IN COLLABORATION WITH THE EPA-FUNDED
AIR, CLIMATE & ENERGY (ACE) *SEARCH* CENTER

USING SATELLITE INFORMATION TO AID IN THE DEVELOPMENT OF HIGH SPATIAL RESOLUTION ESTIMATES OF NO_2 & $PM_{2.5}$

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ROLE OF THE AIR MASS FACTOR (AMF) IN THE CALCULATION OF OMI NO_2 TROPOSPHERIC VERTICAL COLUMNS

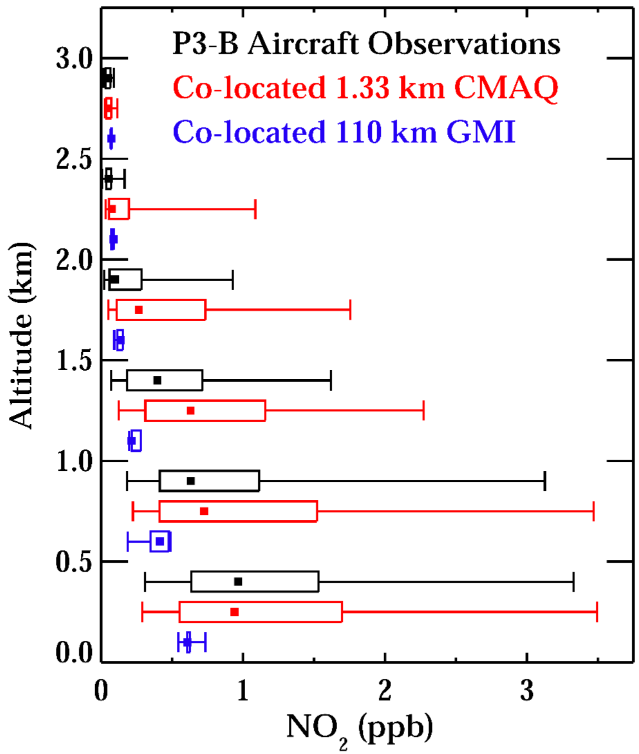
$$VerticalColumnNO_2 = \frac{SlantColumnNO_2}{AMF}$$

$$AMF = \sum_{surface}^{tropopause} w_{satellite} \times S_{Model}$$

$w_{satellite}$ = *scattering weight*

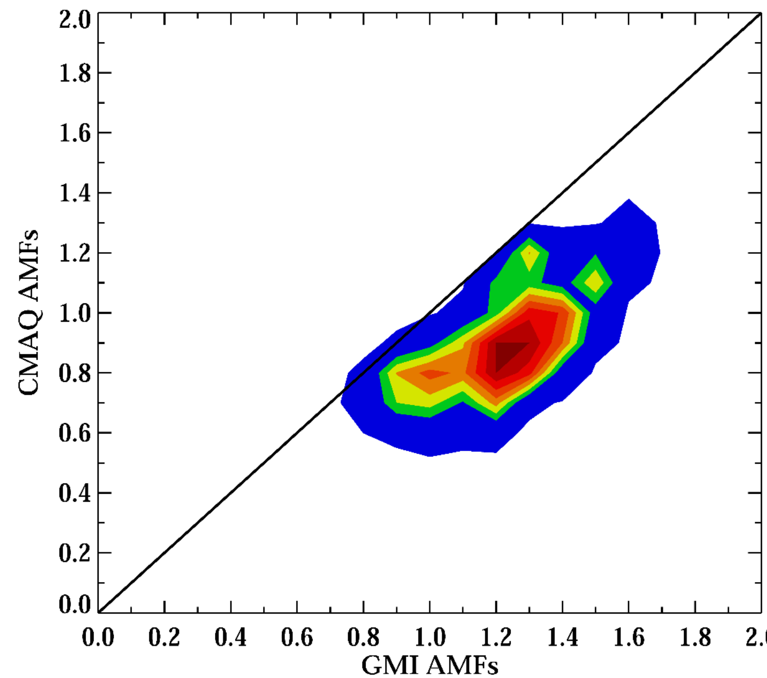
S_{Model} = ***model** shape factor*

GMI & CMAQ vs. Aircraft Observations during DISCOVER-AQ MD



CMAQ is clearly better at capturing the vertical distribution of NO_2 within an urban region

Comparing GMI AMFs vs. CMAQ AMFs in Maryland



Using CMAQ AMFs → smaller AMF → larger NO_2 in urban regions (also shown by Ron Cohen group)

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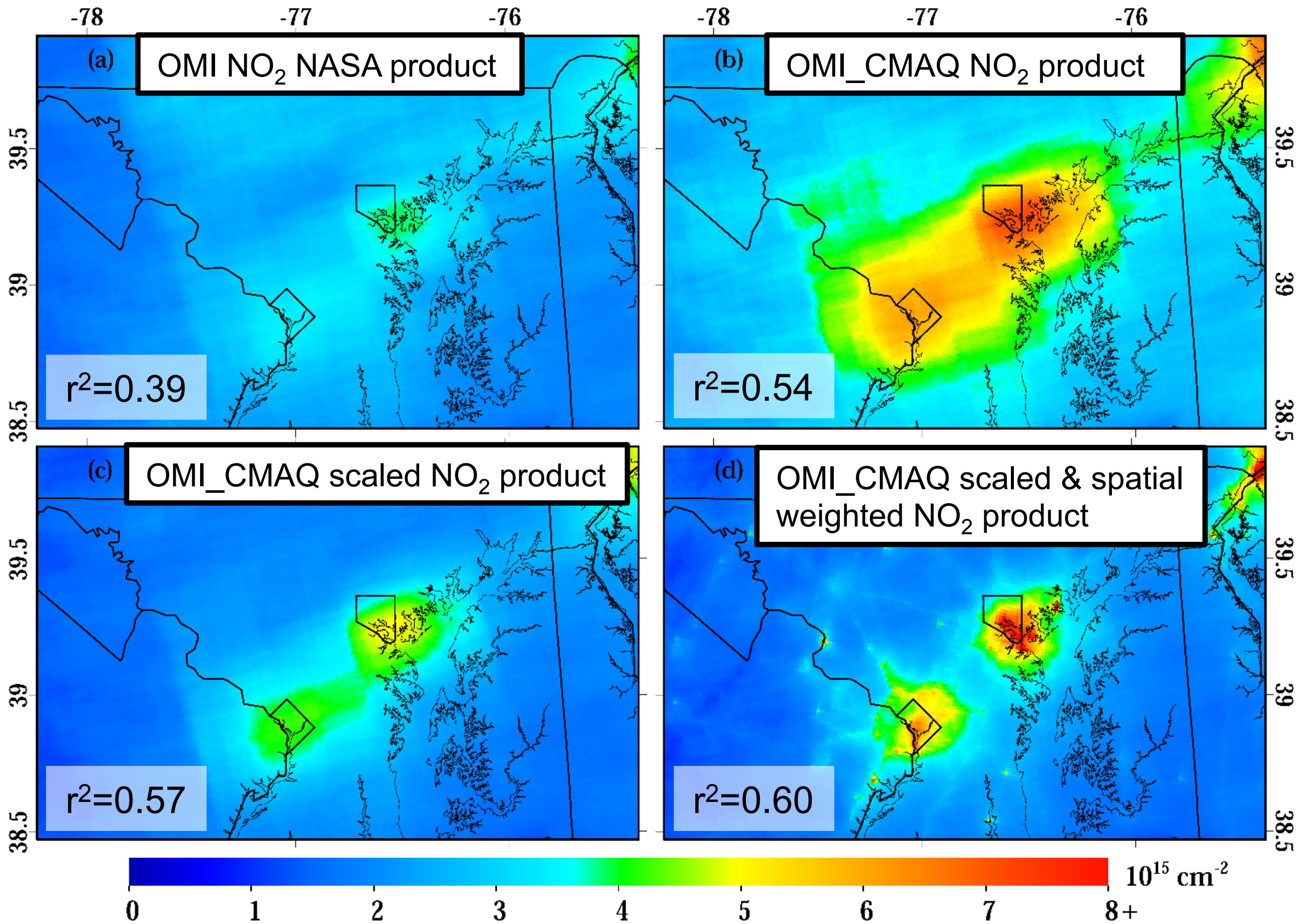
ENHANCED OMI NO_2 PRODUCTS

Goldberg et al., 2017; ACP



(a)→(b): Use CMAQ instead of GMI to calculate the Air Mass Factor (AMF)

(b)→(c): Scale CMAQ based on D-AQ aircraft observations, and then calculate AMF

(c)→(d): Spatial weighting based on the variability within CMAQ [Kim et al., 2016; GMD]

Showing a June & July 2008 – 2012 average; r^2 denotes correlation with ground monitors

(d) Is much better than (a) when compared to in situ observations!

<u>Key takeaways:</u>

- Model resolution plays a significant role in the calculation of air mass factors (high resolution = better)
- Accuracy of model simulation is critical in generating robust satellite observations
  - If model emissions or chemistry are way off, satellite will be unrealistic
- Spatial weighting helps satellite match urban-scale variability better

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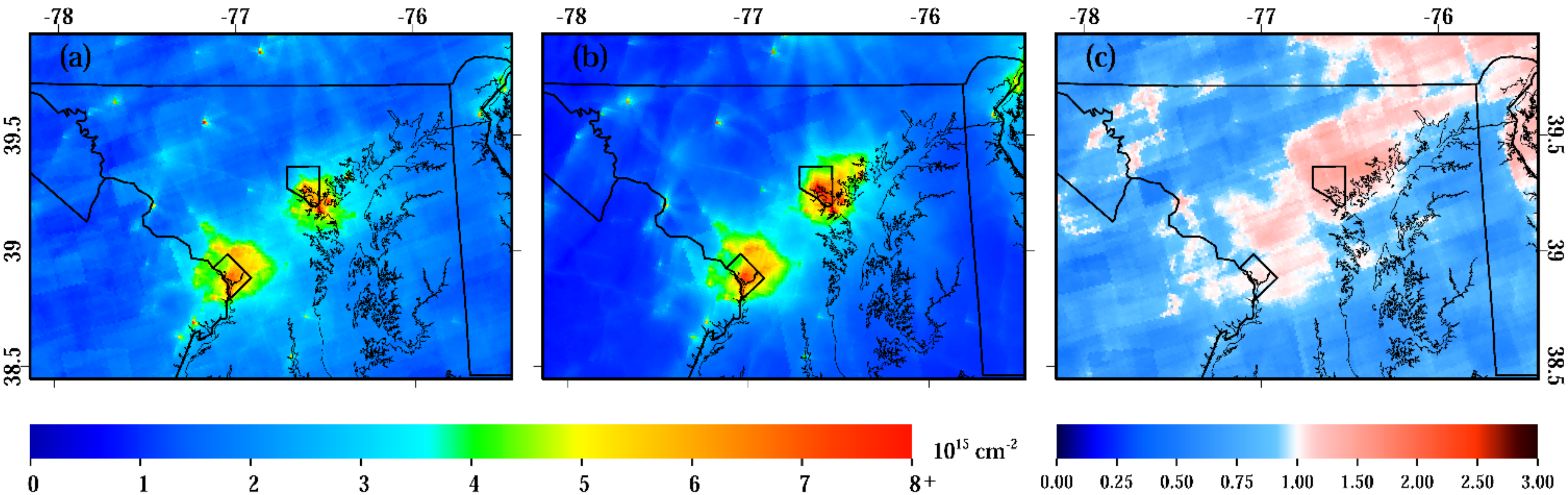
HOW DOES THIS COMPARE WITH CMAQ?

Final OMI_CMAQ NO_2 Product | CMAQ during valid satellite overpass | Ratio: CMAQ / OMI_CMAQ



June & July 2011 only

- Possible reasons for urban overestimate:
  - Mobile and area source emissions may be too large or perhaps an incorrect spatial allocation of these emissions.

- Possible reasons for rural underestimate:
  - Lack of soil NO_x emissions
  - Lightning NO_x emissions incorrectly spatially allocated or too small
  - Not enough recycling of alkyl nitrates to NO_2
  - Not enough lofting of pollutants during large-scale convection

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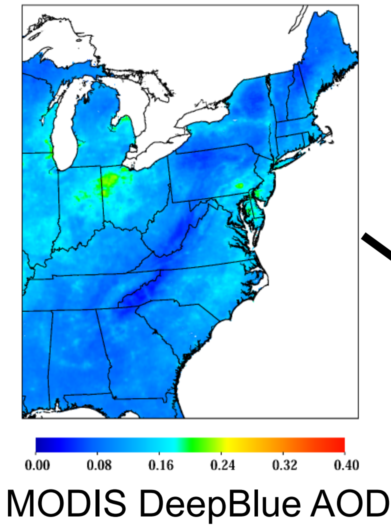
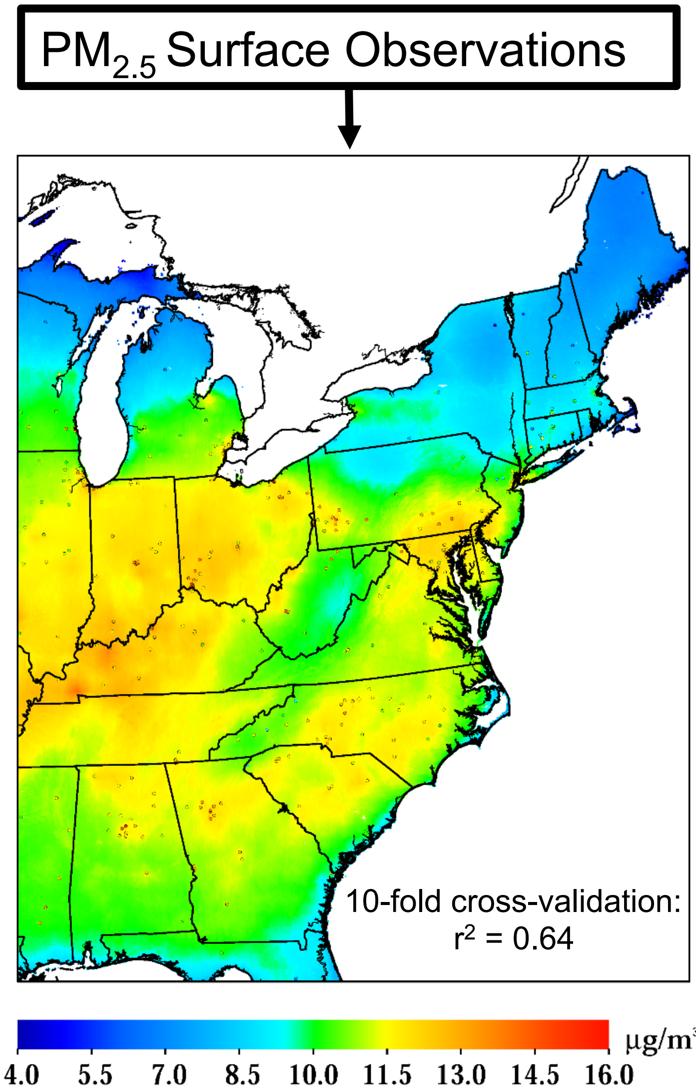
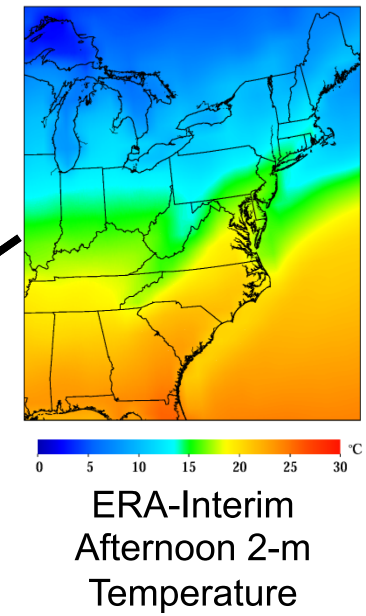
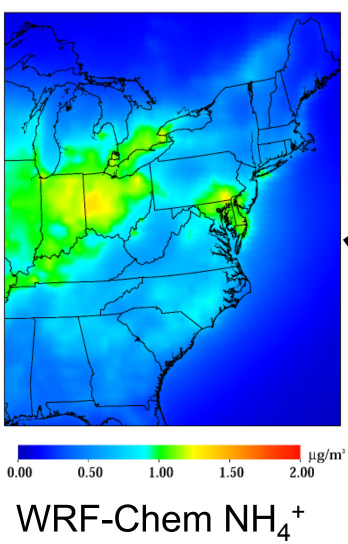
USING GEOGRAPHIC-WEIGHTED REGRESSION TO ESTIMATE $PM_{2.5}$

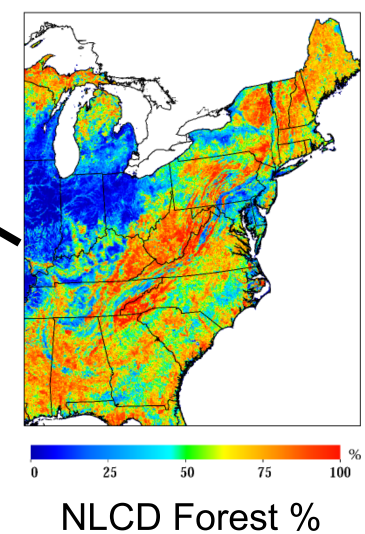




$PM_{2.5}$ Statistical Model for 2008







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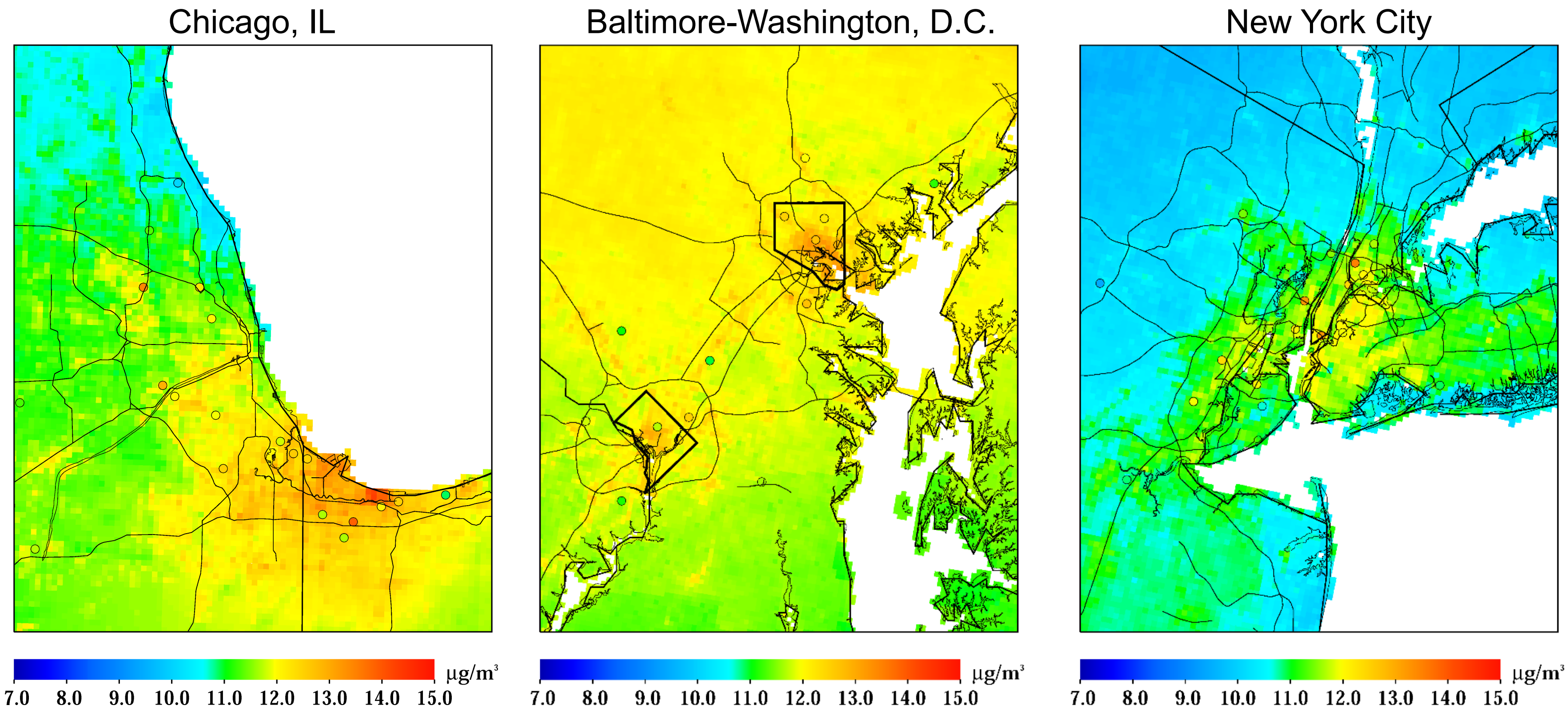
ESTIMATING $PM_{2.5}$ AT HIGH SPATIAL RESOLUTION



Notice the intra-urban variability → This is important for health studies!

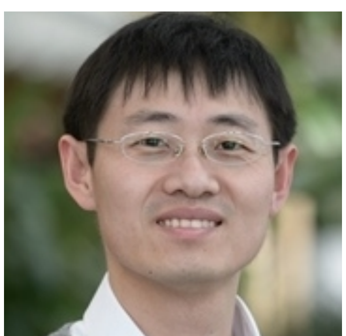
Product shown here is a 2008 annual average, but we have a daily product:

- We use a MODIS AOD "gap-filling" technique [Lv et al., 2016; Lv et al., 2017] to derive daily AOD when it does not exist.
- Work-in-progress!

PLEASE CHECK OUT THE RECENTLY ACCEPTED PAPER ON HI-RES OMI NO_2:

Goldberg, D. L., Lamsal, L. N., Loughner, C. P., Lu, Z., and Streets, D. G.: A high-resolution and observationally constrained OMI NO_2 satellite retrieval, Atmos. Chem. Phys., https://doi.org/10.5194/acp-2017-219, accepted, 2017.

Thank you!



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