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IDL-based Database of Solar Active Regions

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Abstract. A database on solar active regions has been implemented in IDL (Interactive Data Language). The observational parameters of the regions are stored in a multi-level structure array that is distributed as a standard IDL save file. Convenient access to the data is provided by an application equipped with a graphical user interface (GUI). A variety of search modes are implemented. Full-disk 17 GHz radio maps produced by the *Nobeyama Radioheliograph* provide the basis for the database.

1. Introduction

Researchers of solar activity often need to access solar active region data. Sources of such information include the *Solar Geophysical Data* bulletin and other periodical publications. Searching the printed publications requires substantial time and effort. Although it is possible to obtain these data using the Internet, gathering the data from several different data sources remains difficult.

A convenient alternative would be an "illustrated desk book on active regions", in a database form, placed in the researcher's computer and equipped with a means of searching for desired information as well as printing or saving it in a suitable form. Such a "desk book" should be accessed quickly, allow extraction of the data of interest, and should be easily supplemented and extended.

There is a variety of database file formats from which to choose, but some may be limited to particular platforms or are unfamiliar to the larger research community. We have chosen a widely used, platform independent software environment called Interactive Data Language (IDL[1]) which can save data into a machine-independent format (XDR). The IDL programming language ensures complete compatibility with various operating systems (MS Windows, Macintosh, several UNIX versions, and VMS). So far, we have created an IDL-based database on daily active region data from 1992 July 1 to 1994 December 31 (NOAA 7213 thru NOAA 7821)[2]. This database file has a size of 1 MB.

The database is better utilized when combined with daily full-disk radio maps for the same period. The maps were obtained at 17 GHz in total intensity and circular polarization by the *Nobeyama Radioheliograph* (Nishio et al. 1994) (the radio maps are in standard FITS format and occupy three compact disks[3]). A researcher can easily access the database including the radio maps that provide information on the location of the strong magnetic fields, filaments, prominences, and other solar features.

2. Structure of the database

The database is constructed as a multi-level IDL structure arranged into an array, with each element corresponding to a single day. The structure for each day contains: (1) a field with data relevant to the entire visible disk of the Sun and (2) an array of fields for each active region (space limited to 10 active regions per day). Such a structure ensures that each element of the database can be accessed in a logical and flexible manner.
The common field for each day's entry contains:

1. date and time of observation;
2. solar P and B_0 angles and its optical radius;
3. number of active regions visible on the disk;
4. the peak radio brightness temperature at 17 GHz and its location on the visible disk in both intensity and polarization.

The structure fields for the individual active regions contain:

1. NOAA number;
2. geocentric coordinates (offsets in arc seconds from disk center) and heliographic coordinates (longitude and latitude in degrees relative to the solar equator and meridian);
3. magnetic type (α, β, γ, δ configuration);
4. area (in millionths of disk area);
5. Carrington longitude;
6. characteristics of the leader and follower sunspots: coordinates, 17 GHz radio brightness temperature in intensity and polarization, sunspot magnetic field strength (from *Mount Wilson*).

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[1]IDL is the trademark of Research Systems, Inc.

[2]The *Yohkoh NOAA Active Region database* was used to locate the nominal position of each region.

[3]Daily radio maps produced by the *Nobeyama Radioheliograph* can be downloaded by anonymous ftp from `solar.nro.nao.ac.jp/pub/map`

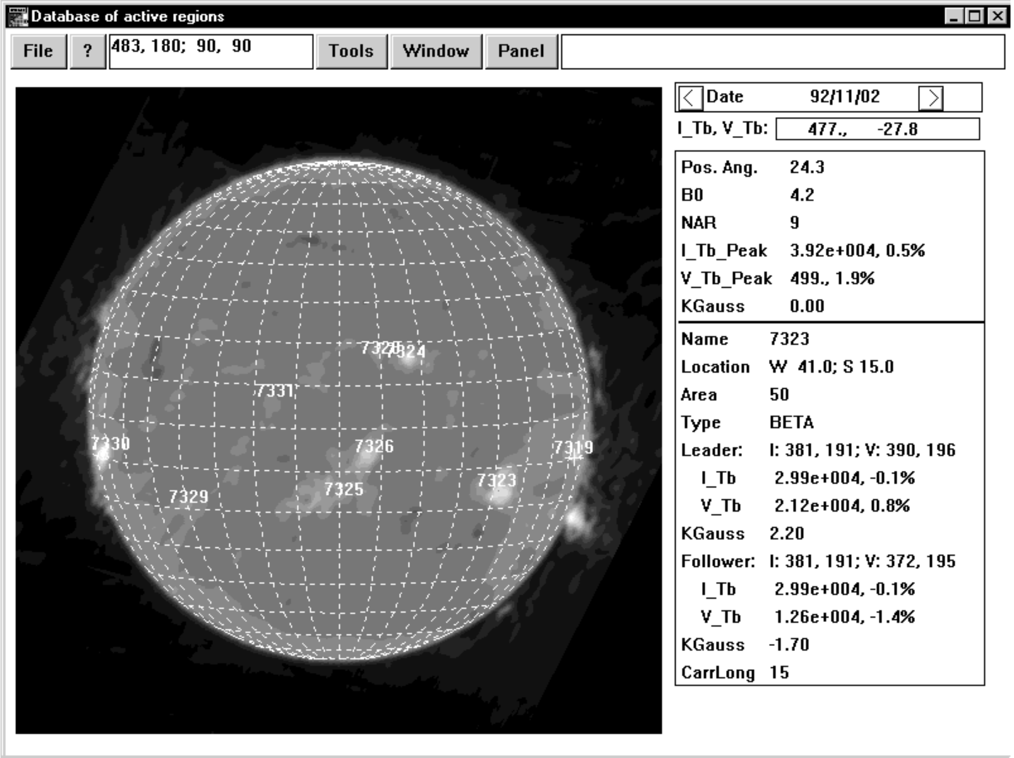

Figure 1. A screen dump of the database control program.

3. The database interface

The database interface is a GUI (Fig. 1), which provides convenient and efficient use of the database. The user can implement various search and selection modes and at the same time can view the Nobeyama 17 GHz radio maps in intensity and circular polarization (if these data are available). The figure shows a screen dump of the database control program. Screen dumps can be made in a graphical file (GIF format) or in a separate graphics window. Data matching a given criterion can be easily selected (e.g., via menu selections and entering values of interest). It is also possible to save data relevant to a selected date or active region into a text file.

In brief, the user has access to the following information:

- position of active regions and their NOAA numbers on the visible disk of the Sun for a selected date (a heliographical grid can be overlaid);
- data for the current date and for a selected active region (the selection is made with the mouse pointer);
- solar coordinates (heliographical and rectangular) under the mouse pointer and (if a radio map is displayed) brightness temperature;
- plots of area, latitude, brightness temperature, magnetic field for the leader and the follower sunspots of a selected active region during its passage across the solar disk, which can be plotted on the screen and saved into a file;

- possibility of viewing radio maps (if the FITS files containing data of the *Nobeyama Radioheliograph* are available) and zooming in to a selected part of the image.

The user can import and view text files and headers of FITS files in a scrollable window.

The program adjusts itself automatically to the resolution of the screen. It provides the user with the standard IDL tools for color table manipulation (e.g., **XLOADCT** routine).

It is also possible to expand the database and to correct or update existing data.

4. Implementation of the search engine and the GUI

The IDL search routine that we have developed is very flexible in setting search criteria. For example, one can search for data matching a given criterion, the absolute value of the criterion, or its inverse (e.g., all active regions except the matching ones).

The selection routine, **db_filter**, first obtains a subset database containing relevant data records, with structure identical to that of the entire database, then employs the IDL built-in function **WHERE** to return the array of indices of matching objects in the database. This implementation makes it possible to search for objects matching any criterion by means of a single procedure that is notable for its transparency and simplicity.

The GUI application is a standard widget-based interface constructed of several functions and procedures that are packaged into a single file (52 kB). This facilitates its installation and use. The program code has been tested successfully under Windows 95 and UNIX with IDL versions from 3.0.1 to 5.0.2. Further development of the application and the database is being planned so that it can accommodate other data, in particular, radio data from the Siberian Solar Radio Telescope (SSRT) (Smolkov et al. 1986).

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References

Nishio, M., et al. 1994, in Proc. of Kofu Symp., (NRO Report No. 360), ed. S. Enome & T. Hirayama, 19

Smolkov, G. Ya., Pistolkors, A. A., Treskov, T. A., Krissinel, B. B., & Putilov, V. A. 1986, Ap&SS, 119, 1