SPRING FORECASTING EXPERIMENT 2012

Conducted by the

EXPERIMENTAL FORECAST PROGRAM

of the

NOAA/HAZARDOUS WEATHER TESTBED

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HWT Facility – National Weather Center
7 May - 8 June 2012

Program Overview and Operations Plan

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Adam Clark[2,6], Jack Kain[2], Steven Weiss[1], Mike Coniglio[2], James Correia[1,6], Israel Jirak[1], Chris Melick[1], Patrick Marsh[2,3,6], Chris Siewert[1], Stuart Miller[3], Ryan Sobash[3], and Andy Dean[1]

(1) NOAA/NWS/NCEP Storm Prediction Center, Norman, Oklahoma
(2) NOAA/OAR National Severe Storms Laboratory, Norman, Oklahoma
(3) School of Meteorology, University of Oklahoma, Norman, Oklahoma
(4) NCAR/NOAA Developmental Testbed Center, Boulder, Colorado
(5) NOAA/NWS/NCEP Hydrometeorological Prediction Center, Camp Springs, Maryland
(6) Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma

1. Introduction

Each spring, the Experimental Forecast Program of the NOAA/Hazardous Weather Testbed conducts a collaborative forecasting experiment. Organized by the Storm Prediction Center (SPC) and National Severe Storms Laboratory (NSSL), these annual forecasting experiments test emerging concepts and technologies designed to improve the prediction of hazardous mesoscale weather. Primary goals include accelerating the transfer of promising new tools from research to operations, inspiring new initiatives for operationally relevant research, and documenting sensitivities and performance of state-of-the art high-resolution experimental modeling systems.

The 2012 Spring Forecasting Experiment (SFE2012) will be conducted 7 May – 8 June. This operations plan will summarize the core interests of SFE2012 and related SFE2012 activities, as well as provide logistical information on the experiment. Detailed information on the organizational structure of the HWT, and information on various forecast tools and diagnostics can also be found in this document. The remainder of the operations plan is organized as follows: Section 2 describes the core interest for SFE2012 and includes a list of participants, Section 3 details the daily activities schedule, and Section 4 provides details on a number of new products/concepts being introduced during SFE2012.

2. SFE2012 Core Interests/Daily Activities

SFE2012 activities will be centered around two components – NSSL staff will lead a component focused on forecasting convection initiation, and SPC will lead a component focused on forecasting severe weather. Given the strong relationship between these focus areas, the daily schedule is designed to facilitate frequent interaction between the two groups, and aside from specific experimental forecast activities, the two groups will work together. There is also an ALPS workstation, which will be run by a visitor from ESRL/GSD each week, and a new visualization machine for viewing model/obs grids using software other than NMAP. Tools from both the ALPS workstation and visualization machines will be integrated into the forecast generation process. A list of SFE2012 participants is provided in Table 1 and details on each component follow below.

Table 1 List of Participants. An asterisk indicates SPC forecasters. Facilitators/leaders attending all weeks include: Adam Clark (NSSL), Michael Coniglio (NSSL), Jack Kain (NSSL), James Correia (SPC), Andy Dean (SPC), Israel Jirak (SPC), Steve Weiss (SPC; limited availability), Patrick Marsh (NSSL), Stuart Miller (NSSL), Dave Imy (SPC), and Dave Turner (NSSL; ~ 1 hr daily).

7-11 May	14-18 May	21-25 May	29 May – 1 June	4-8 June
John Hart (M-T)* Jared Guyer (T-Th)* Ariel Cohen (W-F)* Kent Knopfmeier Sean Crowell Brian Kolts Rentschler Jim Ramer Bill Gallus (T-Th) Dave DeWitt (M)	Jon Garner (M-W)* Greg Dial (T-Th)* Ariel Cohen (M-W)* Elizabeth Leitman (M-W)* Dan Petersen Jason Otkin Valliappa Lakshmanan Dan Dawson Steve Willington Dan Suri Dave Carlsen (1 day) Curtis Alexander Eric James Lance Bosart	Bryan Smith (M-W)* Matt Mosier (T)* Jeff Peters (Th)* Ariel Cohen (Thu)* Corey Pieper Chad Kahler Dustan Wheatley Corey Potvin Jon Case John Huhn Hongli Jiang	Jon Garner (T-W)* Jeremy Grams (Th-F)* Jonathan Wolfe Mark Condler Thomas Jones Bill McCaul Kathrin Wapler Matt Pyle Carl Bullock Clark Evans	Melissa Hurlbut (M-W)* SPC Forecaster* Kenny James Pete Blottman Nathan Hitchens Hugh Morrison (M-W) Victor Homar Helge Tuschy John Brown Greg Thompson

a) Severe Storms Component

For the Severe Storms component, we are exploring the utility of high-resolution ensembles in adding temporal specificity to the forecast (similar to previous years). The new aspect for Severe this year is that the humans will first create a full-period (1630-1200Z) outlook (where SPC forecasters have historically shown skill) and then manually break that outlook down into three periods: 20-00Z, 00-04Z, and 04-12Z. In the next day evaluations, the individual period human forecasts will be compared to forecasts from an automated temporal disaggregation technique that breaks down the full-period human forecast using calibrated severe SSEO guidance. The motivation here is to determine if it is possible to provide the forecaster with skillful first-guess guidance for an enhanced temporal resolution severe forecast. This investigation is very relevant to SPC operations because they are being encouraged to explore higher temporal resolution in their forecast products, but do not anticipate staffing increase commensurate with the additional responsibilities.

The specific forecast products produced by Severe are probability of any severe (hail, wind, and tornado) within 25 miles of a point for 1630-1200Z, 20-00Z, 00-04Z, and 04-12Z for a regional (i.e., three-letter ID) domain of interest.

b) Convection Initiation (CI) Component

SFE2012 will focus on improved understanding and prediction of temporal trends in convective activity – for the CI-component, the focus will be on trends in convective initiation and coverage. This will involve experimentation with CI-related spatial probabilities over fixed time periods, but an additional focus will be on continuous temporal trends in convective activity over fixed regional domains.

Human-generated forecast products will include IHOP-type spatial probabilities of convection (see 2002 Spring Program Ops plan: http://www.spc.noaa.gov/exper/Spring_2002/2002opsw.htm). Specifically, graphical products will be prepared for multiple time periods, tentatively set for 16-20Z, 20-00Z, and 00-04Z. Each graphic will depict expected positions of surface features (particularly along air-mass boundaries) valid at the beginning of the forecast period (or at the time of expected initiation) along with probabilistic predictions of convection during the forecast period. Specifically, probability contours will represent the likelihood that convection will occur within the forecast period within 25 mi. (40 km) of a point[1]. In addition, an estimate of the expected time and location of the first CI point within a TDB moderately high probability contour (if "clean slate") will be depicted. A single text product will accompany the spatial-probability graphic, describing the specific regional scale considerations for convective activity and CI. To save time, large-scale overview from operational SPC Day 1 Outlook may be pasted in at the beginning of the text product.

An additional focus of the CI-component for SFE2012 will include forecasting initiation of specific features/events/episodes. For example, situations often exist in which convection in adjacent areas develops from multiple forcing mechanisms. In these cases, there is often a specific region/forcing mechanism more likely to be associated with high-impact weather for which we would want to devote our attention – for example, supercells initiating just east of a dryline, as

[1] Note, these graphics are designed to represent the likelihood of convection, rather than that subset of convection points that could be called CI. Forecasting the spatial probability of CI over a fixed time period seems straightforward, but gets very complicated and dependent upon specific definitions of CI.

opposed to elevated clusters of storms on the cool side of a warm front. In such a case, we'd want to focus our attention on the supercells by isolating the general areas where initiation occurs so that unambiguous temporal probabilities for their occurrence could be generated and verified later in a straightforward manner. In essence, the idea is to isolate a subdomain that is likely to contain a specific event/episode and extract additional model guidance that should be more specifically related to the event/episode. The final forecast product would be a temporal distribution of the likelihood of CI associated with the event/episode of interest.

c) Daily Activities Schedule – all activities as one large group unless otherwise indicated

0800 – 0915: Evaluation/review of previous day's human forecasts.

- CI evaluation includes discussion/documentation of challenges in isolating an "episode" or object (in the MET/MODE sense) for temporal probability plots, plus interactive refinement of object/feature boundaries (PIs: Clark, Coniglio, Kain, Imy)
- Severe evaluation includes assessment of 1630-1200Z Experimental Outlook plus comparison of 4-hourly human forecasts generated using automated temporal disaggregation technique with human 4h Outlooks (PIs: Jirak, Dean, Weiss)

0915 – 1000: Large-scale overview with look-back 24h, optional hand analysis of uair, sfc data, concluding with a group discussion and consensus selection of a forecast domain (PIs: Coniglio, Weiss, Correia).

1000 – 1200: Breakout in Severe and CI teams:

- Severe Team prepares spatial probability forecasts for 16300Z – 1200Z time frame [GRAPHICS MUST BE SUBMITTED BY 1630], then separate spatial probability forecasts for subset time windows (PIs: Jirak, Dean, Correia, Weiss).
- CI Team prepares IHOP-type plots indicating boundary locations and probability of convection for 16-20Z, 20-00Z, and 00-4Z time periods. Also, one "feature/object" (e.g., dry-line convection in OK) is identified as the primary focus for a second forecast product. The most likely initiation point and time of this feature is indicated on the appropriate spatial probability plot and the second forecast product is a temporal probability plot – probability as a function of time during a 6-8 hour period centered on the time of greatest probability for initiation of this feature (PIs: Coniglio, Clark, Imy, Kain).

1200 – 1300: Lunch

1300 – 1400: Weather Briefing (PI: Marsh)

- 1300-1330: General overview, discussion of forecast challenges and products
- 1330-1400: Discussion of data from local soundings and rooftop instruments, including documentation of impressions (Turner/Coniglio)

1400 – 1600: Evaluation activities:

- Data assimilation sensitivities - Examine 15 min reflectivity fields starting at 00Z initialization time from CAPS C0 and CN, HRRR (00Z and 01Z), and LAPS-initialized run from GSD, document differences on survey form. Estimated time 0.4h (PIs: Kain, Coniglio)

- Multi-panel comparison of deterministic reflectivity guidance from yesterday's microphysics members of CAPS ensemble and corresponding observations, including some or all of 1) composite reflectivity, 2) -10C hourly-max reflectivity, 3) simulated satellite imagery. Document differences on survey form. Estimated time 0.4h (PI: Clark)
- Comparison of sounding structures from PBL members from yesterday's ensemble using sharpy, document significant differences (Marsh). Estimated time 0.4h
- Examine objective verification plots, compare objective stats to subjective impressions, document consistency/inconsistency (Melick). Estimated time 0.4h
- Compare ensemble guidance from SREF, SSEO, SSEF; document impressions. Estimated time 0.4h (Jirak)

3. SFE 2010 Experimental Modeling Systems

a) CAPS Storm Scale Ensemble Forecast (SSEF) System

As in previous years, the cornerstone of SFE2012 experimental model guidance is a 4-km grid-spacing multi-model Storm Scale Ensemble Forecast (SSEF) system produced by the Center for Analysis and Prediction of Storms. This year's SSEF system has 28 members. Much of the following is adapted from the CAPS Program Plan available at: http://hwt.nssl.noaa.gov/Spring_2011/SpringProgram2011_Plan-public.pdf – see this document for a more detailed description of the modeling system and logistics for real-time integrations and dissemination.

Four NWP modeling systems, both WRF solvers, ARW and NMM, the Navy COAMPS model system, and the ARPS model system, comprise the SSEF system for SFE2012. All forecasts use 51 vertical levels, though horizontal grids are different between ARW and NMM. WRF code (both cores) was modified by CAPS to allow initial hydrometeor fields generated from 3DVAR/ARPS Cloud analysis of WRS-88D radar reflectivity to pass into WRF initial condition, and (for ARW) to write out reflectivity field every 5 min. ARPS members have the same horizontal grid as WRF-ARW. As in 2011 season, the 00Z NAM analyses available on the 12 km grid (218) are used for initialization of control and non-perturbed members and as first guess for initialization of perturbed members with the initial condition perturbations coming directly from the NCEP Short-Range Ensemble Forecast (SREF). WSR-88D data, along with available surface and upper air observations, are analyzed using ARPS 3DVAR/Cloud-analysis system. Forecast output at hourly intervals (higher time frequency output for a limited selection of 2D fields) are archived at the NICS mass storage (HPSS). Specifications for all members are provided in Table 2. A list of products derived from the ensemble is in Appendix A (coming soon).

The basic strategy in constructing the SSEF system is to have a set of members accounting for as many error sources as possible that can be used to generate reliable forecast probabilities. These "core" members have IC/LBC perturbations as well as varied physics and model cores. Other sets of members were configured to allow for various sensitivity experiments. Four members (arw_cn, arw_m14-16) are identically configured except for their microphysics parameterizations and five members (arw_cn, arw_m12-13, and arw_m17-18) are identically configured except for their boundary layer parameterizations. The member arw_c0 is identical to arw_cn except without radar data assimilation. Finally, the set of members arw_m19-23 are identical to the core members arw_cn, arw_m3, arw_m6, arw_m8, and arw_m10, except m19-23 have stochastic kinetic energy backscatter (SKEB) perturbations. The purpose of SKEB perturbations is to better depict model error. The following is taken from the WRF users guide on stochastic backscattering: "*Since Version 3.3, WRF has an option to stochastically perturb forecasts via a stochastic kinetic-energy backscatter scheme (SKEB, Shutts, 2005, QJRMS). The scheme introduces temporally and spatially correlated perturbations to the rotational wind components and potential temperature modulated by the total dissipation rate. In the current version, SKEBS 1.0, a spatially and temporally constant dissipation rate is assumed, but future developments will include a flow-dependent dissipation rate. There are several options for the vertical structure of the random pattern generator: barotropic and random phase. Details of the scheme are available in Berner et. al, 2011 (MWR, in press).*"

Table 2 CAPS SSEF system configuration. For the WRF members, version 3.3.1 is used. NAMa and NAMf refer to the NAM analysis and forecast, respectively (12-km grid-spacing). ARPSa refers to ARPS 3DVAR and cloud analysis. Elements in the ICs column followed by a + or – indicate SREF member perturbations added to the control member ICs. All WRF members used RRTM (Mlawer et al. 1997) short-wave radiation and Goddard (Chou and Suarez 1994) long-wave radiation parameterizations. Boundary layer schemes include Mellor-Yamada-Janjic (MYJ; Mellor and Yamada 1982; Janjic 2002), YonSei University (YSU; Noh et al. 2003), Mellor-Yamada Nakanishi and Niino (MYNN; Nakanishi 2000, 2001; Nakanishi and Niino 2004, 2006), Quasi-Normal Scale Elimination (QNSE; Sukoriansky et al. 2006), and the Asymmetrical Convective Model version 2 (ACM2; Pleim 2007). Microphysics schemes include Thompson et al. (2004), WRF single-moment 6-class (WSM-6; Hong and Lim 2006), WRF double-moment 6-class (WDM-6; Lim and Hong 2010), Ferrier et al. (2002), Milbrandt and Yau (2005), and Morrison et al. (2005). Ferrier+ refers to an updated version of Ferrier et al. (2002). Land-surface models include the NOAH (Chen and Dudhia 2001), and RUC (Smirnova et al. 1997, 2000). Member names beginning with "cmp" use the Navy COAMPS modeling system. Red-shaded members names denote "core" members. Grey shaded table cells denote "physics members". Pink shaded cells denote SKEB perturbation members.

Member	IC	BC	Microphy	LSM	PBL
arw_cn	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_c0 (18h)	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_m3	+ em-p1_pert	em-p1	Morrison	RUC	YSU
arw_m4	+ nmm-n2_pert	nmm-n2	Morrison	Noah	MYJ
arw_m5	+ em-n2_pert	em-n2	Thompson	Noah	ACM2
arw_m6	+ rsm-n2_pert	rsm-n2	M-Y	RUC	ACM2
arw_m7	+ nmm-p1_pert	nmm-p1	WDM6	Noah	MYNN
arw_m8	+ rsm-p1_pert	rsm-p1	WDM6	RUC	MYJ
arw_m9	– etaKF-n1_pert	etaKF-n1	M-Y	RUC	YSU
arw_m10	+ etaKF-p1_pert	etaKF-p1	WDM6	Noah	QNSE
arw_m11	– etaBMJ-n1_pert	etaBMJ-n1	M-Y	Noah	MYNN
arw_m12	00Z ARPSa	00Z NAMf	Thompson	Noah	MYNN
arw_m13	00Z ARPSa	00Z NAMf	Thompson	Noah	ACM2
arw_m14	00Z ARPSa	00Z NAMf	M-Y	Noah	MYJ
arw_m15	00Z ARPSa	00Z NAMf	Morrison	Noah	MYJ
arw_m16	00Z ARPSa	00Z NAMf	WDM6	Noah	MYJ
arw_m17	00Z ARPSa	00Z NAMf	Thompson	Noah	QNSE
arw_m18	00Z ARPSa	00Z NAMf	Thompson	Noah	YSU
arw_m19*	00Z ARPSa	00Z NAMf	Thompson	Noah	MYJ
arw_m20*	+ em-p1_pert	em-p1	Morrison	RUC	YSU

arw_m21*	– rsm-n2_pert	rsm-n2	M-Y	RUC	ACM2
arw_m22*	+ rsm-p1_pert	rsm-p1	WDM6	RUC	MYJ
arw_m23*	+ etaKF-p1_pert	etaKF-p1	WDM6	Noah	QNSE
nmm_cn	00Z ARPSa	00Z NAMf	Ferrier+	Noah	MYJ
arps_cn	00Z ARPSa	00Z NAMf	Lin	force-restore	force-restore
cmps_cn	00Z ARPSa	00Z NAMf	Hobbs-Rutledge	?	?
cmps_c1	00Z ARPSa	00Z NAMf	M-Y	?	?
cmps_c0	00Z ARPSa	00Z NAMf	Hobbs-Rutledge	?	?

b) SPC Storm Scale Ensemble of Opportunity (SSEO)

The SSEO is a 7-member, convection-allowing ensemble consisting of deterministic models available operationally to SPC. This "poor man's ensemble" provides a practical alternative to a formal/operational storm-scale ensemble which will not be available in the near-term because of computational/budget limitations. Similar to the SSEF system, hourly maximum storm-attribute fields, such as simulated reflectivity, updraft helicity, and 10-m wind speed are produced from the SSEO. Member specifications are provided in Table 3. Members marked with "-12h" in the Model column are 12h time-lagged members, initialized 12h earlier that the other members. All members are initialized with a "cold-start" from the operational NAM – i.e., no radar data assimilation or cloud model used to produce ICs.

Table 3 SSEO member specifications.

Member #	Model	Grid-spacing	Agency	PBL	Microphysics	LSM
sseo01	WRF-ARW	4-km	NSSL	MYJ	WSM6	Noah
sseo02	Hi-Res Window WRF-ARW	5.15-km	NCEP/EMC	YSU	WSM3	Noah
sseo03	Hi-Res Window WRF-ARW -12h	5.15-km	NCEP/EMC	YSU	WSM3	Noah
sseo04	CONUS WRF-NMM	4-km	NCEP/EMC	MYJ	Ferrier	Noah
sseo05	Hi-Res Window WRF-NMM	4-km	NCEP/EMC	MYJ	Ferrier	Noah
sseo06	Hi-Res Window WRF-NMM -12h	4-km	NCEP/EMC	MYJ	Ferrier	Noah
sseo07	NMMB Nest	4-km	NCEP/EMC	MYJ	Ferrier	Noah

c) Air Force Weather Agency (AFWA) 4-km ensemble

The Air Force Weather Agency (AFWA) has recently implemented a real-time 10-member 4-km WRF-ARW ensemble. Forecasts are initialized at 0000 UTC from 6 or 12 hour forecasts of global models. Diversity in the AFWA ensemble is achieved through IC/LBCs from different global models and varied microphysics and boundary layer parameterizations. SPC is currently ingesting the AFWA grids in their real-time data feeds and these forecast will be available for examination during SFE2012. AFWA ensemble member specifications are provided in Table 4.

Table 4 AFWA ensemble member specifications.

Member #	ICs/LBCs	LSM	Micro-physics	PBL
afwa01	18Z UKMET	Noah	WSM5	YSU
afwa02	18Z GFS	RUC	Goddard	MYJ
afwa03	12Z GEM	Noah	Ferrier	QNSE
afwa04	12Z NOGAPS	Noah	Thompson	MYJ
afwa05	18Z UKMET	RUC	Thompson	MYJ
afwa06	18Z GFS	Noah	Thompson	QNSE
afwa07	12Z GEM	Noah	Goddard	YSU
afwa08	12Z NOGAPS	Noah	WSM5	QNSE
afwa09	18Z UKMET	RUC	Ferrier	QNSE
afwa10	18Z GFS	Noah	WSM5	YSU

d) NSSL-WRF

SPC forecasters have used output from the experimental 4 km WRF-ARW produced by NSSL since the fall of 2006. This WRF model is run once daily at 00 UTC throughout the year over a full CONUS domain with forecasts to 36 hrs. Output is also available online at http://www.nssl.noaa.gov/wrf/.

e) GSD High Resolution Rapid Refresh (HRRR) model

The experimental 3-km grid-spacing HRRR model is nested within the hourly development version of the 13 km Rapid Refresh (RR) model, which provides ICs/LBCs for the HRRR. The HRRR uses a version of the WRF-ARW with generally "RUC-like" physics. A unique aspect of the RR is the hourly GSI data assimilation system that incorporates a wide array of observational datasets including radar reflectivity via the radar-Diabatic Digital Filter Initialization. The HRRR integration is run over a full CONUS domain with forecasts to 15 hrs. At the initial time, the simulated HRRR reflectivity comes from a 1-hr RR forecast; downscaling from the RR 13 km grid to the HRRR 3 km grid occurs very quickly during the first hour.

4. New products/concepts for SFE2012

a) Subjective versus objective forecast verification (PI: Chris Melick)

Objective forecast verification will be conducted in near real-time during SFE2012. The idea will be to test the value of selected traditional (or point-to-point) verification metrics versus non-traditional neighborhood approaches by comparing to subjective evaluations. For the traditional metrics, Critical Success Index (CSI) and Gilbert Skill Score (GSS) will be used, and for the non-traditional metrics, the neighborhood method known as Fractions Skill Score (FSS) will be used. The FSS considers the fraction of grid-points exceeding a specified threshold within a specified radius of influence (ROI). The value chosen for the ROI is designed to account for the inherence spatial uncertainty associated with predicting thunderstorm cells.

One forecast field that will be verified is simulated 1-km AGL reflectivity ≥ 40 dBZ from selected deterministic models. Direct comparison against gridded observations is made possible by utilizing mosaic hybrid-scan reflectivity from the National Mosaic and Multi-Sensor QPE System (Zhang et al. 2011). In addition, probabilistic guidance for severe thunderstorms from various ensembles (i.e. SSEF, SSEO, and AFWA) as well as the experimental forecasts created daily as a part of SFE2012 activities will be verified against practically perfect hindcasts (Brooks et al. 1998) computed from the spatial distribution of observed severe storm reports.

In previous experiments, identification of pattern, placement, and intensity differences in simulated reflectivity was performed subjectively during daily activities, with objective metrics computed post-experiment (e.g., Kain et al. 2008). Similarly, for SFE2012, comparison plots will be displayed on a webpage. However, this year, corresponding skill metrics for each time period will also be provided so that they can be compared to the subjective evaluations of the participants with the goal of evaluating the usefulness of the objective metrics for verifying high-resolution forecasts.

b) Microphysics-dependent simulated reflectivity algorithms (PI: Jack Kain/Scott Dembek)

During recent experiments, model-simulated reflectivity has been heavily utilized as a tool for monitoring the characteristics of storms as depicted by convection-allowing models. Generic simulated reflectivity algorithms like those contained in the WRF-post compute and then add "equivalent reflectivity factors" for each simulated hydrometeor species, which yields reflectivity after converting to units of dBZ. However, the assumptions made in the generic formulation are not directly applicable to some of the newer and more sophisticated double-moment microphysics parameterizations because each of these schemes makes unique assumptions regarding diameter and number concentration of hydrometeor species. A proper formulation of simulated reflectivity should account for these unique assumptions. Thus, for SFE2012 a significant effort has been made to develop post-processing code for computing reflectivity that is scheme-dependent. This effort has involved working closely with each of the developers of the double-moment microphysics parameterization used in the WRF-ARW members of the SSEF system. Initial tests have shown computing reflectivity "correctly" can make a significant difference in how each of the schemes depicts convection. To document these differences, simulated reflectivity computed the "old" way as well as the "new" way will be archived for the SSEF members with only different microphysics, but these comparison will not be made in real-time during daily experiment activities.

c) Forecasting total tornado track length using ensemble updraft helicity (PI: Adam Clark)

Recent research by NSSL/CIMMS scientists has diagnosed a strong relationship between the total path lengths of simulated rotating storms (measured using a 3-dimensional object identification algorithm applied to hourly maximum updraft helicity) and the total path lengths of tornadoes. Examining 13 to 30 hour forecasts (1200 to 0600 UTC) from 47 days of SSEF system forecasts during 2010 and 2011, and filtering out UH path lengths generated from simulated elevated or high-based storms (for details see Clark et al. 2012a, and b), the correlation between total UH and tornado path length was 0.86. Thus, for SFE2012 real-time products that highlight 3-D UH object characteristics from which tornado path length exceedance probabilities are generated will be displayed on the web. An example “summary plot” is shown below.

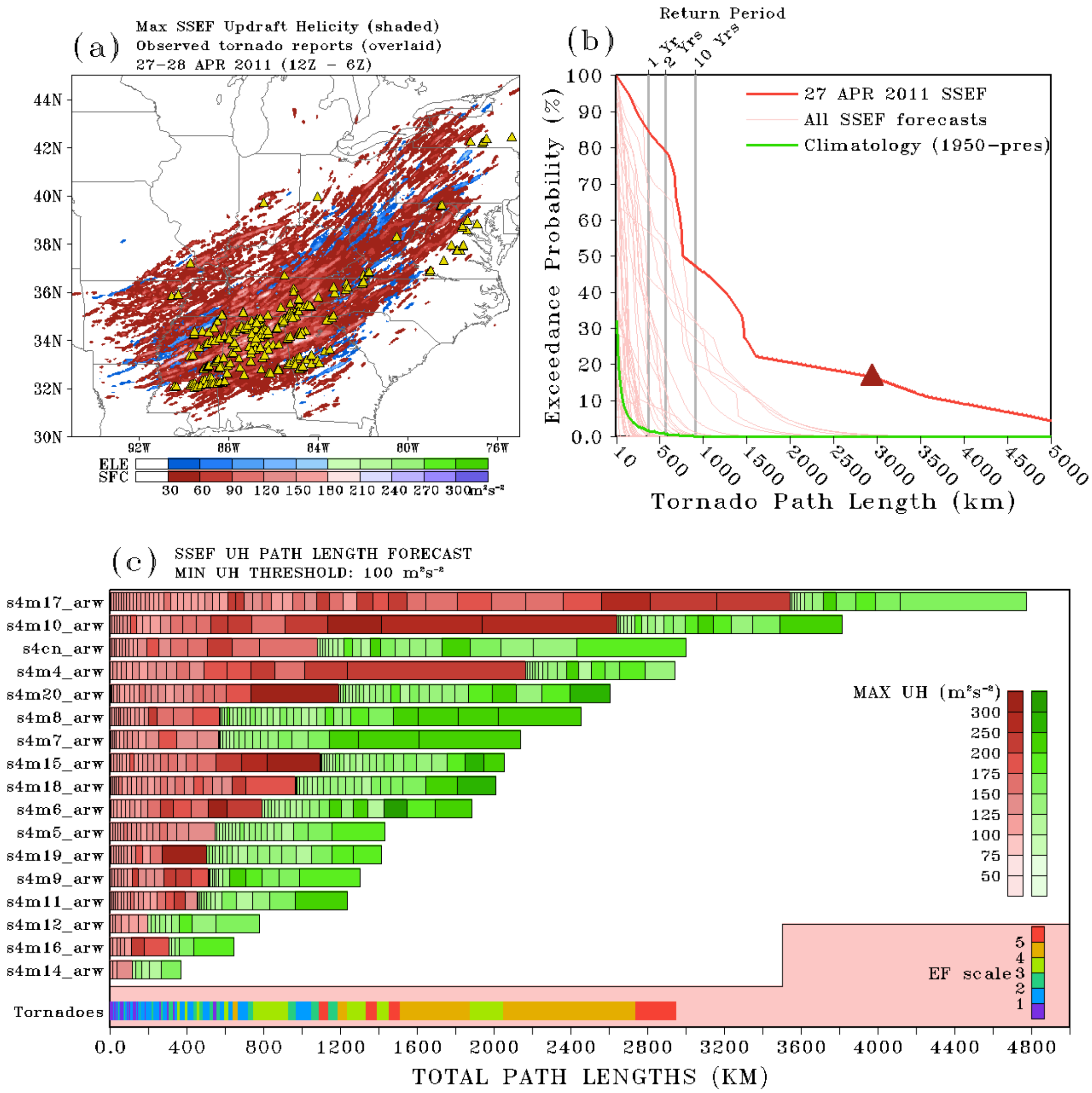

Figure 1 (a) Maximum UH from any SSEF system member initialized 0000 UTC 16 April 2011 for forecast hours 13 to 30 (valid 1200 to 0600 UTC 16-17 April). The red/purple shading scheme is for UH produced by surface-based storms, while the blue/green shading scheme is for UH produced by elevated and/or high-based storms. Tornado reports (yellow triangles) for the corresponding period are overlaid. (b) Exceedance probabilities as a function of total tornado path length computed from the distribution of SSEF member UH path length forecasts. The dark red line is for 16 April, the light red lines are for the 47 other cases in the dataset, and the green line is climatological exceedence probabilities computed from Storm Data for the period 1950 – 2011 (legend provided at top). The dark red triangle marks the actual total tornado path length for 1200 to 0600 UTC 16-17 April. (c) Total length of UH objects for each SSEF member using a minimum threshold of 100 m^2s^{-2}. The length of the individual colored bars that comprise each column indicate the length of each UH object for each member. The colors within these bars indicate the maximum value of UH within the corresponding object, with red/pink shades corresponding to objects produced by surface-based storms and green shades to objects produced by elevated and/or high-based storms (color bars provided on right side). The bars in the bottom column similarly indicate path lengths and maximum intensities, but for observed tornadoes where maximum intensities correspond to enhanced-Fujita scale ratings.

d) Automated Temporal Disaggregation of Full-Period Human Forecasts (PI: Israel Jirak)

Over the years, SPC forecasters have demonstrated skill in creating severe weather forecasts for the convective day (i.e., 12Z-12Z). The goal of temporal disaggregation is to investigate increasing the temporal resolution of Day 1 convective outlooks without requiring a significant increase in workload for the forecaster. The idea is to take the forecaster-generated, full-period Day 1 convective outlook and break it into individual periods using numerical model guidance as the input. The end result will be an automated higher temporal resolution forecast of severe weather consistent with the forecaster full-period forecast.

Specifically for SFE2012, calibrated severe guidance from the storm-scale ensemble of opportunity (SSEO) will be used to temporally disaggregate the full-period human forecast (i.e., 16-12Z). Calibrated severe SSEO guidance from the same period is first scaled to match the human forecast. This scaling factor (unique at every grid point) is then applied to the SSEO calibrated severe guidance for each individual period (i.e., 16-20Z, 20-00Z, 00-04Z, and 04-12Z). Finally, two checks are applied for consistency with the human forecast: 1) the sum of the automated probabilities of the individual periods must be greater than or equal to the full-period human probability, which requires another multiplication factor to be applied across the grid for each period and 2) the automated probabilities of the individual periods cannot exceed the probability for the full-period human forecast, which sets an upper-limit to the automated probabilities. An example is shown below.

Below is an example from 27 April 2012 with the upper-left panel being the 16-12Z full-period human forecast, the upper-right panel being the 20-00Z automated forecast, the lower-left panel being the 00-04Z automated forecast, and the lower-right panel being the 04-12Z automated forecast.

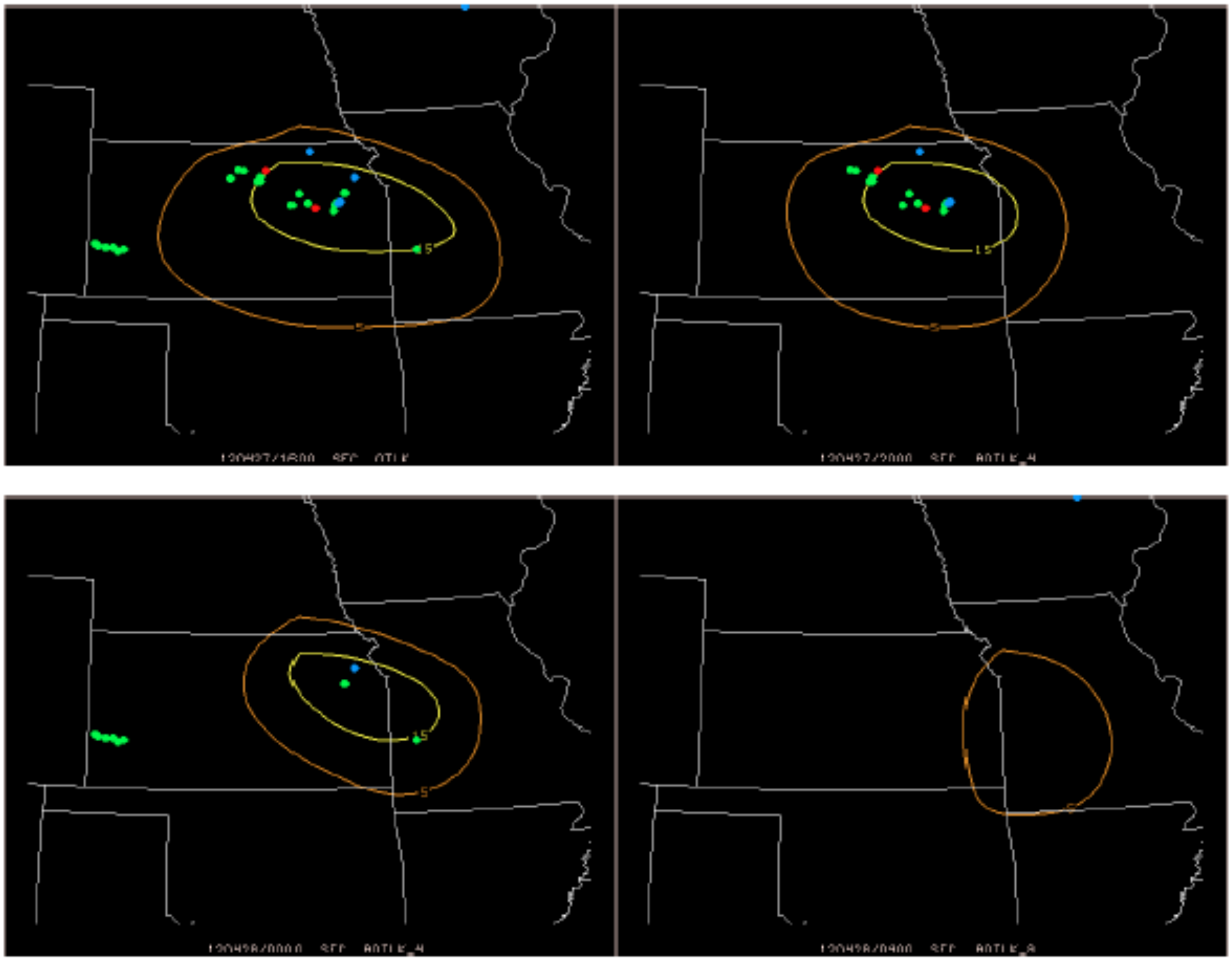

Figure 2 An example of temporal aggregation applied to a full-period human forecast from 27 April 2012. The upper-left panel is the 16-12Z full-period human forecast, the upper-right panel is the 20-00Z automated forecast, the lower-left panel is the 00-04Z automated forecast, and the lower-right panel is the 04-12Z automated forecast.

e) Evaluation of experimental observing systems (PI: Michael Coniglio)

A new component for SFE2012 will be the evaluation of experimental observing systems including a passive microwave radiometer and a GPS-based radiosonde system. Along with an evaluation of the observing systems, these datasets will provide observations for the continuing evaluation of five planetary boundary layer (PBL) scheme options in WRF-ARW (MYJ, YSU, MYNN, ACM2, and QNSE) that began in 2011.

1) Passive Microwave Radiometer

Radiometrics loaned a passive microwave radiometer (MWR, model MP-3000) to researchers at NSSL and OU for evaluation through September 2012. The MWR operates from the roof of the National Weather Center. The HWT/SFE is interested in the capability of the MWR to retrieve vertical profiles of temperature and water vapor for severe weather forecasting applications. An MWR measures the radiation emitted/transmitted by the atmosphere near frequencies sensitive to water vapor and oxygen (Fig. 3). The more opaque channels (i.e., where the atmosphere has a larger optical depth) measure near-surface conditions while the more transparent channels measure conditions higher in the troposphere (Otkin et al. 2011).

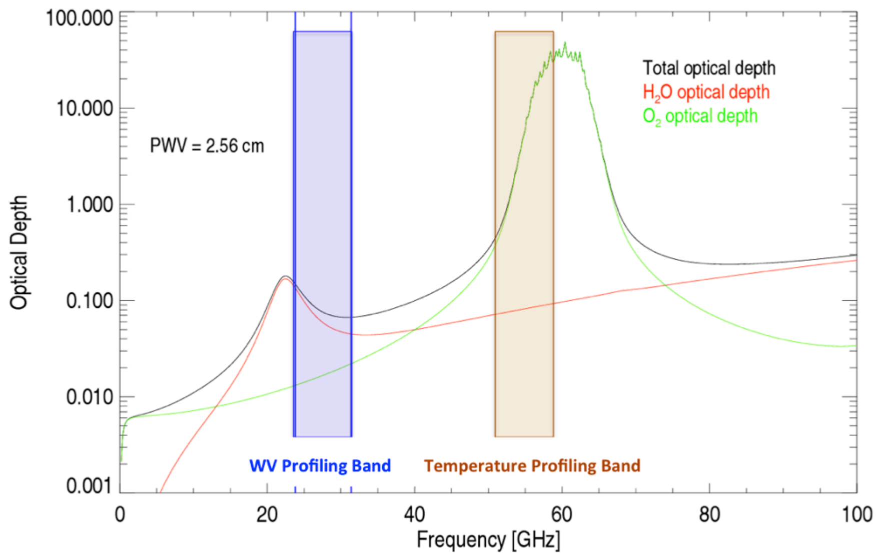

Figure 3 Water vapor and oxygen absorption lines and their summed optical depth, along with the bands used by the Radiometrics MWR to measure water vapor and temperature in the atmosphere.

An MWR is able to obtain radiance observations in most atmospheric conditions, except in precipitation, as the measurements are essentially insensitive to clouds. The radiance measurements are then “inverted” using statistical or physical retrieval algorithms to obtain temperature and water vapor profiles. The retrievals can be obtained at relatively high temporal resolution, with the MP-3000 providing profiles approximately every 5 minutes. However, depending on the scanning strategy and the retrieval algorithm, an MWR can only attain 2 or 3 independent pieces of information in the water vapor profile and only 2 – 4 pieces in the temperature profile in the lower troposphere (Löhnert et al. 2009). Accurate, high temporal measurements of the temperature and humidity profiles could be beneficial for severe weather forecasting. However the vertical structure of the temperature and humidity profiles is important to know. Given the limitations in retrieving the vertical structure of the profiles, it remains to be seen how useful the MWR profiles can be for severe weather forecasting.

2) GPS radiosonde system

Recent technology advances have allowed alternative radiosondes and lower-cost radiosonde ground stations to be competitively marketed compared to the *Vaisala* RS-92 system, the gold standard for research applications (Nash et al. 2005). One such system (sonde and ground station) by *InterMet Systems*, was purchased by NSSL two years ago for evaluation. InterMet uses a proprietary sonde costing about the same as *Vaisala*’s RS92 ($200). The *Vaisala* RS-92 ground stations are relatively costly (> $10-20K). Versions of the *InterMet* ground system currently cost up to $6K for a system with an unlimited license, but options as low as about $1500 total (only about $600 for the receiver) for single field program use are available. NSSL currently has these two *InterMet* ground systems and will be evaluating them against *Vaisala* RS92 sondes during the 2012 HWT/SFE. NSSL is interested in the potential cost savings provided by the *InterMet* system, provided that the observations are comparable to the *Vaisala* measurements.

On selected days during the Experiment, teams of volunteers will launch both the *InterMet* and *Vaisala* sondes attached to the same balloon from outside the National Weather Center. The sondes will be launched approximately every three hours (1400, 1700, and 2000 UTC nominally) and will serve three purposes, 1) to evaluate the performance of the *InterMet* sondes and the two different receiver options, 2) to provide in situ observations of temperature and water vapor mixing ratio to compare to the MWR profiles, and 3) to provide verifying observations for WRW-ARW forecasts of the temperature and humidity profile from the five PBL members of the SSEF at the grid point closest to Norman. An example of how the latter two goals will be accomplished on is provided in Figs. 4 and 5 below. These plots, along with time-height cross sections of the 5-min MWR profiles and the associated 5-min profiles from the SSEF control member, will be evaluated daily. Data from the local radiosonde launches will be plotted when available. The local radiosonde launches will be taken on days when the growth of a convective boundary layer is expected with preference given to days when convection is expected in Oklahoma later in the afternoon.

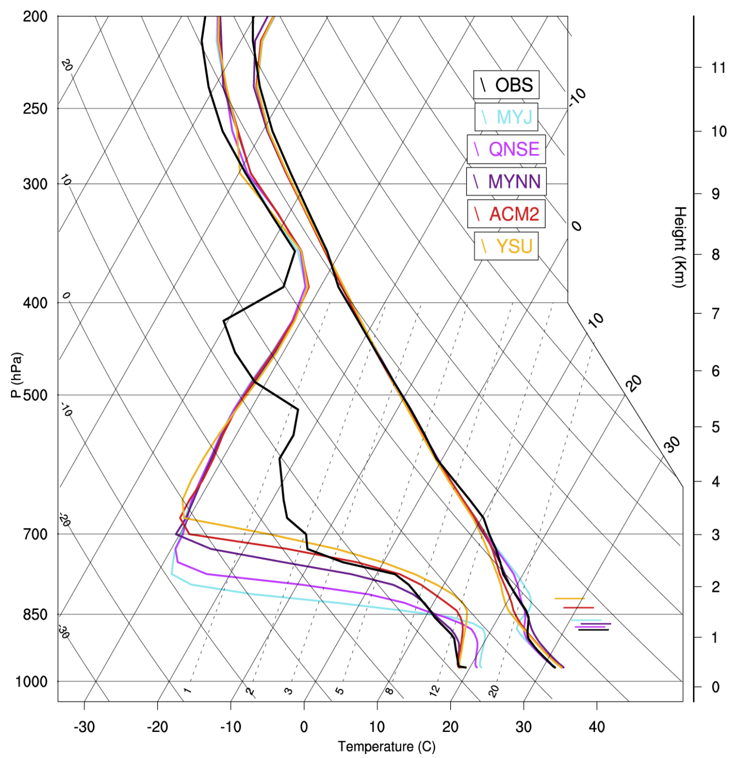

Figure 4 23 h forecasts from the five SSEF members that vary only by PBL scheme compared against the NWS radiosonde observation released at 2300 UTC 9 May 2011 (black line). The horizontal lines to the right of the temperature traces show the diagnosed height of the PBL using a version of the RUC algorithm.

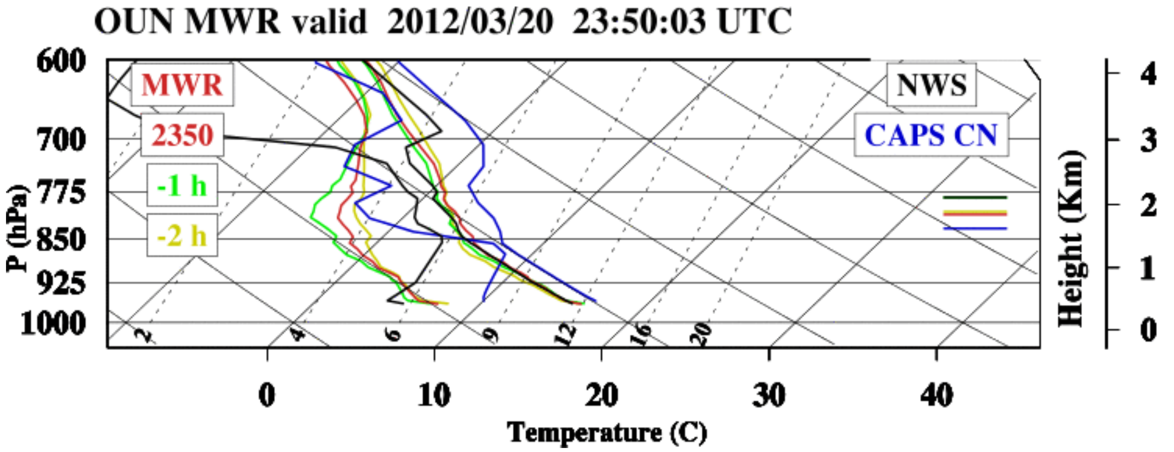

Figure 5 SkewT diagram of the NWC MWR profile valid 2350 UTC 20 March 2012 (red lines) and the profiles valid one and two-hours previous (green and yellow lines, respectively), the 24 h forecast for Norman from the control member of the SSEF (blue lines), and the NWS radiosonde observation valid at 0000 UTC 21 March 2012 (black lines). Horizontal lines on the right of the diagram are as in Fig. 4.

f) Practically perfect storm reports: Phase error (PI: Jim Correia)

The phase errors associated with the practically perfect storm report probabilities associated with each ensemble and ensemble members will be examined. For each grid point observation of 15% we map out where the forecast has or exceeds the same percentage and accumulate over a 400 grid-point box centered on the observation. The result can be used to derive a position displacement relative to the maximum and also reveal the forecast bias when compared to observations. Images for the full period will be displayed on a web page for reference primarily for verification. In addition to individual forecasts we will accumulate the results over the weeks and experiment.

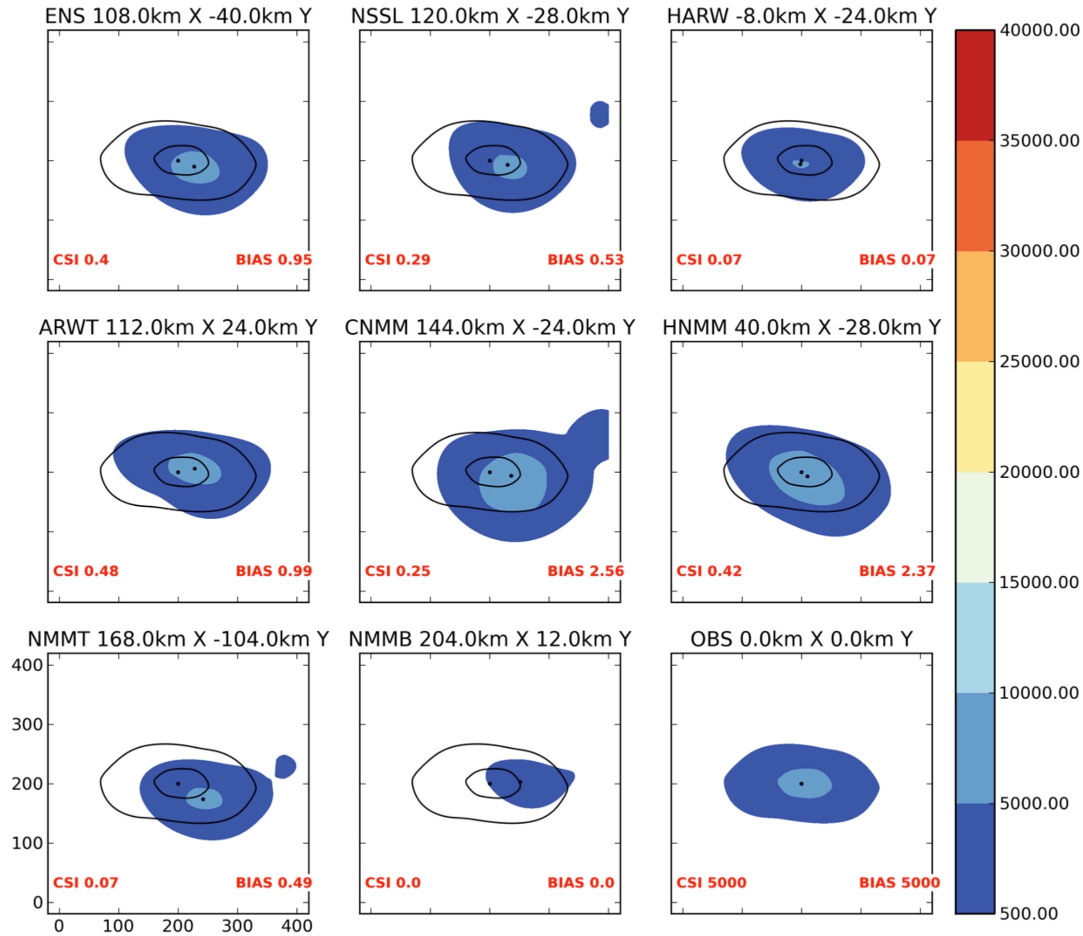

Figure 6 Grid point count for the ensemble, each ensemble member and observations conditional upon a 15% observed grid-point

g) Statistical display of storm objects: Mondrian

Mondrian is a powerful statistical display package and has capabilities to display box, bar charts, scatter, histograms, and mosaic plots. For SFE2012, Mondrian will be used to visualize and interpret statistical information from databases of storm objects and their attributes (CAPS data only) as well as model proxy storm reports. To generate the dataset for display in Mondrian, an object-based algorithm is applied to composite reflectivity using thresholds of 34 and 49 dBZ (stronger storms only) with pixel count requirements of 8 and 2, respectively. From these storm objects, attributes are assigned consisting of maximum and average values of CAPE, 0-6km shear, updraft helicity, etc. One of the primary benefits of Mondrian is linked highlighting and color-brushing. This technique is shown in Figure 6.

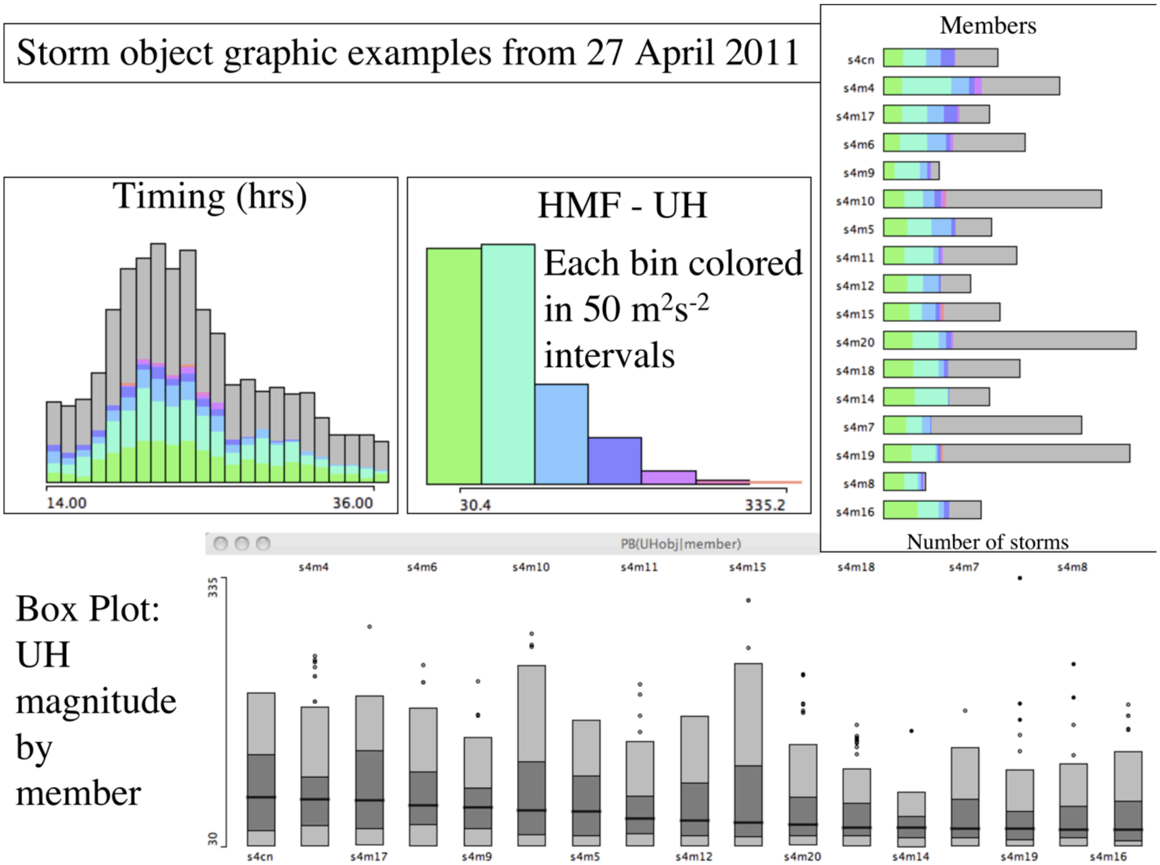

Figure 7 Example Mondrian display. Timing of storm objects is indicated and the color brushing refers to the updraft helicity magnitude distribution. Also shown are the various ways we can display the dependence between UH and ensemble members.

Löhnert, U., D. D. Turner, and S. Crewell, 2009: Ground-based temperature and humidity profiling using spectral infrared and microwave observations. Part I: Simulated retrieval performance in clear-sky conditions. *J. Appl. Meteor. Climatol.*, **48**, 1017-1032.

Nash, J., R. Smout, T. Oakley, P. Pathack, and S. Kurnosenko, 2005: WMO intercomparison of high quality radiosonde systems, Vacoas, Mauritius, 2,Äì25 February 2005. WMO Commission on Instruments and Methods of Observation, Final Rep., 118 pp. [Available online at http://www.wmo.ch/pages/prog/www/IMOP/reports/2003-2007/RSO-IC-2005_Final_Report.pdf.].

Otkin, J. A., D. C. Hartung, D. D. Turner, R. A. Petersen, W. F. Feltz, and E. Janzon, 2011: Assimilation of surface-based boundary layer profiler observations during a cool-season weather event using an observing system simulation experiment. Part I: Analysis impact. *Mon. Wea. Rev.*, **139**, 2309-2326.

Appendix X: Instructions for Creating and Submitting Experimental Severe Thunderstorm Forecasts

1. Experimental Severe Thunderstorm Forecast Graphics

Probabilistic severe weather forecasts will be issued **in the morning by 16Z** for the 16-12z; and **then by 17Z** for 20-00z, 00-04z, and 04-12z time periods. The severe weather forecast graphics will be similar in format to operational SPC outlooks, except only total severe storm probability contours will be formulated (no categorical outlook, and no general thunderstorms will be forecast). The same probability contours used in the operational outlooks will be used for the severe forecasts (5, 15, 30, 45, and 60 %); an area delineating potential for significant severe storms will be included when the probability for significant severe is 10% or greater. The Probability-to-Categorical conversion for total severe is identical to that used for the SPC Day 2 Outlook, and is shown below.

2. Drawing and Saving the Experimental Forecasts in NMAP

a. First, open up **outlook_se2012_work.lpf and delete all existing lines.** The forecaster will draw in NMAP separate probability contours for each valid period, and will save each forecast as a separate graphic product. The process will utilize NMAP software that is used in SPC operations. When saving each experimental forecast graphic (**PROD-OUTLOOK**), the following modifications are required:
1) In the format outlook box, ***change valid time to 1600z to 1200z; 2000z to 0000z, 0000z to 0400z, and 0400z to 1200z. Be sure to change date when crossing 00z.***
2) ***No changes are required in the product save box.***

b. Enter command in xterm window: sp12bg # (such as sp12bg 2)
where # is the NAWIPS workstation number (1-6) where the graphic is created**.** This script archives the severe weather forecast, attaches date/time to the graphics file, and sends graphics to the web page.

3. Completing Model Discussion Section on Internal Web Page

a. On HWT Spring Experiment web page click on Experimental Forecast Generation (Severe Team)

b. Click on ―Full Period Forecast‖ or ―Sub-Period Forecasts‖ and the associated severe forecast graphics will appear

c. Complete Discussion Text Box and when finalized, click on Submit.

Day 2 Probability to Categorical Outlook Conversion

(SIGNIFICANT SEVERE area needed where denoted by hatching - otherwise default to next lower category)

Outlook Probability	Combined TORN, WIND, and HAIL
5%	SEE TEXT
15%	SLGT
30%	SLGT
45%	MDT
60%	HIGH