GHG Lesson Materials

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Hurley Climate Smart Task Force

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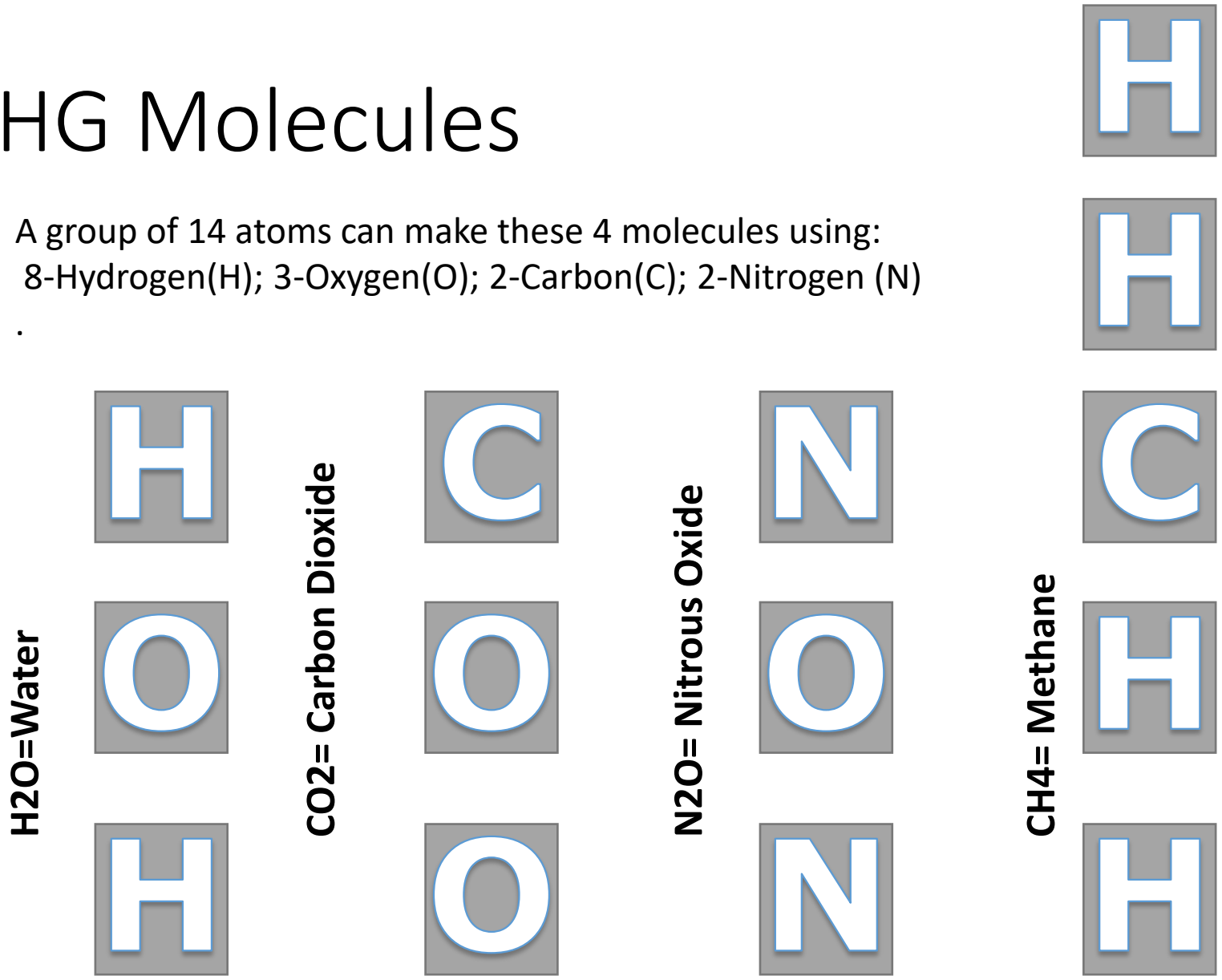
GHG Molecules

A group of 14 atoms can make these 4 molecules using:
8-Hydrogen(H); 3-Oxygen(O); 2-Carbon(C); 2-Nitrogen (N)
.

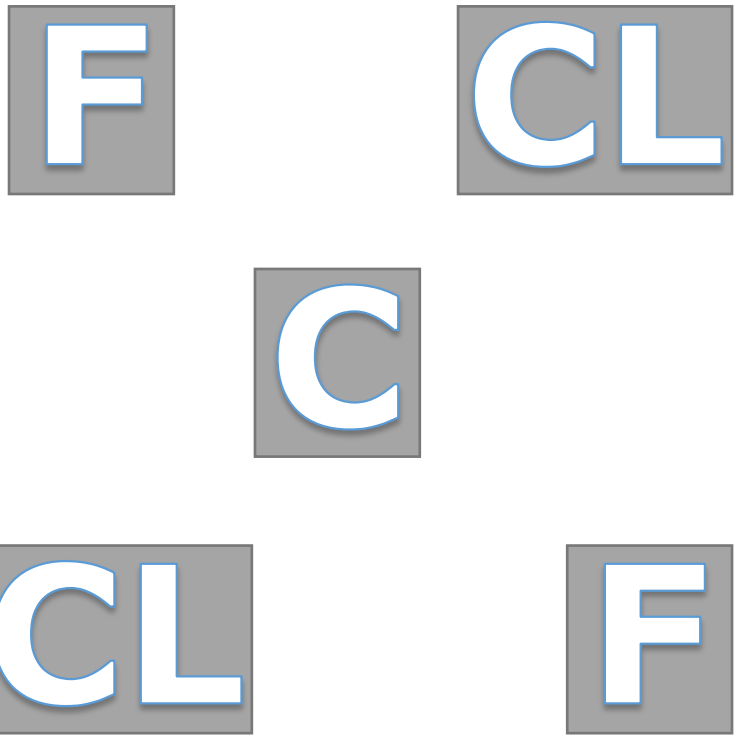


GHG Molecules

If you add 3 more Oxygen atoms, you can create an Ozone molecule. For a CFC molecule, combine another 5 atoms. With 22 atoms build all 6 GHG gases

O3=Ozone

CF2Cl2=Dichlorodifluoromethane



The Greenhouse Effect Word Search

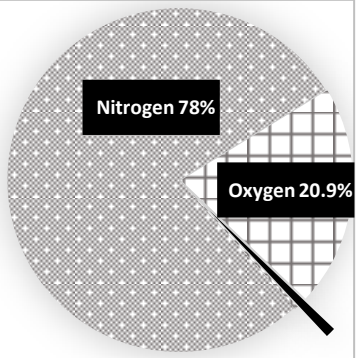
R	D	T	Q	E	D	V	N	N	X	T	F	F	C	E
E	E	T	Y	R	P	R	I	E	O	F	L	H	Y	N
H	P	W	S	E	R	R	O	R	G	O	N	D	I	A
T	K	S	Y	H	H	O	N	U	O	Y	R	M	Y	C
A	L	O	X	P	G	A	P	D	G	A	X	S	E	I
E	H	L	I	S	D	P	B	A	Z	H	N	O	V	R
W	X	A	F	O	D	T	S	Z	V	E	T	L	A	R
C	S	R	X	M	F	C	I	N	G	R	E	N	P	U
O	J	X	C	T	O	L	B	O	O	H	E	S	O	H
C	W	V	X	A	B	H	R	W	E	W	A	T	R	V
C	A	R	B	O	N	D	I	O	X	I	D	E	A	P
G	O	F	F	J	Y	M	E	T	H	A	N	E	T	W
R	H	X	B	H	U	Y	F	E	Y	G	N	R	I	K
E	D	I	X	O	S	U	O	R	T	I	N	K	O	W
T	H	U	N	D	E	R	S	T	O	R	M	B	N	W

Name _____

Word List

Atmosphere
Blizzard
Carbon Dioxide
Drought
Evaporation
Flood
Fog
Hurricane
Hydrogen
Methane
Nitrous Oxide
Oxygen
Thunderstorm
Snow
Solar
Tornado
Water Vapor
Weather

Earth's Atmosphere

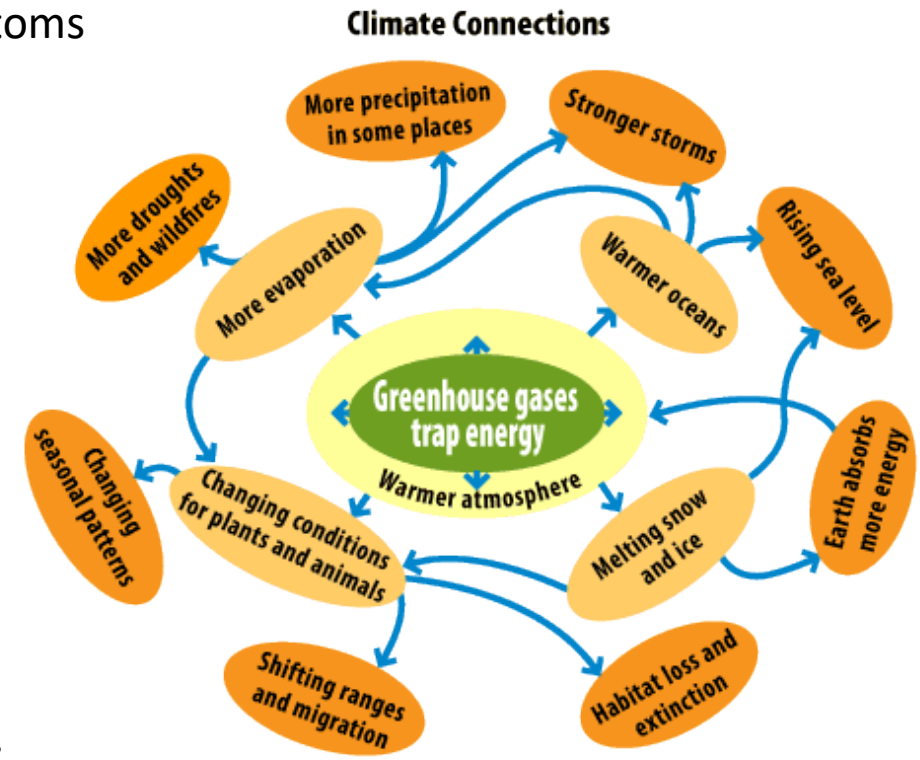


*Water vapor varies a lot by location, from 0-5% and is added to the 'dry' air total. On average, water vapor is .25% of the atmosphere by mass.

Created by Lynne Bailey, Hurley Climate Smart Task Force August, 2022

My GHG is _____

- This gas molecule is made from these atoms (include how many of each):
  __ Hydrogen ___ Oxygen
  __ Carbon ___ Nitrogen
- Greenhouse gases help keep the Earth _____ .
- The man difference between weather and climate is _____ .
- My gas _____
  _____
  _____
  _____.



✦ What is weather? ✦ How is weather different from climate? ✦ How is water connected to weather? ✦ What's the water cycle? ✦ What is the atmosphere? ✦ How is Earth's atmosphere different from Venus and Mars? ✦ What is in the Earth's atmosphere? ✦ What's the greenhouse gas effect on our planet? ✦ What are the most common greenhouse gases? ✦ What happens to water when the air and ocean temperature rises? ✦ How might that affect the weather, or the climate? ✦ What human activities release the most greenhouse gases into the atmosphere? ✦ What are some other effects of rising temperatures? ✦ What can we do to help slow or stop rising temperatures?

Explore Space & Earth at https://spaceplace.nasa.gov/

Vocabulary

- Atmosphere: The protective layer of gases surrounding the Earth; the air.
- Gas: The state of matter able to expand freely to fill a whole container, having no fixed shape (unlike a solid) and no fixed volume (unlike a liquid).
- Ultraviolet: The light (or energy) from the Sun that causes sunburn.
- Matter: Any type of material that has mass and takes up space (solid, liquid, or gas form).
- Atom: The basic building blocks of matter; microscopic particles.
- Molecule: One or more atoms bonded together.
- Water Vapor: Water in gas form.
- Air: A mixture of gases in the atmosphere.
- Weather: The state of the atmosphere with respect to wind, temperature, cloudiness, moisture, and pressure. Most weather occurs in the troposphere, the lowest layer of the atmosphere.
- Climate: Average weather patterns for a large area of the Earth.
- Greenhouse Gas: Natural gases in the atmosphere that trap the Sun's heat.
- Greenhouse Effect: A natural phenomenon occurring in the Earth's atmosphere where the Sun's heat is trapped.
- **Water Cycle**: The natural process through which water moves throughout the Earth's surface, oceans, and atmosphere.
    - **Evaporation**: Water changing from liquid to gas, rising from the surface to the atmosphere.
    - **Precipitation**: Water falling to Earth's surface as rain, snow, hail, etc.
    - **Condensation**: Water changing from a gas to liquid. The process forming clouds. Landfall: When a hurricane arrives on land.
- Ozone: A gas molecule contacting three oxygen atoms.
- Ozone Layer: A layer of ozone molecules within the atmosphere absorbing most of the Sun's harmful radiation from reaching the Earth's surface.
- Troposphere: The lowest layer of the atmosphere, where most weather occurs.
- Exosphere: The outermost layer of the atmosphere, where many satellites orbit Earth.

Group Role Suggestions

- Facilitator / Manager / Leader
- Scribe / Note taker/ Secretary / Recorder
- Summary Presenter / Spokesperson
- Critic / Analyst
- Time Keeper
- Researcher / Library resource collector / Organizer

- Possible Specialists
  - Calculator / Arithmetician
  - Artist / Colorist
  - Musician
  - Poet / Writer
  - Assisant to another group member
  - Builder / Modeler / Assembler
  - Crafter / Sewing / Cutting / Folding / Assembling

CH_4

Fill in the blanks:

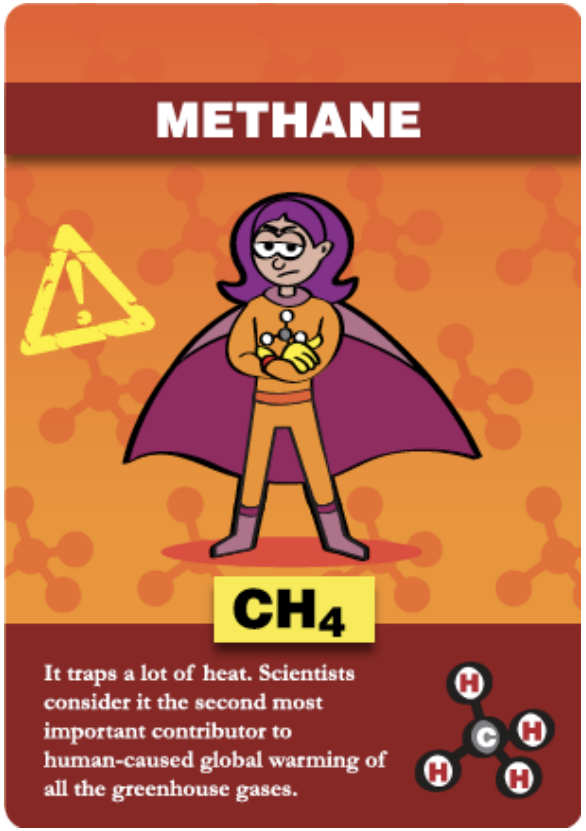
Twp activities that release methane are:

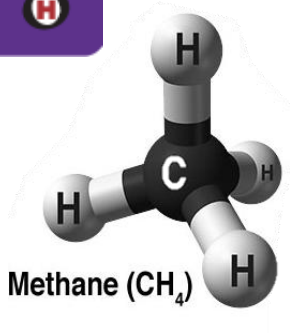
_____

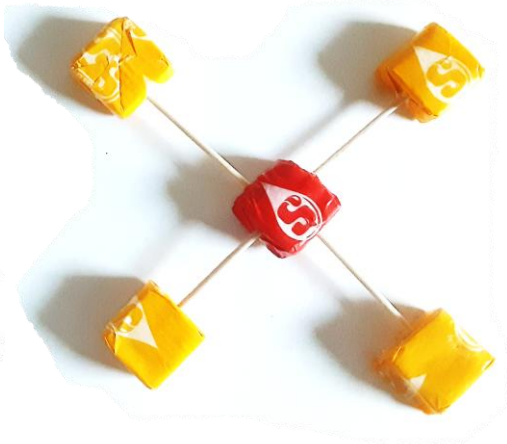
and

_____.

A lot of methane is frozen in the tundra where it does no harm as permafrost. But, as air temperatures rise, this soil will soften and release more methane into the air.







Matter Facts

- **Matter** is any type of material (on or off Earth) that has mass and takes up space – including you.
- According to the law of **conservation of mass**, matter can be neither created nor destroyed – it just changes form. In other words, the mass of an object never changes, no matter how the parts are rearranged.
- We cannot see most of the atmosphere because it is made from billions of microscopic particles called atoms. **Atoms** are the basic "building blocks" of matter.
- Atoms can stick (bond) together to form larger molecules, such as water. Water, also known as a "liquid," is a "state" or "phase" of matter. Matter comes in three common states – **solid, liquid,** and **gas**.
- The atmosphere is an example of a gas. In fact, the atmosphere is made of many different gases

VOCABULARY

Climate:
The average weather conditions in a particular location or region at a particular time of the year. Climate is usually measured over a period of 30 years or more.

Climate change:
A significant change in the Earth's climate. The Earth is currently getting warmer because people are adding heat-trapping greenhouse gases to the atmosphere. The term "global warming" refers to warmer temperatures, while "climate change" refers to the broader set of changes that go along with warmer temperatures, including changes in weather patterns, the oceans, ice and snow, and ecosystems around the world.

Global warming:
An increase in temperature near the surface of the Earth. Global warming has occurred in the distant past as the result of natural causes. However, the term is most often used to refer to recent and ongoing warming caused by people's activities. Global warming leads to a bigger set of changes referred to as global climate change.

Weather:
The condition of the atmosphere at a particular place and time. Some familiar characteristics of the weather include wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. Weather can change from hour to hour, day to day, and season to season.

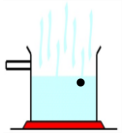
Fill in the names of the H_2O's 3 states of matter below

1)_____
2)_____
3)_____

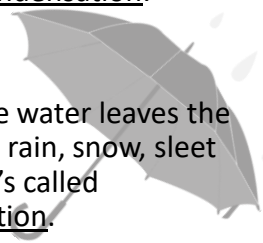
_____

H_2O

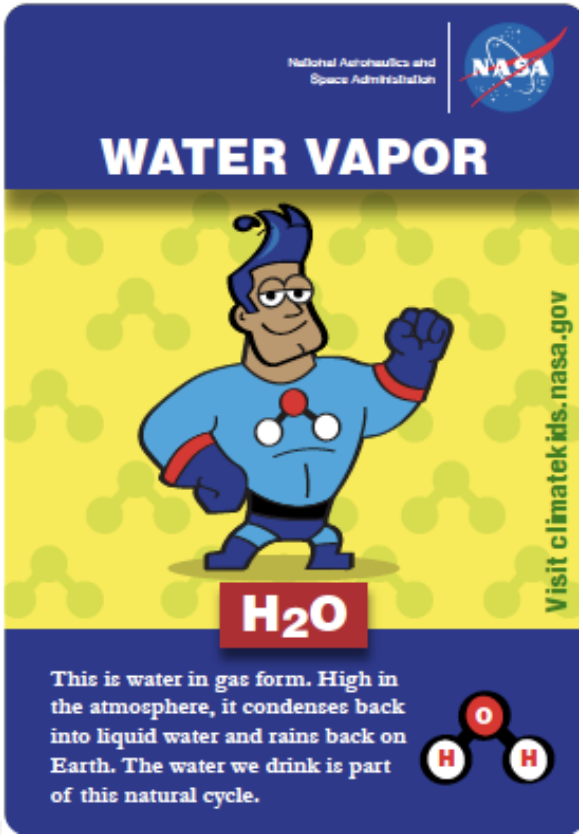
- H_2O, or water, is all around us as ice, rain, oceans, rivers and more. The amount of water on Earth stays the same, but it cycles through different forms, or states of matter.

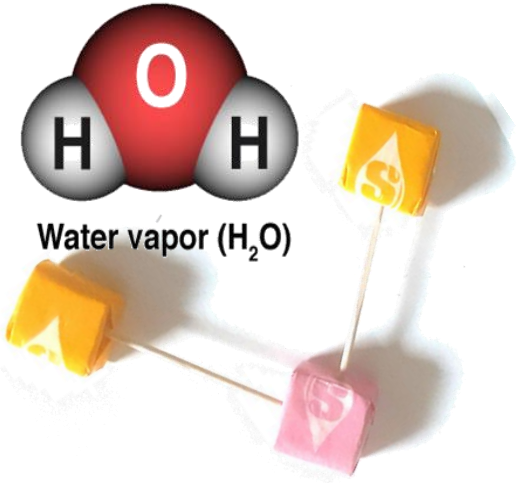


- Energy from the sun causes water to change from liquid to gas in a process called <u>evaporation</u>.
- Warm air holds more water than cool air.
- When the water vapor bumps into dust, pollen, sand and pollutants in the air, it becomes liquid again. That's <u>condensation</u>.

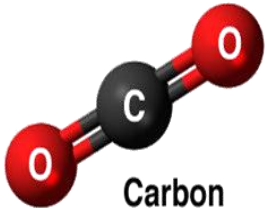


- When the water leaves the clouds as rain, snow, sleet or hail, it's called <u>precipitation</u>.

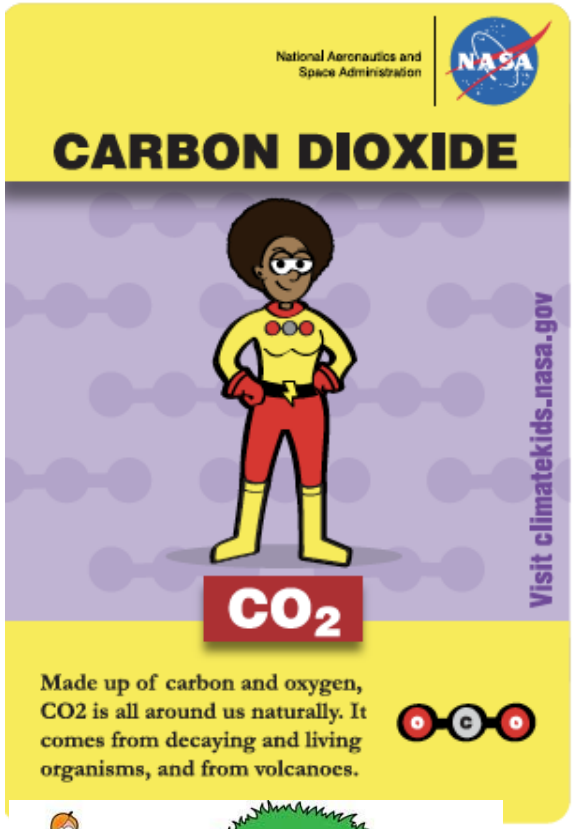




CO_2



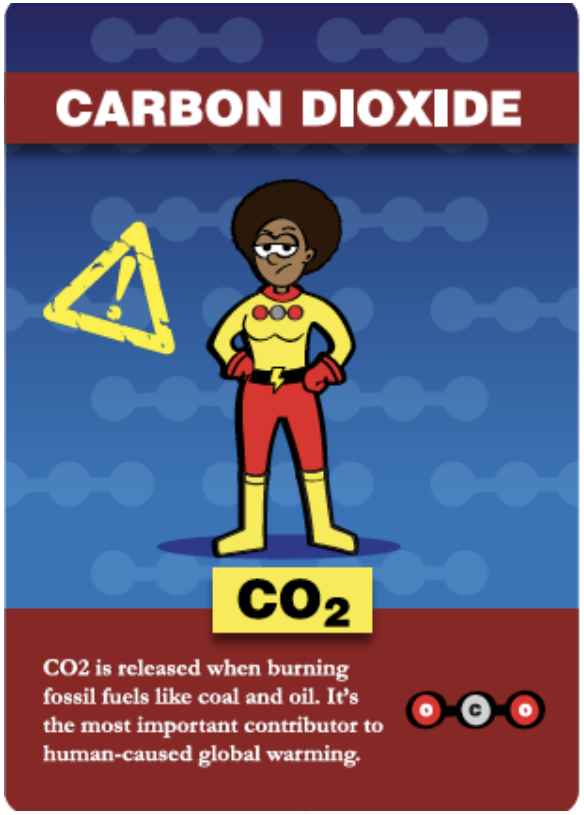
Carbon dioxide (CO_2)

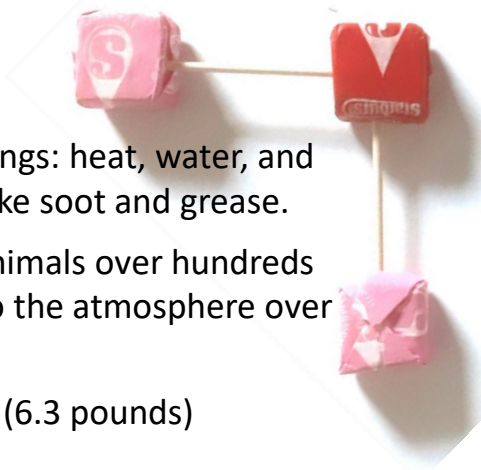


You are 18 percent carbon. Plants are 45 percent carbon.
https://climatekids.nasa.gov/carbon/

Why are they called fossil fuels?
They're called *fossil fuels* because the fuel in your gas tank comes from the chemical remains of prehistoric plants and animals!

All living things on Earth contain carbon. Carbon, an element, combines easily with other elements to form new materials. In fact, a carbon atom combines easily with two oxygen atoms to make the compound carbon dioxide.



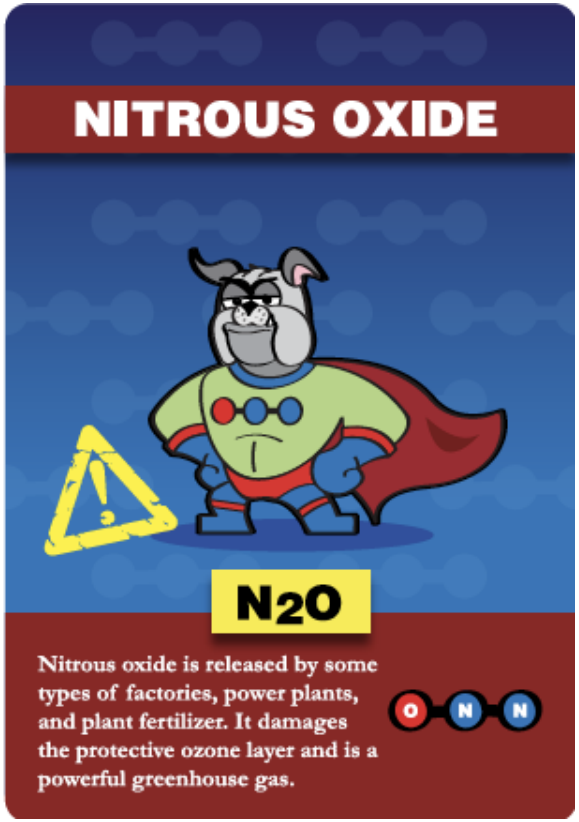


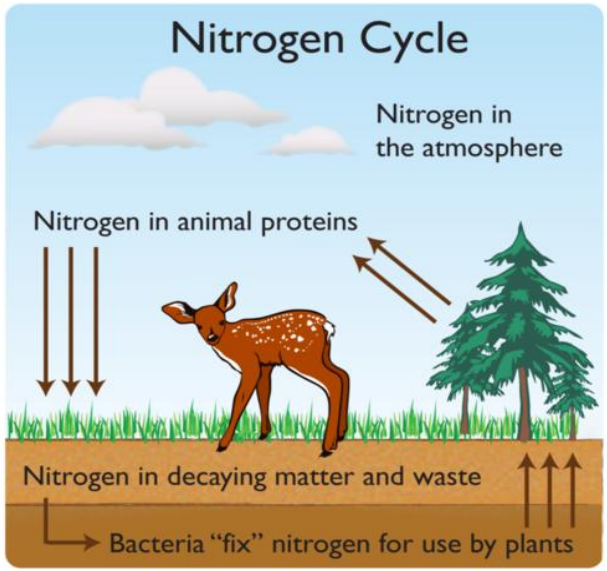
When fossil fuels burn, we mostly get three things: heat, water, and CO_2. We also get some solid forms of carbon, like soot and grease.

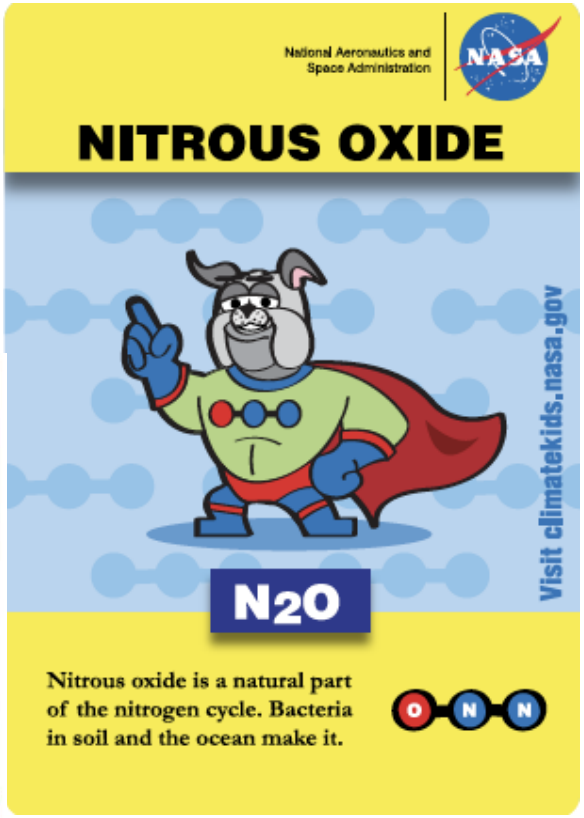
All that carbon stored in all those plants and animals over hundreds of millions of years is getting pumped back into the atmosphere over just one or two hundred years.

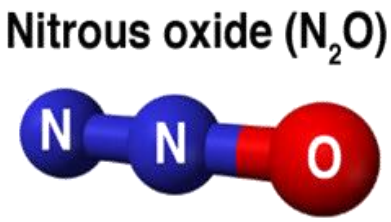
Did you know that burning 1 gallon of gasoline (6.3 pounds) produces 20 pounds of carbon dioxide?

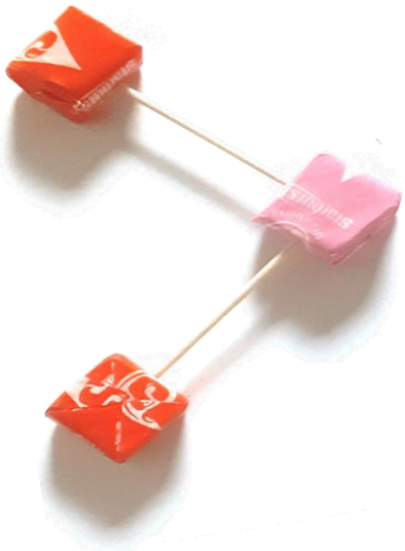
N_2O





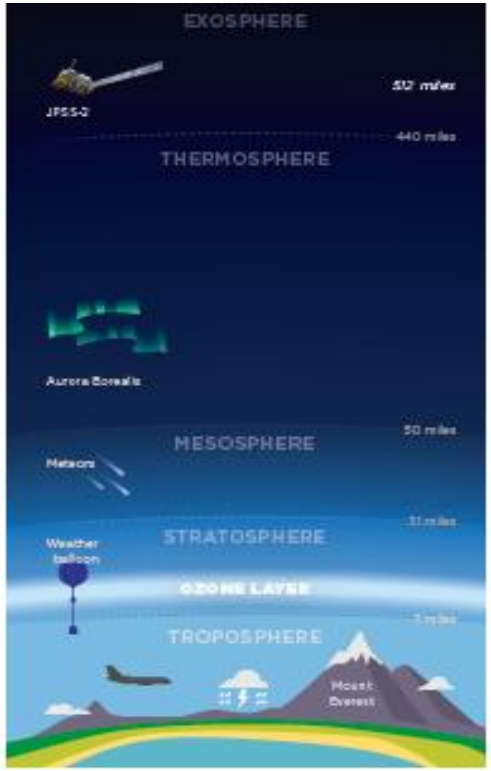


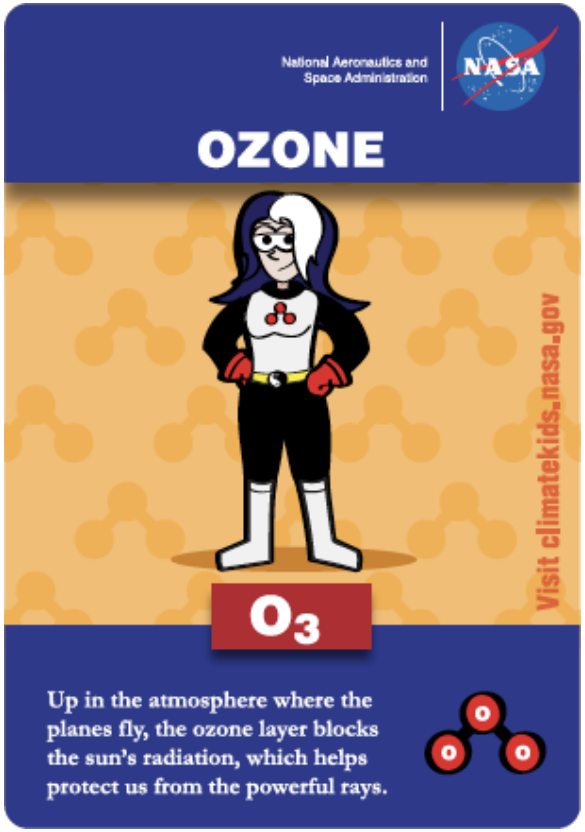




https://www.ck12.org/user:a2vpdghfymfszhdpbkbjy3bzbmv0lm5lda../book/earth-science/section/10.17/
https://www.nesdis.noaa.gov/about/k-12-education/jpss-education/lesson-plan-greenhouse-gases-aerosols

O_3





The picture above shows the different layers of Earth's atmosphere. The lowest level, the troposphere, is where all of Earth's weather activity happens and contains 99% of the atmosphere's water vapor. Just above the troposphere is the ozone layer. The ozone layer is approximately 10-20 miles above the Earth's surface, but this number can vary based on location and season.

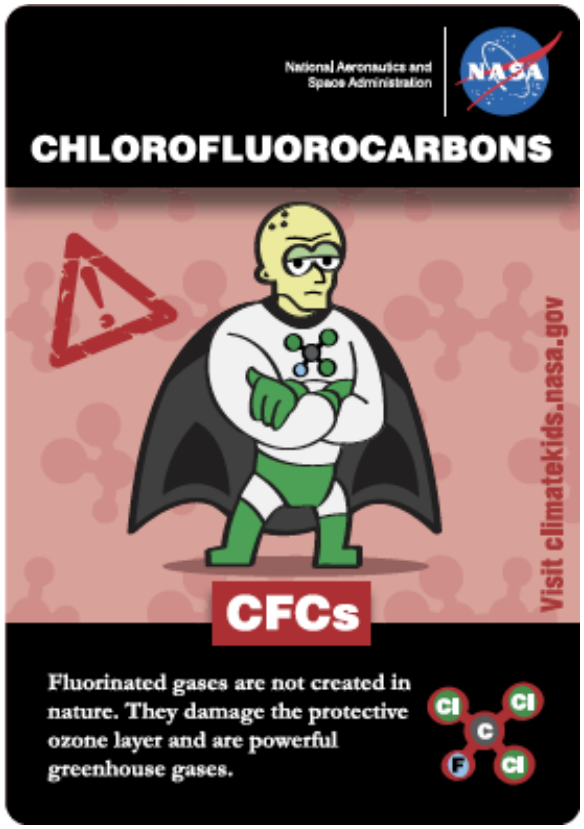
https://www.nesdis.noaa.gov/about/k-12-education/jpss-education/lesson-plan-greenhouse-gases-aerosols

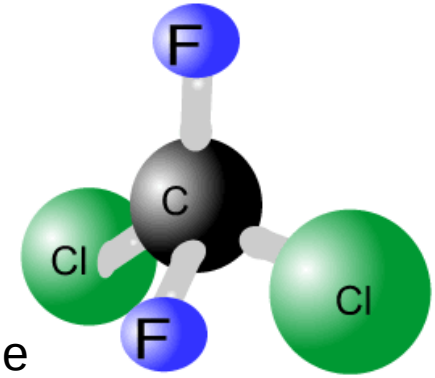
CFC

CFCs are man-made chemicals and were used extensively in aerosols, air conditioners, refrigerators, and for solvents.

Two major types of CFCs are trichlorofluorocarbon ($CFCl_3$) used in aerosols, and dichlorodifluoromethane (CF_2Cl_2), pictured on the right used as a coolant.

It is extremely important to dispose of those appliances properly, and not let the gases escape into the air.

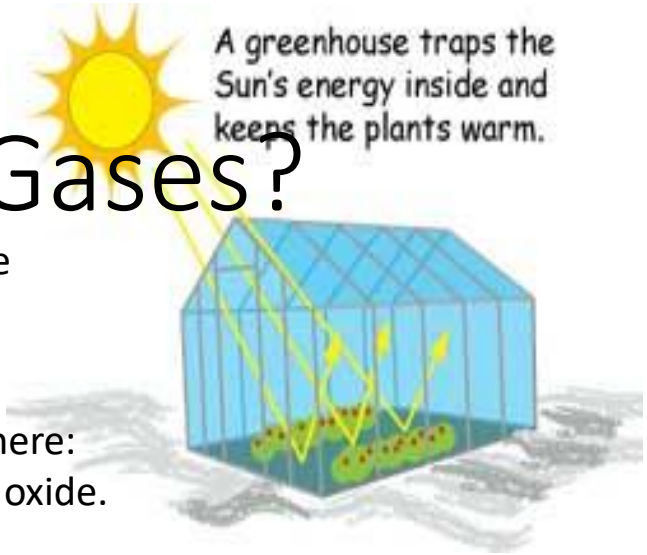




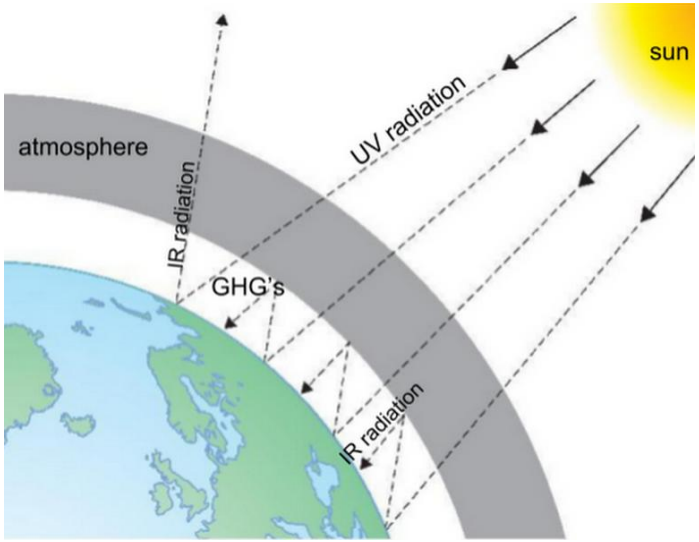
Dichlorodifluoromethane (CF_2Cl_2)
C=Carbon F= Flouride Cl=Chlorine

http://www.dynamicscience.com.au/tester/solutions1/chemistry/greenhouse/cfc.htm
https://www.nesdis.noaa.gov/about/k-12-education/jpss-education/lesson-plan-greenhouse-gases-aerosols

What are Greenhouse Gases?



- Nitrogen, oxygen, carbon, hydrogen, and other gases in the atmosphere can stick (bond) together to form natural gas molecules, or natural greenhouse gases.
- There are five natural greenhouse gases in Earth's atmosphere: Water vapor, ozone, carbon dioxide, methane, and nitrous oxide.



- Greenhouse gases are an important part of the atmosphere because they protect the Earth from the Sun's harmful UV radiation while creating the right temperatures to support life.
- Greenhouse gases allow sunlight to pass through the atmosphere, trapping heat, and warming the Earth. This is what is called the "greenhouse effect." A natural greenhouse effect keeps the Earth at a stable temperature, allowing the Earth to stay warm enough for life to exist. Without greenhouse gases, the Earth would be too cold.

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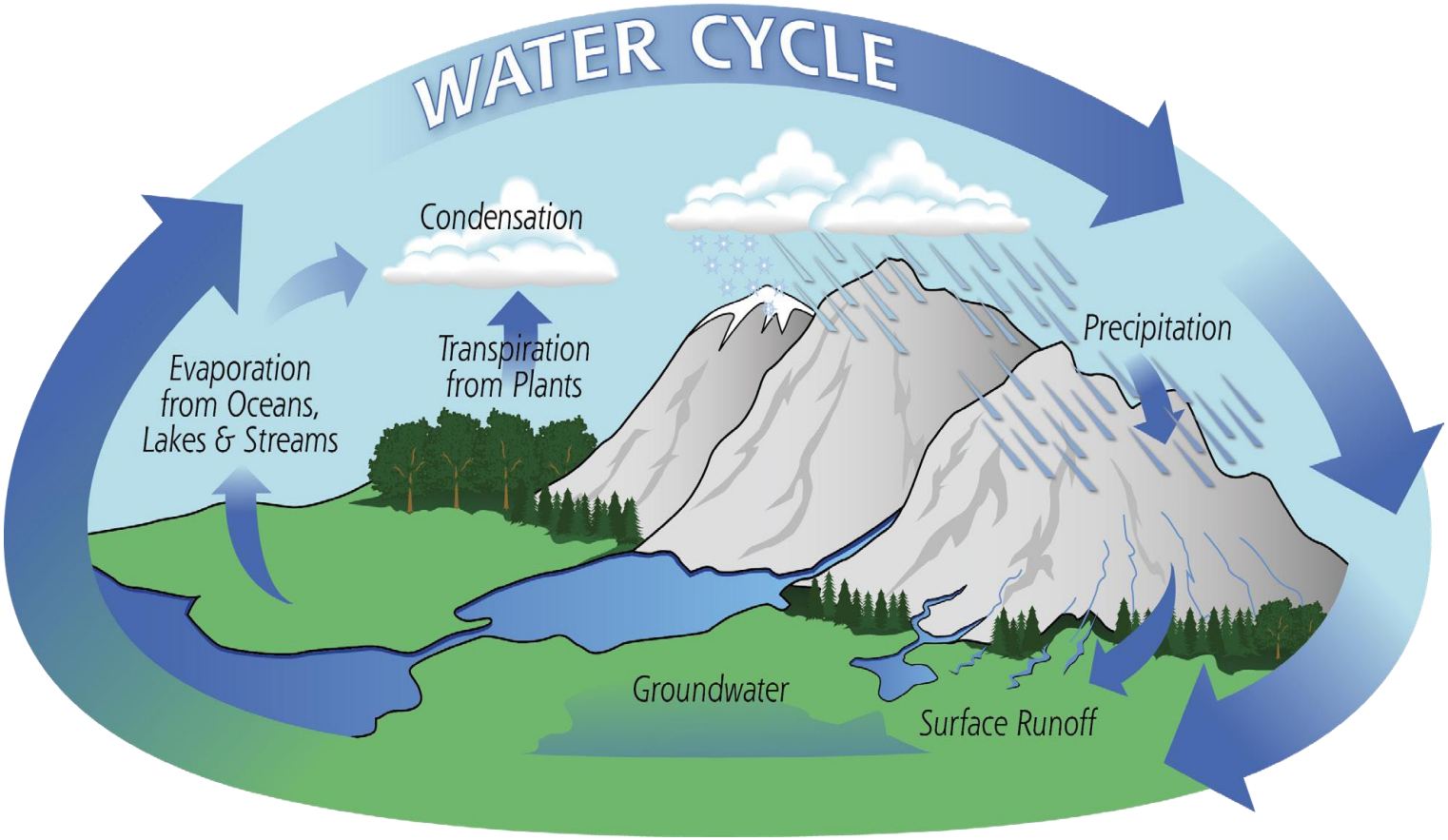
https://www.nesdis.noaa.gov/about/k-12-education/jpss-education/lesson-plan-greenhouse-gases-aerosols

H_2O

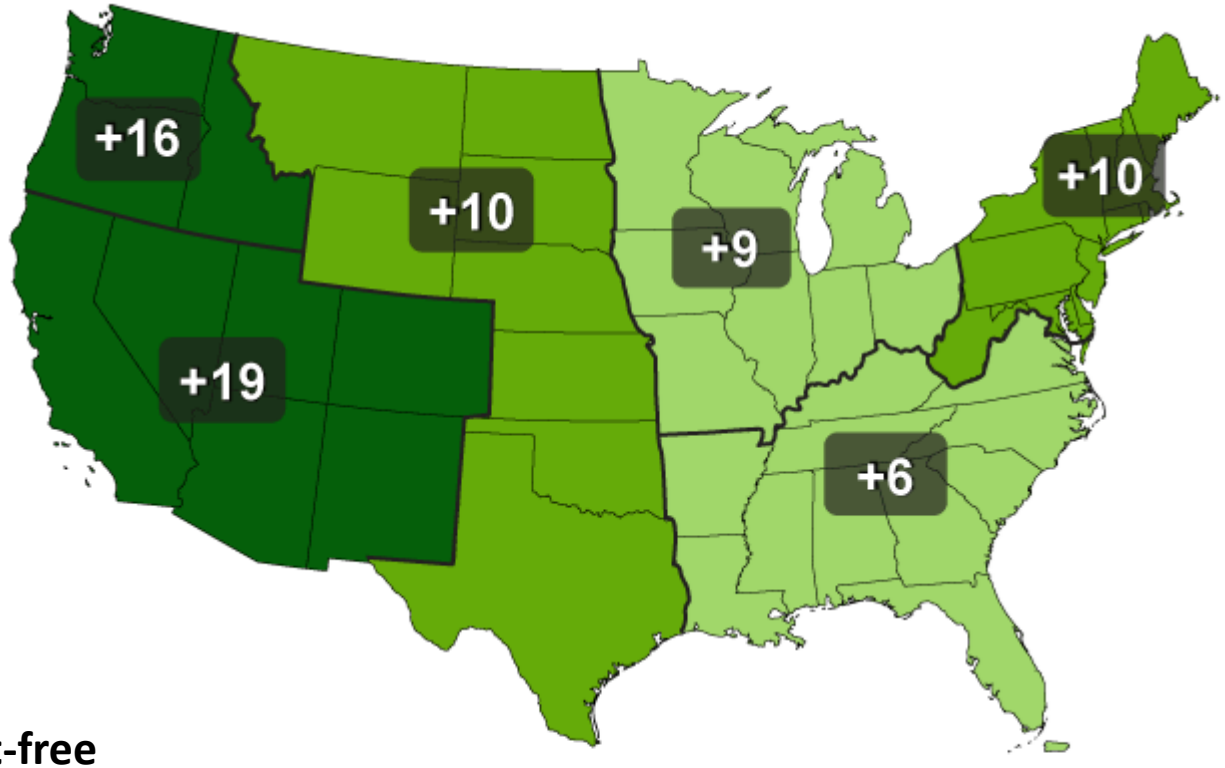
Did you know?

- Approximately 0.001% of the total water on Earth is in the atmosphere as water vapor (water in gas form). This is enough water to cover the entire surface of Earth with 1 inch of rain!
- Water vapor is the most abundant GHG on Earth.
- Understanding where and how much water vapor is in the atmosphere helps scientists predict weather, making it a very important greenhouse gas.
- For example, water vapor influences cloud formation, atmospheric temperature, and moisture. All of these properties of the atmosphere influence the weather.



https://www.nesdis.noaa.gov/about/k-12-education/jpss-education/lesson-plan-greenhouse-gases-aerosols

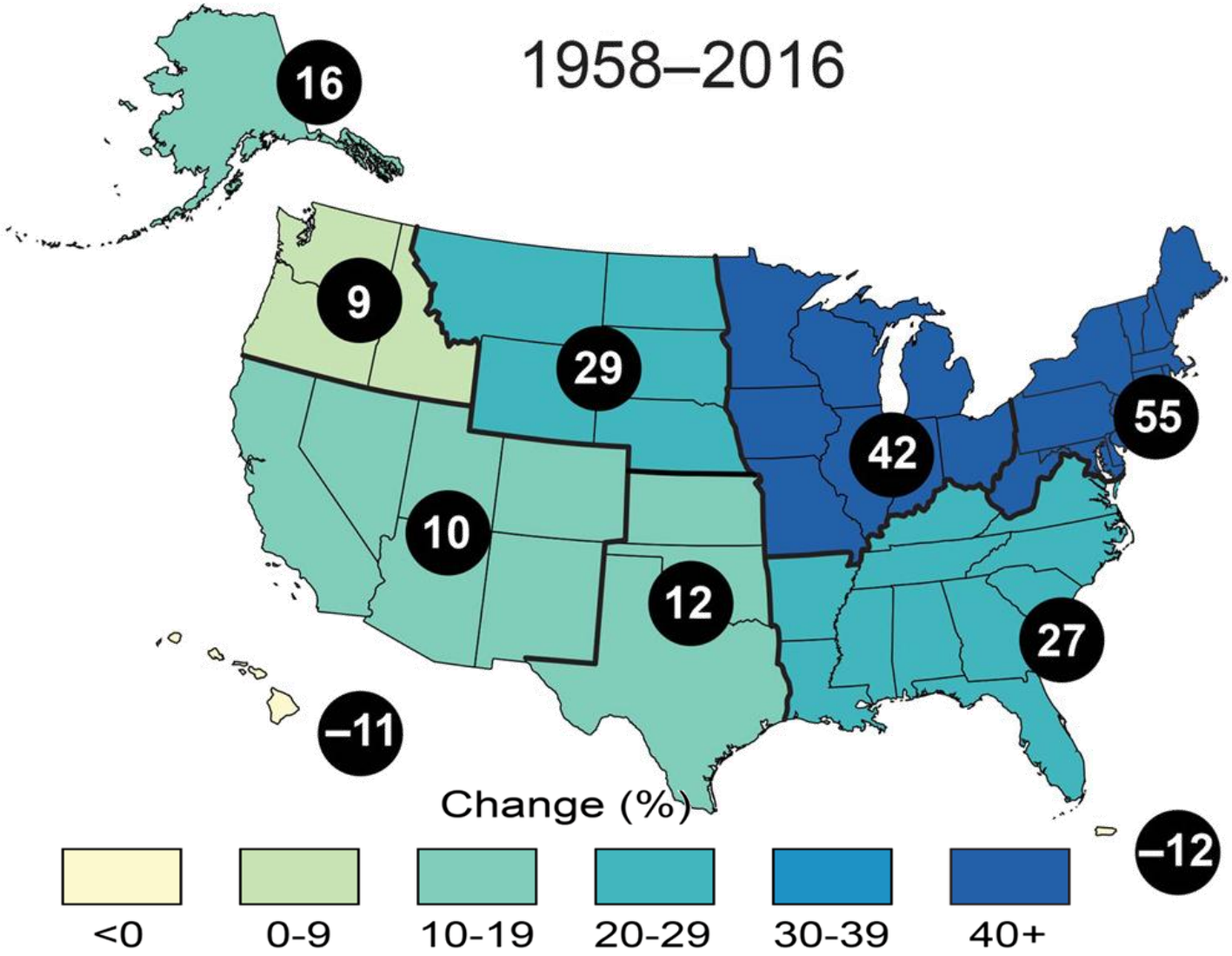
Observed Increase in Frost-free Season Length since 1980's



The frost-free season length has been gradually increasing since the 1980s

Source: USA Third National Climate Assessment 2014

Observed Changes Precipitation

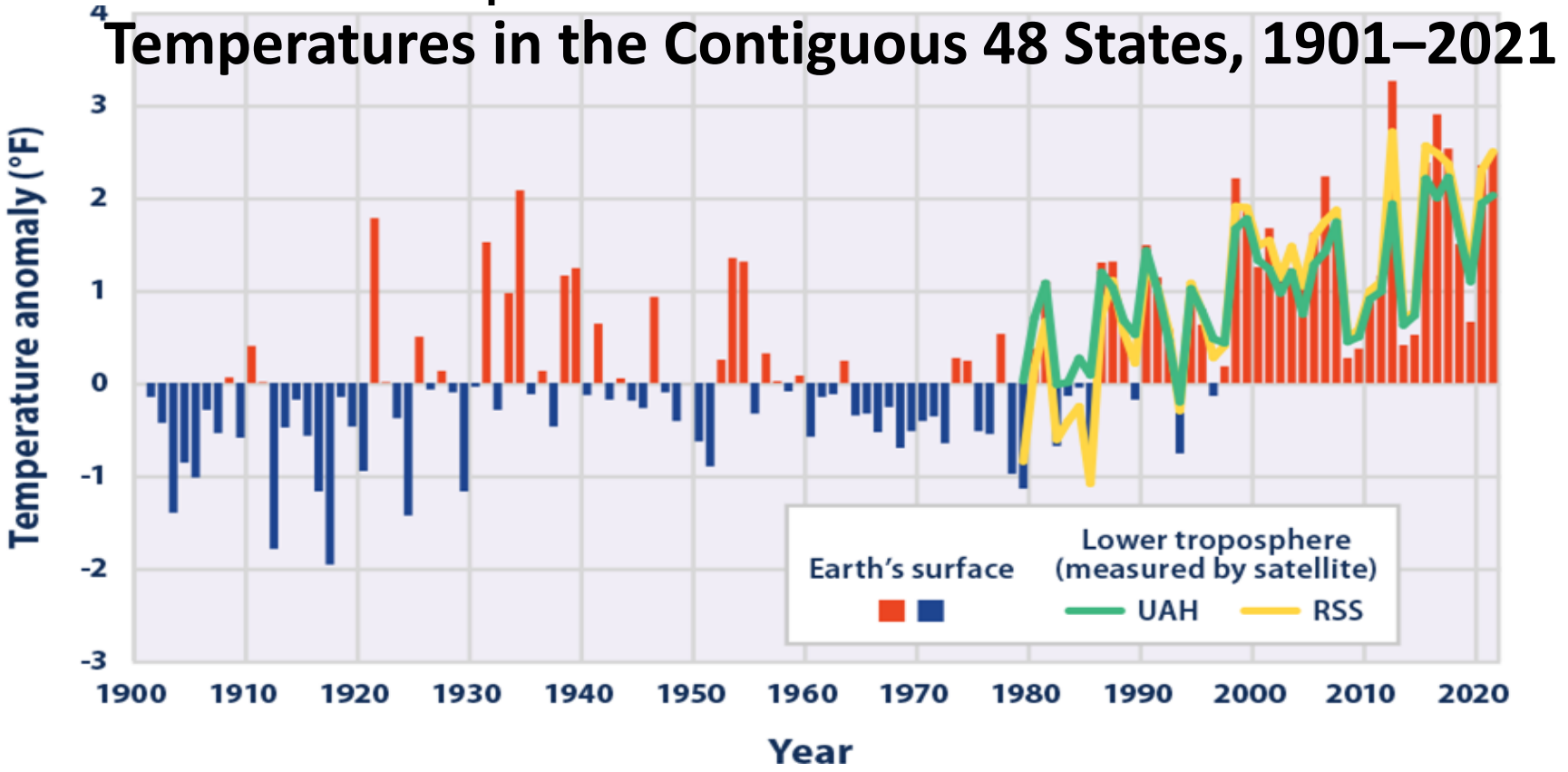


NE – 55% Increase

Increased Flooding

- Inland
  - River rise
  - Flash flood
  - Debris flood
  - Ice-jam
  - Dam & levee failure
  - Local drainage
  - High lake levels
- Coastal
  - High tide
  - Storm surge

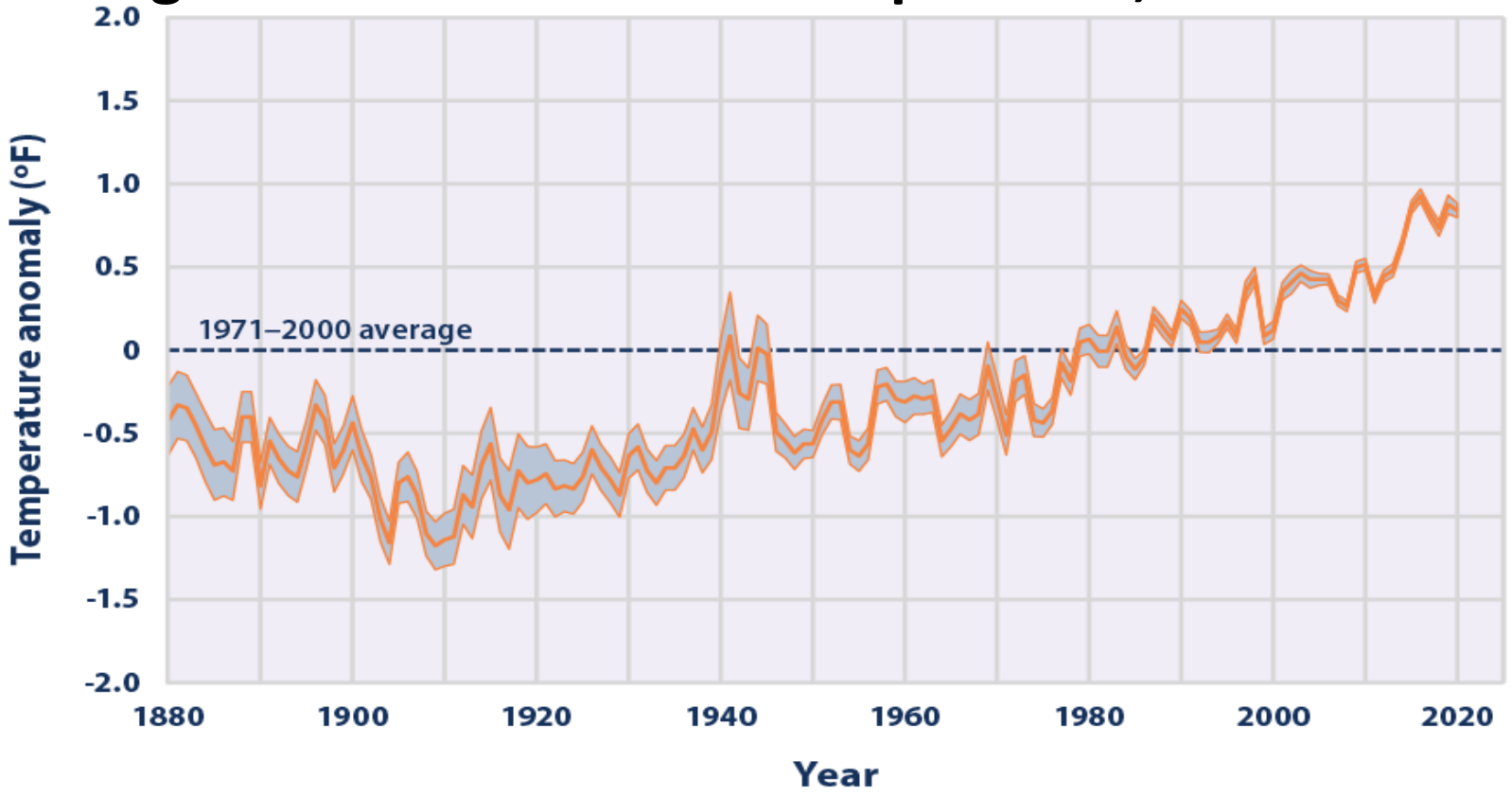
Observed Change in Average Land Temps



Climate is the average of daily weather data such as temperature and precipitation collected over a long period of time. Surface data come from land-based weather stations, while satellite measurements cover the lower atmosphere. "UAH" and "RSS" represent two different methods of analyzing the original satellite measurements. While this graph uses the 1901 to 2000 average as a baseline for depicting change, choosing a different baseline period would not change the shape of the trend. Data source: U.S. EPA, Climate Change Indicators in the United States. https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

Observed Changes in Ocean Temperatures

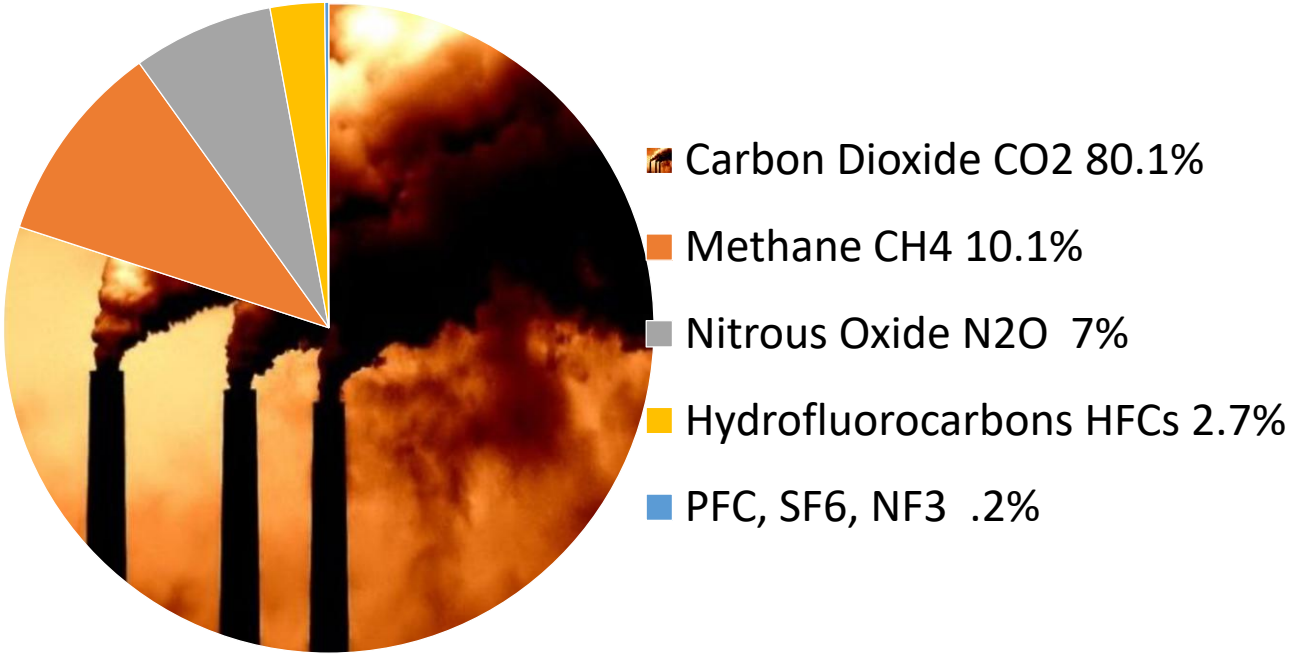
Average Global Sea Surface Temperature, 1880–2020



This graph shows how the average surface temperature of the world's oceans has changed since 1880. This graph uses the 1971 to 2000 average as a baseline for depicting change. Choosing a different baseline period would not change the shape of the data over time. The shaded band shows the range of uncertainty in the data, based on the number of measurements collected and the precision of the methods used. https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature

Greenhouse Gases in the US (GHG) from Human Activity

2019 Total Gas Emissions – 6.55 Bn Metric Tons

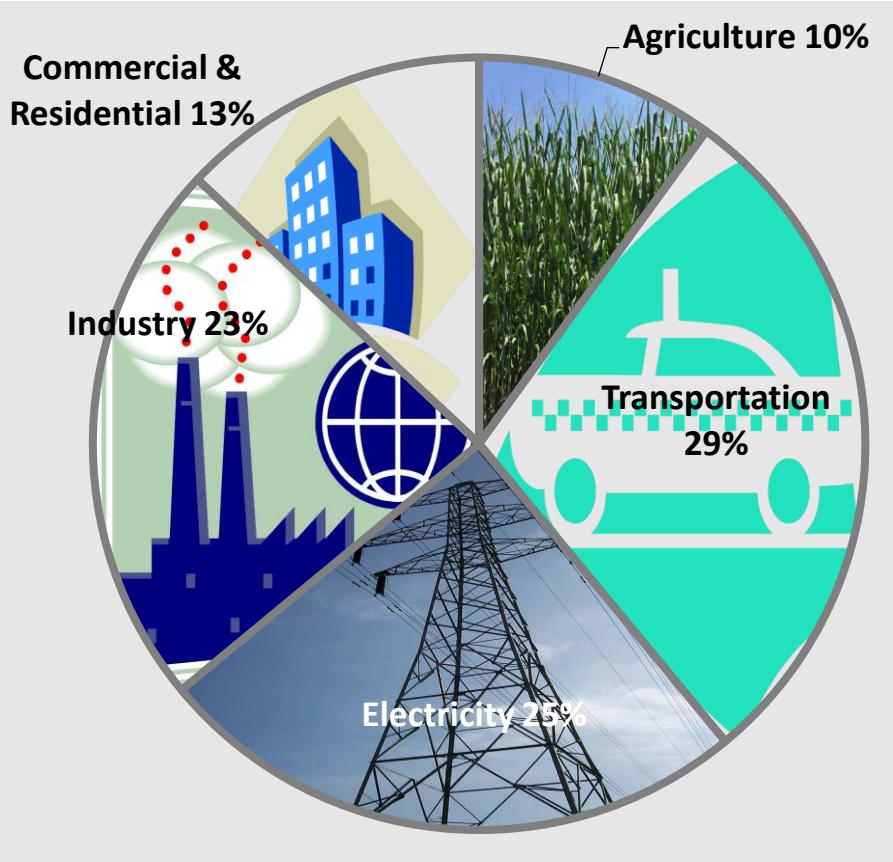


Human sources of CO2 come from activities including cement production and deforestation as well as burning fossil fuels like coal, oil and natural gas

- Perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen triflouride (NF3) combined—0.2%
- Benign gases include water vapor, the most abundant and ozone which is needed to block harmful ultraviolet light, but harmful at lower elevations

Chart: Lynne Bailey | Data: epa.gov/climate-indicators/greenhouse-gases

US GHG Emissions by Economic Sector 2019



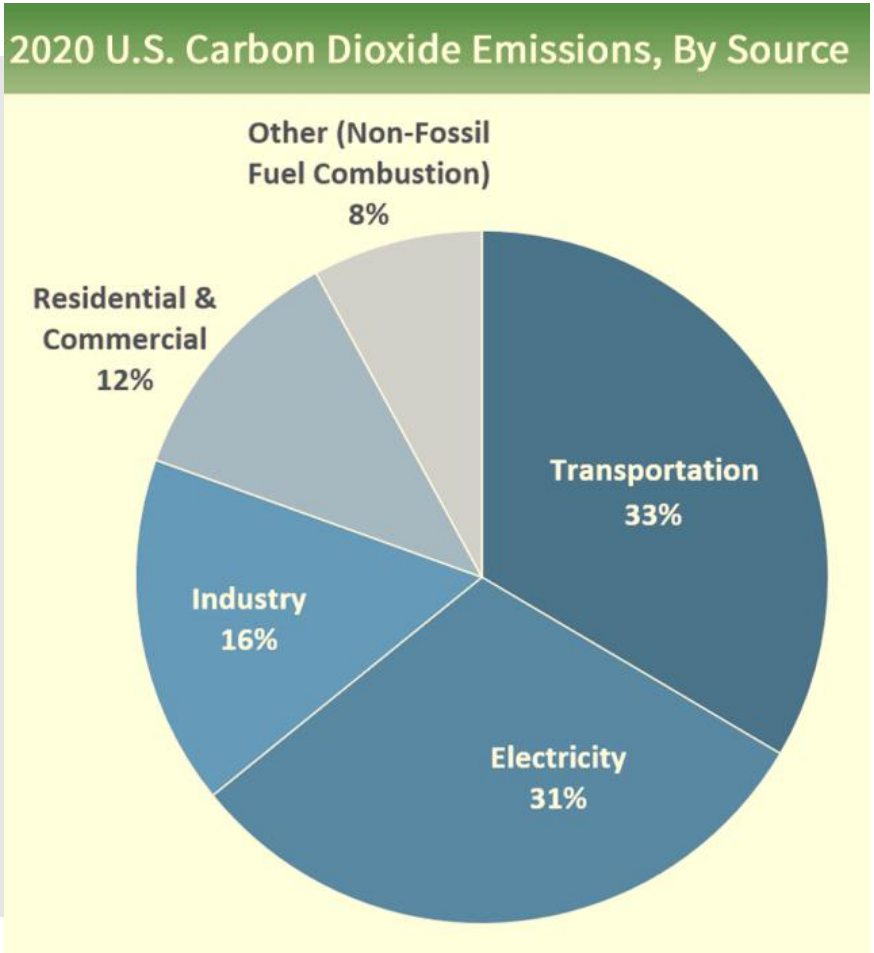
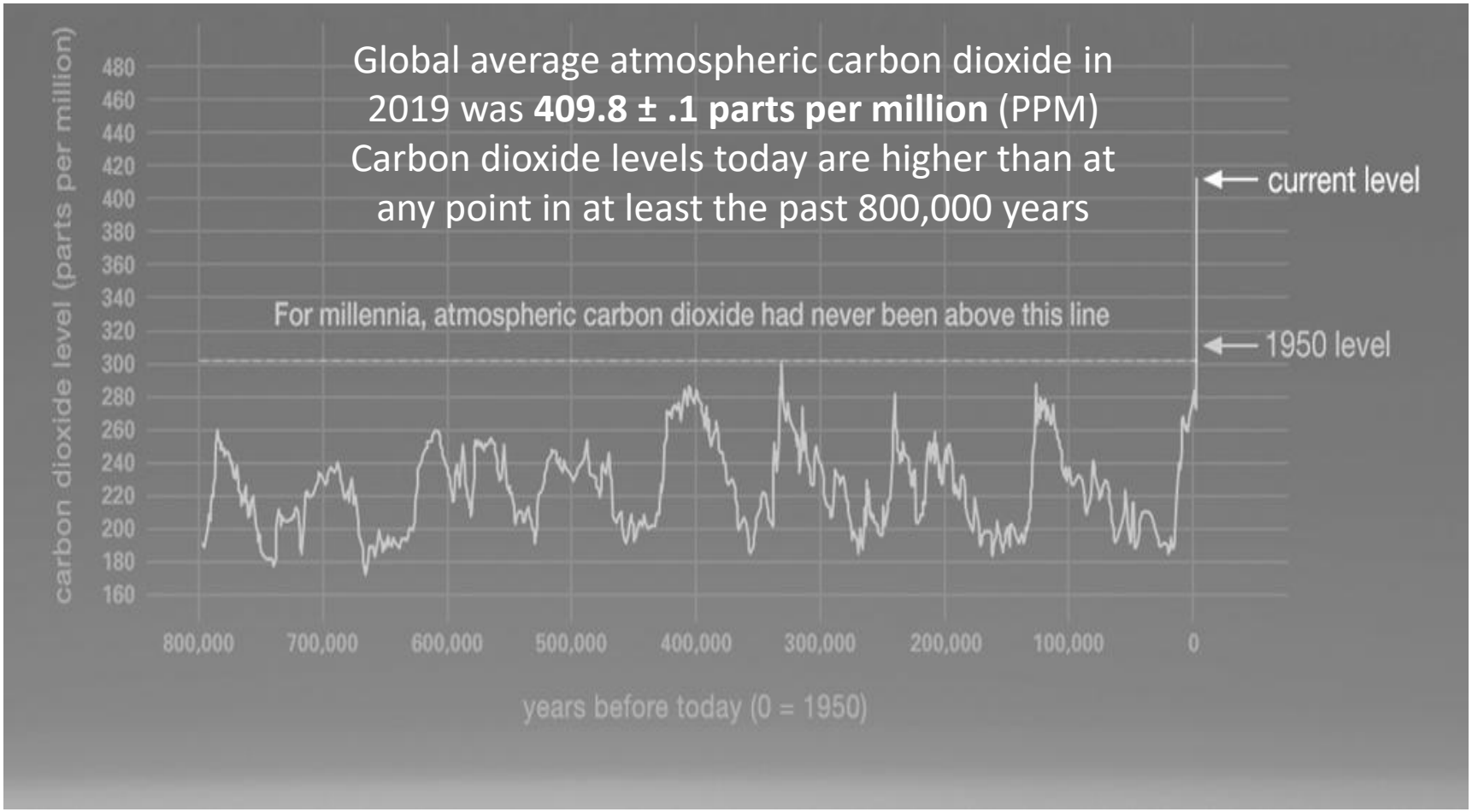


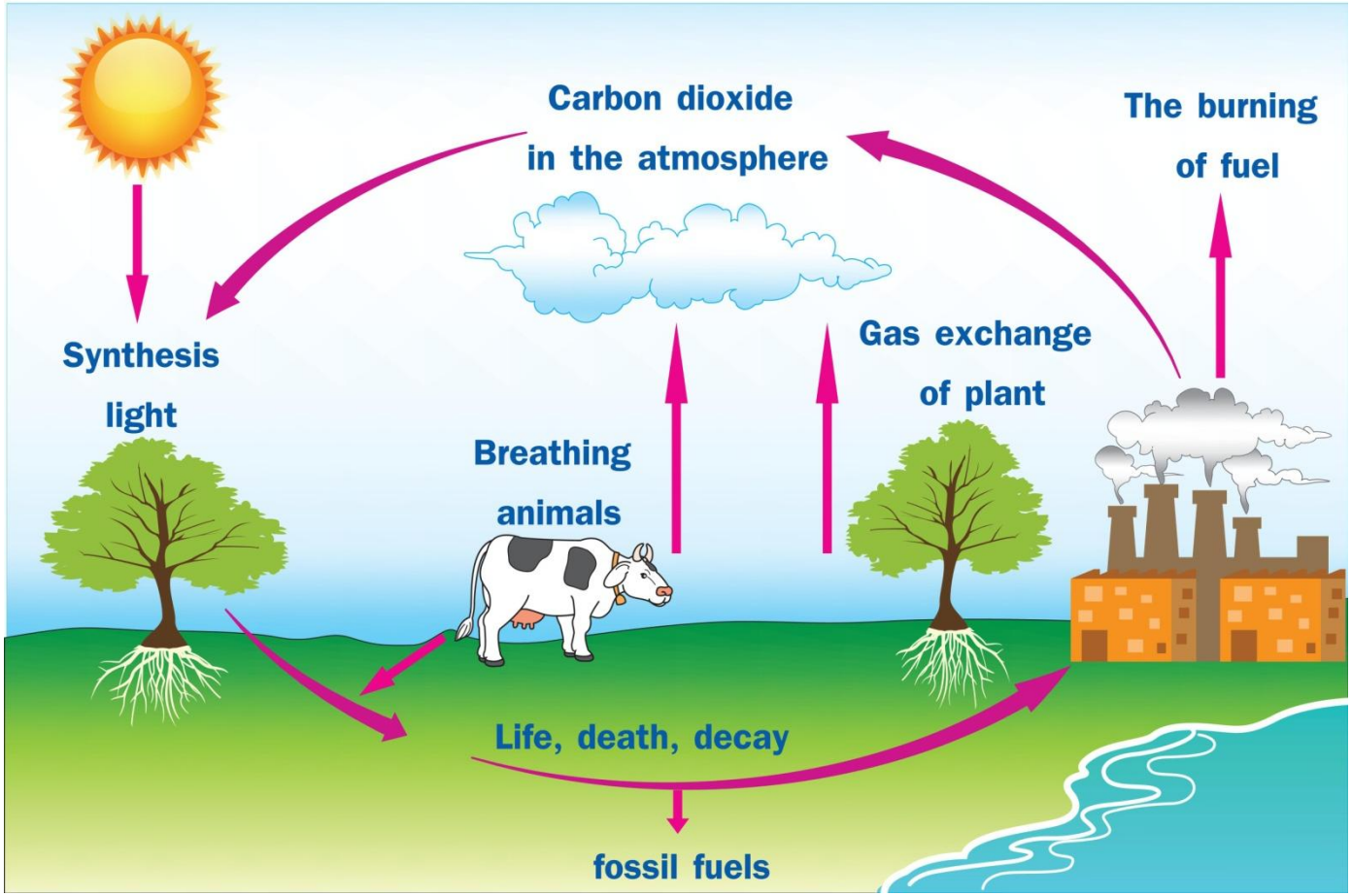
Chart: Lynne Bailey | Data from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Rise of Carbon Dioxide Levels



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.). Online at climate.nasa.gov/evidence

Earth's Carbon Cycle



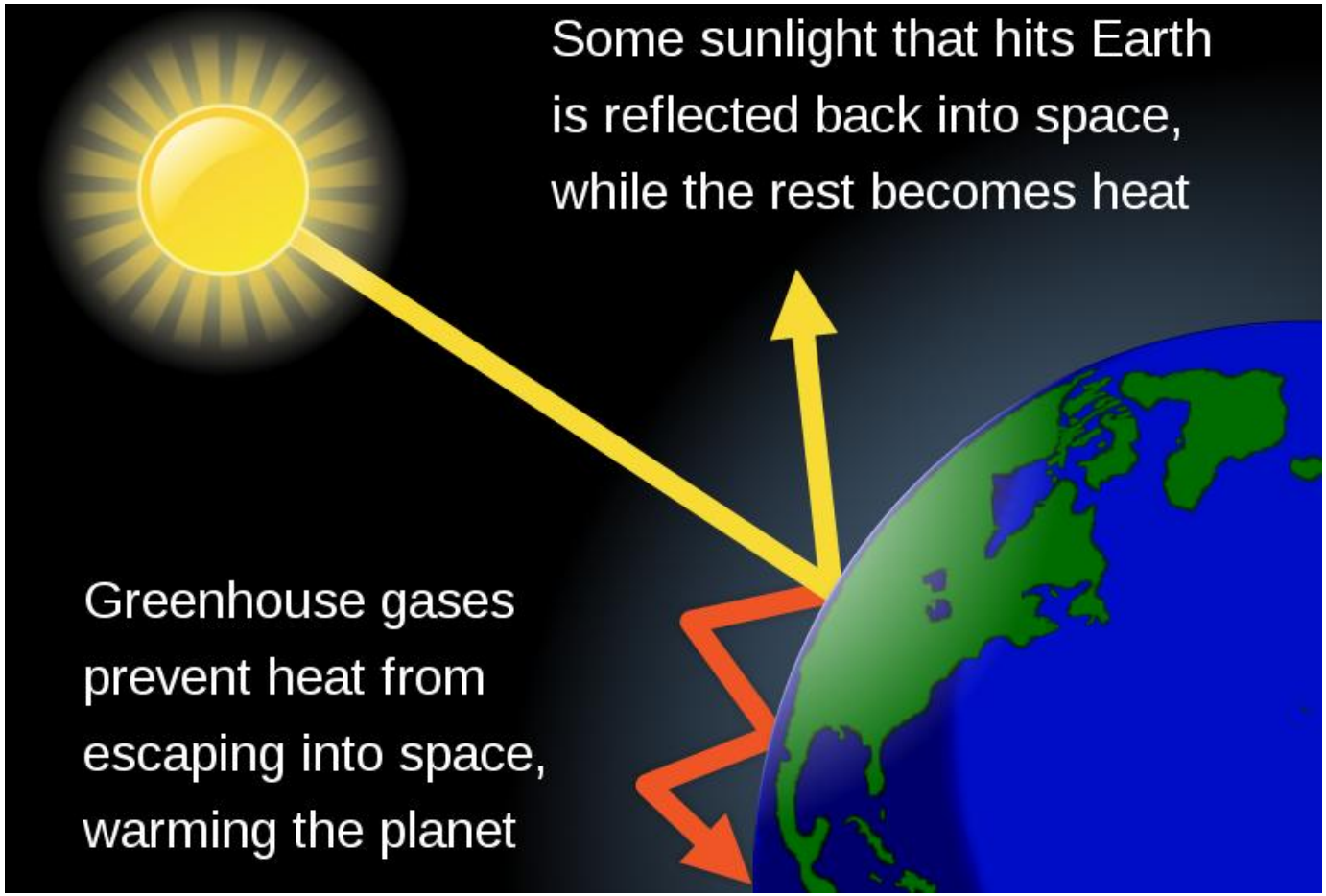
https://kidsgardening.org/resources/digging-deeper-carbon-cycle-and-carbon-sequestration/vector-illustration-of-carbon-cycle/

Earth's Greenhouse Effect

Greenhouse gasses (GHG) trap heat between the earth's surface and its atmosphere.

This makes the Earth hotter than it would be without greenhouse gases creating the "greenhouse effect."

Most GHG's are natural - water vapor is the most common.



https://simple.wikipedia.org/wiki/Greenhouse_gas

How You and Your Community Makes a Difference

- Your Voice….Stay informed and speak out
  - Everyone has a stake in the outcome, and activism of groups and individuals is important
- Getting around....reducing Vehicle Miles Traveled (VMT) and fossil fuel used
  - Consider walking or biking to your destination
  - Use public transportation if available
  - Consolidate or eliminate trips
  - Plan to switch to an Electric Vehicle
- Our shelters…..improve energy efficiency and move off fossil fuels
  - Look for opportunities to reduce waste (air infiltration or leaking water)
  - Convert Heating and Cooking appliances to electric
- Question your decision making….what we consume and waste
  - Reflect upon purchases (both need and quality) and resulting waste
  - Reduce (5 vs 20-minute shower, More Plant Based Meals)
  - Recycle waste when it can be
- Connect with Nature
  - Grow in understanding the connections we have to the natural world