



**Trajectories**  
Univ. Grenoble Alpes



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**Univ. Grenoble Alpes**

October 30th 2019

# **Trajectories : Social-ecological trajectories of French alpine valleys under climate variability**



financé par  
**IDEX Université Grenoble Alpes**

## SCIENTIFIC AND SOCIO-ECONOMICAL CHALLENGES



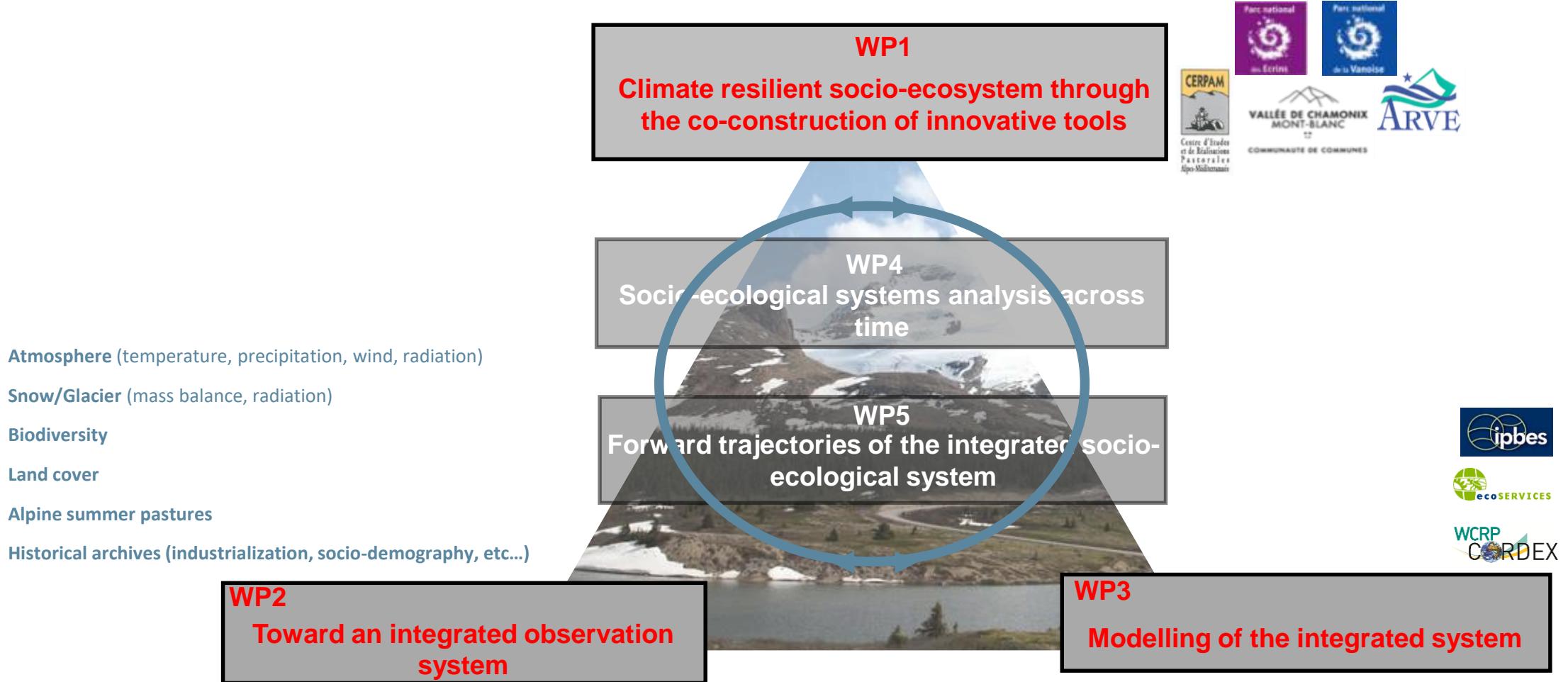
**Understand the adaptation processes of the societies to their environment**

**Trois territoires pilotes : la vallée de l'Arve, la vallée de la Maurienne et le Pays de la Meije.**

**Objectifs :**

- Développer des outils innovants pour construire des passerelles entre la production de connaissances et les besoins des utilisateurs au sein des territoires
- Construire un système intégré d'acquisition et de gestion des données socio-environnementales
- Développer et appliquer des modèles de la dynamique des socio-écosystèmes face aux changements globaux
- Reconstruire les trajectoires socio-environnementales passées sur la base des observations et de la modélisation
- Co-construire avec les acteurs des territoires des trajectoires d'adaptation au changement global

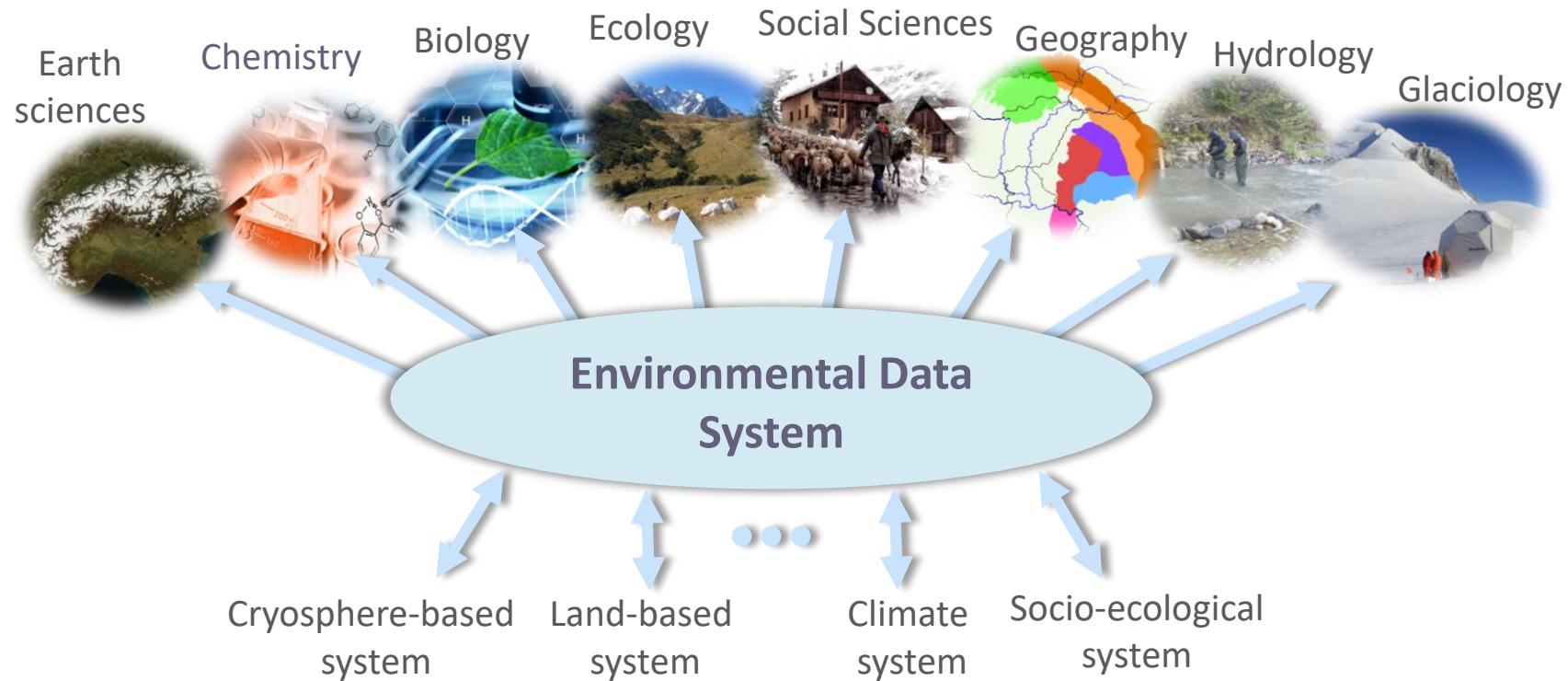
# PROJECT STRUCTURATION



# CONTEXT

## ■ Multidisciplinarity

- ▶ Combining several usually separate domains of expertise
- ▶ Multidisciplinary Environmental Sciences



# CONTEXT

## ■ Focus

### ► Scientific domains

- Climatology
  - climate & microclimate
- Hydrology
- Biology
  - Biodiversity
- Social Sciences
  - Tourism



### ► Many databases



**Kalideos**  
**(CNES)**

Satellite images



**CEN**  
**(Météo France)**

Meteorology



**CRYOBS-CLIM**  
**(IGE)**

Glaciology



**Arve Valley**  
**Hydrology (IGE)**

Hydrologic data



**Lacs**

Alpine lakes data



**Alpages**

Pastoral land uses



**Refuges**  
**Sentinelles**

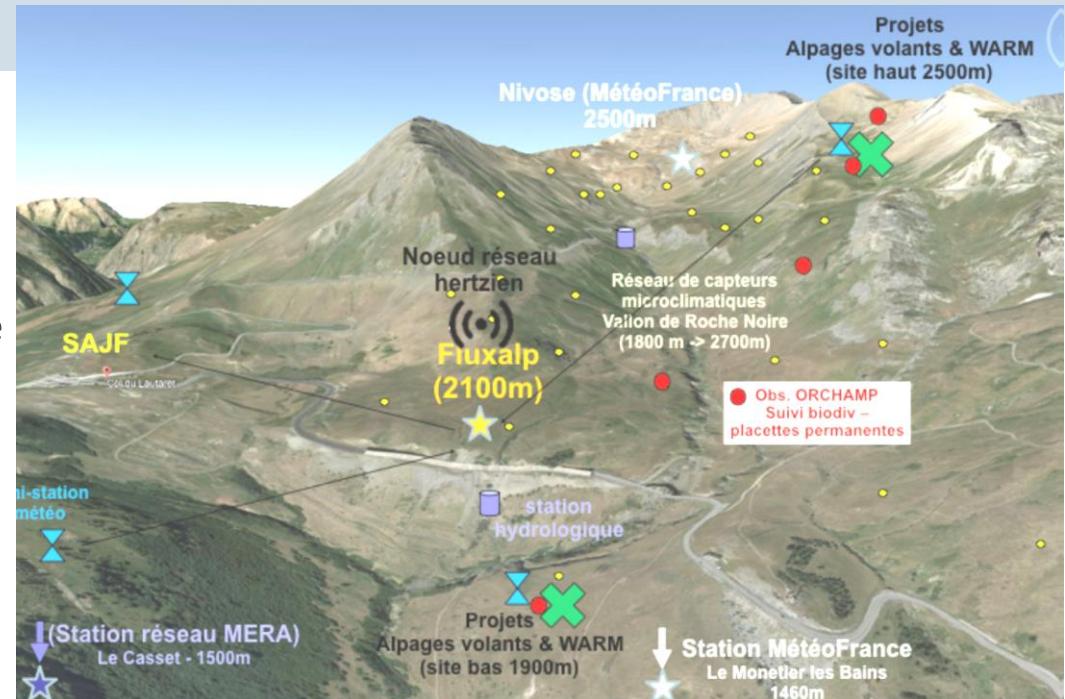
Tourism  
land uses



**ORCHAMP**  
Biology



**data@EDYTEM**  
Sedimentary  
samples



- Meteorology
  - atmospheric
  - precipitation
- Glaciology
  - snow
  - ice

# DATABASE INTEROPERABILITY

## ■ 3 possibilities

### ► Mediator

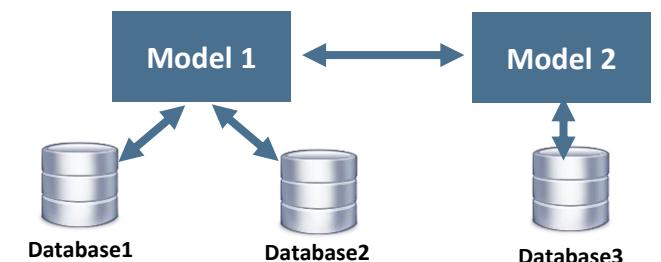
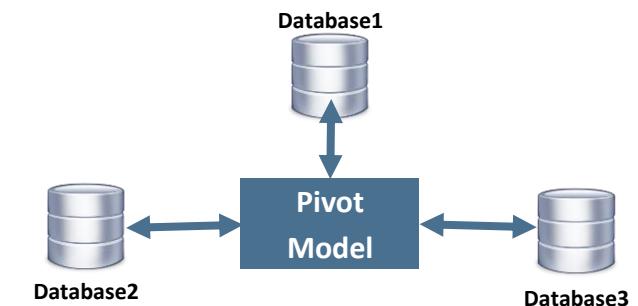
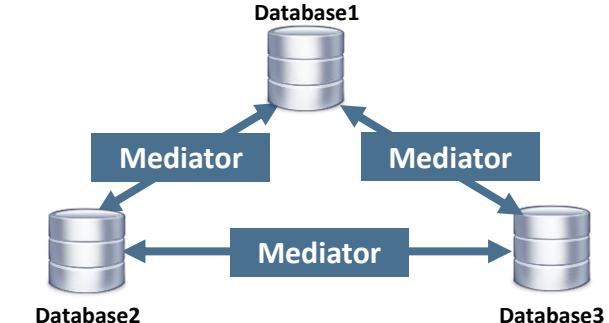
- software component that resolves schematic and semantic conflicts

### ► Pivot model

- Common data model intersecting the different specific data models

### ► Reuse of data models

- Mapping specific data models to common models
- Mapping between different models



# DATABASE INTEROPERABILITY

## ■ 3 possibilities

### ► Mediator

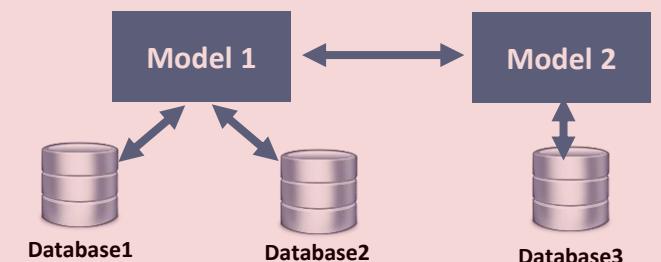
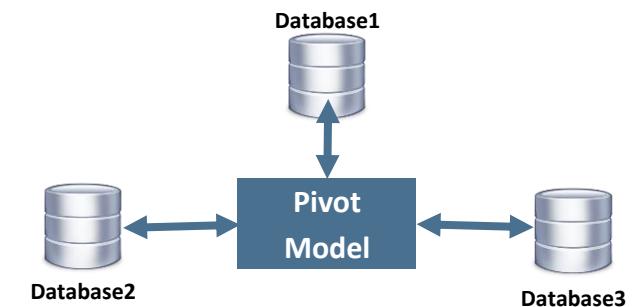
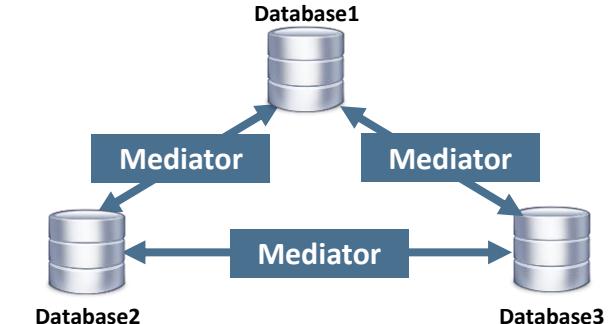
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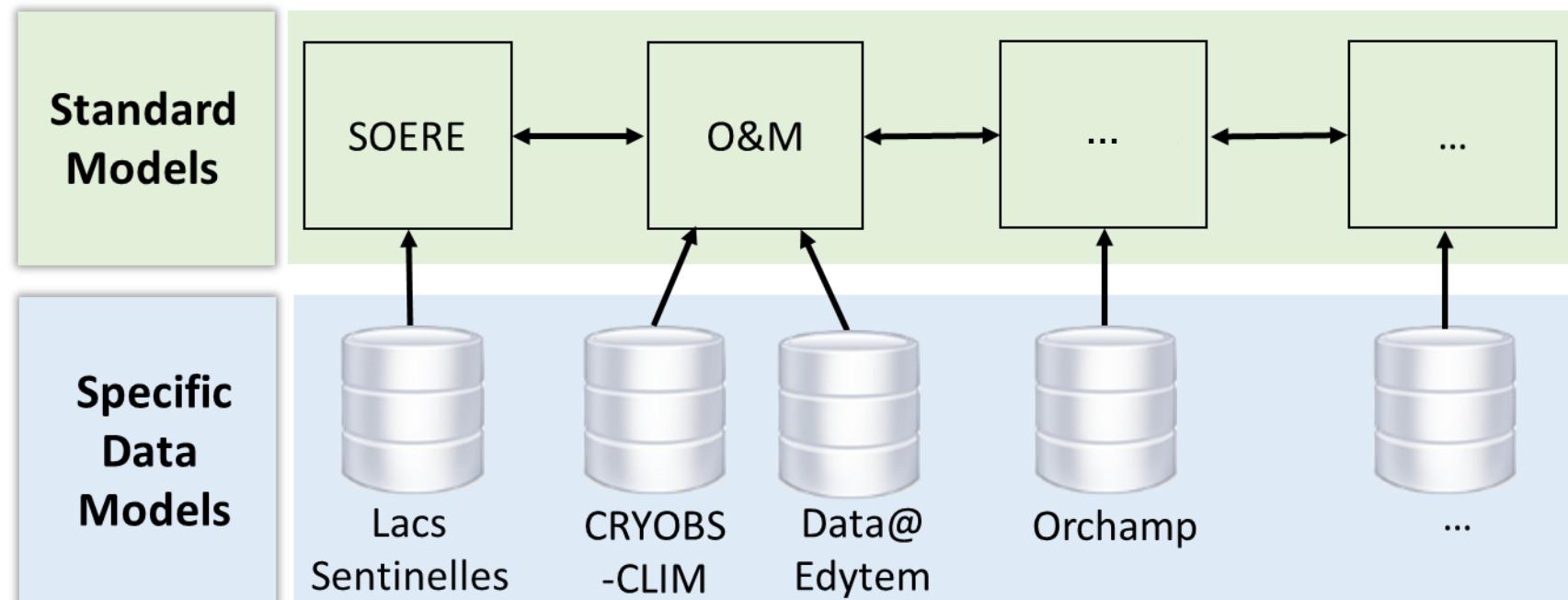


# DATABASE INTEROPERABILITY WITH STANDARDS

## ■ Interoperability of MetaData & Data using standards & norms

### ■ Standards and norms

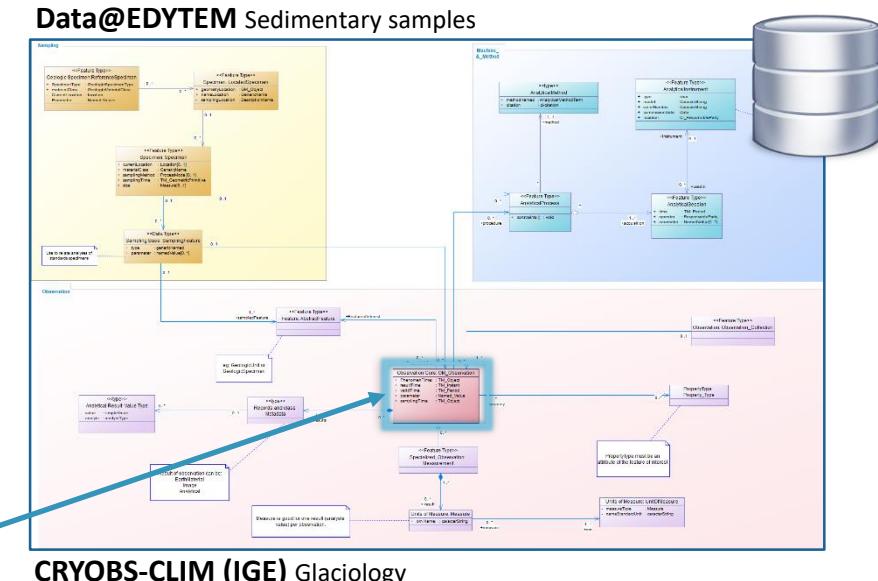
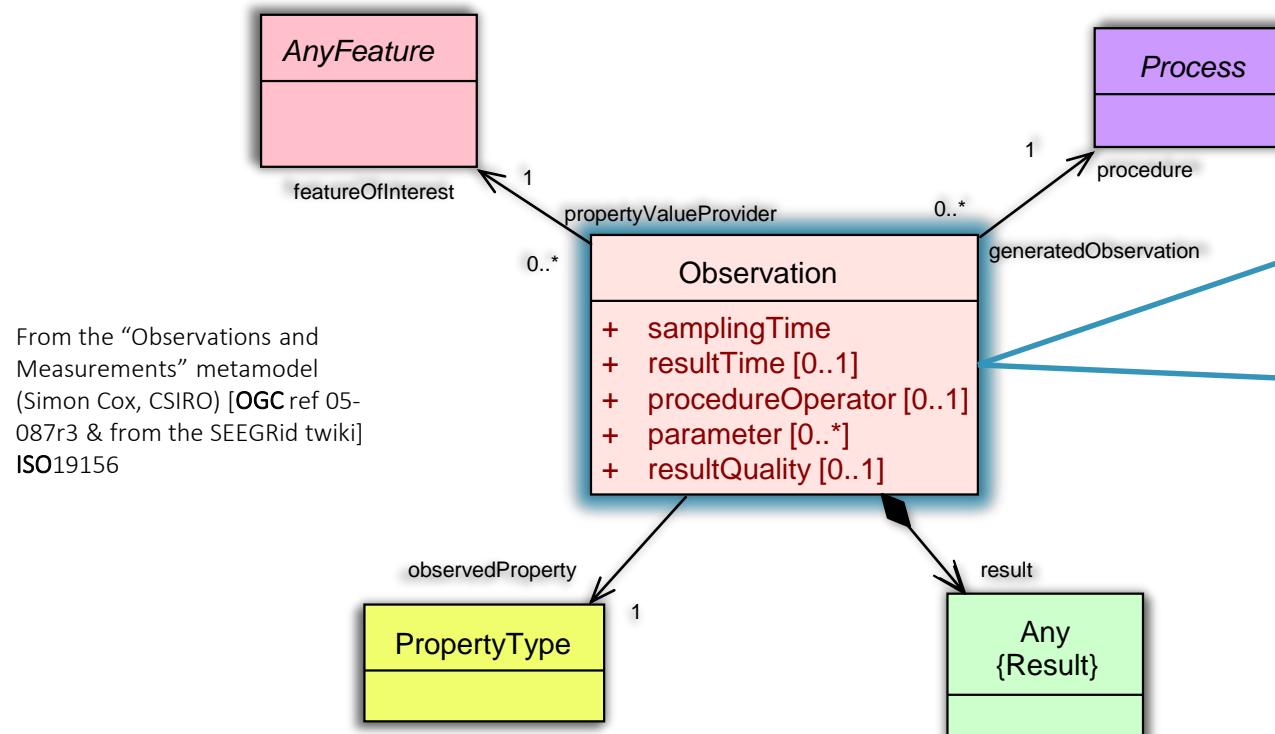
- ▶ norms expressed in formal, non-ambiguous, and machine understandable languages with some consensual rules and directives to describe objects, products, activities...



# LINKS WITH O&M (OBSERVATIONS & MEASURES)

## ■ Observations [Fowler & Odell 1997]

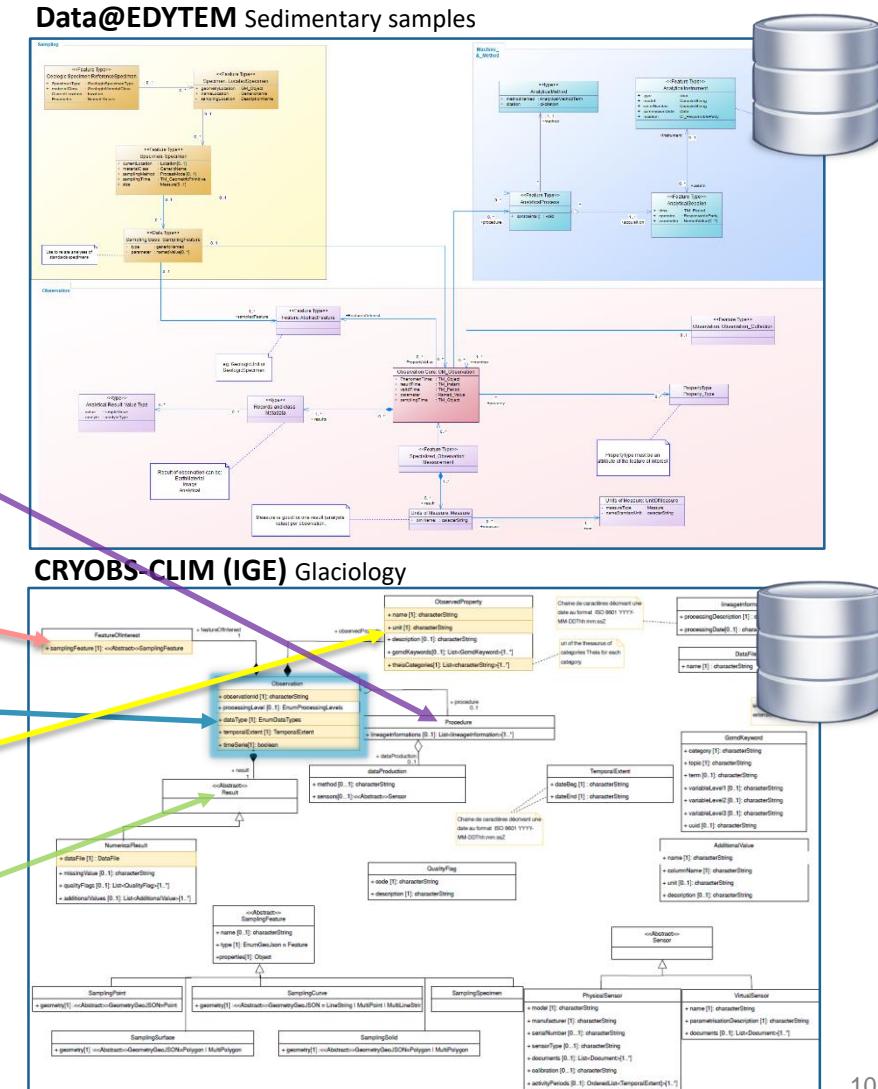
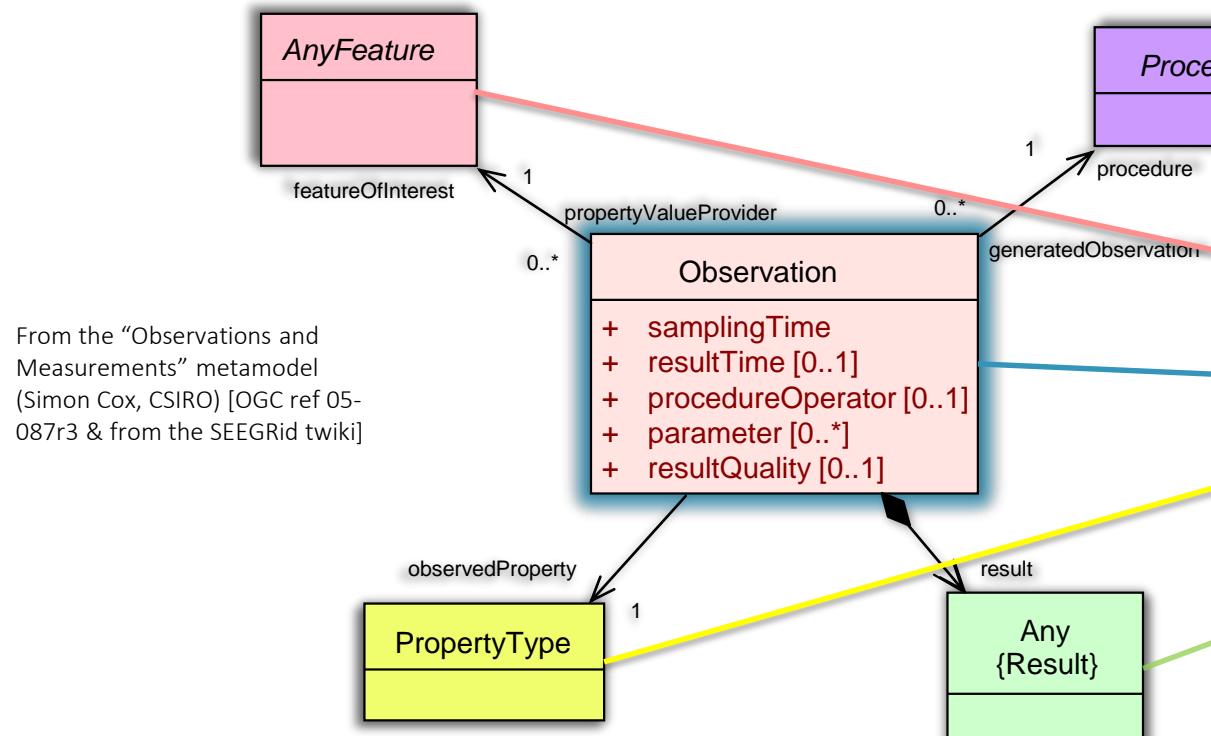
- ▶ Observation is produced by a process applied at a specific time
- ▶ The observation domain is a feature of interest at a specific time
- ▶ The result of an observation is an estimate of some properties



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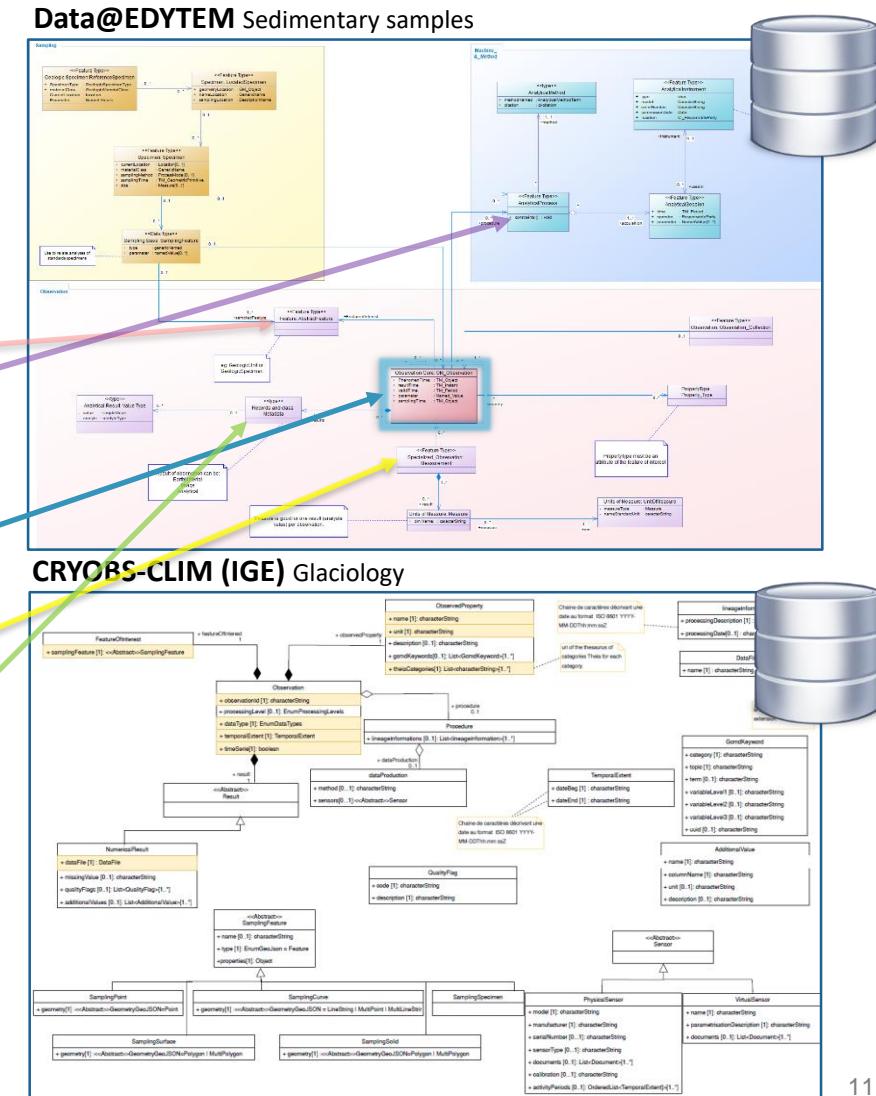
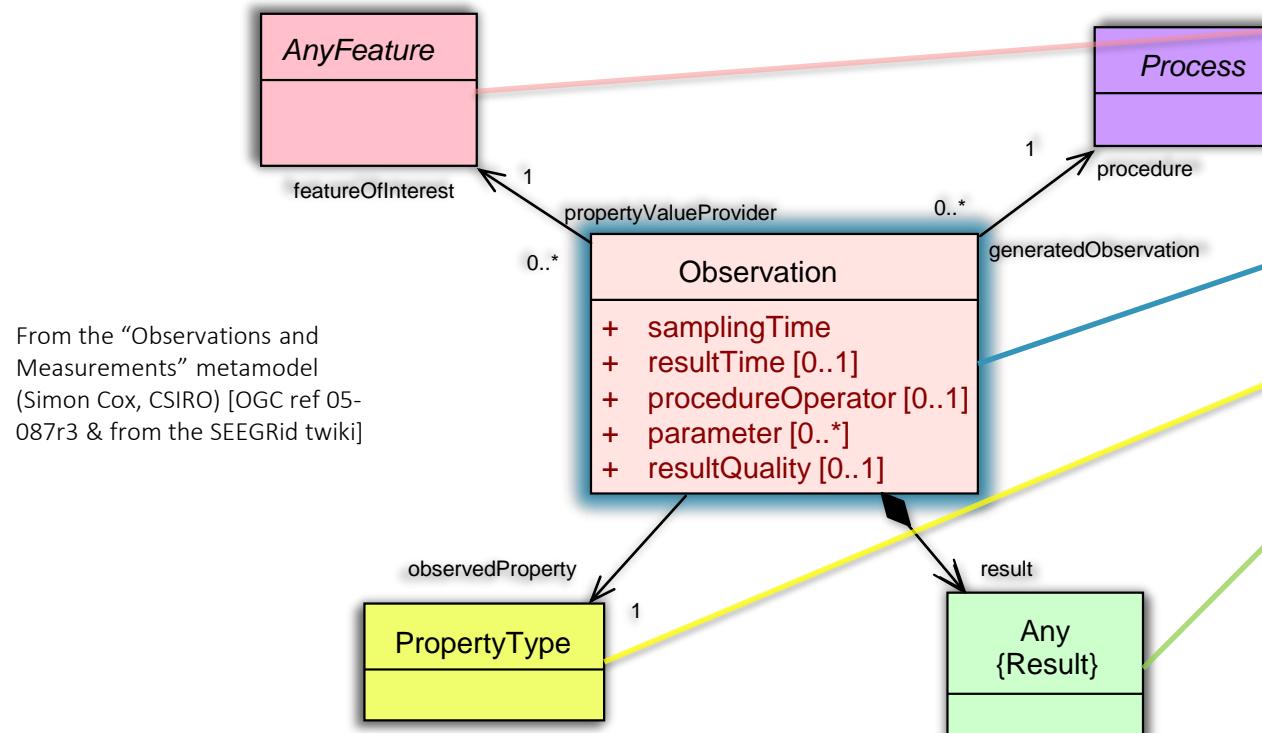
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# INTEROPERABILITY WITH STANDARDS, NORMS AND ONTOLOGIES

- **Syntactic compatibility**
  - ▶ only guarantees that data will *pass through* different applications properly
- **Semantic compatibility**
  - ▶ achieved only when applications agree on the *meaning* of the data they exchange
- **Standards and norms**
  - ▶ norms expressed in formal, non-ambiguous, and machine understandable languages with some consensual rules and directives to describe objects, products, activities...
- **Semantics and Ontology**
  - ▶ An ontology is an explicit specification of a conceptualization. [...] A conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose. [Gruber 1993]
  - ▶ An ontology defines a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). [Gruber 2009]
  - ▶ **Denotational semantics**
    - defines a model, an abstraction, an interpretation
  - ▶ **Axiomatic semantics**
    - builds a logical theory
  - ▶ **Operational semantics**
    - builds an interpreter, or a finite representation

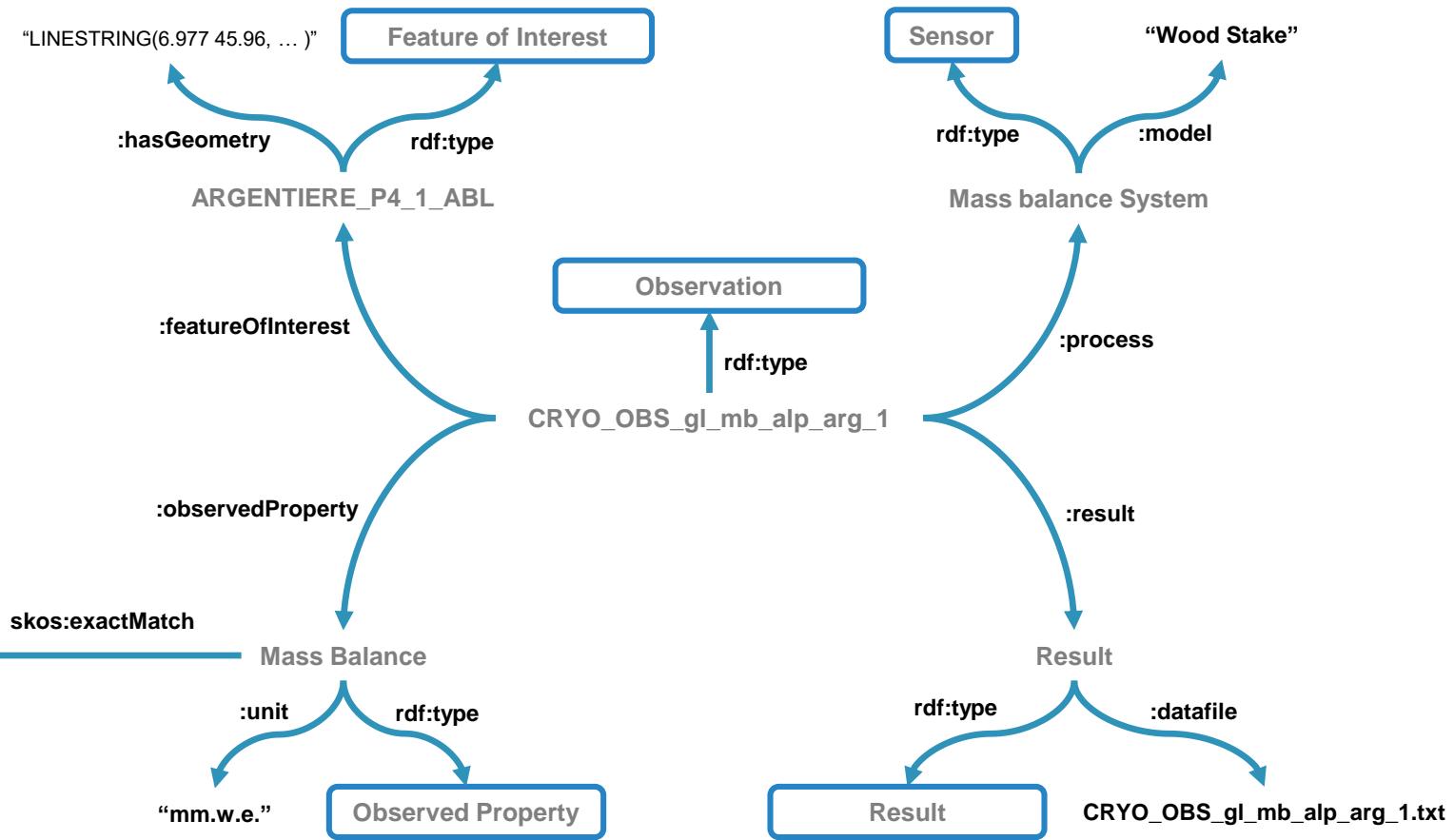
# AN ONTOLOGY AND VOCABULARY : EXAMPLE GCMD

Alphabetical	Hierarchy	
<ul style="list-style-type: none"> <li>- Science Keywords           <ul style="list-style-type: none"> <li>- EARTH SCIENCE</li> <li>- AGRICULTURE</li> <li>- ATMOSPHERE</li> <li>- BIOLOGICAL CLASSIFICATION</li> <li>- BIOSPHERE</li> <li>- CLIMATE INDICATORS           <ul style="list-style-type: none"> <li>- ATMOSPHERIC/OCEAN INDICATORS</li> <li>- BIOSPHERIC INDICATORS</li> <li>- CRYOSPHERIC INDICATORS</li> <li>- AVALANCHE</li> <li>- DEPTH HOAR</li> <li>- FIRN LIMIT</li> <li>- GLACIAL MEASUREMENTS</li> <li>- GLACIER ELEVATION/ICE SHEET ELEVATION</li> <li>- GLACIER FACIES</li> <li>- GLACIER MASS BALANCE/ICE SHEET MASS BALANCE</li> <li>- GLACIER MOTION/ICE SHEET MOTION</li> <li>- GLACIER/ICE SHEET THICKNESS</li> <li>- GLACIER/ICE SHEET TOPOGRAPHY</li> <li>- ICE DEPTH/THICKNESS</li> <li>- ICE EDGES</li> <li>- ICE EXTENT</li> <li>- ICE FLOES</li> <li>- ICE GROWTH/MELT</li> </ul> </li> </ul> </li> </ul>		<p>... &gt; EARTH SCIENCE &gt; CLIMATE INDICATORS &gt; CRYOSPHERIC INDICATORS &gt; GLACIAL MEASUREMENTS &gt; GLACIER MASS BALANCE/ICE SHEET MASS BALANCE</p> <p>PREFERRED TERM</p> <p><b>GLACIER MASS BALANCE/ICE SHEET MASS BALANCE</b></p> <hr/> <p>DEFINITION</p> <p>Mass balance describes the net gain or loss of snow and ice through a given year. It is usually expressed in terms of water gain or loss.</p> <hr/> <p>BROADER CONCEPT</p> <p>GLACIAL MEASUREMENTS</p> <hr/> <p>CHANGE NOTE</p> <p>2012-06-26 13:25:56.0 [gee-cee] Insert Concept add broader relation (GLACIER MASS BALANCE/ICE SHEET MASS BALANCE [6095d796-68e0-4c7d-aa4f-f2e5bd8c4916,39913] - GLACIAL MEASUREMENTS [2d79af4f-d15f-40cc-b0bf-8f5c8eb1fce5,39907]);</p> <p>2012-07-10 10:58:51.0 [mpmorahan] insert Definition (id: null text: Mass balance describes the net gain or loss of snow and ice through a given year. It is usually expressed in terms of water gain or loss. language code: en);</p> <hr/> <p>URI</p> <p><a href="https://gcmdservices.gsfc.nasa.gov/kms/concept/6095d796-68e0-4c7d-aa4f-f2e5bd8c4916">https://gcmdservices.gsfc.nasa.gov/kms/concept/6095d796-68e0-4c7d-aa4f-f2e5bd8c4916</a></p> <hr/> <p>Download this concept:</p> <p>RDF/XML TURTLE JSON-LD</p>

<https://ntrs.nasa.gov/search.jsp?R=20190003887>

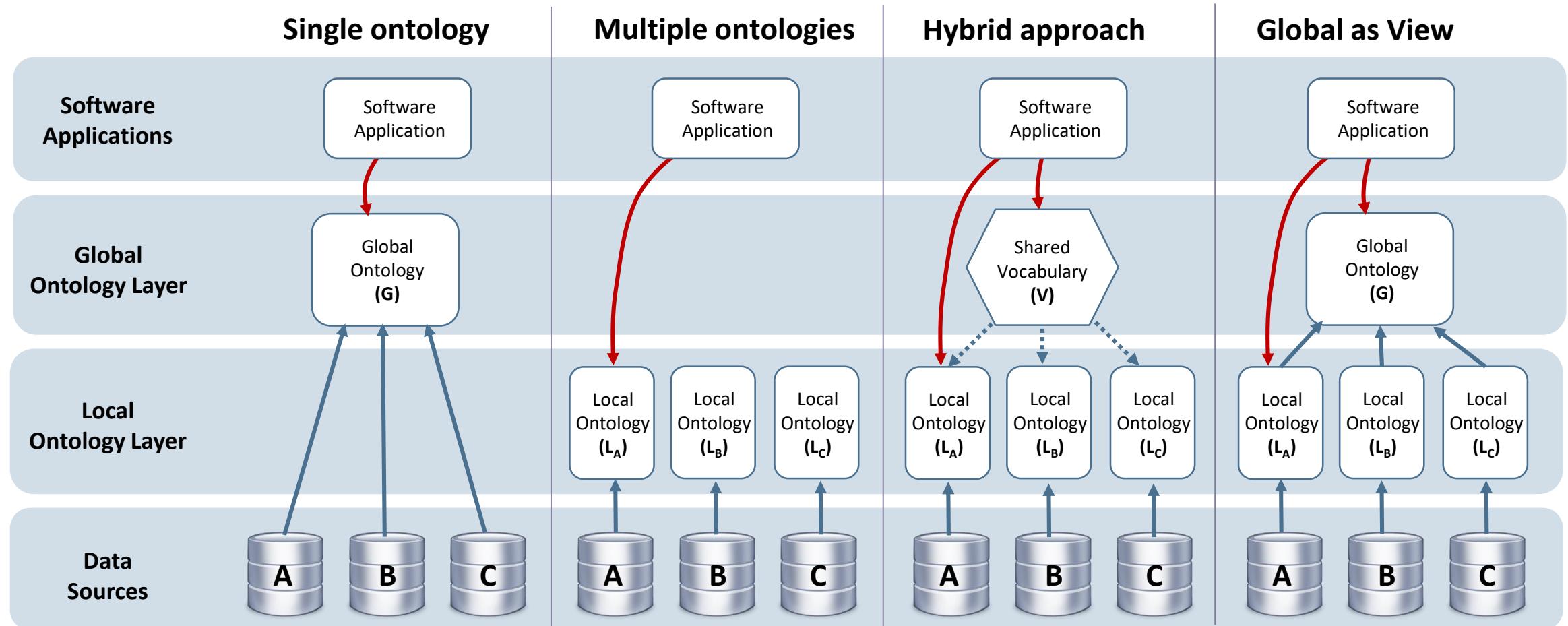
# LINKS BETWEEN DATA RESOURCES AND VOCABULARIES / ONTOLOGIES

Alphabetical	Hierarchy
Science Keywords	
EARTH SCIENCE	
AGRICULTURE	
ATMOSPHERE	
BIOLOGICAL CLASSIFICATION	
BIOSPHERE	
CLIMATE INDICATORS	
ATMOSPHERIC/OCEAN INDICATORS	
BIOSPHERIC INDICATORS	
CRYOSPHERIC INDICATORS	
AVALANCHE	
DEPTH HOAR	
FIRN LIMIT	
GLACIAL MEASUREMENTS	
GLACIER ELEVATION/ICE SHEET ELEVATION	
GLACIER FACIES	
GLACIER MASS BALANCE/ICE SHEET MASS BALANCE	
GLACIER MOTION/ICE SHEET MOTION	
GLACIER/ICE SHEET THICKNESS	
GLACIER/ICE SHEET TOPOGRAPHY	
ICE DEPTH/THICKNESS	
ICE EDGES	
ICE EXTENT	
ICE FLOES	
ICE GROWTH/MELT	



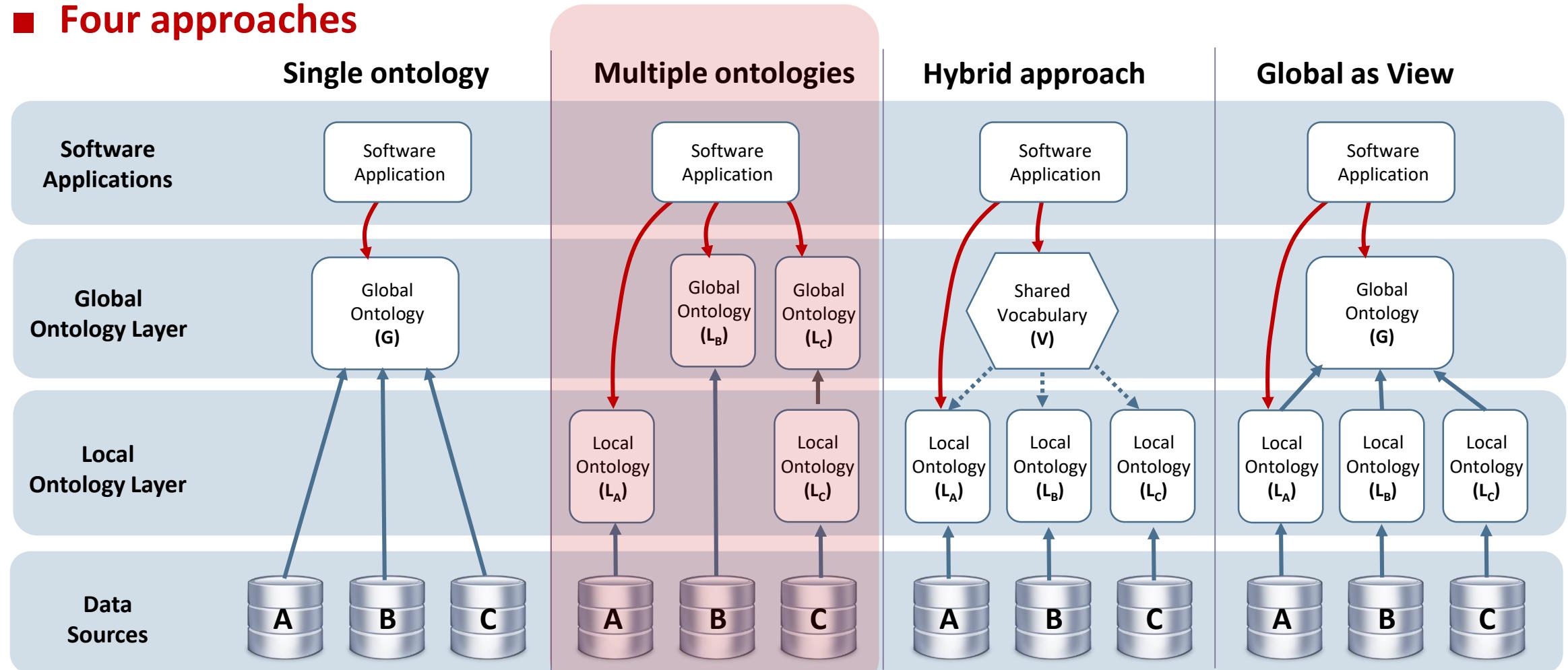
# ONTOLOGY BASED DATA AND METADATA INTEGRATION

## ■ Four approaches

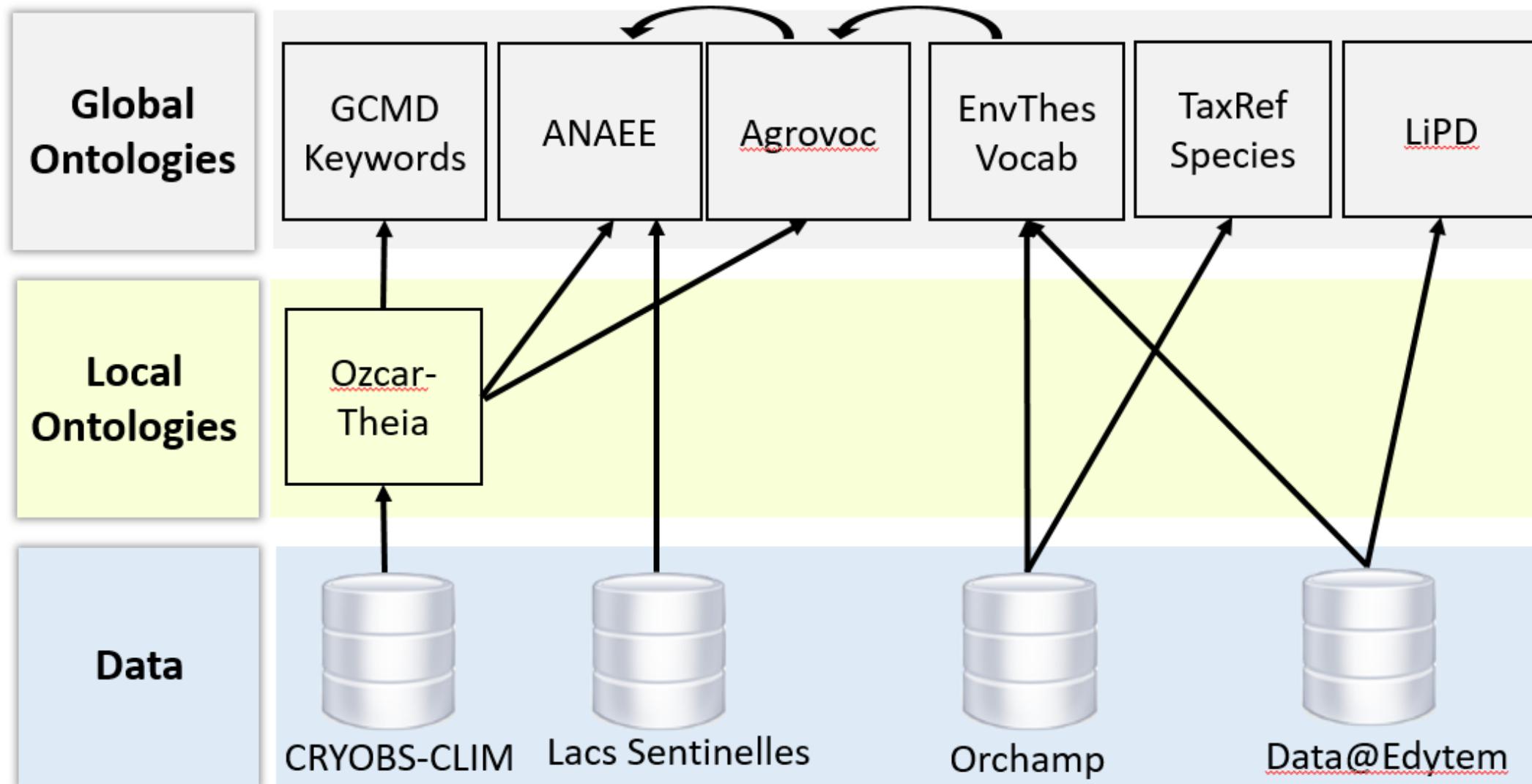


# ONTOLOGY BASED DATA AND METADATA INTEGRATION

## ■ Four approaches



# ONTOLOGIES USED IN TRAJECTORIES



# ONTOLOGY MAPPING

## ■ All observations concerning the word “Rainfall”

### ANAAE ontology : used by Lacs sentinelles

abiotic environment > climate > climate quantity > precipitation	
PREFERRED TERM	<b>precipitation</b>
BROADER CONCEPT	climate quantity
NARROWER CONCEPTS	cumulative precipitation cumulative rainfall pluviometry precipitation intensity snow
ENTRY TERMS	<b>« Rainfall »</b>
SCOPE NOTE	millimetre (mm) mm Wikipedia : any product of the condensation of atmospheric water vapour that falls under gravity.
IN OTHER LANGUAGES	précipitation French
URI	<a href="http://opendata.inra.fr/anaaeThes/c2_2495">http://opendata.inra.fr/anaaeThes/c2_2495</a>
Download this concept:	RDF/XML TURTLE JSON-LD
EXACTLY MATCHING CONCEPTS	precipitation

AGROVOC Multilingual agricultural thesaurus

**Agrovoc**  
« Precipitation »

**Gemet**  
« Atmospheric Precipitation »

**GCMD**  
« Precipitation »

### OZCAR Theia ontology used by CRYOBS-CLIM

Content language	English	Search
Categories of variables	Atmosphere > Precipitation	
PREFERRED TERM	<b>Precipitation</b>	
BROADER CONCEPT	Atmosphere	
NARROWER CONCEPTS	Liquid precipitation Precipitation chemistry Solid precipitation	
BELONGS TO GROUP	Variable categories	
URI	<a href="https://w3id.org/ozcar-theia/precipitation">https://w3id.org/ozcar-theia/precipitation</a>	
Download this concept:	RDF/XML TURTLE JSON-LD	
EXACTLY MATCHING CONCEPTS	<a href="http://aims.fao.org/aos/agrovoc/c_6161">http://aims.fao.org/aos/agrovoc/c_6161</a> <a href="http://vocabularies.unesco.org/thesaurus/concept1217">http://vocabularies.unesco.org/thesaurus/concept1217</a> <a href="https://opendata.inra.fr/anaaeThes/page/c2_2495">https://opendata.inra.fr/anaaeThes/page/c2_2495</a> <a href="https://www.eionet.europa.eu/gemet/en/concept/637">https://www.eionet.europa.eu/gemet/en/concept/637</a>	
	aims.fao.org vocabularies.unesco.org opendata.inra.fr www.eionet.europa.eu	
	PRECIPITATION	GCMD Earth Science keywords Thesaurus



Lacs sentinelles



CRYOBS-CLIM

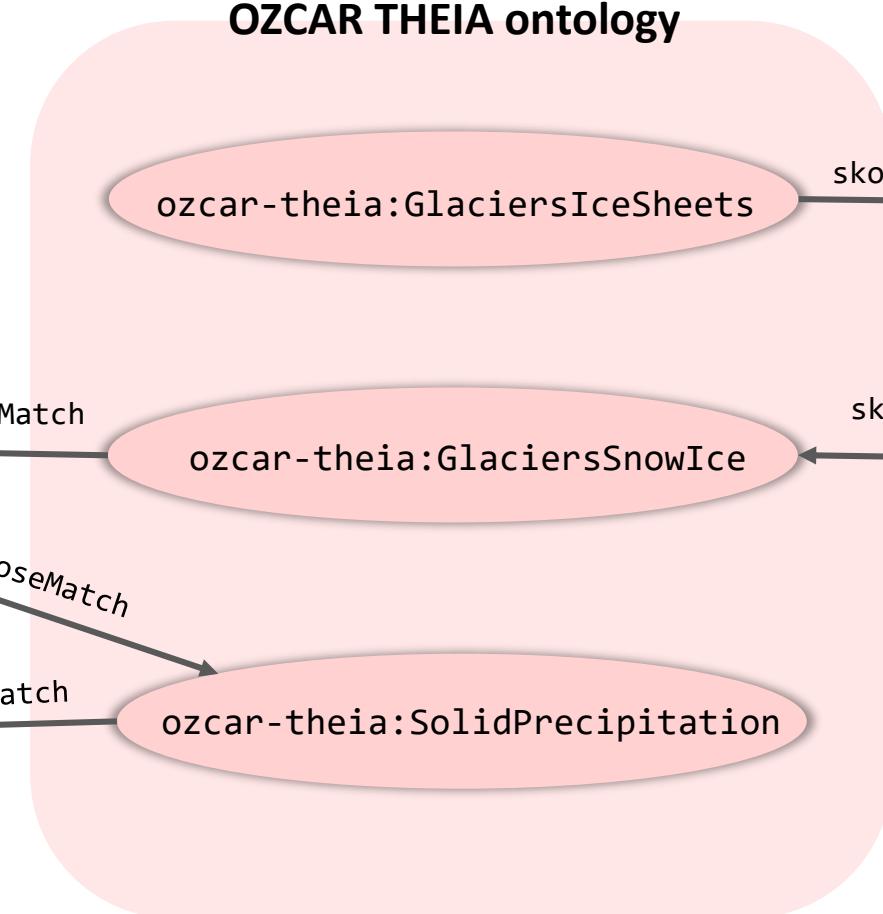
# ONTOLOGY MAPPING

## ■ Exact, close and broad match

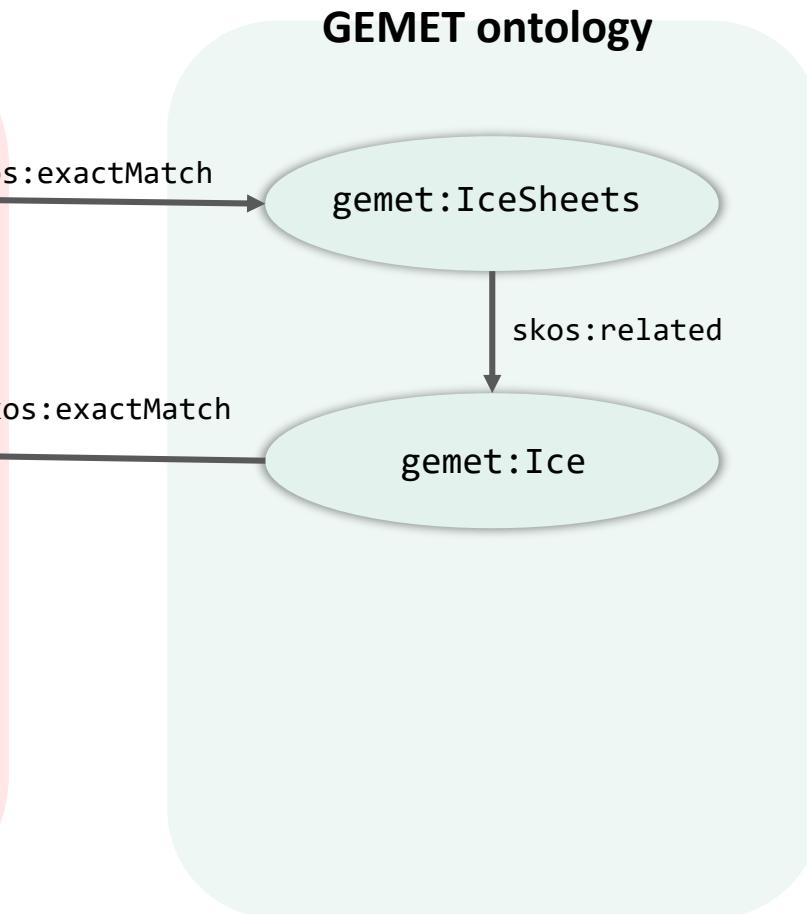
ANAAE ontology



OZCAR THEIA ontology



GEMET ontology



`skos:exactMatch`

`skos:closeMatch`

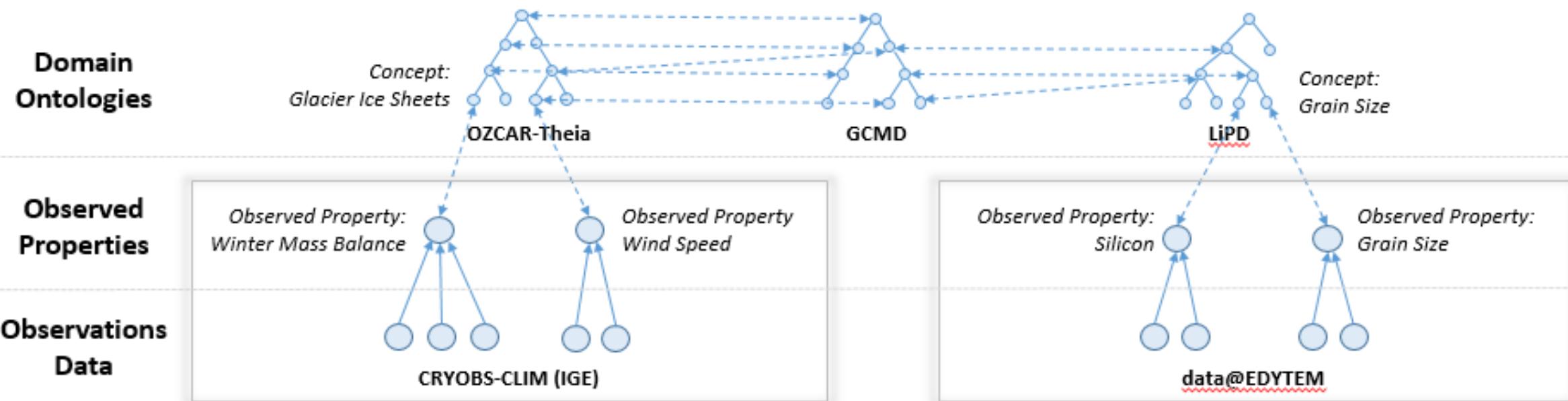
`skos:broadMatch`

`skos:exactMatch`

`skos:exactMatch`

`skos:related`

# ONTOLOGY MAPPING



## SCIENTIFIC AND SOCIO-ECONOMICAL CHALLENGES



**Understand the adaptation processes of the societies to their environment**

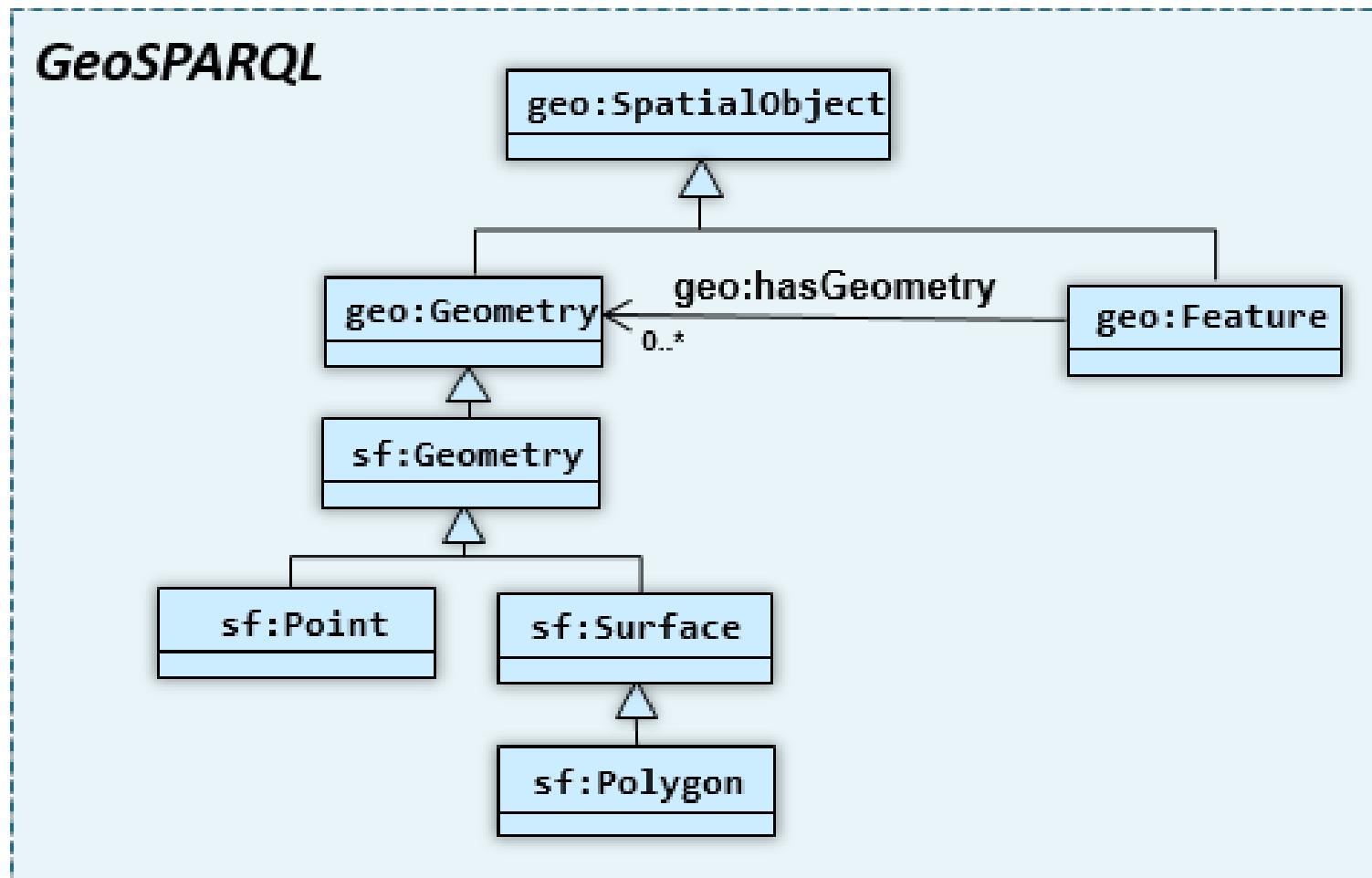
**Trois territoires pilotes : la vallée de l'Arve, la vallée de la Maurienne et le Pays de la Meije.**

**Objectifs :**

- Développer des outils innovants pour construire des passerelles entre la production de connaissances et les besoins des utilisateurs au sein des territoires
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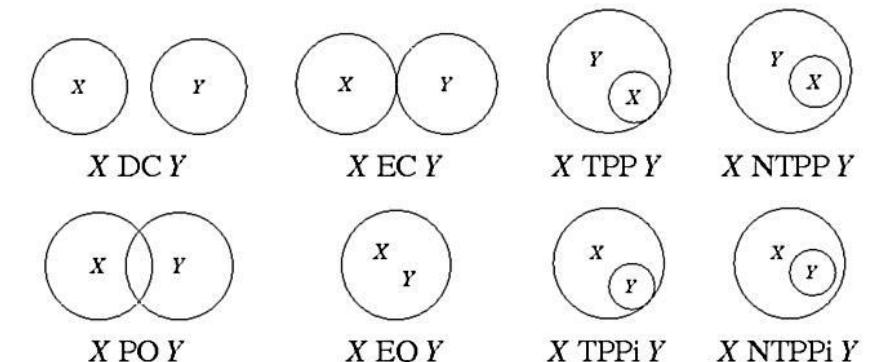
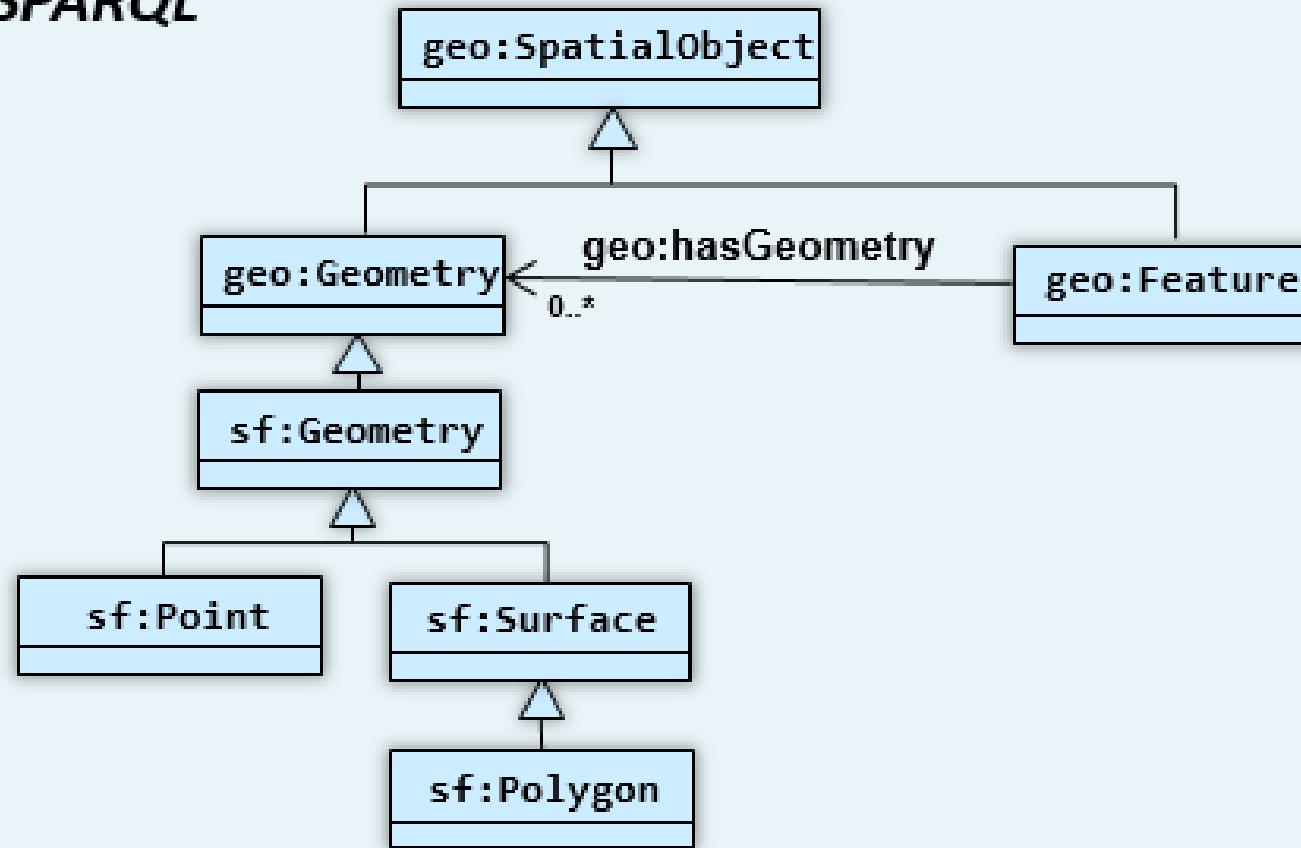
→ construire des requêtes qui permettent de d'alimenter des indices / indicateurs

# GEOSPARQL ONTOLOGY



# GEOSPARQL ONTOLOGY

## GeoSPARQL



DC : disconnected

EC : externally connected

TPP : tangential proper part

NTPP : non-tangential proper part

PO : partially overlapping

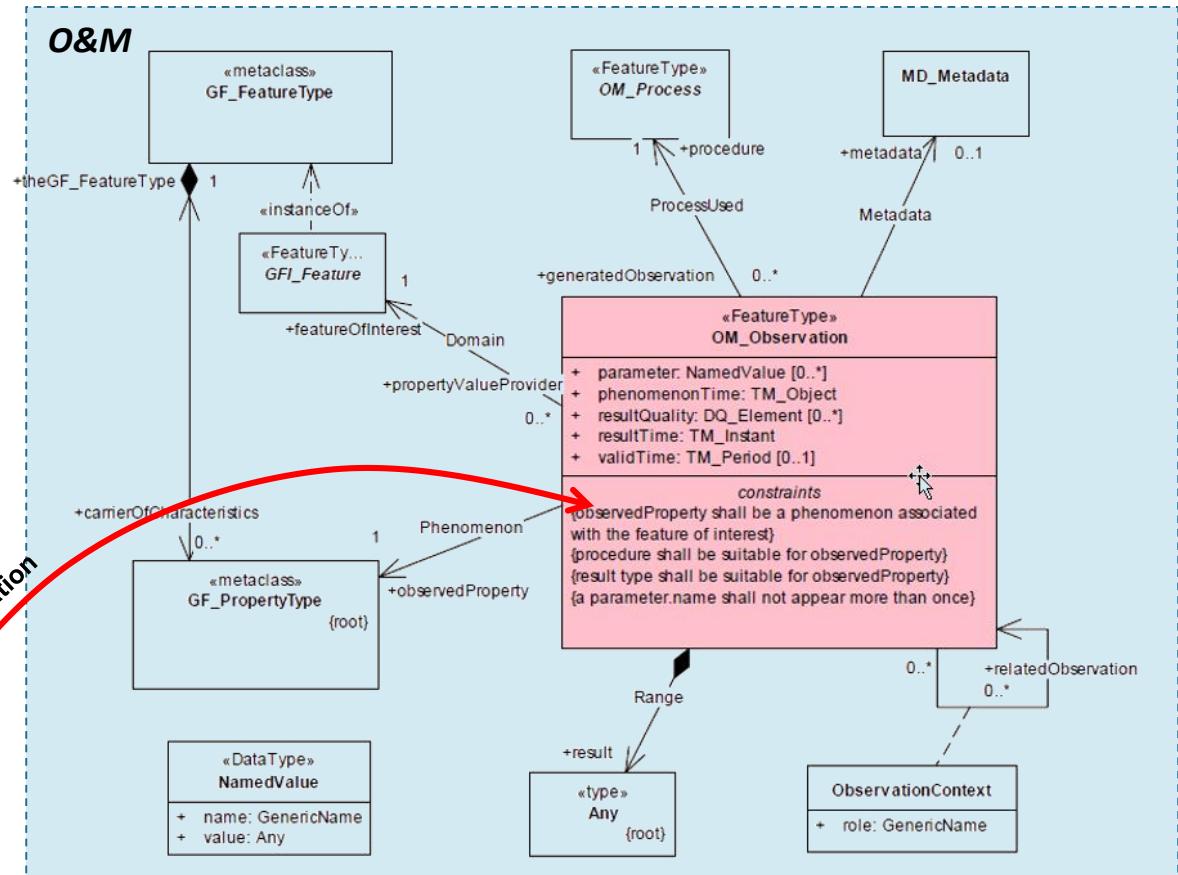
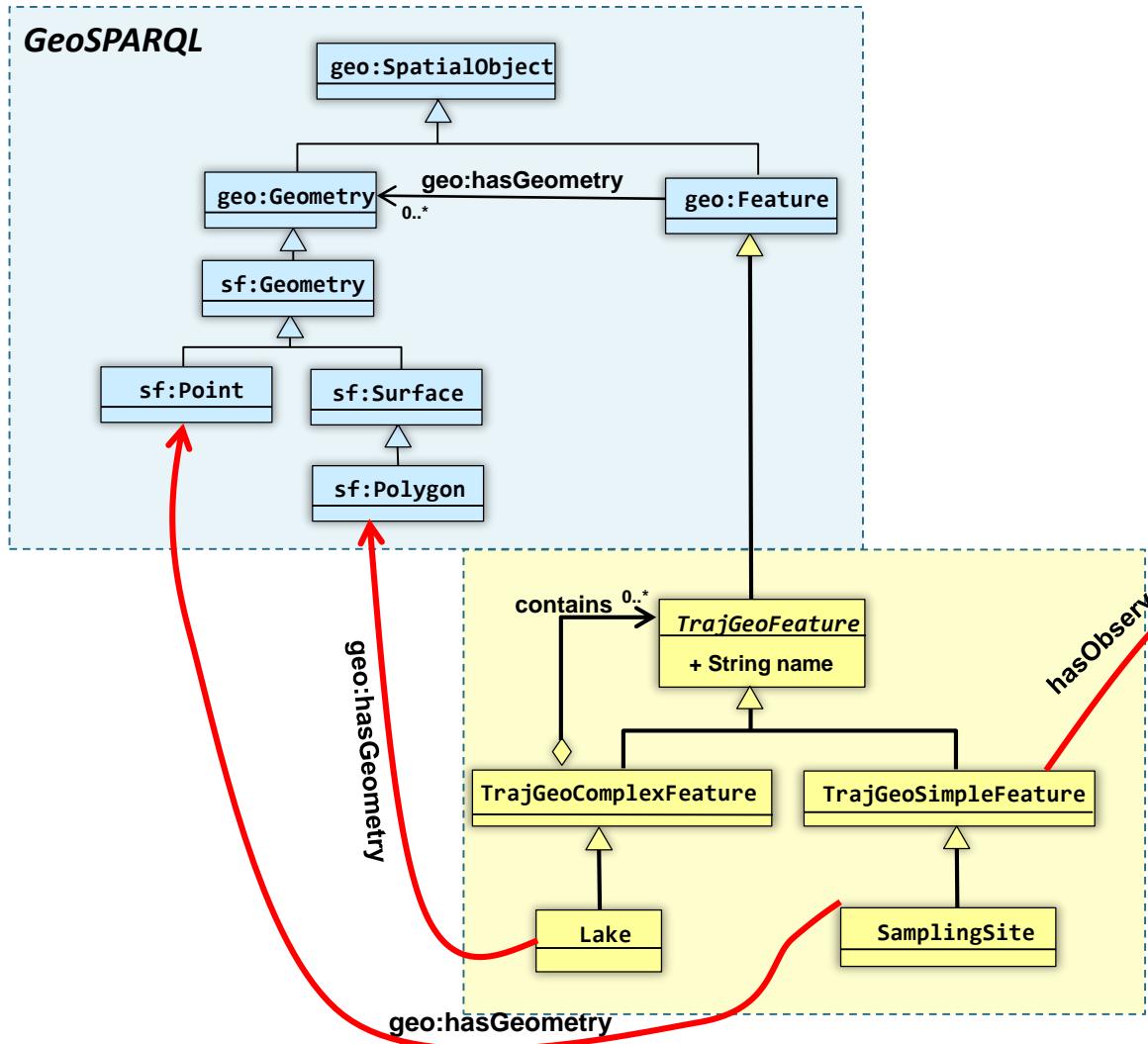
EQ : equal

TPPi : as tangential proper part

NTPPi : as a proper part

RCC8 relations

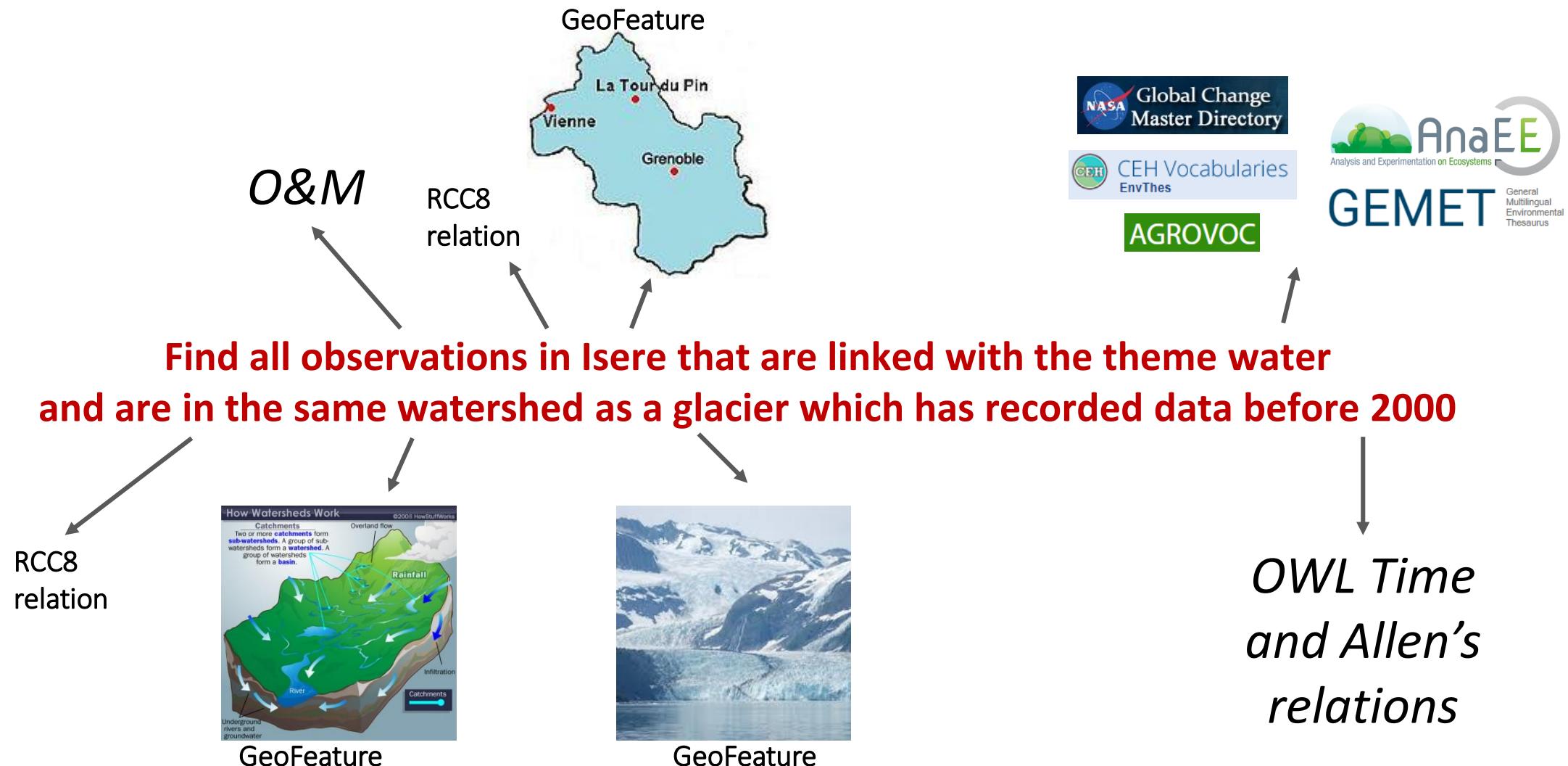
# GEOSPATIAL REPRESENTATION



## EXAMPLE OF QUERIES

**Find all observations in Isere that are linked with the theme water  
and are in the same watershed as a glacier which has recorded data before 2000**

# EXAMPLE OF QUERIES



**Find all observations in Isere that are linked with the theme water  
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```

trajFeature:Isere geo:hasGeometry ?geomIsere.
?obs1 a oml:Observation;
      geo:hasGeometry ?geo1;
      FILTER (geof:stContains(?geomIsere, ?geo1)

?obs1 traj:keywordTag/skos:closeMatch* gcmd:Water.

FILTER EXISTS {
  ?obs2 a oml:Observation;
  geo:hasGeometry ?geo2;
  traj:keywordTag/skos:closeMatch* gcmd:GlacierIceSheets ;
  time:startDate ?startDate .
  FILTER(?startDate < "2000-01-01"xsd:date)
}

?watershed a geoObj:Watershed ;
           geo:hasGeometry ?watershedGeo
FILTER(geof:stIntersects(?watershedGeo, ?geomIsere))

FILTER (geof:stContains(?watershedGeo, ?geo1)
FILTER (geof:stContains(?watershedGeo, ?geo2)

}

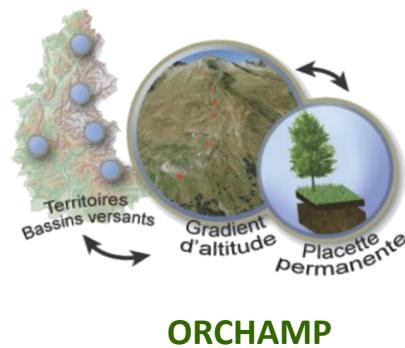
```

# SPECIAL THANKS

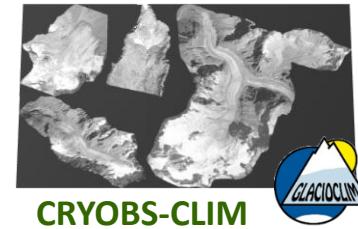
## ■ Data producers



Lacs,  
Alpages,  
Refuges  
Sentinelles



Sedimentary  
Archives  
[data@EDYTEM](mailto:data@EDYTEM)



## ■ And engineers

- ▶ Karine Aubry
- ▶ Matthew Sreeves
- ▶ Philippe Genoud