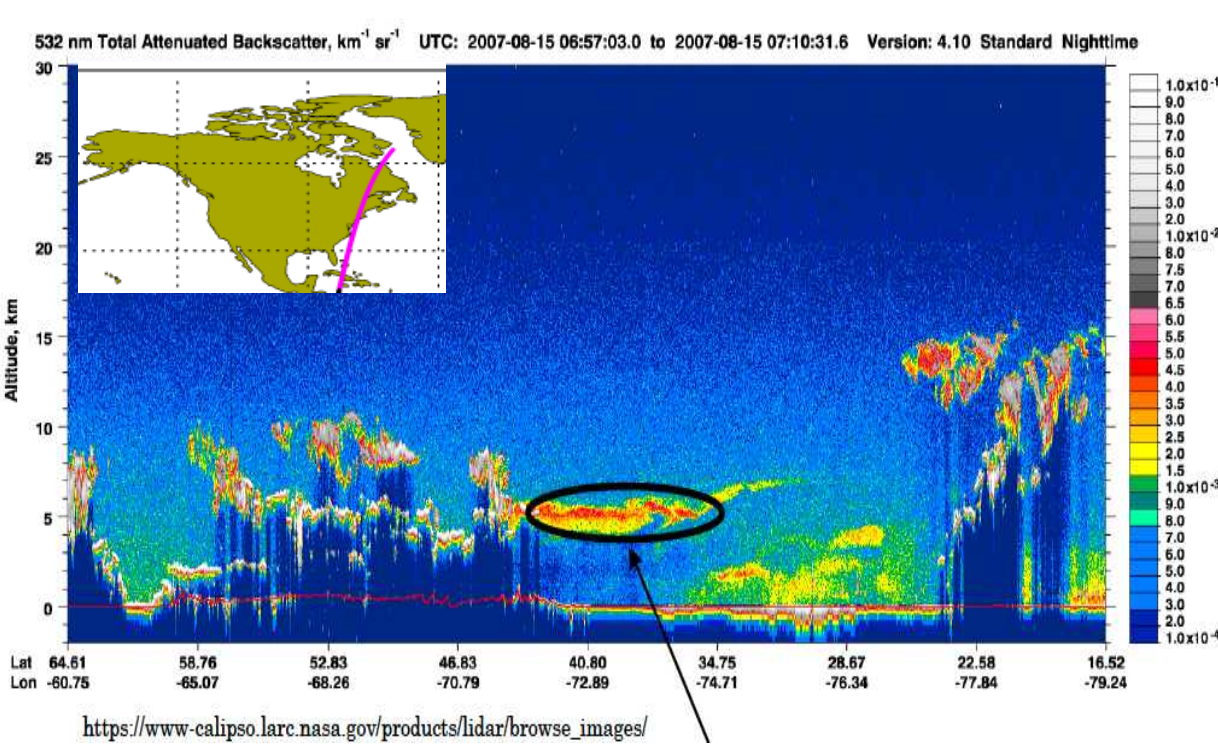
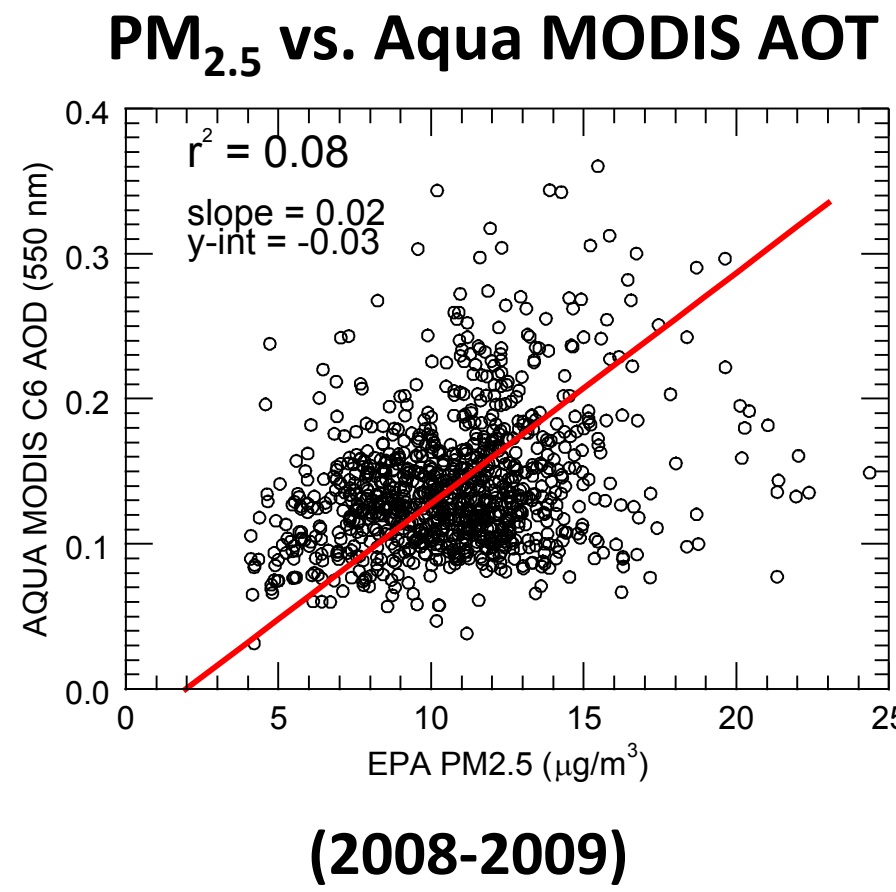


1. Introduction and Motivation

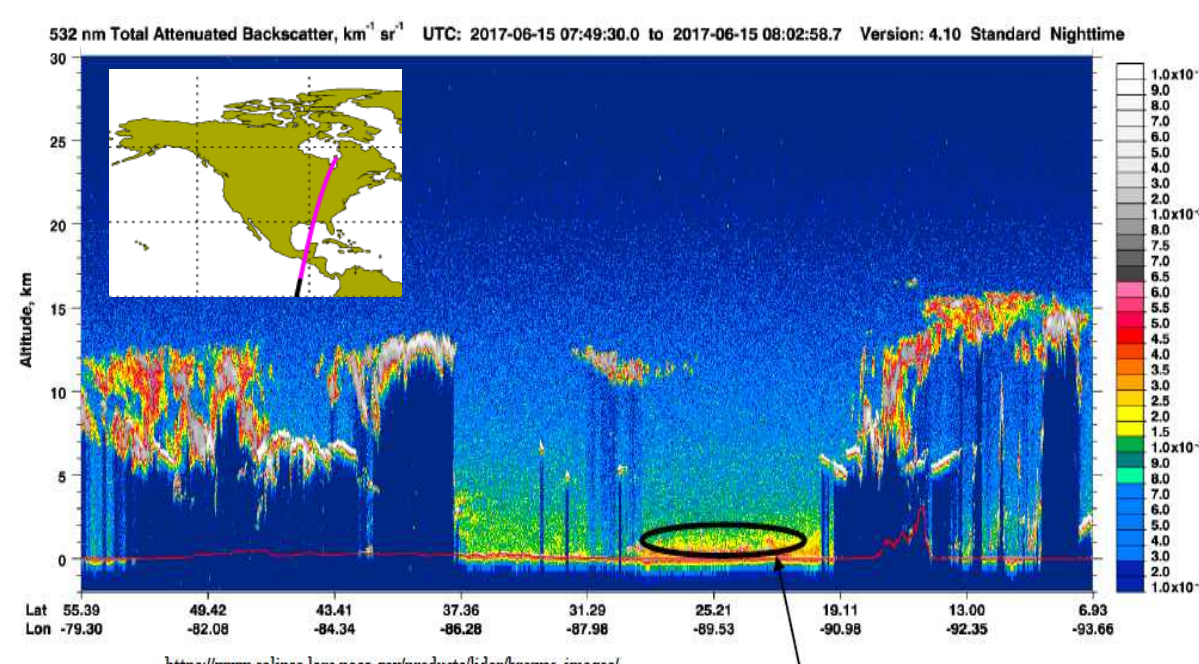
- Past studies have estimated PM_{2.5} concentrations from AOT from passive satellite sensors (e.g., MODIS, MISR)
- Limitations of this approach:**
 - PM_{2.5} is surface-based, but AOT is column-integrated
 - AOT incorporates the effects of humidity, whereas PM_{2.5} is a dry-mass measurement
- CALIOP provides aerosol vertical distribution at both daytime and nighttime
- Unlike AOT, extinction near the ground is (in theory) a more realistic representation of near surface aerosol properties
- Investigate the use of CALIOP near-surface aerosol extinction for PM_{2.5} applications through a bulk mass scattering scheme



Elevated plume

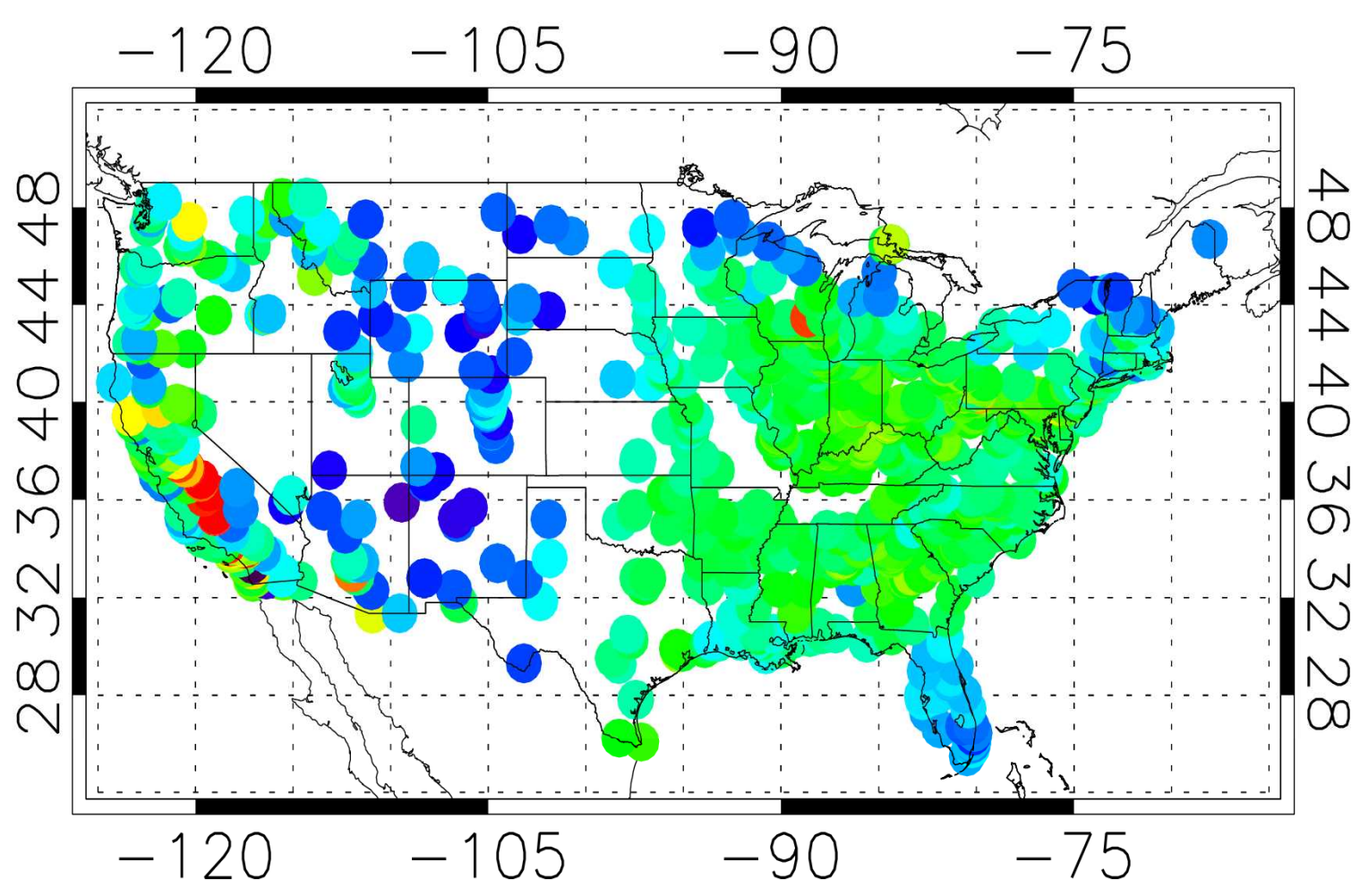


(2008-2009)



Near surface aerosol

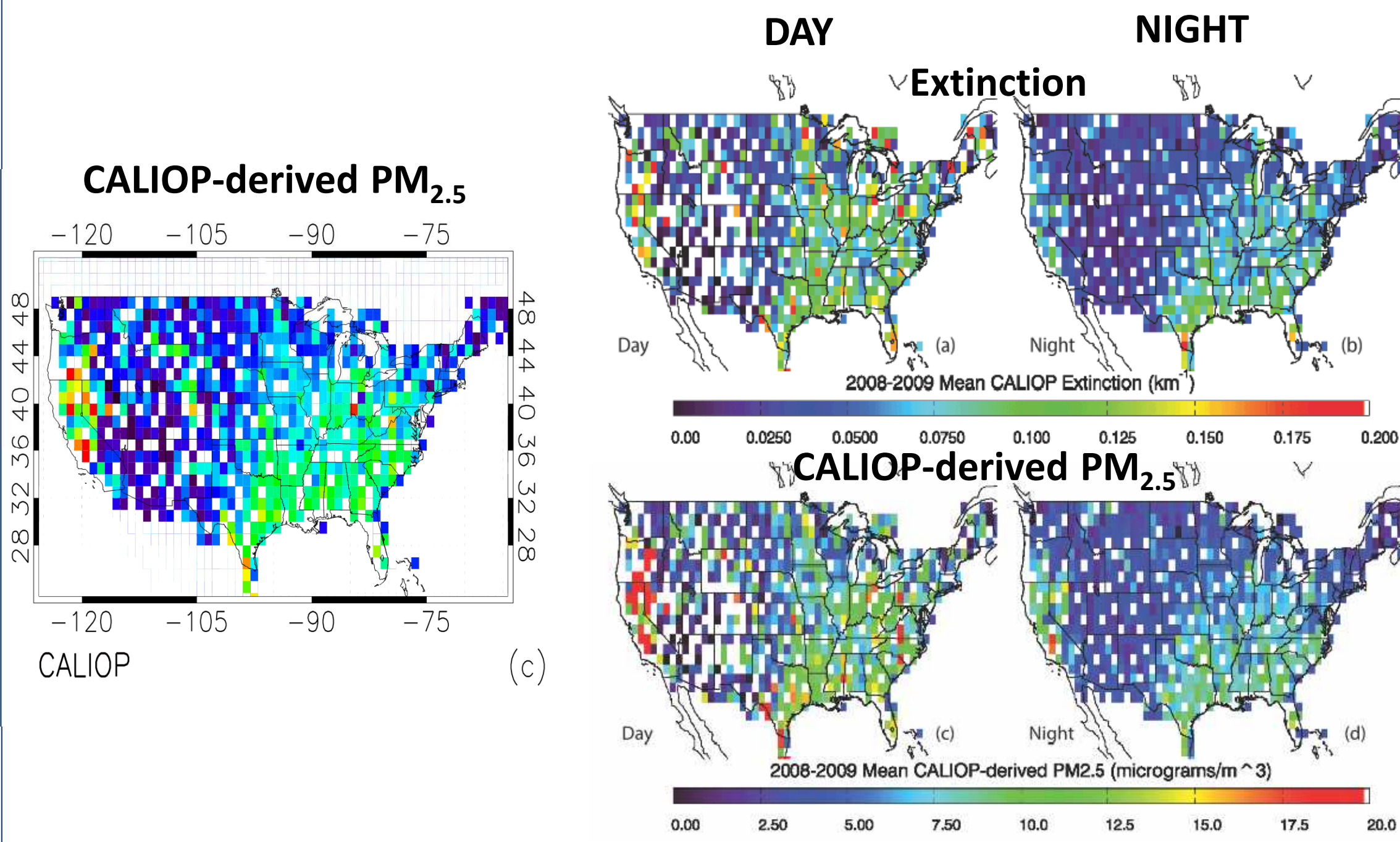
3. EPA-Observed PM_{2.5} Distribution



U.S. EPA

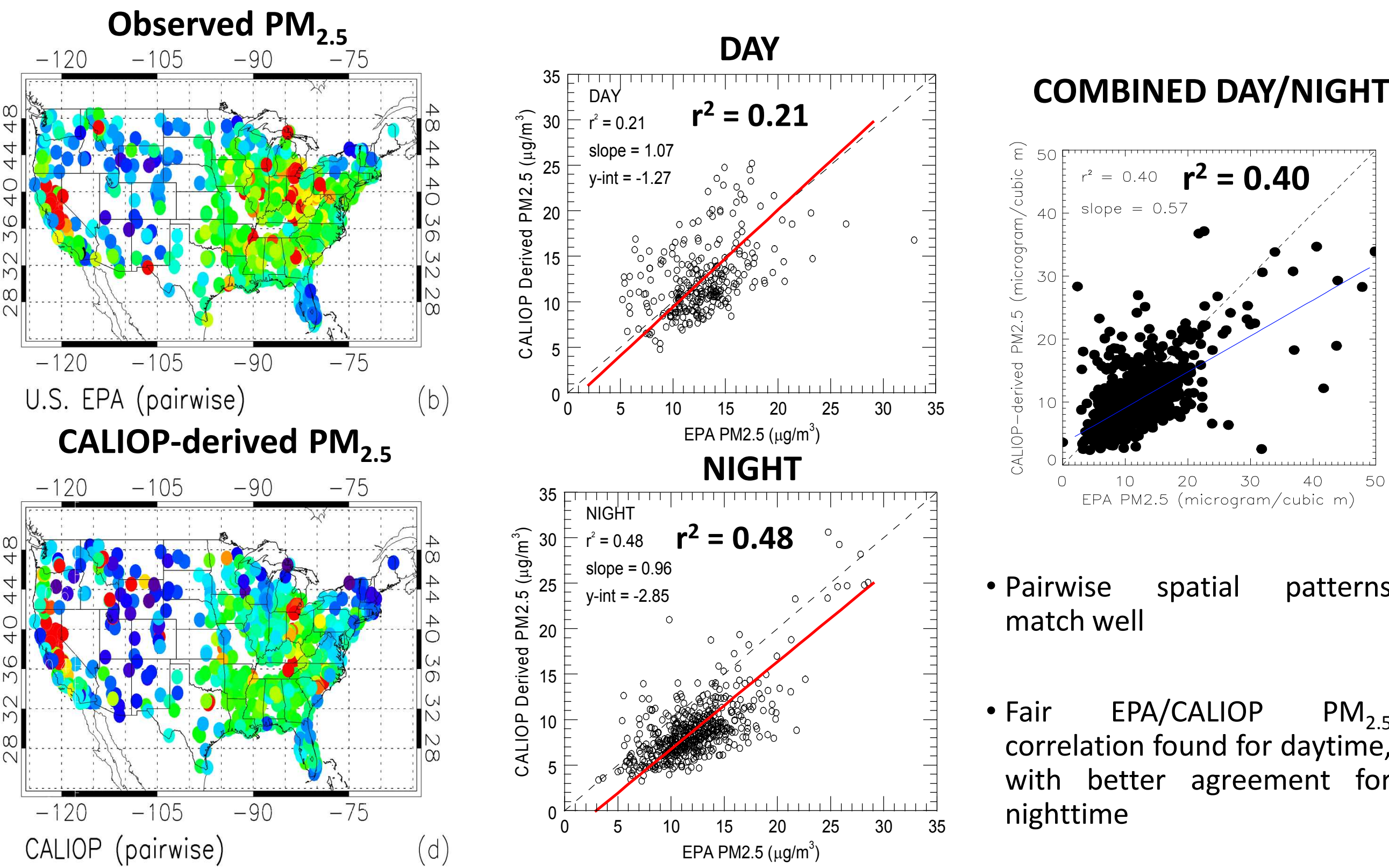
- Larger PM_{2.5} concentrations for the eastern and western CONUS; lowest for the interior
- Spatial distribution is consistent with reported values from past studies

4. Spatial Distribution of CALIOP-derived PM_{2.5}



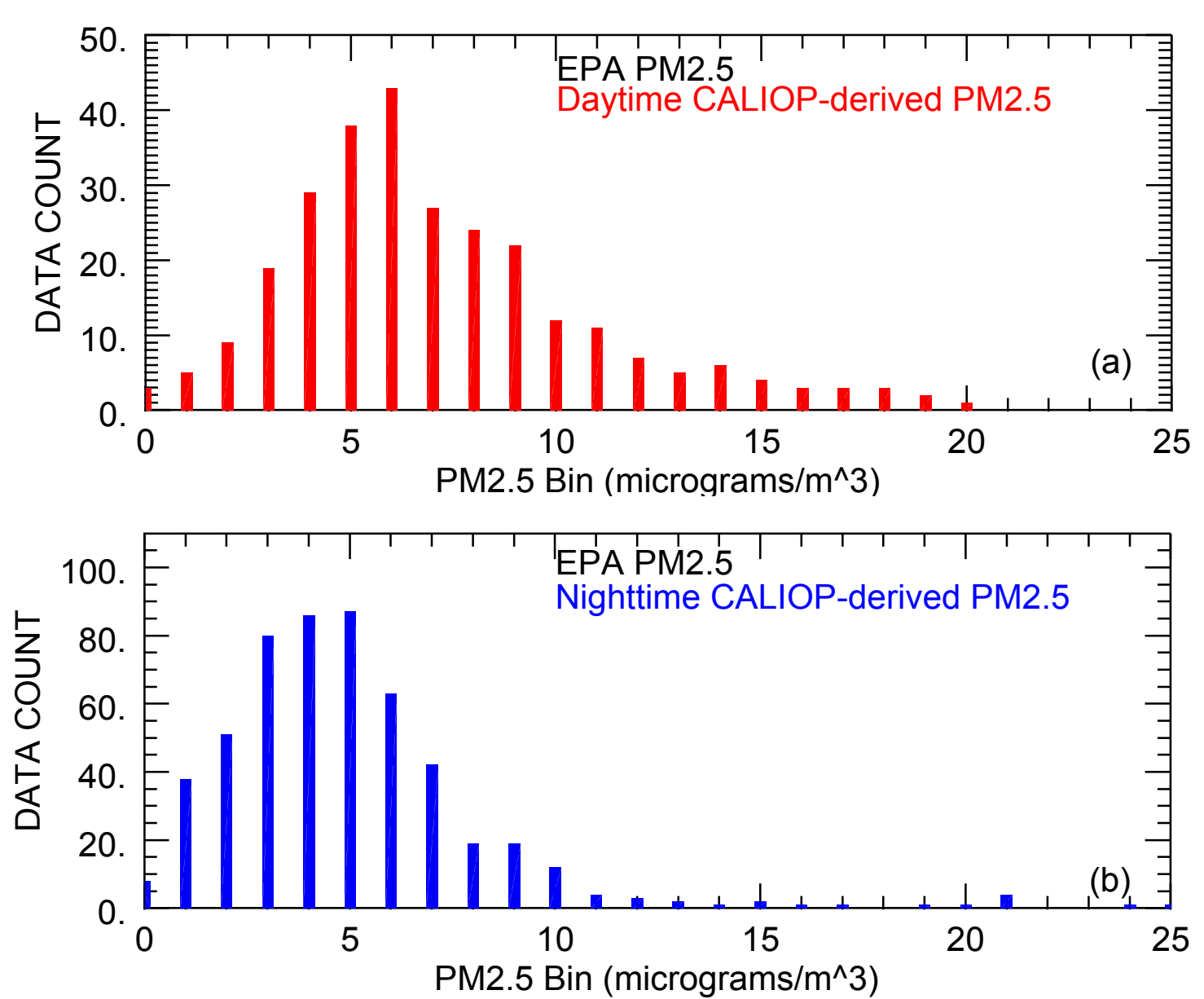
- Spatial distributions of CALIOP-derived PM_{2.5} very similar to those of EPA ground stations
- Day/night differences: Anthropogenic activities and/or solar radiation contamination (daytime noise)

5. Validation efforts: EPA/CALIOP common point analysis



- Pairwise spatial patterns match well
- Fair EPA/CALIOP PM_{2.5} correlation found for daytime, with better agreement for nighttime

6. Sensitivity Study 1: Sampling



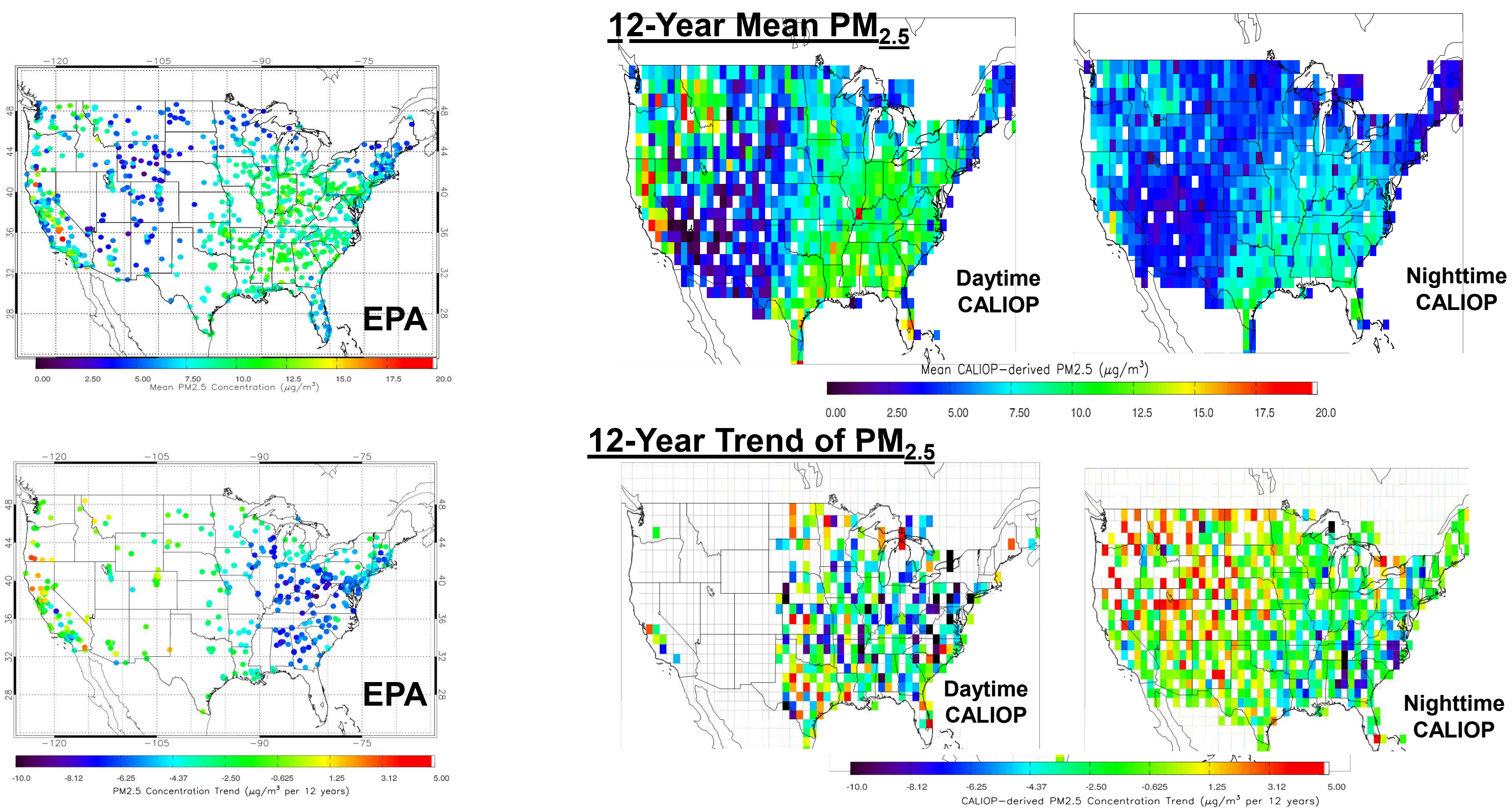
- Daytime CALIOP-derived PM_{2.5} distributions match well with those of EPA
- Distribution shifts towards smaller concentrations using nighttime CALIOP data
- Sampling biases may be due to retrieval biases and day/night differences in PM_{2.5} concentrations

7. Sensitivity Study 2: Surface layer height and aerosol type

Surface Layer (m)	Analysis (Day/Night)				
	R ²	Slope	Mean Bias (CALIOP - EPA; μg m ⁻³)	Error Change (%)	
0-100	0.27/0.41	0.69/0.38	-2.67/-9.06	-13.71/-61.94	
0-200	0.33/0.53	0.77/0.75	-0.52/-5.68	3.79/-23.58	
0-300	0.35/0.54	0.78/0.82	-0.09/-4.70	7.24/-12.15	
0-400	0.38/0.57	0.80/0.85	-0.13/-4.25	6.92/-6.46	
0-500	0.35/0.52	0.75/0.76	-0.21/-4.04	5.70/-4.39	
0-600	0.40/0.53	0.76/0.75	-0.46/-3.91	3.72/-2.15	
0-700	0.44/0.46	0.80/0.66	-0.41/-3.89	2.73/-2.88	
0-800	0.35/0.50	0.62/0.66	-0.59/-3.76	-0.77/-2.04	
0-900	0.17/0.49	0.43/0.63	-0.74/-3.74	-3.91/-2.25	
0-1000	0.13/0.48	0.35/0.62	-1.08/-3.74	-7.48/-2.57	
100-500	0.34/0.44	0.72/0.66	0.54/-3.40	14.21/-0.84	
100-1000	0.21/0.48	0.48/0.67	-0.39/-3.34		

Analysis (Day/Night)						
Aerosol Type	R ²		Slope	Mean Bias (CALIOP-EPA; μg m ⁻³)	% Error Change	
	a _{scat}	a _{abs}				
Smoke	5.26	0.26	0.18	0.10/0.44	0.27/0.52	-1.81/-4.26
Sea salt	1.42	0.01	0.46	0.18/0.48	1.22/1.82	22.42/12.93
Dust	0.52	0.08	0	0.05/0.39	2.06/5.12	102.04/70.82
Sulfate	3.4	0.37	0.63	0.21/0.48	0.48/0.67	-0.39/-3.34

8. Preliminary Results of Trend Analysis (2007-2018)



9. Conclusions and Future Work

- Spatial distribution of 2-year mean PM_{2.5} concentrations derived from near surface CALIOP aerosol data compares well to that of *in situ* PM_{2.5} measurements collected at U.S. EPA stations
- Use of nighttime CALIOP extinction to derive PM_{2.5} results in a higher correlation (**r² = 0.48**; **mean bias = -3.3 μg m⁻³**) with EPA PM_{2.5} than daytime CALIOP extinction data (**r² = 0.21**; **mean bias = -0.40 μg m⁻³**)
- Spatial/temporal sampling and retrieval biases are found
- Sensitivity studies were conducted, and highlight need for accurate aerosol typing for estimating PM_{2.5} concentrations using CALIOP observations
- Spatial distribution of 12-year mean PM_{2.5} concentrations derived from near surface CALIOP aerosol data compares well to that of *in situ* PM_{2.5} measurements collected at U.S. EPA stations, justifying our rationale for using lidar for PM_{2.5} studies
- In general, both EPA and CALIOP show similar trends in PM_{2.5} (i.e., trends in improving air quality over the Eastern CONUS but worsening over the Western CONUS)
- Future work includes examining day/night differences in results, aerosol type analyses, surface layer height/PBL height, HSRL/CATS analyses, and application to other regions
- Future space-based lidar missions (e.g., A-CCP) provide compelling motivation to further explore and improve extinction-based PM concentration retrievals

10. Acknowledgements

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