High resolution fossil fuel CO2 emissions for the North American Carbon Program

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Introduction

The Problem
Quantification of the North American carbon budget requires high resolution, dynamic and process-based estimates of fossil/industrial CO2 emissions. This quantification is crucial for bottom-up calculations and inverse/ assimilation approaches. In the latter instance, the advent of remotely-sensed column CO2 concentrations (Orbital Carbon Observatory) implies the need for fossil/industrial CO2 emissions at comparative spatial and temporal scales (10s km).

Our goals
The "Vulcan" project aims to achieve estimate of fossil/industrial CO2 emissions at scales of 10s of kilometers and hourly temporal scales for the entire United States, Canada and Mexico. We are quantifying these emissions with economic sub-sector process detail.

Our solution
In order to achieve these spatiotemporal scales and achieve the underlying process drivers for the emissions, we have leveraged off of the decades-long history of air quality monitoring in North America.

Methods

Data sources
National Emissions Inventory (NEI), constructed to regulate nationally regulated pollutants (CO, O3, NOx, SOx, particulates) (EPA, 1999, 2002, 2006). This database contains:
- point sources - stack monitoring, emissions reports, etc
- major industrial sources - consumption, etc.
- breakdown of ambient emissions by source category codes

Existing emission inventory for point and line sources project this to 36 km/hourly for US.

Continuous Emissions Monitoring System (CEMS) under the EPA's Acid Rain Program, electric generating facilities over 25 MW and those associated with fuel or sulfur content greater than 0.05%, must report emissions, including CO2, Hourly of dispatchable emissions (EPA CEMS).

Mobile:
- Output from the CEMs and EPA models are used - the National Mobile Inventory Model (NMIM) and Motor Vehicle Emissions Simulator (MOVES), which includes a variety of data sources including Highway Population and Activity Data (US Census Bureau), FHWA Highway Statistics, and FTA National Transit Database (Mendoza, Gurney, and Miller, 2009).

CO2 generation

<table>
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<tr>
<th></th>
<th>Fuel throughput</th>
<th>Non-CEM emissions</th>
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<th>CO2 EF</th>
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<tr>
<td>CO2 direct</td>
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<tr>
<td>Total</td>
<td>0.47</td>
<td>0.20</td>
<td>0.59</td>
<td>0.065</td>
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<tr>
<td>Transport</td>
<td>0.47</td>
<td>0.20</td>
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<td>0.063</td>
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<tr>
<td>Total</td>
<td>1.43</td>
<td>1.56</td>
<td>1.49</td>
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National/sectoral comparison

<table>
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<th>EPA 5</th>
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</tbody>
</table>

1 Alaska and Hawaii are not included in totals  
2 transport is extrapolated from 1999 output  
3 Industrial sources in the current study are incomplete  
4 Energy Information Agency 2005  
5 Environmental Protection Agency 2006

Evaluation

Conclusions

- High res. process-driven fossil CO2 is essential: for science (budgets, inversion) and management (options)
- Our approach for North America (US now) looks promising and early eval. shows no continental-scale problems
- State-scale evaluation show area sources as having the greatest difference from EIA data

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References/Acknowledgements

Mendoza, D., R. Gurney, and C. Miller, US carbon dioxide-richer vehicle emissions resolved hourly at 1 km resolution, presented in the Fall AGU, Dec. 2007

http://www.eas.purdue.edu/carbon/vulcan.html