Satellite/In-Situ Matchup Analysis

Satellite Data Acquisition
- Freely accessible from the NASA Ocean Color Web Browser.
- Download L2 NetCDFs that contain minimal cloud coverage and were captured within 48 hours of in-situ sampling period (May 5, 2023).

In-Situ Data Acquisition
- Using the Acrobat equipped with a chlorophyll fluorometer, conduct transect surveys to collect chlorophyll measurements at the mouth of the Masonboro Inlet.

L2 File Storage
Store the newly acquired satellite NetCDFs in a single folder for easy access.

Data Processing
Using SeaDAS, process the acquired L2 files to L3 data products for a spatial representation of the chlorophyll measurements.

Data Pre-Processing
Download the collected data from the measuring devices. For our devices, we used Sea-Brid's Scientific Seasoft V2: SBE Data Processing software. Save the transect data in CSVs.

Visualize Transect Paths and Satellite Chlorophyll Imagery
Run the sat_mosaic.py script to:
- Load in and overlay in-situ transect paths onto L3 chlorophyll satellite imagery.
- Enhance with scale bars, compass roses, and legends for each satellite sensor type.
- Save the final visualizations as a mosaic map.

Process and Quality Control Transect Data
Run the preprocessing.py script to:
- Load in the raw marine transect data from the CSVs.
- Perform quality control checks to ensure data integrity, including timing consistency and value range validation.
- Handle special data cases, like reversing rows for specific transects to ensure proper orientation.
- Saved cleaned data into a processed, combined dataset and generate a quality control report.

Satellite & In-situ Data Matching
Run the satsitu.py script to:
- Load in processed in-situ transect and satellite-derived chlorophyll datasets.
- Match satellite data with in-situ data based on geographic coordinates.
- Calculate indices to align in-situ measurements with corresponding satellite data grid points.
- Save the combined dataset with matched chlorophyll values from both in-situ and satellite sources.

Visualize Data in 2D Gradients Along Transects
Run the 2D_contour.py script to:
- Read transect CSV to extract chlorophyll data.
- Calculate distances along each transect.
- Interpolate data points to create a continuous gradient representation.
- Include bathymetric data.
- Generate and save the contour plots for each transect as PNGs.

Data Aggregation
Run the aggregate_satsitu.py script to:
- Import satellite and in-situ data of chlorophyll concentrations.
- Apply sliding window averaging (1x1, 2x2, 3x3 pixels).
- Filter in-situ data by specified oceanic depth ranges.
- Combine processed and aggregated data into a single dataset for further analysis, which is outputted as a CSV.

Visualize Data Across Depth Intervals
Run the depth_analysis.py script to:
- Generate depth distribution box plots.
- Calculate average oceanic parameters by depth.

Visualize Data in 3D Gradients
Run the 3D_contour.py script to:
- Do the same as the 2D_contour script, with an additional distance-from-shore calculation for the x axis.

Run the 3D_contours_chl.py script to:
- This separate script was created to handle the logarithmic nature of Chl concentrations.

Evaluate & Visualize Satellite Data Accuracy
Run the satsitu_stats-histogram.py script to:
- Load combined satellite and in-situ aggregated chlorophyll data.
- Select specific satellite data sets based on sensor type and capture date.
- Calculate statistical metrics (RMSE, MAPE, Bias, R-squared) for chlorophyll predictions at various ocean depth ranges.
- Fit a linear regression model to compare predicted and in-situ chlorophyll values.
- Generate scatter plots with regression lines to visualize prediction accuracy.
- Output comprehensive statistics dataset and histogram plots for each depth range and pixel window size configuration.

Evaluate Satellite Data Accuracy
Run the satsitu-bars.py to:
- Load comprehensive statistical dataset.
- Generate bar plots that compare the statistical metrics across all sensor types, depth ranges, and pixel window size combinations.