NASA'S Earth Information System (EIS): Enabling Integrated and Accessible Earth System Science

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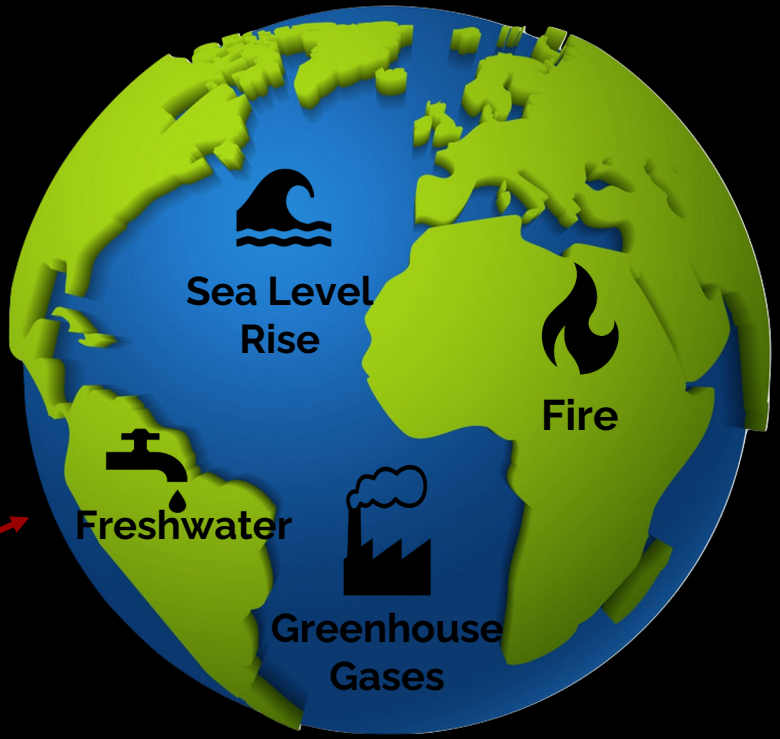
On behalf of EIS science team (>100 scientists across NASA GSFC, MSFC, ARC, JPL, LaRC and several universities)

103rd AMS Annual Meeting, Denver, CO, January 10, 2023

Earth Information System (EIS)

A transdisciplinary collaborative research and application activity → combines NASA's existing Earth science observations and numerical modeling capabilities to produce new integrated information

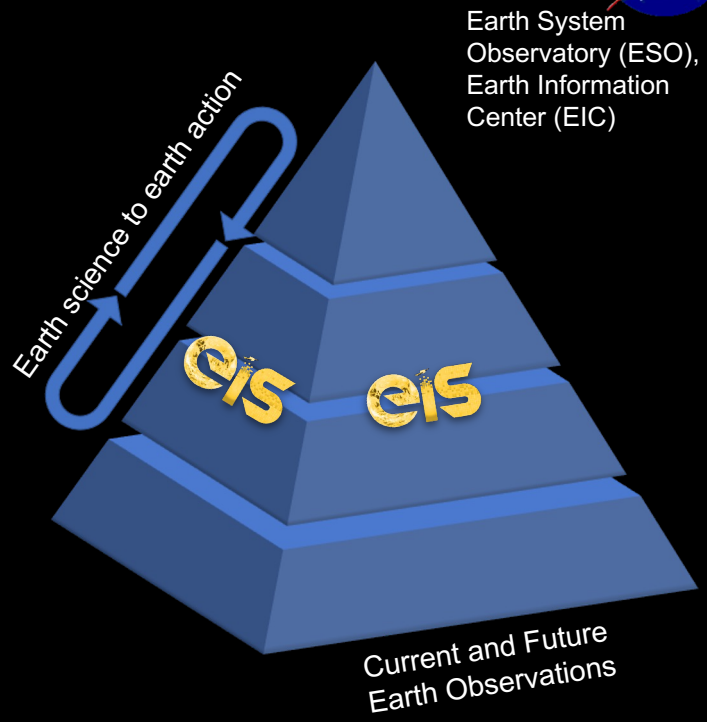
Science disciplines organized around four multidisciplinary thematic area



EIS Mission and Vision

Mission - To deliver accessible and actionable information of the Earth System science and serve as a platform for understanding and answering some critical questions about the Earth's complex system

Vision - To fully understand our changing planet as one Earth System by harnessing the full potential of NASA's scientific expertise, cutting-edge technology and engaging stakeholders



Earth System Observatory (ESO), Earth Information Center (EIC)

EIS is a pathfinder for open source science, in support of the Earth System Observatory (ESO) that further translates into the concept of the Earth Information Center (EIC).

Why 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.

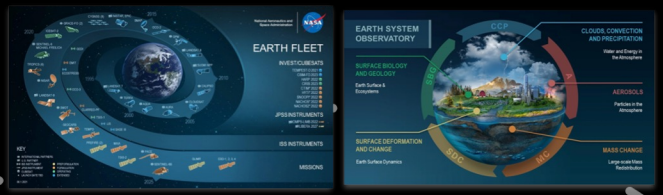
Co-Development Testbed

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

EIS Ecosystem: Integration and Synthesis

EIS **combines *existing* research and technologies** to enhance their value for Earth science and applications.

Current and forthcoming observations



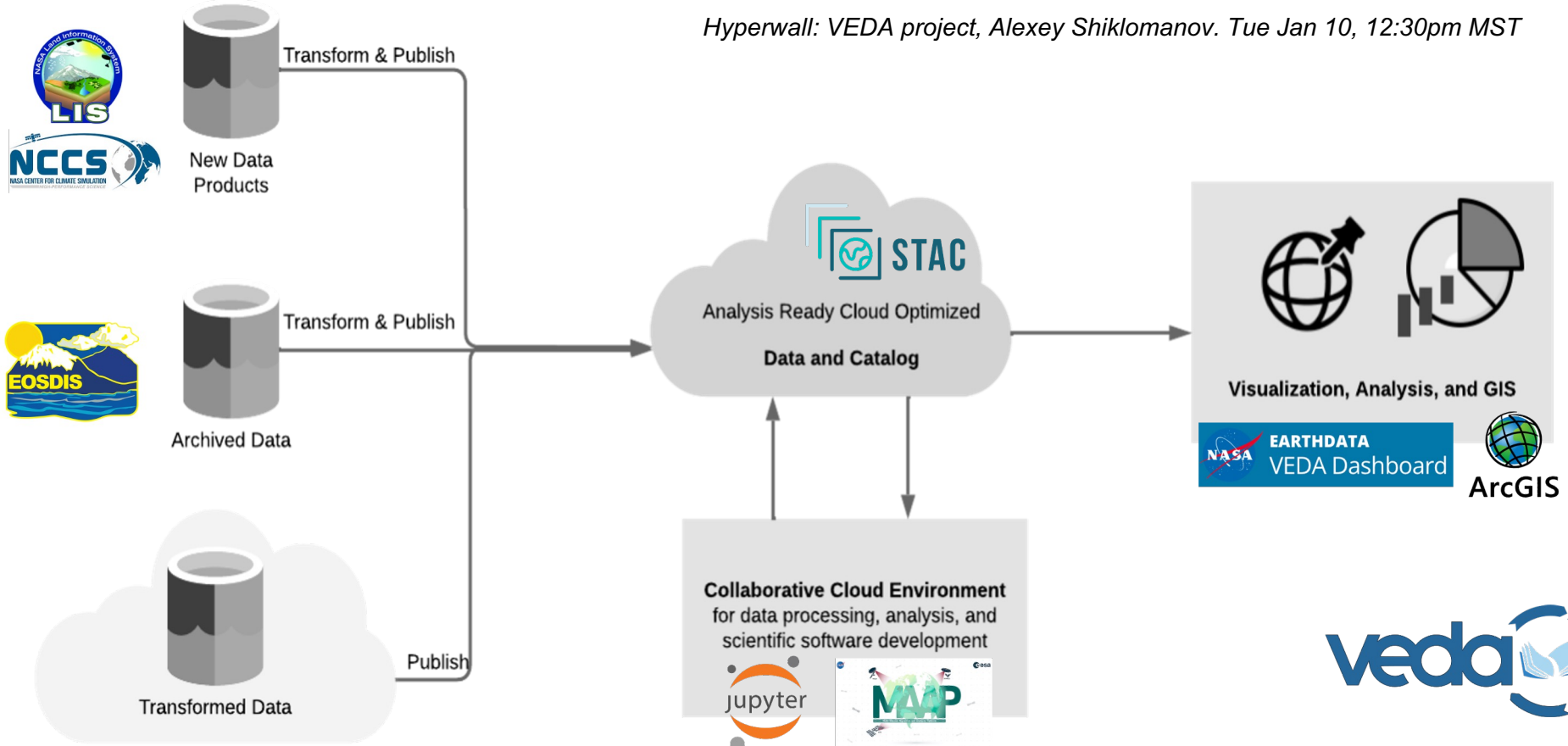
Cyberinfrastructure and open science data systems

Modeling and data assimilation

Science and application users

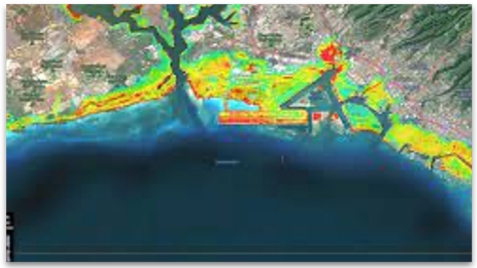
EIS is supported by the Visualization, Exploration, and Data Analysis (VEDA) project

Hyperwall: VEDA project, Alexey Shiklomanov. Tue Jan 10, 12:30pm MST



EIS – Freshwater 2022 Focus Areas and Potential Collaborators

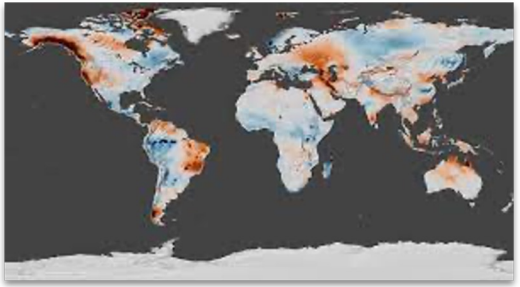
Goal: Combining NASA capabilities in an open science manner that enables broader collaboration to optimize freshwater management.



Inland and coastal flooding risks
NASA Disasters, EIS-Sea Level,
CASI-2, Delta-X, USGCRP, NOAA, FEMA

Water security assessments
EPA, FEMA, NOAA, CWC of India,
Bangladesh WDB,
TNC, NOAA, NRCS

NASA Centers
GSFC, MSFC, ARC, GISS, JPL

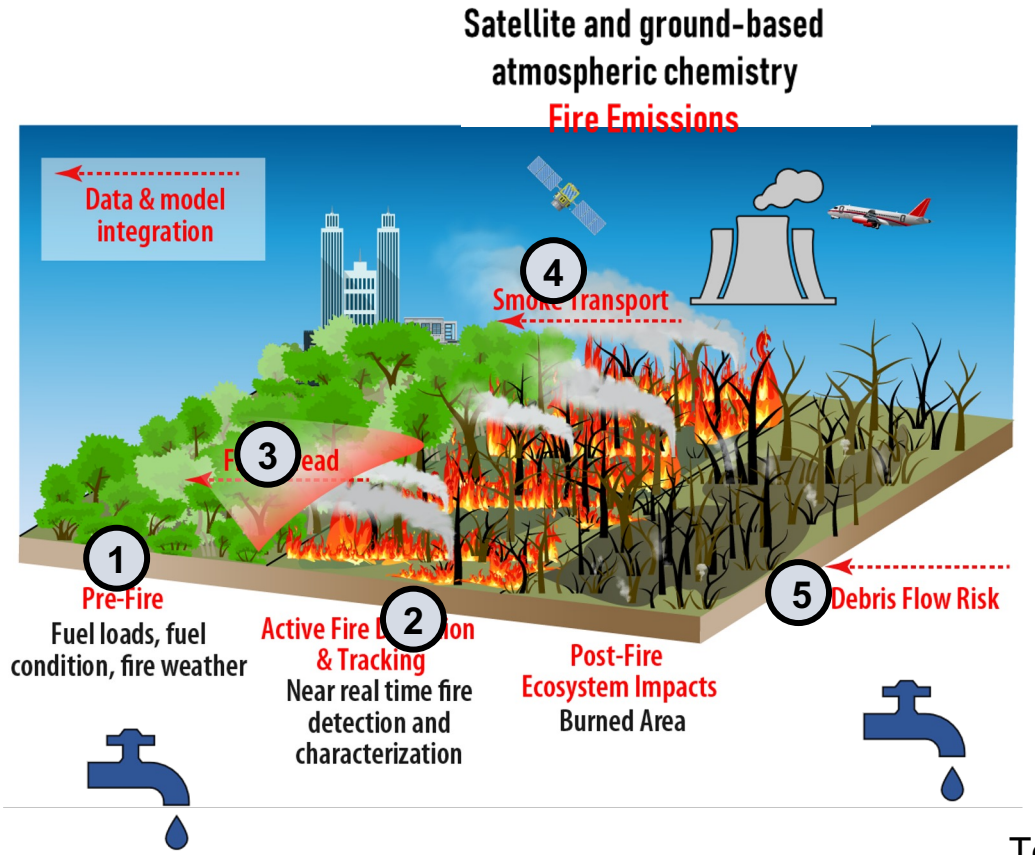


Global water cycle shifts to 2100
CASI-2, HiMAT, AIST, NOAA, WMO HydroSOS,
GISS AgMIP, National Geographic

Fire-hydrology impacts
EIS-Fire, NASA Wildfires, USDA, IPAM Brazil,
UMD GLAD, USFS

Science translation with AI via VEDA
NOAA, FEMA, USDA, SETI,
Frontier Development Lab, NASA STEM

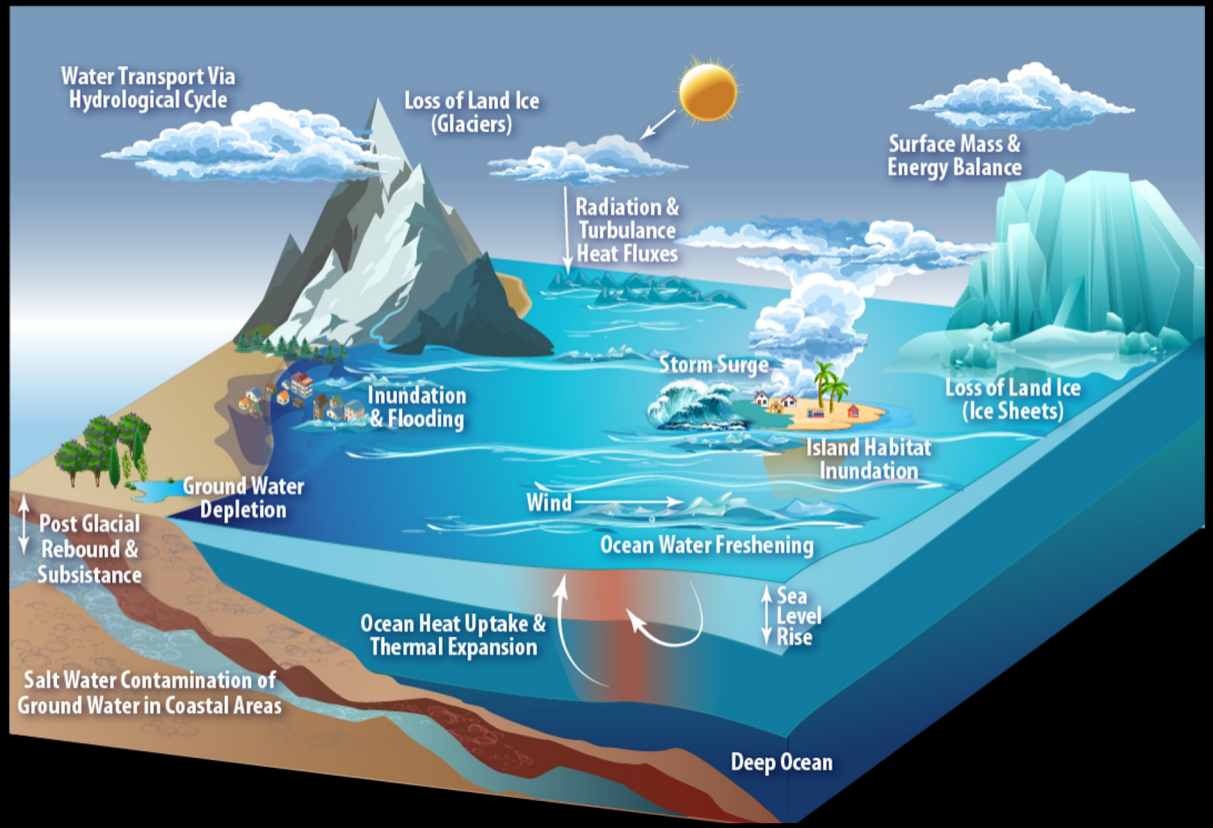
Integrated and actionable near real time information across the fire life cycle



1. Fire risk modeling and forecasting - Fire Weather Index
2. Real-time global fire event monitoring
3. Fire spread forecasting
4. Improving fire emissions - Diurnal cycles (fuels, seasons etc.)
5. Post-fire debris flow monitoring, forecasting, and management

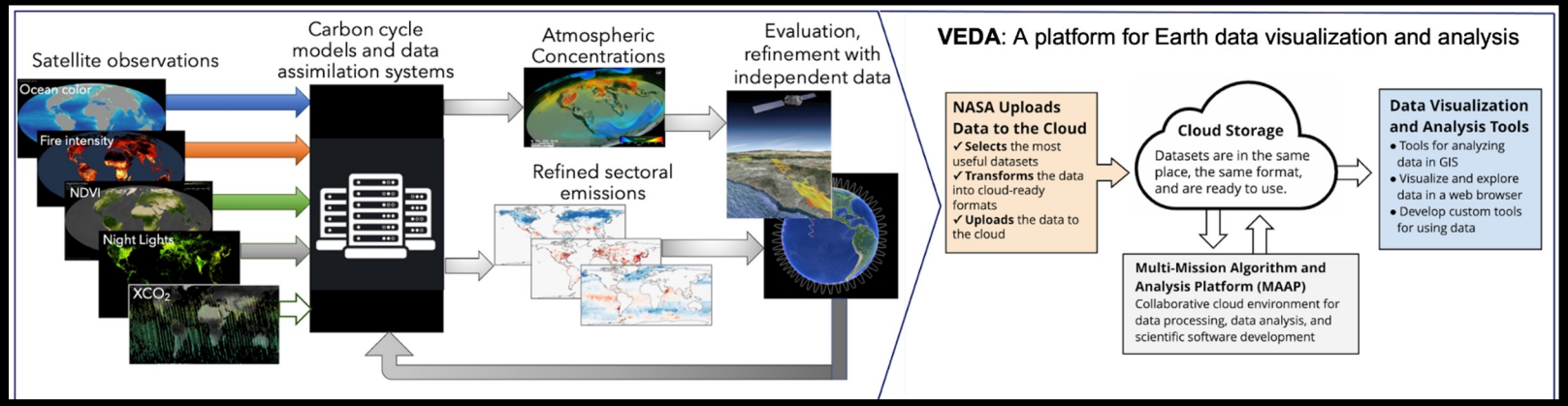
Team: NASA GSFC, GISS, LaRC; UCI, SIG

Integrated, cross-disciplinary **sea-level** research across a wide range of temporal and spatial scales



- Firn Model Ensemble - ice-sheet volume change (ICESat-2)
- ECCO model analysis tool - Attribution of SL variability
- SWOT - analysis of next-gen NASA SL observations
- *SL projection framework* investigating impact of different drivers of ice-sheet mass balance (N-SLCT team)

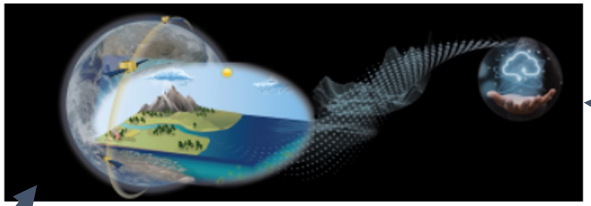
Satellite observations have transformed our understanding of greenhouse gases



- Design and prototype a data system for NASA GHG monitoring products → improve access of gridded anthropogenic GHG inventory data.
- Deliver high quality, low latency updates about recent changes in GHGs
- Provide rigorous benchmarking for NASA GHG products in support of open source science →
- Demonstrate cross-cutting analysis: Balance of natural, anthropogenic anomalies on the carbon balance during the COVID era
- Promote community engagement and report key findings including scoping needs for coherent, long term GHG monitoring and information system

Synergy across EIS Disciplines

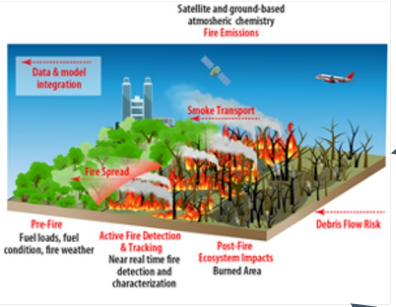
Freshwater,Fire: Connection between fire events and hydrological effects

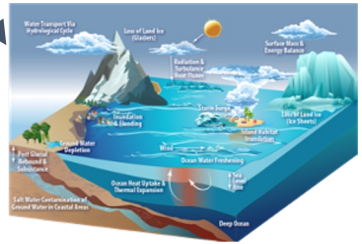


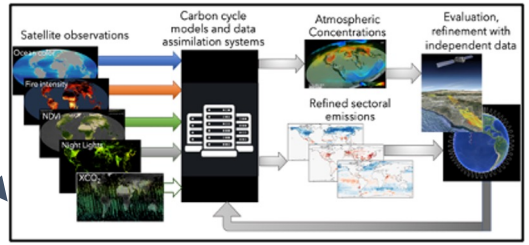
Freshwater, GHG: Shared input data, connection between carbon, air quality, and water cycles

Freshwater, Sea level: Linkages in coastal and inland flooding

Fire, GHG: Complementary output for understanding connections between anthropogenic and natural GHGs







Sea level, Fire, GHG: Shared modeling components

Capturing the impacts of fires on hydrology

- EIS provides a framework for an integrated analysis of factors driving fire risk, behavior, and consequences
- Fires significantly change the soil characteristics, reduces ET that affects the regional water budget, with impacts lasting for multiple years. Reduced ET and changed soil characteristics contribute to the risk of flash floods and debris flow.

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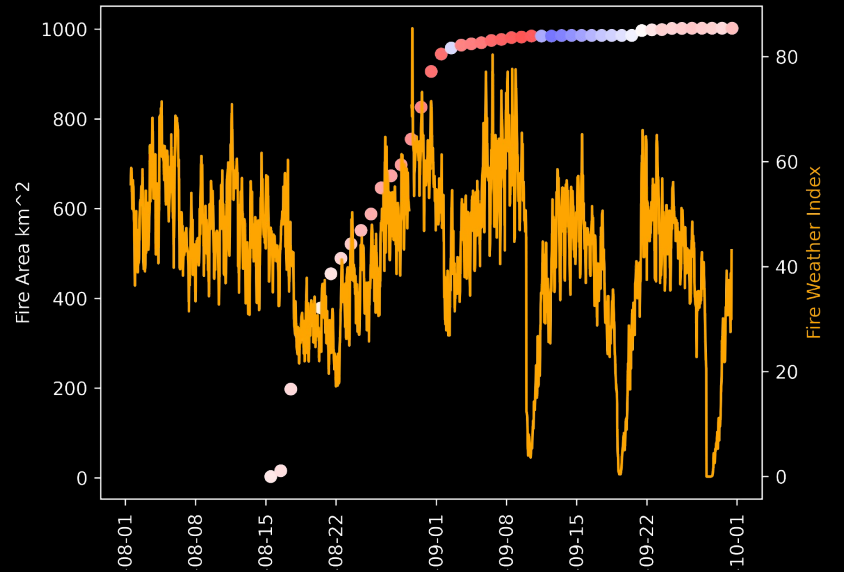
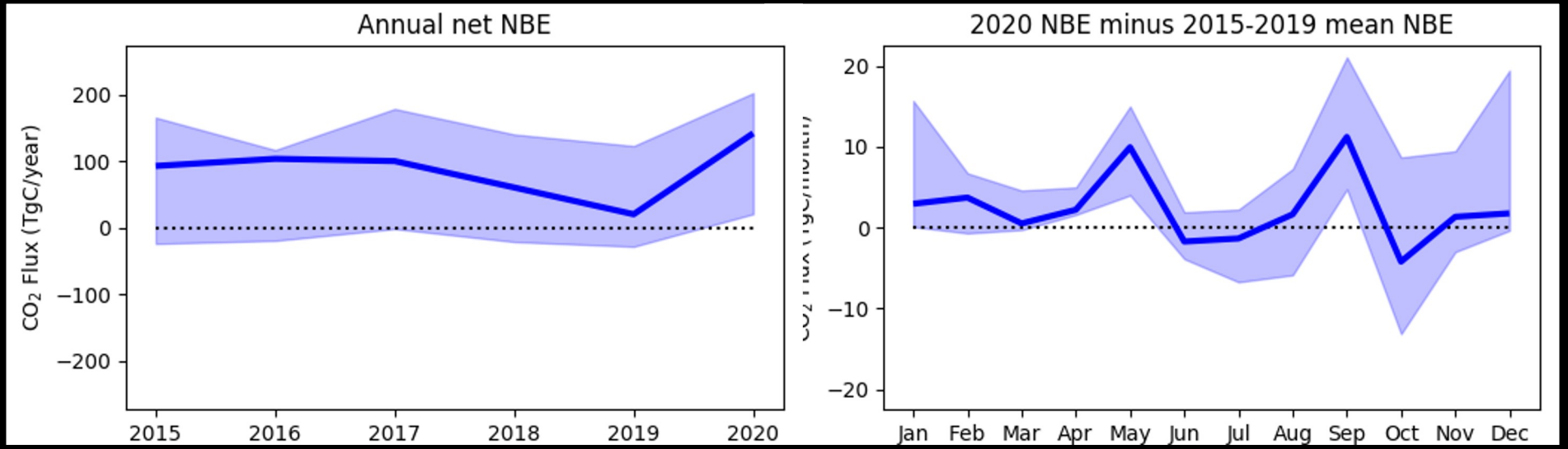


Caldor Fire, 2021

Fire contribution in GHGs: Western US carbon balance

Derived from CEOS/OCO-2 MIP (Byrne et al, 2022)

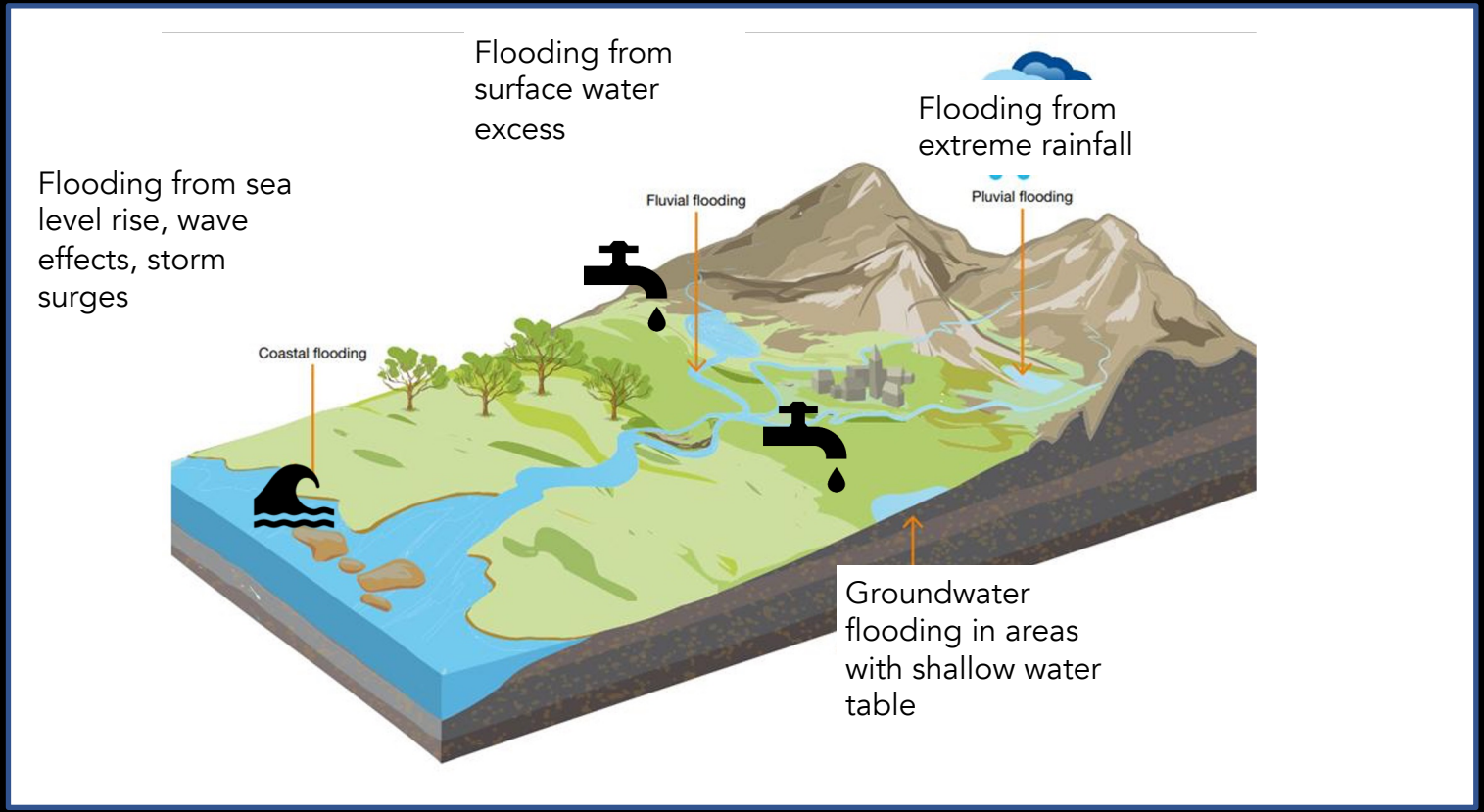


The 2020 Net Biome Exchange (NBE) (142 TgC/yr) is almost twice as high as the 2015-2019 median (78 TgC/yr).

Sept, 2020 was the highest monthly contributor, which occurred during the fires.

As part of EIS, we are bringing together top-down (CO, chem DA) and bottom-up (burned area, fire radiative power) fire estimates. These will help quantify the contribution of fires on GHG.

Compounding risks from sea level rise and changing water cycle



EIS provides a framework for an integrated analysis of factors for the simultaneous assessment of risks to coastal areas from multiple factors.

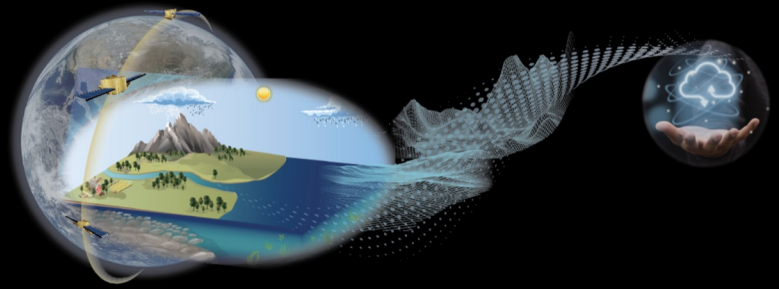
Few examples of EIS Stakeholders Engagement

- EIS supports Species and Habitat Protection: Estimates of current and future snow changes from EIS synthesis is enabling habitat assessments and endangered species protection decisions for the U.S. Fish and Wildlife Service over the Rocky Mountains.
- Fire perimeters to FEMA: Collaboration with FEMA to provide fire perimeters on fire spread and burn severity
- Making National GHG data more accessible through EIS: The gridded EPA CH4 inventory datasets, supported by NASA's Carbon Monitoring System (CMS), are made more accessible through development of the interactive VEDA dashboard.

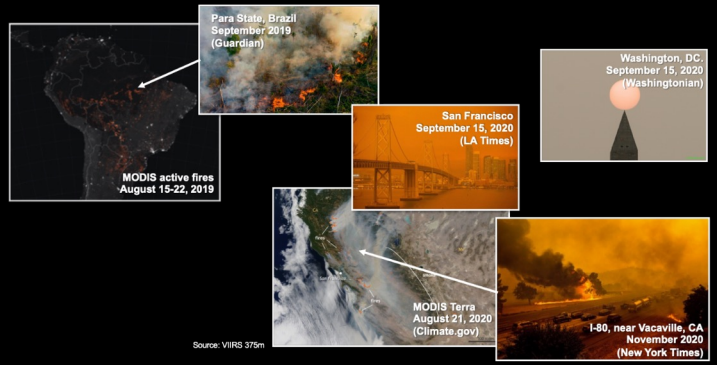
EIS Engagement and Outreach

Organization/ Meeting	Thematic Area	Outcome
NASA Applied Sciences Water Program Annual	EIS Overall, Water, Weather	Follow-on Discussions
CMS Science Team Meeting	GHGs	Feedback from the community
Digital Twin Workshop	Cyberinfrastructure	Briefed on EIS
ESDS/CSDO Quarterly Meeting	EIS Overall, Cyberinfrastructure	Briefed on EIS
NASA FireSense Meeting	Fires, Overall EIS	Briefed on EIS
FEMA Disaster Response Team	Fires, Debris Flows, Floods	Co-developing Product
NOAA Gulf of Mexico Nutrient Runoff Workgroup	Water, Weather, Sea Level Change	Follow-on Meetings
COP27	Overall EIS, GHGs	Representation
EPA Office of Water	Hydrology Models and Water Quality	Follow-on Discussions
US Forest Service	Fire Hydrology, Post-Fire Risk	Follow-on Discussions

How can community engage?



- Exploratory research and development
- Targeted research and development
- Funding requests
- Follow EIS Work



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

- Transdisciplinary: R&A + Applied + Data Systems working together to produce actionable information
- All thematic areas working under one umbrella: common computing and information delivery platform
- EIS provides the platform and technical resources that maximizes the value of next-generation NASA satellites needed by the science community
- Open Science: deliver data/code with lowest possible barriers to accessibility for all (researchers / stakeholders)
- EIS is a pathfinder for open source science integrated Earth system studies, in support of the Earth System Observatory (ESO) that translates into concept of the Earth Information Center (EIC).

Visit our website or contact us!

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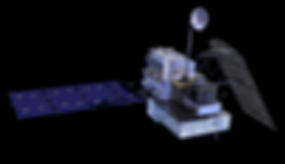
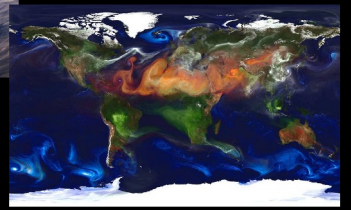
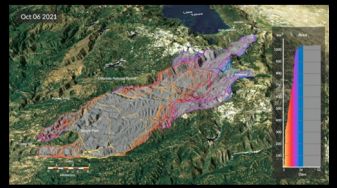
EIS Hyperwall presentation: Jan 10, 2023 @3:30 pm, NASA booth

earthdata.nasa.gov/dashboard/eis







Back-up slides

Models Used in EIS

Model	Domain	Lead organization
Land Information System (LIS)	Land hydrology	NASA
Soil Water and Assessment Tool (SWAT)	Water quality, hydrology	Texas A&M
GEOS	Earth system model	NASA
GEOS-Chem	Chemical Transport Model	Harvard University
ECCO	Ocean model	NASA
CFM	Firn model	NASA
ISSM	Ice sheet and sea level model	NASA