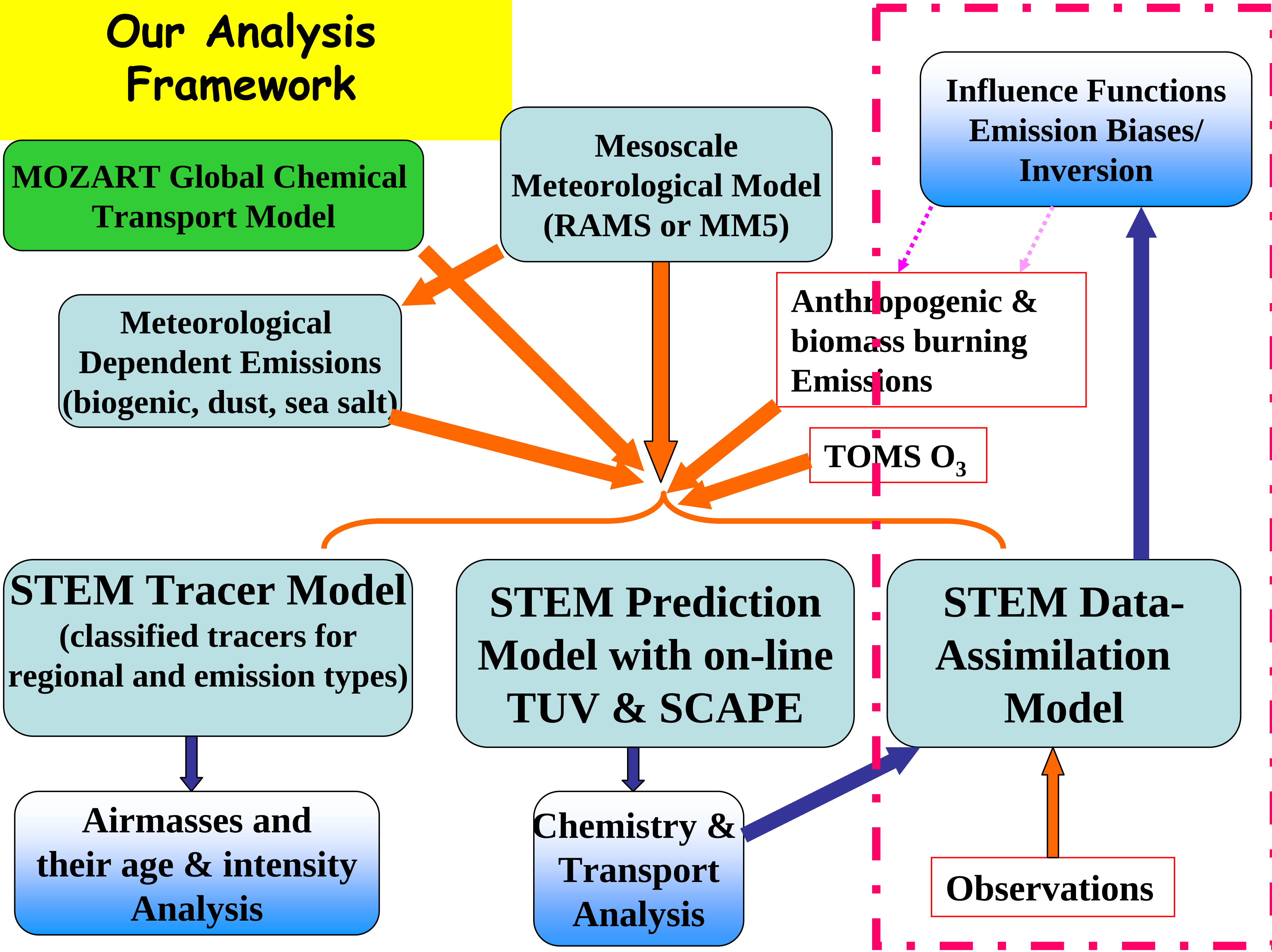
Regional Chemical Modeling in Support of ICARTT

Topics:

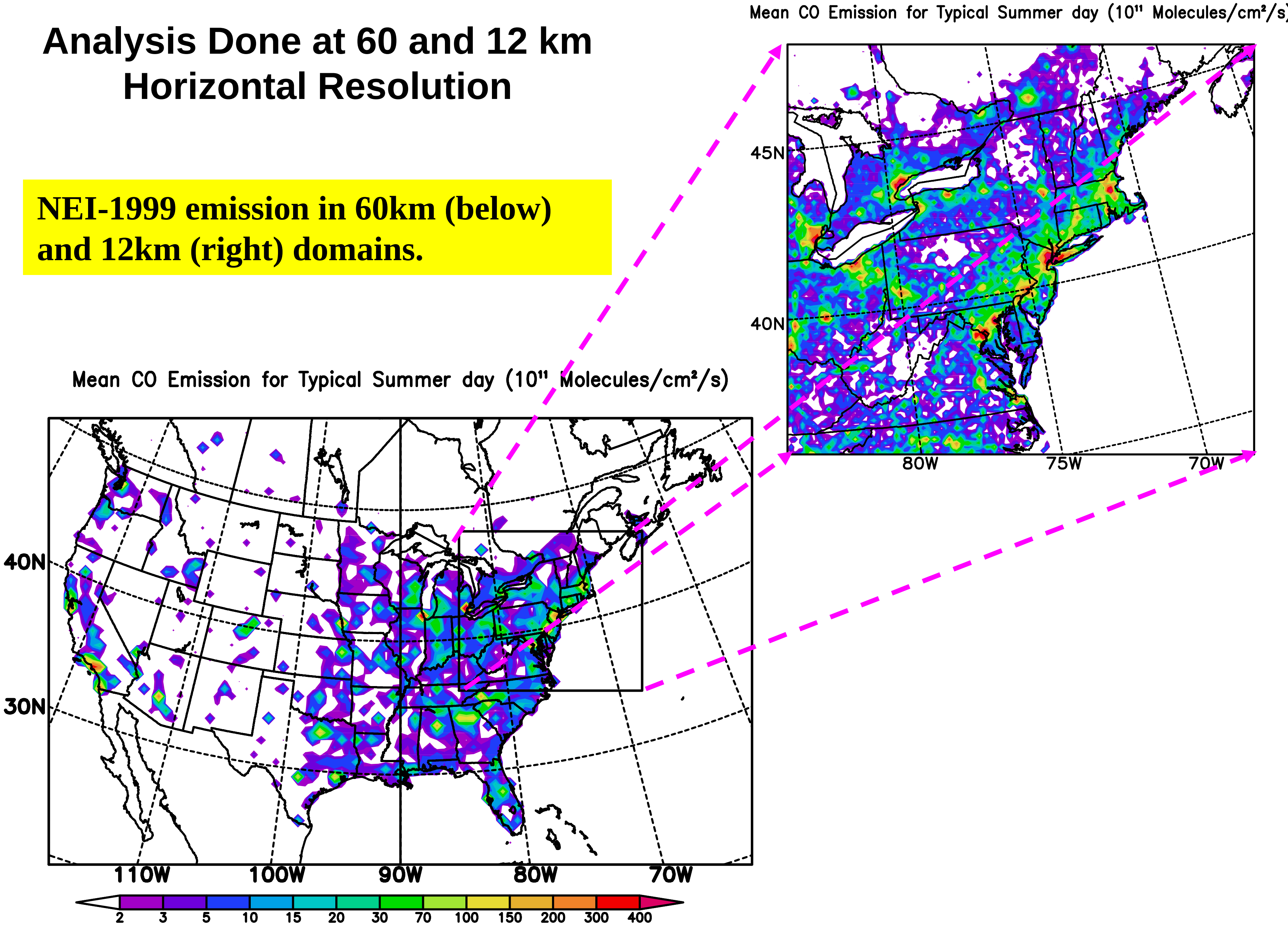
- How good were the regional forecasts?
- What are we learning about the emissions?
- What are our plans for integrating models with observations?

Our Analysis Framework

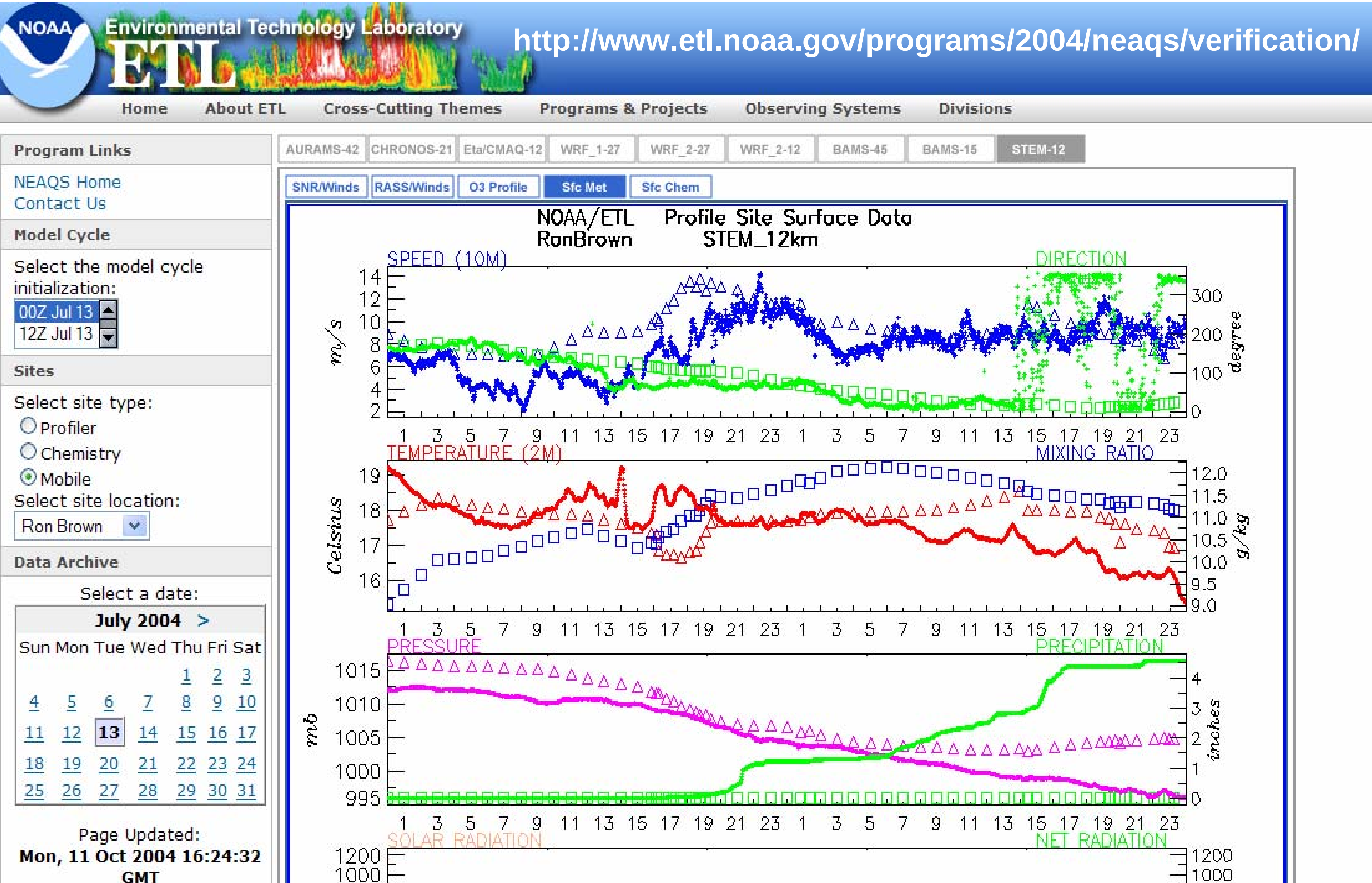


Analysis Done at 60 and 12 km Horizontal Resolution

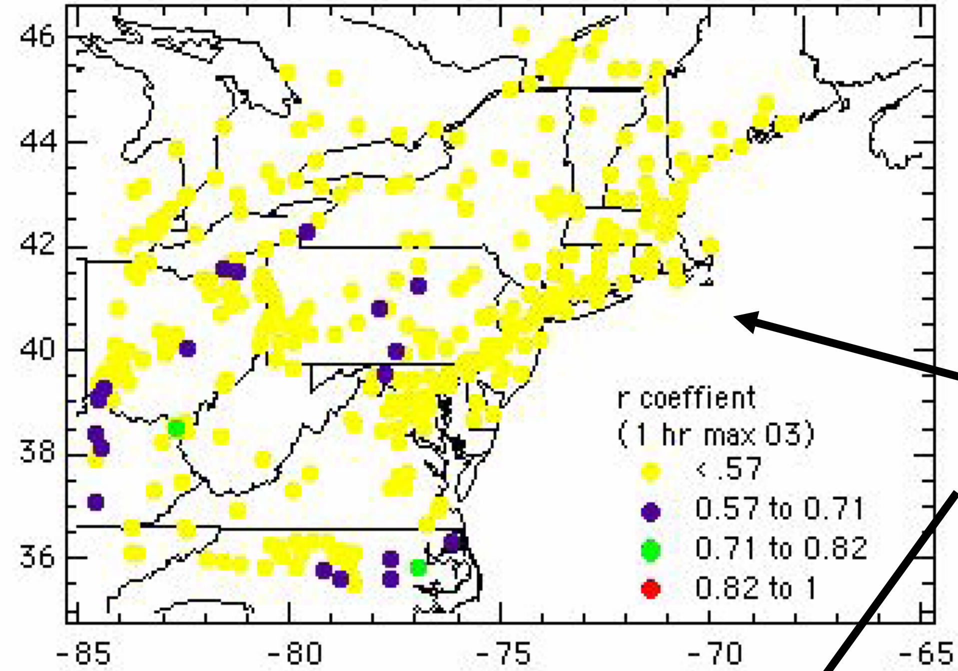
NEI-1999 emission in 60km (below) and 12km (right) domains.



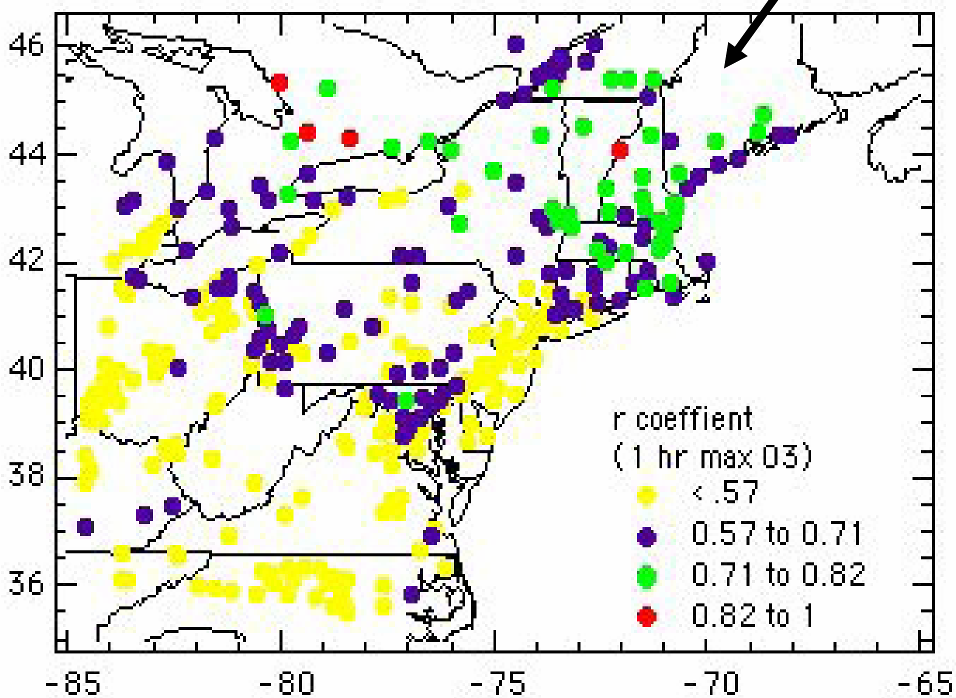
Extensive Real-Time Evaluation of Regional Forecasts – *Stu McKeen*

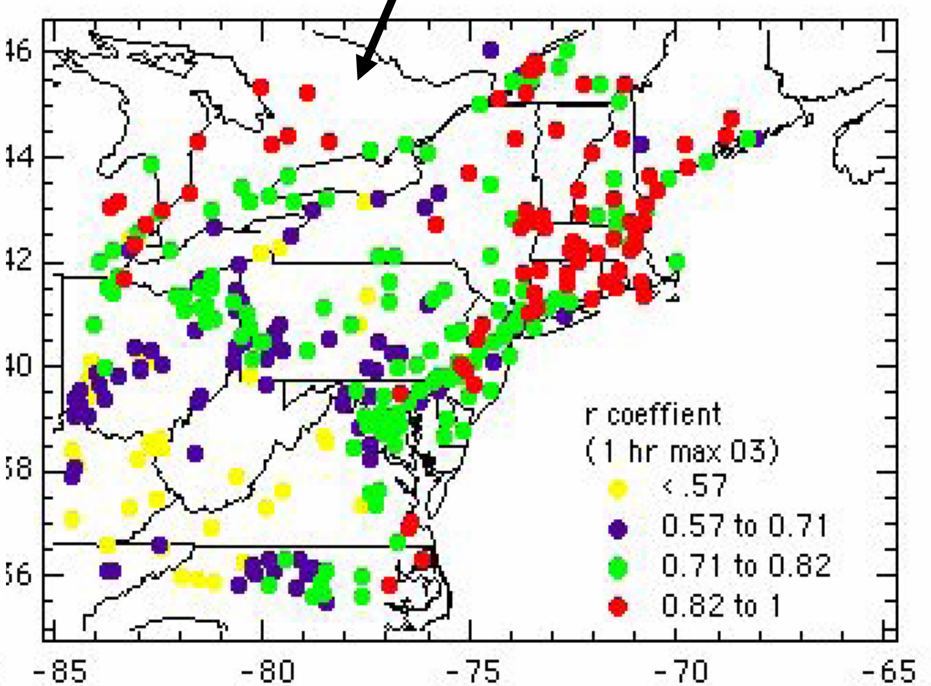


Complimentary Actions to Improve Our Ability to Forecast Pollution are Needed

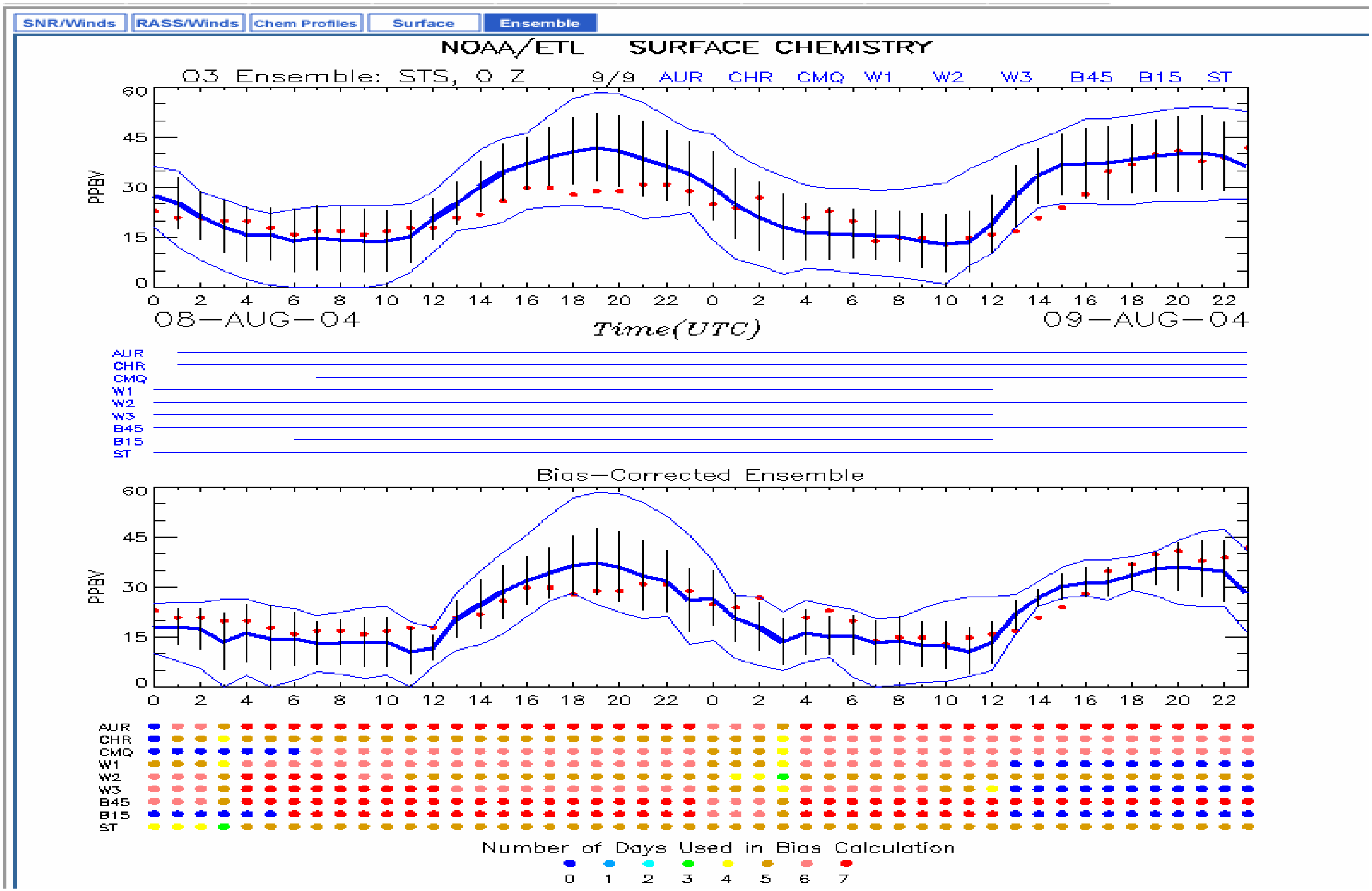


- * Persistence
- * Single Forward Model w/o assimilation
- * Ensemble forecast (8 models) w/o assimilation

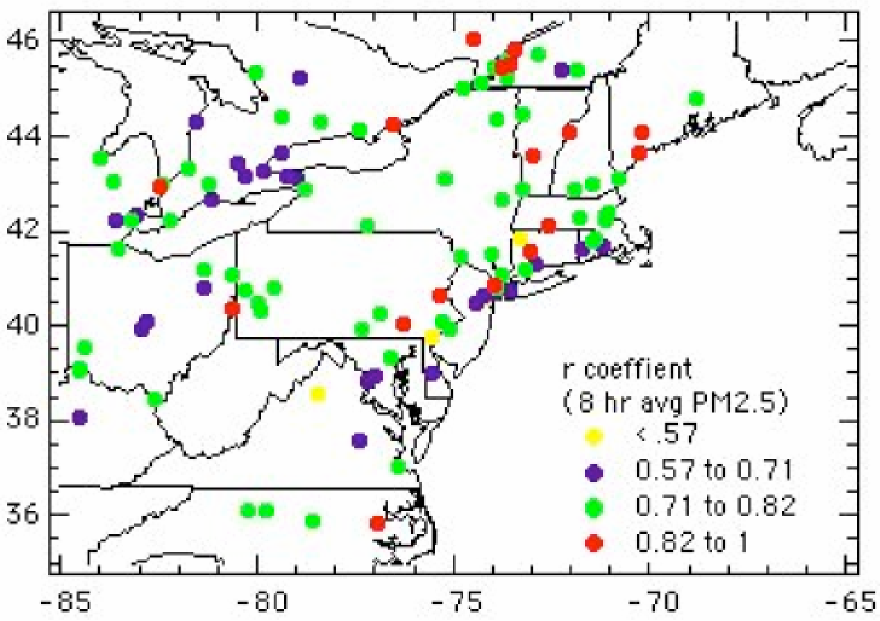




Ensemble Techniques Help !



Ensemble Methods Also Work for PM2.5 Forecasting



Comparison Statistics for
Geometric Ensemble with
AIRNOW daily 8-hr avg PM2.5
7/14/04 through 8/18/04

	median	average
r coeff.	0.75	0.73
Md/Ob ratio	0.86	1.00
ratio RMSE	1.76	1.90
Sdev	5.55	5.84
Skill factor(%)=	75.42	

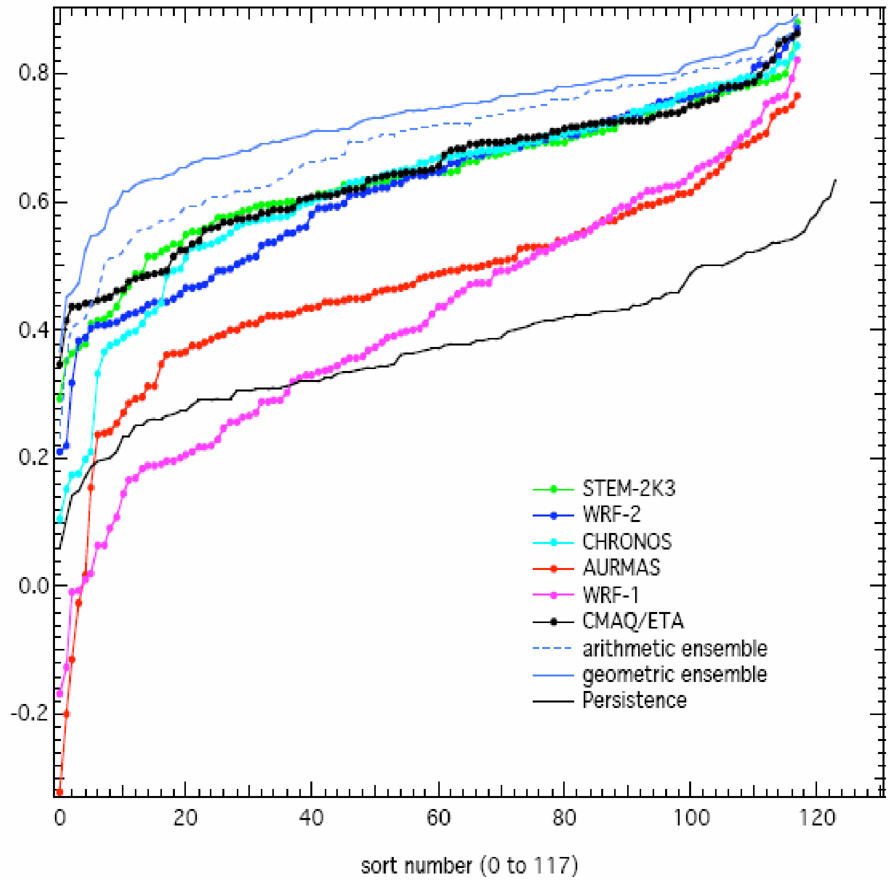
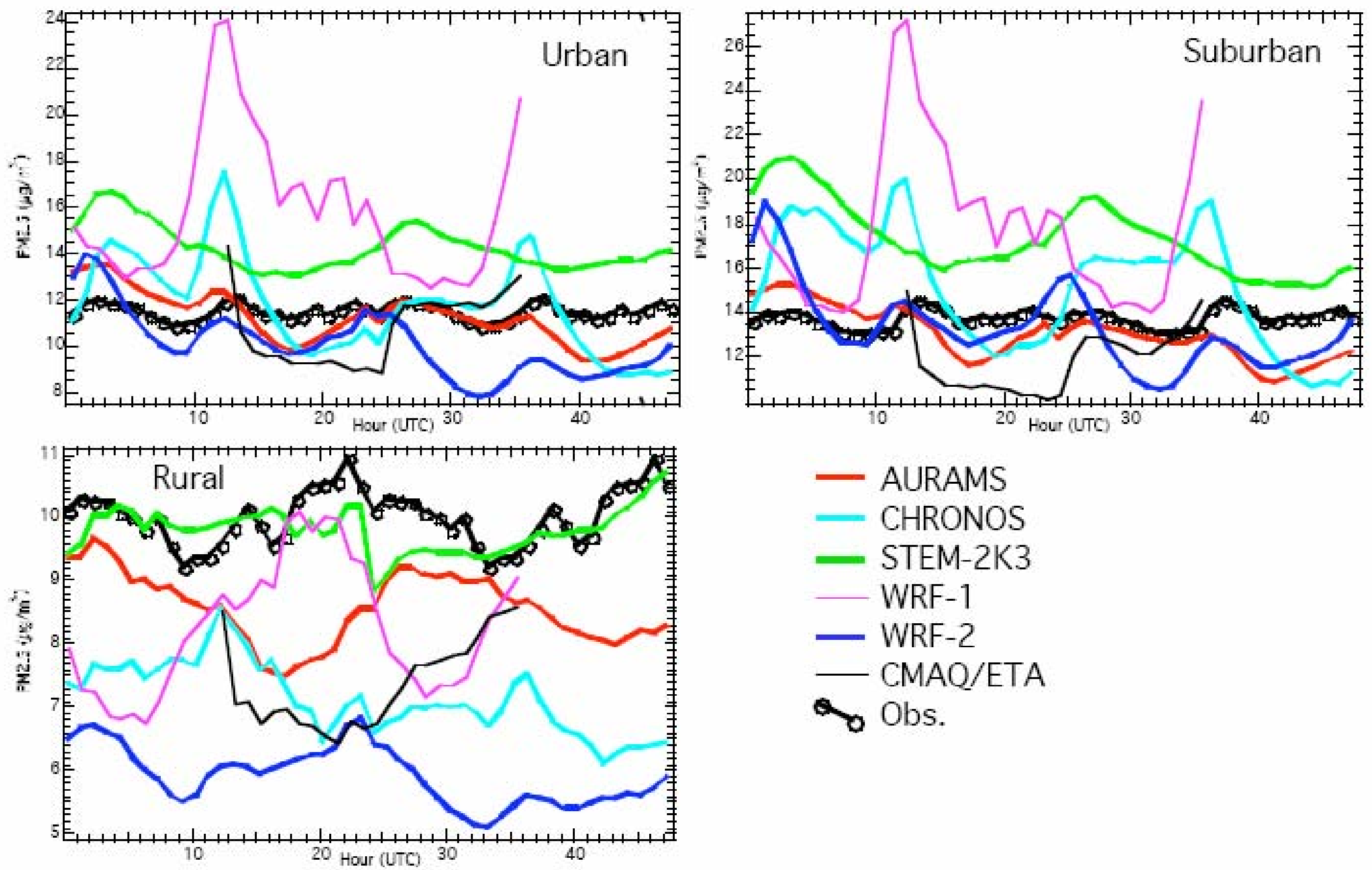


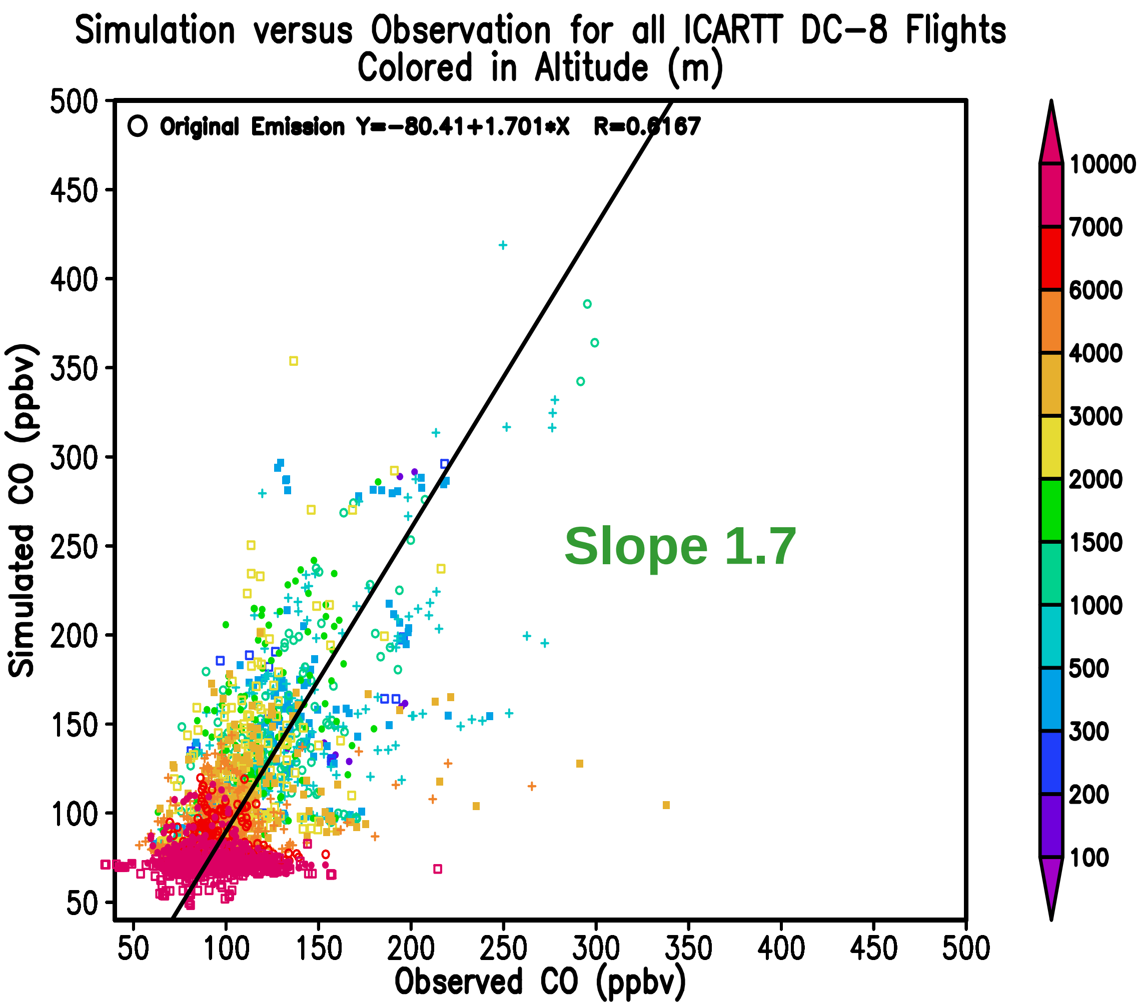
Figure 5. Sorted r-correlation coefficients for the 8 model cases, and persistence

But take little comfort……. We have a long way to go !!

PM2.5 Average Diurnal Profiles, summer 2004, in NE U.S.



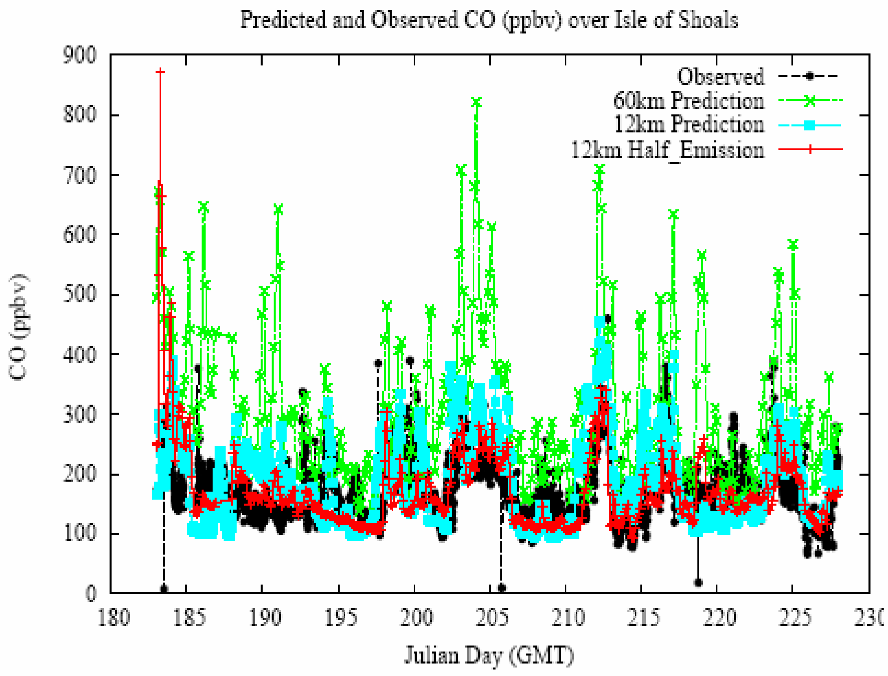
Emission Issues

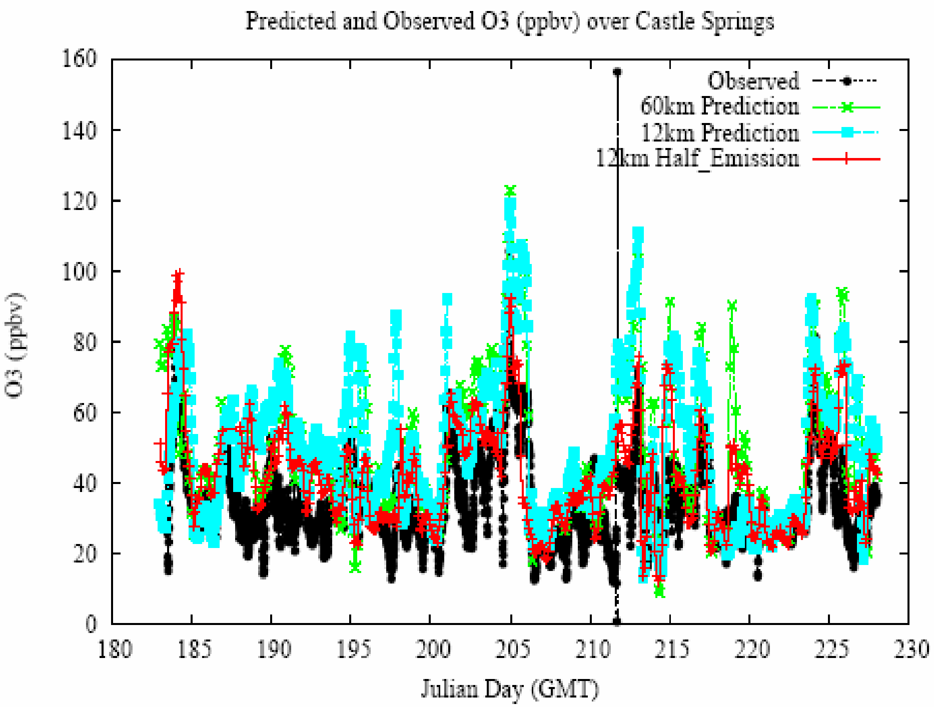


Sensitivity Runs Using Reduced Emissions -- Correlations between STEM simulations and Measurements for All DC-8 flights

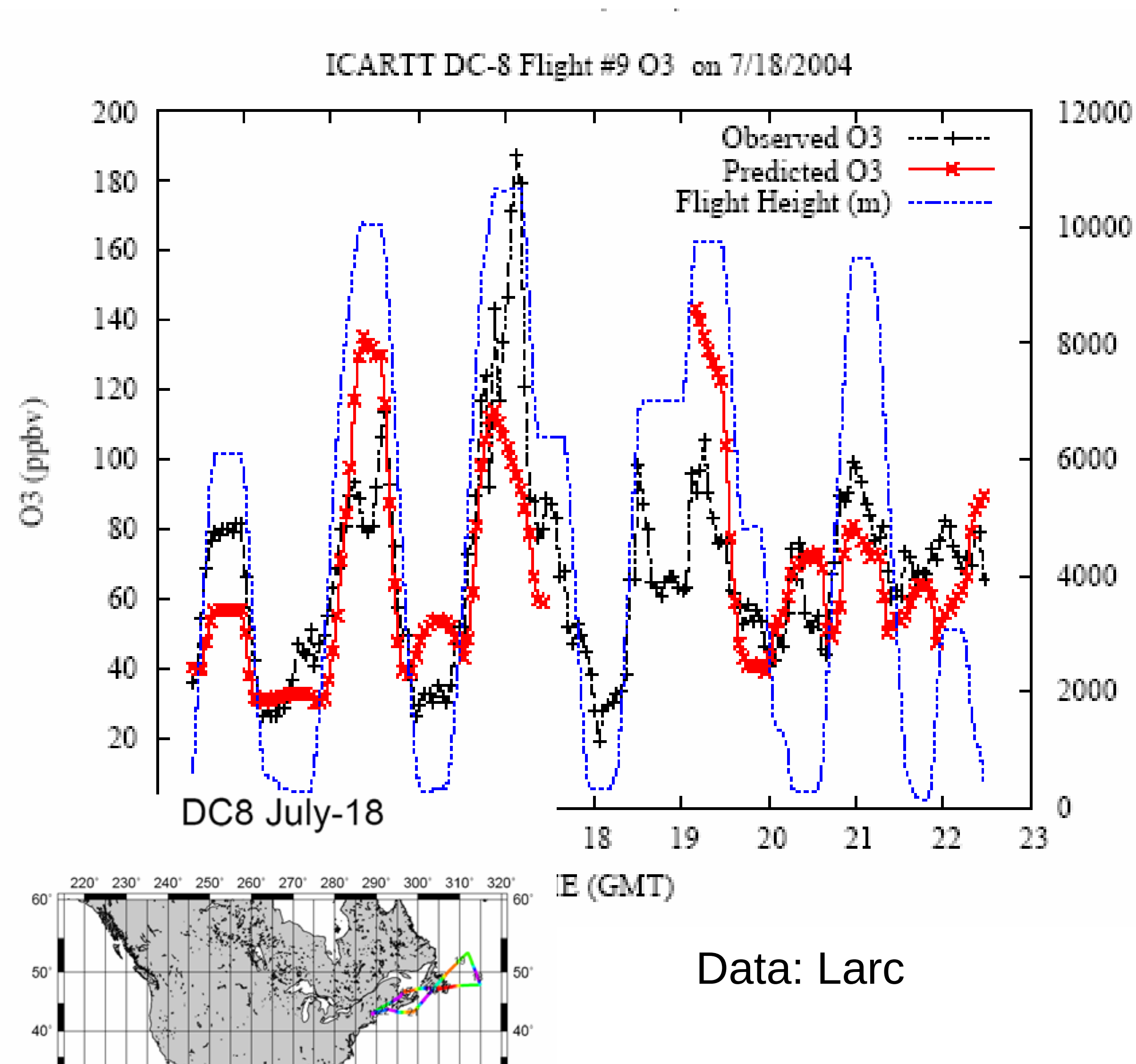
Species	60 km simulation with original NEI-1999v3 emission		60 km simulation with half CO, NO_x and SO_2 emissions	
	Slope	R	Slope	R
CO	1.70	0.62	0.83	0.66
NO_y	4.11	0.48	1.50	0.48
PILS SO_4^{2-}	2.52	0.75	0.78	0.75
SAGA SO_4^{2-}	3.06	0.74	1.13	0.74
PILS NH_4^+	0.35	0.35	0.33	0.48
SAGA NH_4^+	1.60	0.64	1.08	0.66
O_3	1.13	0.46	0.97	0.55
Ethyne	0.21	0.50	0.26	0.51
URI HCHO	0.82	0.84	0.89	0.84
H_2O_2	0.56	0.70	0.47	0.67

Clear Improvement in Surface Predictions





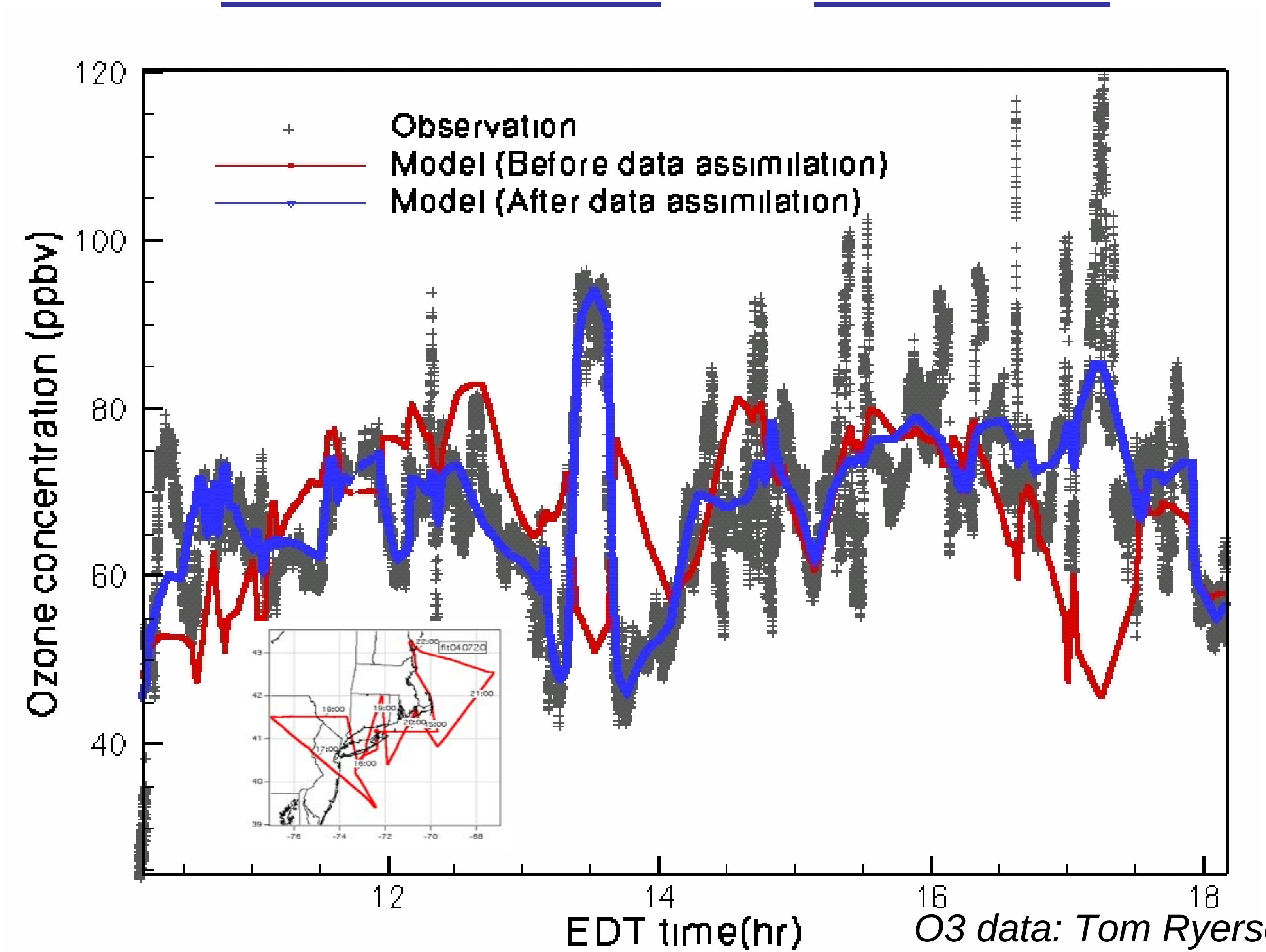
Integration of Measurements & Models



Data: Larc

- **Cost functional** measures the model-observation gap.
- **Goal:** produce an **optimal state** of the atmosphere using:
  - ➢ **Model information consistent with physics/chemistry represented**
  - ➢ **Measurement information consistent with reality**
  - ➢ ***within errors***

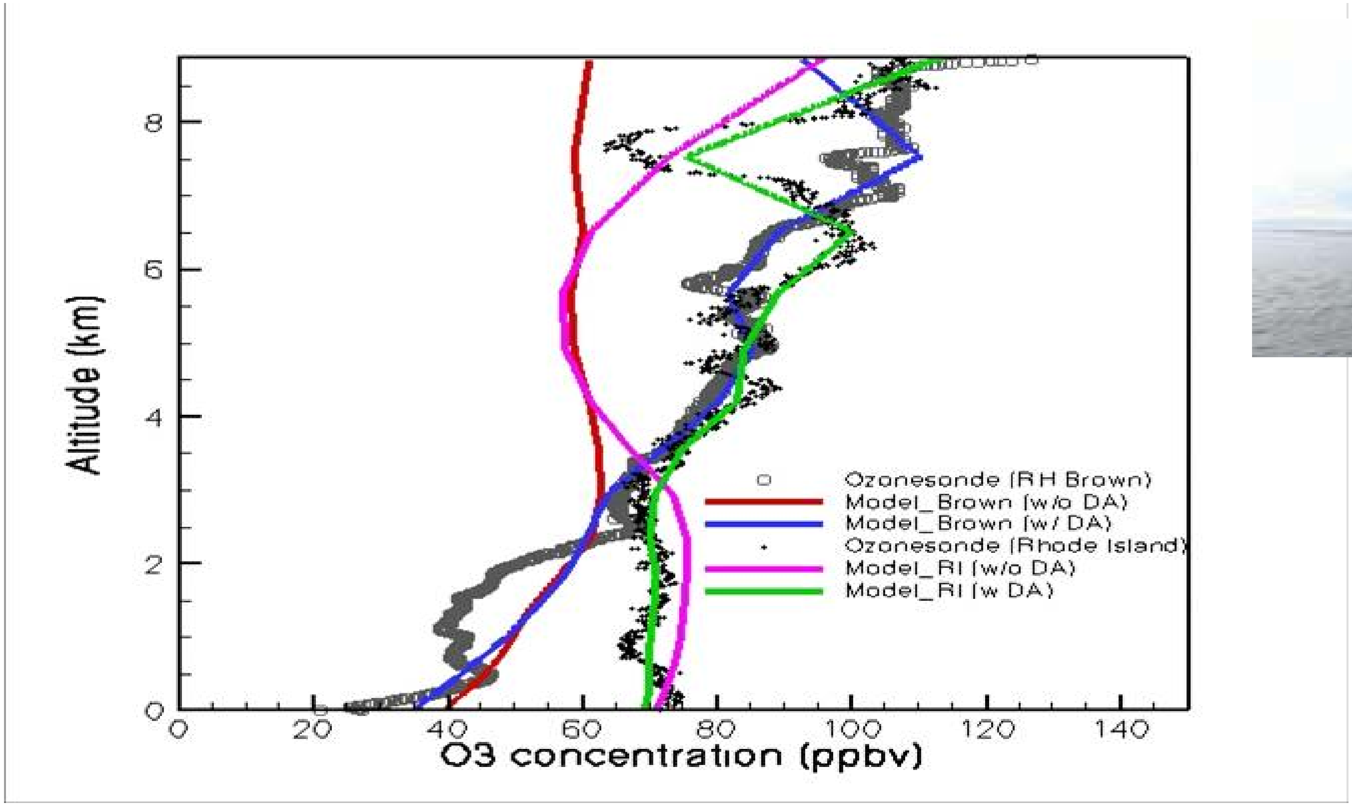
Reanalysis of Ozone using Surface as Well as Ozone Profile and Aircraft Data



O3 data: Tom Ryerson

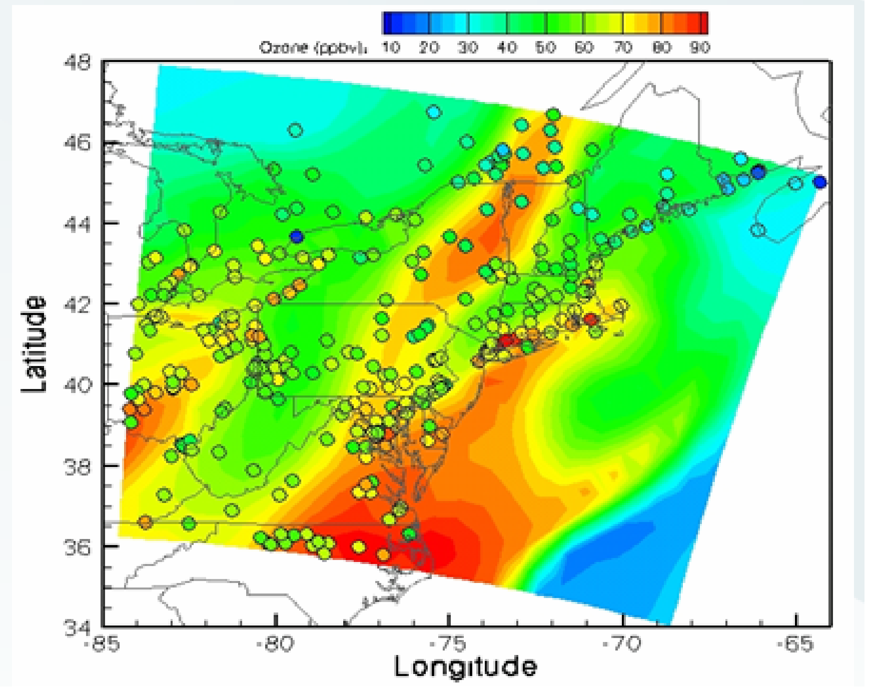
Getting the Vertical Distributions Right is Critical

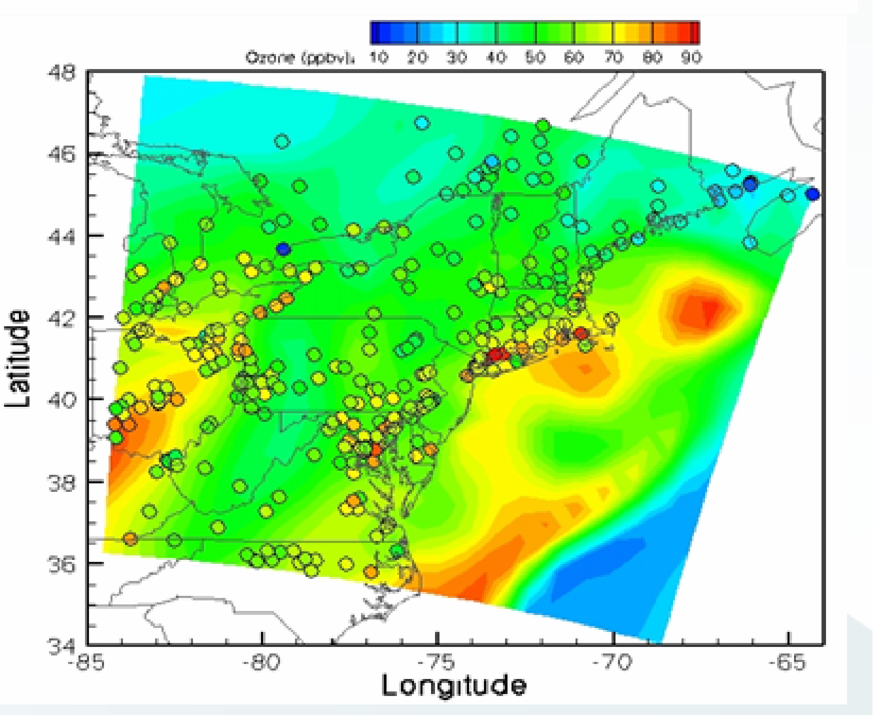
Current models have a difficult time…so data assimilation is important



IONS O3 data: Anne Thompson & John Merrill

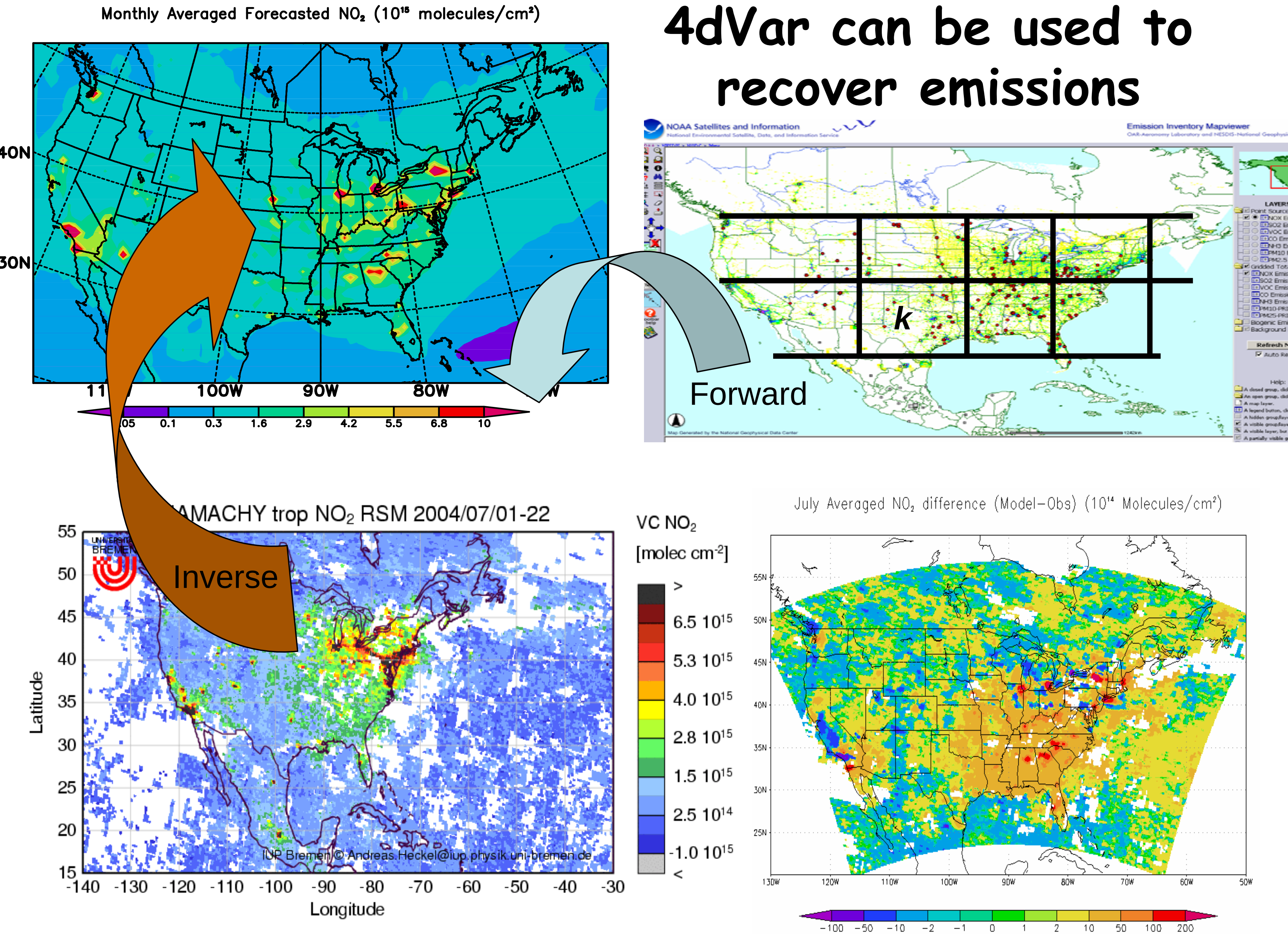
Ozone Forecasts (*left*) and Reanalysis (*Right*)



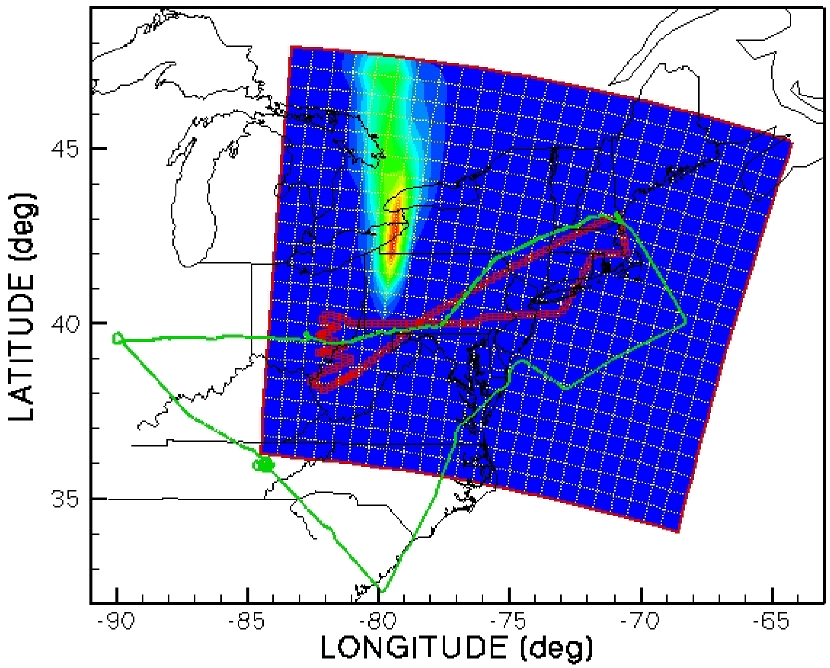


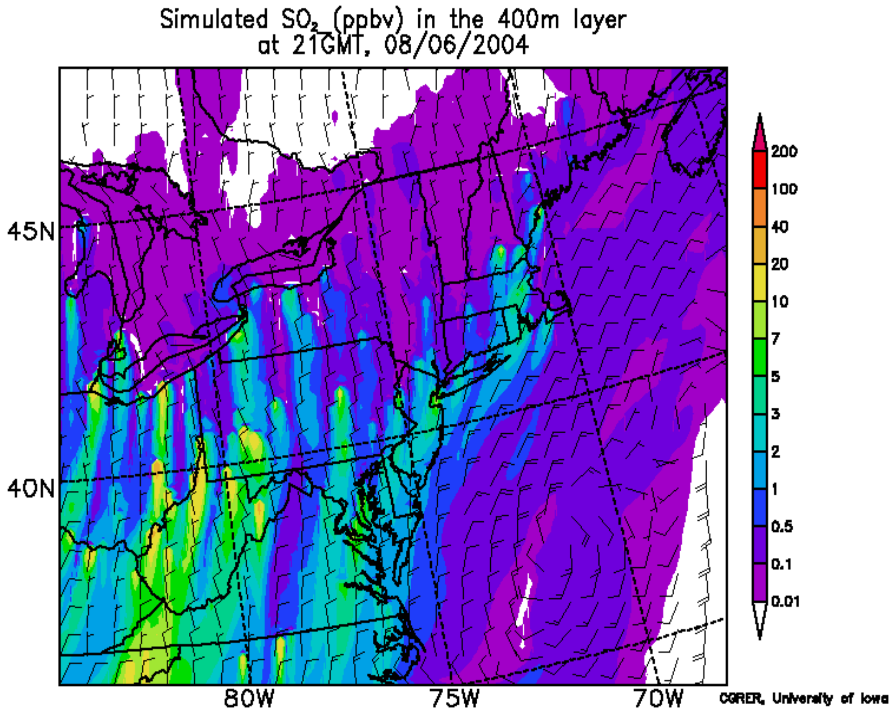
Circles represent observations (locations and values)

4dVar can be used to recover emissions



Influence Function



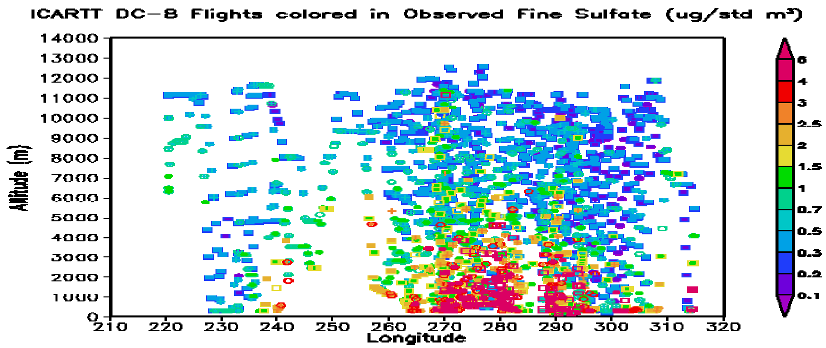


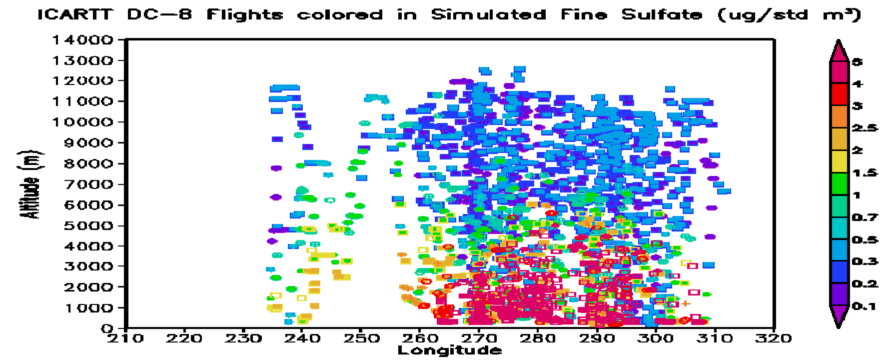
Adjoint Tools Can Also Help in the Characterization of Emissions

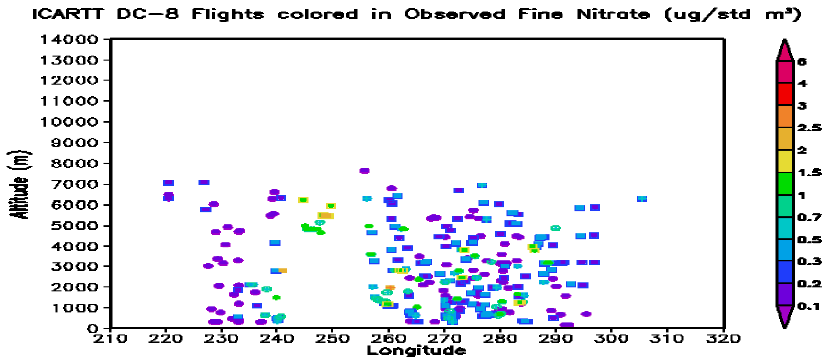
Preliminary Results: CO emission scaling factor ~ 0.7.

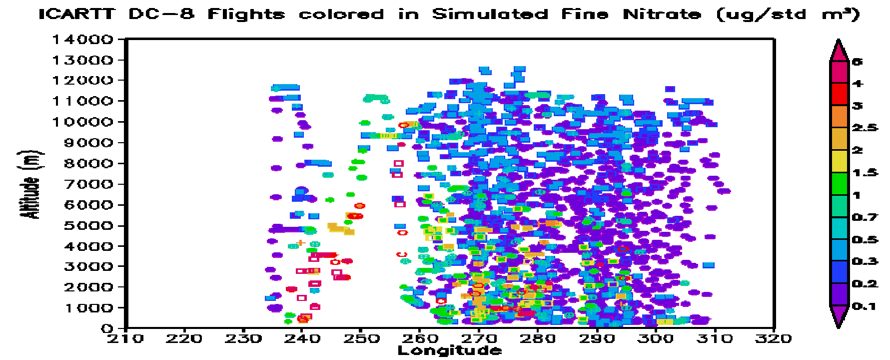
Regional Distributions of Aerosols

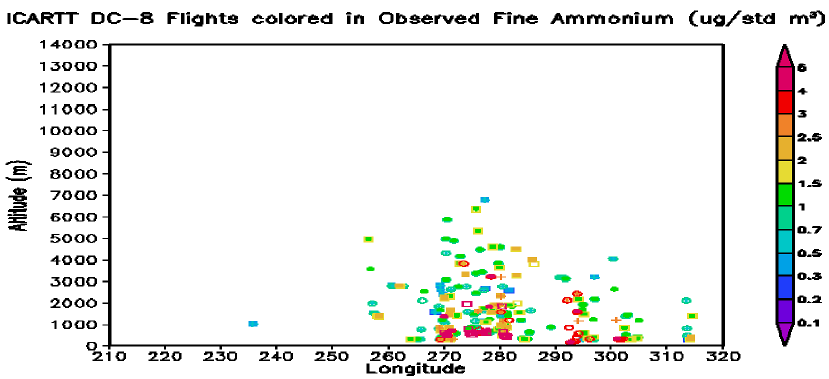
Observed (PILS) | **Predicted**

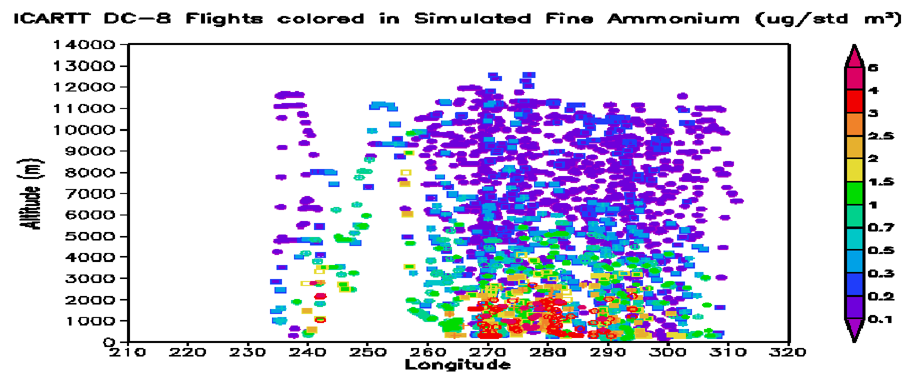




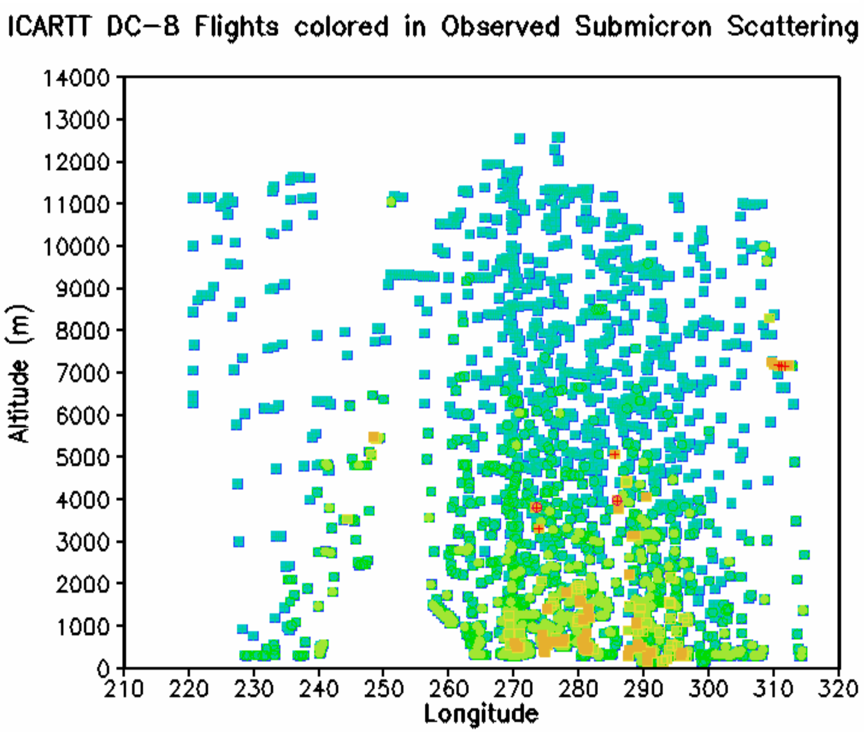


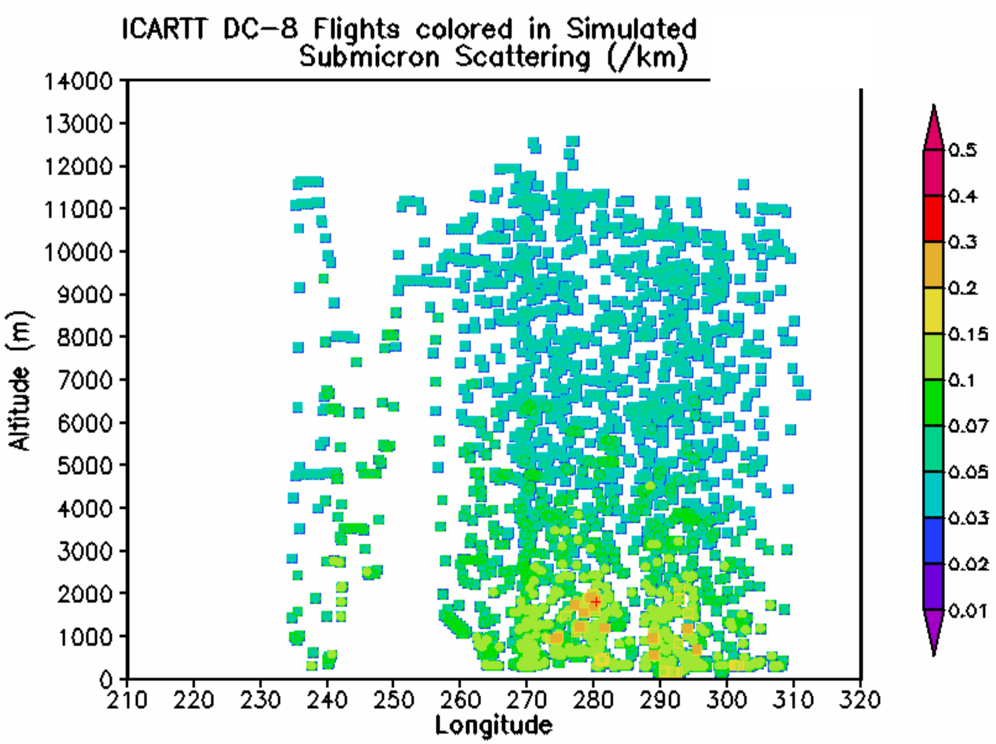




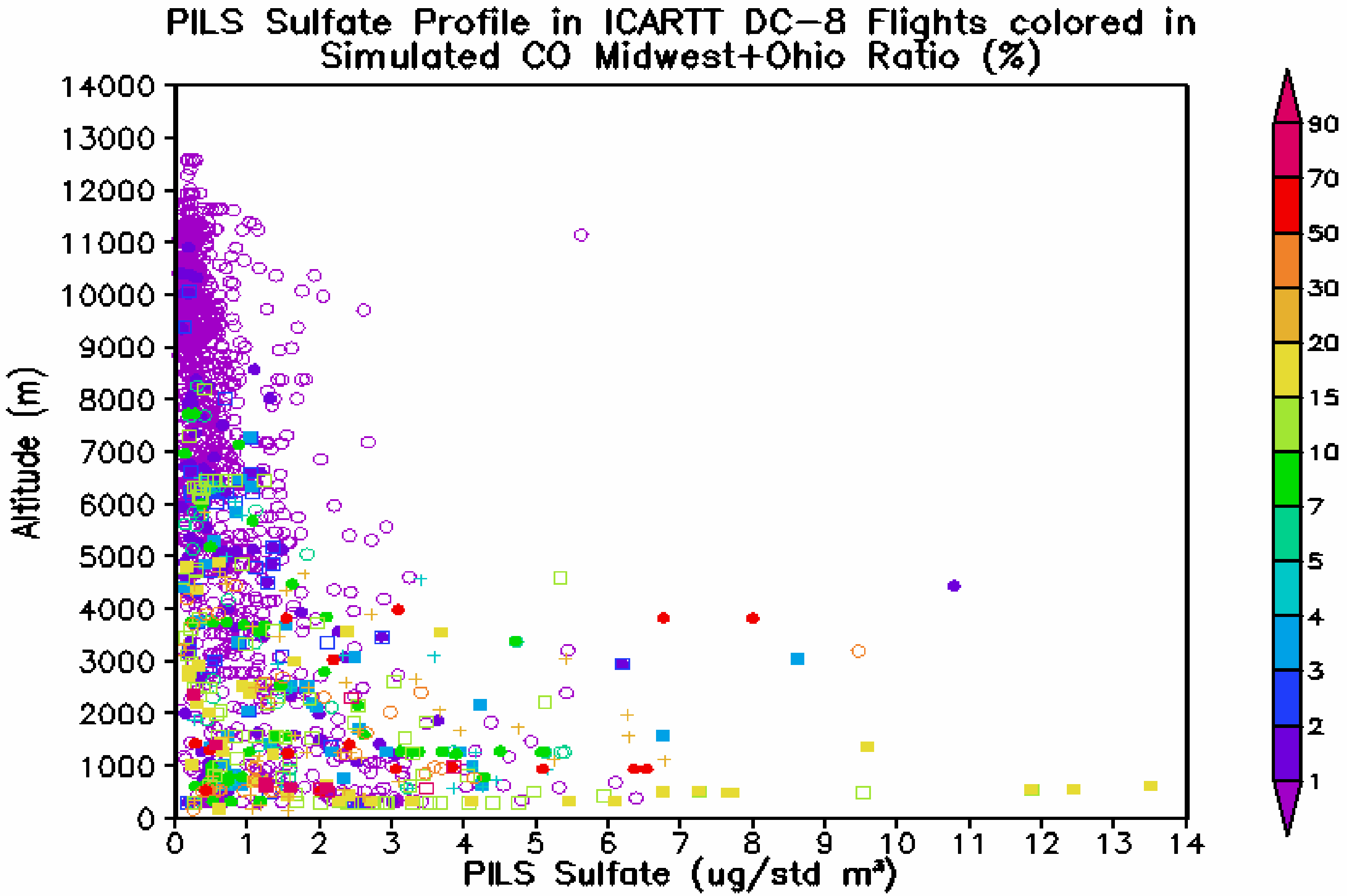


Observed and Predicted Submicron Scattering





STEM Source Region Tracers Can Be Used to Sort Data & Complement Trajectories



Future Plans

- Improve Base Emissions -- Update base year inventory (Streets and Vukovich), Biomass burning (others)
- Emission inversions
- Re-analysis using aircraft, surface, satellites, sondes (Ozone, CO, NOy, HCHO)
- Analysis of aerosols and optical properties, by better linking observations and models
- Better understand and constrain physical removal processes (dry and wet)

We will submit our model products along the flight tracks