Developing & Maintaining Open Source Scientific Cloud Computing in AWS with HelioCloud

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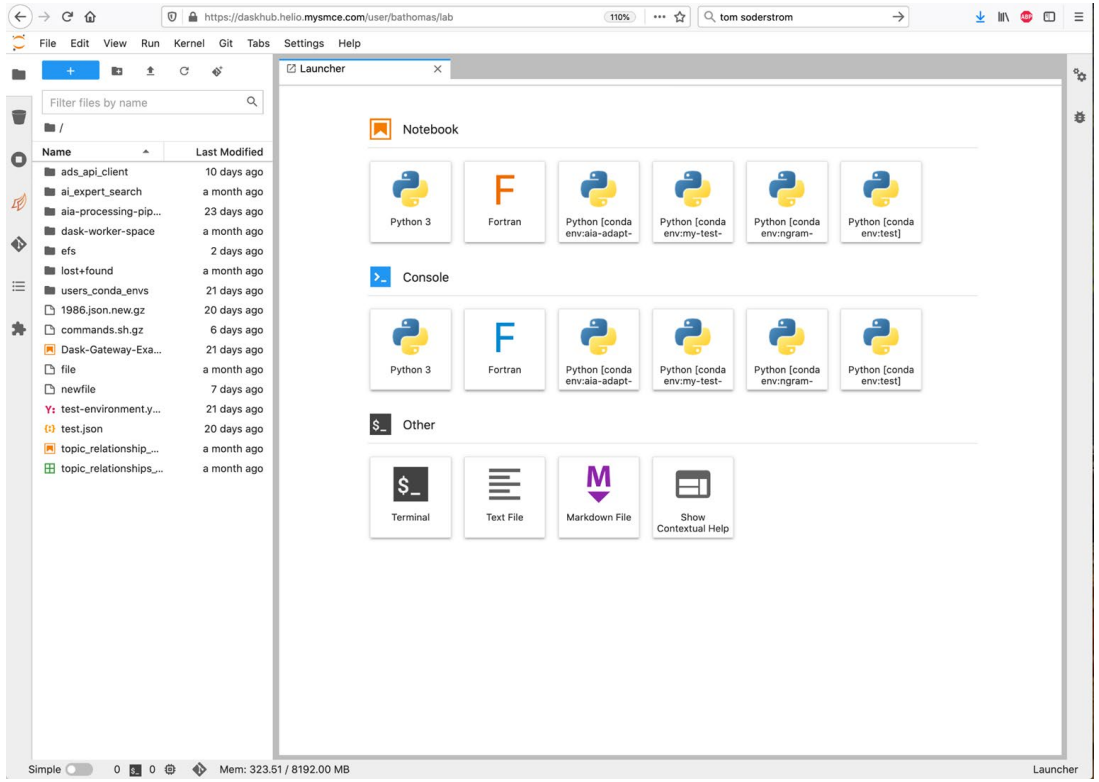
Outline

- HelioCloud Platform
- Engineering Challenges
- Continuous Integration/Continuous Delivery
- Questions

HelioCloud platform: Easy Cloud Onramp for Science

Allows for both Jupyter notebook and terminal-based work

- **Scientific computing focus**
  - Python, IDL, Fortran, C/C++ & libraries
  - AI/ML & GPU tooling
- **Bursting**
  - Create programs which stand up powerful virtual machines (GPU, loads of RAM, etc)
- **Default software install (“Just works”)**
  - Conda (Python) environment for Heliophysics / ML
  - Other research packages
- **Tutorials**
  - How to do a number of basic things
- **Access to large heliophysics datasets**
  - ~8 Pb by 2025
  - Mission, 3rd Party/User Published, “ML Ready”, EPO/Hackathon/Citizen Sci. Datasets
- **Has 125+ science users** so far
  - also 80+ simultaneous student users at PyHC Summer School

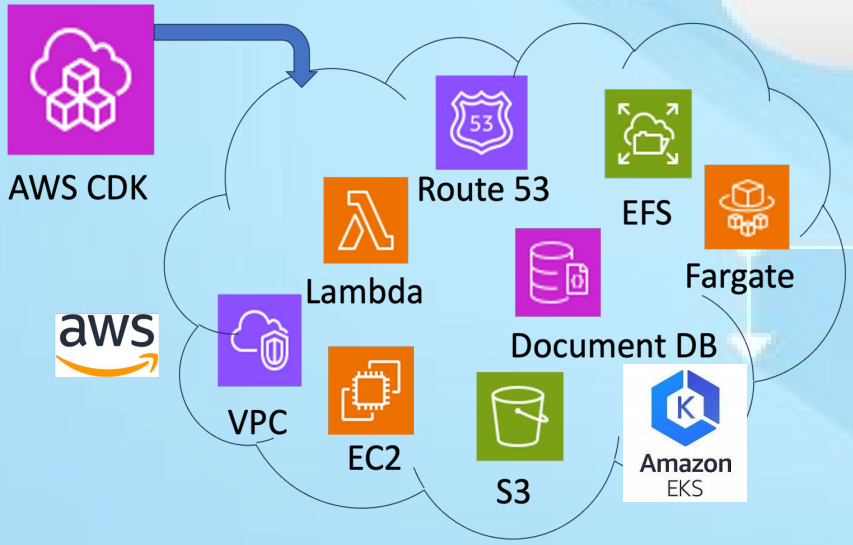


Technology

Architecture

Terraform

Infrastructure as code (IAC) is used to rapidly deploy a fully functional stack atop AWS using one of **Terraform** or **AWS CDK.** This completely automates deployment.



Configurations of perminant installations are stored in git and deployed using the **gitops** model. **Environment specific** configurations are stored in separate **layers** and connected using various **templating tools** allowing **multiple HelioCloud deployments** to be managed within a single repository.

Services

jupyter

dask

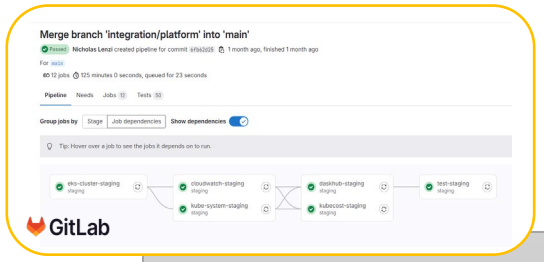
Both platforms prepare a full featured **Jupyter notebook environment** ready for multiple users. **Dask** is included for **parallel computing** - so you can instantly scale up your resources,

User portals let end users spin up their own **customized virtual machines.**

Engineering Challenges

- Software Upgrades of Infrastructure Software - Keeping up with upgrades
  - Kubernetes releases a new minor version every four months, with patch releases monthly.
  - Amazon typically publishes a new AMIs for EKS Managed Node Groups every two weeks; EKS addons once a month
  - Amazon charges more (6 times more) for EKS clusters running older versions of Kubernetes
    - Standard support (approx. $72 per month; $864 per year)
    - Extended support (approx. $432 per month; $5,184 per year)
  - Daskhub typically releases once per year; JupyterHub and Dask are released as a higher frequency
- Making the latest science libraries available to users
  - Interdependency of the various python libraries makes it difficult to upgrade a single library
  - Difficult to tell if existing Science Notebooks “work” with a different runtime
- Multi-institutional
  - A common institution agnostic, base platform
  - To best suit their needs, each institution can choose to tailor the various services

A Multi-repo approach to Configuration Management



HelioCloud Team publishes features with **branching model** with standalone CI/CD pipelines

HelioCloud Platform

GitLab

git

Develop Branch

Feature A

Feature B

...

Kustomize

Jinja

GitLab

On merge to **Develop** branch, **automated pipelines** apply latest changes to **git repo of private institution**

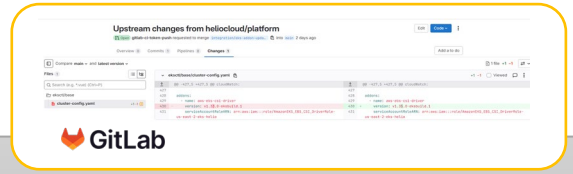
Private HelioCloud Confs

GitLab

git

gitops

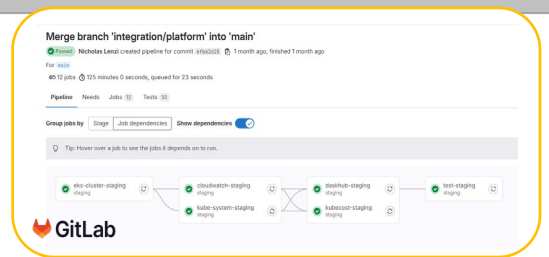
Main Branch



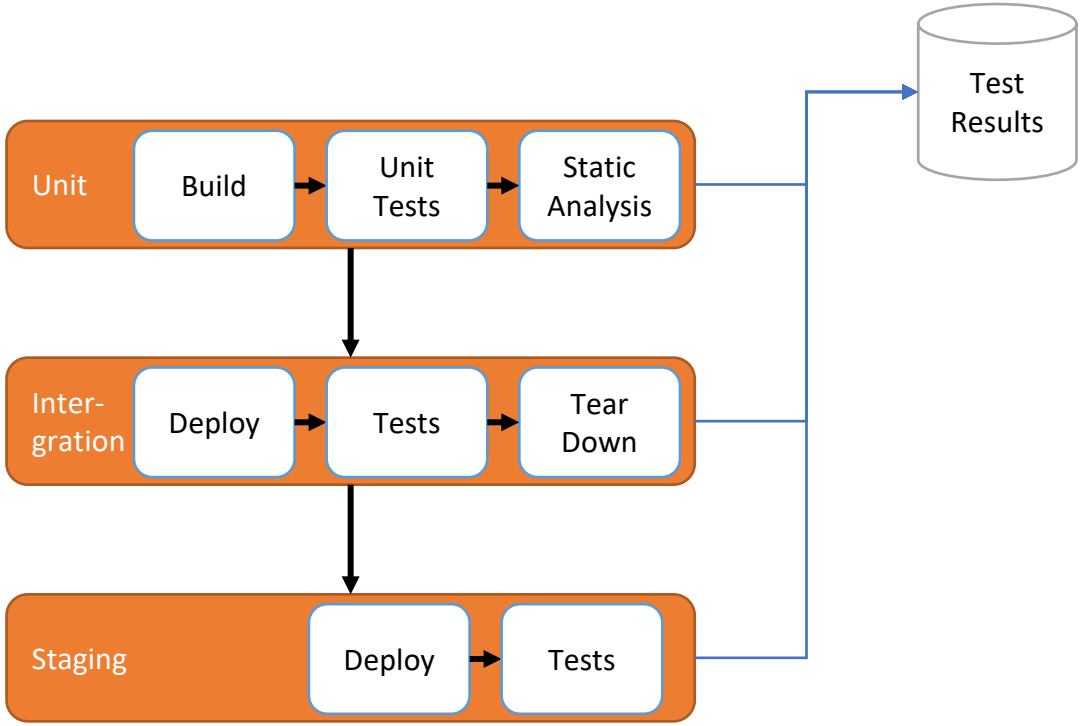
Private institution uses a **Merge Request** process to approve or deny upstream changes

Feature A/Feature B

Private institution apply changes automatically on **merge to main branch**



Continuous Integration Pipeline for the HelioCloud Platform



pytest · Pylint STRICT · Black · Mocking with pytest-mock

aws · aws Cloud Development Kit · Boto 3 · pytest · amazon S3

aws · aws Cloud Development Kit · eksctl · Selenium WebDriver · behave

Questions?

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HelioCloud Project (https://heliocloud.org)