RAPv3 early evaluation - 15 February 2014

Eric James, Stan Benjamin, development by RAP/HRRR team

- Model
  - WRF v3.5.1
  - Modified MYNN PBL scheme
  - Modified RUC LSM scheme
  - Grell-Freitas convective scheme replacing previous Grell-3D scheme
  - RRTMG radiation replacing previous Goddard radiation
  - Improved version of Thompson microphysics
- Assimilation
  - Ensemble weight changed from 0.5 to 0.75 in hybrid data assimilation
  - Updated to latest GSI trunk
- Retrospective tests carried out by Eric James, GSD
  - Comparison with RAPv2 latest version
  - Warm season testing from May-June 2013

Candidate RAPv3/HRRRv2 Changes

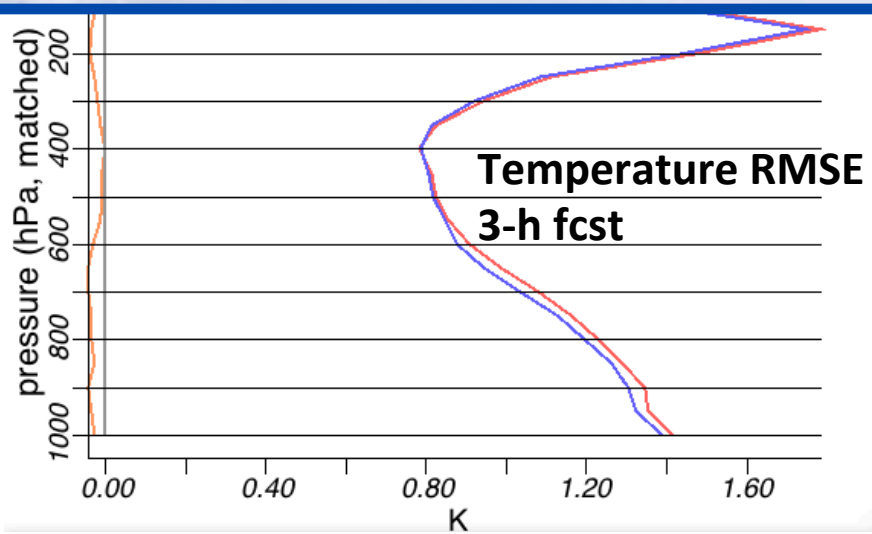
	Model	Data Assimilation
RAP-ESRL (13 km)	WRFv3.5.1+ incl. physics changes Physics changes: Grell-Freitas convective scheme MYNN PBL scheme - Olson version RUC LSM update Thompson microphysics w/aerosols RRTMG radiation scheme Shortwave radiation – updated each time step, direct & diffuse output	Merge with GSI trunk Increase ensemble weight in hybrid DA Improved surface obs assimilation Radial velocity assimilation Mesonet assimilation Full-column cloud assimilation Radiance bias correction RARS sat radiance data assimilation - ?
HRRR (3 km)	WRFv3.5.1+ incl. physics changes Physics changes: MYNN PBL scheme - Olson version RUC LSM update Thompson microphysics w/aerosols RRTMG radiation scheme Shortwave radiation –same as above Shallow cumulus parameterization Numerics changes: 6th order diffusion in flat terrain	3-km hybrid assimilation Improved surface obs assimilation Radial velocity assimilation Mesonet assimilation Changes with high/medium importance for *overall* forecast skill

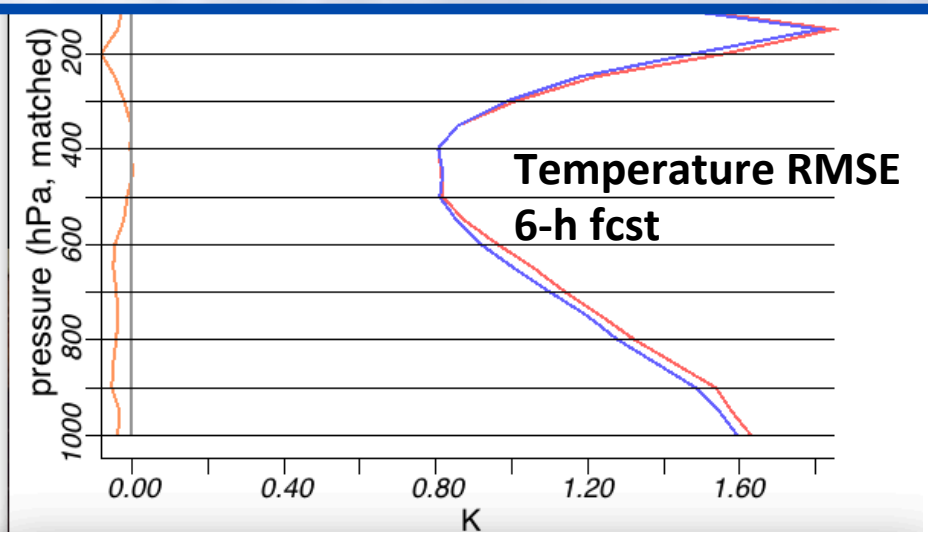
Candidate RAPv3/HRRRv2 Changes

	Model	Data Assimilation
RAP-ESRL (13 km)	WRFv3.5.1+ incl. physics changes Physics changes: Grell-Freitas convective scheme MYNN PBL scheme - Olson version RUC LSM update Thompson microphysics w/aerosols RRTMG radiation scheme Shortwave radiation – updated each time step, direct & diffuse output	Merge with GSI trunk Increase ensemble weight in hybrid DA Improved surface obs assimilation Radial velocity assimilation Mesonet assimilation Full-column cloud assimilation Radiance bias correction RARS sat radiance data assimilation - ?
HRRR (3 km)	WRFv3.5.1+ incl. physics changes Physics changes: MYNN PBL scheme - Olson version RUC LSM update Thompson microphysics w/aerosols RRTMG radiation scheme Shortwave radiation –same as above Shallow cumulus parameterization Numerics changes: 6th order diffusion in flat terrain	3-km hybrid assimilation Improved surface obs assimilation Radial velocity assimilation Mesonet assimilation

Included in these experiments

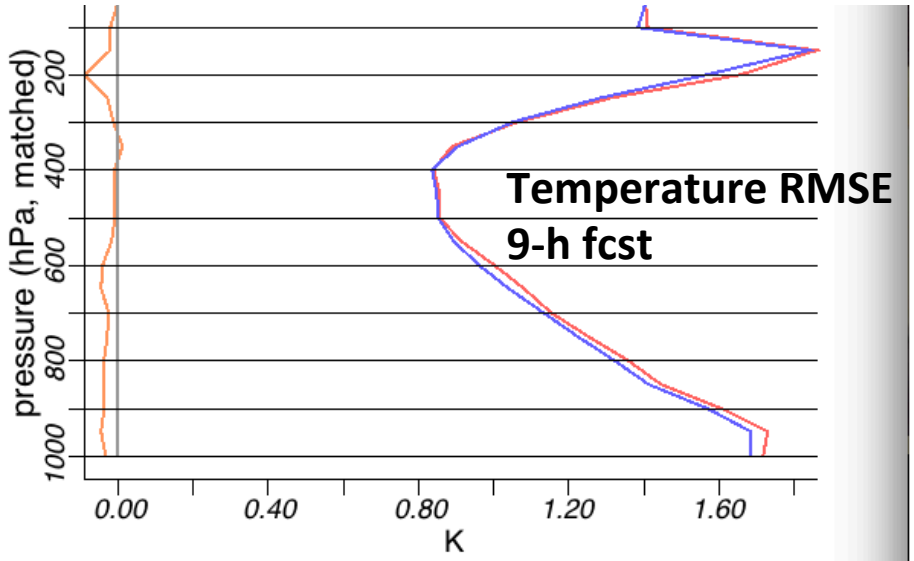
2014 RAPv3 Model Changes

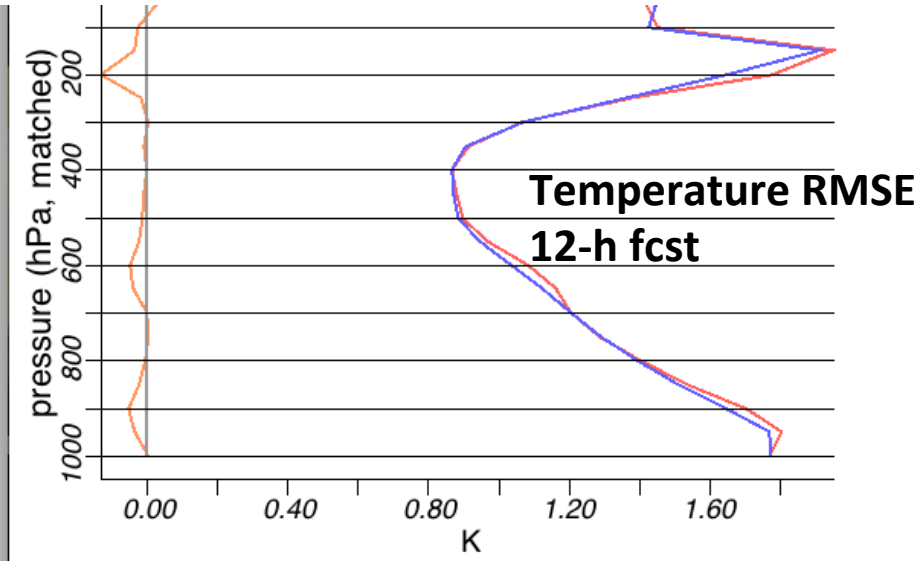




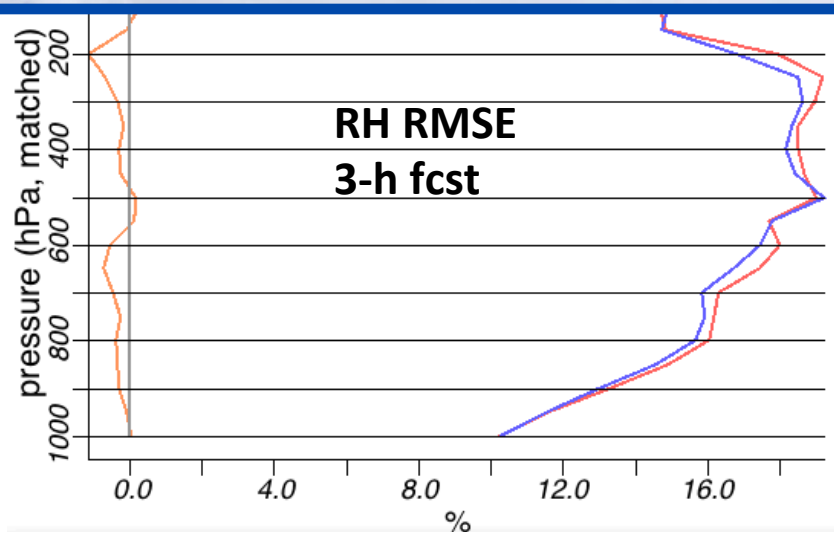
15-31 May 2013 Retrospective Period

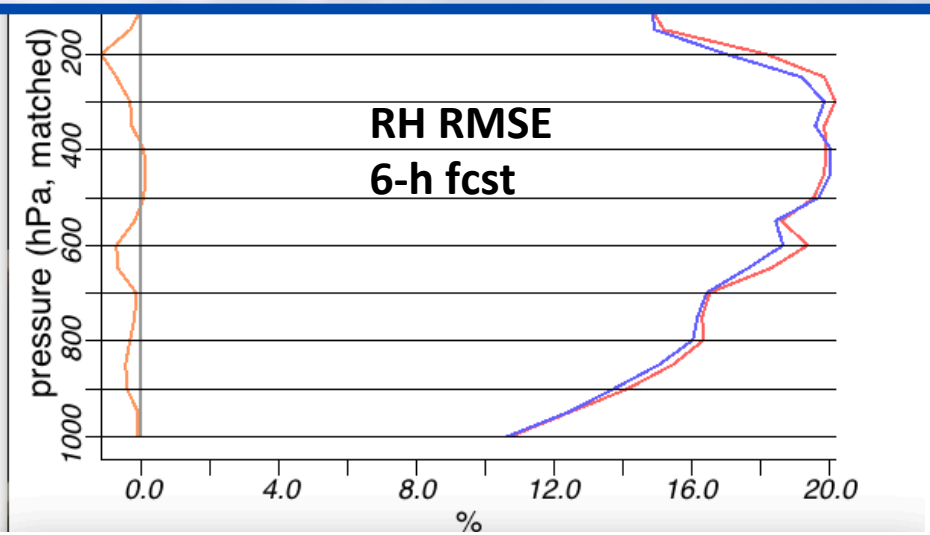
--- RAPv2 --- RAPv3 (Model) --- RAPv3–RAPv2





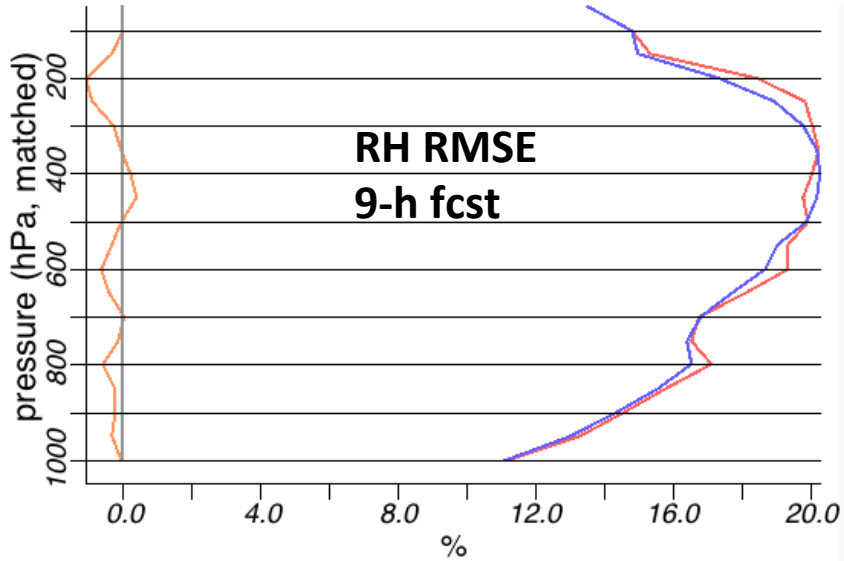
2014 RAPv3 Model Changes

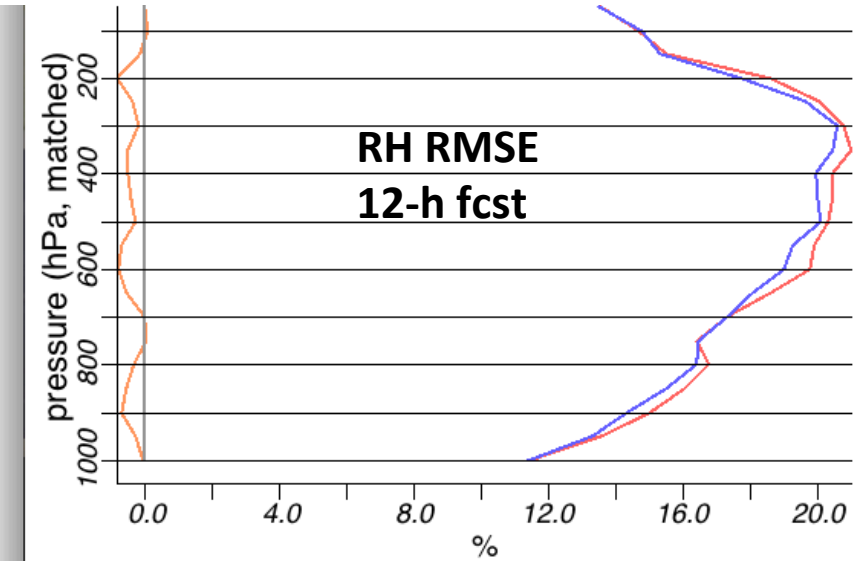




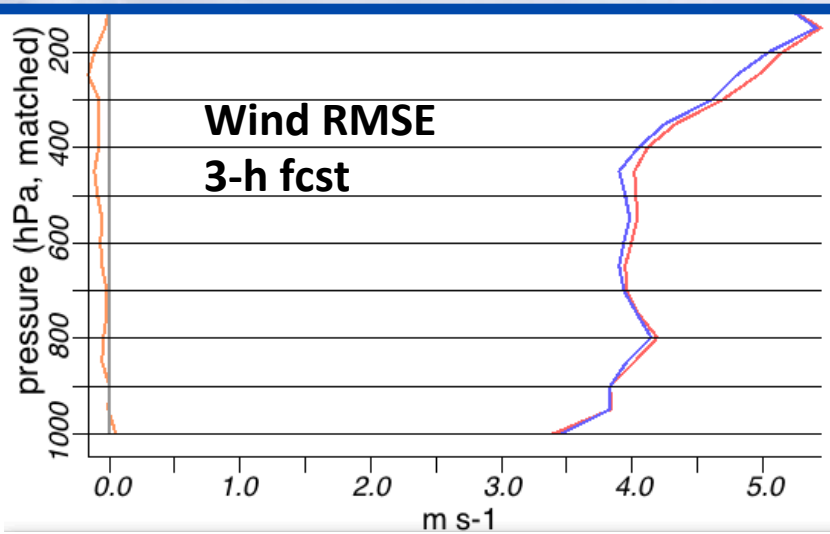
15-31 May 2013 Retrospective Period

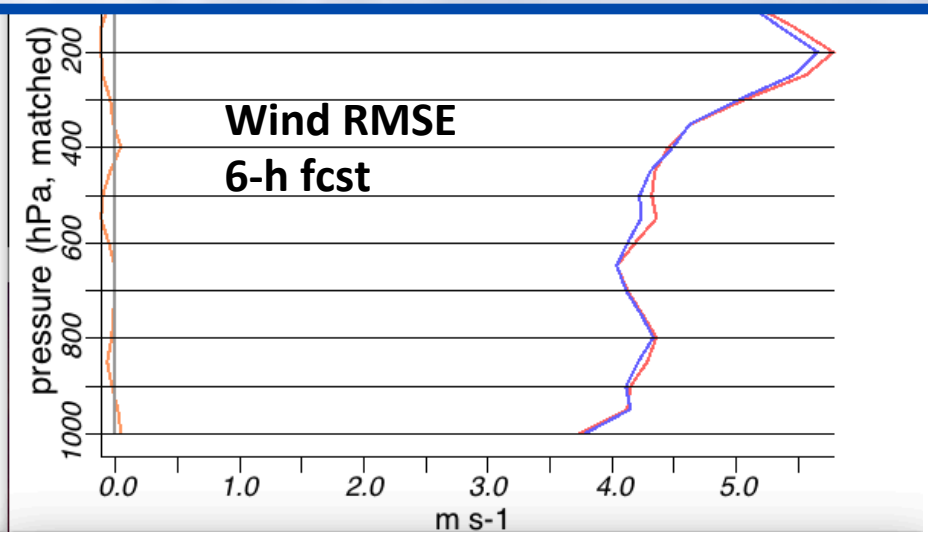
--- RAPv2 --- RAPv3 (Model) --- RAPv3–RAPv2





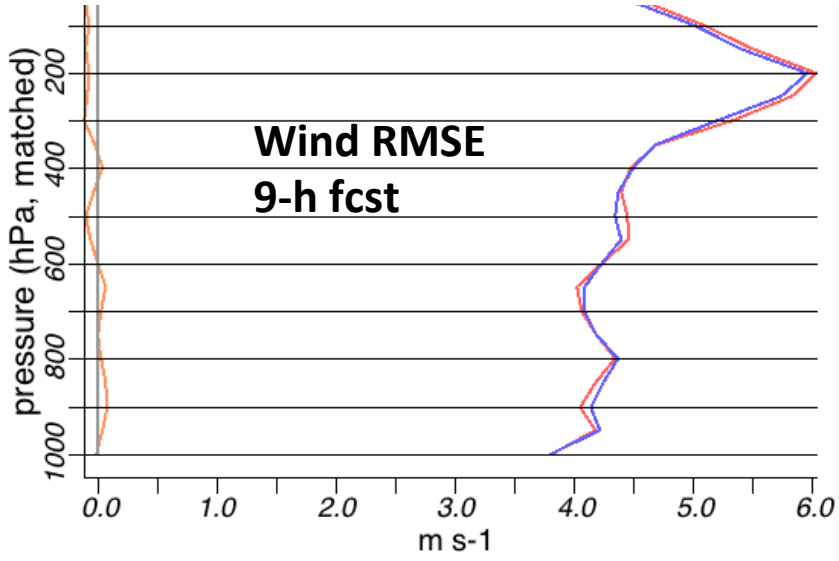
2014 RAPv3 Model Changes

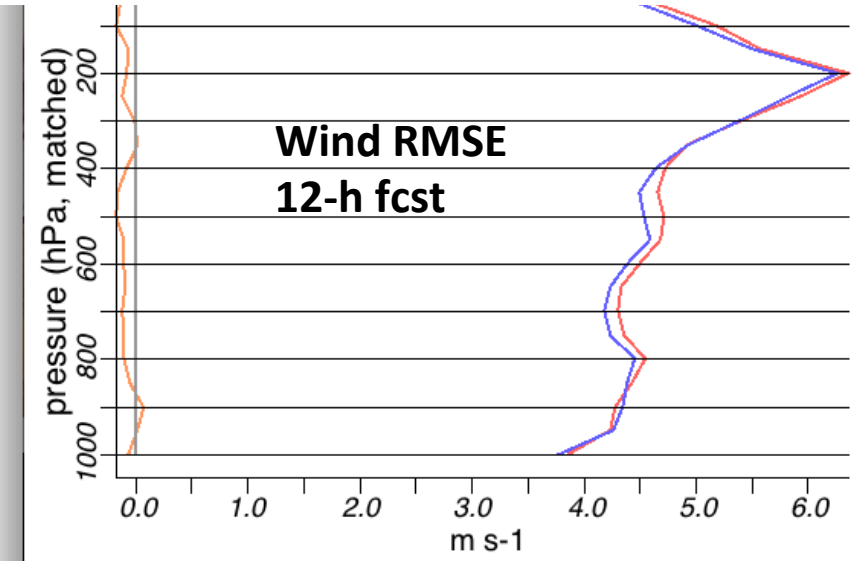




15-31 May 2013 Retrospective Period

--- RAPv2 --- RAPv3 (Model) --- RAPv3–RAPv2



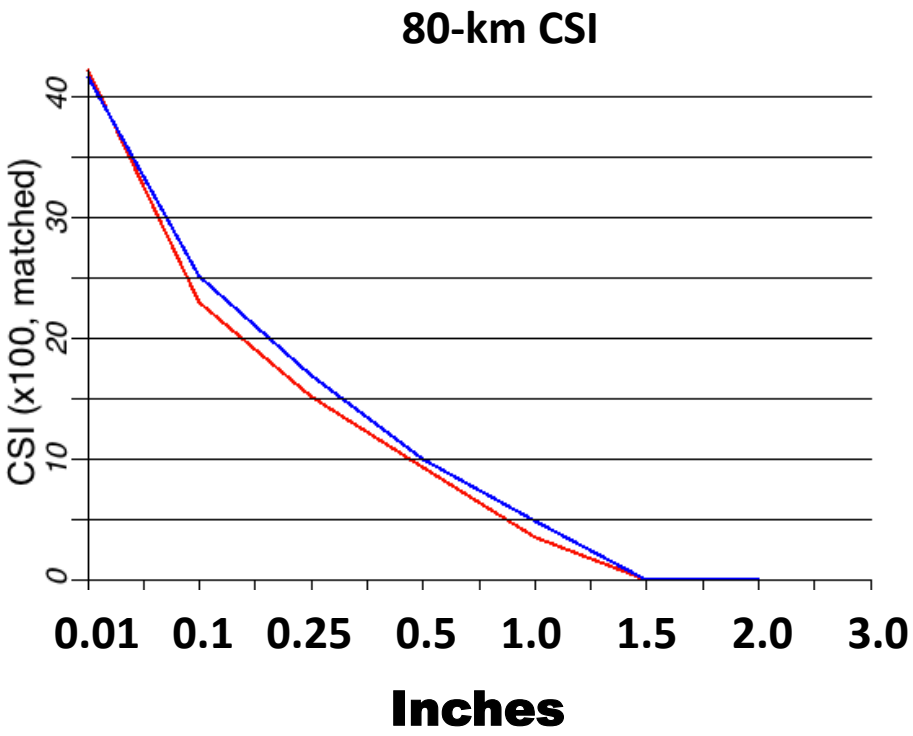


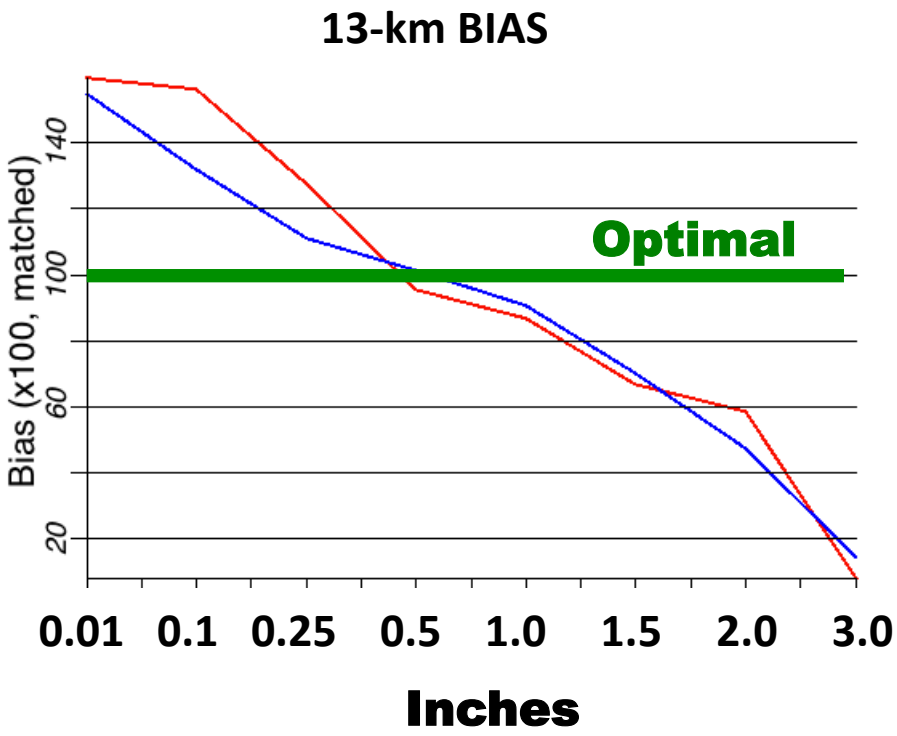
2014 RAPv3 Model Changes

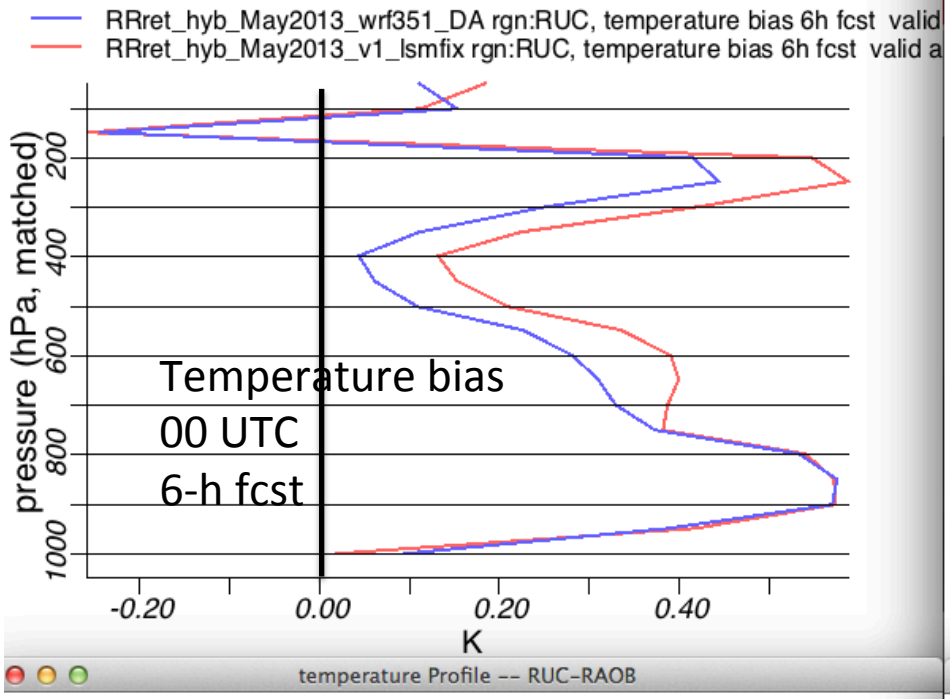
15-31 May 2013 Retrospective Period

--- RAPv2 --- RAPv3 (Model)

6hr Precipitation Eastern US






RRret_hyb_May2013_wrf351_DA rgn:RUC, temperature bias 6h fcst valid
RRret_hyb_May2013_v1_lsmfix rgn:RUC, temperature bias 6h fcst valid a
Temperature bias
00 UTC
6-h fcst
pressure (hPa, matched)
200
400
600
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1000
-0.20
0.00
0.20
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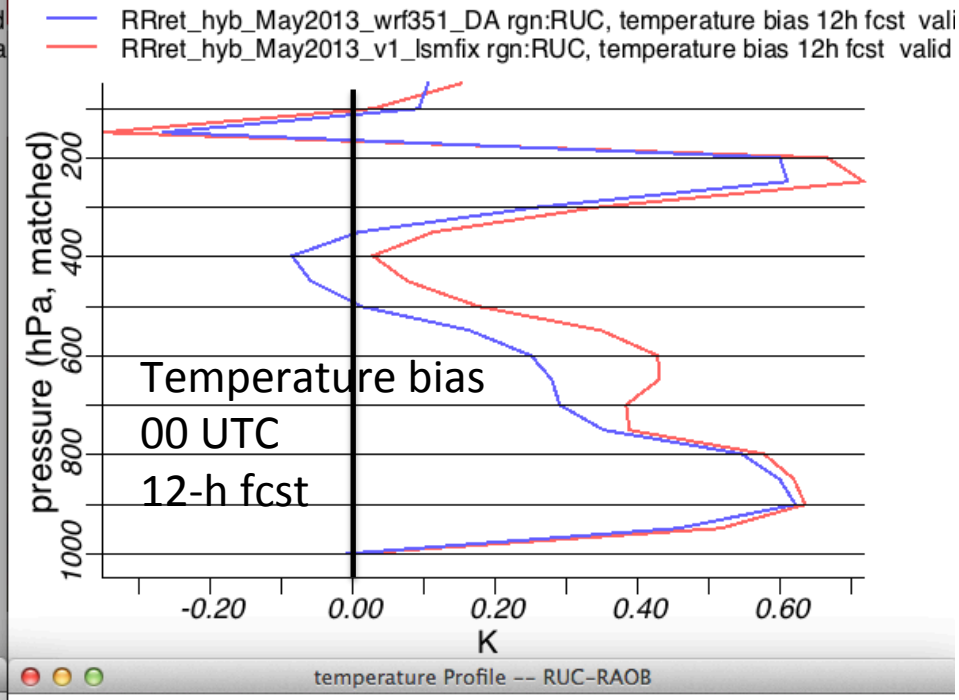
K
temperature Profile -- RUC-RAOB


RRret_hyb_May2013_wrf351_DA rgn:RUC, temperature bias 12h fcst vali
RRret_hyb_May2013_v1_lsmfix rgn:RUC, temperature bias 12h fcst valid
Temperature bias
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pressure (hPa, matched)
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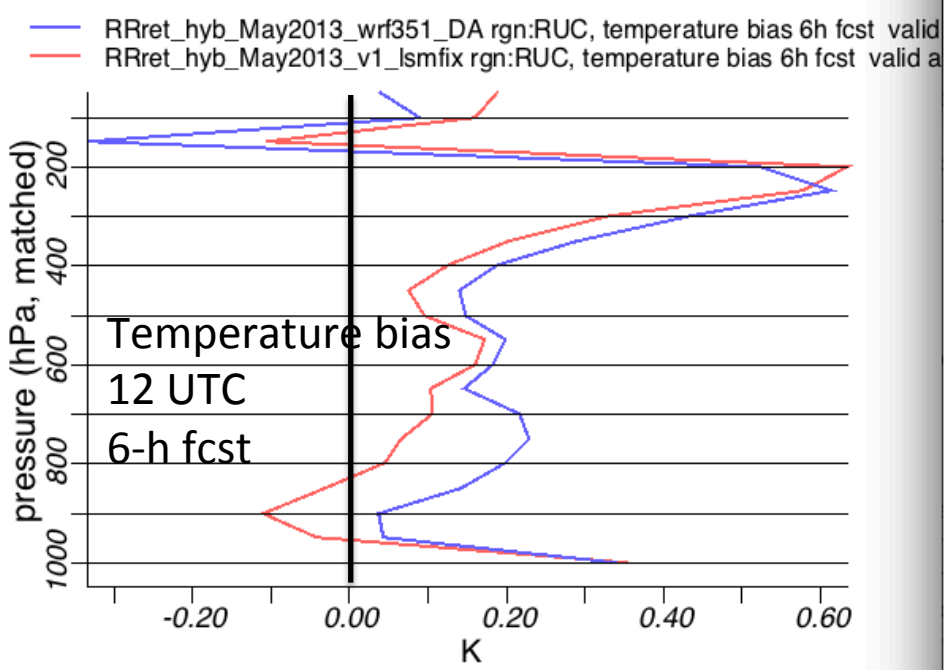
0.60
K
temperature Profile -- RUC-RAOB


RRret_hyb_May2013_wrf351_DA rgn:RUC, temperature bias 6h fcst valid
RRret_hyb_May2013_v1_lsmfix rgn:RUC, temperature bias 6h fcst valid a
Temperature bias
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6-h fcst
pressure (hPa, matched)
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0.40
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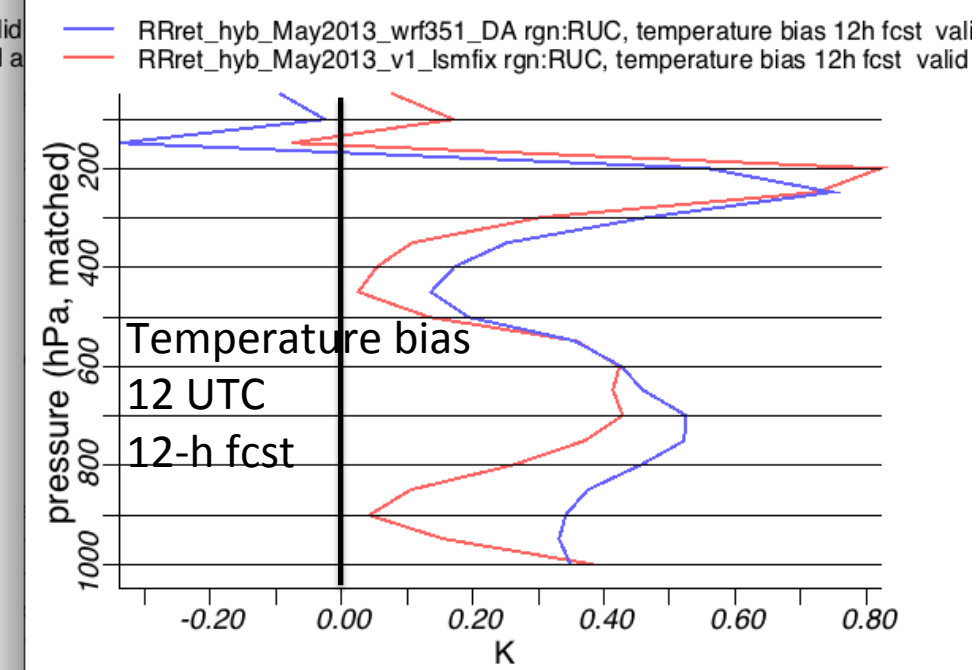
RRret_hyb_May2013_wrf351_DA rgn:RUC, temperature bias 12h fcst vali
RRret_hyb_May2013_v1_lsmfix rgn:RUC, temperature bias 12h fcst valid
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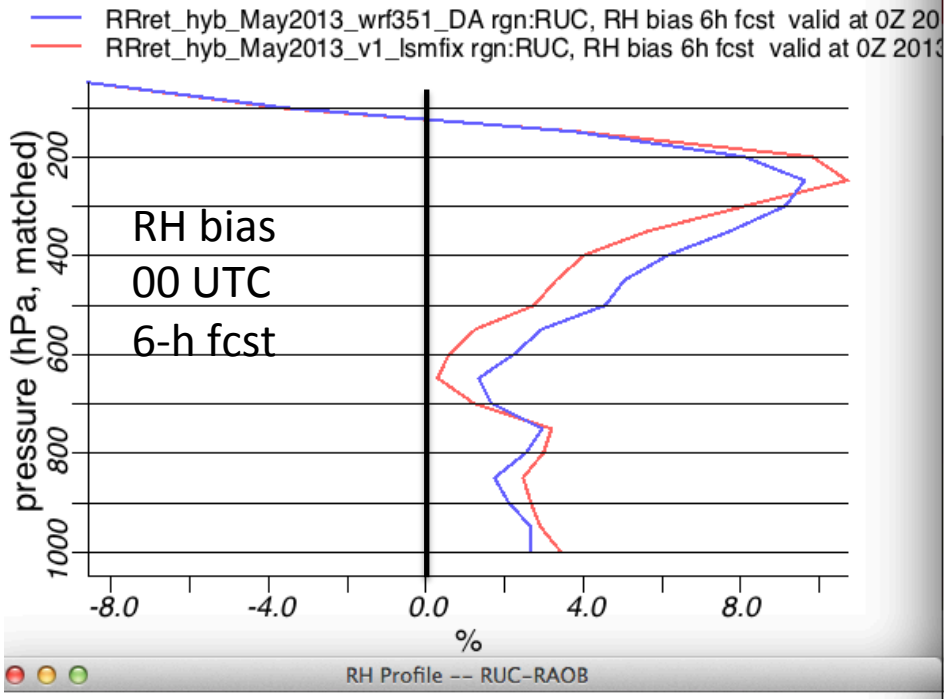
RRret_hyb_May2013_wrf351_DA rgn:RUC, RH bias 6h fcst valid at 0Z 20
RRret_hyb_May2013_v1_lsmfix rgn:RUC, RH bias 6h fcst valid at 0Z 2013
RH bias
00 UTC
6-h fcst
pressure (hPa, matched)
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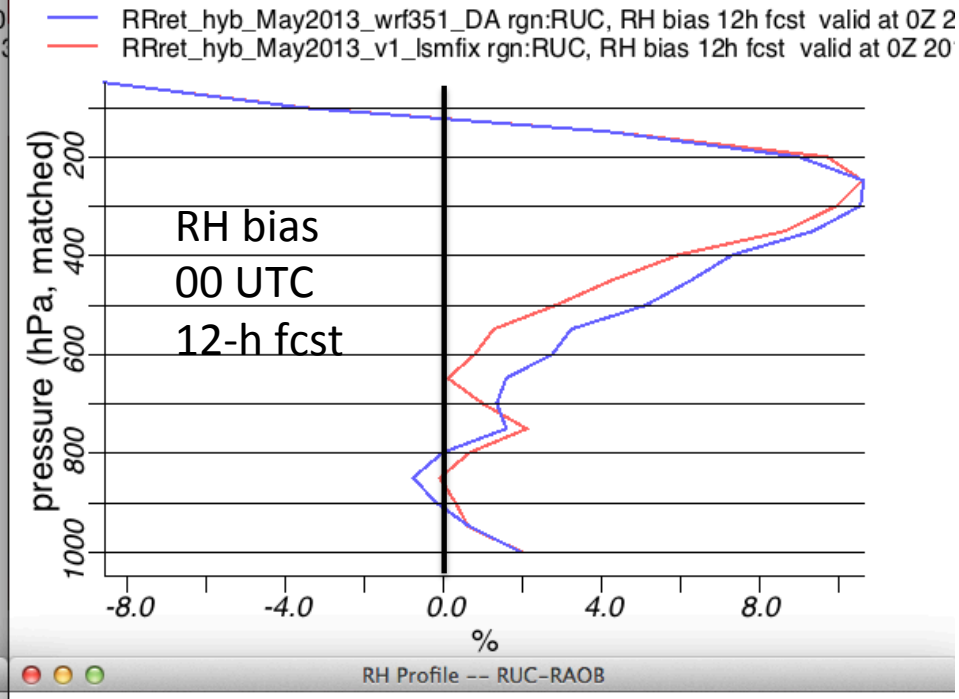
400
600
800
1000
-8.0
-4.0
0.0
4.0
8.0
%
RH Profile -- RUC-RAOB


RRret_hyb_May2013_wrf351_DA rgn:RUC, RH bias 12h fcst valid at 0Z 2
RRret_hyb_May2013_v1_lsmfix rgn:RUC, RH bias 12h fcst valid at 0Z 20
RH bias
00 UTC
12-h fcst
pressure (hPa, matched)
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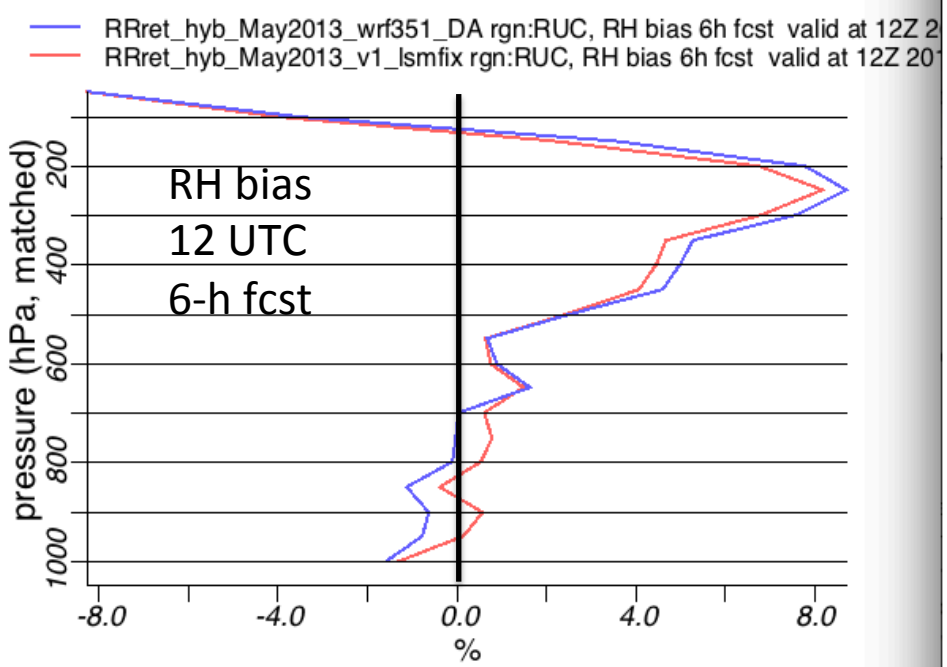
%
RH Profile -- RUC-RAOB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RH bias
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pressure (hPa, matched)
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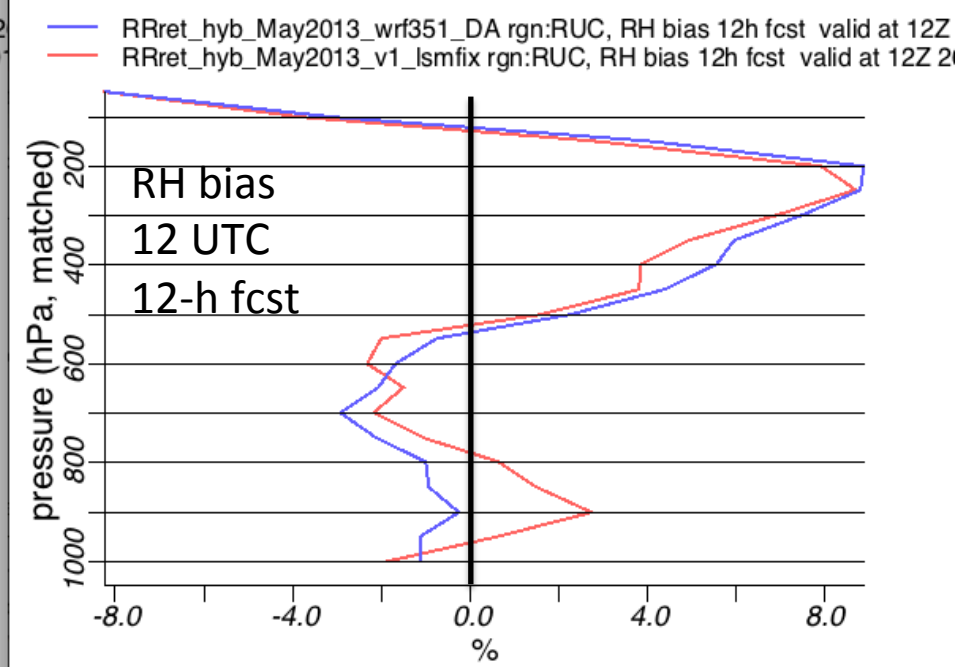
RRret_hyb_May2013_wrf351_DA rgn:RUC, RH bias 12h fcst valid at 12Z
RRret_hyb_May2013_v1_lsmfix rgn:RUC, RH bias 12h fcst valid at 12Z 2
RH bias
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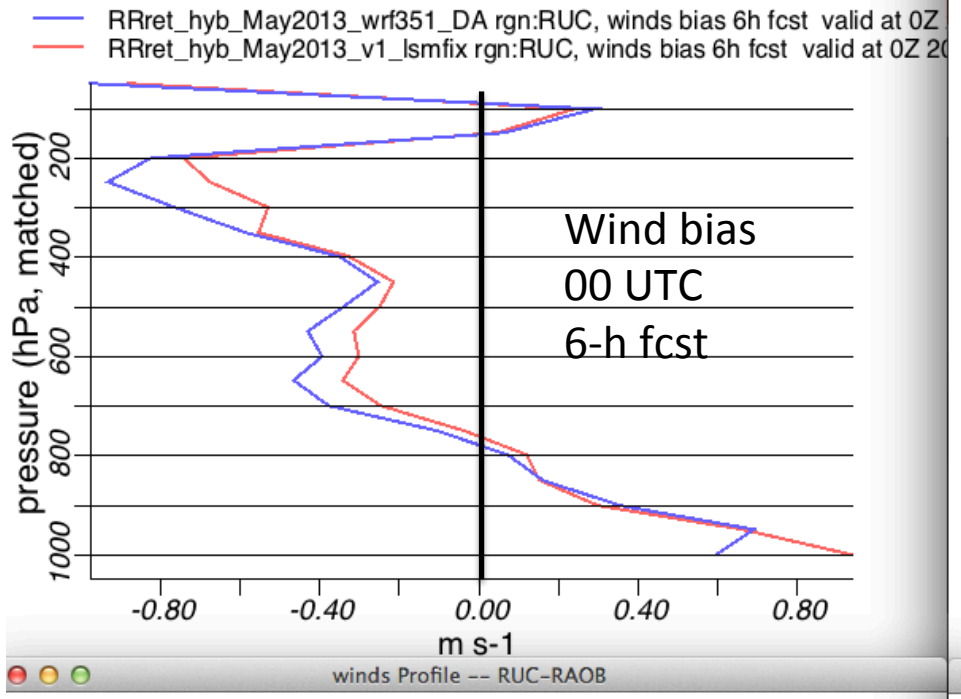
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RRret_hyb_May2013_v1_lsmfix rgn:RUC, winds bias 6h fcst valid at 0Z 2
Wind bias
00 UTC
6-h fcst
pressure (hPa, matched)
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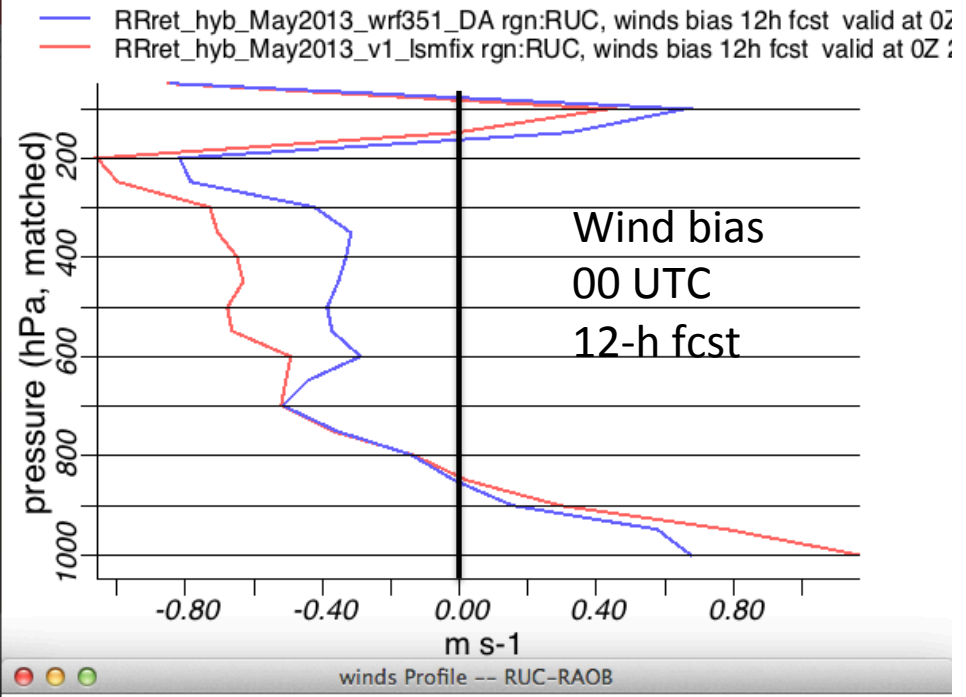
m s-1
winds Profile -- RUC-RAOB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RRret_hyb_May2013_v1_lsmfix rgn:RUC, winds bias 12h fcst valid at 0Z 2
Wind bias
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pressure (hPa, matched)
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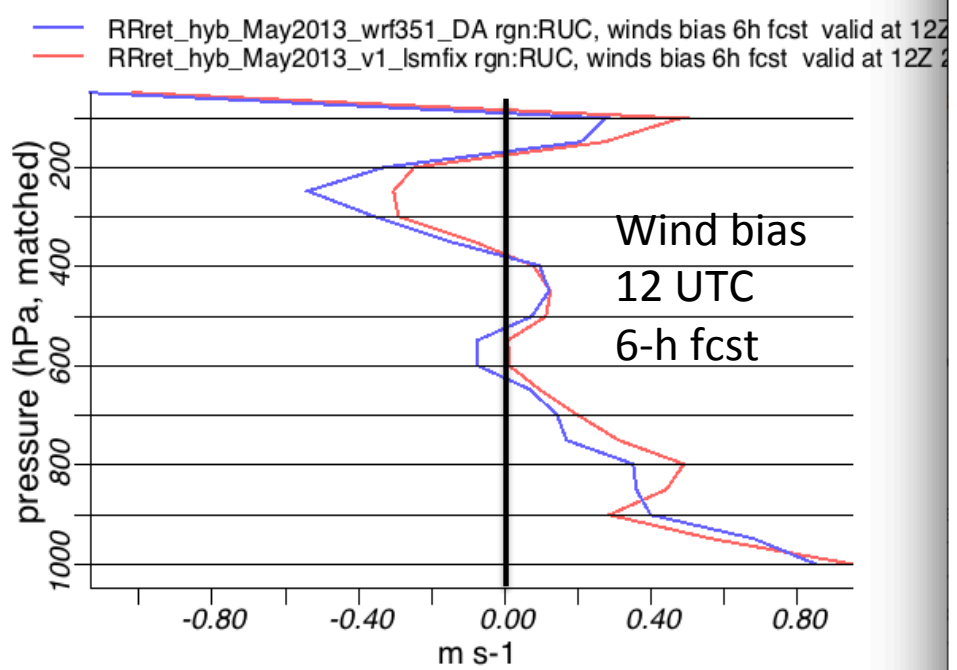
m s-1
winds Profile -- RUC-RAOB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RRret_hyb_May2013_v1_lsmfix rgn:RUC, winds bias 6h fcst valid at 12Z 2
Wind bias
12 UTC
6-h fcst
pressure (hPa, matched)
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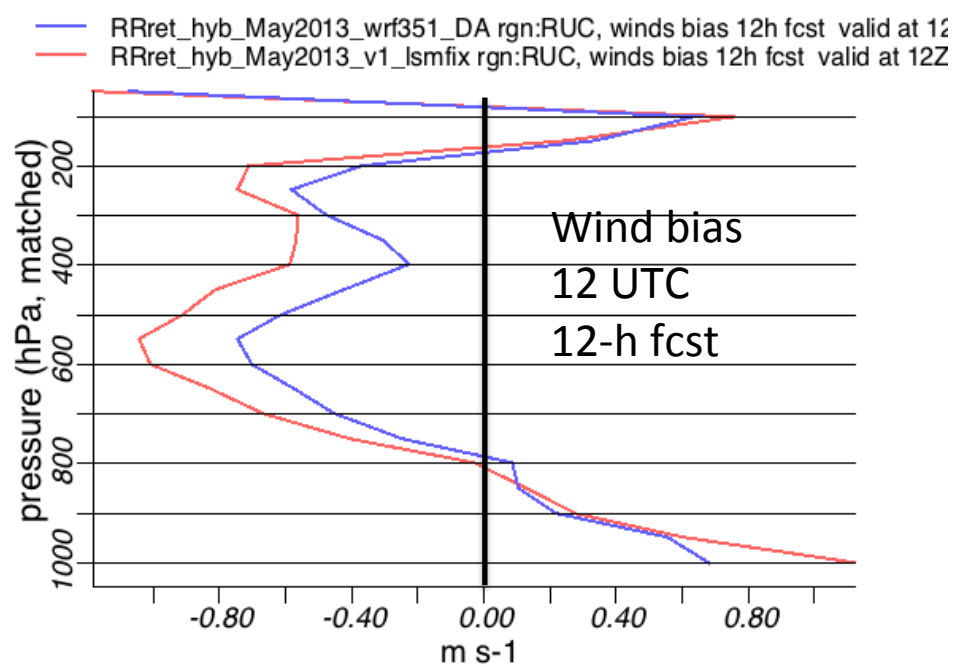
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RRret_hyb_May2013_v1_lsmfix rgn:RUC, winds bias 12h fcst valid at 12Z
Wind bias
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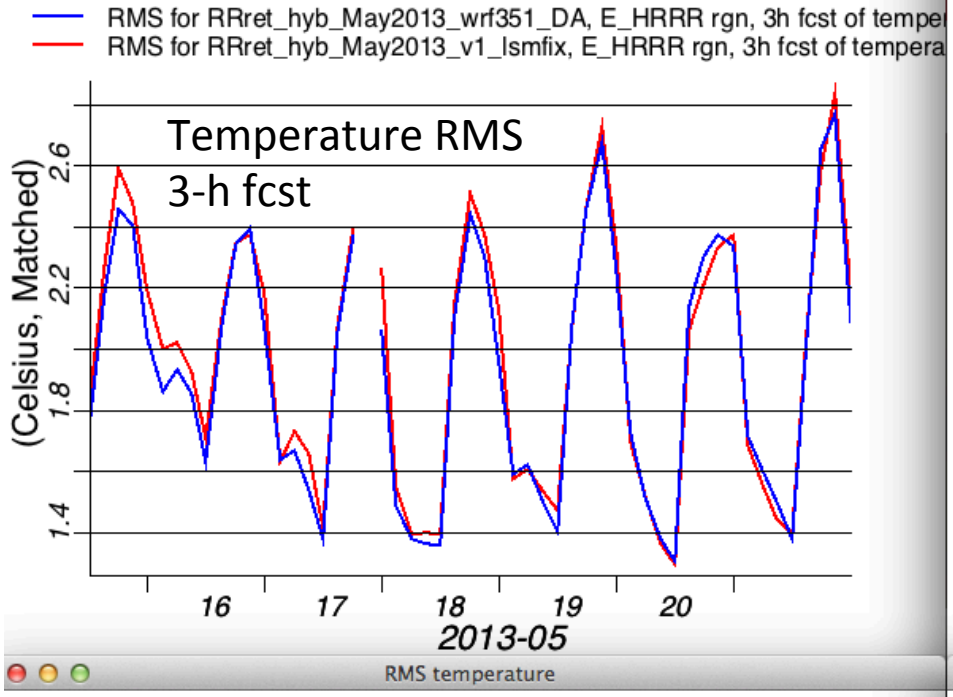
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RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of tempera
Temperature RMS
3-h fcst
(Celsius, Matched)
1.4
1.8
2.2
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16
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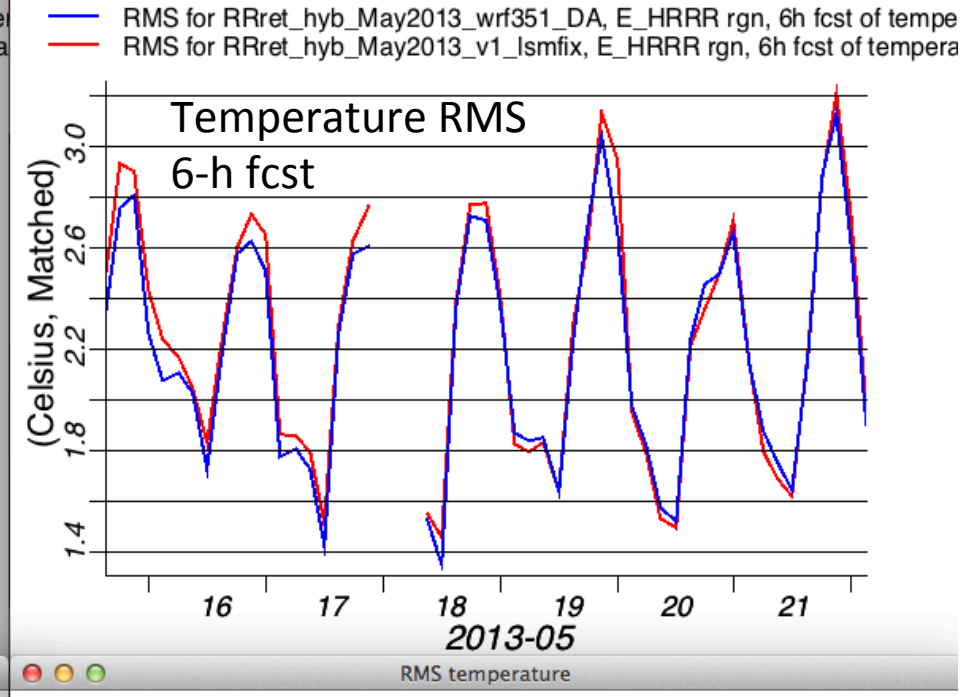
2013-05
RMS temperature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RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of tempera
Temperature RMS
6-h fcst
(Celsius, Matched)
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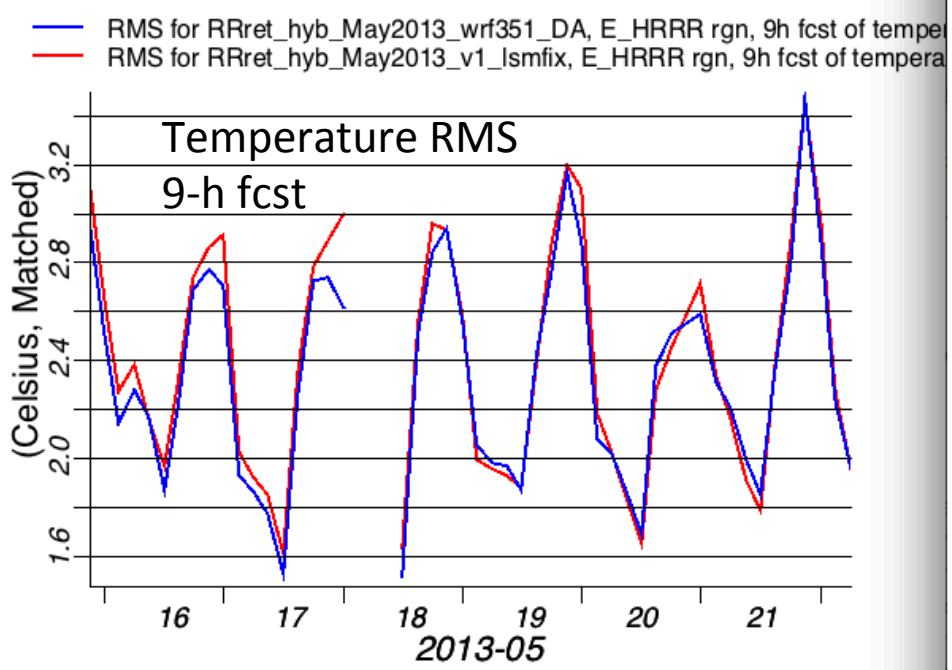
2013-05
RMS temperature


RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of tempe
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of tempera
Temperature RMS
9-h fcst
(Celsius, Matched)
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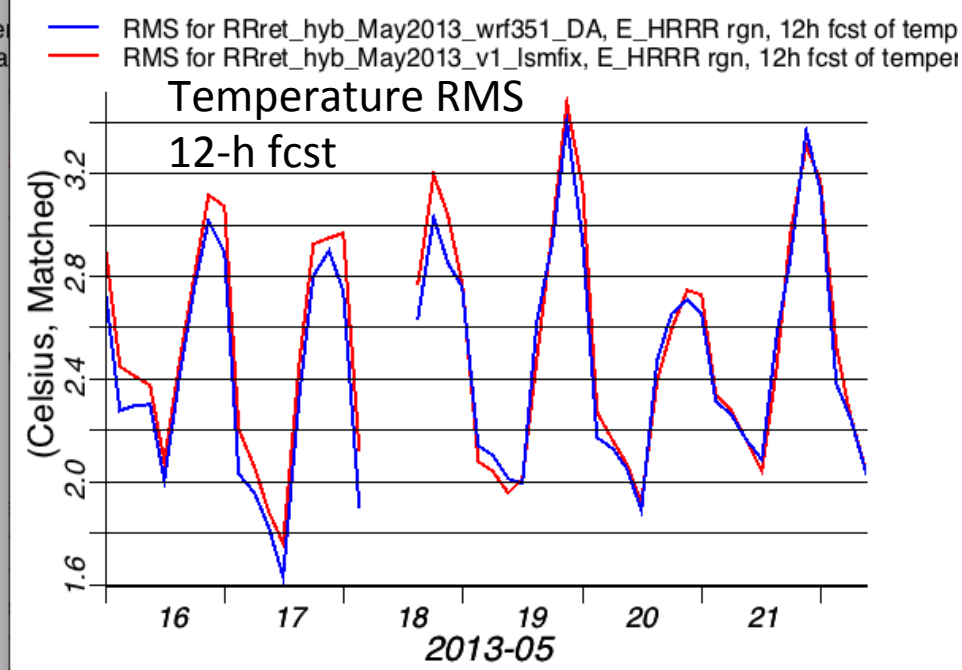
RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of temp
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of tempe
Temperature RMS
12-h fcst
(Celsius, Matched)
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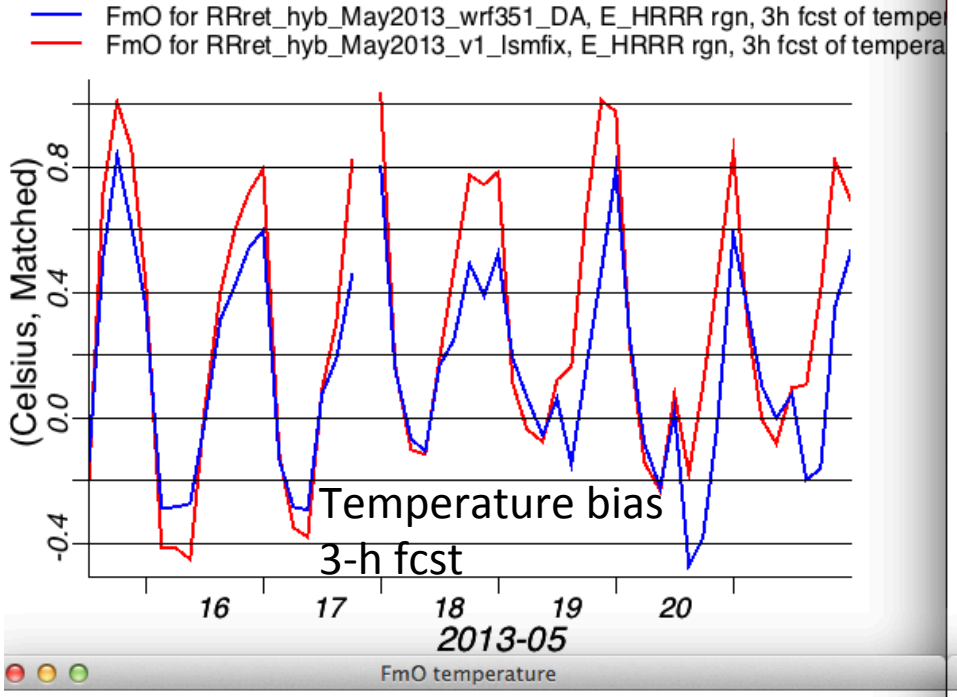
FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 3h fcst of tempe
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of tempera
(Celsius, Matched)
0.8
0.4
0.0
-0.4
Temperature bias
3-h fcst
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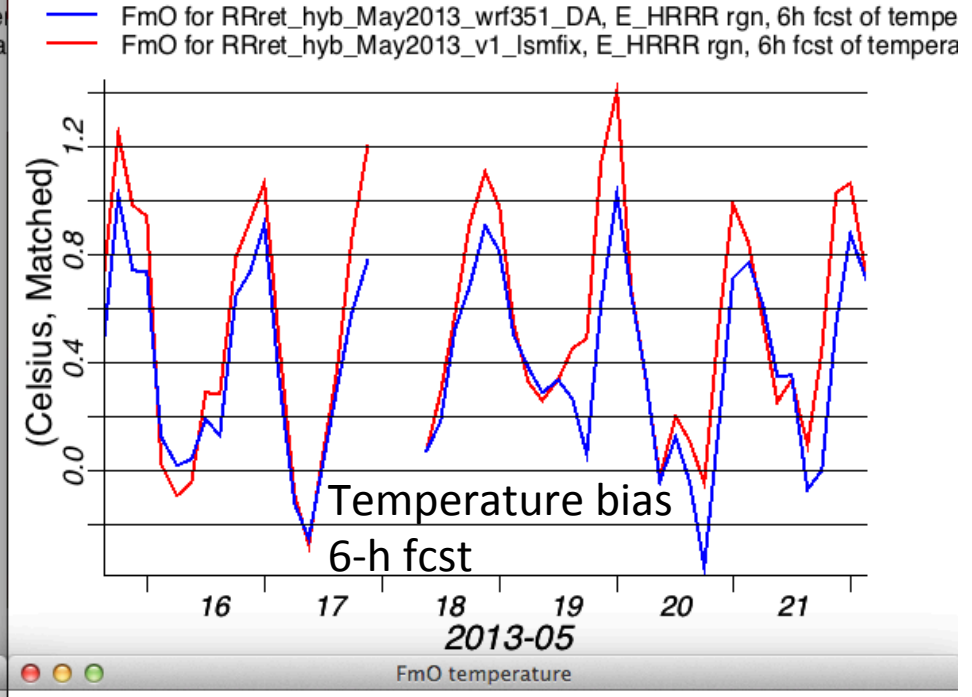
17
18
19
20
2013-05
FmO temperature


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 6h fcst of tempe
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of tempera
(Celsius, Matched)
1.2
0.8
0.4
0.0
Temperature bias
6-h fcst
16
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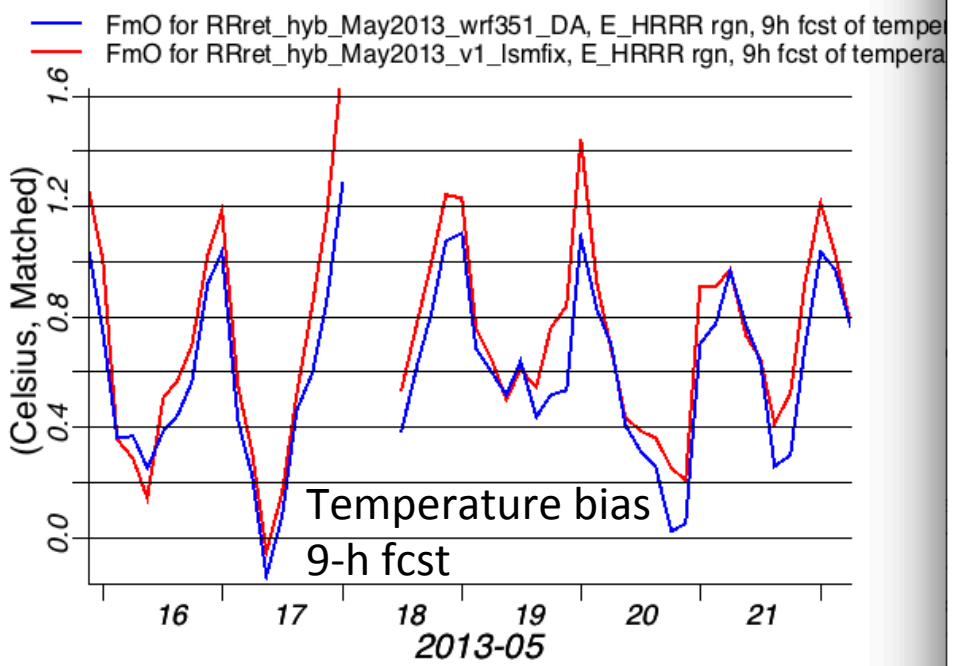
2013-05
FmO temperature


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of tempe
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of tempera
(Celsius, Matched)
1.6
1.2
0.8
0.4
0.0
Temperature bias
9-h fcst
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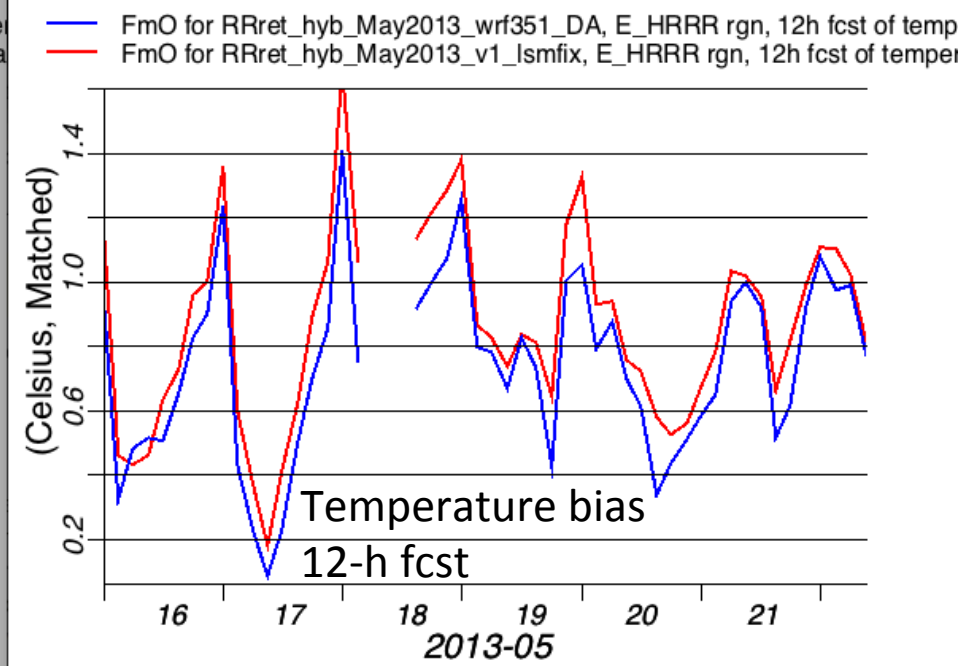
FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of temp
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of tempe
(Celsius, Matched)
1.4
1.0
0.6
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Temperature bias
12-h fcst
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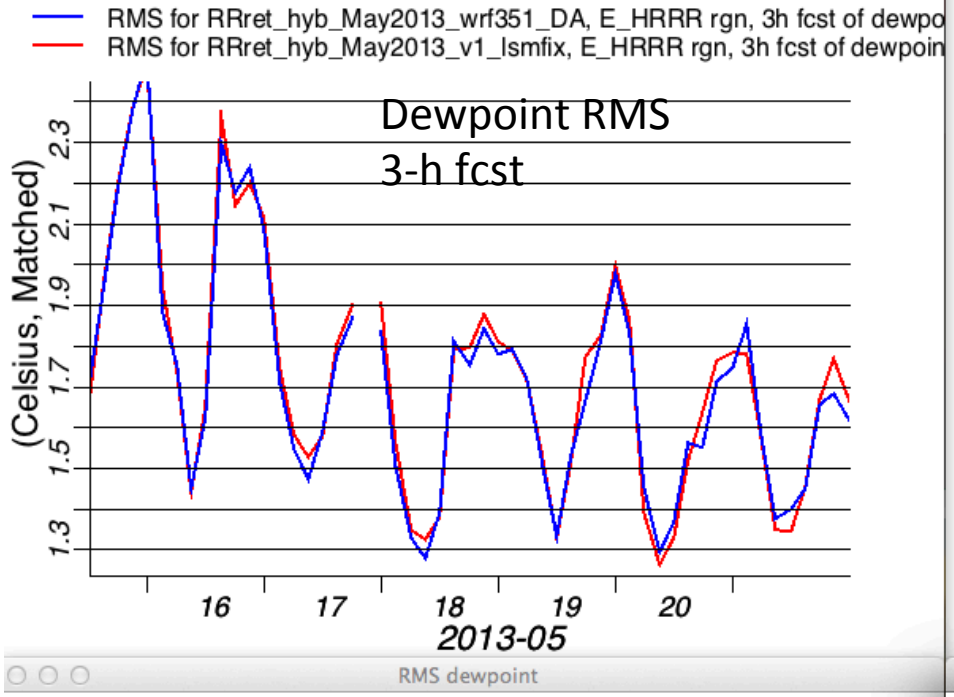
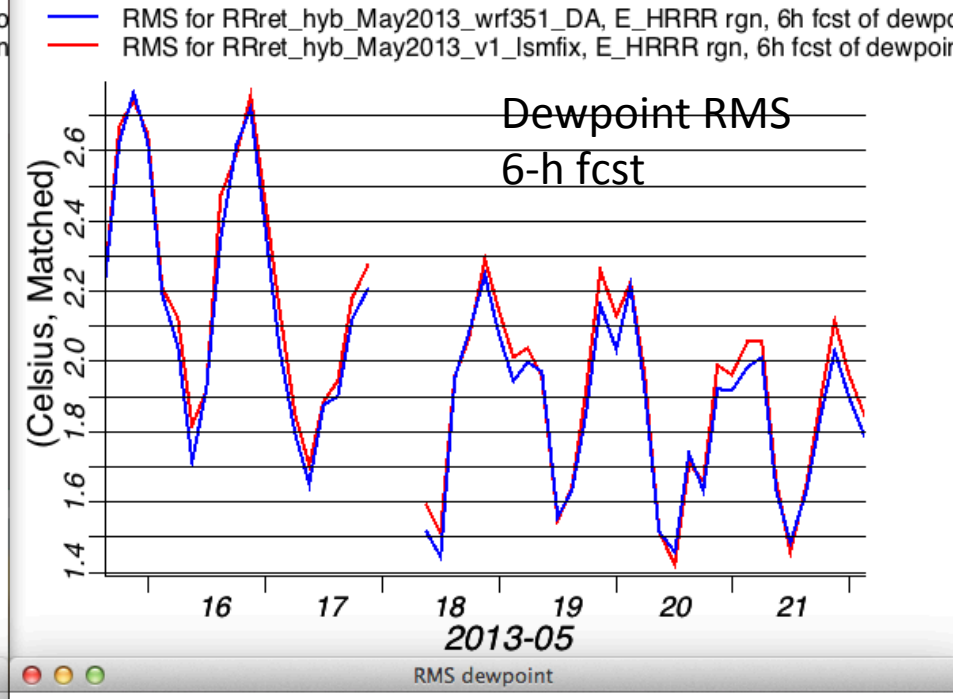
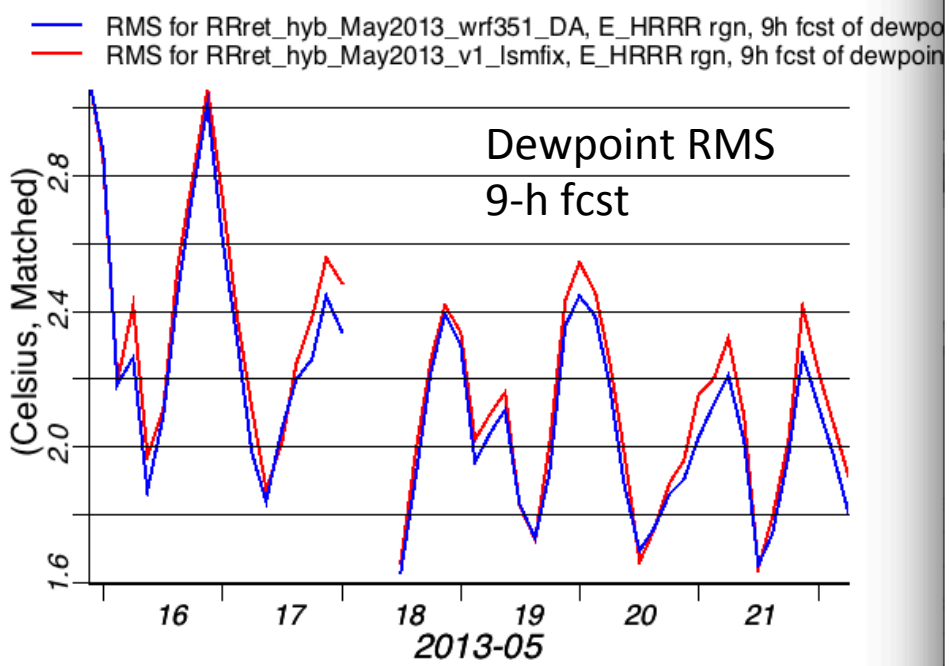
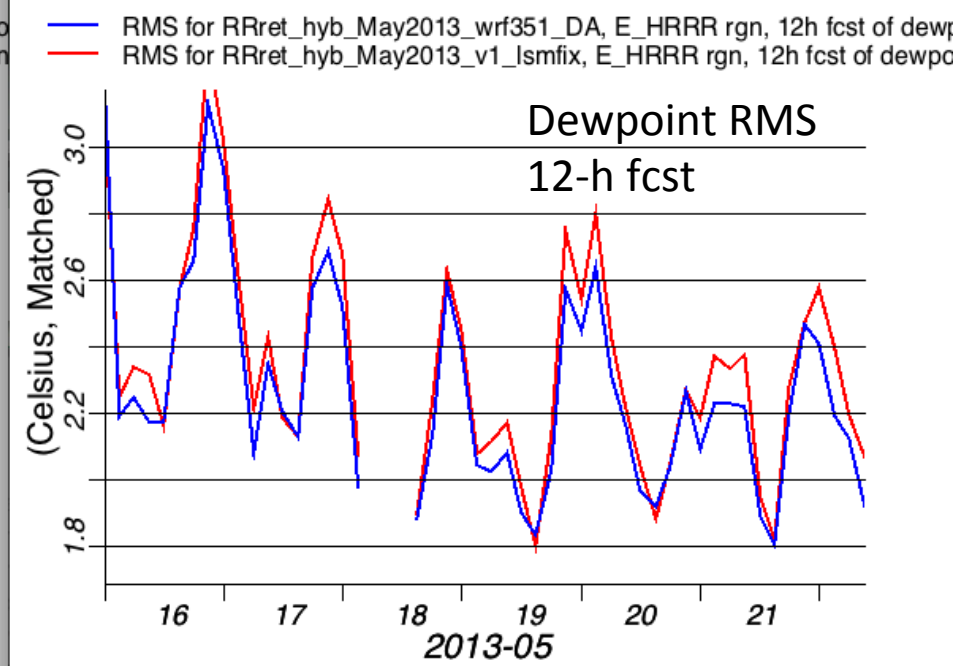
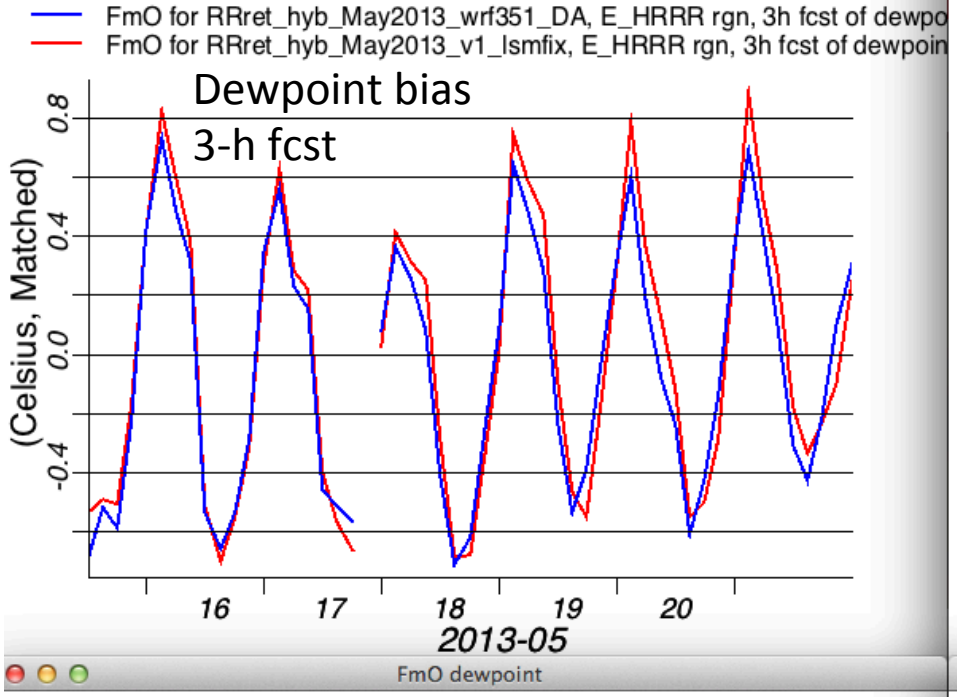
21
2013-05

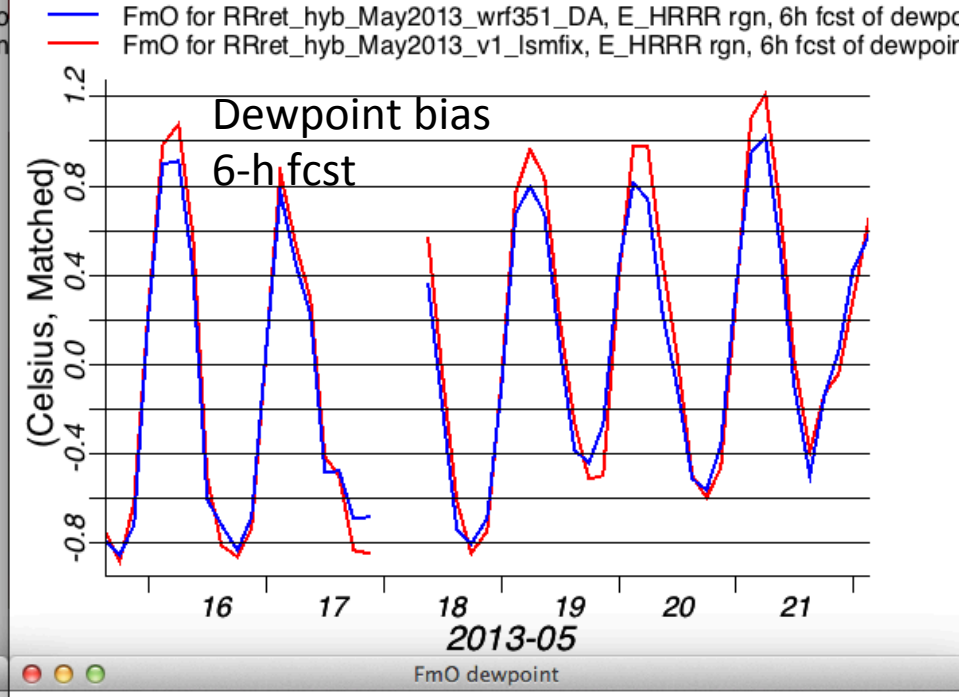

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 3h fcst of dewpo
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of dewpoin
Dewpoint RMS
3-h fcst
(Celsius, Matched)
1.3
1.5
1.7
1.9
2.1
2.3
16
17
18
19
20
2013-05
RMS dewpoint

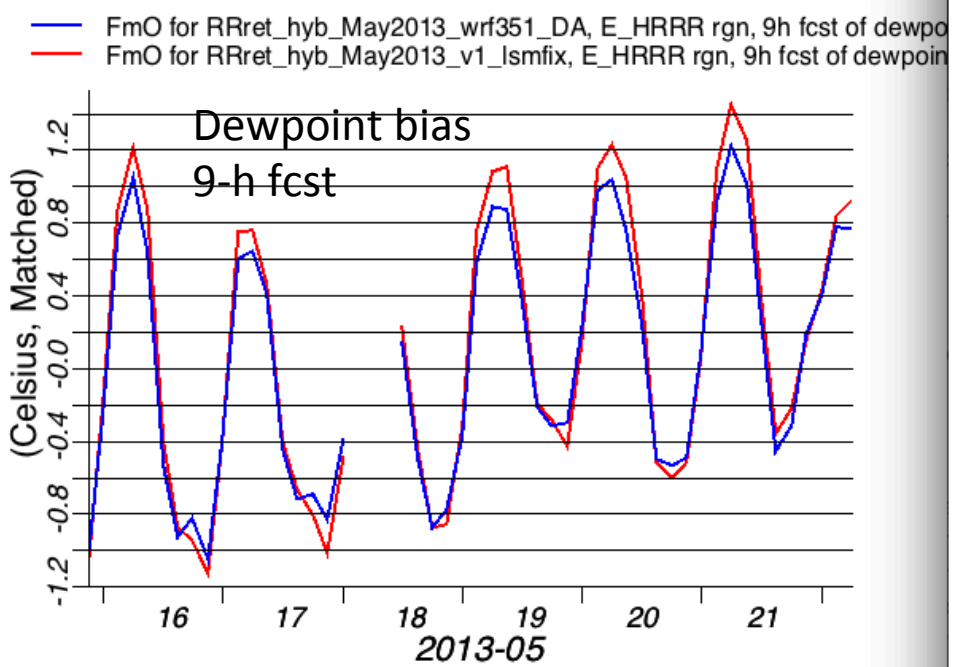

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 6h fcst of dewpo
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of dewpoir
Dewpoint RMS
6-h fcst
(Celsius, Matched)
1.4
1.6
1.8
2.0
2.2
2.4
2.6
16
17
18
19
20
21
2013-05
RMS dewpoint

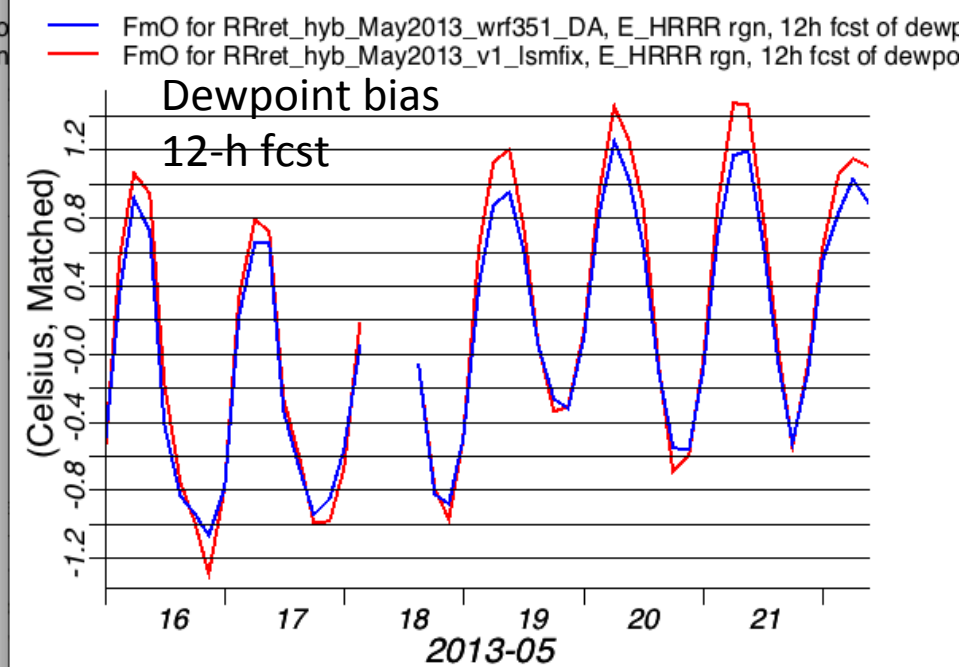

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of dewpo
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of dewpoin
Dewpoint RMS
9-h fcst
(Celsius, Matched)
1.6
2.0
2.4
2.8
16
17
18
19
20
21
2013-05

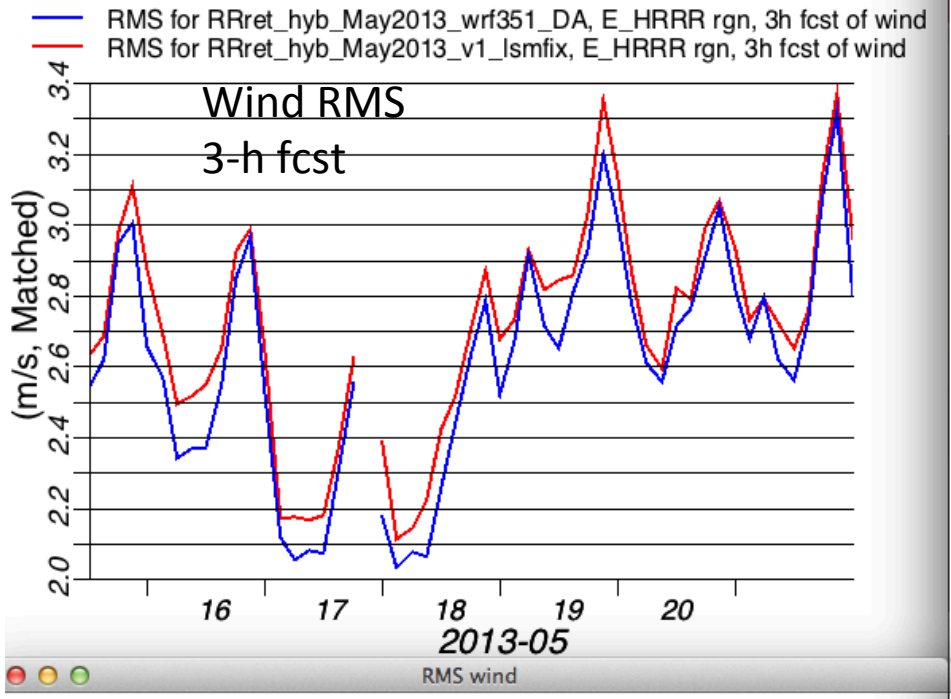

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of dewp
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of dewpo
Dewpoint RMS
12-h fcst
(Celsius, Matched)
1.8
2.2
2.6
3.0
16
17
18
19
20
21
2013-05

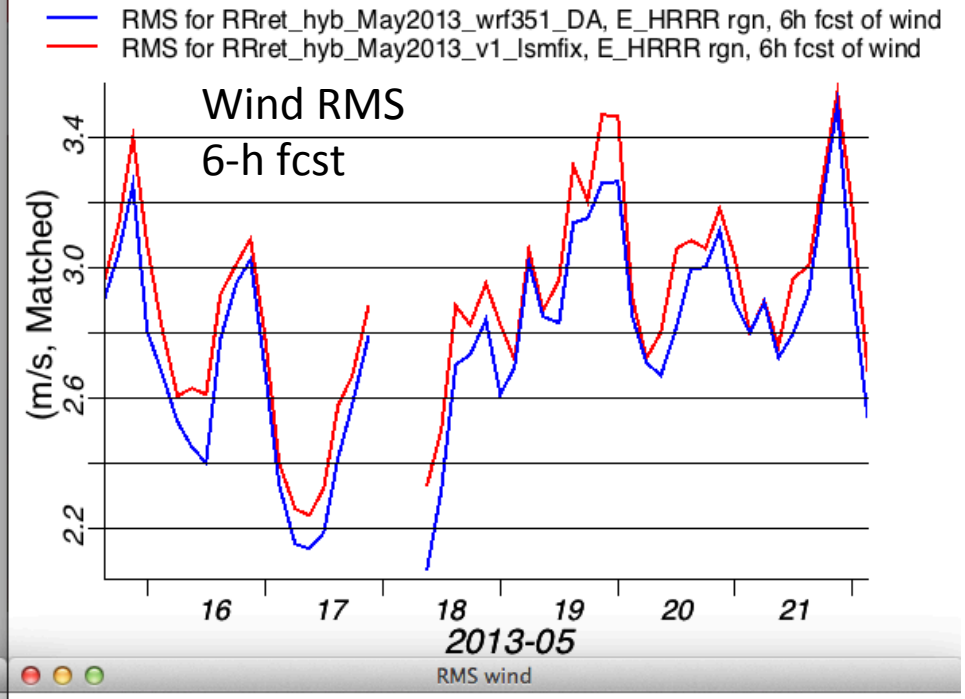

FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 3h fcst of dewpo
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of dewpoin
Dewpoint bias
3-h fcst
(Celsius, Matched)
0.8
0.4
0.0
-0.4
16
17
18
19
20
2013-05
FmO dewpoint

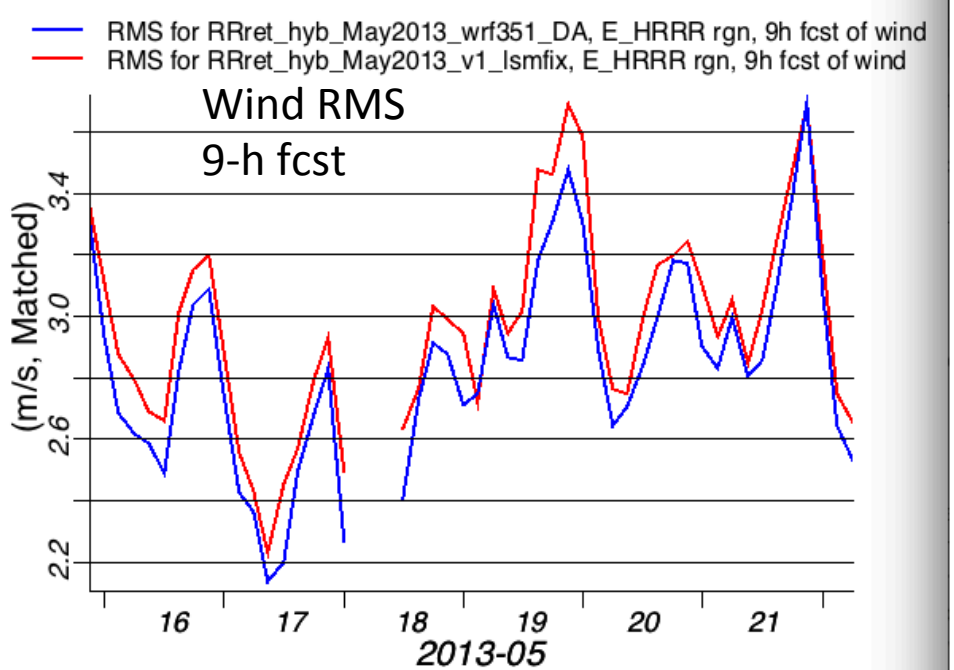

FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 6h fcst of dewpo
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of dewpoir
Dewpoint bias
6-h fcst
(Celsius, Matched)
1.2
0.8
0.4
0.0
-0.4
-0.8
16
17
18
19
20
21
2013-05
FmO dewpoint

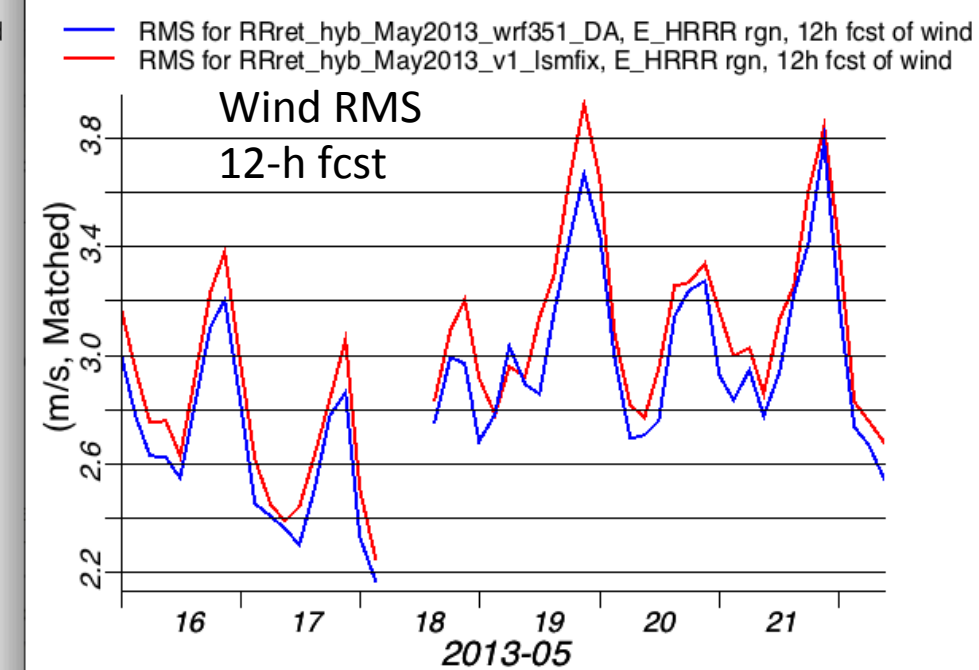

FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of dewpo
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of dewpoin
Dewpoint bias
9-h fcst
(Celsius, Matched)
1.2
0.8
0.4
-0.0
-0.4
-0.8
-1.2
16
17
18
19
20
21
2013-05

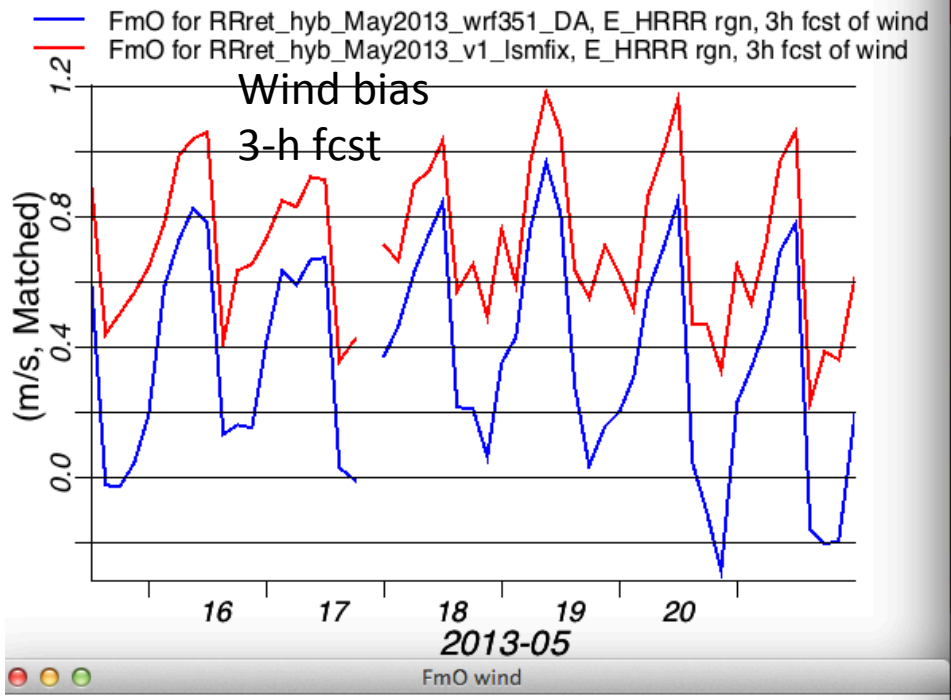

FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of dewp
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of dewpo
Dewpoint bias
12-h fcst
(Celsius, Matched)
1.2
0.8
0.4
-0.0
-0.4
-0.8
-1.2
16
17
18
19
20
21
2013-05

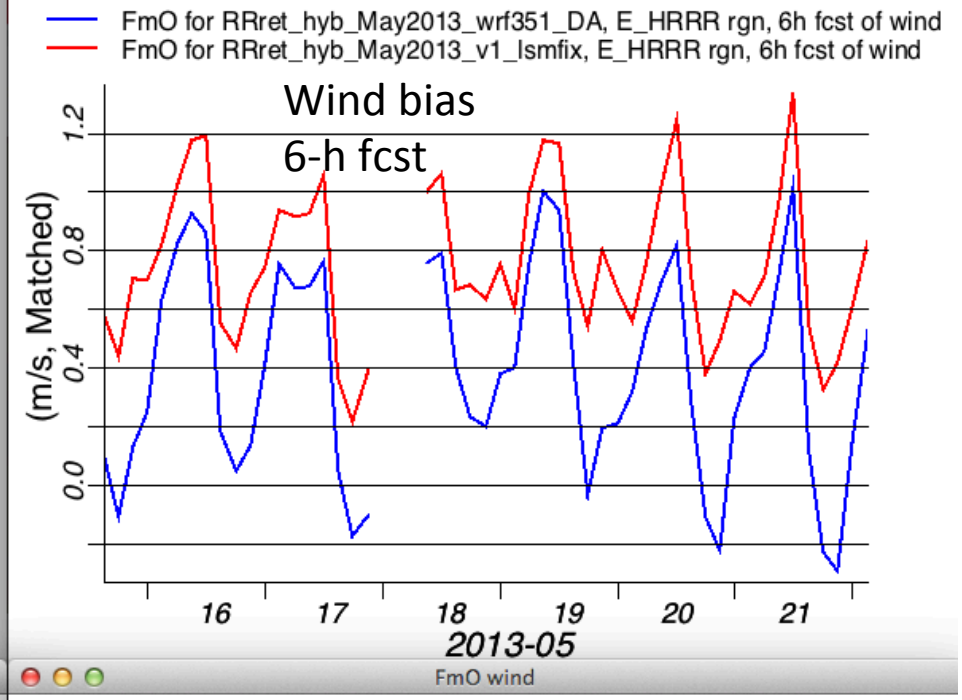

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 3h fcst of wind
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of wind
Wind RMS
3-h fcst
(m/s, Matched)
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
16
17
18
19
20
2013-05
RMS wind

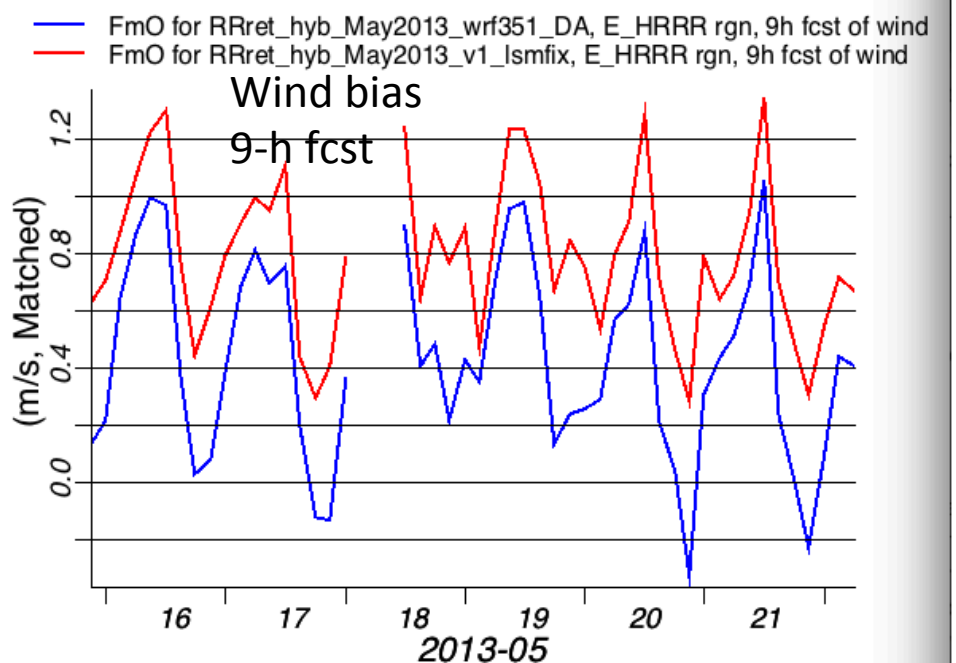

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 6h fcst of wind
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of wind
Wind RMS
6-h fcst
(m/s, Matched)
2.2
2.6
3.0
3.4
16
17
18
19
20
21
2013-05
RMS wind

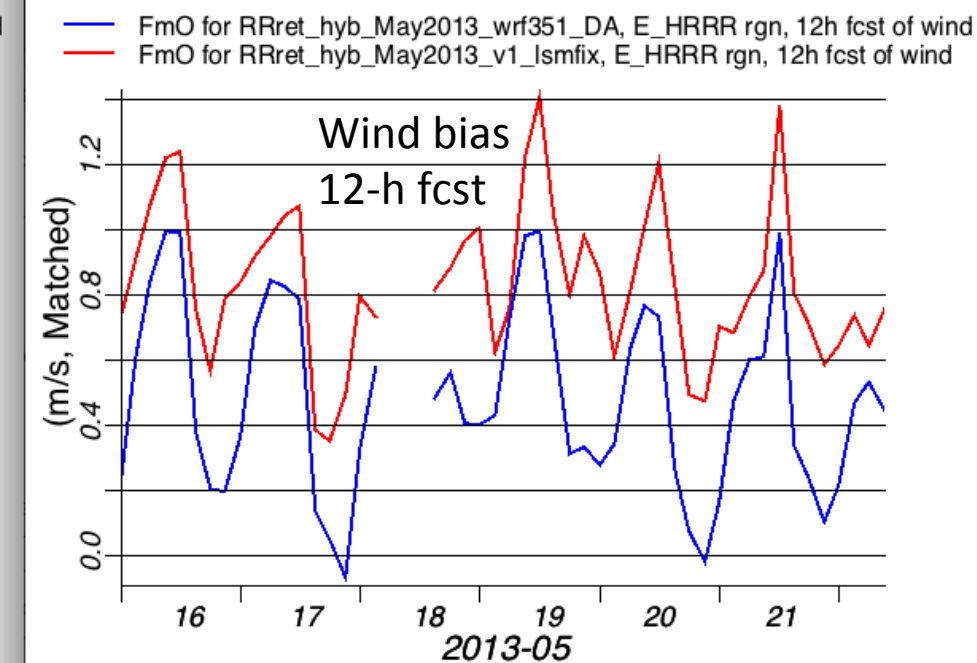

RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of wind
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of wind
Wind RMS
9-h fcst
(m/s, Matched)
2.2
2.6
3.0
3.4
16
17
18
19
20
21
2013-05


RMS for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of wind
RMS for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of wind
Wind RMS
12-h fcst
(m/s, Matched)
2.2
2.6
3.0
3.4
3.8
16
17
18
19
20
21
2013-05


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 3h fcst of wind
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 3h fcst of wind
Wind bias
3-h fcst
(m/s, Matched)
0.0
0.4
0.8
1.2
16
17
18
19
20
2013-05
FmO wind


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 6h fcst of wind
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 6h fcst of wind
Wind bias
6-h fcst
(m/s, Matched)
0.0
0.4
0.8
1.2
16
17
18
19
20
21
2013-05
FmO wind


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 9h fcst of wind
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 9h fcst of wind
Wind bias
9-h fcst
(m/s, Matched)
0.0
0.4
0.8
1.2
16
17
18
19
20
21
2013-05


FmO for RRret_hyb_May2013_wrf351_DA, E_HRRR rgn, 12h fcst of wind
FmO for RRret_hyb_May2013_v1_lsmfix, E_HRRR rgn, 12h fcst of wind
Wind bias
12-h fcst
(m/s, Matched)
0.0
0.4
0.8
1.2
16
17
18
19
20
21
2013-05

Conclusions

- Improvements in
  - Upper winds and RH especially
  - Near-surface winds and temperature
- Will improve aviation forecasts for
  - Ceiling/visibility, turbulence, terminal weather, icing, convection
- Will significantly improve initial conditions for HRRRv2