A NASA OPEN-SOURCE SCIENCE MISSION:
TOPS: TRANSFORM TO OPEN SCIENCE

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Open Science: Accessible, Reproducible & Inclusive…

Creates research that is:

Cited more

Creates a bigger impact

Increases transparency

Generates more scholarly collaborations

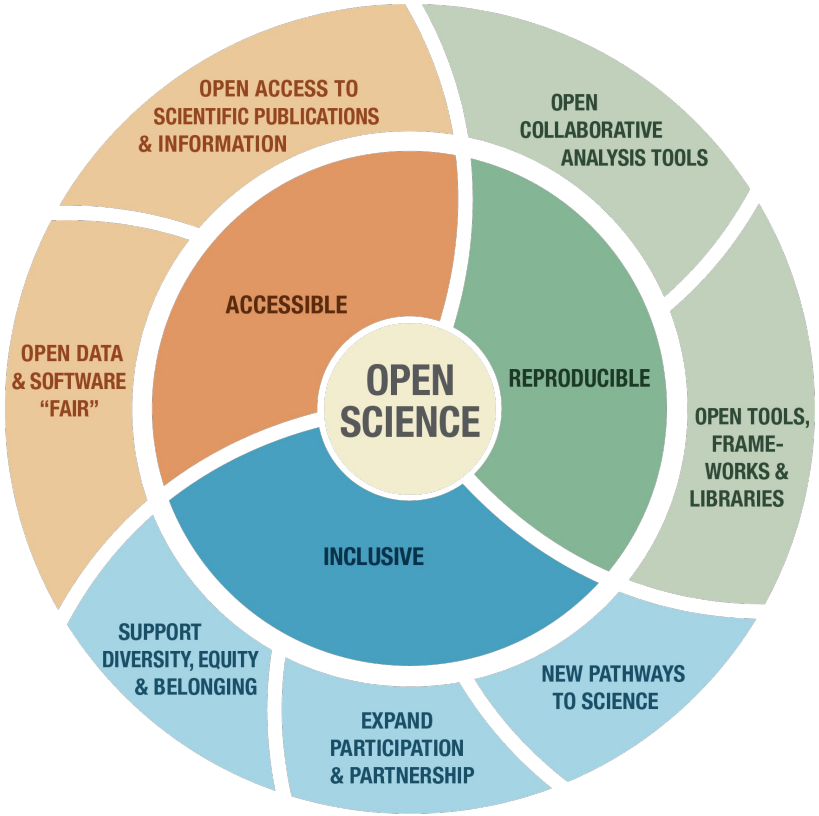
Inclusive science means more:

Collaborative projects

Access to ‘hidden knowledge’

Equitable Systems

Participation



Open-Source Science is NASA's method to put Open Science into practice.

- **Open** the entirety of the scientific process, ***from start to finish***
- **Broaden** community involvement in the scientific process
- **Increase** accessibility of data, software, & publications
- **Facilitate** inclusion, transparency, and reproducibility of science

Why Now?

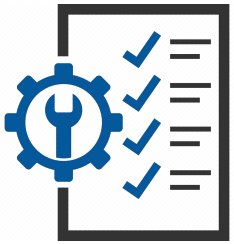
We **now** have the tools to make open science a reality. Advances in technology have created accessible, reproducible, inclusive science at a scale not possible a few years ago.

There is national and global momentum for the move to open science.

Equal and open access benefits the public

Open-Source Science Initiative

Unlocking the full potential of a more equitable, impactful, efficient, scientific future



Policy development, education, compliance tools
Updating NASA policies on scientific information to better enable the activation of open science (eg. SPD-41a)

Core Services for Science Discovery
Developing core data and computing services to enable open science

ROSES Elements
Supporting open-source software, tools, frameworks, libraries, platforms, and training with over $5 million dollars in grants per year

Community Building & Partnerships - Transform to Open Science (TOPS)
Accelerating adoption of open science

Why Open Science?

Image credit: NOAA

We are facing **Big** Challenges:

- Covid, Climate change, ...

We need ***more*** people - more hands, more eyes, more brains - with diverse experiences to participate so that we ask the best questions and find the best solutions

Image credit: Twentieth Century Fox

Open Science:

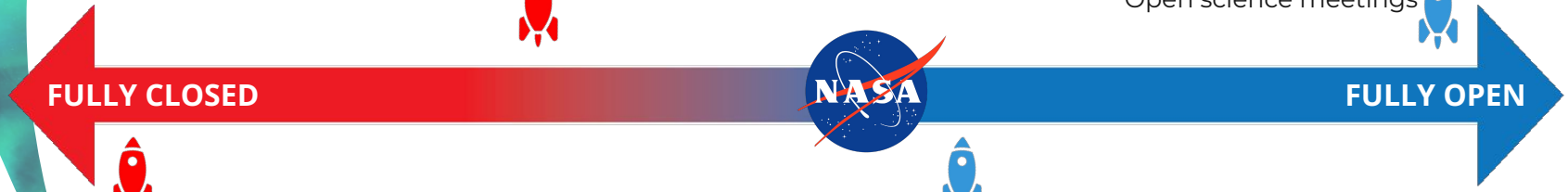
- Accelerates the pace of science
- Increases the impact of science
- Expands applications of data and science
- Shares hidden knowledge & expands participation in science

NASA's Open-Source science is the *activation* of an open science community

A continuum of open-source science

Data access ($$)
Accessible Publications ($$)
Siloed systems
Limited communication
Proprietary Software
"Closed-Tent" culture

Free unlimited data access
Fully documented open software and algorithms
Fully linked data and publications
Open Access Journal publications
Fully Transparent processes
Reproducible across platforms
"Teaching" culture
Open science meetings



No public access data
No publications
No insight into processes
No reproducibility
"Black Box" culture

Free data access
Open software and algorithms
"Green" Journal publication
Documented processes
Reproducible in specific environments
"Open-Tent" culture

Leading the Path to Open-Source Science

Transform to Open Science (TOPS) is a $40 million* 5-year NASA Science Mission Directorate mission

Objectives:

- ★ Increase understanding & adoption of open science.
- ★ Accelerate major scientific discoveries.
- ★ Broaden participation by historically underrepresented communities.

Year of Open Science

Goals for 2027:

- ★ 20K earn Open Science Badge
- ★ 5+ major discoveries
- ★ Increase participation of underrepresented groups by 2x

*pending appropriations

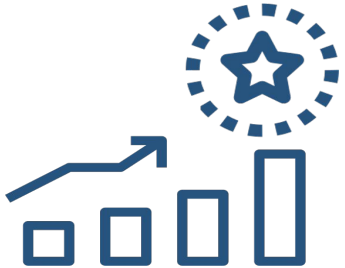
2023 is NASA's Year of Open Science

TOPS will be energizing and uplifting open science across the scientific community through:

Engagement

Capacity Sharing Resources

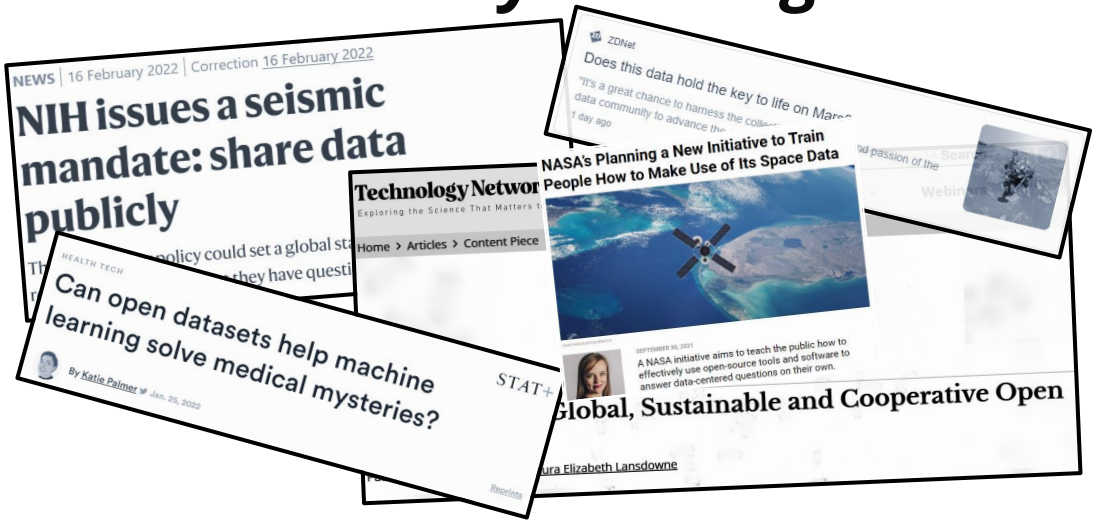
Incentives



Moving towards openness

Engagement:

- ***High level support and visibility***
- ***Community building***



Community **building**

- Outreach
- Monthly Community Forums
- TOPS Community Panel
- Email list
- GitHub (discussions enabled)
- Website

Conference **Visibility**

- Annual 2023 Meeting: Open Science theme
- Promote & Launch the TOPS Open Science Course
- Booths, Events, Workshops, Plenary Talks, Comms
- AGU, AMS, AAS, AAAS, and more….

Capacity Sharing - Resources: Open Science Curricula
5 Modules Organized as a Scientific Workflow

What is open science, why does it benefit me, and why does it benefit the greater scientific community?

How to share software

Best practices for sharing all results and analysis, as well as peer reviewing

ETHOS OF OPEN SCIENCE → OPEN TOOLS & RESOURCES → OPEN SOFTWARE → OPEN DATA → OPEN RESULTS

How to use popular open science tools

How to effectively use and share open data

Earn Badges at Each Level

Complete All 5 & earn TOPS Open Science Badge & Certification

Capacity Sharing : Resources

- Open Science Course on Open edX
  - High quality, interaction Open Online Course
  - Free, public, open - for in-person, virtual, and independent learners
  - Videos / quiz / interactive activities/workbooks
  - Fast-pass option for experienced open science practitioners
  - Open edX Learning Management System (LMS) tracks learners, completion of modules, data analytics

- Incentivize completion of course
  - Gamification: Certification / badges
  - Prizes, challenges, and bootcamps

- Make it easy & everywhere
  - Workshops at all big meetings
  - Workshops at science team meetings
  - Workshops through virtual cohorts

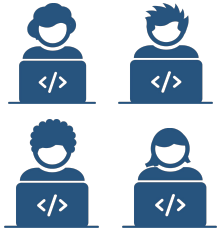
Capacity Sharing within the Community

TOPS Champions

Scientists to help teach modules at events and act as Open Science champions

Cohorts

Engage with learners through a virtual cohort model to increase Open Science Badge achievement



Summer Schools

Institutions selected to run 8-12 weeks of teaching the 5 modules to selected science teams + open competitive student/early career researchers

Curriculum Expansion

Groups funded to migrate/create discipline specific modules and data science skills modules to Open edX TOPS platform

Hackathons

More hackathons that advance data science skills and open science

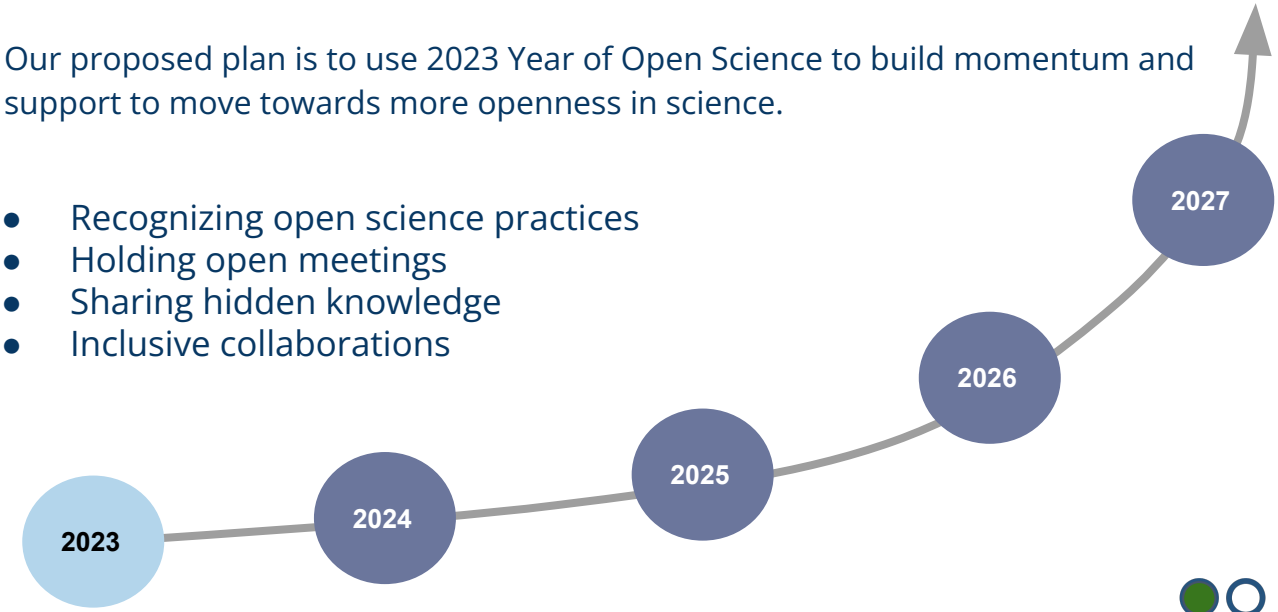
Incentives: Open Science Awards

- Societies create & manage TOPS Open Science Prizes & Awards programs
  - Award Purpose: To reward significant leadership and progress toward open science and showcase the benefits of open science
- Work with societies to evaluate and update their existing awards and recognitions to:
  - Include open science activities as review criteria
  - Where possible allow for team nominations

Moving towards openness:
Year of Open Science and the Future

Our proposed plan is to use 2023 Year of Open Science to build momentum and support to move towards more openness in science.

- Recognizing open science practices
- Holding open meetings
- Sharing hidden knowledge
- Inclusive collaborations



(Proposed) NSPIRES:
Update necessary systems to allow for documentation of past open science activities and proposed data, software, and publication plans

Require a little

Require a little more

Require a lot

Open Science Results Speak for Themselves..

> "We're deeply grateful to all the open source contributors who made our work possible." –Dr. Katie Bouman

First image of black hole

> "The open source community is very important for scientists; imagine if we had to do everything from scratch every single time." –Dr. Chi-Kwan Chan

> We "greatly improve[d] our own work by adopting well-tested community packages that contain the collected wisdom of many other projects." –Dr. Lindy Blackburn

> "with the open source projects in NumFOCUS, we were able to iterate our algorithms so fast that they enabled us to finish our work in two years"

Dr. Julia Stewart Lowndes @juliesquid

Replying to @ChelleGentemann and @theNASEM

Congrats Chelle!
The welcoming, inclusive, collaborate-and-reuse culture of the #rstats community is something that changed my science-life and my life-life. Hard to distill but here are a few attempts:
openscapes.org/blog/2020/02/2...
openscapes.org/blog/2019/02/1...
openscapes.org/blog/2019/08/2...

3:15 PM · Mar 11, 2022 · Twitter Web App

Lucas Sterzinger @lucassterzinger

Replying to @ChelleGentemann and @theNASEM

Probably the most common answer, but using @xarray_dev, @dask_dev, @ProjectJupyter, and @matplotlib has been the backbone of my research since day 1. Working with these tools also motivates me to make the data and code for my plots open source, making my science more reproducible

7:41 AM · Mar 11, 2022 · Twitter Web App

Pierre de Buyl @pdebuyl

Replying to @ChelleGentemann and @theNASEM

In remote sensing: using @PyTrollOrg satpy as a comparison point for reading geostationary satellite data, @scitools_iris and panoply from @NASA for plotting said data.

12:15 PM · Mar 11, 2022 · Twitter Web App

Sam Ehrenstein @elasticsnake

Replying to @ChelleGentemann and @theNASEM

In computer science, research moves very fast. It would not be possible to keep up with the latest work if not for the arXiv and open-access conferences.

1:47 PM · Mar 14, 2022 · Twitter W

Ricardo Barros Lourenço @rblourenco

Replying to @ChelleGentemann and @theNASEM

I've briefly returned to the public-private sector (between 2019-21) and the nicest thing about working with OSS during all my career was the ability to show new methods to be applied in that company, which was of clear understanding, helping auditing efforts.

7:56 AM · Mar 12, 2022 · Twitter Web App

Scott Collis (He/Him) @Cyclogenesis_au

Replying to @ChelleGentemann @openscience and @theNASEM

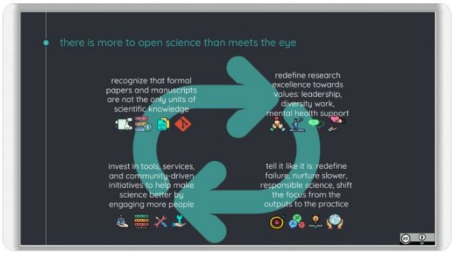
Being an open scientist has:
1) accelerated my career. It has allowed me to choose projects which benefit more people.
2) Has created long lasting collaborations and friendships. When you are open you are… open!
3) Made me a better scientist. "Show your working!"

6:36 AM · Mar 12, 2022 · Twitter Web App

Paola Masuzzo 🦕 @pcmasuzzo

Replying to @ChelleGentemann and @theNASEM

An aspect we should talk more about, open research practices as a driver to a real reform in the research endeavour. I try to depict it in this image :)

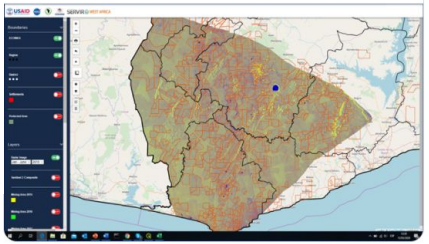


Belize GEO @BzGEO · Mar 11

Replying to @ChelleGentemann and @theNASEM

Our friends @SERVIRGlobal have many examples of how algorithms + code from one region have been customized for use in another. An example is gold mining monitoring, where Amazonia + W. Africa have collaborated in an #OpenScience context, leveraging #GEE.

> **simonestaiger** @simonestaiger · Apr 8, 2020
> Reducing illegal gold mining in the tropical forests of Ghana and Peru: A forthcoming collaboration across the Atlantic #SERVIRamazonia servir.ciat.cgiar.org/illegal-gold-m... @USAIDPeru @SERVIRGlobal @CERSGIS_GH @NovoaSidney @amazonacca @sig_gis @BiovIntCIAT_eng



Max Grover @mgroverwx · Mar 11

Replying to @ChelleGentemann and @theNASEM

Here's a great use-case of @Py_ART , which is funded by @doescience @armnewsteam ! Over 200 citations so far, with many including awesome code like this paper which enables #OpenScience !

> **Milind Sharma** @Gewitter_Blitz · Mar 11
> The power of open source software! The authors (@jehcssou and @deeplycloudy) also provide a clean code to encourage reproducible science. I could apply their technique to my dataset within a few hours. Neat! Yes to #OpenScience

Quotes from https://numfocus.org/case-studies/first-photograph-black-hole

How YOU can Get Involved:

To implement a cultural shift, we need community engagement from the broad spectrum across the scientific community!

We are looking for community partners to co-develop YOOS activities

- Host and fund prizes and challenges,
- Open, online open science curricula development,
- Governance framework structures to develop open science action plans for science teams across agencies and institutions,
- Budget for YOOS activities to support open science learning and funding requirements across science teams

Learn more and collaborate with us - we're working on GitHub!

- https://github.com/nasa/Transform-to-Open-Science
- Contact Yvonne Ivey (yvonne.ivey@nasa.gov)

TOPS Website

TOPS Email List

Questions?

Learn more and collaborate with us!

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TOPS Website