



H2020-INFRAIA-2019-1

Europlanet 2024 RI has received funding from the European Union's Horizon 2020 Research and Innovation Programme under

Grant agreement no: 871149

Deliverable D6.2

Deliverable Title: VESPA VA 2nd Year Report
Due date of deliverable: 31st January 2022
Nature¹: Report
Dissemination level²: Public
Work package: WP6
Lead beneficiary: OBSPARIS
Contributing beneficiaries:
Document status: Final

Start date of project: 01 February 2020
Project Duration: 48 months
Co-ordinator: Prof Nigel Mason

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

2. **Dissemination level:**

PU	PP	RE	CO
Public	Restricted to other programme participants (including the Commission Service)	Restricted to a group specified by the consortium (including the Commission Services)	Confidential, only for members of the consortium (excluding the Commission Services)

Executive Summary / Abstract:

An update for year 2 of the Virtual European Solar and Planetary Access (VESPA) Virtual Activity of the Europlanet 2024 Research Infrastructure is provided. Consolidation and sustainability were the main focus during the second year of the project, with the EPN-TAP protocol finalized and nearly accepted as an international IVOA standard, a major upgrade of the reference data server, the publication of an EPN-TAP service validator, and the storage of most existing services in a single GitLab repository. In addition, 5 new services were published, ~ 15 ones drafted, and many existing services updated to the new standard. Both SSHADE and PVOL enlarged their content significantly, with addition of spectral bandlist to SSHADE and Juno data to PVOL.

A combined workshop was held online in Nov/Dec 2021 to replace the first two workshops scheduled in the programme, with 4 external teams selected. Documents and tutorials were written or updated in this occasion. Two papers have been published, and many presentations given in international conferences and workshops.

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1. Explanation of VESPA WP6/VA2 Work & Overview of Progress

a) Objectives

Task 1.

- Coordination — ObsParis, JacobsUni + CBK-PAN

Task 2.

- Enlarging VO content (beneficiaries) – BIRA/IASB, ObsParis + All
- Design and implementation of services from beneficiaries

Task 3.

- Enlarging VOcontent– JacobsUni, OeAW/IWF + CBK-PAN, ObsParis, CNRS/IRAP
- Design and implementation of services from calls to the community (external AO) and collaborations

Task 4.

- Amateur community linking / services – UPV/EHU, OeAW/IWF + ObsParis
- Design and implementation of selected services from the amateur astronomy community

Task 5.

- Consolidation – INAF/OATs, Heidelberg Uni + ObsParis
- A system to preserve data service definition files, perform technical reviews, and deploy them on EOSC when relevant

Task 6.

- Standards & Sustainability – ObsParis, Heidelberg Uni + JacobsUni, Bristol Uni
- Publication of VESPA standards, contribution to other standards of interest, dissemination through consortia and conferences

b) Explanation of the work carried in WP

The present report is the second deliverable of WP6 VESPA VA (D6.2).

The schematic VESPA infrastructure is summarized in Fig. 1 of the VESPA JRA 2nd Year Annual Report (D7.2) section to help follow this discussion.

Task 1.

Task 1 is responsible for overall coordination and management of the VA and connection with the JRA.

Coordination of the two VESPA WPs has focused on maintaining discussions in smaller groups during year 2, and writing an exaggerated number of reports.

Deliverables and milestones are linked from this page:

<https://voparis-wiki.obspm.fr/display/VES/Deliverables+and+milestones%2C+EPN2024>

The VESPA Confluence site also contains extensive material about the WP activity.

Task 2.

- New data services were published by VESPA beneficiaries during year 2:
 - Mars_craters_Lagain (revised catalogue of Martian craters)
 - spectro_asteroids (direct access to asteroids spectra from VizieR)

- (MS25 and MS99) Vizier_planeto (table of VizieR catalogues relevant for Planetary Science and exoplanets)
 - PlanMap (geological maps from the PlanMap H2020 programme)
 - (MS 72, much in advance) Exotopo (simulations of exoplanetary surfaces)
- There are currently 59 services online. Other are pending publication.

• In addition to services with evolving content, many older services from beneficiaries were updated or upgraded during year 2. These include:

- PVOL (now including JunoCam data) (will be MS65)
- BASS2000 (composite solar database from several observatories)
- HELIO catalogues of solar features (from the FP7 programme; now with footprints)
- HST_planeto (HST planetary data; entirely rebuilt)
- Titan_profiles (atmospheric profiles from Cassini CIRS; content x 2.5)
- SPICAM and Mars Climate Database (atmospheric profiles from Mars-Express and simulations; improved links and additional scenarios) (will be MS68 and MS78)
- Basecom (entirely rebuilt, with 15 more years of comet observations at Nançay radio telescope)
- All services in CNRS/IRAP (Toulouse) have been modernized (will include MS64)

• New services have been drafted, including:

- Mars GEM-Mars Global Circulation Model (will be D6.3)
- Mars pre-Tharsis topography (will be MS69)
- Extension of MCD data to atmospheric dust content (will be included in MS78)
- Global classification maps of Mercury (will be MS66)
- Services at CBK/PAN (will be MS70)
- Venus Global Circulation Model (will be part of MS82)

Finally, about 30% of existing EPN-TAP services have been updated and made compliant with the coming version of the EPN-TAP standard and recent evolutions of the DaCHS server (including update to python 3). This is especially important at ObsParis to switch to a recent version of the 3 servers in use.

• SSHADE hosted more than 50 new datasets and over 1000 additional spectra during year 2, many provided by the 23 SSHADE partners. The SSHADE database now provides public access to 4400+ spectra of ices, minerals, rocks, organic matters and cosmomaterials. Extensions of the types of data (multi-angles spectra, BRDF, etc) and improvements in the user interface, in particular in the dynamic plotting tool, have been implemented.

(MS38) A new database and its tools and interface to store, search, and display absorption and Raman band lists and bands of solids (from VUV to far-IR) has been developed and published on-line, including more than 25 band-lists of ices, solid nitriles and minerals (carbonates) and over 750 bands. Following a SSHADE virtual meeting with the eight new partners from Finland, Greece, Italy, France, Brazil, Canada, and China, three-day training sessions have been conducted for 16 partners' database managers and data providers, to allow them to create and fill their SSHADE database.

During the first two years of the Project, LMSU secured an additional 9,941,823.22 Rubles (115,548.59 Euros) to spend on VESPA project activities from sources external to the Europlanet 2024 RI project, and has been awarded an additional 3 years funding for 2021-2023 (with approximately the same total funding per year).

Task 3.

A combined Implementation Workshop has been organized to replace the 2020 and 2021 workshops initially scheduled. It has been held online from Nov 29 to Dec 2, 2021 with follow-on sessions running until the end of January 2022.

35 people attended, including teams from the USA, Poland, and Romania.

A call for contributions was opened in August 2021, from which 4 projects were selected:

- several assessment projects from the NASA/PDS Planetary Plasma Interaction Node (PPI), represented by UCLA and Iowa University.
- The MOVIS project from the Bucharest Observatory (asteroid colour measurements from the VISTA telescope).
- asteroids images and shape models from LAM in Marseille (from SPHERE on the VLT)
- several solar projects from the Royal Observatory of Brussels (sunspot and coronal holes catalogues), in connection with the ESCAPE programme.

In addition, other projects were advanced during the workshop:

- The MP3C service in OCA, Nice (global properties of asteroids) (from previous contacts)
- Several solar services from IRAP in Toulouse (including observations at Pic du Midi)
- Project from the ML WP: MESSENGER magnetometer data at LMSU in Moscow
- Test project from VU in Amsterdam, related to lab and field data production by EPN 2024 RI TA visits.

Other services have been published during year 2 from external collaborations, including:

- GAIA_DEM at IAS, Orsay/France (solar maps from the SDO mission)
- EIT_SYN at IAS, Orsay/France (solar maps from the SoHO mission)

Another very large project has been advanced but is not yet published:

- eCallisto: large database of solar radio observations worldwide with continuous time coverage, in Geneva (started during the 2019 VESPA workshop in Rome).

A single report will be issued for the combined workshop (MS7+39) at month 25.

Task 4.

PVOL content is increasing faster and faster and now includes more than 57,000 amateur images. Inclusion of amateur spectra of planets is being assessed (in addition to images), for the moment as spectral plots and analysis from the amateurs themselves.

(MS65) Jupiter images obtained by JunoCam on the Juno spacecraft have been included in PVOL as pre-processed cylindrical and polar maps, with navigation information.

Discussions have started to include the data produced in the NA2 WP (telescope and fireball networks).

Task 5.

The main activity has been the design and installation of a procedure to maintain the metadata and definition files of all published services. This is supported by teams in Heidelberg, ObsParis and OATS (“VESPA hubs”).

The outcomes of a user technical study recommended implementing a common GitLab with authentication services that could grant access to external persons, which could enable the three hub teams to manage all services in a single repository. The system has been installed at ObsParis and now hosts most of the existing services and projects (this is a by-product of the VESPA-Cloud activity in the JRA during year 1, reusing the AAI system provided by GÉANT). It is also used to interact on updated and new services (via GitLab issues) and proved particularly handy to interact on material from the implementation workshop. As projects progress, these services may be deployed on institutes’ servers, or possibly on EOSC as required.

Two systems of DOI attached to the data have been installed, the first one internal to SSHADE (for spectra during year 1, another one for bandlists in progress), the second for general use in VESPA; the latter (based on Dataverse) has been tested on BASS2000, APIS and MASER datasets.

Task 6.

Considerable efforts have been made to address sustainability:

- The EPN-TAP protocol and EPNCore metadata set from VESPA have evolved to the status of IVOA Proposed Recommendation during year 2, and is in final review phase to become an IVOA standard. Additional user inputs have been collected during this process. This is a major element of future D6.11.
- (MS36 and MS63) In parallel, support for service implementation has been included in the DaCHS server (EPN-TAP mixin plus extensive documentation), and a service validator has been implemented in TOPCAT / taplint.- A new version of the SSDM-spectra Data Model from SSHADE has been released and the SSDM-bandlist Data Model has been created and published on its website. A complete documentation of interface tools and codes has been written to guaranty sustainability of software developments.
- Simplified tutorials to install services have been produced to prepare the implementation workshop.
- Many interactions with international consortia and projects, as detailed in next section (Impact).

c) Impact to date

No deviation is expected for impact. In practice, several actions have been conducted during the second year:

- Discussions going on in France around two future data hubs supported by CNES for Planetary surfaces and Small bodies, to which VESPA should provide interoperability.
- Increasing importance of data access according to FAIR principles at political level in many EU countries. For Planetary Science and Heliophysics, we expect the Europlanet hubs to promote the VESPA system at this scale.
- VESPA is tightening links with space agencies, through representation of the Europlanet Society in IPDA, participation to the NASA Planetary Data Ecosystem review board, and additional projects with ESA (e.g., serendipity asteroids detections in various sky surveys) and NASA (EPN-TAP data dictionary for PDS4).
- A new protocol TFCat has been proposed to IVOA to describe features in dynamical radio spectra.
- MASER and FRIPON services are now certified by INSU in France.
- Continuous involvement in international consortia such as IVOA in astronomy, IHDEA for heliophysics, Research Data Alliance, and EOSC-related bodies.
- Dedicated data sessions were organized during EPSC (MITM4) and AGU (IN55F) conferences. At EPSC, several VESPA beneficiaries presented in MITM4 and a VESPA user workshop was also organized (SMT12, with 15 attendees); some teams were involved in the amateur astronomy sessions.

VESPA was presented in Europlanet fireball network and EPEC meetings, at ESCAPE provenance meeting (Dec 14-15), ESCAPE European Data Provider Forum and Training Event (Nov 23-24), IVOA Interop meetings (May 25-27, Nov 2), IPDA meetings (Feb 19, Sept 7-9), PSIDA conference (July 2), and VAMDC consortium meeting (June 16)

- SSHADE and TFCat were presented at the ASOV meeting in France ((March 22-24).
- Although the current circumstances are not optimal, more contacts have been made during conferences (EPSC, AGU, Europlanet meetings) with teams looking for on-the-shelf solutions to distribute their data from various projects (including H2020 ones). In more normal times, such projects would be natural candidates for VESPA Implementation Workshops.
- Two peer-reviewed papers using VESPA have been published during year 2, and a third one submitted.

VESPA Access provisions to Research Infrastructures

Data access is difficult to monitor with a system of distributed servers. VESPA access can however be interpolated from statistics of the main planetary science server in ObsParis, which hosts 25% of VESPA services, then checked for consistency with analysis of connections on the heliophysics and radio servers (another 25%).

Since the onset of the programme, there are each month estimated server accesses from 400-700 unique visitors, 1500 visits, and ~4 GB of data downloaded. The largest share used to be from JAXA (nearly 50%) but is now from ESA; other regular visits are from NASA, academic institutes in Europe and some in the US. Connection peaks from India and China occur occasionally, often correlated with conferences and meetings. Again, these figures must be multiplied by 4 to estimate the global usage of VESPA servers.

In 2021, the VESPA portal alone (<http://vespa.obspm.fr>) has received ~ 160 visits / month (Europe: 70%, N America: 10%, Asia: 15%, Other 5%). Access statistics on the servers are more comprehensive than the portals, as they also reflect connections via tools, command line, and other APIs; conversely, many queries can be issued during a single visit of the portal. The figures above are still difficult to interpret, and the VESPA team is looking for a way to improve this.

The public web site (<http://www.europlanet-vespa.eu/>, entry to tutorials and docs) has received 120 visits / month, with marked peaks in September and October 2020 during EPSC and IVOA meetings. The VESPA Confluence wiki (<https://voparis-wiki.obspm.fr>, with more technical information) has 300 connections / month with a large peak (800) in November during the workshop (and 40% attendance from the US).

SSHADÉ is simpler to monitor, as regular users are registered: currently 340. The main access is through a single dedicated interface, not the VESPA portal; SSHADÉ access statistics should be added to the VESPA servers above. Raw aggregate statistics indicate 1450 visitors and 1950 visits per month to SSHADÉ (some of these visitors are not registered regular users), with 3.4 GB downloaded each month (Europe: 46%, N America: 29%, Asia: 20%, Other 5%).

PVOL now has 425 registered contributors (~ 70 more than at the beginning of the project), and the service content enlarged by 20% during year 2. Since it opened in 2003, this reflects a very strong increase in use.

d) Summary of plans for Year 3

Objectives for Year 3 include:

- Finalizing the EPN-TAP document and having it approved as a community standard by IVOA
- Complete backup of existing services on the GitLab at ObsParis
- Practical study of data distribution systems for various activities in NA2 (telescopic network, fireball networks...) and TAs (lab and field measurements)
- Organizing the 3rd VESPA implementation workshop in Warsaw, and finalizing projects started during the 2021 combined workshop.

2. Update of data management plan

A first version of the VESPA DMP section was provided to Management. The projects overall DMP can be found in Deliverable D1.3. An update of the DMP is due at the end of February 2022.

3. Follow-up of recommendations & comments from previous review(s)

The report from the VA review board (Deliverable D1.5) was received mid-December 2020.

The following actions have been performed to follow these recommendations:

- 1) Prioritize the organization of the 2021 community call and online workshop for bringing in new services from the community. This should include completing the

associated tutorials and documentation • The workshop took place on-line in Nov/Dec 2021. Follow up sessions are currently conducted to finalize as many services as possible

- Tutorials have been updated (and new ones released) to support the workshop (see workshop page: <https://voparis-wiki.obspm.fr/display/VES/2021-vespa-implementation-workshop>)

2) Define a work plan for adding content from the amateur community.

- Discussions about amateur services are scheduled with NA2 in Jan / Feb 2022.
- Data from the FRIPON network will be implemented in Paris

Other specific issues were also raised in D1.5:

1) services from the community – this has been addressed by the recent workshop. The next workshop is scheduled in Warsaw, hopefully in June 2022. The last one will take place in Graz in 2023. We're all getting back to test projects studied during EPN2020 and not finalized.

2) DMP: VESPA has provided material during year 1 (included in D1.3). Updates are scheduled in Feb 2022.

3) Content from the amateur community: PVOL content has grown by 20% during year2.

4) no visible tracking in either the website or the wiki of alternate plans: we have a roadmap (<https://voparis-wiki.obspm.fr/display/VES/EPN-TAP+Services>) and a list of potential candidates was set up for the workshop (table in this page: <https://voparis-wiki.obspm.fr/display/VES/2021-online-workshop-discussion>)

5) key tutorials needed for bringing new services online seem to be stuck in DRAFT: possibly, but this is formal, as these are regularly updated. The main documentation is the EPN-TAP standard document under review at IVOA, which is a huge work expected to converge in Feb 2022.