Debrecen Photoheliographic Data for 1987 with image supplements

L. Győri, T. Baranyi, G. Csepura, O. Gerlei and A. Ludmány
Heliophysical Observatory of the Hungarian Academy of Sciences
H-4010 Debrecen, P.O. Box 30, Hungary, (dpd-l@tigis.klte.hu)

Received 5 February 1998; accepted 8 April 1999

Abstract

The present catalogue is the second volume of the Debrecen Photoheliographic Data (DPD). The DPD is a catalogue of daily positions and areas of sunspots compiled by using white-light full-disk observations taken at the Heliophysical Observatory (Debrecen, Hungary) and its Gyula Observing Station as well as at some other observatories. In 1987 the contributing observatories were: Abastumani Astrophysical Observatory (Georgia), Ebro Observatory (Spain), Kiev University Observatory (Ukraine), Kislovodsk Observing Station of Pulkovo Observatory (Russia), Kodaikanal Solar Observatory (India) and Tashkent Observatory (Uzbekistan). The material is divided in two parts. The numerical part contains the measured data and the other part contains the CCD scans of all the active regions that were found on the photographic plates. Every measured spot is marked with the same number in the picture as in the numerical catalogue. The images along with the measured data allow more complex analyses, morphological studies and comparison with magnetic, Hα and other observations.
Key Words:Sun: sunspots — active regions

1 Introduction

The positions and areas of sunspot groups for every day were published at Greenwich (Greenwich Photoheliographic Results) until 1976. After that date, Debrecen Heliophysical Observatory took over this responsibility. The history and description of the Debrecen Observatory as well as its observational material and the catalogue were given by Győri et al. (1998a) and references therein.

The present material is an extended version of DPD for 1987 that was published previously in printed form (Győri et al. 1998b) and also made available electronically (ftp). The original ASCII catalogue is extended with the CCD scans of the photographic plates.

2 The DPD catalogue

The daily photospheric observations are taken both in Debrecen and at the Gyula Observing Station (150 km from Debrecen) which officially belongs to Debrecen Observatory. The Debrecen-Gyula archives comprise about 100,000 plates covering almost four decades. The DPD catalogue is compiled on the basis of these archives.

For those days in which no observations were obtained in Hungary we use foreign observations. In 1987 these were received from the archives of the Kislovodsk Observatory (Russia), Kodaikanal Solar Observatory (India), Tashkent Observatory (Uzbekistan), Ebro Observatory (Spain), Kiev University Observatory (Ukraine) and Abastumani Astrophysical Observatory (Georgia). In some cases, when there were gaps in our observations but when no spots were reported by the observatories involved in the Solar Geophysical Data 1987 (SGD), we decided that there was no need to request plates for these spotless days. In these cases we refer to the station (Boulder or Ramey) and time of observation indicated in the SGD as reporting on a spotless disc. Table 1 gives the number of observations in the catalogue.

At our observatory several series of observations are taken each day, a series usually consisting of three photographic plates exposed within a time interval of 15 minutes. We choose the best triplet (the best pair or single plate if no complete triplet is available) for every day. The area measurement is based on the best of the plates and the method is the same as described in the above-mentioned papers. The method of position measurements is based on the software and procedure developed by L. Győri. The times of observation and the positions measured on the used plates are averaged. The mean precision of the positions in DPD is 0.1 heliographic degrees. The precision of the positions is better than 0.1 heliographic degrees in case of Gyula and it is slightly less accurate in the case of the other observatories.

We measured every spot which could be recognized as such, depending on the quality of the observation. The numbering of spots was made arbitrarily on each plate (or pair or triplet); thus, the number of a specific spot usually changes from one day to the next. For numbering the groups we used the NOAA sunspot group numbers published in the Solar Geophysical Data Nos. 511–522 (Coffey 1987). If there was no data in the SGD for a group found by us, we created a new number by attaching the letters m, n, . . . to a NOAA number existing at the given time.

The position of a spot means the position of the centre of the umbra if we could separate the umbra from the penumbra. If we could not identify any umbrae in the penumbra, we measured the position of the centre of the penumbra.

The DPD is published in ASCII format in file `dpd1987`. The file contains the following data for each spot: time of observation, the NOAA number of its group, the measured (projected) and the corrected (for foreshortening) areas of umbrae (U) and the whole spot (U+P), latitude, longitude, distance in longitude from the central meridian, position angle (measured eastward from the north pole of the Sun's axis) and distance from the disc's centre expressed in solar radii.

The catalogue also contains the total areas and the mean positions of the sunspot groups. The total area is the sum of the areas of each spot in a group. The mean positions of the group were calculated by multiplying the positions of all separately measured components of the group by their corrected U+P areas, and by dividing the sum of these products by the sum of the areas. When there was more than one umbra in a penumbra, the position of the centre of gravity of this component was computed by weighting the positions of the umbrae with the corrected U areas before calculating the mean position of the whole group. If a group was intermittent then zero areas are indicated and no position is given.

Table 1: Number of observations per observing station.

Observatory	n
Gyula	245
Debrecen	53
Kislovodsk	46
Boulder	7
Kodaikanal	3
Ramey	3
Tashkent	3
Ebro	2
Kiev	2
Abastumani	1

The sums of areas and the Julian Date are also included in the table in order to facilitate the use of these data for the investigation of longer time series of observations.

The users of the catalogue asked the authors to publish also the values of P (position angle of the northern extremity of the axis of rotation, measured eastwards from the north point of the disk), B_0 and L_0 (heliographic latitude and longitude of the central point of the disk). We appended the values of P and B_0 at the time of observation to the row of the daily data. For the value of L_0 there were not enough free columns but it can be easily calculated as $L - LCM$.

3 The images

We cannot undertake to publish more information than is available in the DPD. However, we want to put all information contained by our observations at the disposal of any interested member of the solar community. This is why we also publish the CCD scans of the sunspot groups with the marks of the measured spots. This part of the publication allows the supplementation of our data with additional observational data (magnetic polarities, etc.) from other sources.

The images are given in gnu-zipped FITS format (extension `.gz` in directory `1987fits`). Each file name is created from the NOAA number (omitting the first digit) and the date. For example `763_0101` means that the file contains the image of the group 4763 on 1st of January. If the group number has a letter extension, then it is inserted in place of the underscore mark, as in the case of 4763m on January 7 (`763m0107`).

The header contains the size of the image, the date (day/month/year) and the time of the observation (hour:min:sec), the NOAA number of the group, the name of the observing station, the resolution in the sky in arcsec/pixel in the directions of the rows and columns.

The vertical edges of the images are oriented to the North direction within one degree. More precisely, the columns of the arrays are in the geocentric North direction to within a few tenths of a degree. To orientate the images to the direction of the Sun's axis of rotation the values of P have to be taken into account (this also refers to the images of 1986 (Győri et al. 1998a), although it was not emphasized there).

The larger umbrae are often overexposed in order to make the smaller ones more prominent. On account of the limit of 256 grey levels the dynamics of the original images cannot be maintained. Thus, the quality of CCD scans is lower than that of the original observations and the CCD scans are not suitable for photometric measurements.

Sometimes there are some features in the pictures which do not belong to the Sun. These are the cross-wires, the dark segment of the second exposure (which helps to measure the geocentric North direction) and inhomogeneities or plate defects. These features should be neglected.

Acknowledgements

We express our deepest gratitude to the colleagues at the collaborating observatories for putting the necessary material at our disposal: Dr. T. Zaqarashvili and Dr. E. Khutsishvili (Abastumani), Dr. L.F. Alberca (Ebro), Dr. V.G. Lozitskij (Kiev), Dr. V.I. Makarov (Kislovodsk), Dr. S.P. Bagare (Kodaikanal) and Dr. I. Sattarov (Tashkent). Thanks are due to everyone participating in the daily routine observations and helping us in this work. The DPD project was supported by grants of the Hungarian National Foundation for Scientific Research Nos. OTKA T025640 and F019829, as well as by U.S.-Hungarian Joint Fund for Science and Technology under contract No. 95a–524.

References

Coffey H.E., 1987, (ed.) Solar-Geophysical Data, Nos. 511–522.

Győri L., Baranyi T., Csepura G., Gerlei O., Ludmány A.1998a, Debrecen Photoheliographic Data for 1986, Journ. Astron. Data, Vol. 4., 2.

Győri L., Baranyi T., Csepura G., Gerlei O., Ludmány A. 1998b, Debrecen Photoheliographic Data for the year 1987, Publ. Debrecen Obs. Heliographic Series No. 11.

Appendix

```
=====================================================================

                    Explanations to the data file


The file contains three kinds of rows, they are explained separately.

Rows beginning with character "d" (day):

=============================================================================
Column  Fmt   Description
-----------------------------------------------------------------------------
 2- 5   I4    Year
 6- 7   I2    Month
 8- 9   I2    Day of month
10-13   F4.3  Time in thousandths of a day (by convention .500 represents 1200 UT)
14      A1    Blank
15-18   A4    Origin of the observation: ABAS: Abastumani
                                         BOUL: Boulder
                                         DEBR: Debrecen
                                         EBRO: Ebro
                                         GYUL: Gyula
```

```
                                         KISL: Kislovodsk
                                         KODA: Kodaikanal
                                         KIEV: Kiev
                                         RAME: Ramey
                                         TASH: Tashkent
19-23   A5    Blank
24-28   I5    Daily sum of projected U (umbral) area in millionths of the
              solar disc
29-33   I5    Daily sum of projected U+P (umbral+penumbral) area in
              millionths of the solar disc
34-38   I5    Daily sum of corrected U in millionths of the solar hemisphere
39-43   I5    Daily sum of corrected U+P in millionths of the solar hemisphere
44-49   A6    Blank
50-60   F11.3 Julian Date (by convention .500 represents 0000 UT)
62-67   F.6.2 P (position angle of the northern extremity of the axis of
              rotation, measured eastwards from the north point of the disk)
70-74   F.5.2 B0 (heliographic latitude of the central point of the disk
              at the time of observation)
------------------------------------------------------------------------------

Rows beginning with character "g" (group)


==============================================================================
Column  Fmt   Description
------------------------------------------------------------------------------
 2- 5   I4    Year
 6- 7   I2    Month
 8- 9   I2    Day of month
10-13   F4.3  Time in thousandths of a day
14-20   A7    NOAA sunspot group number; if no NOAA number was assigned then
              a number close to another NOAA number was given with an additional
              letter ("m" or "n")
21-23   A3    Blank
24-28   I5    Total projected U (umbra) area of the group in millionths of
              the solar disc
29-33   I5    Total projected U+P (umbral+penumbral) area of the group in
              millionths of the solar disc. Zero means that the given group
              is in an intermittent phase.
34-38   I5    Total corrected U of the group in millionths of the solar hemisphere
39-43   I5    Total corrected U+P of the group in millionths of the solar hemisphere

              If all the total areas are equal to zero it means an intermittent
              phase of the group.

44      A1    Blank

        The following entries refer to the position of the given sunspot
        group, which is the mean position of its spots weighted by the U+P
        areas of the single spots. In the case of several umbras within the
        same penumbra the mean weighted umbra position was calculated
        within their common penumbra prior to the calculation of group
        mean position.
```

```
45-50   F6.2  Heliographic latitude B; positive: North, negative: South
51      A1    Blank
52-57   F6.2  Heliographic longitude L
58      A1    Blank
59-64   F6.2  Longitudinal distance from the Sun's central meridian (LCM)
65      A1    Blank
66-71   F6.2  Position angle
72      A1    Blank
73-78   F6.4  Distance from the centre of the Sun's disc measured
              in units of the solar radius
------------------------------------------------------------------------------
```

Rows beginning with character "s" (spot)

```
==============================================================================
Column  Fmt   Description
------------------------------------------------------------------------------
 2- 5   I4    Year
 6- 7   I2    Month
 8- 9   I2    Day of month
10-13   F4.3  Time in thousandths of a day
14-20   A7    NOAA sunspot group number; if no NOAA number was assigned then
              a number close to another NOAA number was given with an
              additional letter (e.g. "m" or "n")
21-23   I3    No. of spot within the group
24-28   I5    Projected U (umbra) area in millionths of the solar disc
29-33   I5    Projected U+P (umbral+penumbral) area in millionths of the solar
              disc; negative values indicate that several umbrae have a common
              penumbra, e.g. -7 means that the given umbra shares a penumbra with
              umbra No.7, and the U+P value is indicated at No.7
34-38   I5    Corrected U in millionths of the solar hemisphere
39-43   I5    Corrected U+P in millionths of the solar hemisphere, for
              negative values see Column 29-33.
44      A1    Blank
45-50   F6.2  Heliographic latitude B; positive: North, negative: South
51      A1    Blank
52-57   F6.2  Heliographic longitude L
58      A1    Blank
59-64   F6.2  Longitudinal distance from the Sun's central meridian (LCM)
65      A1    Blank
66-71   F6.2  Position angle
72      A1    Blank
73-78   F6.4  Distance from the centre of the Sun's disc measured in units of
              the solar radius
==============================================================================
```