A NASA OPEN-SOURCE SCIENCE INITIATIVE:
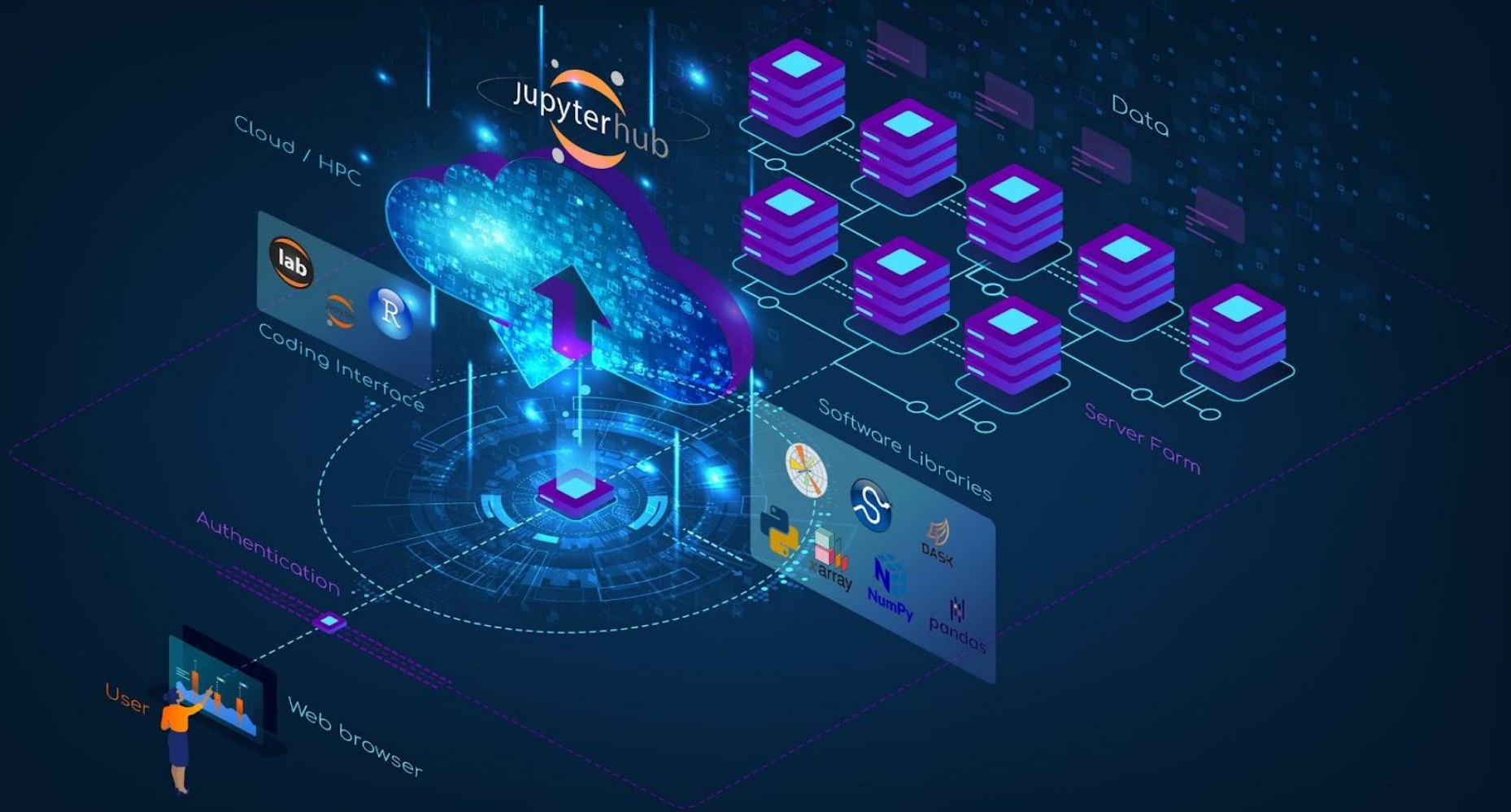# TOPS: TRANSFORM TO OPEN SCIENCE

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Cloud / HPC

JupyterHub

Data

lab

R

Coding Interface

Server Farm

Software Libraries

DASK

xarray

NumPy

pandas

Authentication

User

Web browser

JupyterHub

Cloud / HPC

Data

lab

Coding Interface

Software Libraries

Server Farm

Authentication

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xarray

DASK

Web browser

Science should be...

Transparent
scientific process and results should be visible, accessible, and understandable
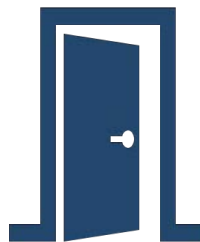
Accessible
data, tools, software, documentation, and publications should be accessible to all (FAIR)

Inclusive
process and participants should welcome participation by and collaboration with diverse people and organizations
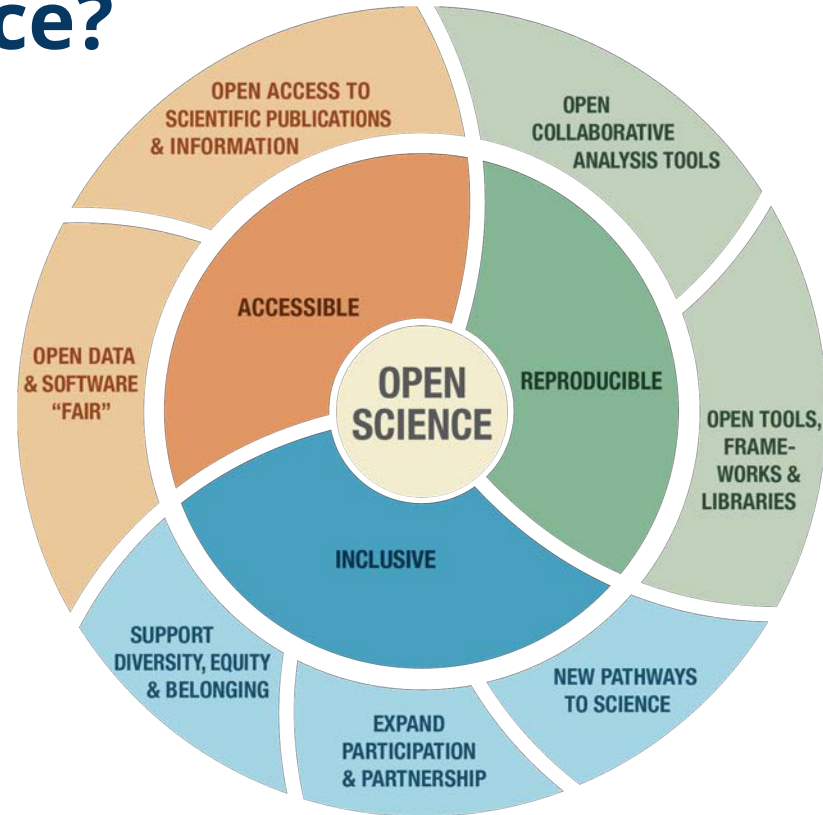
Reproducible
reproducible by members of the community

What is Open Science?

A **collaborative culture enabled by technology** that empowers the **open sharing of data**, **information**, **and knowledge** within the **scientific community and the wider public** to accelerate scientific research and understanding.

NASA SMD's Open-Source Science Initiative

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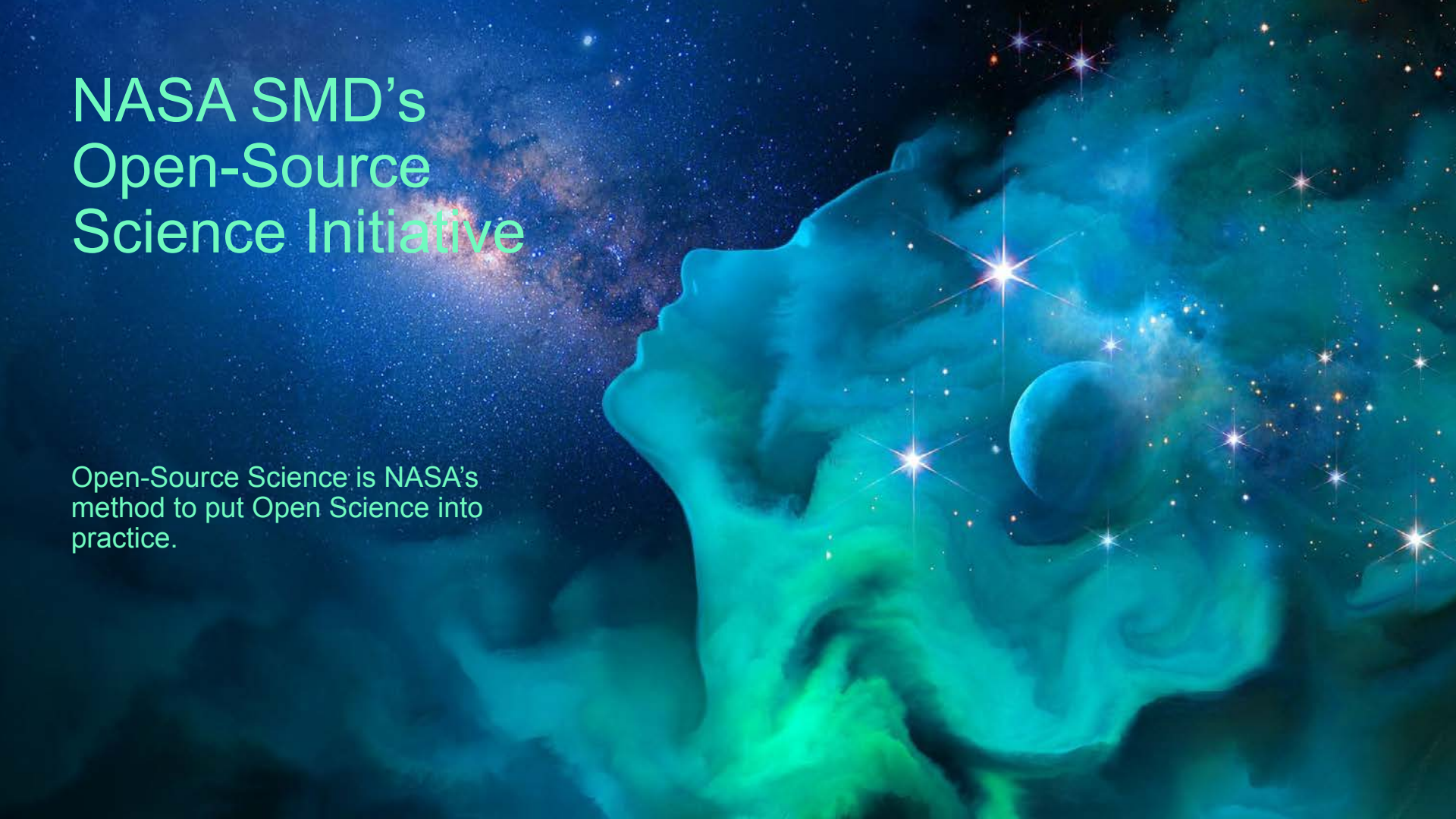
Open-Source Science Initiative

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

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

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

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

2023
2024
2025
2026
2027

Goals for 2027:

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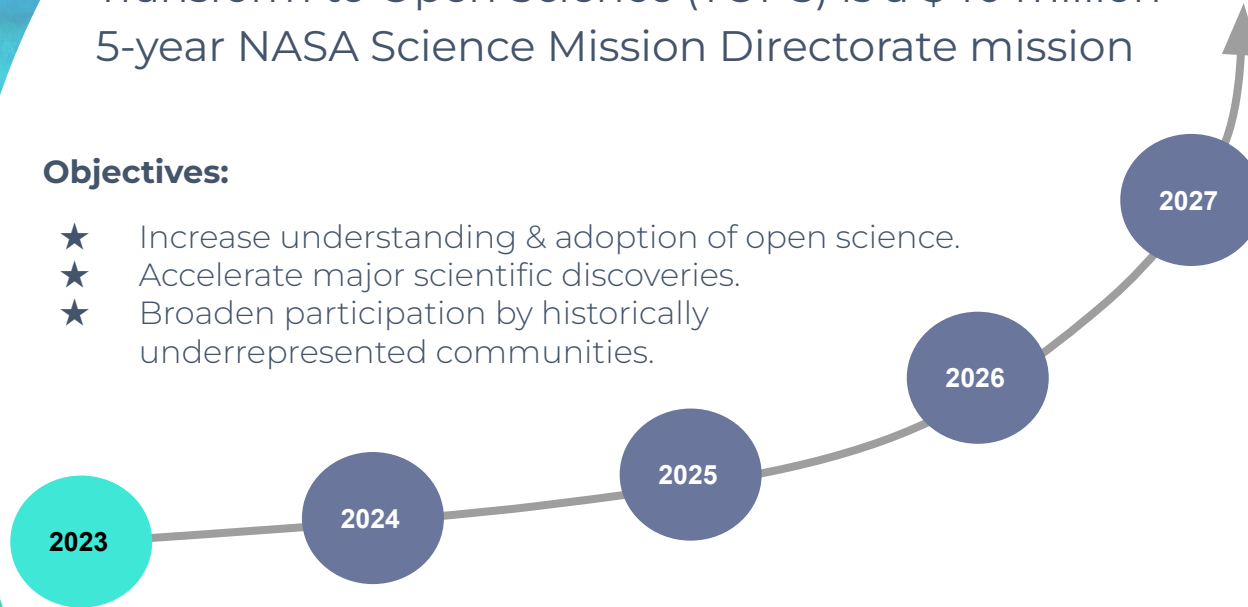
*pending appropriations

2023 is NASA's Year of Open Science

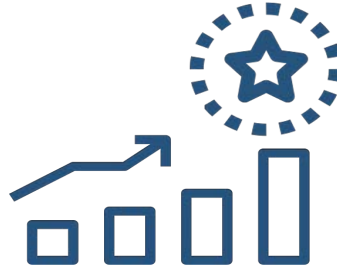TOPS will be energizing and uplifting open science across the scientific community through:

Visibility

Capacity Sharing Resources

Incentives

Moving towards openness

Open Data
Open Software
Open Access
Community

TOPS in the News! We are Everywhere!

NIH issues a seismic mandate: share data publicly

Can open datasets help machine learning solve medical mysteries?

Technology Networks
Exploring the Science That Matters

Does this data hold the key to life on Mars

NASA's Planning a New Initiative to Train People How to Make Use of Its Space Data

Global, Sustainable and Cooperative Open

TOPS and Year of Open Science
Visibility
>   Agency comms
>   Articles
>   Announcements
>   Twitter Spaces
>   Community meetings

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 Course in 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 LMS tracks learners, completion of modules, data analytics

- Incentivize completion of course
  - Gamification: Certification / badges
  - Prizes, challenges, and bootcamps
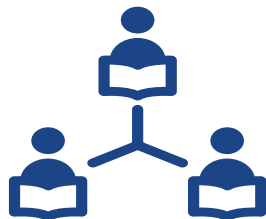
- Make it easy & everywhere
  - Workshops at all big meetings
  - Workshops at science team meetings
  - Workshops through virtual cohorts

Capacity Sharing - 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

Complete All 5 & earn TOPS Open Science Badge & Certification

Earn Badges at Each Level
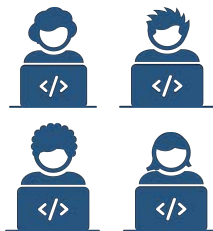
Capacity Sharing within the Community

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
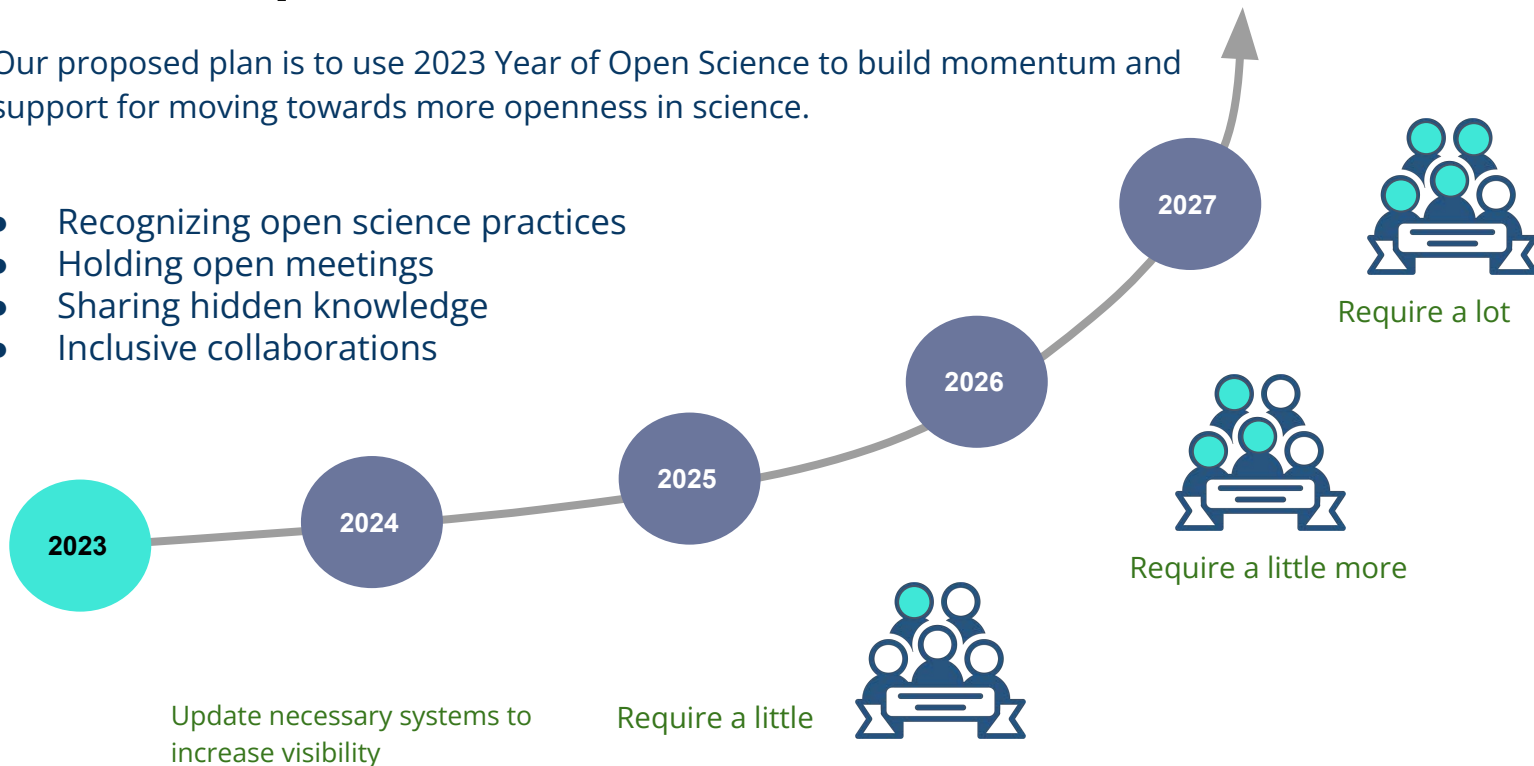
- Societies create & manage TOPS Open Science Prizes & Awards programs
  - Award Purpose: To reward significant leadership and progress toward open science and showcase the benefits of open science
- Work with societies to evaluate and update their existing awards and recognitions to:
  - Include open 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 for moving towards more openness in science.

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

2023

2024

2025

2026

2027

Update necessary systems to increase visibility

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

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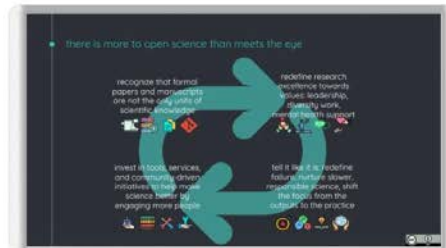
"with the open source projects in NumFOCUS, we were able to iterate our algorithms so fast that they enabled us to finish our work in two years"

First image of black hole

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 :)

there is more to open science than meets the eye

recognize that formal papers and manuscripts are not the only unit of scientific knowledge

redefine research excellence towards values, leadership, diversity, work, mental health support

invest in tools, services, and community driven initiatives to help move science better by engaging more people

tell it like it is: redefine failure, nurture slower, responsible science, shift the focus from the output to the practice

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

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
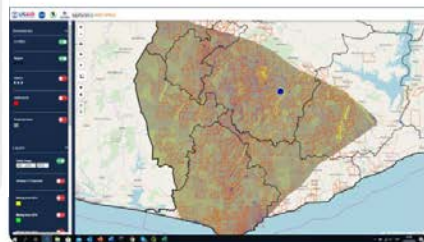
Lucas Sterzinger
@lucassterzinger

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

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 Web App

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...

Max Grover @mgroverwx · Mar 11 3:15 PM · Mar 11, 2022 · Twitter Web App
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

Questions?

BACK UP

Why Open-Source Science?

We are facing **big** challenges

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

Open science enables ***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: NOAA

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

2023 is NASA's Year of Open Science

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

Visibility

Publishing articles, appearing on podcasts, developing targeted communication that expands footprint

Integrating Open Science into themes at large-scale events and conferences

Capacity Sharing

Producing online, free, Open Science curriculum on Open edX

Hosting workshops, events, cohorts, science team meetings, hackathons

Constructing multiple pathways to Open Science Badge

Incentives

Developing Open Science Badge/Certification

Sponsoring high profile prizes and challenges

Establishing high profile awards in support of open science research

Moving toward Openness

Recognizing open science practices

Holding open meetings

Sharing hidden knowledge

Inclusive collaborations

Open Data
Open Software
Open Access
Community