User Guide: Earth Engine Satellite Processor

# Introduction

This document provides comprehensive instructions for using the Earth Engine Satellite Processor module within Google Colab notebooks. The processor allows you to analyze satellite data using Earth Engine's powerful cloud-based platform, enabling you to process, visualize, and export satellite imagery and derived indices without requiring significant computational resources locally.

https://colab.research.google.com/drive/1Bir6mt8tI72Z4vzElcAUwVxqMQPoGw6M?usp=sharing

# Prerequisites

Before using the satellite processor, you need:

1. A Google account with access to Google Colab
   1. You must also create a ‘project’ – Explained below
2. Google Earth Engine account (sign up at <https://earthengine.google.com/> if you don't have one)
3. Access to Google Drive (for exporting results)

## Creating a Google project

To create a new project (or you can just make one for all GEE projects)

1. Follow this link: <https://console.cloud.google.com/>
2. In the top left corner, click the projects tab, and either choose the project you want or make a new one
3. When in the project screen, click the APIs and Services quick access button
4. Search for the earth engine API
5. Open its page and click ‘ENABLE’, this will give you access to it
6. Return to the main project page by clicking the Google Cloud logo, and copy the Project number (a bunch of numbers, not the name)
7. Return to the google colab link and follow the initialization process documented within it

# Using the Satellite Processor

The processor operates in a two-stage workflow:

1. **Data Selection & Processing**: Configure parameters and process satellite data
2. **Visualization & Export**: Explore and export the processed results

## Stage 1: Data Selection & Processing

The first widget allows you to specify your analysis parameters:

| **Parameter** | **Description** |
| --- | --- |
| Start Year | Beginning year for analysis (1985-2025) |
| End Year | Ending year for analysis (1985-2025) |
| Start Month | Beginning month (1-12) |
| End Month | Ending month (1-12) |
| Satellite | Currently supports Landsat |
| Region Asset | Earth Engine asset path of your area of interest |

### Notes on Region Asset:

* You must have a defined region in Earth Engine
* The asset path follows the format: projects/ee-username/assets/asset\_name
* You can create a region by:
  + Using the Earth Engine Code Editor to upload a shapefile as an asset
  + Drawing a geometry and exporting it as an asset
* Using an existing public asset

After setting your parameters, click the **Process Data** button. The processor will:

* Get satellite imagery for the specified time period
* Calculate NDVI (Normalized Difference Vegetation Index) and NDSI (Normalized Difference Snow Index)
* Process yearly composites and statistics
* Present a new visualization widget when complete

## Stage 2: Visualization & Export

After processing completes, a second widget appears with visualization options:

| **Option** | **Description** |
| --- | --- |
| Index | Select between NDVI or NDSI |
| Function | Choose visualization or export type |
| Year | (When applicable) Select specific year to visualize |
| Drive folder | (For batch export) Specify Google Drive folder |

### Available Visualization Functions:

1. **Yearly Deviation from Mean** 
   1. Shows how a specific year compares to the long-term average
   2. Displays three layers: mean index, yearly index, and deviation map
   3. Red areas indicate below-average values, blue indicates above-average
2. **Yearly Composites** 
   1. Shows the composite index value for a specific year
   2. Useful for examining patterns in a single year
3. **Mean Index Map** 
   1. Displays the average index value across all processed years
   2. Provides a baseline for comparison
4. **Yearly Averages Chart** 
   1. Creates a time series chart of yearly average values
   2. Includes a trend line and statistical summary
   3. Useful for detecting long-term trends
5. **Batch Export to Drive** 
   1. Exports all processed data to your Google Drive
   2. Creates TIF files for all yearly composites, deviations, and mean values
   3. Requires specifying a folder name in Google Drive

# Index Interpretation

## NDVI (Normalized Difference Vegetation Index)

* Measures vegetation health and density
* Values range from -1 to 1
* Higher values (greener in visualization) indicate healthier/denser vegetation
* Commonly used for monitoring vegetation changes, drought effects, and agricultural analysis

## NDSI (Normalized Difference Snow Index)

* Measures snow and ice cover
* Values range from -1 to 1
* Higher values (redder in visualization) indicate more snow/ice cover
* Useful for monitoring snow cover, glaciers, and seasonal changes

# Practical Workflows

## Detecting Vegetation Changes

* Set date range spanning multiple years (e.g., 2000-2022)
* Select months during peak growing season (e.g., May-August)
* Process data with NDVI selected
* Use "Yearly Averages Chart" to identify trend
* Examine specific years with "Yearly Deviation from Mean"

## Analyzing Seasonal Snow Coverage

* Set date range for winter months (e.g., January-March)
* Process data with NDSI selected
* Compare yearly composites for specific years of interest
* Use "Batch Export to Drive" to save data for further analysis

# Technical Notes

* The processor automatically selects the appropriate Landsat satellite based on the year:
  + Landsat 5 for years before 2013 (except 2003 and 2012)
  + Landsat 7 for 2003 and 2012
  + Landsat 8 for 2013 and later
* Cloud cover is filtered to less than 20%
* All indices are scaled by 10,000 for easier interpretation
* Export resolution is set to 30 meters (Landsat native resolution)

# Troubleshooting

**Error: Earth Engine needs to be initialized**

* Ensure you’ve run the authentication code block
* Check that you have an active Earth Engine account

**Error with region asset path**

* Verify the path follows the correct format
* Ensure you have access permissions to the asset
* Check that the asset exists in your Earth Engine account

**No data appears in visualizations**

* Verify your date range contains valid Landsat data
* Check that your region intersects with Landsat imagery
* Consider expanding your date range or region

**Export tasks fail**

* Check Google Drive permissions
* Verify the region size isn't too large
* Monitor task progress in the Earth Engine Code Editor