

The Greenhouse Effect

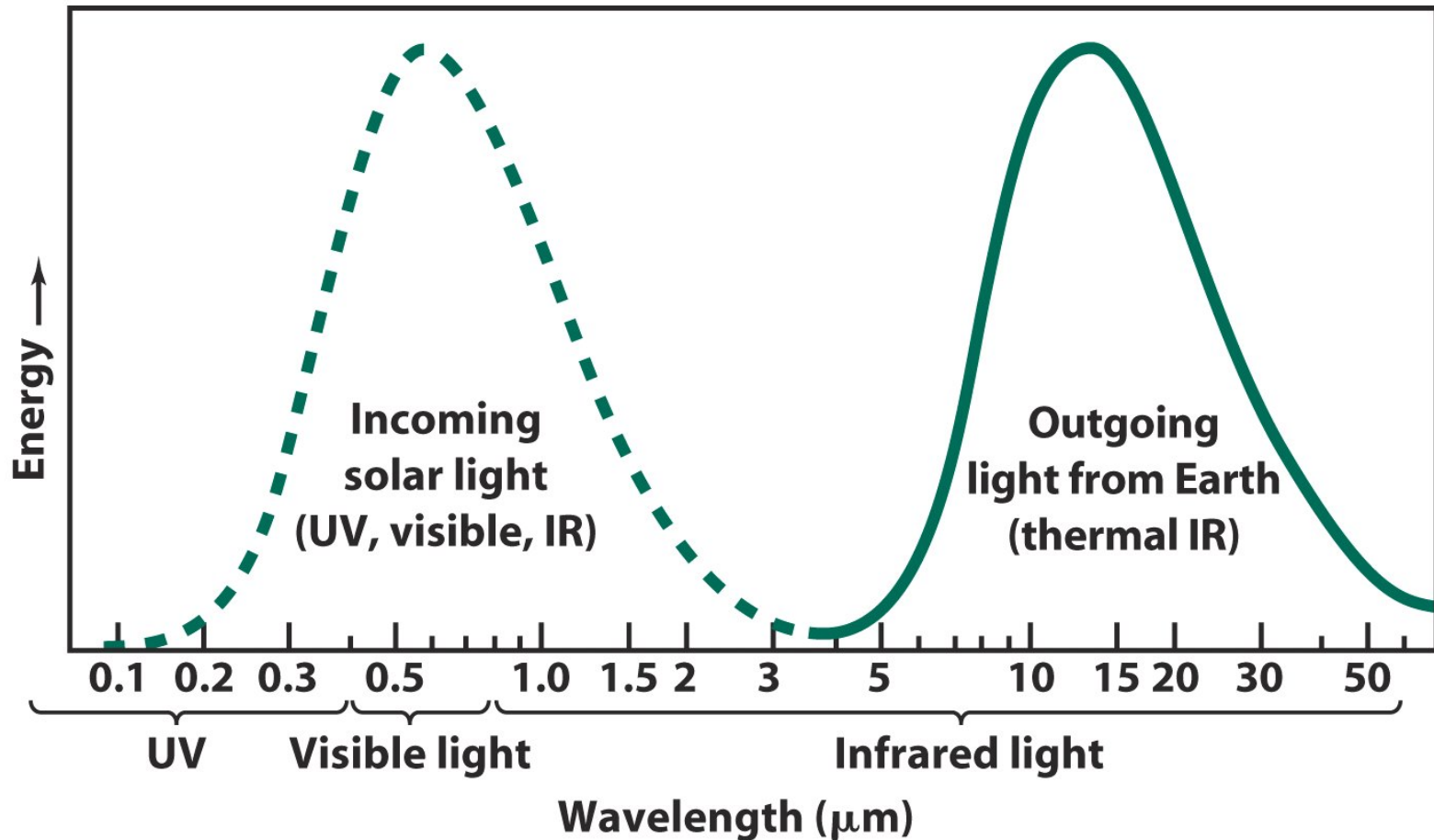
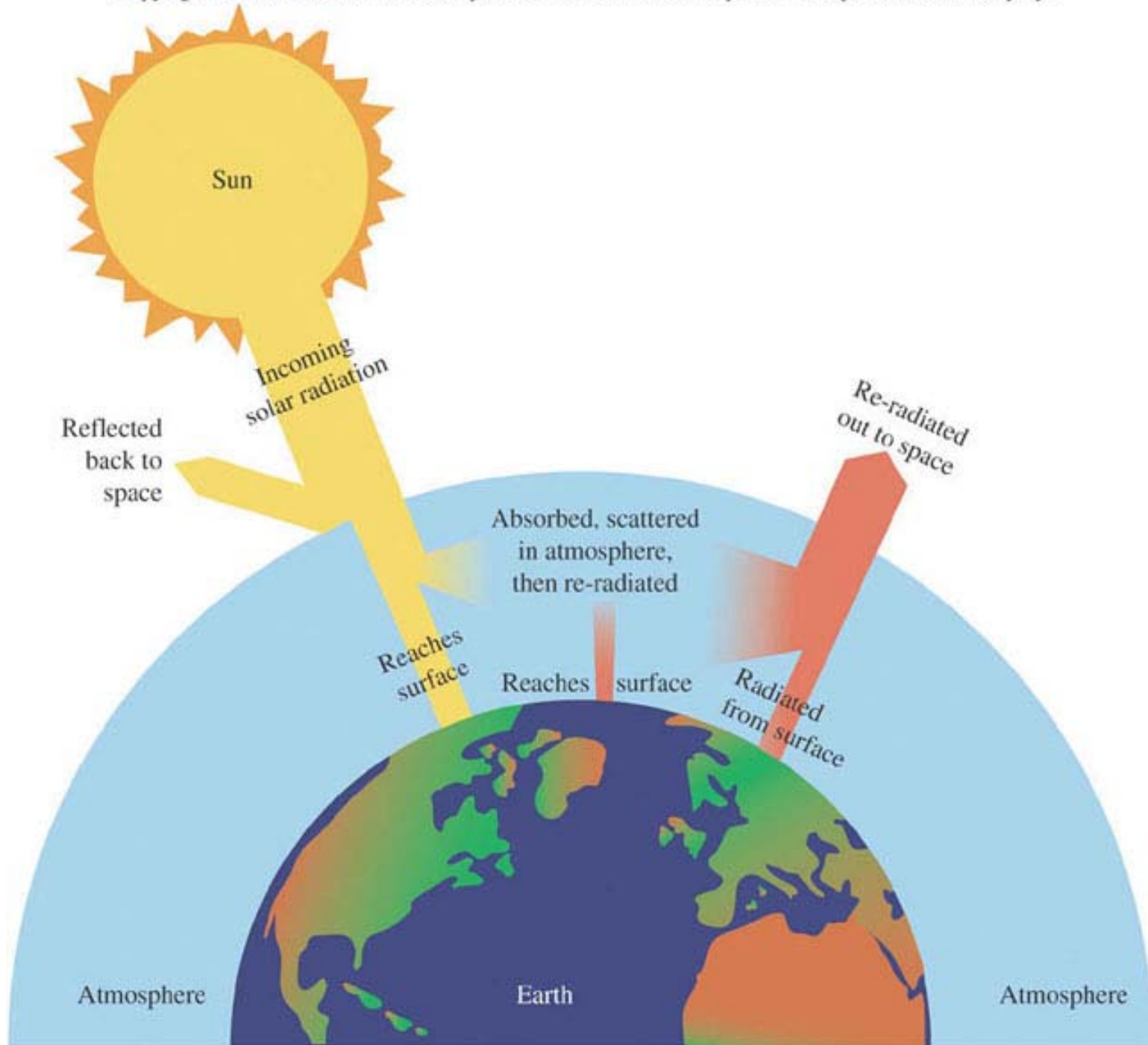


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Blackbodies emit a broad spectrum centered around $\lambda_{\text{max}} = 2897/T$

$$\lambda_{\text{max}}(\text{sun}) = \lambda_{\text{max}}(5800\text{K}) = 0.50 \mu\text{m}$$

$$\lambda_{\text{max}}(\text{earth}) = \lambda_{\text{max}}(300\text{K}) = 10 \mu\text{m}$$



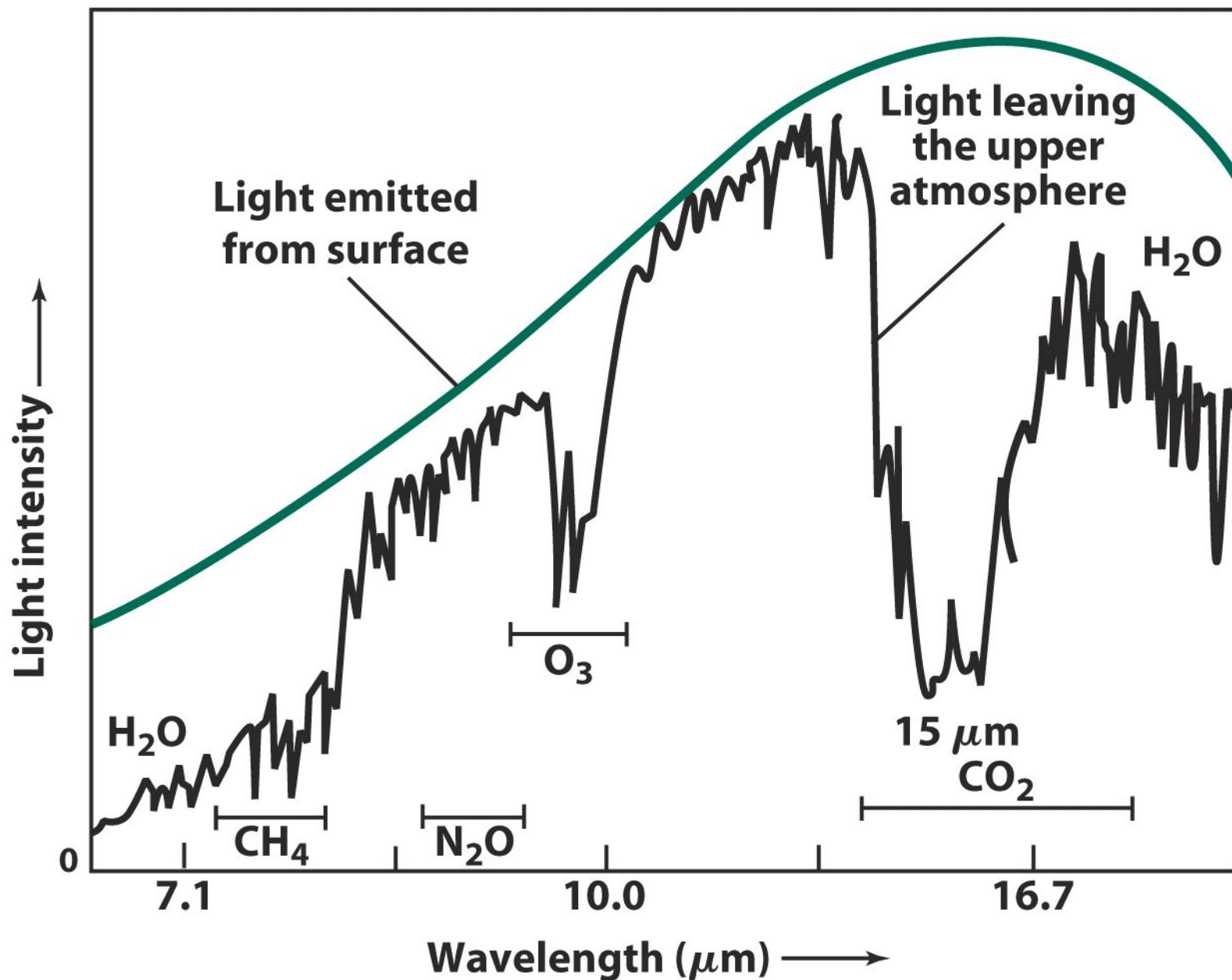
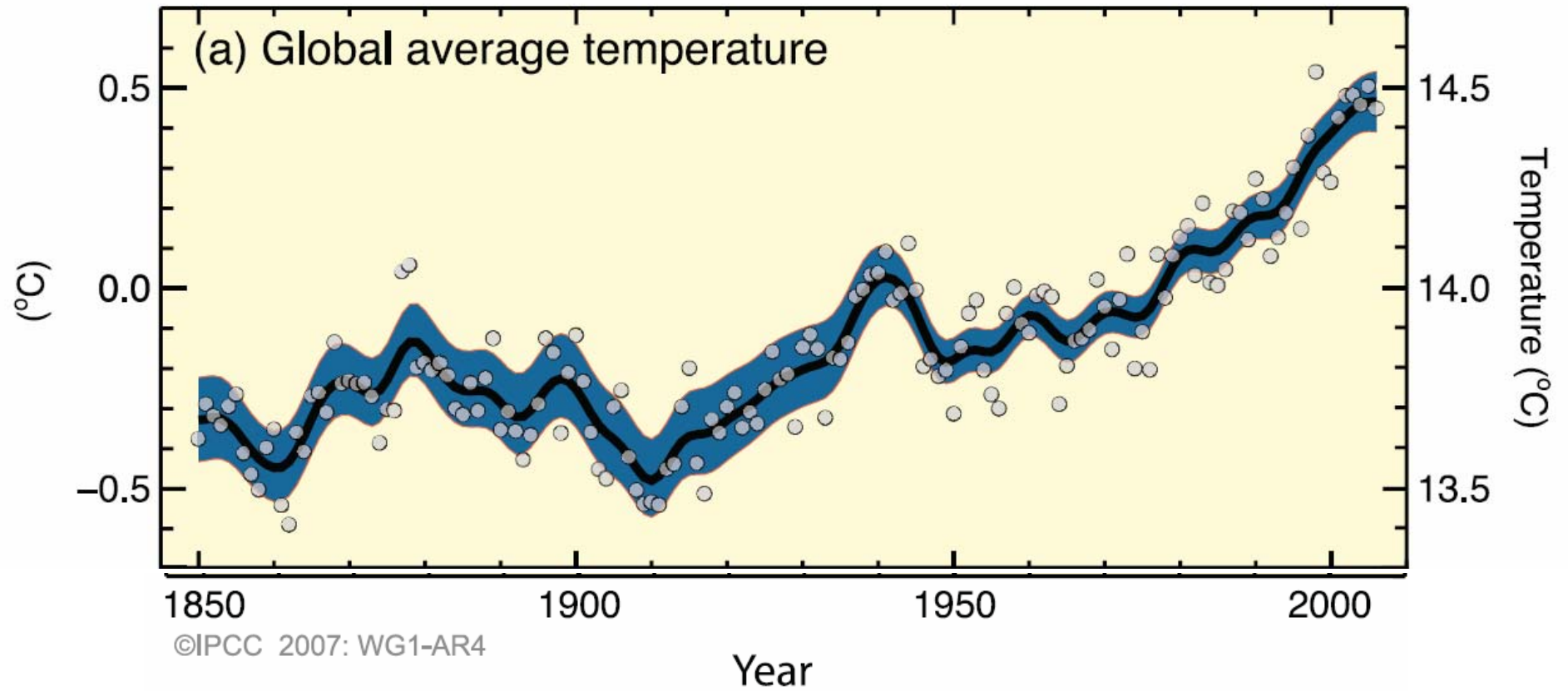


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Ok, so that's the Greenhouse Effect.

What's global warming?

CHANGES IN TEMPERATURE, SEA LEVEL AND NORTHERN HEMISPHERE SNOW COVER



This is global warming

CHANGES IN TEMPERATURE, SEA LEVEL AND NORTHERN HEMISPHERE SNOW COVER

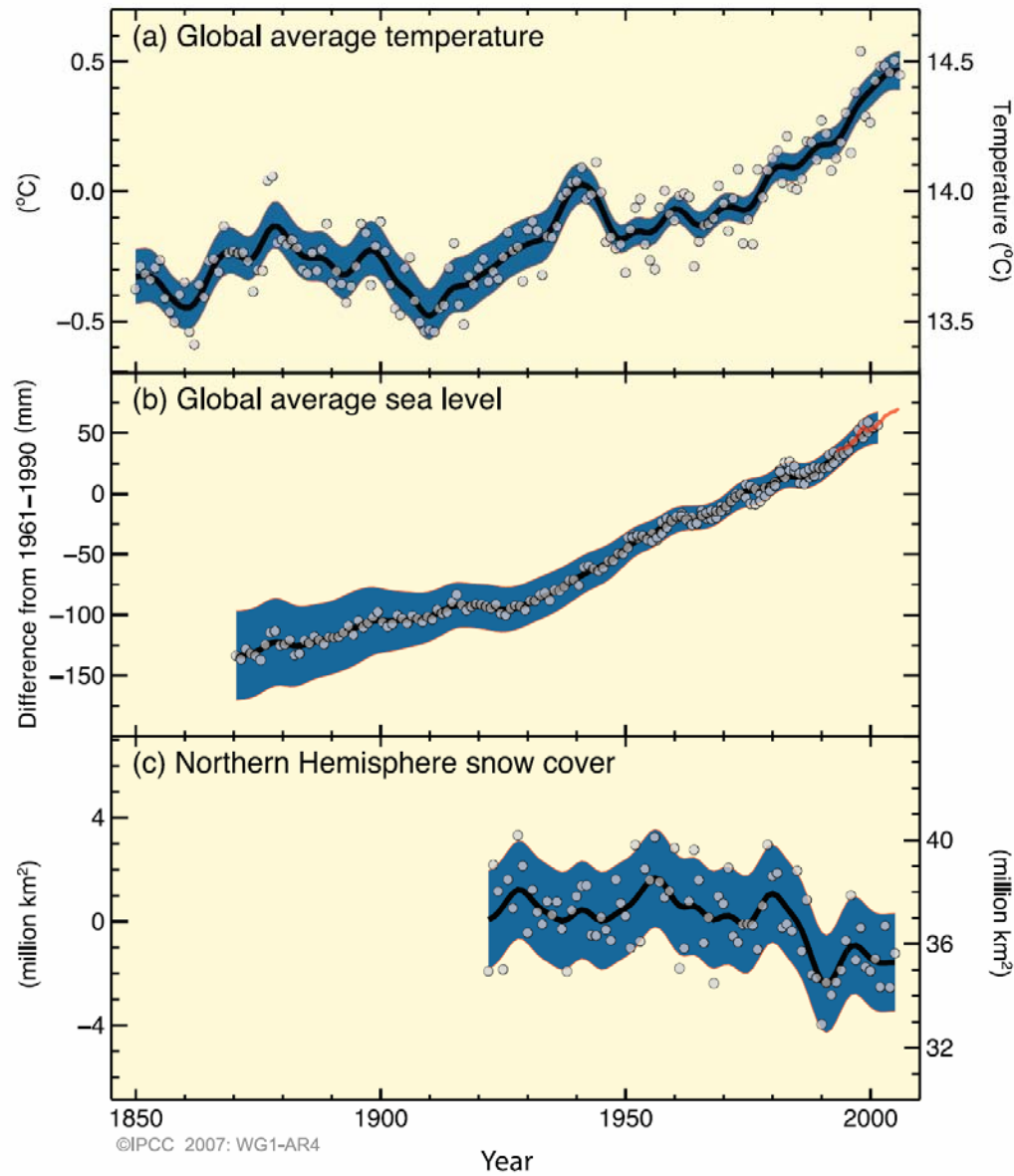
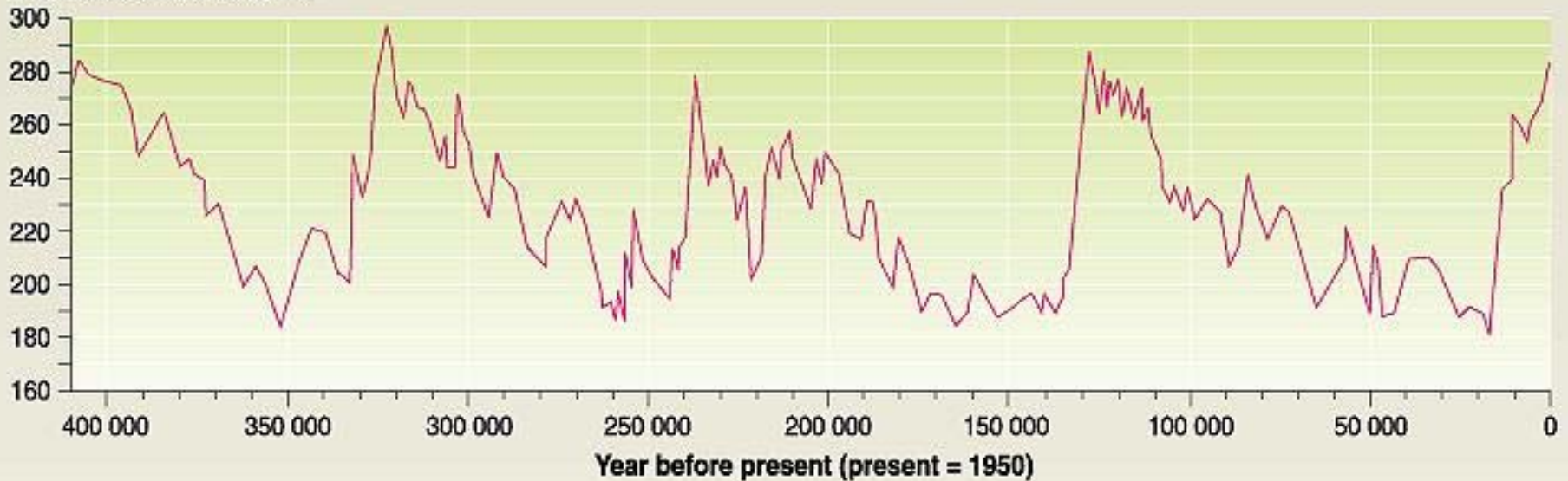


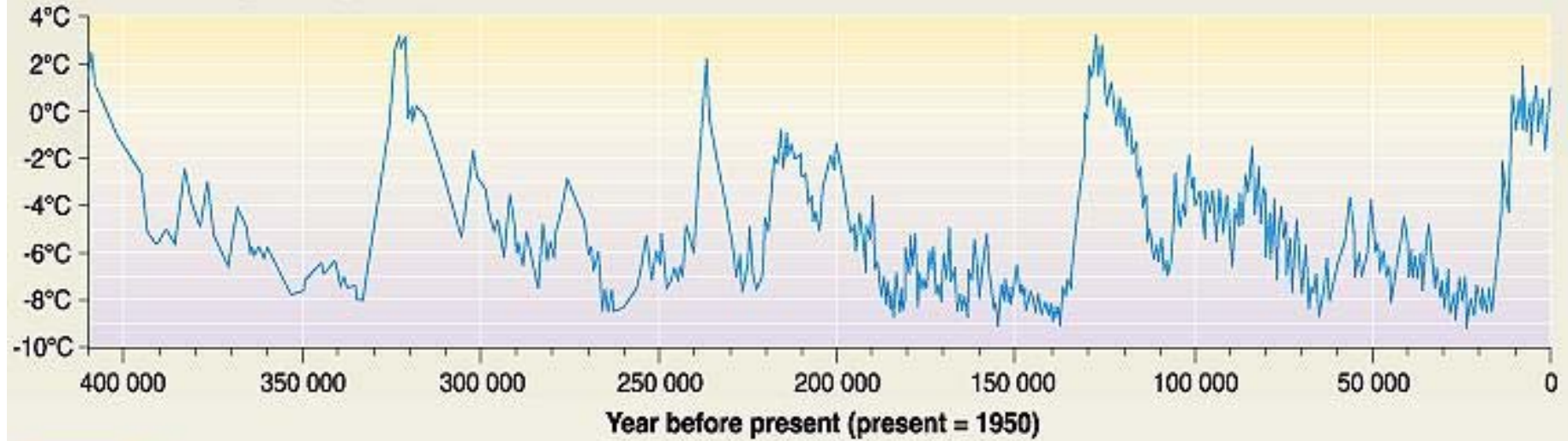
Figure SPM.3. Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). [FAQ 3.1, Figure 1, Figure 4.2, Figure 5.13]

Temperature and CO₂ concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)

CO₂ concentration, ppmv



Temperature change from present, °C



GRAPHIC DESIGN : PHILIPPE REKACENICZ

Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3June), pp 429-436, 1999.

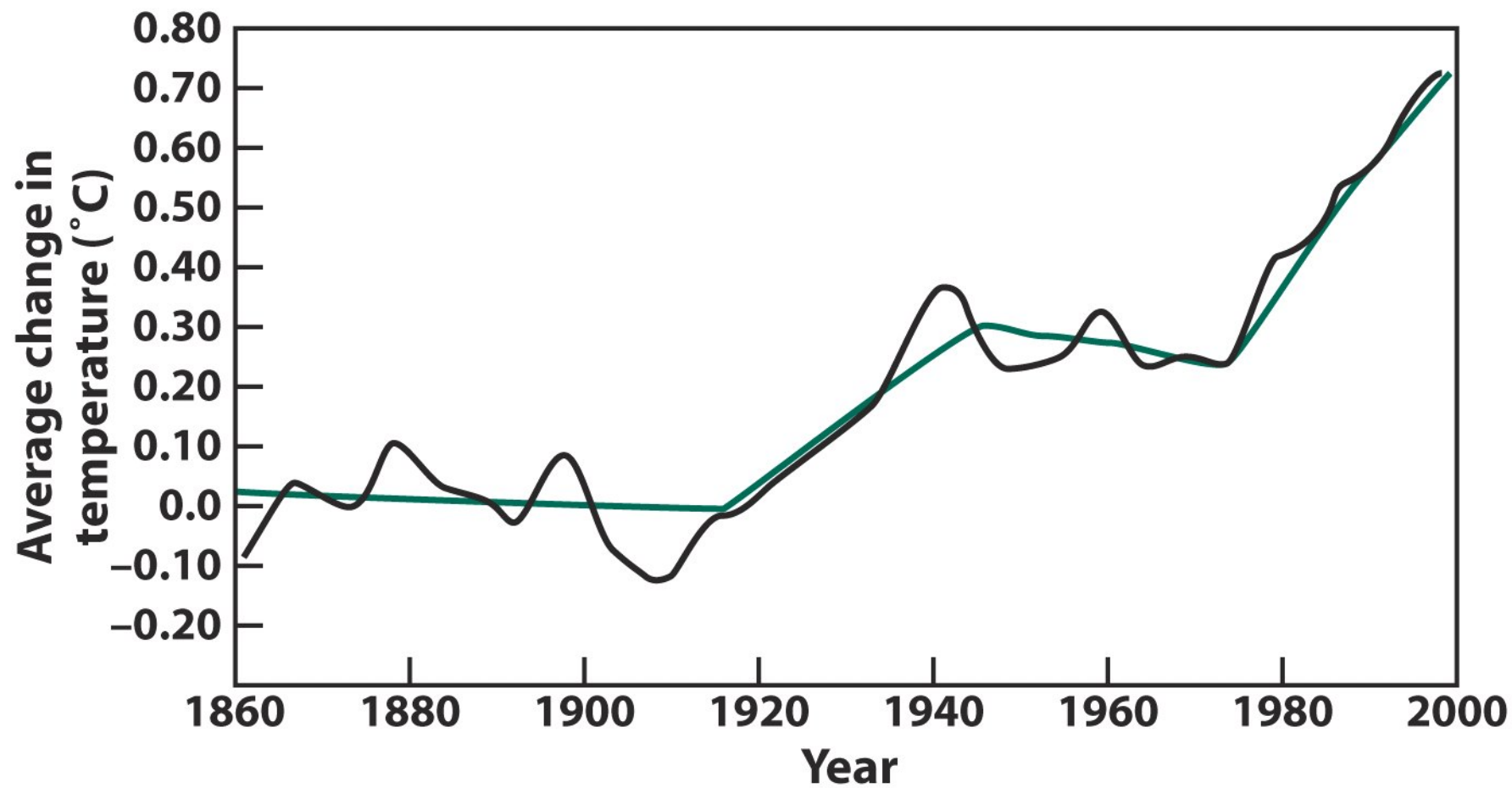


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Greenhouse Gases: CO₂

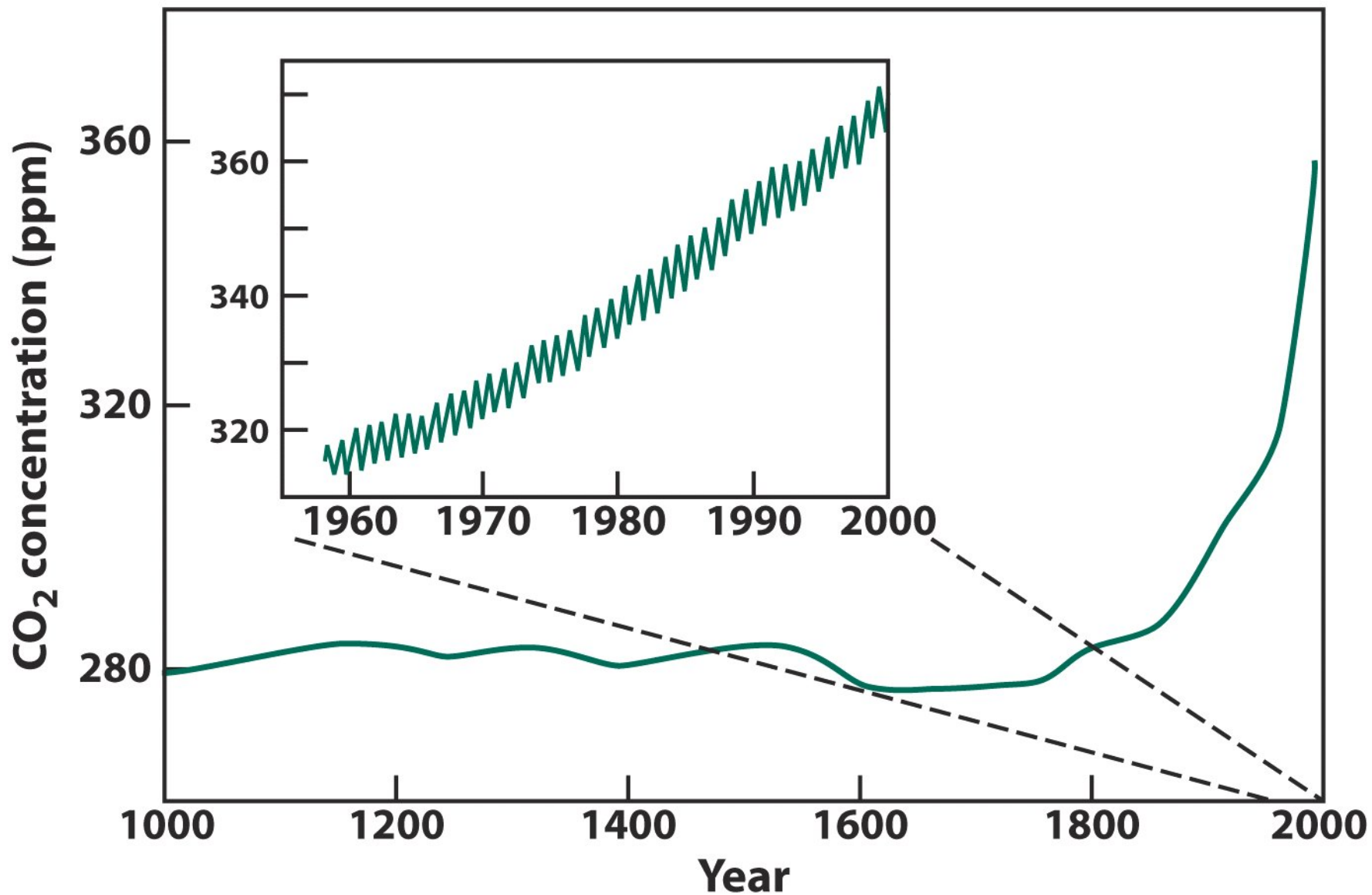


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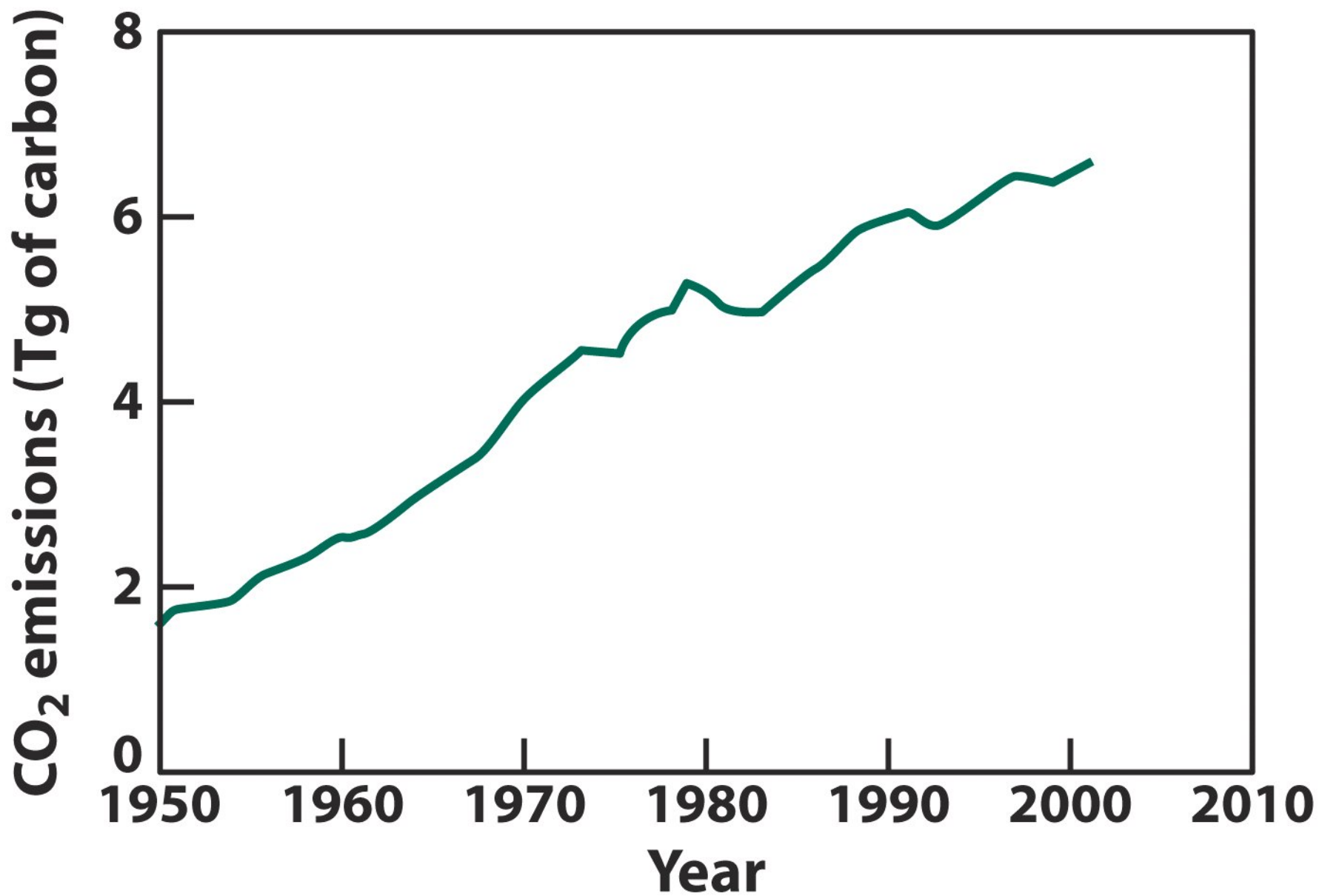


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CO₂ emissions from fossil fuel combustion

Indicators of the human influence on the atmosphere during the Industrial Era

(a) Global atmospheric concentrations of three well mixed greenhouse gases

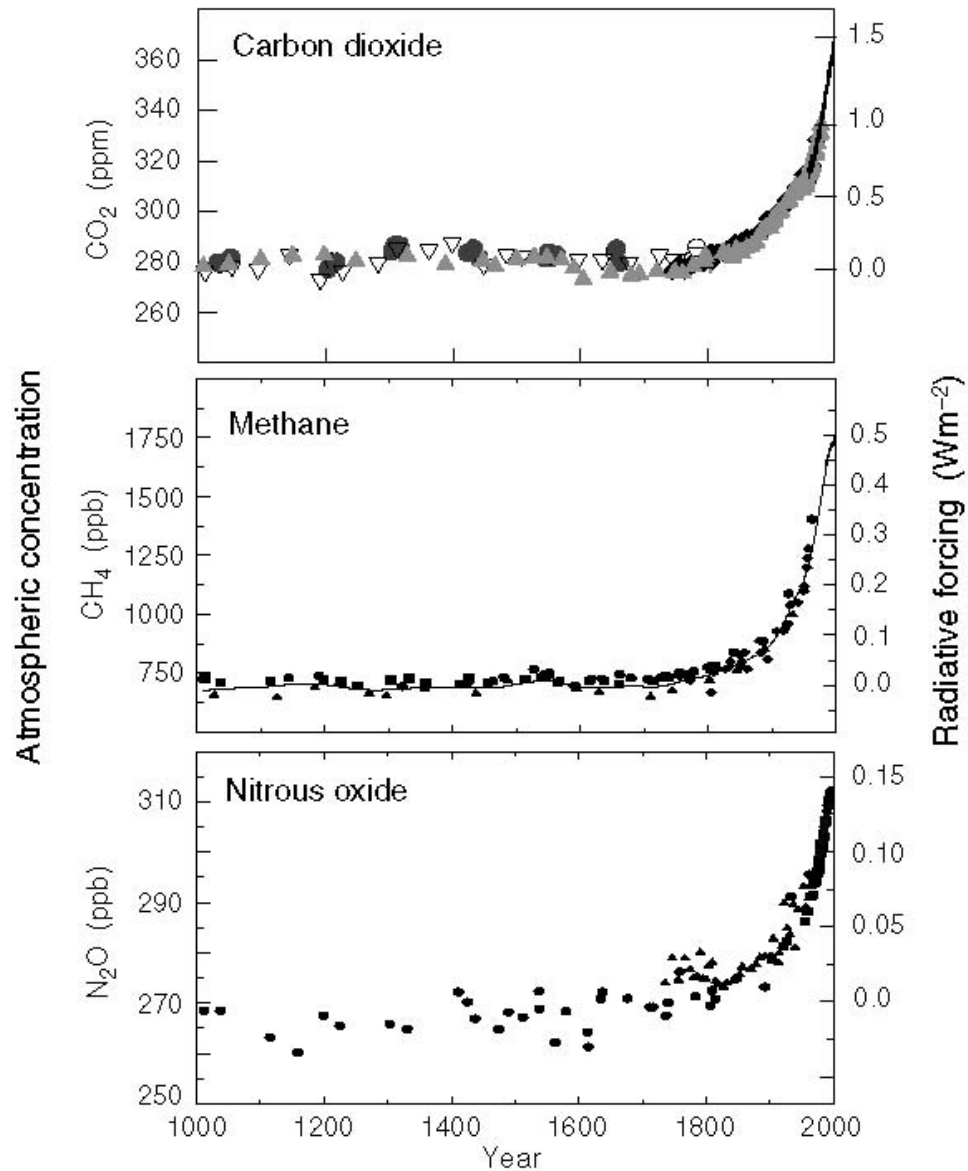


TABLE 4-1**Summary of Information About Some Greenhouse Gases**

Gas	Current concentration	Residence time, in years	Relative global warming efficiency, 100-year horizon
CO ₂	373 ppm	50–200	1
CH ₄	1.77 ppm	12	23
N ₂ O	316 ppb	120	296
CFC-11	0.26 ppb	45	4600
HCFC-22	0.15 ppb	12	1700
HFC-134a	0.01 ppb	14	1300
Halon-1301	0.003 ppb	65	6900

Table 4-1
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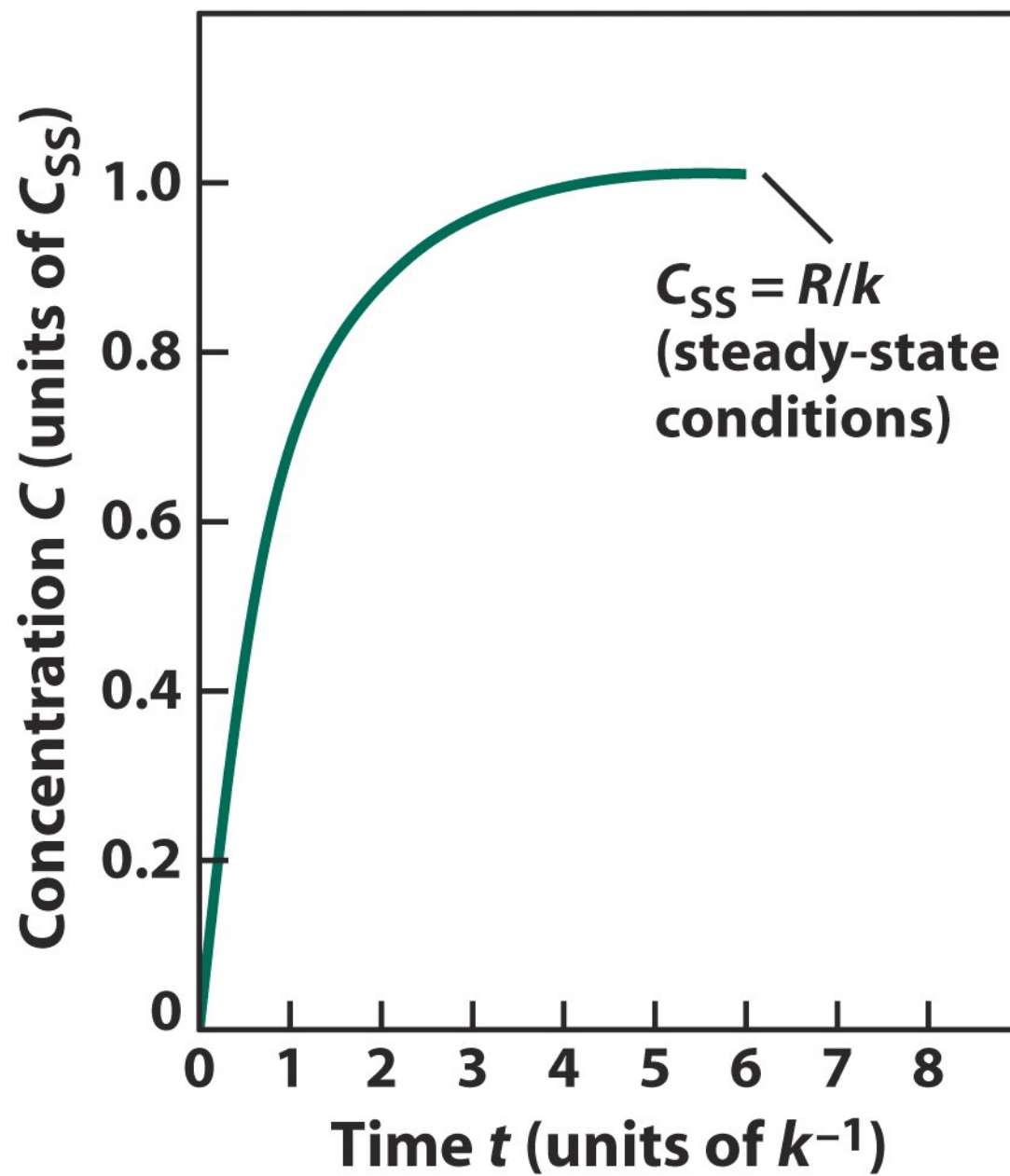


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Greenhouse Gases: Methane

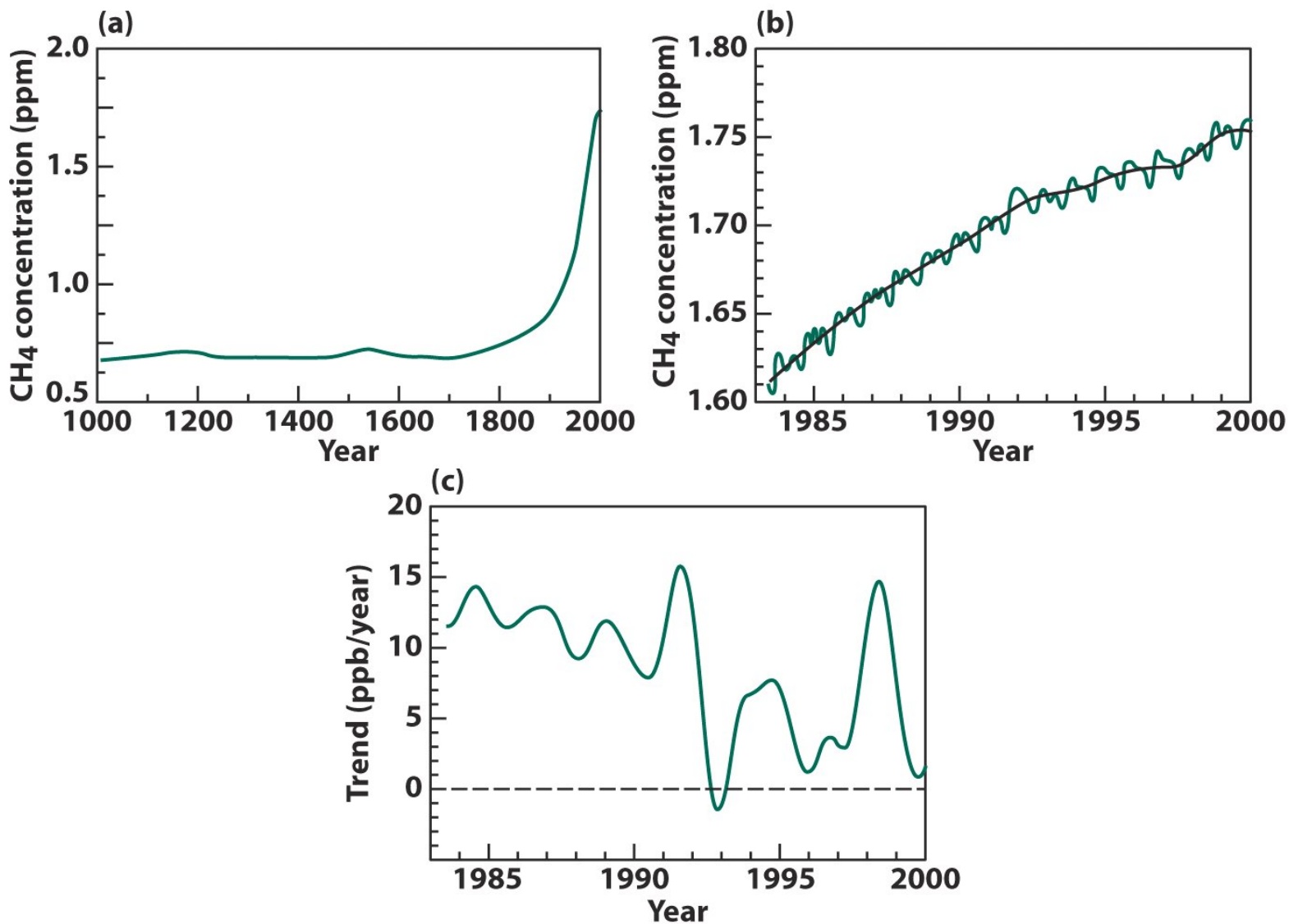
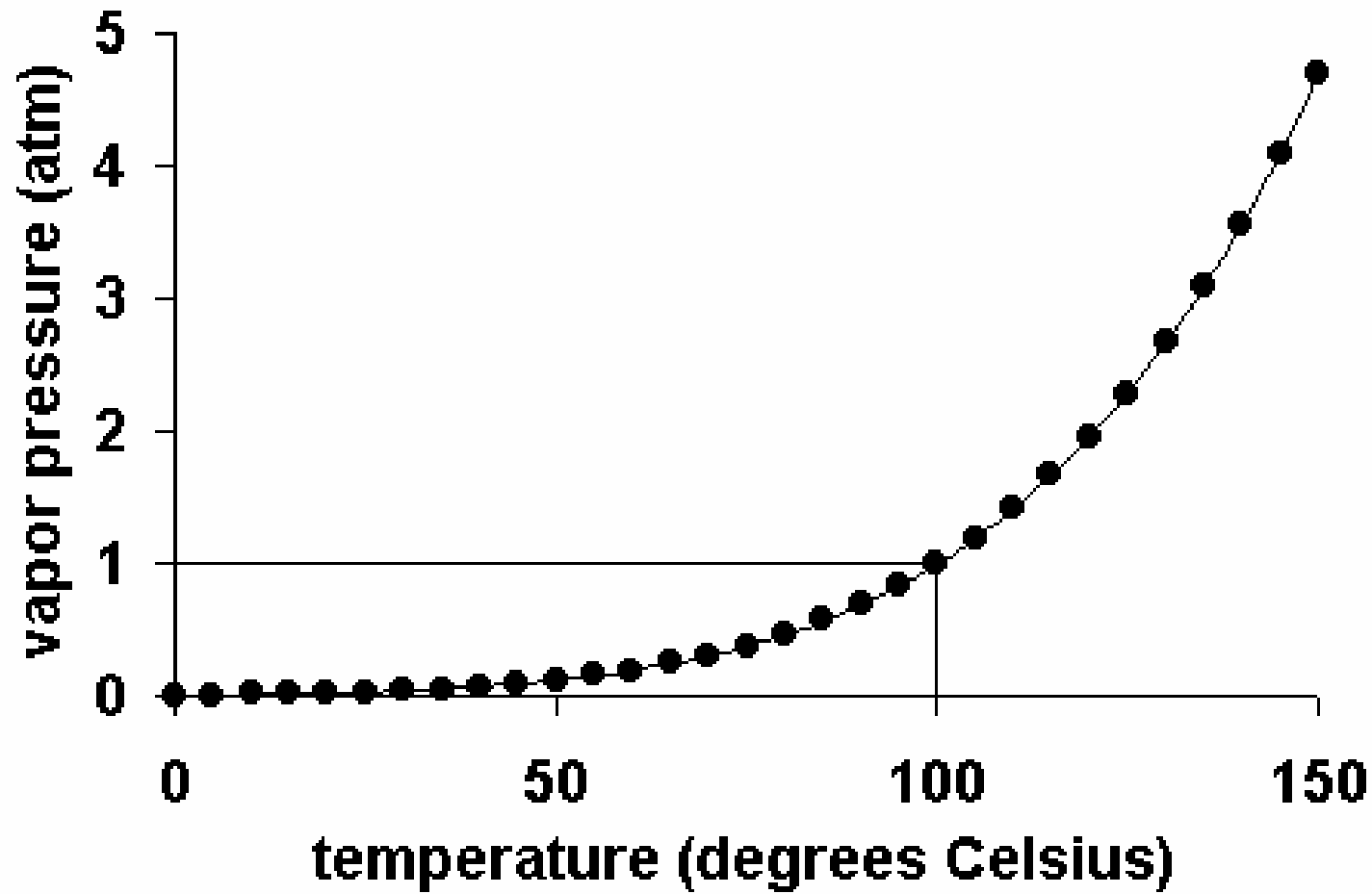


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Greenhouse Gases: Water Vapor



Positive feedback

RADIATIVE FORCING COMPONENTS

