Lamont Atmospheric Carbon Observation Project (LACOP)

The Earth Institute AT COLUMBIA UNIVERSITY

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Introduction

Anthropogenic carbon dioxide (CO_2) emissions have played a major factor in global climate change (90% certainty; IPCC, 2007a) causing noteworthy changes such as increases in sea-level, ecosystem health and viability, fire regimes, disease transmission and overall ecosystem health upon which we depend (IPCC, 2007b). Much of our atmospheric CO_2 originates from urban centers (vehicles, building emissions, land use, cement making and the generation of electricity) as well as transportation sectors from the combustion of fossil fuels. The magnitude of a CO_2 dome can be considerable over urban areas. For example, in London, CO_2 concentrations can reach up to 20% over ambient background conditions on weekdays (Derwent et al., 1995). Around the world, urban centers are growing. Last year in 2008, for the first time in history, the percentage of the world's population that live in urban centers reached 50%. By 2050, the percentage is expected to rise to 70% (UN, 2008).

In rural areas however, CO_2 concentrations are mainly controlled by the photosynthesis and respiration of the plants and animals in the area. A significant amount of CO_2 can be carried via wind from other areas as well. While CO_2 concentration records of relatively "clean" areas around the world [notably Mauna Loa, Hawaii (Keeling et al. 1976)] have been kept since the latter half of the 20th century, there are scarce historic data in our urban areas. LACOP aims to fill in these gaps by monitoring CO_2 levels in urban centers as well as the surrounding rural areas at high spatial and temporal scales. From the mesonet of climate station data, we can better understand the basic physics, biology (notably plant physiology), and chemistry of the environment and have a better understanding of the air quality in our immediate environment which provides policy makers with better knowledge to make sound decisions.

Recent Findings

Plots of March and July presented here compare the variability of CO_2 concentrations from a non-growing season versus well into a growing season, respectively.

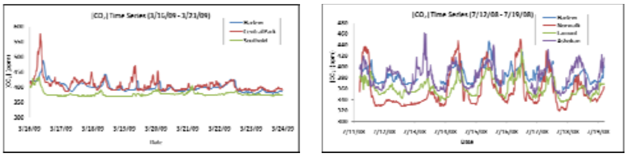

Figure 5: Time Series of CO_2 concentrations during a week.

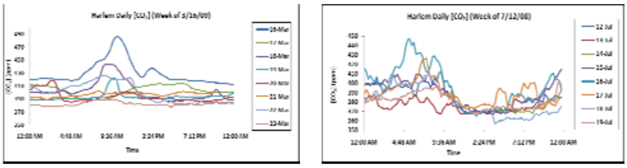

Figure 6: Daily CO_2 concentration fluctuations over a week.

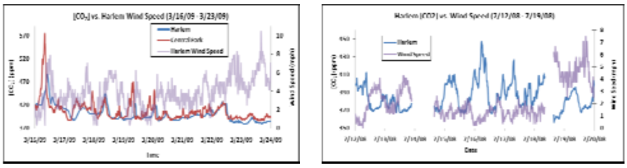

Figure 7: CO_2 concentrations over a week evaluated against Wind Speed.

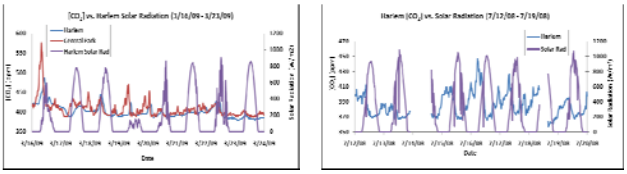

Figure 8: CO_2 concentrations over a week evaluated against Solar Radiation.

Methods

The network of atmospheric CO_2 monitoring stations currently consists of 7 sites in the North East United States. They are located in 1) Central Park, NY (40.78°N, 73.97°W), 2) Harlem, NY (40.808°N, 73.95°W), 3) Palisades, NY (41.0053°N, 73.9078°W) 4) Piermont, NY (41.043°N, 73.897°W) 5) Southold, NY (41.692°N, 72.429°W) 6) Norwalk, CT (41.101°N, 73.418°W) and 7) Ashokan Reservoir, NY (41.9249°N, 74.2475°W). CO_2 is measured by either a Li-820 or Li-840 gas analyzer. The gas analyzer contains an optical path which determines CO_2 concentrations by the amount of light absorption by CO_2 gas particles. Also, each meteorology (MET) station measures several other indices which include rain (inches), air temperature (°F), solar radiation (W/m^2), relative humidity (%), wind direction (°), wind speed (mph) and soil moisture (m^3/m; only Ashokan). These additional data are useful for understanding CO_2 trends in relationship with diurnal variations and weather patterns, such as wind speed or solar radiation. Data is sampled every 30 seconds, logged every quarter hour (15 minutes) and then sent to an online site via telemetry. Current conditions can be found on this website: http://www.ldeo.columbia.edu/outr/LACOP/.

Figure 1: Locations of Climate Stations.

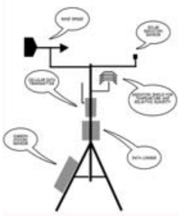

Figure 3: Schematic of a Climate Station.

Figure 4: Climate Station in Norwalk, Connecticut on LI Sound.

Figure 2: Sample CO_2 System at the Ashokan Reservoir site.

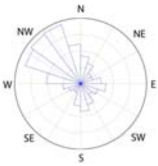

Figure 9: Histogram of wind direction from Harlem. Winds from the North West bring in air with a strong signature of CO_2 in rural areas.

Figure 10: Screenshot of the LACOP URL.

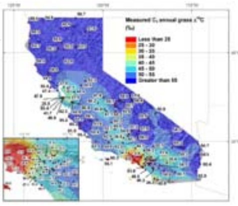

Figure 11: Measured $\Delta^{14}C$ of California C_3 grasses (‰); (inset) expanded view of the Los Angeles Basin. Background interpolation color was built based on 13 nearest neighbors using a cokriging method (including elevation) using Geostatistics Analyst tools in ESRI's ArcMap software.

Ongoing and Future Work

- Continue instrument and site maintenance
- Further data analysis on past and present trends
- Next Station at Frederick Douglass Academy in West Harlem
- Report CO_2 levels from Central Park to the New York Times

Acknowledgements

Internship of the Earth Institute Climate Change Adaptation Initiative is made possible by a grant from HSBC in the Community (USA) Inc.

References

Derwent, R. G., et al. (1995), Analysis and Interpretation of Air-Quality Data from an Urban Roadside Location in Central London over the Period from July 1991 to July 1992, *Atmospheric Environment*, *29*(8), 923-946.

IPCC (2007a), IPCC in Climate Change 2007: The Physical Science Basis, Cambridge, UK.

IPCC (2007b), Summary for Policymakers, 22 pp, Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK.

Keeling, C. D., et al. (1976), Atmospheric Carbon-Dioxide Variation at Mauna-Loa Observatory, Hawaii, *Tellus*, *28*(6), 538-551.

UN (2008), Economic & Social Affairs: World Urbanization Prospects The 2007 Revision: Executive Summary, United Nations, New York.