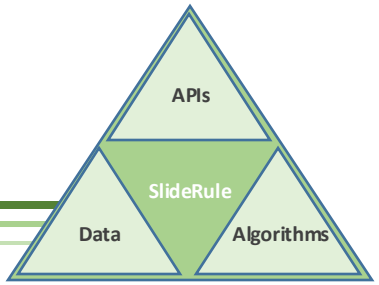
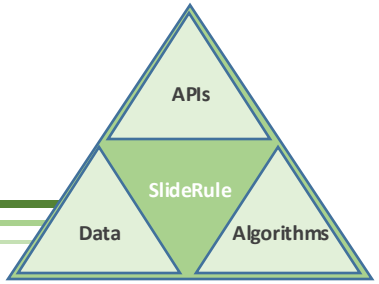


SlideRule Earth

Enabling Rapid, Scalable, Open Science

Tom Neumann, David Shean, Ben Smith, Tyler Sutterley, JP Swinski
Scott Henderson, Carlos Ugarte, Eric Lidwa, Jeff Lee

The team behind SlideRule



Project Manager
Tom Neumann/GSFC

Science Lead
David Shean/UW

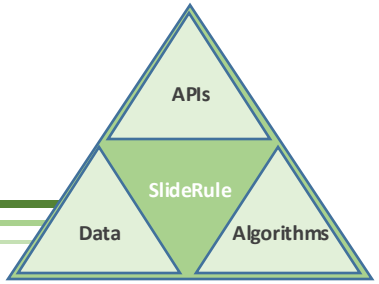
- **ATL06 Algorithm** — Ben Smith/UW
- **Python Developer** — Tyler Sutterly/UW
- **Consultant / Pangeo** — Scott Henderson/UW

Software Lead
JP Swinski/GSFC

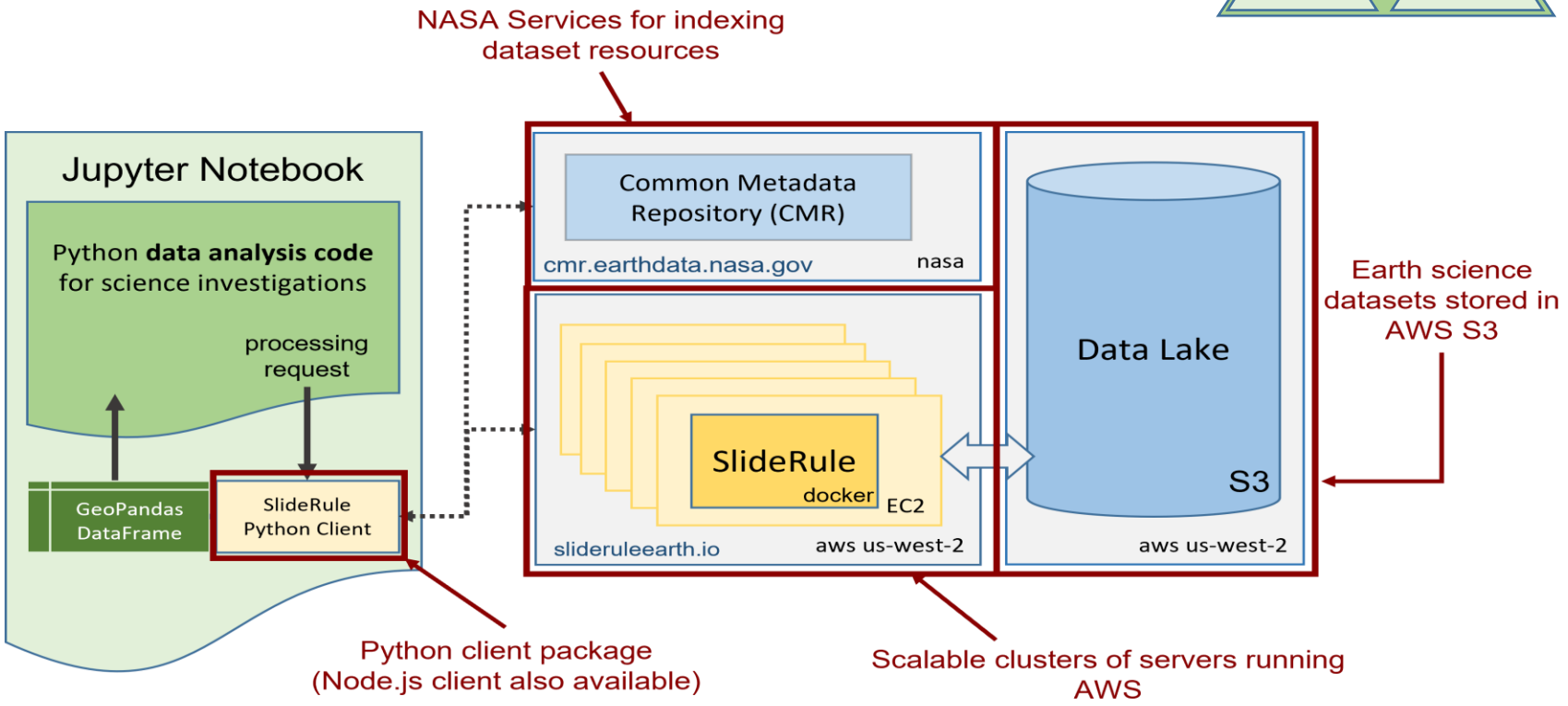
- **Software Developer** — Carlos Ugarte/Microtel
- **Software Developer** — Eric Lidwa/Microtel

ASAS Software Lead
Jeff Lee/WFF

What is SlideRule in a nutshell?

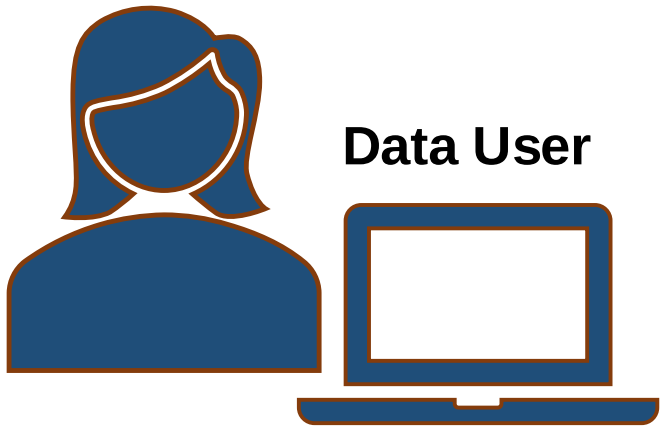


SlideRule is a *public web service* with REST-like APIs for processing science data. It provides researchers and other data systems with low-latency access to *on-demand data products* using processing parameters supplied at the time of the request. SlideRule runs in *AWS us-west-2* and has access to ICESat-2, GEDI, Landsat, and a growing list of other datasets stored in S3. *Python and Node.js* clients are provided that make it easier to interact with SlideRule.

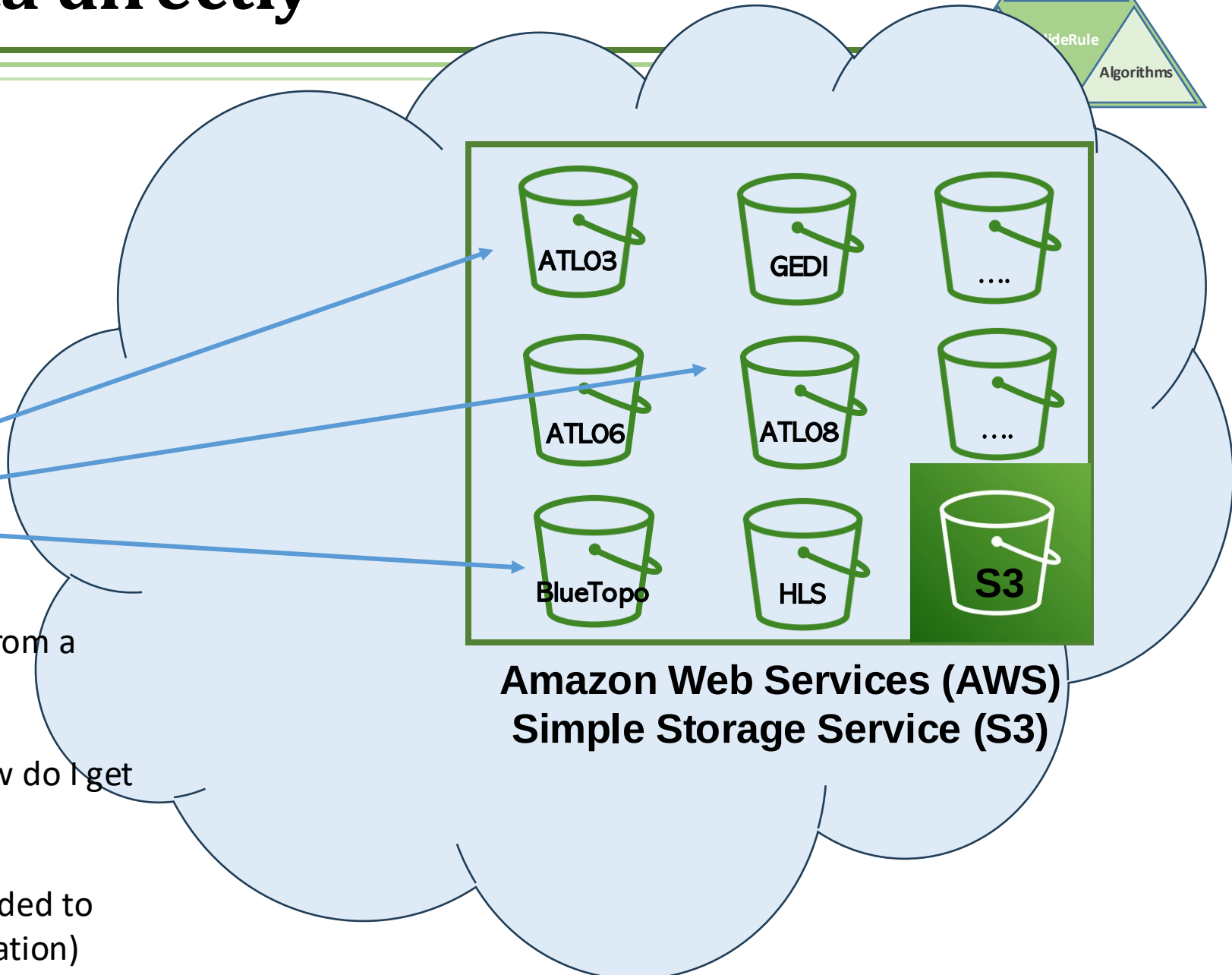


Website: slideruleearth.io
Point of Contact: jp.swinski@nasa.gov
Code: github.com/slideruleearth/sliderule
License: *BSD 3-Clause*

Accessing cloud data directly

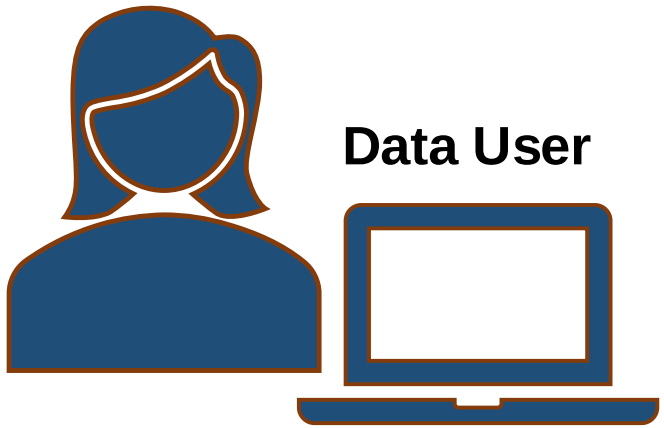


Data User

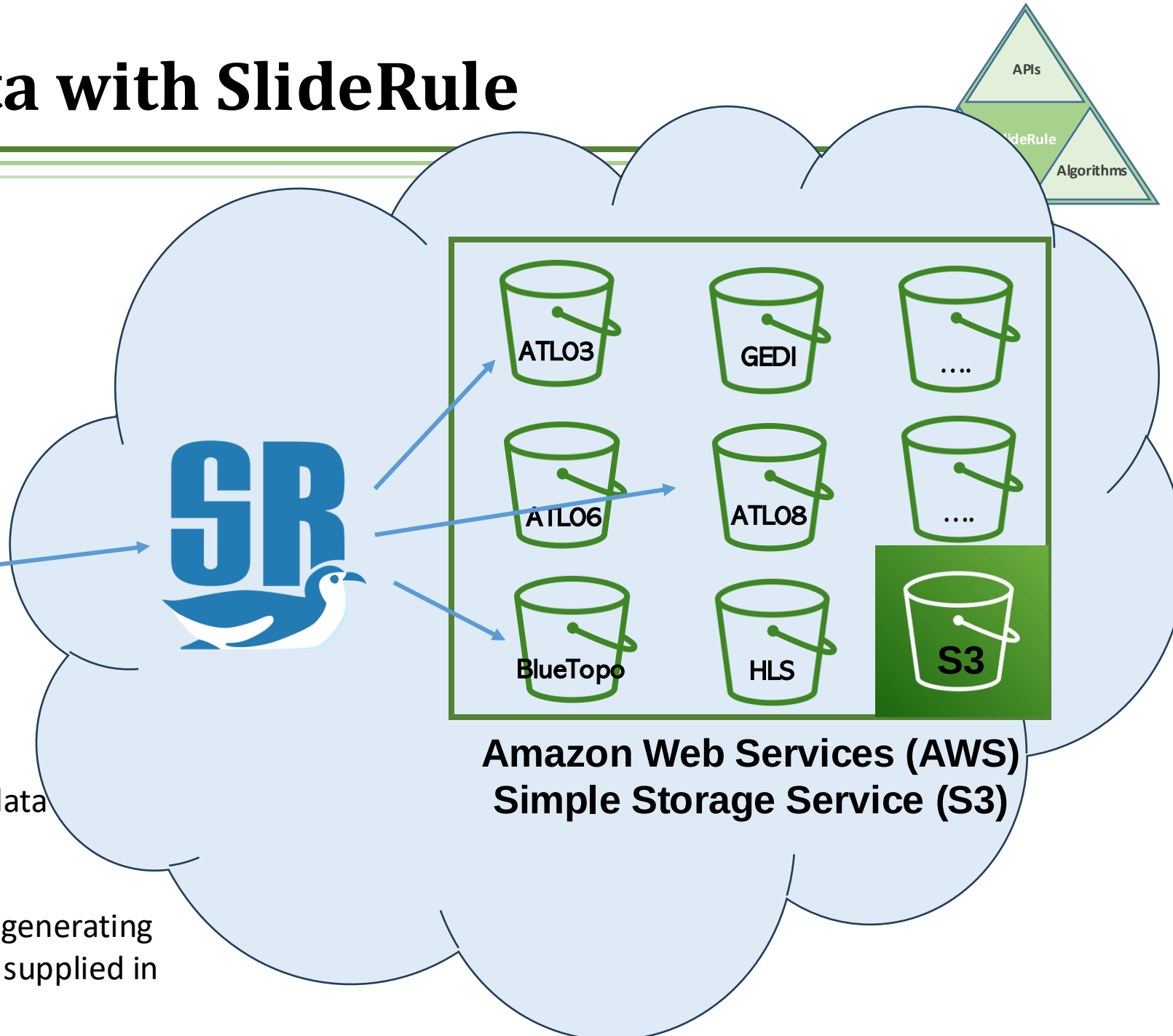


- Challenging to work with global scale data from a laptop or single JupyterHub instance
- Must know format of different datasets (how do I get acquisition date from ArcticDEM rasters?)
- Common compute intensive operations needed to make data ready to use (point-cloud to elevation)

Accessing cloud data with SlideRule

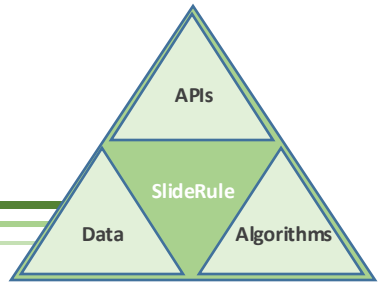


Data User



- Optimized **direct access** to the raw data
- Efficient **subsetting** services for combining data multiple sources into a single response
- **On-demand processing** next to the data for generating customized data products using parameters supplied in the user's request.

SlideRule and ATL24 (coming April 2025)



- Collaboration with University of Texas (Lori Magruder) and Oregon State University (Chris Parrish)

THE UNIVERSITY OF TEXAS AT AUSTIN

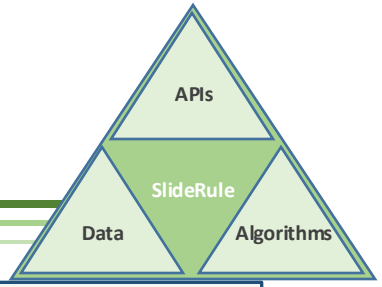
Oregon State University

NASA

SR

- Classified ICESat-2 photon cloud (ATL03) for bathymetry
- Generated the global data product by running the algorithms designed and implemented by UT Austin and OSU.
- Provide following services:
  - **Direct access** to ATL24 granules in S3
  - Efficient **subsetting** of multiple ATL24 granules to a region of interest
  - **Customized runs** of same algorithms that generated ATL24 to tailor the results to your specific region and application
  - **Combine and filter** ATL03 photon cloud with ATL24 classifications and run other algorithms on the results – e.g., ATL06 surface fitter

A “Hello World” example




```python
# import (1)
from sliderule import icesat2

# region of interest (2)
grand_mesa = [ {"lon": -108.3435200747503, "lat": 38.89102961045247},
               {"
               {"
               {"
               {"

# initialize (3)
icesat2.init("sli

# processing para
parms = {
    "poly": grand
    "srt": icesat
    "cnf": icesat
    "len": 40.0,
    "res": 20.0,
    "maxi": 1
}

# make request (5)
gdf = icesat2.atl06p(parms)
```

```javascript
import {core,h5coro,icesat2} from '../sliderule/index.js';

import http from 'http'
core.init({domain:"localhost", organization: null, protocol: http});

icesat2.atl06p(
```

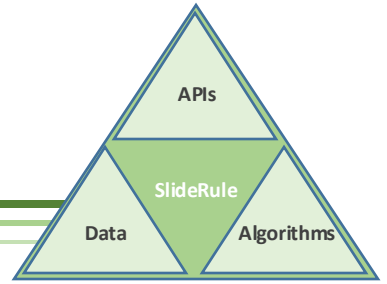
```
th, result[0]),
```

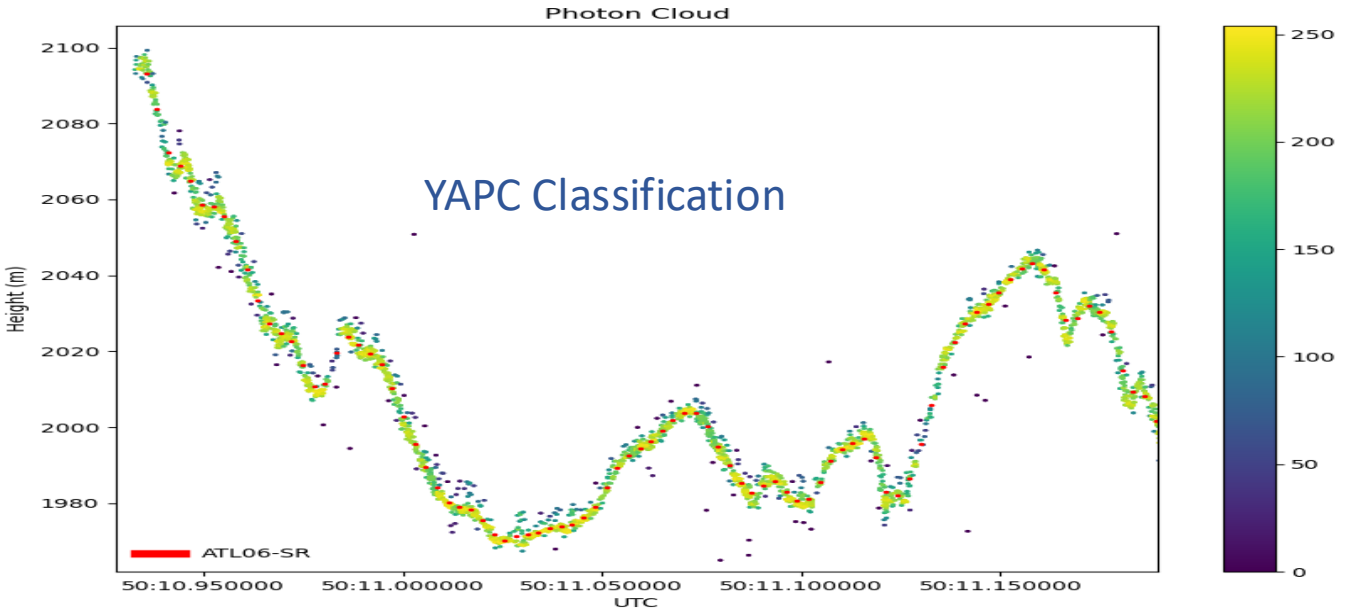
time	pflags	h_sigma	delta_time	rms_misfit	distance	gt	spot	n_fit_photons	w_surface_window_final	h_mean	dh_fit_dx	cycle	dh_fit_dy	rgt	segment_id	geometry
2018-10-17 22:31:17.350047904	0	0.098879	2.505068e+07	0.287631	4.326639e+06	60	1	32	3.000000	1826.151552	0.019818	1	0.0	295	215745	POINT (-108.28629 38.88959)
2018-10-17 22:31:17.352875032	0	0.028634	2.505068e+07	0.244501	4.326659e+06	60	1	73	3.000000	1826.569174	0.021436	1	0.0	295	215746	POINT (-108.28631 38.88977)
2018-10-17 22:31:17.355689608	0	0.026206	2.505068e+07	0.235445	4.326680e+06	60	1	82	3.000000	1827.168388	0.034429	1	0.0	295	215747	POINT (-108.28633 38.88995)
2018-10-17 22:31:17.358488680	0	0.026843	2.505068e+07	0.223318	4.326700e+06	60	1	73	3.000000	1827.804630	0.027981	1	0.0	295	215748	POINT (-108.28636 38.89013)
2018-10-17 22:31:17.361279056	0	0.032435	2.505068e+07	0.243411	4.326720e+06	60	1	59	3.000000	1827.841449	-0.013322	1	0.0	295	215749	POINT (-108.28638 38.89031)
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2022-08-09 04:05:06.945962944	4	0.197430	1.452531e+08	1.736919	4.357488e+06	40	3	78	9.662691	1992.544898	-0.146407	16	0.0	737	217285	POINT (-108.18878 39.15660)
2022-08-09 04:05:06.947338272	4	0.066863	1.452531e+08	0.664648	4.357608e+06	60	1	100	3.000000	1747.700218	-0.036374	16	0.0	737	217291	POINT (-108.15208 39.16045)
2022-08-09 04:05:06.950151072	4	0.133912	1.452531e+08	1.162784	4.357628e+06	60	1	79	3.000000	1746.934890	-0.030975	16	0.0	737	217292	POINT (-108.15211 39.16063)
2022-08-09 04:05:06.952958176	4	0.212574	1.452531e+08	1.646093	4.357648e+06	60	1	60	3.543788	1746.139887	-0.062201	16	0.0	737	217293	POINT (-108.15213 39.16081)
2022-08-09 04:05:06.955760224	4	0.171126	1.452531e+08	1.310574	4.357668e+06	60	1	61	4.766557	1744.744138	-0.108425	16	0.0	737	217294	POINT (-108.15215 39.16099)

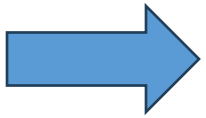
245864 rows × 16 columns

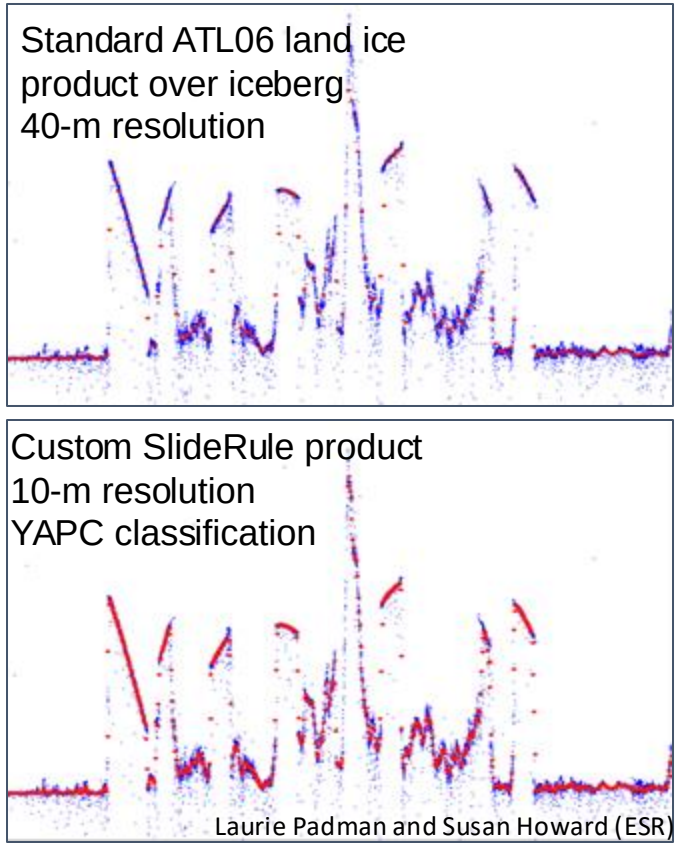
Python

A custom classifier example





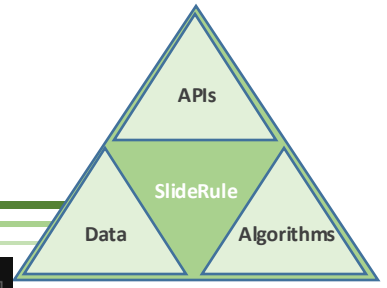




Global Iceberg Detection

Susan Howard, Earth and Space Research (ESR) Institute

A raster-sampling example



[4]:
```
parms = { "poly": region_of_interest["poly"],
          "cnf": "atl03_high",
          "ats": 10.0,
          "cnt": 5,
          "len": 40.0,
          "res": 120.0,
          "rgt": 658,
          "time_start":'2020-01-01',
          "time_end":'2021-01-01',
          "samples": {"strips": {"asset": "arcticdem-strips", "with_flags": True}} }
gdf = icesat2.atl06p(parms)
```

Print Out File Directory

When a GeoDataFrame includes samples from rasters, each sample value has a file id that is used to look up the file name of the source raster for that val

```
12: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV02_20170729_103001006EAACB00_103001006D208B00_2m_lsf_seg1_bitmask.tif',
0: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV01_20120402_102001001A8F1B00_102001001A93FB00_2m_lsf_seg1_bitmask.tif',
29: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV01_20190818_102001008EBDEE00_102001008B650400_2m_lsf_seg1_dem.tif',
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4: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV01_20160926_102001005377FC00_10200100569CB700_2m_lsf_seg1_bitmask.tif',
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17: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV02_20191026_103001009C22C400_103001009CC8F200_2m_lsf_seg1_dem.tif',
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8: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV01_20170612_10200100618B7200_10200100612AED00_2m_lsf_seg1_bitmask.tif',
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13: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV02_20170729_103001006EAACB00_103001006D208B00_2m_lsf_seg1_dem.tif',
10: '/vsis3/pgc-opendata-dems/arcticdem/strips/s2s041/2m/n65w047/SETSM_s2s041_WV02_20170724_103001006D472600_103001006E241A00_2m_lsf_seg2_bitmask.tif',
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```
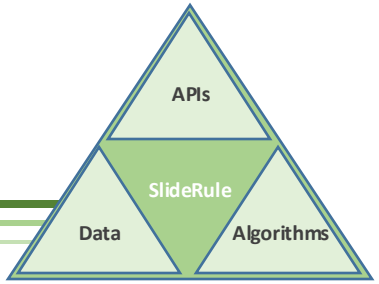

[5]:
```
gdf
```

[5]:

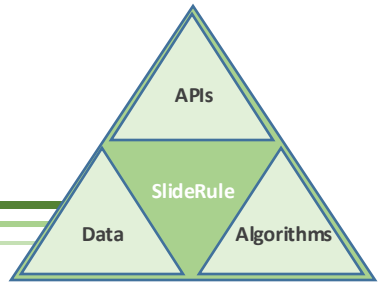
le	n_fit_photons	h_sigma	rgt	region	h_mean	y_atc	rms_misfit	dh_fit_dx	pflags	w_surface_window_final	x_atc	geometry	strips.time	strips.flags	strips.file_id	strips.value
1	11	0.109261	658	3	2275.533651	-1364.037598	0.107745	-0.012619	0	3.0	7303654.0	POINT (-46.65997 65.51029)	[1017414743.0, 1126629403.0, 1158946234.0, 117...	[0, 4, 0, 0, 0, 4, 0, 0, 0, 0]	[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21]	[2277.453125, 2272.9453125, 2271.671875, 2274....
1	227	0.008063	658	3	2263.052227	1790.479004	0.121384	-0.000610	0	3.0	7302232.5	POINT (-46.72430 65.49448)	[1017414743.0, 1126629403.0, 1158946234.0, 118...	[0, 4, 0, 4, 0, 0, 4, 0, 0, 0]	[1, 3, 5, 9, 29, 27, 11, 13, 17, 19, 21]	[2265.4140625, 2260.1484375, 2259.328125, 2264...
1	12	0.052065	658	3	2272.956743	-1362.035522	0.090217	-0.008033	0	3.0	7304855.0	POINT (-46.66288 65.52099)	[1017414743.0, 1126629403.0, 1158946234.0, 117...	[0, 4, 0, 0, 0, 4, 0, 0, 0, 0]	[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21]	[2275.21875, 2269.796875, 2269.0703125, 2271.6...
1	81	0.018742	658	3	2262.851026	1790.565308	0.129675	-0.000366	0	3.0	7302352.5	POINT (-46.72457 65.49547)	[1017414743.0, 1126629403.0, 1158946234.0, 118...	[0, 4, 0, 4, 0, 0, 4, 0, 0, 0]	[1, 3, 5, 9, 29, 27, 11, 13, 17, 19, 21]	[2265.21875, 2260.3125, 2258.9453125, 2264.015...
1	63	0.018720	658	3	2272.678267	-1361.838745	0.148493	0.000223	0	3.0	7304975.0	POINT (-46.66318 65.52206)	[1017414743.0, 1126629403.0, 1158946234.0, 117...	[0, 4, 0, 0, 0, 4, 0, 0, 0, 0]	[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21]	[2274.5546875, 2269.8359375, 2268.7578125, 227...

An ancillary data and geoparquet example



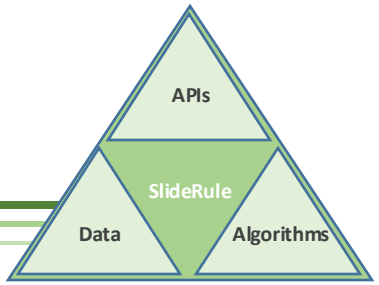

```
# Initialize SlideRule
icesat2.init("slideruleearth.io", verbose=True, loglevel=logging.INFO, organization='utexas', desired_nodes=20, time_to_live=60)

# SlideRule ATL08/PhoREAL Parameters
parms = {
    "t0": f'2023-01-01T00:00:00Z',
    "t1": f'2023-12-31T00:00:00Z',
    "poly": sliderule.toregion(geometry)["poly"]
    "srt": icesat2.SRT_LAND,
    "len": 30,
    "res": 30,
    "pass_invalid": True,
    "atl08_class": ["atl08_ground", "atl08_canopy", "atl08_top_of_canopy"],
    "atl08_fields": ["sigma_topo","segment_landcover","canopy/segment_cover"],
    "phoreal": {"binsize": 1.0, "geoloc": "center", "above_classifier": True, "use_abs_h": False, "send_waveform": False},
    "output": {
        "asset": "sliderule-stage",
        "path": 'boreal_2023_tile'
        "format": "parquet",
        "as_geo": True,
        "ancillary": ["sigma_topo","segment_landcover","segment_cover",],
        "open_on_complete": False
    }
}

# Make ATL08/PhoREAL Request
atl08 = icesat2.atl08p(parms, keep_id=True)
```

Datasets supported by SlideRule



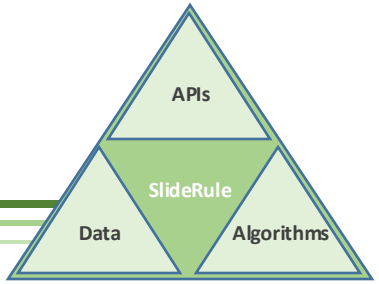
Product	Description
icesat2-atl03	Global Geolocated Photon Data
icesat2-atl06	Land Ice Height
icesat2-atl08	Land and Vegetation Height
icesat2-atl09	Calibrated Backscatter Profiles and Atmospheric Layer Characteristics
icesat2-atl13	Inland Water Surface Height
icesat2-atl24	Coastal and Nearshore Bathymetry
gedil4a	Footprint Level Above Ground Biomass Density
gedil4b	Gridded Above Ground Biomass Density
gedil3-elevation [-stddev]	Land Surface Metrics – Land Elevation
gedil3-canopy [-stddev]	Land Surface Metrics – Canopy Elevation
gedil3-counts	Valid Laser Footprints per Grid Cell
gedil2a	Geolocated Elevation and Height Metrics
gedil1b	Geolocated Waveforms

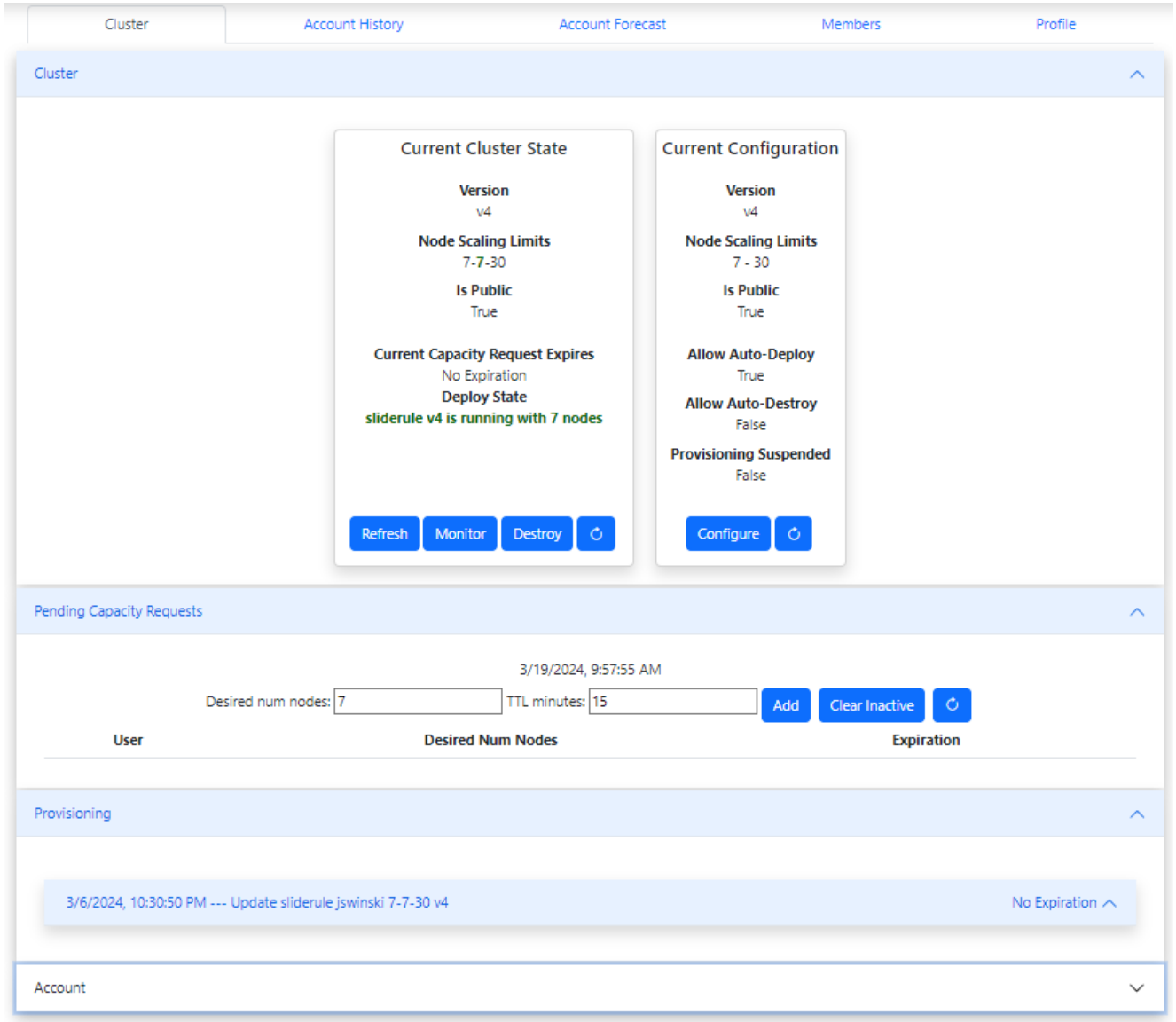
Datasets supported by SlideRule (cont.)



Product	Description
merit-dem	Multi-Error-Removed Improved-Terrain DEM
swot-sim	Simulated (pre-launch) SWOT data
usgs3dep-1meter-dem	USGS 3D Elevation Program 1m DEM
esa-worldcover-10meter	Global Landcover Map
meta-globalcanopy-1meter	Global Canopy Height Map
gebco-bathy	General Bathymetric Chart of the Oceans
bluetopo-bathy	Curated Collection of High-Resolution Seafloor Models for U.S.
landsat-hls	Harmonized Landsat Sentinel-2
arcticdem-mosaic	Arctic Digital Surface Model (mosaic)
arcticdem-strips	Arctic Digital Surface Model (source strips)
rema-mosaic	Reference Elevation Model of Antarctica (mosaic)
rema-strips	Reference Elevation Model of Antarctica (source strips)
viirsj1-s3	8-day Average Global Turbidity

Using a private SlideRule cluster





- Control provisioning and size of cluster from your Python script
- Authenticated access
- Auto-tear-down to save costs
- Multiple users of a private cluster can stack capacity requests
- View historical costs and future forecasts

SlideRule Web Client Pre-Release Demo