10. Recalculations and Improvements

Each year, emission and sink estimates are recalculated and revised for all years in the Inventory of U.S. Greenhouse Gas Emissions and Sinks, as attempts are made to improve both the analyses themselves, through the use of better methods or data, and the overall usefulness of the report. In this effort, the United States follows the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance (IPCC 2000), which states, "It is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included in the national inventory, or when errors in the estimates are identified and corrected."

The results of all methodology changes and historical data updates are presented in this section; detailed descriptions of each recalculation are contained within each source's description contained in this report, if applicable. Table 10-1 summarizes the quantitative effect of these changes on U.S. greenhouse gas emissions and Table 10-2 summarizes the quantitative effect on net CO_2 flux to the atmosphere, both relative to the previously published U.S. Inventory (i.e., the 1990 through 2006 report). These tables present the magnitude of these changes in units of teragrams of carbon dioxide equivalent (Tg CO_2 Eq.).

The Recalculations Discussion section of each source presents the details of each recalculation. In general, when methodological changes have been implemented, the entire time series (i.e., 1990 through 2006) has been recalculated to reflect the change, per IPCC (2000). Changes in historical data are generally the result of changes in statistical data supplied by other agencies.

The following emission sources, which are listed in descending order of absolute average annual change in emissions between 1990 and 2006, underwent some of the most important methodological and historical data changes. A brief summary of the recalculation and/or improvement undertaken is provided for each emission source.

- *Net CO_2 Flux from Land Use, Land-Use Change, and Forestry.* Changes in the Land Use, Land-Use Change, and Forestry sector occurred primarily in calculations for forest and grassland C stock and flux estimates. The most significant changes were in forest aboveground biomass and soil organic carbon within the *Forest Land Remaining Forest Land* land-use category and in the Grassland Remaining Grassland land-use category. In the estimation of forest C stocks within the Forest Land Remaining Forest Land land-use category, newly available state data contributed to a decrease in the average flux. Changes in calculation methodology for state-level estimates, particularly in the scaling up of plot-level stock estimates and in extrapolating C stock and stock change, resulted in significant decreases in forest carbon flux. With regard to C stock recalculation for Grassland Remaining Grassland, several changes to historical estimates resulted from the incorporation of annual survey data from the USDA National Resources Inventory (NRI) in the 1990-2007 Inventory. These changes included: (1) the availability of new data extended the time series of activity data beyond 1997 to 2003; (2) annual area data were used to estimate soil C stock changes, rather than data collected in 5-year increments; (3) each NRI point was simulated separately, instead of simultaneously; and, (4) NRI area data were reconciled with Forest Inventory and Analysis (FIA) area data, which led to adjustments in the NRI dataset. Overall, these changes, in combination with smaller adjustments in the other sources/sinks within the sector, resulted in an average annual decrease in net flux of CO_2 to the atmosphere from the Land Use, Land-Use Change, and Forestry sector of 117.3 Tg CO_2 Eq. (14.1 percent) for the period 1990 through 2006, as compared to estimates presented in the previous Inventory.

- *Agricultural Soil Management*. Changes in the estimates of N_2O emissions from Agricultural Soil Management occurred primarily due to a new operational version of the DAYCENT model and revised structural uncertainty associated with the model. Improvements to the DAYCENT model include elimination of the influence of labile (i.e., easily decomposable by microbes) C availability on surface litter denitrification rates, incorporation of precipitation events as a controlling variable on surface litter denitrification, and allowing the wettest soil layer within the rooting zone to control plant transpiration. Overall, changes resulted in an average annual decrease in N_2O emissions from Agricultural Soil Management of 61.3 Tg CO_2 Eq. (22.7 percent) for the period 1990 through 2006.

- *Iron and Steel Production.* Estimates of CO_2 from iron and steel production have been revised to adhere to the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006). Previously the estimates focused primarily on the consumption of coking coal to produce metallurgical coke and the consumption of metallurgical coke, carbon anodes, and scrap steel to produce iron and steel. The revised estimates differentiate

between emissions associated with metallurgical coke production and those associated with iron and steel production and include CO_2 emissions from the consumption of other materials such as natural gas, fuel oil, flux (e.g. limestone and dolomite use), direction injection goal, sinter, pellets, and natural ore during the iron and steel production process as well as the metallurgical coke production process. Overall, changes to the Iron and Steel Production estimate resulted in an average annual increase in CO_2 emissions of 26.1 Tg CO_2 Eq. (40.7 percent) for the period 1990 through 2006.

- *Fossil Fuel Combustion*. Estimates of CO_2 from the industrial sector have been revised for the years 1990 through 2006 to subtract for non-energy related consumption of coal, distillate fuel, and natural gas used to produce pig iron in iron and steel and metallurgical coke production. A discussion of the methodology used to estimate non-energy related consumption is contained in the Iron and Steel Production and Metallurgical Coke Production section of the Industrial Processes chapter. Additionally, the Energy Information Administration (EIA 2008b) updated energy consumption data for all years. These revisions primarily impacted the emission estimates for 2006. Overall, changes resulted in an average annual decrease in CO_2 emissions from Fossil Fuel Combustion of 17 Tg CO2 Eq. (0.3 percent) for the period 1990 through 2006.

- *Enteric Fermentation*. Changes in the estimates of CH_4 emissions from Enteric Fermentation occurred as a result of (1) including additional heifer and steer stocker populations, (2) adjusting the Cattle Enteric Fermentation Model (CEFM) to allow feedlot placements for the 700-800 lbs category to use excess animals from the over 800 lbs category if insufficient animals are available to place in a given month at 700-800 lbs, (3) adjusting animal weights used in calculations, (4) using revised USDA population estimates that affected historical emissions estimated for swine in 2006, and (5) some historical population estimates for certain beef and dairy populations were also updated as a result of changes in USDA inputs. Overall, changes resulted in an average annual increase in CH_4 emissions from Enteric Fermentation of 10.2 Tg CO_2 Eq. (8.1 percent) from 1990 through 2006.

- *Natural Gas Systems*. Changes in the estimates of CH_4 emissions from this source category resulted primarily from the substitution of activity factors with direct data for all years to adapt the natural gas inventory to publicly available data and adjust the current inventory to better reflect emissions from these sources. Overall, changes resulted in an average annual increase in CH_4 emissions from Natural Gas Systems of 4.3 Tg CO_2 Eq. (3.5 percent) for the period 1990 through 2006.

- *Non-Energy Use of Fuels*. Changes in CO_2 emissions estimates from Non-Energy Use of Fuels resulted from changes in assumptions pertaining to petroleum coke. Non-energy end uses for petroleum coke (other than in the industrial processing sectors, where it is accounted for separately) had not been identified in the past. This year, it was assumed that petroleum coke used for non-energy purposes (and not accounted for in the industrial processes chapter, viz., for production of primary aluminum anodes, electric arc furnace anodes, titanium dioxide, ammonia, urea, and ferroalloys) is used in pigments, with a storage factor of 0.3 (rather than the value of 0.5 used previously). Overall, the changes resulted in an average annual increase in CO_2 emissions from Non-Energy Use of Fuels of 3.9 Tg CO_2 Eq. (2.9 percent) for the period 1990 through 2006.

- *Nitric Acid Production*. Changes in the estimates of N_2O emissions from Nitric Acid Production were mostly due to adjusting the weighted N_2O emission factor (kg N_2O/metric ton HNO_3), which resulted in an increase in emissions across the time series. The weighted N_2O emission factor was previously based on the percentage of facilities equipped and not equipped with non-selective catalytic reduction (NSCR) systems. The emission factor used for the current estimate is based on the percentage of HNO_3 produced at plants with NSCR systems and HNO_3 produced at plants without NSCR systems. Overall, changes resulted in an average annual increase in N_2O emissions from Nitric Acid Production of 3.1 Tg CO_2 Eq. (17.8 percent) for the period 1990 through 2006.

- *Wastewater Treatment*. Changes in N_2O emissions estimates from domestic wastewater resulted primarily from a major refinement to the calculation—per capita protein consumption was reestimated to account for the amount consumed, not simply all protein available for consumption. In addition, the N_2O emission calculation was updated to more accurately represent the N loading of wastewater discharged to aquatic environments. Overall, changes resulted in an average annual decrease in N_2O emissions from Wastewater Treatment of 3.0 Tg CO_2 Eq. (41.0 percent) for the period 1990 through 2006.

- *Forest Land Remaining Forest Land.* Changes in CH_4 emissions from Forest Land Remaining Forest Land

resulted primarily from updated carbon density values, combustion factors, and the inclusion of prescribed fires. The carbon density for Alaska was revised to reflect the entire area that the U.S. Forest Service uses to report carbon, and the default IPCC combustion factor for forests was used to replace the previous combustion factor. Emissions from prescribed fires in the U.S. were included in this year's estimates. Finally, data for land area under wildland fire protection were updated. Overall, changes resulted in an average annual increase in CH_4 emissions from Forest Land Remaining Forest Land of 1.8 Tg CO2 Eq. (20.0 percent) for the period 1990 through 2006.

Table 10-1: Revisions to U.S. Greenhouse Gas Emissions (Tg CO_2 Eq.)

Gas/Source	1990	1995	2000	2004	2005	2006
CO_2	**8.2**	**13.7**	**15.5**	**9.9**	**16.5**	**31.8**
Fossil Fuel Combustion	(15.2)	(18.5)	(15.6)	(12.0)	(7.6)	(2.5)
Electricity Generation	0.1	(0.4)	0.9	0.4	0.8	(0.8)
Transportation	(0.6)	(0.7)	2.1	4.0	11.6	24.8
Industrial	(10.7)	(13.9)	(15.8)	(13.1)	(19.3)	(17.7)
Residential	(2.4)	(2.1)	(1.7)	(2.0)	(0.5)	(4.7)
Commercial	(1.6)	(1.4)	(1.1)	(1.3)	(0.2)	(4.1)
US Territories	NC	NC	NC	NC	+	(0.1)
Non-Energy Use of Fuels	(0.2)	4.2	3.0	0.4	(1.0)	7.2
Iron and Steel Production & Metallurgical Coke Production	23.5	28.4	28.5	23.3	26.6	27.0
Cement Production	NC	NC	NC	NC	NC	0.8
Natural Gas Systems	+	+	+	+	+	1.0
Incineration of Waste	NC	NC	+	(1.5)	(1.1)	(1.1)
Lime Production	(0.5)	(0.7)	(0.8)	(0.7)	(0.8)	(0.7)
Ammonia Production and Urea Consumption	(0.1)	+	+	+	+	(0.1)
Cropland Remaining Cropland	NC	NC	NC	NC	NC	(0.1)
Limestone and Dolomite Use	(0.4)	(0.7)	(0.9)	(0.8)	(0.6)	(0.6)
Aluminum Production	NC	NC	NC	NC	(0.1)	(0.1)
Soda Ash Production and Consumption	NC	NC	NC	NC	NC	NC
Petrochemical Production	NC	NC	NC	NC	NC	NC
Titanium Dioxide Production	NC	NC	NC	NC	NC	NC
Carbon Dioxide Consumption	NC	NC	NC	NC	NC	0.1
Ferroalloy Production	NC	NC	NC	NC	NC	NC
Phosphoric Acid Production	NC	NC	NC	NC	NC	NC
Wetlands Remaining Wetlands[a]	1.0	1.0	1.2	1.2	1.1	0.9
Zinc Production	NC	NC	NC	NC	NC	NC
Petroleum Systems	+	+	+	+	+	+
Lead Production	NC	NC	NC	NC	NC	NC
Silicon Carbide Production and Consumption	+	+	+	+	+	+
Land Use, Land-Use Change, and Forestry (Sink)[b]	*(103.8)*	*(75.6)*	*(43.9)*	*(420.9)*	*(244.1)*	*(166.9)*
Wood Biomass and Ethanol Consumption[b]	*NC*	+	+	+	*4.1*	*5.7*
International Bunker Fuels[b]	*0.6*	*1.0*	*(2.2)*	*(4.1)*	*(11.1)*	*(16.6)*
CH_4	**10.5**	**16.9**	**16.8**	**17.2**	**22.0**	**26.7**
Enteric Fermentation	6.3	11.2	9.8	11.4	11.5	12.0
Landfills	(0.4)	0.2	1.5	3.6	4.2	4.8
Natural Gas Systems	4.9	4.5	4.3	4.0	3.8	2.4
Coal Mining	NC	NC	0.1	(1.6)	+	(0.1)
Manure Management	(0.6)	(0.7)	(0.9)	(0.3)	0.1	0.4
Forest Land Remaining Forest Land	0.1	1.5	1.7	(0.3)	1.9	6.7
Petroleum Systems	+	+	+	+	+	(0.1)
Wastewater Treatment	0.5	0.5	0.6	0.6	0.6	0.6
Stationary Combustion	+	+	+	+	0.2	0.1

Rice Cultivation	NC	NC	NC	NC	NC	NC
Abandoned Underground Coal Mines	NC	NC	NC	+	+	0.1
Mobile Combustion	+	+	+	+	+	0.1
Composting	NC	NC	NC	NC	NC	NC
Petrochemical Production	+	+	+	0.1	+	+
Field Burning of Agricultural Residues	NC	NC	NC	NC	NC	+
Iron and Steel Production & Metallurgical Coke Production	(0.4)	(0.3)	(0.3)	(0.2)	(0.2)	(0.2)
Ferroalloy Production	NC	NC	NC	NC	NC	NC
Silicon Carbide Production and Consumption	NC	NC	NC	NC	NC	NC
International Bunker Fuels[b]	+	+	+	+	+	+
N_2O	**(68.4)**	**(61.5)**	**(56.7)**	**(35.7)**	**(54.1)**	**(55.8)**
Agricultural Soil Management	(69.0)	(62.5)	(57.6)	(35.7)	(54.6)	(56.5)
Mobile Combustion	0.2	0.2	0.3	0.3	0.4	0.5
Nitric Acid Production	3.0	3.4	3.3	2.7	2.8	2.6
Manure Management	+	0.1	0.3	0.3	0.3	0.3
Stationary Combustion	+	+	(0.1)	(0.1)	+	+
Adipic Acid Production	NC	NC	NC	NC	NC	NC
Wastewater Treatment	(2.6)	(2.8)	(3.1)	(3.2)	(3.2)	(3.3)
N_2O from Product Uses	NC	NC	NC	NC	NC	NC
Forest Land Remaining Forest Land	+	0.1	0.2	(0.1)	0.2	0.6
Composting	NC	NC	NC	NC	NC	NC
Settlements Remaining Settlements	+	+	+	+	+	0.1
Field Burning of Agricultural Residues	NC	NC	NC	NC	NC	+
Incineration of Waste	NC	NC	NC	NC	+	+
Wetlands Remaining Wetlands[a]	+	+	+	+	+	+
International Bunker Fuels[b]	*0.1*	*0.1*	+	+	*(0.1)*	*(0.1)*
HFCs	**NC**	**+**	**+**	**(4.2)**	**(5.3)**	**(5.5)**
Substitution of Ozone Depleting Substances	NC	+	+	(4.2)	(5.3)	(5.5)
HCFC-22 Production	NC	NC	NC	NC	NC	NC
Semiconductor Manufacture	NC	+	+	+	+	+
PFCs	**NC**	**+**	**+**	**+**	**+**	**+**
Aluminum Production	NC	NC	NC	NC	+	NC
Semiconductor Manufacture	NC	+	+	+	+	+
SF_6	**0.1**	**0.1**	**0.1**	**(0.2)**	**(0.3)**	**(0.3)**
Electrical Transmission and Distribution	0.1	0.1	0.1	0.1	0.1	+
Magnesium Production and Processing	NC	NC	NC	(0.3)	(0.4)	(0.3)
Semiconductor Manufacture	NC	+	+	+	+	+
Net Change in Total Emissions[c]	**(49.6)**	**(30.7)**	**(24.4)**	**(13.0)**	**(21.3)**	**(3.1)**
Percent Change	**-0.8%**	**-0.5%**	**-0.3%**	**-0.2%**	**-0.3%**	**0.0%**

+ Absolute value does not exceed 0.05 Tg CO_2 Eq. or 0.05 percent.
NC (No Change)
[a] New source category relative to previous Inventory.
[b] Not included in emissions total.
[c] Excludes net CO_2 flux from Land Use, Land-Use Change, and Forestry, and emissions from International Bunker Fuels and Wood Biomass and Ethanol Consumption.
Note: Totals may not sum due to independent rounding.

Table 10-2: Revisions to Net Flux of CO_2 to the Atmosphere from Land Use, Land-Use Change, and Forestry (Tg CO_2 Eq.)

Component: Net CO_2 Flux From Land Use, Land-Use Change, and Forestry	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**
Forest Land Remaining Forest Land	(39.4)	(26.7)	38.1	(408.7)	(232.1)	(155.2)
Cropland Remaining Cropland	0.7	16.4	8.2	22.7	22.7	22.7

Land Converted to Cropland	(12.6)	(6.4)	(7.0)	(3.4)	(3.4)	(3.4)
Grassland Remaining Grassland	(44.9)	(53.0)	(67.8)	(20.9)	(20.9)	(20.9)
Land Converted to Grassland	(8.0)	(6.2)	(15.6)	(10.4)	(10.4)	(10.4)
Settlements Remaining Settlements	NC	NC	NC	NC	NC	NC
Other	0.4	0.2	0.2	(0.3)	(0.2)	0.2
Net Change in Total Flux	**(103.8)**	**(75.6)**	**(43.9)**	**(420.9)**	**(244.1)**	**(166.9)**
Percent Change	**-14.1%**	**-9.8%**	**-6.5%**	**-48.2%**	**-27.8%**	**-18.9%**

NC (No Change)

Note: Numbers in parentheses indicate a decrease in estimated net flux of CO_2 to the atmosphere, or an increase in net sequestration.

Note: Totals may not sum due to independent rounding.