



Growth workshop

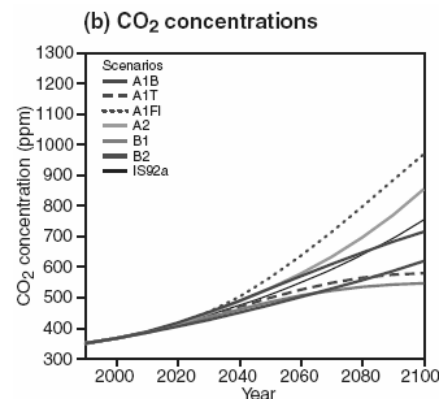
Linear vs Exponential

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Fire, Air, and Water:
Effects of the Sun, Atmosphere, and Oceans in
Climate Change and Global Warming

1. Linear growth

If atmospheric CO₂ starts at C₀=380 ppm and keeps growing at the LINEAR rate of m=2.5 ppm/yr, in a century (t=100 yrs) it will reach C(t)=_____?



$$y = mx + b$$

$$C(t) = mt + C_0$$

$$\Delta C = mt =$$

$$C(t = 100 \text{ yrs}) = C_0 + \Delta C =$$

$$\frac{C(100 \text{ yrs})}{C_0} =$$



2. Double linear growth

Start atmospheric CO₂ at C₀=380 ppm as before, but DOUBLE the linear growth rate: m₂ = 2m = 5 ppm/yr

1. Predict C/C₀ = _____ after a century.
2. Calculate C(t=100 yrs)
3. Plot the C(t) for m=2.5 ppm yr on the same graph as C₂(t) for m₂ = 5 ppm/yr. Compare the two plots.

$$C_2(t) = m_2t + C_0$$

$$\Delta C_2 = m_2t =$$

$$C_2(t = 100 \text{ yrs}) = C_0 + \Delta C_2 =$$

$$\frac{C_2(100 \text{ yrs})}{C_0} =$$

E1. Exponential growth

If atmospheric CO₂ starts at N₀=380 ppm and grows EXPONENTIALLY to 630 ppm in a century as N(t)=N₀e^{kt},

1. Find its growth rate k, and
2. Plot N(t). Note that N(100)/N₀=630/380=1.66

$$N(t) = N_0 e^{kt}$$

$$e^{kt} = \frac{N(t)}{N_0}$$

$$kt = \ln \left(\frac{N(t)}{N_0} \right)$$



E2. Exponential growth

If atmospheric CO₂ starts at N₀=380 ppm as before, but increases at DOUBLE that exponential rate in a century,

$$k_2 = 2k = \underline{\hspace{1cm}},$$

1. Predict $N_2/N_0 = \underline{\hspace{1cm}}$ after a century.
2. Calculate $N_2(t=100 \text{ yrs})$
3. Plot the $N(t)$ for k on the same graph as $N_2(t)$ for $2k$.

Compare the two plots.

$$N_2(t) = N_0 e^{2kt}$$

