LETTERS TO THE EDITORS

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A New Method of Sampling the Upper Atmosphere

THE accurate determination of composition is an important part of investigations into the upper atmosphere. Until now, the only method has consisted of sending up an evacuated vessel incorporating a device which opens a valve at the appropriate height and later closes it. This method has the disadvantage that vessels of practicable dimensions do not contain much gas, even at atmospheric pressure, and their exterior surfaces are bound to adsorb comparable or even larger amounts, of course, the method becomes still less satisfactory at the high altitudes which are now of interest.

Some time ago, I suggested a new method of sampling, and as it has recently been tried out successfully some remarks about the method may be of interest. The main idea is that a vessel should be sent up, cooled with liquid hydrogen. This arrangement acts as a pump, since the vapour pressures of nearly all the constituents of the atmosphere are negligible at liquid hydrogen temperatures. It is true that hydrogen and helium would not be condensed; but they are present in such minute amounts that they would be rushed into the vessel with the other gases and would be occluded. The superiority of this method would become more and more pronounced with falling pressure. At one-tenth of an atmosphere, for example, such a vessel would condense about 10,000 times as much material as it could take up with the old method.

A few points have to be considered in the practical application of this method, of which two will be mentioned here. First, as it may not be certain that the apparatus is found, after its descent, with the Dewar vessel still intact and cool, the vessel and its automatic valves should be built to stand high pressures. A rough calculation shows that the design of a vessel to stand about 100 atm. would give a good compromise between weight and volume. It would seem quite feasible to build a vessel to take a sample of 50 litres at N.T.P. which would weigh about 2 kgm. Secondly, precautions have to be taken to avoid a hydrogen gas 'block' in the mouth of the vessel due to the evaporation of hydrogen during condensation of the air. This can be effected, for example, by attaching a tube of sufficient length to the intake of the apparatus or to the outlet of the Dewar.

I was originally mainly interested in investigating the abundance of helium-4 and helium-3, and tests at very high altitudes would be needed to get results of significance. Rockets able to penetrate into the interesting region are not available in Great Britain, nor are pilot balloons able to reach heights above 25 km. In order to start these experiments we have therefore concentrated at first on the determination of water in the atmosphere. This is a matter of great interest to meteorologists, and significant results can be obtained at relatively low altitudes. The Gassiot Committee of the Royal Society allocated to us last year the necessary funds, and Mr. Peckover and I have built a first model with hand-operated valves which can be used in an aeroplane. Mr. Peckover has recently been able to take this apparatus up to a height of 6 km., thanks to the kind co-operation of the Meteorological Research Flight R.A.E. Station, and has successfully taken a sample of 50 litres at N.T.P.; these experiments will be extended to higher altitudes, and we shall report on the results in due course. We are now designing, with the experience gained, an automatic apparatus to be used with pilot balloons. It should be emphasized, however, that the main field of application of the method would be its use in conjunction with rockets, where, incidentally, limitations of weight are much less severe and a series of samples at varying heights could be collected.

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Production of Ice-Crystal Clouds by Seeding

FOLLOWING Schaefer's cloud-chamber experiments[1] on the formation of ice crystals in supercooled water-droplet clouds by localized cooling, Langmuir has noted the possibilities of producing ice-crystal clouds on a large scale, and has observed the sudden formation of a veil of ice-crystals 600 ft. below a seeded cloud, caused by the passage of 'dry ice' pellets[2].

During a series of induced precipitation experiments in Canada, this generation of ice-crystal clouds in clear atmosphere through the action of 'dry ice' was also observed, and it was thought that it offered an excellent experimental method of observing the immediate full-scale results of 'seeding' with various agents and techniques, without the visual interference of a cloud, or the space restrictions of a cold chamber. In addition, the complication of the presence of supercooled water droplets was removed, leaving only the change from water vapour to ice crystals to be studied. This latter feature would be very useful, for example, in observing the action of silver iodide as a seeding agent. Accordingly, during the latter part of the past winter, whenever clear air was found that was supersaturated with respect to ice but not to water, the opportunity was taken to seed it, using 'dry ice'.

On each occasion when the air was measurably supersaturated, ice crystals have been formed by seeding. About one minute after the 'dry ice' has been dropped (usually from a few hundred feet above, or from inside, the supersaturated layer), and so some appreciable time after its cooling influence, a faint 'vapour trail' would become visible, which developed rapidly within the next minute into a vertical curtain of ice crystals. This curtain appeared to be composed of a very large number of individual vertical streaks, each of which seemed to grow downwards erratically and jerkily as regards both speed and direction, although the curtain as a whole developed with reasonable uniformity. While the immediate impression was of some form of chain reaction, it is more likely that the effect was caused by the crystals becoming visible at a fairly definite interval of time after the passage of the 'dry ice' granules, which were irregular in shape and size.

The length of the curtains depended on the length of seeding run, usually two to three miles. The depth, some 500–2,000 ft., seemed to depend on some factor