

## Quiz #2

The preindustrial concentration of methane ( $\text{CH}_4$ ) in the atmosphere was about 700 ppbv (parts per billion by volume). The residence time of methane in the atmosphere is about 12 years.

What was the preindustrial (i.e., natural) flow of methane into the atmosphere?

Compare this to the estimated current anthropogenic flow of 350 Mt/y.

Atomic weights: H = 1, C = 12 g/mole  
Volume of atmosphere:  $1.8 \cdot 10^{20}$  moles

## Quiz #2 Solution

Molecular weight of  $\text{CH}_4 = 16$  g/mole, residence time  $\tau \approx 12$  y, preindustrial concentration  $c = 700$  ppbv. Natural flow into atmosphere:

$$F = \frac{S}{\tau} = \frac{cV}{\tau}$$
$$= \frac{\left[ \frac{700 \cdot 10^{-9} \text{ mole}_{\text{CH}_4}}{\text{mole}_{\text{atm}}} \right] \left[ 1.8 \cdot 10^{20} \text{ mole}_{\text{atm}} \right] \left[ \frac{16 \text{ g}_{\text{CH}_4}}{\text{mole}_{\text{CH}_4}} \right]}{12 \text{ y}}$$
$$= 1.7 \cdot 10^{14} \text{ g}_{\text{CH}_4} = 170 \text{ Tg}_{\text{CH}_4} = 170 \text{ Mt}_{\text{CH}_4}$$

natural  $\approx$  half  
current anthropo-  
genic emissions

## Beyond the Solution

If natural emissions are unchanged, and anthropogenic emissions remain at current levels:

$$F = F_{\text{nat}} + F_{\text{anth}} = 170 + 350 = 520 \text{ Tg/y}$$

$$c = \frac{S}{V} = \frac{\tau F}{V}$$

$$c = (12 \text{ y}) \left( \frac{520 \cdot 10^{12} \text{ g}_{\text{CH}_4}}{\text{y}} \right) \left( \frac{\text{mole}}{16 \text{ g}_{\text{CH}_4}} \right) \left( \frac{10^9 \text{ ppbv}}{1.8 \cdot 10^{20} \text{ mole}} \right)$$

$$= 2170 \text{ ppbv}$$