CO₂ and Heat Flux Observations in Suburban Baltimore (Cub Hill)
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The Importance of Urban Areas

- Urban areas are extensive – 50% world’s population (3 billion people) live in urban areas. By 2050 the UN predicts this will double
- Cities are major sources of CO₂ and other atmospheric pollutants – the effects of cities extend well beyond their boundaries
- Within urban areas the controls on surface atmosphere exchanges are both the sources of the emissions and the physical meteorology

Objective
To determine the momentum, heat, water, CO₂ fluxes at the local or neighborhood scale for an urban area.

Spatial Scales
To conduct eddy covariance measurements in an urban environment that are representative of the local scale, it is necessary to ensure:
- instruments are located high enough above the roughness elements (buildings, trees); typically > 2z0
- there is sufficient fetch (i.e. the neighborhood is extensive)

Study Site: Cub Hill, Maryland
- Site is near Towson, MD in Greater Baltimore
- Suburban area which is extensively forested (mature deciduous forest - see photos)
- Large increase in number of buildings in recent years. Further increases in density are likely.

The Site and Seasonal Changes
- The buildings in the area around the tower are predominately 1 story single-family dwellings (see photos)

Urban Energy Balance
Modification of the energy balance in urban areas comes from:
- Changes in the surface materials and morphology
- Additional sources of energy from human activities

\[ G' = G_0 + Q_0 + \Delta Q_0 \quad [W/m^2] \]

\[ G' \] not all-wave radiation
\[ Q_0 \] anthropogenic heat flux
\[ \Delta Q_0 \] latent heat flux
\[ \tau Q_0 \] sensible heat flux
\[ \Delta Q_0 \] storage heat flux (heating the urban fabric)

Data Availability
- Complete day, QA
- Incomplete day (rain, etc.) Only ground data
- Missing or invalid 10 Hz data

Daily Energy, Radiation and CO₂ Fluxes

Variability of Fluxes with Wind Direction
- 10° bins
- Data period: 2001/137-275 (biased towards Sept/Oct data)
- \( \tau = Q_0/Q' \) - scale: red numbers
- \( Q_0/Q' \) - scale: 0-4 (yellow circle)

Instrumentation
- Montiel – 40 m above ground level

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Earth at Night

Instruments

Environmental & CO₂

Meteorological and radiation budget
- Solar and Bowen (SW and LW net)
- Net longwave radiation

Fluxes
- Measurement of exchange fluxes over a large area
- Hourly data

Earth at Night

Radiation

Wind Speed (m/s)

Relative Frequency

Wind Distribution by 10° Sector (30 min periods)