

# Using atmospheric observations to assess fossil fuel CO<sub>2</sub> emissions in California

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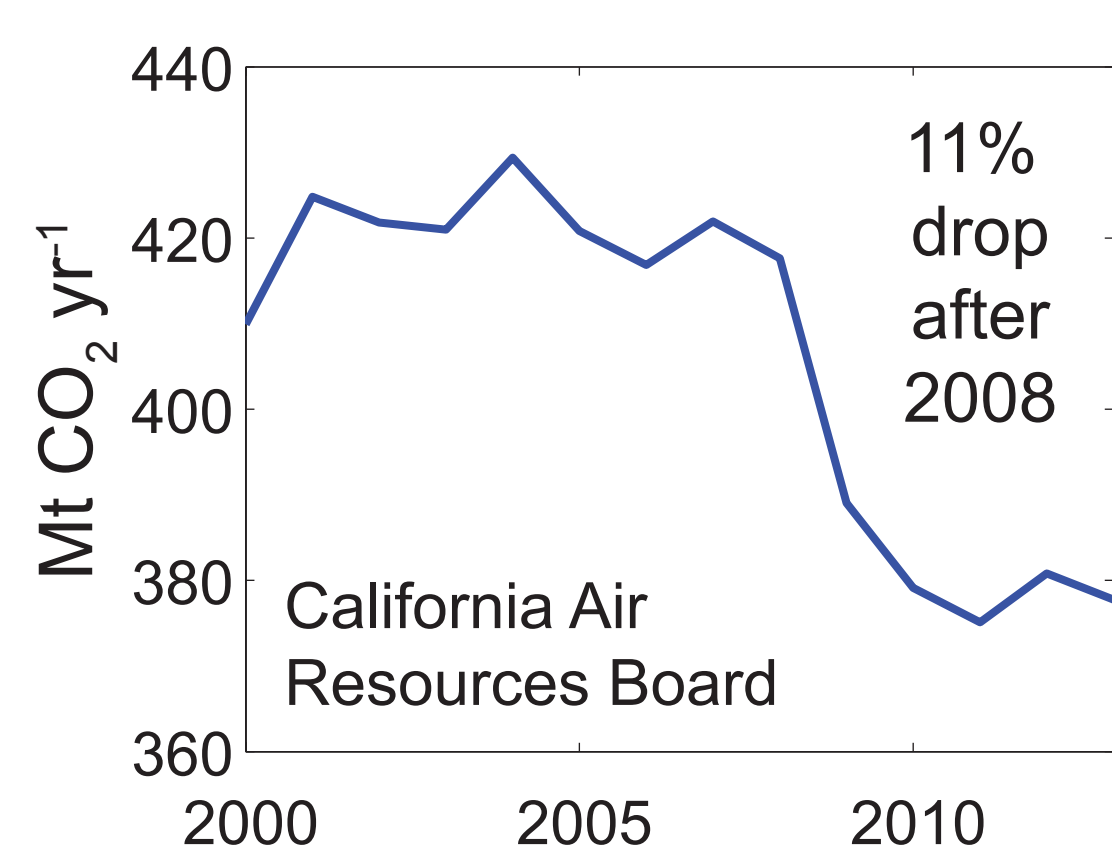
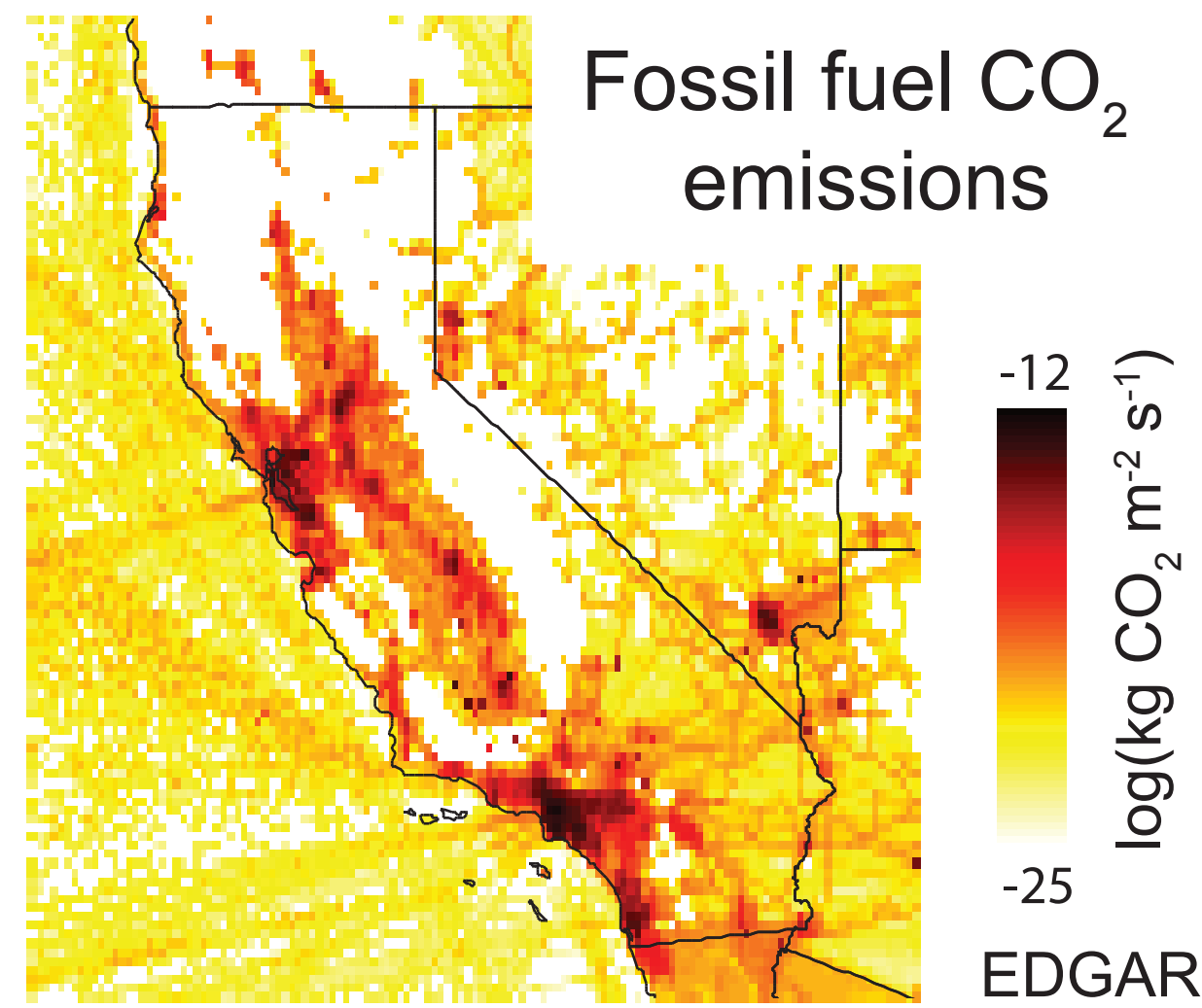
M. Fischer, T. Lueker, K. Brophy, T. Guilderson, R. Keeling, T. Arnold, R. Bambha, W. Callahan, E. Campbell, C. Frankenberg, Y. Hsu, L. Iraci, S. Jeong, J. Kim, B. LaFranchi, S. Lehman, A. Manning, H. Michelson, J. Miller, S. Newman, W. Paplawsky, N. Parazoo, C. Sloop, S. Walker, M. Whelan, D. Wunch

## California's CO<sub>2</sub> budget

California's fossil fuel CO<sub>2</sub> emissions are approx. 370 Mt CO<sub>2</sub> yr<sup>-1</sup>, about 1% of the global total

California's AB-32 law requires GHG emissions be reduced to 1990 levels by 2020, and 80% below that by 2050

Bottom-up fossil fuel CO<sub>2</sub> inventories differ by approx. 15% in their statewide total emissions, with larger differences for some subregions of California in spatially resolved emission maps



## Independent assessment of fossil fuel emissions

We are developing a top-down assessment of fossil fuel CO<sub>2</sub> emissions using tower-based observations of CO<sub>2</sub> concentration and radiocarbon in CO<sub>2</sub>, combined with models and remote sensing

Previously, top-down studies of CO<sub>2</sub> have assumed fossil fuel emissions are well-known and used atmospheric data to estimate natural CO<sub>2</sub> fluxes

Radiocarbon measurements are needed to distinguish fossil fuel influences on CO<sub>2</sub> from natural influences

Observations show similar patterns to simulations of fossil fuel-derived CO<sub>2</sub>

using atmospheric models and fossil fuel emission models, with some differences between models

Validation of bottom-up fossil fuel inventories to within approx. 10% is likely possible with this method, based on simulation experiments

Detection of changes in emissions of less than 10% may thus be possible, depending on location, observation network and emissions

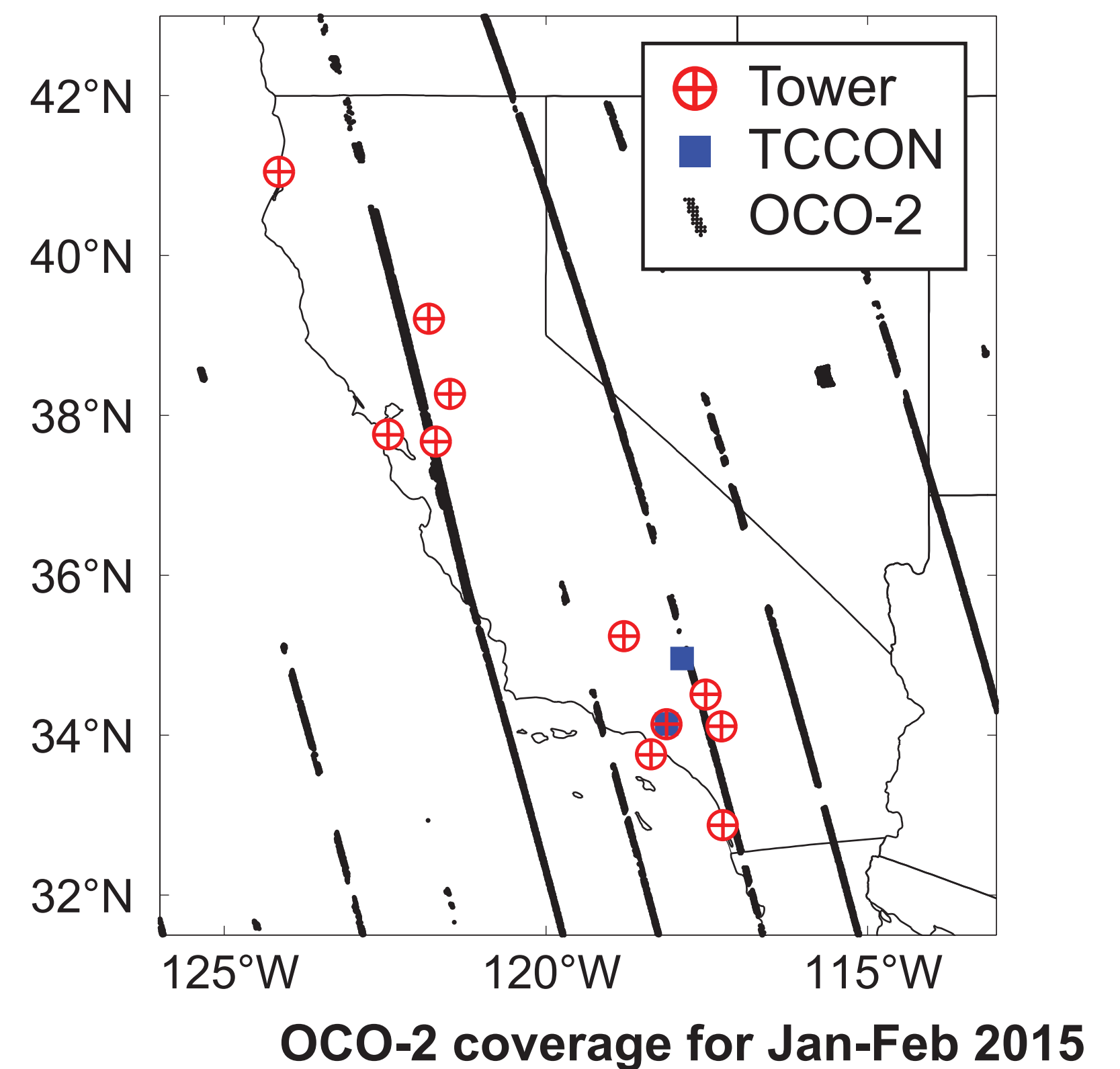
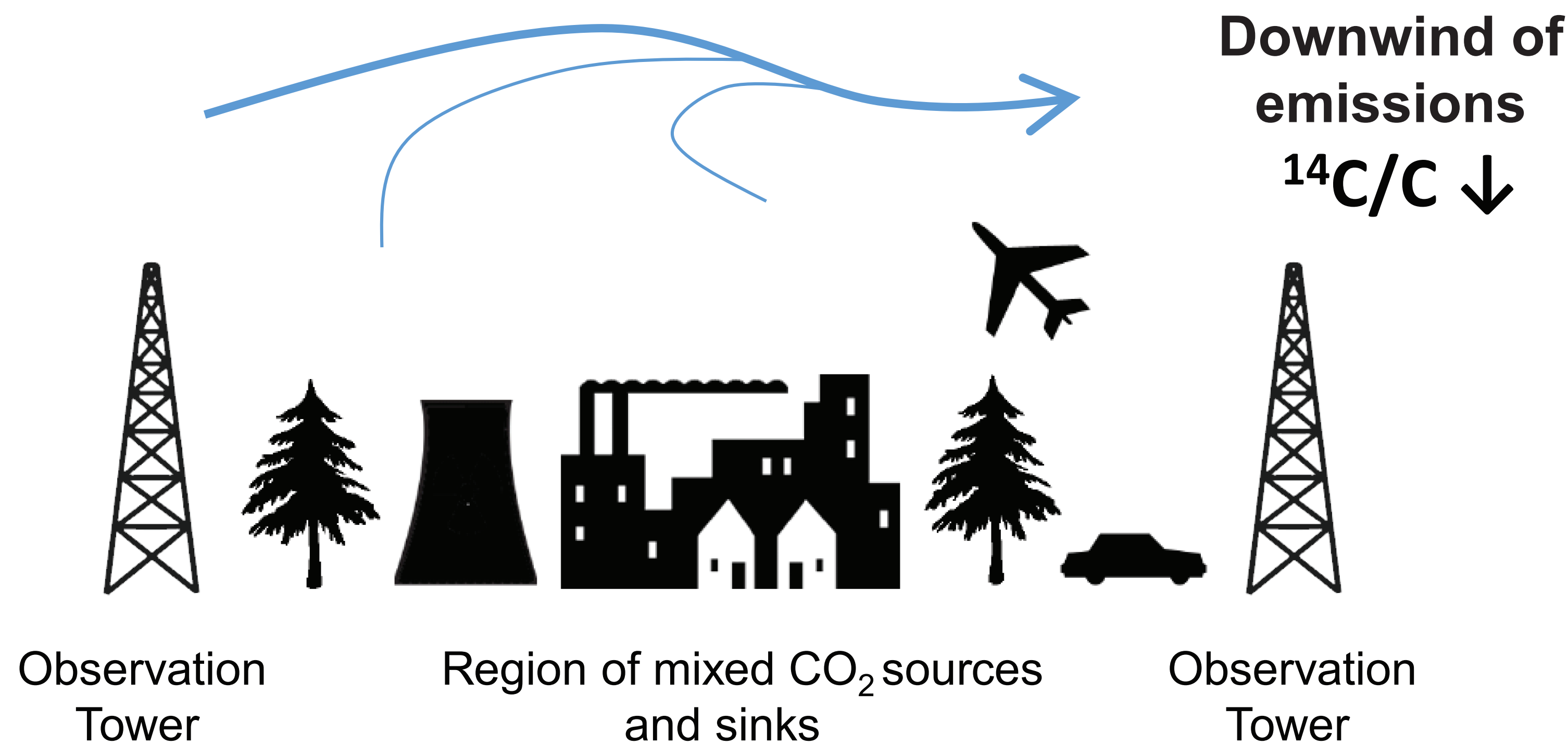
Evaluation of atmospheric transport models is key to establishing the accuracy of top-down methods

## Fossil fuel-derived CO<sub>2</sub> is measured from a network of towers using radiocarbon (<sup>14</sup>C)

Million-year-old fossil carbon has lost all its <sup>14</sup>C from radioactive decay

Fossil fuel combustion decreases the ratio <sup>14</sup>C/C in CO<sub>2</sub>

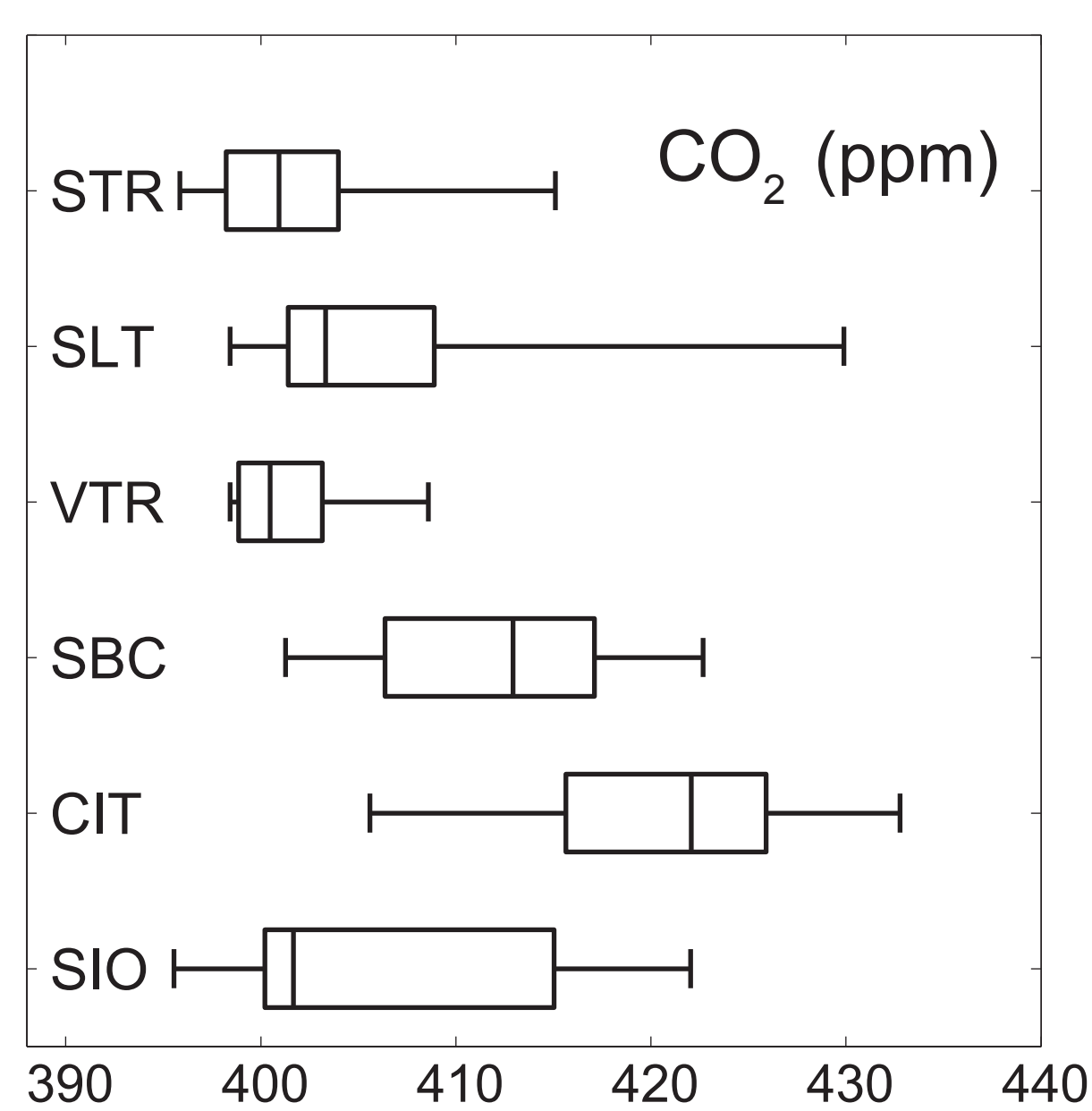
Measuring the change in <sup>14</sup>C/C in CO<sub>2</sub> allows us to calculate CO<sub>2</sub> added by fossil fuel combustion



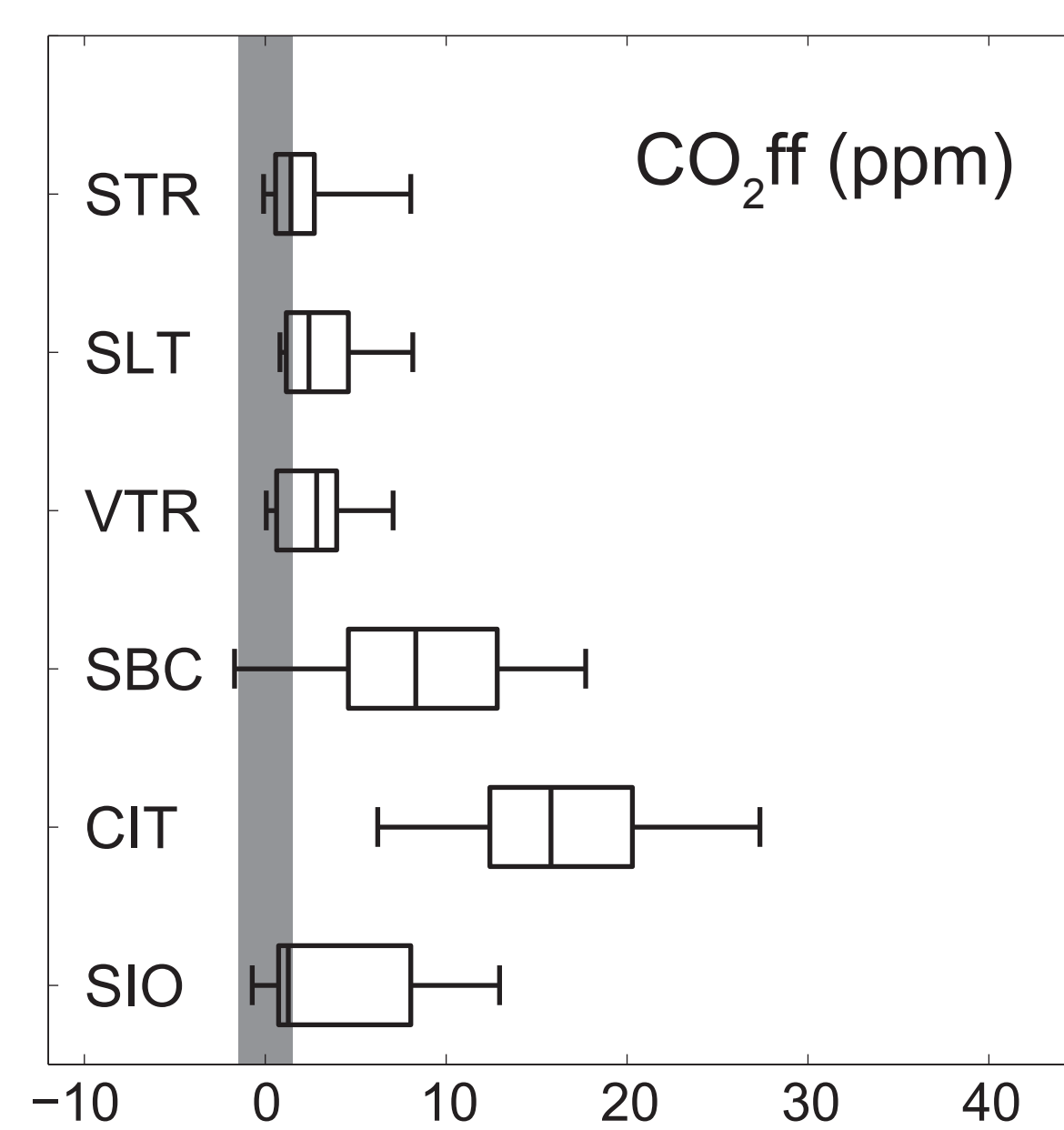
## Comparison of observed and simulated fossil fuel CO<sub>2</sub>

Preliminary results for Oct-Nov 2014 at 6 towers

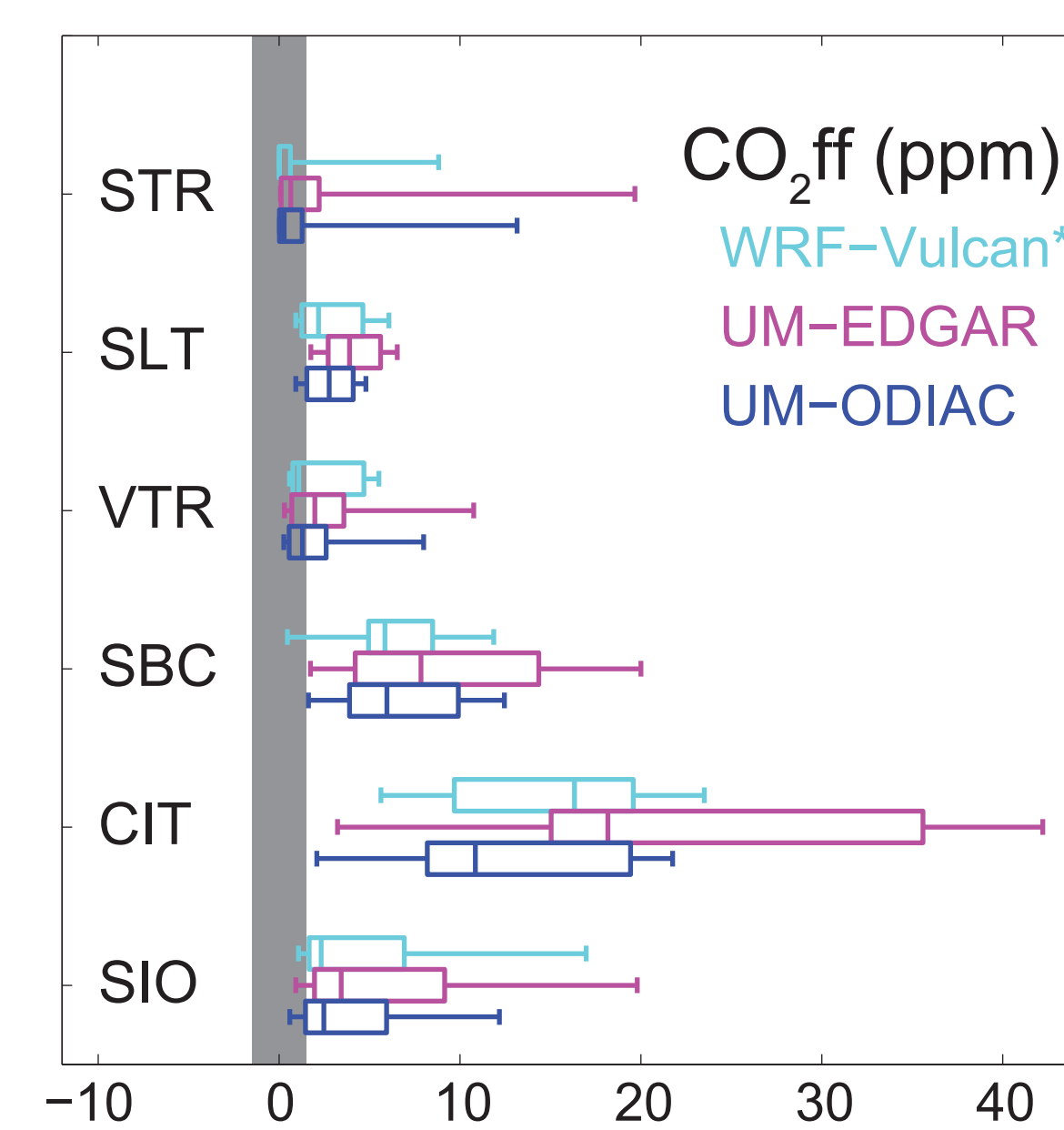
Observed CO<sub>2</sub> Concentration



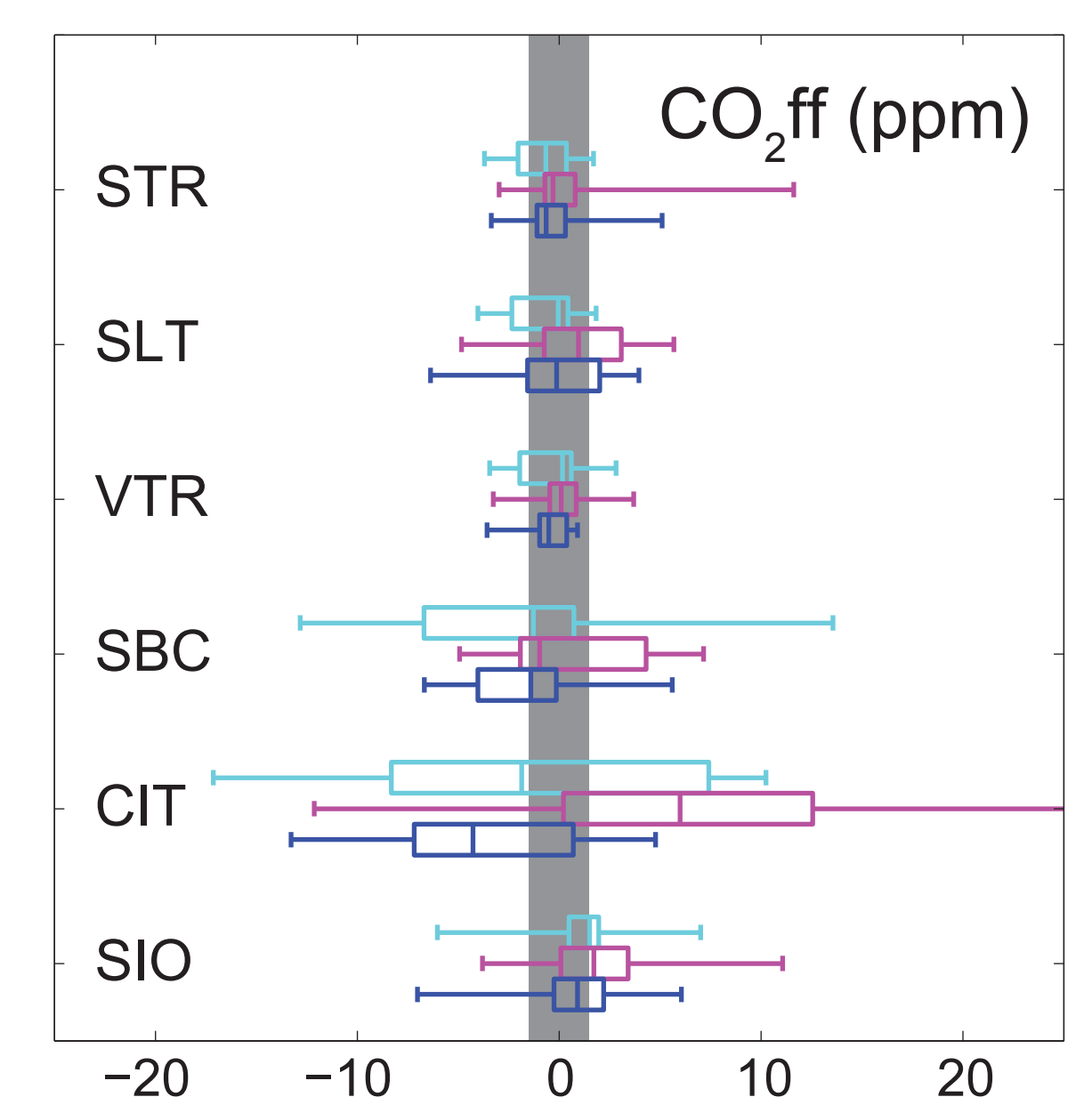
Observed Fossil Fuel CO<sub>2</sub>



Simulated Fossil Fuel CO<sub>2</sub>



Difference in Fossil Fuel CO<sub>2</sub> Simulated - Observed



Boxplots show the range of observed or simulated values. Each segment represents 25% of the data. Gray bar shows detection limit for fossil fuel CO<sub>2</sub>.

Simulations using 2 atmospheric models and 3 fossil fuel emission models at high resolution show similar patterns to the observations, with some variation between simulations. Observations and simulations are being used in an inversion to produce a statistical best estimate of emissions.