2P17

Distribution of radioisotope dust along NW direction from a source

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The diffusion of radioactive suspended particulate matter (SPM) is discussed for the sedimentation and re-diffusion. Where, the data are measured by the Fukushima prefecture [1] or the Ministry of Education [2], which are published until 2011/4/30. Movements of substances are considered only.

1. Ambient dose rate of a source

The radioactive SPM are measured by monitoring cars, when it is from 3/13 0:00 until 3/16 15:55. The source point is (N37.422, E141.033). The ambient dose rate is shown in Fig.1. SPM are exhausted out 6 times. A large amount of SPM is erupted in 3/15, and it diffuses toward NW direction.

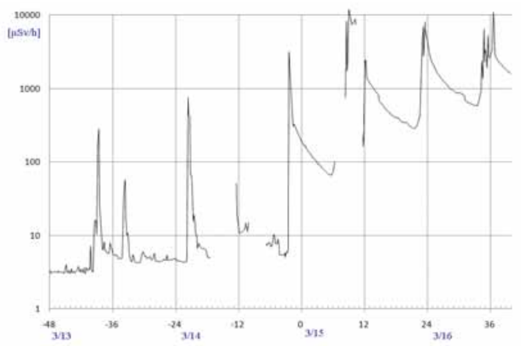

Fig.1 Ambient dose rates [μSv/h] of a source point

2. Sedimentation inner radius 20km

The ambient dose rate is measured on 4/18, when is 34 days after. We search former measurements but can't find it. (There are insufficient ones of 3/30~4/2). We plot the dose rate in Fig.2, where an approximate curve is added. Low dose rate is found near the source. The paradox is understood as followings;

1. The SPM is spread in a layer at low altitude.
2. The source is elevation 10m and the point of 20km is 215m.

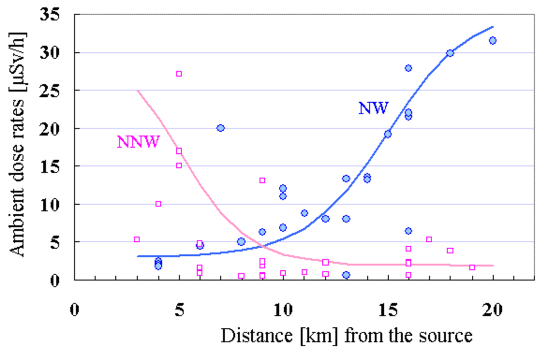

Fig.2 Ambient dose rates [μSv/h] along NW or NNW directions inner radius 20km, measured on 4/18

We can find a sigmoid relation along NW direction in Fig.2; however, such a relation is not for others. Generally, a radioactive area is inner radius 5km, and some hot spot areas are found randomly.

3. Contaminations in 24-33km

Many organizations measure the ambient dose rates of plural points between radiuses 20-60km. We select 4 points along NW direction and listed in Table 1.

Table 1. Observation point's numbers, extrapolated ambient dose rates, and observed ones of 4/18.

Point	Distance	ambient dose rate
83	NW 24km	252-373mSv/Y, 49.8μSv/h
31	WNW 30km	56.5-82.5, 11.4
32	NW 31km	130-186, 28.6
33	NW 33km	92.3-138, 15.5

The dose rates of points are measured every once a day. The period is 3/18-4/30. The measurement time is random. We suspect the values contain noises.

We estimate an approximate function that has 3 exponential functions. The exponents are selected as the half-life of ^{132}Te, ^{131}I, ^{137}Cs. Coefficients of the

3-exponentials are optimized.

We integrate the function through 1 year and estimate predicted dose rates. Those are maximum ones. The most effective term is ^{137}Cs. The half-life is 30 year, but it wouldn't be realized in environments. The effective half-life of Cs in nature is dependent on the regional soil; there is no reference.

We calculate the half-life in a fitting calculation to determine an approximate function for a point of NW 63 km, where observations are reliable. Thus, we get a half-life of 276 d. Using it, we re-calculate dose rates. This is minimum values.

4. Predictions at NW 39 and 63 km points

The ambient dose rate of the NW 39 and 63 km is measured every hour and the period is 3/11-4/30. The number of data is over 1100 and they are valid; thus, we can determine effective half-life of ^{137}Cs in the nature. On use of it, we calculate that the dose rate is 27.3-34.6 mSv/year for 39 km point, and 11.4-15.5 mSv/Y for 63 km. Precision of the approximate functions is listed in Fig.3. Where, the calculations are accumulations of measured values until elapsed time 1127 h, and are integrations of approximate functions after 1127 h.

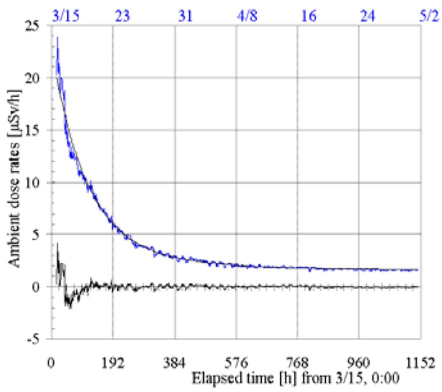

Fig.3 An approximation and the precision at a point of NW 63 km (N37.764, E140.468).

5. Radioactive concentration in the water

There is a pond nearby a point of NW 36 km, where the water is measured for ^{131}I, ^{134}Cs, and ^{137}Cs. We calculate the residence half-times of the water, which are 6.9 d (R^2=0.99) for ^{131}I, and 12d (R^2=0.82) for ^{137}Cs. Thus, radioactive matter is solution and it flows. We watch increasing of separation between 2 curves of ^{134}Cs and ^{137}Cs. It is reasonable that an approximate line of ^{131}I is straight.

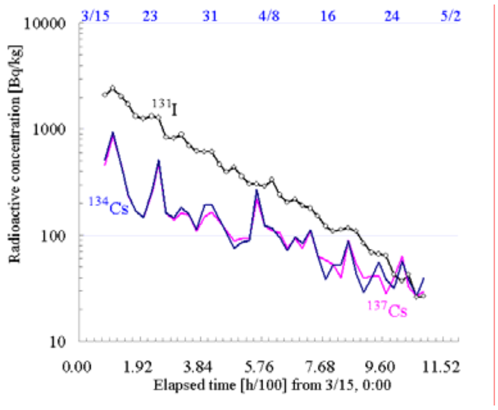

Fig.4 Change of radioactive concentration in the water of a pond at NW 36 km (N37.691, E140.812)

6. Re-diffusion of radioactive SPM

We find effects of the rain and convection about radioactive SPM. There are fine-structures in dose rate curve in Fig.5, and a lower envelope is non-linear. The difference curve doesn't close to the horizontal axis. The small increasing is re-diffusion of radioactive SPM.

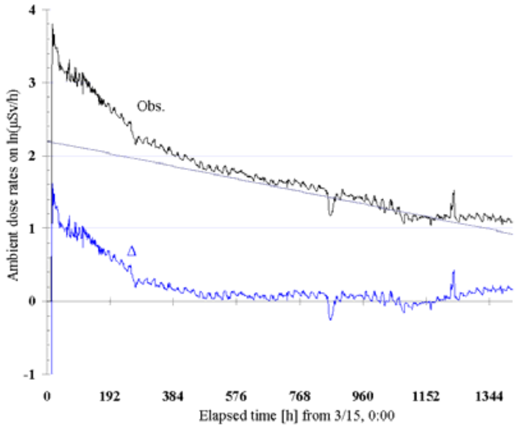

Fig.5 Ambient dose rates at NW 39 km point (N37.679, E140.735).

7. Summary

1. Distribution of radioactive SPM is in limited area, which is depended on the direction and geographical features.
2. Effective half-life of ^{137}Cs is evaluated tentatively; the number of observations is insufficient for long prediction.
3. Movement of radioactive SPM is found.

8. References

[1] http://www.pref.fukushima.jp/j/index.htm.
[2]http://www.mext.go.jp.cache.yimg.jp/component/a_menu/saigaijohou/index.html.

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