Alvar

rev. 1.0

Alvar: Ailanthus altissima visual aid for reconnaissance

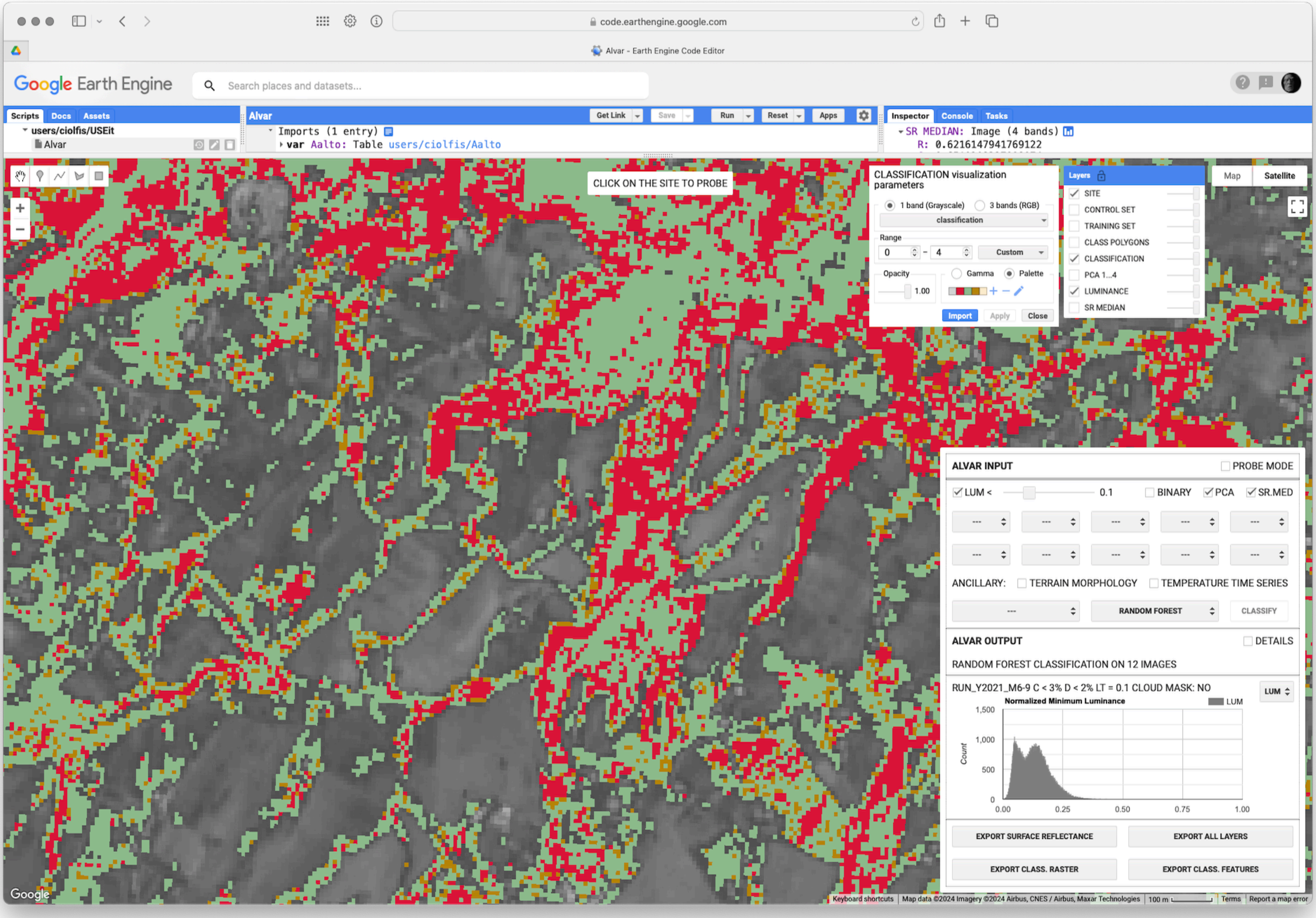
An open Google Earth Engine cloud application
based on Copernicus Sentinel-2 optical imagery
Released under the GNU GPL-3.0 license

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Consiglio Nazionale delle Ricerche

USEit Let's use the aliens

IRET


code.earthengine.google.com
Alvar - Earth Engine Code Editor
Google Earth Engine
Search places and datasets...
Scripts
Docs
Assets
users/ciolfis/USEit
Alvar
Alvar
Get Link
Save
Run
Reset
Apps
Imports (1 entry)
var Aalto: Table users/ciolfis/Aalto
Inspector
Console
Tasks
SR MEDIAN: Image (4 bands)
R: 0.6216147941769122
CLICK ON THE SITE TO PROBE
CLASSIFICATION visualization parameters
1 band (Grayscale)
3 bands (RGB)
classification
Range
0
4
Custom
Opacity
1.00
Gamma
Palette
Import
Apply
Close
Layers
SITE
CONTROL SET
TRAINING SET
CLASS POLYGONS
CLASSIFICATION
PCA 1...4
LUMINANCE
SR MEDIAN
Map
Satellite
ALVAR INPUT
PROBE MODE
LUM <
0.1
BINARY
PCA
SR.MED
ANCILLARY:
TERRAIN MORPHOLOGY
TEMPERATURE TIME SERIES
RANDOM FOREST
CLASSIFY
ALVAR OUTPUT
DETAILS
RANDOM FOREST CLASSIFICATION ON 12 IMAGES
RUN_Y2021_M6-9 C < 3% D < 2% LT = 0.1 CLOUD MASK: NO
LUM
Normalized Minimum Luminance
LUM
Count
1,500
1,000
500
0
0.00
0.25
0.50
0.75
1.00
EXPORT SURFACE REFLECTANCE
EXPORT ALL LAYERS
EXPORT CLASS. RASTER
EXPORT CLASS. FEATURES
Google
Keyboard shortcuts
Map data ©2024 Imagery ©2024 Airbus, CNES / Airbus, Maxar Technologies
100 m
Terms
Report a map error

Introduction

Alvar is a Google Earth Engine cloud application aimed at early Ailanthus altissima reconnoissance.
It is based on Copernicus Sentinel-2 optical imagery, available since mid-2015, at 10m ground pixel resolution.
The rationale is: each plant species can show peculiar signals in the optical range and, moreover, it can possibly show a time-series signature. Finding the invasive alien A. altissima is in principle feasible, given a characteristic optical spatiotemporal signature. However, even if we can have physiological clues, we do not know such a signature.

Alvar supports the seek for an A. altissima optical signature exploiting the cloud computing capability of fast time series search of the images and the vegetation-related associated optical indices, without the need of local data download.

Alvar exploits the machine learning algorithms exposed by the Google Earth Engine APIs, training them by means of a user provided training/control set of empirical observations. A sample set, Aalto, is provided Alvar distribution. The examples in this manual are referred to this Alvar Aalto pair, designing possible classifications based on user choices and machine learning.

The user interface is GUI-based and the intervention on the code consiste only in importing the appropriate training set and tuning the area of interest bounding box accordingly.

The Alvar script is available at https://code.earthengine.google.com/baf3e4144da52ed4e372f6991ca17bf6
and the sample training set at https://code.earthengine.google.com/?asset=users/ciolfis/Aalto
Users must be logged as Google developers in order to use the application.

Training setup

Alvar needs only a training set of input points. Control is optional, but no accuracy assessment can performed without it.

The input can be prepared within any GIS environment.
The fields must be:

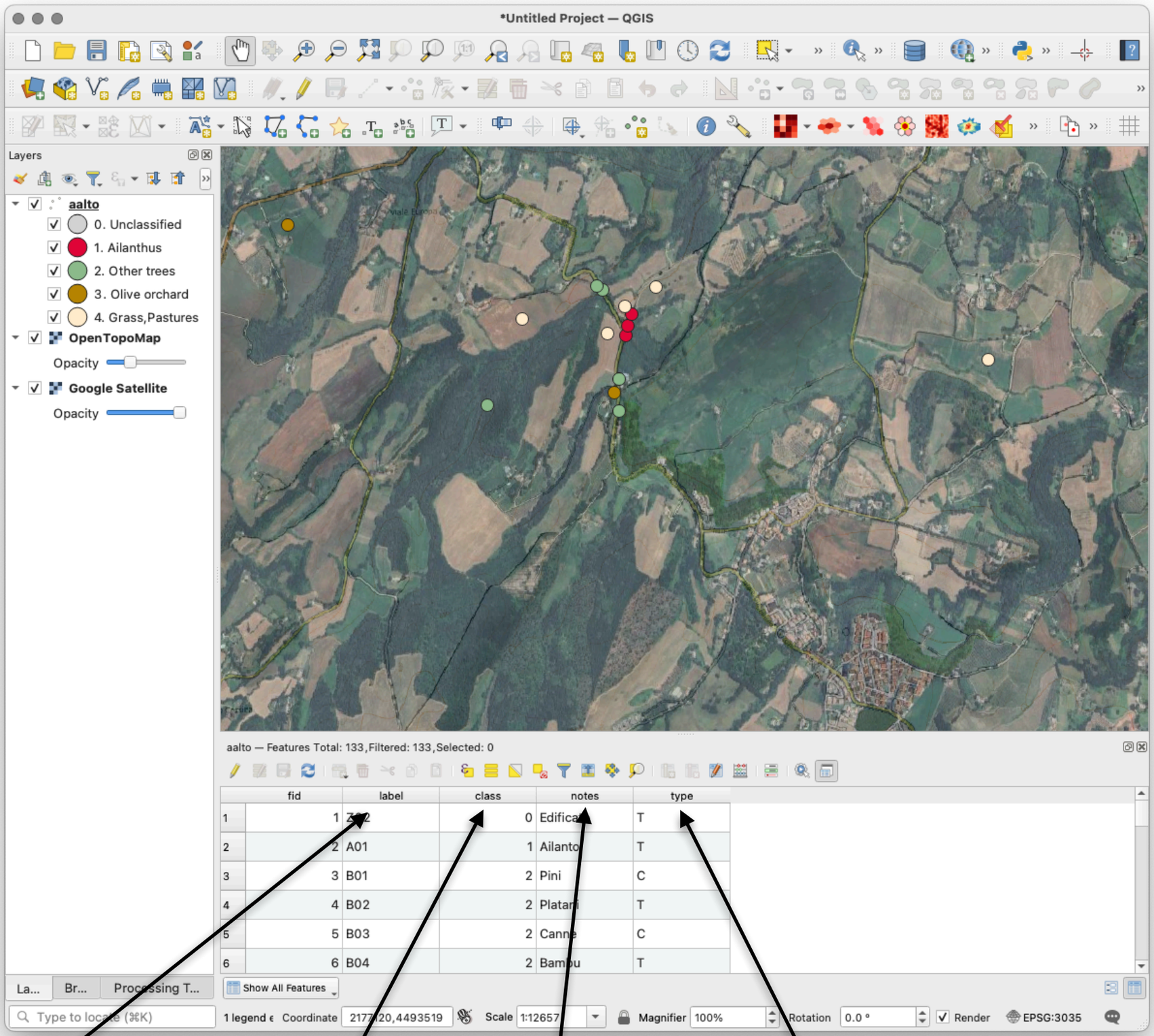
label [string, PK] point label
class [int] point class:
- **0**. unclassified
- **1**. Ailanthus altissima
- **2**. other trees
- **3**. olive orchards- vineyards
- **4**. crop - green area

type [string] point type:
- **T**. training
- **C**. control

note [string] unused

Check the successful import of the training set as a the Google Earth Engine asset named Aalto.

```
Imports (1 entry)
  var Aalto: Table users/ciolfis/Aalto
    type: FeatureCollection
    id: users/ciolfis/Aalto
    version: 1637229649676512
    columns: String
      type: String
      class: Long
      label: String
      notes: String
      system:index: String
```



label: unique & not-null

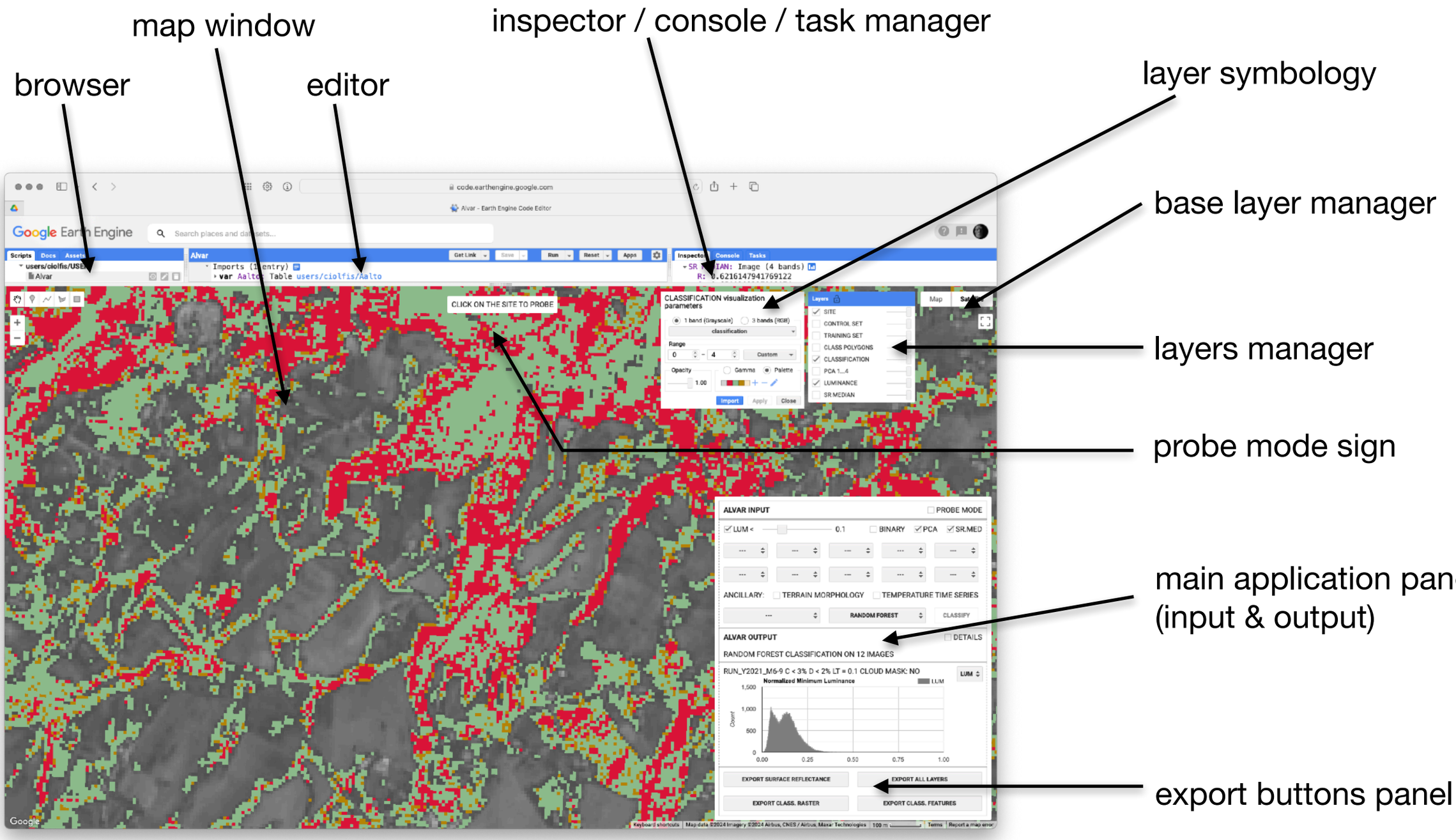
class: 0, 1, [2, 3, 4]

notes: any comment, not used

type: **T**raining (mandatory) or **C**ontrol (optional)

Alvar GUI

The user interaction is GUI-based. The running times depend on the extension of the area, not much on the number of training and control points provided by he user. Timeouts are possible, depending on the general Google earth Engine load, which is not in user's control.



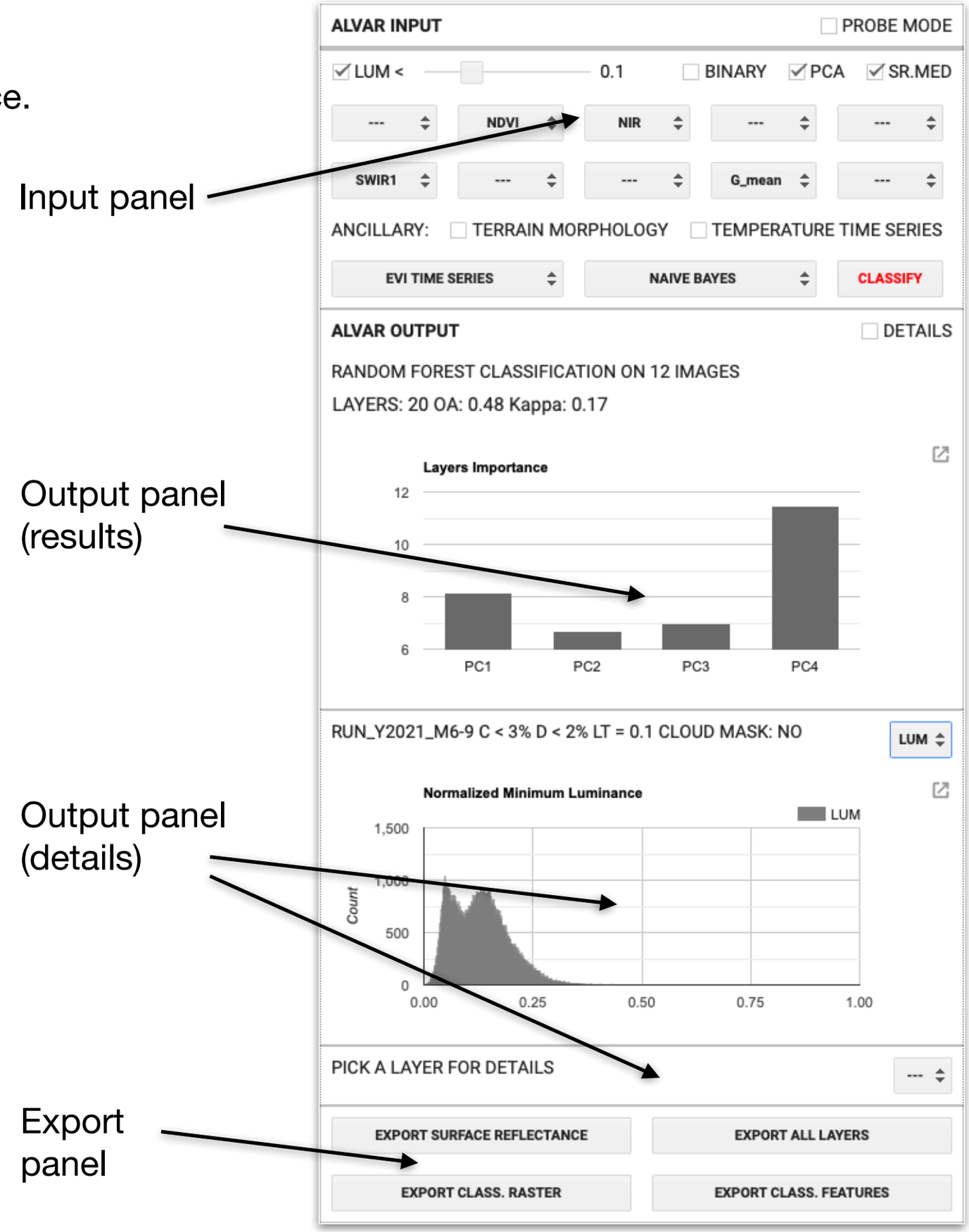
The main application panel

The main panel is where all the action takes place.

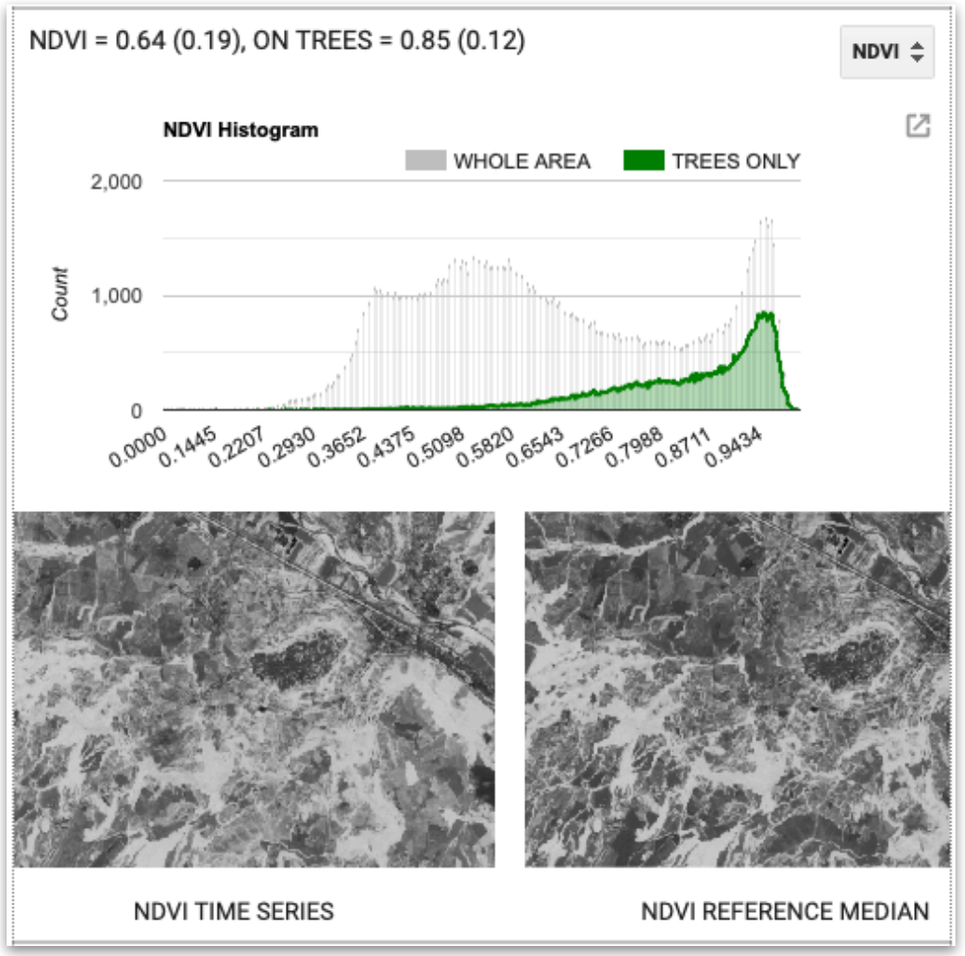
The input panel consists in lists of user-selectable image bands and optical indices, all from Sentinel-2 imagery, a menu of time series, and a choice of machine learning algorithms.
The classification can be performed on bands, indices, surface reflectance medians, luminance or on the principal components of such layers.
A pixel probe shows all the available data at a single site (10 × 10 m pixel).

The output panel consists in a result panel and in a detailed analysis of all the (tens to hundreds of) layers that can be included in the machine learning procedure. the results can be expanded and single points can be probed for a pixel-wise analysis.

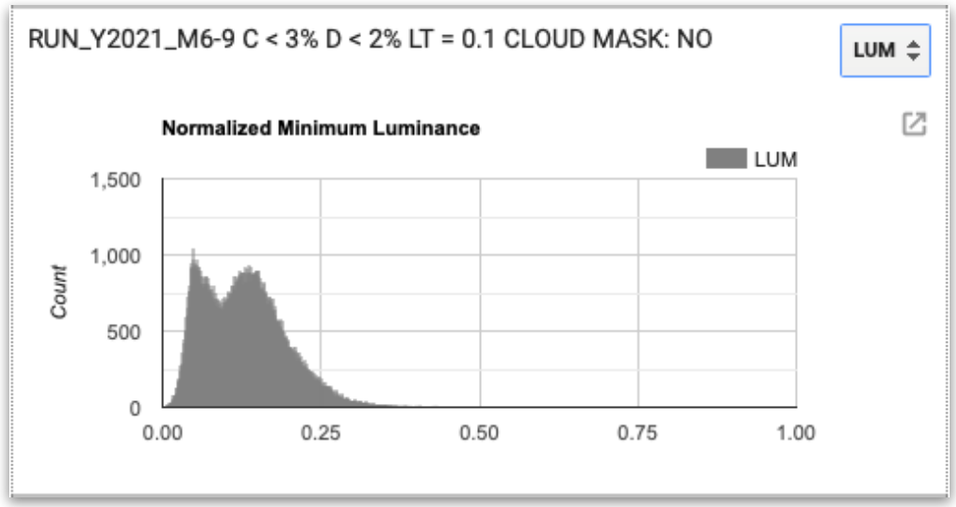
Four buttons prepare the export tasks of input and output data. The download process is asynchronous.



Input images details panels

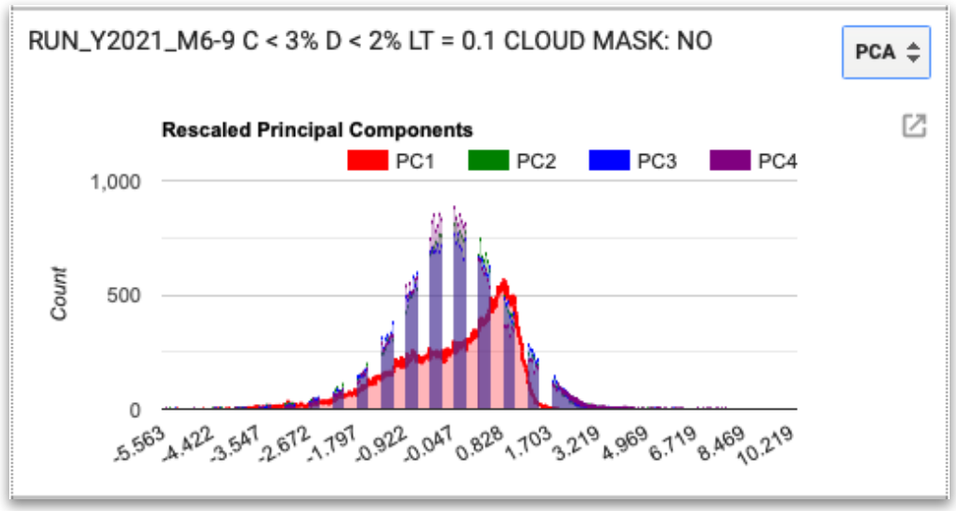


Luminance

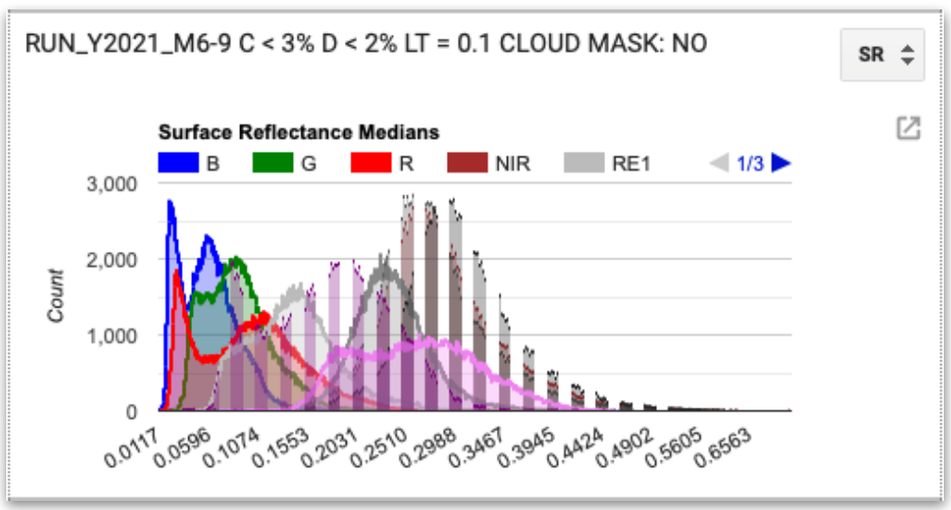


NDVI

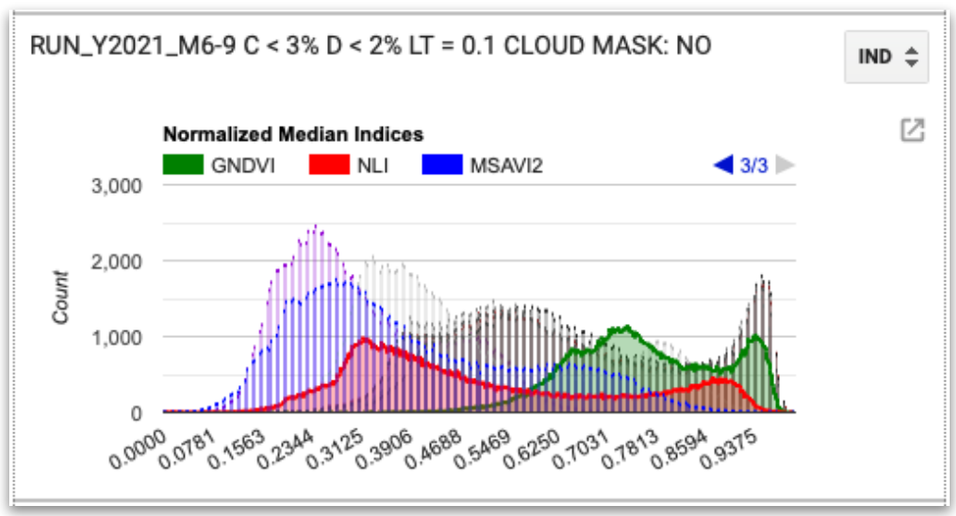
Principal components



Multispectral surface reflectance



Optical indices



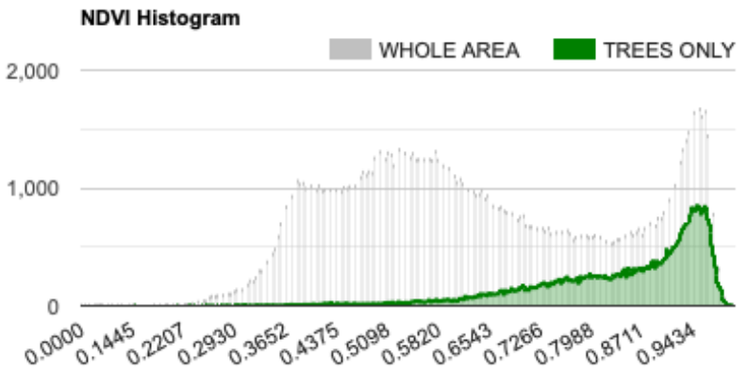
Indices analysis

Each Sentinel-2 band and every index can be analysed in detail, in order to find the best suited Alvar input layers.

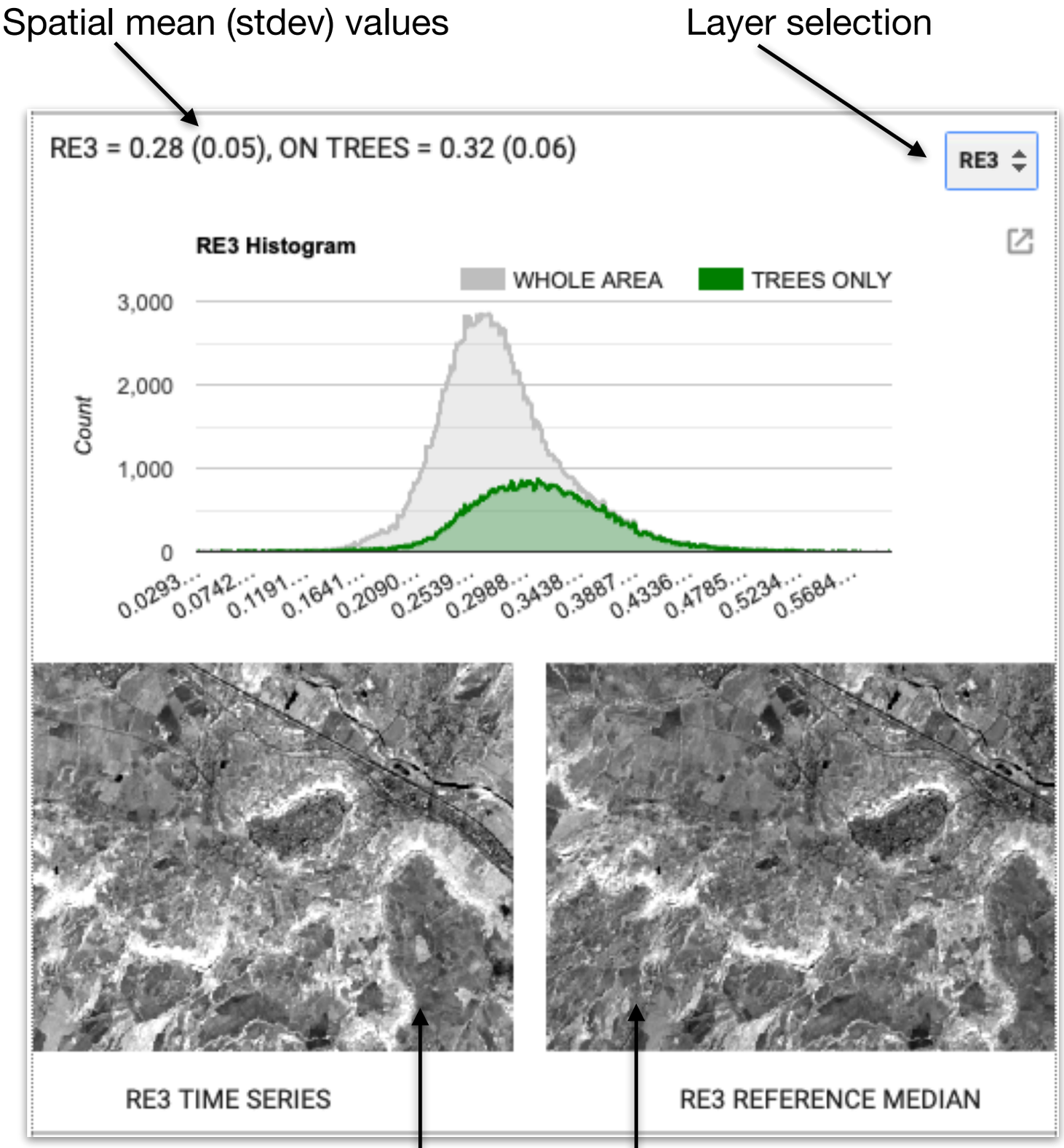
The analysis can be conducted at the image level, selecting the desired layer, or at the pixel level, activating the probe mode.

As it is the case with all the Google Earth Engine graphs, these can be exported as graphics and csv tables.

A layer movie is also shown, each frame referring to a single timestamp.



Histograms are computed according to the native 10m pixel resolution, relatively to the forested-only and the whole area.



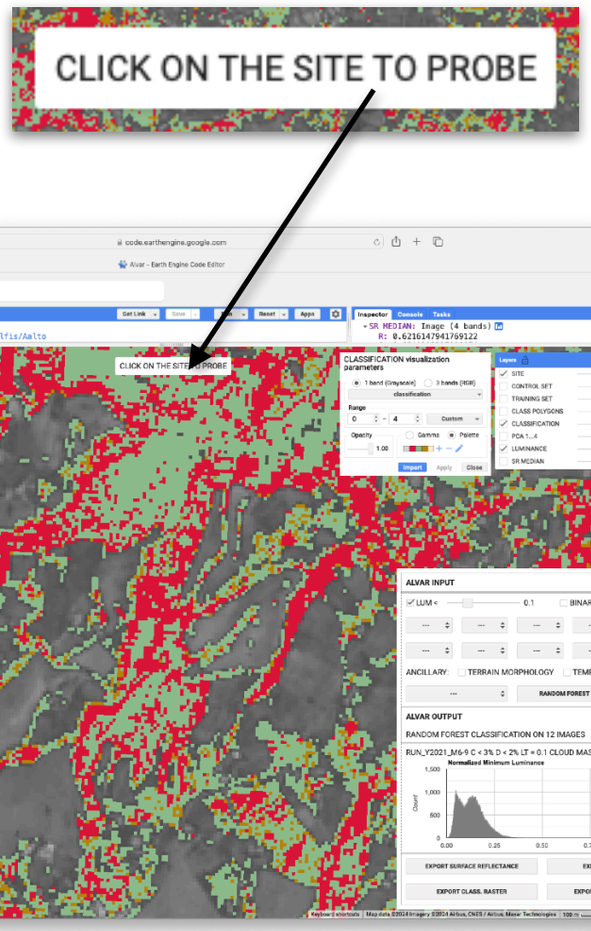
Pixel probe

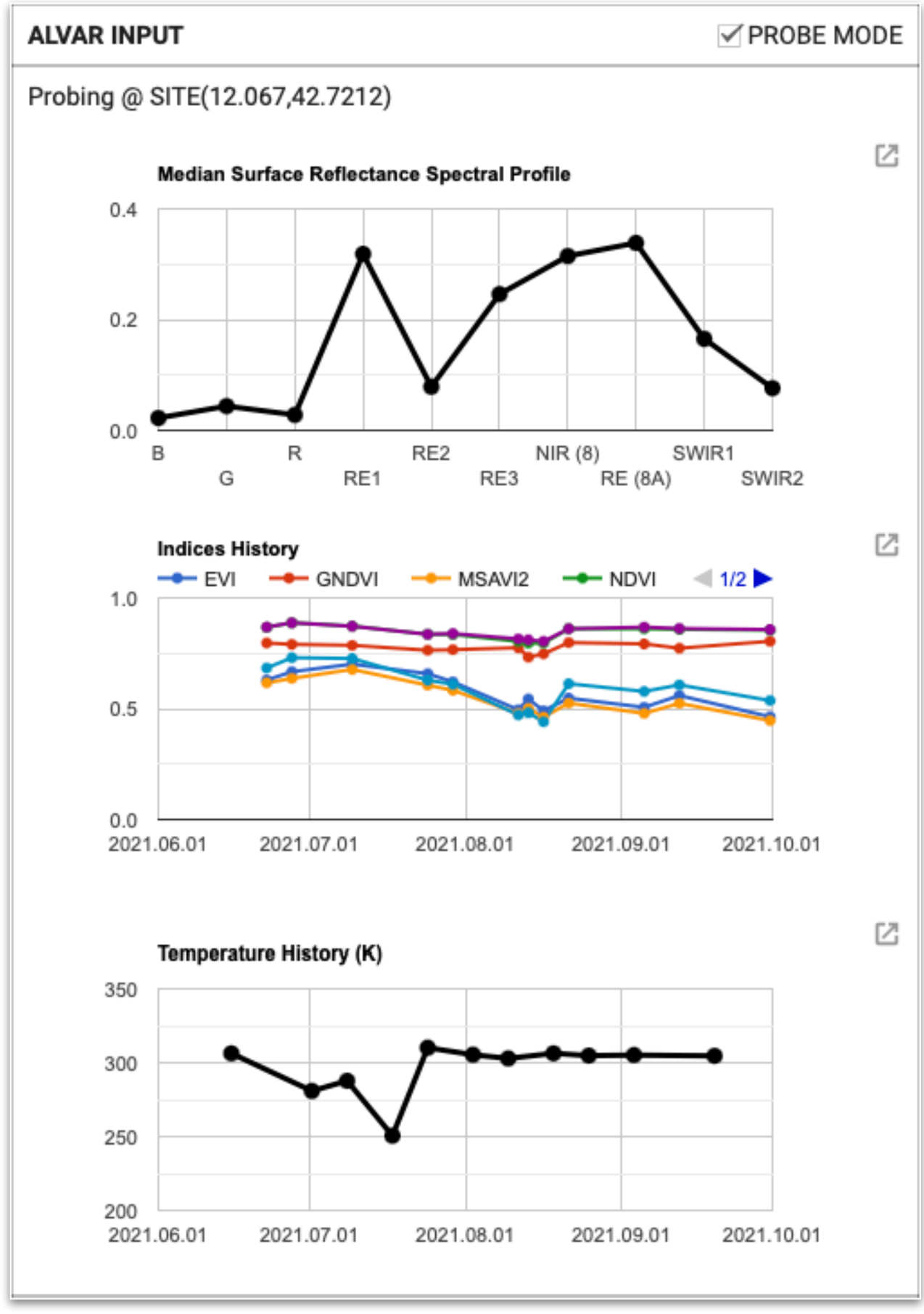
The interface can be operated in probe mode.
This is advised by a

CLICK ON THE SITE TO PROBE

sign box on the map window.
Probing a site shows the pixel's spectral signature, indices time series and estimated ground temperature.

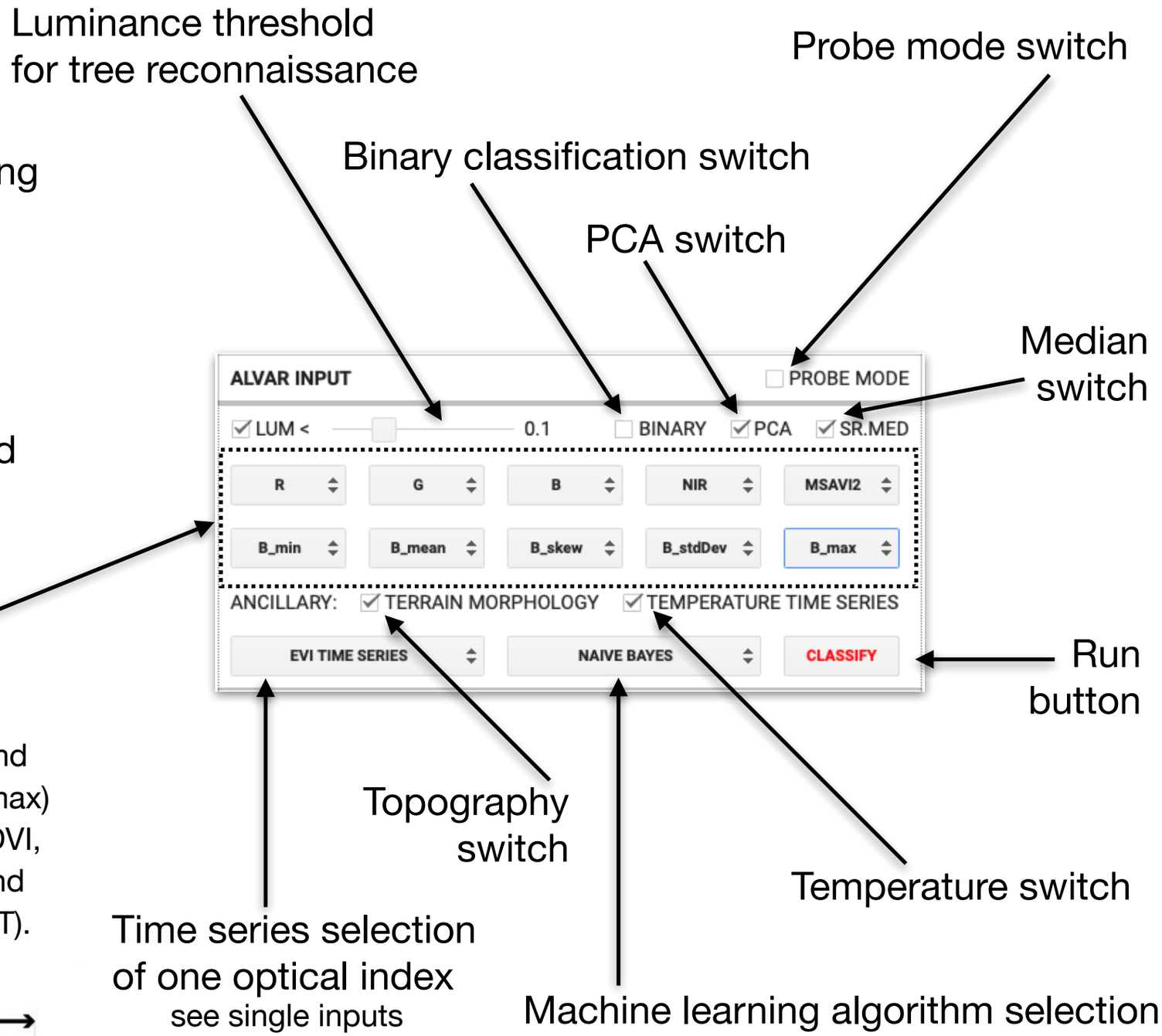
The temperature is extracted from Landsat 8 / 9 imagery. Sentinel-2 does not provide such kind of information.





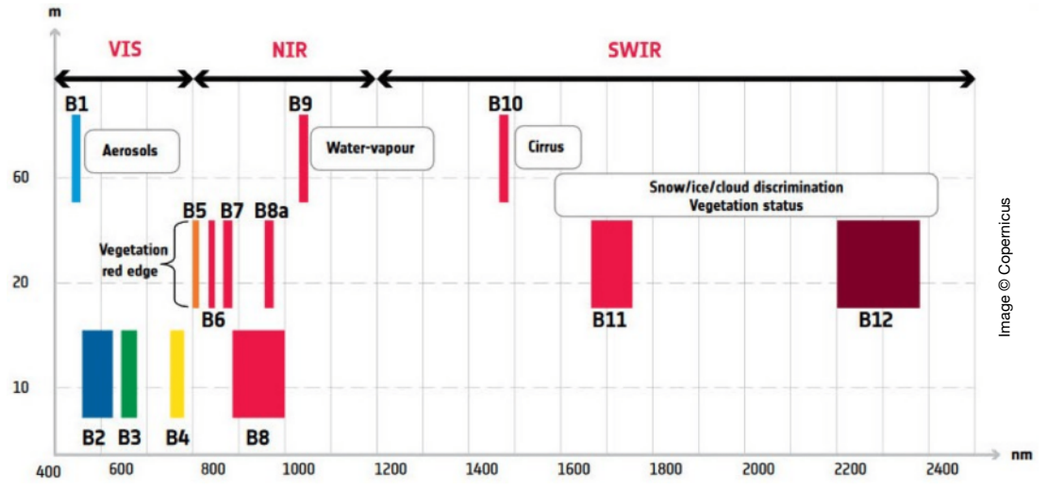
Input parameters

Alvar classification is performed according to the user-selected bands, indices and time series, exploiting a Google Earth Engine machine learning algorithm.
If no selection is made, Alvar uses the main four principal components obtained from all the available informations.



Single inputs selection

Single inputs include all Sentinel-2 bands and band statistics (mean, median, stdev, skewness, min, max) and optical indices (NDVI, EVI, MSAVI2, NLI, GNDVI, NDVI-RE), plus soil temperature (from Landsat) and topographical parameters (ELEV, SLOPE, ASPECT).



Alvar uses
B2, B3, B4 (visible),
B5, B6, B7, B8, B8a (NIR)
B11, B12 (SWIR)

Output — classification results

The results of the classification are shown as a usual, as the confusion matrix evaluated on the control points of the training set provided.The output panel can be expanded to show the detailed results.

Other than the classifications figures, the detailed output shows the ids of all the Sentinel-2 images within the spatial bounds satisfying the user's constraints, the training and control points, and the user-selected layers (ingested layers).

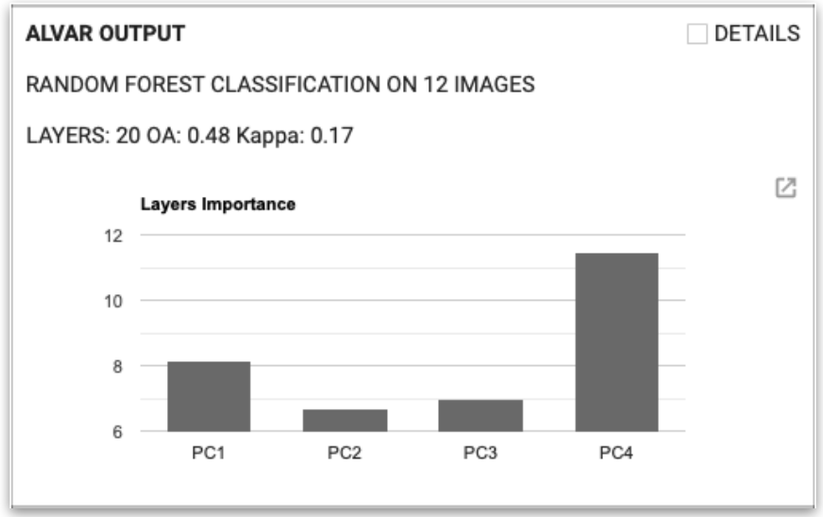
The kappa value, confusion matrix, false positives (PA) and false negatives (CA) are written on a single line, row-wise.

```
CONFUSION MATRIX:
        0       0       3       0       2
        0       5       4       2       0
        0       11      25      4       0
        0       0       4       3       0
        0       6       0       0       0

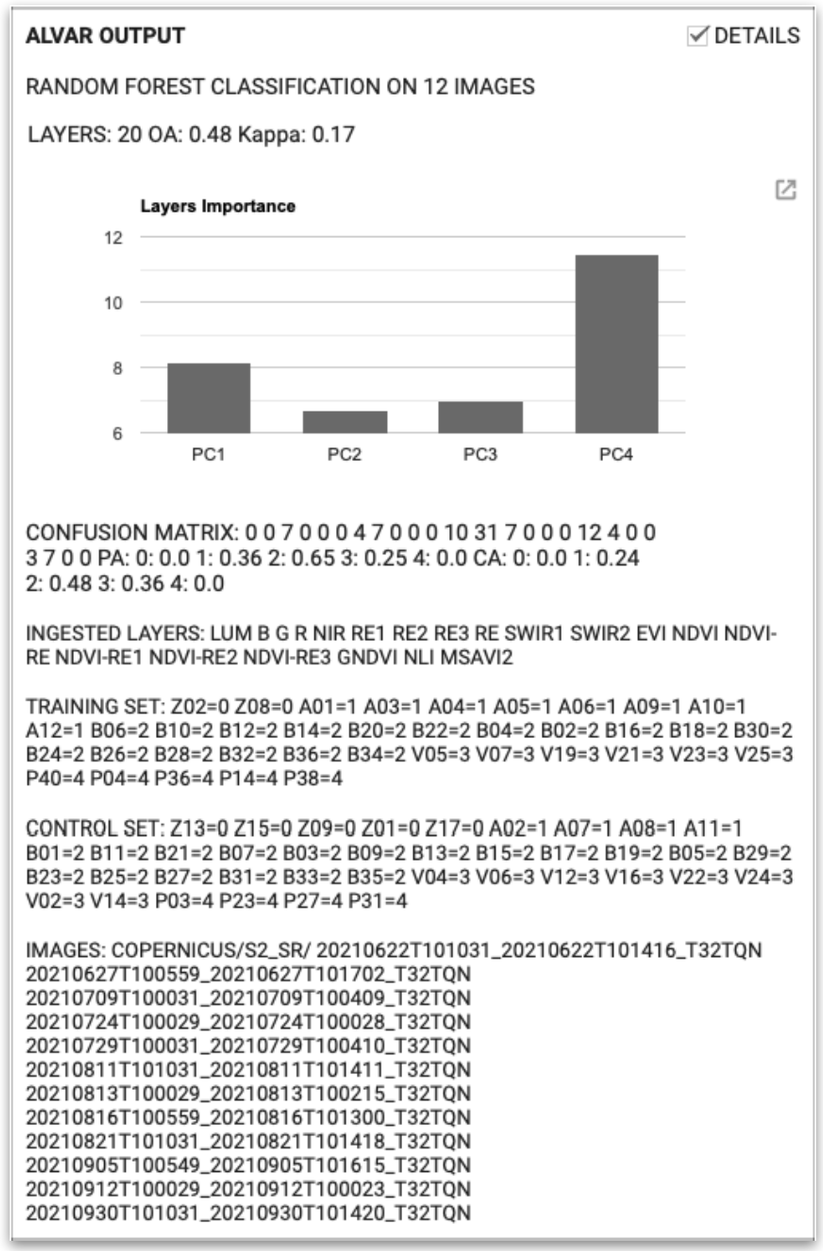
PA:     0: 0.0  1: 0.45 2: 0.63 3: 0.43 4: 0.0

CA:     0: 0.0  1: 0.23 2: 0.69 3: 0.33 4: 0.0
```

collapsed panel



extended panel





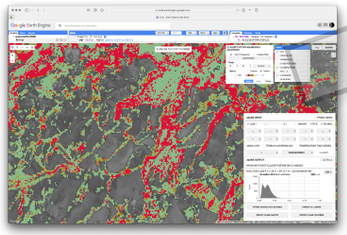
Alvar is a computationally intensive task for cloud computing. Depending on the input complexity and the current Google Earth Engine available resources, Alvar can fail to classify the conceivable A. altissima invasion areas.

Users can lighten the computational load using fewer input layers, nonetheless, time-outs often occur.

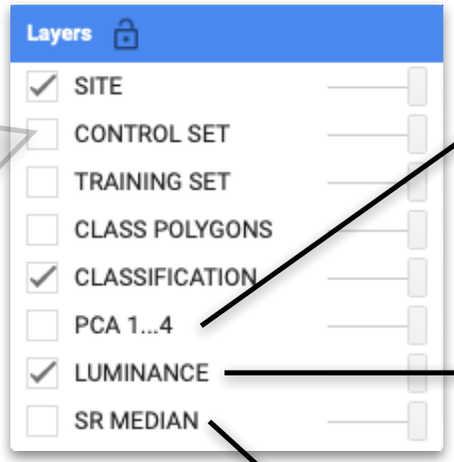
Output — Maps

Alvar main output is a classification map. It is available both as a raster and a polygon vector layer. Other useful outputs include:

- median surface reflectance
- principal components from all layers
- median luminance for forest identification



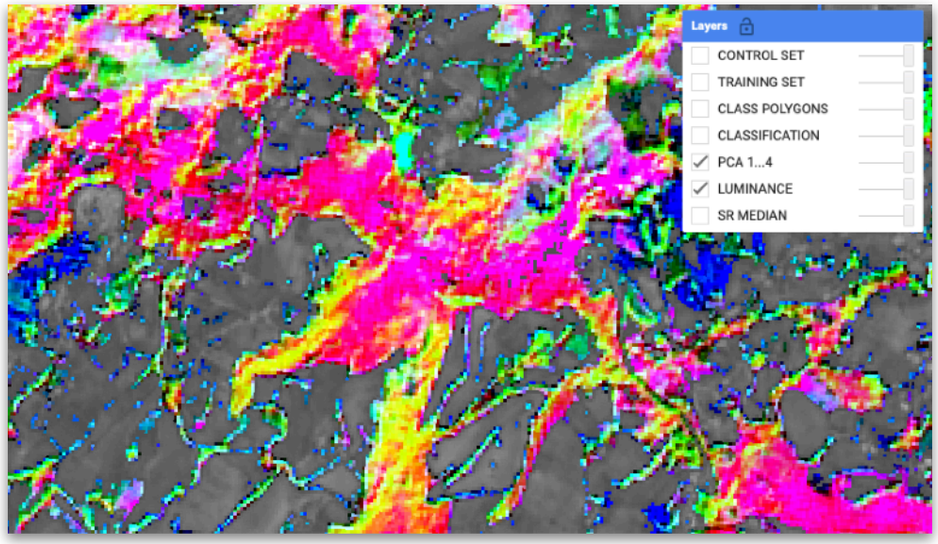
Layers manager



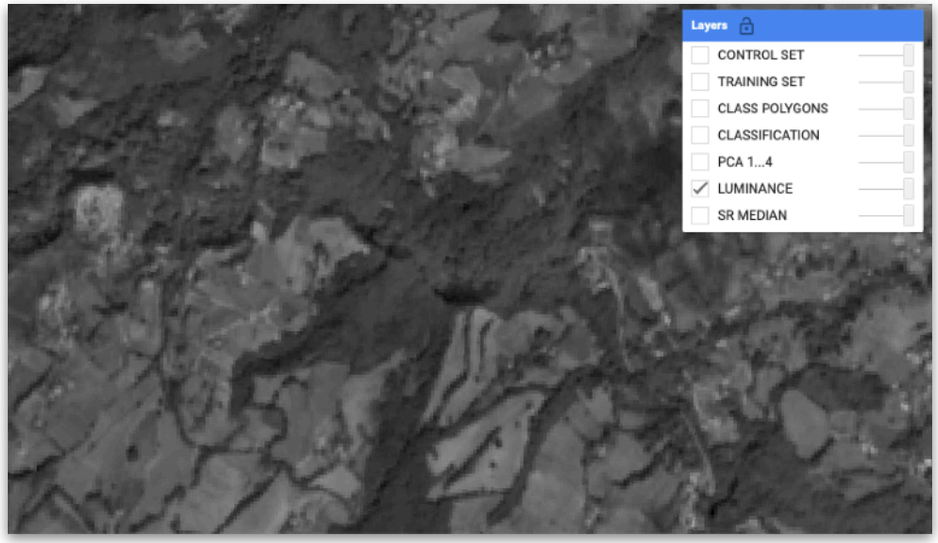
Export panel (bottom of output panel)



Principal components



Luminance



Median surface reflectance

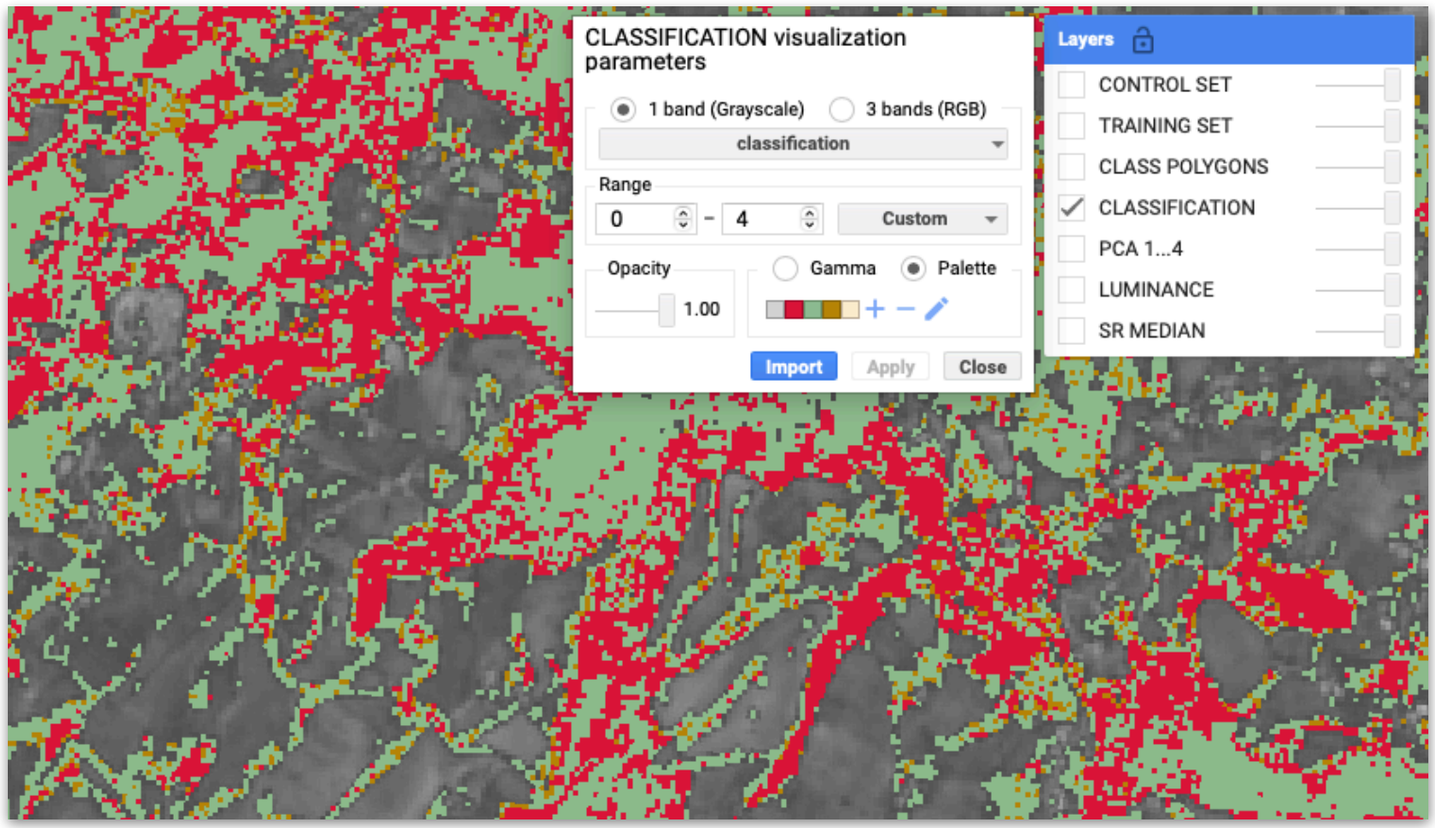


All the input and output layers can be exported as geoTiff files. The classification can also be exported as geoTiff or as a polygon vector GIS file (shapefile, table, etc).

Output — Maps — Classification

The most important Alvar output is the classified area of interest.
The classification output is a binary (yes/no) or multi-class 10 m resolution raster, depending on the training sample and on the status of the BINARY checkbox in the input panel.
The resulting Ailanthus class (1) is also converted to a polygon layer.

Raster



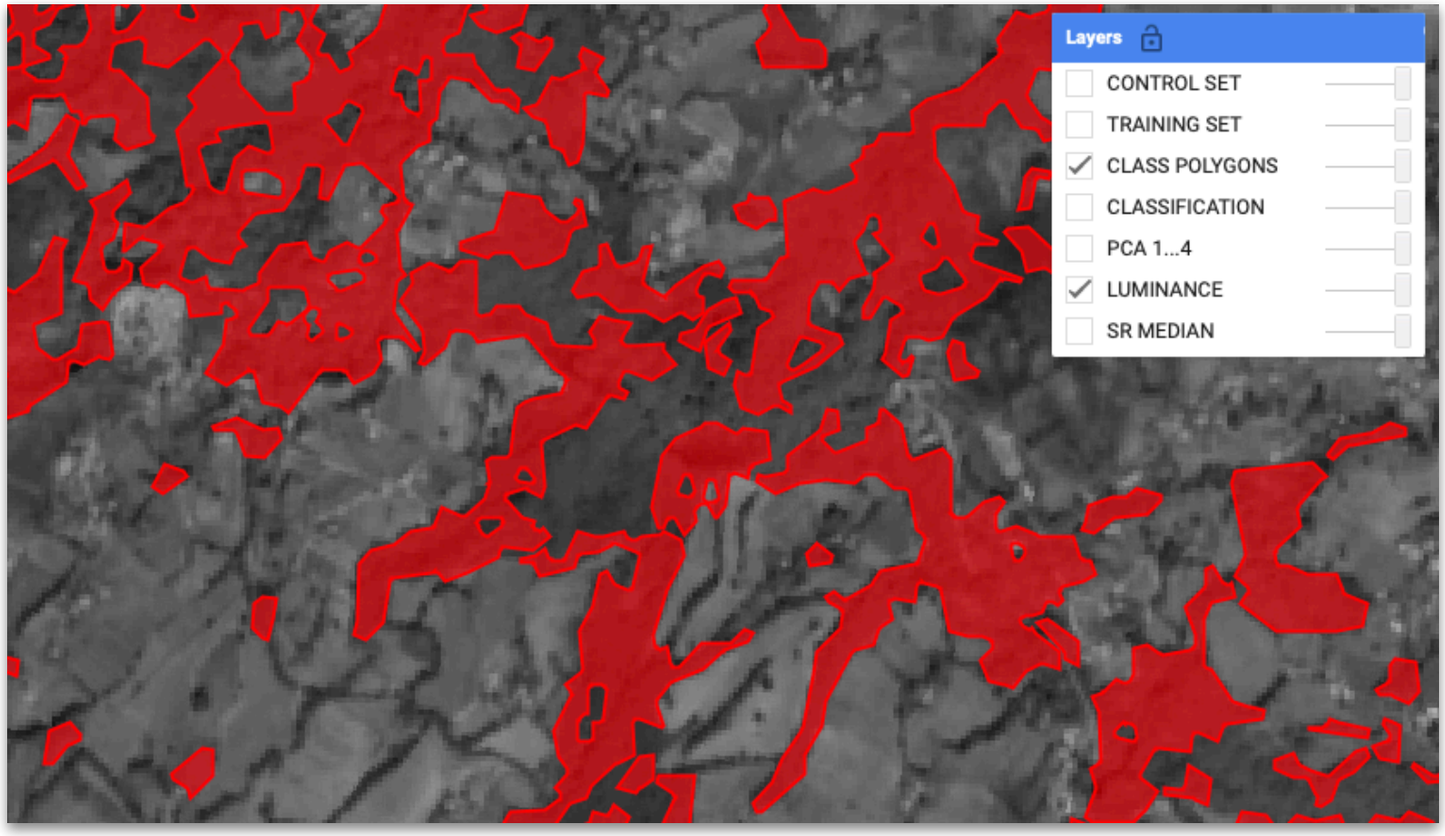
Binary Classification

- 0. All the rest - Unclassified
- 1. Possibly Ailanthus

Ordinary Classification

- 0. Unclassified
- 1. Possibly Ailanthus
- 2. Other trees - Woods
- 3. Olive orchards - Vineyards
- 4. Meadows - Pastures - Crops

Polygons (Ailanthus only)



Alvar

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Developed within the USEit project
https://www.lifewatchitaly.eu/en/pg-related-projects/useit/

Credits

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