



## Environmental Analysis Program

Pomona College  
Biogeochemistry Laboratory

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SOP-F630

# Drone Operations (DJI Mavic and Matrice UAVs)

Standard Operating Procedure

|                     |                               |
|---------------------|-------------------------------|
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| <b>Author(s)</b>    | Liz Johnson, Marc Los Huertos |
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| <b>Organization</b> | EA Program, Pomona College    |

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## 1. Purpose

This SOP details the procedures for safely operating the EA Program's DJI unmanned aerial vehicles (UAVs/drones) for research image collection (DJI, 2015, 2023). It covers pre-flight setup, flight operations, image collection, post-flight procedures, and data transfer. Images obtained from these aircraft are used for photogrammetry (3D modeling), site monitoring, vegetation mapping, and other remote sensing applications.

## 2. Scope

- **Applies to:** All flights of EA Program drones, including the DJI Mavic 3 Pro and DJI Matrice 100, for research and instructional purposes
- **Does not apply to:** Indoor flights; flights conducted by contracted third-party operators; processing of drone imagery beyond data transfer (see future SOP-L805)
- **Location:** All EA Program field sites and approved flying areas

## 3. Definitions

- **AGL (Above Ground Level):** Flight altitude measured from the ground surface directly below the aircraft, not from mean sea level; FAA Part 107 limits sUAS to 400 feet AGL (approximately 122 m) in uncontrolled airspace (Federal Aviation Administration, 2024b).
- **Compass calibration:** A pre-flight procedure that orients the drone's internal compass to the local magnetic field; required at each new site or after transporting the aircraft; performed by rotating the aircraft in specific orientations per the DJI app prompts (DJI, 2023).
- **DJI Mavic 3 Pro:** A compact foldable quadcopter with a three-camera Hasselblad system; the EA Program's primary survey aircraft stored in SGM 106; flight time approximately 43 minutes; maximum wind resistance 12 m/s (Beaufort 6) (DJI, 2023).
- **DJI Matrice 100:** A legacy quadcopter platform capable of carrying a research payload of up to 1 kg; stored in SGM 210; suited for multi-sensor work; requires the DJI Pilot app for operation (DJI, 2015).
- **Gimbal:** The motorized, stabilized mount that holds the camera; compensates for drone movement to produce level, stable imagery; always reinstall the gimbal guard during transport.
- **LAANC (Low Altitude Authorization and Notification Capability):** An FAA system that provides near-real-time airspace authorization for UAS operations in controlled airspace (Classes B, C, D, and E surface areas); authorization is obtained through the B4UFLY or Aloft apps before each flight in controlled airspace (Federal Aviation Administration, 2024a, 2024b).
- **LiPo battery (lithium polymer battery):** The rechargeable battery used in DJI drones; stores significant energy and poses a fire hazard if punctured, short-circuited, or charged incorrectly; must be stored at 40–60% charge for long-term storage and kept away from flammable materials.
- **Nadir angle:** A camera gimbal angle of -90°, pointing the camera directly downward toward the ground surface; the standard angle for photogrammetric mapping and orthomosaic generation.

- **Part 107:** Title 14 CFR Part 107 of the Code of Federal Regulations, governing Small Unmanned Aircraft Systems; requires a Remote Pilot Certificate for commercial and research operations; specifies operating limitations including maximum altitude, VLOS requirement, and prohibited airspace (Federal Aviation Administration, 2024b).
- **Photogrammetry:** The science of making measurements from photographs; in the drone context, software such as Reality Capture or Pix4D processes overlapping aerial images to produce 3D models, dense point clouds, digital surface models (DSMs), and georeferenced orthomosaics (Capturing Reality, 2024).
- **RTH (Return to Home):** An automated failsafe function that returns the drone to its recorded home point (takeoff location) if the controller signal is lost or the battery reaches the RTH threshold; the home point must be set before each flight.
- **sUAS (small Unmanned Aircraft System):** FAA classification for unmanned aircraft weighing less than 55 pounds (25 kg); both EA Program drones qualify as sUAS (Federal Aviation Administration, 2024b).
- **TRUST (The Recreational UAS Safety Test):** An FAA-mandated online safety test for recreational flyers; required when operating under the Exception for Limited Recreational Operations (44809) rather than Part 107.
- **UAS (Unmanned Aircraft System):** The complete system including the drone, remote controller, and associated software.
- **VLOS (Visual Line of Sight):** FAA requirement that the Remote Pilot maintain unaided visual contact with the aircraft at all times during flight; flight beyond VLOS requires a Part 107 waiver (Federal Aviation Administration, 2024b).

## 4. Responsibilities

| Role            | Responsibility                                                 |
|-----------------|----------------------------------------------------------------|
| PI              | Approve flight plans; ensure FAA compliance                    |
| Certified Pilot | Hold FAA Part 107 certificate; conduct flights                 |
| Visual Observer | Maintain visual contact with the drone; alert pilot to hazards |
| New Students    | Complete training before any drone operation                   |

## 5. Safety and Hazards

### 5.1. Critical Safety Rules

- Never fly over people who are not directly participating in the operation
- Never fly beyond visual line of sight (VLOS)
- Never fly near other aircraft or in restricted airspace without authorization
- Never touch spinning propellers
- Never fly under the influence of alcohol or drugs

## 5.2. Hazards

- **Physical:** Spinning propellers can cause lacerations. A drone falling from altitude can cause blunt force injury. LiPo batteries may be hot after flight.
- **Regulatory:** Unauthorized flights can result in FAA fines and criminal penalties (Federal Aviation Administration, 2024b).
- **Property:** Crashes can damage the drone (replacement cost several thousand dollars) and property below.
- **Environmental:** Drones can disturb nesting birds and wildlife. Avoid flying near known nesting sites during breeding season.

## 5.3. Required PPE

- ☐ Safety glasses (recommended during takeoff and landing)
- ☐ Sun protection (hat, sunscreen)
- ☐ Closed-toe shoes

## 5.4. Emergency Procedures

If the drone loses connection, activate RTH immediately. If RTH fails, allow the drone to execute its failsafe. Do not attempt to catch a falling drone. Refer to [SOP-F001 Field Safety](#).

# 6. FAA Regulations

### ! Legal Requirement

All drone flights must comply with current FAA regulations. The pilot is personally responsible for compliance (Federal Aviation Administration, 2024b).

Research operations require FAA Part 107 Remote Pilot certification. Flights in controlled airspace (near airports) require prior LAANC authorization via the B4UFLY or Aloft apps (Federal Aviation Administration, 2024a). Pomona College campus is within Ontario International Airport (KONT) Class C airspace; LAANC authorization is required for on-campus flights. Both EA Program drones are registered with the FAA; registration numbers are on file with the PI and must be displayed on the aircraft at all times.

## 6.1. Flight Restrictions under Part 107

- Maximum altitude: 400 feet AGL (Federal Aviation Administration, 2024b)
- Daylight operations only (civil twilight with anti-collision lighting permissible with appropriate equipment)
- Visual line of sight at all times
- No flights over non-participating persons
- Yield right of way to manned aircraft at all times

## 7. EA Program Fleet

| Aircraft              | Serial Number  | Storage | Notes                   |
|-----------------------|----------------|---------|-------------------------|
| DJI Mavic 3 Pro       | <i>TBD</i>     | SGM 106 | Primary survey aircraft |
| DJI Matrice 100       | M02DF 19020136 | SGM 210 | Legacy; multi-sensor    |
| Mavic 3 batteries     | <i>TBD</i>     | SGM 106 | 3 batteries             |
| Matrice 100 batteries | <i>TBD</i>     | SGM 210 | 6 batteries             |

## 8. Required Materials

### 8.1. Pre-Flight Checklist

| Item                                         | Check                    |
|----------------------------------------------|--------------------------|
| Drone (inspected, propellers attached)       | <input type="checkbox"/> |
| Remote controller (charged)                  | <input type="checkbox"/> |
| Batteries (charged, minimum 3)               | <input type="checkbox"/> |
| Mobile device with DJI app (charged)         | <input type="checkbox"/> |
| MicroSD card (formatted, > 2 GB free)        | <input type="checkbox"/> |
| FAA Part 107 certificate (pilot)             | <input type="checkbox"/> |
| FAA registration number on aircraft          | <input type="checkbox"/> |
| LAANC authorization (if controlled airspace) | <input type="checkbox"/> |
| UAV Forecast app check (weather, KP index)   | <input type="checkbox"/> |
| Flight plan (altitude determined)            | <input type="checkbox"/> |
| Notebook and pen (for flight log)            | <input type="checkbox"/> |

(DJI, 2023; Federal Aviation Administration, 2024b)

### 8.2. Software

| Application              | Purpose                                                                 |
|--------------------------|-------------------------------------------------------------------------|
| DJI Fly or DJI Pilot     | Flight control, camera settings, flight planning (DJI, 2015, 2023)      |
| UAV Forecast             | Weather, wind, KP index, GPS satellite count                            |
| B4UFLY or Aloft          | Airspace authorization (LAANC) (Federal Aviation Administration, 2024a) |
| Reality Capture or Pix4D | Photogrammetry post-processing (Capturing Reality, 2024)                |

## 9. Procedure

### 9.1. Pre-Flight Inspection

1. Inspect the airframe: no cracks, loose propellers, or debris in motors.
2. Charge all batteries to 100% before departure.
3. Check the DJI app for firmware updates; update if prompted (DJI, 2023).

### 9.2. Pre-Flight Checks at the Site

1. Perform compass calibration per the DJI app (DJI, 2023).
2. Check airspace: open B4UFLY or Aloft and verify authorization (Federal Aviation Administration, 2024a).
3. Record weather conditions in the flight log.

### 9.3. Flight Operations

1. Announce “Taking off” to all personnel.
2. Hover at 3–5 m to verify stable flight, GPS lock, and camera orientation.
3. Execute the flight plan:
  - For photogrammetry: use automated waypoint or grid mode with 70–80% front overlap and 60–70% side overlap (Capturing Reality, 2024).
  - For manual survey: fly in a systematic pattern at the planned altitude.
4. Monitor battery: begin return at 30%; land immediately at 20%.
5. Announce “Landing” before descent.

### 9.4. Image Collection Settings

| Setting        | Recommended Value                                      |
|----------------|--------------------------------------------------------|
| Image format   | JPEG + RAW (DNG) for photogrammetry                    |
| Photo interval | 2 seconds (timed shot for grid plans)                  |
| Resolution     | Maximum available                                      |
| Gimbal angle   | Nadir (-90°) for mapping; oblique (-45°) for 3D models |

### 9.5. Post-Flight Procedures

1. Power off the drone and remote controller.
2. Replace the gimbal cover.
3. Remove the MicroSD card and transfer images:
  - Create a folder: `Drone_SiteID_YYYYMMDD_AltitudeAGL`
  - Copy all images; verify file count
4. Format the MicroSD card after confirming backup.

5. Return all equipment to storage (Mavic to SGM 106; Matrice to SGM 210).
6. Complete the flight log: aircraft, date, location, pilot, duration, battery cycles used, any incidents.

## 10. Quality Control

- Complete the pre-flight checklist before every flight.
- Verify GPS lock (minimum 8 satellites) before takeoff.
- After each flight, review a sample of images to confirm coverage, focus, and exposure.
- Report any incidents (crashes, near-misses, property damage) to the PI within 24 hours. FAA reporting may be required for incidents involving injury or property damage exceeding \$500 (Federal Aviation Administration, 2024b).

## 11. References

- DJI (2023)
- DJI (2015)
- Federal Aviation Administration (2024b)
- Federal Aviation Administration (2024a)
- Capturing Reality (2024)

Capturing Reality. (2024). *RealityCapture documentation*. <https://www.capturingreality.com/realitycapture>

DJI. (2015). *DJI Matrice 100 user manual*. <https://www.dji.com/matrice100/downloads>

DJI. (2023). *DJI Mavic 3 Pro user manual*. <https://www.dji.com/mavic-3-pro/downloads>

Federal Aviation Administration. (2024a). *B4UFLY app: Unmanned aircraft systems*. [https://www.faa.gov/uas/getting\\_started/b4ufly](https://www.faa.gov/uas/getting_started/b4ufly)

Federal Aviation Administration. (2024b). *Small unmanned aircraft systems* (14 CFR Part 107).

Federal Aviation Administration. <https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107>

## 12. Related SOPs

| SOP                  | Title                   | Relationship                      |
|----------------------|-------------------------|-----------------------------------|
| <a href="#">F001</a> | Field Safety            | Required prerequisite             |
| <a href="#">F006</a> | GPS and Site Navigation | Flight site coordinates           |
| <a href="#">F620</a> | Camera Traps            | Complementary wildlife monitoring |
| <a href="#">L805</a> | Drone Photogrammetry    | Post-processing workflow          |

## 13. Training Record

Before operating any EA Program drone independently, personnel must:

1. Read this SOP and [SOP-F001](#) in full
2. Hold a current FAA Part 107 Remote Pilot certificate, or have passed TRUST (for recreational operations under direct PI supervision) (Federal Aviation Administration, 2024b)
3. Complete the DJI app tutorial and demonstrate proficiency with simulator mode (DJI, 2023)
4. Demonstrate pre-flight inspection, calibration, takeoff, hover, controlled flight pattern, and landing under supervision
5. Complete at least one supervised photogrammetry data collection flight with acceptable image quality
6. Be signed off by the PI