

Sentinel-1 Soil Moisture Estimation

a practical exercise with SEPAL

Log in to SEPAL

System for earth observations, data access, processing & analysis for land monitoring

SEPAL

USERNAME

lindquist




PASSWORD

.....

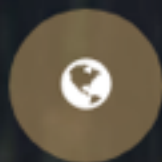


 LOGIN

 [Forgot password](#)

 [Sign up](#)

[Privacy policy](#)



SEARCH GEO DATA

Fast and easy access to scenes and mosaics



BROWSE YOUR DATA

Preview and download your products



PROCESS YOUR DATA

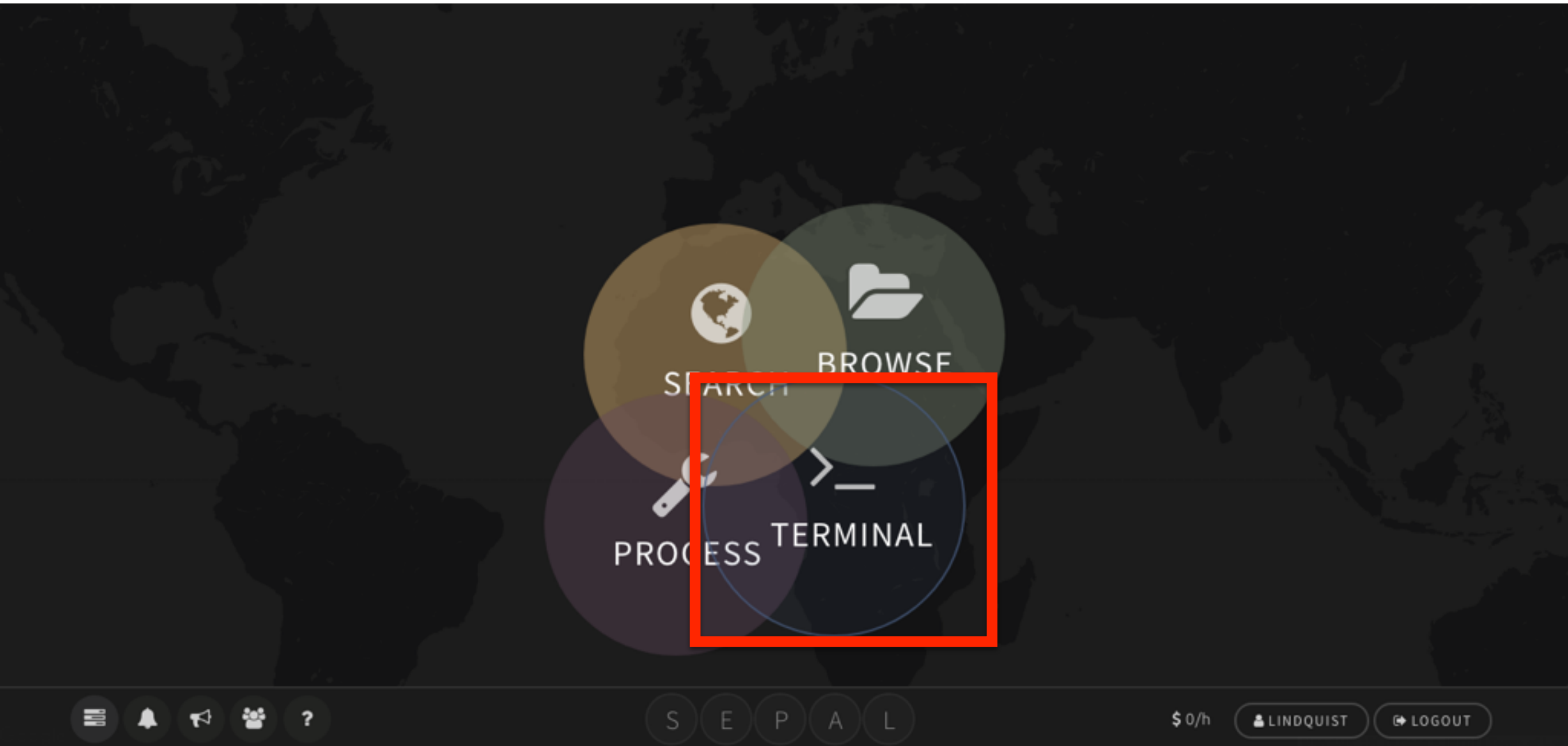
Easy-to-use data processing Apps



TERMINAL

Powerful command-line tools for data processing

Start a Cloud Computer #2



Start a Cloud Computer #2

The screenshot displays a terminal window within a cloud management interface. The terminal shows the connection command: `ssh://lindquist@ssh-gateway?identities=id_rsa`. It lists the SSH identities used and provides spending and storage usage statistics. A list of 21 instance types is shown, each with its name, CPU count, memory, and hourly price. The first instance, `t2.small`, is highlighted. A red box highlights the `Select (1):` prompt at the bottom of the list.

```
Host/IP or ssh:// URL [localhost]: ssh://lindquist@ssh-gateway?identities=id_rsa
Connecting to ssh://lindquist@ssh-gateway:22

The following SSH identities are being used for this connection:
  id_rsa

-----
- Monthly budget -
-----

Instance spending/budget: 6.09/400 USD
Storage spending/budget: 20.31/100 USD
Storage used/quota:      79.48/300 GB

-----
- Create new session -
-----

1  t2.small, 1 CPU / 2.0 GiB, 0.025 USD/h
2  m3.medium, 1 CPU / 3.75 GiB, 0.073 USD/h
3  m4.large, 2 CPU / 8.0 GiB, 0.119 USD/h
4  m4.xlarge, 4 CPU / 16.0 GiB, 0.238 USD/h
5  m4.2xlarge, 8 CPU / 32.0 GiB, 0.475 USD/h
6  m4.4xlarge, 16 CPU / 64.0 GiB, 0.95 USD/h
7  m4.10xlarge, 40 CPU / 160.0 GiB, 2.377 USD/h
8  m4.16xlarge, 64 CPU / 256.0 GiB, 3.803 USD/h
9  c4.large, 2 CPU / 3.75 GiB, 0.113 USD/h
10 c4.xlarge, 4 CPU / 7.5 GiB, 0.226 USD/h
11 c4.2xlarge, 8 CPU / 15.0 GiB, 0.453 USD/h
12 c4.4xlarge, 16 CPU / 30.0 GiB, 0.905 USD/h
13 c4.8xlarge, 36 CPU / 60.0 GiB, 1.811 USD/h
14 r4.large, 2 CPU / 15.25 GiB, 0.148 USD/h
15 r4.xlarge, 4 CPU / 30.5 GiB, 0.296 USD/h
16 r4.2xlarge, 8 CPU / 61.0 GiB, 0.593 USD/h
17 r4.4xlarge, 16 CPU / 122.0 GiB, 1.186 USD/h
18 r4.8xlarge, 32 CPU / 244.0 GiB, 2.371 USD/h
19 r4.16xlarge, 64 CPU / 488.0 GiB, 4.742 USD/h
20 x1.16xlarge, 64 CPU / 976.0 GiB, 8.003 USD/h
21 x1.22xlarge, 128 CPU / 1952.0 GiB, 16.006 USD/h

Select (1):
```

Navigation icons: Home, Search, Settings, Help, and a menu icon.

Footer: \$ 0/h, LINDQUIST, LOGOUT

Make a directory

```
~$ mkdir    smm_test
```

Enter into the new directory

```
~$ cd    smm_test
```

Make a virtual environment

```
~$ virtualenv -p python2.7 env --system-site-packages
```

A virtual environment let's us experiment
without messing up everything.

Activate the virtual environment

```
~$ source env/bin/activate
```

Activating a virtual environment means you are using the tools within that environment to process

Install python soil moisture monitor
pysmm

```
~$ pip install pysmm
```

pip - is a python installer.

Update pysmm with improved files

```
~$ wget https://goo.gl/JZLCo9
```

wget - get's files from a URL

Re-name downloaded file

```
~$ mv JZLCo9 pysmm_upgrade.zip
```

Replace old files with updates

```
~$ unzip pysmm_upgrade.zip -d env/lib/python2.7/site-packages
```

(A) 11

Install a jupyter kernel

```
~$ python -m ipykernel install --user --name=env
```

Download the Jupyter Notebook

```
~$ wget https://goo.gl/NbpUWr
```

Re-name the Jupyter Notebook

```
~$ mv NbpUWr run_pysmm.ipynb
```

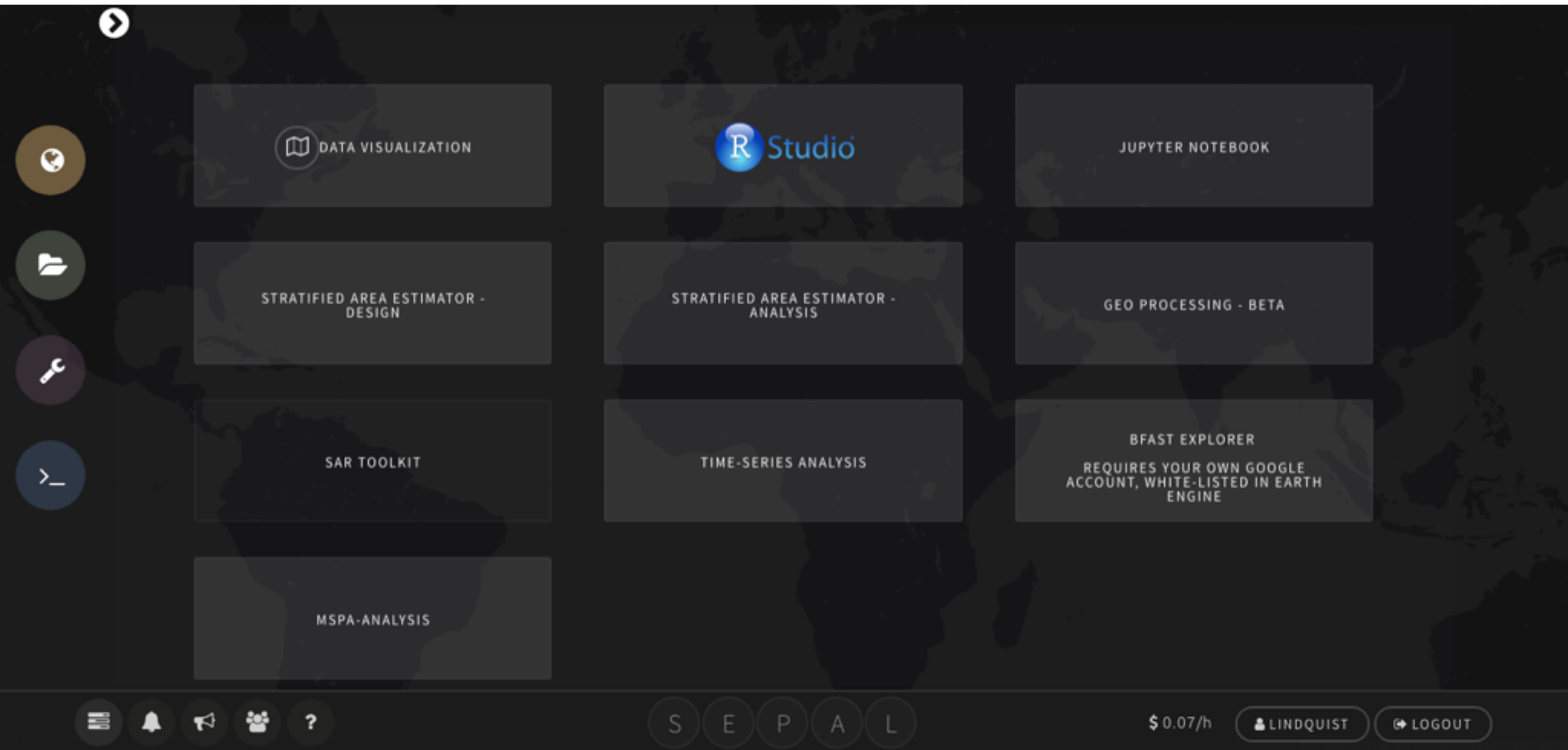
Exit the Virtual Environment

```
~$ deactivate
```

to re-activate a virtual environment:

```
~$ source env/bin/activate
```


Open the Jupyter Notebook in SEPAL



Open the Jupyter Notebook in SEPAL

Quit

Files Running Clusters

Select items to perform actions on them.

Upload New ↕

<input type="checkbox"/> 0 ▾	📁 / python_environments	Name ▾	Last Modified	File size
	📁 ..		seconds ago	
<input type="checkbox"/>	📁 smm_env		20 hours ago	
<input type="checkbox"/>	📄 run_pysmm.ipynb		seconds ago	37.4 kB
<input type="checkbox"/>	📄 Untitled.ipynb		an hour ago	37.4 kB
<input type="checkbox"/>	📄 pysmm_upgrades.zip		2 hours ago	2.37 MB
<input type="checkbox"/>	📄 smm_indo_test.py		a day ago	641 B

Run the Jupyter Notebook in SEPAL

jupyter run_pysmm Last Checkpoint: 15 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help Trusted | smm_env

Run

Import Python modules to run PYSMM

```
In [1]: import pysmm,os
from pysmm.derive_SM import get_map
import sys
import ee
import itertools
#ee.Initialize()
path = os.path.dirname(pysmm.__file__)
```

Print variables to make sure paths are correct

```
In [2]: print path

print str(sys.argv)
```

```
/home/lindquist/python_environments/smm_env/local/lib/python2.7/site-packages/pysmm
['/usr/local/lib/python2.7/dist-packages/ipykernel_launcher.py', '-f', '/home/lindquist/.local/share/jupyter/runtime/kernel-cbdd5884-de53-44a6-8e74-aeace4ebaf51.json']
```

Modify the Year, Month, and Day parameters as desired

```
In [3]: year = [2016]
month = [11]
day = [1,15]
```

Go back to SEPAL

Quit

FilesRunningClusters

Select items to perform actions on them.

UploadNew ↕ ↻

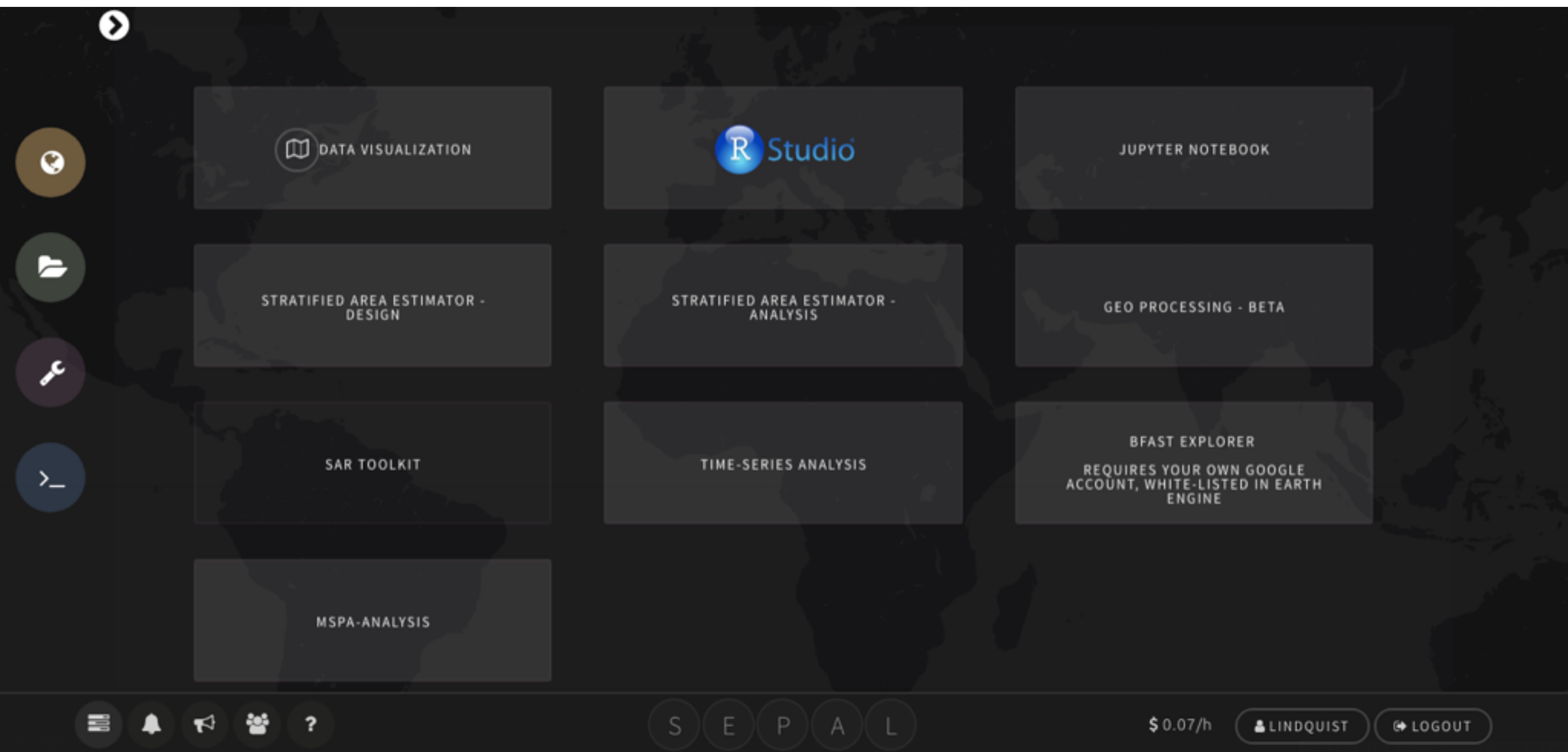
☐ 0 ▾

/ python_environments

Name ▾Last ModifiedFile size

<input type="checkbox"/>	..	seconds ago	
<input type="checkbox"/>	smm_env	20 hours ago	
<input type="checkbox"/>	 run_pysmm.ipynb	seconds ago	37.4 kB
<input type="checkbox"/>	 Untitled.ipynb	an hour ago	37.4 kB
<input type="checkbox"/>	 pysmm_upgrades.zip	2 hours ago	2.37 MB
<input type="checkbox"/>	 smm_indo_test.py	a day ago	641 B

Extend the time your computer will run



Extend the time your computer will run

The screenshot displays the SEPAL user interface. On the left is a vertical sidebar with icons for navigation. The main content is divided into two panels. The left panel, titled 'USER', contains a form with fields for NAME (Erik Lindquist), USERNAME (lindquist), PASSWORD (with a 'CHANGE' button), EMAIL (erik.lindquist@fao.org), ORGANIZATION (FAO), and a 'GOOGLE ACCOUNT' section with a 'USE SEPAL'S ACCOUNT' button. The right panel, titled 'USED RESOURCES', contains a table of resource usage and a 'SESSIONS' table. The resource table shows budgets for instance and storage, and current usage. The sessions table shows a single session for an m3.medium instance that started 4 hours ago with a cost of 0.29 USD and a minimum time frame of 0 hours. The bottom of the interface features a navigation bar with icons, the SEPAL logo, a cost indicator of \$0.07/h, and buttons for the user's name and logout.

USER

NAME Erik Lindquist

USERNAME lindquist

PASSWORD CHANGE

EMAIL erik.lindquist@fao.org

ORGANIZATION FAO

GOOGLE ACCOUNT USE SEPAL'S ACCOUNT

USED RESOURCES

	Quota	Used
Monthly Instance Budget	400 USD	6.38 USD
Monthly Storage Budget	100 USD	20.47 USD
Storage	300 GB	79.49 GB

SESSIONS

	Instance type	Time	Cost	Minimum time frame (hours)
	m3.medium	4 hours ago	0.29 USD	0

S E P A L

\$0.07/h

LINDQUIST

LOGOUT

What are we doing?

1. Running Python code to pre-process Sentinel-1 RADAR
2. Combining S1 data with GLDAS data
3. And a model trained on International Soil Moisture Network
4. To create 100m surface soil moisture estimates in kg/m²

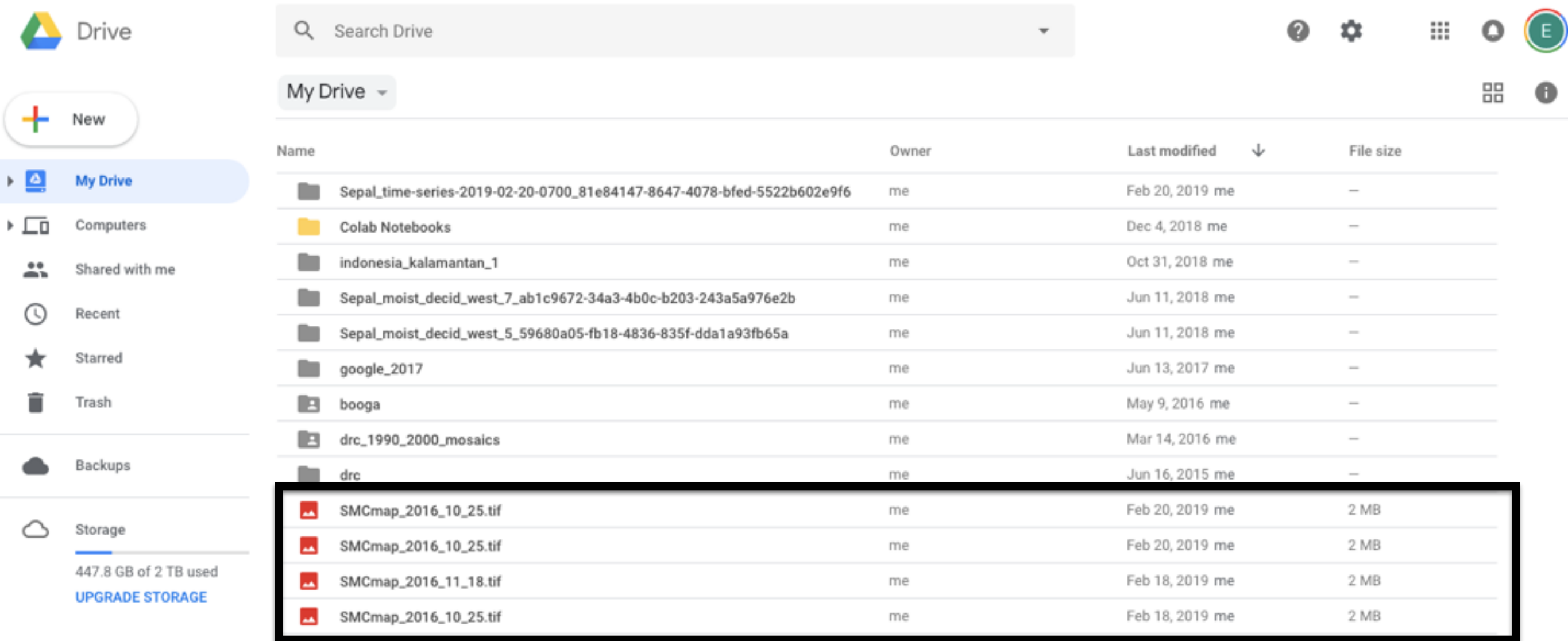
Limitations

1. These are estimates based on training data from far away.
2. C-band SAR is affected by vegetation canopy
3. So...tree areas are not suitably monitored by this method
4. There are a lot of other limitations...

Sources:

1. <https://www.mdpi.com/2072-4292/7/12/15841>
2. <https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-85-3-381>
3. <https://ieeexplore.ieee.org/abstract/document/7005430>
4. <https://ieeexplore.ieee.org/abstract/document/6723717>
5. <https://pubs.geoscienceworld.org/vzj/article-abstract/15/6/vzj2015.03.0048/315717/from-point-to-pixel-scale-an-upscaling-approach?redirectedFrom=fulltext>

Download the Results from Google Drive



Drive

Search Drive

My Drive

New

My Drive

Computers

Shared with me

Recent

Starred

Trash

Backups

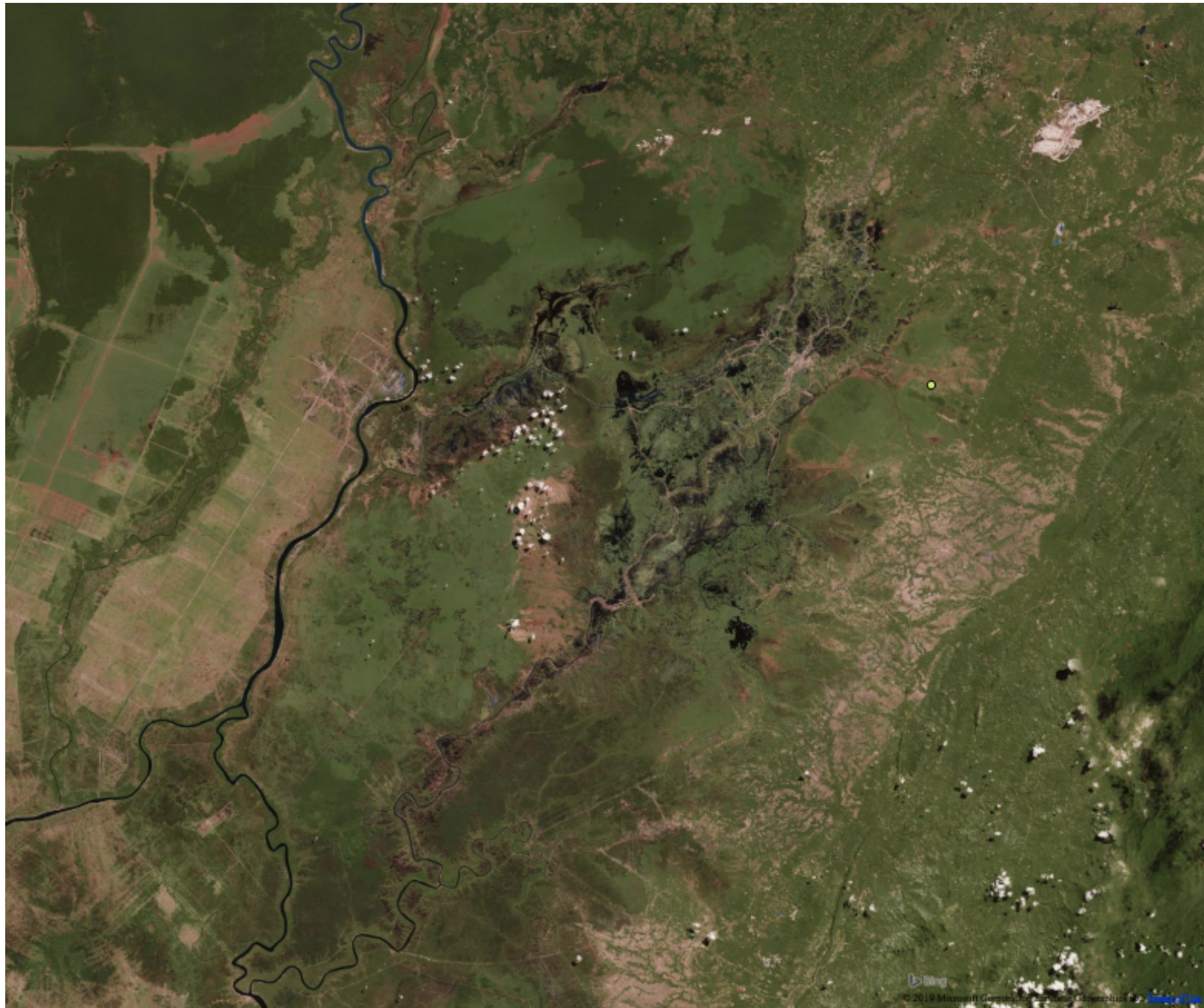
Storage

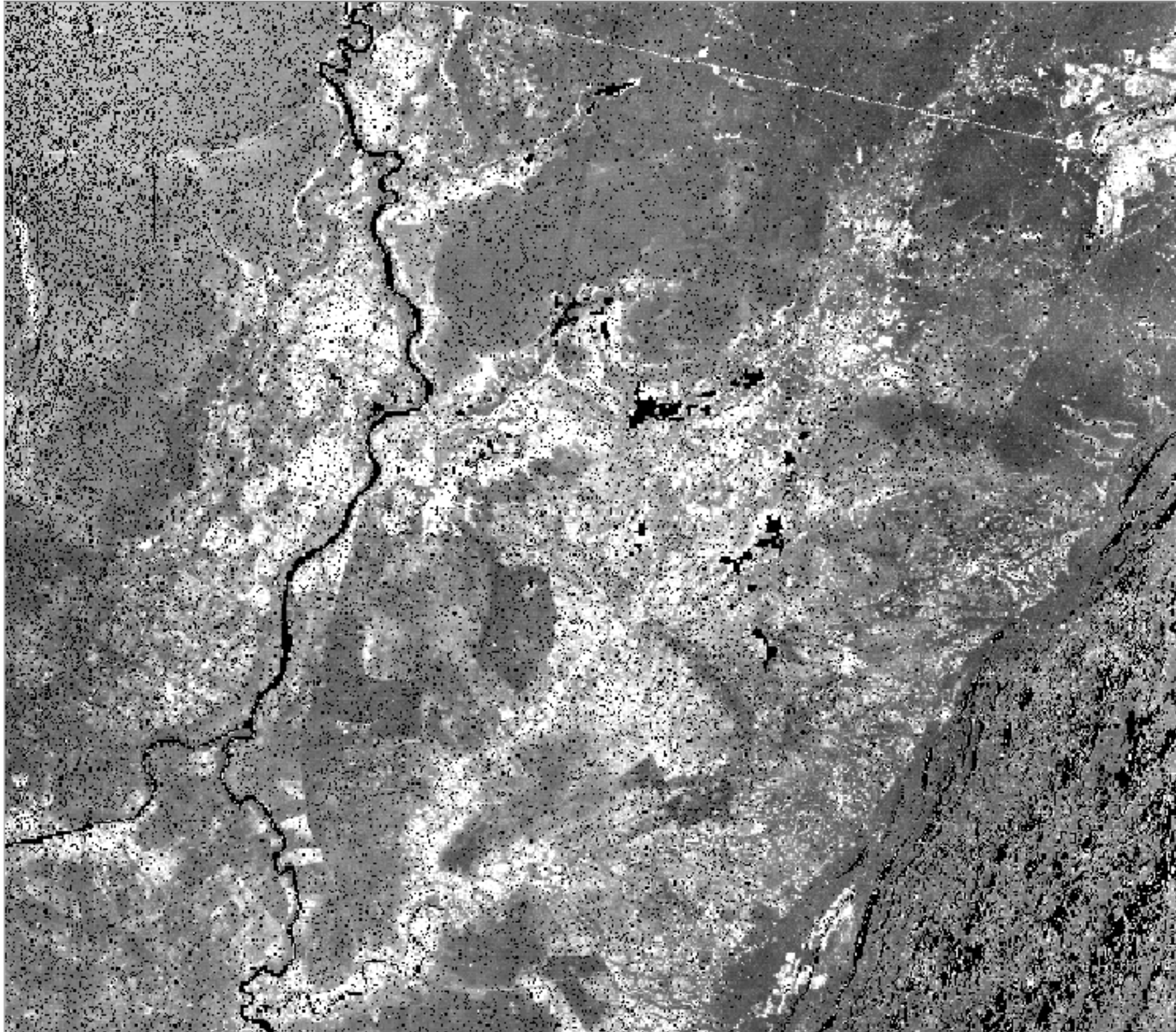
447.8 GB of 2 TB used

[UPGRADE STORAGE](#)

Name	Owner	Last modified	File size
Sepal_time-series-2019-02-20-0700_81e84147-8647-4078-bfed-5522b602e9f6	me	Feb 20, 2019 me	—
Colab Notebooks	me	Dec 4, 2018 me	—
indonesia_kalamantan_1	me	Oct 31, 2018 me	—
Sepal_moist_decid_west_7_ab1c9672-34a3-4b0c-b203-243a5a976e2b	me	Jun 11, 2018 me	—
Sepal_moist_decid_west_5_59680a05-fb18-4836-835f-dda1a93fb65a	me	Jun 11, 2018 me	—
google_2017	me	Jun 13, 2017 me	—
booga	me	May 9, 2016 me	—
drc_1990_2000_mosaics	me	Mar 14, 2016 me	—
drc	me	Jun 16, 2015 me	—
SMCmap_2016_10_25.tif	me	Feb 20, 2019 me	2 MB
SMCmap_2016_10_25.tif	me	Feb 20, 2019 me	2 MB
SMCmap_2016_11_18.tif	me	Feb 18, 2019 me	2 MB
SMCmap_2016_10_25.tif	me	Feb 18, 2019 me	2 MB

Open a GIS





PYSMM Soil Moisture Mapping Algorithm from:

Greifeneder et. al. *Submitted*

and code documentation here:

<https://pysmm.readthedocs.io/en/latest/>

with edits and improvements made by SEPAL team