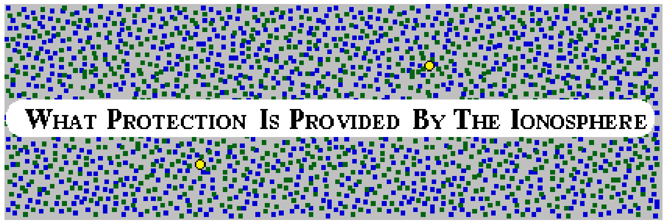
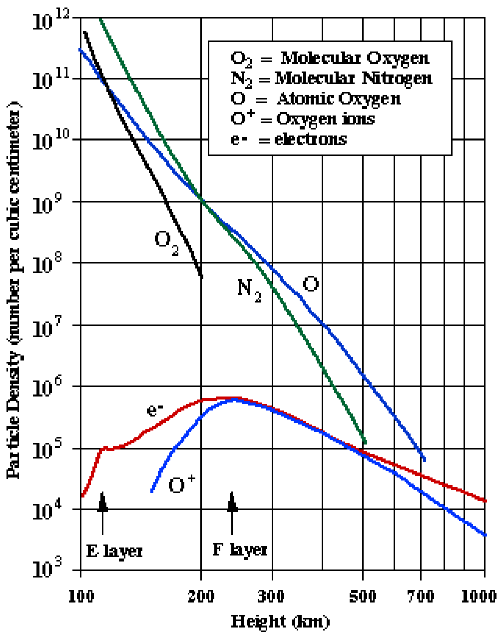
The High Frequency Active Auroral Research Program

HAARP

Home	About HAARP	Technical	On-Line Data	Learn	Photos	Contacts



Earth's atmosphere is a mixture of gases, mostly Nitrogen and Oxygen. At the surface, nearly all of these gases are in molecular form (ie., two atoms of Oxygen, O_2 or two atoms of Nitrogen, N_2). As the altitude above the earth increases, the density of the gases decreases rapidly and the makeup of the gases also changes as some of the molecules are broken into individual atoms by incoming solar radiation. The figure to the left shows how the concentration of atomic and molecular gases changes as the altitude above the earth's surface increases.



At ionospheric heights, atmospheric gases have thinned out dramatically. Moreover, at ionospheric altitudes, atomic Oxygen, O, dominates molecular Oxygen, O_2. In ionospheric physics, these non-ionized particles are called "**neutrals**."

The gases at *all* heights provide protection from the sun's ultraviolet (UV) radiation. At the highest levels of the ionosphere where the F2 layer is found (above 250 km or 150 miles), the gases interact with Extreme Ultraviolet (EUV) radiation. At lower altitudes (less than 30 km or 20 miles), far below the height where HAARP has any effect, the gases interact with lower energy UV and create and are absorbed by the ozone layer. Again, HAARP has no affect on the gases at these lower altitudes.

In the ionosphere, protection is obtained when a **neutral** atom absorbs incoming radiation from the sun (a photon) and becomes an **ion** when one of its **electrons** is liberated. (Please also see the About the Ionosphere page where this process is discussed in greater detail.)

Prior to the absorption of the incoming EUV radiation, we have:

> One high energy (EUV) photon
> One Oxygen atom (a "neutral")

The photon gives up its energy in the collision and causes one of the electrons of the oxygen atom to be dislodged. The result is:

> No EUV photon (it has been consumed in the collision)
> One Oxygen ion (positively charged)
> One electron (negatively charged)

The result has been that a neutral (an oxygen atom) has been ionized and an incoming photon has

Search the Site

Search

Quick Links

Select a Page

Home Page
Site Map
Glossary of Terms

About the Ionosphere
(Wikipedia)

About the Ionosphere
(UCAR)

The Ozone Layer
(NOAA)

The Ozone Layer
(NASA)

How to Contact HAARP
Privacy Statement

Please read the
Cautionary statement

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Page updated November 17, 2007

been blocked. This is the process by which ionization occurs. Referring to the chart, at the height of the F2 layer where the peak of ionization occurs, the density of ionized atoms (almost entirely Oxygen at this altitude) is around 700,000 to 1,000,000 per cubic centimeter (cm^3). Electrons have the same density. The density of non-ionized, or neutral Oxygen atoms is around 500,000,000 per cm^3 or about 500 times as many in any given volume. The density of Nitrogen (molecular at this altitude) is equal to that of Oxygen (again 500 times as great as the ions).

We have used the heading image on this page to illustrate this point. The blue dots could represent the number of Oxygen **neutrals** in a given volume at 250 km (150 miles) the height of the peak ion density in the F2 layer. The green dots would then represent the number of Nitrogen **neutrals** present in the same volume. There are 1000 of each. The **ions** in this volume would then be represented by the two yellow dots, a ratio of 500 to one.

While it is certainly possible that an incoming EUV photon may collide with an already-ionized Oxygen atom, it is clear that the neutral Oxygen atoms greatly outnumber (by 500:1) the ionized Oxygen atoms. Clearly, the neutrals are the primary protection - not the ionized atoms. (Electrons, because of their very small cross section, do not afford any protection from UV radiation). Another way of looking at this is that the ionization in this part of the earth's atmosphere is the **manifestation** of the protection being afforded by the neutrals. The ionization does not, in itself, provide any meaningful protection and the fact that ionization disappears at night is further evidence that the protecting action of the neutrals has ceased temporarily, until the sun rises.

HAARP creates an external electric field at the F2 layer height. Particles interact with an electric field only if they are charged (ionized). As a result, HAARP only affects the 0.2% of the ionospheric volume directly over the facility that has already been ionized by the sun (the yellow dots in the image). The remaining 99.8% of the gas in this limited volume is in the neutral state and remains unaffected by HAARP and ready to intercept incoming UV radiation. That portion of the ionosphere that is not directly over the facility is **not affected in any way** by HAARP. As a result, there will be no impact produced by HAARP on the protective qualities of the earth's atmosphere. This was the conclusion of the environmental impact process, and the question was thoroughly studied by experts in the field prior to granting permission to proceed with the project.

It is very important to realize that the bulk composition of the gas in the volume that is being studied changes imperceptibly. The protective qualities of the atmosphere over HAARP do not change. It takes very sensitive instruments to observe the effects, and some of the best instruments currently available for this purpose are installed at the HAARP facility.

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previous next

References

[1] Kelley, M. C., **The Earth's Ionosphere**, Academic Press, Inc:San Diego 1989.
[2] Davies, Kenneth, **Ionospheric Radio**, Peter Peregrinus Ltd.:London, 1990.

Pioneering Ionospheric Radio Science Research for the Twenty-First Century

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