MONOCLE

RPAS: Remotely Piloted Aircraft Systems

Deployment and Operation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776480.

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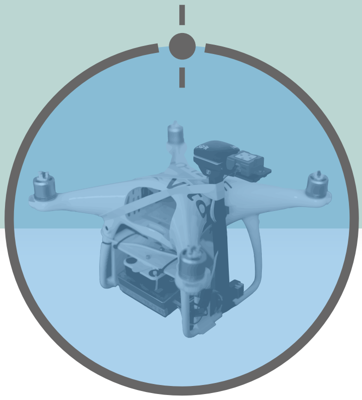


RPAS

Contents

System description

The **Prosumer RPAS systems** comprise imaging sensors on board drones for the observation of water-leaving reflectance and water quality parameters including Total Suspended Matter (TSM) and chlorophyll-a (Chl-a).

In this document, we will discuss two types of sensors/platforms. First, we will give general instructions for using commonly used drones (DJI Phantom 4 pro) in their standard configuration. Secondly, we will look into a specific case where a multispectral camera is mounted under the DJI Phantom 4 pro.

- Hardware components
- MAPEO field software

Prosumer drone system: DJI Phantom 4 pro with multispectral camera MicaSense RedEdge-M mounted underneath.

System installation

Hardware components

Default DJI PH4pro

- DJI PH4Pro + batteries (charged)
- DJI battery charger
- DJI box: remote controller & propellers
- iPad (apps installed) & cable
- PC with Chrome browser & charger
- Ethernet cable (5 m cable is advised)
- SD cards empty
- SD mini to SD adapter

MicaSense RedEdge-M camera, integration kit[1] & Wifi dongle

- Check components (see below)
- Tools for integration: cutting pliers; imbus 2.5 mm + 4 mm
- Straps
- Lens cleaning tissues
- 2 x camera battery pack
- Battery pack charging cable + 220 V adapter

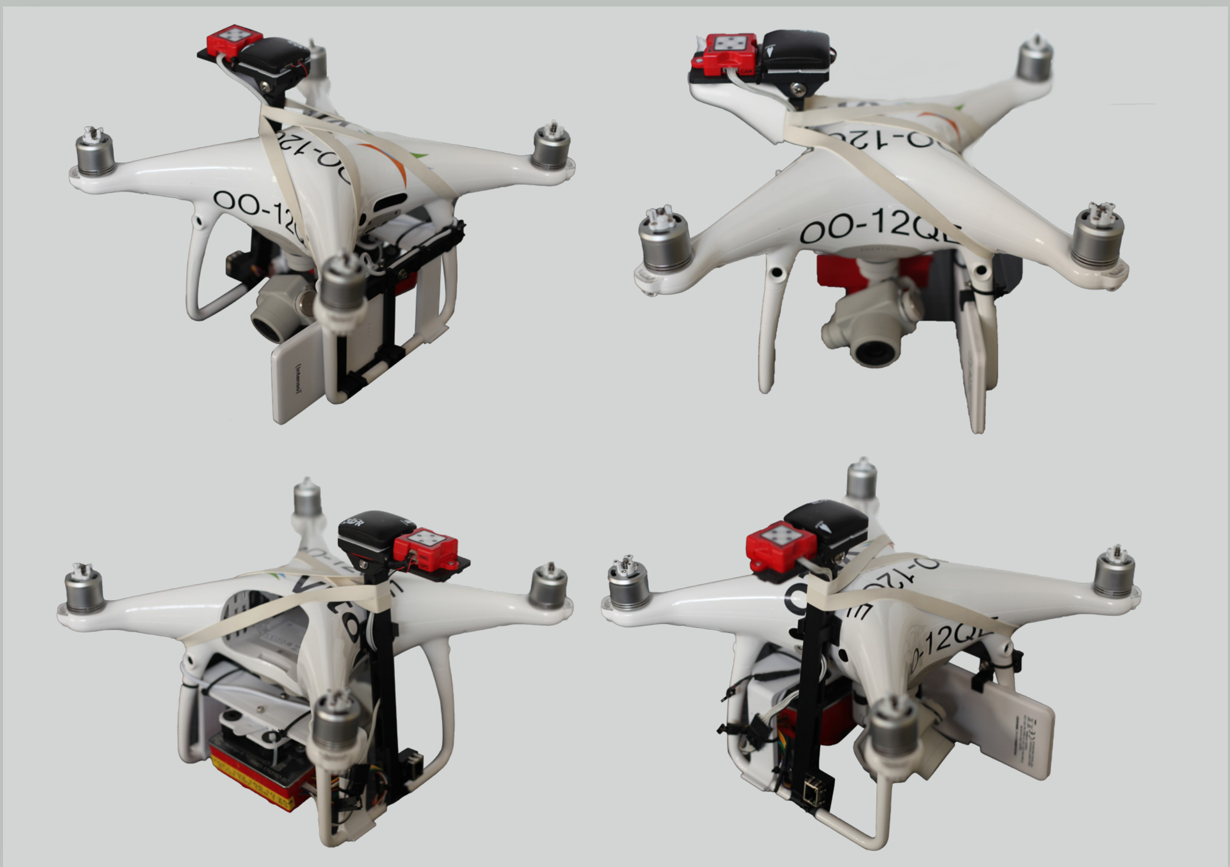
In the field

- GCP radiometric, fixation pins & hammer
- MicaSense reference panel (in case of MicaSense integration)
- Compass
- Platform for take off (in case of unstable underground)

[1]Strackx, G. 2019. 3D prints integration MicaSense RedEdge under DJI PH4 pro. doi:10.5281/zenodo.2578108

Installation MicaSense RedEdge under DJI PH4 pro

1. Remove gimbal transport supports.
2. Click the GPS pole onto the right leg of the DJI. Make sure the arrow points forward and that the support clip is at the correct position with regards to the DJI body. Use two elastic bands to strengthen the connection of the GPS pole. During attachment, make sure you don’t cover any of the DJI sensors and that the elastics are nicely positioned.
3. Mount the camera brace under the drone by sliding the brace into the frame. Apply two straps to fix the brace to the landing gear.
4. Install the battery support on the landing gear of the DJI PH4 pro and apply four straps to fix the brace to the landing gear.
5. Install the camera: first remove the Wifi dongle of the camera, mount the camera to the vibration damping using the 4 screws. Slide the camera onto the camera brace under the drone till it clicks in position.
6. Make an ethernet connection and secure the cable with a strap.
7. Install the battery in the battery support compartment, plugin the power connector and SECURE the battery. Verify that the battery cannot slide out of the mount.
8. Check the result



Final result of the integration of the MicaSense RedEdge-M camera under DJI Phantom 4 pro drone platform.

System check

DJI PH4pro check

- SD card DJI empty or enough space available
- Battery charged

MicaSense integration on DJI solid

- Check pole mount: strap present, 2 elastics present, GPS plate secure, cables secure, GPS solid, DLS solid, stability left/right
- Check battery mount: 4 straps present, battery inserted, battery strap present
- Check camera mount: screws, shock absorbers + 4 straps, slider secure click, camera mount brace solid + 2 straps
- No loose cabling
- Propellers can rotate freely
- Check RGB camera gimbal move freely
- Check centre of gravity (props removed, flight battery installed, DJI power down, full camera system installed, camera battery installed, camera unpowered)
- Check camera SD card: empty and installed
- Check wifi dongle removed
- Check camera lenses clean
- Battery cable secure
- Cable camera to DLS connected
- Cable camera to battery: present but still disconnected
- Connect ethernet cable between camera and laptop
- Connect camera power cable
- Press the camera button shortly to power the camera and wait one minute
- Wait till camera LED flashes green or yellow
- Check camera battery voltage indicator: if only one LED remaining, consider changing the camera battery
- Open Chrome browser and connect to camera and select the HOME tab
- SD card MicaSense empty
- Wait for GPS fix (GPS sats: GREEN; GPS time correct)
- Camera LED should be flashing green

MicaSense camera status

- Tab HOME
- Storage (=SD card space): GREEN
- GPS Sats: GREEN: no. of satellites (≥5)
- DLS Status: GREEN : connected
- Time: correct time GPS displayed (UTC; mind summer time)
- Location: displayed position is correct and stable
- Altitude: correct: about 0 m AGL and stable
- Speed: correct: about 0 m/s and stable
- Heading (= nose heading): correct - 0 = north, 90 = east; ...
- Check/modify the camera settings timer + 1 sec, GPS status, DLS status, integration time, all bands enabled, 16bitTIFF
- Disconnect ethernet cable

Documentation/permits

Check the local drone regulations to find out which documents must be in place before setting up a drone flight, and which restrictions you have to follow. A non-exhaustive list of important documents:

- Operational drone manual
- Certificate of conformance, if applicable
- Pilot licence
- Pilot insurance
- Drone insurance
- Permission from land owners
- Risk assessment
- Check flight restrictions: flight height, range

Field calibration

GPS compass reading

- Check DJI compass reading when facing north: should be 0°
- Use real compass if necessary
- Bring the drone just above the water level and take two picture. This to know the altitude of the water surface in terms of drone GPS.

Reference spectral data

- Put two (or more) spectral reference panels in the flight area (either on shore or on a boat). The albedo of these panels should be around 12%, when obtaining water quality information. When possible, measure the location of these panels with a GPS. This will help in the post-processing steps of the drone data.
- Overfly the panels at least at the beginning and ending of each flight. Although this is sufficient under homogenous sky conditions (clear sky or fully overcast), more overpasses are needed when patchy clouded.

Downwelling Light Sensor calibration

- Downwelling Light Sensor (DLS) magnetometer calibration is required. Ensure that the light sensor has full view of the sun. Do not cover the light sensor while taking a panel capture.

MicaSense calibration

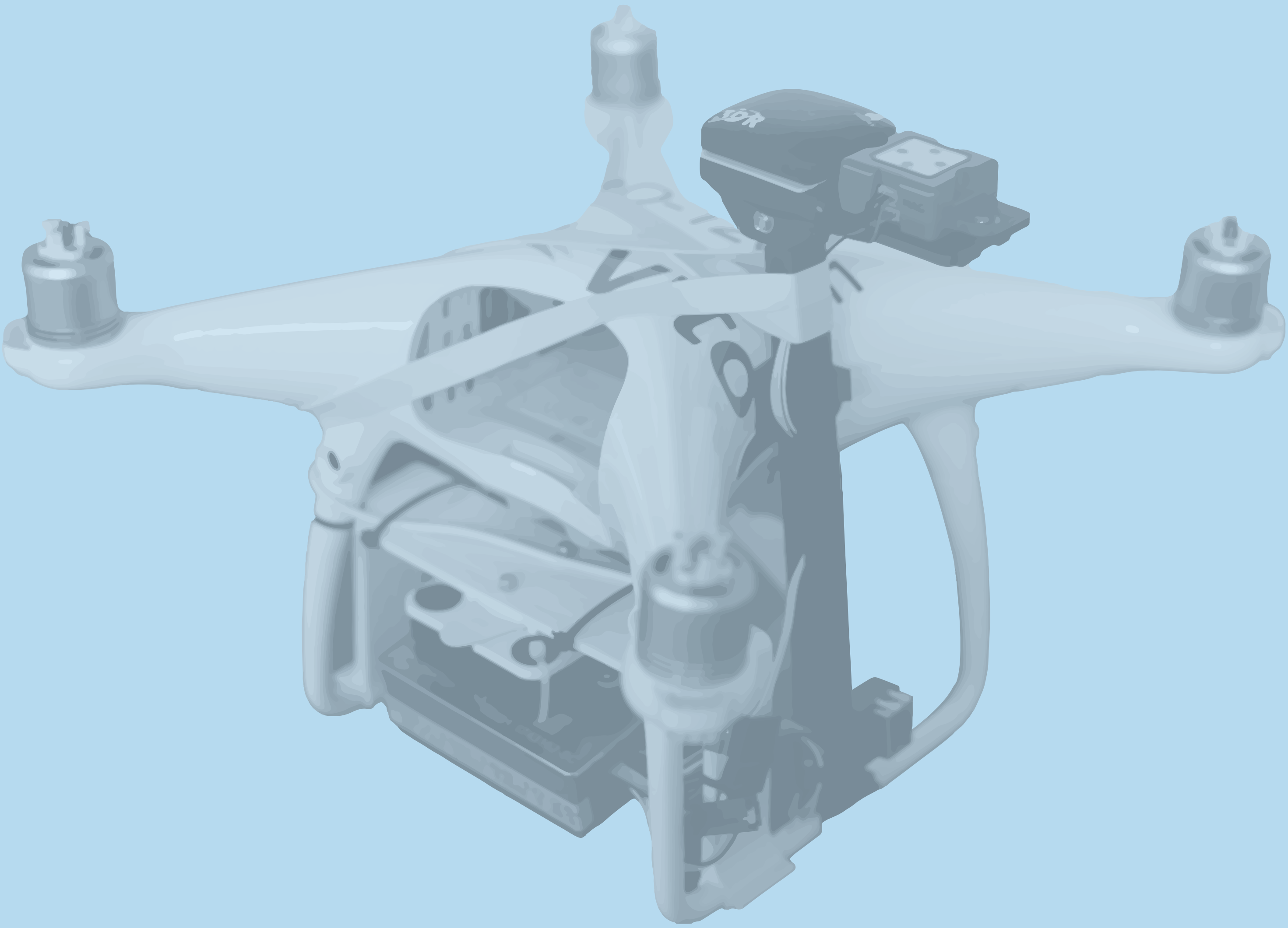
- Take two images of the MicaSense calibration panel before and after each flight! Use the capture button or camera button to take image.
- The MicaSense calibration panel should be placed flat on the ground, away from any objects to avoid contamination from the surroundings and avoid shadow on the panel. Stand in front of the panel with the sun at your back. Then take a large step to the left or to the right.
- Hold the aircraft at chest level and make sure that the camera is looking nadir (perpendicular to the calibration panel). The panel should cover approximately half of the image.
- These calibration guidelines are also included with the MicaSense calibration panel box.

Spectral reference panel placed in the field with known reflectance values: 12% for the dark panels and 36% for the lighter panels.

Data gathering

General considerations for data gathering

- Position the camera under an angles of 15° from nadir (to avoid sun glint)
- Check maximum flying altitude, range, ... allowed by the local drone legislation
- Do not put the camera into wet grass: keep camera lenses clean
- During the flight, the camera should point away from the sun
- Hover at the beginning and end of each flight over the spectral reference targets and take at least 3 pictures.



Introduction

This flight manual explains how to acquire drone data over water surfaces step by step with DJI drones. Deriving quantitative information over water with drones requires careful flight mission planning and a proper camera set-up. This because water bodies are dark objects with low reflectance and can act as a mirror.

The manual list the soft- and hardware requirements, introduces the MONOCLE flight planner and explains the set-up of two different flight scenario's: hovering and mapping. Adequate camera settings are specified.

Requirements

Hardware:

- Drone platform: DJI series
- High Speed SD card min. 64 GB (as raw data are required)

Software:

- iPad running iOS 10 or higher operating system
- Drone pilot app: GS Pro https://www.dji.com/be/ground-station-pro
- DJI GO 4 app
- FTP client (e.g. winscp, https://winscp.net/eng/download.php)

Spectral reference panel with albedo of 12%

The MONOCLE Flight planner[1] is an online tool which supports drone pilots in defining the correct parameters to set-up a flight plan for data acquisition over water. During data acquisition, the drone pilot has to avoid reflection at the water surface as much as possible. This can be done by looking away from the sun with the camera under a slightly tilted pitch angle of about 15°. To avoid any triangulation calculations in the field, depending on the location of the sun, this tool is a useful guide.

The two parameters which are derived with this tool are the heading of the camera and the Lat and Lon location of the drone with respect to a point of interest (POI).

The app consists of two sections:

1. The first section aids in calculating the angle of the sun on a certain location at a certain time.
2. The second section aids in translating the coordinates of buoys to make sure the pilot can capture the buoys in the centre of the image with a tilted camera (15° from nadir).

Sun Angle

The first section aids in calculating the azimuth angle of the sun on a certain location at a certain time. You provide approximate coordinates for the location of the flight and the table will show you the position of the sun throughout the day.

The azimuth angle of the sun is the angle of the sun relative to true north:

0°:	sun is in the north
90°:	sun is in the east
±180°:	sun is in the south
-90°:	sun is in the west

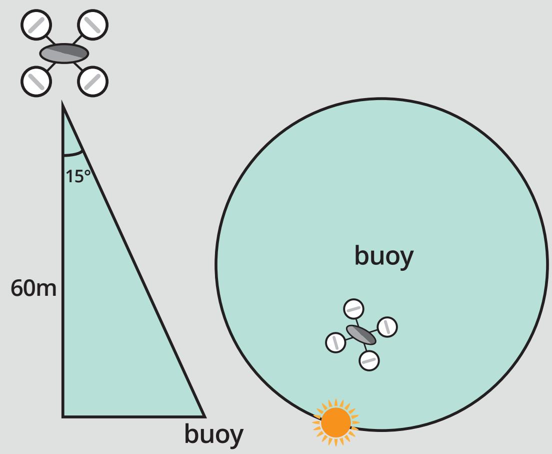
The angle for flight is the angle the drone should use. This is derived from the azimuth angle of the sun, rotated by 180°. This way the drone and camera always face away from the sun. This angle can be transferred directly into GS Pro as the heading of the drone.

Time: the application always refers to the local time zone.

Coordinate Shifter

The second section aids in translating the coordinates of buoys to make sure the pilot can capture the buoys in the centre of the image with a tilted camera (15° from nadir).

The images below explain how it works. With a tilted camera, the coordinates of the drone are slightly shifted compared to the coordinates of the buoy. In which direction depends on the location of the sun.



Schematic view of the coordinate shifter: with a tilted camera, the coordinates of the drone are slightly shifted compared to the coordinates of the buoy (left). The direction depends on the location of the sun (right).

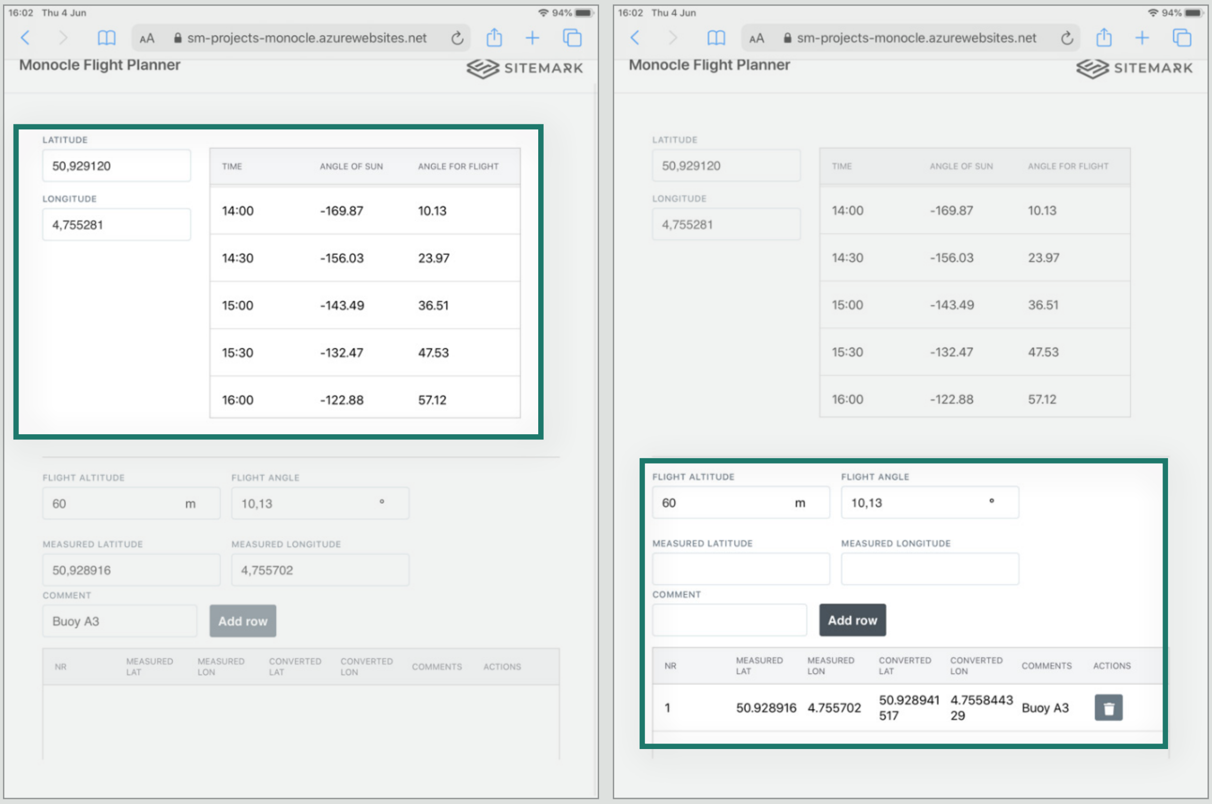
[1]MONOCLE Flight Planner. Online tool. https://sm-projects-monocle.azurewebsites.net/

It is crucial that the drone looks away from the sun, therefore the camera is not automatically aligned with the direction of the flight lines. **Monocle flight planner** allows you to add multiple locations for conversion.

Comment sections: can be used to indicate which buoy the coordinates represent.

The screenshots below demonstrates a simple example:

For a flight at 14:00 local time, we use the 10° flight angle from the table in the first section. We will be flying at an altitude of 60 m above the water level. You then fill in the coordinates of the different buoys and they will appear in the table below. Those coordinates can then be used in GS Pro.



Screenshots taken from the MONOLCE Flight Planner. (Left) By providing latitude and longitude coordinates, you retrieve the angle of the flight throughout the day. (Right) You can fill in the coordinates of the buoys you want to observe and retrieved the drone coordinates, which you can directly insert in the GSpro app.

Flight scenarios

Two flight scenarios for data acquisition over water are foreseen. The first one is a hovering scenario, where data are collected over (a) fixed location(s), e.g. monitoring buoy(s). This hovering can monitor highly dynamic water surface features. Secondly, a mapping scenario is tackled. This is interesting for collecting data over a wider region followed by mosaicking the results.

For both scenarios, the following setting and assumptions are made:

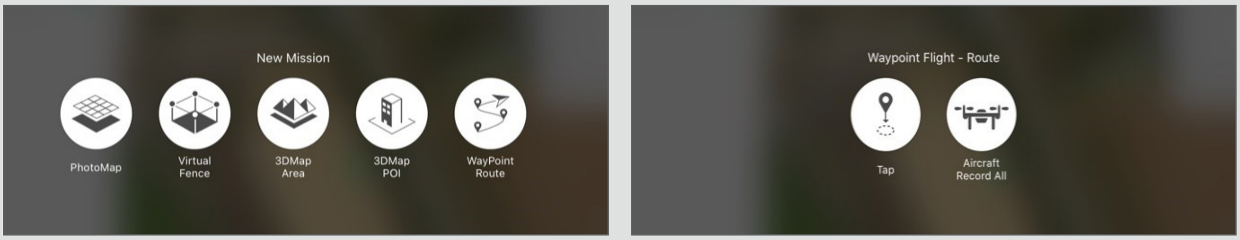
- Flight speed: approx. 4 m/s; return to home speed and towards waypoint_1 up to max 6 m/s
- Height: by default 60 m above the water level (confirm with respect to local drone regulations!)
- The take-off and landing of the drone occur at the same location. The altitude of the takeoff location should be as close to the water level as possible. Otherwise the altitude difference should be given when uploading the data for processing.
- At the beginning and end of each flight, once the drone is at flight height, hover over these panels and take at least 3 pictures.
- A 12% reflectance, spectrally neutral reference panel is located near the take-off and landing site, with known coordinates. Capture one image with the drone, while lifting the drone at chest height. This image will contain the coordinates of the reference panel.
- Always fly with the sun behind the drone. To adequately define the heading, you can make use of the MONOCLE flight planner at https://sm-projects-monocle.azurewebsites.net.

Scenario A: Hover & Capture

Step 1: Prepare the GSpro app

Step 2: Open the Monocle flight app in a different window

Step 3: Select New Mission type – WayPoint Route + Aircraft Record All. To create tackle the Hover & Capture scenario using GS Pro, a waypoint route mission can be used.



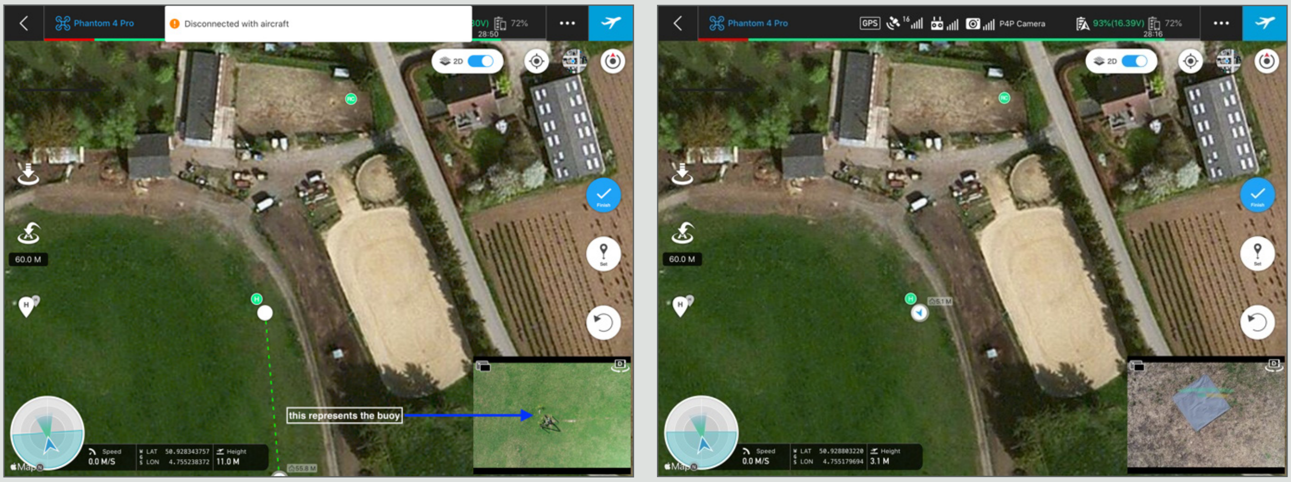
Select New Mission type (left) and choose the Aircraft Record All method (right).

Step 4: Place spectral reflectance panel (12%) nearby take-off location

Spectral reflectance panels placed in the field.

Step 5: Perform the Coordinate Reconnaissance flight

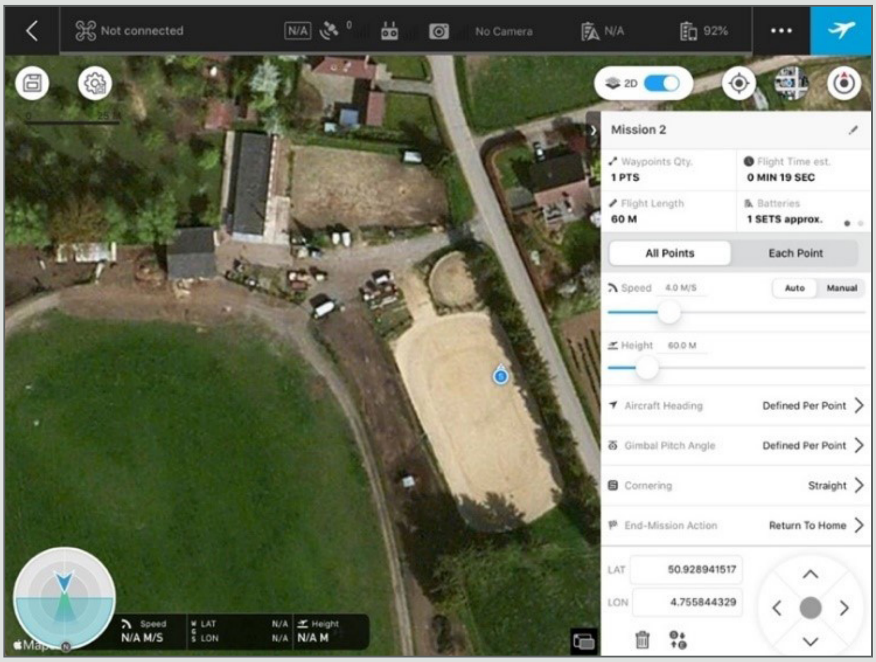
Manually fly over the reflectance panel and over all buoys, centring the points with the camera in nadir to register the coordinates. The drone should hover over each ground control point and take at least 5 pictures. In case you know the coordinates upfront you can skip this and add the coordinates of buoys manually.



Add the points of the buoys.

Once the points are added, the following mission level settings (All Points section in GS Pro) should be used:

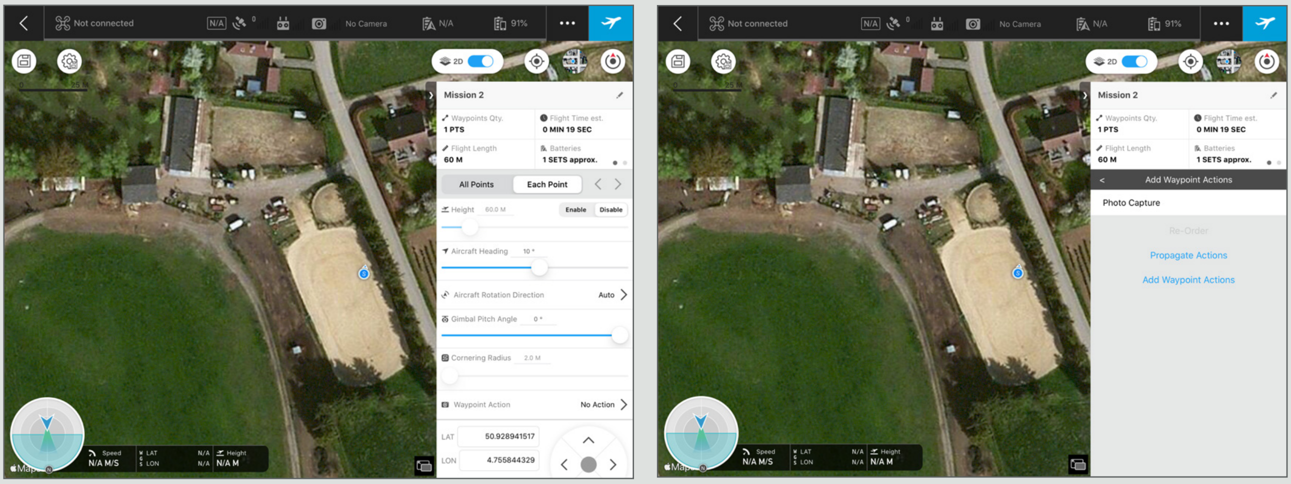
Aircraft Heading: Defined Per Point
Gimbal Pitch Angle: Defined Per Point
Cornering: Straight

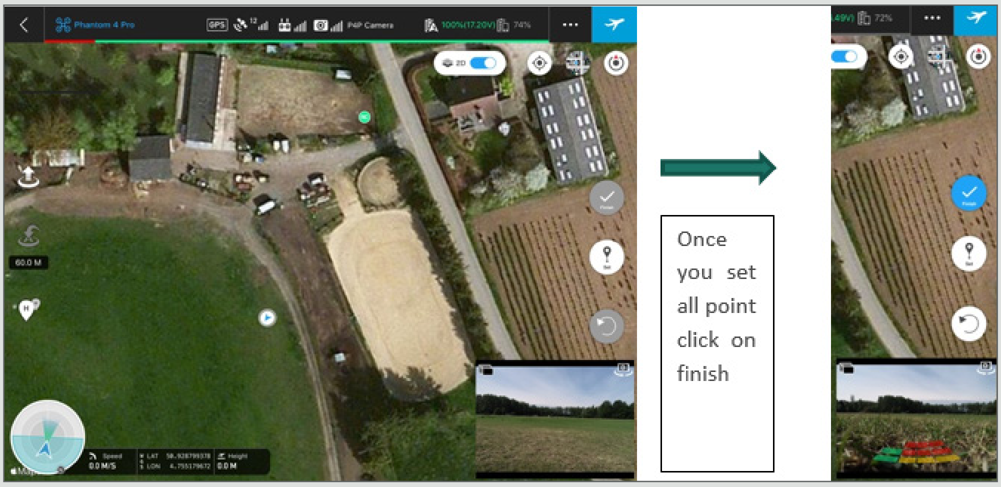


Define mission level settings for all points (All points section in GS Pro)

Then the following mission level settings (**Each Point section in GS Pro**) should be used:

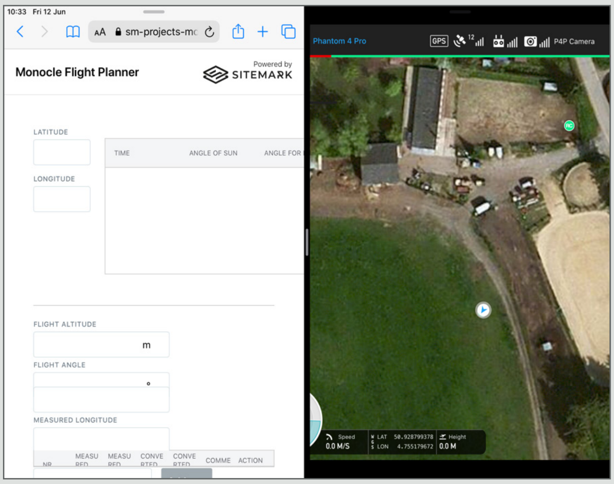
Aircraft Heading: the Angle for Flight as indicated by the Monocle Flight Planner tool
Gimbal Pitch Angle: -75° to make sure it's 15° tilted from nadir
Height: DISABLE





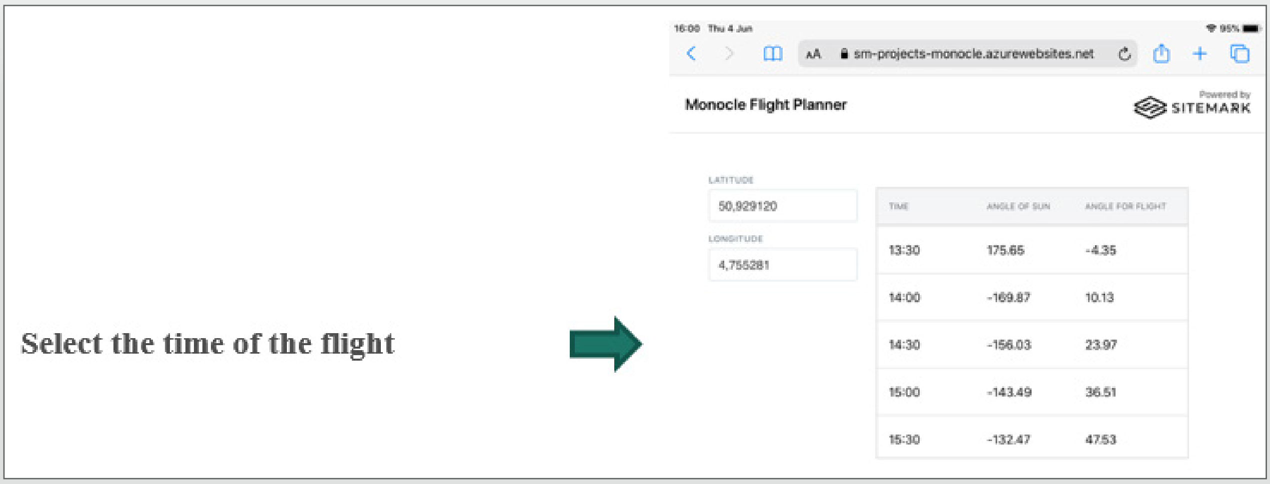
Defining mission level settings for each point and finalize the settings.

Step 6: Copy one of the captured coordinates to the first section of the MONOCLE Flight Planner app to calculate the sun and the flight angle.



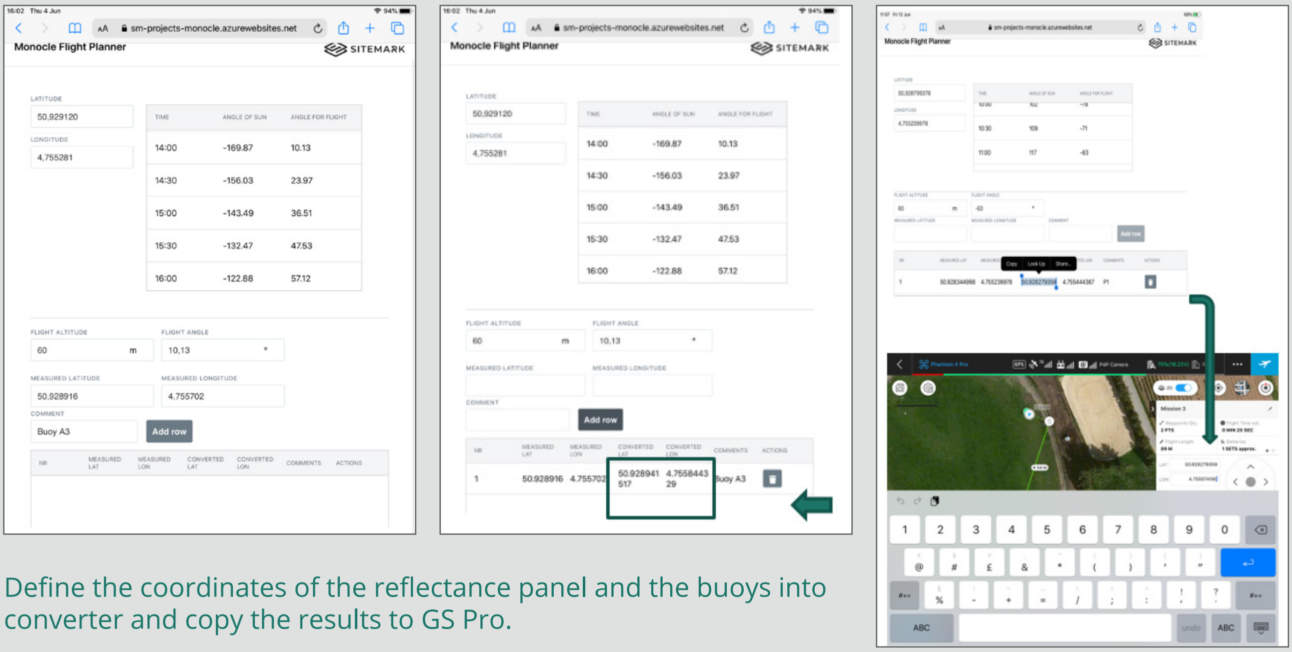
- You don't have to recalculate this angle for every point, just make sure to take the middle time of the flight.
- Place the Monocle Flight Planner tool side by side with the photos app to easily type over the coordinates

Use the MONOCLE flight planner tool to derive the correct drone coordinates if you want to hover over a predefined location (e.g. buoy).

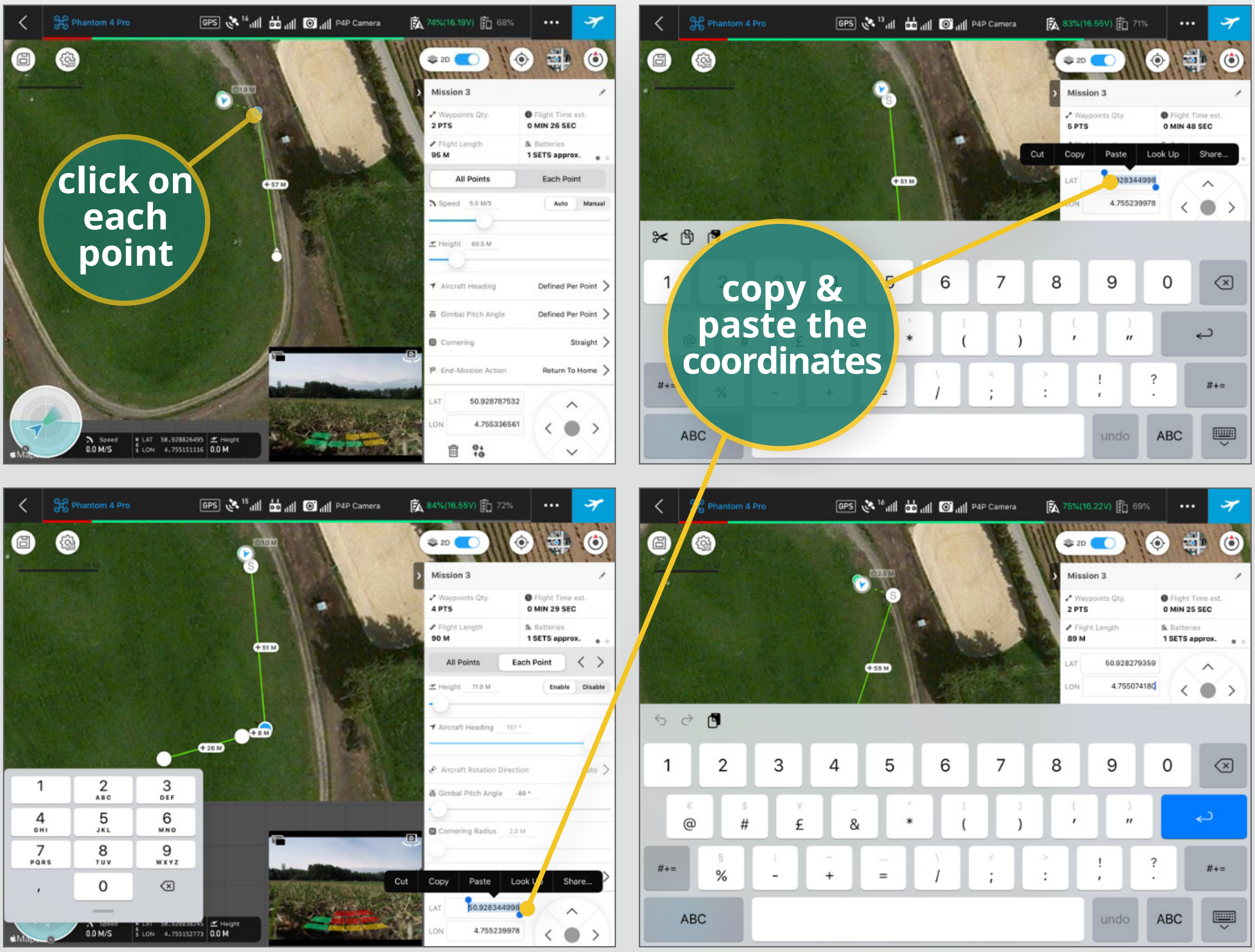


After copying the coordinates, select the time of the flight to retrieve the correct angle towards the sun.

Step 7: Copy one of the captured coordinates to the first section of the MONOCLE Flight Planner app to calculate the sun and the flight angle.



Define the coordinates of the reflectance panel and the buoys into converter and copy the results to GS Pro.

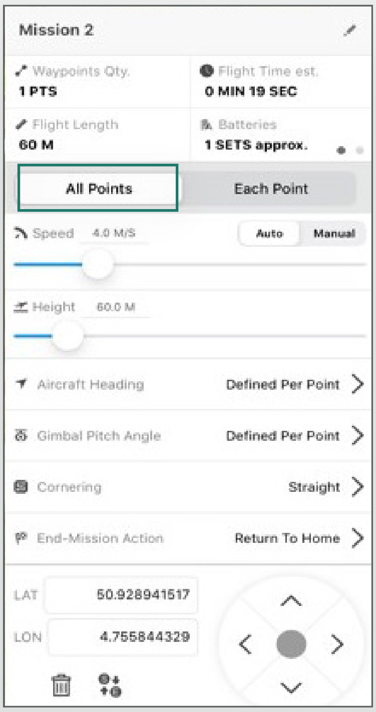


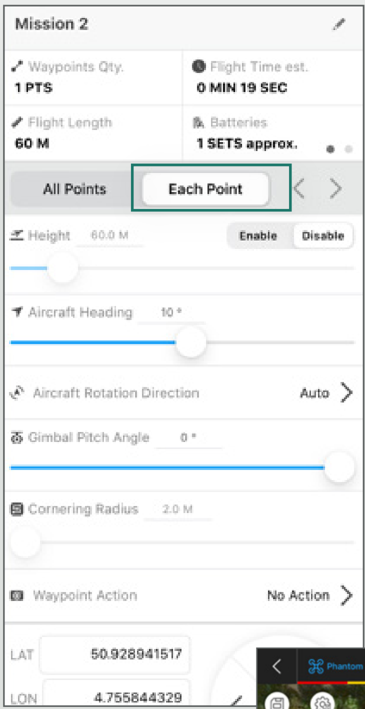
You can copy-paste the retrieved coordinates in the Lat Lon field, selected in the figures above.

Once all the converted coordinates are entered you can start flying. To do so, set up the camera as guided.

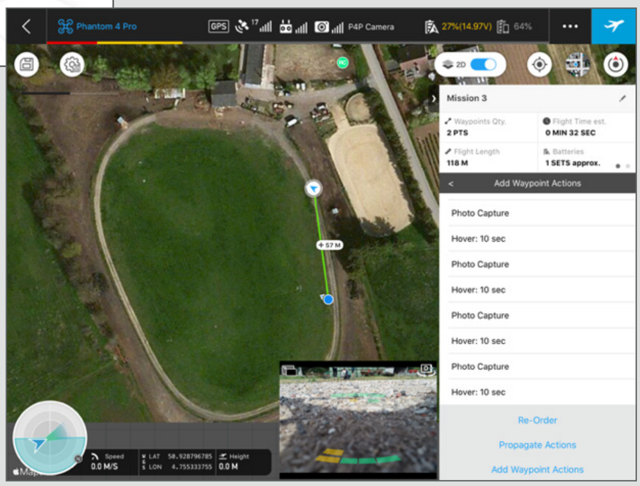
Step 8: Flying parameters in GSPro. Select the parameters as below:

All points	Each point
Speed: 4.0 m/s	Aircraft Heading: 10 degrees
Height: 60.0 m	Gimbal Pitch Angle: -75 degrees
Aircraft Heading: Defined per point	
Gimbal Pitch Angle: Defined per point	
Cornering: Straight	





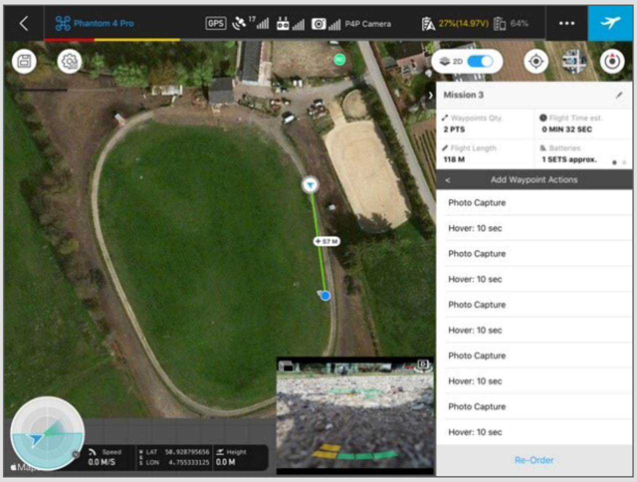
Set the flying parameters for: All Points (left) and Each Point (right) correct.

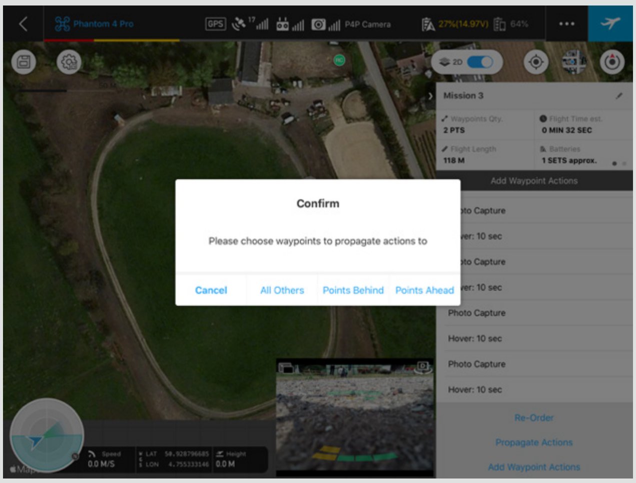


Add waypoint actions: (for 6 photos we need to propagate the action 5 times to ensure the drone will take 5 consecutive photos).

Capture a couple of images when hovering over a buoy.

Add waypoint actions: Create a Photo Capture 5 x times and under always propagate an action: Hover 10sec. Choose to propagate actions to – ALL OTHERS.





Add waypoint actions.

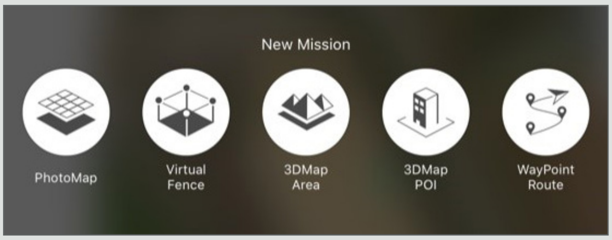
Scenario B: Mapping flight

- Bounding box, with GCP's Included is given → Drone monitors the area
- Overlap requirements: minimum of 80% for RGB camera
- When battery is getting empty → drone lands in time.
- RGB camera at 15° tov nadir, also during flight (in case of only RGB)

Step 1: Prepare the GSpro app

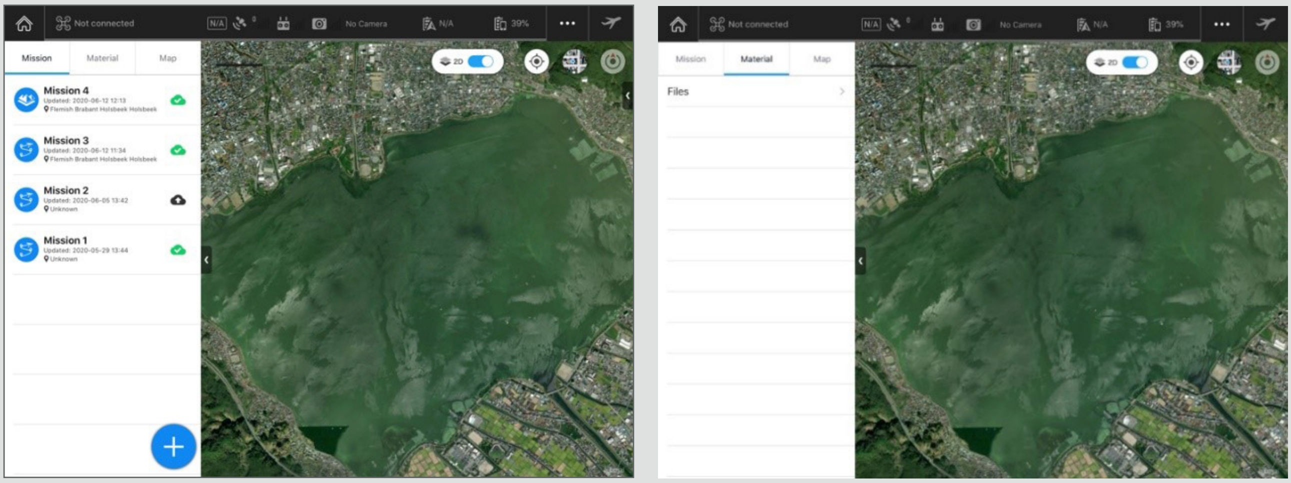
Step 2: Open the Monocle flight app in a different window

Step 3: Select New Mission type – 3DMap Area + Tap or Aircraft



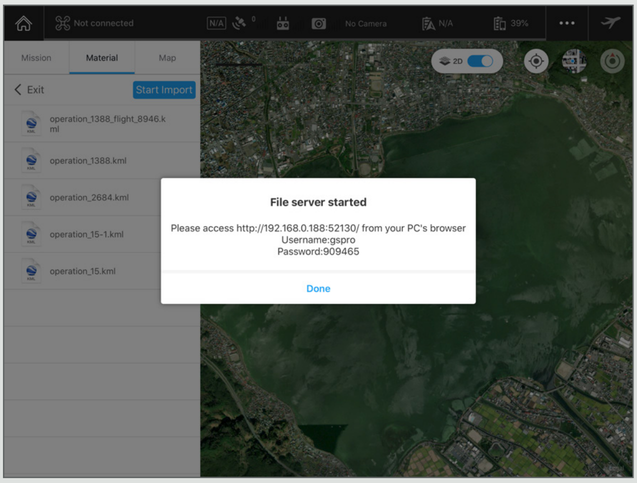
Selection New Mission type

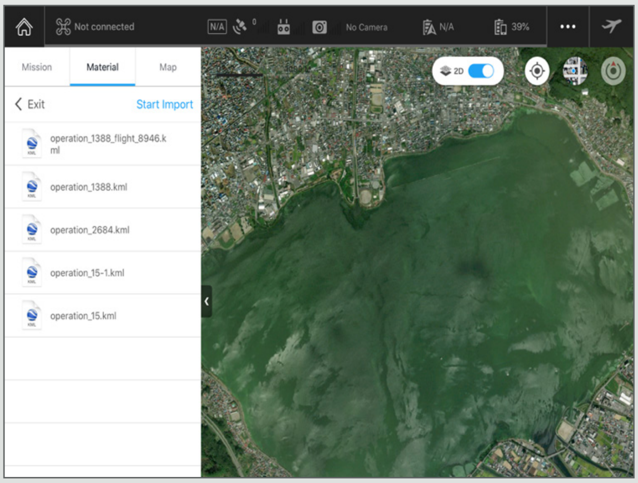
Step 4: Import kml (if no .kml file available please create the mission manually)
Go to the mission section – Material – Start Import – upload the kml via the default link.



Go to mission section (left) and choose the Material tab (right).

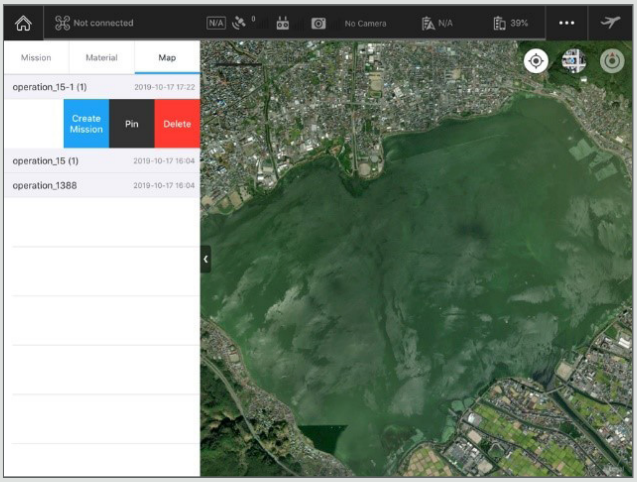
Click on **Start Import.**

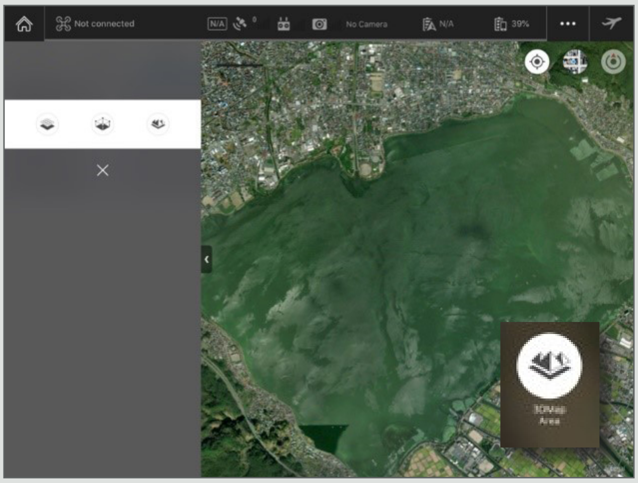




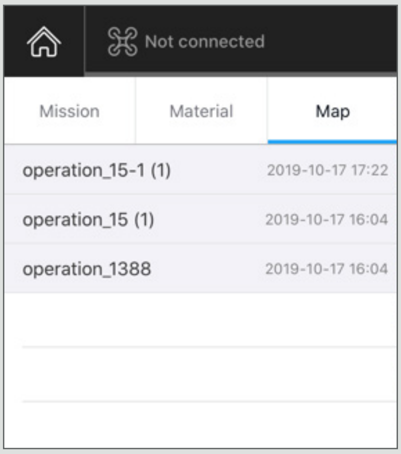
Once you've started to import the files, you will receive a message "File Server started" (left), and upon completion the kml files will be visible in the Material tab (right).

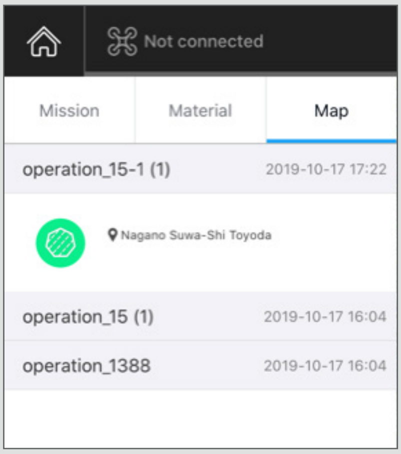
Slide to the left to **Create a mission**. You will receive the three options. Select the 3D map area





By sliding to the left you can create a new mission (left). Select the 3D map area (icon on the right).





Or if you do not have a kml you can select **Map – and choose the place**.

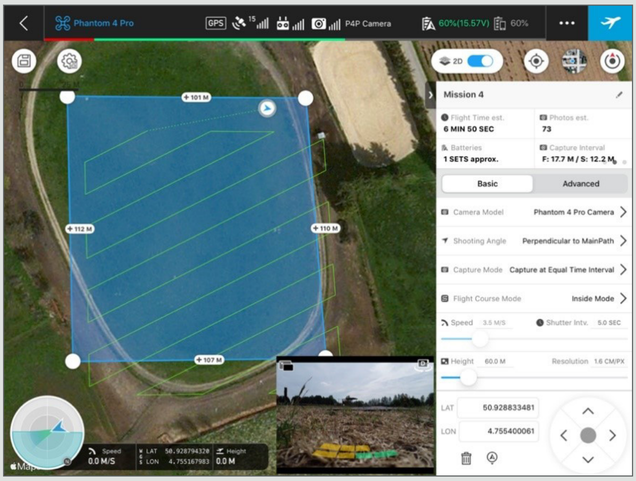
In case no kml is available, go to Map tab and choose the location.

Step 5: Set up the Basic and Advanced

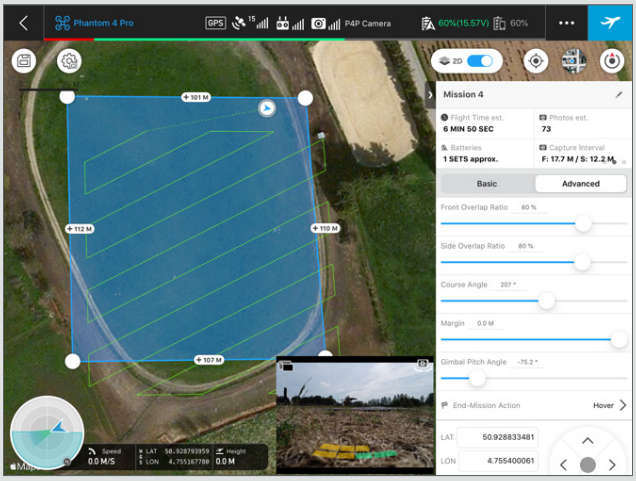
Basic

Camera Model: choose your RGB camera from the list

Shooting Angle: Perpendicular to Course (used to be Perpendicular to MainPath)
Capture Mode: Capture at Equal Time Interval
Flight course Mode: Inside mode
Height: 50.0 M



Overview of basic settings.



Overview of advanced settings (overlap 80% 80%).

Flight Angle

For the calculation of the flight angle in the mapping scenario you should do the following: if the flight angle coming from our tool is between -180 and 90, you should add 270. If it's between 90 and 180, you should subtract 90.

Two examples:

Example A: In our example the flight angle was -63, which is between -180 and 90. Adding 270 gives 207.

Example B: If the angle for example was 104, it's between 90 and 180. Subtracting 90 gives 14.

Camera settings

Flying RGB camera – summary

Camera settings:

- "F-stop fixed" (4.5)
- White balance: fixed: sunny or cloudy
- Focus on infinity
- Light Measuring mode (partial metering or centre-weighted average metering)
- Shutter mode = s (shutter speed priority)
- Shutter iso = auto
- Shutter time = 1/2000 (sun) or 1/1000 (clouded)
- Always zoomed out
- Type of image: RAW*

Drone settings:

- Side overlap: 80%
- Front overlap: 80%

If the weather conditions are stable, it's fine to just capture the reflection panel at the beginning and ending of each flight.

Otherwise, you should capture it between every buoy

GSPro settings (explanation)

Camera settings:

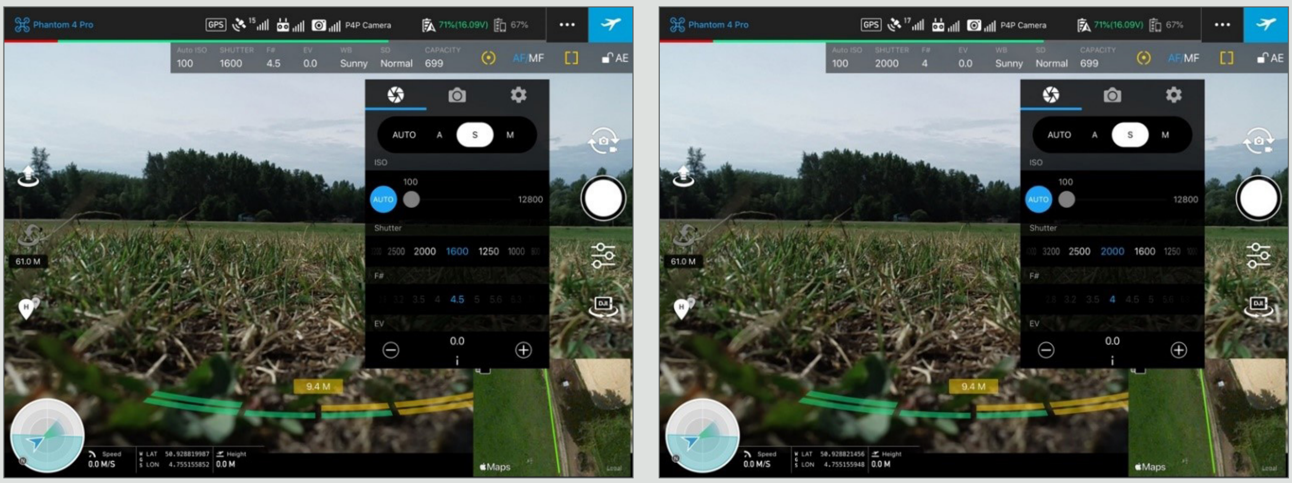
Tap to set the ISO, Shutter Speed, F-number and Exposure Value of the camera, Capture Mode, Image Size, Image Format and White Balance, AF Assistant, MF Assistant and Grid.

Map

Tap the map to return to the Map View. Tap the icon in the left top corner to minimize the map.

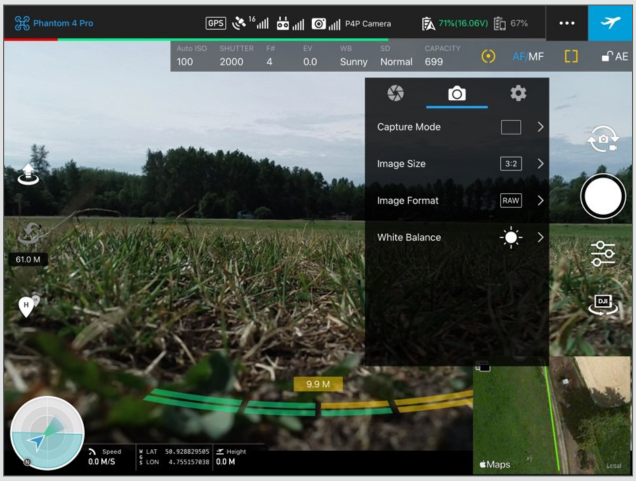
Set up the parameters as below:

Shutter mode = S (shutter speed priority)
F-stop fixed = (4.5)
Shutter time = 1/2000 (sun) or 1/1000 (clouded)



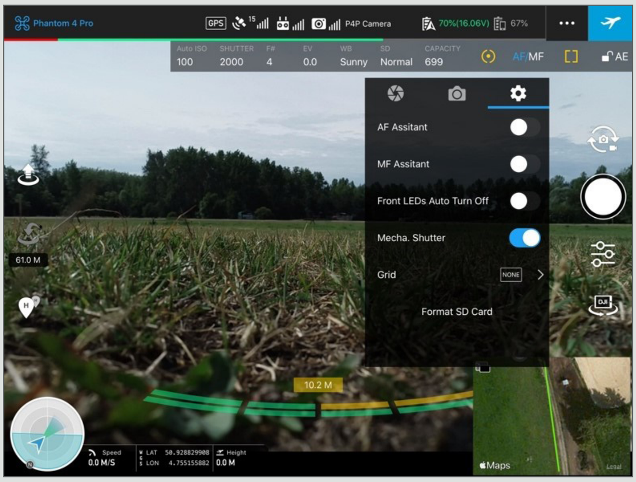
Define camera settings. Shutter time is 1/2000 for sunny conditions (left) and 1/1000 on cloudy sky conditions.

Select Image size: 3:2 / Image Format: RAW



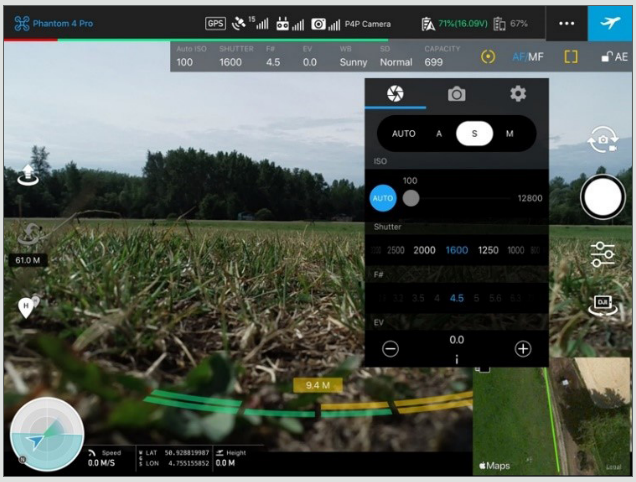
Set the image size and image format correctly. The image format should be RAW.

Mechanical Shutter – ON

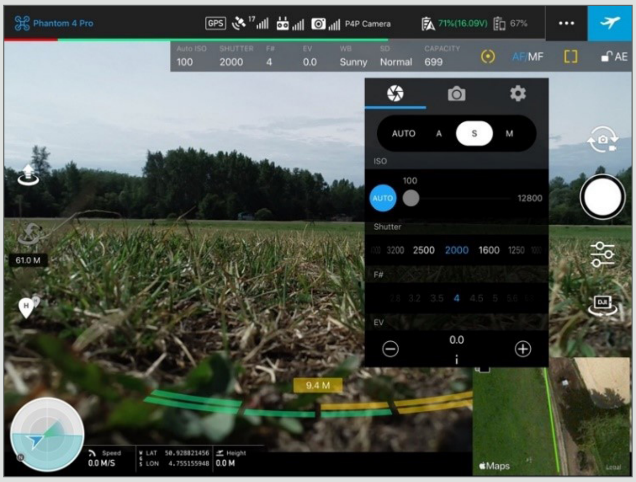


Grid: you can choose a grid in order to centre the buoys for example while looking at the camera - it will give you a squares for better detail.

Grid Diagonal



Grid Line

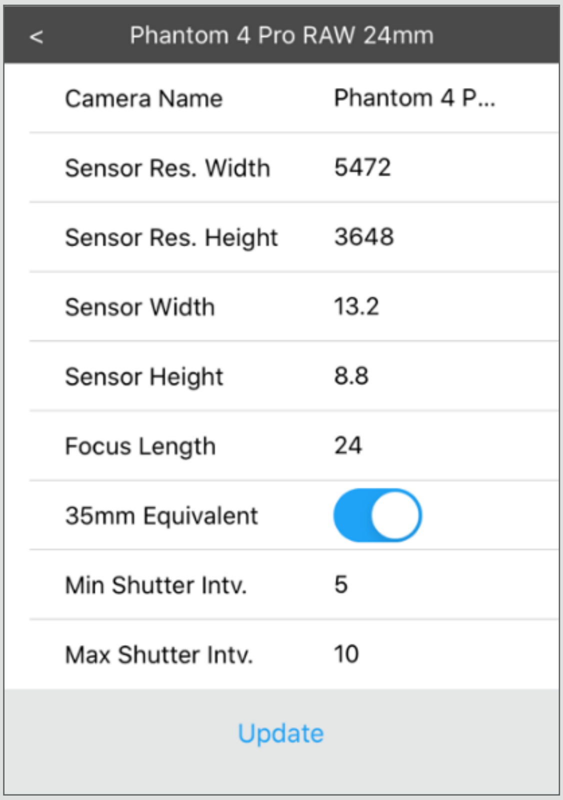


Define the preferred gridding.

Capturing RAW Images

Unfortunately, GS Pro doesn't allow capturing RAW images during a mapping flight by default. In order to correctly take RAW images, you should do the following:

- Optional Step: Add a custom camera to GS Pro that mimics the camera you're trying to use (most likely Phantom 4 Pro), but that has a larger minimum capture interval. Example settings for the Phantom 4 Pro (see image right)
- Set up the flight as usual. You'll notice that the flight speed of the mission is now much lower, because the capture interval is set to 5 seconds automatically.
- Take off manually and fly away from the starting point of the mission. This will give the pilot more time to switch between apps and change settings.
- In the GSPro app start the mission.
- Launch the flight and immediately switch to DJI Go 4 to alter the camera settings.
- Since you're switching apps, you have to disconnect the lightning cable from the iPad and plug it back in. This will now connect DJI Go 4 instead of GS Pro.
- Open the camera settings and change the file format to RAW.
- Confirm that the DJI Go 4 app follows the waypoints defined by GSPro app. Supervise the flight within the DJI Go 4 app till the mission ends and the drone return to home.



Example settings for the Phantom 4 Pro.

Your mission should have been completed capturing RAW photos.

Data check

These data checks need to be made both during and after the flight.

During flight

- Check the camera is oriented away from the sun
- Check the RGB camera keeps pointing 15 degree offset
- Check whether the reference panels are visible in the live stream
- Check the drone battery status. Take into account that the time from ending the flight plan till landing can take several minutes.

After flight

- Check that SD cards are not completely full
- Check if captured data are in RAW format
- Quick check on GPS
- Quick check on camera settings
- Check image saturation
- Look for reference panels in the images

Data upload

MAPEO field software

The MAPEO field software tool has two purposes:

- Check if drone data acquired meets the quality requirement for further uploading and processing in the MAPEO backend.
- Perform the actual upload to the MAPEO backend.

The verification step is conducted in the field, just after the drone mission has been flown, to analyse data quality and coverage. Data upload can be carried out back in the office once a high speed internet connection is available.

System requirements

- Java capable computer with minimally 1 GB – preferably 2GB of RAM
- Java version 8 or higher – Since April 2019, Oracle Java works via a licensing system for commercial use. So, the download at https://www.java.com/nl/download/ is only intended for personal or demonstration use
- Internet access for Java – on first run: Some firewall/internal policies block access or present a pop up when launching Java for the first time, you must allow Internet access.

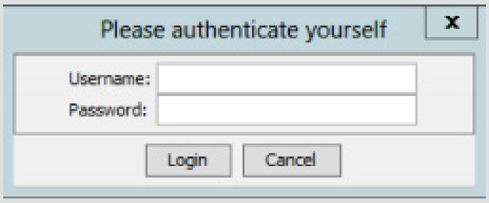
Software installation

You should have received a link to a jar file (uav-pc-fieldsoftware-rgb-0.9.28.jar). Download it somewhere locally on your hard drive, no install is needed. Then double click on it to run the application.

Alternatively, you can open the jar by running it via the "java -jar uav-pc-fieldsoftware-rgb-0.9.28.jar" command.

Authentication – logging in

When you open the Field software for the first time, a log-window will pop-up.

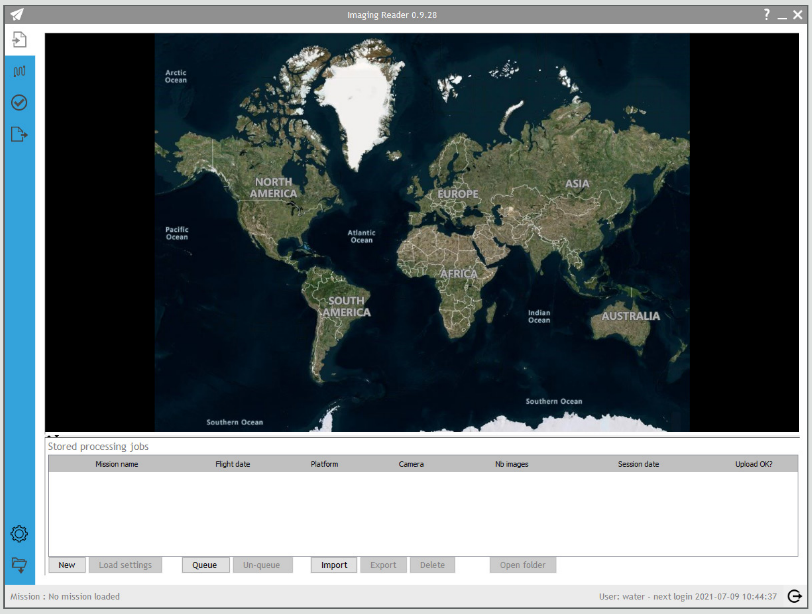


At this point, you need internet access. After successful authentication, you are no longer required to login for a period of 60 days. The username is cached on the Windows user account on the pc.

So, before going in the field without internet access, you should have run the jar at least once and logged in for the active Windows user!

Creating a new mission

On the opening page, you will see a BING map indicating all the locations which have been flown. You can either edit the previous loaded missions or add a new mission by clicking "new" button, which you usually do when you start a new verification procedure or upload.

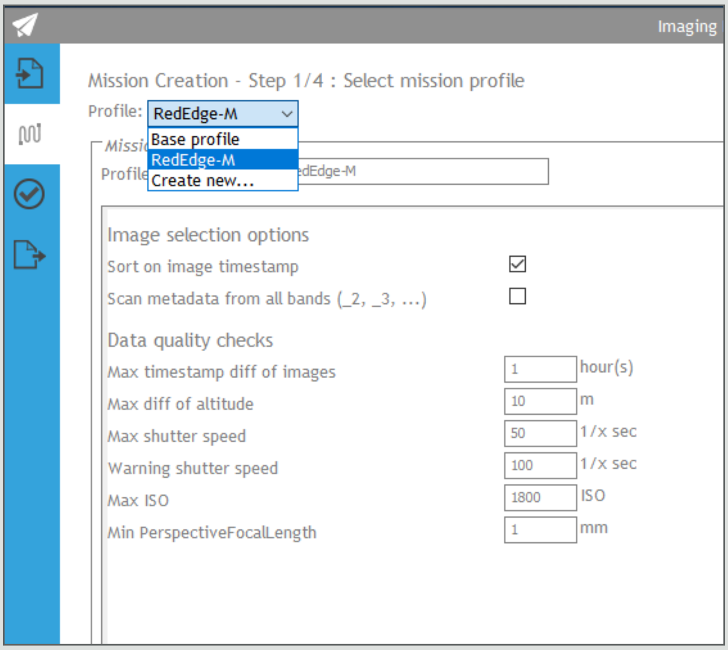


MAPEO field software opening page. To create a new mission, click the "New" button.

Step 1: Select mission profile

In the first step of a mission creation, you select the appropriate mission profile. A mission profile defines the parameters to be used for a specific type of missions, closely linked to the sensor type. You can choose a predefined profile (managed in the cloud by VITO) or one that you created locally.

The selected profile will be used to prepopulate the mission specific profile, which is shown in this screen. So, you can modify the mission specific parameters. Only if you want to reuse the settings later, you need to click on "Store profile".



Create a mission profile.

The following parameters can be set:

Profile name: you only need to change this if you want to store this mission profile to be reused in later mission

Image selection options:

Sort on image timestamp: If you check this box, the flight lines of a mission will be computed and sequenced, based on the image timestamp. If not checked, the flight lines are sequenced based on the alphabetically sorted image names.

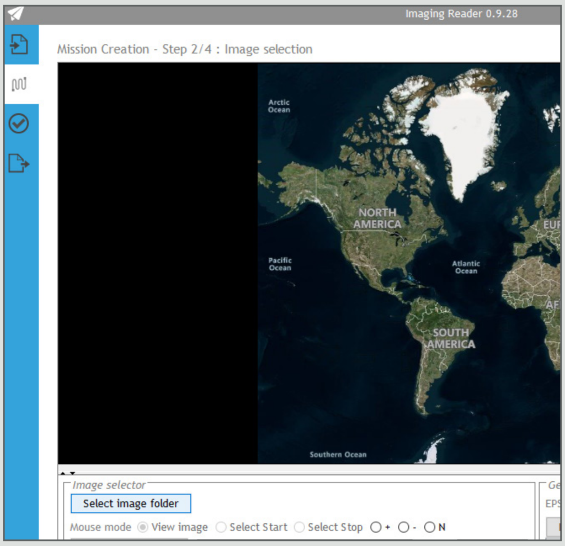
Data quality thresholds:

Max timestamp diff of images: Maximum difference in timestamp of individual images, ensuring no old data ends up in a new mission.
Minimal diff of altitude: Minimal altitude difference in meters for one mission, ensuring stable height of the flight and consistent resolution of the drone based products.
Max. shutter speed: Maximal shutter speed in 1/x seconds
Warning shutter speed: Maximal shutter speed – warning value
Max ISO: Maximal iso value

Step 2: Image selection

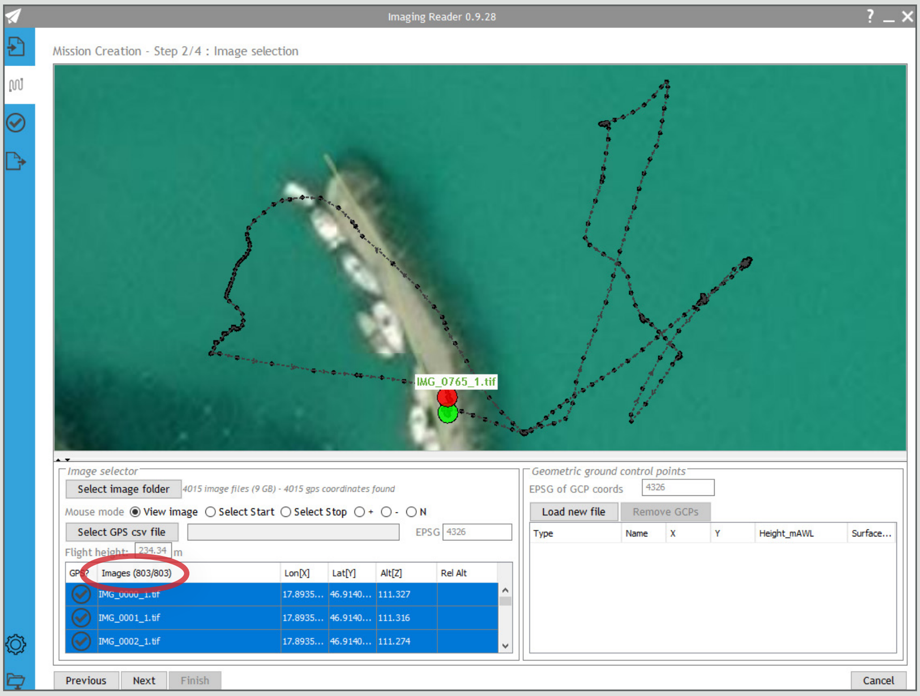
2.1 Loading drone images

To select images for upload, press on the "Select Image folder" and browse to the folder where the drone images are stored. Note that for large missions, the dataset loading may take a few minutes (especially on slow internet connection).



Select image folder to browse to the folder where your images are stored.

When it finishes, the image names will be listed along with their positions. At this point, you get a visualisation of all image locations by dots, and a table list with all images. The header of the table gives you the number of images to be processed. Unselected images are represented by an orange dot, selected images with a black dot.



Once images are loaded, they a shown in the viewer. Orange dots are unselected images, while black dots are selected. You can also see the total number of images selected in the header of the images column (marked with red ellipse).

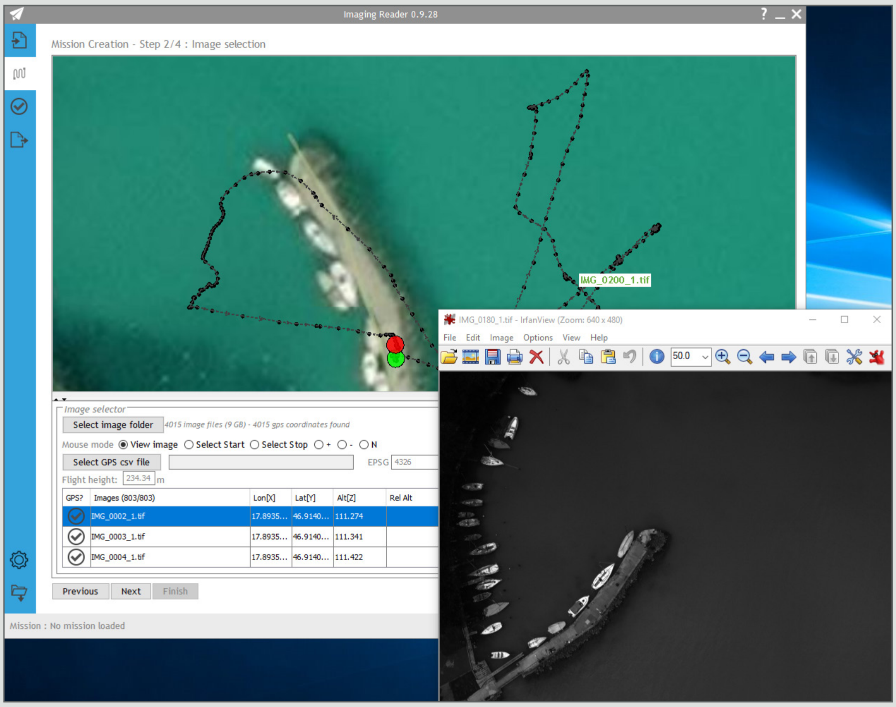
Hint: you can also use the table to export gps data. Click an entry, select "CTRL-A" "CTRL-C" and you can paste the coordinates in for example Excel. Note that this table selection also selects the images for processing so click anywhere to revert that.

2.2 *Visualizing individual drone images*

IMPORTANT - Zooming:

- Use the mouse SCROLL to zoom in/out in steps
- Use SHIFT mouse drag to zoom in to the selected square
- Click anywhere on the screen to return to default zoom level for the mission

Individual images can be visualized in view image mode by clicking the corresponding image position in the main window:



Visualisation of one drone image by clicking on the corresponding dot.

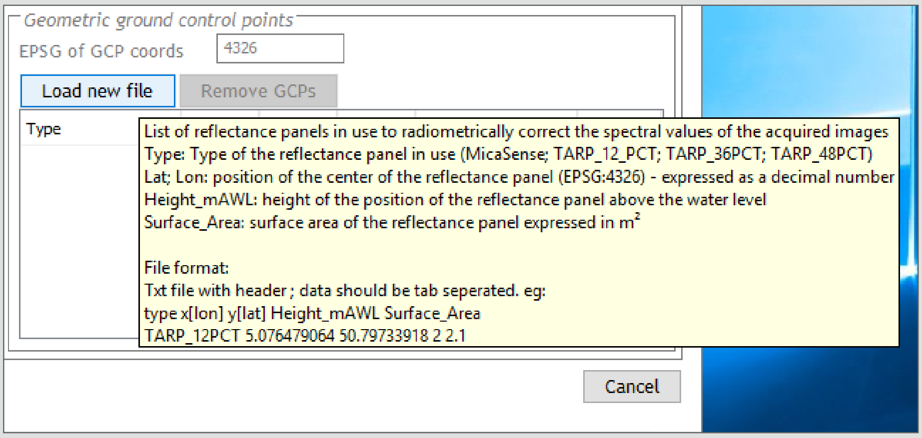
2.3 *Defining start and stop position of the drone flight*

You must specify the **start and end positions** of your mission by selecting “Select start” and “select stop” buttons and clicking on a point representing the camera position. Note that all images before the start position and after the end position will not be considered for image upload nor processing (they will have an orange colour, selected images are coloured in black).

The user can also **select/deselect images manually** using the + and – mouse mode, forcing selection/deselection by dragging a box around the relevant points. The N-button will remove any selection hints by the user.

2.4 Defining geometric ground control points

You can include information on the ground control points, by clicking the ‘Load new file’ in the ‘Geometric ground control points’ box to upload a CSV file (delimiter = TAB) containing information about the reflectance panels.

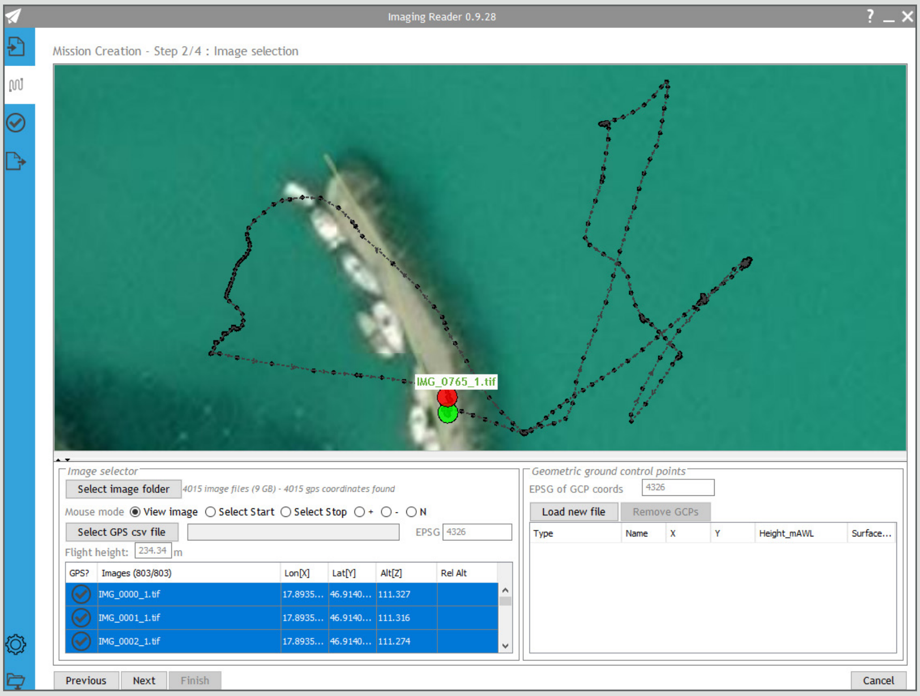


You can load a list a reflectance panels in the mission. The file has to follow a predefined file format structure.

NOTE that the coordinate system used for the GCPs is in EPSG:4326

In the map overview the GCPs are visualized as red dots. The template for the tab separated csv format is given below:

type	x[lon]	y[lat]	Height_mAWL	Surface_Area
TARP_12PCT	17.89348	46.91414	2	2.1
TARP_36PCT	17.89346	46.91416	3	3.1

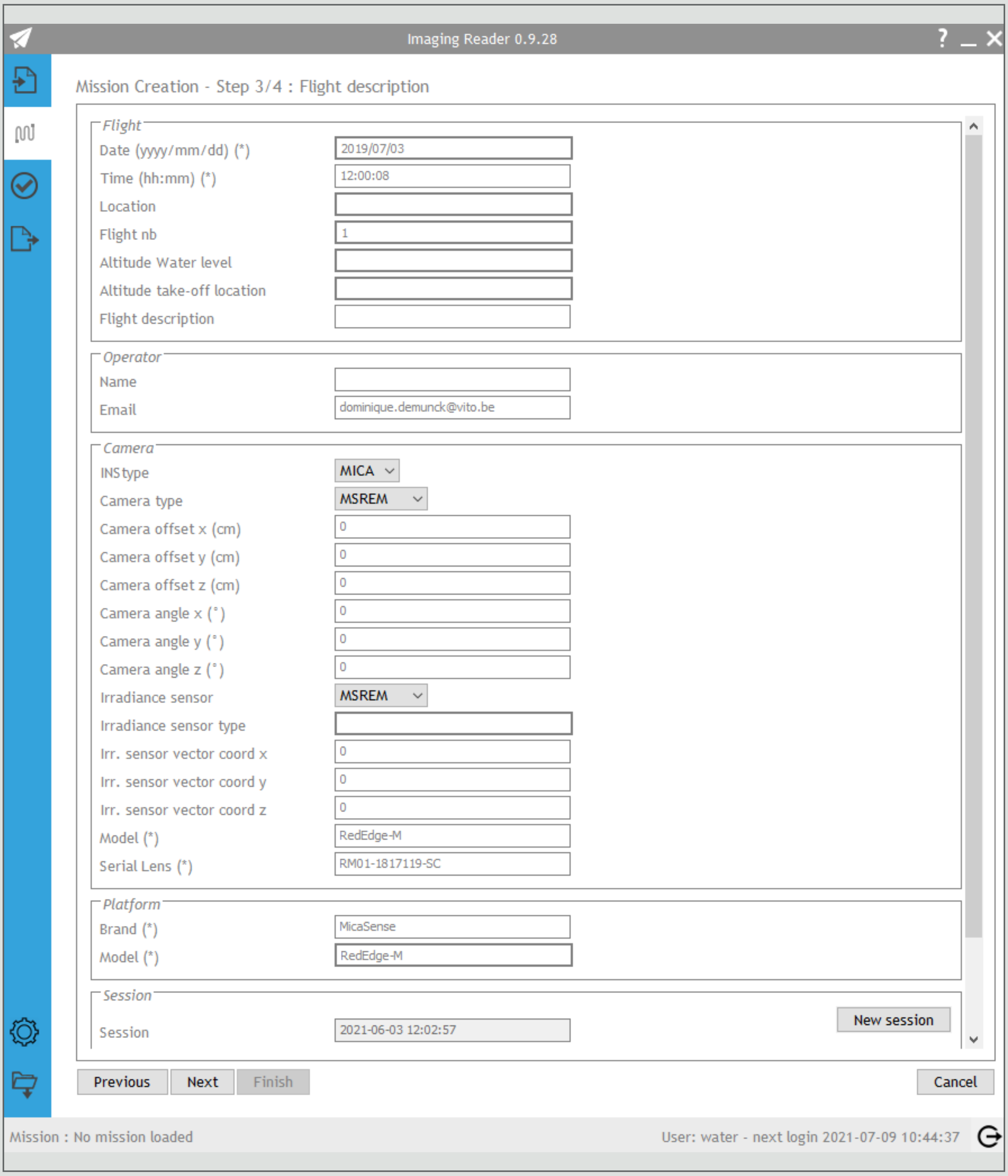


Geometric ground control points are added as red dots to the viewer.

Once all images are loaded, selected and ground control points are added, you can press the “Next button at the bottom of the window to go to the next step.

Step 3: Flight description

After clicking “next”, you go to the flight description page containing some additional mission metadata. Most parameters (indicated with a (*)) are set automatically from the image metadata, but a manual correction or change of these parameters is still possible.



Flight description parameters. The different parameters are described in the following text.

The following parameters can be set:

Flight

Date (yyyy/mm/dd) (*): Date of data acquisition

Time (hh:mm) (*): Time of data acquisition

Location: You can give a name to the location where you've collected your images.

Flight nb: Flight number

Altitude water level: Altitude of the water level with reference to GPS altitude reference

Altitude take-off location: Altitude of the take-off location with reference to the GPS altitude reference

Flight description: You can include a description of the flight

Operator

Name: Name of the operator

Email: Email address of the operator

Camera

INS type: Choose between the different INS (Inertial Navigation System) options. Currently two options are supported:

PH4P: Phantom 4 pro INS system

MICA: Micasense INS system.

Camera type: Choose between the different camera options. Currently two camera sensors are supported:

PH4RGB: Phantom 4 RGB camera

MSREM: Micasense RedEdg-M camera

Camera offset x (cm): Offset of the camera towards the front

Camera offset y (cm): Offset of the camera to the right, view from the top.

Camera offset z (cm): Offset of the camera down (positive sign= camera shifted downwards).

Camera angle x (°): Roll angle of the camera, defined counter-clockwise (+) as seen from the front of the drone.

Camera angle y (°): Pitch angle of the camera, a positive angle (+) means that the camera is tilted forwards and looks in front of the drone position.

Camera angle z (°): Yaw angle of the camera, a positive angle (+) means a clockwise rotation of the camera with regard to the orientation of the drone as seen from the top.

Irradiance sensor: You can choose in the drop-down menu between:

PH4RGB: Phantom 4 RGB camera

MSREM: Micasense RedEdg-M irradiance set-up

Irradiance type: There are two irradiance types supported: Micasense DLS-1 and DLS-2 (Downwelling Light Sensor)

Irr. sensor vector coord x: Offset of the irradiance towards the front

Irr. sensor vector coord y: Offset of the camera to the right, view from the top

Irr. sensor vector coord z: If the irradiance sensor is installed vertically upwards on the drone platform, this z-value should have a value of -1.

Model (*): The model of the camera. This information will be automatically updated when an image folder has been selected.

Serial Lens (*): The serial number of the camera. This information will be automatically updated when an image folder has been selected.

Platform

Brand (*): This information will be automatically updated when an image folder has been selected.

Model (*): This information will be automatically updated when an image folder has been selected.

Session

Session: If a new session is created, the date and time at that moment are given defined for that session.

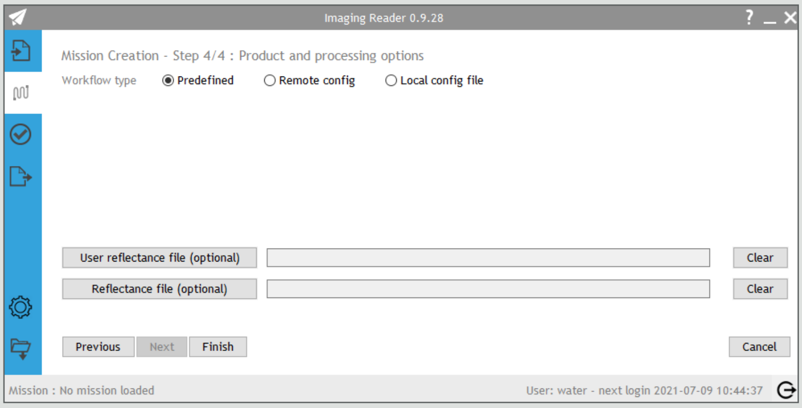
Step 4: Product and processing options

This step let the user set up and select what will be executed from the processing workflow. There are three options foreseen:

Predefined (default option): this option runs through the full data processing workflow.

Remote config file: There is an option to work with remotely defined configuration files. configBase.py and configNoEndProduct.py.

Local config file: the user can upload a local config file which is stored on the local computer.



Product and processing options

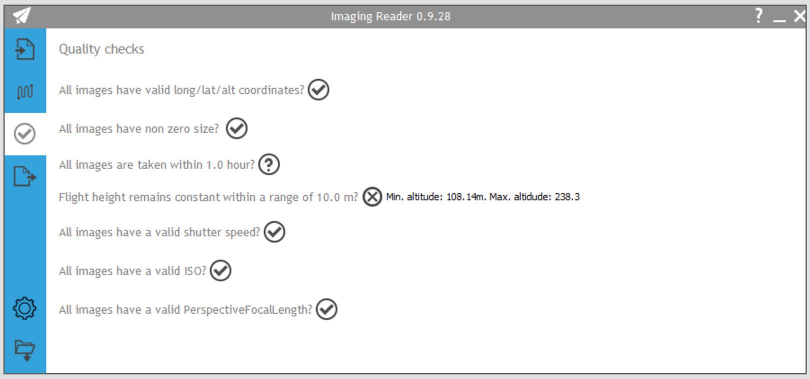
Optionally two files can be uploaded:

User reflectance file: a list of image names or image numbers which are suitable for the picking of spectral reference panels. File format: no header text file, only one column with the image number or image name (excl. file extension).

Reflectance file: Picking reflectance panels on images can be very time consuming. In case a previous run with the same mission data was already performed, the resulting picking file can be uploaded to avoid repicking of the same images.

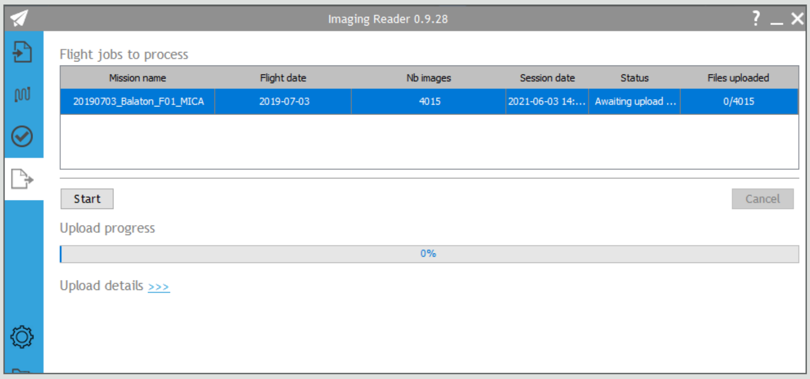
Creating a new mission

By clicking on Finish, all mission data is stored and the quality check will be performed before uploading the data to the cloud. If you don't see any problems with the quality checks you can go to the processing tab to continue.



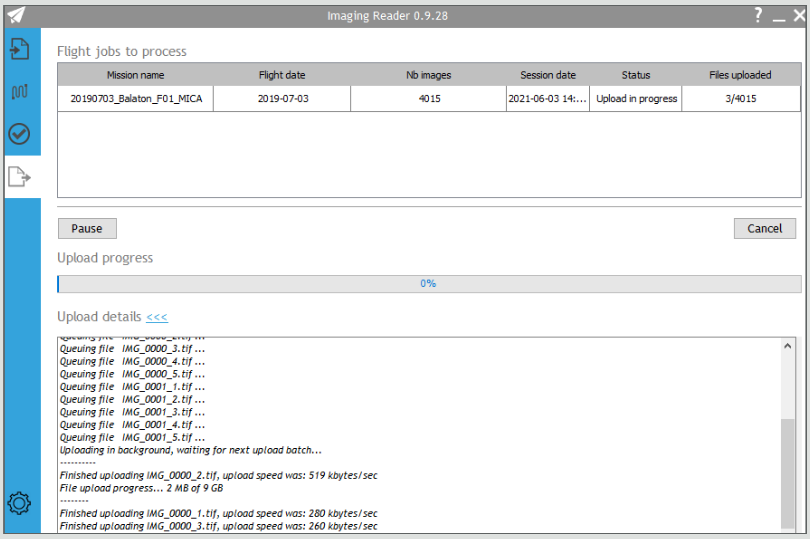
A list of quality checks. Positive and negative results are immediately visible.

Either press on Start to start uploading, or return and press Finish again to store any change. Note: in case you want to remove a queued mission, you can by using the right mouse button.



Starting the upload of the mission and drone data for data processing

Progress can be followed via the Upload details screen:



Progress follow-up.

System maintenance

The **DJI Phantom4 Pro** maintenance guidelines are applicable.

The **Micasense camera** maintenance guidelines are applicable.

MONOCLE

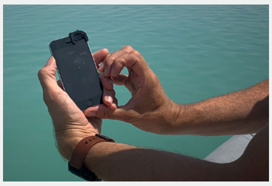
MONOCLE creates sustainable in situ observation solutions for Earth Observation (EO) of optical water quality in inland and transitional waters.

MONOCLE develops essential research and technology to lower the cost of acquisition, maintenance, and regular deployment of in situ sensors related to optical water quality. The MONOCLE sensor system includes handheld devices, smartphone applications, and piloted and autonomous drones, as well as automated observation systems for e.g. buoys and shipborne operation. The sensors are networked to establish interactive links between operational Earth Observation (EO) and essential environmental monitoring in inland and transitional water bodies, which are particularly vulnerable to environmental change.

Other MONOCLE observation solutions include:

FreshWater Watch

Hypersectral Radiometer (HSP1)



iSPEX2

KdUNIO

MapEO Water

Mini-secchi disk

So-Rad

WISPstation

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DDQ innovative mobile projects
earthwatch EUROPE
SITEMARK
vito
UNIVERSITY of STIRLING
Water Insight
Peak Design
GeoEcoMar
Universiteit Leiden