A COMPARISON OF ESTIMATED MIXING HEIGHT BY MULTIPLE REMOTE SENSING INSTRUMENTS AND ITS INFLUENCE ON AIR QUALITY IN URBAN REGIONS

Chuen-Meei Gan[1,2], *Y.H. Wu*[1], *B.M. Gross*[1], *M. Arend*[1], *F. Moshary*[1] *and S. Ahmed*[1]
[1] Optical Remote Sensing Lab, 140th Street at Convent Ave., T553, CCNY, New York, NY 10031, USA
[2]CUNY Graduate Center, Electrical Engineering, 365 Fifth Avenue, New York, NY 10016, USA
Email: chuenmeei@gmail.com

1. INTRODUCTION

Urban areas suffer from high pollutant loadings due to their proximity to emission sources as well as transported aerosols. For example, the New York City region as shown in Figure 1, is often not in compliance with EPA Air Quality Standards and therefore monitoring of pollutants such as aerosol PM2.5 are crucial. However, measurements based on surface sensors are labor intensive and expensive so it is important to be able to use Air Quality Models such as CMAQ for pollutant monitoring on regional scales. For such models to be useful, they must not only be able to provide accurate emission inventories but also be able to determine the atmosphere mixing height (MH), which also known as planetary boundary layer (PBL). For example, incorrect PBL heights determination results biased estimates of surface pollution even if the emission sources are correctly identified since the PBL height defines the total volume available for pollutant transport and dispersion.

2. RESULT

In this study, we will explore and compare the calculation of PBL heights based on multiple instruments including both Lidar and ceilometer (CL31) in City College of New York (CCNY), together with a radar wind profiler in Liberty Science Center which will be compared against meteorological soundings based on the EDAS meteorological model within Hysplit [9]. For our comparisons, the distance between CCNY and Liberty Science Center is approximate 15 km, so when these comparisons are made, we assume a spatially homogeneous atmosphere over this length scale. At the same time, the distribution and total integrated column of particulate matter will be evaluated in adjacent to the PBL height. In our preliminary analysis, we find that for stable PBL development, the measurements between the different instruments are in reasonable agreement. In addition, comparisons to virtual temperature (VT) gradients derived PBL height from radiosonde are explored [2-3]. On the other hand, when lidar observations show multiple layers within the primary layer, both the ceilometers and the wind profiler cannot resolve their detailed structure.

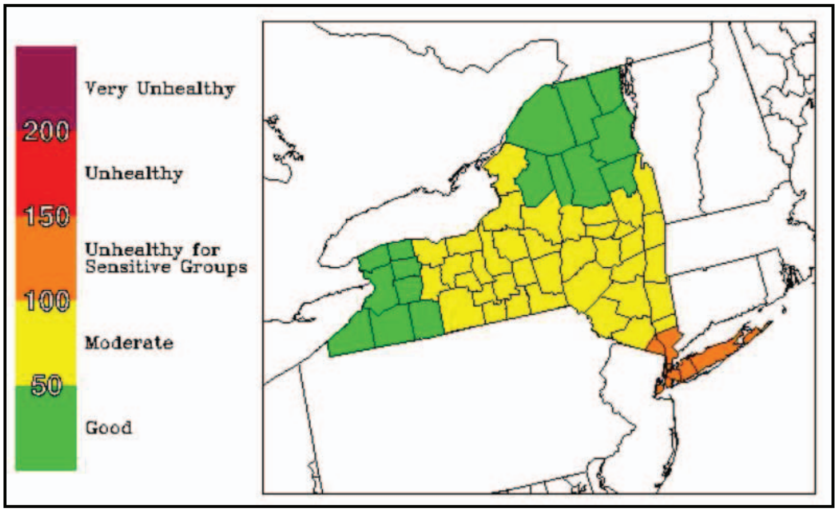

Figure 1: Air Quality Index (AQI) in different parts of New York State

In resolving the multiple sub layers, we develop a wavelet based technique with appropriate thresholds on the resolution parameters which also allows us to discriminate and remove cloud contamination [4] [6]. From these results, we find that without accounting for the multiple structures, correlations between PM2.5 and column aerosol optical depth are poor and the need to account for these layers is needed.

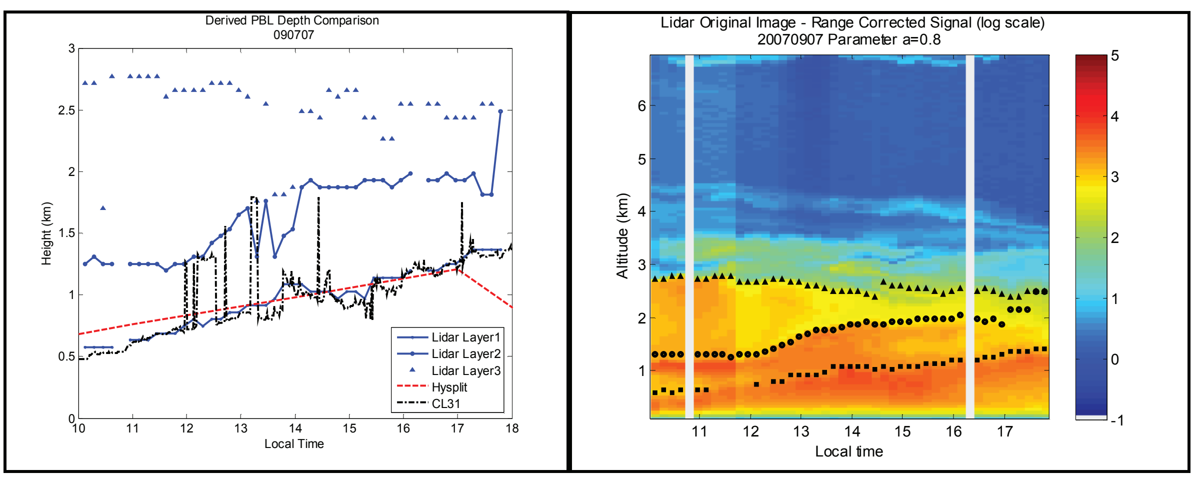

Figure 2: a) Derived PBL Depth Comparison in New York City

b) Wavelet Derived PBL Depth in CCNY Lidar at channel 1064nm

REFERENCES

[1] A. Boselli, M. Armenante, L.D'Avino, M. D'Isidoro, G. Pisani, N. Spinelli and X. Wang, Atmospheric Aerosol Characteization Over Naples During 2000-2003 EARLINET Project: Planetary Boundary-Layer Evolution and Layering, *Boundary-Layer Meteorol 132:151-165*, Springer, 2009

[2] A. Jericevic and B. Grisogono, The Critical Bulk Richardson Number In Urban Areas: Verification And Application In A Numerical Weather Prediction Model, *Tellus 58A,19-27*, Blackwell Munksgaard, Singapore, 2006

[3] B. Hennemuth and A. Lammert, Determination of the Atmospheric Boundary Layer Height from Radiosonde and Lidar Backscatter, *Boundary-Layer Meteorology 120:181-200*, Springer, 2005

[4] Ian M. Brooks, Finding Boundary Layer Top: Application of a Wavelet Covariance Transform to Lidar Backscatter Profiles, *Journal of Atmospheric And Oceanic Technology Volume 20*, AMS, USA, 2003

[5] J. E. Bossert, An Investigation of Flow Regimes Affecting the Mexico City Region, *Journal of Applied Meteorology*, AMS, USA, pp. 119-140, 1996.

[6] K. J. Davis, N. Gamage, C. R. Hagelberg, C. Kiemle, D. H. Lenschow and P. P. Sullivan, An Objective Method for Deriving Atmospheric Structure from Airborne Lidar Observations, *Journal of Atmospheric And Oceanic Technology Volume 17*, AMS, USA, 2000

[7] M. Piringer, S. Joffre, A. Baklanov, A. Christen, M. Deserti and K. De Ridder, The surface energy balance and the mixing height in urban areas – activities and recommendations of COST-Action 715, *Boundary-Layer Meteorol 124:3-24*, Springer, 2007

[8] Roland B. Stull, *An Introduction to Boundary Layer Meteorology*, Kluwer Academic Publishers, USA, 1988

[9] S. A. Cohn and W. M. Angevine, Boundary Layer Height and Entrainment Zone Thickness Measured by Lidars and Wind-Profiling Radars, *Journal of Applied Meteorology Volume 39*, AMS, 2000

[10]T. Ben-Gai, A. Bitan, A. Manes and P. Alpert, Climatic Variations in the Moisture and Instability Patterns of the Atmospheric Boundary Layer on the East Mediterranean Coastal Plain of Israel, *Boundary-Layer Meteorology 100:363-371*, Kluwer Academic Publishers, 2001