Expanding users' analysis capabilities with the CMIP Analysis Platform

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The CMIP Big Data problem

- **The Coupled Model Intercomparison Project, Phase 5 (CMIP5) was a worldwide effort.**
  - http://cmip-pcmdi.llnl.gov/cmip5/
- **Nearly 2 PB of data were published by 20 modeling groups.**
  - 59,000 data sets and 4.3 million files
- **CMIP6 expected to produce 10x or 20x greater data volumes.**
  - NCAR alone may produce 5 PB or more of published CMIP6 data.

Data distribution limits analysis

- **ESGF copes with the CMIP storage challenge with a distributed hosting model.**
  - Data span 23 nodes of the Earth System Grid Federation (ESGF).
  - Solved Big Data "volume" problem by creating "venue" challenge.
- **"Intercomparison," however, requires having the right data in one location.**
  - Few, if any, sites can store large portions of the CMIP5 data on disk for any length of time.
- **Most university researchers have to limit their analyses to fit their local storage and analysis capacity.**

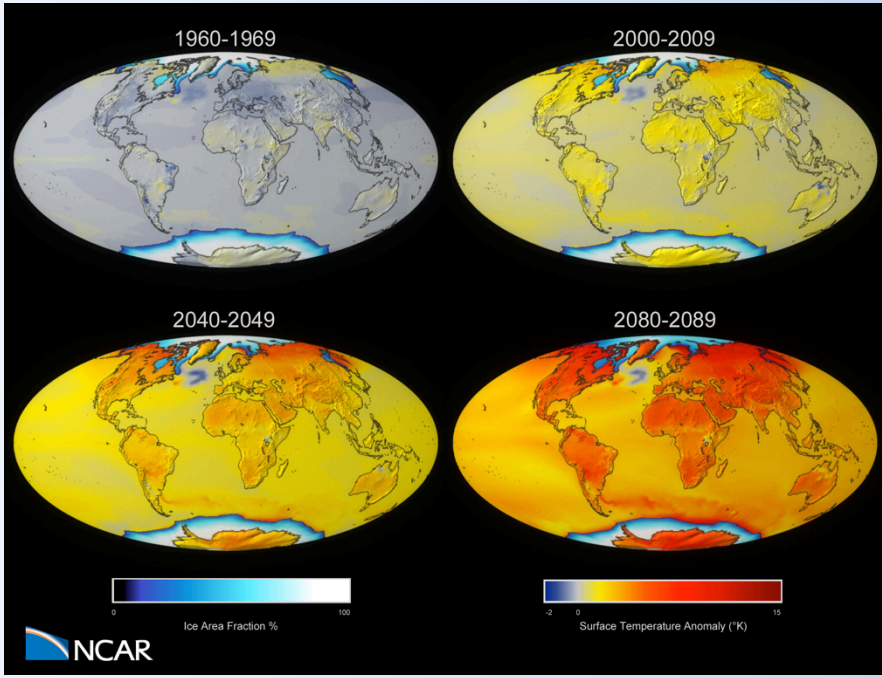
A service to meet community needs

- **CISL has components necessary to address these challenges.**
- **Large-scale disk storage**
  - GLADE: 16-PB GPFS file system
- **CMIP5 data**
  - NCAR's CMIP5 data—200 TB published—already hosted on GLADE
  - NCAR also part of ESGF
- **Large-scale analysis clusters (with untapped capacity)**
  - Geyser: 12 40-core nodes with 1 TB memory
  - Caldera: 30 16-core nodes with 64 GB memory; 16 with dual GPUs
- **Relevant support expertise**
  - HPC and application expertise
  - ESGF and CMIP expertise
- **Needed to create a coherent compute-data-support service out of the integrated components…**

CMIP Analysis Platform

Now Available!

- A new NCAR service provided by CISL to address the Big Data venue and volume problems.
  - Funded by NSF for the university community
- *Access policy:* Available to any researcher who is eligible for a university Small or Educational allocation.
  - Researcher supported by an NSF award in an eligible domain.
  - A grad student or post-doc conducting their dissertation project or postdoctoral research project.
  - Requires account and access token for every user.
- CISL is prototyping service with CMIP5 data sets and preparing to scale up for CMIP6.



Comparison of four decadal averages of temperature anomalies and ice area fraction. Data from the ensemble average of the CCSM4 monthly surface temperature anomaly (relative to 1850-1899 average for each month) from Jan 1850 to Dec 2100, from CMIP5 historical + RCP8.5 scenario runs. Data provided by Gary Strand. Visualization by Tim Scheitlin and Mary Haley.

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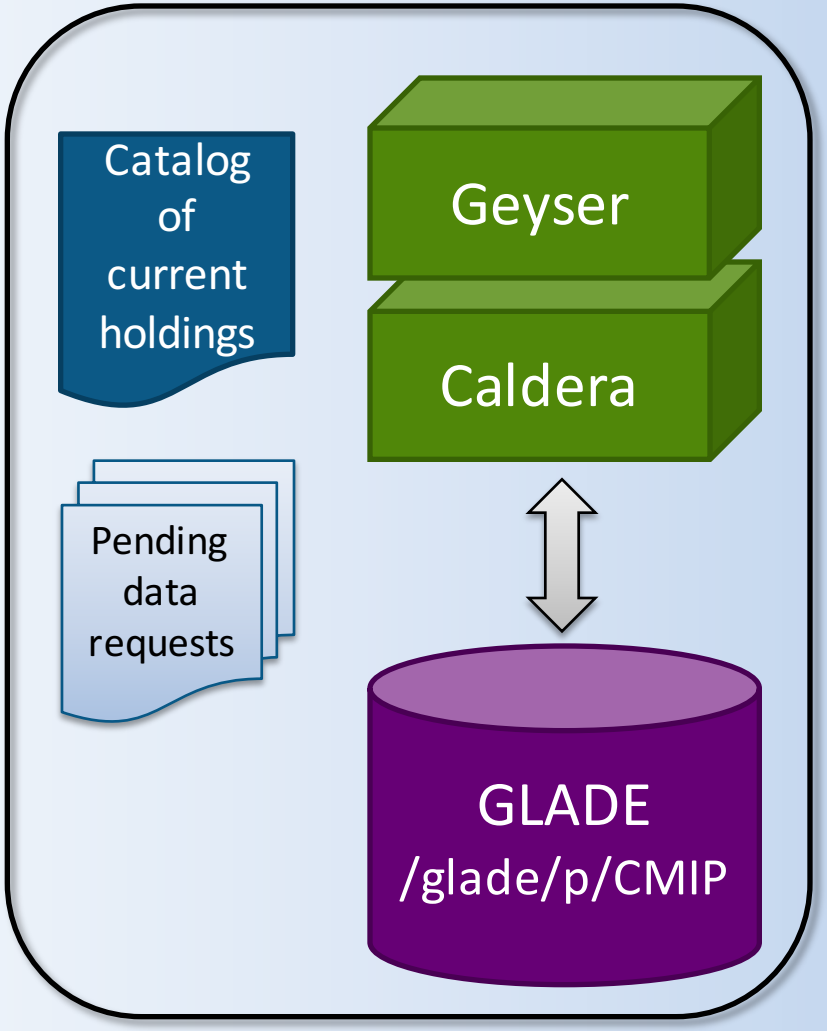
CMIP Analysis Platform in operation

- GLADE disk space at NCAR set aside for the "interlibrary loan" of non-NCAR CMIP5 data sets.
  - *In addition to NCAR's CMIP5 published data already on GLADE.*
- Users can request data sets to be added to the CMIP space.
  - CISL staff will seek out and acquire the data for the platform.
- Geyser and Caldera clusters provide analysis capability.
- Data accessible to any project with a Geyser/Caldera allocation.
  - CMIP Analysis Platform allocation required to *request* a data set be added.

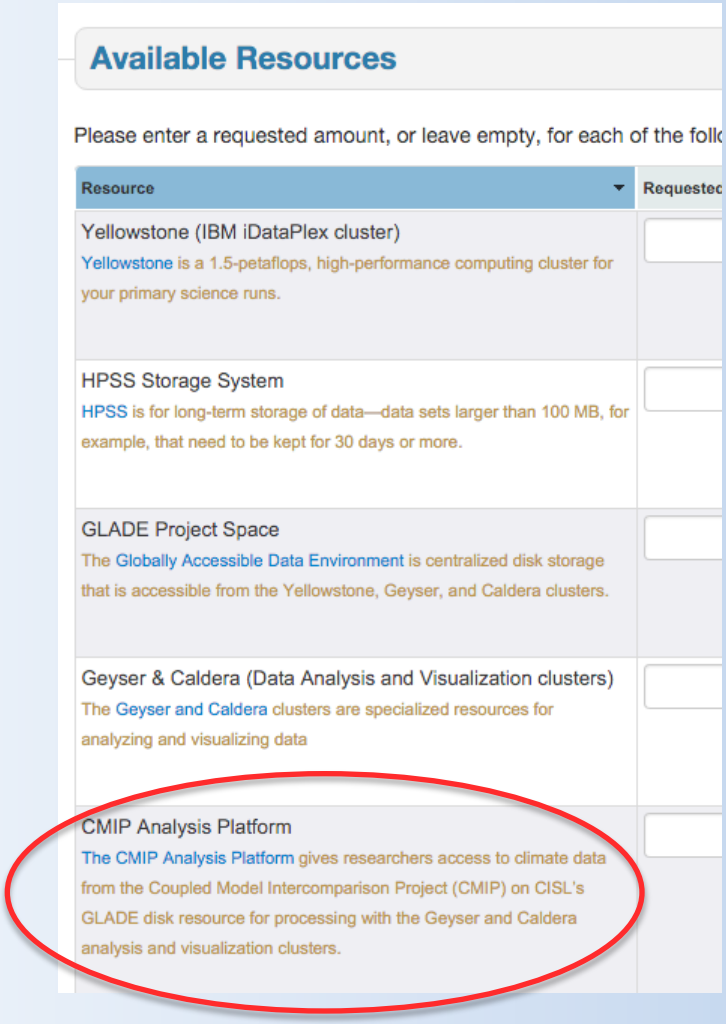


CMIP data arrangement

- **Data on GLADE at /glade/p/CMIP**
  - 500 TB available for CMIP5 "interlibrary loan"
- **Uses "DRS" syntax to guide structure**
  - See http://cmip-pcmdi.llnl.gov/cmip5/docs/cmip5_data_reference_syntax.pdf
  - Includes data set versions
- **Using ESG's "drs_tool" to update**
  - /glade/p/CMIP/CMIP5/output1/NCAR/CCSM4/1pctCO2/day/atmos/day/r2i1p1
  - Working to improve tool and streamline the ingestion process
  - Converting netCDF3 files to netCDF4 with lossless compression to maximize capacity
  - Future plans to evaluate utility of data with lossy compression
- **CISL-augmented metadata includes date added and tentative removal date**
- **Available data listed at www2.cisl.ucar.edu/docs/cmip_ap**
  - CISL will be exploring more formal metadata catalog services

Tracking interest and requests

- **Interested users request a "CMIP Analysis Platform" allocation**
  - Along with a Geyser & Caldera allocation
  - An allocation is required to request a data set
- **Pending data set requests are listed on the platform's documentation page**
  - Along with data request form



Tracking analysis and data use

- **Existing accounting process for Geyser and Caldera clusters will track use on projects that have CMIP Analysis Platform allocations**
  - Existing monitoring will track increased load on the clusters
- **New GLADE monitoring script tracks accesses to files within CMIP file space**
  - Can't map accesses to users, but will track "popularity" of data sets
  - Will help inform data set removal decisions

Current status

- **Available to university community since January 2016**
- **Eight CMIP AP allocation requests received and approved**
- **Four requests for data sets to be added**
- **Monitoring systems all in place and operational**
- **Initial announcements made to the community of scientists**
  - Several positive, unsolicited responses received
- **Feedback from early users already being factored into the process**
  - Most important so far: Organizing data *per topic instead of per model*
  - E.g., organize for easy access to precipitation data from various models
  - Requires some work on our side
- **Investigating storing a "convenience" copy on local tapes rather than re-downloading data sets again later**
- **Still lots of manual work for downloading a new data set, updating the website, notifying the user, etc.**
  - We have started automate the processes (e.g. the data set available section on the web site), and more work underway

Preparing for the future

- **Refining the policies for bringing in users**
- **Integrating the accounting and monitoring into reporting capabilities**
  - Ensuring analysis clusters are not fully utilized
- **Improving and automating the data ingestion processes**
- **Balancing user objectives and schedules with realities of limited space for "interlibrary loan"**
  - That is: What happens when the disk space is full?
- **Assessing the disk needs for published CMIP6 data**

Questions?

www2.cisl.ucar.edu/docs/cmip_ap

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