MTP Mid-Term Evaluations

Change Detection in Remote Sensing

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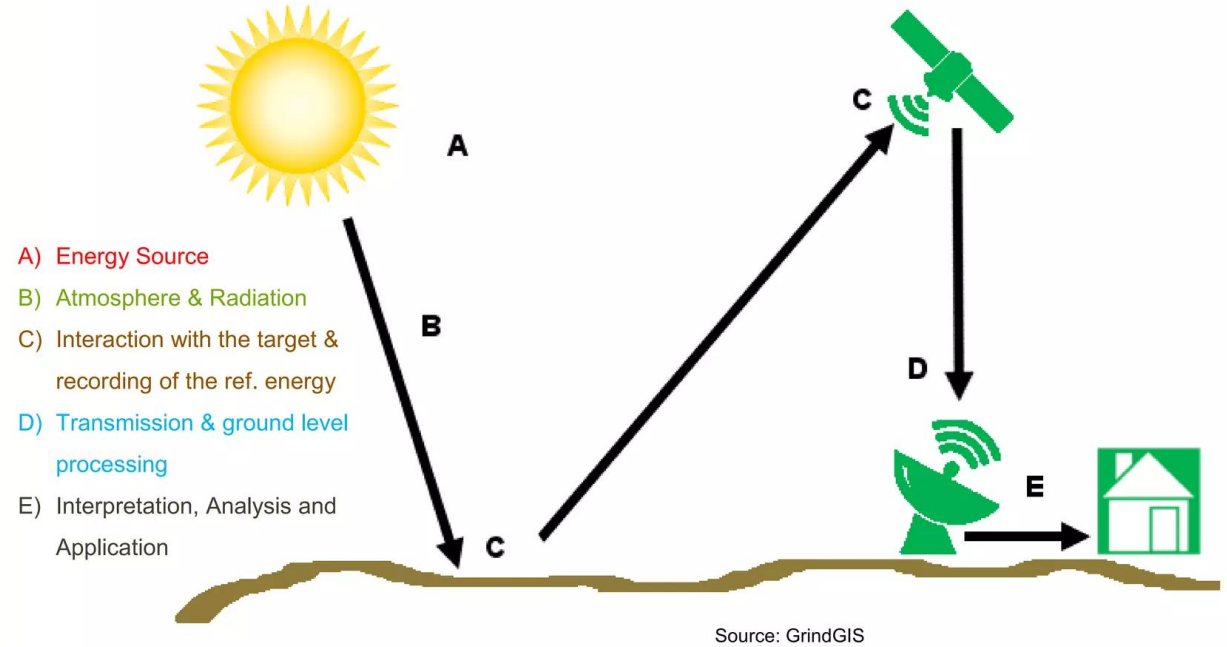
What do we mean by Remote Sensing ??

Remote sensing is a method of obtaining information about the properties of an object without coming into physical contact with it.



Source: GrindGIS

Applications of Remote Sensing

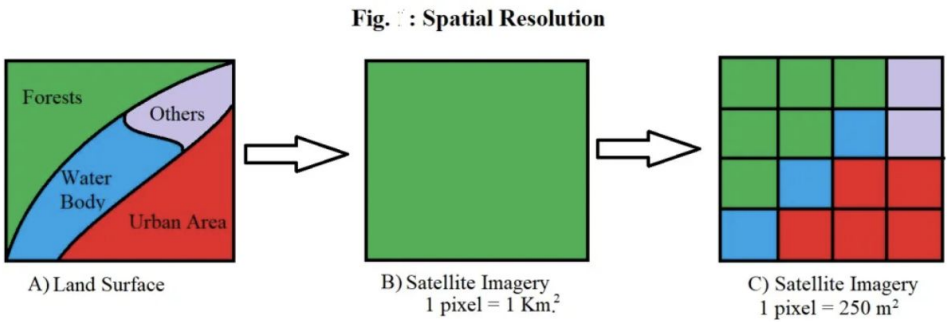
1. Urban Planning
2. Environmental Monitoring
3. Agriculture
4. Disaster Management
5. Forestry Management
6. Infrastructure Monitoring
7. Climate Change Assessment

Applications of Change Detection in GIS

1. Deforestation Monitoring
2. Urban Growth Analysis
3. Crop Health Assessment
4. Flood Detection
5. Glacier Monitoring
6. Land Subsidence Detection
7. Oil Spill Detection
8. Land Use Change

Challenges in Satellite Images

- Cloud Cover
- Spatial Resolution
- Temporal Resolution
- Data Volume and Storage
- Image Preprocessing & Image Interpretation
- Limited Accessibility, Cost and Resources



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- Work done last week
  - Learnt about ArcGIS map(Analysis Software), and Planetscope(Satellite images)
  - Exploring different cloud detection algorithms
- Next week plan
  - Try to Implement overall algorithm of cloud removal with 3 temporal images.
  - Learn more about cloud detection and determination of cloud masks in our dataset.

Why PlanetScope data?

- Almost **daily** coverage worldwide (temporal resolution)
- 3.7-4.1 m pixel size (resampled to **3 m**) (spatial resolution)
- Blue, Green, Red, Near Infrared, [4 Band]
- additional bands Coastal Blue, Green I, Yellow, and Red Edge for the newest generation of satellites. [8 Band]
- Getting access to their data via “Education and Research Program” (Took 2-3 weeks)

Satellite	No. of bands	Spatial Resolution
Sentinel 1	2	5m
Sentinel 2	13	10m, 20m ,60m
Landsat 8	11	15m, 30m, 100m
MODIS	36	250m, 500m, 1000m
Planetscope	4/8	3m

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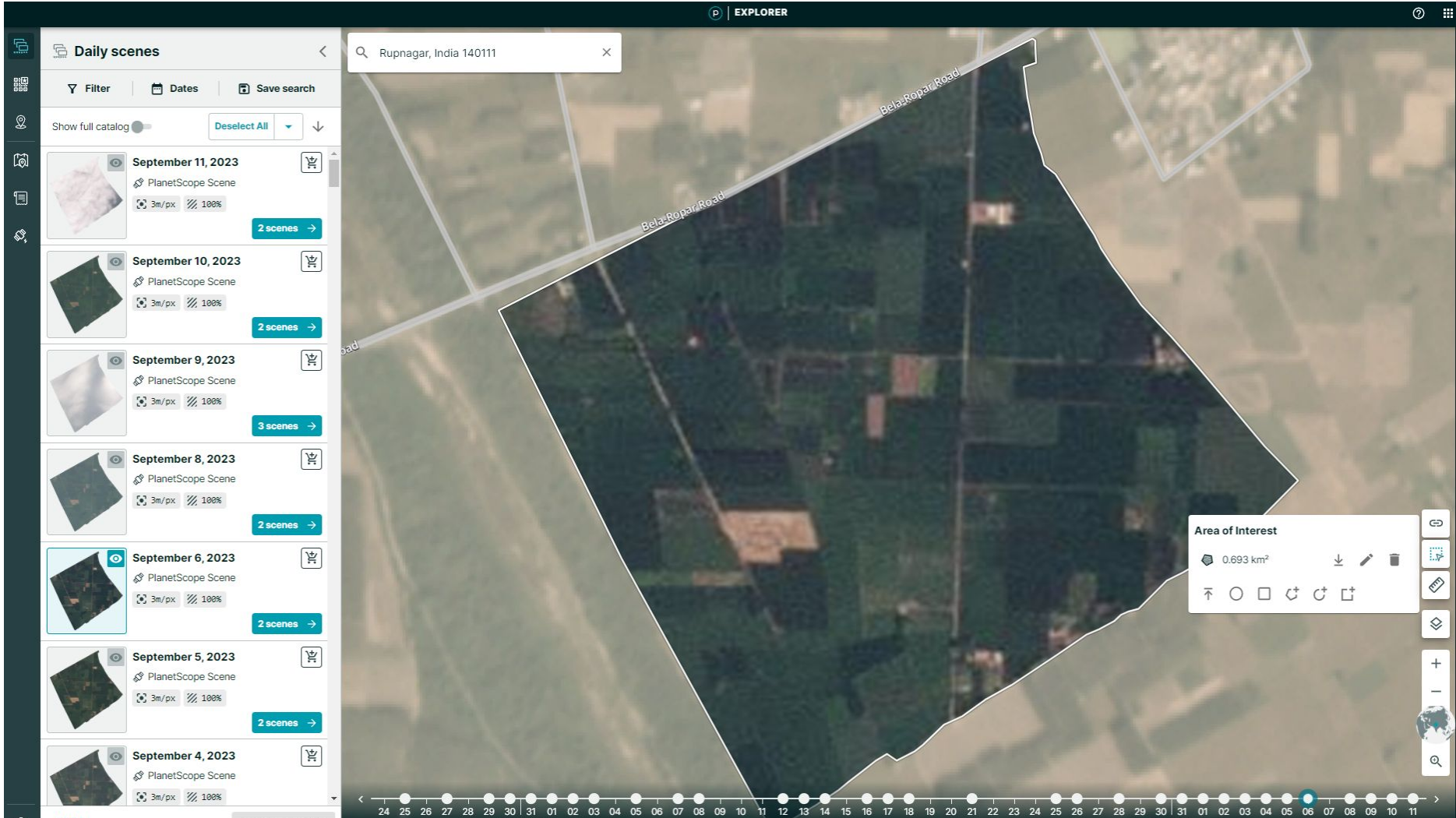
- Work done last week
  - Binary thresholding implemented(doesn’t give good results), used adaptive thresholding(gives decent cloud mask output but not best), try some other method for cloud masking.
  - Dataset downloaded from Planetscope [ROI- Ropar: Chhoti Jhallian] and aggregated the scenes to form one image per day. [Merge Rasters]
- Next week plan
  - Finding the implementation code of previous existing algorithms for cloud masking and carrying out related literature review.
  - Try to find an algorithm for cloud masking that is independent of type/source of satellite data.


EXPLORER
Daily scenes
Filter
Dates
Save search
Show full catalog
Deselect All
September 11, 2023
PlanetScope Scene
3m/px
100%
2 scenes
September 10, 2023
PlanetScope Scene
3m/px
100%
2 scenes
September 9, 2023
PlanetScope Scene
3m/px
100%
3 scenes
September 8, 2023
PlanetScope Scene
3m/px
100%
2 scenes
September 6, 2023
PlanetScope Scene
3m/px
100%
2 scenes
September 5, 2023
PlanetScope Scene
3m/px
100%
2 scenes
September 4, 2023
PlanetScope Scene
3m/px
100%
Rupnagar, India 140111
Bela-Ropar Road
Area of Interest
0.693 km²

Python Code to Merge different scenes of same date

merge_4_band.py - D:\Ashutosh_Work\MTP\merge_4_band.py (2.7.15)

File Edit Format Run Options Window Help

```
import os, arcpy, re

input_folder = r"D:\Ashutosh_Work\MTP\Kapkot_25_Dataset\Kapkot_25_4Band"

output_folder = r"D:\Ashutosh_Work\MTP\Kapkot_25_Dataset\Kapkot_Merged_DS\Kapkot_25_merged_4Band"

# List all the raster files in the input folder and subdirectories
raster_files = []
for root, dirs, files in os.walk(input_folder):
    for file in files:
        if file.endswith('.tif'):
            if file.split("_")[5]=="AnalyticMS" and len(file.split("_"))>7:
                raster_files.append(os.path.join(root, file))

# Dictionary to store the raster files by date
raster_files_by_date = {}

# Group raster files by date
for raster_file in raster_files:
    # Extract the date from the file name
    file_name = os.path.basename(raster_file)
    file_date = file_name.split('_')[0]

    # Add the raster file to the corresponding date group
    if file_date in raster_files_by_date:
        raster_files_by_date[file_date].append(raster_file)
    else:
        raster_files_by_date[file_date] = [raster_file]

# Merge raster files for each date
for date, files in raster_files_by_date.items():
    # Output file path
    output_file = os.path.join(output_folder, 'KP_25_merged_{}.tif'.format(date))
    arcpy.management.MosaicToNewRaster (files, output_folder, os.path.basename(output_file), "","16_BIT_UNSIGNED", "", "4", "", "")

print("Merge successful")
```

Merged_images_final - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:4,712

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merged_20220217.tif
merged_20220218.tif
merged_20220219.tif
merged_20220220.tif
merged_20220221.tif
merged_20220222.tif
merged_20220224.tif
merged_20220225.tif
merged_20220227.tif
merged_20220228.tif
merged_20220301.tif
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merged_20220330.tif
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merged_20220406.tif
merged_20220407.tif
merged_20220408.tif
merged_20220409.tif
merged_20220410.tif
merged_20220411.tif
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cloud_mask_14_otsu_20220505.tif
cloud_mask_merged_20220505_adaptive_g...
cloud_mask_merged_20220802.tif

Catalog

Limitations to be taken care of:

- Cloud cover can obscure temporal information
    - Data Gaps and Incomplete Records
    - Reduced Frequency of Observations
    - Loss of Real-Time Monitoring
    - Decreased Data Consistency

Solution : Cloud Removal using Cloud Masks

Methods to remove clouds

- Spatial-Based Methods:
  - Image Compositing
  - Texture Analysis
- Spectral-Based Methods:
  - Spectral Indices
  - Spectral Unmixing
- Temporal-Based Methods:
  - Time Series Analysis
  - Change Detection
- Combined Methods:
  - Spatio-Temporal Techniques
  - Machine Learning
- Radar Imaging:
  - Use of SAR Data
- Data Fusion:
  - Multi-Sensor Fusion Techniques

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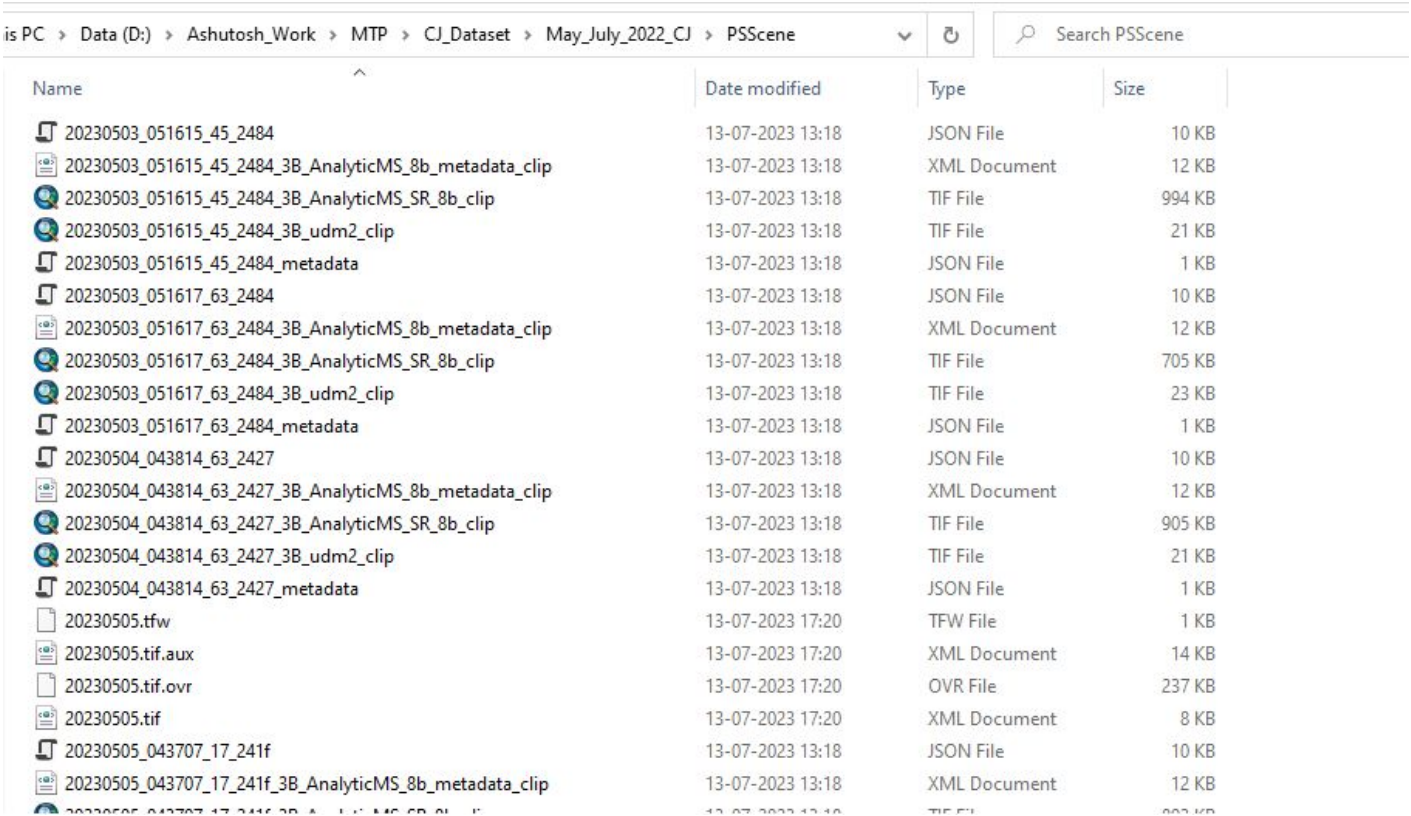
- Work done last week
  - Previous codes are not able to be deployed due to inconsistencies with the source of the data.[Researchers have used Sentinel/Landsat images band's to find cloud] We will now use planetscope UDM2 data to get cloud mask.
  - Snow-Cloud data downloaded of 25 sq. km from planetscope 4 Band, 5-6 years

- Next week plan
  - Literature Survey on "Change Detection in Remote Sensing"

After reading some papers on cloud mask, I found out that there is an “*_udm2_clip.tif” image that stores all the metadata including cloud mask in Band6.



Name	Date modified	Type	Size
20230503_051615_45_2484	13-07-2023 13:18	JSON File	10 KB
20230503_051615_45_2484_3B_AnalyticMS_8b_metadata_clip	13-07-2023 13:18	XML Document	12 KB
20230503_051615_45_2484_3B_AnalyticMS_SR_8b_clip	13-07-2023 13:18	TIF File	994 KB
20230503_051615_45_2484_3B_udm2_clip	13-07-2023 13:18	TIF File	21 KB
20230503_051615_45_2484_metadata	13-07-2023 13:18	JSON File	1 KB
20230503_051617_63_2484	13-07-2023 13:18	JSON File	10 KB
20230503_051617_63_2484_3B_AnalyticMS_8b_metadata_clip	13-07-2023 13:18	XML Document	12 KB
20230503_051617_63_2484_3B_AnalyticMS_SR_8b_clip	13-07-2023 13:18	TIF File	705 KB
20230503_051617_63_2484_3B_udm2_clip	13-07-2023 13:18	TIF File	23 KB
20230503_051617_63_2484_metadata	13-07-2023 13:18	JSON File	1 KB
20230504_043814_63_2427	13-07-2023 13:18	JSON File	10 KB
20230504_043814_63_2427_3B_AnalyticMS_8b_metadata_clip	13-07-2023 13:18	XML Document	12 KB
20230504_043814_63_2427_3B_AnalyticMS_SR_8b_clip	13-07-2023 13:18	TIF File	905 KB
20230504_043814_63_2427_3B_udm2_clip	13-07-2023 13:18	TIF File	21 KB
20230504_043814_63_2427_metadata	13-07-2023 13:18	JSON File	1 KB
20230505.tfw	13-07-2023 17:20	TFW File	1 KB
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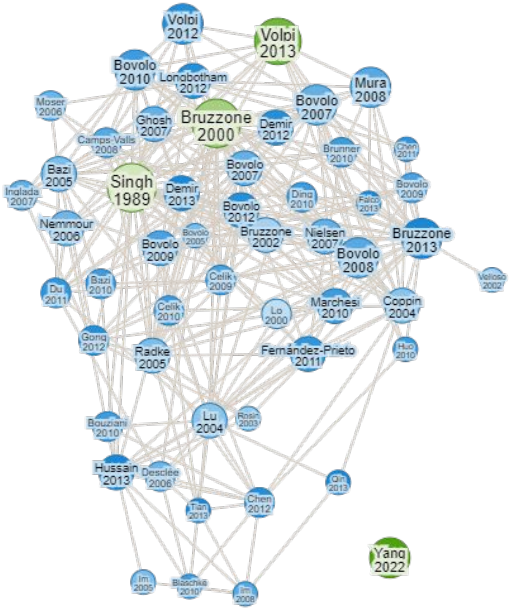
20230505.tif.ovr	13-07-2023 17:20	OVR File	237 KB
20230505.tif	13-07-2023 17:20	XML Document	8 KB
20230505_043707_17_241f	13-07-2023 13:18	JSON File	10 KB
20230505_043707_17_241f_3B_AnalyticMS_8b_metadata_clip	13-07-2023 13:18	XML Document	12 KB

Python code to extract cloud mask from UDM2 PSScene downloaded data

```
import os, arcpy, re

input_folder = r"D:\Ashutosh_Work\MTP\CJ_Dataset\Planet_Scope_Chhoti_Jhallian_DownloadedData\8_band_May_2021_July_2022"

output_folder = r"D:\Ashutosh_Work\MTP\CJ_Dataset\Mask_Dataset\UDM2_cloud_mask"

# List all the raster files in the input folder and subdirectories
raster_files_AMS = []
raster_files_udm2 =[]
for root, dirs, files in os.walk(input_folder):
    for file in files:
        if file.endswith('.tif'):
            if file.split("_")[5]=="udm2" and len(file.split("_"))>5:
                raster_files_udm2.append(os.path.join(root, file))
            if file.split("_")[5]=="AnalyticMS" and len(file.split("_"))>7:
                raster_files_AMS.append(os.path.join(root, file))

print("All files visited...")

# Dictionary to store the raster files by date
raster_files_by_date = {}


# Loop through the analyticMS rasters
for analyticMS in raster_files_AMS:
    analyticMS = os.path.basename(analyticMS)
    date = analyticMS.split("_")[0]  # Extract the date from the filename
    if date in raster_files_by_date:
        raster_files_by_date [date]["analyticMS"].append(analyticMS)
    else:
        raster_files_by_date [date] = {"udm2": [], "analyticMS": [analyticMS]}

# Loop through the UDM2 rasters
for udm2 in raster_files_udm2:
    udm2 = os.path.basename(udm2)
    date = udm2.split("_")[0]  # Extract the date from the filename
    if date in raster_files_by_date:
        raster_files_by_date [date]["udm2"].append(udm2)
    else:
        raster_files_by_date [date] = {"udm2": [udm2], "analyticMS": []}
```

Literature Review: Change Detection in Remote Sensing

1. Volpi, 2013, SVM : Supervised change detection in VHR images using contextual information and support vector machines
https://www.sciencedirect.com/science/article/pii/S0303243411001565
2. Singh 1989, Digital change detection techniques using remotely-sensed data
https://www.tandfonline.com/doi/epdf/10.1080/01431168908903939?needAccess=true&role=button
3. Zhang, 2023 Remote Sensing Image Change Detection Based on Deep Multi-Scale Multi-Attention Siamese Transformer Network https://doi.org/10.3390/rs15030842
4. Bruzzone, 2000: Automatic analysis of the difference image for unsupervised change detection
https://ieeexplore.ieee.org/document/843009



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- Work done last week
  - Found out the cloud mask of images using UDM2 data and made dataset with could mask and its corresponding cloudy images downloaded from Planescope.
  - Literature survey done on “Change Detection in Remote Sensing”

- Next week plan
  - “Cloud Removal in Satellite Images “ and Preparation of MTP presentation
  - Trying to implement cloud removal algorithms and make pair of cloud free images and cloudy images.

Future Work

- Develop an algorithm to make pair of cloud and cloud free images using the mask dataset prepared.
- We are considering one ROI from Himachal Pradesh [Kapkot: ~25 sq. km] for cloudy images with snow and the other ROI is from Ropar(agricultural land)[~0.649 sq. km]
- After getting the cloud mask and forming the pair of cloudy and cloud free images, we will use this dataset for implementation of various change detection algorithms.
- This can help us to monitor crop growth, land use cover, etc in our agricultural studies.


THANK YOU!