S A SCIENTISTS CONTRIBUTE TO RESEARCH ON CLIMATIC CHANGE

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CLIMATIC CHANGE

It is now a well-established fact that the chemistry of the earth's atmosphere is changing as a result of man's activities. The unexpected appearance of the Antarctic ozone hole has shown unequivocally that processes which damage the environment have only been partly recognised and understood and that further changes in the physico-chemical makeup of the atmosphere are likely to take place in future. Such chemical changes will undoubtedly lead to climatic changes on a global scale with adverse effects on the biosphere in general and for mankind in particular.

MONTREAL PROTOCOL NEEDS BASELINE DATA

South African scientists from CSIR, in collaboration with a German research institute, have monitored climatically important trace gases at the Cape Point Baseline station for over a decade. Accurate knowledge on the abundance, distribution and biogeochemical cycles of these gases is a prerequisite for estimating trace gas lifetimes and growth rates in the atmosphere. These Cape Point results, which become more valuable as the data record increases, have been published in air-chemical journals and are widely quoted by international environmental groups and utilised by policy makers to set limits for the production and release of harmful gases – as, for example, the Montreal Protocol.

INTERNATIONAL IMPORTANCE OF CAPE POINT

The acquisition of meaningful and globally representative trace gas data can best be made within the Southern Hemisphere, which has a much larger ocean to continent ratio and which is far removed from the industrialized countries of the Northern Hemisphere. Unfortunately, there is a scarcity of quality long-term trace gas data records within the Southern Hemisphere. The National Oceanic and Atmospheric Administration (NOAA) of the United States is maintaining a baseline station at Cape Matatula, American Samoa (14°S) and one at the South Pole (90°S) as part of the Geophysical Monitoring for Climatic Change Program. However, within the mid-latitudes of the Southern Hemisphere, South Africa and Australia are the only two countries which carry out continuous atmospheric trace gas measurements, i.e. at Cape Point (35°S) and at Cape Grim (43°S) respectively. The information gathered by these two countries is of immense international value. At last year's international conference at Melbourne (The Scientific Application of Baseline Observations of Atmospheric Composition) a comparison of data revealed excellent agreement between Cape Point and Cape Grim, although subtle but significant differences also existed. From a scientific point of view the results gathered at both stations serve as a mutual check, which in turn lends strength to the validity of the results. As a matter of interest, Cape Point has the longest continuous CO record in the Southern Hemisphere. In addition, both Cape Point and Cape Grim are the only monitoring stations in the world where no CO increase has been observed over the last decade. Such a result would hardly have been considered real, if recorded by merely one station.

STRATOSPHERIC OZONE AND THE GREENHOUSE EFFECT

The most important gases which destroy stratospheric ozone, as exemplified by the Antarctic ozone hole, $CFCl_3$, CH_3CCl_3, CCl_4 and N_2O, are being monitored at Cape Point. See figure 1. The growth-rates obtained for these gases (averaged over the last few years) are 4.5, 4.3, 1.8 and 9.2% per year, respectively. Since most of these gases have long residence times in the atmosphere (of the order of 100 years and more), the destruction of the ozone shield will be with us in the decades to come, even if it were practical to stop emissions overnight. As a result of such stratospheric ozone reduction, ultraviolet radiation, in particular the UV-B component, which has a detrimental effect on the biosphere, will increase. The damage will involve man (skin cancer, damage to eyes and immune system), plants (growth, crop yields) and marine micro-organisms (cell damage, photosynthesis and food chain).

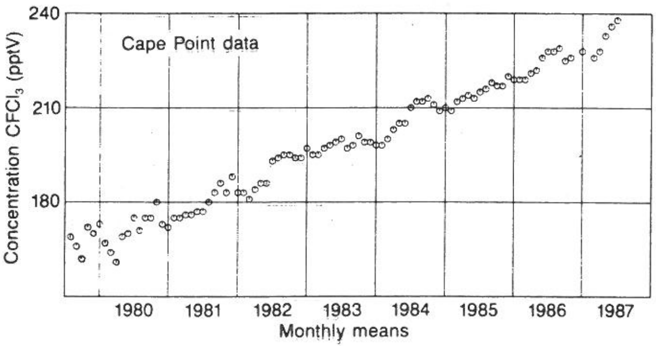

FIGURE 1: Concentrations of CFCI, in parts per trillion (10^{12}) plotted against time in years.

At present, the major ozone reduction has occurred during spring over Antarctica even though the concentrations of ozone-destroying chemicals in the southern hemisphere are less than in the northern hemisphere. The reason for this surprising effect is that the lower temperatures over

Antarctica lead to the formation of fine ice particles trapped within the huge, stable, Polar Vortex which forms in winter. Chemical reactions with ozone destroying gases on the ice particles are greatly speeded up and allow a winter buildup of active chemical species in the air. These active species are triggered into action by the sun's rays in spring, thus rapidly destroying ozone and causing the ozone hole. Because the entire process depends on a unique atmospheric phenomenon, the Polar Vortex, its effects may be limited. Any more widespread ozone destruction would be cause for greater concern if it exposed the world's major inhabited continents to higher UV-B. There is some evidence that the global ozone shield has diminished slightly. However, we have no long-term record of the natural variations in this shield. The Cape Point station will start UV measurements during mid-1989. In time, these measurements will show if the Antarctic ozone hole ever affects South Africa's protection and whether we are experiencing any long-term changes. Such ground-based UV measurements also provide "ground truth" calibration points for satellite ozone scanners.

There is general agreement amongst atmospheric scientists that the average global temperature of the lower atmosphere has risen in the recent past and will continue to do so in the years to come as a result of man's input of the so-called greenhouse gases, into the atmosphere. It is estimated that the global temperature will increase by about $3^{o}C$ if the present CO_2 abundance in the atmosphere is doubled, which at present emission rates is expected to take place in less than 100 years from now. As a consequence of increasing temperatures, it is likely that the sea-level will rise by 1.5 m within the next century. In addition, there will be an overall shift in climatic zones on earth. This in turn will have severe consequences for the world's woodlands and for agriculture and hence on the food supply situation of man. Of the so-called greenhouse gases, CO_2 is the most well-known and undoubtedly the most important. However, the combined effect of other greenhouse gases is as great if not greater than that of CO_2. These gases include CH_4, tropospheric O_3, N_2O and chlorofluoromethanes such as $CFCl_3$, all of which are being monitored at Cape Point. The average annual growth rate for CH_4 is quite substantial (11 pptv or 0.7%).

The many kilometres of ice in Antarctica have trapped trace gases which reveal that over a long period of time the earth has repeatedly experienced simultaneous fluctuations of CO_2 and of global temperature. Thus, there is general agreement that some form of greenhouse effect is probably already unavoidable. However, we lack the ability to predict the details of the extent and speed of change. We also do not fully understand the natural forces which initiated and then later controlled previous CO_2 and temperature oscillations. We should consider well that the latest man-made episode may be out of phase with the natural cycle and the outcome is uncertain. In addition, the CFCs are not a part of the global CO_2 geochemical cycle and cannot be controlled by it. In ages past, Nature, including man, would respond flexibly to these climatic cycles. Forests, grasslands and deserts ebbed and flowed across the face of the earth, nomadic man wandered with them. We often judge the rise of man to be linked to the time when he settled in villages and towns and began to hand on to his children a growing legacy of physical property and intellectual skills. The culmination of this is our present structure of nations with their fixed assets of roads, railways, and dams, depended on by populations intent on using the resources to the full. If climate change proves to be rapid, we could hardly have devised a structure less able to cope with the stresses of drought, famine or flood.

GERMAN CONTRIBUTION TO RESEARCH THE EFFORT

West Germany, one of the most environmentally conscious countries in the world, is actively supporting CSIR to consolidate and expand its atmospheric research activities at Cape Point by contributing sophisticated equipment.

The most modern, state-of-the-art, carbon monoxide and ozone measuring instruments are to be delivered to the Cape Point by the middle of this year, as well as computer software. In view of the possibility that the growing Antarctic ozone hole may spread over Southern Africa, the intensity of ultraviolet light is to be monitored on a continuous basis at Cape Point within the next two months. It is also envisaged to measure the total ozone and moisture content of the atmospheric column to obtain a better understanding of atmospheric chemistry aloft. This work will commence as soon as the specialised equipment, which is under construction at present, is completed.

Active control of the earth's climate may one day be possible, but at present the best we can hope for is to learn to understand the forces of nature and predict the outcome of man's inadvertent tinkering. The Cape Point Project can help us win the ability to ride out the storms of climatic change.