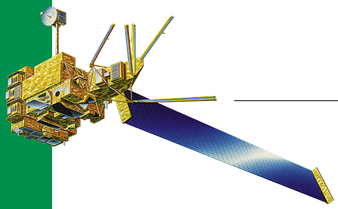

Arctic Ozone Decrease in 1997 Spring

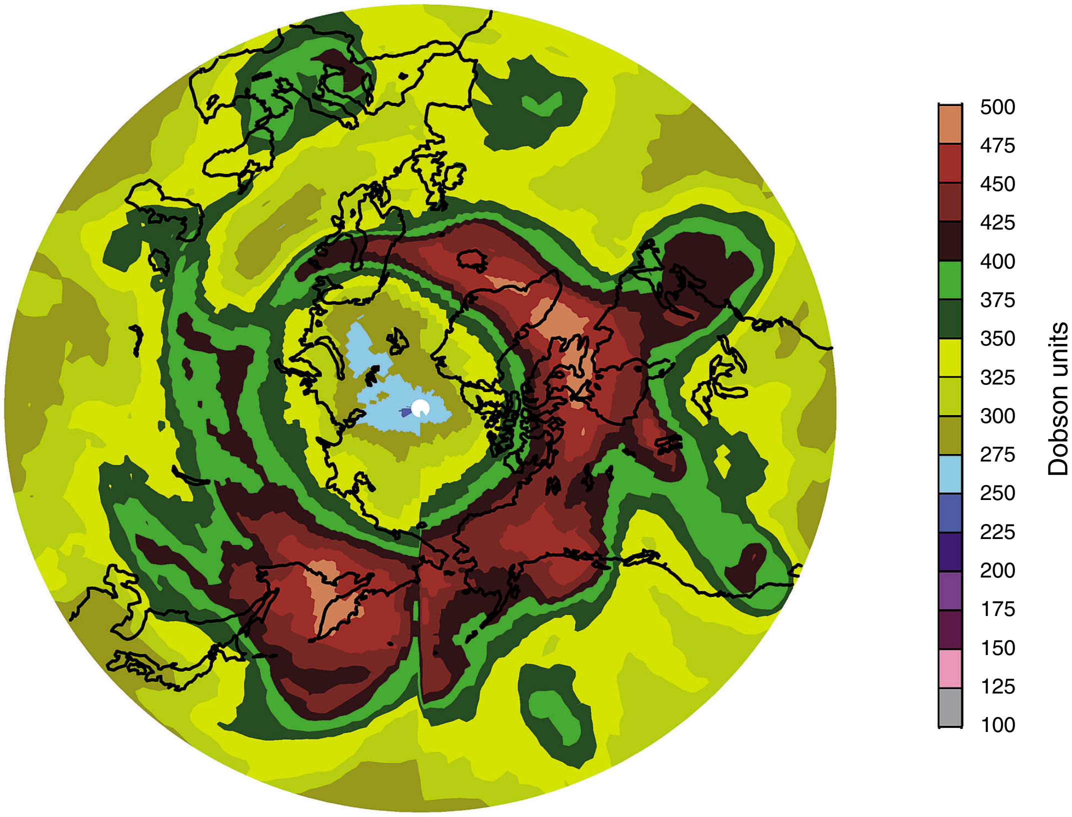

Fig.1 Total Ozone on 2 April 1997

Provided by NASDA/NASA

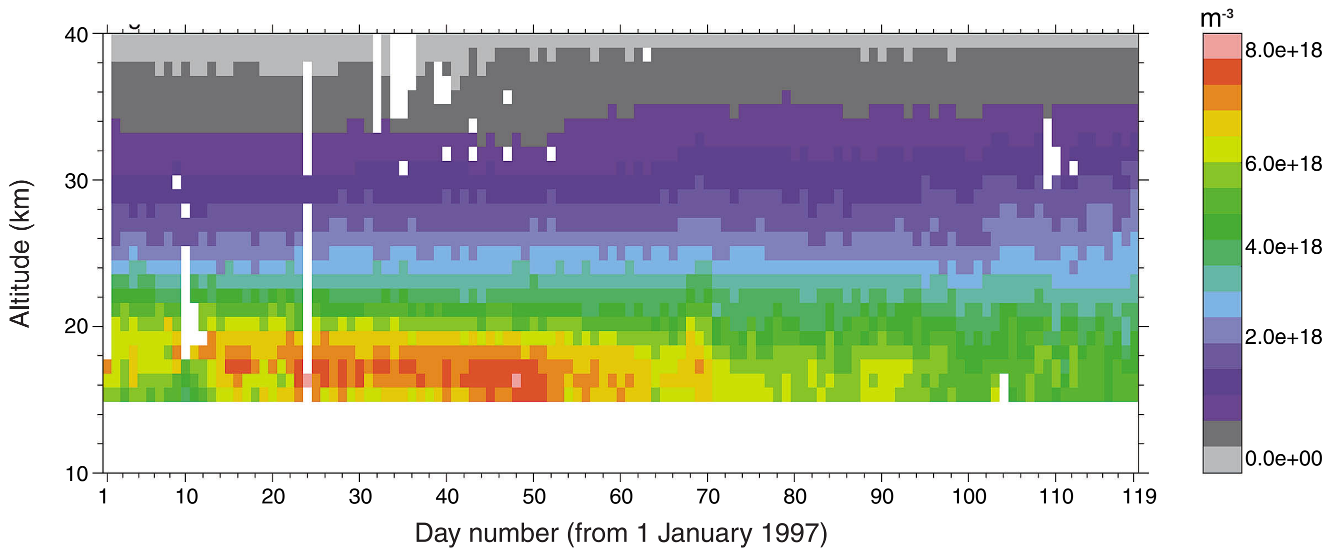

Fig.2 Change in Vertical Ozone Profiles in the Northern Polar Vortex from 1 January to 30 April 1997

Produced by NIES using ADEOS ILAS data

Arctic Ozone Decrease in 1997 Spring

The ozone hole first appeared in the Antarctic spring in the 1980s. The ozone hole is a phenomenon in which ozone is depleted in the lower stratosphere inside the polar vortex (*1) over the Antarctic continent. It occurrs as a consequence of destruction of ozone due to the man-made chlorine, bromine, fluorine, and carbon compounds such as chlorofluorocarbons (CFCs). These substances, once emitted into the atmosphere, move and diffuse up to the stratosphere where they yield active chlorine and bromine to catalytically destroy ozone. The production of these substances has been phased out by international agreement, but it will take more than 10 years for the atmospheric chlorine and bromine concentrations to begin to decrease.

The formation of the ozone hole requires a meteorological condition peculiar to the Antarctic stratosphere. In this condition, the polar vortex is stable and almost circular around the pole, enabling a low temperature to be sustained within the vortex throughout the austral winter. Scientists previously believed that ozone depletion similar to the Antarctic ozone hole should not occur in the Arctic, as the polar vortex frequently meanders southward and sometimes breaks during the winter in the northern hemisohere. However, in the 1990s, the decreasing trend of ozone in the lower stratosphere became significant in winter and spring in high latitudes in the northern hemisphere, ensuring ozone destruction due to chlorine or bromine in the Arctic lower stratosphere.

Under these circumstances, total ozone measurements were begun with the TOMS instrument aboard ADEOS. In spring 1997, TOMS illustrated an ozone decrease in the Arctic quite similar to the Antarctic ozone hole. Figure 1 is the polar projection of the horizontal distribution of total ozone on 2 April 1997. The region of less ozone extends over the Arctic sea, with a low total ozone value of 250 to 275 Dobson Units, which is about 40 percent lower than those for normal years. The Arctic winter started later in 1996/1997 than in normal years, and the stratospheric temperature was warmer than normal. However, in mid-January 1997, the stratospheric temperature became low enough for the polar stratospheric clouds to form, and the polar vortex became stronger and relatively stable. As a consequence, a stable ozone-depleted area existed around the pole in March and continued until the end of April.

In the figure 1. the region of large ozone content can be seen in the equatorial side of the circumpolar region of low ozone content. That region extends to the middle latitudes in some longitudes and time periods in the winter/spring period; Japan is located in the southernmost edge of that region. According to this figure, the total ozone over Japan is less than 300 Dobson Units. This is less than those of the normal years, suggesting that the ozone depletion in the Arctic may influence the ozone layer over Japan. The increase of solar ultraviolet radiation due to the ozone decrease should be a greater concern as a greater ultraviolet dose would be probable outdoors in this time period because of the relatively high solar elevation angle. Consequently, a watch on the ozone layer should be maintained.

Figure 2 shows the time variation of ozone density profiles inside the Arctic polar vortex derived from the ILAS data from 1 January to 30 April 1997. The ozone density decreases in the lower stratosphere at altitudes of 15 to 20 kilometers from mid-March to mid-April. The height of maximum ozone density is also seen to decrease from 18 kilometers to 16 kilometers from mid-February to mid-April, as reflected by the downward motion of the air mass inside the polar vortex.

In 1998 spring, the Arctic ozone dramatically changed from that in 1997 spring, and returned to the situation before 1990s. It is likely that there remains a world of complexity and large variability in the atmosphere beyond our present knowledge.

*1 Polar vortex: Circumpolar stratospheric jet stream in winter and spring in both northern and southern hemisphere.