# CURRENT STATUS OF THE *DEBRECEN PHOTOHELIOGRAPHIC DATA*

**L. Győri, T. Baranyi, A. Ludmány, and G. Mező**

Heliophysical Observatory of the Hungarian Academy of Sciences, H-4010 Debrecen, Hungary

## ABSTRACT

Several recent advances have been made in the procedure and presentation of the Debrecen Photoheliographic Data. We summarize the present status of the catalogue, and the available forms of the access to the data and images of sunspot groups. We also report the present and further steps to speed up the procedure of evaluation.

## 1. INTRODUCTION

The Debrecen Photoheliographic Data (DPD) is a catalogue of positions and areas of sunspots for every days compiled by using white-light full disc observations observations taken at the Heliophysical Observatory of the Hungarian Academy of Sciences (Debrecen, Hungary) and its Gyula Observing Station (150 km from Debrecen) as well as at some other observatories. The daily photospheric observations are taken both in Debrecen and in Gyula and the archives comprise more than 100,000 plates covering almost five decades. For those days when these archives contain no observations we use the observations of the cooperating observatories (Table 1 and 2): Abastumani Astrophysical Observatory (Georgia), Ebro Observatory (Spain), Helwan Solar Station (Egypt), Kanzelhoehe Solar Observatory (Austria), Kiev University Observatory (Ukraine), Kislovodsk Observing Station of Pulkovo Observatory (Russia), Kodaikanal Solar Observatory (India), Mount Wilson (USA), and Tashkent Observatory (Uzbekistan). In some cases we refer to Boulder, Holloman, or Ramey as reporting on a spotless disc in the Solar-Geophysical Data (NGDC/NOAA, ed. H.E. Coffey). In one case we could not get any ground-based observation for the given day, thus we used a space-borne quasi-continuum image from the Michelson Doppler Imager (MDI) on SOHO. This can be made because these images measured with our software show only a small (13%) systematic difference in comparison with the DPD data (Győri et al., 2002).

The DPD catalogues are divided into two parts. The numerical part contains area and position of each spot, the total areas and the mean positions of the sunspot groups, and the daily sums of the area of groups. The following data are available 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 (B), longitude (L), distance in longitude from the central meridian (LCM or CMD), position angle (measured eastward from the north pole of the Sun's axis) and distance from the disc's center expressed in solar radii. The method of position measurements is based on the software and procedure developed by L. Győri, which is basically similar to that used by (Dezső et al. 1987, 1995). The mean precision of the positions in DPD is about 0.1 heliographic degrees. The area data for 1986 and the half of 1987 were derived with the same facility which was used by Dezső et al. (1987). In the catalogue for 1988 and thereafter the area measurements have been based on the CCD scans of the best plates. This new method of area measurements is described in the paper by Győri (1998). The area data are in good agreement with the other photographic data bases from statistical point of view but contain less random errors (Baranyi et al. 2001). The rate of random errors further decreased after using the new measuring method which is seen in the decrease of the standard errors of the mean umbra-penumbra area ratios (Szasz et al. 2003) for instance.

The second 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 are given in FITS and JPG format. The images along with the measured data allow more complex analysis, morphological studies and comparison with other observations. With this level of detail this catalogue is reckoned to be unique.

## 2. PAST AND PRESENT

The positions and areas of sunspot groups for every day were published at Greenwich (Greenwich Photoheliographic Results) until 1976. After that date the Debrecen Heliophysical Observatory took over this responsibility, and the Debrecen Photoheliographic

Results (DPR) was started to be published (Dezső et al. 1987, 1995). The DPR team aimed at enriching the basic data with identification of larger spots, magnetic polarity data, positions of leading and following parts, and other important information but its methodology is extremely time-consuming. Therefore, in 1993 a separate team started to compile a more restricted data base of DPD in order to speed up the procedure. The year 1986 was chosen as the starting year of DPD.

Although our DPD team had large experience in the field of sunspot measurements when the work was started, we soon had to realize that this new job was substantially different from the previous ones. It is not the same to measure the most important spots of a sunspot group on a series of high-quality photoheliogram for a time interval of max. two weeks as opposed to measure every spot (even the smallest ones) on the solar disk on every day even in the hardly measureable cases when the photoheliogram is very far from being perfect (very bad seeing, cloudiness, developing unevenness, over or under exposure, scratches and film emulsion defects). The distribution of the time used for compiling a sunspot catalogue is staggering: we have to use about 60-70 percent of our total working time for about the most problematic 10 percent of the catalogue entries. We also had to realize that our hardware and software facilities are not suitable for this job. Thus, we had to start developing our facilities and to evolve the new way of handling of the large amount of plates, data, and sessions.

The development of our hardwares and hardware-dependent softwares was very difficult and slow because of our low financial support. Although we had permanent financial problems, occasionally we managed to receive some grants. The Hungarian National Foundation for Scientific Research supported the work with limited amounts several times. We are especially grateful to the U.S.-Hungarian Joint Fund for Science and Technology, which supported us in a crucial era of the observatory. We are also grateful to the SCOSTEP, which supported us with photographic plates and in this way we were able to continue the observations during several years. Although the circumstances were far from the optimal stage, we had the basic facilities and tried to compensate the disadvantages with lots of extra work. The efforts still continue at present.

The difficulties of the evaluation are enormous. There are more than 10 different sessions till the completion of a catalogue (e.g. gathering and selection of plates, measuring auxiliary data of the plates, creating files of observational and telescopic data, finding and identifying of groups, their preparation to the measurements, position measurements, making CCD scans, determination of umbra and penumbra areas, matching the position data measured on the full disc to the positions of spots in the scanned images, calculation of position and area data, creating FITS and JPG files, etc.). In each session we have to handle thousands of data, and several types of errors

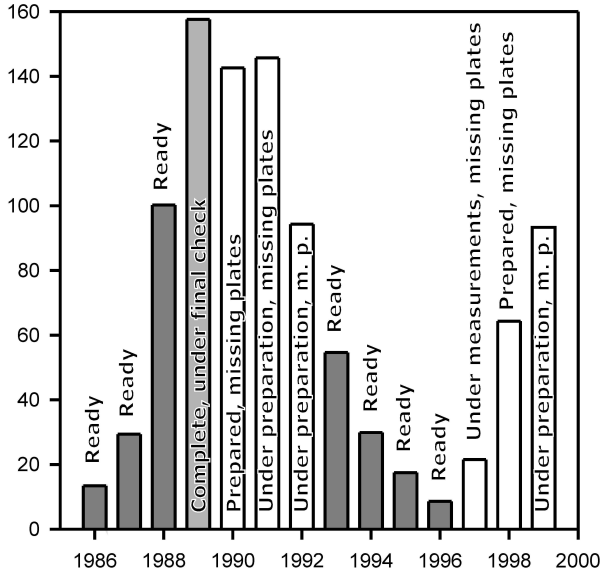


*Figure 1. The level of readiness of DPD catalogues and the yearly mean sunspot number.*

may arise during each session. The check of the data and correcting the errors mean additional sessions which take about the same time as the original ones. We estimate that the evaluation of a daily observation with about ten sunspot groups would take about one week for a person altogether. Another type of problem is the gathering and transport of the missing plates from the cooperating observatories. This task usually takes about three years or more after compiling the list of needed plates till the last borrowed plate arrives to the observatory. We are very grateful to the colleagues in these observatories for putting the necessary material at our disposal. They do this job without any direct benefit, but they will be only compensated in indirect way if the usefullness of the catalogue happens to be proved and appreciated by the solar community.

Since 1993 we have evaluated data for 8 years: 1986, 1987, 1988, 1989, 1993, 1994, 1995, and 1996. The number of the published catalogues is not as much as we would like to have but it is close to the one catalogue/year publishing rate. It is not so bad if we take into account the initial difficulties and the continuously arising new different problems. It is regrettable that the backlog is so large but it also has a small advantage. We started scanning the sunspot groups on the observational plates with a CCD camera in 1997. If we had finished several catalogues before the availability of CCD techniques, those would have been omitted from the archives of images. Now we can provide the image supplements to the solar community for the whole period of DPD.

The published years are available in different forms. The printed volumes were published in the Publication of Debrecen Observatory Heliographic Series with a CD supplement (Győri et al. 1996, 1998a, 2001). and the CCD scans for 1986-87 were published in The Journal of Astro-

nomical Data (Győri et al. 1998b, 2000). The forthcoming volume of the Heliographic Series will contain the catalogues for 1993-96. All the available data and images are accessible on our site (ftp://fenyi.solarobs.unideb.hu/pub/DPD/) and on the site of NOAA (ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SUNSPOT_REGIONS/).
These sites are regularly refreshed by the month, and the incomplete catalogues are also available here. The 'i' letter in the filename designates a temporarily incomplete material. It means that there are missing days in the data base or it means that the data still have to undergo the process of final check. There is no use postponing the publication till the catalogue is perfectly finished because the incomplete material can be used for lots of different statistical studies immediately.

Figure 1 shows the level of readiness at the time of the publication of this paper.

## 3. FUTURE

With the present methods of evaluation we cannot practically achieve larger speed of publication but the one catalogue/year rate is not enough to make up leeway. We have to achieve the two catalogues per year rate, which seems to be much more attainable than it was earlier. At the beginning of this year we received a professional scanner which can scan the whole plate with acceptable spatial and intensity resolutions as well as large enough density range. The development of the softwares is in progress, and the first results are promising. We will be able to contract the sessions of position and area measurements, which will decrease the number of mistakes and makes easier the correction of the errors.

On the basis of these promising test results, we can estimate the publication of the forthcoming catalogues. The final check of DPD 1989 will be finished in 2004. The compilation of DPD 1997 and 1998 is also expected in 2004. The publication of DPD 1990, 1991 and 1992 is expected in 2005-6 at least in incomplete form in the case of missing plates. In this way the present gaps in the time-interval of DPD will be filled in within about 2-3 years. However, the possible users should not necessarily wait until that time. The DPD is suitable for certain studies even in the present form (see e.g. Szasz et al., 2003).

Parallel to the measurements we work on a user friendly web-presentation of DPD. The aim is to create a site similar to the Active Region Monitor of BBSO, which makes it easier to survey the daily full-disc observations as well as the sunspot group data. Now the JPG images help the user, which can be opened by any web-browser.

Nevertheless we have to face with a new problem: the lack of the suitable photographic material for the observations. The narrowing market of the photographic plates brings that the assortment of the available sorts of films is decreasing and the price of the high quality films is increasing. Nowadays the situation becomes crucial because the price of a good quality film is so high that we and a large part of the cooperating observatories can not afford it. Thus, the continuation of the high-quality observations (and as a consequence the high quality sunspot catalogue) can get into danger in the near future. The solution would be the use of CCD cameras. However, we should use a CCD with 8000x8000 pixels so that we could achieve the needed present accuracy of the position and area measurements (see the paper by Győri et al., [2003] about the effect of the plate scale) but this type of camera is not available at the moment.

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*Table 1. The number of observations per observing station in the catalogues for 1986-89.*

| Year | Station | Number |
|---|---|---|
| 1986 | Gyula | 257 |
| | Debrecen | 52 |
| | Kislovodsk | 30 |
| | Boulder | 18 |
| | Ramey | 5 |
| | Holloman | 3 |
| 1987 | Gyula | 245 |
| | Debrecen | 53 |
| | Kislovodsk | 46 |
| | Boulder | 7 |
| | Kodaikanal | 3 |
| | Ramey | 3 |
| | Tashkent | 3 |
| | Ebro | 2 |
| | Kiev | 2 |
| | Abastumani | 1 |
| 1988 | Gyula | 243 |
| | Debrecen | 61 |
| | Kislovodsk | 52 |
| | Kodaikanal | 3 |
| | Tashkent | 3 |
| | Abastumani | 2 |
| | Ebro | 2 |
| 1989 | Gyula | 248 |
| | Kislovodsk | 59 |
| | Debrecen | 38 |
| | Helwan | 15 |
| | Kiev | 2 |
| | Kodaikanal | 2 |
| | Ebro | 1 |

*Table 2. The number of observations per observing station in the catalogues for 1994-96.*

| Year | Station | Number |
|---|---|---|
| 1993 | Gyula | 178 |
| | Debrecen | 128 |
| | Kislovodsk | 49 |
| | Kanzelhoehe | 7 |
| | Helwan | 2 |
| | Kiev | 1 |
| 1994 | Gyula | 257 |
| | Debrecen | 42 |
| | Kislovodsk | 33 |
| | Kanzelhoehe | 28 |
| | Ramey | 4 |
| | Kiev | 1 |
| 1995 | Gyula | 196 |
| | Debrecen | 79 |
| | Kanzelhoehe | 55 |
| | Kislovodsk | 25 |
| | Ramey | 4 |
| | Helwan | 2 |
| | Mount Wilson | 2 |
| | Ebro | 1 |
| | Kodaikanal | 1 |
| 1996 | Debrecen | 144 |
| | Gyula | 125 |
| | Kanzelhoehe | 44 |
| | Ramey | 24 |
| | Kislovodsk | 23 |
| | Helwan | 3 |
| | Ebro | 1 |
| | Kodaikanal | 1 |
| | SOHO/MDI | 1 |

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