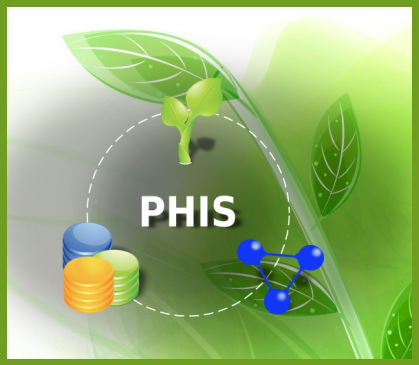


INRA
SCIENCE & IMPACT

Systèmes d'Information pilotés par des Ontologies

Contact: Pascal.Neveu@inra.fr

Data Challenges

More and more data!

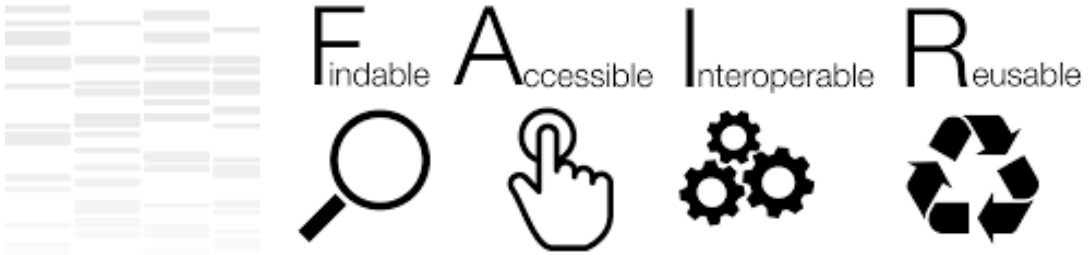
- Evolution of storage and network technologies
  1 Gigabyte : $400K in 1980, $10 in 2000, $0,01 in 2017
- Plenty and various devices, IoT, simulations, crowdsourcing, etc.
- Internet data sources (Open, partnerships,)

Make data valuable!

- **Decision support**
- **Knowledge discovery**
- **New services**

- Population treatment → individualized treatment
- When data did not quite match what we expect!
- Which theories/models are consistent and which ones are not !
- ...

Need: A new generation of Information Systems



Findable: **PID**, standardized metadata and indexed in portals

Accessible: open and standardized protocols (internet protocols), authentication* (if not open)

Interoperable: standardized formats and shared vocabularies (technology, syntactic, **semantic**)

Reusable: provenance, domain relevant **metadata for understanding across disciplines**

High Throughput Plant Phenotyping: searching for the most adapted genotypes

High frequency observation of many genotypes in various environments

Searching for the most adapted species/varieties for field challenges

- **Food security**
- **Climate Change adaptation**
- **AgroEcology**
- **Reduce inputs / natural resource preservation**
- **Safe and healthy food**
- **…**

Decision support

- **Links genomics with plant ecophysiology and agronomy**
- **Phenotype-driven gene function discovery**

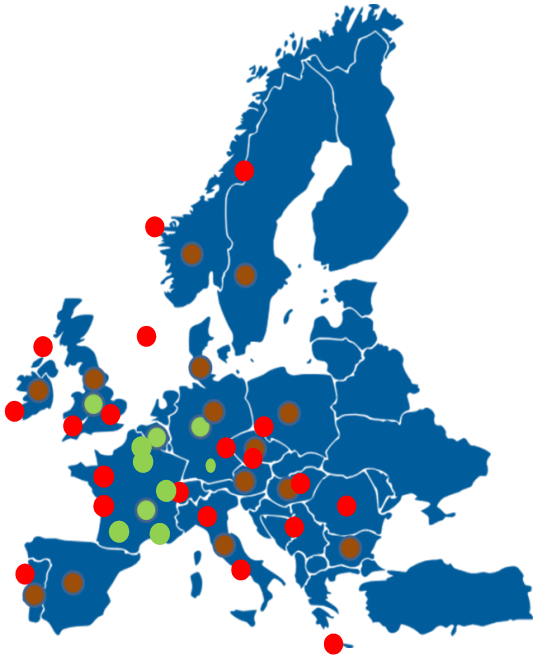
EMPHASIS

European Research e-infrastructure

- Deals with several Petabytes of Phenomics data
- Allow data reuse and data integration

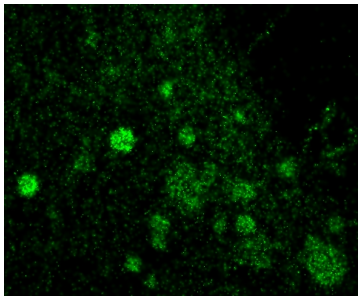
FAIR data → Open technologies and standards (MIAPPE, BrAPI, etc)

- ✔ Standardized Identification
- ✔ Standardized Semantic
- ✔ Provenance and reproducibility data processing



Phenomics Data

Different scales



Intra-cellular

Organ

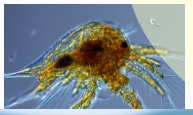
Plant

Field

Region

Phenomics Data

Different interactions






Phenomics Data

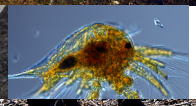
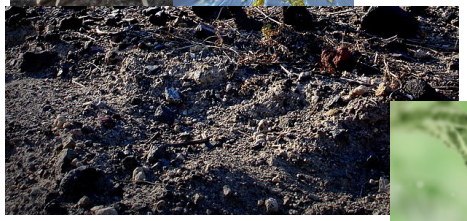
Different stages and transformations

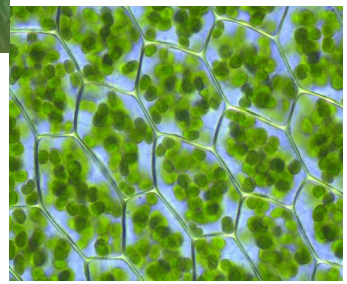











Phenomics Data

Various contexts

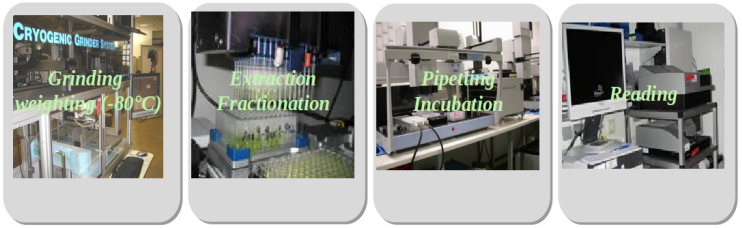
« omics » Platforms

Various data complex types

Genomics

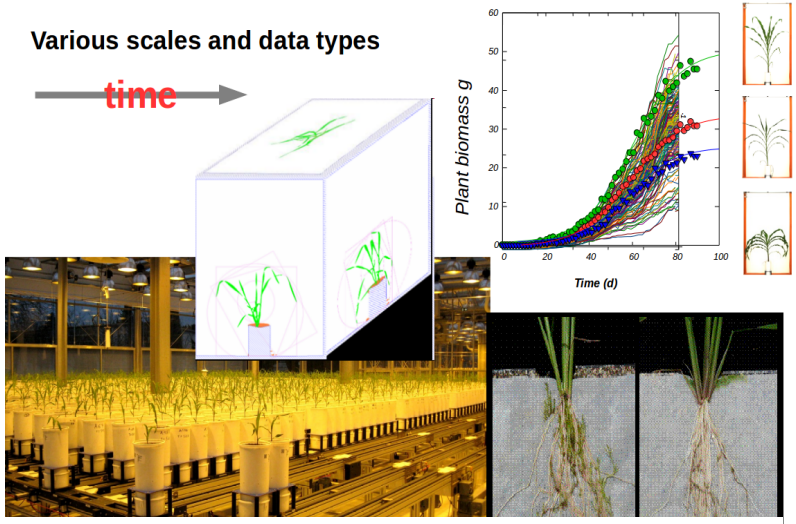
Composition and the structure of biopolymers

Quantification of metabolites and enzyme activities



Green house Platforms

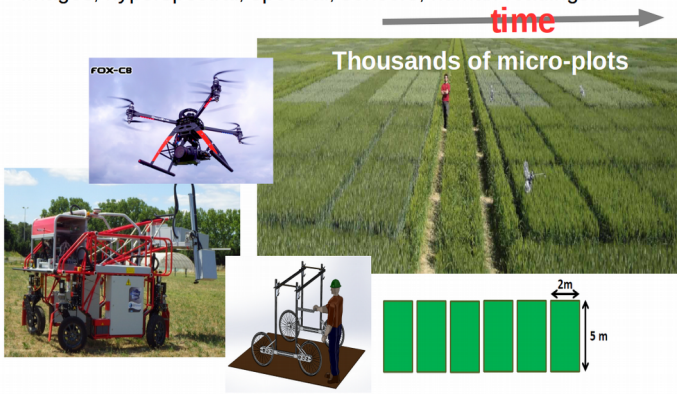
Various scales and data types



Field Platforms

Various scales and data types

- Cell, organ, plant, population
- Images, hyperspectral, spectral, sensors, human readings...



Farm Platforms

Various scales and data types from thousands of farms

- organ, plant, population, site
- Images, sensors, human readings...

Phenomics Data

Different ways

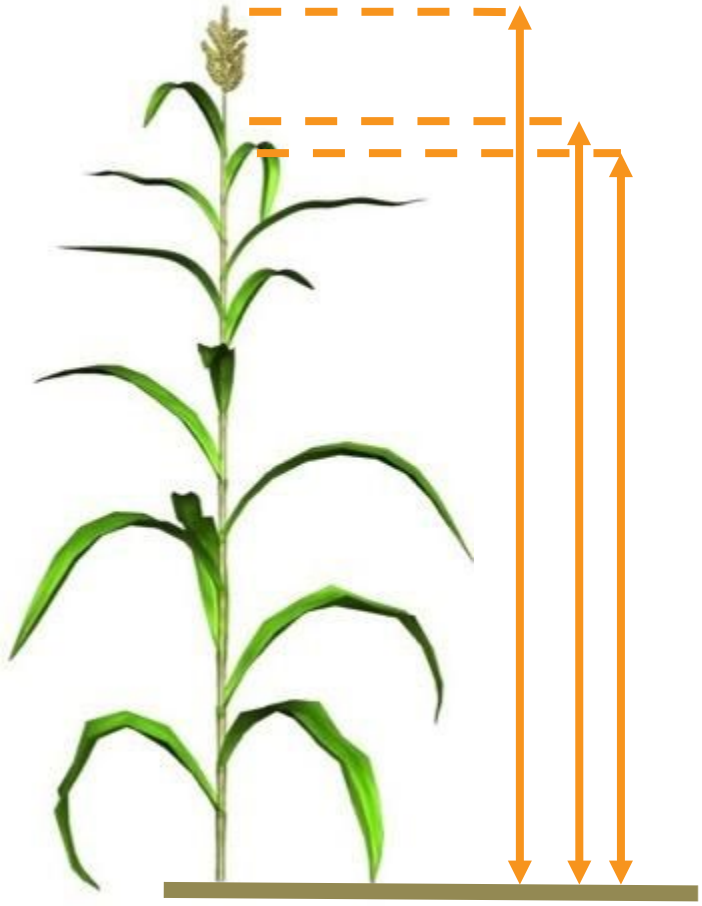


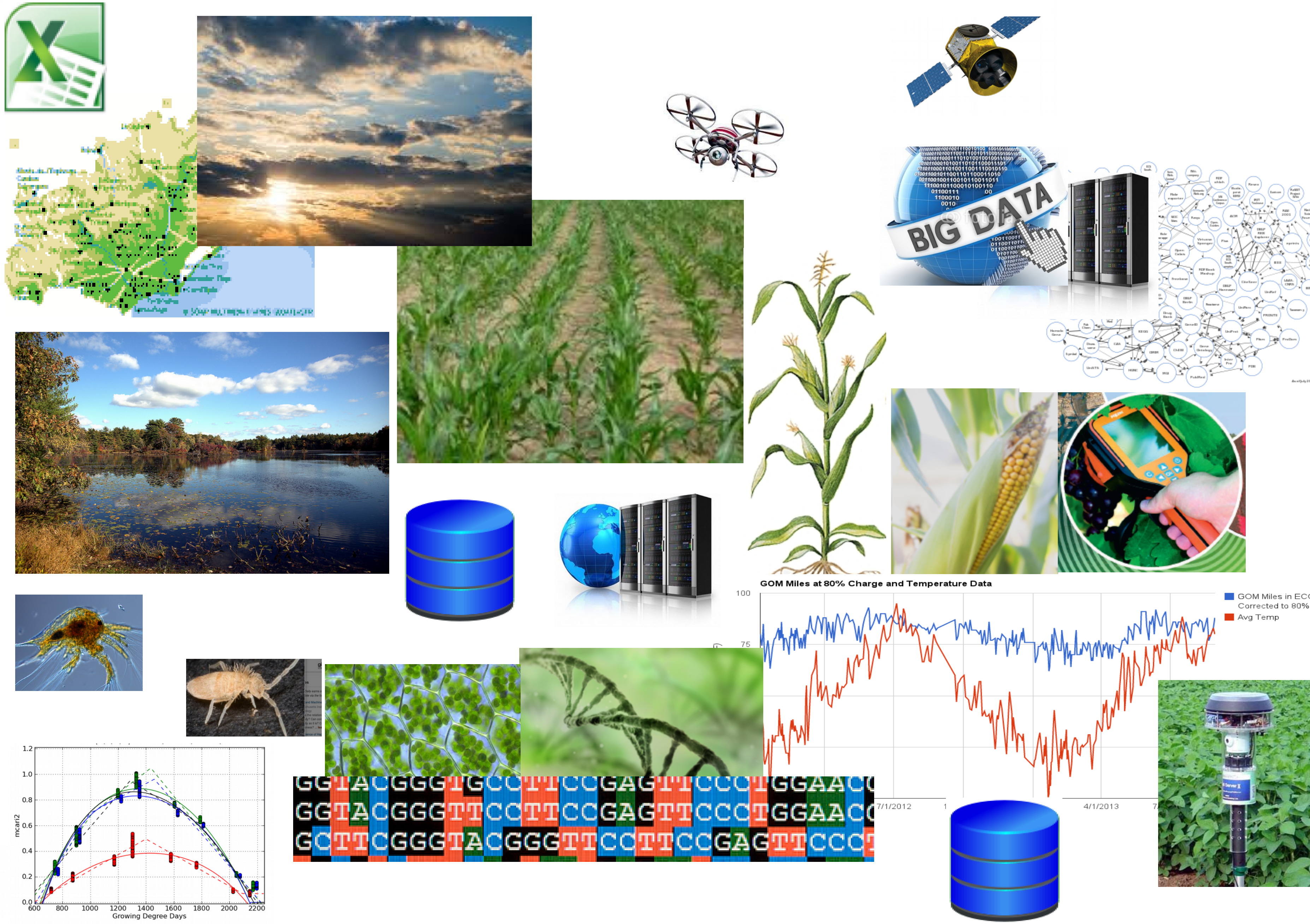
Figure From D. Pot, CIRAD

Plant Height

The example of *Plant Height*

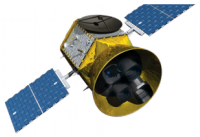
- Plant with root?
- Plant with flower?
- Stem and leaves?
- Only the stem?
- Dry or not?
- In the morning or the end of the day?

Phenomics Data



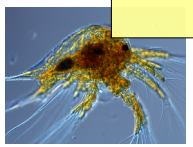
Phenomics Data

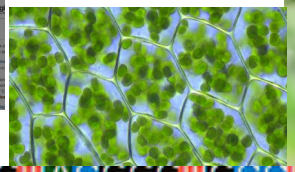


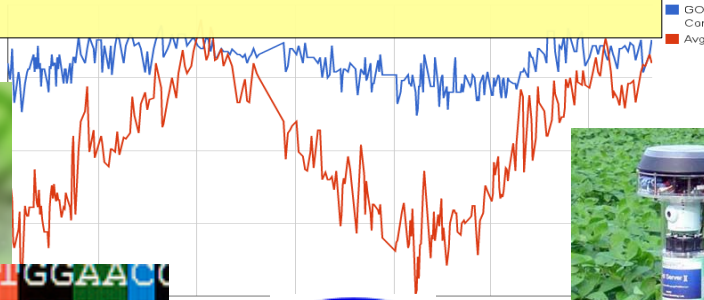




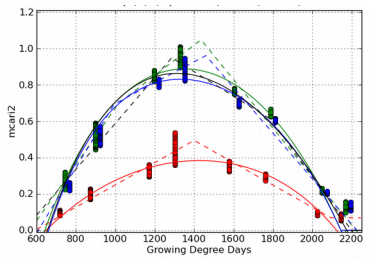






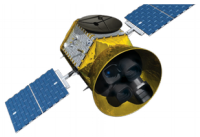





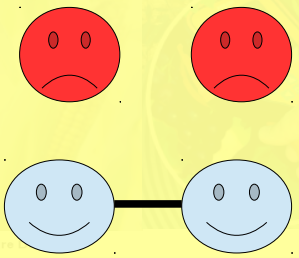


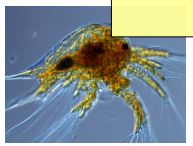
- **Intensive data integration needs**

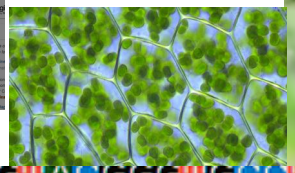
Phenomics Data

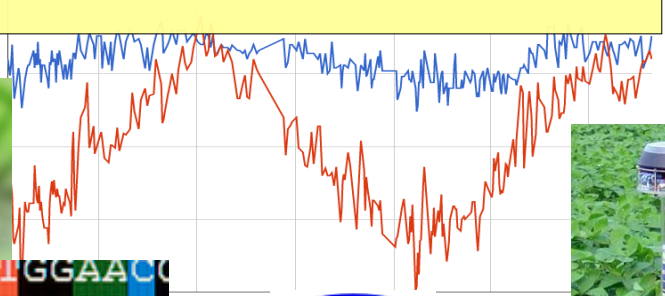


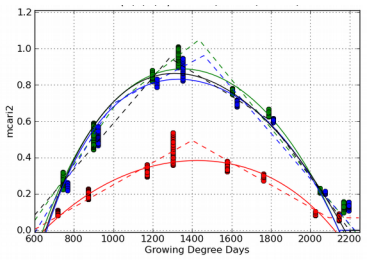
- **Orphan data →Worthless!**
- **Data have value if they are grouped**











Phenomics Data

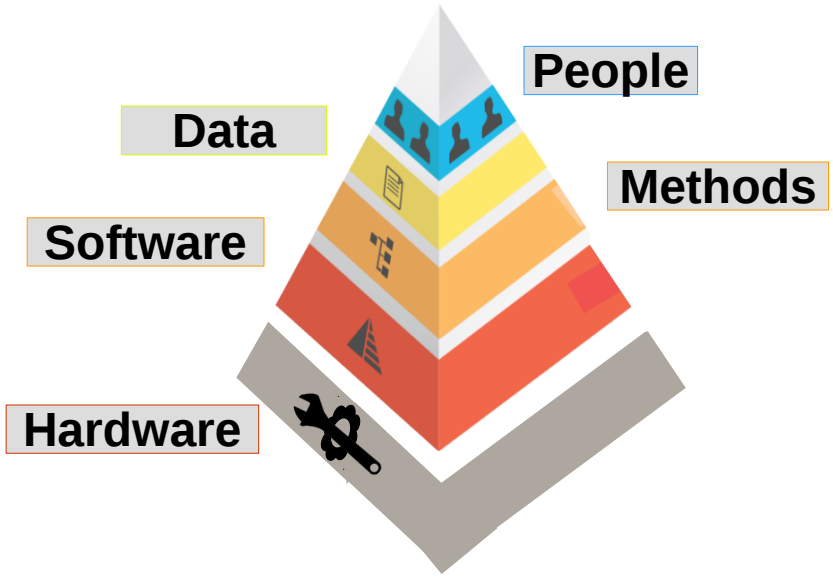
How to structure data?

OpenSILEX

OpenSILEX is an Open source software set

- Methods, tools, components to implement information systems for experimental data in agriculture and environment

→ for organisation, collection, structuration, storage, exchange and treatment of information



OpenSILEX - PHIS

- **PHIS is an instance of OpenSILEX**

- **Designed for data management in phenotyping platforms**
  - Management of huge, complex and heterogeneous data (millions of images, sensor data, from different sites, etc)

- **Implement good practices of data management**
  - Make FAIR data
  - Flexible
  - Ability to understand and reproduce data processing
  - Ability to enforce DMP and Open Science

OpenSilex approach

Scientific objects (plant, plant organ, plot, etc.)
Events (management, faults, meteo, etc :)
Equipement (Facilities, Softwares, sensors, etc.)
Organizational (experiement, study, project, etc.)

- Identified by **URI** → standardized, unambiguous, shared, etc

Organisation and linking → objects and events with a controlled semantic (Ontology) such as a context specific **application Ontologies (RDF*, OWL*)** and allows to **reuse** or link **reference ontologies (SKOS*)**

Measurements, Documents, Observations, Metadata are associated with these Objects and Events

* Semantic Web languages

OpenSILEX–PHIS Identification

URI: string used to identify a resource (Web standardized syntax, prefix)

`http://www.phis.inra.fr/path/identifier`

→ **Unambiguous**
→ **Resolvable (dereferencing)**
→ **Persitence (ePIC)**

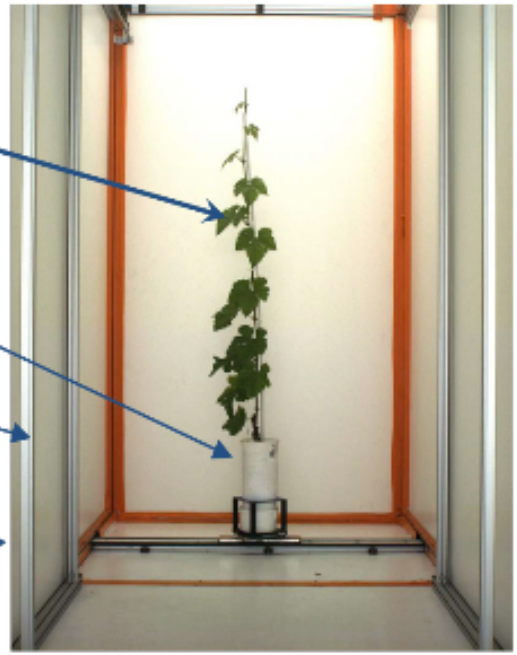
URI of plant :
mp3:arch/2014/pl/000000012

URI of pot :
mp3:arch/2001/pt/000001542

URI of cabin :
mp3:arch/2010/ca/cabine2

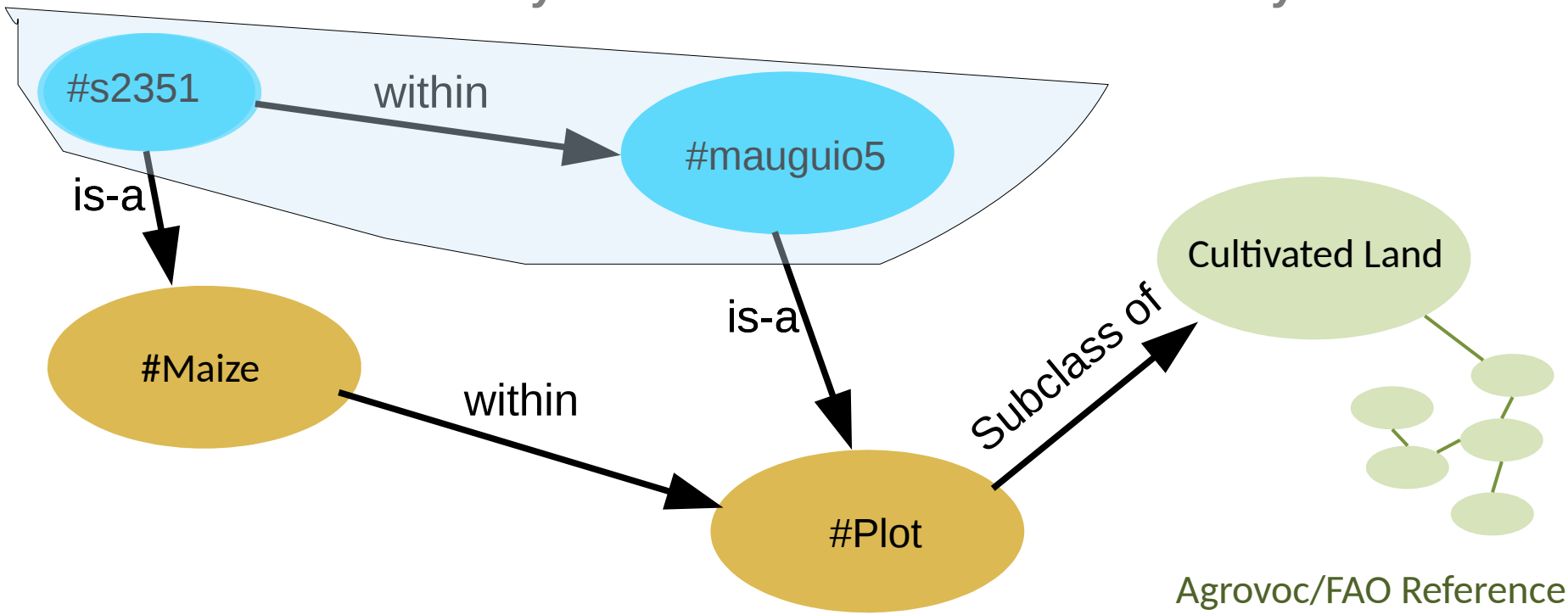
URI of camera :
mp3:arch/2011/ss/00003312

URI of image :
mp3:arch/2015/im/000000564

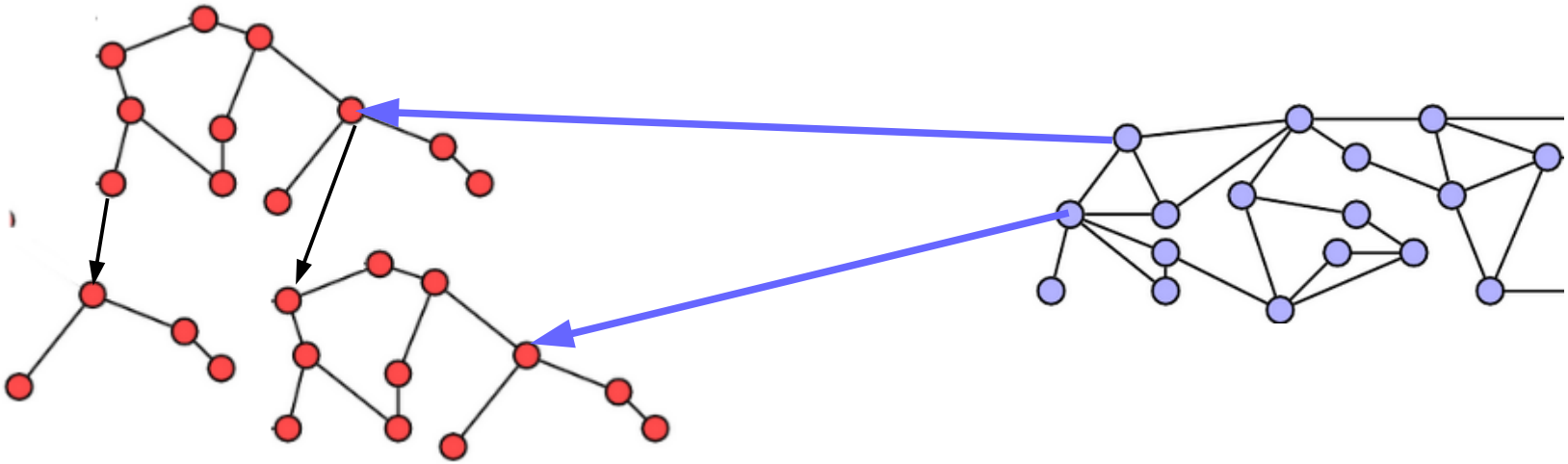


OpenSILEX - PHIS

- Metadata / ontologies provide the meaning of data
  → Link each data element to a controlled, shared, vocabulary and **machine readable** vocabulary



OpenSILEX - PHIS

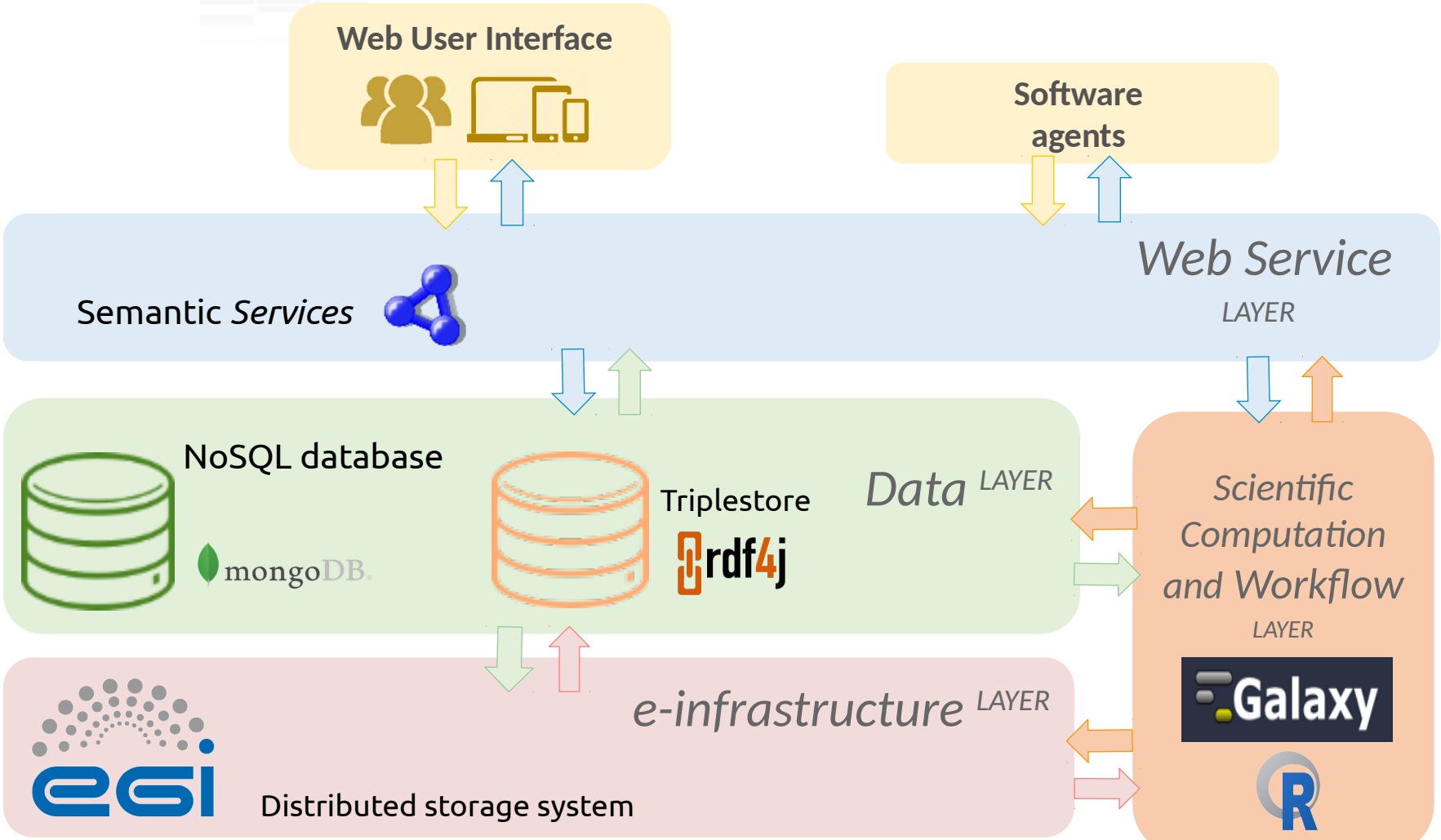


Reference ontologies

Application ontologies

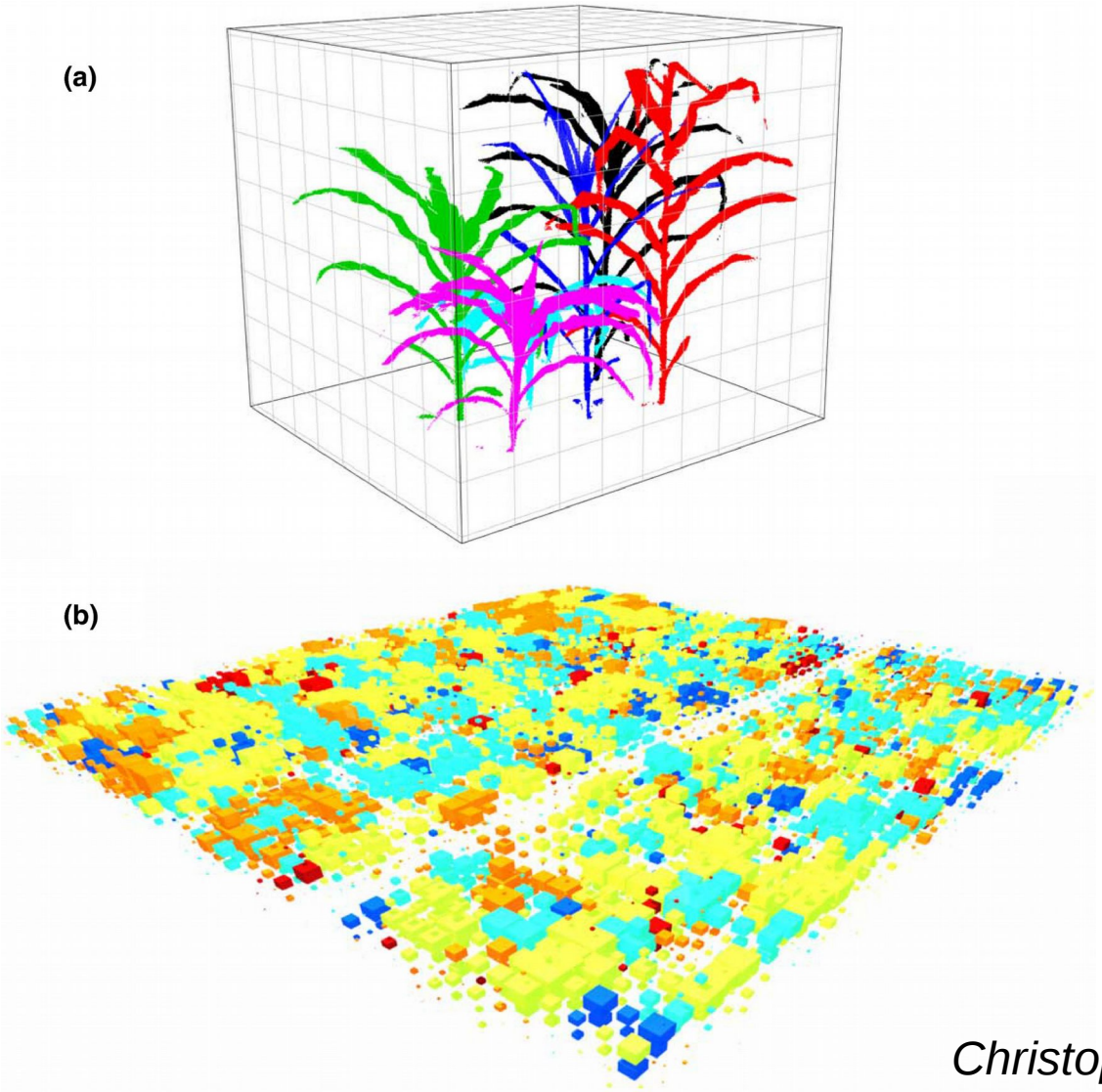
Published in AgroPortal

OpenSILEX - PHIS



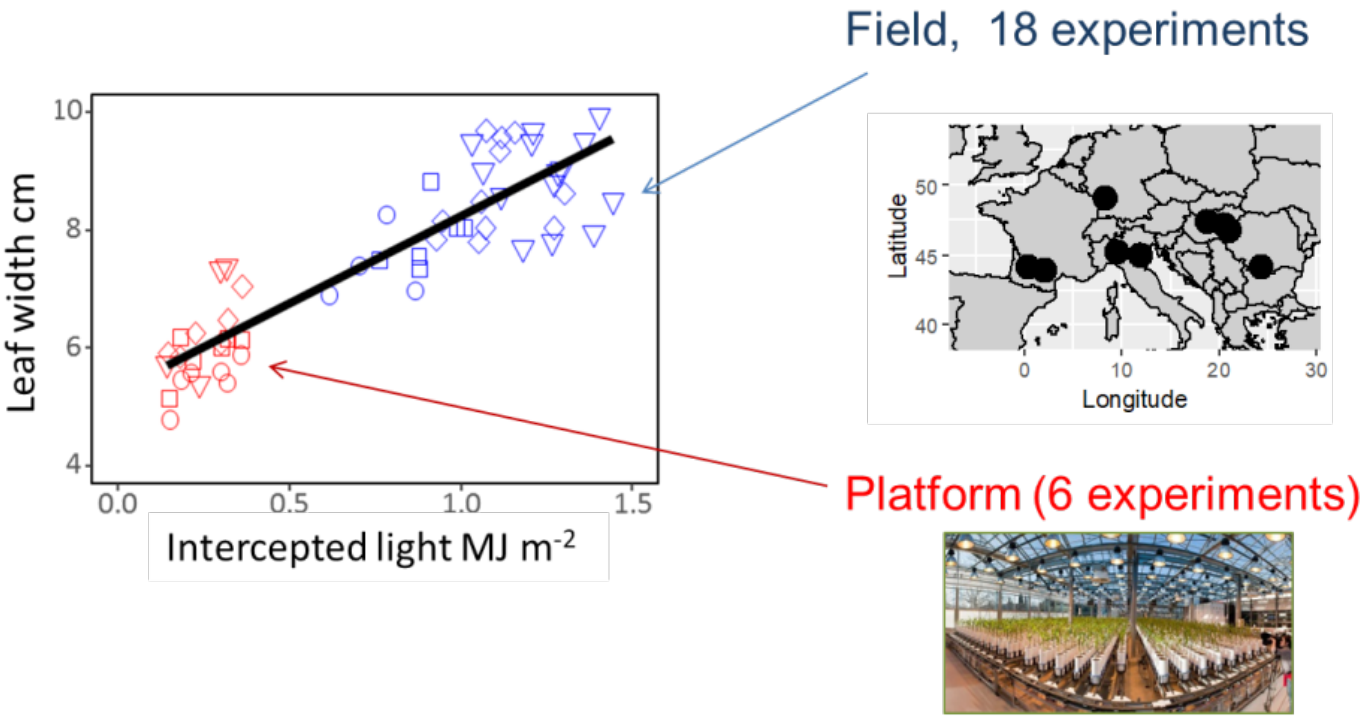
Knowledge Discovery Illustration

PHIS provides contextualisation: intercepted light value computation



Christophe Pradal

Knowledge Discovery Illustration



A common relationship between leaf width and intercepted light per plant accounted for variations in width between fields, and for the difference between field and greenhouse

OpenSILEX

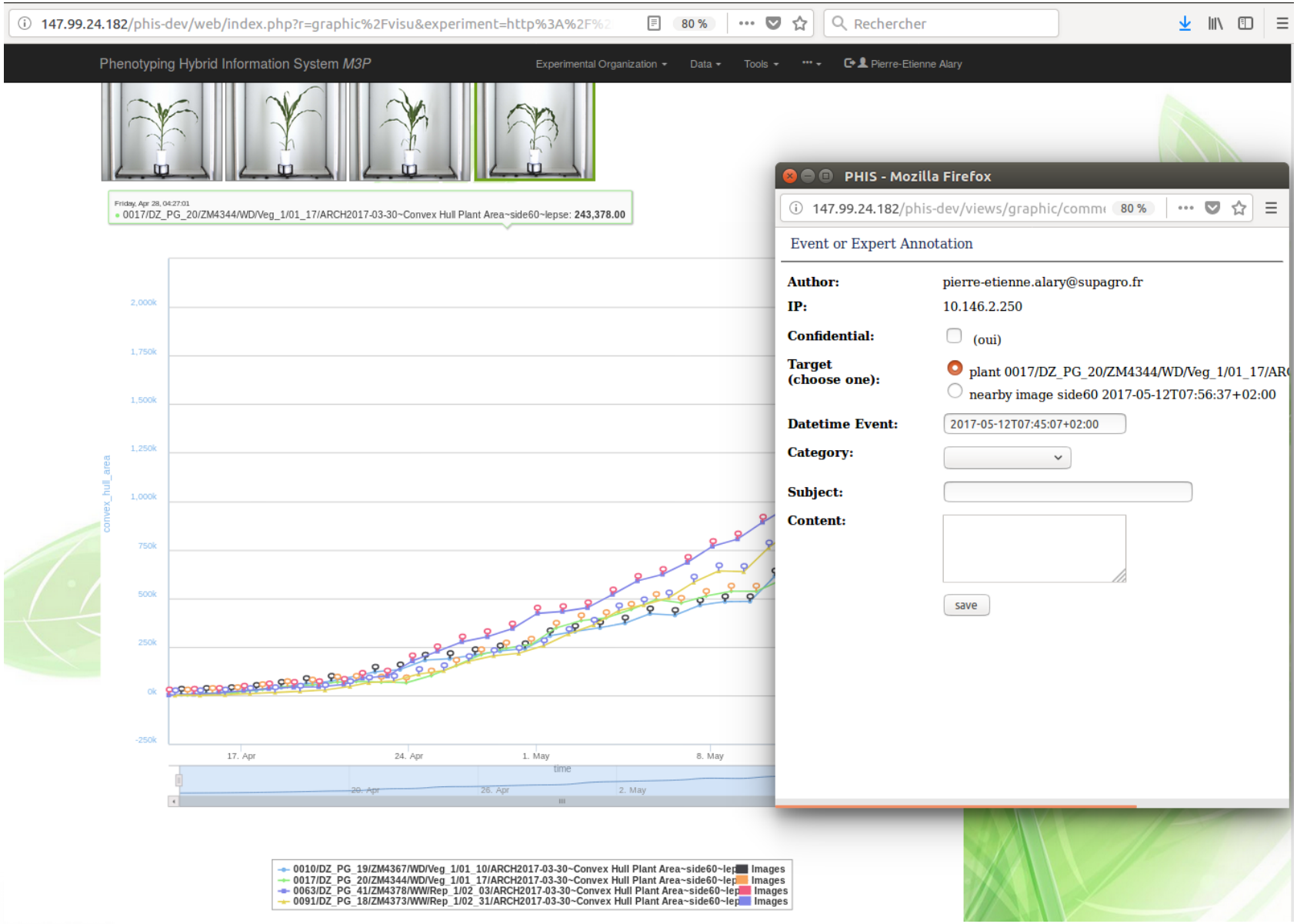
- ✔ Management of huge and complex data
- ✔ Enables and facilitates cloud computing (data center, EGI)

  → distributed computing, distributed storage, backup
- ✔ Free software and Open technologies
- ✔ International identification (URI and DOI)
- ✔ Semantic management (ontologies, standardized vocabularies)
- ✔ Provenance and reproducibility for data processing
- ✔ Flexible design
- ✔ R interface mainly based on OpenCPU package
- ✔ 10 instances for various installations (field and greenhouse)

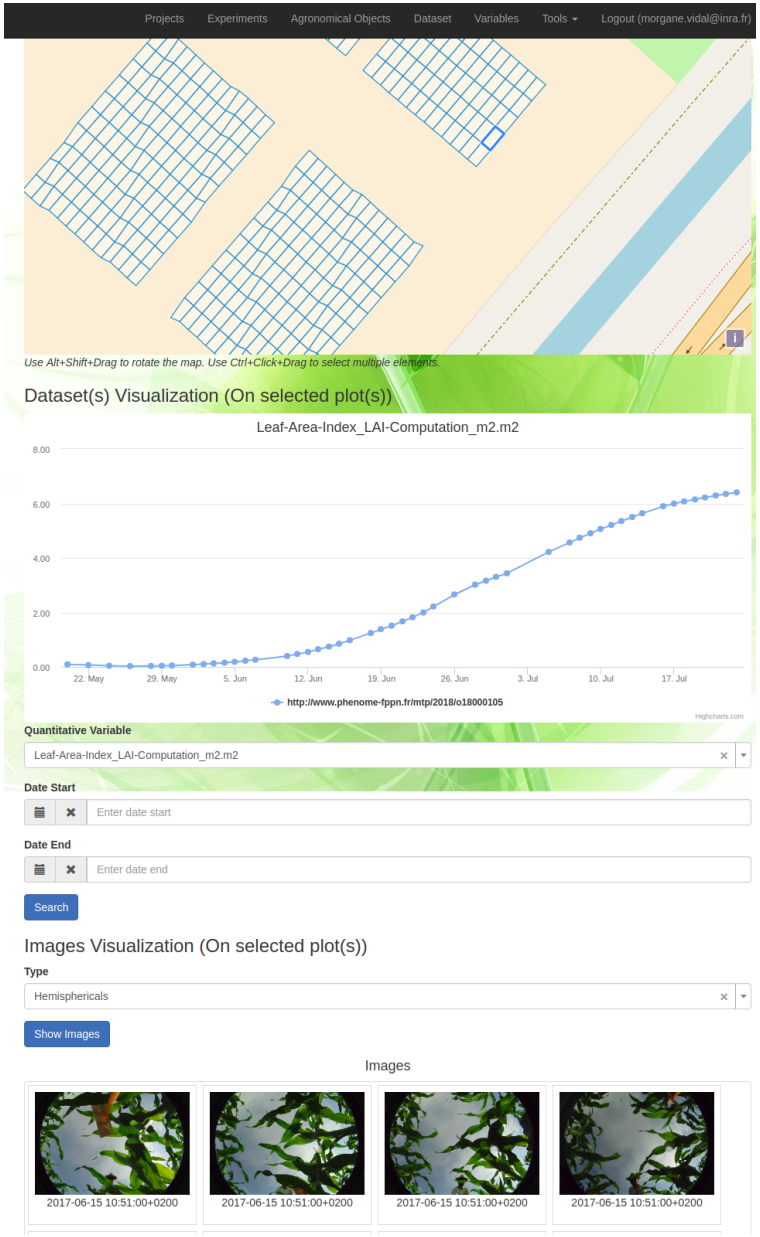
  Phenoarch instance → Over 300 Tb of data + 10 plant species

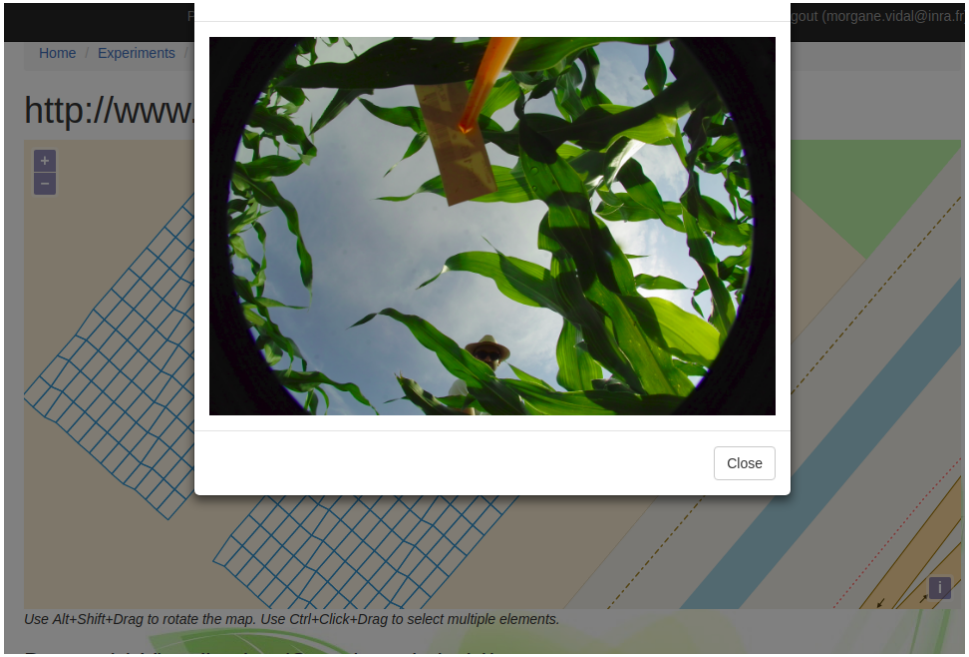
  INRA, WUR, CIRAD, Univ of Tokyo, Nottingham
- ✔ MISTEA team and Start-up project for support and development

PHIS
Event annotation



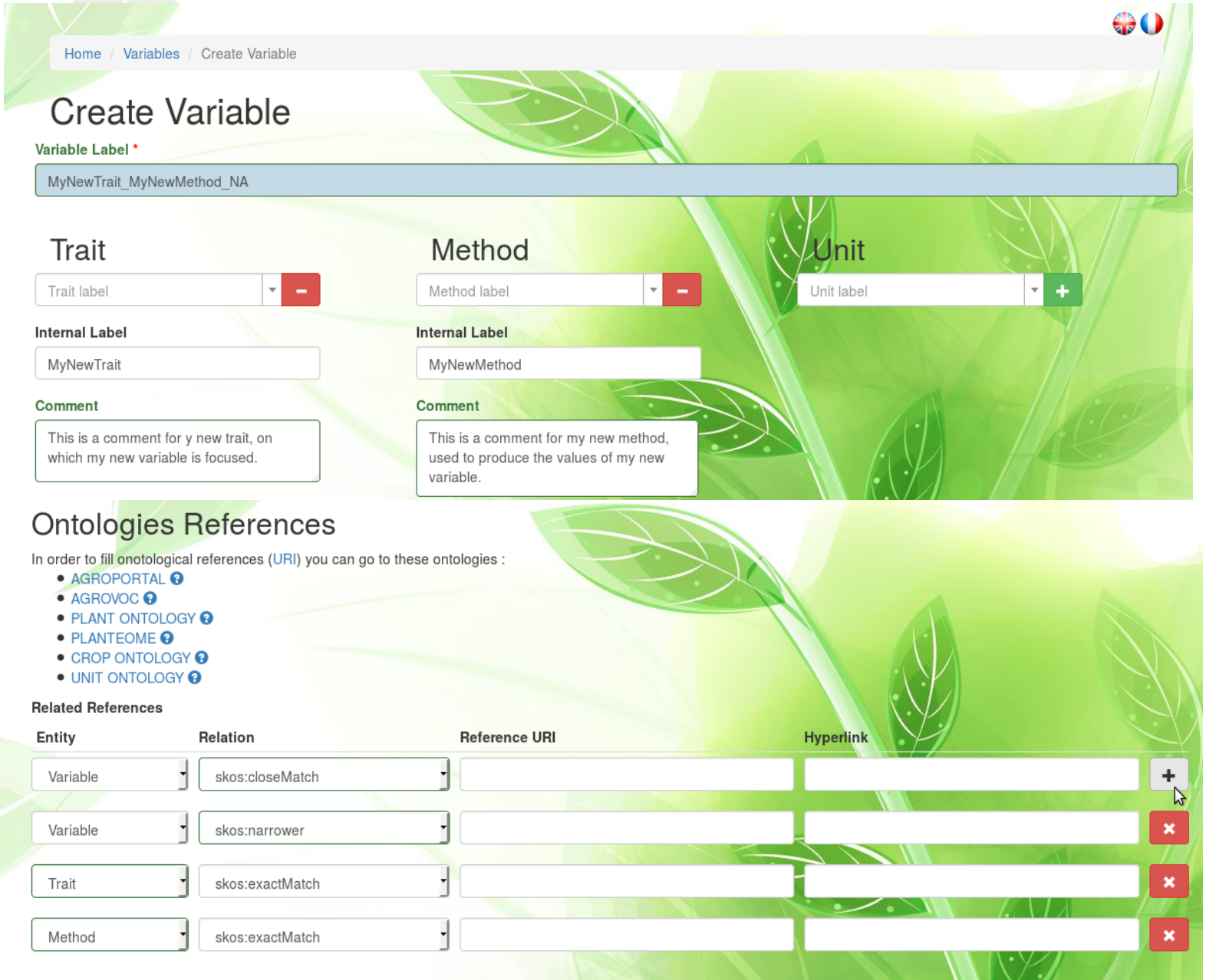
Trait – Images links





PHIS

Variable management and interoperability



OpenSILEX - PHIS

Data Analysis

Global Greenhouse Report

Name	Global Greenhouse Report
URI	http://www.phenome-fppn.fr/id/analysis/daglobal
Description	Visualization of a specified variable of an experiment. A HTML report is produced by this program.
Documents	

Experiment *
ARCH2017-03-30

Trait *
objectSumArea

View Label *
side90

Run

Data Analysis

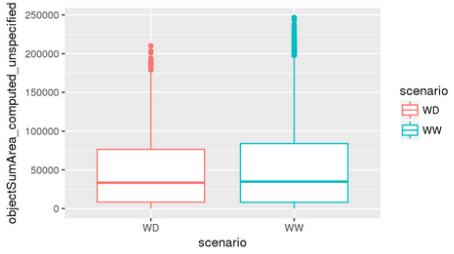
Showing **1-5** of **5** items.

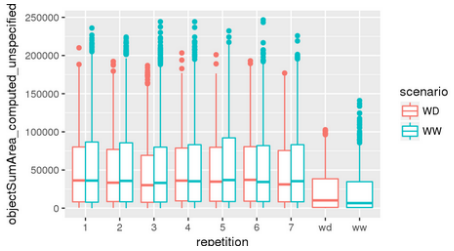
#	Name	URI	Description
1	Daily Greenhouse report	http://www.phenome-fppn.fr/id/analysis/dailyreportphis	Daily description of a PhenoArch experiment (imagery, environnement and so on...) to t running of it. A HTML report is produced by this program.
2	Environment Field Report	http://www.phenome-fppn.fr/id/analysis/daenvirfield	Description of the environment of a field experiment (meteo...). A HTML report is p program.
3	Environment Greenhouse Report	http://www.phenome-fppn.fr/id/analysis/daenvir	Description of environment of PhenoArch experiment (meteo...). A HTML report is p program.
4	Global Greenhouse Report	http://www.phenome-fppn.fr/id/analysis/daglobal	Visualization of a specified variable of an experiment. A HTML report is produced by this
5	Thermal Time Calculation Report	http://www.phenome-fppn.fr/id/analysis/dathermal	For a PhenoArch experiment, a thermal time is calulated according to the user's ch parent's metho). A HTML report and a csv file are produced by this program.

ARCH2017-03-30 - ZA17 experiment on objectSumArea parameter and side90 view

- 60 genotypes
- 2 scenarios: WD, WW
- 9 repetitions
- 1467 pots
- Scientist supervisors: Cabrera-Bosquet, Tardieu, Turc, Welcker
- Technical supervisors: Brichet, LUCHAIRE, Suard
- Experiment performed from 2017-03-30 to 2017-06-30
- Genotypes used in this experiment: IPG004, IPG007, IPG017, IPG026, IPG029, IPG062, IPG063, IPG066, IPG073, IPG077, IPG082, IPG089, IPG101, IPG103, IPG109, IPG110, IPG111, IPG116, IPG117, IPG119, IPG120, IPG121, IPG128, IPG131, IPG136, IPG138, IPG146, IPG148, IPG152, IPG153, IPG155, IPG158, IPG159, IPG164, IPG165, IPG167, IPG169, IPG173, IPG176, IPG181, IPG188, IPG189, IPG190, IPG194, IPG195, IPG202, IPG216, IPG228, IPG233, IPG234, IPG239, IPG303, IPG304, IPG310, IPG311, IPG312, IPG313, IPG314, IPG318, IPG321

Description of objectSumArea parameter





PHIS
Workflow management

Home / Currents Tasks / Clean plant height using default

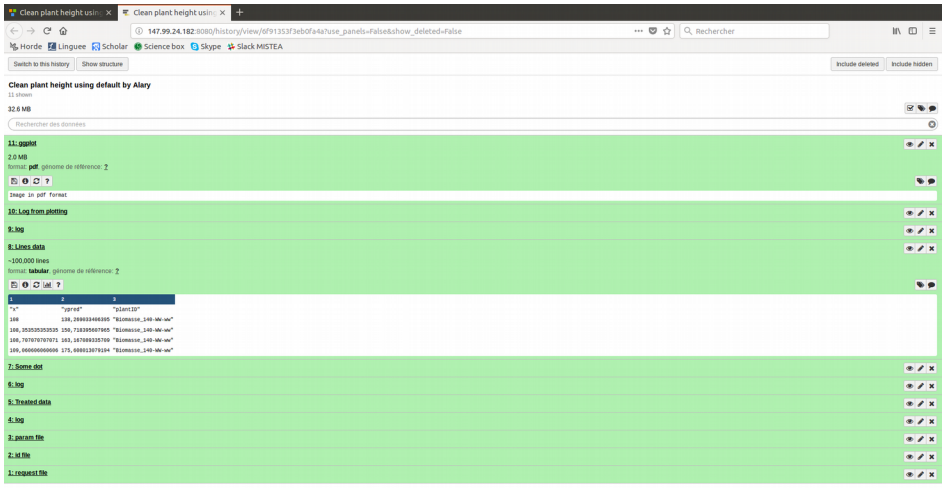
Clean plant height using default

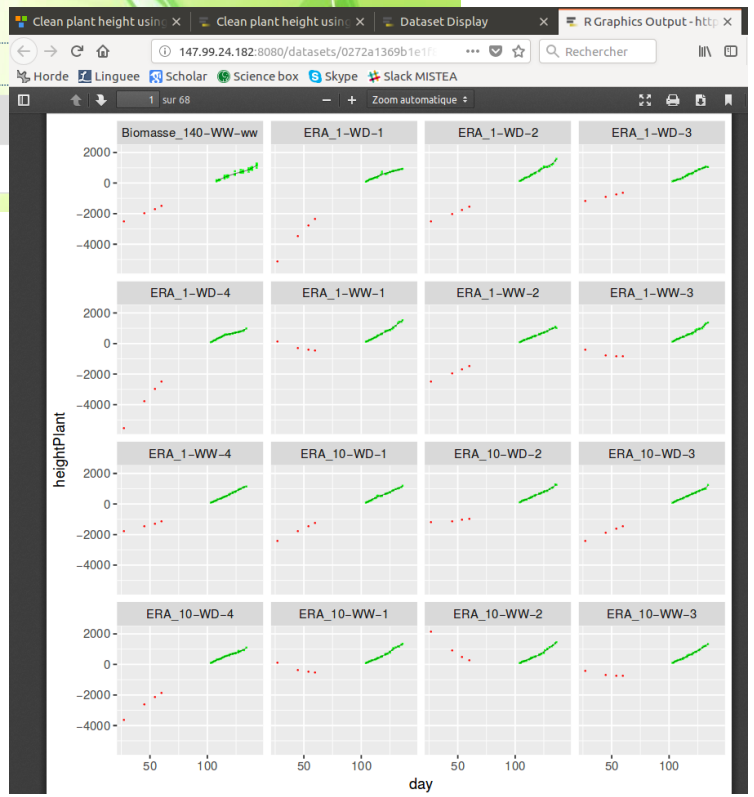
Workflow name	Clean plant height using default
Start	09-01-2018 13:53
End	09-01-2018 14:29

Open in Galaxy

Technical details

Invocation ID	40876639881ca029
History Id	6f91353f3eb0fa4a





OpenSILEX

- **PHIS** demonstration
  - http://phis.inra.fr/ Or http://www.opensilex.org/opensilex/web/
    Research paper:
    https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.15385

- How to contribute to OpenSILEX?
  - Github repository: https://github.com/OpenSILEX/
  - Developer documentation: https://opensilex.github.io/docs-community-dev/

- User documentation of the version in development:
  - https://opensilex.github.io/phis-docs-community/

Conclusion

OpenSILEX

- **Provides description and structuring of data**
- **Ensures and makes easy FAIR data**
- **Recommends and implements standards,**
- **Provides a frame for data analysis and data publication**