Quiz 2 Solutions

A. What was the preindustrial (natural) stock of N_2O in the atmosphere, in Tg?

molecular weight of N_2O $2(14)+16 = 44\ \text{g/mole}$

$$S = \left[\frac{270\cdot10^{-9}\ \text{mole}_{N_2O}}{\text{mole}_{air}}\right]\left[1.8\cdot10^{20}\ \text{mole}_{air}\right]\left[\frac{44\ \text{g}_{N_2O}}{\text{mole}_{N_2O}}\right]\left[\frac{\text{Tg}}{10^{12}\ \text{g}}\right]$$

$$= 2138\ \text{Tg}_{N_2O} \approx 2100\ \text{Tg}$$

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B. What was the natural flow of N_2O into the atmosphere, in Tg/y?

$$F = \frac{S}{\tau} = \frac{2138\ \text{Tg}}{125\ \text{y}} = 17.11\frac{\text{Tg}}{\text{y}} \approx 17\frac{\text{Tg}}{\text{y}}$$

Quiz 2 Solutions

C. If natural emissions remain constant and total anthropogenic emissions are held constant at the 2000 level, what will be the concentration of N_2O? How long will it take to reach this concentration?

$$c = \frac{S}{V} = \frac{F\tau}{V} = \frac{\left(\frac{(17.1+9)\ \text{Tg}}{\text{y}}\right)\left(\frac{\text{mole}}{44\ \text{g}}\right)(125\ \text{y})}{1.8\cdot10^{20}\ \text{mole}_{air}}$$

$$= \frac{7.4\cdot10^{13}\ \text{mole}_{N_2O}}{1.8\cdot10^{20}\ \text{mole}_{air}} = 4.12\cdot10^{-7} = 412\cdot10^{-9} \approx 410\ \text{ppbv}$$

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C. Concentration is proportional to flow:

$$c = \frac{F\tau}{V} \qquad \frac{c_1}{c_0} = \frac{F_1}{F_0} \qquad c_1 = c_0\frac{F_1}{F_0}$$

$$c_1 = (270\ \text{ppbv})\frac{(17.1+9)\frac{\text{Tg}}{\text{y}}}{17.1\frac{\text{Tg}}{\text{y}}} = 1.53(270)$$

$$= 412\ \text{ppbv} \approx 410\ \text{ppb}$$

Because the residence time is 125 y, it will take on the order of 500 years to reach this concentration