

atmospheric transformation product. Ground-level O_3 formation is the result of chemical reactions of VOC, NO_x , and oxygen in the presence of sunlight and generally at elevated temperatures. As a principal ingredient in photochemical smog, elevated episodic concentrations of ground-level O_3 typically occur in the summertime. High concentrations may be found in and downwind of major urban centers as well as across broad regions of elevated precursor emissions. A detailed discussion of atmospheric formation, ambient concentrations, and health and welfare effects associated with direct exposure to O_3 can be found in the Criteria Document and Staff Paper.

Naturally occurring O_3 is found in two sections of the earth's atmosphere,

the stratosphere and the troposphere. The demarcation between these two layers varies between about 8 and 18 kilometers (km) above the earth's surface. As illustrated in Figure 1, depicting the vertical profile of O_3 , most naturally occurring O_3 (> 90 percent) resides in the stratosphere, with the remaining O_3 (< 10 percent) in the troposphere. The band of O_3 between about 15 and 30 km is commonly known as the "ozone layer."

Man-made air pollution has significantly perturbed the natural distribution of O_3 in both layers. It is now widely accepted that emissions of long-lived chlorofluorocarbons (CFCs) and other compounds can deplete the natural O_3 layer in the stratosphere. And, as summarized above, much

shorter lived emissions of VOC and NO_x can markedly increase "smog" O_3 in the lowest portion of the troposphere, which is termed the planetary boundary layer. This fluctuating planetary boundary or "mixing" layer of the troposphere can extend as high as 1 to 3 km above the ground. Assuming a fairly high summertime O_3 pollution reservoir of 65 parts per billion (ppb) in a typical 1 km mixing layer, Cupitt (1994) estimated that pollution would add less than 1 percent to the expected total vertical profile of tropospheric and stratospheric O_3 (*i.e.*, "total column" O_3) that would occur in the natural environment.

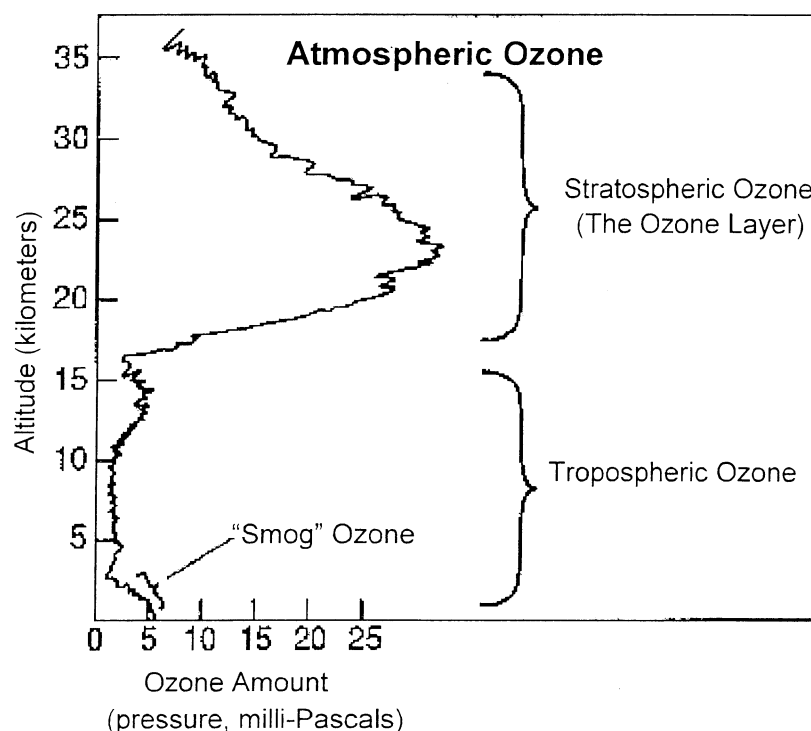


Figure 1. Distribution of Ozone in the Atmosphere
(adapted from World Meteorological Organization, 1994, p. 20)

Ozone at ground level and throughout the troposphere is chemically identical to stratospheric O_3 . Stratospheric O_3 occurs far too high to present any threat of direct respiratory-related adverse effects to people or plants from ambient ground-level exposures, but is known to provide a natural protective shield from excess radiation from the sun by absorbing UV-B radiation¹⁰ before it

penetrates to ground level. Recognizing that exposure to UV-B radiation has been associated with adverse health and welfare effects, EPA and international scientific, regulatory, and legislative organizations have for some time focused on understanding the effects of UV-B radiation and on controlling the man-made pollution that is causing the depletion of the O_3 layer in the

stratosphere, as discussed in section I.D below.¹¹

During the 1997 review, EPA recognized that tropospheric O_3 also absorbs UV-B radiation (U.S. EPA, 1996a, p. 5-79), such that ground-level O_3 formed by man-made pollution has the potential to provide some degree of additional shielding beyond the natural

¹⁰ UV-B radiation refers to the region of the solar spectrum within the range of wavelengths generally

from 280-290 nanometers (nm) at the lower end, to 315-320 nm at the upper end.

¹¹ For example, in 1977 and again in 1990, Congress added provisions to the Act to address stratospheric O_3 depletion and the resultant increase in exposure to UV-B radiation.