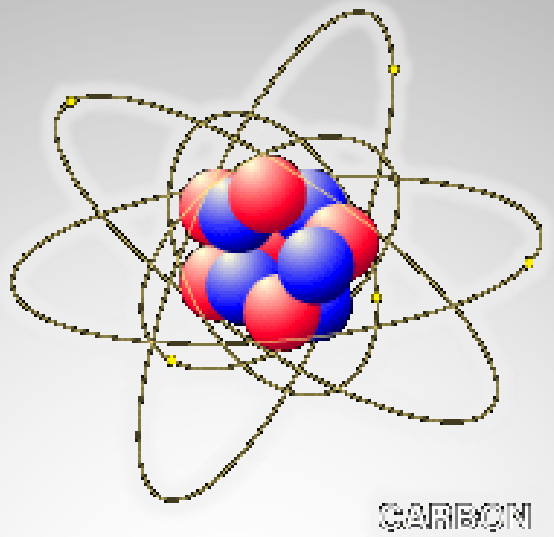

The Carbon Cycle & Soils

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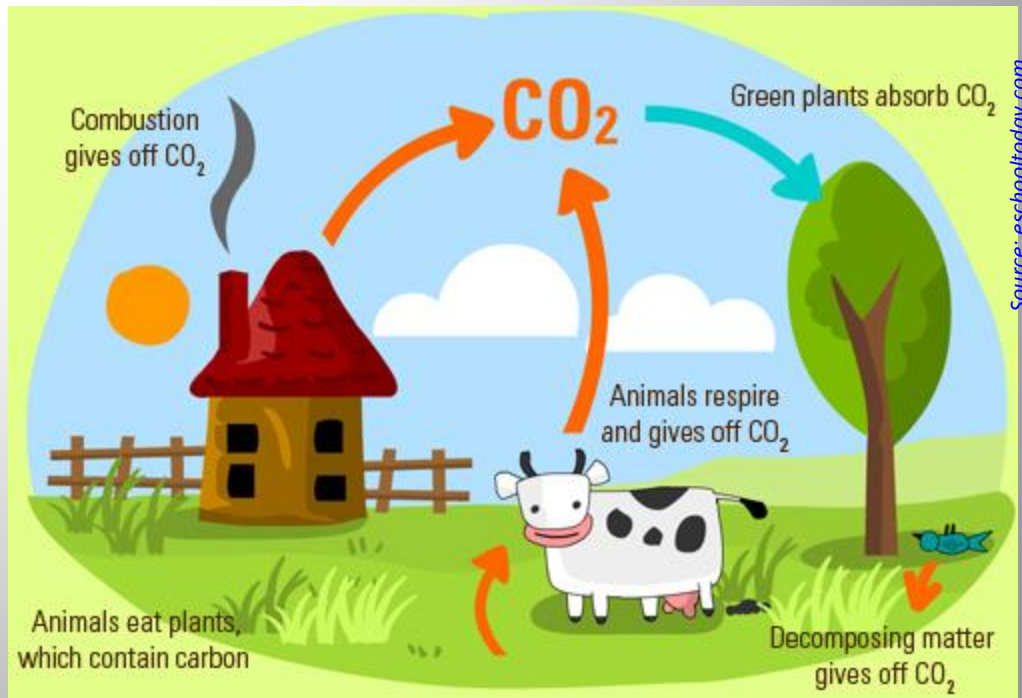
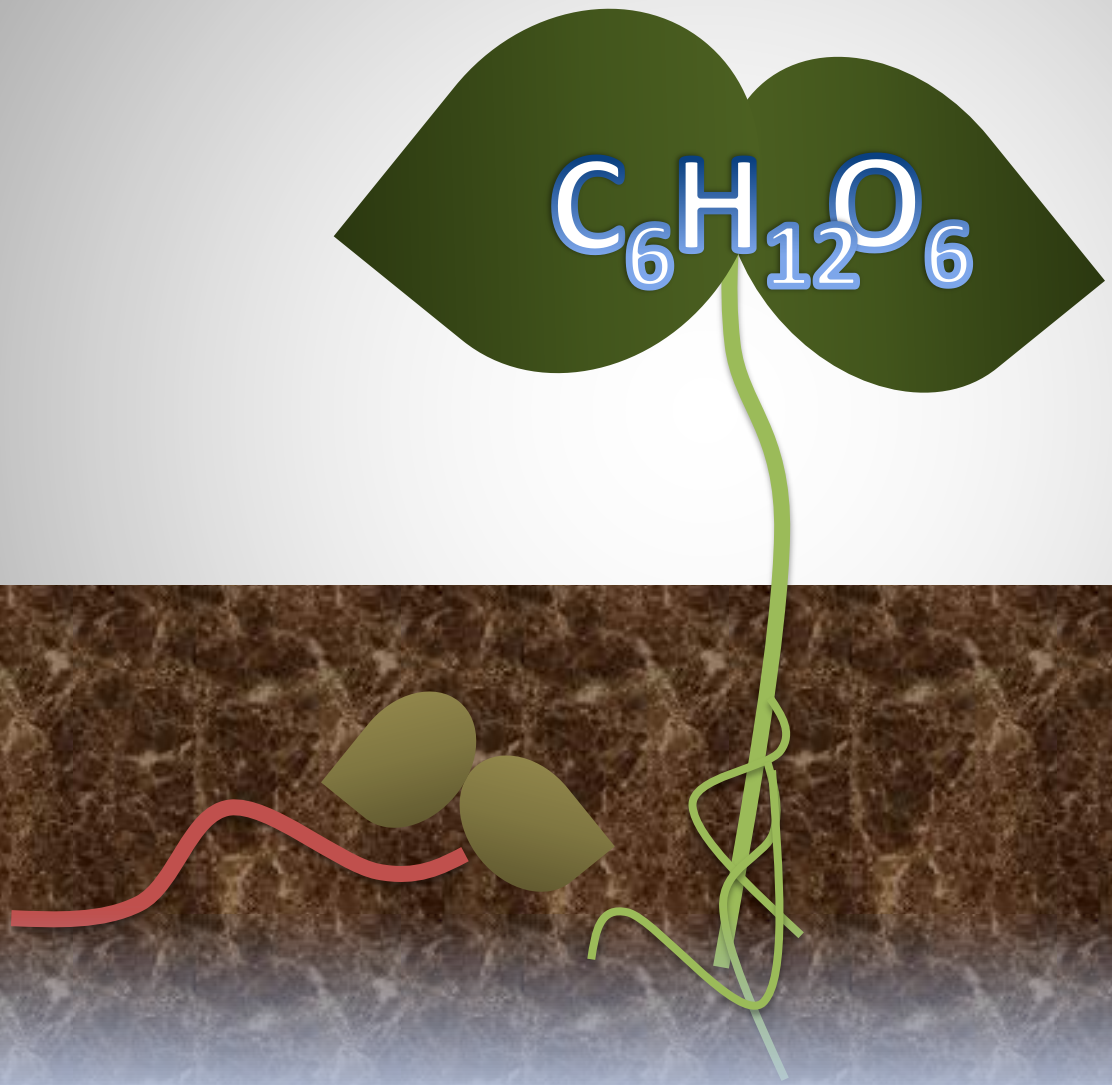
Terms

- **The "carbon cycle" is the term for the process in which carbon transitions between organic and inorganic forms.**
- **For example, plants absorb inorganic CO_2 from the atmosphere and convert into an organic carbon molecule (sugars and carbohydrates).**
- **When plants are consumed or decomposed, the plant matter is converted back into CO_2**

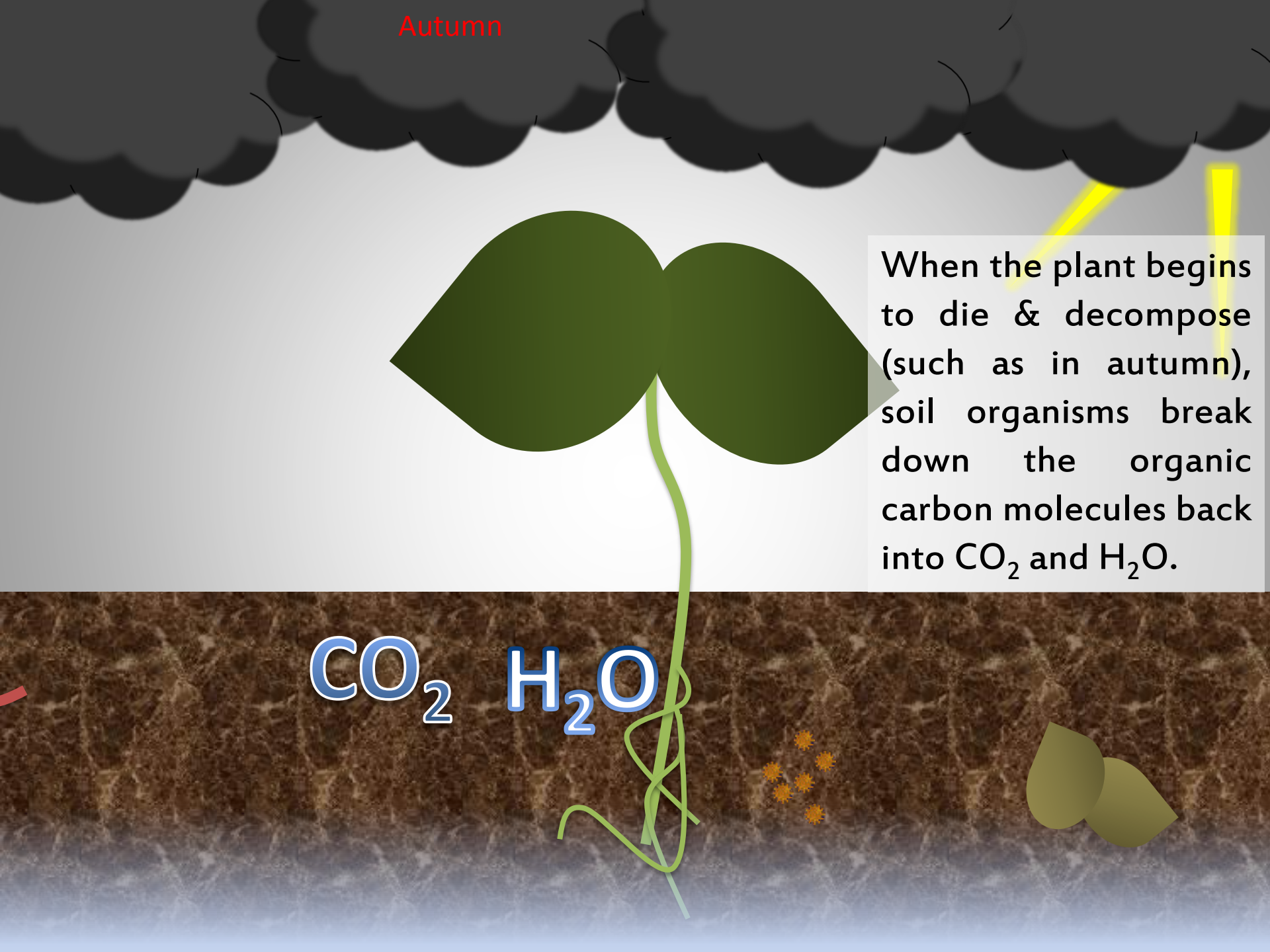


Source: eschooltoday.com

During photosynthesis, plants assemble organic versions of carbon molecules (including simple sugars, starch, and cellulose) using carbon dioxide (CO_2) and water (H_2O).



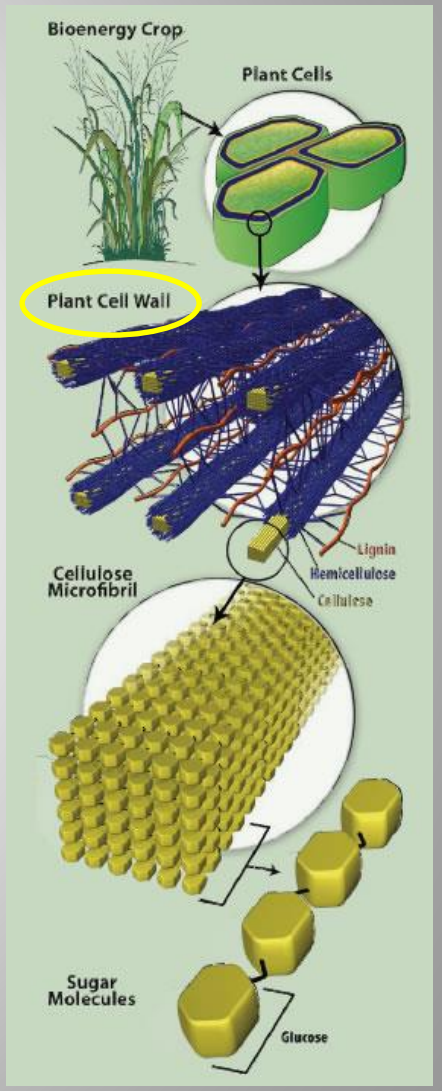
This process of assembling organic molecules of carbon is powered by the sun.


Autumn
When the plant begins to die & decompose (such as in autumn), soil organisms break down the organic carbon molecules back into CO_2 and H_2O.
CO_2 H_2O

What is NOT part of the carbon cycle?

- **In the carbon cycle, the carbon atoms stay carbon – carbon is neither created nor destroyed.**
  - Carbon can only change what it is bonded to. Carbon is always carbon.

- **In the atmosphere, we typically find carbon molecules as carbon dioxide - this is the <u>inorganic version</u> of carbon (it is not part of something alive).**

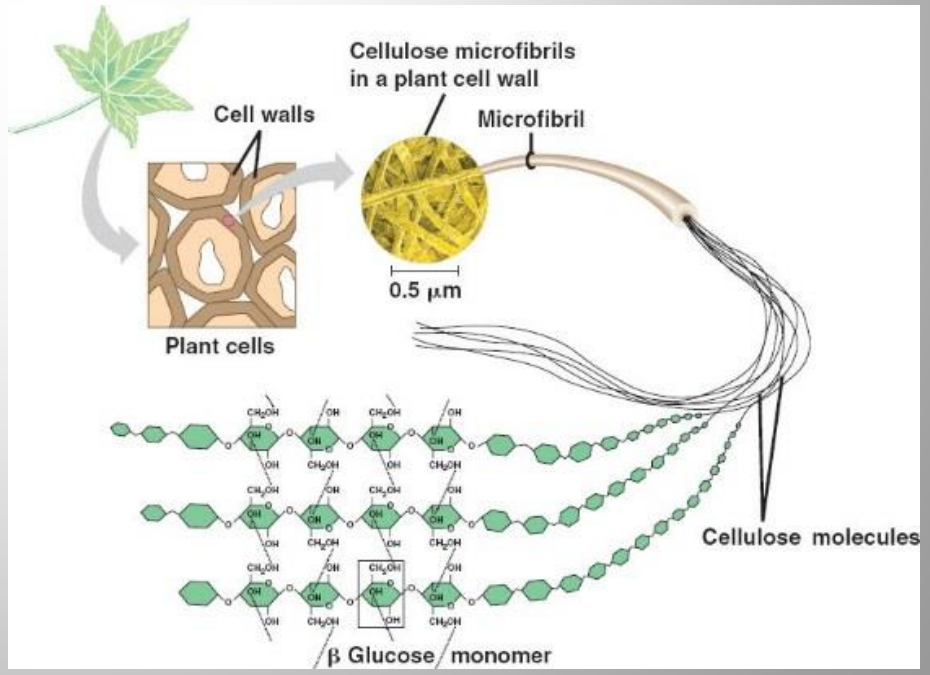


lbl.gov

Organic Forms of Carbon

- **<u>Organic versions</u> of carbon molecules include sugars, cellulose (mostly found in plant cell walls), and living tissue (like your own cells).**
  - We can't use the carbon dioxide from the air – we depend on plants to convert carbon molecules into forms that we can use in our own bodies.

- **While we can increase or decrease the *forms* of carbon molecules, we cannot change the total *amount* of carbon atoms that exist.**
  - As much carbon as we have now is what we will always have.
  - However, this carbon can change forms between inorganic CO_2 and organic forms of carbon like sugar.



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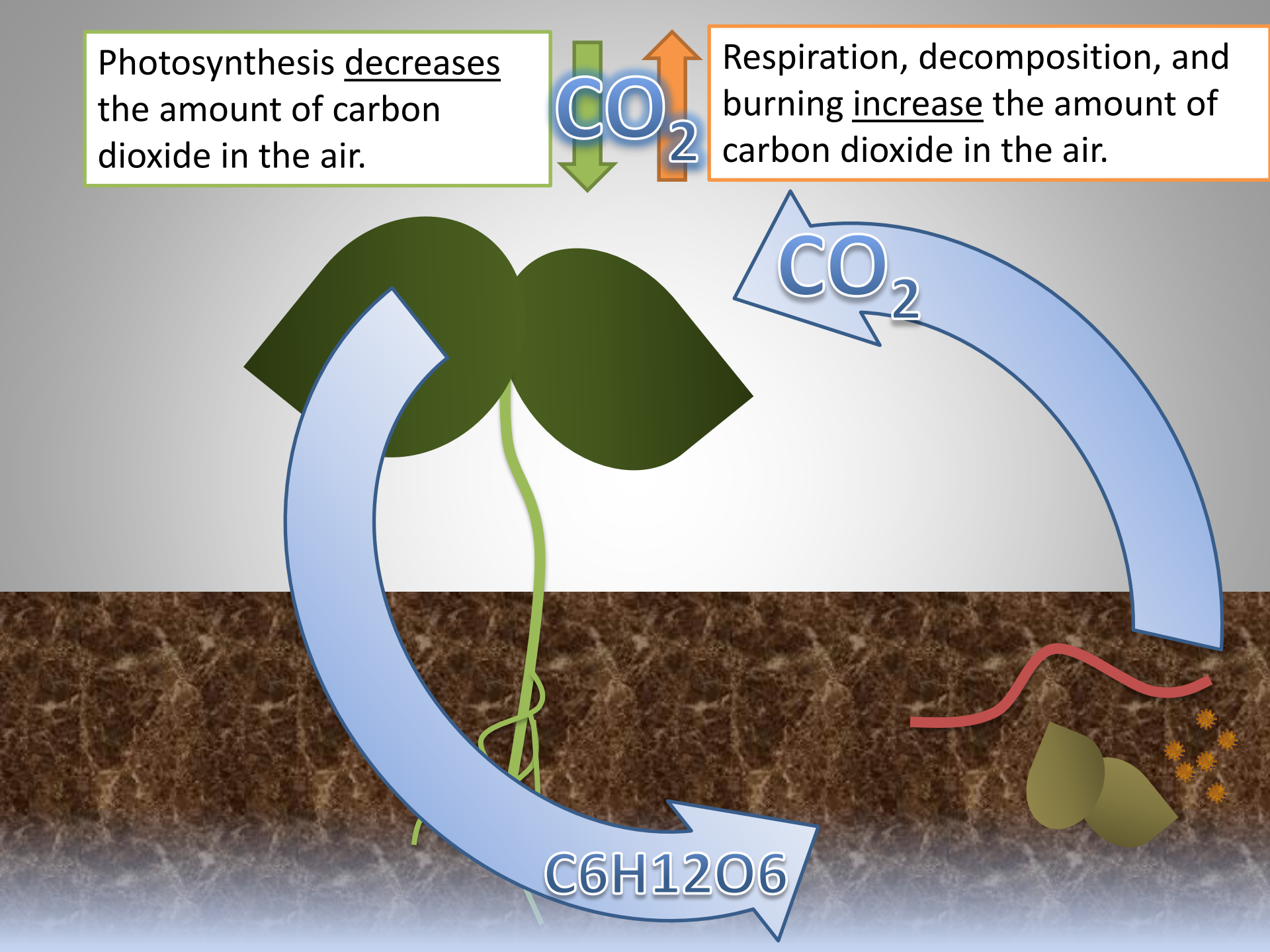
Source: bio1151.nicerweb.com

Forms of Carbon

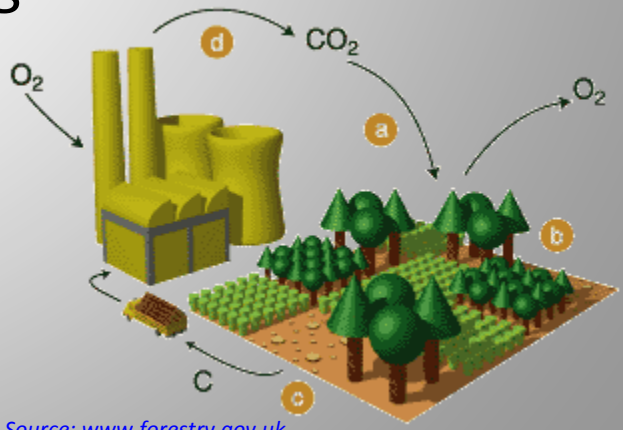
- **Carbon is always carbon**
  - A carbon atom will always stay a carbon atom – it will not turn into other kinds of atoms.
  - However, how carbon atoms behave can change depending on the other atoms it is with.

- **In a way, carbon is like you**
  - You are always you; you will never become someone else.
  - However, how you behave depends on who you are with (e.g. friends vs. family)
  - Similarly, the atoms that carbon is with may change, but the carbon itself will always be carbon.


Photosynthesis decreases the amount of carbon dioxide in the air.
CO_2
Respiration, decomposition, and burning increase the amount of carbon dioxide in the air.
CO_2
$C_6H_{12}O_6$

The Carbon Cycle & Agriculture

- **The carbon cycle is critical to agriculture.**
  - The carbon cycle is the way that plants (including crops) create the food we eat.
  - In order to make crops more productive, an agricultural scientist has to create plants with a greater ability to turn inorganic carbon molecules into organic sugars and other plant molecules.
  - Only though a strong understanding of the carbon cycle can we enable plants to produce more food for more people.

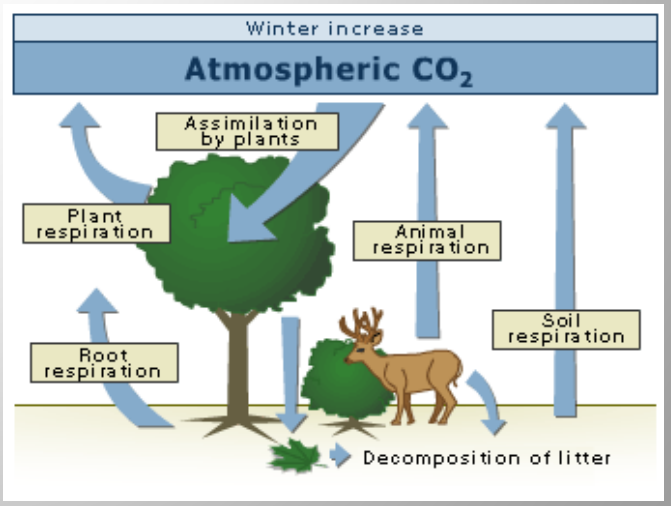


Source: www.forestry.gov.uk

Carbon in Balance

- **Normally, the carbon cycle keeps itself balanced.**
  - Inorganic carbon molecules are used by plants to create sugars (and other plant molecules such as cellulose).
  - Organic forms of carbon molecules convert back into CO_2 when they are consumed or decomposed

- **Today, however, the carbon cycle is not balanced. The levels of atmospheric carbon have risen to the highest levels in recent geological history.**
  - They are also rising at an unprecedented rate.



ecosys.cfl.scf.rncan.gc.ca

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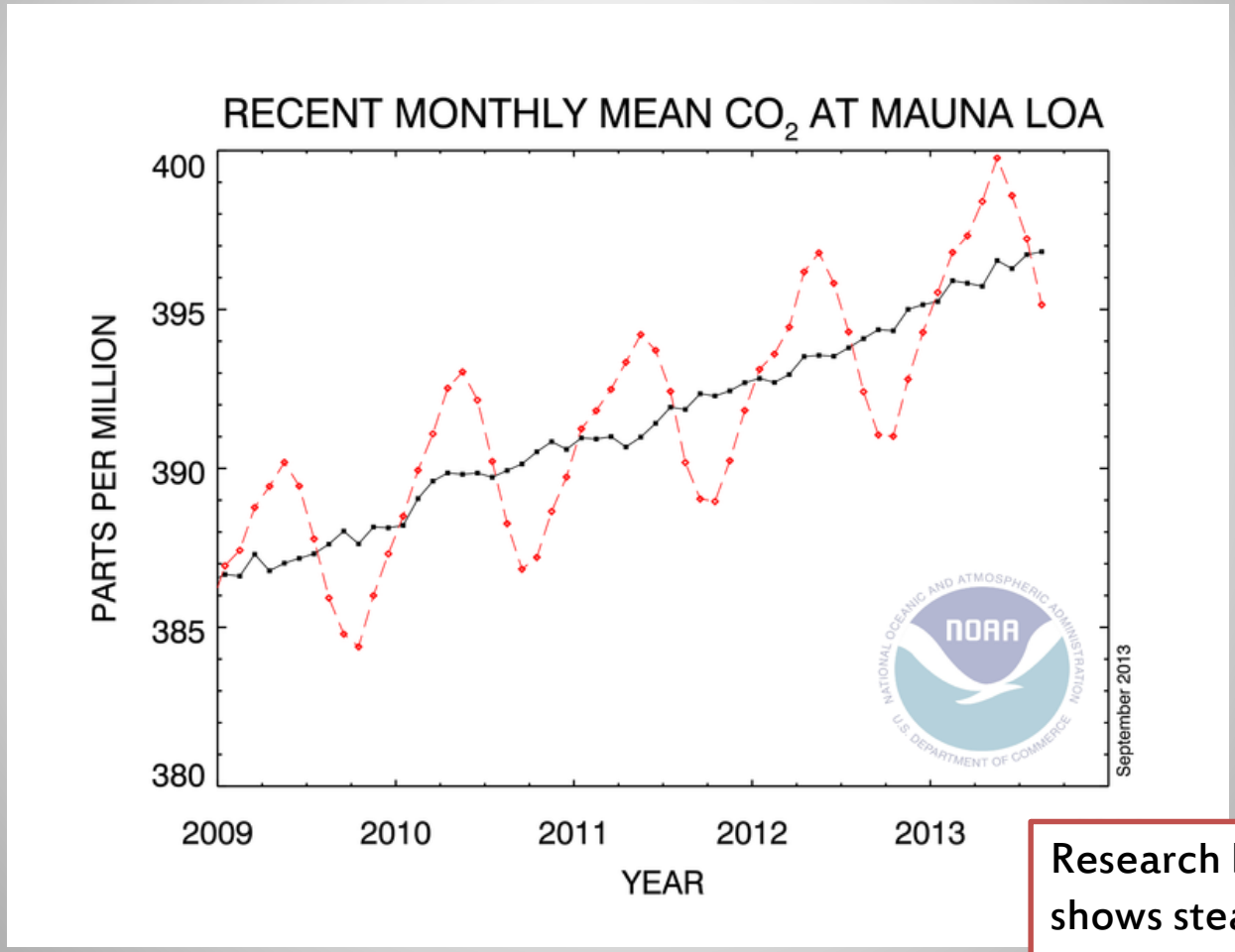
Source: NOAA



Research by the US Gov't shows steady and predictable increases in CO_2 each year.

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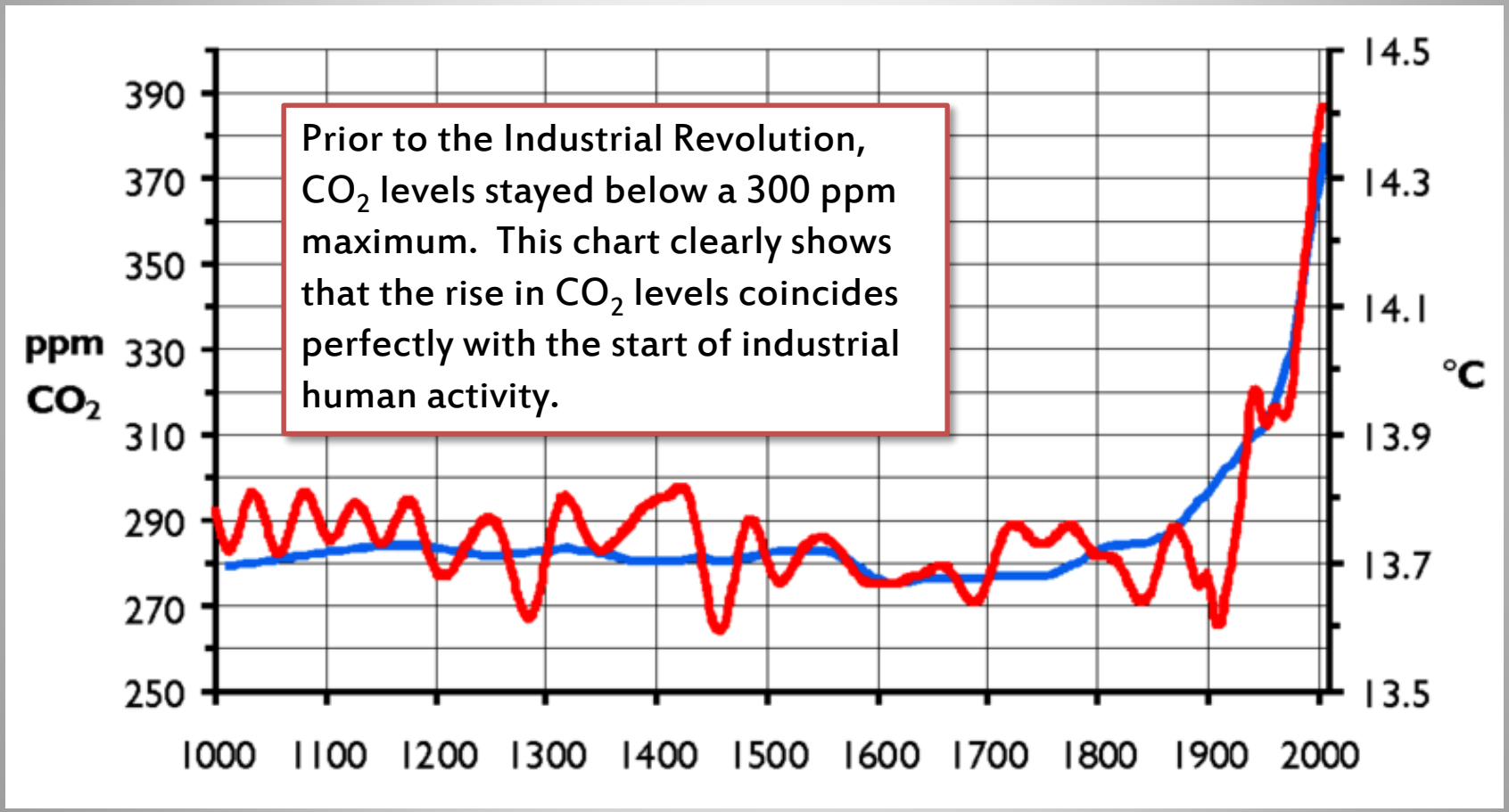
http://www.esrl.noaa.gov/gmd/ccgg/trends/

Source: Univ. of Michigan (blue is CO2, red is temp)



http://www.esrl.noaa.gov/gmd/ccgg/trends/

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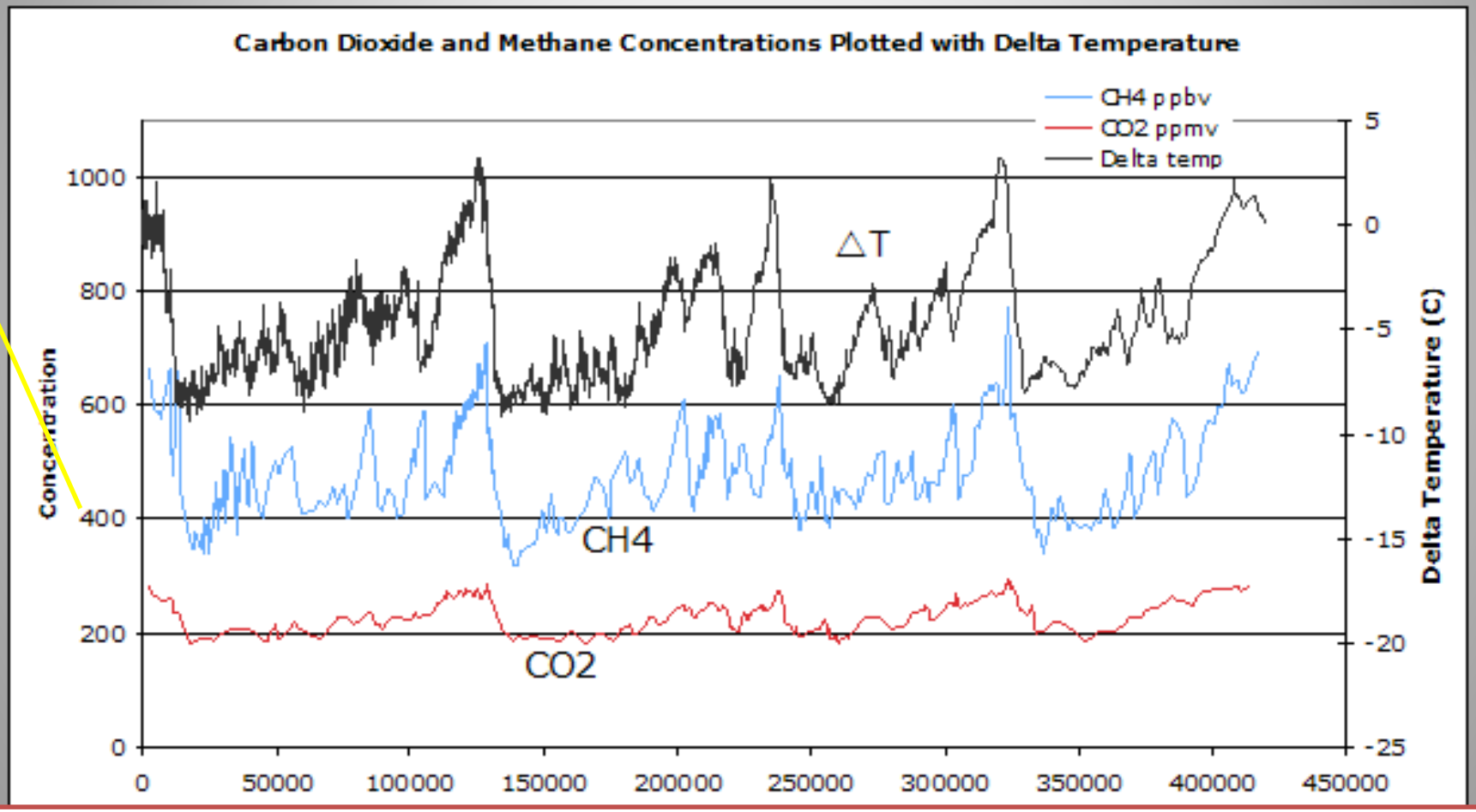
Historic Climate Data

400ppm – reached 2013



If we go back hundreds of thousands of years, we can see that CO_2 levels were consistently below 300 ppm. Today's CO_2 levels (yellow line) are higher than any other point in recent climate history.

Why is this a problem?

- **Having too much CO_2 in the atmosphere is a problem.**
  - CO_2 can absorb and hold onto heat radiation.
  - CO_2 is sort of like a winter coat – the thicker the coat, the more heat your body will retain.

- **CO_2 in the atmosphere can be a good thing – it is what enables our planet to have relatively consistent temperatures.**
  - However, just like wearing a fur coat in summer would be a bad thing, having CO_2 as high as it is causes widespread problems.
  - Because the atmosphere has more heat energy, problems like stronger storms, longer droughts, and more frequent flooding are expected to become more common.

- **The changes to the planet caused by an increase in greenhouse gases like CO_2 are known as <u>Climate Change</u>.**
  - Climate change could have devastating effects on many aspects of modern life, including how we grow our food.

Source: edition.cnn.com

Reducing CO_2

- **4 Ways in which CO_2 could be reduced –**
  - Increased **photosynthesis**
    - *The more CO_2 that is absorbed by plants, the less that is in the atmosphere.*
  - Reduced usage of **fossil fuels**
    - *Burning a fossil fuel releases large amounts of carbon dioxide into the air*
    - *Coal and oil are really just dense forms of carbon; when burned, they become CO_2*
  - Reduced production of CO_2 in **agriculture**
    - *E.g. no-till agriculture keeps organic matter in the soil and reduces CO_2 production by the soil*
  - **Carbon sequestration** (or "carbon traps") – storing carbon underground or underwater

Review

- **The "carbon cycle" is the term for the process in which carbon transitions between organic and inorganic forms (for example, from CO_2 to sugar)**

- **During photosynthesis, plants use carbon dioxide (CO2) and water (H2O) to make organic versions of carbon (from simple sugars to sturdy cell walls)**

- **When the plant begins to die or decompose (such as in autumn), soil organisms break down the organic carbon molecules back into CO2 and H2O.**

Review

- **Photosynthesis <u>decreases</u> CO_2 in the atmosphere by converting it into sugar and other organic carbon molecules**
- **Respiration, decomposition, and burning <u>increase</u> CO_2 levels in the atmosphere by converting organic carbon back into CO_2**
- **In the carbon cycle, carbon is not created or destroyed. It only changes forms.**
- **The soil acts as a carbon cycle regulator, helping to move carbon from one form to another.**

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Review (cont)

- **Normally the carbon cycle balances itself.**
- **Today CO_2 levels in the atmosphere are at highs never before seen in recent geological history.**
- **The cause for this is almost certainly human activity.**
- **Scientists today are trying to determine ways in which we can reduce the amount of carbon dioxide in the atmosphere to "re-balance" the carbon cycle.**