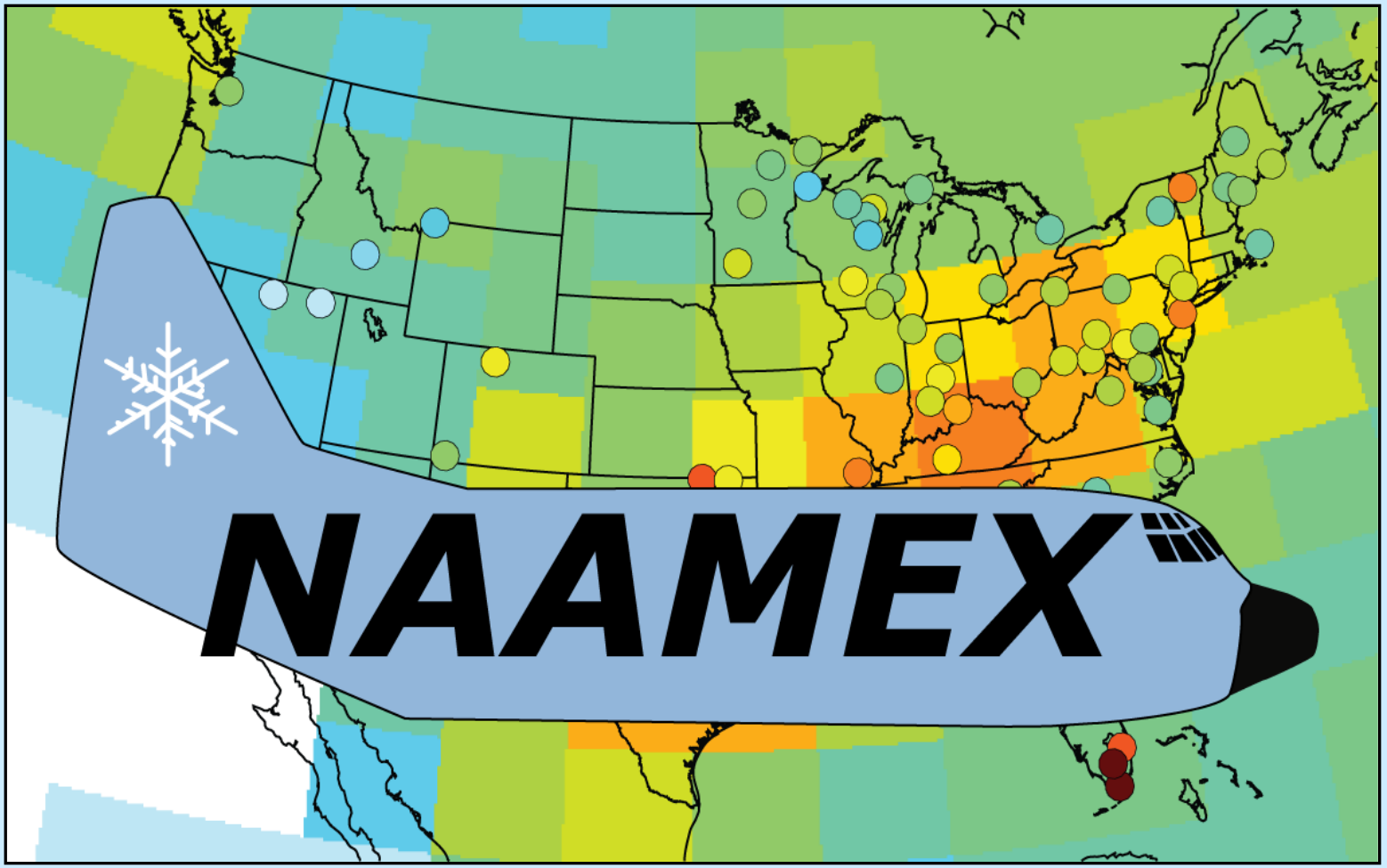
North American Airborne Mercury Experiment (NAAMEX)
Southern Oxidant and Aerosol Study (SOAS)
Re-NOx-ification Pathway in the Troposphere (TROPHONO)



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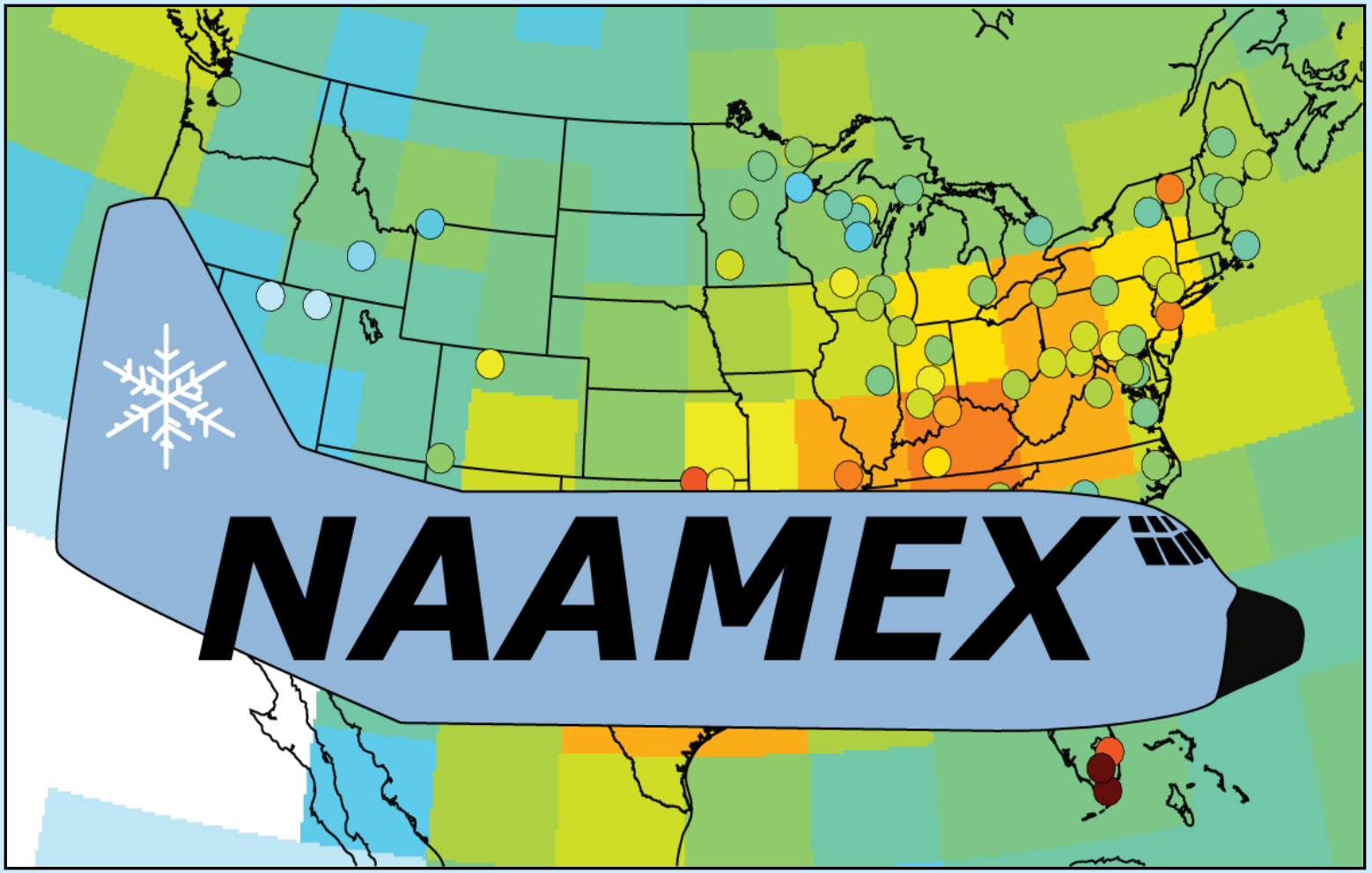
Nitrogen, Oxidants, Mercury and Aerosol Distributions, Sources and Sinks (NOMADSS)



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NAAMEX

- Mercury is an important environmental toxin. New rules on coal fired pp will cost ~2 billion $US per year when fully implemented. Yet there are large uncertainties in our understanding of the global sources and cycling of Hg.
- In past 10 years we have extensive observations of Asian Hg outflow, but almost none from US source region.
- NAAMEX follows on the successful WAMO project, which was a much smaller effort focused on validation of our airborne Hg measurement capabilities.

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Past UW/MIT work on atmospheric Hg

- Observations at Okinawa Japan and Mt. Bachelor to quantify large Asian emissions (Jaffe et al 2005; Chand et 2008);
- Observations at Mt. Bachelor identifying long-range transport of Asian Hg to North America (Weiss-Pezias et al 2006;2007);
- Use of GEOS-CHEM model to interpret observations and to constrain the Asian emissions (Selin et al 2007; Strode et al 2007; 2008)
- Identification of Hg^{+2} reservoir in the free troposphere at Mt. Bachelor (Swartzendruber et al 2006);
- Evaluation of existing methods and development of new methods to measure atmospheric Hg (Swartzendruber et al 2008; 2009; Lyman et al 2010).
- Coupling of global GEOS-CHEM model to nested grid and ocean models (Strode et al 2010; Zhang et al 2011).
- First observations of RGM in UT/LS (Lyman and Jaffe 2011);
- Identification of new sources of RGM in the free trop (Timonen et al 2012)
- Development of new measurement and calibration methods for Hg^{+2} (Ambrose et al 2012; Finley et al 2012).

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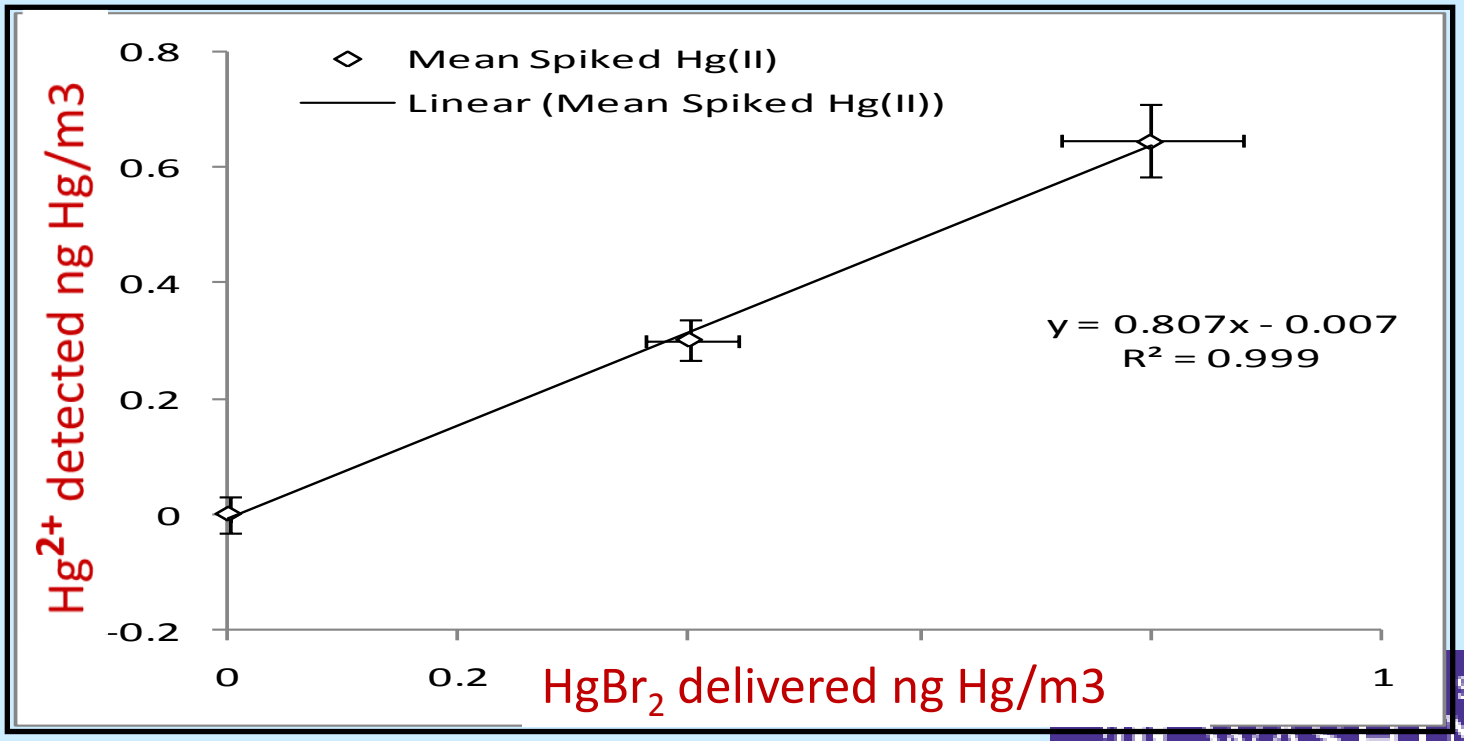
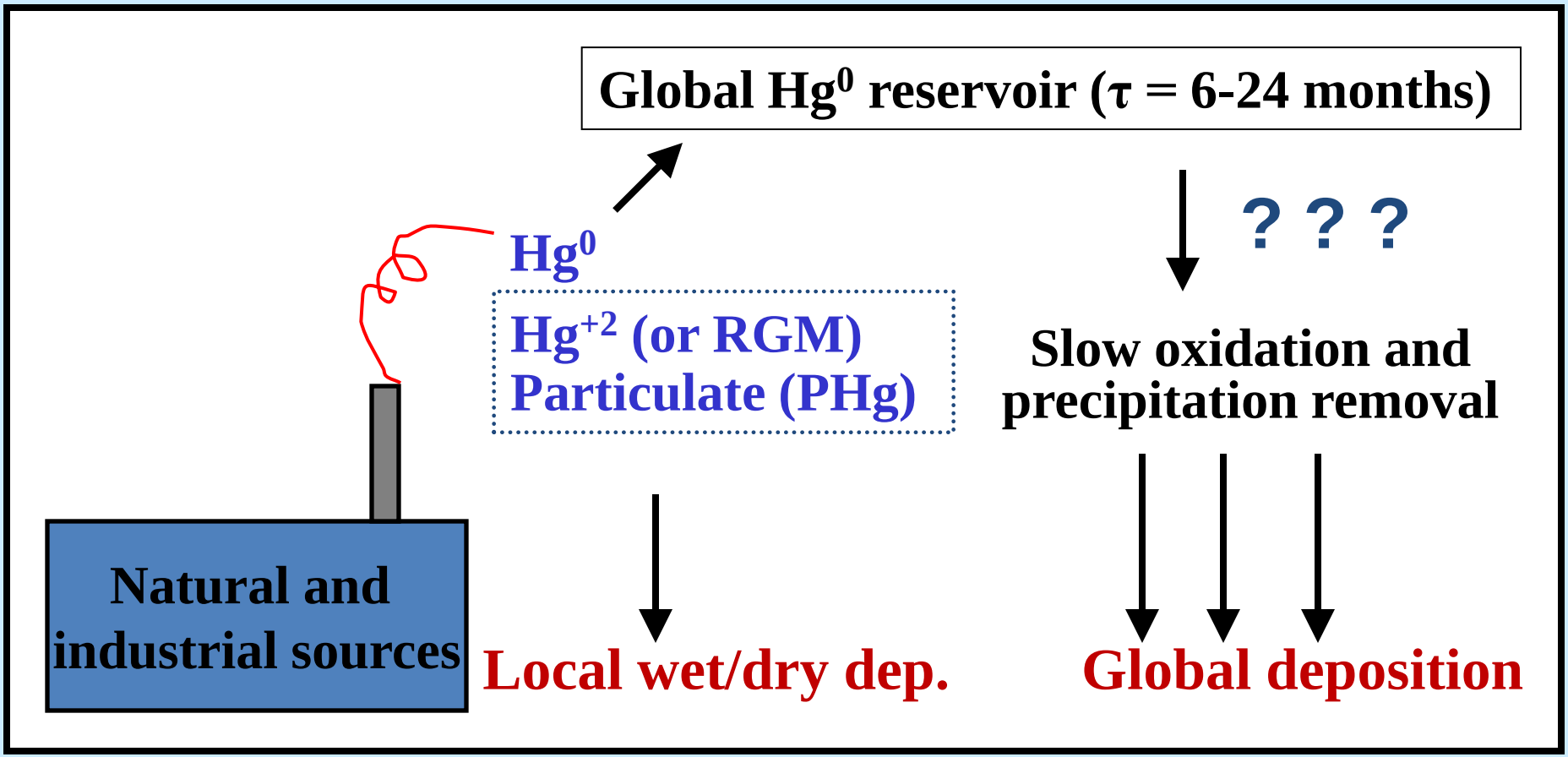
Validation of the UW-Detector of Oxidized Hg Species (UW-DOHGS)

- During WAMO, we successfully detected Hg^{+2} from the C-130 in a stratospheric intrusion (see Lyman and Jaffe 2011)
- During RAMIX, we successfully demonstrated a linear response to blind standard additions of $HgBr_2$ and examined interferences from O_3 and water vapor.



Simplified Atmospheric Mercury Cycle



Whether the Hg is emitted as Hg^0, Hg^{+2} (RGM) or partic. Hg (PHg) is critical. RGM and PHg will deposit locally, whereas Hg^0 will enter the global Hg cycle due to its long lifetime. But measurements of Hg^{+2} are extremely challenging!

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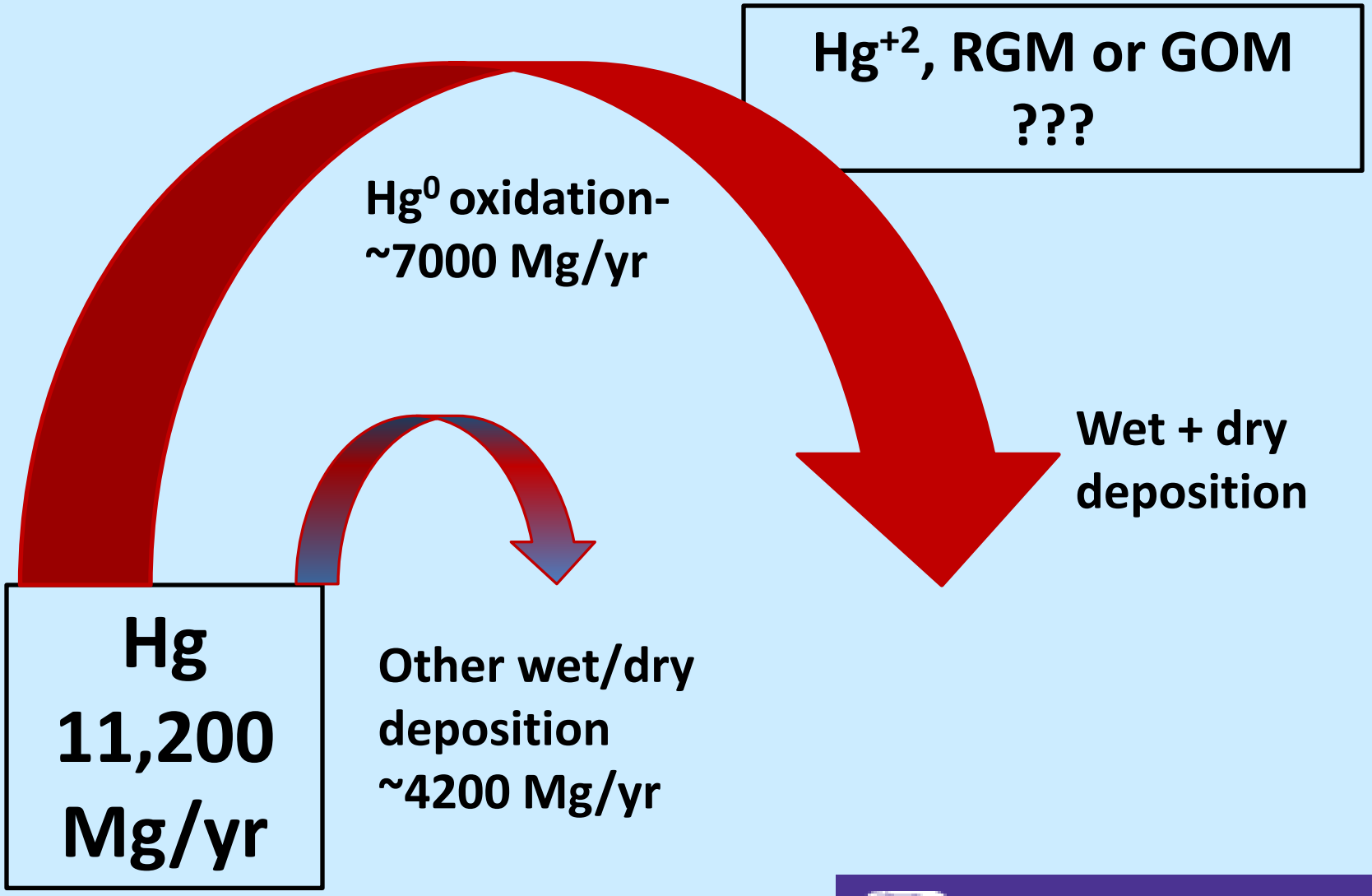
Global Hg budget (based on Selin et al 2008)



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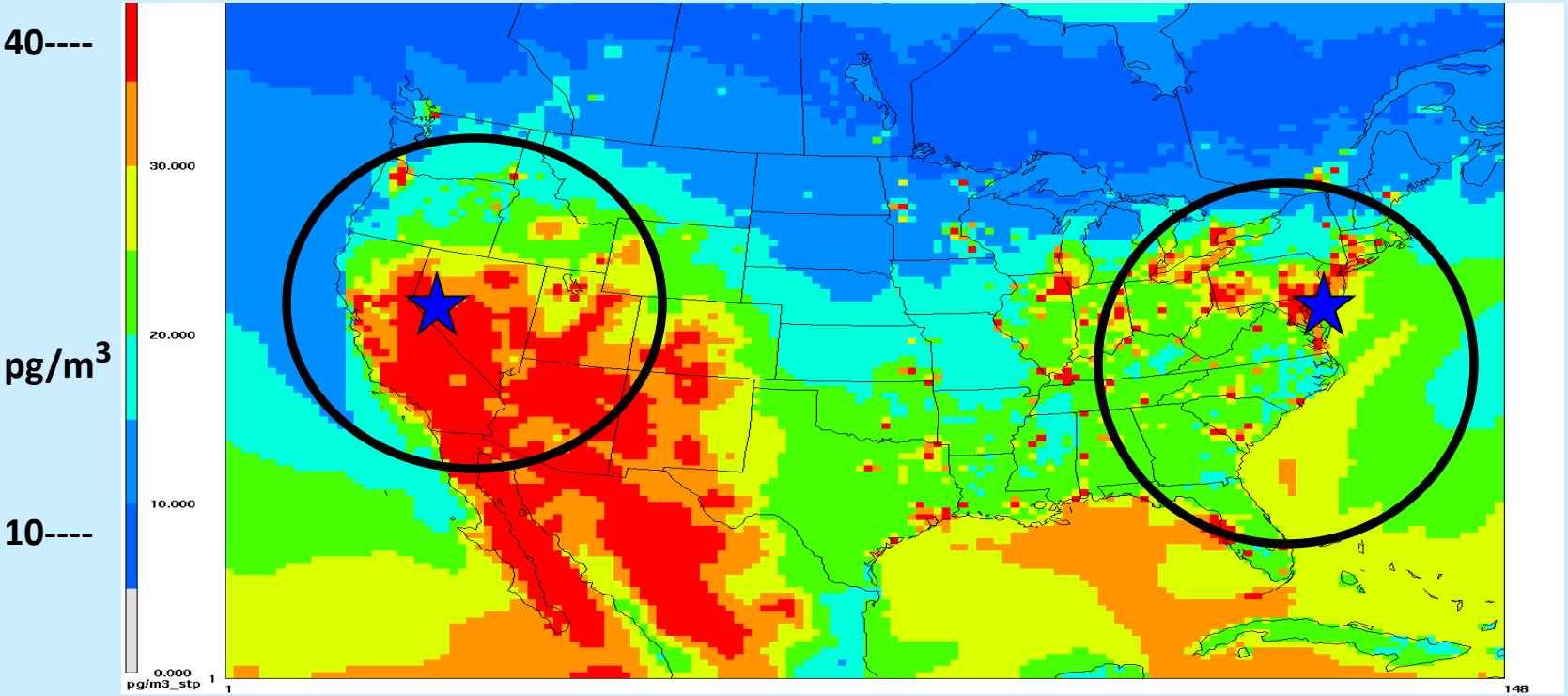
Model calculated concentrations of Hg^{+2} at the surface



- CMAQ model results courtesy of Russ Bullock (EPA/NOAA)
- High concentrations of Hg^{+2} in the Western US are a result of tropospheric oxidation (in the model);
- High concentrations of Hg^{+2} in the Eastern US are from direct industrial emissions;
- Markers show dual bases of operation to examine geographic distribution, sources and atmos chemistry.

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NAAMEX History

- NAAMEX was originally proposed in 2009, but turned down by NSF. Reviewers found the project to be important, but questioned whether instrumentation was ready.
- In the meantime we have successfully completed two additional projects: the Western Airborne Mercury Observations (WAMO-fall 2010) and the Reno Atmospheric Mercury Inter-comparison Experiment (RAMIX-summer 2011).
- The first WAMO paper was published in Nature Geosciences (Lyman and Jaffe, 2011) and a second paper is in preparation.
- RAMIX was completed ~12 months ago, 3 papers submitted in Sept. The UW Detector of Oxidized HG Species (UW-DOHGS) instrumentation successfully detected HgX_2 compounds.

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Primary NAAMEX Goals

- Constrain emissions of Hg from major source regions in the United States;
- Quantify the distribution and chemical transformations of speciated mercury in the troposphere (e.g. Hg^0, Hg^{+2}, Particulate Hg);
- Use observations to evaluate model forecasts for Hg and help constrain key processes.

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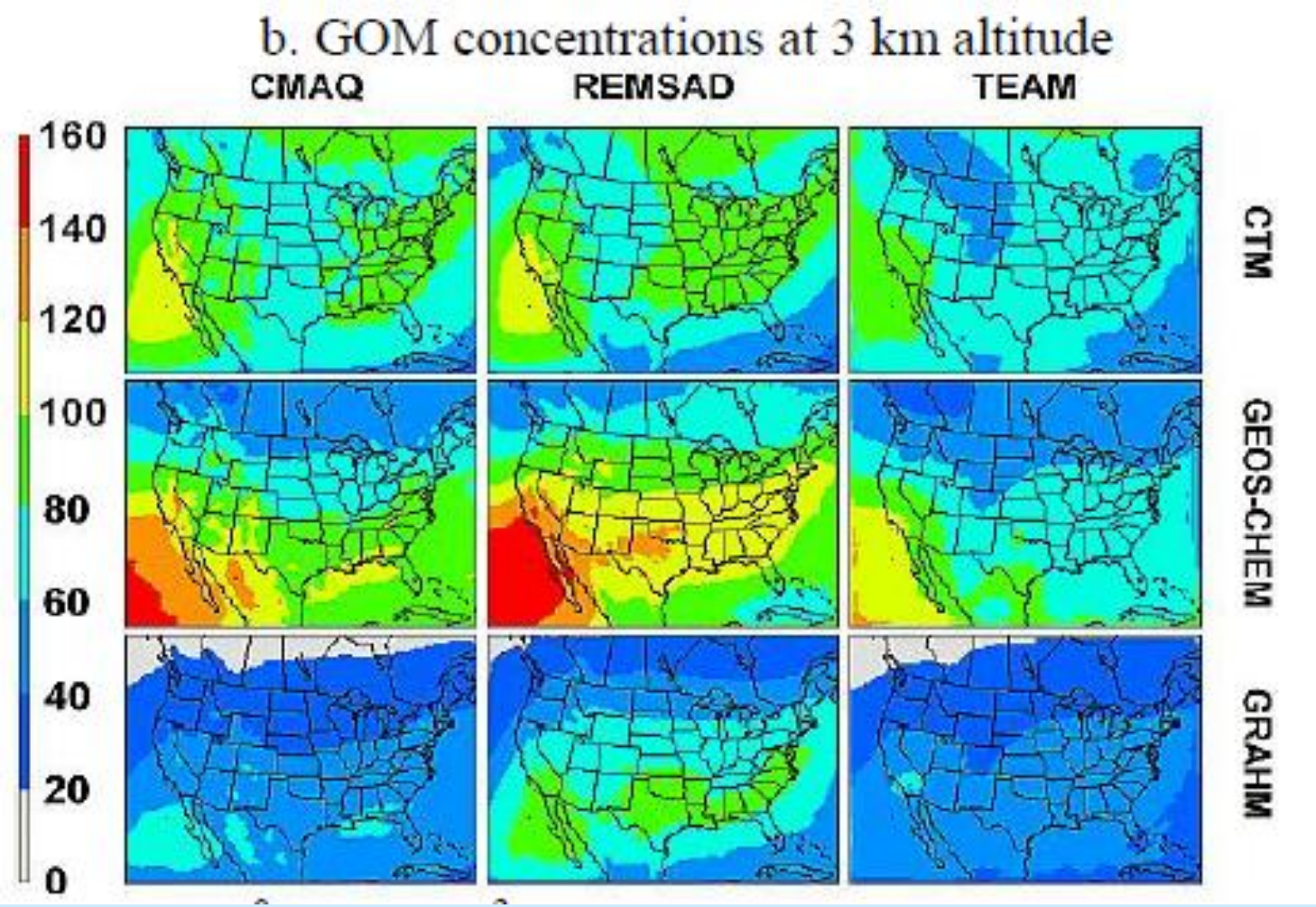
Annual mean calculations of GOM (pg/m^3)



Bullock et al 2008

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NOMADSS flight patterns

1. Horizontal and vertical profiles over rural Eastern US w/vegetation, daytime, 8 flights.
2. Horizontal and vertical profiles over rural Eastern US w/vegetation, afternoon/night, 1 flight.
3. Horizontal and vertical profiles over rural Eastern US w/vegetation, early morning, 1 flight.
4. Ohio Valley transect/profiling, daytime, two flights.
5. Florida/Gulf of Mexico/Texas panhandle transect and profiles, daytime, two flights.
6. Florida to New York transect, with some profiling, daytime, two flights.
7. Offshore outflow flight, daytime, two flights.

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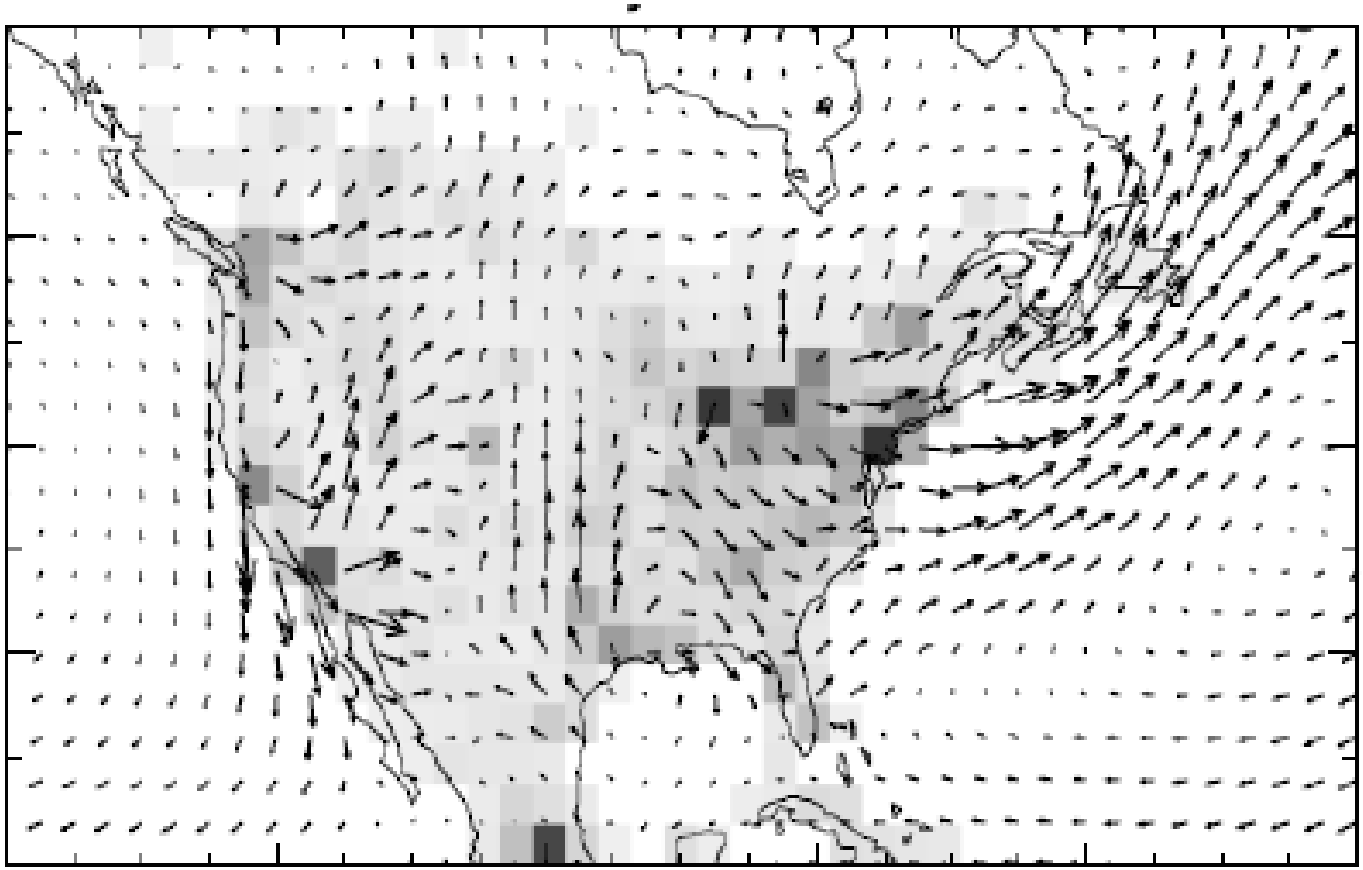
CO emissions and CO flux for at 1000-700 mb July 2000



Li et al 2005

NOMADSS flight patterns

4. **Ohio Valley transect/profiling, daytime, two flights.**
5. **Florida/Gulf of Mexico/Texas panhandle transect and profiles, daytime, two flights.**
6. **Florida to New York transect, with some profiling, daytime, two flights.**
7. **Offshore outflow flight, daytime, two flights.**

- Large scale distribution of Hg across major source region (all flights)
- BL/FT exchange (4)
- Source and concentrations of GOM in free troposphere (4,5)
- N. American outflow (6,7)
- MBL chemistry (5,6,7)
- Convective scavenging (6)

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NAAMEX Participants and collaborators

Name, institution	Role
Dan Jaffe, Jesse Ambrose, Lynne Gratz, Univ of Washington	Hg (full speciation)/Mt. Bachelor site (similar Hg measurements)
Chris Cantrell, Lee Mauldin, CU	OH, HO_2, RO_2 and H_2SO_4
Andrew Weinheimer/Teresa Campos, NCAR	CO, CO_2, NO_x, O_3
Lyatt Jaeglé, UW (Co-mission scientist)	Global and regional modeling
Noelle Selin, MIT	Global and regional modeling
Mark Cohen, NOAA-ARL	Hemispheric modeling
Jerry Lin, Lamar Univ	Hemispheric modeling
Ashu Dastoor, Env. Canada	Global and regional modeling
Nicole Pirrone, CNR-Italy	Coordination with European GMOS project
Franz Slemr, MPI, Germany	Coordination with European CARABIC project
Oleg Travnikov, MSC-East, Russia	Coordination with European Hg modeling

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Agenda

- 8:30-9:45 am: Introductions (Dan Jaffe, Alex Guenther and Xianliang Zhou)
- Overview of project goals, experimental design and flight patterns (NAAMEX, SOAS, TROPHONO, NOAA-SENEX (DeGouw) 15-20 minutes per PI)
- 9:45-10:00 am: Coffee Break
- 10:00-11:00 am: Key instrumentation, capabilities and limitations (5-10 minutes each):
- UW-DOHGS: Ambrose, CU-HOx: Cantrell/Mauldin, HONO/HNO-3-SUNY Albany: Zhou/Stutz,
- O3/CO/CO2/NOx-NCAR: Weinheimer/Flocke/Campos, TOGA: Apel, PTRMS: Guenther/Karl,
- SOAS ground site: Carlton
- 11:00-12:00: In field forecasting tools (20-30 minutes each): GEOS-CHEM: Jaeglé/Selin
- NCAR Chemistry models: Emmons, Data catalog: Stossmeister-EOL
- 12:00-1:00 pm: Break for lunch
- 1:00-1:30 pm: Flight planning and decisions; Coordination with P-3 and ground sites?
- 1:30-2:00: pm: Instrument integration-timeline, test flights, etc. (EOL)
- 2:00-2:30: In-field logistics- Housing, lab space, shipping, internet, etc (Salazar-EOL)
- 2:30-2:45: Coffee Break
- 2:45-3:30: NOMADSS Publications, data sharing and data management, timeline
- 3:30-4:00: Open discussion: **NOMADSS Communications**

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