

**SPASE Simulation Extensions**  
**for the**  
**Space Physics Archive Search and Extract (SPASE) Data Model**

**from the SPASE Consortium**  
**Based on work done the EU FP7 IMPEX project**

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## **1. Executive Summary**

The Space Physics Archive Search and Extract (SPASE) consortium has defined a base information model for describing scientific data and related resources. This document defines a set of extensions for describing the simulation models, runs and the resulting data (numerical or display).

The SPASE Simulation Extensions were originally developed by the Integrated Medium for Planetary Exploration (IMPEX) project, a European Union (EU) Seventh Framework Programme sponsored project, which was subsequently endorsed by the SPASE consortium.

The SPASE group website is located at <http://www.spase-group.org/>

A PDF version of this document can be downloaded from the SPASE site.

## **2. Introduction**

The SPASE (Space Physics Archive Search and Extract) Data Model is a set of terms and values along with the relationships between them that allow describing all the resources in a heliophysics data environment. It is the result of many years of effort by an international collaboration (see <http://spase-group.org>) to unify and improve on existing Space and Solar Physics data models. The intent of this Data Model is to provide the means to describe resources, most importantly scientifically useful data products, in a uniform way so they may be easily registered, found, accessed, and used.

### **2.1. History of Development**

The original implementation of the SPASE Simulation Extensions was developed by the EU FP7 IMPEx project (<http://impex-fp7.oeaw.ac.at/>). In 2014 the SPASE consortium endorsed and adopted the extensions as a part of the SPASE Data Model.

## **3. Guide to the SPASE Data Model**

### **3.1. Resource Types**

The top level entity in the SPASE data model is a Resource. There are 4 different types of resources in the Simulation Extensions. These extensions can be used along side the resources found in the SPASE Base Data Model. Each resource type consists of a set of attributes that characterize the resource. The Simulation Extensions are:

SimulationRun,  
SimulationModel,  
NumericalOutput, and  
DisplayOutput

The Simulation Extensions also override the Granule and Particle classes in the base SPASE schema.

#### 4. The Data Model Presented Hierarchically

The taxonomy tree shows the inter-relationship of elements in the data model. This provides a "big picture" view of the SPASE data model. This taxonomy is implementation neutral. Details for each element are contained in the data dictionary.

Notes: Occurrence specifications are enclosed in parenthesis: 0 = optional, 1 = required, \* = zero or more, + = 1 or more

```

+ Spase (1)
|   + Version (1)
|   + Catalog (+ of A)
|   + DisplayData (+ of A)
|   + NumericalData (+ of A)
|   + Document (+ of A)
|   + Granule (+ of A)
|     + ResourceID (1)
|     + ReleaseDate (1)
|     + ExpirationDate (0)
|     + ParentID (1)
|     + PriorID (*)
|     + StartDate (1 of B)
|     + RegionBegin (1 of B)
|     + StopDate (1 of C)
|     + RegionEnd (1 of C)
|     + Source (+)
|   + Instrument (+ of A)
|   + Observatory (+ of A)
|   + Person (+ of A)
|   + Registry (+ of A)
|   + Repository (+ of A)
|   + Service (+ of A)
|   + Annotation (+ of A)
|   + SimulationModel (+ of A)
|     + ResourceID (1)
|     + ResourceHeader (1)
|     + Versions (0)
|       + ModelVersion (*)
|         + VersionTag (0)
|         + ReleaseDate (1)
|         + Description (0)
|         + Caveats (0)
|     + SimulationType (1)
|     + CodeLanguage (0)
|     + TemporalDependence (0)
|     + SpatialDescription (0)
|       + Dimension (1)
|       + CoordinateSystem (1)
|       + Units (1)
|       + UnitsConversion (0)
|       + CoordinatesLabel (0)

```



		+ CutsDescription (1 of D)
		+ PlaneNormalVector (1 of E)
		+ PlanePoint (1 of E)
		+ CubesDescription (1 of D)
		+ RegionBegin (1 of F)
		+ RegionEnd (1 of F)
		+ Step (0)
		+ SimulatedRegion (*)
		+ InputProperties (0)
		+ Property (*)
		+ Name (0)
		+ Description (0)
		+ Caveats (0)
		+ PropertyQuantity (1)
		+ Qualifier (*)
		+ Units (0)
		+ UnitsConversion (0)
		+ PropertyLabel (0)
		+ PropertyValue (0)
		+ PropertyTableURL (0)
		+ ValidMin (0)
		+ ValidMax (0)
		+ PropertyModel (0)
		+ ModelURL (0)
		+ OutputParameters (0)
		+ Parameter (*)
		+ ModelURL (0)
		+ SimulationRun (+ of A)
		+ ResourceID (1)
		+ ResourceHeader (1)
		+ AccessInformation (*)
		+ ProviderResourceName (0)
		+ ProviderProcessingLevel (0)
		+ ProviderVersion (0)
		+ Model (0)
		+ ModelID (0)
		+ VersionTag (0)
		+ TemporalDependence (0)
		+ SimulatedRegion (+)
		+ LikelihoodRating (0)
		+ Caveats (0)
		+ Keyword (*)
		+ InputResourceID (*)
		+ SimulationTime (0)
		+ Description (0)
		+ Caveats (0)
		+ Duration (0)
		+ TimeStart (0)
		+ TimeStop (0)
		+ TimeStep (0)
		+ DiagnosisTimeStep (0)

			+ TimeStart (1)
			+ Duration (1)
			+ SavedQuantity (*)
		+ SimulationDomain (0)	
			+ CoordinateSystem (1)
			+ Description (0)
			+ Caveats (0)
			+ SpatialDimension (1)
			+ VelocityDimension (0)
			+ FieldDimension (0)
			+ Units (1)
			+ UnitsConversion (0)
			+ CoordinatesLabel (0)
			+ ValidMin (0)
			+ ValidMax (0)
			+ GridStructure (0)
			+ GridCellSize (0)
			+ Symmetry (0)
			+ BoundaryConditions (0)
			+ ParticleBoundary (0)
			+ FieldBoundary (0)
		+ RegionParameter (+ of G)	
			+ SimulatedRegion (0)
			+ Description (0)
			+ Caveats (0)
			+ Radius (0)
			+ SubLongitude (0)
			+ Period (0)
			+ ObjectMass (0)
			+ InputTableURL (0)
			+ Property (*)
			+ Name (0)
			+ Description (0)
			+ Caveats (0)
			+ PropertyQuantity (1)
			+ Qualifier (*)
			+ Units (0)
			+ UnitsConversion (0)
			+ PropertyLabel (0)
			+ PropertyValue (0)
			+ PropertyTableURL (0)
			+ ValidMin (0)
			+ ValidMax (0)
			+ PropertyModel (0)
			+ ModelURL (0)
		+ InputParameter (+ of G)	
			+ Name (1)
			+ Description (0)
			+ Caveats (0)
			+ SimulatedRegion (*)
			+ InputTableURL (*)

		+ Qualifier (*)
		+ ParameterQuantity (0)
		+ Property (+)
		+ Name (0)
		+ Description (0)
		+ Caveats (0)
		+ PropertyQuantity (1)
		+ Qualifier (*)
		+ Units (0)
		+ UnitsConversion (0)
		+ PropertyLabel (0)
		+ PropertyValue (0)
		+ PropertyTableURL (0)
		+ ValidMin (0)
		+ ValidMax (0)
		+ PropertyModel (0)
		+ ModelURL (0)
		+ InputPopulation (+ of G)
		+ Name (1)
		+ Set (*)
		+ ParameterKey (0)
		+ Description (0)
		+ Caveats (0)
		+ SimulatedRegion (*)
		+ Qualifier (*)
		+ ParticleType (0)
		+ ChemicalFormula (0)
		+ AtomicNumber (0)
		+ PopulationMassNumber (0)
		+ PopulationChargeState (0)
		+ PopulationDensity (0)
		+ PopulationTemperature (0)
		+ PopulationFlowSpeed (0)
		+ Distribution (0)
		+ ProductionRate (0)
		+ TotalProductionRate (0)
		+ InputTableURL (0)
		+ DensityProfile (0)
		+ ModelURL (0)
		+ InputField (+ of G)
		+ Name (1)
		+ Set (*)
		+ ParameterKey (0)
		+ Description (0)
		+ Caveats (0)
		+ SimulatedRegion (*)
		+ CoordinateSystem (0)
		+ Qualifier (*)
		+ FieldQuantity (1)
		+ Units (0)
		+ UnitsConversion (0)

		+ InputLabel (0)
		+ FieldValue (0)
		+ InputTableURL (0)
		+ ValidMin (0)
		+ ValidMax (0)
		+ FieldModel (0)
		+ ModelURL (0)
	+ InputProcess (+ of G)	
		+ Name (1)
		+ Set (*)
		+ ParameterKey (0)
		+ Description (0)
		+ Caveats (0)
		+ SimulatedRegion (*)
		+ ProcessType (1)
		+ Units (0)
		+ UnitsConversion (0)
		+ ProcessCoefficient (0)
		+ ProcessCoeffType (0)
		+ ProcessModel (0)
		+ ModelURL (0)
	+ Extension (*)	
	+ NumericalOutput (+ of A)	
		+ ResourceID (1)
		+ ResourceHeader (1)
		+ AccessInformation (+)
		+ ProcessingLevel (0)
		+ ProviderResourceName (0)
		+ ProviderProcessingLevel (0)
		+ ProviderVersion (0)
		+ SimulatedInstrumentID (*)
		+ MeasurementType (+)
		+ TemporalDescription (0 of H)
		+ SpatialDescription (0 of H)
		+ Dimension (1)
		+ CoordinateSystem (1)
		+ Units (1)
		+ UnitsConversion (0)
		+ CoordinatesLabel (0)
		+ CutsDescription (1 of D)
		+ PlaneNormalVector (1 of E)
		+ PlanePoint (1 of E)
		+ CubesDescription (1 of D)
		+ RegionBegin (1 of F)
		+ RegionEnd (1 of F)
		+ Step (0)
	+ SpectralRange (*)	
	+ SimulatedRegion (*)	
	+ Caveats (0)	
	+ Keyword (*)	
	+ InputResourceID (*)	

```

|      | + Parameter (*)
|      | + SimulationProduct (0)
|      | + Property (*)
|      | |   + Name (0)
|      | |   + Description (0)
|      | |   + Caveats (0)
|      | |   + PropertyQuantity (1)
|      | |   + Qualifier (*)
|      | |   + Units (0)
|      | |   + UnitsConversion (0)
|      | |   + PropertyLabel (0)
|      | |   + PropertyValue (0)
|      | |   + PropertyTableURL (0)
|      | |   + ValidMin (0)
|      | |   + ValidMax (0)
|      | |   + PropertyModel (0)
|      | |   + ModelURL (0)
|      | + Extension (0)
| + DisplayOutput (+ of A)
|   + ResourceID (1)
|   + ResourceHeader (1)
|   + AccessInformation (+)
|   + ProcessingLevel (0)
|   + ProviderResourceName (0)
|   + ProviderProcessingLevel (0)
|   + ProviderVersion (0)
|   + SimulatedInstrumentID (*)
|   + MeasurementType (+)
|   + TemporalDescription (0 of H)
|   + SpatialDescription (0 of H)
|     + Dimension (1)
|     + CoordinateSystem (1)
|     + Units (1)
|     + UnitsConversion (0)
|     + CoordinatesLabel (0)
|     + CutsDescription (1 of D)
|     + PlaneNormalVector (1 of E)
|     + PlanePoint (1 of E)
|     + CubesDescription (1 of D)
|     + RegionBegin (1 of F)
|     + RegionEnd (1 of F)
|     + Step (0)
|   + SpectralRange (*)
|   + DisplayCadence (0)
|   + SimulatedRegion (*)
|   + Caveats (0)
|   + Keyword (*)
|   + InputResourceID (*)
|   + Parameter (*)
|   + SimulationProduct (0)
|   + Property (*)

```

			+ Name (0)
			+ Description (0)
			+ Caveats (0)
			+ PropertyQuantity (1)
			+ Qualifier (*)
			+ Units (0)
			+ UnitsConversion (0)
			+ PropertyLabel (0)
			+ PropertyValue (0)
			+ PropertyTableURL (0)
			+ ValidMin (0)
			+ ValidMax (0)
			+ PropertyModel (0)
			+ ModelURL (0)
			+ Extension (0)

## **5. Guidelines for Metadata Descriptions of Products**

The following sections describe the details of the SPASE Simulation Extensions to the Base Data Model. There is a richness in the available metadata that allows very detailed descriptions of products. While there are optional elements, please remember that the better data are described, the easier they will be to use.

To determine what level of detail that is needed, we recommend considering not only what the user needs to find the data, but also what is necessary to know if the data will be useful for the requestor's purpose. The user might get this information by contacting you, but if the data were moved somewhere else and only the data description were available to determine the utility of the data, consider if the user would have sufficient information to know if this is the right data set and what problems might be associated with the use of these data. Also consider if additional documentation is necessary and if so create an Document resource and associate it with the data resource. An "Information URL" may also be used to provide links to more detailed information.

In summary, products need not be described in minute detail, but users will need, at minimum, information for assessing what the data products represent and where to find them. Of course it is also useful to include information on how the data can be applied and common pitfalls in their use, but the first need is to make the products usefully visible.

## 6. Examples

As an example let us describe a person using SPASE metadata. This person is "John Smith" from Smith Foundation. While the SPASE data model is implementation neutral, XML representation is preferred. This example uses the SPASE XML form.

```
<?xml version="1.0" encoding="UTF-8" ?>
<Spase>
  <Version>2.0.0</Version>
  <Person>
    <ResourceID>spase://person/jsmith@smith.org</ResourceID>
    <PersonName>John Smith</PersonName>
    <OrganizationName>Smith Foundation</OrganizationName>
    <Address>1 Main St., Smithville, MA</Address>
    <Email>jsmith@smith.org</Email>
    <PhoneNumber>1-800-555-1212</PhoneNumber>
  </Person>
</Spase>
```

For a more extensive example let us consider a collection of numerical data from the magnetometer on the ACE spacecraft. This data set has been averaged to 1 minute intervals (cadence) and spans the beginning of the mission to the end of 2004 (1997-09-01 through 2004-12-31). The ACE spacecraft orbits the L1 point between the Earth and the Sun. While the SPASE data model is implementation neutral, XML representation is preferred. This example uses the SPASE XML form. The presented URLs are fictitious and will not direct you to the actual data.

```
<?xml version="1.0" encoding="UTF-8" ?>
<Spase>
  <Version>2.0.0</Version>
  <NumericalData>
    <ResourceID>spase://VMO/NumericalData/ACE/MAG/200301</ResourceID>
    <ResourceHeader>
      <ResourceName>ACEMAG200301</ResourceName>
      <ReleaseDate>2006-07-26T00:00:00.000</ReleaseDate>
      <Acknowledgement>
        User will acknowledge the data producer and instrument P.I. in any
        publication resulting from the use of these data.
      </Acknowledgement>
      <Description>
        ACE MFI 1-minute averaged magnetic-field data in GSE coordinates
        from Jan 2003. These data have been derived from the 16 second
        resolution ACE MFI which were linearly interpolated to a 1-minute
        time grid with time stamps at second zero of each minute.
      </Description>
      <Contact>
        <Role>PrincipalInvestigator</Role>
        <PersonID>spase://SMWG/Person/Norman.F.Ness</PersonID>
      </Contact>
      <Contact>
        <Role>Co-Investigator</Role>
        <PersonID>spase://SMWG/Person/Charles.Smith</PersonID>
      </Contact>
      <Contact>
        <Role>DataProducer</Role>

```



```

    <PresonID>spase://SMWG/Person/James.M.Weygand</PresonID>
  </Contact>
</ResourceHeader>

<AccessInformation>
  <AccessRights>Open</AccessRights>
  <AccessURL>

<URL>http://www.igpp.ucla.edu/getResource?format=text&id=spase://UCLA/ACEMAG200
301</URL>
  </AccessURL>
  <Format>Text</Format>
  <Encoding>GZIP</Encoding>
</AccessInformation>

<InstrumentID>spase://SMWG/ACE/MAG</InstrumentID>
<MeasurementType>MagneticField</MeasurementType>

<TemporalDescription>
  <TimeSpan>
    <StartDate>1997-01-01T00:00</StartDate>
    <StopDate>2004-01-31T23:59</StopDate>
  </TimeSpan>
  <Cadence>PT1M</Cadence>
</TemporalDescription>

<InstrumentRegion>Heliosphere.NearEarth</InstrumentRegion>
<ObservedRegion>Heliosphere.NearEarth</ObservedRegion>

<Parameter>
  <Name>SAMPLE_TIME_UTC</Name>
  <ParameterKey>time</ParameterKey>
  <Description>
    Sample UTC in the form DD MM YYYY hh mm ss where
    DD   = day of month (01-31)
    MM   = month of year (01-12)
    YYYY = Gregorian Year AD
    hh   = hour of day   (00:23)
    mm   = minute of hour (00-59)
    ss   = second of minute (00-60).
  </Description>
  <Support>
    <SupportQuantity>Temporal</SupportQuantity>
  </Support>
</Parameter>

<Parameter>
  <Name>MAGNETIC_FIELD_VECTOR</Name>
  <Units>nT</Units>
  <CoordinateSystem>
    <CoordinateRepresentation>Cartesian</CoordinateRepresentation>
    <CoordinateSystemName>GSE</CoordinateSystemName>
  </CoordinateSystem>
  <Description>
    Magnetic field vector in GSE Coordinates (Bx, By, Bz).
  </Description>
  <Field>
    <Qualifier>Vector</Qualifier>
    <FieldQuantity>Magnetic</FieldQuantity>
  </Field>
</Parameter>

<Parameter>
  <Name>SPACECRAFT_POSITION_VECTOR</Name>

```

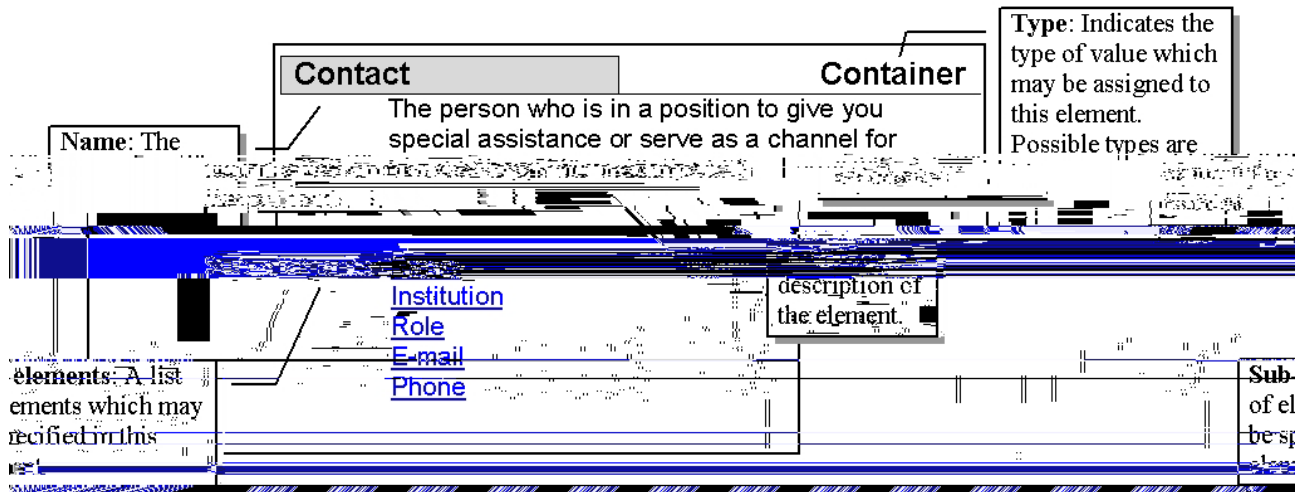
```
<CoordinateSystem>
  <CoordinateRepresentation>Cartesian</CoordinateRepresentation>
  <CoordinateSystemName>GSE</CoordinateSystemName>
</CoordinateSystem>
<Units>EARTH RADII</Units>
<UnitsConversion>6378.16 km</UnitsConversion>
<Description>
  ACE spacecraft location in GSE coordinates (X,Y,Z)."
</Description>
<Support>
  <SupportQuantity>Positional</SupportQuantity>
</Support>
</Parameter>

</NumericalData>
</Spase>
```

## 7. Definitions of the Data Model Terms

### How to Read a Definition

Each element has certain attributes and context for use. The details for each element are presented in the following form:



**Boundary:**

**FloatSequence:**

**StringSequence:**

**Value:**

<b>Axial</b>	Item
Axial symmetry.	
<b>BackWall</b>	Text
Back wall of the simulation domain by which the plasma flow may exit the simulation.	
<b>BoundaryConditions</b>	Container
Parameters associated to the simulation boundaries.	
Sub-elements:	
FieldBoundary	
ParticleBoundary	
<b>CEF1</b>	Item
Cluster Exchange Format (CEF), version 1, is a self-documenting ASCII format designed for the exchange of data. The metadata contains information compatible with the ISTP recommendations for CDF.	
<b>CEF2</b>	Item
Cluster Exchange Format (CEF), version 2, is a self-documenting ASCII format designed for the exchange of data and introduced for Cluster Active Archive. Compared to version 1, the metadata description of vectors and tensors is different.	
<b>Central</b>	Item
Central Symmetry.	
<b>ChargeExchange</b>	Item
Chemical process involving a charge transfer from an ion (which becomes neutral) to a neutral (which becomes ionized).	
<b>ChemicalFormula</b>	Text
Chemical formula representing a population of particle.	
<b>CodeLanguage</b>	Text
Language in which a numerical code is written.	
<b>CoordinatesLabel</b>	StringSequence
A string list of the labels of each dimension of the spatial domain.	
<b>CrossSection</b>	Item
Cross section of the reaction, when the reaction implies the collision of two particles.	
<b>DensityProfile</b>	Text
Density profile of the particles in a population.	
<b>DiagnosisTimeStep</b>	Container
Time at which a diagnosis is performed and quantity saved.	
Sub-elements: TimeStart	
Duration	
Sub-elements:	
Duration	
SavedQuantity	
TimeStart	
<b>Dimension</b>	Count
The number of items along one axis.	
<b>DisplayOutput</b>	Container
A graphical representation of data wherein the underlying numeric values are not (readily)	

accessible for analysis.. Examples are line plots and spectrograms. A Display Data resource is a type of "data product" which is a set of data that is uniformly processed and formatted, from one or more instruments, typically spanning the full duration of the observations of the relevant instrument(s). A data product may consist of a collection of granules of successive time spans, but may be a single high-level entity.

Sub-elements:

- AccessInformation
- Caveats
- DisplayCadence
- Extension
- InputResourceID
- Keyword
- MeasurementType
- Parameter
- ProcessingLevel
- Property
- ProviderProcessingLevel
- ProviderResourceName
- ProviderVersion
- ResourceHeader
- ResourceID
- SimulatedInstrumentID
- SimulatedRegion
- SimulationProduct
- SpatialDescription
- SpectralRange
- TemporalDescription

<b>DissociativeRecombination</b>	<u>Item</u>
Chemical process by which an ion is neutralized by capturing an electron, and splits in two new neutral species.	
<b>Distribution</b>	<u>Text</u>
Velocity distribution of the particles in a population.	
<b>Duration</b>	<u>Duration</u>
Duration of the simulation.	
<b>ElectronImpact</b>	<u>Item</u>
Chemical process by which a neutral is ionized thanks to the energy from the impact of an electron.	
<b>ElementBoundary</b>	<u>Container</u>
Parameters associated to the simulation boundaries.	
Sub-elements:	
<ul style="list-style-type: none"> <li>BackWall</li> <li>Caveats</li> <li>FrontWall</li> <li>Obstacle</li> <li>SideWall</li> </ul>	
<b>FieldBoundary</b>	<u>+ElementBoundary</u>
Parameters associated with the field boundaries of the simulation.	
<b>FieldDimension</b>	<u>Count</u>
Number of field dimensions in the simulation domain.	
<b>FieldModel</b>	<u>Text</u>
Field model imposed in the simulation run.	
<b>FieldValue</b>	<u>StringSequence</u>

A string list of the values of the input parameter.

<b>FrequencyToGyrofrequencyRatio</b>	Item
--------------------------------------	------

The ratio of the characteristic frequency of a medium to gyrofrequency of a particle.

<b>FrontWall</b>	Text
------------------	------

Front wall of the simulation domain by which the plasma flow may be injected.

<b>Ganymede</b>	Item
-----------------	------

The biggest moon of Jupiter planet in our solar system.

<b>Granule</b>	Container
----------------	-----------

Overrides Granule in base schema. An accessible portion of another resource. A Granule may be composed of one or more physical pieces (files) which are considered inseparable. For example, a data storage format that maintains metadata and binary data in separate, but tightly coupled files. Granules should not be used to group files that have simple relationships or which are associated through a parent resource. For example, each file containing a time interval data for a Numerical Data resource would each be considered a Granule. The ParentID of a Granule resource must be a NumericalData resource. The attributes of a Granule supersede the corresponding attributes in the NumericalData resource.

Sub-elements:

ExpirationDate

ParentID

PriorID

RegionBegin

RegionEnd

ReleaseDate

ResourceID

Source

StartDate

StopDate

<b>GridCellSize</b>	FloatSequence
---------------------	---------------

A string list of the cell sizes in each dimension.

<b>GridStructure</b>	Text
----------------------	------

Structure of the simulation grid.

<b>HDF4</b>	Item
-------------	------

Hierarchical Data Format, Version 4

<b>HDF5</b>	Item
-------------	------

Hierarchical Data Format, Version 5

<b>Hybrid</b>	Item
---------------	------

A numerical scheme simulating ions as particles and electrons as a fluid.

<b>Incident</b>	Item
-----------------	------

Direction-dependent property.

<b>InputField</b>	Container
-------------------	-----------

Parameters associated to a field imposed in the simulation

Sub-elements:

Caveats

CoordinateSystem

Description

FieldModel

FieldQuantity

FieldValue

InputLabel

InputTableURL

ModelURL  
 Name  
 ParameterKey  
 Qualifier  
 Set  
 SimulatedRegion  
 Units  
 UnitsConversion  
 ValidMax  
 ValidMin

**InputLabel** StringSequence

A string list of the labels of each dimension of the input parameter.

**InputParameter** Container

A container of information regarding an input parameter of the simulation run.

Sub-elements:

Caveats  
 Description  
 InputTableURL  
 Name  
 ParameterQuantity  
 Property  
 Qualifier  
 SimulatedRegion

**InputProcess** Container

Parameters associated to a chemical process happening in the simulation

Sub-elements:

Caveats  
 Description  
 ModelURL  
 Name  
 ParameterKey  
 ProcessCoeffType  
 ProcessCoefficient  
 ProcessModel  
 ProcessType  
 Set  
 SimulatedRegion  
 Units  
 UnitsConversion

**InputProperties** Container

Properties

Sub-elements:

Property

**InputTableURL** URL

A URL to a table containing input parameters.

**LikelihoodRating** Enumeration

The probability that something is true or possible.

**Model** Container

Attributes of a model.

Sub-elements:

ModelID  
 VersionTag

**ModelID** ID

A string defining the ID of the model.

<b>ModelURL</b>	URL
URL pointing toward the description of a model used in the definition of a property or an input.	
<b>ModelVersion</b>	Container
The version number of the model.	
Sub-elements:	
Caveats	
Description	
ReleaseDate	
VersionTag	
<b>NumericalOutput</b>	Container
Data stored as numerical values in a specified format. A Numerical Data resource is a type of "data product" which is a set of data that is uniformly processed and formatted, from one or more instruments, typically spanning the full duration of the observations of the relevant instrument(s). A data product may consist of a collection of granules of successive time spans, but may be a single high-level entity.	
Sub-elements:	
AccessInformation	
Caveats	
Extension	
InputResourceID	
Keyword	
MeasurementType	
Parameter	
ProcessingLevel	
Property	
ProviderProcessingLevel	
ProviderResourceName	
ProviderVersion	
ResourceHeader	
ResourceID	
SimulatedInstrumentID	
SimulatedRegion	
SimulationProduct	
SpatialDescription	
SpectralRange	
TemporalDescription	
<b>ObjectMass</b>	Value
Mass of an object referenced as a simulated region.	
<b>Obstacle</b>	Text
Obstacle in the simulation domain.	
<b>OutputParameters</b>	Container
A container of information regarding the output parameters of the simulation run.	
Sub-elements:	
Parameter	
<b>PIC</b>	Item
A numerical scheme simulating ions and electrons as macroparticles.	
<b>Paraboloid</b>	Item
A shape generated by the rotation of a parabola around its axis of symmetry.	
<b>ParameterQuantity</b>	Enumeration
The value associated with a parameter.	
Allowed Values:	
<b>Particle</b>	Container



Overrides Particle in base schema. A description of the types of particles observed in the measurement. This includes both direct observations and inferred observations.

Sub-elements:

- AtomicNumber
- AzimuthalAngleRange
- ChemicalFormula
- EnergyRange
- ParticleQuantity
- ParticleType
- PolarAngleRange
- Population
- PopulationChargeState
- PopulationMassNumber
- Qualifier

**ParticleBoundary** +ElementBoundary

Parameters associated with the particles at the boundaries of the simulation.

**Period** Value

A length or era of time.

**PhotoIonization** Item

Chemical process by which a neutral is ionized thanks to the energy from a photon.

**Plane** Item

Symmetry across a plane.

**PlaneNormalVector** FloatSequence

A list of the component in each dimension of the vector normal to a plane.

**PlanePoint** FloatSequence

A list of the component in each dimension of a point in plane.

**Population** String

A concise description of a particle population, for references.

**PopulationChargeState** Numeric

Charge of a particle in a population, in units of the charge of a proton. Charge state of a bare proton = 1.

**PopulationDensity** Value

The number of particles per unit volume.

**PopulationFlowSpeed** Value

The rate at which particles or energy is passing through a unit area in a unit time.

**PopulationMassNumber** Value

The total number of protons and neutrons (together known as nucleons) in an atomic nucleus.

**PopulationTemperature** Value

A measure of the kinetic energy of random motion with respect to the average. Temperature is properly defined only for an equilibrium particle distribution (Maxwellian distribution).

**ProcessCoeffType** Enumeration

Whether the simulation results are obtained from a stationary solution or are dynamically computed.

Allowed Values:

- CrossSection
- Frequency
- Other

## Rate

<b>ProcessCoefficient</b>	Text
Coefficient associated to a chemical process.	
<b>ProcessModel</b>	Text
Model used to describe a chemical process.	
<b>ProcessType</b>	Enumeration
Type of chemical process.	
Allowed Values:	
<ul style="list-style-type: none"> <li>ChargeExchange</li> <li>DissociativeRecombination</li> <li>ElectronImpact</li> <li>PhotoIonization</li> </ul>	
<b>ProductionRate</b>	Value
The number of items that can be produced during a given period of time.	
<b>Property</b>	Container
A container of information regarding a property of an input parameter.	
Sub-elements:	
<ul style="list-style-type: none"> <li>Caveats</li> <li>Description</li> <li>ModelURL</li> <li>Name</li> <li>PropertyLabel</li> <li>PropertyModel</li> <li>PropertyQuantity</li> <li>PropertyTableURL</li> <li>PropertyValue</li> <li>Qualifier</li> <li>Units</li> <li>UnitsConversion</li> <li>ValidMax</li> <li>ValidMin</li> </ul>	
<b>PropertyLabel</b>	StringSequence
A string list of the labels of each dimension of the property.	
<b>PropertyModel</b>	Text
Model used to define a property.	
<b>PropertyQuantity</b>	Enumeration
The value associated with a property.	
Allowed Values:	
<b>PropertyTableURL</b>	URL
A URL to a table containing property values.	
<b>PropertyValue</b>	StringSequence
A string list of the values of the property.	
<b>Radius</b>	Value
The length of a line segment from a center point to the perimeter.	
<b>Rate</b>	Item
Reaction rate: reaction production per unit of time.	
<b>RegionBegin</b>	FloatSequence

The values that define the start point of a region.

**RegionEnd** FloatSequence

The values that define the ending point of a region.

**RegionParameter** Container

Radius of the Region in the simulation.

Sub-elements:

Caveats  
Description  
InputTableURL  
ObjectMass  
Period  
Property  
Radius  
SimulatedRegion  
SubLongitude

**Remote1AU** Item

A roughly toroidal region that includes the Earth's orbit, but exclusive of the region near the Earth.

**SavedQuantity** Enumeration

Quantities that are saved during a given diagnosis.

Allowed Values:

**SideWall** Text

Side walls of the simulation domain.

**SimulatedInstrumentID** ID

The identifier of the a simulated instrument description.

**SimulatedRegion** Enumeration

The portion of space simulated by the code at the time of a diagnosis. A region is distinguished by certain natural features or physical characteristics. It is the location of the observatory for in situ data, the location or region sensed by remote sensing observatories and the location-of-relevance for parameters that are derived from observational data.

Allowed Values:

**SimulationDomain** Container

Parameters associated to the simulation spatial domain.

Sub-elements:

BoundaryConditions  
Caveats  
CoordinateSystem  
CoordinatesLabel  
Description  
FieldDimension  
GridCellSize  
GridStructure  
SpatialDimension  
Symmetry  
Units  
UnitsConversion  
ValidMax  
ValidMin  
VelocityDimension

**SimulationModel** Container

Descriptor of a simulation model: type of numerical scheme, versions,...

Sub-elements:

CodeLanguage  
 InputProperties  
 ModelURL  
 OutputParameters  
 ResourceHeader  
 ResourceID  
 SimulatedRegion  
 SimulationType  
 SpatialDescription  
 TemporalDependence  
 Versions

---

**SimulationProduct** Enumeration

The type of product produced from the simulation.

Allowed Values:

2DCuts  
 3DCubes  
 Lines  
 SpatialSeries  
 Spectra  
 TimeSeries

---

**SimulationRun** Container

Description of a simulation run, including the code ID, the run spatial and temporal description, and all the relevant inputs.

Sub-elements:

AccessInformation  
 Caveats  
 Extension  
 InputField  
 InputParameter  
 InputPopulation  
 InputProcess  
 InputResourceID  
 Keyword  
 LikelihoodRating  
 Model  
 ProviderProcessingLevel  
 ProviderResourceName  
 ProviderVersion  
 RegionParameter  
 ResourceHeader  
 ResourceID  
 SimulatedRegion  
 SimulationDomain  
 SimulationTime  
 TemporalDependence

---

**SimulationTime** Container

Parameters associated to the simulation time.

Sub-elements:

Caveats  
 Description  
 DiagnosisTimeStep  
 Duration  
 TimeStart  
 TimeStep  
 TimeStop

---

**SimulationType** Enumeration

A characterization of the numerical scheme used in the simulation

Allowed Values:

Hybrid

MHD  
 PIC  
 Paraboloid  
 Test\_Particle

**Spase** Container

Overrides Spase in the base schema. Space Physics Archive Search and Extract (SPASE). The outermost container or envelope for SPASE metadata. This indicates the start of the SPASE metadata.

Sub-elements:

Annotation  
 Catalog  
 DisplayData  
 DisplayOutput  
 Document  
 Granule  
 Instrument  
 NumericalData  
 NumericalOutput  
 Observatory  
 Person  
 Registry  
 Repository  
 Service  
 SimulationModel  
 SimulationRun  
 Version

**SpatialDescription** Container

A characterization of the spatial extent over which the measurement was taken.

Sub-elements:

CoordinateSystem  
 CoordinatesLabel  
 CubesDescription  
 CutsDescription  
 Dimension  
 PlaneNormalVector  
 PlanePoint  
 RegionBegin  
 RegionEnd  
 Step  
 Units  
 UnitsConversion

**SpatialDimension** Count

Number of spatial dimensions in the simulation domain.

**SpecificSimulatedRegion** Enumeration

Identifiers for areas of the physical world which may be occupied or observed.

Allowed Values:

Callisto  
 Enceladus  
 Europa  
 Ganymede  
 Incident  
 Io  
 Planet  
 Rhea  
 Titan  
 Title

**Step** Text

Spatial step between two elements of the diagnosis.

<b>StokesParameters</b>	<b>Item</b>
A set of four parameters (usually called I,Q, U and V) which describe the polarization state of an electromagnetic wave propagating through space.	
<b>SubLongitude</b>	<b>Value</b>
The longitude on the surface of an object which is directly below another object.	
<b>Symmetry</b>	<b>Enumeration</b>
Symmetry of the simulation domain. Allowed Values: Axial Central None Plane	
<b>TemporalDependence</b>	<b>Enumeration</b>
Whether the simulation results are obtained from a stationary solution or are dynamically computed. Allowed Values: No Yes	
<b>TestParticle</b>	<b>Item</b>
A numerical scheme simulating the motion of charged particles in a prescribed field.	
<b>TimeStart</b>	<b>Time</b>
Time at which the coverage by the element start.	
<b>TimeStep</b>	<b>Duration</b>
Time Step.	
<b>TimeStop</b>	<b>Time</b>
Time at which the coverage by the element stop.	
<b>TotalProductionRate</b>	<b>Value</b>
The total number of items that can be produced during a given period of time.	
<b>VelocityDimension</b>	<b>Count</b>
Number of velocity dimensions in the simulation domain.	
<b>VersionTag</b>	<b>Text</b>
The text string for a version indicator.	
<b>Versions</b>	<b>Container</b>
A container of one or more sets of version information. Sub-elements: ModelVersion	

## 8. Enumeration of Selected Quantities

Lists are either "open" or "closed". The items in a "closed" list are determined by the SPASE model and definitions of each item is in the SPASE data dictionary. The items in an "open" list are determined by an external control authority. The URL for the control authority is indicated in the definition of each "open" list.

**ParameterQuantity List** Union

**ProcCoefType List** Closed

Whether the simulation results are obtained from a stationary solution or are dynamically computed.

Term	Definition
CrossSection	Cross section of the reaction, when the reaction implies the collision of two particles.
Rate	Reaction rate: reaction production per unit of time.

**ProcessType List** Closed

Type of chemical process.

Term	Definition
ChargeExchange	Chemical process involving a charge transfer from an ion (which becomes neutral) to a neutral (which becomes ionized).
DissociativeRecombination	Chemical process by which an ion is neutralized by capturing an electron, and splits in two new neutral species.
ElectronImpact	Chemical process by which a neutral is ionized thanks to the energy from the impact of an electron.
PhotoIonization	Chemical process by which a neutral is ionized thanks to the energy from a photon.

**Product List** Closed

Type of article or asset.

**SavedQuantity List** Union

Quantities that are saved during a given diagnosis.

**SimulatedRegion List** Union

Identifiers for areas of the physical world which may be occupied or observed.

**SimulationType List** Closed

A characterization of the numerical scheme used in the simulation.

Term	Definition
Hybrid	A numerical scheme simulating ions as particles and electrons as a fluid.
PIC	A numerical scheme simulating ions and electrons as

Paraboloid  
 macroparticles.  
 A shape generated by the rotation of a parabola around its axis of symmetry.

SpecificSimulatedRegion List	Closed
------------------------------	--------

Identifiers for areas of the physical world which may be occupied or observed.

Term	Definition
Ganymede	The biggest moon of Jupiter planet in our solar system.
Incident	Direction-dependent property.

Symmetry List	Closed
---------------	--------

Symmetry of the simulation domain.

Term	Definition
Axial	Axial symmetry.
Central	Central Symmetry.
Plane	Symmetry across a plane.

YN List	Closed
---------	--------

Yes or No



## 9. Bibliography

National Solar Observatory Sacramento Peak

<http://www.sunspot.noao.edu/sunspot/pr/glossary.html>

Terms and Definitions

<http://www.pgd.hawaii.edu/eschool/glossary.htm>

International System of Units (SI)

<http://www.bipm.fr/en/si>

Base units: [http://www.bipm.fr/en/si/si\\_brochure/chapter2/2-1/#symbols](http://www.bipm.fr/en/si/si_brochure/chapter2/2-1/#symbols)

and those for Common derived units: [http://www.bipm.fr/en/si/derived\\_units/2-2-2.html](http://www.bipm.fr/en/si/derived_units/2-2-2.html)

ISO 8601:2004 - Date Format

[http://en.wikipedia.org/wiki/ISO\\_8601](http://en.wikipedia.org/wiki/ISO_8601)

- or -

<http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=40874>

- or -

<http://www.iso.org/iso/en/prods-services/popstds/datesandtime.html>

RFC 3339 - Date and Time on the Internet

The basis for the ISO 8601 standard.

<http://www.iso.org/iso/en/prods-services/popstds/datesandtime.html>

RFC 1014 - XDR: External Data Representation standard

<http://www.faqs.org/rfcs/rfc1014.html>

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## 11. Change History

1.0.0

2014-05-19 Released.

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