EPN2020-RI

EUROPLANET2020 Research Infrastructure

H2020-INFRAIA-2014-2015

Grant agreement no: 654208

Deliverable 5.8 4th PSWS Annual Report

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Responsible WP Leader: CNRS, Nicolas André

	Project funded by the European Union's Horizon 2020 research and innovation programme	
	Dissemination level	
PU	Public	x
PP	Restricted to other programme participants (including the Commission Service)	
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)	

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Abstract: Under Horizon 2020, the Europlanet 2020 Research Infrastructure (EPN2020-RI) includes an entirely new Virtual Access Service, "Planetary Space Weather Services" (PSWS) that extends the concepts of space weather and space situational awareness to other planets in our Solar System and in particular to spacecraft that voyage through it. PSWS provides twelve new services to the research community, space agencies, and industrial partners planning space missions. These services are in particular dedicated to the following key planetary environments: Mars (in support of the NASA MAVEN and European Space Agency (ESA) Mars Express and ExoMars missions), comets (building on the outstanding success of the ESA Rosetta mission), and outer planets (in preparation for the ESA JUpiter ICy moon Explorer mission), and one of these services aims at predicting and detecting planetary events like meteor showers and impacts in the Solar System. This gives the European planetary science community access to new methods, interfaces, functionalities and/or plugins dedicated to planetary space weather as well as to space situational awareness in the tools and models available within the partner institutes. The present report summarizes the status of the project after the fourth year.

Contents

1.1 Objectives

Space Weather – the monitoring and prediction of disturbances in our near-space environment and how they are controlled by the Sun - is now recognised as an important aspect of understanding our Earth and protecting vital assets such as orbiting satellites and power grids. The Europlanet 2020 Research Infrastructure (http://www.europlanet-2020-ri.eu/) aims to enhance the science of space weather, by extending its scope throughout the Solar System. An entirely new Virtual Access Service, "Planetary Space Weather Services" (PSWS, http://planetaryspaceweather-europlanet.irap.omp.eu/) has therefore been included in the Europlanet H2020 Research Infrastructure funded by the European Union Framework Programme for Research and Innovation.

The Planetary Space Weather Services provide 12 services distributed over 4 different service domains – Prediction, Detection, Modelling, Alerts - having each its specific groups of end users. The PSWS portal (http://planetaryspaceweather-europlanet.irap.omp.eu/) gives access to a presentation of PSWS activities (WP5 and WP10, see below).

1.2 Explanation of the work carried per WP

WP10:

The deliverables of WP10 feed into WP5.

During the fourth year of the project the activities for WP10 consisted in finalizing our alert services based on VOEvents.

WP5:

PSWS WP5 includes 12 services that are fully accessible at the end of year 4 (August 2019). The two last cometary services developed by UCL, UK were finalized and delivered during this period.

Those services and their status are summarized below (in parenthesis the institute responsible for the service; in bold the services that relate to WP5 only, the others being also related to WP10):

A1. 1D MHD Solar Wind Prediction Tool - Heliopropa (CNRS)

Status: fully operational (http://heliopropa.irap.omp.eu/)

Ingested in the ESA Space Situation Awareness – space Weather, http://swe.ssa.esa.int/

Documentation available at http://swe.ssa.esa.int/

A2. Propagation Tool (GFI Informatique)

Status: fully operational (http://propagationtool.cdpp.eu/)

Reference paper published in Planetary and Space Sciences, Rouillard et al., A propagation tool to connect remote-sensing observations with in-situ measurements of heliospheric structures, Planetary and Space Science, Volume 147, p. 61-77, doi : 10.1016/j.pss.2017.07.00, 2017

Ingested in the ESA Space Situation Awareness – space Weather, http://swe.ssa.esa.int/

A3. Meteor showers (OBSPARIS)

Status: operational through VESPA as an EPN-TAP service (http://vespa.obspm.fr/planetary/data/epn/query/all/)

Documentation available as a poster on *Meteor showers predictions available as VO-tool* by Vaubaillon et al. presented at the Meteorids 2019 conference, June 2019

A4. Cometary tail crossings - Tailcatcher (UCL)

Status: Operational

http://www.mssl.ucl.ac.uk/comet_tail/

Documentation available at http://www.mssl.ucl.ac.uk/comet_tail/

B1. Lunar impacts (ABER)

Status: Operational at https://twitter.com/lunarnaut and at http://users.aber.ac.uk/atc/alfi.htm

Documentation available at http://users.aber.ac.uk/atc/alfi.htm

B2. Giant planet fireballs (EHU-UPV)

Status: fully operational at http://pvol2.ehu.eus/psws/jovian_impacts/

Reference paper published in SWSC, Hueso et al., Detectability of possible space weather effects on Mars upper atmosphere and meteor impacts in Jupiter and Saturn with small telescopes, Journal of Space Weather and Space Climate, Volume 8, id.A57, 14 pp., doi:10.1051/swsc/2018045, 2018

B3. Cometary tails – Solar Windsocks (UCL)

Operational

http://www.mssl.ucl.ac.uk/comet_tail/

Documentation available at http://www.mssl.ucl.ac.uk/comet_tail/

C1. Transplanet – Earth, Mars, Venus, Jupiter (CNRS)

Status: fully operational (http://transplanet.irap.omp.eu)

Reference paper published in Planetary and Space Sciences, Blelly et al., Transplanet: A web service dedicated to modeling of planetary ionospheres, Planetary and Space Science, Volume 169, p. 35-44, doi:10.1016/j.pss.2019.02.00, 2019

C2. Mars radiation environment (ABER, DLR+CNRS)

Status: fully operational at http://radmaree.irap.omp.eu/

Reference paper published in SWSC, Guo et al., Ready functions for calculating the Martian radiation environment, Journal of Space Weather and Space Climate, Volume 9, id.A7, 11 pp., doi: 10.1051/swsc/2019004, 2019

C3. Giant planet magnetodiscs (UCL+CNRS)

Status: fully operational at http://magnetodisc.irap.omp.eu/

Reference paper published in SWSC, Achilleos et al., A magnetodisc model service for planetary space weather studies, https://doi.org/10.1051/swsc/2019022, 2019

C4. Jupiter's thermosphere (UCL)

Status: Model outputs available at http://planetaryspaceweather-europlanet.irap.omp.eu/

A Zenodo archive with the following details has been created: DOI 10.5281/zenodo.3356827 URL https://zenodo.org/record/3356827#.XUGhFS2ZPyg It contains files and code for accessing and visualising the three 'reference' simulations of the UCL Jovian thermosphere model described by Jaf Yates in his 2012 PSS paper. The archive interface has a link to that paper and in the archive there is AAA_README file with more details.

D. Alerts (OBSPARIS and CNRS)

Status: fully operational at http://alerts-psws.irap.omp.eu/

Reference paper submitted to SWSC, Cecconi et al., VOEvent for Solar and Planetary Sciences, 2019

1.3 Impact

- Science session on planetary space weather organized at the European Planetary Science Congress 2018 in Berlin, September 16-21 (http://meetingorganizer.copernicus.org/EPSC2017/session/26067), 40 participants.
- Science session on Scientific and technological aspects of planetary space weather organized at European Space Weather Week in Leuven, November 09 2018 (http://www.stce.be/esww14/program/session_details.php?nr=1), 50 participants.
- ESWW Exhibition package – PSWS booth, November 9, 2018, Leuven
- Inclusion of the 1D MHD Solar Wind Prediction Tool - Heliopropa service in the ESA SSA programme (Period-E extension, Heliospheric European Science Center) achieved, april 2019.
- Topical issue on planetary space weather for Journal of Planetary Space Weather and Space Climate – Guest Editor: Nicolas André (CNRS), Andrea Optiz (WIGNER), Romain Maggiolo (BIRA, Belgique), Caitriona Jackman (University of Southampton), Manuel Grande (ABER). https://www.swsc-journal.org/component/content/article/11-news/270-topical-issue-planetary-space-weather-deadline-15-april-2018, 10 papers
- NA1-PSWS Workshop on Planetary Environment Modelling, IRAP, Toulouse, May 20-22 2019 ; 14 participants
  Under Horizon 2020, the Europlanet 2020 Research Infrastructure includes an entirely new Virtual Access Service, "Planetary Space Weather Services" (PSWS) that will extend the concepts of space weather and space situational awareness to other planets in our Solar System and in particular to spacecraft that voyage through it. PSWS will provide at the end of 2017 12 services distributed over 4 different service domains – 1) Prediction, 2) Detection, 3) Modelling, 4) Alerts. Several tools and services are in particular developed for planetary observations and image analysis by amateurs. These include software to model planetary environments and the heliosphere. The proposed workshop focused on the modelling of the magnetospheres of Mercury, Jupiter, Saturn, Ganymede and ice giants as well as the Moon-magnetosphere interactions at Jupiter' and Saturn' moons (Callisto, Europa, Enceladus, …). It gave the opportunity to present the latest results based on simulations and compare them to observations as well as to discuss how to use them for future mission planning (BepiColombo, JUICE, Clipper, Ice Giant missions). A large part of the workshop was devoted

to the comparison between the various models and the publication of simulation runs/outputs in the Virtual Observatory.

- NA1 Workshop partly related to PSWS (and VESPA) Services, led by UCL, Kalamata, Greece, July 22-25, 2019. The following URL has further information and a report has been sent to NA1 : 'Uniting Planetary Modelling and Data Analysis' - https://www.ucl.ac.uk/planetary-sciences/news-events/europlanet-na1-workshop-uniting-planetary-modelling-and-data-analysis-part-2

1.4 Statistics

Statistics for the PSWS portal (website) that has been developed during the first year of the project can be found at: http://planetaryspaceweather-europlanet.irap.omp.eu/ more than **14674 visitors since 01/09/2015**

Statistics for the PSWS tools that have been developed during the projects can be found at the following webpages:

— CDPP/AMDA tool (total number of connections, http://amda.cdpp.eu/):

http://amda.cdpp.eu/awstats/awstats.pl more than **22477 connections since 01/09/2015**

— Details on geographical distribution etc. can be found at CDPP/AMDA awstats: http://amda.cdpp.eu/awstats/awstats.pl

Similar tools for statistics have been implemented in all PSWS services.

— Access to CDPP/PROPTOOL (http://propagationtool.cdpp.eu/) **more than 2000 visits since 01/09/2015** http://storms-stats.irap.omp.eu/awstats/awstats.pl, 1087 since 01/08/2018

— Access to TRANSPLANET (http://transplanet.irap.omp.eu/) **185 runs requested and archived from 28 users since 01/09/2015** http://transplanet.irap.omp.eu/awstats/awstats.pl, 709 visits since 01/08/2018

— Access to HELIOPROPA (http://heliopropa.irap.omp.eu/) **1490 visits since 01/09/2015** http://heliopropa.irap.omp.eu/awstats/awstats.pl

— Access to MAGNETODISC (http://magnetodisc.irap.omp.eu/) **204 visits since 01/09/2015** http://magnetodisc.irap.omp.eu/awstats/awstats.pl

— Access to RADMAREE (http://radmaree.irap.omp.eu/) **434 visits since 01/09/2015** http://radmaree.irap.omp.eu/awstats/awstats.pl

— Access to Alerts PSWS (http://alerts-psws.irap.omp.eu/)

— Access to DeTeCt3.1 (http://pvol2.ehu.eus/psws/jovian_impacts/) Statistics of software use: http://www.astrosurf.com/planetessaf/doc/project_detect.php

Jupiter fireball detection statistics

Total : 85 observers	110.350 days	97468 videos	2004/02/29 - 2019/06/23

Saturn fireball detection statistics

Total : 21 observers	13.327 days	5953 videos	2005/02/04 - 2019/06/16

So far the Propagation Tool, Heliopropa, Transplanet and DeTeCt3.1 services have been extensively used since they are operational over a longer time period. The number of users for PSWS services varies at the moment between tens (e.g., Transplanet, Magnetodisc) to several hundreds (Heliopropa, Propagation Tool, DeTeCt3.1).

1.5 Access

The PSWS External review board is composed of the following independent persons:

Chair : Mark Lester (Male / Univ. Leicester, UK). He will help us to connect with ESA/SSA and space weather-related FP7 projects. mle@leicester.ac.uk

Apostolos Christou (Male, Armagh Observatory, Ireland). He will help us to liaise with the amateur community. aac@arm.ac.uk

Angelica Sicard (Female, ONERA, France). She will help us to connect with industries / space agencies. angelica.sicard@onera.fr

Kirsti Kauristie (Female / FMI, Finland). She will help us to connect with COSPAR and their space weather roadmap. kirsti.kauristie@fmi.fi

We have not been able to meet face to face with our reviewers during the period but we have presented our developments during a Europlanet-sponsored NA1 workshop on Planetary environment modelling hosted at IRAP on May 20-22 (14 participants) and we have obtained there feedback from users on each of our services. We have also ingested our Heliopropa service into the Situation Awareness Space Weather Service Network of the European Space Agency and we have received feedback on it during the ingestion. We have also submitted papers for several of our PSWS services in a topical issue of Journal of Space Weather and Space Climate and we have received feedback on them from independent reviewers. All papers but one (in revision) have been accepted to date.

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Annex 1. PSWS participants

PSWS participants are listed below.

Participant	Permanent personnel	Personnel hired by the project
2. OBSPARIS	Baptiste Cecconi M Pierre Le Sidaner M Jérémie Vaubaillon M	Maxime Paillassa, M (09/2016-12/2016)
3. UCL	Nicholas Achilleos M Geraint Jones M Bob Bentley M	Patrick Guio, M
4. CNRS	Nicolas André M	Mikel Indurain, M (01/2015-12/2015) Arnaud Biegun, M (04/2016-

	Vincent Génot M	06/2016)
	Alexis Rouillard M	Antoine Goutenoir, M (10/2016-08/2017)
	Pierre-Louis Blelly M	
	Aurélie Marchaudon F Frédéric Pitout M Myriam Bouchemit F Jean Lilensten M Mathieu Barthélémy M	
11. DLR	Daniel Matthiae M	
12. ABER	Manuel Grande M Tony Cook M	Patrick Dixon, M (18 July 2016-12/2016, part time) Nathalia Alzate, F (04/2017-, 50%) Zoe Hannah Lee-Payne F (part-time)
18. Wigner	Karoly Szego M	Andrea Opitz, F (01/09/2015-31/08/2019, 1/3 time) Zsuzsanna Dálya, F (02/2016-04/2016, 50%) Klaudia Szabó, F (07/2017-, 50%)
19. IAP	Jan Soucek M Benjamin Grison M Ulrich Taubenschuss M Vratislav Krupar M	
23. GFI Informatique	Stéphane Caussarieu M Laurent Beigbeder M Jean-Philippe Toniutti M	
28. UPV/EHU	Ricardo Hueso M Agustín Sánchez-Lavega M	Jon Juaristi, M (02/2016-05/2017 and 01/2018-06/2018)
33. SRC PAS	Lukasz Tomasik M Mariusz Pożoga M Maria Miłodrowska F Iwona Stanisławska F	Piotr Koperski, M (12/2015-05/2016) Michał Szwabowski M (30/11/2015-31/12/2015)

PSWS Structure

PSWS activities consist of two work packages with Joint Research activities feeding Virtual Access activities. These activities consist of the following tasks:

- JRA (WP10)

    - *Task 1.Coordination (CNRS, ABER)*

    - *Task 2.Adapting available tools and methods for planetary space weather (UCL, CNRS)*

    - *Task 3.Enabling planetary event prediction/ensuring reliability of services (Wigner, OBSPARIS)*

- – *Task 4.Testing space weather connections in the Solar System (IAP, DLR, Wigner RCP)*

  – *Task 5. Alert Service (OBSPARIS, UCL, CNRS, SRC PAS)*

- VA (WP5)

  – *Task 1. Coordination (CNRS, ABER)*

  – *Task 2. Implementation (UCL, ABER, CNRS, SRC PAS)*

  – *Task 3. Detection (UPV/EHU, UCL, ABER)*

  – *Task 4. Liaison (CNRS, SRC PAS)*