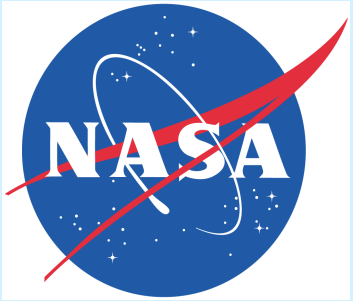
Quantifying source contributions to O_3 and $PM_{2.5}$ pollution episodes across the Eastern U.S.

TT PIs: Arlene Fiore (CU/LDEO), Tracey Holloway (U WI)

AQAST TT Members: Greg Carmichael (U Iowa), Daniel Cohan (Rice U), Bryan Duncan (NASA GSFC), Daven Henze (CU-Boulder), Edward Hyer (NRL), Daniel Jacob (Harvard), Russ Dickerson (U MD), Gabriele Pfister (NCAR)



AQAST7
Harvard University, Cambridge, MA
June 18, 2014

Designing effective SIPs requires knowledge of source contributions to O_3 and $PM_{2.5}$ pollution episodes

Observed pollution levels are the summation of in-state, out-of-state, international and natural sources

AQAST can help quantify these components; how can we be most effective?

→ Build a framework for continued communication with the stakeholders

→ Request priority high-O_3 and high-$PM_{2.5}$ episodes from AQMs (2007-2013)

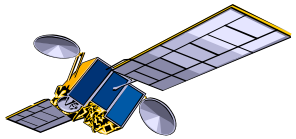
AQAST TT Members

Air Agencies

MDE, MO DNR, NH DES, NYSDEC, TX/TCEQ, WI DNR/LADCO, OTC, NESCAUM, US EPA…
…your agency??

Next teleconference: Monday, June 23, 2pm (EDT)

AQAST resources for source attribution during EUS pollution episodes



satellite instruments

OMI NO2
MOPITT CO
MODIS AOD

Transport events
- Inter-state
- Wildfire
- International

suborbital platforms

DISCOVER-AQ
(2011; SIP Base year)
SEAC4RS/SOAS/SENEX (2013)
EPA AQS
CASTNet

Size of episode
- Areal extent
- Duration
- Transport

models

CAMx
CMAQ
GEOS-Chem
GFDL AM3
STEM

Source attribution
- Several horizontal resolutions
- Forward/adjoint
- HTAP simulations
- Connect suborbital and space-based information

For each episode, organically determine best use of AQAST resources (which team members, tools)

Deliverables & Expected AQ outcomes

1. Establishment of a stakeholder advisory committee (set priorities)
   → Build broader engagement between AQAST and state-level AQMs
2. For each episode, generate reports with technical details of approach in appendices ("the recipe" for the analysis)
   → New info / approaches to support SIP development
   → Build capacity by providing case studies for future analyses
3. Develop website archive of reports, and links to related AQAST resources, including coordination with RSIG TT activity, other web tools
   → Broader dissemination of approaches & findings
4. Online interactive graphics to facilitate exploration of model and satellite data
   → Developing user-friendly space-based and model products to provide information on contributions from transported pollution

Space-based formaldehyde to NO_2 ratio indicates NOx-sensitive O_3 production over Colorado Front Range

Witman, S., T. Holloway, and P. Reddy, 2013

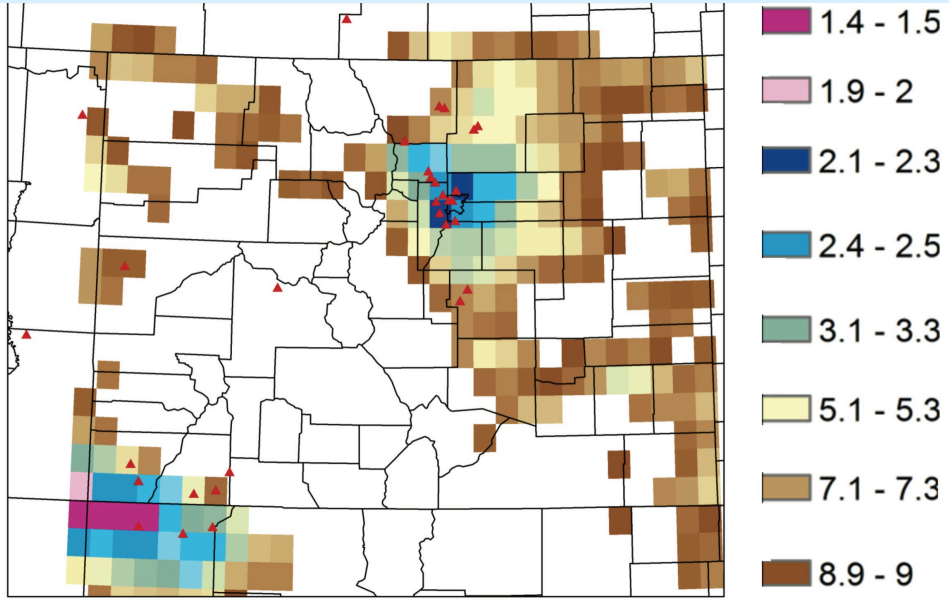
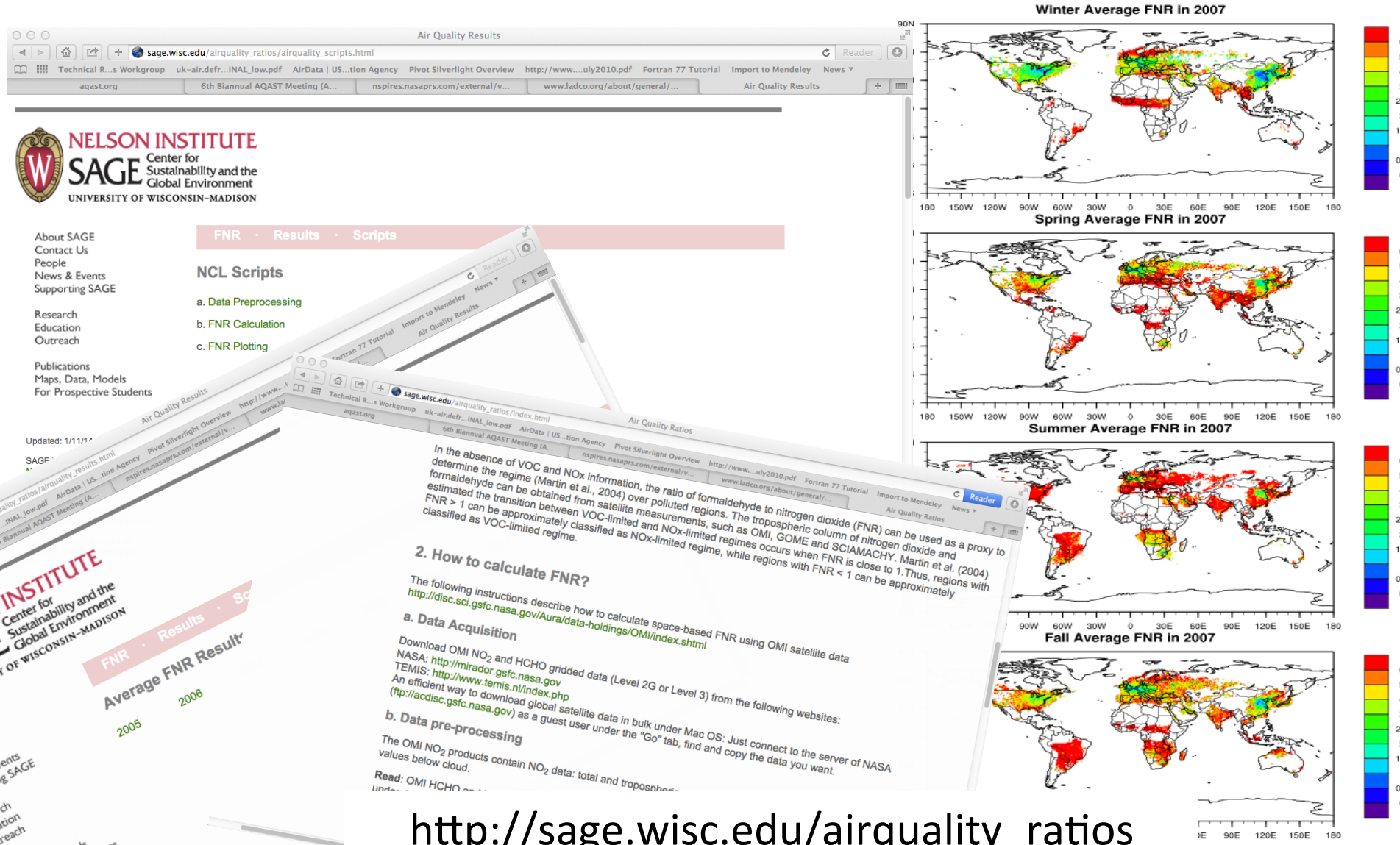


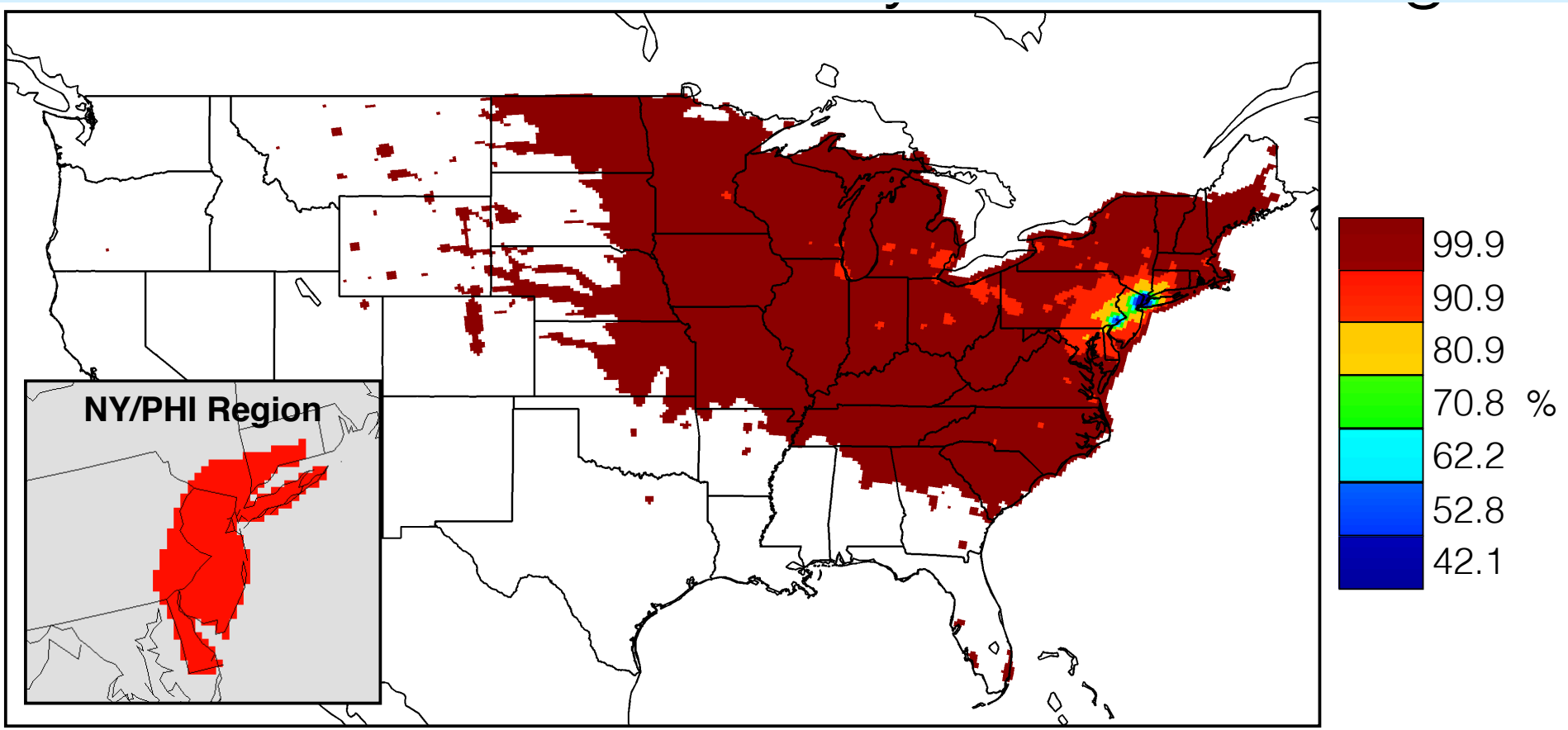
Figure 2: Ratio of tropospheric formaldehyde (HCHO) to tropospheric nitrogen dioxide (NO_2) over the Colorado Front Range area, derived from mean GOME2 satellite measurements for July 2007 and 2008. A ratio of above 1.0 may indicate a NO_x-sensitive ozone production regime. All ratios in this region show ratios are above 1.0. Gridded data from KNMI TEMIS (http://www.temis.nl/airpollution/no2.html). Figure courtesy of **Patrick Reddy**, from presentation "2009 Ozone Season Review: Briefing to the Colorado Air Quality Control Commission," September 17, 2009

"The recipe" for estimating the sensitivity of O_3 production to NO_x vs. VOCs from space-based formaldehyde to NO_2 ratio



T. Holloway

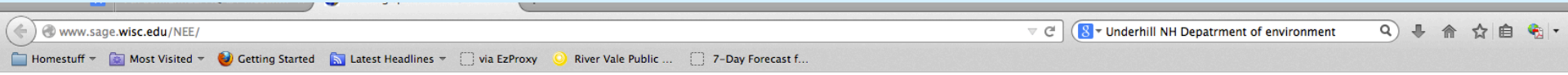
Receptor-oriented modeling: Contributions from local and regional BC emissions to mortality in NY/PHIL (2007)



- Adjoint simulations performed using CMAQ_ADJ (Hakami et. al, 2007)
  - CMAQ_ADJ updated to include aerosol microphysics (Turner, in prep).
  - 11 months of sensitivities calculated (Feb. 2007 - Dec. 2007)
- Cost Function (number of mortalities attributed to exposure to BC exposure in NY/PHI region) = **1,923** mortalities in 2007
  - Cost function calculated using concentration response factor from Krewski et. al (2009)
  - Baseline mortality rates obtained from BenMAP

Matthew Turner, Daven Henze, University of Colorado at Boulder

Password-protected website for sharing materials among AQAST/AQM team members



NASA Eastern Episodes

Texas site specific MDA8 episodes 2007-2013

TCEQ monitoring data for identifying exceptional event candidates

MOPITT and IASI CO images for identified episodes

Analysis of 2007 Emissions from Power Plants and Other Large Combustion Sources in the Mid-Atlantic and Northeastern United States

Short description of episodes identified by the WDNR

Goldberg, D., et al. (2014) Higher surface ozone concentrations over the Chesapeake Bay than over the adjacent lan Observations and models from the DISCOVER-AQ and CBODAQ campaigns, Atmos. Env. (84), p. 9-19.

Information on MDE-identified episodes

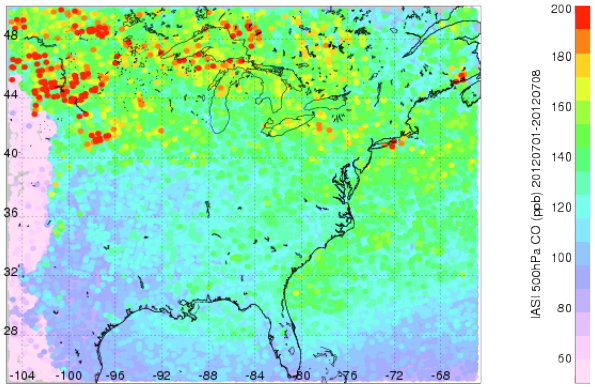
Information on episodes identified by Missouri DNR

Satellite carbon monoxide composites (max value) during selected EUS episodes

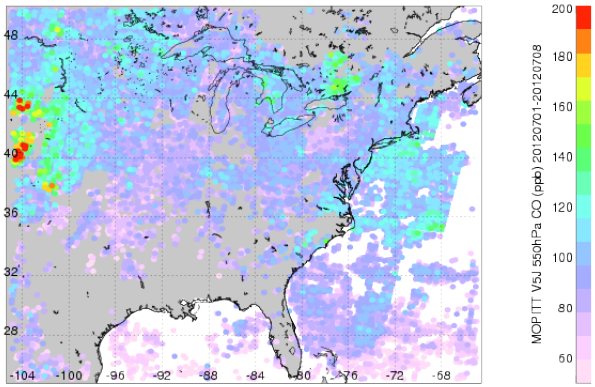
- MOPITT multi-spectral retrieval (increased sensitivity to surface)
- IASI FORLI retrieval processed at NCAR (mostly mid-trop sensitivity)
- Download maps from: ftp://acd.ucar.edu/user/pfister/AQAST/TT_EUS_Episodes/
- Further graphics and time periods available if needed
- IASI O3 Analysis is in progress

1 – 8 July 2012

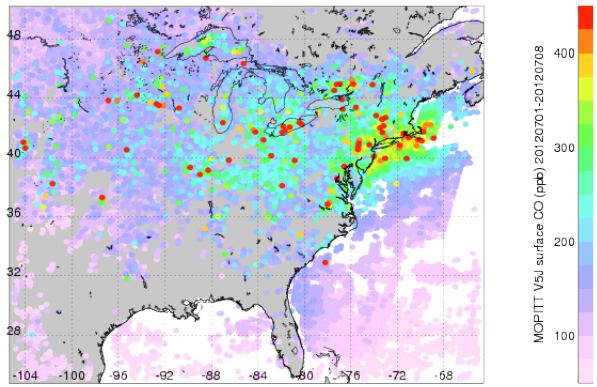
IASI 550 mbar



MOPITT 550 mbar



MOPITT surface



David Edwards, Gabriele Pfister and Helen Worden, NCAR

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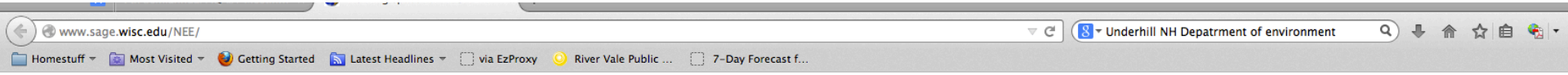

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"highest priority": June 10-18 2007

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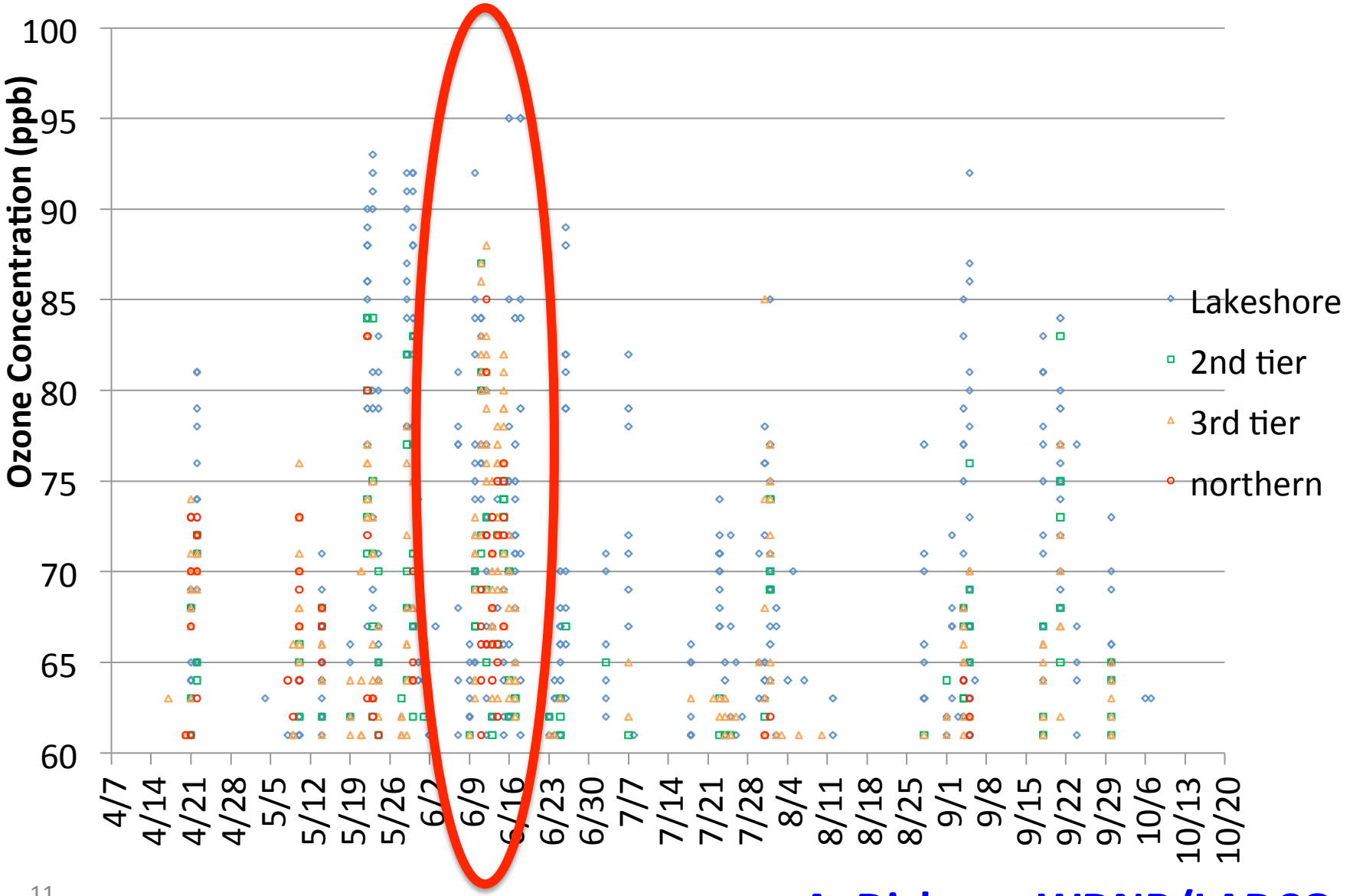
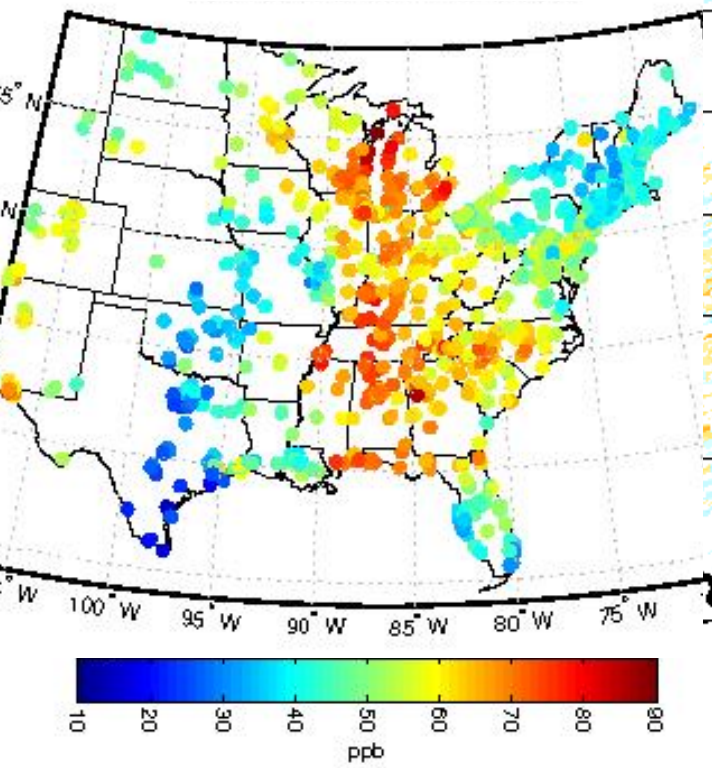
2007 Ozone Concentrations (>60 ppb)

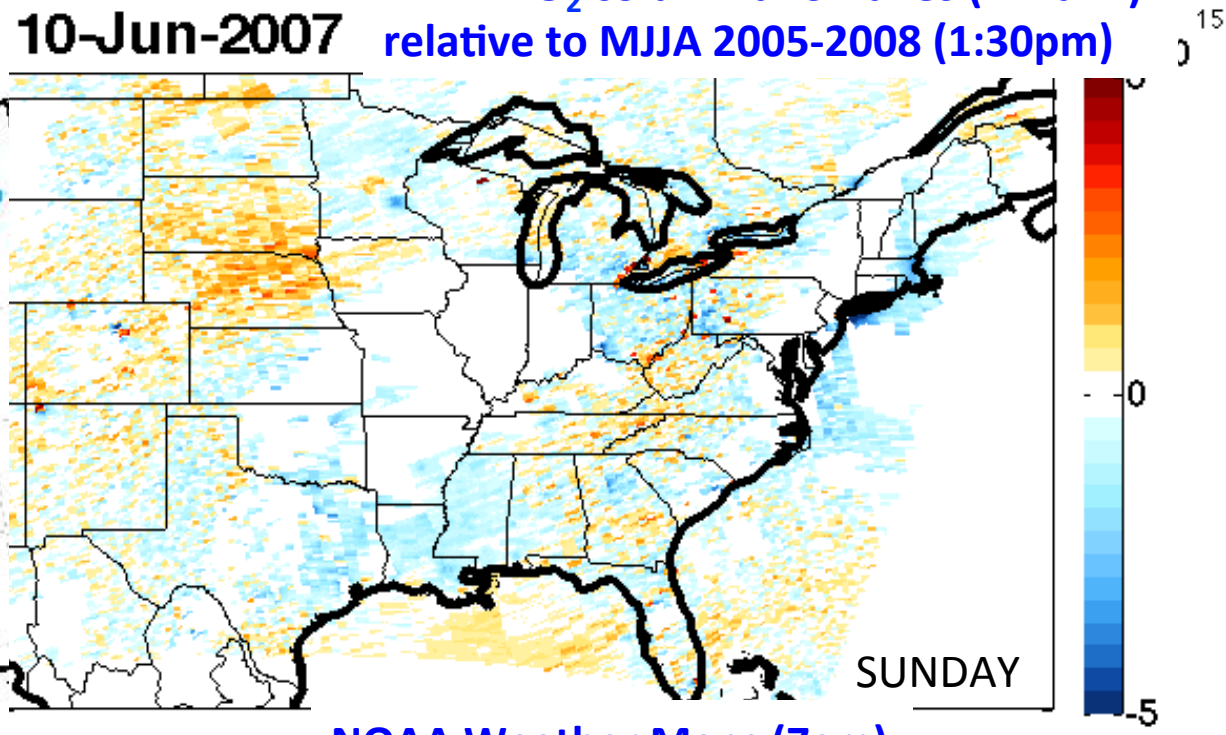


A. Dickens, WDNR/LADCO

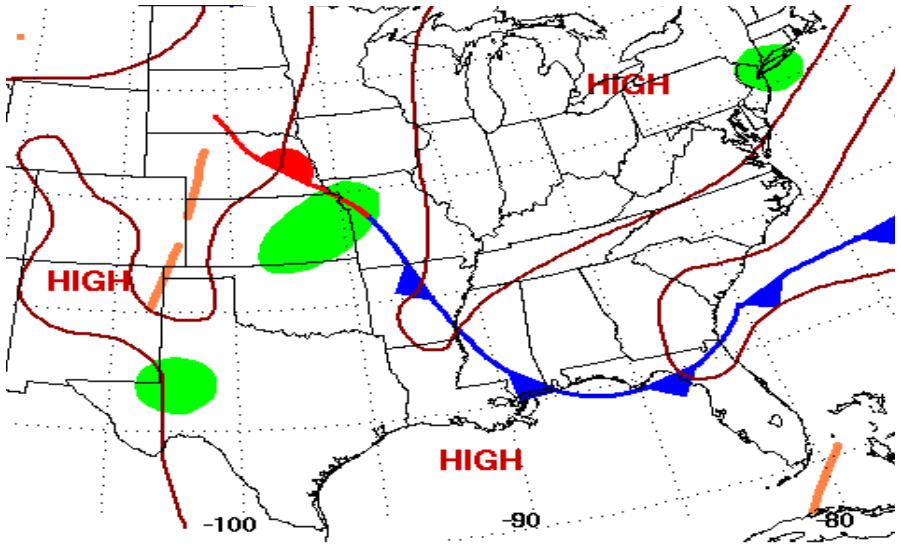
AQS MDA8 OZONE (J. Guo)



BEHR NO_2 column anomalies (L. Valin) relative to MJJA 2005-2008 (1:30pm)



NOAA Weather Maps (7am)

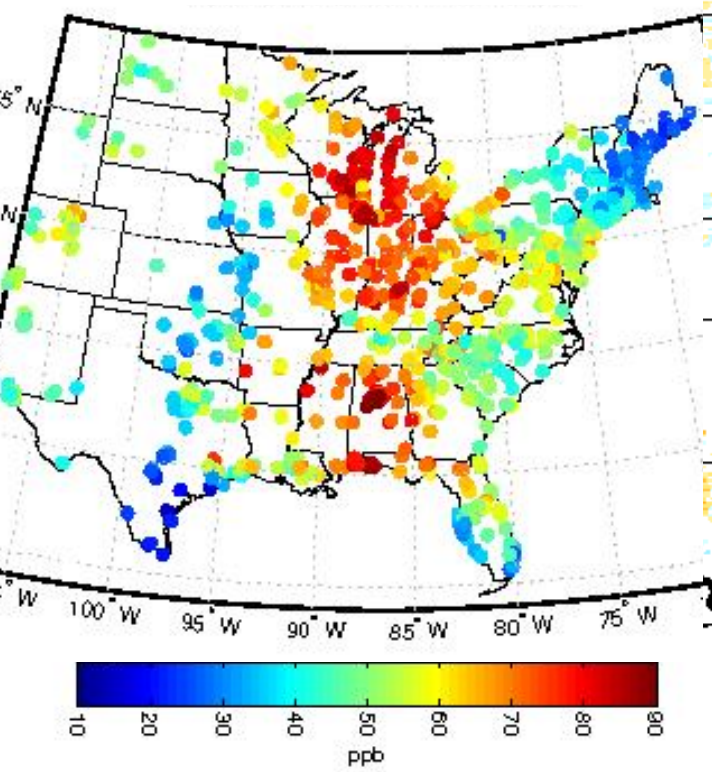


"highest priority O_3 episode" from WI DNR

"started as classic lake breeze"

-A. Dickens (WI DNR/LADCO)

AQS MDA8 OZONE (J. Guo)



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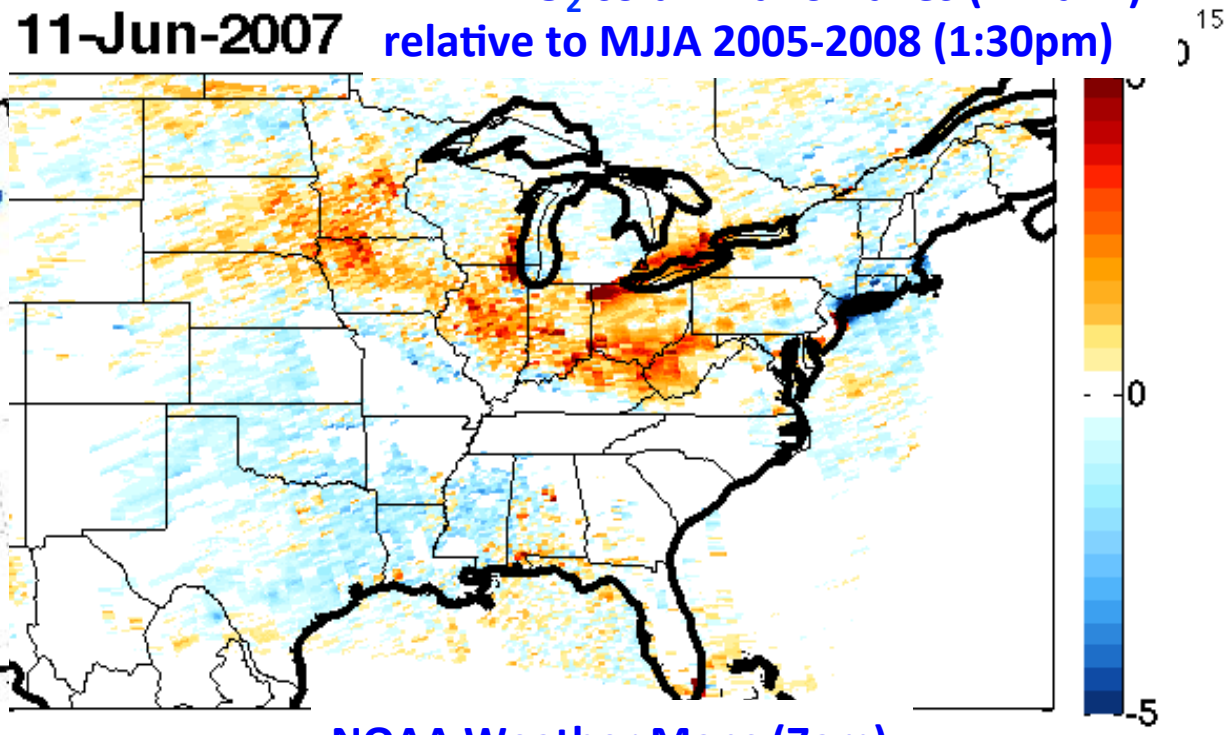

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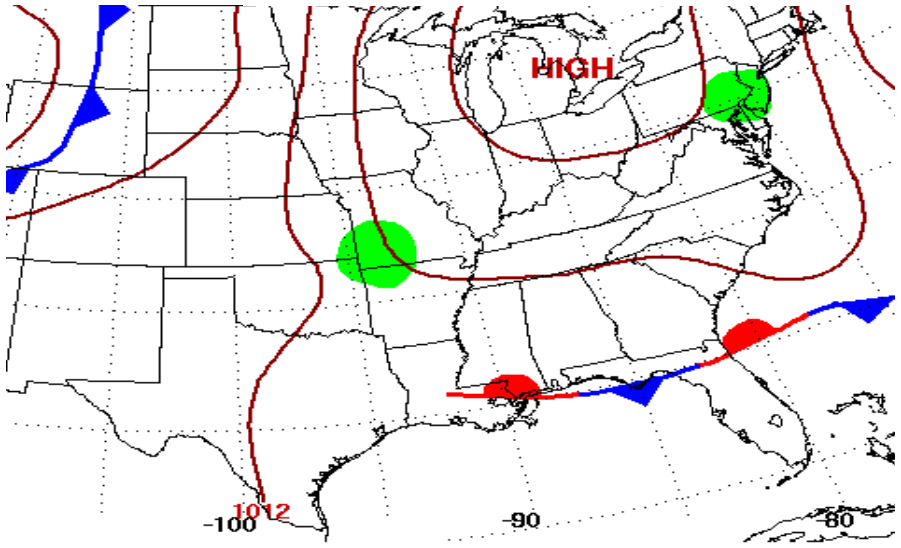

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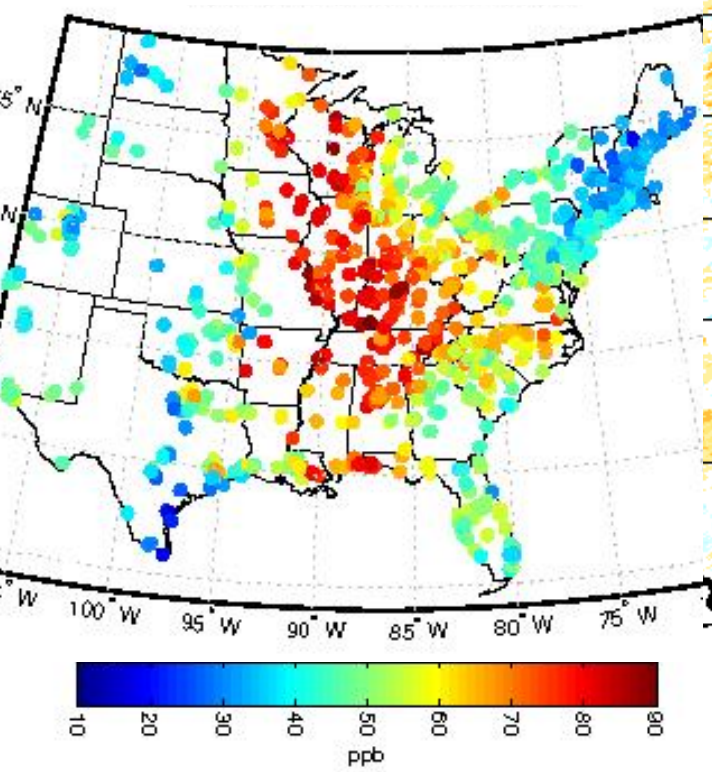

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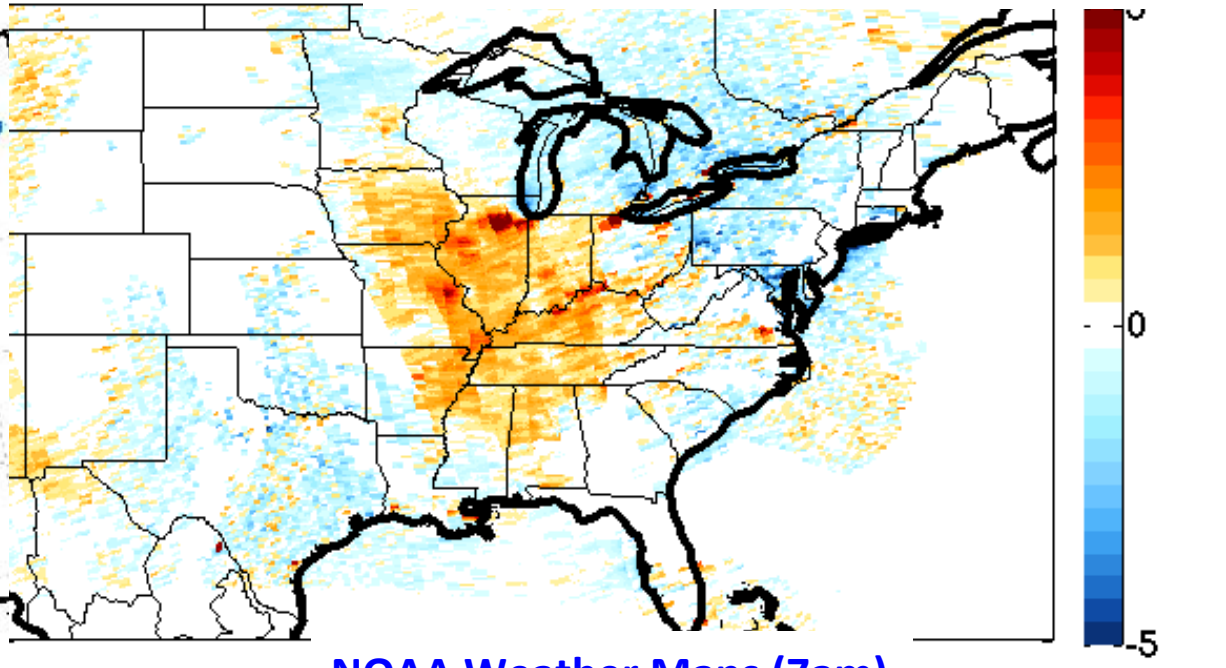

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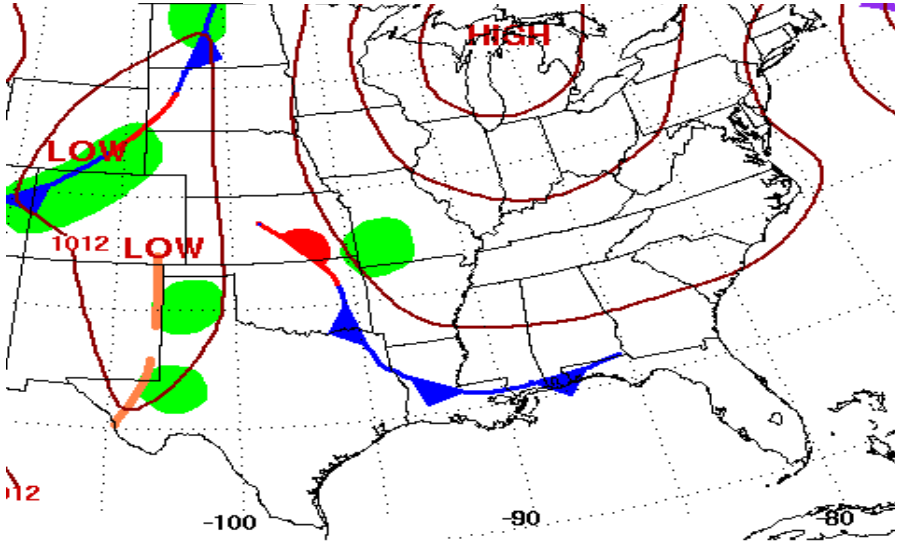
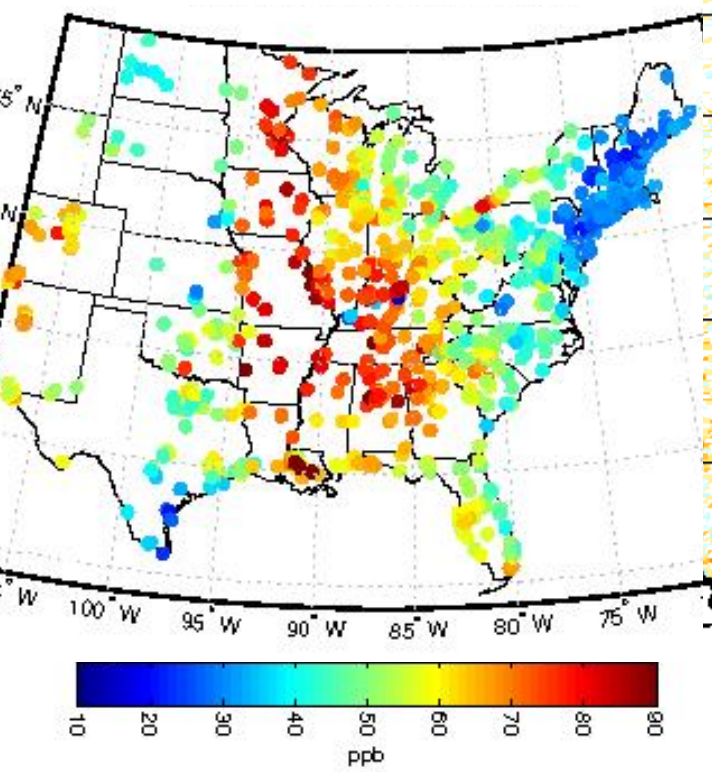


"highest priority O_3 episode" from WI DNR

"middle of episode, highest concentrations inland…even in farthest northern stations; lower along lake; high O_3 in IL"

-A. Dickens (WI DNR/LADCO)

AQS MDA8 OZONE (J. Guo)



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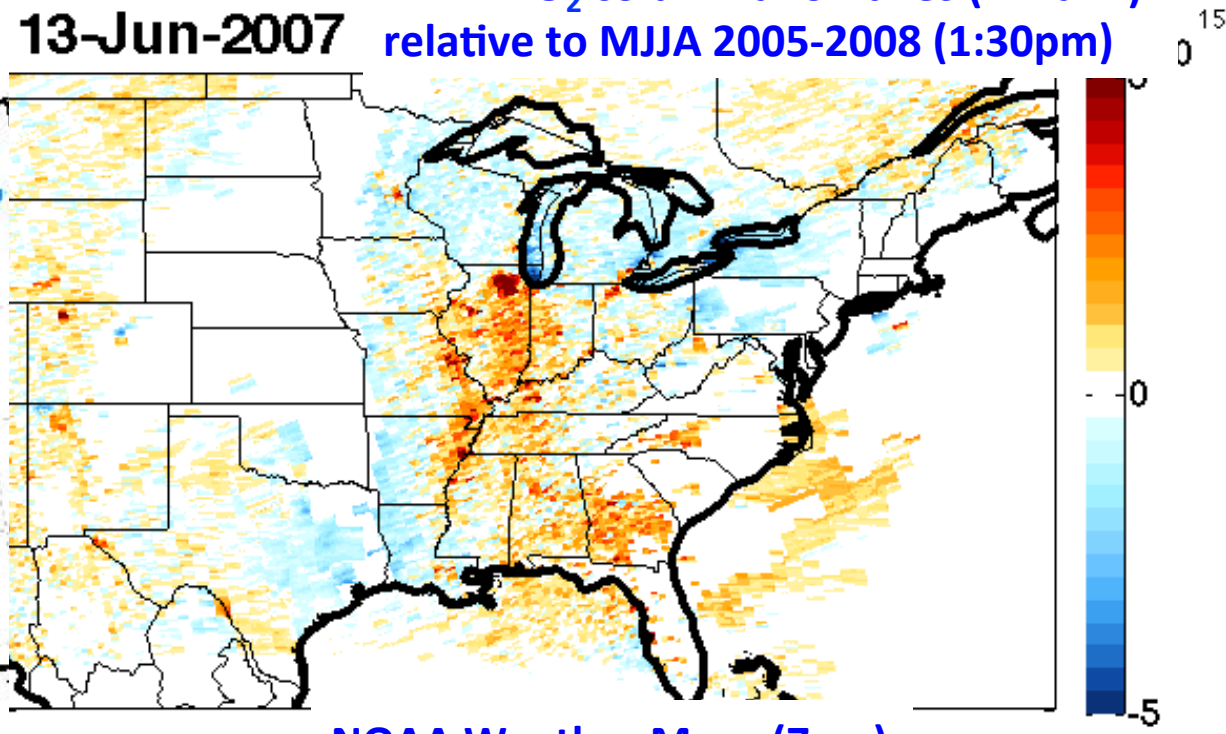

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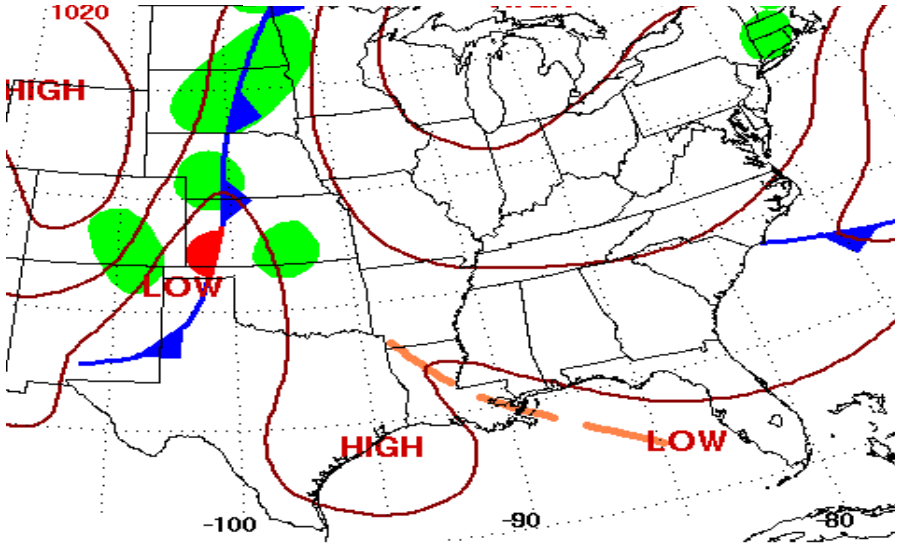

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"middle of episode, highest concentrations inland;
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MN also highest O_3 of the year"
-A. Dickens (WI DNR/LADCO)

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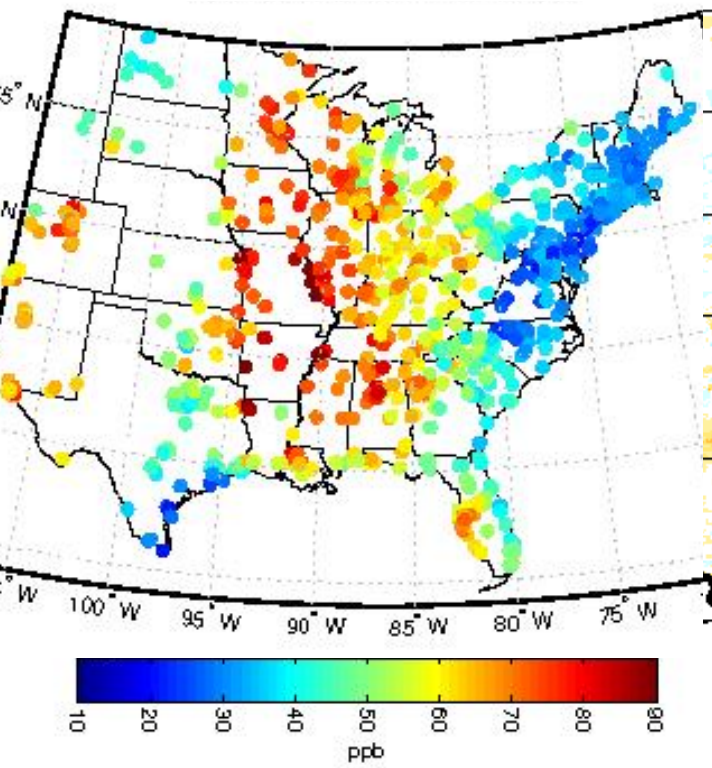

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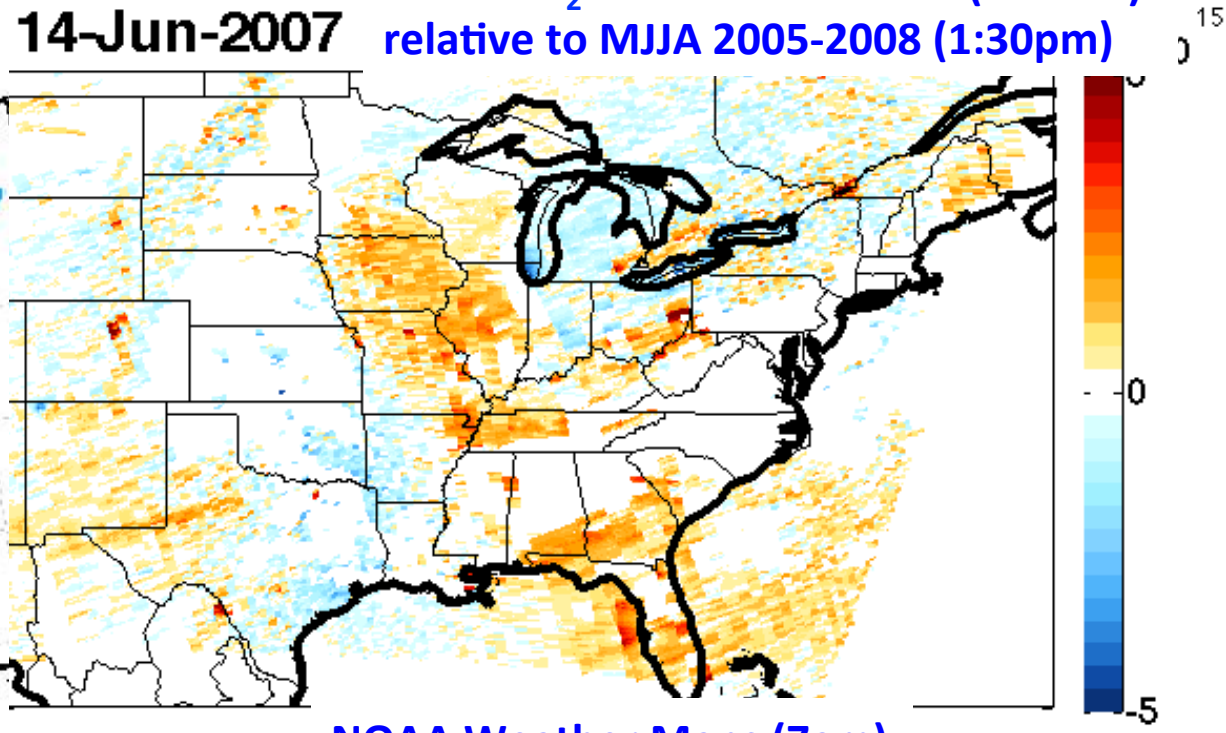

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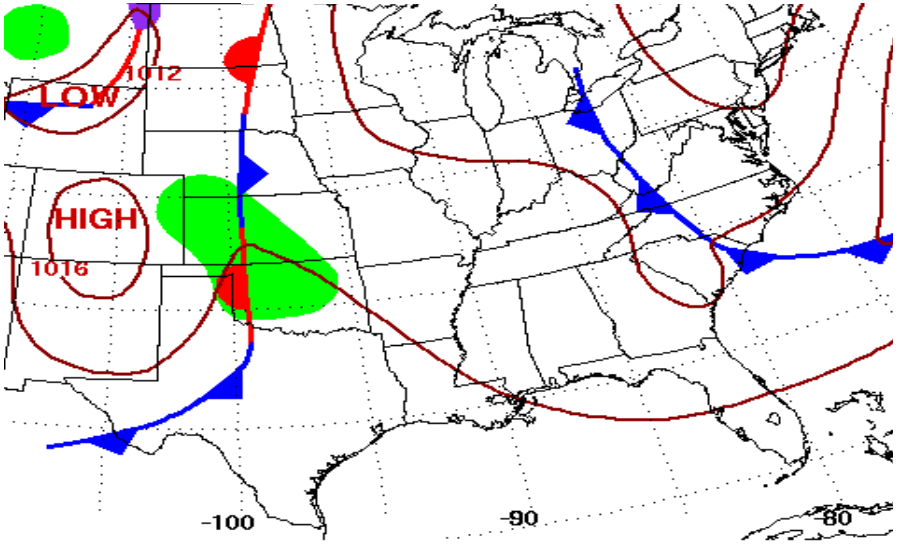

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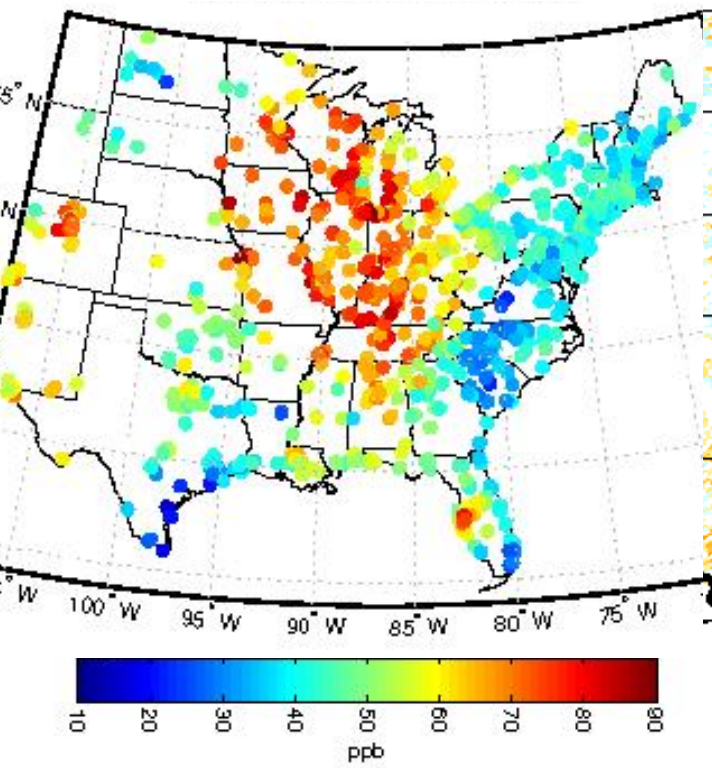

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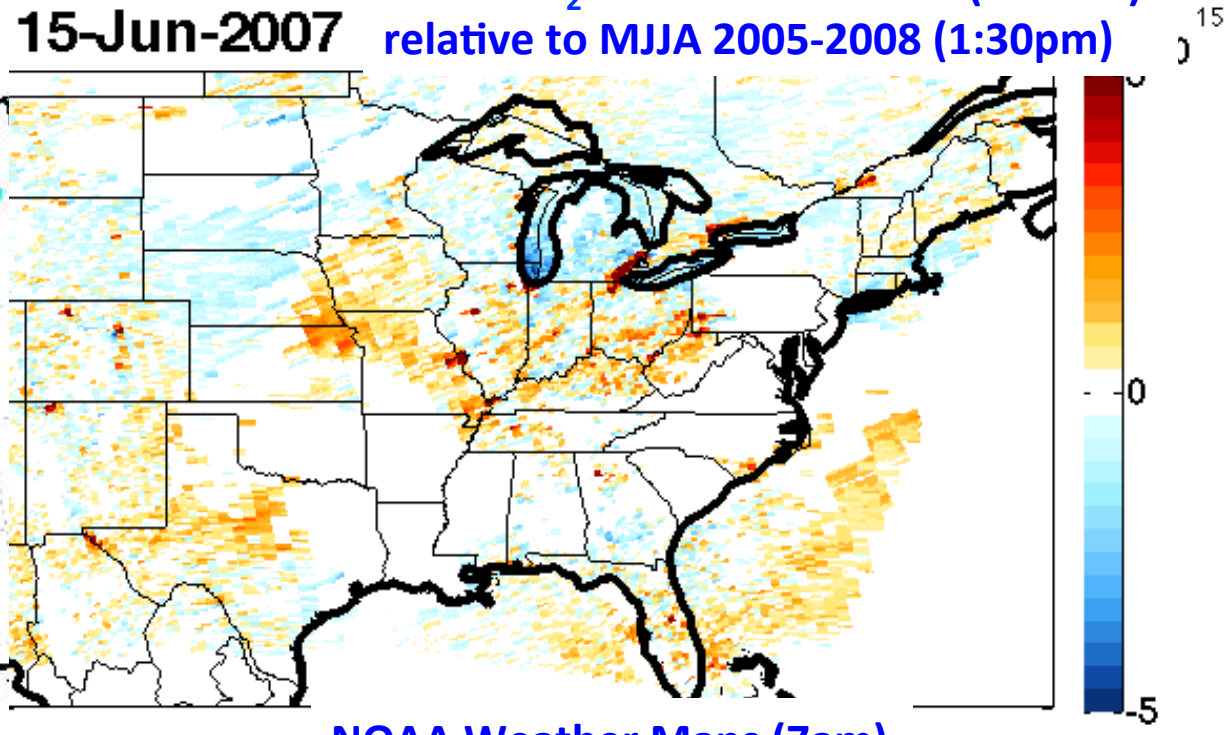

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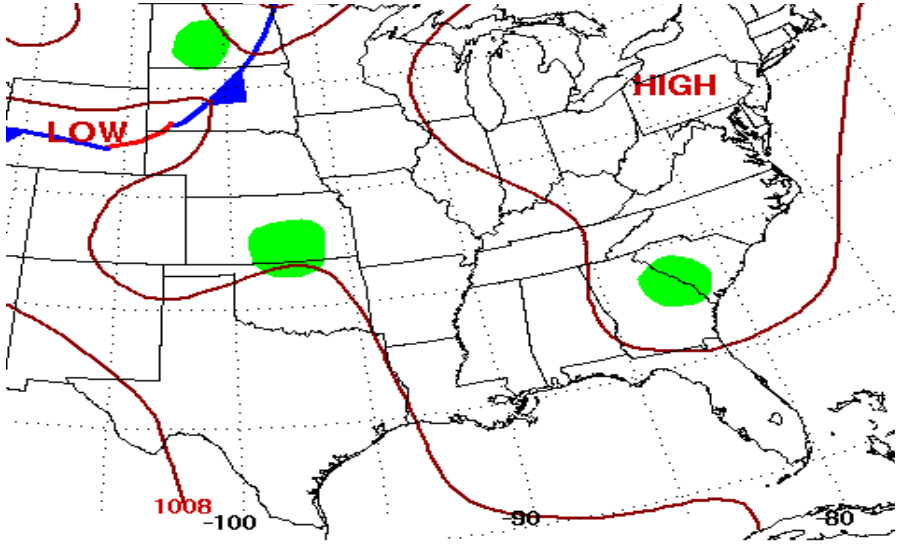

Surface Weather Map at 7:00 A.M. E.S.T.

"highest priority O_3 episode" from WI DNR

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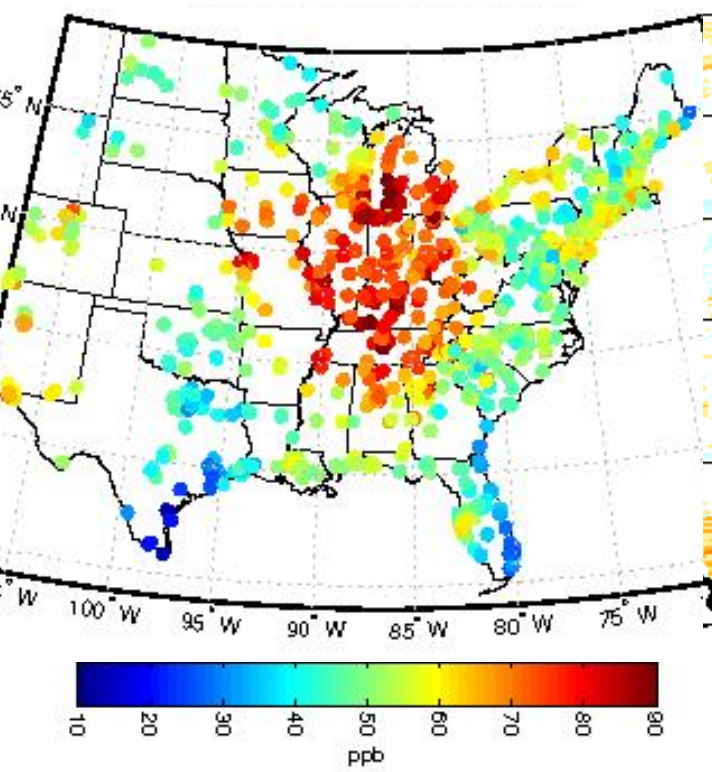

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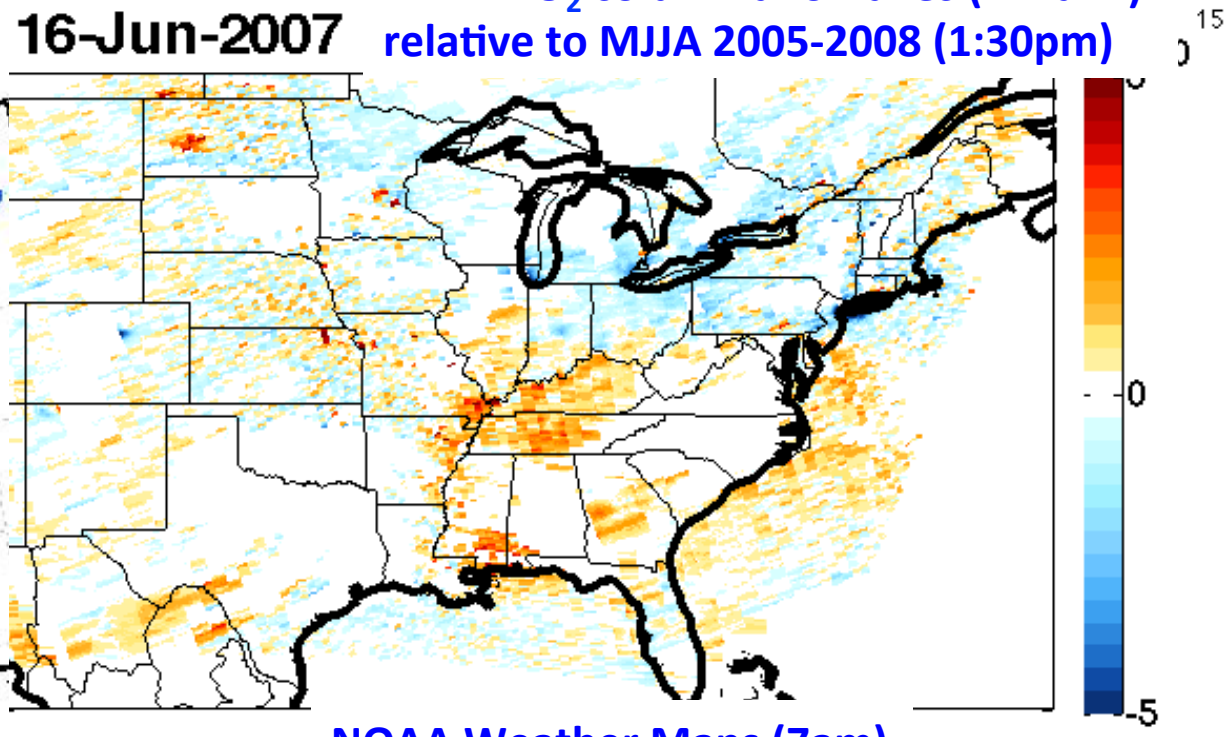

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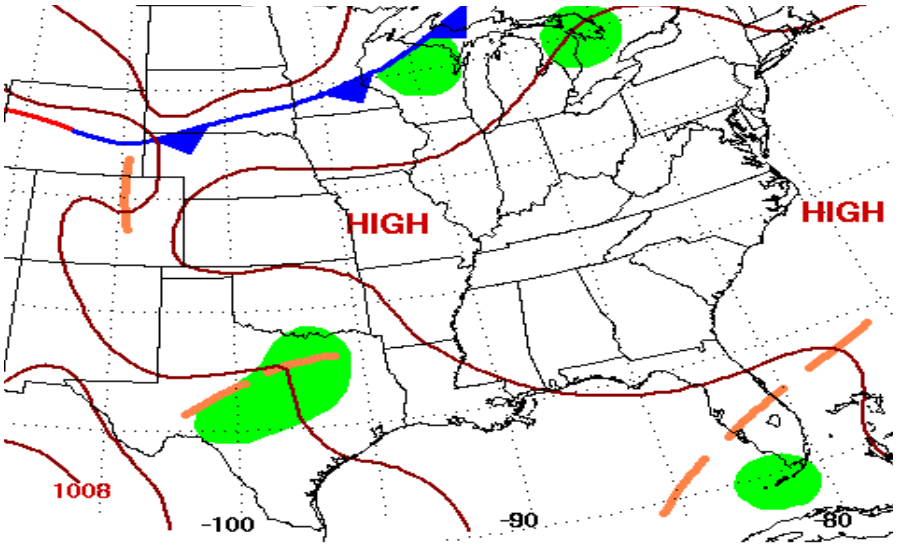


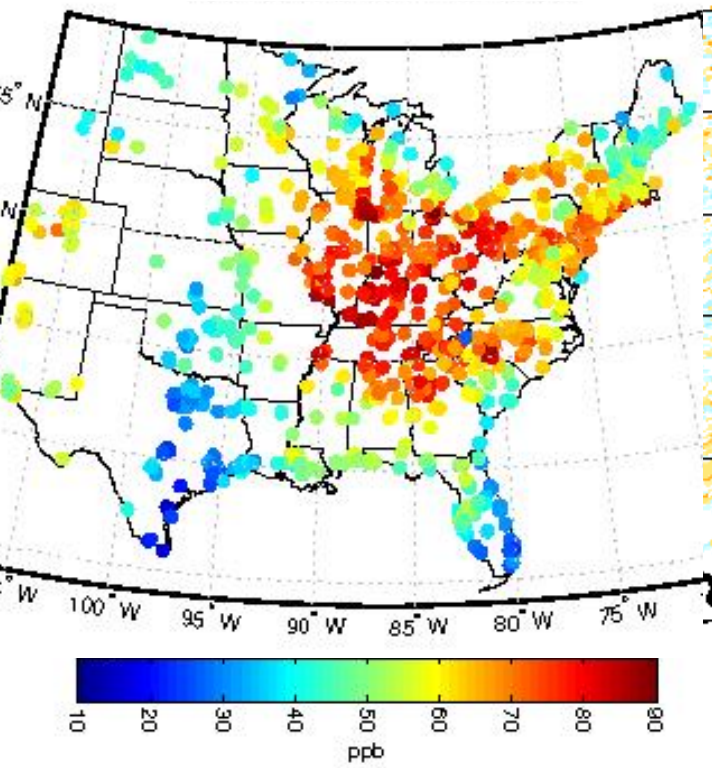
Surface Weather Map at 7:00 A.M. E.S.T.

"highest priority O_3 episode" from WI DNR

"MI also observed the highest ozone concentrations of the year"

-A. Dickens (WI DNR/LADCO)

AQS MDA8 OZONE (J. Guo)



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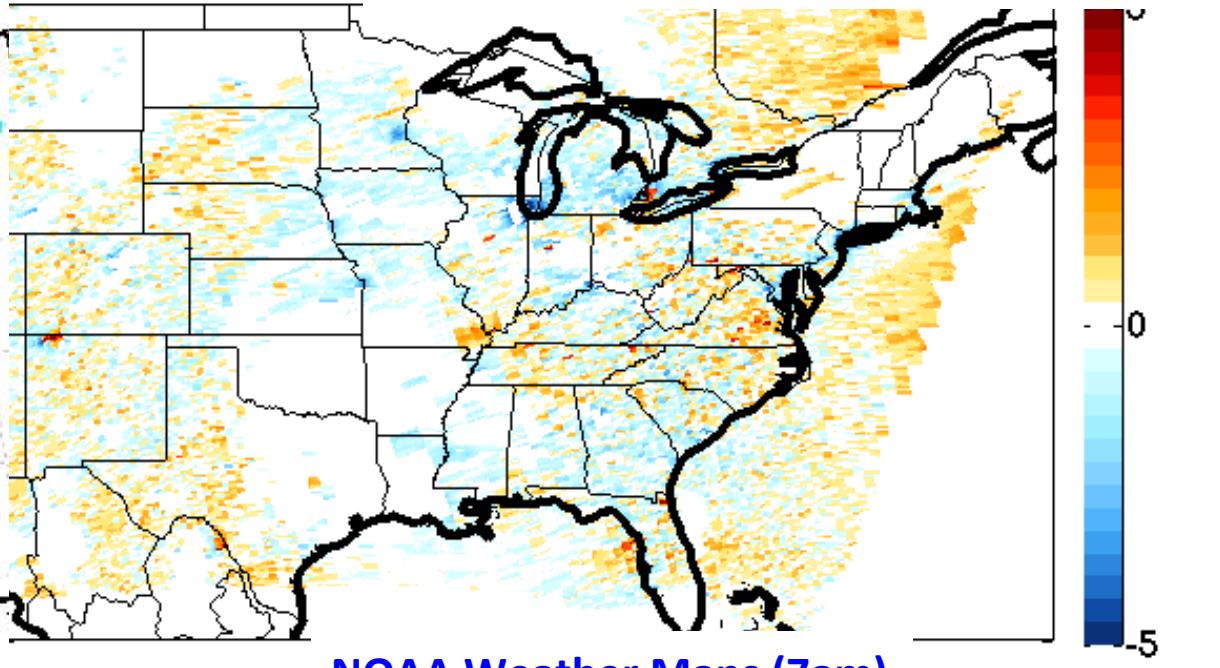

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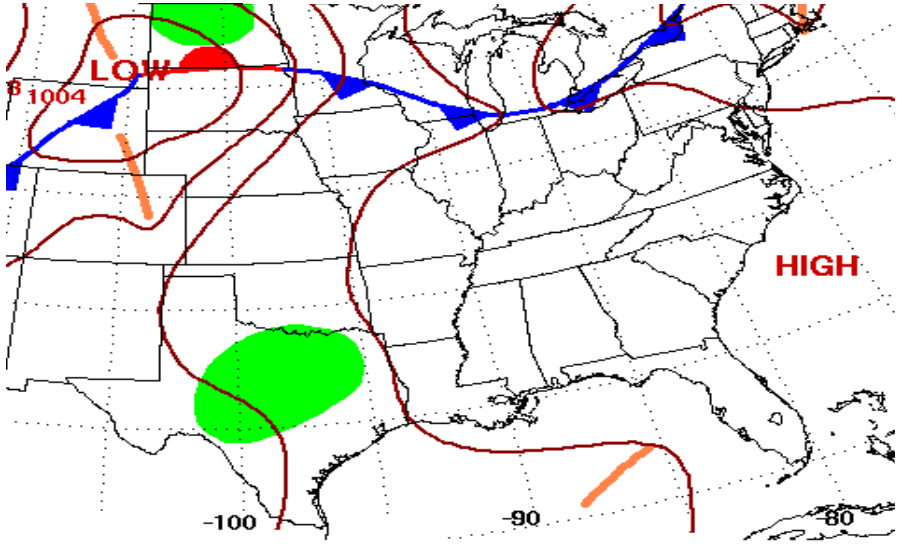

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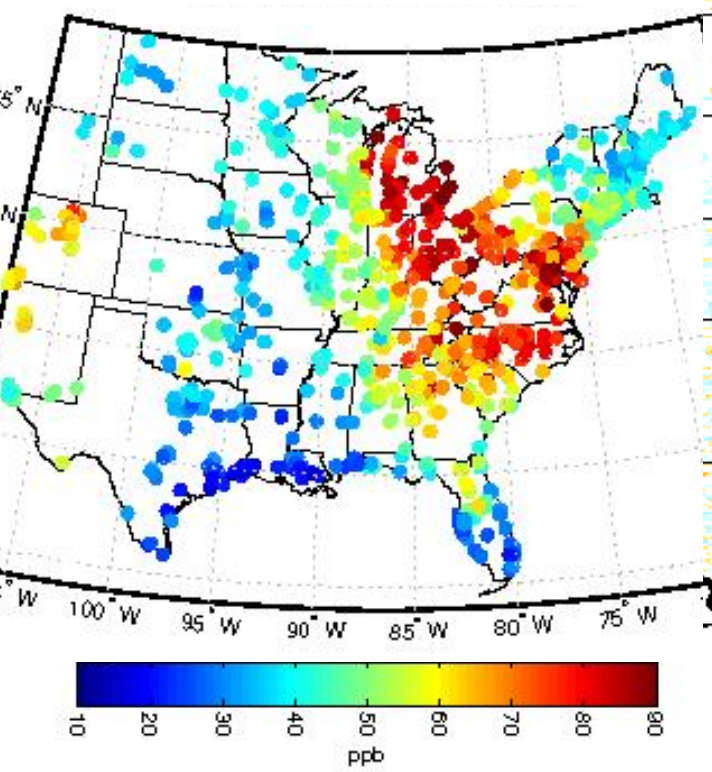

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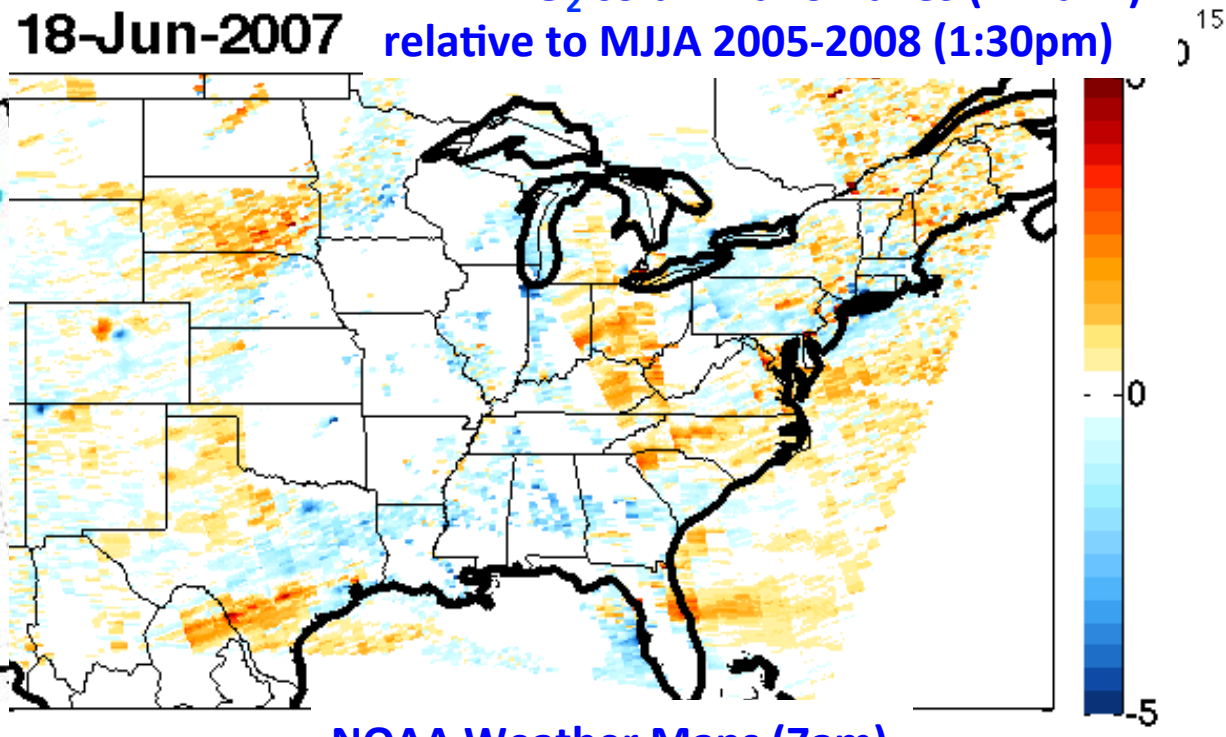

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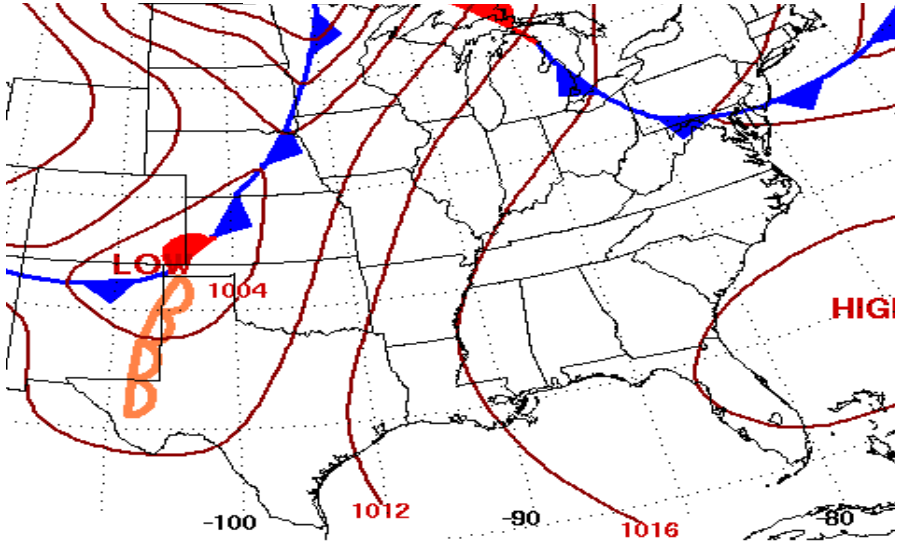


Surface Weather Map at 7:00 A.M. E.S.T.

Similar day-to-day variations in spatial patterns of surface O_3 and NO_2 column anomalies during this regional-scale, multi-day episode (reflects weather variability)

Quantifying source contributions with GEOS-Chem (v9_02): Multi-year (2004-2012) simulations (2°x2.5°)

MERRA winds; NLDN lightning; NEI2005; CH_4 lower BCs from obs

Sensitivity simulations:

- N. Amer. Background

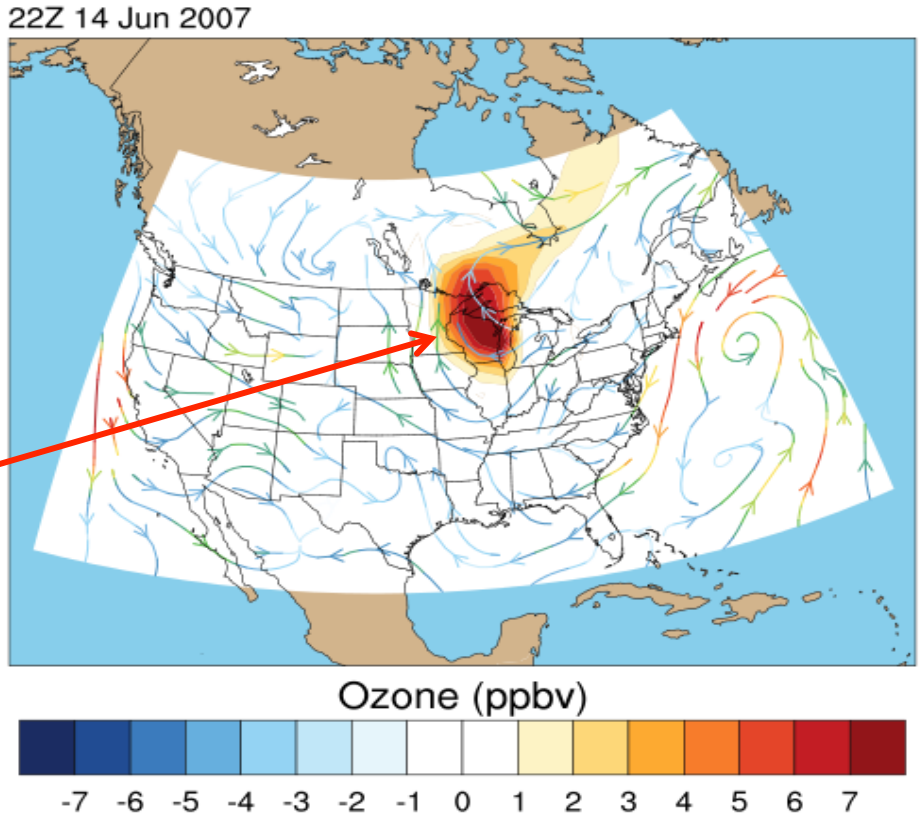
(zero N. Amer Anthr. Emis.)

- U.S. Background
- Natural Background
- Zero soil NO_x
- Zero lightning NO_x
- Zero fires
- Zero a single state's emissions

Some archived fields:

- Columns at 10:00 and 13:30
- Hourly surface O_3 ; $PM_{2.5}$
- Boundary conditions for regional models

Sample estimated contribution of WI emissions to surface O_3



→ Evaluating the ability of the coarse model to provide useful rapid first-look estimates of event source attribution in advance of regional-scale modeling

L. Murray, LDEO/Columbia

Compiling spreadsheet with O_3 and $PM_{2.5}$ episodes requested from air agencies

Notes	2012	O_3	$PM_{2.5}$	other	identified by MARA: MA	MDE	MO	NY	TCEQ	WDNR	AQAST resources
severe widespread event	June 24 - 28	X							X		
widespread	June 24 - 30	X					X				
	June 27 - 28	X								X	
	June 28 - July 8	X				X					
	July 1 - 8			Saharan dust					X		
	July 5 - 7	X					X				
	July 9 - 14	X					X				

MD, MO, TCEQ, WDNR all identified high-O_3 events during the 2012 heat wave beginning late June into mid-July

→ Animation of EUS MDA8 O_3 (J. Guo, Columbia)
→ Also $PM_{2.5}$ available

Designing effective SIPs requires knowledge of source contributions to O_3 and $PM_{2.5}$ pollution episodes

Observed pollution levels are the summation of in-state, out-of-state, international and natural sources

AQAST can help quantify these components; how can we be most effective?

→ Build a framework for continued communication with the stakeholders
→ Request priority high-O_3 and high-$PM_{2.5}$ episodes from AQMs (2007-2013)
→ Analyze some of these episodes & provide "recipes" for determining source contributions

AQAST TT Members

Air Agencies

MDE, MO DNR, NH DES, NYSDEC, TX/TCEQ, WI DNR/LADCO, OTC, NESCAUM, US EPA…
…your agency??

Next teleconference: Monday, June 23, 2pm (EDT)