Collaborative Workbench to Accelerate Science Algorithm Development

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THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Outline

- Motivation
- Collaboration
- CWB Core
- CWB-enabled Applications
  - GLM Validation Tool
  - CWB-AES Integration
  - Giovanni Integration
  - $NEOS^3$ Integration
- Conclusions and Plans

Motivation

- Scientists increasingly find themselves working with a more diverse set of data, complex science algorithms, and models.
  - Each new dataset, algorithm, or model - own knowledge
  - Acquiring this knowledge - difficult and time consuming
  - One way - social collaboration (virtually)
- Adopting social networking and collaboration
  - Only a few have been successfully customized to address and impact Earth science research modalities
  - New set of analysis tools to leverage the collaboration infrastructure
  - Adoption: inhibited by the steep learning curve

Approach

- Collaborative Workbench (CWB)
  - Augment a scientist's current computational research environment
  - Provide a science algorithm development environment that seamlessly integrates the researcher's desktop with a cloud infrastructure.
  - Focus on enabling sharing of research artifacts + collaborative development of algorithms
  - Interpretation of data and analysis results as well as their knowledge (in the form of annotations).
  - Accommodate various modes of collaboration, in order for it to be effective.
  - Let scientists focus on science, rather than learning collaboration tools.

-COLLABORATION-

YOU + OTHER + GOAL

COLLABORATION HAS DIFFERENT LEVELS

REALTIME

You must be present

Chat
Skype
Messenger
Meeting

ASYNC

You will be present

Email
Forum
Dropbox

Managing Collaboration

Versioning + Provenance

Ownership
Who created/modified it
Assumptions
Lineage
Quality
Replication Recipe
....

Science Collaborations

- Occur when 2 or more people work together to achieve a common goal, result or project
- Cover all levels of collaboration
- Find ways to share reuse data, programs, workflows, experiments ..
- Require feedback and iteration
  - Members review each others work and make revisions
- Track – who, what, when, how, why, which

Collaboration Systems

- Need to provide a mechanism for:
  - Communication
  - Content management
  - Workflow for revisions

Components of Collaboration Systems

- Data
  - Cloud for scaling
- Software
  - Cloud for sharing, scaling, and executing
- People
  - Different roles, levels of control, groups, …

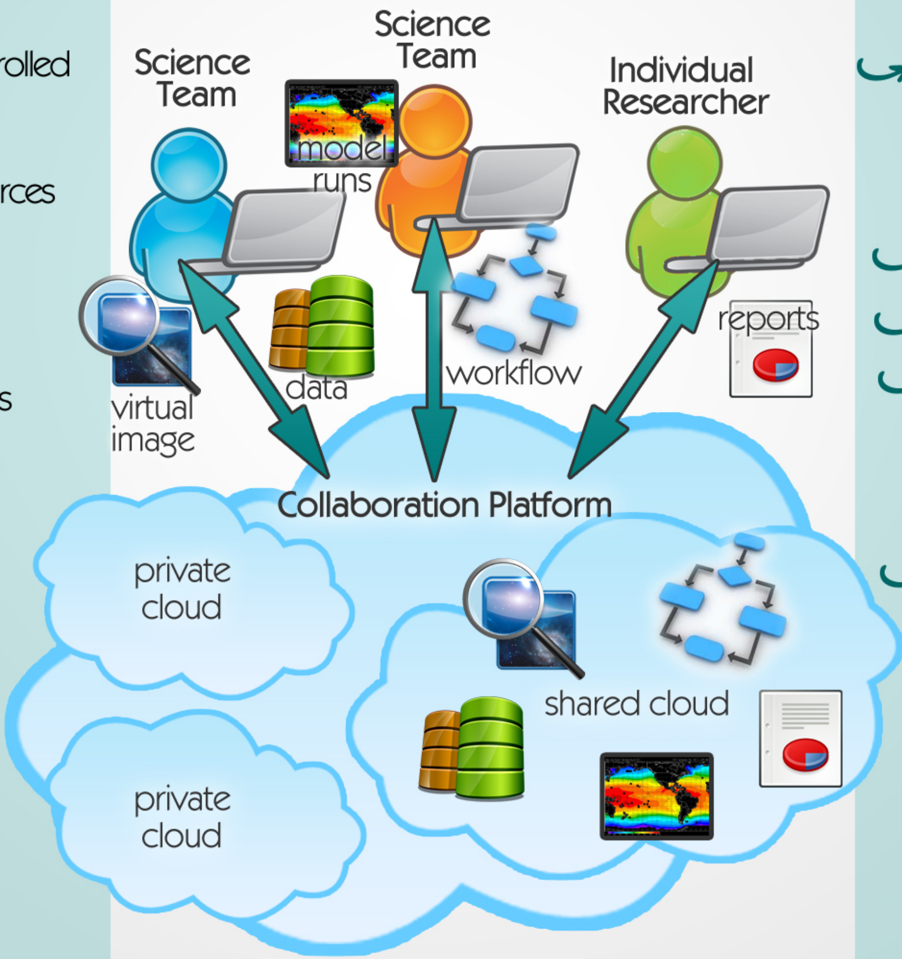
CWB CORE

Collaborative Workbench (CWB)
to Accelerate Science Algorithm Development

Sharing Knowledge is at the heart of science, yet it is challenging for researchers to effectively share information and tools

Goals

- An architecture for scalable, controlled collaboration
- Selective sharing of science resources
  - among individuals
  - within science teams
  - with the entire science community.
- Software that fits how researchers currently do scientific analysis to promote adoption



Benefits

- **Accelerate science algorithm development** by distributed science teams
- **Reduce redundancy**
- **Improve productivity**
- Securely share all science artifacts (data, information, workflow, virtual machines)
- Generalizable to support collaborative science algorithm development for other mission and model enterprises

Project Objectives

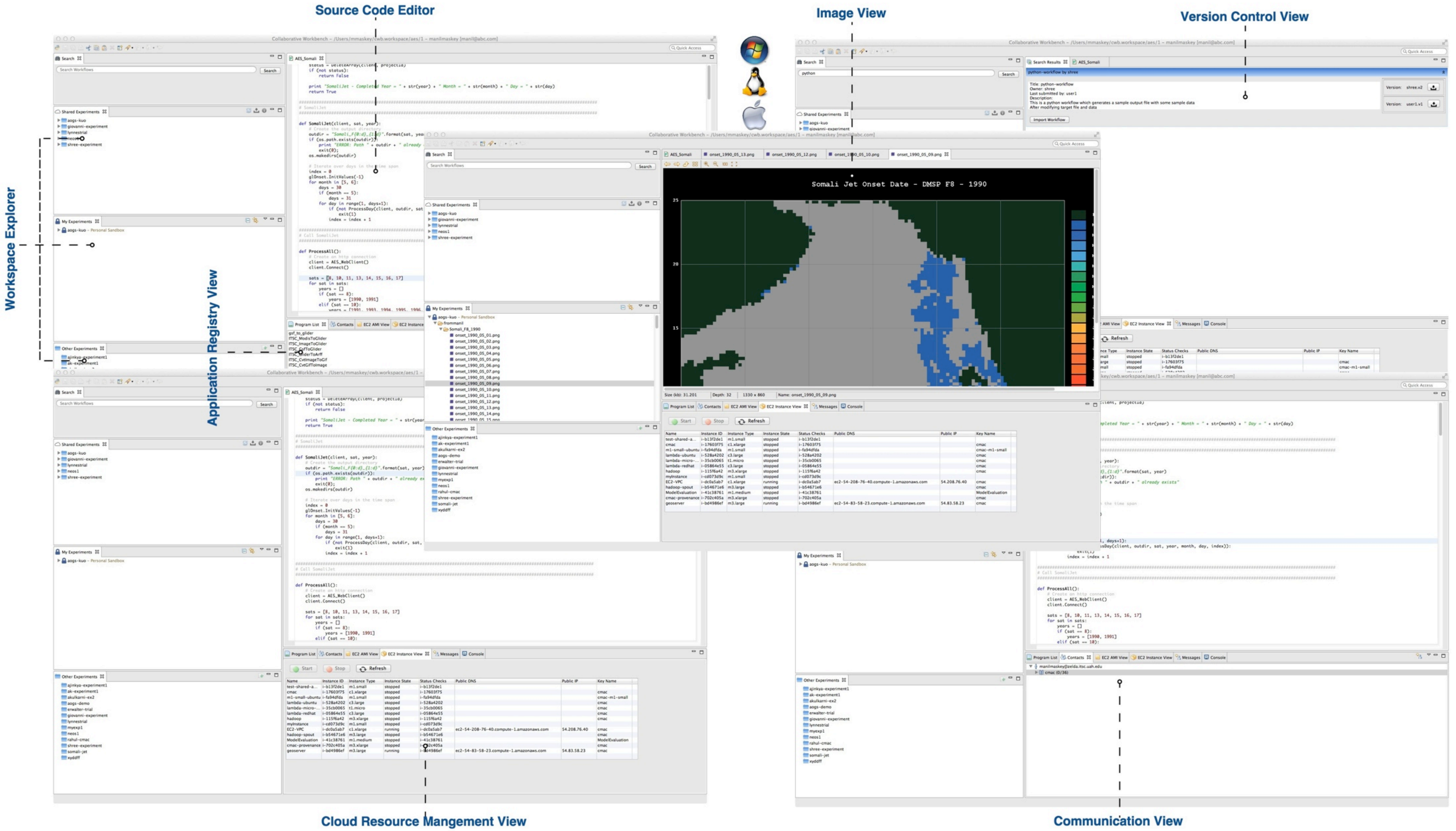
- Investigate different science collaboration modalities:
  - Shared Resources, Local Computation – Dropbox Model.
  - Shared Resources, Cloud Computation
  - Shared Virtual Machine Instances

- Build **core** components required for an Earth Science Collaboratory
  - Collaborative Workbench (CWB)
  - Cloud-Interfaces
  - Catalogs

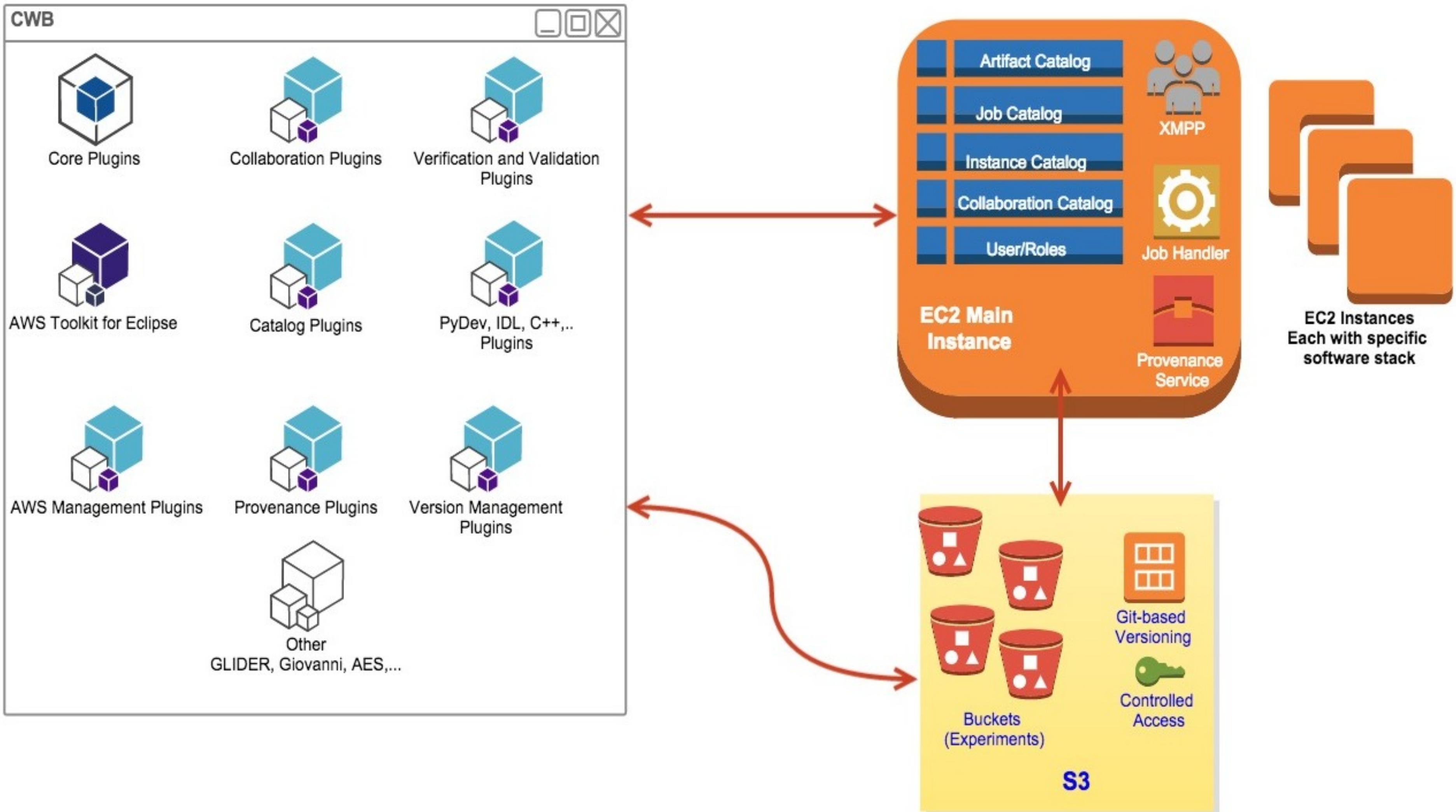
Workbench - CWB

- Sophisticated code editing, navigation, and management tools for development and execution.
- Familiarity
- Eclipse platform
  - Can be specialized for particular requirement.
- Plugin architecture

CWB – An integrated development environment



CWB Components



Core Components

- Communication Plugins
  - Shared Code Editing, Chats, Send files
- Catalog for Data/User/Job management
  - Search, Version, Provenance
- Development tools
  - IDL, Python, ADaM, Visual workflow composer
- Cloud job submission
  - Submit job to multiple instances (multiple software stacks, versions)
  - ENVI Service Engine backend
- Cloud Resource Management
- **Share public/individual**
    - Share Local, Share VM

Versioning

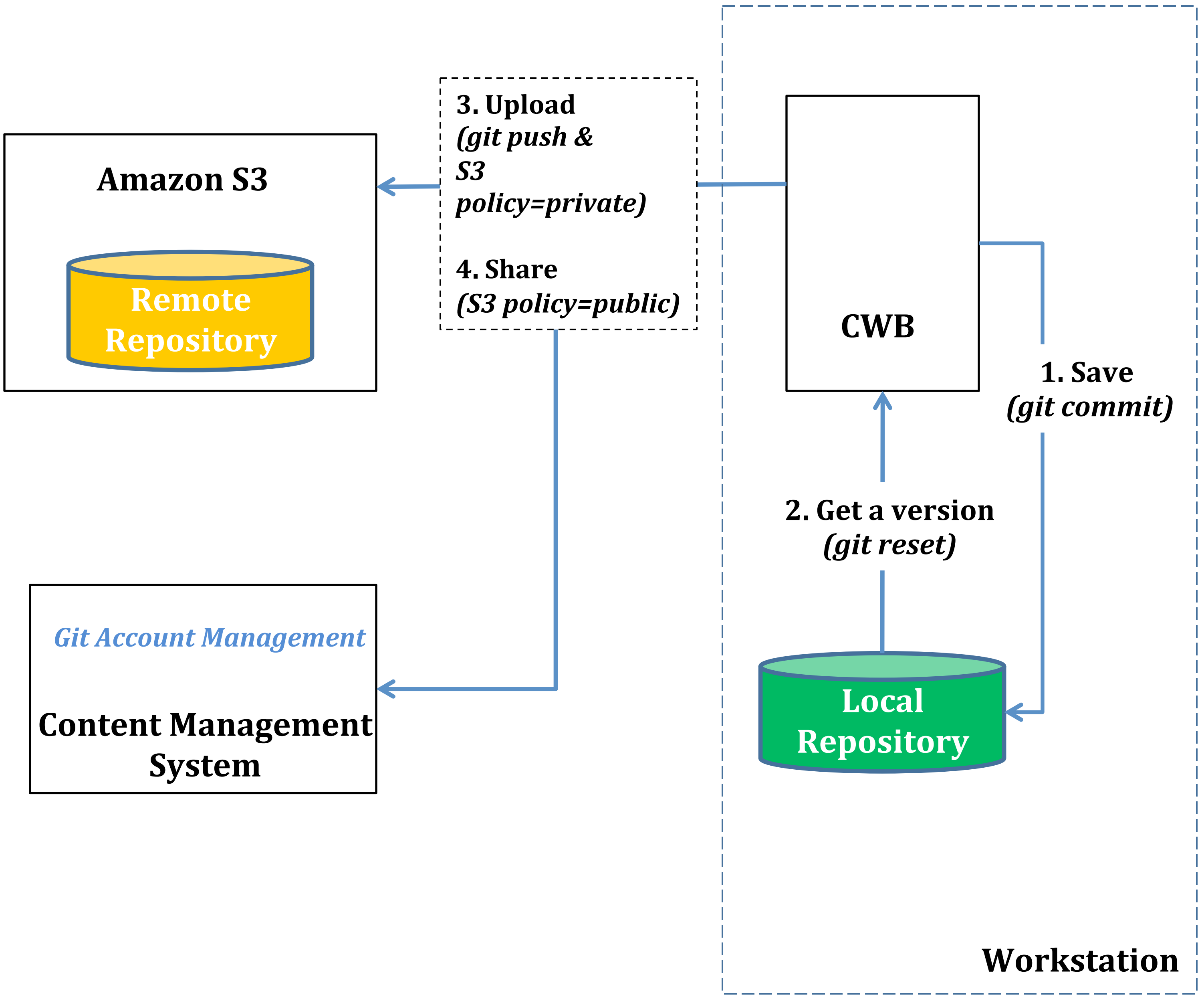
Data and source code versioning using git

Why git?

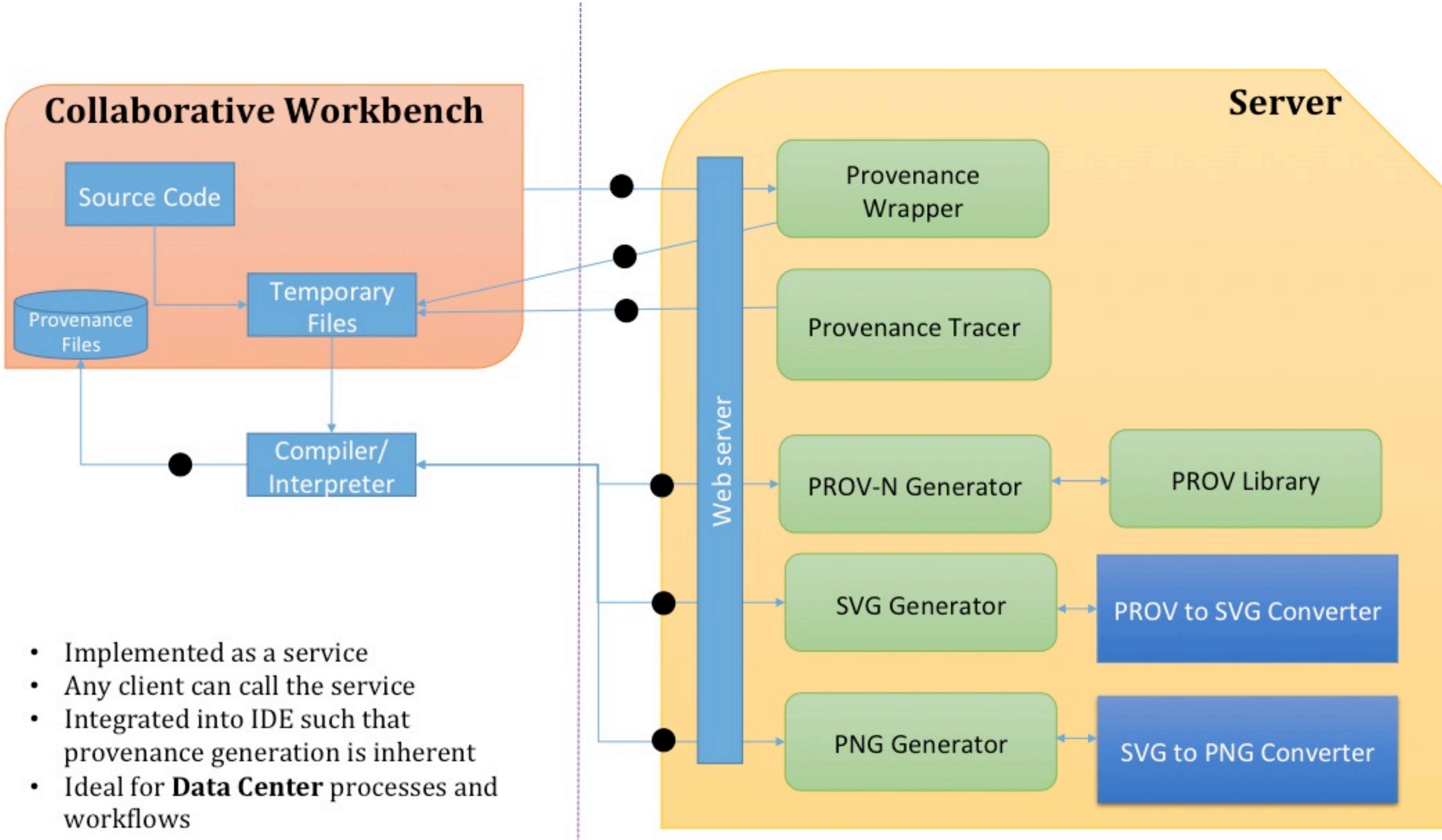
- **git** allows distributed versioning
- Integrates with S3
- Files are compressed
- Only change (deltas) stored

- Plugins
  - **Hide all the version control nomenclature from scientist and provide versioning implicitly – very important**
  - **CWB + Cloud + Git with single sign on**

CWB versioning and sharing using Git



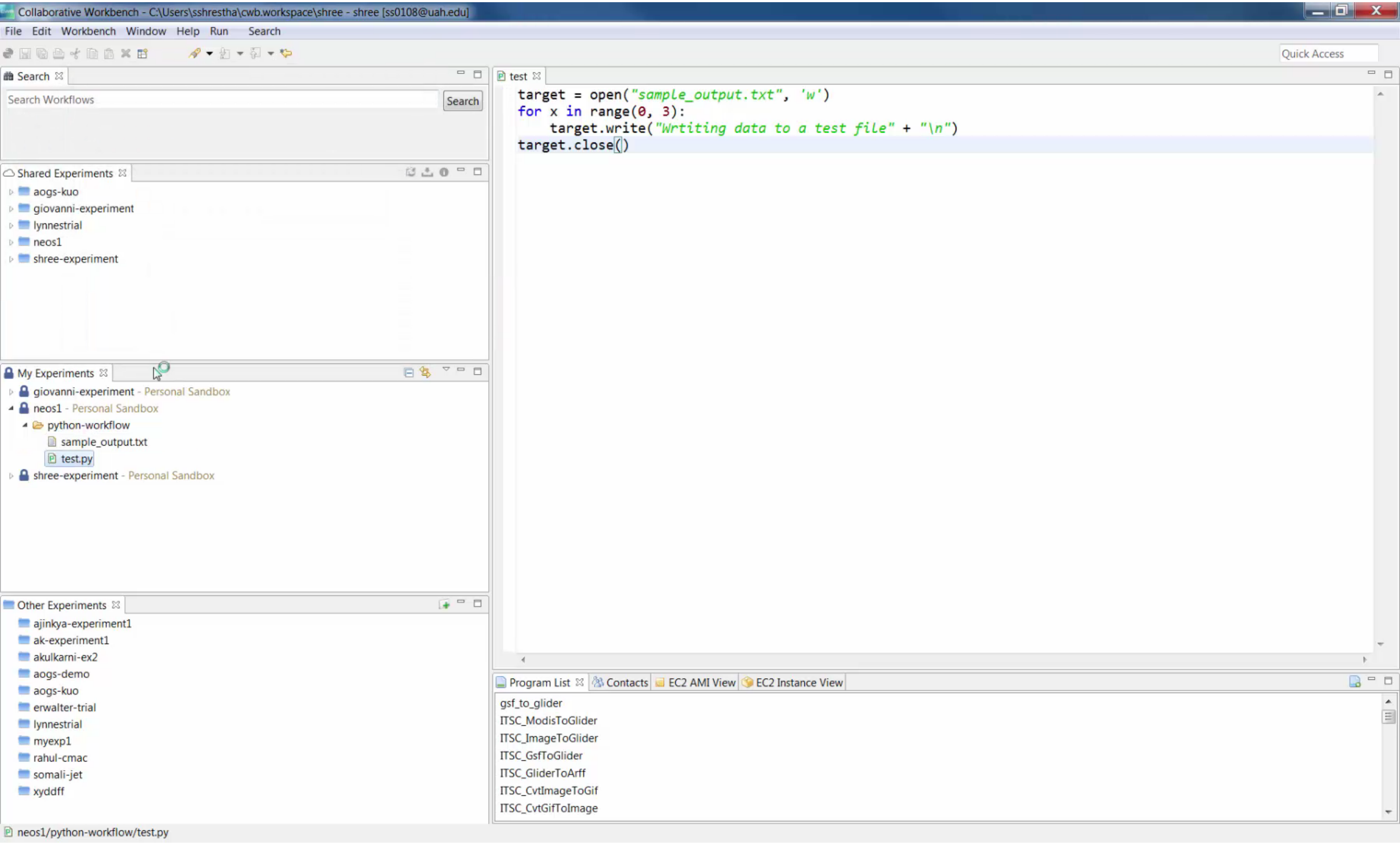
Auto Provenance for CWB



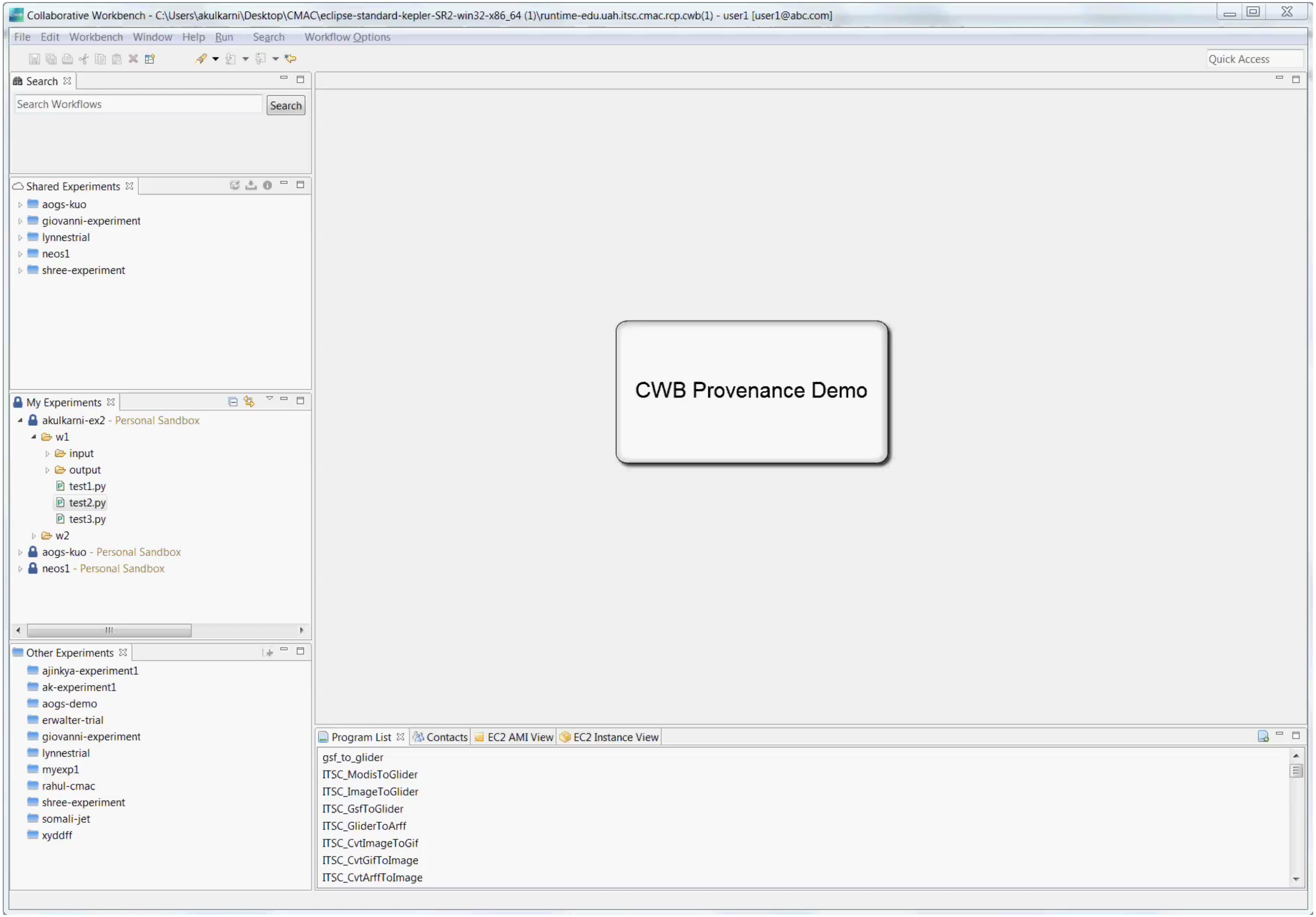
- Implemented as a service
- Any client can call the service
- Integrated into IDE such that provenance generation is inherent
- Ideal for **Data Center** processes and workflows

CWB: Auto Provenance Generation (Python)

Sharing/Versioning



Provenance


Collaborative Workbench - C:\Users\akulkarni\Desktop\CMAC\eclipse-standard-kepler-SR2-win32-x86_64 (1)\runtime-edu.uah.itsc.cmac.rcp.cwb(1) - user1 [user1@abc.com]
File Edit Workbench Window Help Run Search Workflow Options
Quick Access
Search
Search Workflows
Search
Shared Experiments
aogs-kuo
giovanni-experiment
lynnestrial
neos1
shree-experiment
My Experiments
akulkarni-ex2 - Personal Sandbox
w1
input
output
test1.py
test2.py
test3.py
w2
aogs-kuo - Personal Sandbox
neos1 - Personal Sandbox
Other Experiments
ajinkya-experiment1
ak-experiment1
aogs-demo
erwalter-trial
giovanni-experiment
lynnestrial
myexp1
rahul-cmac
shree-experiment
somali-jet
xyddff
CWB Provenance Demo
Program List
Contacts
EC2 AMI View
EC2 Instance View
gsf_to_glider
ITSC_ModisToGlider
ITSC_ImageToGlider
ITSC_GsfToGlider
ITSC_GliderToArff
ITSC_CvtImageToGif
ITSC_CvtGifToImage
ITSC_CvtArffToImage

CWB-ENABLED APPLICATIONS

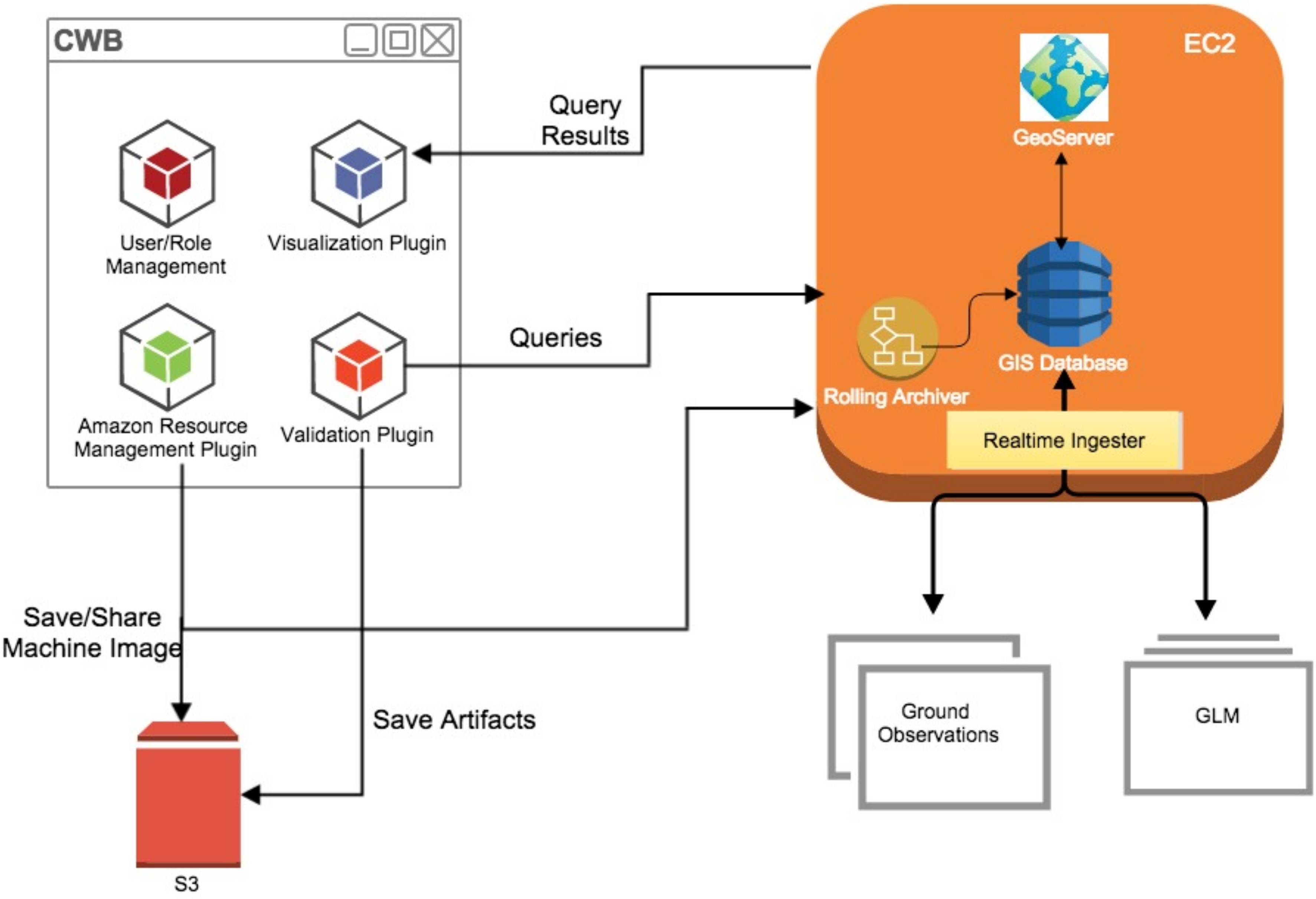
Applications and Integrations

- GLM Verification and Validation
- CWB-AES
- Giovanni upload
  - Upload dataset
  - Run workflow on dataset
- Giovanni
  - Upload
  - GLIDER
- $NEOS^3$
  - netCDF packaging of scattering database
  - Python module: job handling

GLM Verification and Validation

- Validation of the Geostationary Lightning Mapper (GLM) instrument, scheduled to launch on GOES-R in 2016.
- Close collaboration with LIS SCF.
- Uses real time flash rate datasets, such as Earth Networks Total Lightning Network, the National Lightning Detection Network (NLDN) and Vaisala’s Global Lightning Dataset (GLD360) that have been ingested into a GIS database
- Displays thematic layers of each dataset
- Performs real time analysis of discrepancies between GLM and ground based sensors; display interactive statistics, histograms..
- Subsets spatially and temporally
- Saves anomaly as image/video
- Uses CWB features to share artifacts
- Controlled access

GLM Verification and Validation Architecture



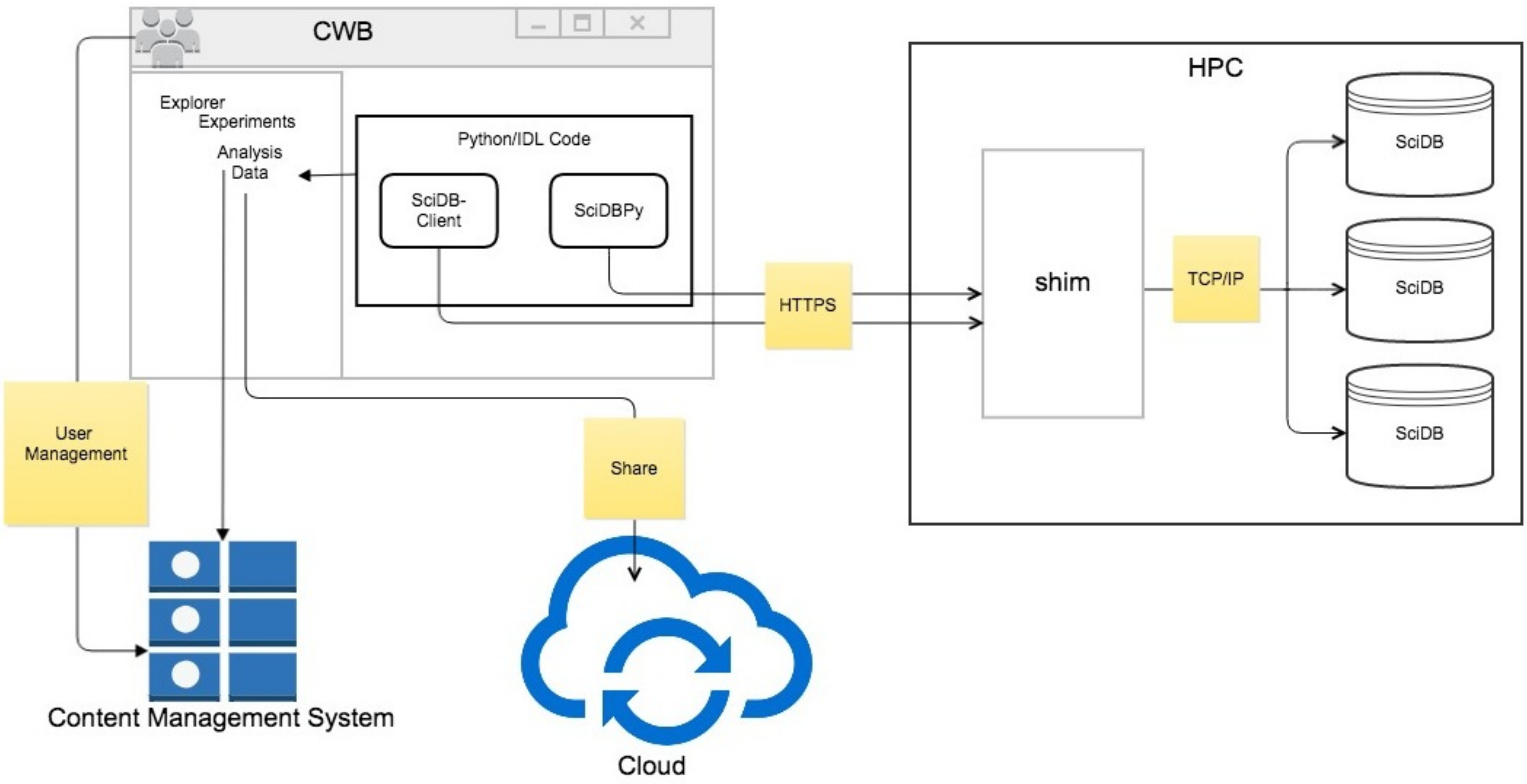
GLM Verification and Validation

CWB-AES Integration

Automated Event Service (AES)

- AIST, PI: Tom Clune
- Observing and studying events
- System being developed to methodically mine custom defined events

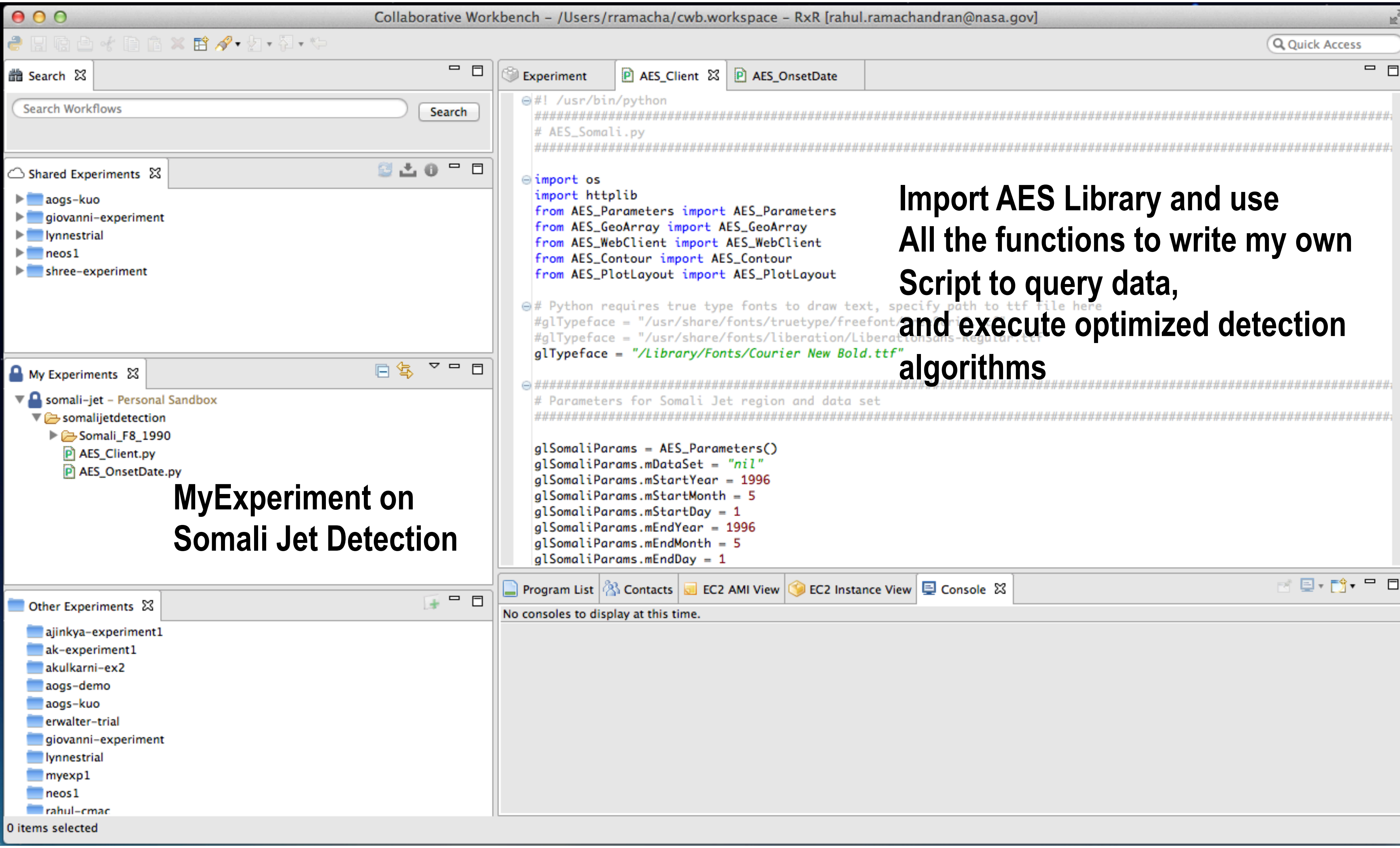
CWB-AES Integration



Starting CWB

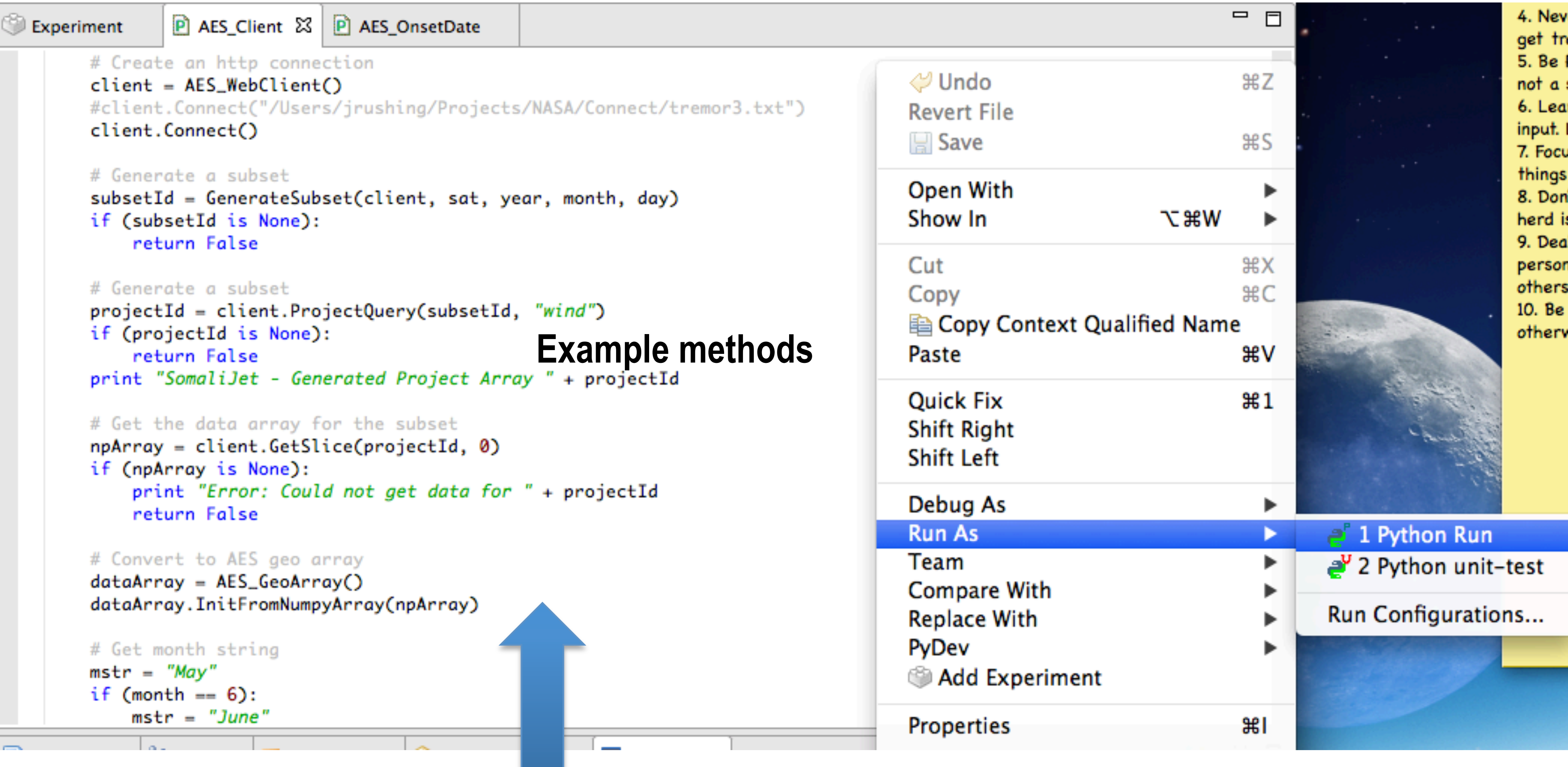
Authentication and authorization Handled by CWB

Point to the appropriate HPD End Point



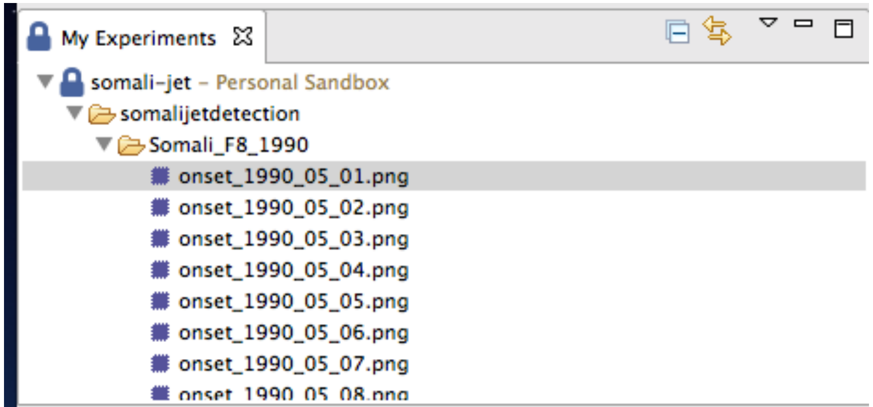
Import AES Library and use All the functions to write my own Script to query data, and execute optimized detection algorithms

MyExperiment on Somali Jet Detection

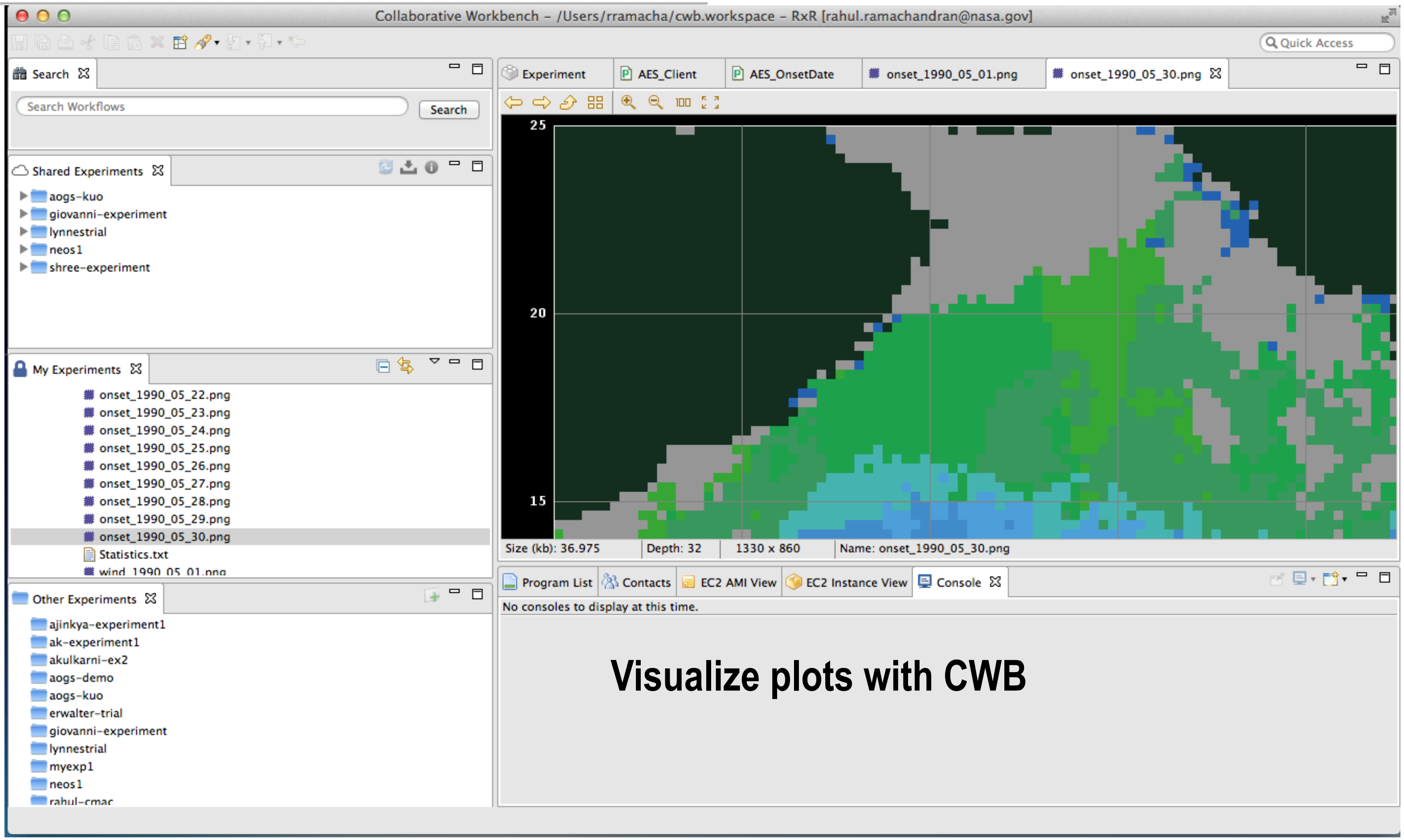


- Execute optimized data parallel queries on a remote HPC
- Integrate local data processing and analysis seamlessly

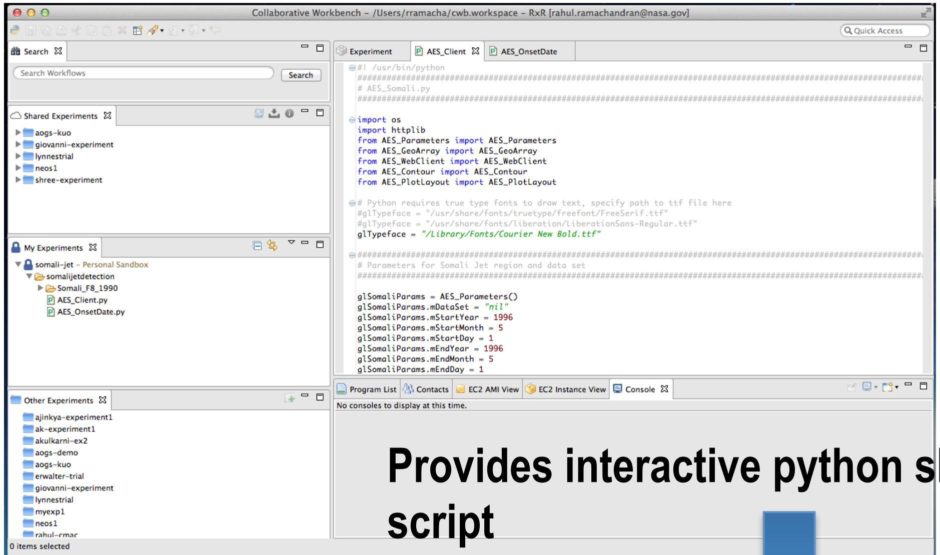
Run my script from CWB



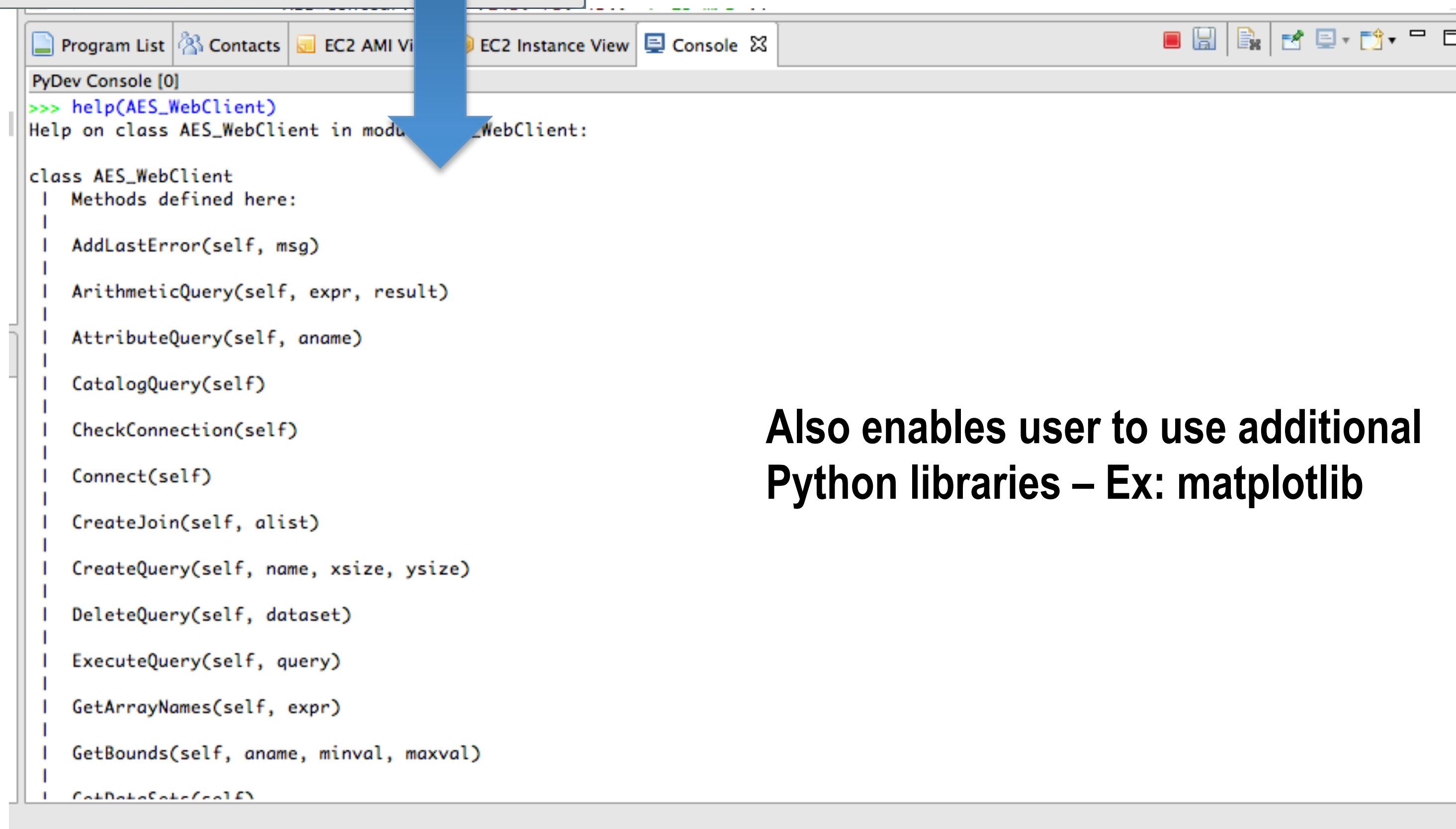
Results saved in MyExperiment folder



Visualize plots with CWB



Provides interactive python shell to try methods while writing the script

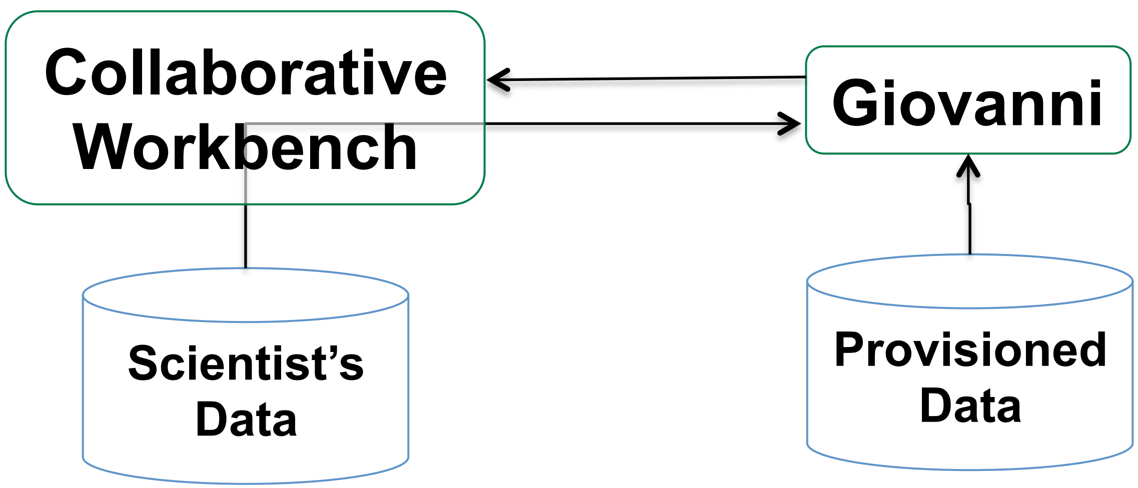


Also enables user to use additional Python libraries – Ex: matplotlib

CWB-GIOVANNI

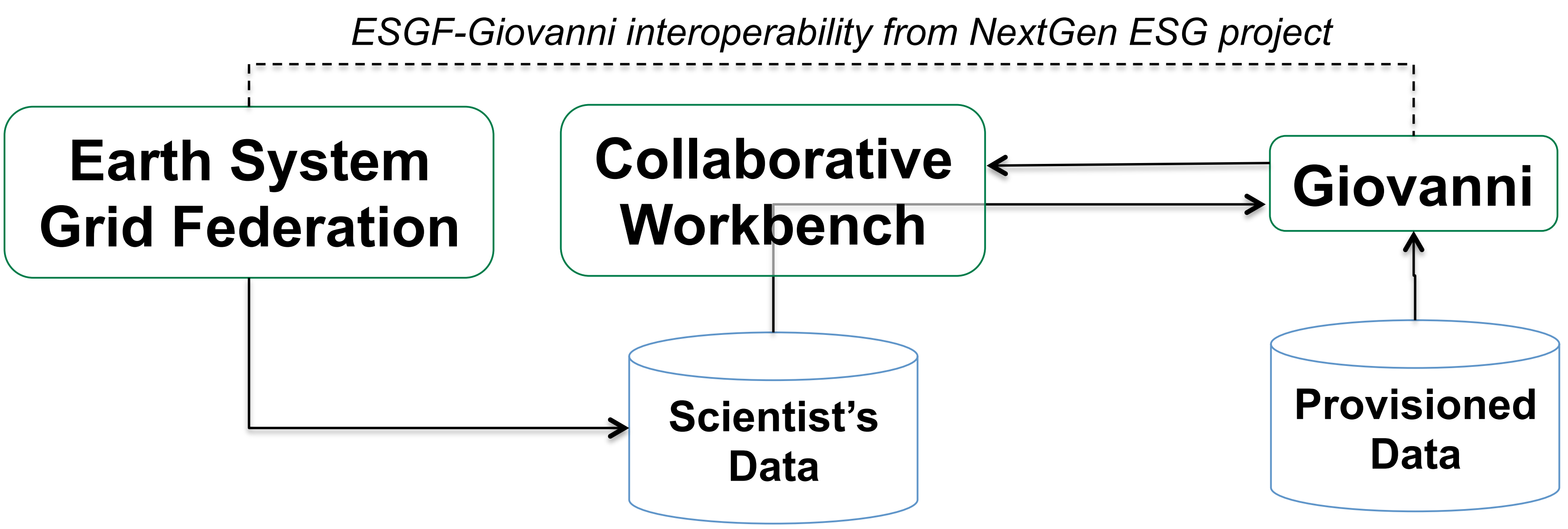
Giovanni Integration

- Giovanni
  - Goddard Interactive Online Visualization ANd aNalysis Infrastructure
  - Popular online visualization and analysis tool
  - Exploration and comparison of remote sensing data +model output
- Integration with CWB
  - CWB python to execute a Giovanni workflow
  - CWB drop-in to upload scientist's own data
  - Giovanni modifications to support workflows with scientist's own data
  - User-Supplied Data Use Cases
    - Upload "my"data to Giovanni for comparison with data already in Giovanni (completed)
    - Upload my data to Giovanni to allow other users to interact with it (90% completed)



Giovanni Integration++

- Earth System Grid Federation
  - NextGen ESG project, PI = C. Mattmann
  - Main Goal: publish DAAC data to ESGF
  - Spinoff: ESGF data turns out to be "Giovanni-friendly"
- CWB "Integration" with ESGF
  - Acquire data from ESGF
  - Upload ESGF data via CWB/Giovanni User-Supplied Data Uploader
  - Run ESGF data in Giovanni workflows



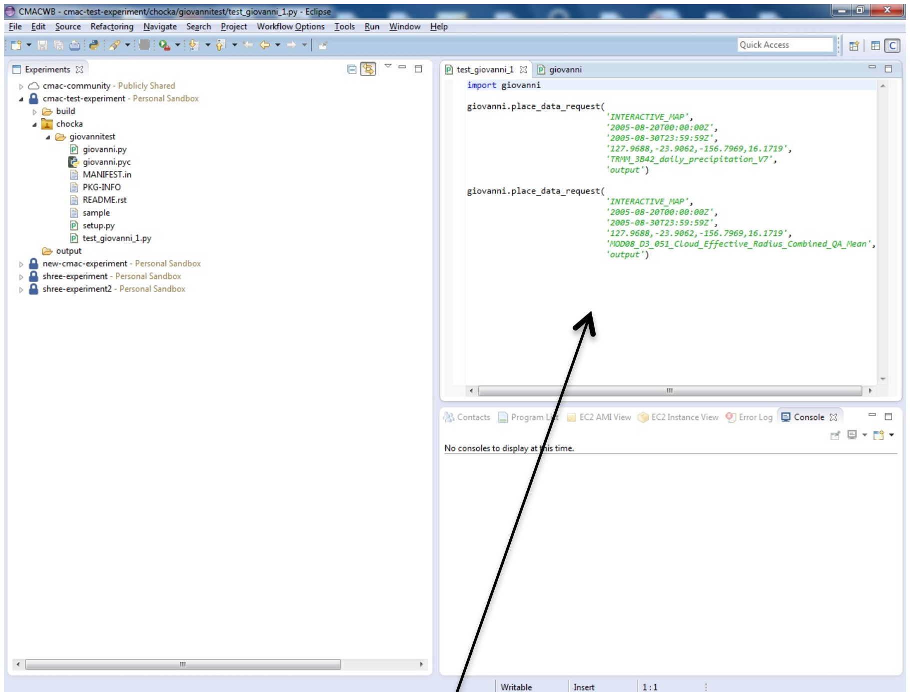
GLIDER Integration

- GLIDER – Globally Leveraged Integrated Data Explorer for Research
  - Desktop tool to easily visualize, analyze and mine satellite imagery
  - Allows image enhancements and pattern recognition algorithms to be applied on the satellite imagery
  - Visualization with **NASA World Wind** 3D tool
  - RCP application consisting of Eclipse plugins
  - Integration to CWB included dropping the GLIDER plugins into CWB dropins folder

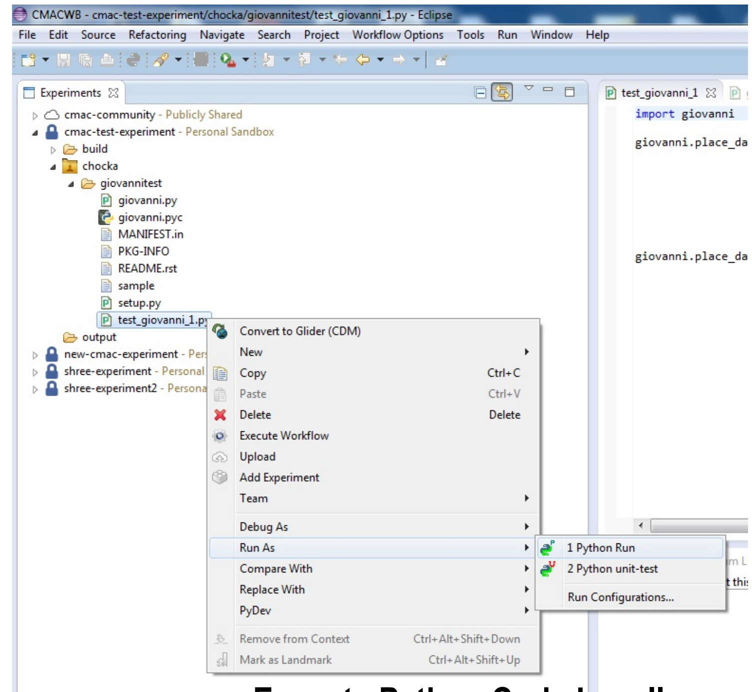
CWB Giovanni-GLIDER plugin: Use Case

- Demonstrate that researchers can use CWB to download data using python code to their workspace and apply GLIDER plugin for image view of the data and use World Wind plugin to visualize and compare.
- Steps:
  - Access Giovanni service via Python Module – Download data to personal space in CWB
  - Convert the result data to GLIDER format
  - Use GLIDER (Eclipse Plugin) to visualize and enhance the data
  - Display the enhanced image on the NASA World Wind globe (Eclipse Plugin)
  - Overlay multiple images on the globe to see the correlation.

CWB Giovanni Python Module



Access Giovanni via Python module with PyDev



Execute Python Code Locally

Data:

TRMM 3B42 Daily Rainfall Estimate V7 0.25 deg.

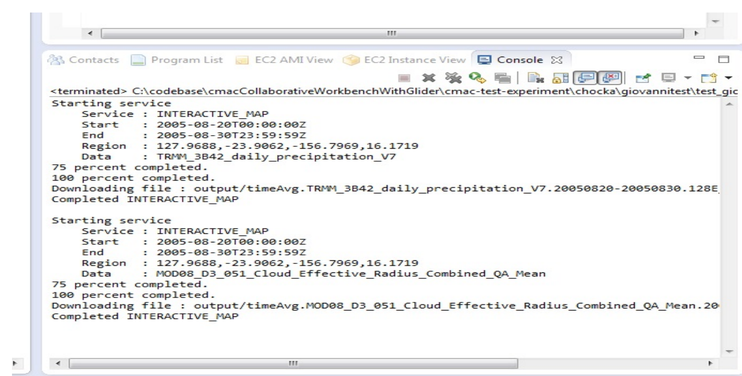
Cloud Effective Radius Combined QA Mean

Temporal Bounds:

2005-08-20 to 2005-08-30

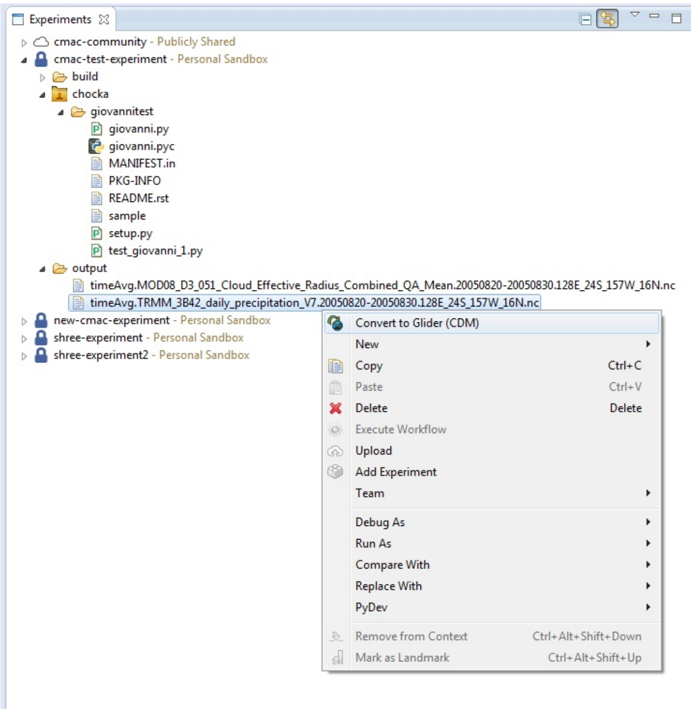
Spatial Bounds:

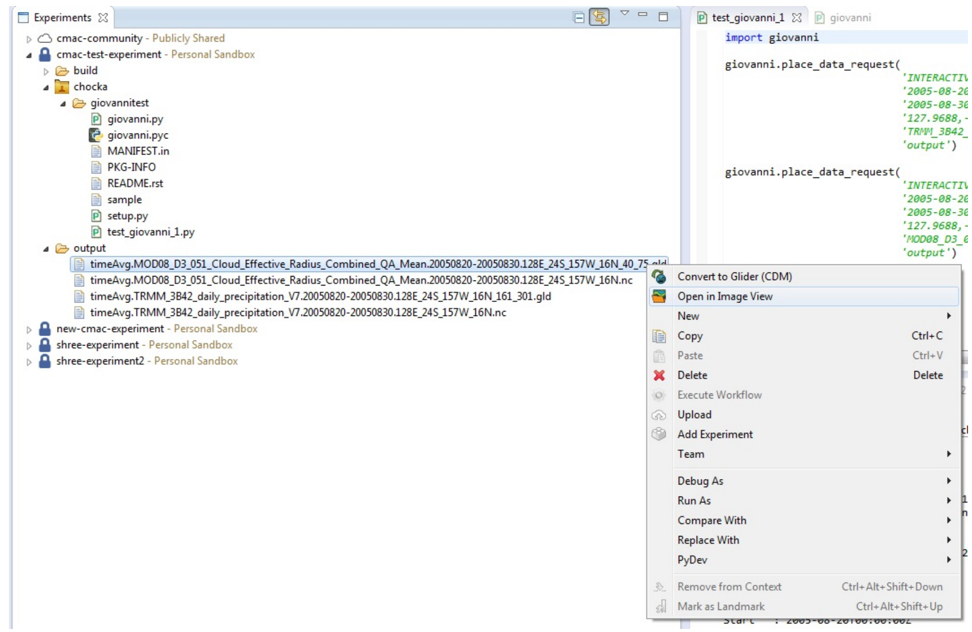
127.9688, -23.9062, -156.7969, 16.1719



Check the log for completion

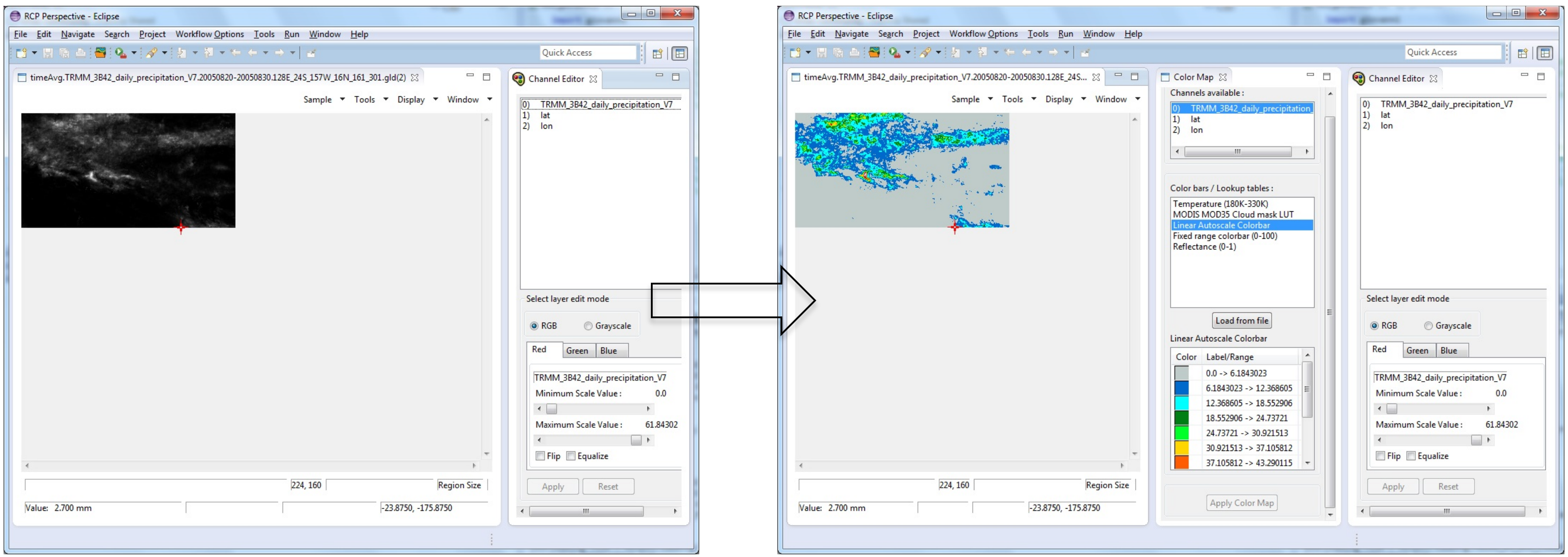
CWB GLIDER Plugin



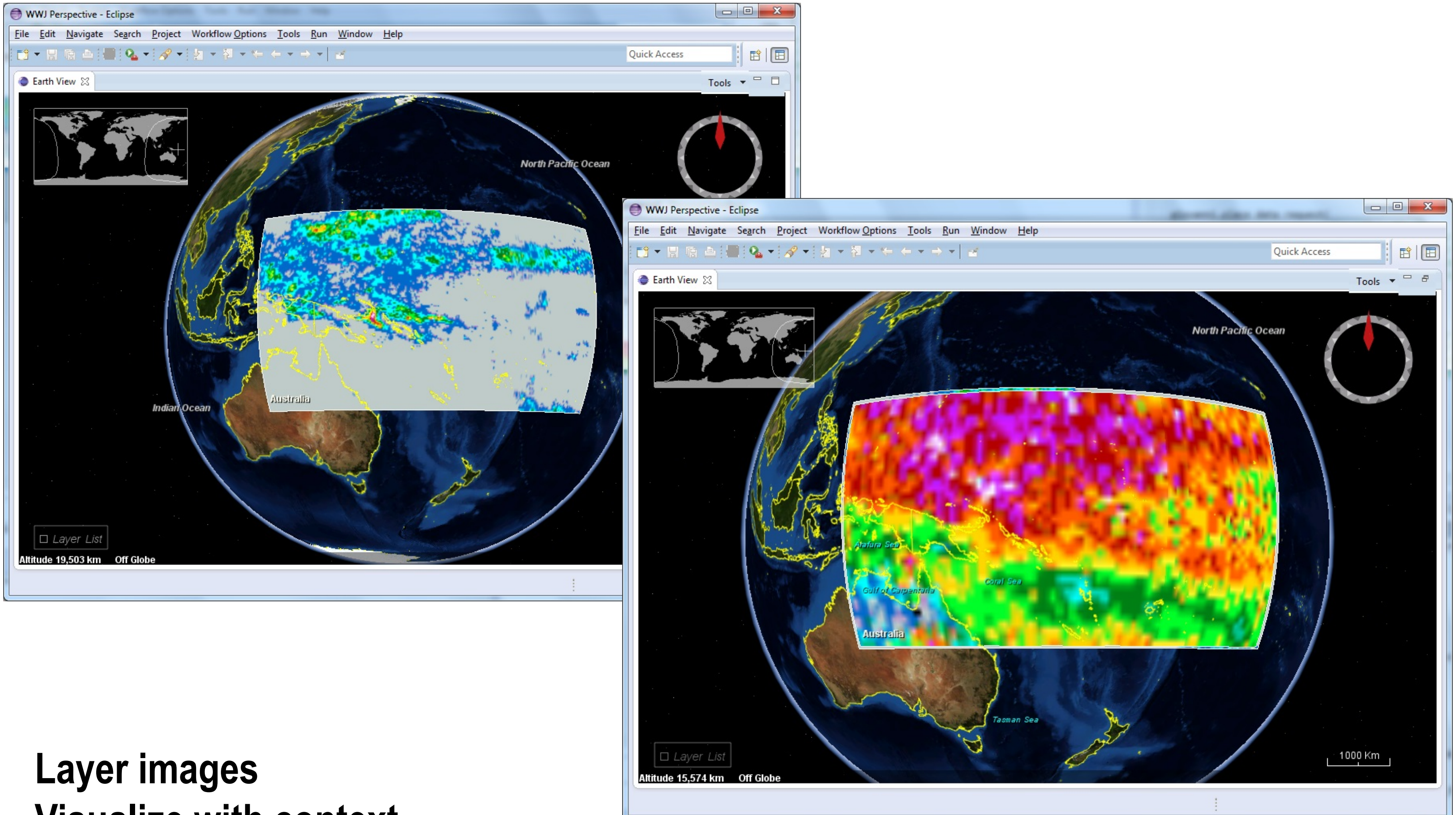


GLIDER functionalities readily available via contextual menus

CWB GLIDER Plugin – Image Enhancement



CWB GLIDER – NASA World Wind Plugin



- Layer images
- Visualize with context

NEOS^3

- NEOS^3: NASA Earth Observing System Simulation Suite
  - AIST: PI Simone Tanelli
  - Web-based integrated simulator for Earth remote sensing applications.
  - Equipped with start-of-the-art modules to enable the realistic simulation of satellite observables.
  - Providing an advanced, sophisticated, and user-friendly simulator package to be used by both scientists for research-oriented applications and by system engineers for an instrument design purpose.
  - Accessible via a web interface and capable of distributing computationally intensive tasks to remote servers such as those at the NASA Advanced Supercomputing (NAS) Division.

CWB-NEOS^3 integration

- Creating NEOS^3 Jobs using templates
- Polling NEOS^3 for completion
- Retrieving outputs to CWB
- Demo

Lessons Learned

“To complicate is easy, to simplify is hard.
To complicate, just add,
Everyone is able to complicate.
Few are able to simplify.”

-Bruno Munari

Conclusion and Plans

- A framework for Science Collaboration
  - Augments existing tools
  - Reduced learning curve
  - Scalable
  - Extendable (Plugin Architecture)
  - Reusability for customizations
- More simplifications
- Integration with other tools based on plugin architecture

Thanks to NASA CMAC and ESTO for their support in our efforts to develop this collaboration framework