Journal of Geophysical Research - Atmospheres

Supporting Information for

Large uncertainties in urban-scale carbon emissions

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Contents of this file

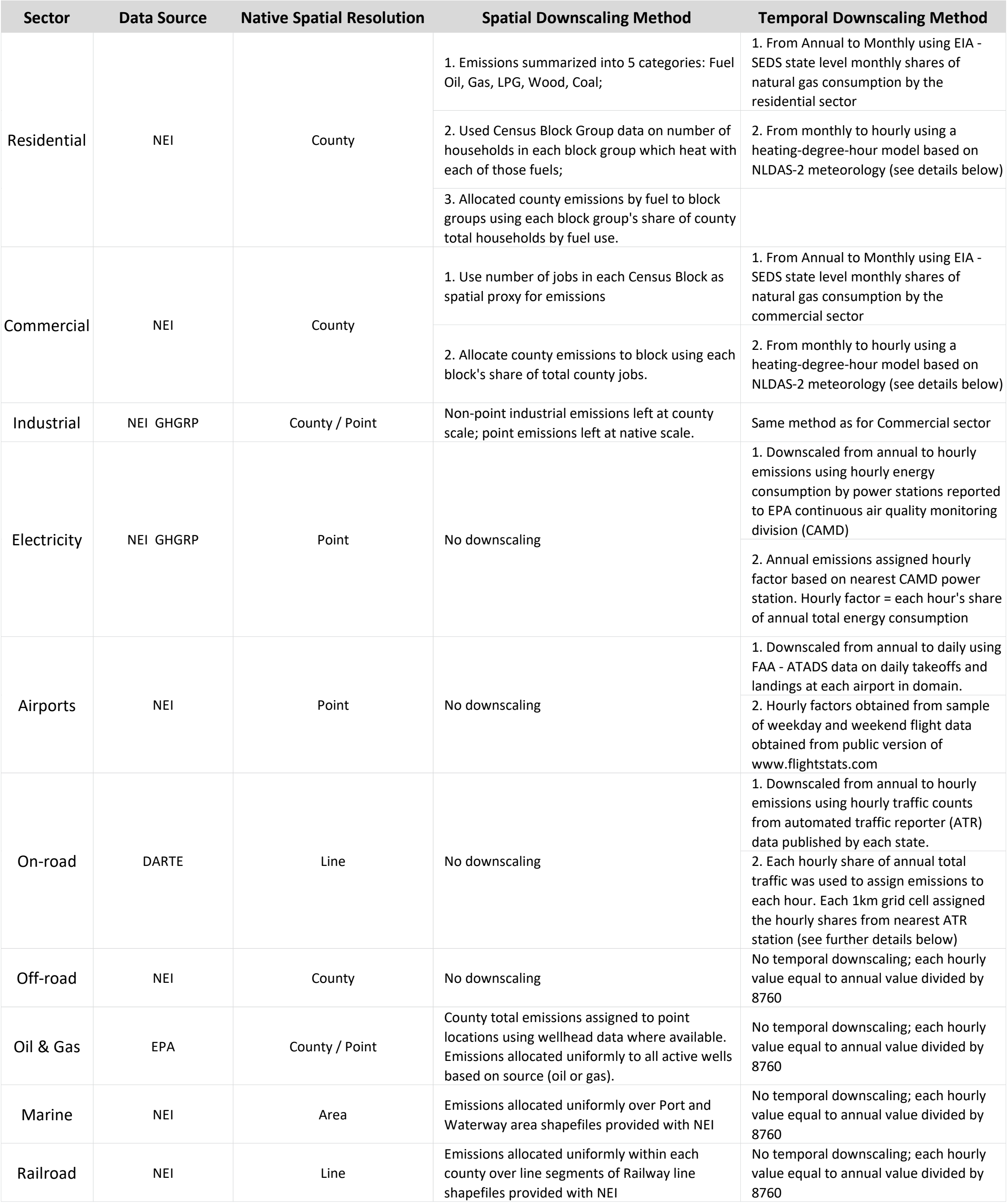
Introduction

This document contains additional details of the methodology used to construct the Anthropogenic Carbon Emissions System (ACES). These additional details are in supplement to the methods section in the main body of the paper, and deal mostly with the selection of emissions factors and the calculation of temporal scaling factors for annual emissions. For all sectors in ACES, the base year annual emissions are from the year 2011. Hourly allocation factors were calculated for 2013 and 2014, in support of atmospheric modeling for those years. All ACES emissions data will be available for download at the Oak Ridge National Laboratories Distributed Active Archive Center: https://doi.org/10.3334/ORNLDAAC/1501

This document also contains several additional figures:

- Figure S1 – Overview of ACES methodology in table form
- Figure S2 – Hourly emissions by sector for two 1 km^2 ACES grid cells in NYC, NY
- Figure S3 – Source sector shares of state emissions in ACES domain
- Figure S4 – Percent relative difference among different combinations of inventories for the domain and for New York City.
- Figure S5 – Percent difference relative to ACES of the other three inventories covered by this study: EDGAR, FFDAS, and ODIAC.
- Figure S6 – Map of Automatic Traffic Recorder (ATR) station locations used to temporally downscale DARTE annual FFCO2 emissions from the on-road sector to hourly ACES emissions.
- Figure S7 – A comparison of ACES emissions with emissions reported by bottom-up inventories conducted by a selection of cities and states within the domain.
- Figure S8 – Comparison of the 2002 Vulcan Inventory with ACES

Appendix A contains a table of the emissions factors used to convert NEI carbon monoxide (CO) estimates into CO$_2$ estimates in ACES.



Sector	Data Source	Native Spatial Resolution	Spatial Downscaling Method	Temporal Downscaling Method
Residential	NEI	County	1. Emissions summarized into 5 categories: Fuel Oil, Gas, LPG, Wood, Coal;	1. From Annual to Monthly using EIA - SEDS state level monthly shares of natural gas consumption by the residential sector
			2. Used Census Block Group data on number of households in each block group which heat with each of those fuels;	2. From monthly to hourly using a heating-degree-hour model based on NLDAS-2 meteorology (see details below)
			3. Allocated county emissions by fuel to block groups using each block group's share of county total households by fuel use.	
Commercial	NEI	County	1. Use number of jobs in each Census Block as spatial proxy for emissions	1. From Annual to Monthly using EIA - SEDS state level monthly shares of natural gas consumption by the commercial sector
			2. Allocate county emissions to block using each block's share of total county jobs.	2. From monthly to hourly using a heating-degree-hour model based on NLDAS-2 meteorology (see details below)
Industrial	NEI GHGRP	County / Point	Non-point industrial emissions left at county scale; point emissions left at native scale.	Same method as for Commercial sector
Electricity	NEI GHGRP	Point	No downscaling	1. Downscaled from annual to hourly emissions using hourly energy consumption by power stations reported to EPA continuous air quality monitoring division (CAMD)
				2. Annual emissions assigned hourly factor based on nearest CAMD power station. Hourly factor = each hour's share of annual total energy consumption
Airports	NEI	Point	No downscaling	1. Downscaled from annual to daily using FAA - ATADS data on daily takeoffs and landings at each airport in domain.
				2. Hourly factors obtained from sample of weekday and weekend flight data obtained from public version of www.flightstats.com
On-road	DARTE	Line	No downscaling	1. Downscaled from annual to hourly emissions using hourly traffic counts from automated traffic reporter (ATR) data published by each state.
				2. Each hourly share of annual total traffic was used to assign emissions to each hour. Each 1km grid cell assigned the hourly shares from nearest ATR station (see further details below)
Off-road	NEI	County	No downscaling	No temporal downscaling; each hourly value equal to annual value divided by 8760
Oil & Gas	EPA	County / Point	County total emissions assigned to point locations using wellhead data where available. Emissions allocated uniformly to all active wells based on source (oil or gas).	No temporal downscaling; each hourly value equal to annual value divided by 8760
Marine	NEI	Area	Emissions allocated uniformly over Port and Waterway area shapefiles provided with NEI	No temporal downscaling; each hourly value equal to annual value divided by 8760
Railroad	NEI	Line	Emissions allocated uniformly within each county over line segments of Railway line shapefiles provided with NEI	No temporal downscaling; each hourly value equal to annual value divided by 8760

Figure S1. Overview of data sources and spatial and temporal downscaling methods used to construct the 1km^2, hourly, ACES gridded emissions fields. Additional details for each sector are provided in the following section.

Text S1. Additional Methods Information

Aircraft and Airport Sector

NEI estimates of CO emissions were converted into CO_2 using emissions factors for jet fuel from Gurney et al. (2010) and assigned to airport point locations. We disaggregated annual emissions to a daily time structure using take-off and landing data from the Federal Aviation Administration's Air Traffic Activity System (ATADS) [http://aspm.faa.gov/opsnet/sys/Main.asp]. We calculated each day's share of total annual flights for a given airport in ATADS and then used those daily shares to distribute annual $FFCO_2$ to daily $FFCO_2$ for 2013 and 2014. Each airport was assigned the time structure of the nearest airport in the ATADS system. For the diurnal temporal pattern, we assigned 70% of daily emissions to the hours between 0600 and 2100 EST, and the remaining 30% of daily emissions to the hours between 2100 and 0600. This diurnal partitioning was based on an examination of a sample of hourly flight activity for one week in May at the largest 5 airports in the ACES domain obtained from the free web-based version of www.flightstats.com. There is no free access to the complete FlightStats database of historical flight activity, which limited our ability to fully characterize diurnal patterns based on actual data. Future versions of ACES may incorporate this data, subject to funding availability. Emissions in these two time periods ('Day' and 'Night') are distributed evenly by hour.

Marine Vessels Sector

Marine vessel CO emission factors were obtained from EPA (2009b**).** We assumed all marine vessels that burn residual oil as fuel have the emissions characteristics of 'Ocean-Going Vessels' and are all 'Medium-Speed Diesel'. We assume that marine vessels that burn 'Diesel Fuel' in the NEI 'Port Emissions' category are 50% 'Ocean-Going Vessels' and 50% 'Harbor Craft'. We assume that marine vessels that burn diesel fuel in the 'Underway emissions' category are 100% 'Harbor Craft'. We partition 'Harbor Craft' activity (both in port and underway) as 25% Category 2 vessels and 75% Category 1 vessels, following EPA (2008). For Category 1 Harbor Craft, we use a CO emission factor of 1.5 g / kWh, which is the median value for Tier 0 / Tier 1 / Category 1 vessels. We use a CO emission factor of 1.1 for Category 2 Harbor Craft. We assume there are no Tier 2 craft. The CO_2 emission factor for all Harbor Craft is 690 g/kWh, as in Table 3.8 of EPA (2008). Marine emissions are given a flat hourly time structure, as no data on seasonal, monthly or diurnal patterns in activity was available.

Railway Sector

Railway CO emissions were obtained from NEI and converted to CO2 using emission factors from EPA [2009a]. Emissions were summed by county and then spatially distributed onto the NEI-provided "Rail Line Shape Files" GIS layer using the

"2011NEIv2 Shape Fractions of County Emissions for Rail and Commercial Marine", both available at https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-documentation. Railway emissions were given a flat hourly time structure, as no data on seasonal, monthly or diurnal patterns in activity was available.

Nonroad Sector

For emissions from vehicles that are not operating on the public road network (e.g. construction vehicles, agricultural vehicles, lawn and garden equipment), estimates of county-level CO_2 were obtained from the NONROAD2008 model included in the EPA MOVES2014a (Motor Vehicle Emission Simulator) model, available at https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles. NONROAD2008 provides time-varying emissions estimates by month and by weekday / weekend, however this time structure was developed based on data from the NONROAD2005 model, and has not been updated since then. This is the same time structure used in the Vulcan Project 'nonroad' emissions layer, as Vulcan estimated emissions using the NONROAD2005 model (Gurney et al. 2010). We therefore applied the temporal structure of the Vulcan 2002 'nonroad' layer to our 2011 annual CO_2 estimates, adjusted to match the weekday/weekend patterns of 2013 and 2014.

Oil and Gas Sector

CO_2 emissions associated with oil and production at the county level were calculated using the EPA Oil and Gas Emission Estimation tool (https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-documentation). The tool partitions emissions into four well-type categories: Oil, Gas, Combined Oil & Gas, and Water. We obtained well type and location information for New York, Pennsylvania, Virginia, and West Virginia. County emissions were evenly distributed across all wells in a county by activity status and well type. Well location data was unavailable for Maryland, so emissions were distributed evenly across each county. Water injection-related emissions were distributed evenly to all wells in each county. If the well location data included a "combined" type the wells were assigned the "combined" emissions, otherwise the emissions were distributed evenly across the other well types. Other well types, if provided, (e.g. geothermal) were excluded from the emission allocation; only oil, gas, and combined oil and gas wells were assigned an emissions value. If there were oil emissions reported in NEI but no oil wells reported in the county, the emissions were averaged across the gas wells in that county (or vice versa). West Virginia did not have well type available; emissions were averaged evenly across all wells. A uniform time structure was used for emissions from this sector.

On-road Sector

ACES on-road emissions are based on annual road-level CO2 emissions estimates reported by the Database of Road Transportation Emissions (DARTE) (Gately et al. 2015). The hourly time structure for emissions was calculated using hourly vehicle counts reported by automatic traffic recorders (ATRs) in the following states: Connecticut, Maryland, Massachusetts, New Hampshire, New York, Pennsylvania, Vermont and Virginia.

Connecticut: http://www.ct.gov/dot/cwp/view.asp?a=3532&q=330402
Maryland: http://maps.roads.maryland.gov/itms_public/ Massachusetts: http://mhd.ms2soft.com/tcds
New Hampshire: http://www.nh.gov/dot/org/operations/traffic/tvr/detailsheets/index.htm
New York: https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services/hdsb
Pennsylvania: http://www.dot7.state.pa.us/itms/default.asp
Vermont: http://vtrans.vermont.gov/operations/technical-services/traffic
Virginia: http://www.virginiadot.org/info/ct-trafficcounts.asp

For Pennsylvania and Maryland, ATR reports for the full 8760 hours of the year were not available. Instead, these states publish daily, weekly and monthly factors that can be applied to annual traffic counts to partition travel to the hourly level across a year. These factors are calculated using the full 8760-hour datasets obtained from ATRs in different regions of each state. We used these factors to obtain hourly fractions of annual traffic at 290 locations in Pennsylvania and 62 locations in Maryland.

For the remaining states, full 8760-hour traffic counts from ATRs were available for download in a variety of formats. However, only a subset of these ATR reports were available for the most recent full calendar year (2013). In order to obtain a sufficient spatial coverage of the study region, we assembled a pooled dataset of all available sensor data from each state for the years 2008-2013. Due to sensor malfunction or other reasons, not every ATR report contained traffic counts for all 8760 hours of the year (or 8784 hours in the case of leap years). With the aim of balancing the need for a sufficient sample size against the necessity of imputing missing values for these incomplete records, we excluded all ATR reports with less than 8100 valid records. This is equivalent to a minimum of 48 weeks of valid count data per report. Further, we excluded any reports where there are more than 7 missing days in any given month. The resulting dataset comprised 142 ATR reports across these six states.

As traffic volumes are strongly dependent on the day of the week, it is not appropriate to impute missing values by an interpolation method based on traffic counts from neighboring days. Therefore in the interest of simplicity we filled missing values with the reported value from the same hour and day of the previous week. Where that value is either missing or unavailable (as in the case of January 1st-7th) we fill with the value from the same hour and day of the following week. While this may introduce small biases to the within-month trends of traffic patterns, it maintains the temporal structure of within-week traffic patterns, which have a much larger day-to-day variation than do week-to-week traffic patterns. After gap-filling, we adjusted each report to match the calendar year of 2013, so as to align all records by the day of the week of a common year. To adjust each report, we shuffle records from the beginning of the year to the end of the year until the first record of each report represents 12am to 1am on the first Tuesday in January. Thus, depending on the original year of the report, records from the first 1-6 days of January are appended to the end of December. Reports from leap years have the records from the resulting "December 32nd" dropped. This adjustment process is necessary to unify all data records into a consistent time structure, but may introduce small biases depending on the local effects of the holiday season on week-to-week travel patterns in late December.

With the records from all reports synchronized to a common year, we calculate the fraction of total annual traffic that occurs in each hour of the year at each ATR. We then apply these hourly fractions to estimates of annual on-road CO_2 emissions as described later below. The process was then repeated to generate a separate set of records that are aligned to the year 2014, using an identical methodology.

All reports were matched with geocoded locations for each ATR station in a GIS (Figure S6). Locations of the ATR stations were obtained either directly as GIS shapefiles from the same sources as the ATR reports or extracted from latitude and longitude coordinates provided with the data. The only exception is with Connecticut, which only provided schematic roadway maps of the ATR location in PDF format. The location of these ATR stations was manually geocoded using visual comparison of Google Earth images with the provided roadway schematic PDFs. For Maryland and Pennsylvania, since factors were used to estimate the hourly time structure for all ATR stations corresponding to each roadway functional class, a random sample of ATR stations (stratified by functional class) was selected from the GIS shapefiles provided by each of these states' respective transportation departments. We used a sample of locations instead of the full list of ATRs so as to maintain a roughly similar areal density of stations across all states in the study region, and to reduce the computational burdens of the following procedure (Figure S6).

For each 1 x 1km grid cell in our on-road emissions layer, we assigned the hourly time structure from the nearest ATR station, as was done by Gurney et al. (2009). The distance between each grid cell and ATR is calculated using a cost-surface that restricts the distance calculation to the land surface. This prevents grid cells in, for example Provincetown, MA at the tip of Cape Cod, from being assigned the time structure of an ATR station in Boston, MA instead of Hyannis, MA, despite the linear distance between Provincetown and Boston being shorter than the distance between Provincetown and Hyannis. This was done on the assumption that spatial correlations in the time structure of traffic patterns are more a function of the connectivity of local road networks rather than their simple linear proximity. With each grid cell assigned an appropriate hourly time structure, we then distribute the annual on-road CO_2 emissions into hourly shares for each grid cell. The hourly emissions have been rounded to the nearest kilogram, and therefore annual totals may not match exactly the totals reported in DARTE.

Point Source Sectors

Data on point-source emissions from the NEI and the GHGRP were partitioned into electricity-generation facilities and non-electricity generation facilities. Records that met at least one of the following conditions were subset into the 'electricity-generation' dataset:

EIS code = 'FUEL COMB - ELECTRIC GENERATION - COAL'
EIS code = 'FUEL COMB - ELECTRIC GENERATION - OIL'
EIS code = 'FUEL COMB - ELECTRIC GENERATION - NATURAL GAS'
EIS code = 'FUEL COMB - ELECTRIC GENERATION - BIOMASS'
EIS code = 'FUEL COMB - ELECTRIC GENERATION - OTHER'
Facility Source Description = 'ELECTRICITY GENERATION VIA COMBUSTION'
EIS level 2 = 'ELECTRIC GENERATION'
Industry Type (Sectors) = 'POWER PLANT'

All other records were subset into 'non-electricity generation' emissions, with two exceptions. Airport emissions from airplane taxiing, takeoff, and landing were removed and used to generate the Airport sector emissions as described earlier in this document, using the condition:

EIS level 1 = 'Mobile Sources' AND EIS level 1 != 'Airport Ground Support Equipment'

All other 'non-road' mobile sources were excluded using the conditions:

EIS level 1 = 'Mobile – Non-Road Equipment – Diesel'
EIS level 1 = 'Mobile – Non-Road Equipment – Other'
EIS level 1 = 'Airport Ground Support Equipment'
EIS level 2 = 'Railroad Equipment'

For the NEI point sources, the reported CO emissions were converted into CO2 emissions using emissions factors from the EPA WEBFire database (http://cfpub.epa.gov/webfire/) and from *Gurney et al.,* [2010]. We also incorporated CO2 emissions from point sources that report under the Greenhouse Gas Reporting Program, as these emissions are directly reported by each facility as CO2, which reduces the potential errors associated with using CO / CO2 conversion factors as was done for the NEI point source facilities. In order to ensure that we did not double count facilities whose emissions are reported in both the NEI and the GHGRP, we filtered the NEI point dataset to remove any facilities that matched GHGRP facilities according to the following criteria:

1. Matching facility name, zip code, and state
2. Matching facility address, zip code, and state
3. Matching latitude and longitude

However, there is considerable variability in facility name and address conventions, and in latitude/longitude data accuracy and precision. To further eliminate any potential double-counting of point facilities we loaded all remaining unmatched facilities (N=937) from NEI and GHGRP into ESRI ArcGIS software and used a spatial buffer to identify all GHGRP facilities whose location falls within 1500 meters of any other NEI facility. Each GHGRP facility record was then manually compared with all of the nearby NEI facilities to determine whether it represented a duplicate record. Where no matching NEI facility was identified, we added the GHGRP facility to our final dataset. Where a matching NEI facility was identified, we replaced the emissions for that facility with the reported CO2 emissions from the relevant GHGRP facility. For this latter case, we did not change the location of the NEI facility whose emissions were replaced with the GHGRP values. A manual comparison of a sample of facility locations with Google Earth satellite imagery indicated that the NEI facility locations were more likely to accurately locate the facility than the comparable GHGRP latitude and longitude values. Thus, we kept the NEI facility locations when replacing the emissions with the GHGRP values. For the facilities reported in the GHGRP that had no detectable counterpart in the NEI, we use the location of the facility as reported in GHGRP.

The hourly time structure of point source emissions from electric power stations was derived from fuel consumption data reported by electric power generating stations as part of the EPA Air Markets Program Database (AMPD) (http://ampd.epa.gov/ampd/). Each facility reports the heat input in million Btu of the fuel combusted to generate power for each hour of the year. We summed the hourly heat input to an annual total for each facility, then divided each hour’s value by this total to generate hourly shares of activity for the facility. Each point source from NEI or GHGRP that was not included in the AMPD was assigned the hourly temporal structure of the nearest AMPD facility. We derived the time structure for non-electricity generating point sources using a similar method, using hourly heat input data for non-electricity-generating facilities from AMPD for 2013. However, due to the widely varying temporal structure of activity in the non-electricity generating facilities reported in AMPD, we elected to use the average 2013 temporal structures of all the facilities in the domain to partition these industrial point source emissions into hourly emissions. A similar method was used to derive hourly allocation factors for 2014.

Commercial Sector

State data on monthly consumption of natural gas for commercial purposes was used to disaggregate annual emissions (Energy Information Administration - State Energy Data System (SEDS), http://www.eia.gov/state/seds). An hourly time structure was calculated within each month using a Heating-Degree-Hours model based on data from the National Land Data Assimilation System [NLDAS-2, http://ldas.gsfc.nasa.gov/nldas], which reports air temperature at 2 meters above the surface at hourly time increments on a 1/8° grid. We calculated heating-degrees as the number of degrees that the temperature in a grid cell was below a reference temperature of 20 degrees Celsius, for each hour of each month. For hours where the temperature is higher than 20 degrees C, the number of heating-degrees for that hour is zero. Heating-degrees were summed across all hours in each month and each hour's share of total monthly heating-degrees was calculated. Monthly emissions were partitioned into two categories before assigning hourly shares: emissions that are presumed to be influenced by temperature (i.e. emissions for space-heating purposes), and emissions presumed not to be influenced by temperature (i.e. hot water heating, cooking, other commercial activities). For emissions not influenced by local temperatures, we gave a flat time structure within the month. For temperature-influenced emissions we used the hourly heating-degree shares to assign an hourly time structure. Monthly emissions were divided into these two categories as follows:

Non-temperature-dependent emissions = Monthly total emissions * (# of hours in month with zero heating-degrees / total # hours in month)

Temperature-dependent emissions = Monthly total emissions * (# of hours in month with non-zero heating-degrees / total # hours in month)

The non-temperature-dependent emissions are then divided equally across every hour in the month. The temperature-dependent emissions are apportioned to each hour of the month according to that hour's share of total monthly heating-degrees. The total emissions in each hour are therefore the sum of the two categories of emissions for that hour.

Residential Sector

To downscale emissions from the county scale, we use data on the number of households in each Census Block Group that use the following fuels to heat their homes: natural gas, heating oil, coal, wood, and LPG. We summarized the NEI-based county scale emissions into these 5 categories using the following conditions:

Gas: EIS level 3 = "Natural Gas"
LPG: EIS level 3 = "Liquified Petroleum Gas (LPG)"
Coal: EIS level 3 = "Anthracite Coal" OR "Bituminous/Subbituminous Coal"
Wood: EIS level 3 = "Firelog" OR "Wood"
Oil: EIS level 3 = "Residual Oil" OR "Kerosene" OR "Distillate Oil"

We calculated the total number of households in each county that used each fuel type, and then used each block group's share of total county households by fuel type to downscale county-level emissions by fuel type into each block group. Emissions from all fuel types were then summed in each block group, and the average emissions per-square meter were calculated. The block-group polygons were then intersected with our 1 x 1 km grid in ArcGIS, and grid-cell emissions totals were calculated by multiplying the per-square meter emissions with the area of the intersected polygon that falls within each grid cell. All emissions were then summed within the grid cell. An hourly time structure was assigned to residential emissions in each grid cell using the same method as for the commercial sector emissions, with the only difference being that monthly emissions shares were obtained using the SEDS monthly natural gas consumption data for the residential sector rather than the commercial sector.

Industrial Sector

Annual, county-level CO emissions for non-point industrial sources that were too small to be included in the NEI Point source or GHGRP databases were obtained from the NEI Nonpoint Sector data files. Emissions were converted to CO_2 using emissions factors from *Gurney et al.* [2010]. Industrial emissions were assigned uniformly across each county, as no data on the sub-county spatial distribution of emissions was available, and then aggregated to the 1km grid.

The time structure of industrial non-point emissions were calculated using the same methodology as for the commercial sector emissions. However the SEDS data on the monthly shares of natural gas consumption by the industrial sector contained a large number of missing values, therefore we elected to use the monthly shares for the commercial sector to calculate monthly shares for the non-point industrial sector. Hourly emissions were assigned using the same heating-degree hour model as was used for commercial and residential emissions.

Comparison of ACES with 2002 Vulcan Inventory Emissions

Total 2002 emissions for Vulcan were actually very similar to ACES 2011 total emissions across our domain (286.3 TgC for Vulcan vs. 281.7 TgC for ACES, a difference of only 1.6%). For the comparison of spatial patterns across the two inventories, we scaled each pixel in Vulcan downwards by 1.6% such that the domain totals of the two products were equal. ACES emissions were aggregated to the Vulcan 10km grid. We then calculated the magnitude and relative differences between the inventories for each pixel, as shown in (Figure S8). In Panel A of Figure S8 we show the ACES emissions minus the Vulcan emissions. Areas of yellow, orange, and red show locations where ACES emissions exceed Vulcan, and vice versa for the green and blue pixels. In Panel B of Figure S8 we show the percent relative differences (absolute difference between the inventories divided by the mean value of the inventories for each pixel, multiplied by 100). We observe significant differences on a per pixel-basis in both the magnitude and relative differences between the ACES and Vulcan inventories. In particular, there are large differences in the western PA and WV area of the domain, where ACES includes the substantial emissions from recent oil and gas development. These emissions are not present in Vulcan from circa 2002, as exploration and development in that region has boomed over the last decade with the advent of new hydraulic fracturing techniques.

We also observe broad disagreement between the two inventories in the major urban and suburban areas, as well as in the rural regions of northern New England. However, there is no clear systematic pattern to explain the large differences observed throughout the domain. These differences are likely to be a combination of differences in spatial proxy choice between Vulcan and ACES along with spatial shifts in the multiple spatial proxies over the 9 years that separate the two inventories. Recent results by [*Gately et al.,* 2015] found that Vulcan tends to overestimate on-road CO_2 emissions in rural and suburban areas of the eastern U.S., relative to the DARTE inventory, which underlies ACES emissions for this sector. This may explain some of the variation between the two products in certain areas, in particular northern New England.

Overall, the mean relative difference across the domain is 49% at pixel scale, with the largest relative differences again observed in urban and suburban cores and the oil and gas regions in the west of the domain. As with the downscaled global inventories we compare to ACES in the main text of this study, we find that while total regional emissions may be similar between inventory products, significant spatial differences are present due to proxy choice, and in the case of Vulcan, vintage year. These results suggest that the use of forward-scaled Vulcan inventory emissions should be done with caution, as the spatial patterns of those 2002 emissions are no longer consistent with the patterns observed in the more contemporaneous ACES bottom-up inventory.

Equation for the calculation of the within-pixel coefficient of variation (CV):

(Eqn. S1) $$CV = \frac{\sqrt{\sum_{i=1}^{N} \frac{(x_i - \bar{x})}{N}}}{\bar{x}}$$

where x_i is emissions per km^2 of each $1km^2$ grid cell contained in the larger grid cell, $\bar{x}$ is the mean of all $1km^2$ grid cell emissions (equivalent to the per-km^2 emissions of the coarser grid cell), and N is the number of $1km^2$ cells in the larger cell.

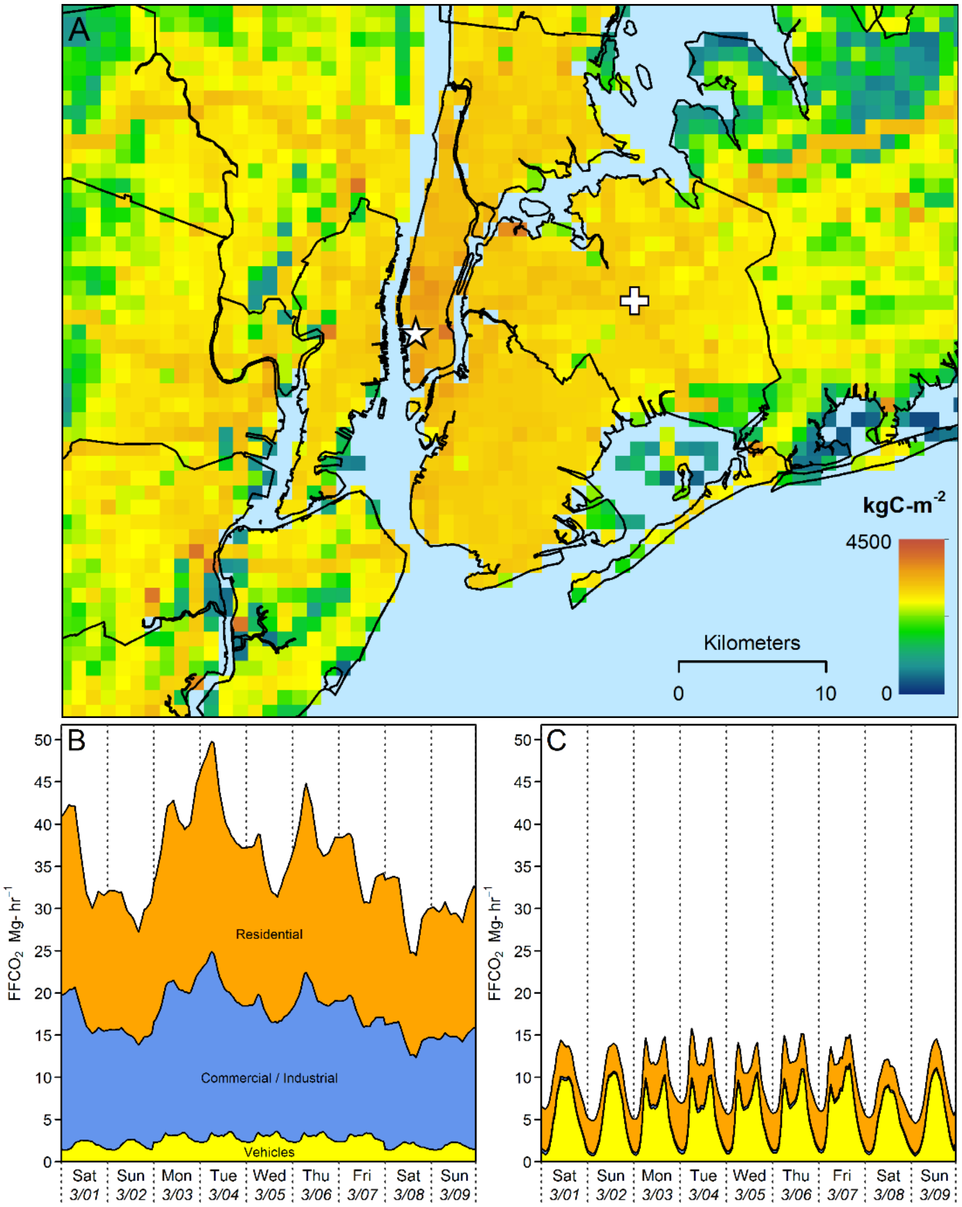


Figure S2. ACES hourly $FFCO_2$ by source sector for two 1 x 1 km grid cells in New York City, NY for the first 9 days of March, 2014. Panel A shows total 2011 annual ACES emissions for the NYC metropolitan area. Panel B shows hourly emissions for the grid cell covered by the white star on the left side of Panel A, a mixed residential and commercial zone in downtown Manhattan. Panel C shows emissions from the white cross on the right of Panel A, a residential neighborhood in Forest Hills, Queens. The Manhattan pixel's emissions are dominated by building sources, with similar magnitudes of commercial and residential emissions. The Queens pixel contains a major expressway that passes through a medium-density residential neighborhood. The diurnal pattern of vehicle traffic dominates the signal in the Queens pixel, while in the Manhattan pixel the hourly fluxes are driven by the influence of daily meteorology on building heating demand.

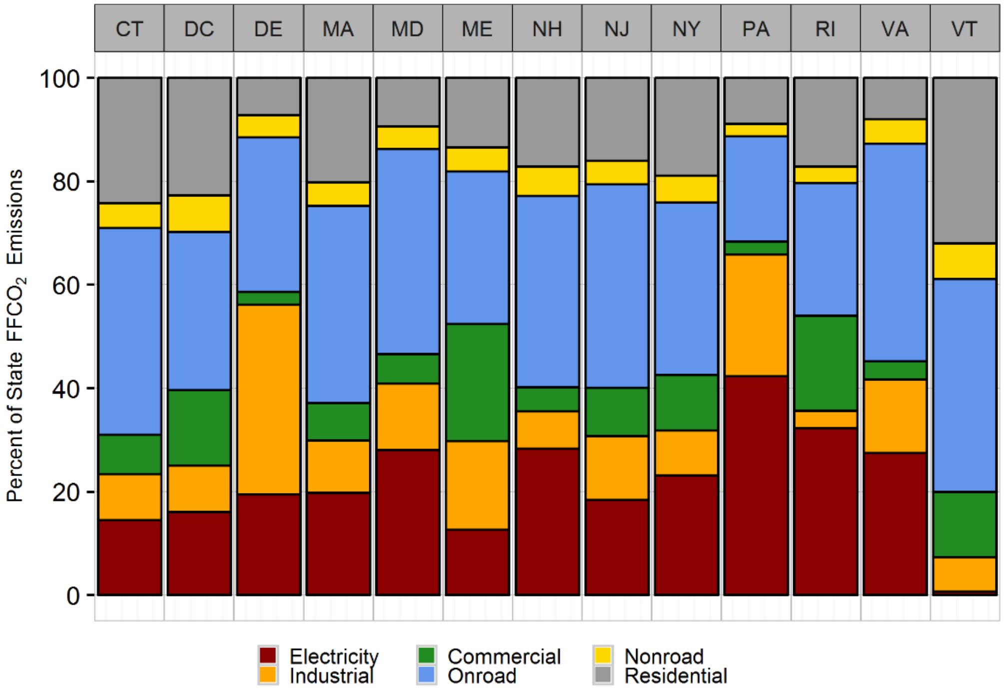


Figure S3. State-level emissions shares by source sector from ACES. Overall, transportation and building sector emissions dominate emissions in the more urbanized states (CT, DC, MA, NJ, NY, and RI), with industrial and electric power emissions only accounting for a third of emissions or less in these states. Other states like Pennsylvania and Delaware have emissions profiles that are dominated by the electric power and industrial sectors. Oil and gas production sector emissions are included in the industrial sector.

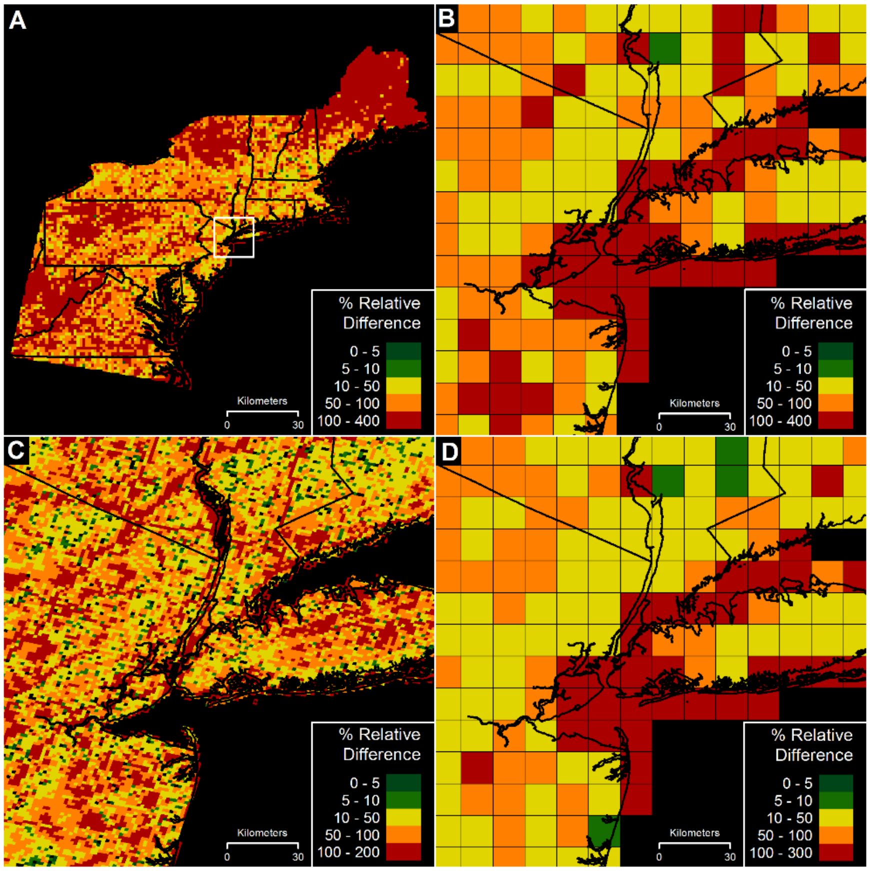


Figure S4. Panel A shows the percent relative difference (RD) in emissions for all four inventories and across the whole domain at 0.1° grid resolution. The white box inset in panel A shows the zoomed in region surrounding the New York City, NY metropolitan area that is presented in panels B, C, and D. Panel B shows the RD for all four inventories, panel C shows the RD between ACES and ODIAC only, at 1km resolution, and panel D shows the RD between EDGAR, FFDAS, and ODIAC at 0.1° resolution (ACES excluded). In all cases, the grid-cell scale RDs exceed 100% across much of the core urban area, even when the ACES inventory is excluded from the comparison (Panel D). Uncertainty between the two 1km^2 resolution inventories, ACES and ODIAC, is highly variable in space, with >100% RD in both the urban core and much of the surrounding suburban areas.

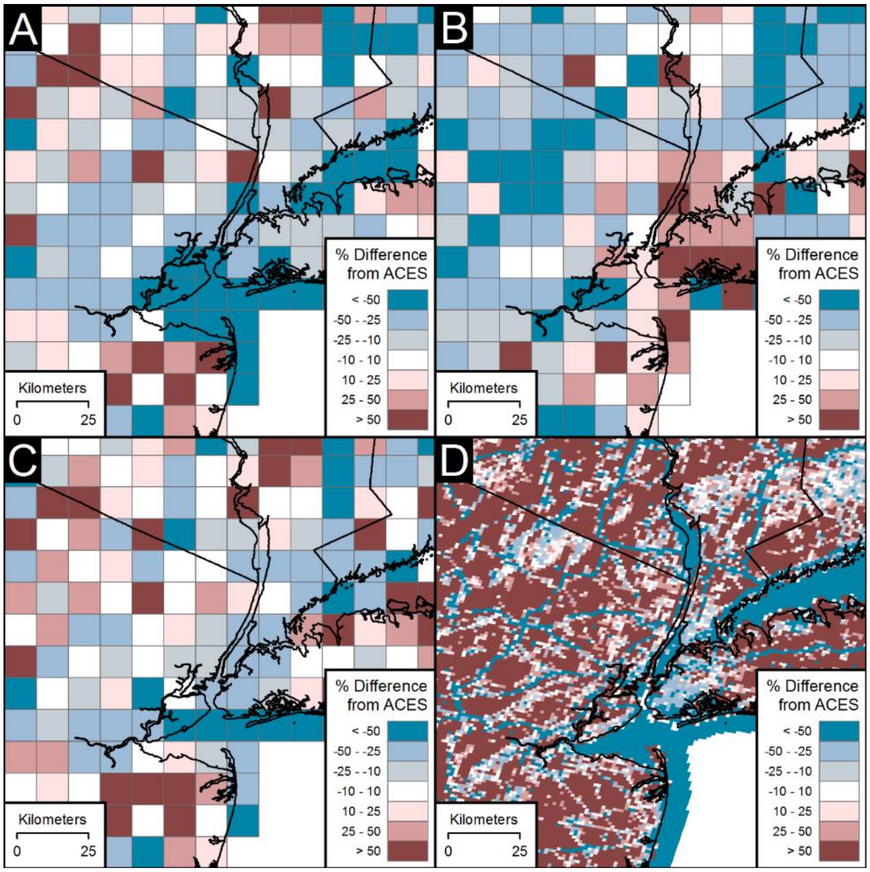


Figure S5. Percent differences between FFDAS, EDGAR, and ODIAC inventories with respect to ACES (i.e., RD = Other Inventory / ACES * 100) for the New York City, NY metropolitan area. Panels A and B show RDs for FFDAS and EDGAR, respectively, at 0.1 degree scale. FFDAS underpredicts ACES by >50% for much of the core urban area, with a mean RD of -32.5%. EDGAR overpredicts ACES by 75% or more for both the urban core and surrounding suburbs, but also underpredicts heavily in the ex-urban areas, such that it's mean RD is -37.9% for the region. Panels C and D compare ACES with ODIAC at 10km^2 and 1km^2 grid scales, respectively. At 1km^2 ODIAC underpredicts ACES by >75% in grid cells dominated by on-road emissions, and underpredicts generally in the urban core. However, ODIAC estimates significantly overpredict ACES in most of the suburban and ex-urban pixels, such that the mean RD is 64.7% for the region. At 10km^2 resolution, spatial agreement between ODIAC and ACES is much improved, with a mean RD of only 44.8%.

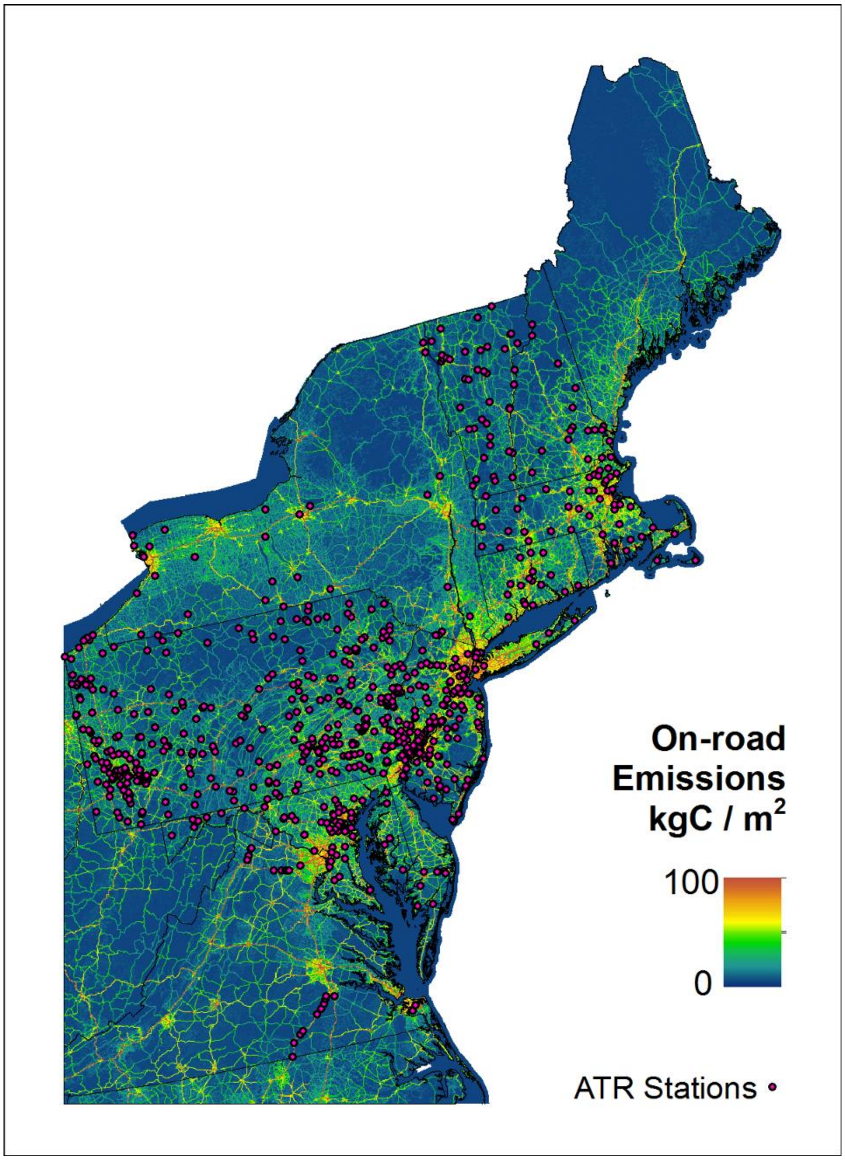


Figure S6. Map of Automatic Traffic Recorder (ATR) station locations used to temporally downscale DARTE annual FFCO$_2$ emissions from the on-road sector to hourly ACES emissions. Each ATR shown provides hourly traffic counts for a full year. Each ACES grid cell was assigned the temporal pattern of the nearest ATR station. Background shows annual total emissions in ACES for the on-road sector in 2011.

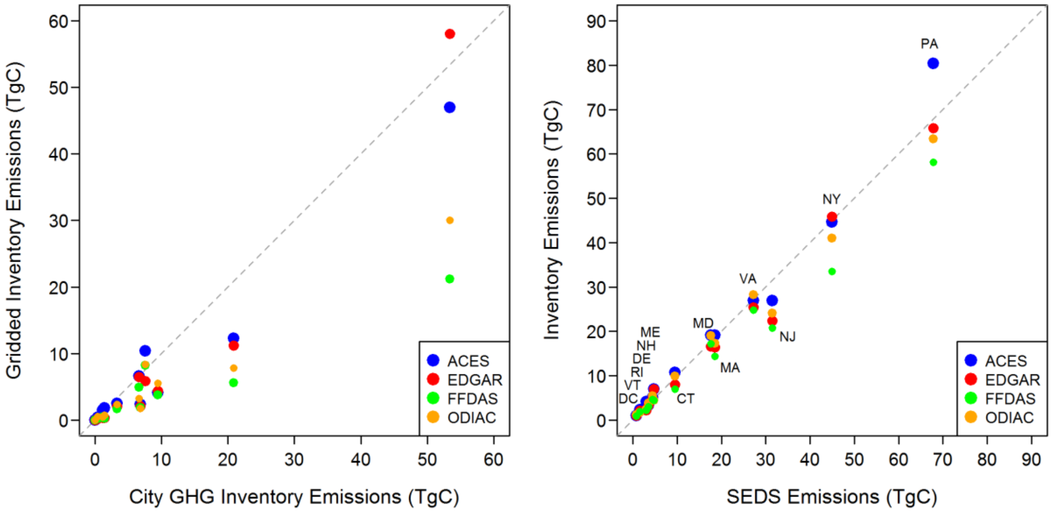


Figure S7. A comparison of gridded inventory emissions with emissions reported by bottom-up inventories conducted by a selection of cities and states within the ACES domain. Panel A compares emissions estimates at city scales, wherein the gridded inventories are clipped to the municipal boundaries used for each city's in-house inventory. The grey dashed line is a 1:1 line. The mean relative difference (RD) across all cities is 33% for ACES, 57% for ODIAC, 65% for EDGAR and 78% for FFDAS. In Panel B, the gridded inventories are compared to state-level emissions estimates reported by the Energy Administration's State Energy Data System (SEDS). Mean relative differences across all states are similar across all inventories: 15.3% for ACES, 12.8 % for ODIAC, 16% for EDGAR and 18.3% for FFDAS. The large difference between ACES and SEDS observed for Pennsylvania is likely due to the omission of oil and gas sector emissions from the SEDS database. In ACES, these account for 9% of PA emissions (7.2TgC). If these emissions are removed from the comparison, the difference between ACES and SEDS for PA is reduced to only 5.3 TgC. From left to right in Panel A, the cities are: Hamilton Twp, NJ; Burlington, VT; Portland, ME; Albany, NY; Richmond, VA; Boston, MA; Pittsburgh, PA; Baltimore County, MD; Washington, DC; Philadelphia, PA; New York City, NY.

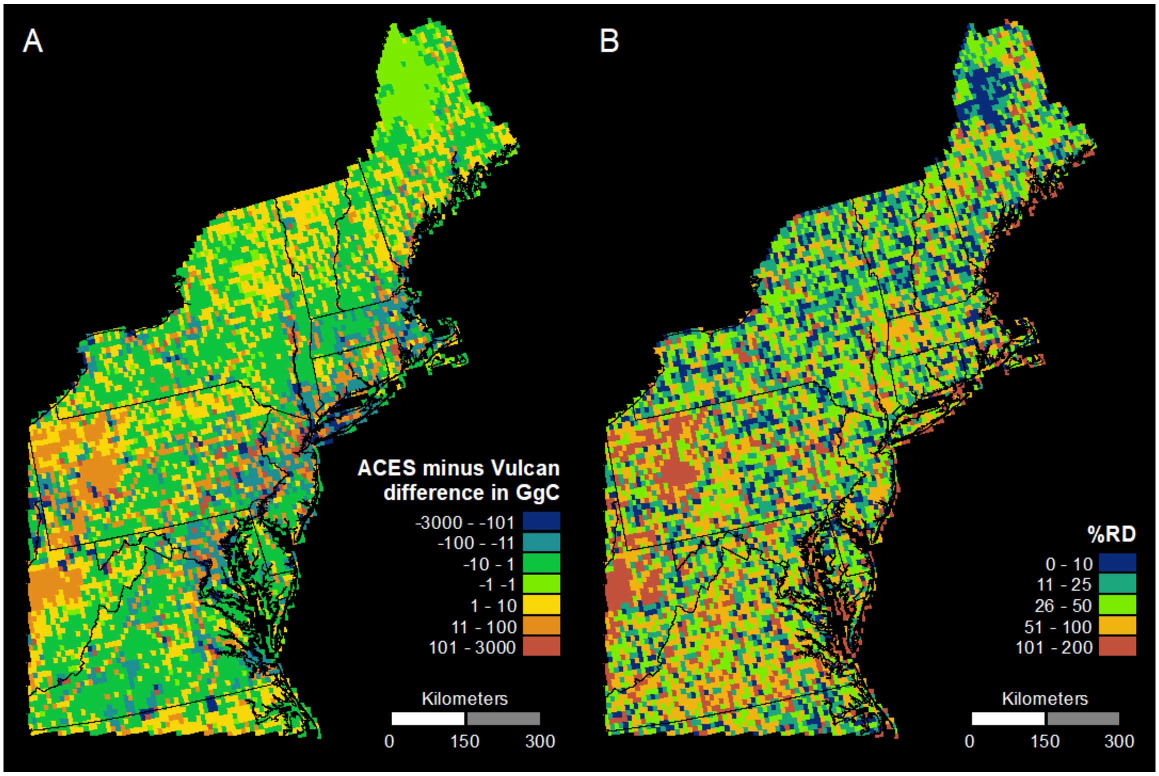


Figure S8. Comparison of Vulcan and ACES emissions for the northeastern U.S. domain. Vulcan 2002 total emissions are scaled down by 1.6% to match ACES domain totals for 2011. Panel A shows difference in emissions in GgC (ACES minus Vulcan). In Panel A, orange and red areas indicate pixels where ACES estimates are higher than Vulcan, while green and blue areas show the opposite. Panel B shows the percent relative difference (%RD) between the two inventories. Areas of major disagreement between the inventories are the oil and gas development regions in western PA and WV as well as in most of the major urban and suburban metropolitan areas. Large relative differences are observed throughout the domain, with a mean %RD of 49% across all pixels.

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

NEI 2011 SCC code	CO emission factor	CO emission factor units	CO_2 emission factor	CO_2 emission factor units	CO factor source	CO factor source notes	CO_2 factor source
10100101	0.6	LB / SHORT TON	5674.27	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	anthracite	*Gurney et al., 2010* - Table A.3
10100201	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100202	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100203	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100204	5.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100212	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100215	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100217	18.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10100226	0.5	LB / SHORT TON	3732.90	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	subbituminous	*Gurney et al., 2010* - Table A.3
10100401	5.0	LB / 1000 GALLONS	27121.15	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 6	*Gurney et al., 2010* - Table A.3
10100404	5.0	LB / 1000 GALLONS	27121.15	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 6	*Gurney et al., 2010* - Table A.3
10100501	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 1 and 2	*Gurney et al., 2010* - Table A.3
10100504	5.0	LB / 1000 GALLONS	23797.25	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 4	*Gurney et al., 2010* - Table A.3
10100601	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10100602	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10100604	65.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
10100701	6.6	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10100702	6.6	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10100902	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire

Appendix A.
Emissions Factors used in ACES fossil fuel CO$_2$ flux calculations

10100903	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10100911	13.6	LB / TONS	2000.00	LB / TONS	EPA WEBFire		EPA WEBFire
10101002	7.0	LB / 1000 GALLONS	12458.86	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	propane	*Gurney et al., 2010* - Table A.3
10101201	0.0	LB / MILLION BTUS	0.02	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10101302	5.0	LB / 1000 GALLONS	22473.27	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	waste oil	*Gurney et al., 2010* - Table A.3
10200104	0.6	LB / TONS	5680.00	LB / TONS	EPA WEBFire		EPA WEBFire
10200202	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200204	5.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200205	6.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200206	11.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200212	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200217	18.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200218	18.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10200225	6.0	LB / SHORT TON	2747.88	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	lignite	*Gurney et al., 2010* - Table A.3
10200301	0.5	LB / SHORT TON	6231.92	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	lignite, all else	*Gurney et al., 2010* - Table A.3
10200401	5.0	LB / 1000 GALLONS	27121.15	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 6	*Gurney et al., 2010* - Table A.3
10200402	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil	*Gurney et al., 2010* - Table A.3
10200403	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil	*Gurney et al., 2010* - Table A.3
10200404	5.0	LB / 1000 GALLONS	25524.39	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 5	*Gurney et al., 2010* - Table A.3
10200501	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 1 and 2	*Gurney et al., 2010* - Table A.3
10200502	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

10200503	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3
10200504	5.0	LB / 1000 GALLONS	23797.25	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 4	*Gurney et al., 2010* - Table A.3
10200601	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10200602	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10200603	84.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
10200604	24.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
10200701	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	refinery gas	*Gurney et al., 2010* - Table A.3
10200704	13.7	LB / MILLION CUBIC FEET	41842.80	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	blast furnace/coke oven gas	*Gurney et al., 2010* - Table A.3
10200707	18.4	LB / MILLION CUBIC FEET	51377.35	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	coke oven gas	*Gurney et al., 2010* - Table A.3
10200710	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10200711	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10200799	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10200802	0.6	LB / SHORT TON	6231.92	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	coke (petroleum coke)	*Gurney et al., 2010* - Table A.3
10200902	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10200903	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10200904	8.2	LB / SHORT TON	2946.97	LB / SHORT TON	AP42, Section 1.6		AP42, Section 1.6
10200905	8.2	LB / SHORT TON	2946.97	LB / SHORT TON	AP42, Section 1.6		AP42, Section 1.6
10200906	8.2	LB / SHORT TON	2946.97	LB / SHORT TON	AP42, Section 1.6		AP42, Section 1.6
10200907	8.2	LB / SHORT TON	2946.97	LB / SHORT TON	AP42, Section 1.6		AP42, Section 1.6
10200908	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10200911	13.6	LB / TONS	2000.00	LB / TONS	EPA WEBFire		EPA WEBFire

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

10200912	1.4	LB / TONS	1800.00	LB / TONS	EPA WEBFire		EPA WEBFire
10201001	3.6	LB / 1000 GALLONS	14300.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10201002	3.2	LB / 1000 GALLONS	12500.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10201003	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
10201302	5.0	LB / 1000 GALLONS	22473.27	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	waste oil	*Gurney et al., 2010* - Table A.3
10201401	35.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
10300102	0.6	LB / TONS	5680.00	LB / TONS	EPA WEBFire		EPA WEBFire
10300203	0.5	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300207	6.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300208	11.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300209	5.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300217	18.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300218	18.0	LB / SHORT TON	4934.21	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	bituminous	*Gurney et al., 2010* - Table A.3
10300224	5.0	LB / SHORT TON	3732.90	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	subbituminous	*Gurney et al., 2010* - Table A.3
10300226	0.5	LB / SHORT TON	3732.90	LB / SHORT TON	*Gurney et al., 2010* - Table A.1	subbituminous	*Gurney et al., 2010* - Table A.3
10300401	5.0	LB / 1000 GALLONS	27121.15	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 6	*Gurney et al., 2010* - Table A.3
10300402	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil	*Gurney et al., 2010* - Table A.3
10300403	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil	*Gurney et al., 2010* - Table A.3
10300404	5.0	LB / 1000 GALLONS	25524.39	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil no. 5	*Gurney et al., 2010* - Table A.3
10300501	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 1 and 2	*Gurney et al., 2010* - Table A.3
10300502	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

10300503	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3
10300504	5.0	LB / 1000 GALLONS	23797.25	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil no. 4	*Gurney et al., 2010* - Table A.3
10300601	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10300602	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10300603	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10300701	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10300799	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
10300811	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
10300902	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10300903	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10300908	0.6	LB / MILLION BTUS	195.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
10300911	13.6	LB / TONS	2000.00	LB / TONS	EPA WEBFire		EPA WEBFire
10301001	2.1	LB / 1000 GALLONS	14300.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10301002	1.9	LB / 1000 GALLONS	12500.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10301003	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
10301302	5.0	LB / 1000 GALLONS	22000.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10500105	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3
10500106	20.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
10500110	3.4	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	lpg	*Gurney et al., 2010* - Table A.3
10500113	2.1	LB / 1000 GALLONS	22000.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10500114	1.7	LB / 1000 GALLONS	22000.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

10500205	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil	*Gurney et al., 2010* - Table A.3
10500206	20.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
10500209	13.6	LB / SHORT TON	2946.97	LB / SHORT TON	AP42, Section 1.6		AP42, Section 1.6
10500210	2.0	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	lpg	*Gurney et al., 2010* - Table A.3
10500213	2.1	LB / 1000 GALLONS	22000.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
10500214	1.7	LB / 1000 GALLONS	22000.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
20100101	6.7	LB / 1000 GALLONS	15076.60	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20100102	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel)	*Gurney et al., 2010* - Table A.3
20100105	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20100106	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20100107	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20100109	6.7	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20100201	150.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20100202	399.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
20100206	400.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + reciprocating	*Gurney et al., 2010* - Table A.3
20100207	400.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + reciprocating	*Gurney et al., 2010* - Table A.3
20100209	150.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20100702	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
20100707	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
20100801	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
20100802	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

20100807	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
20100901	0.0	LB / 1000 GALLONS	18601.13	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet fuel	*Gurney et al., 2010* - Table A.3
20100902	1.0	LB / 1000 GALLONS	18601.13	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet fuel	*Gurney et al., 2010* - Table A.3
20200101	6.7	LB / 1000 GALLONS	15076.60	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20200102	130.0	LB / 1000 GALLONS	22600.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
20200103	6.7	LB / 1000 GALLONS	15076.60	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20200104	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel)	*Gurney et al., 2010* - Table A.3
20200107	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20200109	6.7	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20200201	150.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20200202	399.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
20200203	150.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20200204	399.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
20200207	400.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + reciprocating	*Gurney et al., 2010* - Table A.3
20200209	150.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20200252	1000.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine	*Gurney et al., 2010* - Table A.3
20200253	1000.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine	*Gurney et al., 2010* - Table A.3
20200254	1000.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine	*Gurney et al., 2010* - Table A.3
20200255	1000.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine	*Gurney et al., 2010* - Table A.3
20200256	1000.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine	*Gurney et al., 2010* - Table A.3
20200401	116.0	LB / 1000 GALLONS	22600.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

20200402	7.5	LB / 1000 HORSEPOWER-HOURS	772.00	LB / 1000 HORSEPOWER-HOURS	EPA WEBFire		EPA WEBFire
20200407	1000.0	LB / 1000 GALLONS	22167.51	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	oil	*Gurney et al., 2010* - Table A.3
20200501	130.0	LB / 1000 GALLONS	23114.47	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	crude oil	*Gurney et al., 2010* - Table A.3
20200702	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
20200901	0.0	LB / 1000 GALLONS	18601.13	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet fuel	*Gurney et al., 2010* - Table A.3
20200902	1.0	LB / 1000 GALLONS	18601.13	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet fuel	*Gurney et al., 2010* - Table A.3
20201001	2.6	LB / 1000 GALLONS	12458.86	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	propane	*Gurney et al., 2010* - Table A.3
20201012	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
20201702	7900.0	LB / 1000 GALLONS	20100.79	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	gasoline	*Gurney et al., 2010* - Table A.3
20300101	130.0	LB / 1000 GALLONS	22600.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
20300102	6.7	LB / 1000 GALLONS	15076.60	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20300106	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20300107	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), reciprocating	*Gurney et al., 2010* - Table A.3
20300108	6.7	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), turbine	*Gurney et al., 2010* - Table A.3
20300201	399.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
20300202	150.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20300203	150.0	LB / MILLION CUBIC FEET	162024.00	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + turbine	*Gurney et al., 2010* - Table A.3
20300204	400.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + reciprocating	*Gurney et al., 2010* - Table A.3
20300207	400.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, engine + reciprocating	*Gurney et al., 2010* - Table A.3
20300301	7900.0	LB / 1000 GALLONS	19500.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
20300307	7900.0	LB / 1000 GALLONS	20100.79	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	gasoline	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

20300701	0.0	LB / MILLION BTUS	27.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
20300702	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
20300707	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
20300801	0.4	LB / MILLION BTUS	50.00	LB / MILLION BTUS	EPA WEBFire		EPA WEBFire
20300802	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
20300901	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20301001	2.6	LB / 1000 GALLONS	12458.86	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	propane	*Gurney et al., 2010* - Table A.3
20400101	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20400102	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20400110	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20400112	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20400301	120.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas	*Gurney et al., 2010* - Table A.3
20400302	6.7	LB / 1000 GALLONS	21734.36	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	diesel kerosene	*Gurney et al., 2010* - Table A.3
20400305	113.5	LB / 1000 GALLONS	18786.61	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, engine	*Gurney et al., 2010* - Table A.3
20400401	3940.0	LB / 1000 GALLONS	20100.79	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	gasoline	*Gurney et al., 2010* - Table A.3
20400402	130.0	LB / 1000 GALLONS	21734.36	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	diesel kerosene	*Gurney et al., 2010* - Table A.3
20400403	130.0	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), engine + reciprocating	*Gurney et al., 2010* - Table A.3
20400406	130.0	LB / 1000 GALLONS	18601.13	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	jet kerosene, reciprocating	*Gurney et al., 2010* - Table A.3
27000320	113.5	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), engine	*Gurney et al., 2010* - Table A.3
27300320	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
28500201	113.5	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), engine	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

30190001	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (No 2)	*Gurney et al., 2010* - Table A.3
30190002	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil, all else	*Gurney et al., 2010* - Table A.3
30190003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30190004	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
30190011	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (No 2)	*Gurney et al., 2010* - Table A.3
30190013	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30190014	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
30190023	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30290001	6.7	LB / 1000 GALLONS	22209.14	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (diesel), all else	*Gurney et al., 2010* - Table A.3
30290002	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil, all else	*Gurney et al., 2010* - Table A.3
30290003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30290005	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
30390003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30390004	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
30390023	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30390024	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3
30490003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30490023	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30490031	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (No 2)	*Gurney et al., 2010* - Table A.3
30490033	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30490034	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	process gas	*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

30590001	5.0	LB / 1000 GALLONS	22365.71	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	distillate oil (No 2)	*Gurney et al., 2010* - Table A.3
30590002	5.0	LB / 1000 GALLONS	25788.89	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	residual oil, all else	*Gurney et al., 2010* - Table A.3
30590003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30590013	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30890003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30890004	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	*Gurney et al., 2010* - Table A.1	LPG	*Gurney et al., 2010* - Table A.3
30890013	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
30990003	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
50100410	750.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (landfill gas)	*Gurney et al., 2010* - Table A.3
50100423	5.7	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (landfill gas)	*Gurney et al., 2010* - Table A.3
50100789	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
50190006	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
50200601	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
50290006	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
50300601	35.0	LB / MILLION CUBIC FEET	132163.60	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	gas (for all Landfill/Digester Gas)	*Gurney et al., 2010* - Table A.3
50390006	65.0	LB / MILLION CUBIC FEET	120811.40	LB / MILLION CUBIC FEET	*Gurney et al., 2010* - Table A.1	natural gas, all else	*Gurney et al., 2010* - Table A.3
10200601	84.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
10300102	0.6	LB / SHORT TON	5680.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
10300102	275.0	LB / SHORT TON	5680.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
10300910	6.6	LB / SHORT TON	1900.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
20300101	130.0	LB / 1000 GALLONS	22600.00	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

2104006000	40.0	LB / MILLION CUBIC FEET	130000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
2104006010	40.0	LB / MILLION CUBIC FEET	120000.00	LB / MILLION CUBIC FEET	EPA WEBFire		EPA WEBFire
2104008001	253.0	LB / SHORT TON	3400.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
2104008001	141.0	LB / SHORT TON	3400.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
2104008001	231.0	LB / SHORT TON	3400.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
2104008001	104.4	LB / SHORT TON	3400.00	LB / SHORT TON	EPA WEBFire		EPA WEBFire
2102002000	5.0	LB / SHORT TON	4345.47	LB / SHORT TON	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2102004000	5.0	LB / 1000 GALLONS	22365.70	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2102005000	5.0	LB / 1000 GALLONS	25788.90	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2102007000	151.2	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
2102011000	4.8	LB / 1000 GALLONS	21295.65	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2103002000	5.0	LB / SHORT TON	4345.47	LB / SHORT TON	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2103004000	5.0	LB / 1000 GALLONS	22365.70	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2103005000	5.0	LB / 1000 GALLONS	25788.90	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2103007000	306.9	LB / 1000 BARRELS	12848.53	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
2103011000	4.8	LB / 1000 GALLONS	21295.65	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2104002000	275.0	LB / SHORT TON	4345.47	LB / SHORT TON	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2104004000	5.0	LB / 1000 GALLONS	22365.70	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3
2104007000	2.6	LB / 1000 GALLONS	12848.53	LB / 1000 GALLONS	EPA WEBFire		EPA WEBFire
2104011000	5.0	LB / 1000 GALLONS	21295.65	LB / 1000 GALLONS	EPA WEBFire		*Gurney et al., 2010* - Table A.3

Appendix A.
Emissions Factors used in ACES fossil fuel CO_2 flux calculations

SOURCES:

EPA WEBFire database (http://cfpub.epa.gov/webfire/)

EPA AP-42, Compilation of Air Pollution Emission Factors. (http://www.epa.gov/ttnchie1/ap42/)

See Also: http://www.epa.gov/ttnchie1/ap42/ch01/final/c01s06.pdf

http://www.epa.gov/chp/documents/biomass_chp_catalog_part3.pdf

Gurney, K., Mendoza, D., Zhou, Y., Fisher, M., Miller, C., Geethakumar, S., De La Rue Dy Can, S. (2010), Vulcan Science Methods Documentation, Version 2.0. Available at: http://vulcan.project.asu.edu/pdf/Vulcan.documentation.v2.0.online.pdf; (Accessed on September 1, 2015).