THE TIDAL COMPONENT OF NATURAL RADIATION BACKGROUND

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Abstract

The paper contains temporal analysis of radiation fluctuations on the Kokonín farm. Our main goal was to ascertain whether tidal forces affect the magnitude of the fluctuations in this location. From a nine-month measurement, carried out by minutes, components were obtained with periods corresponding to the tidal frequencies. The value of sum of the amplitudes was correlated with phases of the Moon, as the main tidal agent. This way one can extrapolate that the amplitude of the tidal component constitutes about 15 % of local natural radiation background.

Key words: *Fourier transform; solar and lunar periods; radon.*

INTRODUCTION

Gravitational attraction of the sun and the moon are responsible for the tidal motions on the globe, in all three media, the atmosphere, the oceans and the solid Earth. We will not go into great detail regarding this topic and the interested readers are referred to excellent books on the topic (for example Chapter 13 of *Pond & Pickard, 1989;* Chapter 11 of *Dietrich et al., 1980*). However, we will give enough information here so that the reader can appreciate the nature of tidal processes around the globe.

The rhythmic rise and fall of sea level along the world's coastlines are the most apparent manifestation of tides in the global oceans. In some coastal locations, tides are noticeable but not spectacular, but in other places like the West coast of Korea and the Bay of Fundy, the tides are spectacularly large. In some places, the sea level rises and falls with a period of about half a day (these are called semi-diurnal tides), whereas in other places the period is more like a day (called diurnal tides). Yet again, in some locations the tides are mixed. And there are periods during the year, when the sun and moon line up with the Earth when the tides are unusually large.

Natural radiation can be divided into two main components, one coming from above and the other coming from below. While tide of the atmosphere is arguable and can virtually never be identified from experimental data, and while the periodicity of cosmic radiation can be successfully ruled out, indications exist that looking for tidal periods in the ground component of the radiation background could be successful. Such an indication is first of all the presence of tidal components in small water courses and wells. E.g. the flow of Starosuchdolský stream with mean flow rate of abt. 1.75 l/s is modulated by 30 % by the tidal component in the rain-less period. Similarly, the KV4 water-well has the tidal amplitude of 125 mm. These facts may justify sufficiently the idea that different fluids may be squeezed out from the underlying layers with varying gravitational force. When the gravitational force changes periodically, one can also observe, with a certain delay dependent on local structure, radiation oscillations with the same periods, caused e.g. by the outburst of radon.

Tidal periods can be divided mostly to the ones caused by the effect of the Moon and the ones caused by the effect of the Sun. Following Table 1 shows the tidal periods we were using for the analysis in this work.

Table 1 gives the period and relative size of each of these constituents. While in some isolated situations, where other constituents become important, it is seldom essential to include many more to obtain accurate tidal predictions. In shallow water, the so-called compound tides generated by non-linear interaction of primary constituents become important. For example, M4, generated by non-linear self-interaction of the M2 constituent has half the period of M2.

The aim of study was ascertaining of periodic tidal component in natural radiation background in Western Sudetes region.

Tab. 1 Primary Tidal Components

Tidal Component	Period solar hours	Description	Nature
M1	12.42	Principal lunar	semi-diurnal
S2	12.00	Principal solar	semi-diurnal
N2	12.66	Larger lunar elliptic	semi-diurnal
K2	11.97	Luni-solar	semi-diurnal
K1	23.93	Luni-solar diurnal	diurnal
O1	25.82	Principal lunar diurnal	diurnal
P1	24.07	Principal solar diurnal	diurnal
Q1	26.87	Larger lunar elliptic	diurnal
MF	327.90	Lunar fortnightly	Long term
MM	661.30	Lunar monthly	Long term
SSA	4383.00	solar semi annual	Long term
M4	6.21		Compound
MS4	6.10		Compound

MATERIALS AND METHODS

Data from Marek Drápal from his station by the farm in Kokonín (50°42'00.5"N 15°10'24.1"E), three meters above ground surface, were used for the analysis. The data were collected in the period 21. 8. 2018-22. 1. 2019. Pulses from a SBM-20 GM tube were stored each minute, time synchronized through NTP. The data were scanned with three-day rectangular window (of 4320 samples) with Fourier transformation for periods MS4, M4, K2, S2, M2, N2, K1, P1, O1, Q1 from Table 1. The intervals were shortened to the nearest integral multiple of the sought period. The periods found have been visualised with the gnuplot program ver. 5.2 patchlevel 2.

RESULTS AND DISCUSSION

Data for the given period are displayed in Figure 1.

The sum of periodical components is represented in Figure 2.

The data presented show that tides influence is at most up to 10 % of measured signal of radiation fluctuations in the given location, but they can be successfully detected in it. Step signal changes may easily complicate their identification though. To a certain extent, an interpretation problem is constituted by the advancing of the maxima of tidal periods from the full moon. This is to some extent caused by the data processing method. By cropping the three-day interval to the multiple of the sought period, we albeit avoided unpleasant artefacts of non-integer periods on one hand, however on the other hand we moved the sought signal by sometimes the whole period to anterior time, and generally blurred the signal during the summing. Thus we more asked to what extent the period was present in the given three-day period, without demanding to specify the exact moment when it occurred.

Groves-Kirkby et al. (2004) in their domestic radon measurement study in Northampton, England found that the tide vs. radon concentration correlation and lag depends (among others) on the location and on meteorological conditions. And radon, in fact, accounts for a substantial component of the radiation background researched by us. Later the same group *Crockett et al*. (2006) tried to cross-correlate the radon time-series against the modelled variation in tidal force. They found the lag to be about 3-4 days, the correlation coefficient being cyclic with the 14–15-day tidal cycle, reaching about ±0.15.

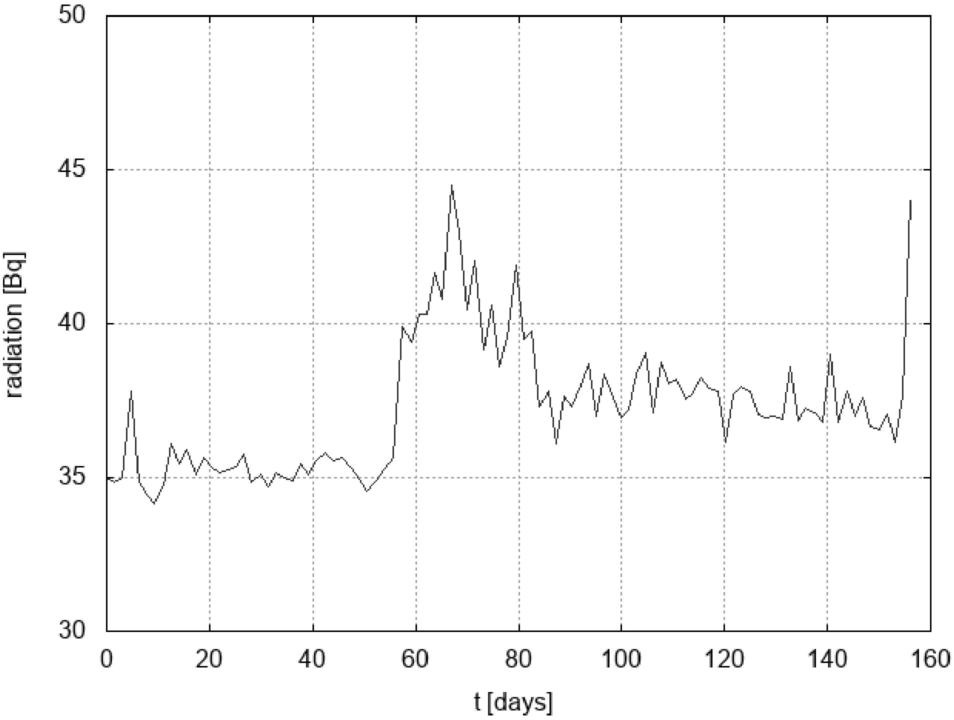

Fig. 1 Recorded period from 2018/08/21 to 2019/01/22. Starting with day 56, i.e. October 16th 2018, one can see increasing radiation level in atmospheric undulation that declines exponentially from November, in total this presumably Belorussian escapade increases the radiation background by 10 % almost permanently.

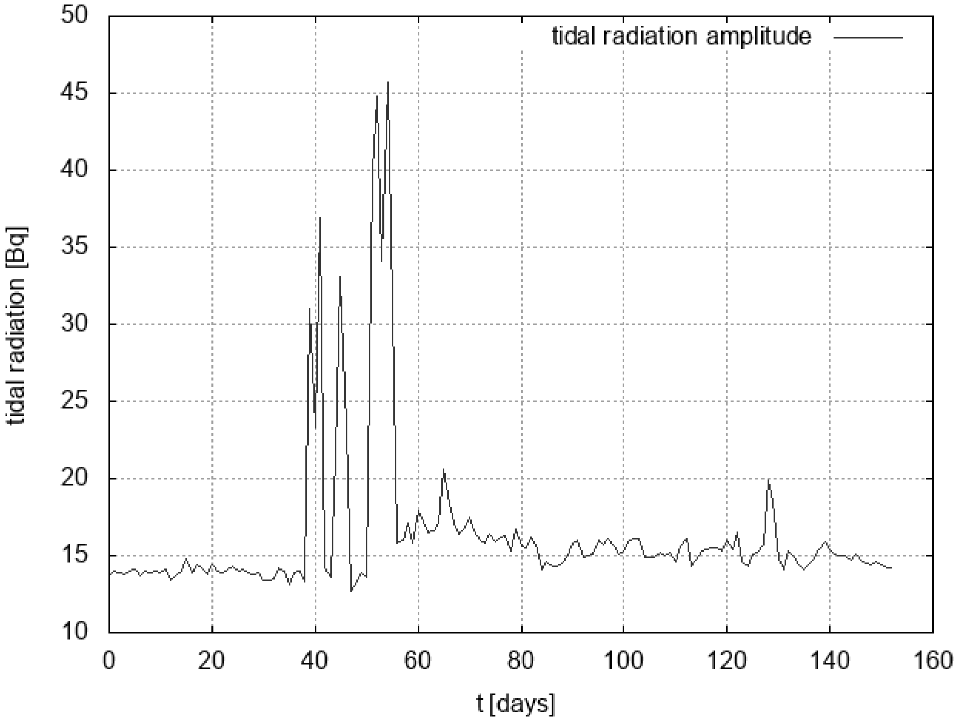

Fig. 2 The data are shifted slightly (by four points against Figure 1); this is caused by the window width. The period displayed is thus 2018/08/24–2019/01/21. Pronounced step increase can be seen in the period of rapid radiation changes in days 39–55 of the record that is more likely an artefact, and further peaks in days 64 (October 25th) and 128 (December 27) in the period of perigee moons of October 24th and December 22nd

CONCLUSIONS

Periodical components have been identified in the radiation background data in Kokonín that one can interpret partially as tidal ones. For verification of this analysis, a longer time series analysis is necessary, and a correlation of computed retarded gravitation with measured radiation background intensity. I seems though that even this analysis carried out by us strengthens the indication (ZD) on the influence of tides on the movement of subsurface fluids.

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