The Rise of AI4EO

on the detection and characterization of events in Near Real Time

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.0 Stack to query our planet
EO
AI
ICE MELTING
ANOMALY IN PERMAFROST
SHIP DETECTED
FOREST LOSS
OCEAN BLOOM
OIL SPILL
EL NIÑO IMPACT
INSIGHT
FIRE ALERT
15

Observing System

esa

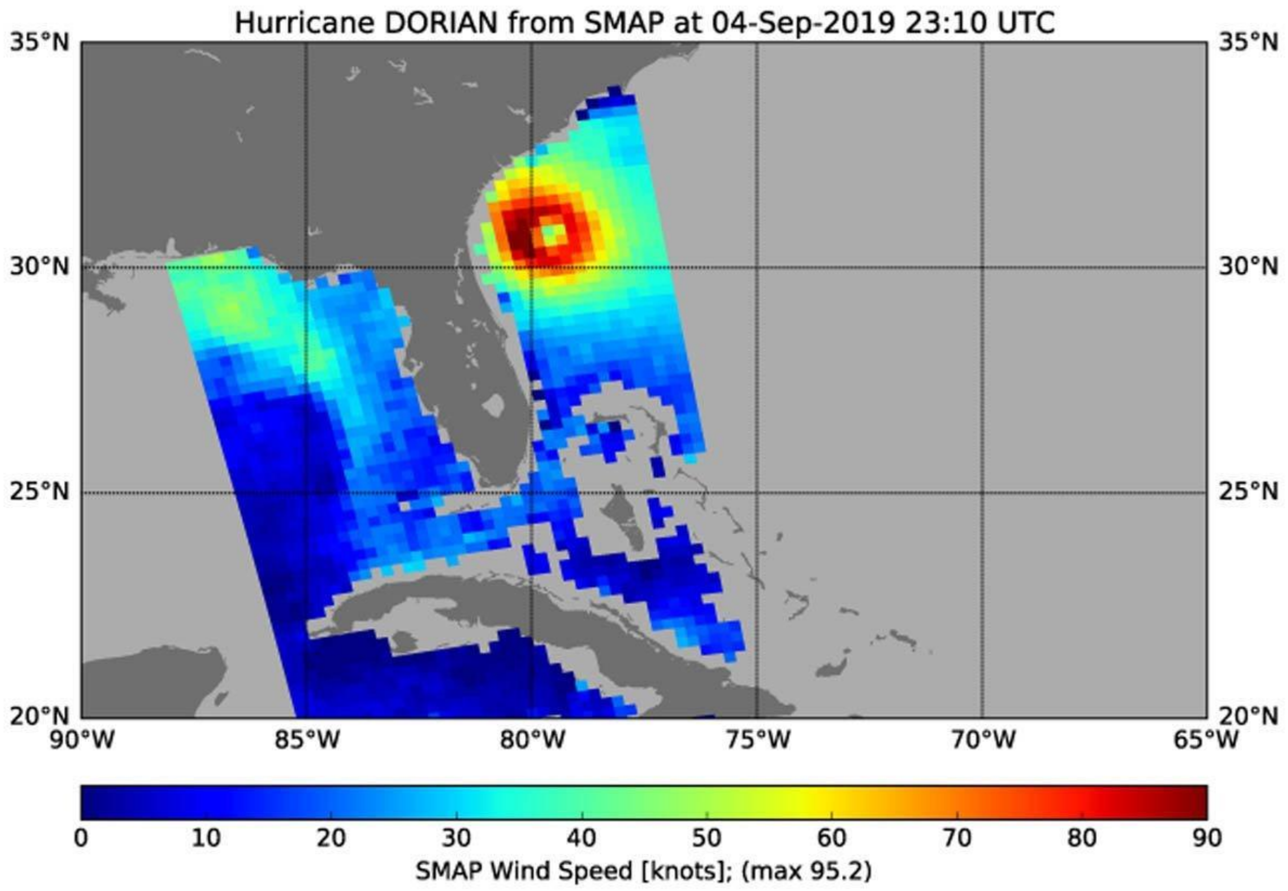
European Space Agency

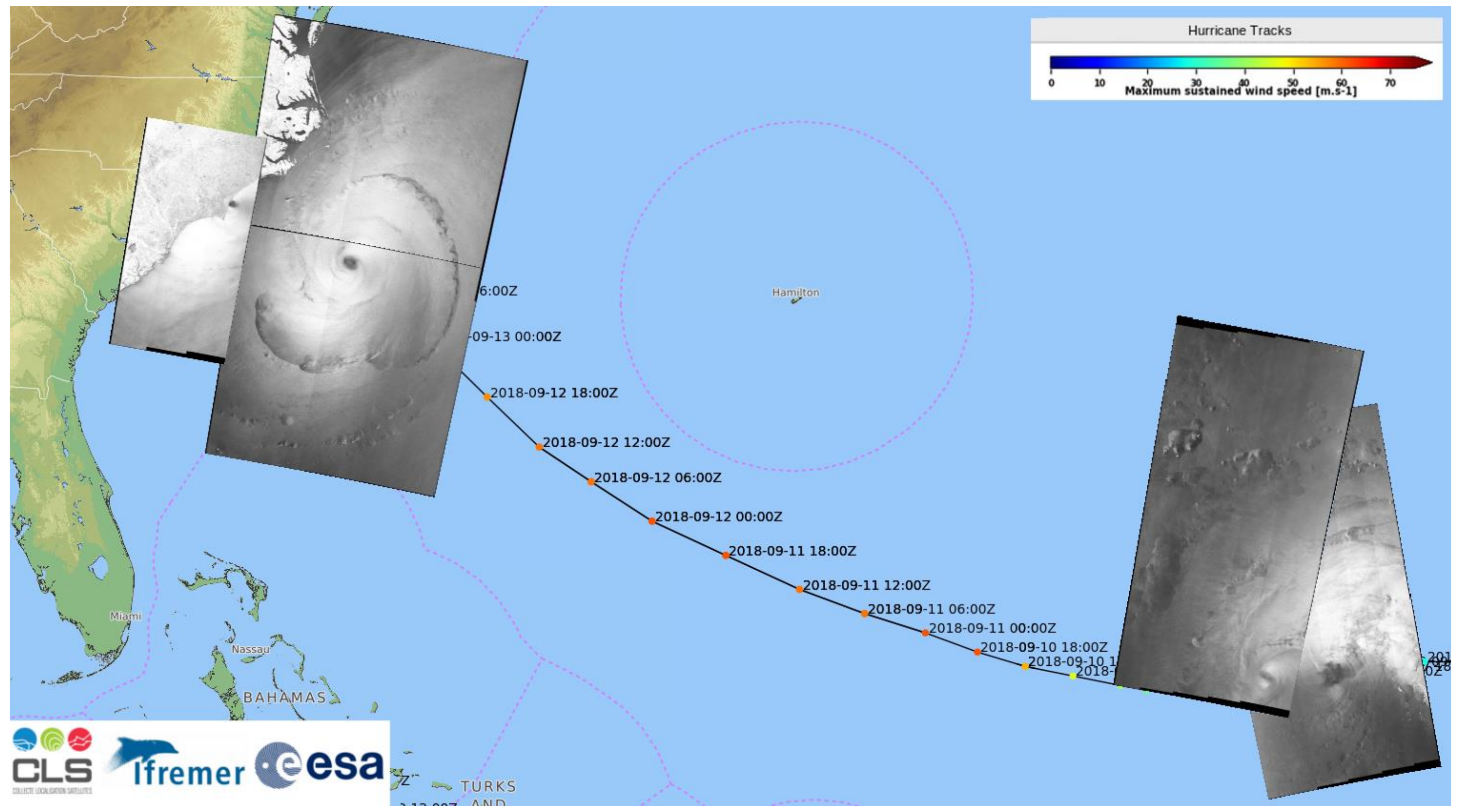
Detection and Categorization of Tropical Cyclones with Computer Vision

Φ-Lab: Raquel Carmo, Nicolas Longépé, Noelle Cremer
IFREMER: Alexis Mouche

Detection and Categorization of Tropical Cyclones with Computer Vision (1/2)

Raquel Carmo, Nicolas Longépé, Noelle Cremer, Alexis Mouche (IFREMER)





Objectives

Build a reliable model to:

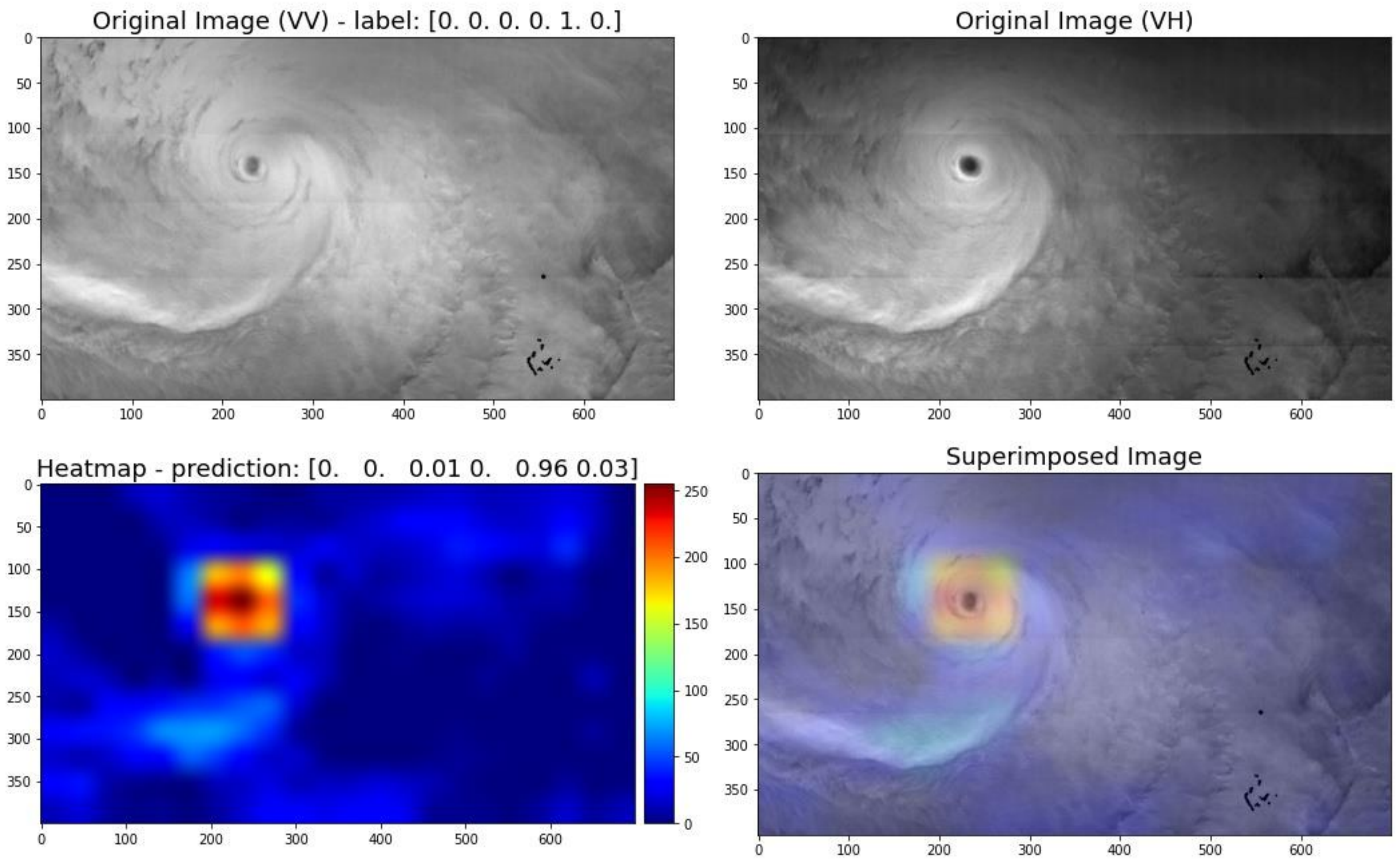
1) Detect presence or absence of the eye of a Tropical Cyclone (TC) in the image;
2) Estimate the strength/category of TCs based on their topology, i.e. sea surface wind and rain-related patterns;
3) Provide explainability on the categorization (from Step 2);
4) Locate the center coordinates of the TC eye, as it is then used to determine specific information per geographical storm quadrant.

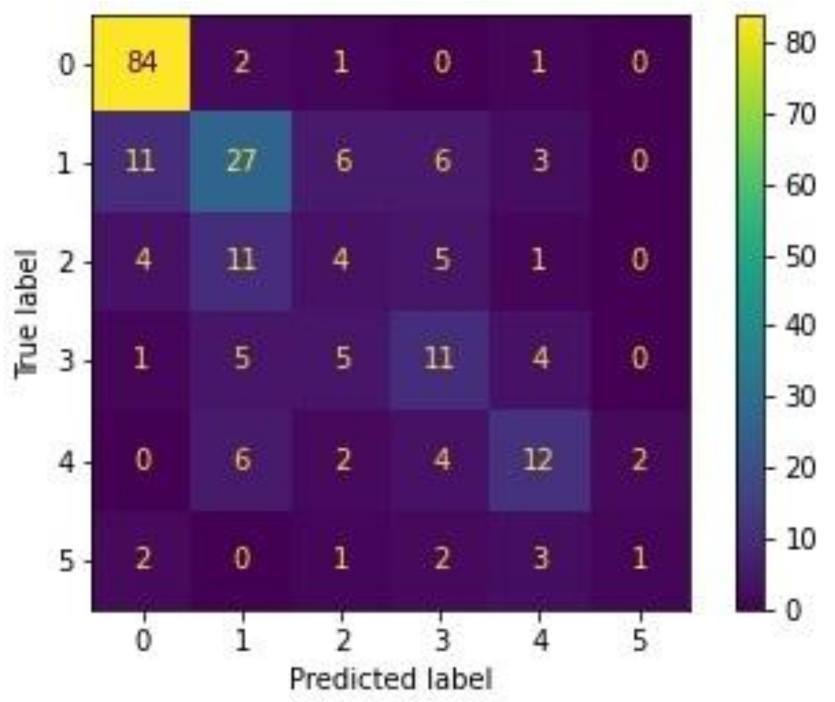
Partners

- IFREMER

Detection and Categorization of Tropical Cyclones with Computer Vision (2/2)

Raquel Carmo, Nicolas Longépé, Noelle Cremer, Alexis Mouche (IFREMER)





Data

- Sentinel-1 C-band SAR imagery
- L-band radiometers: SMOS and SMAP

Methods

- Pre-trained CNNs (ResNet50 or MobileNetV2) on ImageNet for the detection and categorization tasks and R-CNN or YOLO to address the eye-center localisation task.
- To allow for an explainable categorization on SAR data, Gradient-based Class Activation Map (Grad-CAM) is used.
- As the database for SMOS and SMAP is scarce, a parametric 2D hurricane model will be used to create synthetic data.

Progress/Results

- So far, only SAR data has been used, achieving approx. 97% precision in the eye-detection and 66% precision in the categorization. Networks are undergoing further performance improvements.
- Grad-CAM analysis reveal potential for TC eye-center localisation rather than simply TC eye-center detection, however no concrete explanations of why a TC is assigned to a specific category can be derived thus far.

DETECTING WILDFIRES AND HOTSPOTS USING HYPERSPECTRAL DATA

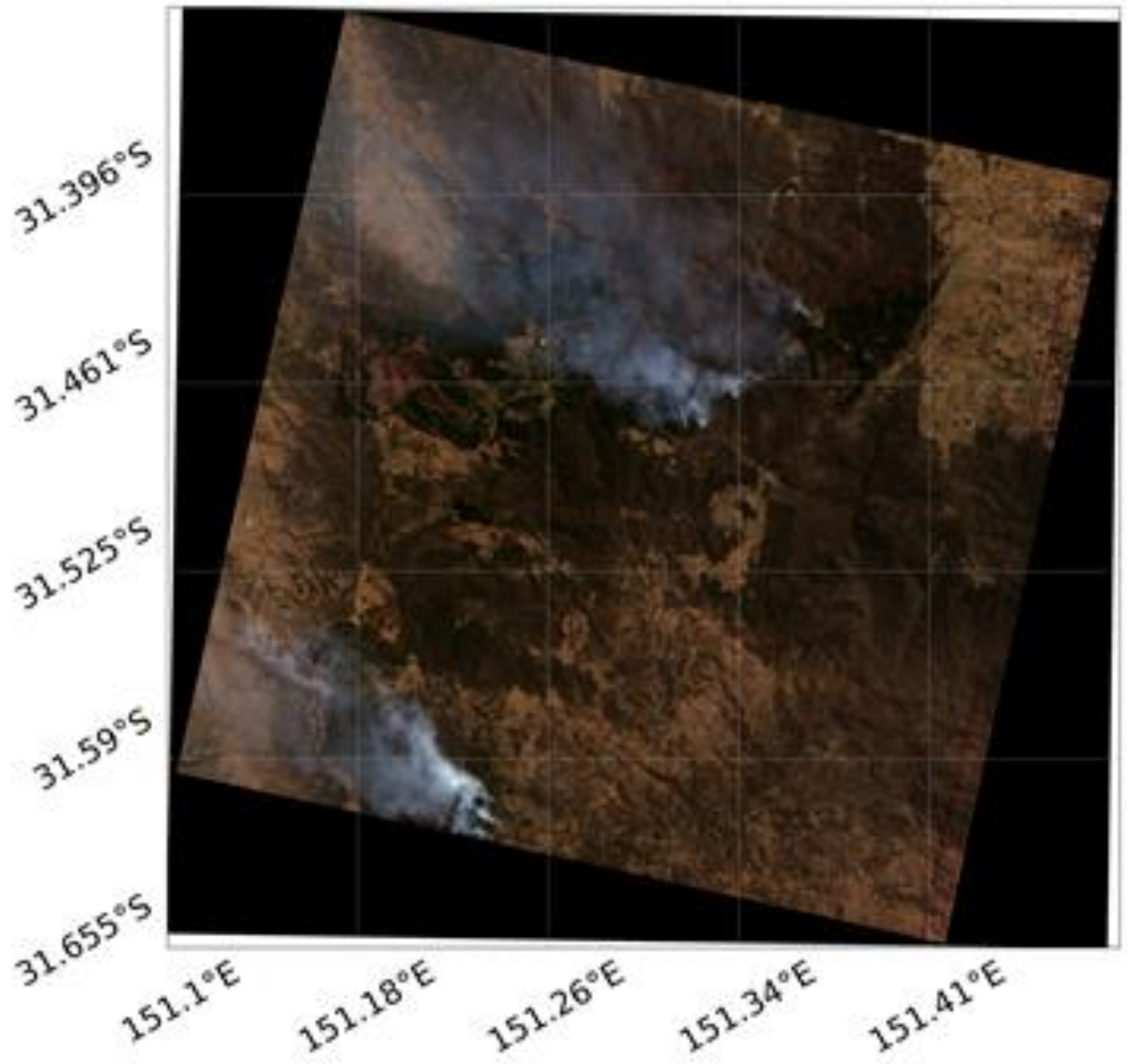
Φ-Lab: Dario Spiller, James Wheeler, Nicolas Longepé
INGV: Stefania Amici, Alessandro Piscini
ASI: Luigi Ansalone

Detecting wildfires and hotspots using hyperspectral data

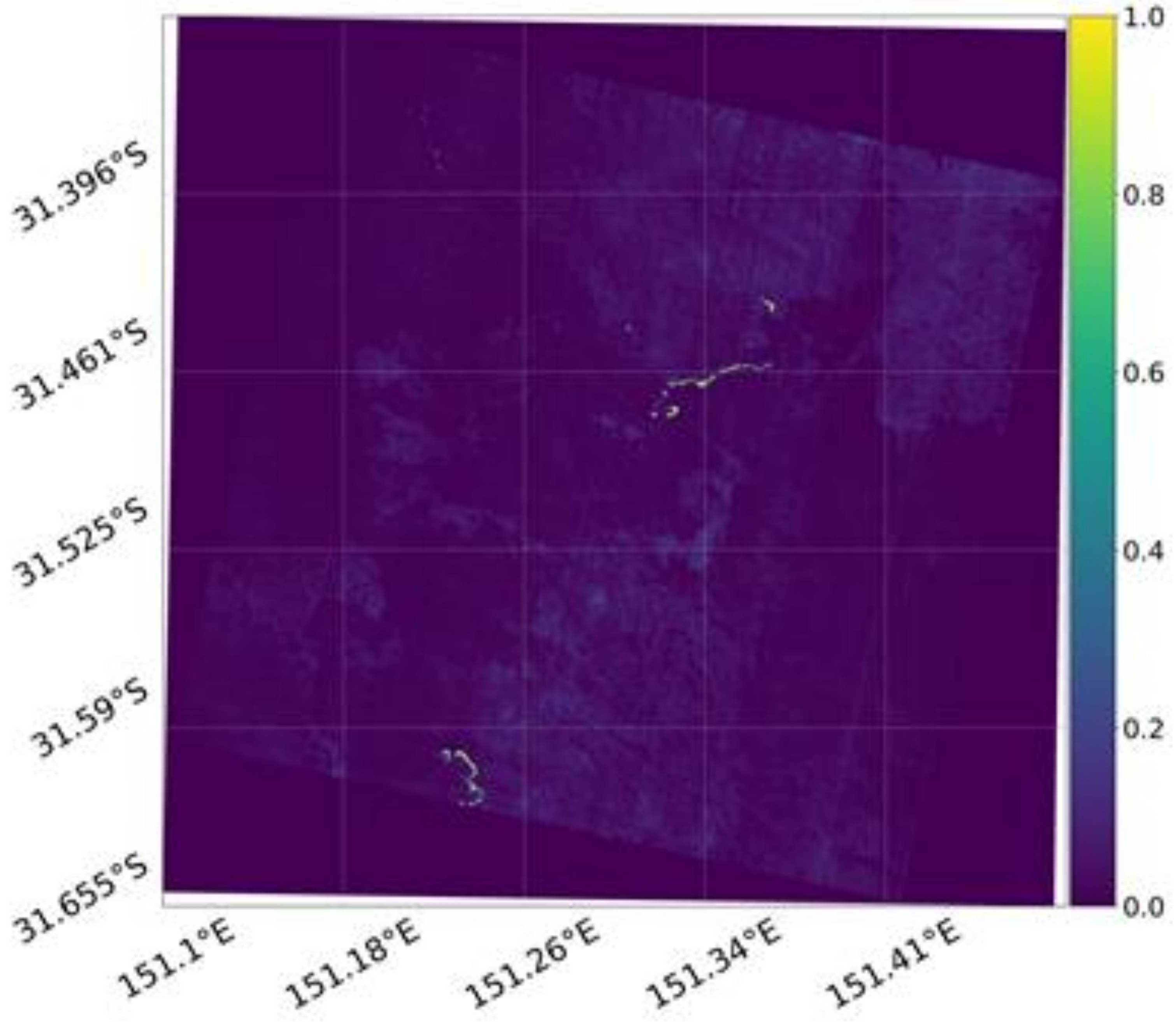
Dario Spiller, James Wheeler, Nicolas Longepé

- **Hyperspectral imagery** presents nonpareil features in support to **remote sensing applications**
- **Hotspots detection** can benefit from the **continue spectral signature** of hyperspectral remote sensing, eventually helping in *counteracting dangerous events and managing rescue operations*.
- This project investigate how the new Italian hyperspectral satellite **PRISMA** can be used to *support ground operations for hotspot detection* and *temperature retrieval*

Hanging Rock wildfire (Australia), Dec. 2019



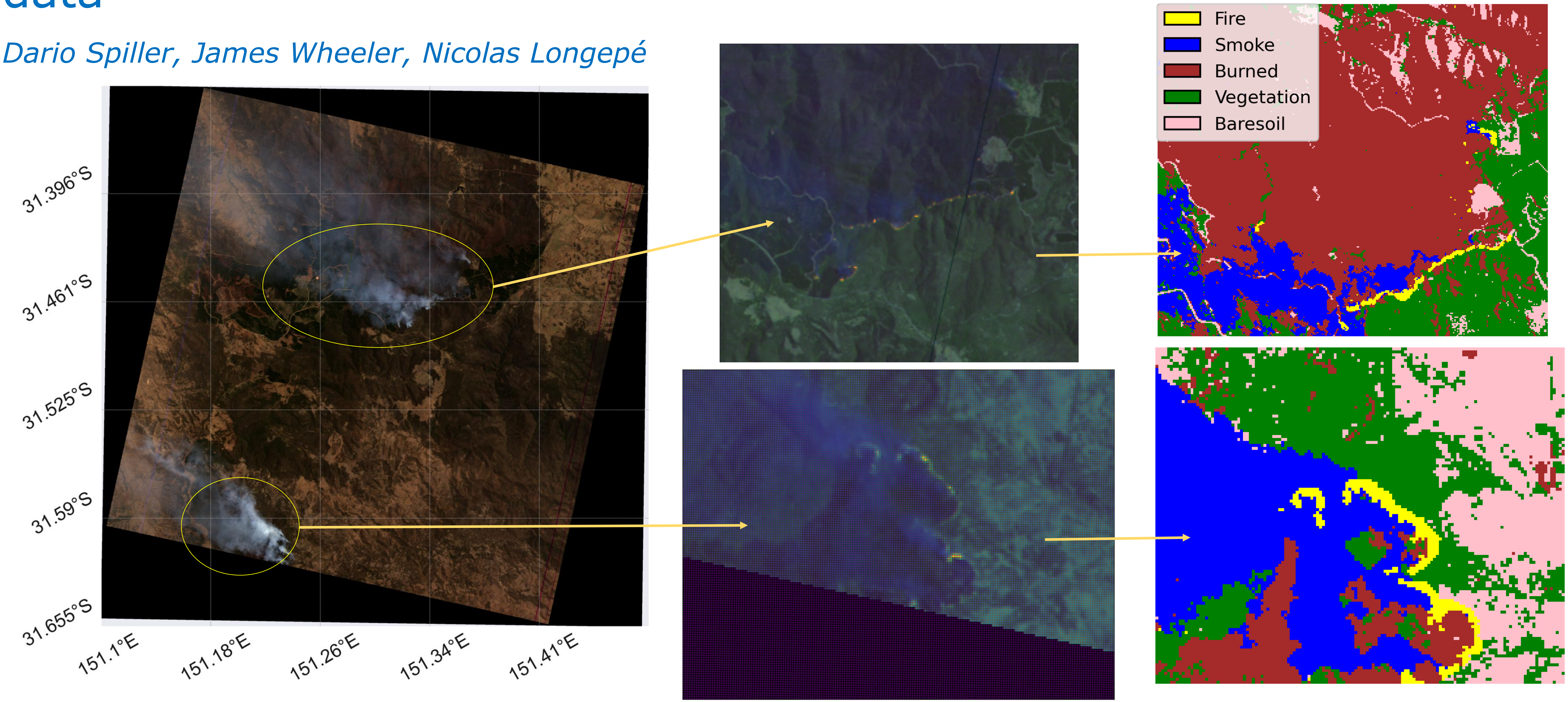
RGB Composite



Far Swir reflectance colormap (2496,87 nm)

Detecting wildfires and hotspots using hyperspectral data

Dario Spiller, James Wheeler, Nicolas Longepé



Observing System

and now AI@edge...

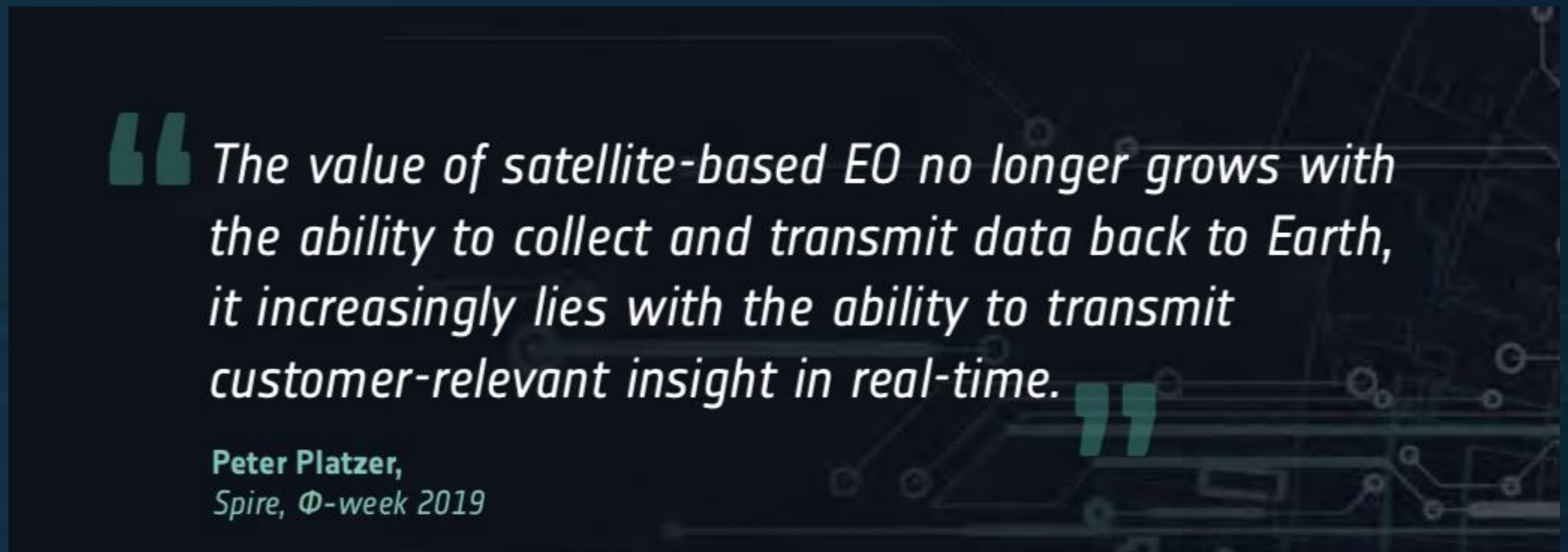
AI @ Edge: why?

Versatility

Enhanced security

High responsiveness

Low data rate



“The value of satellite-based EO no longer grows with the ability to collect and transmit data back to Earth, it increasingly lies with the ability to transmit customer-relevant insight in real-time.”

Peter Platzer,
Spire, Φ-week 2019

AI @ Edge: status as of 2021

Versatility
(see Ops-SAT)

Enhanced security

High responsiveness

Low data rate
(Phisat-1)

"The value of satellite-based EO no longer grows with the ability to collect and transmit data back to Earth, it increasingly lies with the ability to transmit customer-relevant insight in real-time."

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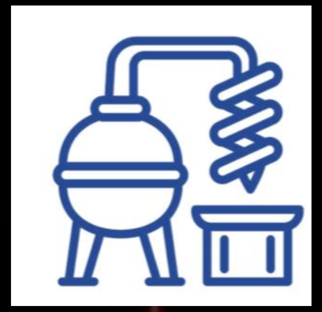
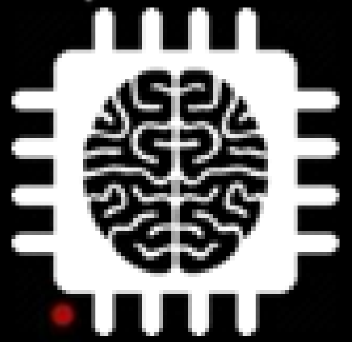
Spire, Φ-week 2019

Φ-sat-1

Training on Ground
(S-2 mimicking)
Cloud detection





Inference in Space

Hardware

This project is **technology driven:**

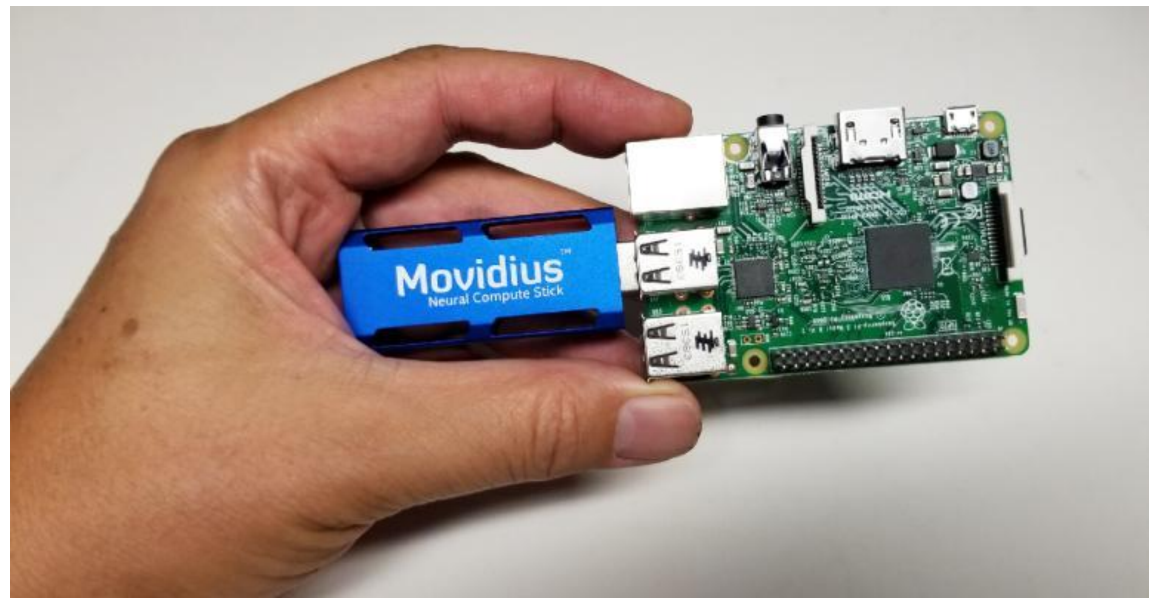
Visual Processing Unit (VPU) Myriad-2

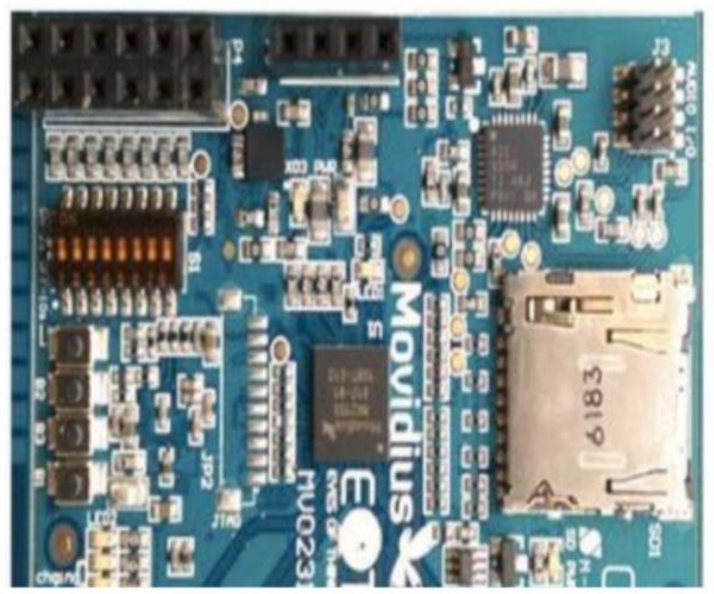
Hardware accelerator for Convolution Neural Networks (CNNs)

Fast: 1 TOPS

Low power: O(1 Watt)

Tiny



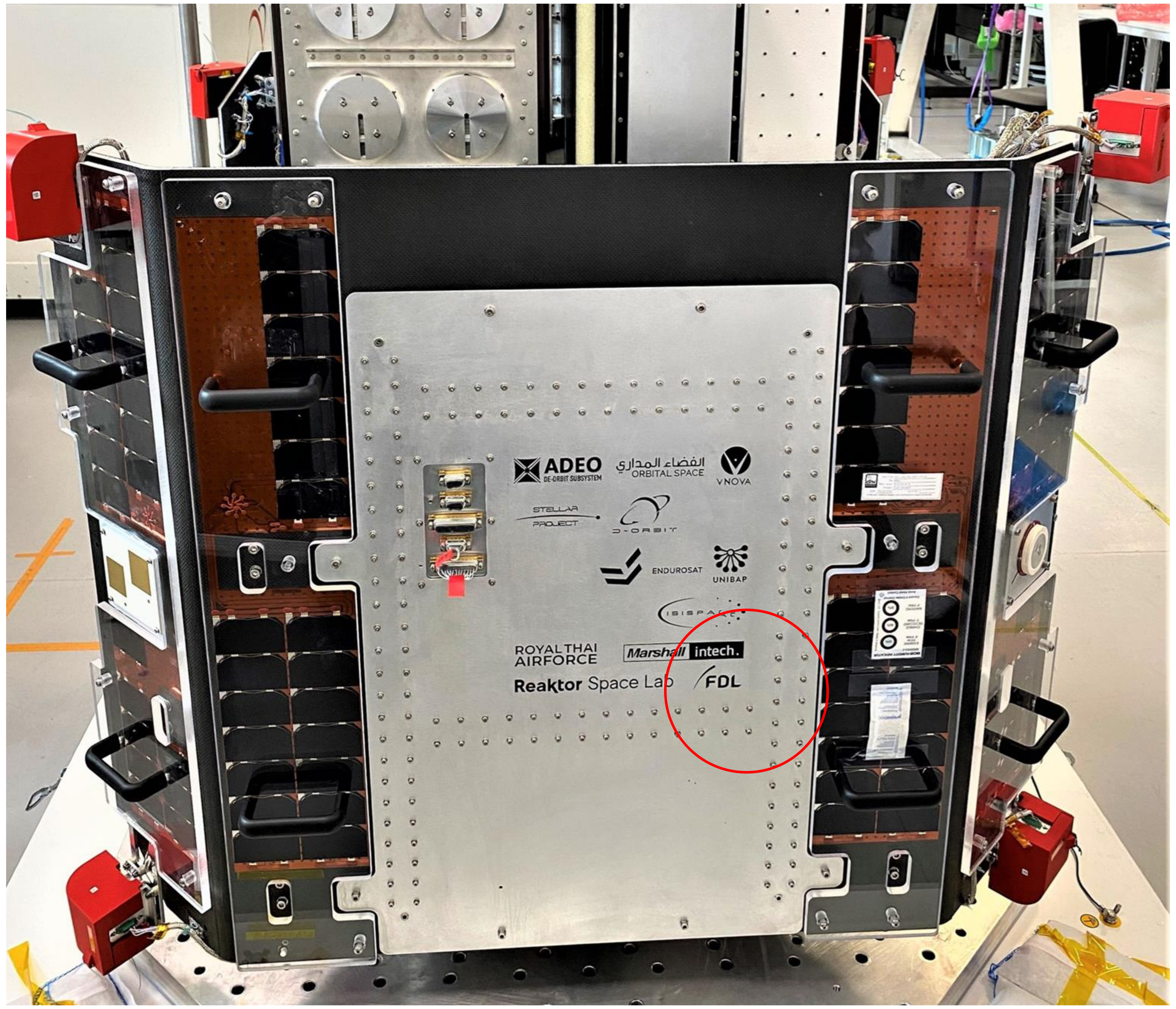


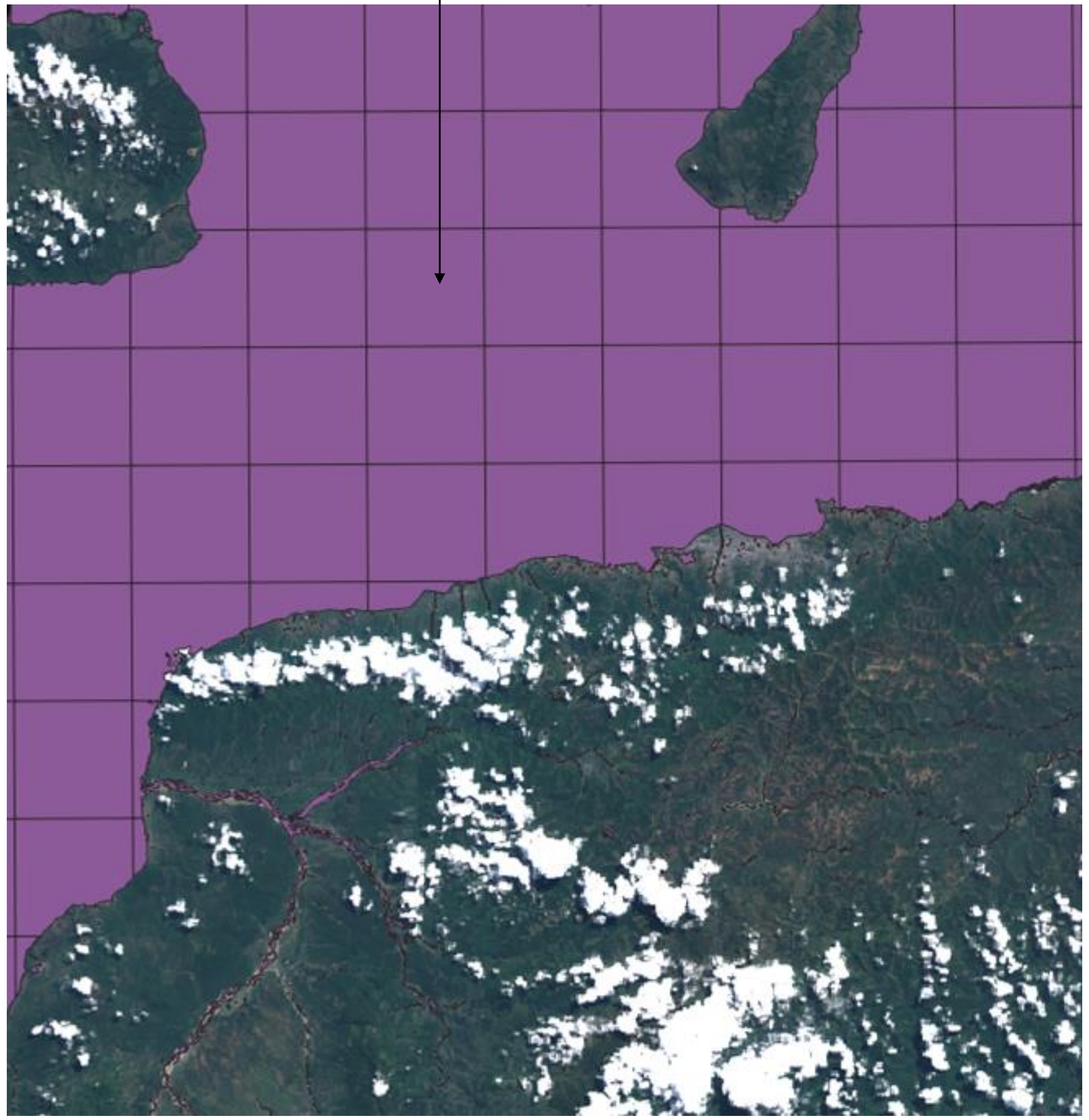
Φ-sat-2

A game-changing Earth Observation CubeSat platform in space capable of running AI Apps that can be developed by its users, then easily deployed in the spacecraft, and operated from ground.

Worldfloods + Space Cloud

Processing S2 imagery in orbit to obtain a flood segmentation.





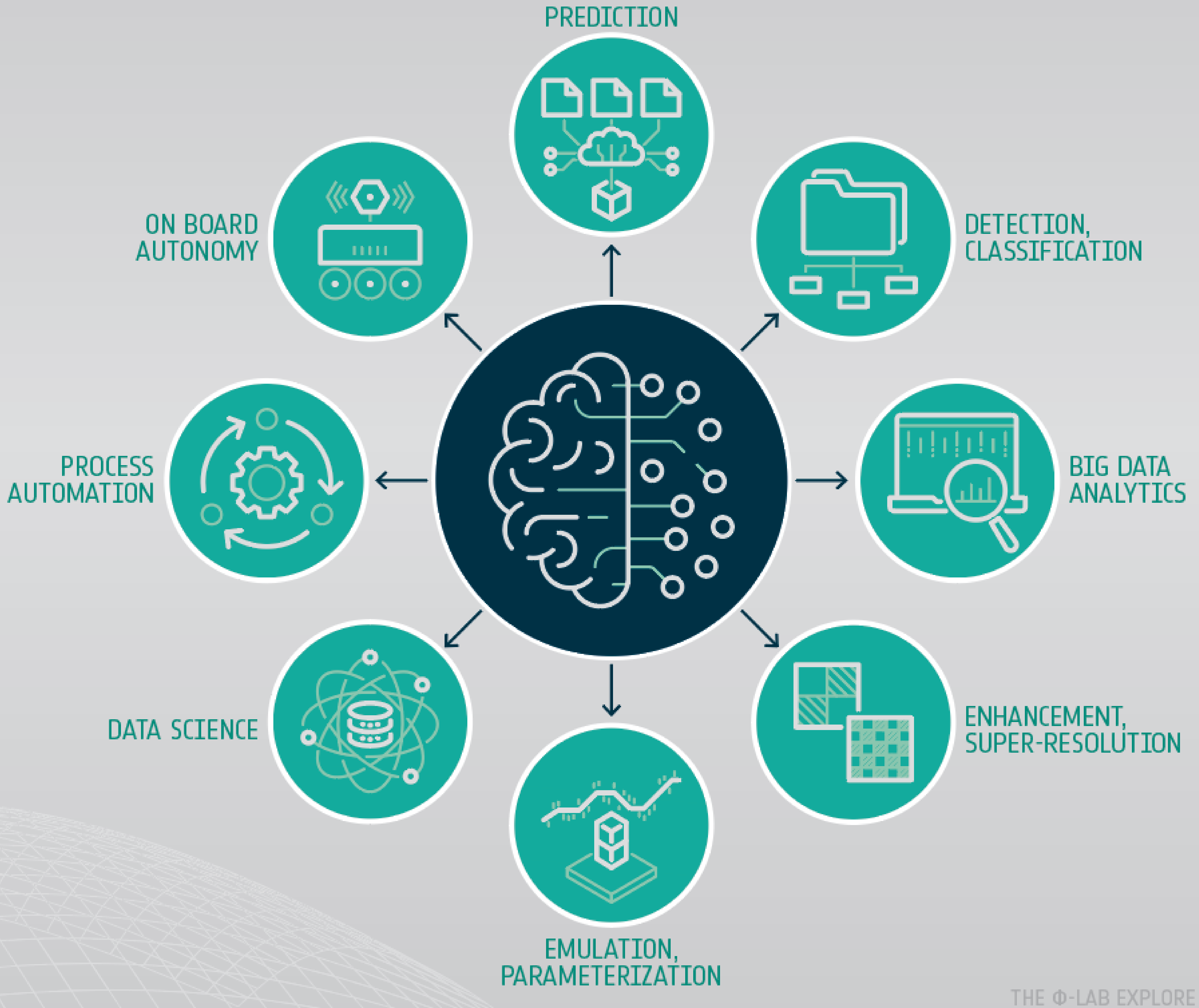
Worldfloods + Space Cloud

FRONTIER DEVELOPMENT LAB
FDL EUROPE
D-ORBIT
UNIBAP
esa

Processing S2 imagery in orbit to obtain a flood segmentation.

Concluding Remarks

AI TURBO-CHARGING EO



AI **accelerates** **Time to Insight** for Copernicus, Earth Explorer ESA mission, and EO data in general

AI can help **learning** the underlying **Structure** of data

The starting point…

How to harness the full potential of **Artificial Intelligence (AI) for Earth Observation (EO) -> AIEO ?** What shall be done at European level? more specifically by ESA?

Capacity Building Activities: create a data ecosystem for AI4EO, providing researchers, industry, and institutions with the data required, in the form required, in order to remove the bottlenecks of data preparation and training data creation.

Ecosystem Building Activities: build an interdisciplinary ecosystem of European AI4EO actors under a single banner, bringing together research, industry, institutions, and users, and based on the major challenges of AI4EO.

Research and Innovation Activities: conduct a suite of R&I activities aiming to accelerate the evolution of technical capabilities of European AI4EO research and industry and foster the uptake of AI in the EO community across applications, from EO product to satellite tasking.

"**Technology**… is only a **magnifier** of **human intent** and capacity. It is not a **substitute**."

Kentaro Toyama
Geek Heresy: Rescuing Social Change from the Cult of Technology

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