Iowa DNR 2002 Annual MM5 Modeling Project

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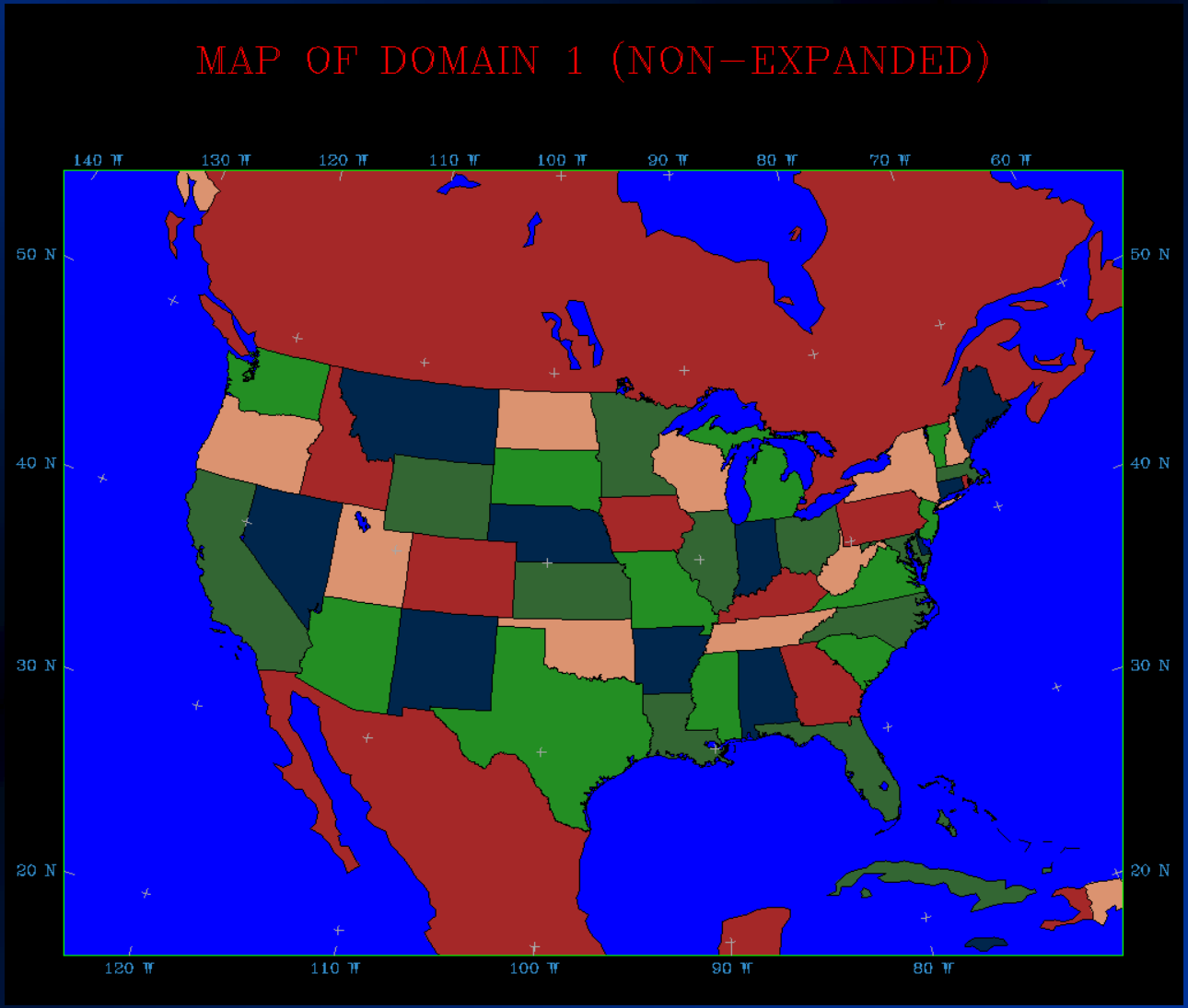
Overview

- 1) Basic info
  - Configuration review
    - Domain
    - Input data
    - Physics options
  - Computational requirements
- 2) *Brief* implementation discussion
- 3) Evaluation
  - Metstat (surface statistics)
  - Raobplot (upper air)
- 4) Summary & Conclusions

Domain

- National RPO specs
- 36 km res
- Projection
  - -97°, 40°
  - 33°, 45°
- Dimensions
  - E-W 165
  - N-S 129



Data Sources

- First-guess fields (REGRID)
  - Eta 3D and surface analysis data (ds609.2)
  - NCEP global tropospheric data (ds083.0)
    - Provides ONLY the sea surface temperatures
      - Eta data uses skin temperatures, which can differ by up to 12º C from observed SSTs along coastlines
- Observational enhancement (LITTLE_R)
  - NCEP ADP surface obs (ds464.0)
    - Land = List E
    - Ship = List F
  - NCEP ADP upper air obs (ds353.4)
    - List A

Physics Options

- Results from the cooperative sensitivity project yielded the following 'optimum' configuration

Physics Option	Selection	configure.user
Moisture	Simple Ice	IMPHYS = 4 (MPHYSTBL = 0)
Cumulus	Kain-Fritsch	ICUPA = 6
Planetary Boundary Layer	Pleim-Chang (ACM)	IBLTYP = 7
Radiation	RRTM	FRAD = 4
Land Surface Model	Pleim-Xiu	ISOIL = 3
Shallow Convection	No	ISHALLO = 0
Nudging (Sfc and Grid)	Yes	FDDAGD = 1

Additional Configuration Choices

- Initialization at 12 Z with 5 day runtime
- Vertical structure
  - 34 Levels - Exactly matched to Dennis McNally's configuration for EPA 2001 run
- PX LSM options
  - Soil temperature and soil moisture fields continuous
    - Requires INTERPX
    - Indirectly nudged using surface conditions
- Additional details and discussion in the protocol:
    - http://www.state.ia.us/epd/air/prof/progdev/RegionModel.htm
    - (Includes modeling system scripts)

Vertical Structure

Level	Sigma	Height (m)	p (mb)	Depth (m)	Level	Sigma	Height (m)	p (mb)	Depth (m)
34	0.000	14662	100	1841	16	0.820	1400	838	166
33	0.050	12822	145	1466	15	0.840	1235	856	163
32	0.100	11356	190	1228	14	0.860	1071	874	160
31	0.150	10127	235	1062	13	0.880	911	892	158
30	0.200	9066	280	939	12	0.900	753	910	78
29	0.250	8127	325	843	11	0.910	675	919	77
28	0.300	7284	370	767	10	0.920	598	928	77
27	0.350	6517	415	704	9	0.930	521	937	76
26	0.400	5812	460	652	8	0.940	445	946	76
25	0.450	5160	505	607	7	0.950	369	955	75
24	0.500	4553	550	569	6	0.960	294	964	74
23	0.550	3984	595	536	5	0.970	220	973	74
22	0.600	3448	640	506	4	0.980	146	982	37
21	0.650	2942	685	480	3	0.985	109	987	37
20	0.700	2462	730	367	2	0.990	73	991	36
19	0.740	2095	766	266	1	0.995	36	996	36
18	0.770	1828	793	259	0	1.000	0	1000	0
17	0.800	1569	820	169					

p_s = 1000 mb; P_{top} = 100 mb; T_s = 275 K; A = 50 K/{ln(PA)}

Temporal Structure

- Annual run consists of four quarters, each quarter ends on the first of a month
  - Dec 29th 2001 - Apr 1st 2002
  - Jun 14th 2002 - Oct 1st 2002
  - Mar 14th 2002 - Jul 1st 2002
  - Sep 14th 2002 - Jan 1st 2003
- Each quarter consists of 27 five day blocks = 108 5 day sims
- Quarterly applications run sequentially (due to PX config)
- Quarters run simultaneously using 4 workstations

Start BLOCK	End BLOCK	Start (Z)	End (Z)	Filename	Metstat Usable		Hrs	Spin	CAMx Usable			
					Start (Z)	End (Z)			Start (Z)	End (Z)	Start (CDT)	End (CDT)
12/13/01 12:00	12/18/01 12:00	12/13/01 12:00	12/13/01 12:00	MMOUT_DOMAIN1_00								
		12/13/01 13:00	12/14/01 12:00	MMOUT_DOMAIN1_01	12/14/01 0:00	12/14/01 12:00	13	11	12/14/01 5:00	12/14/01 12:00	12/14/01 0:00	12/14/01 7:00
		12/14/01 13:00	12/15/01 12:00	MMOUT_DOMAIN1_02	12/14/01 13:00	12/15/01 12:00	24		12/14/01 13:00	12/15/01 12:00	12/14/01 8:00	12/15/01 7:00
		12/15/01 13:00	12/16/01 12:00	MMOUT_DOMAIN1_03	12/15/01 13:00	12/16/01 12:00	24		12/15/01 13:00	12/16/01 12:00	12/15/01 8:00	12/16/01 7:00
		12/16/01 13:00	12/17/01 12:00	MMOUT_DOMAIN1_04	12/16/01 13:00	12/17/01 12:00	24		12/16/01 13:00	12/17/01 12:00	12/16/01 8:00	12/17/01 7:00
		12/17/01 13:00	12/18/01 12:00	MMOUT_DOMAIN1_05	12/17/01 13:00	12/17/01 23:00	11		12/17/01 13:00	12/18/01 5:00	12/17/01 8:00	12/18/01 0:00
12/17/01 12:00	12/22/01 12:00	12/17/01 12:00	12/17/01 12:00	MMOUT_DOMAIN1_00								
		12/17/01 13:00	12/18/01 12:00	MMOUT_DOMAIN1_01	12/18/01 0:00	12/18/01 12:00	13	11	12/18/01 5:00	12/18/01 12:00	12/18/01 0:00	12/18/01 7:00
		12/18/01 13:00	12/19/01 12:00	MMOUT_DOMAIN1_02	12/18/01 13:00	12/19/01 12:00	24		12/18/01 13:00	12/19/01 12:00	12/18/01 8:00	12/19/01 7:00
		12/19/01 13:00	12/20/01 12:00	MMOUT_DOMAIN1_03	12/19/01 13:00	12/20/01 12:00	24		12/19/01 13:00	12/20/01 12:00	12/19/01 8:00	12/20/01 7:00
		12/20/01 13:00	12/21/01 12:00	MMOUT_DOMAIN1_04	12/20/01 13:00	12/21/01 12:00	24		12/20/01 13:00	12/21/01 12:00	12/20/01 8:00	12/21/01 7:00
		12/21/01 13:00	12/22/01 12:00	MMOUT_DOMAIN1_05	12/21/01 13:00	12/21/01 23:00	11		12/21/01 13:00	12/22/01 5:00	12/21/01 8:00	12/22/01 0:00

Computational Requirements

- **CPU**
  - **Each 5 day block requires ~ 42 hours run time***
  - **4536 CPU hours (189 CPU days) required for completion**
    - **47.25 CPU days per quarter**

- **Storage**
  - **Input data: 2.9 Gb per month**
  - **MM5 output: ~ 3.4 Gb per 5 day block**
  - **Intermediate: ~ 4.0 Gb per 5 day block**
  - **TOTAL: ~ 800 Gb**

    MM5 output only: ~ 354 Gb

*** 1 Ghz Pentium III machines, 512 Mb ram**

Methods

- A *brief* overview of the steps comprising the annual run process
  - Determine the modeling system configuration
    - Accomplished through the MM5 sensitivity project
  - Overview of subsequent tasks
    1) Evaluate computational requirements
    2) Obtain necessary input data
    3) Determine the structure of blocks & quarters
    4) Process the first-guess data via pregrid
    5) Build and execute the master and slave scripts
    6) Be patient
    7) Evaluate results

Methods

- **Input data:**
  - **Each month requires 12 input files (occupies 3 Gb)**
    - **3 Eta files (two 3D files, one Sfc file)**
    - **1 NCEP global analysis file**
    - **6 Sfc ADP files**
    - **1 Ship obs ADP file**
    - **1 ADP upper air obs file**

- **Process quarterly first-guess data through PREGRID**
  - **This process is independent of when the MM5 blocks start/end**
  - **Make certain that all *.tm12 Eta files are deleted**

Methods

- Scripting invaluable...
  - The master script is responsible for automating the quarterly simulations
    - Assigns starting/stopping dates
    - Runs each piece of the MM5 modeling system
    - Archives data
    - Ensures correct termination of MM5 before continuation
    - Designed to optimize use of computational resources
  - The MM5 preprocessors are controlled via the master
    - Slight modifications made congruent with the master

Master Script

qrtr.a-JFM.deck (locked) - /raid5/2002mm5/a-JFM/startup-scripts/

File Edit Search Preferences Shell Macro Windows

/raid5/2002mm5/a-JFM/startup-scripts/qrtr.a-JFM.deck 5845 bytes

```
#!/bin/sh
date > .timing


#-----------------------------------------------------------------------------
#       Starting/Ending Date of 1st Block in Loop to Process + other vars
#-----------------------------------------------------------------------------
export    START_YR="2002"
export    START_MO="01"
export    START_DY="02"
export    START_HR="12"

export      END_YR="2002"
export      END_MO="01"
export      END_DY="07"
export      END_HR="12"

              qrtr="a-JFM"
               src="/raid5/cow/node1/mm5v351.px-2k2"
```

```
echo '                INTERPX                                          ' `date`
  ipxdate=`/raid5/2002mm5/STATIC/dategen/src/dategen "${START_YR}-${START_MO}-${START_DY}_${START_HR}" -96
  START_YR_X=`echo $ipxdate | cut -c1-4`
  START_MO_X=`echo $ipxdate | cut -c6-7`
  START_DY_X=`echo $ipxdate | cut -c9-10`
  export ipxdir="/raid5/2002mm5/${qrtr}/${START_YR_X}-${START_MO_X}-${START_DY_X}"
  cd  $src/INTERPX
     ./interpx.deck >>stdout.interpx.txt 2>&1
     cp interpx.deck                        $archive/.
     mv log.interpx.D1.txt                  $archive/.
     mv MMINPUTSM_DOMAIN1                   $archive/.


echo '                MM5                                              ' `date`
  rm -f /mm5tmp/MMINPUTSM_DOMAIN1    ;cp      $archive/MMINPUTSM_DOMAIN1   /mm5tmp/.
  rm -f /mm5tmp/BDYOUT_DOMAIN1       ;cp      $archive/BDYOUT_DOMAIN1      /mm5tmp/.
  rm -f /mm5tmp/LOWBDY_DOMAIN1       ;cp      $archive/LOWBDY_DOMAIN1      /mm5tmp/.
  rm -f /mm5tmp/SFCFDDA_DOMAIN1      ;cp      $archive/SFCFDDA_DOMAIN1     /mm5tmp/.
  cd  $src/MM5/Run
     rm -f MMINPUT_DOMAIN1      ;ln -s      /mm5tmp/MMINPUTSM_DOMAIN1 MMINPUT_DOMAIN1
     rm -f MMINPUT2_DOMAIN1     ;ln -s      /mm5tmp/MMINPUTSM_DOMAIN1 MMINPUT2_DOMAIN1
     rm -f BDYOUT_DOMAIN1       ;ln -s      /mm5tmp/BDYOUT_DOMAIN1   .
     rm -f LOWBDY_DOMAIN1       ;ln -s      /mm5tmp/LOWBDY_DOMAIN1   .
     rm -f SFCFDDA_DOMAIN1      ;ln -s      /mm5tmp/SFCFDDA_DOMAIN1  .
  cd ..
     ./mm5.deck >>stdout.mm5.txt 2>&1  &
     wait
  cd  $src/MM5/Run
     echo '                Moving Output                                ' `date`
     cp ../mm5.deck                         $archive/.
     mv log.mm5.txt                         $archive/.
     mv timing.out                          $archive/.
     mv MMOUT_DOMAIN1_00                    $archive/.
     mv MMOUT_DOMAIN1_01                    $archive/.
     mv MMOUT_DOMAIN1_02                    $archive/.
     mv MMOUT_DOMAIN1_03                    $archive/.
     mv MMOUT_DOMAIN1_04                    $archive/.
     mv MMOUT_DOMAIN1_05                    $archive/.
```

…Master Script & LITTLE_R (as an example MM5 system script)

```
#-----------------------------------------------------------------------------
#                        Check output and Advance (or End)
#-----------------------------------------------------------------------------
  cd  $src/startup
     if tail -10 $archive/log.mm5.txt | grep -F "432000" > /dev/null  ;then
        newsdate=`/raid5/2002mm5/STATIC/dategen/src/dategen "${START_YR}-${START_MO}-${START_DY}_${START_HR}" 96`
        export   START_YR=`echo $newsdate | cut -c1-4`
        export   START_MO=`echo $newsdate | cut -c6-7`
        export   START_DY=`echo $newsdate | cut -c9-10`
        export   START_HR=`echo $newsdate | cut -c12-13`
        newedate=`/raid5/2002mm5/STATIC/dategen/src/dategen "${END_YR}-${END_MO}-${END_DY}_${END_HR}" 96`
        export     END_YR=`echo $newedate | cut -c1-4`
        export     END_MO=`echo $newedate | cut -c6-7`
        export     END_DY=`echo $newedate | cut -c9-10`
        export     END_HR=`echo $newedate | cut -c12-13`
     else
        echo '!!! MODEL ERROR -- STOPPING !!!'
        date >> .timing
        exit 1
     fi

     if [ ${END_YR} -eq 2002  -a  ${END_MO} -ge 04  -a  ${END_DY} -gt 01 ]  ;then
        continue=false
     fi
done
date >> .timing
exit 0
```

little_r.deck - /raid5/cow/node1/mm5v351.px-2k2/LITTLE_R/

File Edit Search Preferences Shell Macro Windows

/raid5/cow/node1/mm5v351.px-2k2/LITTLE_R/little_r.deck line 1, col 0, 3136 bytes

```
#!/bin/sh
date > .timing

DOMAINS="1"
for D in $DOMAINS
do

cat > namelist.input << -EOF-
&record1
 start_year                    =  ${START_YR}
 start_month                   =  ${START_MO}
 start_day                     =  ${START_DY}
 start_hour                    =  ${START_HR}
 end_year                      =  ${END_YR}
 end_month                     =  ${END_MO}
 end_day                       =  ${END_DY}
 end_hour                      =  ${END_HR}
 interval                      = 10800/

&record2
 fg_filename                   = "${archive}/REGRID_DOMAIN${D}"
 obs_filename                  =
-EOF-
/raid5/2002mm5/STATIC/dategen/src/dategen "${START_YR}-${START_MO}-${START_DY}_${START_HR}" 12 >>namelist.input
cat >> namelist.input << -EOF-
 sfc_obs_filename              =
-EOF-
/raid5/2002mm5/STATIC/dategen/src/dategen "${START_YR}-${START_MO}-${START_DY}_${START_HR}"  3 >>namelist.input
cat >> namelist.input << -EOF-
                                                                  /

&record3
 max_number_of_obs             = 10000
 fatal_if_exceed_max_obs       = .TRUE./
```

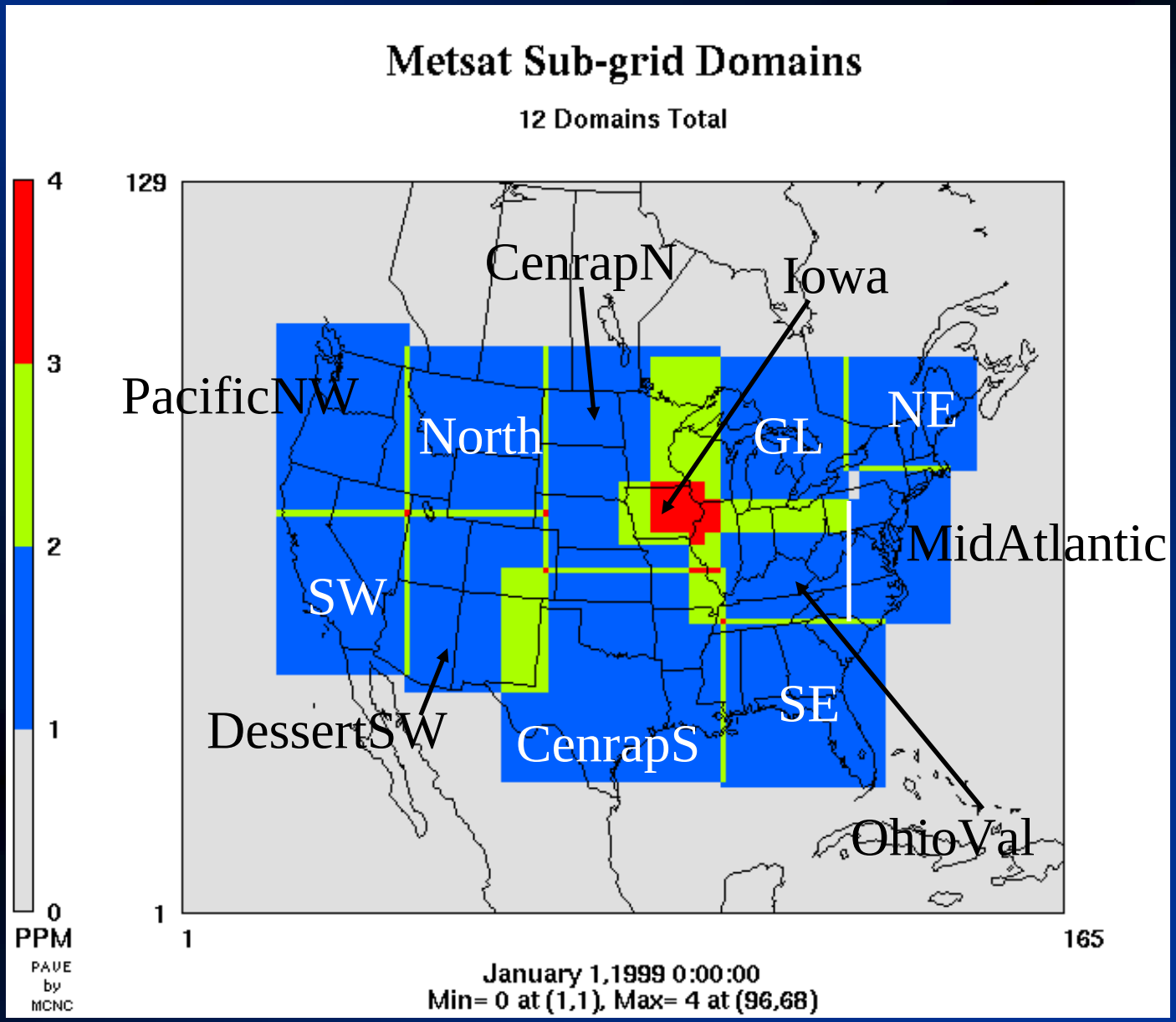
Results

- **Model Performance**
  - **A thorough evaluation of all meteorological data requires both objective and subjective evaluation of many fields across the entire modeling domain**
    - **The time requirements for a thorough evaluation are staggering, thus decisions must be made regarding the nature of evaluation efforts**

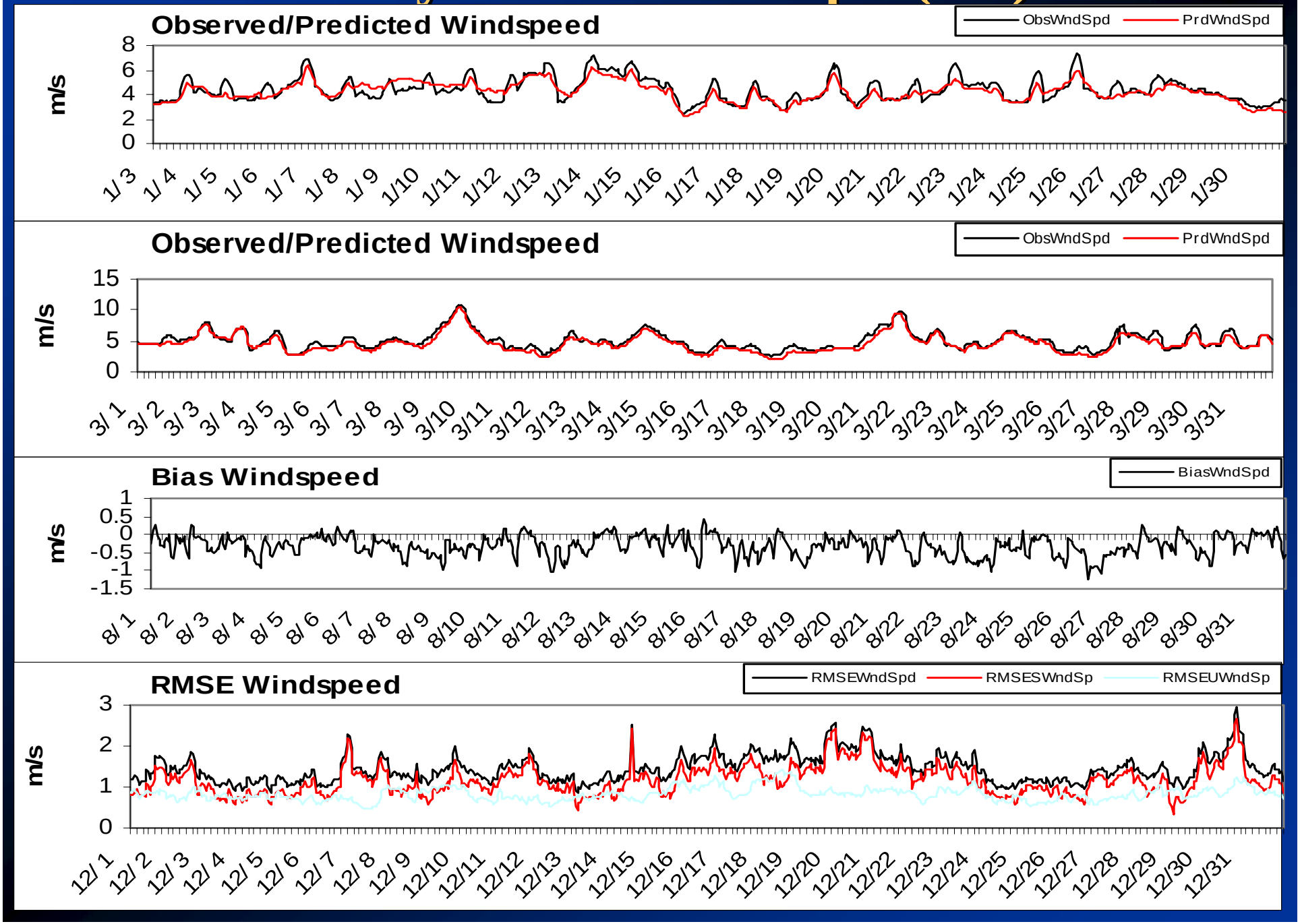
- **Focus → The statistical evaluation produced via Metstat, in combination with analysis of observed vs predicted soundings**

Statistical Model Evaluation - Sub Domains

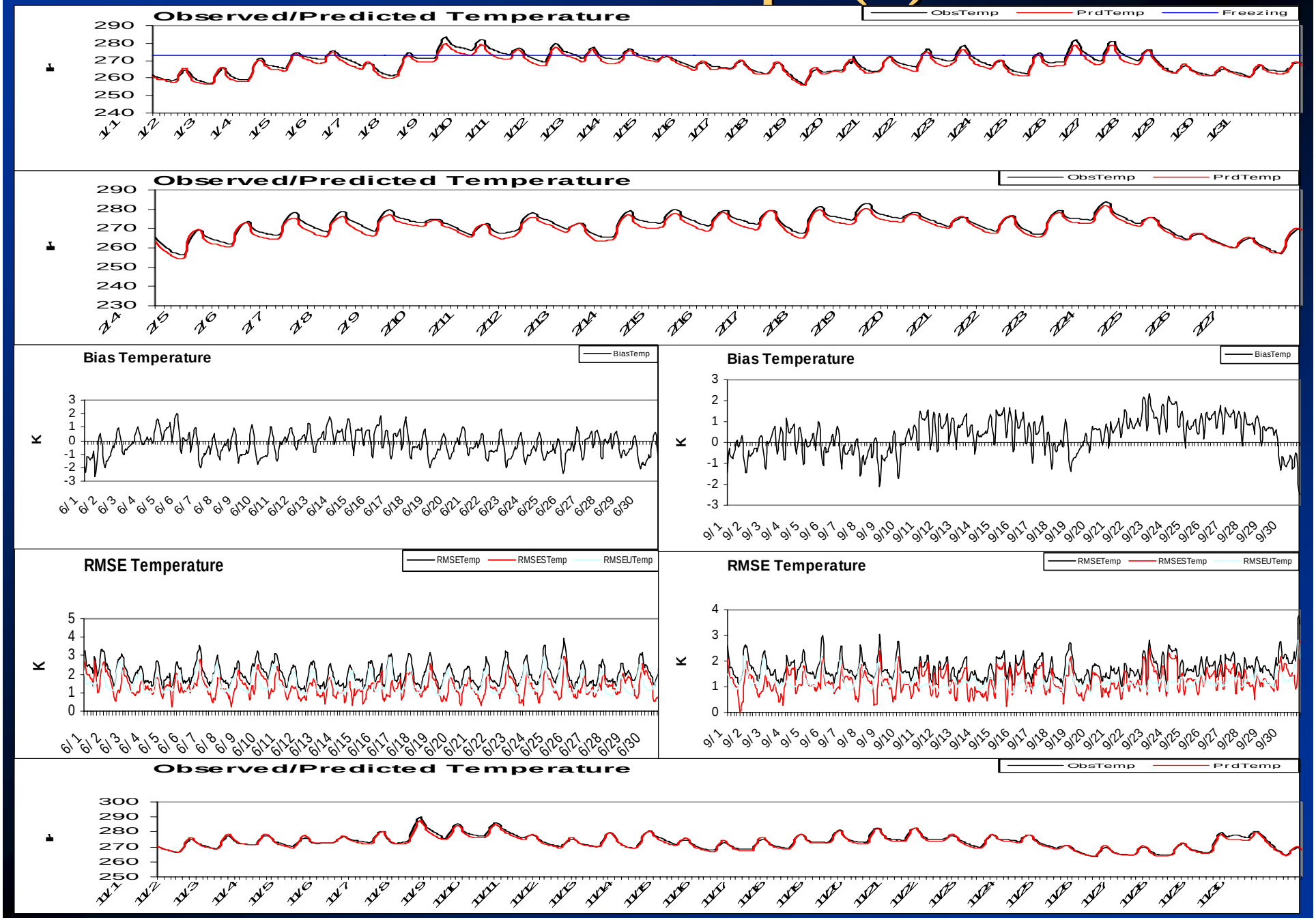
- 12 Sub-domains
  - CenrapN
  - CenrapS
  - DessertSW
  - GL
  - Iowa
  - MidAtlantic
  - North
  - NE
  - OhioVal
  - PacificNW
  - SE
  - SW
- Metstat data processed & plotted over all domains



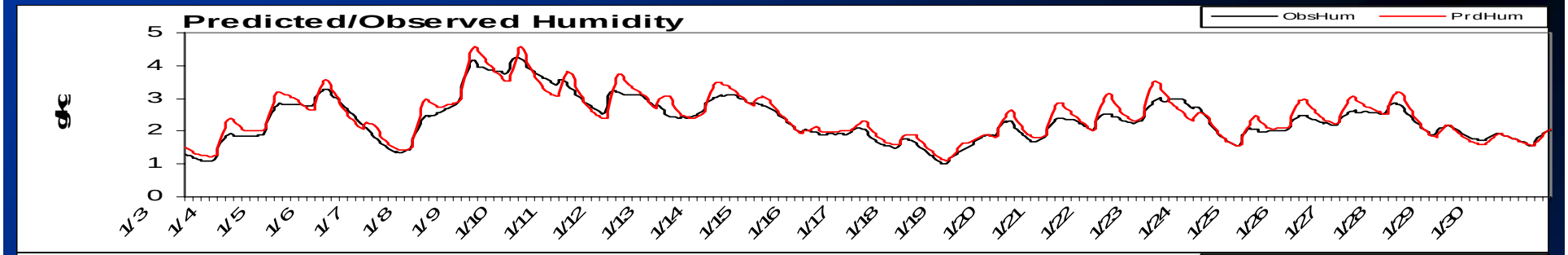
Hourly Results: CenrapN (Ws)

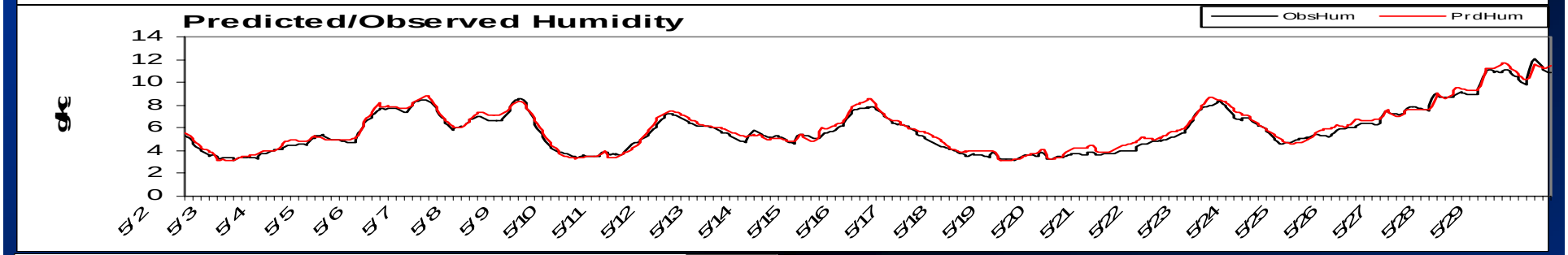


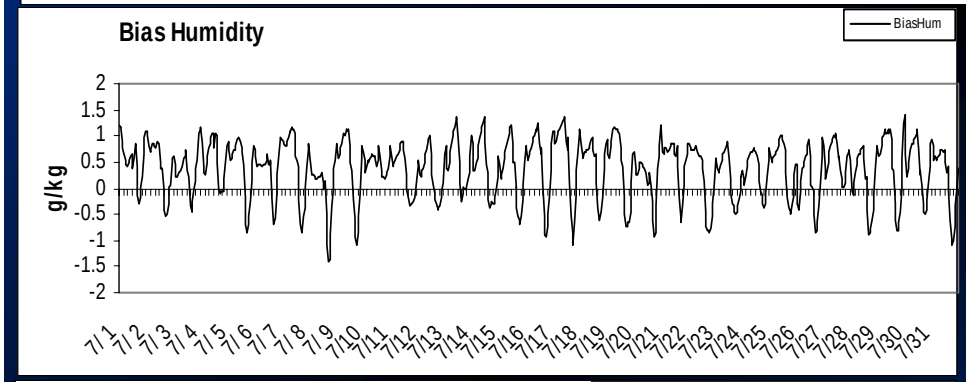
Results: CenrapN (T)

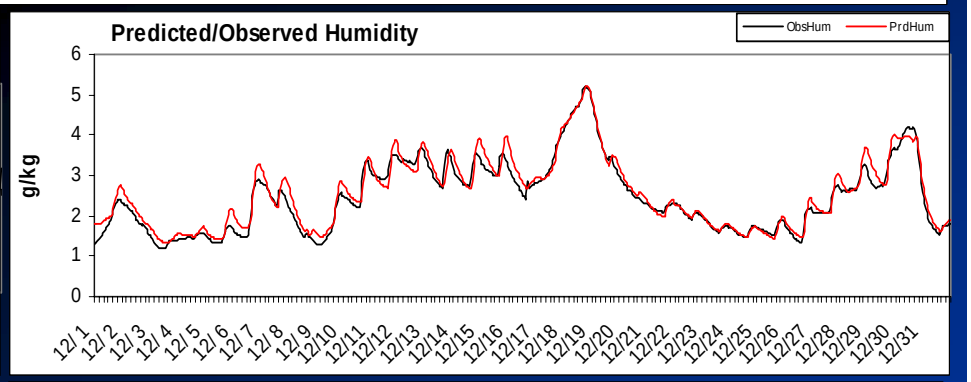


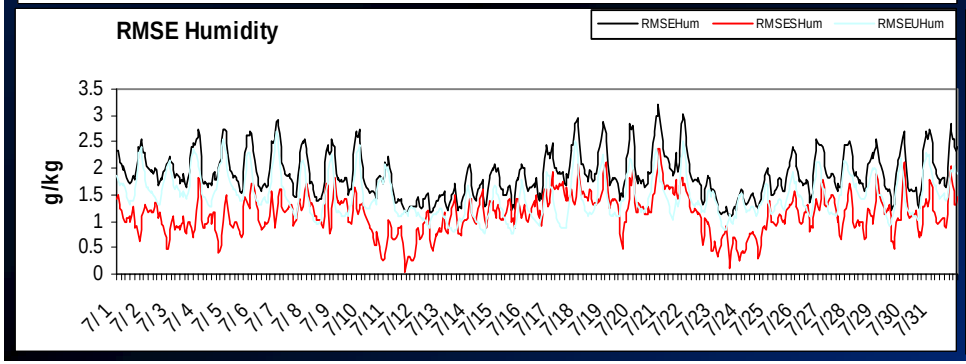
Results: CenrapN (q)

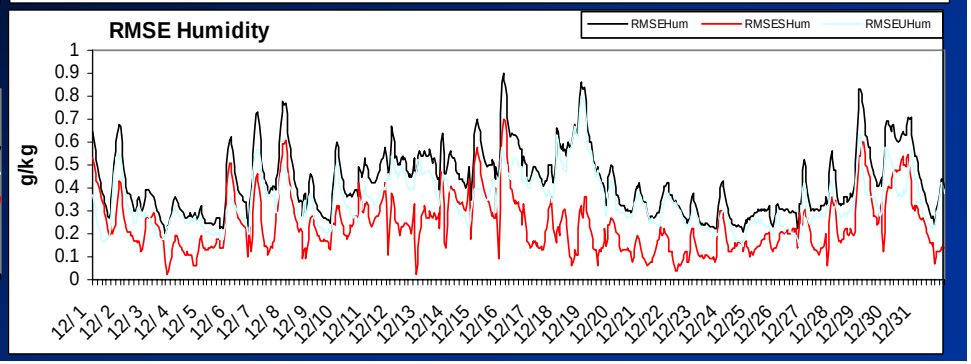








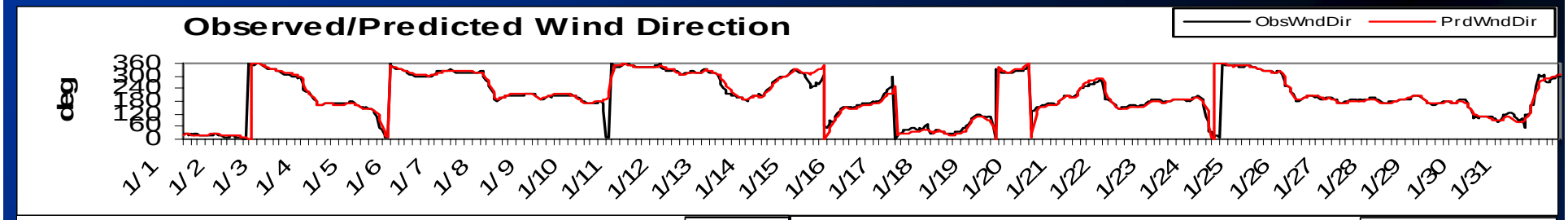


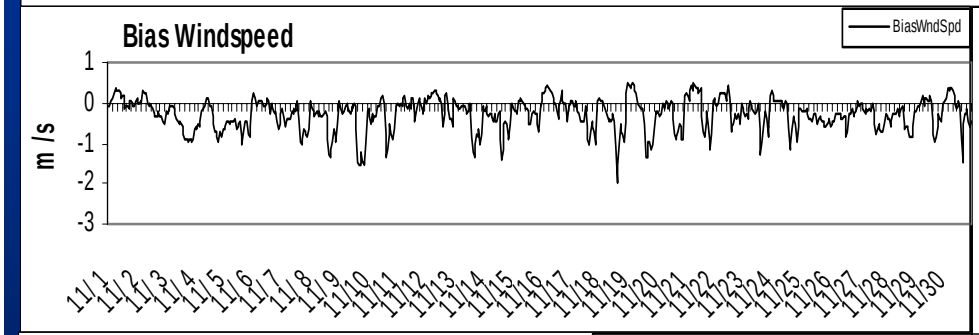


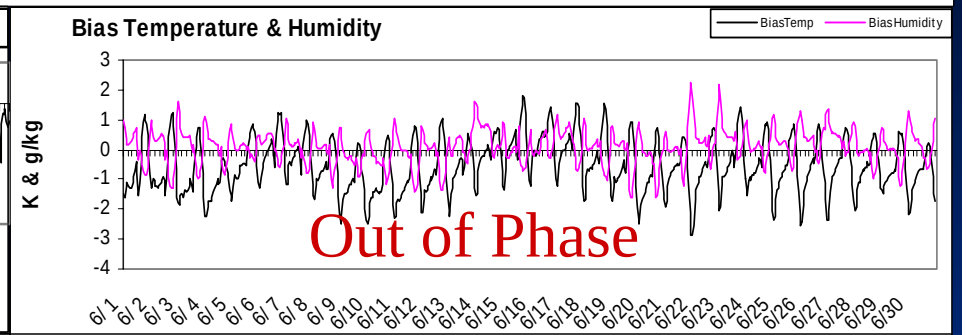
CenrapN Hourly Results Summary

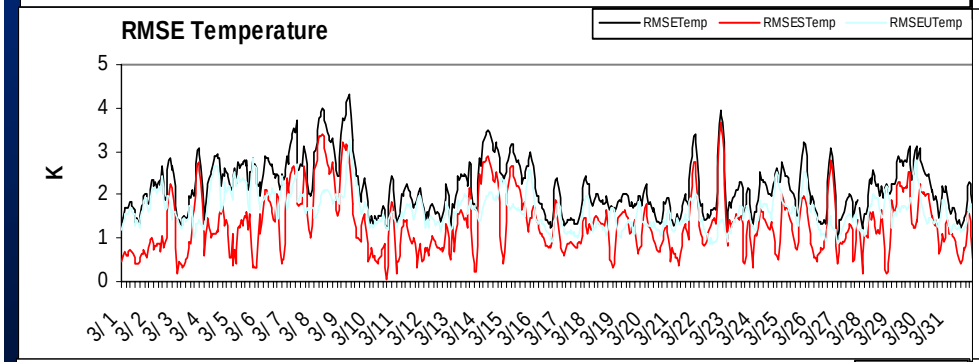
- CenrapN
  - Winter T prediction too cool
    - Lows too low, high temp prediction variable
  - Winter moisture prediction elevated vs obs
  - From late Spring through Fall: T&q predictions improved
    - Towards December, cool bias returns → again, resulting from lows being too cold
  - Throughout the year, a positive moisture bias emerges; errors generally within acceptable limits
  - Wind fields almost always within acceptable limits throughout the annual simulation
    - Worst trend: tendency to underpredict daytime max – nighttime wind fields acceptable

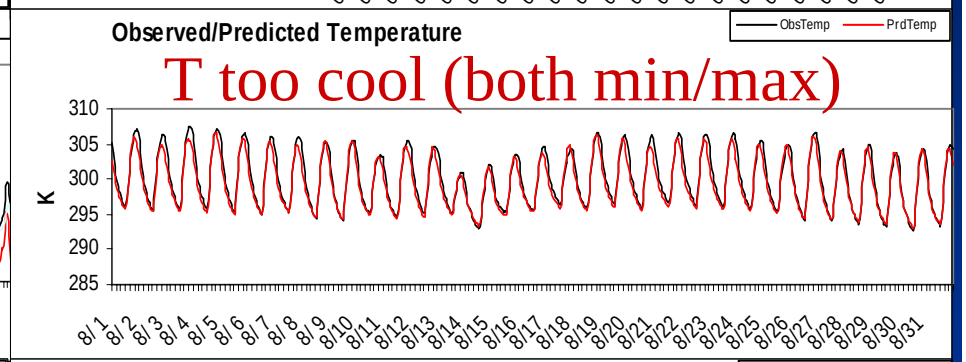
Results: CenrapS

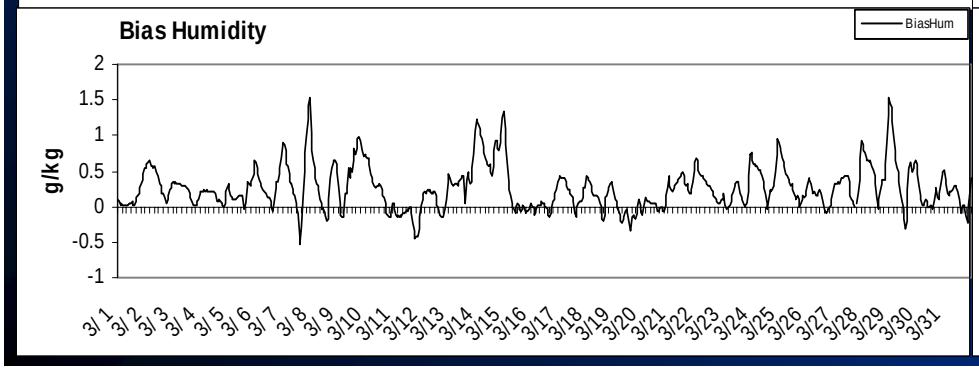


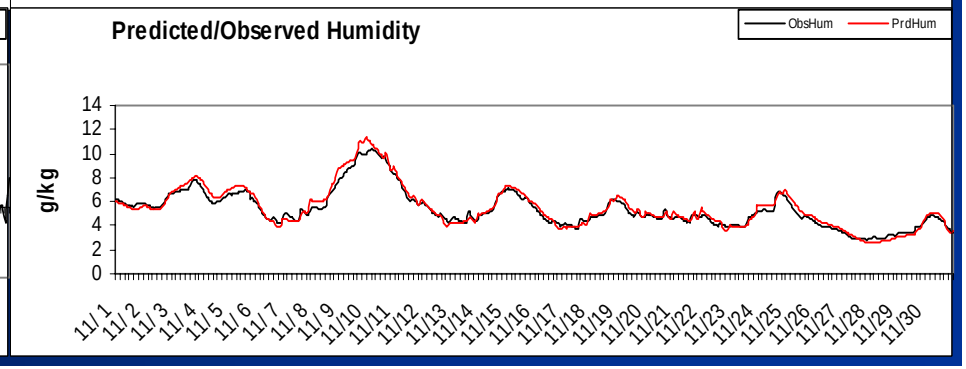




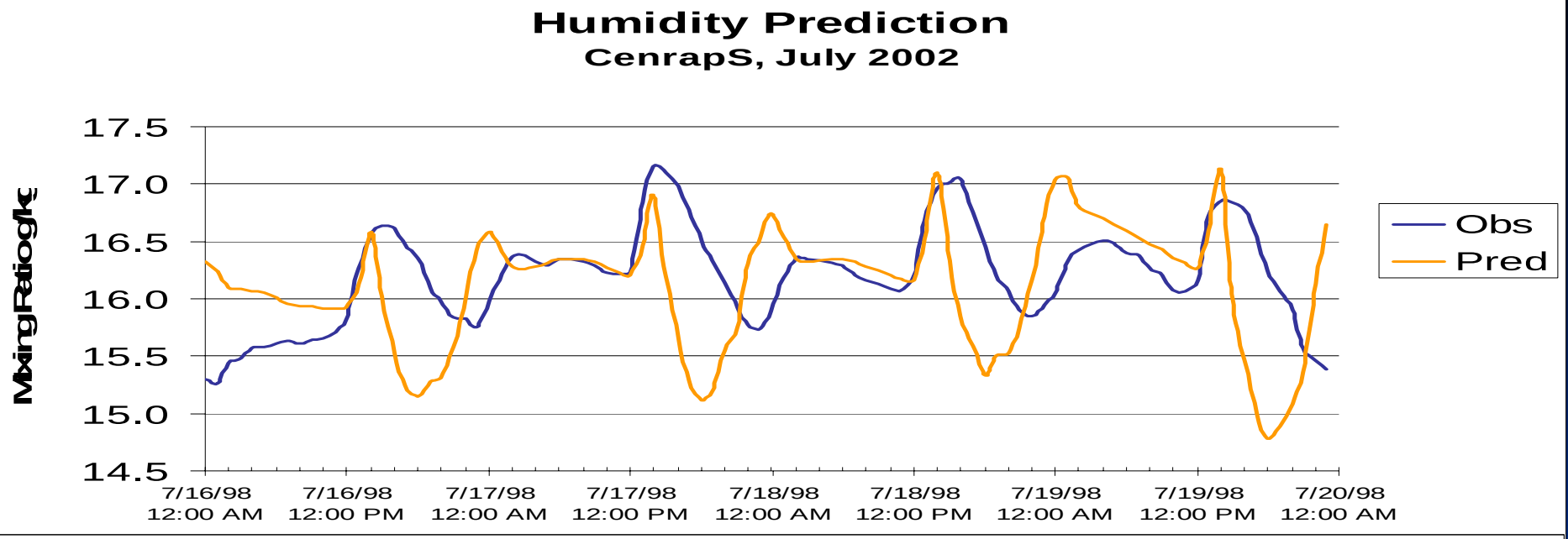


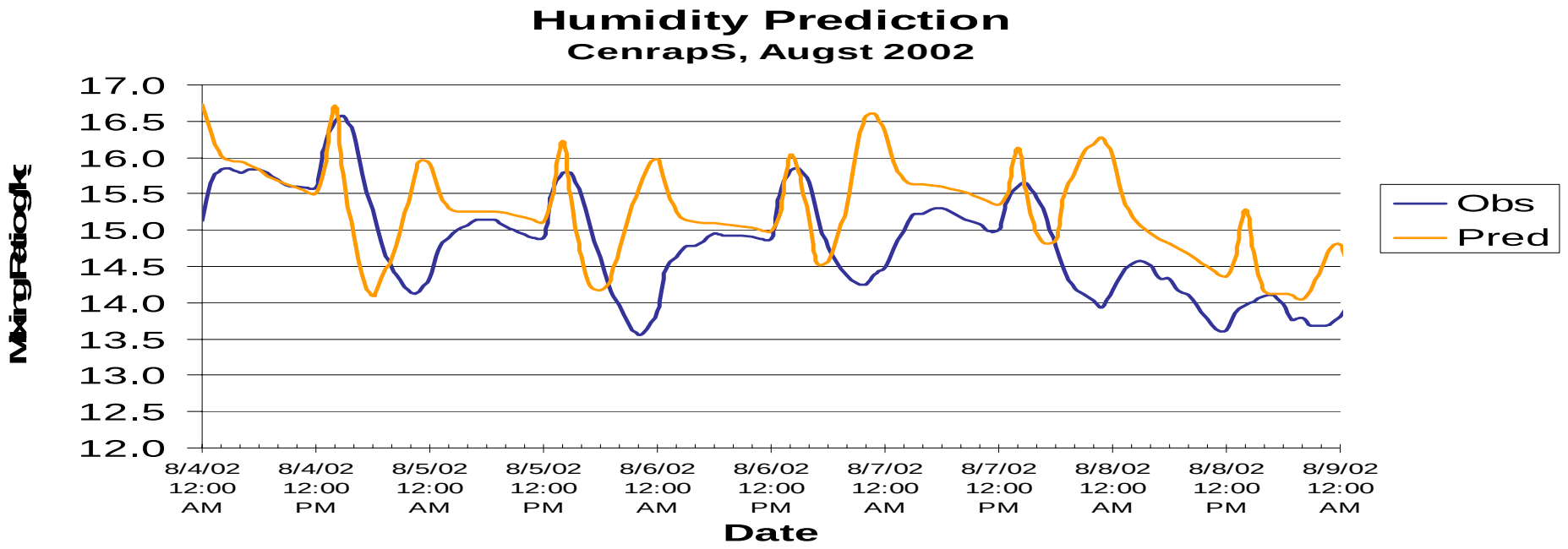






CenrapS: Diurnal Moisture 'Trends'





CenrapS Hourly Results Summary

- Wind speeds consistently underpredicted throughout year (gross error generally < 2 m/s)
- Temperature
  - Winter prediction improved vs CenrapN
  - Jan - May: prediction acceptable, with no predominant biases emerging
  - June through Mid September: neg biases emerge
  - Mid-Sep - Dec: neg T bias erodes, improving the temperature prediction

CenrapS Hourly Results Summary

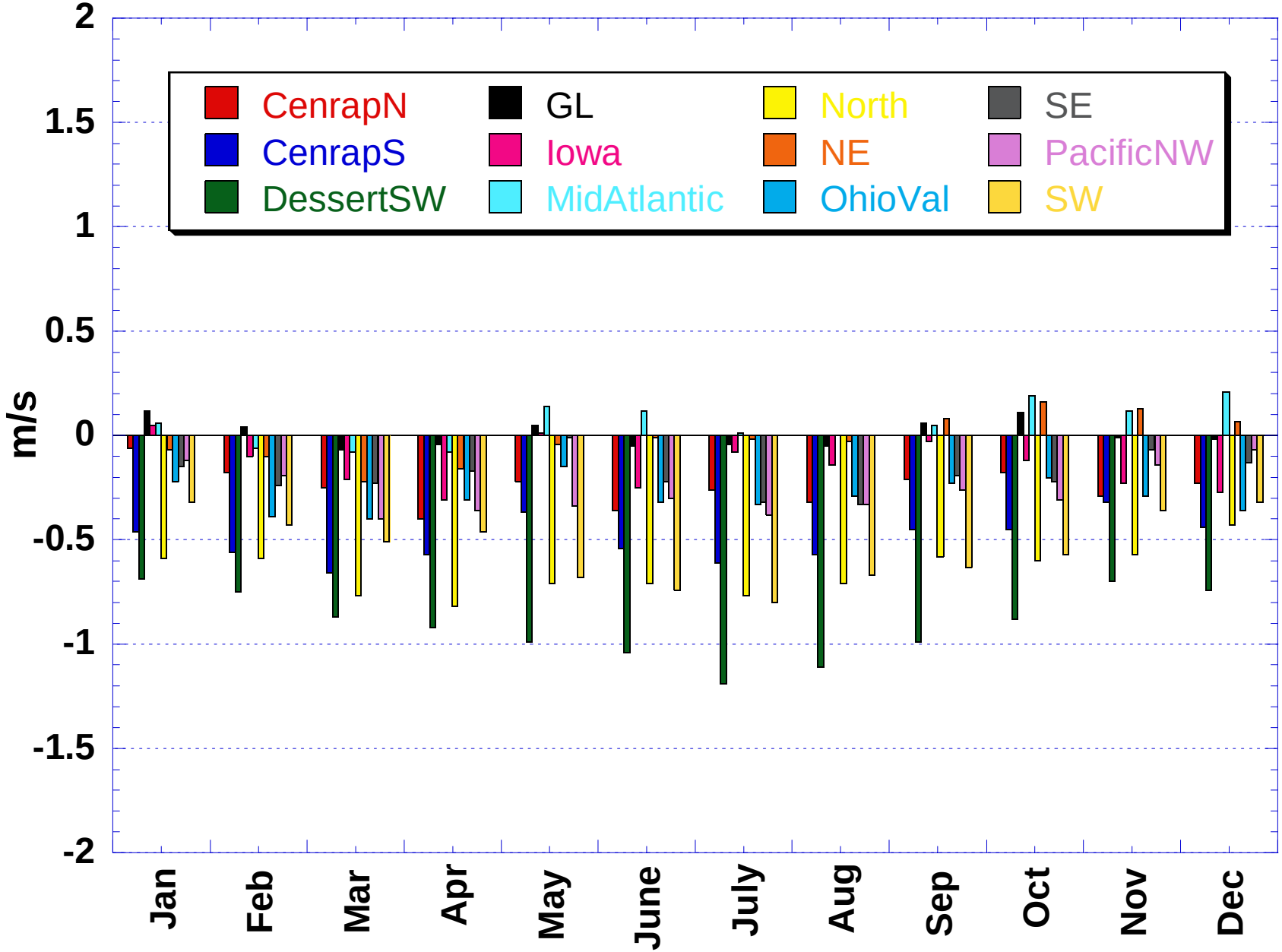
- **Mixing ratio**
  - **Jan-May mixing ratio predominantly positively biased**
  - **May-Sep: q prediction improves, but episodes of degraded performance occur**
  - **Oct-Dec mixing ratio prediction improves**
  - **When biases occur, T&q predominantly out of phase**
  - **Hourly and episodic performance variability the dominant feature in moisture fields**

Daily Averaged Data

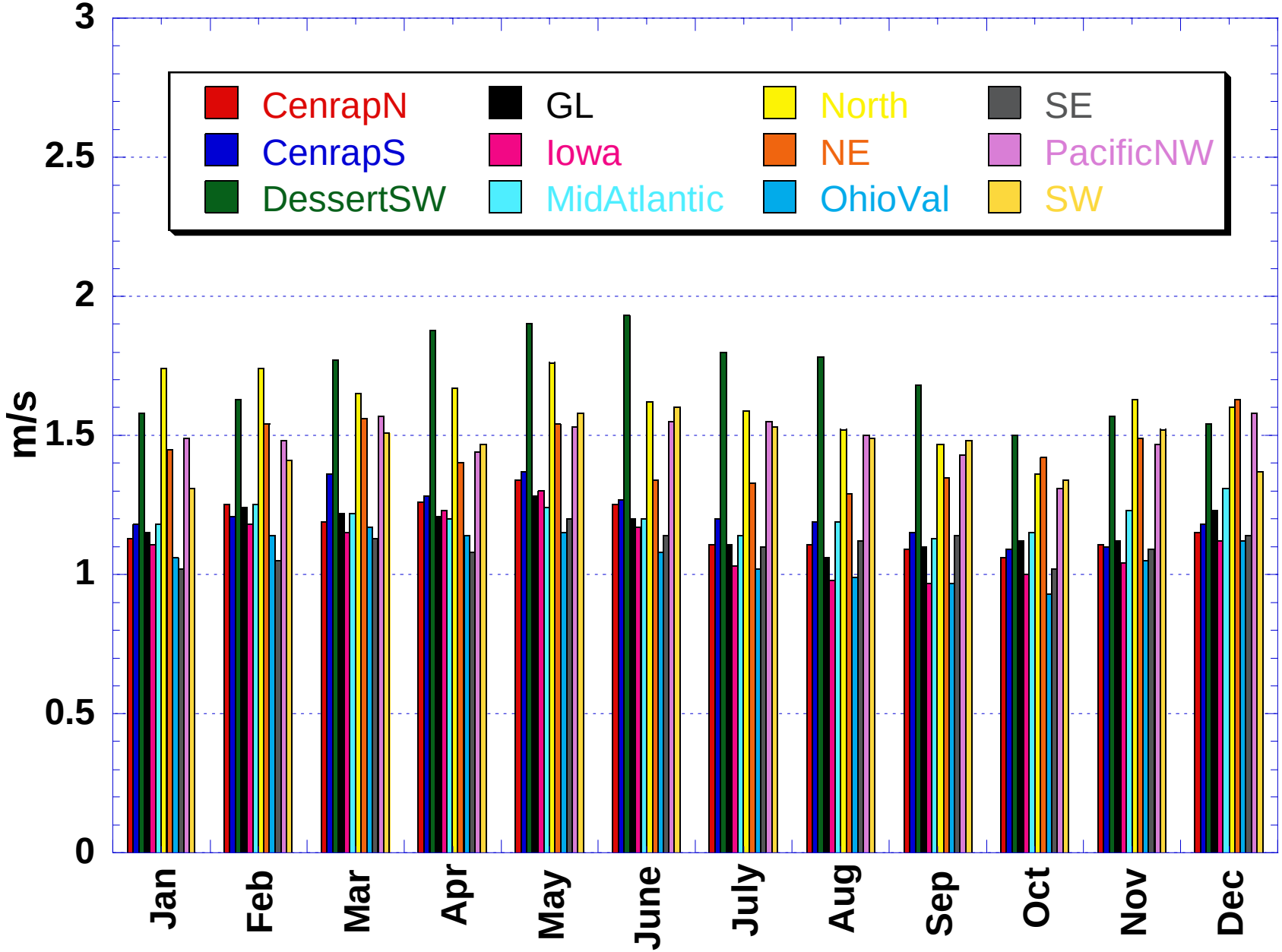
- While certain nuances and biases exist in the CenrapN and CenrapS regions, in general, the simulation is tolerable over these regions

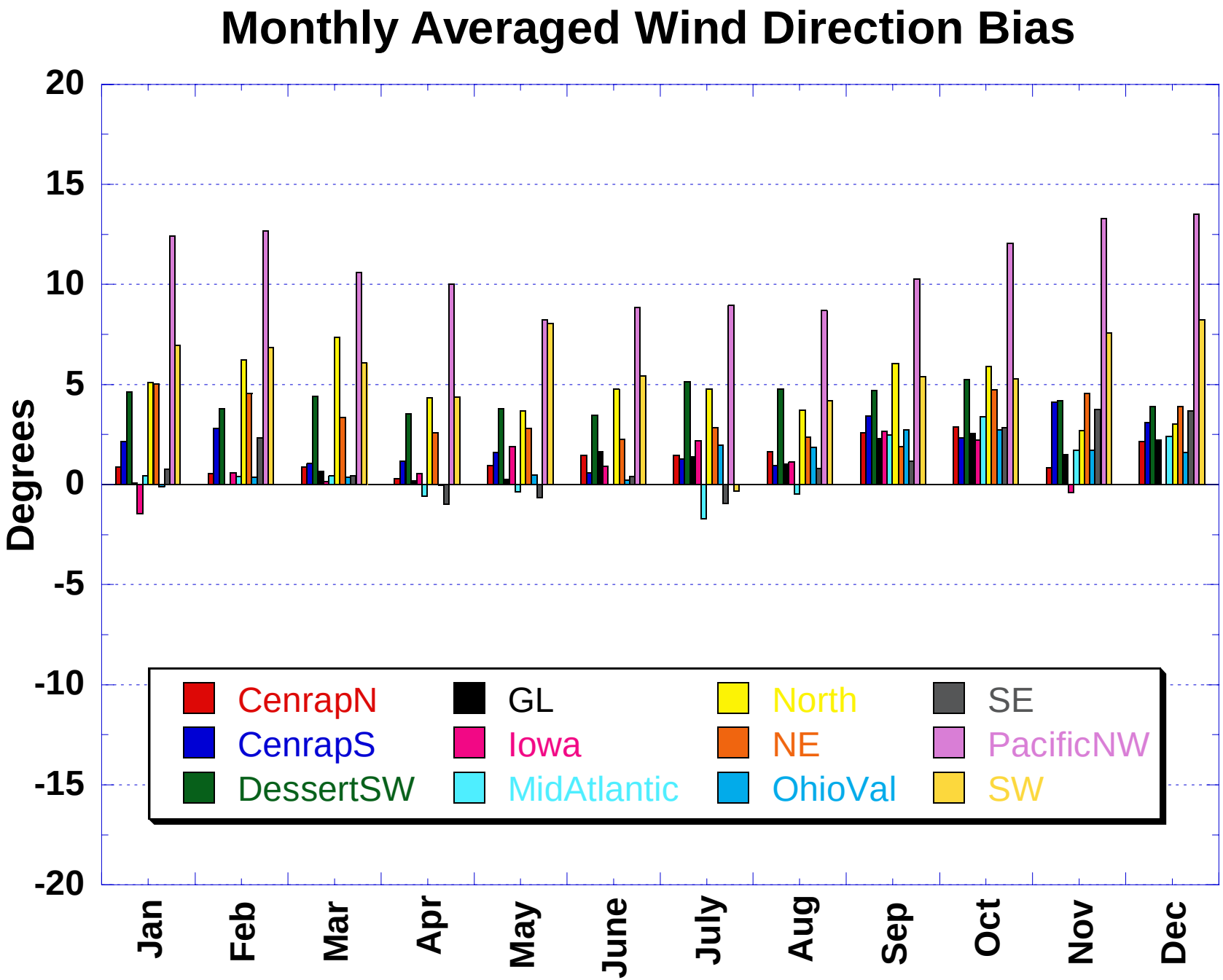
- ...Time to examine other areas of the country
  - Focusing upon hourly statistics far too time consuming
  - Daily statistics only partially improves the problem
    - Solution: Monthly averaged statistics
      - (caveat…not a perfect solution)

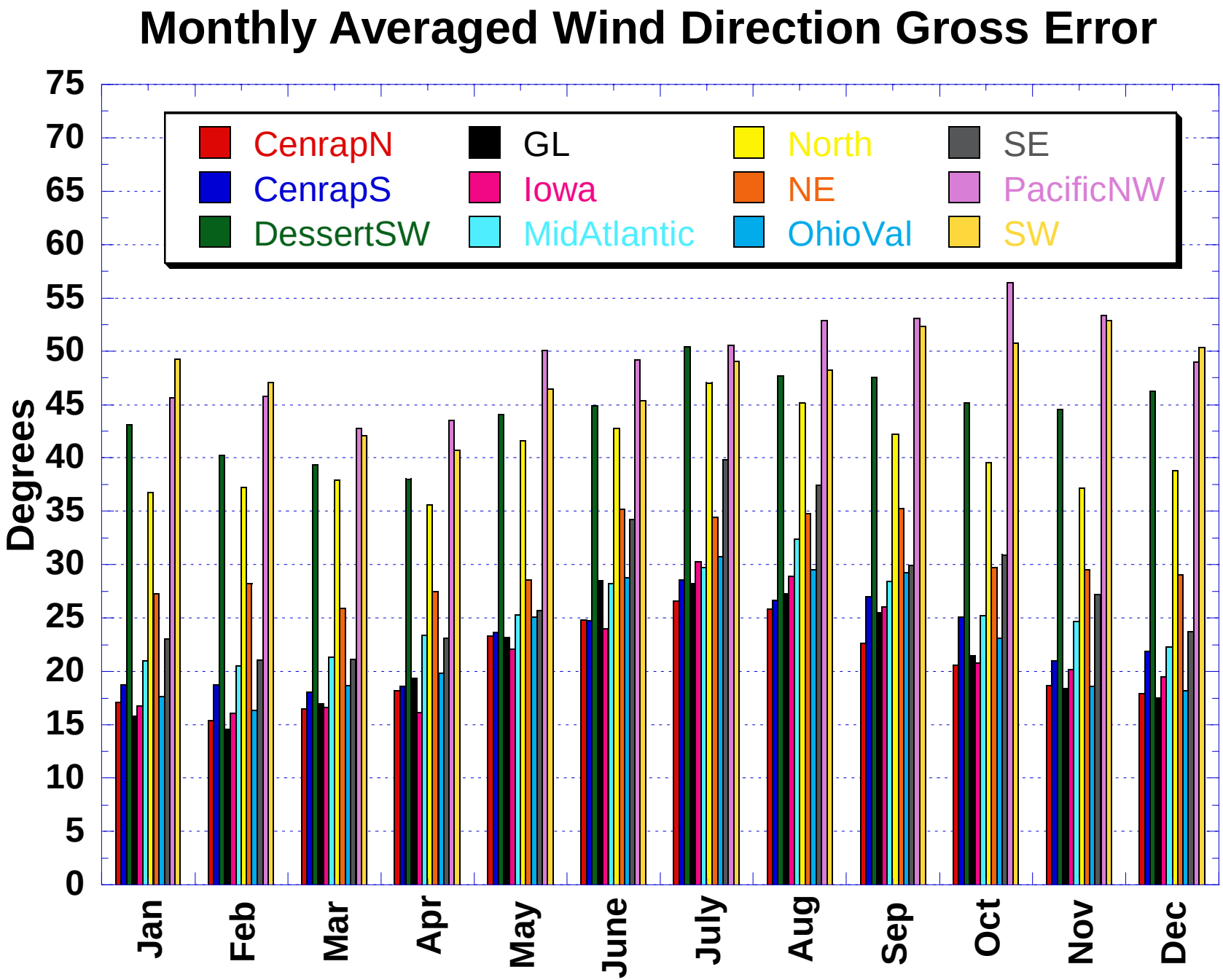
Monthly Averaged Wind Speed Bias



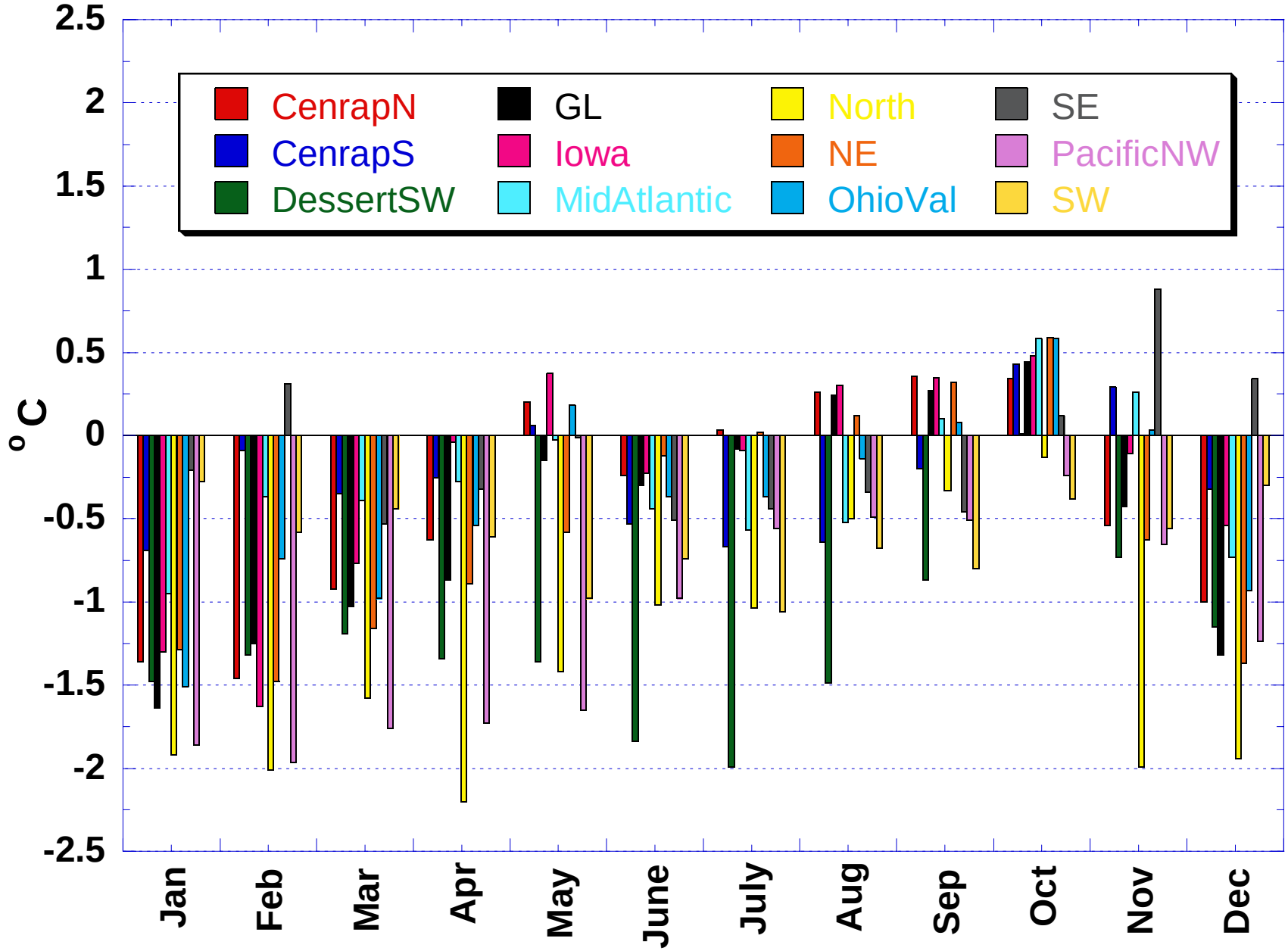
Monthly Averaged Wind Speed Gross Error

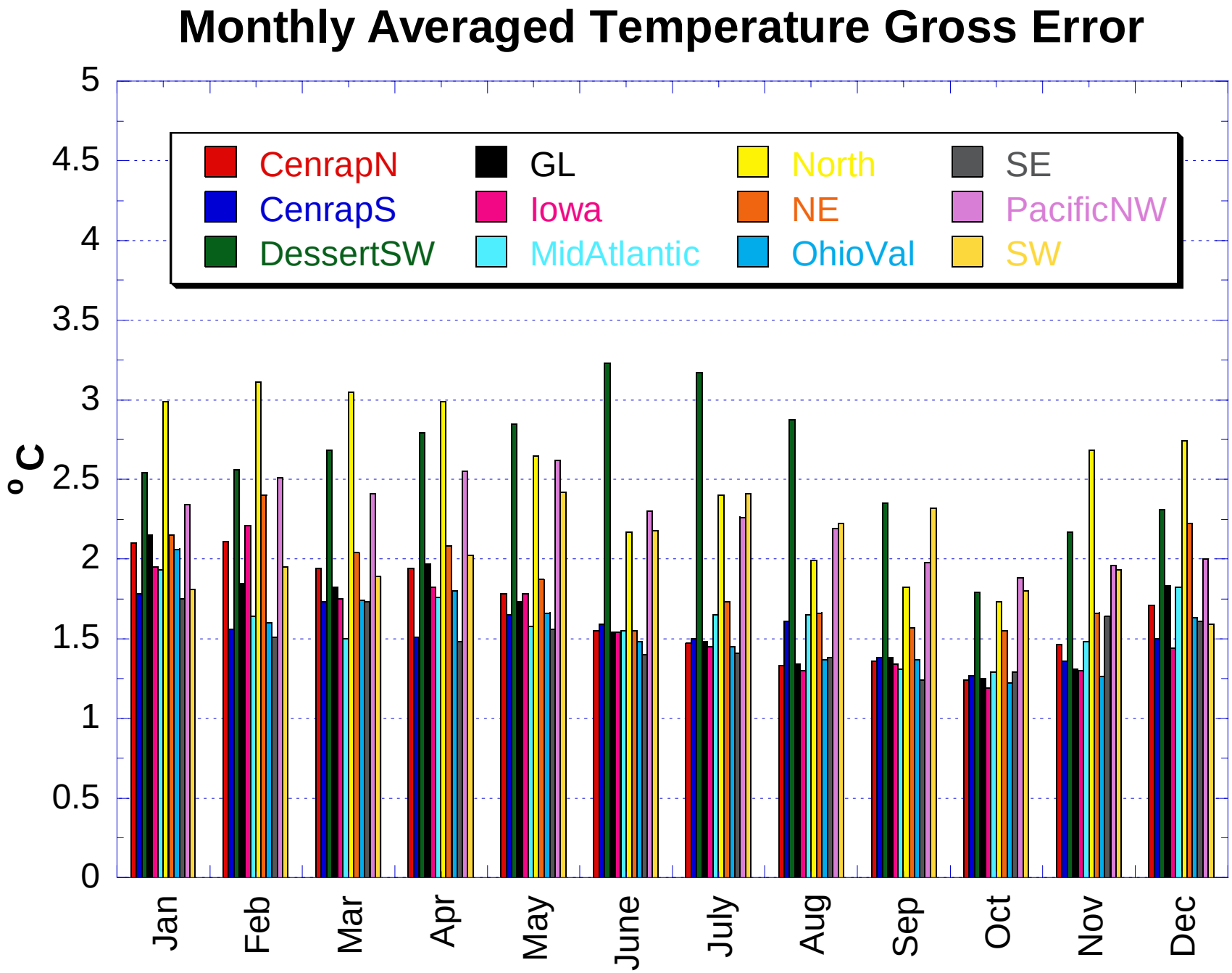



Monthly Averaged Wind Direction Bias
Degrees
20
15
10
5
0
-5
-10
-15
-20
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
CenrapN
CenrapS
DessertSW
GL
Iowa
MidAtlantic
North
NE
OhioVal
SE
PacificNW
SW

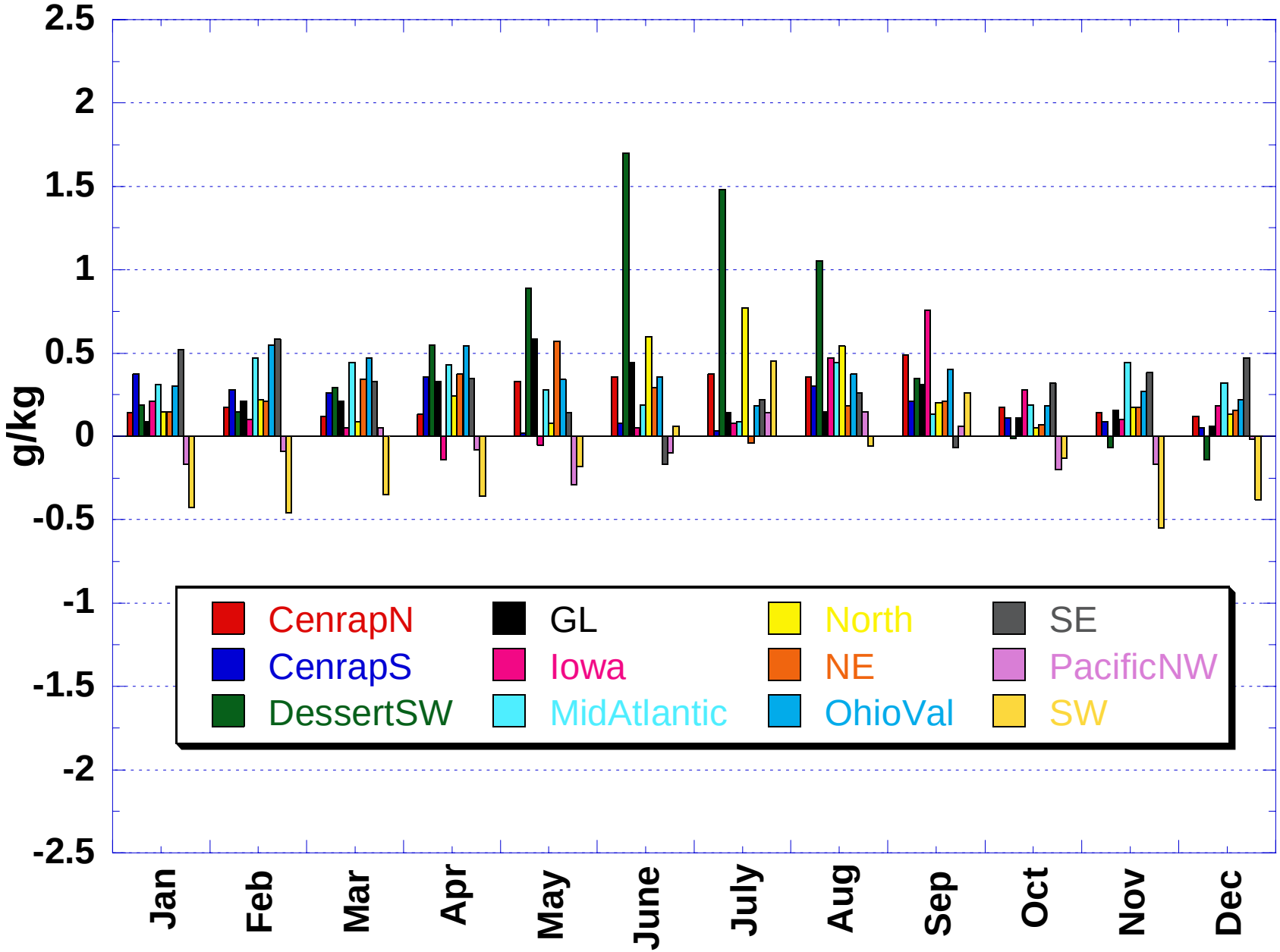

Monthly Averaged Wind Direction Gross Error
Degrees
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
CenrapN
CenrapS
DessertSW
GL
Iowa
MidAtlantic
North
NE
OhioVal
SE
PacificNW
SW
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec

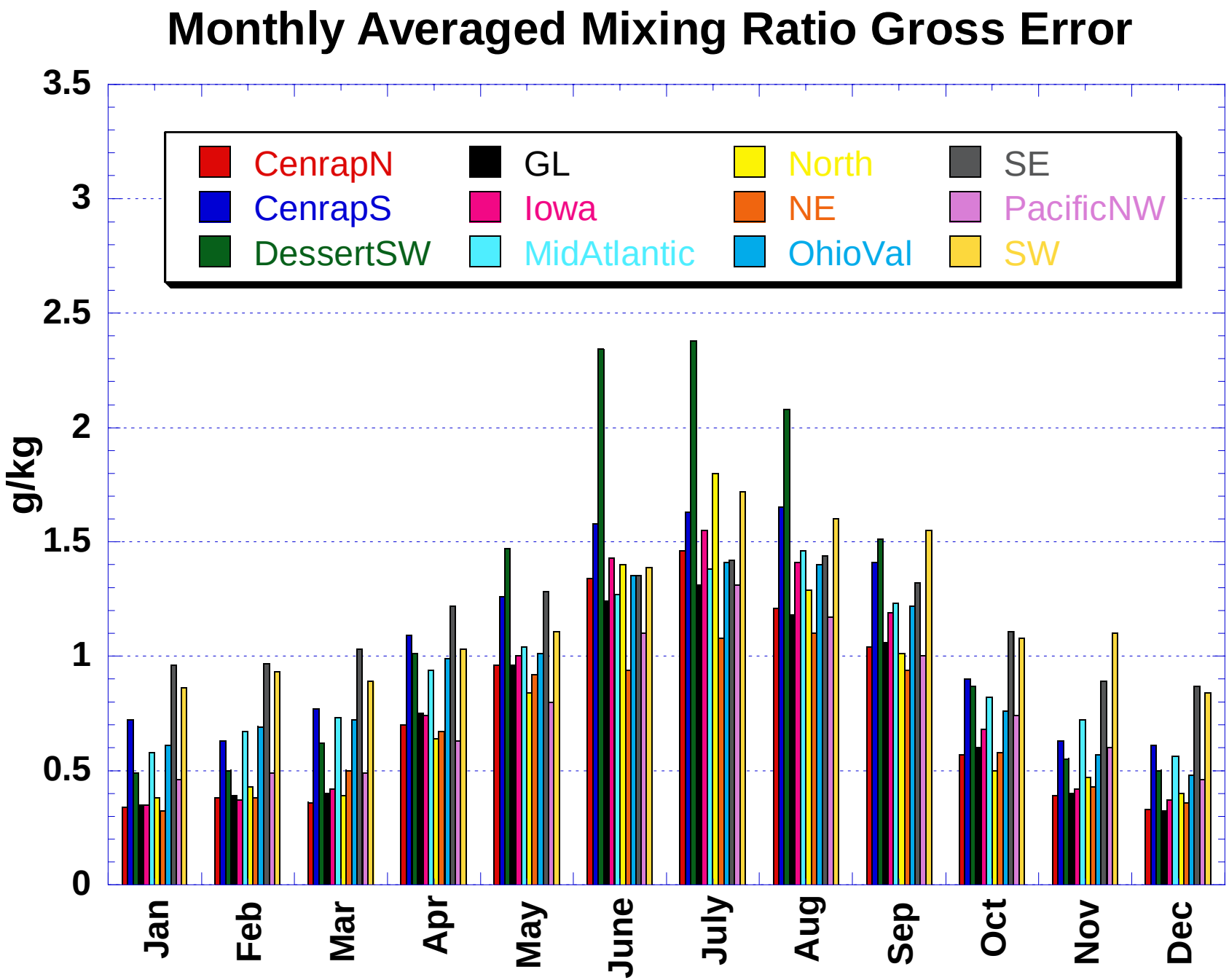
Monthly Averaged Temperature Bias




Monthly Averaged Temperature Gross Error
CenrapN
CenrapS
DessertSW
GL
Iowa
MidAtlantic
North
NE
OhioVal
SE
PacificNW
SW
°C
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec

Monthly Averaged Mixing Ratio Bias



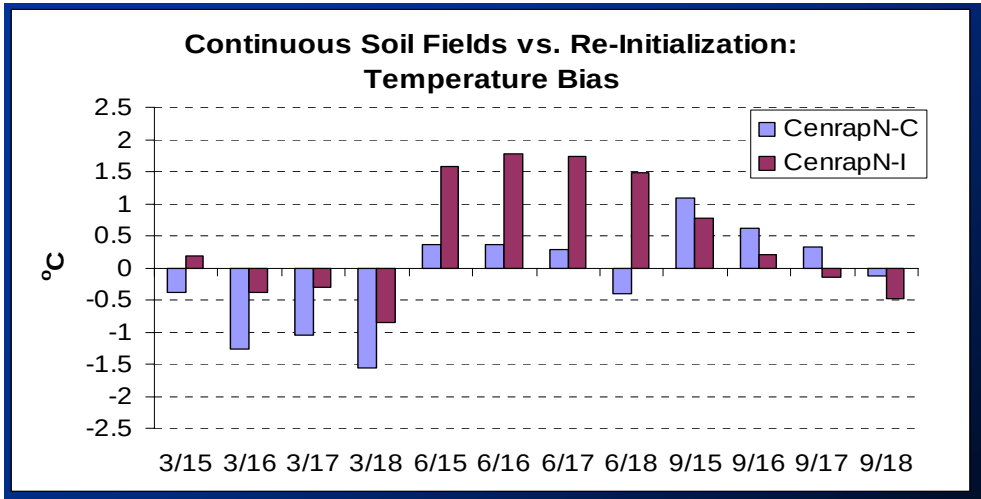

Monthly Averaged Mixing Ratio Gross Error
g/kg
3.5
3
2.5
2
1.5
1
0.5
0
CenrapN
CenrapS
DessertSW
GL
Iowa
MidAtlantic
North
NE
OhioVal
SE
PacificNW
SW
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec

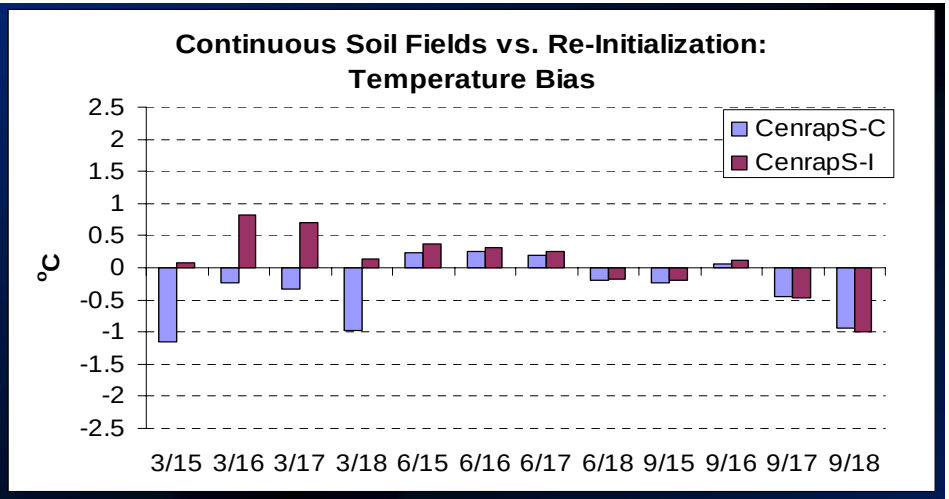
Continuous PX Soil Moisture Fields

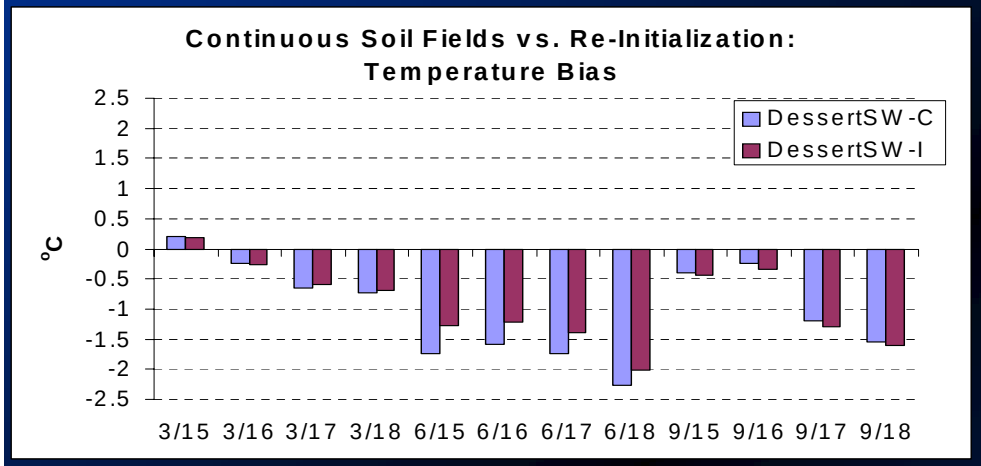
- Due to inclusion of ~14 day spin up periods at the beginning of each quarter, the impact of continuous soil fields can be examined
  - …by comparing the 1st 5 day simulation within a quarter with the corresponding data from the previous quarterly simulation
    - March, June, and September time periods available

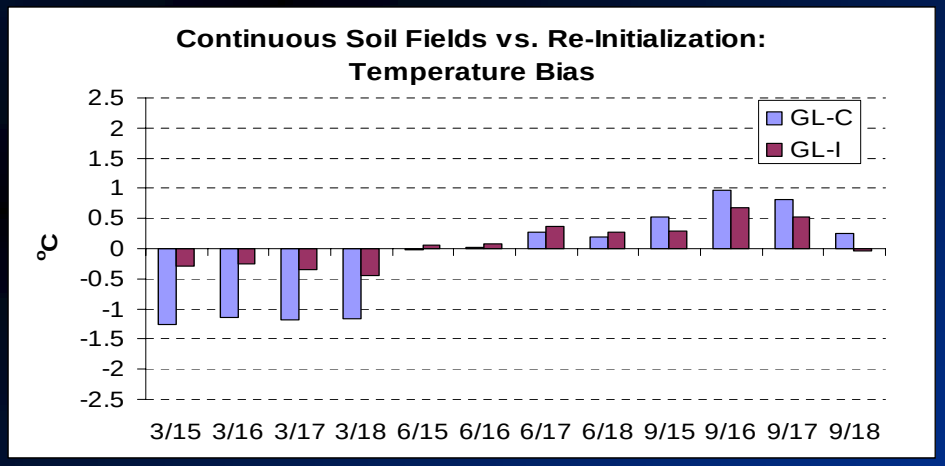
Example

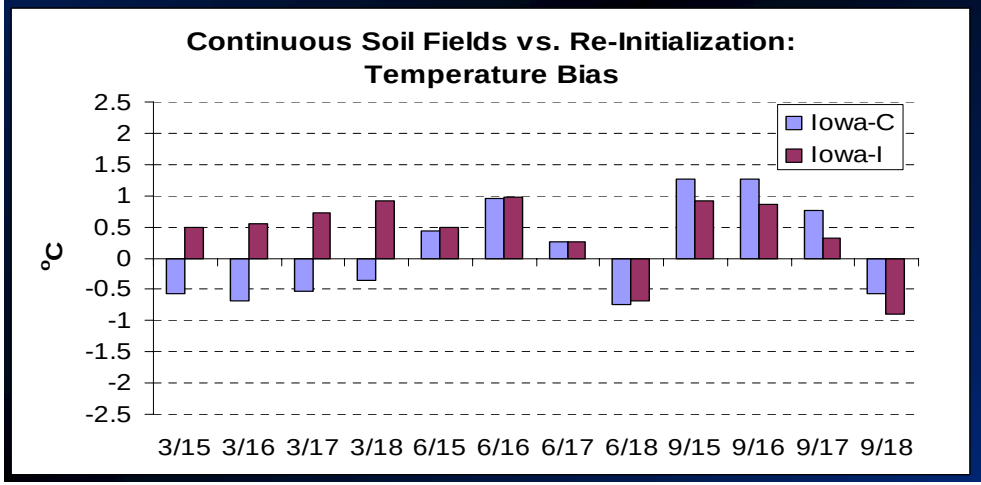
JFM	AMJ
24th Sim: March 15th-19th	1st Sim: March 15th-19th

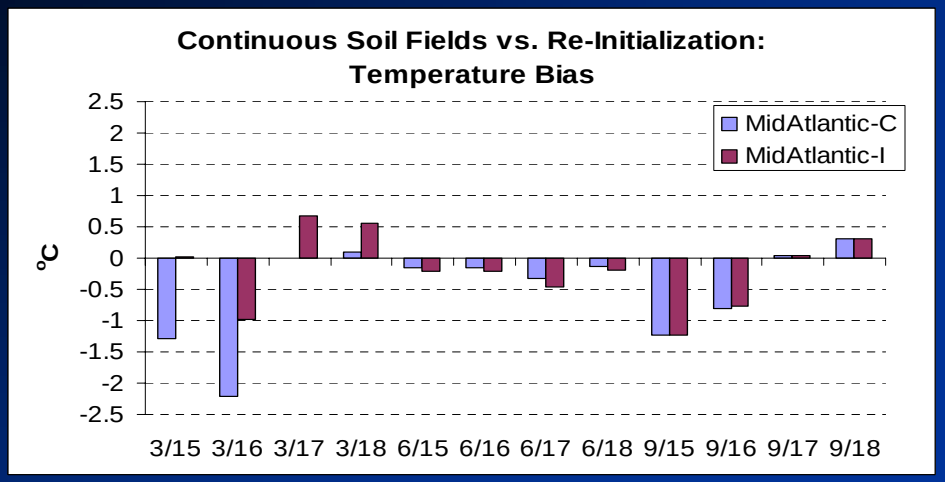

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
CenrapN-C
CenrapN-I

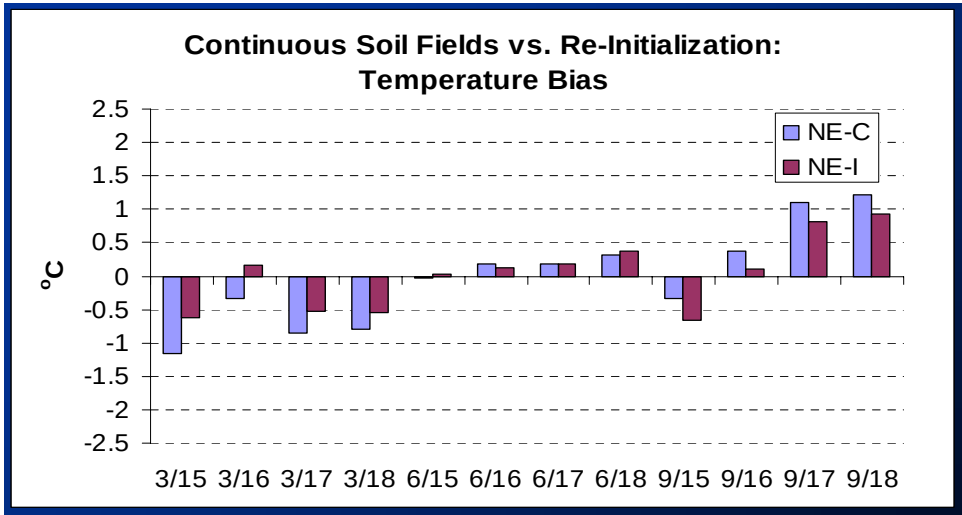

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
CenrapS-C
CenrapS-I

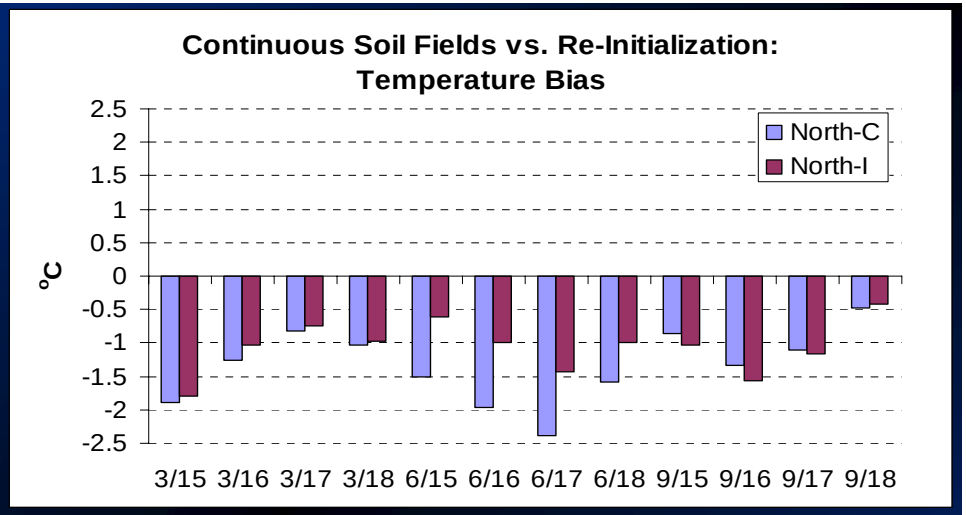

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
DessertSW-C
DessertSW-I

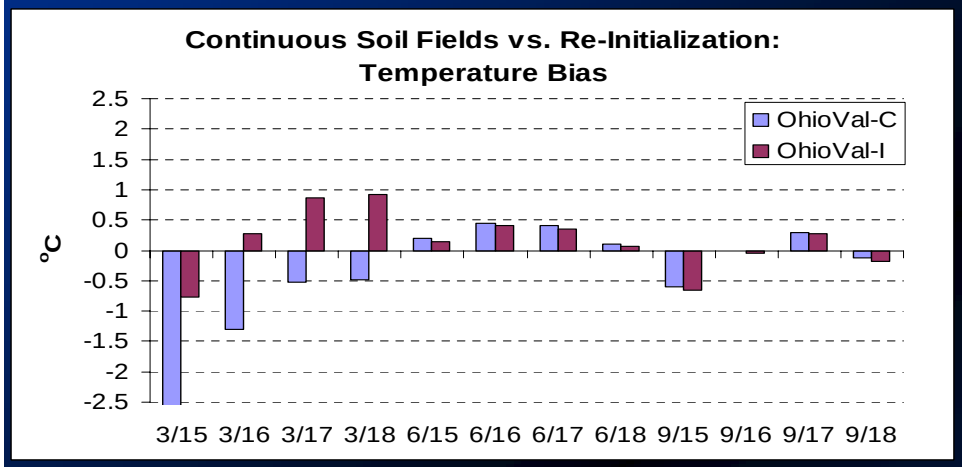

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
GL-C
GL-I

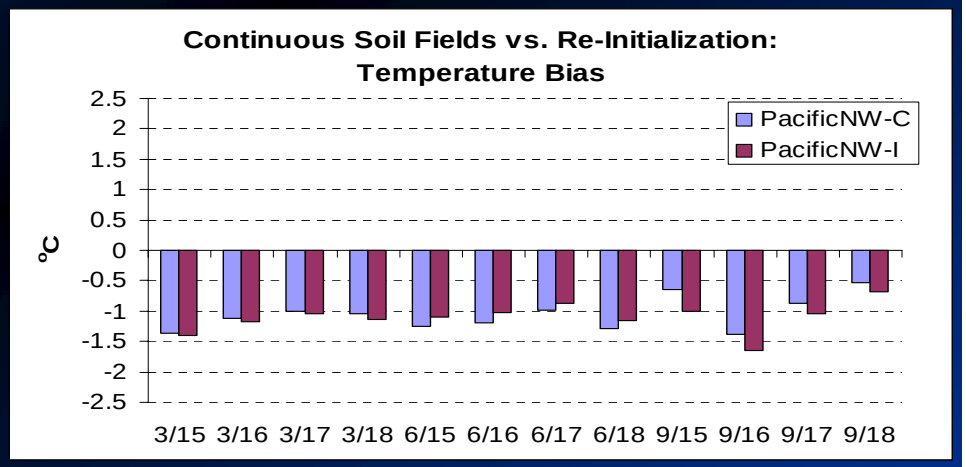

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
Iowa-C
Iowa-I

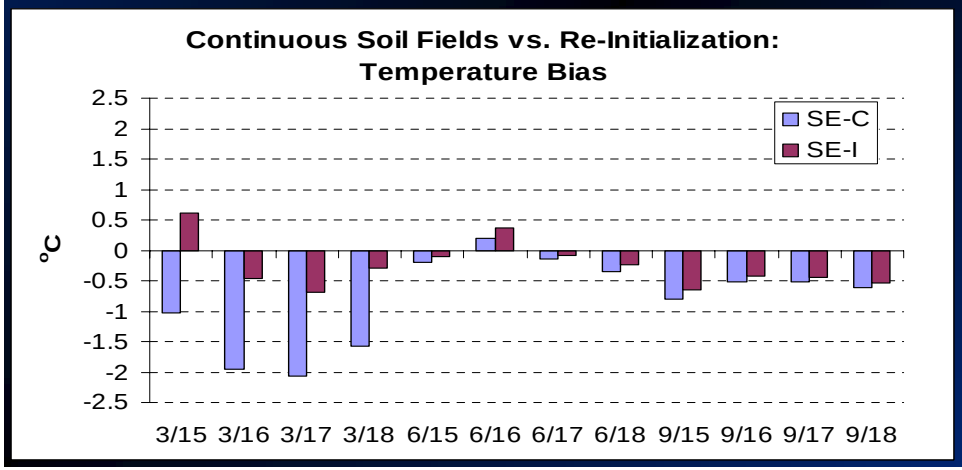

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
MidAtlantic-C
MidAtlantic-I

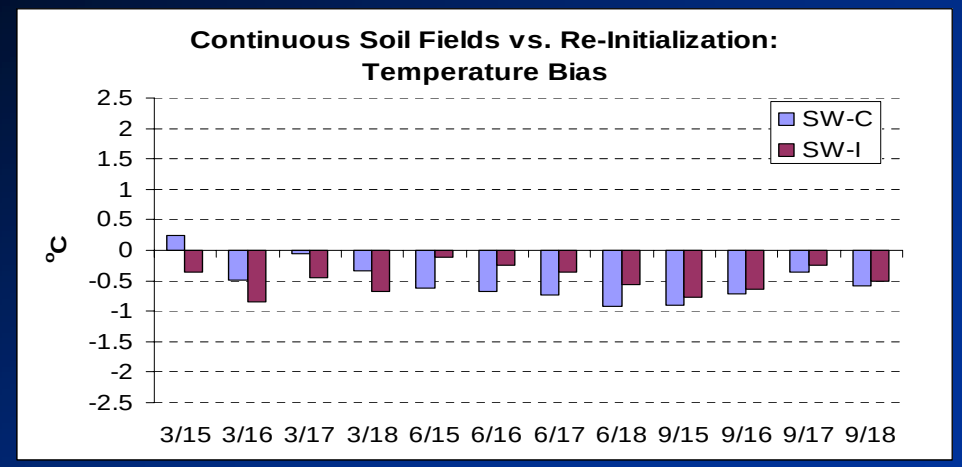

Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
NE-C
NE-I


Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
North-C
North-I


Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
OhioVal-C
OhioVal-I


Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
PacificNW-C
PacificNW-I


Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
SE-C
SE-I


Continuous Soil Fields vs. Re-Initialization:
Temperature Bias
°C
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
3/15 3/16 3/17 3/18 6/15 6/16 6/17 6/18 9/15 9/16 9/17 9/18
SW-C
SW-I

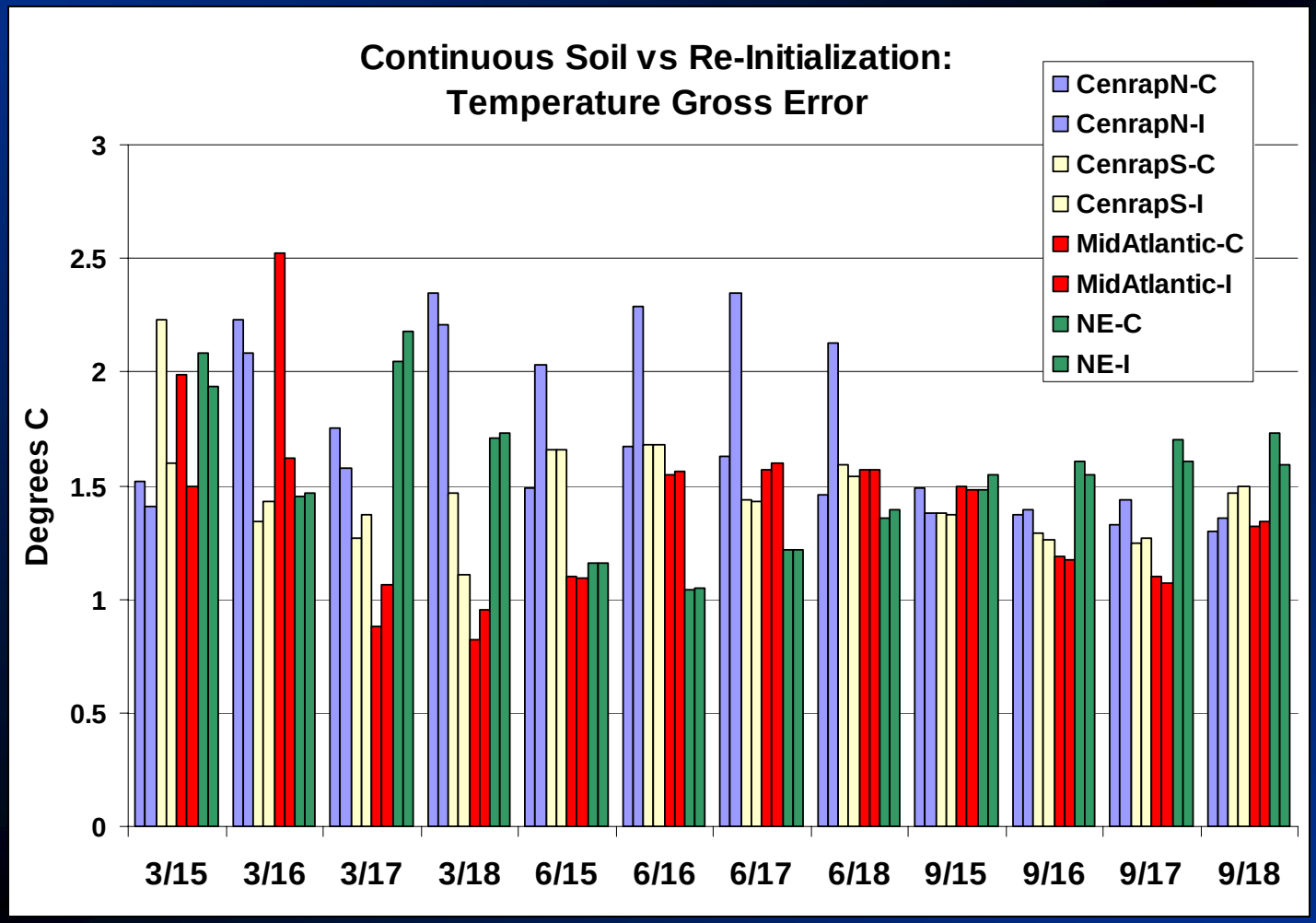
Continuous Soil Fields vs Re-Initialization

Temperature

- **Temperature Bias**
  - **In general, re-initialization reduces the magnitude of the negative and positive biases**
    - **Sign reversal occasionally occurs (Iowa:March)**
  - **In June, CenrapN shows a noticeable disbenefit with re-initialization (not using continuous fields)**
- **Temperature Error**
  - **Overall, there isn't a striking decrease in error with re-init; Most comparisons show similar performance**
  - **However, if errors differed, the errors were almost always lower with re-initialization (except with CenrapN & Iowa)**

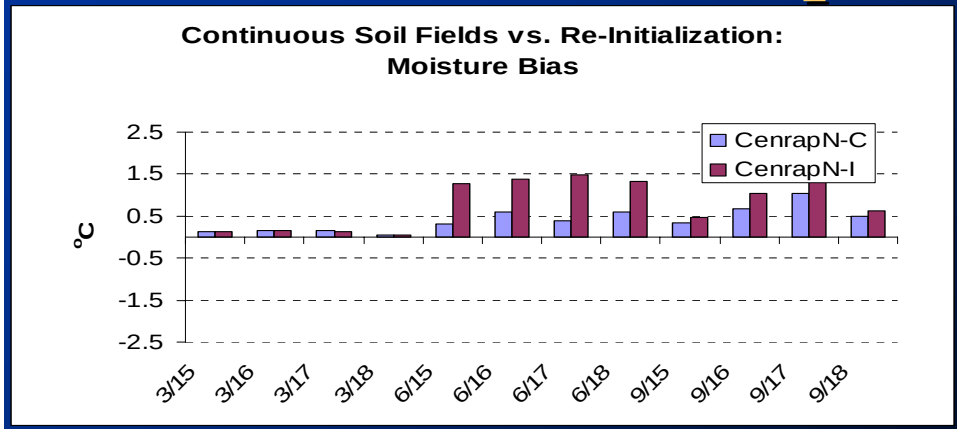
Continuous Soil Fields vs Re-Initialization

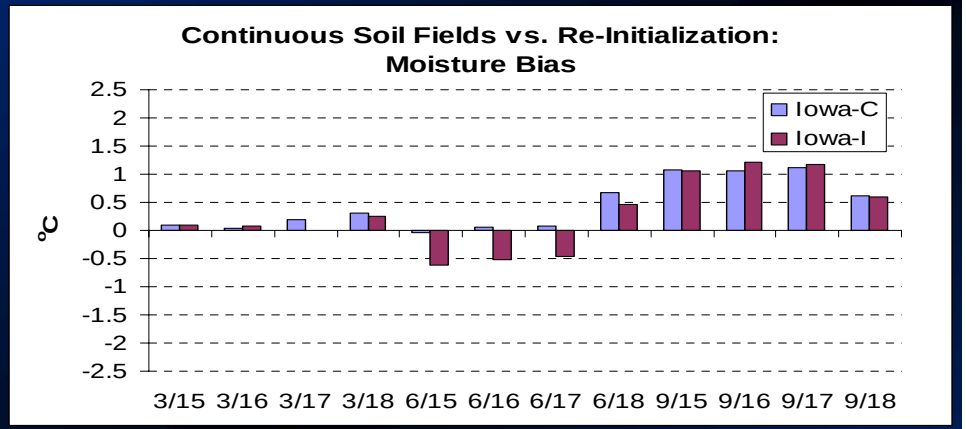
Temperature Error

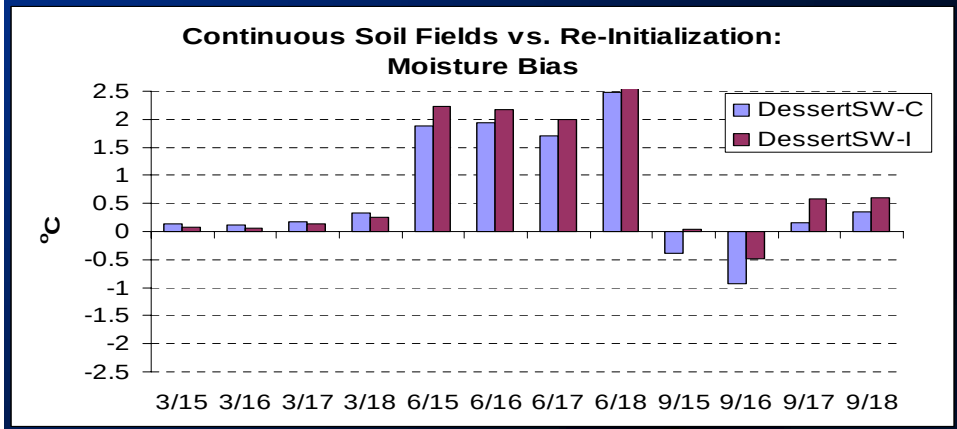


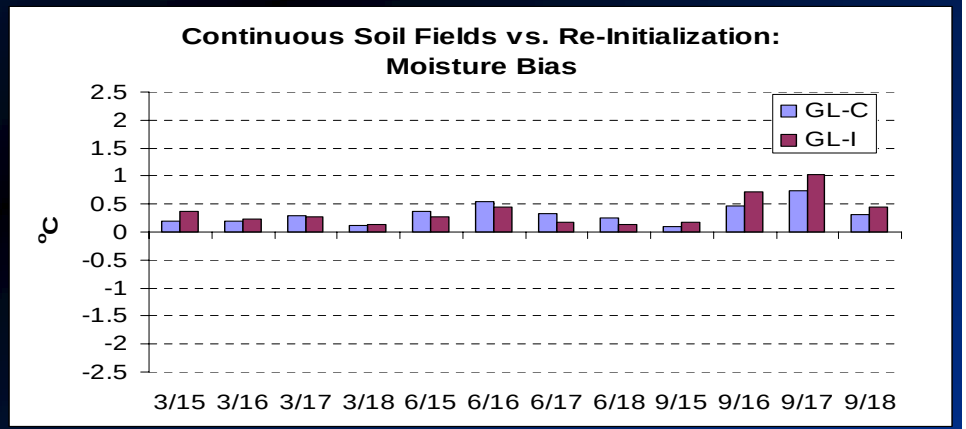
Regions not shown did not display significant changes

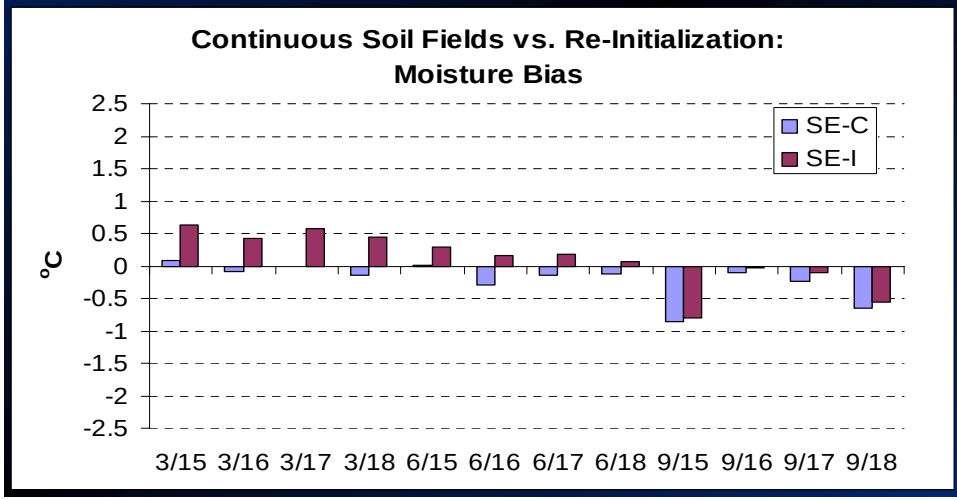
Moisture – Impact Not as Noticeable

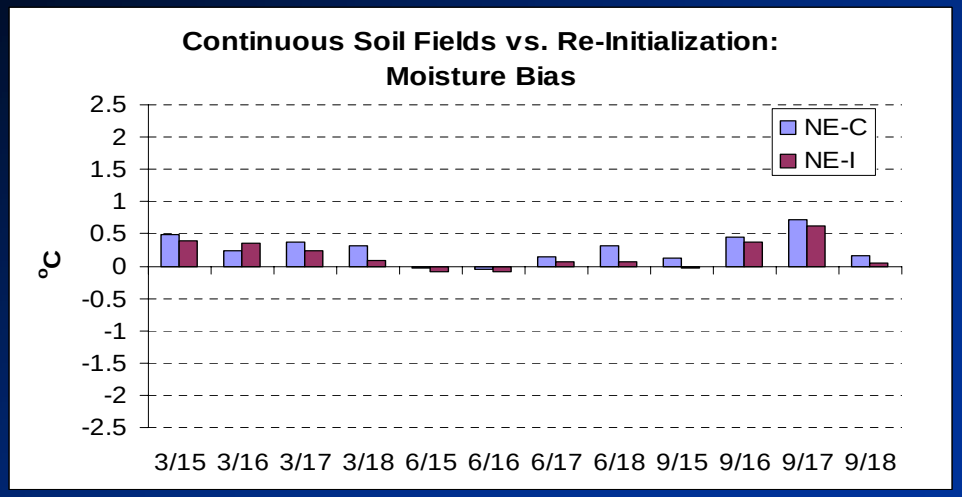












Continuous Soil Fields vs Re-Initialization

Mixing Ratio

- **Little change overall**
  - **Bias tends to be slightly worse with re-initialization**
  - **Worst impact occurred in the CenrapN region, with bias increasing by up to ~0.5 g/kg (total error still less than 2 g/kg)**
- **Majority of gross error differences < 0.2 g/kg**

Upper Air Evaluation

- Reprocessing 360 Gb of output for upper air evaluation not practical
- Partial solution
  - Developed RAOBPLOT (freely available)
    - Post-processing software tool designed to produce observed vs predicted soundings, based on FSL archived data
      - Acknowledgements:
        - Dennis McNally (borrowed portion of code from MAPS which reads TDL datasets)
        - The authors of GRAPH (borrowed SKEW-T code)
        - Mark Stoelinga (borrowed code from RIP)
        - (I did actually write new code)
        - Bret Anderson – beta tester/accessory improvements
  - Tremendous amount of information producible (e.g. ~18,000 soundings created examining only 23 stations)

Results

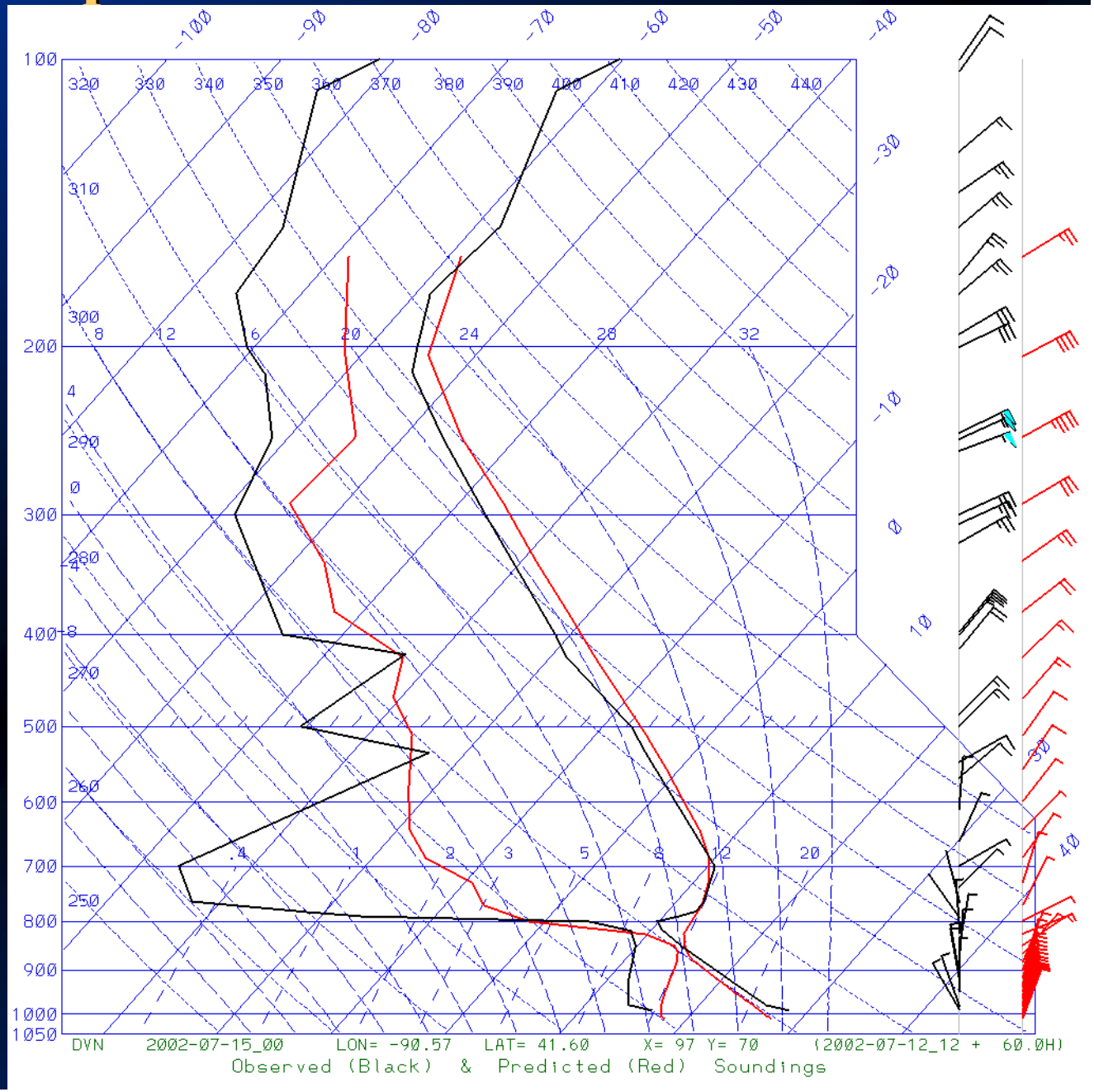
- **Preliminary findings: (finite number of soundings examined)**
  - **Wind field prediction throughout the troposphere subjectively categorized as accurate**
  - **The cool temperature bias & positive moisture bias identified through Metstat evaluation identifiable in the soundings**
    - **The depth through which this trends occur is highly variable (from 25 mb to 200+ mb above the surface)**
    - **Results highly variable, as expected**
  - **Examining DVN (Davenport, Iowa) summertime PBL's: mixing layer appears slightly shallow**
    - **Typically shifted by 50 mb or less**

Example RAOBPLOT

- Davenport, IA
- 2002-07-15_00Z

- An example of the cold bias/high moisture bias, and PBL depth inaccuracies (at 7 PM…)

- Note: No single sounding is representative



Summary

- Overall, investigation of: wind fields, temperatures, and humidity gross errors found to be within acceptable limits. However…

- Bias trends apparent
  - Temperatures underpredicted (cause=location and time dependent (e.g. Feb PacificNW, the entire diurnal cycle too cold; not just the peak temperatures being underpredicted)
  - Mixing ratio positively biased throughout most of the annual simulation: true for most regions
  - Daily peak wind speeds fall short of the observed values, but the associated error is generally small

- Upper Air
  - Wind field prediction acceptable, throughout the troposphere
  - Preliminary… Highly variable with mixed results, no grievous errors or trends yet discovered

Conclusions

- CenrapN: overall, performance acceptable
- Other regions: Biases apparent, but associated errors tolerable (must consider the course grid resolution)
- SIP quality simulation?
  - There is room for improvement...
  - The ultimate answer will depend upon a performance evaluation comparison involving additional annual simulations

- Implementation of continuous soil fields within PX
  - Is this option favorable?
    - Generally: appears beneficial for CenrapN & Iowa only
    - Performance measures do not indicate the generation of continuous soil fields is an advantageous practice
      - Caveat: only 12 days available for comparison
    - Couple the above statements with operational restrictions
      - …the computational burden incurred with the sequential run requirement difficult to justify