Origin of the Term Ionosphere

In recent years, references[1,2] have been made to an unpublished letter (ref. No. 4386, to the secretary of the Radio Research Board, November 8, 1926) by R. A. Watson-Watt, in which he proposed the use of the term "ionosphere" in 1926. The text of this has never been quoted, and the relevant passage may be of interest.

The letter, a file copy, was discovered during building alterations at the Radio and Space Research Station, Slough; it is addressed to the secretary, Radio Research Board, and, referring to discussions on the nomenclature of the "upper conduction layer", advocates the use of the term in the following way.

> "We have in quite recent years seen the universal adoption of the term 'stratosphere' in lieu of a previously well established misnomer 'isothermal layer', and the adoption of the companion term 'troposphere' for the 'convective layer'.
>
> "The term 'ionosphere', for the region in which the main characteristic is large scale ionisation with considerable mean free paths, appears appropriate as an addition to this series. The objection that ionisation occurs throughout the atmosphere is no more adequate against the proposed term that [sic] is the fact that stratification occurs locally in the troposphere, the systematic name should be characteristic of the main 'grand scale' phenomena without reference to minor and local phenomena."

In spite of this, it was not until some 3 years later, in 1929 (ref. 3), that Watson-Watt first used the term in a publication.

G. W. Gardiner

Radio and Space Research Station,
Ditton Park,
Slough, Buckinghamshire.

Received November 10, 1969.

[1] Ratcliffe, J. A., *Electronics and Power*, 36 (February 1966).
[2] Rishbeth, H., and Garriott, O. K., *Introduction to Ionospheric Physics*, 48 (Academic Press, 1969).
[3] Watson-Watt, R., *Quart. J. Roy. Met. Soc.*, **55**, 273 (1929).

Inter-hemispheric Transfer of Fresh Debris from French Nuclear Tests in 1968

Nuclear debris particles from the recent Chinese nuclear explosions provided a suitable medium for studying the global atmospheric circulation of airborne material in the northern hemisphere[1–3]. We have investigated the inter-hemispheric transfer of airborne material by measuring the radioactivities in Japan of short-lived fission products resulting from the recent French nuclear tests in the South Pacific in 1968.

Large amounts of rain water (20–185 l.) were collected by a sampling system installed on the campus of the University of Niigata. The radioactivities were measured, using an NaI(Tl), 3 inch × 3 inch scintillation detector with a 200-channel pulse-height analyser. The ^{140}Ba-activities were determined by measuring the areas of the photopeaks at 1·6 MeV for ^{140}La. The intensity measurement of γ-ray at 365 KeV for ^{131}I was made on a purified silver iodide precipitate. The results obtained are summarized in Table 1; the activity values for rain samples between August and September are corrected for decay to September 1, and the ones for October to October 1.

According to γ-spectrometric examinations, rain samples collected on August 5, 12 and 21 consisted chiefly of long-lived stratospheric radionuclides, ^{95}Zr–^{95}Nb, ^{106}Ru–^{106}Rh, ^{137}Cs and ^{144}Ce, resulting from the recent Chinese nuclear explosions on June 17 and December 28, 1967, and earlier nuclear events. No short-lived fission products, such as ^{131}I and ^{140}Ba, were detected. These findings suggest that there was no fresh nuclear debris in the upper atmosphere over Niigata by mid-August. Some ^{140}Ba, however, was found in a rain sample on August 24–26, which suggests that fresh nuclear clouds arrived over Japan which were washed out in rain during late August (Table 1). A new source of this fresh debris had therefore to be found. One of the underground tests conducted by the USA or the Soviet Union could have been the cause, though we knew of no explosion date. We detected no fresh nuclear debris attributable to an underground test in any rain sample, however, with the exception of the January 15, 1965, Soviet underground test[4], and so this idea had to be discarded.

Table 1. THE SHORT-LIVED FISSION PRODUCTS IN RAIN SAMPLES BETWEEN AUGUST AND OCTOBER 1968

Period of collection		Sample volume (l.)	Ba-140 (pCi/l.)	I-131* (pCi)
Aug.	24–26	58	0·11	
	28–29	64	0·14	
	30–31	46	0·75	
Sept.	6	18	0·53	23
	7	64	0·20	
	10–11	128	0·18	9
Oct.	6– 8	185	0·15	24
	10–11	122	0·22	
	14	74	0·17	21
	15	58	0·15	

* A rain sample was evaporated to less than one litre and the sample solution was then filtered. Iodine-131 in the filtrate was analysed by a liquid–liquid extraction method, followed by precipitation of silver iodide.

France conducted a series of nuclear explosions at her testing ground in the South Pacific. They involved three atomic bombs (July 8 and 16, and August 4) and two hydrogen bombs (August 25 and September 9). Fresh debris produced by these nuclear events would most probably cause the radioactive contamination of the rain samples in question. As can be seen from Table 1, we found two sets of continued ^{140}Ba-activity lasting 1 to 2 weeks between August 24 and October 15. If it is assumed that the first set (August 24–September 11) resulted from two atomic bomb tests on July 8 and 16 and that the second one (October 6–15) from a hydrogen bomb test on August 25, the time required for the airborne fresh debris to reach Niigata (39° N; 138° E) from the French testing ground (20° S; 140° W) was estimated to be 46 ± 3 days.

The activity measurements of ^{141}Ce and ^{144}Ce were made on purified radiocerium samples prepared from some combined rain samples (170–440 l.), using a Ge(Li), 10×4 mm^2, detector; the activity values were all corrected for decay to mid-collection dates. Fig. 1 shows ^{141}Ce : ^{144}Ce activity ratios as a function of time between September 11 and October 31. From this figure, the radioactivities found in a rain sample on September 21–26 are believed to originate from an atomic bomb test on August 4; for this reason, the ^{141}Ce : ^{144}Ce activity ratio (8·5 per cent) on September 21–26 would be expected to decrease to 5·8 per cent if we assume that no fresh activities from the August 4 test were mixed with older ones from the two earlier tests in July. Consequently the time taken for the fresh activities to reach Niigata was estimated to be about 50 days.

The French testing ground is about 10,000 km south of Japan. If we make the reasonable assumption that the French nuclear clouds transferred in the troposphere first travelled from the testing ground north-west across the equator and that they were then carried across south-east Asia in the south-west monsoon, their travelling distance would be about 13,000 km. This assumption seems to be supported by the fact that the two high ^{140}Ba-activity concentrations were found in rain-water samples associated with the hits of typhoons Nos. 10 and 13 on Japan in late August and early September respectively (Table 1), and that typhoons are in general carried to Japan in the south-west monsoon. As a result, it can be said that the French debris reached Japan from its origin at an average