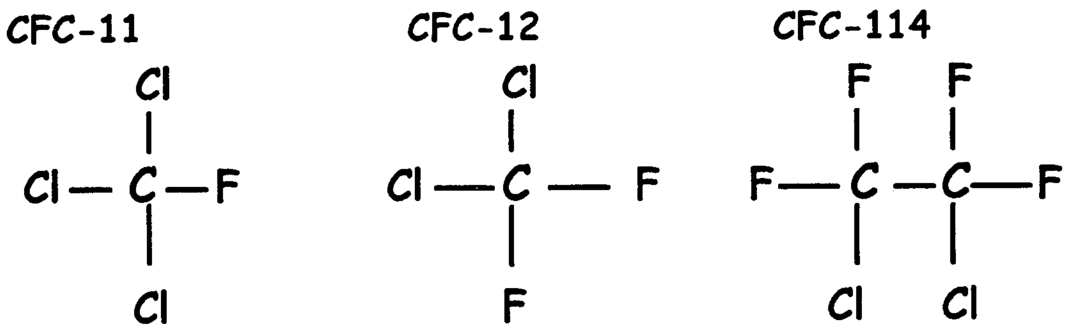
Teacher Background Information: Chlorofluorocarbons (CFCs)

Carbon compounds containing fluorine as well as are called *chlorofluorocarbons* (CFCS), and they are perhaps best known as *Freons,* from their DuPont trade name. At room temperature the CFCS are gases or liquids with low boiling temperatures. They are essentially insoluble in water and inert toward most other substances. These properties make them ideal propellants for use in cans of deodorants, hair sprays and food products. Unfortunately, the inertness of these compounds allows them to persist in the environment for long periods of time.



Examples of chlorofluorocarbon compounds

CFCs have been identified as the primary culprits in the destruction of stratospheric ozone. Because of their long lifetimes in the atmosphere and the fact that they are strong absorbers of infrared energy, they are also recognized as important greenhouse gases. Their sources, sinks and atmospheric distributions have been reviewed in detail. Most CFCS, with the exception of CH_3Cl (methyl chloride), are exclusively of industrial origin. They are used as aerosol propellants, refrigerants, foam blowing agents, solvents for cleaning electronic equipment, and fire retardants. Emission fluxes for 1990 were: CFC-1: 350 Gt/y; CFC-12: 450 Gt/yr; and CFC-113: 150 Gt/yr. The fluxes for others are significantly smaller. As a result of the rapid phase-out required by the Montreal Protocol and its Amendments, the growth rates of atmospheric CFCS, particularly CFC-11 and CFC-12, began to slow in 1991. By mid-1994 global levels of CFC-12 had stopped growing and CFC-11 levels had begun to decline.

There are no significant sinks or removal mechanisms for CFCS. They have long lifetimes in the atmosphere, from decades to centuries, and are primarily removed by photodissociation in the stratosphere. Over the past few decades their concentrations have increased more rapidly (on a percentage basis) than the other than the other greenhouse gases, currently at rates of at least 4% per year.

Many governments, recognizing the harmful effects of CFCs, signed the Montreal Protocol in 1987 to limit their production and consumption in developed countries by 1990. The control measures of the Montreal Protocol freeze the production and consumption of CFCs 11, 12, 113, 114, 115 in developed countries at their 1986 levels beginning in the year 1990, a reduction of 80% of their 1986 levels by 1993, and a further reduction of 50% of their 1986 levels by the year 1998. Developing countries with a per capita use of less than 0.3 kg per capita, are allowed to increase their per capita use up to this limit and can delay compliance with the control measures by 10 years. All major producing and consuming developed countries, and many developing countries, have signed and ratified the Montreal Protocol and successive legislation. Their will likely be a complete global phase-out of these particular chemicals by the year 2000. However, even with a complete cessation of production, concentrations of CFCs will still be significant for at least the next century because of their long atmospheric lifetimes.

A number of new compounds, hydrofluorocarbons (HFCs) and hydrochloro - fluorocarbons (HCFCs) are being considered as replacements for the long-lived CFCs that are regulated under the Montreal Protocol. The lifetimes of these chemicals are controlled by their reaction with tropospheric OH and range between 1 and 40 years. It is estimated that the HFCs and HCFCs will replace the currently used CFCs at a rate of about 0.4 kg of substitute for every kn of CFCs currently produced, with a growth rate of about 3%. Because of their shorter lifetimes and expected rates of substitution and emission, the atmospheric concentrations of HFCs and HCFCs will be much lower than if CFCs ahd continued to be used even at current rates. However, continued use accompanied by increased emissions of these chemicals could result in atmospheric concentrations that would be important in relation to their global warming potential.