Letter to the Editor

The Effect of Fuel Combustion on the Amount of Carbon Dioxide in the Atmosphere

Dear Sir,

Although this matter has been carefully examined in the three valuable papers by H. Craig, R. Revelle —H. Suess, and J. Arnold—E. Anderson, on the exchanges of CO_2 between atmosphere and oceans, in the February issue of *Tellus*',[9] pages 1 to 32, there is one point on which I may be able to throw some further light.

This point is the large discrepancy between recently measured depressions of the radio-carbon activity, (known as the "Suess effect"), and the apparent increase in atmospheric CO_2 as given by measurements of this quantity between 1870 and 1935, (CALLENDAR 1940). Both Revelle and Suess, p. 25, and Arnold and Anderson, p. 31, consider that no increase as large as the 10 % indicated by the latter measurements could actually have occured in such a period, in view of the size of the active CO_2 exchange reservoirs shown by their measurements. However, they suggest other factors which might conceivably account for the discrepancy.

Two suggestions follow which may, in part at least, account for the latter, without having to invoke an unacceptably large error in the atmospheric CO_2 observations made in the 1930s, or an highly improbable rise in sea temperature.

(1) The possibility that the part of the active CO_2 exchange reservoir which constitutes the land biosphere and humus, may be considerably smaller or slower in action than supposed, is mentioned by Arnold and Anderson. p 31. Two considerations support this:

(a). For active exchange—A large fraction of this carbon is in the heart wood of trees, or below the surface of bogs, etc., and thus inaccessable during short periods.

(b). For Pco_2 control—the considerable amount of CO_2 released by clearance of forests, cultivation and drainage of humic soils, etc., (here estimated at about 10^{17} grams this century), should be enough to balance a rise of several percent in the active part of this reservoir. If so the latter would be ineffective in regard to Pco_2, although active in exchange.

(2) A Meteorological cause is suggested for some of the relatively high CO_2 values observed in the 1930s: The year 1934, when Prof. Buch took most of his Persamo series, was one of record mildness in N. Europe, the period May to October being as much as 3° C above former averages in the N. Baltic region. This unusual warmth should cause rapid bacterial oxidation of organic residues in the great "muskeg" areas to the east, and also release CO_2 from shallow water bodies in the region leading to high CO_2 in slow moving air currents. (Buch's average CO_2 value for days when continental air reached Petsamo in May to October 1934 was as high as 341 p.p.m.).

An oceanic cause may also be considered, for BROWN (1953) has shown that the average surface temperature of the N.E. Atlantic rose by nearly 1° C between the 1920:s and 1930:s. This influx of warmer water might lead to some high CO_2 values near the surface, by disturbing the pressure equilibrium of CO_2 saturated cold water bodies, or even by itself having above normal CO_2 tension for these latitudes. If so it could account for the relatively high average value of 319 p.p.m. reported by Prof. Buch on both his crossings of the N. Atlantic in the summers of 1932 and 1935. It seems probable that a combination of these unusual events could give temporary and local averages up to 5 % above the general mean for the zone.

Coming to the present time. The valuable and extensive new series of CO_2 observations reported in Tellus by FONSELIUS and KOROLEFF (1955—1957), show certain features which may be related to the meteorological-biological factors mentioned in (2) above. For example; the high CO_2 average of 349 p.p.m. found at the Finnish stations in the warm period July to September 1955, as compared with only 322 for the same months in 1956, which were relatively cool, wet and windy over a

great area of N.W. Europe It seems probable that the meteorological conditions in 1956 would be unfavourable to decay processes, and also to the accumulation of excess CO_2 in surface air currents.

The overall average computed from the new Scandinavian CO_2 measurements for 1955 and 1956 (to october), comes to 326 p.p.m., and is approximately 36 p.p.m. above the best 19th century averages. This is particularly interesting because the amount of CO_2 released by fossil fuel combustion since the turn of the century, (2.8 $10.^{17}$ gms.), is sufficient to cause an increase of 35 p.p.m. in the whole atmosphere. However, the significance of this remarkable coincidence requires much data for adequate discussion, and this cannot be attempted here.

Finally. In view of the probable climate effects of increased atmospheric CO_2, it is interesting, and possibly significant, to note that both the Suess effect, and the temperature rise appears to be considerably less in the southern than in the northern hemisphere. If the former is confirmed, the air exchange between hemispheres will require careful reassessment.

Horsham, April 15, 1957.

Yours faithfully

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