Ozone depletion is proven to be a scientific fraud

The ozone hole in Antarctica was discovered in 1956, not 1985, and its fluctuations were documented by ozone research pioneer Gordon Dobson. Rogelio A. Maduro reports.

The environmentalist lobby's dream of shutting down modern industrial technologies got closer to realization last March 6, when representatives from 124 countries met in London for a three-day extravaganza dedicated to "saving the ozone layer." On the table was the complete banning of chlorofluorocarbons (CFCs) by the end of the century. Although no conclusive treaty was signed, largely due to the opposition by Third World nations which will be devastated by such a ban, the world is moving toward such a ban, step by step. CFCs, which comprise some of the most useful and versatile chemicals ever invented, are being demonized by the environmentalists, who allege that CFCs have the potential for poking holes in the Earth's delicate ozone layer. The facts, however, indicate that there is no hard scientific evidence that CFCs are depleting the ozone layer. The present hysteria being pushed by the news media is not only unfounded, but the latest chapter of what later became known in the 1960s and '70s as *The Ozone Wars*, after the 1978 book, by L. Dotto and H. Schiff. During that period, environmentalists alleged that chemicals from pesticides to fertilizers, nuclear tests, and vehicles from the Supersonic Transport to the Space Shuttle, were going to poke holes in the ozone layer.

Every single such theory was proven to be a fraud by scientific observation of the behavior of the ozone layer, and the controversy died out, until banner press headlines in 1985-86 blared that a huge ozone hole had suddenly been discovered in Antarctica by intrepid scientists from a British Antarctic Expedition led by Robert Watson. The sudden discovery of this "ozone hole" put the controversy on the front burner, and without much ado a conference was organized in Montreal, where 17 nations, led by the United States and Canada, decided on a 50% ban of CFCs, which were made the culprit. The fact that the "ozone hole" over Antarctica had already been discovered in 1956 by the world's leading ozone layer researcher, Gordon Dobson, and his collaborators, was, at the same time, carefully suppressed from all newspaper accounts. In 1956 CFCs were not in wide use, so the hole couldn't be blamed on them. Dobson correctly postulated the "ozone hole" to be a fascinating natural anomaly.

As we will prove, there has been a systematic campaign of deceit, disinformation, suppression, and threats carried out worldwide to perpetrate this scientific fraud. This is a very serious question, since the banning of CFCs will cost hundreds of billions of dollars, and result in massive impoverishment and death among large portions of the world's population. One of the CFCs to be banned is freon, the main refrigerant used to maintain food from spoilage. Depriving Third World nations, whose resources are at the breaking point, of this benign, non-toxic chemical, means death.

Who benefits? Three leading scientists, who requested anonymity in interviews with *EIR*, have insisted that DuPont Chemicals is behind the banning of CFCs. These scientists have pointed out that DuPont, the only company with patented chemicals that can replace CFCs, stands to profit billions if the CFCs are banned. It was only because DuPont suddenly decided to drop all opposition to a CFC ban that the environmentalists have gotten as far as they have.

Ozone depletion: the scientific fraud

In 1974, two chemists from the University of California, F. Sherwood Rowland and Mario J. Molina, wrote the first technical scare paper condemning chlorofluorocarbons as evil chemicals with the potential for eating up to 10% of the ozone layer. The CFCs are inert chemicals and do not react with other chemicals. Therefore, Rowland postulated, by some unexplained mechanism large numbers of CFCs would rise

30 km into the stratosphere. There, CFCs would be broken up by the same ultraviolet radiation which forms ozone molecules. That will result in the release of a chlorine atom, Cl. This chlorine atom would then combine with ozone molecules, O_3, and break them up. As a catalytic reaction, this would then continue thousands of times, the chlorine molecule breaking up thousands of ozone molecules.

Now, this is all part of a "theoretical model." There are at least 192 chemical reactions and 48 photochemical processes that occur in the stratosphere. Most of these reactions are very fast processes, involving highly reactive species, particularly free radicals and atoms in excited states, whose reactions can affect the chemistry of the stratosphere at very small concentrations. Most of these reactions are extremely difficult even to reproduce in the laboratory, much less to measure their rates. To take a couple of reactions involving just a few molecules, carry them out in an isolated laboratory environment, and then claim this is what happens in the stratosphere (where it can't be measured), is patently absurd.

For this reason, Sherwood and Molina carefully prefaced their paper with the following: "We have *attempted* to calculate the *probable* sinks and lifetimes of these molecules." (Emphasis added.) Such disclaimers never make it to the press; a theoretical model is reported as observed fact. Rowland and his colleagues now point to levels of chlorine at the Antarctic measuring station, which have been reported to be 50-60 times higher than the levels expected, as proof that CFCs are breaking down into chlorine.

The fact is that a few miles upwind from the Antarctic observation post there is a volcano, Mt. Erebus, which has been erupting since 1982, and has been putting more than 1,000 tons of chlorine gases into the atmosphere every day, on average, for the past several years. What has been suppressed is the fact that the major source of atmospheric chlorine is not CFCs, but volcanoes, storms, and the burning of vegetation.

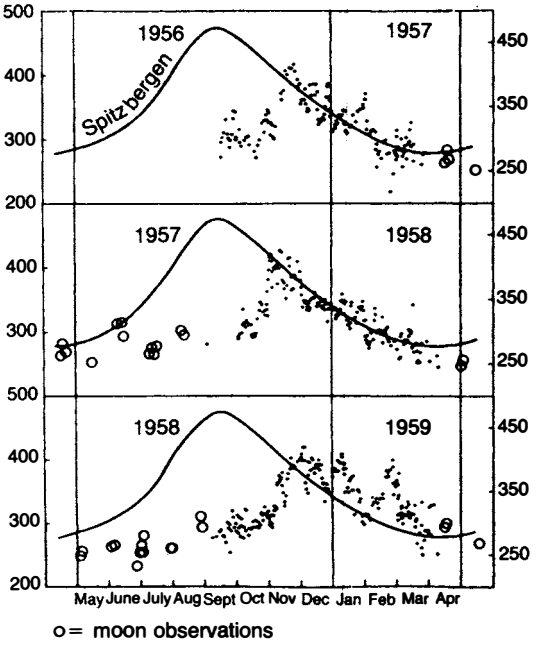
The ozone hole

For the past year Marcel Nicolet, the founder and director of the Institut d'Aéronomie Spatiale de Belgique in Brussels, has been publicly denouncing the claims that CFCs are depleting the ozone layer. Nicolet, one of the pioneer researchers of the ozone layer, was working together with Gordon Dobson in 1956, when they discovered the ozone hole in Antarctica. Nicolet maintains that the ozone hole is a natural oscillation of the weather systems, which periodically goes up and down, and told the German *Die Welt* magazine last March that he doesn't believe CFCs are to blame: "The natural fluctuations in ozone and the discrepancies in measurement are simply too great."

Gordon Dobson also believed the ozone hole to be a natural phenomenon. The ozone layer is measured in Dobson units, and the standard equipment is the Dobson spectrophotometer. In an article entitled "Forty Years' Research on

FIGURE 1

The first three years' observations at Halley Bay, Antarctica



Source: *Applied Optics*, March 1968, Vol. 7, No. 3.

Dobson's original caption reads "The full curve is for Spitzbergen [near the North Pole], shifted by six months. Note the lower values of ozone in the southern spring and the sudden increase in November at the time of the final atmospheric warming." The Antarctic data is represented by individual dots in the chart, representing readings of ozone layer thickness. The amount of ozone take a huge leap at the end of October, as can be seen from Dobson's figure, when the polar vortex breaks up.

Atmospheric Ozone at Oxford: A History," which appeared in *Applied Optics* magazine in March 1968, Dobson states:

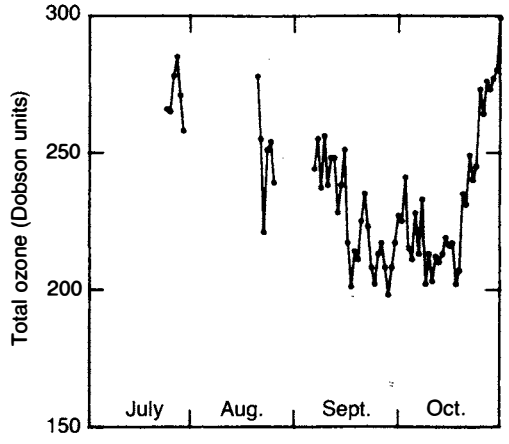
"One of the most interesting results on atmospheric ozone which came out of the IGY [International Geophysical Year] was the discovery of the peculiar annual variation of ozone at Halley Bay. This particular ozone instrument had been to Shotover to be checked up immediately before leaving England. Moreover, Evans, who took the original observations at Halley Bay, had also been to Shotover to become familiar with the working of the instrument and its maintenance. The annual variation of ozone at Spitzbergen [near the North Pole] was fairly well known at that time, so, assuming a six months difference, we knew what to expect. However, when the monthly telegrams from Halley Bay began to arrive and were plotted alongside the Spitzbergen curve, the values for September and October 1956 were about 150 [Dobson] units lower than was expected. We naturally thought that Evans had made some large mistake or that, in spite of checking just before leaving England, the instrument had developed

some fault. In November the ozone values suddenly jumped up to those expected from the Spitzbergen results. It was not until a year later, when the same type of annual variation was repeated, that *we realized that the early results were indeed correct and that Halley Bay showed a most interesting difference from other parts of the world. It was clear that the winter vortex over the South Pole was maintained late into the spring and that this kept the ozone values low. When it suddenly broke up in November both the ozone values and the stratosphere temperatures suddenly rose.*" (Emphasis added. See **Figures 1** and **2.**)

Most of the scientists presently researching the ozone hole believe the ozone is a natural phenomenon, with CFCs playing perhaps a minimal role, if any. This is reflected in the Antarctic ozone depletion special issue of the *Geophysical Research Letters* from November 1986. The overview of the 46 scientific papers presented there was written by Mark R. Schoeberl and Arlin J. Krueger from the NASA/Goddard Space Flight Center in Greenbelt, Maryland.

They state that, "Despite the number of public pronouncements, no clear link between man-made pollutants and ozone depletion over Antarctica has been established; indeed, a number of papers in this issue present serious alternatives to and constraints on the suggested chemical scenarios. . . . The appearance of the South Polar total ozone minimum and higher values at mid-latitudes in the spring has been observed since the late 1950s well before man-made pollutants could have had any important impact on the stratosphere." The scientists end their introduction, "The mechanism behind the ozone hole is still unknown. However, a number of investigators suggest that a large part of the decrease in Antarctic total ozone and stratospheric temperature is the result of small climatic shift in the upper atmosphere, and this region is simply mirroring changes in the lower atmosphere. . . . If a large part of the decrease . . . is shown conclusively to be simply due to a change in the climate of the stratosphere, then it will become increasingly difficult to produce incontrovertible evidence of the chemical destruction of the ozone layer over the background natural variability."

FIGURE 2
Ozone values at Halley in 1988



Source: Letter from J.C. Farman, B.G. Gardiner, J.D. Shanklin, British Antarctic Survey, *Nature*, Nov. 17, 1988.

Notice the same general shape for the ozone hole, and the large jump in the thickness of the ozone layer following the breakup of the polar vortex.

'The ozone wars'

The environmentalists have mustered other phony arguments for the past 30 years to ban all sorts of chemicals and

If nothing else works, say it causes cancer

Robert Watson and the Ozone Trends Panel dramatically announced to the international press in August 1988 that the ozone layer between 29° and 39° N. latitude range had decreased by 3.7%, and 2.7% in the latitude range from 39° to 53° N. between 1978 and 1985, using data from satellite-based instruments. The announcement drew banner headline stories about a massive increase in skin cancer from higher doses of ultraviolet radiation. The line that Watson and F. Sherwood Rowland and the anti-CFC crowd were pushing was that a 1% decrease in stratospheric ozone would cause about a 2% increase in the amount of biologically effective ultraviolet radiation (UVB, 2900-3300Å.) This is the wavelength of solar ultraviolet radiation that can produce sunburn in humans and skin cancer in laboratory animals. The conclusions, thus, were that the alleged depletion of the ozone layer by CFCs had thereby increased the amount of UVB reaching the Earth by at least 7.4%, with a concomitant rise in skin cancer, and devastating effects on plant and animal life.

The claims made by Watson and the Ozone Trends Panel, however, do not stand up to scientific scrutiny. In a study published in *Science* on Feb. 12, 1988, Joseph Scotto from the Biostatistics Branch of the National Cancer Institute and several collaborators, presented hard, scientific evidence showing that the amount of UVB radiation reaching ground levels across the United States had not only not increased, but actually decreased 0.7%

vehicles that were allegedly destroying the ozone layer. In addition to CFCs, they say the ozone layer will be destroyed by:

1. The operation in the stratosphere and mesosphere of aircraft and rockets exhausting water vapor (H_2O), nitrogen oxide (NOx), or clorine (Cl). This was the argument used by the ecological fascists, led by then-Sen. William Proxmire (D-Wisc.), to ban the testing of the Supersonic Transport in 1971. The SST would have been three times the size of the Concorde as well as a lot faster and cheaper. This occurred even though the actual scientific data from meteorological observations contradicted the main thesis that increased water vapor would destroy the ozone layer.

2. Detonation of nuclear devices whose debris clouds can produce or carry NOx into the stratosphere or mesosphere. The environmentalists had whipped up mass hysteria, predicting the destruction of the ozone layer due to these nuclear blasts in the 1950s and 1960s, which never occurred! In 1973, eleven years after the last major U.S. atmospheric nuclear test, scientist P. Goldsmith wrote in *Nature* that, "Analysis of the ozone records reveal no detectable changes in the total atmospheric ozone during and after the periods of nuclear weapons testing. Although two models of nitrogen oxide injection [SSTs and nuclear bombs] may not be identical from the meteorological viewpoint, the conclusion that massive injections of nitrogen oxides into the stratosphere do not upset the ozone layer seems inescapable."

3. Stimulation of N_2O production by addition of fixed nitrogen to the biosphere whether through nitrogen fertilizers, animal wastes, combustion-produced NOx, expanded growth of legumes, infection of non-leguminous plants with nitrogen-fixing bacteria or by green mulching. This particular

on the average between 1974 and 1985. The study, which has been systematically blacked out of the daily press, was based on readings from a network of eight ground-level monitoring stations that has been tracking measurements of UVB radiation since 1974.

The Scotto study states:

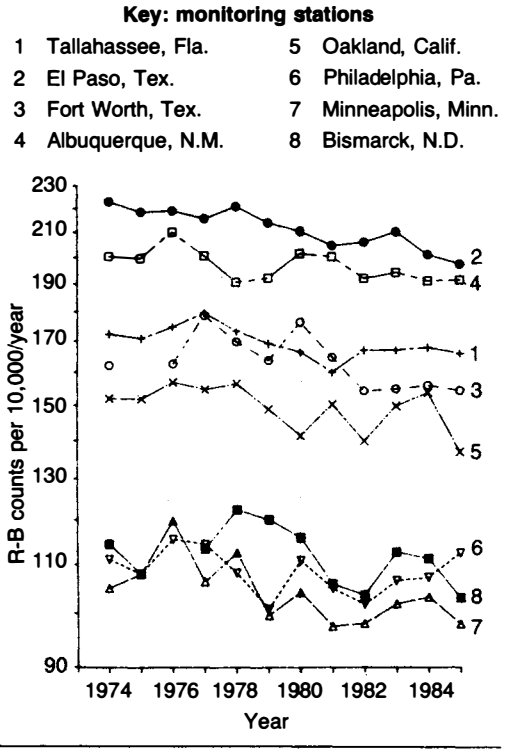
"Average annual R-B counts for two consecutive six-year periods (1974 to 1979 and 1980 to 1985) show a negative shift at each station, with decreases ranging from 2 to 7%. **Figure 3** (semi-logarithmic plot) shows that there are no positive trends in annual R-B counts for 1974 to 1985. . . . The estimated average annual change varied from −1.1% at Minneapolis, Minnesota, to −0.4% at Philadelphia, Pennsylvania. For all the stations the R-B counts dropped an average of 0.7% per year since 1974. . . .

"These results are consistent with earlier reports that used R-B data for a shorter time period from 1974 to 1979 and Dobson meter total column ozone data for the period from 1970 to 1982. Although recent measurements of stratospheric ozone from satellite instruments indicate that total column ozone is being depleted during the 1980s, anticipated resultant increases in solar UVB were not evident. . . .

"Monthly trends of estimated UVB levels showed consistent decreases at each field station. The seasons with the greatest relative decreases were the fall (October, November, or December) and winter (January, February, or March). Analysis of peak daily UVB measures for each of the three 10-day periods within each month showed that the peak day, which is usually cloudless, also had consistent downward trends for the 12-year period. The data were also analyzed with annual calibration factors excluded and the findings remained unchanged."

FIGURE 3

Solar ultraviolet (UVB) trends and annual R-B counts, 1974-85



Source: *Science*, Feb. 12, 1988.

Notice the clear trend toward lower ultraviolet radiation. Greatest total decreases occurred at the field monitoring stations in El Paso, Tex. and Minneapolis, Minn.

silly theory was proposed by Paul J. Crutzen from the Max Planck Institute in 1974, used by environmentalists unsuccessfully to ban fertilizers in agriculture.

4. Atmospheric release of stable chlorine-containing compounds such as chlorocarbons in general and chlorofluorocarbons in particular, which can penetrate the stratosphere before decomposing. This is the original CFC depletion theory proposed by F. Sherwood Rowland and M. Molina in 1974.

5. Atmospheric release of stable bromine-containing compounds such as the CH_3Br, now used as a soil fumigant, which can penetrate the stratosphere before decomposing. Environmentalists were unsuccessful in banning pesticides on the basis of this theory.

6. Stimulation of N_2O production by denitrifying bacteria through increased acidity of precipitation from atmospheric release of oxides of sulfur and nitrogen. This theory claimed that "acid rain" would destroy the ozone layer indirectly through soil bacteria.

7. Operation of the Space Shuttle or similar programs with frequent ballistic return of orbiting vehicles to the atmosphere where they produce NOx by compressional heating. This was a popular hobby horse for the news media in the 1970s, with some scientists even claiming that the space shuttle would make holes in the atmosphere and release the ozone into outer space.

8. Atmospheric release of stable infrared-absorbing gases such as CO_2 or chlorofluorocarbons, which radiatively cool the stratosphere and thus shift the chemical equilibrium concentration of O_3. This mechanism is expected to lead to a thickening rather than a thinning of our ultraviolet screen. Environmentalists have dropped this theory, since it would mean that the avowed "greenhouse effect" would cancel out the "ozone depletion."

One of the world's leading climatologists, Hugh W. Ellsaesser, from Lawrence Livermore National Laboratory in California, who has fought the pseudo-science being pushed by the environmentalists, made the following observations in *Atmospheric Environment* magazine in 1982:

"I can only conclude that . . . during the SST controversy . . . the scientists involved took it upon themselves to act as a priesthood by suppressing information by which the laity could be expected for itself to arrive at conclusions different from those espoused by the priests.

"For example, data indicating concurrent upward trends in ozone and stratospheric water vapor were not widely circulated as long as water vapor was considered theoretically to be a threat to the ozone layer. Also, all during *The Ozone War*, it was quite clear that the principals did not want the public 'to be misled' by being able to estimate thinning of the ozone layer with equatorward displacement, presumably because some might begin to wonder what all the fuss was about. Why the discrepancy between theoretical and observational estimates of stratospheric NOx production rates was ignored remains unclear."

Documentation

Gordon Dobson refutes the ozone priesthood

The most thorough scientific rebuttal of the ozone depletion hysteria being purveyed by the news media is contained in the writings of the foremost pioneer of ozone research, Gordon Dobson. Therefore, we excerpt some relevant sections of a chapter on ozone in Dobson's last published book, Exploring the Atmosphere, *which appeared in 1968.*

Distribution of ozone over the world at different seasons

A. Total Ozone.

We now come to consider the results of the many thousands of measurements of atmospheric ozone that have been made all over the world. It will be convenient to give first a general, worldwide picture and then go on to the changes in the amount of ozone that occurs from day to day and from place to place, and are found to be closely related to changes in the weather conditions. . . . **Figure 4** shows that all places with a latitude greater than 40° N. have a large seasonal variation in the total ozone. Since the ozone is formed by sunlight, it might be expected that at these latitudes the maximum amount would be found in the late summer and the minimum in the late winter, just as the maximum and minimum of temperature are found at these seasons. However, this is far from being the case, the maximum actually being in March or April and the minimum about October. The reason for this will be discussed later. The highest ozone values of all are found in the Arctic regions during the spring, and it is important to note that even in high latitudes the amount of ozone begins to increase during December and January when the Sun is very low even at midday or may actually be below the horizon. It is also interesting to see that during the months of August to November all places with a latitude greater than about 45° N. have almost the same amount of ozone, so that at this season of the year there is hardly any variation in total ozone with latitude; this is an important point to remember when we come to consider how the day-to-day variations of ozone are produced. There is a very rapid decrease in the amount of ozone between latitudes 40° and 30° N., particularly in the spring. South of about 25° N. there seems to be little change of ozone with latitude or with season. It is rather surprising that the tropical belt of low ozone shows little sign of moving north and south with the Sun, being in much the same place in both December and June.

B. Vertical distribution of ozone in different parts of the world.

At all places where observations have been made, at

whatever latitude, little ozone has been found in the troposphere. This is to be expected since ozone is rapidly destroyed at ground level, and the large amount of mixing by turbulence in the troposphere will rapidly transfer ozone from the higher to the lower levels.

In very low latitudes the vertical distribution of ozone is fairly simple and shows little change from day to day and throughout the year. The tropopause here is, of course, always high (about 17 km) and is generally well defined by a sudden increase in temperature. On entering the stratosphere the ozone immediately begins to rise and a regular and steady increase continues up to a maximum at a height of about 25-27 km [see **Figure 5**] Between the tropopause and the maximum, the concentration of ozone increases more than ten times while, owing to the decrease in the density of the air with height, the ozone/air ratio increases more than 100 times. Above about 25-27 km the concentration of ozone begins to decrease at much the same rate as the density of the air decreases, so that the ozone/air ratio remains nearly constant up to the greatest heights reached by balloons (about 35 km).

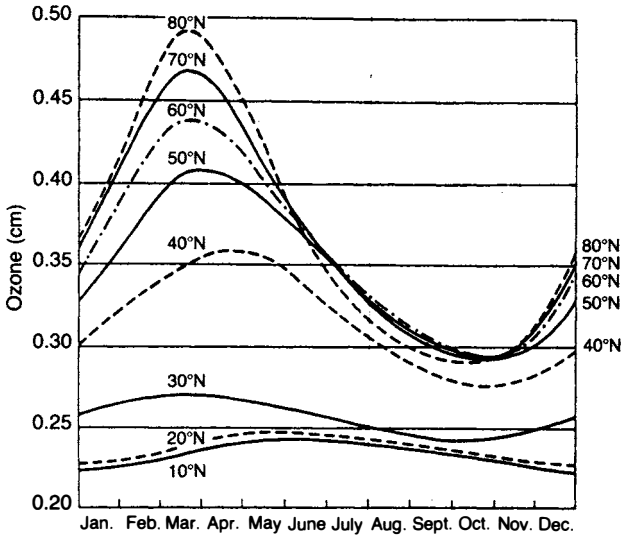
Measurements made in the stratosphere at higher latitudes show a more complicated structure. The level at which the maximum concentration of ozone occurs is much lower near the poles than near the equator, and shows a steady fall with latitude similar to the fall in the height of the tropopause, being only about 18 km at Thule (76° N.) and at Halley Bay (75° S.). Although there is always a general increase in the concentration of ozone with increasing height in the lower stratosphere, there are sometimes large irregularities, and layers of low ozone may be found above layers of higher ozone. In some cases, layers a few kilometers thick are found in which even the ozone/air ratio is less than in a lower layer. . . . The large variations of ozone with height that are sometimes found in the lower stratosphere, in middle and high latitudes, were unexpected, and their cause is still not well understood. They are, however, of much interest. . . .

C. Cause of the variation of ozone with season and latitude.

We must now consider why the ozone in the atmosphere has this curious distribution which we have just described and why it changes in so peculiar a manner from season to season. Since the ozone is formed from oxygen by the photochemical action of sunlight at a height of some 30 km or more, the amount of ozone in this photochemical region may be expected to be greatest at those times and places where the sunlight is most intense, i.e. over the Equator and also in high latitudes in summer. From this photochemical region, the ozone will be carried down by small-scale turbulence, but as the turbulence in the stratosphere is weak, owing to its very stable structure, the transport through the stratosphere will be slow. When the ozone reaches the tropopause it will be caught up in the much stronger turbulence of the troposphere and will be rapidly mixed throughout that region. The amount of ozone in the photochemical region is only about a

FIGURE 4

Annual variation of total ozone for each of 10° of N. latitude



Source: *Exploring the Atmosphere*, by G.M.B. Dobson, 1968.

Notice how thin the ozone layer is near the tropics compared to the middle latitudes. In March the ozone layer is almost three times thicker in northern latitudes compared to the tropics, while at the end of the summer there is a dramatic decrease in the thickness of the ozone layer in northern latitudes, while it remains nearly steady at the tropics. If the ozone layer were depleted by 10% it would be equivalent to having a family pack up and move 84 miles south of their present residence.

quarter of the total ozone in the atmosphere, and the greater part of the ozone is shielded from the active wavelengths of sunlight by the ozone above it and will have a life of some months at least, though any ozone reaching the ground will be rapidly destroyed on contact with vegetation or smoke.

If there were no large-scale movements of air, the ozone distribution over the world might be expected to be similar to that in the photochemical region, but clearly this is not the case, e.g. we find the maximum amount of ozone in high latitudes in spring when, on photochemical grounds, we should expect it to be nearly at a minimum. Any large-scale up or down movements of the air will hinder or help the downward drift of ozone, while large-scale wind currents will transport ozone horizontally to different parts of the world. When looking for the cause of the very dry air in the stratosphere we had to suppose that there was a general, slow, rising current of air from the upper troposphere into the stratosphere in very low latitudes. Such a belt of rising air would also account very well for the low value of the total ozone near the equator.

Air passing upwards from the troposphere into the stratosphere in low latitudes must return to the troposphere some-

where and it is thought that this return takes place mainly in high latitudes [the poles] in winter, and that a given mass of air remains in the stratosphere for a time of the order of six months before it returns to the troposphere. The descent of air in high latitudes in winter is probably aided by the fact that the air at heights of 15-40 km at this season is very cold and therefore heavy. There is probably also some return of air from the stratosphere to the troposphere in cyclonic areas of middle latitudes; it will be remembered that the upper troposphere is very dry in these regions, indicating that the air has descended from the stratosphere.

On entering the equatorial stratosphere the tropospheric air will spread out toward higher latitudes. The descending air at great heights over the winter pole will cause air to flow in from lower latitudes to take its place, and if this movement extends up to the photochemical region, ozone-rich air will be carried polewards, and as it descends it will fill the polar stratosphere with ozone-rich air. Since the tropopause here is low there is relatively much air in the stratosphere, and as this air is rich in ozone the total ozone will be high, agreeing with observation. Observations of the vertical distribution of ozone agree well with these suggestions; the ozone concentration at a height of 25-35 km shows an annual variation with a maximum in the summer and a minimum in the autumn, in agreement with the total ozone.

The concentration of ozone (i.e. ozone per unit volume) is, on the average, nearly constant at all heights throughout the troposphere. . . .

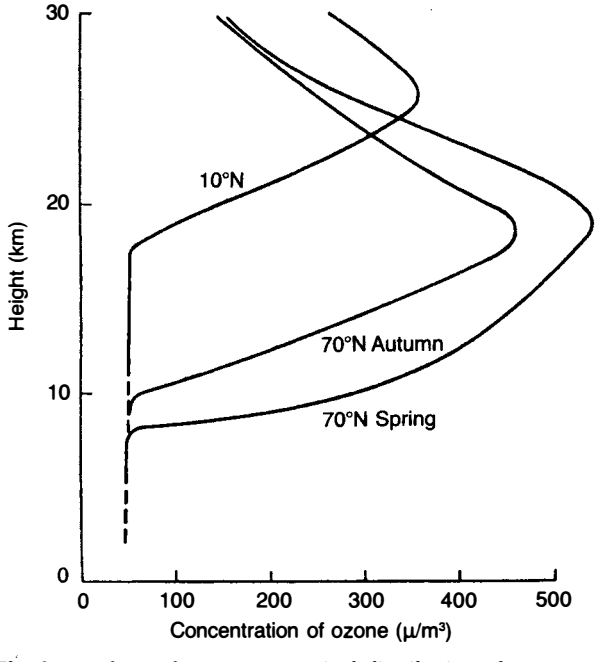
D. Anomalies in the general worldwide pattern.

As already described, the ozone in nearly all parts of the world shows a marked seasonal variation with maximum in the spring and minimum in the autumn, the range increasing from zero at the Equator, until near the North Pole the spring value is nearly twice that in the autumn. Apart from day-to-day changes, which are associated with changing meteorological conditions, the annual curve has a fairly smooth waveform with a tendency to show a steep rise in the spring. There are two major departures from this regular worldwide pattern.

(1) Observations made at Halley Bay in the Weddell Sea (latitude 75°S.), during and since the International Geophysical Year, show that the total ozone there has the usual low value in the autumn, but it does not rise much during the winter, nor even during the spring; then in November—well after the time of the expected spring maximum for the southern hemisphere—the ozone suddenly rises and within a week or two reaches normal values (i.e. values equal to those found at a corresponding season and latitude in the northern hemisphere.) After this it follows the expected curve until the next autumn minimum, but, of course, it never reaches the high values found near the North Pole in March. Measurements of the upper air temperature show that the upper part of the stratosphere at the South Pole is very cold in winter and remains cold during the spring and then suddenly, close to the time of the ozone "jump" in November, the temperature at the highest levels rises sharply and within a few weeks may have risen 50° Centigrade. The change of temperature in the lower stratosphere has undergone a fundamental change. It seems as if in winter the south polar stratosphere is cut off from the general worldwide circulation of air by the very intense vortex of strong westerly winds which blow round the Antarctic continent, enclosing very cold air which is rather weak in ozone; neither the ozone nor the temperature rises much until this vortex suddenly breaks down in November. However, much further work will be necessary before these conditions are fully understood. . . .

FIGURE 5

Average vertical distribution of ozone



The figure shows the average vertical distribution of ozone during the spring and autumn in high latitudes and at all seasons in low latitudes. The rate of decrease of ozone with height above about 30 km is such that the ratio of ozone to air is roughly constant.

Source: *Exploring the Atmosphere*, by G.M.B. Dobson, 1968.

5. Ozone and weather—day-to-day variations

Up to now we have considered the ozone values averaged over a period of a month or more and we now turn to the much more rapid variations which take place within a few days. In the same way we have previously considered only average values over wide areas of the world, averaging out the variations which are found on many days between places

a few hundred miles apart. Actually the rapid, and relatively local, variations of ozone are as large as the seasonal and worldwide variations, so that on a day with relatively low ozone in spring, the ozone value may be the same as on a day with relatively high ozone in the autumn. These rapid, local variations are of great interest since they are found to be closely associated with other meteorological conditions. Since most of the ozone is know to exist above the tropopause, it is only to be expected that these short-period variations would be more closely related to the meteorological conditions in the upper atmosphere than to the surface conditions and this is found to be the case. It has been shown in Chapter 2 that there are close connections between the variations of the temperature, the pressure, the height of tropopause, and other variables in the upper atmosphere, so that we naturally find that the variations in ozone are connected with all these to a greater or lesser extent. There is a tendency for the following associations.

High Ozone	Low Ozone
Cyclonic wind circulation at the tropopause	Anticyclonic wind circulation at the tropopause
High temperature in the stratosphere	Low temperature in the stratosphere
Low temperature in the troposphere	High temperature in the troposphere
Low level of tropopause	High level of tropopause
Low absolute pressure	High absolute pressure

These relations are brought out in **Figure 6** where three-day running means of the ozone, the height of the 200-mb surface, and the height of the tropopause are plotted one above the other. It is found that if three-day running mean values are used, the curves show a rather closer connection than if individual daily values are plotted, probably because small errors of observation are reduced but the real changes are not smoothed out too much.

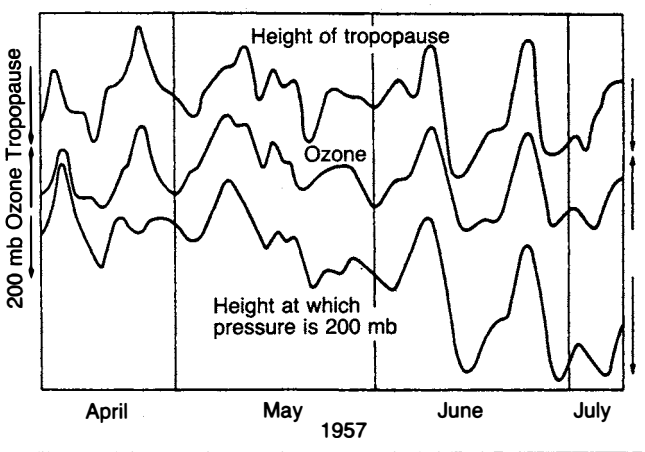
While the variations in the amount of ozone are associated with changes in the height of the tropopause, etc., the closest relation of all is shown by the *type* of pressure distribution at about the height of the tropopause. On those days when the pressure maps for a height of about 9 km (300 mb) show cyclonic conditions, the amount of ozone is relatively large, while when the conditions are anticyclonic there is relatively little ozone. . . . The absolute change in the amount of ozone between cyclonic and anticyclonic days in spring is rather greater than the corresponding change in the autumn, but since the average value of the ozone is lower in the autumn the percentage changes in spring and autumn are not very different. . . .

B. The cause of the connection between ozone and other upper air conditions.

We must now consider what causes the amount of ozone in the upper atmosphere to change from day to day, and why the variations are closely connected with other meteorological conditions. As with the changes in total ozone between spring and autumn, the changes between cyclonic and anticyclonic conditions are found to take place mainly in the first 5-10 km above the tropopause. A cyclonic depression, shown on the surface weather map as a closed low pressure area, is represented at a height of 15 km by a trough of low pressure extending to lower latitudes; on the other hand, an anticyclone, shown on the surface weather map as an area of high pressure is represented at 15 km by a ridge of high pressure extending towards the pole. These troughs and ridges tend to circulate round the pole from west to east, but the general westerly wind at these heights has a much greater speed, and the air actually flows *through* these troughs and ridges. As the air blows into a low pressure trough it descends, while as it approaches a ridge it ascends. These descending and ascending movements of the air will lead to increases and decreases in the amount of ozone as we have described a little earlier, and will, to some extent at least, account for the greater amount of ozone in depressions than in anticyclones. In spring—but not in autumn—the general amount of ozone is greater in high latitudes than in low latitudes, so that north polar currents will tend to carry southward air which is rich in ozone, while equatorial currents will tend to carry poleward air which is weak in ozone.

FIGURE 6

Variations in ozone, height of the tropopause, and height of the 200-mb surface



Source: *Exploring the Atmosphere*, by G.M.B. Dobson, 1968.

Dobson observed that, "The curves show a three-day running mean of the ozone at Oxford, and also the height of the tropopause and the height of the 200-mb surface at Crawley (110 km southeast of Oxford). The top and bottom curves are plotted with heights increasing downwards to conform with the variations of ozone."