GSD
EMC

GSD-EMC RAPv4/HRRRv3 Package Description and Stats

31 May 2017

Curtis Alexander, Stan Benjamin, Steve Weygandt, David Dowell, Terra Ladwig, Ming Hu, Tanya Smirnova, Joseph Olson, Jaymes Kenyon, Georg Grell, Trevor Alcott, Isidora Jankov, Eric James, Haidao Lin, and John Brown

NOAA/ESRL/GLOBAL SYSTEMS DIVISION

Geoff Manikin, Corey Guastini, Ben Blake
NOAA/NCEP/EMC

RAP/HRRR: Hourly-Updating Weather Forecast Suite

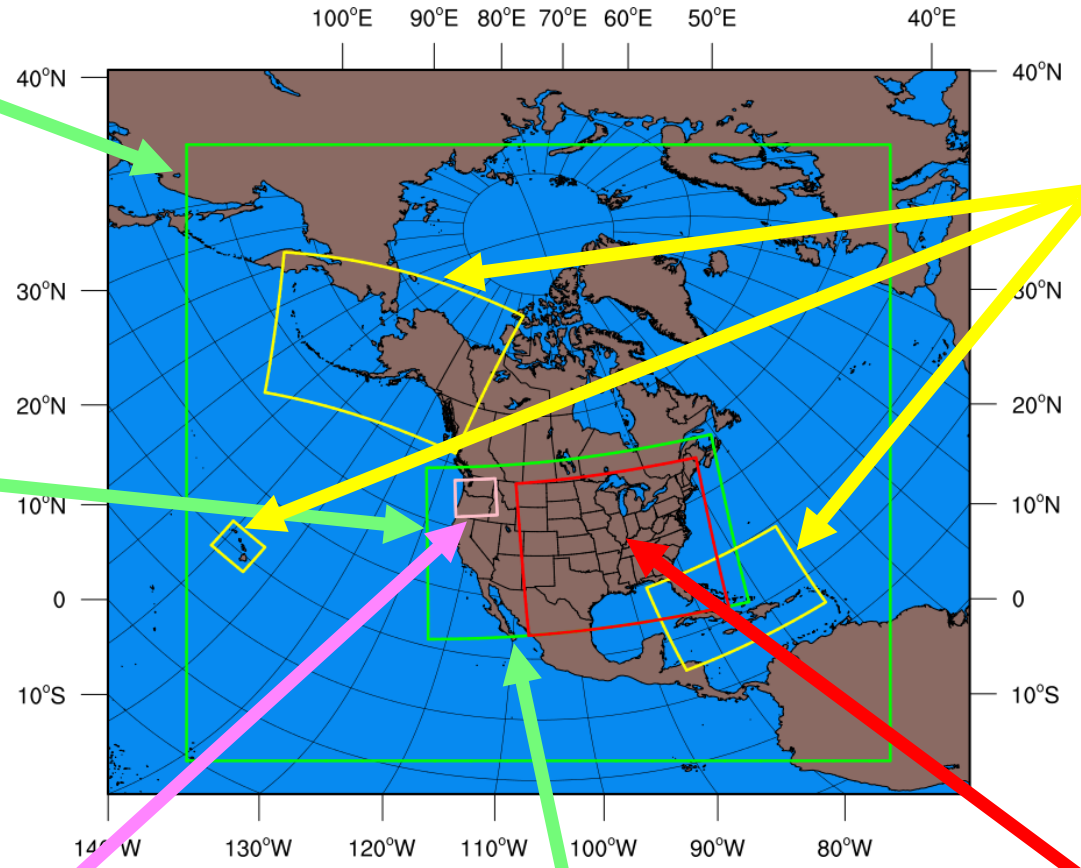
13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)

Initial & Lateral Boundary Conditions

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)

Initial & Lateral Boundary Conditions

750-m HRRR nest Wind Forecast Improvement Project Experiment (ongoing)



3-km High-Resolution Rapid Refresh Alaska, Hawaii and Puerto Rico Testing (HRRR-AK, HRRR-HI, HRRR-PR) Experimental (ongoing)

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km HRRR-Smoke (VIIRS fire data)

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)

RAPv4/HRRRv3 Change Highlights

	Model	Data Assimilation
RAPv4 (13 km)	WRF-ARW v3.8.1+ incl. physics changes ***Physics changes:*** Thompson microphysics – improved upper-level clouds GF Convective update – more optimal precip bias MYNN PBL update – better sub-grid clouds, meso env LSM update – 15” MODIS data – better lower boundary Refined roughness lengths over various land use types ***Numerics changes:*** Improved terrain (cell avg) – better winds /turbulence Hybrid vertical coordinate from NCAR – better meso env	Merge with GSI trunk – last updated in May 2017 ***New Observations for assimilation:*** AMVs over land and TAMDAR Add IASI, CrIS, SEVIRI radiances ***Assimilation Methods:*** Revised PBL pseudo-obs – reduce RH bias More ensemble weight in hybrid DA (0.85/0.15) METAR and GOES cloud building now consistent Cloud num conc to cloud anx – more retention Reduced latent heating – improved precip bias
HRRRv3 (3 km)	WRF-ARW v3.8.1+ incl. physics changes ***Physics changes:*** Thompson microphysics – improved upper-level clouds MYNN PBL update – better sub-grid clouds, meso env LSM update – 15” MODIS data – better lower boundary Refined roughness lengths over various land use types ***Numerics changes:*** Hybrid vertical coordinate from NCAR – better meso env	***New Observations for assimilation:*** AMVs over land and TAMDAR Radar radial velocity and lightning ***Assimilation Methods:*** Revised PBL pseudo-obs – reduce RH bias More ensemble weight in hybrid DA (0.85/0.15) METAR and GOES cloud building now consistent Cloud num conc to cloud anx – more retention

QUICK TIMELINE

- Code delivery to EMC in ~3 weeks
- Evaluation period late August – early October (led by MEG)
- October code delivery to NCO
- Implementation in February 2018
- Working to NCO to determine how to effectively run hourly, high-resource EMC parallels

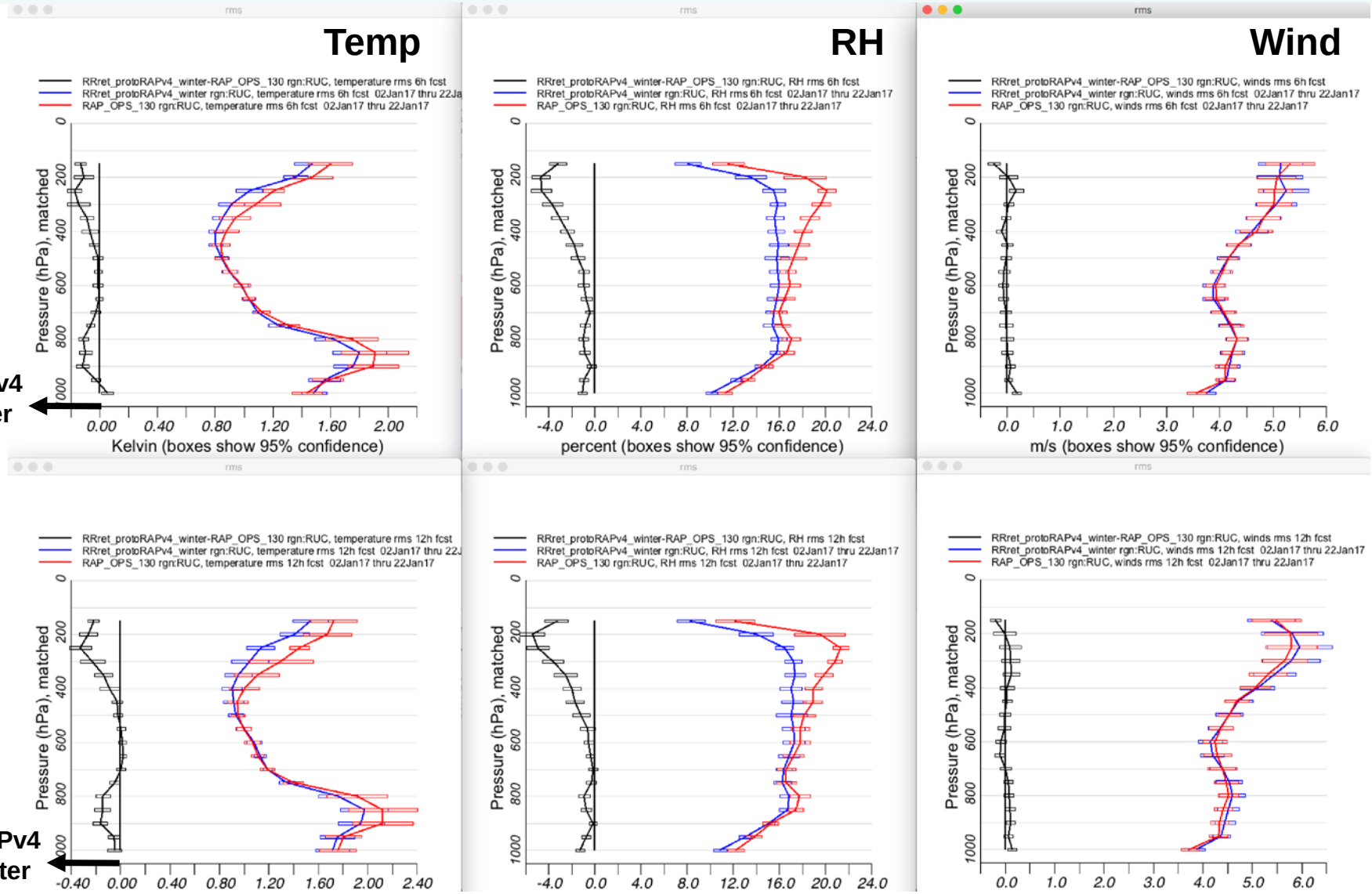
RAP RMSE Upper-Air Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

12 hr

RAPv4 better

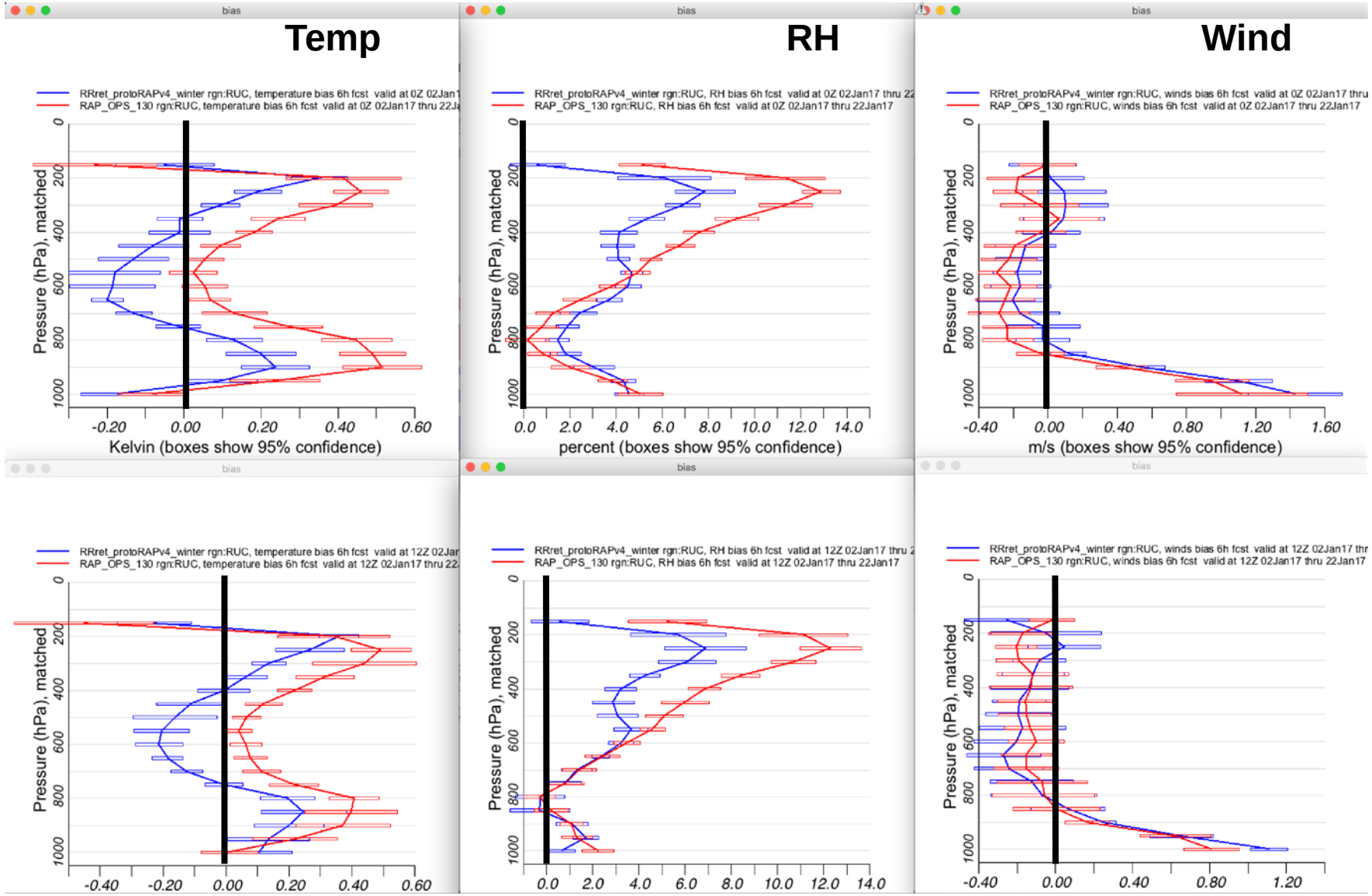


RAP BIAS Upper-Air Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
6 hr fcsts

00 UTC

12 UTC

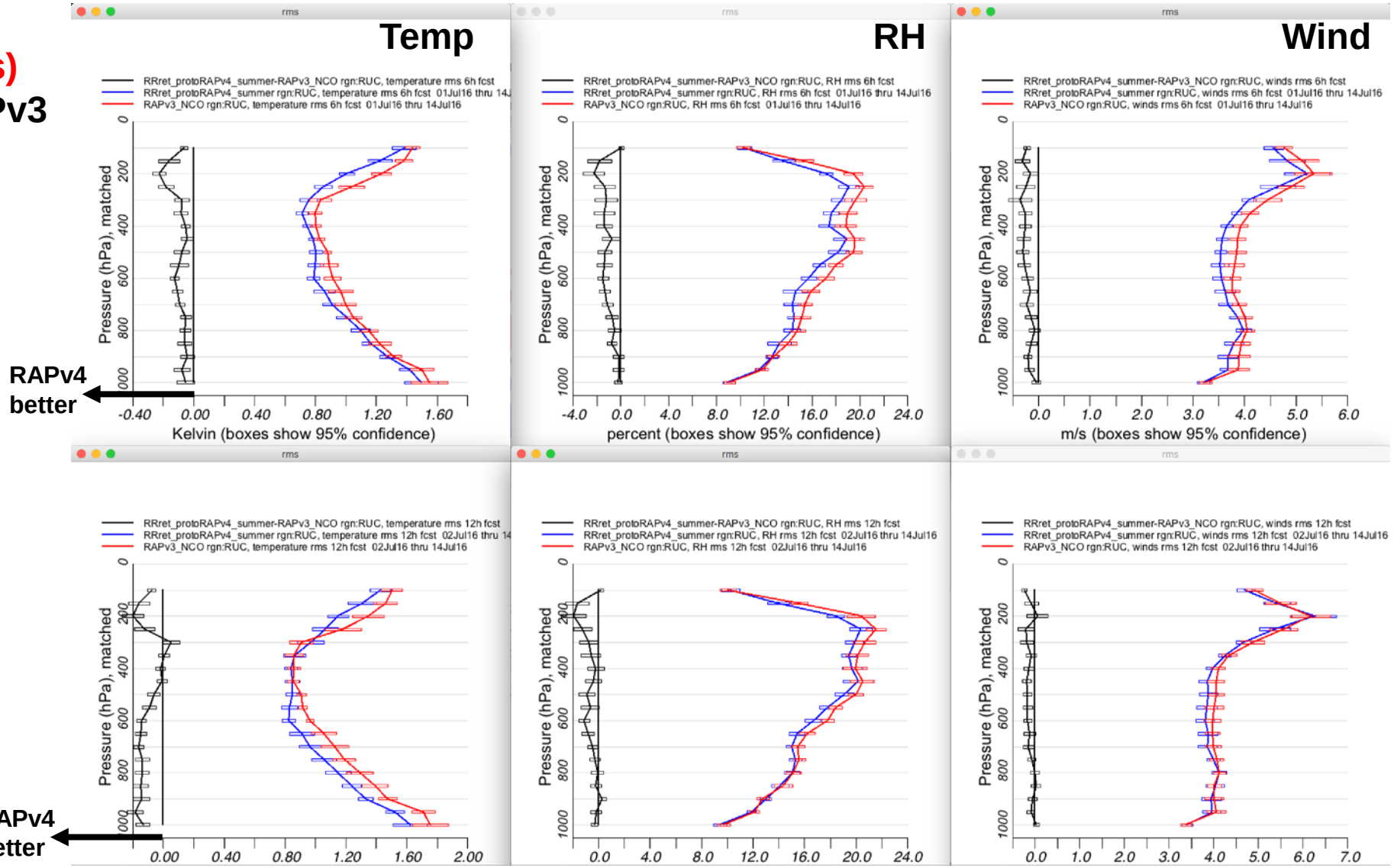


RAP RMSE Upper-Air Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

12 hr

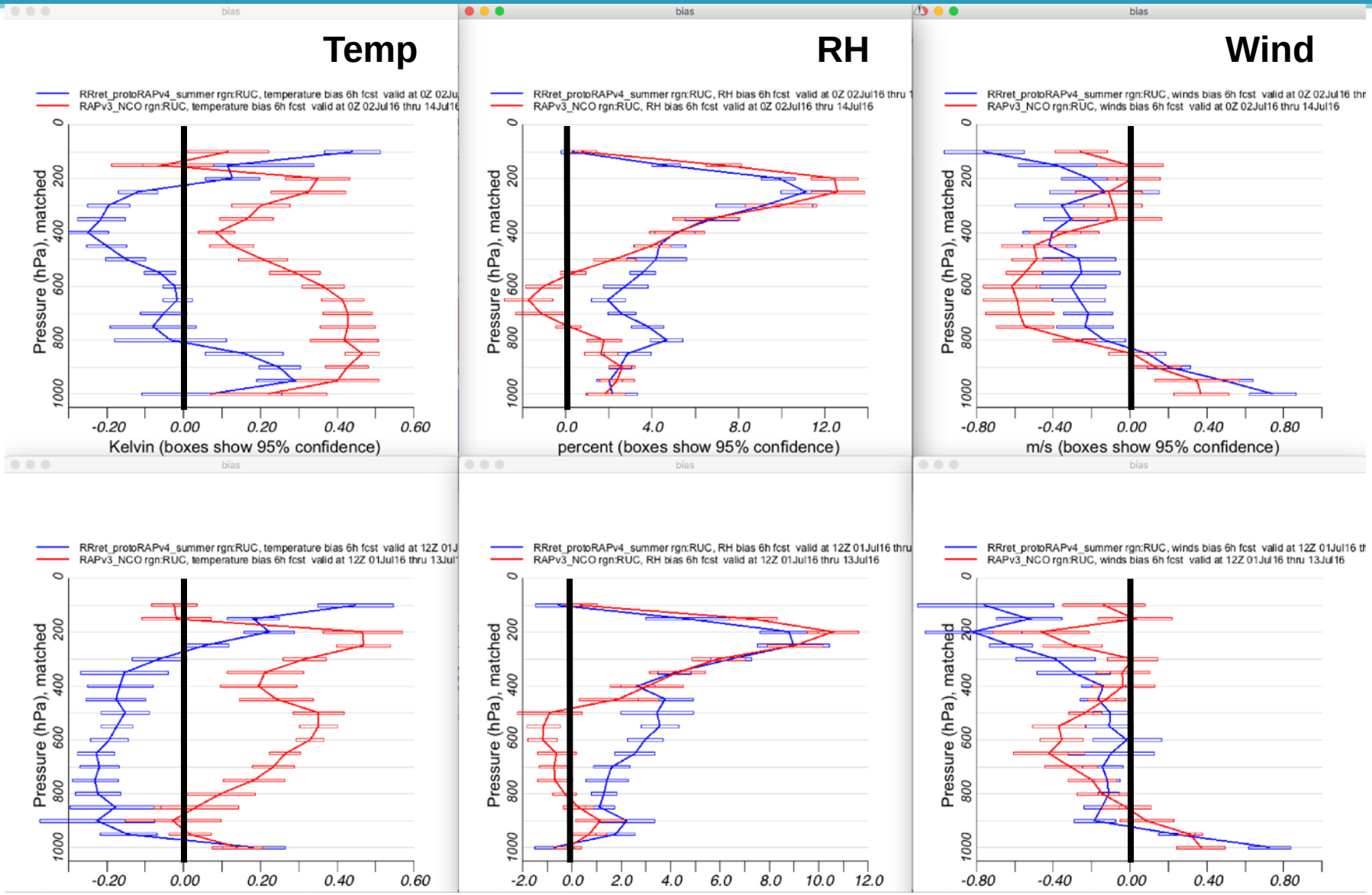


RAP BIAS Upper-Air Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)
6 hr fcsts

00 UTC

12 UTC

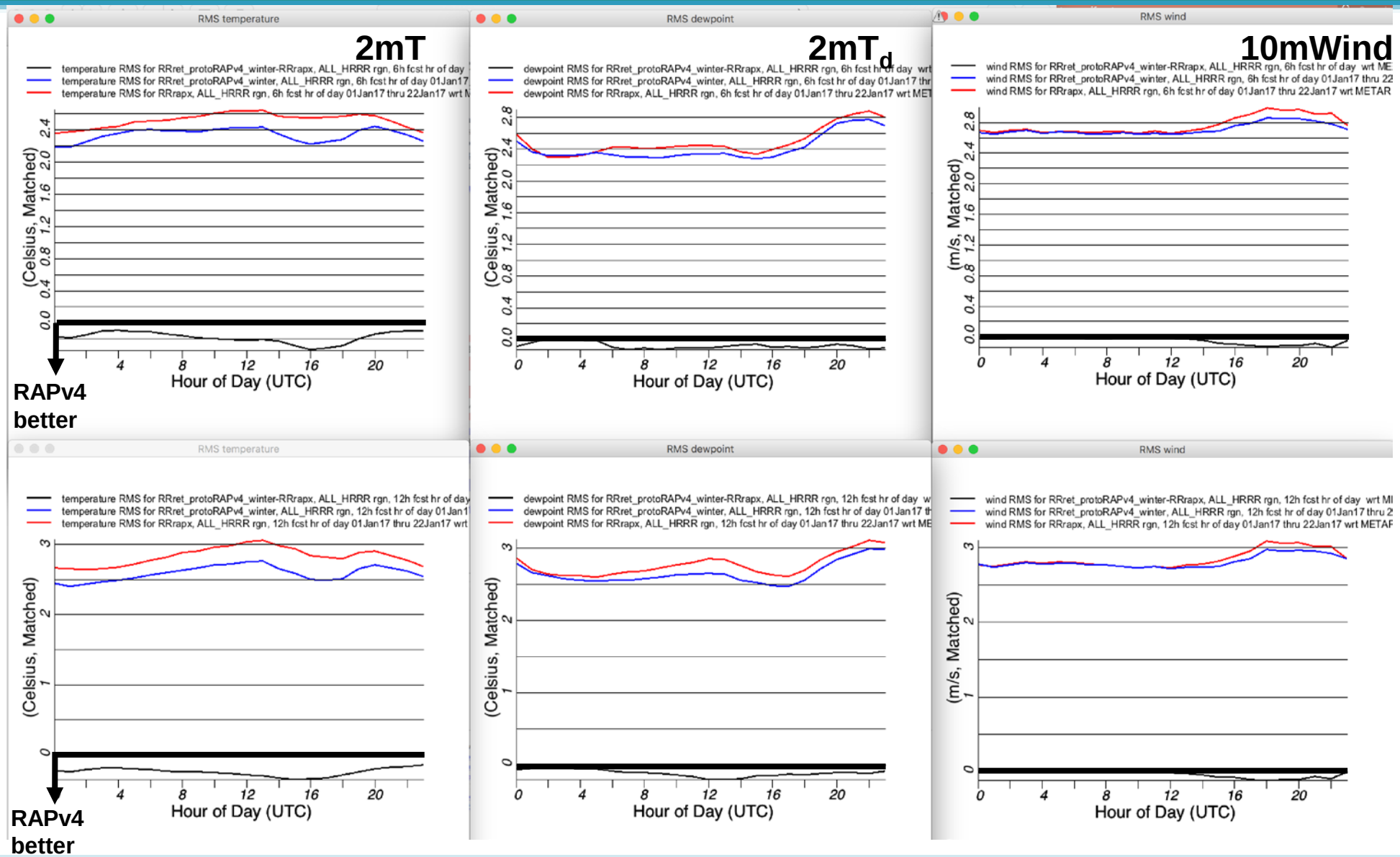


RAP RMSE Surface Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

12 hr

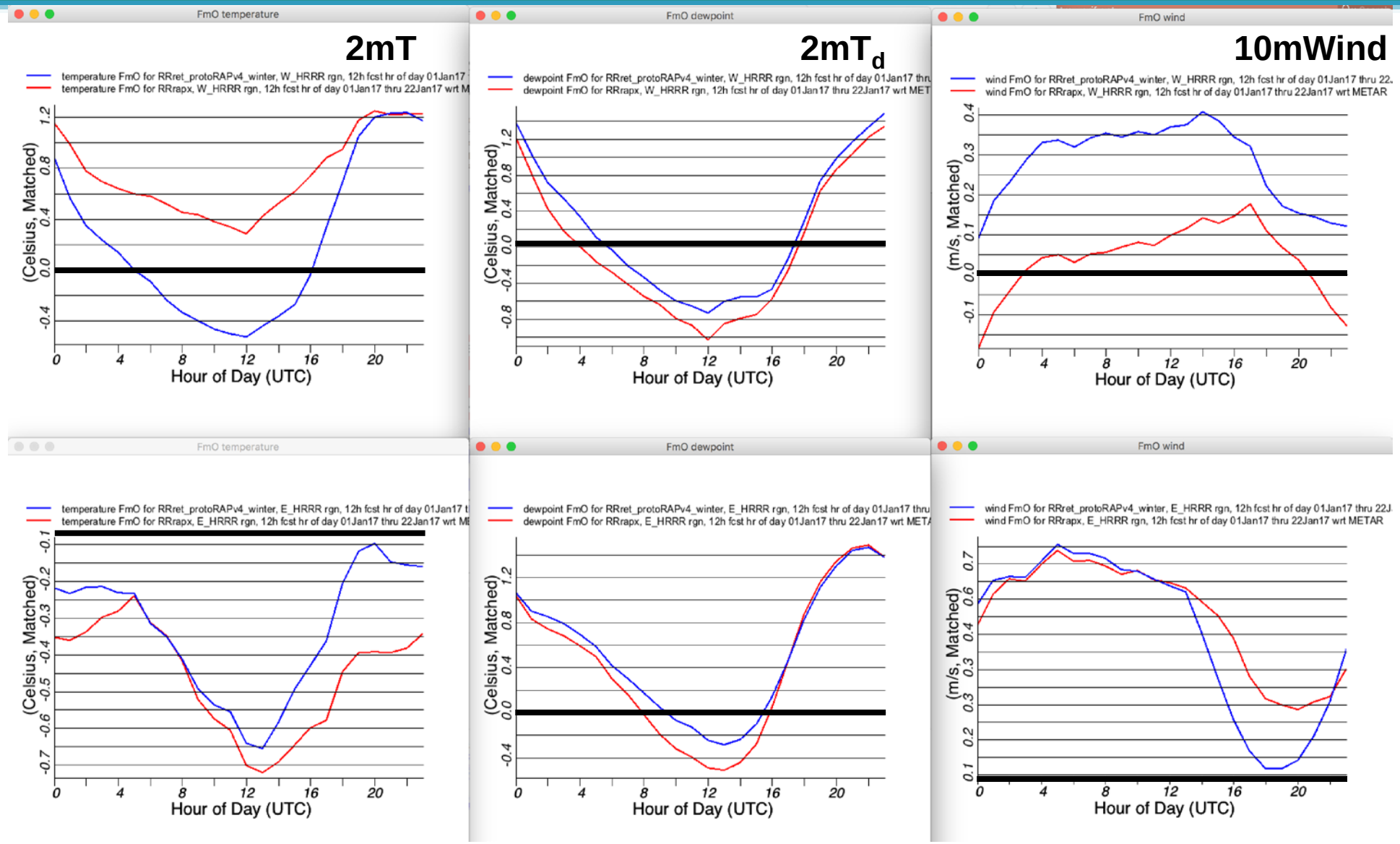


RAP BIAS Surface Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
12 hr fcsts

West US

East US

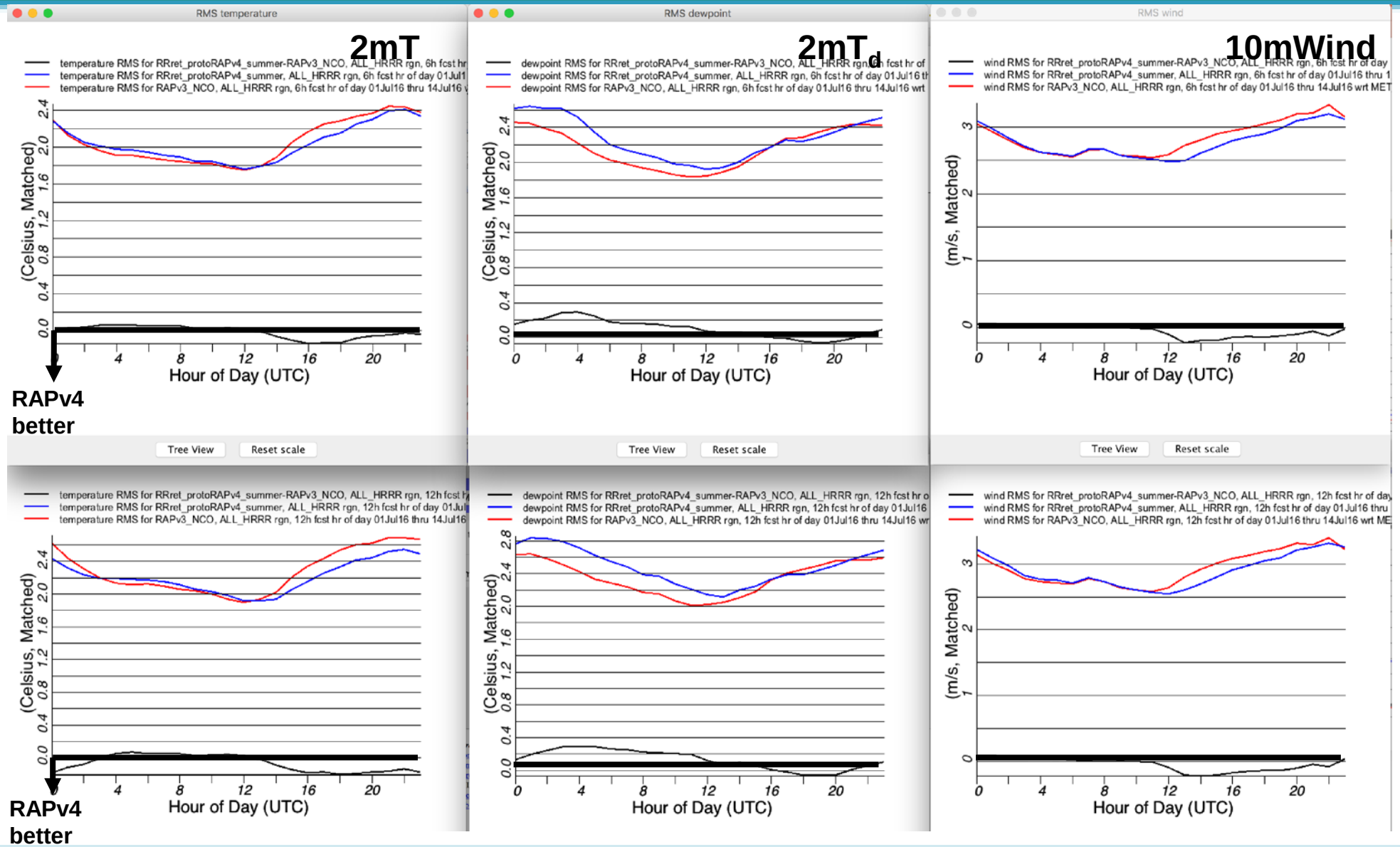


RAP RMSE Surface Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

12 hr

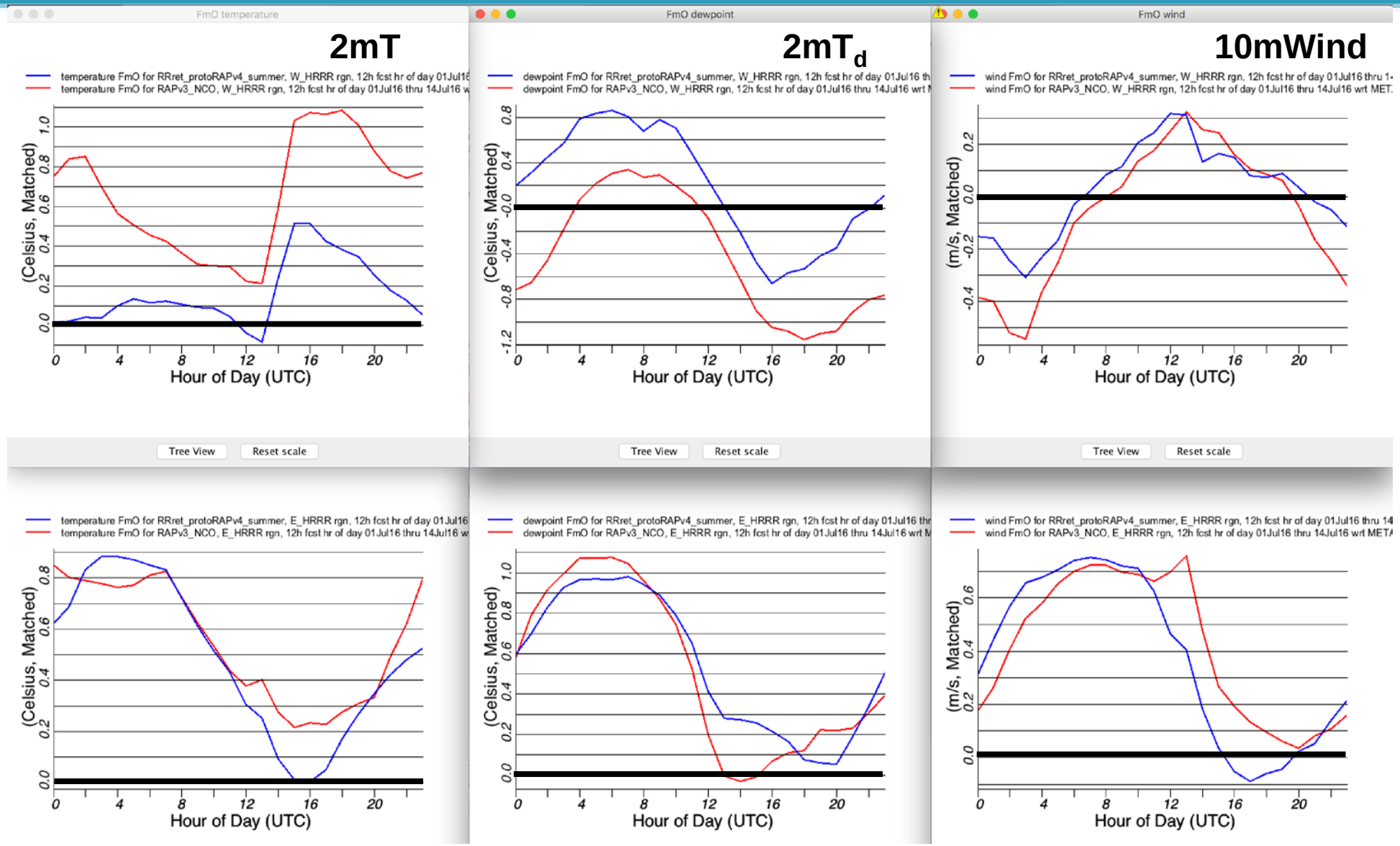


RAP BIAS Surface Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)
12 hr fcsts

West US

East US

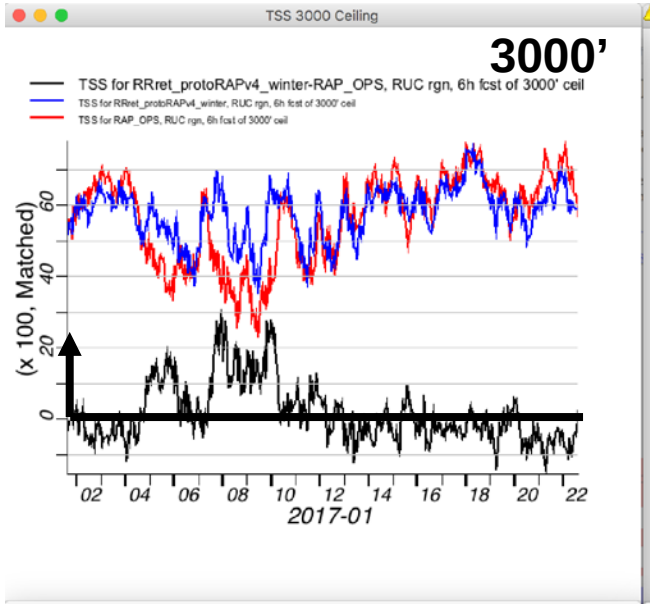


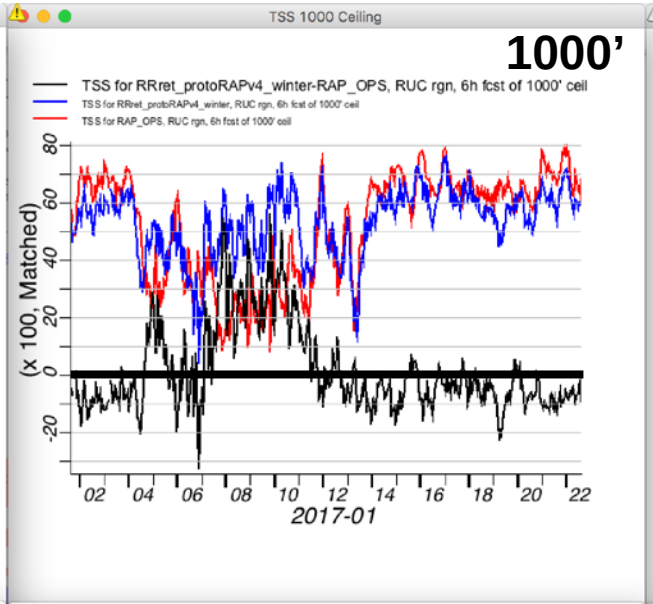
RAP TSS Ceiling Winter (Three Weeks Jan 2017)

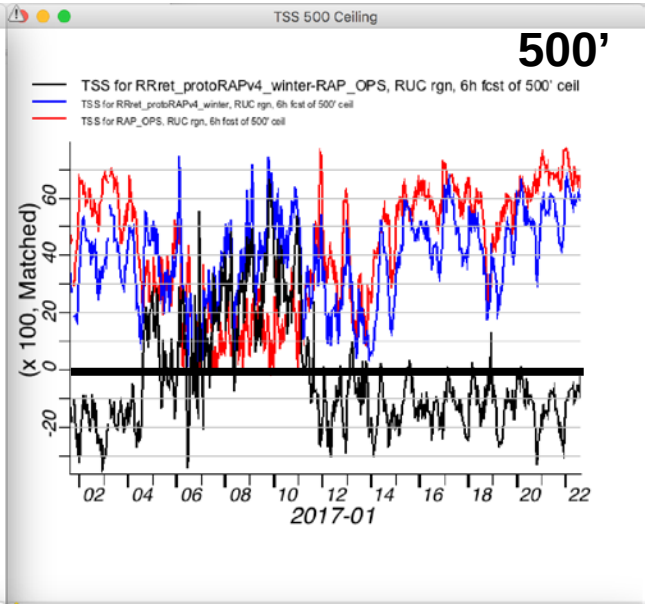
RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

RAPv4 better

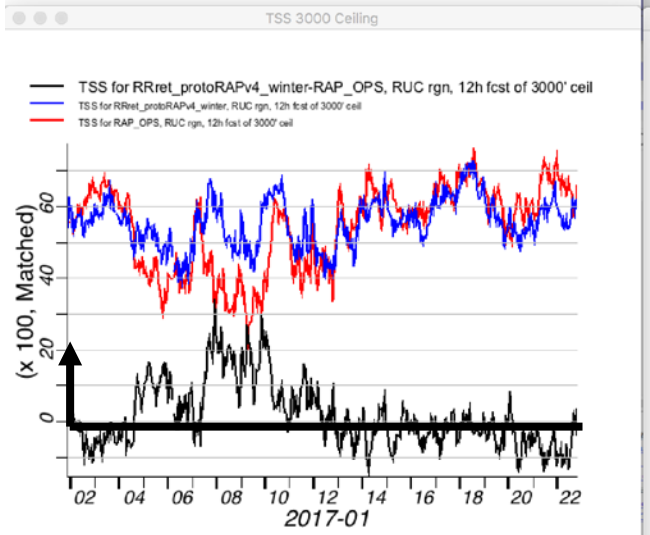


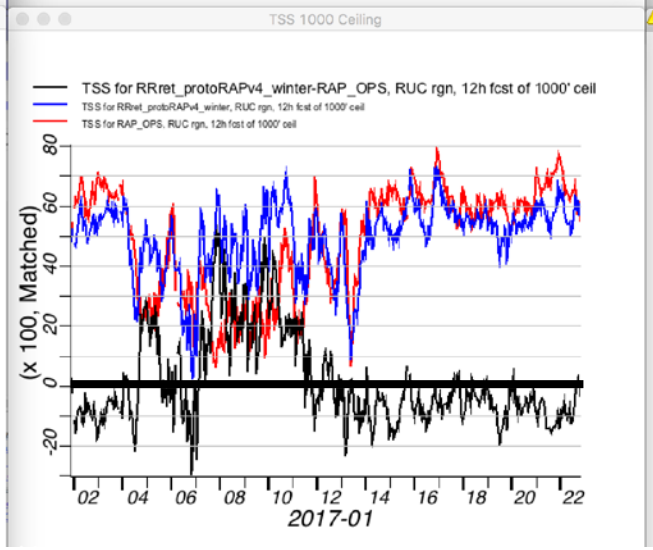


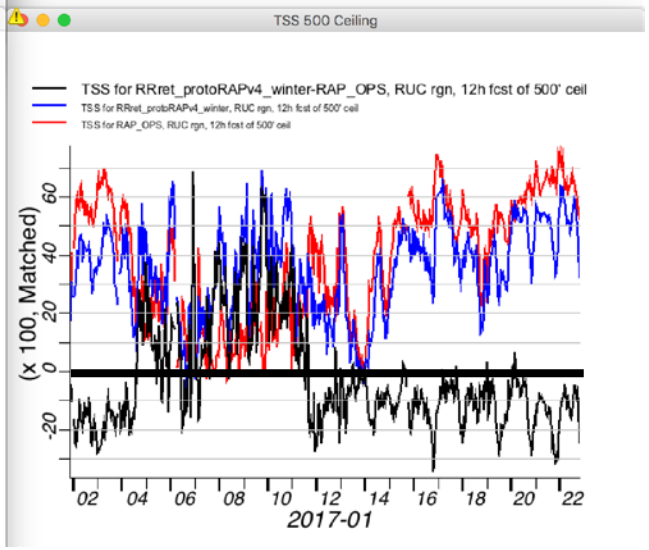


12 hr

RAPv4 better





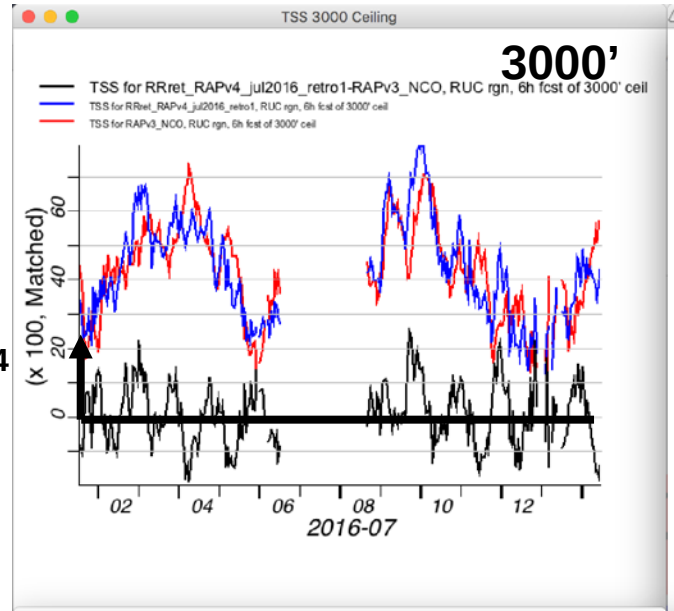


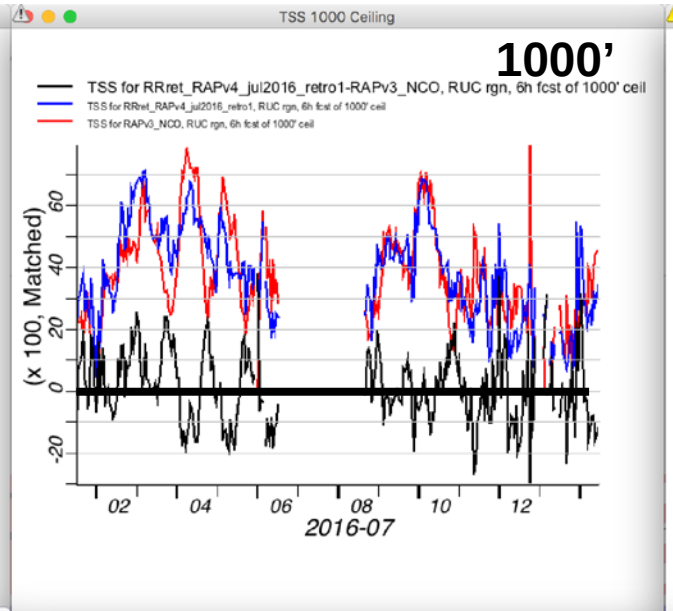
RAP TSS Ceiling Summer (Three Weeks Jul 2016)

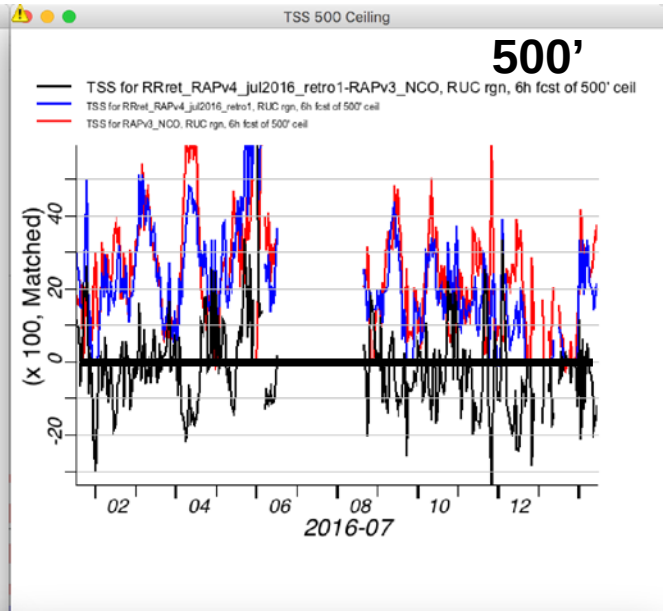
RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

RAPv4 better

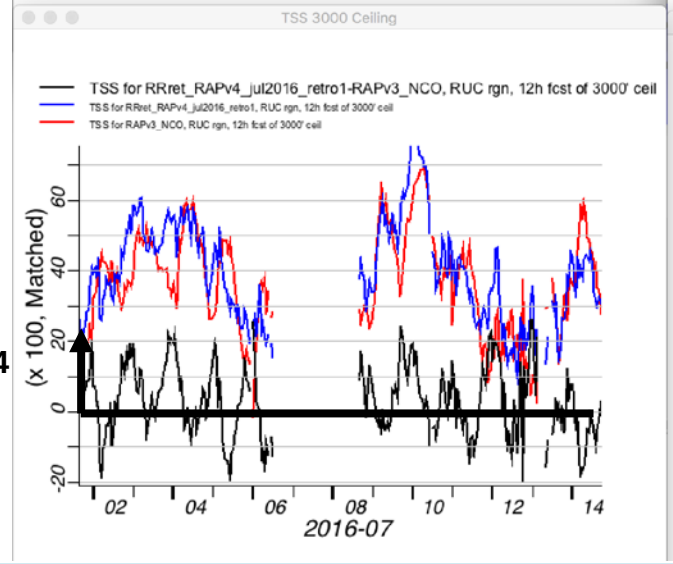


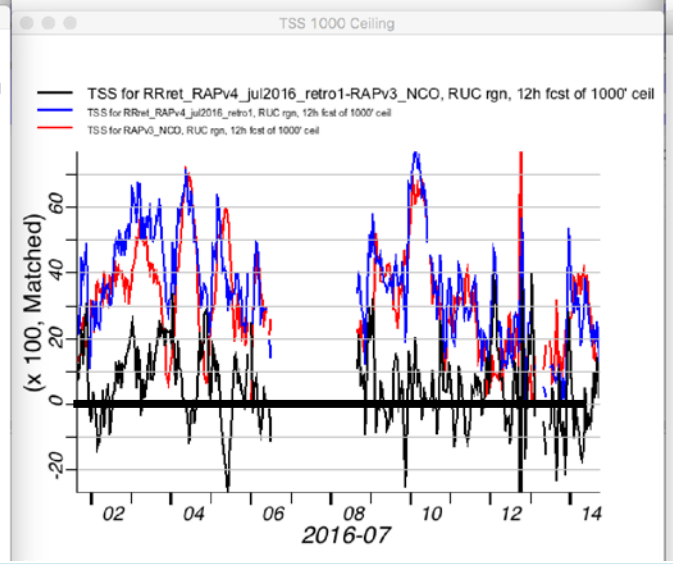


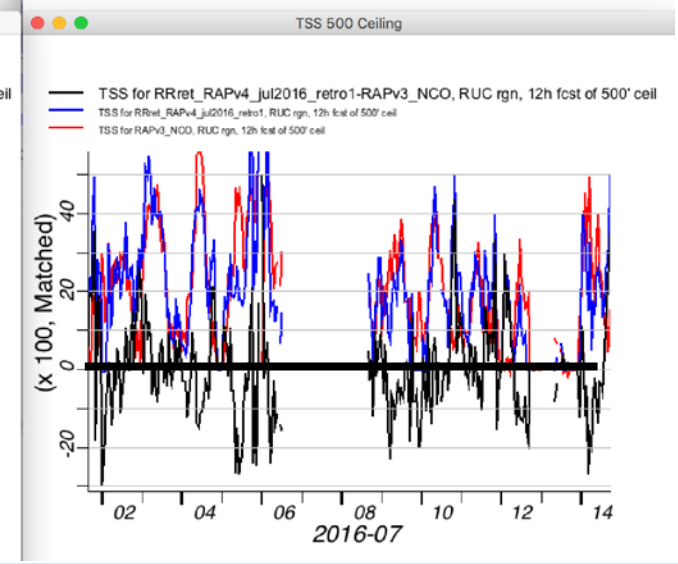


12 hr

RAPv4 better





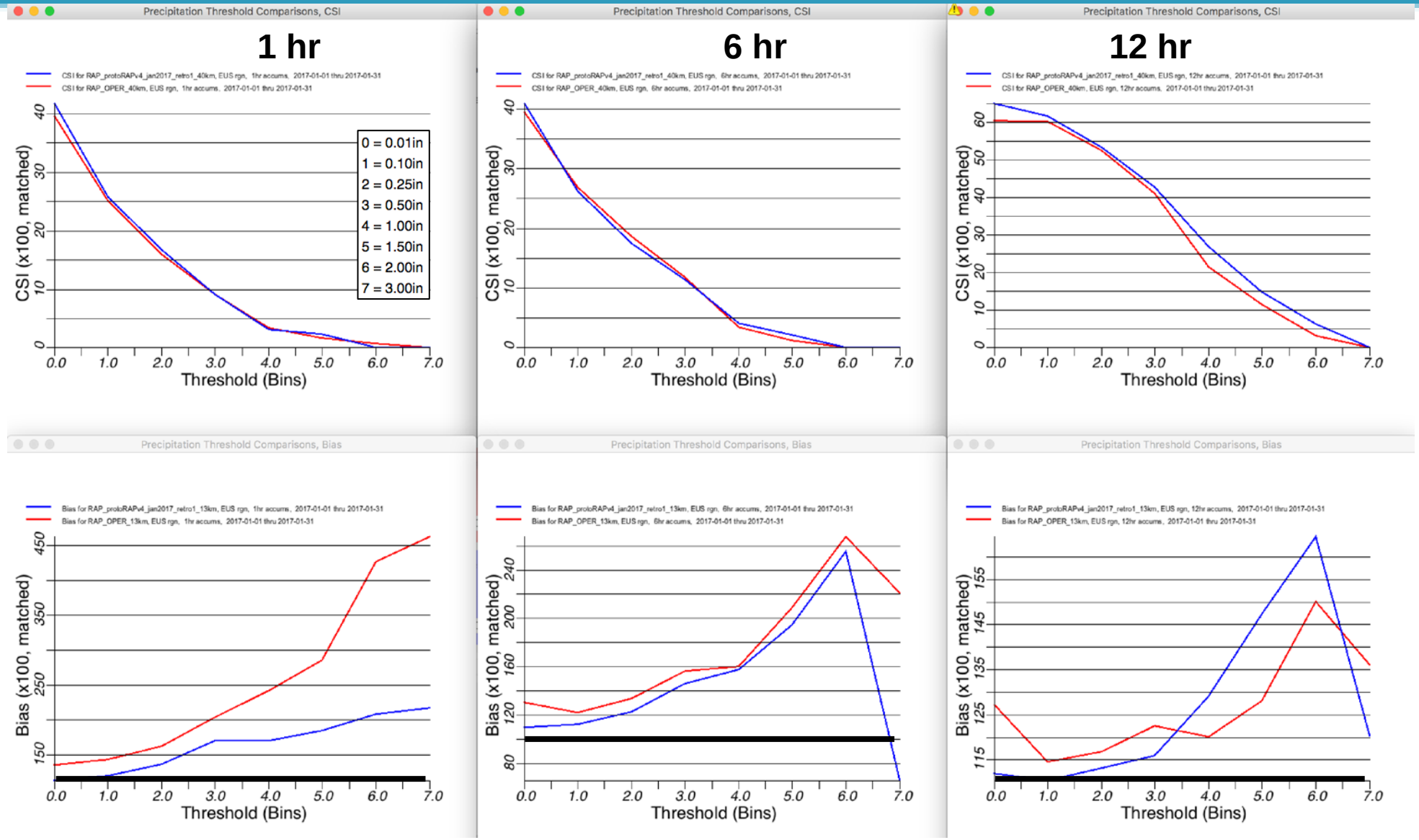


RAP CSI/BIAS Precipitation Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)

CSI
40 km

BIAS
13 km

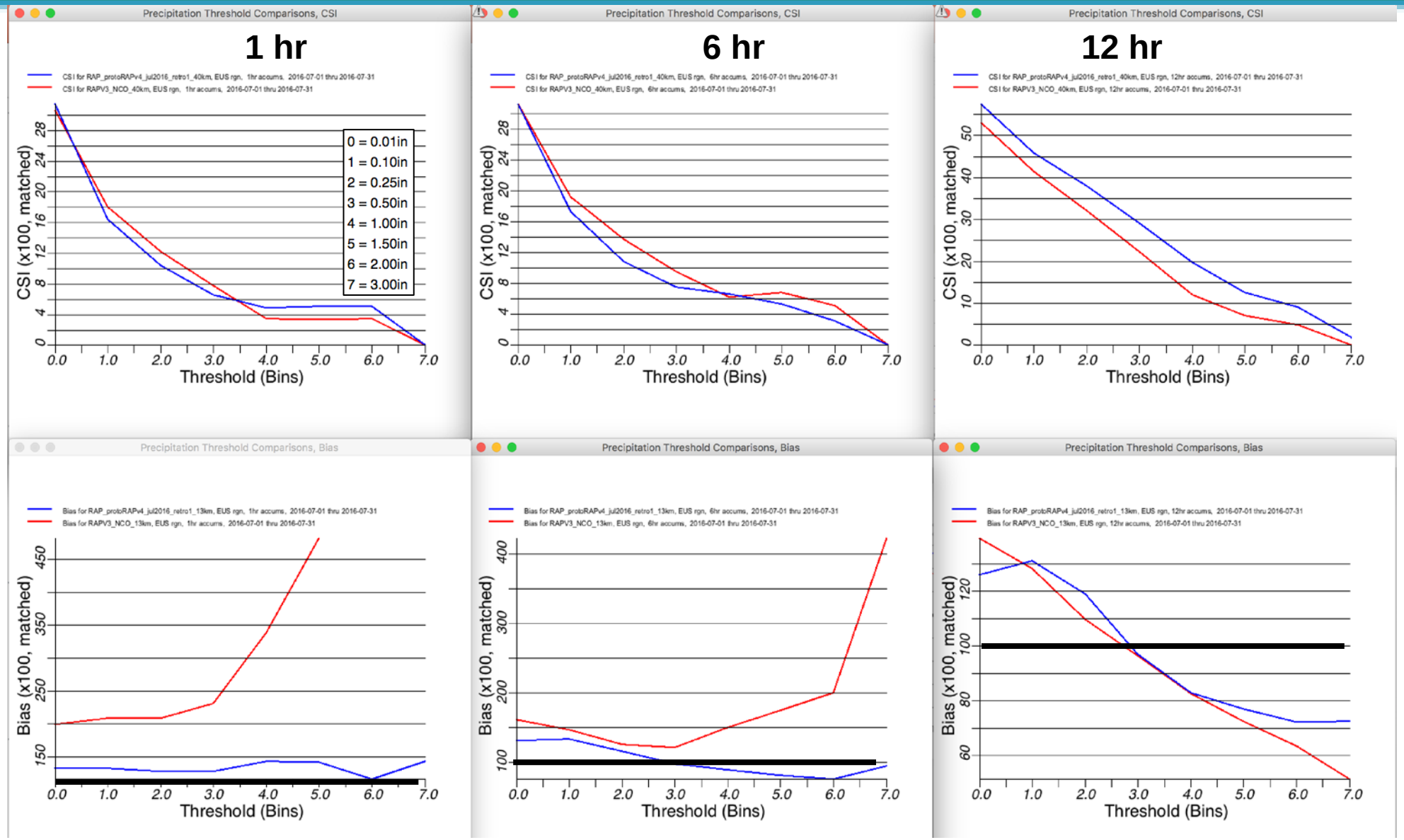


RAP CSI/BIAS Precipitation Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)

CSI
40 km

BIAS
13 km

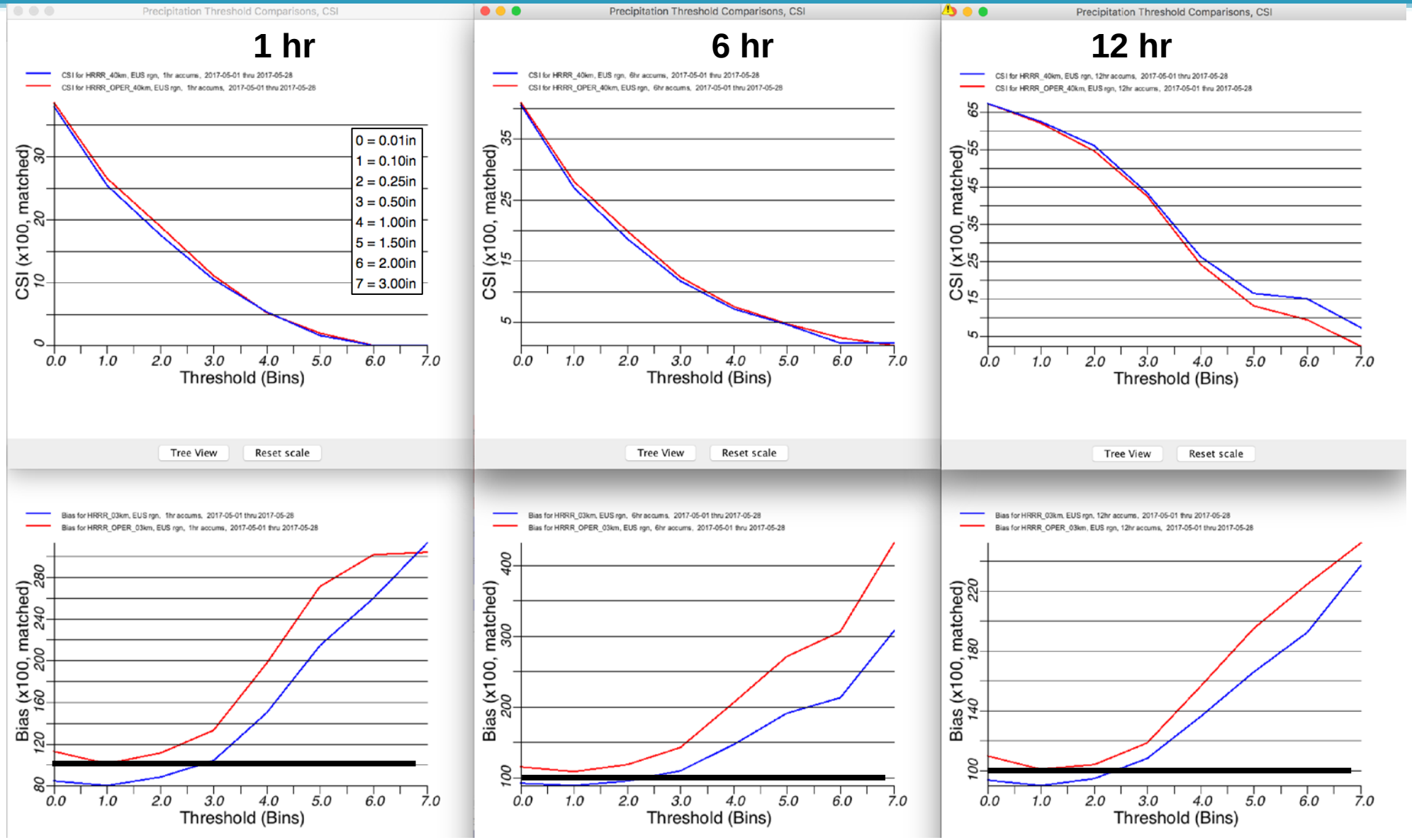


HRRR CSI/BIAS Precipitation Spring (Three Weeks May 2017)

HRRRv3
HRRRv2 (ops)

CSI
40 km

BIAS
3 km

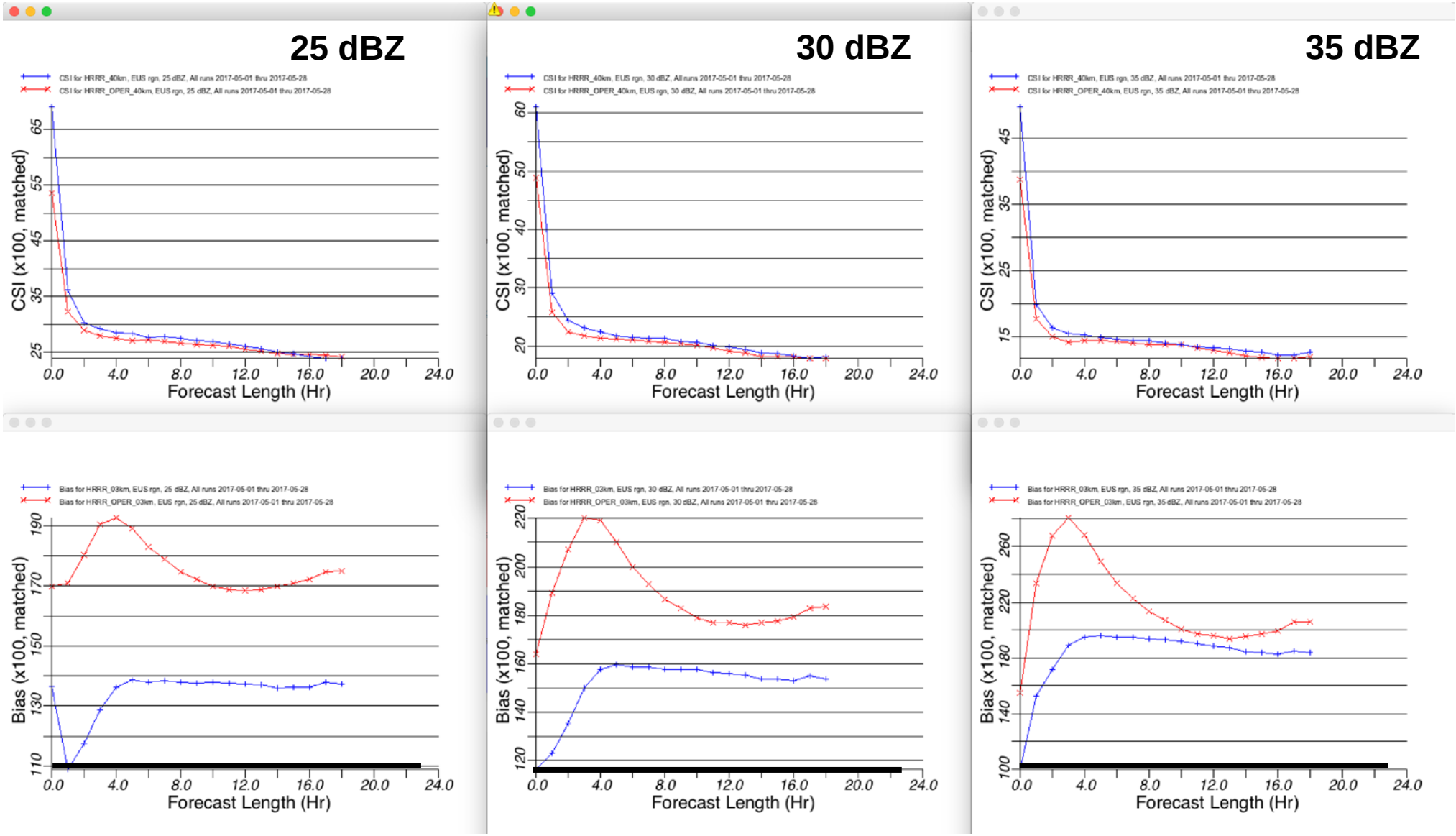


HRRR CSI/BIAS Reflectivity Spring (Three Weeks May 2017)

HRRRv3
HRRRv2 (ops)

CSI
40 km

BIAS
3 km

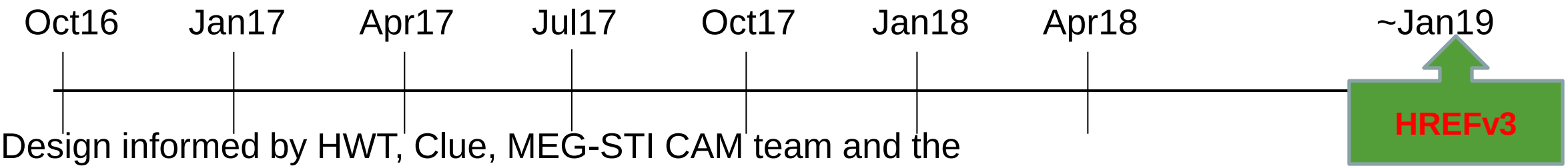


EXTENSION of RUNS

- Plan to extend HRRR CONUS 00,06,12,18z cycles to 36 hr
  * assist with day 2 forecasts
  * possible inclusion in HREFv3

- Need to extend RAP 03,09,15,21z cycles to 39 hr to provide boundary conditions

HREFv3 ~January 2019



- Design informed by HWT, Clue, MEG-STI CAM team and the newly formed SIP working group on CAMs
- Starting with FV3 runs for 2017 HWT Spring Program, continued development & refinement by EMC & community produces candidate FV3 with appropriate performance characteristics at convective-allowing scales
- Database of parallel/retro runs of candidate FV3 are collected along with HREFv2 components and extended HRRR runs
- Evidence is examined to determine best performing HREFv3 configuration
  - Complete replacement using FV3 [w/ stochastic] – this would be ideal solution and would subsume NAM nests and HiResWindow and **possibly HRRR**
  - Partial replacement of components [e.g. NMMB]
  - Additional component along with existing components
  - Additional members (if resources warrant) to eliminate time-lagged members

From G Dimego
Early 2017

ADD HRRR-AK

- Planning to add Alaska domain
- Frequency of cycles to be determined (every 3 hours?)
- Stats suggest improvement to visibility/ceiling forecasts, which are critical in that region
- Need to demonstrate that these more frequent HRRR runs would add value to existing 3 km NAM runs
- Potential benefits to RTMA/URMA first guess

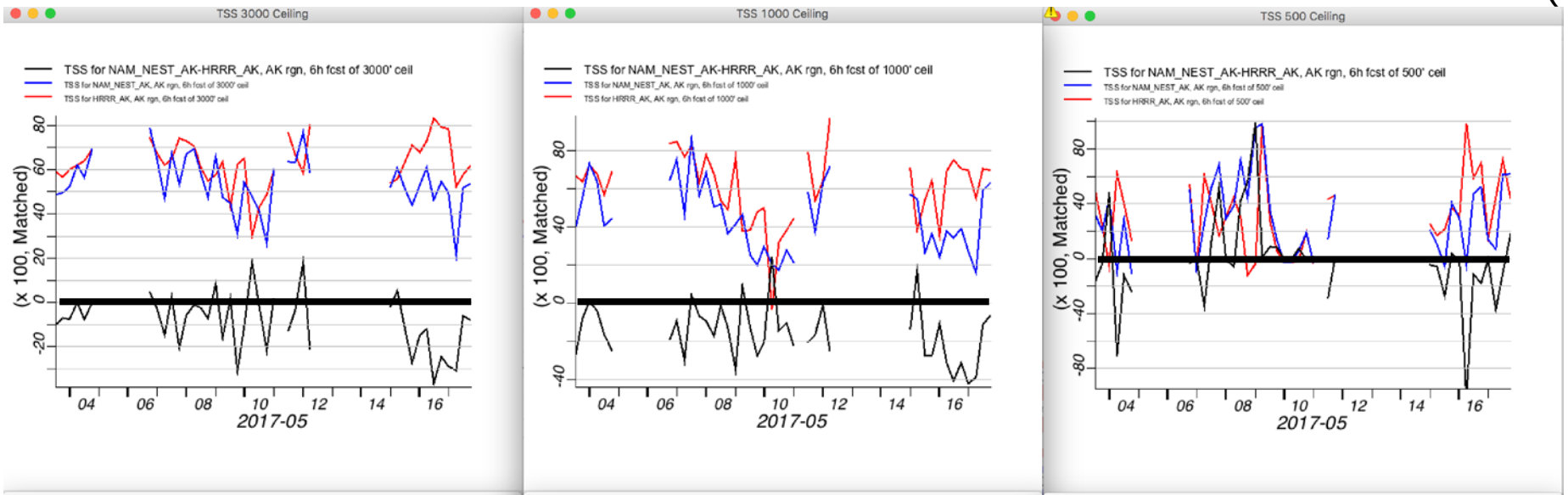
Ceiling (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

NAM-AK
HRRR-AK
NAM-HRRR

3000’ 1000’ 500’ (rare)

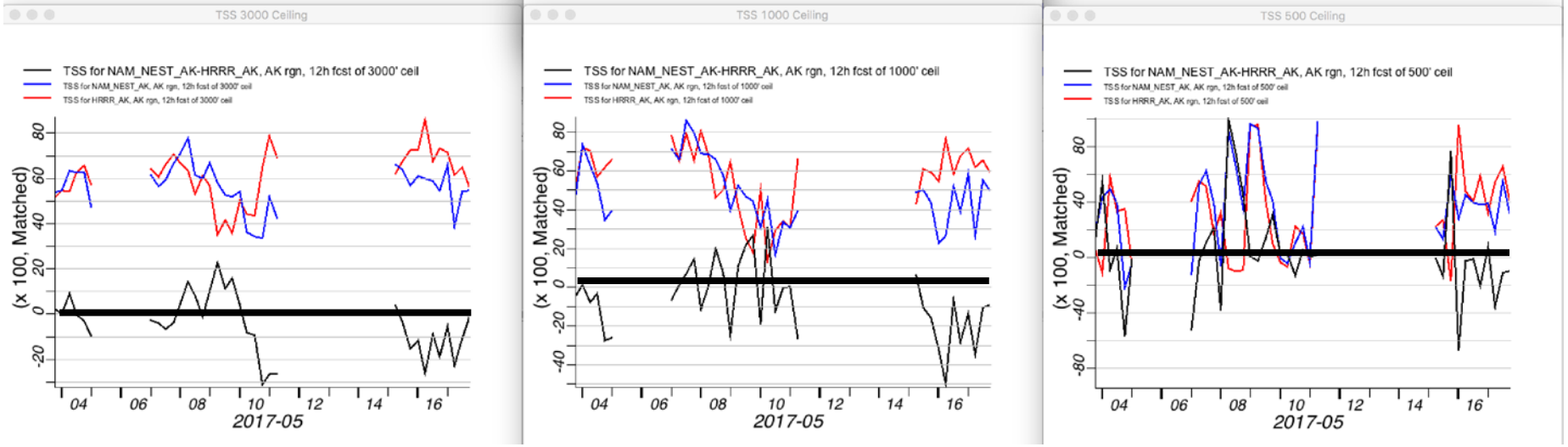
6 hr

HRRR better



12 hr

HRRR better

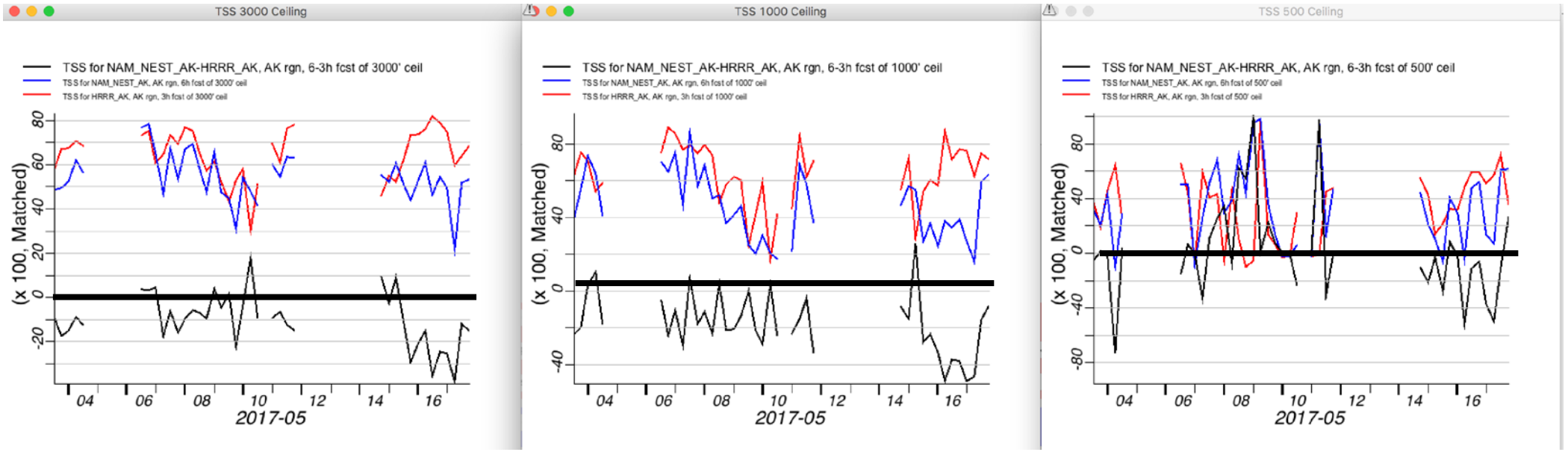


Ceiling (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

NAM-AK (6 hr)
HRRR-AK (3 hr)
NAM-HRRR

3000’ 1000’ 500’ (rare)

HRRR better



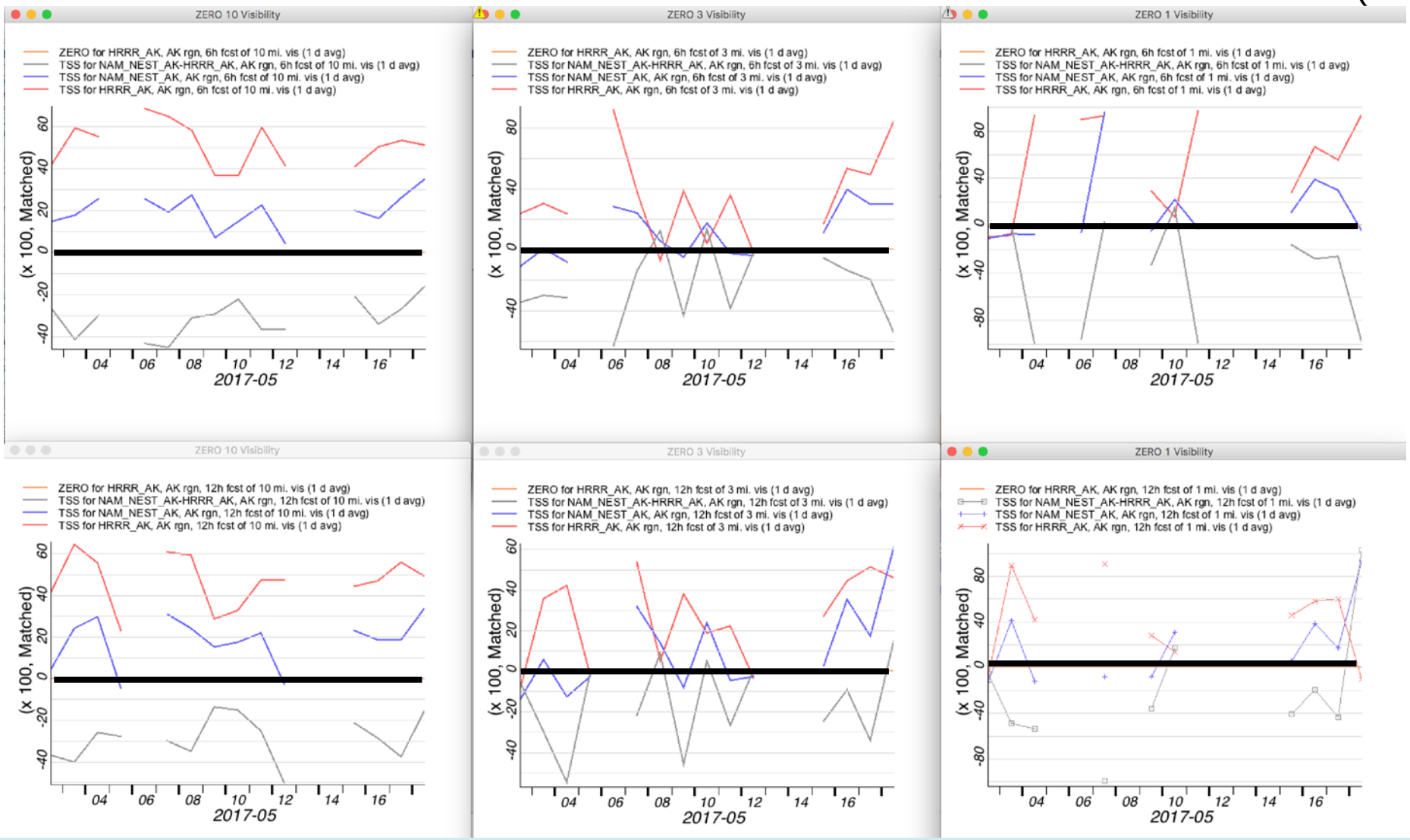
Visibility (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

NAM-AK
HRRR-AK
NAM-HRRR

10 mi | 3 mi | 1 mi (rare)

6 hr

HRRR better



12 hr

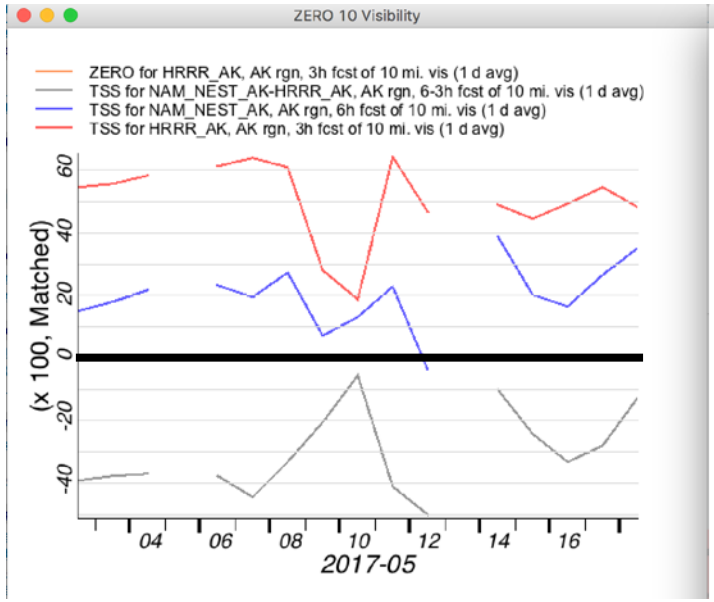
HRRR better

Visibility (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

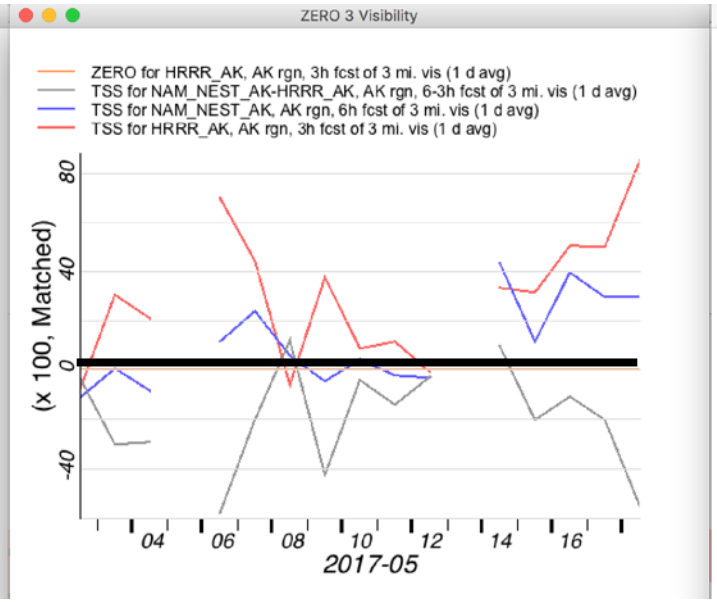
NAM-AK (6 hr)
HRRR-AK (3 hr)
NAM-HRRR

HRRR better

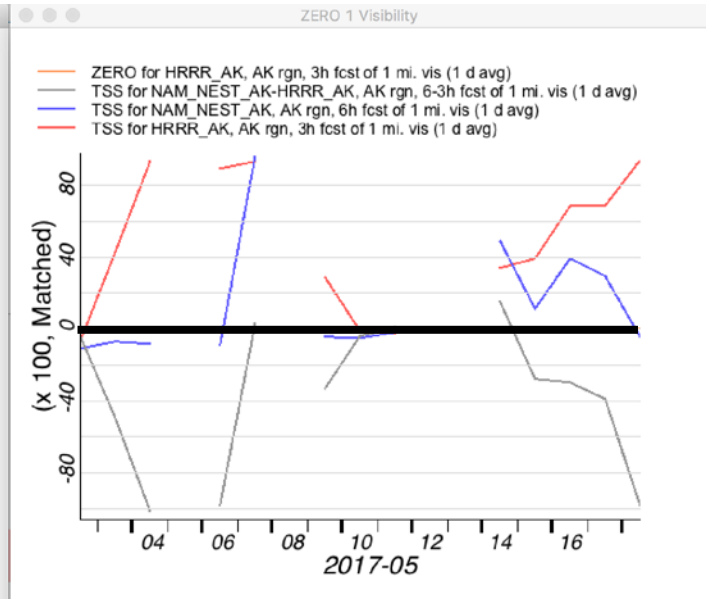
10 mi



3 mi



1 mi (rare)

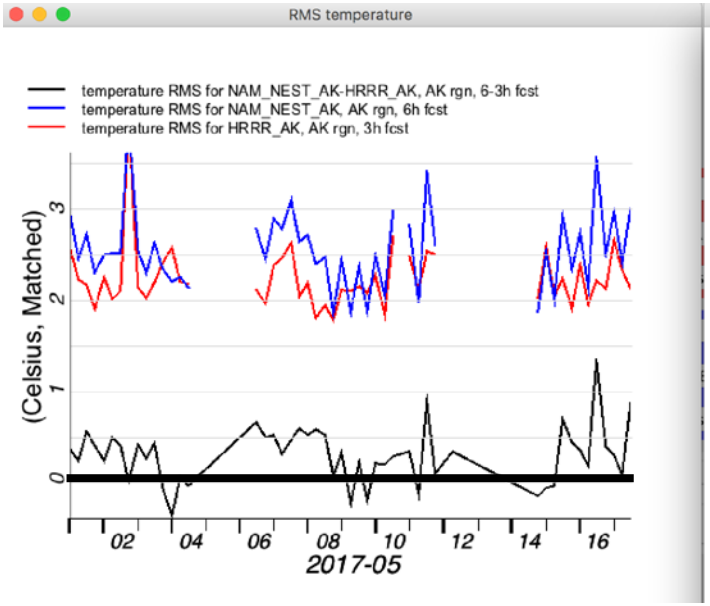


Surface (RMSE) HRRR-AK vs NAM-NEST-AK (two weeks)

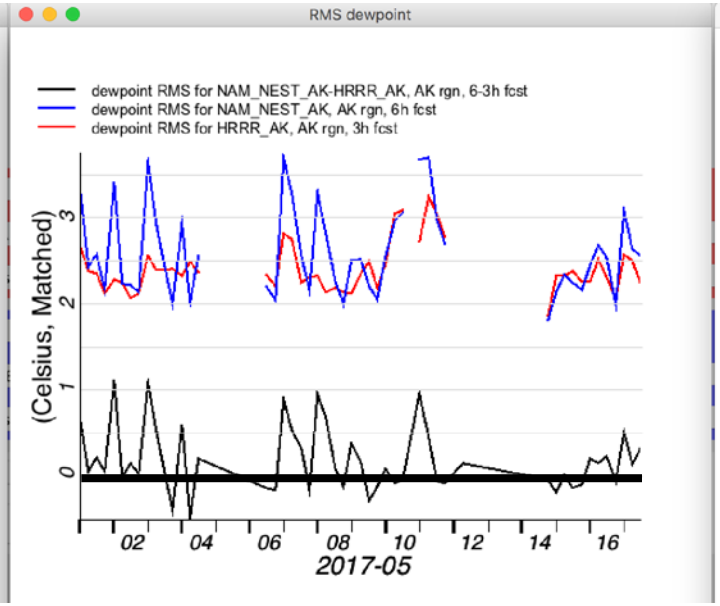
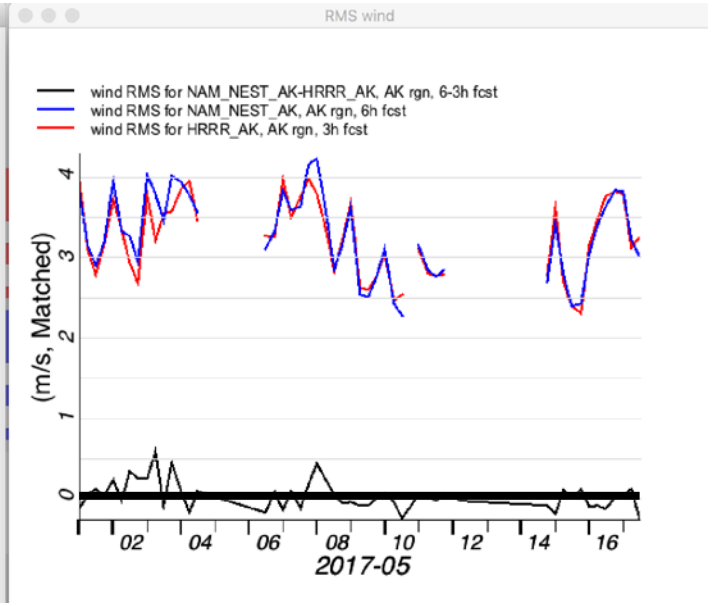
NAM-AK (6 hr)
HRRR-AK (3 hr)
NAM-HRRR

HRRR better

2mT



$2mT_d$



10mWind