

# Buy and Fly

## A Primer to Use Unmanned Aircraft (UA) for Agricultural Mapping

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### 1.0 Introduction

The purpose of this document is to help growers make **actionable decisions** about their crops based on aerial maps created using UA. If a grower cannot look at an aerial image, make a **decision** about the crop and take some appropriate **action** (irrigate, spray, harvest, etc.) then the aerial image is simply artwork.

UA operations use many acronyms and unique words. A glossary of terminology is provided in Section 3.0 below to help you understand this new jargon.

While single images and/or videos captured during manual flight can be useful, this document will focus on flying autonomous missions to capture hundreds of images that can be stitched together into a much larger orthomosaic map.

This primer will discuss DJI aircraft because they are the only UA compatible with almost all software for mission planning. The primer assumes that you are familiar with basic manual operation of your DJI aircraft using the DJI GO mobile app.

This primer is part of ongoing efforts at Penn State through Unmanned Aircraft for Agricultural Applications <http://sites.psu.edu/uaaa/> .

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### 3.0 Glossary

AGL	above ground level
ATC	air traffic control
AWB	auto white balance
B4UFly	before you fly mobile app from FAA
DEM	digital elevation model
FAA	Federal Aviation Administration
FPV	first person view
frontlap	front overlap of photos
GPS	global position system
home point	location for mission launch/landing
MSL	mean sea level
orthomosaic	large image stitched together from multiple images looking straight down
OSD	on screen display
photogrammetry	measuring objects with images
PIC	pilot in command
PIP	picture-in-picture
P3	DJI Phantom 3
P4	DJI Phantom 4
RPC	Remote Pilot Certificate
RTH	return to home
sidelap	side overlap of photos
terrain aware	follow terrain at a fixed height (not currently available)
TSA	Transportation Security Administration
UA	unmanned aircraft
VLOS	visual line of sight
VO	visual observer
waypoint	location in a flight plan to start, turn or end

### 4.0 Federal Aviation Administration

If you are flying for commercial purposes, you must conform with FAA Part 107 summarized in Section 13.0 below. The B4UFly mobile app will provide warnings if you are within five nautical miles of an airport.

## 5.0 Software and Apps

Please download and install the recommended software on your computer (PC or Mac) and install the recommended apps on your mobile device (iPhone, iPad, Android phone, Android tablet). Additionally register for accounts with the recommended software vendors.

All recommended software, mobile apps and vendor accounts are free. You will need to pay vendors for orthomosaic reconstruction.

This document will focus on recommended software and apps. Other packages that were tested are listed in Section 10.0 below.

### 5.1 Register with vendors

- 1) DJI (free) <http://www.dji.com/> (icon of person in upper right corner)
- 2) DroneDeploy (free) <https://www.dronedeploy.com/> (icon in upper right corner)
- 3) Maps Made Easy (free) <https://www.mapsmadeeasy.com/> (icon in upper right corner)

### 5.2 Install Software on Computer

- 1) Google Earth Pro (free) <https://www.google.com/earth/download/ge/> (icon in upper right corner)

### 5.3 Install Apps on Mobile Device

- 1) B4UFly (free) iOS and Android, from FAA
- 2) DJI GO 4 (free) iOS and Android, from DJI - for P4, Mavic, Matrice  
or
- 2) DJI GO (free) iOS and Android, from DJI - for P3, Inspire
- 3) DroneDeploy (free) iOS and Android, from DroneDeploy

## 6.0 Scouting

It is extremely important to scout your proposed mission site **on-line** and **on-site** prior to the actual flight.

### 6.1 Scout with Google Earth Pro

Use Google Earth Pro to inspect your proposed mission site. Check for power lines, tall trees and structures that may cause collisions. Look for potential landing hazards (bodies of water, forest, tall crops) if your aircraft must abort and RTH. Remember that satellite images may be two to three years old and may not show details that are present today.

Most importantly, check for airports and restricted air space. The DJI GEO System <http://www.dji.com/flysafe/geo-system> may prevent you from flying older aircraft in some areas. You can see these areas on a map at <http://www.dji.com/flysafe/geo-system/unlock> and unlock Warning Zones (green) and Authorization Zones (yellow) at the bottom of that web page using your DJI login.

Lastly, check for large changes in elevation over your proposed mission site. Currently mission planning software will fly your aircraft at a fixed altitude above the home (launch/landing) point rather than follow the terrain at a fixed height (not terrain aware). Consequently, select your home point near the highest elevation.

### 6.2 Personally Scout Mission Site

You must assess four very important issues by visiting the mission site **prior to flying** the mission.

- 1) Open the B4UFly mobile app at the mission site to check for unexpected flight restrictions.
- 2) Check for hazards that may not appear in Google Earth Pro. Look for power lines that may run along the edges or diagonally across corners of the proposed mission site. Additionally look for new structures that may have been erected since the Google Earth Pro image was taken.
- 3) Check if your PIC can maintain VLOS over the entire mission area.
- 4) Lastly, check for **cell phone reception** at the proposed mission site. You may need to save your mission plan to your mobile device to cache it for off-line use.

## 7.0 Mission Planning

Use the DroneDeploy web site on your office computer to plan and save your mission on-line. Then use the DroneDeploy mobile app to make it available off-line before you leave your office.

Alternately, you can plan and save your mission directly on the DroneDeploy mobile app. However you still must make it available off-line if there will be no cell phone service at the mission site.

### 7.1 DroneDeploy Web Site

Login at DroneDeploy <https://www.dronedeploy.com/>. You will need your email and password created in Section 5.1 above. Firefox, Google Chrome and Microsoft Edge all work well. The Dashboard should open automatically as shown to the right.

All of the following instructions are the same for the DroneDeploy web site and the DroneDeploy mobile app. All windows and icons look the same between web and mobile interfaces.

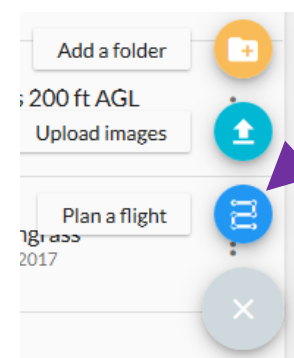
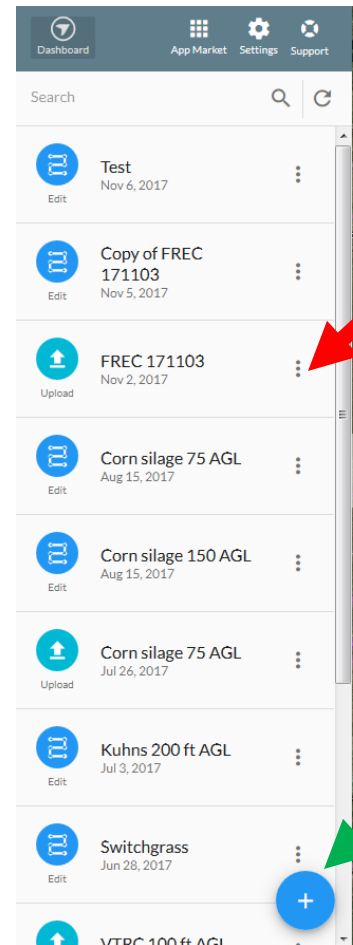
At the top of the Dashboard, click on the "Settings" gear icon. Then set "Units" = Imperial, "Max Altitude" = 500 feet, "Audio Alerts" = ON and "Use 3rd Party Camera" = OFF. Use the "Dashboard" arrow icon at upper left to return to the Dashboard.

Click on the name of an existing plan to open and edit. Click on the three dots to the right of an existing plan to "Make a copy", "Move to folder", "Share" or "Delete" (red arrow pointer).

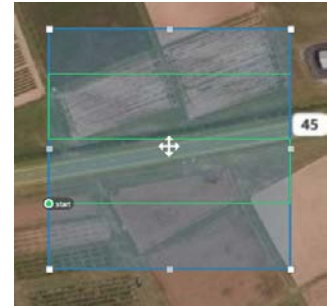
To plan a new mission, click on the blue circle plus mark icon near the bottom of the Dashboard (green arrow pointer). Then click the pop-up blue circle serpentine icon to "Plan a flight" (purple arrow pointer).

At the top of the "Planning" window, replace "Untitled Plan" with a name that includes location and date for flight.

The satellite map will default to the current location of your computer or mobile device whichever is being used for planning. You may select a new location by dragging the mission outline in the satellite map or search using the magnifying glass "Search" icon at the top of the "Planning" window. You may search by entering an address, a general location name or longitude,latitude (not latitude,longitude).



The mission outline has a four-way arrow icon for dragging, bright white dots for primary vertices around the edge, gray dots for new vertices, green lines to show the flight plan and a small green dot to show the first waypoint. Click and drag any vertex to change the shape of the outline. Single click on a vertex to delete. The size of the mission outline “Acres” will be shown near the top of the “Planning” window.



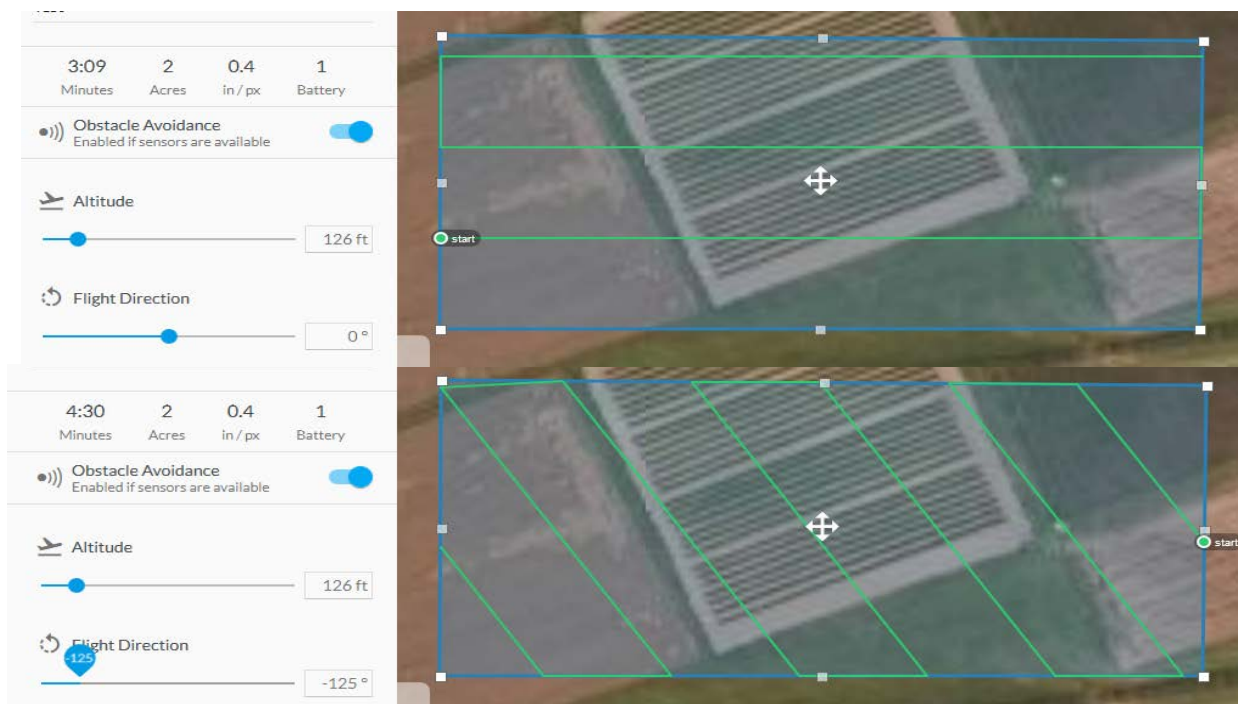
Use the white square plus/minus buttons at the lower right of the satellite map (red arrow pointer) to change map scale. Use the white circle undo icon at lower right to undo any unwanted actions (green arrow pointer). Use the blue circle diskette icon at lower right to save the mission (purple arrow pointer).



In the “Planning” window, you should ENABLE "Obstacle Avoidance" hardware.

You can set "Altitude" using the slider bar or manually enter a number in the box to the right of the slider. Note that changing altitude will change the spacing between legs of the flight as well as flight time “Minutes” and resolution “in/pix”. It may require more than one “Battery”. More discussion on “Altitude” is provided in Section 7.3 below.

You can also control "Flight Direction" with the slider or numerical box. Note that changing “Flight Direction” can dramatically affect flight time and “Battery” as shown below.



Click on the "Advanced" tab in the "Planning" window. Use sliders or numerical boxes to set "Sidelap" = 75% and "Frontlap" = 75%. Use the default setting for "Max Flight Speed" and the default "Starting Waypoint" = 1. The aircraft will skip all waypoints before "Starting Waypoint".

You should DISABLE all three settings for "Exposure Set by DroneDeploy", "Focus Set by DroneDeploy" and "Orbit at End of Mission". Disabling "Orbit at End of Mission" will cause the aircraft to auto-land. Use the "Planning" arrow icon in the upper left to return to the "Planning" window.

When you return to the Dashboard, your new mission should have a blue circle serpentine icon to left of it.

**Optional** - Open the DroneDeploy Dashboard and select the "App Market" 3x3 grid icon in the upper left. The "KML and SHP Import" module will allow experienced users to import mission polygons from KML files created by Google Earth Pro.

Documentation on mission planning is available from DroneDeploy at <https://support.dronedeploy.com/docs> .  
<https://support.dronedeploy.com/docs/desktopplanning>  
<https://support.dronedeploy.com/docs/planning-flights-with-shapefiles>

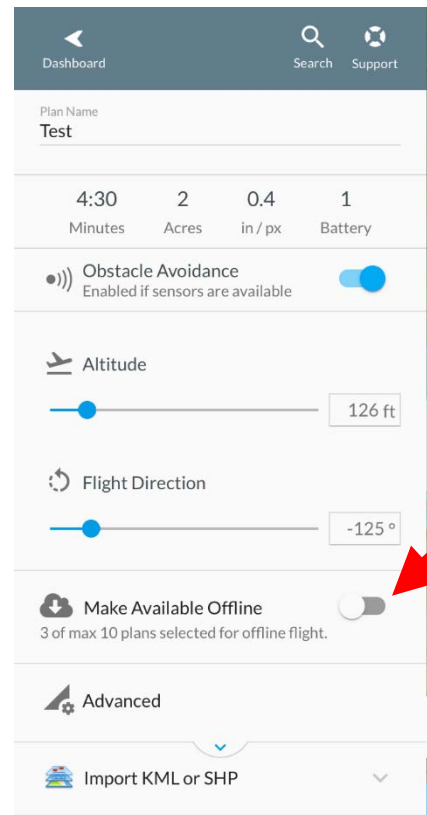
## 7.2 DroneDeploy Mobile App

Open the DroneDeploy app on your mobile device. You will need your email and password created in Section 5.1 above. The Dashboard should open automatically and should look like the web interface described above.

You may actually plan your mission using your mobile device if you have good cell phone service or if you have wi-fi connection for your mobile device.

**Before you leave your office,** tap on the name of your new mission to check it in the mobile app. The "Planning" window should look identical to the one shown above **with one exception** - the tab for "Make Available Offline" (red arrow pointer).

**If you will not have cell phone reception** at the proposed mission site, you must ENABLE "Make Available Offline" and wait for the satellite map tiles and waypoints to be downloaded and cached on your mobile device. Although you may retain many missions in the Dashboard, you may only cache 10 missions off-line on your mobile device.





If you receive a message that you exceeded the maximum of 10 offline plans but you recently deleted some offline plans, you may need to logout of DroneDeploy and login again on your mobile device to clear the offline cache counter.

### 7.3 Altitude and Flight Direction

You can modify "Altitude" and "Flight Direction" settings with the DroneDeploy mobile app at the mission site if cached values need to be changed.

The "Altitude" that you set in DroneDeploy is measured AGL relative to the home point at which you launch the mission. The aircraft is controlled by GPS which can only measure height above MSL. It measures height above MSL at the home point and then adds the mission "Altitude" to determine a fixed height at which it will fly. Consequently, it will fly in a flat plane at a fixed distance above the home point. It **will not follow the contour of the terrain** at a fixed height above the local terrain. There are currently no simple mission planners that are terrain aware.

You should select the home point for launch/recovery near the highest point in your mission plan. Remember that the home point is not the first waypoint.

You should then select DroneDeploy "Altitude" that will clear the tallest obstacle based on height above the home point. A general recommendation is to fly at 200 feet AGL which should clear most trees, buildings and power lines. Typical values for resolution versus AGL are provided below.

AGL [ft]	50	100	200	300	400
P4 resolution [in/pix]	0.1587	0.3174	0.6348	0.9522	1.2696

In general, "Flight Direction" should be parallel to the long axis of the mission to minimize flight time. However if wind conditions are above 10 mph, "Flight Direction" should be changed at the mission site to cross the wind rather than have the aircraft fly directly upwind and downwind. This will reduce battery drain rather than fighting the wind on long upwind legs.

### 7.4 Simulator

DroneDeploy can simulate your flight. However the simulator assumes a perfect aircraft under perfect flight conditions. The simulator can be run from either web or mobile mission planners.

Click the blue "Test the simulator" hyperlink at the bottom of the "Planning" window and then follow instructions in Section 8.3 below.

[Don't own a drone?](#)      [Test the simulator](#)

Novice users should run the simulator to become familiar with flight procedures. Experienced users often run the simulator to estimate number of photos that will be captured. The simulator typically predicts about 30% more photos than will actually get captured.

## 8.0 Flying the Mission

This primer assumes that you are familiar with basic manual operation of your DJI aircraft using the DJI GO mobile app. Specific settings and controls for DJI GO will be mentioned.


### 8.1 Pre-flight Checklist

- 1) Remove the gimbal lock.
- 2) Check aircraft frame, landing legs, propellers and gimbal.
- 3) Check aircraft battery power.
- 4) Check if an SD card is inserted into aircraft.
  
- 5) Check if cell phone service is available.
- 6) Check battery level on mobile device.
  
- 7) Check the weather prediction for the next hour. Do not fly in rain or heavy mist.
- 8) Check visibility. Do not fly if visibility will prevent VLOS over the entire mission area.
- 9) Check wind speed. Do not fly if wind is faster than 15 mph.
- 10) Check air temperature. Temperature below 40° F can significantly reduce battery life.
- 11) Check if your PIC can maintain VLOS over the entire mission area.
- 12) Check for manned aircraft in the vicinity.
- 13) Check for people and moving vehicles within the entire mission area.

### 8.2 Pre-flight with DJI GO Mobile App

- 1) Connect USB cable from mobile device to controller.
- 2) Power on aircraft.
- 3) Power on controller.
- 4) Power on mobile device.
- 5) Open DJI Go mobile app.
- 6) Wait for “Ready to Go (GPS)” to appear at the top of the OSD.





- 7) Use the small quadcopter icon  to open Main Controller Settings and check if “Beginner Mode” = OFF, if “Set Max Flight Altitude” is compatible with the mission and if “Enable Max Distance” = OFF. Make changes as needed.

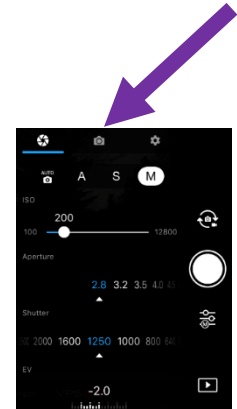
8) Check if an SD card is inserted and if it has space for at least 500 JPEGs (red arrow pointer). Use the Simulator in Section 7.4 to estimate the actual number of photos that will be captured.



9) Check if camera AWB is set to Cloudy (green arrow pointer). If not,

use the small triple slider bar icon  on the right side of the OSD to open the camera control panel shown to the right.

Then use the small camera icon  near the top (purple arrow pointer) to open the White Balance menu. Select “Cloudy” and then tap the live image to exit menus.



10) Use the manual shutter button on the upper right corner of controller to capture 2 or 3 photos while the aircraft is still sitting on the ground at the home point. These photos will help sort beginning/end of multiple missions during upload in Section 9.

11) Check the Mode Switch setting on upper left corner of controller.  
**mission = P setting for P4 and Mavic, F setting for P3 and Inspire**

12) Keep mobile device power on and mobile device connected to controller.

13) Keep controller power on.

14) Keep aircraft power on.

15) **Completely close DJI GO mobile app.**

Documentation on aircraft setup is available from DroneDeploy at <https://support.dronedeploy.com/docs/initial-setup-for-inspire-and-phantom-3>

Note: DroneDeploy will automatically set picture size to 4:3 mode (P3 4000 x 3000 pixels, P4 4864 x 3648 pixels).

### 8.3 Fly with DroneDeploy Mobile App

Open the DroneDeploy app on your mobile device and check if the “Drone Connected” message is displayed at the bottom of the “Planning” window as shown below. You may need to cycle the controller off and then on again if the aircraft is not connected.

 A grey rectangular box containing a green circle on the left and the text "Drone Connected" in a sans-serif font on the right.



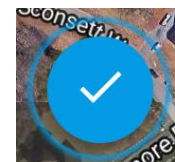
Tap on your mission to open it and review your settings. A blue circle airplane icon should replace the blue circle diskette icon in the lower right of the satellite map. If the blue circle airplane icon does not appear, cycle the controller off and then on again to reset connection.

You can change any settings at this time. However to save the new settings you must turn controller power off to disconnect the aircraft. This will cause the blue circle diskette icon to reappear so that you can save your new settings. Turn controller power back on to reset connection and the blue circle airplane icon should reappear.

When you are satisfied with your settings, tap the blue circle airplane icon in the lower right of the satellite map. DroneDeploy will sequence through a checklist including “Permissions”, “Drone”, “Camera”, “Controller” and “Flight Plan”. If all items are satisfied and turn green, the blue circle airplane icon will be replaced by a pulsing blue circle check mark icon.

Use the manual shutter button on the upper right corner of the controller to capture 2 or 3 photos while the aircraft is still sitting on the ground at the home point if you did not do so in step 8.2.10 above. These photos will help sort beginning/end of multiple missions during upload.

Tap the pulsing blue circle check mark icon to start the mission. The aircraft will launch, point the camera straight down, climb to altitude and then fly to the first waypoint. It will automatically capture photos with programmed sidelap/frontlap as it flies from waypoint to waypoint. When it reaches the final waypoint, it will stop taking photos, fly above the home point and automatically land. You may manually adjust landing motion using joysticks on the controller.



A snapshot of a mission in progress is shown below. During the mission, the home point (blue house icon), current controller location (blue dot), current aircraft location/heading (aqua arrow icon), next waypoint (smaller blue dot), blue planned path and white completed path are superimposed on top of the satellite map. Note that the actual path of the aircraft may deviate from the planned path due to wind. Battery power, number of photos captured, AGL, aircraft speed, distance from home point and flight time are provided at the left side of the OSD. A PIP in the upper right of the satellite map shows a live image from the camera.



The red circle home icon in the lower right of the satellite map serves the same function as the RTH button on the controller. Both the home icon and the RTH button will abort the mission at any time and cause the aircraft to RTH. You may manually adjust landing motion using joysticks on the controller.

You may regain manual control at any time during the mission using the Mode Switch on upper left corner of the controller.

**manual = S setting for P4 and Mavic, P setting for P3 and Inspire**

During the mission, DroneDeploy will beep to provide a low battery warning at 30% power and the battery icon will turn red. At 20% power, DroneDeploy will start automatic RTH.

Any mission that is interrupted by you or by DroneDeploy may be restarted. This is particularly useful for long missions that may require more than one battery. An interrupted mission will have a blue circle quadcopter icon to the left of the name in the Dashboard. After replacing the aircraft battery, you may open the interrupted mission and resume the mission at the last successful waypoint as if it were a new mission. You do not need to repeat Sections 8.1 or 8.2 above. You do not need to reset “Starting Waypoint” manually.

Documentation on using multiple batteries is available from DroneDeploy at <http://support.dronedeploy.com/docs/flying-a-larger-area-with-multiple-batteries>

## 8.4 Post-Flight Tasks

There are three important tasks that should be completed after the mission is complete.

- 1) Manually feel the temperature of the aircraft battery **immediately after landing**. If any LiPo battery is too hot to touch after use, be very careful when charging and using it in the future.
- 2) Remove the SD card from the aircraft and store it in a safe place. Copy all image files to a computer as soon as possible so that you **do not lose that tiny SD card**.
- 3) A completed mission will have an aqua circle up-arrow icon to the left of the mission name in the DroneDeploy Dashboard. The three dots to the right of name provide “Make a copy”, “Download flight logs”, “Move to folder” and “Delete”. You **must make a copy of a completed mission** to create a new flight plan and fly the same pattern again. Experienced users may be interested in flight logs.

## 9.0 Orthomosaic Reconstruction

Orthomosaic reconstruction provides two important functions to create a large composite image from many smaller photos. The "mosaic" function uses GPS and heading metadata to roughly align multiple images taken at different locations and orientations. Stitching then identifies matching homologue features in adjacent images to merge images seamlessly. The "ortho" function removes perspective distortion from the edges of constituent photos to create a composite that appears to look straight down over the entire area. Orthomosaic reconstruction software also provides color DEMs that show terrain elevation.

Maps Made Easy is recommended for orthomosaic reconstruction based on three important metrics - fee structure, ability to download full resolution GeoTIFF images and ability to share results with the public.

### 9.1 Manage UA Image Files

UA photos captured by DJI aircraft should be JPEG format. P3 photos are 4000 x 3000 pixels and typically 5 MB. P4 photos are 4864 x 3648 pixels and typically 7 MB. Large missions may capture 400 to 600 images. Consequently, each mission can generate 2 to 4 GB of data.

You should develop a **serious plan to store and archive** these very large data sets specifically in regard to data transfer speed. Your datasets must be uploaded on-line to orthomosaic service providers. Upload time can be very slow if you have slow Internet connection.

### 9.2 Payment for Services

Most orthomosaic reconstruction vendors charge a monthly subscription fee which can become expensive for small growers. However, Maps Made Easy uses a pay-as-you-go pricing system based on points which are related to photo size and number of input photos. Their pricing system is described at <https://www.mapsmadeeasy.com/pricing>

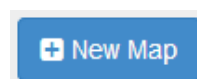
Maps Made Easy provides all new accounts with 500 Points as a starting balance which should be enough to map 200 acres with P3 (60% overlap, 2 inch/pixel resolution, 400 feet AGL) or 50 acres with P4 (75% overlap, 0.6 inch/pixel resolution, 200 feet AGL). Small maps that require 250 Points or fewer are free.

You may purchase more points on-line nominally \$100 for 6000 points.

### 9.3 Create a New Map

Login at Maps Made Easy <https://www.mapsmadeeasy.com/>. You will need your email and password created in Section 5.1 above. Firefox, Google Chrome and Microsoft Edge all work well. The Dashboard should open automatically.

To create a new map, click on the blue rectangle "New Map" button at the upper right of the Dashboard.

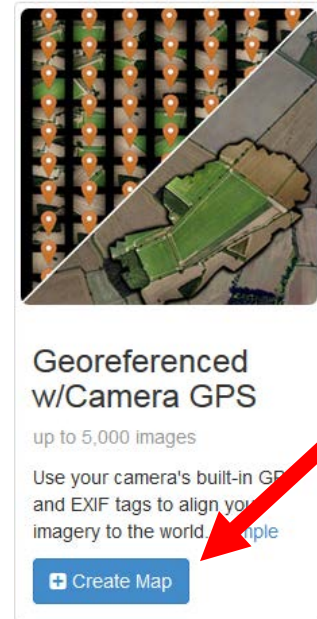
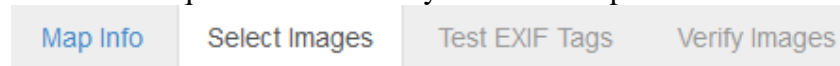




On the "Create a New Map" page, click on the blue rectangle "Create Map" button (red arrow pointer) at the bottom of the "Georeferenced w/Camera GPS" section as shown at right.

On the next page "MAP Info", enter a name for the map that includes location and date for flight. The same name used for the DroneDeploy mission in Section 7.1 above is recommended. You may also enter additional information under "Map Description". When complete, click on the green rectangle "Next" button at lower right.

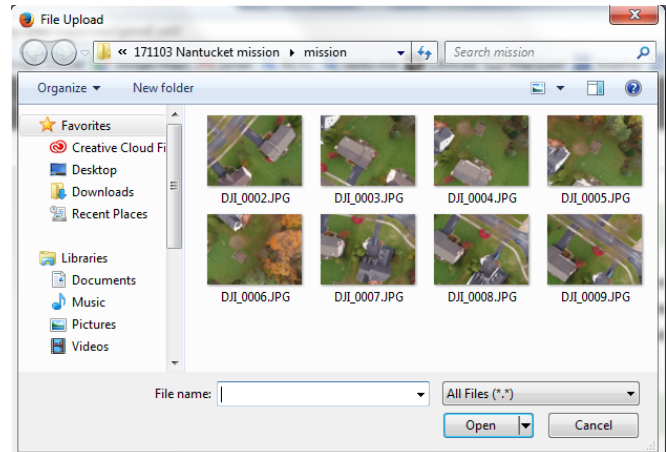
Workflow sequence is tracked by tabs at the top of the screen.



On the "Select Images" page, approve all three check boxes and then click on the blue rectangle "Select Images to Upload" button.



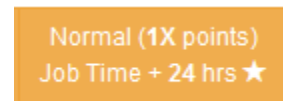
Use the "File Upload" pop-up window shown at right to browse for the JPEG image files. Highlight and select images with the "Open" button. This will return you to the "Select Images" page. When complete, click on the green rectangle "Next" button at lower right.



On the "Test EXIF Tags" page, use the gray rectangle "Browse" button and then the "File Upload" pop-up window to select one of your images. This will return you to the "Test EXIF Tags" page and report metadata including "Camera", "Focal Length", "Width Pixels", "Height Pixels", "Location" and "Capture Date and Time". If satisfactory, verify with the check box and click on the green rectangle "Next" button at lower right.

On the "Verify Images" verify with the check box and click on the green rectangle "Next" button at lower right.

On the "Point Use" page, under "Processing Urgency" click on the orange rectangle "Normal (1X points)" button shown at right. You may select a higher urgency if needed. Then check your current balance and determine if sufficient for the current mission based on the estimate provided (Total Images x





Megapixels per Image x Points per Megapixel). Use default "Processing Options" which will automatically trim edges of your map. If acceptable, click on the green rectangle "Next" button at lower right.

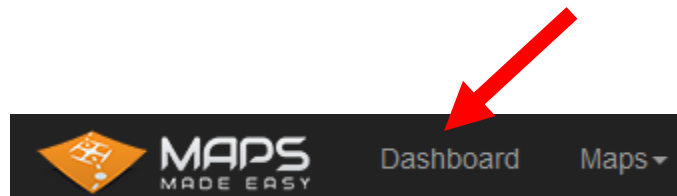
On the "Georeference" page, confirm the location for your mission with the check box and click on the green rectangle "Next" button at lower right.

On the final "Upload and Process" page, approve submission of the job with the check box and click on the green rectangle "Upload Now" button shown at right. You **must not close** the following upload page until all images have been uploaded.



You will then be transferred to the "Map Detail" page for your new map that shows an estimate of when it will be completed. Typically, Maps Made Easy predicts that maps with 1X processing urgency will require 24 hours to complete. However they are often done in 2 to 4 hours. You will receive an email confirmation when your job starts processing and when your map is ready.

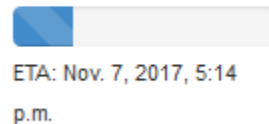
If you return to the Dashboard using the toolbar icon in the upper left of the window (red arrow pointer), your map should appear in the pending category with a blue progress bar graph as shown below.



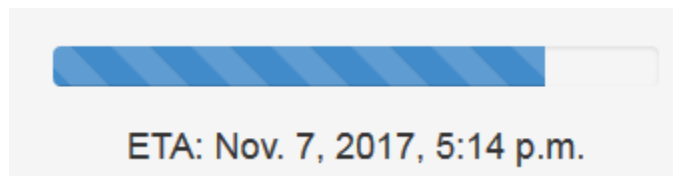
## Pending recent



171103 Nantucket mission  
8 photos



You may click on your pending map to view its "Map Detail" page periodically and check status by the blue progress bar graph shown below.



## 9.4 Map Detail and Sharing

Once your map is complete, you may view "Map Detail" by clicking on the map name in the Dashboard.

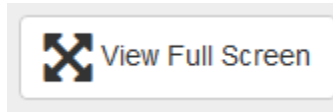
Left-click on the map to drag and pan location. Right-click on a map location to show latitude-longitude in a pop-up window. Use the white square plus/minus buttons in the upper left of the map to control map scale. The buttons below the scale allow you to add polyline, polygon, square, circle and marker annotations as well as control annotation color and delete annotations.



Use the layers icon in the upper right of the map to display either a satellite or street map underlay and to display either an orthomosaic or color DEM.



The white rectangle “View Full Screen” button below the map to the right will open a new window to view the map in full screen mode. Close the window when done.



The “Settings” panel on the left side of the “Map Detail” page provides latitude-longitude for your map.

The “Job” panel on the left side of the “Map Detail” page lists date/time for the flight, local weather conditions, number of images uploaded, output image size and resolution, average AGL, map area, and elevation range.

The “Overlap Report” panel at the bottom of the “Map Detail” page provides a color map of overlap between adjacent images used to construct the orthomosaic.

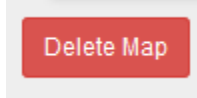
The “Sharing” panel is on the right side of the “Map Detail” page just below the map. To share your map with the public, click on the large red X beside “Public Hosting”. Check the blue square in the pop-up menu and then click on the small green check mark to the right. A large green check mark should appear beside “Public Hosting” and a “Shareable URL” hyperlink should appear below your map. You may cut text for the “Public Link” to your map from the bottom of the “Sharing” panel or you may click on the “Shareable URL” hyperlink to open the full-screen public version of your map. Use the browser BACK button to return to the “Map Detail” page.

[Shareable URL](#)

The “Advanced Output” panel on the right side of the “Map Detail” page provides the most important information. It contains links to download full resolution GeoTIFF and JPG orthomosaic images. Both images will be huge. The JPG is very valuable for manual inspection. The GeoTIFF provides latitude-longitude for each pixel and is essential for computational analysis of crop health. Maps Made Easy will not retain these large files forever. **Be certain to download** the GeoTIFF and JPG orthomosaics before their expiration date.

The “Advanced Options” panel also contains links to download TIFF, GeoTIFF and JPG color DEMs as well as a 3D color KMZ model that can be viewed in Google Earth Pro. Again, be certain to download these files before their expiration date.

Use the red “Delete Map” button at the bottom left of the “Map Detail” page to delete a map.



## 10.0 Other Mission Planning Software

The recommendation to use DroneDeploy for mission planning was based on several factors after comparing the top seven mission planners and several other bad packages.

DroneDeploy provides the following five capabilities while others only provide two or three.

- 1) both web and mobile planning apps
- 2) cache plans for use without cell phone coverage.
- 3) simulator for training
- 4) simple battery swap for longer missions
- 5) intuitive file management within Dashboard

Other mission planners are listed by category – area planners, path planners and ground station planners.

### 10.1 Area Mission Planners

Six mission planners listed below were tested extensively against DroneDeploy using an iPhone or iPad. A comparison matrix based on different capability metrics is available by request.

tested

DroneDeploy - free - iOS, Android - <https://www.dronedeploy.com/>

Pix4D Capture Grid - free - iOS, Android <https://pix4d.com/product/pix4dcapture-app/>

Map Pilot - free - iOS <https://www.dronesmadeeasy.com/Articles.asp?ID=254>

PrecisionFlight - free - iOS, Android <http://www.precisionhawk.com/precisionflight>

Skycatch - free - iOS <https://www.skycatch.com/products/>

Altizure - free - iOS, Android <https://www.altizure.com/>

DJI GS Pro - free - iPad <http://www.dji.com/ground-station-pro/info>

### 10.2 Path Mission Planners

Path planners capture a sequence of photos or a video along a path with a limited number of waypoints that are manually set by the user. Path planners may be useful for specialized scanning of unusual crops (e.g. hops, long thin trellises). Two path planners were tested.

tested

DJI GS Pro - free - iPad <http://www.dji.com/ground-station-pro/info>

DJI GO 4 - free - iOS, Android <https://itunes.apple.com/us/app/dji-go-4/id1170452592?mt=8>

not tested

Litchi - \$22.99 - iOS, Android <https://flylitchi.com/>

Hangar Autopilot - \$29.99 - iOS <https://autoflight.hangar.com/autopilot>

### 10.3 Base Station Mission Planners

Base station mission planners require a laptop PC or Mac at the mission site and use either a mobile device or wireless telemetry to interface between the PC/Mac and aircraft.

Concomitantly they are much more powerful and can do both area and path planning. UgCS claims to provide terrain awareness. None of the packages were tested because they are far too complicated for growers to learn.

not tested

UgCS - free - Win, Mac, Linux <https://www.ugcs.com/>

ArduPilot Mission Planner - free - Win <http://ardupilot.org/planner/index.html>

QGroundControl - free - Win, Mac, Linux <http://qgroundcontrol.com/>

### 11.0 Other Orthomosaic Reconstruction Software

The recommendation to use Maps Made Easy for orthomosaic reconstruction was based on several factors after comparing seven commercial mission planners.

Maps Made Easy was superior to the other packages based on three metrics.

- 1) pay-as-you-go versus monthly subscription fees
- 2) ability to download full resolution GeoTIFF images
- 3) ability to share results with the public

Six orthomosaic reconstruction packages listed below were tested extensively in direct comparison to Maps Made Easy. A comparison matrix based on pricing structure and capability metrics is available by request. Although AgiSoft Photoscan is the preeminent orthomosaic reconstruction package for research, it requires significant training and was not be tested for use by growers.

tested

Maps Made Easy <https://www.mapsmadeeasy.com/>

DroneDeploy <https://www.dronedeploy.com/>

Pix4D <https://pix4d.com/>

PrecisionMapper <http://www.precisionhawk.com/precisionmapper>

Skycatch <https://www.skycatch.com/>

Altizure <https://www.altizure.com/>

MicaSense Atlas <http://www.micasense.com/atlas/> (does not do reconstruction after 11/1/17)

not tested

AgiSoft PhotoScan <http://www.agisoft.com/>

## **12.0 Frequently Asked Questions (FAQ)**

### **Why use many photos but not videos?**

Most UA record latitude, longitude and altitude above MSL into metadata that are contained within each image. For example, on a Windows PC, right-click on a UA image and select "Properties" then "Details". DJI aircraft also record vehicle and gimbal flight information into metadata. Video streams do not encode latitude, longitude or other flight information.

### **Why use the DroneDeploy web site for mission planning? Why not just use a mobile app?**

DroneDeploy is the only mission planner that provides a unified platform on a web site and mobile devices. It is much easier to use a mouse and a large computer screen to layout a mission compared to a smaller mobile touch screen.

### **Why not use DroneDeploy for both mission planning and orthomosaic reconstruction?**

Orthomosaic reconstruction with DroneDeploy is both accurate and user-friendly. However its monthly fee structure and reduced resolution for entry level service are prohibitive for small growers who may fly less frequently or not at all during the winter.

### 13.0 FAA Part 107

If you are flying for commercial purposes, you must conform with FAA Part 107.

The following example is a simplistic explanation of "commercial purposes". If you fly UA over your garden and decide to turn on a sprinkler, that would not be a commercial purpose because your garden is a hobby. If you fly UA over your commercial orchard and decide to turn on irrigation, that would be a commercial purpose.

**You must know and understand Part 107 rules.** A summary is provided at - [https://www.faa.gov/uas/media/Part\\_107\\_Summary.pdf](https://www.faa.gov/uas/media/Part_107_Summary.pdf)

The following list highlights Part 107 requirements that are most pertinent to agricultural mapping. This list should not be construed as a verbatim substitute for actual FAA requirements. The three biggest issues for Part 107 compliance in agriculture are listed first.

- 1) PIC must hold a Remote Pilot Certificate (RPC) which requires passing knowledge test at FAA testing center, be vetted by TSA and be at least 16 years old.
- 2) Must have ATC permission to fly in Class B,C,D,E airspace (5 nautical miles around airports with control towers)
- 3) UA must remain within VLOS of the PIC or VO with unaided vision
  
- 4) No careless or reckless operation
- 5) May not fly over people
- 6) May not fly at night
- 7) Must yield right of way to manned aircraft
- 8) Maximum 400 feet AGL
- 9) Maximum groundspeed 100 mph
- 10) Minimum weather visibility 3 miles
- 11) UA must be registered with FAA and marked with registration number
- 12) UA plus cargo must weigh less than 55 pounds total
- 13) May not carry hazardous materials
- 14) External loads must be securely attached and not adversely affect flight
- 15) Transportation of property for hire allowed with special restrictions

The single biggest concern is for your PIC to obtain their RPC. While this may initially seem daunting, the RPC exam is easy to pass after some study. Although most agriculture is outside controlled airspace, it is relatively easy to get ATC permission to fly except for highly congested areas near airport landing patterns. VLOS is generally not a problem over most fields and orchards, but may require a VO in direct contact with the PIC for hilly terrain.