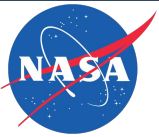


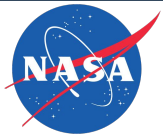
# Proposed Knowledge Graph to Connect Data, Applications and People

Suggestion for joint work with Group on Earth Observations (GEO)  
Expert Advisory Group (EAG)



# GEOSS<sup>1</sup> Knowledge Hub Aspiration

- Curated and Linked Documents to...
- ...make reproducible results available
  - Methods
  - Data (esp. ARD)
  - Software
- Technologies
  - Cloud Computing
  - JSON-LD
  - schema.org



# GEOSS Knowledge Hub Aspiration

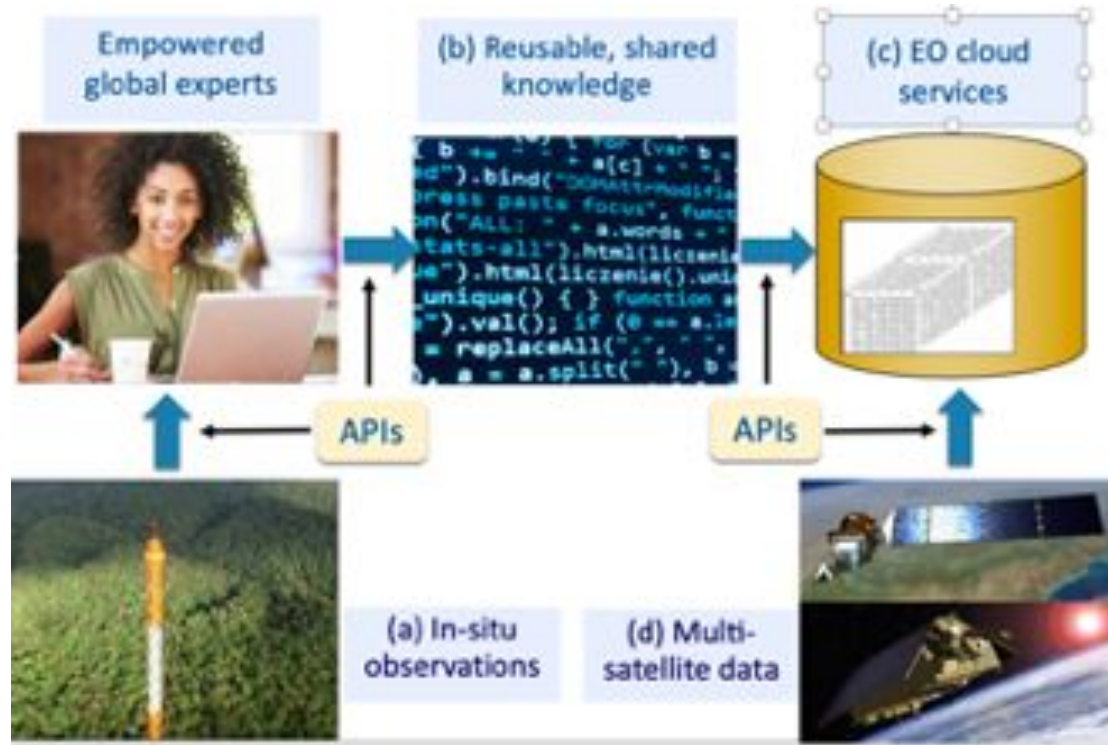
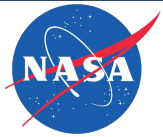


Fig. 1 in GEO EAG Discussion Paper “Building the infrastructure for a results-oriented GEOSS”



# Useful Artifacts in the Knowledge Hub

**(a) Journal paper**

ISPRS Journal of Photogrammetry and Remote Sensing

**(b) In-situ data**

PANGAEA

Big earth observation time series analysis for monitoring Brazilian agriculture

Michelle Cristina Araujo Pires<sup>1</sup>, Gilberto Camara<sup>2</sup>, Inês Sanches<sup>3</sup>, Rolf Wackel<sup>4</sup>, Alexandre Carvalho<sup>5</sup>, Adeline Marçal<sup>6</sup>, Alexandre Coutinho<sup>7</sup>, Julia Espenhe<sup>8</sup>, João Antunes<sup>9</sup>, Rodrigo Rangel Bagnoli<sup>10</sup>, Damien Arvor<sup>11</sup>, Claudio Almeida<sup>12</sup>

Received 16 June 2019; revised 20 May 2020; accepted 10 June 2020  
This paper is published as an open access article in the ISPRS Journal of Photogrammetry and Remote Sensing. The copyright for this article is held by the International Society for Photogrammetry and Remote Sensing, Inc. (ISPRS), 3960 Willingboro Road, Suite 800, Willingboro, NJ 08094, USA. <https://doi.org/10.1016/j.isprsjprs.2019.10.027>

Câmara, Gilberto; Pires, Michelle; Simoes, Rolf; Wackel, Adeline; Carvalho, Alexandre X Y; Coutinho, Alexandre; Espenhe, Julia; Antunes, João; Bagnoli, Rodrigo; Arvor, Damien (2017): Land cover change maps for Mato Grosso State in Brazil: 2001-2016. Link to files: PANGAEA, <https://doi.org/10.1594/PANGAEA.411291>.

Supplement to: Pires, Michelle; Câmara, Gilberto; Sanches, Inês; Simoes, Rolf; Carvalho, Alexandre X Y; Wackel, Adeline; Coutinho, Alexandre; Espenhe, Julia; Antunes, João; Bagnoli, Rodrigo; Arvor, Damien; Almeida, Claudio (2018): Big earth observation time series analysis for monitoring Brazilian Agriculture. ISPRS Journal of Photogrammetry and Remote Sensing, 145, 328-335. <https://doi.org/10.1016/j.isprsjprs.2018.08.007>

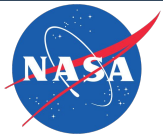
**(c) R code in github**

github.com/michellepires/landcover\_classification

**(d) Cloud data in AWS**

Object Name	Created	Last Modified	Size
LANDSAT_20000_2014-08-05_01.tif	Apr 8, 2019 1:48:01 PM (UTC-05:00)	1.4 MB	
LANDSAT_20000_2014-08-05_02.tif	Apr 8, 2019 1:48:01 PM (UTC-05:00)	1.4 MB	
LANDSAT_20000_2014-08-05_03.tif	Apr 8, 2019 1:48:01 PM (UTC-05:00)	1.4 MB	

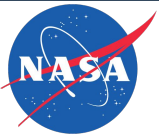
**(e) Results**



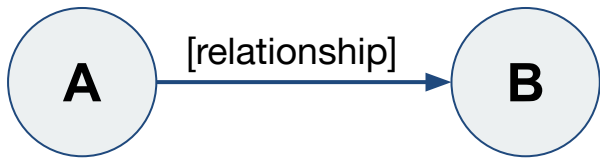
# Earth Observation Knowledge Graph

Connect together the main elements of EO knowledge AND context in a way that is:

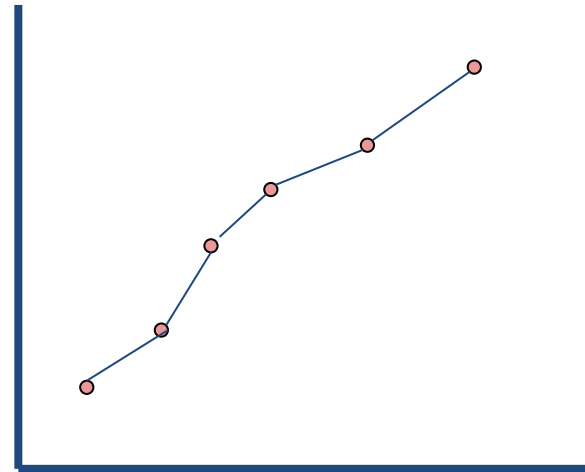
- Machine-readable
- Human-usable
- Curatable

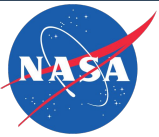


This kind of Graph



*Not* this kind of Graph





# Important Entities

Publication

Result

Exploitation  
System

Instrument

Satellite

Person

Workflow

Dataset

Application

Discipline

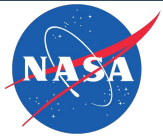
Software

Model

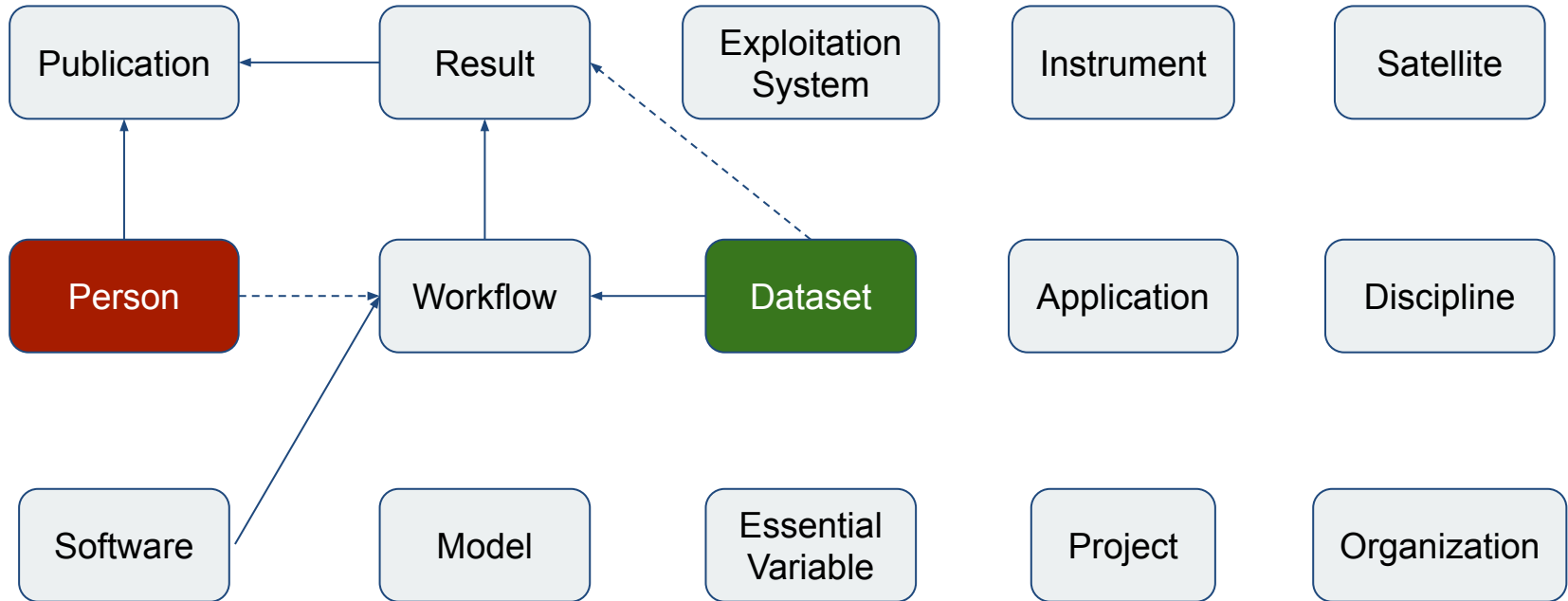
Essential  
Variable

Project

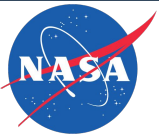
Organization



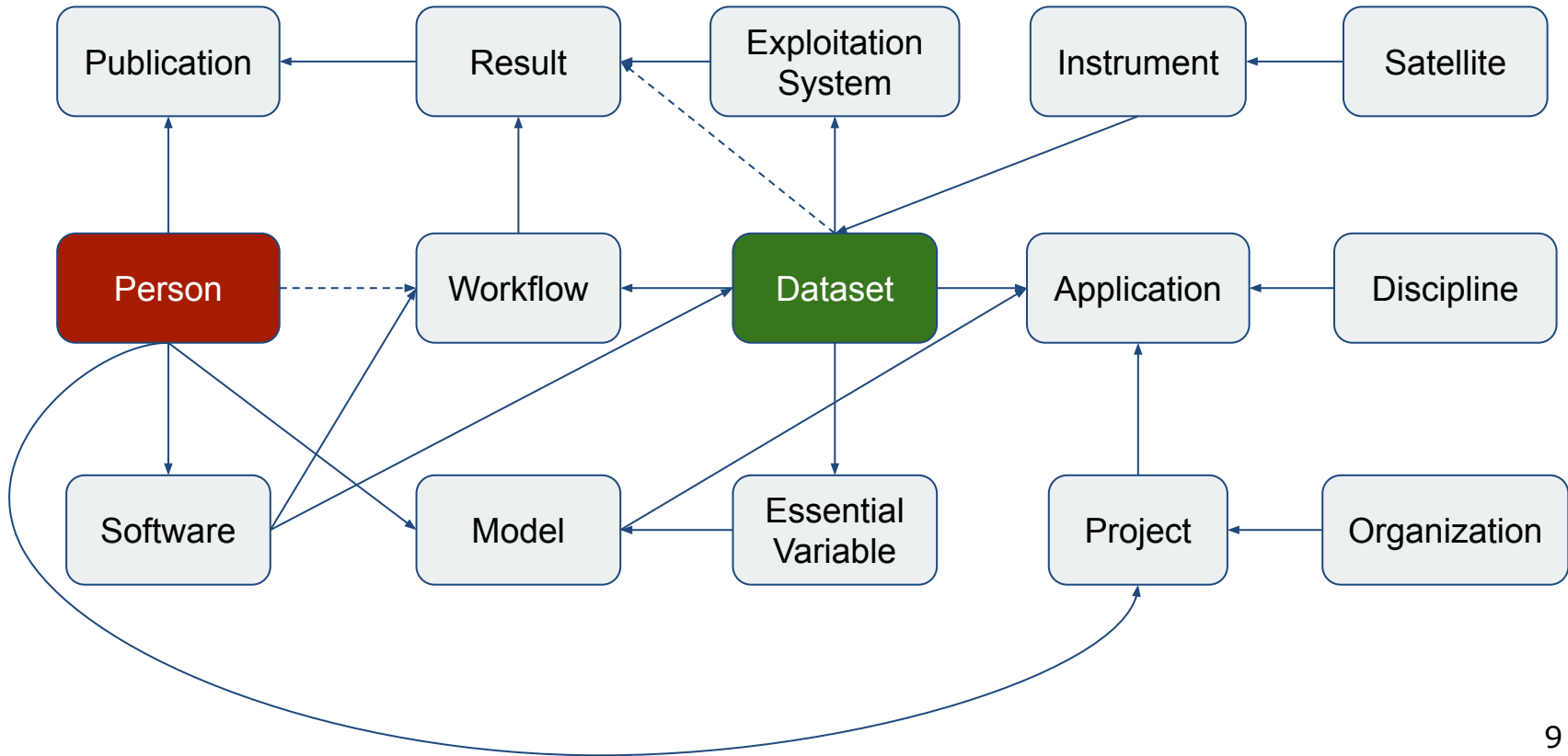
# GEOSS Connections

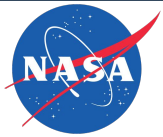




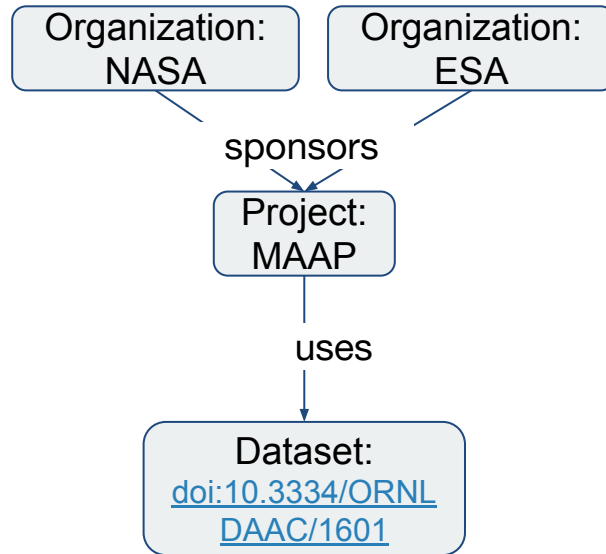


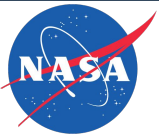
# Other Important Connections



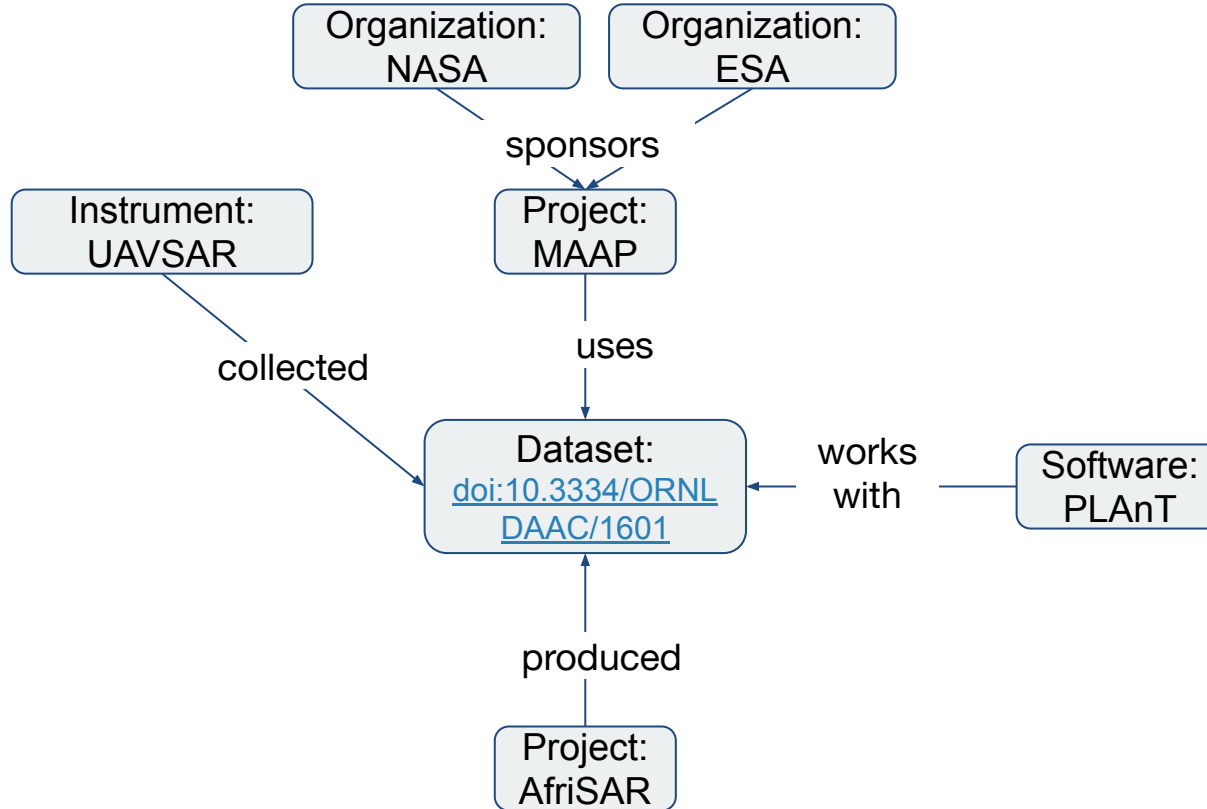


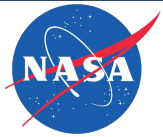
# Example



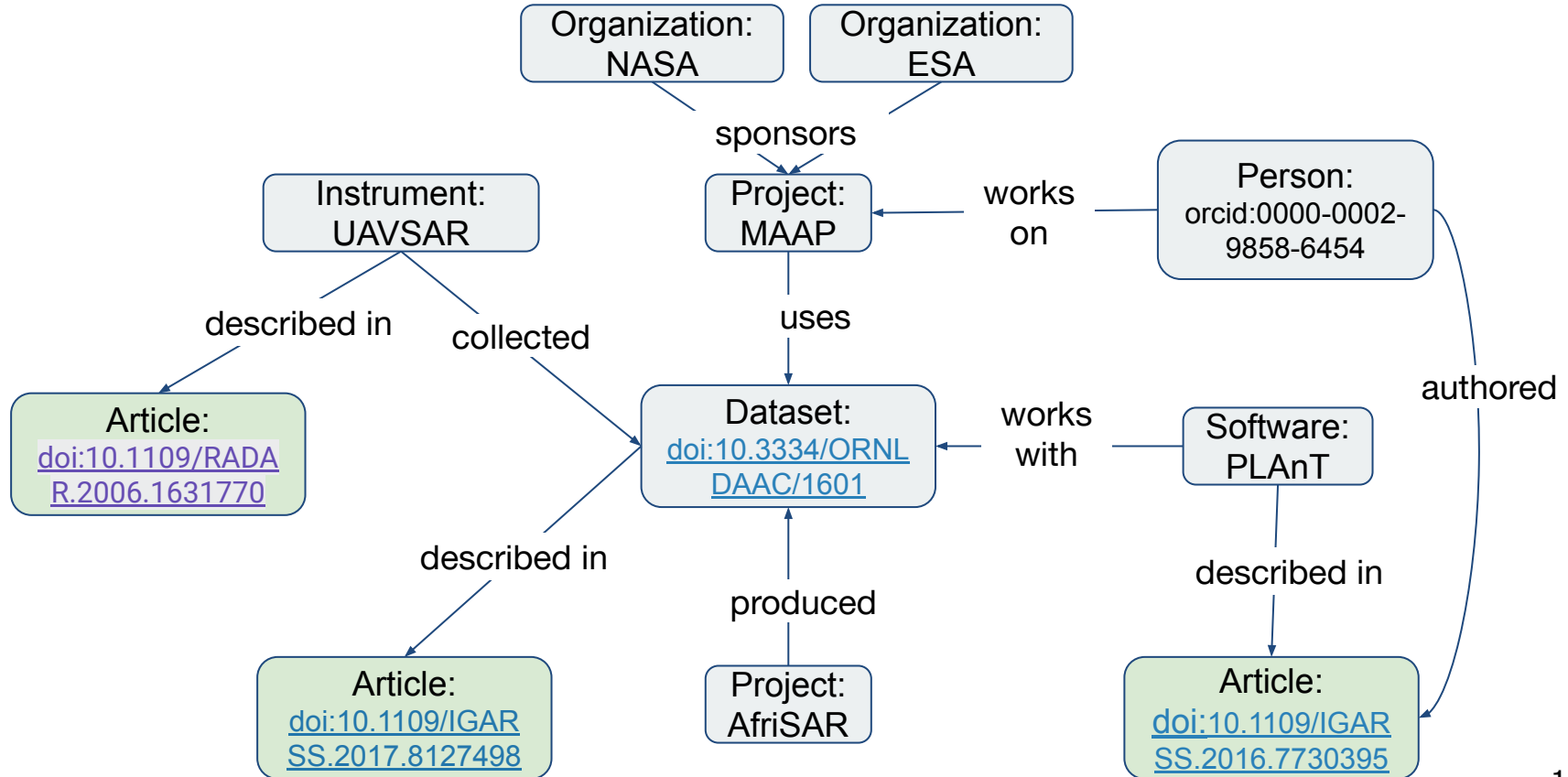


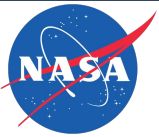
# Example





# Example



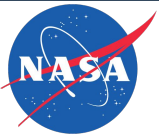


# Potential Use Cases

## Answering Questions for Developers and Users

- What **Organizations** are producing **Datasets** used by **Exploitation System X**?
- **Who** knows a lot about **Science Application X**?
- Which **Organizations** are using **Dataset X** and for what purpose?
- How was **Result X** obtained: which **data** and **tools/services**?

## Connecting Systems



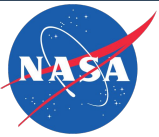
# Suggested Pilots

- Knowledge Graph for NASA-ESA MAAP
- Knowledge Graph for GeoGLAM Crop Monitor
- Demonstration queries

ESA = European Space Agency

MAAP = Multi-mission Algorithm and Analysis Platform

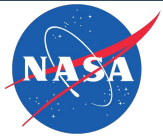
GeoGLAM = Group on Earth Observations Global Agricultural Monitoring Initiative



# Suggested Division of Labor

<b>Task</b>	<b>GEO</b>	<b>WGISS / CEOS</b>
Requirements and Design	✓	✓
Knowledge Hub Implementation	✓	
Knowledge Graph Collection Mechanisms		✓
Knowledge Graph Population		✓
Naming Authority Engineering*		✓
Knowledge Hub Operations	✓	

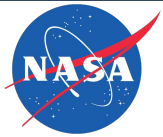
\*Eliminating duplication is the key to curation;  
Unique identifiers is the key to preventing eliminating



# Leveraging and Learning from Current Efforts

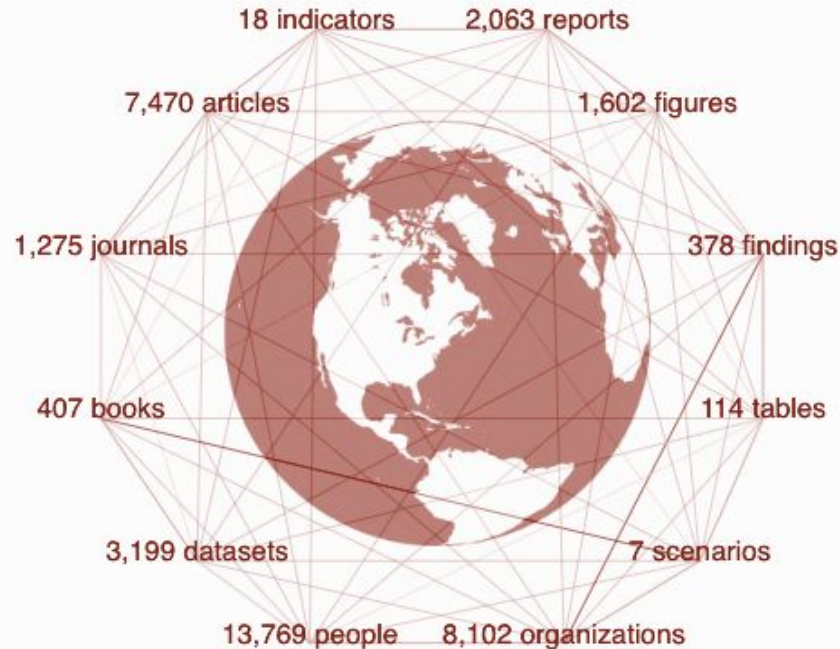
- Global Change Information System (GCIS)
- Global Change Master Directory (GCMD)
- Committee on Earth Observing Satellites (CEOS)  
Tool Inventory
- Unified Metadata Model (Services ↔ Collections)
- Javascript Object Notation-Linked Data (JSON-LD)
- OGC Testbed 15 EOPAD thread (JSON + Services)





# Global Change Information System

Connecting global change resources.



JSON YAML