



Intégration de données de capteurs dans le *Linked Open Data*



Sommaire

Présentation succincte du *LOD*

Structuration des données

Insertion dans le *triplestore*

Moyens d'accès aux données



Le Linked Open Data

Le LOD, qu'est-ce que c'est ?

Projection de la vidéo disponible sur

<https://vimeo.com/album/2072014/video/49231111>

Le Linked Open Data

Le LOD est un des piliers du **web sémantique**

température à Montoldre le 18/03/2018 à 15:00



Web sans sémantique :

Météo Montoldre(03150) : prévisions météo Montoldreheure ...

Ce matin à Montoldre ... 15:00. 23°C. Ressenti : 25 ...
Températures à Montoldre : moyennes annuelles. La météo Montoldre sur votre site.

my-meteo.com/meteo-france/montoldre/

Météo Montoldre- Météo à14 jours - tameteo.com

Météo Montoldre - Prévisions météorologiques à 14 jours. Les données sur la météo: température, pluie/neige, vent, humidité, pression,... pour Montoldre

https://www.tameteo.com/meteo_Montoldre-Europe-France-Allier--1-3...

Météo agricole pour MONTOLDRE (03150) | Meshectares.com

Suivre la météo pour anticiper les conditions météorologiques à MONTOLDRE (03150), ... des conditions de températures, pluies, couvertures nuageuses

...

Web avec sémantique :

Température :

- ▼ Météo
 - Température de l'air
 - Température de surface
 - Température ressentie
- Médecine

Montoldre :

- Montoldre (commune), Allier, France

2018-03-18T15:00:00 :

- UTC
- Local time (UTC+1, TZ : Paris, Amsterdam, ...)

Résultats

GAEC Thomas : 14,28 °C

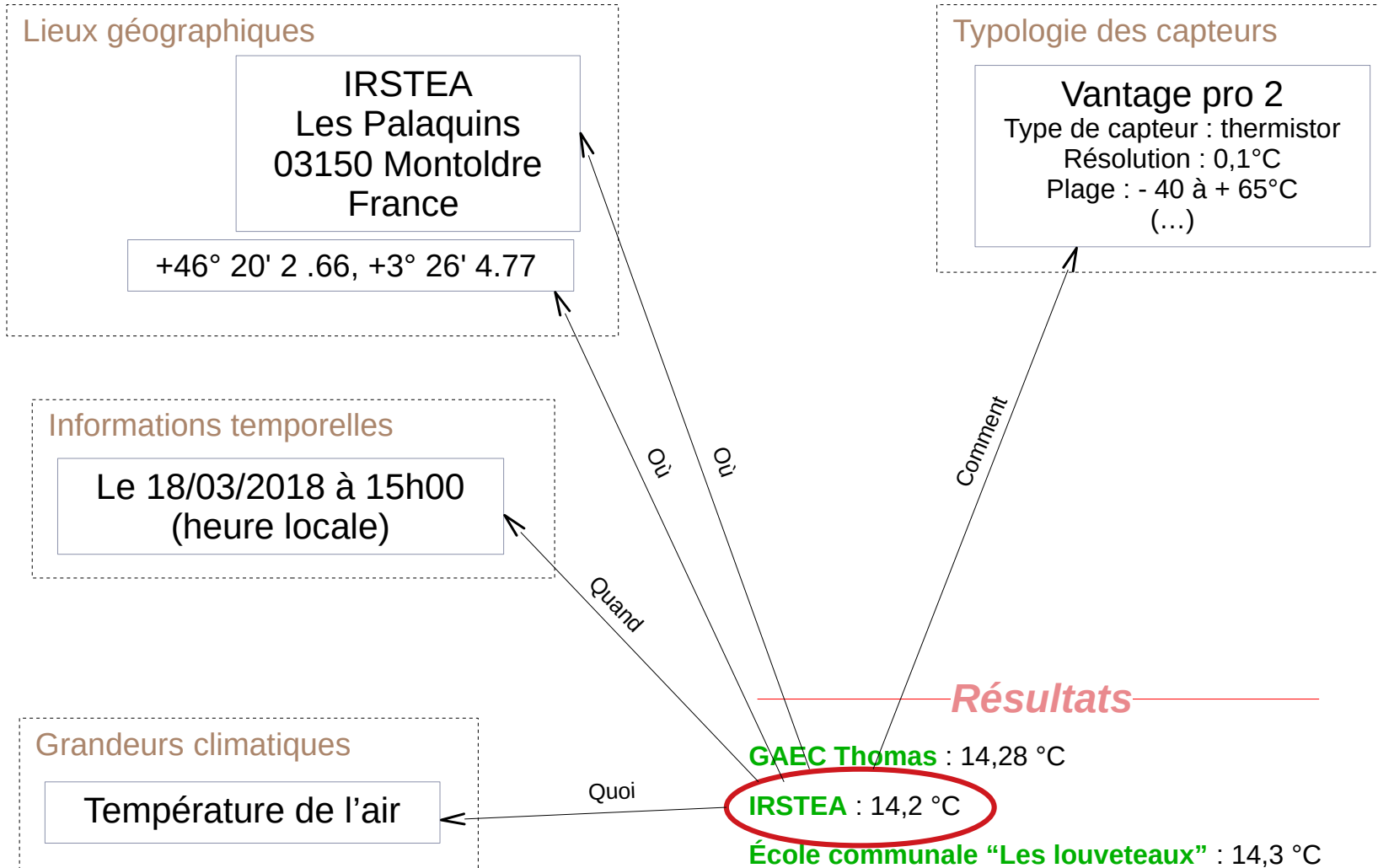
IRSTEA : 14,2 °C

École communale "Les louveteaux" : 14,3 °C

Le LOD
Les données
Le triplestore
Les services



Le Linked Open Data



Le LOD
Les données
Le triplestore
Les services



Le *Linked Open Data*

Concepts

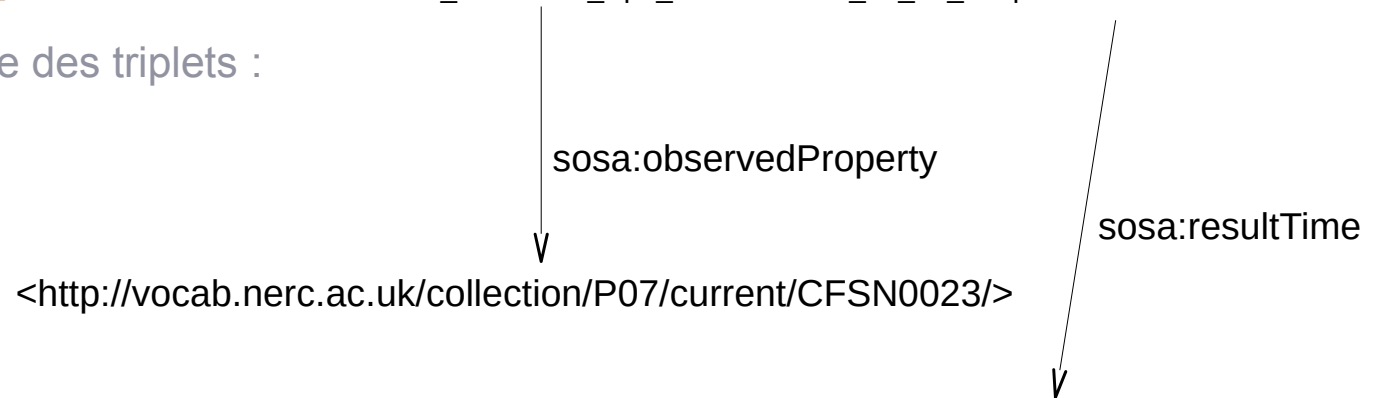
- Des identifiants uniques, sous forme d'URI :

<http://ontology.irstea.fr/weather/resource/observation/2018-01-01T15:00:00+01:00_Montoldre_Vp2_Thermometer_on_air_temperature>

... qu'on peut simplifier à l'aide d'un préfixe :

irstea_obs:2018-01-01T15:00:00+01:00_Montoldre_Vp2_Thermometer_on_air_temperature

- On ne stocke que des triplets :



- Des valeurs (typées) :

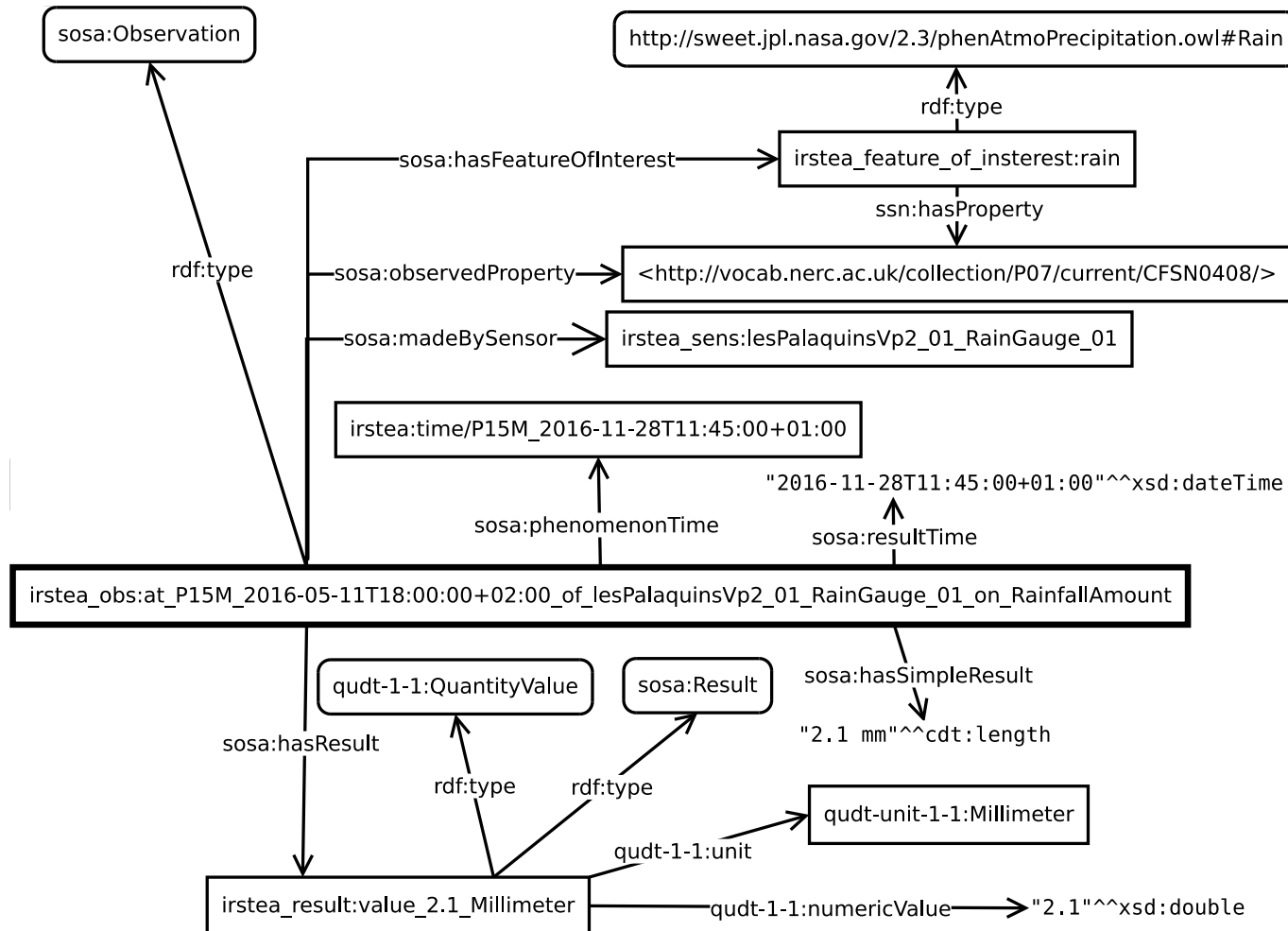
"2017-03-18T15:00:00+01:00"^^xsd:dateTime

Le LOD
Les données
Le triplestore
Les services



Structuration des données

Ce qu'on veut :



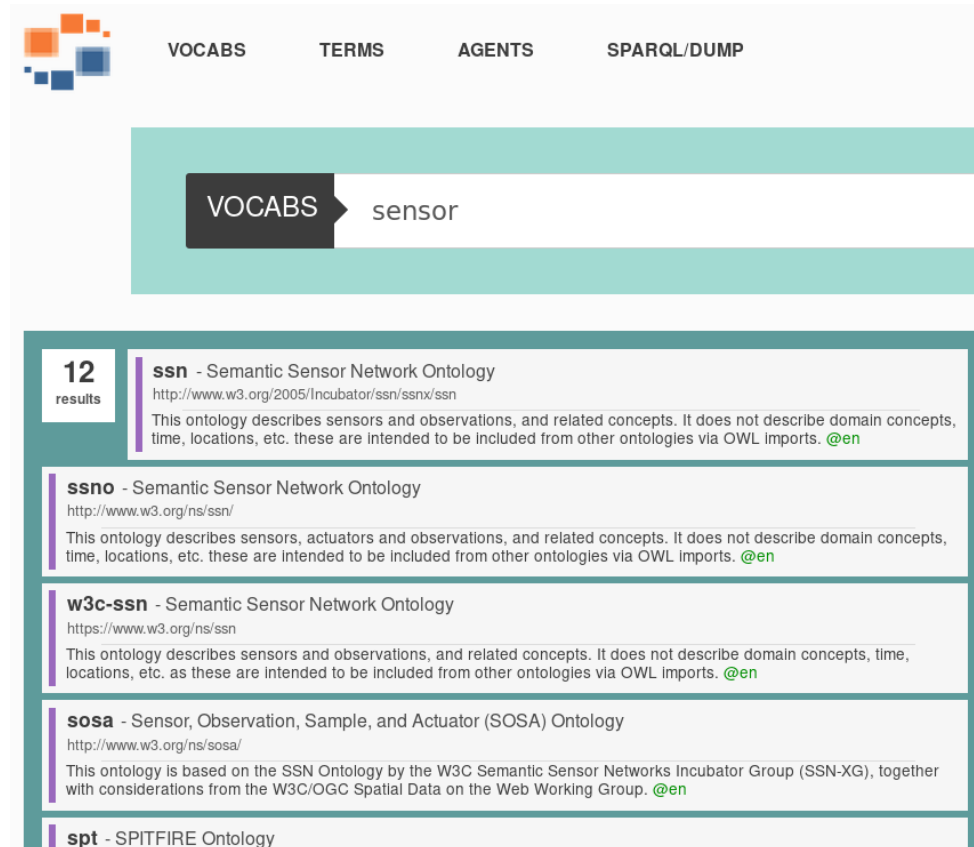
Le LOD
 Les données
 Le triplestore
 Les services



Structuration des données

Choisir une ontologie (vocabulaire)

Catalogue Lov (<https://lov.linkeddata.es/>)



The screenshot shows the Lov Catalogue interface. At the top, there are navigation tabs: VOCABS, TERMS, AGENTS, and SPARQL/DUMP. Below the tabs, a search bar contains the text 'VOCABS' and 'sensor'. The search results are displayed in a list format, showing 12 results. The first result is highlighted.

Results	Vocabularies
12	<p>ssn - Semantic Sensor Network Ontology http://www.w3.org/2005/Incubator/ssn/ssnx/ssn This ontology describes sensors and observations, and related concepts. It does not describe domain concepts, time, locations, etc. these are intended to be included from other ontologies via OWL imports. @en</p>
	<p>ssno - Semantic Sensor Network Ontology http://www.w3.org/ns/ssn/ This ontology describes sensors, actuators and observations, and related concepts. It does not describe domain concepts, time, locations, etc. these are intended to be included from other ontologies via OWL imports. @en</p>
	<p>w3c-ssn - Semantic Sensor Network Ontology https://www.w3.org/ns/ssn This ontology describes sensors and observations, and related concepts. It does not describe domain concepts, time, locations, etc. as these are intended to be included from other ontologies via OWL imports. @en</p>
	<p>sosa - Sensor, Observation, Sample, and Actuator (SOSA) Ontology http://www.w3.org/ns/sosa/ This ontology is based on the SSN Ontology by the W3C Semantic Sensor Networks Incubator Group (SSN-XG), together with considerations from the W3C/OGC Spatial Data on the Web Working Group. @en</p>
	<p>spt - SPITFIRE Ontology</p>

Le LOD
 Les données
 Le triplestore
 Les services



Structuration des données

Utilisation d'un vocabulaire

W3 Semantic Sensor Network

Rechercher

4.3.2.2 [sosa:Observation](#)

IRI: <http://www.w3.org/ns/sosa/Observation>

a OWL Class

Observation - Act of carrying out an (Observation) [Procedure](#) to estimate of a property of a [FeatureOfInterest](#). Links to a [Sensor](#) to describe what [Observation](#) and how; links to an [ObservableProperty](#) to describe what the estimate of, and to a [FeatureOfInterest](#) to detail what that property was

Example The activity of estimating the intensity of an Earthquake intensity scale is an [Observation](#) as is measuring the magnitude, i.e., the energy released by said earthquake.

Restrictions

- [sosa:madeBySensor](#) **EXACTLY 1**
- [sosa:madeBySensor](#) **ONLY** [sosa:Sensor](#)
- [sosa:usedProcedure](#) **ONLY** [sosa:Procedure](#)
- [sosa:hasFeatureOfInterest](#) **EXACTLY 1**
- [sosa:hasFeatureOfInterest](#) **ONLY** [sosa:FeatureOfInterest](#)
- [sosa:observedProperty](#) **EXACTLY 1**
- [sosa:observedProperty](#) **ONLY** [sosa:ObservableProperty](#)
- [ssn:wasOriginatedBy](#) **EXACTLY 1**
- [ssn:wasOriginatedBy](#) **ONLY** [ssn:Stimulus](#)
- [sosa:phenomenonTime](#) **EXACTLY 1**
- [sosa:hasResult](#) **MIN 1**
- [sosa:hasResult](#) **ONLY** [sosa:Result](#)
- [sosa:resultTime](#) **EXACTLY 1**

[Hide additional SSN axioms][Back to module overview and

```
sosa:Observation a rdfs:Class , owl:Class ;
  rdfs:label "Observation"@en ;
  skos:definition "Act of carrying out an(...)"@en ;
  rdfs:comment "Act of carrying out an (...)"@en ;
  skos:example "The activity of estimating (...)"@en ;
  rdfs:isDefinedBy sosa: .
```

```
sosa:madeObservation a owl:ObjectProperty ;
  rdfs:label "made observation"@en ;
  skos:definition "Relation between a Sensor and an
  Observation made by the Sensor."@en ;
  rdfs:comment "Relation between a Sensor and an
  Observation made by the Sensor."@en ;
  schema:domainIncludes sosa:Sensor ;
  schema:rangeIncludes sosa:Observation ;
  owl:inverseOf sosa:madeBySensor ;
  rdfs:isDefinedBy sosa: .
```

```
sosa:madeBySensor rdf:type owl:ObjectProperty ;
  rdfs:label "made by sensor"@en ;
  skos:definition "Relation between an Observation
  and the Sensor which made the Observation."@en ;
  rdfs:comment "Relation between an Observation and
  the Sensor which made the Observation."@en ;
  schema:domainIncludes sosa:Observation ;
  schema:rangeIncludes sosa:Sensor ;
  owl:inverseOf sosa:madeObservation ;
  rdfs:isDefinedBy sosa: .
```

```
sosa:observedProperty a owl:ObjectProperty ;
  rdfs:label "observed property"@en ;
  skos:definition "Relation linking (...)"@en ;
  (...)
```

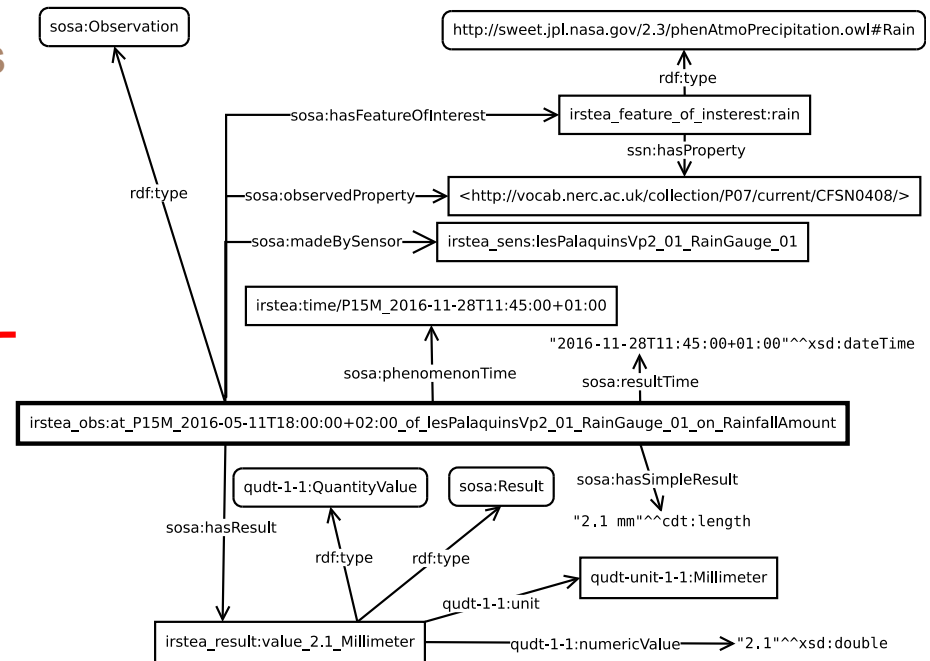
4.3.2.3 [sosa:observedProperty](#)

Le LOD
Les données
Le triplestore
Les services



Structuration des données

Transcription des données



```

irstea_obs:at_P15M_2016-05-11T18:00:00+02:00_of_lesPalaquinsVP2_01_RainGauge_01_on_RainfallAmount
  a sosa:Observation ;
  sosa:resultTime "2016-11-28T18:00:00+02:00"^^xsd:dateTime ;
  sosa:phenomenonTime irstea_time:P15M_2016-05-11T18:00:00+02:00 ;
  sosa:observedProperty <http://vocab.nerc.ac.uk/collection/P07/current/CFSN0408/> ;
  sosa:featureOfInterest irstea_feature_of_interest:rain ;
  sosa:madeBySensor irstea_sens:lesPalaquinsVp2_01_RainGauge_01 ;
  sosa:hasSimpleResult "2.1 mm"^^cdt:length ;
  sosa:hasResult irstea_result:value_2.1_Millimeter .

```

```

irstea_result:value_2.1_Millimeter a qudt-1-1:QuantityValue , sosa:Result ;
  qudt-1-1:unit qudt-1-1:Millimeter ;
  Qudt-1-1:numericValue "2,1"^^xsd:double .

```

Le LOD
Les données
Le triplestore
Les services



Structuration des données

Transcription des données

Ce qu'on a :

Date	Time	Temp Out	Hi Temp	Low Temp	Out Hum	Wind Speed	Wind Dir	Bar	Rain	Rain Rate	Solar Rad. (...)
11/05/16	17:55	17.6	17.6	17.6	74	0.0	ESE	749.6	0.00	0.0	193 (...)
11/05/16	17:56	17.6	17.6	17.6	74	0.0	ESE	749.7	0.00	0.0	190 (...)
11/05/16	17:57	17.6	17.6	17.6	75	0.0	ESE	749.7	0.00	0.0	185 (...)
11/05/16	17:58	17.6	17.6	17.6	74	0.0	---	749.7	0.00	0.0	181 (...)
11/05/16	17:59	17.6	17.6	17.6	74	0.0	---	749.7	0.00	0.0	176 (...)
11/05/16	18:00	17.6	17.6	17.5	75	0.0	---	749.7	0.00	0.0	172 (...)
11/05/16	18:01	17.6	17.6	17.5	75	0.0	ESE	749.7	0.00	0.0	171 (...)
11/05/16	18:02	17.6	17.6	17.5	75	0.0	---	749.7	0.00	0.0	169 (...)
11/05/16	18:03	17.6	17.6	17.5	75	0.0	---	749.7	0.00	0.0	167 (...)



Le LOD
Les données
Le triplestore
Les services

```

irstea_obs:at_P01M_2016-05-11T18:00:00+02:00_of_lesPalaquinsVP2_01_RainGauge_01_on_RainfallAmount
  a sosa:Observation ;
  sosa:resultTime "2016-05-11T18:00:00+02:00"^^xsd:dateTime ;
  sosa:phenomenonTime irstea_time:P01M_2016-05-11T18:00:00+02:00 ;
  sosa:observedProperty <http://vocab.nerc.ac.uk/collection/P07/current/CFSN0408/> ;
  sosa:featureOfInterest irstea_feature_of_interest:rain ;
  sosa:madeBySensor irstea_sens:lesPalaquinsVp2_01_RainGauge_01 ;
  sosa:hasSimpleResult "0.0 mm"^^cdt:length ;
  sosa:hasResult irstea_result:value_0.0_Millimeter .

```

```

irstea_result:value_0.0_Millimeter a qudt-1-1:QuantityValue , sosa:Result ;
  qudt-1-1:unit qudt-1-1:Millimeter ;
  Qudt-1-1:numericValue "0.0"^^xsd:double .

```



Les triplestores

Base de données dédiée aux triplets.

Quelques implémentations :

- Openlink Virtuoso  OPENLINK SOFTWARE
Making Technology Work For You®
- Apache Jena-Fuseki 
- Corese 
- ...

Le LOD
Les données
Le triplestore
Les services

Caractéristiques des *triplestores*

Langage de requêtes : SPARQL

```
PREFIX sosa: <http://www.w3.org/ns/sosa/>
PREFIX qudt: <http://qudt.org/1.1/schema/qudt#>

SELECT ?obs ?time ?value
WHERE {
  ?obs a sosa:Observation ;
    sosa:observedProperty <http://vocab.nerc.ac.uk/collection/P07/current/CFSN0038/> ;
    sosa:resultTime ?time ;
    sosa:hasResult [ qudt:numericValue ?value ] .
} ORDER BY ?time
```

Protocole de communication : HTTP

Méthodes PUT, GET, POST et DELETE (envoi de données, requêtes, modifications – update – et effacement) : architecture REST.

Balises pour le format de réponse, le contenu des requêtes, ...

Le LOD
Les données
Le triplestore
Les services





Accès au triplestore

URLs

Requêtes (SPARQL – HTTP GET)

- <http://ontology.irstea.fr:3030/weather2017/query>
- <http://ontology.irstea.fr:3030/weather2017/sparql>

Envoi de données (rdf-xml ou turtle – HTTP PUT)

- <http://ontology.irstea.fr:3030/weather2017/upload>

Modifications (SPARQL – HTTP POST)

- <http://ontology.irstea.fr:3030/weather2017/update>

Modifications (SPARQL Graph Store Protocol – HTTP GET/PUT/DELETE/POST)

- <http://ontology.irstea.fr:3030/weather2017/data>

Clients SPARQL

Accès HTTP

Exemple de code python

```
import requests

### Interrogation (HTTP GET) :
query = {'query': 'SELECT * WHERE { ?a ?b ?c }'}
url = "http://cfs-sparql.clermont.cemagref.fr:3030/weather2017/query"
r = requests.get(url, params=query)
print(r.text)

### Modification (HTTP POST) :
Query = { 'update': """prefix : <http://ontology.irstea.fr/weather2017#>
DELETE { ?s <http://www.w3.org/ns/sosa/madeObservation> ?o }
WHERE { ?s <http://www.w3.org/ns/sosa/madeObservation> ?o }""" }

url = "http://cfs-sparql.clermont.cemagref.fr:3030/weather2017/update"
r = requests.post(url, data=query)
if (r.status_code == 200) :
    print('>>>>>> SUCCÈS <<<<<<<')
else :
    print(r.text)
```

Le LOD
Les données
Le triplestore
Les services



APIs

Apache Jena (Java), CubicWeb (Python), ...

Clients SPARQL

En ligne

Exemple : Snorql (<https://github.com/kurtjx/SNORQL>)



The screenshot shows a web browser window with the URL `http://ontology.irstea.fr:888/?query=SELECT+%3Fp+%3Fo+WHERE+%7B%0D%0A+%3Fp+%3Fo+%7C+%3Fp+rdfs:type+%3Ffo+%7D`. The page title is "Snorql: Exploring http://ontology.irstea.fr/weather2017/query".

SPARQL:

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX sosa: <http://www.w3.org/ns/sosa/>
PREFIX aws: <http://purl.oclc.org/NET/ssnx/meteo/aws#>
PREFIX time: <http://www.w3.org/2006/time#>
PREFIX qudt: <http://qudt.org/1.1/schema/qudt#>
PREFIX qudt:unit: <http://qudt.org/1.1/vocab/unit#>
PREFIX irstea: <http://ontology.irstea.fr/weather2017/resource/>

SELECT ?p ?o WHERE {
  <http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01> ?p ?o
}

```

Sample queries:

- [Wind speed](#)
- [Average temperature](#)
- [Solar flux](#)

Results:

SPARQL results:

p	o
rdf:type	sosa:Platform
rdf:type	<http://www.opengis.net/ont/geosparql#Feature>
<http://www.w3.org/ns/locn#location>	irstea:location/irsteaClermontMontoldre
<http://www.opengis.net/ont/geosparql#hasGeometry>	irstea:geometry/point_lesPalaquinsVp2_01
sosa:hosts	irstea:sensor/lesPalaquinsVp2_01_Barometer_01
sosa:hosts	irstea:sensor/lesPalaquinsVp2_01_WindVane_01
sosa:hosts	irstea:sensor/lesPalaquinsVp2_01_WindGauge_01
sosa:hosts	irstea:sensor/lesPalaquinsVp2_01_Hygrometer_01

Le LOD
Les données
Le triplestore
Les services



Documentation

En ligne



The screenshot shows a web browser window with the URL <http://ontology.irstea.fr:800/pmwiki.php/Site/Weather2017>. The page title is "Weather 2017 with SOSA ontology". The main content includes a description of the data, a list of reused ontologies, and information about data availability and access.

Weather 2017 with SOSA ontology

Weather 2017 is the providing of RDF data about one of the meteorological stations that Irstea owns in its experimental farm at Montoldre. A set of data collected between January and July 2017 is available. It uses the new [Semantic Sensor Network Ontology](#), called (and prefixed) *sosa*. We also reused some specific ontologies:

- To reference weather phenomena, the [sweet ontology](#) is reused.
- The [Climate and Forecast thesaurus](#) is reused directly to describe property of weather phenomena.
- The unit are described by the [QUDT ontology](#).
- The sensor are described by the [AWS ontology](#).
- The location of the weather station is described by the [LOCN vocabulary](#) and the [geosparql ontology](#).

This was done for the same station with data collected from years 2010 to 2015, using the old [Semantic Sensor Network Ontology](#) and is available [here](#).

The data are available under the french open licence of etalab <https://www.etalab.gov.fr/licence-ouverte-open-licence>. This licence is compatible with the «Open Government Licence» (OGL) of the United Kingdom, the «Creative Commons Attribution 2.0» (CC-BY 2.0) licence of Creative Commons and the «Open Data Commons Attribution» (ODC-BY) licence of the Open Knowledge Foundation.

Access to SPARQL End Point

[Access with a Web browser](#)

- A query interface using [snorql](#) is available at <http://ontology.irstea.fr/weather2017/snorql/>.
- Pubby frontend is available at <http://ontology.irstea.fr/weather2017/>.

Navigation menu:

- HomePage
- WikiSandbox
- WikiExtension

Weather data

- Data before 2017
- Data after 2017

BSV

- Archives des bulletins / Bulletin archive
- Thesaurus FrenchCropUsage

AgronomicTaxon

AgroTechnoPôle

- Présentation
- Séjour de Maria Poveda à l'Irstea de Clermont-Ferrand
- Visite de Raul Garcia Castro et

Le LOD
Les données
Le triplestore
Les services



Déréférencement des URI

Principe

Exemple : On veut en savoir plus sur l'élément désigné par l'URI

http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01

Avec un navigateur web :

➡ GET http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01
Accept=text/html

⬅ Error 303
Location=http://ontology.irstea.fr/weather2017/page/resource/system/lesPalaquinsVp2_01

➡ GET http://ontology.irstea.fr/weather2017/page/resource/system/lesPalaquinsVp2_01

⬅



Station météo du centre IRSTEA de Montoldre — Vantage Pro 2 at IRSTEA

weather2017
http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01

Station type : Vantage Pro 2 Wireless Weather Station Construtor : Davis Instruments Located in : IRSTEA, Les Palaquins, Montoldre, Allier (03), France.

Property	Value
rdfs:comment	<ul style="list-style-type: none"> Station type : Vantage Pro 2 Wireless Weather Station Construtor : Davis Instruments Located in : IRSTEA, Les Palaquins, Montoldre, Allier (03), France.
geosparql:hasGeometry	<ul style="list-style-type: none"> atp_geom:point_lesPalaquinsVp2_01
sosa:hosts	<ul style="list-style-type: none"> atp_sensor:lesPalaquinsVp2_01_Barometer_01 atp_sensor:lesPalaquinsVp2_01_Hygrometer_01 atp_sensor:lesPalaquinsVp2_01_RainGauge_01 atp_sensor:lesPalaquinsVp2_01_SolarCell_01 atp_sensor:lesPalaquinsVp2_01_Thermometer_01 atp_sensor:lesPalaquinsVp2_01_WindGauge_01 atp_sensor:lesPalaquinsVp2_01_WindVane_01
locn:location	<ul style="list-style-type: none"> atp_loc:irsteaClermontMontoldre
foaf:name	<ul style="list-style-type: none"> Station météo du centre IRSTEA de Montoldre — Vantage Pro 2 (fr)
rdf:type	<ul style="list-style-type: none"> geosparql:Feature sosa:Platform

This page shows information obtained from the SPARQL endpoint at <http://ontology.irstea.fr/weather2017/query>.
[As Turtle](#) | [As RDF/XML](#) | [Browse in Disco](#) | [Browse in Tabulator](#) | [Browse in OpenLink Browser](#)

Le LOD
Les données
Le triplestore
Les services



Déréférencement des URI

Principe

Exemple : On veut en savoir plus sur l'élément désigné par l'URI

http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01

Avec un client RDF :

➡ GET http://ontology.irstea.fr/weather2017/resource/system/lesPalaquinsVp2_01
Accept=application/rdf+xml

⬅ Error 303
Location=http://ontology.irstea.fr/weather2017/data/resource/system/lesPalaquinsVp2_01

➡ GET http://ontology.irstea.fr/weather2017/data/resource/system/lesPalaquinsVp2_01

⬅

```
@prefix cdt:      <http://w3id.org/lindt/custom_datatypes#> .
@prefix rdf:      <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix atp_system: <http://ontology.irstea.fr/weather2017/resource/system/> .
(...)

<http://ontology.irstea.fr/weather2017/data/resource/system/lesPalaquinsVp2_01>
  rdfs:label "RDF description of Station météo du centre IRSTEA de Montoldre – Vantage Pro 2" ;
  foaf:primaryTopic atp_system:lesPalaquinsVp2_01 .

atp_system:lesPalaquinsVp2_01
  rdf:type  sosa:Platform , geosparql:Feature ;
  rdfs:comment "\n  Station type : Vantage Pro 2 Wireless Weather Station\n  Construtor : Davis
Instruments\n  Located in : IRSTEA, Les Palaquins, Montoldre, Allier (03), France.\n  " ;
  geosparql:hasGeometry
    atp_geom:point_lesPalaquinsVp2_01 ;
  locn:location atp_loc:irsteaClermontMontoldre ;
  sosa:hosts atp_sensor:lesPalaquinsVp2_01_WindVane_01 , atp_sensor:lesPalaquinsVp2_01_WindGauge_01 ,
atp_sensor:lesPalaquinsVp2_01_Hygrometer_01 , atp_sensor:lesPalaquinsVp2_01_Thermometer_01 ,
atp_sensor:lesPalaquinsVp2_01_SolarCell_01 , atp_sensor:lesPalaquinsVp2_01_Barometer_01 ,
atp_sensor:lesPalaquinsVp2_01_RainGauge_01 ;
  foaf:name "Station météo du centre IRSTEA de Montoldre – Vantage Pro 2"@fr .
```



Regroupement des différents outils

Bilan :

SPARQL Endpoint (accès au *triplestore*)

- <http://ontology.irstea.fr:3030/weather2017/{query,sparql,upload,update}>

Client SPARQL interactif (snorql)

- <http://ontology.irstea.fr:888/>

Accès à la documentation en ligne (pmWiki)

- <http://ontology.irstea.fr:800/>

Consultation des URIs (pubby)

- [http://ontology.irstea.fr:8080/weather2017/resource/\(...\)](http://ontology.irstea.fr:8080/weather2017/resource/(...))

Regroupement des différents outils

Apache mod_proxy (port 80) :

<http://ontology.irstea.fr/weather2017/{query,sparql}>

- <http://ontology.irstea.fr:3030/weather2017/{query,sparql}>



<http://ontology.irstea.fr/weather2017/snorql/>

- <http://ontology.irstea.fr:888/>



<http://ontology.irstea.fr/weather2017/pmWiki/>

- <http://ontology.irstea.fr:800/>



<http://ontology.irstea.fr/weather2017/{resource,data,page,...}>

- <http://ontology.irstea.fr:8080/weather2017/>



<http://ontology.irstea.fr>



Merci de votre attention

