CAPS Storm-Scale Ensemble Forecasts for the NOAA 2012 HWT Spring Experiment: New Features and QPF Verification

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In collaboration with: SPC, NSSL, NICS, NESDIS, CIRA, CIMSS

13th WRF Users Workshop, June 25-29, Boulder, CO

Outline

- History
- 2012 configuration highlight
- QPF verification
- Simulated synthetic GOES brightness temperature products
- SKEB in convection-allowing resolution

CAPS SSEF history

	2007	2008	2009	2010	2011	2012
Member	10	10	20	26	51	28
Domain (grid spacing)	2/3 CONUS (4 km)	3/4 CONUS (4 km)	3/4 CONUS (4 km)	Full CONUS (4 km)	Full CONUS (4 km)	Full CONUS (4 km)
Forecast	33 h	30 h	30 h	30 h	36 h	36 h
NWP Model	WRF-ARW (v2.2)	WRF-ARW (v2.2)	ARW, NMM (v3.0.1.1) ARPS	ARW, NMM (v3.1.1) ARPS	ARW, NMM (v3.2.1) ARPS	ARW, NMM (v3.3.1) ARPS, COAMPS
Radar DA	No radar	Radial wind & reflectivity	Radial wind & reflectivity	Radial wind & reflectivity	Radial wind & reflectivity	Radial Wind & reflectivity

Funded primarily by the NOAA CSTAR program, and leveraged by other NSF , NOAA and ONR grants

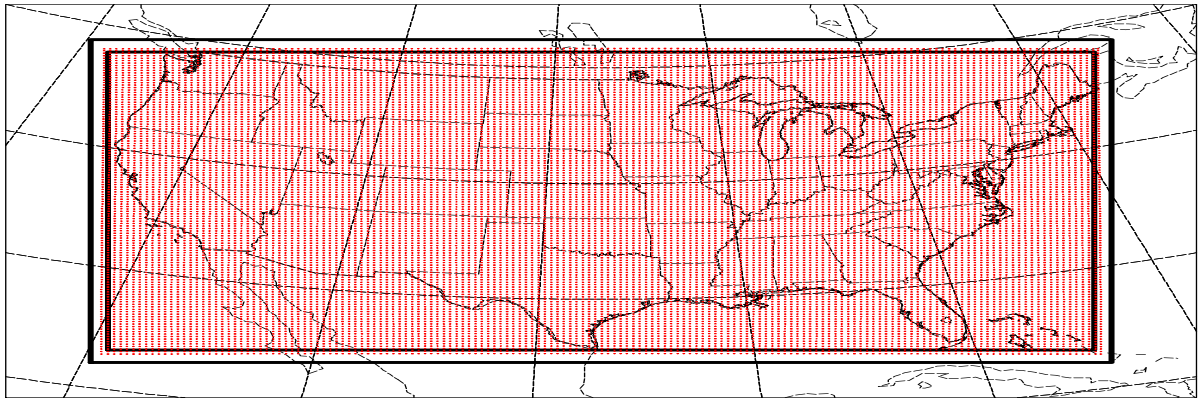
Major changes from 2011

- **WRF version 3.3.1** is used for 2012 season. (ARPS v5.3)
- Total **28** SSEF members (4 km grid spacing) at 0000 UTC, running on *Kraken* at NICS
- Added 3 **COAMPS members**, including one with the new 2-moment Milbrandt-Yau microphysics CAPS just added into COAMPS
- **Upgraded** CI and Lightning Threat algorithm (in ARW members)
- **Native reflectivity algorithm** from each microphysics scheme
- **Synthetic GOES satellite IR** radiance and BTs (for GOES-R Proving Ground)
- A 5-member sub-ensemble with WRF-ARW newly available stochastic kinetic energy backscatter (**SKEB**) perturbation (Berner et al. 2011)
- A new **1200 UTC** initiated SSEF (15-member), running on local computer system (new OSCER *Boomer* – unable to fulfill due to hardware not fully in place)

2012 CAPS SSEF highlight

- 28 ensemble members (4-km grid spacing)
  - 23 WRF-ARW members (with a parallel 5-member with SKEB)
  - 1 WRF-NMM members
  - 1 ARPS member
  - 3 COAMPS member (experimental)
- 36h forecast, starting 00 UTC Mon-Fri
- Run on NICS Kraken (~9000 cores, 7 h)
- April 23 – June 8 (HWT: May 7 - June 8)

2012 Spring Experiment Domains



NMM
790x999

3DVAR
1200x780

ARW, ARPS, COAMPS & verification
1160x720

51 vertical levels

2012 ARW member configuration (23)

Member	IC	BC	Radar data	Microphy	LSM	PBL
arw_cn ▲	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYJ
arw_c0 (18h)	00Z ARPSa	00Z NAMf	no	Thompson	Noah	MYJ
arw_m3 ▲	arw_cn + em-p1_pert	21Z SREF em-p1	yes	Morrison	RUC	YSU
arw_m4	arw_cn + nmm-n2_pert	21Z SREF nmm-n2	yes	Morrison	Noah	MYJ
arw_m5	arw_cn + em-n2_pert	21Z SREF em-n2	yes	Thompson	Noah	ACM2
arw_m6 ▲	arw_cn + rsm-n2_pert	21Z SREF rsm-n2	yes	M-Y	RUC	ACM2
arw_m7	arw_cn + nmm-p1_pert	21Z SREF nmm-p1	yes	WDM6	Noah	MYNN
arw_m8 ▲	arw_cn + rsm-p1_pert	21Z SREF rsm-p1	yes	WDM6	RUC	MYJ
arw_m9	arw_cn + etaKF-p1_pert	21Z SREF etaKF-p1	yes	M-Y	RUC	YSU
arw_m10 ▲	arw_cn + etaKF-n1_pert	21Z SREF etaKF-n1	yes	WDM6	Noah	QNSE
arw_m11	arw_cn + etaBMJ-p1_pert	21Z SREF etaBMJ-p1	yes	M-Y	Noah	MYNN
arw_m12	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYNN
arw_m13	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	ACM2
arw_m14	00Z ARPSa	00Z NAMf	yes	M-Y	Noah	MYJ
arw_m15	00Z ARPSa	00Z NAMf	yes	Morrison	Noah	MYJ
arw_m16	00Z ARPSa	00Z NAMf	yes	WDM6	Noah	MYJ
arw_m17	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	QNSE
arw_m18	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	YSU
arw_m19*	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYJ
arw_m20*	arw_cn + em-p1_pert	21Z SREF em-p1	yes	Morrison	RUC	YSU
arw_m21*	arw_cn – rsm-n2_pert	21Z SREF rsm-n2	yes	M-Y	RUC	ACM2
arw_m22*	arw_cn + rsm-p1_pert	21Z SREF rsm-p1	yes	WDM6	RUC	MYJ
arw_m23*	arw_cn + etaKF-n1_pert	21Z SREF etaKF-n1	yes	WDM6	Noah	QNSE

For all ARW members: *ra_lw_physics*= RRTM; *ra_sw_physics*=Goddard; *cu_physics*=none

SKEB

2012 NMM member configuration (1)

member	IC	BC	Radar data	mp_phy	lw_phy	sw-phy	sf_phy
nmm_cn	00Z ARPSa	00Z NAMf	yes	Ferrier	GFDL	GFDL	Noah

For all NMM members: *pbl_physics*=MYJ; *cu_physics*=none

2012 ARPS member configuration (1)

member	IC	BC	Radar data	Microphy.	radiation	sf_phy
arps_cn	00Z ARPSa	00Z NAMf	yes	Lin	Chou/Suarez	Force-restore

For all ARPS members: no cumulus parameterization

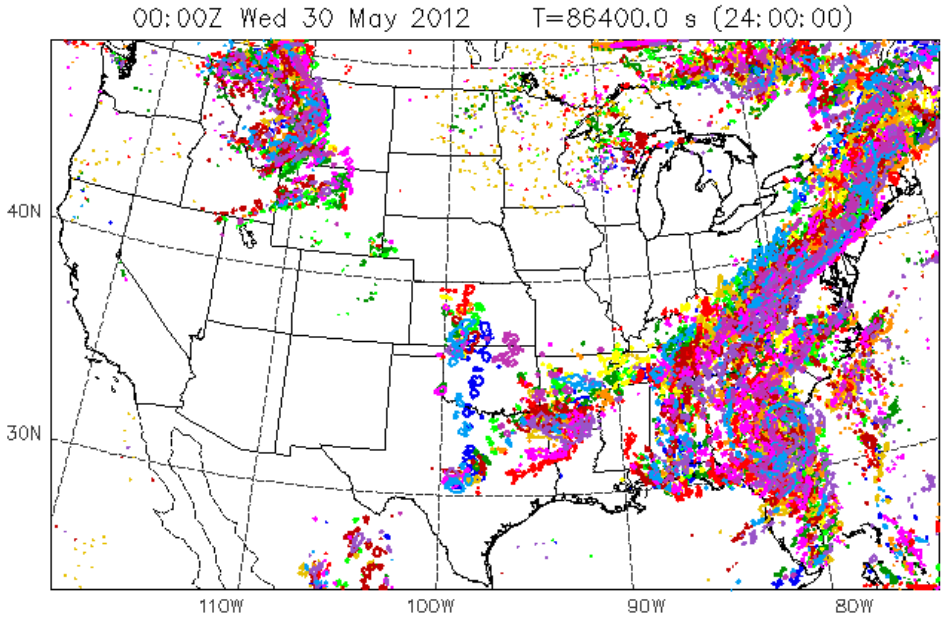
2012 COAMPS member configuration (3)

member	IC	BC	Radar data	Microphy.	radiation	sf_phy
cmps_cn	00Z ARPSa	00Z NAMf	yes	Hobbs-Rutledge	-	-
cmps_c1	00Z ARPSa	00Z NAMf	yes	M-Y	-	-
cmps_c0	00Z NAMa	00Z NAMf	no	Hobbs-Rutledge	-	-

Members in red contribute to the **12-member** baseline ensemble for post-processing

CAPS SSEF product page

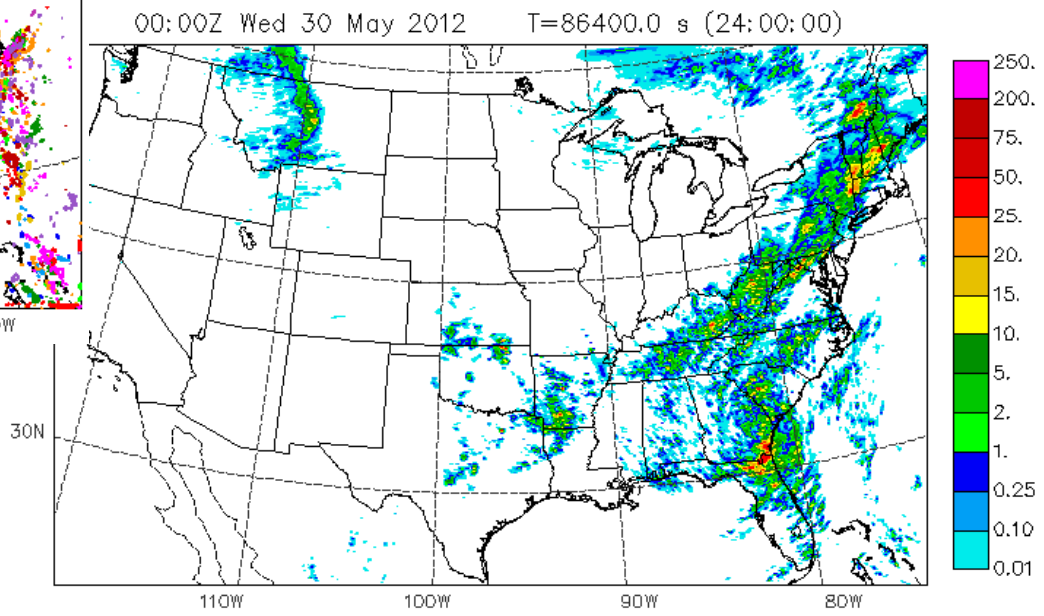
- http://forecast.caps.ou.edu
- http://www.caps.ou.edu/~fkong/sub_atm/spring12.html



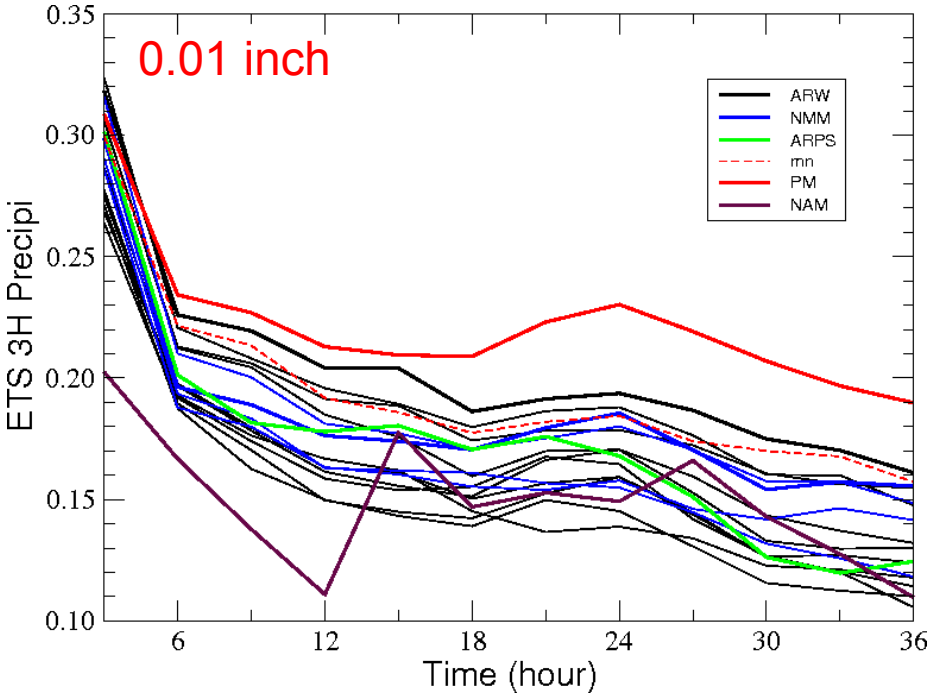
Spaghetti of cref = 35 dBZ

(24-h fcst, valid 00Z May 30, 2012)

Probability matched mean hourly precipitation

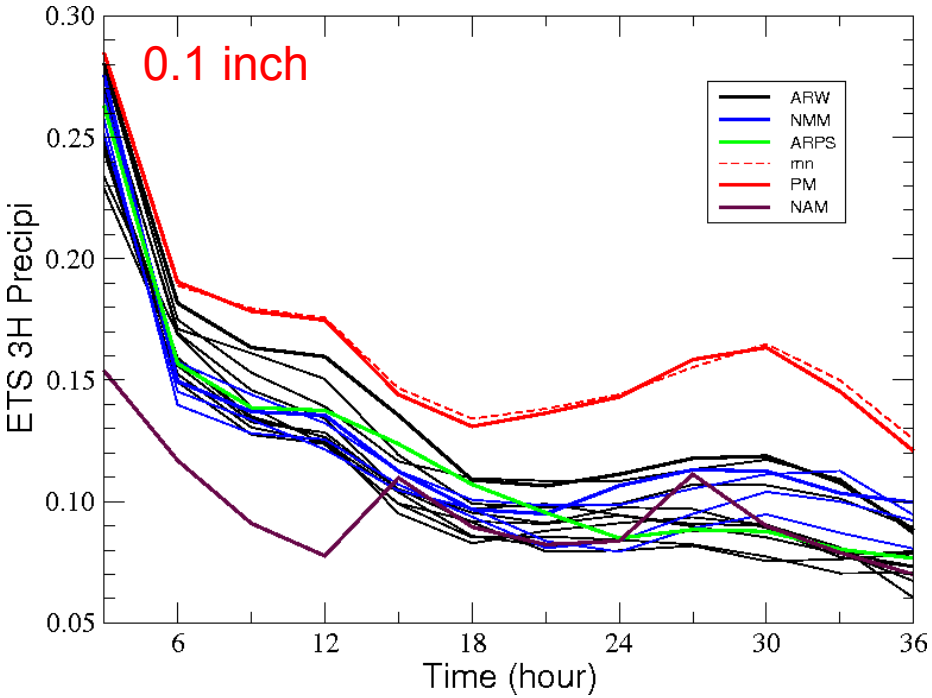


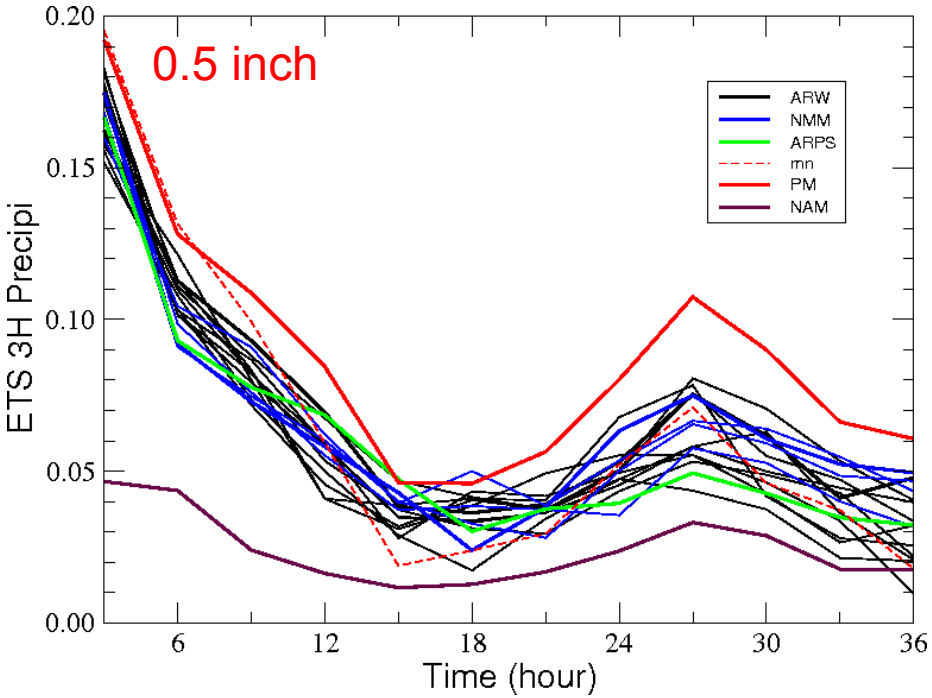
QPF verification



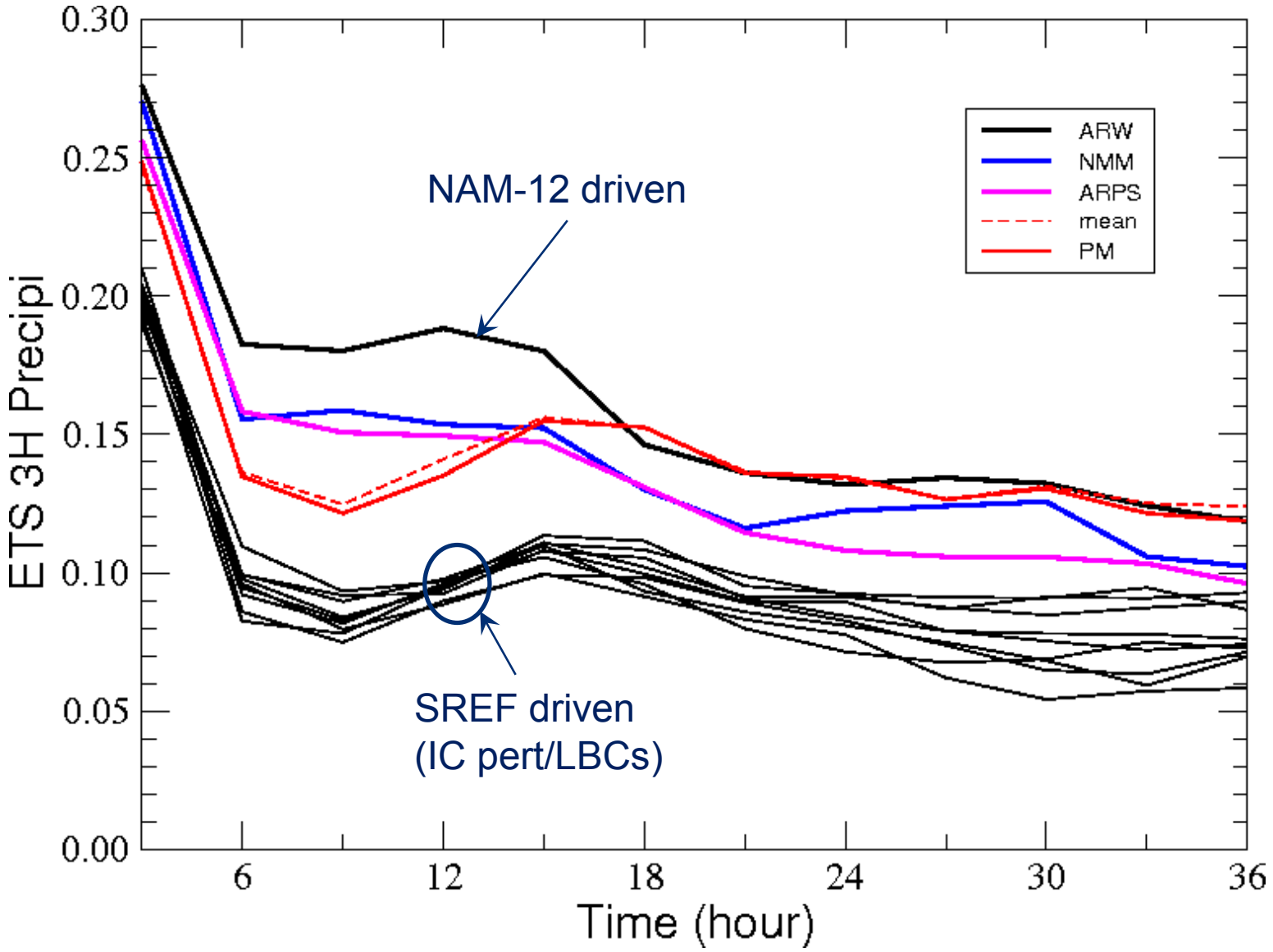
ETS for 3-h accumulated precipitation

(2011data)

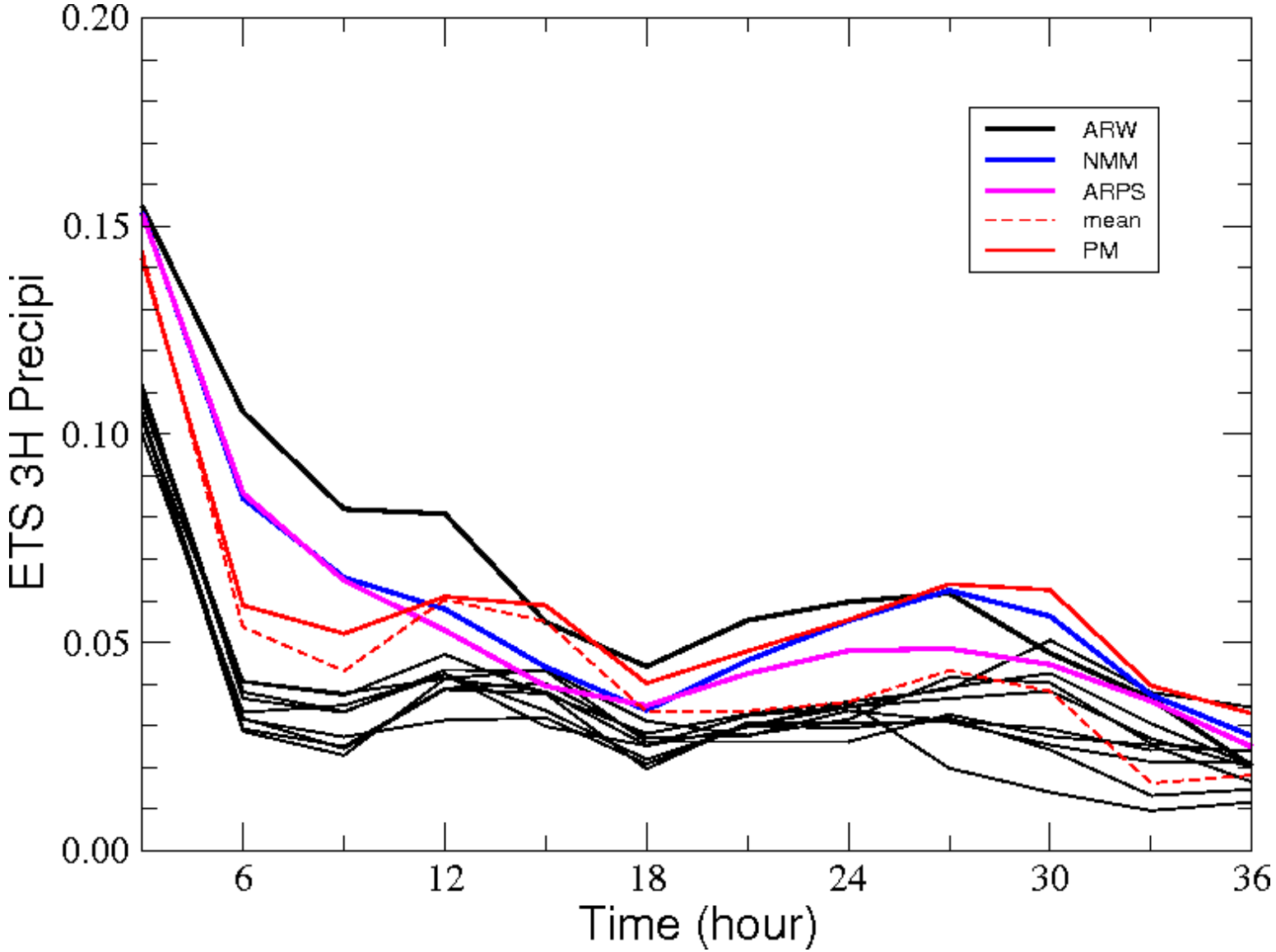




ETS of 3-h accumulated precipitation ≥0.1 in

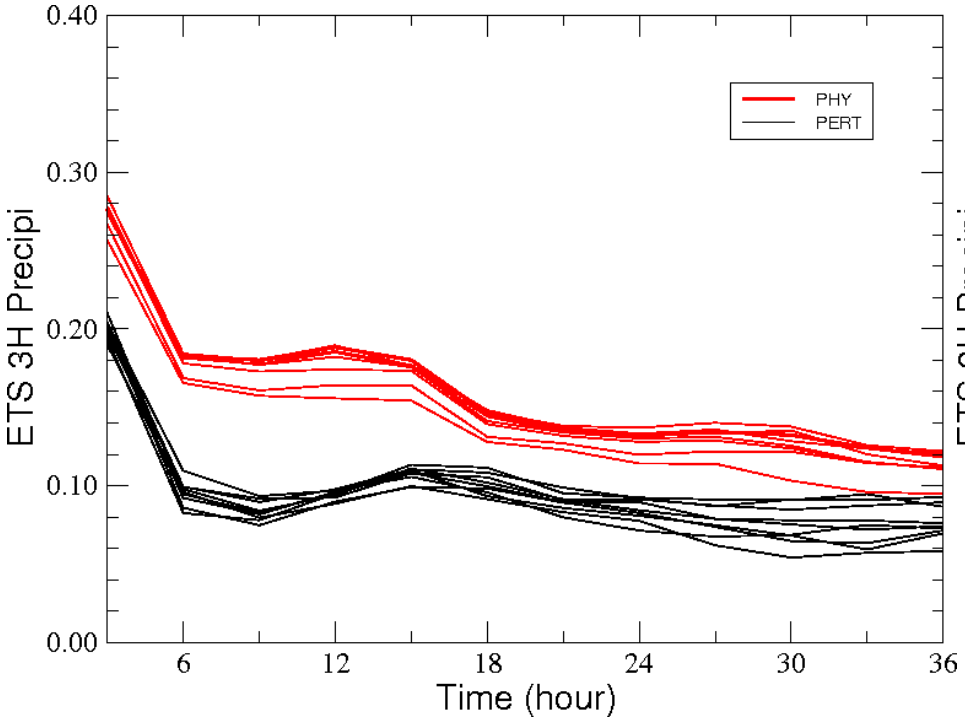


ETS of 3-h accumulated precipitation ≥0.5 in

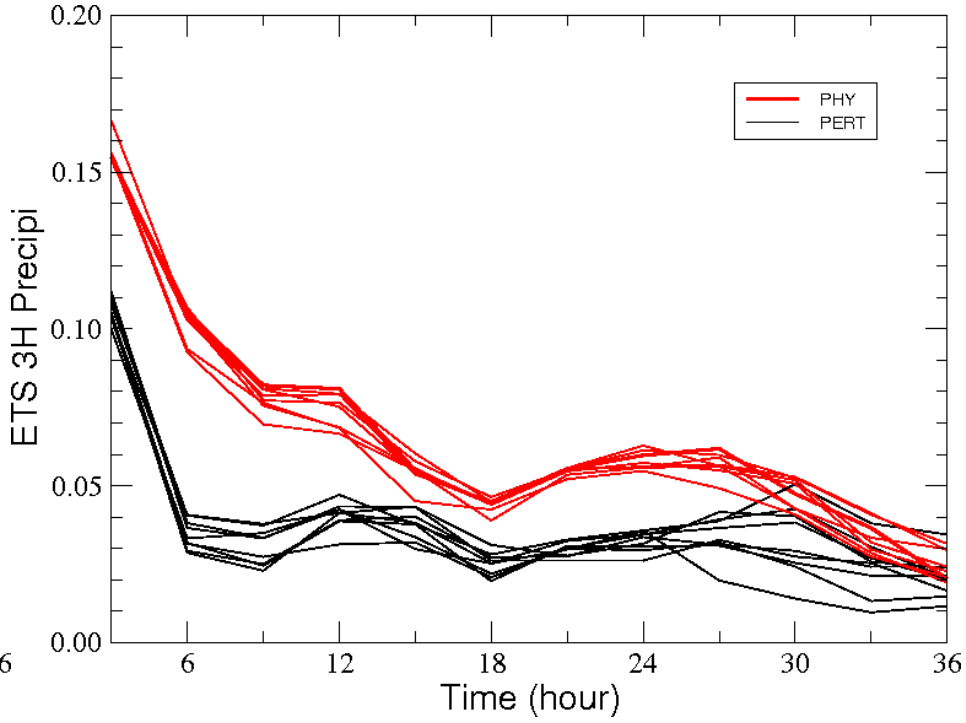


ETS of 3-h accumulated precipitation

≥ 0.1 in

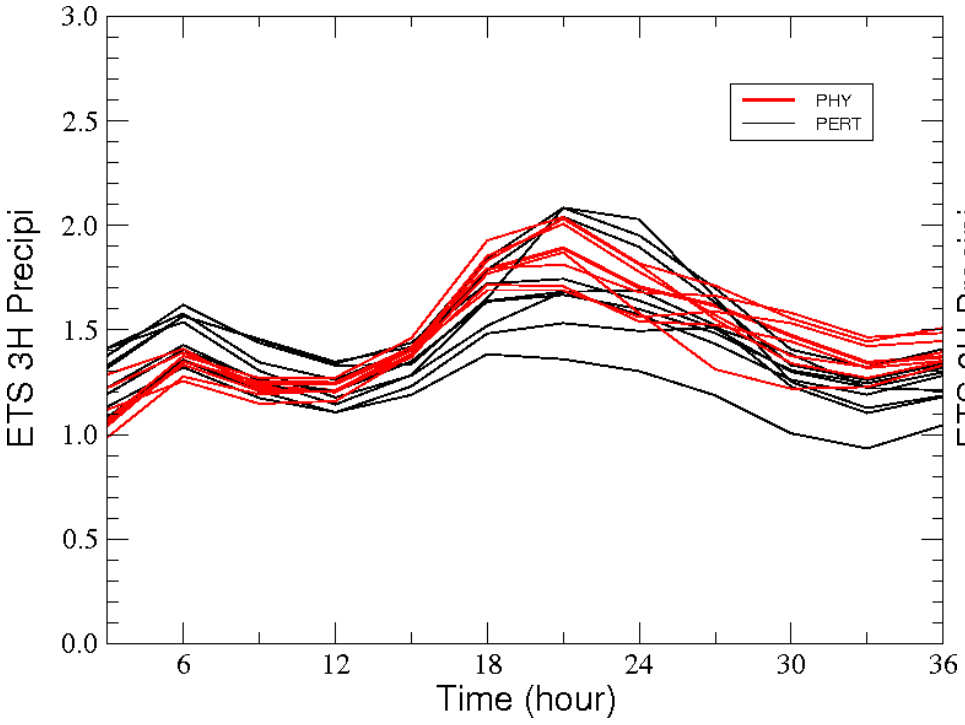


≥ 0.5 in

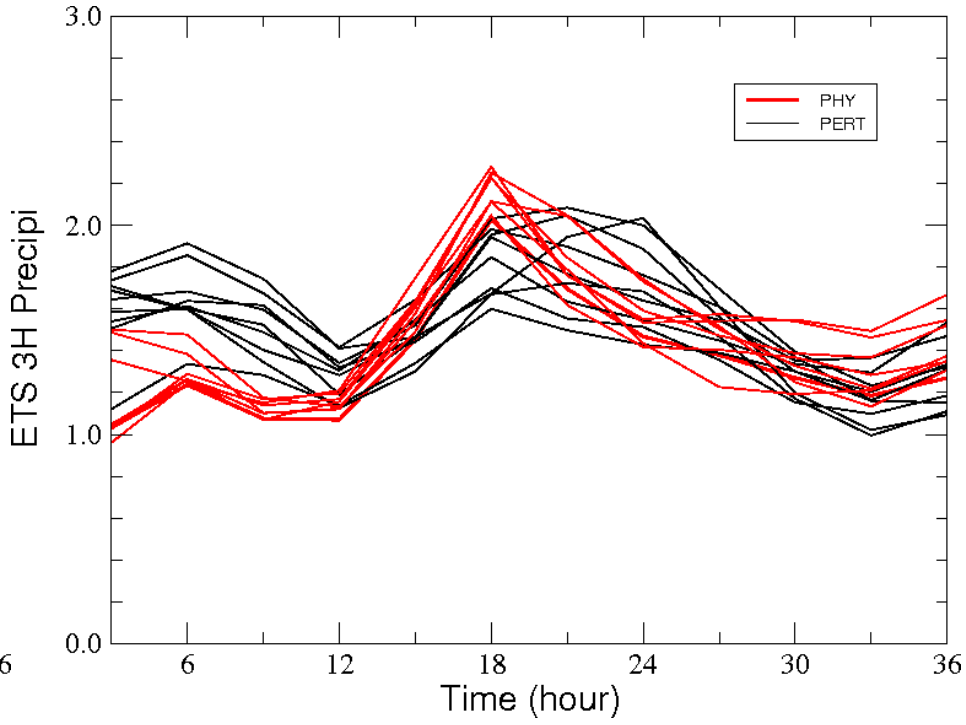


BIAS of 3-h accumulated precipitation

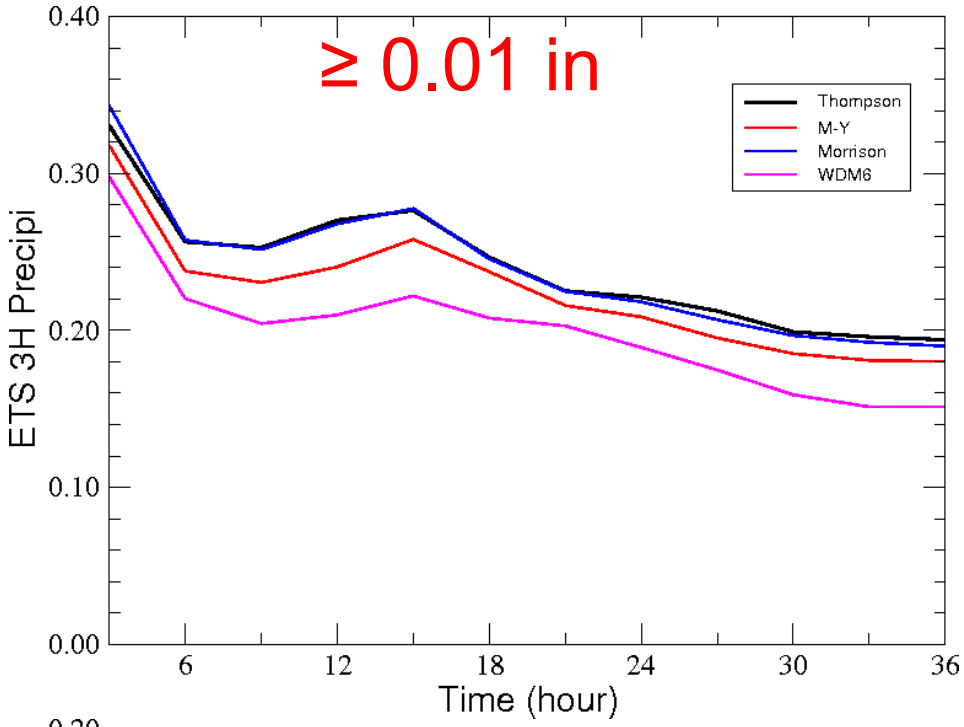
≥ 0.1 in

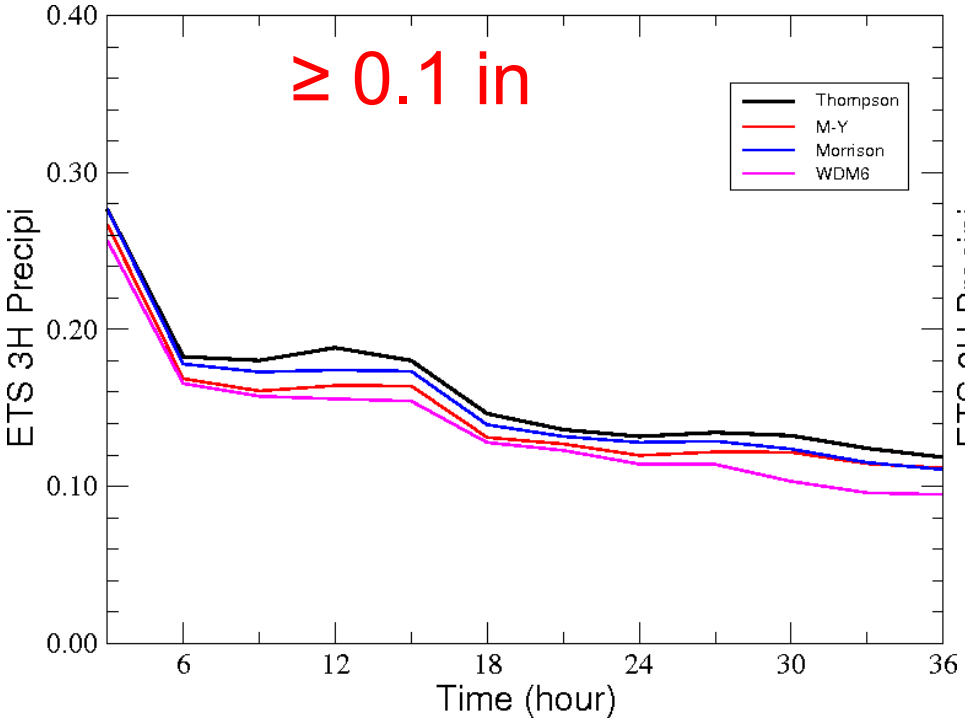


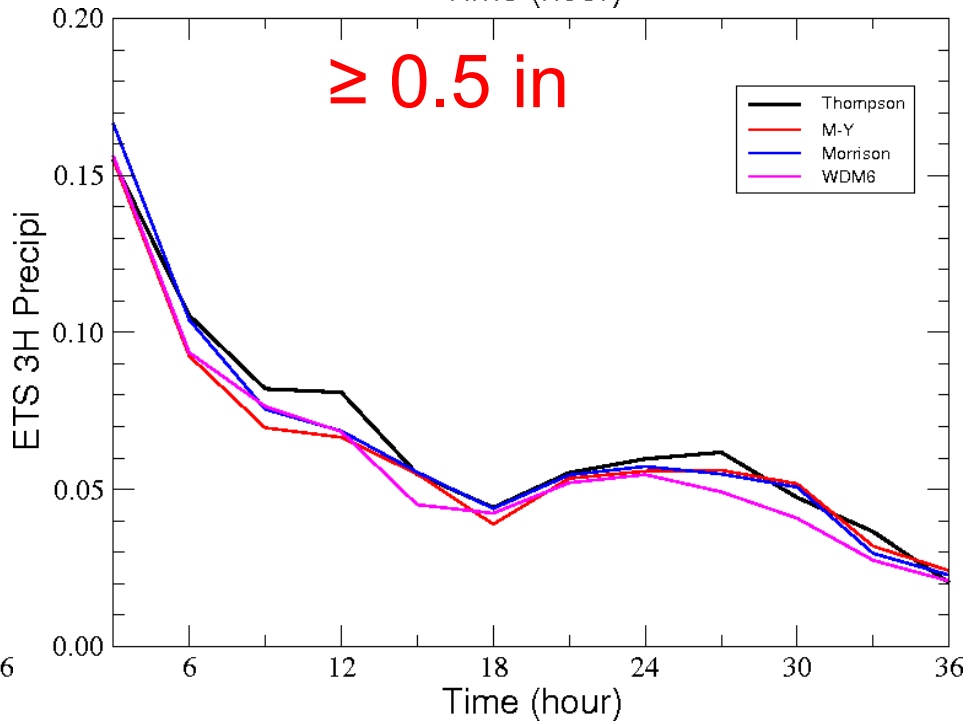
≥ 0.5 in



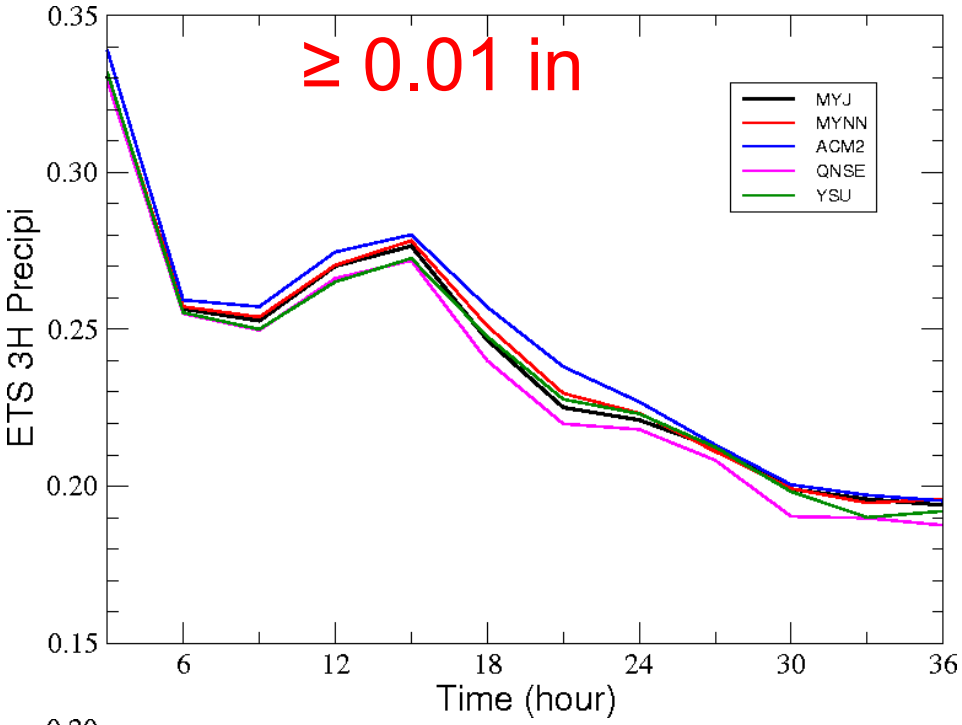
ETS of 3-h accumulated precipitation -- microphysics impact

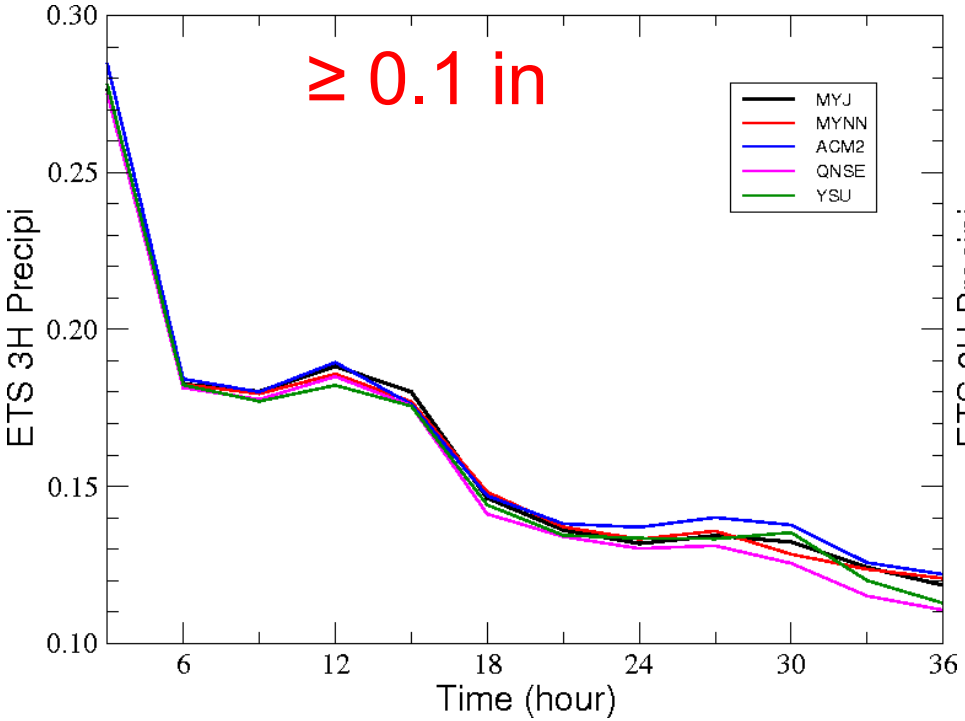


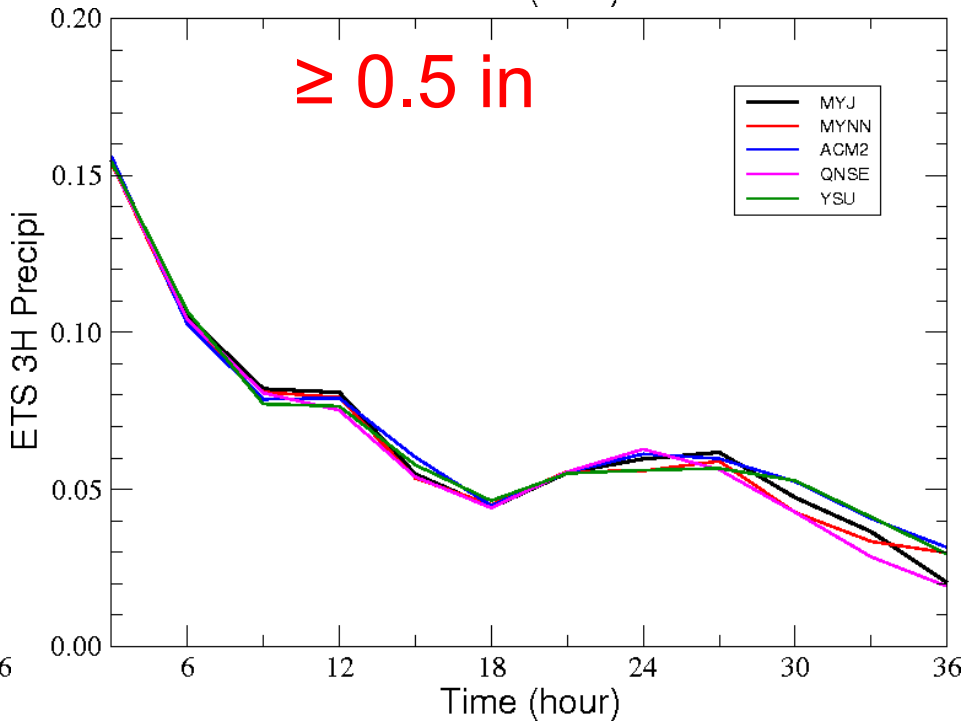




ETS of 3-h accumulated precipitation -- PBL scheme impact



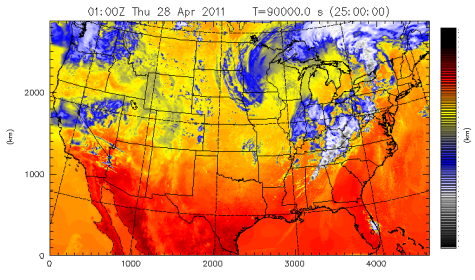




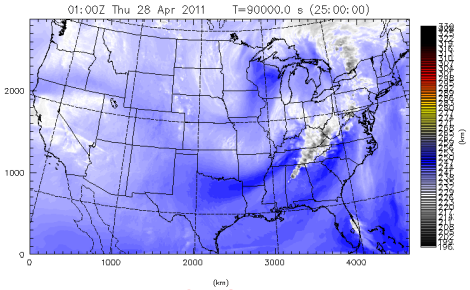
Synthetic satellite IR imagery

- Three radiative transfer models (RTMs)
  - CRTM, CIRA RTM, CIMSS RTM
- Support various sensors, mainly GOES IR imagers
- Programmed into CAPS post-processing module
- Run in realtime using MPI with direct reading of tiled (split) MWP model output
- Apply to all members, with ensemble probability generated

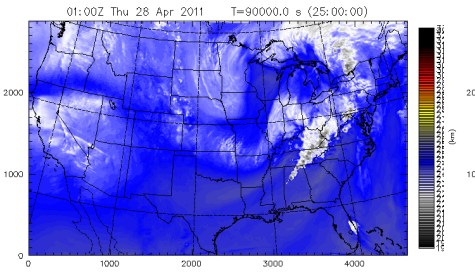
CRTM synthetic GOES-R IR imagery
4/27/2011 case (25 h forecast)



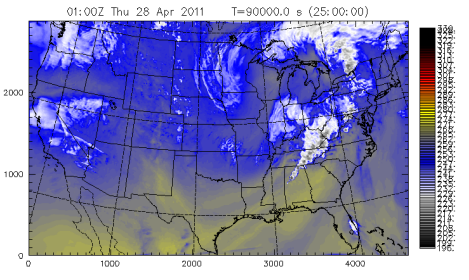
3.90



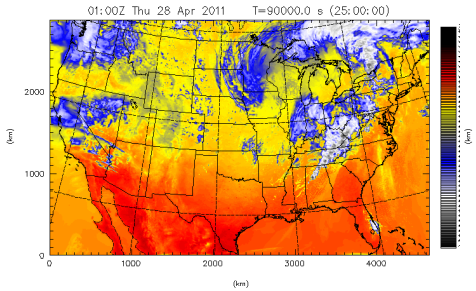
6.15



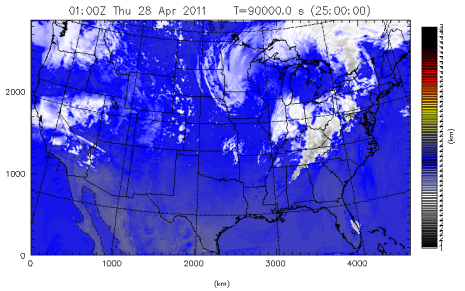
6.93



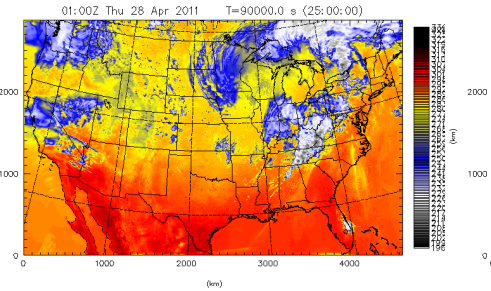
7.34



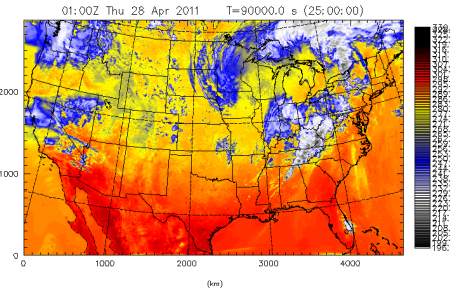
8.50



9.60



10.36



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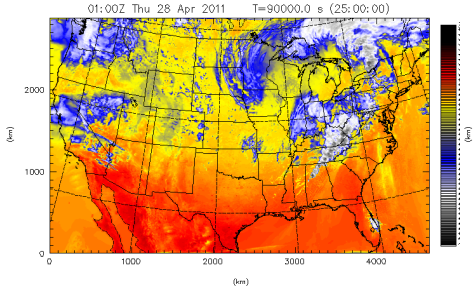

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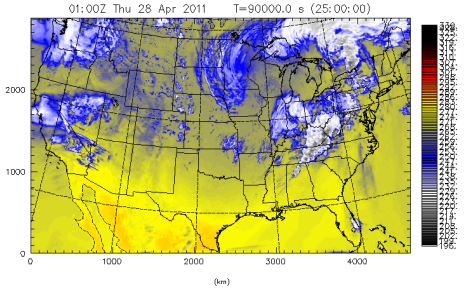

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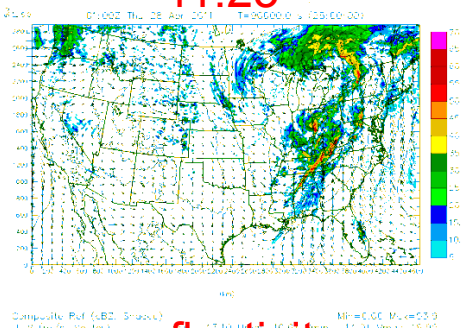
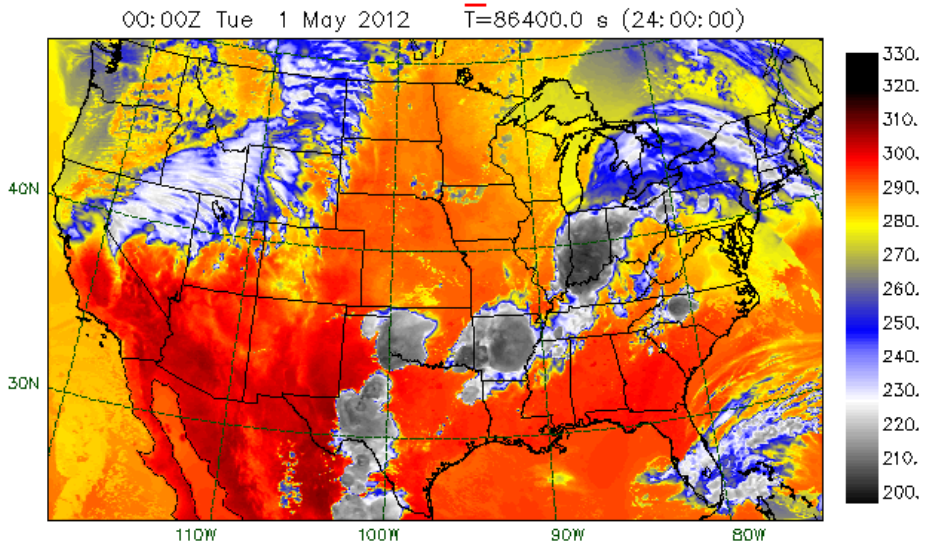


reflectivity

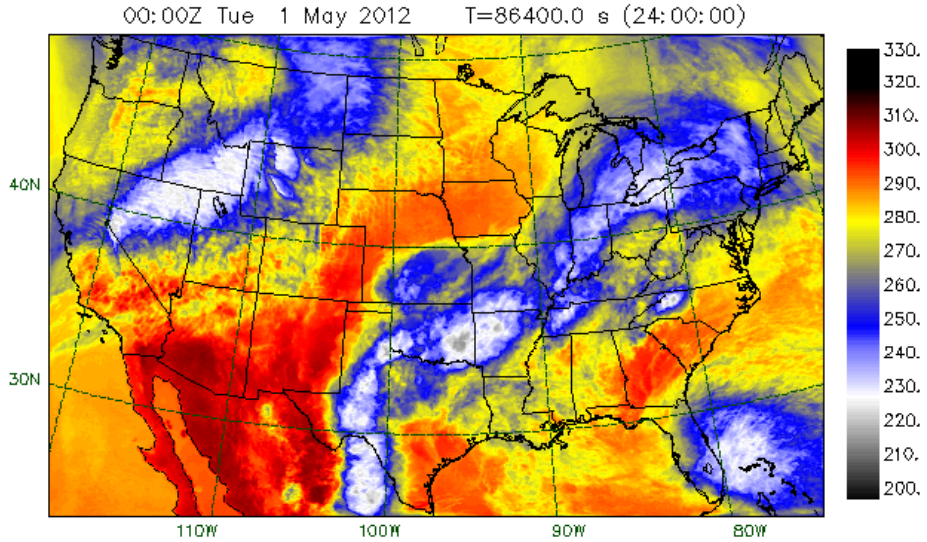
Simulated GOES-13 10.7μm BT products

(24 h forecast valid 5/1/2012 00 UTC)

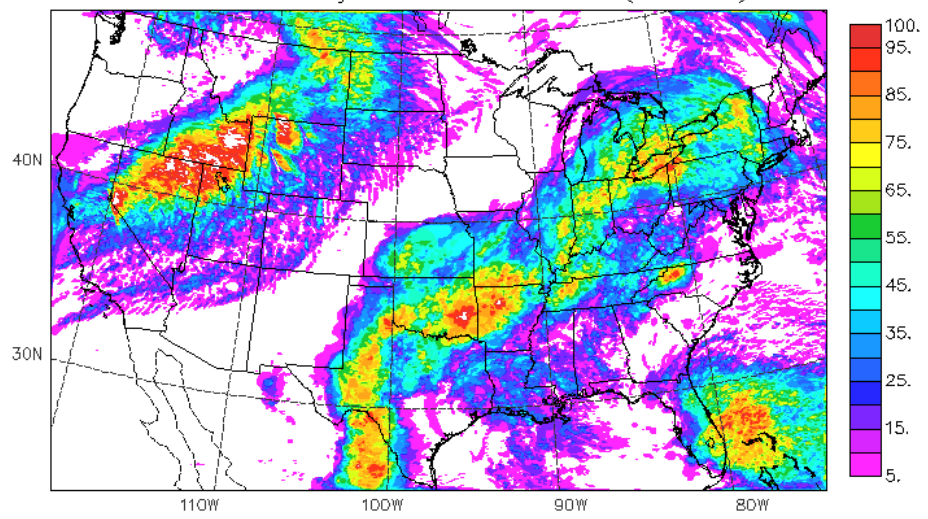
ARW_CN



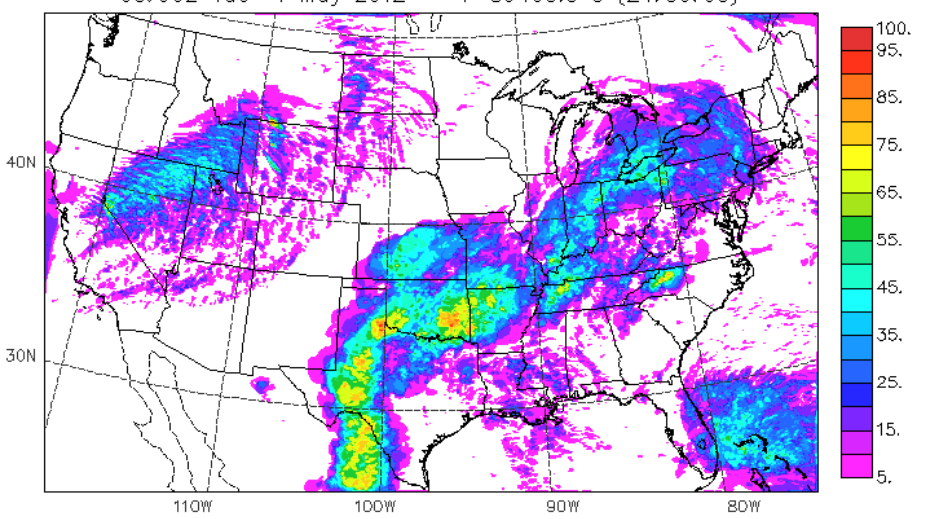
MEAN



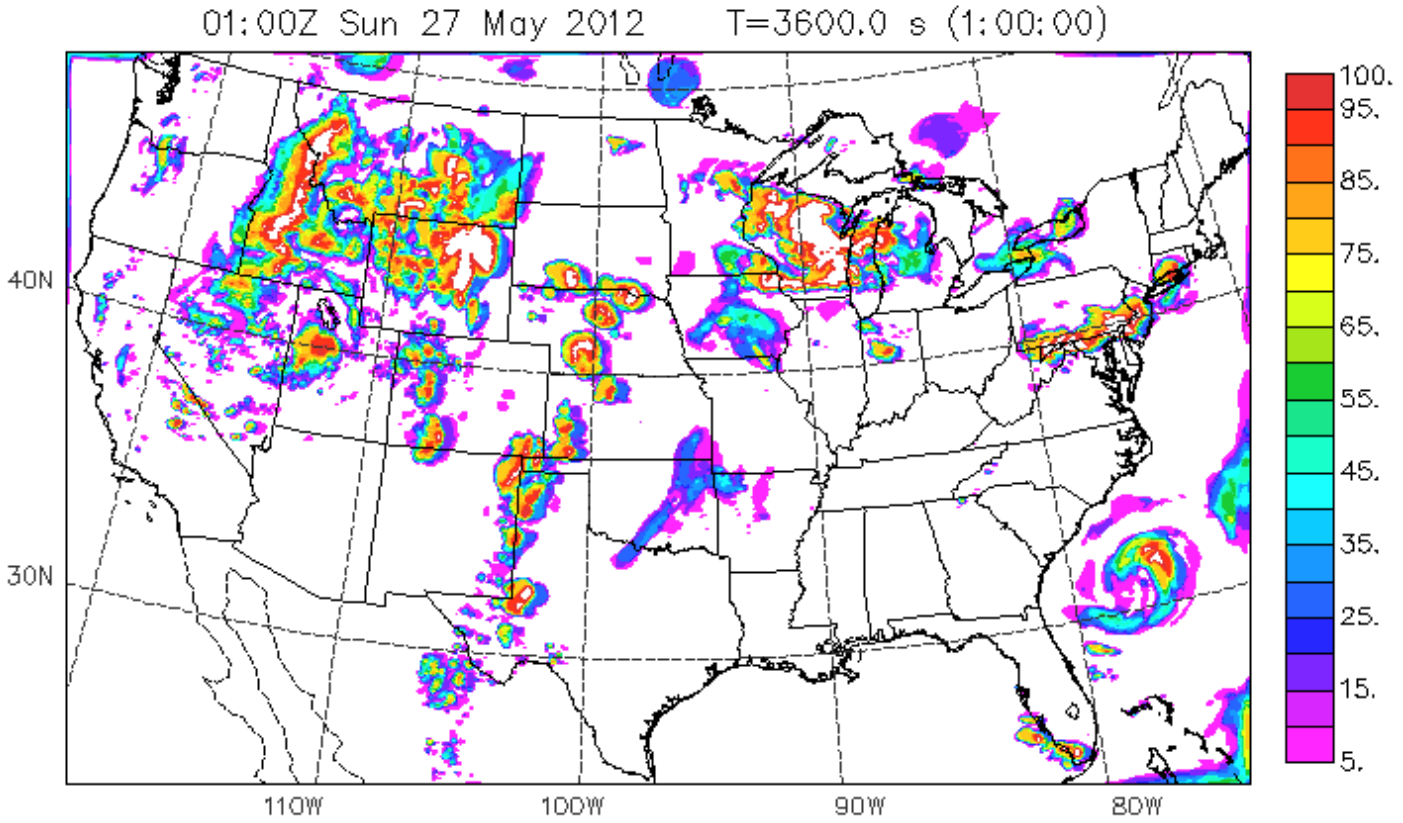
Probability BT≤-32C



Probability BT≤-52C



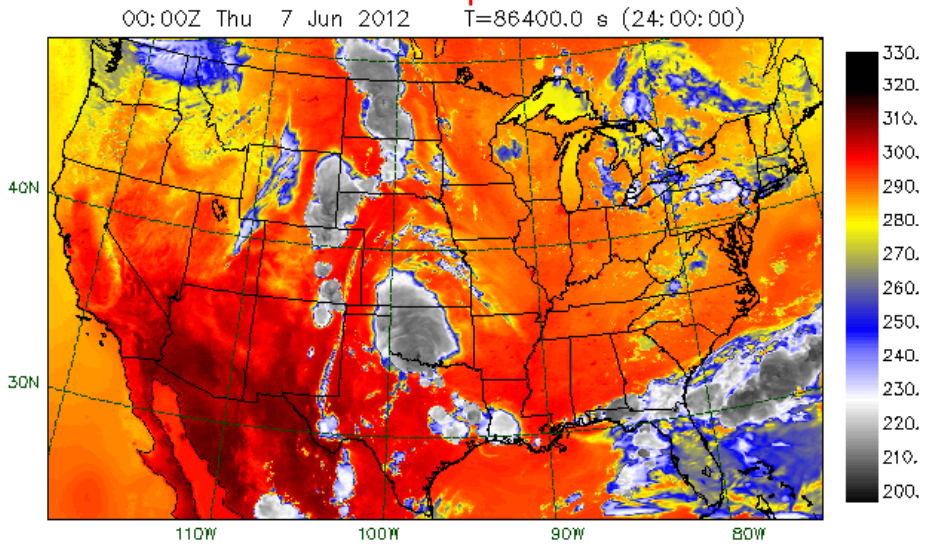
Probability of 10.7 μm BT≤ -32C
(TS Beryl -- 00 UTC May 27 initiation)



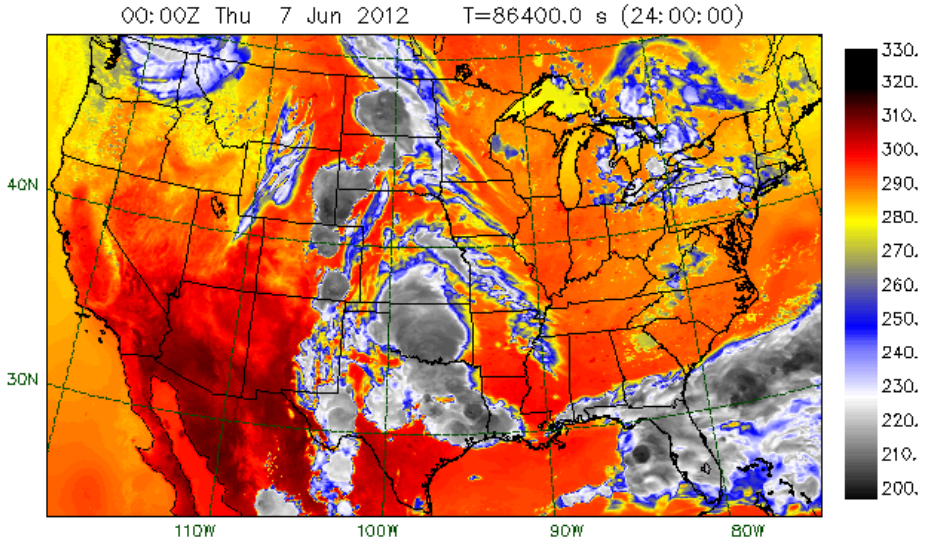
Simulated GOES-13 10.7μm BT products

(24 h forecast valid 6/7/2012 00 UTC)

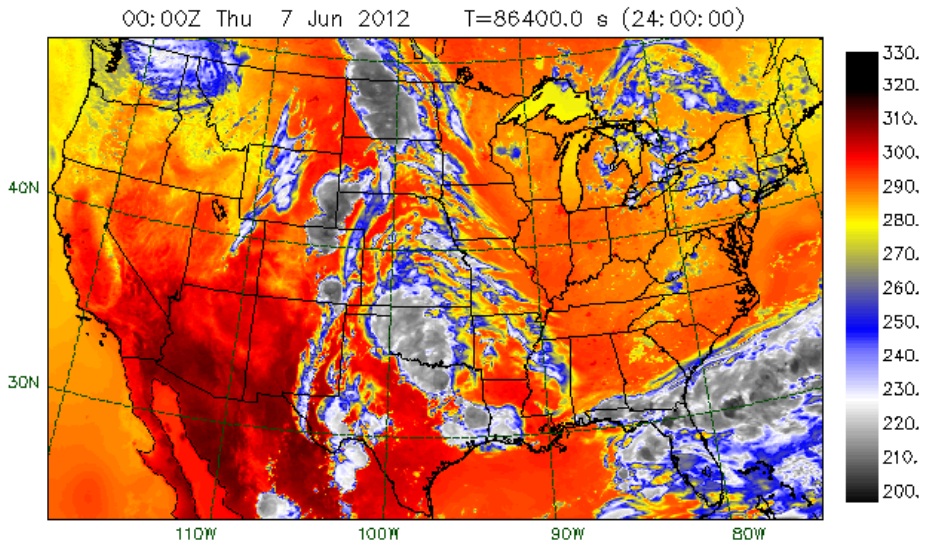
Thompson



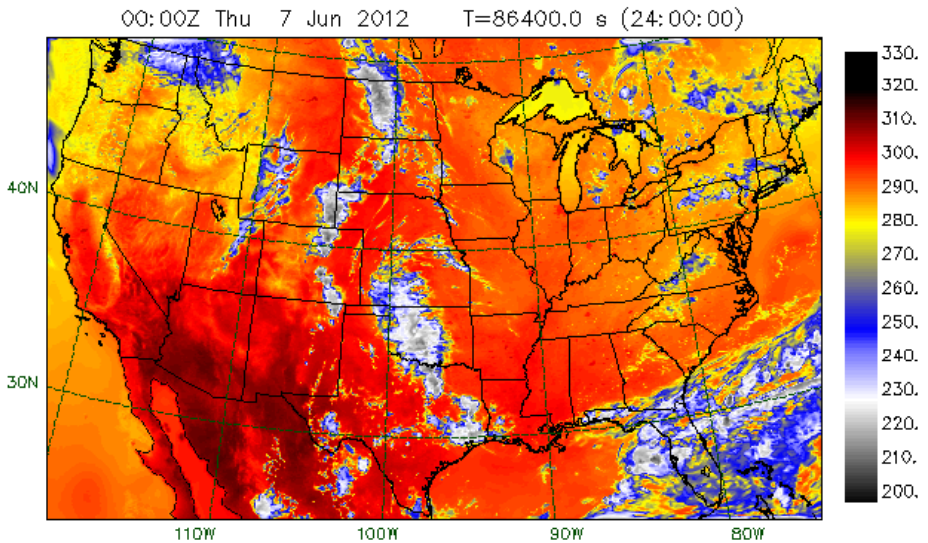
Milbrandt-Yau



Morrison



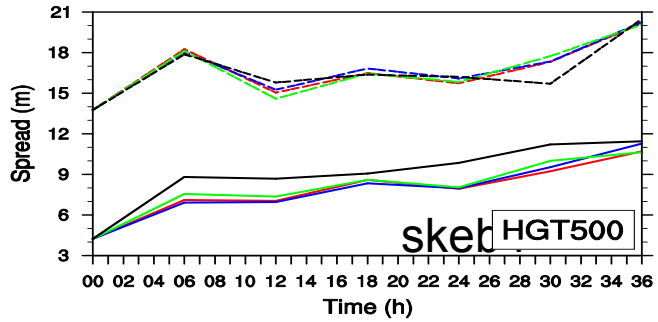
WDM6



SKEB impact at storm-scale

- SKEB1: 5-member sub-ensemble with SKEB **default** perturbation turned on
  (arw_m19 ~ arw_m23)
- SKEB2, SKEB4: 2x, 4x default perturbation amplitude
- NOSKEB: 5-member without SKEB
  (arw_cn, arw_m3, arw_m6, arw_m8, arw_m10)
- Ensemble spread and mean rmse evaluated for the case of June 7, 2012

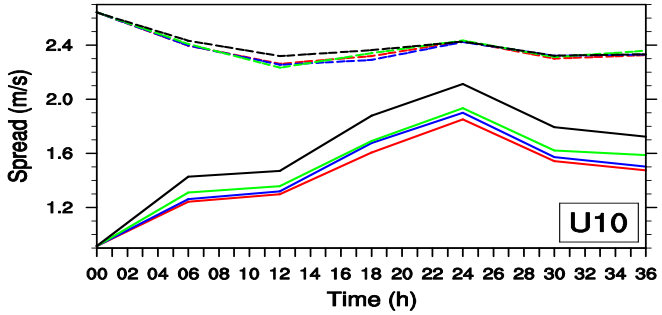
500 hPa height



rmse

spread

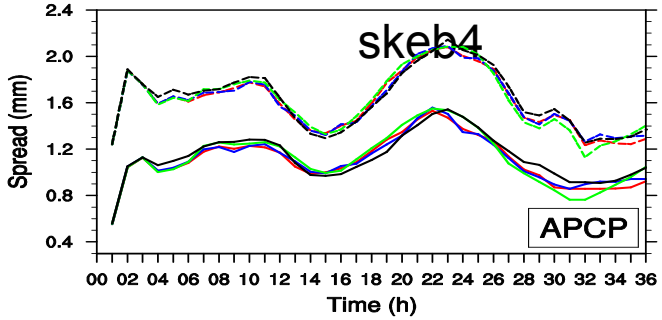
10-m U



rmse

spread

1-h acc. precipitation



rmse

spread

Poster P87 (Zhu et al.)

Thanks!