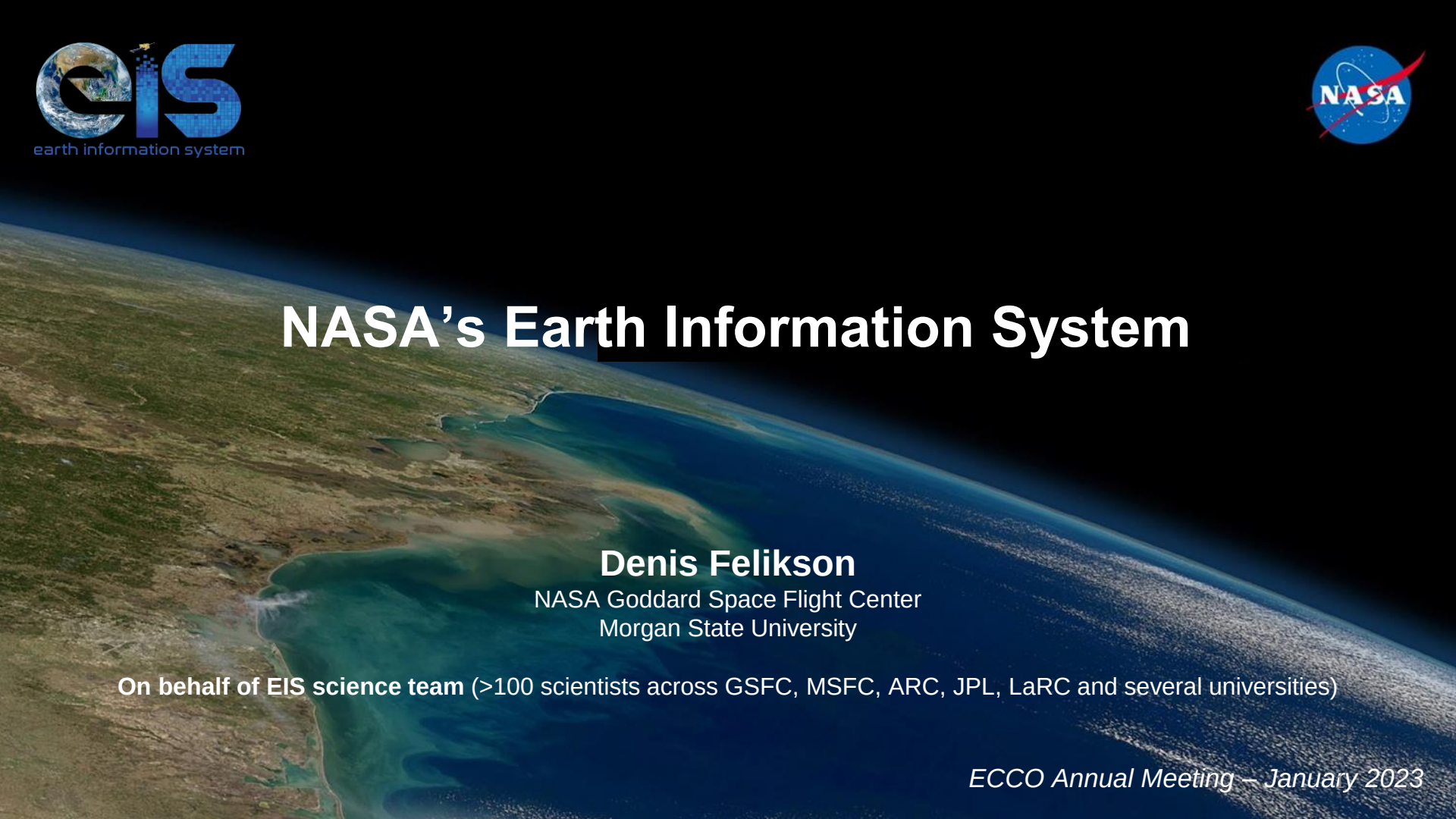


NASA’s Earth Information System

Denis Felikson
NASA Goddard Space Flight Center
Morgan State University

On behalf of EIS science team (>100 scientists across GSFC, MSFC, ARC, JPL, LaRC and several universities)

ECCO Annual Meeting – January 2023

EIS goals have evolved through time

Phase 1 (pilot study) Apr 2021 – Sept 2021

- Explore and prototype running models and analyses in the cloud

Phase 2 **Apr 2022 – Apr 2023**

- Connect with ESO missions
- Utilize new ESDS platform (VEDA Dashboard)
- Show how the cloud is the way forward for NASA Earth Science!

Future

- Goal: sustained, long-term project
- Core funded team that curates, with open community input
- Build off existing NASA projects and programs

NASA-curated, community-driven Earth System Science

Project Goals:

1. Synthesize discipline-specific understanding into **Earth system understanding**, with relevance to applications and enabled by emerging cyberinfrastructure.

2. Open-source science: deliver information with **lowest possible barriers** to accessibility for both researchers and stakeholders.

Currently four thematic areas:

Fire

Freshwater

Sea Level Rise

Greenhouse Gases

Co-leads: Ian Fenty & Denis Felikson

Pillars of EIS

Earth System Science

NASA-wide effort encompasses wide-ranging expertise, enabling unique synthesis and new science findings.

Transdisciplinary

Partnership between science, data systems, applications, and stakeholders.

Open Science

Data discoveries and analytics enable persistence of capabilities, science findings, and knowledge.

Common cyberinfrastructure

Collaborative environment enables co-development with users and accelerates transition for decision making environments.

Researchers

Jupyter notebooks | Jupyter notebooks | Jupyter notebooks | Jupyter notebooks

CFM Community Firn Model

ISSM

SESAW

Estimating the Circulation and Climate of the Ocean ECCO National Aeronautics and Space Administration

Visualization of vertical land motion at the coast.

APIs

EarthData Cloud AWS S3 storage

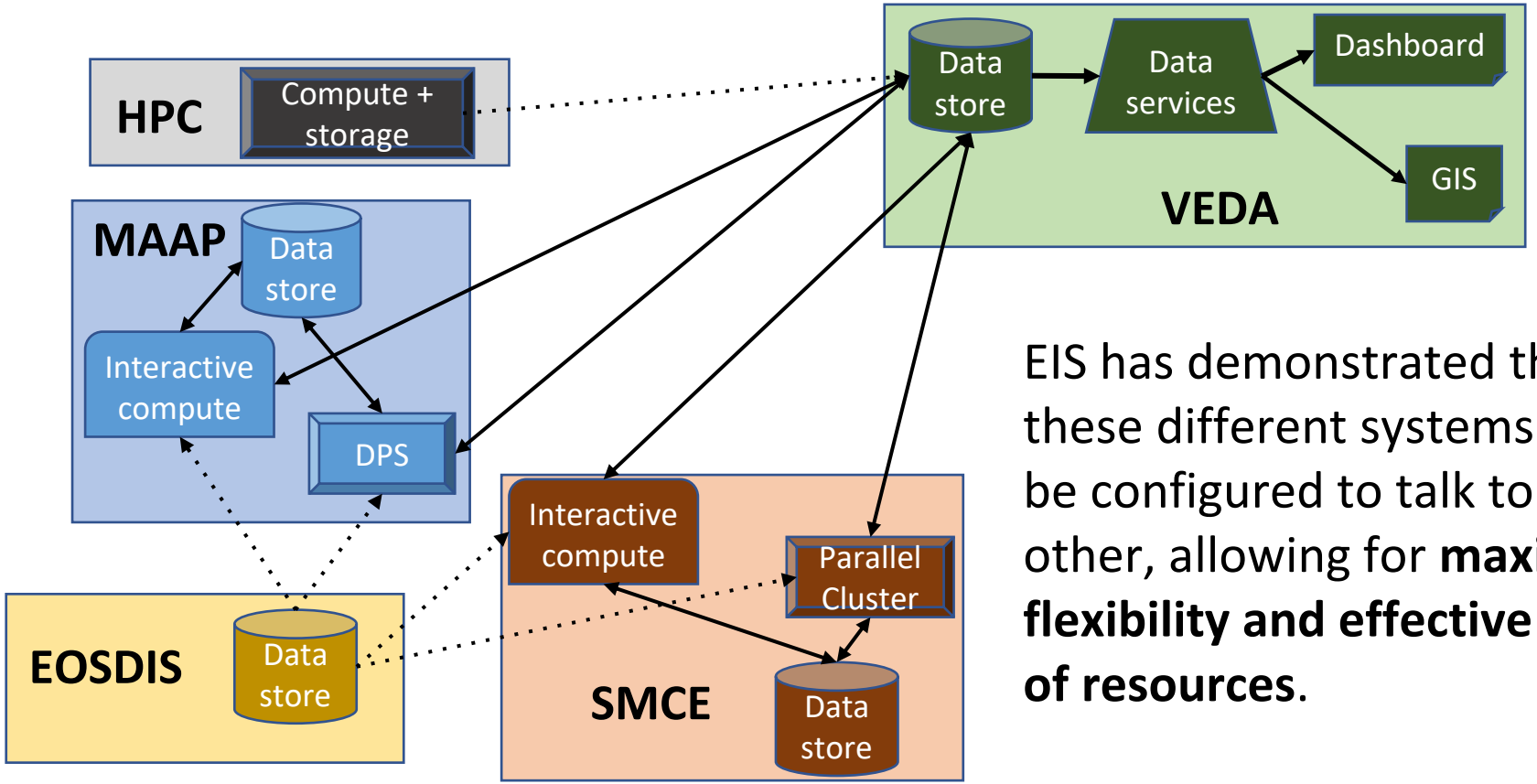
Private AWS S3 storage

HPC in the cloud

Science Managed Cloud Environment (SMCE)

Public AWS S3 storage

EIS approach to cyberinfrastructure: Flexibility, modularity, and interoperability



EIS has demonstrated that all these different systems can be configured to talk to each other, allowing for **maximum flexibility and effective use of resources**.

Current EIS Sea Level Change Tasks

1. **Improved estimates of ice sheet contribution to sea-level change**
   - Show how cloud computing can enable new science
2. **Sea-level change attribution with ECCO**
   - Develop open/accessible cloud-based analyses for community
3. **SWOT cloud analysis platform**
   - Create building blocks on cloud-based platform for future SWOT science
4. **Sea-level projection framework in the cloud**
   - Enable creation of team products
5. **Deploy N-SLCT portal tools on flexible, extensible cloud platform**
   - Make the transition from research to public tools easier

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Lowering the barrier for sea-level modeling

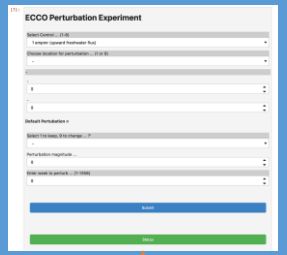
- Perturbation Tool: computes ocean's response to a change in forcing using the ECCO model
- Useful for exploring "what if" scenarios of the ocean without having to set up the model

- Web and open-source Jupyter notebook interface (1-to-1 functionality)
- Maximum code re-use between notebook and webpage using Python open-source package
- ECCO model runs on SMCE cluster on AWS

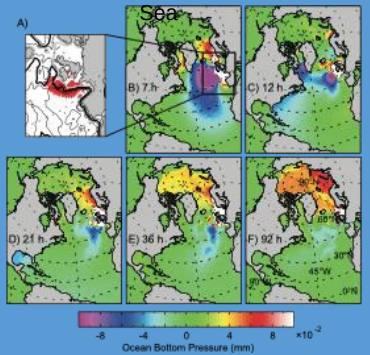
http://ecco.smce.nasa.gov/

Web interface

Notebook interface



Sample output (not yet implemented): time-series of sea-level anomaly resulting from change in meridional wind in the Celtic Sea



From Fukumori et al (2015), doi:10.1016/j.pocean.2015.01.013.

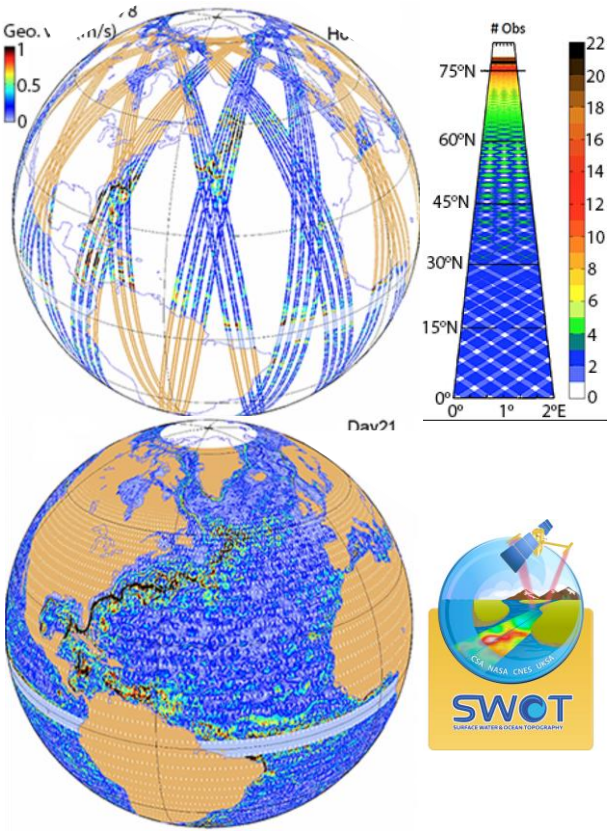
EIS and the SWOT (Surface Water Ocean Topography) Mission

Deliverables:

- SWOT Lab: a JupyterHub cloud compute environment configured with tutorials for accessing NASA assets in the cloud and analysis.
- swotpy: an open-source software library for the ocean, hydrology, and coastal thematic areas
- science team outreach: prepare the SWOT community for analyzing SWOT data using new cloud-based open-science tools

Why is EIS needed?

- SWOT will provide a “big data” dataset, natively hosted in the NASA Earthdata cloud
- EIS provides the platform and technical resources to develop the new technologies and approaches needed by the science community to maximize the value of next-generation NASA satellites



SWOT Launch: 15 Dec 2022 from Vandenberg Space Force Base in California

NASA curated, community driven Earth System science

NASA observations

NASA models and data assimilation

Emerging technology and cyberinfrastructure

Synthesize current understanding within thematic areas

Researchers can easily reproduce all EIS analyses

Research community reviews, comments, discusses in an open forum

Research community submits suggested changes

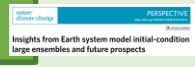
EIS team reviews and implements suggested changes

Interactive science analyses (e.g., Jupyter notebooks)

Science stories, visualizations, dashboards (e.g., StoryMaps)

Data products

Publications



Goal is to establish a long-term, sustainable project to support this paradigm.

NASA curated, community driven Earth System science

Synthesize current understanding within thematic areas

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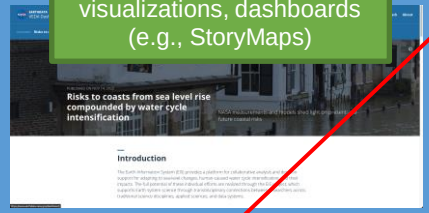

https://www.earthdata.nasa.gov/dashboard/eis/discoveries/eis-coastal-risks

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DOI 10.5281/zenodo.7335607

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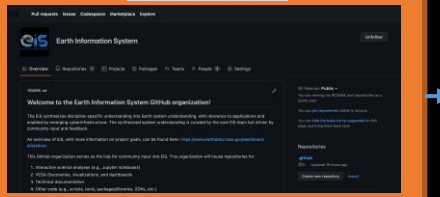
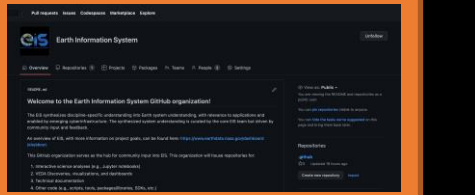


https://github.com/Earth-Information-System/

Issues

open community discussion

Research community submits suggested changes



https://github.com/Earth-Information-System/

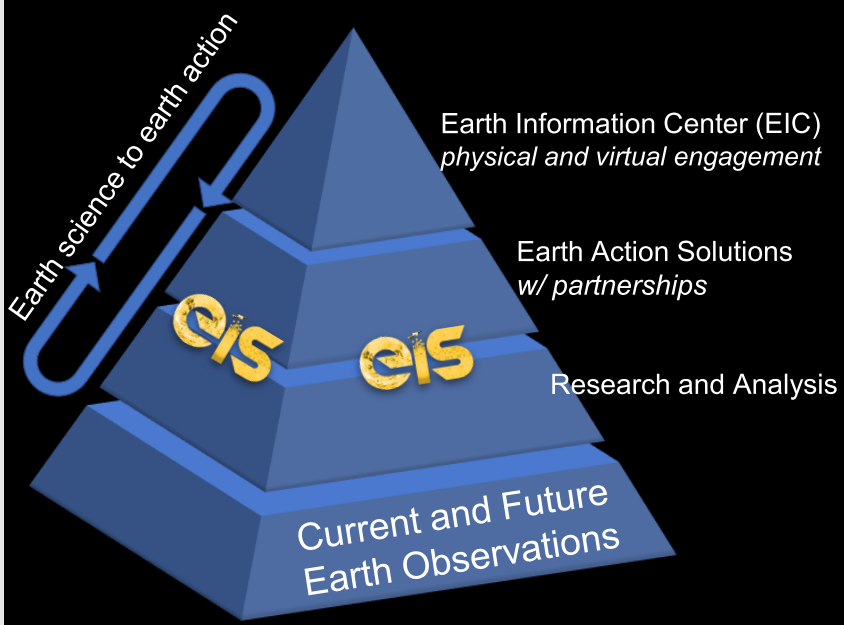
Fork 26

New pull request

EIS team reviews and implements suggested changes

EIS is developing a comprehensive model for open, transdisciplinary, impactful Earth system science

- Transdisciplinary: **R&A + Applied + Data Systems** working together to produce actionable information
- Open Source Science: deliver data/code with **lowest possible barriers** to accessibility for all (researchers / stakeholders)
- All thematic areas working **under one umbrella**: common computing and information delivery platform
- EIS is a pathfinder for open source science integrated Earth system studies, in support of the concept of the Earth Information Center (EIC).



Visit us at: https://www.earthdata.nasa.gov/dashboard/eis/about