Enabling a new era of science on the cloud (NASA ROSES 80NSSC21K0564 Award # 20-TWSC20-2-0003)
Annual Progress Report: Year 3 of 3; co-leads Julia Lowndes and Erin Robinson
The following is the third annual progress report for Openscapes. This report covers the period from December 8, 2022 through December 20, 2023 (today's date). This represents most of Year 3 of this grant.

This project supports scientists using data from NASA Earthdata served from the Distributed Active Archive Centers (DAACs) as they migrate workflows to the cloud. Priorities throughout are promoting Open Science through skill development and role-modeling, and diversity, equity, and inclusion as part of daily work.

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Years 1-3 Summary: Project Impact

NASA Openscapes is a multi-year effort to grow a cross-DAAC Mentor community supporting Open NASA Earth Science in the Cloud. Looking back from where we started in February 2020: we have changed the way NASA teaches Cloud. There is now a way to teach Cloud, and we have built and supported a growing community of learner-oriented empathetic teachers from across 11 DAACs. These "NASA Openscapes Mentors" practice open science daily to create a common set of tutorials, organize and lead virtual, hybrid, and in-person workshops, and have a feedback & review process for tutorial creation and teaching. The successes and momentum of NASA Openscapes is due to the Mentors having **paid time as part of their jobs** to collaborate and learn together. NASA Openscapes work is not extra: it is the "how" to do the work aligned with DAAC and broader NASA goals. We are appreciative of DAAC Managers and NASA leadership for supporting Mentors' time.

In Year 3, we have focused on "operational hardening" to formalize processes, move toward sustainability, communicate impact, and engage more expansively with the broader open community. We report on this as a new first section, adding to the sections included in Year 1&2 Annual Reports. 2023 is the Year of Open Science, and we have continued to be active members of the global open science community, amplifying NASA work and connecting with and amplifying collaborator efforts. Throughout this project, we have not only used technology, but we've collaborated with technology builders to improve the user/learner experience for these technologies for Open science and Cloud. This includes 2i2c and Jupyter, Quarto from Posit/RStudio; OPeNDAP, MATLAB from Mathworks, the R community, Coiled, as well as connected communities across NASA Earthdata, NOAA Fisheries, EPA, Black in Marine Science (BIMS), Black Women in Ecology, Evolution, and Marine Science (BWEEMS), Fred Hutch Cancer Center, RLadies, and beyond.

We approach this work as movement building. We developed the Openscapes Flywheel, an open source tool – we reach for this tool for planning, progress, and impact tracking as we would reach for R and Quarto for data analysis and documentation. We developed it with NASA Earth science Mentors, using the concept where transformations occur from consistently doing key activities that add up over time (Collins). The

Flywheel supports teams across NASA DAACs to to grow morale and technical capacity across their organizations by (1) Engage bright spots, through welcoming them and creating space and place; (2) Empower a learning culture through investing in learning and trust and working openly (3) Amplify Open science leaders, through leveraging the common and inspiring the bigger movement (Robinson & Lowndes 2022).

Through this work, some highlights of impact to date:
(1 Engage): 11 DAACs participating (NSIDC, PO.DAAC, LP DAAC, GES DISC, ASDC, ASF, ORNL, SEDAC, GHRC, OB.DAAC, LAADS) (and we will join the 12th CDDIS's first User Working Group in January 2024); have a JupyterHub and Notebook-Quarto-GitHub workflow for documentation and publishing; have co-created a consistent set of tutorials, teaching style, and mindset; co-led the 2021 Cloud Hackathon and 2022+2023 Champions programs; have documented our work through the Flywheel publication and Approach Guide; and have given many "imagine what's possible" talks & keynotes about NASA Openscapes work – including the global announcement of Quarto and a talk on Documenting Things that describes 3 approaches to onboarding NASA Mentors.
(2 Empower): Mentors have led 10+ workshops internally with DAAC staff and externally with researchers; developed the Earthdata Cloud Cookbook; Reused tutorials, slides, graphics and facilitation and open practices; were more aware cross-DAAC, less recreating; from user feedback developed Cheatsheets and the earthaccess python library; wrote the Value of Hosted JupyterHubs (White paper RFI); Collaborating on Hackweeks, developed a 2i2c access policy and onboard/offboard approach; and also started meeting regularly with Openscapes Mentors from NASA, EPA, Fred Hutch, and Pathways to Open Science, connecting about challenges and opportunities beyond NASA – we developed coaching skills that make us better open data science mentors and co-authored a preprint called Shifting institutional culture to develop climate solutions with Open Science that is now in peer-review. We now support R and MATLAB users in 2 ways (as we do python users): Python, R, and MATLAB part of the 2i2c JupyterHub (via corn environment); and we teach how to work in these languages: partnering with Mathworks and Carl Boettiger, who have created `earthaccess` equivalent approaches and identifying needs for dev and teaching to support.
(3 Amplify): Mentors are amplifying across-DAACs and beyond: Career advancement & bringing mindset to new places; Speaking up in other meetings (User Needs TIM, TRAIN, Cloud Playground conversations); Connecting & consulting based on experiences - Pathfinder for 2i2c, comparing w/ SMCE; AWS; Engaging beyond (Pangeo Forge, Ladies of Landsat, pyOpenSci).

From one Mentor, Cassandra Nickles (PO.DAAC):

> Openscapes has created a collaborative environment for DAAC staff to collectively support open science initiatives for NASA Earthdata users. It enables us to work more openly with other DAACs toward our common goal of making the Earthdata ecosystem more accessible and inclusive. We've developed awesome material to help Earthdata users such as workflow cheatsheets, a python package (earthaccess), and data recipes hosted in the cross-DAAC NASA Earthdata Cloud Cookbook. Perhaps just as important as what we've done however, are mindsets we've grown

into along the way. It's okay to share imperfect works in progress. The virtual environment can be conducive to laughter and connection. Ideas are not too big or too small to share. **We are better at dreaming and implementing the future together.**

Year 3 Summary

The overarching vision of our project is to support scientific researcher teams using NASA EOSDIS data as they migrate their workflows to the cloud. We are doing this working with NASA Distributed Active Archive Centers (DAACs) over three years by:

1. Developing a cross-DAAC Mentor community
2. Empowering science teams through the Champions program
3. Scaling the Champions program with DAAC Mentors

In Year 3 we maintained and grew existing activities, and started new activities listed first. New activities are listed in a new section "Operational hardening", as well as listed first in each section following.

The Mentors are truly recognized leaders: One example of this showing up was Aaron Friesz (LP DAAC) saying that in previous years at ESIP meetings he showed up, presented about LP, and that was that. This year, he was recognized as a cloud expert, an open science expert, and a collaborator: he knew so many people at the meeting already but made new connections of people interested in talking and hearing his ideas.

DAAC Mentors were more-than-busy with leading workshops, giving invited presentations, and developing new software and conceptual support from what they learned working directly with users. Several things that emerged as priorities this year that we continue to support, listed in the Operational Hardening section that follows.

Amy Steiker (NSIDC)'s summary

Amy Steiker provided this summary to NSIDC leadership for 2023. It lists all the NSIDC priorities and work that Amy Steiker, Andy Barrett, Luis Lopez, and Matt Fisher have accomplished, supported by being part of the NASA Openscapes community.

1) Live Tutorial Event support and new Jupyter notebook tutorials

- NASA/USFS Joint Applications workshop: ICESat-2 Discovery, Access, and Services to Address Land Monitoring Needs
- NASA Earthdata Webinar: Demystifying the cloud: Simple workflows for accessing nsidc daac data in the cloud (we also updated our tutorial on cloud data access for this webinar: https://github.com/nsidc/NSIDC-Data-Tutorials/blob/main/notebooks/ICESat-2_Cloud_Access/ATL06-direct-access_rendered.ipynb)
- ICESat-2 Hackweek: Andy developed and contributed to several tutorials on cloud data access: https://icesat-2-2023.hackweek.io/tutorials/data-access-and-format/index.html

- ICESat-2 Science Team Meeting workshop: Andy presented similar tutorials to the ones we developed for the UWG meeting, available in the CryoCloud book: https://book.cryointhecloud.com/external/ICESAT2_ATL10-h5coro_large_scale_time_series.html . The image below is a nice one that you could use, which is the final plot we produced, demonstrating a year's worth of ATL10 Sea Ice Freeboard height data gridded over the Ross Sea, Antarctica (taken from over 16 million points using h5coro direct access!).

2. Openscapes mentor engagement

- We participated as mentors in the Science Champions program this past spring. This is a great blog post that highlights our involvement: https://openscapes.org/blog/2023-08-01-nasa-champions/. I'll copy two blurbs:
    - Amy Steiker from NSIDC designed and led the Earthdata Cloud Clinic! This was a hands-on 1-hour clinic that allowed teams to get familiar with the 2i2c JupyterHub, and practice finding and accessing NASA Earthdata via direct access through two methods from a Jupyter Notebook: earthaccess and Harmony-py services. This material can be found in the cookbook here -> https://nasa-openscapes.github.io/earthdata-cloud-cookbook/examples/Earthdata-cloud-clinic.html
    - Understanding 'When to Cloud.' The Cloud makes some things easier and some things harder. Over the series of five synchronous cohort calls, we considered when Cloud is effective and when the download model may still be more appropriate. Andy Barrett highlighted some considerations in Call 2 on Data Strategies for Future Us. Slides: https://nsidc.github.io/data_strategies_for_future_us/data_strategies_slides#/when-to-cloud
- NASA Openscapes Earthdata cookbook contributions including new organization/structure and a new tutorial on how to subset data using Harmony: https://nasa-openscapes.github.io/earthdata-cloud-cookbook/

3. earthaccess development

- We have released several new versions over the past year, including features such as enhanced documentation, DOI-based collection search, and improved AWS credential handling.
- We have a growing community of maintainers and contributors outside of NSIDC, demonstrating our open science and open source software practices. We are continuing to work on a more formal community development model and roadmap to ensure we sustain and further grow this community.

4. Cloud Optimized Format Investigation and prototyping (COFI) project

- Andy's slides from the UWG are great to use here but I'll copy some notes:
    - The goal is to prototype cloud optimized ICESat-2 data based on science value to fully realize the benefits of storing data in the cloud.
    - We surveyed ICESat-2 and CryoCloud users to understand existing and desired data access patterns and cloud optimized format usage.
- Of note, we utilized the ICESat-2 Hackweek to work alongside our science community to benchmark various cloud optimized format options for ATL03 data (another notable open science story for our DAAC). The picture of the full team, including folks from other DAACs, DevSeed, and other universities, is below:

5. And finally, another open science / open source software - related activity is our team's push towards moving our project management processes to GitHub:

- Moving towards the implementation of GitHub project management for our Data Use and Education Team in order to improve team processes as well as support community development and open science. Our goal is for all of our work and Issue tracking to reside in GitHub, beyond our existing tutorials repo.

Operational hardening

Moving Toward Sustainability

As demonstrated leaders, Mentors articulated what has been so valuable about the NASA Openscapes community, needs, and ideas for sustainability. They did this in part through an in-person Mentors Retreat Workshop in July ahead of the summer ESIP conference. From the Retreat Summary Slides that Mentors presented to ESDS and NASA HQ Leadership in September:

What makes the NASA Openscapes Community Work for DAAC Staff Mentors

Shared Mission

- Collectively, agreed on the goal to move users to the Cloud.
- Built on existing efforts
- Trust from DAAC Leadership to invest in this approach
- Co-designed to tailor community to meet needs of the Mentors

Open, Growth Mindset (AKA Openscapes Mindset)

- We don't know, but we will figure it out together
- Erin/Julie facilitate these conversations and connections.
- Being able to reach out to probe and poke and explore.

All of this together: Helps us explore, build, be so productive together.

Space, Place and Technology (a third place) - a place to learn and explore and develop and teach; "a comfort working with each other", "latitude to work on things where we see the need."

- From Google Docs to 2i2c JupyterHub to the NASA-openscapes Github org.
- Seeing these evolving to Cloud Playground: Earthdata Cloud Cookbook & Github workflows is one piece of this group's efforts that we want to keep building on/integrate into Cloud Playground.

We also have been moving away from thinking of ourselves as a "Cohort" and **towards a NASA Openscapes "Community"** to be more welcoming and grow.

Communicating Impact & Metrics

We are using the Openscapes Flywheel to communicate impact. Following our preprint (Robinson & Lowndes 2022) we developed slides to share impact in March 2023 for ESDSWG and also presented this at an invited talk at the Women In Data Science Conference at Stanford University, at the AGU Fall Meeting, and elsewhere.

We then started using the Flywheel to Monthly update slides to NASA leadership at ESDS and Headquarters. We create one slide per month, and this fall started including screenshots of AWS cloud costs and usage.

In Fall 2023, in collaboration with SGCI and Nancy Maron, we brainstormed metrics and measuring impact with a small team including Erin Robinson, Julie Lowndes, Luiz Lopez, Ileana Fenwick, and Eli Holmes. This will result in a survey and also helped us prepare for and submit an Openscapes submission to the The White House Office of Science & Technology Policy Open Science Recognition Challenge that recognizes open science stories to benefit society.

2i2c access policy

Erin Robinson has led efforts to analyze users in our 2i2c JupyterHub and developed **2i2c Access Policies for NASA Openscapes Users:** https://github.com/NASA-Openscapes/2i2cAccessPolicies

> A key objective of NASA Openscapes is to minimize "the time to science" for researchers. Cloud infrastructure can facilitate shortening this time. We use a 2i2c-managed JupyterHub, which lets us work in the cloud next to NASA Earthdata in AWS US-West-2. The purpose of the JupyterHub is to provide initial, exploratory experiences accessing NASA Earthdata in the cloud. It is not meant to be a long-term solution to support on-going work. For those users that decide working in the Cloud is advantageous and want to move there, we support a migration from the Hub to their own environment through Coiled.io.

Part of this work is about **understanding storage**: the fact that we still pay monthly storage for a user who created intermediate files when they ran a tutorial months ago. Erin has collaborated closely with Yuvi Panda from 2i2c/Jupyter to identify, quantify, and ultimately remove files (in a zip folder in case researchers need it later on). Erin Robinson has been in close collaboration with 2i2c/Jupyter's Yuvi Panda https://hackmd.io/tWfqVai4SDC1CbQ4mhflbw.

Erin has also focused on **assessing cost per day.** This is ongoing and has led to a deeper **understanding of costs** through the grafana interface https://grafana.openscapes.2i2c.cloud/.

User Needs - open communities collaborations

Mentors have been identifying and addressing User Needs together. They are empowered by connecting and collaborating with the broader Open science community.

When to Cloud

In 2023 Mentors began developing information about "**when to cloud**" as well as "how to cloud". This showed up in many places, including slides taught to the 2023 Champions Cohort: Data strategies for Future Us for Cloud, contributed by Andy Barrett, NASA National Snow and Ice Data Center (NSIDC).

Alexis Hunzinger and Chris Battisto (GES DISC) also led interactive posters at ESIP summer meeting and AGU fall meetings to capture challenges for cloud.

2i2c

Quarto from Posit/RStudio

Most of this work was in 2021 but we didn't fully articulate this collaboration. NASA Openscapes were the first external users of Quarto, a open-source scientific and technical publishing system. Collaborating closely with J.J. Allaire and his team, we helped influence the way that Quarto supports Python users via Jupyter Notebook execution. We use Quarto for our Earthdata Cloud Cookbook, as it makes beautiful e-books and websites. This has become the foundation for how DAAC Mentors bundle and present tutorial material for workshops. Other projects like VEDA use Quarto as well, and AGU is collaborating with Posit to support notebooks as part of the publishing process. At the 2022 RStudio/Posit conference, Lowndes keynoted the global launch of Quarto, with stories from NASA Openscapes.

OPeNDAP

This work was largely Mentor initiated and led by Chris Battisto (GES DISC) and Michele Thornton (ORNL), and the collaboration strengthened by Erin Robinson's long-standing collaborations with OPeNDAP. Chris had a poster at AGU about this work.

MATLAB from Mathworks

We now support MATLAB users in 2 ways; this work resulted from Erin Robinson's long-standing collaborations with Lisa Kemplar at Mathworks. (as we do Python and R users): Python, R, and MATLAB part of the 2i2c JupyterHub (via corn environment); and we teach how to work in these languages: partnering with Mathworks and Carl Boettiger, who have created `earthaccess` equivalent approaches and identifying needs for dev and teaching to support.

Through the NASA Openscapes Champions, an annual program that supports cohorts of science teams, a number of researchers expressed interest in using the data hosted on NASA Earthdata with MATLAB. The initial NASA Openscapes' JupyterHub platform hosted by 2i2c, and tutorials, were Python-based. However, to make this transition, users need to be able to use software tools that are familiar to them that enable access to the data and can process it. The NASA Openscapes team reached out to MathWorks, developers of MATLAB, to support the effort to integrate MATLAB into NASA Openscapes JupyterHub and tutorials. The goal was to enable direct Cloud data access from MATLAB.

Together, our two teams have successfully installed MATLAB on NASA Openscapes JupyterHub, visible in the screenshot below. It is now available for researchers participating in NASA Openscapes affiliated learning events to try out with Earthdata data. Researchers will "bring their own license" (BYOL) and will be prompted to input that information to access MATLAB.

Learn more: https://openscapes.org/blog/2023-10-17-matlab-on-openscapes/

R with Carl Boettinger (UC Berkeley)

The earthdatalogin R library that complements the python earthaccess library https://boettiger-lab.github.io/earthdatalogin.

> `earthdatalogin` seeks to streamline the process of accessing NASA data from the Earth Data cloud program *from anywhere*. Because Amazon Web Services (AWS) typically charges egress fees whenever network traffic leaves the data center which hosts it, NASA has restricted access to its data hosted by Amazon to only be accessible from AWS servers running in the same data center (`us-west-2`) when using the S3 access protocol. However, NASA also makes this cloud data available publicly to any machine using a standard HTTPS connection. Both cases require requesting and managing credentials tied to a registered user name. This package merely makes that process easier.

This work resulted from a conversation between Bri Lind (LP DAAC) and Carl Boettiger at the Ecological Society of America Conference in Portland Oregon in Summer 2023, and strengthened by Julie Lowndes' long-time ties with rOpenSci, of which Carl is a co-founder. Carl Boettiger (UC Berkeley and R community lead) joined our regular coworking that we specifically named as R Hackdays: https://github.com/NASA-Openscapes/earthdata-cloud-cookbook/discussions/247. He was soon joined by Eli Holmes (NOAA Fisheries) as a tester, power user, and co-developer, working closely with Luis Lopez (NASA Openscapes Mentor from NSIDC) and Yuvi Panda (2i2c and Jupyter).

The work and conversations are ongoing, for example:
https://github.com/NASA-Openscapes/py-rocket/issues/2

Coiled

This work resulted from a conversation between Luis Lopez (NSIDC) and Matt Rocklin at JuypterCon in France in Summer 2023. Our collaboration with Coiled includes engineering support – that has been really important to help Mentors and Champions leverage the power of parallel computing via Dask – in addition to the software itself. One story is that Aronne Merrelli (2023 Champion) started working in our 2i2c JupyterHub, then transitioned to Coiled with the Coiled team's help. After working there and learning how to make the best use of it, he was able to transfer out of the NASA Openscapes account and into his own account, and attach his university credit card. This is one strong examples of "where do researchers go when they leave the NASA Openscapes JupyterHub?

Stories about parallelizing code, cost and other details, and screenshots are included in these 3 blog posts.

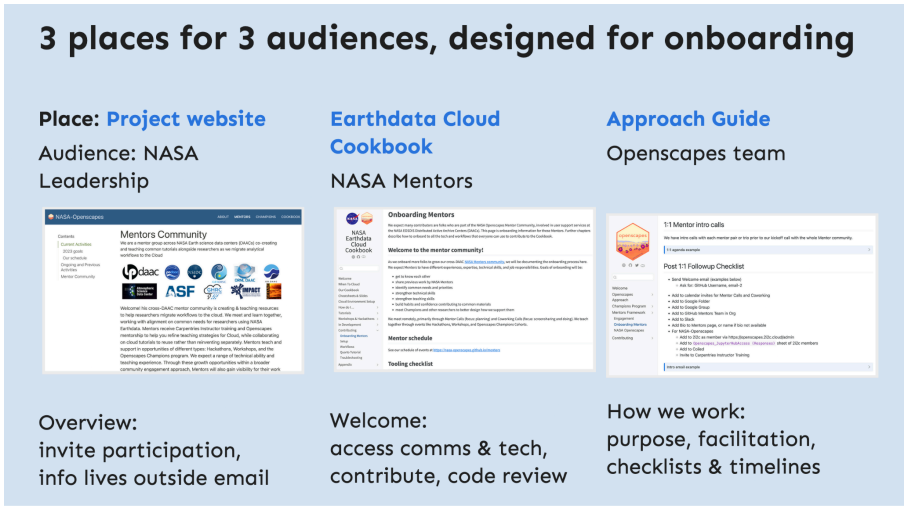
https://nasa-openscapes.github.io/news/2023-12-08-coiled-community-call/
https://nasa-openscapes.github.io/news/2023-11-07-coiled-openscapes/
https://nasa-openscapes.github.io/news/2023-10-13-nasa-jupyterhub-coiled/

Onboarding Mentors

We formalized our approach to onboarding Mentors, at the same time we onboarded an Openscapes team member (Stefanie Butland) to further support Mentors.

We have documented our approach to onboarding mentors: 3 places we have for for 3 audiences, designed for onboarding. We shared this in **Documenting things: openly for future us**, a talk at the Posit conference in Chicago in September 2023.
Slides: https://openscapes.github.io/documenting-things
Blog post: https://openscapes.org/blog/2023-09-27-documenting-things-posit-conf

1. Place: Project website; Audience: NASA Leadership. Purpose: Project Overview to invite participation, have a system so that info lives outside email.
2. Place: Earthdata Cloud Cookbook; Audience: NASA Mentors. Purpose: Welcome Mentors, describe access communications channels & technologies, how to contribute, code review.
3. Place: Approach Guide; Audience: Openscapes team. Purpose: How we work beyond NASA: purpose, facilitation, checklists & timelines.



Project website

We've updated the language and posted the schedule and activities: https://nasa-openscapes.github.io/mentors.html

Cookbook

We further improved and formalized our process for onboarding Mentors in a new section in our Approach Guide: https://nasa-openscapes.github.io/earthdata-cloud-cookbook/contributing/onboarding.html

Approach Guide

We further improved and formalized our process for onboarding Mentors with a new section in our Approach Guide so that it can be repeated for other groups, like NOAA Fisheries Openscapes https://openscapes.github.io/approach-guide/mentors-framework

Maintain and grow DAAC Mentors program

We are supporting and strengthening the community of DAAC folks that are already creating cloud learning resources, having formalized this as a community in Year 1. We designed the program with active engagement with NASA communities and using open source software for all communication.

ESDSWG engagement

In Year 3, we attended ESDSWG in person in Baltimore and co-presented a talk with Justin Rice, Deputy Director, NASA Earth Science Data and Information System (ESDIS), who introduced NASA Openscapes saying "The impact that Openscapes has had in last 2 years is unprecedented at NASA". (Of course, this builds from decades of community building by Erin Robinson and Julie Lowndes in Earth science, data repositories, researchers, and R communities, and the collaborative work of open science).

Slides: Communicating impact: NASA Openscapes - March 22 2023, Julie Lowndes, Erin Robinson, & Justin Rice. NASA ESDSWG Meeting, Baltimore Maryland

As in Year 1 & 2 this Year 3 talk shared about the momentum and accomplishments of NASA Openscapes. Working with Justin Rice, we thanked DAAC Managers for supporting the current Mentors so far and asked to nominate members of their team to give paid time to join the NASA Openscapes DAAC Mentors program.

Nominations, selection, onboarding

Our Year 1 Cohort included Mentors from 5 DAACs: PO.DAAC, NSIDC, ASDC, LP DAAC, GES DISC, as well as IMPACT and JPL. In Year 2, ORNL and ASF pairs and trios joined the Cohort, including additional Mentors from LP DAAC, PO.DAAC, and GES DISC. In Year 3, we're joined as well by OB.DAAC, SEDAC, GHRC, LAADS.

We held 1:1 intro calls to meet the nominees and describe more about the program. We accepted all teams, and onboarded the new DAAC Mentors in Fall. Cohort Calls, as described more below, created space for Mentors across DAACs to start building relationships and seeing the common parts of their work.

Participating mentors

As we switch more to a Mentor community from a Mentor cohort, this list is not fully representative of the people contributing to NASA Openscapes. However, these are the Mentors that have been part of NASA Openscapes with that we have been onboarding and are supported by their DAAC Managers with paid time as part of their jobs, as Openscapes aligns with their work.
List as of December 2023. (* indicates part of Year 1 Cohort)

- Andy Barrett*
- Chris Battisto
- Brandon Bottomley
- Ian Carroll
- Matt Fisher
- Aaron Friesz*
- Alexis Hunzinger*
- Mahsa Jami
- Daniel Kaufman
- Alexander Lewandowski
- Bri Lind
- Luis Lopez*
- Catalina Oaida Taglialatela*
- Celia Ou
- Kytt MacManus
- Juan Martinez
- Victoria McDonald
- Jack McNelis*
- Cassie Nickles
- Brianna Pagán

- Navaneeth Selvaraj
- Rupesh Shrestha
- Sargent Shriver
- Geoffrey Stano
- Amy Steiker*
- Lucas Sterzinger
- Nikki Tebaldi
- Michele Thornton
- Makhan Virdi*
- Guoqing Wang
- Jess Welch

Maintain GitHub Organization: NASA-Openscapes

We maintain the GitHub Organization where Mentors continue to collaborate. It is a shared neutral space (i.e. not within any specific DAAC) and acts as a sandbox for us all to try things out, test things, and develop together. As described more below, we held GitHub clinics, co-working sessions, and 1:1 screensharing help as needed to help everyone learn and share together so that all Mentors became confident GitHub users and confident collaborating and sharing imperfect work with each other.

GitHub Org: https://github.com/nasa-openscapes

Maintain NASA-Openscapes website

Website: https://nasa-openscapes.github.io/

This website includes activities and presentations by the Mentors and makes the Earthdata Cloud Cookbook more prominent from the menu. We also added a News tab, and cross-post NASA Openscapes posts here (they are first posted at openscapes.org).

Presentations: https://nasa-openscapes.github.io/about.html#slides
Blog posts: a selection from 2023:

- Exciting Progress for Research Teams using NASA Earthdata in the Cloud: 2023 NASA Openscapes Champions Wrap-up
    - https://nasa-openscapes.github.io/news/2023-08-01-nasa-champions/
- How coaching skills have made us better open data science mentors
    - https://nasa-openscapes.github.io/news/2023-05-17-mentor-coach/
- Openscapes Community Call: NASA Earthdata Cloud with Coiled
    - https://nasa-openscapes.github.io/news/2023-12-08-coiled-community-call/
- MATLAB on Openscapes
    - https://nasa-openscapes.github.io/news/2023-10-17-matlab-on-openscapes/

Maintain collaborative Cloud infrastructure

We maintain accounts and manage users in collaborative Cloud infrastructure, partnering with 2i2c for all 3 years and now Coiled in Year 3.

JupyterHub 2i2c

We maintain the Openscapes JupyterHub created in 2021 partnering with 2i2c that is available to DAAC Mentors, Hackathon and AGU Workshop participants. Mentors have said this has been critical to support researchers migration to the cloud - without this hands-on experience it is very difficult to advise. To extend the utility of this "proving ground", we've made it available to other DAAC staff.

As of December 2023 there are 567 users in our JupyterHub.

JupyterHub: https://openscapes.2i2c.cloud/hub/

Coiled

As of December 21 2023, there are 30 users in our nasa-openscapes Coiled space.

Open science & DEI summary

The design of the NASA Openscapes Framework builds on Openscapes' investment in increasing diversity, equity, and inclusion in all activities and facilitation style to create spaces that are psychologically safe for folks to learn together and share imperfect work. For new examples in 2023, see:

- Training for culture change in Open Science - June 18, 2023. Julie Lowndes & Erin Robinson, Down To Earth: A podcast for Geoscientists by Geoscientist (30 minutes)
- Openscapes: Supporting kinder science for future us - Oct 17, 2023. Ileana Fenwick & Julia Lowndes. USEPA R Users Group Workshop (45 minutes)

There is diversity in the Mentors cohort across gender, race, job title, technical level.

Support DAAC Mentors with emerging needs

All activities begin with a summary of our Code of Conduct: openscapes.org/code-of-conduct/.

Openscapes Mentorship: Cohort Calls, Clinics and Co-working

Supporting the DAAC Mentors means creating space (time) and place (through collaborative software) to build trust and find the common, and welcoming new Mentors to this community. We continue to hold twice-monthly regular meetings and coworking sessions on Zoom, have standing Google Docs and Slack for asynchronous communication and so folks stay connected and up-to-date whether or not they are able to attend meetings. All calls conclude with Efficiency and Inclusion Tips.

Through a GitHub Clinic and co-working sessions, we skillshared and learned how to use GitHub collaboratively with branches, pull requests, and are beginning to formalize using it for code review.

Maintain & update Earthdata Cloud Cookbook

Earthdata Cloud Cookbook: https://nasa-openscapes.github.io/earthdata-cloud-cookbook

We continued developing and supporting the a tutorial book architecture using Quarto, which combines Jupyter Notebooks into beautiful online books that can be easily shared, navigated, and used by learners of all skill levels (i.e. it is a friendlier experience than notebooks in a GitHub repository).

In 2023, in part via **4 Hackdays** we are iterating and improving on our original cookbook structure, incorporating current technical approaches and what we've learned teaching NASA colleagues and Earth science researchers. We will increasingly track our tasks and progress using issues in this repository. We are having ongoing virtual Hackdays (ongoing notes and spreadsheet) to focus progress together. https://github.com/NASA-Openscapes/earthdata-cloud-cookbook#hackdays.

Support DAAC Internal trainings

As Mentors led DAAC internal trainings, for example at GES DISC, they reused materials and workflows co-developed by the Mentors and iterated since the 2021 Cloud Hackathon. Support involved creating and managing the Quarto book, helping establish norms around scope and style (including live-coding) coordinating tutorial reviews and reviewing tutorials, dry runs for each teacher to practice live-coding and get feedback.

Support External trainings

External trainings for NASA Earthdata users - at least 5 events, including ECOSTRESS, SWOT, and User Working Groups, reused materials and workflows developed from the Hackathon. We develop tutorials for teaching events that each has its own e-book, using Quarto, and linked in the Cookbook. Tutorials are developed to teach open science and Cloud workflows for specific audiences. They are a snapshot in time as workflows with NASA Earthdata Cloud emerge and evolve. Some examples:

2023 Cloud Workshop at AGU

https://nasa-openscapes.github.io/2023-Cloud-Workshop-AGU

In this workshop, NASA Openscapes Mentors from NASA's Earth Observing System Data and Information System (EOSDIS) DAACs (data centers) will teach the foundations of an open science mindset and apply these concepts to work in the cloud with NASA Earthdata. Participants will take part in hands-on tutorials using a JupyterHub managed by 2i2c in AWS. Participants will leave with a better understanding of how to leverage data and services from NASA Earthdata Cloud within their work across a variety of disciplines and data types, as well as how to apply the concepts of open science as a daily practice. The workshop will encourage discussion and reflection on how Earth science is evolving. Tutorials will be taught in Python. The target audience is anyone interested in using NASA Earth Science data within the AWS cloud. Previous experience in the AWS cloud is not necessary. Experience using Python is recommended but not required.

2023 VITALS Workshop at AGU

https://nasa.github.io/VITALS

The International Space Station is a critical asset for the Earth science community – both for advancing critical science and applications priorities, and as a platform for technology demonstrations/pathfinders. These benefits have been particularly significant in recent years, with the installation and operation of instruments such as ECOSTRESS, a multispectral thermal instrument, and EMIT, a visible to short wave infrared imaging spectrometer with best-in-class signal to noise - both acquiring data at field-scale (<70-m). With both sensors mounted on the ISS, there is an unprecedented opportunity to demonstrate the compounded benefits of working with both datasets. In this workshop we highlight the power of these tools when used together, through the use of open source tools and services, cloud compute resources to effectively combine data from ECOSTRESS and EMIT to perform scientific analyses and apply data to real world issues.

This workshop is hosted by NASA Land Processes Distributed Activate Archive Center(LP DAAC) and NASA Jet Propulsion Laboratory (JPL) with support from the NASA Openscapes project.
Hands-on exercises will be executed from a Jupyter Hub on the Openscapes 2i2c cloud instance.

2023 GEDI / ICESat-2 Workshop

https://nasa-openscapes.github.io/2023-ssc/

The goal of this workshop, as part of the 2023 Space and Sustainability Colloquium, is to demonstrate how to find, access, and work with GEDI and ICESat-2 data from the Earthdata Cloud. Participants will learn how to search for and download data from NASA's Earthdata Search Client, a graphical user interface (GUI) for search, discovery, and download application for also EOSDIS data assets. Participants will learn how to perform in-cloud data search, access, and processing routines where no data download is required, and data analysis can take place next to the data in the cloud.

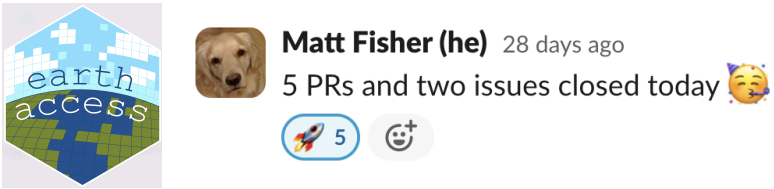
2023 EMIT Workshop

https://github.com/nasa/EMIT-Data-Resources

This workshop was designed to be completed locally, however it was offered to use the Openscapes 2i2c JupyterHub cloud workspace to revisit the EMIT Data Tutorials Workshops hosted February 3, 10, and 17th 2023. The Feb 17th event had 91 active users in large python instances in the 2i2c JupyterHub; Aaron Friesz, Bri Lind (LP DAAC) and Luis Lopez (NSIDC) worked ahead of time with 2i2c engineers to accommodate the increased CPU needs for this workshop.

Support earthaccess python library

Luis Lopez (NSIDC) has been maintaining and further developing the earthaccess python library. This is a software response to pain points identified by users and Mentors through all of this work. In 2023, in collaboration with Coiled, earthaccess can now work with parallelized code and Dask.
Matt Fisher (NSIDC) has also made substantial contributions to earthaccess:



Support Cheatsheets and Guides

We developed a workflow where each cheatsheet is its own Google Slide that can be embedded in multiple places, for example the Earthdata Cloud Cookbook and PO.DAAC's website. This way, any updates to the Cheatsheet (slide) will propagate to all these places with no extra maintenance. The Google Slides are organized internally and linked from the Cheatsheets page in the Cookbook.

Support manuscript: Shifting institutional culture to develop climate solutions with Open Science

Shifting institutional culture to develop climate solutions with Open Science
This was written in collaboration with Mentors from NASA Earthdata, NOAA Fisheries, EPA, Black in Marine Science (BIMS), Black Women in Ecology, Evolution, and Marine Science (BWEEMS), Fred Hutch Cancer Center, RLadies, and beyond. We think it is a huge deal. It was rejected at 4 parts of *Nature*, then *Science*, *PNAS*, and is now in peer review at *Ecology and Evolution*.

Abstract:

"To address our climate emergency, we must rapidly, radically reshape society. We need every solution and every solver". - Ayana Elizabeth Johnson & Katharine Wilkinson, *All We Can Save*

This call to action by Drs. Johnson and Wilkinson is part of a mosaic of voices sharing tangible progress within the climate movement [1,2]. This call speaks to us as environmental and Earth scientists motivated by the urgency of climate change and social inequity and who contribute to finding science-driven climate solutions as part of our daily jobs. Unfortunately, we are often unable to efficiently move this critical and urgent work forward because we are impeded by cumbersome daily workflows and restrictive workplace cultures. Our workplaces have not kept pace with the modern realities of data-intensive science: increasing data volumes and storage needs, rapidly-evolving technology, new skill requirements, and a growing need for extensive and diverse collaboration. Struggling with old approaches and learning new ones in isolation can fuel burnout and turnover, preventing us from working on science-driven climate solutions effectively.

We are making progress forward through Open Science, a movement that has grown through decades of grassroots efforts and over many organizational levels [3]. Open Science is "the principle and practice of making

research products and processes available to all, while respecting diverse cultures, maintaining security and privacy, and fostering collaborations, reproducibility, and equity" (https://open.science.gov), and the U.S. White House Office of Science and Technology Policy (OSTP) declared 2023 as a Year of Open Science with an action to "accelerate discovery and innovation"[4]. We are experiencing indispensable scientific benefits and positive culture shifts in our research workplaces by using Open Science to elevate our colleagues, build collaboration, and ultimately address climate change impacts.

Here, we share our best advice for connecting climate solutions and Open Science through our daily work. "Climate" need not be in our job titles or project descriptions for us to identify as part of climate solutions: all of our work must consider a changing climate. We work with people and ecosystems impacted by climate change, including managing fish species that are migrating due to changing ocean temperatures, and freshwater ecosystems impacted by fluctuating drought, flooding, and pollutants. We have found vast improvements to the quality and impact of our work and our teams' morale through a culture change that helps us identify as part of the Open Science and climate movements. Culture change will not happen without learning the unfamiliar and unlearning the familiar; yet, this process does not need to be an upheaval or started from scratch. It starts with holding intentional, respectful conversations and tapping into the knowledge base of our workplaces, and reusing what works in new places. Climate change solutions will require novel, multifaceted solutions that employ many nuanced skills and perspectives, which are best nurtured through trust and deliberate sharing of knowledge. We emphasize the need to prioritize peer learning as part of our jobs.

Support Mentors' presentations and posters

In Year 3, Mentors were increasingly invited to give presentations to share about their work and lessons learned. As Cloud migration has been moving fast and DAAC Mentors and user support has been responsive, presentations have proved to be a powerful way to communicate not only to the target audience, but to reuse and amplify. Many slides are reused and iterated across DAACs, including to support User Working Groups.

We have supported DAAC Mentors in shaping, creating, and reusing content between talks, as well as adding them to the NASA Openscapes website and Cookbook for broader reach.

The following talks are included as a full list at https://nasa-openscapes.github.io/about.html#slides.

- NASA Openscapes: Approaches and Stories of Kinder, Open Science in the Cloud - Julie Lowndes, Erin Robinson & NASA Openscapes Mentors. Dec 15, AGU Fall Meeting
- NASA Openscapes: Supporting NASA EarthData Users Transition to the Cloud - Nov 2 2023. Erin Robinson, GHRC User Working Group
- Cloud Environment Opportunities: Managed JupyterHub options for Cryosphere and Earthdata user communities - September 2023. Amy Steiker, Andrew Barrett, & Luis López, NSIDC User Working Group. (blog post)
- Documenting things: openly for Future Us - September 19, 2023. Julie Lowndes, Posit Conf.

- NASA Openscapes Mentors' Retreat 2023: Summary and Moving Toward Sustainability - September 18, 2023. Catalina Taglialatela et al, NASA HQ Meeting
- NASA Openscapes: Open communities and continued learning - August 11, 2023. ICESat-2 Hackweek
- Getting to Know Open Science: How to Engage and Flourish in the Growing Open Science Community - August 9, 2023. Bri Lind. NASA Hyperwall, Ecological Society of America 2023 Annual Meeting, Portland, Oregon.
- Training for culture change in Open Science - June 18, 2023. Julie Lowndes & Erin Robinson, Down To Earth: A podcast for Geoscientists by Geoscientist.
- Accessing data from NASA's DAACs & Earthdata - Spring 2023, Michele Thornton, USFS Applications workshop.
- NASA Openscapes: Movement building with the Flywheel - March 31, 2023, Erin Robinson & Julie Lowndes. NASA Open Source Science Working Group
- Communicating impact: NASA Openscapes - March 22 2023, Julie Lowndes, Erin Robinson, & Justin Rice. NASA ESDSWG Meeting, Baltimore Maryland
- 3 approaches for the year of open science - March 2023 Clatterbuck et al.: blog post from our ESIP session with colleagues from NASA, NOAA, California WaterBoards, UNC Chapel Hill
- Lessons from NASA Openscapes - February 2023 presentation to AWS Cloud team
- Working with NASA Earthdata in the Cloud - January 24, 2023 - Amy Steiker, Bri Lind, Julie Lowndes, Luis López, Michele Thornton, and the NASA Openscapes Mentors. ESIP Winter Meeting "Enabling Open Science with NASA's Earthdata in the Cloud" Session

Carpentries Instructor Training

Our Year 2 Carpentries Platinum Membership has 15 seats available for Instructor training.

Mentors take Carpentries Instructor Training to learn teaching pedagogy and see and practice live coding when teaching. Live coding means typing live at a pace where your learners can follow along with you, and is a deeper learning experience than only seeing a demo scroll that learners do not experience themselves.

Not all Mentors who have taken Instructor training have completed certification (7/26). We convened a cross-NASA Carpentries Subcommunity call to find other Carpentries activities at NASA, in collaboration with Elizabeth Joyner (NASA)
https://openscapes.org/blog/2023-12-07-engaging-with-a-cross-nasa-subcommunity/.

2022-02-09-ttt-online-MST	Ileana Fenwick <ileana.fenwick@gmail.com>	Instructor (all lesson programs) (Sept. 7, 2022)
2021-08-02-ttt-online-PDT	Chandana Gangodagamage <chhandana@gmail.com>	—
2021-06-21-ttt-online-PDT	Andrew Barrett <andrew.barrett@colorado.edu>	—
2021-06-21-ttt-online-PDT	Aaron Friesz <amfriesz@gmail.com>	—
2021-06-21-ttt-online-PDT	Christine Smit <christine.e.smit@nasa.gov>	—
2021-06-21-ttt-online-PDT	Matthew Tisdale <matthew.s.tisdale@nasa.gov>	—
2021-06-21-ttt-online-PDT	chelle Gentemann <cgentemann@faralloninstitute.org>	Instructor (all lesson programs) (Dec. 22, 2021)
2021-06-21-ttt-online-PDT	Jack McNelis <jmcnelis@jpl.nasa.gov>	—
2021-06-21-ttt-online-PDT	Catalina Oaida <catalina.oaida@jpl.nasa.gov>	—
2021-06-21-ttt-online-PDT	Vishal Bagadia <vishal.bagadia@gmail.com>	Instructor (all lesson programs) (Feb. 14, 2022)
2023-09-25-ttt-online-EDT	Sarah Johnson <sarah@coiled.io>	—
2023-09-25-ttt-online-EDT	Mackenzie Blanusa <mackenzie.blanusa@uconn.edu>	—
2023-08-15-ttt-online-EDT	Patrick Hoefler <patrick@coiled.io>	—
2023-08-09-ttt-online-PDT	Daniel Kaufman <daniel.kaufman@nasa.gov>	Instructor (all lesson programs) (Oct. 10, 2023)
2023-08-09-ttt-online-PDT	Ziheng Sun <zsun@gmu.edu>	—
2023-08-09-ttt-online-PDT	Julia Lowndes <lowndes@nceas.ucsb.edu>	Instructor (all lesson programs) (April 19, 2016)
2023-07-10-ttt-online-PDT	Erin Robinson <erin@metadatagamechangers.com>	Instructor (all lesson programs) (July 31, 2023)
2023-01-25-ttt-online-EST	Mahsa Jami <mjami@contractor.usgs.gov>	—
2022-12-19-ttt-online-MST	Cassandra Nickles <cassandra.l.nickles@jpl.nasa.gov>	—
2022-12-19-ttt-online-MST	Michele Thornton <thorntonmm@ornl.gov>	—
2022-12-19-ttt-online-MST	Brianna Lind <blind@contractor.usgs.gov>	—
2022-11-08-ttt-online-AEST	Jessica Nicole Welch <welchjn@ornl.gov>	Instructor (all lesson programs) (Dec. 7, 2022)
2023-11-01-ttt-online-EDT	Matt Fisher <matthew.j.fisher@colorado.edu>	—
2023-10-17-ttt-online-EDT	Juan Fernando Martinez <jmartine@ciesin.columbia.edu>	—
2023-10-17-ttt-online-EDT	Nikki Tebaldi <nicole.tebaldi@jpl.nasa.gov>	—
2023-10-17-ttt-online-EDT	Guoqing Wang <guoqing.wang@nasa.gov>	—

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Open science & DEI summary

All events (Mentor Cohort Calls and Hackathons) begin with a Code of Conduct. We work to normalize open, imperfect, reuse through building trust and psychological safety.

Lead the Champions Program

The Openscapes Champions Program is our flagship program and we adapted it to support research teams interested in migrating workflows to the Cloud, with support from the NASA Mentors. We led the second Cohort in Spring 2023.

Cloud migration can often have a steep learning curve and feel overwhelming. The NASA Openscapes Champions Cohort brings together **research teams** that are interested in migrating their existing NASA Earthdata workflows to the Cloud with **NASA DAAC Mentors** who are extremely knowledgeable about the data they serve and the initial pathways to using that data on the Cloud. This Cohort provides a common, welcoming place for teams to learn together, ask questions about using the Cloud, plan their transition, and do initial experimentation using the NASA Openscapes 2i2c JupyterHub. Because this is a more intensive experience, the teams build collaborative partnerships with DAAC mentors, and the mentors can more quickly identify and work on solving issues that will make Cloud migration easier for many more users.

The second NASA Openscapes Champions Cohort ran formally in April-June 2023 with seven research teams interested in a wide variety of NASA Earthdata and various stages of Cloud technology familiarity. You can learn more about their research in the blog post linked below.

Thanks to the NASA Openscapes Mentors for supporting the Champions and for their contributions to the curriculum! In particular, the NASA Openscapes Champions Curriculum had significant additions:

1. Andy Barrett from the National Snow and Ice Data Center (NSIDC) created a version of **Data Strategies for Future Us that is applicable to gridded, remotely sensed data**. Slides are here: https://nsidc.github.io/data_strategies_for_future_us/data_strategies_slides#/title-slide
2. Amy Steiker and Luis Lopez from NSIDC and Alexis Hunzinger from Goddard Earth Sciences Data and Information Services Center (GES DISC) refactored the **Coding Strategies for Future Us to be tailored to NASA Earthdata search**, **the earthaccess python library**, **and experiences** from teams at Goddard DAAC (GES DISC) that have learned to use the Cloud.
3. Amy Steiker from NSIDC designed and led the **Earthdata Cloud Clinic**! This was a hands-on 1-hour clinic that allowed teams to get familiar with the 2i2c JupyterHub, and practice finding and accessing NASA Earthdata via direct access through two methods from a Jupyter Notebook: earthaccess and Harmony-py services. This material can be found in the cookbook here -> https://nasa-openscapes.github.io/earthdata-cloud-cookbook/examples/Earthdata-cloud-clinic.html

Blog post: https://nasa-openscapes.github.io/news/2023-08-01-nasa-champions/
Announcement website: https://nasa-openscapes.github.io/champions
Cohort website: https://nasa-openscapes.github.io/2023-nasa-champions

Community Engagement within NASA and Beyond

Lowndes & Robinson gave fewer talks to NASA audiences in Year 3 as compared to Years 1&2, as NASA Openscapes Mentors were increasingly invited to give talks about their work directly. Below are our direct activities for community engagement; see the previous section for the Mentor talks we supported.

Our community engagement approach focuses on inspiring and attracting folks to join the open science movement, using original artwork, storytelling, and practical tips.
Full list of slides shared from our project are:

- https://nasa-openscapes.github.io/about.html#slides
- https://openscapes.org/media

Talks & Community Calls “Imagine what’s possible”

Openscapes: supporting kinder science for future us - March 8, 2023 - Julie Lowndes. Women in Data Science Conference, Stanford University (video) (15 minutes); (panel discussion)

Openscapes: supporting kinder science for future us - March 31, 2023 — Julie Lowndes, Ileana Fenwick. Univ. Toronto Mississauga Biology Seminar Series (45 minutes)

Openscapes Community Call: NASA Earthdata Cloud with Coiled - Our 9th Openscapes Community Call featured NASA Openscapes Mentors and the Coiled team demoing approaches to supporting researchers using NASA Earthdata in the Cloud. This built from a previous demo at the National Snow and Ice Data Center

User Working Group that presented different Cloud Environment Opportunities to meet users where they are (blog post).

Engaging with a Cross-NASA Subcommunity: Recap of a Carpentries Community Session with NASA and Openscapes.

How the Kyber R package connects Google Sheets, RMarkdown, GitHub, and Agenda docs for open education - Our 8th Openscapes Community Call featured a "celebrity interview" with Dr. Sean Kross. Sean is a Data Staff Scientist at the Fred Hutch Data Science Lab. His work includes understanding data science as a practice, and approach combines computational, statistical, ethnographic, and design-driven methods. Sean earned his PhD in Human-Computer Interaction at UC San Diego where he was advised by Philip Guo, and interned at Microsoft Research. Before grad school Sean was the Chief Technology Officer at the Johns Hopkins Data Science Lab. He is a frequent consultant for data analysis and software development projects, and a maintainer of several open source software projects. Sean was interviewed by Stefanie Butland, MSc, Openscapes Team member.

Reimagining open science as part of the climate movement - Our 7th Openscapes Community Call featured a "celebrity interview" with Monica Granados, PhD. Monica is the Open Climate Campaign Manager at Creative Commons and on the Leadership team of PREreview. She is an open science specialist and a trained ecologist. Monica was interviewed by Julie Lowndes, PhD, Openscapes Director. Watch the recording on Openscapes YouTube.

Social media

We transitioned to Mastodon from Twitter/X in early 2023. It has been slow to learn a new platform and develop community there, and we have also experimented with BlueSky and LinkedIn. Ultimately, Slack is where we engage the most, and Openscapes Slack has grown as a community for collaboration with the DAAC Mentors and collaborators.

Open science & DEI summary

With a priority of connecting NASA Openscapes with the global Open Science movement, here are a few ways we centered DEI in our work:

- co-presenting talks
- emphasizing coaching skills throughout Mentors' work (empathy, asking questions)
- amplifying psychological safety first

Appendix: Testimonials