of underlying uncertainties and assumptions, no one number for the remaining global carbon budget can be considered definite.

Using the IPCC estimated carbon budget, as of 2011, approximately 51 percent, or 515 Gt C (1,890 Gt CO_2), of this budget had already been emitted, leaving a remaining budget of 485 Gt C (1,780 Gt CO_2) (IPCC 2013b). From 2011 to 2015, CO_2 emissions from fossil fuels, cement production, and land-use change totaled approximately 50 Gt C (183 Gt CO_2), leaving a remaining budget from 2016 onwards of 435 Gt C (1595 Gt CO_2) (CDIAC 2016). Under the No Action Alternative, U.S. passenger cars and trucks are projected to emit 23 Gt C (83 Gt CO_2) from 2016 to 2100, or 5.2 percent of the remaining global carbon budget. Under Alternative 1, this projection increases to 25 Gt C (91 Gt CO_2) or 5.7 percent of the remaining budget.

The emissions reductions necessary to keep global emissions within this carbon budget could not be achieved solely with drastic reductions in emissions from the U.S. passenger car and light truck vehicle fleet but would also require drastic reductions in all U.S. sectors and from the rest of the developed and developing world. In addition, achieving GHG reductions from the passenger car and light truck vehicle fleet to the same degree that emissions reductions will be needed globally to avoid using all of the carbon budget would require substantial increases in technology innovation and adoption compared to today's levels and would require the economy and the vehicle fleet to substantially move away from the use of fossil fuels, which is not currently technologically feasible or economically practicable.

5.4.2 Direct and Indirect Impacts on Climate Change Indicators

The direct and indirect impacts of the Proposed Action and alternatives on five relevant climate change indicators are described in Section 5.4.2.1, *Atmospheric Carbon Dioxide Concentrations*; Section 5.4.2.2, *Temperature*; Section 5.4.2.3, *Precipitation*; Section 5.4.2.4, *Sea-Level Rise*; and Section 5.4.2.5, *Ocean pH*. Section 5.4.2.6, *Climate Sensitivity Variations*, presents the sensitivity analysis. The impacts of the Proposed Action and alternatives on global mean surface temperature, atmospheric CO_2 concentrations, precipitation, sea level, and ocean pH would be small compared to the expected changes associated with the emissions trajectories in the GCAM Reference scenario. This is due primarily to the global and multi-sectoral nature of climate change. Although these effects are small, they occur on a global scale and are long-lasting. The combined impact of these emissions increases with emissions increases from other sources could have health, societal, and environmental impacts.

MAGICC6 is a reduced-complexity climate model well calibrated to the mean of the multi-model ensemble results for four of the most commonly used emissions scenarios—RCP2.6 (low), RCP4.5 (medium), RCP6.0 (medium-high), and RCP8.5 (high) from the IPCC RCP series—as shown in

Table 5.4.2-1.[29] As the table shows, the results of the model runs developed for this analysis agree relatively well with IPCC estimates for both CO_2 concentrations and surface temperature.

Table 5.4.2-1. Comparison of MAGICC Modeling Results and Reported IPCC Results[a]

	CO_2 Concentration (ppm)		Global Mean Increase in Surface Temperature (°C)	
Scenario	IPCC WGI (2100)	MAGICC (2100)	IPCC WGI (2081—2100)	MAGICC (2100)
RCP2.6	421	426	1.0	1.1
RCP4.5	538	544	1.8	2.1
RCP6.0	670	674	2.2	2.6
RCP8.5	936	938	3.7	4.2

Notes:
[a] The IPCC values represent the average of the 5 to 95 percent range of global mean surface air temperature.
ppm = parts per million; °C = degrees Celsius; MAGICC = Model for the Assessment of Greenhouse-gas Induced Climate Change; IPCC = Intergovernmental Panel on Climate Change; RCP = Representative Concentration Pathways; WGI = Working Group 1
Source: IPCC 2013a

As discussed in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, NHTSA used the GCAM Reference scenario to represent the No Action Alternative in the MAGICC modeling runs. CO_2 concentrations under the No Action Alternative are 789.11 ppm and range from 789.27 under Alternative 7 to 789.76 ppm under Alternative 1 in 2100 (Table 5.4.2-2). For 2040 and 2060, the corresponding range of ppm differences across alternatives is even smaller. Because CO_2 concentrations are the key determinant of other climate effects (which in turn drive the resource impacts discussed in Section 8.6, *Cumulative Impacts—Greenhouse Gas Emissions and Climate Change*), this leads to very small differences in these effects.

Table 5.4.2-2. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increase, Sea-Level Rise, and Ocean pH (GCAM Reference) by Alternative[a]

	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b, c]			Sea-Level Rise (cm)[b, d]			Ocean pH[e]		
	2040	2060	2100	2040	2060	2100	2040	2060	2100	2040	2060	2100
Totals by Alternative												
Alt. 0—No Action	479.04	565.44	789.11	1.287	2.008	3.484	22.87	36.56	76.28	8.4099	8.3476	8.2176
Alt. 1	479.15	565.73	789.76	1.288	2.010	3.487	22.87	36.58	76.34	8.4098	8.3474	8.2173
Alt. 2	479.14	565.71	789.72	1.288	2.010	3.487	22.87	36.57	76.33	8.4098	8.3474	8.2173
Alt. 3	479.14	565.70	789.68	1.288	2.009	3.486	22.87	36.57	76.33	8.4098	8.3474	8.2173
Alt. 4	479.12	565.66	789.60	1.287	2.009	3.486	22.87	36.57	76.32	8.4098	8.3474	8.2173
Alt. 5	479.10	565.61	789.48	1.287	2.009	3.486	22.87	36.57	76.31	8.4099	8.3475	8.2174
Alt. 6	479.09	565.57	789.40	1.287	2.009	3.485	22.87	36.57	76.31	8.4099	8.3475	8.2174
Alt. 7	479.07	565.52	789.27	1.287	2.009	3.485	22.87	36.57	76.30	8.4099	8.3475	8.2175
Alt. 8	479.08	565.54	789.32	1.287	2.009	3.485	22.87	36.57	76.30	8.4099	8.3475	8.2175

[29] NHTSA used the MAGICC default climate sensitivity of 3.0 °C (5.4 °F).