Maximizing the impact of science for society through mission applications: the ECOSTRESS experience

Christine Lee with contributions from the ECOSTRESS Team

July 7, 2025

Jet Propulsion Laboratory, California Institute of Technology

Mission Applications

<u>increase impact of science on society</u>

- Impacts span prime mission goals as well as other domains
- Responsive Science for Society: actionable and timely information
- Opportunities for cross-mission collaboration can amplify benefits of NASA observations to partners

ECOSTRESS

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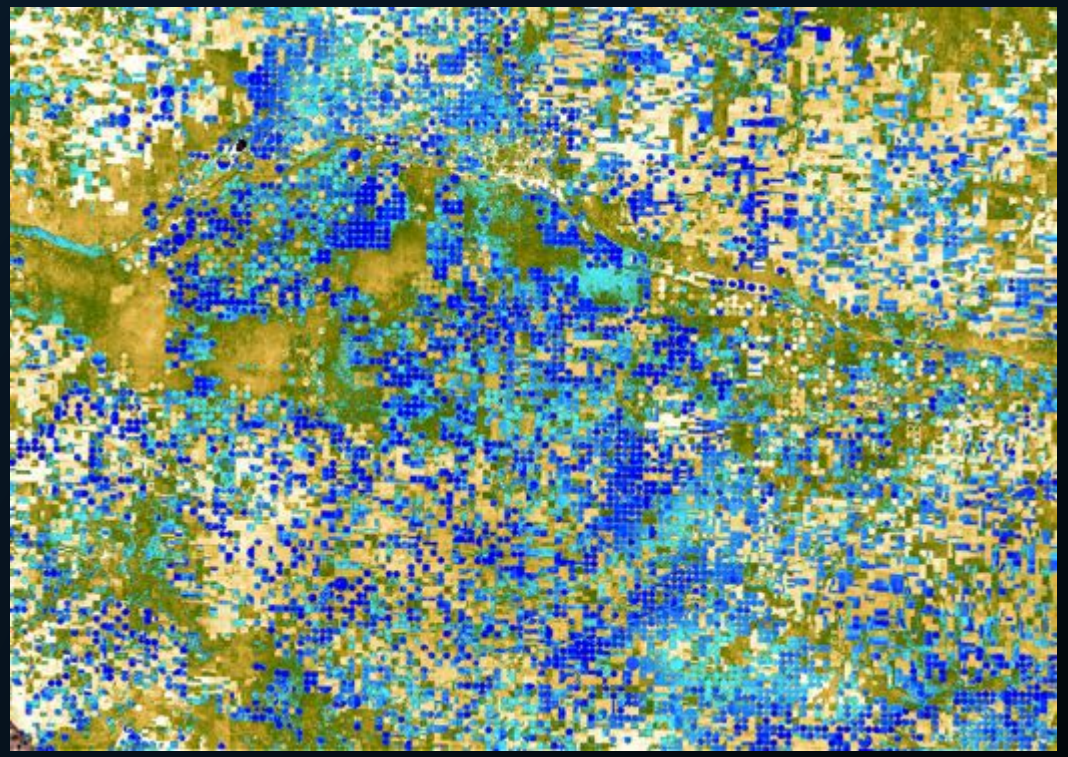
ECOSTRESS

ECOSTRESS at-a-glance

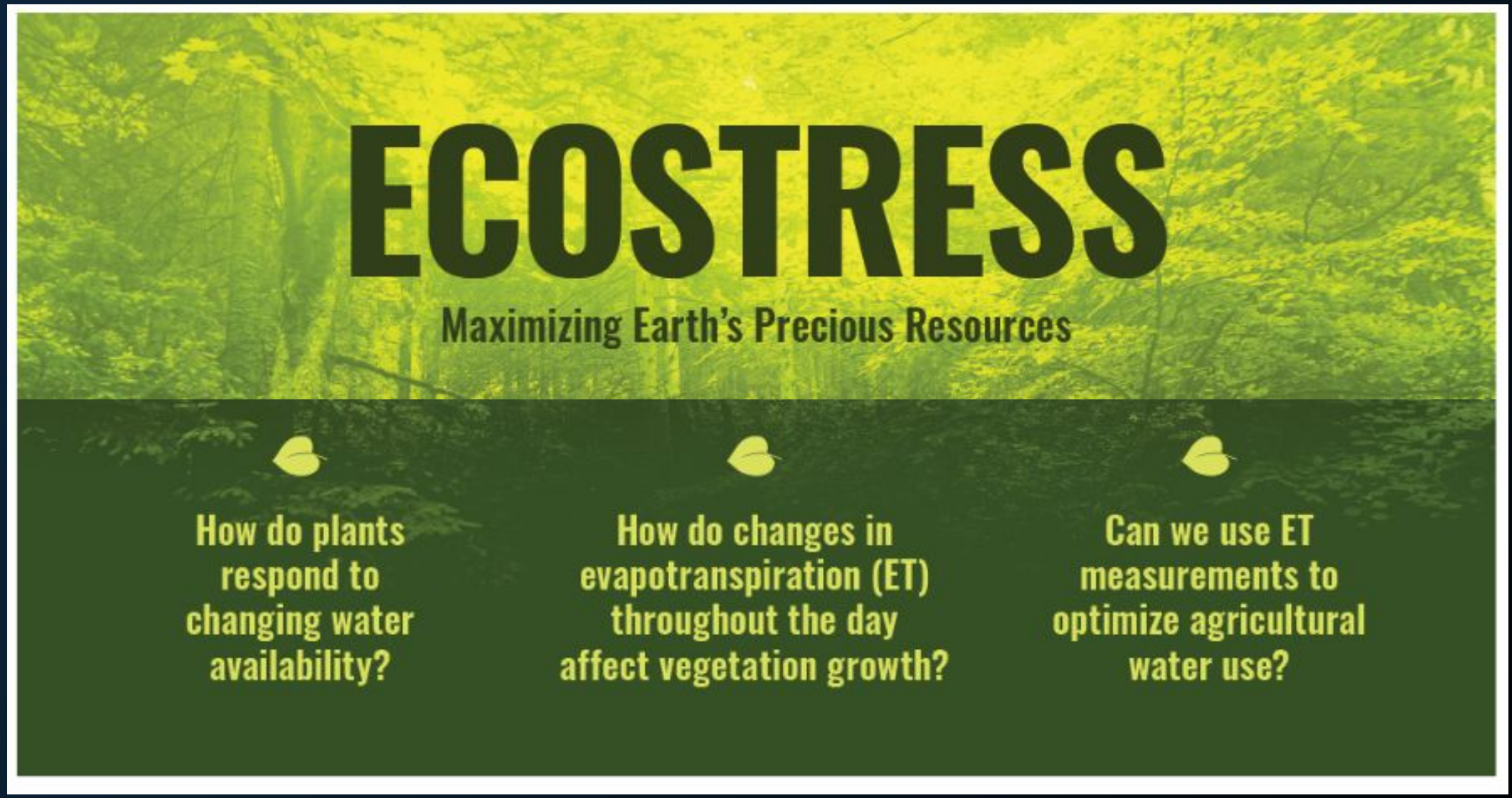
- Selected July 30, 2014
- Launched June 29, 2018 to the ISS
- Began operations August 20, 2018
- 30 M$ Cost Capped, on schedule, on budget
- Measures surface temperature (5 bands, 8-12 micron)
- More information at: https://ecostress.jpl.nasa.gov



70-m spatial resolution, ~weekly revisit

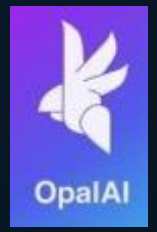
Products: Calibrated Radiance and Geolocation, Land Surface Temperature and Emissivity, Evapotranspiration, Water Use Efficiency, Evaporative Stress Index

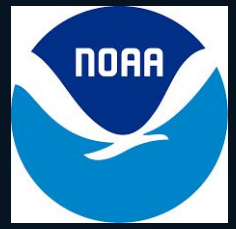
ECOSTRESS


ECOSTRESS
Maximizing Earth's Precious Resources
How do plants respond to changing water availability?
How do changes in evapotranspiration (ET) throughout the day affect vegetation growth?
Can we use ET measurements to optimize agricultural water use?

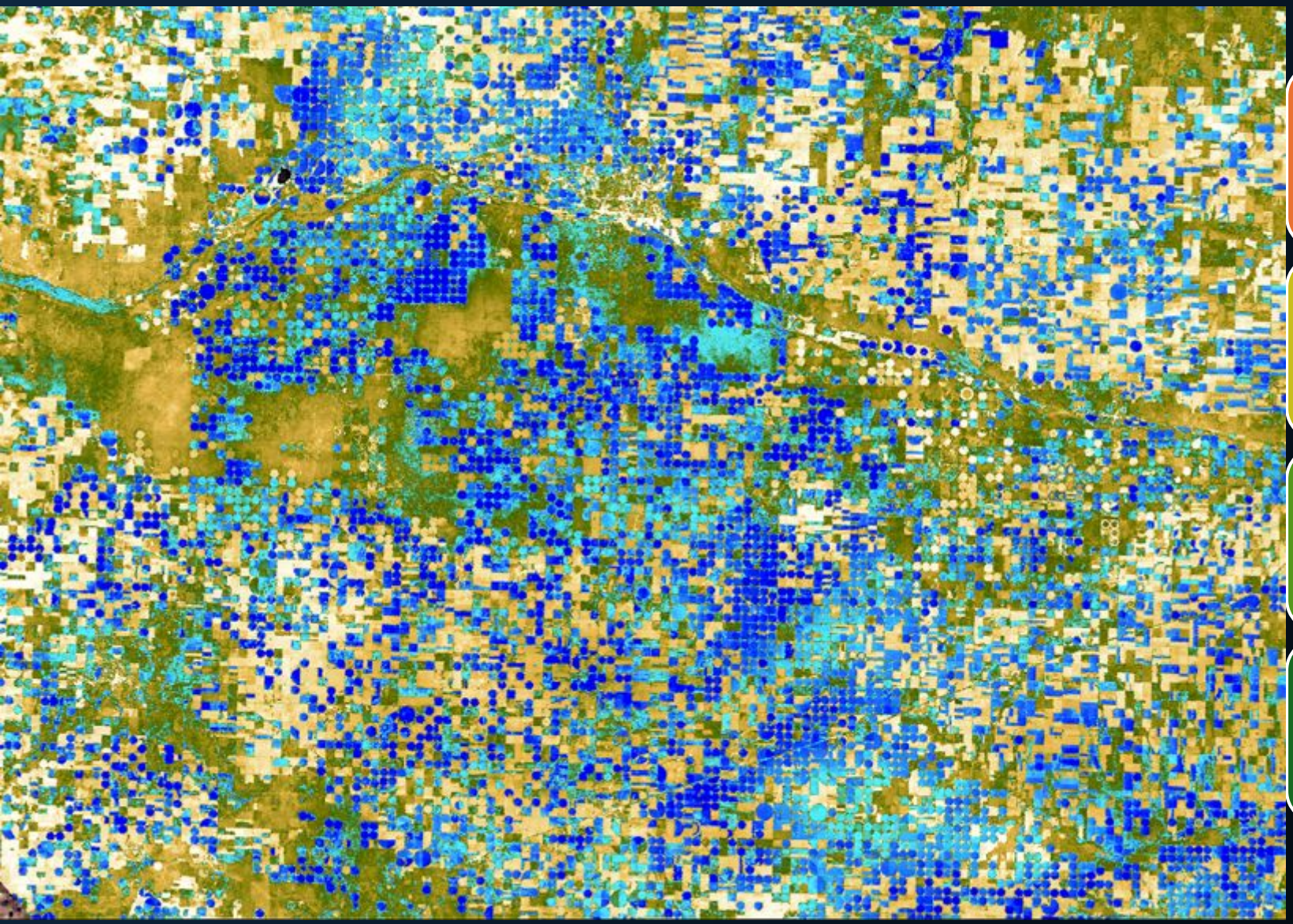
ECOSTRESS Early Adopters

- Grassroots: Early Adopters (and Community of Practice) had 300+ participants
- Listened and incorporated: new community tools, product improvements
- New applications and impacts: use of data by public and private entities





Part of Core Mission: Agriculture



ECOSTRESS produces an evapotranspiration (ET) product, which is a measure of plant water use

ECOSTRESS ET can be used to optimize irrigation strategies in agriculture

Thus, we can maximize crop yields “per drop”

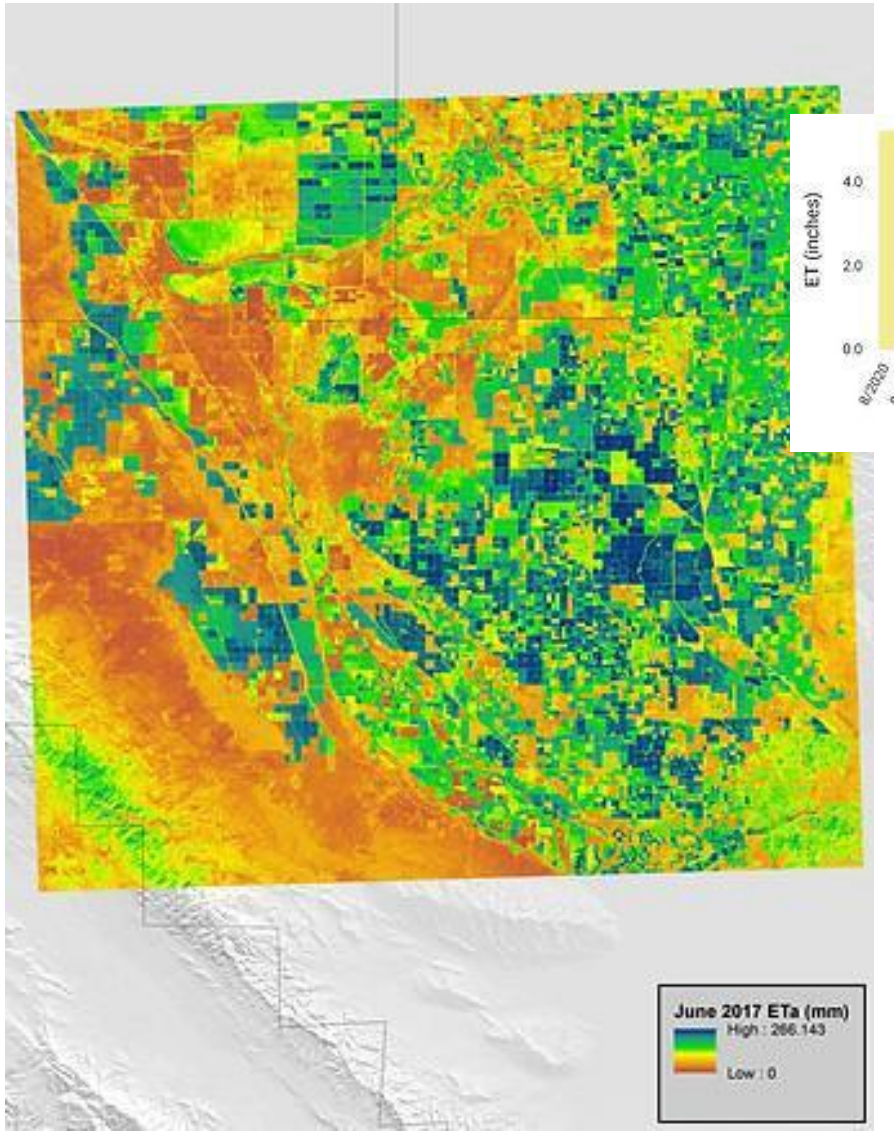
*Blue colors show higher water-use, and beige colors show low water-use

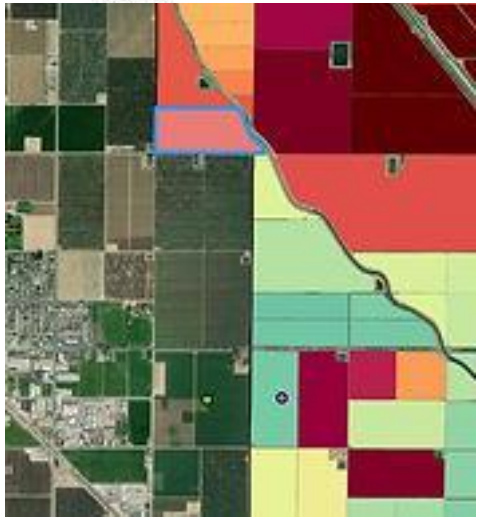
Application: Irrigation Optimization

ECOSTRESS monitors water use in California central valley

Land IQ uses ECOSTRESS surface temperature as one of its inputs to produce field-by-field evapotranspiration for 3.3M acres in the Central Valley of California. These data are used by 40 groundwater sustainability agencies and irrigation districts to support overall water management, regulatory compliance, fee structures, water trading, and land management decisions related to California's Sustainable Groundwater Management Act implementation.

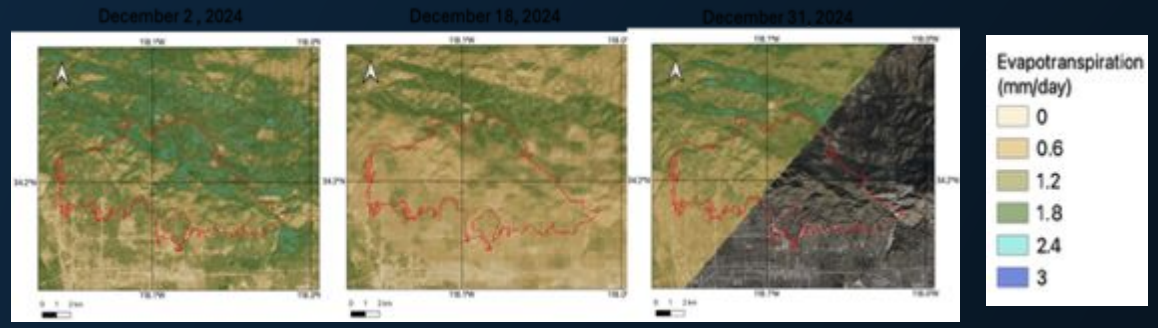
- Joel Kimmelshue, LandIQ



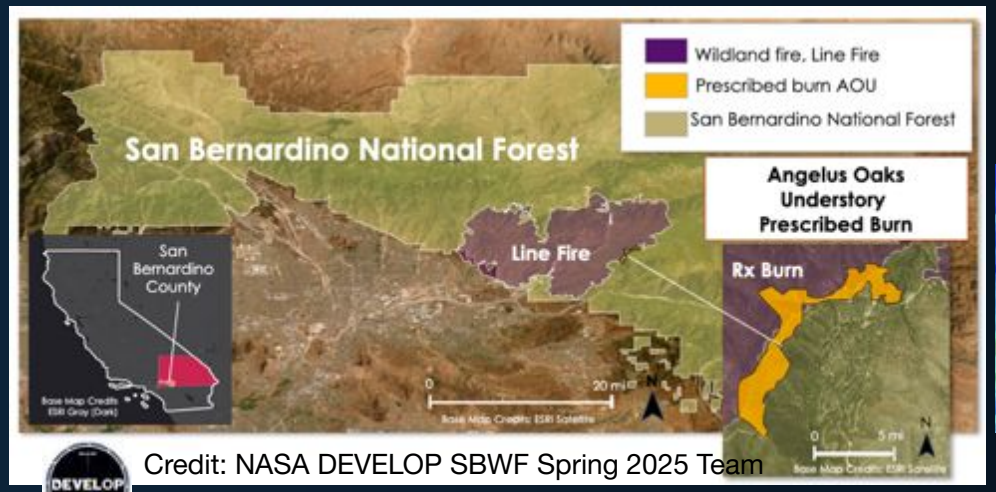


Wildfire applications

ECOSTRESS reveals pre-fire vegetation stress and condition within fire perimeter

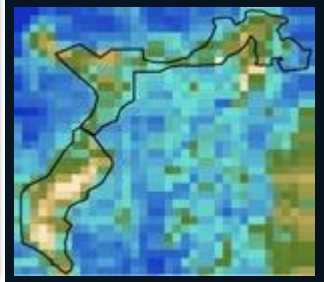


Post wildfire recovery and vegetation mapping can be used to assess pre-fire fuels treatment



Credit: NASA DEVELOP SBWF Spring 2025 Team

ESI 3 months post-prescribed burn

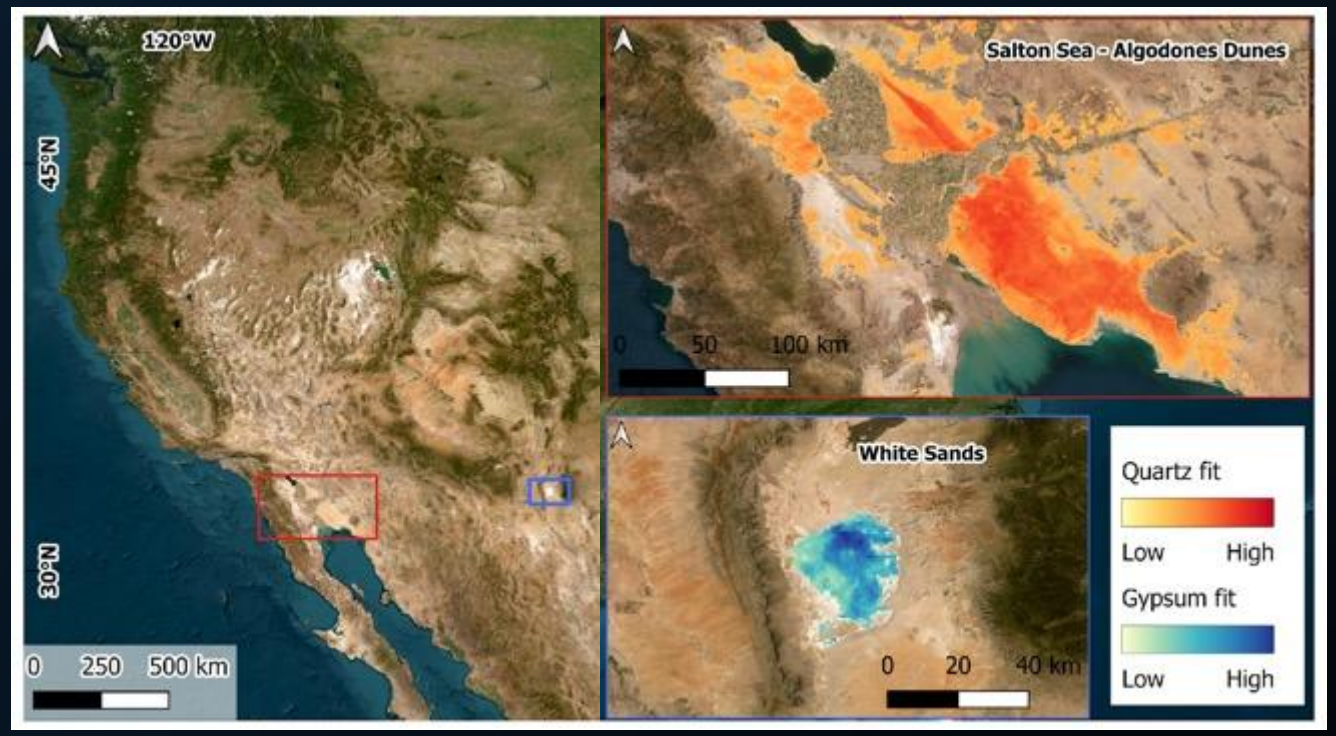


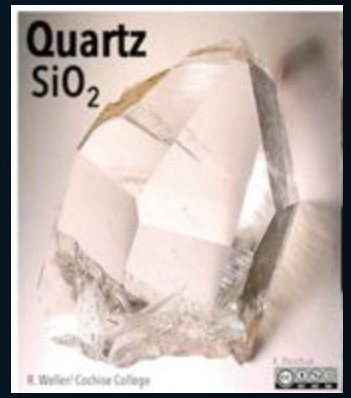
ECOSTRESS can be used to map active wildfires and temperatures

Critical Minerals

Silicates make up approximately 90% of the Earth's crust and are a host for rare earth minerals that are essential for many high-tech devices such as cell phones and electric cars.

ECOSTRESS can be used to detect other mineral classes such as sulfates, whose presence along with other minerals could indicate hydrothermal features with potential for relevant mineral deposits (e.g. porphyry copper deposits, epithermal gold deposits) and energy generation





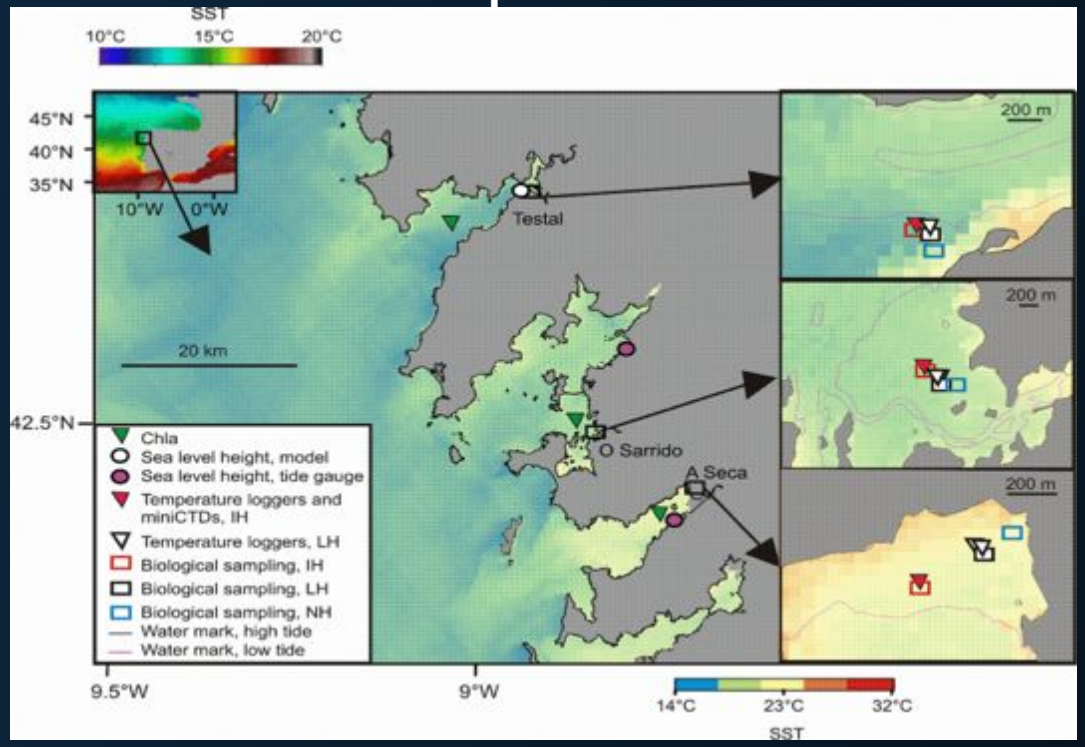
ECOSTRESS can be used to estimate the abundances of silicates based on the distinct spectral features exhibited in the thermal infrared.

Credit: Federico Rabuffi

Urban resilience

ECOSTRESS and coastal resources

Protecting small scale fisheries and shellfish aquaculture



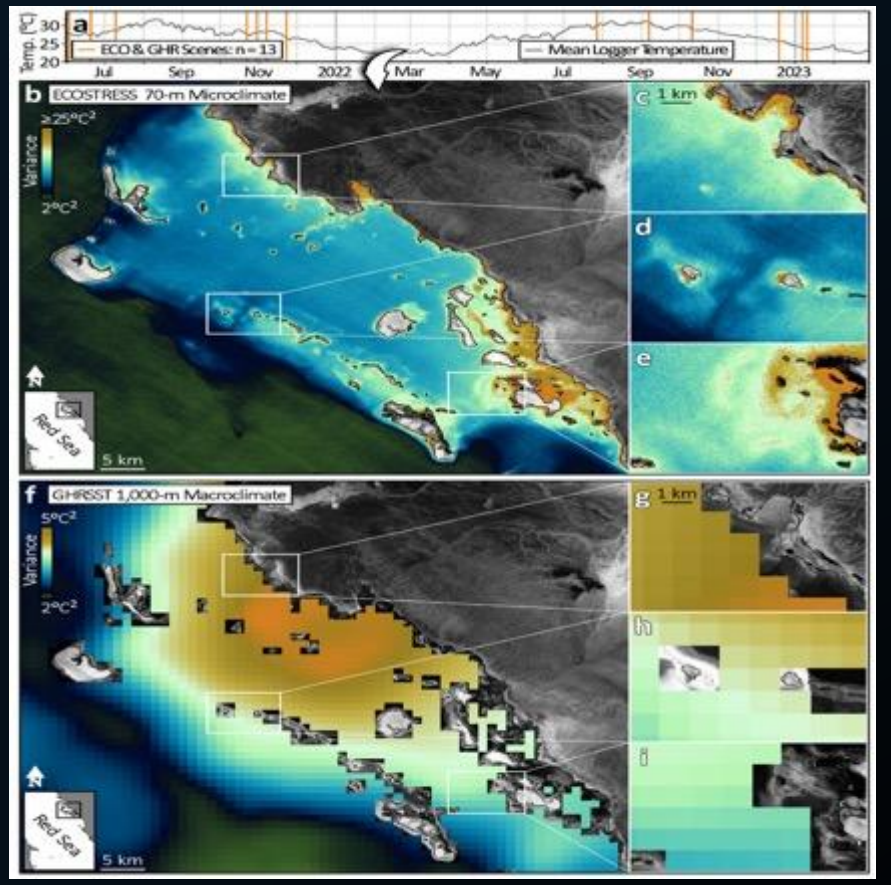
Rev Fish Biol Fisheries
https://doi.org/10.1007/s11160-023-09791-6

ORIGINAL RESEARCH

Population structure and habitat assessment for two commercial clam species exploited in small-scale fisheries

Salvador Román · Celia Olabarria · Nicolás Weidberg · Marta Román · Elsa Vázquez

Healthy corals and ecosystems: protecting coastal resources and tourism economies



Longenecker, J., Benzoni, F., Dunn, N., Fox, H. E., Gleason, A., Otis, D., ... & Purkis, S. J. (2025). Coral reef thermal microclimates mapped from the International Space Station. *Coral Reefs*, 1-18.

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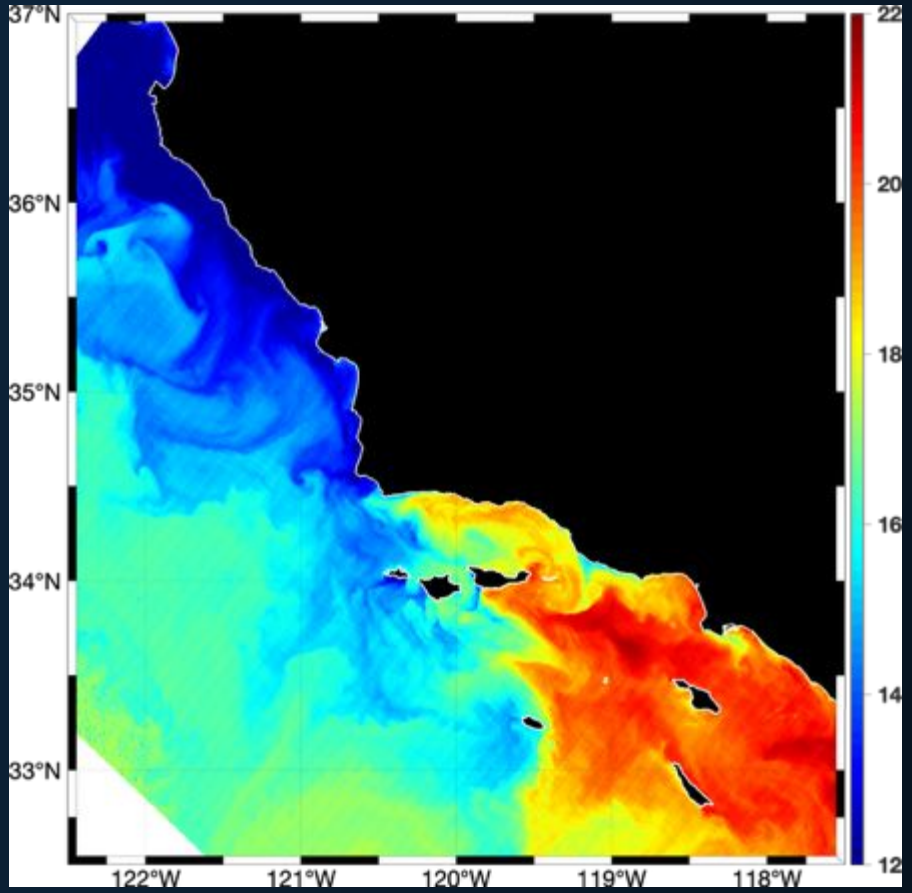
ECOSTRESS and coastal resources



Credit: D. Otis

Aquaculture Opportunity Atlas Sites

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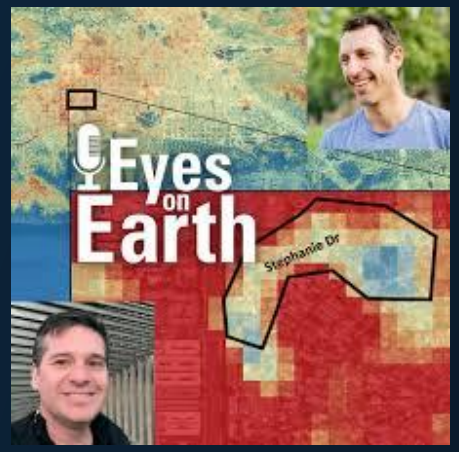
Responsive Science for Society: actionable and timely information



CITY OF LOS ANGELES STREETS LA

Glynn Hulley (JPL), and partners at City of Los Angeles, use SBG precursor measurements for heatwave mitigation to secure funding for urban resilience projects

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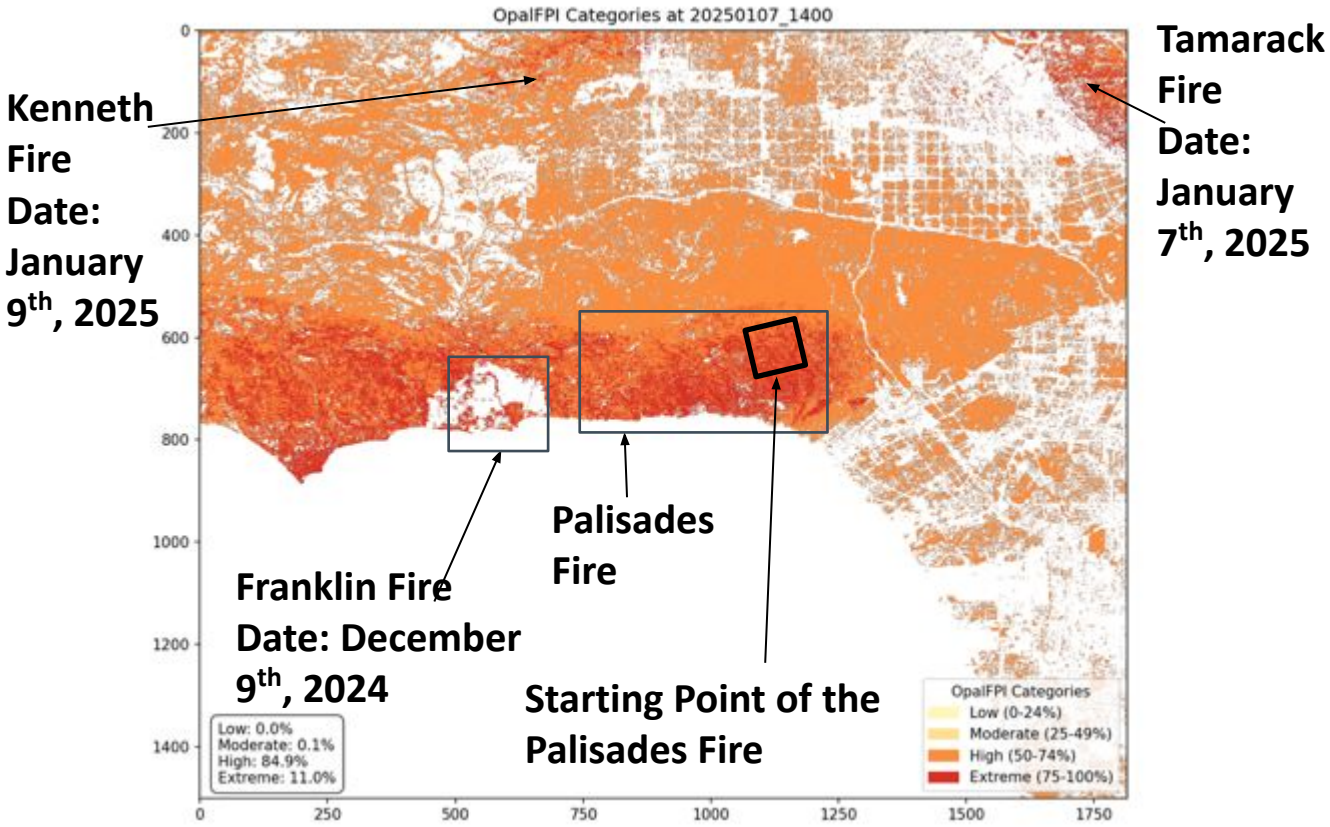
LA wildfires in early 2025

Opal Fire Potential Index

(applied in Palisades)

Firm: OpalAI Inc.
Proposal Title: FireVision: A Vision Language Model for Burn Decision Support Using NASA Earth Science Data
Funded by NASA IGNITE SBIR



- **ECOSTRESS evapotranspiration from before the fire were used to create the Fire Potential Index.**
- **Local governments, fire departments, and utility companies.**

"We are using ECOSTRESS data in our Fire prediction OpalAI tool. By using ECOSTRESS data with other variables, we were able to accurately predict wildfire hazard for LA Fires" –Ryan Alimo (Opal AI Co-Founder & CEO)

Temporal Evolution of Fire Potential Index in Palisades area from 6th to 7th January 2025

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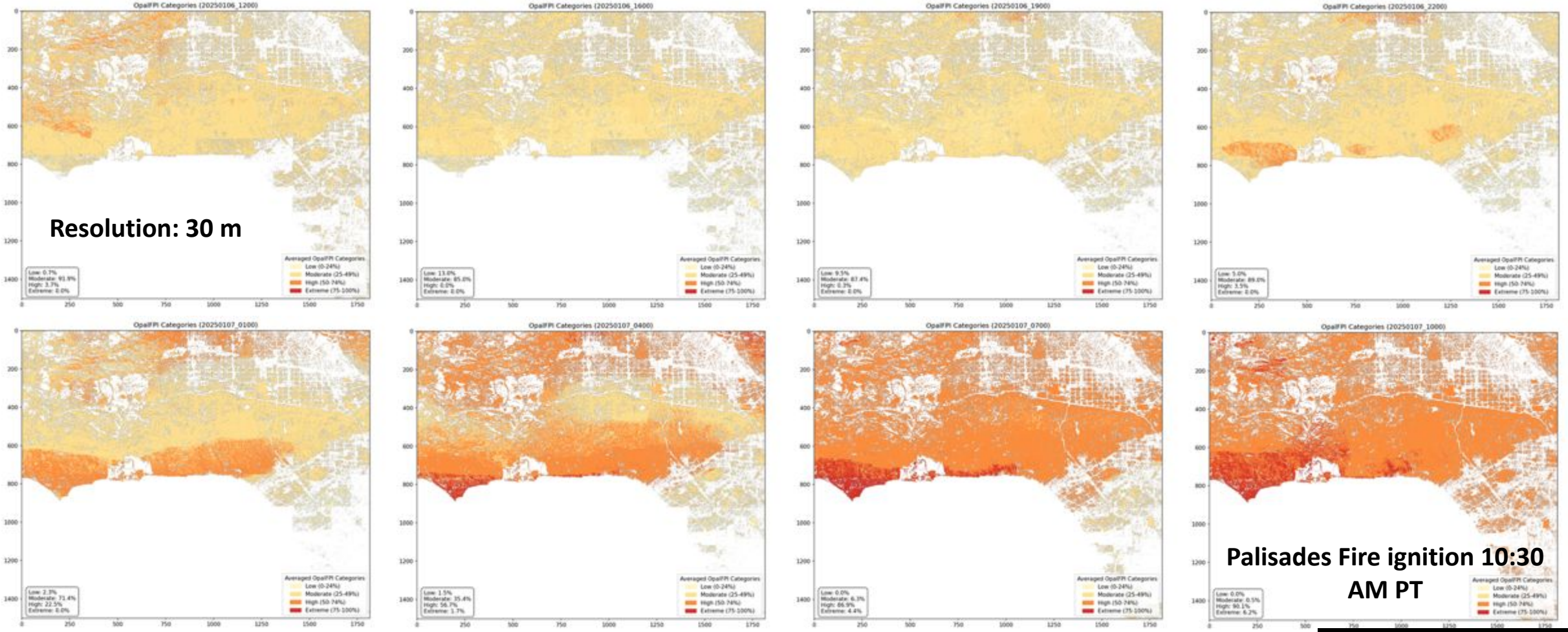
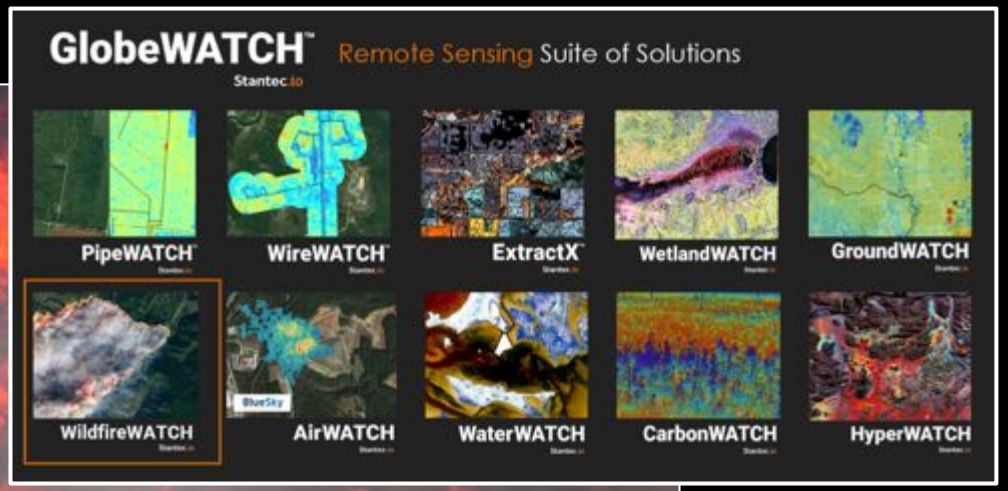
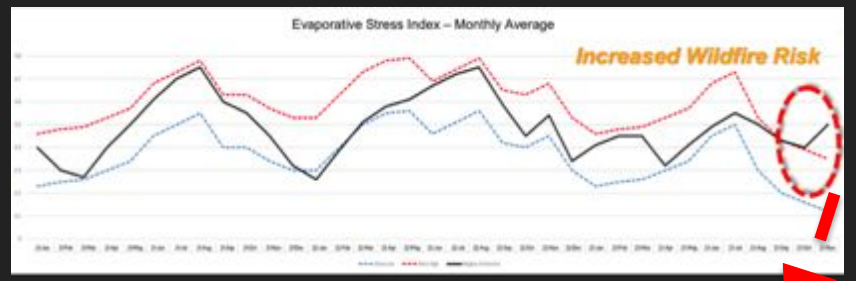
Proposal Title: FireVision: A Vision Language Model for Burn Decision Support Using NASA Earth Science Data
Funded by NASA IGNITE SBIR



WildfireWATCH identifies locations with increased wildfire susceptibility using ECOSTRESS ESI data and serves Stantec's power utility, insurance, and government clientele





The figure to the right uses ECOSTRESS to highlight areas of drier vegetation (in red), which may lead to greater wildfire severity.

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Cross-mission collaboration example

Key Takeaway: NASA data can be used to reduce fire hazards and understand fire impacts by tracking pre fire conditions, active wildfires, and post fire recovery.

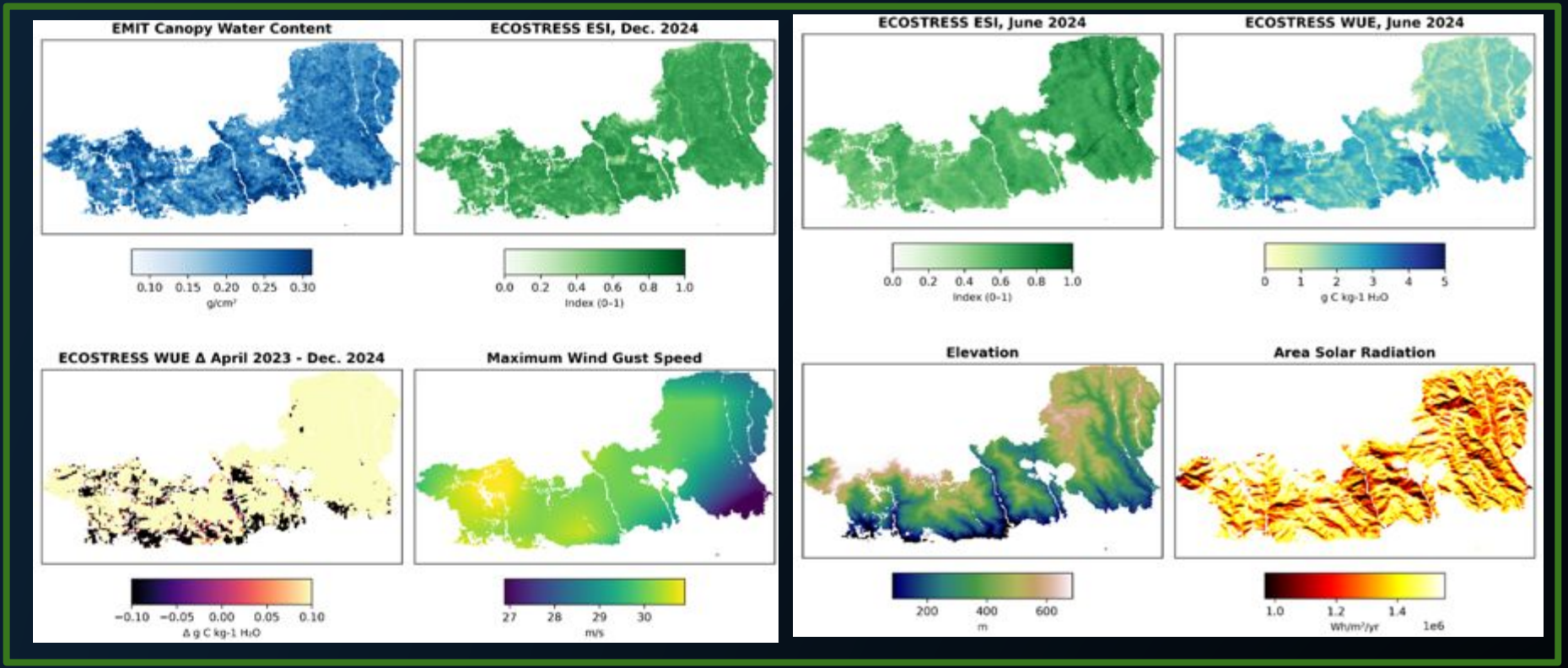
Pre-fire fuels, critical for assessing wildfire risk and predicting burn severity, include: vegetation type, fuel load, fuel moisture, and water content, surface temperature and evapotranspiration

Active fires can be monitored more effectively as well, including hotspots, fire perimeters, and intensity

Post-fire assessments can include burn severity, ecosystem recovery, and downstream hazards such as erosion and water quality impacts

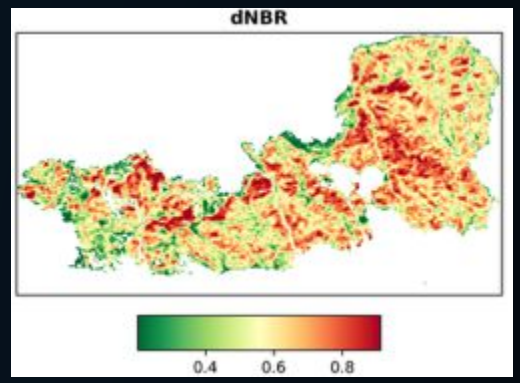
Leveraging unique information from multiple missions

Example: ECOSTRESS and EMIT



Random Forest Regression Modeling

Prefire → Post-Fire



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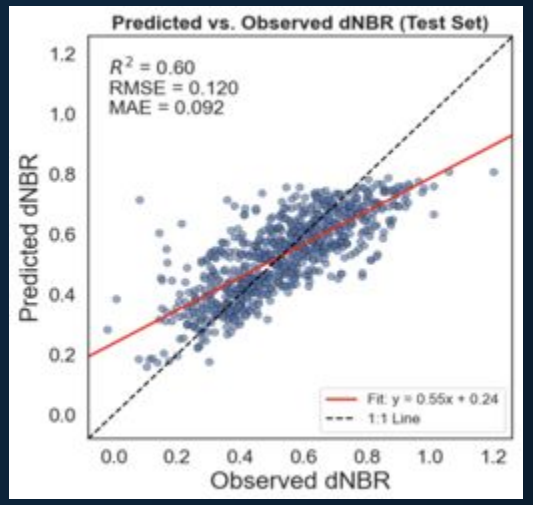
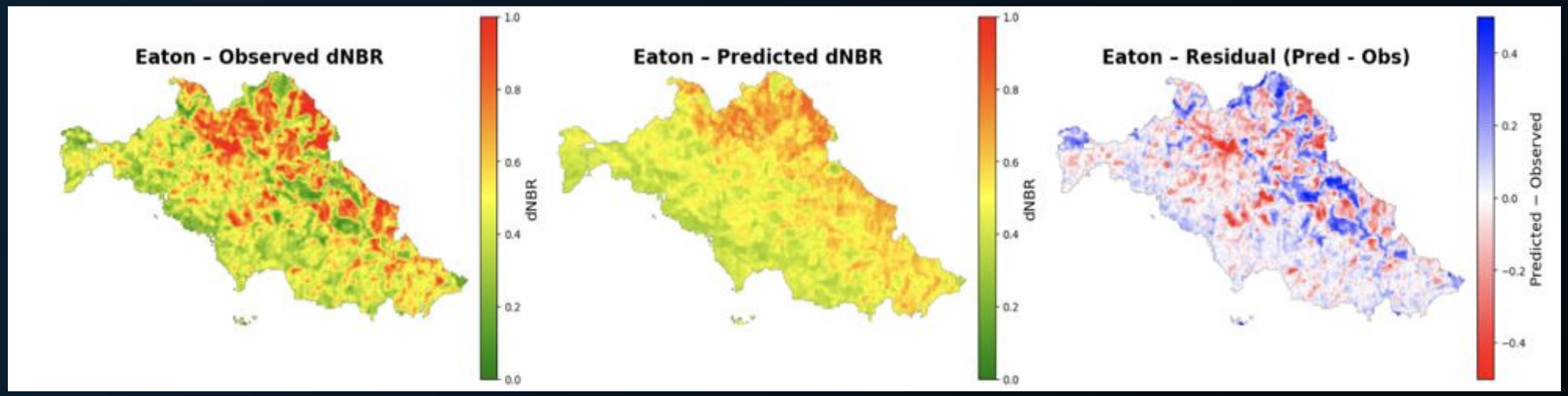
☆ Pre fire fuel states are critical in predicting burn severity





Credit: M. Ward Baranyay

Want to emphasize here is that products from NISAR, GEDI (eg biomass, canopy height) and other sensors could be incorporated, and may further improve model

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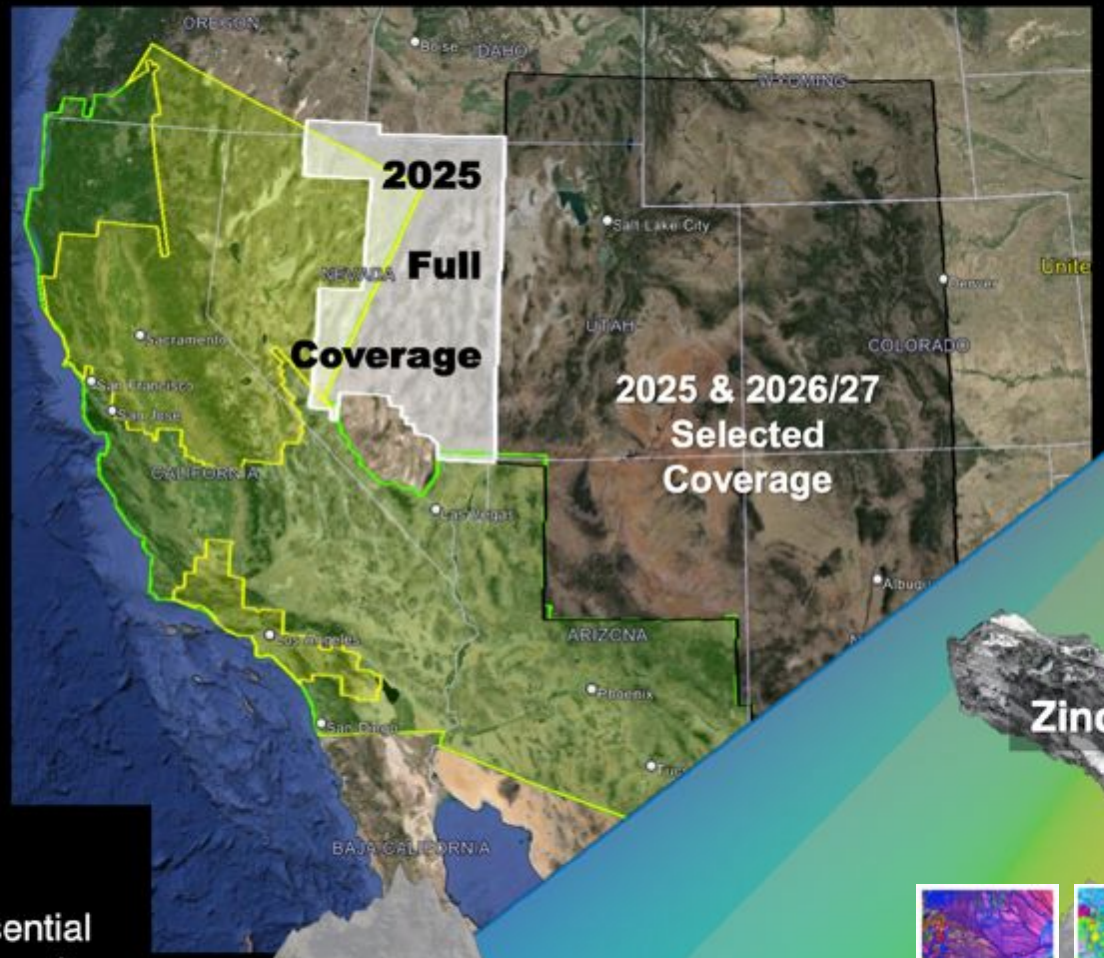
Uncovering Precious Minerals:
NASA and USGS's Mapping Efforts from Above

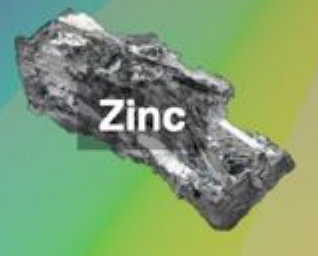
Critical minerals are essential for America's security and prosperity.

NASA and the USGS have embarked on a multi-year survey, called the **GEMx campaign,** to map some of these minerals in the **Western US.**

NASA's advanced instruments AVIRIS and MASTER onboard NASA's near-space ER-2 aircraft use spectral information to find mineral deposits that otherwise would be missed, given the vast area to search.



GEOLOGICAL EARTH MAPPING EXPERIMENT
GEMx
ER-2
AVIRIS-Classic
MASTER
NASA • USGS



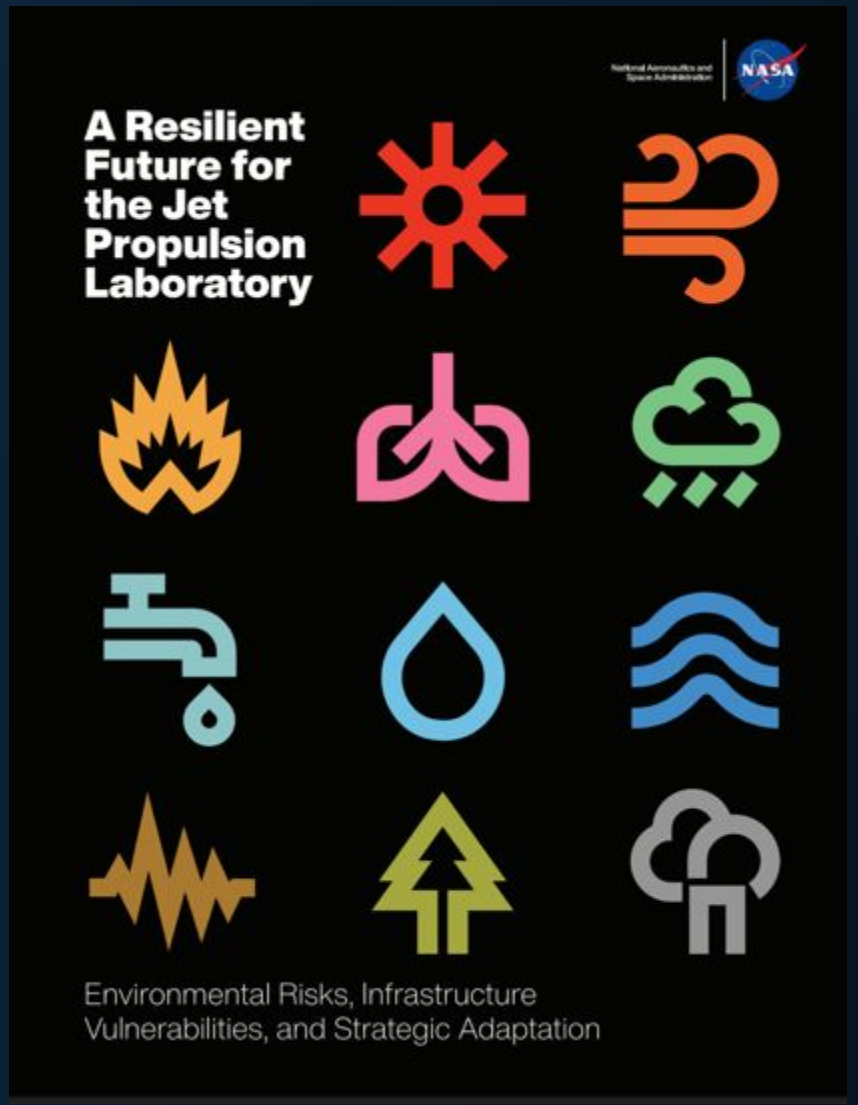
Intrinsic Dimensionality in Combined Visible to Thermal Infrared Imagery

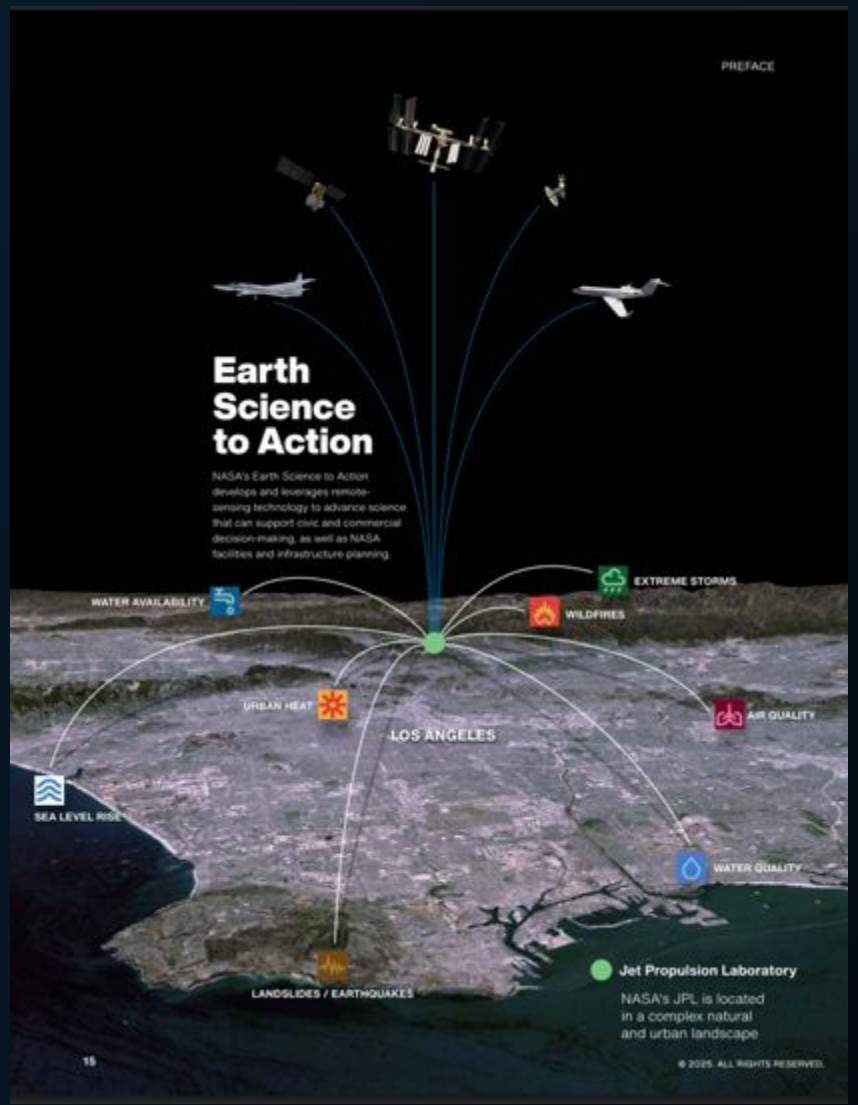
Kerry Cawse-Nicholson, Simon J. Hook, Charles E. Miller, and David Ray Thompson, *Senior Member, IEEE*

Discovering critical minerals and energy resources

Key Takeaway:

NASA is facilitating the identification of essential minerals within the U.S., bolstering both security and prosperity while decreasing reliance on foreign sources.





- NASA Integrated Model and Analysis Projects
- NASA Satellite Projects and Products
- NASA Airborne Projects

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Thank you – questions or follow up

Christine Lee
(christine.m.lee@jpl.nasa.gov)