

**Catalogues of Forbush Decreases for the Period of 1957 - 1967**¹Okike, O., ²Nwuzor, O. C., and ¹Akande, P. I.¹Department of Industrial Physics, Ebonyi State University, Abakaliki²Department of Industrial/Medical Physics, David Umahi Federal University of Health Sciences, Uburu*Corresponding author's email: nwuzorogoo@gmail.com**ABSTRACT**

This work presents catalogues of Forbush Decreases (FDs) between the periods of 1957 – 1967. Forbush Decrease is a short-time decrease in the intensity of galactic cosmic rays. Such decreases are traced to solar wind disturbances. This work aims to study the catalogues of FDs. To achieve this aim, two approaches will be adopted namely; (1) downloading and presenting the IZMIRAN FDs from their website (2) applying the automated methods of FD identification developed by Okike and Umahi (2019) to identify and present FDs. The IZMIRAN catalog which applied the global survey method, identified a total of 450 FDs while the automated generated FDs (FD1 and FD2) which applied Fourier transformation, identified 500 and 458 FDs respectively. A close study on the three catalogues, pinpointed some differences and similarities. These were attributed to the differences in their methods of identification.

Keywords:

Cosmic rays,
Galactic cosmic rays,
Forbush Decrease,
Catalogue.

INTRODUCTION

Forbush decrease (FD) is a short-term reduction in the Galactic cosmic ray (GCR) flux (Okike *et al*, 2021). This reduction in GCR flux was traced to the pioneering work of Scott Forbush (Forbush, 1937). However, FD as a striking cosmic ray time variation is characterized by its profile (Musalem-Ramirez *et al*, 2013). Within a period of few hours, the intensity recorded at a particular CR station can be reduced from 5% up to 20 or 30% in most uttermost instances (Musalem-Ramirez *et al*, 2013). Upon reaching a minimum, the intensity starts to recover slowly. This recovery may last from days to weeks. Contrary to diurnal variation, an FD can be simultaneous which in such cases, the FD is recorded almost the same time all over the world (Musalem-Ramirez *et al*, 2013).

The definition and method of FD identification have been viewed in different ways by cosmic ray (CR) research groups (Belov, 2008; Okike and Umahi, 2019b; Okike, 2020b). While some focus on the magnitude of FD (Lockwood, 1990; Tinsey and Dean, 1991; Ananth and Venkatesan, 1993; Oh ET AL, 2009, 2013; Dumbovic ET AL, 2011), others channel their attention on its interim distribution (Badrudin and Singh, 2006; Verma ET AL, 2014). GCRs can be recorded on the Earth by Neutron Monitors (NMs). Outside NM, several researchers have compiled different datasets to study GCRs and the associated FDs (Papaioannou *et al*, 2019). For instance, (i) the anticoincidence guard data

on Interplanetary Monitoring Platform (IMP) 8 (Cane, 2000; Richardson and Cane, 2011), (ii) the anticoincidence shield (ACS) of the International Gamma-Ray Astrophysics Laboratory (INTEGRAL) spectrometer (SPI), (Jordan *et al*, 2009, 2011), (iii) the measurements of the Electron Proton Helium Instrument (EPHIN) detector onboard the Solar and Heliospheric Observatory and Chandra (Heber *et al*, 2015) and (iv) Cassini's Magnetosphere Imaging Instrument (MIMI)/Low Energy Magnetospheric Measurement System (LEMMS) measurements (Roussos *et al*, 2017). These varying views of FD definition and identification have led to inconsistencies as a continuous challenge in FD identification (Okike ET AL, 2021). Following the relation of FDs to preceding solar emissions, Belov ET AL, (2008) reported that the Forbush Effect and Interplanetary Disturbances database (FEID) maintained by IZMIRAN contains FDs identified without reference to interplanetary (IP) conditions (Okike ET AL, 2021). Claims equally had it that small CR flux reductions in the 0.5-1.0 % range may be regarded as FDs if significant solar wind disturbances are recorded concurrently (Okike ET AL, 2021). It is noted that the IZMIRAN CR group applies the global survey method (GSM) for the selection of FDs in FEID (Okike *et al*, 2021). The GSM records a continuous series of hourly characteristics of variation of the density and vector anisotropy of CR with the rigidity of 10 GV (Okike ET AL, 2021). The group has created comprehensive FD

catalogues using data from the worldwide network of NMs from 1957 July to the present (e.g. Belov ET AL, 2018a, b).

In contribution to this challenge of FD identification, Okike and Umahi (2019b) and Okike (2020b) developed an algorithm for detection of FDs. This algorithm normalizes raw and Fourier transformed CR data using appropriate filters (Okike and Umahi, 2019b; Okike, 2020). For the FDs identified in the raw data, the impact of diurnal anisotropy was not removed. In addition, FDs can be identified using a careful adjustment for diurnal anisotropy (Okike, 2020).

In furtherance, numerous researchers have presented a great number of FD catalogues. For instance, Okike (2020) presented a large FD catalog using FTS on CR data from Apatity (APTY), Sanae (SNAE), Moscow (MOSC), Oulu (OULU), Magadan (MGDN), Potchefstroom, (PTFM) and South Pole (SOPO), McMurdo (MCMD) and Inuvick (INVK) stations for the year 2003. Papaioannou *et al*, 2019 compiled a catalog of 424 FDs at Mars using RAD dose rate data, from 2012 to 2016. Okike *et al*, (2021) compared the Forbush decreases identified from individual and a network of neutron monitors and suggested that while there are significant disparities between the IZMIRAN FD and other event lists, there is a beautiful agreement between FDs they identified in and those in the FEID.

In this paper, we will carefully present a catalog of FDs from the IZMIRAN database and those developed by Okike CR research group for the period of the 1957 – 1967.

MATERIALS AND METHODS

Data Description

The downloaded and processed/filtered data presented in the tables in this article are generated from IZMIRAN website (<http://spaceweather.izmiran.ru/eng/dbs.html>) for IZMIRAN FDs and the raw CR data equally generated from <http://cr0.izmiran.ru/common> for Moscow (MOSC) station for processed/filtered FDs. The IZMIRAN FDs are configured in hourly average while the raw data for the CR stations are of daily averages and presented at the IZMIRAN website using the American Standard Code for Information Interchange (ASCII) format. The data format for each of the raw CR data from the stations are the same (YYYY.mm.dd HH:MM, followed by the CR count). The complete automated FD event detection developed by Okike and Umahi (2019b) was used to generate FD1 and FD2. The method applies Fourier transformation (FT) on CR data which may be of hourly or daily resolutions. The algorithms are capable of analyzing FDs using hourly or daily data from any arbitrary station.

RESULTS AND DISCUSSION

Catalogues of Forbush Decreases downloaded from IZMIRAN website

The catalogues of FDs downloaded from IZMIRAN website are displayed in Tables 1a – d. The FDs are of hourly resolutions. They are selected using the Global Survey Method (GSM)

Table 1a: A catalog of IZMIRAN FDs

S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)
1	1957-07-05	3.8	51	1957-10-16	2.1	101	1958-02-23	1.5
2	1957-07-06	1.6	52	1957-10-20	1.4	102	1958-02-27	1.9
3	1957-07-09	1.4	53	1957-10-21	11.4	103	1958-03-03	1.5
4	1957-07-11	1.5	54	1957-10-24	1.2	104	1958-03-05	3.5
5	1957-07-13	1.2	55	1957-10-27	1.6	105	1958-03-09	1.4
6	1957-07-16	1.8	56	1957-10-29	4.6	106	1958-03-11	2.1
7	1957-07-18	1.5	57	1957-11-02	1.1	107	1958-03-14	3.6
8	1957-07-19	3.2	58	1957-11-04	1.2	108	1958-03-17	1.7
9	1957-07-22	2.7	59	1957-11-05	1	109	1958-03-20	2.3
10	1957-07-26	1.5	60	1957-11-06	2.5	110	1958-03-23	0.9
11	1957-07-27	2.4	61	1957-11-08	2.1	111	1958-03-25	9.2
12	1957-07-29	2.8	62	1957-11-11	1	112	1958-03-29	1
13	1957-08-01	1.2	63	1957-11-13	1.6	113	1958-03-31	1.9
14	1957-08-03	8.4	64	1957-11-15	1	114	1958-04-01	1.3
15	1957-08-06	2.4	65	1957-11-17	1.7	115	1958-04-04	1.7
16	1957-08-09	0.9	66	1957-11-22	4.7	116	1958-04-06	1.1
17	1957-08-10	2	67	1957-11-26	7.5	117	1958-04-10	2.8
18	1957-08-12	1.1	68	1957-11-29	5	118	1958-04-14	1
19	1957-08-14	2.4	69	1957-12-01	1.2	119	1958-04-16	1.7
20	1957-08-18	2.7	70	1957-12-03	1.1	120	1958-04-23	0.8
21	1957-08-20	1.5	71	1957-12-04	1.5	121	1958-04-25	2.8
22	1957-08-21	2	72	1957-12-07	0.9	122	1958-04-26	1
23	1957-08-23	1	73	1957-12-09	1.9	123	1958-04-28	2.9
24	1957-08-24	2.2	74	1957-12-12	1.1	124	1958-05-05	1.6
25	1957-08-26	3.2	75	1957-12-14	1.1	125	1958-05-08	4.6
26	1957-08-29	12.1	76	1957-12-16	4.3	126	1958-05-11	1.5
27	1957-08-31	4.3	77	1957-12-19	6.3	127	1958-05-14	1.5
28	1957-09-02	5.8	78	1957-12-20	2.5	128	1958-05-18	1.2
29	1957-09-03	2.8	79	1957-12-22	2.5	129	1958-05-20	1
30	1957-09-04	4.9	80	1957-12-24	4.5	130	1958-05-24	1.1
31	1957-09-06	1.5	81	1957-12-27	2.5	131	1958-05-26	1.8
32	1957-09-08	1.4	82	1957-12-30	5.4	132	1958-05-28	5.5
33	1957-09-10	1.7	83	1958-01-01	1.2	133	1958-05-31	2.9
34	1957-09-13	6.3	84	1958-01-03	1.3	134	1958-06-02	2.7
35	1957-09-14	1.1	85	1958-01-04	1.3	135	1958-06-05	1.2
36	1957-09-16	1.2	86	1958-01-09	1.7	136	1958-06-07	2.1
37	1957-09-17	2.2	87	1958-01-14	1.1	137	1958-06-08	1.3
38	1957-09-21	4.5	88	1958-01-16	2.2	138	1958-06-10	0.8
39	1957-09-22	4.7	89	1958-01-17	3.1	139	1958-06-14	0.7
40	1957-09-23	4.3	90	1958-01-20	2.1	140	1958-06-16	1.2
41	1957-09-25	1	91	1958-01-22	1.3	141	1958-06-19	1.8
42	1957-09-27	1.5	92	1958-01-25	1.5	142	1958-06-21	2
43	1957-09-29	8.3	93	1958-01-27	0.7	143	1958-06-28	2.75
44	1957-10-01	1.4	94	1958-01-29	1.5	144	1958-06-29	2.9
45	1957-10-03	1	95	1958-02-04	2.3	145	1958-07-01	1
46	1957-10-05	2.1	96	1958-02-08	2.5	146	1958-07-03	0.5
47	1957-10-08	1.9	97	1958-02-11	7.8	147	1958-07-04	0.8
48	1957-10-10	2.1	98	1958-02-12	2.2	148	1958-07-07	0.7
49	1957-10-12	1.1	99	1958-02-16	1.3	149	1958-07-08	9.9
50	1957-10-14	1.3	100	1958-02-19	1.4	150	1958-07-11	2.2

Table 1b: A catalog of IZMIRAN FDs

S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)
151	1958-07-13	1.6	201	1958-11-16	0.9	251	1959-04-19	1.1
152	1958-07-17	1.4	202	1958-11-19	1	252	1959-04-23	4.4
153	1958-07-18	1.4	203	1958-11-23	1	253	1959-04-26	1.1
154	1958-07-20	0.9	204	1958-11-25	2	254	1959-04-28	1.1
155	1958-07-21	4.2	205	1958-11-28	2.4	255	1959-04-30	1.5
156	1958-07-24	1.4	206	1958-12-01	0.7	256	1959-05-02	1.2
157	1958-07-26	3.6	207	1958-12-02	1.2	257	1959-05-03	1.7
158	1958-07-29	1.1	208	1958-12-04	3.3	258	1959-05-04	1.2
159	1958-07-31	3.1	209	1958-12-05	1.4	259	1959-05-08	1
160	1958-08-02	1.3	210	1958-12-07	1	260	1959-05-09	1
161	1958-08-07	1.2	211	1958-12-08	1.2	261	1959-05-11	14.6
162	1958-08-10	1.1	212	1958-12-10	2.6	262	1959-05-13	3
163	1958-08-11	0.7	213	1958-12-13	2.6	263	1959-05-15	1.6
164	1958-08-13	1.4	214	1958-12-14	1.5	264	1959-05-18	1.1
165	1958-08-15	1.3	215	1958-12-15	1.2	265	1959-05-20	0.8
166	1958-08-17	3.8	216	1958-12-17	2.55	266	1959-05-21	0.8
167	1958-08-18	3.6	217	1958-12-19	1.6	267	1959-05-24	3.7
168	1958-08-22	3.2	218	1958-12-22	1.1	268	1959-05-26	1.3
169	1958-08-24	8.1	219	1958-12-25	2.3	269	1959-05-28	0.7
170	1958-08-25	3.2	220	1959-01-02	1.1	270	1959-05-31	1.2
171	1958-08-27	4.3	221	1959-01-05	2.4	271	1959-06-02	0.9
172	1958-08-30	1.5	222	1959-01-07	1.3	272	1959-06-03	1.2
173	1958-09-03	6.3	223	1959-01-09	3.8	273	1959-06-06	1
174	1958-09-04	3.1	224	1959-01-11	1.6	274	1959-06-09	1.9
175	1958-09-07	1.1	225	1959-01-14	0.8	275	1959-06-11	3.7
176	1958-09-09	1.2	226	1959-01-16	1.3	276	1959-06-13	2.9
177	1958-09-15	3.7	227	1959-01-25	5.2	277	1959-06-17	1.4
178	1958-09-16	3.6	228	1959-01-28	2.7	278	1959-06-23	1.1
179	1958-09-20	1.6	229	1959-02-02	1.5	279	1959-06-26	0.7
180	1958-09-25	3.1	230	1959-02-08	2.5	280	1959-06-27	2.9
181	1958-09-30	4.1	231	1959-02-11	3.95	281	1959-06-29	1
182	1958-10-03	1.2	232	1959-02-14	5.3	282	1959-06-30	1.8
183	1958-10-05	1	233	1959-02-16	2.7	283	1959-07-02	0.9
184	1958-10-06	2.9	234	1959-02-22	0.9	284	1959-07-03	2.1
185	1958-10-07	1	235	1959-02-25	2.3	285	1959-07-05	1.1
186	1958-10-09	1.4	236	1959-02-27	1.2	286	1959-07-06	1.2
187	1958-10-12	1.4	237	1959-03-04	1	287	1959-07-11	10
188	1958-10-16	0.8	238	1959-03-07	1.2	288	1959-07-14	0.9
189	1958-10-18	1.1	239	1959-03-10	1.7	289	1959-07-15	19.3
190	1958-10-20	1.1	240	1959-03-17	0.9	290	1959-07-17	15.2
191	1958-10-22	3.55	241	1959-03-19	1	291	1959-07-19	3.1
192	1958-10-24	2	242	1959-03-22	1.5	292	1959-07-22	1.1
193	1958-10-27	1	243	1959-03-25	2.4	293	1959-07-24	1.3
194	1958-10-28	1.2	244	1959-03-26	6.7	294	1959-07-25	1
195	1958-10-29	0.6	245	1959-04-03	0.9	295	1959-07-27	1
196	1958-10-30	0.7	246	1959-04-06	1.4	296	1959-07-31	2
197	1958-11-01	0.95	247	1959-04-08	0.9	297	1959-08-02	1
198	1958-11-07	1	248	1959-04-09	4.9	298	1959-08-03	1.4
199	1958-11-10	0.8	249	1959-04-11	1.1	299	1959-08-06	1.2
200	1958-11-11	2.8	250	1959-04-15	1.3	300	1959-08-08	1.3

Table 1c: A catalog of IZMIRAN FDs

S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)	S/NO	DATE	IZMIRAN FD (%)
301	1959-08-13	1	351	1959-12-10	1	401	1960-05-05	1.8
302	1959-08-15	1.1	352	1959-12-13	1	402	1960-05-08	10.5
303	1959-08-16	3.9	353	1959-12-14	1.2	403	1960-05-11	1.9
304	1959-08-18	2.8	354	1959-12-18	2.3	404	1960-05-13	2.6
305	1959-08-20	3.85	355	1959-12-19	0.8	405	1960-05-15	1.4
306	1959-08-21	1.4	356	1959-12-22	2.4	406	1960-05-16	1.9
307	1959-08-24	1.1	357	1959-12-26	1	407	1960-05-20	1.3
308	1959-08-29	2.1	358	1959-12-27	2	408	1960-05-22	4
309	1959-08-31	2.7	359	1960-01-03	1.5	409	1960-05-24	2.3
310	1959-09-01	1.2	360	1960-01-04	1.4	410	1960-05-26	1.1
311	1959-09-03	3.2	361	1960-01-05	1.8	411	1960-05-28	4.6
312	1959-09-06	0.9	362	1960-01-10	1.5	412	1960-05-31	1.7
313	1959-09-08	1.2	363	1960-01-13	6.7	413	1960-06-02	1.3
314	1959-09-10	1	364	1960-01-16	1.6	414	1960-06-04	5.9
315	1959-09-13	1.1	365	1960-01-18	2.7	415	1960-06-07	1.6
316	1959-09-14	1.5	366	1960-01-19	1.4	416	1960-06-10	1.3
317	1959-09-17	0.9	367	1960-01-24	1.7	417	1960-06-13	1.8
318	1959-09-19	8.2	368	1960-01-26	1.4	418	1960-06-17	3.2
319	1959-09-20	1.8	369	1960-01-28	1.8	419	1960-06-21	1
320	1959-09-23	1.5	370	1960-02-01	3.2	420	1960-06-23	1.6
321	1959-09-25	1.2	371	1960-02-05	1.7	421	1960-06-25	1.1
322	1959-10-01	1	372	1960-02-08	2.4	422	1960-06-27	3.6
323	1959-10-02	1.5	373	1960-02-12	2	423	1960-06-29	3.6
324	1959-10-04	0.9	374	1960-02-15	1.6	424	1960-06-30	2.4
325	1959-10-05	1	375	1960-02-17	1.3	425	1960-07-01	1.5
326	1959-10-08	1.1	376	1960-02-20	1.5	426	1960-07-06	1.6
327	1959-10-12	0.9	377	1960-02-25	0.9	427	1960-07-11	1.7
328	1959-10-14	1.3	378	1960-02-26	1.6	428	1960-07-14	4.3
329	1959-10-16	1.3	379	1960-03-01	1.2	429	1960-07-19	2.2
330	1959-10-21	1.5	380	1960-03-04	1.3	430	1960-07-22	1
331	1959-10-24	2	381	1960-03-08	0.9	431	1960-07-26	1.3
332	1959-10-27	1	382	1960-03-10	1.1	432	1960-07-29	1.8
333	1959-10-29	3.1	383	1960-03-14	1.8	433	1960-08-01	1.3
334	1959-11-01	1.3	384	1960-03-15	2	434	1960-08-04	1.1
335	1959-11-05	1	385	1960-03-19	1.2	435	1960-08-08	1.7
336	1959-11-07	0.9	386	1960-03-23	2.2	436	1960-08-10	1.6
337	1959-11-09	1.2	387	1960-03-27	1.3	437	1960-08-11	2
338	1959-11-13	1.1	388	1960-03-30	13.9	438	1960-08-14	3.2
339	1959-11-16	1	389	1960-04-02	3.1	439	1960-08-16	3.2
340	1959-11-18	1	390	1960-04-05	1.2	440	1960-08-19	2
341	1959-11-20	0.8	391	1960-04-06	1.3	441	1960-08-22	1.3
342	1959-11-21	1.5	392	1960-04-07	2.8	442	1960-08-24	1.2
343	1959-11-22	1	393	1960-04-10	1.3	443	1960-08-27	1.1
344	1959-11-25	1.2	394	1960-04-11	0.9	444	1960-08-29	5.1
345	1959-11-27	2.7	395	1960-04-14	2	445	1960-08-31	2.4
346	1959-11-30	1	396	1960-04-17	1.9	446	1960-09-02	1.6
347	1959-12-01	0.5	397	1960-04-23	1.9	447	1960-09-04	2.55
348	1959-12-02	6.8	398	1960-04-26	1.2	448	1960-09-06	1.2
349	1959-12-05	1.7	399	1960-04-27	4.5	449	1960-09-10	1.2
350	1959-12-07	1.9	400	1960-04-30	6.3	450	1960-09-13	1.1

Catalogues of Forbush Decreases (FD1) Selected from Raw CR Data

The catalogues of FDs (FD1) identified from raw CR data are displayed in Tables 2a – d. The used CR station name and abbreviation is Moscow (MOSC).

Table 2a: Catalogues of Forbush Decreases (FD1) Identified from raw CR Data

S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)
1	1958-01-18	-2.34	51	1959-02-17	-10.66	101	1960-03-31	-2.41
2	1958-01-21	-1.07	52	1959-02-25	-2.46	102	1960-04-26	-1.28
3	1958-01-23	-1.29	53	1959-02-28	-2.53	103	1960-08-01	-1.52
4	1958-01-26	-0.24	54	1959-03-27	-10.16	104	1960-08-03	-0.38
5	1958-02-13	-9.93	55	1959-05-12	-9.56	105	1960-08-12	-0.35
6	1958-03-11	-3.67	56	1959-05-14	-12.64	106	1960-08-15	-5.13
7	1958-03-15	-1.5	57	1959-05-25	-1.56	107	1960-08-17	-2.86
8	1958-03-28	-17.1	58	1959-06-19	-0.29	108	1960-08-19	-2.62
9	1958-03-30	-13.02	59	1959-06-22	-0.52	109	1960-08-23	-0.4
10	1958-04-06	-7.41	60	1959-07-01	-0.15	110	1960-08-30	-3.61
11	1958-04-13	-3.06	61	1959-07-04	-1.32	111	1960-09-01	-2.82
12	1958-04-18	-1.99	62	1959-07-12	-16.87	112	1960-09-07	-7.25
13	1958-04-23	-0.81	63	1959-07-27	-8.9	113	1960-09-12	-3.65
14	1958-04-26	-2.87	64	1959-08-04	-5.62	114	1960-09-17	-2.34
15	1958-04-30	-4.61	65	1959-08-08	-6.13	115	1960-09-20	-1.23
16	1958-05-02	-3.23	66	1959-08-12	-4.28	116	1960-09-23	-1.81
17	1958-05-09	-4.35	67	1959-08-16	-5.45	117	1960-09-25	-2.18
18	1958-05-12	-2.22	68	1959-08-20	-12.36	118	1960-09-27	-2.14
19	1958-05-14	-2.31	69	1959-08-27	-4.01	119	1960-10-01	-2.96
20	1958-05-31	-4.11	70	1959-08-30	-5.08	120	1960-10-06	-9.65
21	1958-07-01	-3.26	71	1959-09-01	-5.16	121	1960-10-14	-6.33
22	1958-07-03	-2.58	72	1959-09-05	-12.06	122	1960-10-21	-2.14
23	1958-07-06	-2.12	73	1959-09-11	-5.48	123	1960-10-25	-3.5
24	1958-07-09	-9.78	74	1959-09-16	-3.18	124	1960-10-27	-3.3
25	1958-07-14	-2.65	75	1959-09-20	-6.65	125	1960-10-29	-2.97
26	1958-07-18	-0.08	76	1959-09-26	-3.09	126	1960-11-03	-0.52
27	1958-07-22	-3.06	77	1959-09-28	-2.55	127	1960-11-14	-17.31
28	1958-07-25	-0.62	78	1959-10-04	-0.32	128	1960-11-16	-16.38
29	1958-07-28	-2.62	79	1959-10-07	-0.58	129	1960-11-24	-8.63
30	1958-07-30	-1.9	80	1959-10-30	-1.17	130	1960-11-29	-1.36
31	1958-08-01	-1.54	81	1959-12-03	-4.88	131	1960-12-01	-1.11
32	1958-08-18	-0.57	82	1959-12-08	-0.77	132	1960-12-04	-0.29
33	1958-08-25	-7.11	83	1959-12-24	-0.62	133	1960-12-10	-2.17
34	1958-08-27	-6.42	84	1959-12-30	-0.77	134	1960-12-14	-0.71
35	1958-09-04	-2.79	85	1960-01-01	-0.74	135	1960-12-27	-0.8
36	1958-09-06	-1.93	86	1960-01-05	-4.65	136	1961-01-06	-1.63
37	1958-09-18	-2.35	87	1960-01-11	-3.43	137	1961-01-10	-0.73
38	1958-11-03	-1.22	88	1960-01-15	-7.75	138	1961-01-17	-0.2
39	1958-11-05	-1.42	89	1960-01-17	-9.08	139	1961-01-19	-1.18
40	1958-11-13	-2.81	90	1960-01-19	-10.2	140	1961-01-23	-1.28
41	1958-11-16	-1.34	91	1960-01-23	-5.2	141	1961-01-28	-1.63
42	1958-11-29	-0.98	92	1960-01-28	-5.22	142	1961-02-07	-0.12
43	1959-01-07	-0.39	93	1960-01-30	-5.48	143	1961-02-10	-0.05
44	1959-01-10	-3.03	94	1960-02-03	-6	144	1961-02-12	-0.16
45	1959-01-16	-0.53	95	1960-02-07	-6.66	145	1961-02-14	-0.12
46	1959-01-29	-7.01	96	1960-02-13	-2.15	146	1961-02-17	-2.44
47	1959-02-01	-2.86	97	1960-02-16	-1.33	147	1961-02-20	-1.47
48	1959-02-05	-1.16	98	1960-02-19	-1.81	148	1961-02-23	-0.95
49	1959-02-09	-1.5	99	1960-02-21	-1.54	149	1961-08-01	-4.51
50	1959-02-15	-11.52	100	1960-02-28	-7.33	150	1961-08-05	-1.74

Table 2b: Catalogues of Forbush Decreases (FD1) Identified from Raw CR Data

S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)
151	1961-08-09	-0.92	201	1962-07-11	-0.21	251	1963-03-11	-0.88
152	1961-08-11	-1.5	202	1962-07-13	-0.2	252	1963-03-13	-0.16
153	1961-08-13	-1.53	203	1962-07-17	-0.24	253	1963-04-20	-0.91
154	1961-08-16	-1.1	204	1962-07-19	-0.7	254	1963-04-30	-5.14
155	1961-08-18	-1.29	205	1962-07-27	-1.8	255	1963-05-04	-7.43
156	1961-08-21	-1.9	206	1962-07-30	-1.52	256	1963-05-15	-1.37
157	1961-08-25	-1.12	207	1962-08-03	-2.89	257	1963-05-19	-1.17
158	1961-08-28	-1.1	208	1962-08-06	-0.87	258	1963-05-21	-0.36
159	1961-08-31	-1.05	209	1962-08-09	-1.36	259	1963-05-29	-0.16
160	1961-09-12	-1.1	210	1962-08-12	-0.89	260	1963-06-03	-0.87
161	1961-09-15	-2.42	211	1962-08-14	-0.58	261	1963-06-07	-0.04
162	1961-09-18	-1.61	212	1962-08-17	-0.79	262	1963-06-17	-0.84
163	1961-09-21	-1.63	213	1962-08-23	-1.11	263	1963-06-19	-1.12
164	1961-10-01	-6.69	214	1962-08-25	-1.02	264	1963-06-27	-2.28
165	1961-10-08	-0.5	215	1962-08-28	-0.89	265	1963-06-29	-2.54
166	1961-10-12	-0.71	216	1962-08-31	-2.1	266	1963-07-06	-2.28
167	1961-10-29	-0.46	217	1962-09-05	-3.61	267	1963-07-10	-1.34
168	1961-11-01	0	218	1962-09-08	-3.99	268	1963-07-16	-1.69
169	1961-11-07	-0.22	219	1962-09-11	-3.18	269	1963-07-22	-2.55
170	1961-11-16	-0.15	220	1962-09-13	-3.8	270	1963-07-25	-2.66
171	1961-11-18	-1.09	221	1962-09-16	-2.8	271	1963-08-02	-3.1
172	1961-12-02	-2.34	222	1962-09-19	-2.73	272	1963-08-05	-2.39
173	1961-12-06	-2.25	223	1962-09-21	-3.13	273	1963-08-10	-1.99
174	1961-12-08	-2.2	224	1962-09-28	-2.72	274	1963-08-12	-1.3
175	1961-12-11	-0.71	225	1962-10-01	-8.05	275	1963-08-14	-1.15
176	1961-12-13	-0.63	226	1962-10-06	-4.72	276	1963-08-20	-2.39
177	1961-12-30	-1.42	227	1962-10-09	-4.5	277	1963-08-23	-3.89
178	1962-01-02	-0.4	228	1962-10-18	-4.09	278	1963-08-29	-3.48
179	1962-01-10	-0.18	229	1962-10-21	-3.4	279	1963-09-06	-0.22
180	1962-01-12	-0.07	230	1962-10-23	-2.93	280	1963-09-08	-0.41
181	1962-02-06	-3.41	231	1962-10-27	-4.09	281	1963-09-12	-0.66
182	1962-02-08	-5.36	232	1962-11-05	-2.17	282	1963-09-17	-5.93
183	1962-02-14	-0.68	233	1962-11-07	-1.58	283	1963-09-19	-5.8
184	1962-02-22	-2.01	234	1962-11-10	-2.78	284	1963-09-23	-16.22
185	1962-02-28	-3.98	235	1962-11-14	-1.88	285	1963-09-28	-9.5
186	1962-03-03	-1.5	236	1962-11-22	-3.19	286	1963-10-05	-2.31
187	1962-03-07	-2.08	237	1962-11-27	-4.15	287	1963-10-08	-1.79
188	1962-03-25	-1.03	238	1962-11-29	-3.32	288	1963-10-13	-2.84
189	1962-03-28	-0.8	239	1962-12-04	-1	289	1963-10-16	-3.71
190	1962-04-01	-2.49	240	1962-12-07	-1.36	290	1963-10-23	-3.15
191	1962-04-19	-1.7	241	1962-12-10	-1.6	291	1963-10-26	-3.89
192	1962-04-21	-6.94	242	1962-12-14	-1.59	292	1963-10-30	-8.99
193	1962-06-01	-1.34	243	1962-12-17	-0.75	293	1963-11-04	-1.52
194	1962-06-04	-0.57	244	1962-12-22	-1.25	294	1963-11-06	-0.84
195	1962-06-09	-0.53	245	1962-12-27	-0.28	295	1963-11-09	-0.35
196	1962-06-24	-1.27	246	1963-01-18	-2.82	296	1963-11-11	-2.11
197	1962-06-28	-2.93	247	1963-01-21	-4.3	297	1963-11-17	-3.21
198	1962-07-04	-0.29	248	1963-01-27	-0.33	298	1963-11-19	-4.82
199	1962-07-06	-0.35	249	1963-02-01	-3.89	299	1963-11-27	-3.8
200	1962-07-08	-0.05	250	1963-02-04	-2.01	300	1963-11-30	-3.89

Table 2c: Catalogues of Forbush Decreases (FD1) Identified from Raw CR Data

S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)
301	1963-12-06	-2.15	351	1964-10-04	-0.72	401	1965-08-07	-0.87
302	1963-12-08	-2.81	352	1964-10-06	-1.4	402	1965-08-10	-0.43
303	1963-12-22	-3.71	353	1964-10-14	-0.9	403	1965-08-16	-4.22
304	1963-12-25	-1.4	354	1964-10-16	-1.18	404	1965-08-18	-4.21
305	1963-12-29	-2.02	355	1964-10-18	-1.6	405	1965-08-23	-3
306	1964-01-04	-1.71	356	1964-10-21	-1.7	406	1965-08-27	-2.84
307	1964-01-11	-0.23	357	1964-10-26	-2.48	407	1965-08-31	-2.33
308	1964-01-31	-0.4	358	1964-10-29	-2.61	408	1965-09-07	-4.29
309	1964-02-02	-0.09	359	1964-11-02	-1.88	409	1965-09-11	-1.69
310	1964-02-05	-0.45	360	1964-11-05	-2.52	410	1965-09-18	-1.68
311	1964-02-15	-0.36	361	1964-11-10	-2.3	411	1965-09-20	-1.61
312	1964-03-01	-0.29	362	1964-11-12	-2.02	412	1965-09-24	-1.51
313	1964-03-27	-0.54	363	1964-11-16	-1.62	413	1965-09-28	-3.78
314	1964-04-28	-0.38	364	1964-11-18	-2.51	414	1965-10-03	-2.97
315	1964-05-01	-0.59	365	1964-11-20	-2.1	415	1965-10-08	-3.96
316	1964-05-06	-0.24	366	1964-11-24	-1.72	416	1965-10-10	-2.52
317	1964-05-08	-0.35	367	1964-11-26	-1.25	417	1965-10-15	-1.17
318	1964-05-10	-0.21	368	1964-11-28	-0.61	418	1965-10-18	-0.48
319	1964-06-04	-1.12	369	1964-12-02	-1.21	419	1965-10-24	-0.82
320	1964-06-09	-1.21	370	1964-12-05	-0.46	420	1965-10-27	-1.43
321	1964-06-11	-1.8	371	1964-12-10	-0.06	421	1965-10-29	-1.5
322	1964-06-14	-0.48	372	1964-12-19	-0.58	422	1965-11-13	-1.03
323	1964-06-16	-0.24	373	1964-12-22	-0.49	423	1965-11-16	-1.72
324	1964-06-18	-0.22	374	1964-12-30	-0.74	424	1965-11-19	-3.76
325	1964-06-23	-1.28	375	1965-01-06	-1.74	425	1965-11-21	-0.96
326	1964-06-25	-1.13	376	1965-01-13	-2.9	426	1965-11-27	-2.66
327	1964-06-29	-1.15	377	1965-01-16	-5.74	427	1965-12-20	-0.9
328	1964-07-03	-1.69	378	1965-02-09	-1.77	428	1965-12-25	-0.89
329	1964-07-09	-2.24	379	1965-02-14	-4.01	429	1965-12-29	-4.91
330	1964-07-12	-2.41	380	1965-03-05	-1.62	430	1966-01-03	-0.73
331	1964-07-14	-2.41	381	1965-03-30	-3.77	431	1966-01-08	-0.45
332	1964-07-19	-2.56	382	1965-04-20	-0.55	432	1966-01-21	-1.91
333	1964-07-23	-1.87	383	1965-06-04	-0.11	433	1966-01-24	-2.33
334	1964-07-25	-1.22	384	1965-06-09	-1.73	434	1966-01-26	-2.26
335	1964-07-27	-1.27	385	1965-06-12	-0.26	435	1966-01-29	-3.21
336	1964-07-31	-1.19	386	1965-06-16	-5.6	436	1966-02-14	-0.64
337	1964-08-07	-0.65	387	1965-06-18	-3.73	437	1966-02-21	-7.07
338	1964-08-09	-1.33	388	1965-06-23	-2.08	438	1966-03-01	-4.22
339	1964-08-13	-3.08	389	1965-06-25	-1.3	439	1966-03-04	-4.3
340	1964-08-18	-1.94	390	1965-06-28	-1.41	440	1966-03-09	-0.58
341	1964-08-21	-0.81	391	1965-07-02	-2.08	441	1966-03-13	-0.34
342	1964-08-25	-1.01	392	1965-07-06	-2.07	442	1966-04-01	-4.02
343	1964-08-28	-2.06	393	1965-07-11	-3.06	443	1966-04-05	-3.62
344	1964-09-06	-2.61	394	1965-07-13	-4.74	444	1966-04-11	-0.85
345	1964-09-10	-1.31	395	1965-07-17	-3.22	445	1966-04-24	-1.05
346	1964-09-16	-2.01	396	1965-07-19	-2.89	446	1966-05-27	-0.65
347	1964-09-18	-2.39	397	1965-07-22	-1.68	447	1966-05-29	-0.57
348	1964-09-20	-1.82	398	1965-07-25	-1.3	448	1966-06-01	-5.44
349	1964-09-22	-3.11	399	1965-07-27	-0.6	449	1966-06-08	-0.59
350	1964-09-28	-1.95	400	1965-08-02	-3.36	450	1966-06-25	-0.28

Table 2d: Catalogues of Forbush Decreases (FD1) Identified from Raw CR Data

S/NO	DATE	FD 1 (%)	S/NO	DATE	FD 1 (%)
451	1966-07-01	-1.32	501	1967-06-28	-5.01
452	1966-07-09	-1.48	502	1967-07-01	-3.76
453	1966-07-13	-0.97	503	1967-07-31	-3.27
454	1966-07-17	-0.45	504	1967-08-03	-2.29
455	1966-07-19	-0.42	505	1967-08-06	-2.45
456	1966-07-29	-2.58	506	1967-08-09	-1.92
457	1966-08-01	-1.26	507	1967-08-11	-2.38
458	1966-08-04	-1.6	508	1967-08-14	-0.39
459	1966-08-23	-0.83	509	1967-08-17	-1.81
460	1966-08-31	-8.87	510	1967-08-21	-1.62
461	1966-09-04	-11.33	511	1967-08-26	-2.3
462	1966-09-12	-0.74	512	1967-08-29	-1.69
463	1966-09-17	-6.12	513	1967-09-02	-0.62
464	1966-09-20	-7.59	514	1967-09-05	-1.45
465	1966-09-24	-10.75	515	1967-09-14	-0.09
466	1966-10-02	-6.11	516	1967-09-21	-1.34
467	1966-10-09	-1.51	517	1967-09-23	-1.47
468	1966-10-12	-1.49	518	1967-10-07	-0.21
469	1966-10-16	-2.56	519	1967-10-11	-0.11
470	1966-10-27	-4.28	520	1967-10-30	-4.96
471	1966-11-06	-0.96	521	1967-11-01	-3.81
472	1966-11-08	-0.21	522	1967-11-05	-1.49
473	1966-11-11	-0.73	523	1967-11-07	-0.82
474	1966-11-14	-0.21	524	1967-11-25	-0.53
475	1966-11-18	-2	525	1967-11-27	-1.14
476	1966-12-15	-2.8	526	1967-12-01	-1.4
477	1966-12-18	-3.56	527	1967-12-05	-0.57
478	1966-12-26	-2.12	528	1967-12-08	-0.11
479	1966-12-29	-2.05	529	1967-12-16	-0.62
480	1967-01-02	-0.95	530	1967-12-19	-0.41
481	1967-01-10	-4.74	531	1967-12-21	-2.45
482	1967-01-14	-6.55	532	1967-12-30	-2.42
483	1967-01-18	-2.75			
484	1967-01-25	-1.19			
485	1967-01-27	-0.96			
486	1967-01-30	-0.8			
487	1967-02-04	-1.37			
488	1967-02-08	-5.32			
489	1967-02-17	-4.52			
490	1967-03-06	-1.59			
491	1967-03-10	-1.88			
492	1967-04-05	-3.31			
493	1967-05-02	-3.74			
494	1967-05-04	-2.2			
495	1967-05-10	-3.64			
496	1967-05-26	-7.5			
497	1967-05-31	-5.78			
498	1967-06-07	-4.34			
499	1967-06-15	-0.33			
500	1967-06-17	-0.36			

Catalogues of Forbush Decreases (FD2) Identified from Fourier Transformed Signal

The catalogues of FDs (FD2) are presented in Tables 3a - d. These FDs were identified by Fourier Transformed signal (FTS).

Table 3a: Catalogues of Forbush Decreases (FD2) Identified from Fourier Transformed signal

S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)
1	1958-01-18	-0.97	51	1959-05-12	-4.48	101	1960-10-01	-0.95
2	1958-01-21	-0.35	52	1959-05-14	-6.03	102	1960-10-06	-4.32
3	1958-01-23	-0.46	53	1959-05-25	-0.54	103	1960-10-14	-2.71
4	1958-02-13	-4.82	54	1959-06-19	-0.03	104	1960-10-21	-0.66
5	1958-03-11	-1.7	55	1959-06-22	-0.16	105	1960-10-25	-1.37
6	1958-03-15	-0.62	56	1959-07-01	-0.03	106	1960-10-27	-1.28
7	1958-03-28	-8.44	57	1959-07-04	-0.63	107	1960-10-29	-1.12
8	1958-03-30	-6.4	58	1959-07-12	-8.41	108	1960-11-14	-8.4
9	1958-04-06	-3.6	59	1959-07-27	-4.39	109	1960-11-16	-7.95
10	1958-04-13	-1.43	60	1959-08-04	-2.7	110	1960-11-24	-4.13
11	1958-04-18	-0.89	61	1959-08-08	-2.93	111	1960-11-29	-0.53
12	1958-04-23	-0.31	62	1959-08-12	-1.98	112	1960-12-01	-0.42
13	1958-04-26	-1.34	63	1959-08-16	-2.54	113	1960-12-04	-0.03
14	1958-04-30	-2.21	64	1959-08-20	-5.97	114	1960-12-10	-1.01
15	1958-05-02	-1.52	65	1959-08-27	-1.75	115	1960-12-14	-0.31
16	1958-05-09	-2.07	66	1959-08-30	-2.27	116	1960-12-27	-0.35
17	1958-05-12	-1.01	67	1959-09-01	-2.29	117	1961-01-06	-0.7
18	1958-05-14	-1.06	68	1959-09-05	-5.72	118	1961-01-10	-0.22
19	1958-05-31	-1.94	69	1959-09-11	-2.39	119	1961-01-19	-0.39
20	1958-07-01	-1.47	70	1959-09-16	-1.21	120	1961-01-23	-0.41
21	1958-07-03	-1.13	71	1959-09-20	-2.92	121	1961-01-28	-0.56
22	1958-07-06	-0.9	72	1959-09-26	-1.12	122	1961-02-17	-0.89
23	1958-07-09	-4.72	73	1959-09-28	-0.84	123	1961-02-20	-0.39
24	1958-07-14	-1.15	74	1959-12-03	-1.82	124	1961-02-23	-0.11
25	1958-07-22	-1.33	75	1960-01-05	-1.58	125	1961-08-01	-1.88
26	1958-07-25	-0.11	76	1960-01-11	-0.96	126	1961-08-05	-0.47
27	1958-07-28	-1.1	77	1960-01-15	-3.11	127	1961-08-09	-0.04
28	1958-07-30	-0.74	78	1960-01-17	-3.77	128	1961-08-11	-0.32
29	1958-08-01	-0.55	79	1960-01-19	-4.33	129	1961-08-13	-0.33
30	1958-08-18	-0.02	80	1960-01-23	-1.82	130	1961-08-16	-0.1
31	1958-08-25	-3.28	81	1960-01-28	-1.82	131	1961-08-18	-0.19
32	1958-08-27	-2.92	82	1960-01-30	-1.95	132	1961-08-21	-0.48
33	1958-09-04	-1.09	83	1960-02-03	-2.21	133	1961-08-25	-0.07
34	1958-09-06	-0.66	84	1960-02-07	-2.53	134	1961-08-28	-0.05
35	1958-09-18	-0.83	85	1960-02-13	-0.27	135	1961-08-31	-0.01
36	1958-11-03	-0.23	86	1960-02-19	-0.1	136	1961-09-12	0
37	1958-11-05	-0.33	87	1960-02-28	-2.87	137	1961-09-15	-0.65
38	1958-11-13	-1.01	88	1960-03-31	-0.42	138	1961-09-18	-0.24
39	1958-11-16	-0.27	89	1960-08-15	-1.83	139	1961-09-21	-0.24
40	1958-11-29	-0.06	90	1960-08-17	-0.7	140	1961-10-01	-2.76
41	1959-01-10	-1.07	91	1960-08-19	-0.59	141	1961-12-02	-0.59
42	1959-01-29	-3.04	92	1960-08-30	-1.12	142	1961-12-06	-0.55
43	1959-02-01	-0.97	93	1960-09-01	-0.73	143	1961-12-08	-0.53
44	1959-02-05	-0.11	94	1960-09-07	-2.98	144	1961-12-30	-0.2
45	1959-02-09	-0.28	95	1960-09-12	-1.2	145	1962-02-06	-1.33
46	1959-02-15	-5.29	96	1960-09-17	-0.57	146	1962-02-08	-2.31
47	1959-02-17	-4.86	97	1960-09-20	-0.03	147	1962-02-22	-0.7
48	1959-02-25	-0.76	98	1960-09-23	-0.33	148	1962-02-28	-1.71
49	1959-02-28	-0.8	99	1960-09-25	-0.53	149	1962-03-03	-0.48
50	1959-03-27	-4.65	100	1960-09-27	-0.52	150	1962-03-07	-0.79

Table 3b: Catalogues of Forbush Decreases (FD2) Identified from Fourier Transformed signal

S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)
151	1962-03-25	-0.35	201	1962-12-22	-0.59	251	1963-11-19	-2.17
152	1962-03-28	-0.25	202	1962-12-27	-0.1	252	1963-11-27	-1.65
153	1962-04-01	-1.11	203	1963-01-18	-1.31	253	1963-11-30	-1.69
154	1962-04-19	-0.79	204	1963-01-21	-2.05	254	1963-12-06	-0.82
155	1962-04-21	-3.42	205	1963-01-27	-0.05	255	1963-12-08	-1.15
156	1962-06-01	-0.57	206	1963-02-01	-1.82	256	1963-12-22	-1.6
157	1962-06-04	-0.18	207	1963-02-04	-0.88	257	1963-12-25	-0.44
158	1962-06-09	-0.15	208	1963-03-11	-0.27	258	1963-12-29	-0.75
159	1962-06-24	-0.48	209	1963-04-20	-0.28	259	1964-01-04	-0.6
160	1962-06-28	-1.3	210	1963-04-30	-2.4	260	1964-03-27	-0.15
161	1962-07-19	-0.15	211	1963-05-04	-3.55	261	1964-04-28	-0.16
162	1962-07-27	-0.7	212	1963-05-15	-0.53	262	1964-05-01	-0.27
163	1962-07-30	-0.56	213	1963-05-19	-0.43	263	1964-05-06	-0.11
164	1962-08-03	-1.24	214	1963-05-21	-0.03	264	1964-05-08	-0.17
165	1962-08-06	-0.23	215	1963-06-03	-0.31	265	1964-05-10	-0.1
166	1962-08-09	-0.47	216	1963-06-17	-0.32	266	1964-06-04	-0.5
167	1962-08-12	-0.24	217	1963-06-19	-0.46	267	1964-06-09	-0.53
168	1962-08-14	-0.08	218	1963-06-27	-1.06	268	1964-06-11	-0.82
169	1962-08-17	-0.19	219	1963-06-29	-1.19	269	1964-06-14	-0.15
170	1962-08-23	-0.35	220	1963-07-06	-1.08	270	1964-06-16	-0.03
171	1962-08-25	-0.3	221	1963-07-10	-0.62	271	1964-06-18	-0.01
172	1962-08-28	-0.24	222	1963-07-16	-0.82	272	1964-06-23	-0.53
173	1962-08-31	-0.85	223	1963-07-22	-1.26	273	1964-06-25	-0.45
174	1962-09-05	-1.61	224	1963-07-25	-1.32	274	1964-06-29	-0.45
175	1962-09-08	-1.8	225	1963-08-02	-1.54	275	1964-07-03	-0.72
176	1962-09-11	-1.4	226	1963-08-05	-1.17	276	1964-07-09	-0.98
177	1962-09-13	-1.71	227	1963-08-10	-0.96	277	1964-07-12	-1.06
178	1962-09-16	-1.22	228	1963-08-12	-0.61	278	1964-07-14	-1.05
179	1962-09-19	-1.18	229	1963-08-14	-0.53	279	1964-07-19	-1.12
180	1962-09-21	-1.39	230	1963-08-20	-1.13	280	1964-07-23	-0.77
181	1962-09-28	-1.19	231	1963-08-23	-1.87	281	1964-07-25	-0.44
182	1962-10-01	-3.86	232	1963-08-29	-1.65	282	1964-07-27	-0.46
183	1962-10-06	-2.2	233	1963-09-06	0	283	1964-07-31	-0.41
184	1962-10-09	-2.1	234	1963-09-08	-0.1	284	1964-08-07	-0.13
185	1962-10-18	-1.92	235	1963-09-12	-0.21	285	1964-08-09	-0.48
186	1962-10-21	-1.57	236	1963-09-17	-2.83	286	1964-08-13	-1.34
187	1962-10-23	-1.35	237	1963-09-19	-2.76	287	1964-08-18	-0.77
188	1962-10-27	-1.94	238	1963-09-23	-7.97	288	1964-08-21	-0.2
189	1962-11-05	-1	239	1963-09-28	-4.59	289	1964-08-25	-0.29
190	1962-11-07	-0.7	240	1963-10-05	-0.98	290	1964-08-28	-0.82
191	1962-11-10	-1.31	241	1963-10-08	-0.71	291	1964-09-06	-1.08
192	1962-11-14	-0.88	242	1963-10-13	-1.23	292	1964-09-10	-0.44
193	1962-11-22	-1.55	243	1963-10-16	-1.66	293	1964-09-16	-0.78
194	1962-11-27	-2.04	244	1963-10-23	-1.37	294	1964-09-18	-0.97
195	1962-11-29	-1.63	245	1963-10-26	-1.73	295	1964-09-20	-0.68
196	1962-12-04	-0.49	246	1963-10-30	-4.28	296	1964-09-22	-1.33
197	1962-12-07	-0.67	247	1963-11-04	-0.53	297	1964-09-28	-0.75
198	1962-12-10	-0.8	248	1963-11-06	-0.19	298	1964-10-04	-0.13
199	1962-12-14	-0.78	249	1963-11-11	-0.82	299	1964-10-06	-0.47
200	1962-12-17	-0.36	250	1963-11-17	-1.36	300	1964-10-14	-0.22

Table 3c: Catalogues of Forbush Decreases (FD2) Identified from Fourier Transformed signal

S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)	S/NO	DATE	FD 2 (%)
301	1964-10-16	-0.36	351	1965-08-27	-1.17	401	1966-09-12	-0.07
302	1964-10-18	-0.57	352	1965-08-31	-0.9	402	1966-09-17	-2.74
303	1964-10-21	-0.63	353	1965-09-07	-1.87	403	1966-09-20	-3.48
304	1964-10-26	-1.02	354	1965-09-11	-0.56	404	1966-09-24	-5.05
305	1964-10-29	-1.08	355	1965-09-18	-0.54	405	1966-10-02	-2.71
306	1964-11-02	-0.72	356	1965-09-20	-0.5	406	1966-10-09	-0.41
307	1964-11-05	-1.04	357	1965-09-24	-0.45	407	1966-10-12	-0.4
308	1964-11-10	-0.94	358	1965-09-28	-1.57	408	1966-10-16	-0.93
309	1964-11-12	-0.8	359	1965-10-03	-1.16	409	1966-10-27	-1.78
310	1964-11-16	-0.6	360	1965-10-08	-1.65	410	1966-11-06	-0.12
311	1964-11-18	-1.05	361	1965-10-10	-0.92	411	1966-11-11	-0.01
312	1964-11-20	-0.85	362	1965-10-15	-0.24	412	1966-11-18	-0.65
313	1964-11-24	-0.66	363	1965-10-24	-0.05	413	1966-12-15	-1.08
314	1964-11-26	-0.42	364	1965-10-27	-0.35	414	1966-12-18	-1.47
315	1964-11-28	-0.11	365	1965-10-29	-0.38	415	1966-12-26	-0.76
316	1964-12-02	-0.41	366	1965-11-13	-0.12	416	1966-12-29	-0.73
317	1964-12-05	-0.04	367	1965-11-16	-0.47	417	1967-01-02	-0.2
318	1964-12-19	-0.12	368	1965-11-19	-1.49	418	1967-01-10	-2.11
319	1964-12-22	-0.07	369	1965-11-21	-0.08	419	1967-01-14	-3.03
320	1964-12-30	-0.21	370	1965-11-27	-0.93	420	1967-01-18	-1.14
321	1965-01-06	-0.71	371	1965-12-20	-0.04	421	1967-01-25	-0.38
322	1965-01-13	-1.3	372	1965-12-25	-0.04	422	1967-01-27	-0.27
323	1965-01-16	-2.73	373	1965-12-29	-2.05	423	1967-01-30	-0.2
324	1965-02-09	-0.77	374	1966-01-21	-0.57	424	1967-02-04	-0.5
325	1965-02-14	-1.89	375	1966-01-24	-0.78	425	1967-02-08	-2.49
326	1965-03-05	-0.72	376	1966-01-26	-0.75	426	1967-02-17	-2.13
327	1965-03-30	-1.81	377	1966-01-29	-1.23	427	1967-03-06	-0.73
328	1965-04-20	-0.2	378	1966-02-21	-3.2	428	1967-03-10	-0.89
329	1965-06-09	-0.76	379	1966-03-01	-1.8	429	1967-04-05	-1.6
330	1965-06-12	-0.02	380	1966-03-04	-1.85	430	1967-05-02	-1.7
331	1965-06-16	-2.69	381	1966-04-01	-1.75	431	1967-05-04	-0.93
332	1965-06-18	-1.75	382	1966-04-05	-1.56	432	1967-05-10	-1.62
333	1965-06-23	-0.91	383	1966-04-11	-0.19	433	1967-05-26	-3.5
334	1965-06-25	-0.52	384	1966-04-24	-0.34	434	1967-05-31	-2.62
335	1965-06-28	-0.57	385	1966-05-27	-0.25	435	1967-06-07	-1.88
336	1965-07-02	-0.9	386	1966-05-29	-0.22	436	1967-06-28	-2.16
337	1965-07-06	-0.89	387	1966-06-01	-2.67	437	1967-07-01	-1.53
338	1965-07-11	-1.37	388	1966-06-08	-0.27	438	1967-07-31	-1.23
339	1965-07-13	-2.21	389	1966-06-25	-0.09	439	1967-08-03	-0.74
340	1965-07-17	-1.44	390	1966-07-01	-0.59	440	1967-08-06	-0.82
341	1965-07-19	-1.28	391	1966-07-09	-0.64	441	1967-08-09	-0.55
342	1965-07-22	-0.66	392	1966-07-13	-0.37	442	1967-08-11	-0.78
343	1965-07-25	-0.47	393	1966-07-17	-0.1	443	1967-08-17	-0.49
344	1965-07-27	-0.12	394	1966-07-19	-0.07	444	1967-08-21	-0.39
345	1965-08-02	-1.48	395	1966-07-29	-1.11	445	1967-08-26	-0.73
346	1965-08-07	-0.22	396	1966-08-01	-0.45	446	1967-08-29	-0.43
347	1965-08-10	0	397	1966-08-04	-0.61	447	1967-09-05	-0.31
348	1965-08-16	-1.88	398	1966-08-23	-0.16	448	1967-09-21	-0.26
349	1965-08-18	-1.87	399	1966-08-31	-4.16	449	1967-09-23	-0.33
350	1965-08-23	-1.26	400	1966-09-04	-5.38	450	1967-10-30	-2.12

Table 3d: Catalogues of Forbush Decreases (FD2) Identified from Fourier Transformed signal

S/NO	DATE	FD 2 (%)
451	1967-11-01	-1.55
452	1967-11-05	-0.4
453	1967-11-07	-0.07
454	1967-11-27	-0.27
455	1967-12-01	-0.41
456	1967-12-16	-0.05
457	1967-12-21	-0.98
458	1967-12-30	-0.98

Discussions

IZMIRAN FD Catalogue

The IZMIRAN FD list is the FD catalogue of the Russian investigators (Belov ET AL, 2018a) which was downloaded

from <http://spaceweather.izmiran.ru/eng/dbs.html>. The FDs were generated using the global survey method. It is the most comprehensive and up-to-date Forbush event catalogue. Several CR investigators have employed the catalogue. Some of the publications based on the IZMIRAN FD list are displayed at <http://spaceweather.izmiran.ru/eng/papers.html>. Belov (2008) asserts that the list is more accurate, as it was selected using several CR physical characteristics (e.g. density and anisotropy). The results of this work indicated that IZMIRAN recorded a total of 450 FDs, for the period under study, while a total of 500 and 450 FDs were recorded for FD1 and FD2 respectively which were generated using Fourier transformed algorithm on raw CR data. The disparity in the number of recorded FDs is traced to the differences in data type, resolution, and program efficiency which are some of the factors that may account for the large number of differences in the two catalogues (Okike ET AL, 2021). While assimilated CR data are needed for effective comparison of the efficiency of the two techniques, the number of FDs detected using hourly averages should be larger than those identified using daily averaged CR data (Lockwood 1971).

Automated Generated FD Catalogue

Table 2a – d shows FDs (FD1) Selected from Raw CR Data. They are considered raw in the sense that neither the contribution from CR anisotropy nor the solar cycle is disentangled. A total of 500 FDs were identified for the period under study. Generally, some FDs were identified to have large magnitudes, for instance, the events of 30/03/1958 and 05/09/1959 recorded large magnitudes of -13.02% and -12.06% respectively. On the other side, some FDs equally recorded small magnitudes, for example, the events of 18/07/1958 and 14/02/1961 recorded small magnitudes of -0.08% and -0.12% respectively.

Table 3a – d shows FDs (FD2) identified from FTS. Here, the contribution from anisotropy is removed but the influence of 11-year solar cycles is not removed. A total number of 458 FDs were identified in this catalogue. Generally, FD2 were observed to have smaller magnitudes when compared to FD1. However, an overall study of the catalogue indicated few FDs with large magnitudes above -5%. For instance, the events of 15/02/1959 and 24/09/1966 recorded large magnitudes of -5.29% and -5.05% respectively. On the other side, the greater number of FDs recorded smaller magnitudes, for instance, the events of 20/12/1965, 29/11/1958 and 18/07/1958 recorded small magnitudes of -0.04%, -0.06% and -0.08% respectively.

Generally, similarities and differences were identified when these two catalogues (FD1 and FD2) were compared with the IZMIRAN FD catalogue. For instance, contrary to the IZMIRAN catalogue, the FD1 catalogue recorded no FD for the year 1957. The first FD in this catalogue was recorded on 18/01/1958. On the side of similarity, the event of 17/01/1958 in IZMIRAN catalogue is the same as that of 18/01/1958 in FD1. The magnitudes of this event for IZMIRAN and FD1 are respectively -3.1 and -2.4%. However, it is clear from the Table that the differences between the two catalogues are significant.

CONCLUSION

This work concludes that the differences and similarities between large numbers of FDs obtained from the year 1957 - 1967 can be studied by presenting their catalogues.

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