Plot the record.

About 40 minutes
On your own or in pairs
Pencil, ruler, calculator

Since 1976 the Kennaook / Cape Grim station in north-west Tasmania has measured carbon dioxide in clean air from the Southern Ocean. The table gives the yearly average for every second year. Plot it, measure how fast it is changing, and use your model of the carbon cycle to explain it.

The data

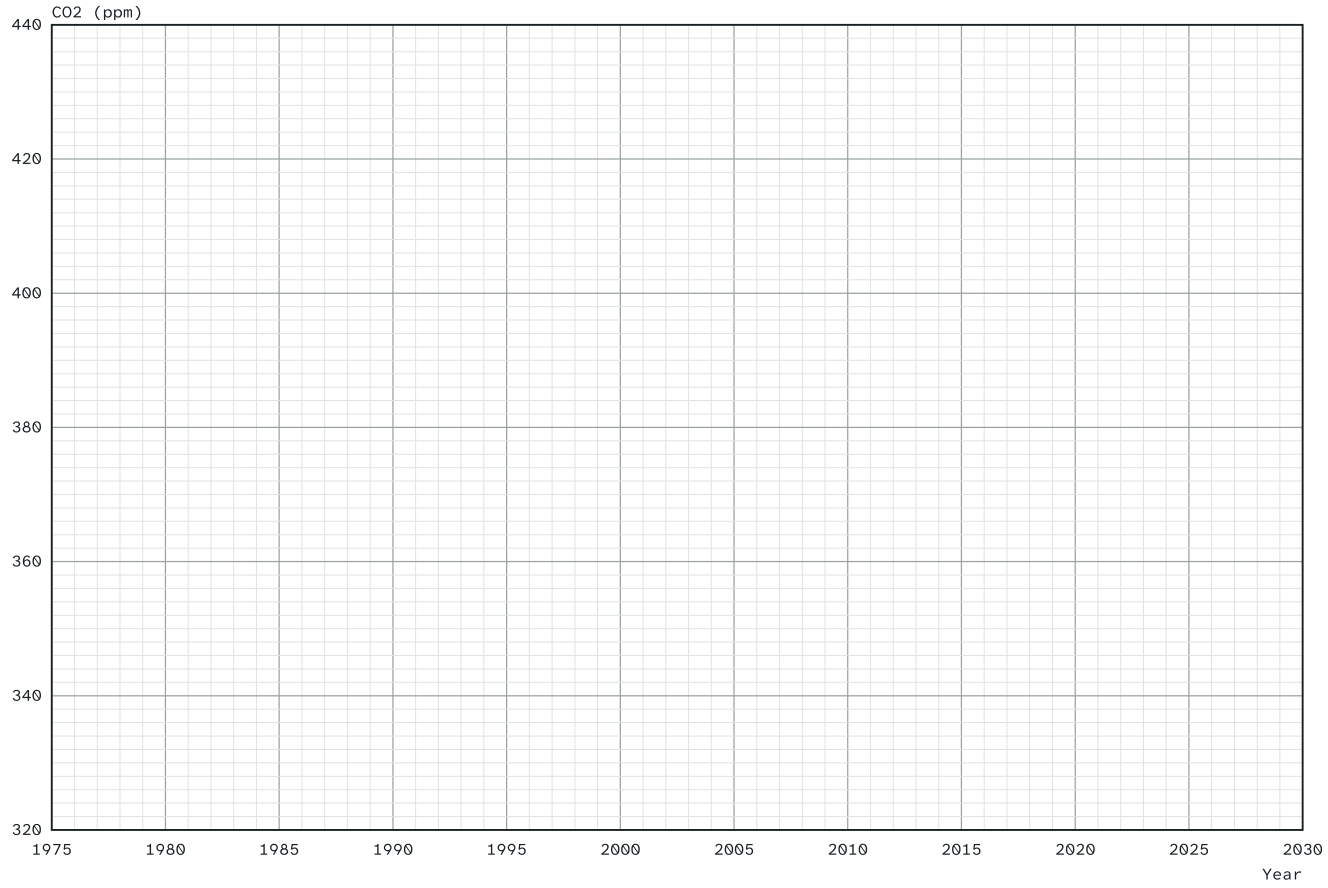
YEAR	CO_2 (PPM)	YEAR	CO_2 (PPM)
1977	331.7	2003	373.0
1979	335.3	2005	376.9
1981	337.6	2007	380.7
1983	340.0	2009	384.4
1985	343.3	2011	388.1
1987	346.1	2013	393.0
1989	349.5	2015	397.5
1991	352.7	2017	402.6
1993	355.0	2019	407.5
1995	358.5	2021	412.0
1997	361.4	2023	416.4
1999	365.8	2025	422.9
2001	368.5		

Yearly averages of monthly baseline measurements, CSIRO and the Bureau of Meteorology, Kennaook / Cape Grim Baseline Air Pollution Station. ppm is parts per million.

What to do

1. **Plot** each year as a small cross on the grid below. The grid has a line for every year and every 2 ppm.
2. **Join** the crosses with a smooth line.
3. **Measure the rate.** Draw a straight line from 1977 to 1987 and another from 2015 to 2025. Work out the rise in ppm per year for each (rise divided by 10).
4. **Extend** your recent line to the edge of the grid and read off when it crosses 450 ppm.
5. **Explain** on the next page, using your model of the carbon cycle.

Carbon dioxide in baseline air at Kennaook / Cape Grim



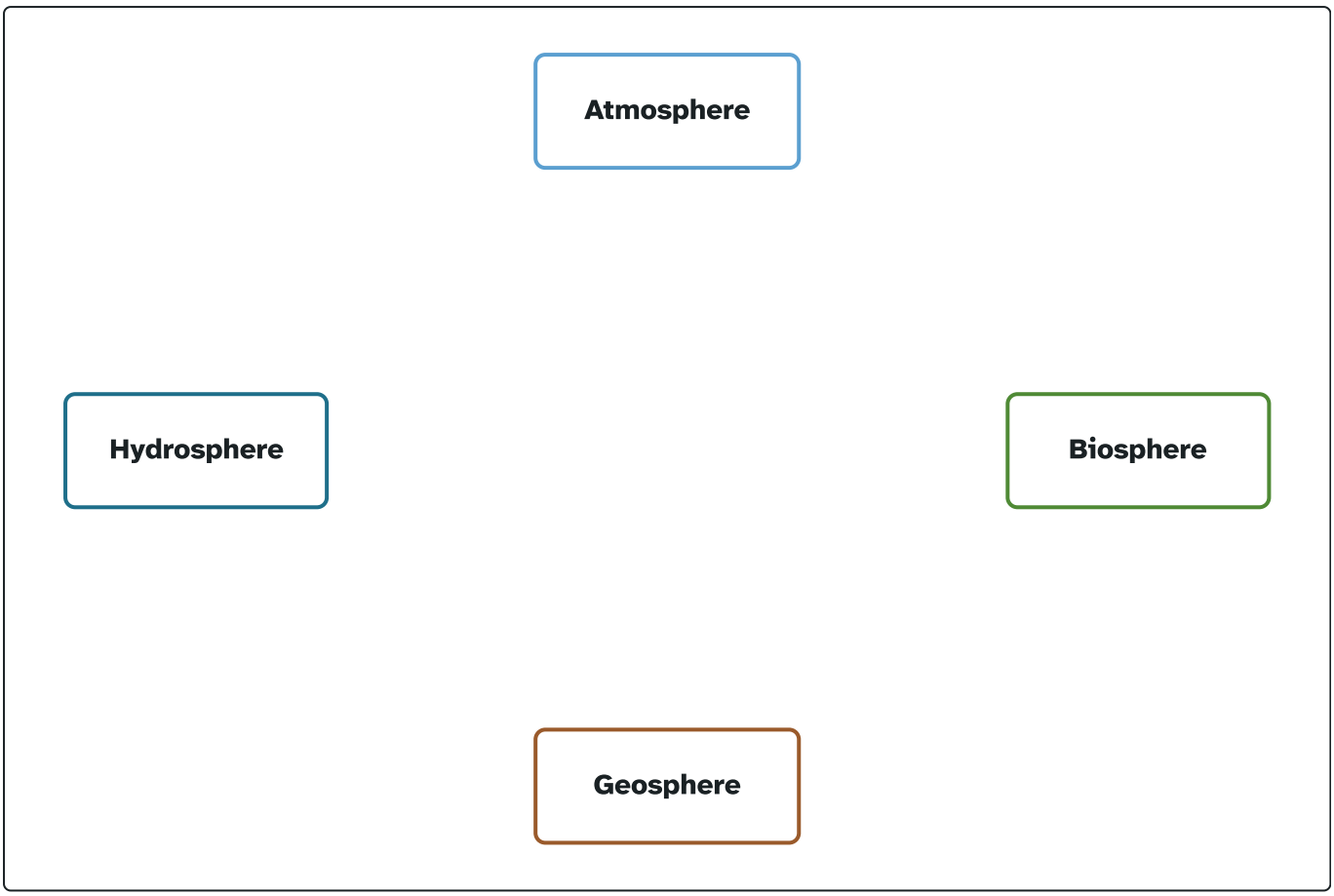
Questions

1. Describe the shape of your line in one sentence.

2. Rate of rise, 1977 to 1987: _____ ppm per year. Rate of rise, 2015 to 2025: _____ ppm per year. How many times faster is the recent rate?

3. If the recent rate continues, in what year will the air reach 450 ppm? Show your working.

4. Draw your revised model of the carbon cycle. Draw an arrow for each process between the spheres, label it, and make the arrows that carry the most carbon the thickest.



Processes to include: photosynthesis, respiration, decomposition, burning fossil fuels, bushfires and land clearing, the ocean taking in and giving off carbon dioxide, weathering, shells and limestone forming, burial, volcanoes.

5. Use your model to explain the rise you plotted. Name what adds carbon to the air, what takes it out, and why the air still rises.

Notes and answers.

Purpose

Students represent and interpret the Cape Grim record by hand (AC9S9U03 and the inquiry skills on data representation and analysis), then connect it to their model of the carbon cycle. It goes with screens 2, 7 and 9 of the online lesson but stands on its own.

Running it

- Twenty-five points take about 15 minutes to plot. Pairs can split the table and share one grid.
- A ruler matters for step 3. The rates are read from the straight lines, not from the data table, so small differences between students are expected.
- The grid runs to 2030 so students can extend the recent trend. Reading beyond the grid is a reasonable extension task.

Answers

- (1) A steady rise that gets steeper, with no years of decrease.
- (2) 1977 to 1987: 1.4 ppm per year (331.7 to 346.1). 2015 to 2025: 2.5 ppm per year (397.5 to 422.9). The recent rate is close to twice as fast.
- (3) 450 minus 422.9 is 27.1 ppm. At 2.5 ppm per year that takes about 11 years: around 2036. Accept 2034 to 2038 depending on the line drawn.
- (4) Look for photosynthesis from the atmosphere to the biosphere; respiration, decomposition and fire from the biosphere to the atmosphere; burning fossil fuels and volcanoes from the geosphere to the atmosphere; ocean exchange both ways between the atmosphere and the hydrosphere; weathering into the hydrosphere; shells and limestone from the hydrosphere to the geosphere; burial from the biosphere to the geosphere. The thickest arrows are photosynthesis, respiration plus decomposition, and the two ocean arrows.
- (5) Burning fossil fuels adds about 10 billion tonnes of carbon a year, land clearing about 1. The ocean and plants take up roughly half of that. The rest stays in the air, so the amount in the air rises every year.

Extension

- Plot the 1976 to 1990 monthly values from the lesson’s table and look for the yearly wiggle.
- Compare the recent rate with the rate the Global Carbon Budget reports for atmospheric growth (about 2.5 ppm a year over 2014 to 2023).