Estimating global climatological $PM_{2.5}$ from MODIS and MISR AOD

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Approach

Health impacts of $PM_{2.5}$ motivate measurements beyond the current, sparse networks outside North America

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Following *Liu et al.*, 2004:

$$\boxed{\text{Estimated } PM_{2.5} = \eta \cdot \tau}$$

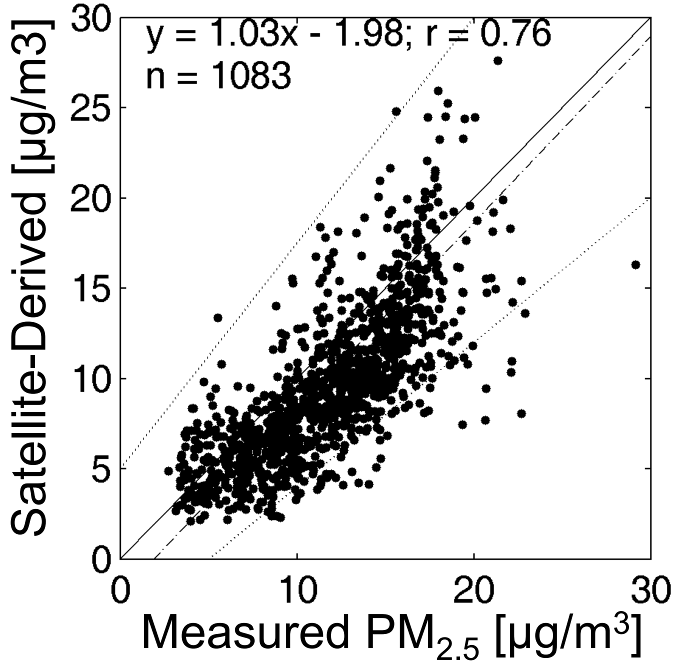
τ — Combined MODIS/MISR Aerosol Optical Depth

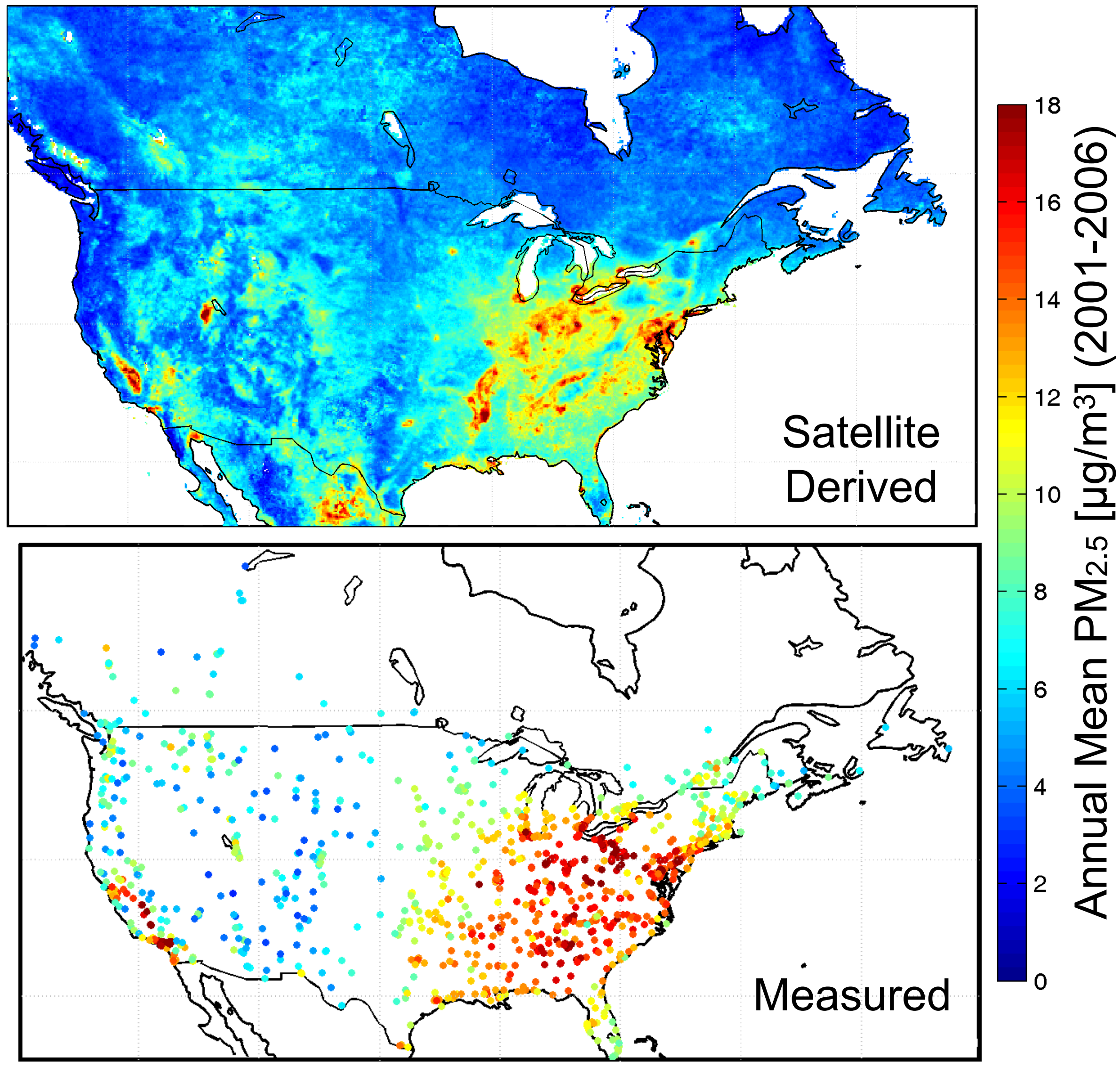
GEOS-Chem ~v8-01-04
&
Satellite (subgrid variation *Lamsal et al., 2008*)

η
- vertical structure
- aerosol type
- meteorological effects
- meteorology

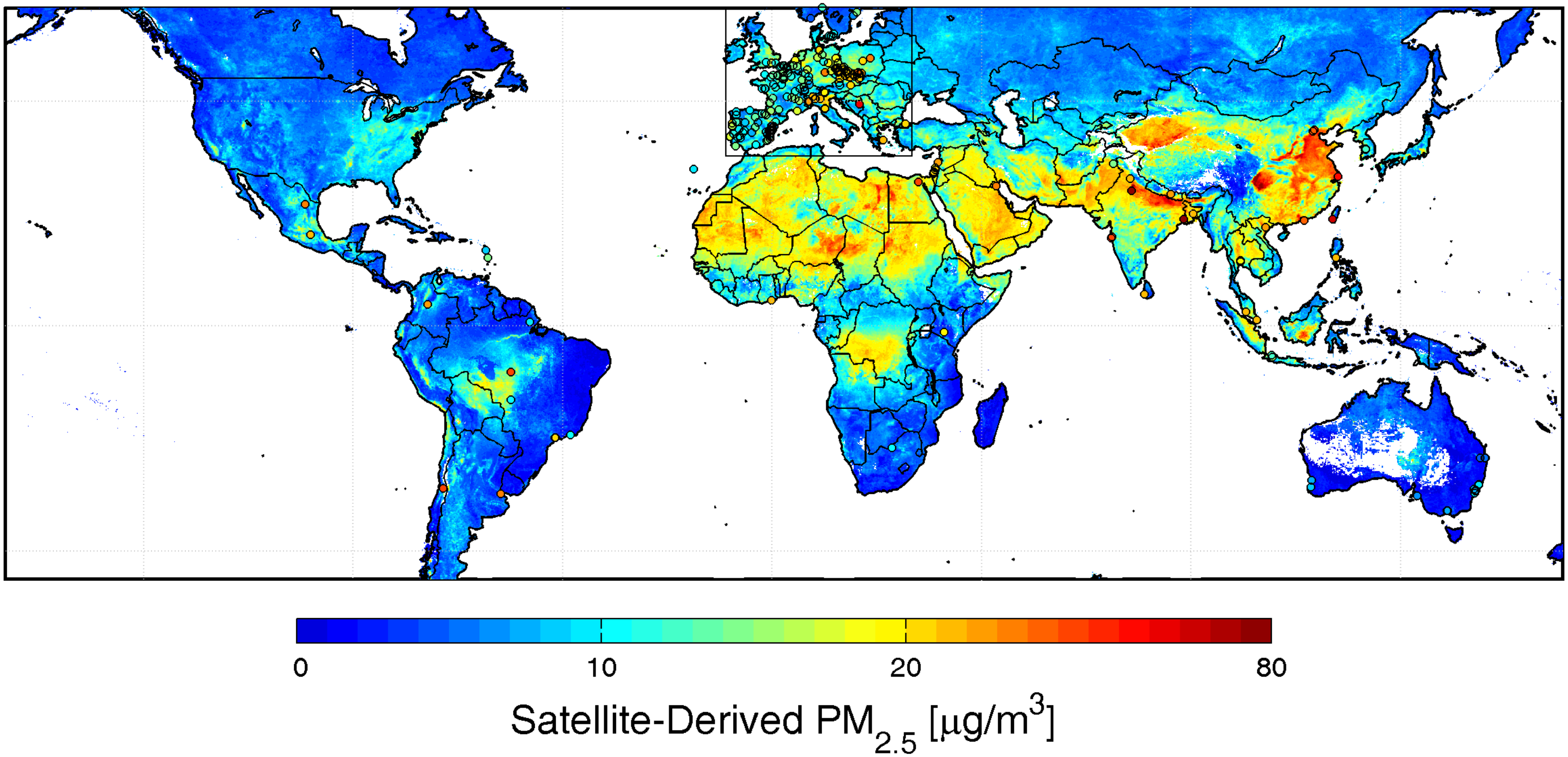
Significant agreement with coincident ground measurements over NA

	r
MODIS τ	0.40
MISR τ	0.54
Combined τ	0.63
Combined $PM_{2.5}$	0.76





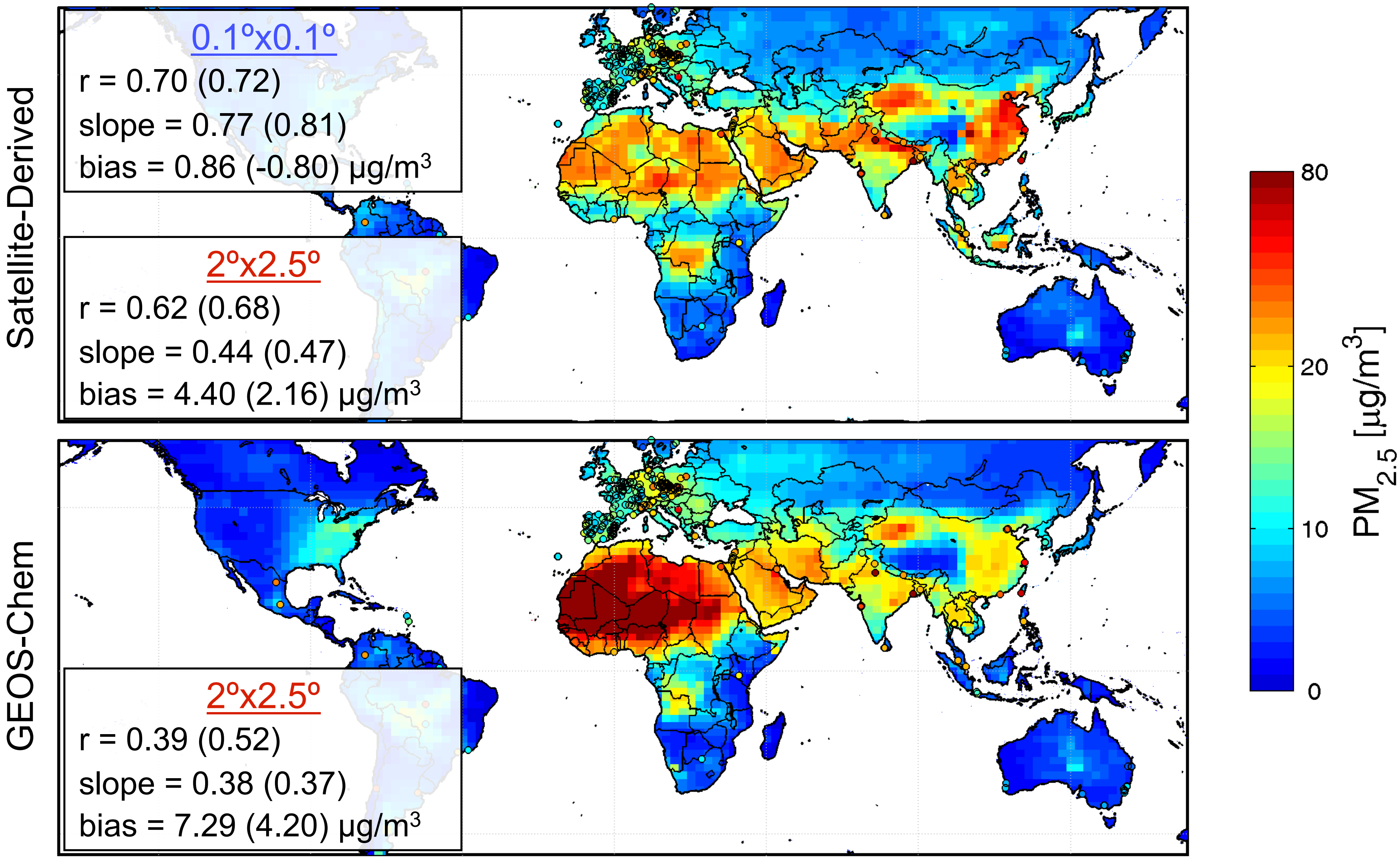
Agreement is global



- Annual mean measurements
  - Outside Canada/US
  - 295 sites (105 non-EU)

- r = 0.70 (0.72)
- slope = 0.77 (0.81)
- bias = 0.86 (-0.80) μg/m^3

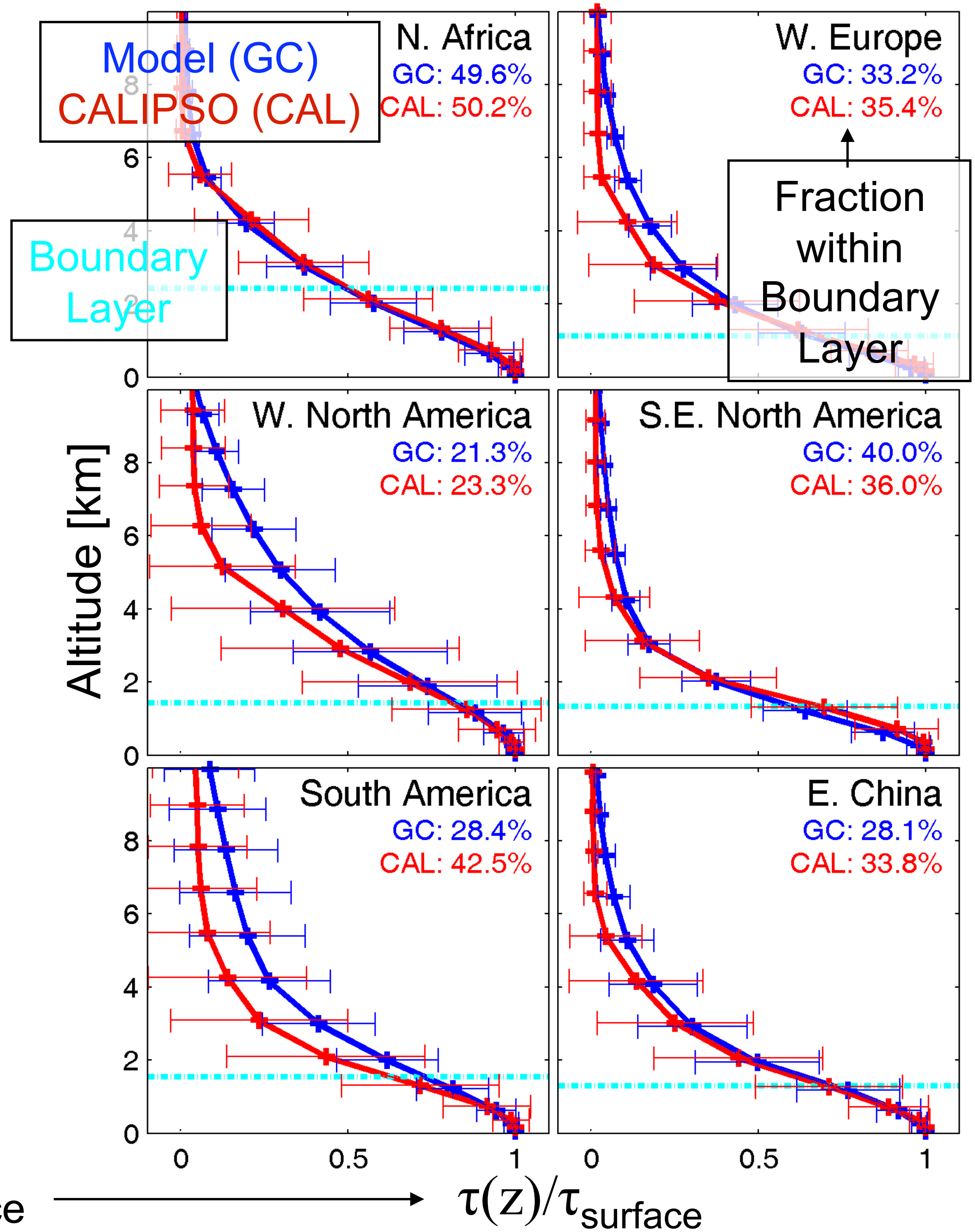
In-situ agrees better with satellite-derived $PM_{2.5}$



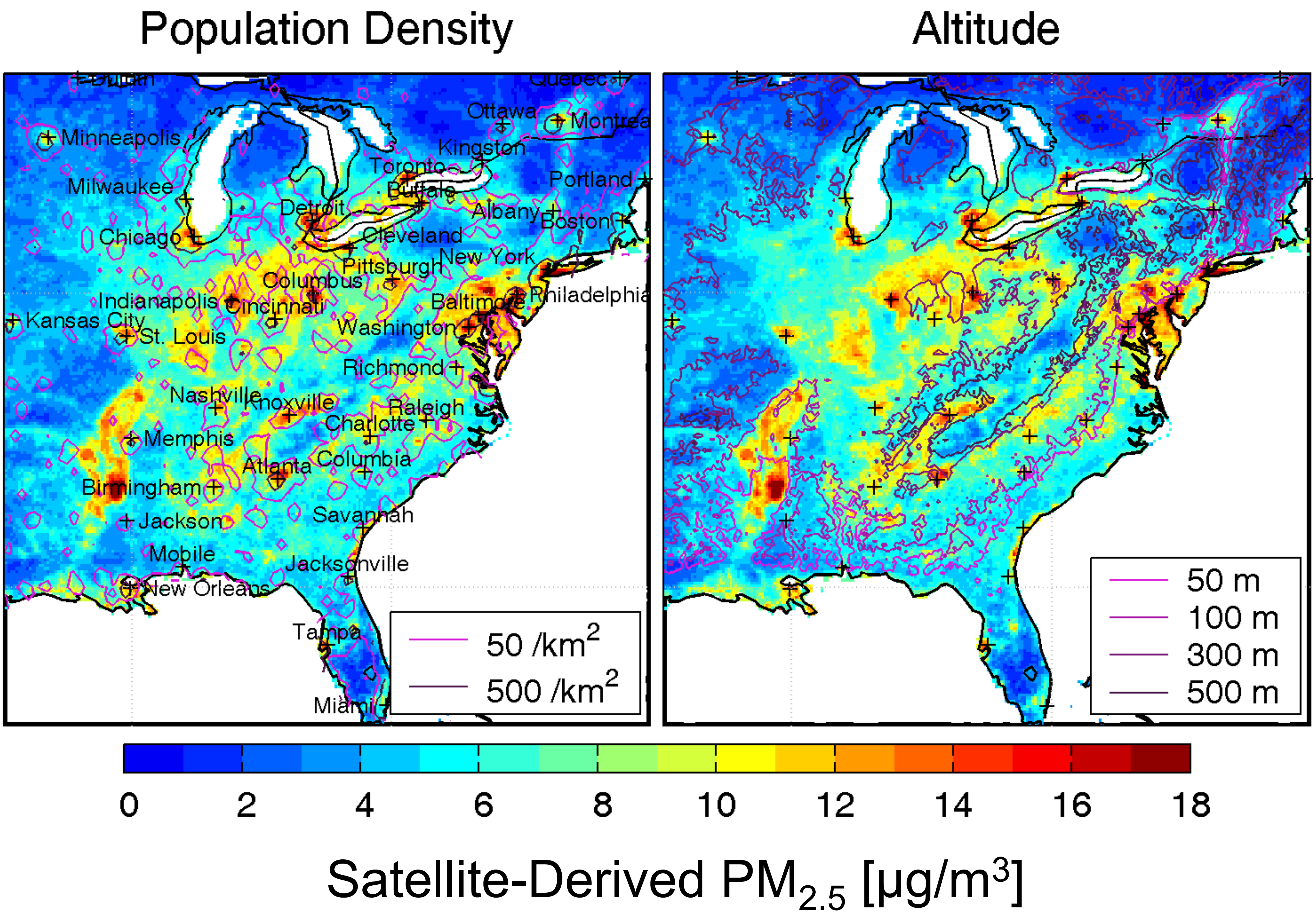
- Annual mean measurements
  - 295 sites (105 non-EU)

Error Estimate

- Two sources
  - Satellite (0.1 + 25%)
  - Model (vertical profile)
- Compare CALIPSO and model extinction profile
  - Jun-Dec 2006
  - Compare % within boundary layer
- Mean coincident error of ±(5 μg/m^3 + 25%)
- Contains 95.1% of NA data



Optical Depth from TOA / Optical Depth from TOA to surface



Population Density
Altitude
Duluth
Quebec
Ottawa
Montreal
Minneapolis
Kingston
Toronto
Buffalo
Portland
Milwaukee
Detroit
Albany
Boston
Chicago
Cleveland
New York
Pittsburgh
Columbus
Indianapolis
Cincinnati
Baltimore
Philadelphia
Kansas City
St. Louis
Washington
Richmond
Nashville
Knoxville
Raleigh
Charlotte
Memphis
Atlanta
Columbia
Birmingham
Jackson
Savannah
Mobile
Jacksonville
New Orleans
Tampa
Miami
50 /km^2
500 /km^2
50 m
100 m
300 m
500 m
0
2
4
6
8
10
12
14
16
18
Satellite-Derived PM$_{2.5}$ [μg/m^3]

Satellite-$PM_{2.5}$ can assess global impact of $PM_{2.5}$

- PM2.5 exposure related to life expectancy
  - 0.61±0.20 years lost per 10 μg/m^3 [*Pope et al.*, 2009]
- Satellite-$PM_{2.5}$ + population map + lost-life relationship →
  - Global estimate of decreased life expectancy due to $PM_{2.5}$ exposure