EPN-TAP
the VO standard to share and access Solar System data

S. Erard, B. Cecconi, P. Le Sidaner, M. Demleitner, M. Taylor

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PADC Paris Astronomical Data Centre

europlanet SOCIETY

l'Observatoire de Paris

UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

University of BRISTOL

EPN-TAP / Motivation

- Europlanet EU programme(s): consistent access to Solar System data (including derived data)?

Scope = Planetary Science, Heliophysics, exoplanets

=> VO framework seemed appropriate

- Difficulties:

- Moving objects / targets, seldom clearly identified in existing archives
- Targets are resolved: many coordinate systems - related to targets or configurations
- More diverse types of measurements:
  Not only (reflected) light, but also particles, fields + lab samples
- Need to cross-correlate data services => vocabulary needs to be uniform

EPN-TAP = Usual TAP mechanism
EPNCore metadata vocabulary + associated UCDs
Set of rules related to services and tables

Similar to ObsCore standard for celestial objects (but different constraints)

EPN-TAP status

- First draft published in Astronomy and Computing (Erard et al 2014) — v1.0
- Refined and detailed with implementation of actual (50+) data services plus use cases
- **Mature v2.0 approved by IVOA, Aug 2022: https://ivoa.net/documents/EPNTAP/**

- All existing services are in v2.0, being reviewed and updated to latest version
- Service validator included in taplint / TOPCAT
  includes check on EPNcore parameter name/ucd/units + range of values
- EPN-TAP v2 mixin in DaCHS (will define EPNcore parameter correctly in services)

Europlanet VESPA: Data services connected via EPN-TAP / field

Open
Open in test | upgrade required
Drafted
Scheduled 2024 (selection)
• New or upgraded in 2021/22
• New content in 2021/22

Atmospheres

- Titan profiles - CIRS (Cassini, LESIA)
- *Venus spectroscopy - VIRTIS (VEx, LESIA)*
- Mars & Venus Climate Databases (modeling, LMD)
- GEM_Mars (modeling, IASB-BIRA)
- Venus profiles - SPICAV/SOIR (VEx, IASB-BIRA)
- Mars profiles - SPICAM (MEx, LATMOS)
- *All MEx derived atmospheric products (via MEx IDS)*
- *Venus cloud products (LATMOS)*
- TGO/NOMAD (BIRA-IASB)

Small bodies

- *M4ast (ground based spectroscopy, IMCCE)*
- 1P/Halley spectroscopy (IKS / Vega-1, LESIA)
- BaseCom (Nançay Obs, LESIA)
- TNOs are cool (Herchel & Spitzer + compilation, LESIA & LAM & Utinam)
- SBNAF (from H2020 prog, Konkoly Obs)
- *MP3C: Small body properties (OCA)*
- *Vesta & Ceres spectroscopy - VIR/DAWN (IAPS)*
- DynAstVO: NEO refined parameters (IMCCE)
- *MPCorb: Small bodies orbital cat (MPC/Heidelberg)*
- *Rosetta ground-based support (Edinburgh)*
- 67P illumination config (IRAP)
- Meteor_showers predictions (IMCCE)
- *Occultations predictions, ast & sat (IMCCE)*
- *LuckyStar, occultations (ERC prog, LESIA)*
- *Natural satellites db (IMCCE)*
- asteroid spectra (CDS / LESIA)

Solid spectroscopy

- SSHADE ices & minerals spectro (IPAG & network)
- *Planetary Spectral Library (DLR)*
- PDS spectral library (LESIA)
- *Berlin Reflectance Spectral Lib (DLR)*
- *Hoserlab (Winnipeg U)*

Surfaces

- Mars craters (Jacobs U, + update by GEOPS)
- USGS planetary maps WMS (Jacobs U)
- PlanMap: geol maps (H2020 prg, Jacobs U)
- CRISM WCS service (MRO, Jacobs U)
- *M3 WMS service (Chandrayaan-1, Jacobs U)*
- HRSC nadir images, WMS (MEx, Frei Univ)
- OMEGA cubes and maps (MEx, IAS)
- VIMS satellites, w/geometry (Cassini, LPG)
- Mars topo preTharsis (GEOPS)
- *Global spectral param of Mercury (DLR)*

Magnetospheres / radio

- APIS (HST/Cassini, LESIA)
- NDA (Jupiter & Sun radio, LESIA/CDN)
- AMDA (CDPP / IRAP)
- MASER & related services (LESIA)
- *RadioJove (PDS PPI: US amateur network)*
- *Datasets from PDS / PPI (UCLA)*
- Iitate HF data of Jupiter (Tohoku Univ, Jap)
- *UTR-2 Juno ground support (Kharkiv)*
- MDISC & JASMIN (modeling, UCL)
- Cluster & Themis data (IAP, Prague)
- *IMPEx models (from FP7 prog, IWF Graz)*
- *Hisaki (Tohoku Univ., Jap)*
- Transplanet (CDPP / IRAP)
- LOFAR Jupiter (CBK/PAS, Warsaw)
- *Magnetic field simus (LMSU)*
- *ASPERA & MARSIS atm obs (MEx, Iowa U)*

Solar

- *HELIO AR & 1T3 solar features (FP7 prog, LESIA)*
- Bass2000 (LESIA)
- *Radio Solar db (Nançay, LESIA)*
- CLIMSO (Pic du Midi, IRAP)
- IPRT/AMATERAS (Tohoku Univ, Jap)
- Gaia-DEM (SDO, IAS)
- EIT_syn (SoHO, IAS)
- *e-Callisto (Windisch, Sw)*

Generic / interdisciplinary

- BDIP (LESIA)
- PVOL (UPV/EHU & amateur network)
- Telescopic planetary spectra collection (LESIA)
- PSA complete archive (ESA)
- HST planetary data (LESIA, to CADC archive)
- *Catalogues of planetary maps (Budapest)*
- VizieR_planets: Planetary Science catalogues (CDS)
- *Gas absorption cross-sections (Granada)*
- Planets *then satellites properties* (LESIA/IMCCE)
- *Nasa dust catalogue (IAPS)*
- *Stellar spectra, support for observations (LESIA)*
- *DARTS (JAXA - currently via PDAP)*
- *ESAsky planetary data (ESA)*
- *Interface with VAMDC ?*

Exoplanets

- Encyclopedia of exoplanets (LUTH/LESIA)
- *Catalogue of exo disks (LESIA)*
- *Interface with DACE (Geneva)*
- *ARTECS climate simulations (AOTS/INAF)*
- *Atmospheric studies (UCL)*
- Exotopo: exoplanet surface simulations (GEOPS)

EPN-TAP rules

Tables

- One table / service (similar to ObsCore) - called <service>.epn_core
- One product / row (= “granule”) - associated thumbnail is allowed and recommended
- Products can be sets of scalar in the table, or provided through a unique URL: either files or web services
- Related products, especially docs, can be associated with datalink

Parameters

- Most parameters appear as pair of min/max values and both must be provided in all cases (=> search intersections of coverages)
- Multivalued parameters are provided as #-separated lists
- Some parameter values must be taken from predefined lists

EPNcore — Resource

(EPN-TAP parameter - optional in blue)

- **service_title**:
  full name of resource / schema name
- **creation/ modification/ release/ _date**:
  required for mirrors & proprietary periods
- **publisher**:
  Publisher from VOResource
- **bib_reference**:
  publication related to granule
- **processing_level**:
  can adapt to existing nomenclature
  default is to use CODMAC levels (PDS3)

(equivalent in ObsCore)

- obs_title
- obs_creation_date
- publisher_id
- bib_reference
- calib_level
  not the same definition/values

EPNcore — Product

(EPN-TAP parameter)

- **granule_uid** :
unique id for granule in service = 1 granule per row
- **obs_id** :
original observation id, to cross-reference granules with various processing, but from the same original observation
- **granule_gid** :
granule group id for granules that have same processing, coordinate system, etc, to cross-reference granules with comparable processing
- **dataproduct_type**:
predefined list: **im** (image), **ma** (map), **pr** (profile), **sp** (spectrum), **ds** (dynamic spectrum), **sc** (spectral cube), **vo** (volume), **mo** (movie), **cu** (cube), **ts** (time series), **ca** (catalogue), **ci** (catalogue item), **sv** (spatial vector), **ev** (event)
- **instrument_host_name**:
spacecraft of observatory name (archive names recommended)
- **instrument_name**:
name of instrument (archive names recommended)
- **measurement_type**:
ucd - allows searching by physical quantity

(equivalent in ObsCore)

- obs_publisher_did?
definition are alike
- obs_id
same definition
- obs_collection?
very similar definition
- dataproduct_type
predefined list: image, cube, spectrum, sed, timeseries, visibility, or event.
same name, but not the same list!
- facility_name
from VODataService (but no constraints)
- instrument_name
- o_ucd

EPNcore — Target

(EPN-TAP parameter)

- **target_name**:
  Solar System target(s) or exoplanet name
  from IAU standard lists
  or sample / meteorite name or ID

- **target_class**:
  predefined list:
  planet, satellite, dwarf_planet, asteroid,
  comet, exoplanet, sample, sky, star,
  interplanetary_medium, calibration,
  spacecraft, spacejunk

- **alt_target_name**:
  other names of the target(s)

- **feature_name**:
  local name *on* target (e.g., crater, region…)

- **target_region**:
  type of region on target (atmosphere, surface…)

(equivalent in ObsCore)

- target_name
  (which standard?)

- target_class
  (list to be defined?)

EPNcore — Time

(EPN-TAP parameter - optional in blue)

- **time_min**, **time_max**:
  Time range min and max value of data product
  Unit: JD
- **time_exp_min**, **time_exp_max**:
  Exposure time min and max values of data product
  Unit: seconds
- **time_sampling_step_min**, **time_sampling_step_max**:
  Sampling step min and max values of data product
  Unit: seconds
- **time_scale**:
  = UTC, except for modeling
- **time_origin**:
  Where time is measured (important for space obs)

(equivalent in ObsCore)

- t_min t_max
  same definition, but in MJD
- t_exptime
  single valued (no min/max)
- t_resolution

  single valued (no min/max)

EPNcore — Spectral

(EPN-TAP parameter)

- **spectral_range_min**, **spectral_range_max**:
  Spectral range min and max value
  Unit: Hz
- **spectral_resolution_min**, **spectral_resolution_max**:
  Filter bandwidth min and max values
  Unit: Hz
  (will evolve to resolving power f / Δf)
- **spectral_sampling_step_min**, **spectral_sampling_step_max**:
  Spectral sampling min and max values
  Unit: Hz

(equivalent in ObsCore)

- em_min
  em_max
  same definition, but unit in meter
- em_res_power
  not the same definition
  relative resolution here: | λ / Δλ | = | f / Δ f |

EPNcore — Spatial

(EPN-TAP parameter) (equivalent in ObsCore)

- **spatial_frame_type**:
  none / celestial / body / cartesian / cylindrical / spherical
- **c1_min**, **c2_min**, **c3_min**,
  c1_max, **c2_max**, **c3_max**:
  Spatial ranges min and max values on 3 axes, as defined in spatial_frame_type
  Unit: degrees or km / au
  - s_ra
    s_dec
    s_fov
- **c1_resol_min**, **c2_resol_min**, **c3_resol_min**
  c1_resol_max, c2_resol_max, c3_resol_max:
  Spatial resolutions min and max values
  Unit: degrees or km / au
  - s_resolution
- **spatial_coordinate_description**:
  full identification of frame with std ID - TBD
- **spatial_origin** :
  origin of frame in case of ambiguity
- **s_region**:
  contours (STC-S strings) — issues spotted
  - s_region
- **coverage**:
  MOC - faster and flexible, but longer strings

EPNcore — Illumination & geometry

(EPN-TAP parameter) (no equivalent in ObsCore)

- **incidence_min** ,
  incidence_max :
  The incidence angle parameters define the upper and lower bounds of the incidence angle variation in the data (also known as Solar Zenithal Angle)
  Unit: degrees (0° = normal to surface)

- **emergence_min**,
  emergence_max:
  The emergence angle parameters define the upper and lower bounds of the emergence angle variation in the data (viewing angle)
  Unit: degrees (0° = normal to surface)

- **phase_min** ,
  phase_max :
  The phase angle parameters define the upper and lower bounds of the phase angle variation in the data
  Unit: degrees (0° = opposition)

- **solar_longitude_min/max**:
  ~ true anomaly counted from N spring equinox position defines the season on the target at time of observation
  Unit: degrees (0° = N spring equinox)

- **local_time_min/max**:
  Local time on FoV at time of observation
  Unit: degrees (0° = midnight)

- **target_distance_min/max**:
  distance to observed FoV at time of observation

- **target_time_min/max**:
  time at target location, to handle simultaneous observations from different locations in the Solar system

EPNcore — Access

(EPN-TAP parameter)

- **access_url**:
  URL used to access the data
  may be a web service
- **access_format**:
  VO-compliant formats preferred, but anything is acceptable to accommodate archive data:
  VOTable, Fits, CSV, ASCII, PDS (+ standard image formats), etc
- **access_estsize**:
  approximate size of data file
  Unit : kB
- **file_name** :
  name of the data file, in case this bears information
- **thumbnail_url** :
  URL used to get a preview of data as a small sized image

(equivalent in ObsCore)

- access_url
- access_format
- access_ estsize

EPNCore vocabularies

Lists of accepted values / parameter:

- Uses IVOA vocabularies whenever relevant
- target names / classes: IAU values with name resolver (Quaero)
- instrument and host names: list built from WikiData in progress, resolver scheduled
- Coordinate frames (CRS): parameters according to IAU publications
  IDs need to be compliant with OGC usage to use Earth Observation tools
  Being discussed in OGC working groups

  Frame definition server: http://voparis-vespa-crs.obspm.fr:8080/

  astropy support in progress

EPNCore usage

- With TAP => EPN-TAP — coordinated access to on-line databases
  - All TAP clients / tools OK, but the VESPA portal queries all EPN-TAP services together
  - May be used for Solar System data in telescope archives

- To document on-going science work:
  - provides a standard framework for Solar System studies, supported by VO tools
  - data are ready for archives or VO repositories (e.g. after publication of a paper)

- For experiments, either on-ground or space borne:
  - provides an off-the-self data management system, handles proprietary periods
  - TAP and VO tools are handy to monitor an instrument or operation plan
  - cross-system dictionaries drafted, in particular with PDS4 + new fits keywords for planetary surfaces

- Baseline for contributive works
  - Pro-am activities: fireballs networks, Europlanet Telescope Network, etc
  - Natural framework to integrate independent databases in Solar System studies

Prospects

- EPNCore Extension system

  New parameters related to specific fields can be discussed in small groups and validated without the need to enter a new review phase

  Available from here: https://hdl.handle.net/21.15110/epn_tap_extensions

- Support for new data services from the community