North Carolina Department of Environment and Natural Resources

Division of Air Quality

ALPINE GEOPHYSICS

Processing Mobile Emissions in SMOKE

Is it worth simulating everyday for onroad mobile emission estimates to support 8-hr ozone and PM2.5 modeling?

15th Annual Emission Inventory Conference

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New Orleans, LA

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Outline

- Background
- MOBILE6 / SMOKE set up
- Methods (Daily vs. Representative Week)
- Model Run Times
- Emissions Differences
- Predicted Air Quality Differences
- Recommendations

Background

Typically… the most computationally limiting step in emissions modeling is the generation of the onroad mobile sources

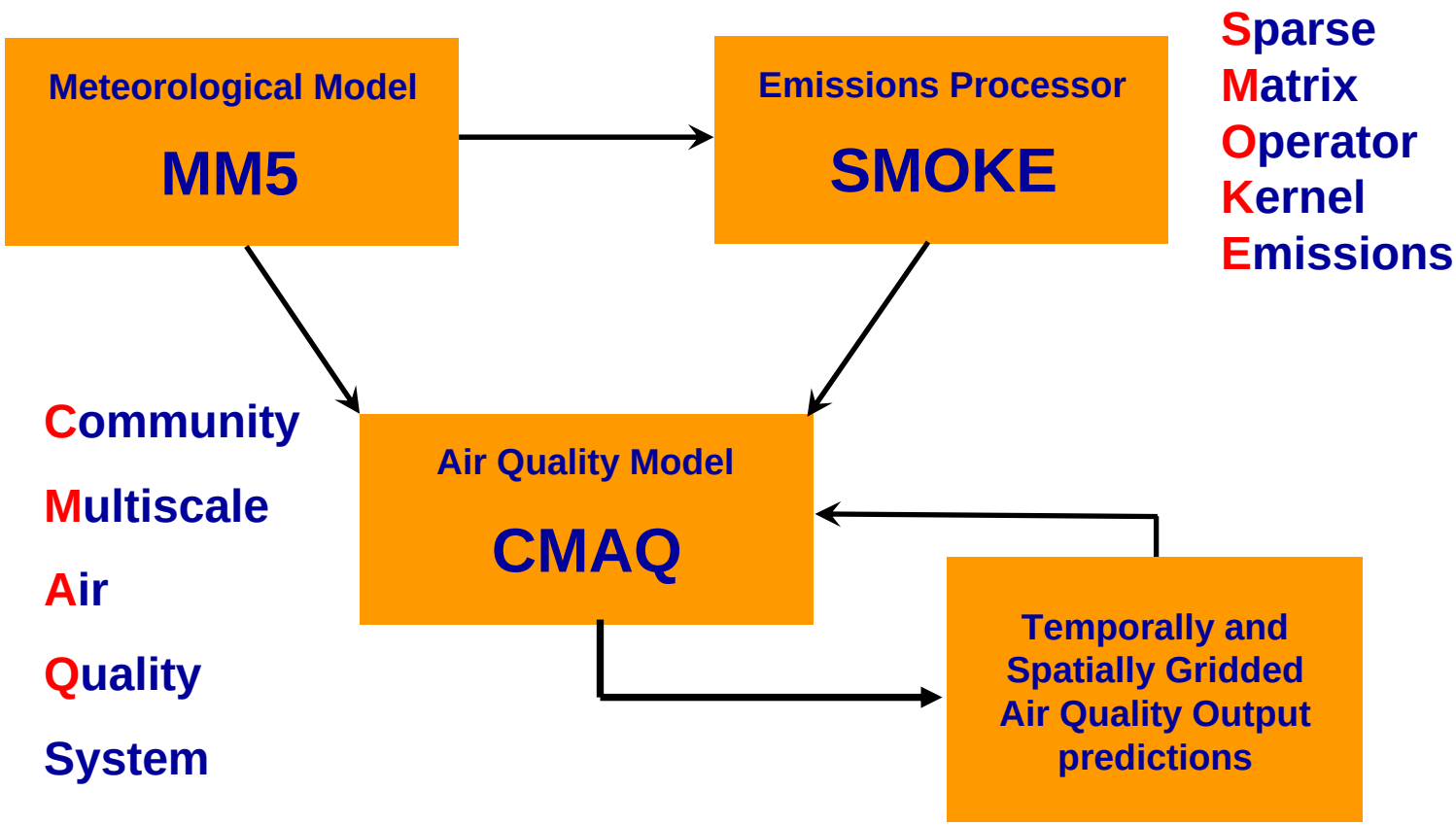
Background

Rather than utilizing averaged meteorological data or pre-calculated motor vehicle emissions, modeling team developed an emissions processing approach that models a representative week for each month of the year in order to make the SMOKE processing time more manageable and consistent with VISTAS/ASIP modeling schedules

Background

This representative week was selected from mid-month, to try to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would require atypical processing

Air Quality Modeling System



MOBILE / SMOKE Set Up

SMOKE v.2.0 was configured to generate point, area, nonroad, onroad mobile, and biogenic source emissions

Certain subcategories, such as fires and EGUs were maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies

MOBILE / SMOKE Set Up

With the exception of biogenic and onroad mobile source emissions, pre-computed annual emissions were processed using the month, day, and hour specific temporal profiles of the SMOKE model

Area, nonroad, and point sources were modeled as a block of Thursday, Friday, Saturday, Sunday, Monday one per month (total of 60 days modeled)

Biogenics were modeled for each day of the episode

Methods
Daily vs. Representative Week

Modeling selected weeks (seven days) of each month and using these days as representative of the entire month

This selection criterion allows for the representation of day-of-the-week variability in the onroad mobile sources and models a representation of the meteorological variability in each month

Representative Weeks

January 15-21

February 12-18

March 12-18

April16-22

May 14-20

June 11-17

July 16-22

August 13-19

September 17-23

October 15-21

November 12-18

December 17-23

Representative Day Mapping

Modeled Date	Representative Day	Modeled Date	Representative Day	Modeled Date	Representative Day
1/1/2002*	1/20/2002	1/11/2002	1/18/2002	1/22/2002	1/15/2002
1/2/2002	1/16/2002	1/12/2002	1/19/2002	1/23/2002	1/16/2002
1/3/2002	1/17/2002	1/13/2002	1/20/2002	1/24/2002	1/17/2002
1/4/2002	1/18/2002	1/14/2002	1/21/2002	1/25/2002	1/18/2002
1/5/2002	1/19/2002	1/15/2002	1/15/2002	1/26/2002	1/19/2002
1/6/2002	1/20/2002	1/16/2002	1/16/2002	1/27/2002	1/20/2002
1/7/2002	1/21/2002	1/17/2002	1/17/2002	1/28/2002	1/21/2002
1/8/2002	1/15/2002	1/18/2002	1/18/2002	1/29/2002	1/15/2002
1/9/2002	1/16/2002	1/19/2002	1/19/2002	1/30/2002	1/16/2002
1/10/2002	1/17/2002	1/20/2002	1/20/2002	1/31/2002	1/17/2002
		1/21/2002	1/21/2002		

* Modeled holiday

MOBILE / SMOKE run times

Using Athlon MP 2600+ w/ 1.5 GB RAM
Mobile Processing = 63 minutes/run day

Daily Method (12km)	Rep Week Method (12km)
365 days * 63 min/day =	84 days * 63 min/day =
383.25 hours or	88.2 hours or
16 days of CPU run time	3.5 days of CPU run time

January Comparisons

Daily vs. Representative Week NOx and VOC emissions

- State emissions tables
- North Carolina Statewide NOx
- North Carolina Statewide VOC
- Mecklenburg County (Charlotte) VOC
- Temperature Differences
- PM2.5 Percent Differences

State Emission Comparisons

(Tons/Month)

	January 2009 Emissions (Everyday Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,567	8,774	105,011	51	266	174	500
Florida	28,354	26,686	336,541	171	834	529	1,736
Georgia	15,558	17,935	224,920	100	509	328	999
Kentucky	5,321	8,618	102,603	47	250	165	453
Mississippi	3,928	5,999	61,323	31	191	130	312
North Carolina	13,590	18,406	231,897	104	489	311	988
South Carolina	5,372	7,934	92,169	44	240	159	429
Tennessee	8,729	12,954	142,906	67	356	238	609
Virginia	7,377	11,708	156,617	72	311	190	716
West Virginia	2,025	3,177	41,742	18	91	59	168
	96,821	**122,190**	**1,495,728**	**705**	**3,536**	**2,283**	**6,910**

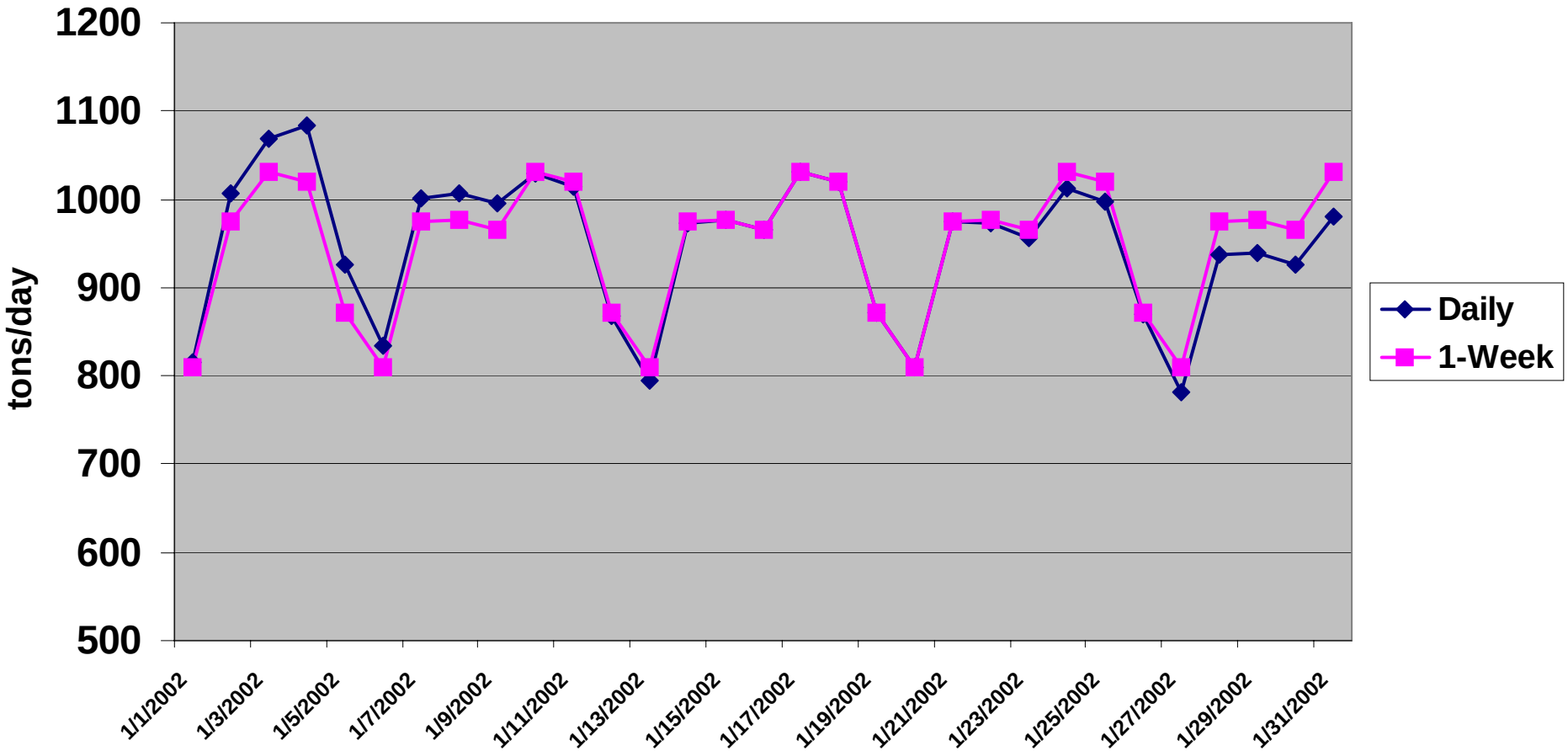
	January 2009 Emissions (Representative Day Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,394	8,765	102,800	51	266	174	500
Florida	28,852	26,476	333,248	171	833	529	1,736
Georgia	15,337	17,867	218,990	100	509	328	999
Kentucky	5,023	8,679	104,247	47	250	165	453
Mississippi	3,710	6,012	60,454	31	191	130	312
North Carolina	12,605	18,383	225,563	104	489	311	988
South Carolina	5,226	7,911	89,001	44	240	159	430
Tennessee	8,011	13,000	141,962	67	356	238	609
Virginia	7,005	11,735	155,321	72	311	190	715
West Virginia	1,941	3,194	42,096	18	91	59	168
	94,104	**122,021**	**1,473,682**	**705**	**3,536**	**2,283**	**6,909**

State Emission Comparisons

	January 2009 Emissions (Difference as Percent)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	-2.6%	-0.1%	-2.1%	0.0%	0.0%	0.0%	0.0%
Florida	1.8%	-0.8%	-1.0%	0.0%	0.0%	0.0%	0.0%
Georgia	-1.4%	-0.4%	-2.6%	0.0%	0.0%	0.0%	0.0%
Kentucky	-5.6%	0.7%	1.6%	0.0%	0.0%	0.0%	0.0%
Mississippi	-5.5%	0.2%	-1.4%	0.0%	0.0%	0.0%	0.0%
North Carolina	-7.2%	-0.1%	-2.7%	0.0%	0.0%	0.0%	0.0%
South Carolina	-2.7%	-0.3%	-3.4%	0.0%	0.0%	0.0%	0.0%
Tennessee	-8.2%	0.4%	-0.7%	0.0%	0.0%	0.0%	0.0%
Virginia	-5.0%	0.2%	-0.8%	0.0%	0.0%	0.0%	0.0%
West Virginia	-4.1%	0.6%	0.8%	0.0%	0.0%	0.0%	0.0%
	-2.8%	**-0.1%**	**-1.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

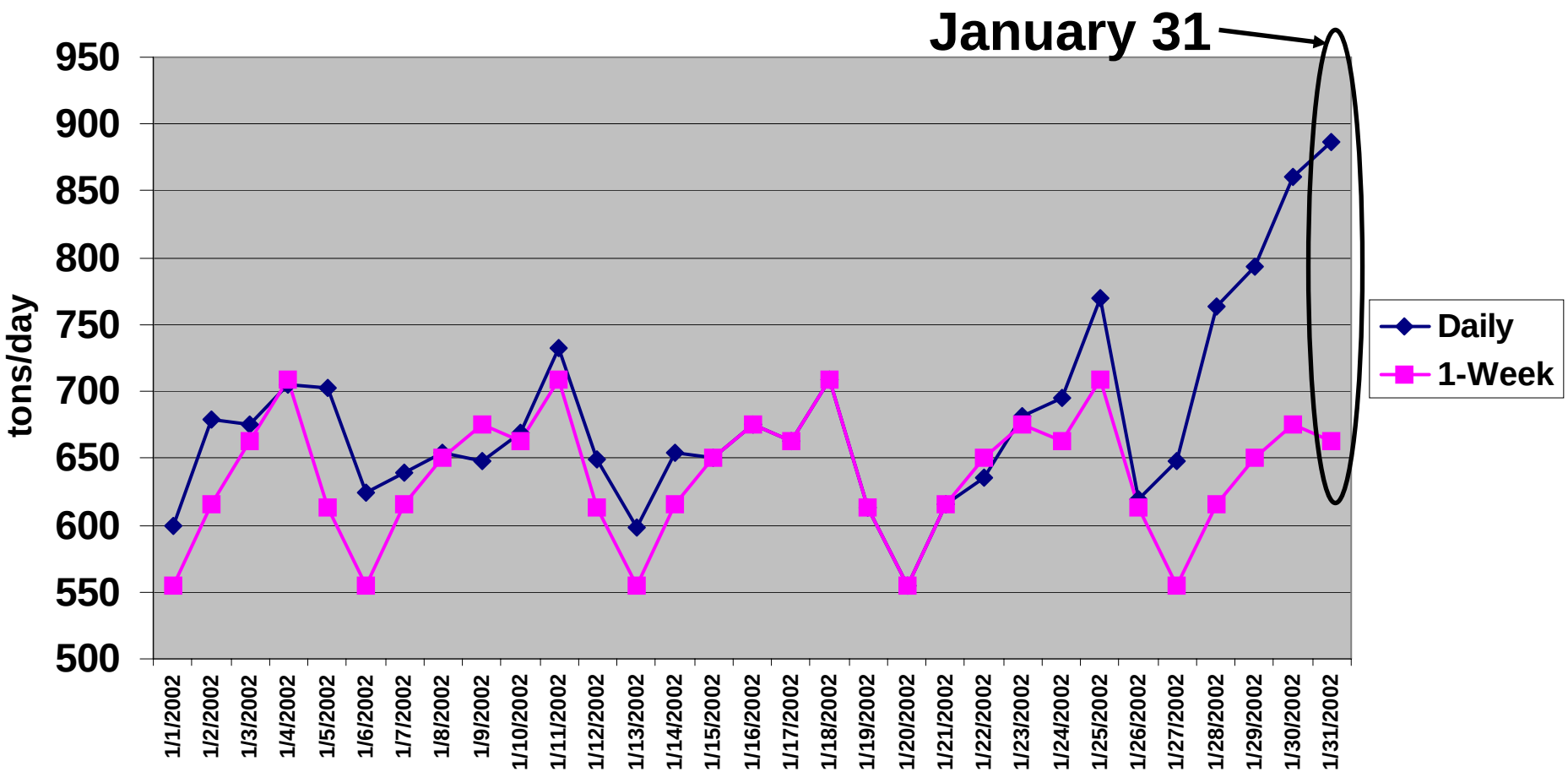
NC Statewide January NOx Emissions

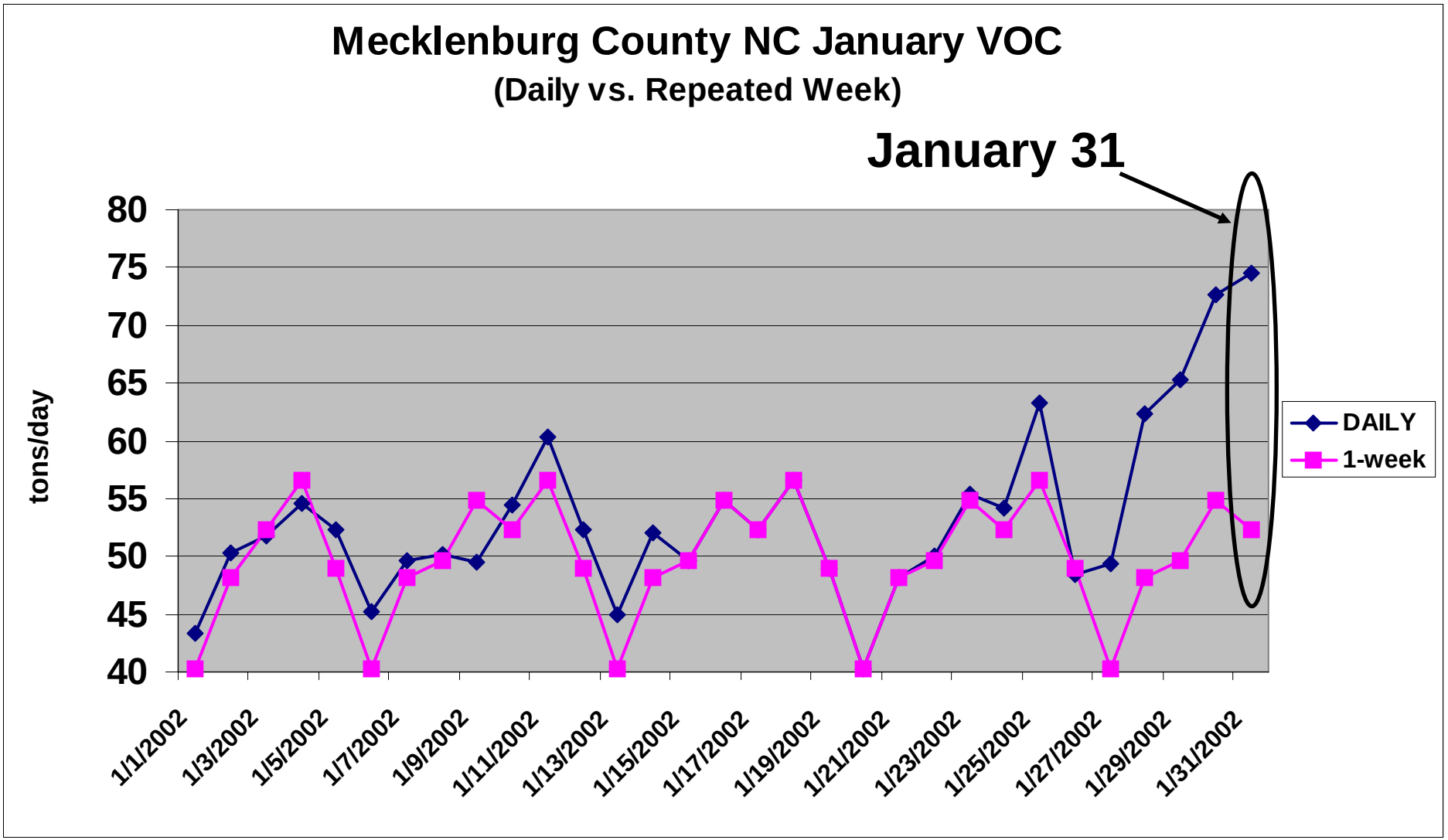
(Daily vs. Repeated week)



NC Statewide January VOC Emissions

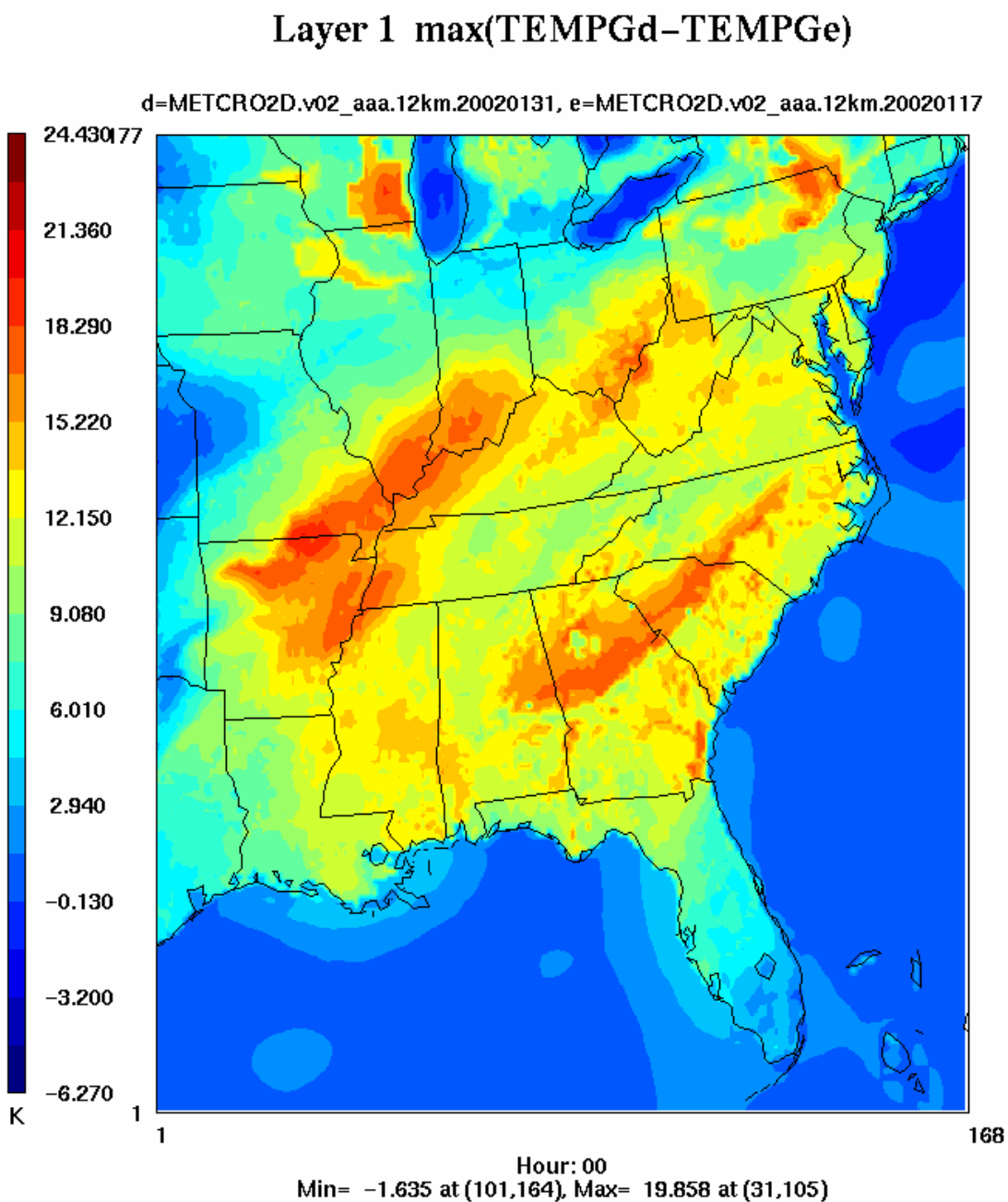
(Daily vs. Repeated week)




Mecklenburg County NC January VOC
(Daily vs. Repeated Week)
January 31
tons/day
80
75
70
65
60
55
50
45
40
1/1/2002
1/3/2002
1/5/2002
1/7/2002
1/9/2002
1/11/2002
1/13/2002
1/15/2002
1/17/2002
1/19/2002
1/21/2002
1/23/2002
1/25/2002
1/27/2002
1/29/2002
1/31/2002
DAILY
1-week

Skin Temp Differences

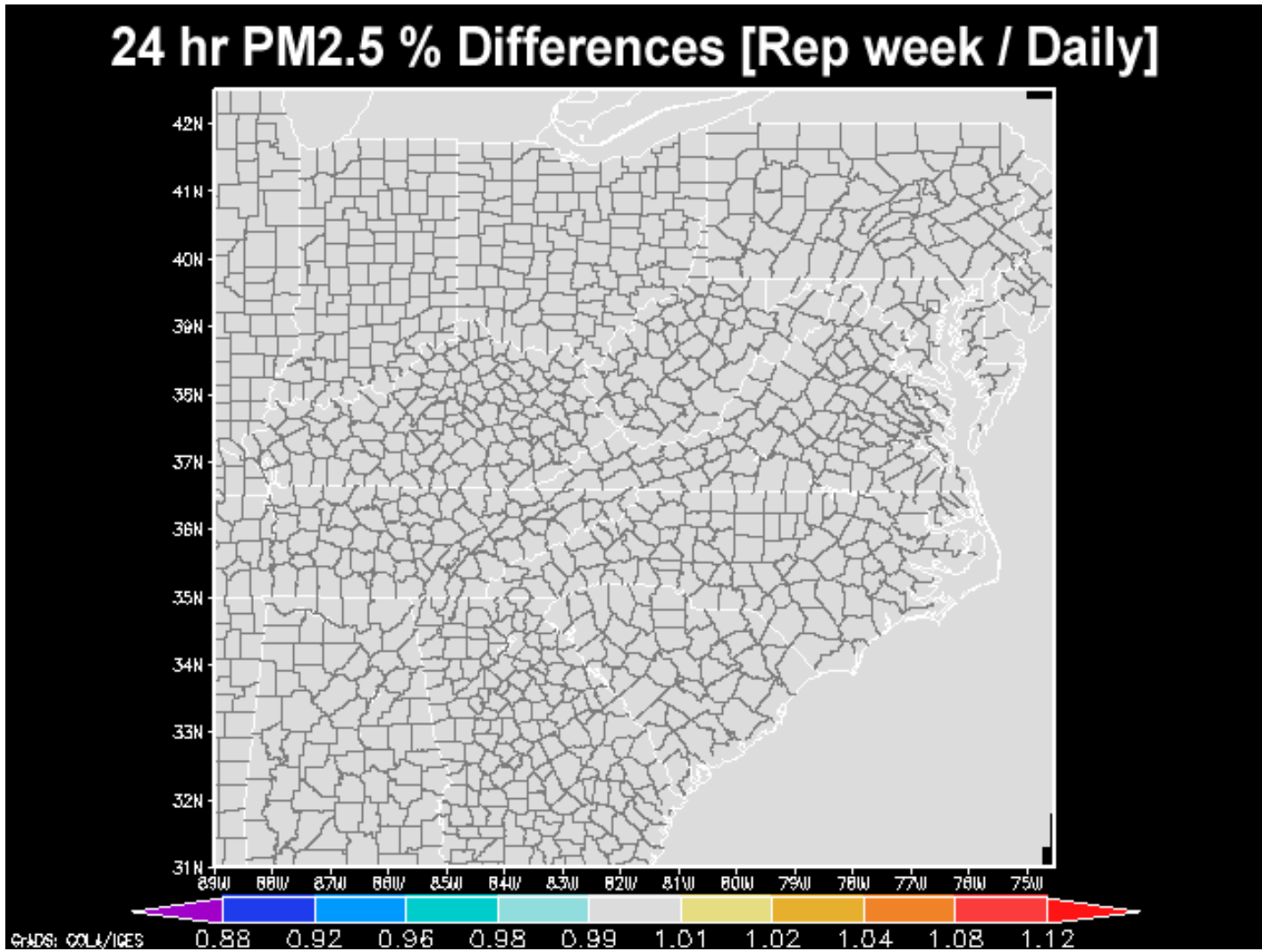
Thursday, January 31
vs
Thursday, January 17



PM2.5 % Differences

Thursday, January 31 vs.

Thursday, January 17



July Comparisons

Daily vs. Representative Week NOx and VOC emissions

- State emissions tables
- North Carolina Statewide NOx
- North Carolina Statewide VOC
- Mecklenburg County (Charlotte) VOC
- Fulton County (Atlanta) VOC

State Emission Comparisons

(Tons/Month)

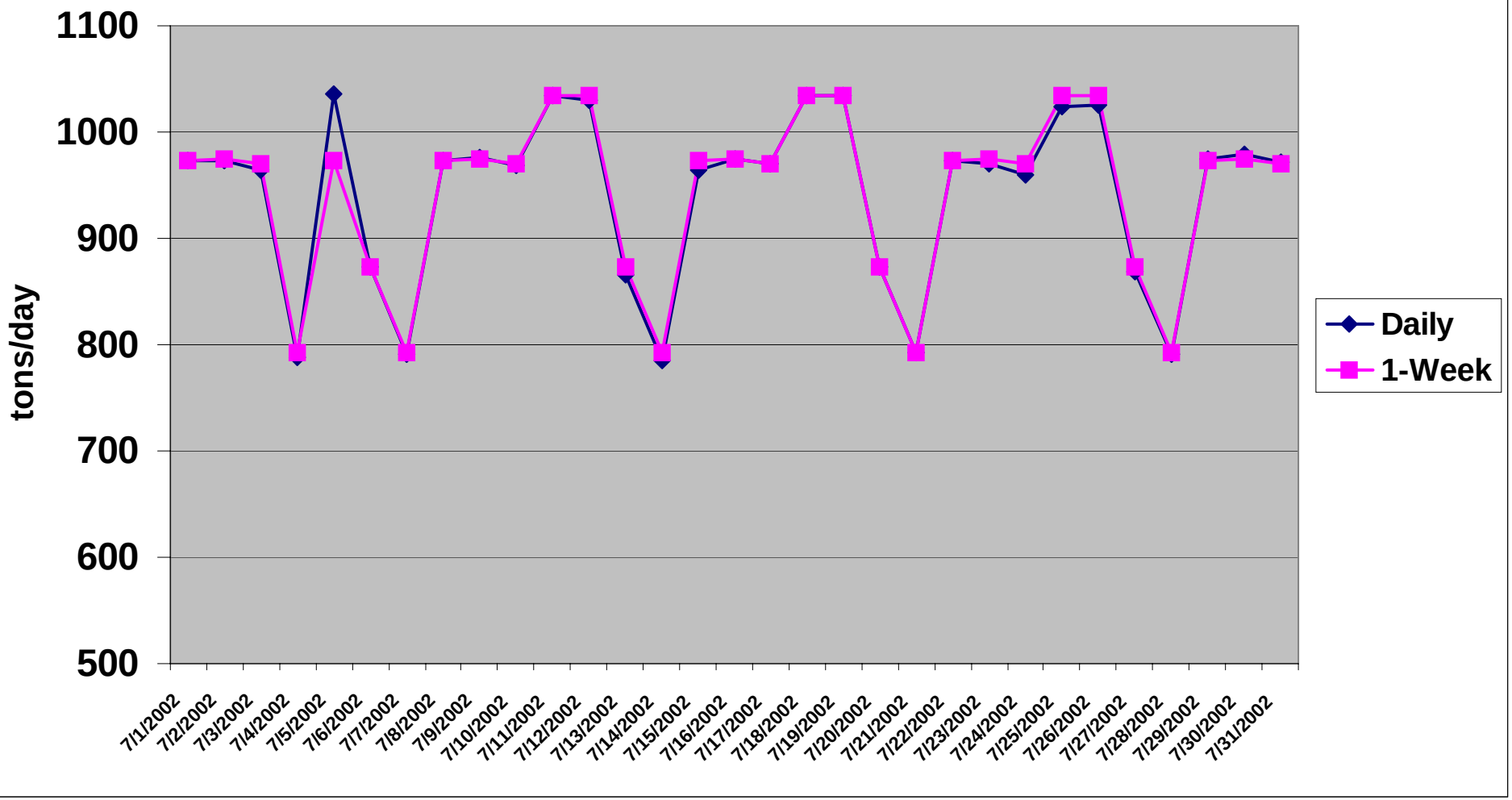
	July 2009 Emissions (Everyday Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	5,968	8,654	61,362	58	278	175	584
Florida	21,715	27,067	208,947	190	864	531	1,971
Georgia	15,833	17,965	133,828	114	533	332	1,162
Kentucky	5,289	8,196	56,333	53	262	166	537
Mississippi	3,934	6,013	38,674	36	200	130	376
North Carolina	12,975	17,340	130,042	120	512	311	1,171
South Carolina	5,316	7,859	57,163	51	251	160	512
Tennessee	8,797	12,446	81,289	75	368	237	712
Virginia	7,064	11,221	87,946	82	331	195	832
West Virginia	2,038	3,006	23,429	21	96	61	205
	88,930	**119,768**	**879,013**	**800**	**3,695**	**2,299**	**8,063**

	July 2009 Emissions (Representative Day Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,017	8,682	61,581	58	278	175	585
Florida	22,006	27,217	210,901	190	864	531	1,971
Georgia	16,252	18,091	135,119	114	533	332	1,163
Kentucky	5,274	8,196	56,184	53	262	167	537
Mississippi	3,960	6,023	38,911	36	200	130	376
North Carolina	13,160	17,394	130,728	120	512	311	1,171
South Carolina	5,449	7,903	57,867	51	251	160	512
Tennessee	8,798	12,454	81,930	75	368	237	712
Virginia	7,104	11,248	87,523	82	331	195	832
West Virginia	2,047	3,010	23,419	21	96	61	205
	90,068	**120,218**	**884,162**	**800**	**3,695**	**2,299**	**8,063**

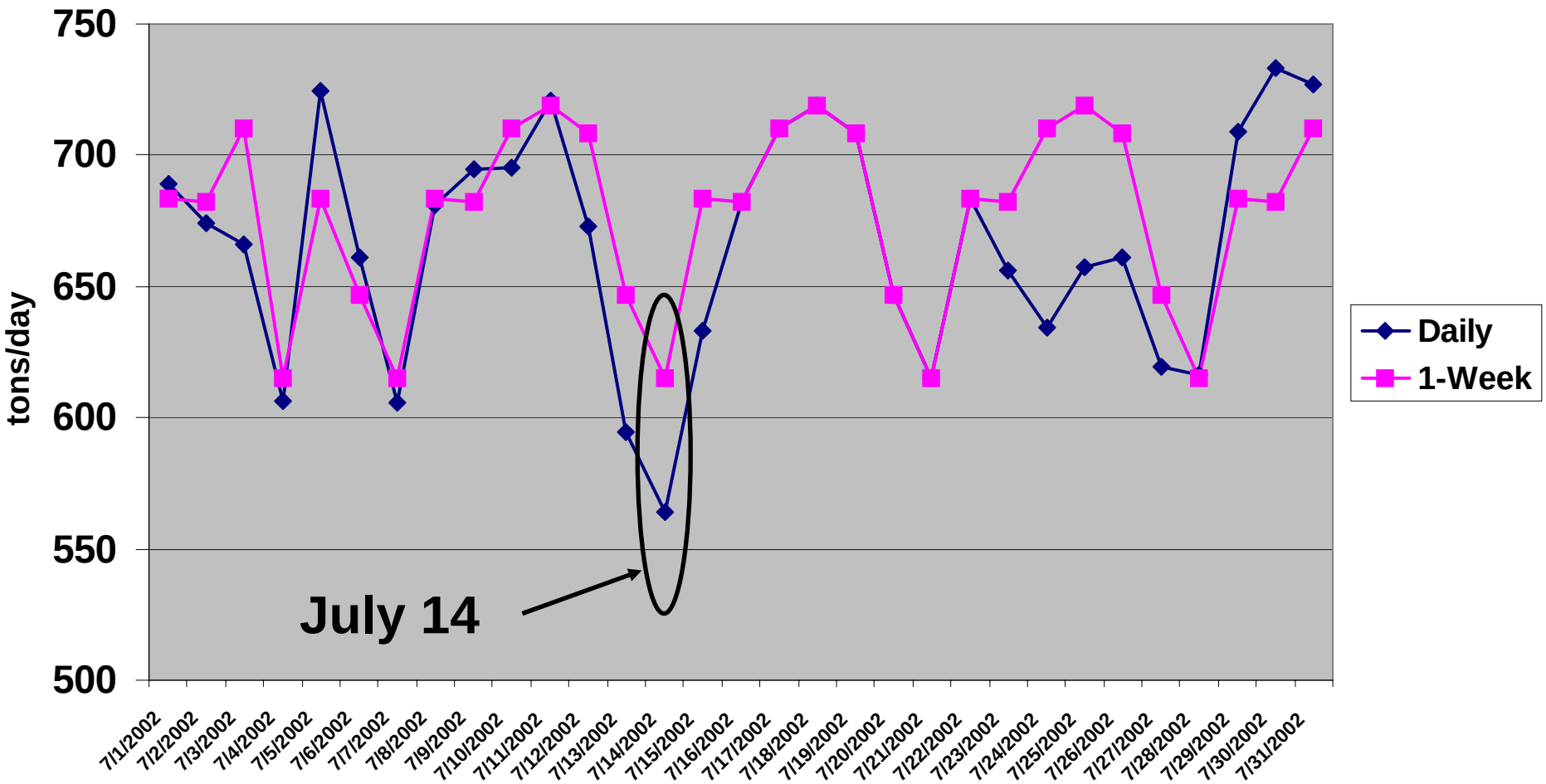
State Emission Comparisons

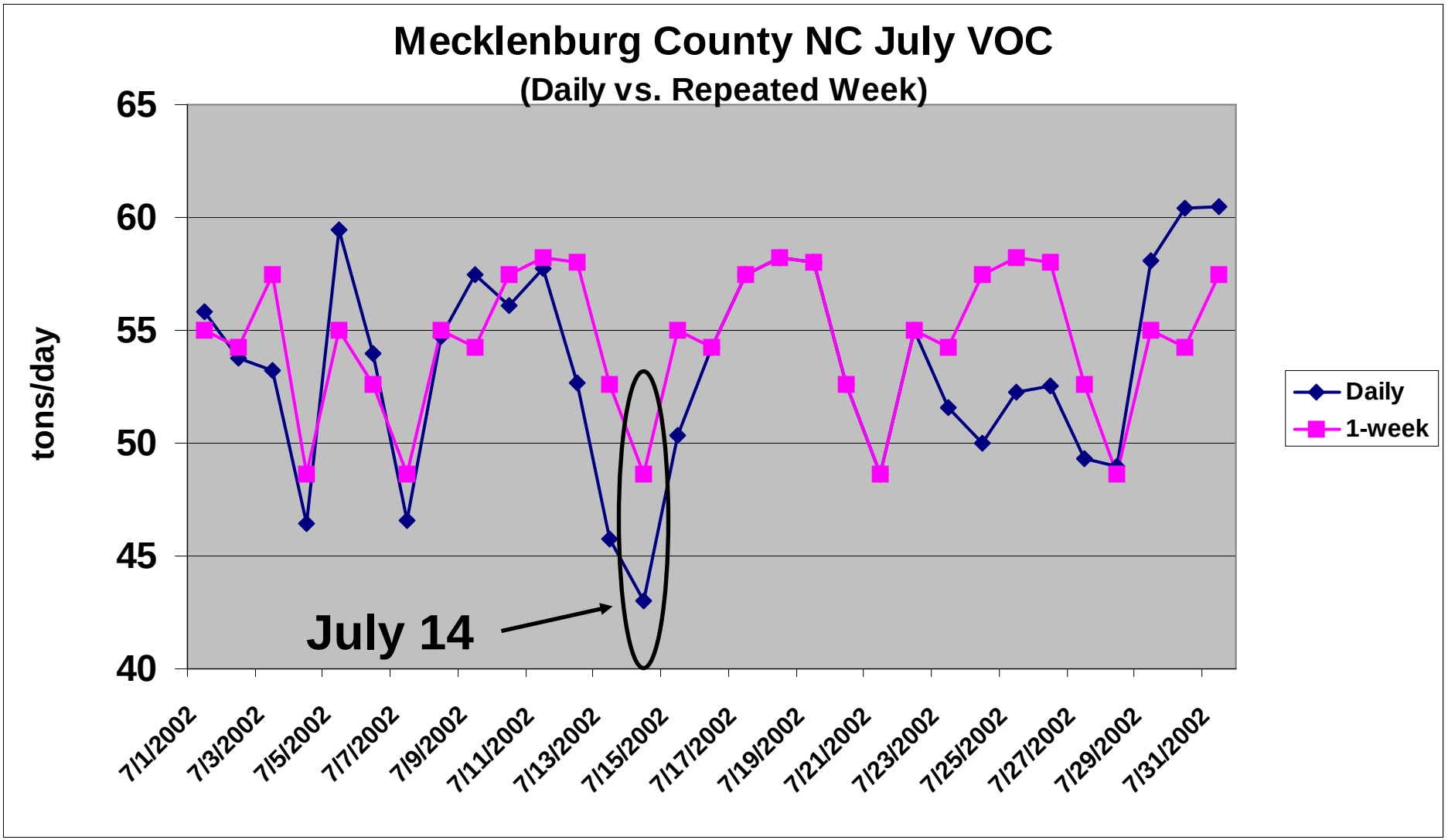
	July 2009 Emissions (Difference as Percent)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	0.8%	0.3%	0.4%	0.0%	0.0%	0.0%	0.0%
Florida	1.3%	0.6%	0.9%	0.0%	0.0%	0.0%	0.0%
Georgia	2.6%	0.7%	1.0%	0.0%	0.0%	0.0%	0.0%
Kentucky	-0.3%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%
Mississippi	0.7%	0.2%	0.6%	0.0%	0.0%	0.0%	0.0%
North Carolina	1.4%	0.3%	0.5%	0.0%	0.0%	0.0%	0.0%
South Carolina	2.5%	0.6%	1.2%	0.0%	0.0%	0.0%	0.0%
Tennessee	0.0%	0.1%	0.8%	0.0%	0.0%	0.0%	0.0%
Virginia	0.6%	0.2%	-0.5%	0.0%	0.0%	0.0%	0.0%
West Virginia	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	1.3%	**0.4%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

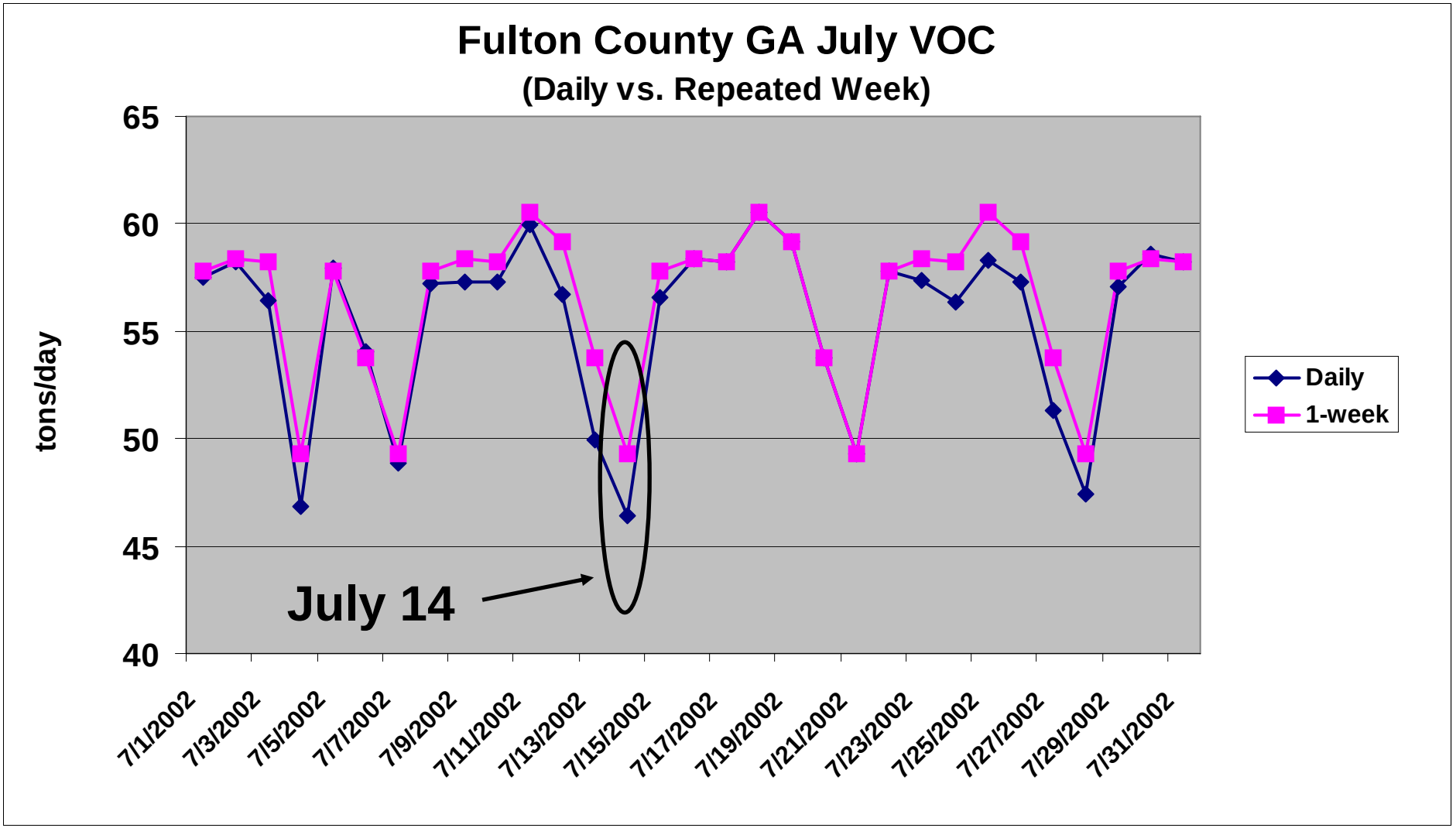
NC Statewide July NOx Emissions (Daily vs. Repeated week)



NC Statewide July VOC Emissions (Daily vs. Repeated week)

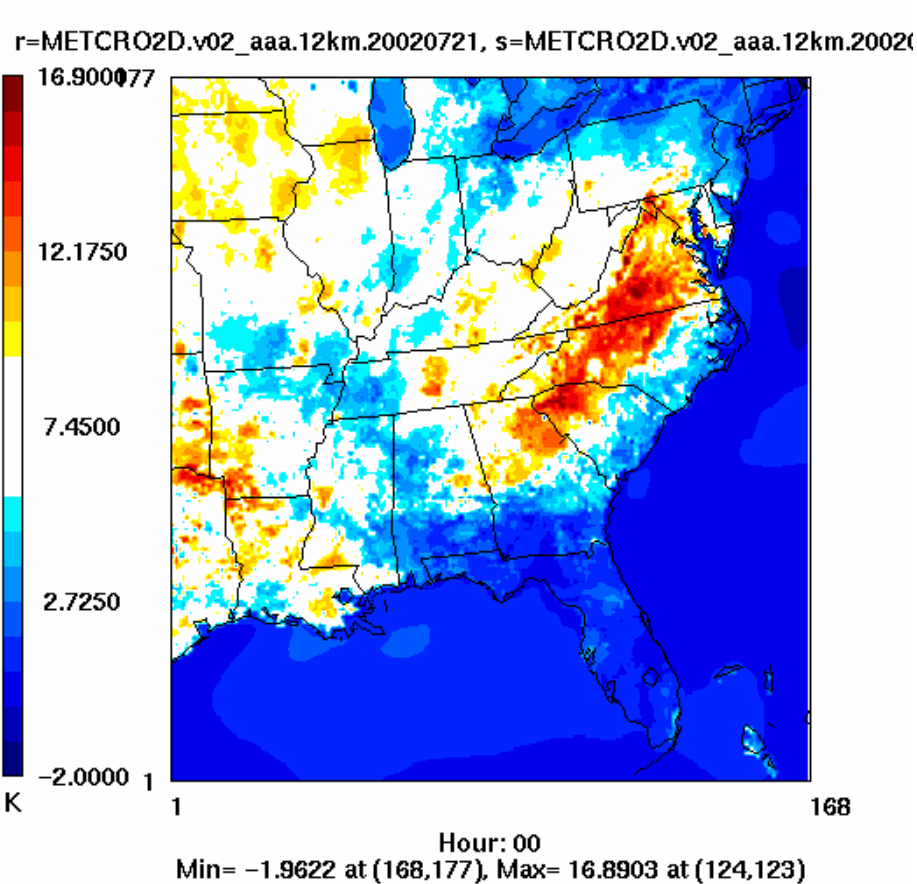



Mecklenburg County NC July VOC
(Daily vs. Repeated Week)
tons/day
65
60
55
50
45
40
July 14
7/1/2002
7/3/2002
7/5/2002
7/7/2002
7/9/2002
7/11/2002
7/13/2002
7/15/2002
7/17/2002
7/19/2002
7/21/2002
7/23/2002
7/25/2002
7/27/2002
7/29/2002
7/31/2002
Daily
1-week


Fulton County GA July VOC
(Daily vs. Repeated Week)
tons/day
65
60
55
50
45
40
July 14
7/1/2002
7/3/2002
7/5/2002
7/7/2002
7/9/2002
7/11/2002
7/13/2002
7/15/2002
7/17/2002
7/19/2002
7/21/2002
7/23/2002
7/25/2002
7/27/2002
7/29/2002
7/31/2002
Daily
1-week

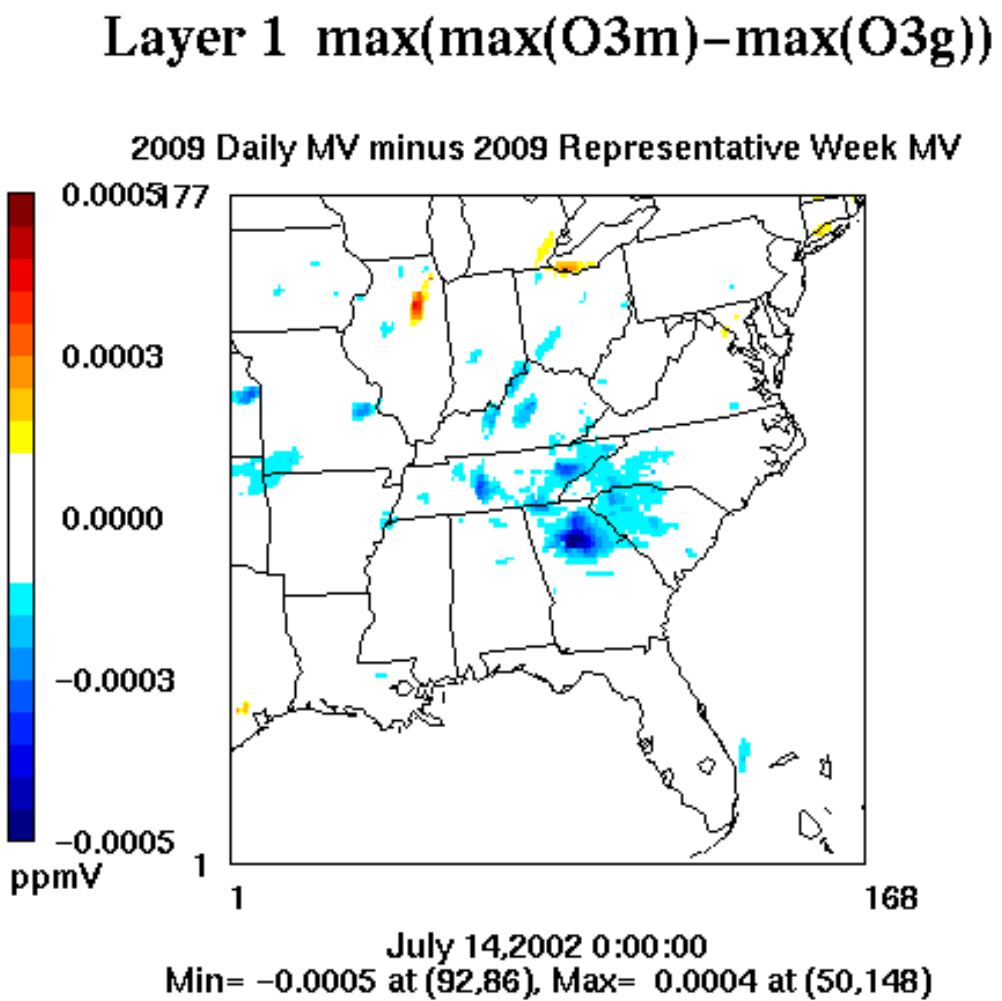
Skin Temp Max Differences

July 14 vs. July 21



1-hour Ozone Max Differences

July 14 vs. July 21



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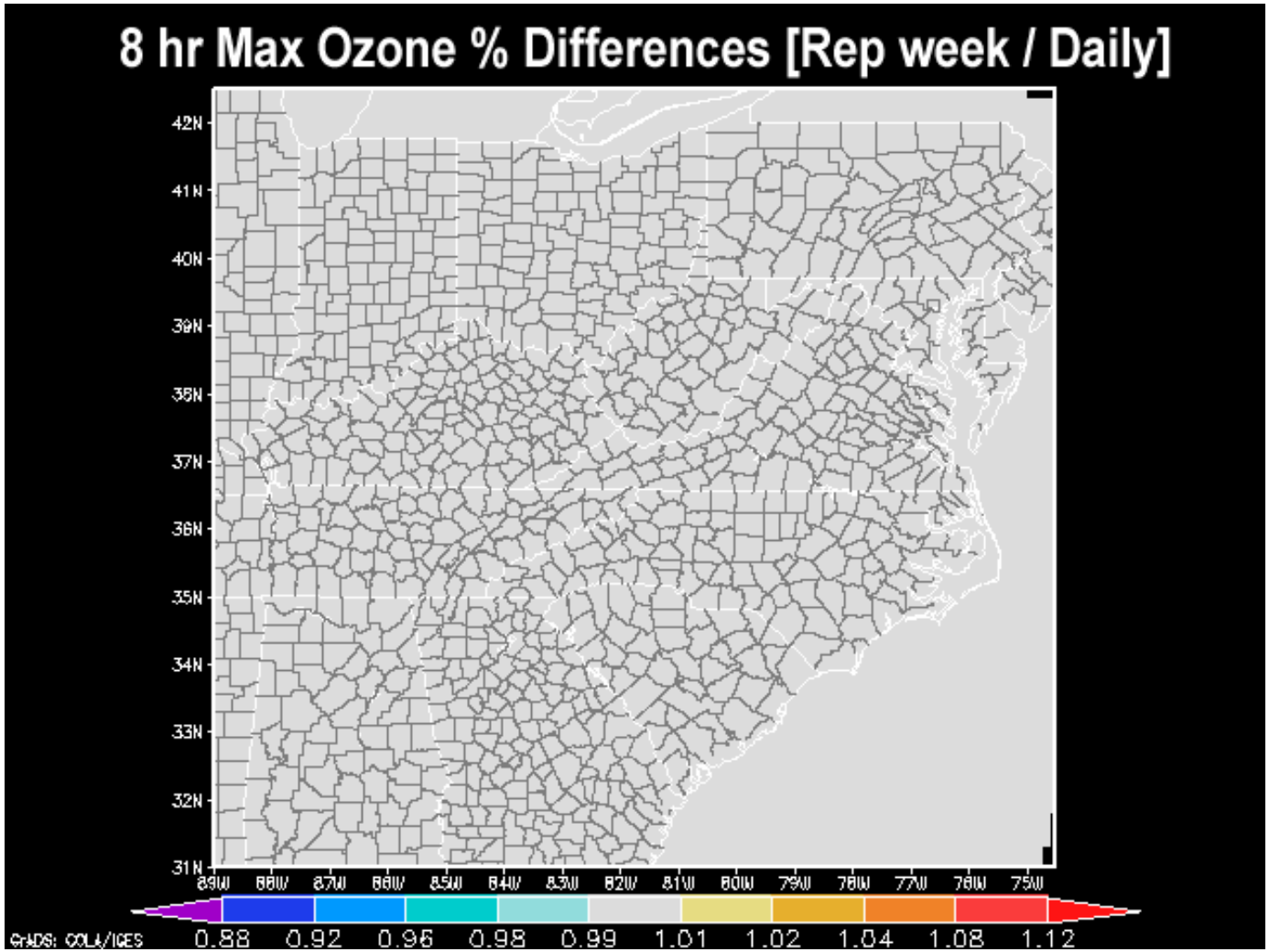
8-hour ozone Max

% Differences

July 14

vs.

July 21



Results

Daily vs. Representative Week Mobile Modeling

- Some small NOx and VOC emissions differences result due to temperature differences
- Impact on 8-hour ozone and 24-hr PM2.5 concentrations are insignificant for our modeled episodes and domain
- Length of time necessary for daily methodology is 4.5 times greater than the representative week method

Conclusions

U.S. EPA attainment demonstration modeling guidance notes that in some cases it may be useful to evaluate how the response of an air quality model to emissions changes varies as a function of alternative model inputs or model algorithms

These types of tests can be used to assess the robustness of a base case or control strategy modeling evaluation

Conclusions

Our research in using *reasonable alternate sets of onroad emission projections* has determined that the use of representative week onroad mobile emissions for each month of our episodes within our 12km modeling domain predicts ozone and particulate matter concentration differences from annual, everyday onroad mobile modeling which could be considered insignificant from an air quality modeling standpoint

Conclusions

VISTAS / ASIP modeling team recommended that representative week onroad mobile emissions methodology be carried forward in the remaining VISTAS regional haze modeling and the ASIP PM2.5 and 8-hour ozone modeling

Acknowledgements

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