Working Towards Open Source Science at NASA's Science Mission Directorate

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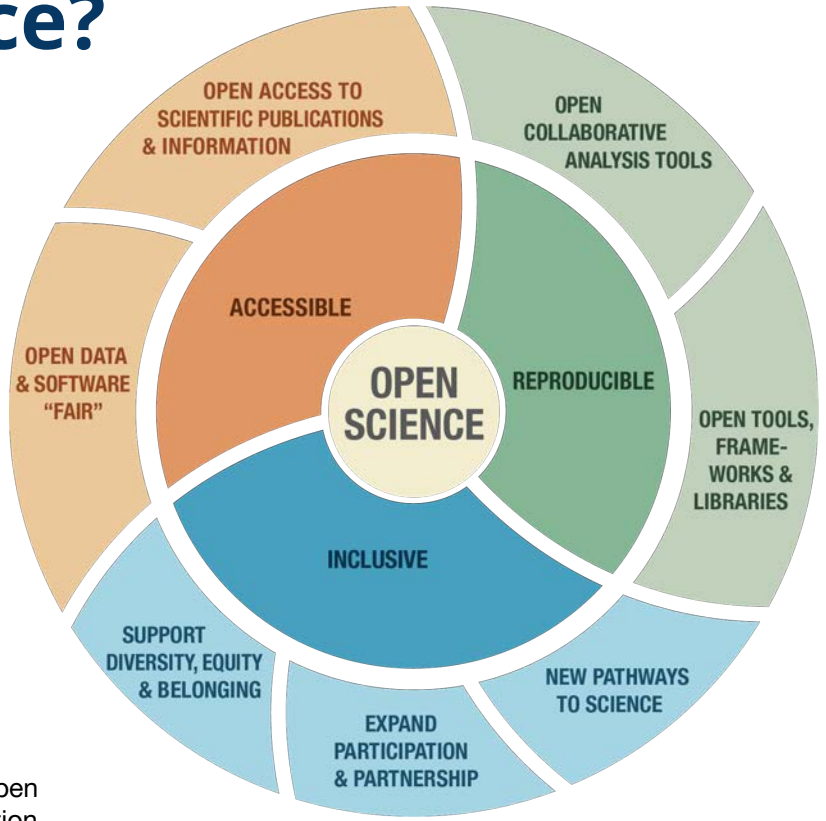
What is Open Science?

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.



Ramachandran, R., Bugbee, K., & Murphy, K. J. Moving from Open Data to Open Science. Earth and Space Science, Wiley Publication https://doi.org/10.1029/2020EA001562

Science should be…

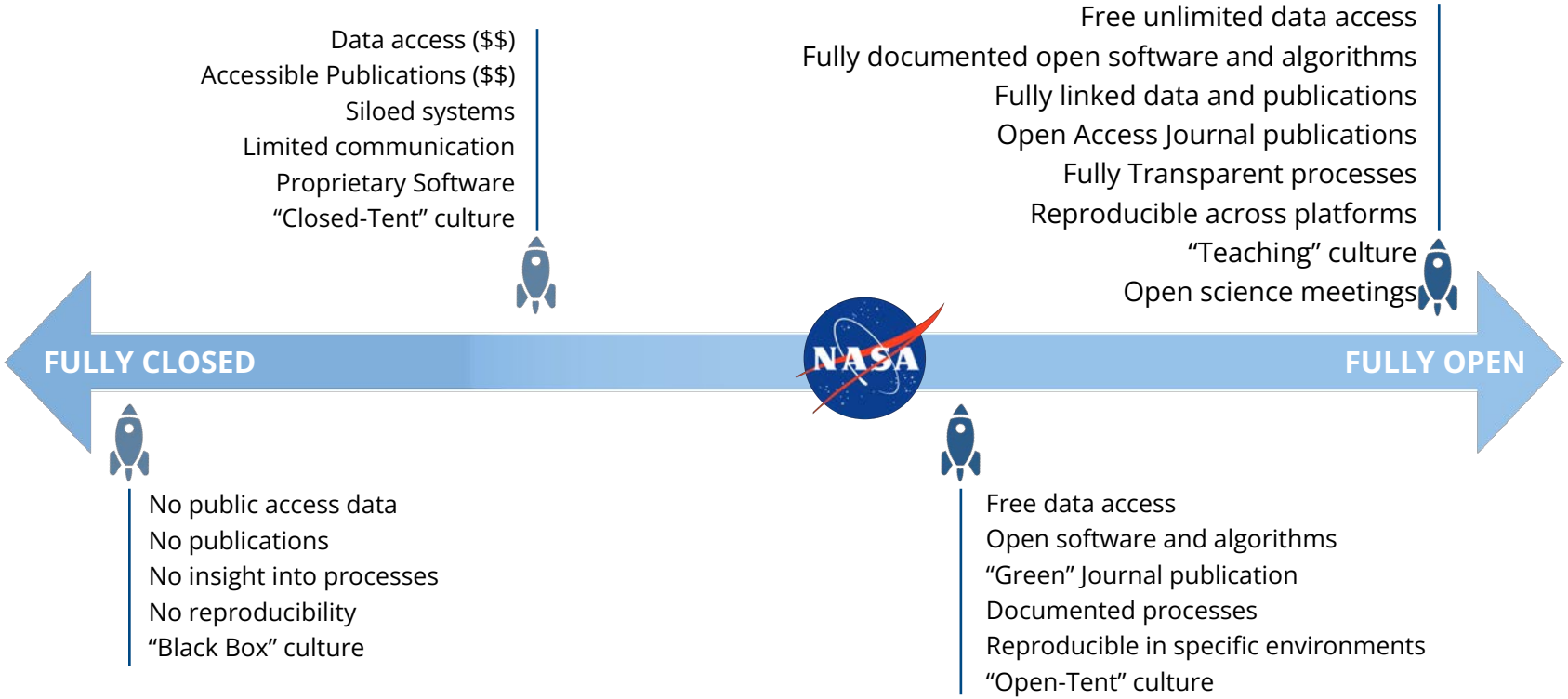
Transparent
scientific process and results should be visible, accessible, and understandable

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

A Continuum of Open Science



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

Advancing science requires the *sharing* of information.

SPD-41 is the NASA SMD Information Policy.

SPD-41 brings together existing NASA and Federal guidance.

It applies to all SMD-funded activities related to producing scientific information.

- **SPD-41: The Science Information Policy - https://go.usa.gov/xtNTJ**
- **Science Information Policy Website - https://go.usa.gov/xtNTt**

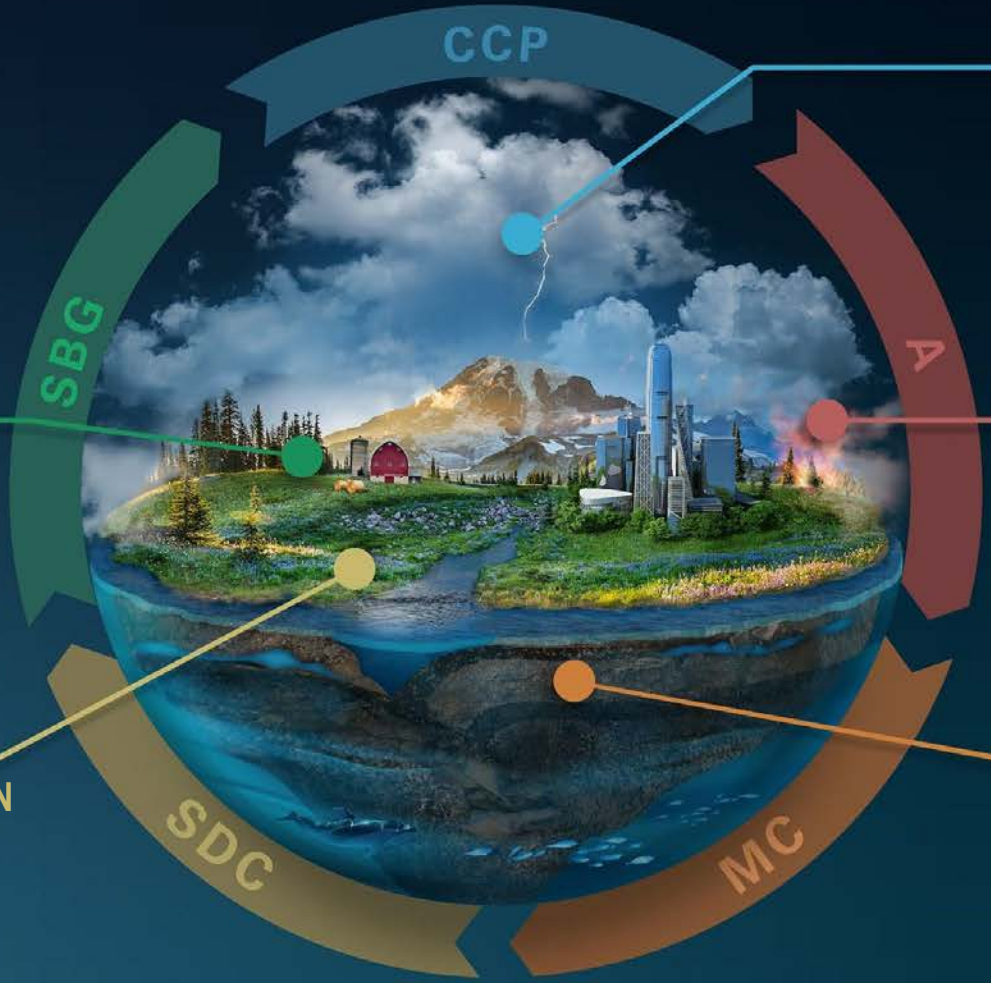
Feedback on proposed additions to SPD-41 were due by **March 4, 2022**

- **An update to SPD-41 will be released no earlier than June 2022**

How we share information matters - it affects the impact, the transparency, the reproducibility, and the accessibility of research.

EARTH SYSTEM OBSERVATORY

INTERCONNECTED CORE MISSIONS



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

AEROSOLS

Particles in the Atmosphere

MASS CHANGE

Large-scale Mass Redistribution

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

SURFACE BIOLOGY AND GEOLOGY

Earth Surface & Ecosystems


NISAR
MC
AOS
SBG
GLIMR
PACE

Exemplar: Open-Source Science Policy for Earth System Observatory

A. **All mission data, metadata, software, databases, publications, and documentation shall be available on a full, free, open, and unrestricted basis starting in Phase B** with no period of exclusive access.

B. **Science workshops and meetings** shall be **open** to broad participation and documented in public repositories.

1	**Software shall be developed openly** in a publicly accessible, version-controlled platform using a **permissive software license allowing for community use and contributions.**	4	Scientific data, metadata, software, publications and documentation **shall be archived and made available by NASA and/or [Partner] starting in Phase B.**
2	**Manuscripts shall be published with open access licenses**; versions of as-accepted manuscripts shall be made available as open preprints and deposited in a NASA or [Partner] **repository upon publication.**	5	**NASA and [Partner]** software, documentation and data **shall be properly marked, cited, and/or attributed**. Metrics to measure and acknowledge open-source science contributions will be developed.
3	All mission **data, calibration information, and simulated products supporting development and validation of algorithms shall be made available without any conditions to use.**	6	**NASA and [Partner] will mutually develop an Open-Source Science Plan** that specifies details of collaboration.

Envisioning Archives as Science Enabling Centers

1	**Data and metadata stewardship**
2	**Information management**
3	**Open-source software support**
4	**Cross-mission science and modeling**
5	**User support: Research and Applications**

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

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

Targeting Barriers and Misconceptions

TOPS will accelerate the adoption of open science by targeting common misconceptions which prevent the adoption of open science practices.

Cultural Barriers

Effort
"Sharing is more work . This takes time away from science."

Competition
"If I share my knowledge, I will be less competitive if more people can do what I do."

Integrity
"Sharing openly will increase misuse of data, misuse of software."

Lack of training resources

Lack of incentives

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

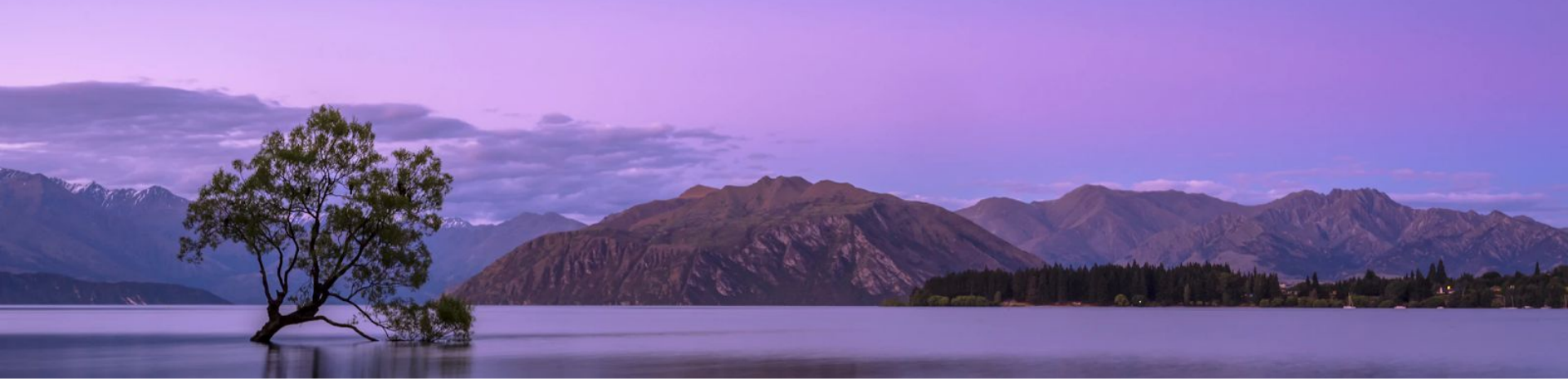
Moving toward Openness

Recognizing open science practices

Holding open meetings

Sharing hidden knowledge

Inclusive collaboration



In Summary

We have a strong vision for the future and have been making strides towards open source science within the ESDS program and NASA Science more broadly.

For upcoming missions, we will build-in open science principles at project initiation to tackle common challenges.

We are excited to continue to **build a community** dedicated to transparency, inclusivity, accessibility, and reproducibility.