8th NOAA TBPG Workshop
Kansas City, MO
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Roundup Presentation

Hazardous Weather Testbed (HWT)

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Hazardous Weather Testbed

Where practitioners and researchers work together to enhance community collaboration and accelerate the transfer of research to operations…

Local NWS Forecast Office (OUN): Regional responsibility

NCEP Storm Prediction Center (SPC): Nationwide Responsibility

Warning Research

Forecasting Research

Satellite-based Research

Experimental Warning Program

Detection/prediction of hazardous weather events ***up to several hours in advance***

Experimental Forecast Program

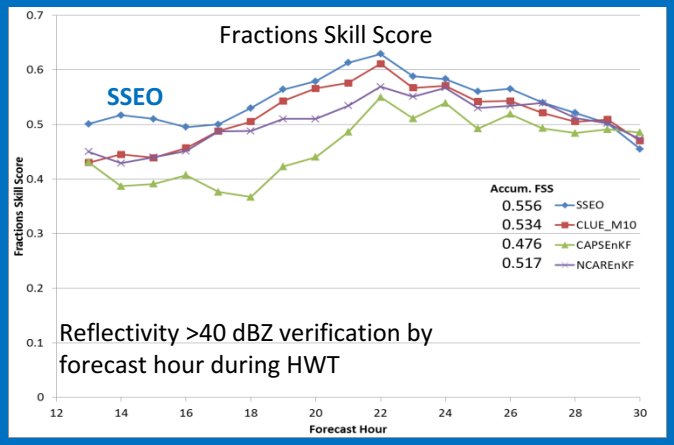
Prediction of hazardous weather events from ***a few hours to a week in advance***

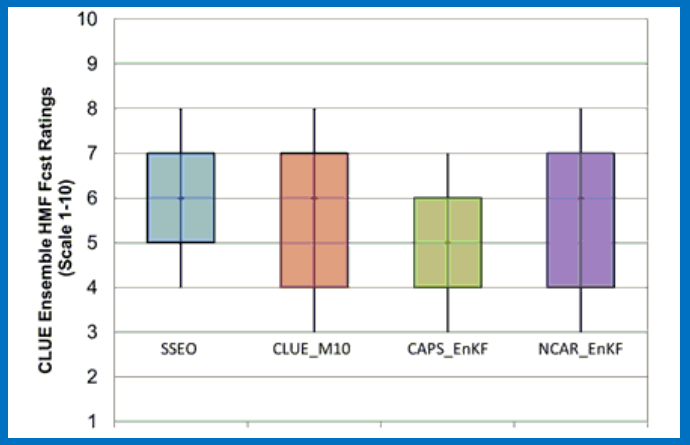
FY16 Highlights

HWT

- Experimental Forecast Program (3)
  1. Controlled experiment comparison between SSEO, CLUE Mixed Core (ARW and NMMB), NCAR EnKF, and CAPS EnKF ensembles
  2. Again in 2016 HWT, SSEO was as good or better than more formal CAM ensembles => SSEO is baseline for future development
  3. EMC has developed operational version of SSEO that will be implemented in September 2017

Hourly Reflectivity Forecast Verification





Subjective Ratings of Hourly Max Field Utility

FY16 Transition Metrics

HWT

- Experimental Forecast Program

Major Tests Conducted	Transitioned to Operations	Recommended for Transition to Operations	Advanced to Experimental Testing Phase	Rejected for Further Testing	Decision Pending or Deferred on Advancement
Updated 4-hr Outlooks for Individual Severe Hazards		X			
Community Leveraged Unified Ensemble (CLUE)			X		
CLUE Result: SSEO Performance		X			
CLUE Result: Dynamic Core Testing			X		
CLUE Result: Radar Data Assimilation			X		
CLUE Result: Number of Ensemble Members			X		
NAMRR and HRRR Comparison				X	
Hail Size Guidance			X		
Microphysics Param.					X
Ensemble Sensitivity					X
3-D CAM Visualization					X
MPAS Convection-Allowing Output					X
Totals	0	2	5	1	4

FY17 Activities

HWT

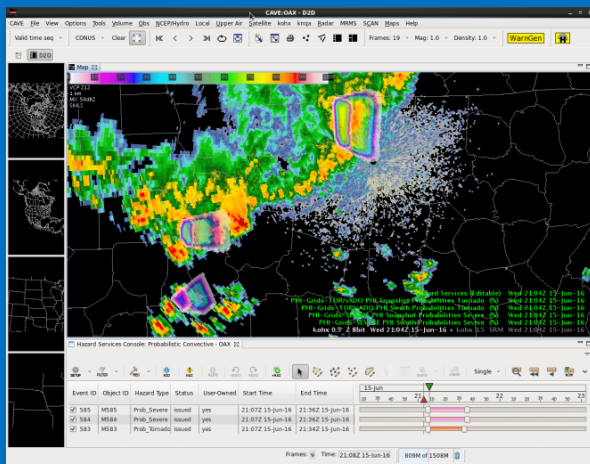
• Experimental Forecast Program

- **Community-Leveraged Unified Ensemble (CLUE) Configuration**
  - 81 Total members: OU/CAPS 36, NSSL 15, NCAR 10, OU 10, GSD 9, GFDL/EMC 1
  - WRF 3.8.1, 3 km grid-spacing, CONUS domain, 51 vertical levels, UPP output fields
- Experiments
  - Multi-Core vs. Single Core – Two ensembles will be compared. One using 5 ARW and 5 NMMB members and one using 10 ARW members.
  - Physics Perturbations - Three ensembles with with perturbed ICs/LBCs are compared. One each with single physics, mixed physics, single physics with stochastic perturbations.
  - GSD Radar vs. CAPS Radar – Two members are configured identically, except one will use GSD's method for radar DA and one will use CAPS method.
  - Data Assimilation – Multiple DA methods will be compared: GSI-EnKF, NCAR-EnKF, CAPS-EnKF, HRRRE-EnKF, and CAPS-3DVAR .
  - **Operational HRRR vs. Parallel HRRR** – Comparison as part of upcoming EMC science evaluation
  - **3 km FV3 Initial Testing** - Two experimental versions of FV3 (GFDL/EMC; OU-CAPS) at convection-allowing scales will be examined.
  - Microphysics Sensitivities – The impact from different microphysical parameterizations on the resulting convective storm forecasts will be examined.
  - **SPC SSEO vs. EMC HREFv2-SSEO** – The new EMC HREFv2-SSEO will be compared to the baseline SPC SSEO prior to planned operational implementation of the HREFv2.

FY16 Highlights

HWT

- Experimental Warning Program
  - Probabilistic Hazards Information with Hazard Services Experiment
    - First foray into generating PHI with AWIPS 2 Hazard Services.
    - Involved NWS forecasters, NSSL, GSD, MDL, WDTD, and human factors experts.
    - Many software issues discovered and fixed.
  - Probabilistic Hazards Information Experiment
    - Included emergency managers and, for the first time, broadcast meteorologists into the experiment
    - Diverse group of researchers including numerous social scientists (OU, University of Akron, Howard University, California Univ. of Pennsylvania)
    - Importance of timing and continuous flow of information
  - Hydrology Experiment
    - Integrated with HMT FFAIR experiment
    - NWS WFO and RFC participants
    - Utilized experimental techniques to generate warnings for several flash flood events, including WV flash flood



FY16 Transition Metrics

HWT

- Experimental Warning Program

Major Tests Conducted	Transitioned to Operations	Recommended for Transition to Operations	Advanced to Experimental Testing Phase	Rejected for Further Testing	Decision Pending or Deferred
Probabilistic Hazard Information Prototype tool			X		
Probabilistic Lightning Information			X		
FLASH Hydrologic modeling products	X				
Hazard Simplification based convective text products*					X
CIMSS ProbSevere Guidance		X			
PHI –Hazard Services Tool			X		
Totals	**1**	**1**	**3**	**0**	**1**

* - testing results provided to NWS AFS, who integrated into HazSimp project.

FY17 Activities

HWT

- Experimental Warning Program
  - PHI - Hazards Services Experiment
    - March 20 – April 18
    - 3 weeks
  - PHI - Prototype Experiment
    - May 8 – June 9
    - 3 weeks
  - GOES-R and JPSS Proving Ground Experiment
    - June 19 – July 21
    - 4 weeks

Best Practices/Lessons Learned

HWT

- Early community/stakeholder collaboration and engagement is a key
  - Most effective when partners work together on topics of mutual interest
  - Forecasters, model developers, researchers, emergency managers, broadcasters
- Close interaction between researchers, forecasters, and training groups are critical to R2O
  - Researchers better understand real-world forecasting and workload challenges
  - Forecasters provide feedback on next-generation tools and better understand research challenges
  - Training groups ensure more effective transition to operational practices
- Real-time forecast experiments are conducted in simulated operational environments
  - Replicates operational challenges with real-world requirements and constraints
  - No one knows the forecast "answer" ahead of time
- Project testing and R2O is an incremental process over multiple years that builds upon results from prior experiments

Supplemental Slides

NOAA Hazardous Weather Testbed

History Timeline – Selected Milestones

1997: SPC moves from Kansas City to Norman.

2000-01: Spring Program formalized.

- Decision made to focus on SPC-specific forecast problems.
- Visiting scientist from EMC co-funded by NSSL and SPC helped jump-start inter-agency working relationships

2006: NSSL and SPC move to the NWC and the HWT is created.

1970s – 1990s: *Culture of Collaboration* established between NSSL and the local WFO.

- Doppler radar demonstrations, data collection/forecasting for field programs, experimental modeling.
- Experimental Forecasting Facility

2003-04: Initial testing of "storm-scale models".

- Models with high enough resolution to explicitly depict convective storms.
- Forecasters excited: **"A turning point in the use of model output"**
- EMC starts year-round runs for SPC and includes storm-scale models in 5-10 year production-suite plans.

2007-present: Focus on using storm-scale models and ensembles.

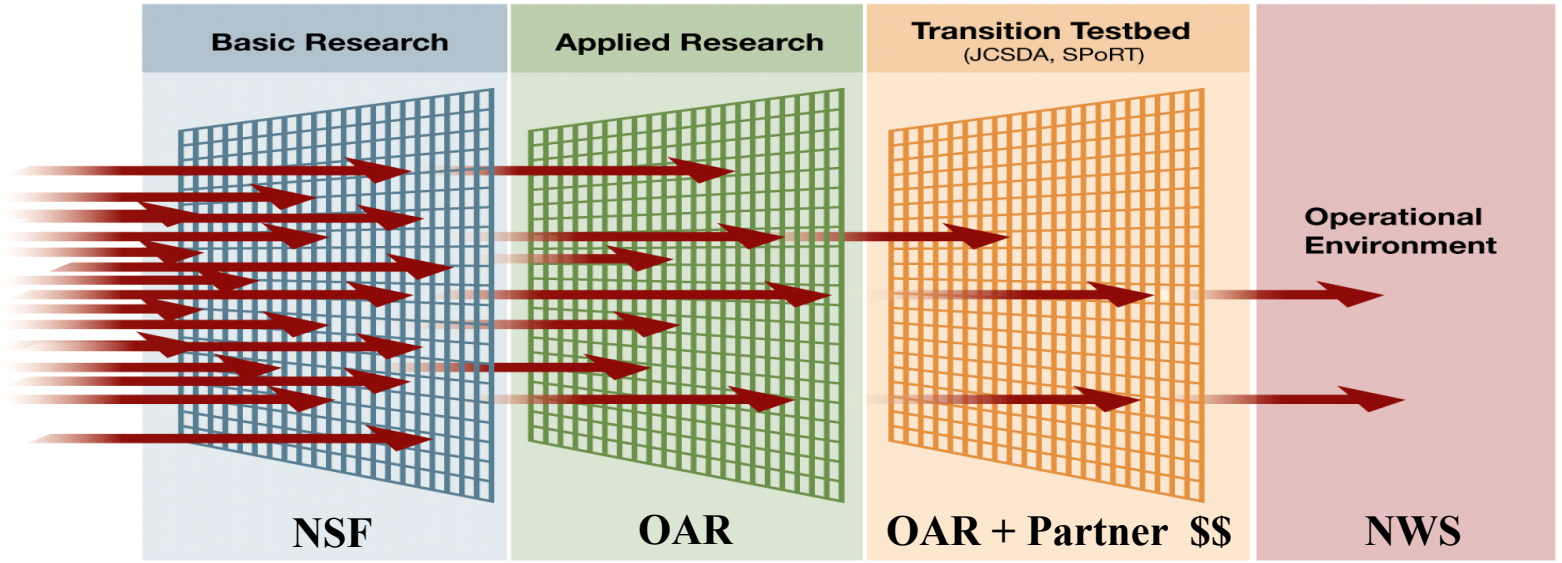
- Innovative data mining and visualization techniques.
- **Numerous R2O and O2R successes.**
- Development of CLUE to inform evidence-based HREF development.

Testbeds are Diverse

Tools

Directed $$$ ← HWT Engagement → Directed $

SPC SSB →



Ideas

Challenges

pathway for operational assessment and feedback

NWP

Directed $$$ ← HWT Engagement → Directed $$

Directed $

EMC NCO

HWT Funded Grant Projects

- NOAA/NWS: *Round 1 of Research to Operations Initiative* (NOAA-NWS-NWSPO-2015-2004117) – HWT EFP projects:
  - Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting by Jirak (SPC), Melick (CIMMS/SPC), Brooks (NSSL), and Pyle (EMC)
  - Improvement of Convective/Severe Weather Prediction through an Integrative Analysis of WRF Simulations and NEXRAD/GOES Observations over the CONUS by Dong, Kennedy, and Gilmore (UND)
  - Test and Evaluation of Rapid Post-Processing and Information Extraction From Large Convection Allowing Ensembles Applied to 0-3hr Tornado Outlooks by Correia (CIMMS/SPC), LaDue (OU/CAPS), Karstens, Wheatley, and Knopfmeier (all CIMMS/NSSL)
- NOAA/OAR: *Office of Weather and Air Quality Hazardous Weather and Hydrometeorology Testbed Competitions* (NOAA-OAR-OWAQ-2015-2004230) – HWT EFP projects:
  - Developing and Evaluating GSI-based EnKF-Variational Hybrid Data Assimilation for NCEP NAMRR to Improve Convection-Allowing Hazardous Weather Forecast by Wang (OU), Carley (EMC) DiMego (EMC), Jirak and Weiss (SPC), Kain and Clark (NSSL)
  - Convection-Permitting Ensemble Forecast System for Prediction of Extreme Weather by Romine, Schwartz, and Sobash (all NCAR), and Coniglio (NSSL)
  - Information Extraction and Verification of Convection-Allowing Models for Severe Hail Forecasting by Jirak (SPC) and Melick (CIMMS/SPC)
  - Improving Initial Conditions and their Perturbations through Ensemble-Based Data Assimilation for Optimized Storm-Scale Ensemble Prediction in Support of HWT Severe Weather Forecasting by Xue, Kong, Jung, and Snook (all OU/CAPS)

HWT Funded Grant Projects

- NOAA/OAR: *Office of Weather and Air Quality Internal Research to Operations Transition Competitions* (NOAA-OAR-OWAQ-2015-2004230) – HWT project:
  - Probability of What? Understanding and Conveying Uncertainty Through Probabilistic Hazard Services by Rothfusz, Gurley, and Brooks (NSSL), Hansen (GSD), Manross (CIRA/GSD), Schneider and Jirak (SPC), Smith and Karstens (CIMMS/NSSL), Stumpf (CIMMS/MDL), Smith (MDL), Novak (WPC), Ripberger and Silva (OU), and Ling (U. Akron)
- NOAA/OAR: : *Office of Weather and Air Quality Joint Technology Transfer Initiative* (NOAA-OAR-OWAQ-2016-2004824) – HWT EFP Projects:
  - Development and Implementation of Probabilistic Hail Forecast Products using Multi-Moment Microphysics and Machine Learning Algorithms by Snook, Xue, Jung and McGovern (OU)
  - Assessing the Impact of Assimilating Ground-Based Infrared Radiometer Data into Convective-Scale Numerical Weather Prediction Models by Wagner and Otkin (CIMSS/UW), Jones (CIMMS/OU) and Turner (GSD)
  - Development of NWS convective scale ensemble forecasting capability through improving GSI-based hybrid ensemble-variational data assimilation and evaluating the multi-dynamic core approach by Wang (OU), Dowell, Benjamin, Whitaker and Alexander (GSD), Carley and DiMego (EMC), Weiss and Jirak (SPC), and Clark (NSSL)

HWT Funded Grant Projects

- NOAA/NWS: *Next Round of Research to Operations Initiative: NGGPS and HFIP* (NOAA-NWS-NWSPO-2016-2004713) – HWT EFP project:
  - Information Extraction and Verification of Convection-Allowing Models for Tornado Forecasting by Jirak (SPC), Melick (CIMMS/SPC), Brooks (NSSL), and Pyle (EMC)