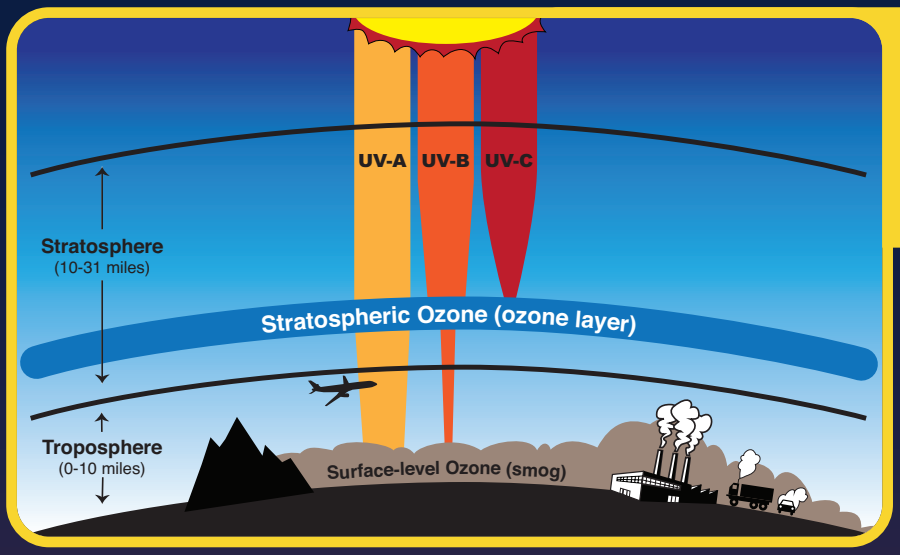
eo kids
earth observatory for kids

The Ozone Hole
We Need More Sunscreen

We all know oxygen as a gas that we need to breathe on Earth. But high up in the atmosphere, oxygen takes on another form that we also need: ozone, a natural sunscreen.



The two lowest layers of our atmosphere are most important to life. One of those layers, the stratosphere, stretches 15 to 50 kilometers (10 to 31 miles) above Earth's surface. The ozone layer is part of the stratosphere.

The Ozone Layer

When sunlight interacts with oxygen (O_2) in our stratosphere, **ozone** (O_3) is created. This ozone layer acts like a shield, blocking most of the Sun's damaging ultraviolet (UV) rays from reaching Earth's surface.

Earth's Sunscreen

If the ozone layer gets thinner, then we have less protection from ultraviolet light. Excessive UV light can cause sunburns, cataracts, and skin cancer. It can also damage plant DNA.

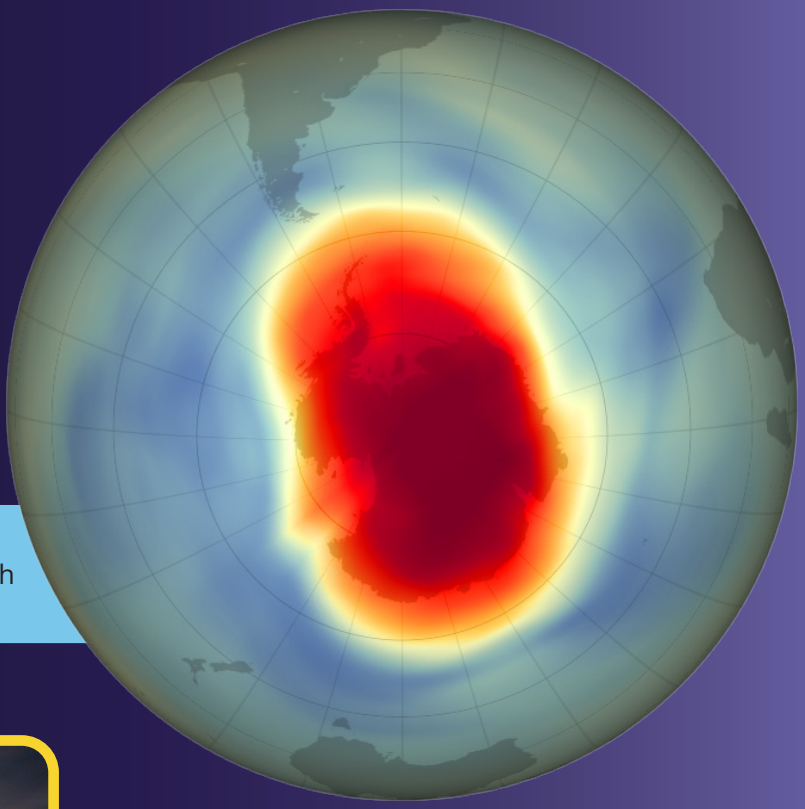
Though we cannot see it, the ozone layer is part of the stratosphere. This photo of Earth's atmosphere was taken from the International Space Station.

Vocabulary

ozone - A molecule made up of three oxygen atoms.

The Ozone Hole

Each year a "hole" forms in the ozone layer over the South Pole. It isn't a literal hole, and you cannot see it with your eyes. It is a local thinning of the ozone layer caused by human-made chemicals that rise to the stratosphere. Once there, these chemicals destroy ozone **molecules**. Scientists first detected the ozone hole in the 1970s and 80s with instruments on balloons and satellites.

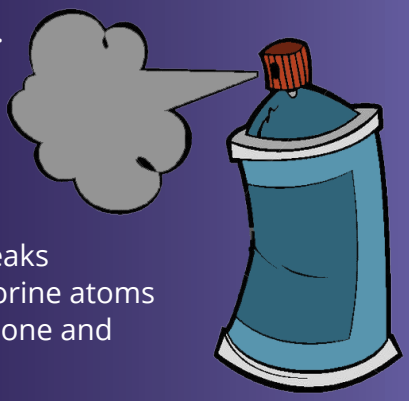


The ozone hole grew to its largest area in 2006. Reds and oranges indicate areas with much less ozone.

Polar stratospheric clouds form high in the atmosphere and at very low temperatures (-78°C or -109°F). Though they are gorgeous to look at, these types of clouds can collect chemicals that help destroy ozone.

Why Does This Happen?

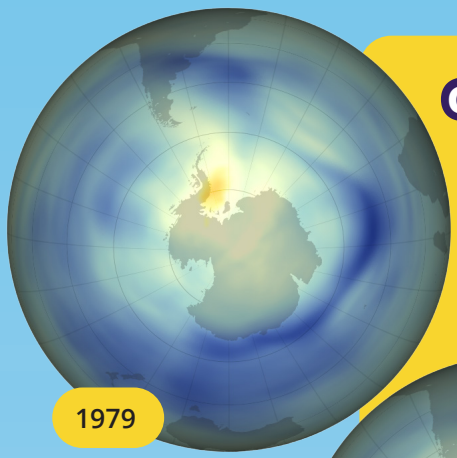
Humans caused the damage to our ozone layer. How did it happen? We invented **chlorofluorocarbons (CFCs)** and similar chemicals. We then used them in aerosol sprays, foams, air conditioners, and refrigerators. Unfortunately, these chemicals can accumulate on high clouds in the stratosphere. Then sunlight breaks the CFCs into chlorine atoms that react with ozone and destroy it.



Vocabulary

molecule - Two or more atoms that create the smallest unit of a pure substance.

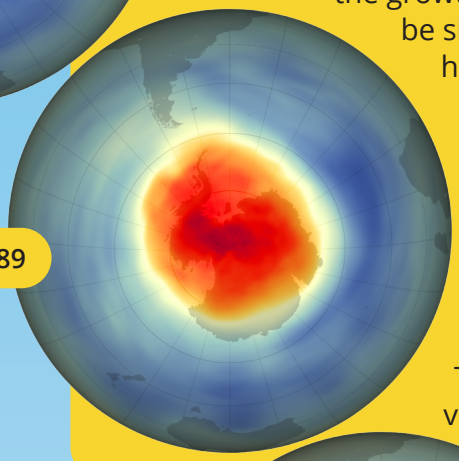
chlorofluorocarbons (CFCs) - Non-flammable chemicals containing atoms of carbon, chlorine, and fluorine.



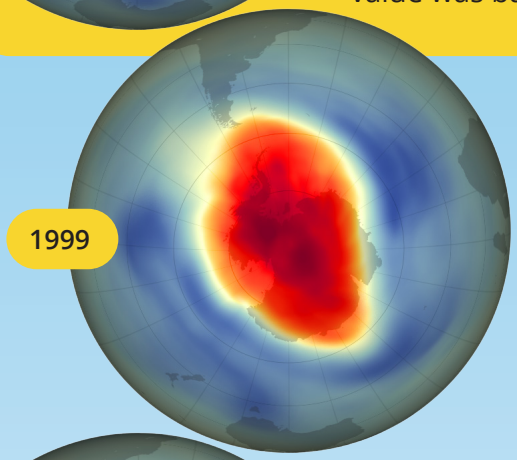
Good News

Once scientists figured out that CFCs were destroying ozone, they worked together with lawmakers to stop people from making the chemicals. The treaty was called the Montreal Protocol. It will take many years for the ozone layer to recover because there are already a lot of CFCs in the air – and they stay for as long as 100 years. But the growth of the ozone hole slowed down and seems to be shrinking. By 2070, the ozone layer is expected to heal to what it looked like in the 1970s.

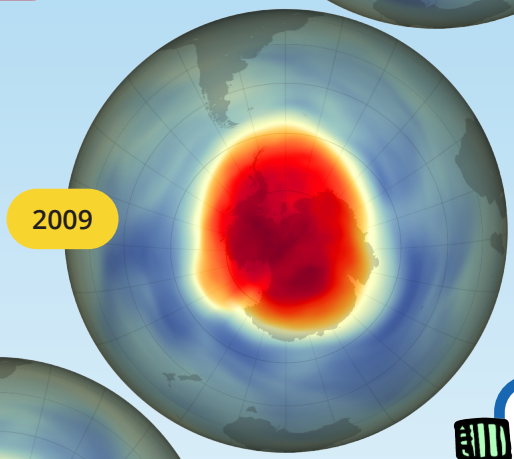
These globes show NASA measurements of the ozone hole across 40 years. The hole is usually largest in September and October. When ozone was first measured by satellite in 1979, the average concentration above Antarctica was 225 **Dobson units** (DU). In 1989, when the Montreal Protocol took effect, it was 127 DU. The lowest level was 92 DU in 1994. By 2019, the value was back up to 167 DU.



Chlorine atoms from CFCs have a major impact on ozone. A single atom of chlorine can destroy as many as 100,000 molecules of ozone.

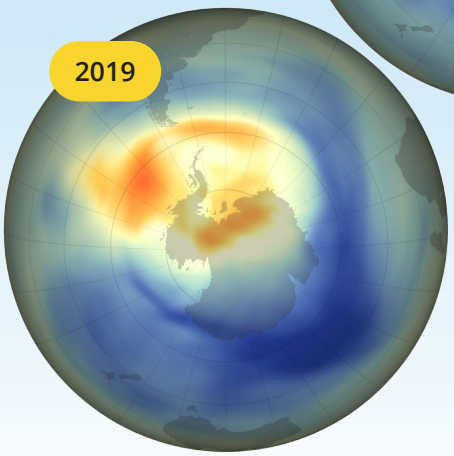


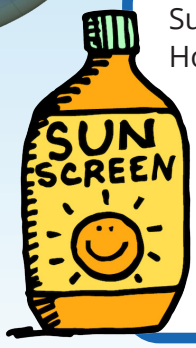
The Montreal Protocol ended the creation and use of CFCs around the world. It has been called the most successful treaty in the United Nations' history.



Vocabulary

Dobson unit - The unit of measure for total ozone. One DU equals 0.01 mm of ozone (at standard temperatures and pressure).

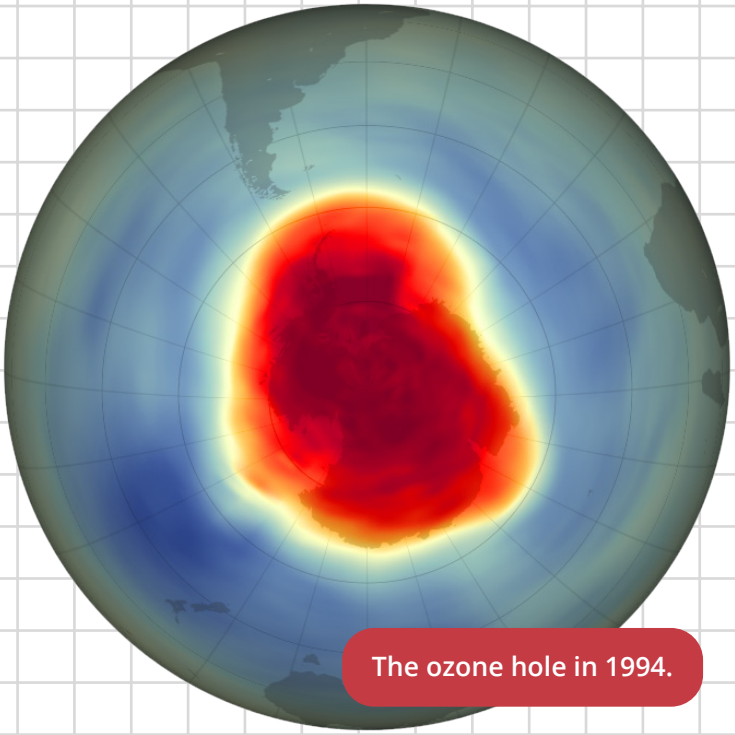




Sunburn in five minutes? No, thank you. However, if we hadn't stopped the ozone hole from growing and spreading around the Earth, this could have been our future.

The ozone layer protects us from some of the Sun's most harmful rays. However, it's still important to wear sunscreen when we go outdoors.

Data Viz
Mapping Ozone



The ozone hole in 1994.

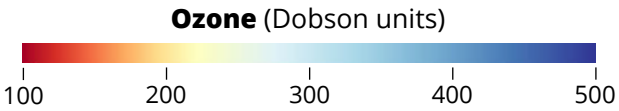
We cannot see ozone with our eyes, so how do we know the ozone layer is thinning? Through measurements made by scientific balloons and satellites, scientists collect data about the ozone layer every day. They then use techniques to turn that data into **visualizations**. One such technique is mapping data values to certain colors.

Follow the directions to make your own ozone map. These data come from NASA's Aura satellite.

Materials:

- Crayons, markers, or colored pencils
- A printout of page 5

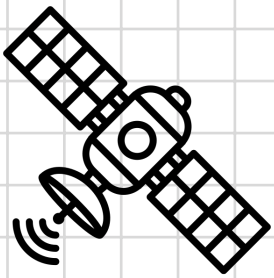
NASA uses shades of red, orange, and yellow to show lower DU areas on their ozone hole maps.



Instructions:

1. Color the scale on the bottom of page 5 with seven different colors or shades that you select. When selecting your colors/ shades, consider ones that will best highlight the ozone hole area (numbers around and below 220).
2. Label the data ranges for each color. Start at the lowest value on the map (169 DU) and end at or just above the highest value (424 DU). For example, 169-205, then 206-242, then 243-278, and so on (adding 36 each time).

The average ozone concentration over the entire planet is 300 Dobson units. A DU value lower than 220 is considered a depletion in the ozone layer.



Vocabulary

visualization - Using images, diagrams, or maps to communicate a message (often about data).

NASA's satellites gather 1,500 terabytes of data about our planet each year. That is enough to fill 3,000 laptops each with 500 gigabytes of data.

Color by Number Worksheet

Map of Statospheric Ozone

292	306	318	329	338	347	352	361	368	367	361	356	342	330	320	306
302	320	327	339	354	368	378	389	397	389	381	367	359	342	331	316
304	322	330	345	361	376	395	406	411	408	397	388	376	358	341	326
311	323	341	349	366	385	404	412	424	423	423	413	396	378	359	340
315	326	331	356	362	381	397	402	401	407	415	415	406	390	369	348
315	325	340	348	359	368	363	352	357	347	366	399	409	397	376	357
320	329	331	332	342	340	304	285	279	283	307	353	395	403	383	362
324	326	327	328	327	297	247	224	216	222	254	306	375	408	386	358
322	328	326	325	304	253	210	187	177	186	219	287	359	402	388	364
321	325	321	330	288	232	195	179	169	180	216	280	357	400	376	352
305	316	325	325	289	242	208	194	196	217	247	301	368	386	370	347
305	314	317	318	300	259	236	232	236	257	291	342	374	372	356	332
293	305	311	315	310	289	283	279	290	314	336	359	360	353	339	320
279	292	308	313	312	310	306	311	322	331	345	343	346	332	324	308
280	289	296	304	309	311	314	314	323	330	334	329	330	317	307	297
274	289	291	300	305	307	312	314	312	320	318	319	309	302	296	292

Color Scale (Dobson units)
