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INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

EGI Conference 2020
Experience from Around the World with Federated Clouds and Data

ENES climate data infrastructure

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DKRZ

European Network for Earth System Modelling (ENES)

The IS-ENES3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

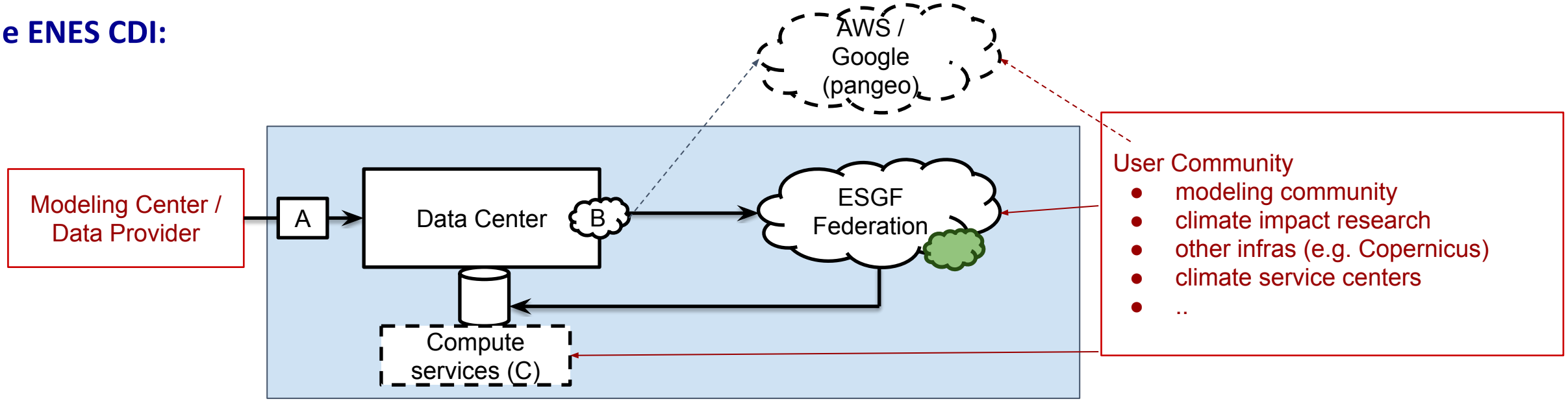
The ENES Climate Data Infrastructure (CDI)

Overview

- Main objectives, user groups, evolution
- Core infrastructural components and services of the data infrastructure
- Evolving aspects:
  - computation near to the data
  - towards cloud based infrastructure(s)

The ENES Climate Data Infrastructure (CDI)

The ENES CDI:



- **A: Metadata and Data standards**
- **B: Data centers integrating services in a federation (ESGF based)**
- **C: Enabling data analysis activities near to the data**

towards cloud deployments:

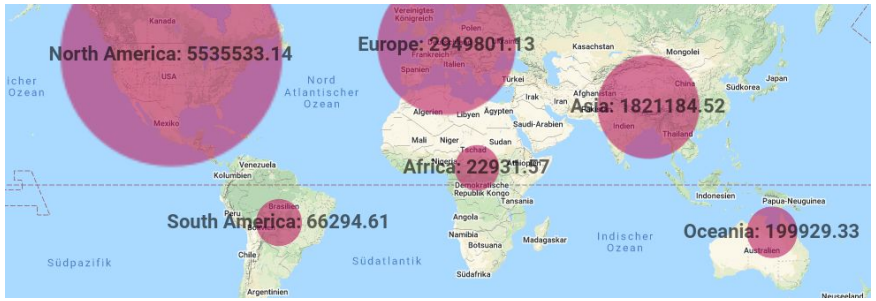
- **a) hosting of core components in commercial clouds**
- **b) hosting data and compute in commercial (and institutional) clouds**

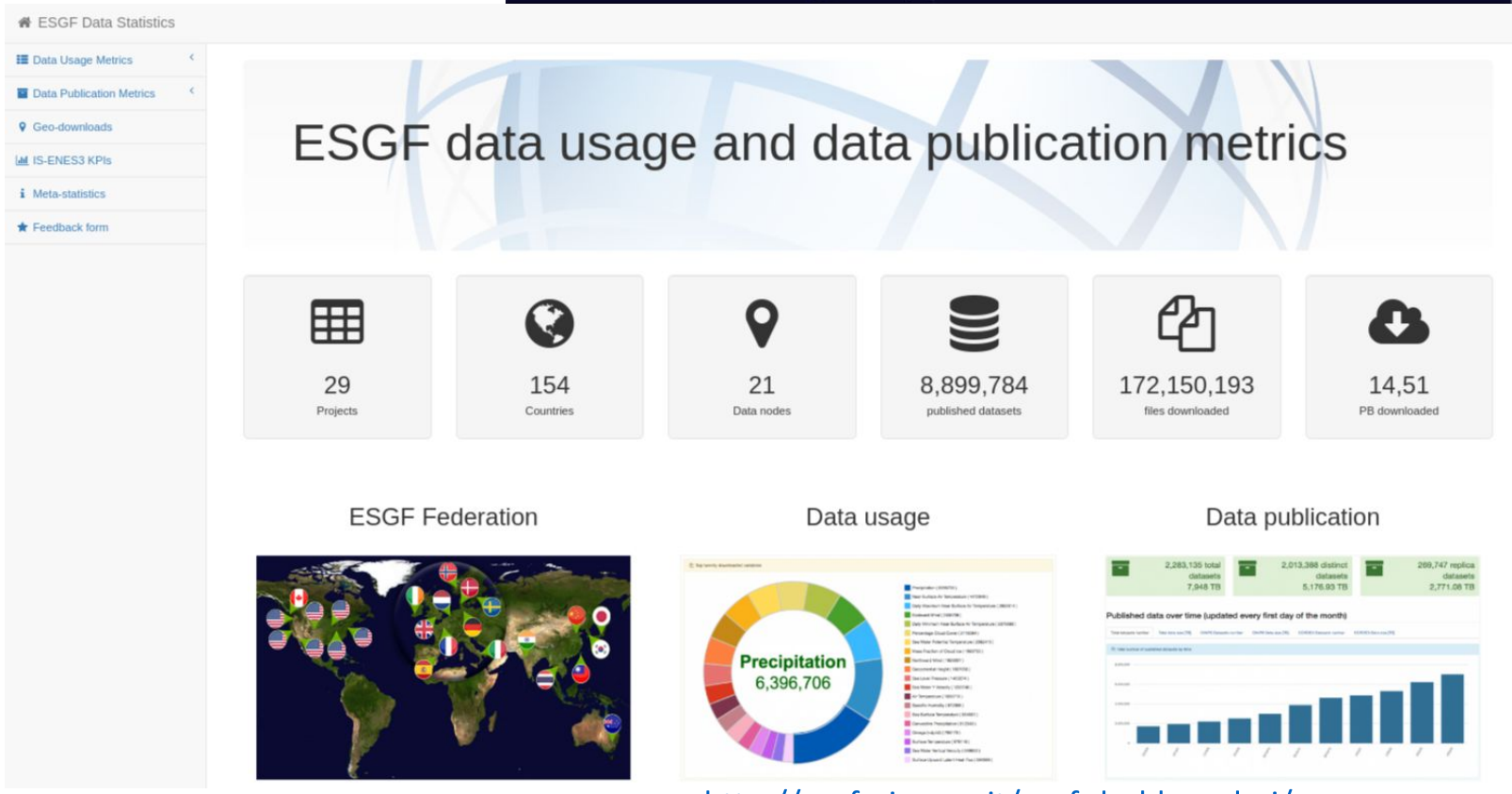
The ENES CDI: objectives

Support data distribution for internationally coordinated climate model intercomparison projects (CMIP, currently CMIP6)

Example: ENES CDI supporting CMIP6:

- 4 ESGF portals (world: 10)
- 11 ESGF data nodes (world: 29)
  - France, Germany, UK (tier1)
  - Ireland, Italy, Norway, Spain, Sweden
- Models: 46 (world: 103)
- Modeling Institutes: 19 (world: 41)



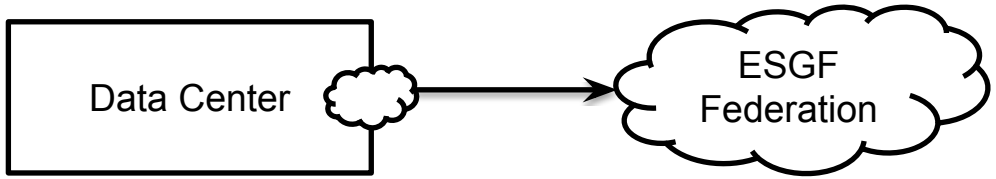


http://esgf-ui.cmcc.it/esgf-dashboard-ui/

ENES CDI: The ESGF software stack

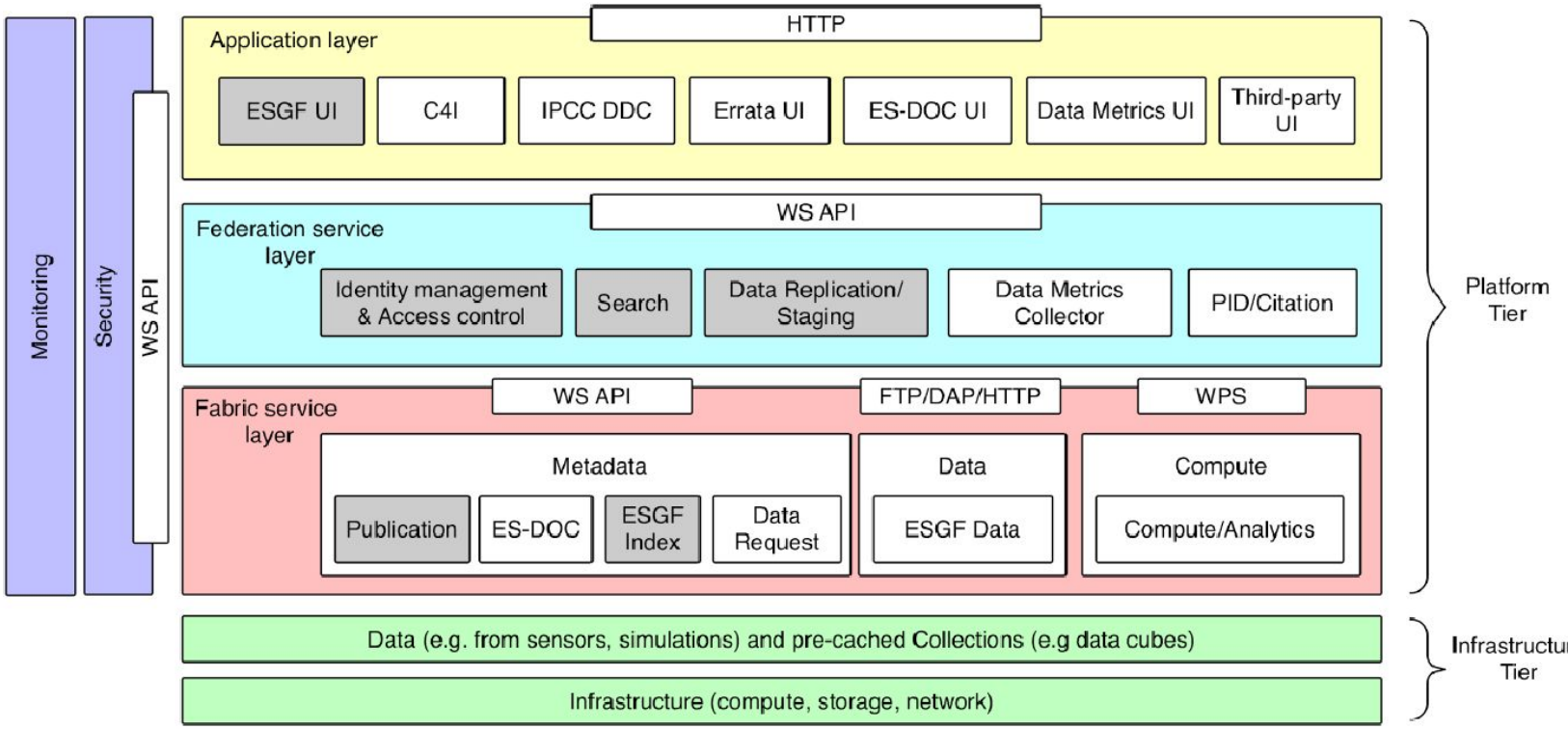
The ESGF SW stack evolved over the past > 10 years as part of an international collaborative effort supported by national/institutional funding

- IS-ENES3 project is currently coordinating the European contributions (white boxes in picture)
- github hosted and open source



Current challenges:

- Modularization, orchestrated deployment support (docker, ansible, kybernetes)
- Worldwide operating system, best effort funding → sustainability
  - EU: discussed as part of IS-ENES3
  - Worldwide: ESGF XC, WCRP, .. discussions



ENES CDI: example services beyond basic data distribution

Beyond data search and access services in support of CMIP6:

- Persistent data identification service (PID service)
- Errata service
- Data citation service (DOI service)

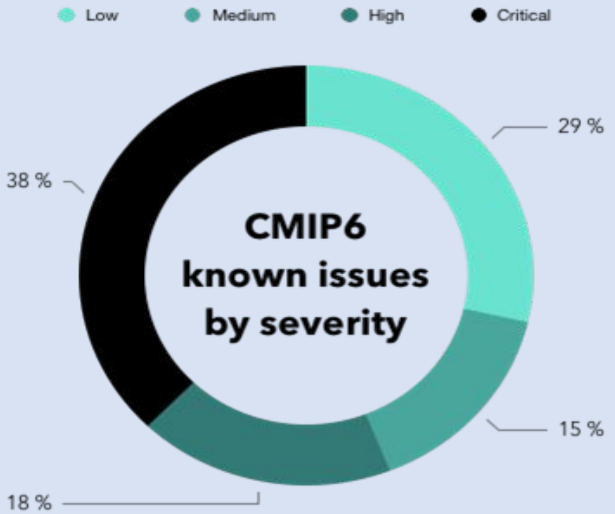
} Supporting key aspects of FAIR data principles

PID service:

- Operational integration based on worldwide distributed message queue
- overall 16.5 * 10^6 PIDs assigned (including retracted etc.)
- << 0.1% registration problems
- automatic curation scripts in place
- Cooperation with EOSC, EPIC, EUDAT, RDA for sustainability

Errata service:

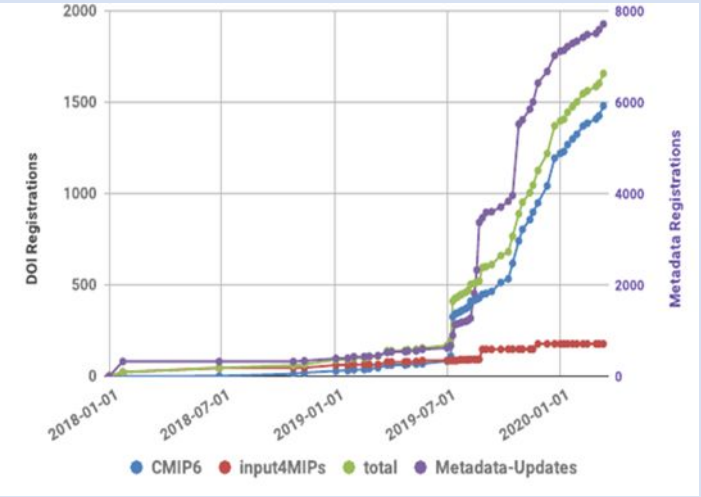
- > 175 issues registered
- > 90.000 data sets affected
  3% of CMIP6 archive



Data citation service:

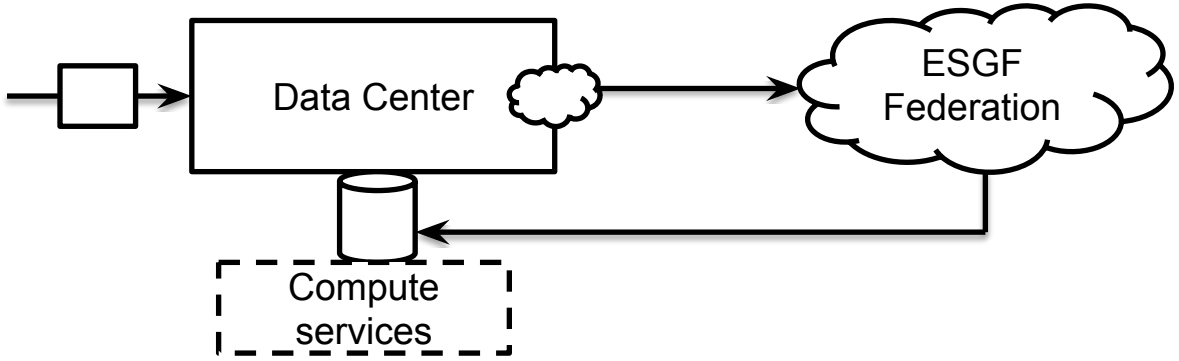
- > 6000 DOI registrations for CMIP6
- > 8000 citation metadata updates

DataCite DOI Registration for CMIP6



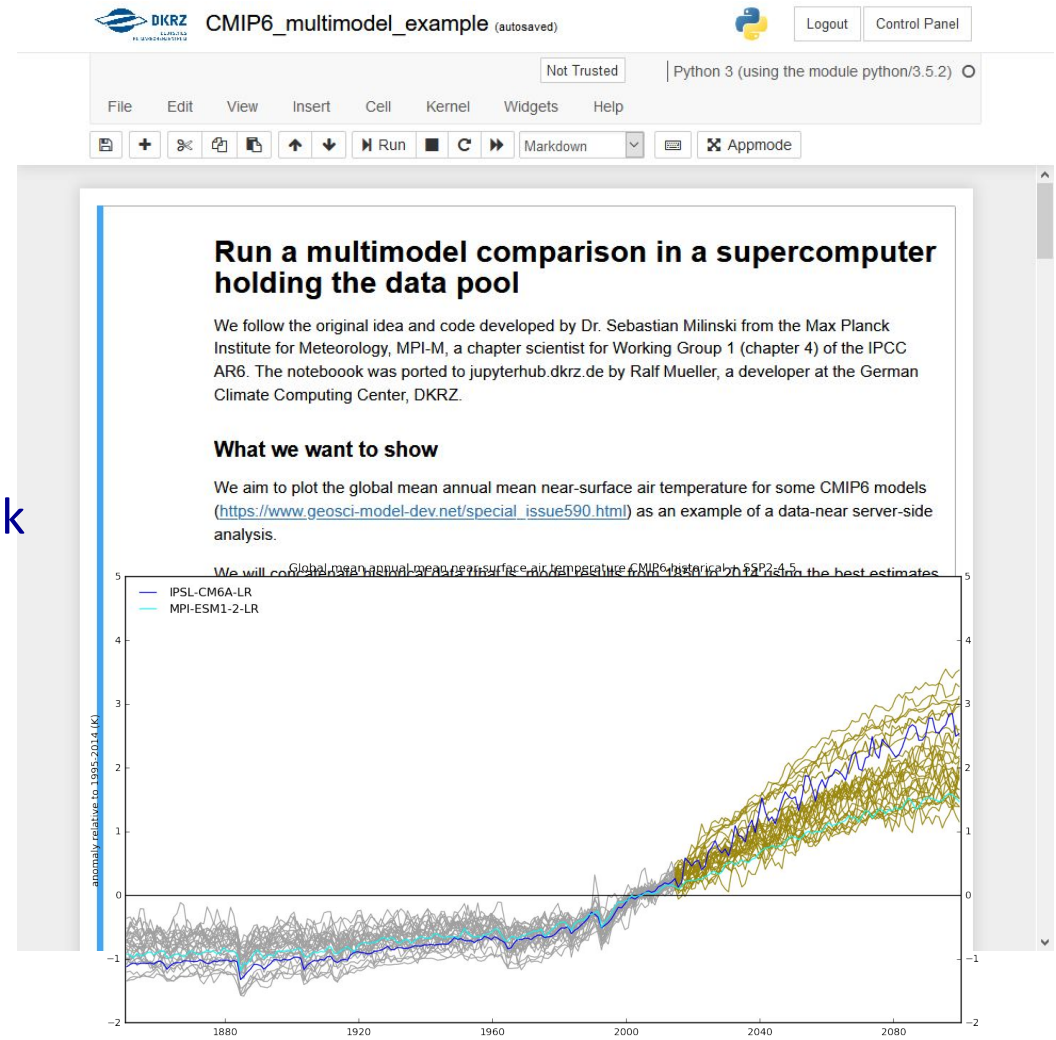
stats: http://bit.ly/CMIP6_DOI_Statistics

ENES CDI: processing services



Supporting data near processing

- Prerequisit: Replication of CMIP6 collections into Multi-PByte disk pools (coordinated replication strategy)
- Different processing approaches:
  - Hosting of data near VMs
  - Jupyter-hub installations
  - OGC Web Processing Services (WPS)
    - also for interaction with Copernicus CDS
  - Direct access to virtual workspaces



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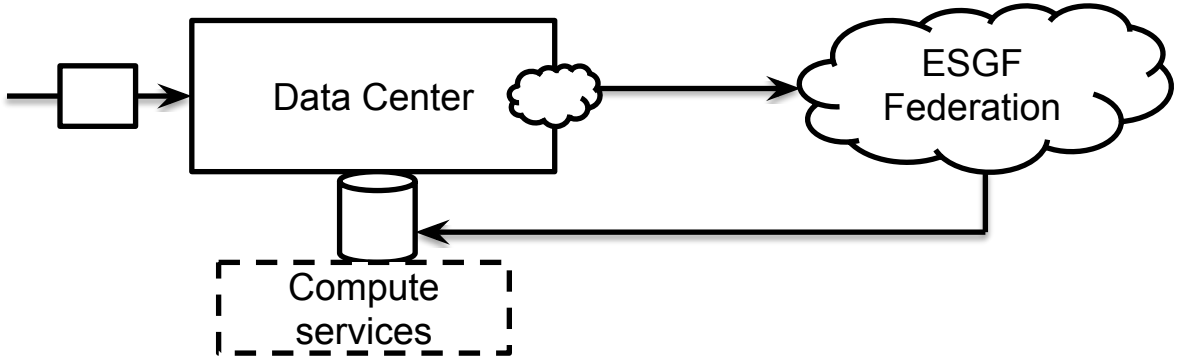
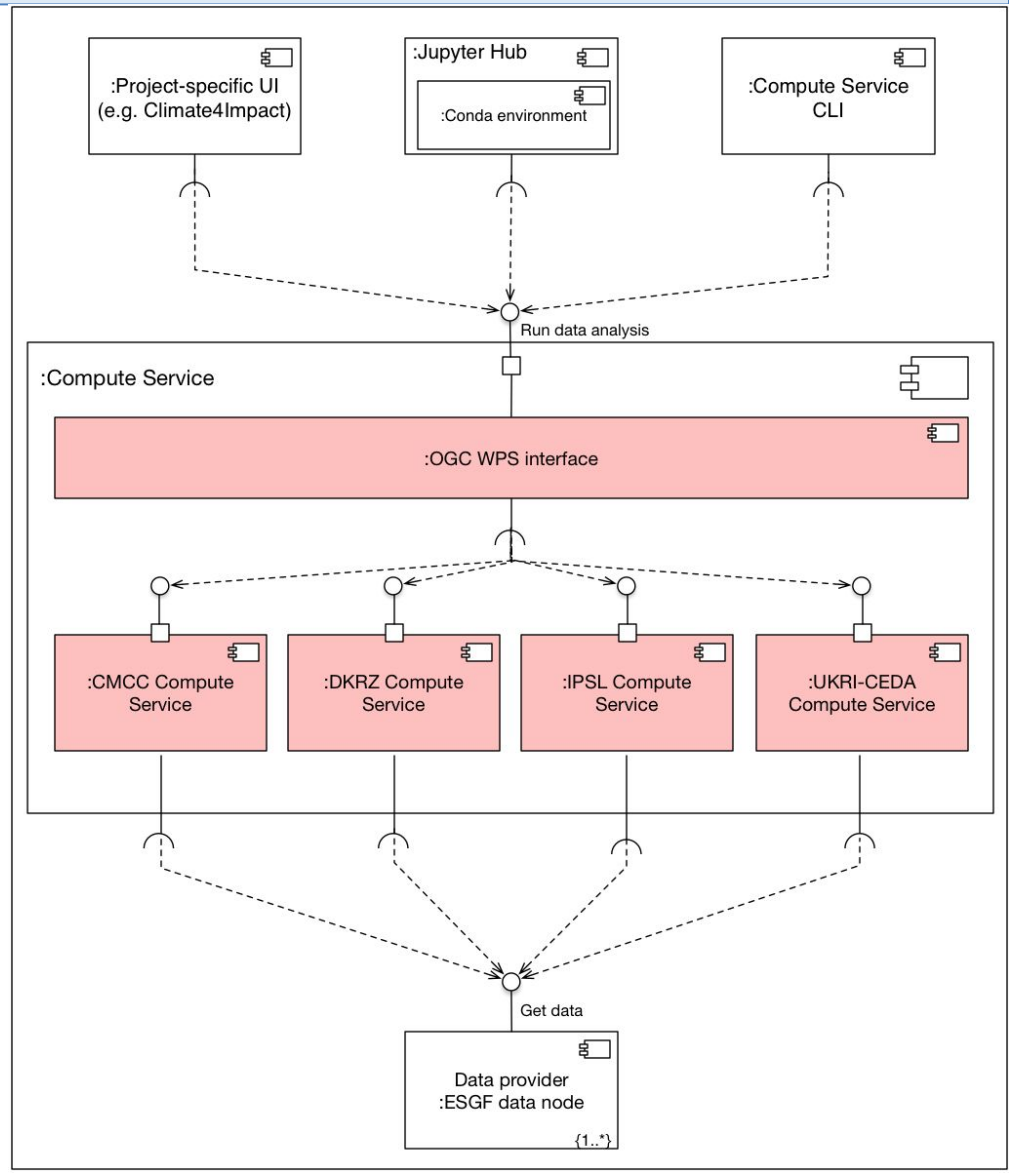
ENES CDI: processing services



Supporting the diverse data near processing requirements

- data center organized data pools
- basic data reduction and transformation services as web processing services
- jupyter-hub installations
- dedicated portals/services for e.g. climate impact community (C4I portal)
- Coordinated service activities at European level (e.g. IS-ENES3, Copernicus)
- different, flexible compute backends (xarray, dask, ophidia, ..)
- ..

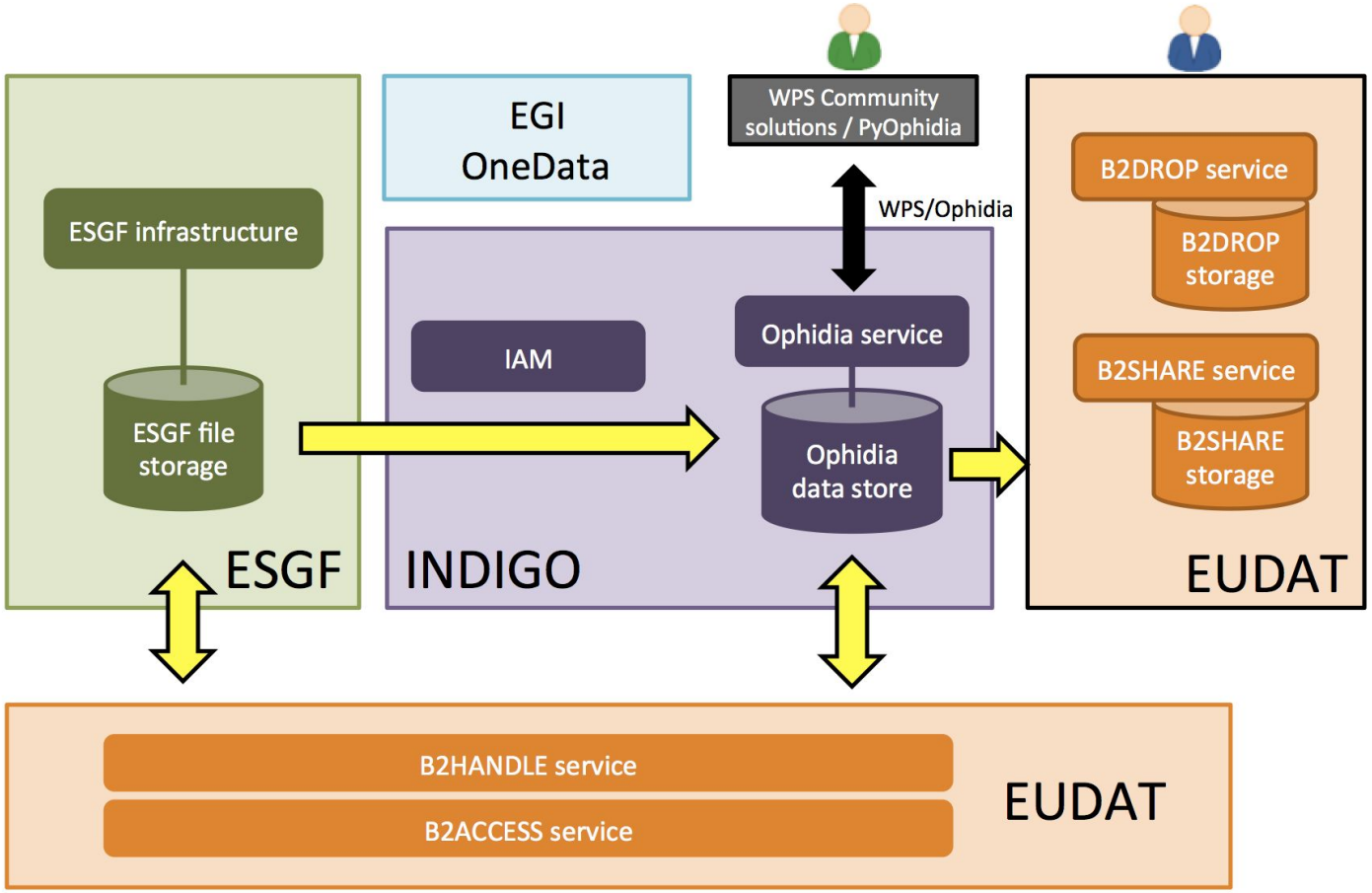


ENES CDI: ECAS service example

The ENES Climate Analytics Service (ECAS), proposed by CMCC & DKRZ in the EU H2020 EOSC-Hub project, supports climate data analysis experiments with a strong focus on data intensive analysis, provenance management, and server-side approaches

It is one of the EOSC-Hub Thematic Services as well as a Compute Service in the IS-ENES3 project

ECAS consists of multiple integrated components from INDIGO-DataCloud, EUDAT, ESGF and EGI, centered around the Ophidia HPDA framework



EOSC-hub receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 777536

ENES CDI: Future Perspectives

Moving towards cloud based solutions:

A) data hosting on the cloud

- google cloud hosting of CMIP6 subset (Pangeo community)
- AWS cloud prototype (US initiated, partners from IS-ENES contributing)
- institutional pilots
- data storage based on Zarr → "analysis ready data" → "analytics optimized data store"

→ future funding model(s) unclear

B) Individual infrastructural component hosting

- centralized search index
- centralized portal and Identity Proxy
- load balancing components (used e.g. to provide >99% availability services for Copernicus)
- …

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THE CONSORTIUM

Coordinated by **CNRS-IPSL**, the IS-ENES3 project gathers **22 partners** in **11 countries**

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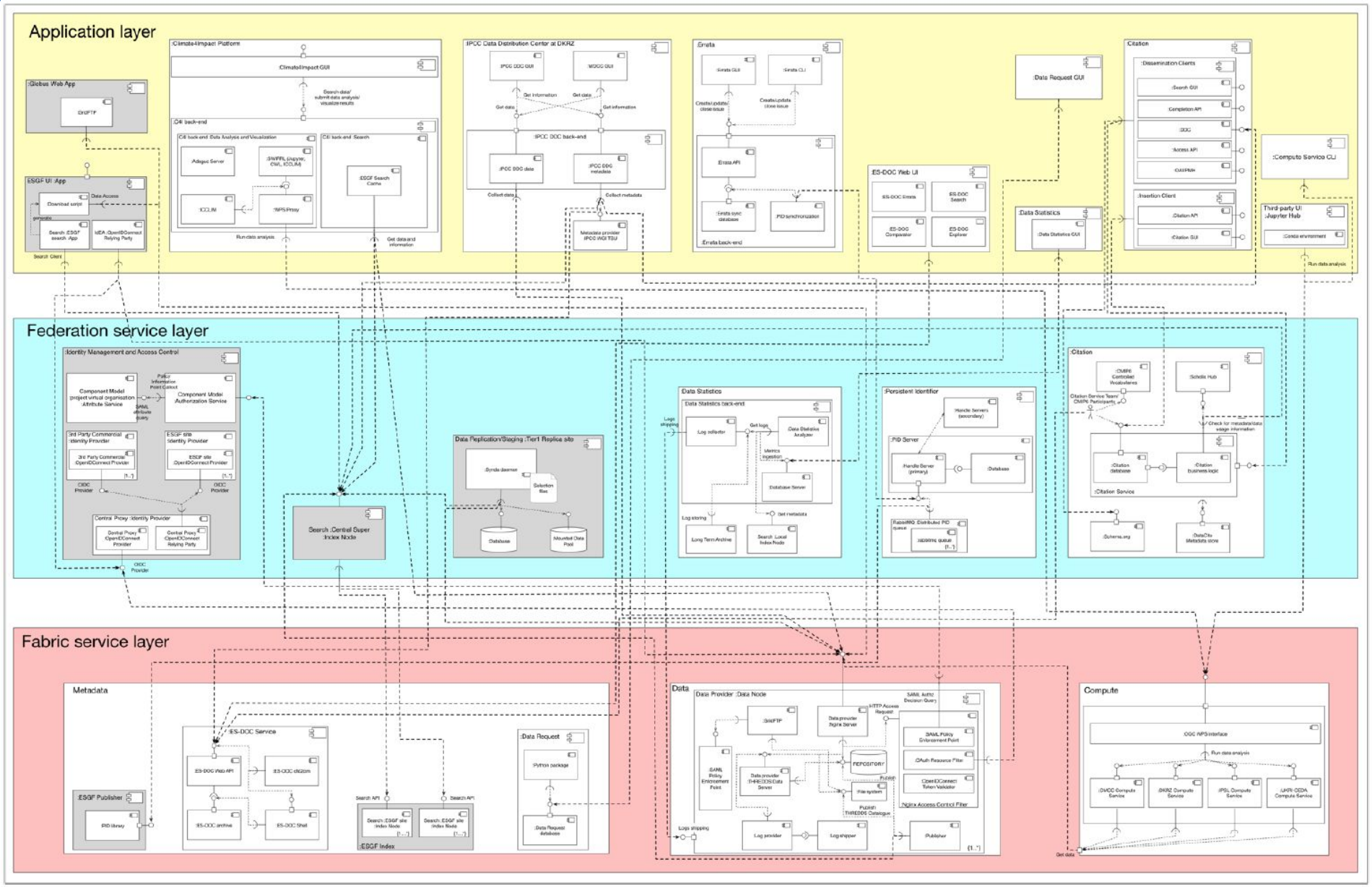
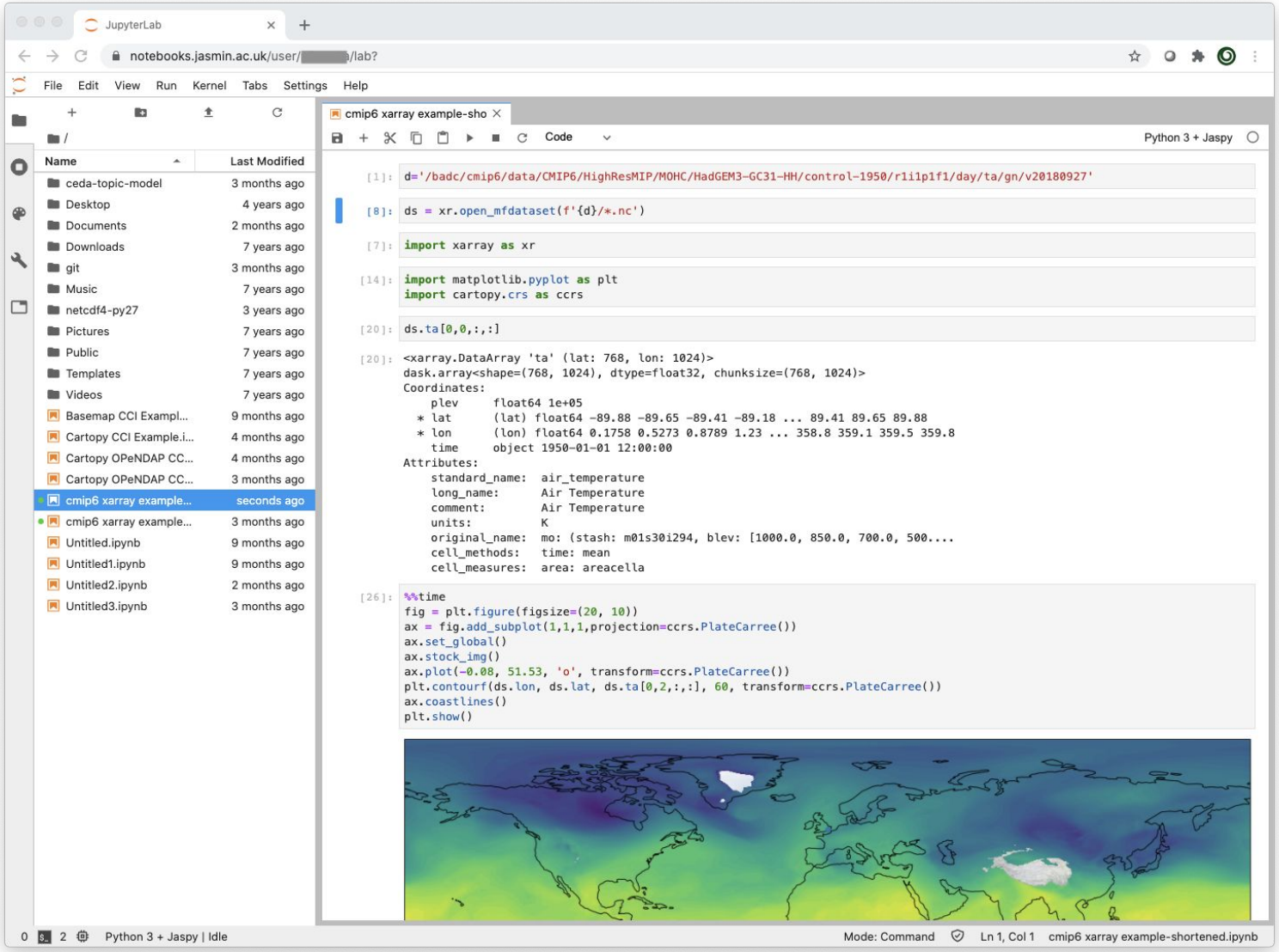
ENES CDI

Current architecture:

- complex dependencies
- intervoven partially maintained components



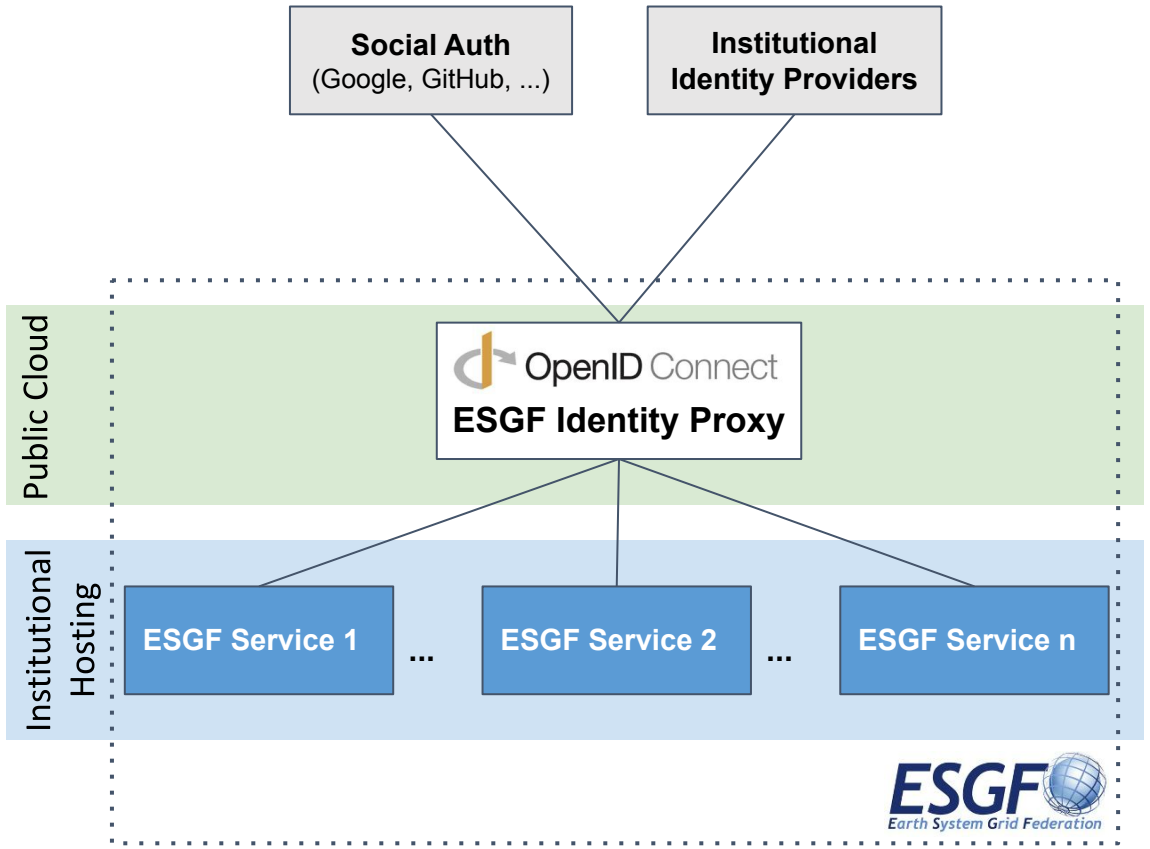
Jupyter Notebooks



- Jupyter Notebooks enable users to perform analysis of large data holdings at centres like DKRZ and CEDA (JASMIN facility)
- Avoids the need for “download and process at home” model
- Also provides potential as a training tool
- Notebooks could be a shared resource for the community demonstrating different analyses of data

ESGF Future Architecture - Examples of Planned Improvements: Identity Management

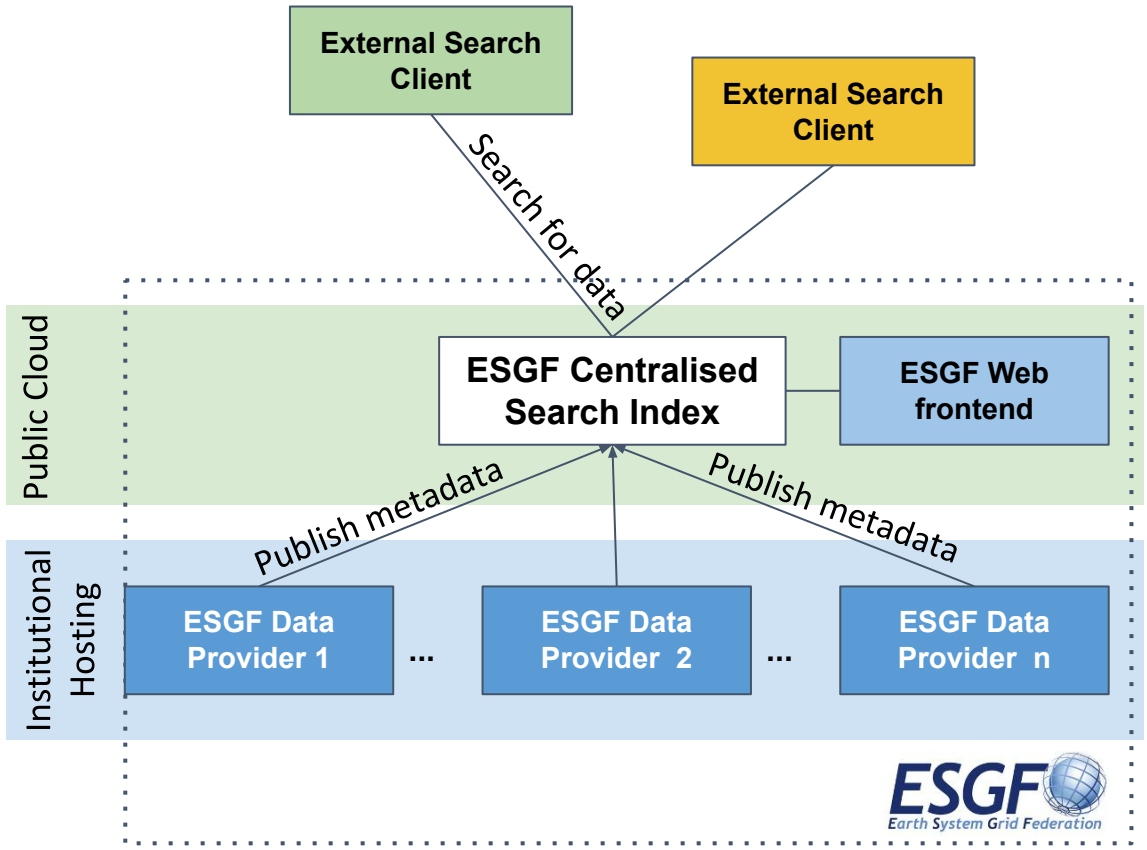
Identity Proxy Model



- Identity management and access control is needed in ESGF to secure access to restricted datasets and other resources
- The current system uses a many-to-many relationship between identity services and those services that are dependent on them
- The European AARC2 Project provides an alternative model
- External identity providers are proxied through a centralised Identity Proxy
- The Identity Proxy enables the presentation of a common interface to ESGF services
- It simplifies the interface between ESGF services and external identity providers

ESGF Future Architecture - Examples of Planned Improvements: Search Services

Centralised Search Service



- ESGF Search services provide users with the ability to find the model data they are interested in accessing
- The existing architecture for ESGF uses a system of distributed search services at hosting institutions in the federation
- This is flexible but complex to maintain
- A new proposal is for a centralised search service (index) for ESGF
- This would be hosted on public cloud to make it resilient
- Access is simplified for applications because they can go to the one overall service for search queries