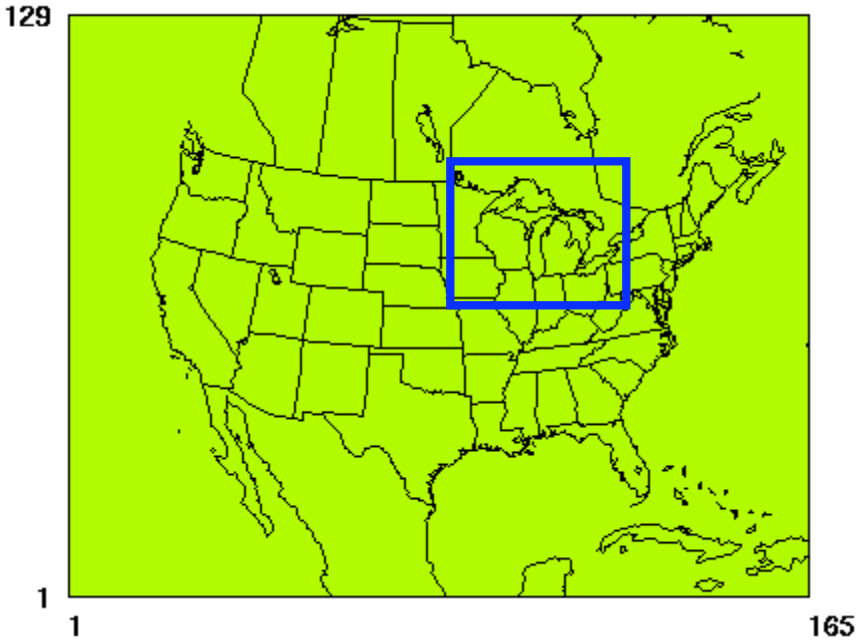
MM5 Model Performance Great Lakes Region: 2002-04

Kirk Baker

June 2005

Ad-Hoc Meteorological Modeling Meeting – Denver, CO

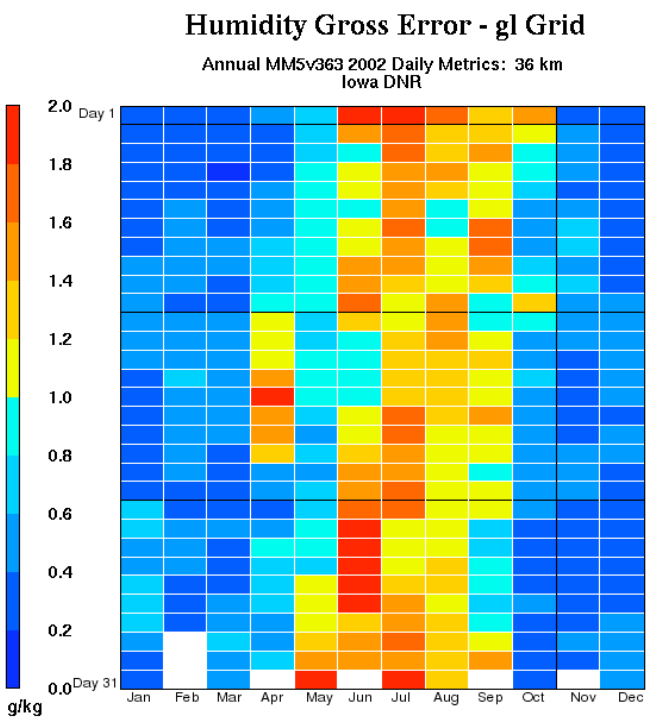
MM5 simulations: **2002 Matthew Johnson, Iowa DNR**
2004 Wusheng Ji, Wisconsin DNR
2003 Wusheng Ji; Steven King, Illinois EPA; Kirk Baker

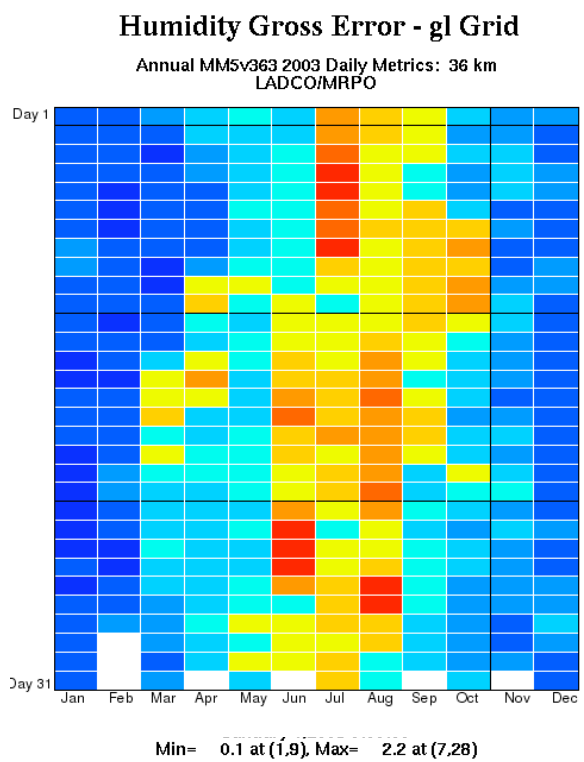


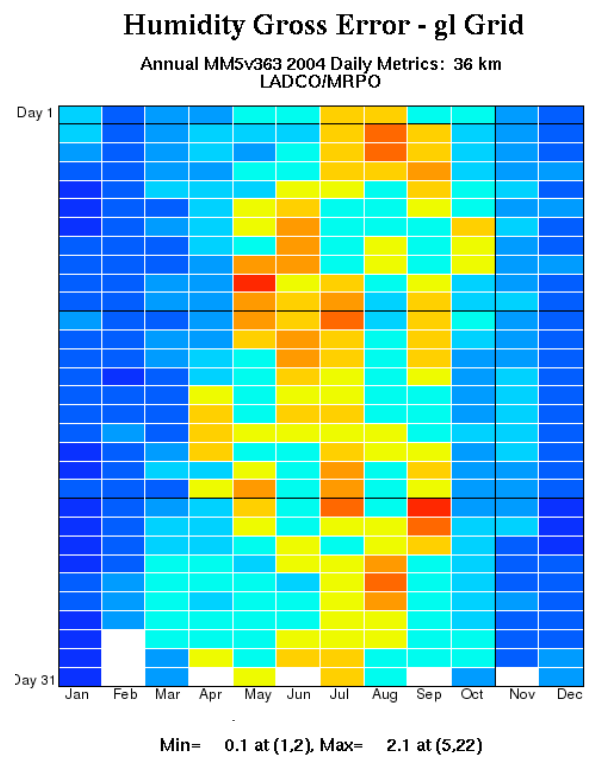
Configuration	36km and 12km Domains
Explicit Moisture	Mixed Phase (Reisner I)
Cumulus	Kain-Fritsch 2
PBL	Pleim-Chang (ACM)
Radiation	RRTM
Multi-Layer Soil Model	Pleim-Xu
Shallow convection	No
4-D Data Assimilation	Analysis nudging on above PBL
Moist Physics Table	No

k(MM5)	sigma	press.(mb)	height(m)	depth(m)
34	0.000	10000	14662	1841
33	0.050	14500	12822	1466
32	0.100	19000	11356	1228
31	0.150	23500	10127	1062
30	0.200	28000	9066	939
29	0.250	32500	8127	843
28	0.300	37000	7284	767
27	0.350	41500	6517	704
26	0.400	46000	5812	652
25	0.450	50500	5160	607
24	0.500	55000	4553	569
23	0.550	59500	3984	536
22	0.600	64000	3448	506
21	0.650	68500	2942	480
20	0.700	73000	2462	367
19	0.740	76600	2095	266
18	0.770	79300	1828	259
17	0.800	82000	1569	169
16	0.820	83800	1400	166
15	0.840	85600	1235	163
14	0.860	87400	1071	160
13	0.880	89200	911	158
12	0.900	91000	753	78
11	0.910	91900	675	77
10	0.920	92800	598	77
9	0.930	93700	521	76
8	0.940	94600	445	76
7	0.950	95500	369	75
6	0.960	96400	294	74
5	0.970	97300	220	74
4	0.980	98200	146	37
3	0.985	98650	109	37
2	0.990	99100	73	36
1	0.995	99550	36	36
0	1.000	100000	0	--SURF--

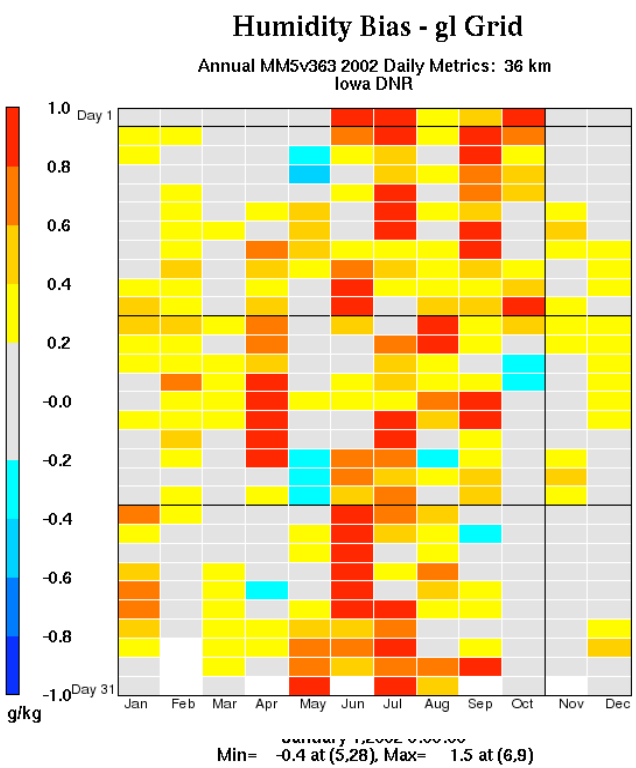
Daily Humidity Error

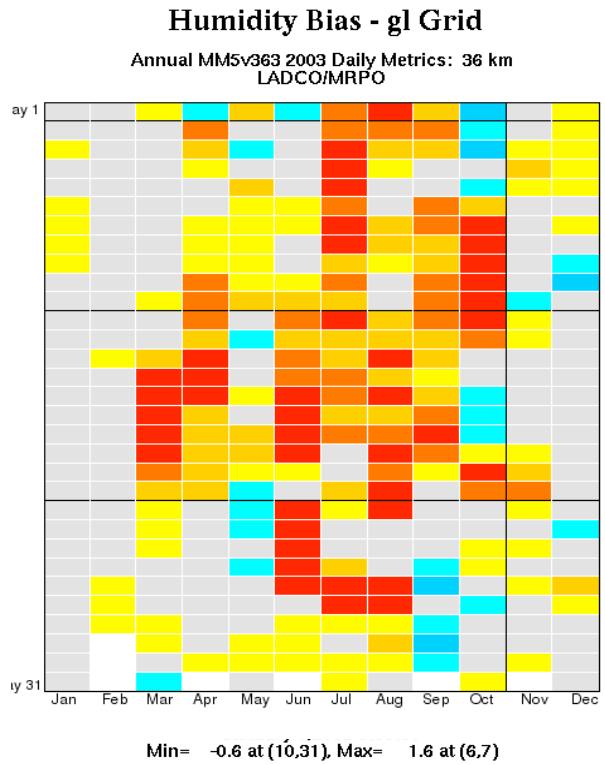


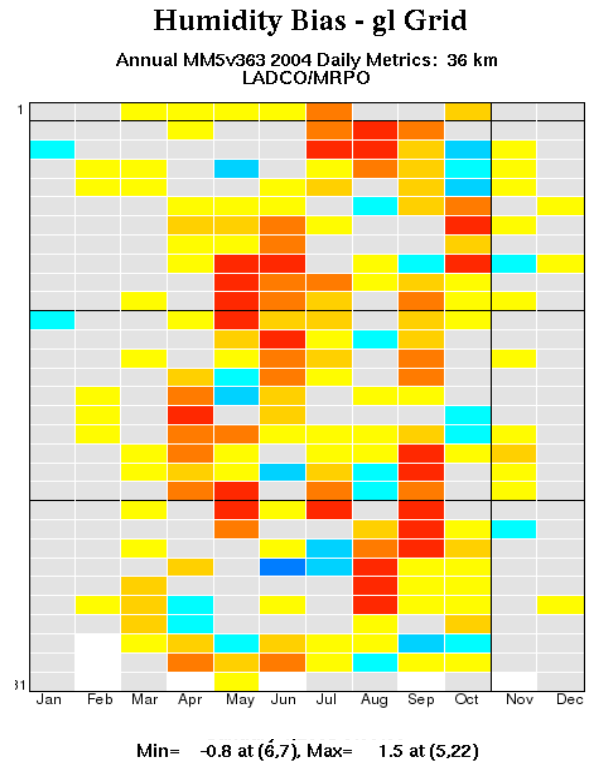




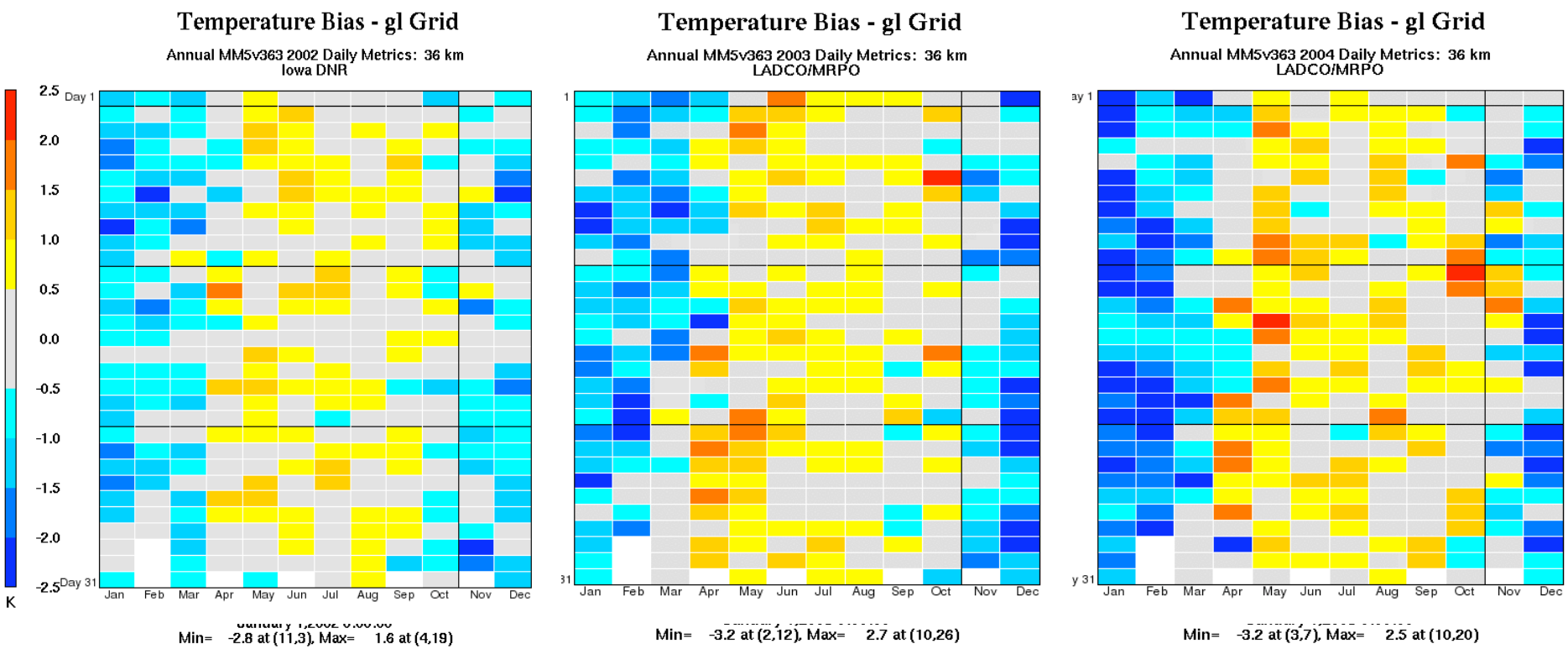
Daily Humidity Bias





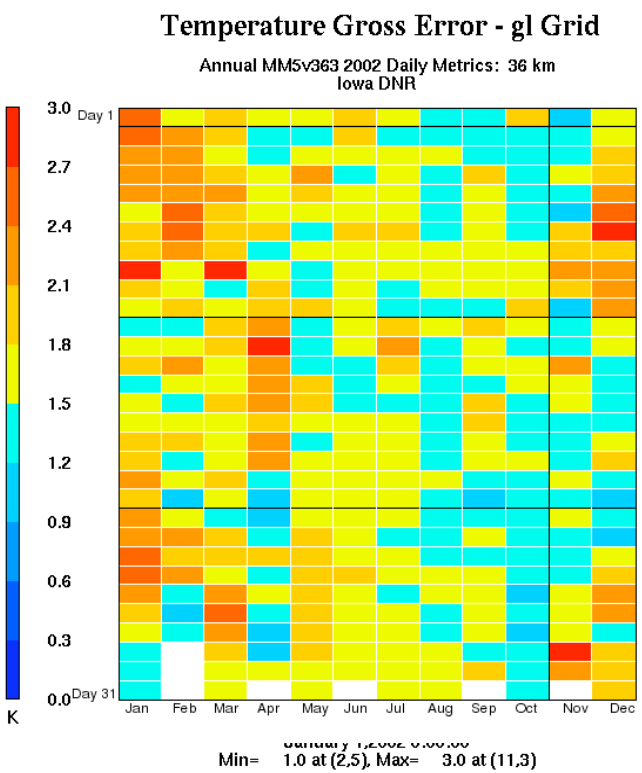


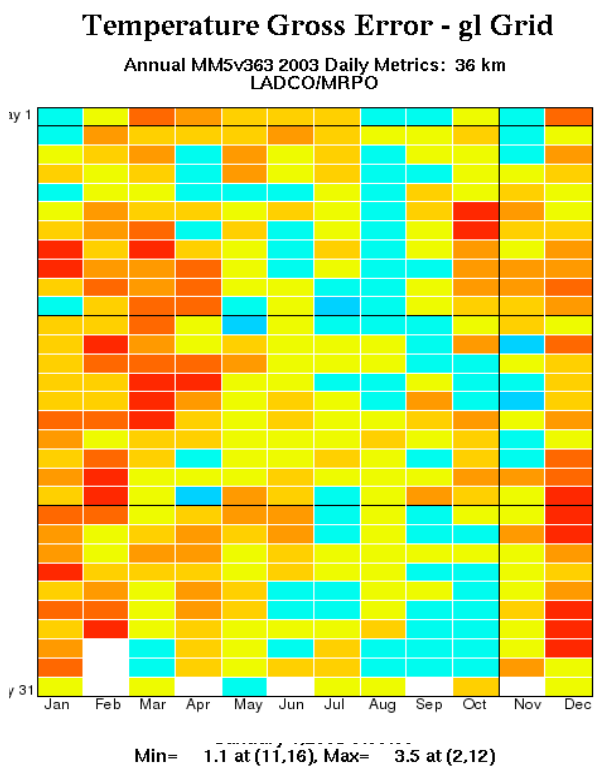
Daily Temperature Bias

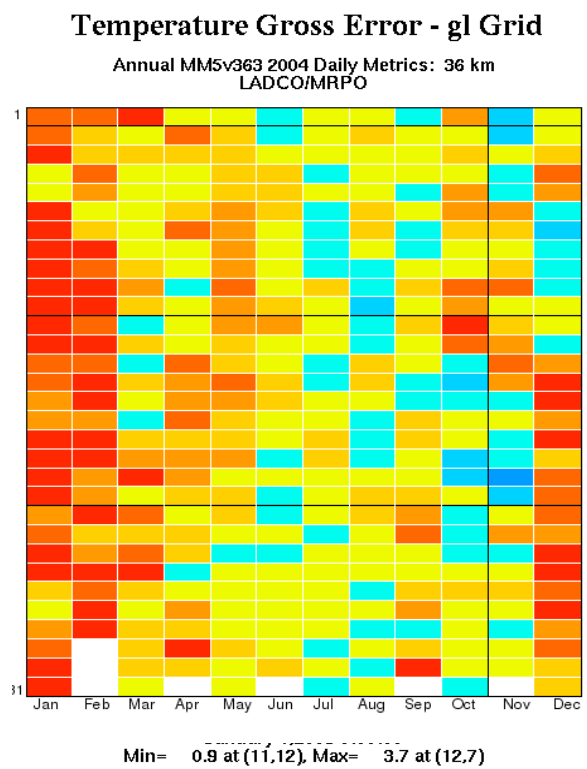


* Summer over-predictions dominated by over-night over-predictions; summer daytime peaks tend to be slightly under-predicted.

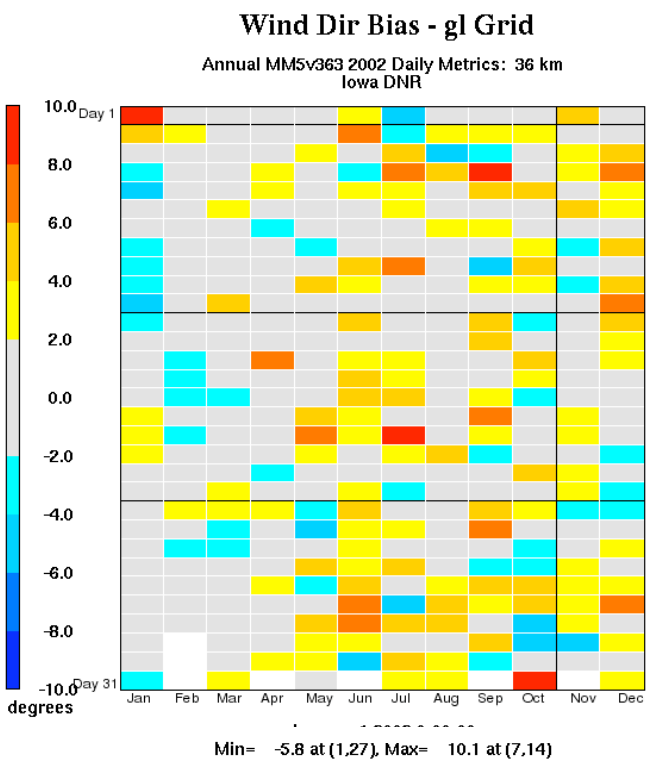
Daily Temperature Error

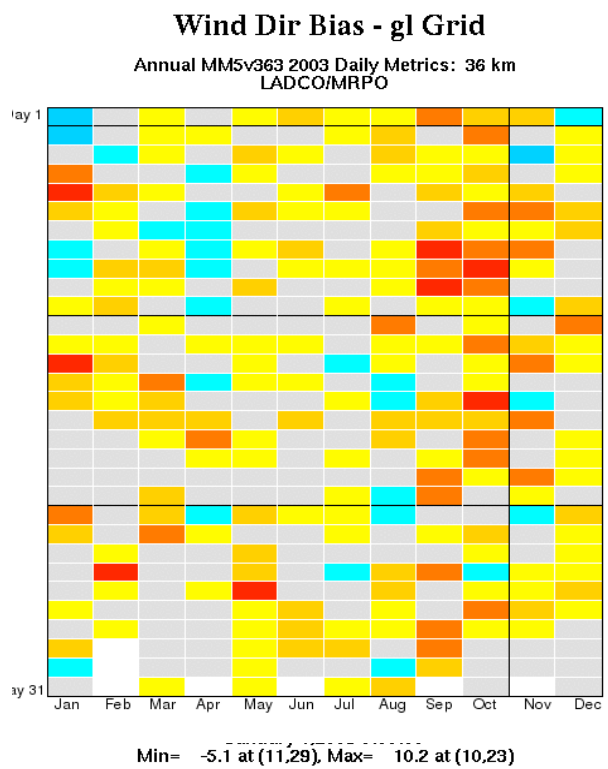


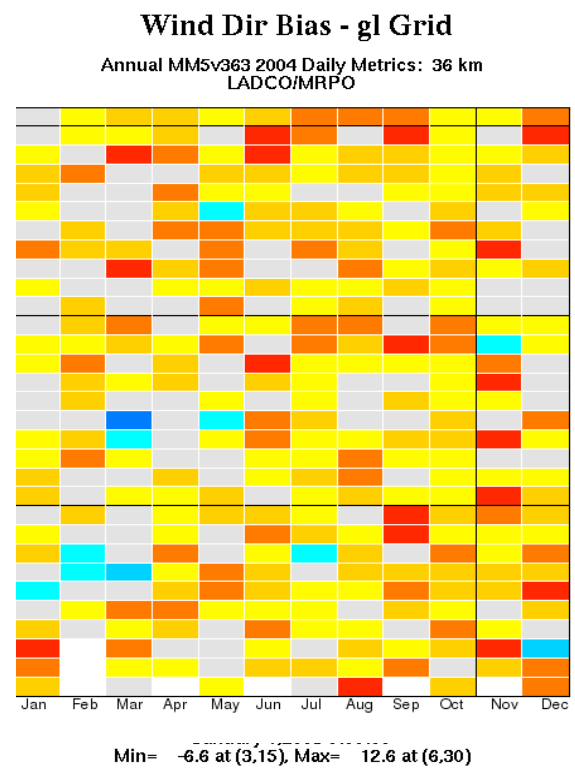




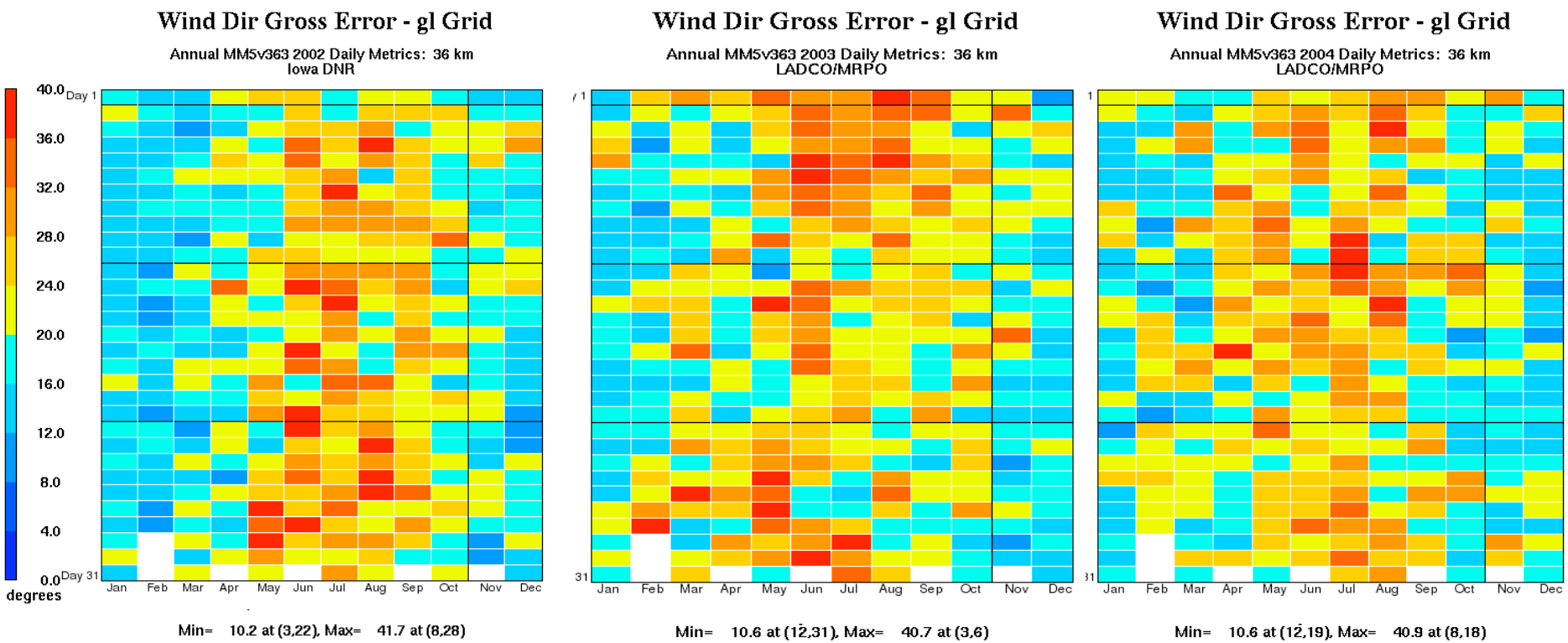
Daily Wind Direction Bias



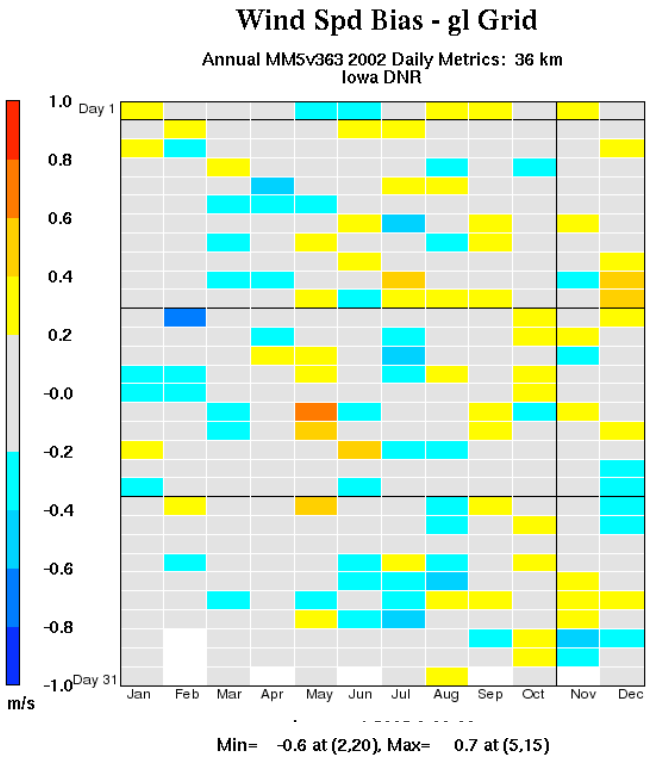


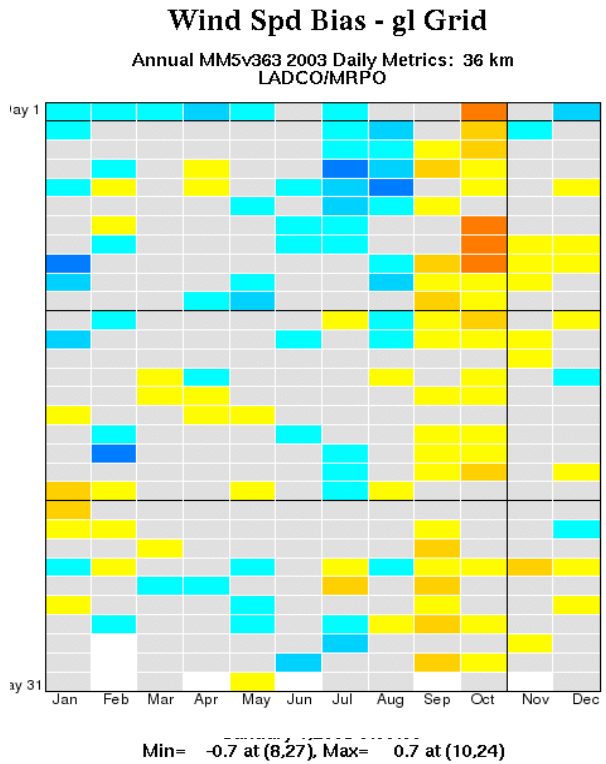


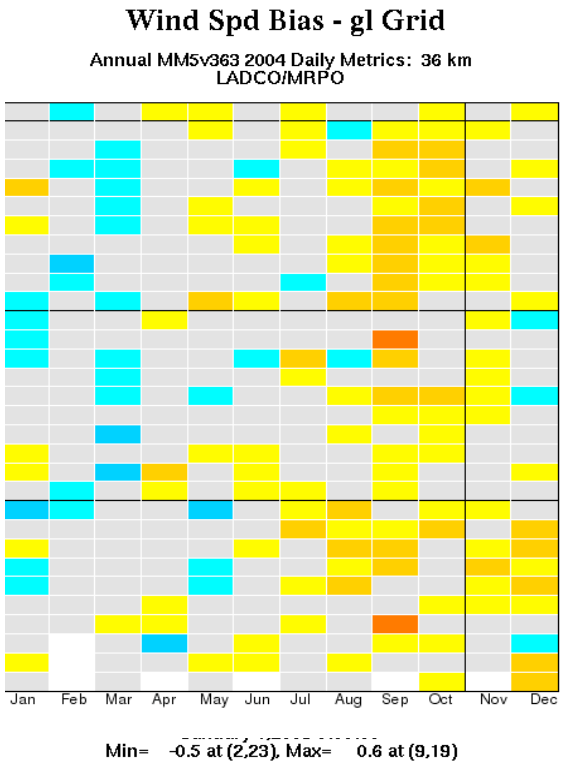
Daily Wind Direction Error



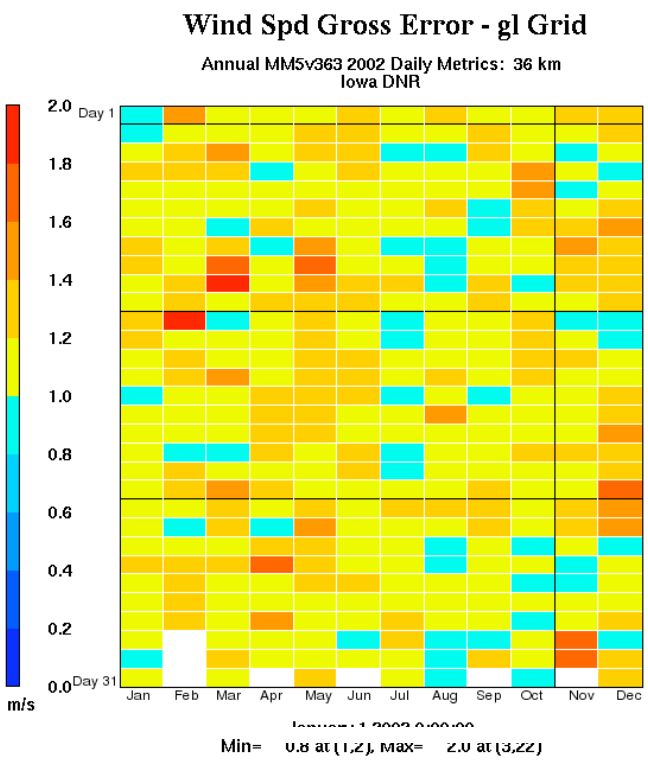
Daily Wind Speed Bias



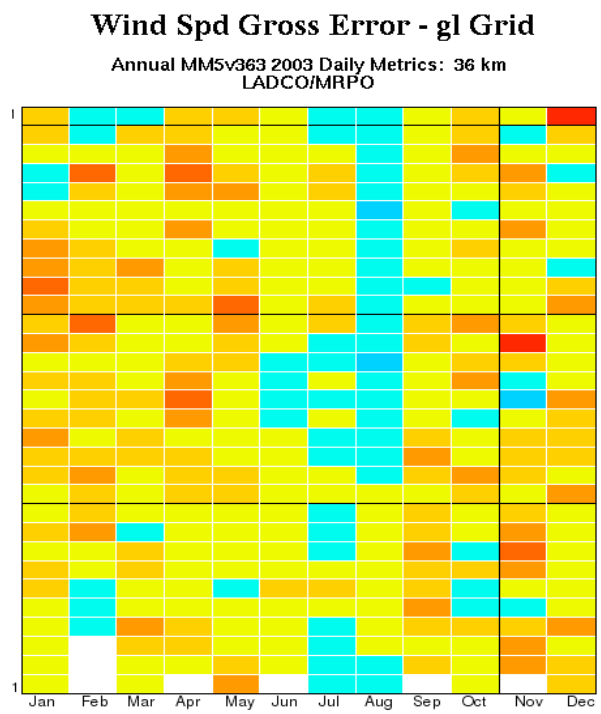




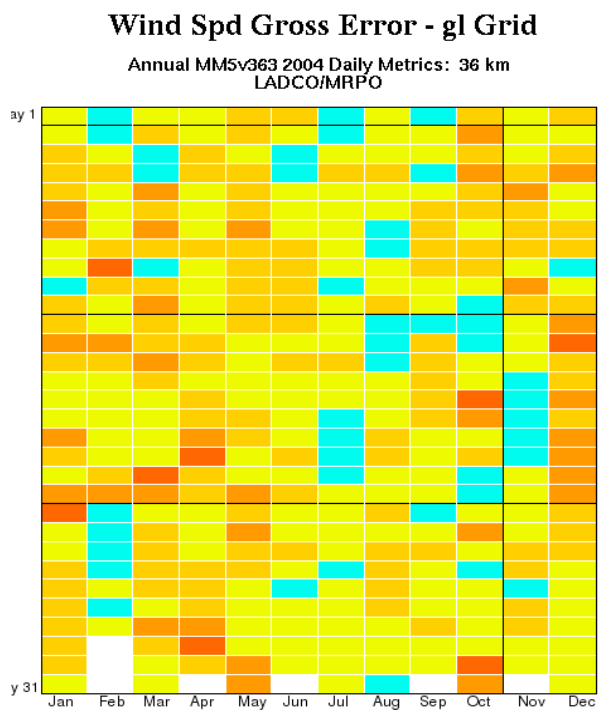
Daily Wind Speed Error



Min= 0.8 at (1,2), Max= 2.0 at (3,22)

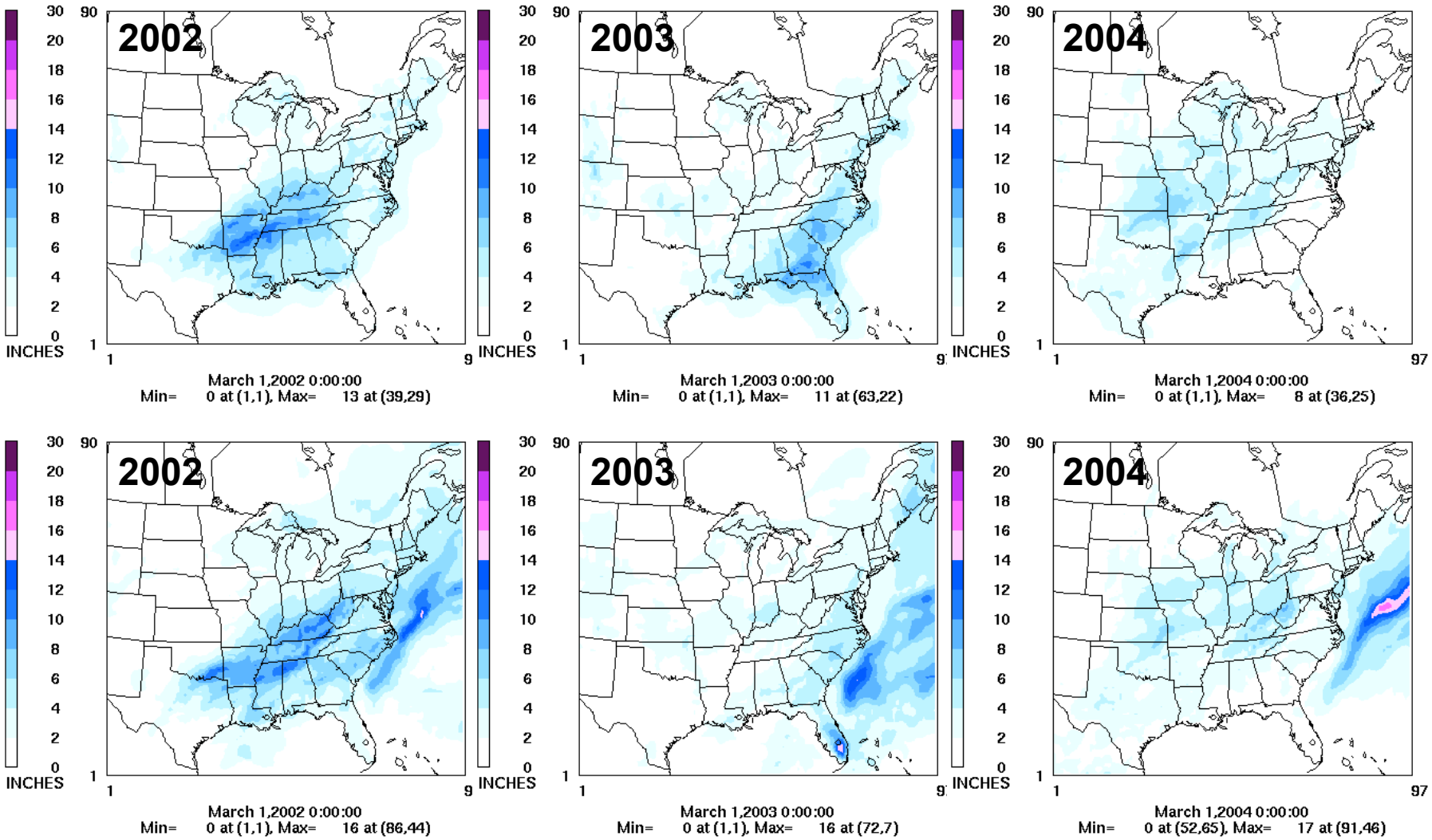


Min= 0.7 at (11,16), Max= 1.9 at (11,19)

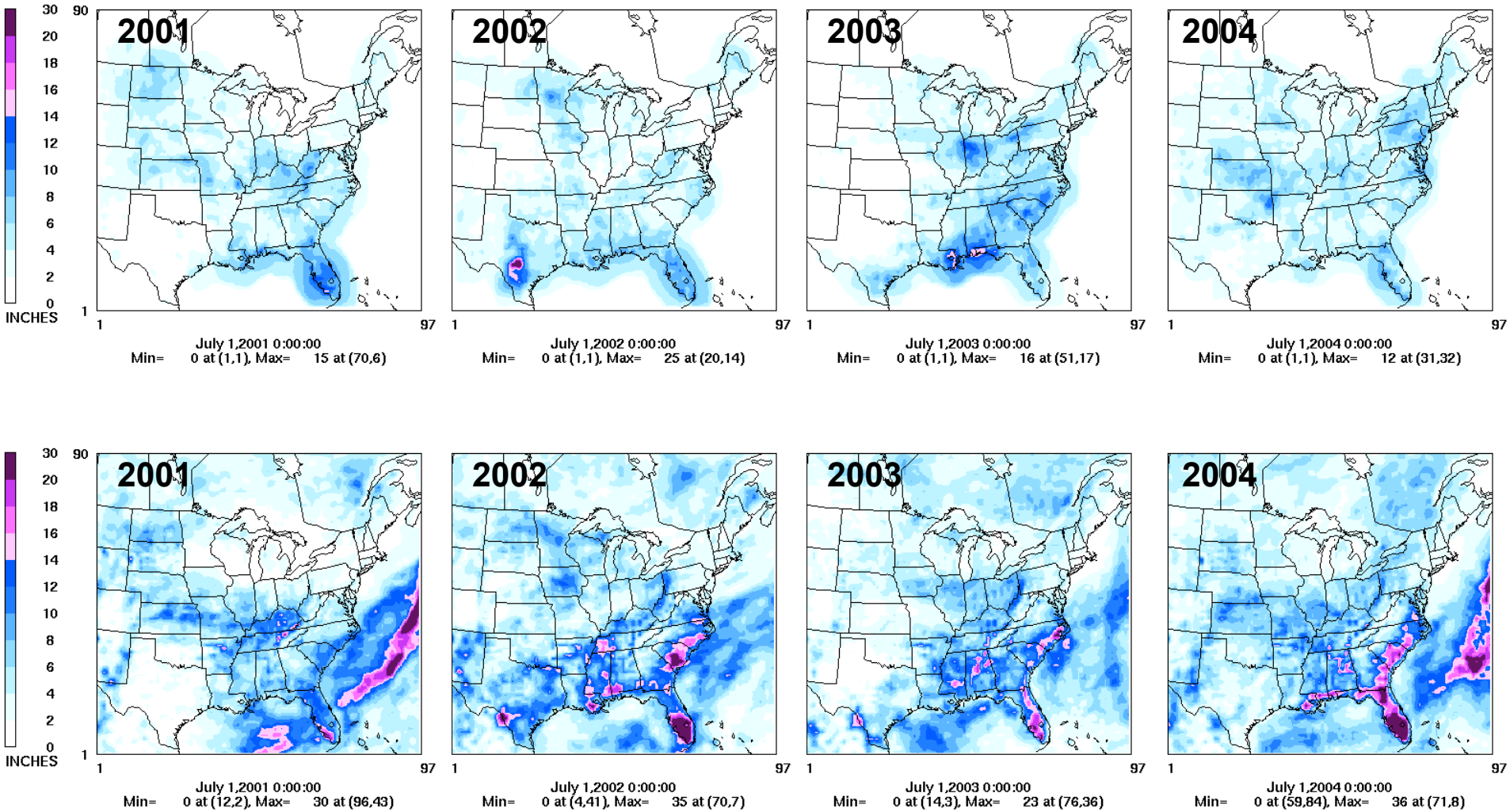


Min= 0.9 at (10,20), Max= 1.7 at (12,19)

Total March Rainfall
OBS (top) and MM5 (bottom)



Total July Rainfall
OBS (top) and MM5 (bottom)



Closing Remarks

- MM5 model performance in Great Lakes region at 36 km consistent between all 3 annual simulations
- Summer rainfall over-predicted
- Summer humidity biased high
- Early Fall high wind speed bias
- Temperatures biased low in winter and high in summer
- Wind direction error highest in summer months

(Trying to) Relate PM Modeling System Performance to MM5 Performance

Kirk Baker

June 2005

Ad-Hoc Meteorological Modeling Meeting – Denver, CO

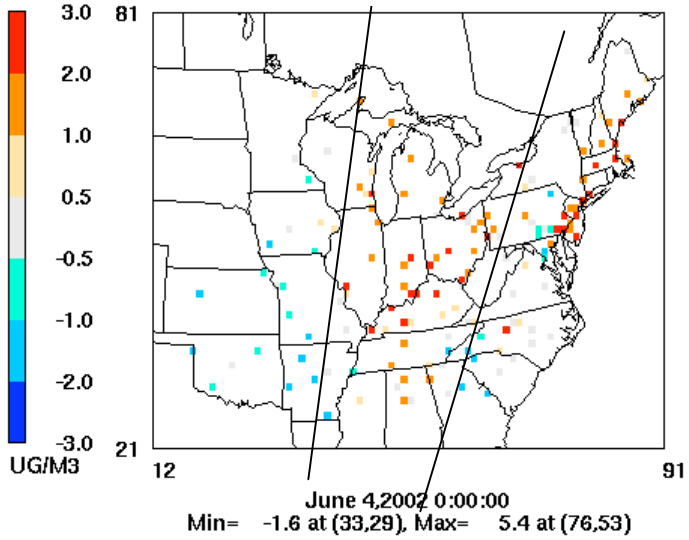
Background

- Relating ambient concentrations and wet deposition performance to MM5 rainfall
  - **Examine monthly total rainfall plots – obs and MM5**
  - **Examine monthly average PM sulfate ion bias**
  - **Examine monthly average sulfate deposition**

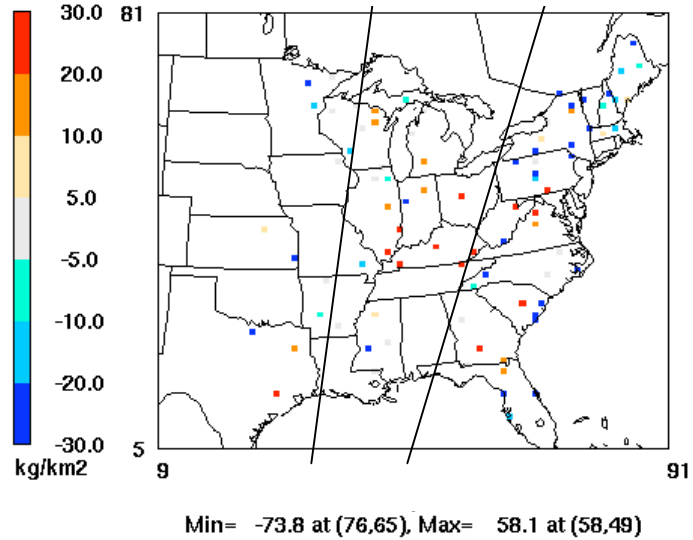
- Wind Field performance

- Relating sub-domain averaged daily metrics between MM5 and photochemical model

Ambient Monthly Bias

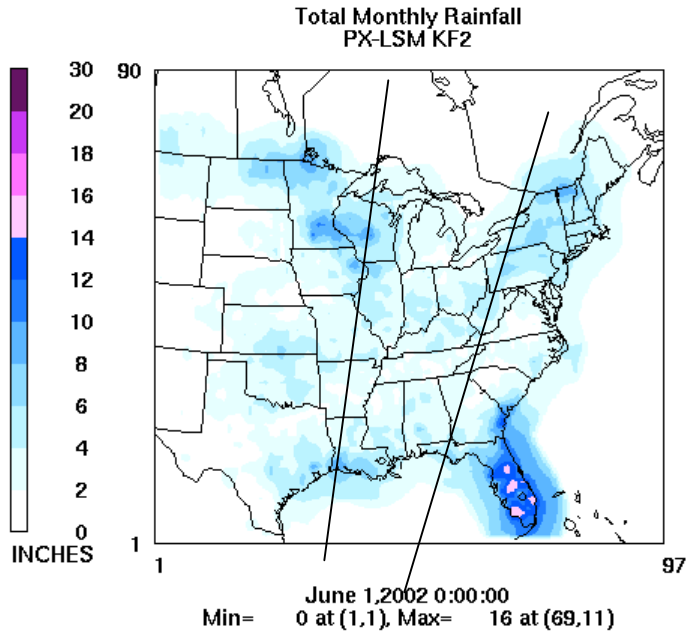


Wet Dep. Monthly Bias

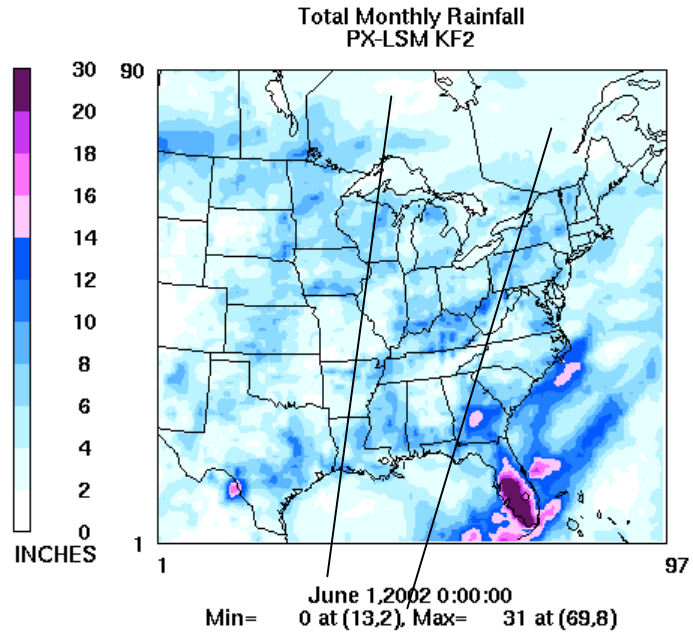


June 2002

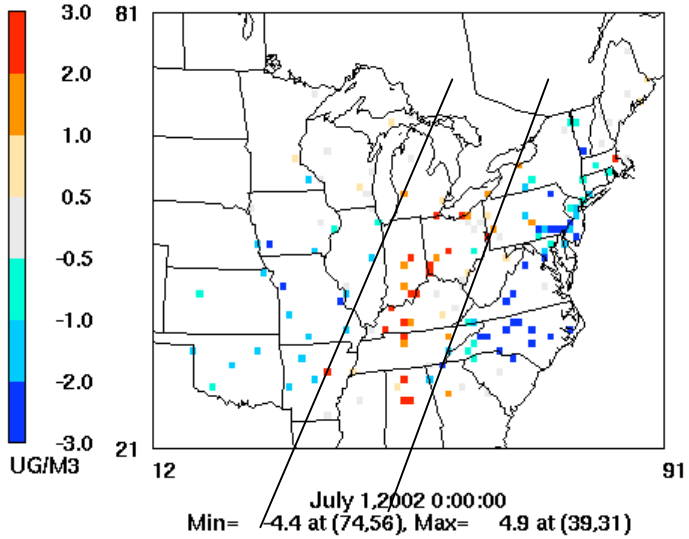
OBS



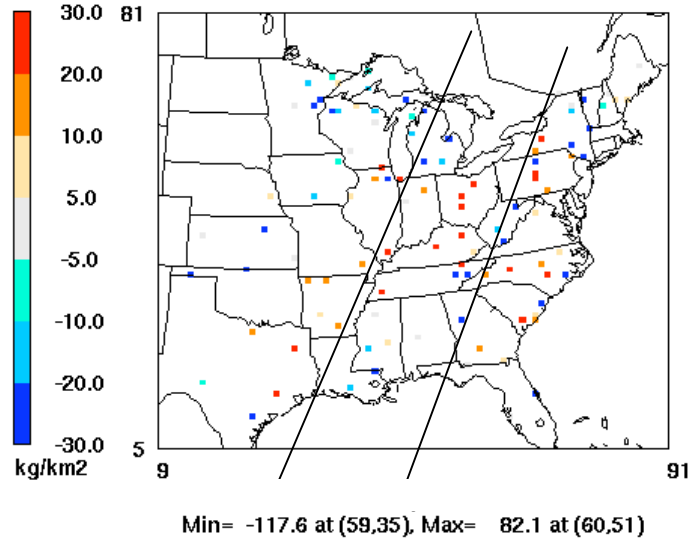
MM5



Ambient Monthly Bias

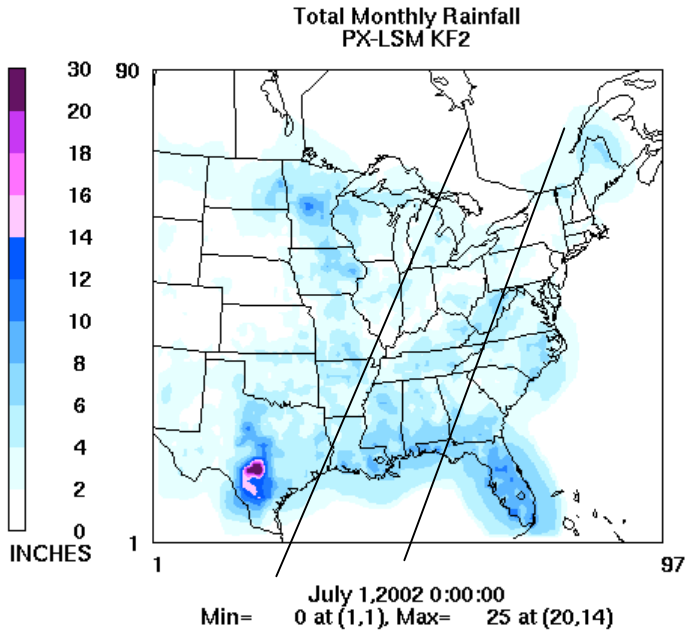


Wet Dep. Monthly Bias

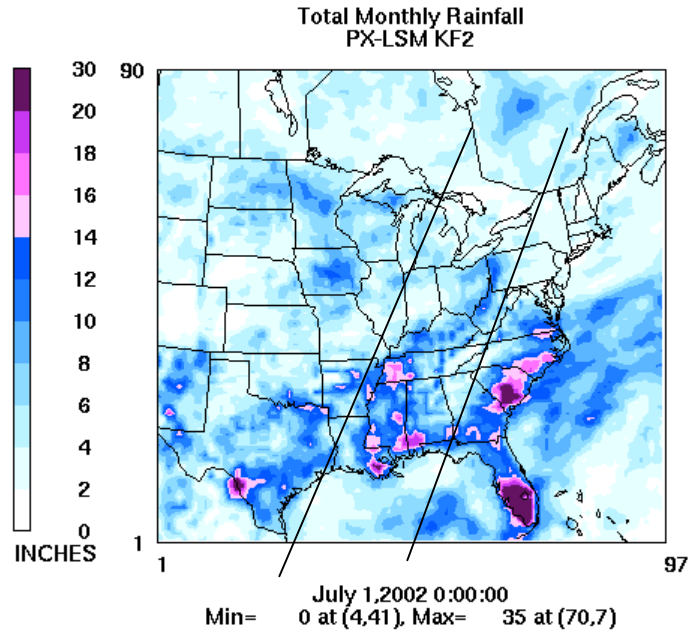


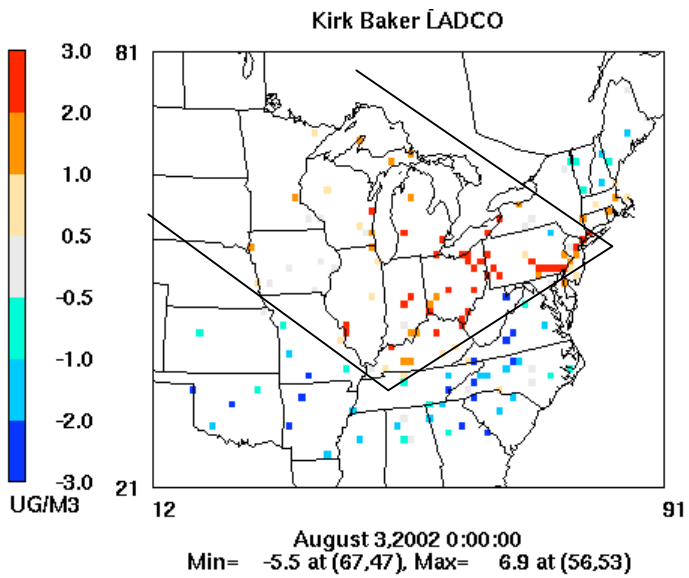
July 2002

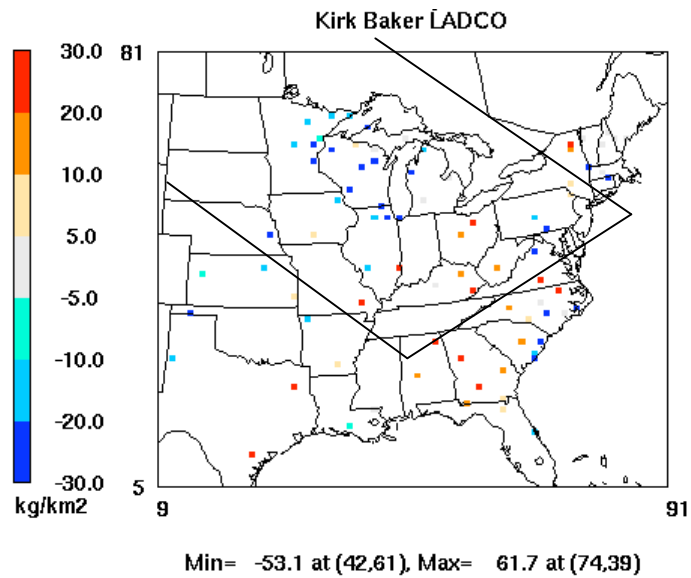
OBS



MM5

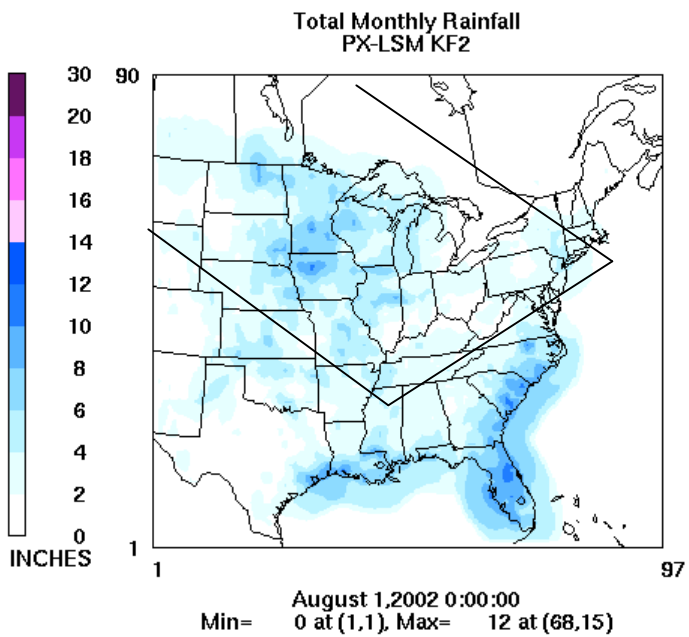




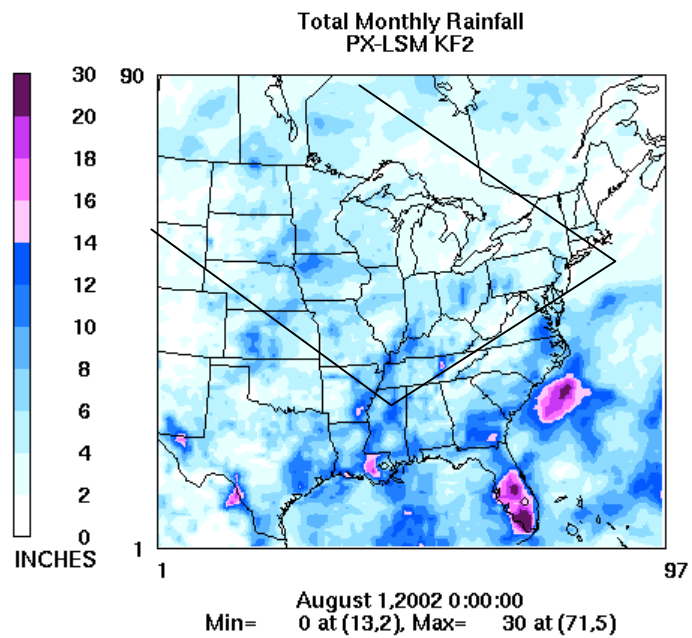


August 2002

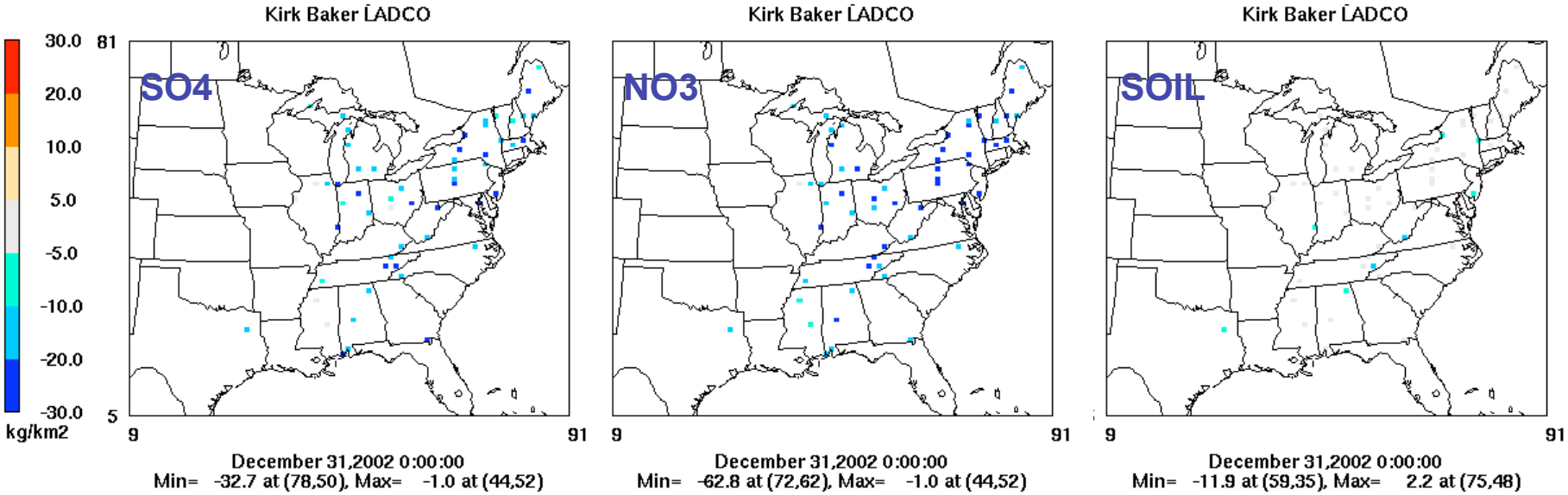
OBS



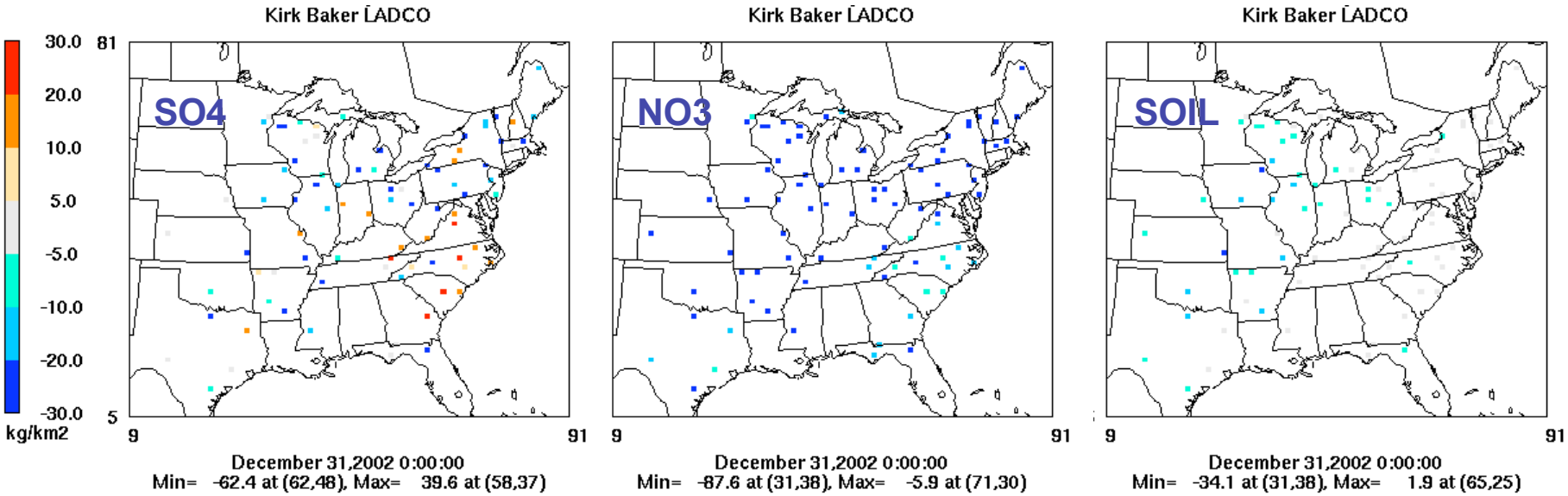
MM5



November 2002 Monthly Average Wet Deposition Bias

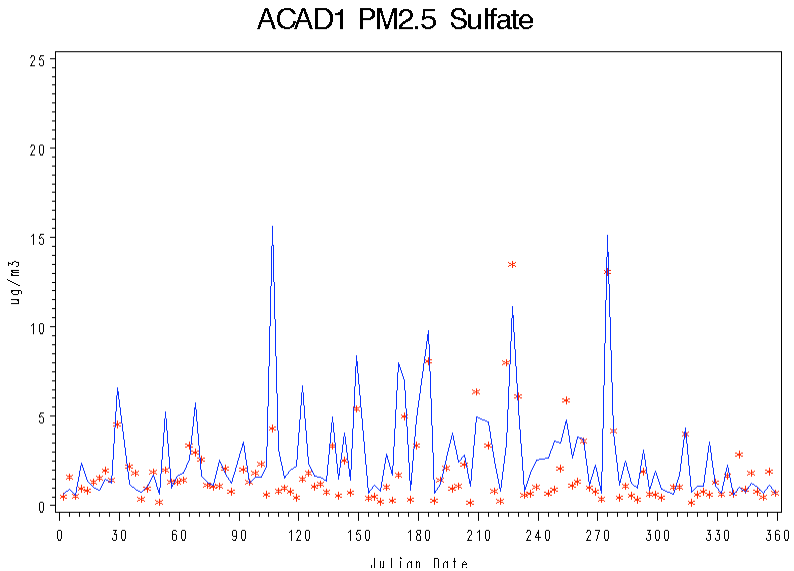


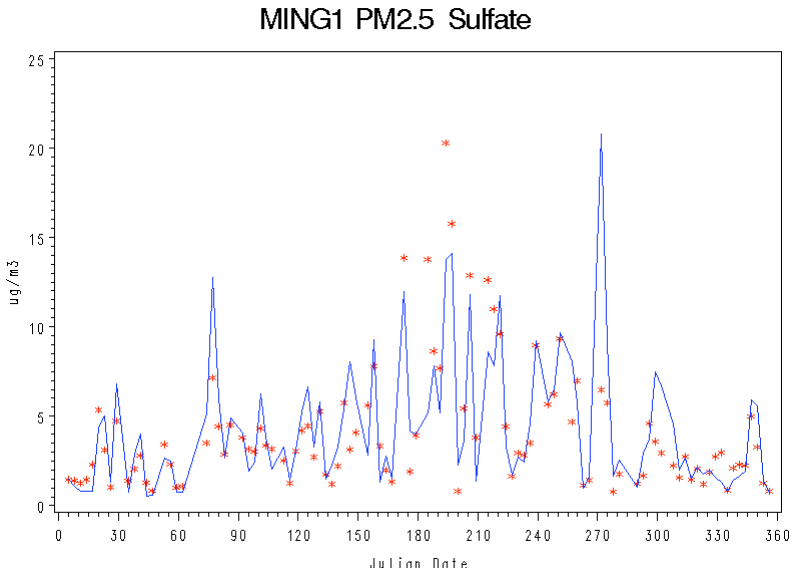
May 2002 Monthly Average Wet Deposition Bias

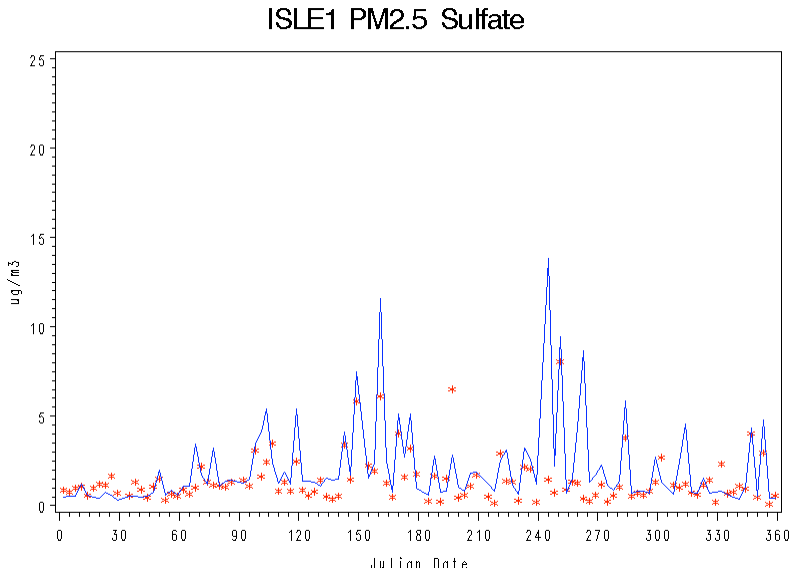


Wind Field Performance

- **Long range transport of pollutants**
- **Indicator of wind field performance**
- **Performance at remote Class I area monitors for PM sulfate ion to see if synoptic weather patterns are captured**





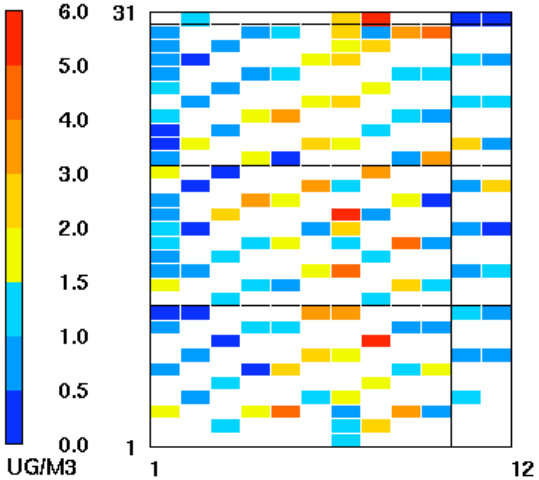


Relationships in Daily Metrics

- Examine trends in daily error and bias metrics for the Great Lakes region
- Sulfate and nitrate ions most likely to be associated with met model performance
- Nitrate relationships confounded by emissions, deposition, and chemistry

PSO4 Daily Error

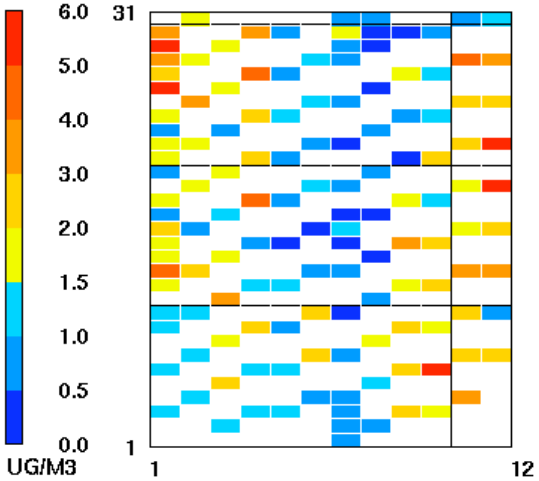
basel2
Kirk Baker LADCO



December 25,2002 0:00:00
Min= 0.2 at (10,18), Max= 7.5 at (7,17)

PNO3 Daily Error

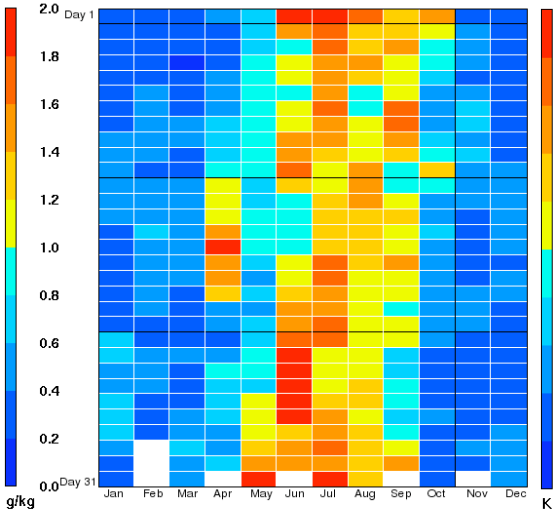
basel2
Kirk Baker LADCO



December 25,2002 0:00:00
Min= 0.2 at (7,17), Max= 12.7 at (12,19)

Humidity Gross Error - gl Grid

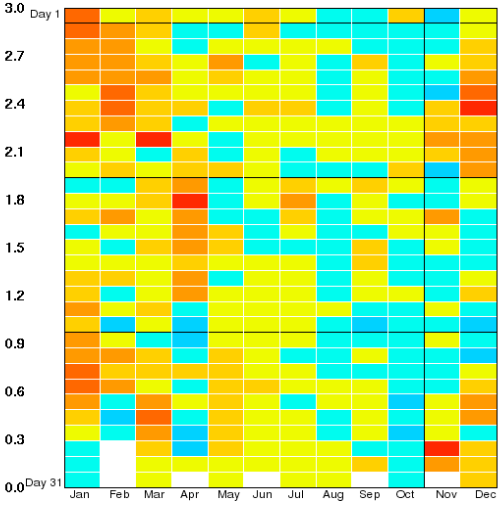
Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= 0.2 at (3,28), Max= 2.0 at (6,7)

Temperature Gross Error - gl Grid

Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
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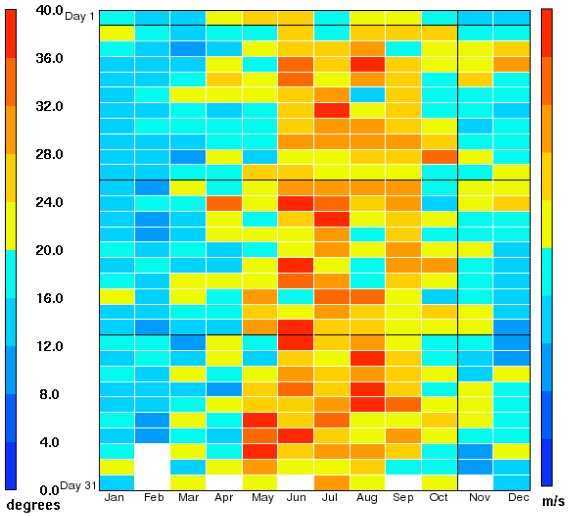
Wind Dir Gross Error - gl Grid

Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
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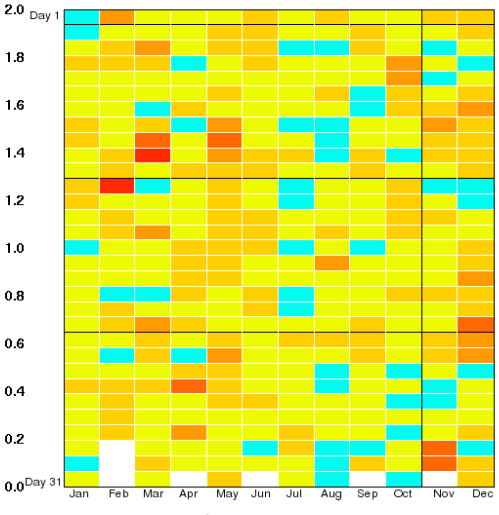
Wind Spd Gross Error - gl Grid

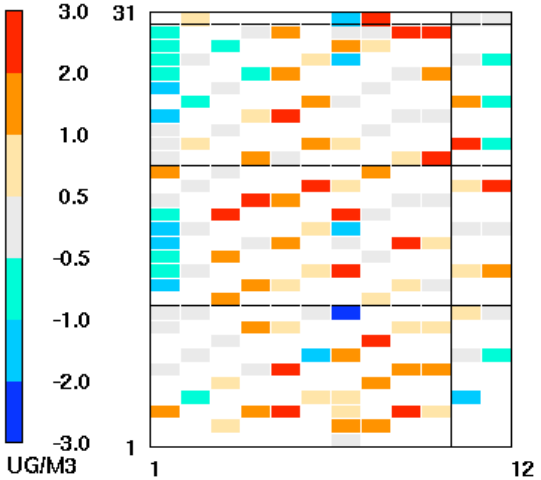
Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= 0.8 at (1,2), Max= 2.0 at (3,22)

PSO4 Daily Bias

basel2
Kirk Baker LADCO



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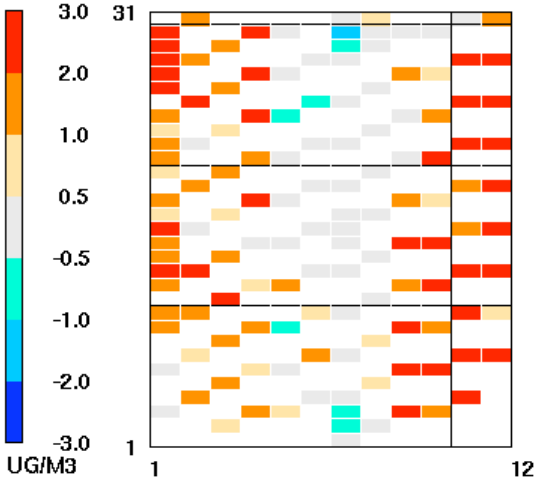
PNO3 Daily Bias

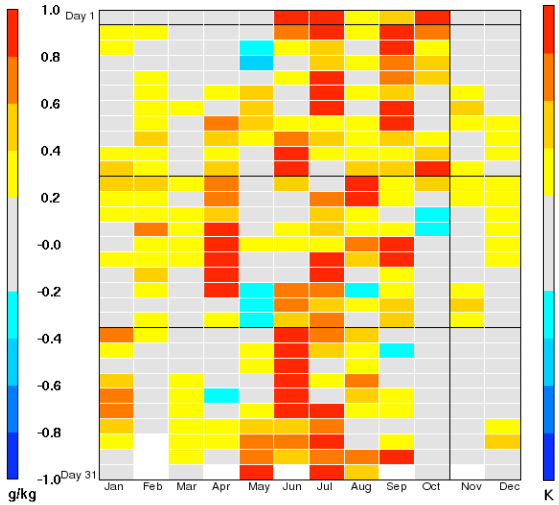
basel2
Kirk Baker LADCO



December 25,2002 0:00:00
Min= -1.7 at (7,30), Max= 12.7 at (12,19)

Humidity Bias - gl Grid

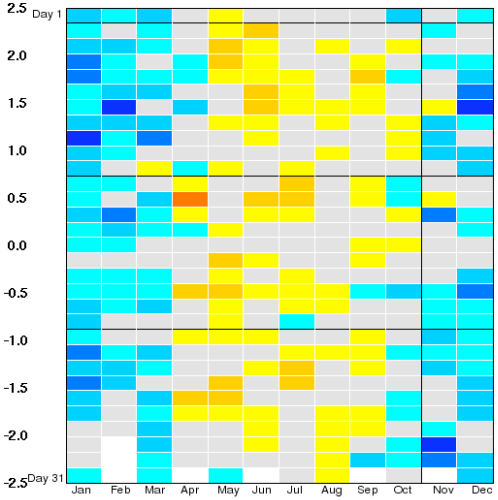
Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= -0.4 at (5,28), Max= 1.5 at (6,9)

Temperature Bias - gl Grid

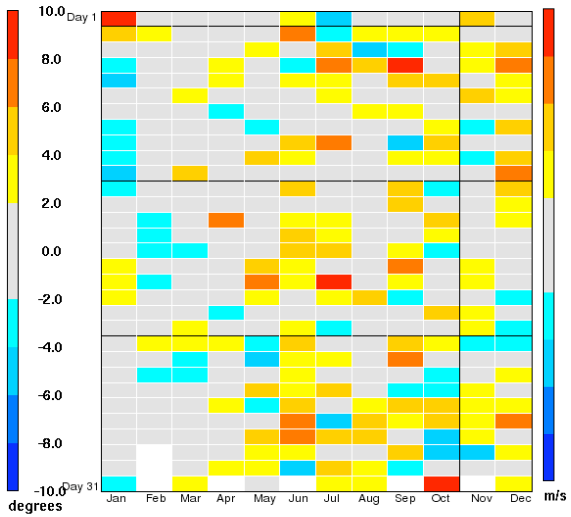
Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= -2.8 at (11,3), Max= 1.6 at (4,19)

Wind Dir Bias - gl Grid

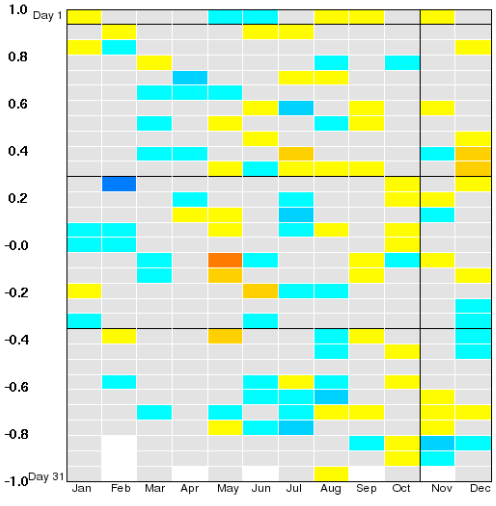
Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= -5.8 at (1,27), Max= 10.1 at (7,14)

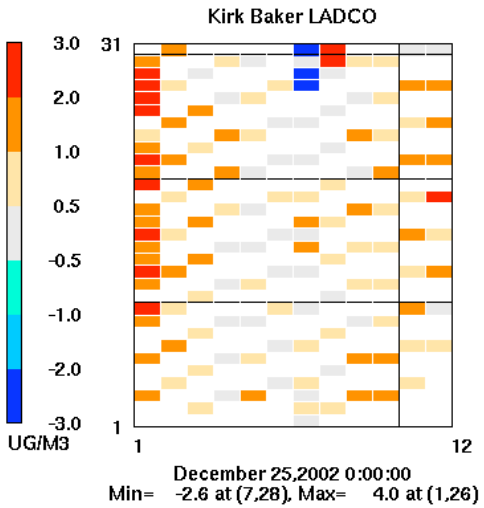
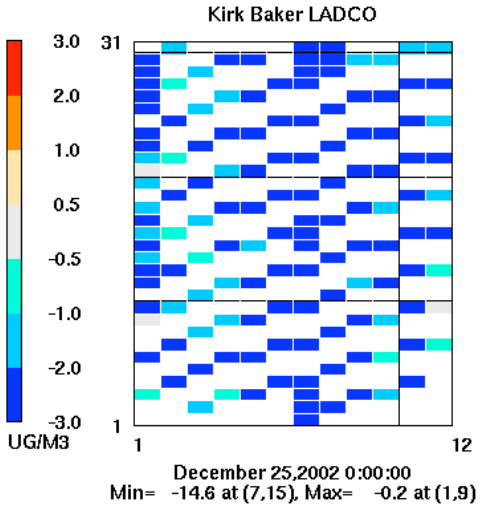
Wind Spd Bias - gl Grid

Annual MM5v363 2002 Daily Metrics: 36 km
Iowa DNR



January 1,2002 0:00:00
Min= -0.6 at (2,20), Max= 0.7 at (5,15)

Other Relationships in Daily Metrics

- Currently not using met data to drive dust emissions – so no relationship is expected

- Currently missing some important pathways of SOA production and polymerization – so no relationship is expected