Temporal and spatial forecasting of chemical phenomena for data collection and sampling by airplane (& ozonesonde, & Ronald H. Brown, & satellite)

Chemical model designed entirely for purposes of flight planning during ICARTT

ICARTT – International Consortium for Atmospheric Research on Transport and Transformation

- NASA - Intercontinental Chemical Transport Experiment - North America (INTEX-NA)
- NOAA - New England Air Quality Study - Intercontinental Transport and Chemical Transformation (NEAQS-ITCT)
- Europeans (U.K., Germany, and France) - Intercontinental Transport of Pollution (ITOP).
- ICARTT was formed to take advantage of this synergy by planning and executing a series of coordinated experiments concerning:
  - regional air quality
  - intercontinental transport
  - radiation balance

Points of Emphasis

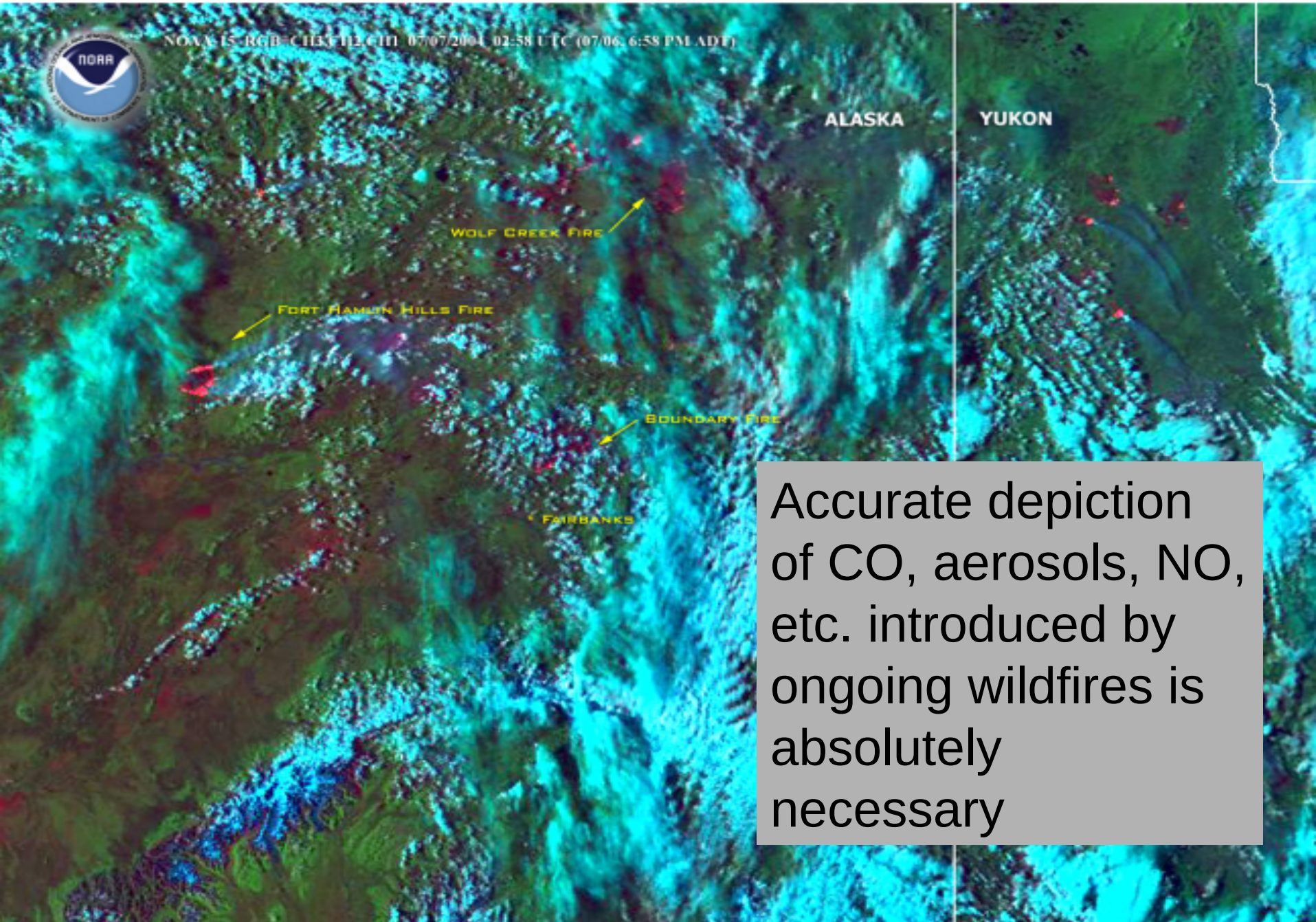
- Source data
- Meteorology
- Chemistry
- Model Validation

Source Data

- EPA gridded emission inventory
  - 24 hours vs. workday only
  - Weekday vs. weekend
  - Land use changes
- Daily NOAA satellite wildfire area coverage
- Topography for emission heights

Heat signatures (red) and smoke plumes (light blue haze) are visible from fires burning in Alaska and Canada's Yukon. The National Interagency Fire Center's Incident Management Situation Report from 07/07/2004 reports the Wolf Creek Fire Northeast of Fairbanks has burned 200,000 acres was 0% contained. The Boundary Fire northeast of Fairbanks had burned 312,000 acres and was 27% contained. The Fort Hamlin Hills fire had burned 45,000 acres and was 5% contained.

CREDIT: NOAA

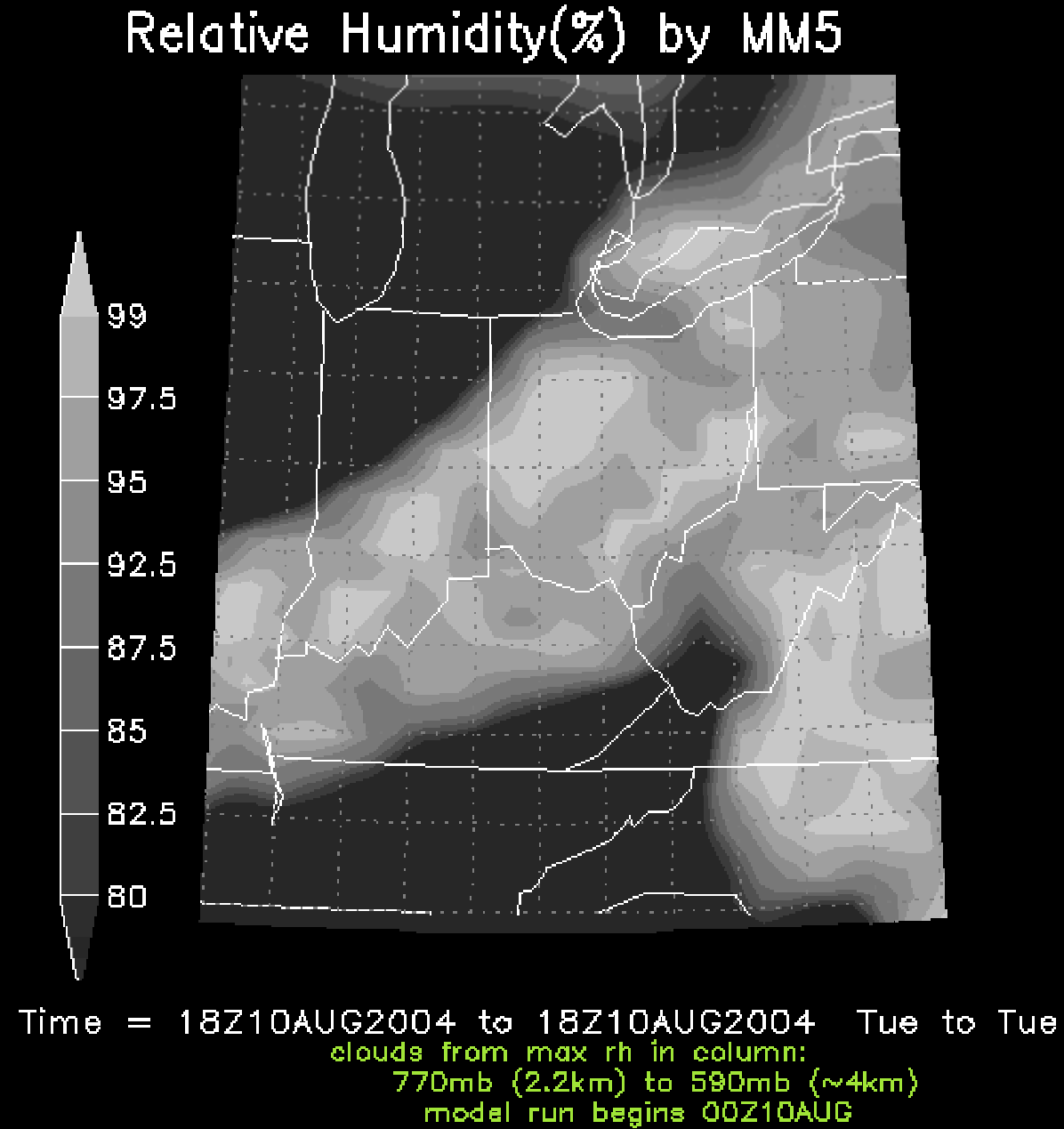


Accurate depiction of CO, aerosols, NO, etc. introduced by ongoing wildfires is absolutely necessary

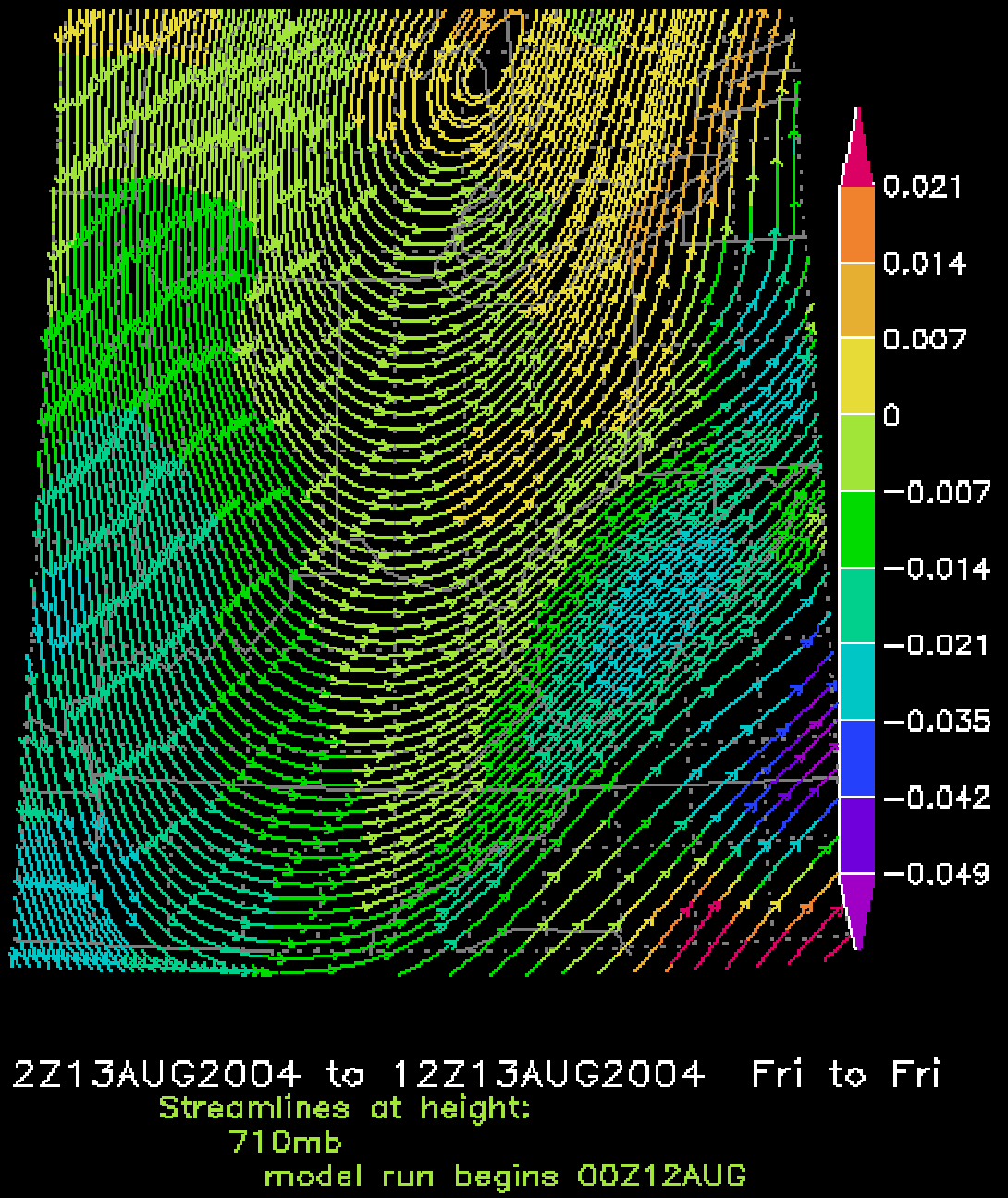
Meteorology

- MM5
  - Initialized from 24 hour AVN forecast
  - Initialized at 0Z (6pm EDT)
  - 72 hour forecast
  - Nested 4km, 12km, 60km grids
  - Also used for cloud forecasting during ICARTT

- MM5 also used for regional cloud modeling (NO ONE publishes a cloud model)

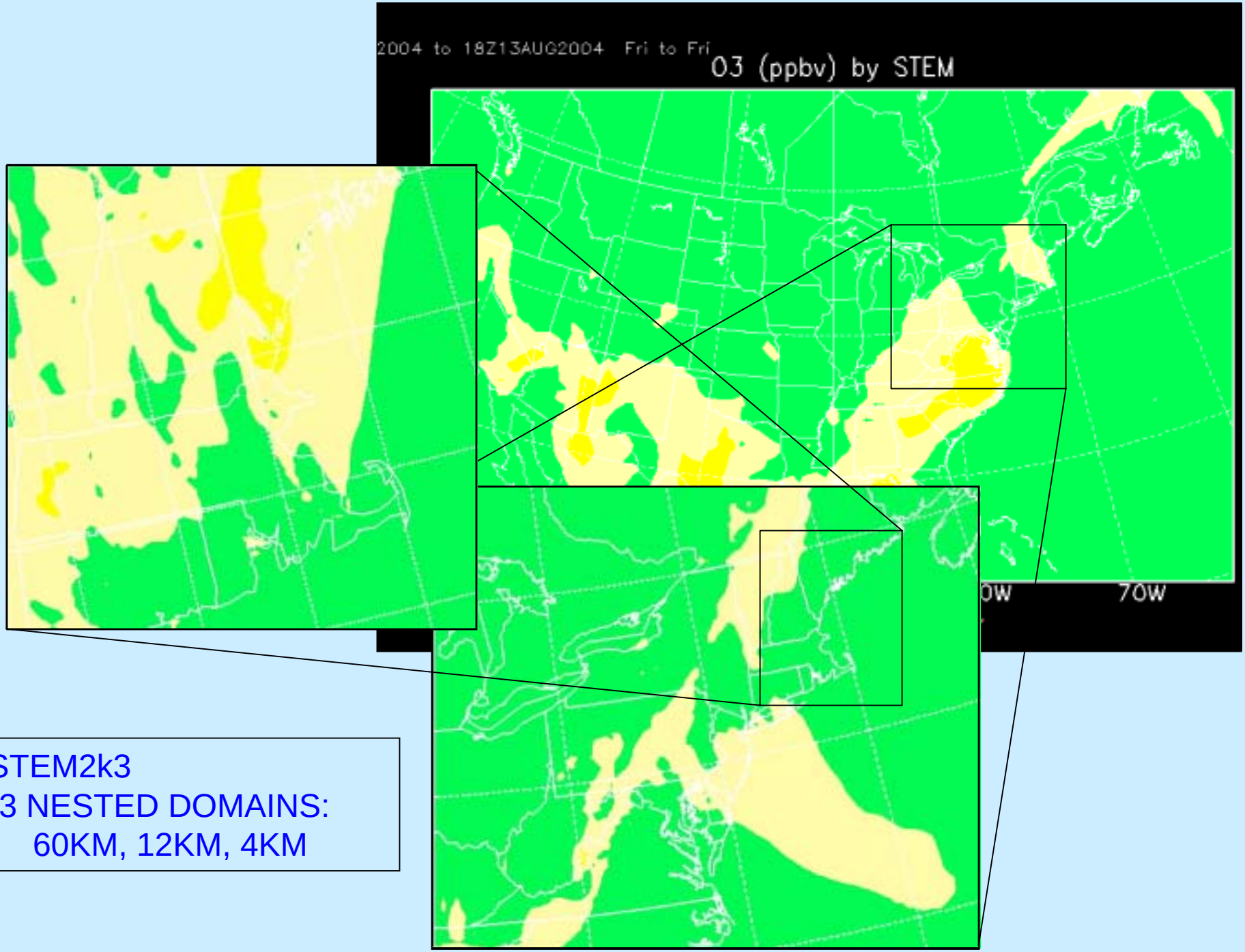


- Another example of MM5 data used for cloud forecasting (NO ONE publishes a vertical motion forecast either)



Chemistry

- Statewide Air Pollution Research Center (SAPRC) chemical mechanism (218 reactions)
- 30 photolysis rates are explicitly computed through UCAR's Tropospheric Ultra-Violet and Visible radiation model (TUV)
- Aerosol Ions are calculated by the on-line four-bin SCAPE II module
- Lateral and top boundary conditions are provided by MOZART-2



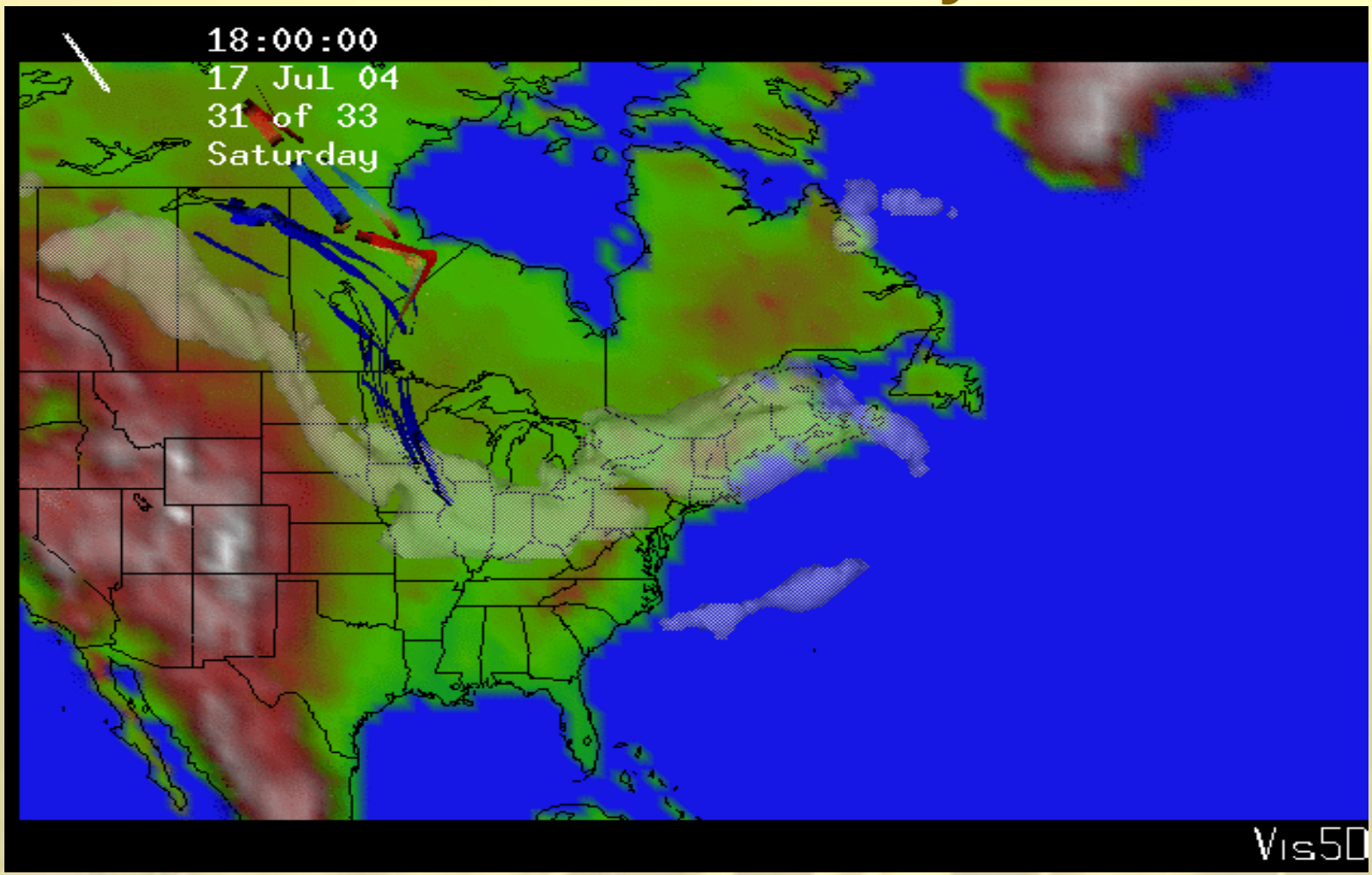
STEM2k3

- 3 NESTED DOMAINS:
  60KM, 12KM, 4KM

Species Forecasted

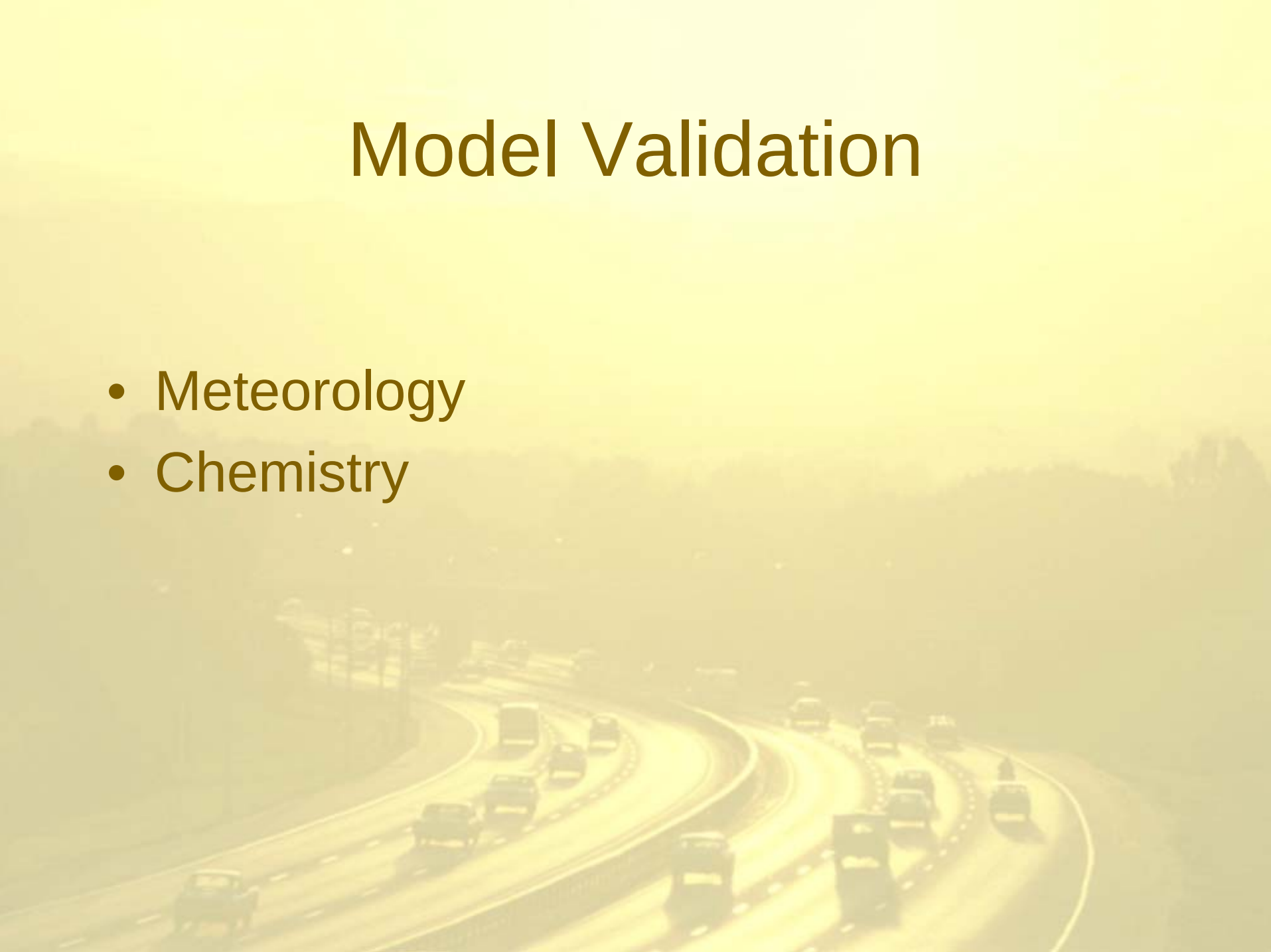
RH, SO2, O3, CO, NO2, HNO3, PAN, RNO3, NH3, OH, NOy, Ethane, Propane, HO2, H2O2, HCHO, Total AOE, BC AOE, OC AOE, Sulfate AOE, AOD, Single Scattering Albedo, Sulfate, Nitrate, NO3 Aerosol Ratio, Ammonium, NH4(3) Aerosol Ratio

Smoke Invades Midwest and Northeast on July 17



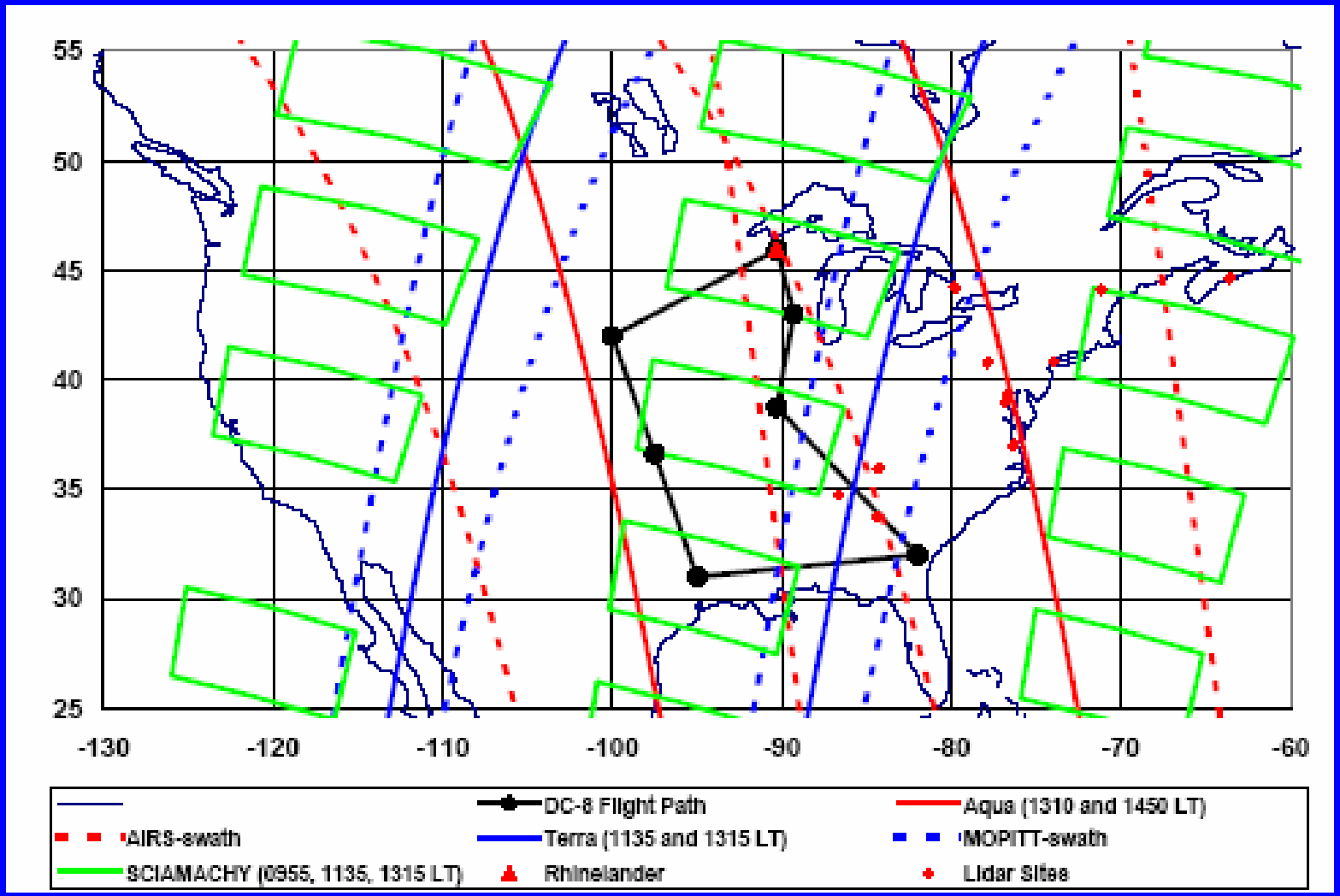
Model Validation

- Meteorology
- Chemistry



ICARTT DC-8

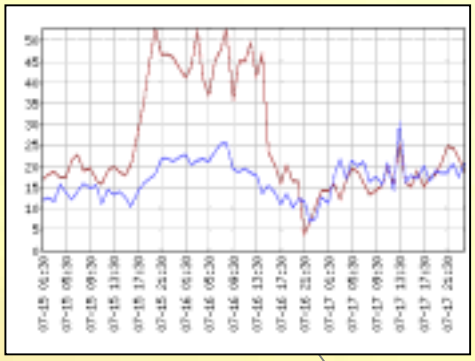
Flight #7 July 12, 2004



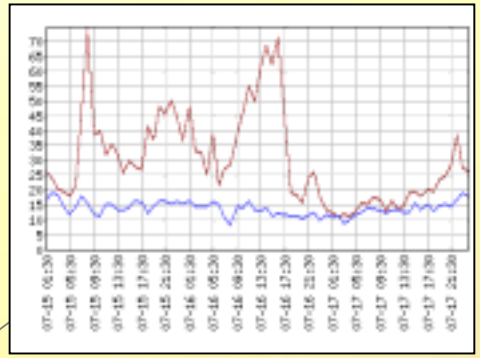
Objectives:

1. **Boundary layer mapping of south-central U.S. (natural gas/pollution?)**
2. **Aged convective/lightning outflow over southeast U.S.**
3. **Validation of CO2 column/Rhinelander, SCIAMACHY, AIRS**

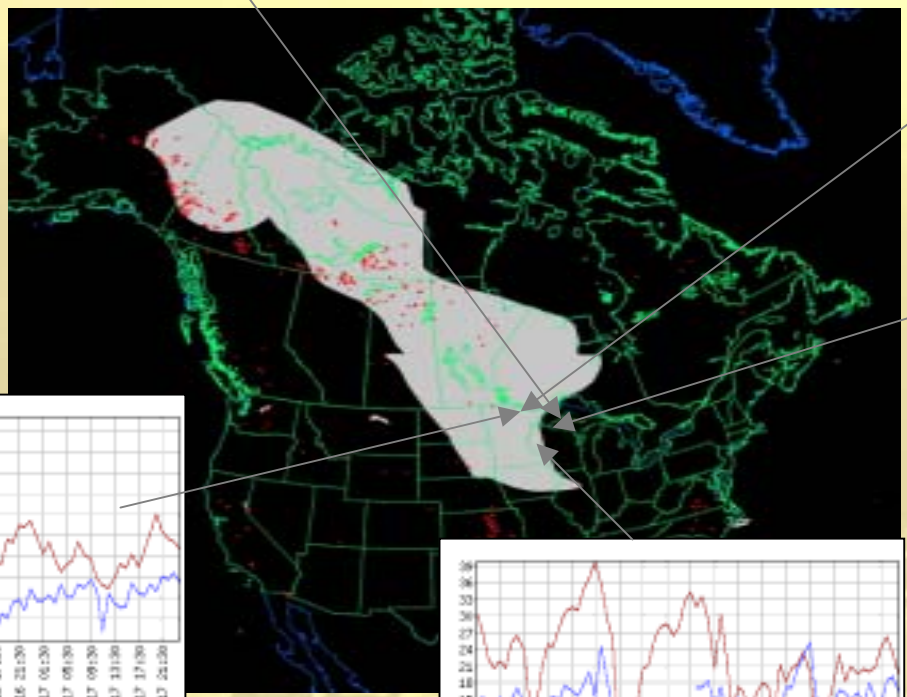
07-16. Smoke episode begins in Iowa

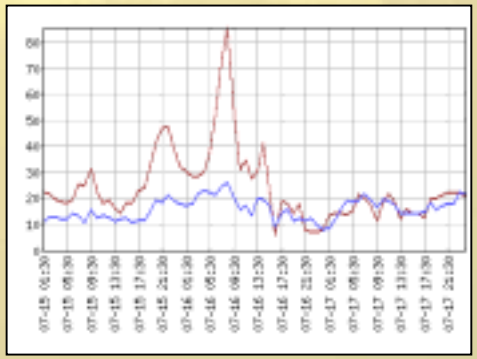


Clinton

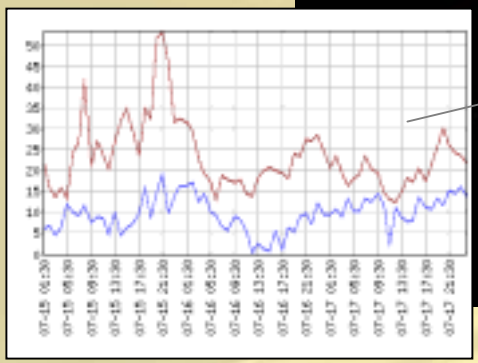


Mason City

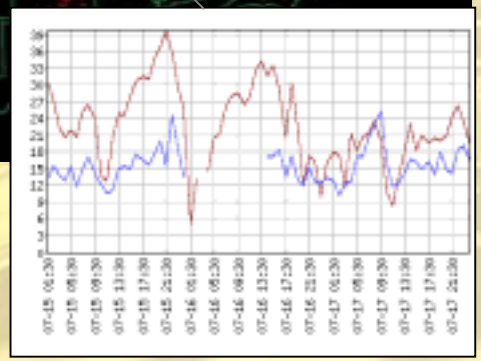




Davenport

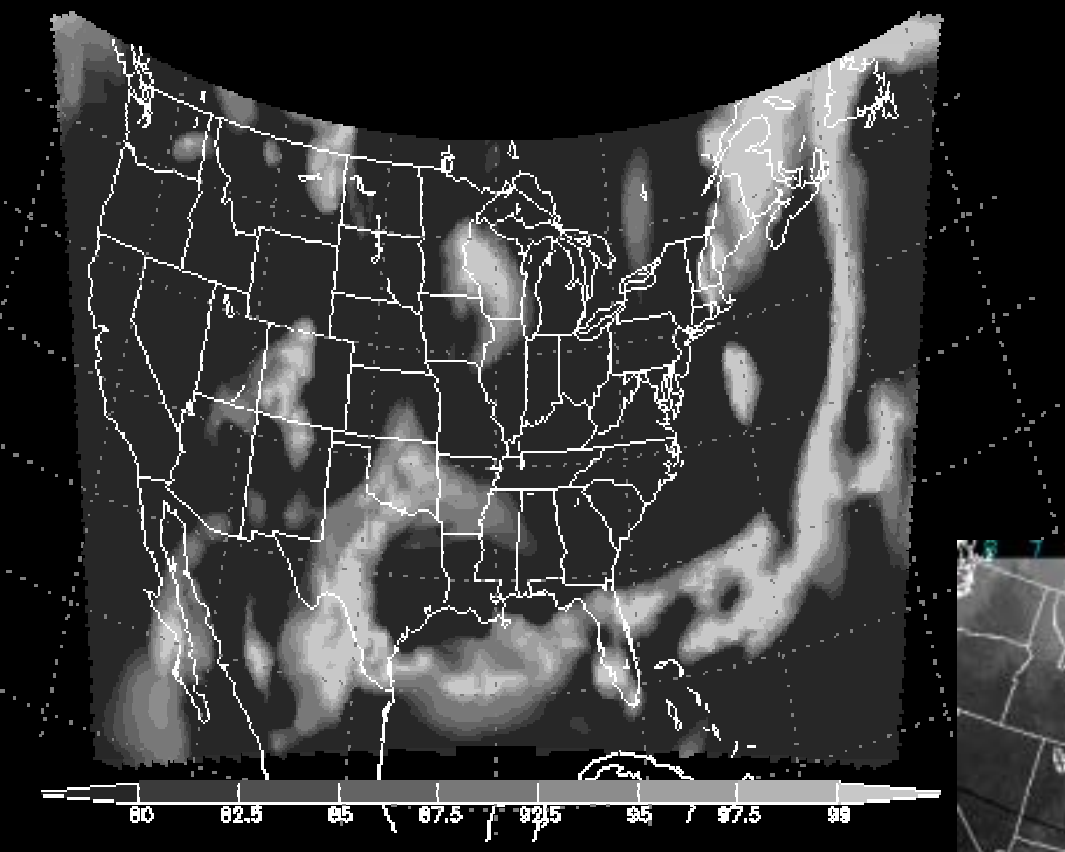


Emmetsburg



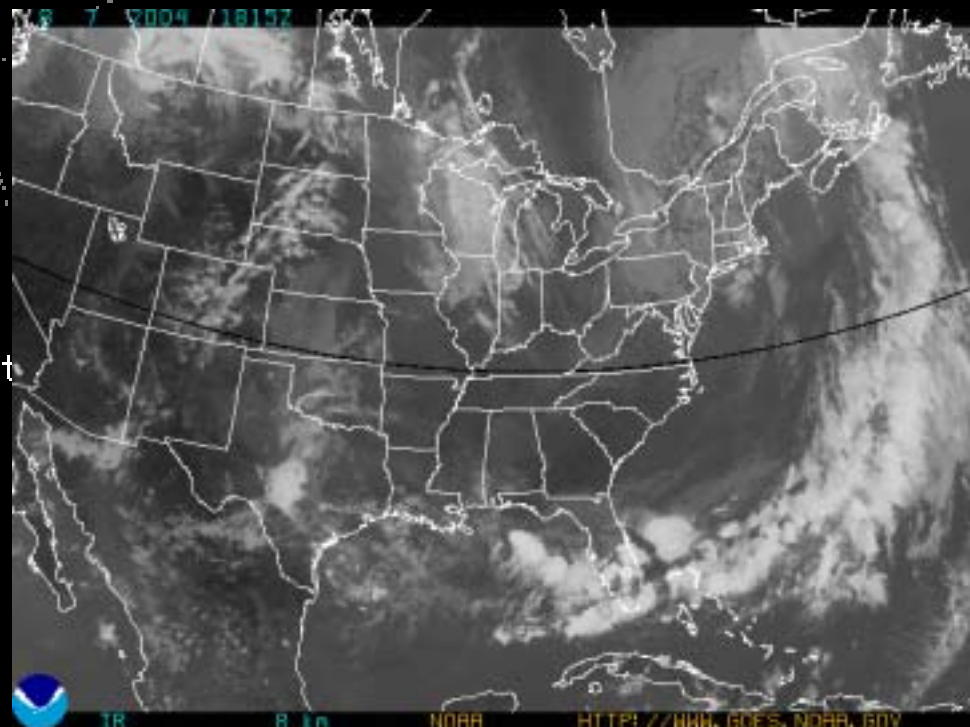
Lake Sugema

Relative Humidity(C) by MM5

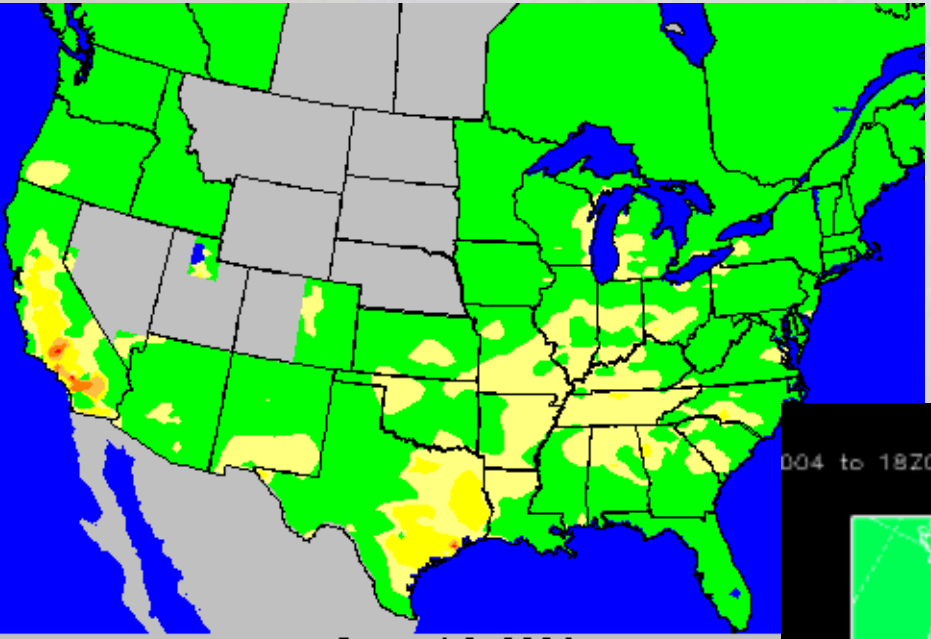


ne = 18Z07AUG2004 to 18Z07AUG2004 Sat t
clouds from max rh in range:
710mb (~freezing level) to 210mb

The MM5's ability to model clouds well is imperative for correct photolysis rates to be modeled



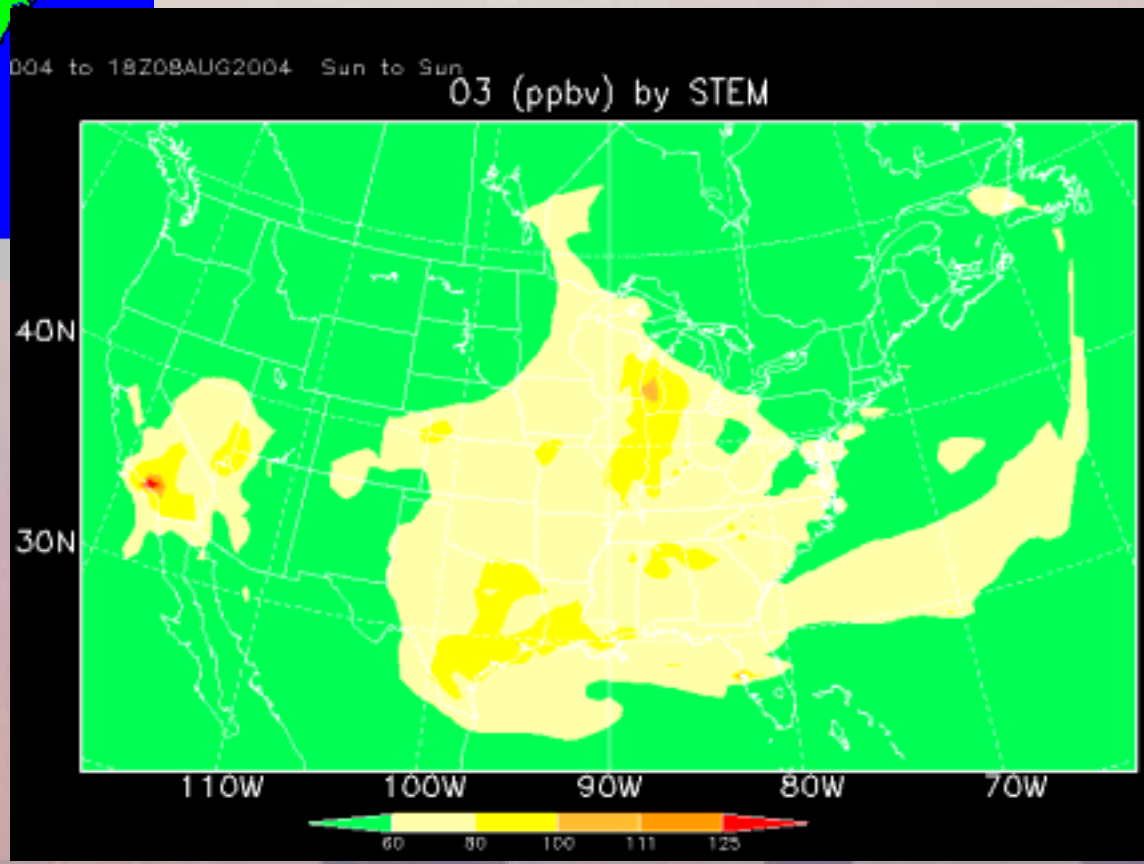
August 8



August 8, 2004

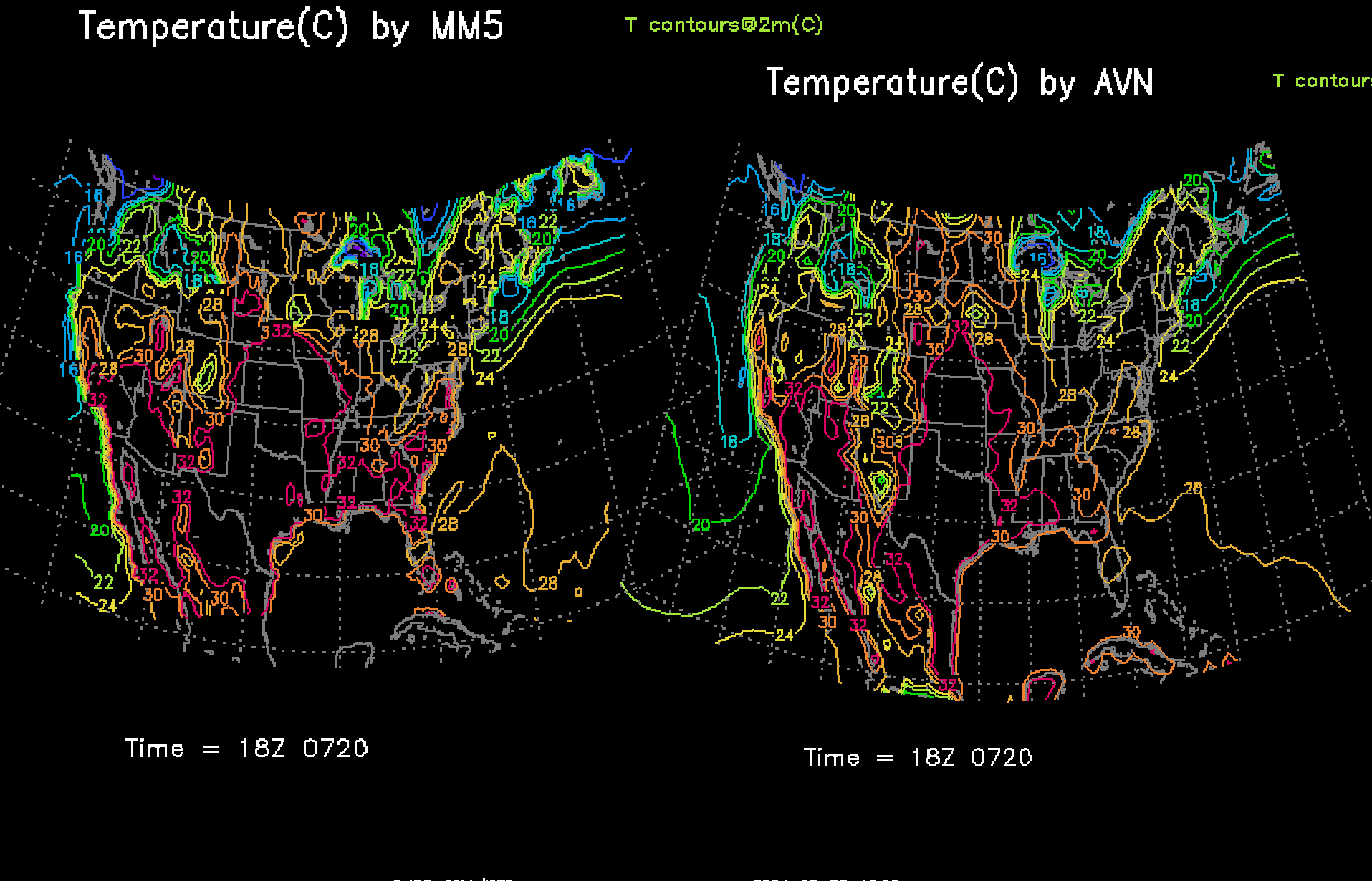
1-hour Average Peak Concentration

- 0-60 ppb
- 61-79 ppb
- 80-99 ppb
- 100-110 ppb
- 111-124 ppb
- 125+ ppb
- Data not available

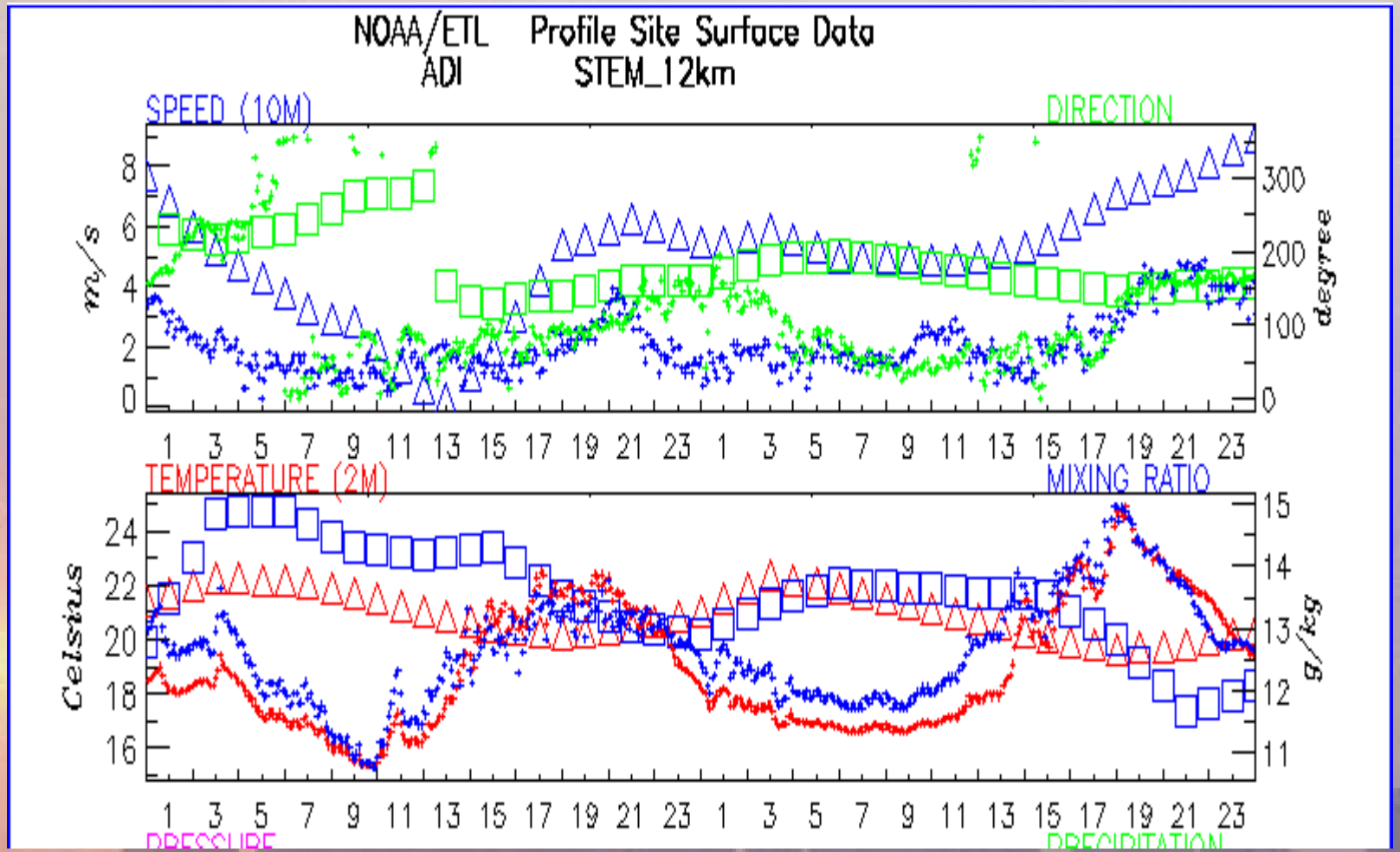


Temperatures continually show a 2 C discrepancy

07/20



Temperature and wind from Appledore Island (July 21 & 22)



The Future

- Post-analysis
- Settle some arguments
- Informed policy decisions (we can only inform and encourage)
- Global transport in great evidence

Not just thank you

- Department of Energy, GCEP
- Center for Global and Regional Environmental Research, University of Iowa
- Gregory Carmichael, Narisara Nthongboonchoo, Bhupesh Adhikary, Marcelo Mena, Youhua Tang
- Renyi Zhang
- Jeff Gaffney, Milt Constantin