Redefining Image Analysis with ENVI 6.0, IDL 9.0, and the ENVI Ecosystem

November 2023

Zach Norman
JP Metcalf

N|V|5

Before we Begin…

- The webinar is being recorded
  - Slides & on-demand version of the webinar will be available within a few business days

- Questions?
  - Please post any questions in the Questions box

Today's Speakers

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Product Manager

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Agenda

Introduction and Setting the Stage

Choose Your Own Adventure

Back to Our Roots: ENVI Workflows for Hyperspectral

Back to the Future: IDL for VSCode

IDL and ENVI Notebooks

Enabling Collaboration with ENVI Connect

AI-Accelerated Analysis

The Next Generation of Applied Deep Learning

Persistent Monitoring and Scalable Processing

Questions and Discussion

It's a Special Release Cycle

- All of our core products, and some new ones, are getting major versions bumps

- These bumps correspond with big features and changes to user experience and key capabilities

NV5 Geospatial Software's Groundbreaking Products Roar into Market

In a dazzling display of innovation, NV5 Geospatial Software has unleashed a storm of new products that have swept the geospatial market off its feet. With a flair for the future and a nod to the past, the 2020s are witnessing a technological revolution like never before.

NV5 Geospatial Software, a name synonymous with cutting-edge imagery solutions, has catapulted itself to the forefront of the industry with its latest offerings. These game-changing releases have sent shockwaves through the market, captivating the attention of professionals and enthusiasts alike.

The pièce de résistance of this triumphant launch is NV5's ENVI Ecosystem, a marvel of modern engineering. This suite combines the precision of traditional imagery tools with the magic of accessible products, enabling users to navigate the world of imagery with unparalleled ease of use. It's the bee's knees for analysts, scientists, and everyone in between.

IDL and ENVI Get a Face-lift

All of our products have gotten some extra love when it comes to their design!

For IDL and ENVI (from left to right):

- New logos

- New product icons (shortcuts, application launchers, etc.)

- New splash screens on product launch
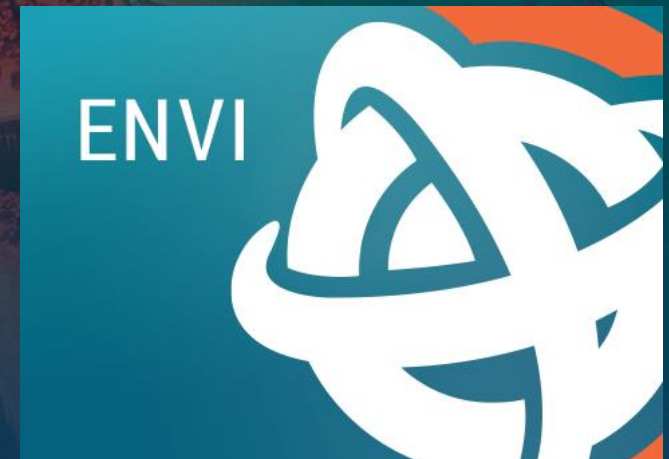
Products and Capabilities Covered Today

- IDL 9.0
- ENVI 6.0
- ENVI Deep Learning 3.0
- ENVI Connect 2.0
- IDL for VSCode
- IDL and ENVI Notebooks

The **ENVI Ecosystem** is a family of imagery and data analysis solutions that's optimized to deliver value where it counts and enable collaboration across your organization

Imagery Experts

Imagery experts can perform advanced analysis and create imagery products, or create image processing workflows, and add them to ENVI Connect.

Analysts
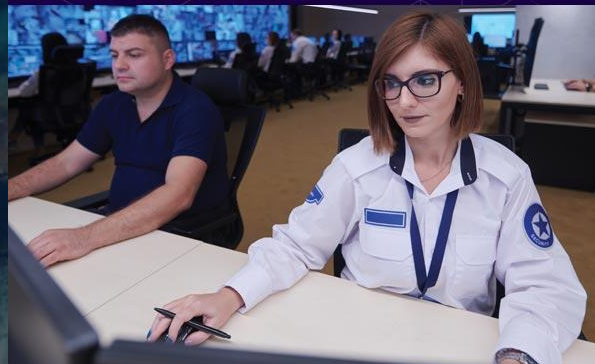
Analysts can access products created by imagery experts and other analysts. They can easily perform literal or non-literal analysis to create products and insights – selecting the data and running analytics is simple.

Decision Makers

Decision makers can easily access and review results to make informed decisions.

Choose Your Own Adventure

The flexibility of ENVI and IDL allow you to process data how and where you want

What kind of user are you?

ENVI Inform

ENVI Connect

IDL (and the ENVI API)

IDL and ENVI Notebooks

ENVI

Workflows

Visual Programming

Choose Your Own Adventure

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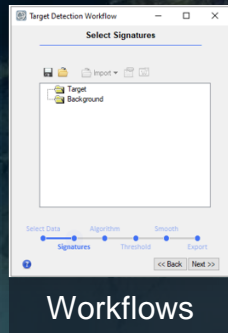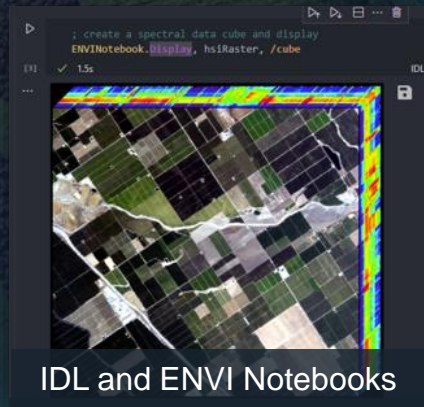
Experts can create content that other kinds of users can consume

ENVI Connect

Visual Programming
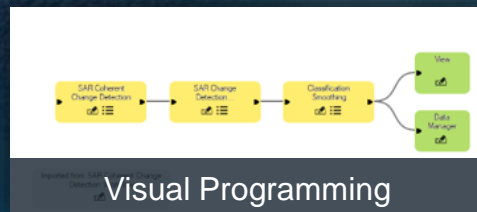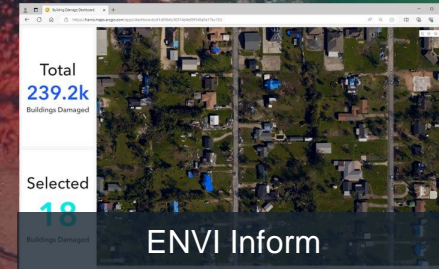
ENVI

Back to our Roots

With ENVI 6.0, one of our key development areas was revisiting and modernizing the spectral user experience

ENDMEMBER COLLECTION

- Quick and easy tool to map the location of known features

- Examples:
  - I have a spectral library containing the signatures of minerals that I want to map
  - I found several features of interest with ROIs and want to find where else they appear in my image

TARGET DETECTION

- I have known features that I'm looking for and I want to find where they are in my scene

- Example:
  - Map the location of kaolinite across a mountain range

MATERIAL ID

- I don't know anything about my dataset, so I want to find unique features in my image, map their locations, and optionally use Material ID to determine what I found

- Example:
  - Find unique spectra within an image (i.e. water, urban, minerals) and map their locations throughout the rest of your dataset

SPECTRAL HOURGLASS

- Given spectral information from a dataset, compare that information against known spectra and determine potential matches

- Example:
  - Determine what kind of mineral I have displayed in a spectral profile within ENVI

Easily Map Features with Endmember Collection

- Endmember Collection allows you to easily map spectra/targets within a given dataset

- You can use spectral libraries, ROIs, plot windows (i.e. pixels within your image), and a few other sources of information

- It's a friendly "try things out" interface that is very easy to use

- Easy to run more than one algorithm at a time and compare results
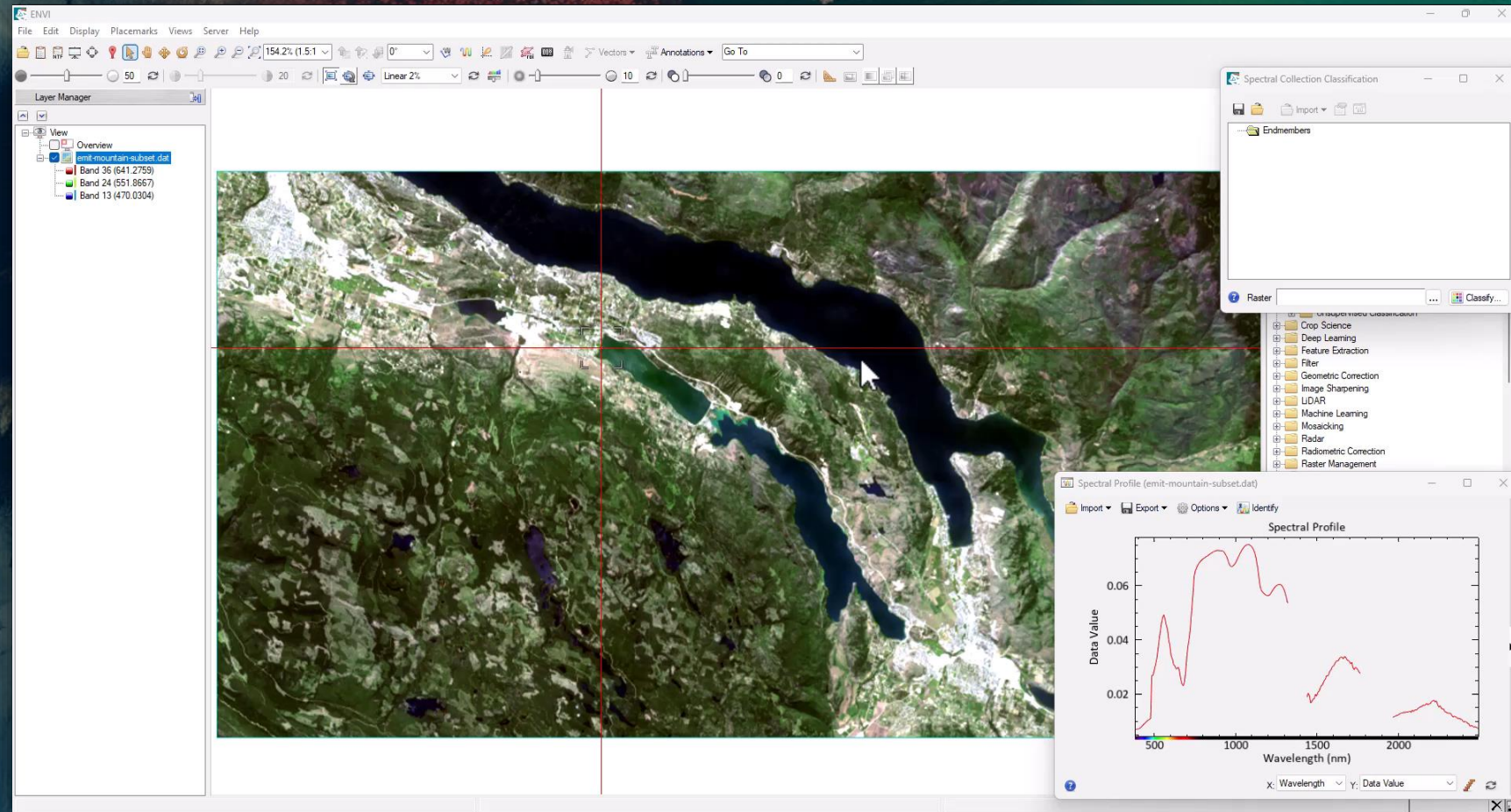
Short video demonstrating how you can create a landcover classification image using the Endmember Collection dialog and Spectral Profiles in ENVI

Endmember Collection: Paint by Pixels

Alternatively, use ENVI ROIs with an EMIT hyperspectral image to perform a more advanced landcover classification

Target Detection Workflow

- The Target Detection Workflow locates pixels within hyperspectral or multispectral images that match the signatures of in-scene regions.

- The targets may be a materials, minerals of interest, or man-made objects

- You can think of target detection as a more advanced image classification tool compared to endmember collection

- **Important note**: Some algorithms in Target Detection require background experience in spectral science
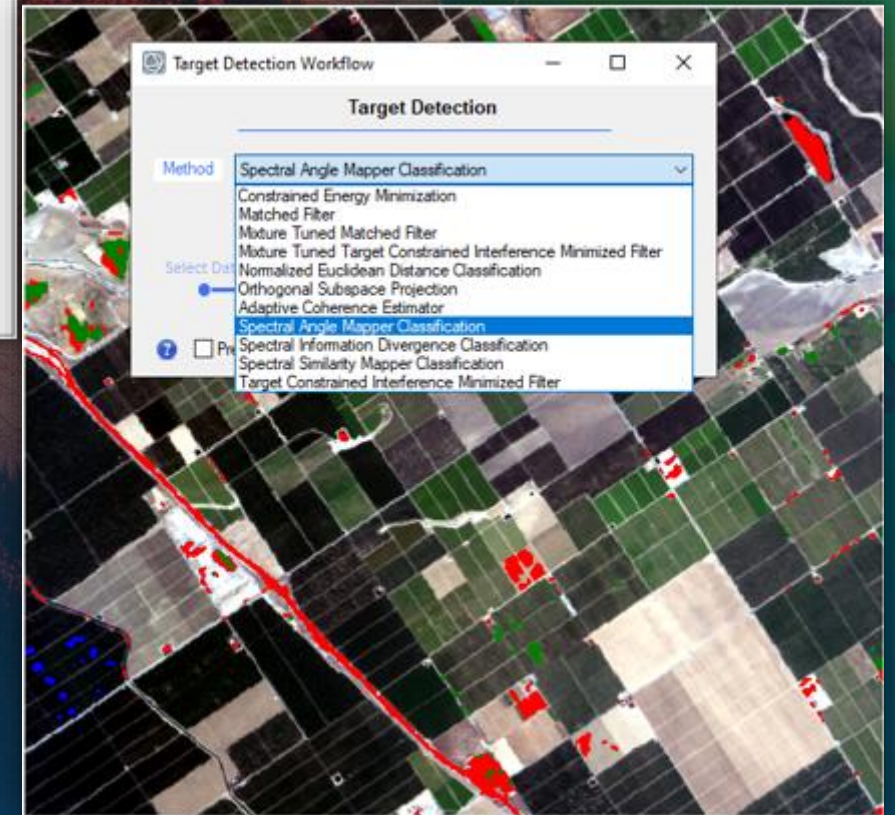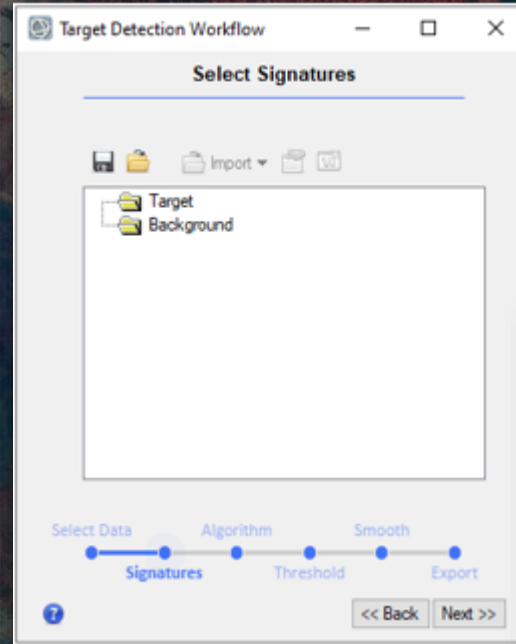
Target Detection in Action

- The target detection workflow allows you to interactively refine image classification results

- Here we use the thresholds to:
  - Improve the amount of vegetation being correctly identified
  - Remove false-positives from the water detection

- This step is quick, easy, and improves the overall quality of results that you generate

- **Pro tip:** If you are just getting started with target detection, skip the data transform and use Spectral Angle Mapper for the algorithm (as shown here)

Short video that shows how Target Detection, compared to Endmember Collection, includes interactive steps to refine the classification results

Material Identification for Everyone!

- From spectral profiles, new button "Identify" that opens material identification (ID)

- Once the dialog appears, you can switch between different spectral libraries and see potential matches from 5 algorithms

- **<u>Important note</u>**: Material ID requires background experience in spectral science

Material ID in Action

- As you select different pixels, the material ID dialog updates with potential matches

- Clicking on rows of the material ID dialog shows the spectra within the Spectral Profile so you can do a manual comparison

- You can pick different spectral libraries to compare against

- Each column on the right represents a different material ID algorithm that you can sort by
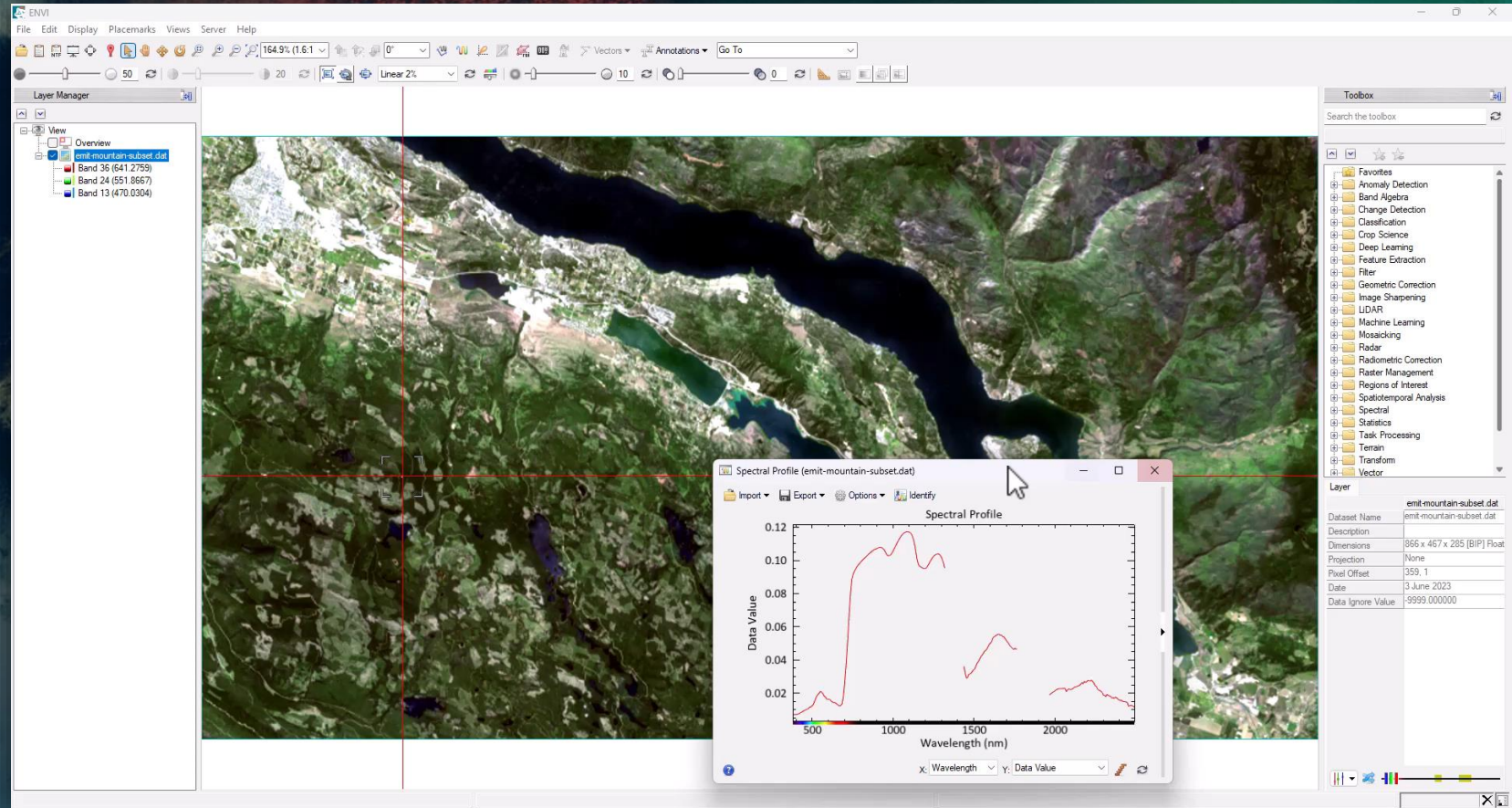
Short video that shows how to access Material ID, process new pixels, and view the potential matching spectral from a spectral library

Spectral Hourglass

- The Spectral Hourglass Workflow helps you identify and map unique spectra (endmembers) from your scene.

- Useful when you know nothing about your data and want to do some "spectral exploration"

- Material ID is integrated to help you identify the endmembers in your image

- **Important note**: Requires background experience in spectral science

The first step of the spectral hourglass workflow is to reduce the dimensionality of your data with an MNF transform as shown here

Spectral Hourglass in Action

- Use the n-D visualizer to identify outliers and unique pixels in your scene

- You can automatically identify potential pixels, as shown in the video, or you can do the work manually

- Once you have your classes, you can map their potential locations throughout the scene

- Here we use linear unmixing to get a relative abundance of each endmember within each pixel because we have low-resolution hyperspectral data
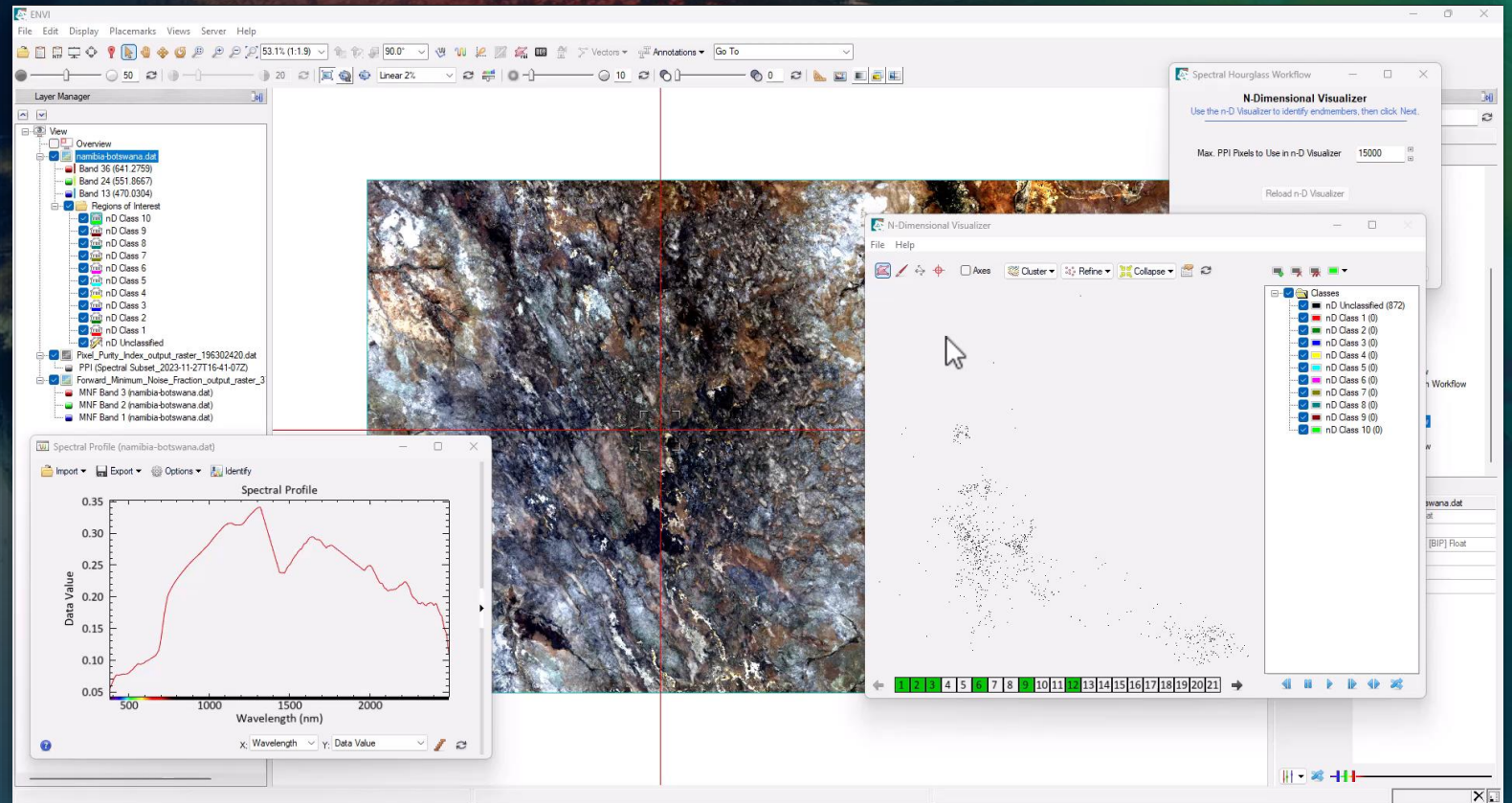
More than Just Spectral: ENVI SAR Essentials Sneak Preview

- Coming soon – A new user experience for processing and working with SAR data

- Drag-and-drop display of key SAR formats and step-by-step ENVI Workflows

- Capabilities include:
  - Dynamic Aperture
  - Sub-Color Aperture
  - Generate SIDD
  - Detect Amplitude
  - Amplitude Change Detection
  - Coherent Change Detection
  - Motion Change Analyzer
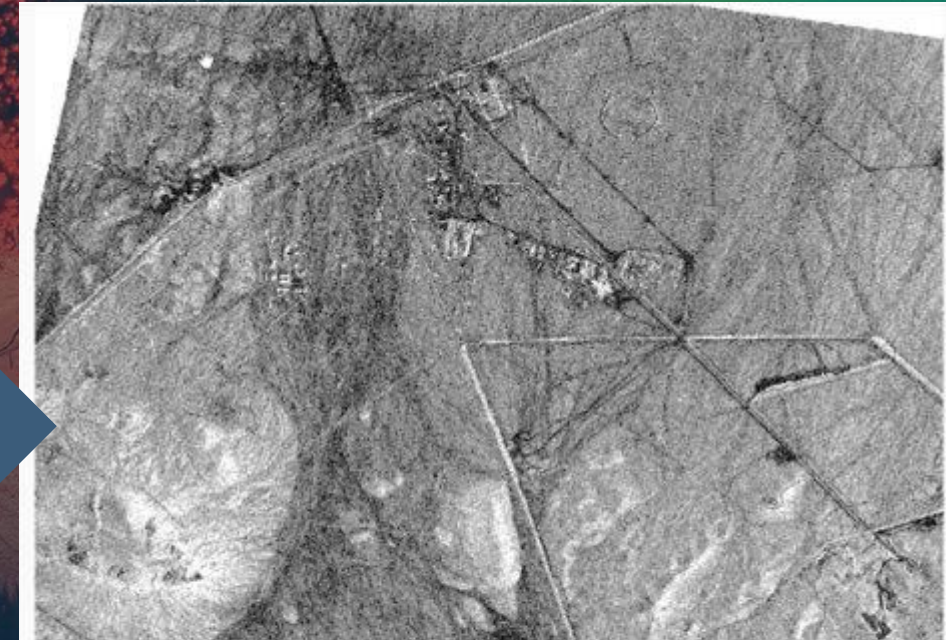
The output from running CCD (Coherent Change Detection). Dark areas correspond to low values of coherence and represent change

Data credits: TerraSAR-X

Workflows: More than Just Steps

The new workflows in ENVI capture your clicks and generate an automated version as an ENVI Modeler workflow

Workflows: Clicks to Code

- You can convert ENVI Modeler workflows to IDL code to get a jump-start at how you can program with the ENVI API

- With the ENVI Modeler, ***or*** the ENVI API, the analytics can then be shared with other types of users

- You can add to other ENVI Desktop instances or deploy them to ENVI Connect

Example showing the IDL code generated from an ENVI Modeler workflow using the machine learning tools in ENVI

Embracing Open Source with IDL 9.0: IDL for VSCode

- New, modern developer environment for IDL using Visual Studio Code

- Key benefits:
  - Native multi-language support
  - Make the editor your own with extensions and themes
  - Integrated help content for rich developer experience
  - Basic type detection for seamless auto-complete
  - Automation for formatting, adding docs, and updating docs as you write code
  - Detects more than 100 problems in your code without having to compile

New developer environment: IDL for VSCode! New paradigm and user experience for writing IDL code.
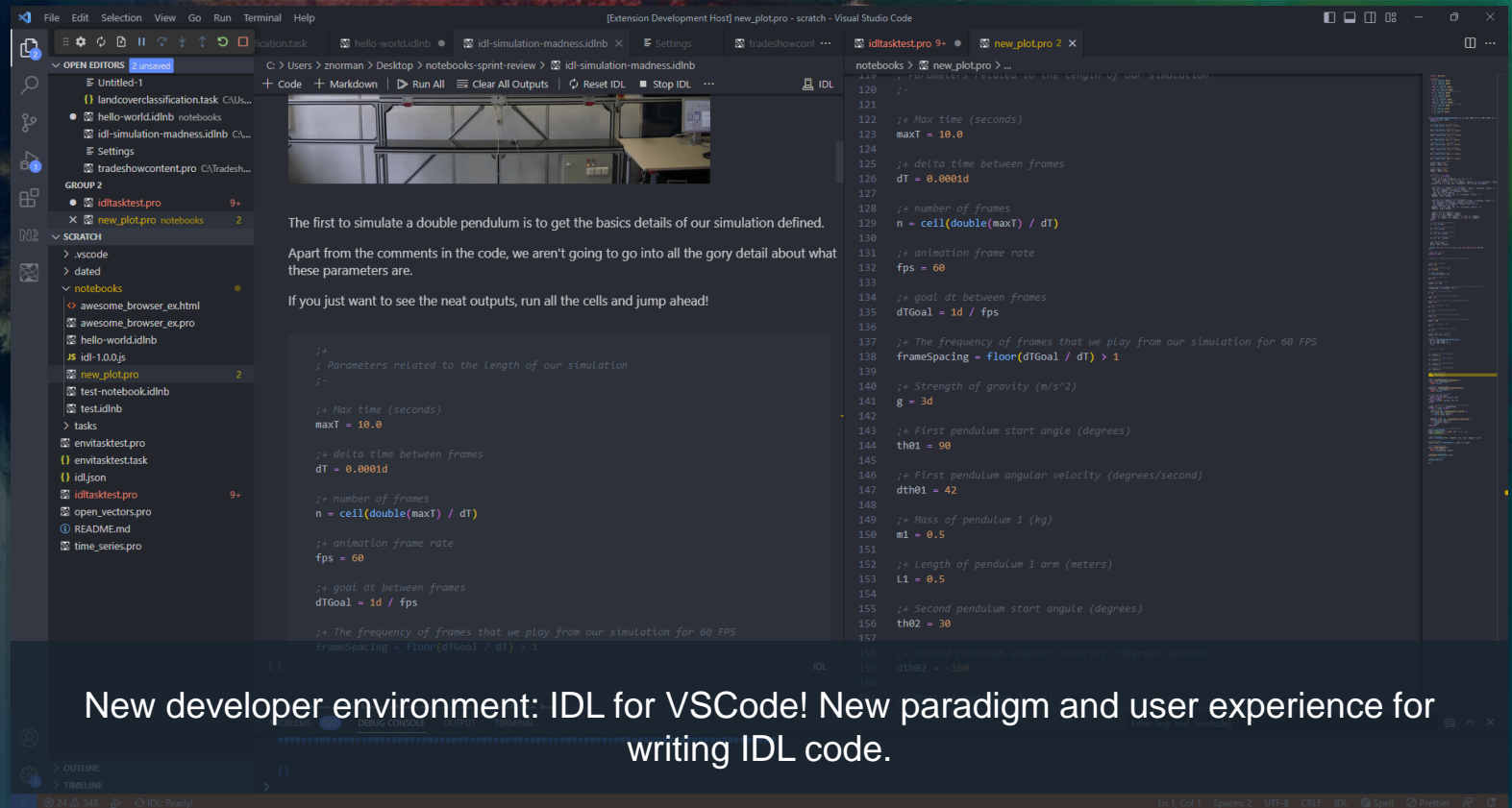
IDL for VSCode: Auto-complete and Hover Help

The documentation for the latest versions of ENVI is packaged with the extension, making it easier than ever to learn about and use the ENVI API

Auto-complete showing properties and methods for the "MachineLearningClassification" ENVI Task

Hover-help for the same ENVI Task with examples from the documentation
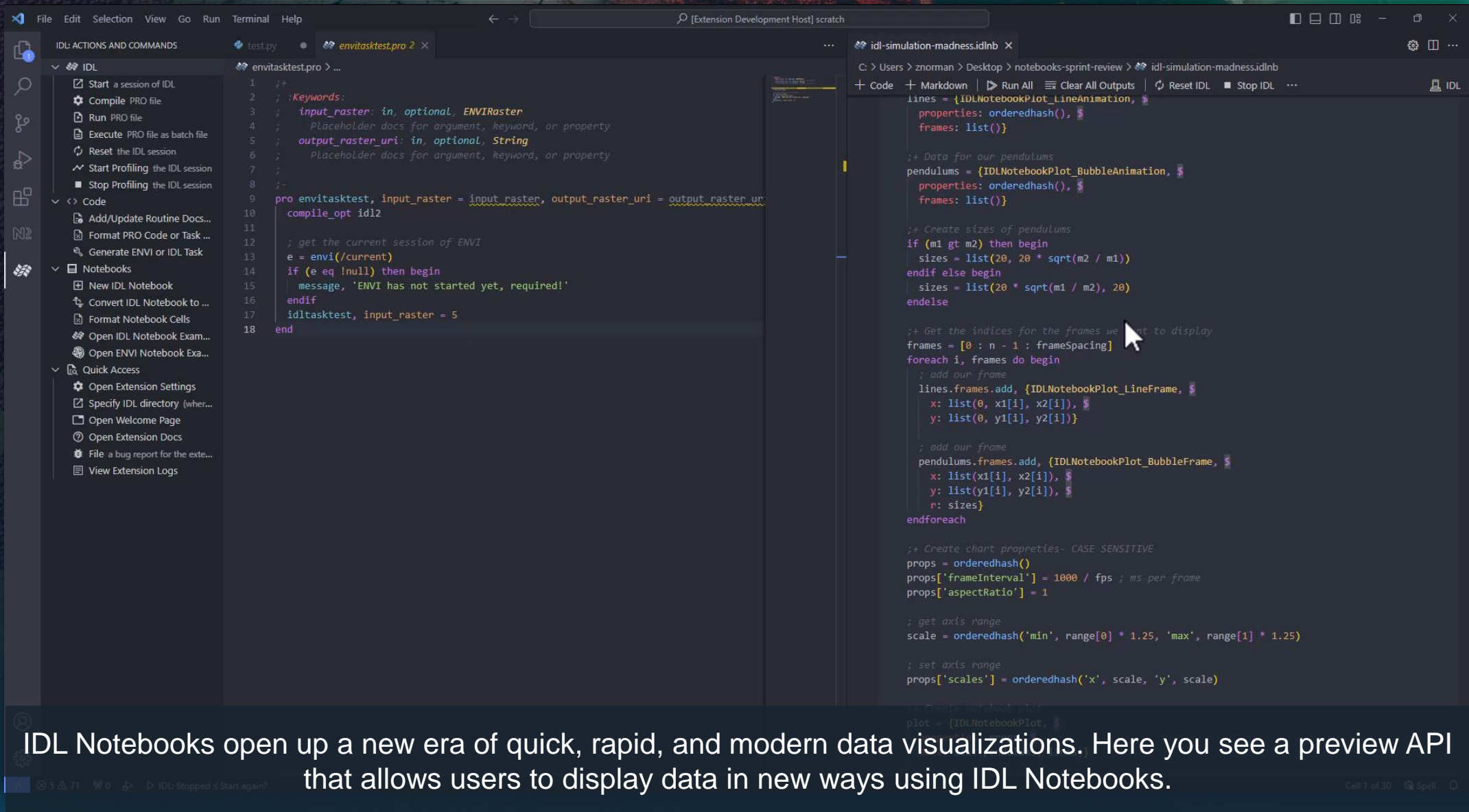
Introducing IDL Notebooks!

- Enabled through VSCode, we have a native IDL Notebook format and developer environment

- Notebooks are:
  - A friendly format for capturing logic/training and code in one place
  - The way that new developers are learning to program
  - More approachable compared to creating files on disk

- Note: This is *not* using Python or Jupyter behind the scenes and comes with the extension
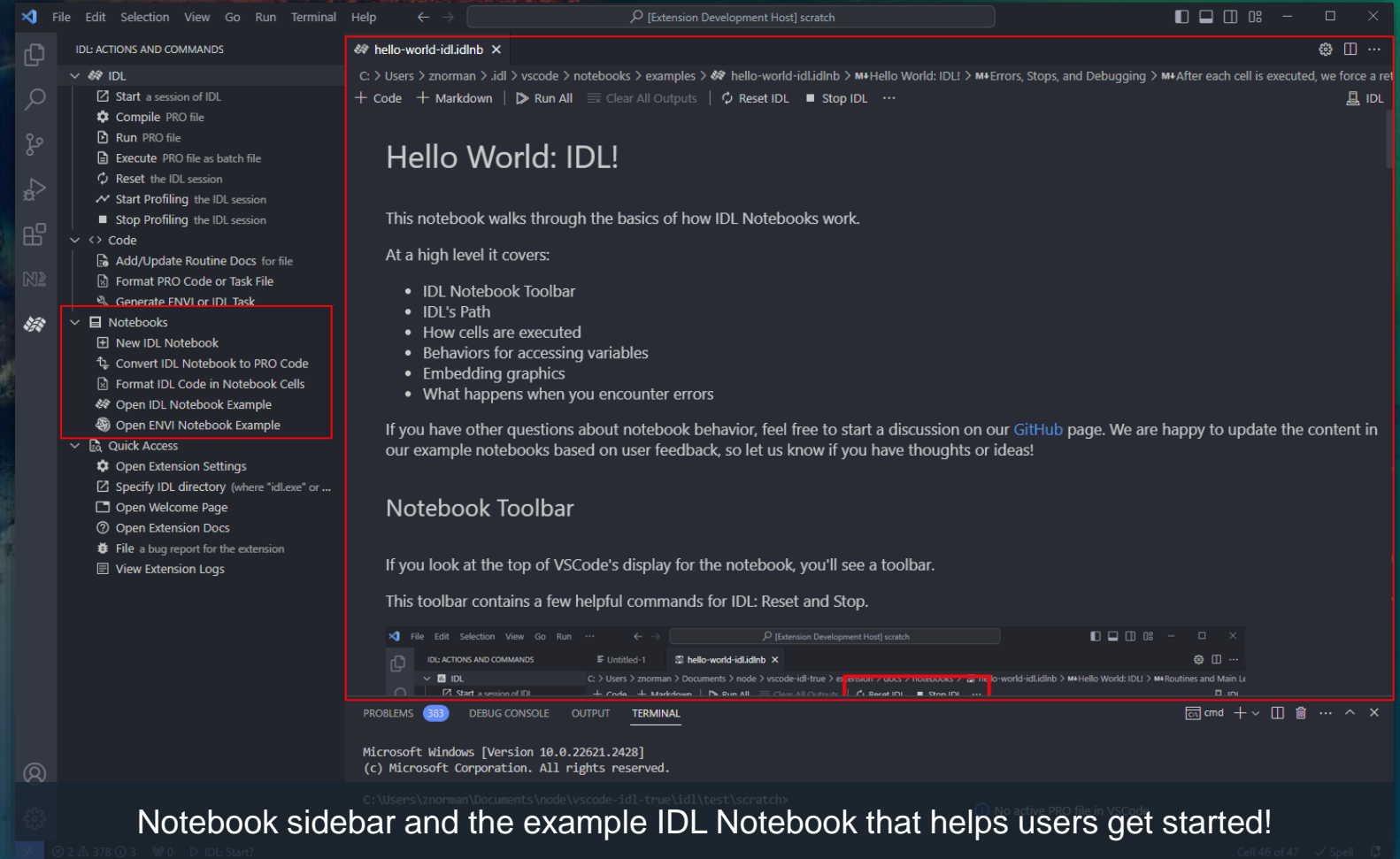
Notebook sidebar and the example IDL Notebook that helps users get started!

IDL Notebooks: A Look at the Future

IDL Notebooks open up a new era of quick, rapid, and modern data visualizations. Here you see a preview API that allows users to display data in new ways using IDL Notebooks.

Notebooks: Not Just for IDL

- IDL Notebooks also have special APIs for ENVI

- Similar to IDL, they allow you to embed graphics and maps within notebook cells

- ENVI maps use your VSCode theme to pick a base map

Example ENVI Notebook showing the display of a hyperspectral data cube (left) and a raster and vector data (right)

Example: ENVI Notebooks in Action

Short video showing an IDL Notebook running ENVI. This notebook uses machine learning to map burned areas after a wildfire from 2022 in New Mexico using PlanetScope data.

IDL 9.0: IDL for Apple Silicon

- As a part of IDL 9.0, we are including support for Arm processors on the Mac!

- This offers performance gains because you no longer need Rosetta (graphics on right)

- This only applies to IDL and not ENVI at this point in time
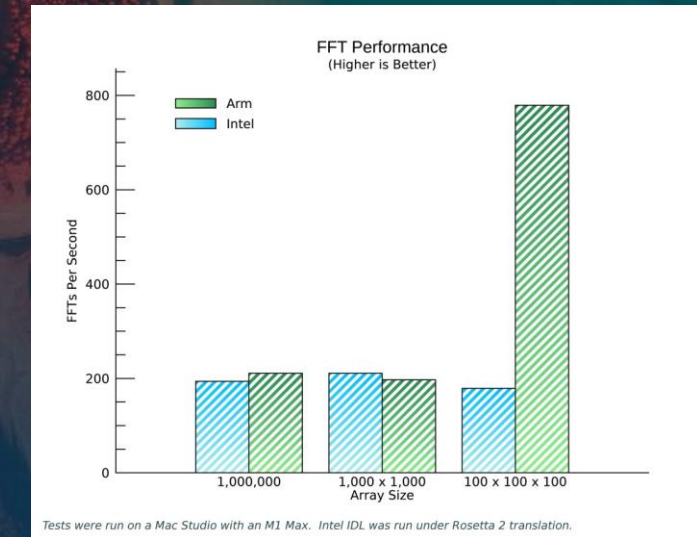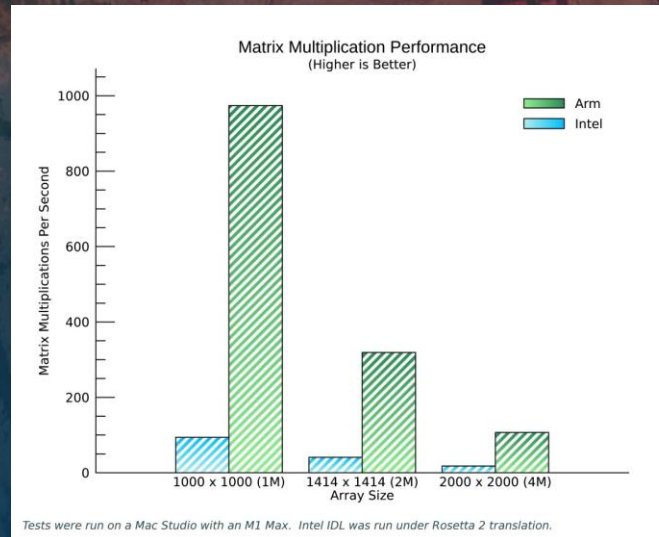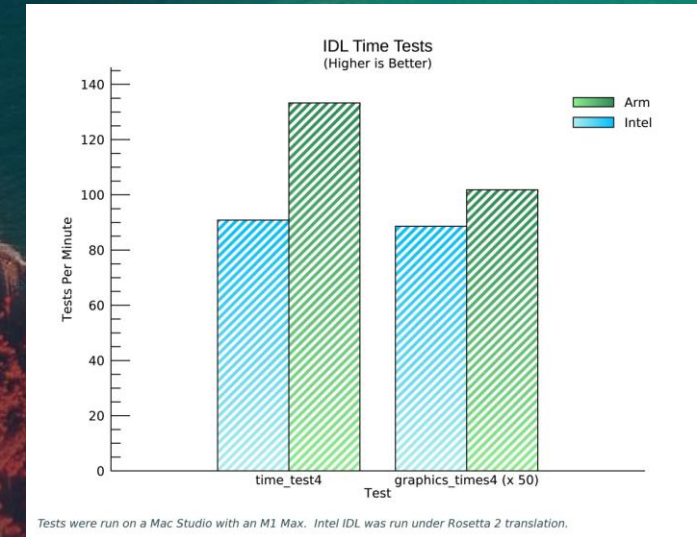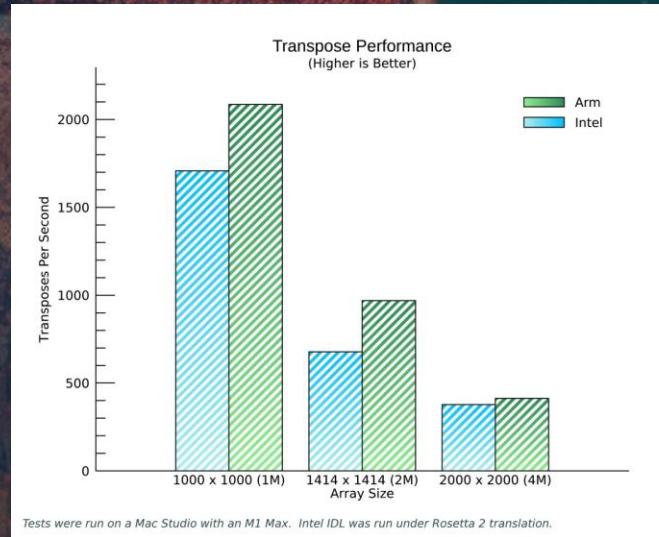
Performance metrics showing (higher is better) how native Arm support for Mac is much faster than using an emulator like Rosetta

Choose Your Own Adventure

The flexibility of ENVI and IDL allow you to process data how and where you want

What kind of user are you?
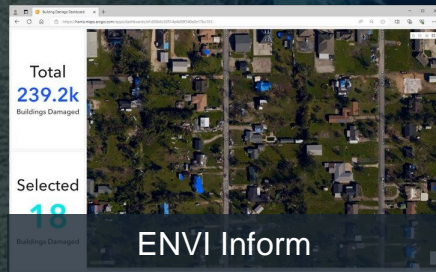
ENVI Inform
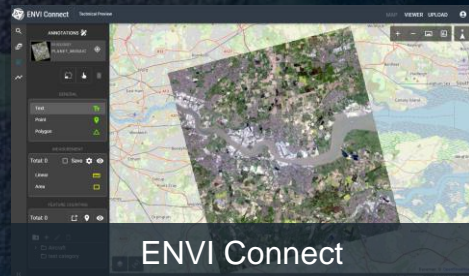
ENVI Connect

ENVI

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IDL and the ENVI API

IDL and ENVI Notebooks

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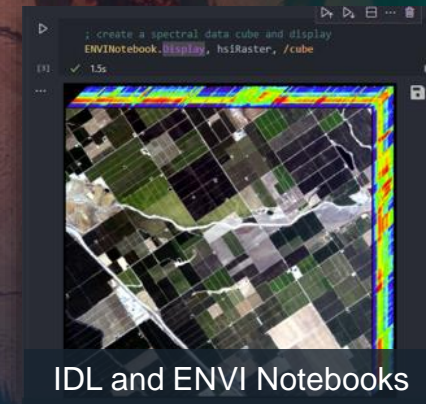
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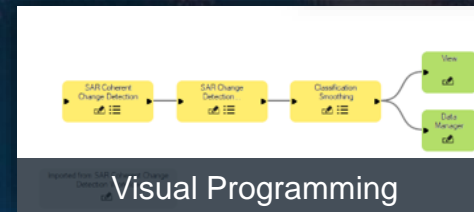
Experts create automated analytics

Experts use science-based workflows to create information layers

Analysts have data-modality based workflows for analyzing imagery and videos and can re-use the analytics and information that experts create

ENVI Inform
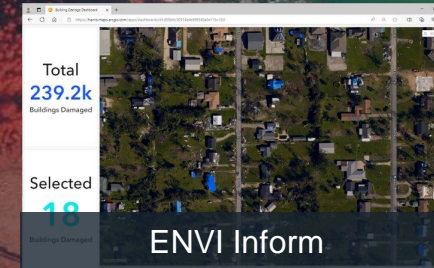
ENVI Connect

ENVI

View. Collaborate. Solve.

ENVI® Connect Is a Web Application That Enables Users To Easily Work Together and Solve Geospatial Problems.
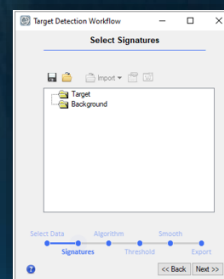
ENVI Connect lets users quickly discover, visualize, and extract information from data as well as generate products. ENVI Connect increases and simplifies collaboration for experts and non-experts so they can more effectively tackle problems with geospatial data, extending the scientific reach across an organization.

Use ENVI Connect to:

- › Work With Imagery
- › Find and Discover Data
- › Visualize Data
- › Perform Literal Image Exploitation
- › Perform Non-Literal Exploitation
- › Generate Products
- › Perform Tipping and Cueing
- › Collaborate With Others

Science Made Accessible with ENVI and ENVI Connect

Experts can create automated analytics using ENVI and IDL then deploy to lightweight, simple tools like ENVI Connect. Enabling other kinds of users to process imagery and gain insights without needing to use a desktop application

ENVI Connect: The Enterprise Solution for Imagery Analysis

ENVI Connect handles the same types of data as ENVI Desktop to support operational analysts

ENVI Connect

RGB

SAR (SICD)

Panchromatic

Video

Multispectral

Hyperspectral
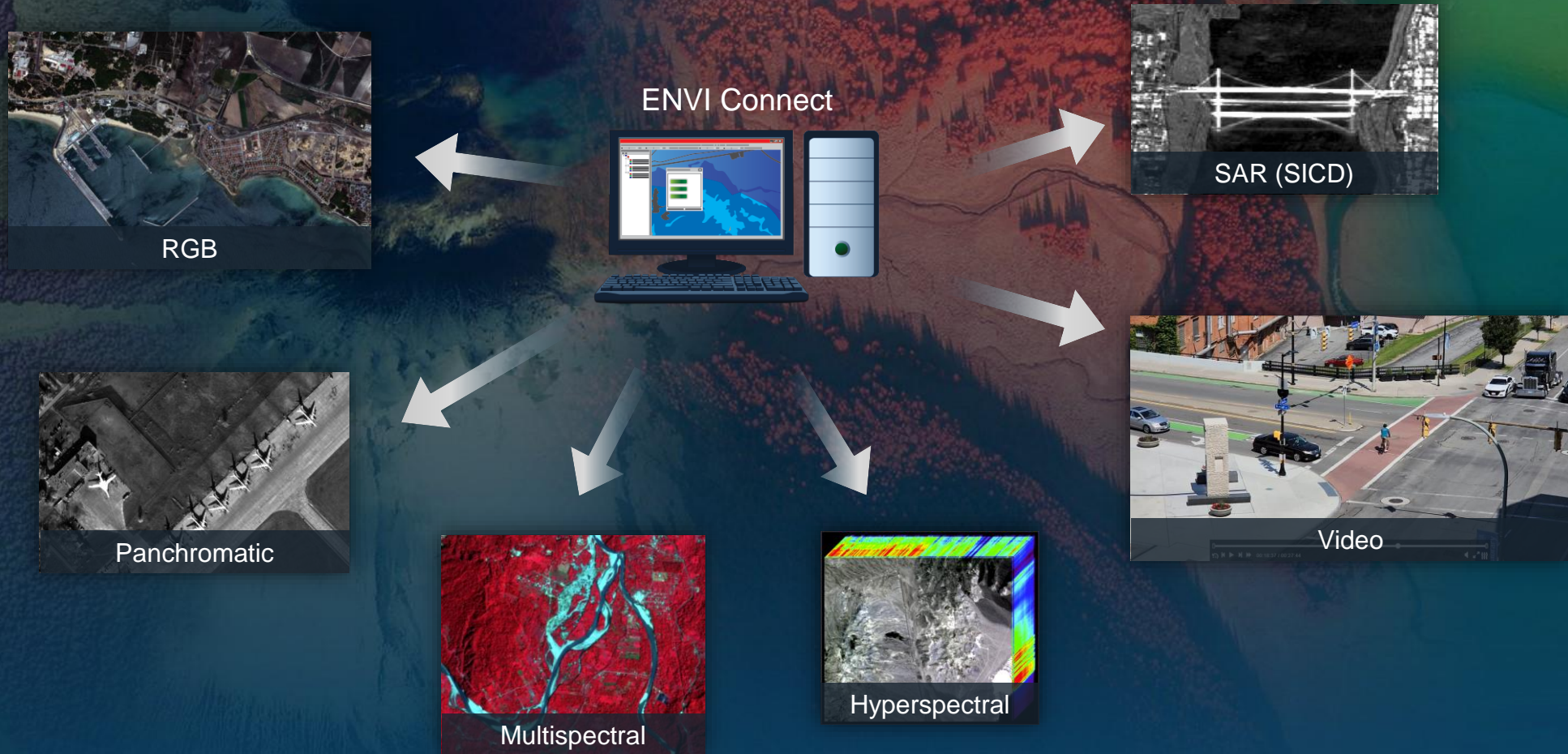
Deep Learning for Video Analysis

- Video analysis workflow:
  - Ingest into ENVI Connect and process with AI as ingested
  - Find video over AOI (Area Of Interest)
  - Navigate to video dashboard
  - Investigate automated detections
  - Contextualize observations
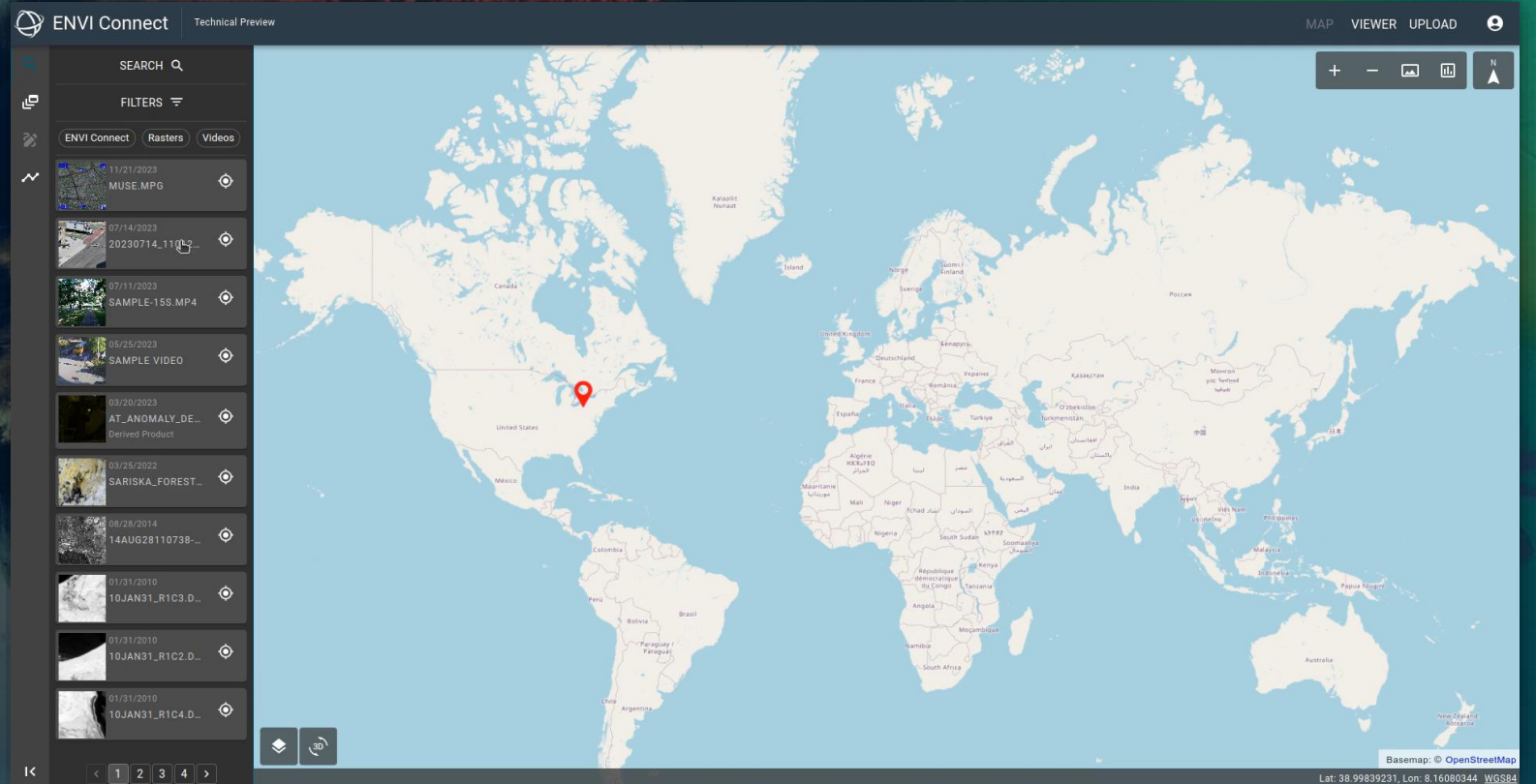
Video exploitation in ENVI Connect is intuitive, easy to use, and helps draw your attention to key points in videos that need further analysis

Deep Learning: Not Just for Enterprise

- ENVI provides all the tools needed to create custom deep learning and machine learning models

- We make the deep learning workflow simpler by providing an easy set-up and tools you can use without needing to program

Create training data → Generate models → Evaluate performance

Grid

Hyperspectral

Segmentation

Landcover

Anomaly Detection

Object Detection
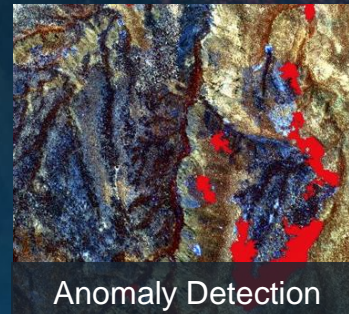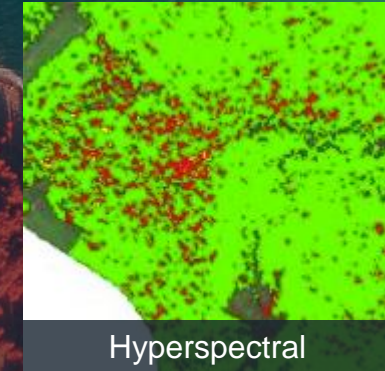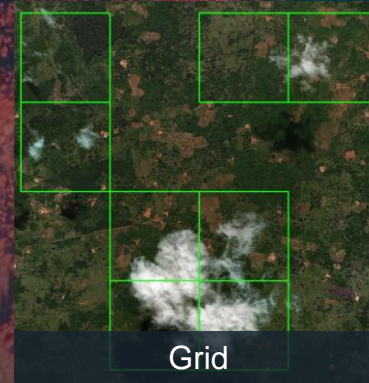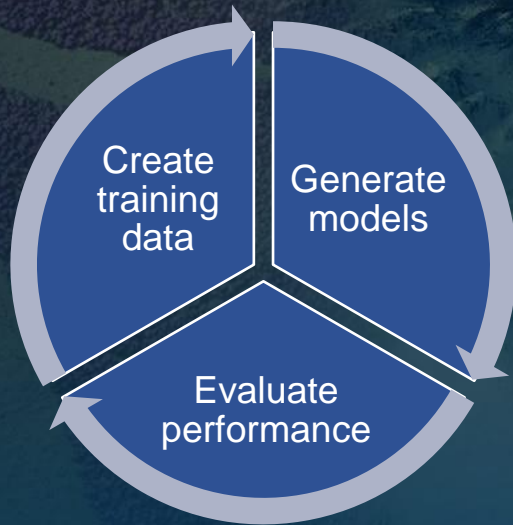
ENVI Deep Learning 3.0: Grids

- New type of deep learning that creates a binary, gridded output with likely locations of features

- Reduce false positives and processing time by only working with positive grid cells

- Plug and play with existing models

- For any previously labeled data, you get grids for **FREE**
  - That's right, you don't have to label any other data to make a grid model!
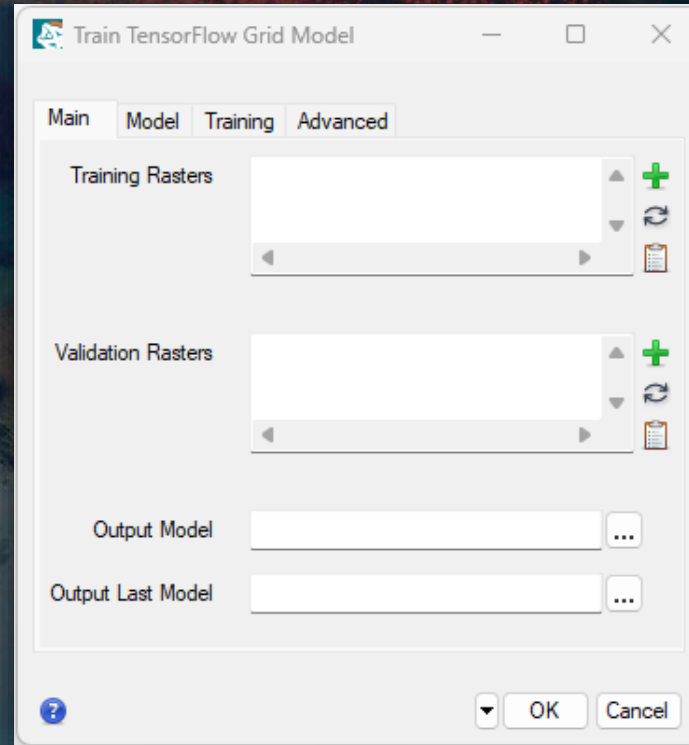
Grid training dialog that accepts all kinds of previously generated training data
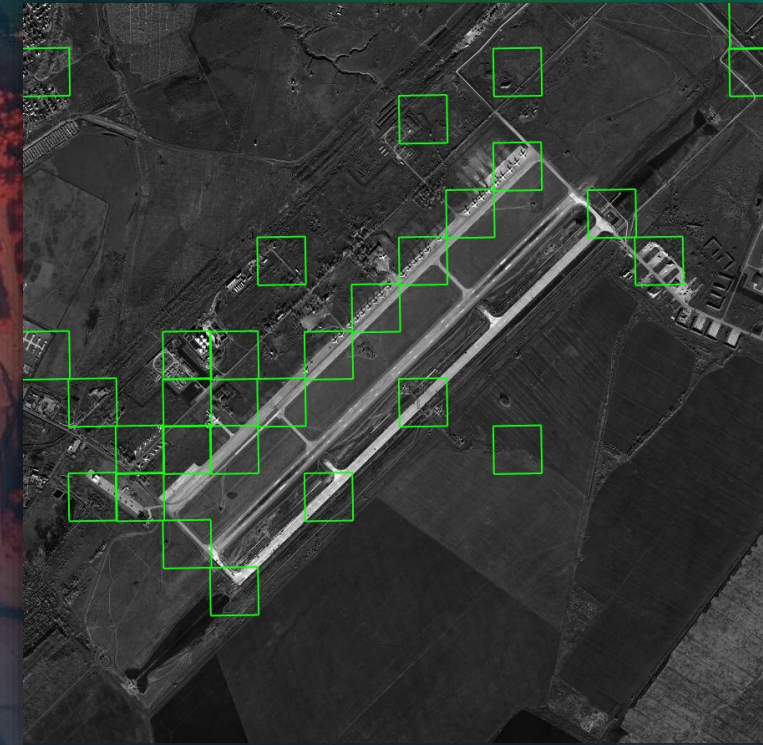
The primary output from grid which shows potential locations in an image with aircraft

Grid: Reducing False Positives

Use grids to remove likely false positives. Here we remove 160 false positives with a minimally trained object detection model!

Before – 381 Detections

After – 181 Detections

Grid: Time Savings

- Using grids, we can not only reduce false positives, but we can save processing time as well

- For rare features, this can have a dramatic impact

- Real world time savings for aircraft detection:
  - 41 Panchromatic WorldView scenes
  - Without grid: ~9 hours
  - With grid: ~30 minutes

Pairing grids and segmentation models can process a WorldView image in 40 seconds compared to 13 minutes without grid
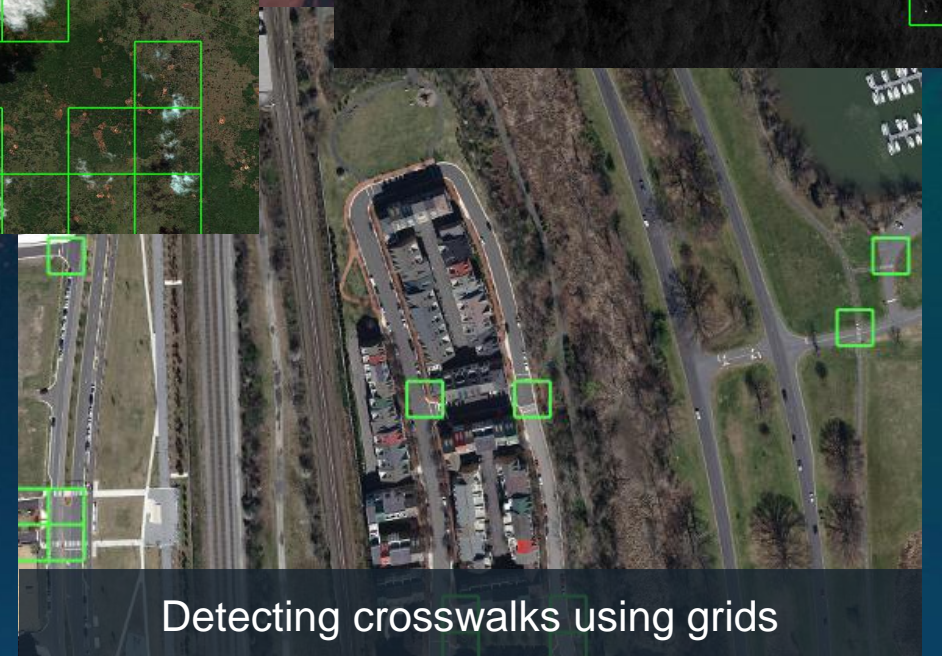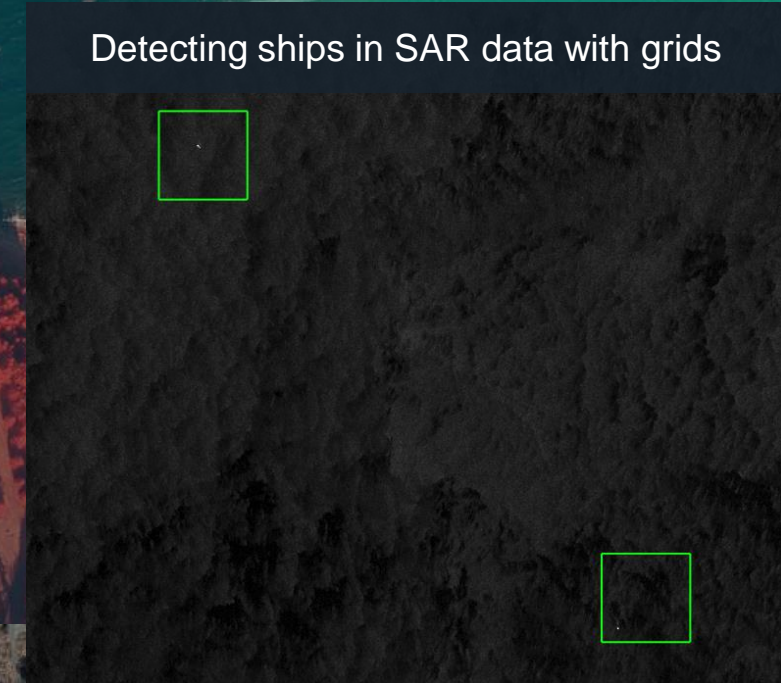
Positive Impacts from Using Grid

- Grid models are free and re-use existing training data!

- Reduce false positives and directly reduce manual labor to correct results from deep learning

- Save processing time to directly save time (and money) for cloud-based processing

- Improve throughput of hardware-limited applications that can't automatically scale to meet processing demands

- Makes it feasible to use more complex models and architectures that can better detect features
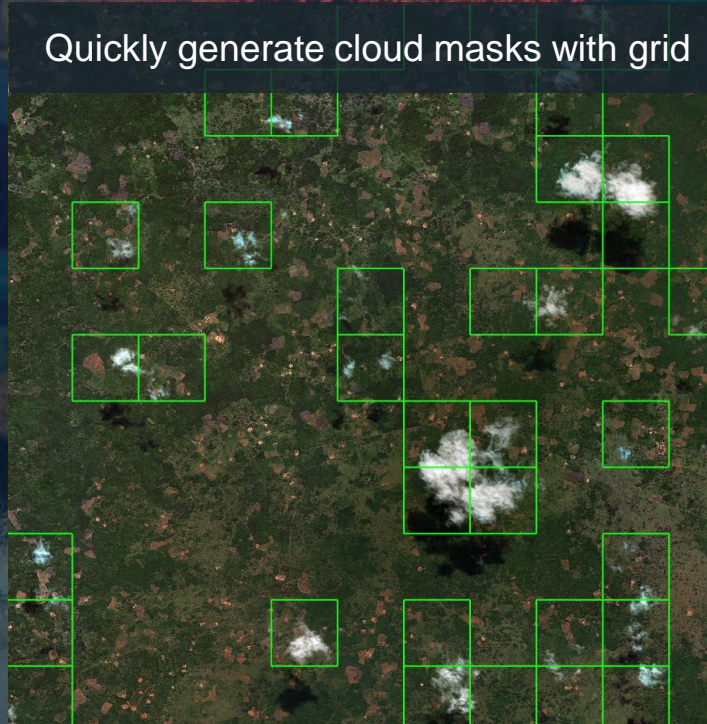
Quickly generate cloud masks with grid

Detecting ships in SAR data with grids

Detecting crosswalks using grids

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IDL and the ENVI API

```
; create a spectral data cube and display
ENVINotebook.Display, hsiRaster, /cube
```
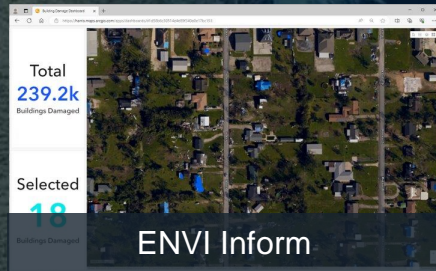IDL and ENVI Notebooks

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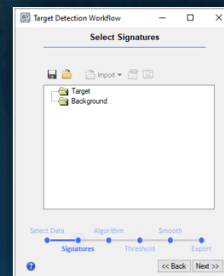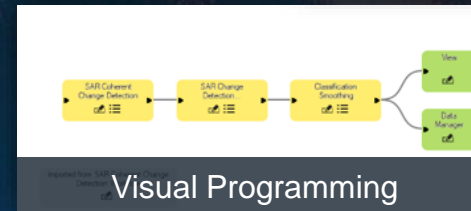The flexibility of ENVI and IDL allow you to process data how and where you want

Experts create automated analytics

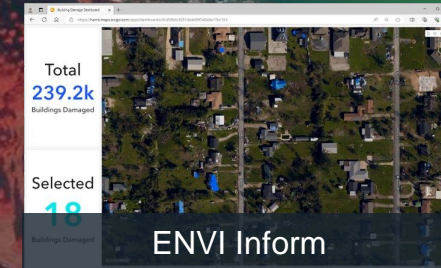Process large volumes of data or persistently monitor areas of interest using scalable infrastructure

Decision makers and analysts can get just the information layers that they need, when they need them, and integrated into existing GIS applications

ENVI Inform

ENVI Connect

ENVI Inform: Automated Monitoring and Scalable Processing

- Take the analytics that experts create and run them in the cloud

- Easily process large areas or monitor areas for continuous observation

Perform global and country-wide monitoring

Use SAR data to monitor dams on a regular basis and look for changes

Process data at scale to get answers faster when time matters
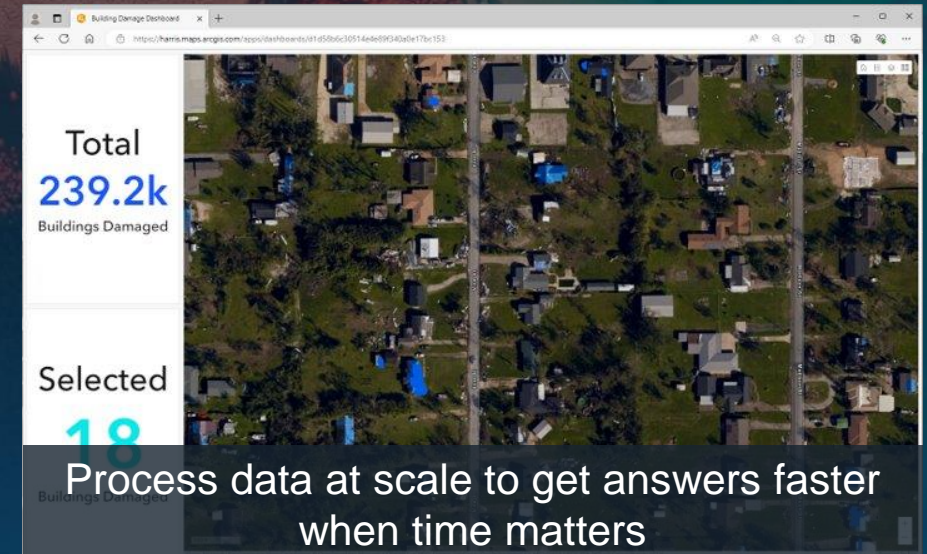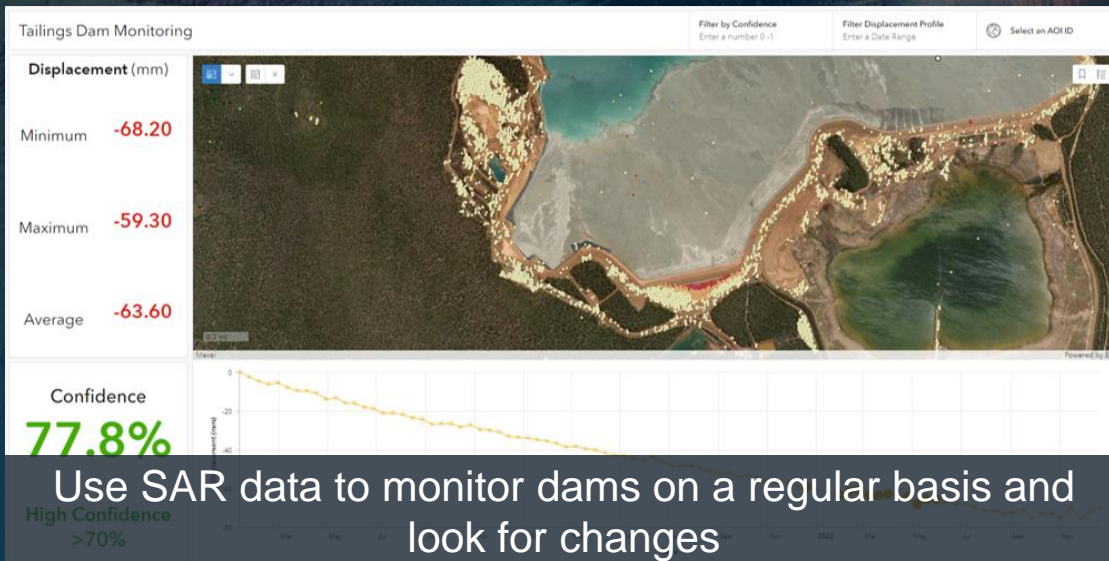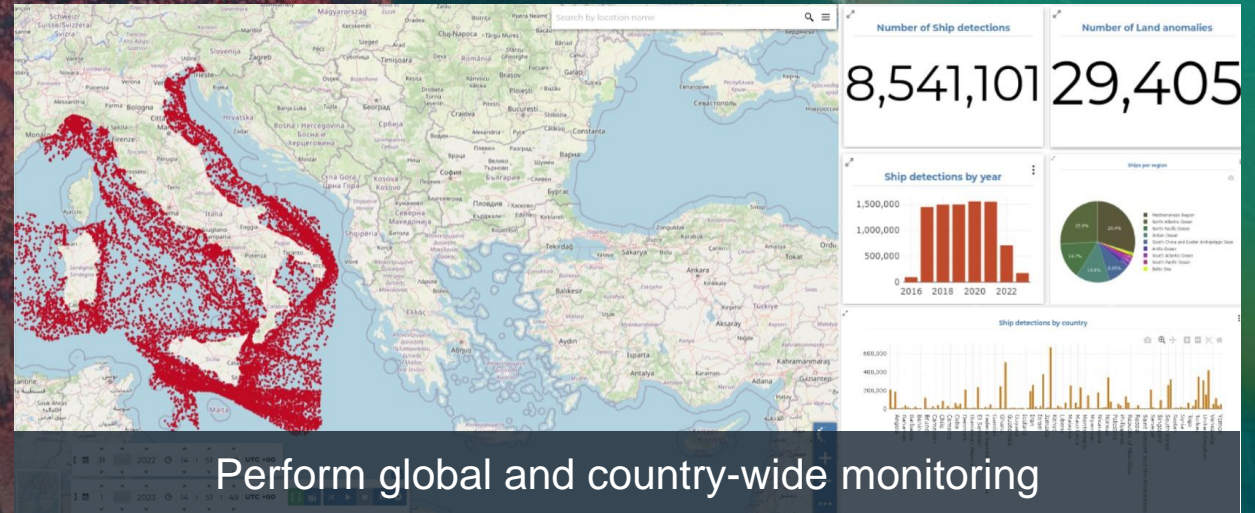
Recap: Demonstration goals

Today was about showcasing how our family of products come together to solve real-world problems

SCIENCE MADE ACCESSIBLE	EMPOWER USERS TO COLLABORATE	DATA ANALYSIS MADE INTUITIVE
• Step-by-step spectral workflows to make image science more approachable • A new future of SAR analysis is coming soon! • Improve productivity for programmers with IDL for VSCode	• Deploy analytics that experts create where you need them to run • Experts can create information layers and publish to other tools like ENVI Connect	• Friendly, web-accessible tools for working with and processing imagery • AI accelerated exploitation • Automation and monitoring at scale

Products and Release Timelines

- IDL 9.0 – Available today!

- ENVI 6.0 – Available today!

- ENVI Deep Learning 3.0 – Either just before or right after the holidays

- ENVI Connect 2.0 – Either just before or right after the holidays

- IDL for VSCode – Available today! Download through VSCode or the web

- IDL and ENVI Notebooks – Included in IDL for VSCode

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