SHORTER CONTRIBUTION

Radiocarbon variations in the atmosphere

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Introduction

Radiocarbon, produced by atomic bombs, is one of the tracers which are suitable for studies of the mixture of the atmosphere. MACHTA (1958), HAGEMANN *et al.* (1959), FERGUSSON (1963) and others have discussed the subject. MÜNNICH & VOGEL (1963) could show that there is a seasonal effect in the concentration of C^{14} in the atmosphere. They could show that this effect, showing maxima in summers and minima in winters in the northern hemisphere, was a real effect not always caused by man by increased combustion of fossil fuels during winters. These variations could not be explained by variations in the carbon dioxide content in the atmosphere. They developed a model for the mixing in the troposphere assuming that the C^{14} rich carbon dioxide was injected from the stratosphere into the troposphere rather close to the North Pole and then diffused along the surface of the earth. The diffusion as seen in Central Europe was not much affected by the exact location of the injection. Their model was developed to explain the latitudinal effect.

The data

In 1959 there was a pronounced peak and the next marked increase, in summer 1962, followed the Russian tests in the autumn 1961. The curve now shows marked maxima and minima 1963, 1964 and 1965. The samples collected through the Uppsala laboratory in Abisko 1960, but measured in Heidelberg, gave a much more pronounced peak than did the samples from lower latitudes. The March peak in 1961 for Abisko might have been the result of a contamination as discussed elsewhere, OLSSON & KARLÉN (1965). It should also be noted that Münnich draws the intensity curve as an envelope for the measured points to avoid wrong results due to contamination from fossil fuels. In doing so he might get an earlier increase in springtime than we get, which maybe is not real but only the result of the fact that he has many points. Values from ÖSTLUND & ENGSTRAND (1963), Bredkälen (63°54′ N Lat., 15°18′ E Long.) in Sweden, agree rather well with our values from Abisko. These are, however, only from 1959 to early 1962.

To extend the good collection stations further to the north we also started to collect samples at Kapp Linné on Spitsbergen. Both at Kapp Linné and Abisko the samplers are situated a few meters above ground level and at localities where contamination by fossil fuels is extremely small. In Fig. 1 the values from Abisko and Kapp Linné are given. In Fig. 2 these values are given again but in the same diagram we have drawn the curves from the laboratories in Heidelberg, MÜNNICH & VOGEL (1963), Stockholm, ÖSTLUND & ENGSTRAND (1963) and Los Angeles, FERGUSSON (1963), BERGER *et al.* (1965). The American values are from China Lake (35° N Lat.), California. In Fig. 3 we have plotted our values from samples collected onboard a ship Stratus during 1964. The collection areas are shown in Fig. 4.

A close study of the results reveals that the increase indeed occurs almost one month later on Spitsbergen than in Abisko. The increase in Central Europe might occur earlier than in Abisko if some of the collection sites not are good so that Münnich is right in drawing the envelope. Later values from the Heidelberg laboratory, Münnich, priv. comm., may also show an earlier increase. It seems as if the heights of the peaks are about the same on Spitsbergen, in Sweden and in Central Europe with excep-

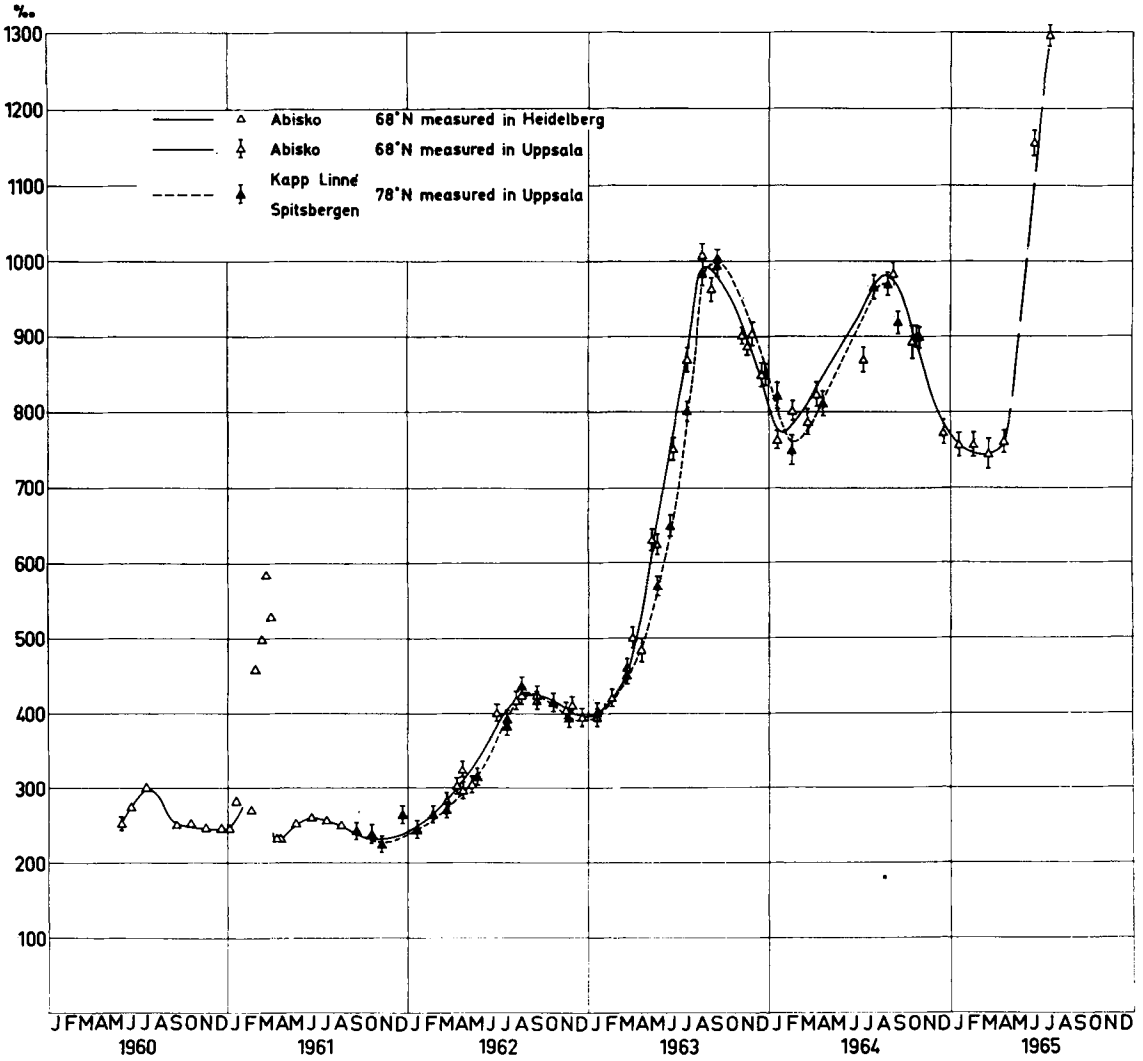

FIG. 1. The per mil C^{14} excess over natural concentration at Abisko and Kapp Linné. Points given with statistical errors are determined at the Uppsala C^{14} lab. Points given without statistical errors are determined at the Heidelberg C^{14} lab, but collected through the Uppsala lab.

tions 1960 and March 1961. The minimum 1960/61 was not as low in Abisko as in Central Europe but it seems as if the minima agree rather well as a rule. All the maxima from 1962 are higher in Europe than in North America. The 1963 maximum is higher in Europe than the 1964 maximum but in North America the reverse is true. This seems to be confirmed at the Lamont laboratory to judge from samples collected at Fairbanks, Alaska, Thurber, priv. comm. In North America the minimum in winter 1963 to 1964 is not as deep and much broader than the minimum we have observed. It is difficult to explain the difference between the continents as an industrial effect.

Awaiting some more results to be published from other laboratories we have not treated our results mathematically to determine a diffusion constant. The conclusion we can draw from the points available is that the location for mixing between the stratosphere and the troposphere varies but is usually at a lower latitude than 60° on the northern hemisphere—thus more to the south than suggested by

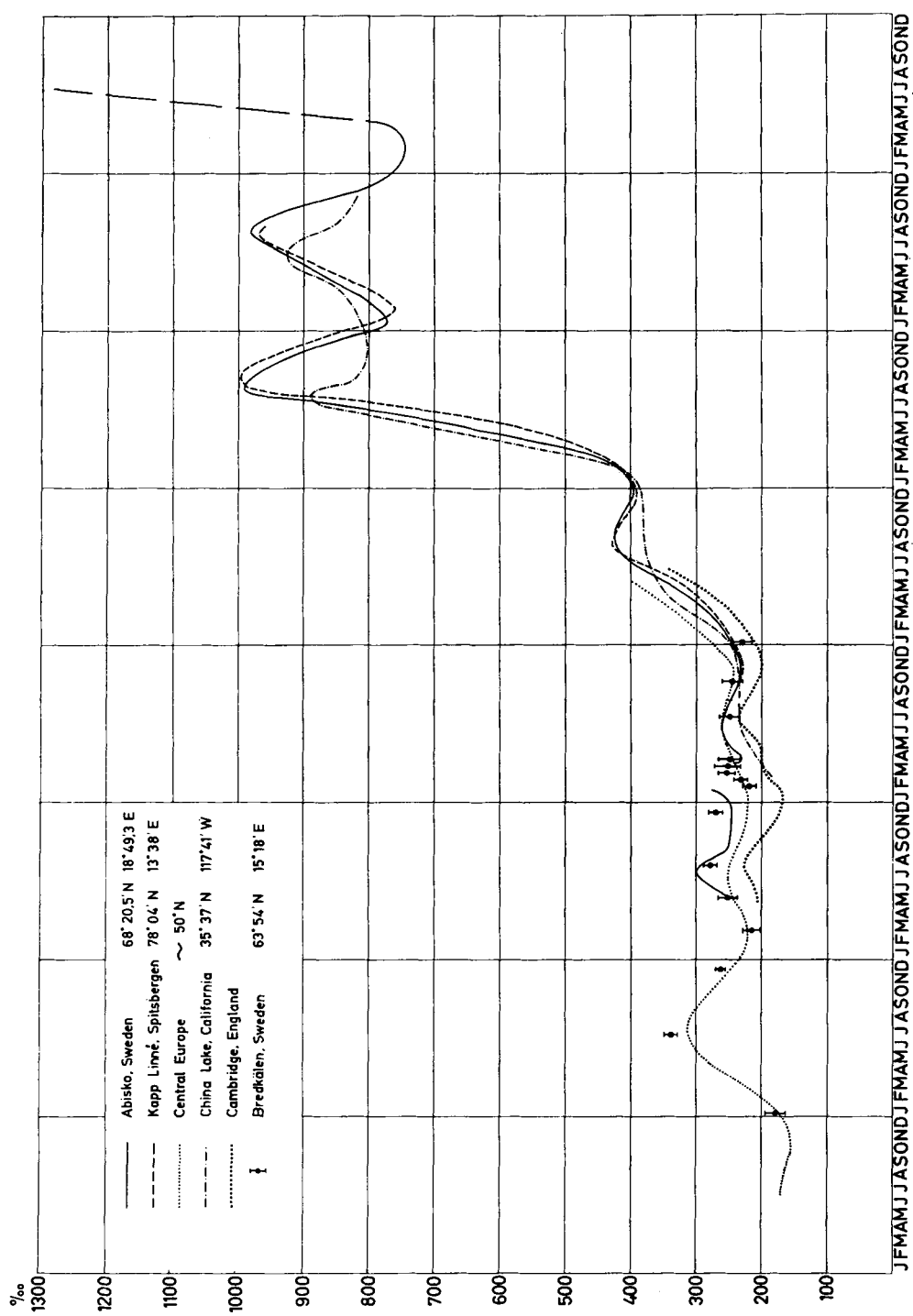

FIG. 2. The per mil C^{14} excess over natural concentration at Kapp Linné, Abisko, Bredkälen, Cambridge, Central Europe (Fig. 4) and China Lake. The samples are measured at the C^{14} laboratories in Uppsala, Stockholm, Cambridge, Heidelberg and Los Angeles.

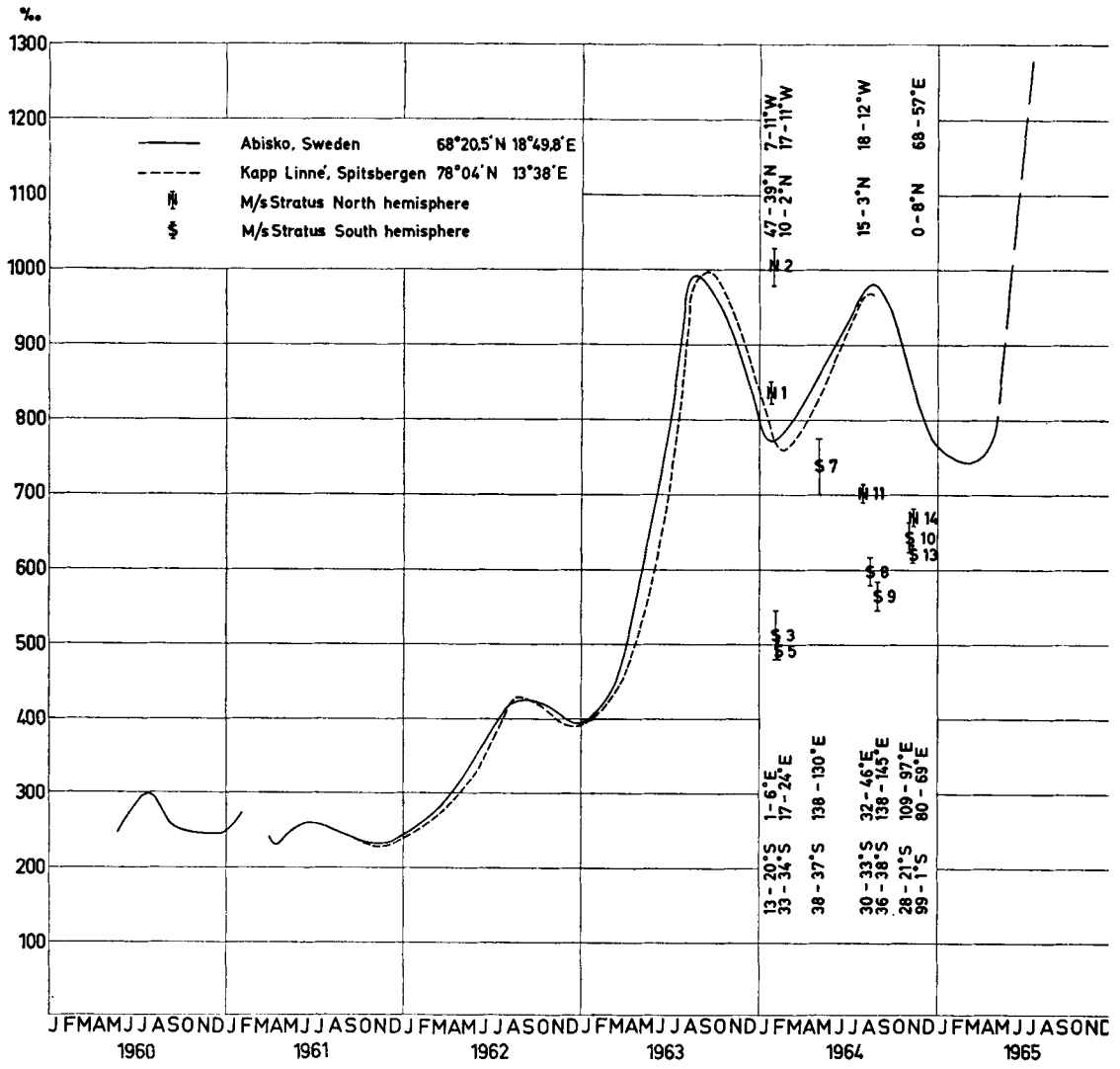

FIG. 3. The per mil C^{14} excess over natural concentration at Kapp Linné, Abisko and along some routes on the northern and southern hemisphere followed by the M/S Stratus (Fig. 4).

MÜNNICH & VOGEL (1963). The mixing is rather slow even in west-east direction.

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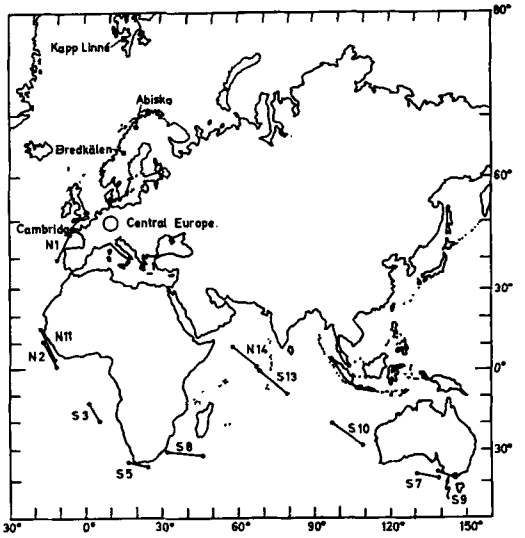

FIG. 4. Map showing the collection places.

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