Preliminary Evaluation of WRF Modeling for CalNex Study Period

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Objectives

- Improve fine scale modeling capabilities (1 to 4 km)

- Understand and improve operational meteorological and photochemical model skill in areas of the western United States with persistent model performance issues: Los Angeles, and other parts of California (Sacramento, Imperial valley)

CalNex/CalMex

- CalNex 2010 is a major climate and air quality field study in California conducted by the National Oceanic and Atmospheric Administration (NOAA) and the California Air Resources Board (ARB), with the participation of numerous academic researchers
- Field Study extends from May through June 2010

- CalNex-2010 offers a unique opportunity for US-Mexico collaboration since the composition of the atmosphere over the US-Mexico border region is affected by cross-border transport of emissions in both directions.
- The cross-border studies are expected to improve our understanding of the importance of different emissions sources (urban, biomass burning, natural) along the Cal-Mex border and the opportunity to study poorly understood but important processes (coupled gas, aerosols, radiation, meteorology) in aging urban air.

- LINK: http://cires.colorado.edu/jimenez-group/wiki/index.php/CalNex-LA

Modeling Overview

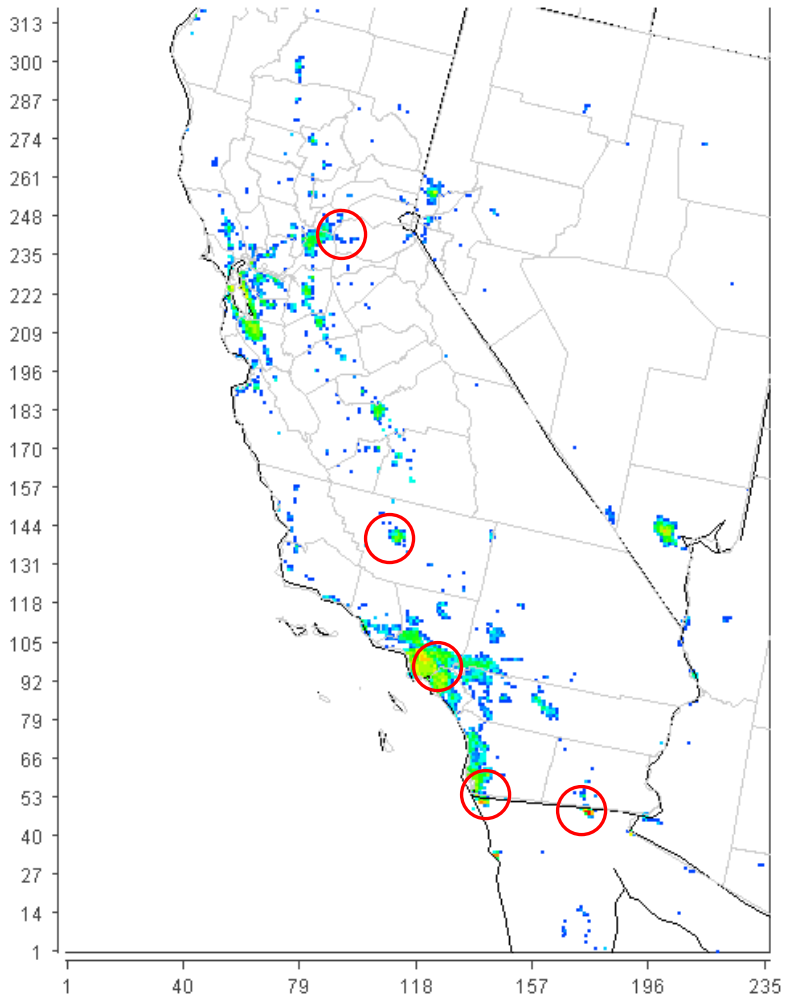
- Modeled May-July 1, 2010 episode

- CMAQ v4.7.1 (N2a)
- CB05 & AERO5

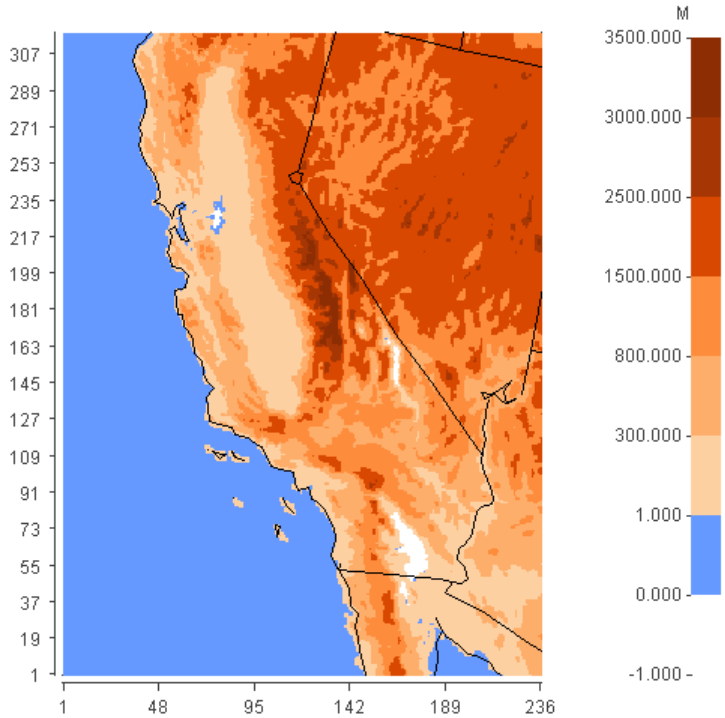
- WRF v3.2
- MCIP v3.6

- BEIS v3.14
- MEGAN v2.04
- WRF 2 m temperature and WRF shortwave downward radiation

- 2005 v2 based anthropogenic emissions for U.S.
- Mexico emissions based on 1999 inventory



US EPA Model Domain



- Horizontal grid cell size = 4 km
- NX = 236, NY = 317
- Lambert projection centered at (-97,40) with true latitudes 33 and 45
- Domain origin (-2416 km, -832 km)

Vertical Layers				
k	sigma	press	height	Depth
34	0	100	15,676	2,004
33	0.05	145	13,672	1,585
32	0.1	190	12,087	1,322
31	0.15	235	10,765	1,139
30	0.2	280	9,626	1,004
29	0.25	325	8,622	900
28	0.3	370	7,721	817
27	0.35	415	6,904	750
26	0.4	460	6,154	693
25	0.45	505	5,461	645
24	0.5	550	4,816	604
23	0.55	595	4,213	568
22	0.6	640	3,645	536
21	0.65	685	3,109	508
20	0.7	730	2,601	388
19	0.74	766	2,212	282
18	0.77	793	1,931	274
17	0.8	820	1,657	178
16	0.82	838	1,478	175
15	0.84	856	1,303	172
14	0.86	874	1,131	169
13	0.88	892	961	167
12	0.9	910	795	82
11	0.91	919	712	82
10	0.92	928	631	81
9	0.93	937	550	80
8	0.94	946	469	80
7	0.95	955	390	79
6	0.96	964	310	79
5	0.97	973	232	78
4	0.98	982	154	39
3	0.985	986.5	115	39
2	0.99	991	77	38
1	0.995	995.5	38	38
0	1	1000	0	38

Meteorological Modeling

- **WRF version 3.2**
- **WPS version 3.2**

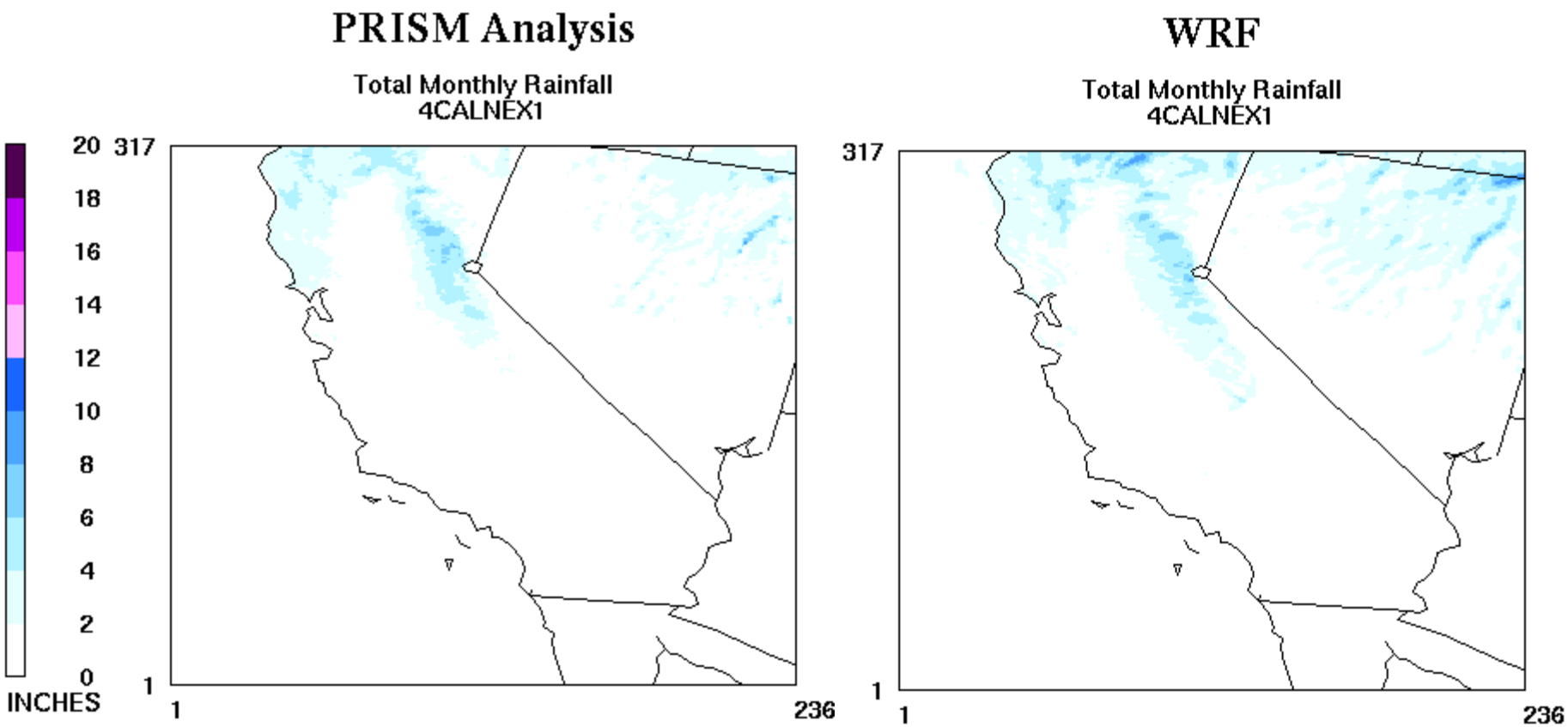
- NAM-12 analysis
- OBSGRID for soil nudging
- Soil moisture and temperature continued from one 5 day block to the next
- First 5 day block used average 2m temperature to initialize deep soil temperature
- Analysis nudging for temperature, winds, and moisture above PBL only

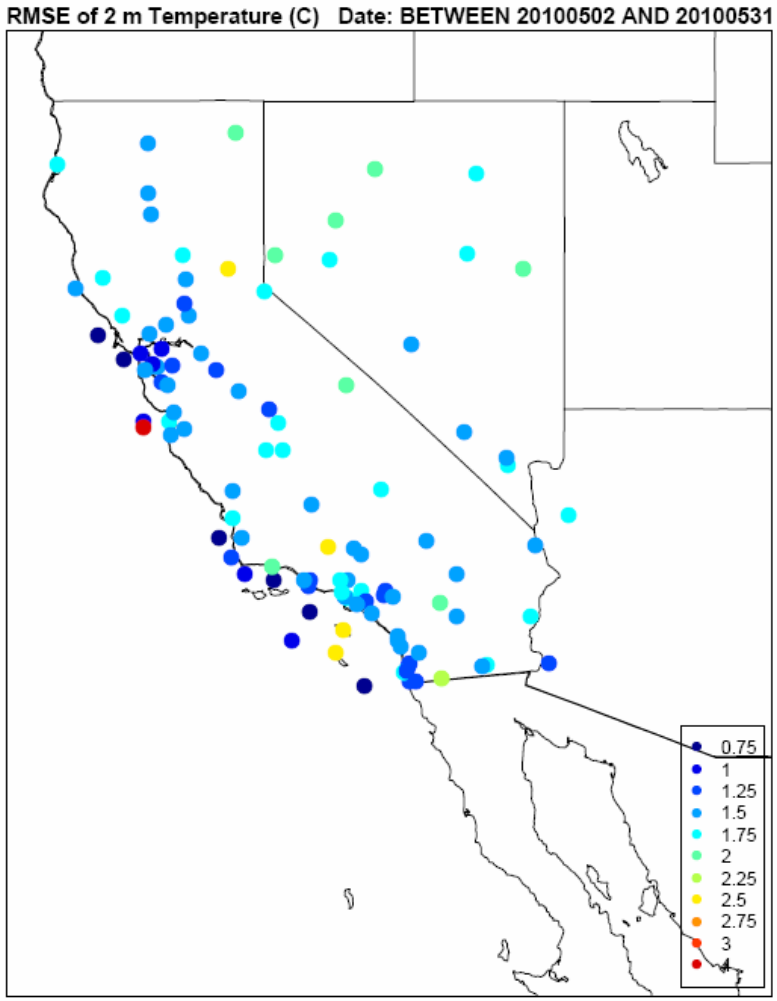
- Morrison double moment microphysics
- RRTMG longwave and shortwave radiation
- Pleim-Xiu land-surface and surface layer models
- ACM2 planetary boundary layer scheme
- Kain-Fritsch cumulus parameterization

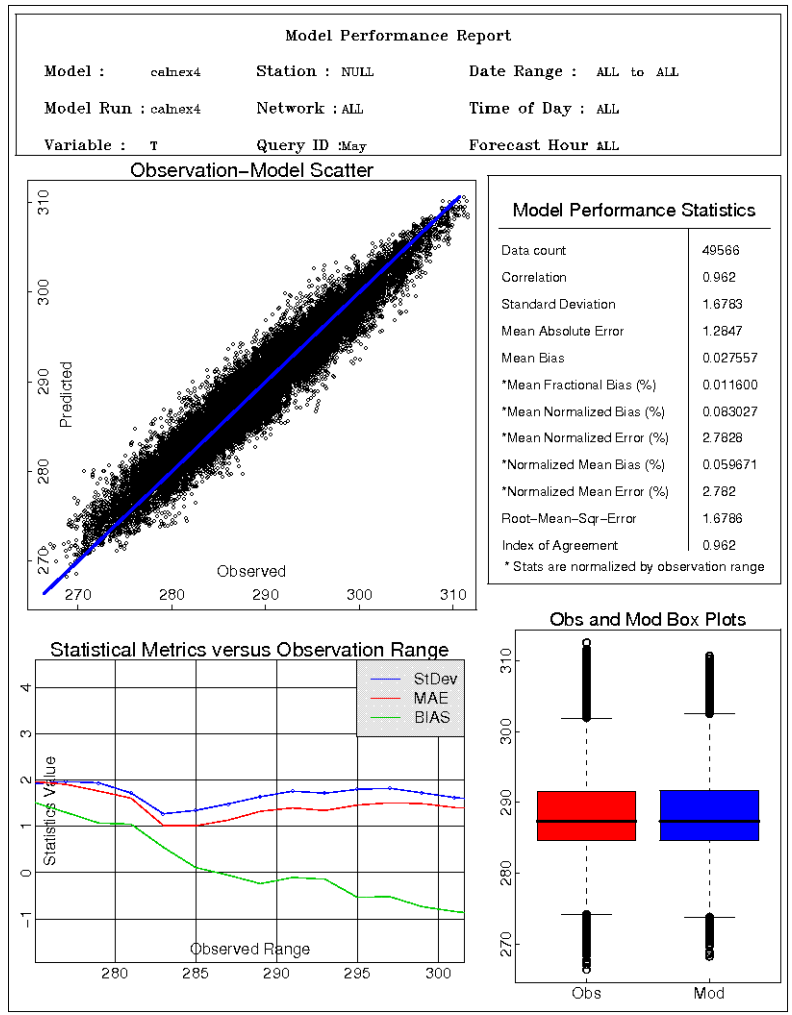
Evaluation

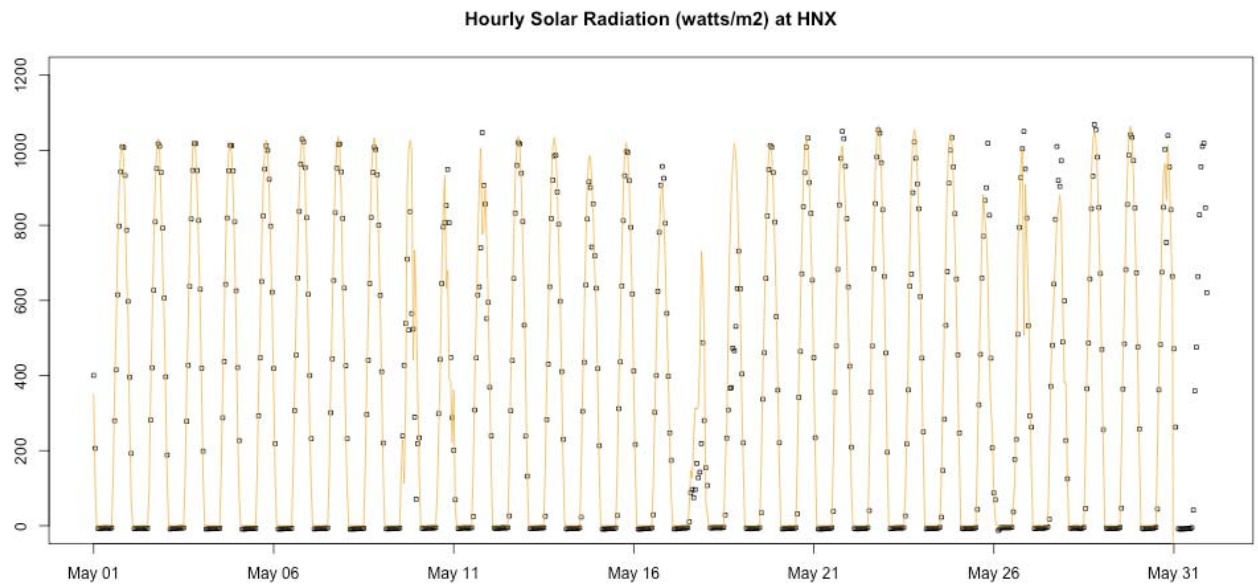
- SURFRAD/ISIS (solar radiation)
- PRISM precipitation analysis
- NCAR ds472 (T, WS, WD, MR)

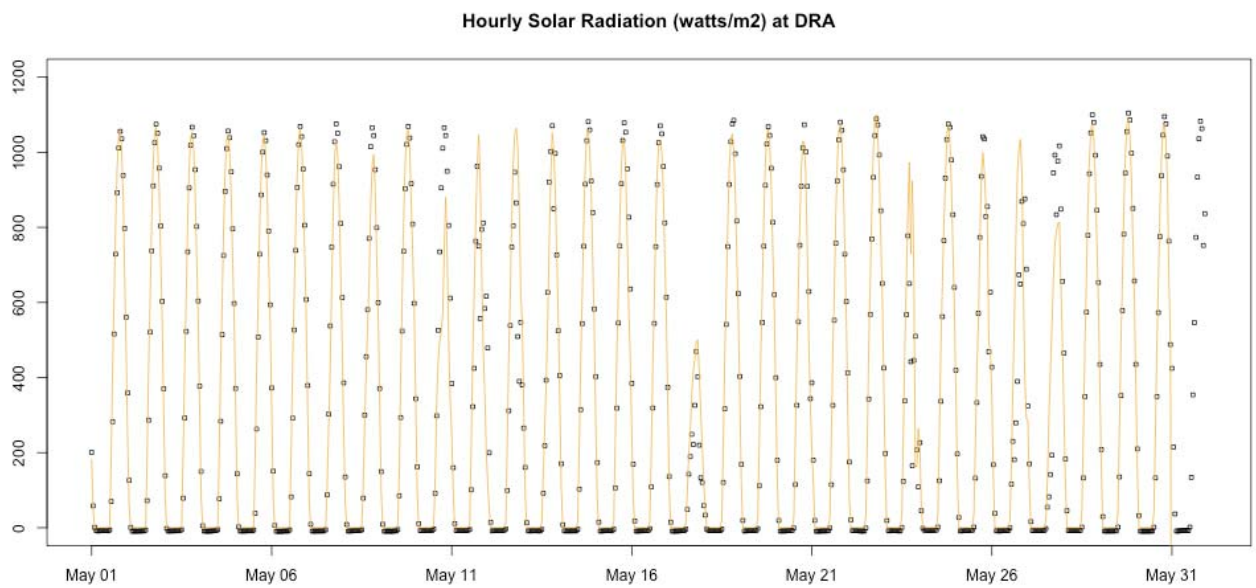
May 2010 Monthly Total Precipitation

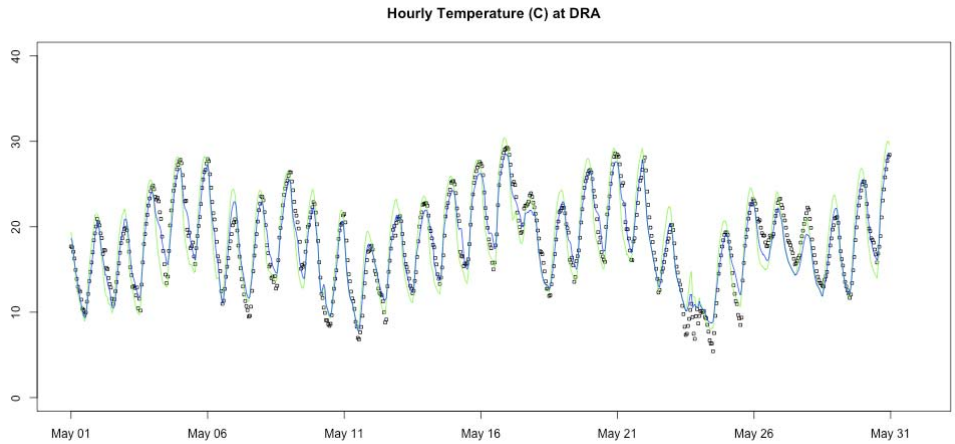


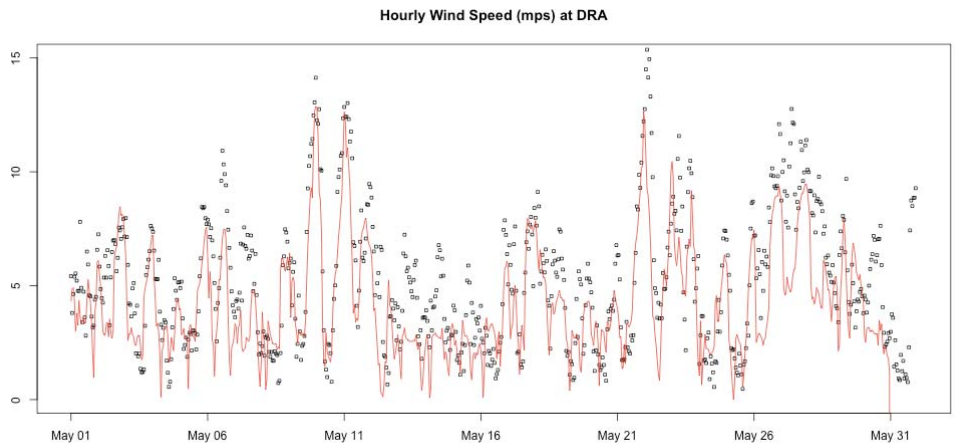

RMSE of 2 m Temperature (C) Date: BETWEEN 20100502 AND 20100531
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
4

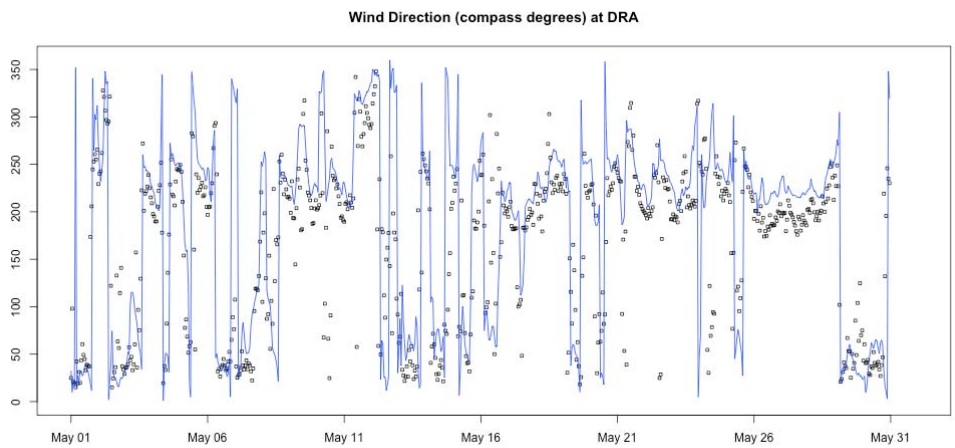

Model Performance Report
Model : calnex4
Station : NULL
Date Range : ALL to ALL
Model Run : calnex4
Network : ALL
Time of Day : ALL
Variable : T
Query ID :May
Forecast Hour ALL
Observation–Model Scatter
Predicted
Observed
270
280
290
300
310
Model Performance Statistics
Data count 49566
Correlation 0.962
Standard Deviation 1.6783
Mean Absolute Error 1.2847
Mean Bias 0.027557
*Mean Fractional Bias (%) 0.011600
*Mean Normalized Bias (%) 0.083027
*Mean Normalized Error (%) 2.7828
*Normalized Mean Bias (%) 0.059671
*Normalized Mean Error (%) 2.782
Root–Mean–Sqr–Error 1.6786
Index of Agreement 0.962
* Stats are normalized by observation range
Statistical Metrics versus Observation Range
StDev
MAE
BIAS
Statistics Value
Observed Range
280
285
290
295
300
Obs and Mod Box Plots
Obs
Mod


Hourly Solar Radiation (watts/m2) at HNX
0
200
400
600
800
1000
1200
May 01
May 06
May 11
May 16
May 21
May 26
May 31


Hourly Solar Radiation (watts/m2) at DRA
0
200
400
600
800
1000
1200
May 01
May 06
May 11
May 16
May 21
May 26
May 31


Hourly Temperature (C) at DRA
0
10
20
30
40
May 01
May 06
May 11
May 16
May 21
May 26
May 31


Hourly Wind Speed (mps) at DRA
0
5
10
15
May 01
May 06
May 11
May 16
May 21
May 26
May 31


Wind Direction (compass degrees) at DRA
0
50
100
150
200
250
300
350
May 01
May 06
May 11
May 16
May 21
May 26
May 31