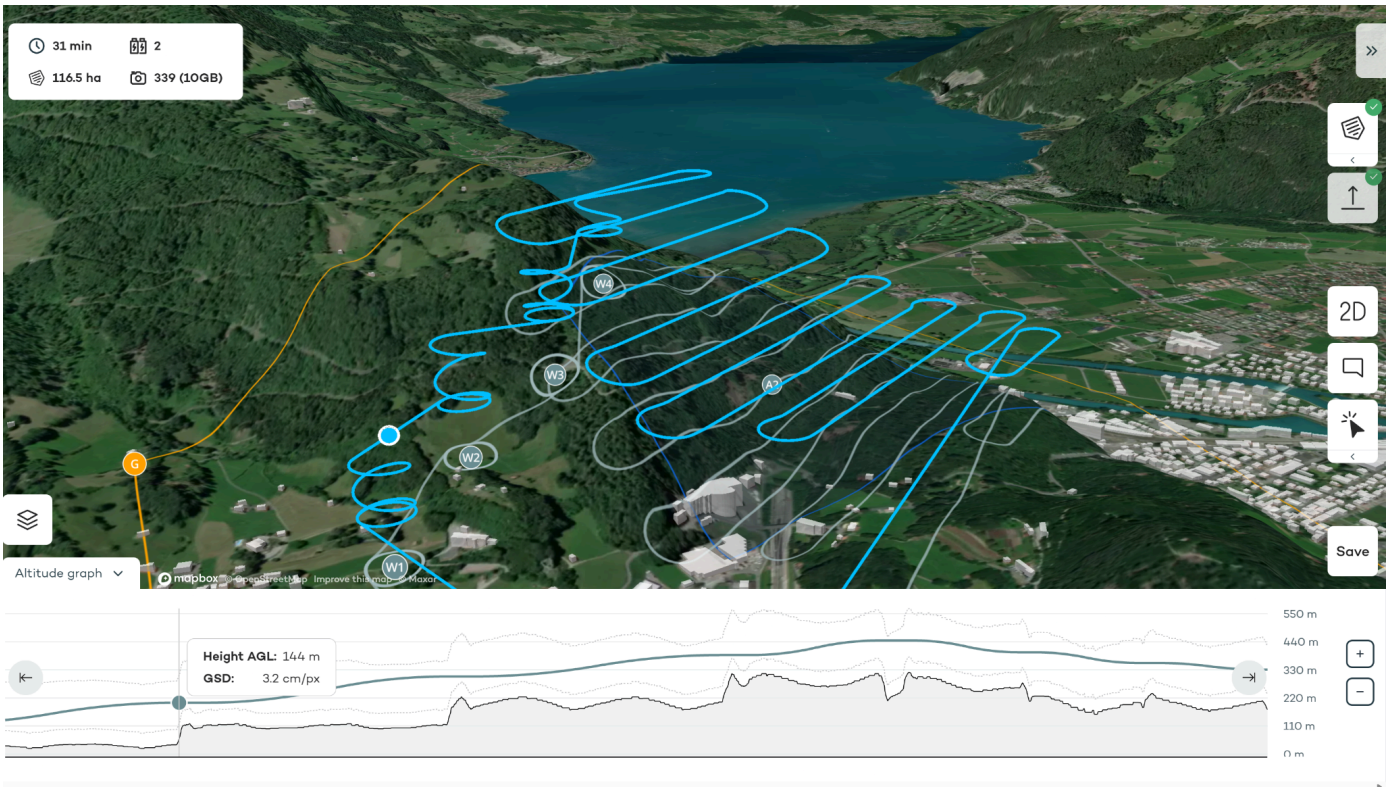
6. 3D flight planning view and altitude graph

The 3D flight planning view and altitude graph are essential when planning flights in vertically varying environments such as near mountains or cities with high skylines.

The altitude graph shows you where in your flight lines you are regarding your altitude above ground and if this is respecting the set minimum and maximum limits in the safety parameters.

You can place your cursor over any part of the altitude graph and the corresponding location in the flight path is shown as a blue dot in the 3D view.



7. Geobarrier, Flight termination barrier and safety parameters

Geobarrier is automatically generated and meant to prevent fly-aways of the drone by triggering Return To Home RTH function. The geobarrier can be adjusted by selecting it in the list on the right edge and other safety parameters for the flight are also set from here. You can also set default parameters for any new flights created from your account settings.

The shape of the geobarrier can be set either as a polygon or a circle. In case of polygons the only allowed shapes are convex shapes. If you draw a concave polygon, you will be prevented from saving the flight plan with this geobarrier before fixing the shape to be convex. The flight plan cannot be saved also if any flightline is out of the geobarrier.

The geobarrier functions also as your method of limiting your maximum flight altitude by setting the geobarrier ceiling. The unit for this setting is meters above take-off point.

Flight termination buffer is an optional additional barrier set at a distance from the geobarrier having the same shape as the geobarrier. The purpose of this barrier is to activate the parachute on a WingtraRAY if equipped with one. The breaching of this barrier would already require that the geobarrier RTH function failed to prevent a fly-away of the drone. If the drone is not equipped with a parachute this barrier once more tries to activate the Return To Home function.

- The flight termination buffer's **horizontal distance** from the geobarrier can be set as any value between 60 m and 2000 km.
- The **vertical distance** from the geobarrier can be set as any value between 10 m and 2000 km.

Ground risk buffer is a visualization to be used on the map for showing the estimated possible landing locations outside of the flight termination buffer after a termination event. The drone will not use the ground risk buffer for any logic; it is purely a reference visualisation for the pilot during flight planning when comparing against other operational limitations applicable to the flights. The ground risk buffer is a definition in the common SORA risk assessment methodology and the EASA STS-02 permit in Europe. The ground risk buffer begins where the contingency volume (FTS barrier) ends.
The ground risk buffer can be set as any value between 0m and 2000 km.

To calculate a suitable distance for the ground risk buffer for WingtraRAY equipped with a parachute, use the following formula (1) and see the table for example calculations.

$$Ground\ risk\ buffer\ (m)\ =\ 60\ +\ 2\ *\ (Max.planning\ height\ AGL(m)\ -\ 15) \quad (1)$$

Example table of ground risk buffer sizes calculated for Maximum planning heights above ground.

Max. planning height above ground	Calculated ground risk buffer
60 m	150 m
120m	270 m
150m	330 m
200m	430 m
250m	530 m

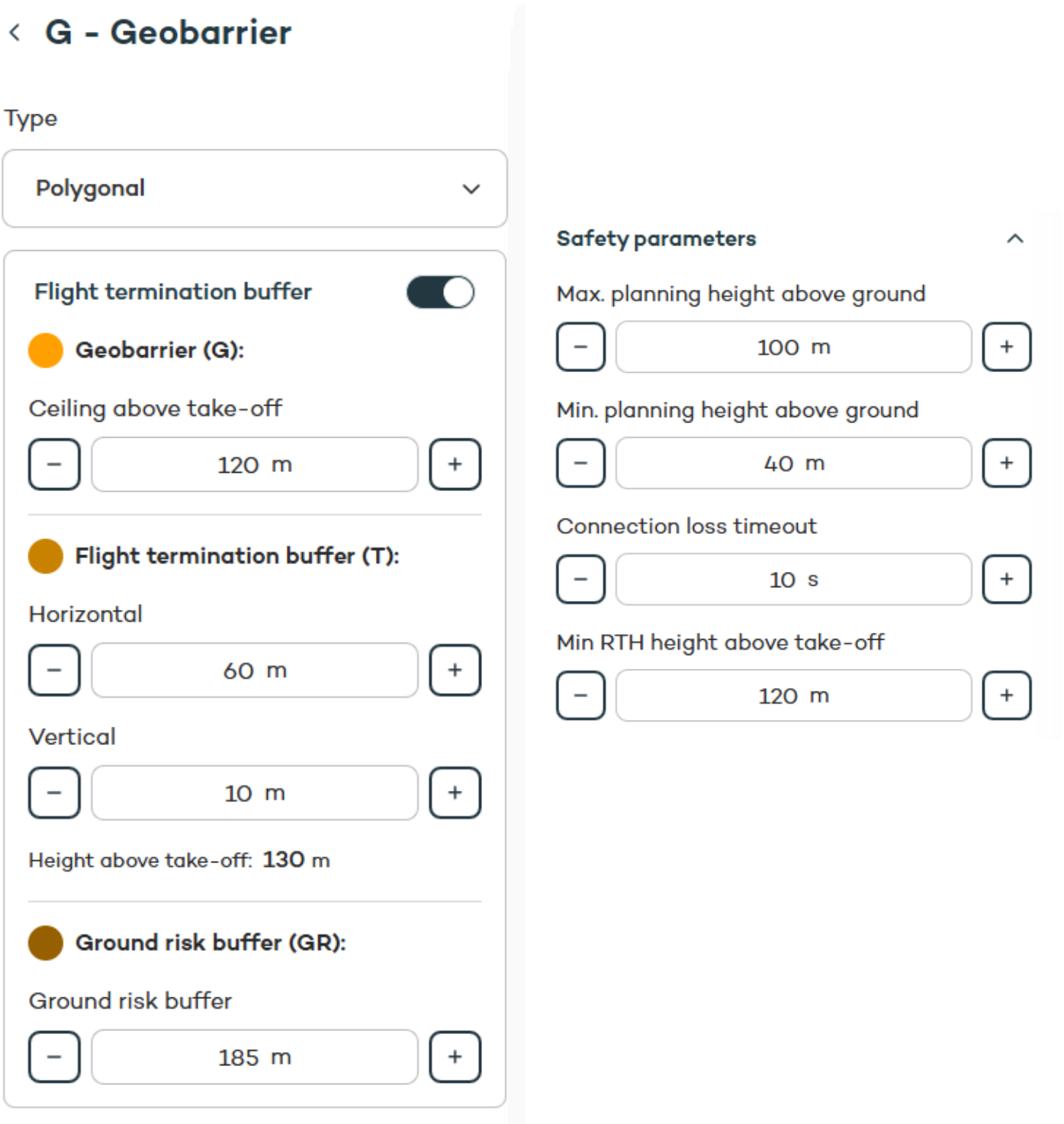
Max. planning height above ground
This value sets a limit for the planning algorithm for placing flight lines above the digital elevation model. If any part of the flight lines is above the set limit then the flight plan cannot be saved.

Min. planning height above ground
This value sets a limit for the planning algorithm for placing flight lines above the digital elevation model. If any part of the flight lines is below the set limit then the flight plan cannot be saved.

The elevation model has inaccuracies as large as ±30m, so if the tallest obstacle in your vicinity is 50m then set this value as 100m to ensure your drone will fly at a comfortable height above the tallest obstacle.

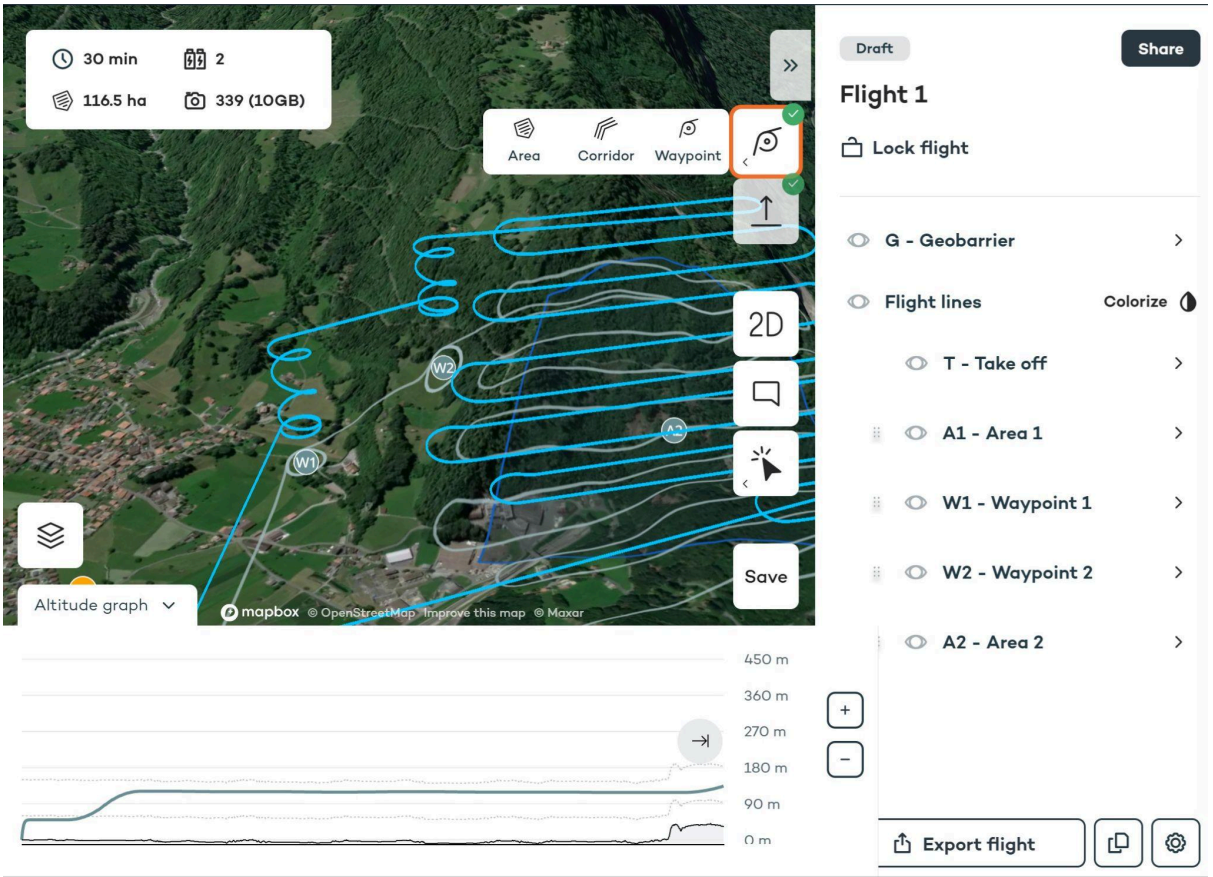
Min RTH height above take-off
This value defines the minimum height at which the drone returns to home.
If the flight altitude is below this limit, the drone will climb to the set value in a loiter circle and only then will it fly directly home.
If the flight altitude is above, the drone will fly straight home at the current altitude.

Connection loss timeout
This value sets a time limit for a connection loss between the drone and the ground control telemetry. RTH will be triggered if this time limit is exceeded.



8. Altitude graph and use of waypoints

Often planning a flight to avoid certain areas or staying below required flight altitudes in hilly terrain require the use of waypoints. In WingtraCloud and App you can set new waypoints by selecting the area icon under which you can also find the waypoint option. Then clicking on the map will place a new waypoint which will also appear in the list of flight planning items on the right. This list is in the order in which the drone will fly the different items, so dragging items up or down on the list will change the order of the flight plan. Place the waypoint in the correct position in the plan and then you can set the exit height above ground for the waypoint. The entry height above ground is determined by the flight height of the previous item in the list.



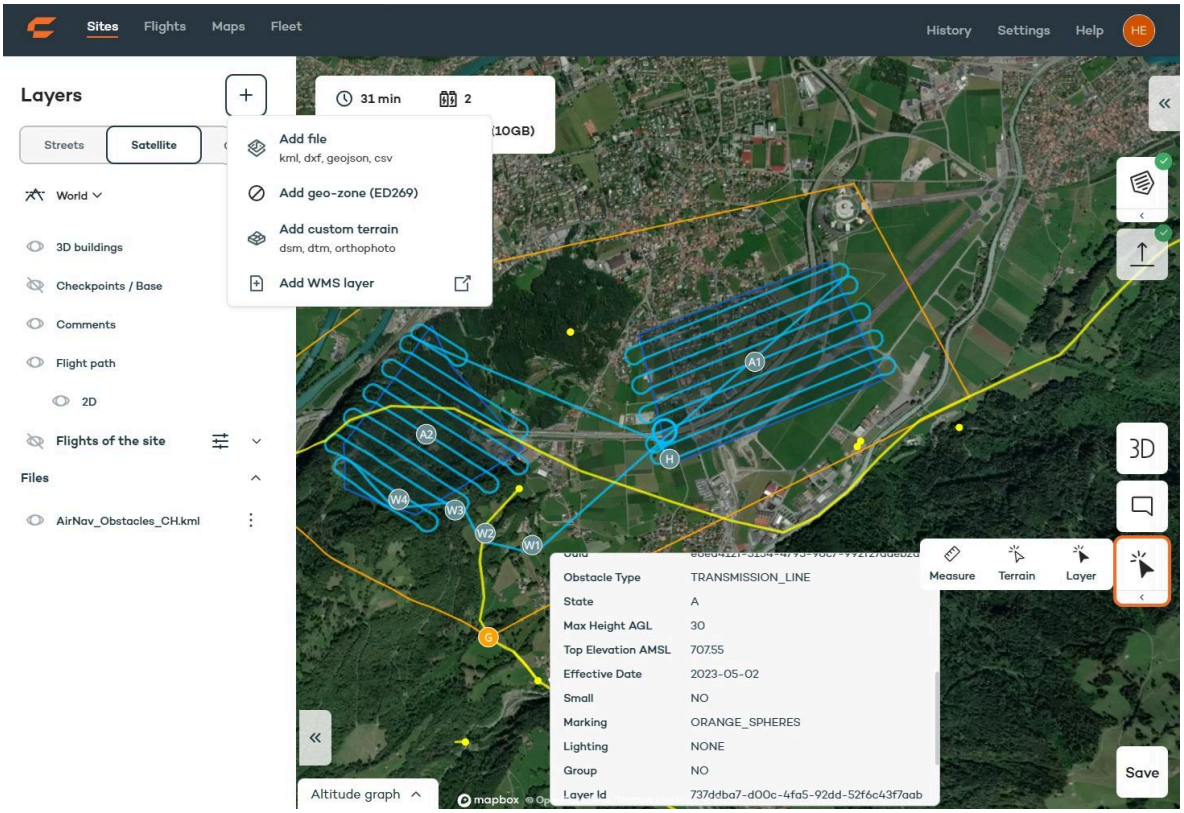
The altitude graph below the map shows when opened as a scale the altitude above home point, the digital elevation model as the lowest gray line, the set minimum flight altitude limit as the lower dotted line and the maximum height above ground limit as the upper dotted line. The solid line is the altitude for the entire flight path of the drone which can be compared to all the limits and ground. This tool helps you plan your flight within all the required parameters for the operation.

9. Layers, Geozones and inspection tools

You can add all the necessary flight planning information sources directly to your flight plan by adding new layers.
Open the **Layers** menu from the icon at the bottom left corner of the map. Here you have the default layer options always available under the “World” heading and above this you can choose as the Basemap either Streets view, Satellite view or Select the Basemap completely Off.

From the add Layers icon on top of the menu you can add new layers to the flight plan in several different formats:

- Add kml, geojson, csv files
- Add geozones in format ED269 (EU market)
- Add custom terrain models as DSM, DTM or Orthophoto
- Add WMS layers



In the image above for example the Swiss Air Navigation Obstacles have been added as a new layer through the Add file upload. The selected object in the layer is a transmission line at a height of 30m Above Ground Level AGL.
Select the Inspection tool icon at the right edge of the map to inspect items or measure distances in your flight plan. If you select the layer inspection tool you can click on a specific object within your uploaded layers on the map to read the metadata within the layer files. This will allow you to read the specific information related to Geozones or any other layer that is necessary for your flight planning.

5.2 Return To Home function (RTH)

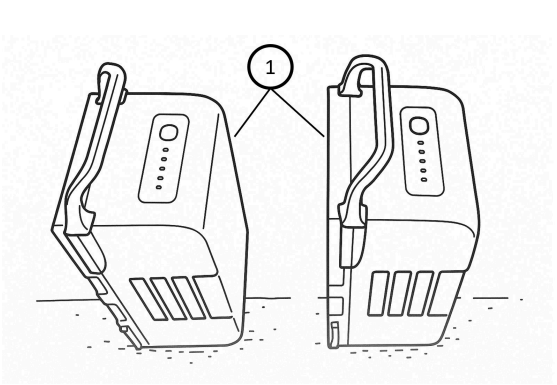
The RTH function is triggered if:

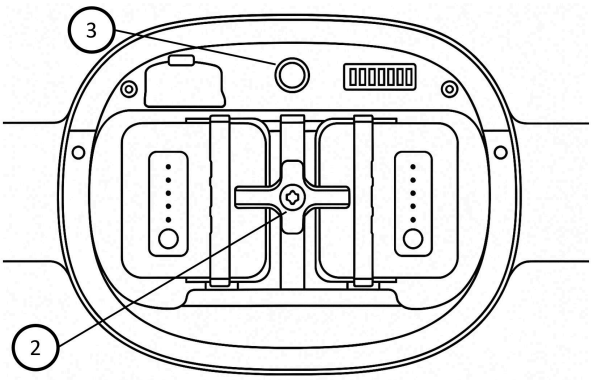
1. The drone flies beyond your geobarrier
2. The telemetry connection between pilot and drone is lost
3. Battery charge gets low
4. The pilot manually activates the RTH function

The drone will return back on a straight line from its current position towards the pilot when RTH is activated. If the drone's current altitude is above the set minimum RTH altitude limit then it will fly back at the current altitude.
If the drone's current altitude is below the set minimum RTH altitude limit the drone will first loiter up to the set limit and then fly back towards the pilot at this altitude.

5.3 Pre-flight checks

Batteries and Power switch

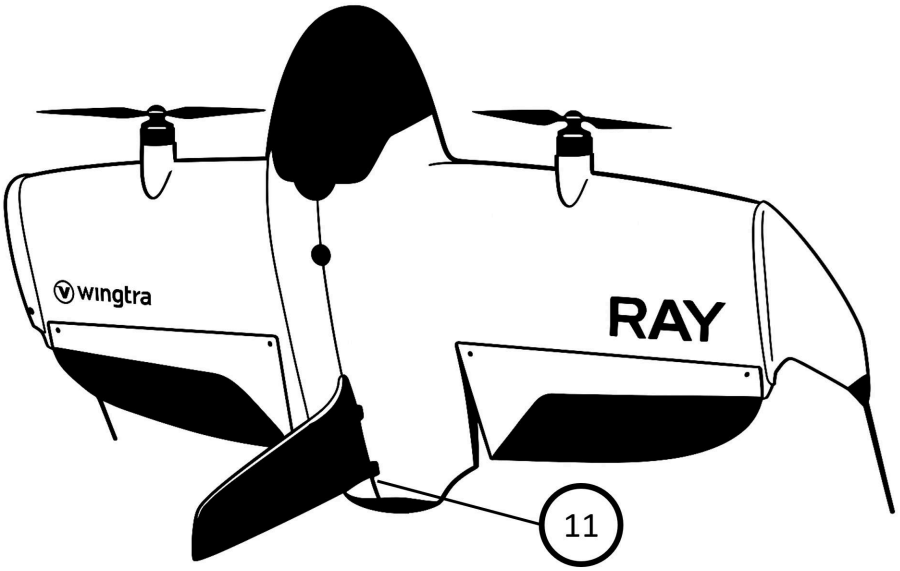




1. Put the two smart batteries in the battery compartment in the nose. You can test the charge of the batteries by pressing their indicator button and looking at the indicator LEDs.
2. Push them down enough that you are able to turn the battery latch into a closed position.
3. Press the Power button in the middle of the battery compartment to turn the Drone ON. The LED ring will light up around the button.
4. Put the nose cone back on the drone

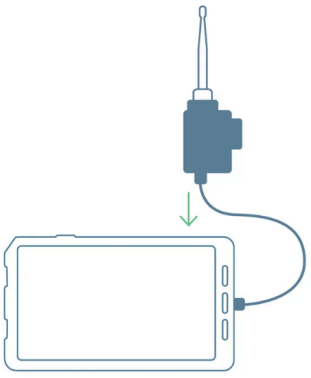
Winglets, Fin, Nose and Tail distance sensor

Make sure the winglets, tail fin and nose cone are mounted on the drone correctly. Also check that the tail distance sensor (11) is clean. It is a small optical lens at the root and behind the tail fin.



Ground station

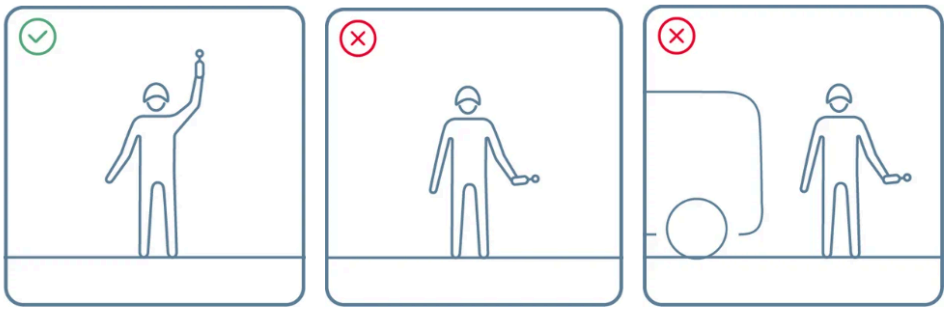
Assemble your ground station by connecting the telemetry module to the provided tablet. Telemetry modules are not interchangeable; make sure the ID of your telemetry matches that of your drone.



The telemetry connection between drone and tablet operates on 2.4016 to 2.4776 GHz frequencies.

Measure the wind speed

Use the wind measurement tool to measure the wind speed.
Don't measure the wind speed while standing behind big obstacles such as buildings or trees. Raise the tool above your head to get the most accurate results.



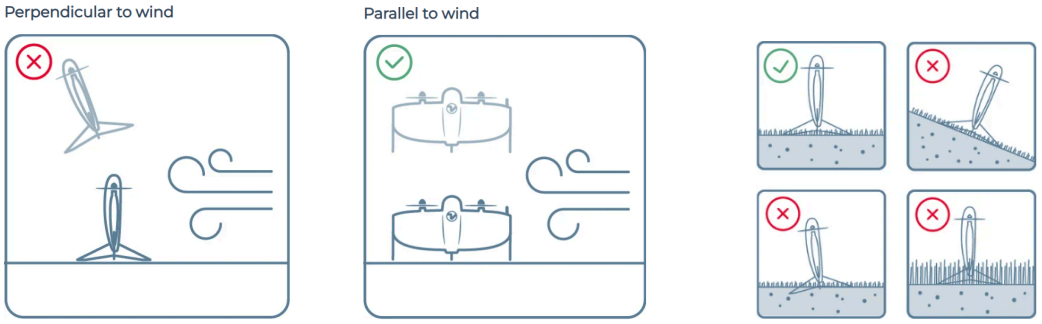
Drone tipping expectations
In calm conditions, WingtraRAY lands smoothly on its tail. In windy conditions, the aircraft can tip over upon landing. Generally this is not a problem and damages rarely occur.

Measured on ground*	Surface wind**	Tipping expectations
0-5 m/s (0-11 mph)	0-7 m/s (0-16 mph)	Rarely occur
5-8 m/s (11-18 mph)	7-10 m/s (16-22 mph)	Can occur
>8 m/s (>18 mph)	>10 m/s (>22 mph)	Not recommended to fly

* As measured with the wind measurement tool from the pilot box
** As referenced in most weather forecasts

Take-off position

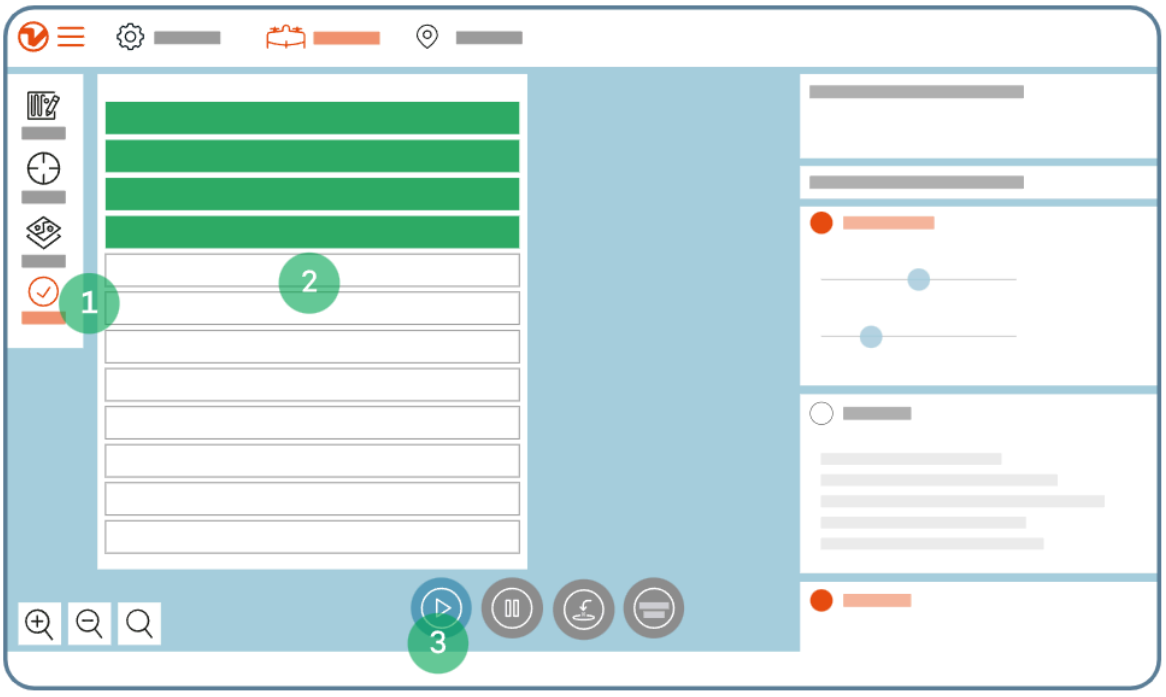
Make sure there is at least 2m of free space around the drone take-off position When placing the drone for take-off, make sure it is positioned parallel to the wind direction.
Be aware that the obstacle clearance zone should correspond to the wind conditions. The stronger the wind, the farther from obstacles the drone should take-off.
Make sure the take-off point is safe distance from people and obstacles.
Place the drone on even ground. Make sure it does not sink into mud or get in high grass.



Start the ground station

Start the WingtraCloud app on the ground station and either select a preplanned flight plan or plan your flight using the tablet. Press fly on the selected plan in the app.

Go through the checklist for the flight to ensure all necessary items and functions are in place for a successful flight. Once the checklist is ready and all items are marked green press the play button to start the flight.



WingtraApp features an extensive, partially automated, and mandatory safety checklist to be completed before allowing take-off:

The following pre-flight checks are covered:

- Automated ground clearance check for the full flight, comparing all flight altitudes to terrain data.
- Automated check against geozones to ensure no geozones are violated with the flight plan or a warning if no geozones are uploaded.
- Manual instructions for examining the hardware for potential damages.
- Automated check for an active data link.
- Automated check for charged flight batteries.
- Automated check for the level position for take-off.
- Automated check for GNSS lock and number of satellites.
- Automated check for the payload sensor to ensure complete data collection.
- Automated check for the PPK
- Automated check to ensure the SD card is inserted and ready
- Automated check to ensure Remote ID is broadcasted before take-off
- User confirmation that flight plan and flight restrictions have been reviewed and the flight plan can be uploaded