

Appendix A. Description of the elements involved in the inputs/pre-processing steps and post-processing features

| Elements | Description | Supplementary figures | Figure label |
|------------------------------------|--|-----------------------|--------------|
| <i>(i) Inputs/pre-processing</i> | | | |
| Image folder path | Path to the folder directory containing the folder of the raw hyperspectral images (.raw format), “UAV” folder containing a GPS file (csv file), “Dark” folder containing the dark reference, “WhiteRef” folder containing the white reference | Appendix B | 1(a) |
| Spectrometer folder | A series of text files (.txt), each containing the absolute irradiance information ($\mu\text{W}/\text{cm}^2/\text{nm}$) at wavelengths covering the entire spectral range of the hyperspectral camera | Appendix B | 1(b) |
| Prefix for files | User-assigned label to processed images | Appendix B | 1(c) |
| Location to store processed images | User-defined folder where processed images are stored in | Appendix B | 1(d) |
| Upload config file | Configuration file that contains all the user-defined options that was created during the previous processing can be uploaded. Fields will be automatically filled in to improve efficiency. | Appendix B | 1(e) |
| Launch to select region | A GUI window where user can specify the range of flight regions to conduct stitching (See Appendix H) | Appendix C | 2(a) |
| Drone Height | User-specified height (in metres) at which the drone operates and where imaging is conducted. <i>Note:</i> GPS information entails the altitude information but not the height information, where altitude = height + surface topography | Appendix C | 2(b) |
| Upload .txt file | After the selection of flight regions in the GUI window, the GPS indices are stored in a .txt file for future repeated process | Appendix C | 2(c) |
| Range of lines to process | User-defined option to choose how many lines to process | Appendix C | 2(d) |
| Launch image correction | Launch image correction GUI window to conduct time delay correction (See Appendix I) | Appendix C | 2(e) |
| Upload correction indices | For fine tuning of individual lines, the corrected indices (saved from 2(e)) can be uploaded | Appendix C | 2(f) |
| Slider | Global time delay correction can alternatively be used if the user has a prior knowledge on the time delay | Appendix C | 2(g) |

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|--|----------|---|------------|------|
| Water quality .csv file | | A csv file containing information of the in-situ water quality measurements. It should contain columns with the measurements of the water quality concentration, and two other columns with its corresponding latitude and longitude information | Appendix D | 3(a) |
| Column of latitude/longitude/ water quality variable | of | Drop-down boxes based on the input .csv file's columns will be automatically filled in. User can choose the columns that corresponds to latitude, longitude and the water quality variable. Spectral information and the in-situ measurements will be extracted from the images based on the coordinates supplied | Appendix D | 3(b) |
| Querying & filtering | | For querying and filtering the data using SQL syntax using variables in the dropdown box. Users can then view the water quality file by clicking on 'View water quality file'. | Appendix D | 3(c) |
| Pre-processing | | <p>Checkboxes that allow users to select the pre-processing methods</p> <ul style="list-style-type: none"> • Mask objects (masking of non-water objects. <i>Note:</i> A pop-up box will appear to allow users to input the segmentation model) • Classify objects (only when 'Mask objects' is checked. Classify vessels and land/caisson) • Noise removal (de-stripping) • Radiometric correction (only if spectroradiometer folder is provided) • Sun glint correction (see Appendix J for choosing glinted regions interactively) | Appendix E | 4(a) |
| Select pseudo- RGB bands | | Bands to create false-composite images | Appendix E | 4(b) |
| Prediction | | Prediction checkbox to produce a predicted map of the water quality variable. Users have the flexibility to supply their own trained model (e.g. XGBoost model in.json or .model format) that can be used to predict any water quality variable of interest. Users can further specify which bands to be used as predictors, based on the input trained model. | Appendix E | 4(c) |
| Down sampling factor | sampling | Coarsening of the predicted output by a factor indicated by user-manipulated slider. The coarsening allows the reduction of noises through smoothening of the output | Appendix E | 4(d) |
| Process | | After the user has indicated their selection, clicking on 'Process' will start the processing | Appendix E | 4(e) |

(ii) Post-processing

| | | | |
|---------------------------------------|---|------------|------|
| Preview previously processed images | Folder to open that contains the previously processed images | Appendix F | 5(a) |
| View georeferenced images | Dropdown list that contains prefixes of different batches of images will be filled in after specifying the 'Processed image folder'. Upon clicking the 'View georeferenced images', a GUI window will pop up for users to view the georeferenced images/predicted images and add features to make a production-ready map (see Appendix K) | Appendix F | 5(b) |
| Assess extracted spectral information | Dropdown list that contains different extracted spectral information files will be filled in after specifying the 'Processed image folder'. Upon clicking on 'Plot spectral curve', a GUI window will pop up for users to assess the quality of the extracted spectral information from the supplied water quality .csv file | Appendix F | 5(c) |
| Select hyperspectral bands | A GUI window will pop up for users to create various false composite images by specifying the desired bands (see Appendix L) | Appendix F | 5(d) |
| Select processed image from the list | List of processed images' file name will be automatically filled in upon selecting the 'Processed image folder'. Upon selecting the file name, the processed image will be shown on the right panel | Appendix F | 5(e) |
| Generate hyperspectral images | Users can choose to generate hyperspectral images if desired, as hyperspectral images are not produced as outputs by default due to increased processing time and high storage requirements on the local machine (However, during the extraction of spectral information, hyperspectral images are generated implicitly already). | Appendix F | 5(f) |

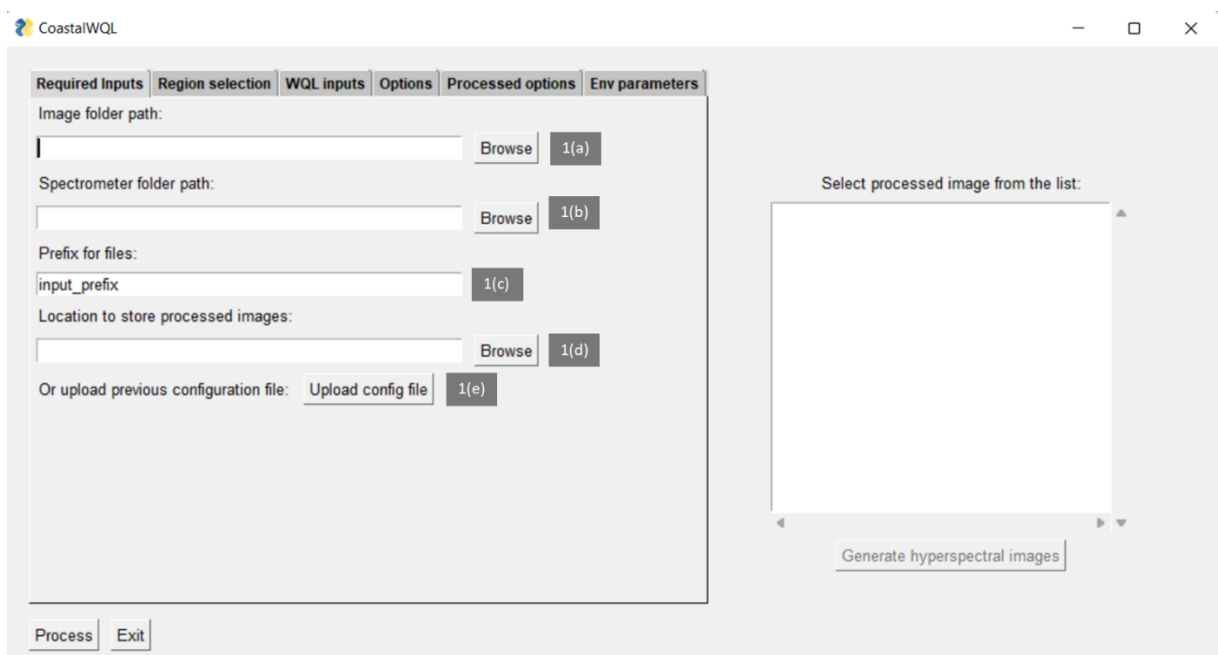
(iii) Retrieval of ancillary data (environmental parameters)

| | | | |
|--------------------------|--|------------|------|
| List of dates/time | Users can select date from a calendar widget by clicking on 'Select Date' for when they want to retrieve the environmental parameters. Users can also optionally indicate the range of time (start time and end time) | Appendix G | 6(a) |
| Environmental parameters | Up to four environmental parameters can be selected to retrieve the information from https://data.gov.sg/dataset?groups=environment (Note: Currently only configured to retrieve data from stations in Singapore, and are currently only limited to these options) | Appendix G | 6(b) |

| | | | |
|-------------------------|---|------------|------|
| Fetch data | A pop-up window will appear to indicate the directory where the user wants to save the retrieved environmental parameters. After the retrieval of the data, a csv file with the retrieved environmental parameters will be saved in a folder 'retrieved_env_variables'. | Appendix G | 6(c) |
| Plot environmental data | A pop-up window will appear to show the time series plot of the retrieved environmental parameter(s) (see Appendix M) | Appendix G | 6(d) |

Note: Demonstration video for the workflow can be found [here](#)

Appendix B. Required inputs for *CoastalWQL*

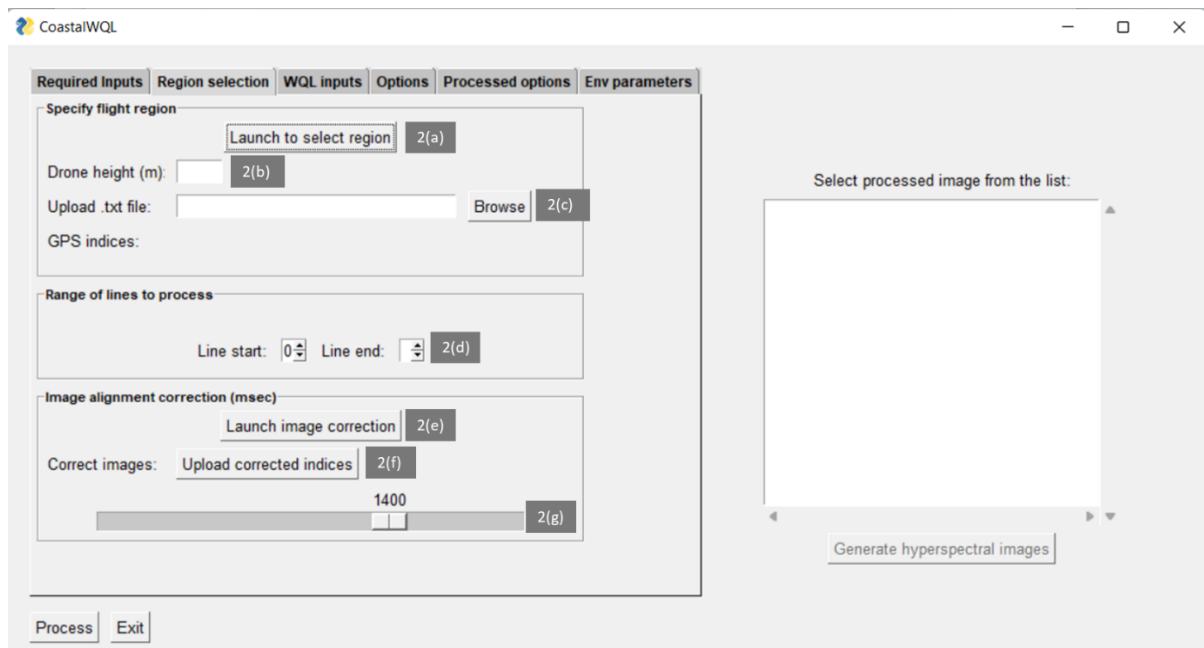


The screenshot displays the 'CoastalWQL' application window with the 'Required Inputs' tab selected. The interface includes several input fields and buttons for configuring the workflow:

- Image folder path:** A text input field with a 'Browse' button and a label '1(a)'.
- Spectrometer folder path:** A text input field with a 'Browse' button and a label '1(b)'.
- Prefix for files:** A text input field containing 'input_prefix' with a label '1(c)'.
- Location to store processed images:** A text input field with a 'Browse' button and a label '1(d)'.
- Or upload previous configuration file:** A button labeled 'Upload config file' with a label '1(e)'.

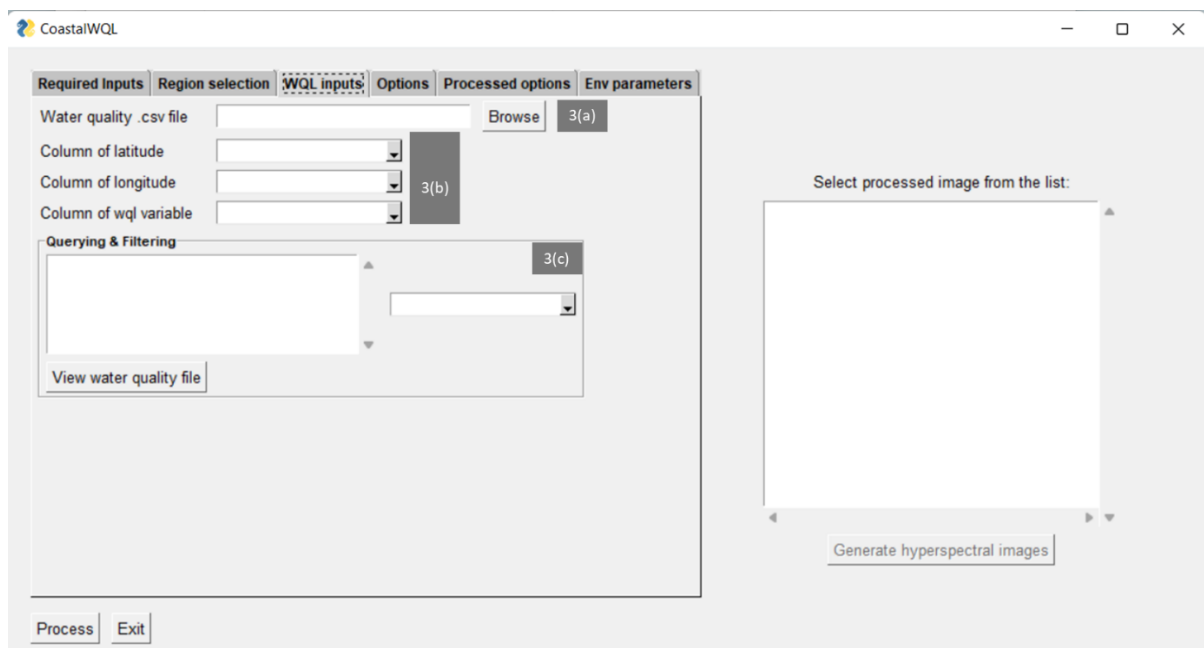
On the right side of the window, there is a section titled 'Select processed image from the list:' with a large empty box for image selection. Below this box is a button labeled 'Generate hyperspectral images'. At the bottom left of the window, there are 'Process' and 'Exit' buttons.

Appendix C. Region selection for image stitching in *CoastalWQL*



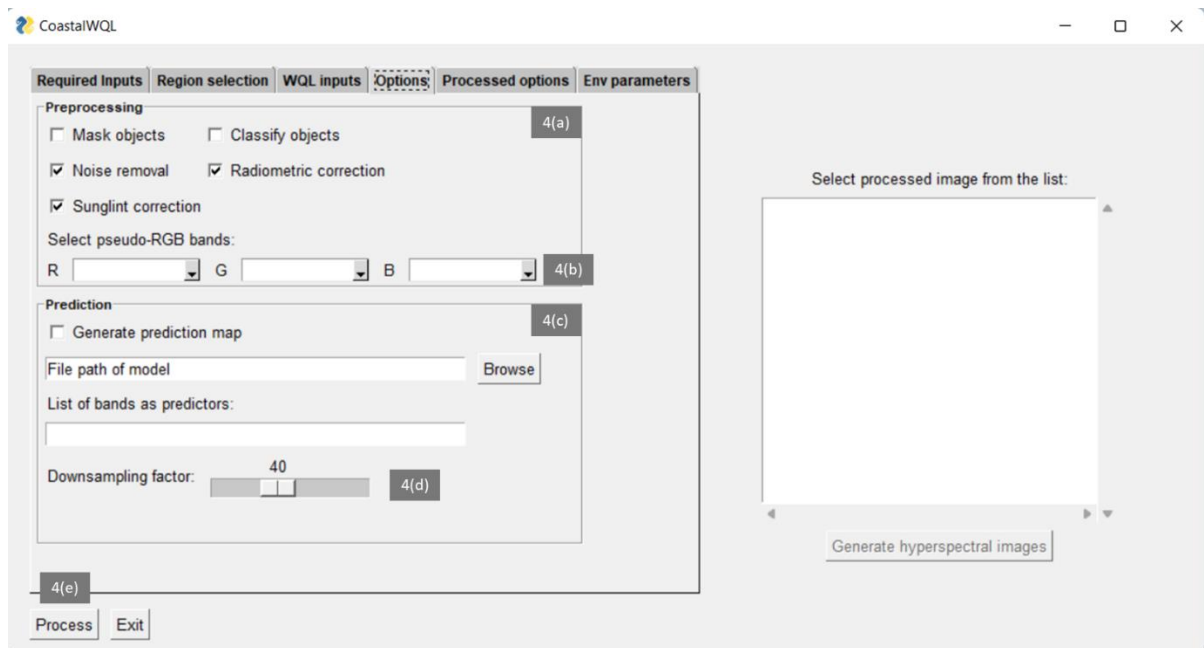
The screenshot shows the 'Region selection' tab in the CoastalWQL application. The interface includes several input fields and buttons for configuring region selection parameters. The 'Specify flight region' section contains a 'Launch to select region' button (2(a)), a 'Drone height (m):' input field (2(b)), an 'Upload .txt file:' input field with a 'Browse' button (2(c)), and 'GPS indices:' input fields. The 'Range of lines to process' section has 'Line start:' and 'Line end:' input fields (2(d)). The 'Image alignment correction (msec)' section includes a 'Launch image correction' button (2(e)), a 'Correct images:' input field with an 'Upload corrected indices' button (2(f)), and a slider for '1400' (2(g)). A 'Generate hyperspectral images' button is located at the bottom right. The 'Process' and 'Exit' buttons are at the bottom left.

Appendix D. Water quality inputs for extraction of spectral information

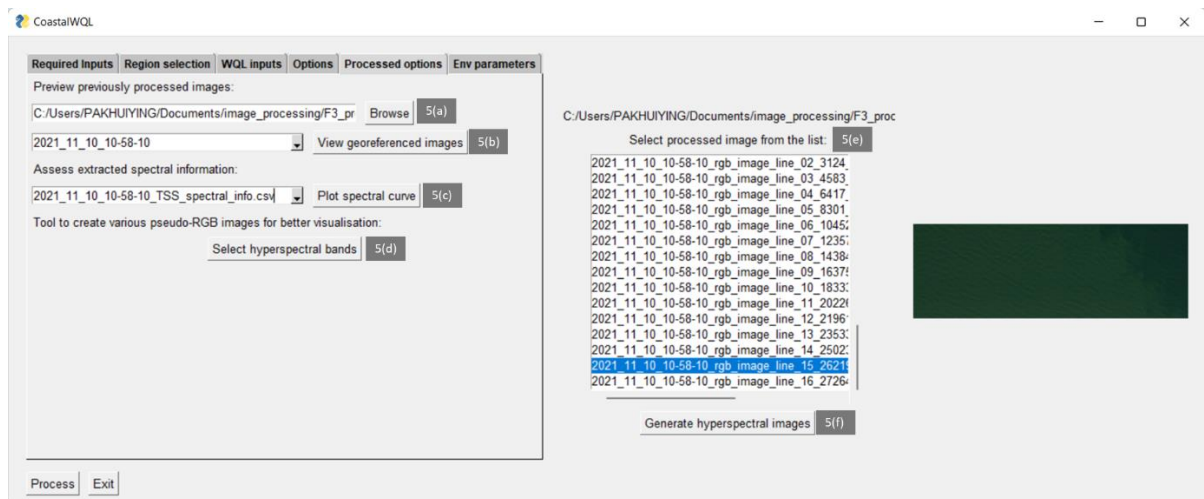


The screenshot shows the 'WQL inputs' tab in the CoastalWQL application. The interface includes input fields and buttons for configuring water quality inputs. The 'Water quality .csv file' input field has a 'Browse' button (3(a)). The 'Column of latitude', 'Column of longitude', and 'Column of wql variable' input fields are grouped together (3(b)). The 'Querying & Filtering' section has a text input field (3(c)) and a 'View water quality file' button. A 'Generate hyperspectral images' button is located at the bottom right. The 'Process' and 'Exit' buttons are at the bottom left.

Appendix E. Additional options for pre-processing and prediction



Appendix F. Visualisation features post-processing

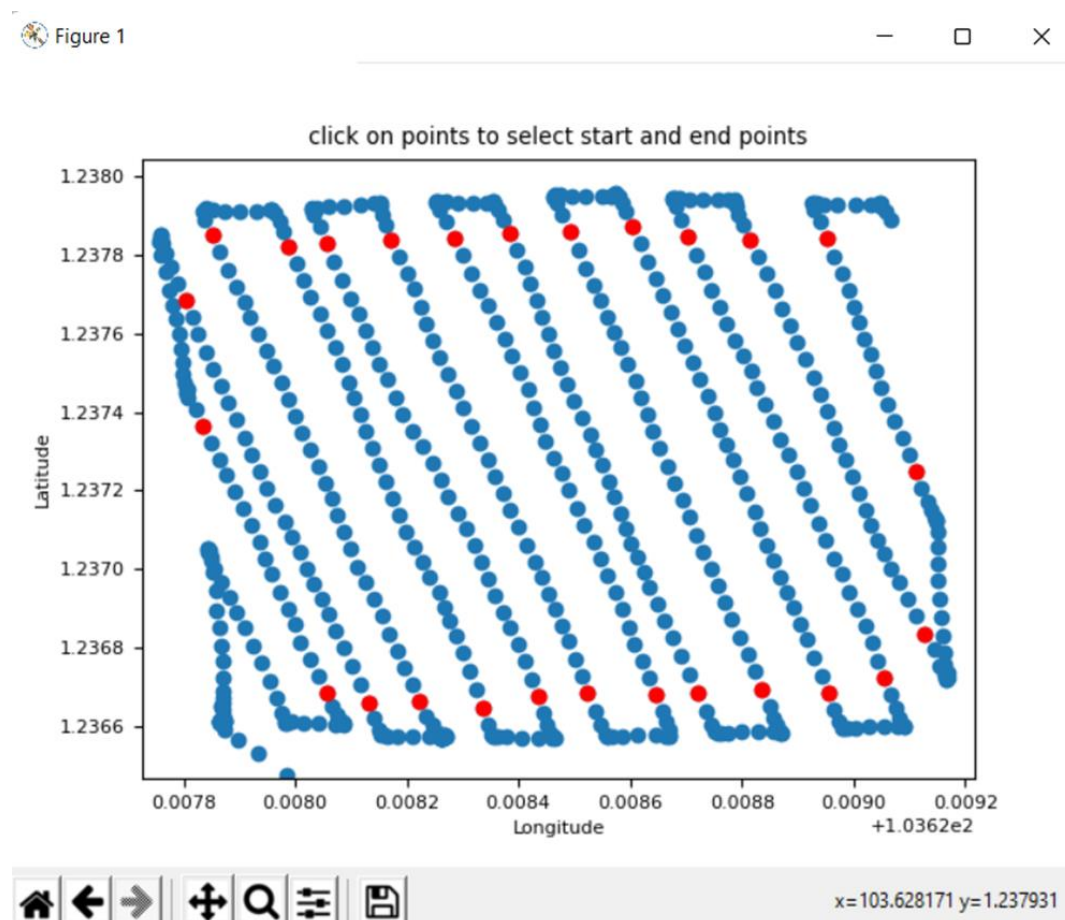


Appendix G. Retrieval of environmental parameters

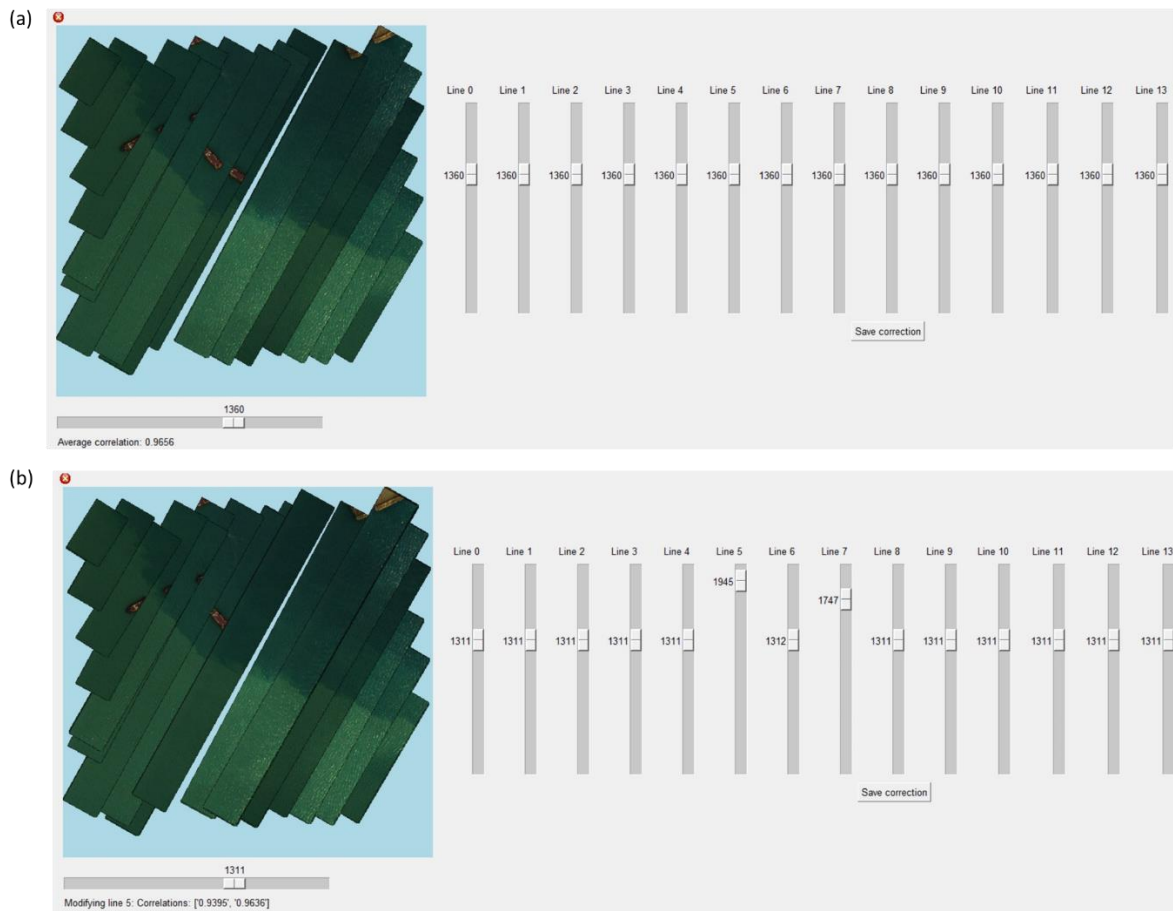
The screenshot displays the CoastalWQL software interface with the 'Env parameters' tab selected. The interface includes several input fields and buttons:

- List of dates:** A text input field with a 'Select Date' button next to it.
- List of start time:** A text input field.
- List of end time:** A text input field.
- Environmental parameters:** A section with four checkboxes: 'Wind direction', 'Wind speed', 'Air temperature', and 'Relative humidity'. A '6(b)' label is positioned to the right of these checkboxes.
- Select location:** A dropdown menu with a '6(c)' label next to it.
- Buttons:** 'Fetch data', 'Plot environmental data', and '6(d)' are located below the location dropdown.
- Process and Exit:** Buttons at the bottom left of the interface.
- Right Panel:** A section titled 'Select processed image from the list:' with a large empty text area and a 'Generate hyperspectral images' button at the bottom.

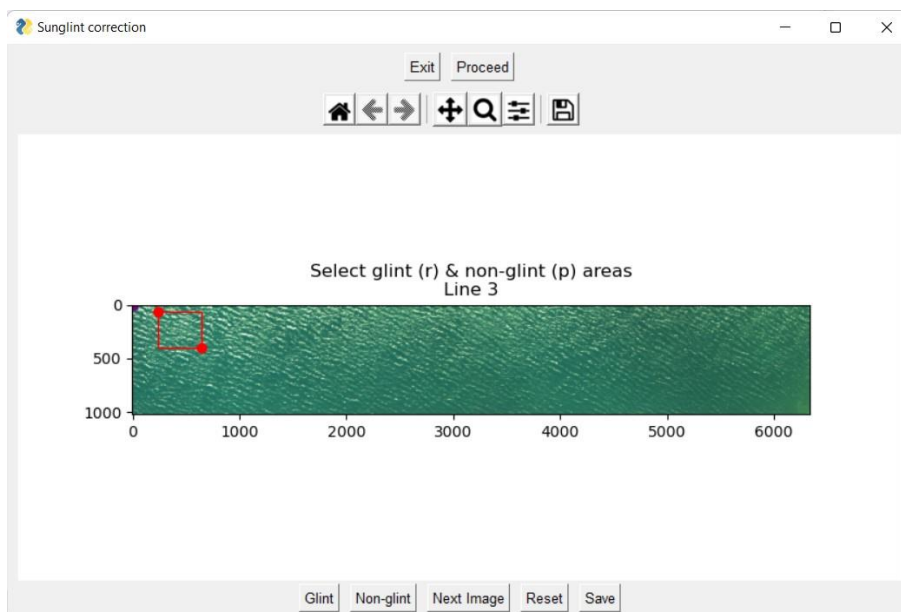
Appendix H. Selecting flight regions based on GPS points (*Note: Red points are user-selected points to indicate the start and end of each flight line*)



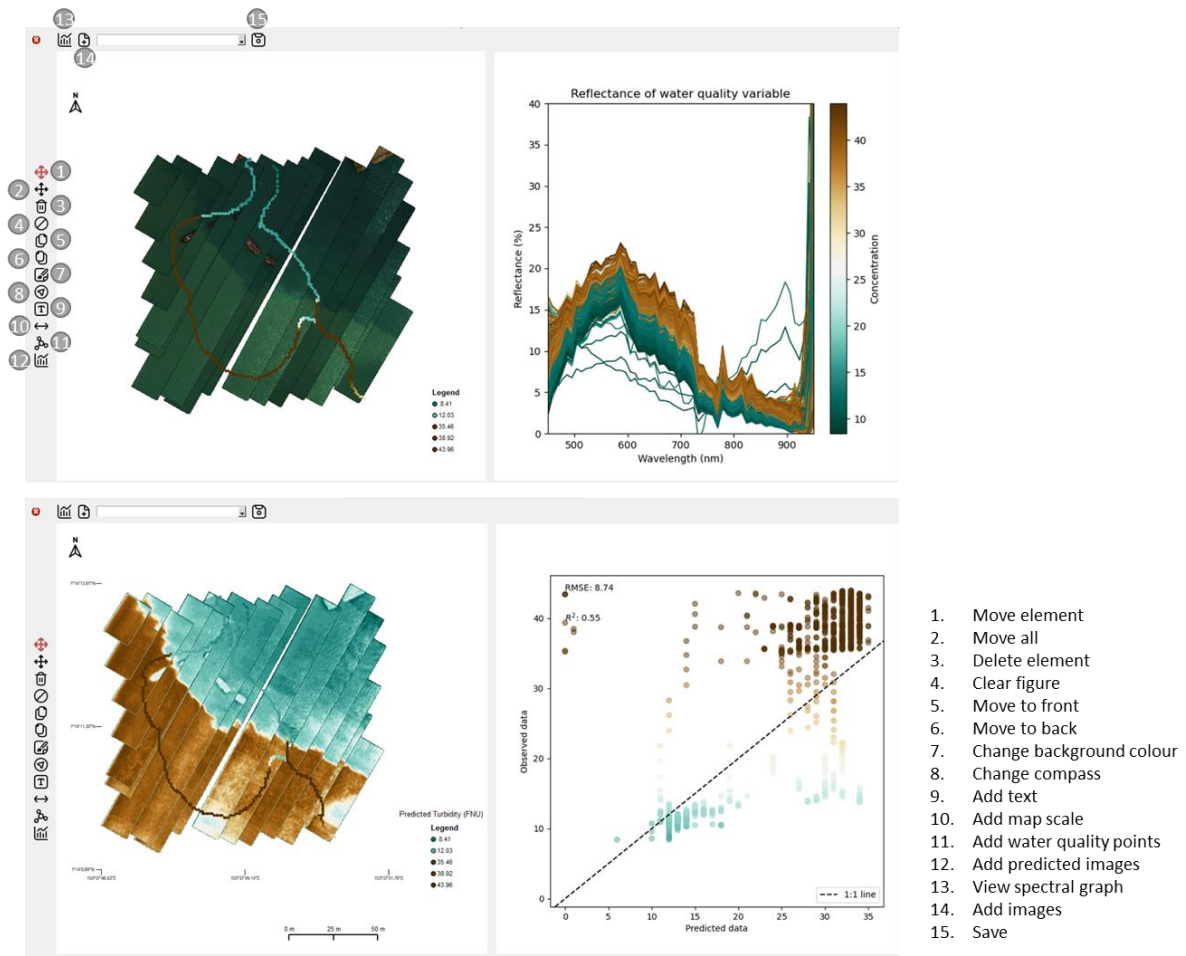
Appendix I. Interactive image alignment (a) global alignment using the horizontal slider (b) fine-tuning of image alignment of individual image line using the vertical sliders



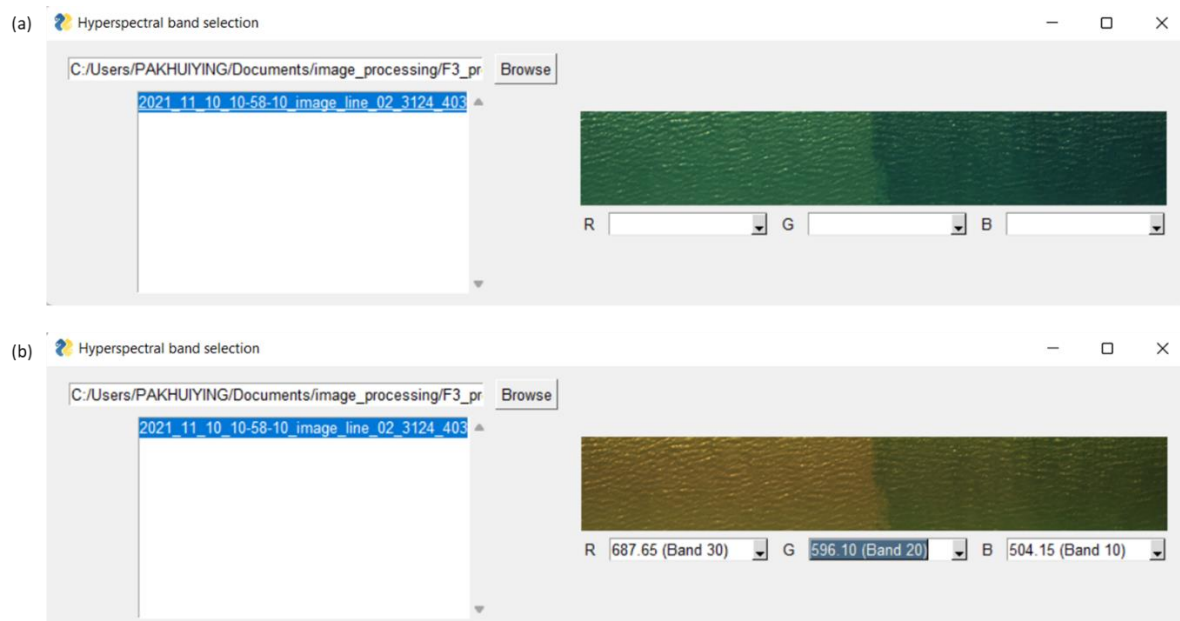
Appendix J. An interactive toolkit for user-selection of an ROI affected by sun glint in *CoastalWQL*



Appendix K. Visualisation and map generation toolkit (a) Viewing false composite images (b) Viewing predicted images



Appendix L. Selection of bands to create different false composite images



Appendix M. Time series of retrieved user-defined environmental variables

