E2 data history, format, and availability

Helios mini workshop
27. 06. 2016

Lex Wennmacher

Institut für Geophysik und Meteorologie

Universität zu Köln

Overview

- My talk is based on the following available documents:
    - Kehr, Joachim (Ed.): Helios - Interplanetary Experience, German Space Operation Center (GSOC), Germany, 1977
    - Documentation of the data archive of the Institute of Geophysics and Meteorology
    - Source code of the conversion programs

E2 data: history, format, availability

Figure 4.2-1: Experiment Data Flow
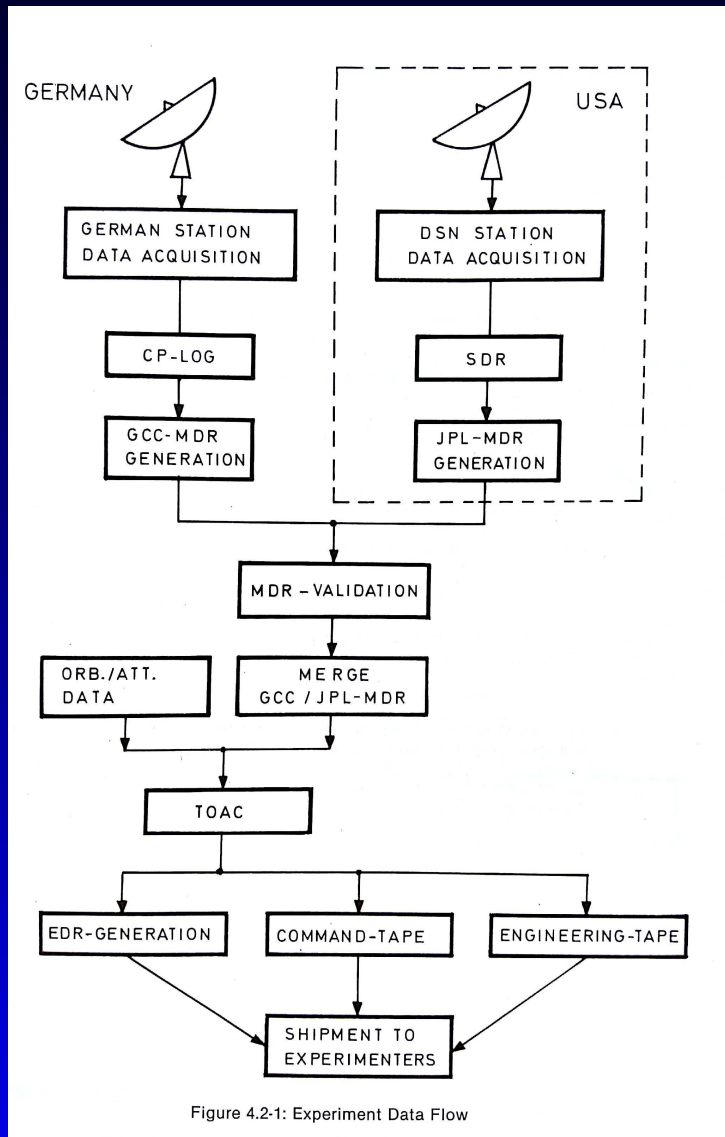
SDR   Station (?) Data Records
MDR   Master Data Records
TOAC   Telemetry Orbit Attitude Command
EDR   Experiment Data Records

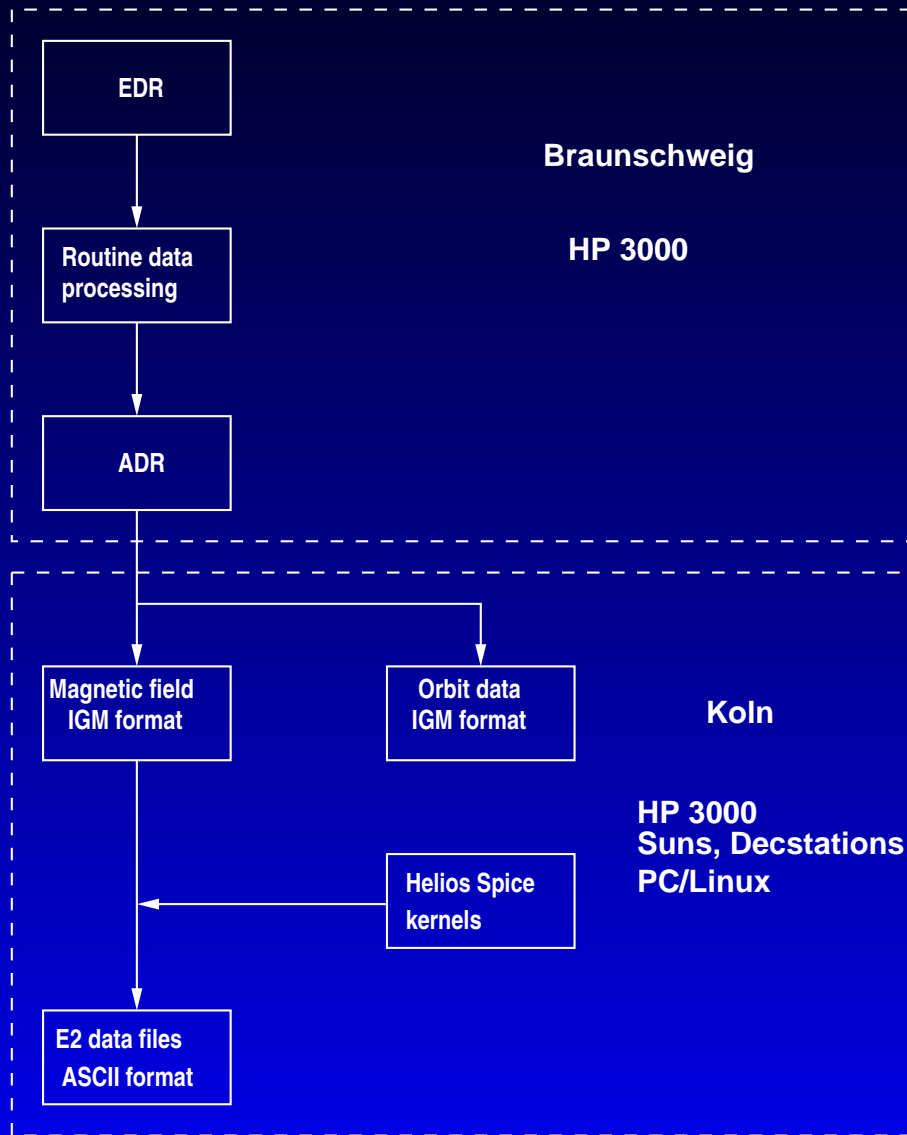Tapes processed by March 1977 (Helios 1):

MDR/JPL	726 tapes
MDR/GSOC	367 tapes
Merge tapes	268 tapes
TOAC	714 tapes
Orbit/Attitude	28 tapes
EDR	4960 tapes

E2 data: history, format, availability

- Data were processed on a CDC 3800 with 64k-words core storage (48 bit/word)
- Data processing power was a huge bottleneck – leading to processing backlog of 45 weeks

E2 data: history, format, availability

EDR

Braunschweig

HP 3000

Routine data processing

ADR

Magnetic field IGM format

Orbit data IGM format

Koln

HP 3000 Suns, Decstations PC/Linux

Helios Spice kernels

E2 data files ASCII format

ADR   Analysis Data Records

- Data were processes with a HP 3000 in Braunschweig
- Transferred to Cologne
- Changed to IGM-format on Suns and Decstations
- Written to CDs

Helios 1	14 CDs
Helios 2	12 CDs
Orbit & other products	3 CDs

E2 data: history, format, availability

ADR format - header

Data type	Field name	Description
I*2	NDAY	Day of year (0: Jan 1st)
I*2	YEAR	Year (e.g.: 1977)
I*4	FRAC	Seconds of day * 10000
I*2	MIS	No misalignement indicator (0/1)
I*2	NVEC	Number of vectors in record
I*2	VECR	Vector rate
I*2	FORM	Format number
I*2	BITR	Bit rate
I*2	DISM	Distribution mode
R*8	VECS	Vector step time [in seconds * 10000]
I*2	MISS	Mission identifier (90: Helios A, 91: B)
R*4	ECLA	Ecliptical Latitude of S/C spin axis in radians
R*4	ECLO	Ecliptical Longitude of S/C spin axis in radians
R*4	ELOM	Ecliptical Longitude, counted from mean equinox, in radians
R*4	D2SU	Distance from Sun in A. U.
R*4	HELA	Heliographic latitude in radians
R*4	HSEA	H - S - E angle
R*4	SCFX	S/C Field in x in nT
R*4	SCFY	S/C Field in y in nT
R*4	SCFZ	S/C Field in z in nT
R*4	OSFX	Offset Field in x in nT
R*4	OSFY	Offset Field in y in nT
R*4	OSFZ	Offset Field in z in nT
I*2	MISL	Misalignment angle LAMBDA in 1/10 degrees
I*2	MISA	Misalignment angle ALPHA in 1/10 degrees
I*2	MISG	Misalignment angle GAMMA in 1/10 degrees
I*2	MISB	Misalignment angle BETA in 1/10 degrees
I*2	MISE	Misalignment angle EPSILON in 1/10 degrees
I*2	MISD	Mean deviation * $\sqrt{3}$ of last misalignment calculation in 1/100 degrees
R*8	TRLT	Trip time of light in seconds * 10000
R*8	SPIN	Spin period in seconds*10000

E2 data: history, format, availability

ADR format - data

The following complex is repeated for NVEC times

Data type	Field name	Description
I*2	MAGX	Field in x in 1/10 nT
I*2	MAGY	Field in y in 1/10 nT
I*2	MAGZ	Field in z in 1/10 nT
I*2	ISTA	Integrated Status Word

E2 data: history, format, availability

IGM format

Data type	Field name	Description
C*3	CSON	Mission identifier
C*1	CFLAG	Quality flag
I*2	IYEAR	Year (e. g., 1976)
I*2	IDAY	Day of year
I*4	IFRAC	Seconds of day * 10000
I*4	IMAG(1)	Field in x in pT
I*4	IMAG(2)	Field in y in pT
I*4	IMAG(3)	Field in z in pT
I*4	IMAG(4)	Total field B in pT
I*4	IMAG(5)	BN
I*4	IMAG(6)	RMS
I*2	IMIT	Number of averaged values per vector
C*1	CFOR	Endianness (s: Sun, big endian, d: DEC, little endian)
C*5	CSPARE	unused

$$B = \sqrt{\langle B_x \rangle^2 + \langle B_y \rangle^2 + \langle B_z \rangle^2}$$

$$BN = \left\langle \sqrt{B_x^2 + B_y^2 + B_z^2} \right\rangle$$

$$RMS = \sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_z^2} \text{ with } \sigma_x = \sqrt{\langle B_x^2 \rangle - \langle B_x \rangle^2}$$

Coordinate system: HSE

- Helios-centered solar-ecliptical system

- Helios 1 and 2 had opposite spin directions

- Different conventions are used for Helios 1 and Helios 2:

- Helios 1: x-axis points from Helios 1 to the Sun, z-axis perpendicular to ecliptic, pointing northwards, y-axis complements right-handed coordinate system
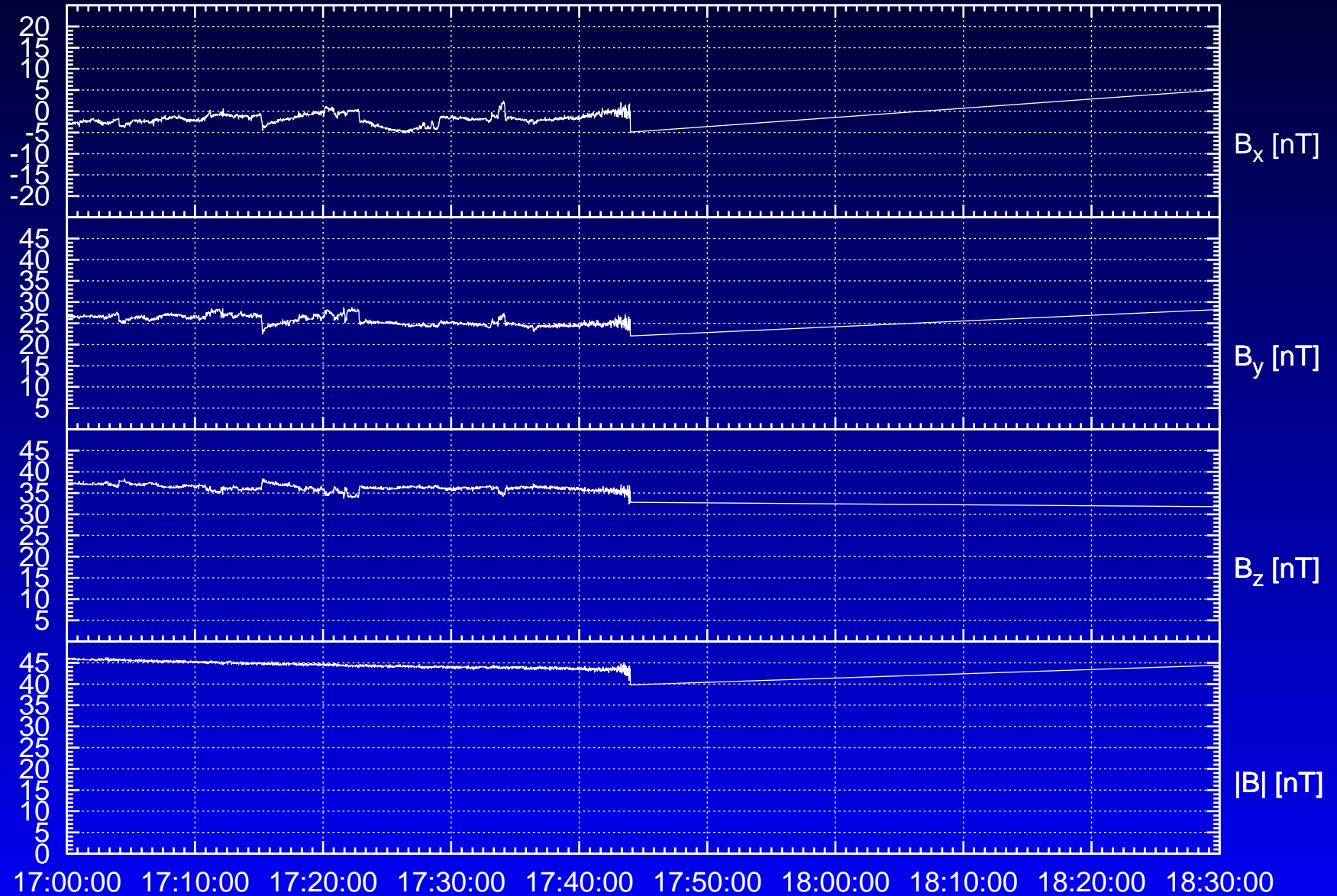
- Helios 2: x-axis points from Helios 1 to the Sun, z-axis perpendicular to ecliptic, pointing southwards, y-axis complements right-handed coordinate system

E2 data: history, format, availability

Helios 1 E2 data: 1975-01-08 shock
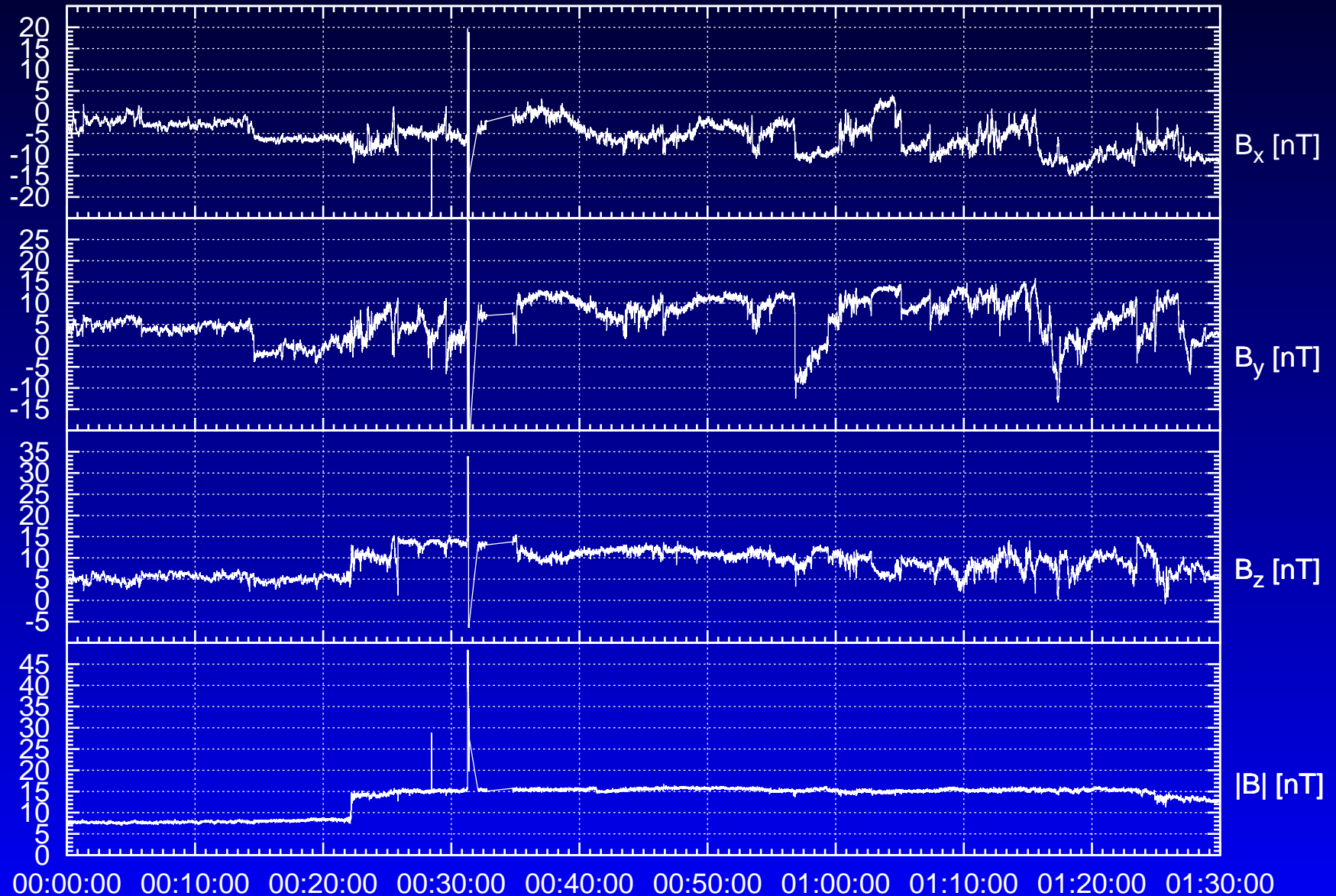
E2 data: history, format, availability

Helios 2 E2 data: 1976-03-30 shock

E2 data availability – IGM format

- No ADR-data available anymore - tapes have been disposed of

- All ADR-data had been converted to IGM data format (big endian) and are available in this format

- Data currently stored on $\sim$ 30 CDs, 2 copies

- Programs used for the conversion have been archived

E2 data availability – ASCII format

- Usage of IGM format is not widespread

- I converted the Helios data into plain ASCII format for convenience

- Format:

```
Column:  1                          2              3          4
    date/time                   coordinates (km, ecliptical, J2000)
1975-01-08T00:00:00.225   -21857543.3  135654177.4   28214.2
1975-01-08T00:00:00.473   -21857548.5  135654174.6   28214.2
1975-01-08T00:00:00.722   -21857553.6  135654171.7   28214.2
1975-01-08T00:00:00.970   -21857558.7  135654168.8   28214.2


(continued)
Column:  5       6     7
         Bx, By, Bz [nT]
         -5.0  2.7  4.9
         -4.4  2.6  5.3
         -4.9  2.5  5.4
         -4.7  2.0  5.4
```

E2 data: history, format, availability
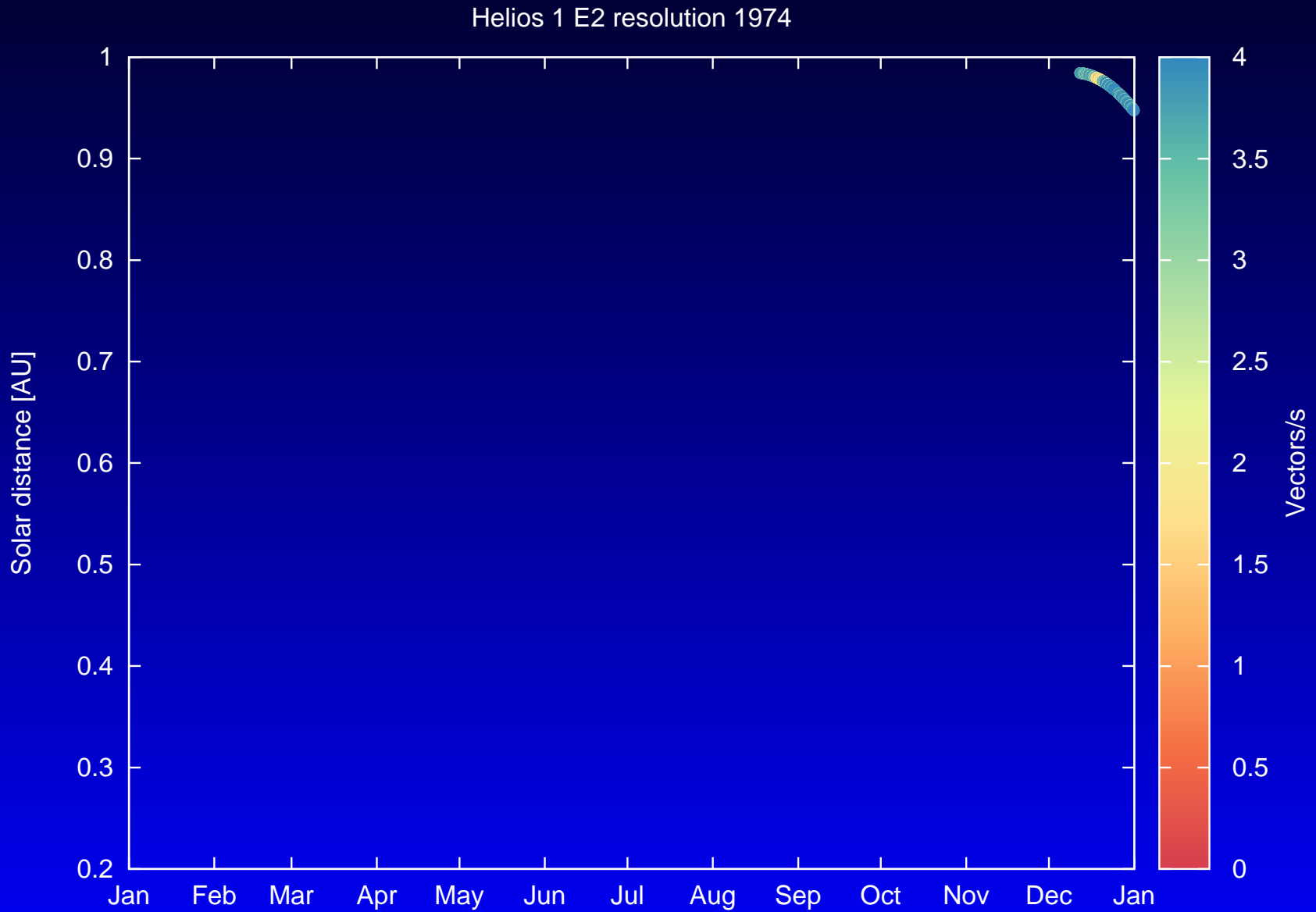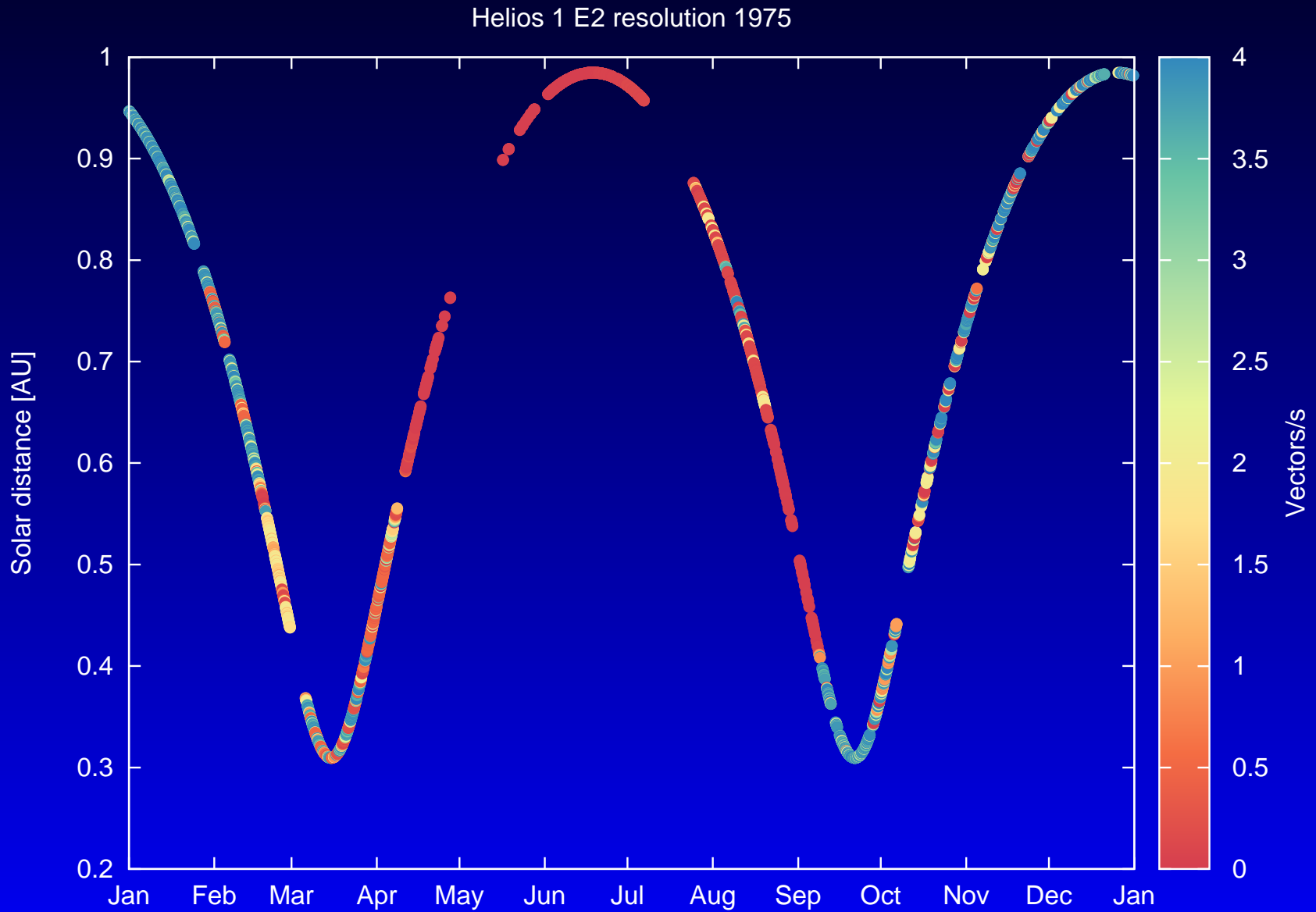
Helios 1 E2 resolution 1974

E2 data: history, format, availability

Helios 1 E2 resolution 1975

E2 data: history, format, availability

Helios 1 E2 resolution 1976

E2 data: history, format, availability

Helios 1 E2 resolution 1977

E2 data: history, format, availability

Helios 1 E2 resolution 1978

E2 data: history, format, availability

Helios 1 E2 resolution 1979

E2 data: history, format, availability

Helios 1 E2 resolution 1980

E2 data: history, format, availability

Helios 2 E2 resolution 1976

E2 data: history, format, availability

Helios 2 E2 resolution 1977

E2 data: history, format, availability

Helios 2 E2 resolution 1978

E2 data: history, format, availability

Helios 2 E2 resolution 1979

E2 data: history, format, availability

Helios 2 E2 resolution 1980

E2 data: history, format, availability

Time coverage of Helios 1/2 data
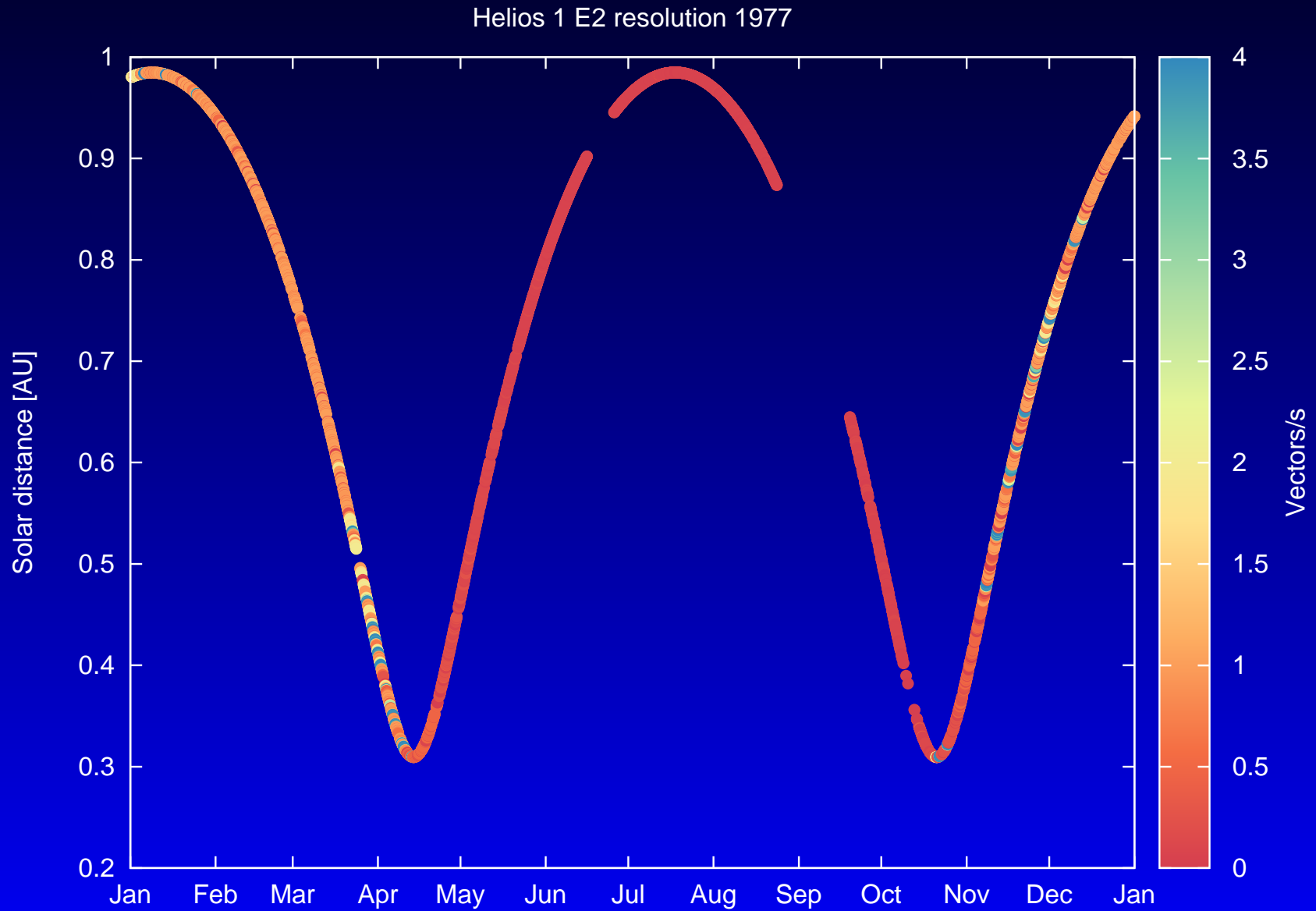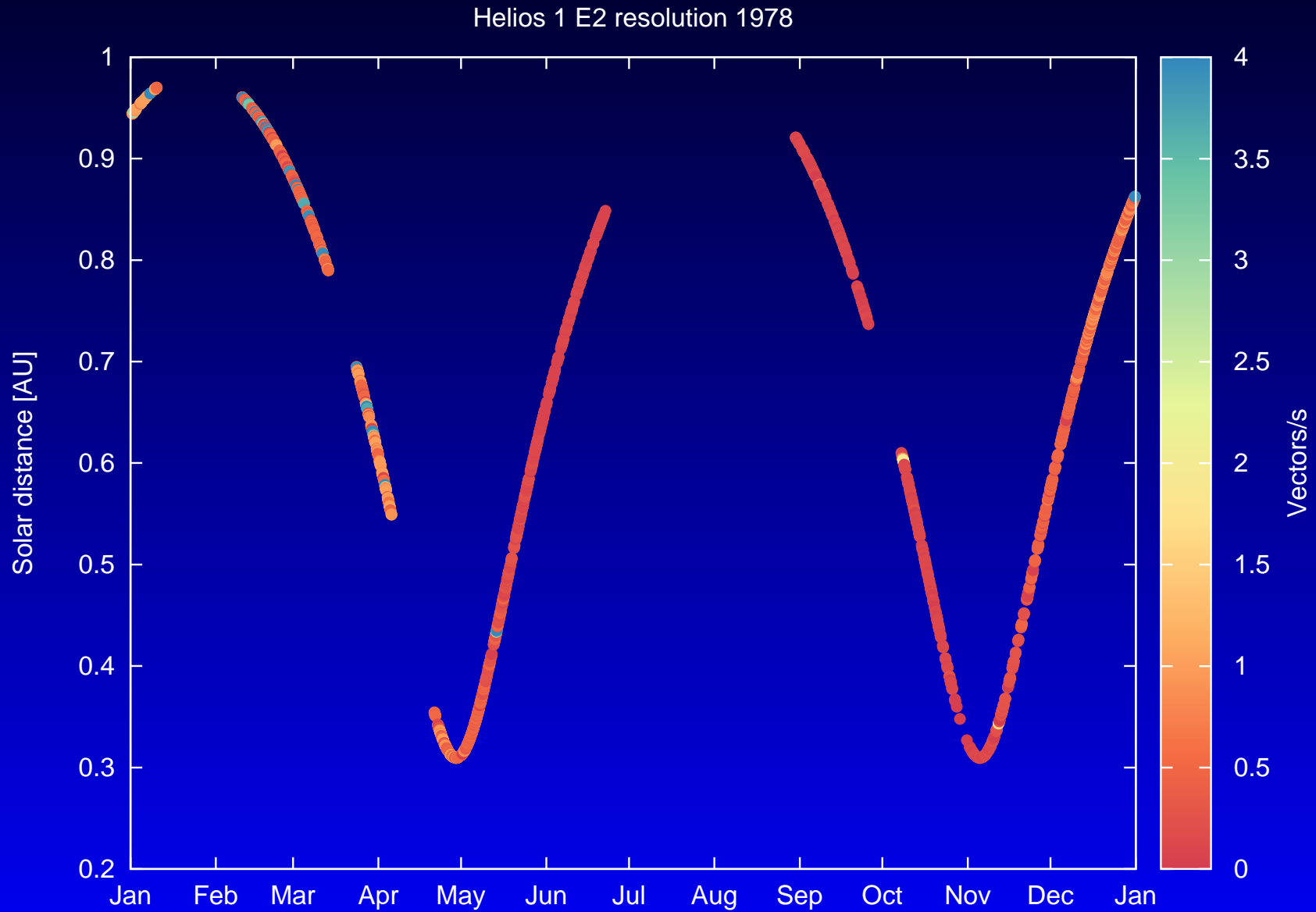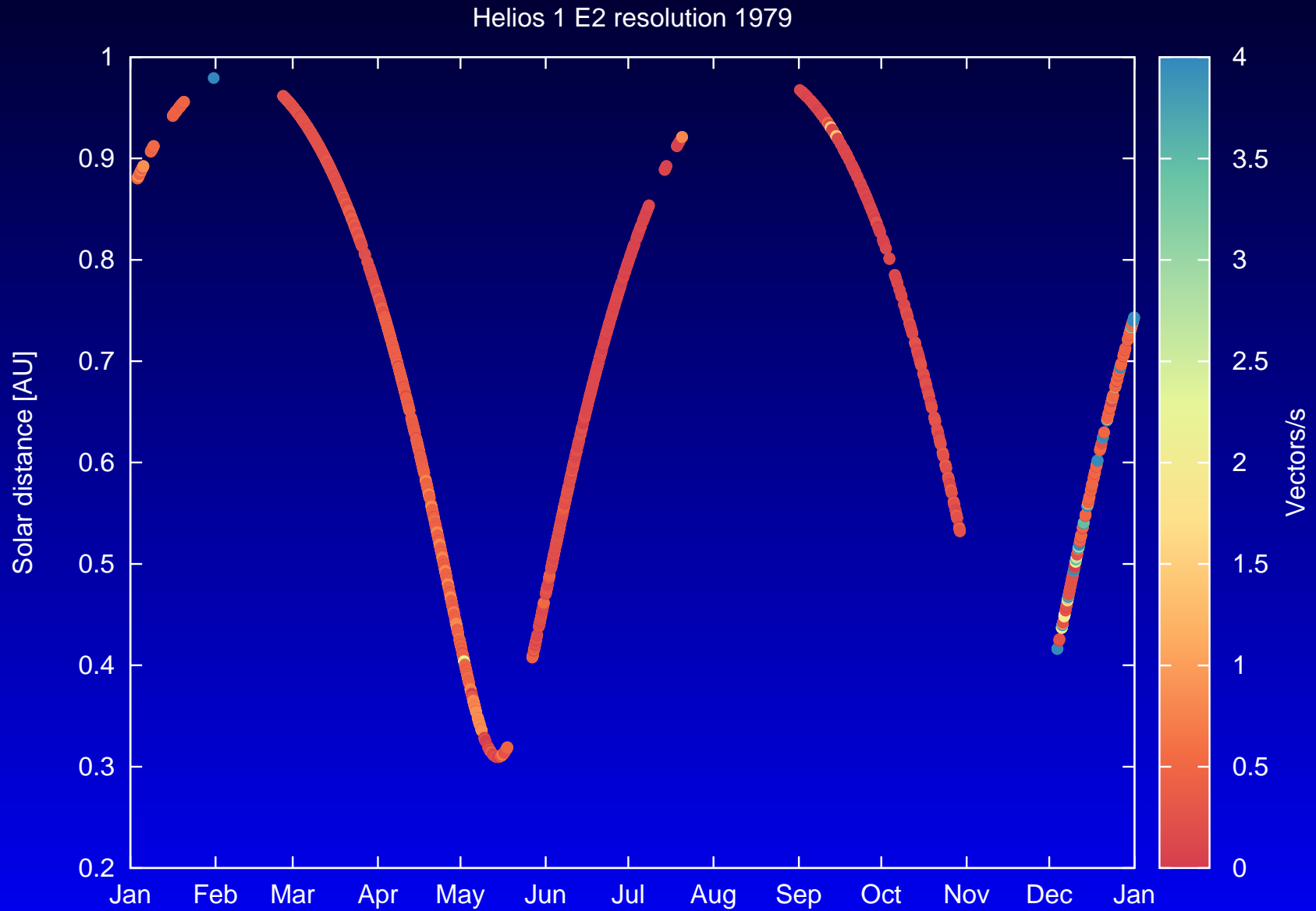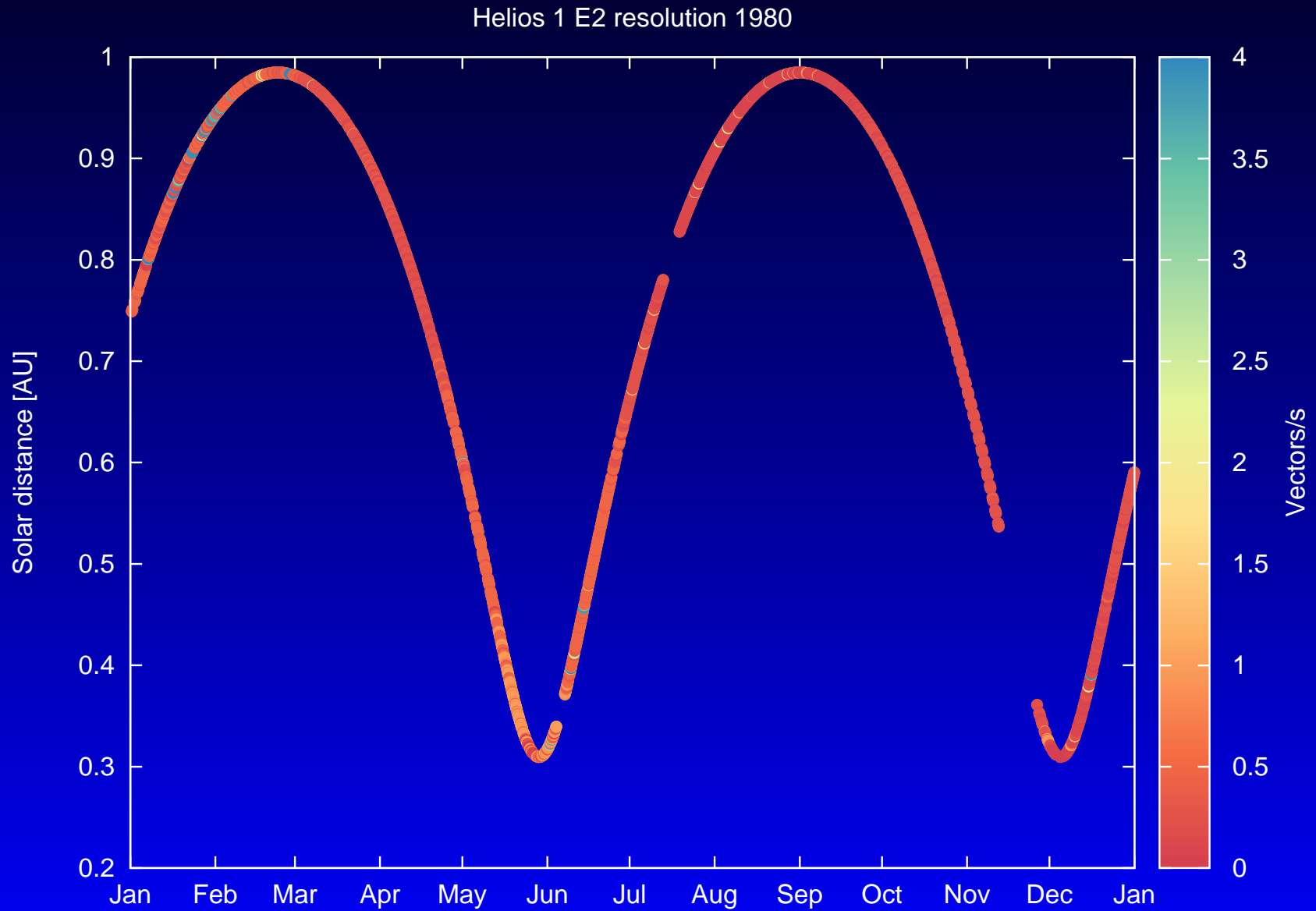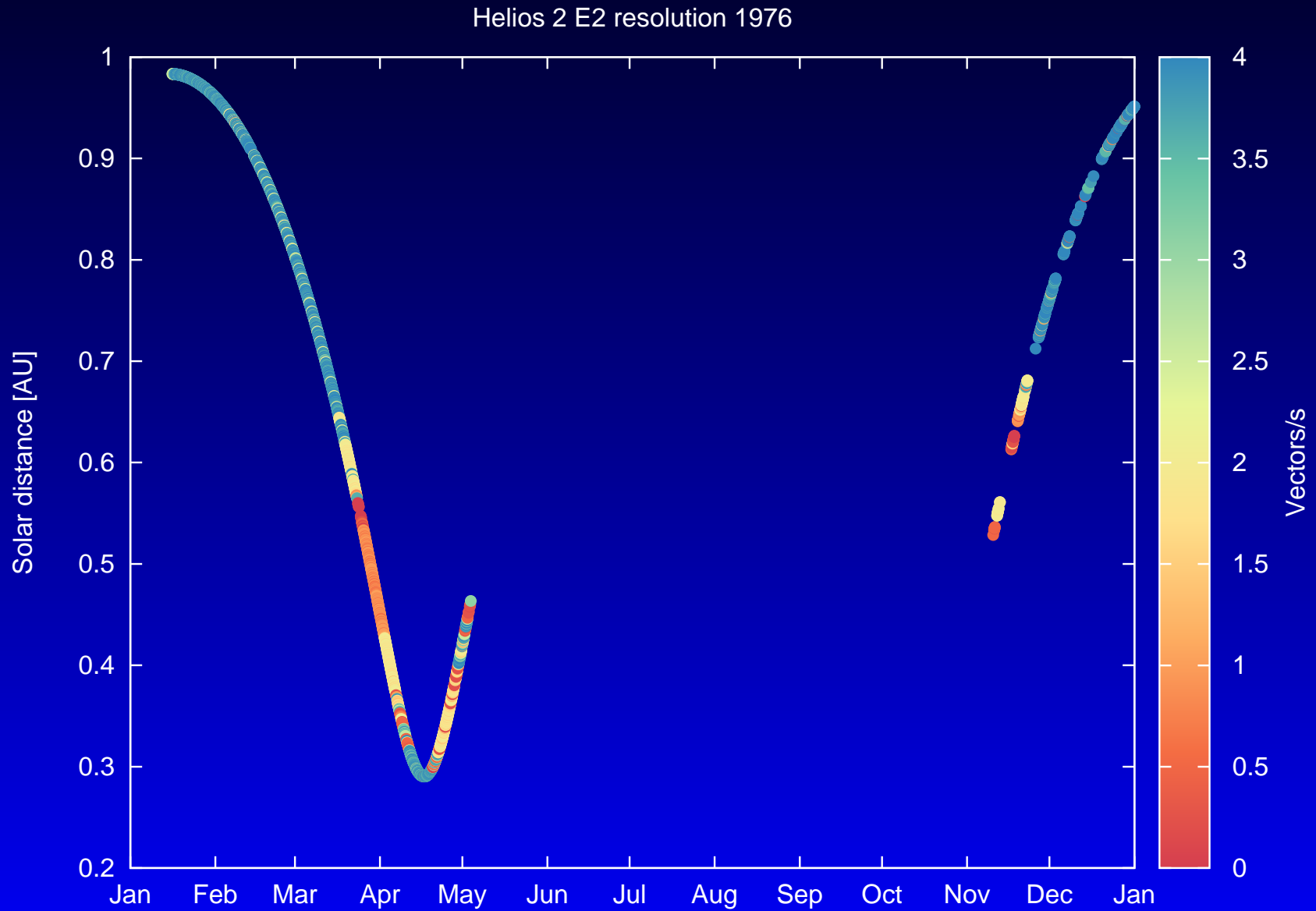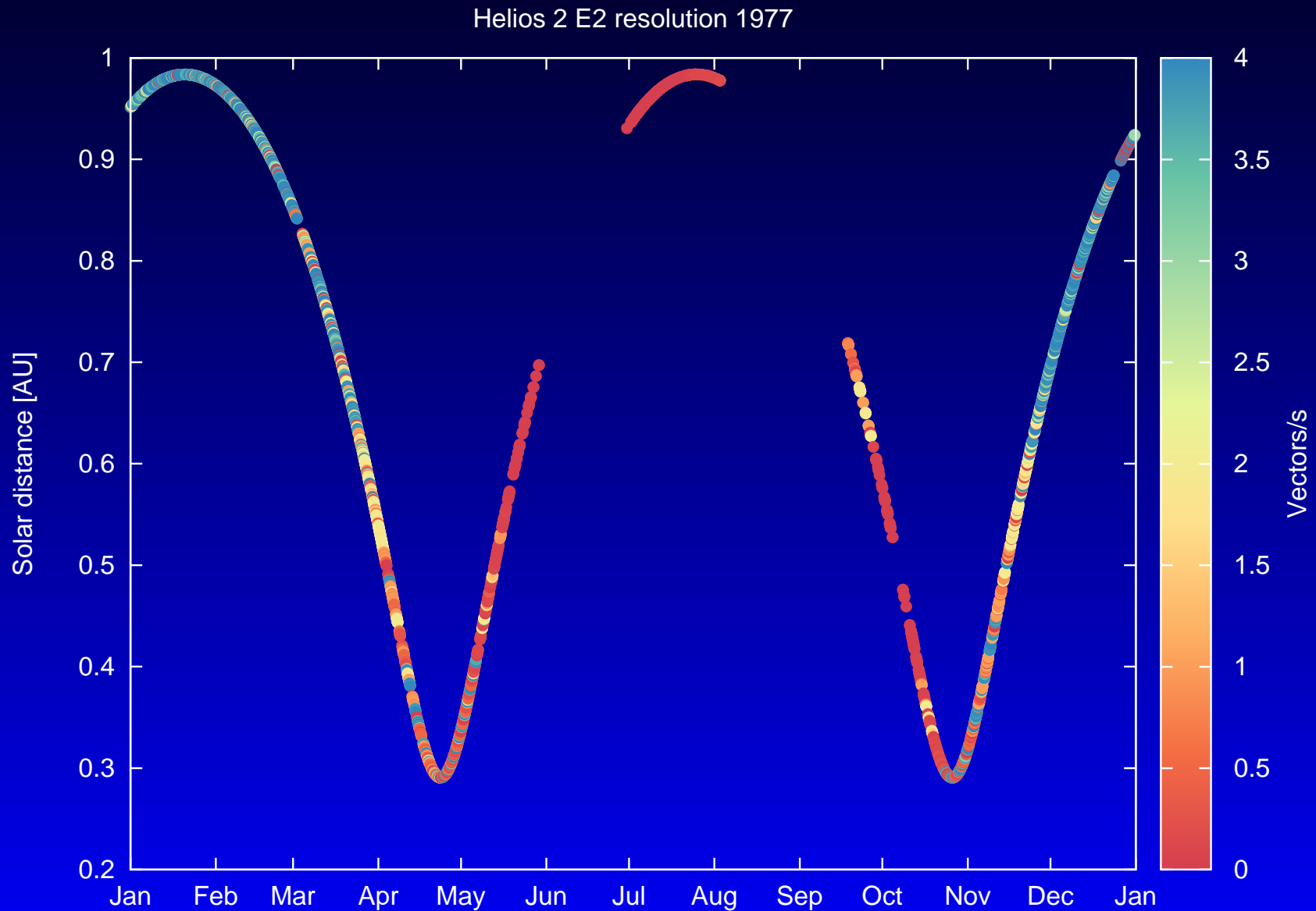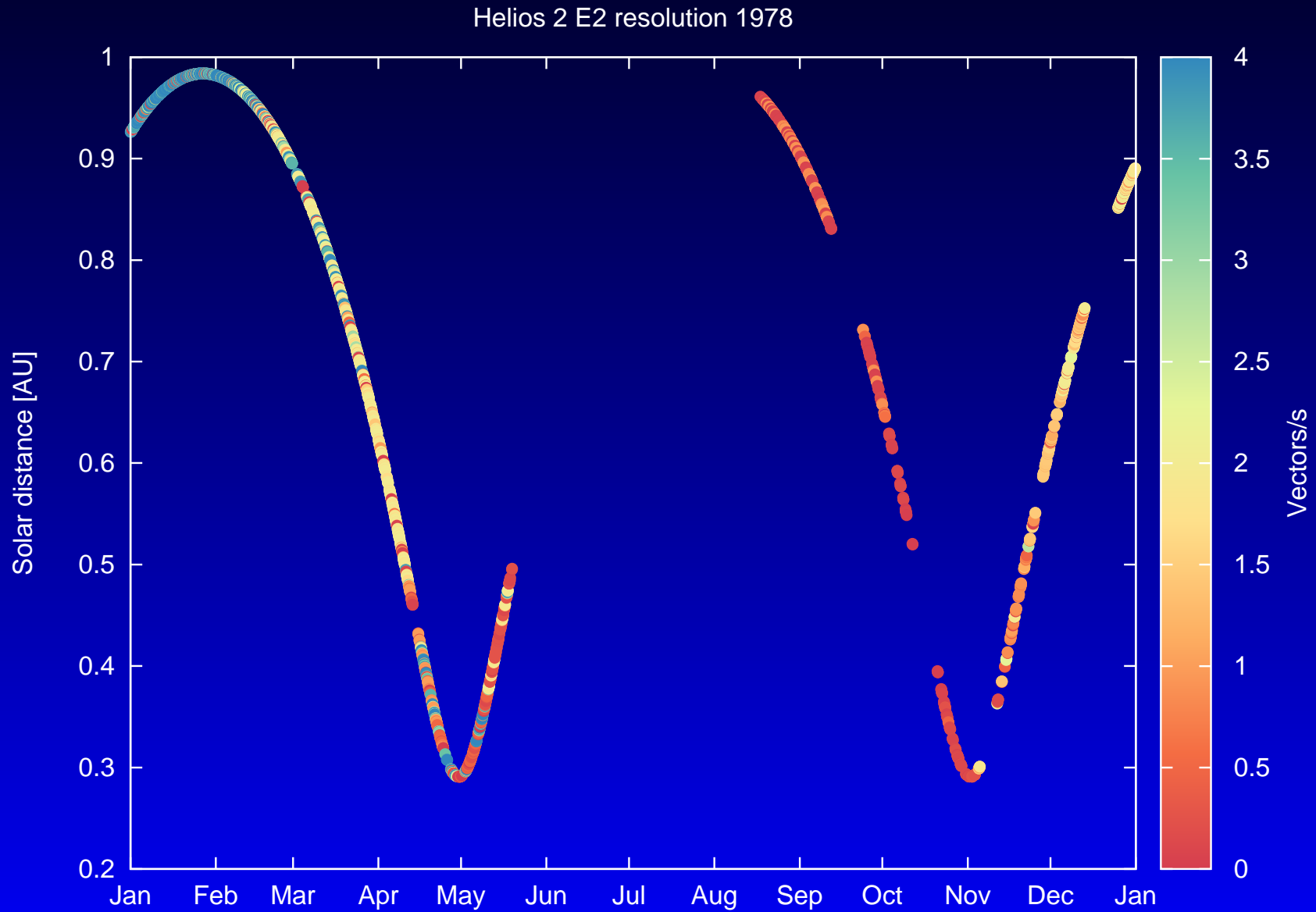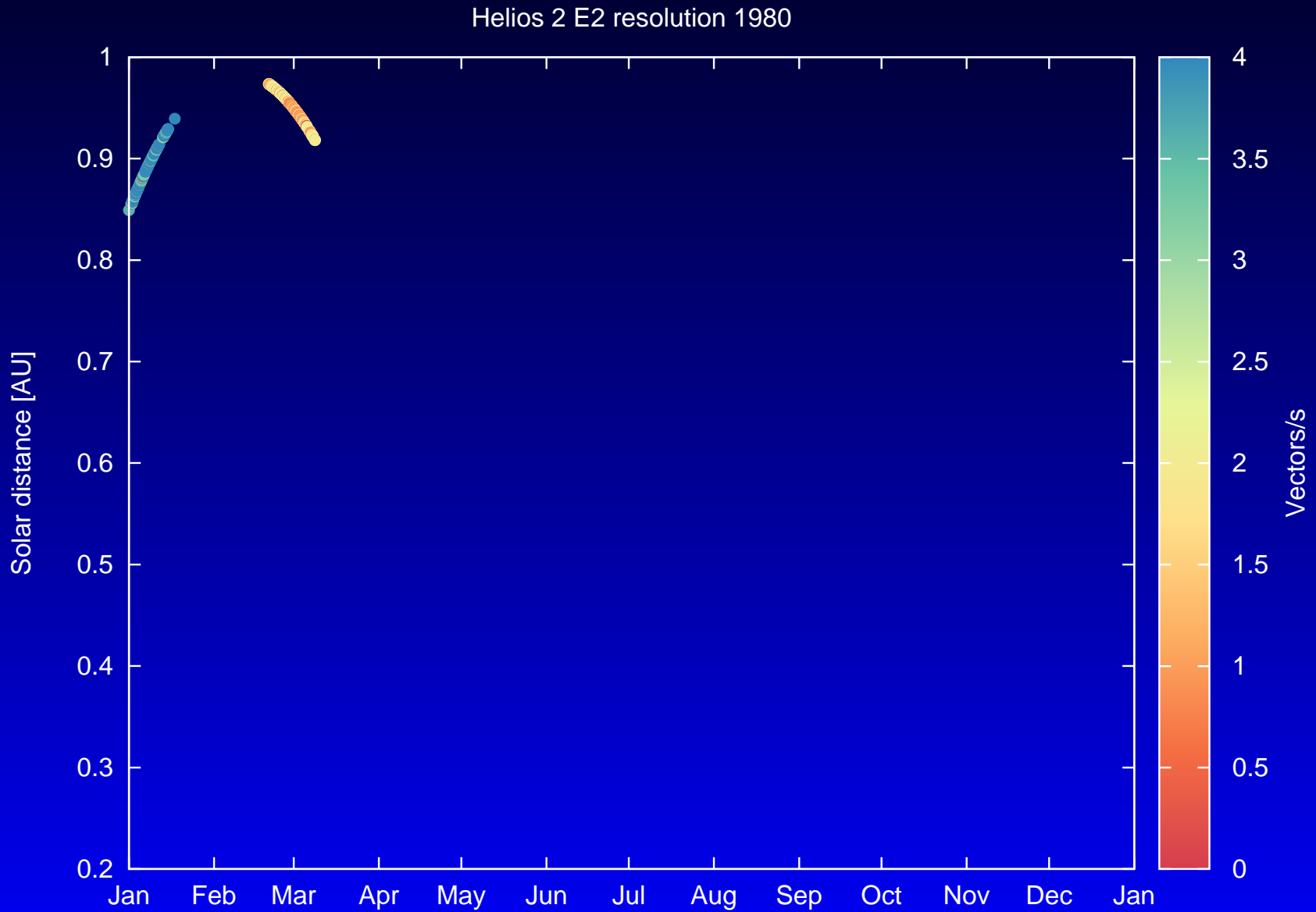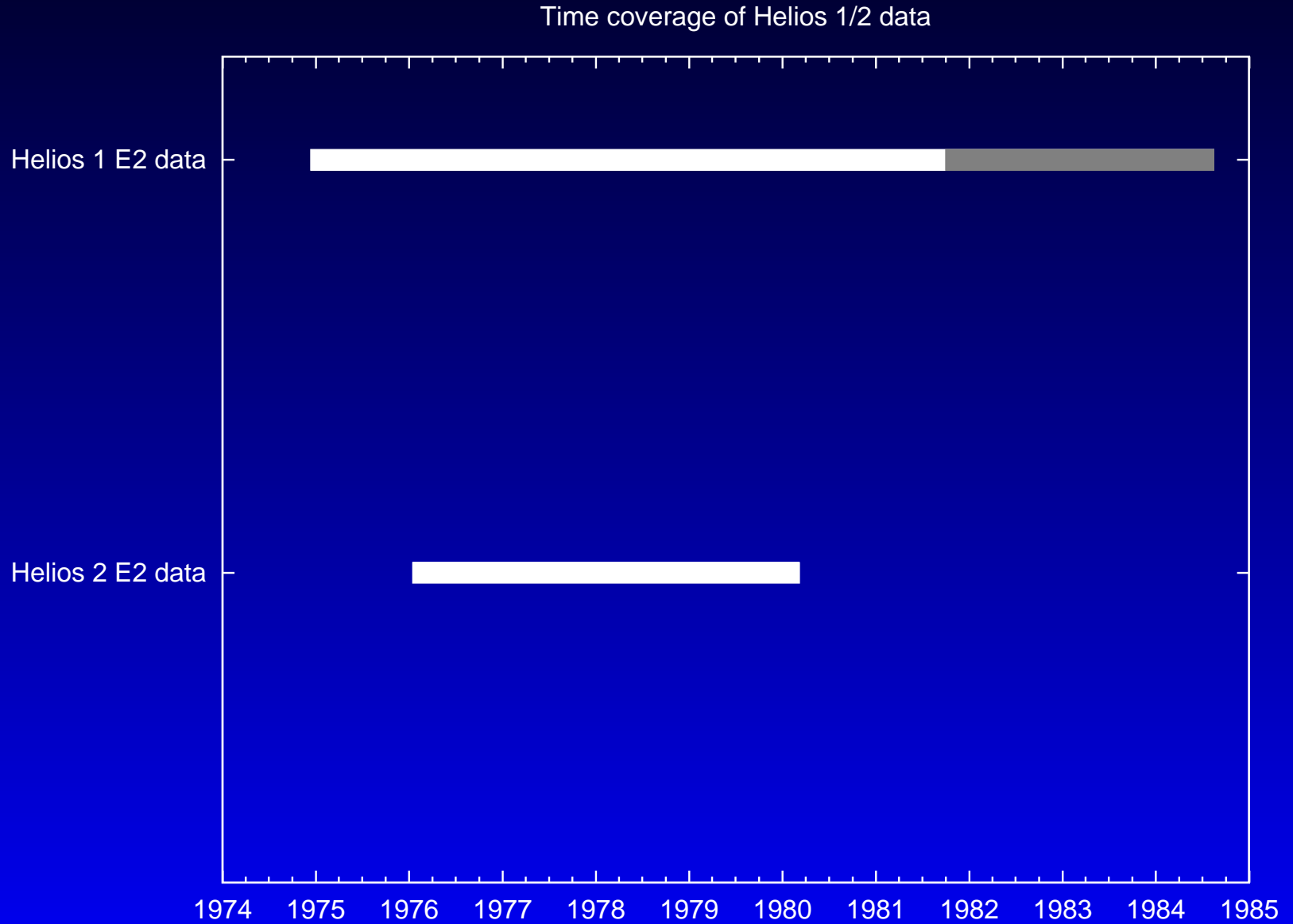
E2 data: history, format, availability

Thank you for your attention