Global Chemical Modeling – Relevance to Regional Air Quality Management

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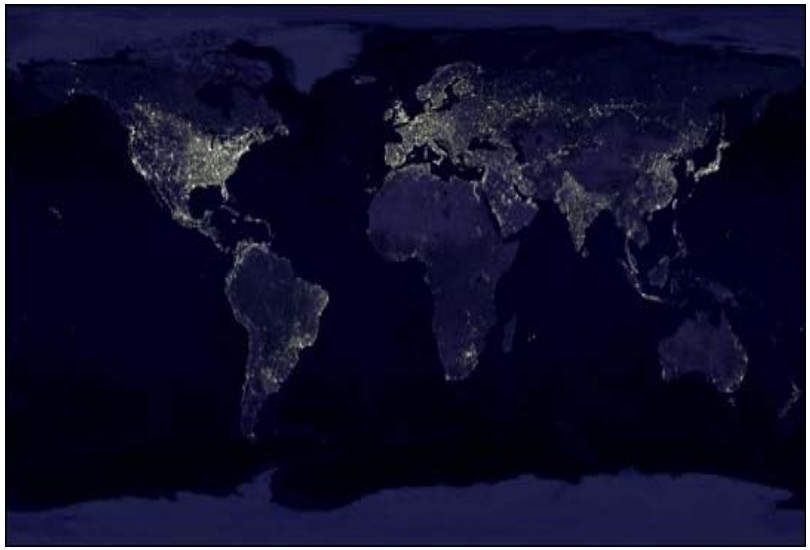
U.S. Air Quality Standards

- Ozone
  - 1971 – 0.08 ppm (1-hr)
  - 1979 – 0.12 ppm (1-hr)
  - 1997 – 0.08 ppm (8-hr)
  - 2008 – 0.070-0.075 ppm (8-hr) *proposed*
  - Current continental background
    - 0.03-0.04 ppm

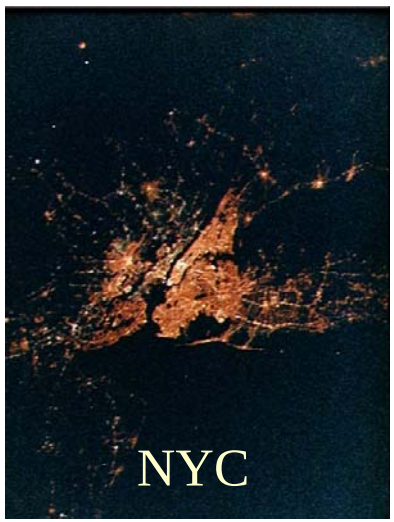
U.S. Air Quality Standards (cont.)

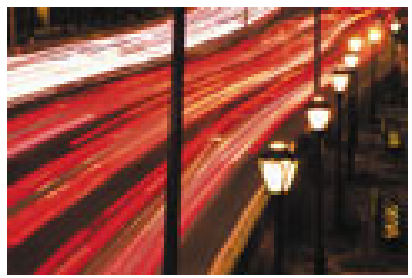
- PM2.5
  - 1997
    - 15 µg/m^3 (annual average)
    - 65 µg/m^3 (24-h average)
  - 2006
    - 15 µg/m^3 (annual average)
    - 35 µg/m^3 (24-h average)
- Persistent Bioaccumulative Toxics (PBTs)
  - Hg, Dioxins, Polychlorinated Biphenyls (PCBs)

Understanding and Predicting Changes in Air Quality Requires the Development of Modeling Tools that Connect Among Various Scales



- **Global** – e.g. climate change, stratospheric ozone, intercontinental transport, persistent-bioaccumulative toxic pollutants (Hg, dioxins)
- **Regional** – e.g. ozone, fine particles health, acid rain, visibility, nutrient loadings
- **Local** –e.g. ozone, PM health, air toxics
- **Personal** – indoor air/outdoor penetration, asthma

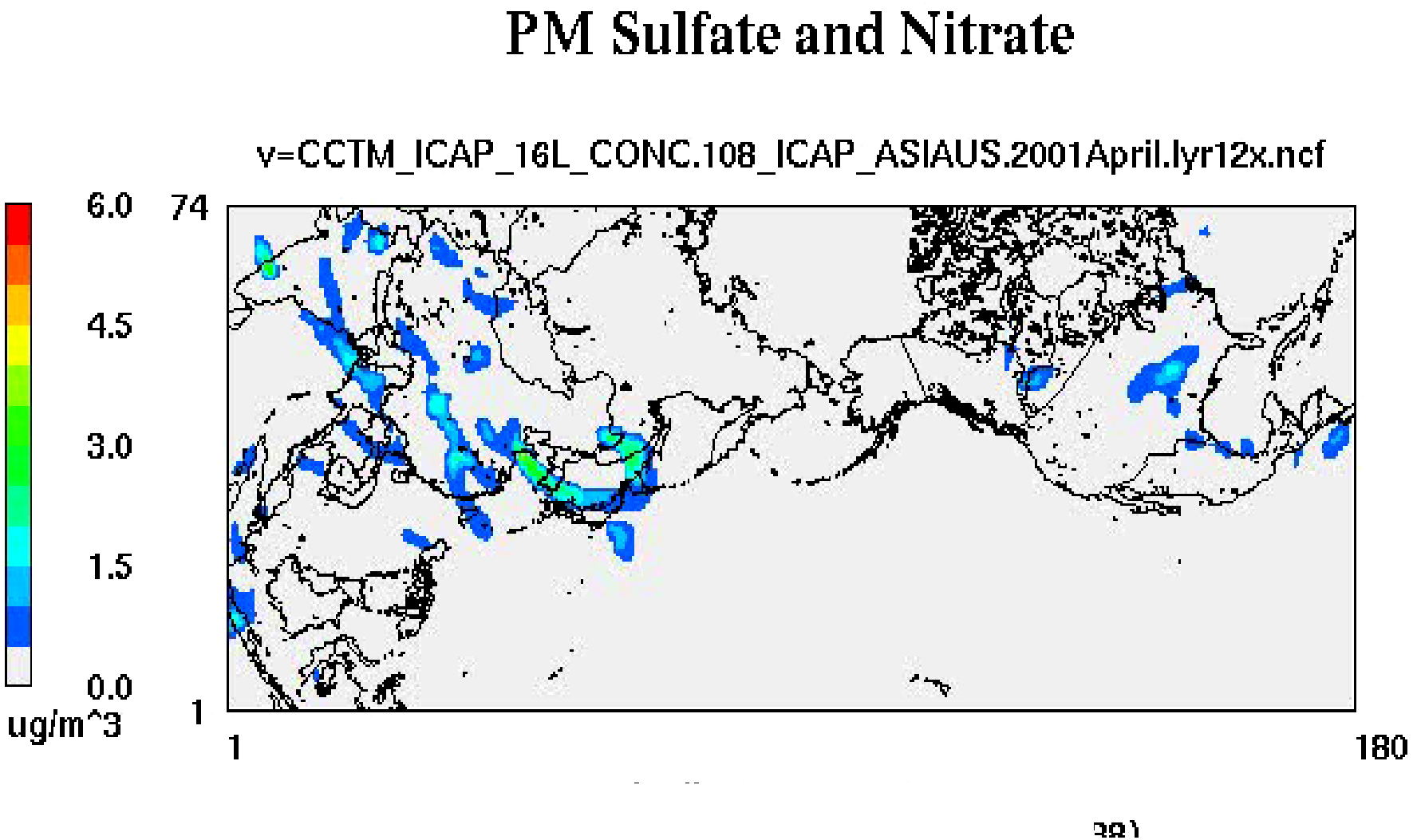




Application: Informing Continental/ Regional Scale Modeling with Appropriate Boundary Concentrations

- Intercontinental transport of air pollutants
- Stratosphere-Troposphere exchange

Trans-Pacific Transport of Air Pollutants: PM

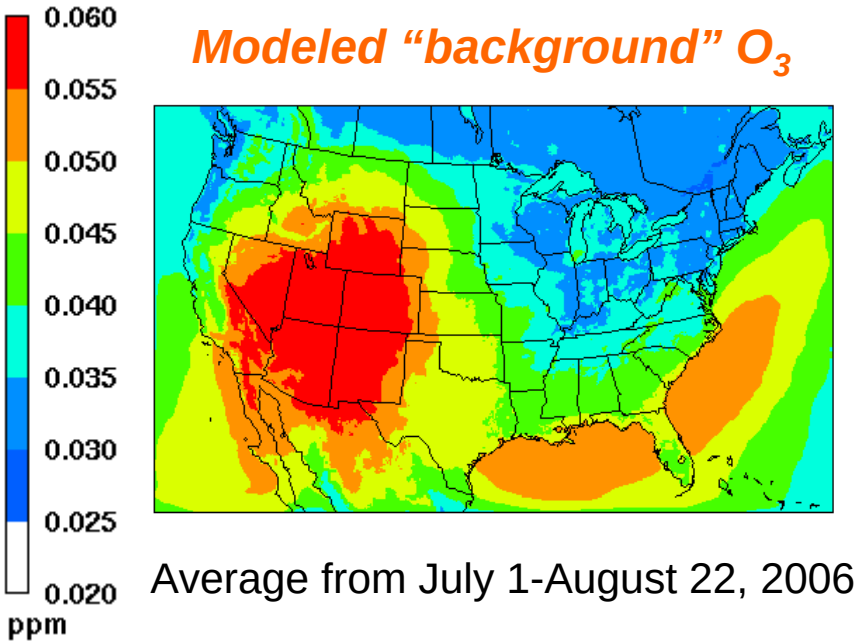


CMAQ model application, courtesy of Carey Jang (EPA/OAQPS, ICAP project)

Impact of Boundary Conditions

- Added diagnostic tracers to track impact of lateral boundary conditions: surface-3km (***BL***) and 3km-model top (***FT***)
  - Quantify modeled background

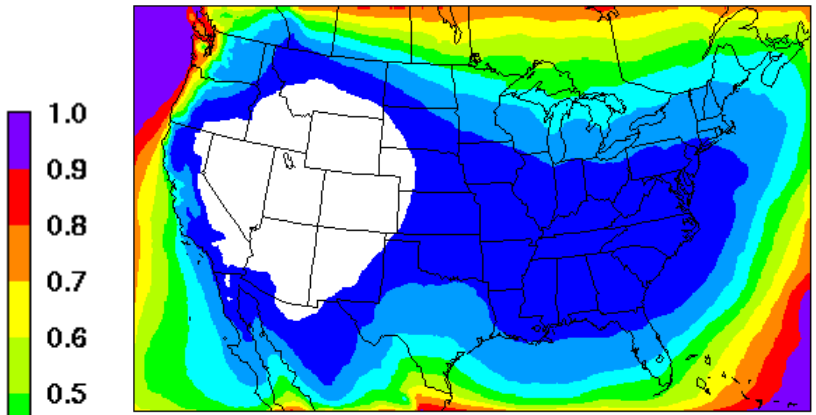
Modeled "background" O_3



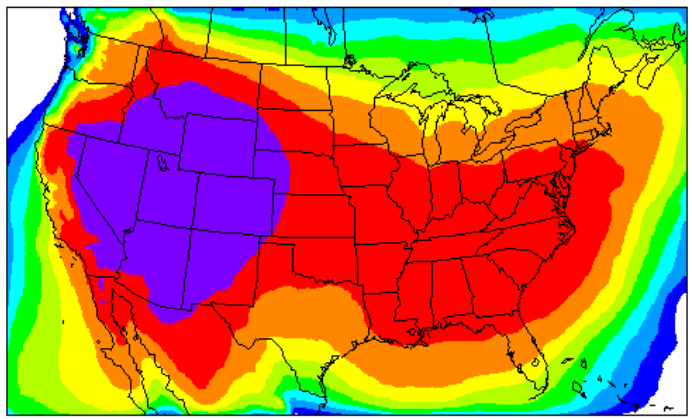
Average from July 1-August 22, 2006

Relative Contributions

"Boundary Layer": Surface – 3km



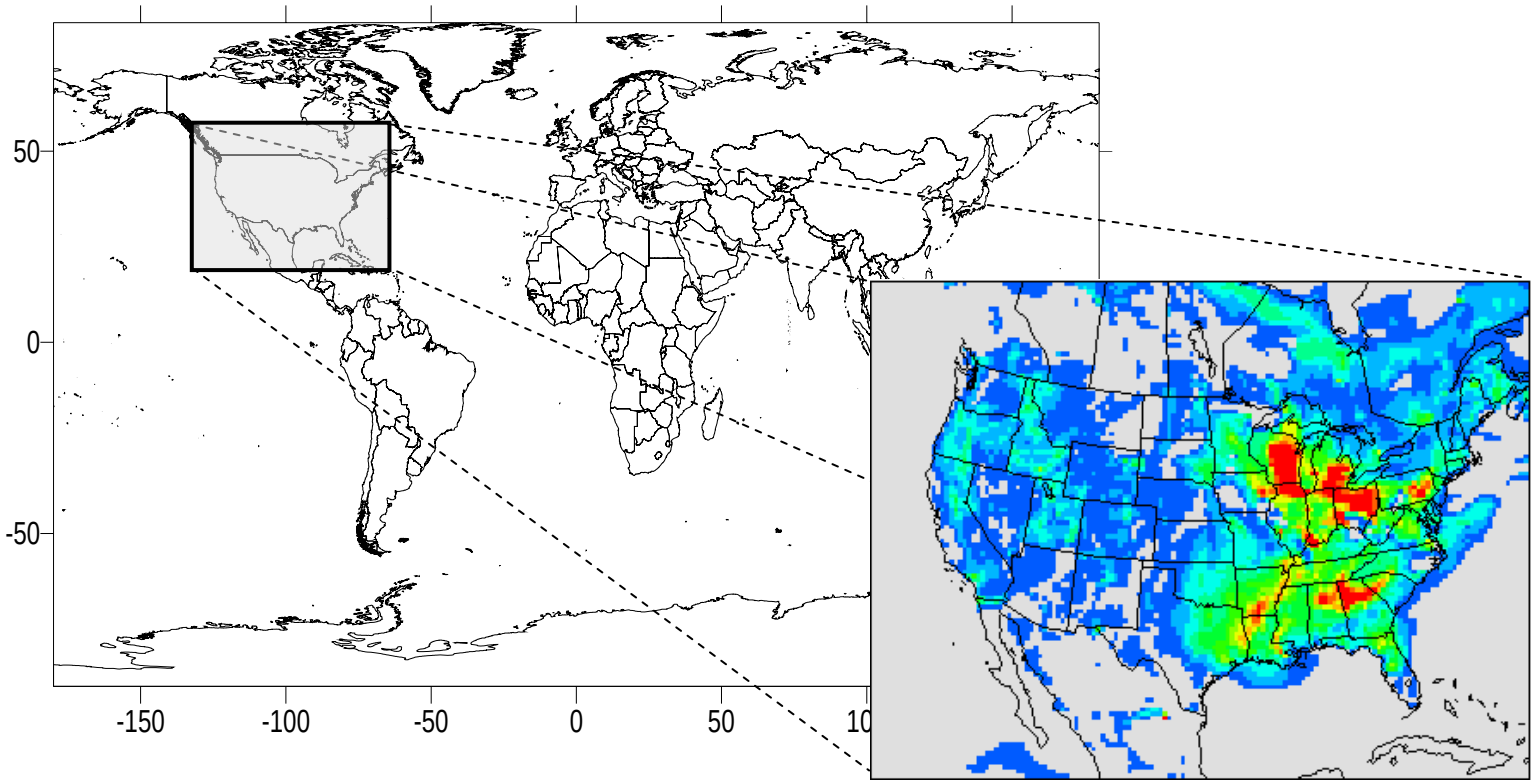
"Free Troposphere": 3km – Model top



➡ LBC in FT determines surface background

⇨ FT processes are important in regional modeling and deserve greater attention

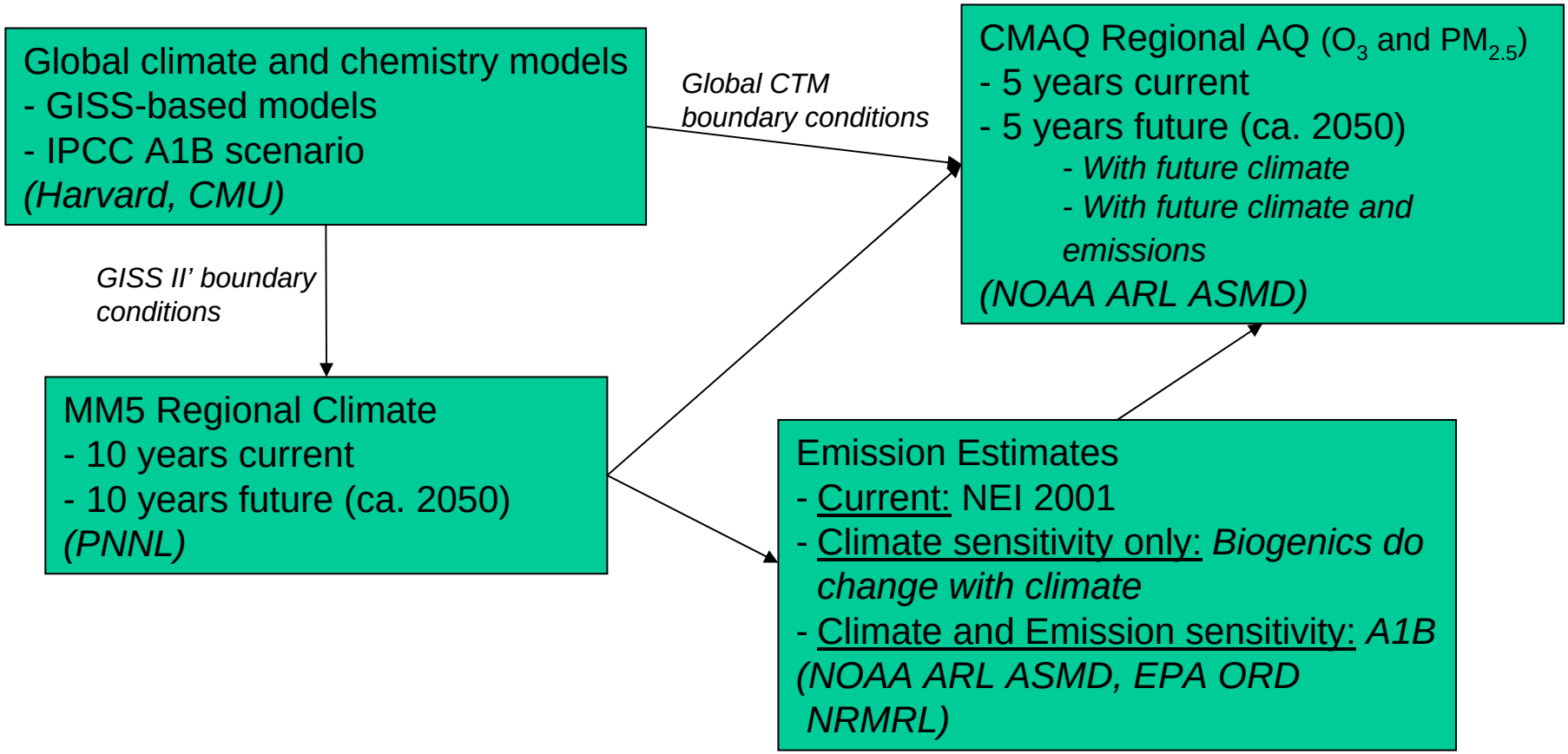
Application: Evaluating the Interactions of Climate Change and Air Quality



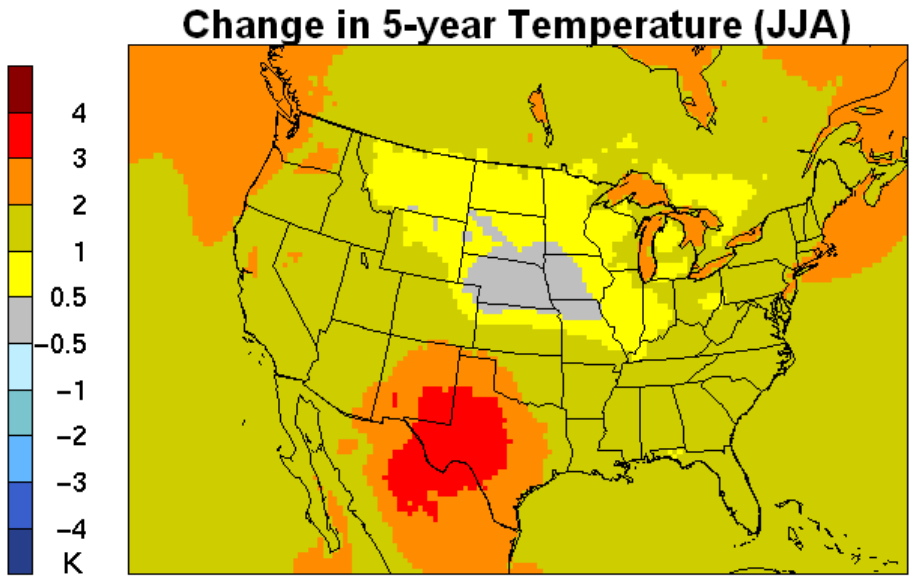
- **Downscaling of Global to regional-scale models of climate and air quality**
  - ***– How sensitive is air quality to potential climate change scenarios?***

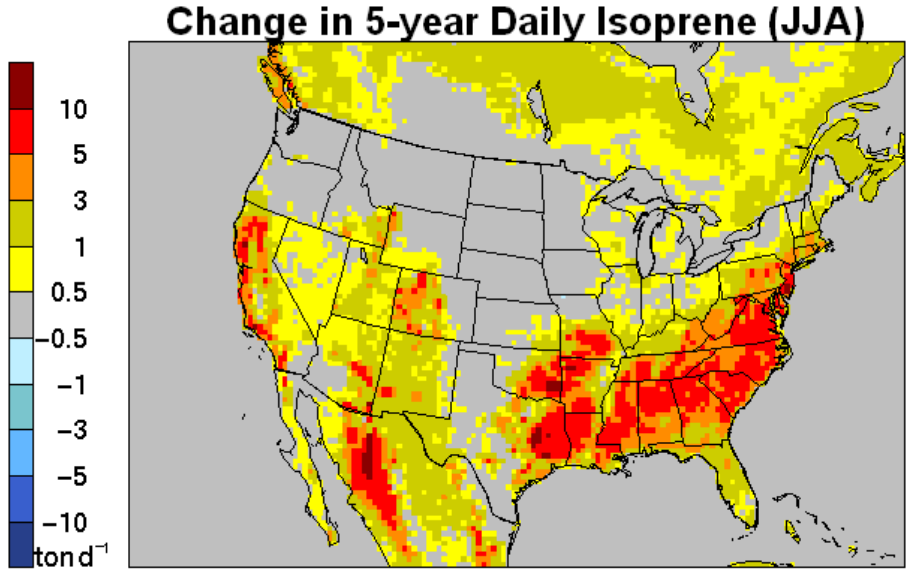
Linking Global to Regional Models:

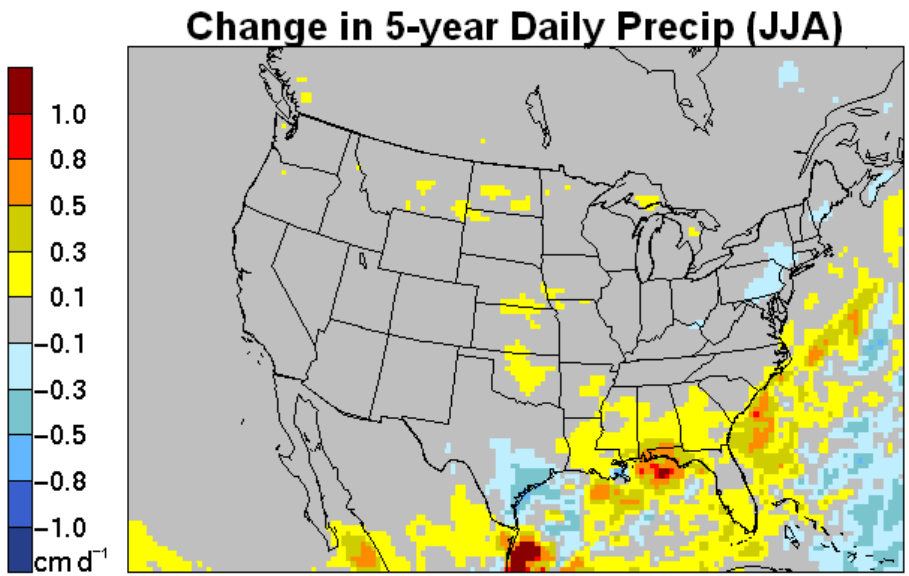
Assessment of Climate Impacts on Regional Air Quality (CIRAQ)

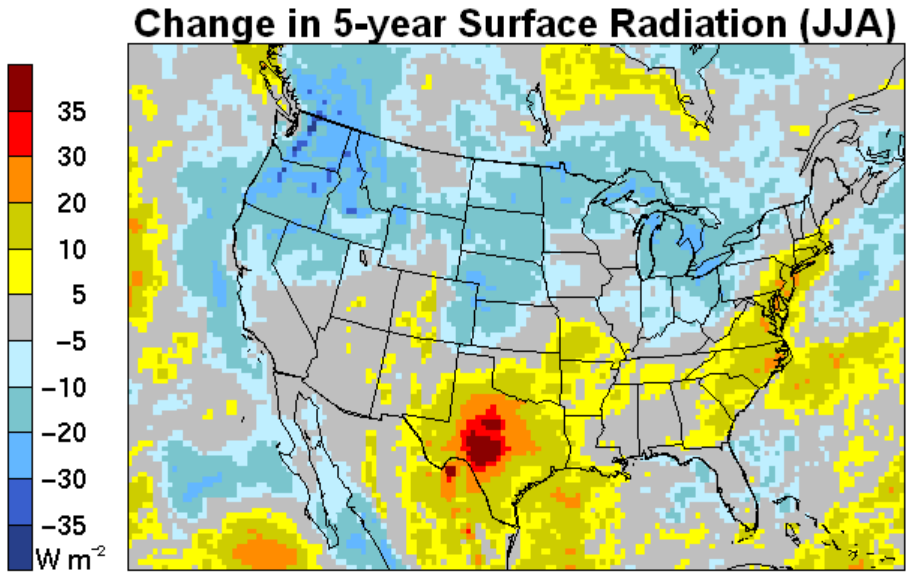


[Future – Current] Summer (JJA)







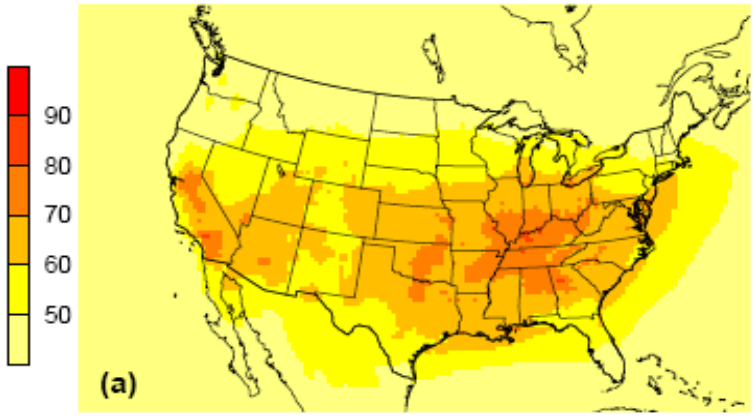


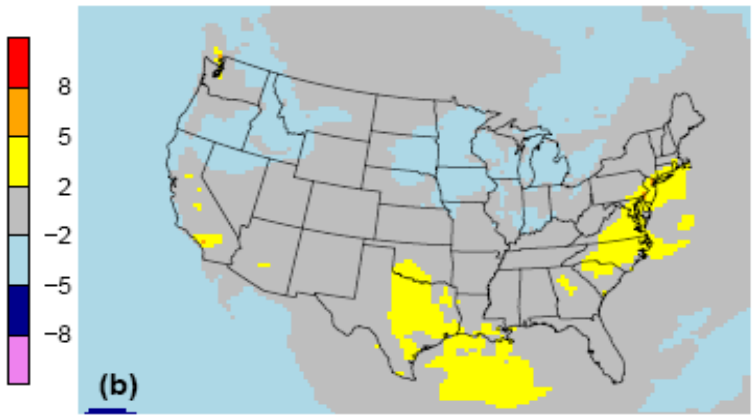
Future vs. Current CMAQ Max. Daily 8hr O_3(MDA8) : June – August Mean

Mean MDA8 O3 (ppb), Jun-Aug “1999-2003” **(Current)**

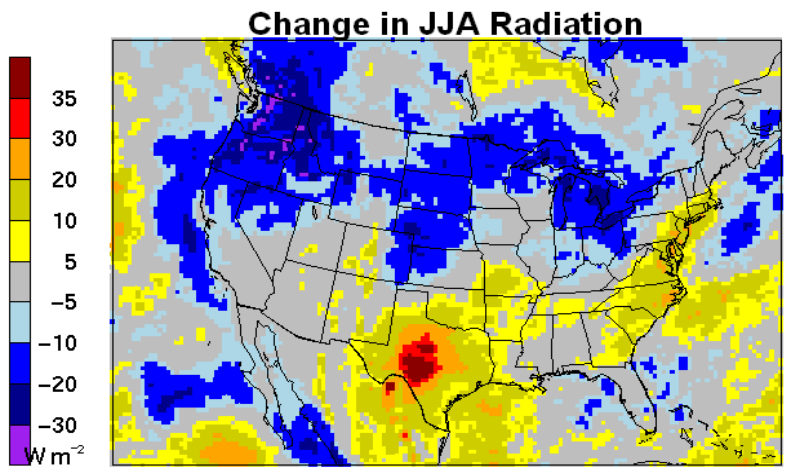
Change (future-current) in mean Jun-Aug MDA8 O3, **Future =**

- **“2048-52” A1B Climate**
- **2001 anthropogenic emissions**





2-5 ppb increase in TX, eastern U.S.; comparable decreases in Midwest, PNW



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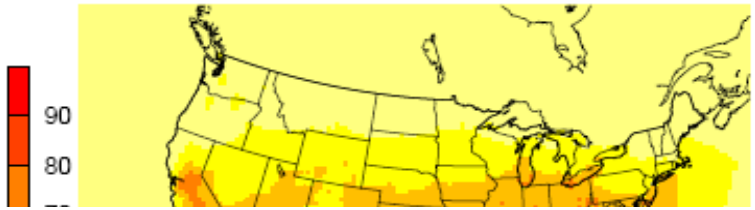

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- **“2048-52” A**
- **2001 anthrc**

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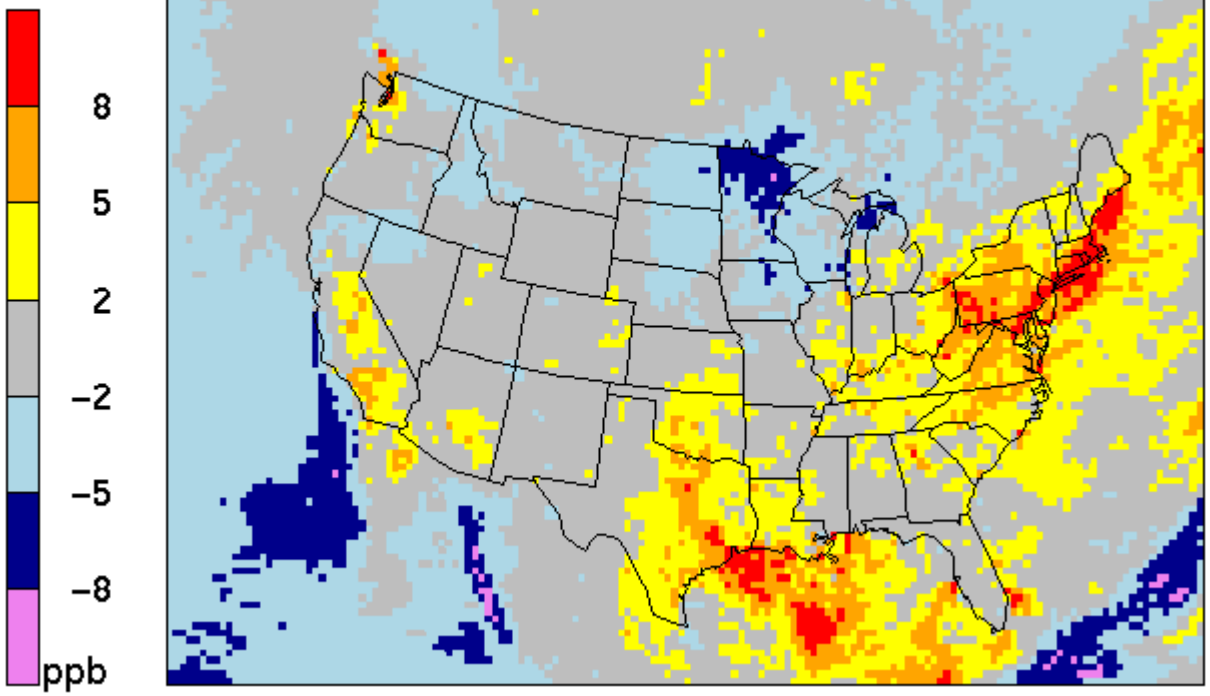

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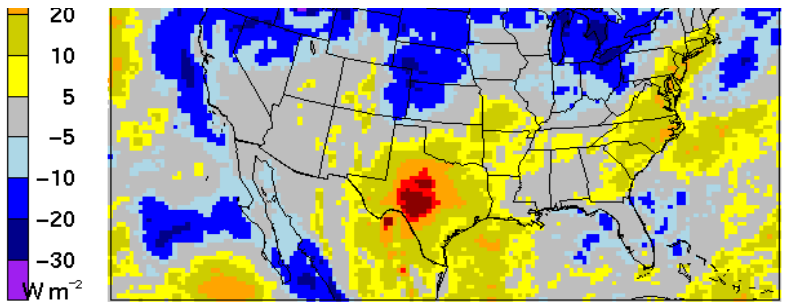
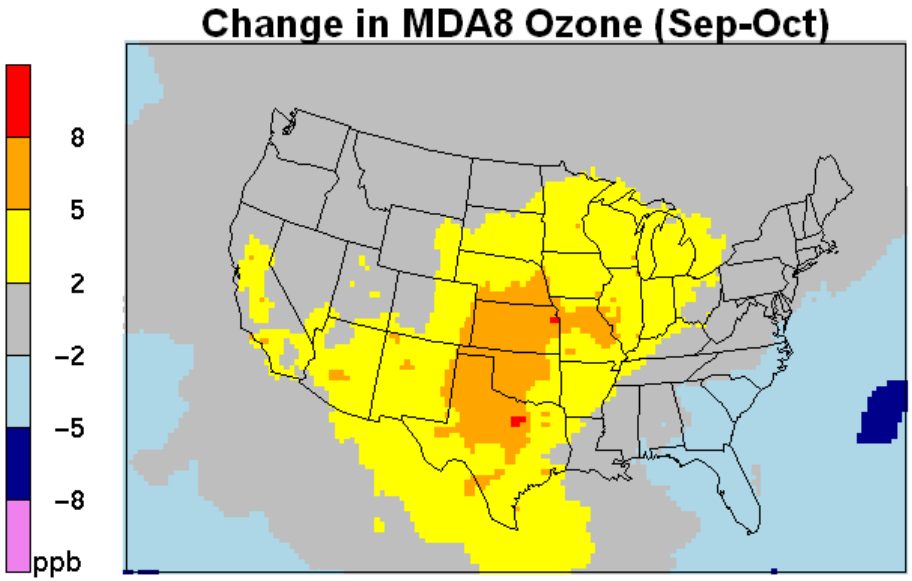
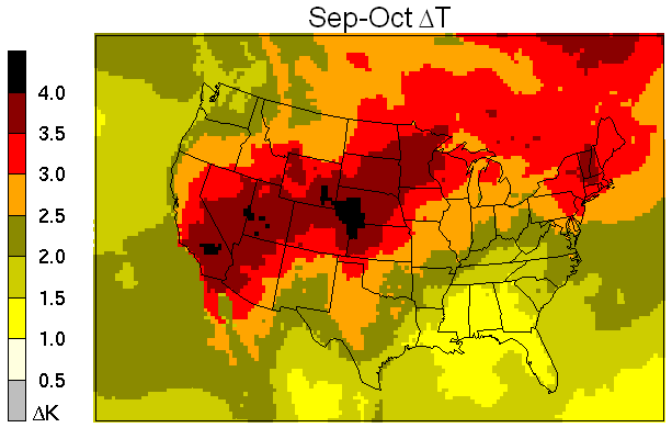
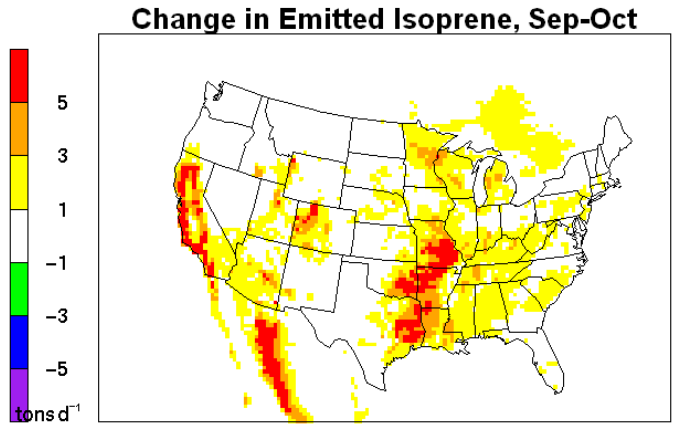
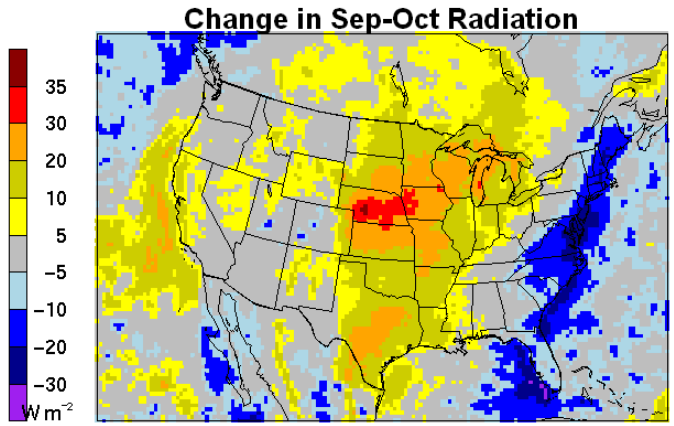


Future Climate Simulations Suggest Extension of Ozone Season









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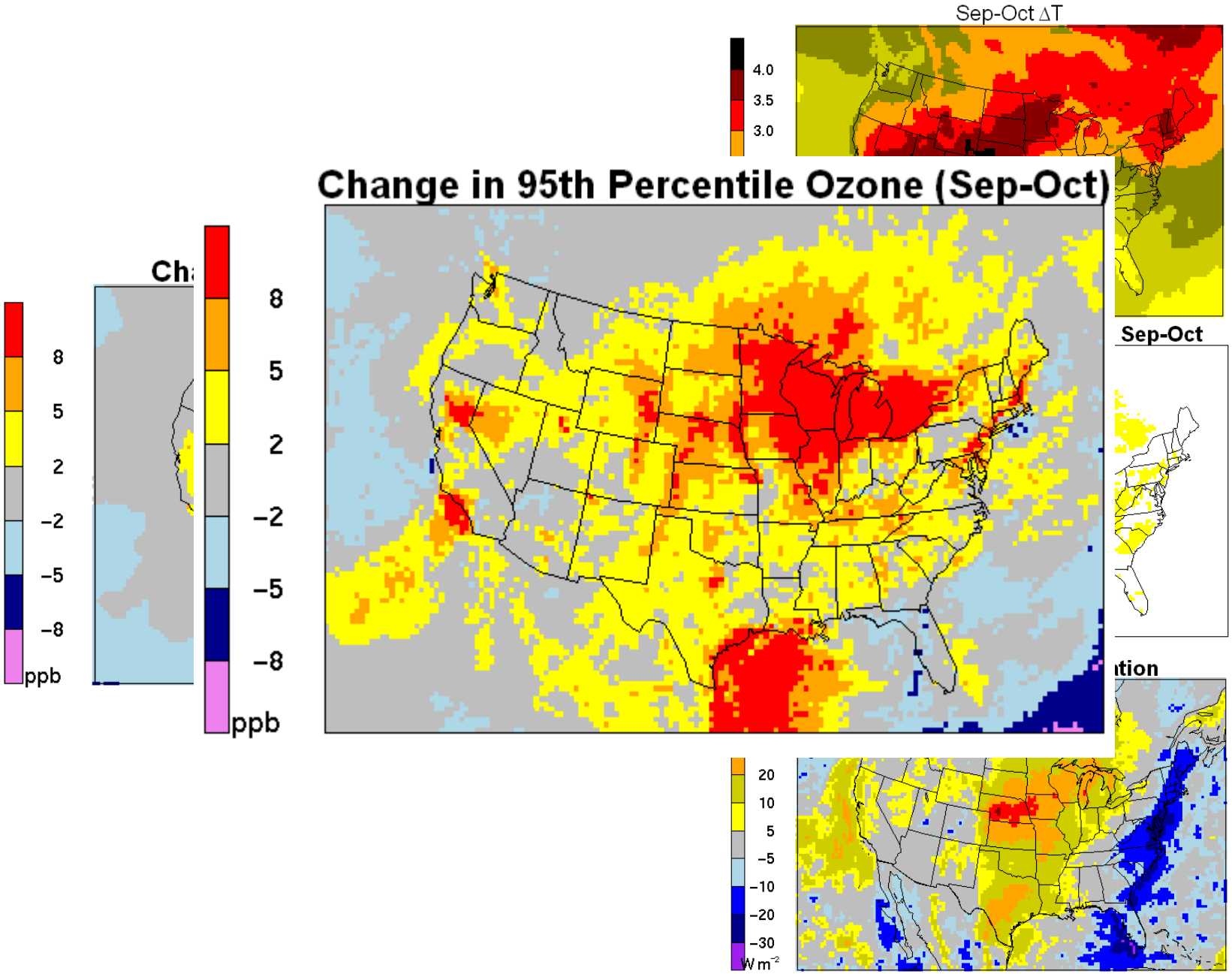

Summary

- Linkage of continental/regional models to global CTMs is desirable for air quality management analyses
  - Quantify impacts on boundary concentrations from:
    - Intercontinental and outside-domain transport (discrete events)
    - Exchange between stratosphere, free troposphere, and lower troposphere (continuous process)
    - Potential climate change impacts on regional/urban air quality (decadal analyses)