to change everything, we need everyone

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

- WE HAVE LOST THE LUXURY OF TIME
- COVID-19, CLIMATE CHANGE, ...
- THE WORLD IS CHANGING RAPIDLY
- SCIENTISTS MUST ADAPT

"We need every solution and every solver. As the saying goes, to change everything, we need everyone. What this moment calls for is a mosaic of voices— the full spectrum of ideas and insights for how we can turn things around."

Ayana Elizabeth Johnson and Katharine Wilkinson (Eds.). All We Can Save: Truth, Courage, and Solutions for the Climate Crisis. 2021.

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TOPS: TRANSFORM TO OPEN SCIENCE

TOPS Team












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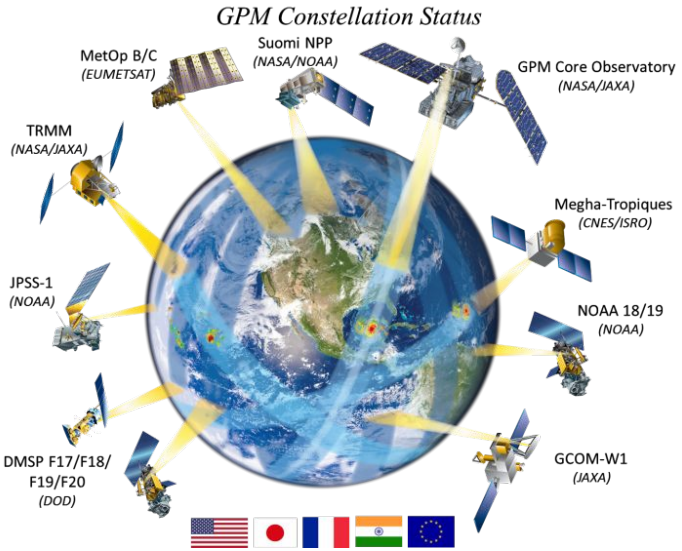
Why am I here? Business as usual is broken.

For >20 years I've worked on satellite algorithm development, data production, and science applications.

All the algorithms I worked on pre-2018 were developed in completely closed environments with minimal sharing of knowledge and code.

Sharing knowledge and code will accelerate algorithm development.



Open knowledge ➡ Better data ➡ Better science ➡ Bigger impacts

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Why are we here?

We have to tackle a really hard problem: ***changing the cultural norms that are preventing us from embracing new ideas, truly working together and moving forward***.

It isn't enough to talk about diversity and strengthen policies that foster inclusivity - we must change the power dynamics that disempowered and excluded people

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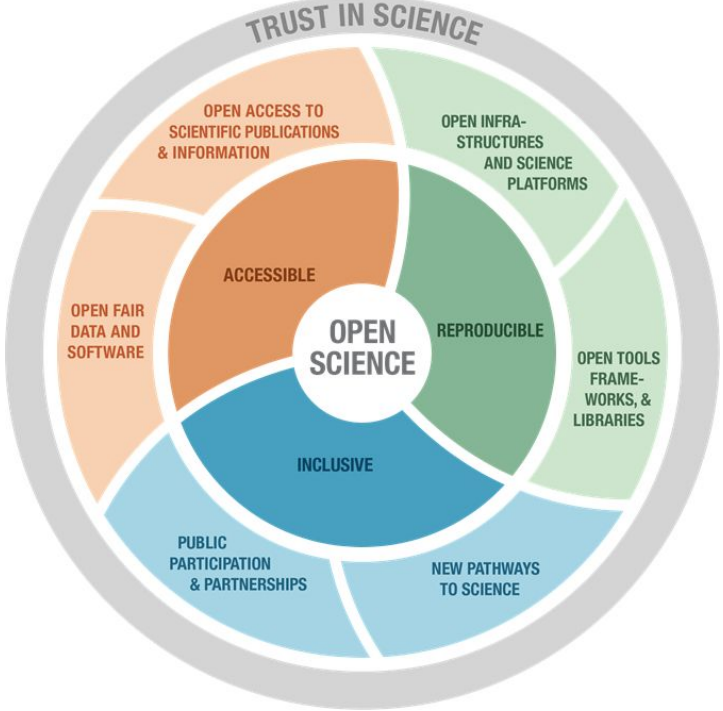
What is open science?

Open Science:

- Accessible: open data, open software, open information
- Reproducible: Make sharing and collaborating more efficient by supporting open software tools, frameworks, libraries, and open infrastructures
- Inclusive: innovative pathways to participation and expand public/private partnerships



Open knowledge ➡ Better data ➡ Better science ➡ Bigger impacts

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Why do open science?

How:

- Open, transparent, collaborative, and inclusive scientific practices
- More accessible & verifiable scientific knowledge subject to scrutiny and critique

Results:

- Increases trust in science
- More efficient enterprise
- Improves quality
- Improves reproducibility
- Expands the impact of science
- Provides robust evidence for decision-making and policy
- Creates new pathways for participation
- More equitable

Sharing hidden knowledge

Image credit: Twentieth Century Fox

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Why transform now?

Current challenges:

- Climate change
- Protecting our interconnected world from extreme space weather events
- Identifying threats from interplanetary space
- Searching for life beyond Earth
- Unlocking the secrets of the Universe

What are we going to do about it?

- Recognize the transformative potential of open science to reduce inequalities AND advance science

Image credit: NOAA

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How is **NASA's Science Mission Directorate** going to respond?

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> PROTECTING & IMPROVING LIFE ON EARTH
> LIFE ON OTHER PLANETS
> MYSTERIES OF THE UNIVERSE

Accelerating Scientific Discovery

These activities are designed to ***support and strengthen*** other NASA SMD initiatives on Inclusion, Diversity, Equity, and Accessibility (IDEA) and work for environmental justice.

Overview

- TOPS 5-year initiative will act as a catalyst to ***jump-start*** a suite of coordinated activities designed to rapidly transform science
- Designate **2023 as the Year of Open Science (YOOS)**

Goals

- Promoting a **common understanding** of open science, associated benefits and challenges, as well as diverse paths to open science.
- Investing in human resources, education, digital literacy and **capacity sharing** for open science.
- Fostering a **culture** of open science and aligning incentives for open science.
- Promoting innovative **approaches** for open science at different stages of the scientific process.
- Promoting international and multi stakeholder **cooperation** in the context of open science and in view of reducing digital and knowledge gaps.

Key Performance Indicators for TOPS

In 5 years, TOPS will:

1. Increase understanding and adoption of open science principles and techniques in our Mission and Research Communities
   a. 75% of mission and research principal investigators certified in open science principles
   b. 20K scientists achieve open science certification
2. Accelerate major scientific discoveries through supporting the adoption of open science
   a. One major scientific discovery using open science methods supported in each division (5 community moon shots) within 5 years
3. Broaden participation by historically excluded communities
   a. Double participation by historically excluded communities in submitted proposals, applications from students, and participation in mission teams.

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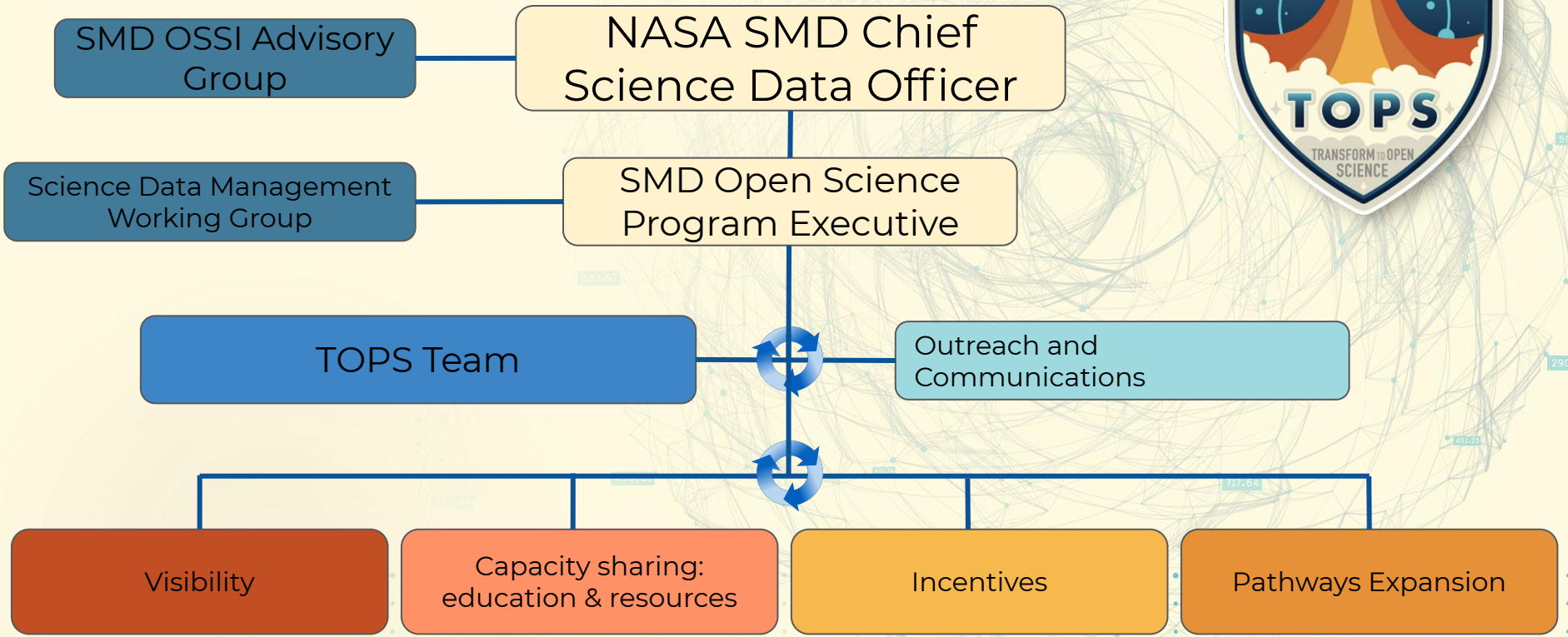
TOPS organizational structure



SMD = Science Mission Directorate

Areas of Action

Visibility

A lack of high-level support has left many scientists unsure about whether they are even 'allowed' to share knowledge and how moving to open science may impact their careers and funding.

- Promote 2023 - Year of Open Science (YOOS)
- Publish articles about TOPS and open science
- Build partnerships with scientific organizations to hold open science learning events at their annual meetings
- Provide visibility to solutions that advance adoption of open science
    - Eg. Software Release Agreements / tenure evaluations / award criteria
- Highlight open science success stories

Areas of Action

Capacity sharing: Learning resources and activities

Goal: 20K scientists & 75% PIs move to open science practises.

- Interactive open science platform populated by curated content that can be taught in-person or remote.
  - Build on existing resources to advance literacy in open source science methods, data science, tools and practices
    - Open data science events at annual meetings
    - Dedicated open data science summer schools
    - Open science cohorts
    - Open science events throughout year
    - Massive open online courses (MOOCs)

Areas of Action

Incentives

Reward and recognize 'the work'

- NASA Open Source Science Awards program
- Open science certifications / badges
- Prizes and challenges and cross-division science use cases, (eg. SpaceApps type events)
- Open science activities recognized in NASA reviews
- Support opening domain-specific course materials
- Support open learning resources
- Support to attend TOPS activities and events

Areas of Action

Pathways expansion

Double participation by historically excluded groups. Prioritize true change, collaborate with excluded communities to co-develop opportunities.

- New resources and opportunities for learning and participating in open science
  - Expand accessibility to free and open science research infrastructures
  - Leverage Public Participation and Partnerships
  - Host environmental justice targeted data science events
  - Invest in summer schools
- Engagement with historically excluded communities
  - Building partnerships with HBCU/MSI/HSI/TCU
    - Opening up hidden knowledge
    - Collaborative resource development
  - Funding (with mentorship) to attend TOPS activities and science meetings
  - Strengthen support for English as Second Language learners

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Next Steps

> Prepare for 2023 Year of Open Science
> Visibility
> Co-develop learning resources
> Incentives program
> Expand pathways & build partnerships
> Support open science
> Plan open science events

https://science.nasa.gov/open-science/

https://github.com/nasa/Transform-to-Open-Science

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Asks

> How can we advance open science?
> Potential contributions to TOPS from institutions and other agencies?
> Is there anything we are missing?

https://science.nasa.gov/open-science/

https://github.com/nasa/Transform-to-Open-Science

Backup

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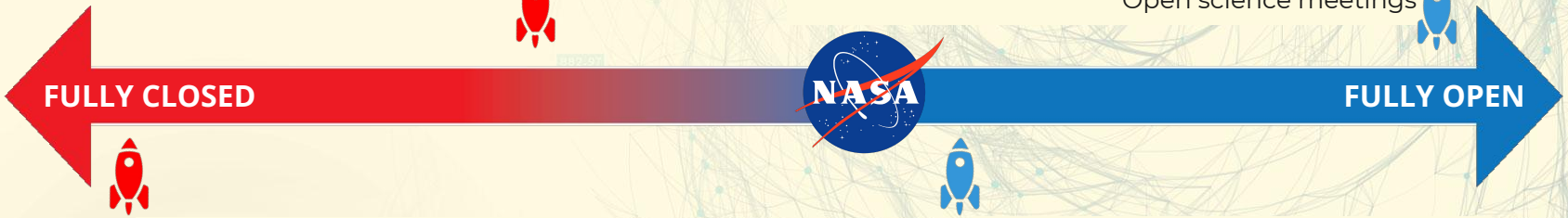
A continuum of open-source science

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

Open Science Resources

- 2021 UNESCO Recommendation on Open Science
- NASEM Open Science by Design
- NASEM Best Practices for a Future Open Code Policy for NASA Space Science
- From open data to open science: article

Some Educational Resources

- Guidance for authors: Jupyter Notebooks
- The Turing Way handbook to reproducible, ethical and collaborative data science
- A Guide to Using GitHub for Developing and Versioning Data Standards and Reporting Formats
- Open coding and data learning materials: The Carpentries
- Openscapes open science mentorship program
- Online resource list
- Scientific *python*

Areas of Action

Capacity sharing: Infrastructure - (OSSI)

We need to advance the open data and open cyber-infrastructure needed to support YOOS

- Accelerate the move of NASA data to the cloud
- Create FAIR - Analysis-Ready Cloud-Optimized (ARCO) data to increase accessibility of high-use datasets
- Improve accessibility to cloud-agnostic open science platforms
- Support open source software tools that advance open science needs or address gaps
- Contribute to open source communities - We want to build with the OSS community to benefit everyone.