

Near-Term Modeling Support for the 2010 HGB 8-hr Ozone SIP

prepared for
Houston 8-hr Coalition

prepared by

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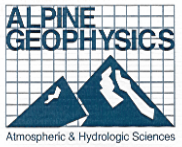
Overview

- **Goals of the 8-hr Ozone Coalition efforts**
 - **Make direct contributions to the overall modeling science foundation available to the TCEQ for developing the 2010 8-hr Ozone SIP**
 - **Develop greater understanding of ozone formation during 2005 and 2006 through corroborative and alternative modeling**
 - **Develop greater understanding of the impacts of alternative emissions control strategies for 2018**
 - **Produce parallel data sets that may be helpful in other on-going science investigations in the region (e.g., H97)**
 - **SMOKE emissions inventories (base case, future baseline, OSAT)**
 - **Alternative emissions control scenarios**
 - **Produce data sets that may be of interest to other modeling and analysis groups seeking greater participation in the 2010 HGB ozone SIP development process (e.g., EPA/OAQPS/ORD)**
 - **Provide independent review and assessment of meteorological, emissions, and air quality modeling data sets**
- **Achieving these goals would not be possible without support and collaborative efforts of the TCEQ**

Overview

- **Progress of modeling and analysis work funded by the Houston 8-hr Ozone Coalition**
 - **Part I – Corroborative air quality modeling (CAMx)**
 - **Part II – Fine-scale Meteorological modeling (MM5)**
 - **Part III – Emissions modeling (SMOKE)**

Part I - Corroborative Air Quality Modeling (CAMx)



- **Objectives**
- **Methods**
- **Results**
- **Conclusion & Summary**

Part I - Objectives

- **Replicate 2005 and 2006 SIP base cases using TCEQ CAMx-ready inputs**
- **If significant differences arise, determine underlying cause**
- **Again, the overarching goal is to improve the SIP-related process by elucidating the processes that impact ozone formation in the greater-Houston area and diagnosing/improving the underlying data sets that are used in the tools and models used to understand these processes**

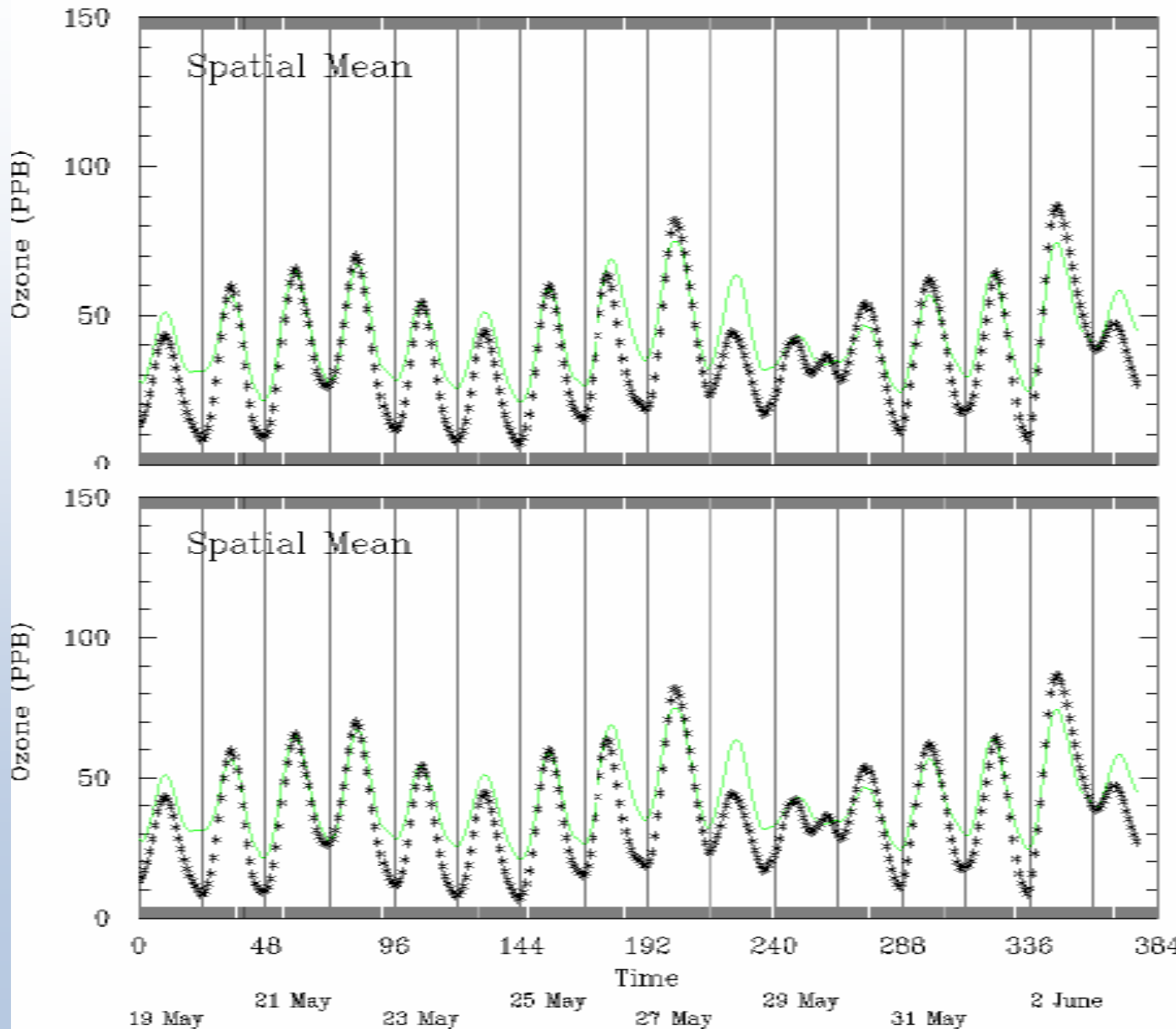
Part I - Methods

- **Obtain base case input and output**
 - **2005 Episodes**
 - **Episode 0: 19 May – 3 June 2005**
 - **Episode 1: 17 June – 30 June 2005**
 - **Episode 2: 26 July – 8 August 2005**
 - **2006 Episode**
 - **Episode 0: 31 May – 15 June 2006**
- **Install modeling files on AG computers**
- **Exercise CAMx for four 2005/2006 episodes**
 - **TCEQ uses CAMx v4.50 (TCEQ has recently moved v4.51)**
 - **AG uses CAMx v4.51, released 22 May 2008**
- **Statistically and graphically inter-compare TCEQ and AG runs for 14 species**
 - **ALD2, CO, ETH, ETHA, IOLE, ISOP, NO, NO2, NO_x, O3, OLE, PAR, TOL, and XYL.**

Part I - Results

- **Examples are presented in following slides**
- **Bottom-line – corroborative modeling has uncovered no discernible errors**

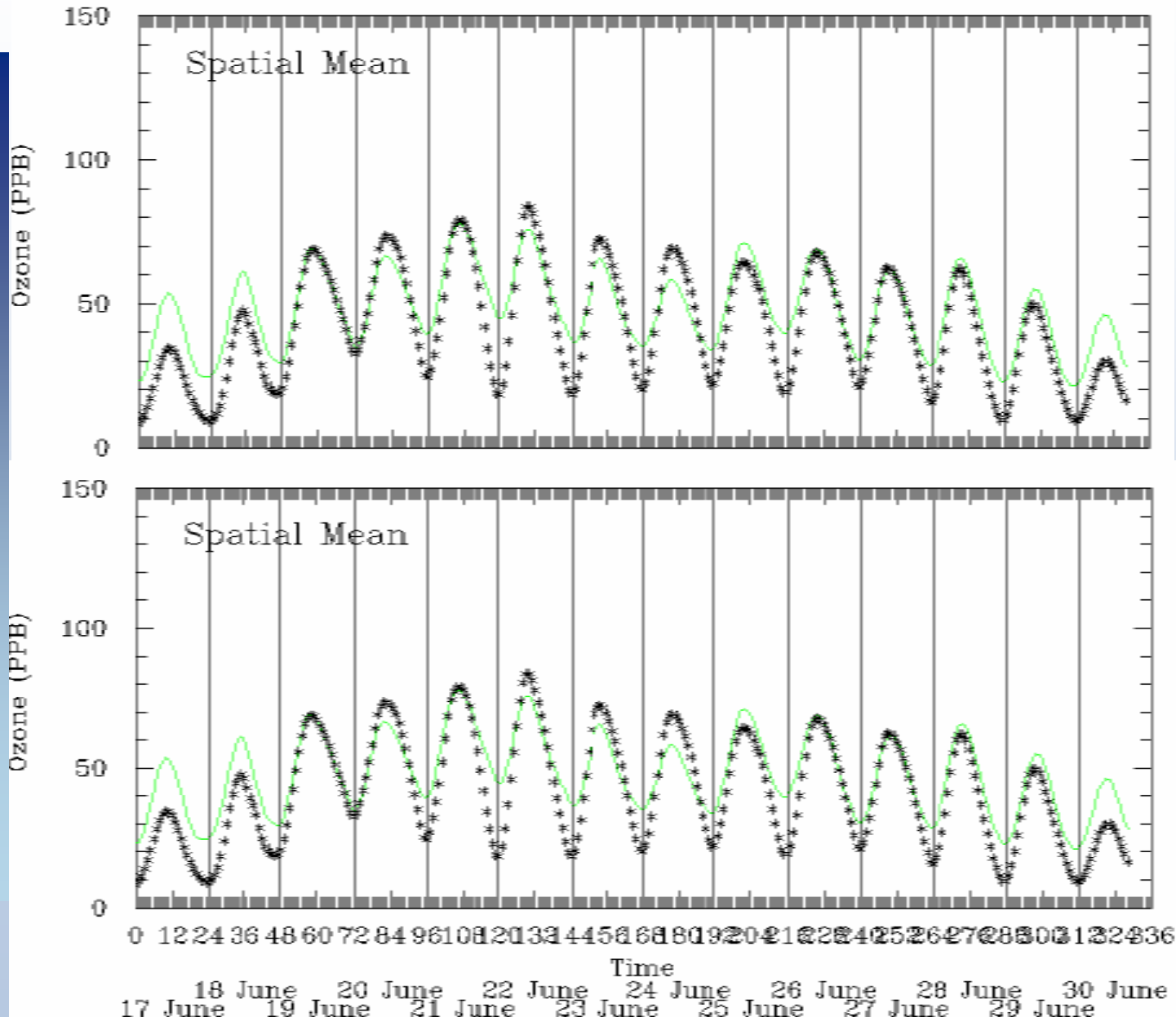
Part I (Example Results) - May 2005



TCEQ

Alpine Geophysics

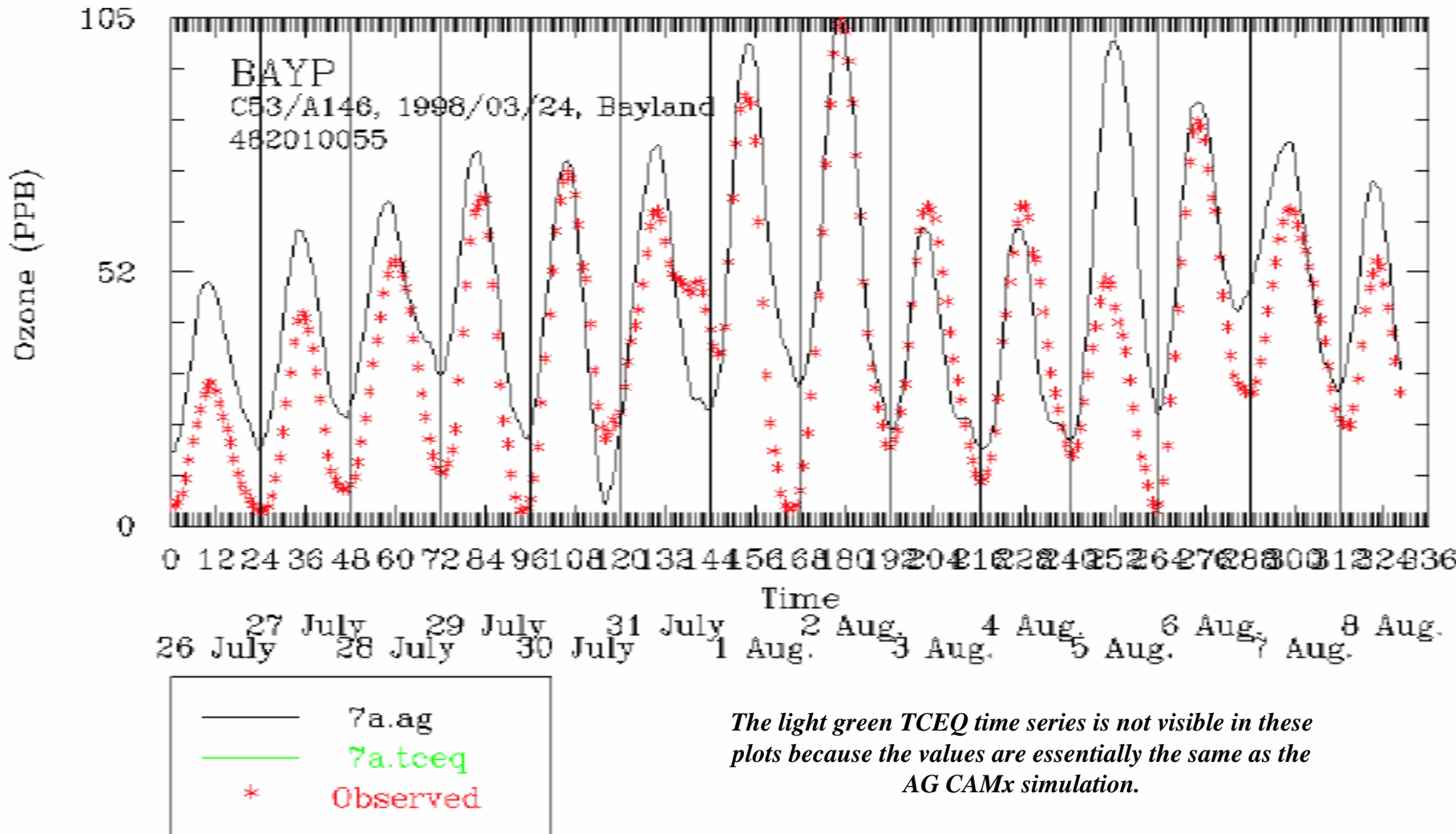
Part I (Example Results) - June 2005



TCEQ

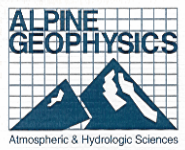
Alpine Geophysics

Part I (Example Results) - Bayland Park, July 2005



The light green TCEQ time series is not visible in these plots because the values are essentially the same as the AG CAMx simulation.

Part I (Example Results) - 8-hr Ozone Performance Statistics, June 2006

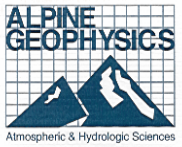


Day	TCEQ June 2006 Episode						Alpine Geophysics June 2006 Episode						TCEQ minus Alpine Geophysics					
	NME	MFE	MB	MNB	MFB	NMB	NME	MFE	MB	MNB	MFB	NMB	NME	MFE	MB	MNB	MFB	NMB
151	45.62	46.44	9.11	85.53	39.70	37.32	45.62	46.44	9.12	85.52	39.71	37.34	0.00	0.00	-0.01	0.01	-0.01	-0.02
152	49.86	52.34	10.89	454.91	49.02	47.54	49.85	52.34	10.90	454.33	49.06	47.57	0.01	0.00	-0.01	0.58	-0.04	-0.03
153	27.98	38.33	7.11	86.62	32.01	18.66	27.99	38.33	7.13	86.55	32.03	18.73	-0.01	0.00	-0.02	0.07	-0.02	-0.07
154	21.25	26.71	6.33	38.01	19.07	14.35	21.25	26.70	6.32	37.96	19.04	14.33	0.00	0.01	0.01	0.05	0.03	0.02
155	24.60	28.37	5.66	32.12	18.57	12.44	24.58	28.36	5.66	32.09	18.56	12.45	0.02	0.01	0.00	0.03	0.01	-0.01
156	20.03	25.29	2.65	22.27	11.47	5.53	20.01	25.27	2.67	22.28	11.49	5.57	0.02	0.02	-0.02	-0.01	-0.02	-0.04
157	18.30	22.27	1.83	15.97	7.81	3.67	18.27	22.25	1.83	15.96	7.81	3.68	0.03	0.02	0.00	0.01	0.00	-0.01
158	16.42	19.34	2.65	14.51	8.74	5.93	16.41	19.34	2.66	14.52	8.75	5.96	0.01	0.00	-0.01	-0.01	-0.01	-0.03
159	19.59	22.71	1.28	15.02	8.82	2.59	19.57	22.69	1.30	15.02	8.84	2.62	0.02	0.02	-0.02	0.00	-0.02	-0.03
160	19.42	23.29	0.42	12.86	5.65	0.81	19.42	23.29	0.44	12.87	5.66	0.84	0.00	0.00	-0.02	-0.01	-0.01	-0.03
161	23.99	26.74	9.57	33.88	22.51	19.35	23.94	26.70	9.54	33.78	22.45	19.28	0.05	0.04	0.03	0.10	0.06	0.07
162	27.55	32.78	9.02	58.43	29.38	22.89	27.50	32.73	8.99	58.31	29.32	22.83	0.05	0.05	0.03	0.12	0.06	0.06
163	41.22	48.87	11.18	104.48	41.88	29.69	41.27	48.89	11.21	104.53	41.92	29.77	-0.05	-0.02	-0.03	-0.05	-0.04	-0.08
164	28.88	36.03	6.72	58.61	21.68	15.66	28.90	36.06	6.71	58.61	21.64	15.64	-0.02	-0.03	0.01	0.00	0.04	0.02
165	18.06	21.34	-2.41	9.58	-0.20	-4.05	18.05	21.33	-2.42	9.53	-0.23	-4.07	0.01	0.01	0.01	0.05	0.03	0.02
166	18.08	20.49	5.73	25.39	14.77	11.65	18.06	20.48	5.68	25.26	14.67	11.53	0.02	0.01	0.05	0.13	0.10	0.12

Part I - Conclusions

- **Established that the four TCEQ modeling episodes examined have been satisfactorily replicated using the inputs and outputs supplied by TCEQ on 25 July 2008.**
- **The differences in CAMx model outputs with the current code (v4.51) used by AG vs. the previous code (v4.50) used by TCEQ are inconsequential.**

Part II - Fine-scale Meteorological Modeling (MM5)



- **Objectives**
- **Methods**
- **Results**
- **Conclusion & Summary**

Part II - Objectives

- **Determine if fine-scale meteorological and air quality modeling improve model performance**
- **Determine if inclusion of high-resolution and more detailed meteorological data sets for purposes of “nudging” results in better meteorological performance**

Part II - Methods

- **For the TCEQ CAMx 25 May–24 June 2006 episode, replace the TCEQ 2 km MM5 domain with Alpine’s 1.3 km MM5 domain.**
 - **Note: Currently, TCEQ ‘flexi-nests’ the meteorological fields from the 4 km domain onto their 2 km domain.**
 - **Flexi-nesting is believed to miss enhanced, land/sea interactions that can be represented in higher resolution prognostic model runs.**
- **Run CAMx with a 36/12/4/1.3 km nested grid**
- **Evaluate CAMx model performance with the enhanced 1.33 km nest for ozone and precursors, comparing with TCEQ model performance with the 2 km flexi-nest configuration.**
- **Compare and contrast CAMx model performance alternative approaches to fine-scale modeling of the May-June 2006 episode**
- **Repeat this fine scale modeling experiment with the Aug-Oct ’06 episode if warranted.**

Part II - Why 1.33 km instead of 1 km or 2 km?

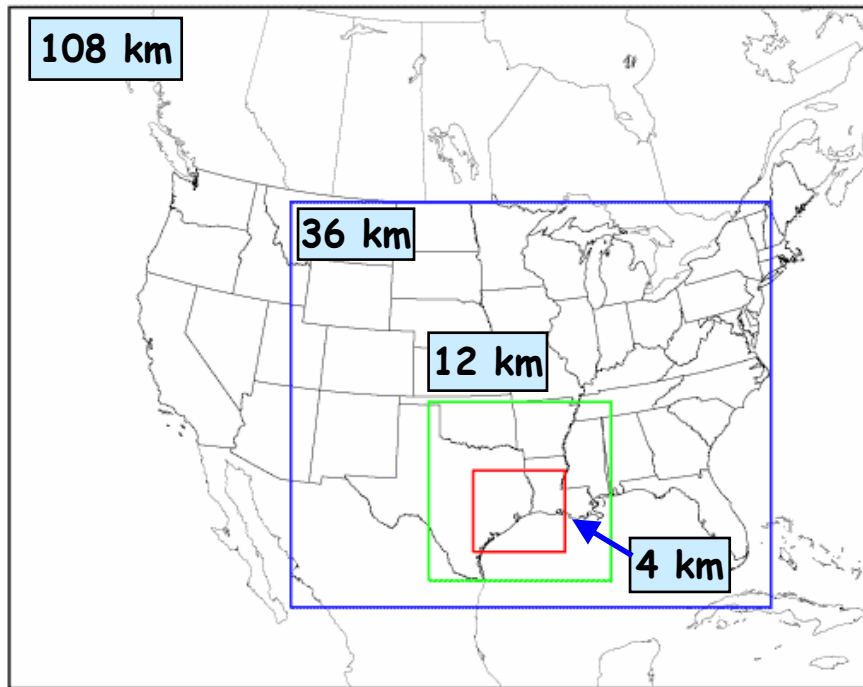
- **Grid nesting in MM5 and CAMx allows two-way interactive grids provided the grid nest scale is a 3:1 ratio.**
- **Use of 1.33 km nesting allows *both* the meteorological and CAMx air quality model to use two-way nesting at each integration time step.**
- **CMAQ allows only 1-way nesting**
- **Use of 1 km or 2 km inner nests allow 1-way nesting only for MM5, CAMx and CMAQ**
- **Given the length of Gulf coastline and perimeter of near shore embayments (e.g., Galveston Bay), there are technical concerns about the adequacy of ‘flexi-nesting’ (i.e., straight interpolation down from the 4 km grid) to represent local the land-gulf winds and thermodynamic structures.**

Part II - Meteorological Modeling Progress Report

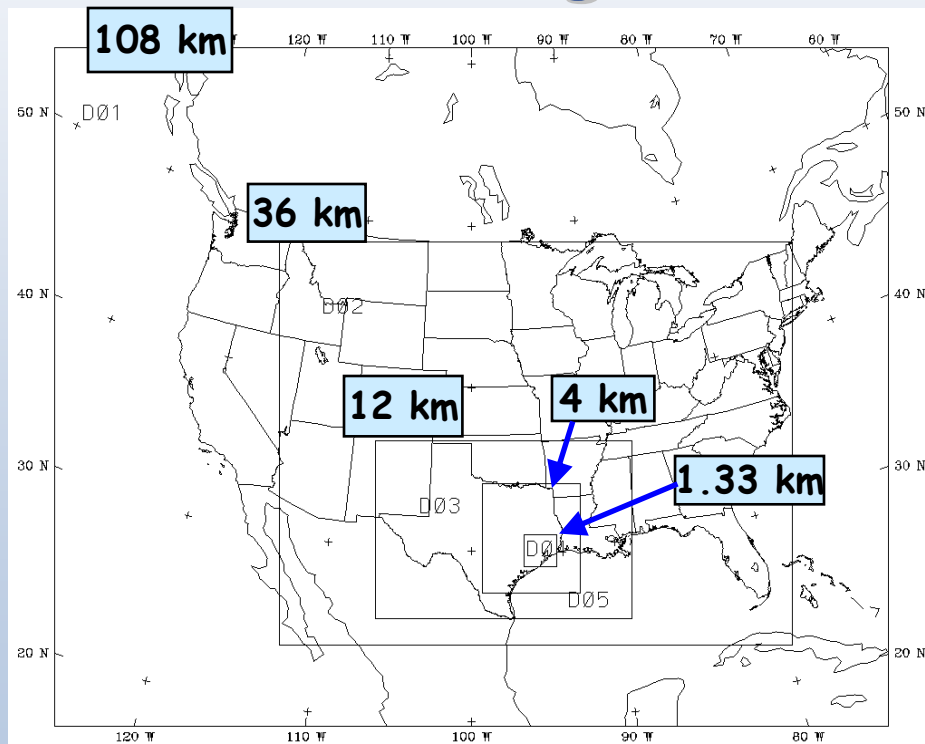
- For the 25 May- 24 June and 15 Aug-14 Oct 2006 Episodes:
 - Evaluate the TCEQ 4 km MM5 Simulation (May-June only)
 - Evaluate the Alpine 4 km and 1.33 km nested MM5 Simulations
 - With standard aloft meteorology nudging
 - With enhanced aloft meteorology nudging with Nielson-Gammon data
- Inter-compare MM5 performance results on available grids for four surface observation networks
 - National Data Buoy Center (NDBC)
 - Ports Monitoring Network
 - TDL & CAMs Network
 - Combined Networks
- Results for 25 May- 24 June 2006 and 15 Aug-14 Oct 2006 also compared with Ad Hoc goals and performance in over 70 other modeling studies in the U.S.



TCEQ MM5 Modeling Domain

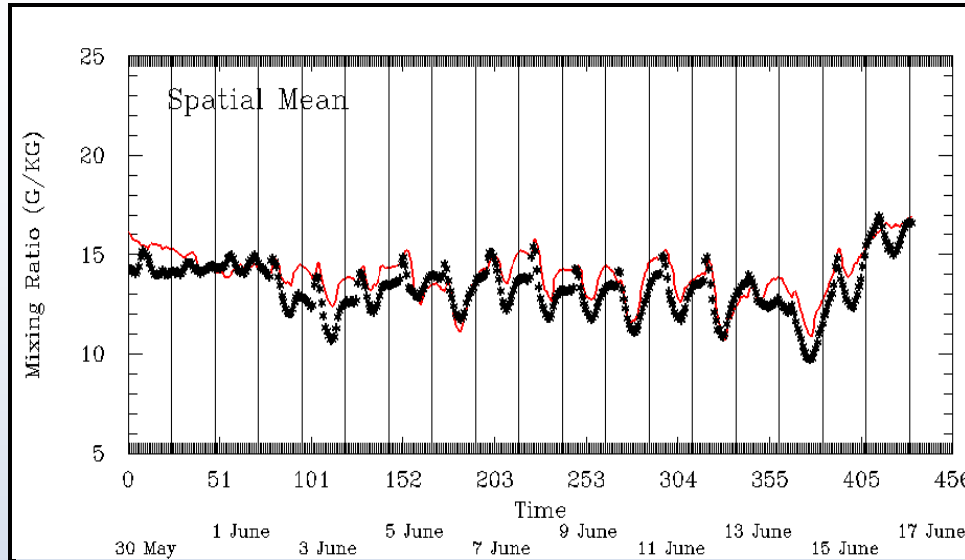


Alpine Geophysics MM5 Modeling Domain

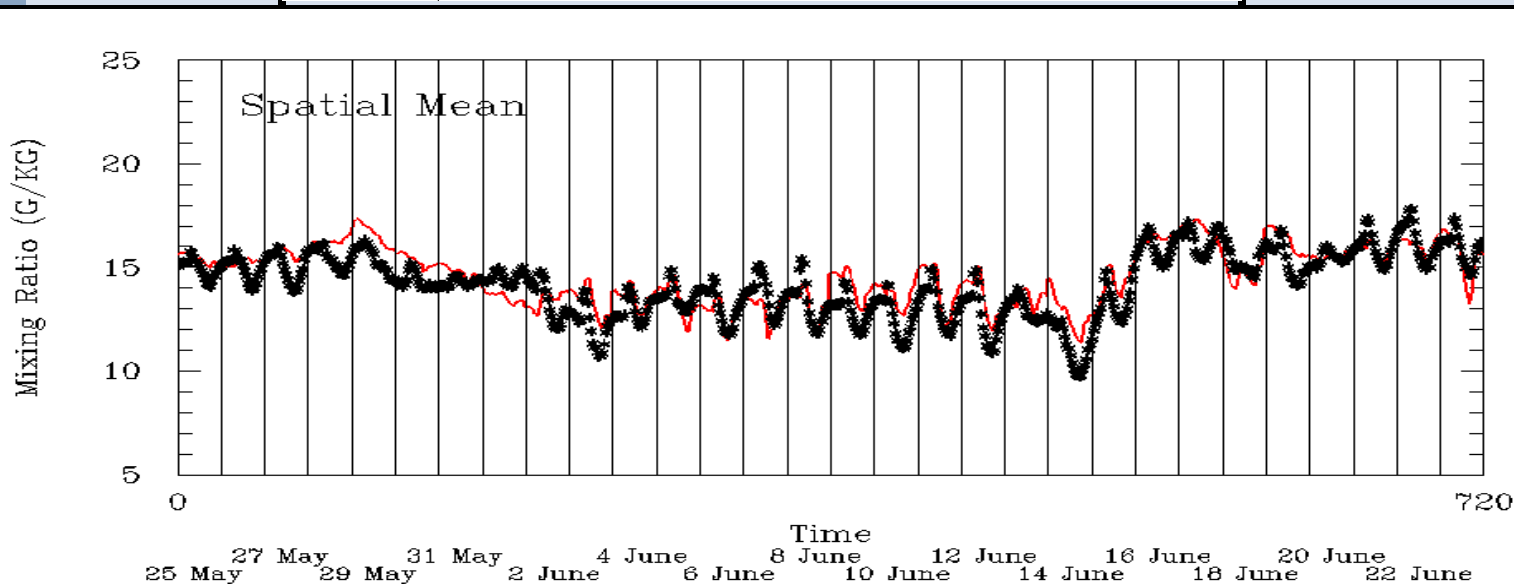


Part II (Example Results) - Spatial Mean Mixing Ratio

TCEQ



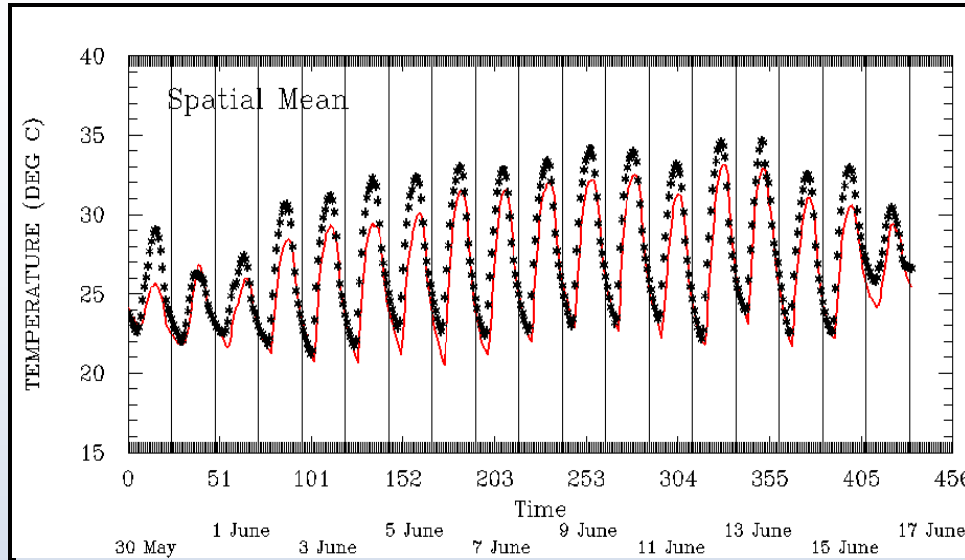
25 May-24 June 2006
(4km Grid, All Monitors)



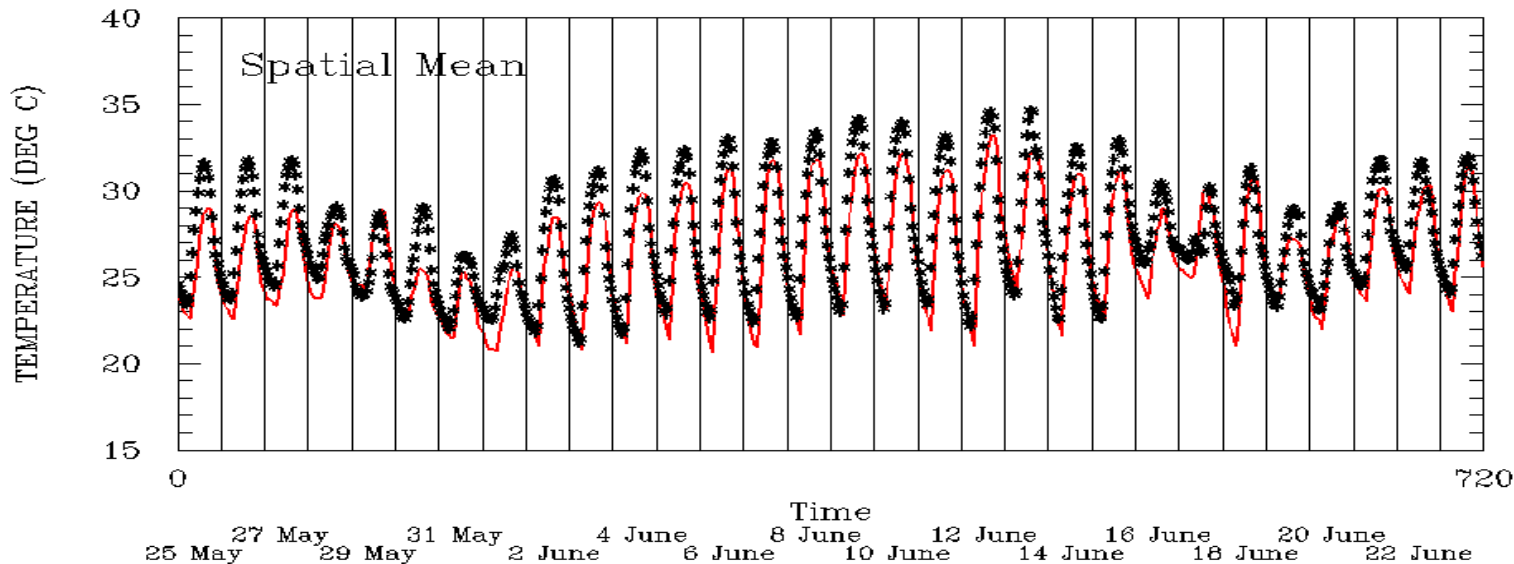
Alpine

Part II (Example Results) - Spatial Mean Temperature

TCEQ



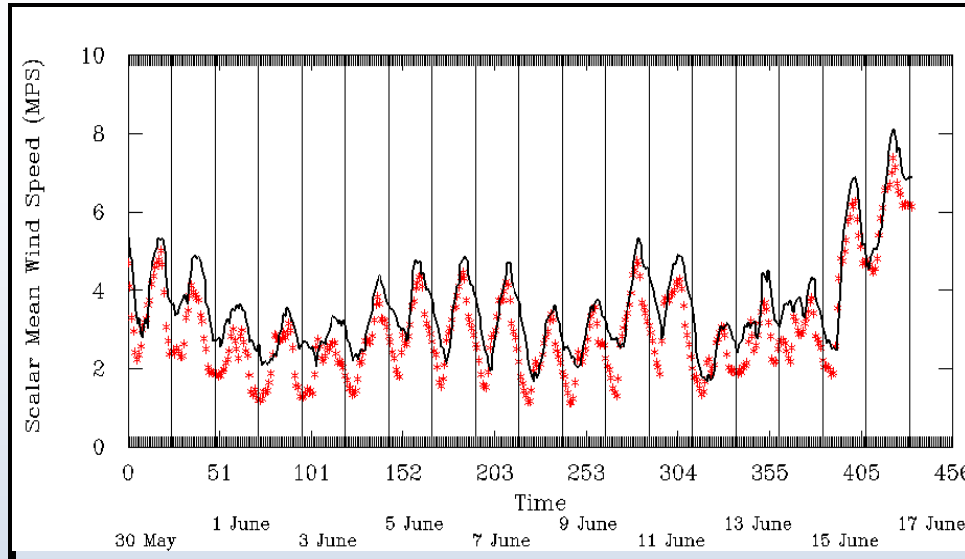
25 May-24 June 2006
(4km Grid, All Monitors)



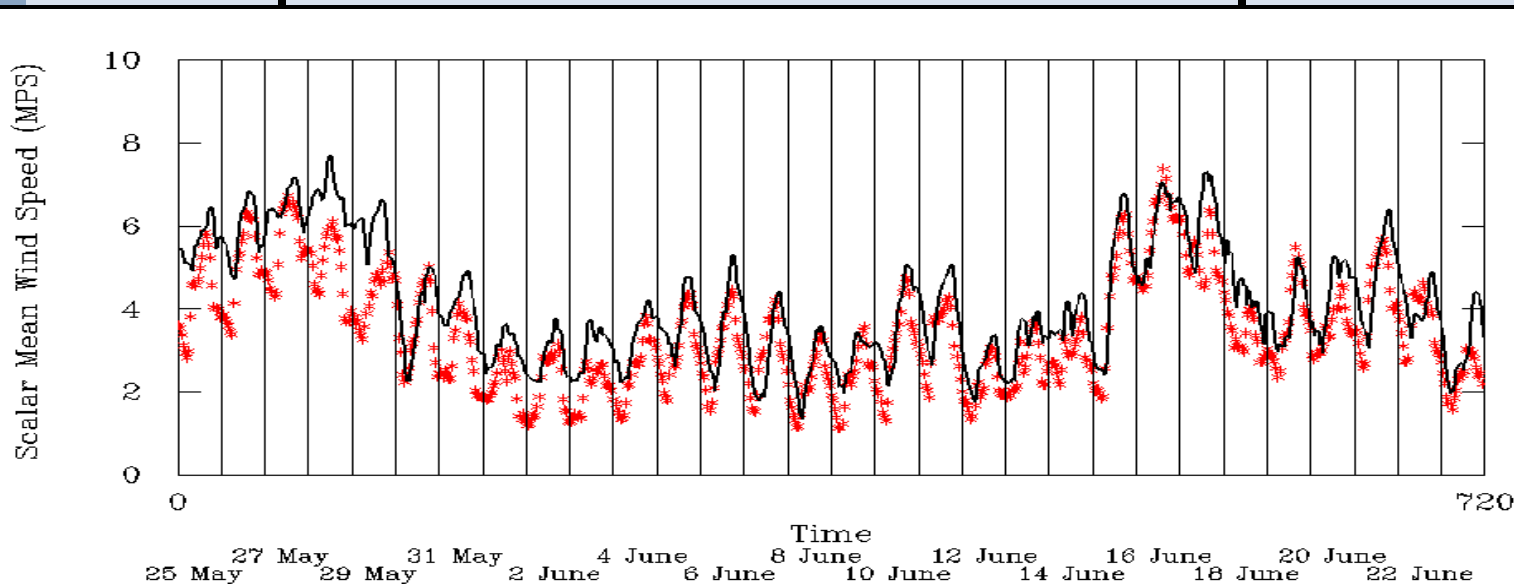
Alpine

Part II (Example Results) - Scalar Mean Wind Speed

TCEQ



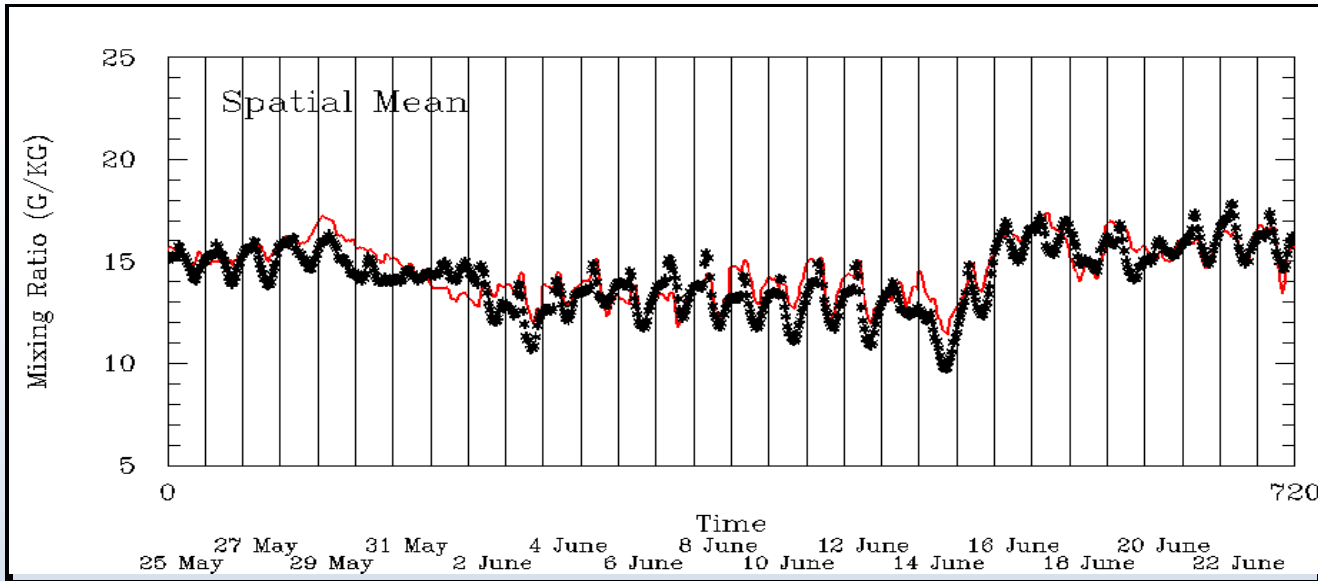
25 May-24 June 2006
(4km Grid, All Monitors)



Alpine

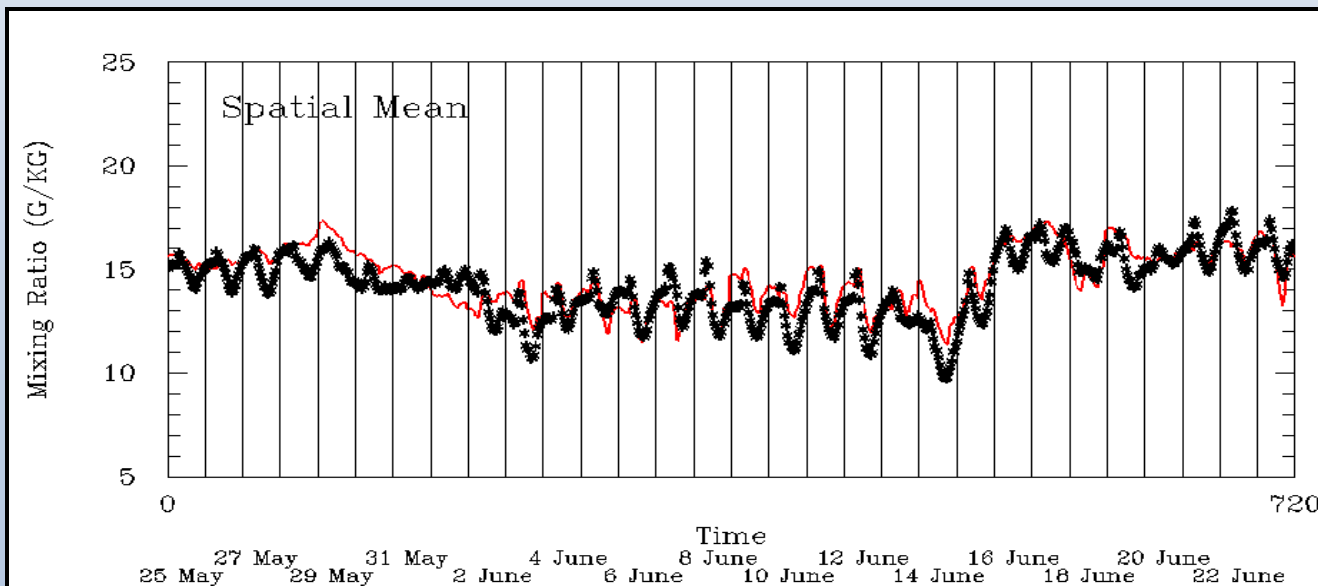
Part II (Example Results) - 4 km Grid - Alpine Standard and Enhanced (N-G) Nudging

Part II (Example Results) - Spatial Mean Mixing Ratio (water)



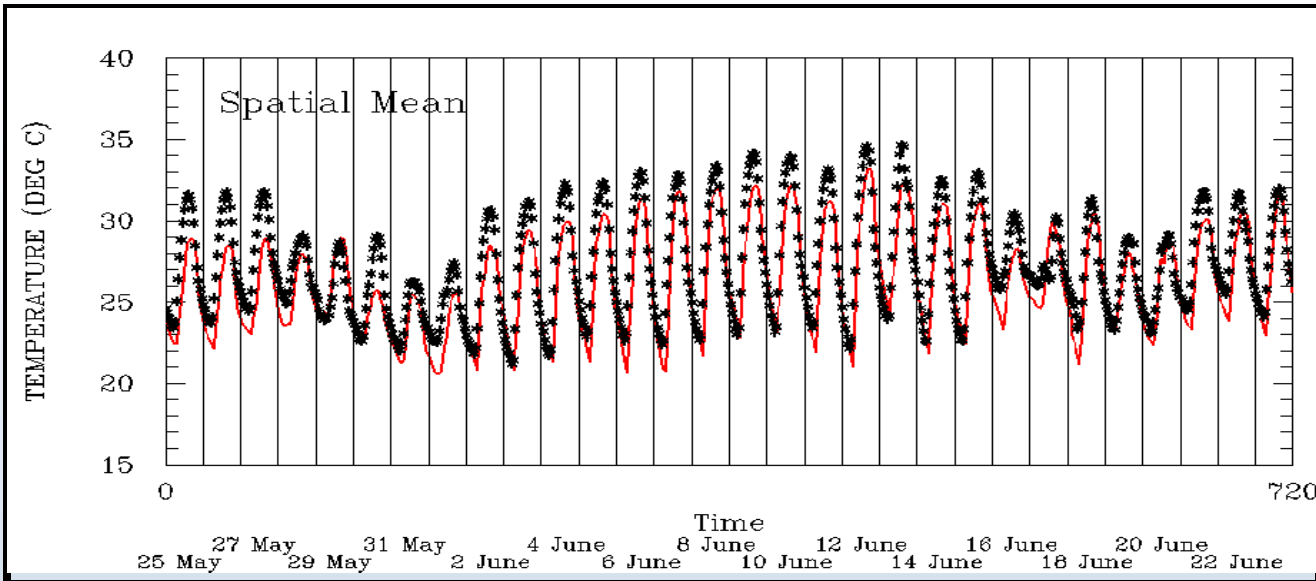
Standard
Nudging

25 May-24 June 2006
(4km Grid, All
Monitors)



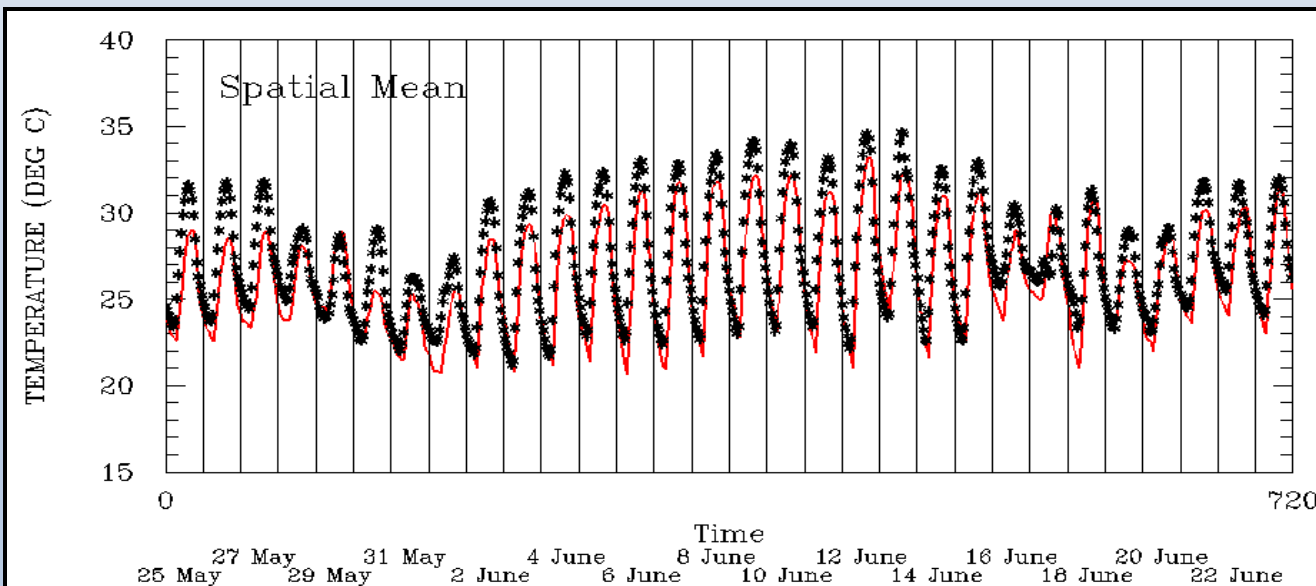
Enhanced
Profiler
Nudging

Part II (Example Results) - Spatial Mean Temperature



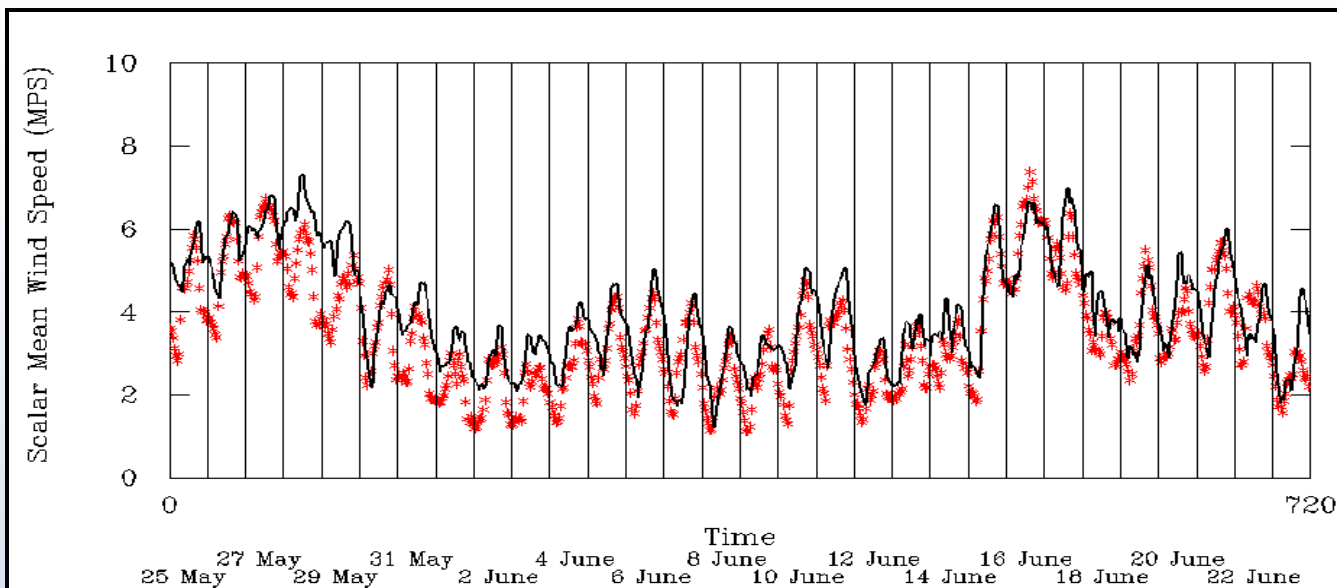
Standard
Nudging

25 May-24 June 2006
(4km Grid, All
Monitors)



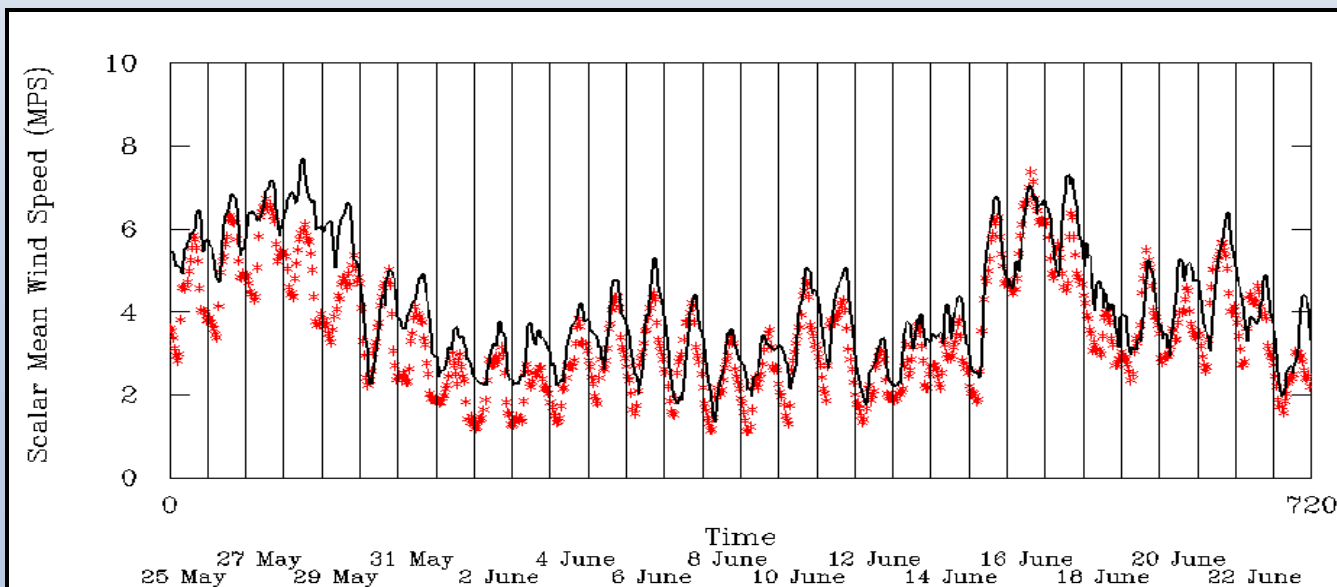
Enhanced
Profiler
Nudging

Part II (Example Results) - Scalar Mean Wind Speed



Standard
Nudging

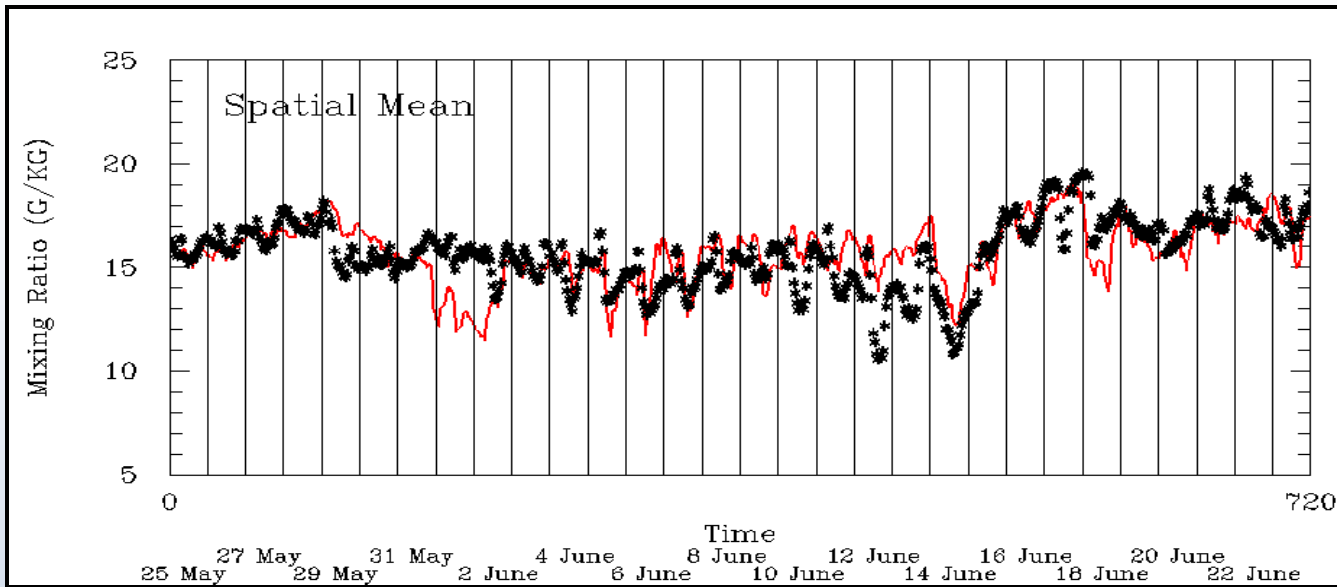
25 May-24 June 2006
(4km Grid, All
Monitors)



Enhanced
Profiler
Nudging

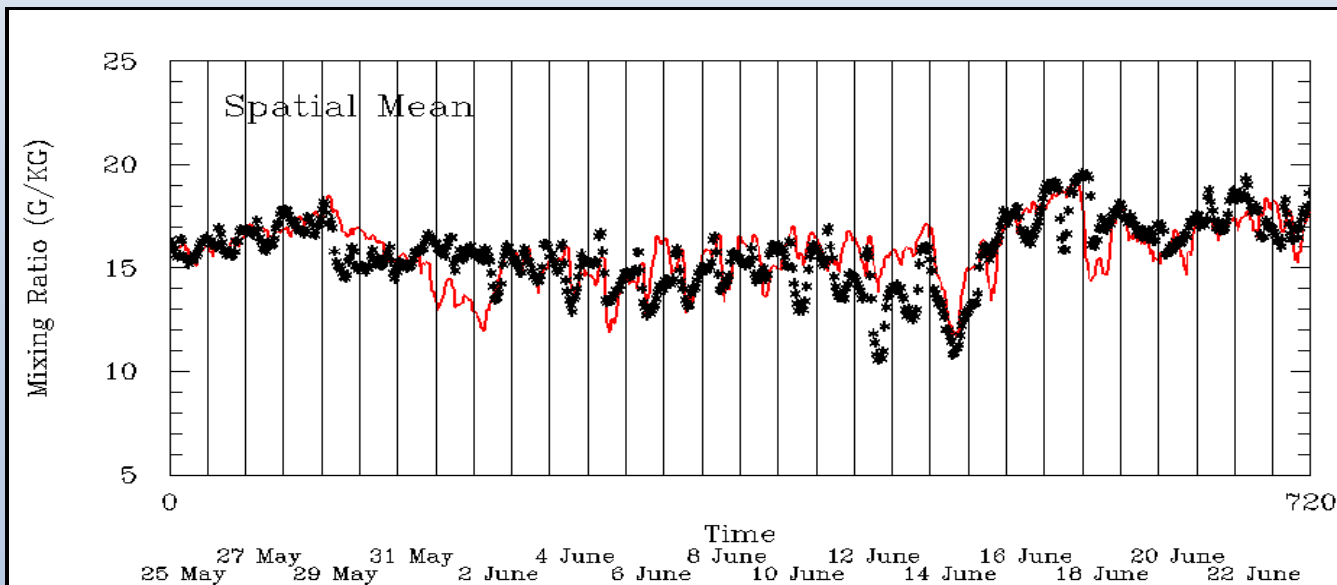
Part II (Example Results) - 1.33 km Grid - Alpine Standard and Enhanced (N-G) Nudging

Part II (Example Results) - Spatial Mean Mixing Ratio (water)



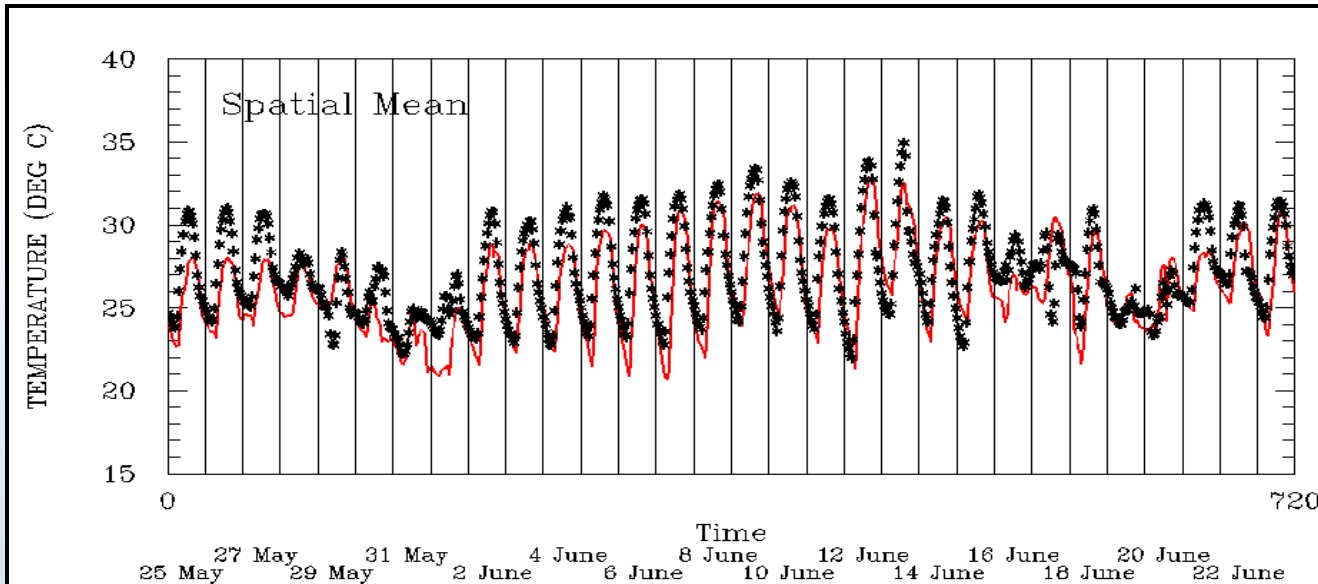
Standard
Nudging

25 May-24 June 2006
(1.33km Grid, All
Monitors)



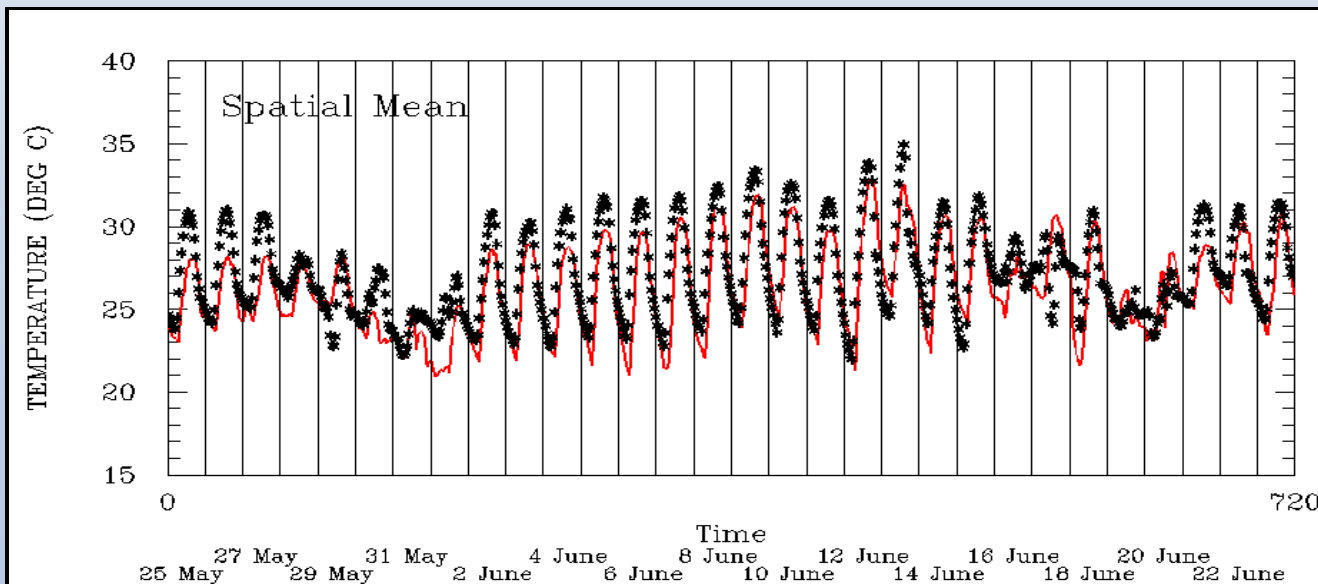
Enhanced
Profiler
Nudging

Part II (Example Results) - Spatial Mean Temperature



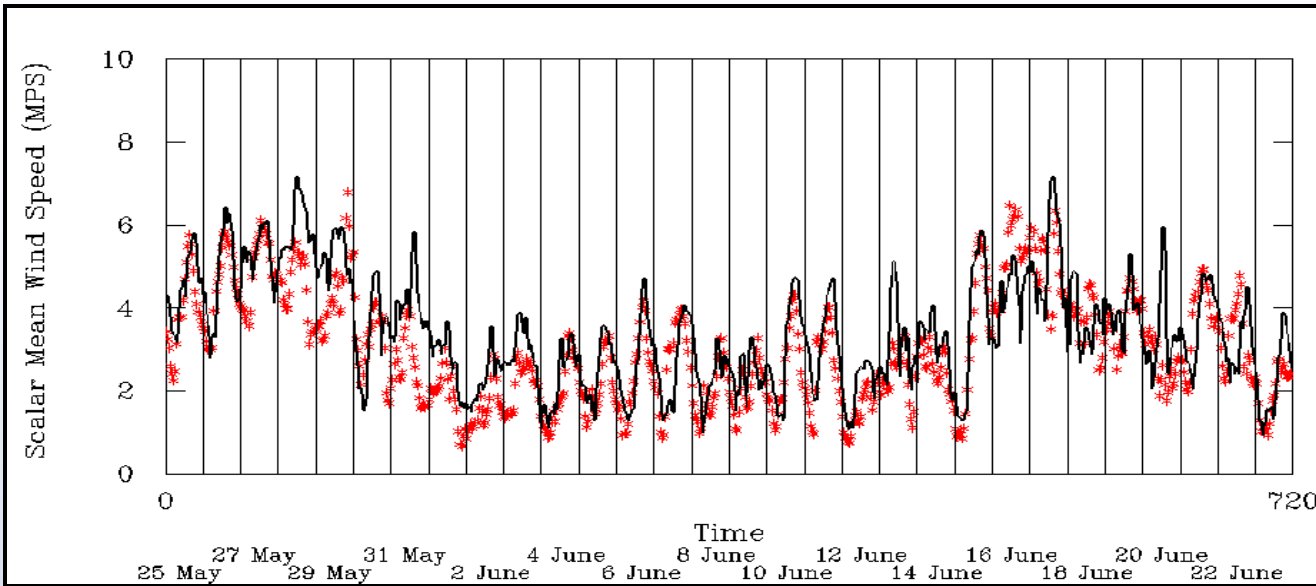
Standard
Nudging

25 May-24 June 2006
(1.33km Grid, All
Monitors)



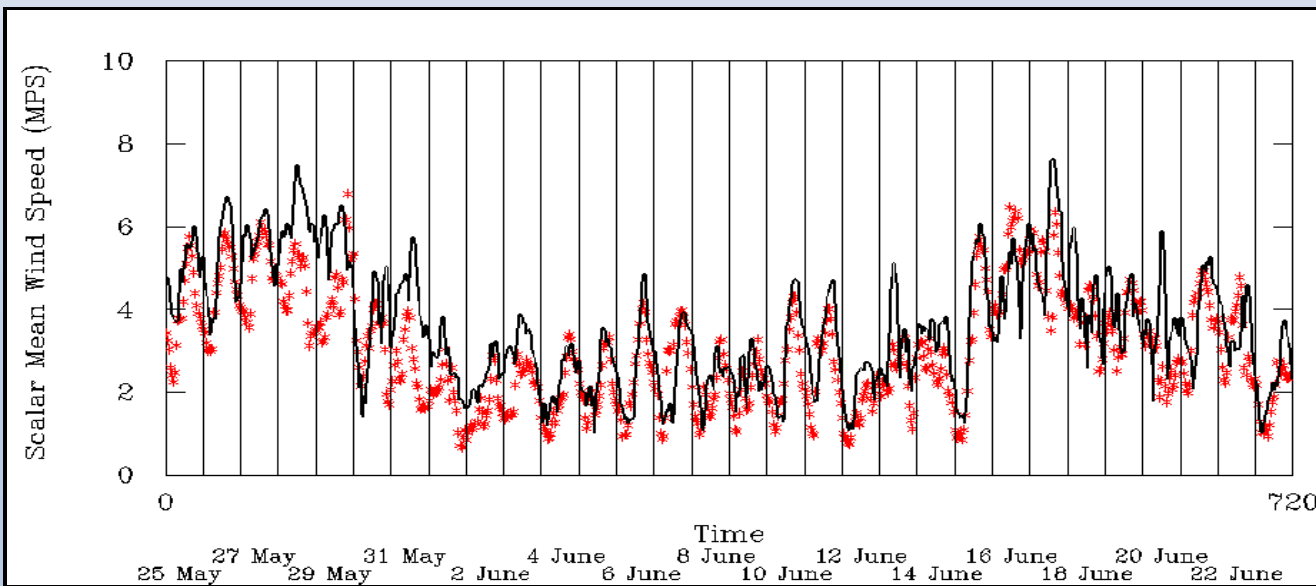
Enhanced
Profiler
Nudging

Part II (Example Results) - Scalar Mean Wind Speed



Standard
Nudging

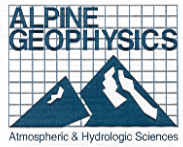
25 May-24 June 2006
(1.33km Grid, All
Monitors)



Enhanced
Profiler
Nudging

Part II (Example Results) - Statistical Summaries

Part II (Example Results) - Episode Average Statistics on 4 km MM5 Domain: 30 May-17 June 2006 Episode



All Networks					
Modeling Group	Mixing Ratio		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All	0.79	1.54	-1.00	1.87	0.76
TCEQ-LA	1.04	1.65	0.08	2.22	0.51
TCEQ-TX	0.77	1.54	-1.08	1.85	0.76
AG-std-All	0.47	1.54	-1.04	1.93	0.75
AG-std-LA	0.43	1.54	-0.25	2.21	0.51
AG-std-TX	0.49	1.55	-1.09	1.92	0.74
AG-enh-All	0.50	1.55	-1.03	1.93	0.75
AG-enh-LA	0.48	1.53	-0.29	2.22	0.52
AG-enh-TX	0.51	1.57	-1.08	1.91	0.75
TDL & CAMs					
Modeling Group	Mixing Ratio		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All	0.79	1.54	-1.05	1.95	0.72
TCEQ-LA	1.04	1.65	0.08	2.22	0.51
TCEQ-TX	0.77	1.54	-1.14	1.93	0.71
AG-std-All	0.47	1.54	-1.06	2.01	0.72
AG-std-LA	0.43	1.54	-0.25	2.21	0.51
AG-std-TX	0.49	1.55	-1.13	2.00	0.71
AG-enh-All	0.50	1.55	-1.06	2.01	0.72
AG-enh-LA	0.48	1.53	-0.29	2.22	0.52
AG-enh-TX	0.51	1.57	-1.12	1.99	0.71
NDBC					
Modeling Group	SST		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All	-0.28	0.87	-0.58	1.09	0.70
AG-std-All	-0.61	1.02	-0.72	1.20	0.65
AG-enh-All	-0.61	1.02	-0.67	1.19	0.66
Ports					
Modeling Group			Temperature		Index of Agreement
			Bias	Error	
TCEQ-All			-0.69	1.21	0.62
AG-std-All			-0.90	1.34	0.58
AG-enh-All			-0.84	1.32	0.59

All - all monitors in 4 km domain

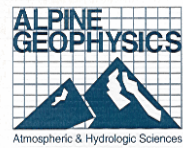
LA - all Louisiana monitors in 4 km domain

TX - all Texas monitors in 4 km domain

std - standard aloft nudging in MM5

enh - enhanced aloft nudging in MM5 using Texaqs II data from Nielsen-Gammon (TAMU)

Part II (Example Results) - Episode Average Statistics on 4 km MM5 Domain: 15 Aug-14 Oct 2006 Episode



All Networks					
Modeling Group	Mixing Ratio		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All					
TCEQ-LA					
TCEQ-TX					
AG-std-All	-0.22	1.46	-0.52	1.83	0.74
AG-std-LA	0.18	1.37	-0.18	2.47	0.54
AG-std-TX	-0.26	1.48	-0.55	1.79	0.74
AG-enh-All	-0.17	1.49	-0.57	1.86	0.74
AG-enh-LA	0.20	1.37	-0.24	2.50	0.54
AG-enh-TX	-0.21	1.51	-0.59	1.82	0.74
TDL & CAMs					
Modeling Group	Mixing Ratio		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All					
TCEQ-LA					
TCEQ-TX					
AG-std-All	-0.22	1.46	-0.54	1.92	0.70
AG-std-LA	0.18	1.37	-0.18	2.47	0.54
AG-std-TX	-0.26	1.48	-0.57	1.88	0.69
AG-enh-All	-0.17	1.49	-0.59	1.95	0.70
AG-enh-LA	0.20	1.37	-0.24	2.50	0.54
AG-enh-TX	-0.21	1.51	-0.62	1.91	0.70
NDBC					
Modeling Group	SST		Temperature		Index of Agreement
	Bias	Error	Bias	Error	
TCEQ-All					
AG-std-All	-0.26	0.96	0.08	0.75	0.62
AG-enh-All	-0.27	0.96	0.08	0.75	0.62
Ports					
Modeling Group			Temperature		Index of Agreement
			Bias	Error	
TCEQ-All					
AG-std-All			-0.60	1.18	0.60
AG-enh-All			-0.62	1.19	0.61

All - all monitors in 4 km domain

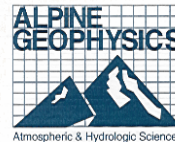
LA - all Louisiana monitors in 4 km domain

TX - all Texas monitors in 4 km domain

std - standard aloft nudging in MM5

enh - enhanced aloft nudging in MM5 using Texaqs II data from Nielsen-Gammon (TAMU)

Part II (Example Results) - MM5



Performance in Houston vs. ~ 70 U.S. Model Evaluations and *Ad Hoc* Goals

MM5 Modeling Group	Domain	Episode	MixR, (gm/Kg)		Temp, (°C)		Wind Index
			Bias	Error	Bias	Error	
TCEQ	HGB 4k	May-Jun '06	0.79	1.54	-1.00	1.87	0.76
Alpine	HGB 4k	May-Jun '06	0.50	1.55	-1.03	1.93	0.75
Alpine	HGB 4k	Aug-Oct '06	-0.17	1.49	-0.57	1.86	0.74
Ad Hoc Benchmarks			1.00	2.00	0.50	2.00	0.60
More than 70 MM5/RAMS Studies Across the U.S.							
Mean			-0.12	1.78	-0.10	2.00	0.72
Lower Sigma			-1.04	0.00	-0.82	1.55	0.61
Upper Sigma			0.80	3.58	0.62	2.45	0.84
Std. Dev.			0.92	1.81	0.72	0.45	0.11
All Studies Examined in Western United States							
Mean.			-0.22	1.63	0.09	2.19	0.69
Lower Sigma			-0.99	0.00	-0.74	1.74	0.54
Upper Sigma			0.55	2.15	0.93	2.64	0.84
Std. Dev.			0.77	0.52	0.84	0.45	0.15

Note: These statistics are based on a running compilation of MM5/RAMS performance evaluation summaries for the period 1995 to present.

Part II - Conclusions

- **For the *May-June 2006* Episode**
 - **The operational performance of the TCEQ and Alpine MM5 run for the *May-June 2006* episode are functionally equivalent and adequate for SIP modeling.**
 - **Only for mean bias in hourly temperatures do the TCEQ and Alpine MM5 runs exhibit slightly poorer performance compared with results from *70 other U.S. evaluations*; for the other statistical measures, the performance in the HGB domain is noticeably better.**
 - **The TCEQ and Alpine runs achieve the *ad hoc* goals for all comparisons except hourly temperature bias, where the models exhibit under-prediction biases about twice the level of the goals.**
 - **There is no significant performance gain in using the TAMU profiler nudging data in favor of standard nudging methods for this episode**

Part II - Conclusions

- For the **August-October 2006 Episode**
 - The operational performance of the August-October 2006 Alpine episode run is somewhat better than the performance of the TCEQ and Alpine MM5 runs for the May-June 2006 episode. For this episode, the model simulation is judged adequate for SIP modeling.
 - The Alpine MM5 run gives better performance compared with results from *70 other U.S. evaluations*.
 - The Alpine run achieves the *ad hoc* goals for all comparisons except hourly temperature bias, where the model gives slightly larger under-prediction bias ($-0.57\text{ }^{\circ}\text{C}$) compared to the goal ($-0.50\text{ }^{\circ}\text{C}$).
 - There is no significant performance gain in using the TAMU profiler nudging data in favor of standard nudging methods for this episode

Part II - Conclusions

- **Based on this operational evaluation, for both 2006 episodes, the TCEQ and Alpine MM5 simulations exhibit essentially comparable and adequate model performance for SIP modeling purposes.**
- **The results of this operational evaluation should be regarded as *provisional*, pending a more intensive diagnostic examination of the hourly surface wind flow fields, particular along the Gulf Coast and adjacent embayments.**
- ***Potentially* significant local wind simulation problems may exist in these MM5 runs that are not yet elucidated with standard operational evaluation statistical and graphical summaries employed to date.**

Part III - Emissions Modeling (SMOKE)

- **Objectives**
- **Methods**
- **Results**
- **Conclusion & Summary**

Part III - Objectives

- **Task begun in early Jan '06**
- **Goal: set up latest version of EPA SMOKE emissions system utilizing, wherever possible, emissions input files available from TCEQ 2005, 2006, and 2018 modeling**
- **Include the 2006 TexAQS II Special Inventory study data for the two '06 episodes.**
- **Create independent SMOKE emissions modeling framework to support base year and future year modeling as well as future emissions sensitivity and targeted VOC and/or NO_x control runs**
- **Wherever possible, corroborate SMOKE ('05, '06, '18) emissions and those produced by TCEQ's EPS processors.**
- **SMOKE inventories completed for the three 2005 episodes and both 2006 episodes (except MM5-dependent biogenics and motor vehicles).**

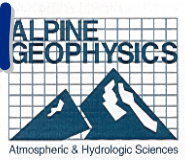
PART III - Objectives

- **Key input to air quality models**
- **Uncertainty & variability abound (category, temporal, spatial, speciation)**
- **Tools to estimate emissions in and of themselves introduce other uncertainties**
- **Routine emissions difficult to estimate, with transient/episodic emissions even more so**
- **Possible exception is CEM of NOX & SO2 required under various provisions of CAAA**

Part III - Methods

- **Obtain TCEQ EPS data sets**
- **Convert/reformat/adapt data sets for use in SMOKE**
- **QA emissions during conversion process**
- **Report errors/concerns to TCEQ for resolution**

PART III - Problems Resolved (selected examples)

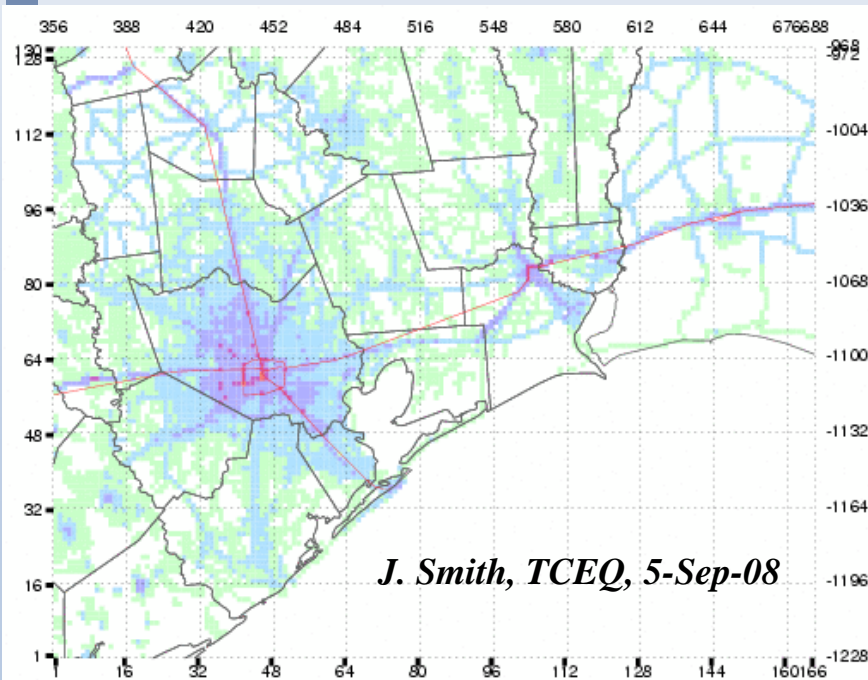


- Point source coordinates were based on a projection of Lambert Conformal (meters) and needed to be in decimal degrees for SMOKE - **resolved; used PostgreSQL-PostGIS**
- afs.gwei2000.20000801.3pol.lcp has illegal data for CEQEFF (pollutant [e.g., CO] is placed there instead of a real number), RULEFF (characters instead of real number), and RULPEN (characters instead of real number) - **resolved; additional format added to EPS-to-SMOKE conversion system**
- Duplicate emissions records in many of the hour-specific data sets - **resolved; TCEQ stated that duplicate records needed to be summed to a single record**
- Numerous EGUs with missing or invalid stack parameters - **resolved; TCEQ corrected and reposted new data sets**
- Missing SCCs for EGU sources in LA, AR, and OK - **resolved; TCEQ corrected and reposted new data sets**

Part III - On-road Mobile Sources

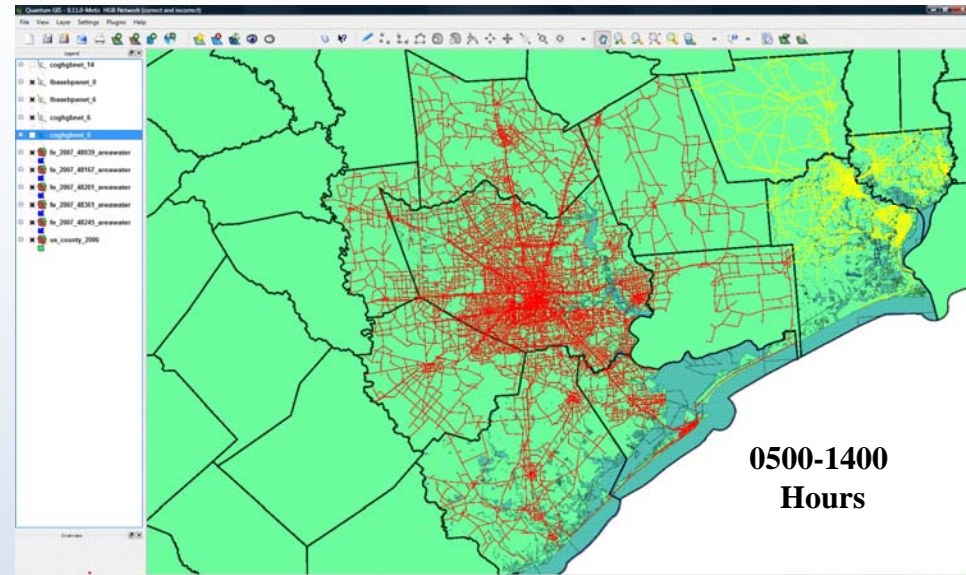
On-Road Mobile Sources

- Example of improper link location (link used to spatially allocate emissions)
- QA of just the emissions estimates do no reveal underlying spatial error
- Hourly emissions are okay but spatial distribution is not
- Error has been corroborated with TCEQ and TTI
- TCEQ has received corrected data from TTI and has revised appropriate on-road mobile source data (currently undergoing final QA by TCEQ)

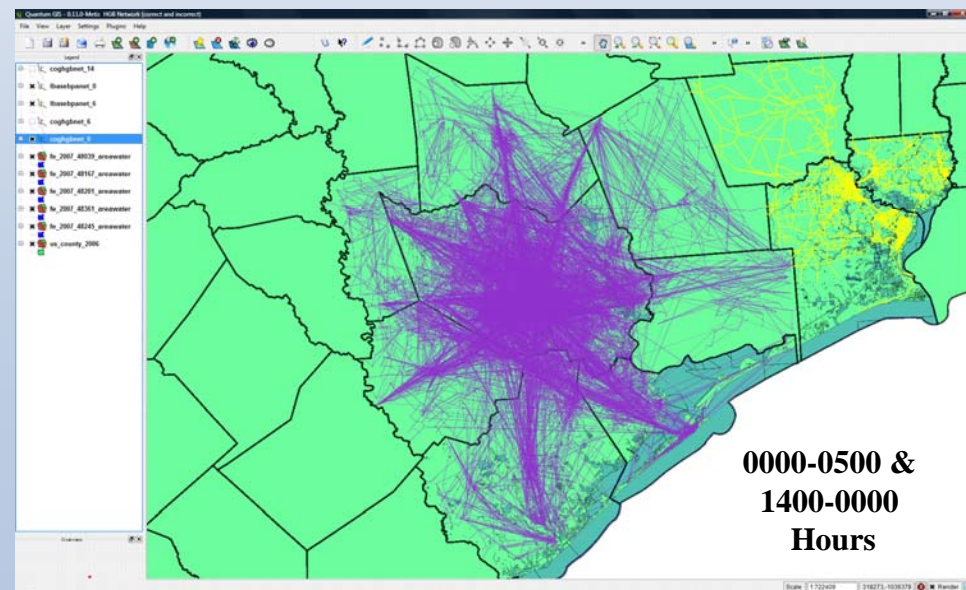


J. Smith, TCEQ, 5-Sep-08

HGB8H2 On-road Mobile, m62.2005.school.Texas_knox.07Nov08, weekday: NO_x



**0500-1400
Hours**



**0000-0500 &
1400-0000
Hours**

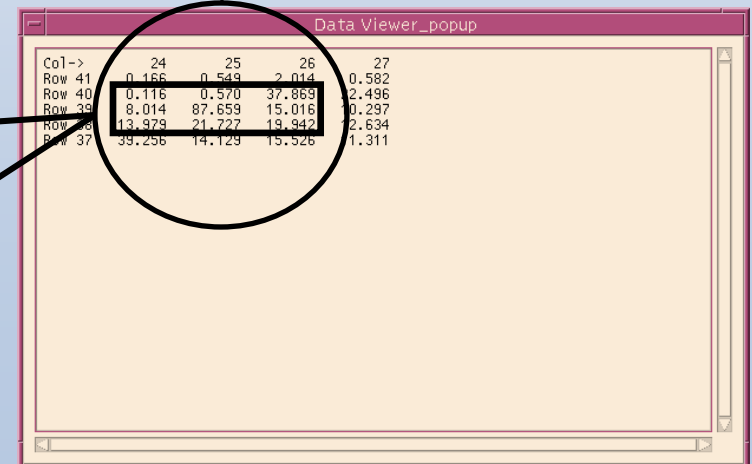
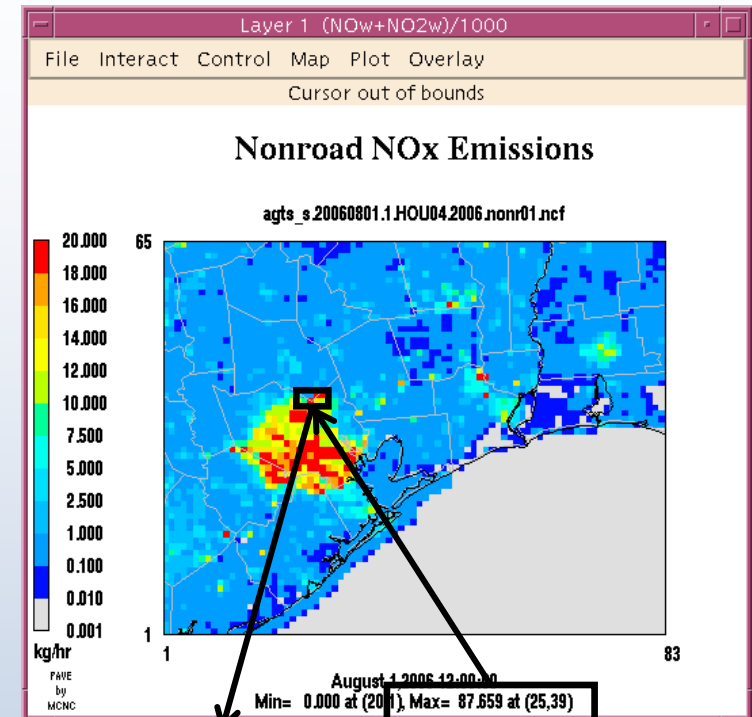
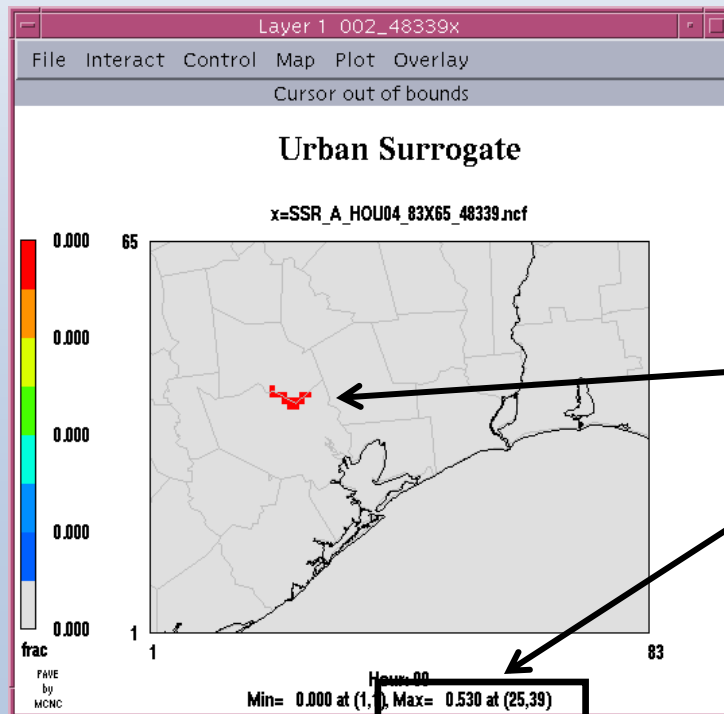
Part III - Area Source Spatial Surrogates

- Population
- Urban
- Rural
- Commercial Aircraft
- General Aircraft
- Military Aircraft
- County Area
- Water
- Ships
- Harbors
- Canals
- Railroad
- Autobody
- MARCOT?? (not used)
- Gas Stations
- Dry Cleaning
- Restaurants
- Residential
- Forest
- Agriculture
- Commercial-Industrial
- Commercial-Residential
- Oil & Gas Wells
- Offshore Oil & Gas

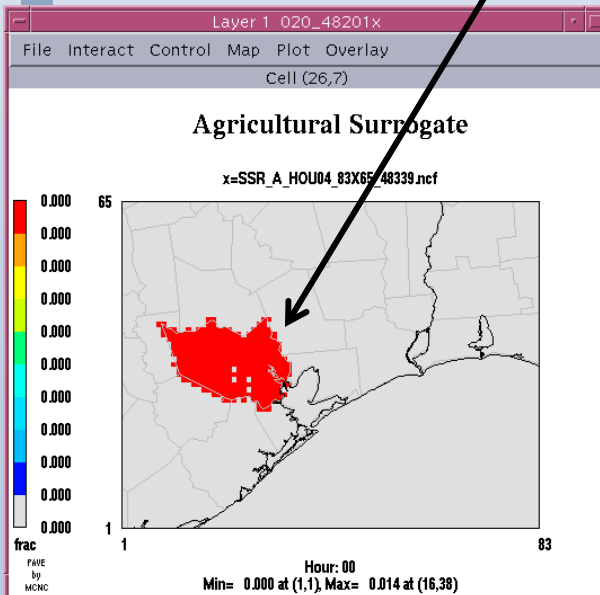
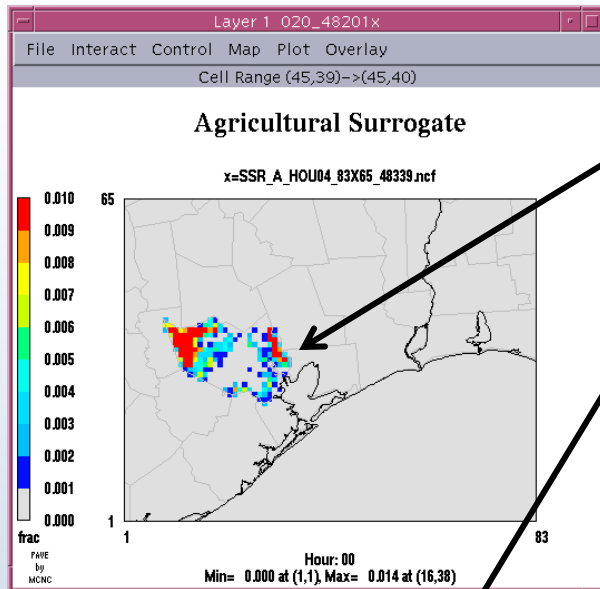
Part III - Nonroad Emissions QA

Nonroad Sources (mobile sources not related to aircraft, commercial marine, or railroad)

- Unusual spike in emissions
- Leads to investigation of area source surrogates
- Discover that 53% of nonroad emissions in Montgomery County are allocated to grid cell (25, 39) via the “urban” surrogate
- Does one grid cell in Kingwood really represent 53% of the urbanized area in Montgomery County? (consider The Woodlands and Conroe)

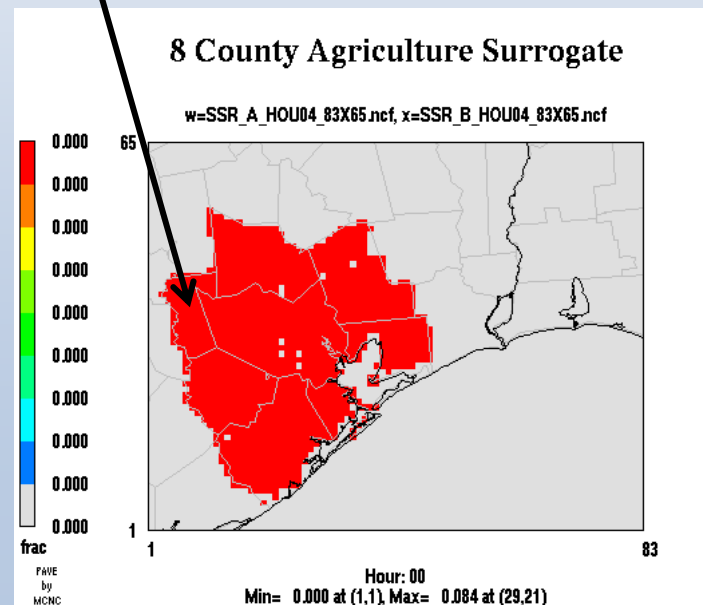


Part III - Agricultural Emissions Surrogate



Agricultural Related Sources

- **Ag surrogate for Harris County is suspect even at first glance (ag surrogate is encroaching on urban core)**
- **Further investigation reveals that emissions from this broad category are allocated across the county....even to high density urban core areas**
- **Though emissions are somewhat small for ag sources in Harris, this simple QA step suggests that larger errors may exist elsewhere in the surrogates**
- **Looking at the broader 8 county area, we see similar, odd across county dilution of ag emissions**
- **Please note, that ag emissions are small in these areas**

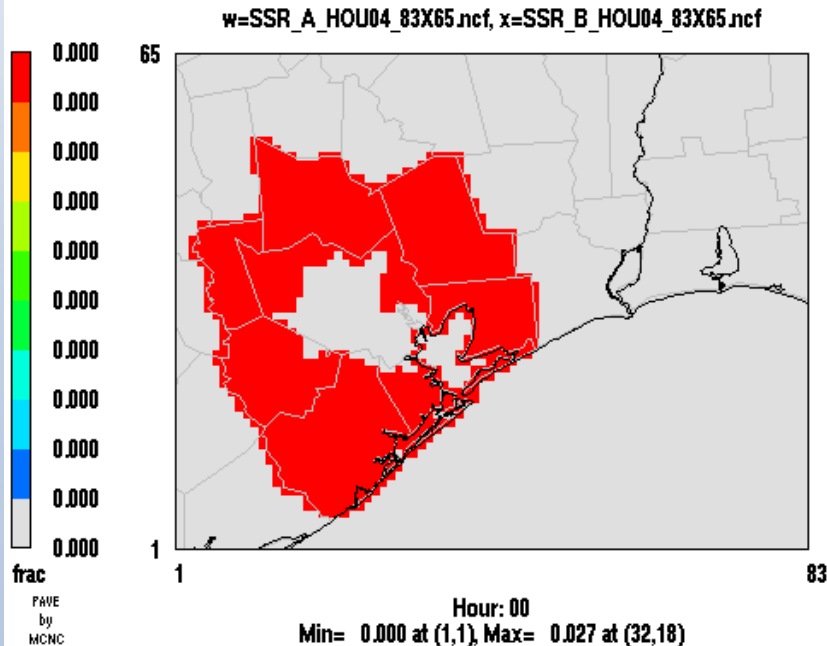


Part III - Urban & Rural Surrogates

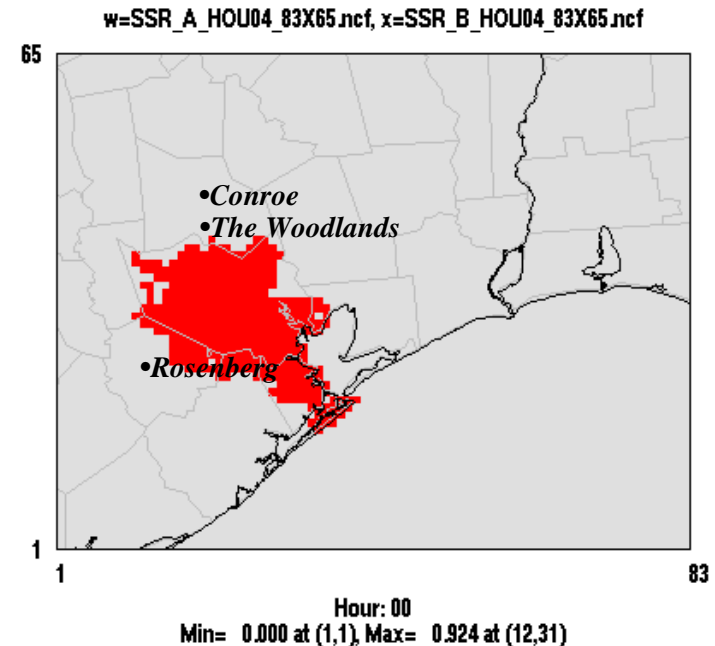
Urban and Rural Surrogates

- Rural surrogate dominate in some urbanized areas
- A few urbanized areas not represented in urban surrogate

8 County Rural Surrogate



8 County Urban Surrogate



Overall Conclusions

- **Houston ozone problem is complex**
- **Tools & models that we use to understand and estimate ozone introduce their own uncertainties, which further complicates the picture**
- **We must be rigorous in our pursuit of getting the right answer for the right reason, which requires that we adhere to the best science**
- **An open and collaborative process is key to bringing the best science and tools to bear on the Houston ozone problem**
- **The 8-hour Coalition continues to offer resources to help further the scientific underpinnings of the entire Houston 8-hour ozone air quality modeling effort**