EARTH'S ATMOSPHERE

CO_2 versus Aerosols

from our Geomagnetism Correspondent

It has been known for many decades that carbon dioxide in the atmosphere produces a "greenhouse effect"—the trapping of heat in the Earth's lower atmosphere which can lead to an increase in temperature at the Earth's surface. This has often led to the prediction that if man continues to increase the atmospheric content of carbon dioxide by, for example, the burning of fossil fuels, the Earth's surface temperature will rise sufficiently to melt the ice caps and thus inundate many of the world's major cities. The problem with this thesis is that detailed calculations of the effects of carbon dioxide in the atmosphere are hard to find. Thus although it is known that during the past few decades the concentration of carbon dioxide in the atmosphere has increased by about 7 per cent, the precise effects of such an increase are not clear. More to the point, perhaps, the problem of determining the effect of a further increase in atmospheric carbon dioxide is more intractable though even more important. In particular, is it possible that man's activities could produce a "runaway" greenhouse effect whereby in a comparatively short time the Earth's surface temperature would approach, say, that of Venus (700 K)?

According to a calculation by Rasool and Schneider (*Science*, **173**, 138; 1971) such a catastrophe is unlikely because, although the addition of carbon dioxide to the atmosphere will increase the Earth's surface temperature, the rate of temperature increase becomes smaller with increasing amounts of carbon dioxide. Thus even if the quantity of carbon dioxide were to increase by a factor of 8 the increase in surface temperature would be no more than 2 K. The basis of Rasool and Schneider's calculation is a model atmosphere which represents current globally averaged conditions. Details of the calculation cannot be given here; but basically it is a question of computing the outgoing and incoming radiation flux for various concentrations of carbon dioxide in the atmosphere (making, of course, certain simplifying assumptions without which the problem would not be amenable to calculation). The results for the present atmosphere for both incoming and outgoing radiation are in close agreement with experimental data from meteorological satellites; and this gives some confidence that the corresponding calculations for hypothetical quantities of carbon dioxide are likely to give results somewhere near the truth.

Rasool and Schneider have computed the increase in tropospheric temperature required to balance the incoming solar flux (for the different concentrations of carbon dioxide) for the case in which the absolute humidity near the Earth's surface is assumed to be constant and for the case where the relative humidity remains constant. The latter produces the higher temperature for any given quantity of carbon dioxide because a warmer atmosphere contains more water vapour; and in the sense that the relative humidity assumption is probably closer to the meteorological truth, the corresponding calculation is probably the better to consider. In fact, although the percentage difference in the temperature increases from the two cases is quite large the absolute temperature difference is small because the increases themselves are small. Moreover, in each case the tropospheric temperature increase tends to reach a plateau as the carbon dioxide content increases. Thus a doubling of the carbon dioxide concentration produces a maximum tropospheric temperature change of 0.8 K whereas a factor of 10 increase in the carbon dioxide concentration produces a temperature change of 2.5 K. No runaway greenhouse effect is thus possible unless the concentration of carbon dioxide were to become so high that the pressure of the atmosphere were to increase. Because of the pressure effect an increase in carbon dioxide by a factor of 1,000 would produce a runaway temperature rise; but such an increase is unlikely because of the restraining interactions of carbon dioxide with the oceans, the Earth's crust and the biosphere.

The temperature effect of atmospheric carbon dioxide is thus likely to be small even in the long term. In the short term, if the carbon dioxide increases by 10 per cent during the next thirty years

Contact Inhibition and Ribosome Metabolism

The rate of multiplication of untransformed cells growing in culture is, of course, dependent on the cell density; at high cell densities, in crowded cultures, the individual cells either stop dividing or divide only very slowly, while at low cell densities the cells divide rapidly. And each particular type of cell growing in a given set of culture conditions reaches a characteristic saturation density at which the cells cease to divide. As yet the nature of the chemical signals which bring about this contact or density dependent inhibition of cell division is largely obscure but something must tell a cell when it is in a dense culture and cause it to slow down its macromolecular metabolism. The problem then is to define these signals and also the metabolic processes which they regulate and Emerson reports in next Wednesday's *Nature New Biology* a start in this direction.

Emerson's experiments indicate that both the rate of transcription of ribosomal RNA genes and the turnover of mature 28S and 18S ribosomal RNAs in primary cultures of chick skin fibroblasts are coupled to the rate at which the cells are growing.

He finds that the amounts of ribosomal RNAs in contact inhibited cells dividing every 90–120 hours are about half those in cells dividing every twenty to twenty-four hours and that the rate of net accumulation of ribosomal RNA is about ten-fold less in the contact inhibited cells than in the rapidly dividing cells. After adding a pulse of fresh serum to contact inhibited cells, however, the net rate of accumulation of ribosomal RNA increased within two hours while an increase in the rate of DNA synthesis did not take place until about eight hours after the serum was added.

Obviously the rate of accumulation of ribosomal RNAs might be regulated either at the level of transcription and processing of the ribosomal RNA precursor molecules or by altering the rate of turnover of mature molecules. In fact it seems that both these processes are coupled to the rate of cell multiplication. For although in contact inhibited cells the rates of formation of 28S and 18S RNAs are some two to four times less than in rapidly dividing cells, the rates of net accumulation differ ten-fold. This indicates that not only are ribosomal RNAs made more slowly in contact inhibited cells than in dividing cells but also that they are less stable and have a shorter lifetime.

Finally Emerson has done a series of labelling experiments in an attempt to decide whether it is the rate of transcription or the rate of ribosomal RNA processing which is reduced by contact inhibition. From measurements of the rate of incorporation of adenosine into ribosomal RNA precursor molecules, coupled with measurements of the specific activity of the pools of ATP and the DNA content of the cultures, he concludes that it is the rate of synthesis of ribosomal RNA precursor molecules, rather than the rate at which they are processed, which is regulated. An analysis of the distribution of labelled AMP along the length of 28S and 18S ribosomal RNAs supports this conclusion. The question now, of course, is what is the mechanism which controls both the rate at which ribosomal RNA genes are transcribed and the stability of the mature RNAs and links these two processes to the rate at which the cells divide.