

CAMR Mercury Deposition Modeling

Newport, RI
April 26, 2005

Community Multiscale Air Quality (CMAQ) Model Version 4.3

- Grid based 3-dimensional photochemical model
- Developed by US EPA's Office of Research and Development to provide assessment capabilities for multiple atmospheric pollutants
- Photochemistry to link pollutants (e.g. ozone, particulate matter, mercury)
- Regional scale with local specified nested grid capabilities

CMAQ Mercury Science - CAMR

- Largely based on:
 - Bullock, R. and Brehme, K., Atmospheric Environment 36, 2135-2146, 2002 (Peer Reviewed)
- Updates (Peer Reviewed May 2005):
 - Elemental Mercury (Hg⁰) Reaction with Hydrogen Peroxide to form 100% Reactive Gaseous Mercury (RGM)
 - Hg⁰ Reaction with Ozone to form 50% RGM and 50% Particulate Mercury (HgP)
 - Hg⁰ Reaction with Hydroxyl Radical (OH) to form 50% RGM and 50% HgP
 - Rate Constant for Hg⁰ reaction with OH from 8.7 to 7.7 x 10⁻¹⁴ cm³ molecules⁻¹ s⁻¹

Horizontal and Vertical Resolution

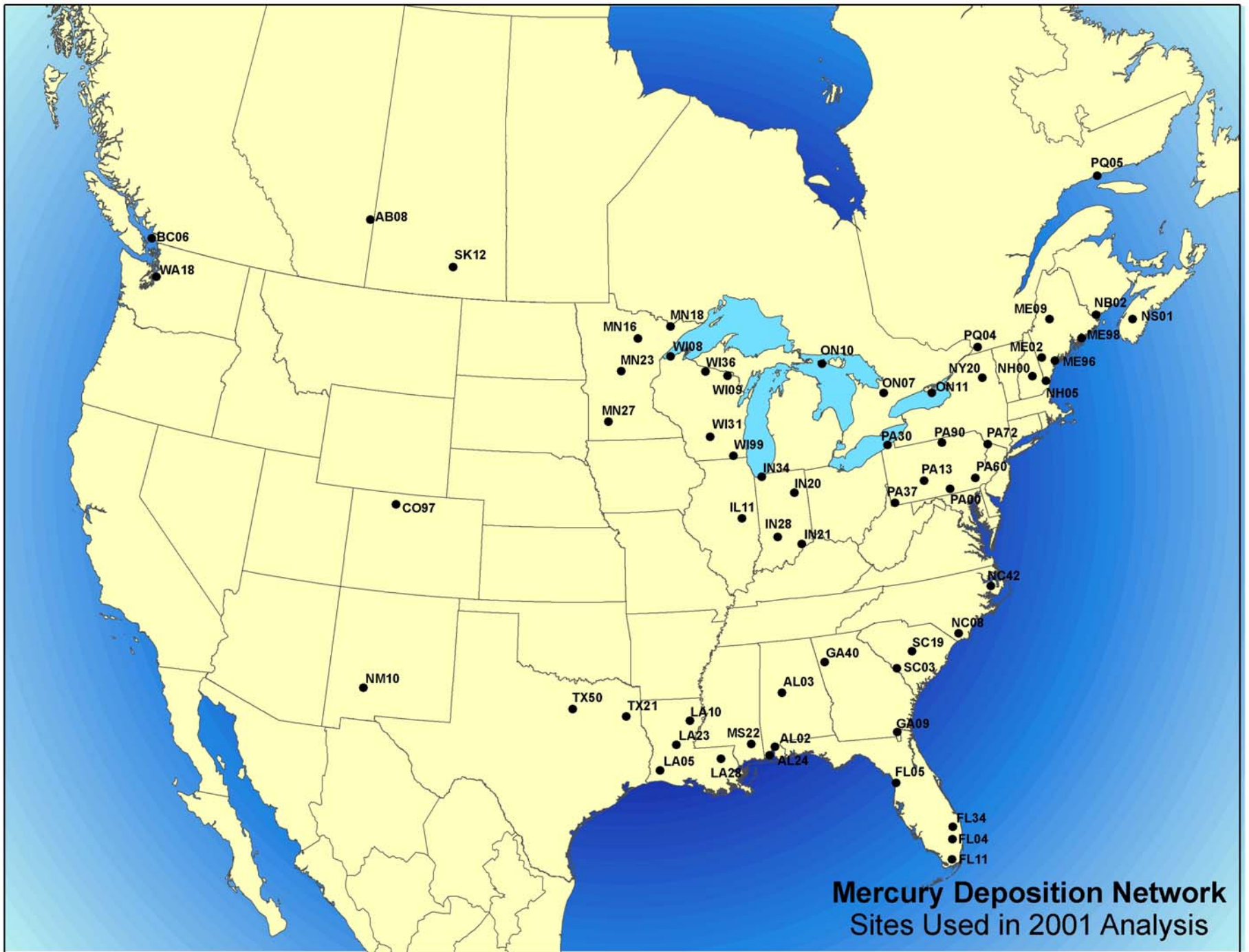
- 36 km on a side grid squares
- 14 vertical layers
- Surface layer height – 38 meters
- 3rd layer height – 154 meters
- 6th layer height – 712 meters
- 10th layer height – 3,108 meters
- 14th layer height – 15,674 meters

CMAQ Mercury Deposition Modeling Inputs

- 2001 Penn State mesoscale meteorological model Version 5 (MM5)
- US/Canada anthropogenic mercury emissions
- Updated 1999 NEI emissions inventory by mercury species (MWI 2002)
- Harvard's GEOS-CHEM global model used for inflow of pollutants to the modeling domain through the boundaries (varied horizontally and vertically every three hours)

Scenarios Modeled

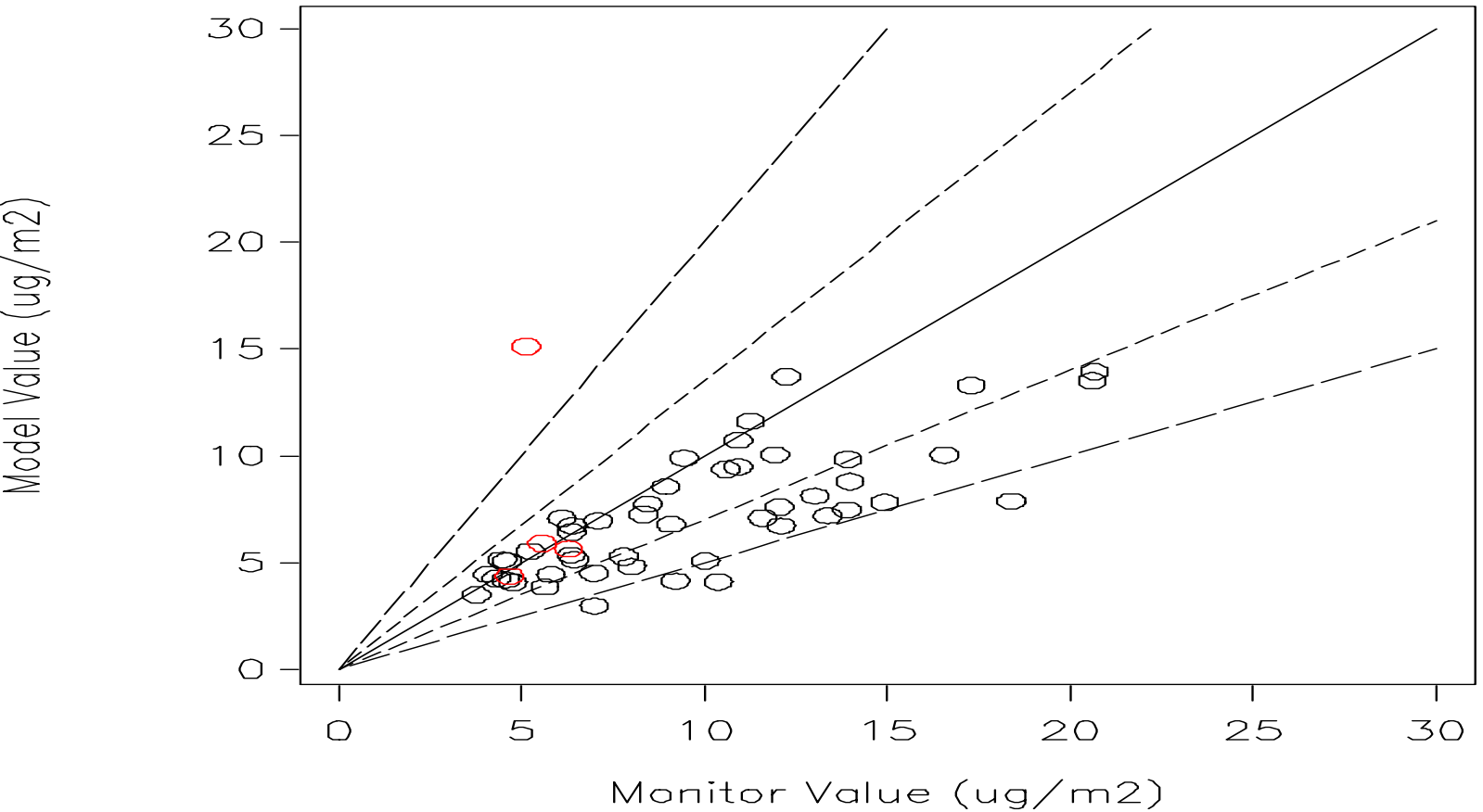
- 2001 Base Case
- 2001 Utility Mercury Emissions Zero-Out
- 2001 Boundary Condition Zero-Out
- 2020 with CAIR
- 2020 Utility Mercury Emissions Zero-Out
- 2020 with CAIR & CAMR



**Mercury Deposition Network
Sites Used in 2001 Analysis**

CMAQ 2001 Wet Hg Depositoion

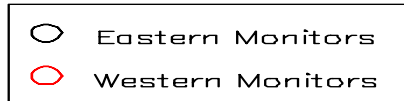
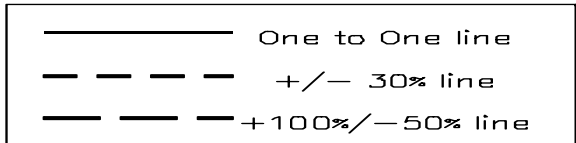
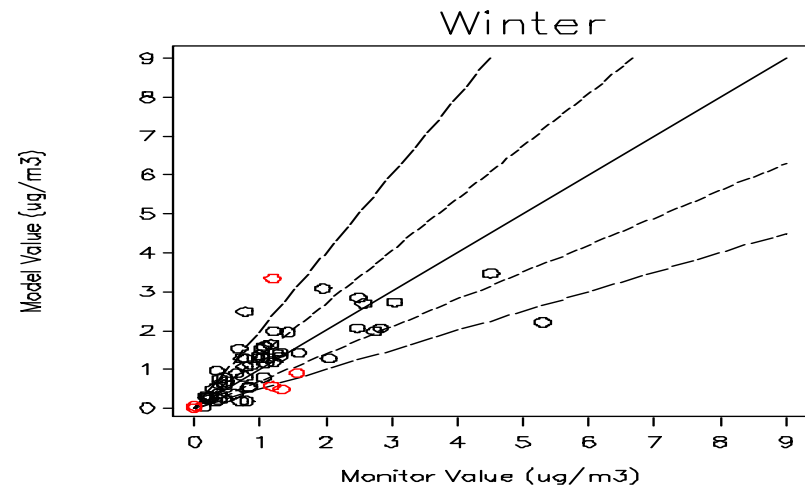
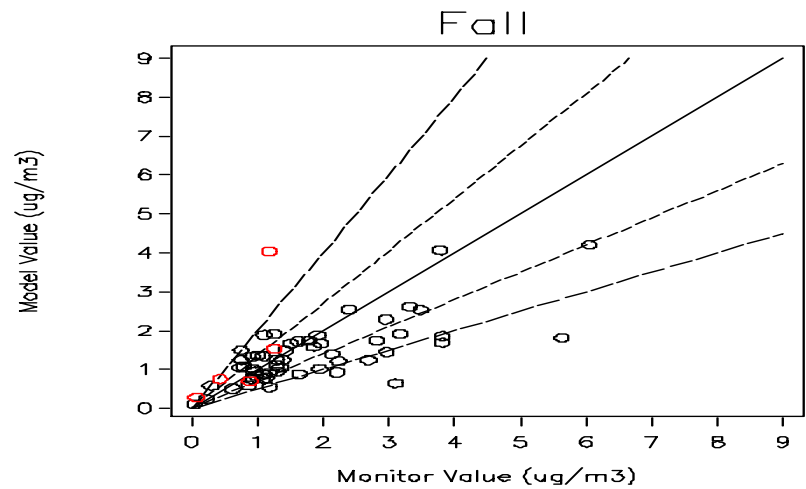
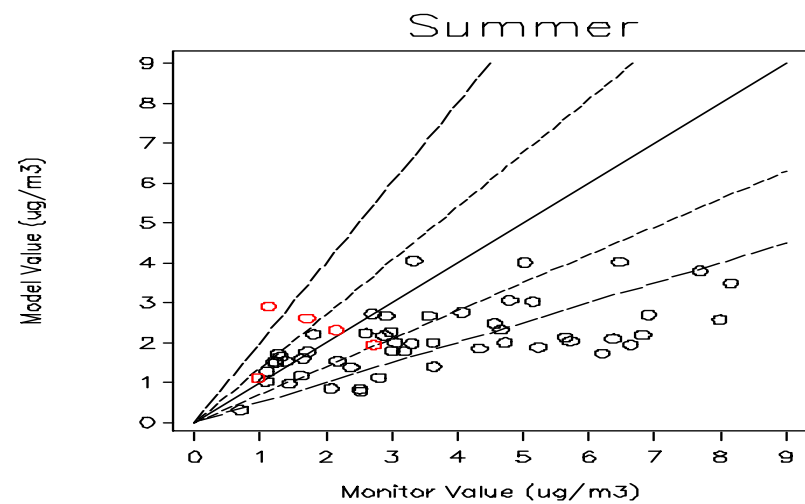
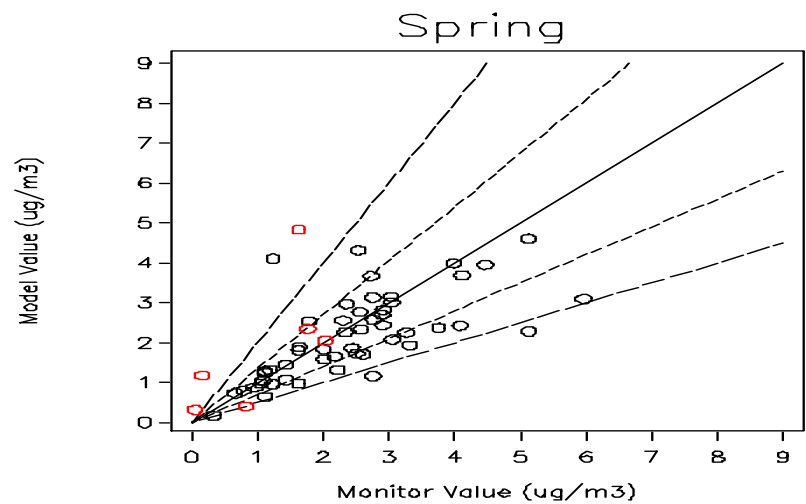
Annual Deposition



— One to One line
- - - +/- 30% line
- - - +100%/-50% line

○ Eastern Monitors
○ Western Monitors

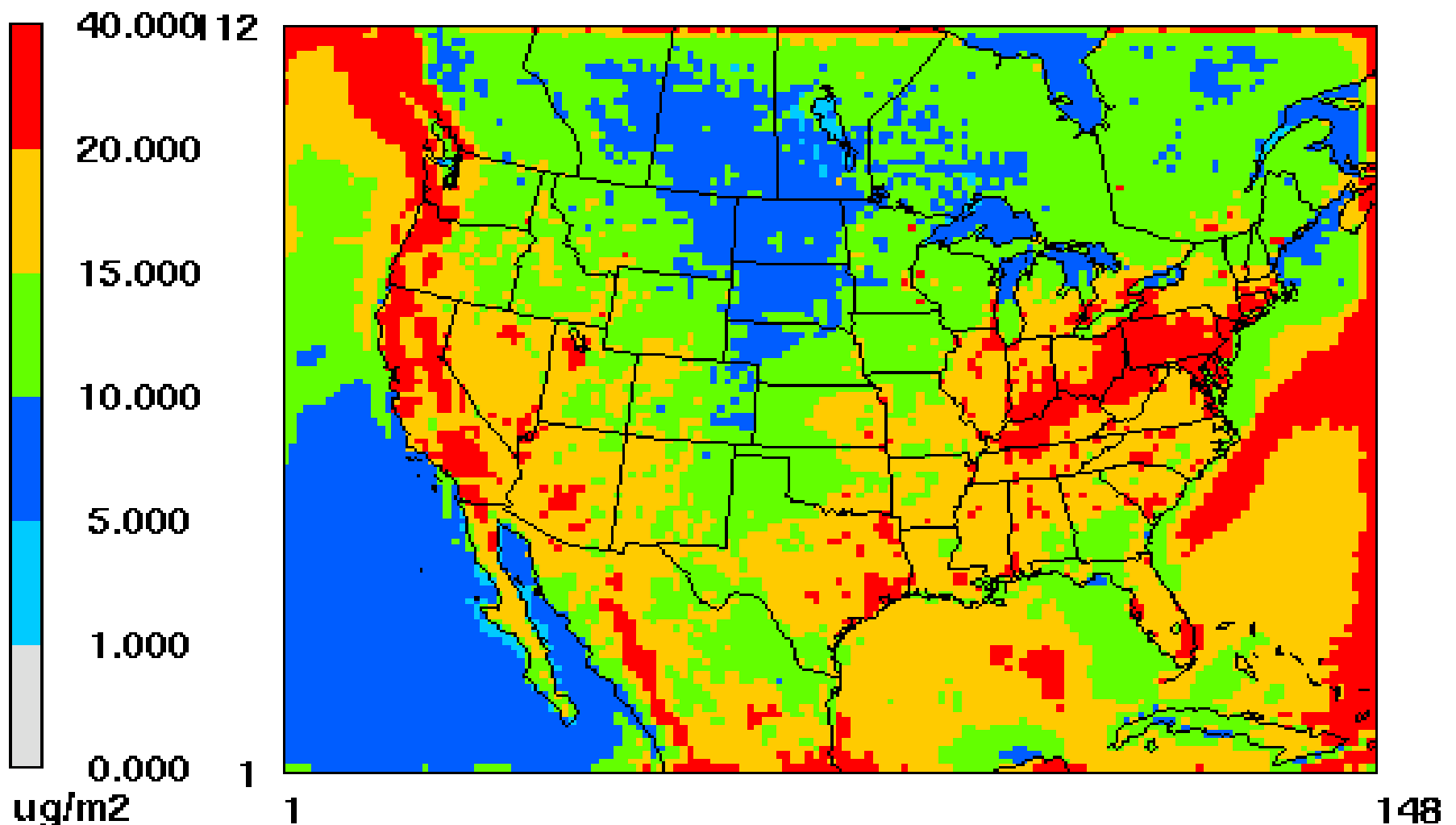
Wet Hg Depositions MDN vs. CMAQ



CMAQ 2001 Annual Mercury Wet Deposition Model Performance at MDN Sites in NE

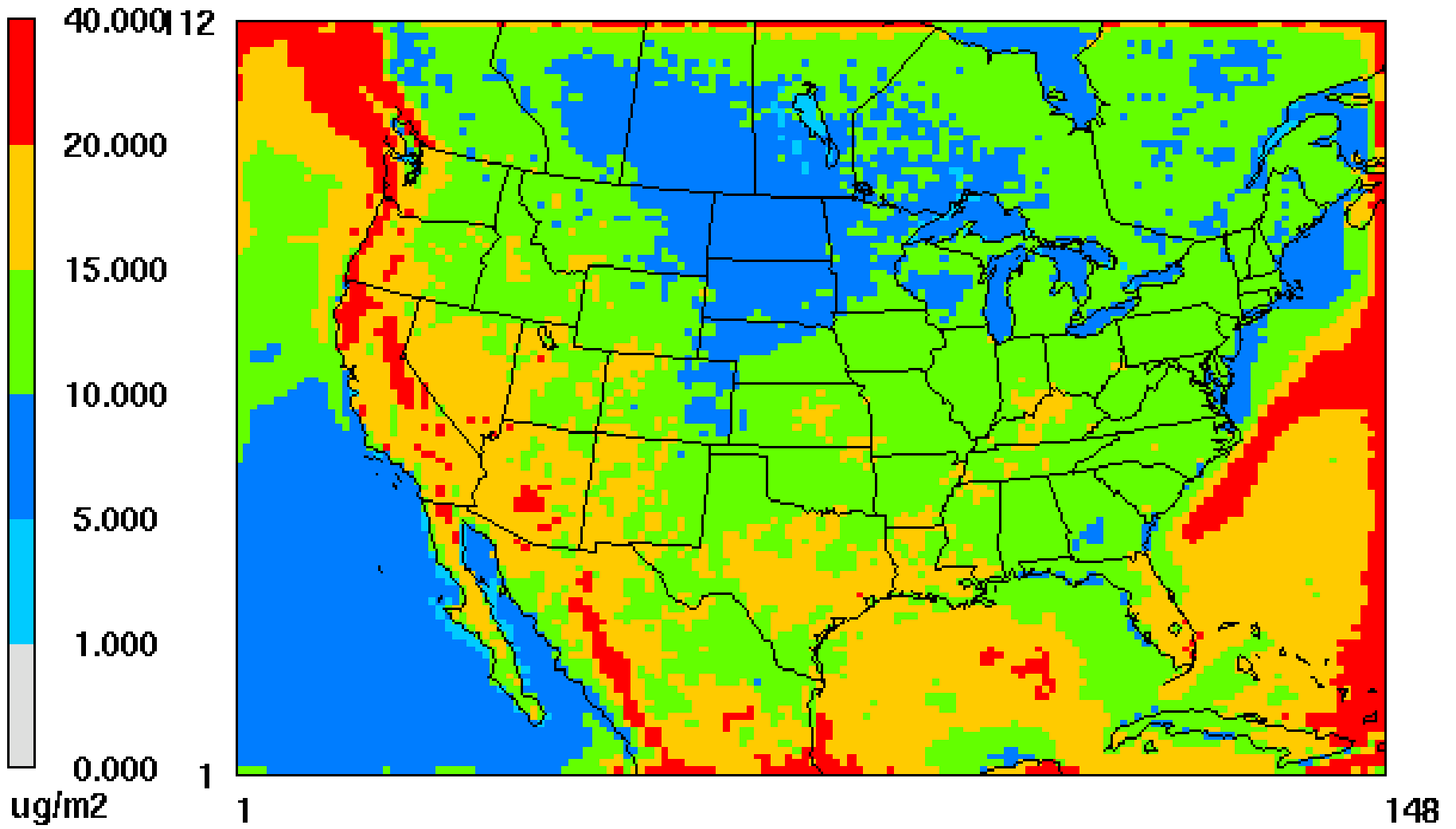
Site ID	Average Observed (ug/m ²)	Average Predicted (ug/m ²)
ME02	4.50	4.20
ME09	3.76	3.50
ME96	4.76	4.08
ME98	4.61	5.06
PQ04	5.24	5.55
PA72	8.33	7.26

Mercury Deposition From All Sources: 2001



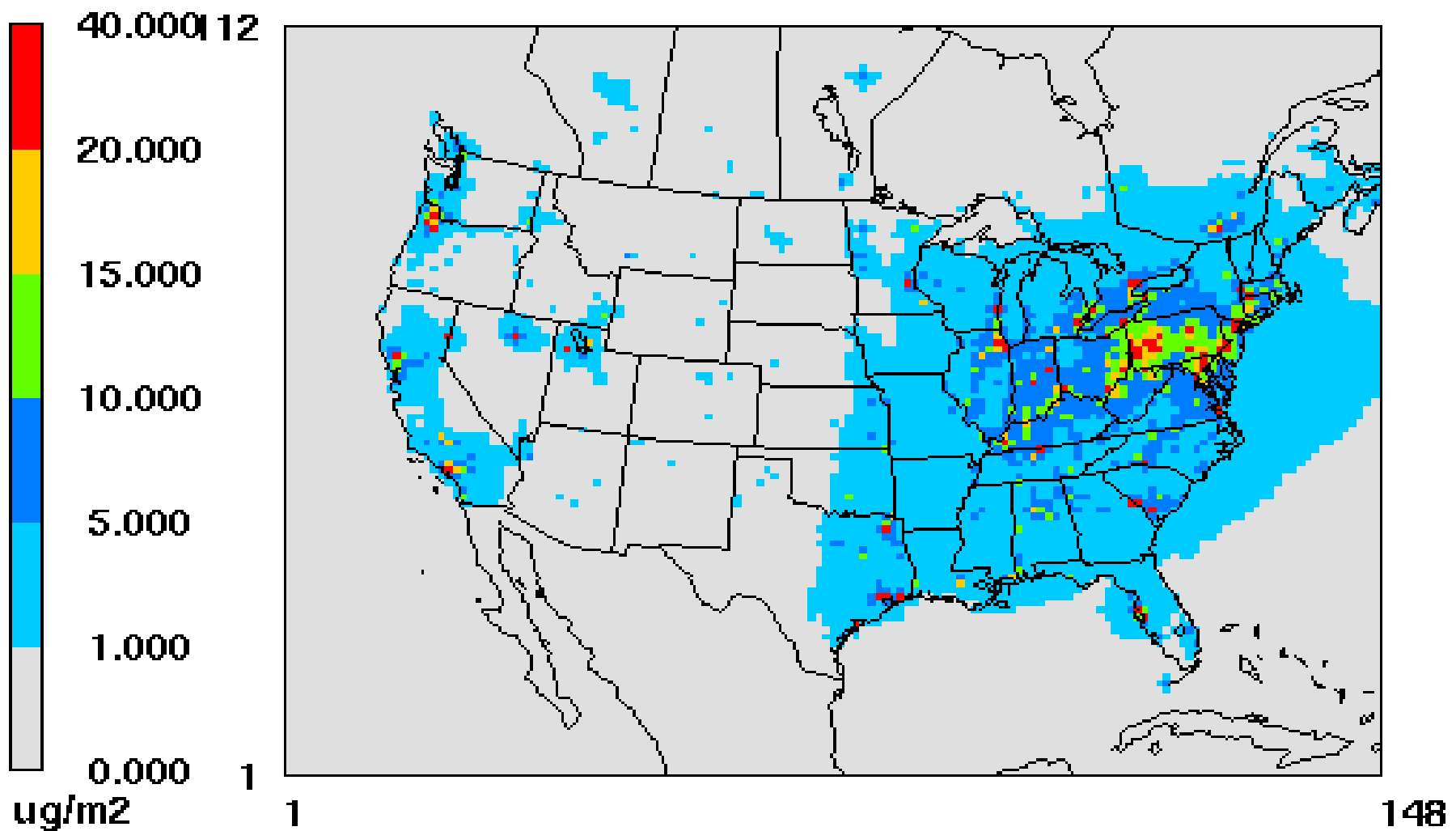
January 1, 0 0:00:00
Min= 3.348 at (33,19), Max= 133.229 at (21,84)

Mercury Deposition from Global Sources: 2001



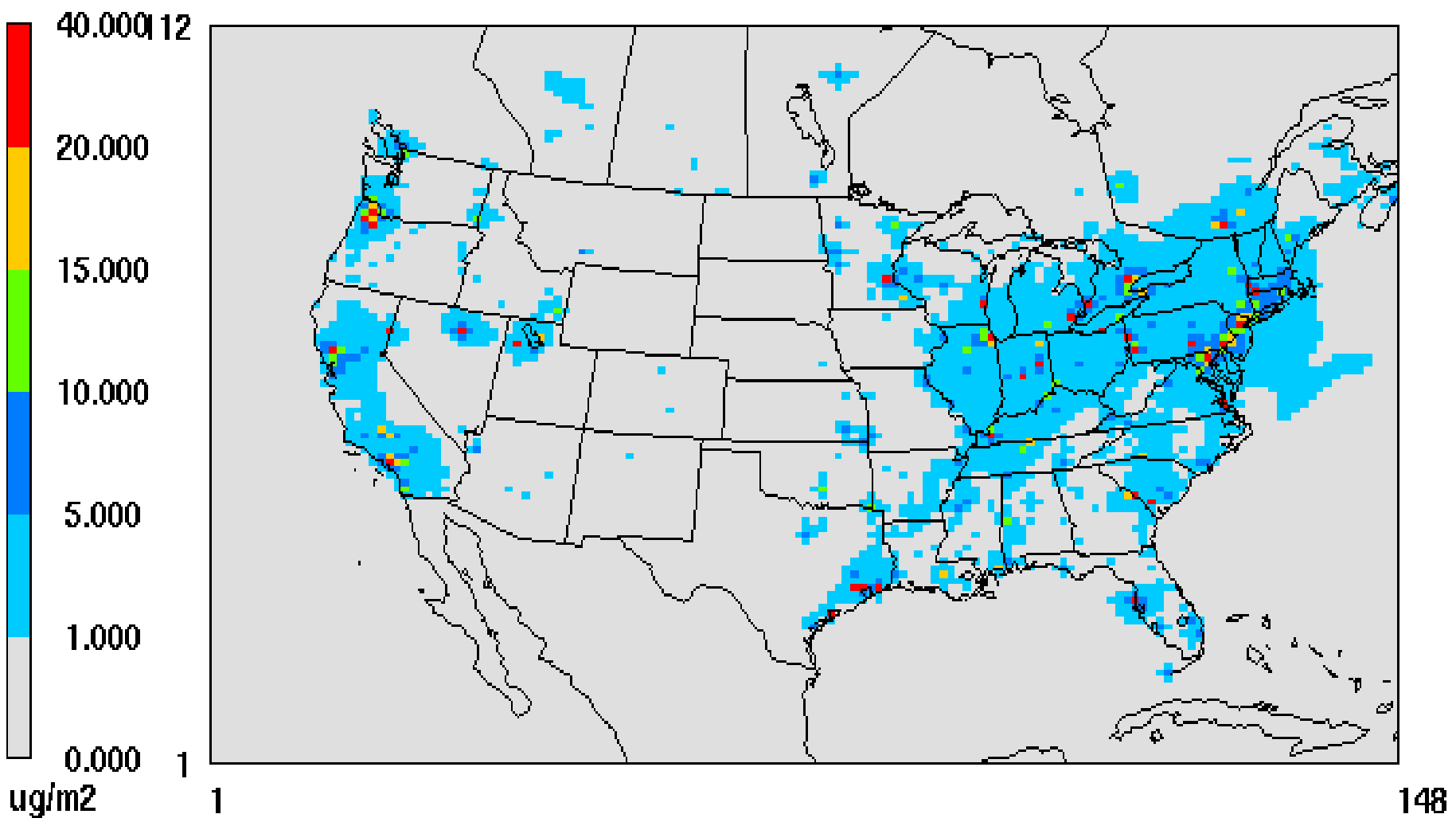
January 1, 0 0:00:00
Min= 2.904 at (23,92), Max= 42.726 at (148,62)

Mercury Deposition From All US and Canadian Sources: 2001



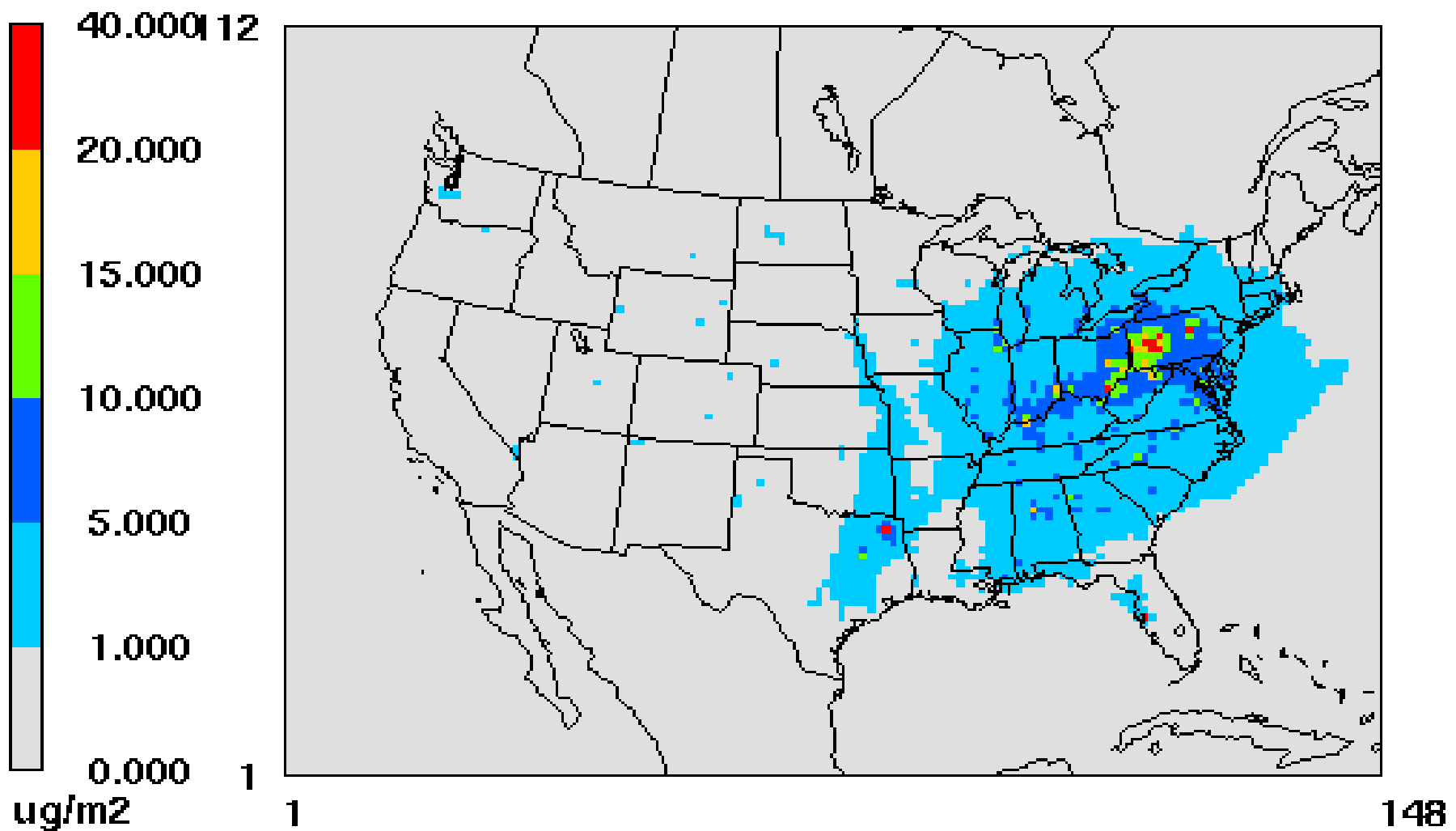
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Min= 0.002 at (148,1), Max= 114.476 at (21,84)

Mercury Deposition from Local (Non-US Power Plant) Sources: 2001



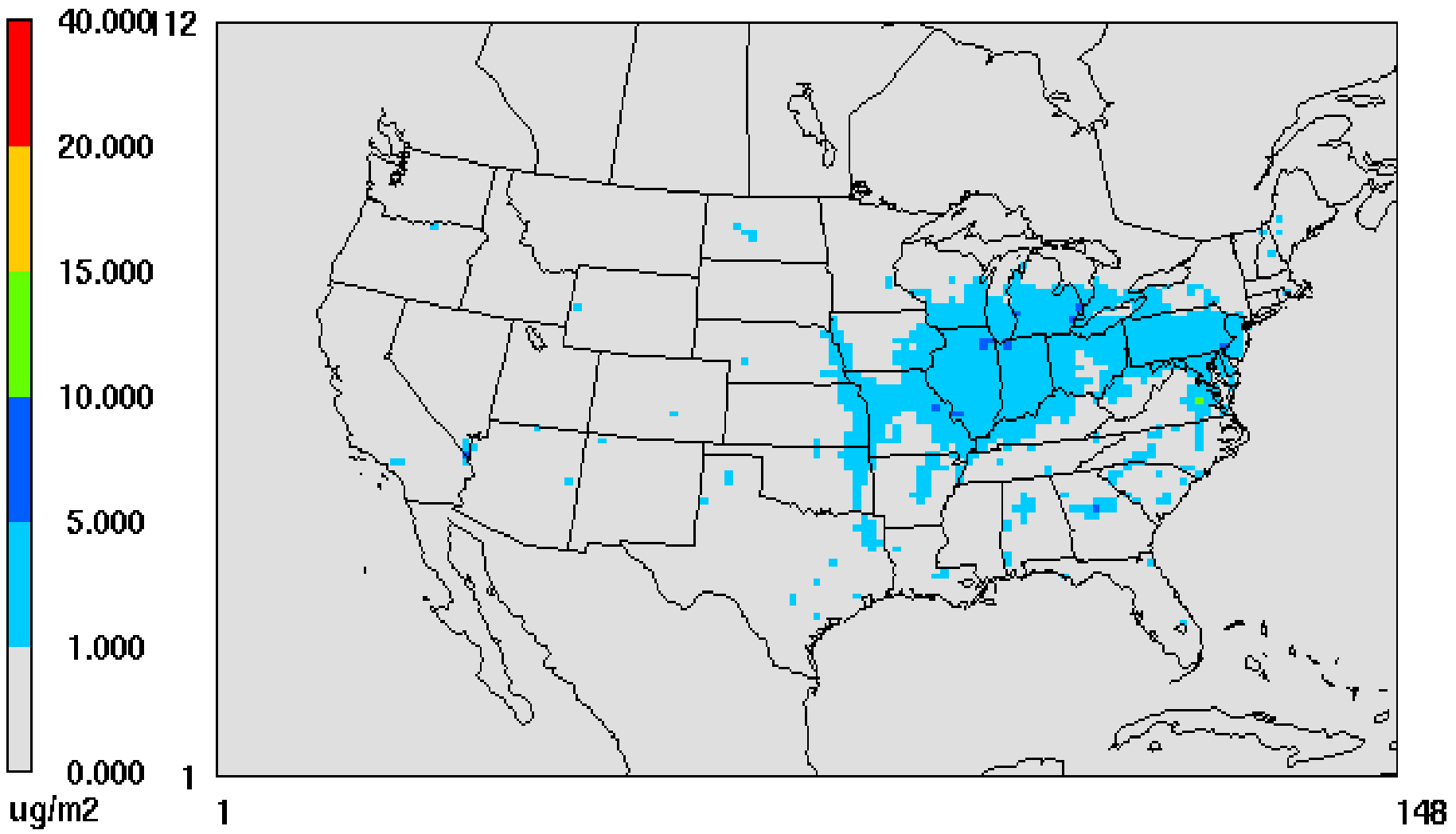
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Min= 0.001 at (148,1), Max= 114.301 at (21,84)

Mercury Deposition from US Power Plants: 2001



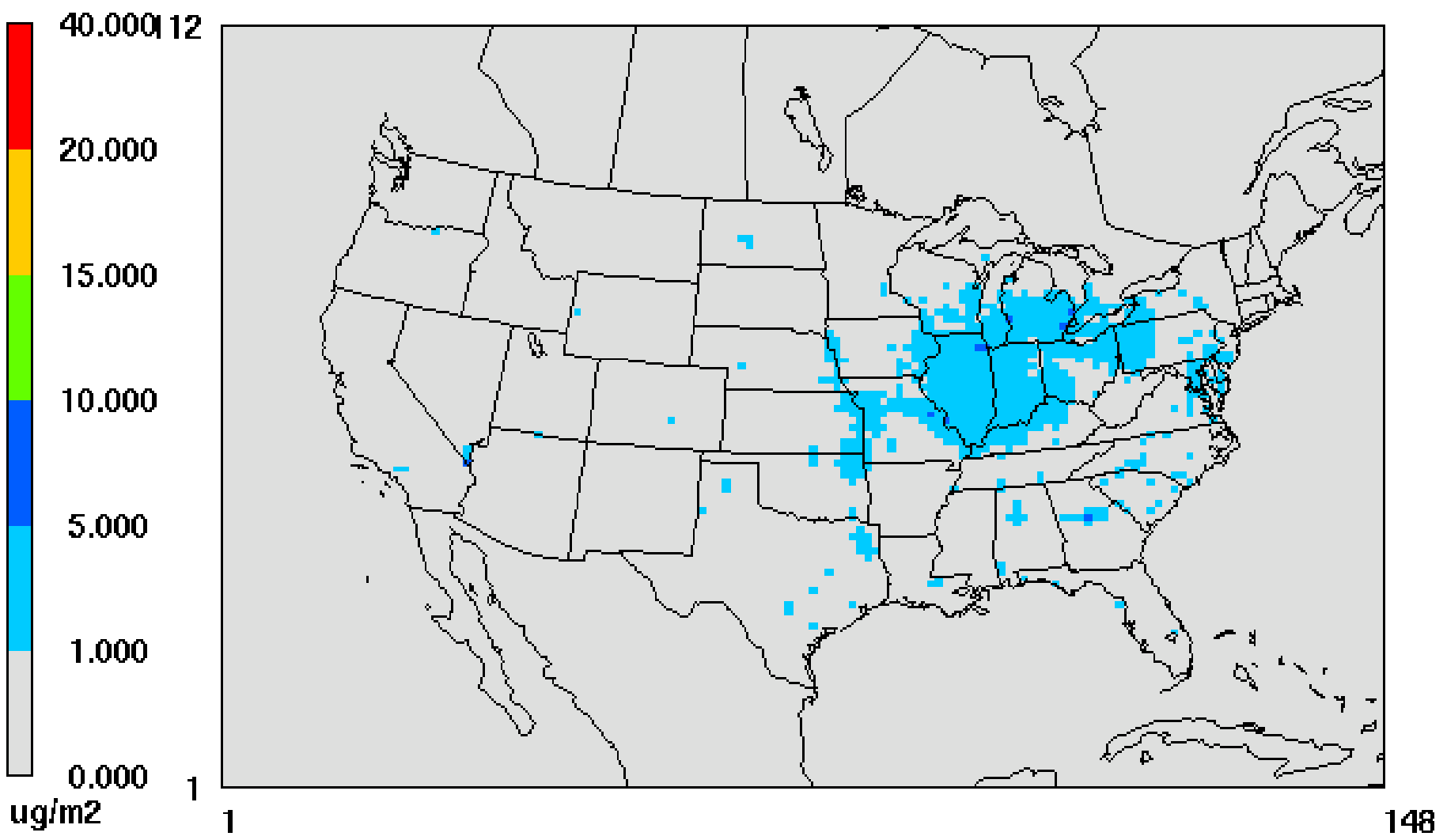
January 1, 0 0:00:00
Min= 0.000 at (1,88), Max= 33.589 at (118,64)

Mercury Deposition from US Power Plants: 2020 with CAIR



January 1, 0 0:00:00
Min= -0.000 at (145,1), Max= 11.806 at (124,56)

Mercury Deposition from US Power Plants: 2020 with CAIR & CAMR



January 1, 0 0:00:00
Min= -0.010 at (24,67), Max= 8.297 at (98,65)

Limitation of the Modeling Analysis

- There is not a dry deposition monitoring network in which to compare model predictions
- There is considerable uncertainty about mercury atmospheric chemistry
- Mobile, natural and re-emitted mercury emissions were not included in the CMAQ modeling domain
- Grid squares were 36 km on a side
- There is uncertainty in global emissions