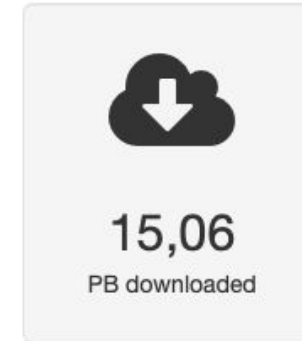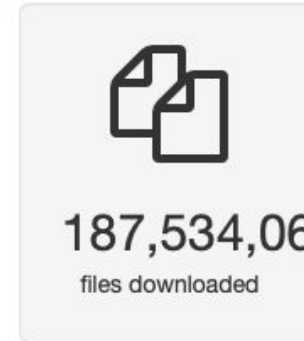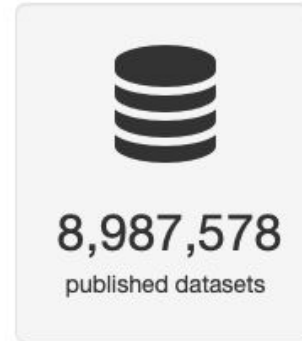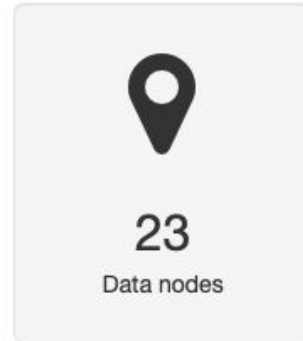# Cloud futures for CMIP data – evaluating object storage models and re-evaluating federation for data distribution

AGU, Session IN032-02, 14 December 2020

Ag Stephens, **Philip Kershaw**, Alan Iwi, Matthew Jones, Bryan Lawrence, Neil Massey, Ruth Petrie, Matt Pryor, Eleanor Smith

Earth System Grid Federation: 10+ years of operations

29 Projects	154 Countries	23 Data nodes	8,987,578 published datasets	187,534,064 files downloaded	15,06 PB downloaded

ESGF Federation

Data usage

Precipitation
6,396,706

Data publication

2,283,135 total datasets 7,948 TB — 2,013,388 distinct datasets 5,176.93 TB — 269,747 replica datasets 2,771.08 TB

Published data over time (updated every first day of the month)
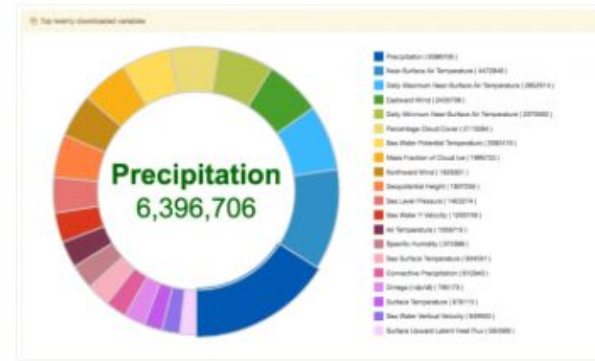
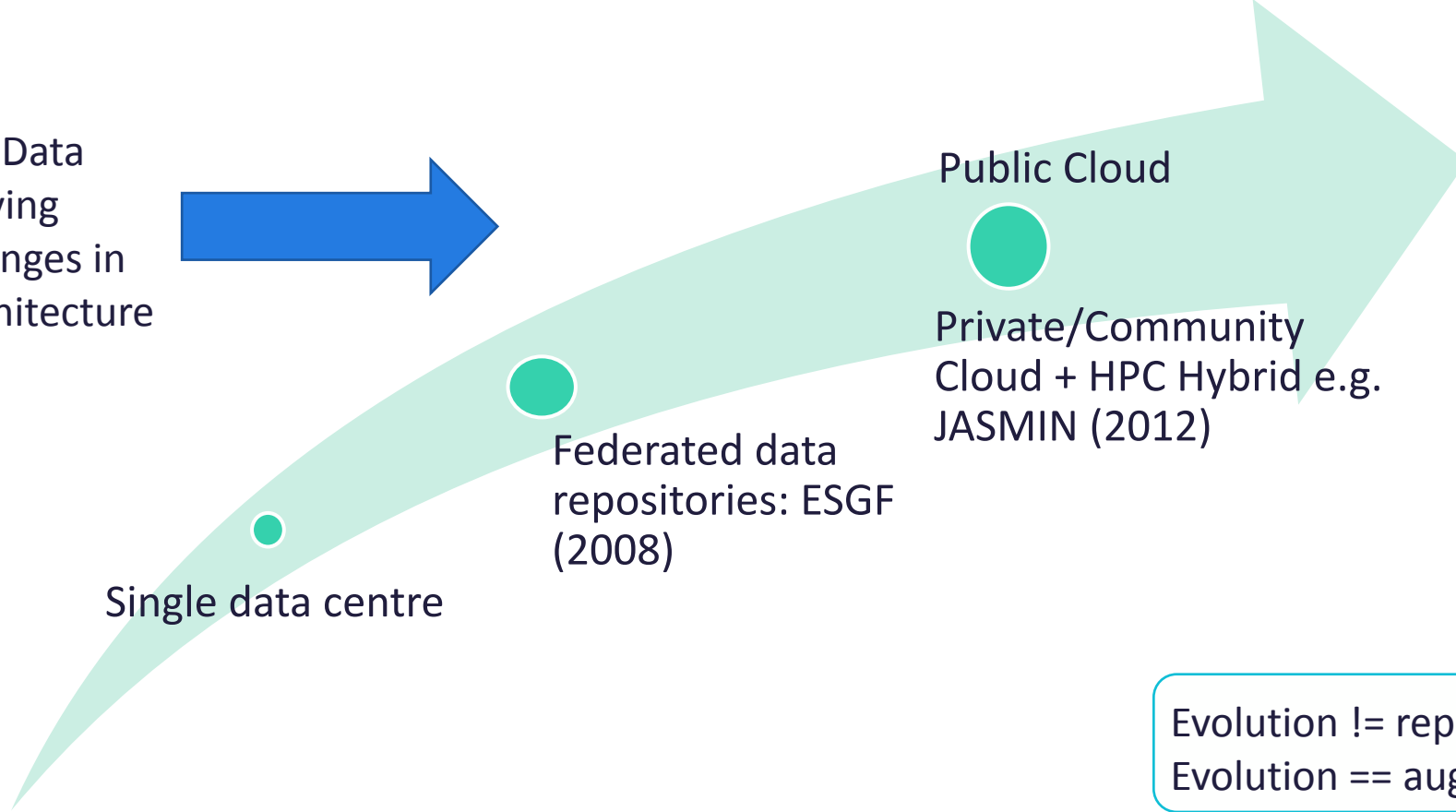# Evolution to regional clusters aggregating data + co-locating it alongside processing capability

Big Data driving changes in architecture

Single data centre

Federated data repositories: ESGF (2008)

Public Cloud
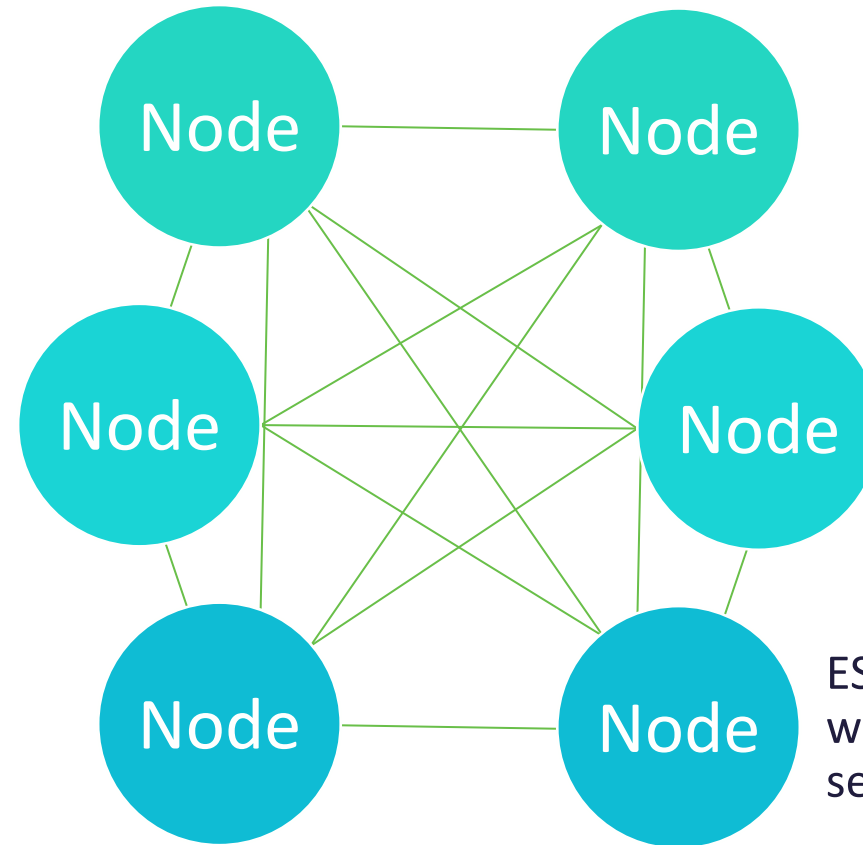
Private/Community Cloud + HPC Hybrid e.g. JASMIN (2012)

Data Analysis Platforms
- Co-located compute and data
- Analysis Ready Data (ARD)

Evolution != replacement
Evolution == augmentation + replacement

UKRI Science and Technology Facilities Council / Natural Environment Research Council

Centre for Environmental Data Analysis
SCIENCE AND TECHNOLOGY FACILITIES COUNCIL
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

Federation enables scaling and resilience

ESGF Nodes at sites around the world deliver data and associated services

Public Cloud has in-built capabilities for scaling and resilience
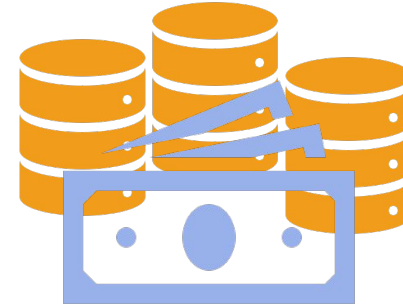
Cloud super-node

Aggregate data and services into the cloud

There are technical, policy and financial challenges and opportunities for wider adoption of public cloud

Object Storage

Public cloud popularised object storage as a convenient alternative to POSIX storage.
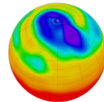
Large-Volume Scientific Data

Overall costs for hosting large volumes of scientific data on public cloud remains high when compared to on-premise hosting.

Federation and Cloud can augment and complement one another

Federation glue: search, identity, metrics, monitoring public cloud-hosted

Node

Centralised Cloud Services for federation
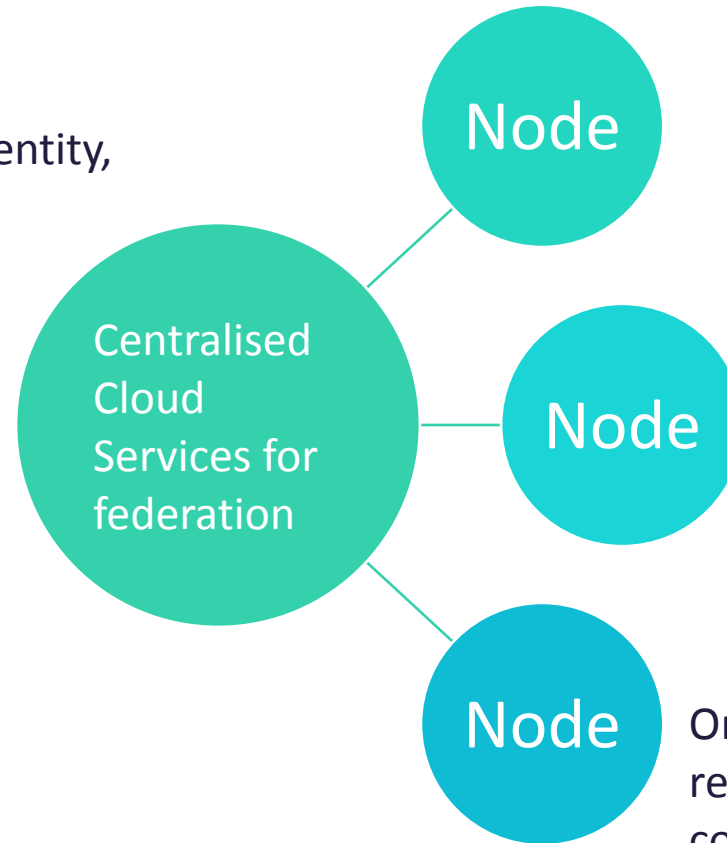
Node

Node

On-premise nodes for big data serving – research community labs, private and community clouds, computing centres

Build a cloud-compatible s/w stack to maximise portability between public cloud and on-premise

Public (commercial) cloud

On-premise: private/community cloud

technical agility for migration

Kubernetes

Object Store

JASMIN

[Example of National Facility for the research community]

DevOps, Infrastructure-as-Code approach

Develop a Strategy for CMIP Data with Object Store for JASMIN and ESGF

Performance-based: evaluate different technologies

- S3netcdf4 https://github.com/cedadev/S3-netcdf-python)
- NetCDF4-python with HTTP range GET extension
- Xarray / zarr

Functional and user-directed: populate a subset of CMIP Data using xarray / zarr

Object Store performance test design
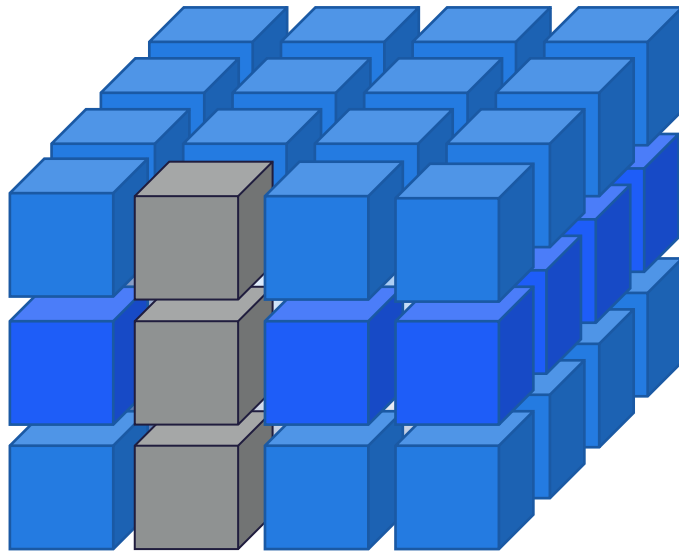
- Use JASMIN *Caringo* object store (S3 compliant interface)
- Use serial client queries – x/y and time series slicing
- Used BCC test dataset, relative humidity
- Object / chunking (□ ~250MB objects)

Serialisation	Time steps	Height	latitude	longitude
S3netcdf4	60	19	160	320
NetCDF4-python	7200	19	160	320
xarray/zarr	68	19	160	320

Object testing *preliminary* results reflect the chunking strategies; more analysis needed

X-Y map reads from Caringo
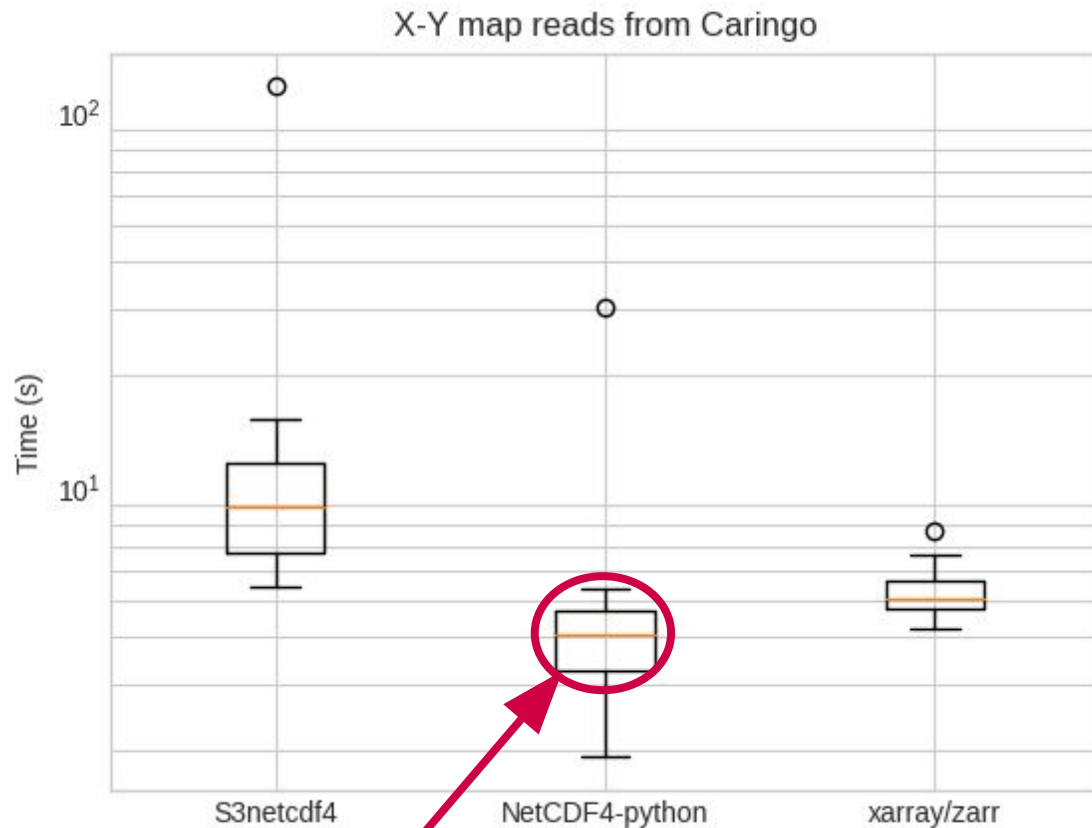
Complete slices in lat/lon allow for efficient retrieval

Timeseries reads from Caringo
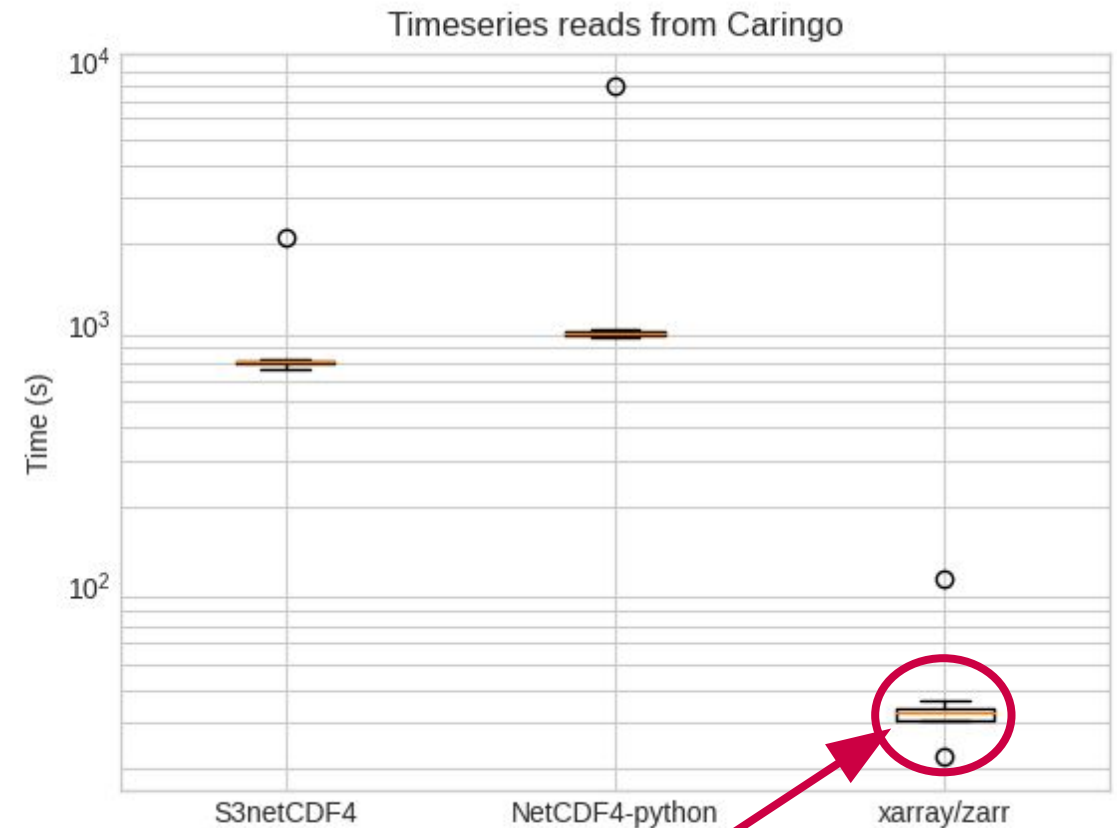
xarray/zarr performed well on time series queries

CMIP6 Subset on JASMIN Object Store: functional evaluation

Ongoing work and next steps

Collaboration on CMIP data on object store: Pangeo community, AWS ESGF node, DKRZ, …
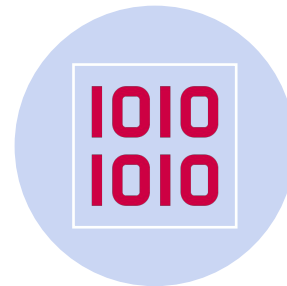
Long-term preservation and archiving – to address:
- Checksums

- Versioning

- Reconstruction from data corruption

Search:

- object store and traditional HTTP file serving

- ESM profile for STAC?

Interface for multiple storage media
 - S3 as interface for tape and object store

Acknowledgements + Contact Details

- This work has been carried out through IS-ENES3, a project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

Philip.Kershaw@stfc.ac.uk

@PhilipJKershaw