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GIOVE-B/SREM data processing

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1 Introduction

On April 26, 2008 ESA's Galileo In Orbit Validation Element B (GIOVE-B) was launched on a Starsem Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan into a circular Medium Earth Orbit (MEO). On-board is a unit of the Standard Radiation Environment Monitor (SREM), an instrument manufactured by CONTRAVES SPACE AG, Switzerland in cooperation with the PAUL SCHERRER INSTITUT (PSI) under a development contract of the EUROPEAN SPACE AGENCY (ESA).

SREM was switched on on May 6, 2008 and is since then delivering valuable measurements of the high energy charged particle environment of the spacecraft.

This document summarizes the first six month of SREM operations.

2 Data coverage

Figure 1 summarizes the on/off times of the SREM since the beginning of the mission. The plot shows when the instrument was in one of the three states OFF, STANDBY (switched on but not accumulating), or ACCUMULATING.

Since SREM was first put into operation on May 6, 2008 it was for 71% of the time in state ACCUMULATING (20% OFF, 9% STANDBY). SREM was not operated without interruption. There are three major gaps where SREM was either in OFF or STANDBY mode.

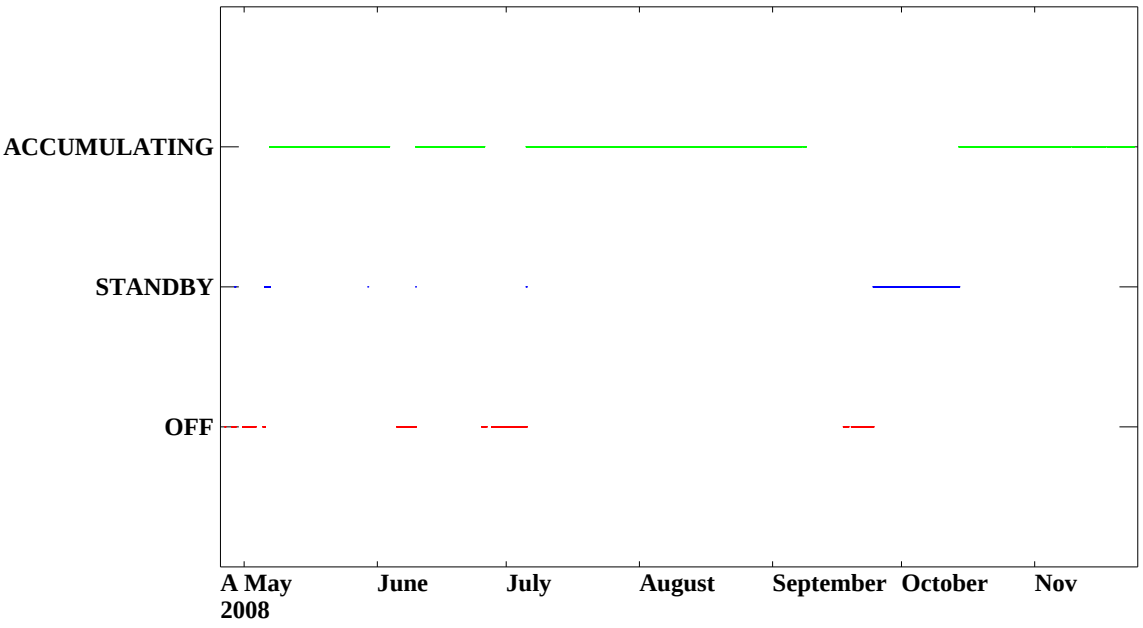


Figure 1: Status of the SREM since the launch of GIOVE-B.

In order to give an overview of the radiation environment along the GIOVE-B orbit during this period, the count rates in SREM counters TC1, TC2, TC3, and C1 are shown in figure 2 as function of time. The temporal variations observed in the TC1 to TC3 counters are due to the varying electron fluxes. The rate in counter C1, which is only sensitive to protons with $E > 40$ MeV is very stable over the whole period.

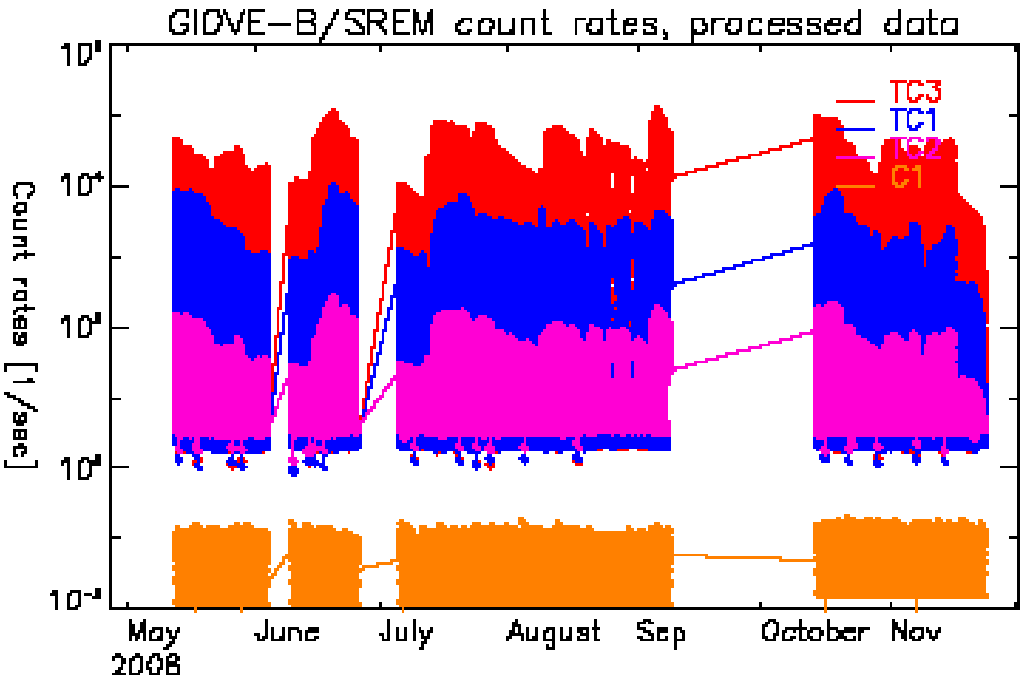


Figure 2: Count rates in SREM counters TC1, TC2, TC3, and C1.

3 Data quality

3.1 Temperature

The measured temperature of the SREM is plotted in figure 3 as function of time. The maximum temperature was 11.2 $°C$ and the lowest temperature was -12.8 $°C$ (average temperature of 7.8 $°C$).

3.2 Time information

To control the quality of the received data, several checks are performed. Especially tests which aim at finding and correcting bad time information. These tests include

- check TM for multiple occurrences of the same data point with different absolute time stamps
- check difference between SREM time at start and stop of an accumulation to correspond to the nominal accumulation time
- check linear dependence between SREM time and absolute time

Most raw data files contain data points which are listed several times. In these cases only the first one is kept for further processing. There are only very few cases where the difference between the

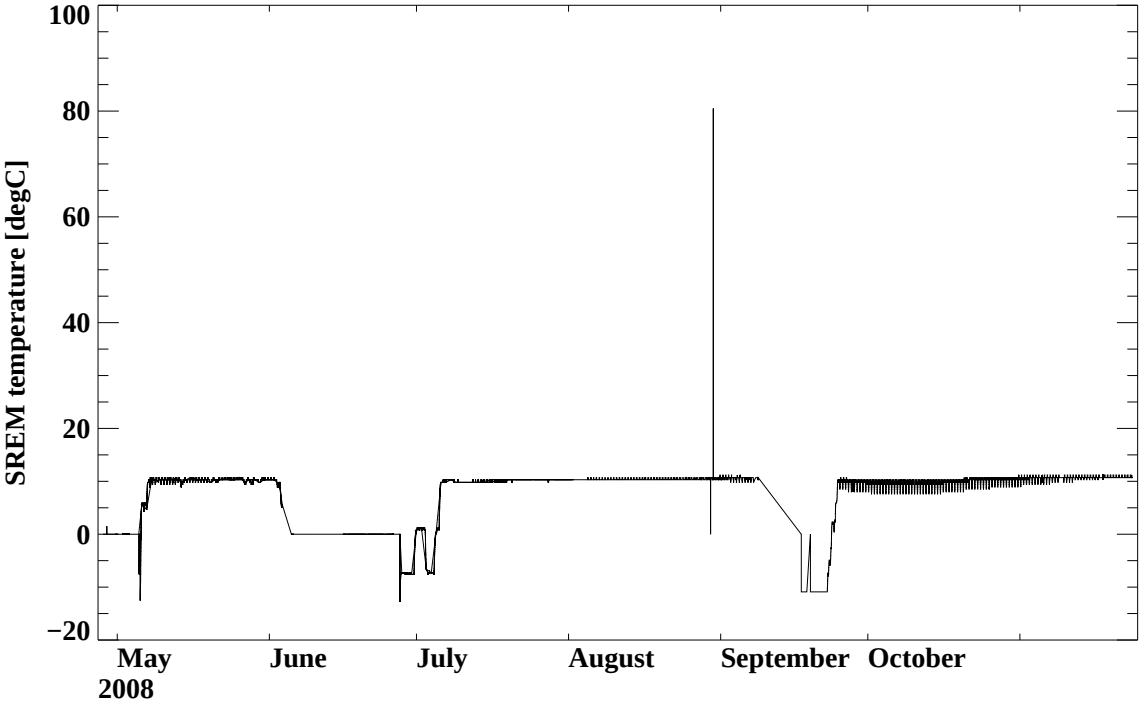


Figure 3: Temporal variations of the temperature of the SREM instrument.

reported start and stop time of an accumulation does not agree with the nominal accumulation time of 80 seconds (60 seconds since October 14, 2008). These cases are eliminated as well.

Generally the SREM time and the absolute time information given in the raw data files yield a linear relation. There are however some data points which deviate significantly from this average trend. In these cases it is assumed that the absolute time information is wrong and it is corrected to the value which is given by the average linear relation found for the SREM time and absolute time.

A wrong timing would directly influence the orbit calculation and with this the computation of the magnetic field and related parameters. A good test of the timing is to plot the count rates versus the L-shell parameter. For consecutive passages of the satellite through the radiation belts one expects to find count rate curves which peak at the same L-value. In case of a wrong timing the peak position of the count rate curve would be displaced and different for in- and outbound legs.

In figure 4 two examples of such plots are shown in comparison with data from the SREM aboard Integral (IREM). Subplot a) contains data from July 18/19, 2008 and subplot b) contains data from November 3, 2008. Data from IREM are contained in the left column of panels and the data from SREM/GIOVE-B is contained in the panels in the right column. In the upper panels of each subplot the L-shell parameter is plotted versus the magnetic field strength. The lower panels show the count rates in counters TC1, TC2, and TC3 as function of L.

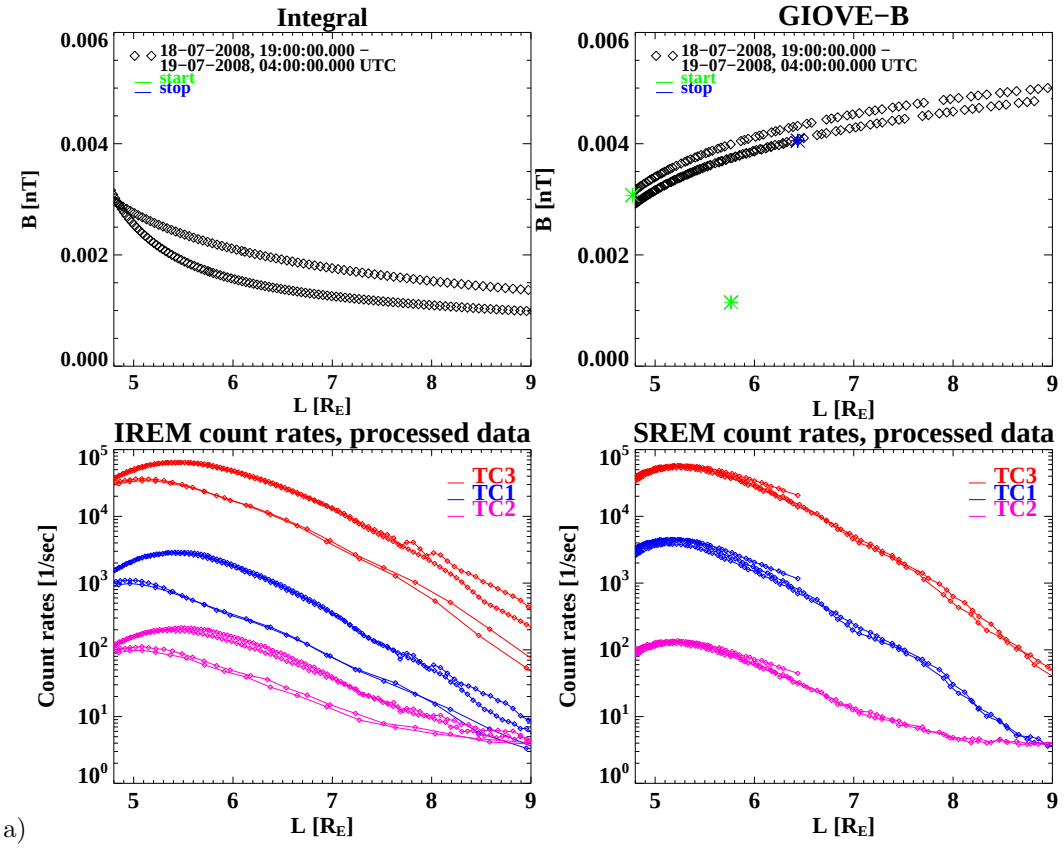
Concentrating first on the GIOVE-B data only one can note, that in- and outbound legs have similar tracks in the B-L-plane. One can therefore expect the count rates along both ways to show a similar L-dependence (assuming temporal variations of the radiation environment to be negligible for the selected short period). This is indeed the case. In both cases, a) and b), the count rate curves of the in- and outbound legs are very similar. These examples, which are representative for the entire data set, suggest that the timing information as well as the orbit and magnetic field computations are sufficiently accurate.

In case for the IREM data the tracks in the B-L-plane of the in- and outbound legs as well as the count rate curves of different passages through the outer radiation belt differ more than in the case

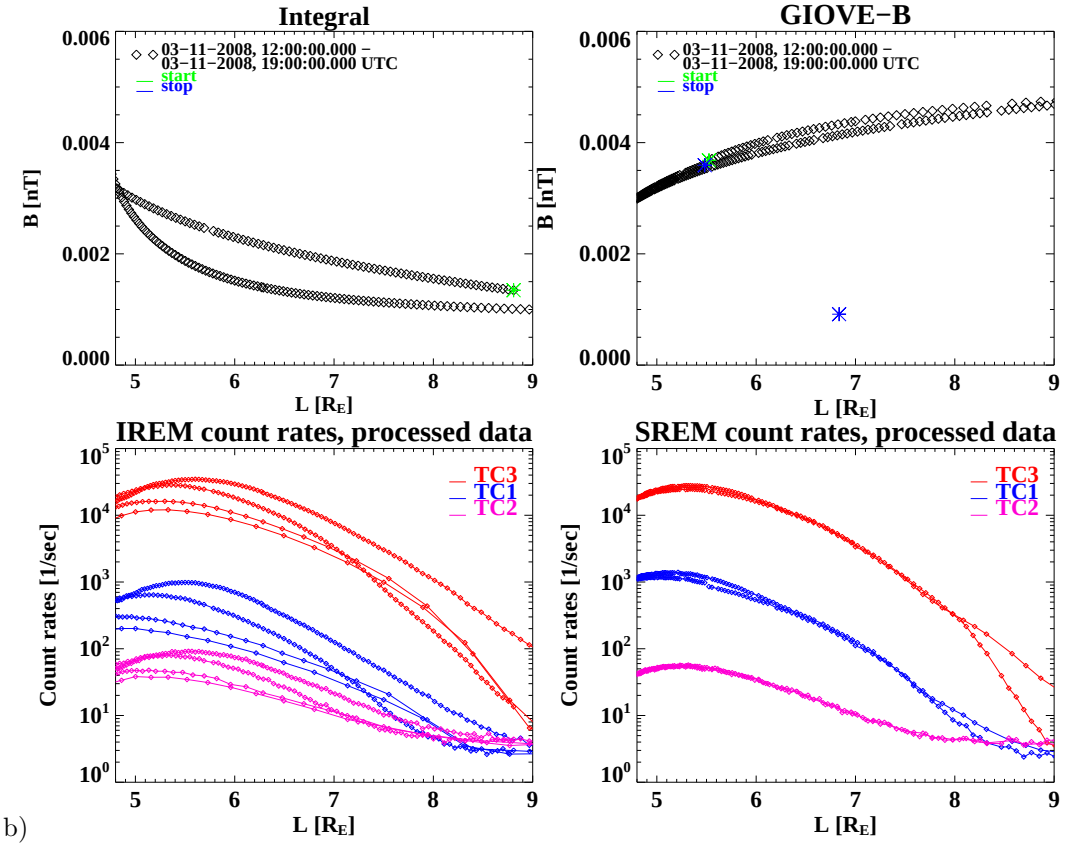
of the SREM/GIOVE-B data. Although the IREM count rates vary much between different belt passages, one finds a general agreement of the shape as well as the absolute values of the count rate curves of the two instruments. A careful joint analysis of these two data sets could be interesting and could e.g. allow to obtain some information about the pitch angle distribution close to the magnetic equator.

4 In summary

- The SREM aboard GIOVE-B is properly working and delivers significant data
- In the first six month of operation SREM was accumulating data during 70% of the time. It is desirable that this fraction can be enhanced in the future.
- Data processing procedures are in place and have proved to be effective in producing valuable data
- New data is automatically processed once per day and made available at http://srem.web.psi.ch/data/gioveb/



a)



b)

Figure 4: Comparison of IREM and SREM/GIOVE-B data for two selected periods a) July 18, 2008 and b) November 12, 2008. Panels in the left column show IREM data and the panels on the right side contain SREM/GIOVE-B data. In the upper panels of each subplot, the L-shell parameter is plotted versus the magnetic field strength along the orbit. The lower panels display the count rates in counters TC1, TC2, and TC3 versus the L-shell parameter.