Observation of gamma ray intensity fluctuations during thunderstorms in Darwin

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[Abstract] Using our ground-base-observation results, we have examined the correlation between gamma ray intensity fluctuations on the ground and summer thunderstorm activities in Darwin. The results indicate that summer thunderstorm activities have apparently no influence on the gamma ray intensity fluctuations near sea level, and are consistent with our previous calculation results.

1. Introduction

Recently, gamma ray dose increases associated with thunderstorm activities have been observed in experiments using detectors installed on the ground (mostly in mountainous areas over 2000m msl), as well as those mounted on airplanes or balloons [1]. At present, the runaway breakdown of air [2] triggered by energetic electrons and gamma rays such as secondary cosmic rays, is thought to be one of the most promising causes to account for these phenomena. We have performed the Monte Carlo simulations concerning this mechanism and obtained results suggesting that, in winter, the runaway breakdown in strong thundercloud E-fields can contribute to the gamma ray dose increases near the ground of lowland areas such as those observed by Torii et al. [4], while in summer it is unlikely because thundercloud E-field regions are too distant from the ground. In this paper, we discuss the causes of gamma ray intensity fluctuations observed during our 2004 campaign in Darwin and whether there is any obvious contribution by thunderstorm activities. Based on this discussion, the validity of our simulation results is examined.

2. Observation results

The observations mentioned in this paper were conducted from 9 November through 22 December, 2004, in the suburbs of Darwin, using an NaI scintillation detector, an atmospheric radon monitor, and VHF broadband digital interferometers. Diurnal variations of gamma ray intensity highly correlated with that of atmospheric radon concentration were routinely observed throughout the campaign. These are attributable to the variation of the intensity of gamma rays from radon daughters. Also, gamma ray intensity enhancements with the duration of several hours were frequently observed. They always entailed rainfall and didn't take place in the cases of thunderstorm activities without rainfall. Therefore, they are estimated to be due to the washout effect, not thunderstorm activities. Finally, we have calculated the correlation coefficients between indices concerning gamma ray intensity enhancements, atmospheric radon concentration, and the intensity of thunderstorm activities, using observation results throughout the campaign. The indices (1 through 5) and their correlation coefficients are shown in the attached table. These results show that gamma ray intensity enhancements are highly correlated with atmospheric radon concentration, but have apparently no association with thunderstorm activities.

3. Summary

We have presented the ground-based gamma ray observation results obtained during our campaign in Darwin, along with their correlation with thunderstorm activities. The observed fluctuations of gamma ray intensity are estimated to be the consequences of diurnal variation of atmospheric radon concentration and the washout effect during rainfall, and no obvious impact by thunderstorm activities is found. This result, combined with our previous observation results [4], is in good agreement with the theory shown by our numerical simulations [3].

[References]

[1] T. Torii, JIEED Japan, 46 (3), 52-57
[2] A. V. Gurevich et al., Phys. Lett. A 254, 79-87
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	1. Hourly average of X-ray intensity	2. Hourly number of X-ray intensity data exceeding u + 3s
3. Hourly average of Radon concentration.	0.70	0.52
4. Hourly number of detected lightning flashes	−0.17	−0.03
5. Hourly number of detected lightning radio pulses	−0.10	−0.03