2016 CAPS Spring Forecast Experiment Program Plan

May 18, 2016

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1. Overview of New Features for 2016 Season

Major features for 2016:

- **3-km** horizontal grid spacing over the CONUS domain (1680×1152, Figure 1), same as in 2015
- **WRF version 3.7.1** is used for 2016 season. (coupled with ARPS v5.4)
- New **NMMB** members (6 members)
- Two SSEF suites:
  - A **3DVAR-based SSEF** (baseline) at 3-km with **19+** ARW members and 6 NMMB members, initiated with 3DVAR analysis at 0000 UTC,, with up to 60-h forecast, running on ***Stampede*** at TACC
  - **GSI+EnKF-based ensemble forecast**: Up to a 40-member storm-scale ensemble background, six hours of hourly cycled GIS+EnKF and one hour of cycled EnKF at 15 min intervals, followed by a 12-member ensemble forecast (up to 60-h) starting at 0000 UTC, running on the same CONUS domain (see Figure 1). Twelve ensemble forecasts initiated at 0000 UTC from the EnKF mean and ensemble members, and another with cycled 3DVAR analysis are also produced. Running on ***Darter*** at NICS
- A second run period with up to 15 SSEF members in support of **HMT FFaIR**
- 3D visualization: 3D fields from the control run covering a 200x200 grid-point area (600 km x 600 km) region will be extracted from the CONUS domain and shipped to the NWC in real-time and 3D visualized fields made available to the forecast teams.

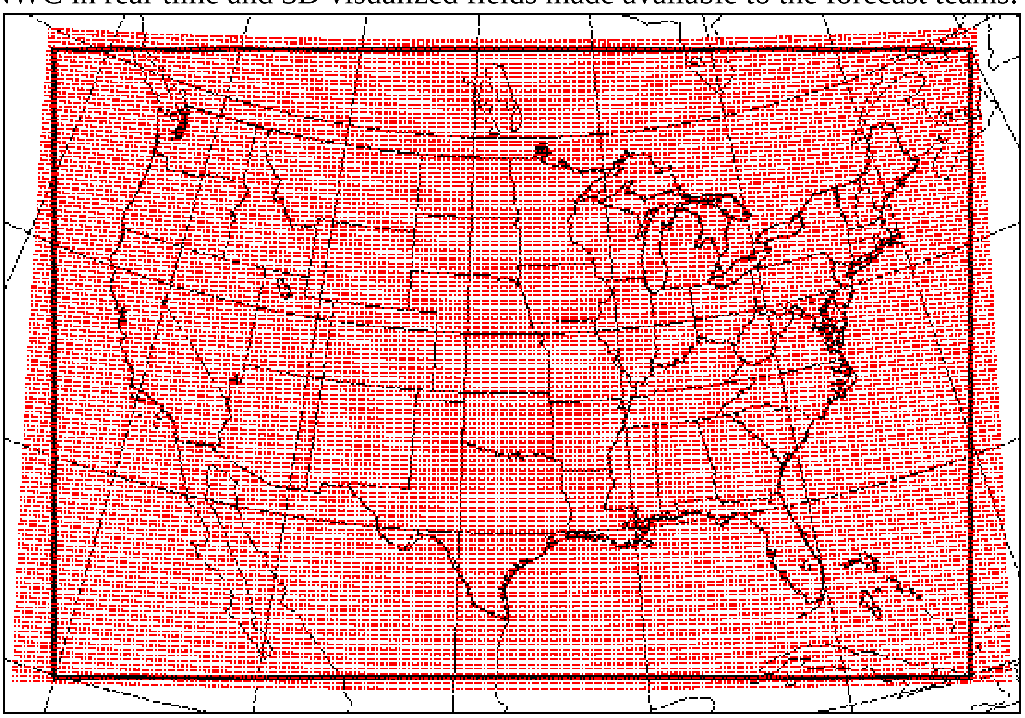

Figure 1. The computational domain for the 2016 Season. The red dot area is the NMMB domain (1568×1120); The inner domain is for ARW with both 3DVAR and EnKF forecasts (3-km grid spacing, 1680×1152 horizontal grid points); The outer domain (1860×1280) is used for providing IC/LBC for the NMMB.

2. Program Duration

HWT: From **18 April 2016** through **3 June 2016**
HMT FFaIR: From **20 June 2016** through **22 July 2016** (with one week off during 4-8 July)

The 2016 SPC/NSSL HWT Spring Forecast Experiment, a joint effort among NOAA Storm Prediction Center (SPC) and National Severe Storm Laboratory (NSSL) and the Center for Analysis and Prediction of Storms (CAPS) at University of Oklahoma, will officially **start on 2 May and end on 3 June**, with five days a week (Monday through Friday). CAPS 2016 Spring Program begins regular forecast production two weeks earlier on 18 April to identify possible issues, and remains five days a week (running forecasts on the night of Sunday through Thursday) with possible weekend runs upon SPC request according to weather circumstance.

The 2016 HMT Flash Flood and Intense Rainfall Experiment (FFaIR) will **start on 20 June and end on 22 July**, with five days a week (Monday through Friday). The July Fourth week (4-8 July) will be the off week. CAPS will produce up to 15 ARW (or ARW + NMMB) members on Stampede to support FFaIR Experiment.

3. SSEF Configuration

WRF-ARW and NMMB are used in the 2016 Spring Forecast Experiment. All ARW forecasts use **51** vertical levels. WRF code (V3.7.1) 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 6 min.

All NMMB forecasts use 50 vertical levels. Interface software (arps2nmb – actual program name is *arps4wrf*, and *nmb2arps*) has been developed within the ARPS package. 3DVAR/ARPS Cloud analysis and IC/LBC perturbation are first processed over the outer domain in Figure 1, and then interpolated to the NMMB grid (red dot region in Figure 1 for running NPS (*nemsinterp.exe*) and NMMB (*NEMS.x*).

3.1 3DVAR Baseline SSEF initialized at 0000 UTC

SSEF forecasts are generated with the Weather Research and Forecast (WRF) modeling system (**Version 3.7.1)**, with the Advanced Research WRF (ARW) core, and the NCEP operationally used NMMB modeling system. As in 2015 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). SREF data with Grid 132 data form are directly processed. 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, and of 3D full dump for the visualization application) are archived at the TACC mass storage facility.

The *daily* ensemble forecast configuration includes the following, all of which are run on ***Stampede***, a Dell C8220 supercomputer system with over 6400 Intel Xeon Phi computing nodes at TACC. CAPS SSEF forecasts will have dedicated access to the system over the project period.

- ARW: 19 members at 3-km grid spacing initialized at 0000 UTC. Model execution begins around 0145 UTC (8:30pm CDT) and finish in 6 hours, with results being processed as they become available. **Table 1** lists the configuration and physics options for each ARW member. All forecasts are up to 60-h. Extra ARW members (up to 4) may be produced with different LSM options for internal comparison studies.
- NMMB: 6 members, 1 with radar data 3DVAR and 5 without (see **Table 2**)

Table 1. Configurations for ARW members. NAMa and NAMf refer to 12 km NAM analysis and forecast, respectively. ARPSa refers to ARPS 3DVAR and cloud analysis.

Member	IC	BC	Radar data	Microphy	LSM	PBL
arw_cn	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYJ
arw_m2	RAPa+3DVAR	00Z GFSf	yes	Thompson	RUC	MYNN
arw_m3	arw_cn + arw-p1_pert	21Z SREF arw-p1	yes	P3	Noah	YSU
arw_m4	arw_cn + arw-n1_pert	21Z SREF arw-n1	yes	MY	Noah	MYNN
arw_m5	arw_cn + arw-p2_pert	21Z SREF arw-p2	yes	Morrison	Noah	MYJ
arw_m6	arw_cn + arw-n2_pert	21Z SREF arw-n2	yes	P3	Noah	YSU
arw_m7	arw_cn + nmmb-p1_pert	21Z SREF nmmb-p1	yes	MY	Noah	MYNN
arw_m8	arw_cn + nmmb-n1_pert	21Z SREF nmmb-n1	yes	Morrison	Noah	YSU
arw_m9	arw_cn + nmmb-p2_pert	21Z SREF nmmb-p2	yes	P3	Noah	MYJ
arw_m10	arw_cn + nmmb-n2_pert	21Z SREF nmmb-n2	yes	Thompson	Noah	MYNN
arw_m11	arw_cn + arw-p1_pert	21Z SREF arw-p1	yes	Thompson	Noah	MYJ
arw_m12	arw_cn + arw-n1_pert	21Z SREF arw-n1	yes	Thompson	Noah	MYJ
arw_m13	arw_cn + arw-p2_pert	21Z SREF arw-p2	yes	Thompson	Noah	MYJ

arw_m14	arw_cn + arw-n2_pert	21Z SREF arw-n2	yes	Thompson	Noah	MYJ
arw_m15	arw_cn + arw-p3_pert	21Z SREF arw-p3	yes	Thompson	Noah	MYJ
arw_m16	arw_cn + nmmb-p1_pert	21Z SREF nmmb-p1	yes	Thompson	Noah	MYJ
arw_m17	arw_cn + nmmb-n1_pert	21Z SREF nmmb-n1	yes	Thompson	Noah	MYJ
arw_m18	arw_cn + nmmb-p2_pert	21Z SREF nmmb-p2	yes	Thompson	Noah	MYJ
arw_m19	arw_cn + nmmb-n2_pert	21Z SREF nmmb-n2	yes	Thompson	Noah	MYJ

Note 1: For all members: *ra_lw_physics*= RRTMG; *ra_sw_physics*=RRTMG; *cu_physics*=none

Table 2. Configurations for each individual member with NMMB core

member	IC	BC	Radar data	mp_phy	lw_phy	sw-phy	sf_phy
nmmb_cn	00Z ARPSa	00Z NAMf	yes	Ferrier-Aligo	RRTMG	RRTMG	Noah
nmmb_m1	00Z NAMa+ arw-p3_pert	21Z SREF arw-p3	no	Ferrier-Aligo	RRTMG	RRTMG	Noah
nmmb_m2	00Z NAMa+ nmmb-p1_pert	21Z SREF nmmb-p1	no	Ferrier-Aligo	RRTMG	RRTMG	Noah
nmmb_m3	00Z NAMa+ nmmb-n1_pert	21Z SREF nmmb-n1	no	Ferrier-Aligo	RRTMG	RRTMG	Noah
nmmb_m4	00Z NAMa+ nmmb-p2_pert	21Z SREF nmmb-p2	no	Ferrier-Aligo	RRTMG	RRTMG	Noah
nmmb_m5	00Z NAMa+ nmmb-n2_pert	21Z SREF nmmb-n2	no	Ferrier-Aligo	RRTMG	RRTMG	Noah

Note 1: For all members: *pbl_physics*=MYJ; *cu_physics*= NONE

3.2 GSI+EnKF-based SSEF initialized at 0000 UTC

The 3-km GSI+EnKF system will be initialized at 1800 UTC each day, and assimilate the RAP/HRRR GSI data stream hourly (except satellite data) from 1900–2300 UTC over the CONUS domain. Radar data will then be assimilated every 15 minutes from 2300–0000 UTC using the CAPS EnKF system. The ensemble used will consist of 40 WRF ARW members with initial perturbations and mixed physics options to provide input for the EnKF ensemble analyses. Each member uses Thompson microphysics, although with varied parameter settings (see Table 3). A 12- member ensemble forecast (run for 60hours) follows using the final EnKF analyses at

0000 UTC using the same multi-physics multi-microphysics WRF-ARW configurations as the 3DVAR baseline SSEF (Table 1). In addition, three deterministic forecasts from the ensemble mean analysis at 0000 UTC using three different microphysics schemes and one from 3DVAR analysis, are also produced. This suite of forecasts will be run On Darter at NICS.

Table 3. Configuration for the EnKF ensemble

Member	IC	BC	BMP – Thomp (ρg)	LSM	PBL
enk_m1	18Z NAMa	18Z NAMf	500	Noah	MYJ
enk_m2	enk_m1 + arw_n1_pert	15Z SREF arw_n1	500	Noah	YSU
enk_m3	enk_m1 + arw_n2_pert	15Z SREF arw_n2	673	Noah	MYJ
enk_m4	enk_m1 + arw_n3_pert	15Z SREF arw_n3	666	Noah	ACM2
enk_m5	enk_m1 + arw_n4_pert	15Z SREF arw_n4	659	Noah	ACM2
enk_m6	enk_m1 + arw_n5_pert	15Z SREF arw_n5	652	Noah	MYNN
enk_m7	enk_m1 + arw_n6_pert	15Z SREF arw_n6	645	Noah	MYJ
enk_m8	enk_m1 + arw_p1_pert	15Z SREF arw_p1	638	Noah	YSU
enk_m9	enk_m1 + arw_p2_pert	15Z SREF arw_p2	631	Noah	MYJ
enk_m10	enk_m1 + arw_p3_pert	15Z SREF arw_p3	624	Noah	MYNN
enk_m11	enk_m1 + arw_p4_pert	15Z SREF arw_p4	617	Noah	MYJ
enk_m12	enk_m1 + arw_p5_pert	15Z SREF arw_p5	610	Noah	YSU
enk_m13	enk_m1 + arw_p6_pert	15Z SREF arw_p6	603	Noah	ACM2
enk_m14	enk_m1 + nmb_n1_pert	15Z SREF nmb_n1	596	Noah	MYNN
enk_m15	enk_m1 + nmb_n2_pert	15Z SREF nmb_n2	589	Noah	MYNN
enk_m16	enk_m1 + nmb_n3_pert	15Z SREF nnb_n3	582	Noah	ACM2
enk_m17	enk_m1 + nmb_n4_pert	15Z SREF nmb_n4	575	Noah	MYJ
enk_m18	enk_m1 + nmb_n5_pert	15Z SREF nmb_n5	568	Noah	ACM2

enk_m19	enk_m1 + nmb_n6_pert	15Z SREF nmb_n6	561	Noah	MYJ
enk_m20	enk_m1 + nmb_p1_pert	15Z SREF nmb_p1	554	Noah	ACM2
enk_m21	enk_m1 + nmb_p2_pert	15Z SREF nmb_p2	547	Noah	MYJ
enk_m22	enk_m1 + emb_p3_pert	15Z SREF emb_p3	540	Noah	MYJ
enk_m23	enk_m1 + nmb_p4_pert	15Z SREF nmb_p4	533	Noah	YSU
enk_m24	enk_m1 + nmb_p5_pert	15Z SREF nmb_p5	526	Noah	MYNN
enk_m25	enk_m1 + nmb_p6_pert	15Z SREF nmb_p6	519	Noah	MYNN
enk_m26	enk_m1 + arw_n1_pert	15Z SREF arw_n1	512	Noah	MYJ
enk_m27	enk_m1 + arw_n2_pert	15Z SREF arw_n2	505	Noah	YSU
enk_m28	enk_m1 + arw_n5_pert	15Z SREF arw_n5	498	Noah	ACM2
enk_m29	enk_m1 + arw_n3_pert	15Z SREF arw-n3	491	Noah	MYNN
enk_m30	enk_m1 + arw_p1_pert	15Z SREF arw_p1	484	Noah	MYJ
enk_m31	enk_m1 + arw_p2_pert	15Z SREF arw_p2	477	Noah	YSU
enk_m32	enk_m1 + arw_p4_pert	15Z SREF arw_p4	470	Noah	MYNN
enk_m33	enk_m1 + arw_p5_pert	15Z SREF arw_p5	463	Noah	MYJ
enk_m34	enk_m1 + arw_p6_pert	15Z SREF arw_p6	456	Noah	YSU
enk_m35	enk_m1 + nmb_n1_pert	15Z SREF nmb_n1	449	Noah	ACM2
enk_m36	enk_m1 + nmb_n3_pert	15Z SREF nmb_n3	442	Noah	MYNN
enk_m37	enk_m1 + nmb_n4_pert	15Z SREF nmb_n4	435	Noah	MYNN
enk_m38	enk_m1 + nmb_n5_pert	15Z SREF nmb_n5	428	Noah	MYJ
enk_m39	enk_m1 + nmb_n6_pert	15Z SREF nmb_n6	421	Noah	YSU
enk_m40	enk_m1 + nmb_p1_pert	15Z SREF nmb_p1	414	Noah	MYJ

Table 4. Configuration for the EnKF 12-member ensemble forecasts

Member	IC	BC	Microphysics	LSM	PBL
enkf_cn	enk_m1a	00Z NAMf	Thompson	Noah	MYJ
enkf_m2	enk_m8a	21Z SREF arw-p1	P3	Noah	YSU
enkf_m3	enk_m10a	21Z SREF arw-n1	MY	Noah	MYNN
enkf_m4	enk_m17a	21Z SREF arw-p2	Morrison	Noah	MYJ
enkf_m5	enk_m23a	21Z SREF arw-n2	P3	Noah	YSU
enkf_m6	enk_m24a	21Z SREF nmmb-p1	MY	Noah	MYNN
enkf_m7	enk_m12a	21Z SREF nmmb-n1	Morrison	Noah	YSU
enkf_m8	enk_m9a	21Z SREF nmmb-p2	P3	Noah	MYJ
enkf_m9	enk_m6a	21Z SREF nmmb-n2	Thompson	Noah	MYNN
enkf_mn1	enk_mn	00Z NAMf	Thompson	Noah	MYJ
enkf_mn2	enk_mn	00Z NAMf	P3	Noah	MYJ
enkf_mn3	enk_mn	00Z NAMf	Morrison	Noah	MYJ
3dvar_nm	3dvar	00Z NAMf	Thompson	Noah	MYJ

4. Forecast Product and Deliverables to HWT/HMT

4.1 Products available to HWT and HMT (NSSL/SPC, WPC) in GRIB2

The 107 mandatory forecast fields, plus 4 HAIL size diagnose fields, for 2016 HWT/HMT Spring Experiment are listed in Table 5. The NCEP Unified Post Processing System (UPP, Version 3.0) is used to post-process WRF-ARW and NMMB history output data and to generate the **111** fields (101 HRRR output fields[1] + 6 additional fields requested by SPC, WPC, and AWC + 4 HAIL size fields) in GRIB2 format.

[1] http://www.nco.ncep.noaa.gov/pmb/products/hrrr/hrrr.t00z.wrfsfcf00.grib2.shtml

A complete set of extracted 2D fields in hdf4 format (Table 8) over the full CONUS domain are archived by CAPS for post-analysis and external collaborations.

Table 5. 2D fields of each member for HWT/HMT

Number	Field Description	Parameter name	Unit	Level/Layer
001	Composite reflectivity	REFC	dB	Entire atmosphere
002	Echo top	RETOP	m	Cloud top
003	Vertically Integrated Liquid	VIL	kg/m^2	Entire atmosphere
004	Visibility	VIS	m	Surface
005	Reflectivity	REFD	dB	1000 m above ground
006	Reflectivity	REFD	dB	4000 m above ground
007	Wind Speed (Gust)	GUST	m/s	Surface
008	Geopotential Height	HGT	gpm	500 hPa
009	Temperature	TMP	K	500 hPa
010	Dew Point Temperature	DPT	K	500 hPa
011	U-Component of Wind	UGRD	m/s	500 hPa
012	V-Component of Wind	VGRD	m/s	500 hPa
013	Geopotential Height	HGT	gpm	700 hPa
014	Temperature	TMP	K	700 hPa
015	Dew Point Temperature	DPT	K	700 hPa
016	U-Component of Wind	UGRD	m/s	700 hPa
017	V-Component of Wind	VGRD	m/s	700 hPa
018	Geopotential Height	HGT	gpm	850 hPa
019	Temperature	TMP	K	850 hPa
020	Dew Point Temperature	DPT	K	850 hPa
021	U-Component of Wind	UGRD	m/s	850 hPa
022	V-Component of Wind	VGRD	m/s	850 hPa
023	Temperature	TMP	K	925 hPa
024	Dew Point Temperature	DPT	K	925 hPa

025	U-Component of Wind	UGRD	m/s	925 hPa
026	V-Component of Wind	VGRD	m/s	925 hPa
027	Temperature	TMP	K	1000 hPa
028	Dew Point Temperature	DPT	K	1000 hPa
029	U-Component of Wind	UGRD	m/s	1000 hPa
030	V-Component of Wind	VGRD	m/s	1000 hPa
031	Hourly Maximum of Upward Vertical Velocity in the lowest 400hPa	MAXUVV	m/s	400-1000 hPa above ground
032	Hourly Maximum of Downward Vertical Velocity in the lowest 400hPa	MAXDVV	m/s	400-1000 hPa above ground
033	Vertical Velocity (Geometric)	DZDT	m/s	0.5-0.8 sigma layer
034	Pressure Reduced to MSL	PRMSL	Pa	mean sea level
035	Geopotential Height	HGT	gpm	1000 hPa
036	Hourly Maximum of Simulated Reflectivity at 1 km AGL	MAXREF	dB	1000 m above ground
037	Hourly Maximum of Updraft Helicity over Layer 2km to 5 km AGL	MXUPHL	m^2/s^2	5000-2000 m above ground
038	Total Column Integrate Graupel	TCOLG	kg/m^2	entire atmosphere
039	Lightning	LTNG	-	surface
040	U-Component of Wind	UGRD	m/s	80 m above ground
041	V-Component of Wind	VGRD	m/s	80 m above ground
042	Pressure	PRES	Pa	surface
043	Geopotential Height	HGT	gpm	surface
044	Temperature	TMP	K	surface
045	Moisture Availability	MSTAV	%	0 m underground
046	Water Equivalent of Accumulated Snow Depth	WEASD	kg/m^2	surface
047	Snow Cover	SNOWC	%	surface
048	Snow Depth	SNOD	m	surface

049	Temperature	TMP	K	2 m above ground
050	Specific Humidity	SPFH	kg/kg	2 m above ground
051	Dew Point Temperature	DPT	K	2 m above ground
052	U-Component of Wind	UGRD	m/s	10 m above ground
053	V-Component of Wind	VGRD	m/s	10 m above ground
054	Wind Speed	WIND	m/s	10 m above ground
055	Percent frozen precipitation	CPOFP	%	surface
056	Precipitation Rate	PRATE	kg/m^2/s	surface
057	Total Precipitation	APCP	kg/m^2	surface
058	Water Equivalent of Accumulated Snow Depth	WEASD	kg/m^2	surface
059	Total Precipitation	APCP	kg/m^2	surface
060	Water Equivalent of Accumulated Snow Depth	WEASD	kg/m^2	surface
061	Categorical Snow	CSNOW	-	surface
062	Categorical Ice Pellets	CICEP	-	surface
063	Categorical Freezing Rain	CFRZR	-	surface
064	Categorical Rain	CRAIN	-	surface
065	Vegetation Type [Integer(0- 13)]	VGTYP	-	surface
066	Surface Lifted Index	LFTX	K	500-1000 mb
067	Convective Available Potential Energy	CAPE	J/kg	surface
068	Convective Inhibition	CIN	J/kg	surface
069	Precipitable Water	PWAT	kg/m^2	entire atmosphere
070	Low Cloud Cover	LCDC	%	low cloud layer
071	Medium Cloud Cover	MCDC	%	middle cloud layer
072	High Cloud Cover	HCDC	%	high cloud layer
073	Total Cloud Cover	TCDC	%	entire atmosphere

074	Pressure	PRES	Pa	cloud base
075	Geopotential Height	HGT	gpm	cloud base
076	Geopotential Height	HGT	gpm	cloud ceiling
077	Pressure	PRES	Pa	cloud top
078	Geopotential Height	HGT	gpm	cloud top
079	Convective Cloud Cover	CDCON	%	convective cloud layer
080	Upward Long-Wave Rad. Flux	ULWRF	W/m^2	top of atmosphere
081	Downward Short-Wave Radiation Flux	DSWRF	W/m^2	surface
082	Storm Relative Helicity	HLCY	m^2/s^2	3000-0 m above ground
083	Storm Relative Helicity	HLCY	m^2/s^2	1000-0 m above ground
084	U-Component Storm Motion	USTM	m/s	0-6000 m above ground
085	V-Component Storm Motion	VSTM	m/s	0-6000 m above ground
086	Vertical U-Component Shear	VUCSH	1/s	0-1000 m above ground
087	Vertical V-Component Shear	VVCSH	1/s	0-1000 m above ground
088	Vertical U-Component Shear	VUCSH	1/s	0-6000 m above ground
089	Vertical V-Component Shear	VVCSH	1/s	0-6000 m above ground
090	Best (4 layer) Lifted Index	4LFTX	K	180-0 hPa above ground
091	Convective Available Potential Energy	CAPE	J/kg	180-0 hPa above ground
092	Convective Inhibition	CIN	J/kg	180-0 hPa above ground
093	Planetary Boundary Layer Height	HPBL	m	surface
094	Geopotential Height	HGT	gpm	level of adiabatic condensation from sfc
095	Convective Available Potential Energy	CAPE	J/kg	90-0 hPa above ground
096	Convective Inhibition	CIN	J/kg	90-0 hPa above ground

097	Convective Available Potential Energy	CAPE	J/kg	255-0 hPa above ground
098	Convective Inhibition	CIN	J/kg	255-0 hPa above ground
099	Geopotential Height	HGT	gpm	equilibrium level
100	Pressure of level from which parcel was lifted	PLPL	Pa	255-0 hPa above ground
101	Land Cover (0=sea, 1=land) [Proportion]	LAND	-	surface
102	Ice Cover [Proportion]	ICEC	-	surface
103	Geopotential Height	HGT	gpm	250 hPa
104	Temperature	TMP	K	250 hPa
105	U-Component of Wind	UGRD	m/s	250 hPa
106	V-Component of Wind	VGRD	m/s	250 hPa
107	W-Component of Wind	VVEL	m/s	700 hPa
108	-10C Reflectivity	REFD	dB	-10C level
108	HAIL_MAXK1	HAILK1	m	surface level
108	HAIL_MAXK1	HAILK1	m	surface level
110	HAIL_MEAN	AFWAMEAN	mm	surface level
111	HAIL_STD	AFWASTD	mm	surface level

4.2 Post-processed ensemble products in GEMPAK for HMT FFaIR

A list of post-processed ensemble products are produced in the 2016 Spring Experiment (see Table 7). 15 ensemble members are contributed to the products. **During HWT period**, these 15 members are consisting of the following (in Table 1), with 36 h forecast duration (due to some HWT members only run 36 h):

arw_cn, arw_m3~m14, nmmb_cn, nmmb_m1 (3DVAR-based)

During HMT FFaIR, a slightly different membership is configured to reflect the desire to examine microphysics impact on QPF. Table 6 is the ARW membership during the NMT FFaIR, plus nmmb_cn and nmmb_m1 listed in Table 2, all will run 60 h. The 4 shaded members in Table 6 are designed to evaluate microphysics impact on QPF.

In order to save disk space, the HMT GEMPAK data are trimmed off 100 grid points in west and south edges, 50 grid points in east edge, and 80 grid points in north edge (see Figure 2). This reduces the GEMPAK file sizes by 23%.

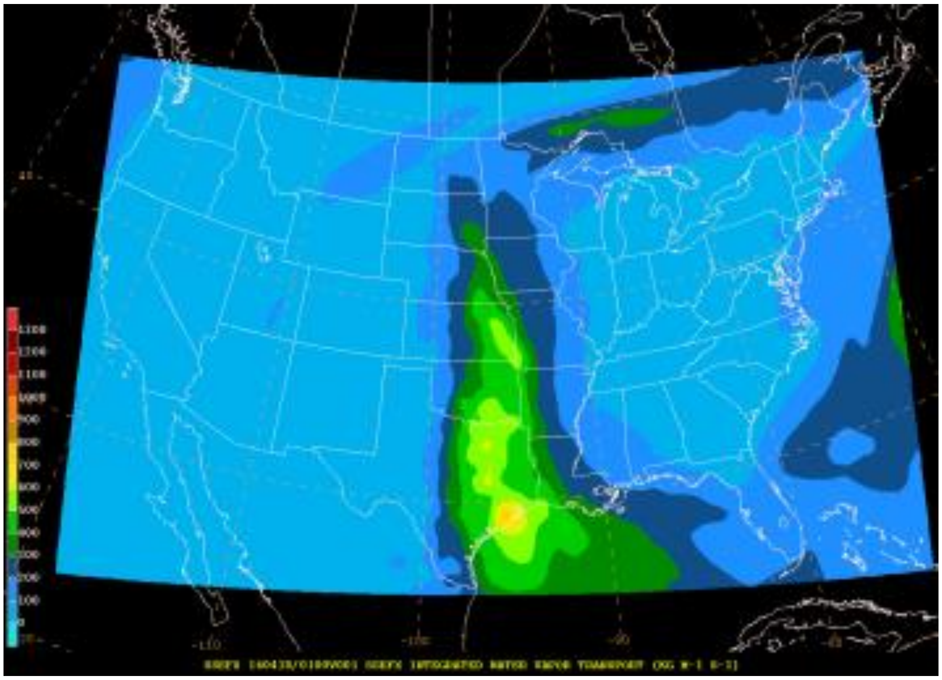

Figure 2. Sub-domain for the GEMPAK data for HMT.

Table 6. Ensemble members for HMT during FFaIR

Member	IC	BC	Radar data	Microphy	LSM	PBL
arw_cn	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYJ
arw_m3	arw_cn + arw-p1_pert	21Z SREF arw-p1	yes	P3	Noah	YSU
arw_m4	arw_cn + arw-n1_pert	21Z SREF arw-n1	yes	MY	Noah	MYNN
arw_m5	arw_cn + arw-p2_pert	21Z SREF arw-p2	yes	Morrison	Noah	MYJ
arw_m6	arw_cn + arw-n2_pert	21Z SREF arw-n2	yes	P3	Noah	YSU
arw_m7	arw_cn + nmmb-p1_pert	21Z SREF nmmb-p1	yes	MY	Noah	MYNN
arw_m8	arw_cn + nmmb-n1_pert	21Z SREF nmmb-n1	yes	Morrison	Noah	YSU
arw_m9	arw_cn + nmmb-p2_pert	21Z SREF nmmb-p2	yes	P3	Noah	MYJ
arw_m10	arw_cn + nmmb-n2_pert	21Z SREF nmmb-n2	yes	Thompson	Noah	MYNN

arw_m11	00Z ARPSa	00Z NAMf	yes	P3	Noah	MYJ
arw_m12	00Z ARPSa	00Z NAMf	yes	Morrison	Noah	MYJ
arw_m13	00Z ARPSa	00Z NAMf	yes	MY	Noah	MYJ
arw_m14	arw_cn + arw-n2_pert	21Z SREF arw-n2	yes	Thompson	Noah	MYJ

Table 7. Ensemble post-processed products for HMT

Field	GEMPAK name	Unit	Type	Ens type
Sea level pressure	PMSL	hPa	Surface/single layer	Mean
Sea Level pressure Spread	MSLS	hPa	Surface/single layer	STDEV
850 hPa Z	HGHT850	m	Surface/single layer	Mean
500 hPa Z	HGHT500	m	Surface/single layer	Mean
250 hPa Z	HGHT250	m	Surface/single layer	Mean
500 hPa Z Spread	H500S	m	Surface/single layer	Mean
850 hPa u-wind	UREL850	m/s	Surface/single layer	Mean
850 hPa v-wind	VREL850	m/s	Surface/single layer	Mean
250 hPa u-wind	UREL250	m/s	Surface/single layer	Mean
250 hPa v-wind	VREL250	m/s	Surface/single layer	Mean
500 hPa u-wind	UREL500	m/s	Surface/single layer	Mean
500 hPa v-wind	VREL500	m/s	Surface/single layer	Mean
850-300 hPa mean u-wind	UREL850_300	m/s	Surface/single layer	Mean
850-300 hPa mean v-wind	VREL850_300	m/s	Surface/single layer	Mean
IVTu	IVTU	kg/m/s	Surface/single layer	Mean
IVTv	IVTV	kg/m/s	Surface/single layer	Mean
500 hPa absolute vorticity	AVORT500	1/s	Surface/single layer	Mean
1-h precip	P01M_PM	mm	Surface/single layer	PM-mean
1-h precip	P01M_M	mm	Surface/single layer	Mean
1-h precip	P01M_MX	mm	Surface/single layer	Max

1-h precip ≥ 0.50 in	PR01MTH2_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
1-h precip ≥ 1.00 in	PR01MTH3_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
1-h precip > 2.00 in	PR01MTH4_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
3-h precip	P03M_PM	mm	Surface/single layer	PM-mean
3-h precip > 0.50 in	PR03MTH2_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
3-h precip > 1.00 in	PR03MTH3_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
3-h precip > 2.00 in	PR03MTH4_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
6-h precip	P06M_PM	mm	Surface/single layer	PM-mean
6-h precip	P06M_M	mm	Surface/single layer	Mean
6-h precip	P06M_MX	mm	Surface/single layer	Max
6-h precip ≥ 1.0-in	PR06MTH3_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
6-h precip ≥ 2.0-in	PR06MTH4_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
6-h precip ≥ 3.0-in	PR06MTH5_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
12-h precip	P12M_PM	mm	Surface/single layer	PM-mean
12-h precip > 1.00 in	PR12MTH3_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
12-h precip > 2.00 in	PR12MTH4_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
12-h precip > 3.00 in	PR12MTH5_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
24-h precip	P24M_PM	mm	Surface/single layer	PM-mean
24-h precip > 1.00 in	PR24MTH3_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
24-h precip > 2.00 in	PR24MTH4_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)

24-h precip > 3.00 in	PR24MTH5_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h FFG	FFG03_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h FFG	FFG06_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h FFG	FFG12_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h FFG	FFG24_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 2-y RI	RI03_002_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 5-y RI	RI03_005_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 10-y RI	RI03_010_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 25-y RI	RI03_025_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 50-y RI	RI03_050_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 3-h 100-y RI	RI03_100_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 2-y RI	RI06_002_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 5-y RI	RI06_005_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 10-y RI	RI06_010_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 25-y RI	RI06_025_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 50-y RI	RI06_050_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 6-h 100-y RI	RI06_100_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h 2-y RI	RI12_002_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)

Exceeding 12-h 5-y RI	RI12_005_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h 10-y RI	RI12_010_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h 25-y RI	RI12_025_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h 50-y RI	RI12_050_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 12-h 100-y RI	RI12_100_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 2-y RI	RI24_002_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 5-y RI	RI24_005_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 10-y RI	RI24_010_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 25-y RI	RI24_025_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 50-y RI	RI24_050_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Exceeding 24-h 100-y RI	RI24_100_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Lowest model level temp	TMPF	F	Surface/single layer	Mean
Lowest model level dew point	DWPF	F	Surface/single layer	Mean
precipitable water	PWAT	mm	Surface/single layer	Mean
10 m U	UREL	m/s	Surface/single layer	Mean
10 m V	VREL	m/s	Surface/single layer	Mean
1 km AGL reflectivity	REFL1KM	dBZ	Surface/single layer	PM-mean
1 km refl ≥ 40 dBZ	REFL1KMTH1_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Composite reflectivity	REFLCMP	dBZ	Surface/single layer	PM-mean
Comp refl ≥ 40 dBZ	REFLCMPTH1_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Surface-based CAPE	CAPE	J/kg	Surface/single layer	Mean

Surface-based CIN	CIN	J/kg	Surface/single layer	Mean
Surface-based LCL	HLCL	m	Surface/single layer	Mean
Max Updraft helicity	VHEL	m^2/s^2	Surface/single layer	Max
Max sfc-400 hPa W	VVELMAX	m/s	Surface/single layer	Max
Max sfc-400 hPa W ≥ 10 m/s	VVELMAX10	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Max sfc-400 hPa W ≥ 20 m/s	VVELMAX20	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
mlCAPE	MLCAPE	J/kg	Surface/single layer	Mean
mlCIN	MLCIN	J/kg	Surface/single layer	Mean
muCAPE	MUCAPE	J/kg	Surface/single layer	Mean
muCIN	MUCIN	J/kg	Surface/single layer	Mean
0 – 3 km AGL lapse rate	LLLR	K/km	Surface/single layer	Mean
700-500 mb lapse rate	LR75	K/km	Surface/single layer	Mean
0-1 km AGL wind shear	SHR01	1/s	Surface/single layer	Mean
0-6 km AGL wind shear	SHR06	1/s	Surface/single layer	Mean
Vertical-integrated Qg	COLQG	kg/ m^2	Surface/single layer	Max
Vertical-integrated Qg ≥ 40	COLQG40	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Wind speed lowest model level	WMAGM	m/s	Surface/single layer	Max
Surface wind speed (10-m)	WMAGSFC	m/s	Surface/single layer	Max
Surface wind speed (10-m) ≥ 15 m/s	WMAGSFC15	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Surface wind speed (10-m) ≥ 25 m/s	WMAGSFC25	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)

4.3 Products that will be extracted and archived as 2D HDF4 files

Table 8 lists the 2D fields that are produced and archived in HDF4 format over the full domain for each ensemble member.

Table 8. 2D fields archived for CAPS post-analysis

Field	Variable name	Variable ID	Unit	Type	Level

Surface pressure	PRES	sfpres	hPa	Surface/single layer	0
Sea level pressure	PMSL	mspres	hPa	Surface/single layer	0
1-h precipitation	P01M	accppt	mm	Surface/single layer	0
Precipitable water	PWAT	pwat__	mm	Surface/single layer	0
2 m temperature	TMPF	temp2m	F	Surface/single layer	0
2 m dew point	DWPF	dewp2m	F	Surface/single layer	0
2 m mixing ratio	MIXR	qv2m__	g/kg	Surface/single layer	0
1st level temperature	TMPF	tempk2	F	Surface/single layer	0
1st level dew point	DWPF	dewpk2	F	Surface/single layer	0
1st level mixing ratio	MIXR	qvk2__	g/kg	Surface/single layer	0
1st level wind speed	WMAGM	wsp2mx	m/s	Surface/single layer	0
10 m U	UREL	u10m__	m/s	Surface/single layer	0
10 m V	VREL	v10m__	m/s	Surface/single layer	0
Surface wind speed (10-m)	WMAGSFC	wspmax	m/s	Surface/single layer	0
Wind speed (1-km)	WMAG1KM	wsp1km	m/s	Surface/single layer	0
Surface geo- height	HGHT	hgtsfc	m	Surface/single layer	0
1 km AGL reflectivity	REFL1KM	ref1km	dBZ	Surface/single layer	0
1 km AGL reflectivity	REFL1KM_HM	refmax	dBZ	Surface/single layer	0
4 km AGL reflectivity	REFL4KM	ref4km	dBZ	Surface/single layer	0
Composite reflectivity	REFLCMP	cmpref	dBZ	Surface/single layer	0
Composite reflectivity	REFLCMP_HM	crefmx	dBZ	Surface/single layer	0
Reflectivity at -10C	REFLMTR	r10cmx	dBZ	Surface/single layer	0
Surface-based CAPE	CAPE	sbcape	J/kg	Surface/single layer	0
Moist unstable CAPE	MUCAPE	mucape	J/kg	Surface/single layer	0
Mixed-layer CAPE	MLCAPE	mlcape	J/kg	Surface/single layer	0
Surface-based CIN	CINS	sbcins	J/kg	Surface/single layer	0
Moist unstable CIN	MUCINS	mucins	J/kg	Surface/single layer	0

Mixed-layer CIN	MLCINS	mlcins	J/kg	Surface/single layer	0
Surface-based LCL	HLCL	sblcl_	m	Surface/single layer	0
0-1 km AGL SRH	SRH01	srh01_	m^2/s^2	Surface/single layer	0
0-3 km AGL SRH	SRH03	srh03_	m^2/s^2	Surface/single layer	0
Updraft helicity	VHELMAX	uh_max	m2/s2	Surface/single layer	0
Updraft helicity - E	VHELE	uhemax	m2/s2	Surface/single layer	0
Updraft helicity - P	VHELF	uhpmax	m^2/s^2	Surface/single layer	0
0-3km Updraft helicity	VHEL3KM	uh03mx	m^2/s^2	Surface/single layer	0
Sfc-400hPa max W	VVELMAX	wupmax	m/s	Surface/single layer	0
Sfc-400hPa min W	VVELMIN	wdnmax	m/s	Surface/single layer	0
0-1 km AGL wind shear	SHR01	shr01_	1/s	Surface/single layer	0
0-6 km AGL wind shera	SHR06	shr06_	1/s	Surface/single layer	0
1-h accumulated snow	SNOW	snow01	mm	Surface/single layer	0
1-h accumulated graupel	GRAUP	grpl01	mm	Surface/single layer	0
1-h accumulated hail	HAIL	hail01	mm	Surface/single layer	0
Bunkers right-moving U	BKU	bku___	m/s	Surface/single layer	0
Bunkers right-moving V	BKV	bkv___	m/s	Surface/single layer	0
IVT - U	IVTU	ivtu__	kg /m s	Surface/single layer	0
IVT - V	IVTV	ivtv__	kg /m s	Surface/single layer	0
Echo top (>= 18 dBZ)	ECHOTOP	Echotp	km	Surface/single layer	0
Vertical-integrated Qs	COLQS	cqsmax	kg/ m2	Surface/single layer	0
Vertical-integrated Qg	COLQG	cqgmax	kg/ m2	Surface/single layer	0
Vertical-integrated Qg (0-5km)	LLQG	llqg05	kg/ m^2	Surface/single layer	0
0-3km lapse rate	LLLR	lllr__	K/km	Surface/single layer	0
700-500hPa lapse rate	LR75	lr75__	K/km	Surface/single layer	0
80 m U	U80M	u80m__	m/s	Surface/single layer	0
80 m V	V80M	v80m__	m/s	Surface/single layer	0

Sfc total downward radiation flux	RADDN	raddn_	W/ m^2	Surface/single layer	0
Sfc downward sw radiation flux	RADSW	radsw_	W/ m2	Surface/single layer	0
Qs above surface	QSSFC	qsk2__	g/kg	Surface/single layer	0
Qg above surface	QGSFC	qgk2__	g/kg	Surface/single layer	0
Qh above surface	QHSFC	qhk2__	g/kg	Surface/single layer	0
Ns above surface	QNSSFC	qnsk2_	g/kg	Surface/single layer	0
Ng above surface	QNGSFC	qngk2_	g/kg	Surface/single layer	0
Nh above surface	QNHSFC	qnhk2_	g/kg	Surface/single layer	0
Qt above surface	QTSFC	qtsfc_	g/kg	Surface/single layer	0
Hail size	HAILSIZE	hailsz	mm	Surface/single layer	0
GT Hail size at k1	HAILSIZE_k1	hailk1	mm	Surface/single layer	0
GT Hail size in column	HAILSIZE_2d	hail2d	mm	Surface/single layer	0
500 hPa absolute vorticity	VORT500	vrt500	1/s	Surface/single layer	0
Lightning flash rate	LTG_MAX	Lg_max	Flashes/km^2/5 min	Surface/single layer	0
LFC height	LFCH	lfch__	m	Surface/single layer	0
PBL height	PBLH	pblh__	m	Surface/single layer	0
W at PBL top	WPBL	wpbl__	m/s	Surface/single layer	0
Simulated satellite BT Ch 3.90 CRTM	SIMSAT1	btch01	K	Surface/single layer	0
Simulated satellite BT Ch 6.48 CRTM	SIMSAT2	btch02	K	Surface/single layer	0
Simulated satellite BT Ch 10.67 CRTM	SIMSAT3	btch03	K	Surface/single layer	0
Geopotential height 925	HGHT	hgt925	m	pressure	925 hPa
Geopotential height 850	HGHT	hgt850	m	pressure	850 hPa
Geopotential height 700	HGHT	hgt700	m	pressure	700 hPa
Geopotential height 500	HGHT	hgt500	m	pressure	500 hPa
Geopotential height 250	HGHT	hgt250	m	pressure	250 hPa
925 hPa U	UREL	u925__	m/s	pressure	925 hPa
850 hPa U	UREL	u850__	m/s	pressure	850 hPa

700 hPa U	UREL	u700__	m/s	pressure	700 hPa
500 hPa U	UREL	u500__	m/s	pressure	500 hPa
250 hPa U	UREL	u250__	m/s	pressure	250 hPa
925 hPa V	VREL	v925__	m/s	pressure	925 hPa
850 hPa V	VREL	v850__	m/s	pressure	850 hPa
700 hPa V	VREL	v700__	m/s	pressure	700 hPa
500 hPa V	VREL	v500__	m/s	pressure	500 hPa
250 hPa V	VREL	v250__	m/s	pressure	250 hPa
925 hPa W	VVEL	w925__	m/s	pressure	925 hPa
850 hPa W	VVEL	w850__	m/s	pressure	850 hPa
700 hPa W	VVEL	w700__	m/s	pressure	700 hPa
500 hPa W	VVEL	w500__	m/s	pressure	500 hPa
250 hPa W	VVEL	w250__	m/s	pressure	250 hPa
925 hPa T	TMPC	tmp925	C	pressure	925 hPa
850 hPa T	TMPC	tmp850	C	pressure	850 hPa
700 hPa T	TMPC	tmp700	C	pressure	700 hPa
500 hPa T	TMPC	tmp500	C	pressure	500 hPa
250 hPa T	TMPC	tmp250	C	pressure	250 hPa
925 hPa mixing ratio	MIXR	sph925	g/kg	pressure	925 hPa
850 hPa mixing ratio	MIXR	sph850	g/kg	pressure	850 hPa
700 hPa mixing ratio	MIXR	sph700	g/kg	pressure	700 hPa
500 hPa mixing ratio	MIXR	sph500	g/kg	pressure	500 hPa
250 hPa mixing ratio	MIXR	sph250	g/kg	pressure	250 hPa

4.4 Name convention

SPC/NSSL file name *CAPS web name*

ARW members (3DVAR based):

ssef_s3cn_arw_2015032500 SPC3-EF CN WRFARW Fcst ssef_s3c0_arw_2015032500 SPC3-EF C0 WRFARW Fcst

ssef_s3m3_arw_2015032500 SPC3-EF M3 WRFARW Fcst

ssef_s3m4_arw_2015032500 SPC3-EF M4 WRFARW Fcst

ssef_s3m5_arw_2015032500 SPC3-EF M5 WRFARW Fcst

ssef_s3m6_arw_2015032500 SPC3-EF M6 WRFARW Fcst

ssef_s3m7_arw_2015032500 SPC3-EF M7 WRFARW Fcst

ssef_s3m8_arw_2015032500 SPC3-EF M8 WRFARW Fcst

ssef_s3m9_arw_2015032500 SPC3-EF M9 WRFARW Fcst

ssef_s3m10_arw_2015032500 SPC3-EF M10 WRFARW Fcst

ssef_s3m11_arw_2015032500 SPC3-EF M11 WRFARW Fcst

ssef_s3m12_arw_2015032500 SPC3-EF M12 WRFARW Fcst

ssef_s3m13_arw_2015032500 SPC3-EF M13 WRFARW Fcst

ssef_s3m14_arw_2015032500 SPC3-EF M14 WRFARW Fcst

ssef_s3m15_arw_2015032500 SPC3-EF M15 WRFARW Fcst

ssef_s3m16_arw_2015032500 SPC3-EF M16 WRFARW Fcst

ssef_s3m17_arw_2015032500 SPC3-EF M17 WRFARW Fcst

ssef_s3m18_arw_2015032500 SPC3-EF M18 WRFARW Fcst

ssef_s3m19_arw_2015032500 SPC3-EF M19 WRFARW Fcst

ssef_s3m20_arw_2015032500 SPC3-EF M20 WRFARW Fcst

ARW members (ENKF based):

enkf_s3cn_arw_2015032500 ENKF3 CN WRFARW Fcst

enkf_s3m2_arw_2015032500 ENKF3 M2 WRFARW Fcst

enkf_s3m3_arw_2015032500 ENKF3 M3 WRFARW Fcst

…

NMMB members:

ssef_s3cn_nmb_2015032500 SPC3-EF CN NMMB Fcst

…

Ensemble summary product:

ssef_s3ens_2015032500 (12-member)

enkf_s3ens_2015032500

5. 3D Visualization

3D fields from the 00Z control run covering a 200x200 grid-point area (600 km x 600 km) region will be extracted from the CONUS domain and shipped to the NWC in real-time. The domain will be centered on the SPC-determined daily area of interest as set on the NSSL HWT web site the previous afternoon. Expected arrival of all 3D files will be by 0800 CDT. Workflow for the 3D data processing is shown in Figure 3.

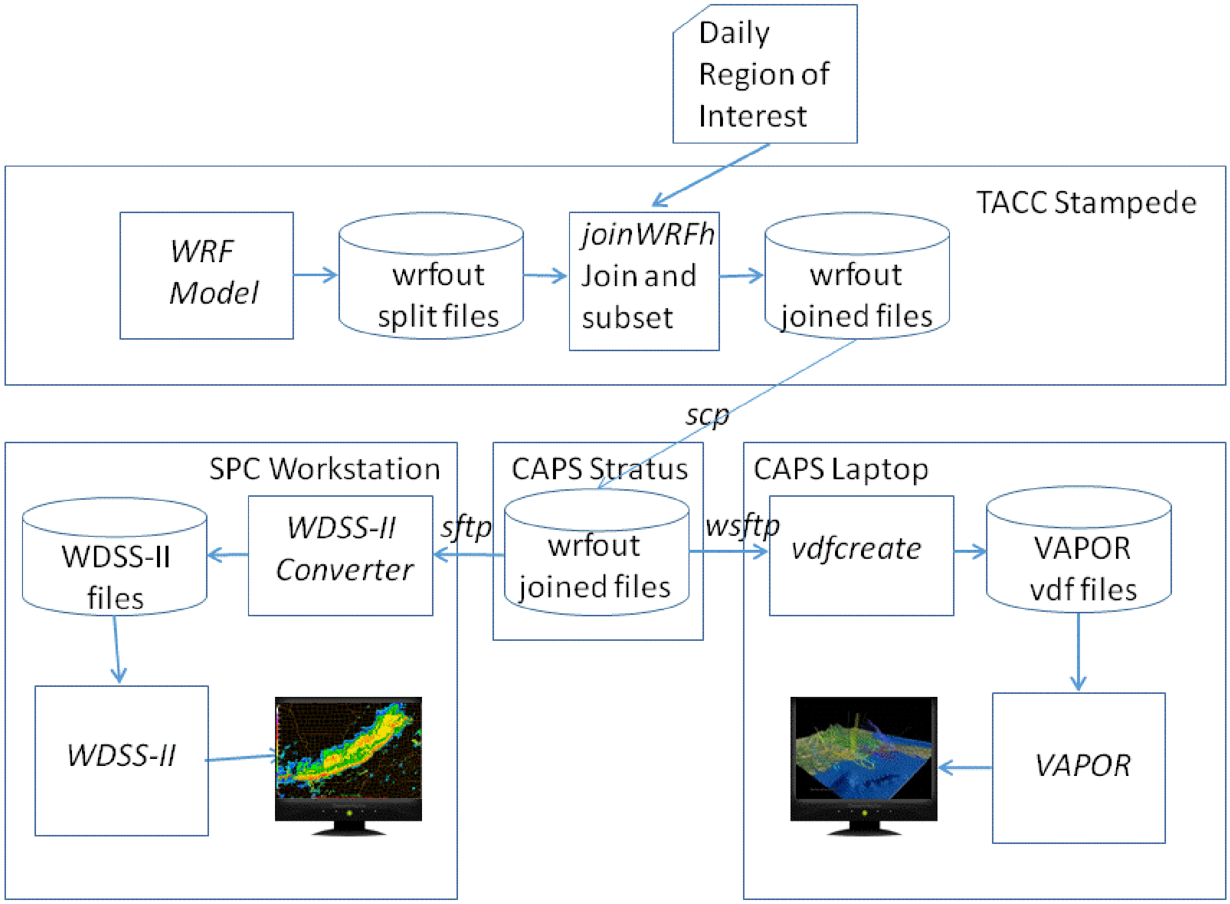

Figure 3. Workflow for 3D data extraction, transmission and 3D visualization processing.

The realtime system will create 10-minute output for 3D visualization from 1800 UTC to 0600 UTC (forecast hours 18-30) on TACC Stampede for the following members: control, m17, m18, m19, m20. The WRF subsetting and join program, joinwrfh, will be queued on Stampede at 0530 CDT each morning to create joined wrfout files of a 600 x 600 km domain centered on the HWT centerpoint of the day. The joinwrf script will include copying of files to Norman where they will be staged on the CAPS cluster (stratus). CAPS personnel, Keith Brewster or Derek Stratman, will copy the wrfout files from there to a laptop to process the 3D fields into vdf files using the VDCWizard tool . Then they will then use the NCAR VAPOR software to display relevant fields of the day for one or more members and present these to the forecast teams and at the HWT briefing at 11am CDT. A sample static VAPOR field from the 03 June 2014 is shown in Figure 4. A question about the utility of the 3D visualization and suggestion for additional fields will again be included in the HWT forecast questionnaire. The joined wrfout files and the image and movies shown in the briefings will be archived on an external harddrive for post-realtime analysis.

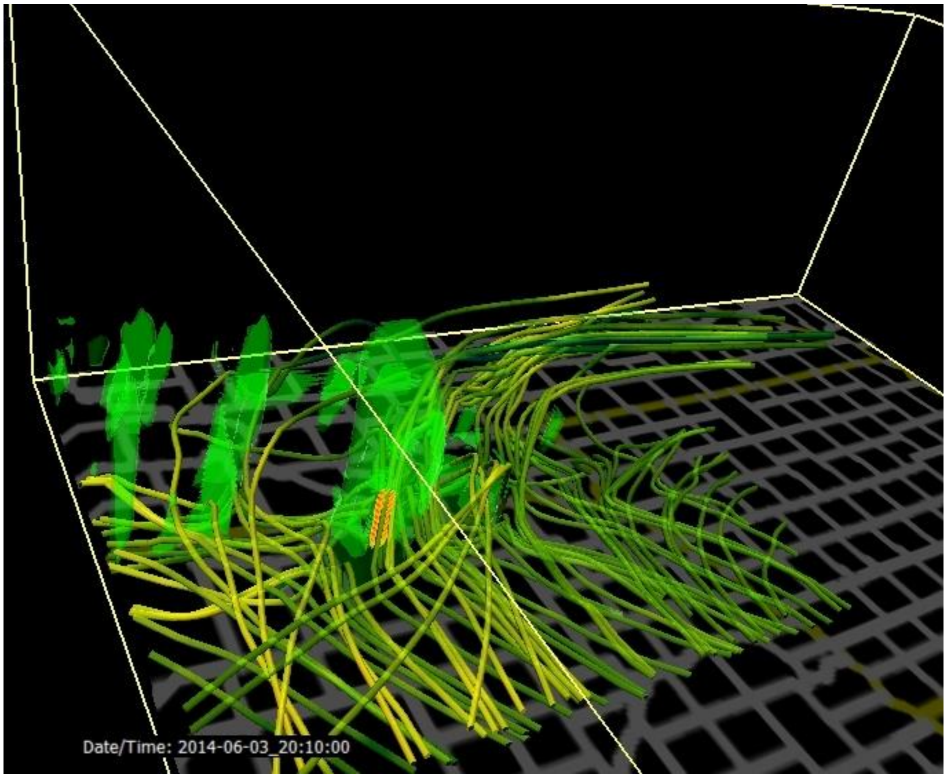

Figure 4. Sample VAPOR visualization from 03 June 2014 showing low-level parcel trajectories, envelope of reflectivity > 35 dBZ and updraft helicity (orange to red shading).

Appendix

A.1 WRF-ARW timing

A.2 NMMB timing

A.3 List of SREF members

24 perturbed SREF members:
sref_arw_n1
sref_arw_n2
sref_arw_n3
sref_arw_n4
sref_arw_n5
sref_arw_n6
sref_arw_p1
sref_arw_p2
sref_arw_p3
sref_arw_p4
sref_arw_p5
sref_arw_p6
sref_nmb_n1
sref_nmb_n2
sref_nmb_n3
sref_nmb_n4
sref_nmb_n5
sref_nmb_n6
sref_nmb_p1
sref_nmb_p2
sref_nmb_p3
sref_nmb_p4
sref_nmb_p5
sref_nmb_p6