NGGPS Team Plan Update: NOAA Testbeds and Proving Grounds

Paula Davidson
TBPG Team Lead

Paula Davidson, Ph.D.
Senior Science Advisor
Science & Technology Integration
NOAA/National Weather Service

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Outline

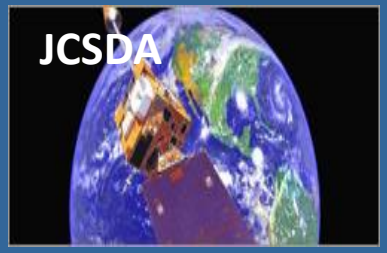
- NGGPS Testbeds and Proving Grounds (TBPG) Team
- NOAA Testbeds and Proving Grounds (TBPG): who they are and what they do
- NGGPS/TBPG Strategy
- NGGPS/TBPG Team Priorities and Progress
- Top ccomplishments and a Look Ahead

NGGPS Testbeds and Proving Grounds (TBPG) Team

Member	Organization
Paula Davidson (Lead)	NWS/STI
Michael Ek	NWS/NCEP/EMC
David Novak	NWS/NCEP/WPC
Russell Schneider	NWS/NCEP/SPC
John Cortinas	OAR/OWAQ
Kevin Kelleher	OAR/ESRL/GSD

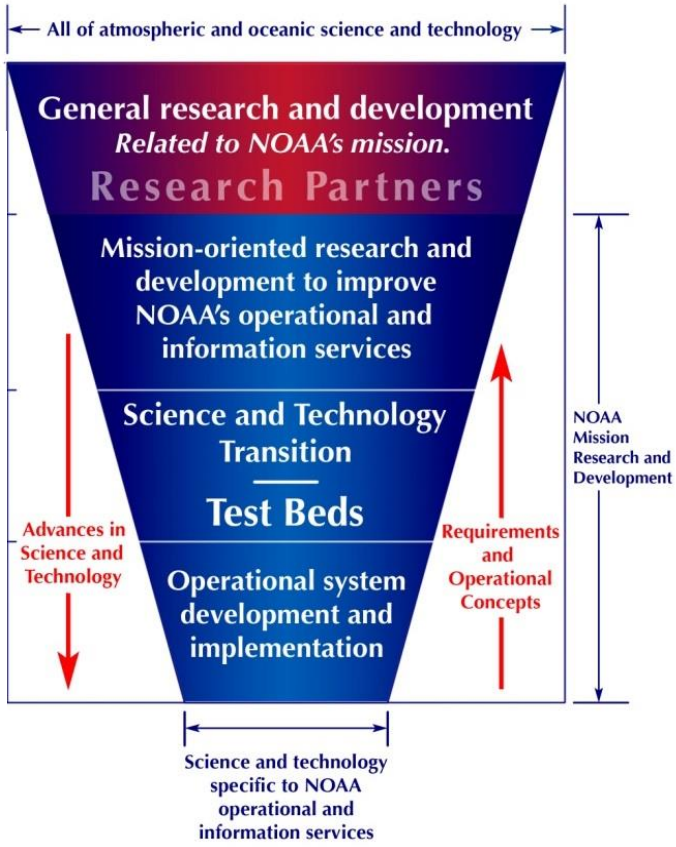
Current NOAA TBPG

http://www.testbeds.noaa.gov (thanks to: Rich Lataitis & Barb deLuisi)

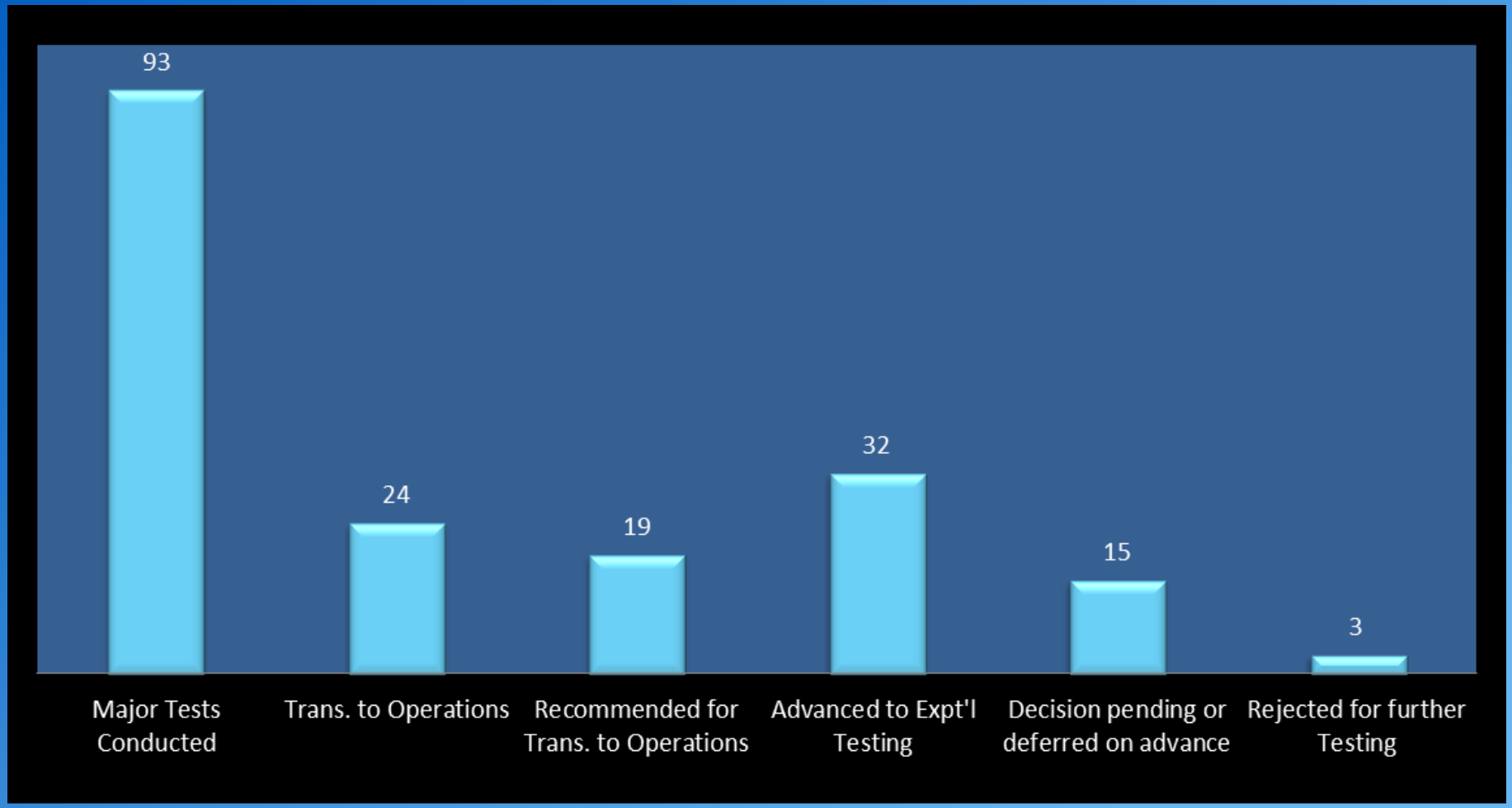


Framework for Transition: NOAA and Partners

	Phase	Key Q	Key Metric	Facility
	R&D	Does it work?	Peer-reviewed Publication	Universities, Government Labs, Private Industry
TB →	Developmental Testing	Works with operational systems?	Feasibility/ Engineering Analysis Successful	Testbed with operations-like environment
PG →	Experimental Testing	Meets operational performance criteria?	Go/No Go based on: Objective Performance (e.g. accuracy) Subjective Feedback Production Readiness	Operational proving ground for clinical tests and full "dress rehearsal"
	Operations	Maintains required performance?	Objective criteria: accuracy and reliability	Operations



NOAA TBPG Transitions: 2015 Summary



TBPG Strategy

Role in NGGPS

Conduct testing needed to exploit NGGPS advances for service improvements

- Testing forecast service impacts for NGGPS prototypes, establish skill baselines/improvement targets
- Testing advanced forecaster tools/applications needed to exploit NGGPS in achieving service improvements
- Facilitate phased NGGPS transition through rigorous TBPG testing methods for transition testing including operational readiness/suitability evaluation:
  - assessment of performance criteria for objective & subjective accuracy/reliability, workforce/workflow impacts, effectiveness for end-users

Team Priorities

- Establishing Verification Methods & Benchmark Skill (EBS)
- Testing Advanced Forecaster Tools and Applications (ATA); extracting useful, actionable information from NGGPS for decision support

Above apply to all NGGPS timescales, with TBPG focus initially on improving forecast information to address gaps in several critical service areas

- Global Scale and extended-range forecasts (Weeks 3-4 and Day 6-10)
- Storm-scale & high-resolution applications (high-impact)

Week 3-4 Forecasts

- Current gap in explicit forecast products despite widespread user demand; NGGPS to provide basis for high-impact forecast information
  - Beginning baseline skill assessments in forecast guidance for significant large-scale events, e.g. hurricane, drought/floods, prolonged heat/cold
  - Extending object-oriented evaluation, identification of signal from noise in coupled model/ensemble guidance for reliable, consistent forecast information
- TBPG testing forecast service impacts for NGGPS components, coupled system prototypes and feedbacks

Day 6-10 Forecasts

- Current NWS detailed forecasts only through Day 7; NGGPS advances in skill/reliability provide basis for extending to Day 10.
  - Rapid drop in skill for forecasts of “sensible” weather
  - Beginning evaluations of reliable skill in model guidance to be mined for potential useful information for decision support
- TBPG engaged in evaluating guidance and translation into consistent, actionable products & services

High-impact weather forecasts (Stormscale) for US

- Current NWS forecasts for high-impact weather including tornado outbreaks, flash floods, major aviation disruptions from thunderstorms do not yet contain the temporal and spatial detail needed to support optimal decision making; NGGPS to provide framework
  - Lack of operational guidance from convection-allowing ensembles at high spatial/temporal resolutions
  - Beginning to ingest high-resolution, rapidly updating observations from radar; satellites next
- TBPG engaged in evaluating guidance and translation into consistent, actionable products & services

Round I Sponsored Projects: Testbeds-related activities

Focus Area	Project	Outcomes*
Global-scale & extended-range wx applications Weeks 3-4 & Days 6-10	Exploitation of Ensemble Prediction System Information in support of Atlantic Tropical Cyclo-genesis Prediction (Thorncroft)	EBS, ATA
	Application of a Hybrid Dynamical-Statistical Model for Week 3-4 Forecast of Atlantic/Pacific Tropical Storm and Hurricane Activities (Schemm)	ATA
	An Investigation of the Skill of Week Two Extreme Temperature and Precipitation Forecasts at NCEP-WPC (Bosart)	EBS
	Validation of Significant Weather Features and Processes in Operational Models Using a Cyclone Relative Approach (Colle)	EBS
Storm-scale & high-resolution applications Day 0-3	Test and Evaluation of Rapid Post-Processing and Information Extraction from Large Convection 3hr Tornado Outlooks (Correia)	ATA
	Data Mining of High-resolution Storm-scale Data Sets (Smith)	ATA
	Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting (Jirak)	EBS, ATA
	Improvement of Convective/Severe Weather Prediction through an Integrative Analysis of WRF Simulations and NEXRAD/GOES Observations over the CONUS (Dong)	EBS
Cross-cutting	Incorporation of near real-time Suomi NPP Green Vegetation Fraction and Land Surface Temp data into the NCEP Land modeling suite (Csiszar)	ATA, EBS

*** Projected Outcomes: Establish Baseline Skill (EBS), Advanced Forecaster Tools /Applications**

Sponsored Projects and Partners

Focus Area	Projects	Principal TB Partners
Week 3-4	Global-scale and extended range weather Thorncroft, Schemm, Csiszar)	Thorncroft: JHT (also EMC) Schemm: CTB Csizar: JCSDA (EMC, NESDIS/STAR)
Day 6-10	Extended range weather (Thorncroft, Bosart, Colle, Csiszar)	Bosart: HMT (also EMC) Colle: HMT (also EMC)
Day 0-3 high impact weather	Storm-scale and high-resolution applications (Correia, Smith, Jirak, Dong, Csiszar))	Corriea: HWT Smith: HWT Jirak: HWT (also EMC) Dong: HWT

Sponsored Projects Milestones Status (6/15/16)

Project	Testbed	PI	Institution	Status 6/15/16	#Milestones	Complete	On track	Not started	Delayed	not reported
Exploitation of Ensemble Prediction System Information in support of Atlantic Tropical Cyclogenesis Prediction	JHT	Christopher Thorncroft	SUNY Albany	**Add 6 mos to all milestones	8	0	5	2	1	0
Application of a Hybrid Dynamical-Statistical Model for Week 3 to 4 Forecast of Atlantic/Pacific Tropical Storm and Hurricane Activities	CTB	Jae-Kyung Schemm	NOAA/CPC		5	2	1	2	0	0
An Investigation of the Skill of Week Two Extreme Temperature and Precipitation Forecasts at the NCEPWPC	HMT	Lance Bosart	SUNY Albany		5	2	1	2	0	0
Validation of Significant Weather Features and Processes in Operational Models Using a Cyclone Relative Approach	HMT	Brian Colle	SUNY/Stony Brook Univ		14	1	5	5	3	0
Test and Evaluation of Rapid Post-Processing and Information Extraction from Large Convection Allowing Ensembles Applied to 0-3hr Tornado Outlooks	HWT	James Correia	University of Oklahoma		11	5	2	4	0	0
Data Mining of High-resolution Storm-scale Data Sets	HWT	Travis Smith	University of Oklahoma		6	0	1	4	1	0
Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting	HWT	Israel Jirak	NOAA/SPC		8	2	2	2	2	0
Improvement of Convective/Severe Weather Prediction through an Integrative Analysis of WRF Simulations and NEXRAD/GOES Observations over the CONUS	HWT	Xiquan Dong	University of North Dakota		17	8	0	7	0	2
Incorporation of near real-time Suomi NPP Green Vegetation Fraction and Land Surface Temp data into the NCEP Land modeling suite	JCSDA	Ivan Csiszar	NOAA/NESDIS		18	5	8	4	1	0

- **At midpoint, projects are on track**

NGGPS Testbeds Team Summary: Major accomplishments in FY 16

- **Weeks 1-4:**
  - Tools developed for predicting TC genesis (Atlantic, and North Pacific basins) using African Easterly Waves, and hybrid dynamical statistical approaches (in testing, 2016 season)
  - Improved land surface analyses (VIIRS-based near-real time GVT and LST, Suomi NPP) developed for more consistent, updated basis for land-surface models and verification
- **Day 6-10**
  - Developed methodology to identify extreme T and precipitation events and antecedent governing flow patterns; tool based on N Pac Jet phase diagram tested for operational use in WPC
  - Cyclone-relative evaluation methodology developed and transferred into Model Evaluation Tools framework for use in other feature-based evaluation; partners applying to convective complexes and flooding events
- **Day 0-3 High-Impact Weather**
  - Developed object-based approach for identification/verification of severe wind events, providing baseline verification metrics for current 10-m winds predictions in CAMs
  - Tested CAM-based situational awareness tools for tornado outlooks; real-time testing maintains content with data latency ~ 4mins and data volume reduced by factor of 10^3
  - Characterized regional variations in precipitation and associated synoptics to help assess baseline skill of current ensemble predictions of convective/severe weather events
  - Data-mining techniques for high-resolution storm-scale data sets developed with 12 years NEXRAD data processed as MRMS data; initial real-time testing of visualization tool

NGGPS Testbeds Team Summary: Looking Ahead

- **Priority Focus in FY16:**
  - Developing and applying new methods to assess and extract skill from current prediction models as a basis for future service improvements
- **Priority Focus for FY17**
  - Evaluation and real-time testing of promising potential high-impact service improvements to be extracted from NGGPS
  - New efforts to include broader range of service area improvements
- **Key Issue**
  - Continuing efforts to ensure effective coordination among project investigators and partners in EMC and NCEP service centers

NGGPS Testbeds Project Summaries

Exploitation of Ensemble Prediction System Information in Support of Atlantic Tropical Cyclogenesis Prediction

Chris Thorncroft, Jason Dunion & Alan Brammer
University at Albany, State University of New York.
July 2016

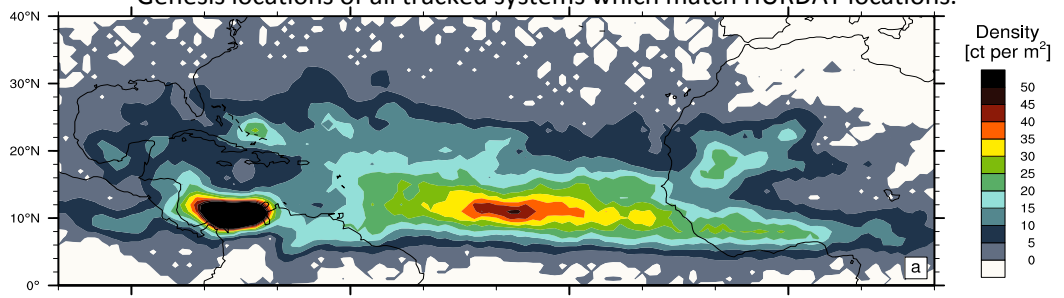
Scientific Accomplishments

- Developed pre-genesis tracking algorithm and methodology.
- Tracked pre-genesis disturbances across the Atlantic in CFSR and GEFS across 2002-2015
- Developed storm centric bias correction.
- Over-intensification bias for storms originating from West Africa. Conversely storms are typically under-developed in the forecast when originating over the ocean.

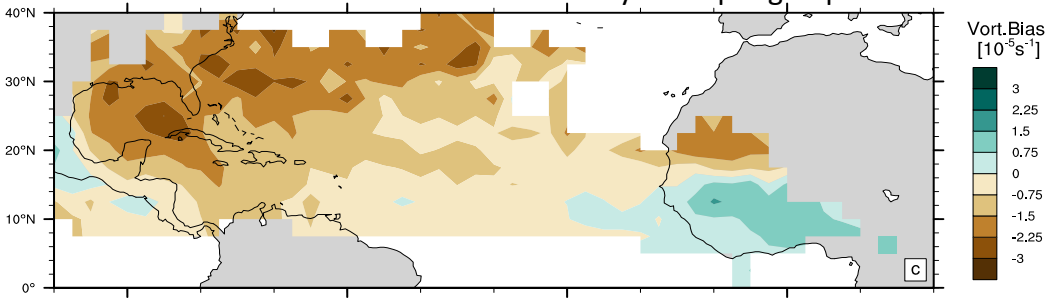
Significance/Future:

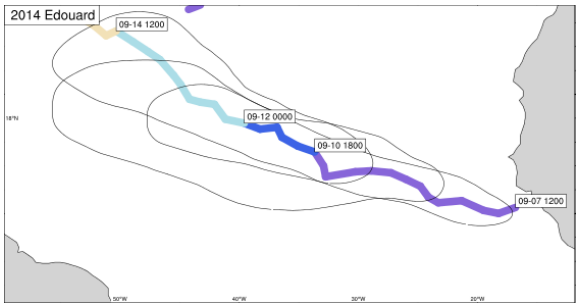
- Evaluating TC genesis cases with high ensemble spread and cases with high false alarm rates.
- These results will highlight environmental regions or modelling processes that can be improved for better forecast skill.

Track density for pre and post genesis disturbances during 2002-2015.
Genesis locations of all tracked systems which match HURDAT locations.



Mean GEFS ensemble bias for tracked systems per grid point





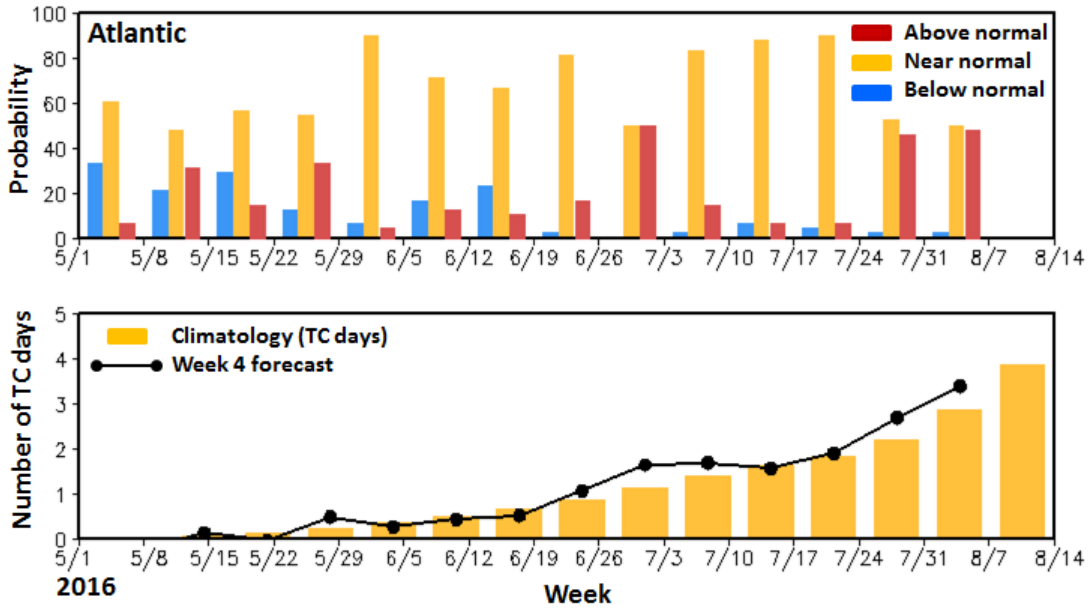
Example pre-genesis GEFS forecast cones from 3 pre-genesis initialization times. Analysis track overlaid. These cones are currently being generated objectively in real-time. Bias-correction will be also be applied for intensity forecasts based.

Title of Project: Application of a Hybrid Dynamical–Statistical Model for Week 3 to 4 Forecast of Atlantic/Pacific Tropical Storm and Hurricane Activities

PI(s): Jae-Kyung E. Schemm and Hui Wang, CPC/NCEP/NWS/NOAA

Key scientific accomplishment to date:

- Established the empirical relationships between observed tropical cyclone (TC) activity and large-scale atmospheric circulation predicted for weeks 1 – 4 for tropical North Atlantic(NATL), tropical eastern North Pacific(ENP), and tropical western North Pacific (WNP) basins
- Identified three potential predictors, including vertical wind shear, local and remote sea level pressure
- Developed the hybrid dynamical–statistical model for forecasting weekly TCs for each ocean basin and assessed the forecast skills with different predictors
- Experimental real-time prediction of weekly TC activity commenced in May 2016



Real-time probability forecast (top) and number of TC day forecast (bottom) of week 4 tropical cyclone activity for the first 14 weeks (May 1 – August 7) of the 2016 hurricane season for the tropical North Atlantic basin, using vertical wind shear as a predictor.

SIGNIFICANCE: Testing and evaluating the potential forecast skill for high-impact events in weeks 3-4 time scale to provide additional tool for CPC's operational Tropical Hazards Outlooks products.

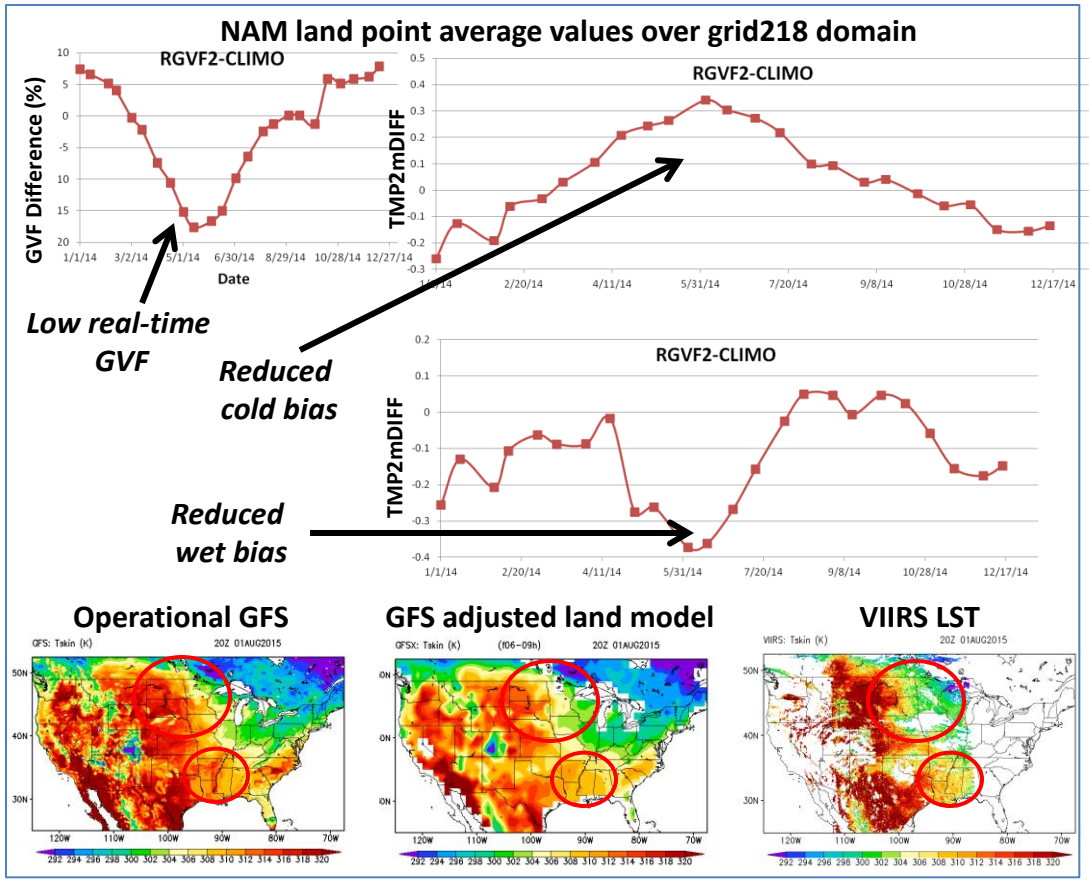
Title of Project: Incorporation of near-real-time Suomi NPP Green Vegetation Fraction and Land Surface Temperature data into NCEP Land modeling suite

PIs: I. Csiszar (STAR), M. Ek (EMC)

Team: M. Vargas, W. Zheng, Y. Wu, Y. Yu, Z. Jiang, Z. Song

Key scientific accomplishment to date:

- sensitivity on NCEP land model performance of the real-time VIIRS Green Vegetation Fraction (GVF) has been demonstrated
- differences between VIIRS- and heritage AVHRR- based GVF data have been characterized and adjustments were developed to improve continuity
- VIIRS-based prototype gridded Land Surface Temperature (LST) product was developed
- the value of the VIIRS LST product as model verification tool has been demonstrated



Top: Impact of real-time VIIRS (RGVF2) vs. multi-year mean AVHRR GVF (CLIMO) on NAM near-surface air and dewpoint temperatures in 2014

Bottom: VIIRS LST used to verify GFS with updated land model physics.

SIGNIFICANCE: It is critical to replace the current static multi-year datasets of land characteristics with a consistent suite of updated products. The stand-alone and coupled models are sensitive to updated Green Vegetation Fraction. VIIRS Land Surface Temperature provides spatially explicit verification data.

Title of Project: An Investigation of the Skill of Week Two Extreme Temperature and Precipitation Forecasts at the NCEP-WPC

PIs: Lance F. Bosart and Daniel Keyser

Key scientific accomplishments to date:

- Developed methodology to identify extreme temperature and precipitation events and to cluster them by geographic region (Figs. 1a,b).
- Employed the two leading modes of 250-hPa zonal wind variability to develop a N. Pacific Jet phase diagram and to identify antecedent environments conducive to the production of extreme events (Figs. 1c,d,e).
- Initiated efforts with WPC personnel to transition the N. Pacific Jet phase diagram into operations as a tool to characterize the upper-tropospheric flow pattern in the N. Pacific (Fig. 1f)

Significance:

- Provide forecasters with a "first alert" to the possibility of the occurrence of extreme events during week two on the basis of current conditions and model forecasts.

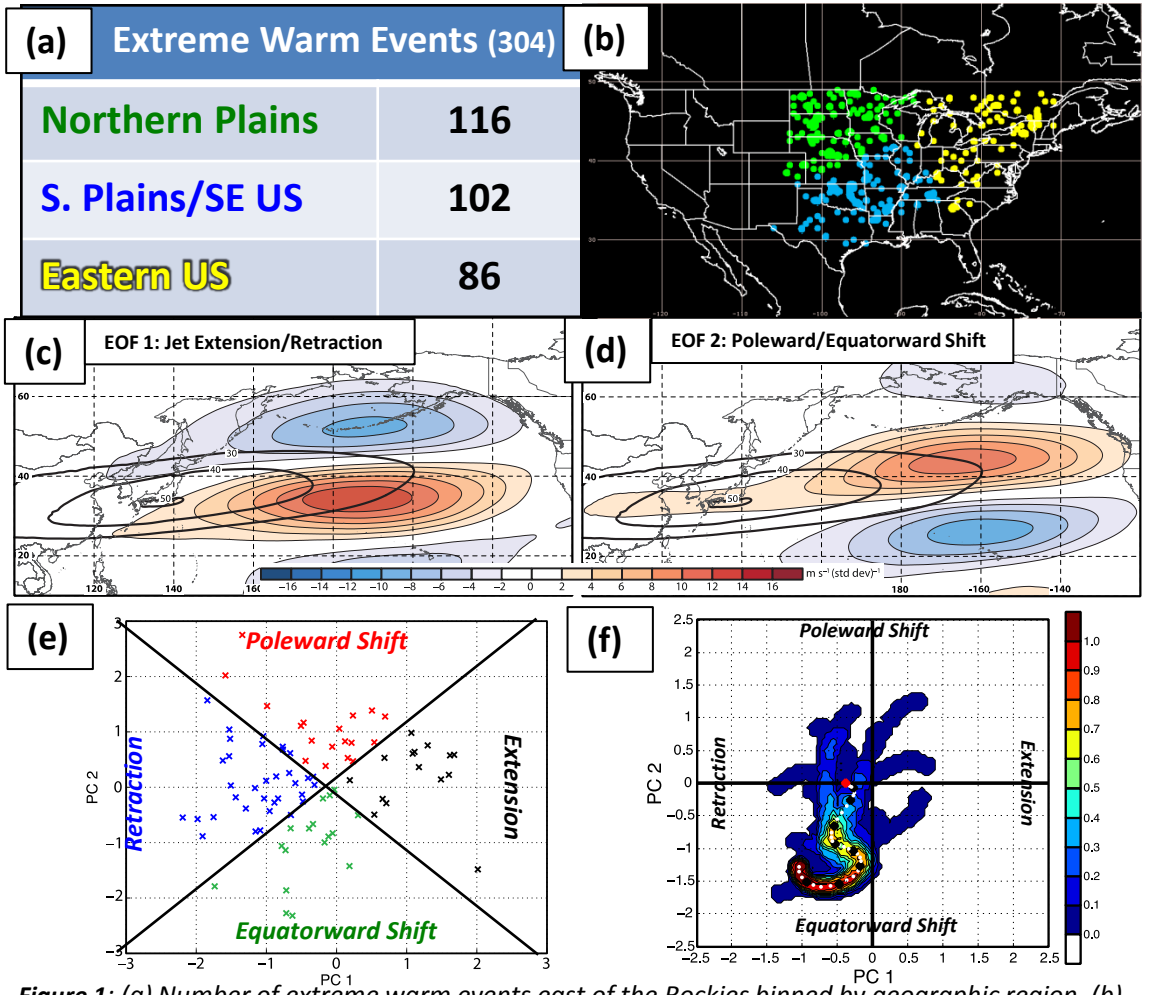


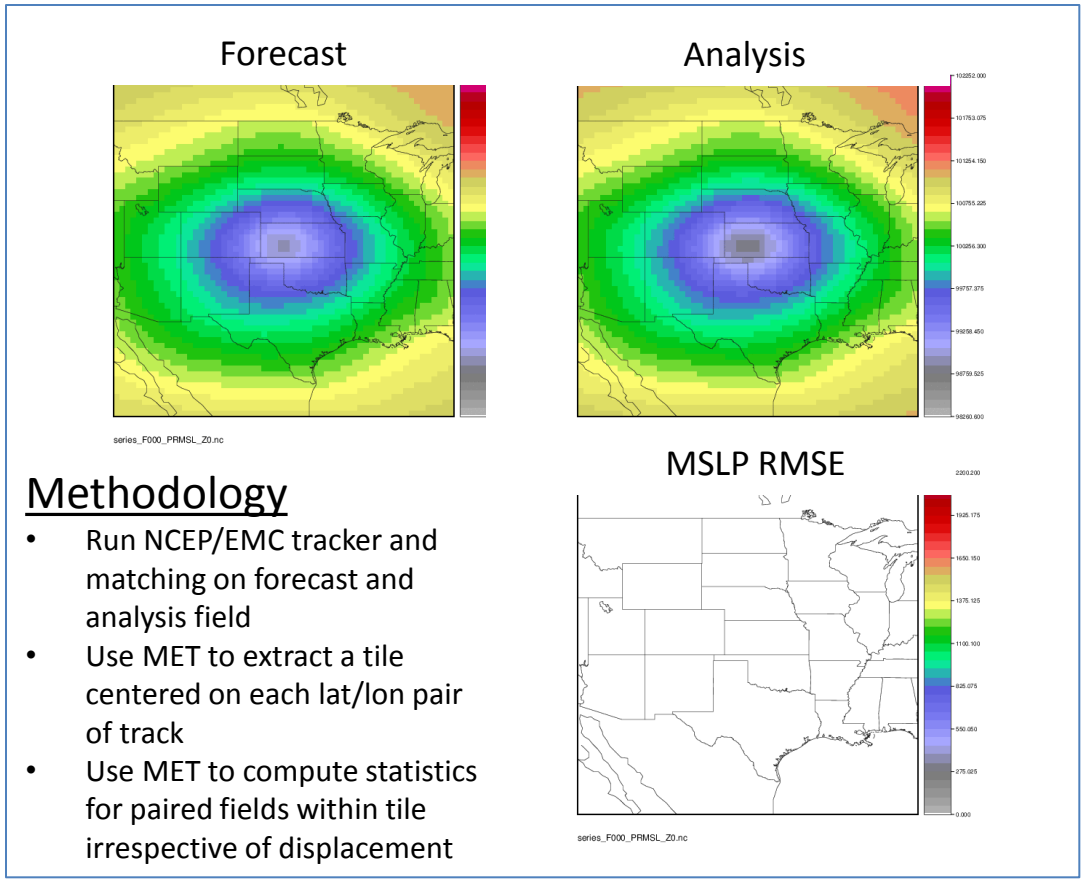
***Figure 1**: (a) Number of extreme warm events east of the Rockies binned by geographic region. (b) Event centroids for extreme warm events colored by geographic region. (c) 1st and (d) 2nd EOFs of 250-hPa zonal wind in N. Pacific during Sept.–May (shading) and Sept.–May mean 250-hPa zonal wind (m s^{-1}; black contours). (e) N. Pacific Jet phase diagram with S. Plains/SE US extreme warm events (x's) projected onto the EOFs in (c) and (d). (f) 9-day probabilistic forecast trajectory within the N. Pacific Jet phase diagram employing GEFS forecasts initialized at 0000 UTC 24 May 2016; probability is shaded and ensemble mean is denoted by dotted black and white line.*

Title of Project: Validation of Significant Weather Features and Processes in Operational Models Using a Cyclone Relative Approach

PI(s): Brian A. Colle (brian.colle@stonybrook.edu) and Edmund Chang, Stony Brook University; Paul Kucera, Tara Jensen, and John Gotway, NCAR-RAL

Key scientific accomplishments to date:

- Cool Season Validation of Eastern US/Western Atlantic Cyclones in the ECMWF, GEFS, and CMC ensembles from 2008-2015.
- Developed and tested a cyclone relative evaluation methodology
- Model Evaluation Tools (MET) enhanced to support this type of evaluation
- Any field available in forecast/analysis files may be used for evaluation (e.g. MSLP, 500mb Height, 300mb jet, etc…)
- Cyclone relative evaluation is now available for other weather phenomena such as tropical storms, convective cells, snowbands, etc…
- Automated system in development at NCAR for porting to EMC/WPC in Year 2
- Gridded and analysis data for four cases gathered for inclusion in DTC Mesoscale Model Evaluation Testbed (MMET)



Methodology

- Run NCEP/EMC tracker and matching on forecast and analysis field
- Use MET to extract a tile centered on each lat/lon pair of track
- Use MET to compute statistics for paired fields within tile irrespective of displacement

Resulting Forecast, Analysis and Error Field

SIGNIFICANCE:

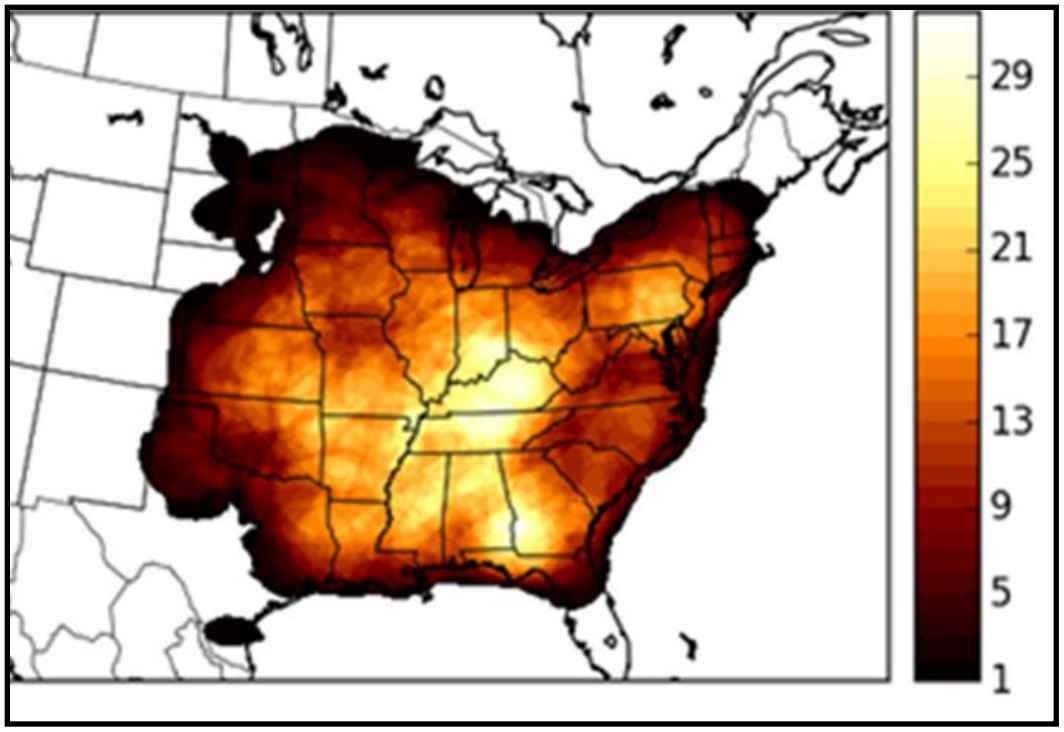
** Cyclone relative evaluation methodology transferred into MET framework and now available for other feature relative evaluations as well (e.g. TCs, Jets, Convective Complexes, etc…)

Title of Project: Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting

PI(s): Israel L. Jirak (SPC), Christopher J. Melick (OU/CIMMS & SPC), Harold E. Brooks (NSSL), and Matthew E. Pyle (EMC)

Key scientific accomplishments to date:

- Developed an object-based approach for defining a severe wind event
- Created an object-based climatology of severe-wind-producing MCSs
- Performed grid-point and object-based verification of NSSL-WRF 10-m wind forecasts for severe wind events
- Utilized an object-based approach to verify probabilistic 10-m wind forecasts from the SPC Storm-Scale Ensemble of Opportunity for severe wind events
- Assessed the sensitivity of SSEO performance when removing individual members and subsets of members
- Revealed the importance of ARW members in a convection-allowing ensemble for forecasting severe-wind-producing MCSs



Climatology of severe-wind-producing MCSs (counts) from 2012-2014 using object-based identification.

SIGNIFICANCE: As global models approach convection-allowing scales, development of innovative methods for extracting and verifying model information will be critical to improving forecasts of high impact events

Test and Evaluation of Rapid Post-Processing and Information Extraction From Large Convection Allowing Ensembles Applied to 0-3hr Tornado Outlooks

PIs: James Correia, Jr, C. Karstens, D. LaDue, K. Knopfmeier, & D. Wheatley

Key scientific accomplishments to date:

- Through interviews of NWS forecasters learned that CAM trust is low b/c of low familiarity and un-calibrated expectations
- Developed & tested our post-processing approach to meet situational awareness
- Minimized data while providing a similar amount of information (20KB vs 18MB)
- Implemented system in real-time during HWT 2016 PHI experiment with minimum latency (~4 minutes) for this task
- Analysis of 2016 HWT PHI experiment ongoing

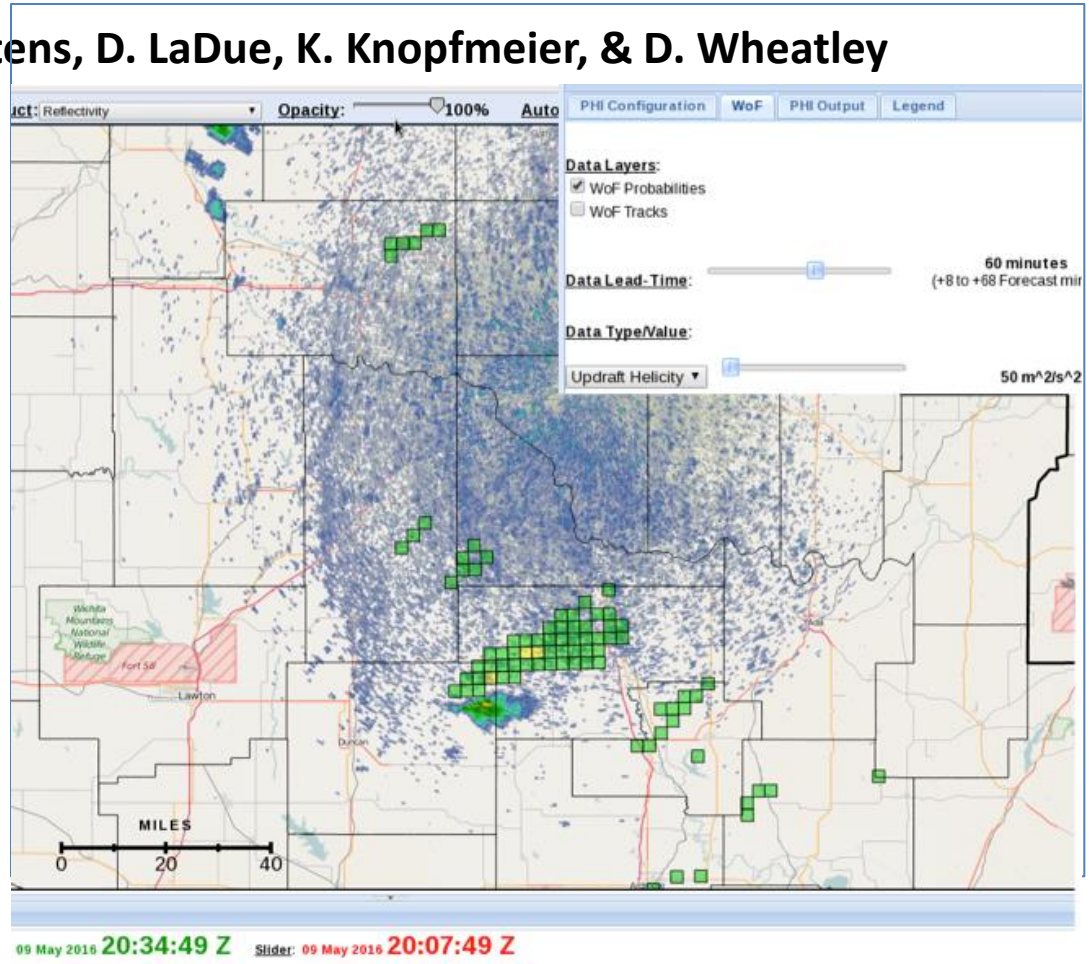


Image of display options available to forecasters showing pseudo-probability of updraft helicity by lead-time and intensity. We designed our data to allow rapid queries without having to add additional computations after post-processing

SIGNIFICANCE: Can leverage post processing to minimize data volume, data latency in time pressure based short term environments from large ensemble.

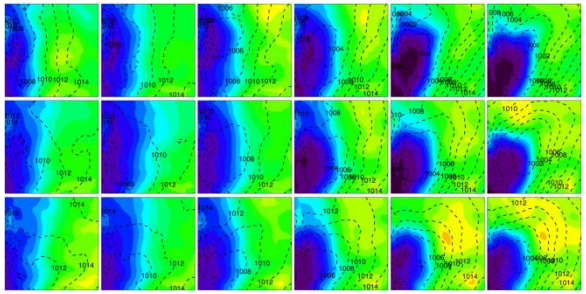
Title of Project: Improvement of Convective/Severe Weather Prediction through an Integrative Analysis of WRF simulations and NEXRAD/GOES Observations over the CONUS

PI(s): Xiquan Dong, CO-I: Aaron Kennedy and Matt Gilmore – University of North Dakota

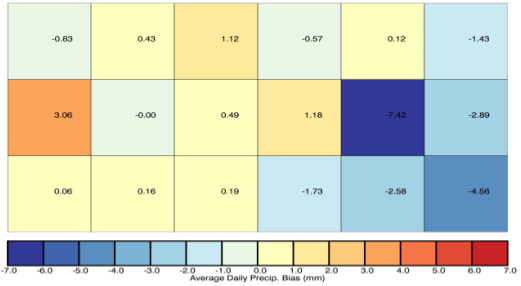
Key scientific accomplishment to date:

- Statistical study of operational WRF runs (NSSL/NCEP complete (Goines 2016)
- Convective cases identified for five regions (~200 for each region) and classified as heavy, moderate and light rains, and their associated
- Synoptic study (right)
  - Evidence of precipitation varying by synoptic pattern
  - Preliminary: Negative bias for strongly forced case, slight positive bias for weaker forcing
- Real-time microphysics ensemble run for 2016 HWT SFE

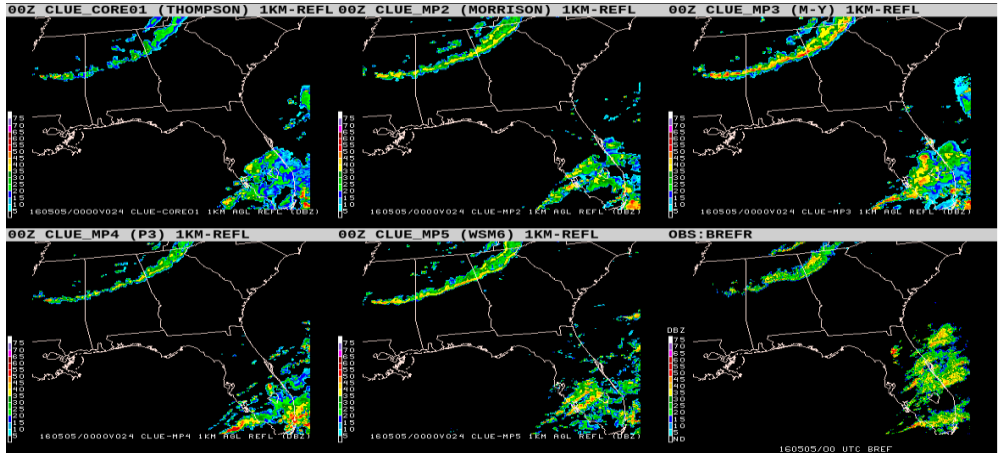
Cluster Analysis for Southern Plains



NSSL WRF Precipitation Bias



HWT SFE MP Ensemble



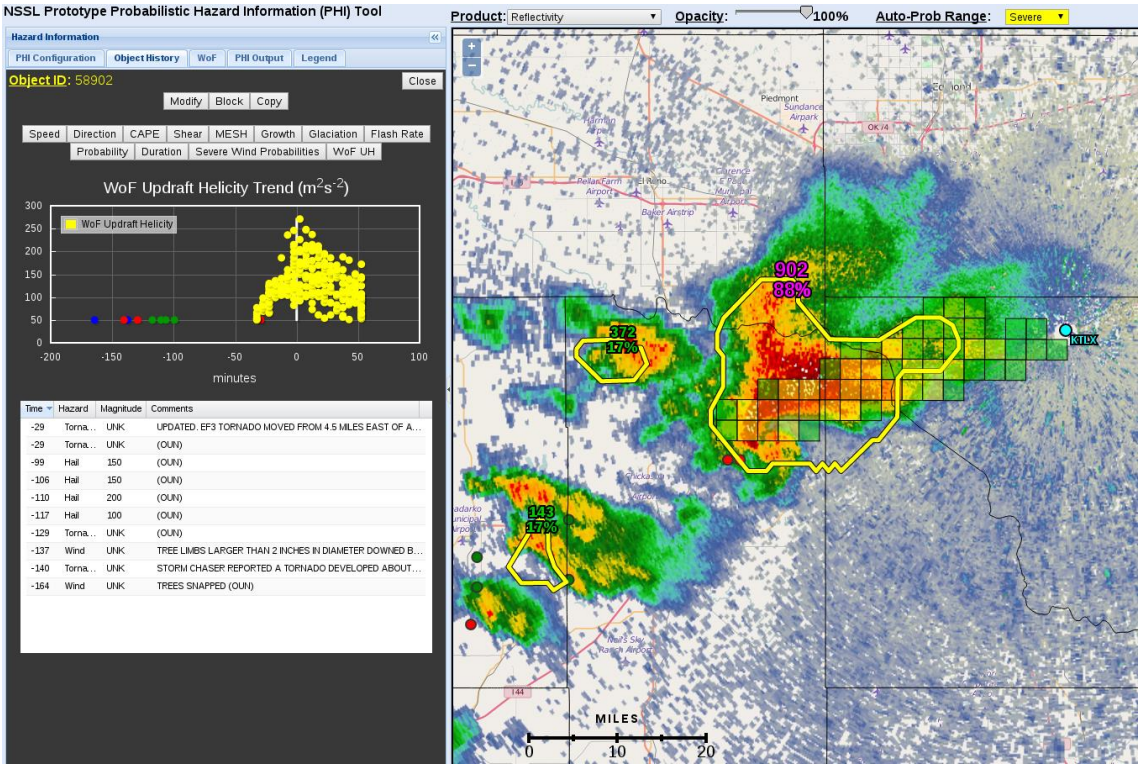
SIGNIFICANCE: What configurations of convection permitting models are most beneficial for convective forecasting and how does this vary by synoptic state? Potential for on-demand ensembles/deterministic runs based on day-to-day patterns

Title of Project: Data Mining of High-Resolution Storm-Scale Datasets

PI(s): Smith, Correia, Karstens, Ortega (U. of Oklahoma / CIMMS)

Key scientific accomplishment to date:

- Real-time test of visualization tool in Hazardous Weather Testbed
  - Blends radar-identified storm objects from Multi-Radar/Multi-Sensor (MRMS) system with forecast objects from Warn-on-Forecast (WoF) storm scale ensemble
  - Click on MRMS-based object contour and get WoF object and trend.
- Pattern recognition and machine learning software is ready to process the training and testing data sets for storm type classification. Tested by forecasting storm duration predictions from objects.
- Data sets acquired.



The forecast Updraft Helicity (UH) values (yellow dots in chart) from WoF objects that are associated with the MRMS-observed supercell object (contour). The WoF-based probabilities of UH > 50 representing a strong rotating updraft are shown as boxes.

SIGNIFICANCE:

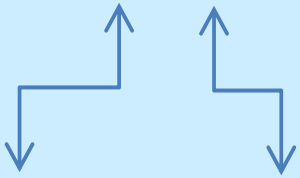
Visualization capabilities for blending observational radar and forecast model ensemble data developed and tested in Hazardous Weather Testbed.

Backup

TBPG Testing Coordination for NGGPS

1. CODE testing:

Global components — DTC (new role) — potentially TBA: COMT, CTB, GRPG, JCSDA, SWPT



2. Regional & Storm-scale components:

HWT ⟷ AWT (?on storm-scale convection?)

Forecaster and service impacts (including Post-processing and forecaster apps):

Service centers — JHT HMT/WPC HWT AWT

Local offices — OPG (for WFOs, RFCs)

Longer-Range Plans

- Increasing partnerships with related NOAA activities
- Expand testing activities to include additional NWS service areas impacted by NGGPS
- Expand involvement to include OPG in assessing service impacts (WFOs/RFCs)
- Refine and test impact-based performance targets for critical NWS service areas; address gaps in decision support services
- Continuing phased testing of advanced forecaster tools and applications: rigorous and conclusive evaluation of accuracy, reliability, utility and services impacts in providing actionable decision support

Related NOAA efforts

- Leveraging established procedures and coordination among NOAA TBPG
- Ongoing coordination with USWRP-sponsored efforts
- Working with Office of Water Prediction to advance nascent testing activity
- Working with NOAA-wide efforts led by NOAA's Chief Scientist to accelerate transition