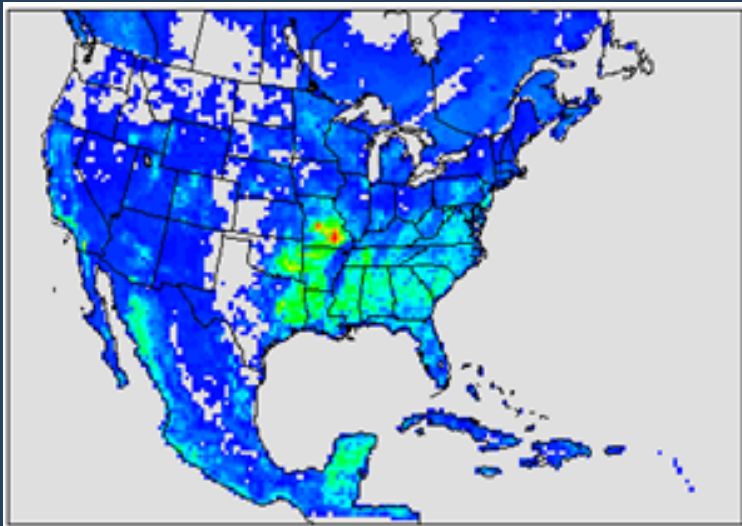


Florida Mercury TMDL Project

Atmospheric Modeling



Annual Stakeholders' Meeting
Tallahassee, Florida
January 04, 2011

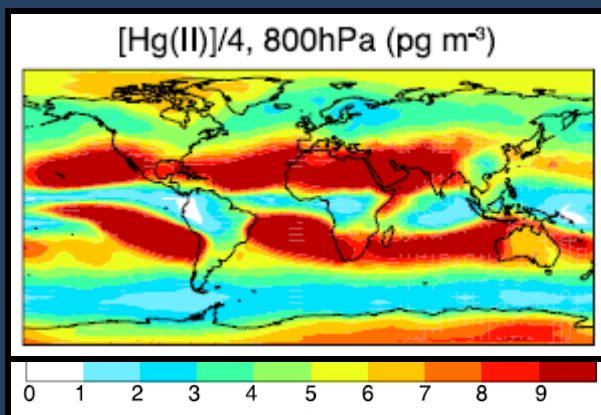
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Overview

- Goals of the overall modeling effort:
 - Provide speciated wet and dry loading estimates of mercury and other species of interest for TMDL eco-regions and basins across the State of Florida for Calendar Year 2009.
 - Provide a measure of source attribution, that is, relative importance of in-state versus out of state emissions for TMDL eco-regions and basins.
 - Provide a measure of potential reduction in atmospheric loadings resulting from future emission reduction scenarios.

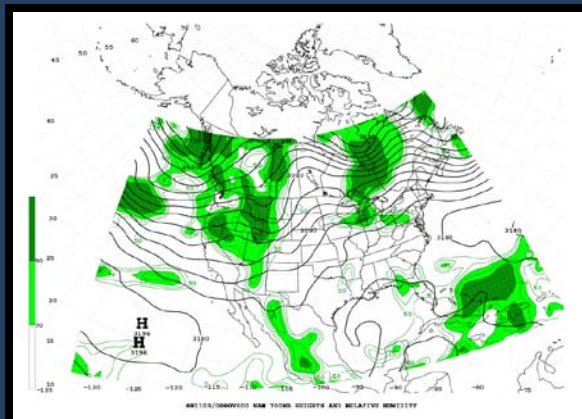


Global Chemical Model (ECHMERIT)



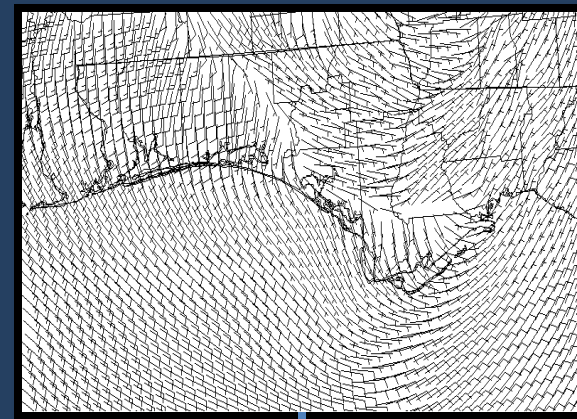
**Initial and
Boundary Conditions**

Regional Meteorological Model (WRF)

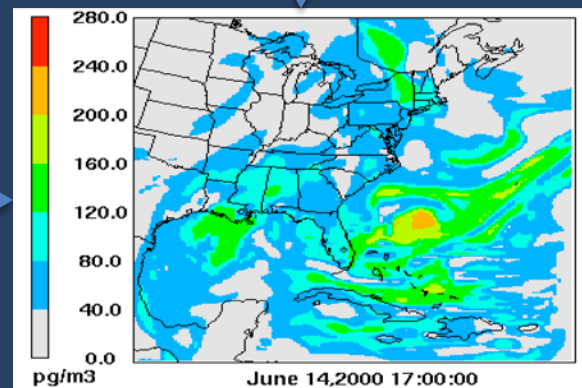


**Regional Thermodynamic
and Wind Fields**

WRF Nested Domain



**Local Thermodynamic
and Wind Fields**



**Regional Chemical Transport Model
(CMAQ)**

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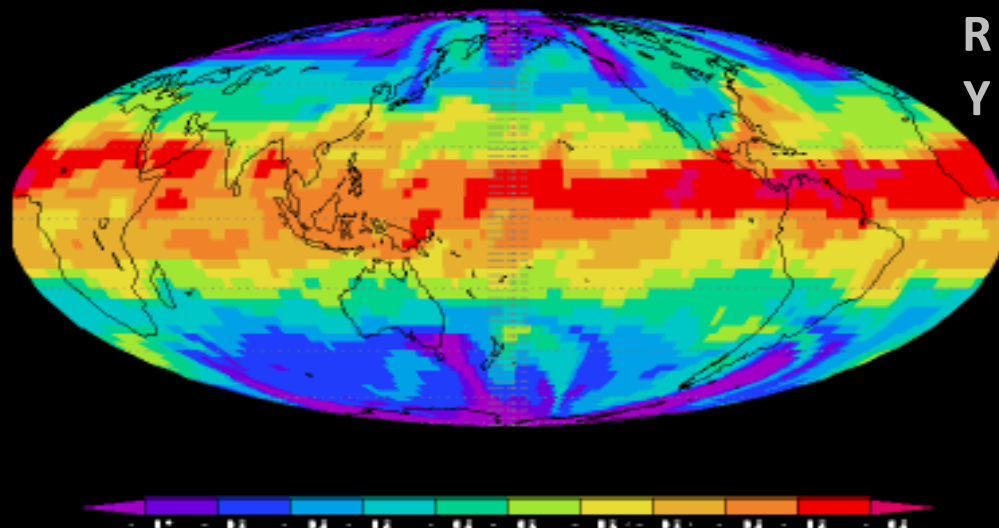
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ECHMERIT an online coupled Hg model

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Gerlinde Jung
Ian M. Hedgecock
Nicola Pirrone



C.N.R. Institute for Atmospheric Pollution, Division of Rende, Italy
<http://www.cs.iaa.cnr.it/>



Jung et al. (2009) in Geoscientific Model Development Discuss., 2, 385–453

Preliminary Results

Model setup

- Horizontal resolution: T42 (2.81 degrees)
- Vertical resolution: 19 layers
- Lower boundary: AMIP monthly mean SST
- ECMWF reanalysis data for nudging of meteorological fields



ECHMERIT – Global Chemical Modeling

- Emissions Inputs:
 - AMAP (Arctic Monitoring and Assessment Program) 2000 Mercury inventory
 - National estimates of annual anthropogenic mercury
 - » Inventory for US was replaced with that from USEPA 2005 National Emissions Inventory
 - Precursors of Ozone and their Effects in the Troposphere (POET) emissions inventory
 - Global emissions of gases (ozone precursors, including CO) from anthropogenic, natural, and biomass burning sources.
 - GEIAv1 (Global Emissions Inventory Activity)
 - Global estimates of all other anthropogenic, natural and biomass burning emission on a one degree grid for the entire world

ECHMERIT – Global Chemical Modeling

- Emissions Inputs:
 - Mercury: Natural emissions
 - Global emissions of mercury from oceans, biosphere and soils
 - Emissions were scaled with CO emissions, the latter of which were obtained from the POET emissions inventory described above.
 - Mercury: Biomass burning emissions
 - Emissions algorithm for estimation of mercury from global biomass burning
 - Friedli et al. (2009)

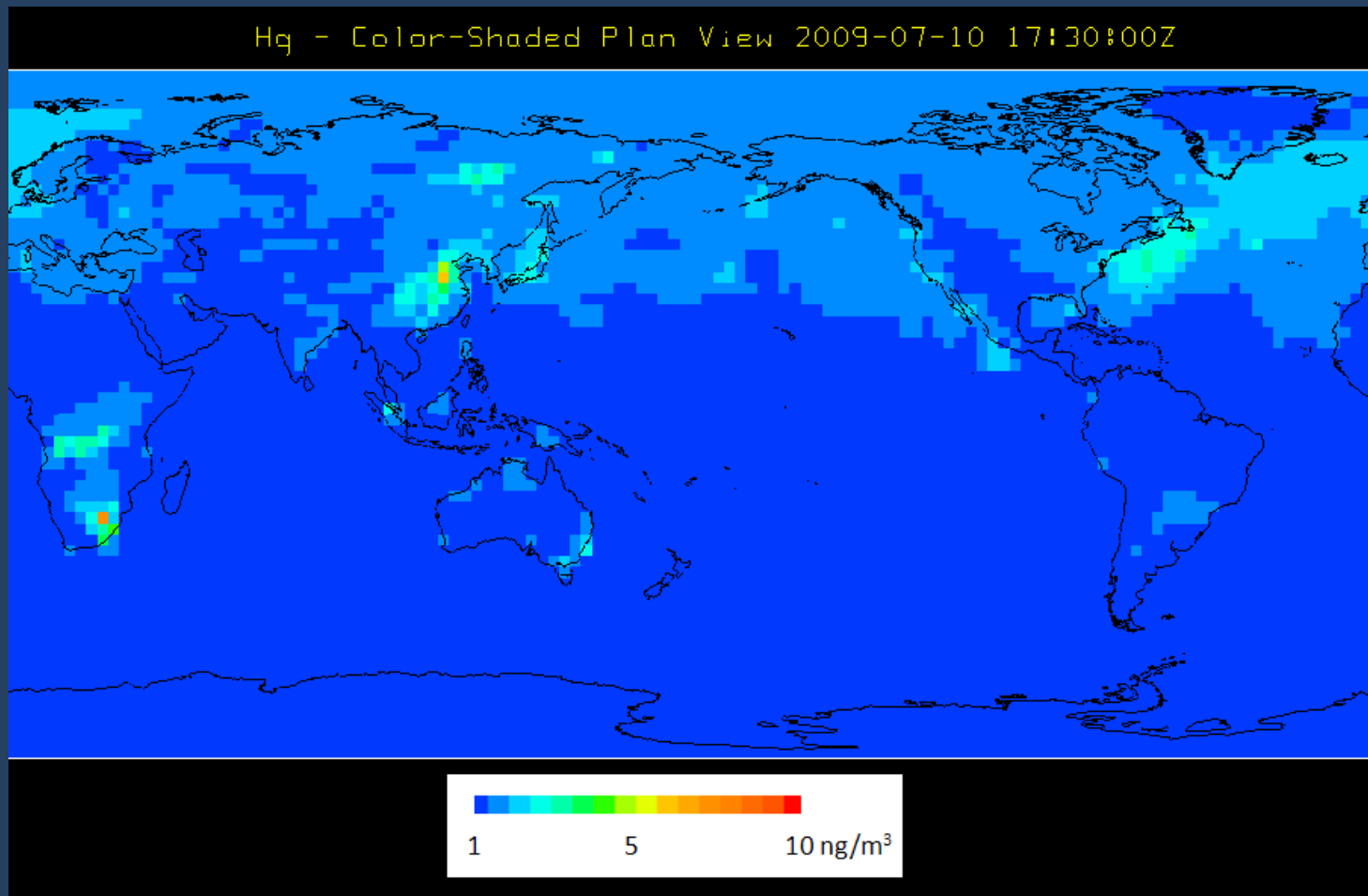
ECHMERIT – Global Chemical Modeling

- Three-year [2006-2008] model “spin-up” performed
 - Allow thermodynamic and ambient chemical fields to come to equilibrium
- Global chemistry simulations were performed for CY2009.
 - Output provided in six-hour time steps.
 - Output is currently undergoing quality assurance review

ECHMERIT – Global Chemical Modeling

Surface Level Ambient Hg(0) Concentrations

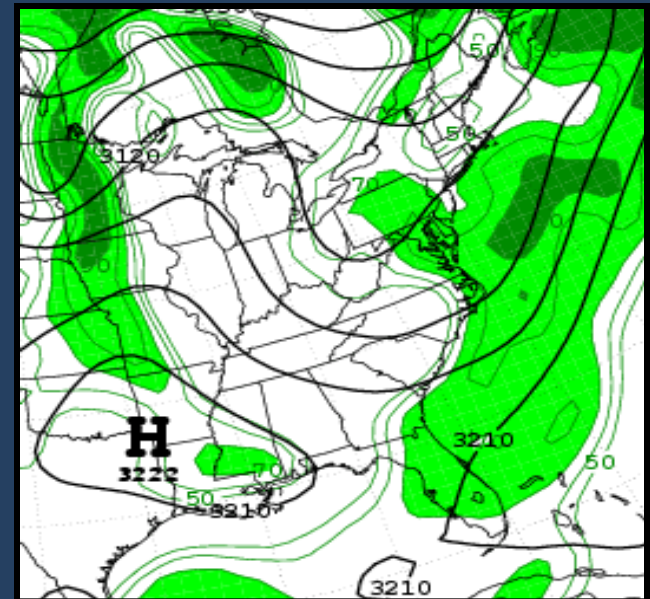
- Example of model output from July 10, 2009



Preliminary data: Do not cite or quote.

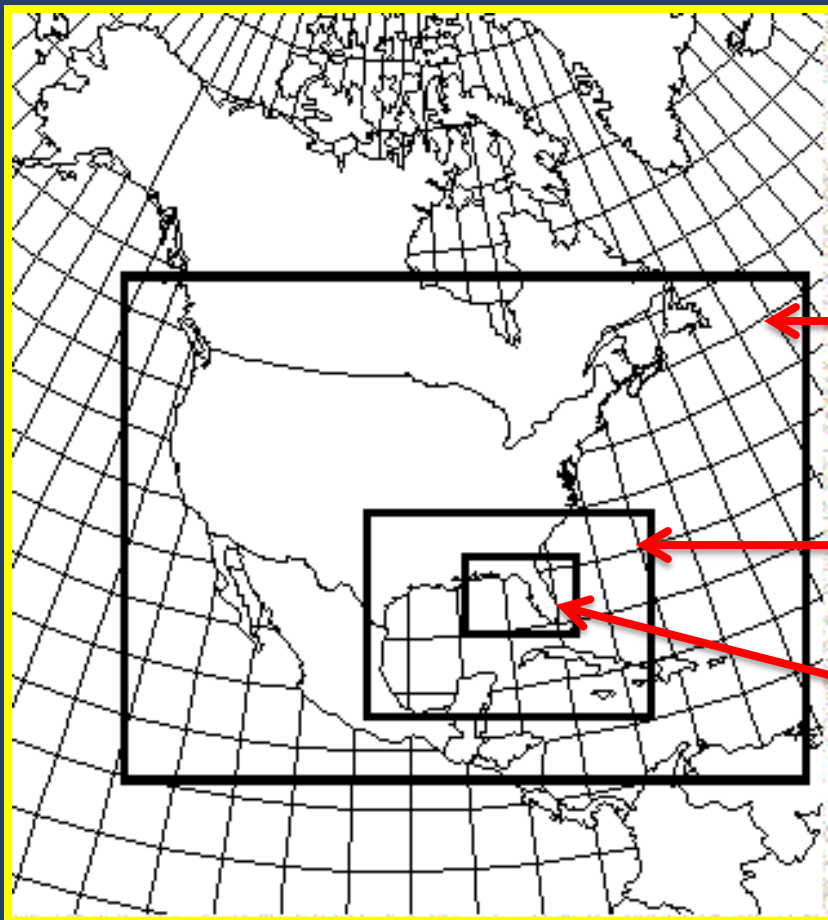
Regional Meteorological Model

- Weather Research and Forecasting (WRF) Model
 - WRF is maintained and supported as a community model to facilitate wide use internationally, for research, operations, and teaching.
 - It is suitable for a broad span of applications across scales ranging from mesoscale to global-scale simulations.
 - Highly adaptable to different configurations:
 - Microphysics
 - Cumulus parameterization
 - Land surface characteristics
 - Planetary Boundary layer scheme
 - Atmospheric Radiation Scheme



Regional Meteorological Model

- Weather Research & Forecasting (WRF) Model



36 km Hemispheric Grid

12 km Regional Grid

4 km Regional Grid

WRF Meteorological Modeling

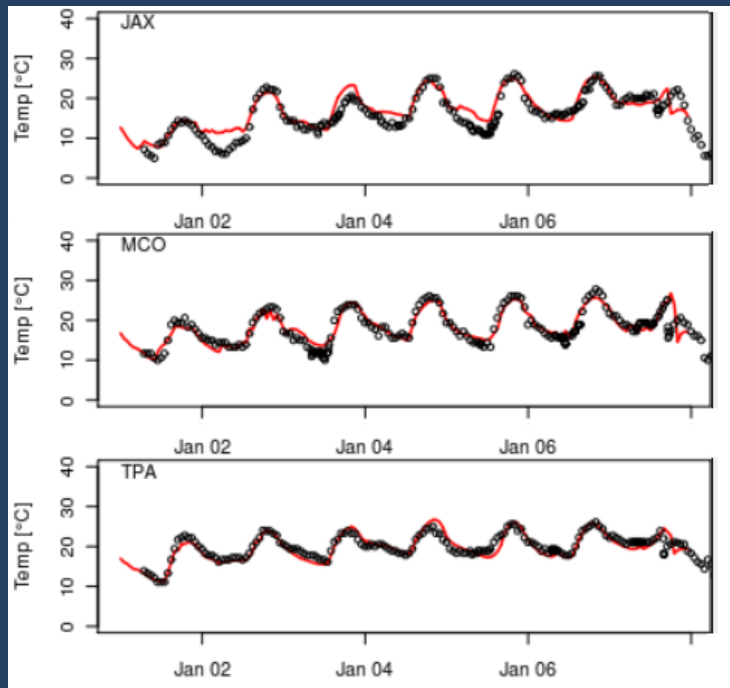
- As part of TMDL study, WRF model was utilized in selection of supplemental sampling sites for Summer 2009/2010 measurement intensives.

WRF Meteorological Modeling Milestones

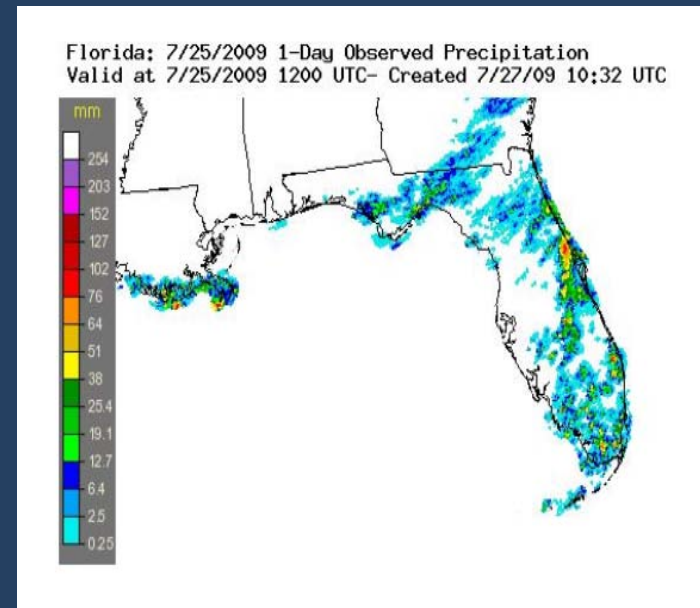
- Have completed meteorological modeling for CY2009.
 - Input data used: NCEP Global Tropospheric Analysis
- Currently performing data evaluation activities on WRF model output.

Evaluation of WRF Simulations

- Examples: Temperature and precipitation distribution/magnitude



— Model
○ Observations



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Preliminary data: Do not cite or quote.

Rainfall

Climatological Averages (1971-2000) vs 2009

PENSACOLA													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971-2000	5.33	4.65	6.4	3.88	4.4	6.39	8.09	6.72	5.75	4.38	4.46	3.97	64.43
2009	1.49	4.41	7.38	4.84	10.72	5.21	5.32	8.86	10.19	11.28	4.85	13.75	88.3
JACKSONVILLE													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971-2000	3.69	3.14	3.93	3.14	3.48	5.36	5.97	6.87	7.9	3.86	2.33	2.64	52.33
2009	3.01	0.98	4.79	5.9	13.51	3.24	5.49	7.05	6.48	2.02	0.85	5.88	59.2
ORLANDO													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average	2.46	2.35	3.58	2.36	3.75	7.37	7.24	6.31	5.91	2.81	2.39	2.31	48.85
2009	2.08	0.62	0.48	1.06	14.56	8.05	6.05	4.74	4.58	2.85	1.02	5.39	51.48
TAMPA													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971-2000	2.27	2.67	2.84	1.8	2.85	5.5	6.49	7.6	6.54	2.29	1.62	2.3	44.77
2009	2.38	0.71	0.98	1.22	9.11	5.1	10.23	3.52	5.24	2.24	2.82	2.32	45.87
FT LAUDERDALE													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971-2000	2.94	2.7	2.8	3.91	6.33	10.01	6.7	6.88	8.26	6.44	4.57	2.65	64.18
2009	0.35	0.33	7.08	0.73	11.24	7.87	10.11	8.17	8.22	2.95	4.63	3.48	65.16

Regional Transport and Fate Model

- Community Multi-scale Air Quality (CMAQ) Model
 - Bullock, O.R. and K. A. Brehme (2002)
 - The model includes the transport, photochemistry and atmospheric deposition (both wet and dry) of major gas and aerosol species.
 - Version being used for TMDL: CMAQ v4.7.1
 - 50 vertical layers
 - CB05 Chemical Mechanism
 - Considering both criteria air pollutants (CAPs) and hazardous air pollutants (HAPs)

Regional Transport and Fate Model

- Model simulation period: CY2009
- BASE CASE modeling will employ tagging of mercury species
 - Tag #1: Florida Sources
 - Tag #2: Regional Sources

Alabama

Arkansas

Georgia

Louisiana

Mississippi

North Carolina

South Carolina

Tennessee

Texas

Regional Transport and Fate Model

- Modeling updates
 - Examples:
 - CMAQ soil type classification corrected to match classifications utilized by WRF (i.e., USGS classification)
 - Minor changes to stabilize the model simulation
 - » Ex: Modification to avoid “division by zero” when LAI=0 (over water)

Regional Transport and Fate Model

- Regional Chemical Modeling Emissions Inventory
 - USEPA 2005 National Emissions Inventory
 - Includes Canada and Mexico
 - Inventory for Florida has been updated for 2009 by:
 - Removal of major point sources no longer in operation for CY2009
 - Addition of major point sources which were started up between CY2005 and CY2009
 - Update of total mercury emissions for major point sources provided by FDEP Division of Air Resource Management
 - Cement Kilns
 - Medical Waste Incinerators
 - Municipal Waste Combustors

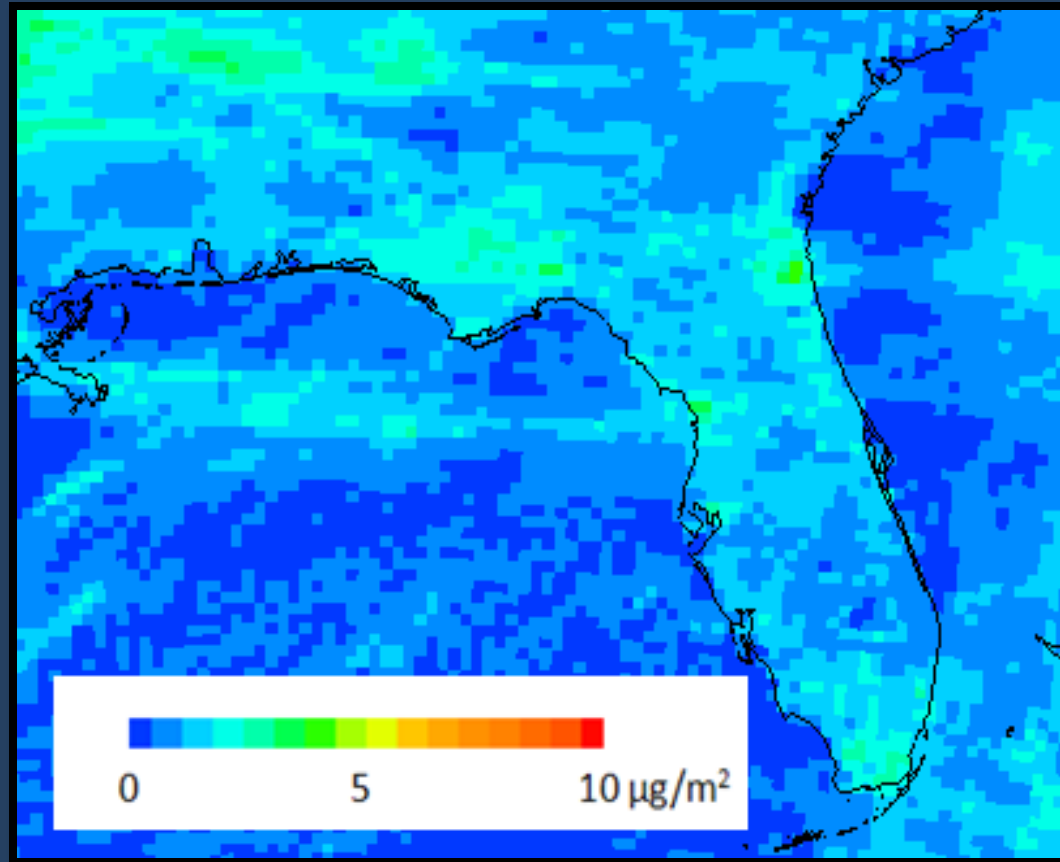
Regional Transport and Fate Model

- Regional Chemical Modeling Emissions Inventory
 - Additional inventory updates:
 - Finalizing update of stack parameters for EGUs
 - Utilization of updated speciation profiles for coal fired EGUs
 - EPRI algorithm
 - Incorporated into files provided by Krish Vijayaraghavan
 - Utilization of CEMS data for CY2009 for 4km domain
 - Provides description of daily emissions activity

Regional Transport and Fate Modeling

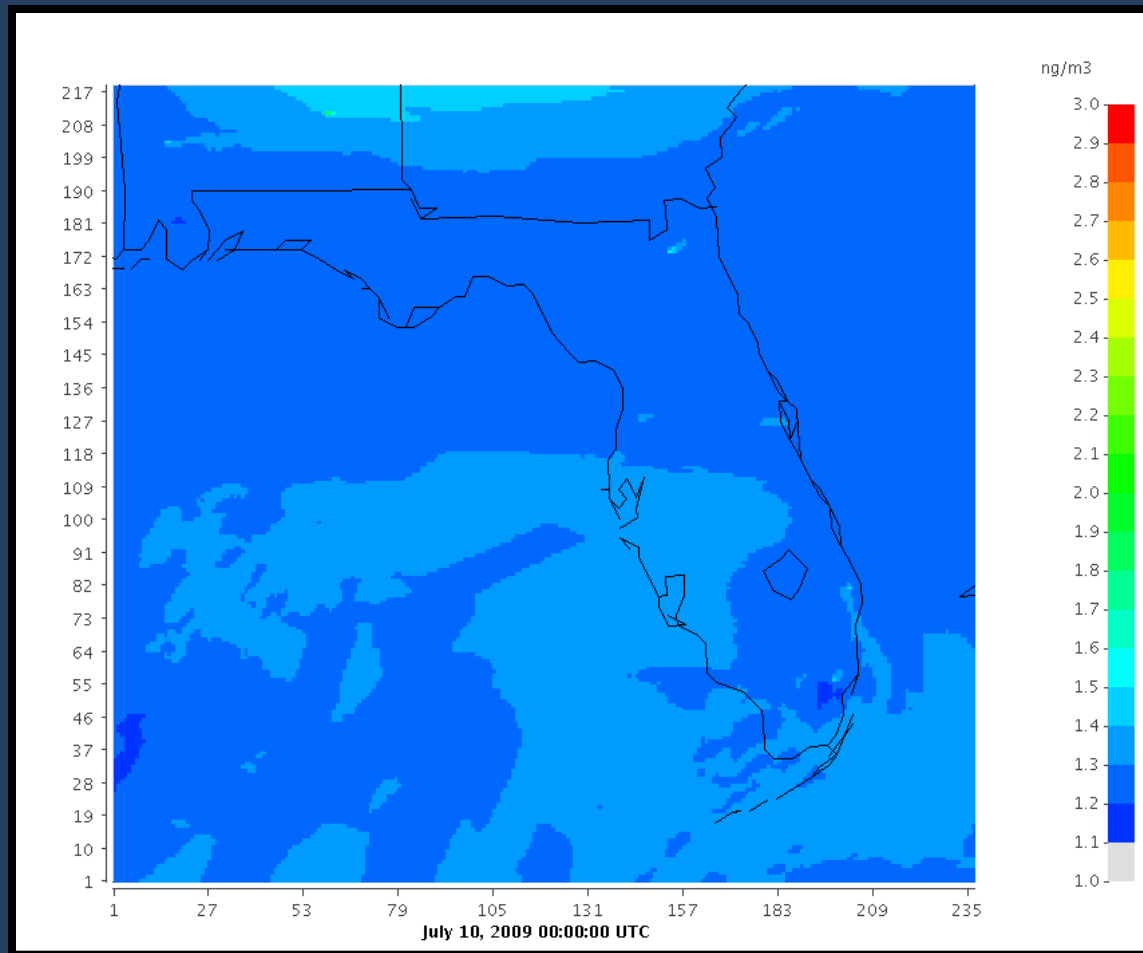
- Currently performing model evaluation for period July 4 to July 30th, 2009.
 - Comparison with data collected during 2009 Summer Intensives
- Example of evaluations:
 - Comparison of modeled vs. observed monthly wet- and dry-deposition measurements
 - Comparison of modeled vs. measured ambient concentrations.
- Goal of evaluations:
 - Assessment of potential errors in emissions inventory
 - Assessment of potential model biases

Modeled Wet Deposition of Total Mercury ($\mu\text{g}/\text{m}^2$) July 4-29, 2009 – From Current Evaluation Simulation



Preliminary data: Do not cite or quote.

CMAQ Modeled Surface Gaseous Elemental Mercury 0000 UTC 10 July 2009



Preliminary data: Do not cite or quote.

Summary

- Atmospheric modeling:
 - Modeling being performed for CY 2009
 - Global
 - Regional
 - Assessment of the magnitude and spatial distribution of speciated wet- and dry-atmospheric loadings of mercury to TMDL eco-regions and basins
 - Provide basic source attribution through tagging exercise
 - Provide statewide atmospheric depositional loading estimates for mercury for use as input into aquatic modeling portion of TMDL study