

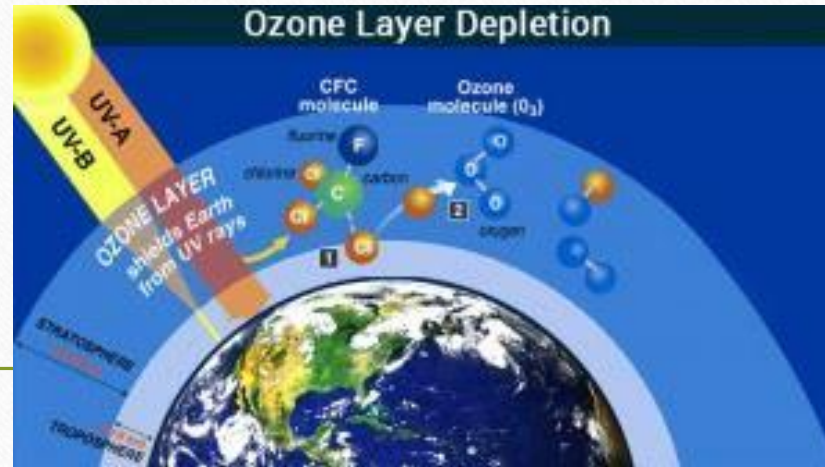
Global warming

By: Ar. Dilip Deshmukh

Ozone layer

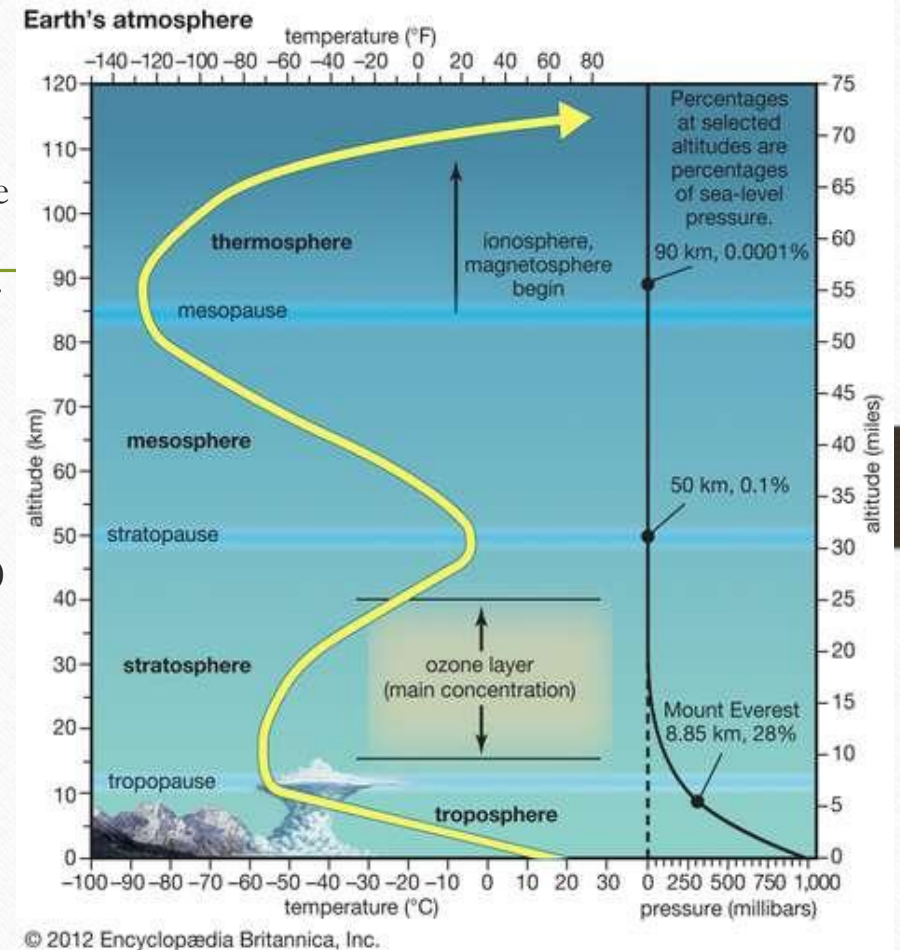
- The ozone layer is one layer of the stratosphere, the second layer of the Earth's atmosphere. The stratosphere is the mass of protective gases clinging to our planet.
- Stratosphere gets warmer. The stratosphere increases in warmth with elevation because ozone gases in the upper layers absorb intense ultraviolet radiation from the sun.
- Ozone is only a trace gas in the atmosphere—only about 3 molecules for every 10 million molecules of air. But it does a very important job. Like a sponge, the ozone layer absorbs bits of radiation hitting Earth from the sun. Even though we need some of the sun's radiation to live, too much of it can damage living things. The ozone layer acts as a shield for life on Earth.
- Ozone is good at trapping a type of radiation called ultraviolet radiation, or UV light, which can penetrate organisms' protective layers, like skin, damaging DNA molecules in plants and animals. There are two major types of UV light: UVB and UVA.
- UVB is the cause of skin conditions like sunburns, and cancers like basal cell carcinoma and squamous cell carcinoma.





- The ozone layer is getting thinner. Chemicals called chlorofluorocarbons (CFCs) are a reason we have a thinning ozone layer. A chlorofluorocarbon (CFC) is a molecule that contains the elements carbon, chlorine, and fluorine. CFCs are everywhere, mostly in refrigerants and plastic products. Businesses and consumers use them because they're inexpensive, they don't catch fire easily, and they don't usually poison living things. But the CFCs start eating away at the ozone layer once they get blown into the stratosphere.
- Ozone molecules, which are simply made of three joined oxygen atoms, are always being destroyed and reformed naturally. But CFCs in the air make it very difficult for ozone to reform once it's broken apart. The ozone layer, which only makes up 0.00006 percent of Earth's atmosphere, is getting thinner and thinner all the time.
- "Ozone holes" are popular names for areas of damage to the ozone layer. This is inaccurate. Ozone layer damage is more like a really thin patch than a hole. The ozone layer is thinnest near the poles.
- In the 1970s, people all over the world started realizing that the ozone layer was getting thinner and that this was a bad thing. Many governments and businesses agreed that some chemicals, like aerosol cans, should be outlawed. There are fewer aerosol cans produced today. The ozone layer has slowly recovered as people, businesses, and governments work to control such pollution.

- Ozone layer**, also called **ozonosphere**, region of the upper atmosphere, between roughly 15 and 35 km (9 and 22 miles) above Earth's surface, containing relatively high concentrations of ozone molecules (O_3). Approximately 90 percent of the atmosphere's ozone occurs in the stratosphere, the region extending from 10–18 km (6–11 miles) to approximately 50 km (about 30 miles) above Earth's surface. In the stratosphere the temperature of the atmosphere rises with increasing height, a phenomenon created by the absorption of solar radiation by the ozone layer. The ozone layer effectively blocks almost all solar radiation of wavelengths less than 290 nanometres from reaching Earth's surface, including certain types of ultraviolet (UV) and other forms of radiation that could injure or kill most living things.
- In the midlatitudes the peak concentrations of ozone occur at altitudes from 20 to 25 km (about 12 to 16 miles). Peak concentrations are found at altitudes from 26 to 28 km (about 16 to 17 miles) in the tropics and from about 12 to 20 km (about 7 to 12 miles) toward the poles. The lower height of the peak-concentration region in the high latitudes largely results from poleward and downward atmospheric transport processes that occur in the middle and high latitudes and the reduced height of the tropopause (the transition region between the troposphere and stratosphere).

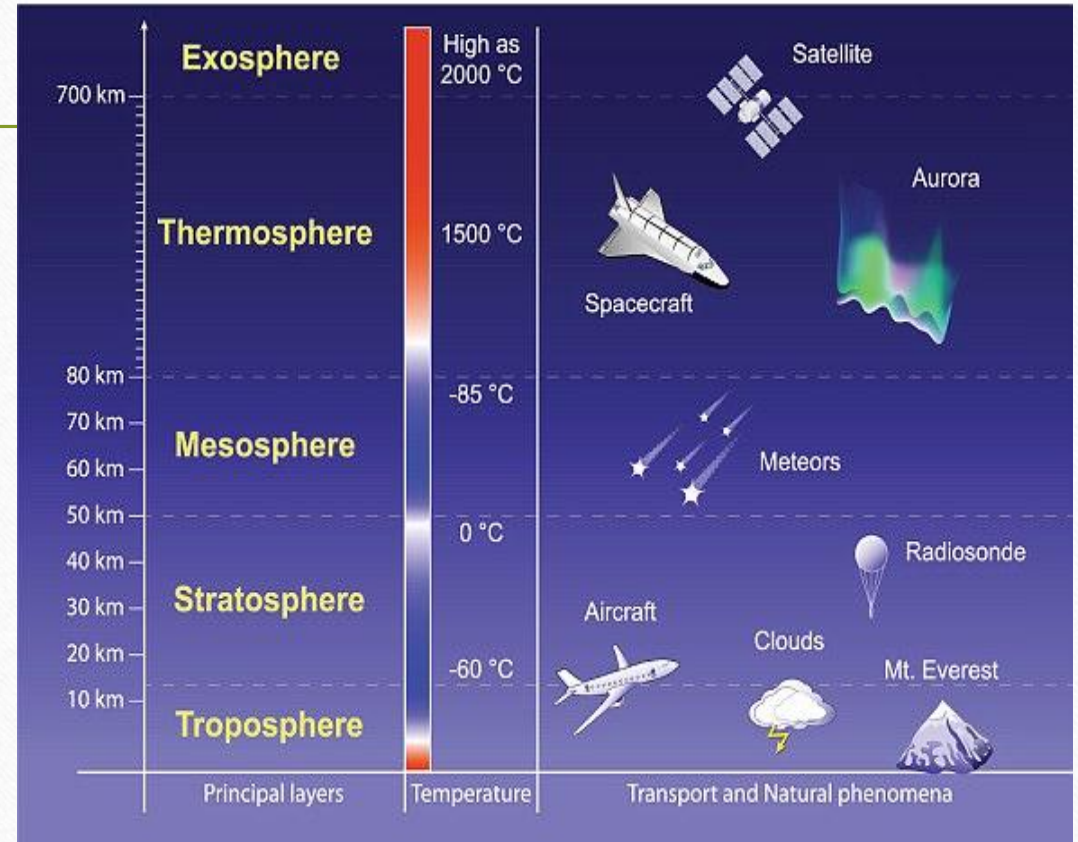


Location In Earth's Atmosphere

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Most of the remaining ozone occurs in the troposphere, the layer of the atmosphere that extends from Earth's surface up to the stratosphere. Near-surface ozone often results from interactions between certain pollutants (such as nitrogen oxides and volatile organic compounds), strong sunlight, and hot weather. It is one of the primary ingredients in photochemical smog, a phenomenon that plagues many urban and suburban areas around the world, especially during the summer months.

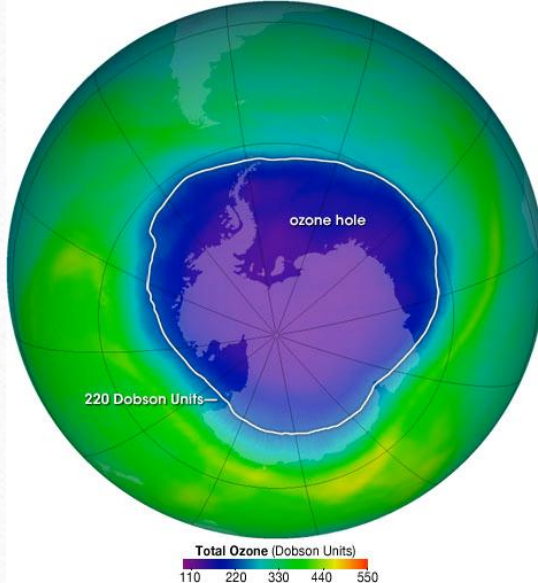
LAYERS OF THE ATMOSPHERE



Ozone Creation And Destruction

- The production of ozone in the stratosphere results primarily from the breaking of the chemical bonds within oxygen molecules (O_2) by high-energy solar photons. This process, called photodissociation, results in the release of single oxygen atoms, which later join with intact oxygen molecules to form ozone. Rising atmospheric oxygen concentrations some two billion years ago allowed ozone to build up in Earth's atmosphere, a process that gradually led to the formation of the stratosphere. Scientists believe that the formation of the ozone layer played an important role in the development of life on Earth by screening out lethal levels of UVB radiation (ultraviolet radiation with wavelengths between 315 and 280 nanometres) and thus facilitating the migration of life-forms from the oceans to land.
- The amount of ozone in the stratosphere varies naturally throughout the year as a result of chemical processes that create and destroy ozone molecules and as a result of winds and other transport processes that move ozone molecules around the planet. Over the course of several decades, however, human activities substantially altered the ozone layer. Ozone depletion, the global decrease in stratospheric ozone observed since the 1970s, is most pronounced in polar regions, and it is well correlated with the increase of chlorine and bromine in the stratosphere.
- Those chemicals, once freed by UV radiation from the chlorofluorocarbons (CFCs) and other halocarbons (carbon-halogen compounds) that contain them, destroy ozone by stripping away single oxygen atoms from ozone molecules. Depletion is so extensive that so-called ozone holes (regions of severely reduced ozone coverage) form over the poles during the onset of their respective spring seasons. The largest such hole—which has spanned more than 20.7 million square km (8 million square miles) on a consistent basis since 1992—appears annually over Antarctica between September and November.

What is the Ozone Hole?



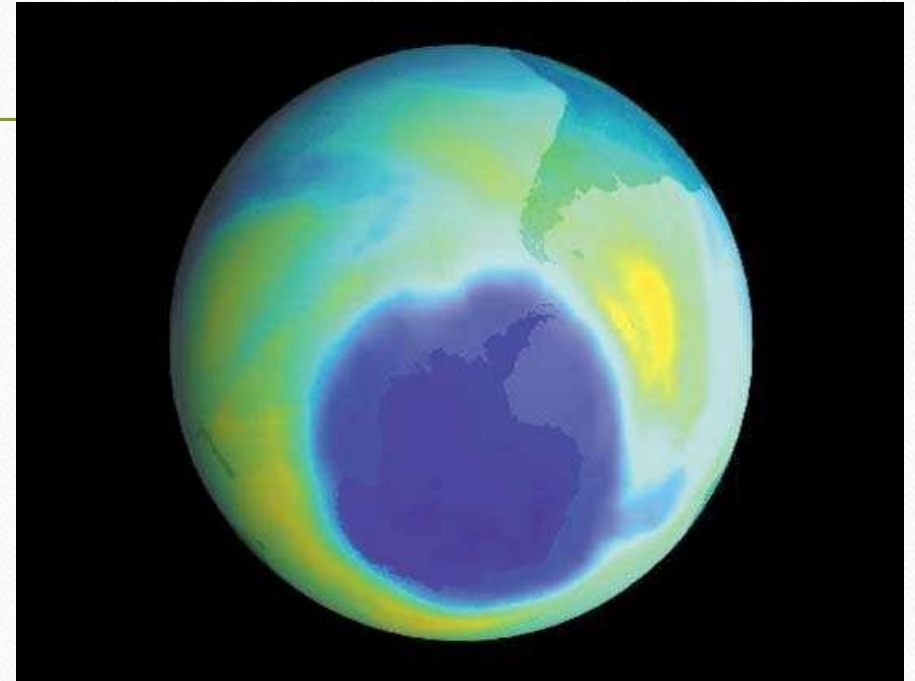
The ozone hole is the region over Antarctica with total ozone of 220 Dobson Units or lower. This map shows the ozone hole on October 4, 2004. The data were acquired by the [Ozone Monitoring Instrument](#) on

NASA's [Aura](#) satellite.

The ozone hole is not technically a “hole” where no ozone is present, but is actually a region of exceptionally depleted ozone in the stratosphere over the Antarctic that happens at the beginning of Southern Hemisphere spring (August–October). Satellite instruments provide us with daily images of ozone over the Antarctic region. The ozone hole image below shows the very low values (blue and purple colored area) centered over Antarctica on 4 October 2004. From the historical record we know that total column ozone values of less than 220 Dobson Units were not observed prior to 1979. From an aircraft field mission over Antarctica we also know that a total column ozone level of less than 220 Dobson Units is a result of catalyzed ozone loss from chlorine and bromine compounds. For these reasons, we use 220 Dobson Units as the boundary of the region representing ozone loss. Using the daily snapshots of total column ozone, we can calculate the area on the Earth that is enclosed by a line with values of 220 Dobson Units (the white line in the figure below).

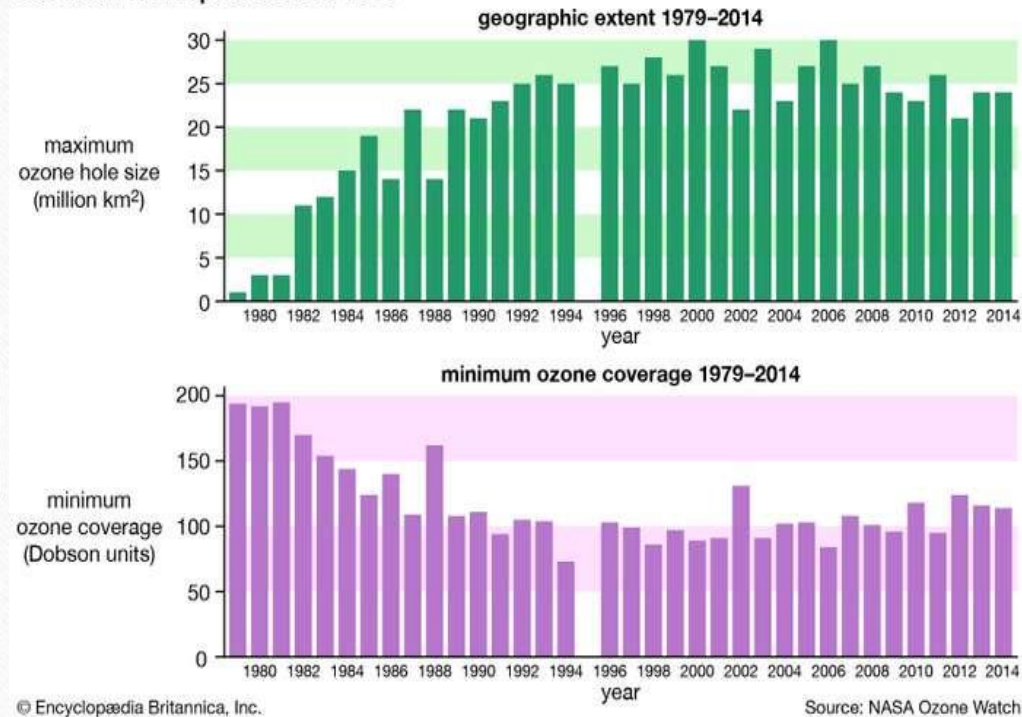
Chlorofluorocarbons and ozone

- Many people have heard that the ozone hole is caused by chemicals called CFCs, short for chlorofluorocarbons. CFCs escape into the atmosphere from refrigeration and propellant devices and processes. In the lower atmosphere, they are so stable that they persist for years, even decades. This long lifetime allows some of the CFCs to eventually reach the stratosphere. In the stratosphere, ultraviolet light breaks the bond holding chlorine atoms (Cl) to the CFC molecule. A free chlorine atom goes on to participate in a series of chemical reactions that both destroy ozone and return the free chlorine atom to the atmosphere unchanged, where it can destroy more and more ozone molecules. For those who know the story of CFCs and ozone, that is the part of the tale that is probably familiar.
- The part of the story that fewer people know is that while the chlorine atoms freed from CFCs do ultimately destroy ozone, the destruction doesn't happen immediately. Most of the roaming chlorine that gets separated from CFCs actually becomes part of two chemicals that—under normal atmospheric conditions—are so stable that scientists consider them to be long-term reservoirs for chlorine. So how does the chlorine get out of the reservoir each spring?



Southern hemisphere ozone hole

Southern Hemisphere ozone hole



- As the amount of stratospheric ozone declines, more UV radiation reaches Earth's surface, and scientists worry that such increases could have significant effects on ecosystems and human health. The concern over exposure to biologically harmful levels of UV radiation has been the main driver of the creation of international treaties such as the Montreal Protocol on Substances That Deplete the Ozone Layer and its amendments, designed to protect Earth's ozone layer. The Montreal Protocol has been a success, with some 99 percent of the ozone-depleting chemicals regulated by the treaty having been phased out since its adoption in 1987. Compliance with international treaties that phased out the production and delivery of many ozone-depleting chemicals, combined with upper stratospheric cooling due to increased carbon dioxide, is thought to have contributed to the shrinking of the ozone holes over the poles and to slightly higher stratospheric ozone levels overall. Continued reductions in chlorine loading are expected to result in smaller ozone holes above Antarctica after 2040. However, some scientists noted that gains in stratospheric ozone levels have only occurred in the upper stratosphere, with declines in ozone concentrations in the lower stratosphere outpacing increases in the upper stratosphere.
- The percentage of oxygen, nitrogen, and carbon dioxide in the air in the mesosphere is essentially the same as that in the levels of the Earth's atmosphere immediately above the Earth's surface. The principal differences are that the density of the air is much less, there is very little water vapour in the mesosphere, and the mesosphere contains higher percentages of ozone than the lower levels.

Carbon emission

How have global emissions of carbon dioxide (CO₂) changed over time?

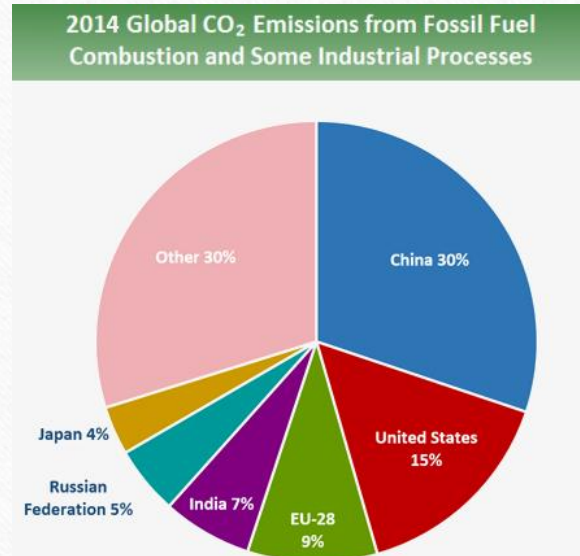
In this chart we see the growth of global emissions from the mid-18th century through to today.

We see that prior to the Industrial Revolution, emissions were very low. Growth in emissions was still relatively slow until the mid-20th century. In 1950 the world emitted just over 5 billion tonnes of (CO₂) – about the same as the US, or half of China's annual emissions today.

By 1990 this had quadrupled to 22 billion tonnes. Emissions have continued to grow rapidly; we now emit over 36 billion tonnes each year.

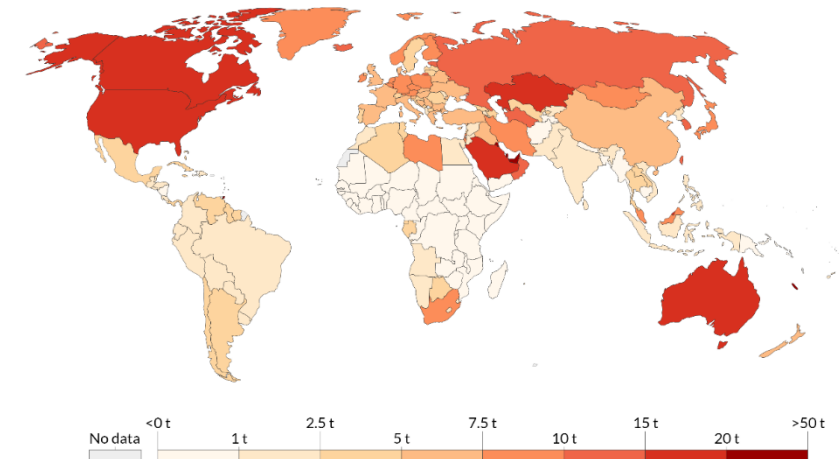
Emissions growth has slowed over the last few years, but they

have yet to reach their peak



Per capita CO₂ emissions, 2018

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.

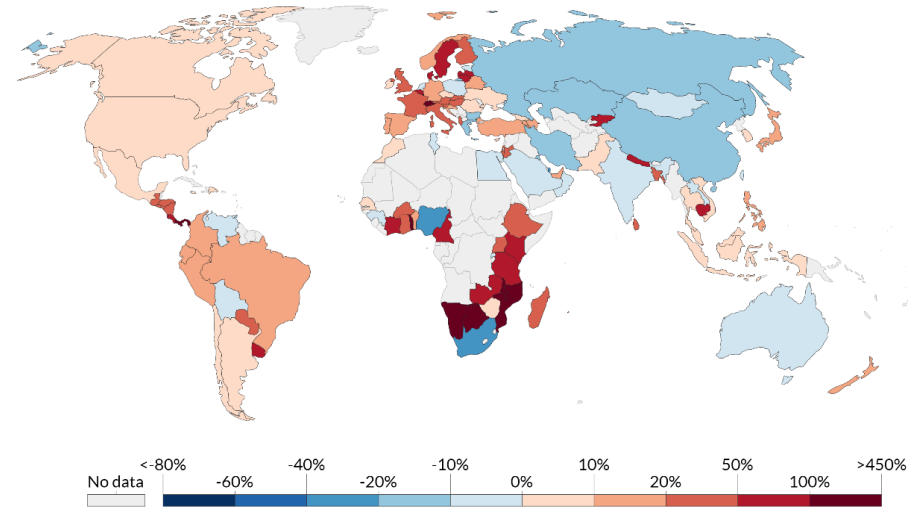


Source: OWID based on CDIAC; Global Carbon Project; Gapminder & UN
Note: CO₂ emissions are measured on a production basis, meaning they do not correct for emissions embedded in traded goods.
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

CO₂ emissions embedded in trade, 2017

Share of carbon dioxide (CO₂) emissions embedded in trade, measured as emissions exported or imported as the percentage of domestic production emissions. Positive values (red) represent net importers of CO₂ (i.e. "20%" would mean a country imported emissions equivalent to 20% of its domestic emissions). Negative values (blue) represent net exporters of CO₂.

Our World
in Data



Source: Peters et al. (2012 updated); Global Carbon Project (2018)

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- In the interactive map we see the emissions of traded goods. To give a perspective on the importance of trade these emissions are put in relation to the country's domestic, production-based emissions.⁶
- Countries shown in red are net importers of emissions – they import more CO₂ embedded in goods than they export.

For example, the USA has a value of 7.7% meaning its net import of CO₂ is equivalent to 7.7% of its domestic emissions. This means emissions calculated on the basis of 'consumption' are 7.7% higher than their emissions based on production.

- Countries shown in blue are net exporters of emissions – they export more CO₂ embedded in goods than they import.

For example, China's value of -14% means its net export of CO₂ is equivalent to 14% of its domestic emissions. The consumption-based emissions of China are 14% lower than their production-based emissions.

- We see quite a regional East-West split in net exporters and importers: most of Western Europe, the Americas, and many African countries are net importers of emissions whilst most of Eastern Europe and Asia are net exporters.