

Regional Air Quality in a Global Context

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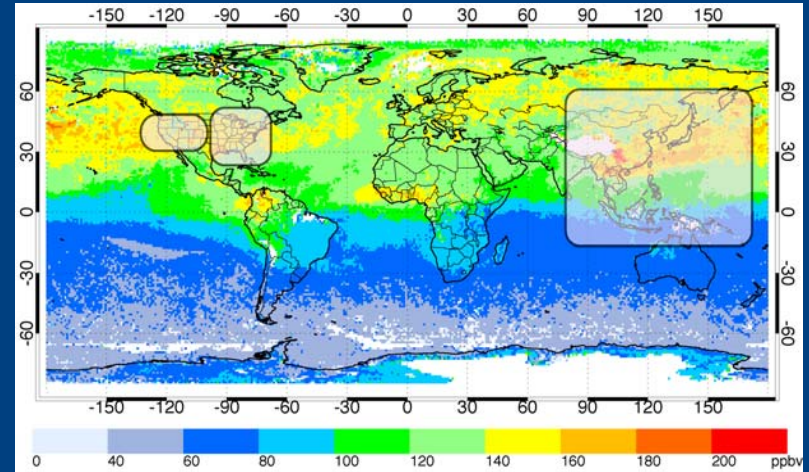


Regional Air Quality Issues



- Changing global air pollution
 - What are the characteristics of inflow from other regions?
 - How sensitive are regional models to this inflow?
 - What regional processes affected imported species?
- Climate change
 - What is the relationship of regional pollution to current climate variability?
 - How might this change under future climate?
- Urban growth
 - How much control do cities have over their local AQ?
 - How do mega-cities affect pollution throughout the region?
- Energy Use
 - Impacts of more efficient and/or cleaner fuel and technologies
 - Impacts of different energy use patterns (driving, electricity demand, etc.)

Related Work



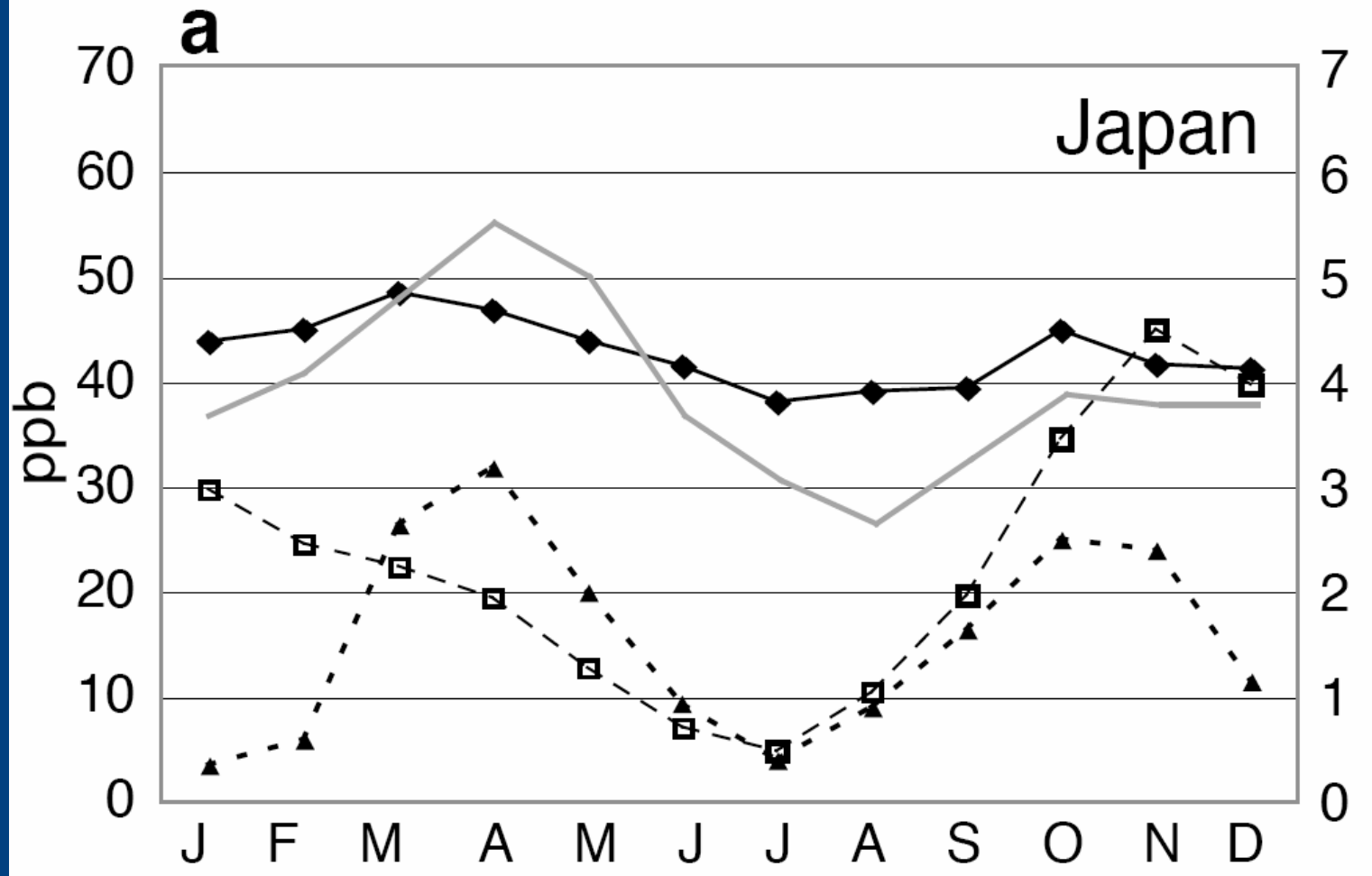
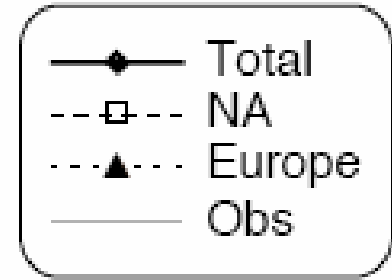
- Examining the effect of regional processes on hemispheric air pollution with WRF-Chem and CAM-Chem
 - *Louisa Emmons, Peter Hess, Meiyun Lin, Claus Moberg*
- Transport and chemistry over the Great Lakes with CMAQ
- Seasonality of long-range transport impacts on North America with MOZART
- Impact of climate on O₃ and PM (data analysis and CMAQ modeling)
- Impact of urban growth and technology on transportation emissions in the Midwestern U.S.



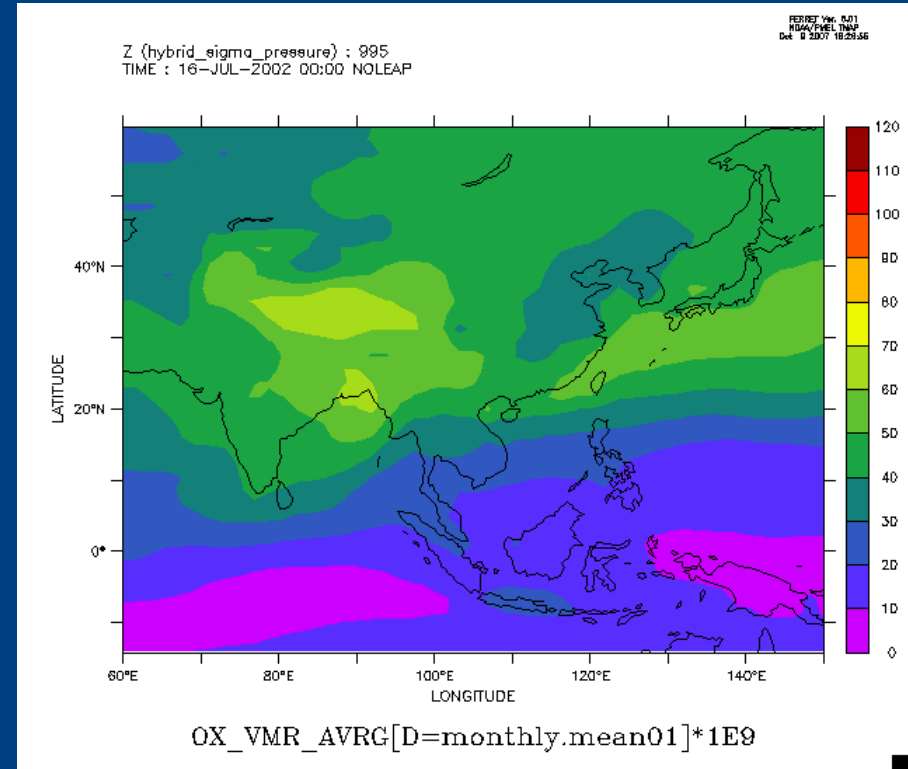
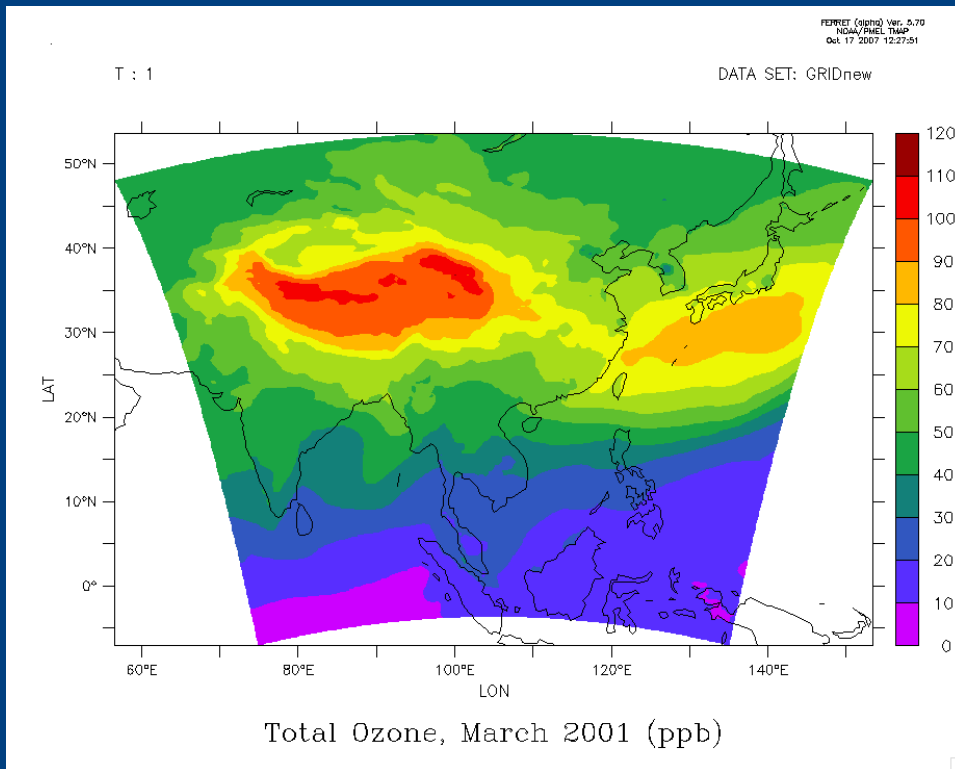
Strategies for connecting with HTAP

- Identify key import processes
 - Free troposphere to surface mixing
 - Stagnation associated with regional features (trapping over lakes, valleys)
 - Dry and wet deposition
 - Chemical interactions with local emissions
- Which of these are not well captured in HTAP global simulations?
- Design MICS-Asia experiments to explore the most uncertain mechanisms

Global Model + Obs to inform design of RAQM simulations



March 2001, Total O₃

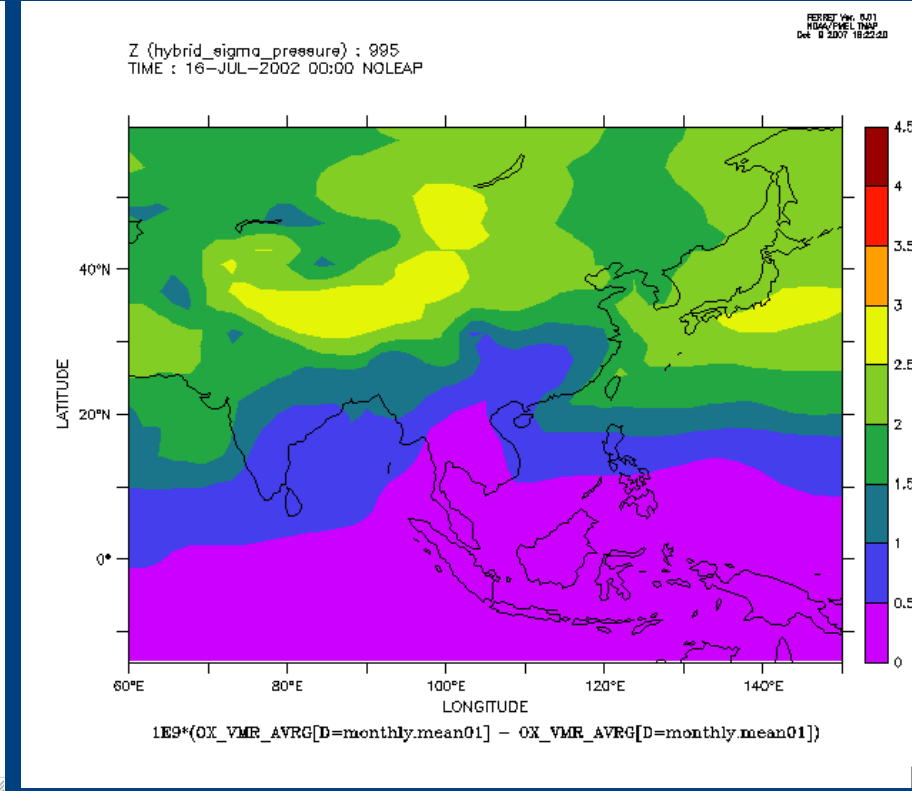
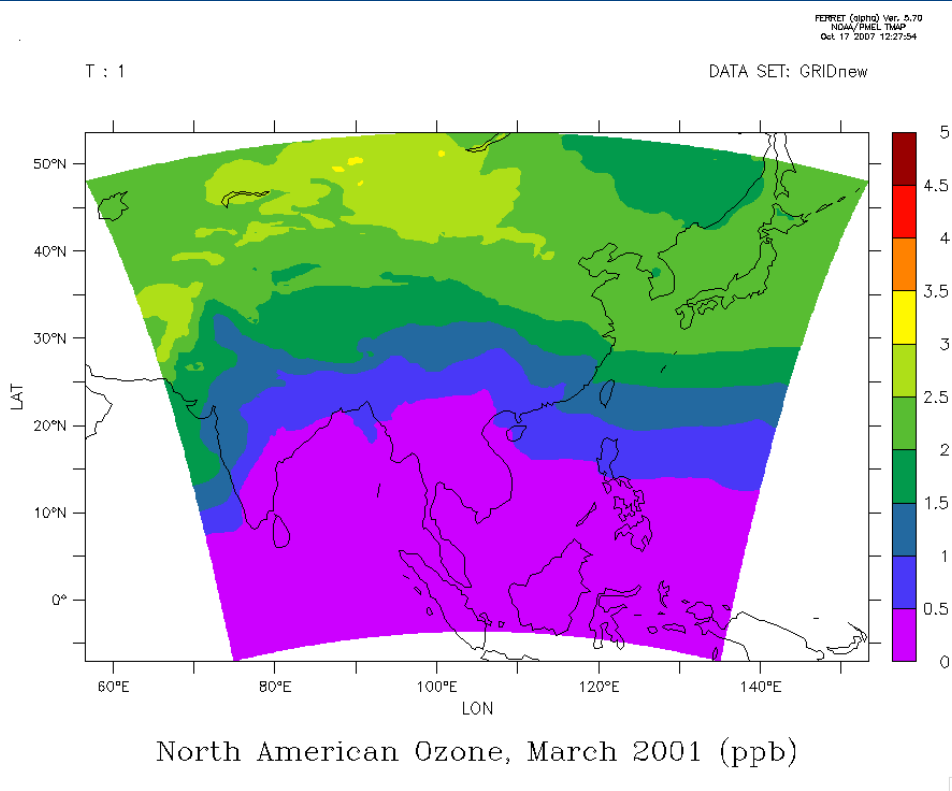


CMAQ

MOZART

T. Holloway, S. Spak, C. Littlefield, H. Hyami,

North American Impact

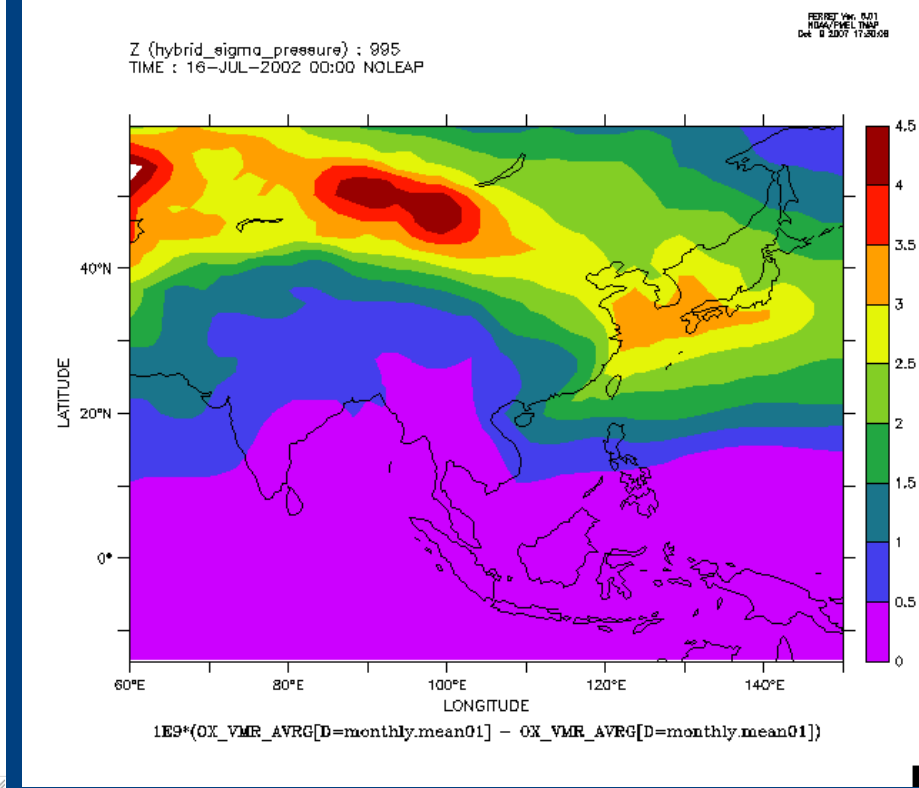
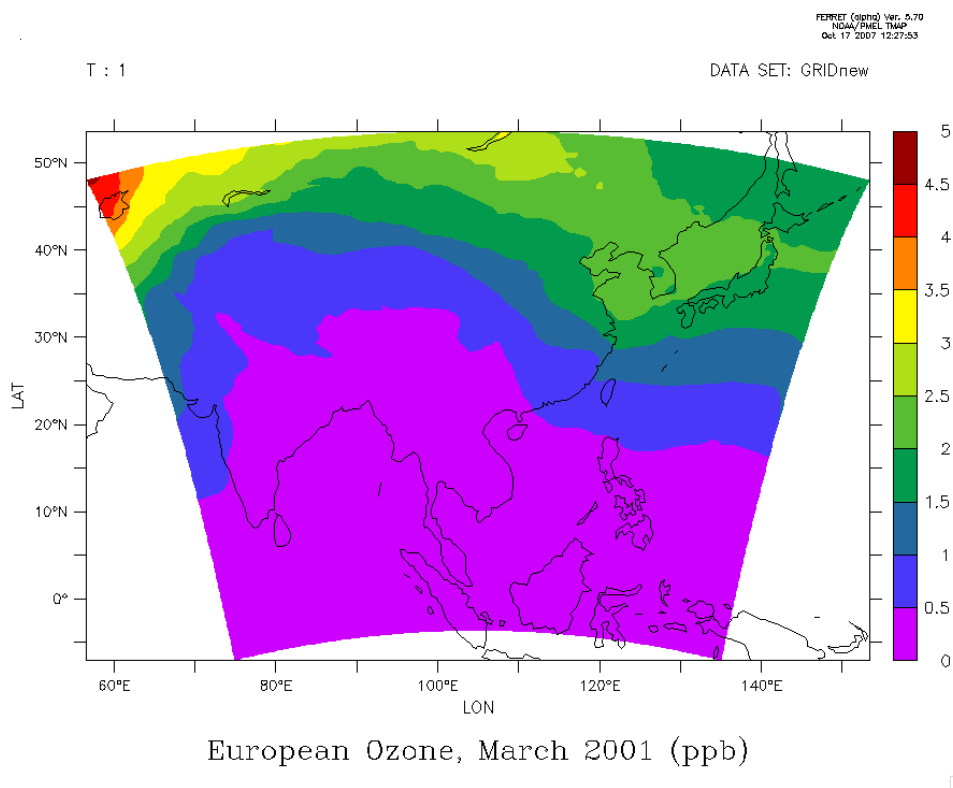


CMAQ

T. Holloway, S. Spak, C. Littlefield, H. Hyami,

MOZART

European Impact



CMAQ

MOZART

T. Holloway, S. Spak, C. Littlefield, H. Hyami,



Proposed Steps (1)

- Identify study questions
- Can questions be preliminarily addressed with existing data?
 - If yes, use MICS-Asia II results, HTAP simulations, EANET data, and satellite measurements to explore hypotheses
- Can MICS-Asia II model configurations be used to perform short-term sensitivity tests (e.g. to HTAP boundary conditions)?
- Are new simulations necessary?
 - Design recommended modeling protocol

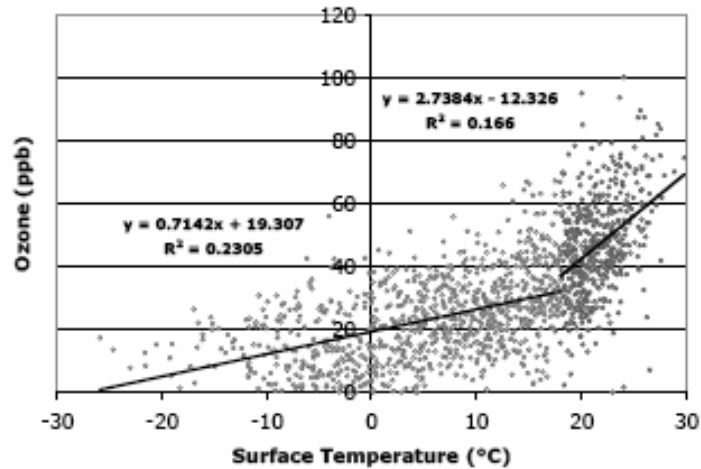


Strategies for considering climate & air quality

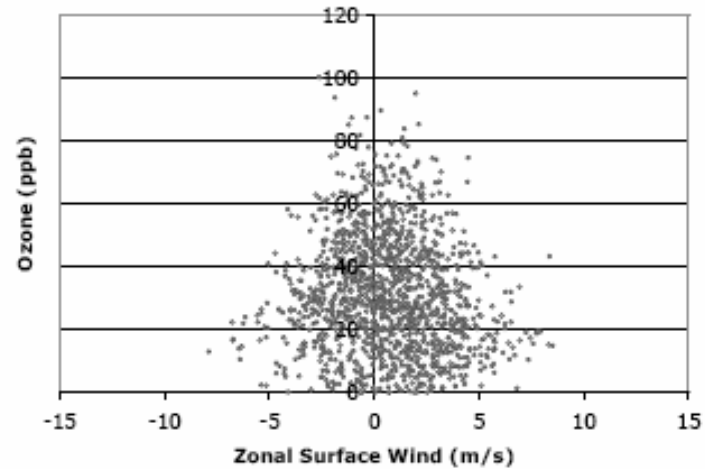
- Define the key questions of interest
 - Current response to climate?
 - Sensitivity and future response of chemistry?
 - Air quality forecasting?
 - Climate response to pollution?
- Consider how to utilize measurement data
 - Quantify climate-chemistry response
 - Compare modeled and measured regression metrics
 - Employ satellite data as appropriate (e.g. AOD)

Chicago Climate-O₃ Correlations

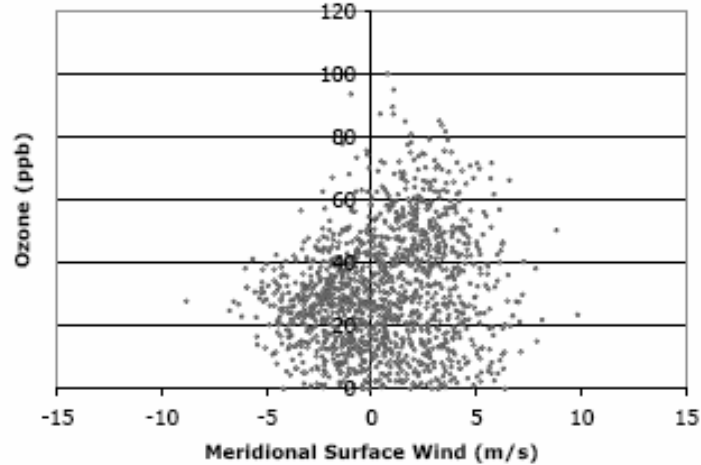
a)



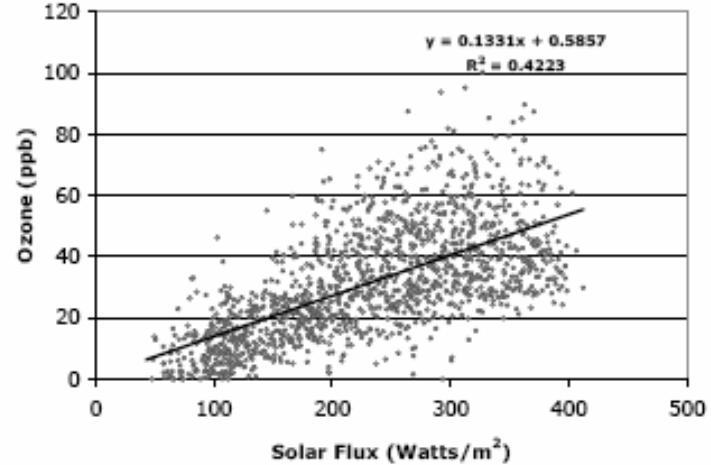
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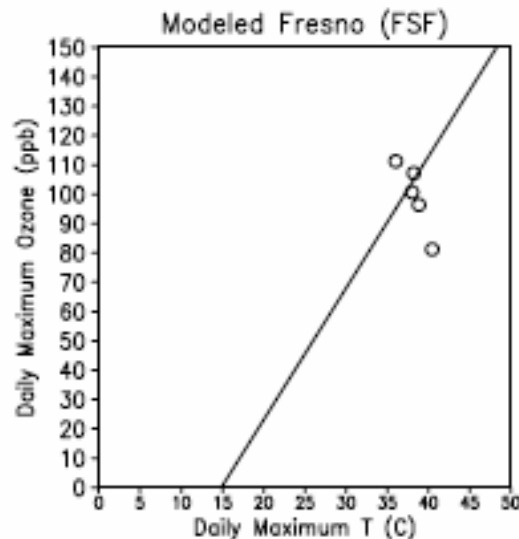
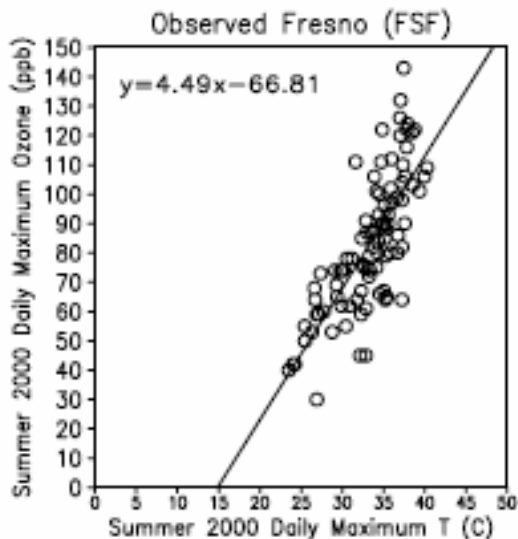
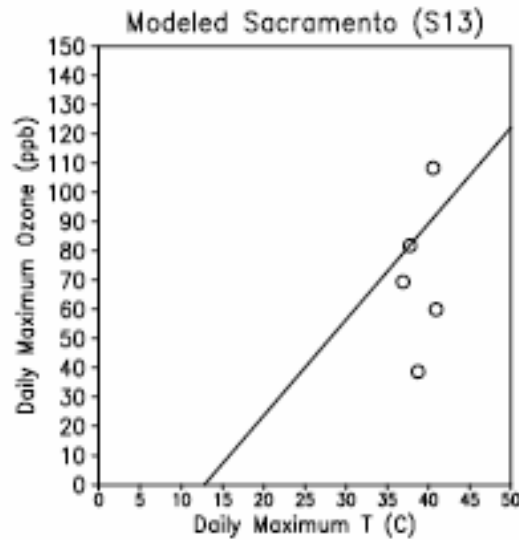
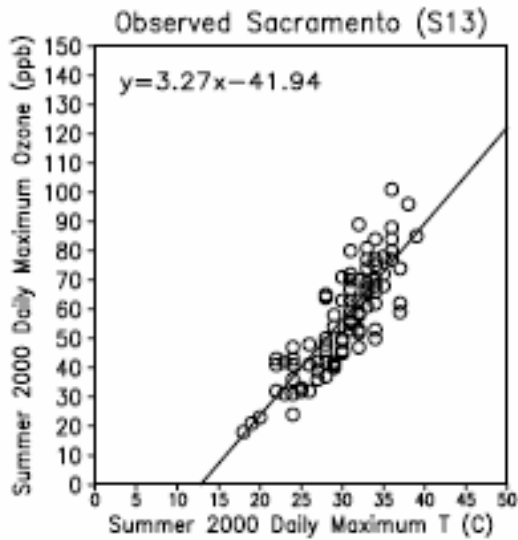
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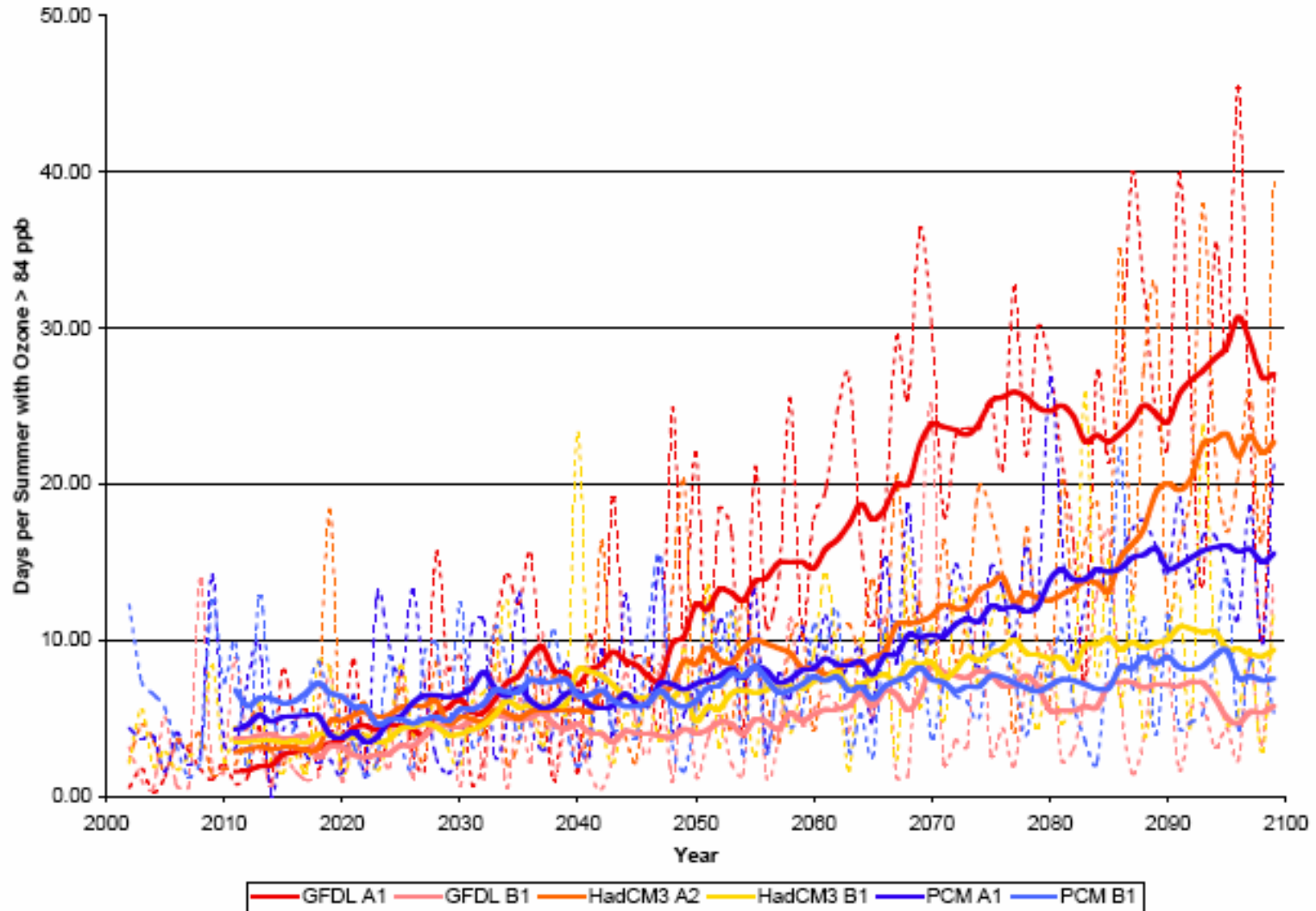
d)



T vs. O_3 in obs & models

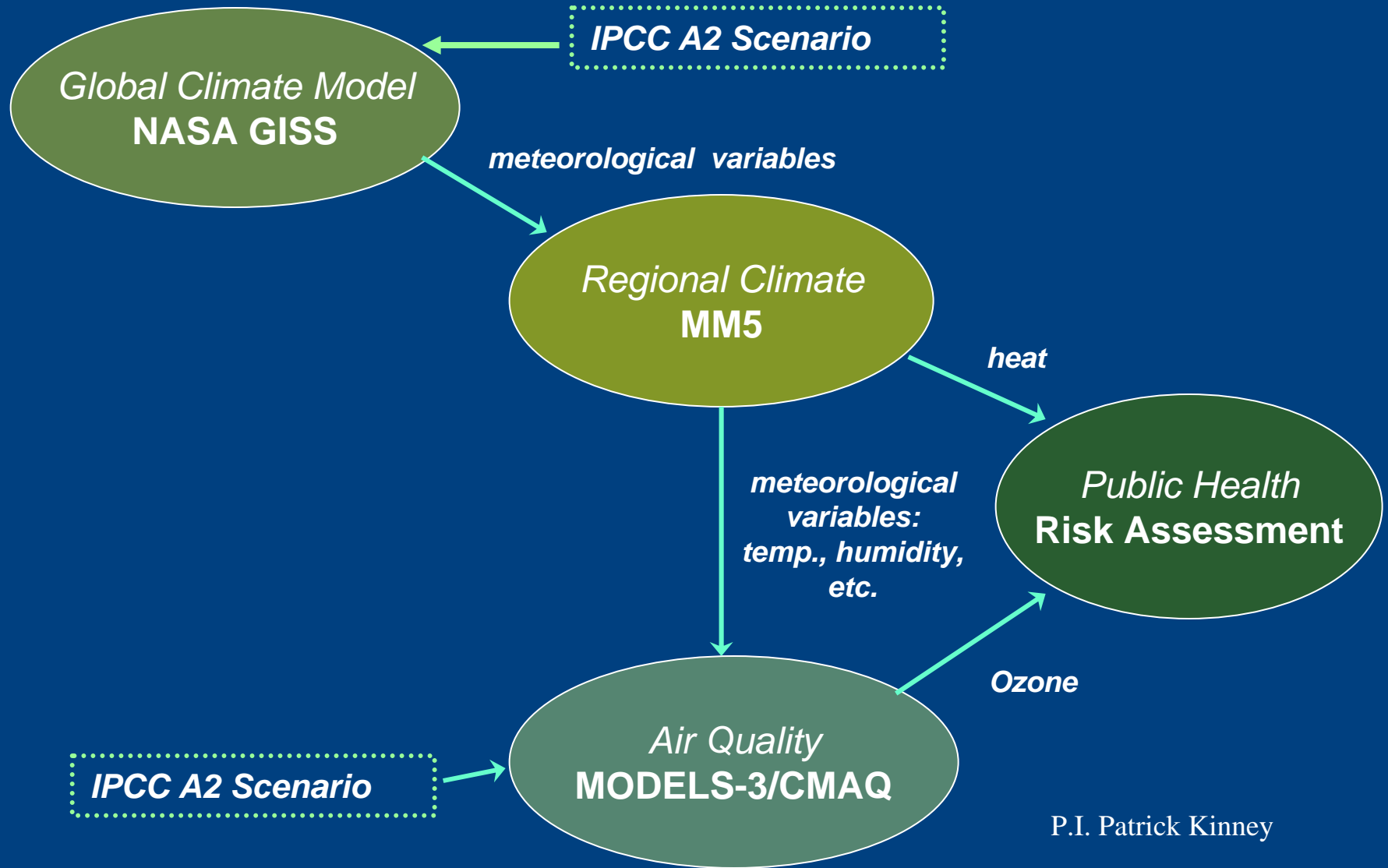


Chicago Projected High-O₃ Days

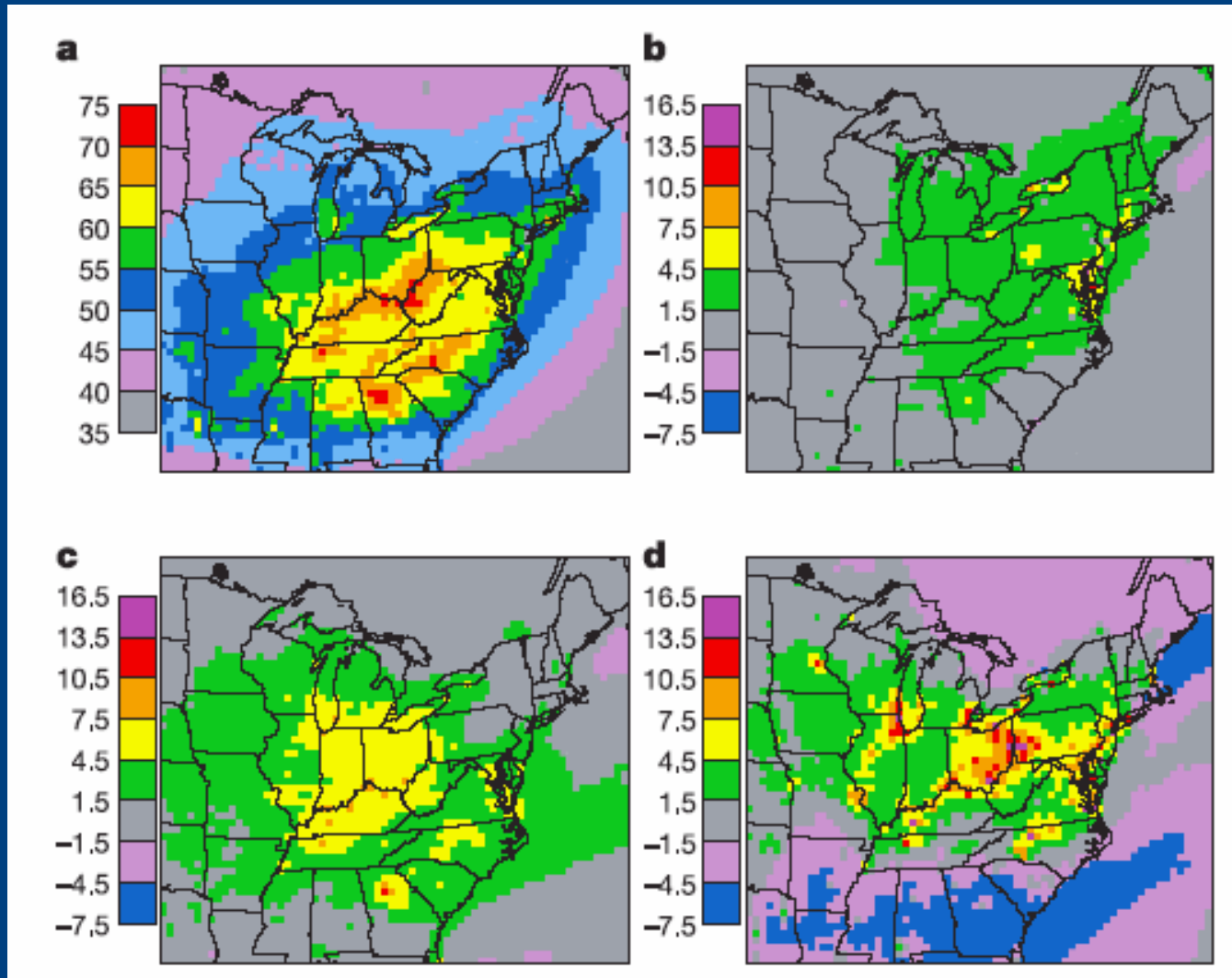


Holloway et al., in review JGR; S. Spak, D. Barker, M. Bretl

Modeling Future AQ Response to Climate



U.S. O₃ in the 2020's, 2050's, 2080's





Proposed Steps (2)

- Identify if/why/how to consider climate response
- Can questions be **addressed with existing data**?
 - Climate-chemistry correlations between EANET & weather
 - Climate-chemistry correlations in MICS-Asia II simulation (and maybe HTAP)
 - Future projection of EANET O₃ to estimate “1st order” response
- Can **MICS-Asia II model configurations** be used to perform short-term sensitivity tests (e.g. comparing 2001 & future)?
- Are **new simulations** necessary?
 - New base year to take advantage of newer data, inventories
 - First estimate of climate impacts on AQ in Asia
 - Examine non-linear response mechanisms

Conclusions

- What have we learned from work to date?
- What new data are available to benefit MICS-Asia Phase III?
 - MICS-Asia Phase II
 - HTAP global model archives
 - Satellite measurements of tropospheric species
 - New ground-based stations, INTEX-B, etc.
- What issues do we hope to inform?
 - Model skill and development (particular processes?)
 - Understanding of urban-regional-global pollution exchange
 - Improved AQ forecasting
 - Climate-chemistry connections
 - Policy options on energy use