Ottawa River Keeper

Automating Ice On/Off dates with remote sensing

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Ottawa River Keeper

About the Organization:

- Dedicated to protecting and promoting the health of the Ottawa River Watershed

- Community-driven initiatives

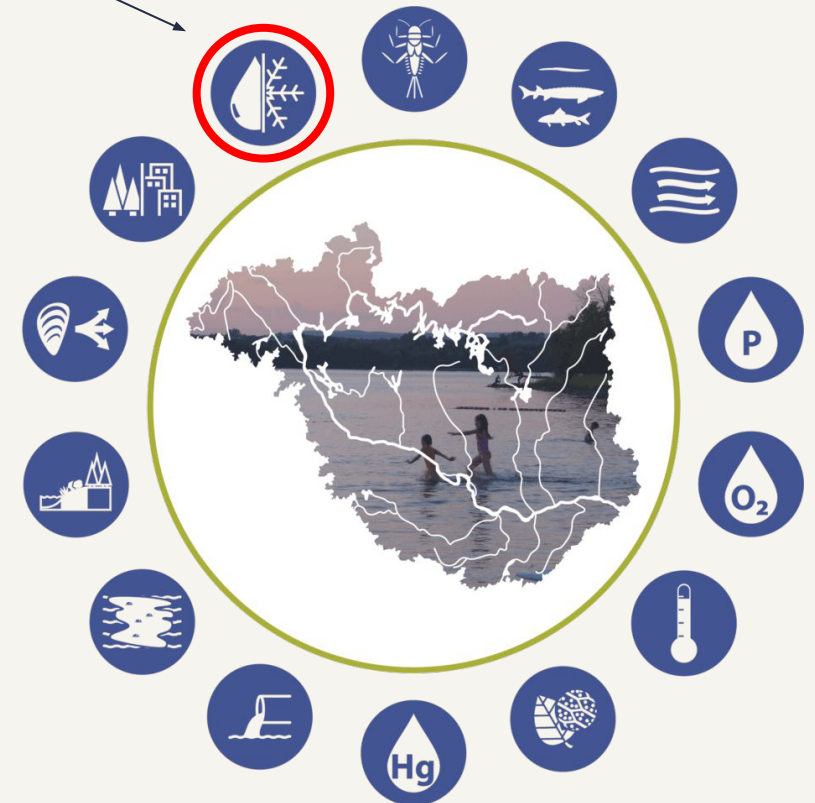- Watershed Health Assessment and Monitoring (WHAM)

Ottawa RIVERKEEPER®
GARDE-RIVIÈRE *des Outaouais*

Ice On / Ice Off Project

- Part of the WHAM project

- Important for:

  - Water Chemistry

  - Biological and Physical Processes

  - Ice Users

- Currently, ice cover assessments rely on public observations

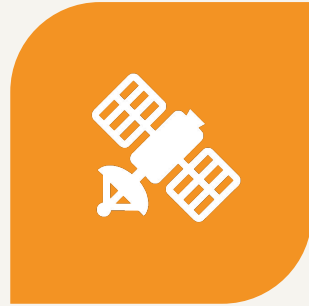- Remote sensing and automation

Ice On / Ice Off

Project Outline

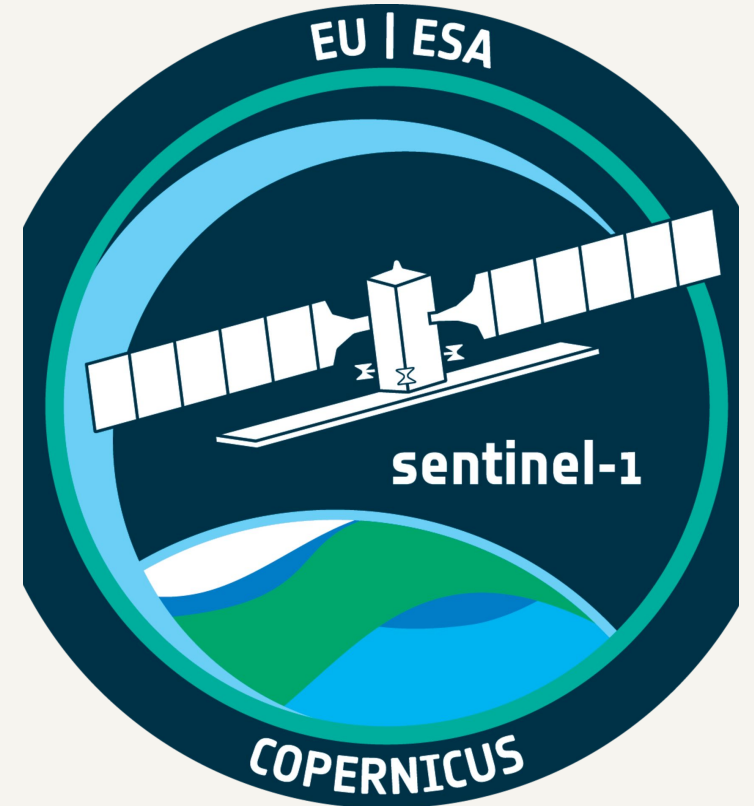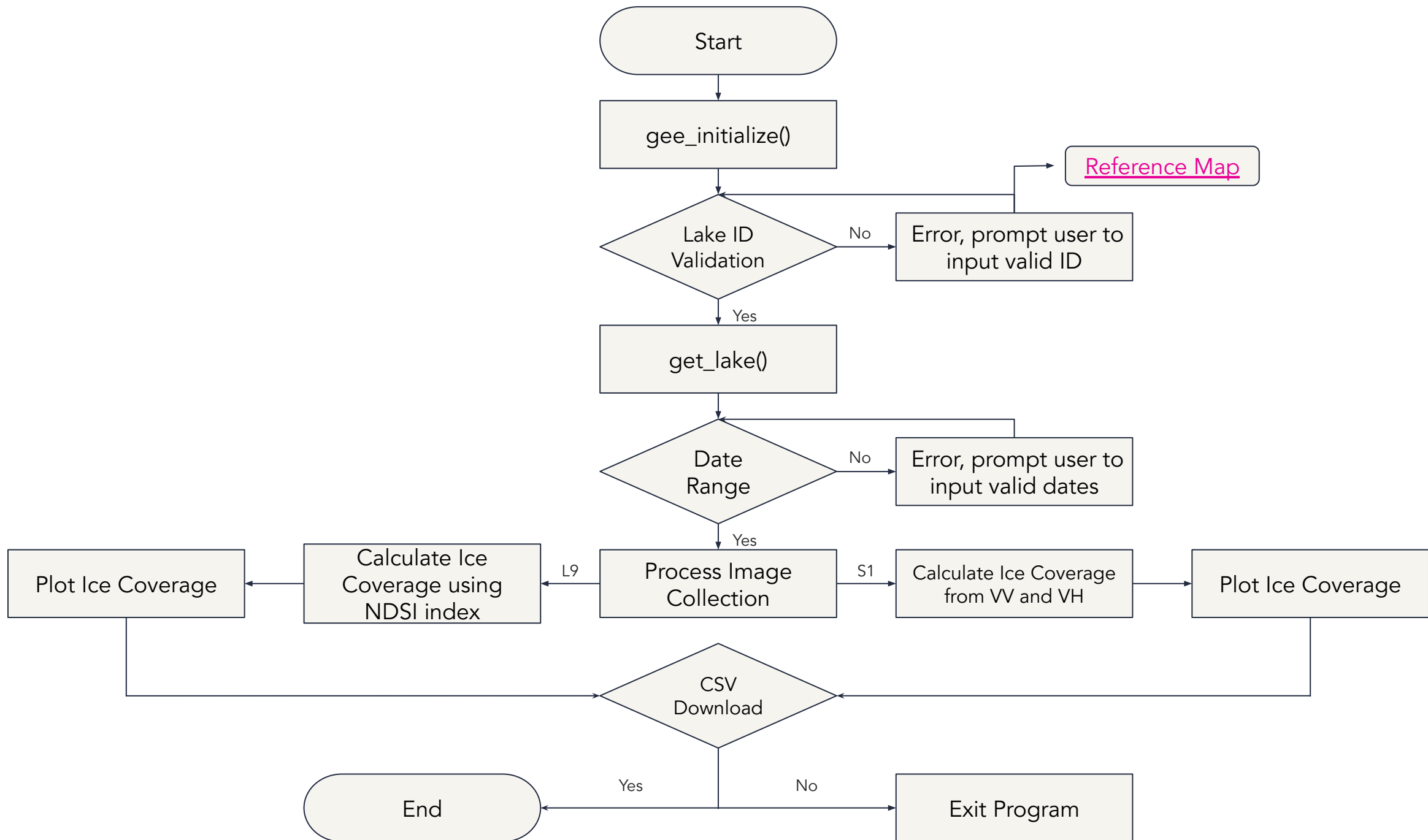|			
ACCEPT WATERBODY AND DATE(S)	COLLECT SATELLITE IMAGERY	CALCULATE ICE COVER PERCENTAGE	SUMMARIZE AND PLOT ICE COVER CHANGES

Data Sources

```
                              ┌──────────────┐
                              │    Start     │
                              └──────┬───────┘
                                     │
                              ┌──────┴───────┐
                              │ gee_initialize() │
                              └──────┬───────┘
                                     │                    ┌──────────────┐
                                     │         ┌─────────▶│ Reference Map │
                                     ▼         │          └──────────────┘
                              ◇──────────────◇   No    ┌──────────────────┐
                              │   Lake ID    │────────▶│ Error, prompt user to │
                              │  Validation  │         │  input valid ID      │
                              ◇──────┬───────◇         └──────────────────┘
                                     │ Yes
                                     ▼
                              ┌──────────────┐
                              │  get_lake()  │
                              └──────┬───────┘
                                     │
                                     ▼
                              ◇──────────────◇   No    ┌──────────────────┐
                              │    Date      │────────▶│ Error, prompt user to │
                              │   Range      │         │  input valid dates   │
                              ◇──────┬───────◇         └──────────────────┘
                                     │ Yes
```

Plot Ice Coverage ← **Calculate Ice Coverage using NDSI index** ← L9 ← **Process Image Collection** → S1 → **Calculate Ice Coverage from VV and VH** → **Plot Ice Coverage**

```
                              ◇──────────────◇
                              │    CSV       │
                              │  Download    │
                              ◇──────────────◇
                     Yes  │              │  No
                          ▼              ▼
                   ┌──────────┐   ┌──────────────┐
                   │   End    │   │ Exit Program │
                   └──────────┘   └──────────────┘
```

Example

```
(IceOnOff_ORK) C:\GEOM_4009\RiverKeeper_Project>python IceOnOff_L9.py

Enter the name of your Google Earth Engine Project: ee-benschellenberg04

Initialization Successful!

You'll need the HYDROUID of the waterbody you'd like to analyze. Would you like to open a reference map showing all
waterbodies and their IDs? (yes/no): no

Enter the HYDROUID of the lake you would like to analyze (ID cannot include commas): 25916

Enter the start date in the format 'YYYY-MM-DD': 2024-01-01
Enter the end date (optional) in the format 'YYYY-MM-DD'. Leave blank for single day: 2025-03-25

           Date  Ice Coverage (%)     Sensor
0    2024-01-29             87.67  LANDSAT_9
1    2024-02-05            100.00  LANDSAT_9
2    2024-02-14            100.00  LANDSAT_9
3    2024-03-01             99.86  LANDSAT_9
4    2024-03-08             99.04  LANDSAT_9
5    2024-03-24             49.40  LANDSAT_9
6    2024-04-09              0.00  LANDSAT_9
7    2024-04-25              0.00  LANDSAT_9
8    2024-06-28              0.00  LANDSAT_9
9    2024-07-14              0.00  LANDSAT_9
10   2024-07-30              0.00  LANDSAT_9
11   2024-08-15              0.00  LANDSAT_9
12   2024-09-16              0.00  LANDSAT_9
13   2024-10-18              0.00  LANDSAT_9
14   2024-11-03              0.00  LANDSAT_9
15   2024-11-19              0.00  LANDSAT_9
16   2024-12-14             16.16  LANDSAT_9
17   2024-12-21              4.85  LANDSAT_9
18   2025-01-06            100.00  LANDSAT_9
19   2025-01-22            100.00  LANDSAT_9

Would you like to download these results to a CSV? (yes/no): no
Ok! No CSV file was saved
```
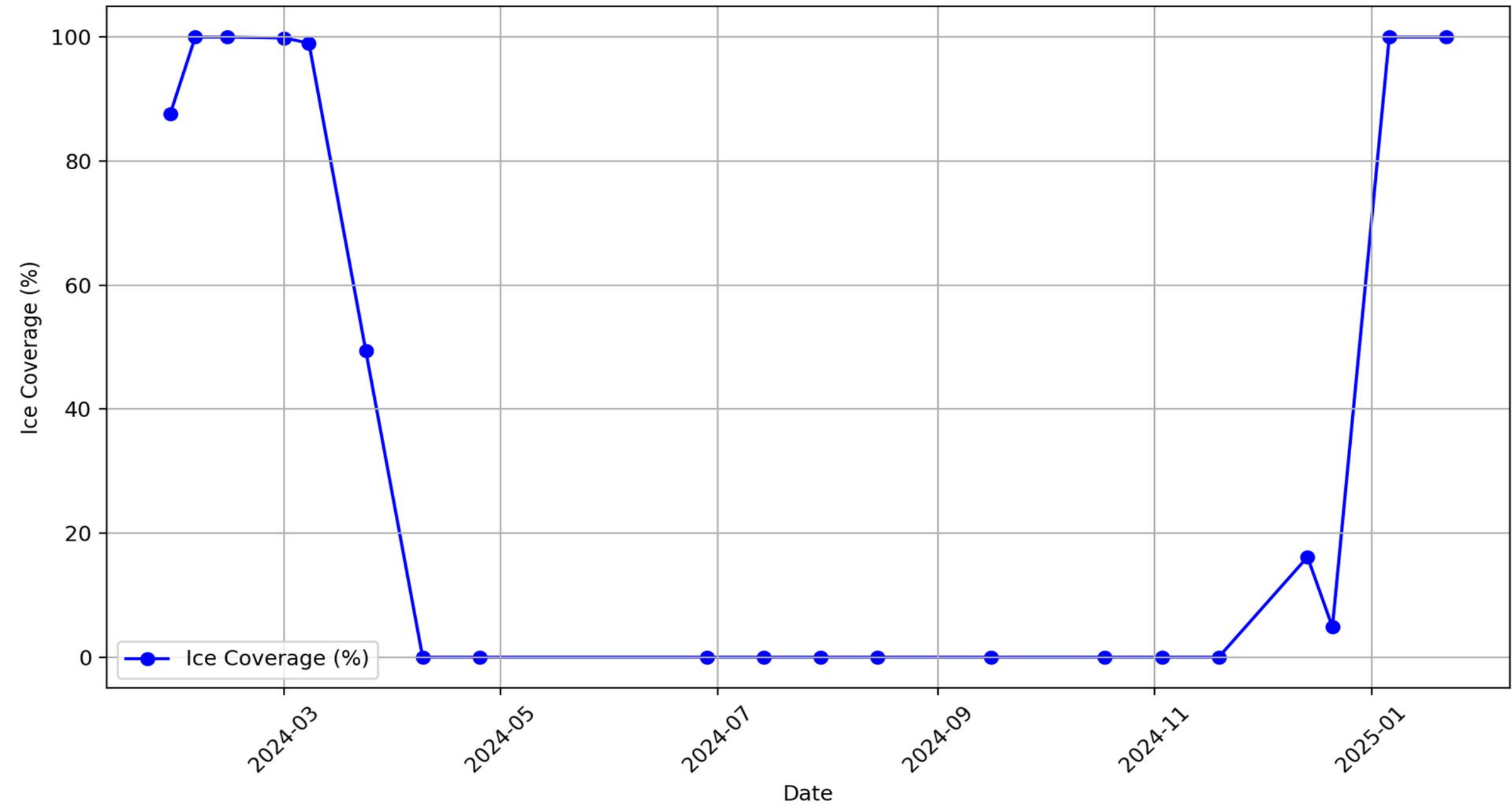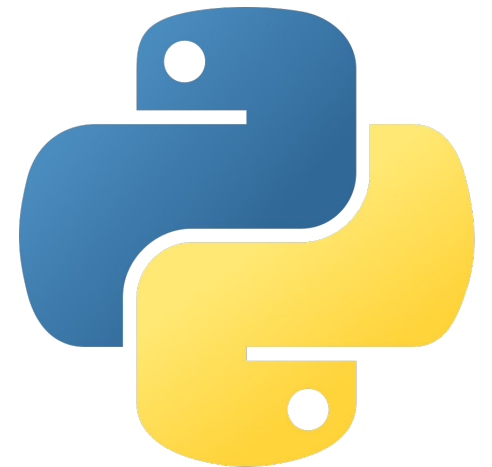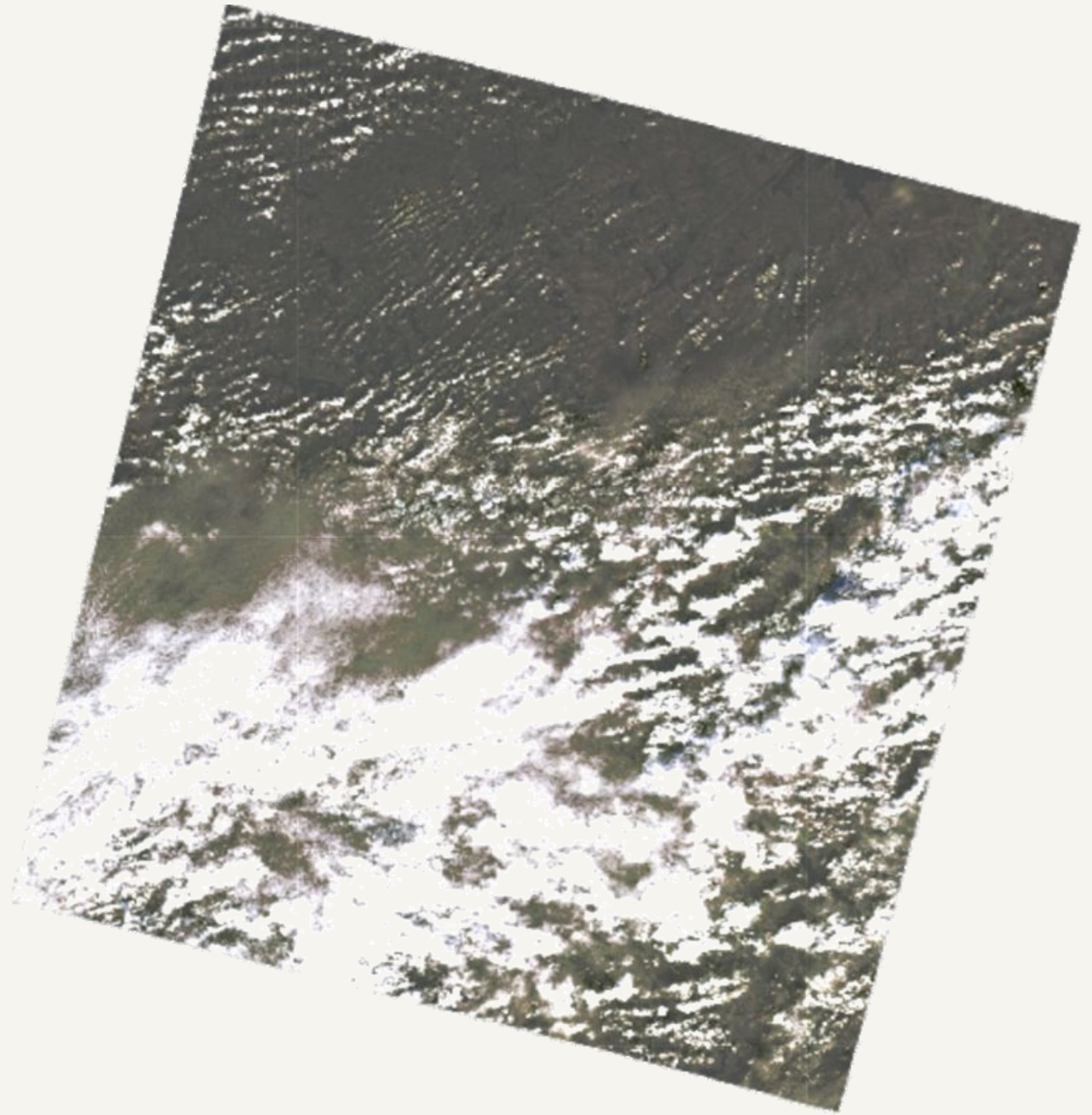
Ice Coverage Over Time

Documentation & Reproducibility

- Sphinx-generated documentation

- IceOnOff_ORK python environment

- Annotated scripts

Landsat-9

- Cloud Cover
- Feature Size
- NDSI Threshold

Challenges and Limitations

Sentinel-1

- Speckle noise
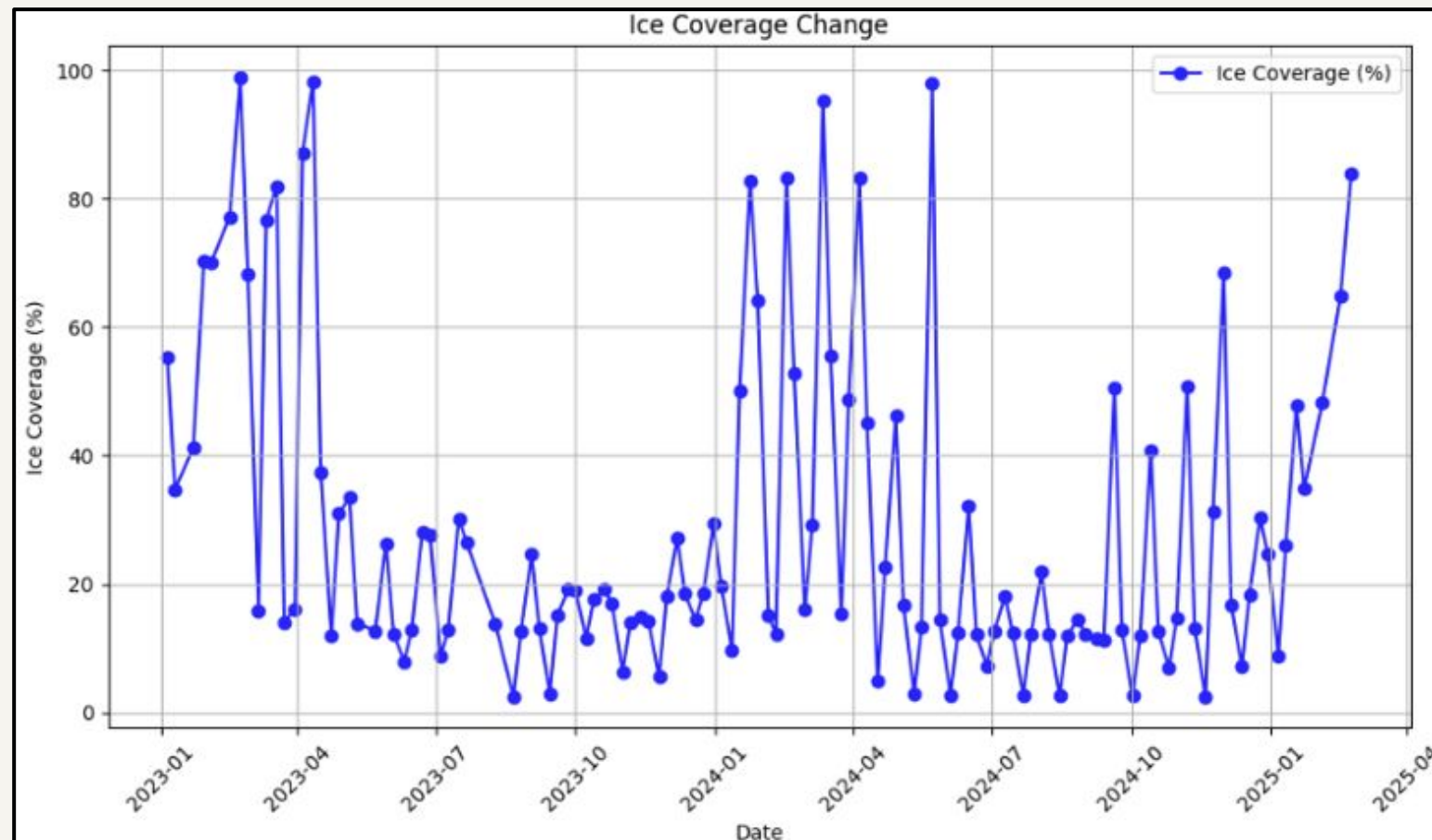- Thresholding errors
- Unnatural fluctuations in results

Figure 2. Graph showing seasonal ice coverage percentages for Baskatong Lake (Jan 2023 - Feb 2025) using sentinel-1. Peaks during winter months, with fluctuations due to speckle noise and thresholding inconsistencies.

Challenge: Runtime

- This workflow requires significant processing power

- Google Colab's free memory limit is insufficient

- Local execution offers better performance and stability

Future Work

Landsat 9

- Broaden Data Sources
  - Previous Landsat missions

- Include Imagery download option

Sentinel 1

- Refine Thresholding

- Temporal Smoothing

- Incorporate into broader workflow

Conclusion

- Ice On/Off dates were successfully automated with Landsat 9

- Speckle noise and thresholding remain challenges for the Sentinel-1 approach

- Future directions include expanding data sources, refining SAR filters, a developing a more visual user platform