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Autonomous Measurements and Processing with an end-to-end Cloud-Based Framework

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2023 Global Summit
on Environmental Remediation
@REMPLEX



PNNL is operated by Battelle for the U.S. Department of Energy





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AETHER – Backbone of the Framework In Development Since 2017 – Race to the Cloud!

- Complete framework with access control, file management, and abstracted for custom modules
- 100% Cloud-based, emphasis on serverless architecture
- End-to-end automation of complex, computationally rich algorithms
- Emphasis on business-2-business API, integrated commercial API's and other national labs
- Real-time/near real-time connectivity with streaming data sources
- Enterprise-scale “Production Ready” application suite, extensively tested
- Developed in close collaboration with PNNL Risk and Governance for robust security profile
- Rich distributed compute model with extensive data architecture/modeling for petabyte scale data

AETHER Implementations

PROJECT

Electrical Grid Resilience and Assessment System (EGRASS)

Rapid Analytics for Disaster Response (RADR)

EV-Charging

Chemical Security Mapping Tool (CSMT)

Enhanced Plume Modeling for Rapid Response to Explosives (EPMRE)

Suite Of Comprehensive Rapid Analysis Tools for Environmental Sites (SOCRATES)

National Transmission Expansion (NTP)

OPEN WELL

Western Offshore Wind – Resilience Planning (WOW-RP)

Stakeholder Tool for Assessing Radioactive Transport (START)

DOE/FEMA – Office of Recovery

DOE – Cybersecurity, Energy Security and Emergency Response

Joint Department of Energy and Department of Transportation

DHS – Defense Threat Reduction Agency

DHS – Office of State

DOE – Environmental Management

DOE – Office of Electricity

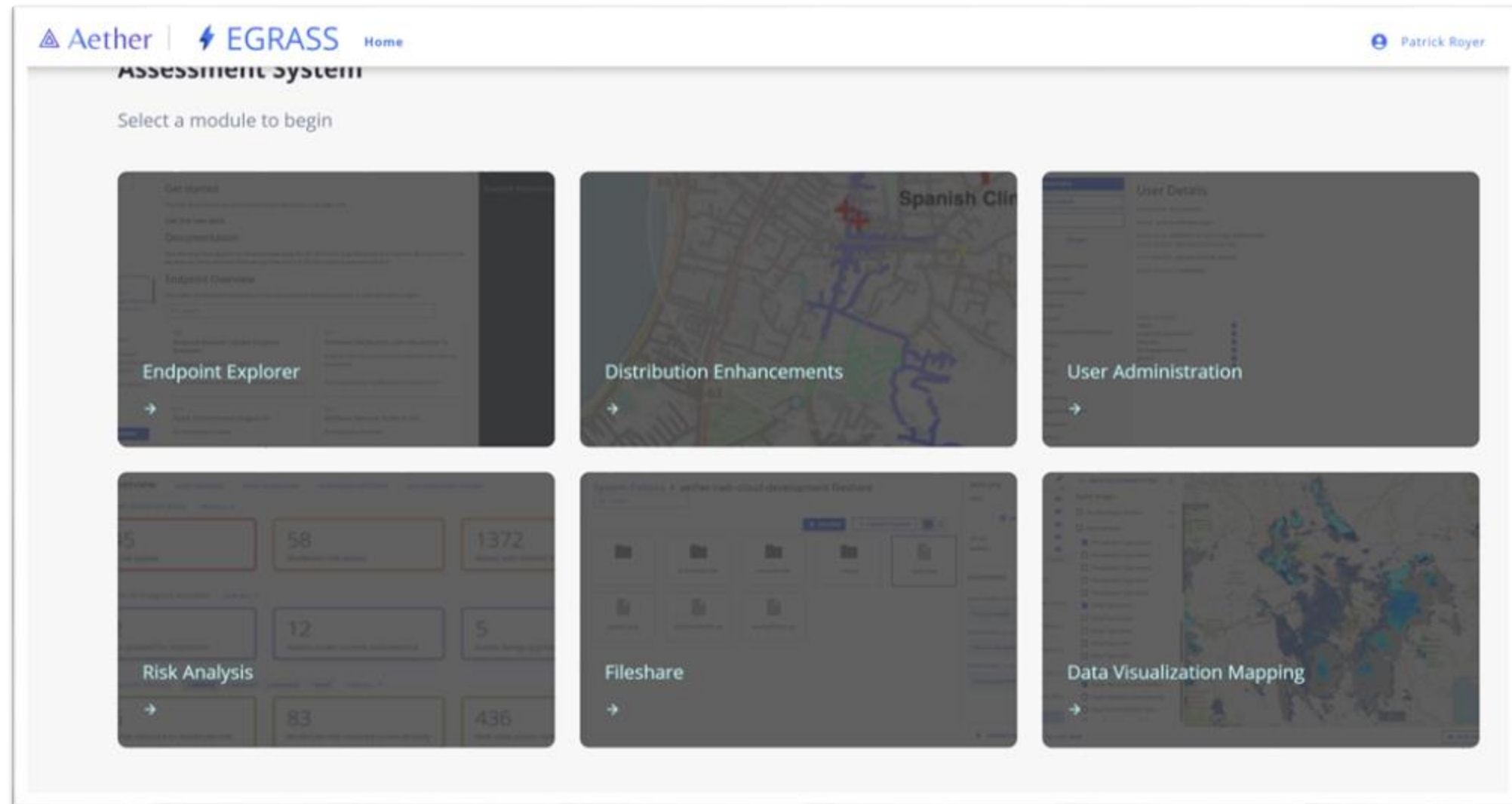
DOE – Environmental Management

DOE - Office of Electricity

DOE – Office of Nuclear Energy



AETHER Landing page





User Admin and access control

- Cognito
- IAM

5

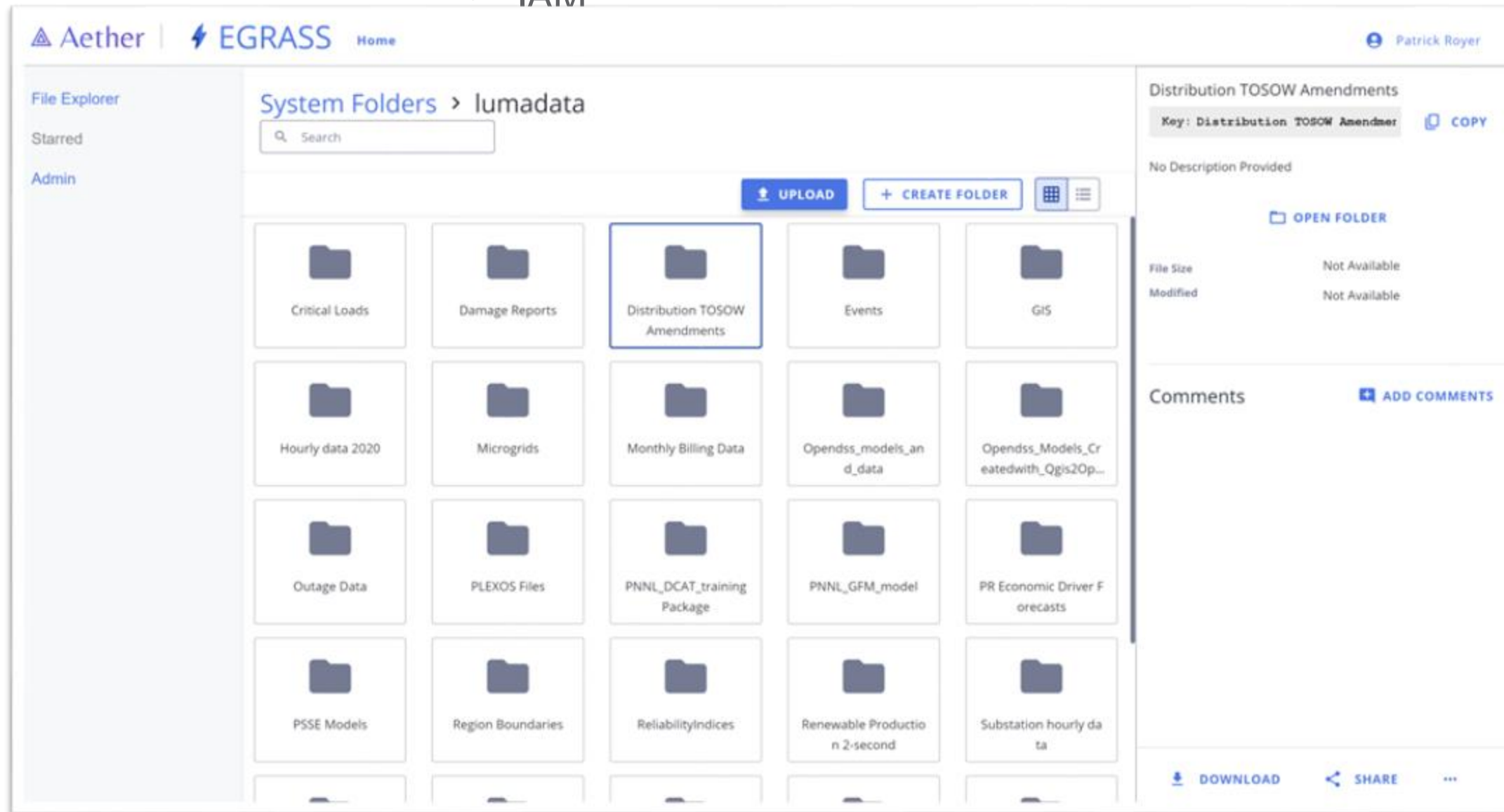


AETHER Universal Modules

File Share

AWS Service Highlights;

- S3
- S3 lifecycle management
- IAM





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AETHER Universal Modules

API Explorer

AWS Service Highlights;

- Lambda
- Aurora

The screenshot displays the Aether API Explorer interface. The top navigation bar includes the Aether logo, EGRASS logo, and a 'Home' link. A user profile for 'Patrick Royer' is visible in the top right. The left sidebar contains a search bar and a list of navigation items: 'Get Started', 'Documentation', 'Endpoint Overview' (selected), 'Default', and 'Request Codes'. The main content area is titled 'Endpoint Overview' and includes a search bar. Below the search bar, there are four endpoint cards arranged in a 2x2 grid. The first card is for a GET endpoint named 'test7' with the route '/api/test/test7'. The second card is for a POST endpoint named 'List File Share Folders/Files' with the route '/api/fileShare/listFileShareFiles'. The third card is for a POST endpoint named 'Get Point of Interest Index' with the route '/api/judgementCalculation/getPointOfInterestIndex'. The fourth card is for a POST endpoint named 'Gets Category Index' with the route '/api/judgementCalculation/getCategoryIndex'. A blue button labeled 'DOCUMENT A NEW ENDPOINT' is located at the bottom left of the main content area. The right sidebar is titled 'Example Responses' and is currently empty.

Aether | EGRASS Home Patrick Royer

Search

Get Started

Documentation

Endpoint Overview

Default

Request Codes

Get started

Describe some popular use cases and have example output on the right side

Documentation

Describe what the endpoints can bring to people using the API. What kind of questions would it answer? What are some of the key features? What are some of the settings? like return to S3, CSV or copy a javascript and such

Endpoint Overview

Description on the method overviews, or how many methods are here currently, or what data does it ingest

Search

GET

test7

test7

Route:/api/test/test7

POST

List File Share Folders/Files

Runs List File Share Files lambda. Returns metadat folders and files present at specified prefix for the specified bucket (Frank Test).

Route:/api/fileShare/listFileShareFiles

POST

Get Point of Interest Index

Gets the index for points of interest

Route:/api/judgementCalculation/getPointOfInterestIndex

POST

Gets Category Index

Runs call to get the list of categories for creating an index.

Route:/api/judgementCalculation/getCategoryIndex

DOCUMENT A NEW ENDPOINT

Example Responses



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Internet of Things (IoT)

Devices with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications network





Remote Sensing offers Invaluable Alternative to Field-Based Monitoring

- Synoptic perspective for detecting changes and variation at different scales
- Return periods ranging from 2 weeks to 1 day depending on location for characterizing temporal trends
- Many data offerings are available at no charge





Projects at PNNL

- Electrical resistivity tomography (ERT) for monitoring groundwater treatment, visualize I near-time results
- Advanced Remote-sensing Image USeR Interface (ARIUS). Thermal monitoring for characterizing ground water flux & radar-based analysis for detecting geologic subsidence.
- Rapid Analytics for Disaster Response (RADR) Early alert for flood detection and disaster preparedness;

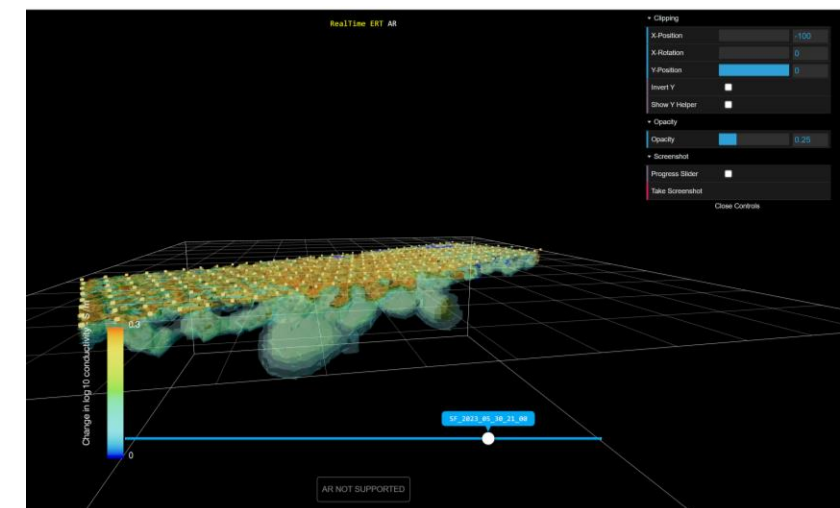
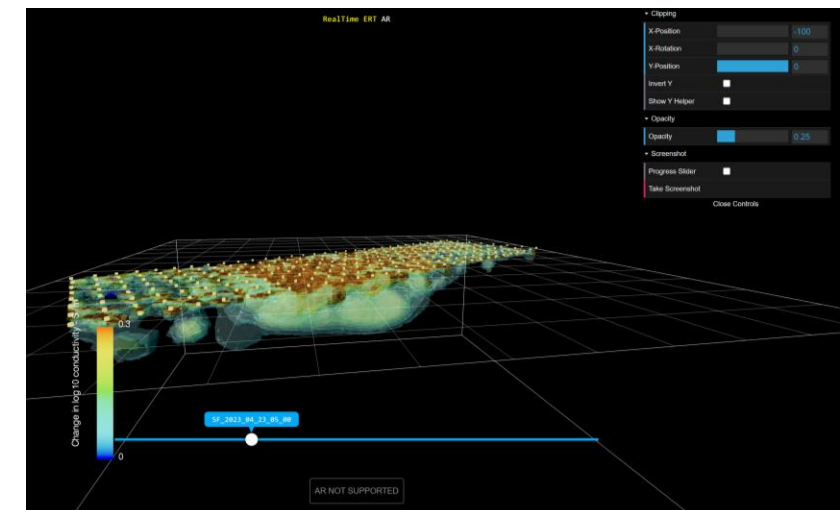
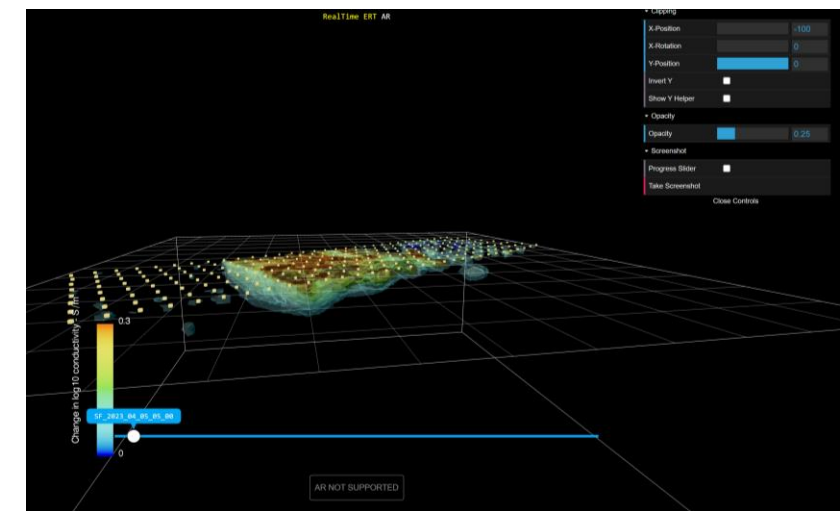




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Real-Time Visualization of ERT During Treatment

- Electrical resistivity tomography (ERT) for monitoring delivery of groundwater treatment for uranium, visualize near-time results





Real-time feeds: Electrical Resistivity Tomography (ERT) Monitoring of Soil Flushing of Chromium

- Soil Flushing
 - Surface infiltration to mobilize residual chromium in soils above the water table
 - Hydraulic capture and treatment of mobilized chromium with groundwater pump-and-treat
- ERT Monitoring Technology
 - Sensitive to changes in porosity, saturation, chemistry and mineralogy
 - Time-lapse 3D imaging using E4D software
- Real-time and Web-based Monitoring Advantages
 - Improved remediation performance evaluations
 - Time-lapse 3D ERT imaging shows spatial and temporal distribution of soil flushing fluids within the targeted treatment zone
 - Guides operational decisions such as surface application rate and duration of flushing
 - Conventional analysis and visualization software (licenses) can be expensive



3D Soil Flushing Monitoring (CPCCo)

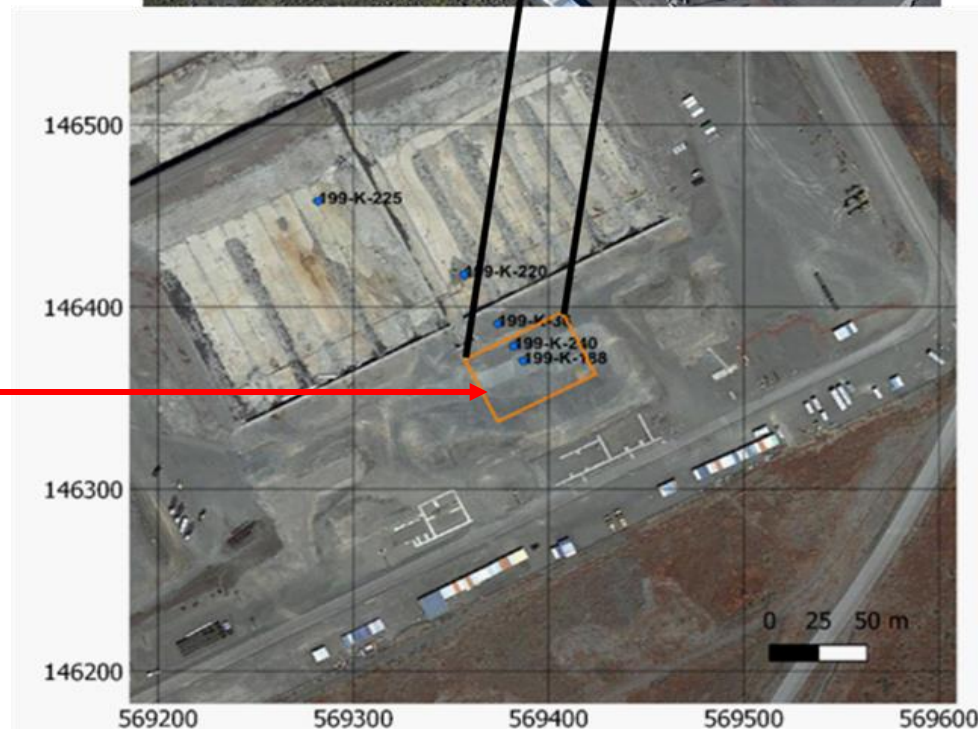
Hanford Site 100-K East Area

Surface ERT Array

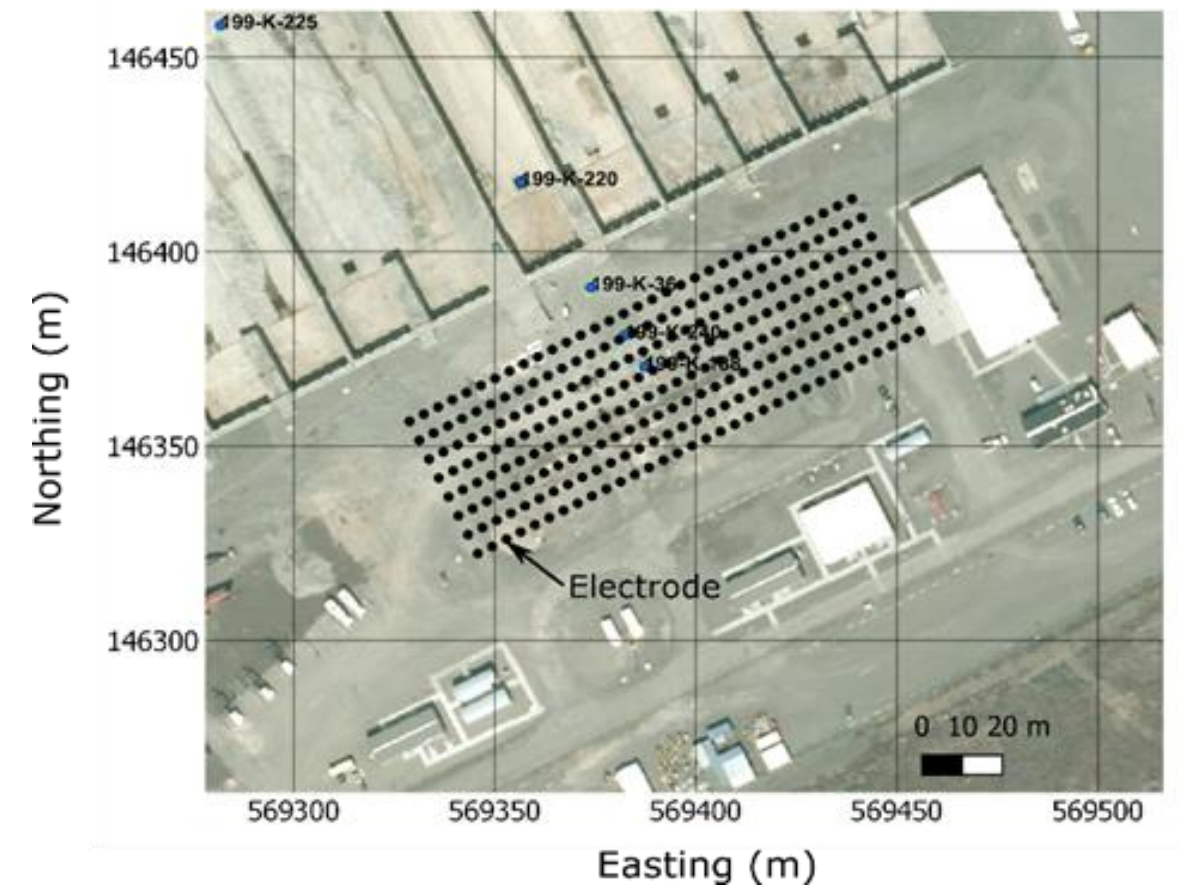
chromium
contamination
excavation



soil flush water
infiltration footprint



A) 256 electrode configuration

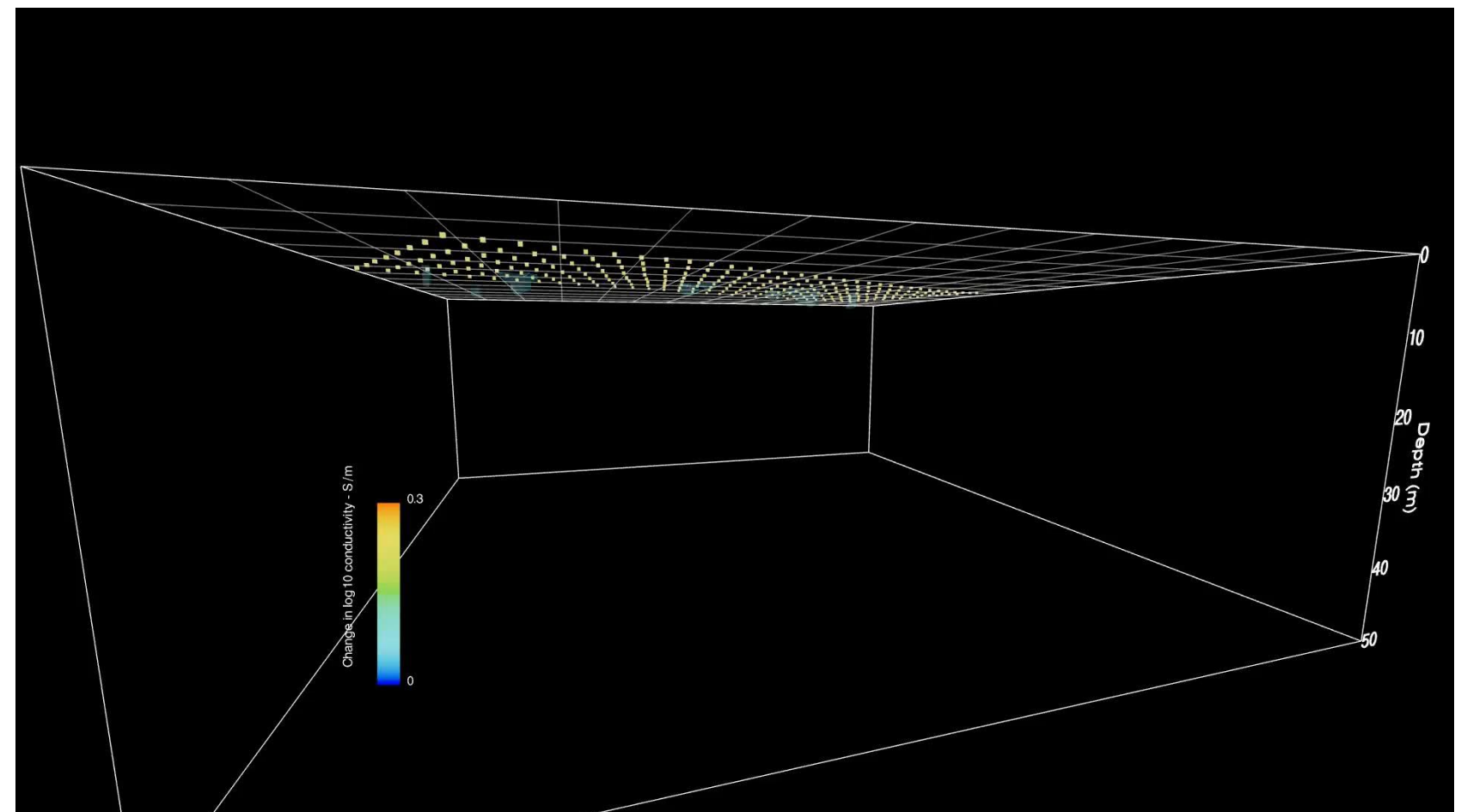
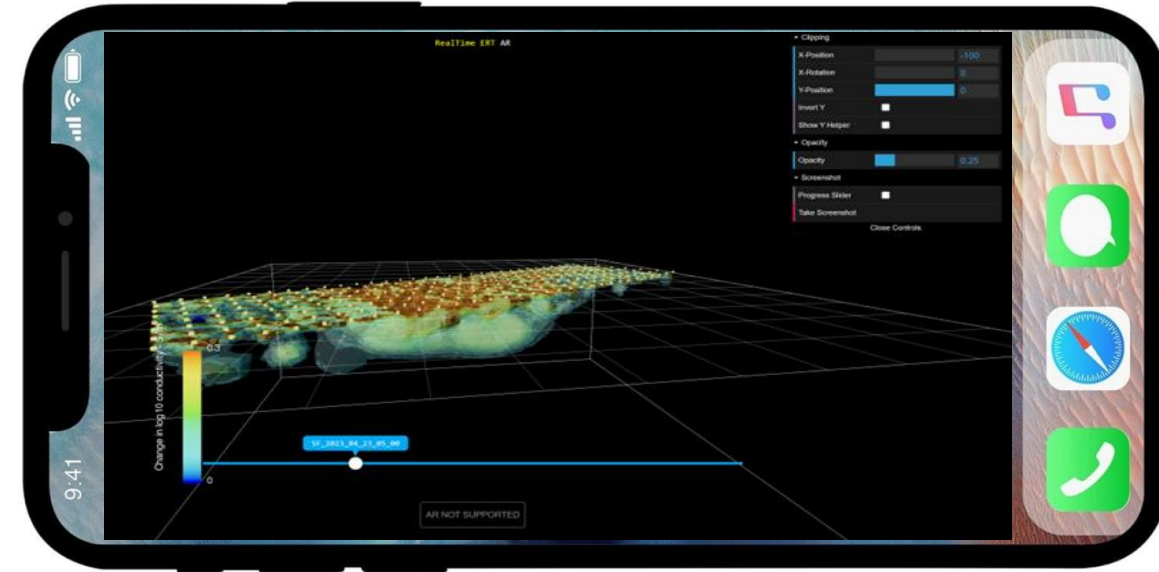
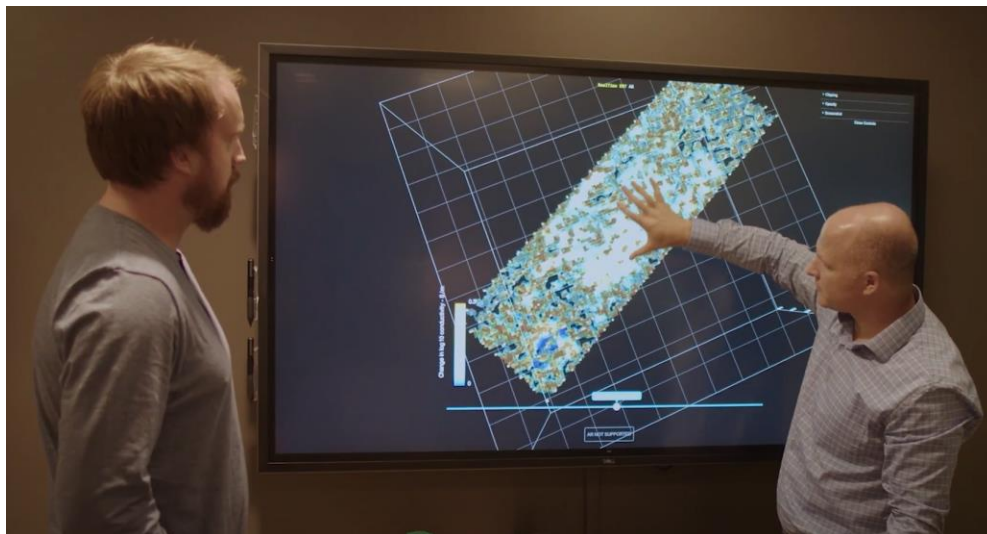




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Real-time feeds: ERT Soil Flushing

- Web-based
 - Built on previous work
 - Fast spin-up
 - Accessible and interactive
 - Real-time data feeds
- Remote user access
 - Increased stake-holder engagement

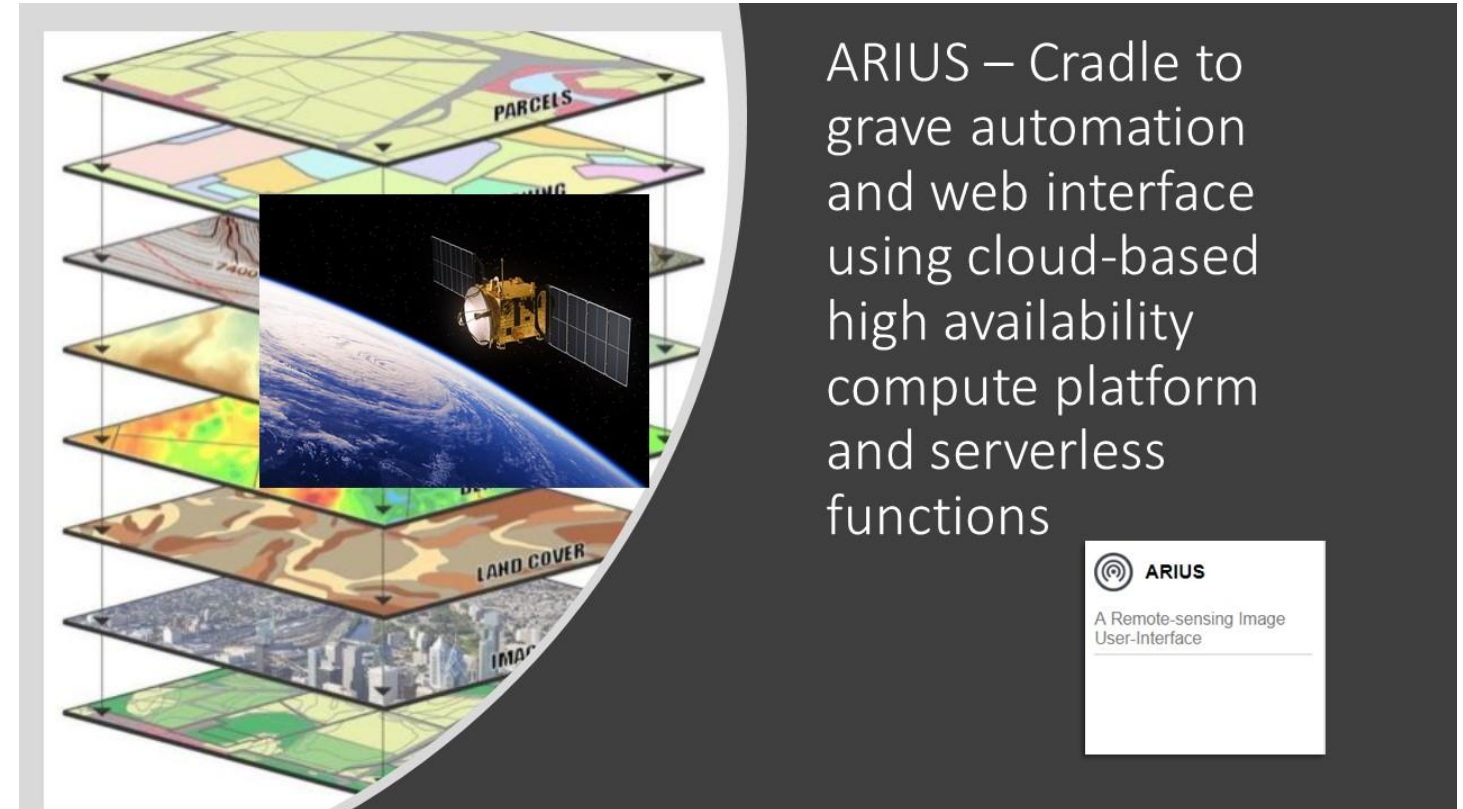




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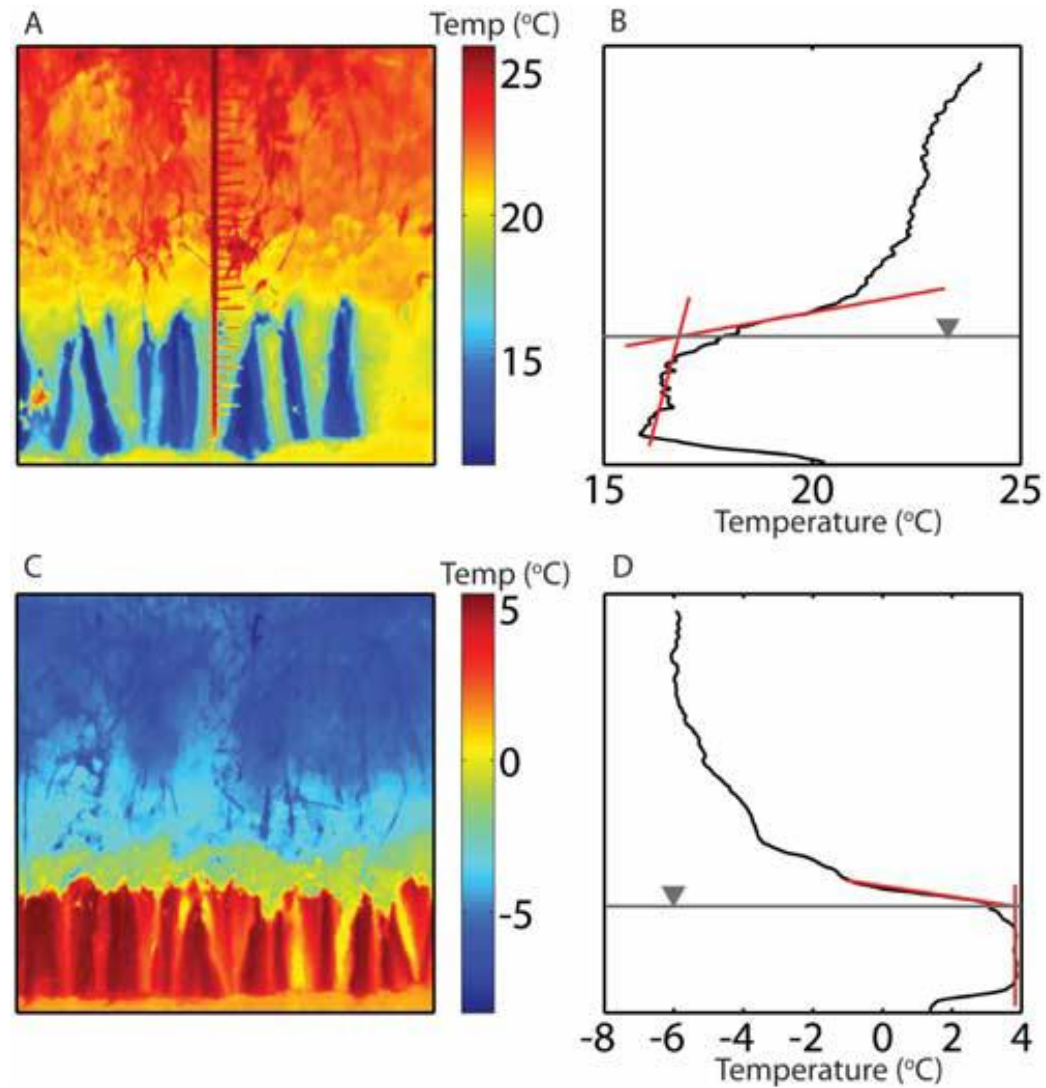
Satellite Data for Characterizing Variation in Columbia River Extent and Ground Water Flux

- Thermal monitoring for characterizing ground water flux & radar-based analysis for detecting geologic subsidence.
- Auto detect new thermal imagery available from Landsat with **queue** in AWS cloud storage
- Auto start satellite data processing and analysis
- Correlation analysis with field-based monitoring
- Alert users that new data is available

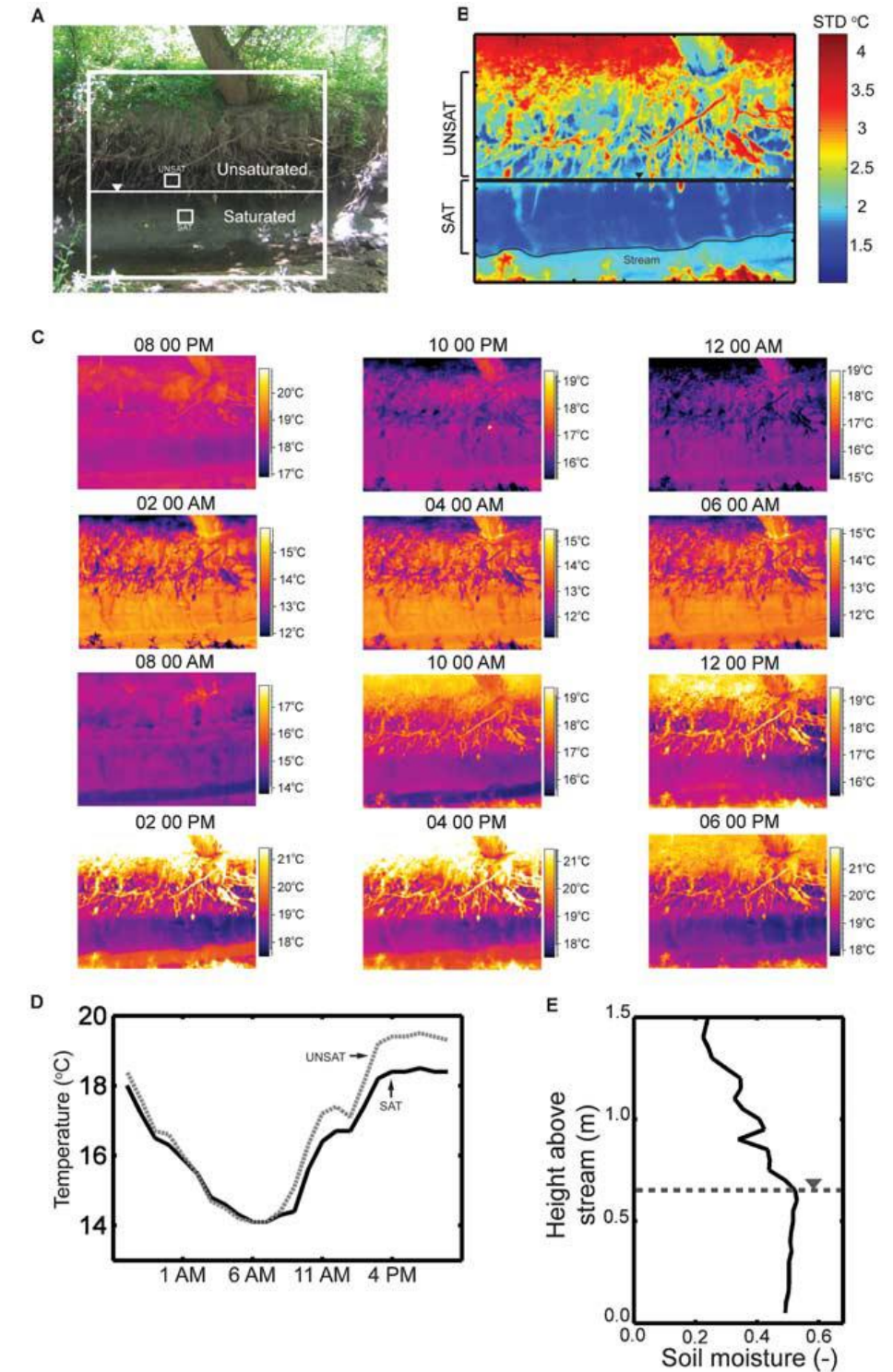




Characterizing Flux with Thermal Data



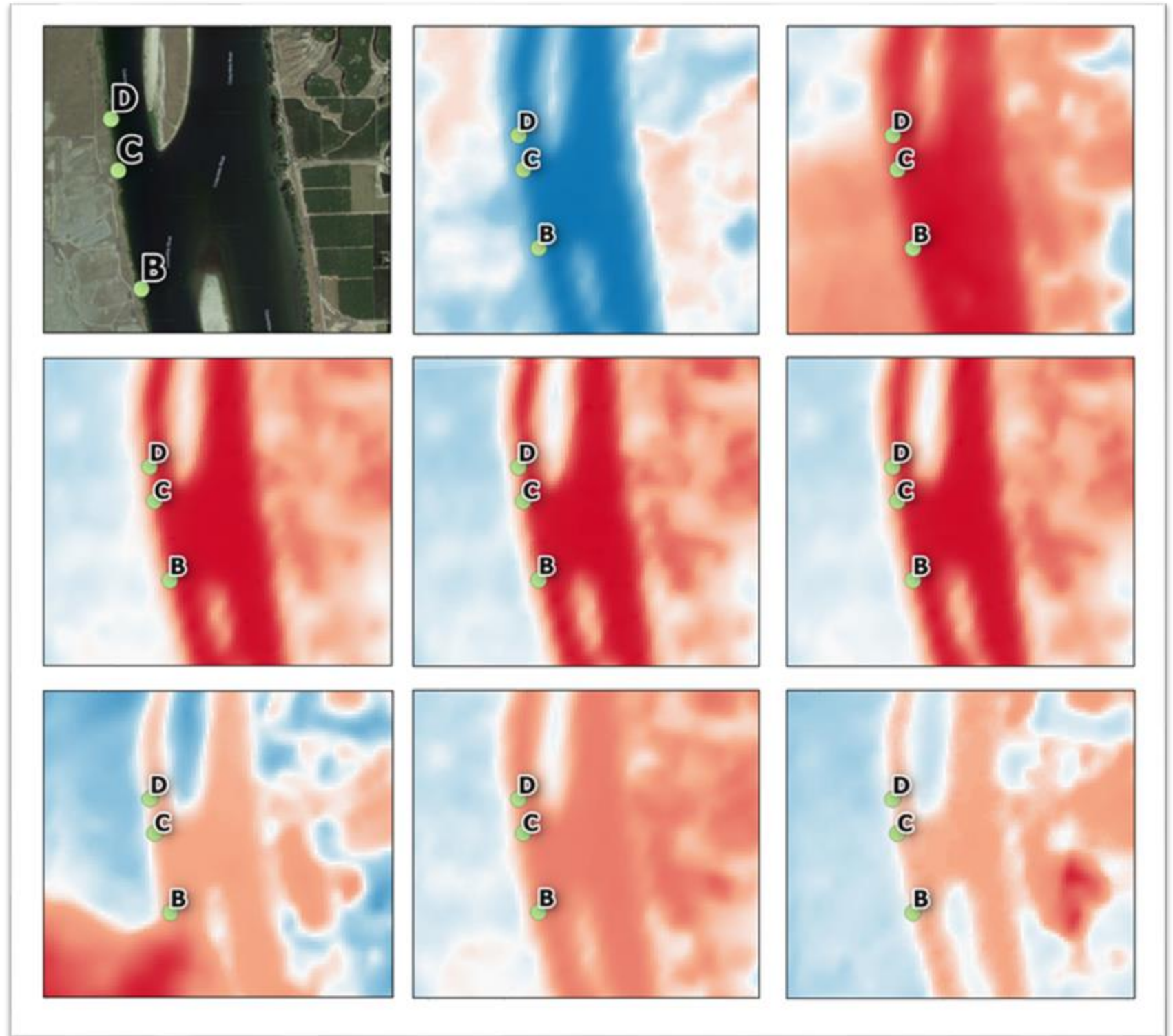
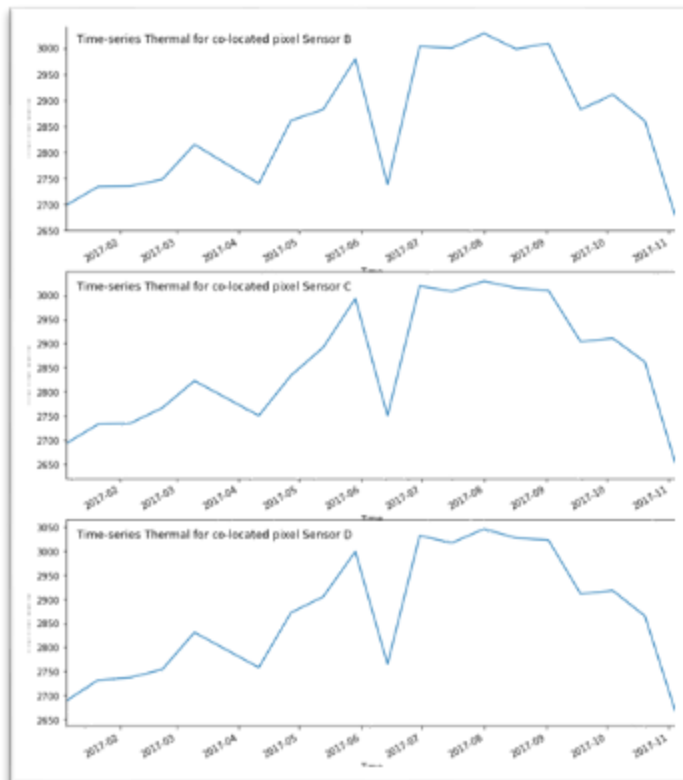
GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L14401,
doi:10.1029/2009GL038103, 2009





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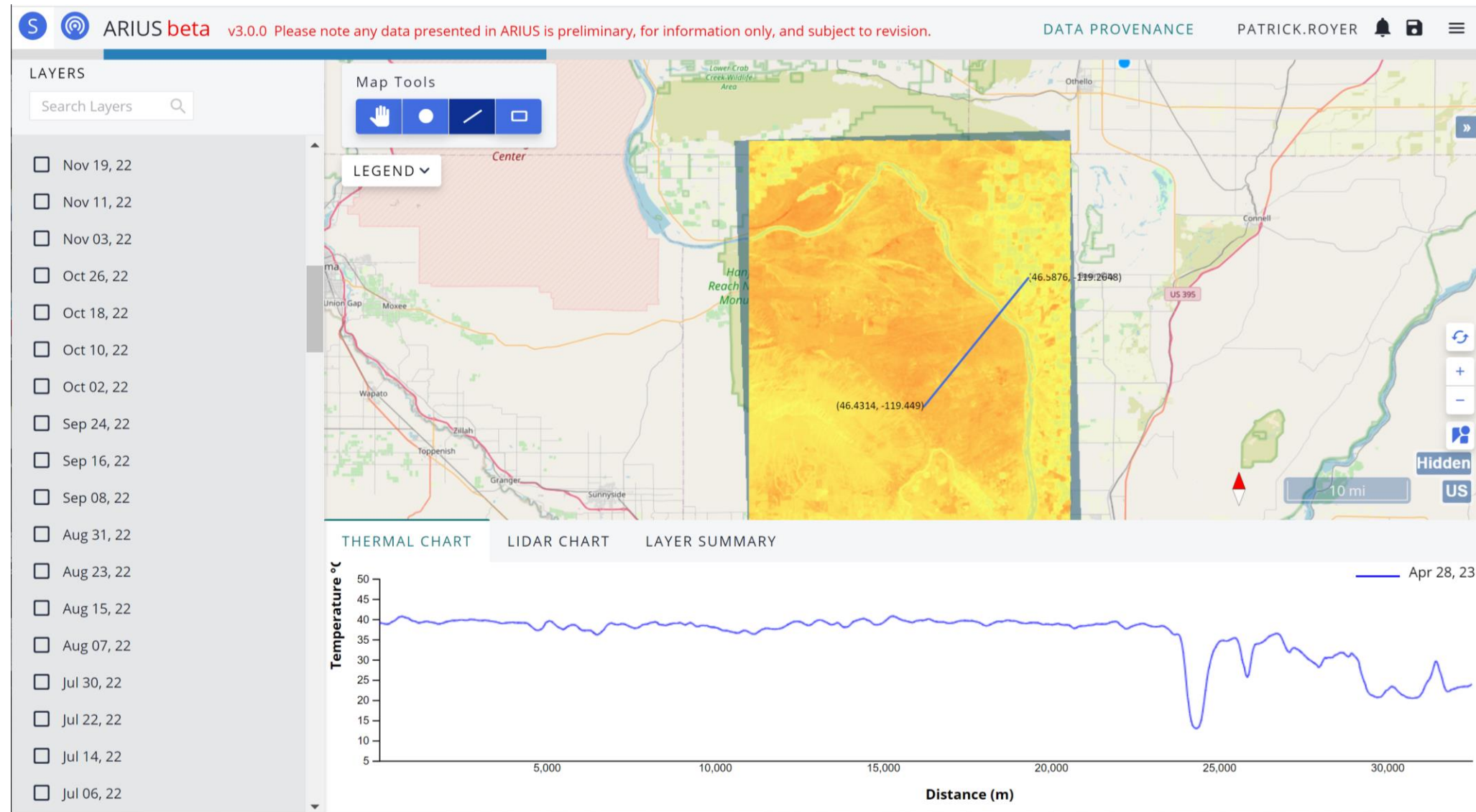
Using Thermal Imagery to Characterize Extent and Ground Water Flux





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ARIUS User Interface and Demonstration



<https://socrates.pnnl.gov/arius/>



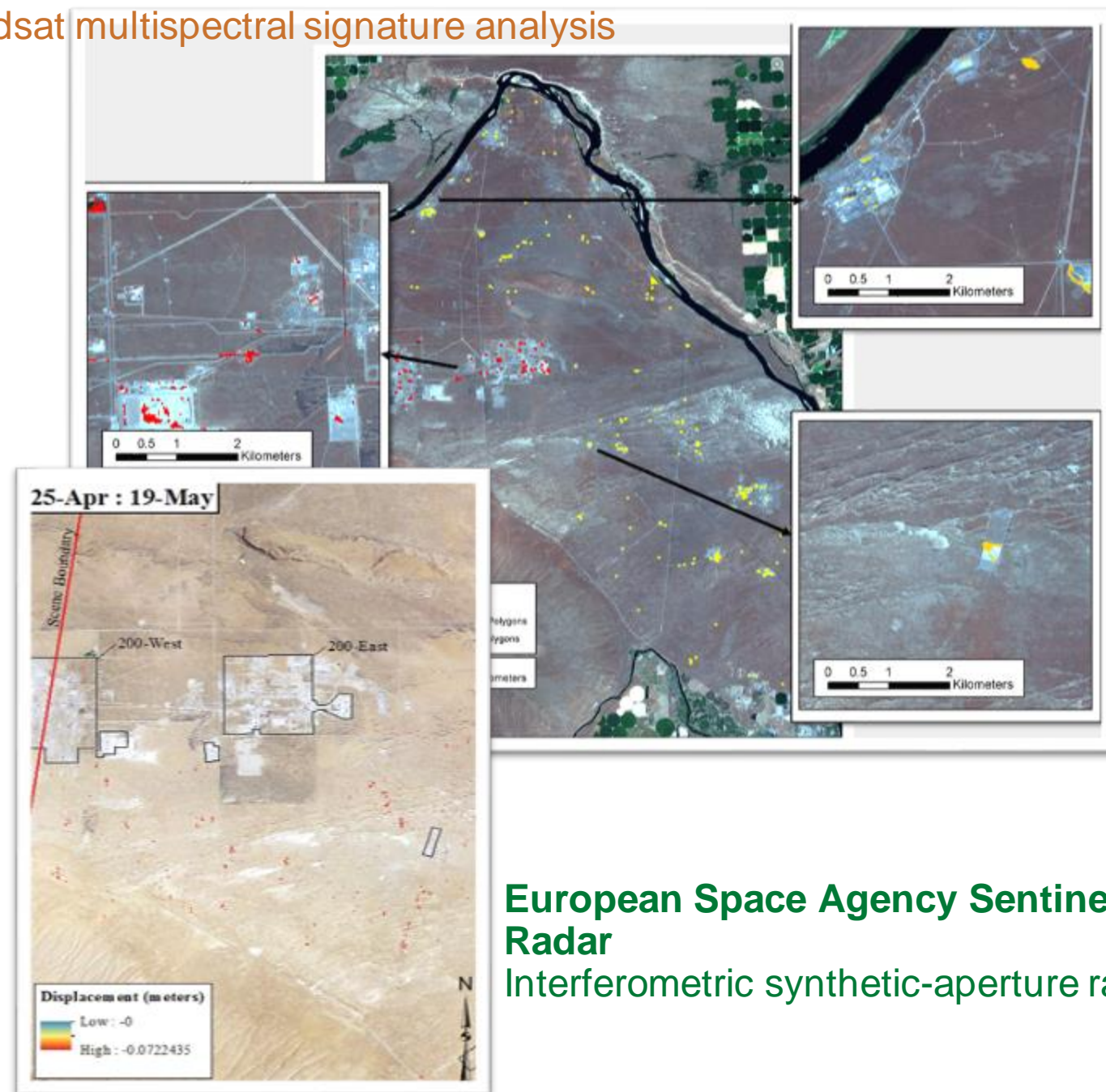
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Using Interferometric synthetic-aperture Radar and Multispectral Imagery to Detect Geologic Subsidence



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Landsat multispectral signature analysis



**European Space Agency Sentinel 1
Radar**
Interferometric synthetic-aperture radar

Tagestad, J., Royer, P., and K. Larson. 2017. *Analysis of Remotely Sensed Datasets to Detect Changes in Waste Sites*. [PNNL-27157](#), Pacific Northwest National Laboratory, Richland, Washington.



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Motivation: Hanford 200 Area Tunnel Collapse in May 2017



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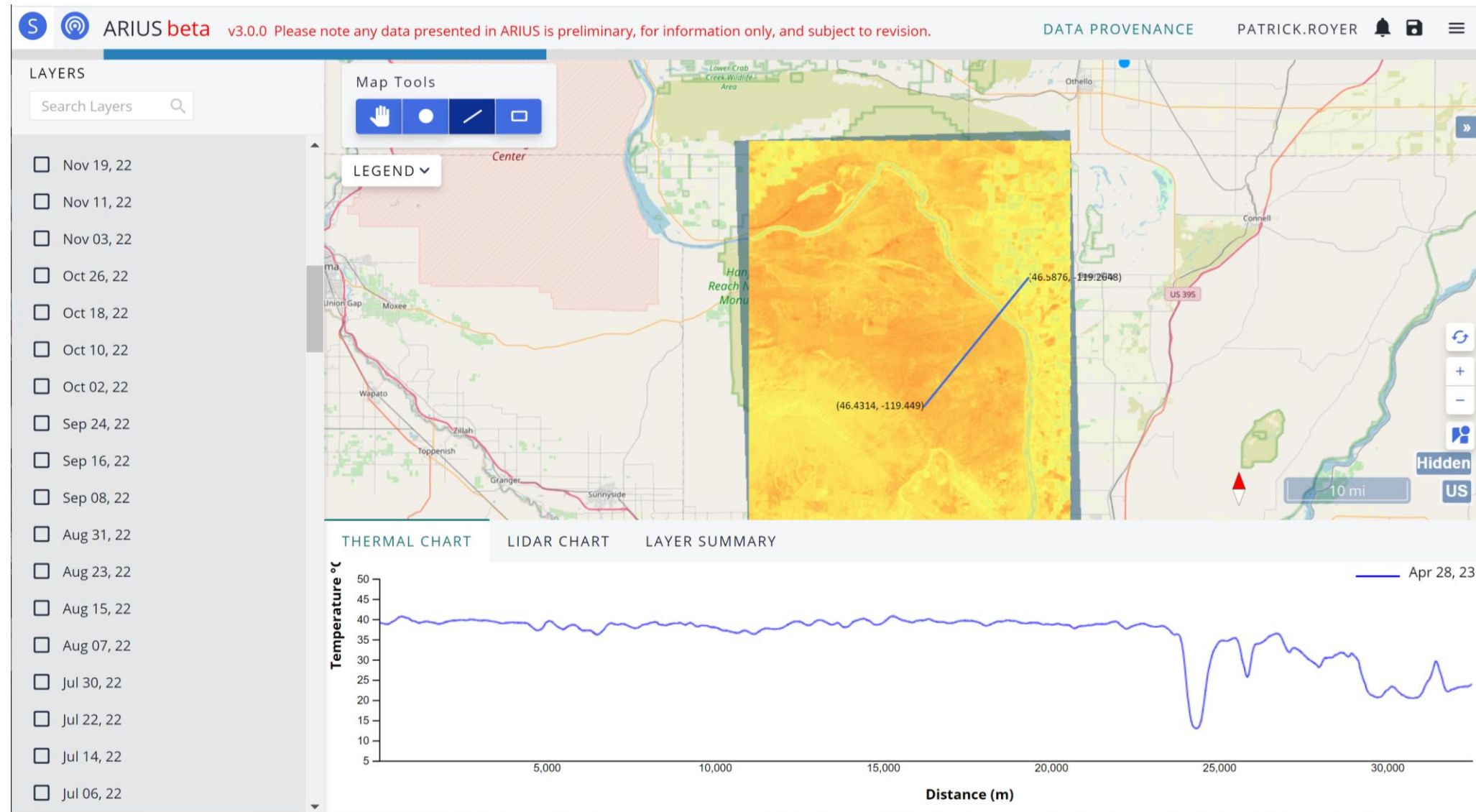


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ARIUS User Interface and Demonstration



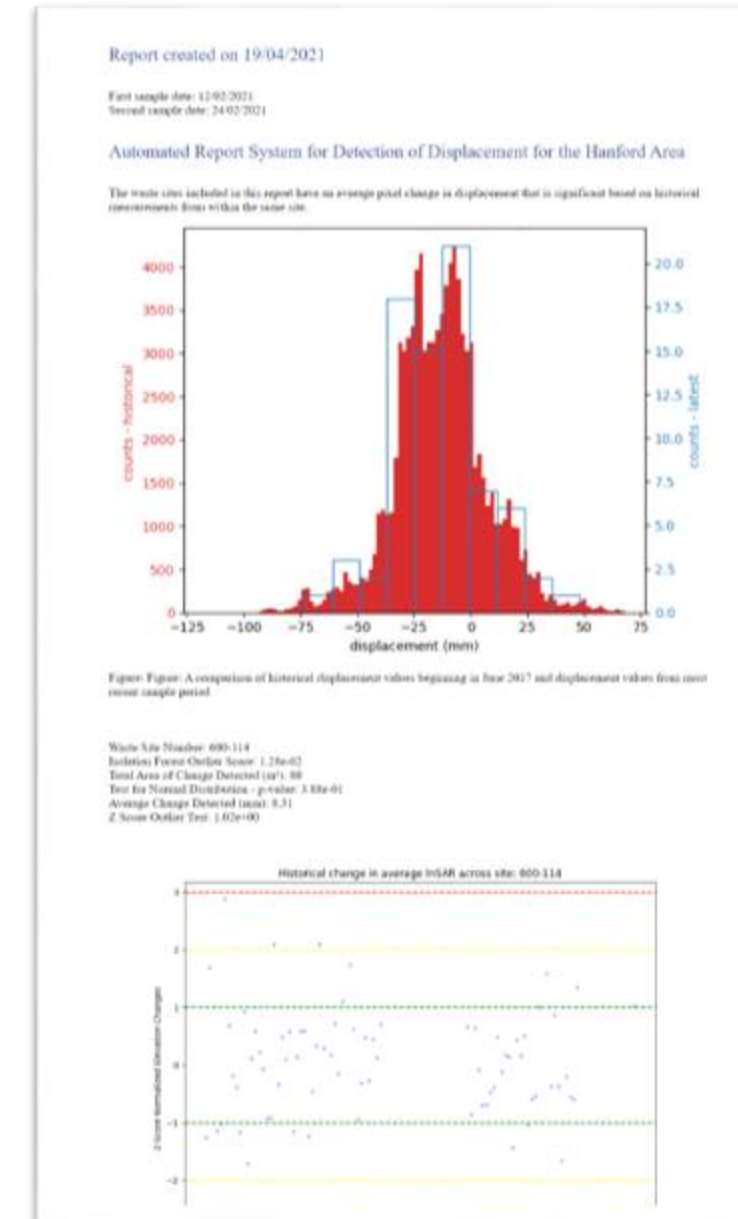
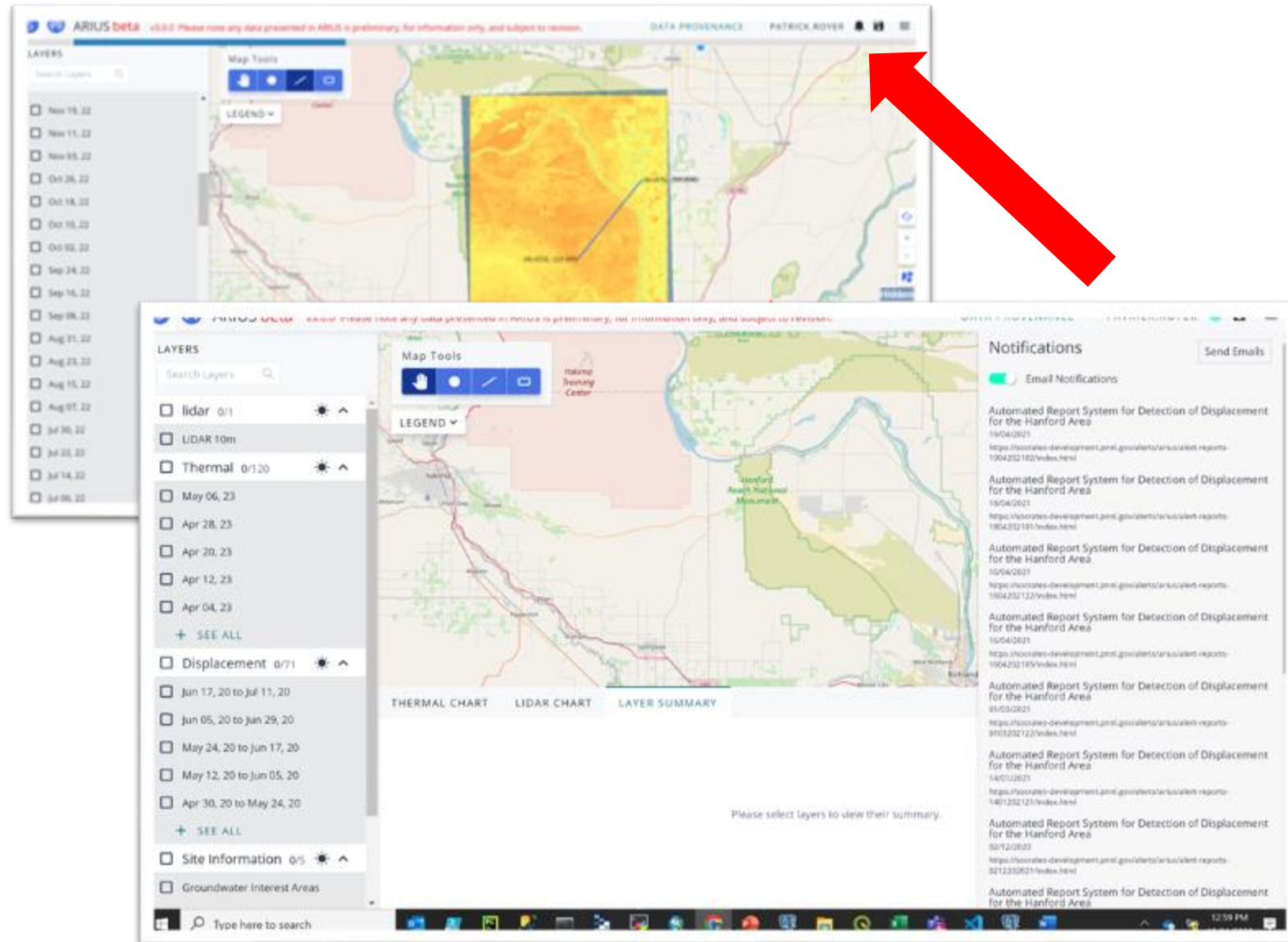
<https://socrates.pnnl.gov/arius/>



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ARIUS User Interface and Demonstration

Event Management and Alerts



<https://socrates.pnnl.gov/arius/>



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Thank You

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