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1. **Nature:** R = Report, P = Prototype, D = Demonstrator, O = Other

2. **Dissemination level:**

PU

Public Restricted to other programme participants (including the Commission Service)

PP

RE

Restricted to a group specified by the consortium (including the Commission Services)

CO

Confidential, only for members of the consortium (excluding the Commission Services)

Executive Summary / Abstract:

The MASER (Measuring, Analysing and Simulating Emissions in the Radio range) service is proposing a toolbox for low-frequency radio astronomy [1]. At the beginning of the Europlanet 2024 Research Infrastructure project, the service was a prototype. It is an official SNO (Service National d’Observation) approved by CNRS/INSU (Institut National des Sciences de l’Univers) since November 2021. As such it is supported by PADC (Paris Astronomical Data Centre) in Observatory of Paris. Thanks to Europlanet 2024 RI/VESPA, we have been able to publish, to date, 7 data collections, 6 supplementary materials associated with publications, 6 event catalogues, 3 journal articles and 5 software tools.

1	MASER data management plan	3
2	Tools and Papers	3
	a) Jupiter-Probability-Tool	3
	b) Time-Frequency Catalogue format and library	3
	c) LESIA-Mag_IDL: LESIA Planetary Magnetic Field	3
3	New Data Collections	3
	a) Space missions (STEREO, WIND, Juno).....	4
	b) Ground observatories (Nançay).....	4
4	Supplementary material for papers.....	4
5	New Catalogues	5
	References.....	5

1. MASER data management plan

The MASER project has set up a DMP (Data Management Plan) based on the [EPN2024RI/VESPA individual DMP](#). Each collection has its own DMP, which describes the collection, as well as its access interfaces, such as the *EPN-TAP* table, as well as the *das2* streaming interface, when available. The release of the MASER collections consists in three steps, making the MASER data collection FAIR:

1. Release of the data, with a DOI and a landing page, including data description and link to data specification: the data is *accessible*, *citable* and *reusable*;
2. Then, publishing of the *EPN-TAP* interface on the [voparis-tap-maser.obspm.fr](#) or [vogate.obs-nancay.fr](#) servers: making the data *findable* and *interoperable*;
3. Finally, setting up the *das2* interface, together with a reader module in the *maser.data* Python library: making the data more *accessible* and *reusable*.

All the collections presented in this report have passed stage 1. Some of them have passed stage 2 (or are being reviewed). The MASER *das2* are currently being redeployed with a newer version of the software, hence they are not available at the time of writing.

EPN-TAP service descriptors are all maintained on <https://voparis-gitlab.obspm.fr>

2. Tools and Papers

a) Jupiter-Probability-Tool

The [Jupiter-Probability-Tool](#) online application (Aicardi et al, 2022) is a science-ready tool for preparing and analysing Jupiter radio observations. It has been developed with the support of Europlanet 2024 RI (Cecconi et al 2023b, in press).

b) Time-Frequency Catalogue format and library

The MASER team has developed a new catalogue format dedicated to storing, annotating and sharing features identified in low frequency radio spectrograms. The specification of the Time-Frequency Catalogue (TFCat) has been published (Cecconi et al, 2022b). Software libraries have been developed to create, update and display TFCat feature catalogues: the TFCat python module (Cecconi et al. 2023a) and the SPACE Labelling Tool (Louis et al, 2022). A validator for TFCat has been implemented into STLITS, thanks to the support of Europlanet2024 RI to M. B. Taylor (Univ. Bristol).

c) LESIA-Mag_IDL: LESIA Planetary Magnetic Field

The LESIA-Mag_IDL set of routines have been developed in the frame of the MASER team service to provide magnetic field modelling to the MASER users. It has been updated twice in the course of the EPN2024RI project [Cecconi et al 2021, 2022a].

3. New Data Collections

New data collections have been implemented in MASER since the beginning of the Europlanet2024 RI project. Seven collections have been published (see below)

a) Space missions (STEREO, WIND, Juno)

- Bonnin, X., Q.N. Nguyen, B. Cecconi, L. Debisschop, & M. Maksimovic (2023). STEREO/Waves/LFR-HFR L2 Data Collection (Version 1.0) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/bw9r-n353>
 - EPN-TAP: http://voparis-tap-maser.obspm.fr/browse/stereo_waves/epn
- Krupar, V., Q.N. Nguyen, X. Bonnin, B. Cecconi & M. Maksimovic (2022). STEREO/Waves/LFR-HFR L3 DF Data Collection (Version 1.0) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/4TAK-5225>
 - EPN-TAP: http://voparis-tap-maser.obspm.fr/browse/stereo_waves/epn
- Louis, C.K., P. Zarka and B. Cecconi (2021). Juno/Waves estimated flux density Collection (Version 1.0) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/6jg4-mk86>
- Waters, J.E., B. Cecconi, C. M. Jackman, D. K. Whiter, X. Bonnin, L. Lamy & K. Issautier (2021). Wind/Waves flux density collection calibrated for Auroral Kilometric Radiation (Version 1.0) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/wxv0-vr90>
 - EPN-TAP: http://voparis-tap-maser.obspm.fr/browse/wind_waves/q

b) Ground observatories (Nançay)

- Lamy, L., G. Kenfack, P. Zarka, B. Cecconi, C. Viou, P. Renaud, F. Jacquet, A. Loh, L. Denis, A. Coffre. (2021). Nançay Decameter Array (NDA) Jupiter Juno-Nançay data collection (Version 1.0) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/PBPE-BF82>
- Lamy, L., A. Le Gall, B. Cecconi, A. Loh, P. Renaud, L. Denis, A. Coffre, P. Zarka, & A. Lecacheux. (2021). Nançay Decameter Array (NDA) Jupiter Routine observation data collection (Version 1.7) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/DV2F-X016>
 - EPN-TAP: <http://vogate.obs-nancay.fr/browse/nda/q>
 - das2: <https://das2server.obs-nancay.fr/das2/server>
- Lamy, L., A. Le Gall, B. Cecconi, A. Loh, P. Renaud, S. Masson, L. Denis, A. Coffre, P. Zarka, & A. Lecacheux. (2021). Nançay Decameter Array (NDA) Solar Routine observation data collection (Version 1.7) [Data set]. PADC.
 - DOI: <https://doi.org/10.25935/ZZV2-PE64>
 - EPN-TAP: <http://vogate.obs-nancay.fr/browse/nda/q>
 - das2: <https://das2server.obs-nancay.fr/das2/server>

1 Supplementary material for papers

The MASER service also hosts supplementary material for papers published within the scope of the service.

- Cecconi, B., C. K. Louis, C. Muñoz & C. Vallat. (2021). Jovian Auroral Radio Source Occultation Modeling and Application to the JUICE Science Mission Planning. Supplementary Material: Galileo Flybys (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/8ZFF-NX36>
- Fogg, A. R., C. Jackman, J. E. Waters, X. Bonnin, L. Lamy, B. Cecconi, K. Issautier, C. K. Louis (2021). Bursts of Auroral Kilometric Radiation individually selected from Wind/WAVES data (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/HFJX-XX26>

- Lamy, L., Cecconi, B., & Aicardi, S. (2022). Collection of Jovian Radio Emission Probability and Occurrence Maps (Version 1.0). PADC/MASER. <https://doi.org/10.25935/1ZBG-EK27>
- Lamy, L., S. Yerin, P. Zarka, B. Cecconi, J. N. Girard & J.-M. Griessmeier (2021). Determining the beaming of Io decametric emissions, a remote diagnostic to probe the Io-Jupiter interaction. Supplementary material : NenuFAR Data (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/E556-GM25>
- Wu, Siyuan, P. Zarka, L. Lamy, C. K. Louis, S. Y. Ye, R. Prangé, B. Cecconi, & W. S. Kurth (2023), What can be deduced from the High Frequency Limit of Saturn's Kilometric Radiation. Supplementary material (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/dz99-s514>
- Zarka, P. & B. Cecconi (2022). Solar System Low Frequency Radio Spectra (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/YAWF-AF18>

2 New Catalogues

The TFCat specification has been used in several event catalogue publication, as listed below.

- Cecconi, Baptiste, L. Debisschop, L. Lamy (2021). A catalogue of Jovian decametric radio observations from January 1978 to December 1990 (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/1FQM-FS07>
- Louis, C.K., P. Zarka and B. Cecconi (2021). Catalogue of Jupiter radio emissions identified in the Juno/Waves observations (Version 1.0) [Data set], PADC, <https://doi.org/10.25935/nhb2-wy29>
- Taubenschuss, U., Cecconi, B., & Lamy, L. (2021). Catalogue of Faraday Rotation patches identified in Saturn Kilometric Radiation (SKR) observations by Cassini/RPWS/HFR (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/R11G-6J63>
- Wu, Siyuan, Shengyi Ye, G. Fischer, Jian Wang, Minyi Long, J. D. Menietti, B. Cecconi & W. S. Kurth (2021). Statistical Study of Spatial Distribution and Polarization for Saturn Narrowband Emissions. Supplementary material : Event catalogue (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/ZMMZ-CA38>
- Wu, Siyuan, Philippe Zarka, Laurent Lamy, Ulrich Taubenschuss, Baptiste Cecconi, Shengyi Ye, Georg Fischer (2022). Catalogue of First Harmonic Saturn Kilometric Radiation Observations during Cassini's Grand Finale (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/T033-QS72>
- Wu, Siyuan, Shengyi Ye, Georg Fischer, Ulrich Taubenschuss, Caitriona Jackman, Elizabeth O'Dwyer, William Kurth, S. Yao, Z. H. Yao, J. Douglas Menietti, Y. Xu, M. Y. Long, Baptiste Cecconi (2022). Saturn Anomalous Myriametric Radiation, A New Type of Saturn Radio Emission Revealed by Cassini. Supplementary material: Catalogue of events (Version 1.0) [Data set]. PADC. <https://doi.org/10.25935/8MAY-4320>

References

1. Aicardi, S., B. Cecconi & L. Lamy (2022). Jupiter Probability Tool (Version 1.0) [Interactive resource]. PADC. <https://doi.org/10.25935/TV9M-HX48>
2. Cecconi, B., Loh, A., Sidaner, P. L., Savalle, R., Bonnín, X., Nguyen, Q. N., et al. (2020). MASER: A Science Ready Toolbox for Low Frequency Radio Astronomy. Data Science Journal, 19(18), 1062. <https://doi.org/10.5334/dsj-2020-012>
3. Cecconi, B., Louis, C. K, Lamy, L., Zarka, P., & Hess, S. L G. (2021). LESIA-Mag_IDL: LESIA Planetary Magnetic Field IDL computing scripts (V1.0). Zenodo. [doi:10.5281/zenodo.7234785](https://doi.org/10.5281/zenodo.7234785)

4. Cecconi, B., Louis, C. K, Lamy, L., Zarka, P., & Hess, S. L G. **(2022a)**. LESIA-Mag_IDL: LESIA Planetary Magnetic Field IDL computing scripts (V1.1). Zenodo. [doi:10.5281/zenodo.7235424](https://doi.org/10.5281/zenodo.7235424)
5. Cecconi, B., M. B. Taylor, X. Bonnin, A. Loh. **(2022b)**, JSON Implementation of Time-Frequency Radio Catalogues: TFCat (Version 1.0). PADC. <https://doi.org/10.25935/6068-8528>
6. Cecconi, B., Louis, C.K., Bonnin, X., Loh, A., and Taylor, M.B. **(2023a)**, Time-frequency catalogue: JSON implementation and python library. Front. Astron. Space Sci. 9:1049677. <https://doi.org/10.3389/fspas.2022.1049677>
7. Cecconi, B., S. Aicardi & L. Lamy **(2023b)**. Jupiter Radio Emission Probability Tool. Front. Astron. Space Sci., 9:1091967. <https://doi.org/10.3389/fspas.2022.1091967> (in press)
8. Louis, C.K, Jackman, C.M. Mangham, S, Smith, K. O'Dwyer, E., Empey, A., Cecconi, B. Boudouma, A., Zarka, P. and Maloney, S. **(2022)**. The "SPectrogram Analysis and Cataloguing Environment" (SPACE) labelling tool. Front. Astron. Space Sci., 9:1001166. <https://doi.org/10.3389/fspas.2022.1001166>