The Carbon Cycle

Human Perturbations of the Carbon Cycle

MODULE 4.2

4.2 Human Perturbations of the Carbon Cycle

Lesson Goals:

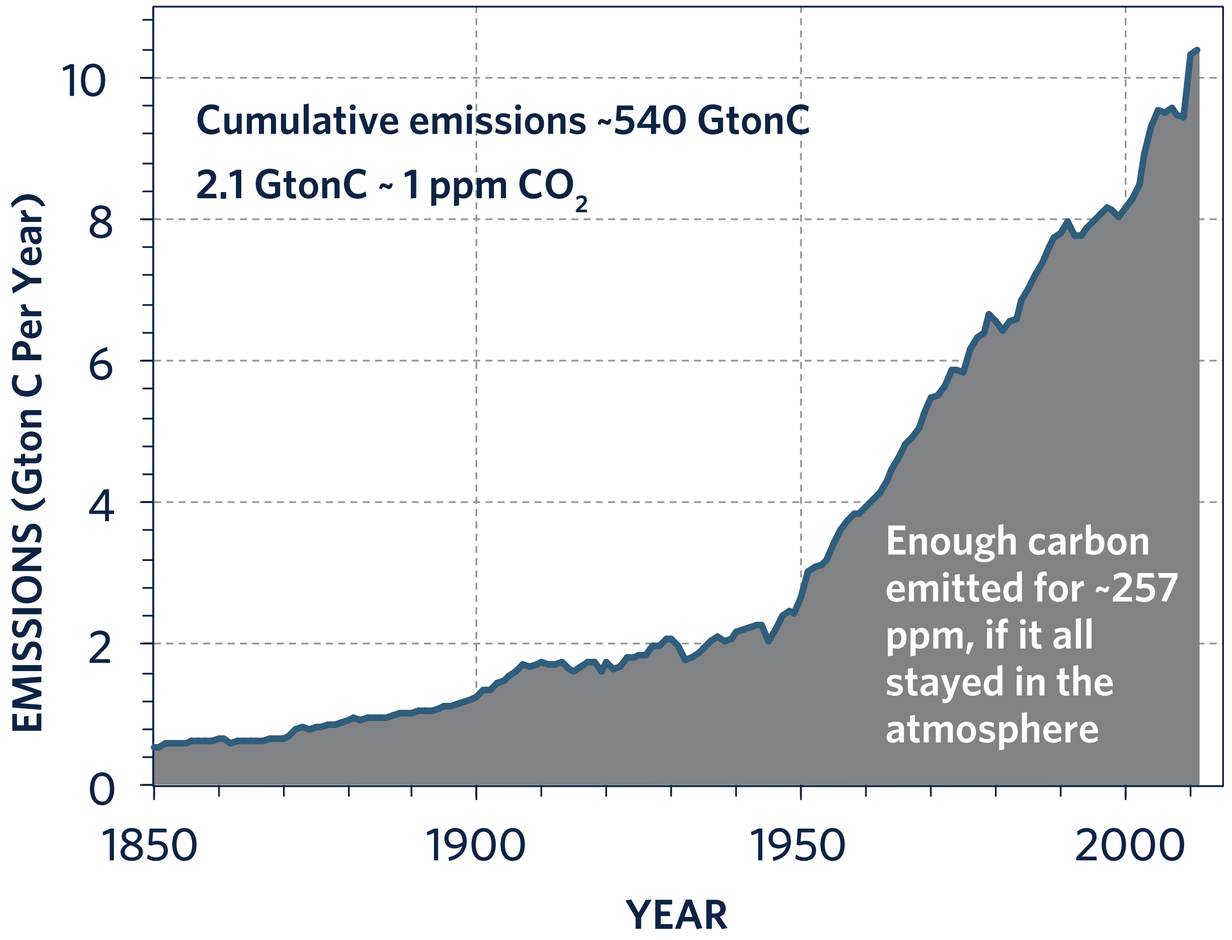
» Evaluate chemical and mass balance evidence linking human activities to the atmospheric carbon increase in the recent past

» Evaluate hypotheses regarding when human activities began to measurably alter atmospheric greenhouse gas concentrations.

SMOKESTACKS: PUBLIC DOMAIN HTTP://PIXABAY.COM/EN/BUILDING-CHIMNEYS-CLOUDS-COAL-2058/

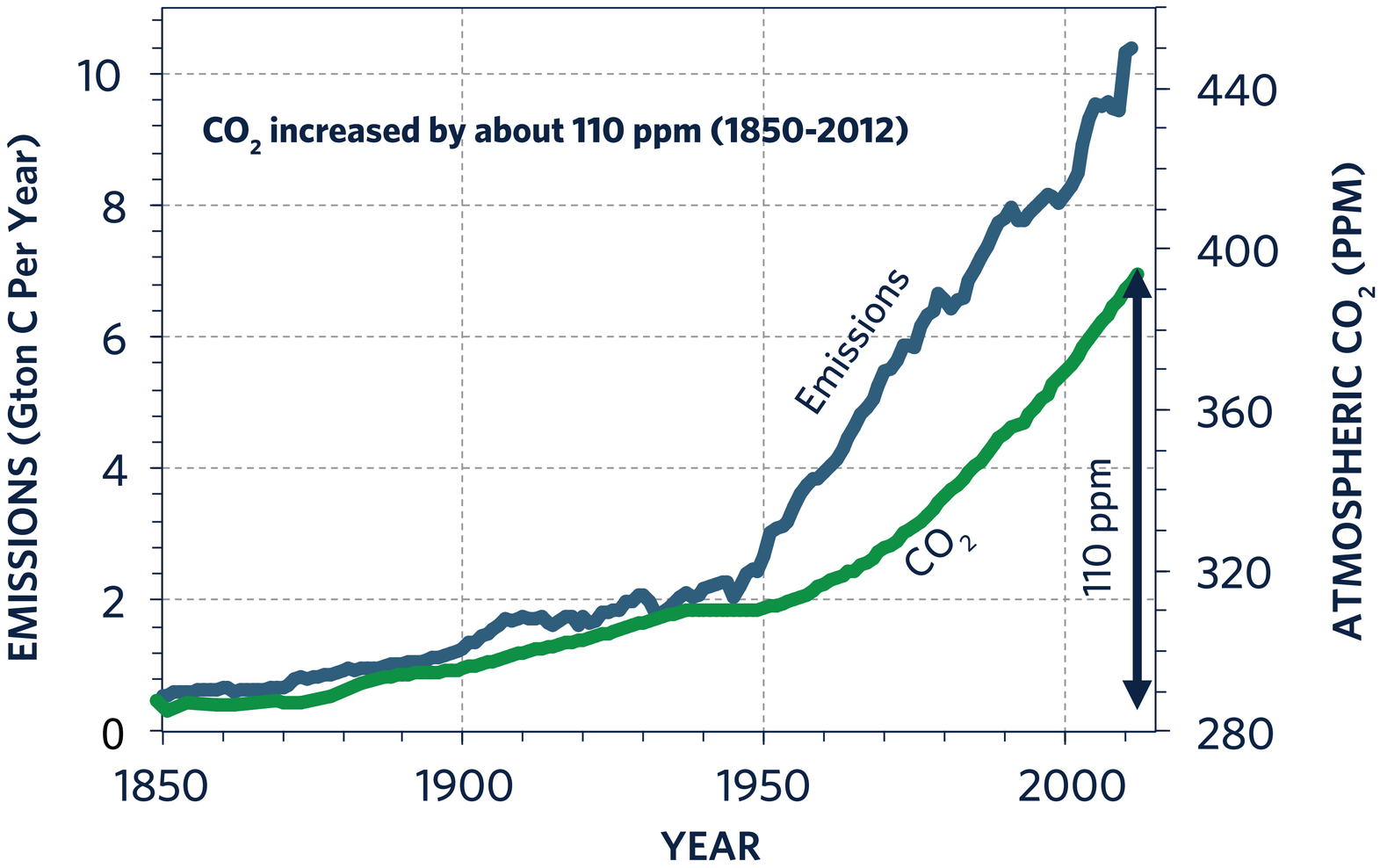
DEFORESTATION. PUBLIC DOMAIN. HTTP://PIXABAY.COM/EN/DEFORESTATION-FOREST-TREE-STUMP-62486/

Human carbon emissions from fossil fuels, cement, and land use change



DATA FROM CDIAC

Emissions & CO_2



DATA FROM CDIAC AND FROM ETHERIDGE ET AL., 1998

Land and Oceans take up extra

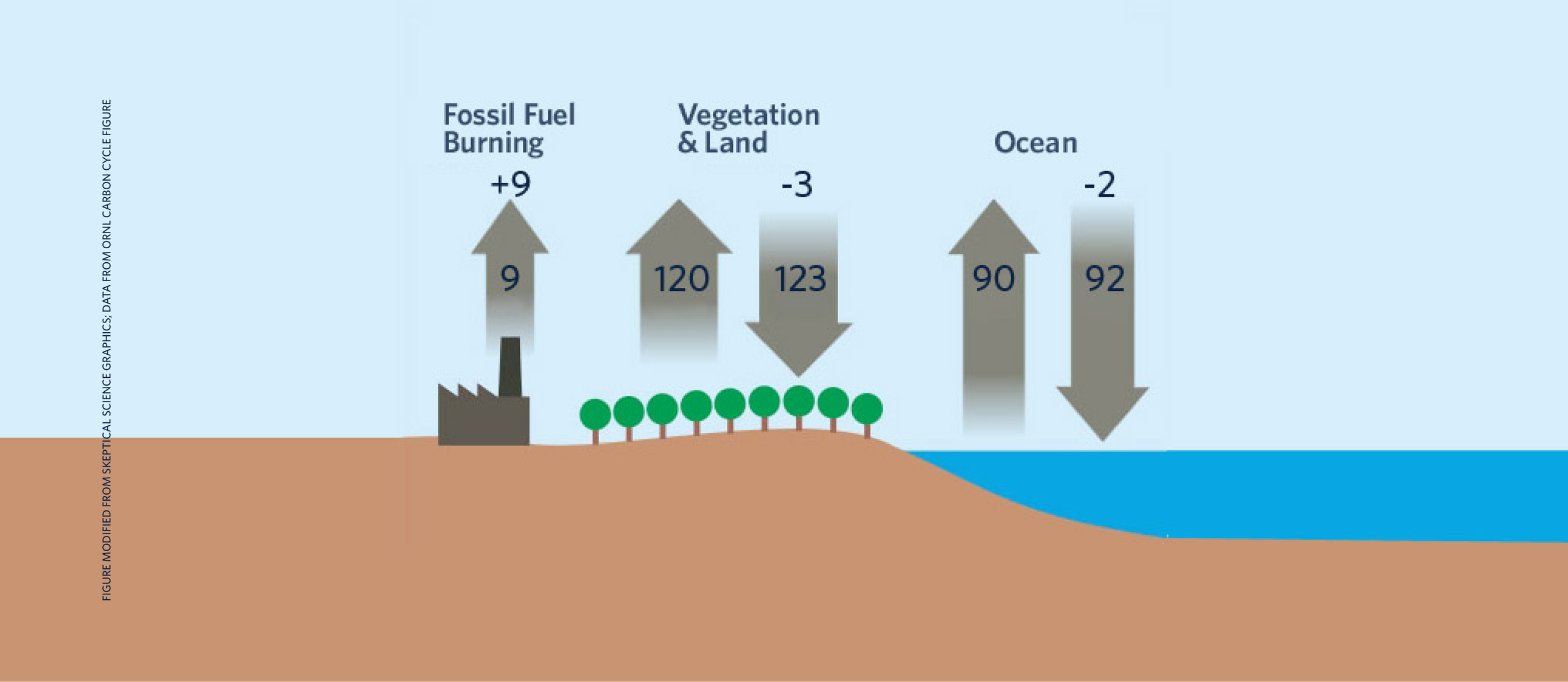


FIGURE MODIFIED FROM SKEPTICAL SCIENCE GRAPHICS; DATA FROM ORNL CARBON CYCLE FIGURE

About what % of emissions stays in the atmosphere?

A. ~100%
B. ~88%
C. ~67%
D. ~55%
E. ~45%

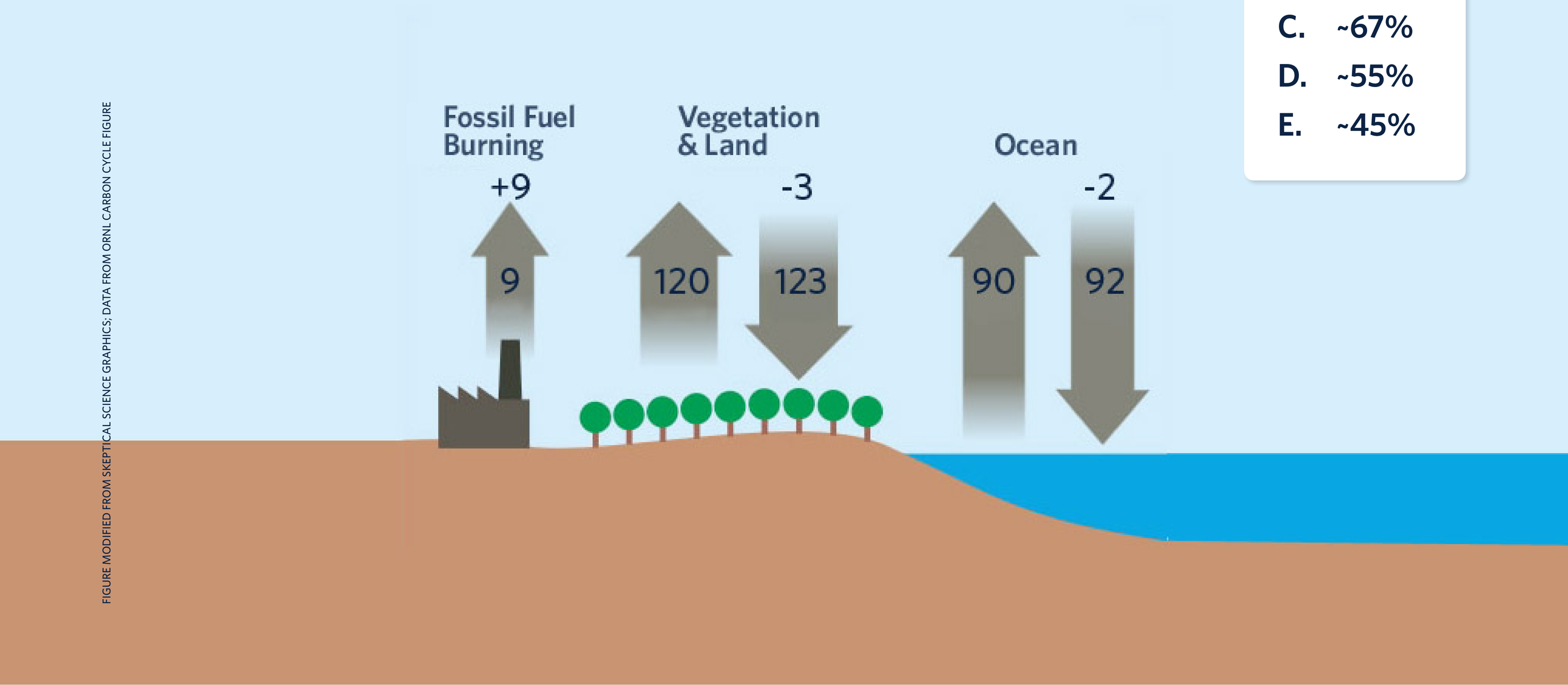


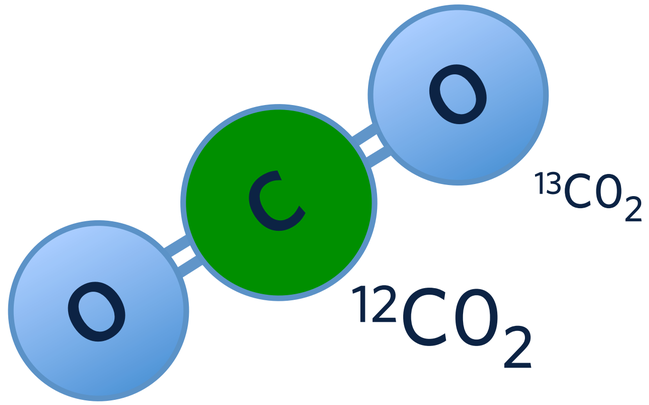
FIGURE MODIFIED FROM SKEPTICAL SCIENCE GRAPHICS; DATA FROM ORNL CARBON CYCLE FIGURE

Carbon comes in different forms

Stable isotopes of CARBON:

^{12}C (98.9% of all carbon)

^{13}C (1.1% of all carbon)



Measure $\frac{^{13}C}{^{12}C}$ in the atmosphere, in other carbon stocks

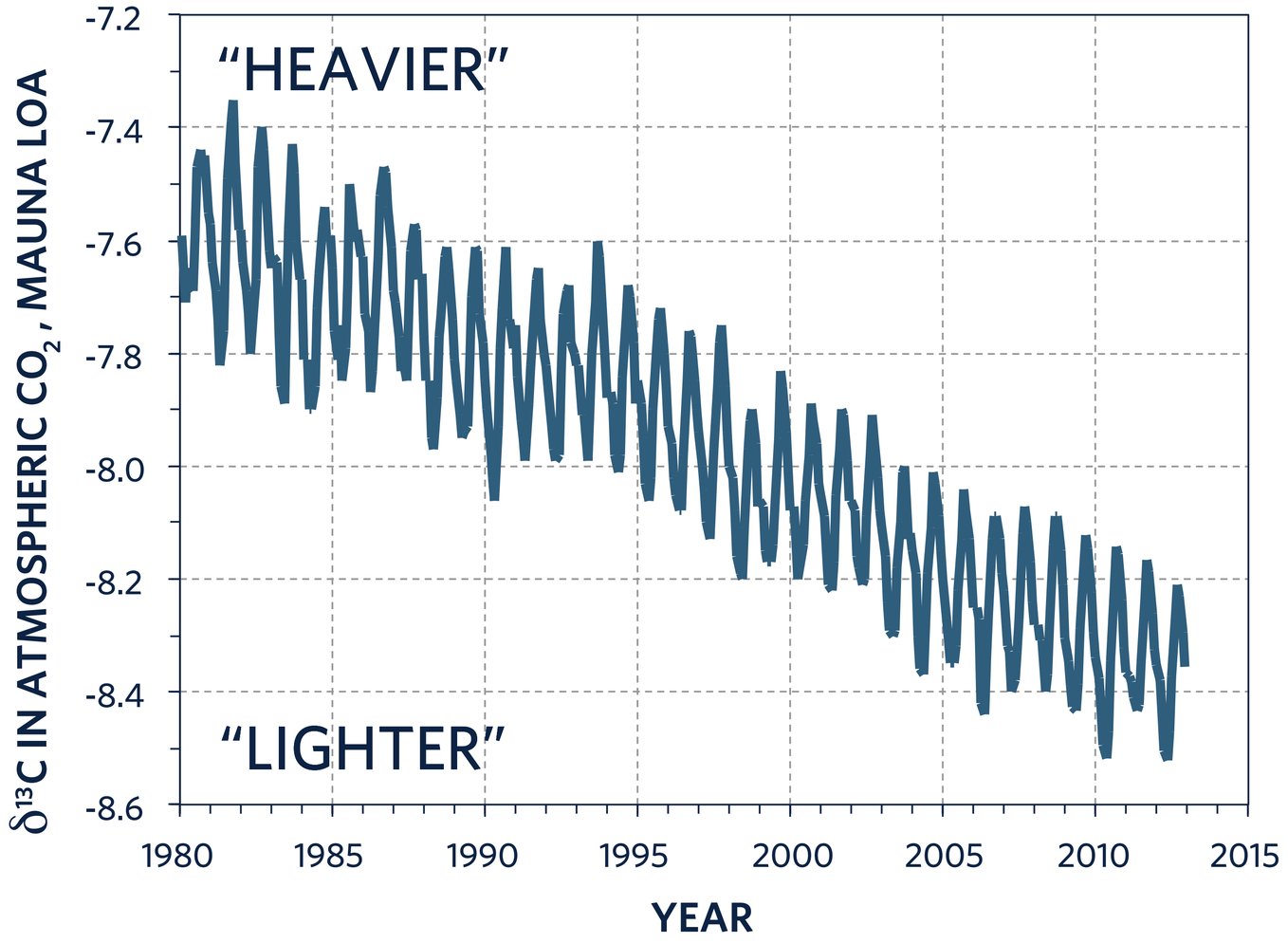
RELATIVELY HIGH $\frac{^{13}C}{^{12}C}$ = “HEAVY”

RELATIVELY LOW $\frac{^{13}C}{^{12}C}$ = “LIGHT”

Plants prefer ^{12}C over ^{13}C. Which has a LOWER ("lighter") $^{13}C/^{12}C$ ratio?

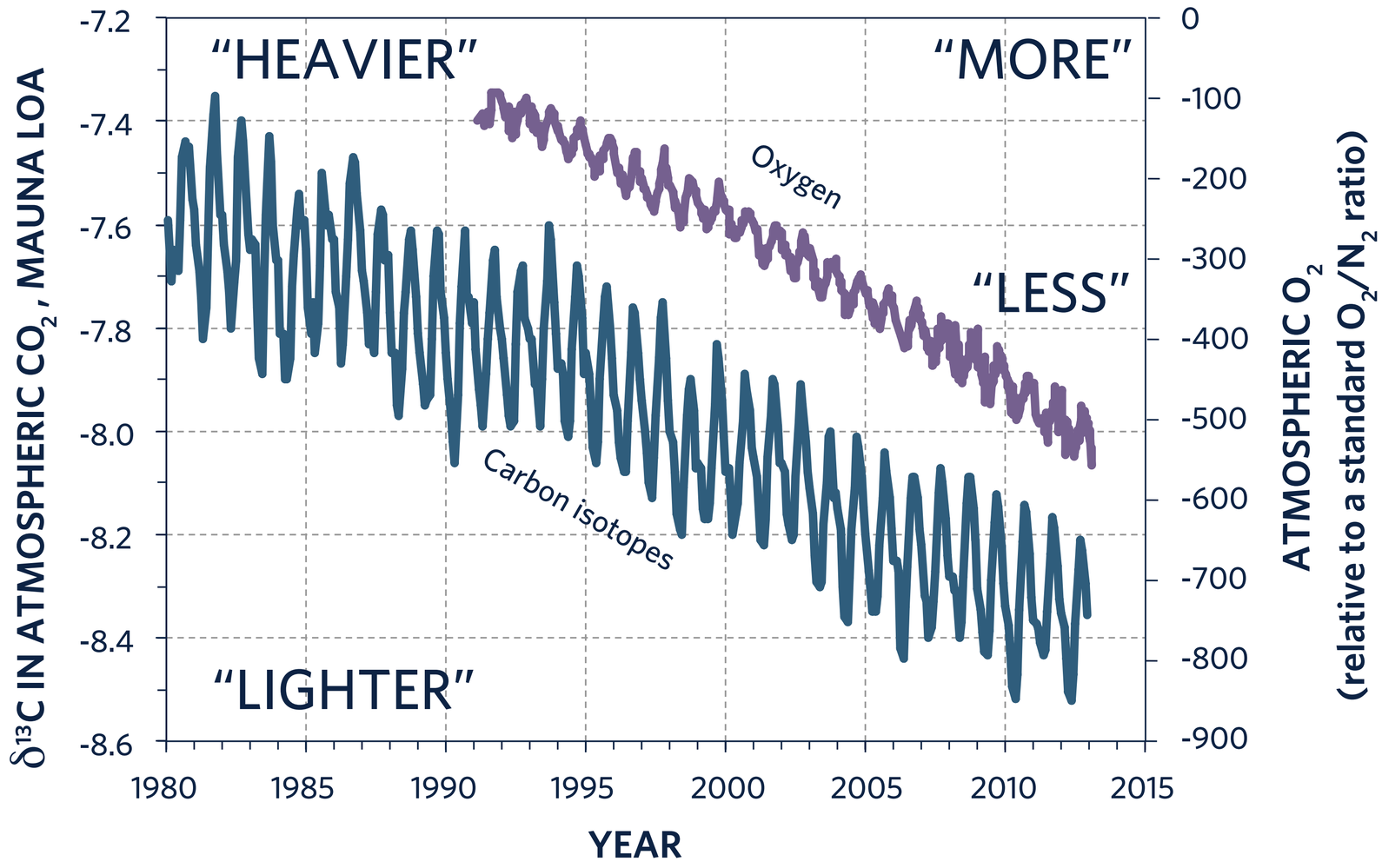
A. Atmospheric CO_2
B. Plants
C. They're the same

Carbon isotopes in CO_2



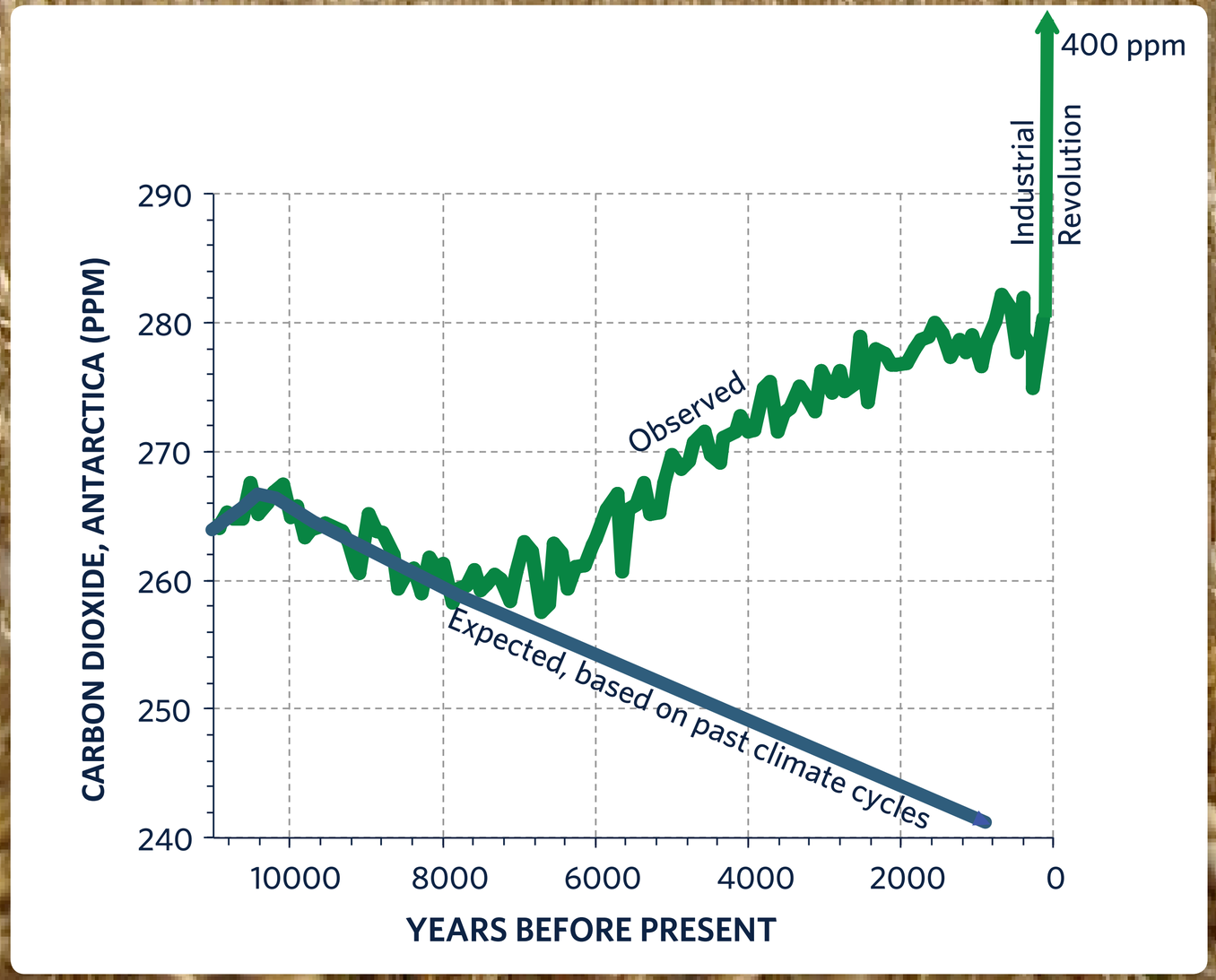
DATA FROM CDIAC AND NOAA

...and Oxygen



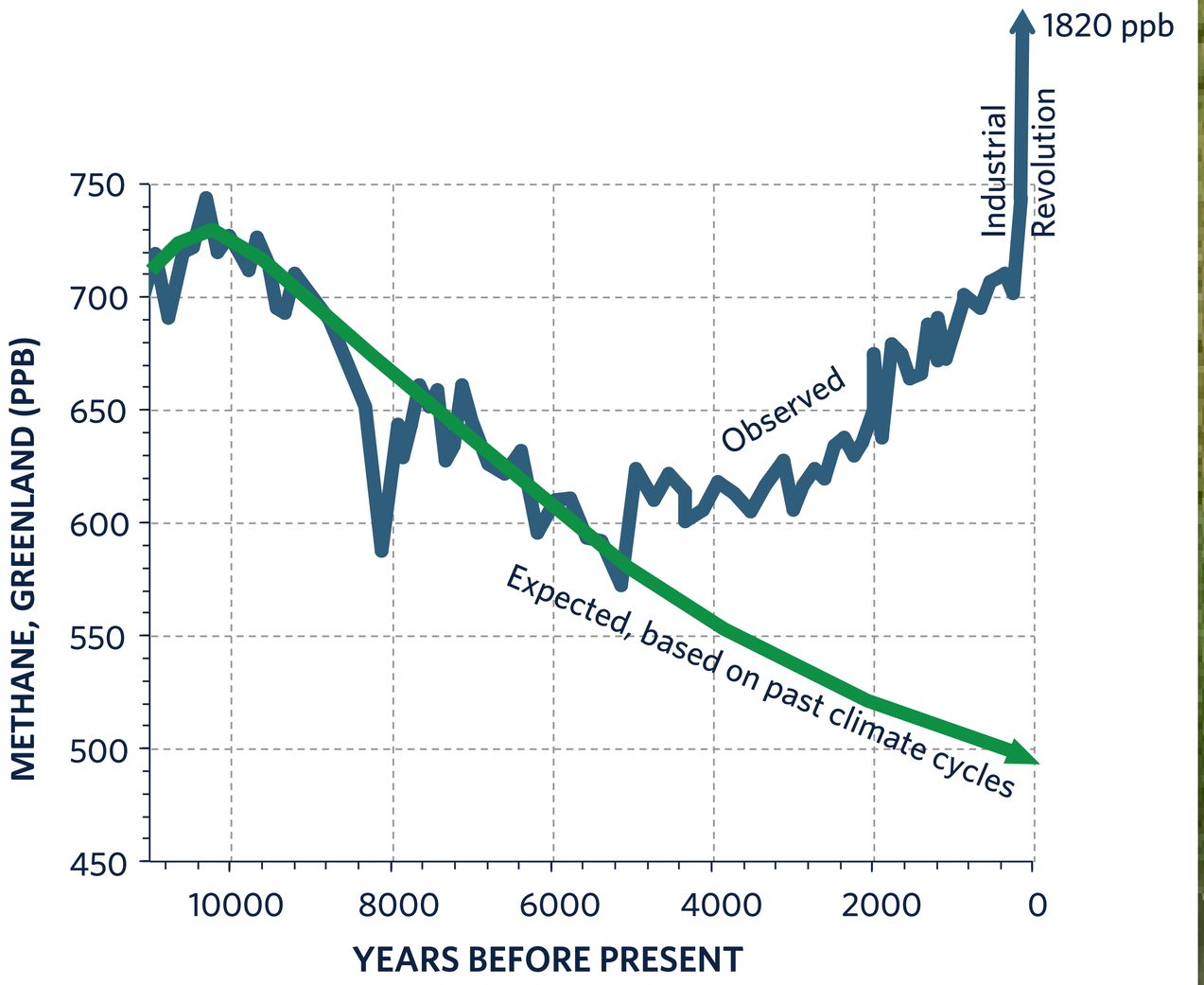
DATA FROM CDIAC, NOAA, AND SCRIPPS INSTITUTION OF OCEANOGRAPHY

How long ago...



DATA FROM EPICA; IDEAS FROM W. RUDDIMAN

How long ago...



DATA FROM GRIP; IDEAS FROM W. RUDDIMAN

Key Points

» Human activities, in particular fossil fuel burning, clearing forested land for agriculture, and cement making, have increased the inflows of carbon to the atmosphere.

» Some of the excess inflow is taken back out by plants and soils on land, and by the ocean, but about 45% of our emissions stay in the atmosphere each year.

» Chemical data from carbon isotopes and oxygen align well with the explanation that the recent rise in atmospheric carbon dioxide is due to human activities.

» Farther back in time, it's plausible that we began altering the composition of the atmosphere as far back at 8,000 years ago, with the expansion of agriculture.