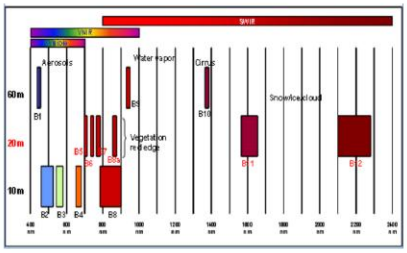
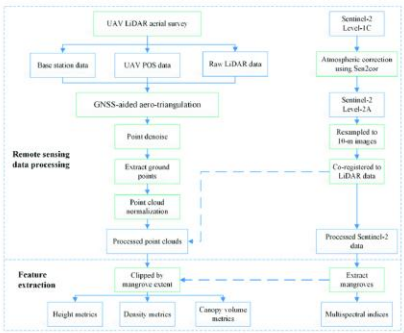
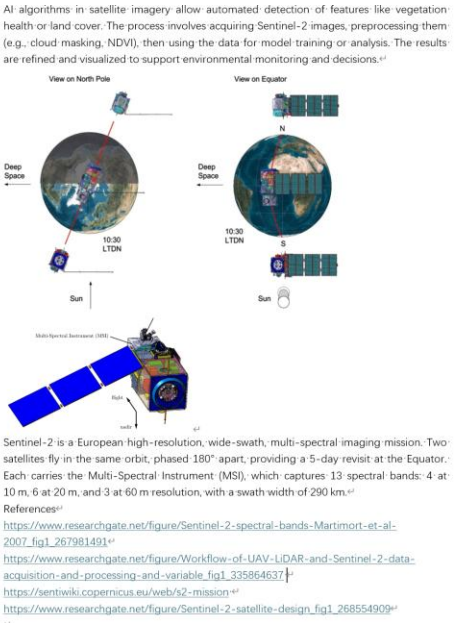
Vegetation Change Detection Using NDVI and Unsupervised Clustering on Sentinel-2 Imagery in part of Iceland

description of the problem to be tackled

This project tackles the challenge of monitoring vegetation health changes over time using satellite imagery. As climate change and human activities increasingly impact ecosystems, tracking these changes becomes crucial for environmental management. The solution analyzes Sentinel-2 satellite images from two different months (April and May) to identify areas where vegetation has improved, degraded, or remained stable. Unlike simple visual inspection, this automated approach provides quantitative measurements of change through advanced image processing and machine learning techniques, enabling more objective and comprehensive environmental monitoring.







environmental cost of this research project is minimal due to its efficient design and use of existing resources. All analysis was performed using pre-collected Sentinel-2 satellite imagery from the Copernicus program, eliminating any additional emissions from new data acquisition. The computational work was conducted in Google Colab's cloud environment, which utilizes renewable energy sources, and focused exclusively on lightweight algorithms like K-means clustering and Gaussian Mixture Models that don't require energy-intensive GPU processing.

Several optimizations were implemented to further reduce the environmental impact. The code employed downsampling techniques to decrease image resolution for analysis, processed only cropped subsets of the full images, and used vectorized NumPy operations for maximum efficiency. These choices kept the total computational demand extremely low - estimated at less than five hours of standard CPU time. To put this in perspective, the project's total carbon footprint is comparable to that of a few hours of typical internet browsing or video streaming, likely under 0.1 kg of CO_2 emissions.

This approach demonstrates that meaningful environmental research can be conducted with negligible ecological impact. The project's design carefully balances analytical rigor

with sustainability, showing how remote sensing studies can maintain scientific value while minimizing energy consumption. Future improvements could explore additional optimizations like adaptive resolution processing or more efficient clustering convergence criteria, but even in its current form, this work sets a strong example of environmentally-conscious research practices.