The documentation to the sample of IAU MDC radio-meteor data

CONTENT

1 Description of the data and radar

The Meteor Data Center (MDC) of the International Astronomical Union (IAU) provides a sample of the data on the meteors detected from four points by the radars at the Hissar Astronomical Observatory (HisAO) of the Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan.

Specifically, the sample consists of 8916 radio-meteor records. The observations were performed in period December 1968 to October 1969 and in December 1969.

For measurements of radiants and meteor velocities, the bearing-time radio method was used. A special set of radar equipment MIR-2 (an abbreviation for "meteor pulse radar, second generation") was created in $1964-68$. Its structure, principles of operation, and detailed characteristics were described by Chebotarev et al. (Chebotarev R.P., Sidorin V.N., Polushkin G.A. et al.: The complex of equipment for radar studies meteors in Dushanbe. Bulletin of the Institute of Astrophysics, Academy of Sciences of Tadjukistan SSR, 1970, No. 55, p. 25-28.) and Chebotarev and Issamutdinov (Chebotarev R.P., Isamutdinov Sh.O. Multibeam Meteor Radar Indicator. Bulletin of the Institute of Astrophysics, Academy of Sciences of Tadjikistan SSR, 1970, No. 55, p. 34-39.). The main characteristics of the radar were as follows:

- the transmitter frequency $\nu = 37.4\,\mathrm{MHz}$;
- the transmitter wavelength $\lambda = 8\,\mathrm{m}$;
- the transmitter output power per pulse $65\,\mathrm{kW}$;
- the bandwidth of the primary and remote receivers $600\,\mathrm{kHz}$;
- the threshold sensitivity of the receivers (at Uc/Uw = I) $8 \cdot 10^{-14}\,\mathrm{W}$ or $2.5\,\mu\mathrm{V}$;
- sensitivity in the measurement of radiants and velocities varied from 17 to $34\,\mu\mathrm{V}$;
- the bandwidth of the signals retransmission from the removed points $2\,\mathrm{MHz}$, at the frequencies about $100\,\mathrm{MHz}$.

Antennas in the radiant and velocity measurement mode were half-wave vibrators located at a height of $\lambda/3$ above the ground, having a maximum power gain of about 5.3 at an elevation angle of about 45° in the east and west directions.

The limiting magnitude of meteors in the measurement of radiant positions and velocities was $+5^m$.

2 IAU MDC format - version 2018

FILE: HISSAR.d18

The current version of the IAU MDC database is given in the standard format, which was established with the "version 2013" of the IAU MDC photographic database. Since the radio-meteor data require another characteristics, the original set of provided parameters is enlarged. It currently consists of 34 parameters, in maximum, about each meteor. The list of all parameters is given in Table 1.

Basically, a unique identification code is assigned to each meteor. In the *radio-meter* data, the identification code is introduced by two letters, rH (radio-Hissar), followed by five-digit integer number of meteor.

Each parameter is given in two lines of the datafile. In the first line, the code of the parameter (listed in the 2nd column of Table 1) and two binary values are written. If the first value is "1" and the second value is "0", then only the value of the parameter, without the determination error, is presented in the second line. If both values are "1", then the second line contains the value of the parameter together with the determination error. (The place for the parameter can be reserved with its code, binary values both equal to "0", and blank second line. Such a record is identical to the omission of the parameter.) The number of decimal digits of the value of any parameter and its determination error is arbitrary, usually depending on the precision of its determination. (We speak here about the number of *valid* decimal digits. Because of the automatic, computer writing, there can occur a lot of redundant 0s or 9s beyond the valid decimal digits. These should be ignored, of course.)

The record about a given meteor begins with the meteor identification code and is terminated with the line containing 3 spaces and character &. It is not necessary to list all 34 parameters in a particular record. Only the identification code is mandatory. The order of parameters within each record is optional, except for the code, which always begins the record.

Table 1: The list of parameters in the current, 2018 version, of IAU MDC database. No.P. is the serial number of the parameter in the list and C.P. is the code of the parameter. The positional parameters are referred to the equinox 2000.0.

No.P.	C.P.	explanation
1	#IC:	IAU MDC identification code
2	ANo:	number/code assigned to the meteor by author
3	Yr :	year of the detection
4	Mn :	month of the detection
5	Day:	day and fraction of day of the detection (UT)
6	LS :	solar longitude corresponding to the date of the detection [deg]
7	mv :	magnitude of maximum photographic brightness of meteor
8	HB :	height of beginning of meteor trail [km]
9	HM :	height of maximum brightness [km]
10	HE :	height of end of meteor trail [km]
11	RA :	right ascension of geocentric radiant [deg]
12	DEC:	declination of geocentric radiant [deg]
13	Vi :	extra-atmospheric velocity $[\mathrm{km\,s^{-1}}]$
14	Vg :	geocentric velocity $[\mathrm{km\,s^{-1}}]$
15	Vh :	heliocentric velocity $[\mathrm{km\,s^{-1}}]$
16	cZ :	cosine of the angular distance of geocentric radiant from the zenith
17	Qm :	quality code
18	q :	perihelion distance [AU]
19	e :	numerical eccentricity of orbit
20	1/a:	reciprocal semi-major axis $[\mathrm{AU^{-1}}]$
21	a :	semi-major axis [AU]
22	Q :	aphelion distance [AU]
23	i :	inclination of orbit to the ecliptic [deg]
24	arg:	argument of perihelion [deg]
25	nod:	longitude of ascending node [deg]
26	pi :	longitude of perihelion [deg]
27	Sh :	shower number
28	Mas:	pre-atmospheric photometric mass [g]
29	lgM:	decadic logarithm of the mass
30	cor:	correction mark (type of correction if any)
31	crh:	extreme-hyperbolicity mark
32	mr :	magnitude (stellar) of radio meteor
33	Hrf:	the height of the central point of the meteor trail [km]
34	LpA:	decadic logarithm of linear electron density of the central point of meteor trail, p_α; the unit of the density is $[\mathrm{electron\,cm^{-1}}]$

The prevailing majority of parameters and their determination errors, if given, are double-precision (REAL*8) numerical values, which can be read into an array (or the errors into another, independent array). Unfortunately, the old photographic data contained some non-numerical marks, which implied an establishment of five exceptions:

(1) Meteor number/code given by the original author (ANo) sometimes contains a character, therefore

this parameters is given as the text, 7-character variable.

(2) Quality of meteor data (Qm) was given as a single or two-character code. In the IAU MDC data, this paramater is given as 2-character variable. (Our reading subroutine returns only the first character and the second position is always a space.)

(3) Shower number is, sometimes, not a numerical, but a composite (numeral and character) variable. In the IAU MDC, this parameter is, therefore, given as the 2-character variable.

(4) A tiny fraction of photographic meteors was corrected in the IAU MDC and the character of this correction was given as a single-character variable. (A more detailed description of these corrections is given in the documentation to the photographic catalogs.)

(5) A small part of photographic meteors (video and radio meteors have not been analyzed in this respect, yet) has an extremely hyperbolic (beyond the Gaussian tail) eccentricity. (This phenomenon was described in the paper by Lindblad B.A., Neslušan L., Porubčan V., Svoreň J.: 2003, Earth, Moon, and Planets 93, 249-260.) The mark indicating the extreme hyperbolicity is the single character "h" in the IAU MDC data.

3 Format of data files readable with OS-Windows word editors

FILE: HISSAR.xlsx

Since there are the researchers prefering the environment of the OS Windows and corresponding word editors, the large set of the parameters in the IAU MDC catalogues is also provided in the form of the Excel sheet. In the case of radio-meteor data, the sheet consists of 23 parameters:

#IC, Yr, Mn, Day, Hrf, mr, RA, DEC, Vi, Vg, Vh, cZ, q, e, 1/a, a, Q, i, arg, nod, pi, LpA, lgM.

The codes are explained in Table 1. Number of lines is equal to the number of meteors in the catalogue.

4 Reduced data: meteor in a single line

FILE: HISSAR.1l (alternatively: HISSAR_by_date.1l)

The single-line format provides the reduced and unified set of parameters on each meteor in a single line of the datafile (the file is written as a common, plain text). This format is provided to enable an easy visual reading of the data.

The *reduced set* consists of 11 parameters listed in Table 2. (This set is the same as in 2013 version.) In the files with the 1-line data, the parameters are arranged in successive columns in the same order as in Table 2. The IAU MDC attempts to achieve that all these parameters are provided for each meteor included into the center's data.

Table 2: The reduced (compulsory) set of the parameters in the IAU MDC database. h.c. is the code of parameter in the headings of single-line file (table).

h.c	parameter	unit
IC	identification code	
yr mn day	date of meteor fall in the form year-month-day;	
	time of the fall is given as the fraction of day	[UT]
q	perihelion distance	[AU]
e	numerical eccentricity	[1]
i	inclination to the ecliptic	[deg]
arg	argument of perihelion	[deg]
nod	longitude of ascending node	[deg]
RA	right ascension of geocentric radiant	[deg]
DEC	declination of geocentric radiant	[deg]
Vg	geocentric velocity	[$\mathrm{km\,s^{-1}}$]
Vh	heliocentric velocity	[$\mathrm{km\,s^{-1}}$]