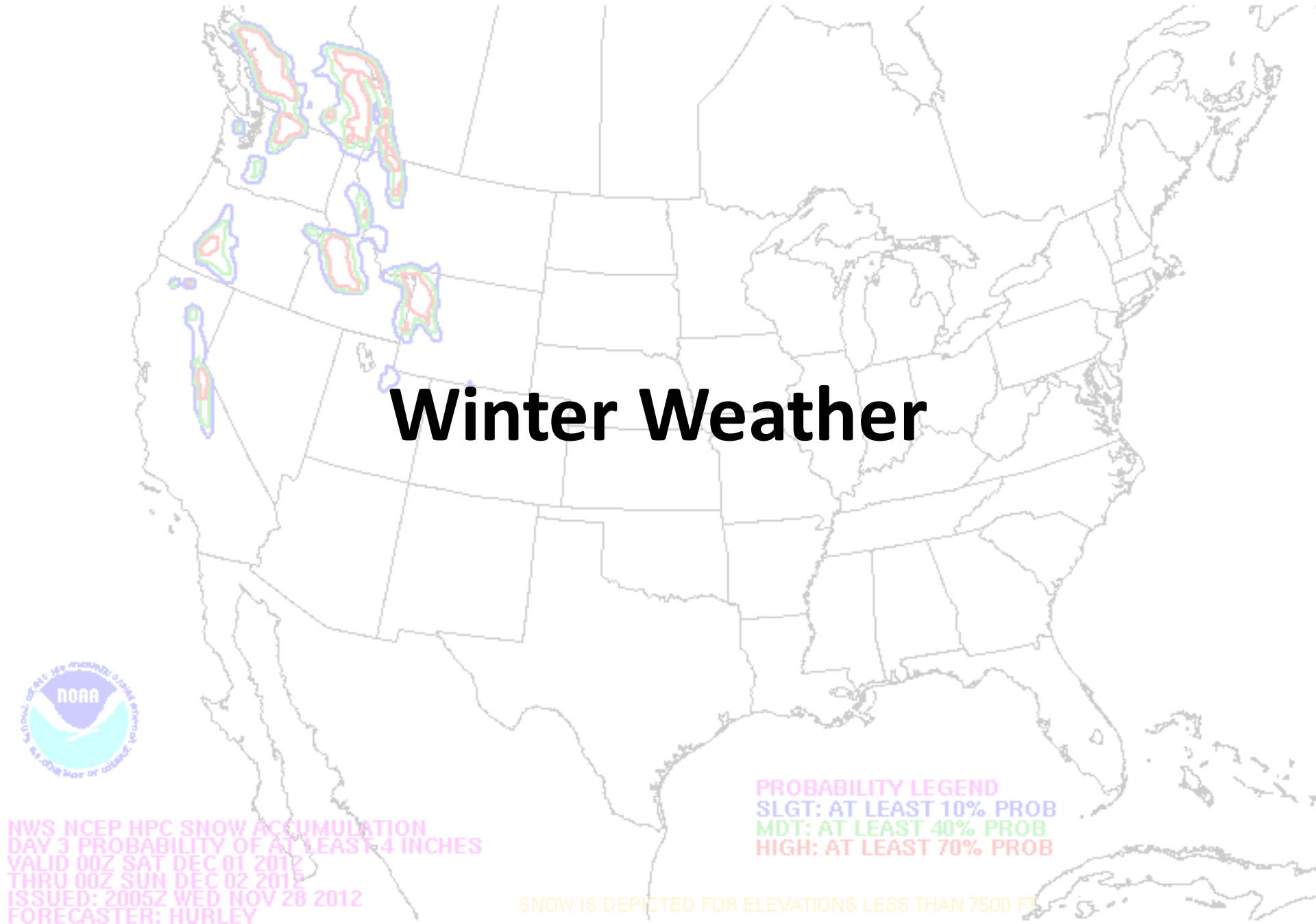
Observed



Decision Support: Sandy

- Internal DSS: NOC, FEMA, Regions, WFOs
- External DSS: Media (CNN, Univision, etc.)
- Flexible web presence, with Sandy-specific products highlighted on HPC homepage
- HPC QPF linked on NHC webpage
- HPC Public Advisories linked on NWS homepage after landfall
- Heavy snow mentioned in advisory for the first time





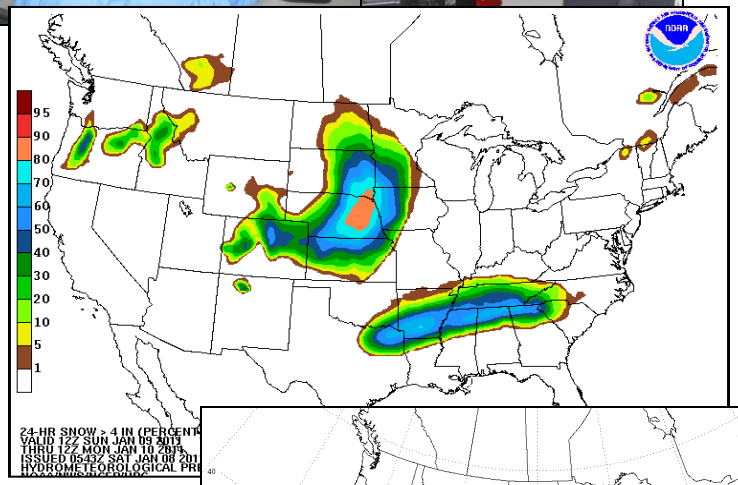
Winter Weather

HPC's Winter Weather Products and Services

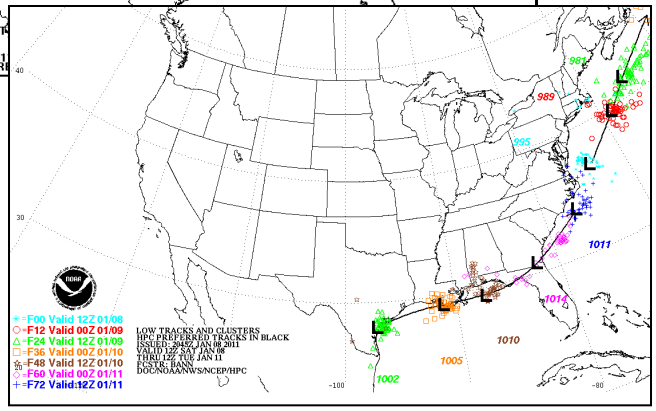
Internal NWS collaboration

24 & 48 h probabilities for:

- -Snow/Sleet/Freezing Rain
- -Probabilities computed from deterministic forecast and ensemble spread



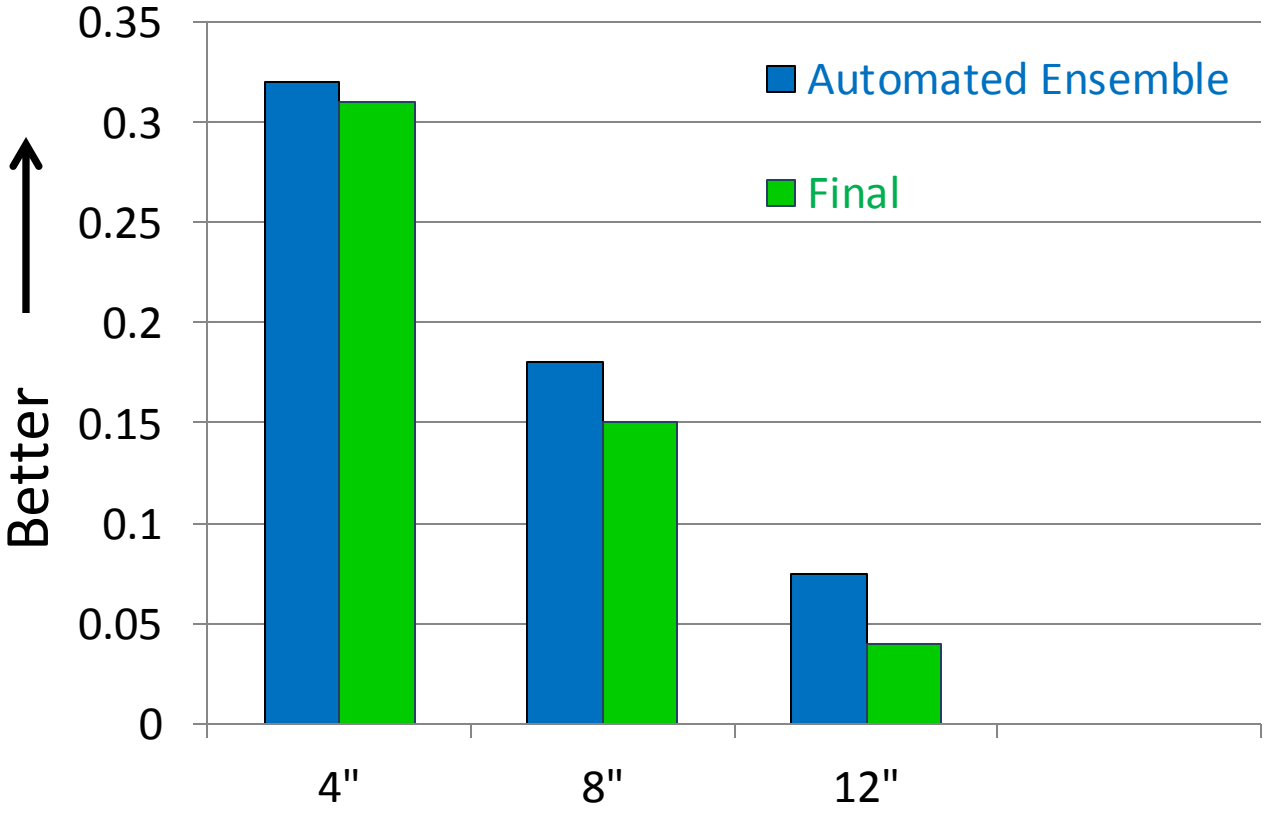
Track forecasts for surface lows associated w/ significant winter weather



Heavy Snow and Ice Discussion

HPC Deterministic Snowfall Forecast

2011-12 Day **One** Snow Threat Score East of the Rockies

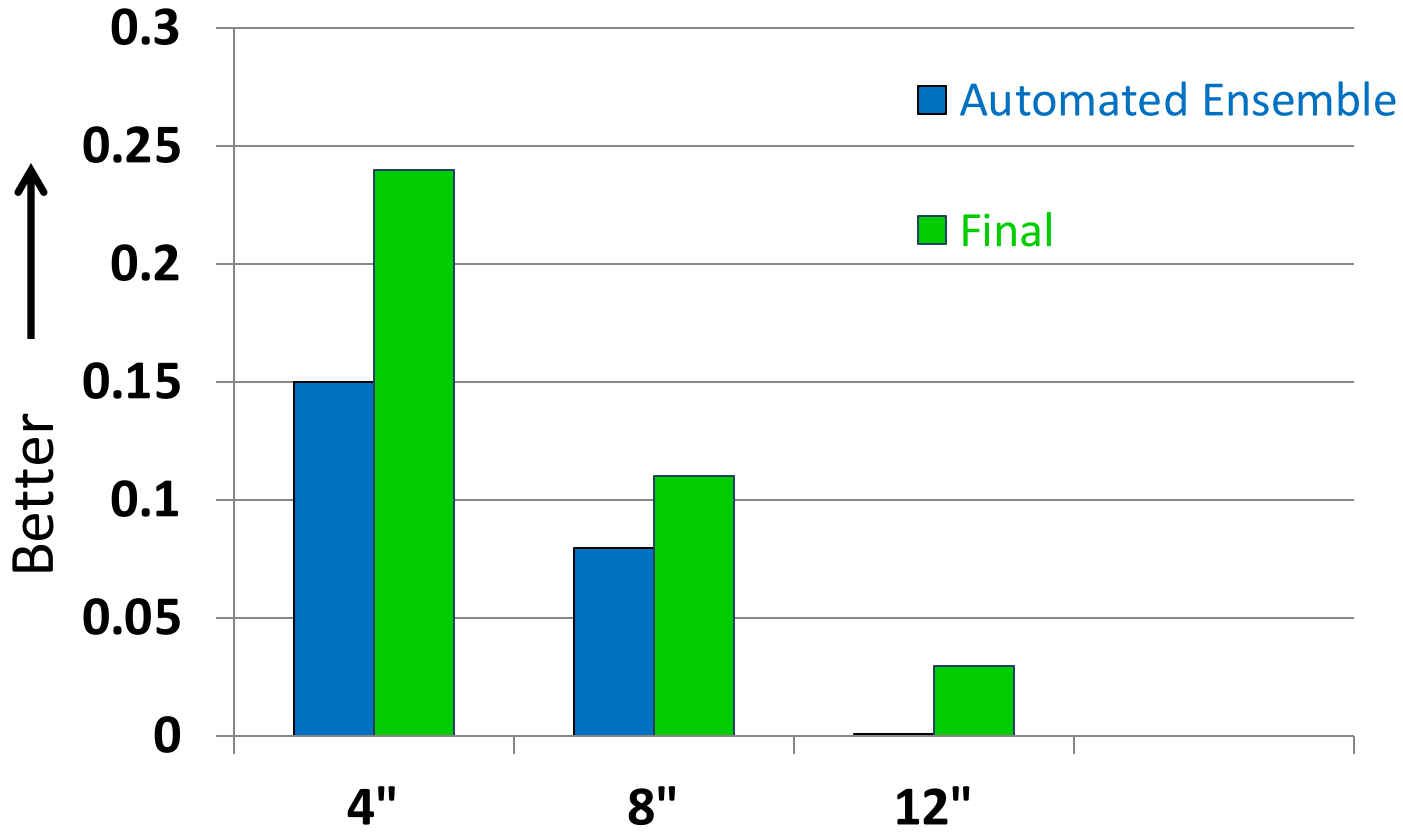


Final forecasts are outperformed by the Automated Ensemble

Automated Ensemble : NAM + GFS + ECMWF + SREF members + GEFS members

HPC Deterministic Snowfall Forecast

2011-12 Day **Three** Snow Threat Score East of the Rockies

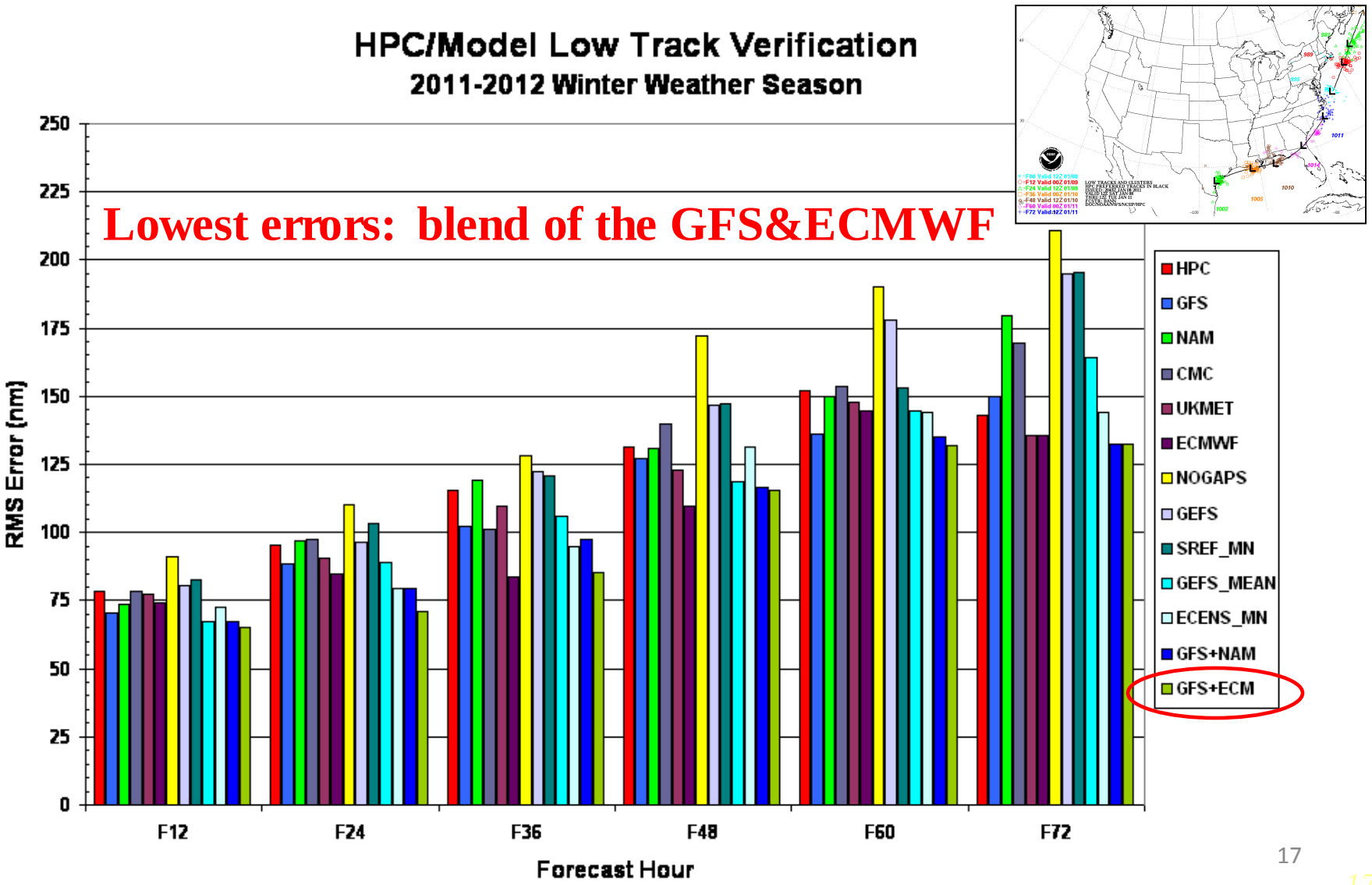


Final forecasts outperform the Automated Ensemble for all thresholds

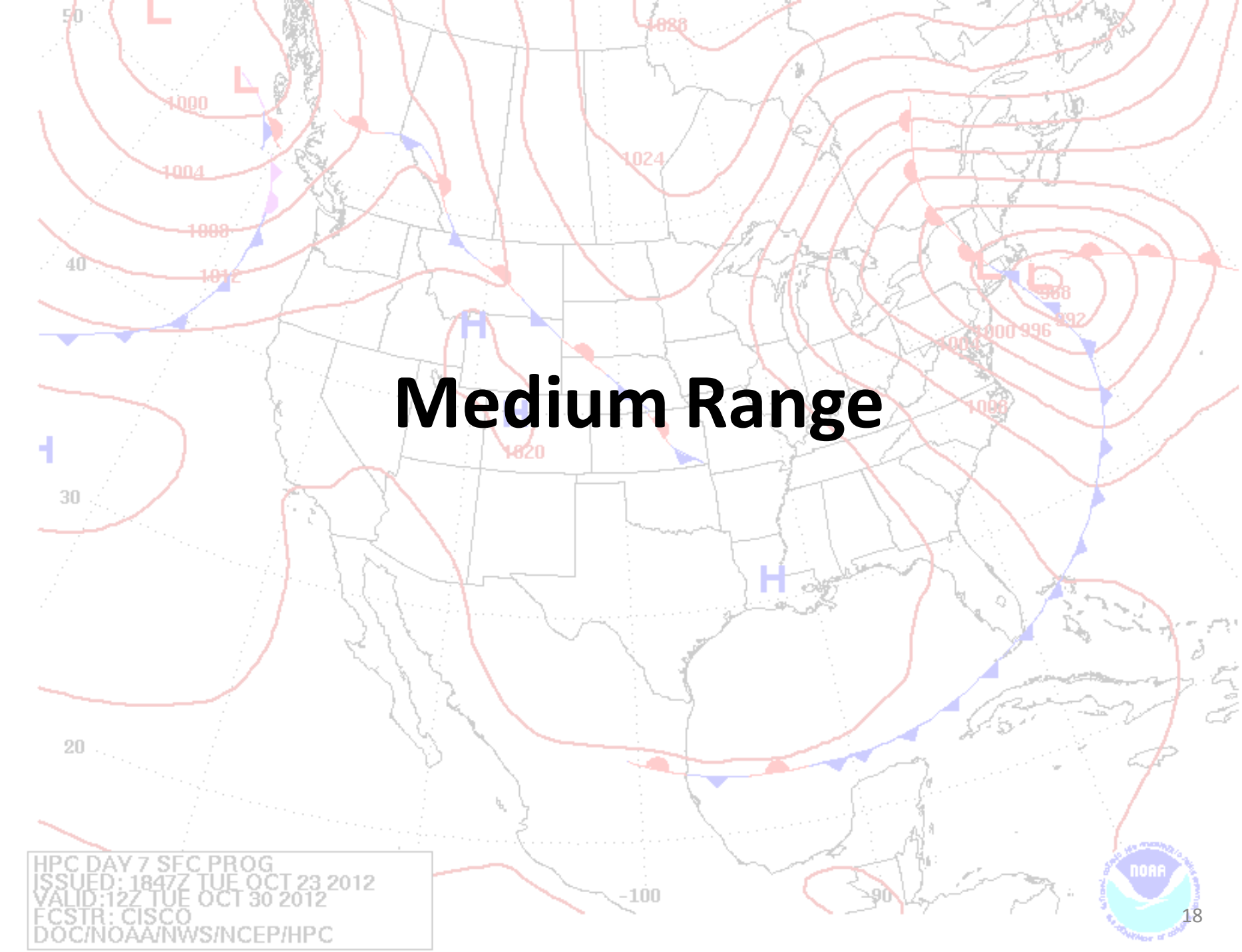
Automated Ensemble : NAM + GFS + ECMWF + SREF members + GEFS members

2011-12 Verification of HPC low tracks

(position at each forecast hour)



17



Medium Range

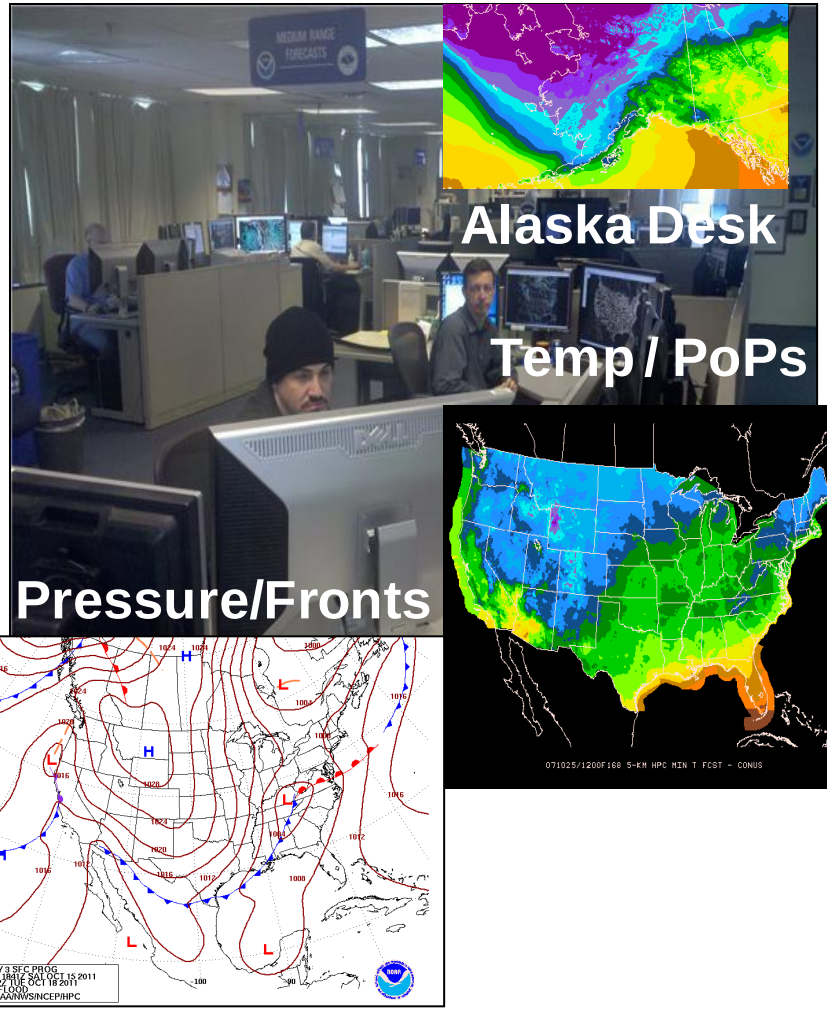
Twice-Daily Medium-Range Grids -- An Enhanced Resource for the Field Offices

Previously once-daily suite for CONUS and Alaska

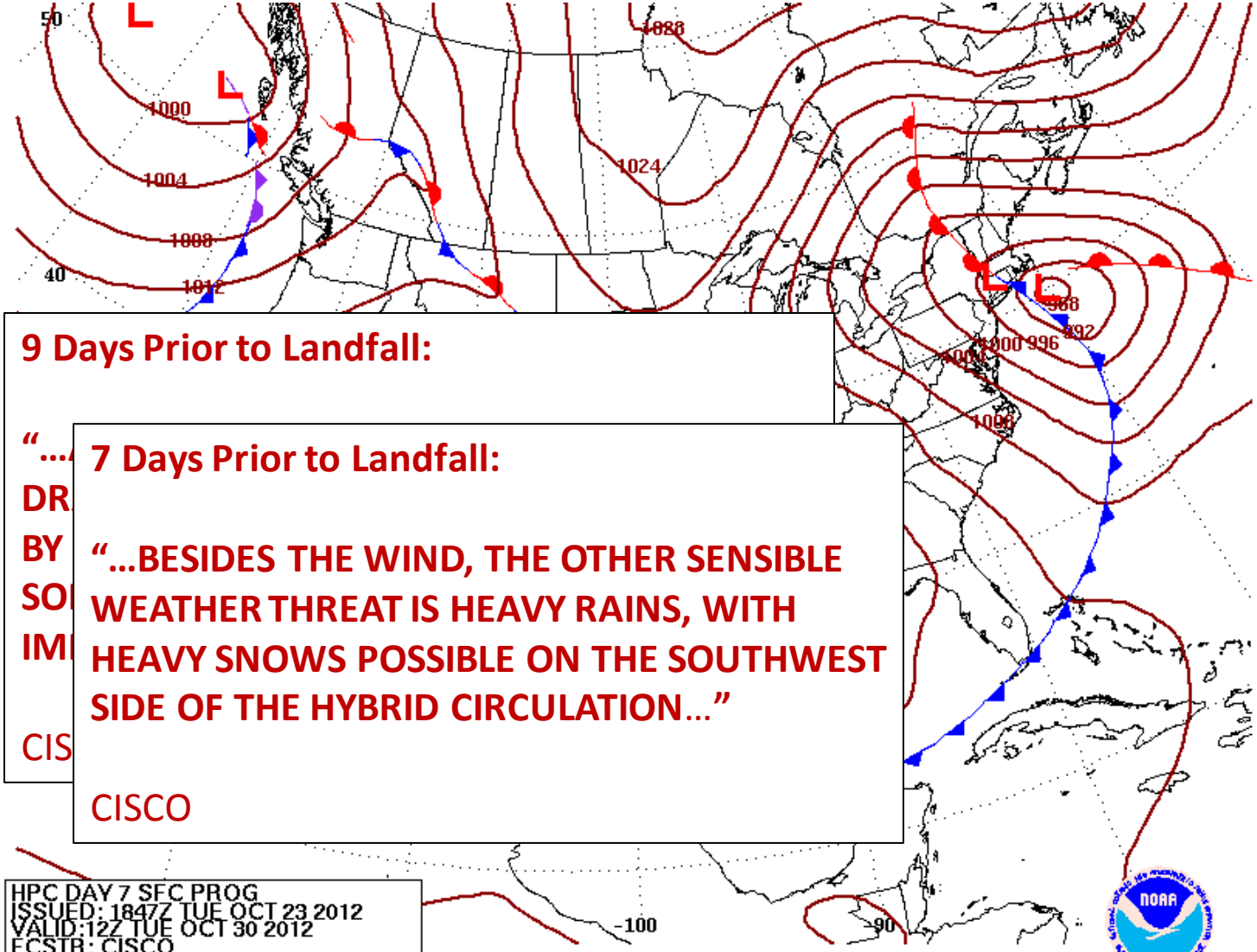
- Not sufficient for WFO/RFC needs
- Grids were often 'old' when needed
- Only available for collaboration 9 hours

HPC rearranged staffing to provide twice-daily suite for CONUS, while keeping once-daily for Alaska

- More-current forecasts
- Improved accuracy
- Available for collaboration 18 hours
- Implemented Dec 18, 2012

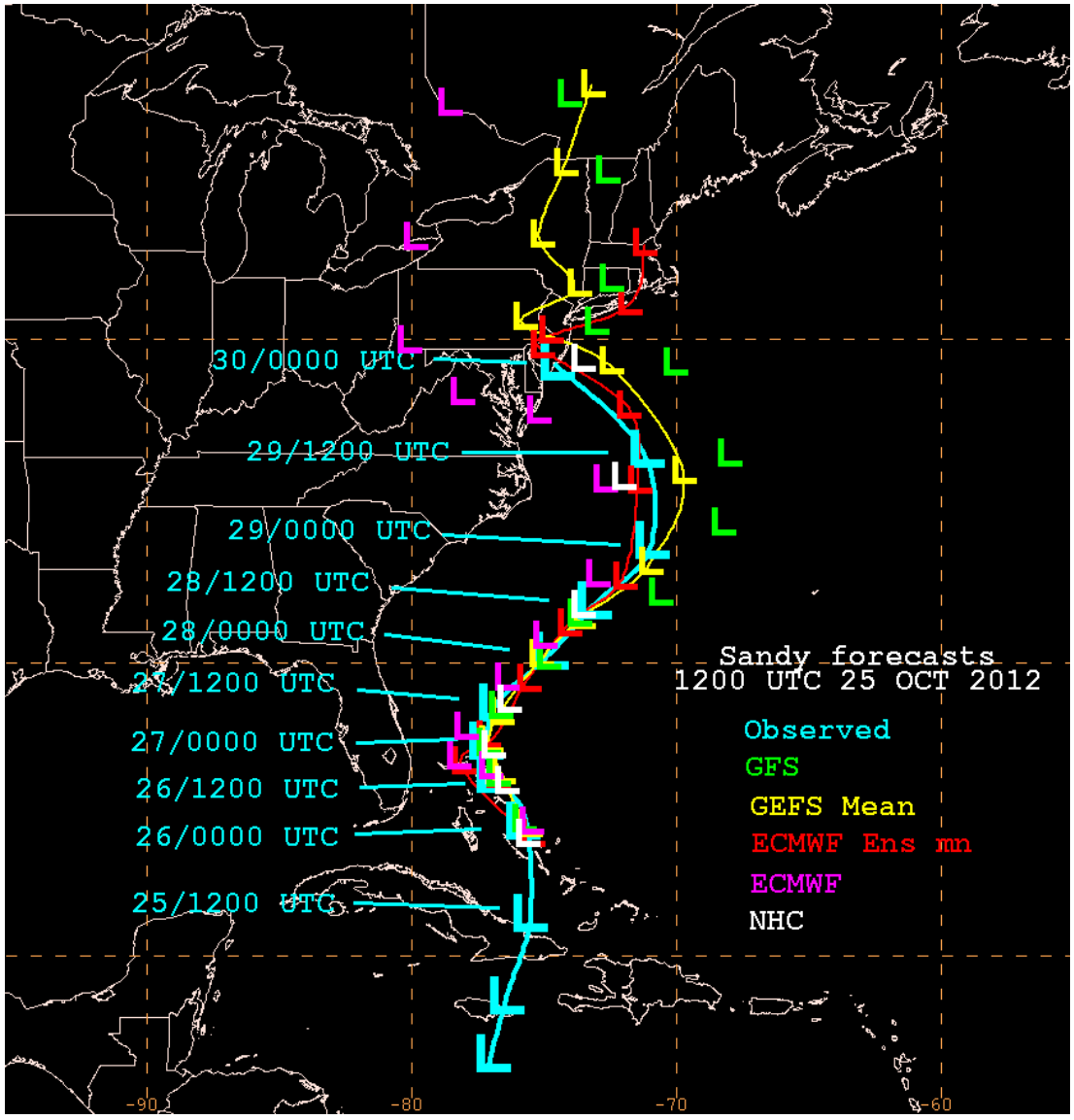


3-7 day forecasts valid at Sandy landfall



Use of Ensembles - Sandy

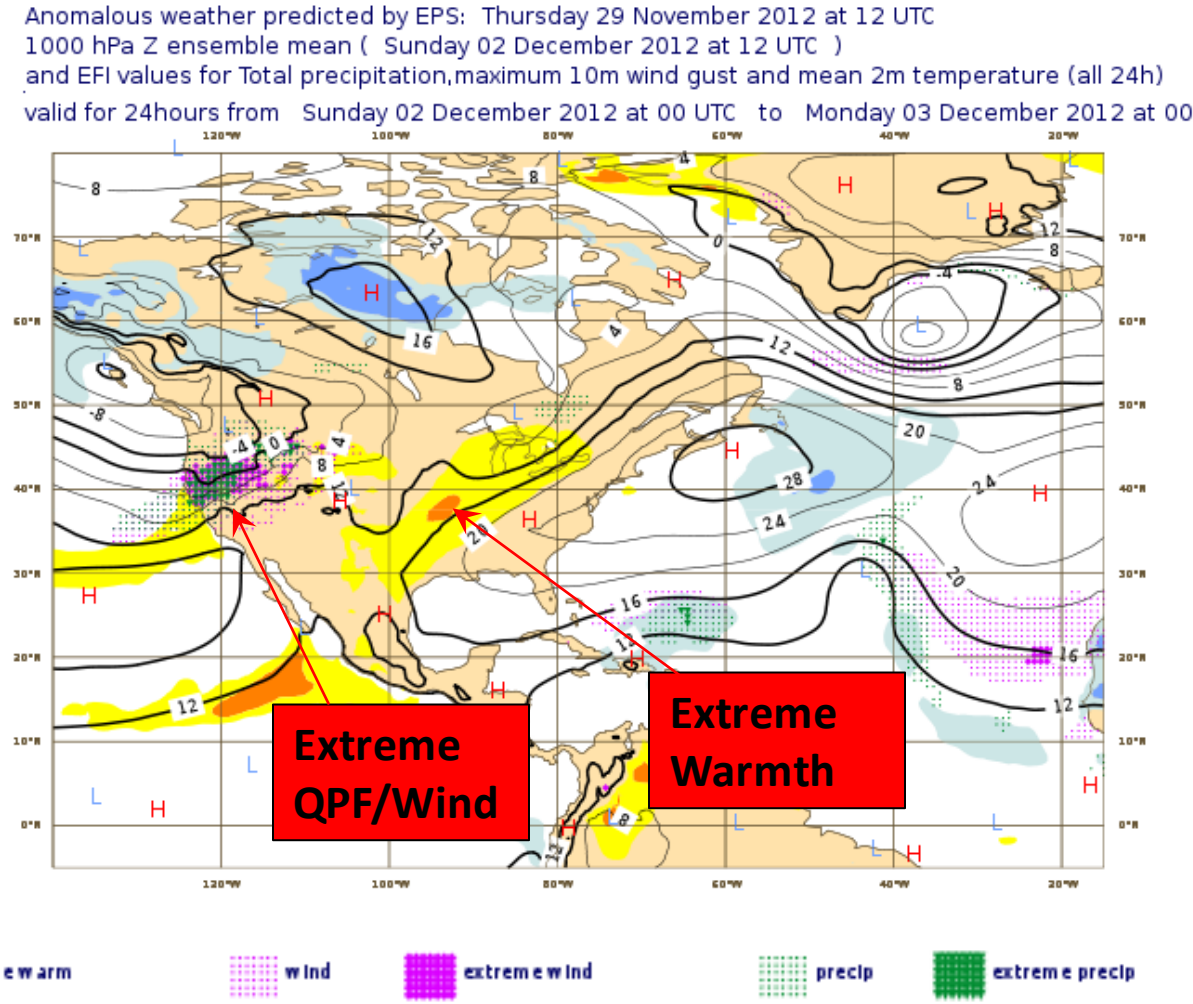
- Deterministic GFS and ECMWF forecasts diverged 5 days prior to landfall.
- However, consistency between their ensemble means gave forecasters confidence in the ensemble solutions.

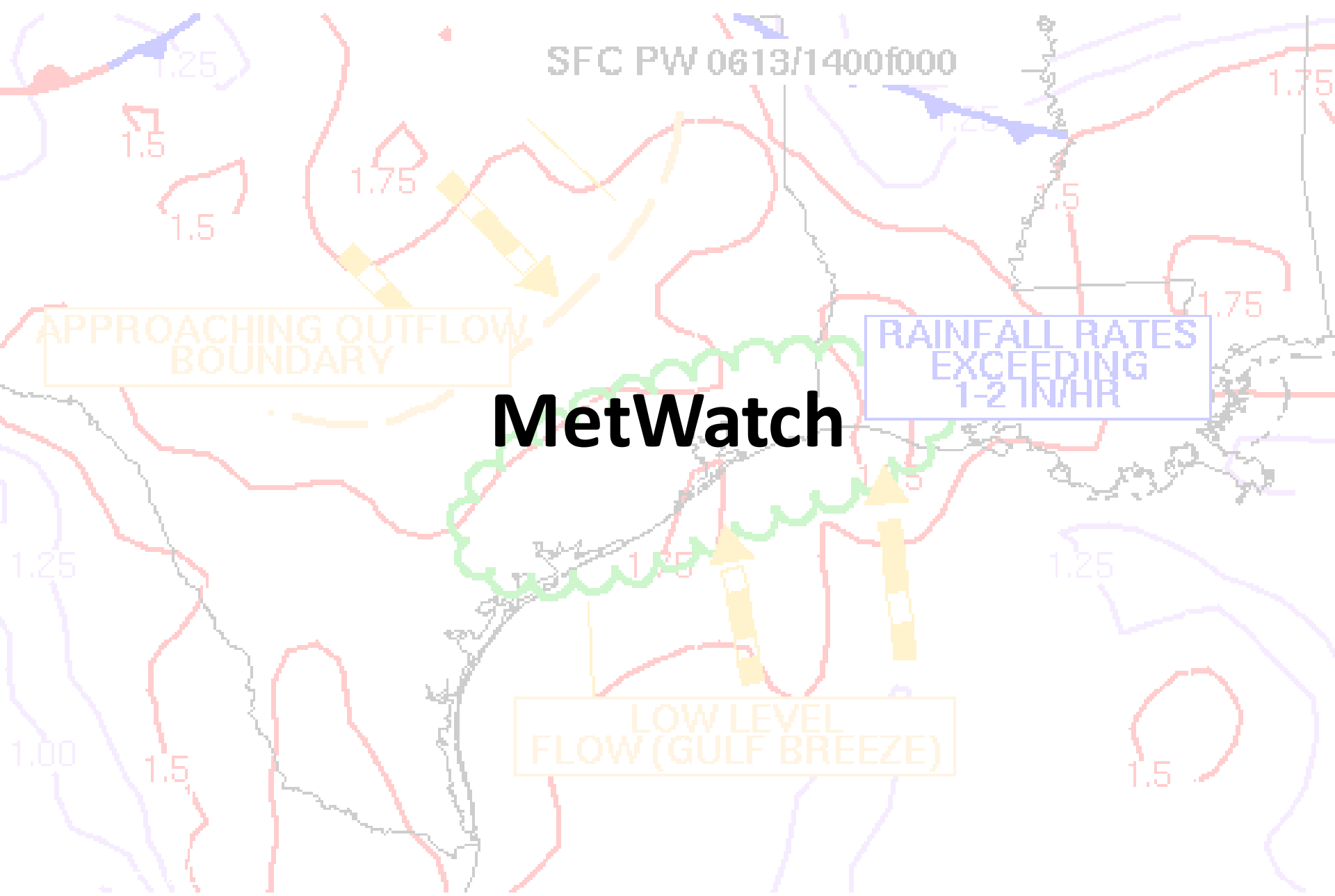


Ensemble-Derived Products

ECMWF Extreme Forecast Index (EFI)

- Need tools that condense ensemble data into actionable information.
  - Mean, spread
  - Extreme Forecast Index
- This topic is increasingly relevant as data volume increases.

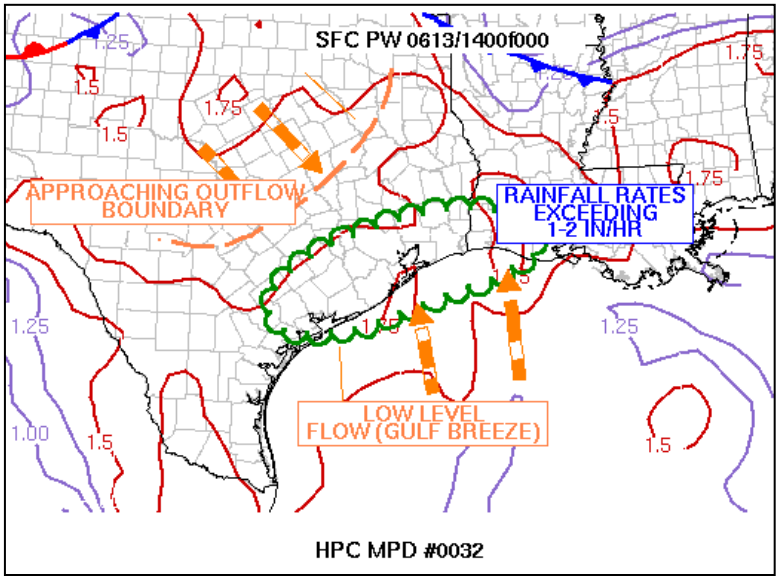



SFC PW 0613/1400f000
APPROACHING OUTFLOW BOUNDARY
RAINFALL RATES EXCEEDING 1-2 IN/HR
LOW LEVEL FLOW (GULF BREEZE)
HPC MPD #0032

MetWatch

MetWatch Background

- HPC will provide a product similar to SPC Mesoscale Convective Discussions (MCD) focusing on heavy rainfall.
- The goal is to provide enhanced situational awareness of potential flash flood events (1-6 hrs).
- *Requirement: high-resolution ensemble system capable of skillful and reliable short-term heavy rainfall forecasts. SSEO, SSEF, etc.*



MESOSCALE PRECIPITATION DISCUSSION 0032
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
1216 PM EDT WED JUN 13 2012

AREAS AFFECTED...SOUTHEAST TEXAS...SOUTHWST LOUISIANA

CONCERNING...HEAVY RAINFALL...FLASH FLOODING POSSIBLE

VALID 131600Z - 132000Z

...SLOW MOVING CONVECTION WITH POTENTIALLY EXCESSIVE RAINFALL AMOUNTS ACROSS COASTAL AREAS IN SOUTHEAST TEXAS AND WESTERN LOUISIANA...

COMPOSITE RADAR LOOPS SHOW REGENERATING CONVECTIVE CLUSTERS ALONG THE GULF BREEZE BOUNDARY ACROSS COASTAL PORTIONS OF SOUTHEAST TEXAS...EAST OF VICTORIA...AND SOUTHWEST LOUISIANA. THESE CELLS ARE AIDED BY THE STRENGTHENING DIURNAL DESTABILIZATION...WITH THE LATEST SPC MESOANALYSIS INDICATING SURFACE-BASED CAPES BETWEEN 3,000-4,000 J/KG...COINCIDENT WITH THE RICH...DEEP MOIST ENVIRONMENT WITH SURFACE DEWPOINTS IN THE MID 70S...K INDICES IN THE MID TO UPPER 30S...AND PWATS BETWEEN 1.75 AND 2.00 PER THE LATEST GPS AND 12Z UPPER AIR ANALYSIS.

...HURLEY.. 06/13/2012

ATTN...WFO...LCH...HGX...CRP...EWX... LAT...LON 28399668 28419704 28719735 29229718 29779637 30179525 30429385 30219268 29789250 29519279 29159377 28839481 28499573 28399668

Benefits of High-Resolution

High-resolution SSEF system provides more skillful and reliable precipitation forecasts than the operational SREF.

**note 32km SREF used here

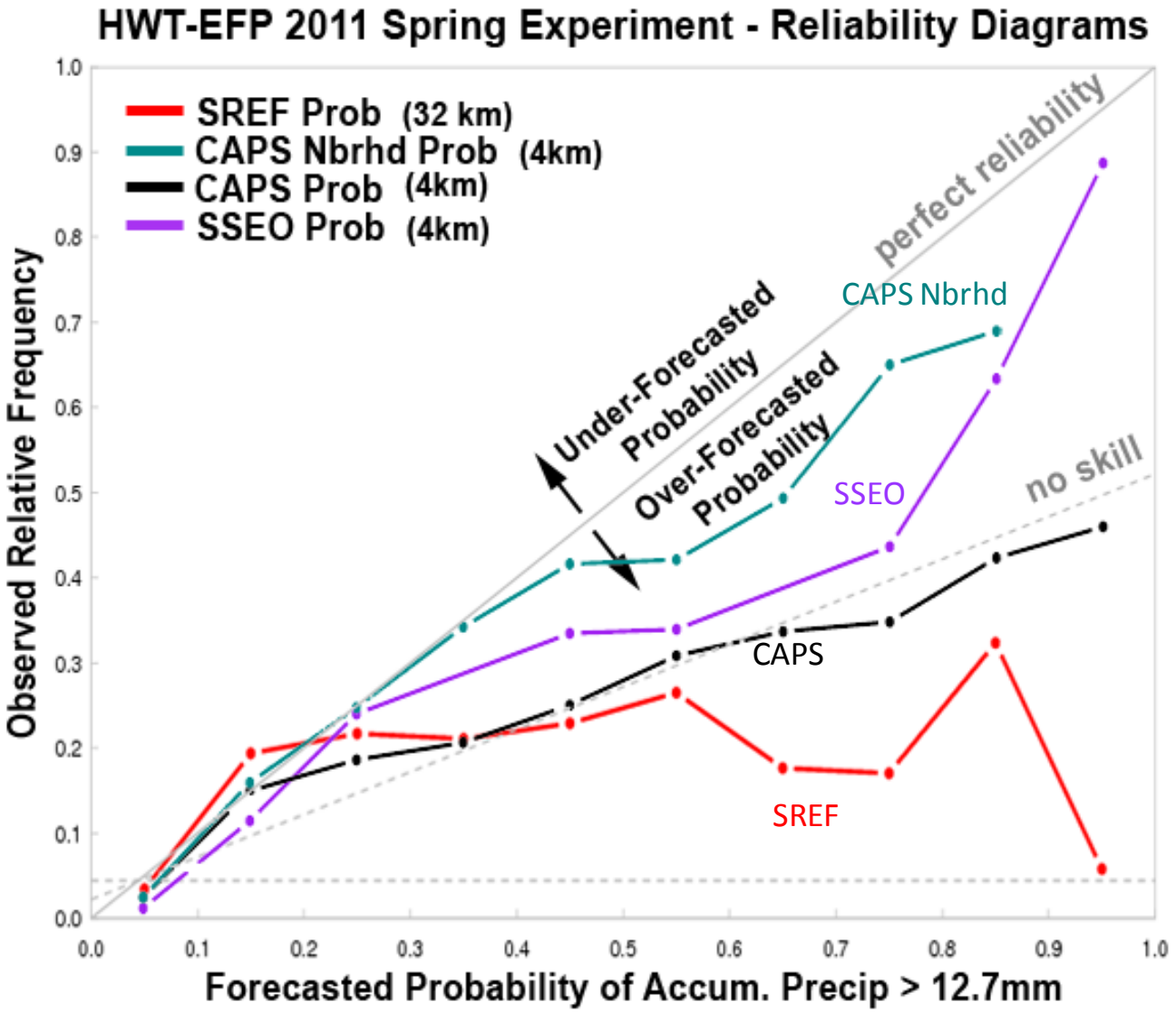


Figure courtesy of DTC

Ensemble Reliability

- 24h SREF freezing line forecast outside the envelope.
- SREF example demonstrates a broader issue with ensemble prediction systems (EPSs).
- *Probabilistic forecasts only as good as the underlying EPS.*

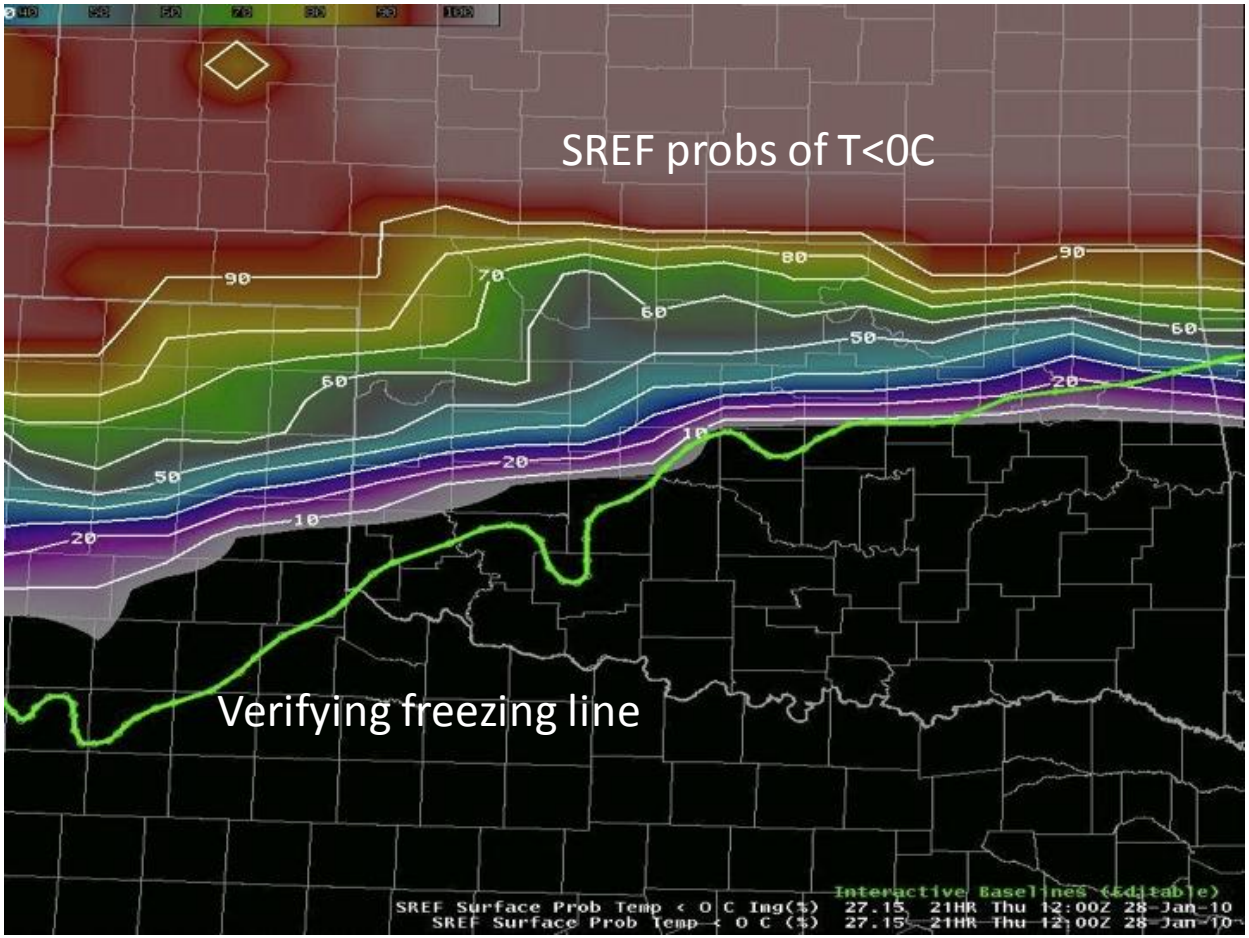


Figure courtesy of Patrick Burke (HPC) and Bill Leatham (UMASS-Lowell)

Hydrometeorological Testbed (HMT) at HPC

HMT-HPC Focus and Methods

Focus: Improve and extend prediction of heavy precipitation

Approach:

- Improve understanding of heavy precipitation phenomena
- Improve application of high-resolution and ensemble guidance

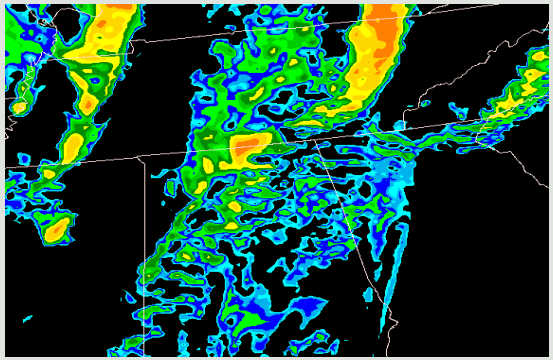
Real-Time Collaborative Experiments

Test New Datasets

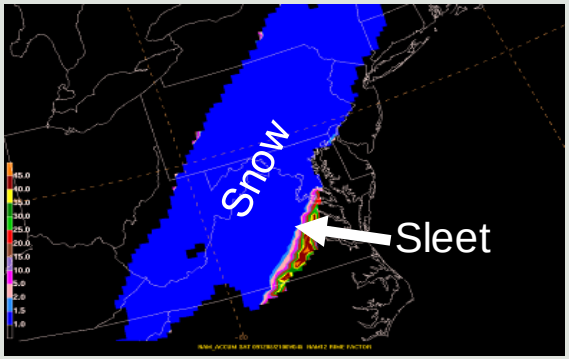
Develop New Tools/Techniques

Train Forecasters & Researchers

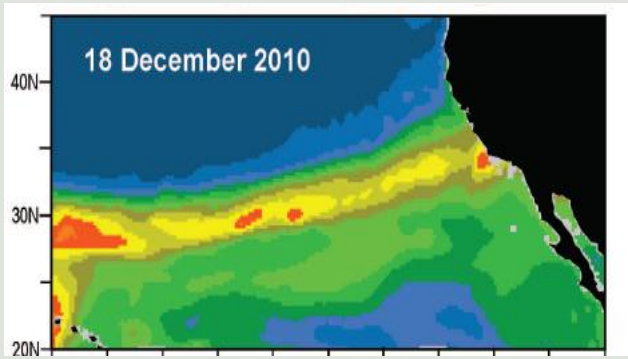
Warm-Season



Winter Weather



Atmospheric River



2012 Atmospheric Rivers Retrospective Experiment

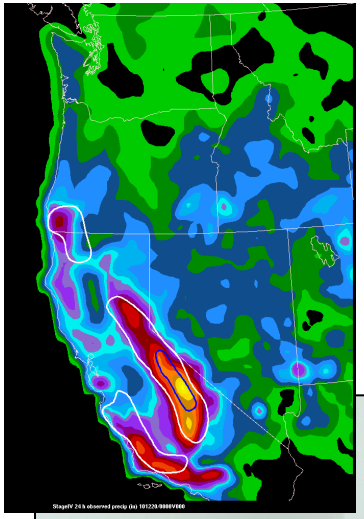
- Hosted 17 forecasters, researchers, and model developers at HPC
- Used 8 past cases over the 2008-2011 time period
- Verified using RFC precip analysis and HMT AR Observatories

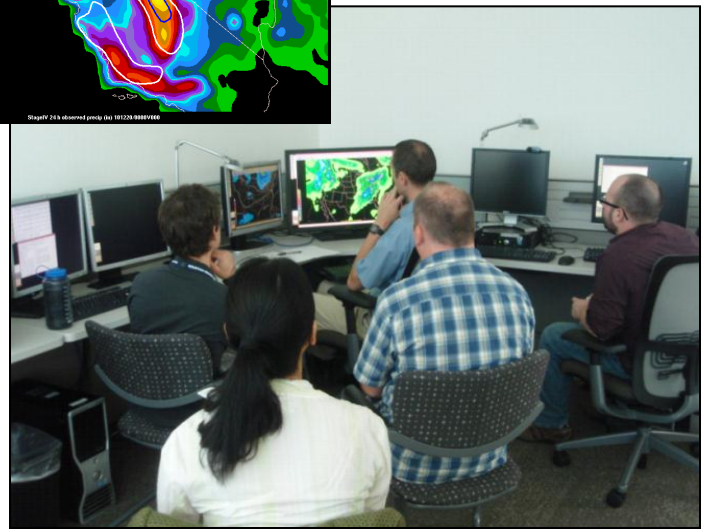
GOALS

Does the HMT-ensemble, multi-model ensemble, and reforecasting dataset improve extreme precipitation forecasts?

What are the strengths & weaknesses of current model guidance?

How can forecasters add value to extreme precipitation forecasts?





2013 WWx Experiment Plans

Featured Datasets

	Provider	Model	Resolution	Forecast Hours	Notes
Operational	EMC	SREF (21 members)	16 km	87	Operational SREF
Operational	EMC	NAM	12 km (parent) 4 km (nest)	84 60	Operational NAM; includes 12 km parent model and 4 km nest
Operational	HPC	Autoensemble (28 members)	32 km	72	Composed of 21 SREF members, GEFS mean (2), ECMWF mean, and deterministic NAM, GFS, CMC, and ECMWF
Experimental	AFWA	WRF (10 members)	20 km	144	UKMET boundary and initial conditions
Experimental	AFWA	WRF (10 members)	4 km	72	Multi-physics, multi-initial condition convection-allowing ensemble
Experimental	EMC	NAM	12 km (parent)	84	New snow accumulation algorithm based on modified SLR technique (rime factor)

* all other operational guidance will also be available to the participants

FY13 Heavy Rainfall and Flash Flood Experiment

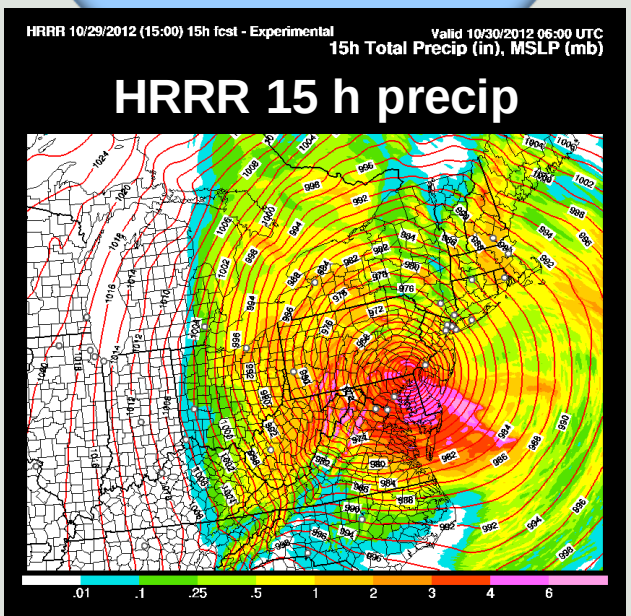
Meteorology

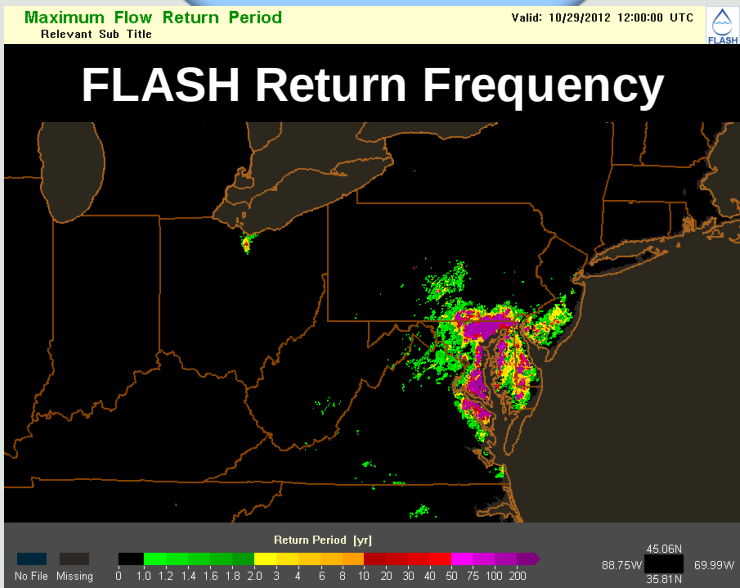
- Zero to 12 h probabilistic rainfall forecasts
- Satellite Nowcast
- MDL Nowcast
- HRRR

Probabilistic Flash Flood threat product

Hydrology

- QPE
- River Stages
- Flash Flood Guidance
- FLASH hydrologic model





HPC "Wish List"

In addition to the high-quality and constantly improving EMC guidance suite, HPC would like to see:

- Storm-scale ensemble forecast (SSEF) system
  - Initially for short-term QPF
  - Formalized Storm-scale Ensemble of Opportunity (SSEO)
- Improved reliability of probabilistic QPFs (SREF/GEFS)
- Improved snowfall forecasts (microphysics, land use)
- Ensemble-derived products: e.g., EFI, improved clusters

- New datasets and tools are tested and operationalized through the Hydrometeorological Testbed at HPC