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Update on the GLE database; solar cycle 19

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Abstract. An effort has been underway to collect, evaluate, and archive the neutron monitor data for the major ground-level events of solar cycle 19. While numerical records in various forms have been located for the four major events: 23 February 1956, 4 May 1960, 12 November 1960 and 15 November 1960, some of the data are difficult to interpret. Questions have arisen, primarily with respect to the event on 4 May 1960. In addition we present a list of stations for which data are still being sort.

1 Introduction

At the 26th International Cosmic Ray Conference we presented a paper on a project to compile ground-based cosmic ray detector data for the major ground-level proton events of Solar Cycle 19 (Shea et al., 1999). A list of events and station data already acquired was included in that publication. At the same time we requested members of the cosmic ray community to search their laboratory notebooks and personal archives to aid us in this task. In this paper we present a report on the progress of this project.

2 Data Acquired

The work over the past two years has concentrated on acquiring, sorting, and archiving, in standard GLE format (Gentile, 1993), the data for the 4 May 1960 event. This was a major ground-level enhancement with increases greater than 200% recorded by neutron monitors in North America. The particle increase was extremely anisotropic (associated flare position 90° West) with much smaller increases recorded by European monitors. Table 1 presents a summary of information gathered from the various records that have been examined.

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3 Discussion

An inspection of Table 1 shows the following:
1. Polar and mid-latitude stations recorded this event. Equatorial stations did not record the event.
2. The onset times varied considerably. The onset time from the Zugspitze data appears to indicate a mistake of an hour in the printed data.
3. Several stations (i.e. Heiss Island, Munich, and Yakutsk) have data missing at the time of the event. The increase in counting rate may have been considered to be noisy data and been removed before the data were distributed.
4. Data in small time intervals is extremely important for analyses of these events. However, even the large interval data are useful for an overall evaluation of the event.

From investigators we know that the late onset time recorded by the College monitor was suspect, and it was believed by many that there was a clock timing error. These data must be compared with other neutron monitor data, and analyzed with modern techniques such as described by Cramp et al. (1997) before some of the discrepancies can be resolved.

4 Request to the Cosmic Ray Community

Table 1 is an example of what we would like to prepare for the three other large relativistic solar proton events of the 19th solar cycle. Obviously we would like to have smaller time interval data than the bi-hourly or hourly data we presently have for many of the neutron monitors. However, we recognize that many stations distributed and/or archived their data in the bi-hourly time intervals recommended during the IGY. While smaller time interval data may have been recorded at these stations, these data generally were circulated within the cosmic ray community and usually only upon receipt of a special request. These are the data sets we hope will be found in old notebooks or personal records.

Table 1. Summary of 4 May 1960 Ground-Level Event from neutron monitor data

Station	Time Interval (Min)	Onset	Time of Maximum	Percent Increase (Note 1)	Additional Comments
Ahmedabad	7200				No increase
Berkeley	120	1032-1034	1038-1040	36	
Buenos Aires	3600				No increase
Chicago	7200		1000-1200	26	
Churchill	60	1025-1030	1036-1037	270	
Climax	3600		1000-1100	42	
College	900	1040-1055	1040-1055	18	
Deep River	60	1025-1030	1039-1041	210	
Ellsworth	900	1030-1045	1030-1045	110	
Heiss Island	7200				Note 2
Hermanus	900	1030-1045	1030-1045	8	Note 3
Herstmonceux	600	1040-1050	1040-1050	4	
Huancayo	3600				No increase
Jungfraujoch	3600		1000-1100	3	
Kerguelen	7200		1200-1400	5	
Kodaikanal	7200				No increase
Lae	3600				No increase
Leeds	900	1030-1045	1100-1115	8	Note 3
Limeil	7200				Note 4
Lincoln	7200		1000-1200	27	
Lindau	900	1015-1030	1045-1100	11	Note 3
Mina Aguilar	3600				No increase
Makerere	7200				No increase
Mawson	600	1035-1040	1040-1045	20	
Munich	7200				Note 2
Murmansk	7200				Note 4
Mt. Norikura	7200				No increase
Mt. Washington	120	1025-1030	1040-1042	211	
Nera	7200		1000-1200	4	
Ottawa-1	60	1030-1032	1039-1040	185	
Ottawa-2	60	1030-1032	1039-1040	182	
Pic du Midi	7200				Note 4
Prague	7200				Note 4
Rio de Janeiro	7200				No increase
Rome	900				No increase
Resolute	600	1035-1040	1045-1050	42	
Sacramento Peak	3600		1000-1100	10	
Sulphur Mt.	60	1025-1030	1041-1042	342	
Syowa	7200		1000-1200	22	
Thule	120	1030-1032	1042-1048	134	Note 3
Uppsala	3600		1100-1200	4	
Yakutsk	7200				Note 2
Zugspitze	900	1145-1200	1215-1230	15	Note 3

Note 1: Increases have not been corrected to sea level
Note 2: Data missing at the time of the event
Note 3: Scaling factor problem (or dead time correction) needed to reconcile hourly with short time data.
Note 4: Poor statistics make it difficult to discern event.

5 Data Requested

5.1 Event of 23 February 1956

From Dorman (1957) we know that cosmic ray data for the 23 February 1956 event were recorded by several neutron monitors. We do not have any data for the following stations for this event:

Berkeley
Durham
Gottingen
Mt. Washington
Stockholm
Weissenau

Professor Dorman also published many graphs of ionization chamber data for this same event. We would be extremely grateful to anyone who can provide the original data as we can then compare the high-energy characteristics of this event with the 29 September 1989 relativistic solar proton event.

5.2 Event of 4 May 1960

We are looking for data, in as small a time interval as available, from the following stations:

Buenos Aires
Durham
Ellsworth
Makapuu Point
Mexico City
Mirny
Ushuaia

While we believe that low latitude stations such as Buenos Aires and Makapuu Point would not have recorded any increase in cosmic ray intensity, these data would supplement what is presently available in the archive. Although it appears unlikely that the Mexico City monitor would have recorded any discernible increase in cosmic ray intensity, the data from this station would be valuable in helping to establish the upper limit of the energy of the solar particles in this event.

5.3 Events of 12 and 15 November 1960

These two events were extremely unusual with substantial increases in the cosmic radiation intensity resulting from solar activity near the central meridian of the sun. The intensity-time profiles for the 12 November 1960 event were extremely complex, with the complexity attributed to the impact of an interplanetary disturbance from previous solar activity. We are looking for small time interval data from the following neutron monitors:

Ahmedabad	
Alma Ata	
Bergen	
Berkeley	
Churchill	
Deep River	(15 Nov)
Durham	
Halle	
Heiss Island	
Hobart	
Irkutsk	
Kiel	
Kodaikanal	
Lae	
Lincoln	(12 Nov)
Makapuu	
Makerere	
Mirny	
Moscow	
Mt. Washington	(15 Nov)
Murmansk	
Mt. Norikura	
Ottawa	
Resolute	
Rio de Janeiro	
Rome	
Sacramento Peak	(15 Nov)
Schauinsland	
Sulpher Mt.	
Syowa	
Yakutsk	
Zugspitze	

For a few of the stations we have small time interval data for one of the two events. When a date is shown in the above table, we are missing the detailed data for the specific event as indicated.

We recognize that many of these stations would not have recorded an increase during these November 1960 events; however, the extreme geomagnetic disturbances resulted in simultaneous decreases recorded by low latitude stations, making this an extremely interesting period for re-evaluation in light of present knowledge.

6 Summary and Conclusions

We have presented a progress report on the data acquired from neutron monitors during ground-level events of the 19^{th} solar cycle. The assistance of the cosmic ray community is requested to help locate some of the data that we know was acquired, but we do not have in this archive. The database will be eventually deposited in the World Data Centers.

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