Utilizing Remote Sensors to evaluate WRF-CMAQ model in urban environment Chuen-Meei Gan^{1,2}, Lina Cordero², Yonghua Wu², Barry Gross²



Motivation

- •Air quality models (WRF-CMAQ) are commonly used in air quality applications.
- •In urban environments, these models become more complex due to the inherent complexity of the land surface coupling and the enhanced pollutants emissions.
- •Clear model performance anomalies are seen in urban area
- •Use Vertical Profiling tools to assess root cause of anomalies.



- •We explored the usefulness of vertical sounding measurements on assessing meteorological and air quality forecast models.
- •Particularly, we focused on assessing the WRF model (12km x 12km) coupled with the CMAQ model for the urban New York City area using multiple vertical profiling and column integrated remote sensing instruments.
- •In addition, this study includes a mathematical method using a direct Mie scattering approach to convert aerosol microphysical properties from CMAQ model into optical parameters for direct comparisons with multi-wavelength (1064-532-355 nm) lidar and sunphotometer measurements, located in CCNY.
- •This multispectral information may provide better insight into aerosol speciation and production inconsistencies within the model.





Doraiswamy et al. (2010).

Physics Options	2007 WRF Run 1	2007 WRF Run 2	2010 WRF Run
PBL	Modified Blackadar	ACM2	MYJ 2.5
Surface Layer	Pleim-Xiu	Pleim-Xiu	NOAH Unified 5-layer Land-surface
Microphysics	WSM6	Morrison II	Ferrier Gridscale
Cumulus Parameterization	Kain-Fritsch	Kain-Fritsch	Cumulus-Betts-Miller-Janjic
Shortwave Radiation	Dudhia	Dudhia	Lacis-Hansen
Longwave Radiation	RRTM	RRTM G	Fels-Schwartzkopf

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Ground Based Vertical Profile Comparisons





Satellite Retrieval using Geostationary satellites (GOES)

Background

Satellite observations can be used to measure olumn integrated Aerosol Optical Depth (AOD)	Ν
etrievals but use a single wavelength This forces significant assumptions that might ot be met in urban environments. Preliminary efforts are to baseline retrieval erformance of AOD and to assess feasibility of sing AOD to help retrieve PM2.5 Future efforts will allow for refinement over urban reas accounting for better assumptions on erosol model and surface reflection	Brookhav

•The strong surface emission behavior in the diurnal pattern predicted by CMAQ are not seen in the ceilometer observation as these actual emissions are evenly distributed in the PBL. •CMAQ primary emissions are not properly distributed vertically which may caused by the very low PBL of the model during predawn and post-sunset period. •On the other hand, for summer 2010, the expansion of the PBL height seems to allow at least partial venting of the pollutants, which is more in line with ceilometers based observations. •These results seem to be consistent with further matchups for summer 2011 data •Preliminary comparisons of GOES AOD with ground based AOD shows that satellite performance is generally sufficient bit extra dispersion is seen in Urban areas. •Preliminary PM25 matchups against GOES illustrarte general feasibility for summer months using 3 x 3 (12km) averages with correlations R^2 > .7 •Newer algorithms which will be applied to urban areas may further improve these preliminary results.

<u>Reference</u>: Chuen-Meei Gan, Yonghua Wu, <u>Barry Gross</u>, Fred Moshary, Sam Ahmed Atmospheric Environment **45**, 6613-6621 (2011)

Connection between PM2.5 distribution and PBL

•Newest Data using ensembles from NYSDEC runs for Aug 2011.

AOD Assessment:



Generally better performance out of urban area (slope)

Summary





Sunphotometer

PM25 capability from GOES:





•Summer retrievals with high correlation possible •This is in part due to better solar geometry in summer allowing measurements to be more accurate and better mixing of aerosols in the PBL layer

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