

# Crop Mapping using Synthetic Aperture Radar (SAR) and Optical Remote Sensing

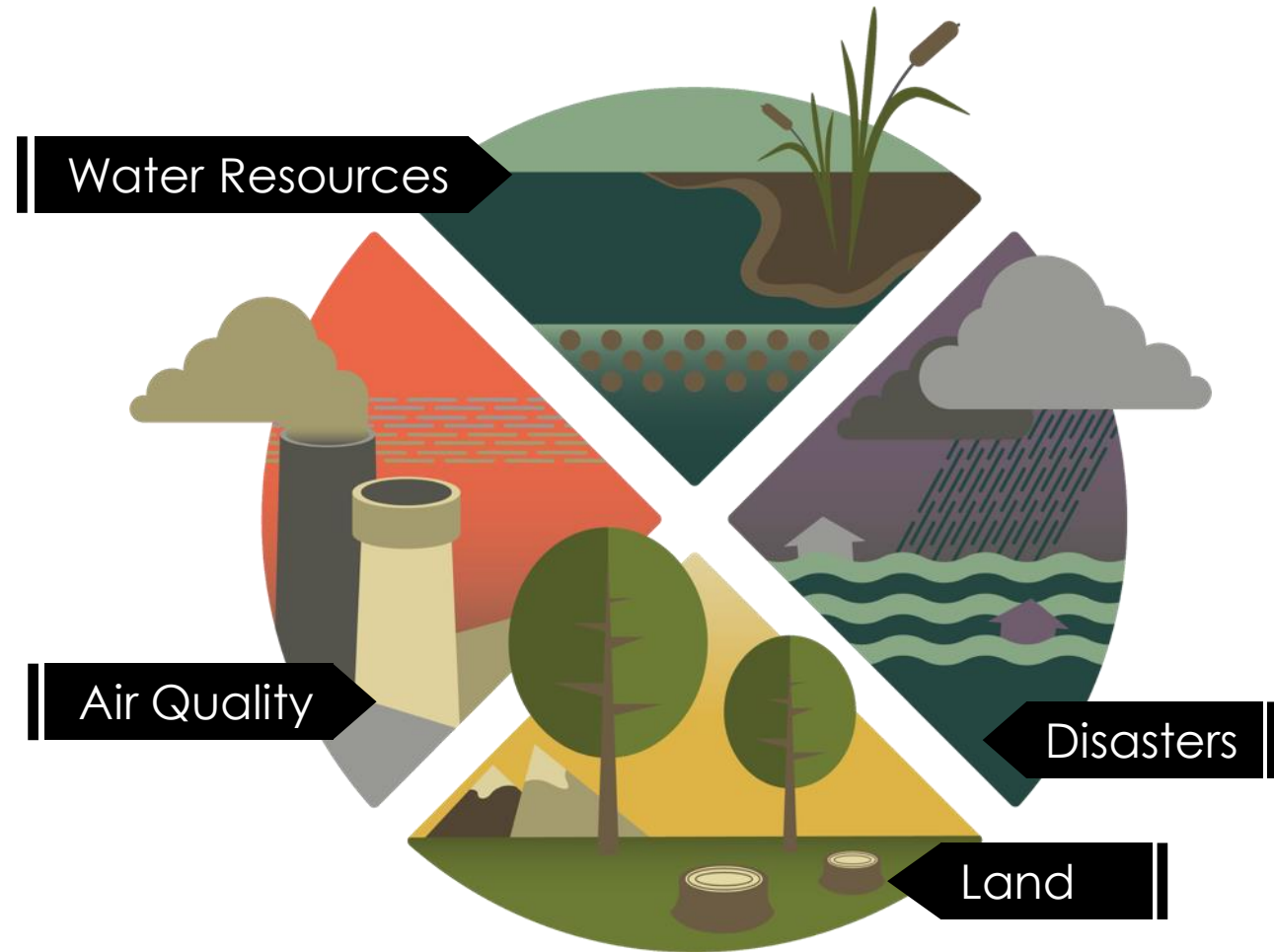
April 4, 2023



# NASA's Applied Remote Sensing Training Program (ARSET)

<https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset/about-arset>

- Part of NASA's Applied Sciences Capacity Building Program
- Empowering the global community through online and in-person remote sensing training
- Topics for trainings include:
  - Water Resources
  - Air Quality
  - Disasters
  - Land
  - Climate & Energy (recently added)



# NASA's Applied Remote Sensing Training Program (ARSET)

<https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset>

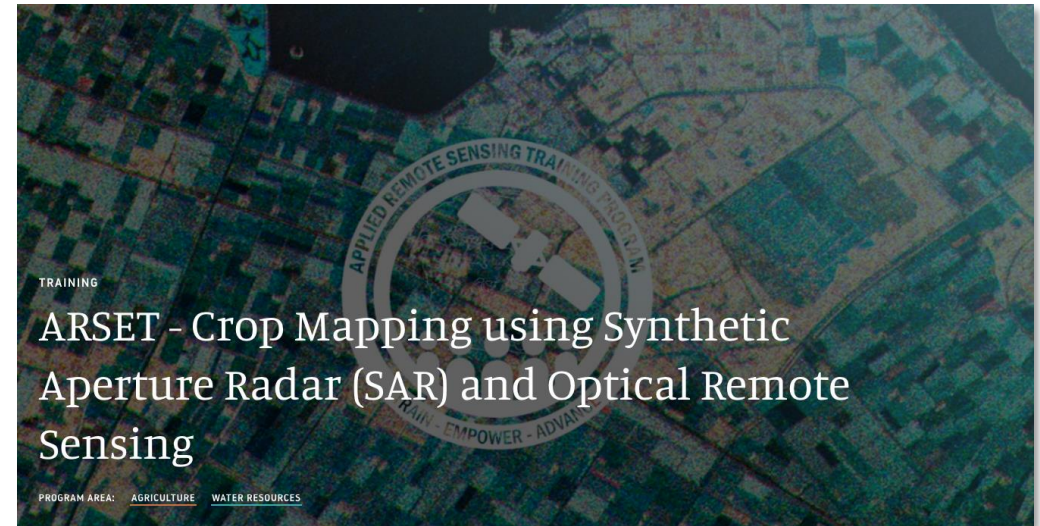
- ARSET's goal is to increase the use of Earth science remote sensing and model data in decision-making through training for:
  - Professionals in the public and private sector
  - Environmental managers
  - Policy makers

All ARSET materials are freely available to use and adapt for your curriculum. If you use the methods and data presented in ARSET trainings, please acknowledge the NASA Applied Remote Sensing Training (ARSET) program.



# Training Format

- Three 2.5-hour sessions including presentations, demonstrations, and question and answer sessions
- The same content will be presented at two different times each day.
- Session A will be presented in **English**.
- Session B will be presented in **Spanish**.
  - Session A: 10:00-12:30 EST (UTC-4)
  - Session B: 13:00-15:30 EST (UTC-4)
- Training materials and recordings will be available from:  
<https://appliedsciences.nasa.gov/join-mission/training/english/arset-crop-mapping-using-synthetic-aperture-radar-and-optical-0>



# Homework and Certificate

- Homework Assignment:
  - Answers must be submitted via Google Form
  - Due Date: April 25, 2023
- A certificate of completion will be awarded to those who:
  - Attend all live webinars
  - Complete the homework assignment by the deadline (access from website)
  - You will receive a certificate approximately two months after the completion of the course from: [marines.martins@ssaihq.com](mailto:marines.martins@ssaihq.com)





# Prerequisites

## Fundamentals of Remote Sensing:

<https://appliedsciences.nasa.gov/join-mission/training/english/fundamentals-remote-sensing>

TRAINING

## Fundamentals of Remote Sensing

PROGRAM AREA: [CAPACITY BUILDING](#) [DISASTERS](#) [ECOLOGICAL FORECASTING](#) [FOOD SECURITY & AGRICULTURE](#) [HEALTH & AIR QUALITY](#) [WATER RESOURCES](#)

HOME / JOIN THE MISSION / TRAINING

DESCRIPTION

These webinars are available for viewing at any time. They provide basic information about the fundamentals of remote sensing, and are often a prerequisite for other ARSET trainings.

OBJECTIVE

Participants will become familiar with satellite orbits, types, resolutions, sensors and processing levels. In addition to a conceptual understanding of remote sensing, attendees will also be able to articulate its advantages and disadvantages. Participants will also have a basic understanding of NASA satellites, sensors, data, tools, portals and applications to environmental monitoring and management.

DETAILS

LANGUAGES: [English](#)

TRAINING TYPE: [Online Training](#)

LEVEL: [Introductory](#)

TRAINING SOURCE: [ARSET](#)

## Agricultural Crop Classification with Synthetic Aperture Radar and Optical Remote Sensing:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-agricultural-crop-classification-synthetic-aperture-radar-and>

TRAINING

## ARSET - Agricultural Crop Classification with Synthetic Aperture Radar and Optical Remote Sensing

PROGRAM AREA: [AGRICULTURE](#) [WATER RESOURCES](#)

HOME / JOIN THE MISSION / TRAINING

DESCRIPTION

For years, mapping of crop types and assessment of their characteristics has been carried out to monitor food security, inform optimal use of the landscape, and contribute to agricultural policy. High-quality crop mapping has become a requirement for most nations given its importance in national and international economics, trade, and food security and is a major topic of interest in the domains of policy, economics, and land management. Most countries or economic regions currently and increasingly use freely available satellite imagery for crop type classification and biophysical variable assessment as they provide a synoptic view, multi temporal coverage, and are cost effective. Remote sensing methods based on optical and/or microwave sensors have become

DETAILS

October 5, 2021 - October 19, 2021

LANGUAGES: [English](#)

TRAINING TYPE: [Online Training](#)

LEVEL: [Intermediate](#)

## Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-mapping-crops-and-their-biophysical-characteristics>

TRAINING

## ARSET - Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing

PROGRAM AREA: [AGRICULTURE](#) [WATER RESOURCES](#)

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DESCRIPTION

Mapping crop types and assessing their characteristics is critical for monitoring food production, enabling optimal use of the landscape, and contributing to agricultural policy. Remote sensing methods based on optical and/or microwave sensors have become an important means of

DETAILS

April 12, 2022 - May 3, 2022

LANGUAGES: [English](#)



# Training Outline



**April 4, 2023**

**Crop Classification with  
Time Series of  
Polarimetric SAR Data**

April 6, 2023

Crop Classification with  
Time Series Optical and  
Radar Data

April 11, 2023

Monitoring Crop Growth  
Through SAR-Derived Crop  
Structural Parameters



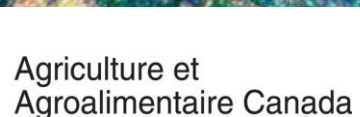
# Training Objectives

After participating in this 3-part training, attendees will be able to:

- Explain how polarimetric parameters are used for crop condition assessment
- Demonstrate how to perform Sentinel-1 SAR preprocessing to derive quasi polarimetric parameters
- Perform a calibration of a SAR-based vegetation index to NDVI
- Monitor crop growth with multitemporal polarimetric SAR (PolSAR) data from Sentinel-1
- Examine crop growth using a canopy structure dynamic model and time series of Sentinel-1 imagery
- Classify crop type using a time series of radar and optical imagery (Sentinel-1 & Sentinel-2)







# Crop Classification with Time Series of Polarimetric SAR Data

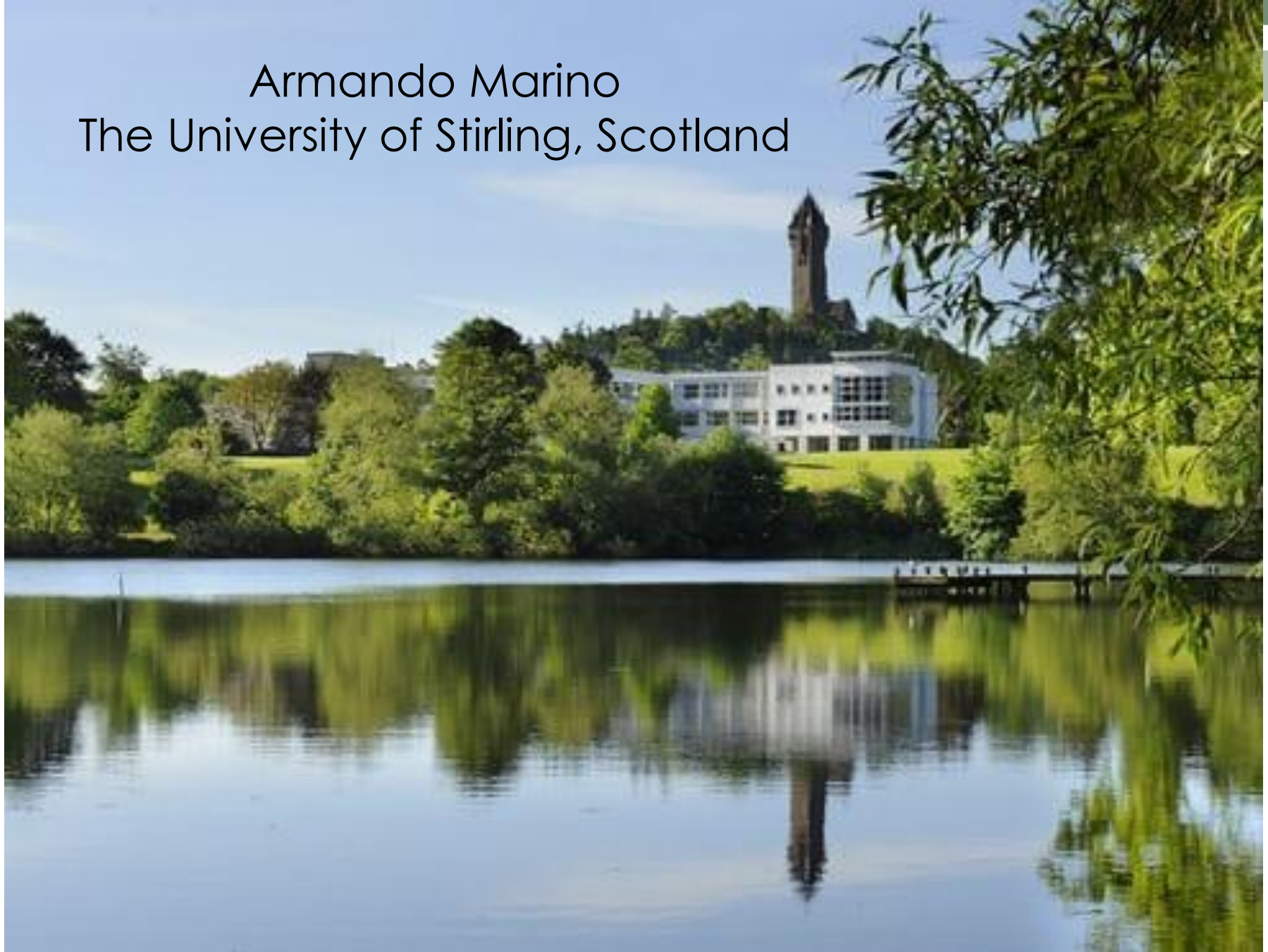
Armando Marino

April 4, 2023



# Introduction

Armando Marino  
The University of Stirling, Scotland



# Learning outcomes:

By the end of this practical you will learn how to:

- Run Python code for machine learning of multitemporal PolSAR data
- Pre-process PolSAR data for using machine learning
- Format the data in feature vectors
- Run random forest and K-Means classifiers
- Evaluate the accuracy of your classifiers





# Before you start:

- This practical builds on skills from a previous ARSET training: *Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing*  
<https://appliedsciences.nasa.gov/join-mission/training/english/arset-mapping-crops-and-their-biophysical-characteristics>
- If you are not very familiar with Python, you may want to go through the materials from the previous training before you attempt this training.
- In the training folder, you will find files with and without solutions. My suggestion is to try to solve the coding exercises on your own before you listen to the training or look at the solutions.



# Python

*“Python is a programming language that lets you work quickly and integrate systems more effectively.”*

<https://www.python.org/>



You can find many tutorials or books on the web. The one I use is the following:

<https://docs.python.org/3/tutorial/>



# Downloading/Installing: Anaconda

My suggestion is to use the *Anaconda installer*, because it comes with most of the common libraries: <https://www.anaconda.com/products/individual?modal=nucleus>

If you do not want to use Anaconda, please make sure you use Python 3.x version (3.6+ will be fine), but **NOT 2.7**, since some functions have changed!

The 2.7 version will NOT run with the code I am sharing!

## Anaconda Installers

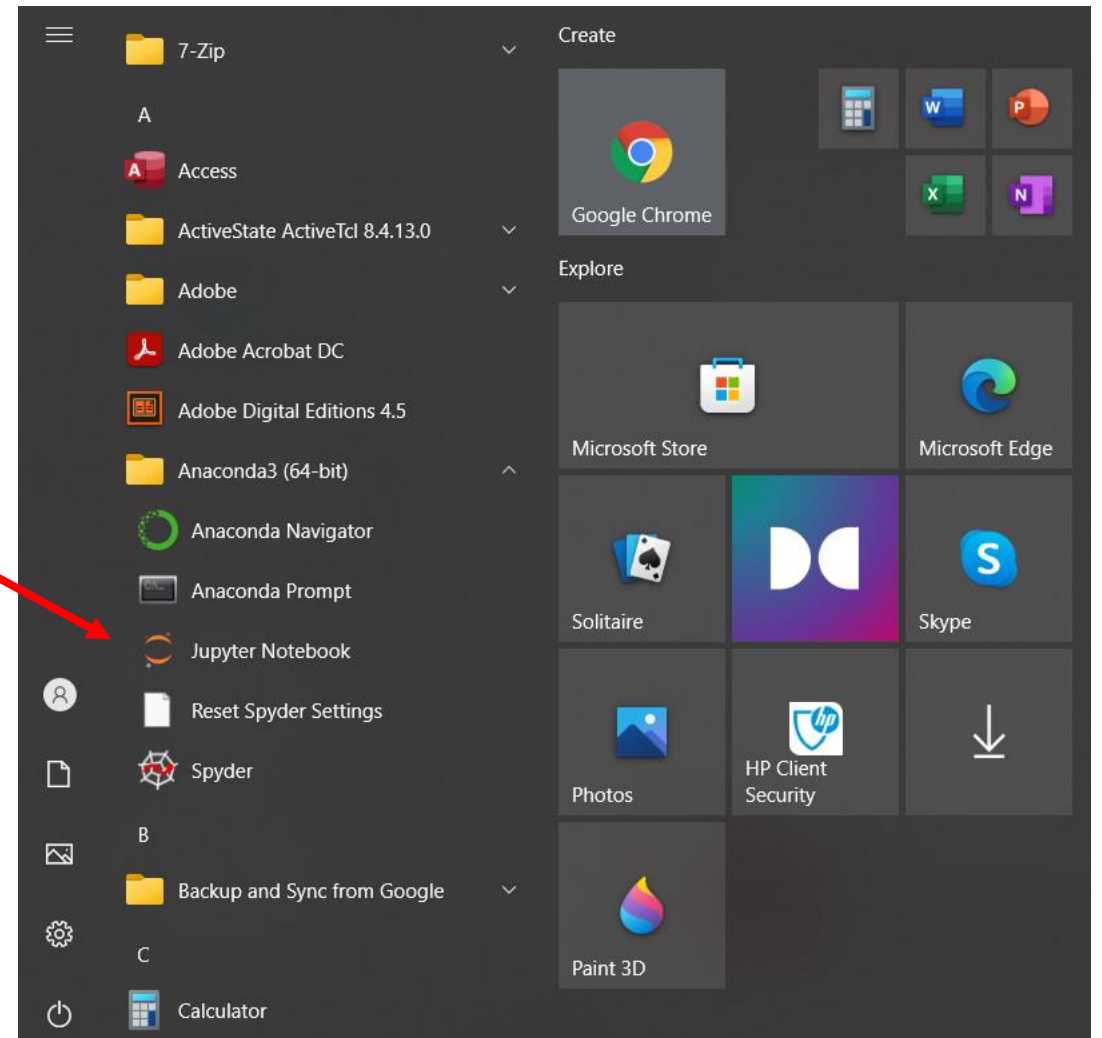
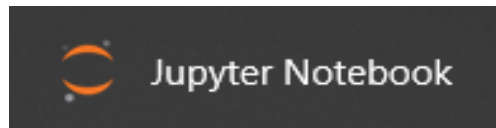
Windows 	MacOS 	Linux 
Python 3.9 64-Bit Graphical Installer (510 MB) 32-Bit Graphical Installer (404 MB)	Python 3.9 64-Bit Graphical Installer (515 MB) 64-Bit Command Line Installer (508 MB)	Python 3.9 64-Bit (x86) Installer (581 MB) 64-Bit (Power8 and Power9) Installer (255 MB) 64-Bit (AWS Graviton2 / ARM64) Installer (488 M) 64-bit (Linux on IBM Z & LinuxONE) Installer (242 M)



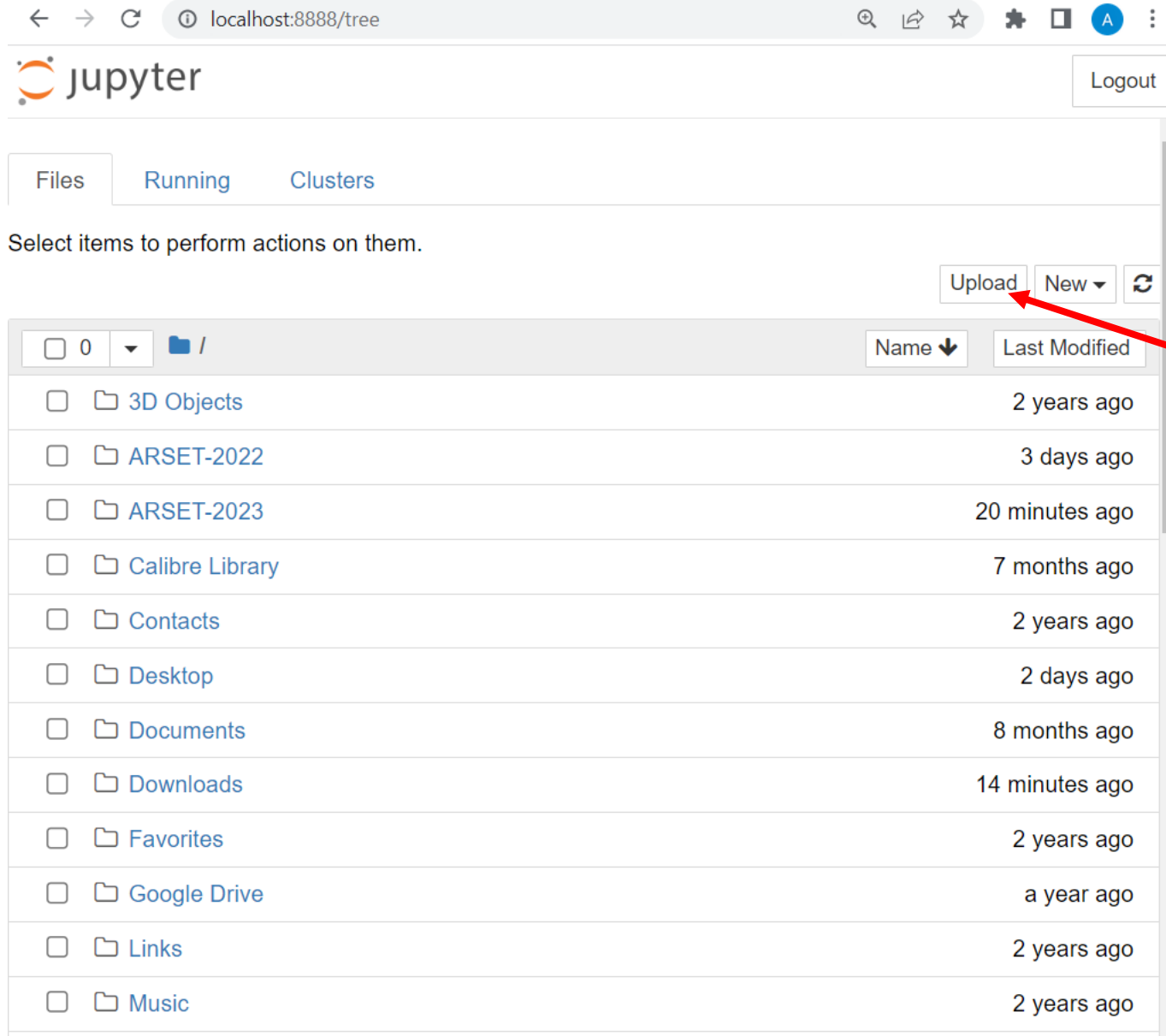


# Jupyter Notebook

Anaconda will install Jupyter Notebook and you should see its icon in the Start menu (Windows OS).



# Jupyter Notebook



The screenshot shows the Jupyter Notebook web interface in a browser. The address bar displays 'localhost:8888/tree'. The Jupyter logo is in the top left, and a 'Logout' button is in the top right. Below the logo are tabs for 'Files', 'Running', and 'Clusters'. A message says 'Select items to perform actions on them.' To the right of this message are buttons for 'Upload', 'New', and a refresh icon. Below this is a file browser table with columns for 'Name' and 'Last Modified'. A red arrow points from the 'Upload' button to the text on the right.

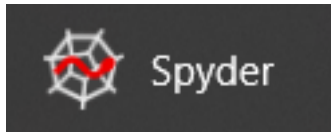
<input type="checkbox"/>	0	Name ↓	Last Modified
<input type="checkbox"/>	0	3D Objects	2 years ago
<input type="checkbox"/>	0	ARSET-2022	3 days ago
<input type="checkbox"/>	0	ARSET-2023	20 minutes ago
<input type="checkbox"/>	0	Calibre Library	7 months ago
<input type="checkbox"/>	0	Contacts	2 years ago
<input type="checkbox"/>	0	Desktop	2 days ago
<input type="checkbox"/>	0	Documents	8 months ago
<input type="checkbox"/>	0	Downloads	14 minutes ago
<input type="checkbox"/>	0	Favorites	2 years ago
<input type="checkbox"/>	0	Google Drive	a year ago
<input type="checkbox"/>	0	Links	2 years ago
<input type="checkbox"/>	0	Music	2 years ago

Jupyter opens in a web browser, and you can upload scripts using the **Upload** button.

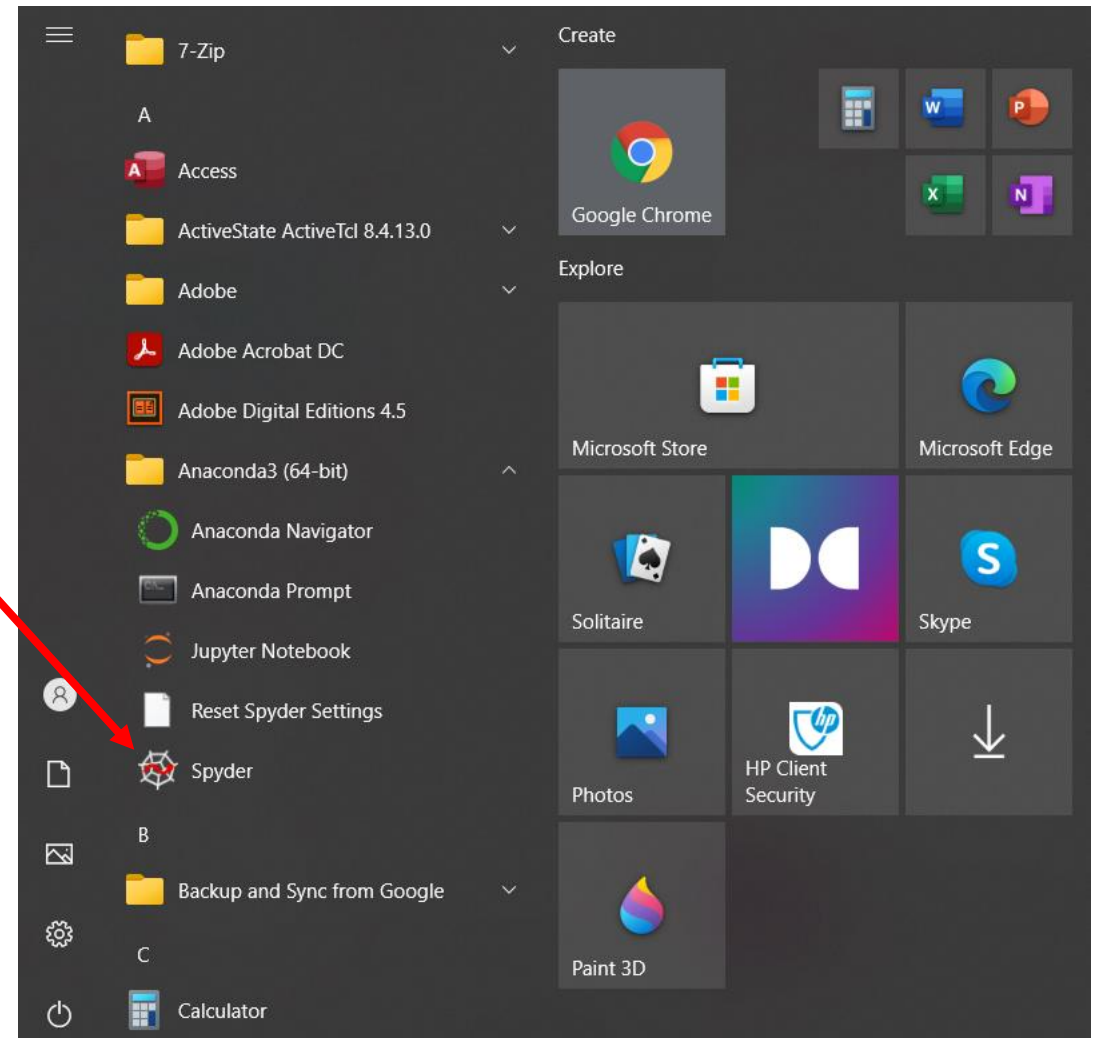


# Spyder

Anaconda will install the Python editor **Spyder** and you should see the icon below.

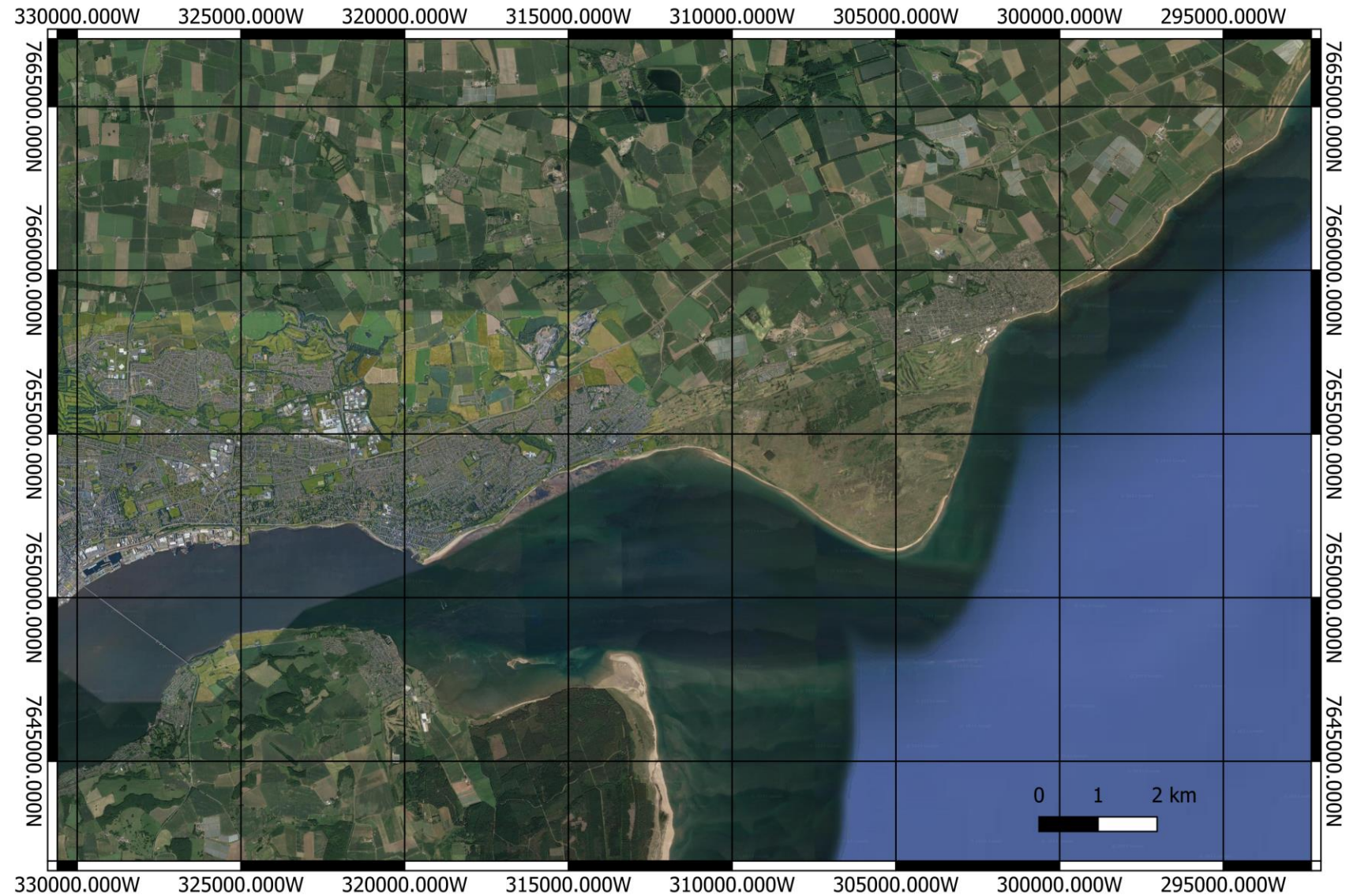
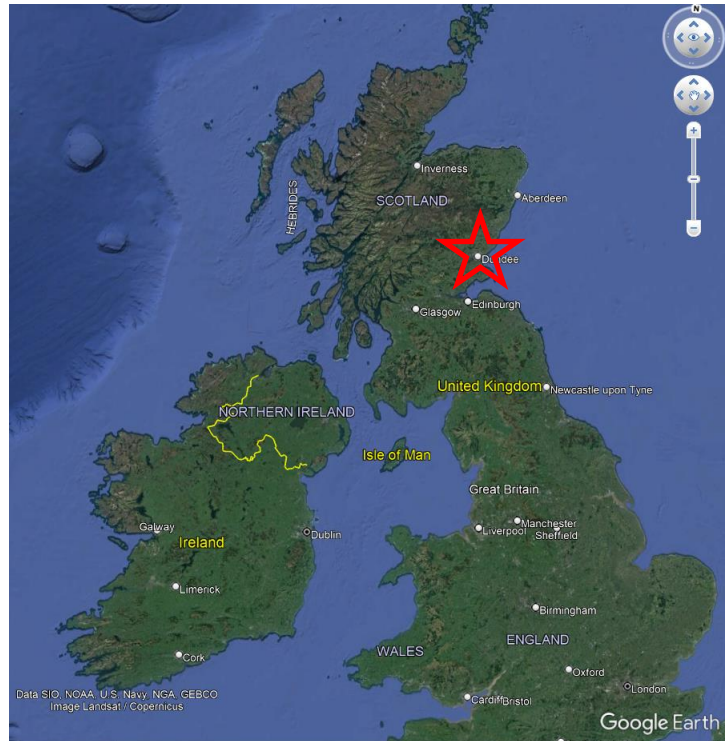


Spyder is a handy editor, and you may want to use it when you are scripting **operational/automatic processing stacks**.





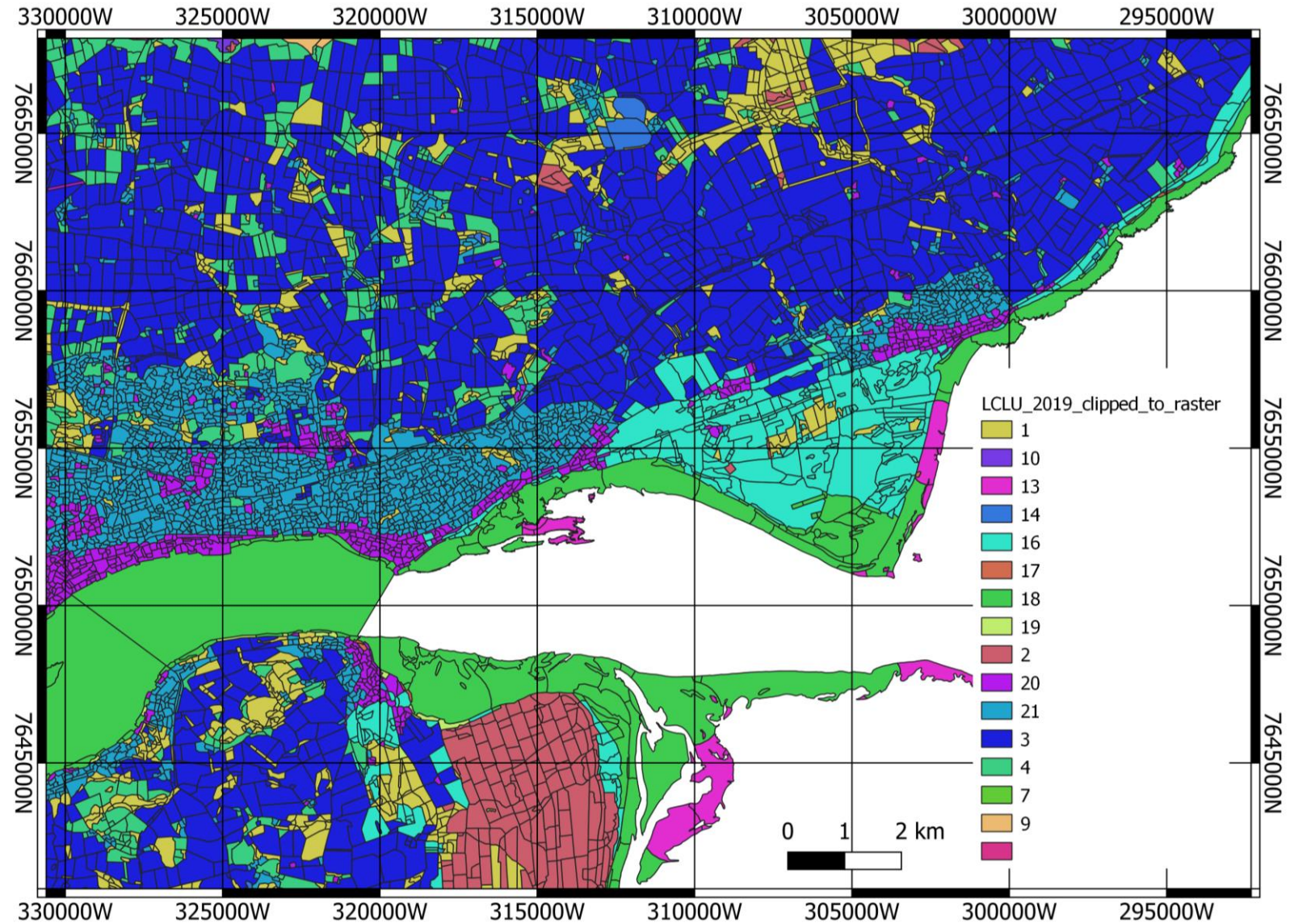
# Data: Sentinel-1 ESA; Location: Angus, Scotland





# Data: Sentinel-1 ESA; Location: Angus, Scotland

The **crops** are mostly cereals, potatoes, and rapeseed oil.



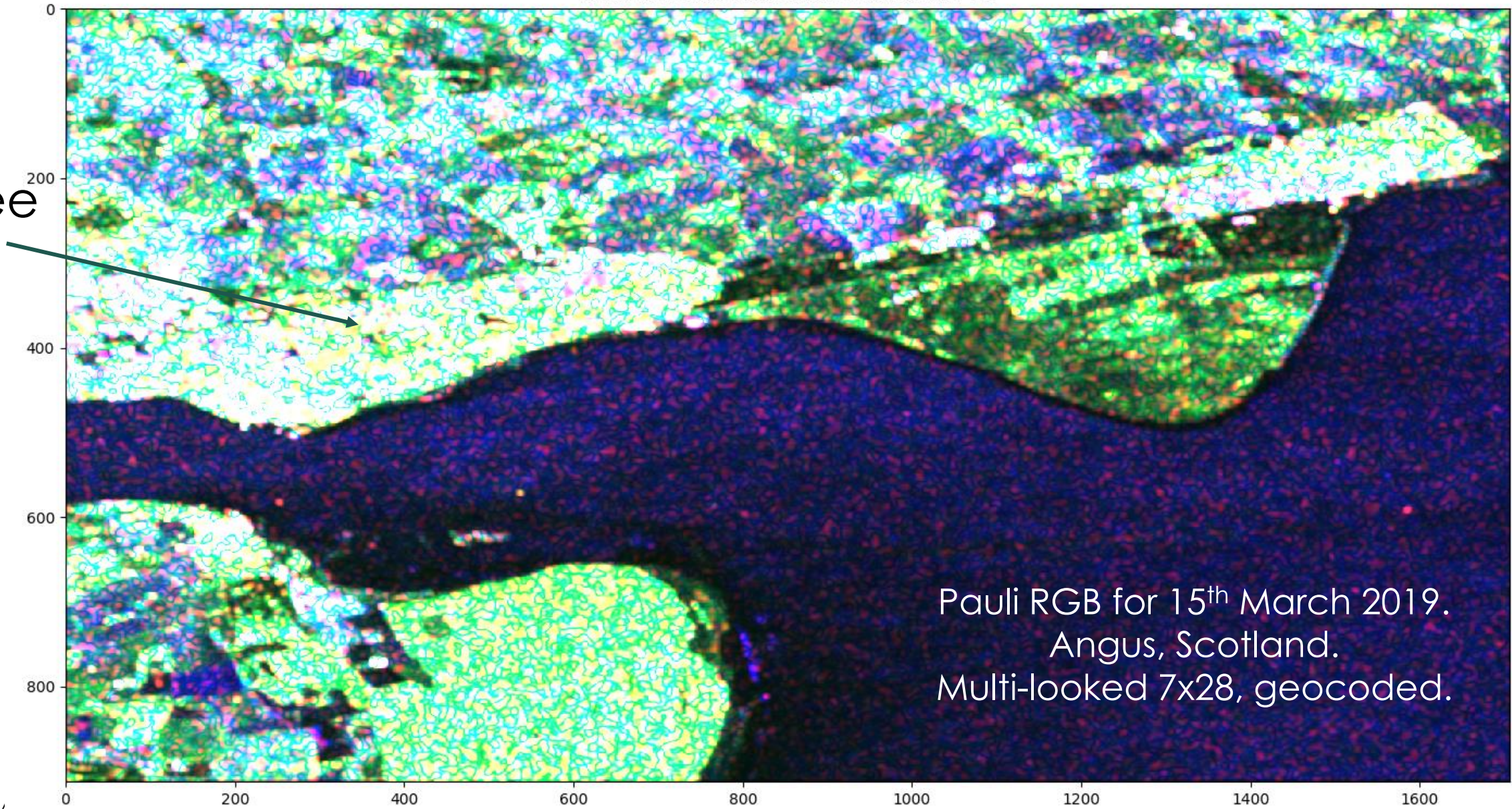


# Data: Sentinel-1 ESA; Location: Angus, Scotland

RGB Pauli: After BOXCAR FILTER. 2019-03-15



Dundee



Pauli RGB for 15<sup>th</sup> March 2019.  
Angus, Scotland.  
Multi-looked 7x28, geocoded.

Nz

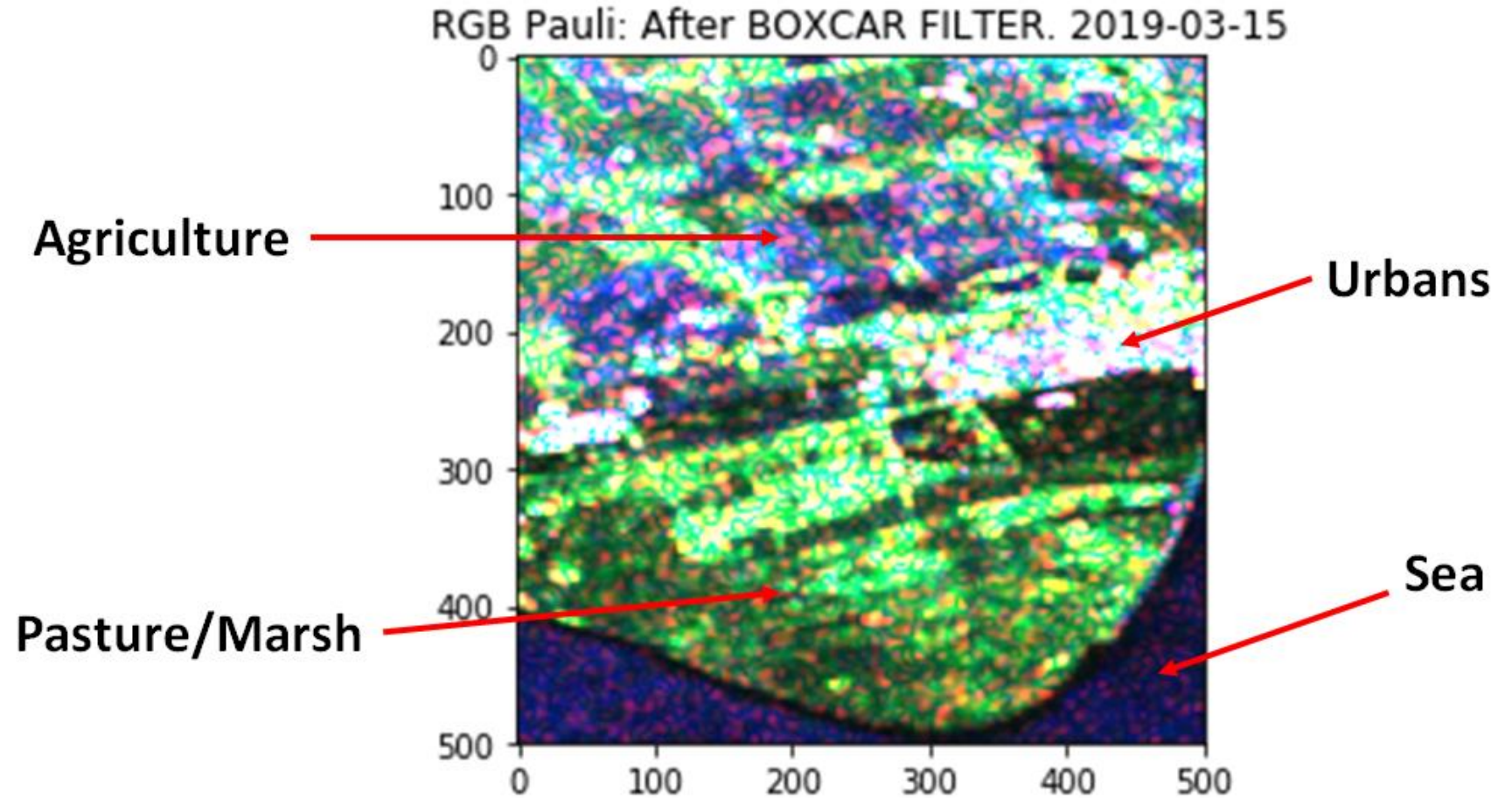




# Data: Sentinel-1 ESA; Location: Angus, Scotland

Pauli RGB for 15<sup>th</sup>  
March 2019.  
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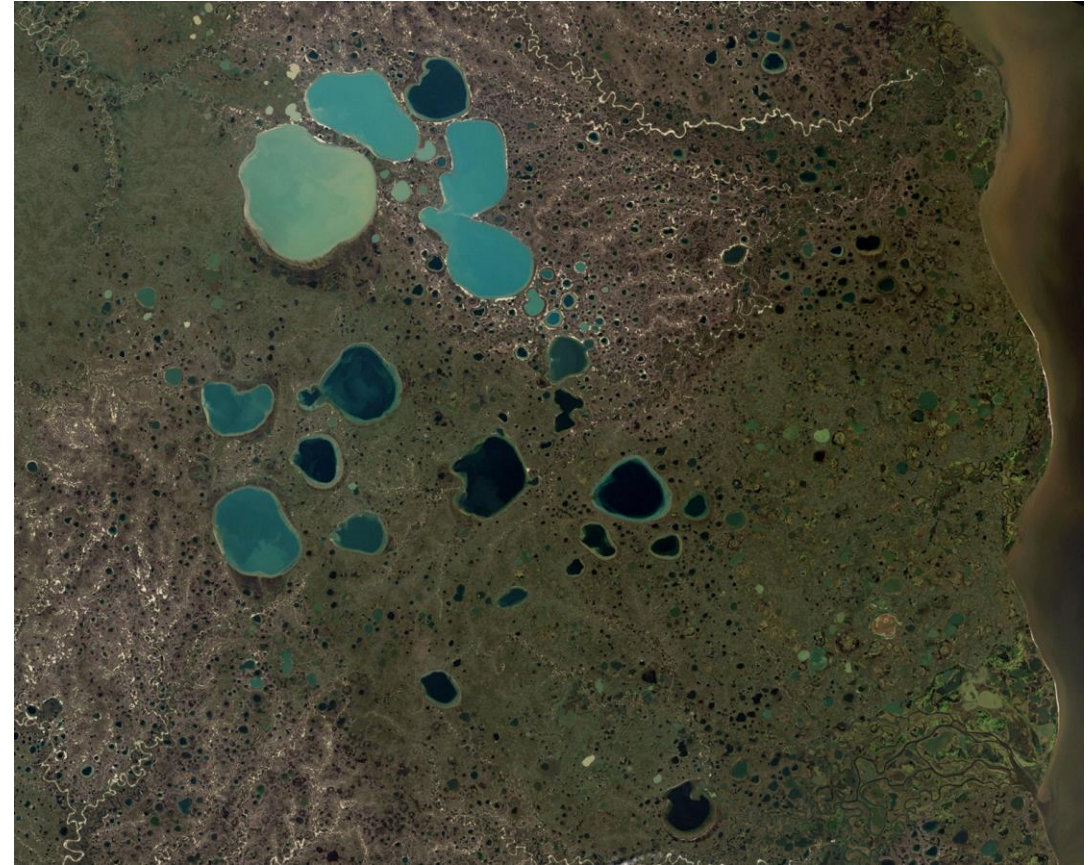
This is the small area  
we will initially  
concentrate on in  
this practical.





# Questions?

- Please enter your questions in the Q&A box. We will answer them in the order they were received.
- We will post the Q&A to the training website following the conclusion of the webinar.



<https://earthobservatory.nasa.gov/images/6034/pothole-lakes-in-siberia>



# Contacts

- Trainer:
  - Armando Marino: [armando.marino@stir.ac.uk](mailto:armando.marino@stir.ac.uk)
- Training Webpage:
  - <https://appliedsciences.nasa.gov/join-mission/training/english/arset-crop-mapping-using-synthetic-aperture-radar-sar-and-optical-0>
- ARSET Website:
  - <https://appliedsciences.nasa.gov/arset>
- Twitter: [@NASAARSET](https://twitter.com/NASAARSET)

Check out our sister programs:





**Thank You!**

