



# **Airborne GPS (AGPS) Best Practices**

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**Oregon GPS Users Group, January 11, 2012**  
**Shelby Griggs, PLS**  
**OrbiTech, Inc.**

# Topics

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- **What is AGPS?**
- **What does this mean to you?**
- **What might be your involvement?**

# What is AGPS?

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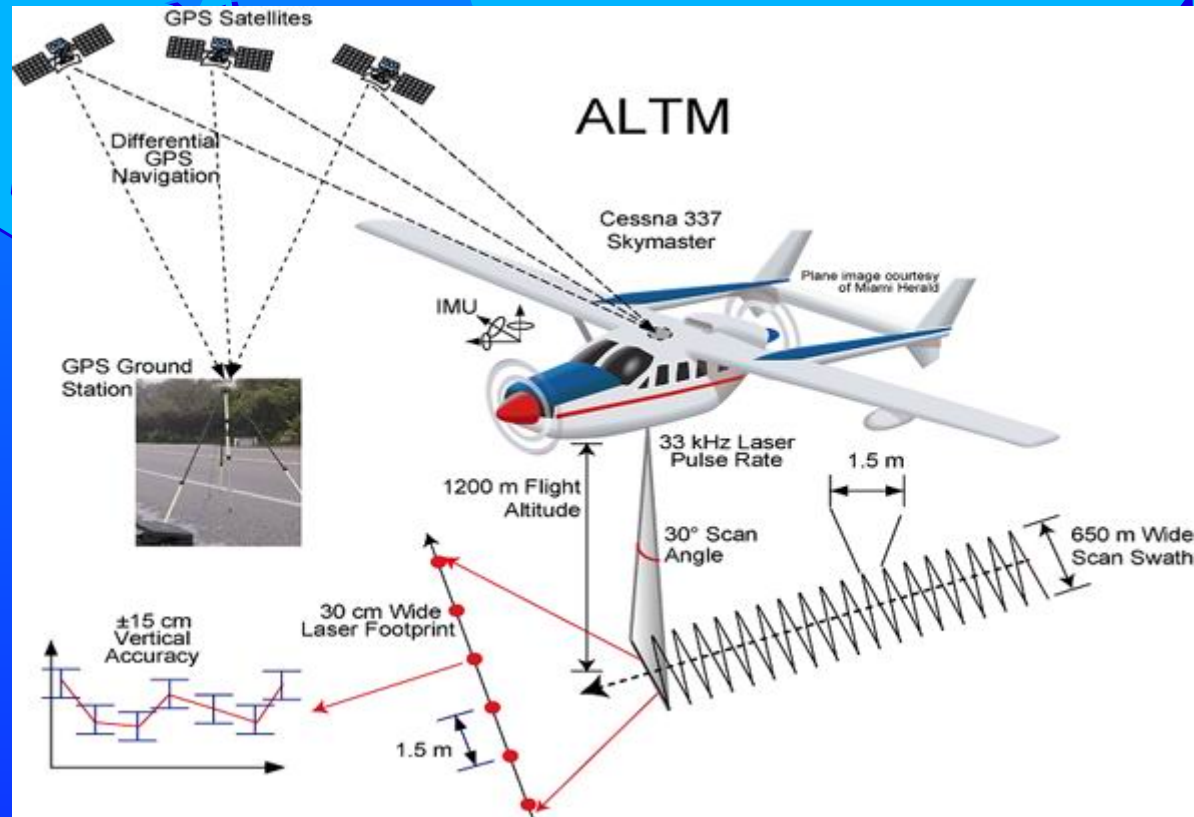
- **AGPS = Post Processed Kinematic GNSS**
  - Provides trajectory of antenna on a moving platform
    - **Aerial platform**
      - ▶ Camera system
      - ▶ LiDAR system
    - **Ground vehicle**
      - ▶ LiDAR / mobile mapping system
      - ▶ Simple trajectory

# What is the purpose of AGPS?

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- Reduces amount of ground control required for mapping projects
  - Direct positioning of sensor, rather than positioning by resection
  - Does NOT eliminate ALL ground control
  - Does reduce project costs on most projects
  - Primary positioning method of moving LiDAR sensors (along with Inertial Motion Unit (IMU))

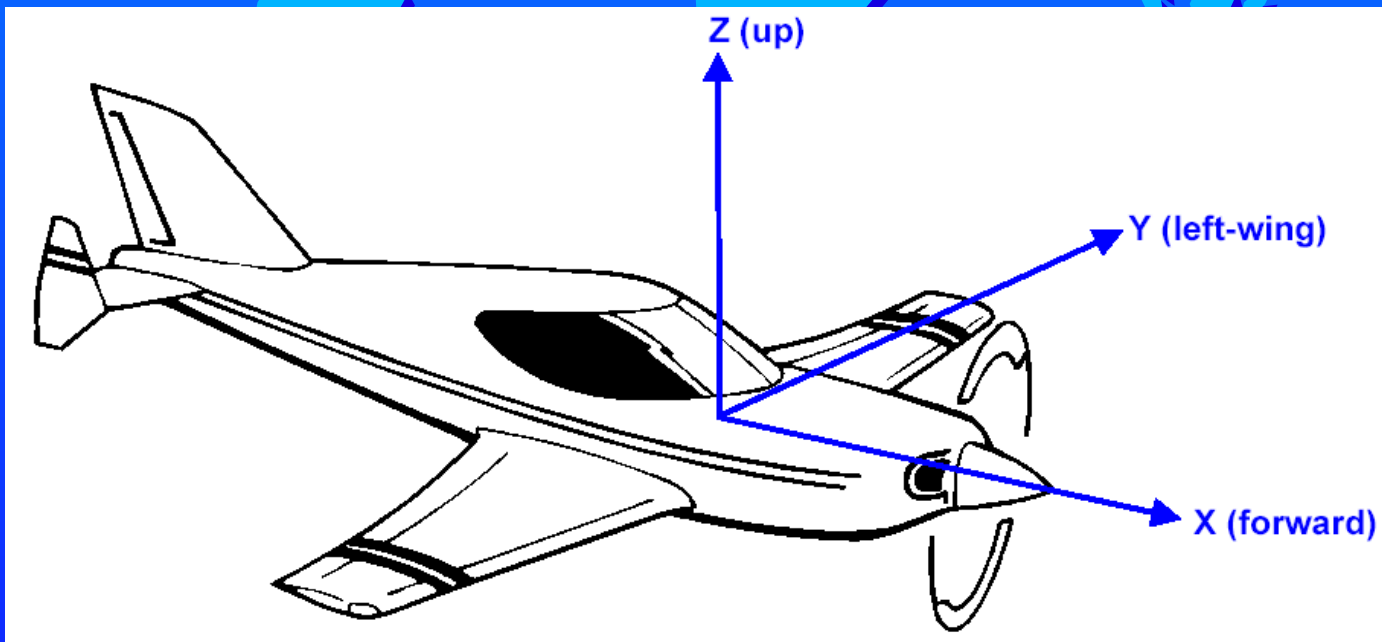
# What is AGPS?



# Antenna - Sensor Offsets

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- Offsets from entry nodal point on aerial camera to APC in aircraft reference frame
  - X = positive axis through nose of aircraft
  - y = positive axis through the left wing
  - z = positive axis through the roof



# Measuring Antenna - Sensor Offsets

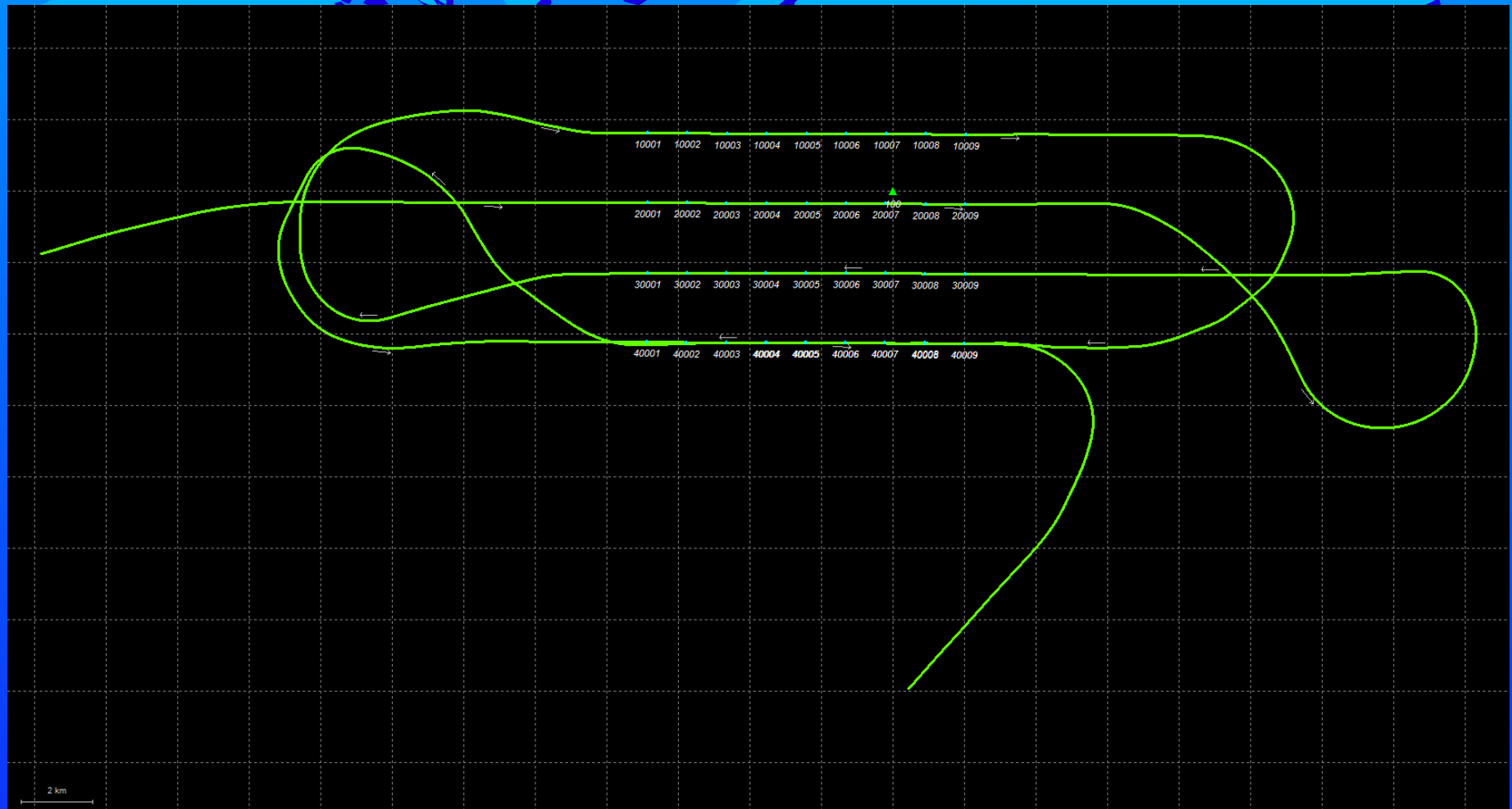


# Aircraft GNSS receiver?

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- **Geodetic quality receiver**
  - Typically same as ground survey receiver
  - Sometimes part of sensor system
- **Key difference, MUST have interface to camera system for input of time pulses at instant of exposure**
  - Factory upgrade option on many geodetic receivers

# Sample AGPS Trajectory



# What does this all mean to me?

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- **AGPS is in common use**
  - Reduces ground control
  - Reduces mapping costs
- **You may be called on to provide a ground base station or stations for an aerial mission**
  - Likely you won't be involved with measuring aircraft
  - Likely you won't be involved with processing flight data

# If I ask you to run an AGPS ground station, what do I want?

## (Communication is above all else!)

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- **Keep communication open at all times**
  - **With flight crew**
    - **Critical for mission time changes, etc.**
      - ▶ **Hand-held airband transceiver recommended (+/- \$300)**
  - **With data processing person**
  - **With your field crews**

# If I ask you to run an AGPS ground station, what do I want?

## (Site requirements)

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- **Static GNSS survey with strict requirements!**
  - Wide open skies
    - Above  $10^\circ$  horizon / full  $360^\circ$
  - No RF interference (including your phone)
  - Essentially what would be a CORS site criteria!
- **Located within 20 km of aircraft**
  - Projects covering large areas (i.e.: entire county, corridors, etc.) may require multiple ground stations

# If I ask you to run an AGPS ground station, what do I want?

## (Equipment requirements)

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- **Dual frequency receiver**
  - Prefer GPS / GLONASS
  - Adequate power
    - EIGHT+ hours
  - Adequate memory
    - Will likely need several Mb
      - ▶ Some equipment with internal memory will be inadequate
  - Ability to collect data at 1 Hz or faster

# If I ask you to run an AGPS ground station, what do I want?

## (Field operations pre-flight)

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- Arrive early to predetermined location
  - Preference is one hour before arrival of aircraft
- Stable setup, remember you may be on station ALL day
- Verify battery and memory status
- Start static survey
  - 10° mask
  - High data rate
    - Usually 1.0" (1 Hz) OR 0.5" (2 Hz)
    - Sometimes as high as 0.1" (10 Hz)



# If I ask you to run an AGPS ground station, what do I want?

## (Field operations checks)

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- As with any static observation, check and double check!
  - Antenna height
    - This ALWAYS needs to be to the ARP!!!!
      - ▶ If need be, reduce slant distances to the ARP or provide ALL information for later reduction. Remember this data will be processed in a 3rd party software
  - Document receiver type and EXACT antenna type (photos are good)
  - Verify level and over the point

# Field Notes are important

|  |  |   |
|--|--|---|
|  <b>OrbiTech, Inc.</b><br><small>Geospatial Solutions in Mapping, Surveying and GIS<br/>a member of the GeoTerra Mapping Group</small>   |  | <b>Julian Day:</b> 11-267   |
| <b>OrbiTech #1</b>   | <small>421 NE Robin Court<br/>Prineville, OR 97754</small> | <b>Session:</b> 267-1->2  |
|  | <small>(541) 233-2018<br/>survey@orbitechinc.com</small>   | <b>Base at:</b> 9FMK  |
| <b>Leica GPS System 1200 Log Sheet</b>   |  |   |
| <b>Station Description:</b> Found 3 1/2" diameter USGS brass disk<br>inside 6" soil pipe   |  | <b>Station I.D.:</b> 9FMK   |
| <b>Date:</b> 09/24/2011  |  |   |
| <b>Job #:</b> 10-012   | <b>Project:</b> B2H Power Line Post ID Control             |   |
| <b>Sensor #:</b> 468151 (OrbiTech#1) <b>Controller #:</b> 115736 (OrbiTech#1) <b>Operator:</b> SHG (LS 2578)   |  |   |
| <b>Start Time:</b> 10:00 <input type="checkbox"/>  | <b>End Time:</b> 22:00 <input type="checkbox"/>            | <b>Time Zone:</b> MDT (-6) <input type="checkbox"/>                                   |
| <b>Instrument Height</b>   |  |   |
| <b>Starting H.I.:</b> 1.1730 Meters  | <b>3.855 Feet</b>  | <input type="checkbox"/> 1.175 <input type="checkbox"/>                               |
| <b>Antenna Data</b>  |  |   |
| <b>S/N:</b> OrbiTech #1 (7240022)  |  |   |
| <b>Ending H.I.:</b> 1.1735 Meters  | <b>3.855 Feet</b>  | <input type="checkbox"/> 1.175 <input type="checkbox"/> <b>OFFSET:</b> Tripod 0.360 m |
| <b>Pseudorange Geographic Coordinates</b>  |  |   |
| <b>Latitude:</b> 43° 45' 09" North   |  |   |
| <b>Longitude:</b> 117° 15' 22" West  |  |   |
| <b>Point Notes</b>   |  |   |
| <p><i>Found 3 1/2" diameter USGS brass disk inside 6" soil pipe. Point is located in Section 7, T21S, R45E, WM, approximately 15.8 miles south of the Malheur County Courthouse in Vale, OR. To reach from the intersection of Owyhee Avenue and State Highway 201 approximately 8 miles south of Nyssa, OR, proceed west on Owyhee Avenue for 6.0 miles, turn left on Mitchell Butte Road and go south for 0.5 miles, bear right and follow Mitchell Butte Road 0.5 miles to end of pavement, continue westerly (up Rock Spring Canyon) for 4.4 miles to a fork, bear left and continue for 0.3 miles to the point on the right at a 4-way dirt road intersection. Point is located 41 feet NW of the main dirt road.</i></p> |  |   |
|    |  |   |
| <small>OrbiTech Job No. 10-012    09/24/2011    OrbiTech Job No. 10-012    09/24/2011 14:55</small>  |  |   |

# If I ask you to run an AGPS ground station, what do I want?

## (Field operations during flight)

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- During mission, periodically verify that collection is running normally
  - Verify tracking ALL IN VIEW satellites
    - Minimum of SIX satellites at all times
  - Verify PDOP is low
    - Maximum of 5 (or pre-mission determined value)
- Don't just ignore receiver and assume all is well, stay on top of your game
  - If something goes to mission critical status, attempt to communicate with flight crew

# If I ask you to run an AGPS ground station, what do I want?

## (Field operations post-flight)

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- At end of mission continue to collect data for a minimum of 30 minutes
- Checks **BEFORE** breaking the setup
  - Receiver is still level
  - Receiver is still over point
  - Verify antenna height

# **If I ask you to run an AGPS ground station, what do I want?**

## **(Office operations post-flight)**

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- **Download and backup data ASAP**
- **Verify data looks reasonable**
  - **Tracked entire mission**
- **Provide raw data files (usually native format is just fine)**
- **Provide copies of all field notes to include**
  - **Point name**
  - **Antenna height**
  - **Receiver and antenna type**
  - **Photos (if taken)**
  - **Coordinates / elevation of point**

# Do not forget your basics!

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- You are going to probably think this is easy, it is, yet it is **VERY** unforgiving!
  - Common issues:
    - Dead batteries
    - Out of memory
    - Set up in wrong location
    - Wrong antenna type / measurements
- Flight time is **VERY** expensive
  - It could also be days before weather / aircraft / ground crews can **ALL** be rescheduled

# Questions / Contact Information

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***OrbiTech, Inc.***

*Geospatial Solutions in Mapping, Surveying and GIS*

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*a member of the GeoTerra Mapping Group*

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