Great opportunity for ESRL collaboration
  • GMD long-term monitoring + CSD short-term intensives

Mutual benefits of carbon cycle and air quality measurements
  • Evaluate and improve air quality emission inventories
  • Improve carbon cycle flux determinations

Today’s presentation
  • A few examples of ESRL top-down evaluations of bottom-up inventories
    ➢ Texas urban areas: aircraft, tall tower CO and CO\textsubscript{2} measurements
    ➢ East Coast: $^{14}$C measurements

Future collaborations
  • 2008 - BAO Tall Tower, Erie, CO
  • 2010 - California Air Quality Study
Need for Top-Down Assessment of Emission Inventories

- Emission inventories for CC and AQ uses are evolving

EDGAR 2000 $CO_2$

NEI 1999 $NO_x$

- AQ inventory emissions and trends subject to considerable uncertainties

NOAA observations provide top-down assessment of bottom-up inventories

Aircraft Observations of Houston Urban Emissions

- Derive urban emission ratios from targeted aircraft sampling

G. Frost, S. McKeen, M. Trainer, K. Aikin, J. Peischl, T. Ryerson, J. Holloway (CSD); G. Pétron, P. Tans (GMD); R. Harley (UCB)
Aircraft Assessment of Houston/Dallas CO Emissions

• CO\textsubscript{2} emissions relatively well known
  ➢ Evaluate CO emissions

• Aircraft observations detect decline in mobile source CO emissions
  ➢ Cleaner gasoline vehicles

➢ Inventories also report decline in CO emissions
➢ But inventory mobile source CO emissions overestimated (factors of 2-3)
• Urban CO emissions overestimated in inventory
• Ties field project inventory “snapshots” to longer-term monitoring time scales
• Top-down assessments critical for carbon cycle and air quality issues
Aircraft Observations of Houston Urban Emissions

CO/CO$_2$ = 0.0121 ($r = 0.96$)

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Bridging Carbon Cycling and Air Quality Studies using $^{14}$CO$_2$

- $^{14}$C naturally occurs in atmosphere (cosmic rays)
- $^{14}$C is absent from fossil fuels ($^{14}$C half-life = 5.7 kyrs)
- $^{14}$C excellent tracer for fossil fuel emissions

Some isotopic notation:

$$\Delta^{14}C = \left[ \frac{(^{14}C/C)_{sam}}{(^{14}C/C)_{std}} - 1 \right] \times 1000$$

$\Delta_{ff} = -1000$ per mil
$\Delta_{atm} \sim +55$ per mil

$^{14}$CO$_2$ allows partitioning of CO$_2$ into fossil fuel and biological components


J. B. Miller, S. Montzka, C. Sweeney, P. Tans (GMD, CIRES); S. Lehman, J. Turnbull (INSTAAR)
GMD Airborne Sampling of CC and AQ Gases

J. B. Miller, S. Montzka, C. Sweeney, P. Tans (GMD, CIRES); S. Lehman, J. Turnbull (INSTAAR)
Tracer Relationships to CO$_{2ff}$

Many species appear to exhibit significant seasonal emission cycles.

Use relationships with CO$_{2ff}$ to calculate regional emissions of anthropogenic gases.

$$m_{\text{gas}} \times E_{ff} = E_{\text{gas}}$$

J. B. Miller, S. Montzka, C. Sweeney, P. Tans (GMD, CIRES); S. Lehman, J. Turnbull (INSTAAR)
USA Emission Estimates: EPA Bottom-Up vs. $^{14}$CO$_2$ Top-Down

Concurrent analysis of $^{14}$CO$_2$ and atmospheric gas samples

- Assessment of regional emission inventories
- Factor of 2 overestimate in CO inventory

J. B. Miller, S. Montzka, C. Sweeney, P. Tans (GMD, CIRES); S. Lehman, J. Turnbull (INSTAAR)