

HELAS: Local Helioseismology Data Website

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Abstract. The *Local Helioseismology Network Activity* is part of the European Helio- and Asteroseismology Network (HELAS). One aspect of the network activity is to collate multipurpose data sets and make them available to the community for local helioseismic analysis. The first stage of the project is underway whereby high quality and useful data sets have been selected and acquired. The HELAS *Local Helioseismology Network Activity* website at <http://www.mps.mpg.de/projects/seismo/NA4/> provides this data ready to download. Furthermore, the data is supplemented with relevant documentation necessary for further analysis, including details about the data reduction process that has already been applied. The data primarily consists of Doppler velocity observations but also includes observations of the line-of-sight magnetic field, vector magnetic field measurements, intensity and travel time maps. The website will be continuously updated with data thereby providing convenient access to comprehensive data sets appropriate for use in local helioseismology.

1. About this Website

The HELAS *Local Helioseismology Network Activity* website, at <http://www.mps.mpg.de/projects/seismo/NA4/>, is a junction where knowledge, data, data analysis tools and modeling tools related to local helioseismology may be shared. The first stage is currently being implemented - high quality observational data has already been selected and made available to download. In addition, information required to handle the data and supplementary observations, besides the Doppler velocity maps which are specifically used in helioseismology, are supplied. Therefore, these data sets are the most comprehensive, easily accessible and useful data for local helioseismology obtainable. The auxiliary information provided on the website is aimed at professionals already studying helioseismology as well as newcomers to the field.

2. The Observational Data

The oscillations of the solar surface are measured using the Doppler shift of solar spectral lines. Currently, the Doppler velocity data available from the website hails from three sources: the Magneto Optical filters at Two Heights (MOTH) [1] instrument, the Solar and Heliospheric Observatory's Michelson Doppler Imager (SOHO-MDI) [3] and the Global Oscillations Network Group (GONG) [2] observations. The particular data sets available were chosen because they are high quality observations.

The most complete data set available on the website is 'AR9787', featuring a full MDI data set of Doppler velocity, line-of-sight magnetic field and intensity observations as well as Solar Flare Telescope (SFT) vector magnetograms of active region (AR) 9787. This sunspot was selected

because it is the best example of a “theorist’s” sunspot to date with minimal evolution over a long observational period (nine days). The evolution of the active region (or lack, thereof) is evident in the quick look movies of the line-of-sight intensity, magnetic field and Doppler velocity. The size of the umbra and penumbra, images of the radial moat flow, potential field extrapolations and a farside image give a comprehensive overview of the active region. In addition to the observations the active region’s Zurich-Macintosh classification, disk position, area and type are presented for each day so that there is a quantitative measure of the magnetic development of the spot. Each data set will have auxiliary information continuously added to provide a thorough overview.

In addition to the AR9787 data set, other data sets available for download are:

- GONG data from two entire Carrington rotations (CRs), CR1988 and CR2024;
- 35 hours of MDI Doppler velocity, line-of-sight magnetic field and intensity observations of AR8558 with a large region of nearby quiet Sun;
- 56 hours of MDI Doppler velocity measurements and the SFT vector magnetograms of AR9236 which is a large, complex sunspot;
- 8 hours of high-resolution MDI Doppler velocity, intensity and magnetic field data of three sunspots close together in AR8403 and AR8402;
- 4 hours of quiet Sun MDI high-resolution Doppler velocity observations;
- 17 hours of MOTH Doppler velocity observations in different spectral lines K, Na and Ni;
- travel time maps of 7 sunspots calculated from MDI observations.

The observational data available from the website covers a range of interesting local solar phenomena.

3. How to Access the Data

On the website, an overview of the data sets available is presented in a table format (Figure 1). For each data set, the table lists the name, a quick look image typical of the data, a description of the observational feature (for example, a sunspot), as well as the time and duration the observing took place. Links to AR maps and CR maps represent a contemporaneous quick look of the magnetic nature of the entire observed solar disk. The pixel size and resolution of the data indicate the surface area covered by the observation. The items in the *Type* column (that is, the observing method and which was the observing instrument) provides a direct link to the data download directories (Figure 2). A `README` text file in each data directory describes what each file in that directory contains. These directories list the name of the data, the size of the data and when it was made available. It is requested that if data is used in publications that it be duly acknowledged and the user must inform HELAS personnel which helps to keep track of how and by whom the data is used. The last column of the table links to pages of more in depth information about the data sets.

The 880 GB of data are stored in FITS format and this website links to the FITS format webpage to familiarise newcomers. These FITS files are stored predominantly as ‘datacubes’ - a collection of two dimensional observations bundled together and sequenced in time with a header. This makes the first two sides of the ‘cube’ spatial and the third temporal. FITS files have headers attached to the image which hold the technical details of that particular observation as well as important information regarding the observation and subsequent reduction. The headers consist of a list of keywords with associated values. The definitions of the relevant FITS keywords which are necessary for further analysis of the data are given on the website. These keywords include the exact time, duration, central coordinates of the observation, as well as the size of the data.



Max Planck Institute for
 Solar System Research



European Helio- and Asteroseismology Network (HELAS)

Local Helioseismology Network Activity



Data Download

The data provided on this page must be acknowledged appropriately. Please contact us (schunker@mps.mpg.de or gizon@mps.mpg.de) to obtain the necessary acknowledgement for the data you use.

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Name	Quick Look	Description	Type	Time	AR	Size/Res.	Extra Information
AR9787		A relatively large, isolated sunspot. This data is ideal for helioseismic analysis of a sunspot as it is not polluted by any nearby strong active regions.	MDI, I(fd) , V(fd) , M(fd) inc. Vec. Mag. , SFT Vec. Mag.	20.01.2000-28.01.2000 (24x9 hrs)	Solar Monitor images of AR9787	512x512x1440 pix (9) 0.12 deg/pix	Extra info
CR1988		16 x 16 degree tiles at various lat/lon 30 March 2002 - 26 April 2002	GONG, V	28.03.02-27.04.02	Carrington Rotation map	128x128 pix 0.125 deg/pix	Extra info
CR2024		16 x 16 degree tiles at various lat/lon 5 December 2004 - 2 January 2005	GONG, V	04.12.2004-04.01.2005	Carrington Rotation map	128x128 pix 0.125 deg/pix	Extra info
AR8558		Nice 256 x 512 pix data with a sunspot and plenty of quiet sun useful for comparison analysis	MDI, V(hr) , M(fd) , I(fd)	02.06.1999 (35 hrs)	Solar Monitor images of AR8558	512 x 256 x 2100 pix 0.068 deg/pix	Extra info
AR9236		A large complex sunspot in high-resolution.	MDI, V(hr) , SFT Vec. Mag.	22.11.2000-24.11.2000 (56 hrs)	Solar Monitor images of AR9236	512 x 512 x 3360 0.068 deg/pix	Extra info
AR8403, AR8402		MDI Data of three sunspots in AR 8403, 8402 close together	MDI, I(hr) , V(hr) , M(hr)	06.12.1998 (8 hrs)	Solar Monitor images of the three sunspots	512 x 256 x 480 pix 0.068 deg/pix	Extra info
Quiet Sun		Quiet Sun region (with a hint of AR8116 in top left)	MDI, I(hr) , V(hr) , M(hr)	07.12.1997 (4 hrs)	Active region map	900 x 500 x 240 pix 0.068 deg/pix	Extra info
South Pole Data		MOTH data from South Pole observations. Different heights of the atmosphere, K, Na, Ni.	MOTH, K , Na , MDI Ni	20.01.2003 (~17 hrs)	Active region map	123 x 123 x 6416 pix 0.3089 deg/pix	Extra info
Travel Time Maps		Travel time maps of AR7973, 8038, 9056, 9138, 9142, 9779	MDI, V , travel time , sound speed inversions	512 minutes each	Active region maps	128 x 128 x 512 pix 0.125 deg/pix	Extra info

The data are stored as [FITS](#) files.

Figure 1. The HELAS local helioseismology data table describing the data that is available. The menu links to the HELAS Local Helioseismology Network Activity homepage, *Outreach*, *Data* and *Links*. Each of these has drop-down sub-menus which appear when the cursor rolls-over the menu item.

4. Auxiliary Information Provided

The observational data available from this website has been reduced from the raw instrument data. This makes the data immediately ready to analyze and of a size more convenient to handle. Local helioseismology usually uses ‘local’ regions of the Sun that are much smaller than the whole solar disk and these regions are observed over at least a few hours. To achieve this, specified coordinates are ‘tracked’ through time by following them in a frame co-rotating with the Sun. The regions are also ‘mapped’ where the solar surface is projected onto a plane. Generally, the central coordinates for the mapping coincide with the central coordinates of the tracked area. For example, when studying a sunspot, the centre of the sunspot is most conveniently defined to be at the centre of the tracking and mapping. This keeps the sunspot close to the middle of the

Index of /projects/seismo/data/AR9787/V

Name	Last modified	Size	Description
 Parent Directory			-
 READ_ME	13-Feb-2007 10:47	174	
 TrkV_020120.tar.gz	12-Jan-2007 14:22	470M	
 TrkV_020121.tar.gz	12-Jan-2007 14:23	538M	
 TrkV_020122.tar.gz	12-Jan-2007 14:23	542M	
 TrkV_020123.tar.gz	12-Jan-2007 14:24	542M	
 TrkV_020124.tar.gz	12-Jan-2007 14:24	542M	
 TrkV_020125.tar.gz	12-Jan-2007 14:25	545M	
 TrkV_020126.tar.gz	12-Jan-2007 14:25	546M	
 TrkV_020127.tar.gz	12-Jan-2007 14:26	533M	
 TrkV_020128.tar.gz	12-Jan-2007 14:26	442M	

Figure 2. A data directory showing the name of the files, the date they were uploaded and the size. From here downloading data simply requires clicking on the item. This is the download directory for AR9787 mapped and tracked Dopplergrams.

resulting spatial images for all of the reduced observations, providing the sunspot itself does not move too much locally. This is typical of the observational data provided on the website and it is necessary to understand the procedures to further work with the data. Solar rotation, the importance of tracking and mapping, links to the associated mathematics, and visual descriptions of commonly used projections are outlined on the website. In addition, instructions on how to use specific programs which perform the tracking and mapping are supplied. Routines to calculate maps of the corresponding solar longitude and latitude coordinates of the projected data are also available.

In addition to the data reduction procedure, information about the observational features are also provided. In particular, there is information about sunspot classification, the solar environment, solar coordinate definitions, and ephemeris calculations, similar to that of AR9787 which was discussed previously.

The website links directly to related data catalogues where science level data may be obtained by request: the MDI data request webpage (Stanford-Lockheed Institute for Space Research and Solar Oscillations Investigation - NASA), the sunquake database (Monash University), vector magnetogram catalogues from the Solar Flare Telescope (National Astronomical Observatory of Japan) and the Haleakala Stokes Polarimeter (Mees Solar Observatory, University of Hawaii), the GONG (National Solar Observatory) data request webpage and the Solar Monitor daily solar data webpage (NASA - Solar Data Analysis Centre). These links are helpful to garner more information related to the data provided on the website or to request complimentary data to that provided by HELAS.

5. Future Stages

The provision and accessibility of these data sets and associated relevant information provided by this website means that there are comprehensive helioseismic data sets readily available for analysis. We intend to provide a more varied data selection by obtaining data from other resources, such as the Taiwan Oscillations Network, and including observations of other features,

such as observations of an active region associated with a sunquake and of an emerging active region. The next stage of the HELAS local helioseismology network activity is to collate data analysis tools suitable for local helioseismology and make them available from the website. Further in the future, models and modeling tools will also be added.

Please contact Hannah Schunker (schunker@mps.mpg.de) if you have anything to contribute.

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References

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