Goal of this Documentation/Research:

- On our website, when the user clicks on the glacier to view data about it, they are provided an elevation graph and an ice area graph. However, both of these graphs are very difficult to understand without a visualization of the glacier. We are hoping to give an option to toggle between these graphs and a satellite image of the glacier to help users understand the data they are looking at.
- To do this, we need to find an API that consistently displays updated images of glaciers from around the world. This type of API can be difficult to find because the Arctic Circle and Antarctica are not often photographed because few to no people live there.

Options for Satellite Image API

API Name	**Pros**	**Cons**
GIBS (NASA's Global Imagery Browse Services)	Images are updated daily, fast access, several methods of access, download formats are easy to display, python library for requests is already provided, have specific file types and access methods for glaciers / arctic	Images may have clouds in the way depending on the day
Google Earth API	Open source python library, REST API image retrieval, extra datasets and computing capabilities provided	Access process and sample code seemed overly complicated
SkyWatch API	Access to high-quality satellite images, research grade, active online community and tech support	Not free for high resolution images

NASA GIBS

- I chose NASA GIBS for the satellite image API. It had the most straightforward documentation and access methods. The other API services had a more user-friendly UI, but ultimately made accessing via code more difficult.
- Visualizations are generated by the EOSDIS LANCE processing system in near-real time
    - Available around 3 hours after satellite observation
    - Visualizations are retaken and recreated on regular intervals

How are we accessing GIBS data?

Open Geospatial Consortium (OGC) Web Map Tile Service (WMTS)	OGC Web Map Service (WMS)
- API request that supports REST and KVP (key-value pair) get types - Query parameters: LayerIdentifier (type of visualization), time, TileMatrixSet (based on the layer), TileMatrix (specifies zoom), TileRow & TileCol (specify latitude and longitude bounds for request), FileFormat (specifies type of raster return) - Projection types (specifies layer identifier) - Geographic (EPSG:4326) - High-quality, colored image of Earth - Web Mercator (EPSG:3857) - Colored image of Earth, provides some outlines / overlaying on map	- Can contain multiple layers (multiple types of visualizations) in one API request / one raster file - Retrieved by KVP (key-value pair) - Query parameters: bounding box (latitude and longitude), image dimensions (size), layers, file format - Newer, more user friendly version of the WMTS - Supports same projection types as WMTS

- We will be requesting satellite images through OGC WMS. WMS has an open-source python package that makes it extremely easy to request, download, and access satellite images that are the same quality as WMTS file requests. WMS is also generally more compatible with python, and there is sample code posted on the GIBS documentation size specifying satellite image access using WMS in python.

Types of Visualizations API can return

Raster	Vector
- PNG, GeoTiff - Pixel-based images with layers - Colors in layers are mapped to specific locations in the image	- AI, PDF, SVG - Images are stored as shape objects - Infinite resolution and small file sizes, but can be difficult to convert

- We will be accessing a raster file in the png format because it is the easiest to display on our website via RShiny. We don't particularly care about infinite resolution since we are not displaying the image in a large window, and png files are sufficiently small.

Tile Matrix

- NASA GIBS API response images are formatted as “tiles”. These tiles are different images of Earth taken by satellites at different locations that are compiled together to form a complete satellite image of Earth. There are also different tiles for different types of images (examples: elevation plots, weather plots, satellite images, carbon dioxide concentration maps, etc). Users request different areas and types of tiles. Tiles are basically the storage format for the NASA GIBS satellite data.

Requesting using WMTS

- Starting URL: https://gibs.earthdata.nasa.gov/wmts/epsg4326/best/
- After the slash, you can add the query parameters specified above, separated by slashes
- Plopping this URL directly into the search engine will also provide access to the image
- Query parameters we will be using to access glacier satellite images
    - Layer: MODIS_Terra_CorrectedReflectance_TrueColor
        - Returns a satellite image that shows color of Earth as it appears from space, where the image was taken
    - Time: yesterday’s date
    - Tile Matrix Set: 500m
        - Provides us enough area to show entire glacier without making file/image size too large to display and store
    - Format Extension: png

Requesting API Images using WMS via Python

Important Modules

Module Name	Submodules	Functions	Capabilities
urllib	request	Open, get	Allowing python to access and download information from links on the internet
owslib	wms	WebMapSeri vce, getmap	Connect python to API, make request (based on query parameters) to retrieve images from GIBS OGC WMS
IPythonDisplay	display	Image	Displays an image in python
datetime	date, timedelta	Today, timedelta(da ys)	Allow python to format time as query parameters and access the current, past and future dates

Installing OWSLIB

- Command prompt installation
    - Conda install -c conda-forge owslib

- Pip install owslib

The Process

1) Connect to the WMS online API using the WebMapService() function from owslib
2) Send a get request to the API using the getmap() function from owslib
3) Store API response in a local variable
4) Open and save the API response as a png using open(), write(), and read()
5) Visualize the image in the Python editor using the Image() function from IPythonDisplay