

Cesium-137 in air late after the Chernobyl reactor accident

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Cesium-137 in air as high as $88.1 \mu\text{Bq}\cdot\text{m}^{-3}$ was recorded in Thessaloniki, Northern Greece ($40^{\circ}38'\text{N}$, $22^{\circ}58'\text{E}$) on June 3, 1998 very late after the Chernobyl reactor accident following a radiological incident occurred in a steel factory at Acerinox, Spain.

Cesium-137 was released on April 26, 1986 from the reactor unit No. 4 in Chernobyl, Ukraine, a 1000 MWe RBMK* type reactor operated since December 1983 in large amounts estimated to be about $4\cdot 10^{16}$ Bq.¹ Its concentration in air at that period of time (May 1986) was in the level of some becquerels per m^3 in many countries of Europe. A month later, in the beginning of June 1986, the ^{137}Cs concentration in air was in the level of some milli-becquerels per m^3 , and in the next year (1987) it was in the level of some micro-becquerels per m^3 . In the beginning of the decade of '90s, ^{137}Cs was mostly undetectable in air, which means lower than $1 \mu\text{Bq}\cdot\text{m}^{-3}$.

For about seventeen years since 1986, air samples have been collected continuously by filtering at the Atomic and Nuclear Physics Laboratory, Aristotle University of Thessaloniki (Greece) to study the temporal variation of the specific activities of natural (e.g., ^7Be of cosmogenic origin) and anthropogenic (^{137}Cs of Chernobyl origin) radionuclides in the surface air. Cesium-137 in air at Thessaloniki area ($40^{\circ}38'\text{N}$, $22^{\circ}58'\text{E}$), Northern Greece peaked on May 5–6, 1986 as high as $1.95\pm 0.09 \text{Bq}\cdot\text{m}^{-3}$ immediately after the Chernobyl reactor accident.²

The ^{137}Cs concentration in air at Thessaloniki region was mostly undetectable for the years followed. The minimum detectable activity (MDA) was $1 \mu\text{Bq}\cdot\text{m}^{-3}$ or less. Suddenly on June 3, 1998 a high ^{137}Cs record in air as high as $88.1\pm 4.1 \mu\text{Bq}\cdot\text{m}^{-3}$ was observed and registered. The sampling period started at 0.9:00 hour on June 3, 1998 for 24 hours. The sample quantity was about 2800m^3 of air and the flow rate was about $2 \text{m}^3\cdot\text{min}^{-1}$ (68 cfm). The filter was glass fiber type TFAGF 810 of STAPLEX with dimensions of $20.32 \text{cm}\times 25.40 \text{cm}$ ($8''\times 10''$) and the collection efficiency was 95% of particles $0.5 \mu\text{m}$ and over.

The air sampler was type TFIA-2 of STAPLEX. The gamma-radioactivity of the filters was measured by a high resolution (1.9 keV at 1.33 MeV of ^{60}Co) and high efficiency (42%) high purity Ge detector and the uncertainty of the measurements of the gamma-spectroscopic system was better than 5%. Figure 1 shows the ^{137}Cs concentrations in air at Thessaloniki, at the period January 1998–March 2000. It is evident that the highest value of ^{137}Cs in air ($88.1 \mu\text{Bq}\cdot\text{m}^{-3}$) was recorded on June 3, 1998 and followed by the lower values of $18.8 \mu\text{Bq}\cdot\text{m}^{-3}$ on June 15, 1998 and $8.95 \mu\text{Bq}\cdot\text{m}^{-3}$ on July 2, 1998.

SURBECK³ indicated that he measured increased ^{137}Cs concentration in air as high as $150 \mu\text{Bq}\cdot\text{m}^{-3}$ for the period from May 26, 1998 until June 8, 1998 at Fribourg, Switzerland ($46^{\circ}48'\text{N}$, $7^{\circ}09'\text{E}$). He also said that at ISPRA, the Research Laboratory of EURATOM, at Arona, Northern Italy, they had seen an increase of ^{137}Cs concentration in air starting on June 1, peaking on June 2 and being back to normal on June 5, 1998. Also the French OPRI recorded high ^{137}Cs levels in air at the Alps Mountains in Austria, France, Italy and Switzerland, reaching to 1000 up to $2000 \mu\text{Bq}\cdot\text{m}^{-3}$ around June 2, 1998 in Southern France.³

On June 12, 1998 increased activity on stack filters was reported by Acerinox at Algeciras, Spain ($36^{\circ}09'\text{N}$, $5^{\circ}30'\text{W}$), a steel factory, close to Gibraltar, according to the Spanish authority, the National Council of Nuclear Safety (Consejo de Seguridad Nuclear, CSN).⁴ So, the most probable cause for the increased ^{137}Cs level measured over Europe, was that the steel factory Acerinox at Algeciras, Spain, melted up together with scrap metal a ^{137}Cs source. The activity of the source melted in one of the furnaces was estimated to be in the

* Russian acronym of the light-water cooled, graphite-moderated reactor

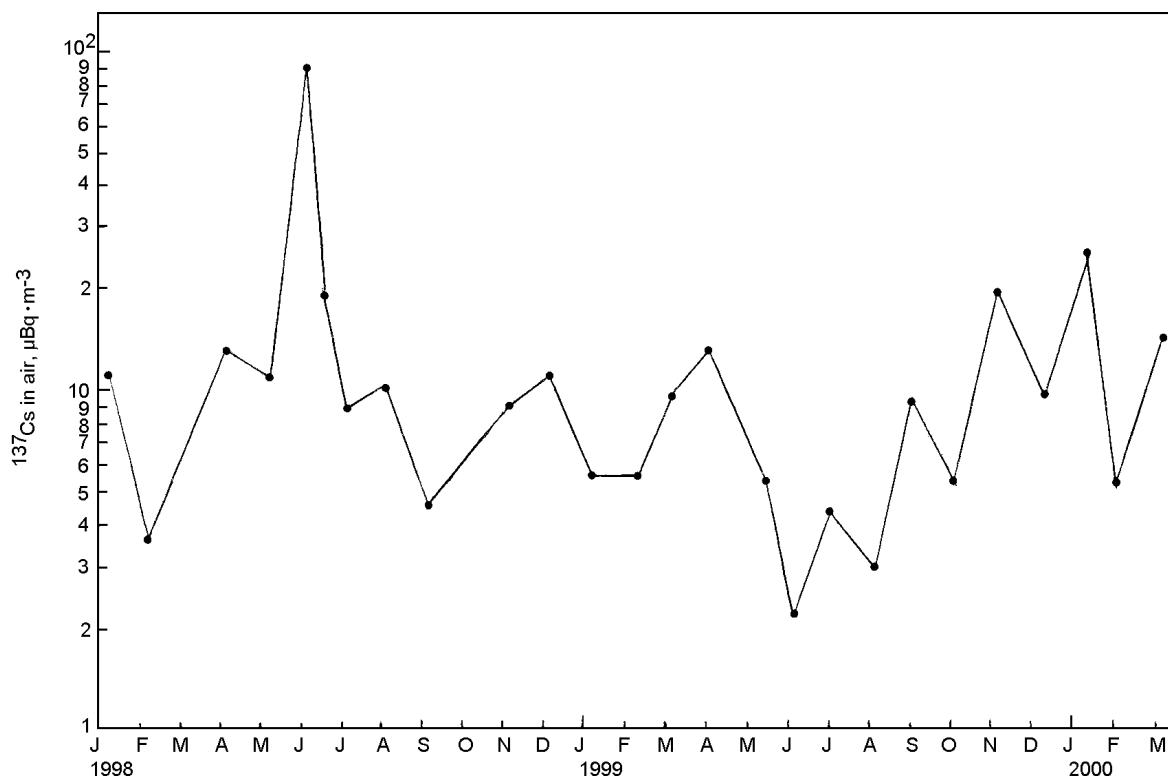


Fig. 1. Cesium-137 in air at Thessaloniki, Greece at the period January 1998–March 2000

range of $3\cdot 10^{11}$ to $3\cdot 10^{12}$ Bq (8 to 10 Ci) and that the release of ^{137}Cs in the atmosphere could have taken place between May 25 and June 1, 1998, with a high probability on May 27 or 28, 1998. In Almeria (Palomares), Spain, in air records of 1400 to 1800 $\mu\text{Bq}\cdot\text{m}^{-3}$ ^{137}Cs were reported.⁴

This paper confirms the occurrence of a radiological incident that was taken place at a great distance. It also shows how radioactive contaminants can spread not just across countries but also across continents as it was with the Chernobyl reactor accident.

References

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