Measurement of lighting induced radiation background

Application report of Radiometer PCE-RAM 10

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About Stormchasers.sk

Stormchasers.sk is a project and non-profit group oriented mostly to a documentation of storms in area of Slovakia.

Since 2009, Stormchasers.sk are the first official storm-chasing group in Slovakia, with a team of core members highly specialized to summer extreme weather observations and documentation. All members have the storm-chasing as a hobby, with self-learning over the time.
All core members have several years of storms observation knowledge thanks to their own storm chases before the official group have been created.

The main goal of the Stormchasers.sk group is to study the storms over the time, including all phenomena related to them, like downburst, wind gusts, heavy rain, severe lightning, and tornadoes. By accessing large amount of publicly free data, we focus on performing pre-chasing analyses, to better understand storm development, and after-chase analysis, to understand the effects of a storm phenomena that occurred.

By using the latest technology to measure low 2m parameters like rain, temperature, pressure, and wind, we are able to enhance basic forecasting models by comparing measured data with forecasted ones. Stormchasers.sk is currently extensively using 4 mobile probes (weather stations), which comply with 2m wind requirements as per WMO, with calibrated sensors and data loggers from our partners.

Stormchasers.sk group is continuously improving the help by talking to the public via media (TV&radio broadcasts, newspaper articles) and cooperation with Slovak Hydrometeorological Institute (SHMU), along with the publication of storm documentation articles on www.stormchasers .sk.

Reasons for Radiometer usage need

Every second, the Earth is struck by lightning 40-50 times. By a recent observation (2001/2002) it has been confirmed, that lighting in special occasions may produce X-ray radiation, as well as some other particulate radiation, mostly in middle energy spectra.

There is only very few evidence and a very low count of research done, to evaluate the observation of possibility of α,β and γ rays as well. Therefore we decided to obtain a radiometer device, which is able to measure best all 4 types of radiation and to do our own research, because we are mostly very near intense lightings during our storm-chases.

Normally, standard alpha rays are low energy and very low penetrating depth, so that usually few centimeters of air will stop them. In this case, we are targeting so-called "long range alpha" particles, which are mostly present as a part of natural cosmic radiation pattern, but some theoretical works show off, that they may be present during strong lightning discharge.

On other hand, the beta rays are higher energy loaded, traveling higher distances, and may be 100 times more penetrating than alpha particles. In this case, there is no evidence for now that beta rays may be present in low distance from lightning, but there is a lot of evidence, that beta decays are present near the lighting channel of ionized air.

For the gamma rays, recent discovery of Japan scientists has shown, that lightning may produce high energy gamma radiation probably thanks to nitrogen-14 decay. There will be for sure more research done later on. According to literature available, gamma ray and X-ray creation by lighting has to be researched more, therefore we decided to extend our point of interest, in order to study the intense lightning more in detail.

By browsing some manufacturers offers, we decided to go on with PCE Instruments radiometer RAM-10 (PCE-Instruments.com/RAM-10) thanks to the described parameters which fully fit our requirements (accuracy, repeatability, stability and types of measured radiation) as well as easy to understand design of the instrument itself.

Using the radiometer

Radiometer came very well packed, in a handy box for easy transportation of the instrument. We have studied the attached manual which describes all necessary steps to be carried out in order to obtain good measurement results. The device itself fits very good in hand and has an easy to understand menu, what makes the operation of the instrument simple, without a need of special preparation before measurements can be done. This is a good plus point, because some other devices require time consuming steps before the measurement can be taken.

As we were using the radiometer mostly in dangerous weather conditions, the device was held by a person in a car or outside, few hundred meters away from storms, so that the radiometer was always in dry conditions. Anyhow, for further longterm use, a tripod mount would be very beneficial.

Fig.1 Measurement of gamma ray radiation increase in approaching storm.

After initial setup (date/time) we proceeded to measure first the natural radiation background within the selected areas in west Slovakia in order to have reference measurements.

In a sunny day, we got a readings between 0.06 and 0.11µSv/h, what corresponds with standard radiation background in Slovakia according to European measurements available on internet. This value has been used as reference "zero" to see any increase during the research.

Several measurement attempts have been made during the season between july - september. When checking data from 8 measurements, from which 5 were made in near of weak single-cell type thunderstorms and 3 near very electrically active multicell/complex storms, electrically very active thunderstorms with CG-/CG+ lightning dominance show an increase in gamma radiation, from reference by up to 0.22 µSv/h in one event, where we were in the center of storm with CG lightning striking less than 200m away, what confirms the research done by Japan scientists.

Background of the increase in gamma radiation remains unclear, but it is an open point for further research in future. The increase has been confirmed by comparison to European Commission REM. Below a confirmation measurement done by station in Hainburg(AT), which clearly shows an increase in gamma radiation in two dates, where heavy thunderstorms were present in the area.

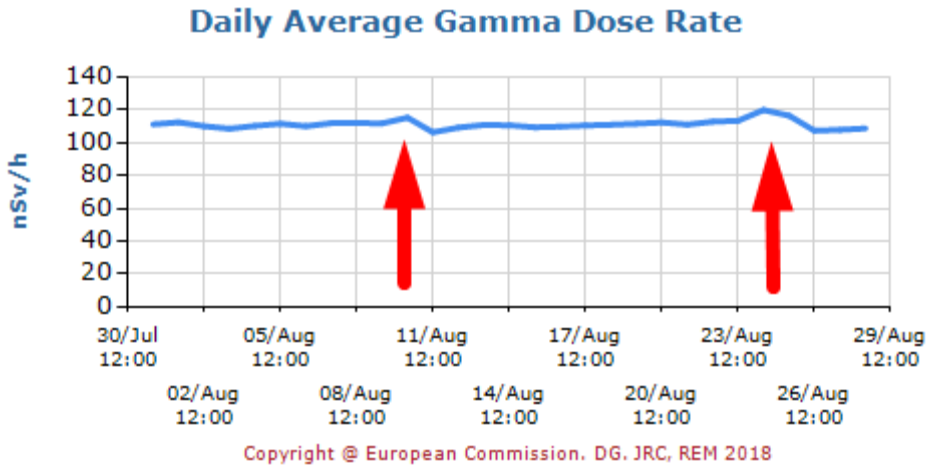

Fig.2. Hainburg station gamma ray dose rate

There is as well available another date, from a station in Bratislava, near to our location, which clearly shows increase in average gamma dose rate over 1-3.9.2018, with a peak on 1.9.2018, when heavy thunderstorms hit Bratislava, lasting for several hours with high lighting intensity.

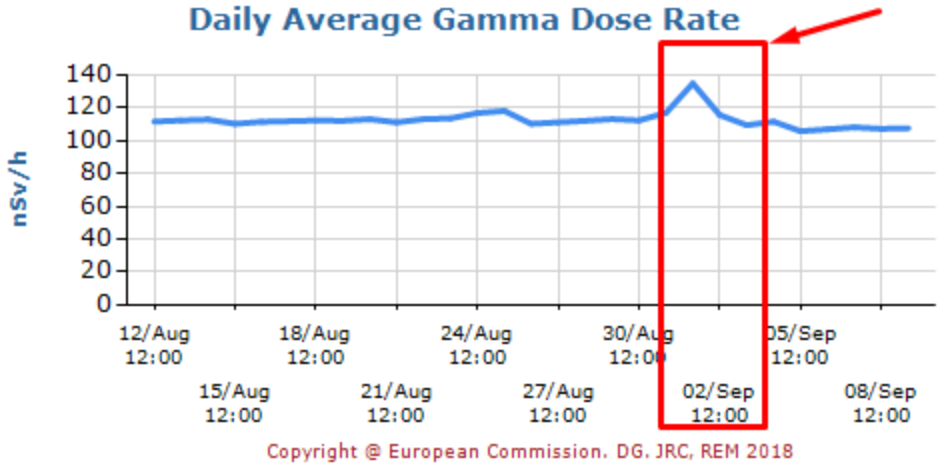

Fig.3 Bratislava station gamma ray dose rate

Conclusions:

Gamma radiation is being continuously measured by many stations around the globe, in order to monitor any nuclear acidents. Anyhow, this network may be used also for further investigation of radiation background created by strong lighting, especially when compared to measurements done with handheld instruments like PCE-RAM10, in the close proximity of intense lightning. Since we were not able to get too close to some intense lightning bolts, we cannot for now confirm an α,β ray generation, since these are low penetrating radiation, which is fairly good absorbed by standard atmosphere. However, these will be added to further research in season 2019, with additional detectors, especially a so called "spark gap" detector for α radiation.

We will be using the PCE-RAM10 next season as well, because of its ability to measure both α,β radiation, so that we can later confirm the observation made by spark gap detectors. The PCE-RAM10 comes as very handy instrument, with low power consumption, so that it can be left unattended for several hour, to obtain measurement from desired location. Automatic data logging feature is a big plus, what brings it to the front among other manufacturers.