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Introduction to EarthScope and Cloud Computing

What We Do

We give scientists the tools to examine the Earth with extreme precision to better understand natural hazards and our changing planet.

About EarthScope

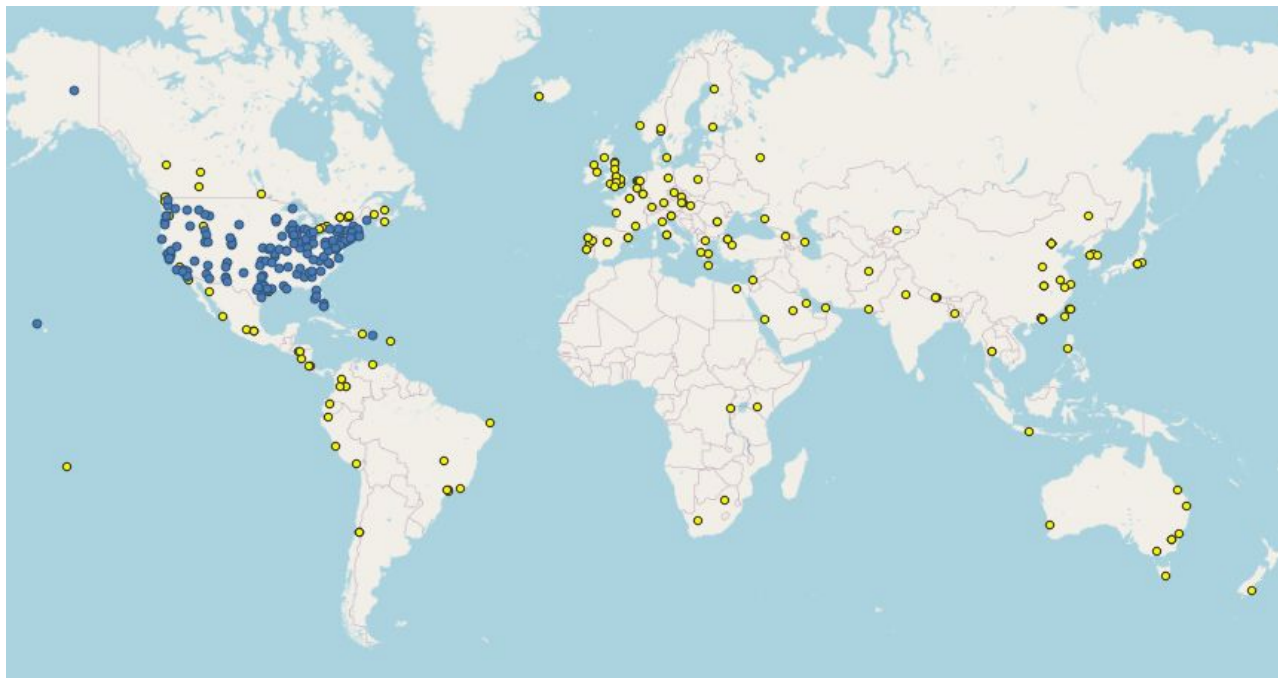


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EarthScope is a global community of scientists, scholars, and educators of 400 voting and associate members



● voting members

● associate members

About EarthScope



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- Maintain and Design Advanced Geophysical Instrumentation
 - Spans frequency spectrum
 - Extreme environments, long periods of time
- Enable Transformative Data Analysis and Modeling
 - Adopt standards for data archival, discovery, distribution
 - Support multidisciplinary research and analysis
 - Modeling, simulation, machine learning
- Investigate Processes and Hazards That Shape the Planet
 - Inner core to outer atmosphere
 - Build infrastructure for hazard monitoring
- Educational Outreach and Workforce Development
 - Equip students to engage real-world career opportunities.
 - Environmental management, urban planning, emergency management, surveying, etc.

Geodesy & Seismology Support



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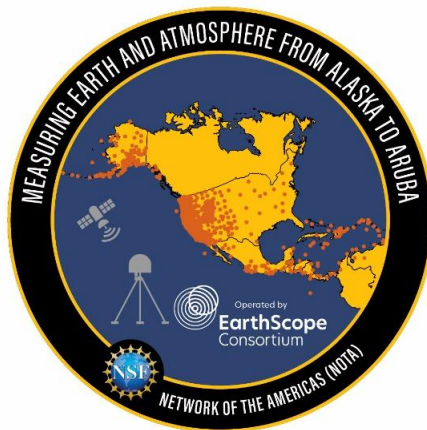
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	Geodetic	Seismologic
Data Archival	GNSS (RINEX), SAR, borehole strainmeters	Short-period and broadband timeseries (miniSEED), associated metadata
Operational Network(s)	Network of the Americas (NOTA)	Global Seismograph Network (GSN), Polar network
Portable Instrumentation Services	GNSS, terrestrial laser scanning, UAV mapping	Seismometers, GPR, magnetotelluric

Geodesy support



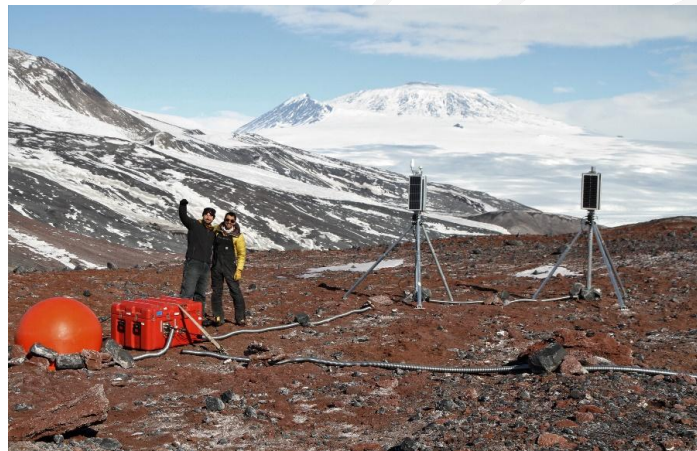
- **Data archiving:** GNSS, SAR, borehole strain/etc.
- **Network of the Americas** operation (GNSS and borehole)
- **NASA Global GNSS Network** support
- **Portable instrumentation services:** GNSS, terrestrial laser scanning, UAV structure from motion



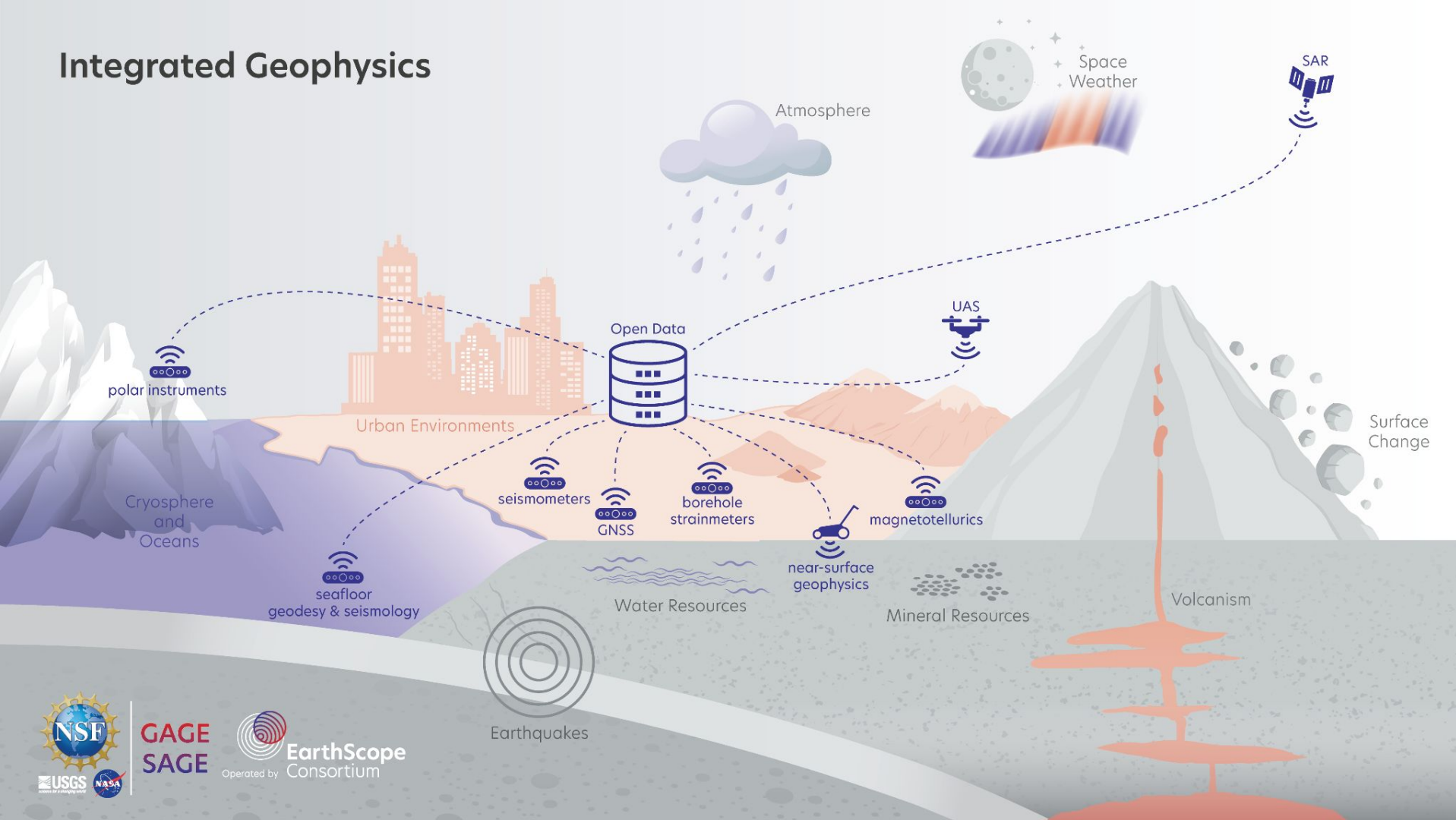
Seismology support



- **Data archiving:** raw seismic and derived products
- **Global Seismographic Network** operation (with USGS)
- **Portable instrumentation services:** seismometers, active-source support, magnetotelluric, ground penetrating radar



Integrated Geophysics





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Data

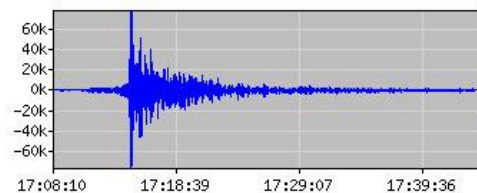
NSF SAGE Data



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<https://service.iris.edu/>



Time Series Data

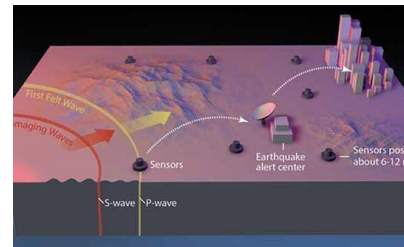
control headers

dataless SEED

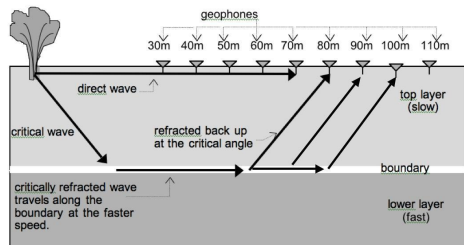
ASCII

Volume Header
Abbreviation Header
Station Header
Time Span Header

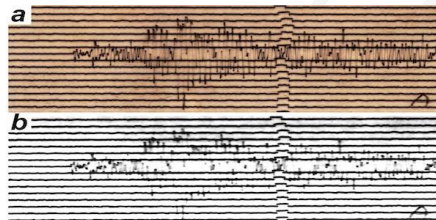
Metadata



Event Data



Assembled Data



Historical Data

Current SAGE Data Access



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- Web services: <https://service.iris.edu/>
- Download tools:
 - FetchData – <https://earthscope.github.io/fetch-scripts/>
 - Rover – <https://earthscope.github.io/rover/>
 - Wilber – <https://ds.iris.edu/wilber3/>
- Python packages:
 - Obspy
 - MsPASS
- Real-time - SeedLink

NSF GAGE Data



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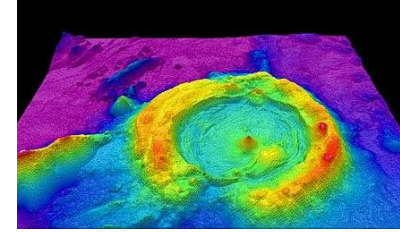
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GPS/GNSS Data



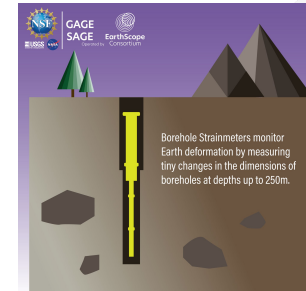
Synthetic Aperture Radar
(SAR)



LIDAR/SfM



Tropospheric Data



Strain & Seismic Data

Current GAGE Data Access



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File server

<https://data.earthscope.org/>

EarthScope Data Server

Help | Data HomeS

root / archive / gnss / rinex / obs / 2025 / 001

☒ Show subdirectories x Files: 2 | Size: 14 GB

Name	⌵	Last Modified	Size	Description
p0380010.25d.Z		2025-01-01 17:39:06	3 MB	Hatanaka UNIX-compressed RINEX observation file
p0380010.25o.Z		2025-01-01 17:39:06	10 MB	UNIX-compressed RINEX observation file

Current GAGE Data Access



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<https://api.earthscope.org/>

Requires authentication
with EarthScope CLI

QUERY-STRING PARAMETERS

* latitude number	<input type="text" value="34.147255"/>	Min: 90 Max: 90
Latitude in decimal degrees Examples: 35.1		
* longitude number	<input type="text" value="-103.4073"/>	Min: -180 Max: 180
Longitude in decimal degrees Examples: -118.5		
* distance number	<input type="text" value="50"/>	More than 0
Search radius distance in km Examples: 50		
tier enum	<input type="text" value="station"/>	Default: station Allowed: station stream
Whether to search for stations or streams.		
network array of string	<input type="text" value="add=multiple *"/>	
Network name(s). Can contain leading/trailing wildcards. Used to filter both stations and streams. Omit to search all networks. ShakeAlert uses the network namespace <code>SHAKE:</code> , with valid network names being <code>SHAKE:ShakeAlert</code> (all stations in ShakeAlert), <code>SHAKE:IGS</code> , <code>SHAKE:PNGA</code> , <code>SHAKE:WCDA</code> , <code>SHAKE:ORGN</code> , <code>SHAKE:NOTA</code> , <code>SHAKE:CRTN</code> , <code>SHAKE:NCGN</code> , <code>SHAKE:BARD</code> , and <code>SHAKE:WSRN</code> .		
stream_type enum	<input type="text"/>	Allowed: gnss_ppp gnss_raw
Filter stream results by type. Defaults to all stream types. This only applies to streams.		
facility enum	<input type="text" value="earthscope"/>	Allowed: caltech csn cws earthscope igppn ineter sgc ucbl ucsl unknown usgs_csrc usgs_merilo_park
Filter stream results based on facility, i.e. where the position was processed, not where the raw stream originated. Defaults to all facilities. Only applies to streams.		
with_information boolean	<input type="text" value="true"/>	Default: false
Include station/stream name(s) and location. Defaults to <code>false</code> , and only returns EarthScope Datasource IDs (EDIDs).		

API Server: <https://api.earthscope.org/beta>
Authentication: OAuth (OAuth2Implicit) in header

Response Status: 200
Took 335 milliseconds

[FILL EXAMPLE](#) [CLEAR](#) [TRY](#)

[CLEAR RESPONSE](#)

RESPONSE RESPONSE HEADERS CURL

```
[
  {
    "edid": "01H46MTXV05SRVXJVG9GG7EQAE",
    "pnum": "PNUM:P038",
    "igs": "IGS:P03800USA",
    "lat": 34.14725482,
    "lon": -103.4073405,
    "elev": 1213.01009
  }
]
```

[Copy](#)

Observable Notebooks (@earthscope)



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observablehq.com/@unavco



All the **<data>**
That's Fit to **GET.**

Ergonomic, human-friendly, and **sustainably** made notebooks.

UNAVCO © Observable

Brooks.Mershon / Kelly.Enloe / Alex.Hamilton / Henry.Berglund / Dave.Mencin

Use open-source notebooks for data access, analysis, visualization:

- Create RINEX data requests
- Geoid Height Calculator
- Earth Model Collaboration (EMC) contribution and visualization
- GMV and other SPUD products

<https://observablehq.com/@earthscope>



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Hands-on with Jupyter, GeoLab, and Git

JupyterHub and GeoLab




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- JupyterHub offers compute environments hosted on shared infrastructure
- GeoLab is a cloud computing platform for the geophysical community, built in collaboration with 2i2c.
- Adjacent to EarthScope-operated data archives

<https://geolab.earthscope.org/>

 jupyterhub Home Token

google-oauth2|112969120435953538875 Logout

Server Options

☒

Shared Small: 1-4 CPU, 8-32 GB

A shared machine, the recommended option until you experience a limitation.

Image

☐

Small: 4 CPU, 32 GB

A dedicated machine for you.

Image

Start

GeoLab: Server Options



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jupyterhub Home Token

google-oauth2|112969120435953538875 Logout

Server Options

Shared Small: 1-4 CPU, 8-32 GB

A shared machine, the recommended option until you experience a limitation.

Image

GeoLab

Jupyter

MT-ShortCourse

RStudio

Other...

Small: 4 CPU

A dedicated machine for

Image

Start

GeoLab: Read the Docs



<https://docs.earthscope.org/projects/GeoLab>

GeoLab Documentation

⌕ + K

GeoLab Documentation


Outside the GeoLab

- Welcome to GeoLab
- Getting Started: GeoLab

Inside the GeoLab

- How to Notebook
- A Guide for Early Adopters & Contributors

Welcome to GeoLab



About GeoLab

The EarthScope-operated data systems of the NSF GAGE and SAGE Facilities are transitioning to cloud services, introducing new capabilities for users to leverage cloud computing for their projects. As part of this transition, the EarthScope GeoLab JupyterHub provides a powerful platform for accessing Jupyter Notebooks in a shared, cloud-based environment. GeoLab is a collaborative environment for

Contents

- Welcome to GeoLab
- About GeoLab
 - Why Migrate?
 - Why use notebooks?
 - GeoLab Code of Conduct
- About Our Partners
 - 2i2c
 - Amazon Web Services (AWS)
- About the Hub
 - What Are Docker Containers?
 - What Are Docker Images?
 - What are GeoLab Compute Instances
 - What are Notebooks?
- External Resources
 - How to Get Help / Ask Questions
 - Extras

JupyterHub Tour



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The JupyterHub Launcher interface. On the left is a sidebar with icons for File, Edit, View, Run, Kernel, Git, Tabs, Settings, and Help. Below these are sections for OPEN TABS (Close All), KERNELS (Shut Down All), LANGUAGE SERVERS (Shut Down All), RECENTLY CLOSED (Forget All), WORKSPACES (Delete All), and TERMINALS (Shut Down All). The main area is titled "Launcher" and contains three sections: "Notebook" with icons for Python 3 (ipykernel) and panel [1]; "Console" with a Python 3 (ipykernel) icon; and "Other" with icons for Terminal, Text File, Markdown File, Python File, and Show Contextual Help.

GeoLab Tour



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Run	Kernel	Git	Tabs	Settings	Help
Run Selected Cell					↻ ↺
Run Selected Cell and Insert Below					↻ ↺
Run Selected Cell and Do not Advance					⌂ ↺
Run Selected Text or Current Line in Console					
Run All Above Selected Cell					
Run Selected Cell and All Below					
Render All Markdown Cells					
Run All Cells					
Restart Kernel and Run All Cells...					

Kernel	Git	Tabs	Settings	Help
Interrupt Kernel				⌂, ⌂
Restart Kernel...				0, 0
Restart Kernel and Clear Outputs of All Cells...				
Restart Kernel and Run up to Selected Cell...				
Restart Kernel and Run All Cells...				
Restart Kernel and Debug...				
Reconnect to Kernel				
Shut Down Kernel				
Shut Down All Kernels...				
Change Kernel...				

Git	Tabs	Settings	Help
Initialize a Repository			
Clone a Repository			
Merge Branch...			
Push to Remote			
Push to Remote (Advanced)			
Pull from Remote			
Pull from Remote (Force)			
Reset to Remote			
Manage Remote Repositories			
Open Git Repository in Terminal			
Simple staging			
Double click opens diff			
Open .gitignore			
Help			⌂

Untitled2.ipynb

⌂ + ✂ 📄 📌 ▶ ■ ↻ ▶▶ Code ⌵ 💬 📄 ⌚ ...

Collaboration with Git



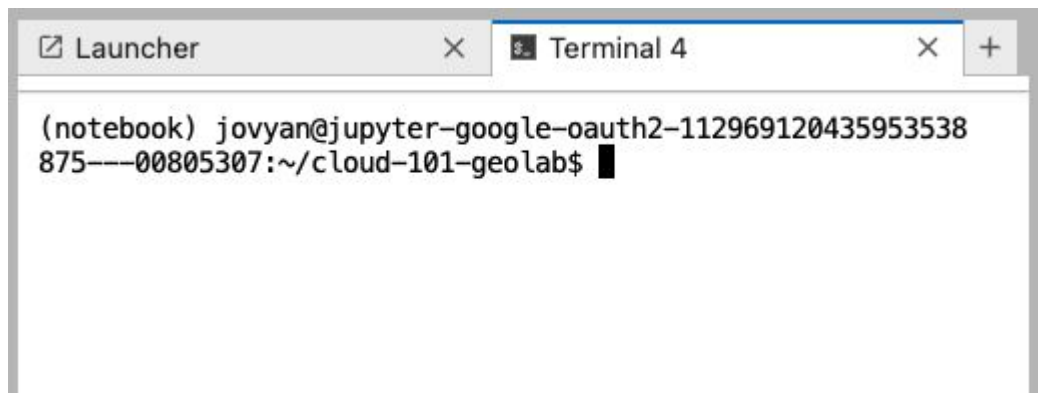
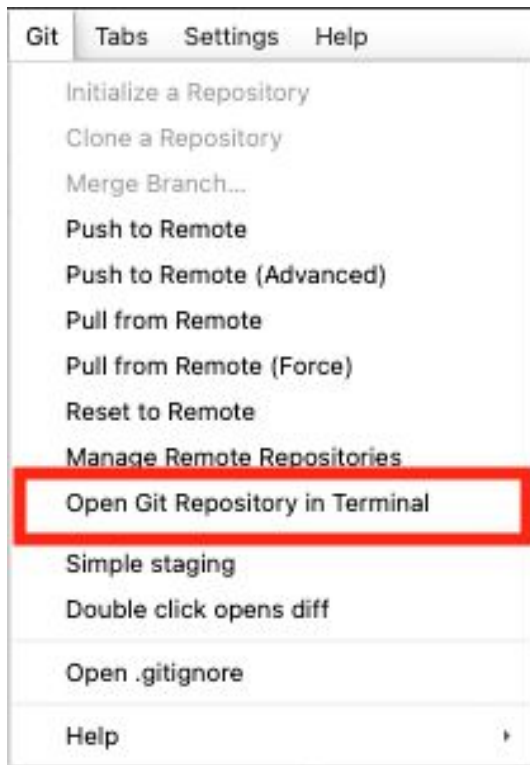
Git is a version control system that:

- Tracks code changes in files
- Tracks who made changes
- Enables coding collaboration

Two commonly used git providers

- GitHub
- GitLab

Getting Started with git



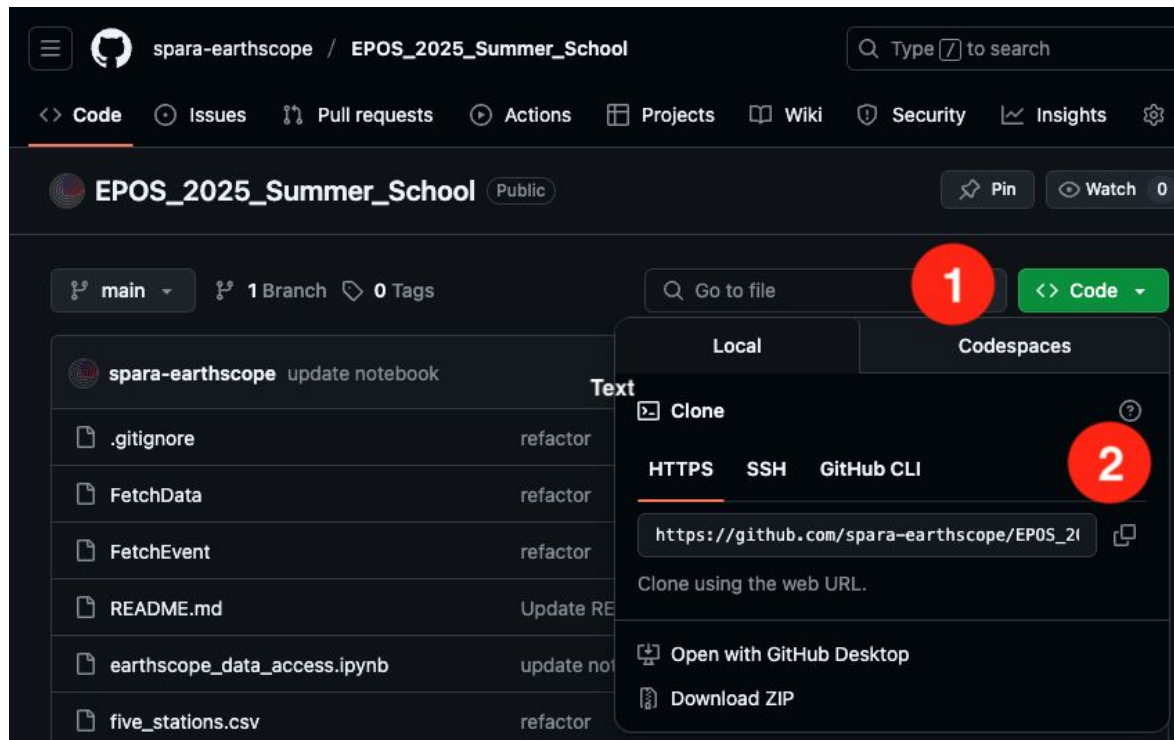
Clone repository



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https://github.com/spara-earthscope/EPOS_2025_Summer_School



Clone repository



git clone https://github.com/spara-earthscope/EPOS_2025_Summer_School

```
Terminal 1
X +
(notebook) jovyan@jupyter-google-oauth2--112969120435953538875---00805307:~$ git clone https://github.com/spara-earthscope/EPOS_2025_Summer_School
Cloning into 'EPOS_2025_Summer_School'...
remote: Enumerating objects: 53, done.
remote: Counting objects: 100% (53/53), done.
remote: Compressing objects: 100% (34/34), done.
remote: Total 53 (delta 23), reused 45 (delta 17), pack-reused 0 (from 0)
Receiving objects: 100% (53/53), 48.97 KiB | 2.45 MiB/s, done.
Resolving deltas: 100% (23/23), done.
(notebook) jovyan@jupyter-google-oauth2--112969120435953538875---00805307:~$
```



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Let's get to work!