A CATALOGUE OF HIGH-SPEED STREAMS IN THE SOLAR WIND WITH PREFERENCE FOR LARGE-SCALE AND LONG-TERM VELOCITY STRUCTURES

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ABSTRACT. We present a catalogue of 375 high-speed solar wind streams, which covers the period of 223 Bartels rotations (No. 1784-2006) from Nov. 29, 1963 to May 23, 1980. The catalogue was compiled using the interplanetary data published by King (1977, 1979, 1983) and it reflects large-scale and long-term structures of enhanced velocities in the solar wind. The characteristic value, with respect to which we define a high-speed stream, is the median value of the daily average velocities for every Bartels rotation increased by an additional value of 80 km/sec.

КАТАЛОГ ВЫСОКОСКОРОСТНЫХ ПОТОКОВ В СОЛНЕЧНОМ ВЕТРЕ С ПРЕДПОЧТЕНИЕМ КРУПНОМАСШТАБНЫХ И ДОЛГОЖИВУЩИХ СКОРОСТНЫХ СТРУКТУР. Мы приводим каталог 375 высокоскоростных потоков в солнечном ветре, который покрывает интервал времени 223 оборота Бартелса (№ 1784-2006) с 29 ноября 1963 г. до 23 мая 1980г. Каталог был составлен на основе данных о межпланетном пространстве , которые публиковал Кинг (King, 1977, 1979, 1983) и отражает крупномасштабные и долго-

живущие структуры повышенных скоростей в солнечном ветре. Характеристической величиной, относительно которой мы определяем высокоскоростный поток, является величина медианы средних суточных скоростей для каждого оборота Бартелса повышенна на величину скорости 80 км/сек.

KATALÓG VYSOKORÝCHLOSTNÝCH PRÚDOV V SLNEČNOM VETRE S PREDNOSTNÝM VÝBEROM VEĽKOŠKÁLOVÝCH A DLHOŽIJÚCICH RÝCHLOSTNÝCH ŠTRUKTÚR. Uvádzame katalóg 375 vysokorýchlostných prúdov slnečného vetra, ktorý pokrýva obdobie 223 Bartelsových rotácií (č. 1784-2006) od 29. novembra 1963 do 23. mája 1980. Katalóg bol zostavený na základe údajov o medziplanetárnom prostredí, ktoré publikoval King (1977, 1979, 1983) a odráža veľkoškálové a dlhodobé štruktúry zvýšených rýchlostí v slnečnom vetre. Charakteristická hodnota, vzhľadom ku ktorej definujeme vysokorýchlostný prúd, je mediánová hodnota priemerných denných rýchlostí pre každú Bartelsovu rotáciu zvýšená o hodnotu rýchlosti 80 km/s.

1. INTRODUCTION

The solar wind, a highly ionized gas continuously flowing away from the Sun, is one of the most important feature of the interplanetary medium, the existence of which was directly (in situ) discovered by space probes in the sixties. Shortly afterwards a large amount of measurements carried out aboard space satellites yielded quantitative details of various parameters such as density, temperature, chemical composition, magnetic field intensity and velocity of the flow of charged particles (mostly protons) from the Sun. In the very first years of solar wind observations in space, periodical occurrences of enhanced solar wind speed lasting several days were detected on the background of the relatively slow and continuously flowing solar wind. These features, called high-speed solar wind streams or high-speed plasma streams (abbreviation HSPS), are important characteristics of the solar wind.

The presence of the streams in the solar wind was established for the first time by observations carried out on board of Mariner 2 (Neugebauer and Snyder, 1966). A large number of studies have dealt with various aspects of the HSPS, and even good statistical relations were established between the occurrence of coronal structures, solar wind streams and geomagnetic disturbances (see, for example, Nolte et al., 1976; Nolte and Roelof, 1977; Sheeley et al., 1976; Sheeley and Harvey, 1978 and others). Using the Atlas of the green corona synoptic charts for the period 1947-1976 (Letfus and Sýkora, 1982) and solar wind data (King, 1977, 1979, 1983), our objective was to investigate and establish some large-scale and long-term relations between these two kinds of data. Several lists or catalogues of HSPS occurrences have already been published (e.g., Intriligator, 1973; Feldman et al., 1976; Iucci et al., 1977; Iucci et al., 1979; Lindblad and Lundstedt, 1981, 1983), but none of them suits our purpose in full. The purpose of this paper is to present our catalogue of the HSPS.

2. ON THE DEFINITION OF HSPS

To begin with it should be said that there is no common acceptable definition of HSPS so far. In general, by HSPS one understands a flow of charged particles of the solar wind in the interplanetary medium, restricted to a defined space in which values of various parameters (plasma density, proton temperature, magnetic field intensity, velocity and others) are different from the ones in the surrounding environment. Although all the above-mentioned solar wind parameters have been found to vary systematically throughout the high-speed stream, for certain reasons usually only the speed is considered in definning HSPS and, consequently, it was also called a "high-speed" stream. In terms of velocity-time contours a HSPS is characterized as an enhancement of solar wind speed with respect to the adjacent (usually preceding) time interval, usually lasting several days.

Several definitions of HSPS have already been suggested by various authors, but each of them reflects only a certain aspect of HSPS, usually the one which is most suitable for a particular purpose and author. All these definitions can be devided into three large groups. The first group contains those which define HSPS in terms of absolute values of the solar wind speed, e.g., the one introduced by Intriligator (1977), who defined an HSPS as displaying a rapid increase in the solar wind speed and a peak speed greater than or equal to 450 km/sec. Broussard et al. (1977) defined an occurrence of HSPS as a time interval when the daily average speed of the solar wind is $\geq$ 500 km/sec. The second group of definitions includes those for which it is characteristic that an HSPS - in terms of velocity-time contours - is defined on the basis of a velocity difference between the maximum speed reached in the HSPS and the speed of the quiescent solar wind usually observed on preceding days of possible HSPS. To this group belongs, e.g., the definition of Bame et al. (1976) who defined an HSPS as displaying a velocity increase of at least 150 km/sec within a five-day interval. In compiling their catalogue, Lindblad and Lundstedt (1981, 1983) considered all cases of velocity increases as possible HSPS in which the velocity difference between the smallest 3-hr velocity value a given day and the largest 3-hr value of the following day was $\geq$ 100 km/sec or $\geq$ 80 km/sec when the HSPS could be identified as a member of a 27-day recurrent series. Iucci et al. (1979) defined HSPS as events in which $\Delta V = V_{max} - V_o \geq 100$ km/sec, where V_{max} is the maximum daily mean speed and V_o the mean value between the speeds immediately preceding and following the stream, and in which the total duration of the event was at least 2 days. The third group includes the cases in which not only the absolute velocity value or the velocity difference, but both these characteristics are considered. For example, Iucci et al. (1977) defined an HSPS as a stream of enhanced velocity greater than 400 km/sec and $\Delta V = V_{max} - V_o \geq 100$ km/sec, where V_{max} is the maximum daily value in the fast stream and V_o is the daily value just outside the stream, for $\geq$ 3 days.

We can thus see that different authors use different criteria for selecting HSPS. This is evidently connected with the investigation of various

specific properties of HSPS (see, e.g., Feldman et al., 1976 and others already mentioned).

In our opinion creating and using a uniform and generally valid definition of high-speed plasma streams is disputable. It is indeed evident that, to study particular, precisely defined properties of HSPS and of the solar wind as a whole, it is convenient to use a certain narrower set of events which have been selected from a large number of possible ones. This selection clearly depends on the aspect we want to study.

As was stated above, we wanted to investigate large-scale and long-term aspects of the relations between the structure of emission green corona and the solar wind. For this purpose we needed to know the large-scale and long-term patterns in the solar wind. An analysis of all the above-mentioned lists or catalogues of HSPS showed that none of them wholly fulfilled our requirements and this fact led us to make our own catalogue.

For evident reasons we shall not analyse the individual events and give all the reasons and causes which have led us to the decision not to use the catalogues mentioned earlier. We shall only mention some of the cases which will show why these catalogues were unsuitable for our purposes.

Even if we were to use only the second part of Intriligator's HSPS list (Intriligator, 1973), recorded by Vela satellites, which are relatively closer to the Earth than Pioneer satellites, we would find several cases of HSPS, in which either the maximum speed (380 km/sec - Dec. 16, 1965) or the velocity increase was extremely low (50 km/sec - Dec. 4, 1965).

The catalogue of Lindblad and Lundstedt (1981, 1983) also contains such solar wind streams whose inclusion among HSPS was unsuitable for our purposes because the streams are not pronounced enough (small velocity). Among these events are the HSPS of Mar. 3, 1966, Apr. 22, 1968 and others. On the other hand, this catalogue does not contain some solar wind streams which would be suitable for our purposes. These HSPS are not included in the catalogue either because of the lack of velocity data within the particular time interval , or because the stream had no ascending branch (e.g. Aug. 5, 1964; May 15, 1969; Sept. 23, 1973; Sept. 25, 1974, etc.).

Similarly both the catalogues compiled by Iucci et al. (1977, 1979) contain, on the one hand, some solar wind streams which were not suitable for our purposes (June 8-12, 1969; Nov. 2-5, 1969), and on the other, some streams which would have been suitable for our purposes have been omitted (Mar. 25-28, 1966; Nov. 8-11, 1969).

As to the HSPS list of Feldman et al. (1976), it contains those events, the maximum speed of which is equal to or higher than 650 km/sec and, moreover, it only covers the period from March 1971 through July 1974.

We are aware that also our catalogue contains HSPS which reflect only certain structural aspects of the solar wind and that its use is limited to a certain extent.

3. METHOD OF DATA PROCESSING

To compile our catalogue we have used the solar wind data published by King (1977, 1979, 1983). The data are recorded on magnetic tape, a copy of which we obtained through the NSSDC/WDCA, Greenbelt, Goddard Space Flight Center. The hourly plasma data are available on the magnetic tape for the period of Nov. 2, 1963 - Aug. 7, 1980 (Bartels rotations Nos. 1783-2009).

Since our objective was to compile an HSPS catalogue which would reflect, as far as possible, the large-scale properties of the solar wind, we have used the daily averages of the solar wind velocity for further processing. If a particular day had at least one non-zero hourly velocity value, the average daily value of the solar wind velocity for that particular day was determined as the arithmetic average of all observed non-zero hourly velocity values. We also tested the coverage of the individual days by observed non-zero hourly data, on the one hand, and the coverage of the individual Bartels rotation by days on which the average daily velocities were non-zero. If the average daily velocity on a particular day was determined from a small number of non-zero hourly values (1-3, sometimes exceptionally as much as 6), we decided whether to include the particular day in the set of HSPS days on the basis of other auxiliary criteria (e.g. visual inspection of the velocity contours in King's book, changes of other parameters of the solar wind such as the density and magnetic field on that day, duration of the stream, its recurrence, etc.). If a particular Bartels rotation contained more than 13 days (regardless of their distribution) for which no observational data were available (i.e. daily averages were zero), this rotation was discarded. There were 21 such cases and all of them are given in Table 1.

Table 1

Number of Bartels rotation	Time interval
1787 - 1792	Feb. 18, 1964 - July 28, 1964
1817 - 1818	May 8, 1966 - June 30, 1966
1849 - 1851	Sept. 18, 1968 - Dec. 7, 1968
1887 - 1892	July 11, 1971 - Dec. 19, 1971
1899	May 30, 1972 - June 25, 1972
1901 - 1903	July 23, 1972 - Oct. 11, 1972

Drawing on the daily average solar wind velocities, we determined several parameters for each Bartels rotation which characterized it (part from the rotations given in Table 1), for example, the average velocity value, the median velocity value, the highest and lowest daily velocity value within a particular rotation, etc. By adding or subtracting (depending on the

nature of the parameter) a particular fixed velocity value to/from the various characteristic values, thus obtained, for the individual Bartels rotations, we obtained a certain velocity level with respect to which we defined the HSPS. Using the results of several tests, we adopted the median value as the parameter with respect to which we defined the criterion for selecting HSPS. We then included among the HSPS days those on which the average daily velocity values were equal to or higher than the median velocity value characteristic for a particular rotation, increased by the constant value of 80 km/sec.

Selecting the median as the value with respect to which the HSPS are defined, had the following consequences:

1) The character of the median value, to a certain extent, guarantees the elimination of the long-term trend in the solar wind velocity.

2) The median acts as a kind of large-scale velocity filter.

3) If the range of maximum stream velocities within a rotation was very large, i.e. streams with high and low maximum values occur, the high peaks were preferred, whereas the low velocity peaks were usually omitted from the selection, regardless of the magnitude of the maximum velocity value and/or of how large the increase of velocity in these low peaks as compared to the closest velocity background. As a result of this selection effect, there we-

Table 2

Bartels rotation	Median velocity value (km/sec)	Bartels rotation	Median velocity value (km/sec)
1821	492	1929	519
1842	504	1930	551
1844	483	1931	496
1845	471	1932	510
1847	488	1933	538
1909	514	1934	522
1910	529	1935	530
1911	558	1936	537
1913	530	1937	477
1920	494	1938	481
1921	521	1939	475
1922	504	1940	471
1923	507	1941	493
1924	525	1947	491
1925	547	1949	550
1926	539	1950	547
1927	565	1978	489
1928	546		

re several cases of Bartels rotations whose median velocity values were equal to or higher than 470 km/sec. For these rotations, which are given in Table 2, we expanded the above-mentioned criterion of selecting HSPS by the condition that the average daily velocity of the stream had to be higher than or at least equal to 550 km/sec for the stream to qualify for HSPS. The adding of this absolute velocity criterion to our definition of HSPS enables it to be included in the third group of HSPS definitions (see above).

4) If there were no conspicuous velocity fluctuations within a rotation, i.e. the velocity variation did not exceed the value $\pm$ 80 km/sec, the selection of streams qualifying for HSPS was suppressed, which is caused by the value + 80 km/sec over and above the median, which we adopted (e.g. Bartels rotation No. 1846). Another consequence of the HSPS selection criterion we adopted is as follows: with a considerable number of HSPS the increase of velocity is relatively rapid and cases in which the velocity increased by 100 km/sec or more during a single day are no exception. Since we have used the average daily velocity values as the initial data, on days with abrupt velocity increases we may obtain an average daily velocity whose value does not qualify for HSPS. For this reason the first day of existence of an HSPS usually did not qualify for our catalogue (e.g. July 29, 1964; Apr. 9, 1971). For reasons of low time resolution our catalogue may not include short-lived HSPS (around 24 hours) whose velocity changes have the character of very narrow and/or high peaks (e.g. May 2, 1967; Jan. 27, 1971; May 30, 1971; Feb. 24, 1975, etc.). On the other hand, however, excluding such cases from the selection is in agreement with the conditions we imposed on the HSPS, i.e. that large-scale and sufficiently long-lived velocity structures in the solar wind should be studied.

4. STRUCTURE OF THE CATALOGUE

The catalogue, which is given in Table 3, contains 375 HSPS, which occurred in the period from Nov. 29, 1963 to May 23, 1980 (Bartels rotations No. 1784 - 2006).

The first column gives the catalogue number of the stream. Streams whose catalogue number has a lower-case letter attached (a, b, c, etc.) are doubtful as regards their existence as independent HSPS. It is possible that these streams are really only parts of one and the same stream (e.g. beginning or end of a stream), marked with the same catalogue number in the first column, but with no lower-case letter. In such cases, the program indicated the existence of two or more separate streams because the time interval between them did not have sufficient data coverage (e.g. the interval between streams Nos. 10a and 10b on Sept. 8, 1964), or because the average daily velocities in the interval between two streams briefly dropped to values which did not qualify them for inclusion among HSPS (e.g. HSPS Nos. 80a, 80b, 80c). The next four columns list the time of the HSPS occurrence, i.e. the number of Bartels rotation, year, month and day of the beginning of the stream. The

beginning of the HSPS is not given in the sense of the first day, when the velocity of the HSPS started to rise from the quiescent solar wind level; by the "beginning of the HSPS" we understand the first day, on which the daily average velocity satisfies for the first time our selection condition, defined by the median value for a given Bartels rotation. Thus, the beginning times of the same HSPS occurring in two different catalogues (one of them being ours) may be different. As a rule the time of the HSPS beginning in our catalogue is shifted by 1 - 3 days in the positive direction of time scale. The same method was applied to the HSPS duration, which is listed in units of whole days in the seventh column. The last day of the HSPS is the one on which the daily average velocity has not yet dropped below the velocity level determined by median value. The sixth column shows the maximum daily average velocity of the stream. The eighth column gives the sign of the polarity of the interplanetary magnetic field prevailing during the period of the HSPS event. The polarities were adopted from Svalgaard (1975), King (1977, 1979, 1983) and from Solar-Geophysical Data (inferred polarities from groundbased polar stations). The last column gives the importance or "efficiency" of the stream, which is simply the sum of daily average velocities for all the HSPS days. Since the importance strongly depends on the duration of the stream, this parameter may be useful for investigations of long-term variations in the solar wind or of geophysical effects on the Earth. We did not investigate whether there was any connection between the streams and solar flares.

Table 3

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
1a	1784	1963	12	2	463	5	+	2208
1b	1784	1963	12	9	434	1	+	434
1	1784	1963	12	2	463	8	+	2642
2	1785	1964	1	2	505	3	+	1496
3	1785	1964	1	9	511	3	-	1440
4	1786	1964	1	29	496	3	+	1453
5	1786	1964	2	6	470	1	-	470
6	1793	1964	7	30	660	1	-	660
7	1793	1964	8	4	677	2	+	1315
8	1793	1964	8	12	665	2	-	1239
9	1794	1964	9	1	631	2	+	1218
10a	1794	1964	9	6	636	2	-	1146
10b	1794	1964	9	9	618	2	-	1182
10	1794	1964	9	6	636	5	-	2328
11	1795	1964	9	24	546	2	-	1091

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
12	1795	1964	10	4	722	3	-	2112
13	1796	1964	10	19	609	3	-	1721
14a	1797	1964	11	15	531	2	-	1051
14b	1797	1964	11	18	519	1	-	519
14	1797	1964	11	15	531	4	-	1570
15	1798	1964	12	16	556	2	+	1106
16	1800	1965	2	10	545	1	+	545
17	1800	1965	2	14	527	2	+	1052
18	1800	1965	2	26	565	2	+	1128
19a	1801	1965	3	23	612	3	+	1807
19b	1801	1965	3	27	579	3	+	1586
19	1801	1965	3	23	612	7	+	3393
20a	1802	1965	4	18	566	2	+	1017
20b	1802	1965	4	22	450	2	+	886
20	1802	1965	4	18	566	6	+	2903
21	1803	1965	5	9	501	2	-	990
22	1803	1965	5	17	544	1	+	544
23	1804	1965	6	15	585	2	+	1084
24	1805	1965	6	29	538	2	-	1046
25	1806	1965	7	29	590	2	-	1164
26	1807	1965	8	19	551	2	+	1072
27a	1807	1965	8	24	527	1	-	527
27b	1807	1965	8	26	536	1	-	536
27	1807	1965	8	24	536	3	-	1063
28	1807	1965	9	5	585	3	-	1626
29	1809	1965	10	28	544	1	-	544
30	1810	1965	11	2	478	1	-	478
31	1810	1965	11	21	458	1	+	458
32	1811	1965	12	11	530	2	-	1014
33	1812	1965	12	26	589	4	+	2169
34	1812	1966	1	8	485	1	-	485
35	1813	1966	1	21	562	2	+	1062
36	1813	1966	1	24	589	4	+	2282
37	1813	1966	2	4	520	3	-	1543
38	1814	1966	2	20	667	6	+	3420
39	1815	1966	3	19	542	1	+	542
40	1815	1966	3	25	580	4	+	2198
41	1816	1966	4	22	512	3	+	1459
42	1819	1966	7	9	570	3	-	1671
43	1820	1966	8	13	484	1	+	484

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
44	1821	1966	8	31	664	3	-	1886
45	1821	1966	9	9	589	3	+	1713
46	1822	1966	9	28	599	2	-	1143
47	1822	1966	10	5	595	3	+	1711
48	1823	1966	10	27	629	1	-	629
49	1823	1966	10	31	597	4	+	2274
50	1824	1966	11	28	538	1	+	538
51	1824	1966	12	5	591	2	-	1142
52	1825	1966	12	14	558	1	-	558
53	1825	1966	12	26	638	2	+	1208
54	1826	1967	1	11	468	1	-	468
55	1826	1967	1	14	470	2	-	929
56	1827	1967	2	8	558	2	-	1093
57	1827	1967	2	16	540	2	+	1037
58	1827	1967	2	26	489	1	+	489
59	1828	1967	3	19	494	3	-	1429
60	1829	1967	4	4	534	3	-	1495
61	1830	1967	4	24	669	2	+	1306
62	1831	1967	5	25	657	4	+	2400
63	1831	1967	5	31	543	1	-	543
64	1832	1967	6	28	484	1	-	484
65	1832	1967	6	30	473	1	-	473
66	1832	1967	7	11	681	5	-	2680
67	1833	1967	7	29	483	1	-	483
68	1834	1967	8	11	550	2	-	1098
69	1834	1967	8	17	607	4	-	2341
70a	1835	1967	9	20	589	1	-	589
70b	1835	1967	9	22	589	1	-	589
70	1835	1967	9	20	589	3	-	1178
71	1835	1967	9	29	633	2	+	1225
72	1836	1967	10	10	597	8	-	4437
73	1836	1967	10	29	532	1	-	532
74	1837	1967	11	9	556	1	-	556
75	1837	1967	11	12	607	2	-	1189
76	1838	1967	12	6	750	6	-	3892
77a	1838	1967	12	19	589	1	+	589
77b	1838	1967	12	21	606	1	+	606
77	1838	1967	12	19	606	3	+	1195
78	1839	1967	12	23	533	1	+	533
79	1839	1968	1	6	536	2	-	1062

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
80a	1840	1968	1	20	560	1	+	560
80b	1840	1968	1	22	546	1	+	546
80c	1840	1968	1	24	543	1	+	543
80	1840	1968	1	20	560	5	+	1649
81a	1840	1968	2	2	569	1	-	569
81b	1840	1968	2	5	578	1	-	578
81	1840	1968	2	2	578	4	-	1147
82	1841	1968	2	15	658	9	+	5272
83	1842	1968	3	15	649	6	+	3676
84	1842	1968	4	1	624	1	-	624
85	1842	1968	4	6	623	2	+	1231
86	1843	1968	4	14	613	4	+	2326
87	1843	1968	4	27	550	2	-	1095
88	1843	1968	5	3	597	1	+	597
89	1844	1968	5	11	627	4	+	2445
90	1845	1968	6	3	598	2	-	1179
91	1845	1968	6	11	725	2	+	1399
92	1845	1968	6	17	646	3	-	1824
93a	1847	1968	8	14	622	3	+	1785
93b	1847	1968	8	18	630	2	+	1227
93	1847	1968	8	14	630	6	+	3012
94	1848	1968	9	3	561	4	-	2191
95	1852	1968	12	22	553	2	-	1088
96	1853	1969	1	16	570	5	-	2753
97	1853	1969	1	25	650	3	+	1724
98	1854	1969	2	3	592	2	-	1108
99	1855	1969	2	27	615	3	+	1687
100	1855	1969	3	25	593	2	+	1160
101	1856	1969	3	30	527	1	+	527
102	1856	1969	4	2	537	2	-	1065
103	1857	1969	5	2	701	2	-	1246
104	1857	1969	5	15	626	1	-	626
105	1858	1969	5	21	469	1	+	469
106	1858	1969	5	24	535	2	+	1009
107	1859	1969	6	16	559	5	+	2625
108	1860	1969	8	4	466	1	-	466
109	1861	1969	8	9	484	1	+	484
110	1861	1969	8	12	539	2	+	1060
111	1862	1969	9	18	571	2	-	1110
112	1862	1969	9	25	504	1	-	504

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
113	1862	1969	9	28	603	3	-	1693
114	1863	1969	10	22	509	1	-	509
115	1864	1969	11	8	645	4	+	2303
116	1865	1969	11	27	511	1	+	511
117	1865	1969	11	29	606	3	+	1609
118	1865	1969	12	5	573	3	+	1620
119	1866	1969	12	25	571	3	+	1538
120	1866	1970	1	2	543	2	+	1079
121	1867	1970	1	21	470	1	+	470
122	1867	1970	2	2	576	5	-	2665
123	1868	1970	3	2	569	3	-	1630
124	1868	1970	3	8	668	2	-	1271
125	1869	1970	3	31	561	1	-	561
126	1869	1970	4	6	604	2	+	1150
127	1870	1970	4	9	639	1	+	639
128	1870	1970	5	4	506	1	+	506
129	1871	1970	5	6	594	2	-	1122
130	1872	1970	6	1	639	3	+	1708
131	1872	1970	6	27	529	1	+	529
132	1873	1970	7	4	618	1	+	618
133	1873	1970	7	22	560	1	+	560
134	1874	1970	7	25	791	1	+	791
135	1874	1970	7	29	575	2	+	1131
136	1874	1970	8	9	583	2	-	1122
137	1874	1970	8	17	539	1	+	539
138a	1875	1970	9	2	515	1	-	515
138b	1875	1970	9	4	610	2	-	1203
138	1875	1970	9	2	610	4	-	1718
139	1875	1970	9	14	534	2	+	1029
140	1876	1970	9	20	508	1	+	508
141	1876	1970	10	3	680	3	-	1777
142	1877	1970	10	16	480	1	+	480
143	1877	1970	10	30	606	2	-	1098
144	1877	1970	11	7	588	1	+	588
145a	1877	1970	11	9	582	2	+	1127
145b	1878	1970	11	12	517	1	+	517
145	1877	1970	11	9	582	4	+	1644
146	1878	1970	11	25	539	3	-	1584
147	1879	1970	12	8	503	2	+	974
148	1879	1970	12	14	567	2	-	1082

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
149	1879	1971	1	2	628	4	+	2351
150	1880	1971	1	19	707	3	-	1961
151	1881	1971	1	30	638	3	+	1754
152	1881	1971	2	15	620	3	-	1721
153	1881	1971	2	25	615	3	+	1737
154	1882	1971	3	13	642	4	-	2373
155	1883	1971	4	10	583	2	-	1148
156	1884	1971	5	6	652	4	-	2337
157	1885	1971	6	2	647	3	-	1860
158	1886	1971	6	26	567	1	+	567
159	1886	1971	6	30	565	3	-	1636
160	1894	1972	1	17	626	2	+	1203
161	1895	1972	2	13	584	4	+	2186
162	1895	1972	3	7	596	2	+	1111
163	1896	1972	4	4	620	3	+	1720
164	1897	1972	5	2	497	2	+	963
165	1898	1972	5	6	467	1	+	467
166	1898	1972	5	16	477	1	+	477
167	1898	1972	5	28	532	2	+	1017
168	1900	1972	6	26	506	3	+	1419
169	1904	1972	10	31	618	3	-	1690
170	1905	1972	11	16	489	1	+	489
171	1905	1972	11	26	477	2	-	940
172	1906	1972	12	13	490	2	+	959
173	1906	1972	12	23	484	2	-	956
174a	1907	1973	1	10	674	3	+	1916
174b	1907	1973	1	14	539	1	+	539
174	1907	1973	1	10	674	5	+	2455
175	1907	1973	1	27	718	4	-	2568
176	1908	1973	2	7	622	3	+	1763
177	1908	1973	2	23	735	8	-	5392
178	1909	1973	3	19	756	9	-	6267
179	1910	1973	4	3	597	2	+	1741
180	1910	1973	4	16	760	8	-	5619
181	1911	1973	4	27	650	1	-	650
182	1911	1973	4	29	673	4	+	2567
183	1911	1973	5	7	570	2	+	1127
184	1911	1973	5	14	745	10	-	6728
185	1912	1973	6	3	719	4	+	2525
186	1912	1973	6	11	751	5	-	3402

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
187	1913	1973	6	18	683	3	-	1939
188	1913	1973	6	29	749	4	+	2709
189	1914	1973	7	15	622	2	-	1197
190	1914	1973	7	27	693	5	-	3226
191	1915	1973	8	6	528	2	+	1020
192a	1915	1973	8	23	664	2	+	1194
192b	1915	1973	8	29	613	2	+	1139
192	1915	1973	8	23	664	8	+	2333
193	1916	1973	9	16	535	1	-	535
194	1916	1973	9	23	634	3	+	1790
195	1917	1973	10	10	617	5	-	2973
196	1917	1973	10	21	608	2	+	1185
197	1918	1973	11	6	587	4	-	2172
198	1918	1973	11	18	516	1	+	516
199	1919	1973	11	25	681	3	+	1804
200	1919	1973	12	8	539	2	-	1058
201	1920	1973	12	21	669	3	+	1920
202a	1920	1973	12	29	634	4	-	2400
202b	1920	1974	1	6	560	1	-	560
202	1920	1973	12	29	634	9	-	2960
203a	1921	1974	1	16	633	2	+	1185
203b	1921	1974	1	20	603	1	+	603
203	1921	1974	1	16	633	5	+	1788
204	1921	1974	1	26	733	6	-	3881
205	1922	1974	2	11	648	4	+	2403
206	1922	1974	2	23	715	7	-	4654
207	1923	1974	3	10	737	3	+	2124
208	1923	1974	3	21	695	6	-	3961
209	1924	1974	4	6	713	4	+	2463
210	1924	1974	4	10	651	2	+	1284
211a	1924	1974	4	20	676	4	-	2538
211b	1924	1974	4	25	582	1	-	582
211	1924	1974	4	20	676	6	-	4120
212	1925	1974	5	3	679	6	+	3768
213a	1925	1974	5	18	608	5	-	2906
213b	1925	1974	5	24	603	1	-	603
213	1925	1974	5	18	608	7	-	3509
214	1926	1974	5	31	764	5	+	3550
215	1926	1974	6	12	653	6	-	3695
216	1926	1974	6	20	555	1	-	555

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
217	1927	1974	6	27	781	6	+	4087
218	1927	1974	7	6	734	9	-	5578
219	1928	1974	7	23	777	6	+	4058
220a	1928	1974	8	3	599	5	-	2931
220b	1928	1974	8	10	581	1	-	581
220	1928	1974	8	3	599	8	-	3512
221	1929	1974	8	20	789	6	+	4225
222	1929	1974	8	31	664	6	-	3781
223	1930	1974	9	19	645	5	+	2993
224	1930	1974	9	24	664	4	-	2449
225	1930	1974	9	29	675	5	-	3170
226	1931	1974	10	17	631	4	+	2399
227	1931	1974	10	25	730	6	-	4005
228	1932	1974	11	12	716	4	+	2715
229	1932	1974	11	20	751	8	-	5539
230	1933	1974	12	9	651	6	+	3758
231	1933	1974	12	18	729	7	-	4725
232	1934	1975	1	4	714	5	+	3412
233	1934	1975	1	14	721	6	-	3978
234a	1935	1975	2	1	705	3	+	1990
234b	1935	1975	2	5	592	1	+	592
234	1935	1975	2	1	705	5	+	2582
235	1935	1975	2	10	742	8	-	5388
236	1936	1975	2	24	591	1	+	591
237a	1936	1975	3	1	656	2	+	1248
237b	1936	1975	3	4	590	3	+	1708
237	1936	1975	3	1	656	6	+	2956
238	1936	1975	3	10	755	6	-	4064
239	1937	1975	3	27	727	5	+	3109
240	1937	1975	4	8	673	7	-	4402
241	1938	1975	4	21	698	5	+	3167
242	1938	1975	5	6	639	4	-	2467
243	1939	1975	5	17	686	2	+	1286
244	1939	1975	5	20	624	3	+	1782
245	1939	1975	6	2	636	3	-	1853
246a	1940	1975	6	12	697	3	+	1864
246b	1940	1975	6	16	687	4	+	2568
246	1940	1975	6	12	697	8	+	4432
247	1940	1975	6	30	583	2	-	1138
248a	1941	1975	7	10	560	1	+	560

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
248b	1941	1975	7	14	621	5	+	2919
248	1941	1975	7	10	621	9	+	3479
249	1941	1975	7	26	620	3	-	1817
250	1942	1975	8	6	534	1	+	534
251	1942	1975	8	21	605	4	-	2255
252	1943	1975	9	13	490	2	+	974
253	1943	1975	9	18	562	2	-	1102
254	1944	1975	10	8	616	4	+	2252
255	1944	1975	10	16	495	1	-	495
256	1945	1975	11	3	707	5	+	3038
257	1946	1975	11	30	691	4	+	2573
258	1946	1975	12	16	558	1	-	558
259	1947	1975	12	26	646	5	+	3133
260	1947	1976	1	12	554	1	-	554
261	1948	1976	1	21	697	4	+	2480
262	1948	1976	2	1	612	3	-	1789
263a	1949	1976	2	11	598	1	-	598
263b	1949	1976	2	13	605	2	-	1162
263	1949	1976	2	11	605	4	-	1760
264	1949	1976	2	18	682	2	+	1355
265a	1949	1976	2	28	591	1	-	591
265b	1949	1976	3	1	628	3	-	1819
265	1949	1976	2	28	628	5	-	2410
266	1949	1976	3	6	670	8	-	5036
267	1950	1976	3	18	619	3	+	1823
268	1950	1976	3	27	578	1	-	578
269	1951	1976	4	3	674	6	-	3698
270	1951	1976	4	12	647	3	+	1909
271	1952	1976	5	2	679	3	-	1814
272	1952	1976	5	12	553	1	+	553
273	1953	1976	6	4	613	5	+	2974
274	1953	1976	6	18	583	1	+	583
275	1954	1976	7	1	666	5	+	2864
276	1954	1976	7	16	566	1	+	566
277	1955	1976	7	28	637	4	+	2452
278	1955	1976	8	10	483	1	+	483
279a	1956	1976	8	24	620	2	+	1240
279b	1956	1976	8	28	518	1	+	518
279	1956	1976	8	24	620	5	+	1758
280	1956	1976	9	2	548	4	+	2082

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
281	1957	1976	9	19	649	5	+	2882
282	1957	1976	9	26	478	1	-	478
283	1957	1976	10	1	516	2	+	996
284	1958	1976	10	15	655	5	+	2860
285	1958	1976	10	31	499	2	+	987
286	1959	1976	11	11	621	4	+	2251
287	1959	1976	11	20	466	1	-	466
288	1960	1976	12	11	531	2	+	1032
289	1960	1976	12	18	505	1	-	505
290	1961	1976	12	31	560	2	-	1063
291	1961	1977	1	12	516	1	-	516
292	1961	1977	1	15	559	1	-	559
293	1962	1977	2	7	618	5	-	2793
294	1963	1977	2	23	506	4	-	2005
295	1963	1977	3	9	602	4	-	2313
296	1964	1977	4	4	619	7	-	3794
297	1965	1977	4	19	586	3	-	1643
298	1965	1977	5	2	491	1	-	491
299	1965	1977	5	5	486	1	+	486
300	1966	1977	5	16	539	3	-	1560
301	1966	1977	5	24	525	2	+	1014
302a	1967	1977	6	18	556	3	+	1588
302b	1967	1977	6	22	545	2	+	1041
302	1967	1977	6	18	556	6	+	2629
303	1967	1977	7	2	489	1	+	489
304	1968	1977	7	9	607	3	-	1724
305	1968	1977	7	16	607	2	+	1251
306	1969	1977	8	5	698	4	-	2522
307	1969	1977	8	17	628	3	+	1841
308	1970	1977	9	20	684	5	+	2948
309	1971	1977	10	19	501	2	+	984
310	1972	1977	10	30	497	1	-	497
311	1972	1977	11	14	610	3	+	1655
312	1973	1977	11	27	474	1	-	474
313	1973	1977	12	12	515	2	+	999
314a	1974	1978	1	4	650	4	-	2242
314b	1974	1978	1	9	485	2	+	966
314	1974	1978	1	4	650	7	-	3208
315	1975	1978	1	26	480	1	-	480
316	1975	1978	1	29	583	6	-	3006

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
317	1976	1978	2	15	585	1	-	585
318	1976	1978	2	23	476	1	+	476
319	1976	1978	2	26	615	6	-	3539
320	1977	1978	3	9	513	1	+	513
321	1977	1978	3	17	533	2	-	1055
322	1977	1978	3	27	641	3	-	1880
323	1978	1978	4	6	559	1	+	559
324	1978	1978	4	19	695	3	+	1875
325	1978	1978	4	24	572	1	-	572
326	1979	1978	5	1	916	5	-	3678
327	1979	1978	5	9	652	3	+	1726
328	1979	1978	5	24	540	1	-	540
329	1980	1978	6	2	634	4	-	2342
330	1980	1978	6	12	491	1	+	491
331	1980	1978	6	21	578	2	-	1071
332	1982	1978	8	4	546	4	+	1975
333	1982	1978	8	13	447	1	+	447
334	1983	1978	8	28	582	7	+	3713
335	1984	1978	9	26	778	7	+	4110
336	1985	1978	10	14	481	1	-	481
337	1986	1978	11	12	587	2	-	1127
338	1986	1978	11	21	594	3	+	1695
339	1986	1978	11	26	596	2	+	1170
340	1987	1978	12	14	499	2	-	982
341	1987	1978	12	18	648	5	+	2905
342a	1988	1978	12	30	655	3	-	1881
342b	1988	1979	1	3	524	1	-	524
342	1988	1978	12	30	655	5	-	2405
343	1988	1979	1	7	531	1	-	531
344a	1989	1979	1	25	547	4	-	2083
344b	1989	1979	1	30	487	1	-	487
344c	1989	1979	2	1	486	1	-	486
344	1989	1979	1	25	547	8	-	3056
345	1989	1979	2	18	534	2	+	1038
346	1990	1979	2	22	576	3	-	1671
347	1990	1979	3	17	557	1	+	557
348	1991	1979	3	28	573	1	-	573
349	1991	1979	4	2	621	2	-	1179
350	1991	1979	4	5	643	2	-	1241
351	1992	1979	4	16	613	2	+	1218

Table 3 (continued)

Catalogue number	Bartels rotation	Year	Month	Day	Maximum speed	Duration	IMF polarity	Importance
352a	1992	1979	4	25	613	1	-	613
352b	1992	1979	4	28	593	2	-	1179
352	1992	1979	4	25	613	5	-	1792
353	1993	1979	5	25	626	3	-	1801
354	1993	1979	5	30	531	1	-	531
355	1993	1979	6	7	620	6	+	3441
356	1994	1979	6	23	474	1	-	474
357	1995	1979	7	6	541	2	+	1064
358	1995	1979	7	18	512	1	-	512
359	1996	1979	8	20	613	2	-	1194
360	1997	1979	8	29	496	1	+	496
361	1998	1979	9	27	465	1	+	465
362	1998	1979	9	29	500	2	+	976
363	1998	1979	10	3	475	1	-	475
364	1998	1979	10	8	495	1	+	495
365	1999	1979	11	1	431	1	+	431
366	1999	1979	11	11	446	3	+	1321
367	2000	1979	11	18	455	1	+	455
368	2000	1979	12	9	448	1	-	448
369	2001	1979	12	29	487	1	+	487
370	2001	1980	1	3	632	4	-	2290
371	2002	1980	1	17	469	2	+	928
372	2002	1980	1	29	496	5	-	2362
373a	2003	1980	2	6	478	4	+	1831
373b	2003	1980	2	11	428	1	+	428
373	2003	1980	2	6	478	6	+	2259
374	2004	1980	3	7	420	1	+	420
375	2005	1980	4	11	580	3	-	1605

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