

# The FITS database of Nobeyama Radio Polarimeters (NoRP)

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Dear all,

The original raw data of Nobeyama Radio Polarimeters (NoRP<sup>1</sup>) are stored with the distinctive format and can be read only using the IDL (Interactive Data Language) with the SSW (SolarSoftWare). From the point of view of the persistency of NoRP data, it was not an allowable situation. To change it, we create the FITS files of the NoRP data and store the files in this FTP/Web site<sup>2</sup>. A FITS file in the database is constructed from the Primary Header Unit (PHU) and binary extension and includes the following data with 1, 2, 3.75, 9.4, 17, 35, and 80 GHz obtained in a day<sup>3</sup>.

- ✓ Stokes-I, and Stokes-V fluxes calibrated automatically (Unit: SFU)
- ✓ Raw data (Stokes-I, Stokes-V)
- ✓ Time series of the calibration-scans indicators (Sun, Sky, Amb, Zero)
- ✓ Time series of the attenuation level
- ✓ Values for the automatic calibration (Sky, Amb, Zero)
- ✓ The daily fluxes with 1, 2, 3.75, and 9.4 GHz calculated manually (in PHU)

Except for the daily fluxes, all data are stored on the binary extension. The details of FITS header of NoRP FITS files are described in the tables at the end of the documents. The summary plots of the FITS file can be seen on the web page<sup>4</sup>.

The FITS database includes the NoRP observing data obtained since 1 June 1994. The FITS files are stored in the "Month" directory under the "Year" directory. The "TFCL" directory includes the FITS files that the automatic calibrations with all observing frequencies are failed. Even when the automatic calibration is succeeded, the calibrated data contains the influences of the interference, weather condition, and

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<sup>1</sup> NoRP website: <https://solar.nro.nao.ac.jp/norp/index.html>

<sup>2</sup> <ftp://solar-pub.nao.ac.jp/pub/nsro/norp/fits>

<sup>3</sup> While the start and end times of NoRP observations vary in season, most observation starts around 22:00UT and ends around 7:00UT. The filename of the FITS files includes the date, but it is the date of the start time in Japan Standard Time (UTC+9), not in UT.

<sup>4</sup> [https://solar.nro.nao.ac.jp/norp/html/fits\\_png\\_q1/](https://solar.nro.nao.ac.jp/norp/html/fits_png_q1/) The plots show the time profile of the calibrated Stokes-I and Stokes-V fluxes with all observing frequencies in a day.

instrument troubles. So, please consider such effects, especially when you obtain the total solar flux at non-flare. In higher frequencies (17, 35, 80 GHz), the weather condition affects strongly. Hence, it is impossible to get the solar fluxes with the frequencies at a non-flare time. On the other hand, the files in the "TFCL" directory store the raw data that includes the value at the calibration scans (Sun, Sky, Amb, Zero). Therefore, we might be able to calibrate the data manually.

The daily fluxes with 1, 2, 3.75, and 9.4 GHz stored in the PHU can be used to indicate the instrument's condition. If the daily flux does not exist in the PHU (or the value is -10000), we recommend not using the data with the observing frequency.

We also provide the Python library<sup>5</sup> for reading the NoRP FITS files.

We adopt an open data use policy for scientific and educational purposes. Please be sure to acknowledge the use of NoRP data as follows.

in footnote or acknowledgement

- The Nobeyama Radio Polarimeters (NoRP) are operated by Solar Science Observatory, a branch of National Astronomical Observatory of Japan, and their observing data are verified scientifically by the consortium for NoRP scientific operations<sup>6</sup>.
- Facility keywords can be added in the journal articles published by the American Astronomical Society. The facility keyword for the Nobeyama Radio Polarimeters is "NoRP". For details please see the web site of the American Astronomical Society: AAS Facility Keywords.

Please enjoy the NoRP data!

Best regards,

Masumi Shimojo

as the manager of the NoRP operation since April 2019

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<sup>5</sup> [https://solar.nro.nao.ac.jp/norp/Python/norp\\_fits.py](https://solar.nro.nao.ac.jp/norp/Python/norp_fits.py)

<sup>6</sup> The participated institutes in the consortium for NoRP scientific operations.

- Astronomical Observatories, Graduate School of Science, Kyoto University
- Department of Science, Ibaraki University
- Institute for Space-Earth Environmental Research, Nagoya University
- Space Environment Laboratory, National Institute of Information and communications technology
- Solar Science Observatory, National Astronomical Observatory of Japan

## The details of the NoRP FITS header

Note: The following tables include only specific keywords for NoRP, and the standard keywords of the FITS format are not included.

### The keywords in the Primary Header Unit (PHU)

FREQ1	Indicate the existence of 1 GHz data
DAILYF01	1 GHz daily flux calculated manually [SFU]
FREQ2	Indicates the existence of 2 GHz data
DAILYF02	2 GHz daily flux calculated manually [SFU]
FREQ3	Indicates the existence of 3.75 GHz data
DAILYF04	3.75 GHz daily flux calculated manually [SFU]
FREQ4	Indicates the existence of 9.4 GHz data
DAILYF09	9.4 GHz daily flux calculated manually [SFU]
FREQ5	Indicates the existence of 17 GHz data
FREQ6	Indicates the existence of 35 GHz data
FREQ7	Indicates the existence of 80 GHz data

### The values of the “TTYPEn” keyword in the binary extension

Time	Time from 00:00:00UT, 1 January 1979 [unit: sec]
DVal_xGHz	Indicating the data is valid (1) or not (0)
CalI_xGHz	Calibrated Stokes-I flux [unit: SFU]
CalV_xGHz	Calibrated Stokes-V flux [unit: SFU]
RawI_xGhz	Stokes-I Raw data
RawV_xGHz	Stokes-V Raw data
Cal_xGHz	Time series of the calibration-scans indicators 0: Sun, 1: Sky, 2: AMB, 4:Zero
ATT_xGHz	Time series of the attenuation level
CalD_xGHz	Values for the automatic calibration (Sky, Amb, Zero)
SQLD_80GHz	The data obtained Square-Law Detector (80 GHz only)

”x” indicates the observing frequency (1, 2, 4 [=3.75], 9 [=9.4], 17, 35, and 80).