Q4: Is total ozone uniform over the globe?

No, the total amount of ozone above the surface of Earth varies with location on time scales that range from daily to seasonal. The variations are caused by stratospheric winds and the chemical production and destruction of ozone. Total ozone is generally lowest at the equator and highest near the poles because of the seasonal wind patterns in the stratosphere.

Total ozone. Total ozone at any location on the globe is found by measuring all the ozone in the atmosphere directly above that location. Total ozone includes that present in the stratospheric ozone layer and that present throughout the troposphere (see ***Figure Q1-2***). The contribution from the troposphere is generally only about 10% of total ozone. Total ozone values are often reported in *Dobson units,* denoted "DU." Typical values vary between 200 and 500 DU over the globe (see ***Figure Q4-1***). A total ozone value of 500 DU, for example, is equivalent to a layer of pure ozone gas on Earth's surface having a thickness of only 0.5 centimeters (0.2 inches).

Global distribution. Total ozone varies strongly with latitude over the globe, with the largest values occurring at middle and high latitudes (see ***Figure Q4-1***). This is a result of winds that circulate air in the stratosphere, moving tropical air rich in ozone toward the poles in fall and winter. Regions of low total ozone occur at polar latitudes in winter and spring as a result of the chemical destruction of ozone by chlorine and bromine gases (see *Q11* and *Q12*). The smallest values of total ozone (other than in the Antarctic in spring) occur in the tropics in all seasons, in part because the thickness of the ozone layer is smallest in the tropics.

Natural variations. The variations of total ozone with latitude and longitude come about for two reasons. First, natural air motions mix air between regions of the stratosphere that have high ozone values and those that have low ozone values. Air motions also increase the vertical thickness of the ozone layer near the poles, which increases the value of total ozone in those regions. Tropospheric weather systems can temporarily reduce the thickness of the stratospheric ozone layer in a region, lowering total ozone at the same time. Second, variations occur as a result of changes in the balance of chemical production and loss processes as air moves to new locations over the globe. Reductions in solar ultraviolet radiation exposure, for example, will reduce the production of ozone.

Scientists have a good understanding of how chemistry and air motion work together to cause the observed large-scale features in total ozone such as those seen in ***Figure Q4-1***. Ozone changes are carefully monitored by a large group of investigators using satellite, airborne, and ground-based instruments. The analysis of these observations helps scientists to estimate the contribution of human activities to ozone depletion.

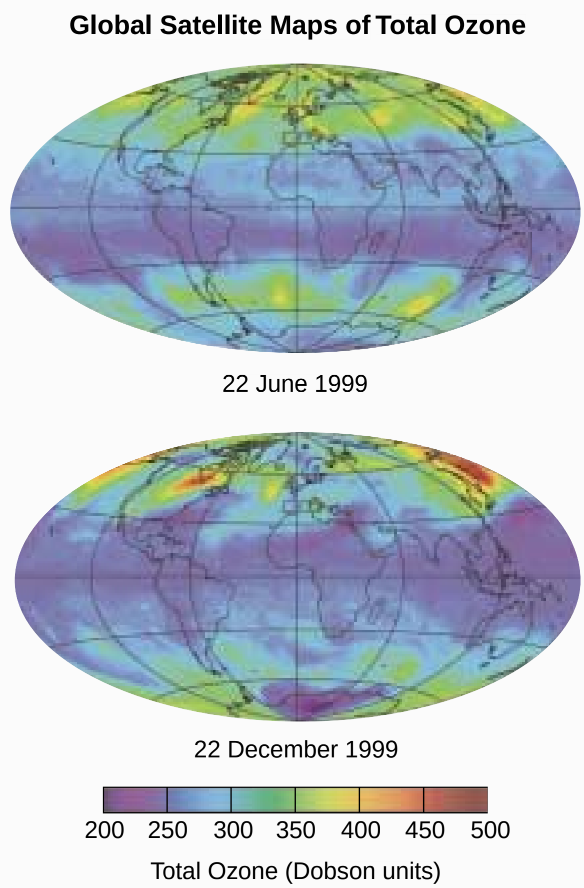

Figure Q4-1. Total ozone. A total ozone value is obtained by measuring all the ozone that resides in the atmosphere over a given location on Earth's surface. Total ozone values shown here are reported in "Dobson units" as measured by a satellite instrument from space. Total ozone varies with latitude, longitude, and season, with the largest values at high latitudes and the lowest values in tropical regions. Total ozone at most locations varies with time on a daily to seasonal basis as ozone-rich air is moved about the globe by stratospheric winds. Low total ozone values over Antarctica in the 22 December image represent the remainder of the "ozone hole" from the 1999 Antarctic winter/spring season (see *Q11*).