How Can Communities Less Familiar with Climate Models be Better Served Data?

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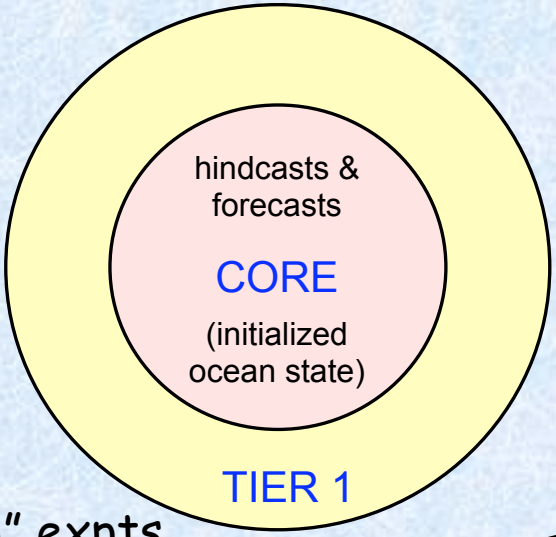
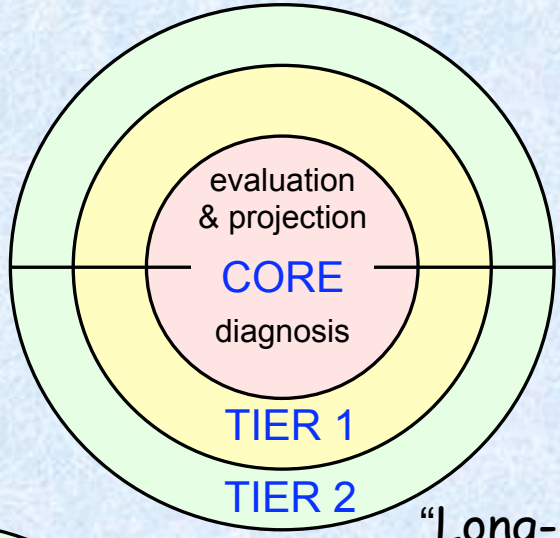
Outline

- How is CMIP model output currently archived and served?
- What challenges face communities less familiar with climate models?
- What can be done to facilitate access to model output by a wider community?

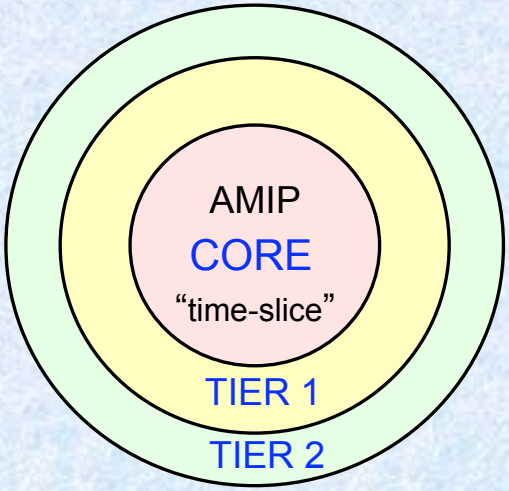
CMIP5 is organized around three types of simulations



"Near-Term" expts.
(decadal prediction)



"Long-Term"
traditional expts.
(century & longer)

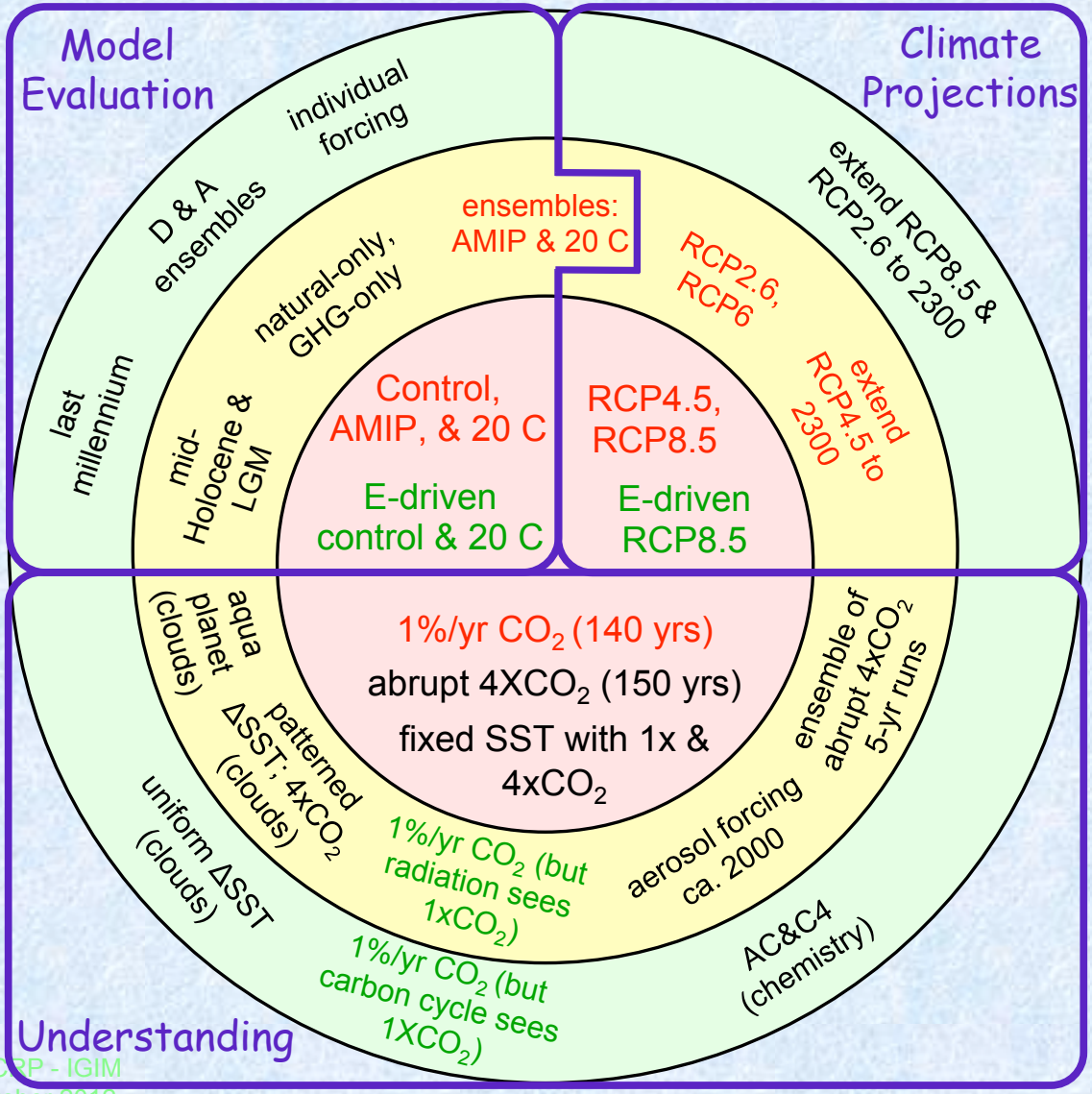


Atmosphere-Only Simulations

(for computationally demanding and NWP models)

See Taylor, Stouffer, & Meehl, *Bull. Amer. Meterol. Soc.*, 2012

A rich set of "long-term" experiments, drawn from several predecessor MIPs, focuses on model evaluation, projections, and understanding



Red subset matches the entire CMIP3 experimental suite

Green subset is for coupled carbon-cycle climate models only

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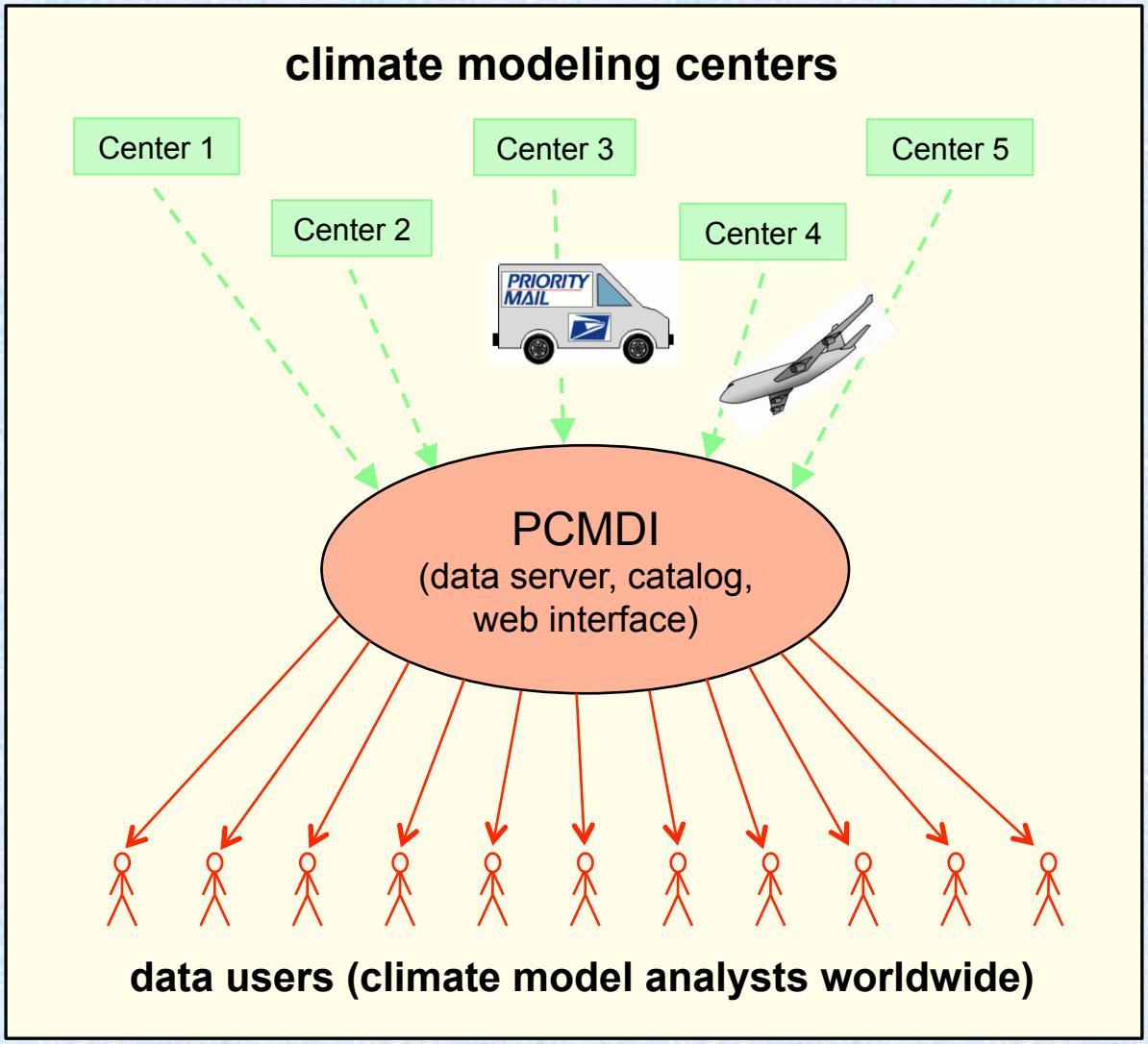
CMIP5 output fields requested (goes well beyond what was available from CMIP3)

- Domains (number of monthly variables*):
  - Atmosphere (60)
  - Aerosols (77)
  - Ocean (69)
  - Ocean biogechemistry (74)
  - Land surface & carbon cycle (58)
  - Sea ice (38)
  - Land ice (14)
  - CFMIP output (~100)
- Temporal sampling (number of variables*)
  - Climatology (22)
  - Annual (57)
  - Monthly (390)
  - Daily (53)
  - 6-hourly (6)
  - 3-hourly (23)

*Not all variables are saved for all experiments and time-periods

http://cmip-pcmdi.llnl.gov/cmip5/output_req.html

CMIP3 data handling: ESG* central archive at PCMDI

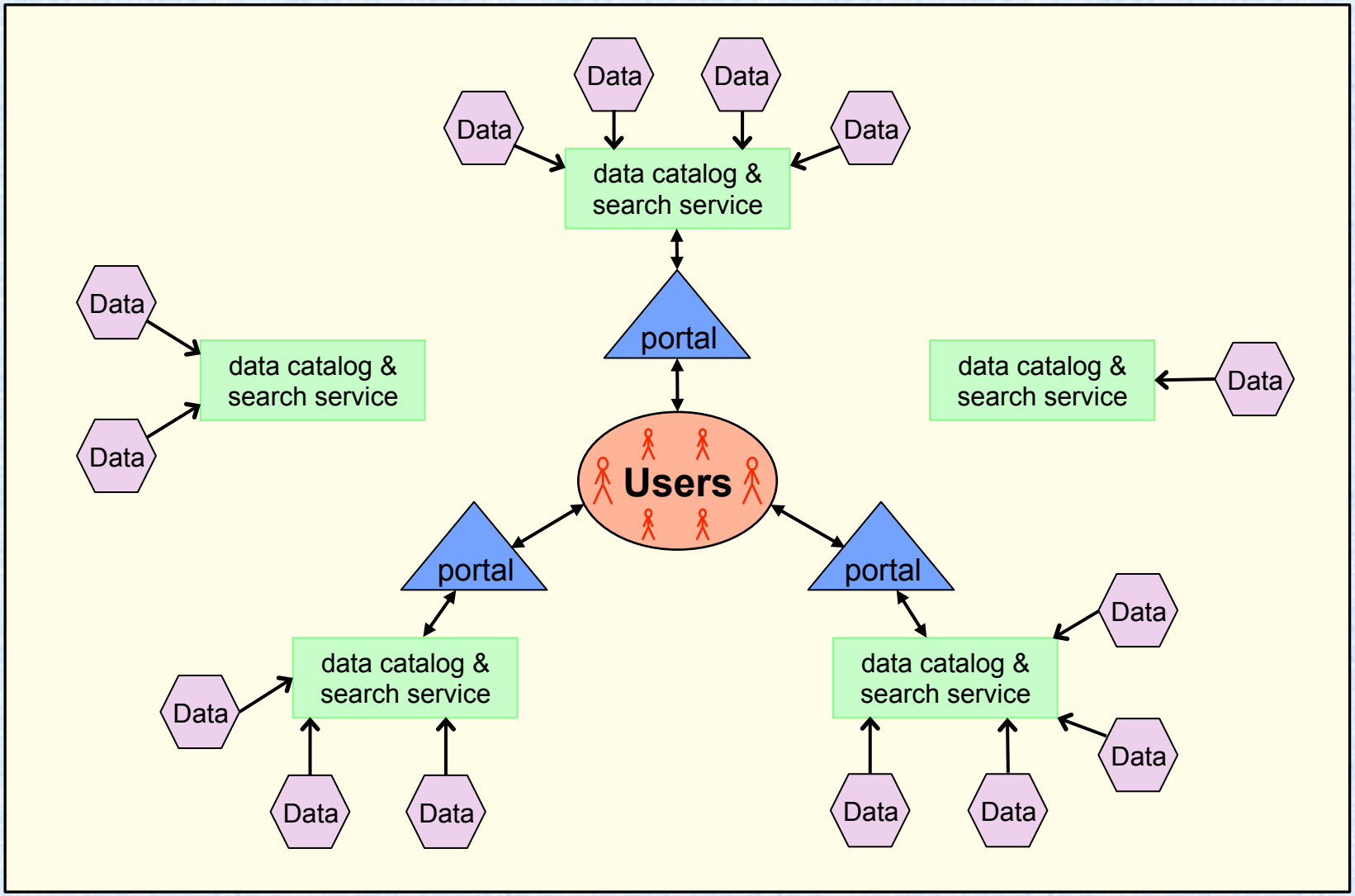


- Data shipped to PCMDI on hard disks
- Delayed availability
- Hindered corrections

- Search service via web gateway
- Download from single location (ftp, http)
- Fragile dependence on a single server.

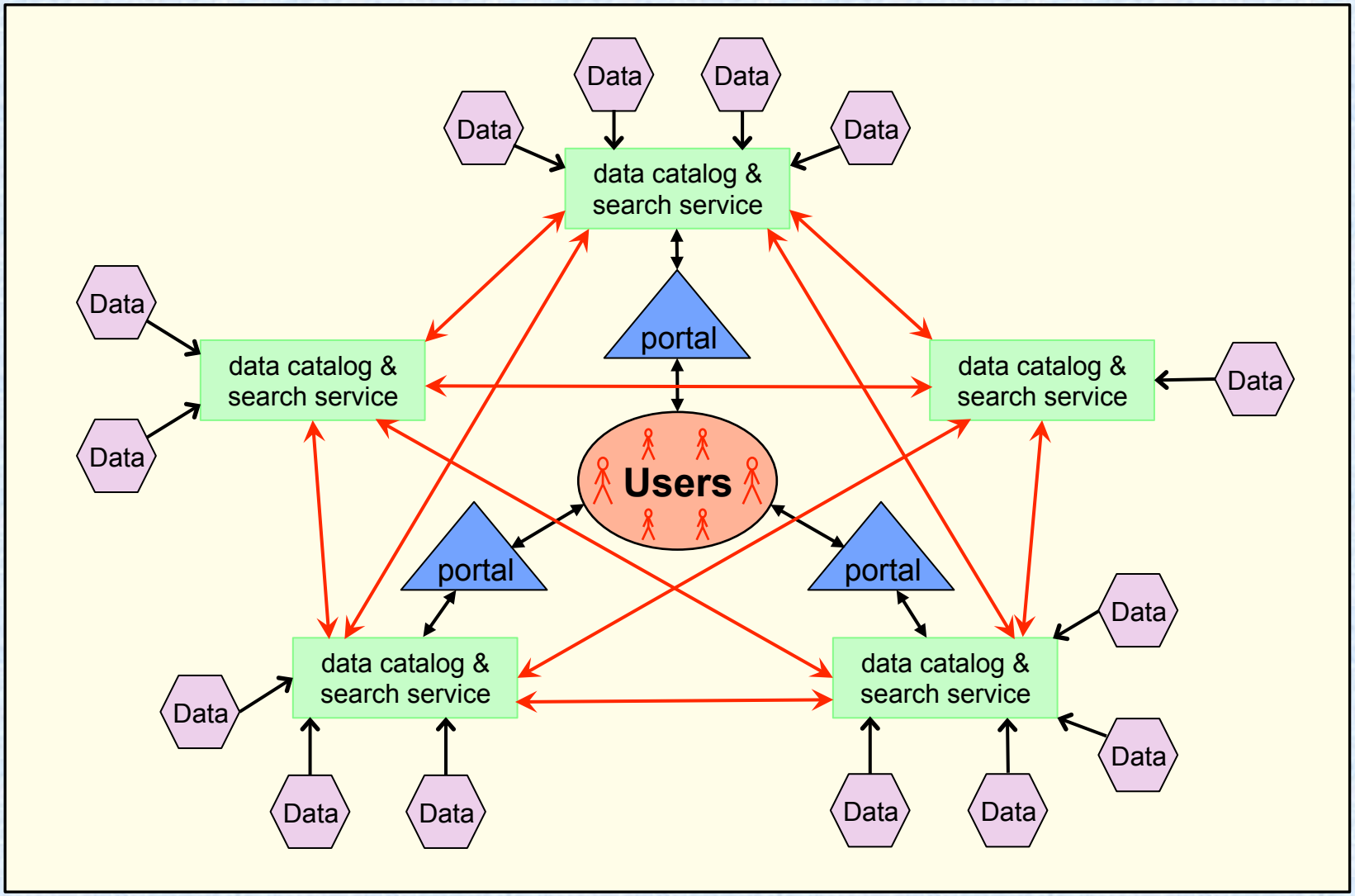
*ESG = Earth System Grid

CMIP5 new approach: Distributed data archive (ESGF*)

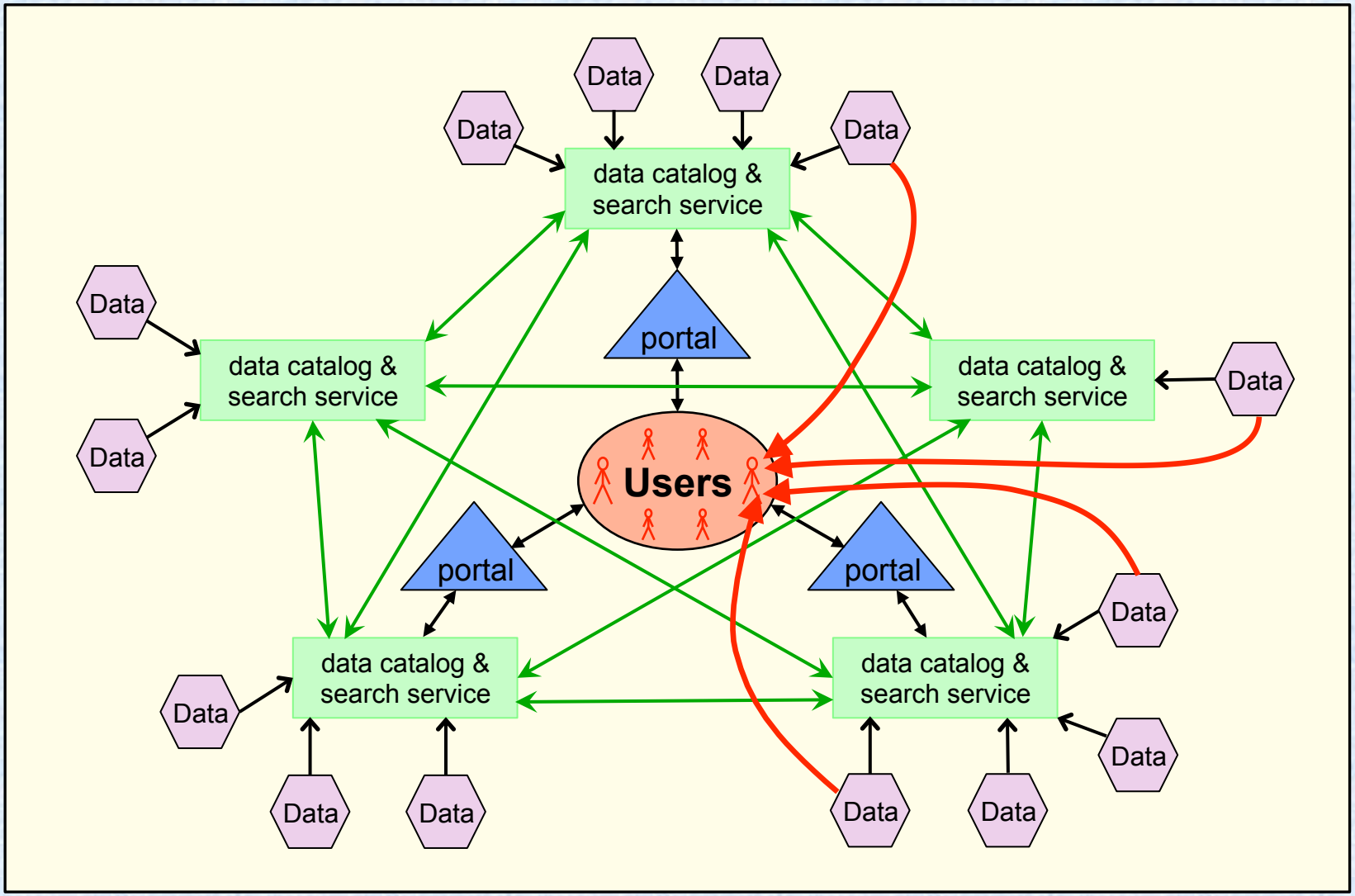


*ESGF = Earth System Grid Federation

All data can be browsed through a single portal because index nodes are federated.

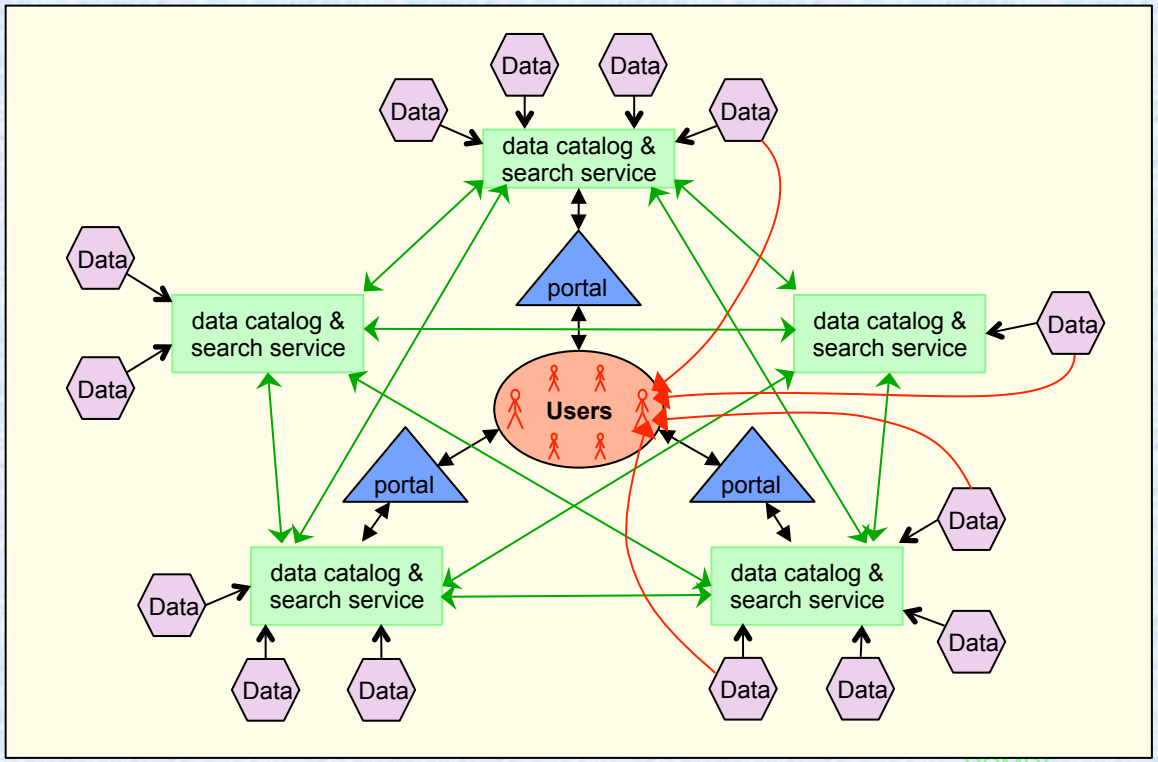


Once desired datasets have been found, user harvests data directly from the nodes.



ESGF is unparalleled in capabilities and complexity

- Diagram does not show:
  - Script-driven direct access route to data (bypassing portal)
  - Server-side computer services
  - Security & authentication layer
- Also:
  - PCMDI and other major data centers have replicated high-demand datasets.



CMIP5 output can be obtained at **http://pcmdi9.llnl.gov**

Users are rewarded with multi-model output conforming to strict standards

- A common set of experiments
- A single "format": netCDF files
- Conforming to CF metadata standards
  - Self-describing data
  - Full grid information
- With specific vocabulary defining
  - Model
  - Experiment name
  - Forcing factors
  - And more

Output from all models can be read and analyzed uniformly

Challenges dealing with CMIP5 data

- A complex array of experiments
- An unusual method for downloading data
- For many, an unfamiliar data format
- Data reported on various grids
- Ensembles of simulations with members differing in sometimes misunderstood ways
- Data reported at a resolution too coarse to be useful (requiring downscaling)
- And more

Not trivial for a novice to find out what data might be useful and to avoid misinterpretations

- What experiment?
  - Which RCP? What are differences?
  - What's the difference between emission-driven and concentration-forced?
- Which model(s)?
  - Are some superior?
  - For models with multiple realizations, which ones should be used?
- How can I correct for biases?
  - Drift in long-term experiments (drift removal)
  - Initial adjustments in decadal experiments (bias correction)

Extending CMIP data to non-specialists

- PCMDI was charged to make model output available to the climate research community.
- PCMDI has partnered with the IPCC's TGICA* to offer data service through its Data Distribution Centre (DDC), which serves communities less familiar with climate models.
- This partnership has successfully opened up model output to users everywhere, but
  - the data remain enigmatic to many
  - The DDC website is slow to evolve (requires cumbersome process of approval)

* TGICA= Task Group on Data and Scenario Support for Impact and Climate Analysis

With more resources additional services could be provided in support of CMIP data

- Tutorials providing guidance on use/limitations of CMIP data
- Better documentation of models, experiments, and methodology for forcing and boundary condition data sets (including the RCP process)
- Derived data products, e.g.,
  - All models on a common grid
  - Multi-model mean (and measure of spread)
  - Drift-corrected data
- Downscaled data
  - Using a variety of approaches
  - With guidance on strengths and limitations of each approach
- What else?

What else could be done?

- Seek more input from users outside the climate research community
- Additional output fields?
- Improvements to CMIP5 and DDC websites
- What else?

"Long-term" experiments: output available, as of (March 3 and) Sept. 22, 2012

Experiment(s)	# of models
* Control & historical	(29) 48
* AMIP	(18) 28
* RCP4.5 & 8.5	(24) 40
RCP2.6	(21) 29
RCP6	(15) 22
RCP's to year 2300	?
* 1% CO2 increase	(21) 32
* Fixed SST CO2 forcing diagnosis	(10) 12
* Abrupt 4XCO2 diagnostic	(20) 30

Experiment(s)	# of models
Fast adjustment diagnostic	?
Aerosol forcing	(6) 9
*ESM cntrl, hist. & RCP8.5	(8) 13
Carbon cycle feedback isolation	(7) 10
Mid-Holocene	(11) 13
LGM	(4) 7
Millenium	(6) 7
CFMIP runs	(6) 10
D & A runs	(16) 17

* *Core simulations*

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"Decadal" experiments: Output available, as of (March 3 and) Sept. 22, 2012

** Core simulations simulations*

Experiment(s)	Number of models
*Hindcasts and predictions	(14) 18
AMIP	(7) ?
Volcano-free hindcasts	(1) 2
2010 "Pinatubo-like" eruption	(1) 3
Initialization alternatives	?
Pre-industrial control	(12) ?
1% CO2 increase	(7) ?