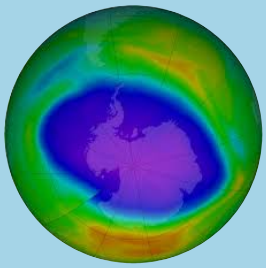
THE CASE OF THE OZONE LAYER



We are an 11th-grade class at Charles Gide High School. Together with our two teachers, Ms. Libot and Mr. Galiny, we have explored various subjects about the ozone layer, including history, our understanding of CFCs, and scientific explanations.

Hélène Angot is a CNRS researcher at the "Institut des Géosciences de l'Environnement" in France. She specialises in the measurement and modeling of atmospheric contaminants and the impact of global change on the cycle of toxic and climate-active chemicals. She is contributing to the commitment of ERCA, the European Research Course on the Atmosphere, to excellence in doctoral training and to solving contemporary environmental challenges. She currently leads research projects in remote regions of the world, including the Arctic, and uses both field observations and modeling.

Abstract

CFCs are widely utilized across the globe, yet their use has sparked significant controversy. These substances pose serious threats to the ozone layer. To gain a clearer understanding, we will explore both historical and scientific perspectives. Initially, we will outline the origins of CFCs, followed by a discussion of the key issues surrounding the debate about their usage. Finally, we will explain the mechanisms by which CFCs operate.

Once upon a time....

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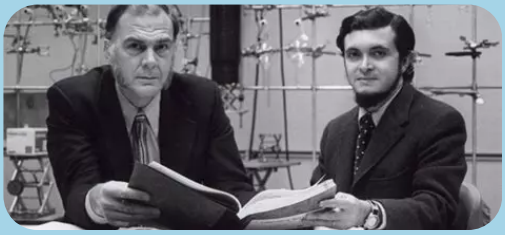


Roland and Molina are two scientists who studied CFCs and their effects on the ozone layer.

In the 1920s there was a developement of synthetic refrigerants, in particular chlorofluorocarbons called CFCs. CFCs were promoted as 'miracle molecules' because of their low toxicity and chemical stability. They were made to replace toxic refrigerants such as chloromethane and sulphur dioxide.

In 1930, the first CFC, dichlorodifluoromethane (Freon), was introduced. In the 1970s, studies revealed that CFCs were responsible for destroying the ozone layer, raising global awareness of their harmful environmental effects.

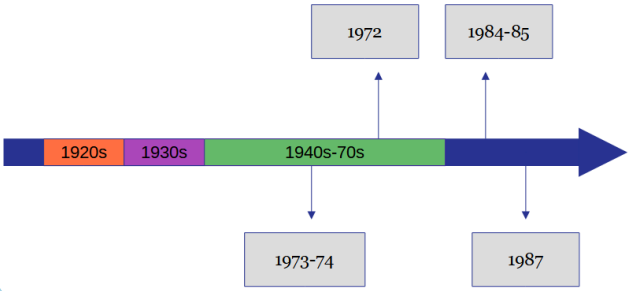
In 1972, Rowland heard a talk on CFCs and he began to study this. Research into CFCs, notably by Rowland and Molina, began to show that these substances could migrate to the stratosphere and destroy ozone molecules.

In 1973, Rowland and Molina calculated that CFC molecules released near the surface of Earth were in the stratosphere.

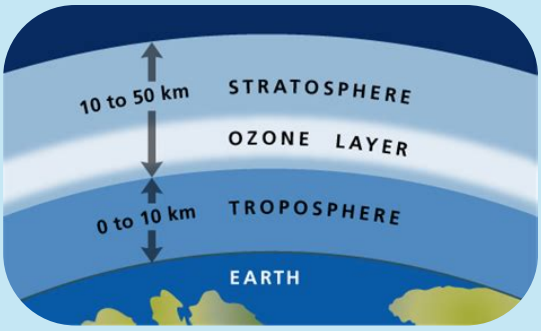
In 1974, they published their results in Nature. They say that CFCs had major environnemental consequences.

In 1984, a British atmospheric scientist discovered a depletion of the stratospheric ozone layer. In 1985, an article showed that stratospheric ozone had decreased. After that, in 1987, 56 countries signed the Montreal Protocol.

There was a 10 year gap between Rowland And Molina's report and the Montreal Protocol because the data on the effects of CFCs on the ozone layer were initially contested by the chemical industry, which delayed political action. A total ban of CFCs could have reduced ozone depletion, but residual effects would have persisted because of CFCs already present in the atmosphere.

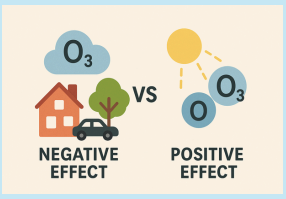


Perceptions of chemicals



The ozone molecule (O_3) is always the same. Whether it's in the stratosphere or near the Earth's surface.
However, its effects depend largely on its location in the atmosphere.

From 0 to 6 miles above the ground (troposphere) ozone has a negative effect because it can be a harmful air pollutant (contributes to smog and respiratory problems, damages crops...)
From 6 to 31 miles (stratosphere) ozone in the ozone layer has a positive effect that protects all life on Earth by absorbing most of the sun's harmful radiations.



1940s CFCs were seen as a breakthrough in chemical technology. They were considered safe, non-toxic and were widely used as refrigerants, or propellants in aerosol cans and in air conditioning systems. (there were an alternative to 1920 toxic components that could lead to injury or even death!)

Late 1970s Scientists discovered that CFCs were depleting the ozone layer. This realization raised concerns about the harmful effects of CFCs on the environment. The perception of CFCs began to deteriorate.

Late 1980s It was clear the ozone depletion was linked to CFCs use (scientists discovered the "Antarctic ozone hole), and it lead to international action such as the 1987 Montreal Protocol, that called for the end of CFCs production and use.

The predicted consequences of Ozone depletion (increase of skin cancer) made definitely bad perception of CFCs globally... even though some countries are still using them nowadays...

CFCs debate

In the 1970, Rowland and Molina argued that CFCs were dangerous because they rose into the stratosphere and broke down the ozone layer. This layer protects us from harmful UV rays. If CFCs kept being used, more ozone would be destroyed, leading to serious problems like an increase in skin cancer.

However, many people doubted their research (hypothesis) because scientists at the time only had basic tools—like balloons, aircraft, and satellite instruments—which weren't always precise. Because of this, Rowland and Molina faced criticism, and some people questioned whether CFCs were really harmful.

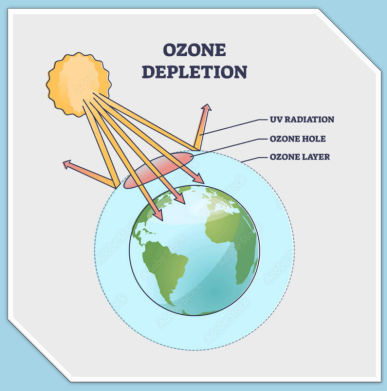
Scientific institutions, such as the National Academies of Science and the British Antarctic Survey, supported these findings. As a result, governments wanted to ban CFCs. However, the chemical industry resisted, arguing that there was no urgent need for action.

Despite a ban in 2010, CFC levels in the atmosphere kept rising between 2010 and 2020. This was mainly due to the production of hydrofluorocarbons (HFCs), which replaced CFCs in refrigerants and air conditioning. Unfortunately, making HFCs also releases CFCs. Additionally, many countries do not strictly regulate industrial CFC emissions, keeping the problem alive today.

CFC-11, a type of CFC used in refrigeration and insulation, was supposed to be phased out under the Montreal Protocol in 1987. However, production continued, especially in China, where the use of polyurethane foam (which relies on CFCs) increased.

Scientific Explanations

CFCs, like CFC-11, are chemicals that, when exposed to UV rays in the stratosphere, break down and release chlorine radicals (Cl•). These radicals react with ozone (O_3) and destroy it, regenerating the chlorine radical and causing continuous ozone depletion. A single chlorine radical can destroy multiple ozone molecules, damaging the ozone layer.



THIS SUMMARY GIVES YOU AN ESSENTIAL OVERVIEW. TO FIND OUT MORE, CLICK ON THE QR CODE BELOW!

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Conference with Hélène Angot

On Monday the 7th of April, we had a conference with Hélène Angot. It was really interesting! She presented her projects and work, and explained to us what the ozone hole is, why it only forms over Antarctica, its causes and consequences... She also insisted on the difference between global warming and ozone hole.
Then we could ask questions about her work and her studies, about ozone, global warming, about anything we wanted... It was an enriching dialogue.
Furthermore it was really enjoyable to talk with a scientist who is a woman and has travelled and seen so many things...
Hélène Angot was very nice taking time for us and we thank her for that!

Journal de bord

Pour ce projet, nous avons eu des temps de travail différents depuis le mois de février à raison de 2 heures par semaine:
Tout d'abord un travail assez classique d'appropriation du sujet par les élèves : recherches documentaires suivies d'exposés à l'oral.
Puis nous avons crée des équipes suivant les compétences de chacun : rédaction des articles, correction des articles, enregistrement des parties vocales, mise en page des documents, réalisation des schémas, préparation des questions à poser lors de la visioconférence, préparation d'une intervention orale à destination des 3ème.
Dans le but de promouvoir l'enseignement SELO, 5 élèves doivent aller au collège Lou Redounet d'Uzès pour faire une conférence « in English of course » sur le thème « Ozone Layer ». Ils ont préparé un diaporama et ont simplifié leur discours à l'oral pour pouvoir être compris par un public d'élèves de 3ème ayant candidatés pour rejoindre notre section SELO « Anglais - Sc Physiques » en 2nde.
Un très bon entraînement pour leurs futures épreuves à l'oral que de devoir être compréhensibles aussi bien scientifiquement que linguistiquement!