# Bridger Latitude Data Considerations

**Roberts Fire NM-CIF-000143 Notes**
**July 24-31, 2019**
**Compiled by J. Murgoitio**

**Highlights**

- GCS Maps exported as 1200 dpi geotiffs from ESRI generally work with no issues.
- Launch, recovery, and control require minimal footprint
- Gimballed CM142 imaging system shoots EO/SWIR/LWIR, can stop and start recording in flight, and can download data on the fly.
- Fire Mapper system was useless for orthomosaics in our systems. A different camera setup is (hopefully) in the works for the Latitude.
- Piccolo has no ability to calculate transects with set overlap and sidelap, it must be done manually.

**Site Selection**

Predicted mission altitude was coordinated with the flight crew based on the highest elevation in the area of the fire. Visibility calculations were run from the aircraft, with a position at the far side offset of the fire at 3 altitude blocks (11k' MSL, 12k', 13k'). In other words, we looked at where the LRZ would likely be, simulated the aircraft's flight position on the side of the fire where line of sight would be the worst, and worked from there. Based on these calculations, the UASM expanded the TFR from 5nm to 8nm to allow for better LOS between the aircraft and control station.

The launch, recovery, and control site was selected on the top of a bluff with good LOS into the fire area, solid radio comms with dispatch via repeater, and 4G LTE service. Having internet at the GCS site was huge for troubleshooting. LRZ was a 1nm radius, surf to 13k' msl which was the ceiling of the TFR.

Vendor footprint included 2 cargo vans and 2 pickups with associated popup shades and generators. GCS was situated in one of the transport vans. The footprint was probably larger than normal because of the additional folks that Bridger brought along for training and logistics. Agency UAS module consisted of 1 truck, a popup, and a generator. Not having the trailer made working from a laptop screen hard in full daylight. We spent several hours with our rain coats draped over our heads and screens.

**GCS Maps**

Data acquisition and initial GCS map construction took the better part of a day and was performed before checking in with the incident. No local GISS was available. Data was assembled using various web resources and local contacts. NIFC FTP was sparsely populated, but an IR perimeter was available.

The flight control computer (used by the pilot in command) and the Sensor Operator (SO) computer are separate systems and they each have to load GCS maps. They will both take geotiff basemaps, but the SO typically used the GCS map with incident information (perimeter, division breaks, DPs, etc.). The PIC preferred to use aerial imagery. Both systems can load and switch between basemaps dynamically. The PIC and the SO worked together closely for aircraft positioning and camera placement.

Line and point shapefiles may be useful for SA, particularly if the PIC does not use the prepared basemap and would rather use imagery or a topographic map. Piccolo had no ability to create transects with set overlap and sidelap (eg Mission Planner) so transects and turnpoints were created by hand. Having incident reference information as shapes could be helpful for this process.

Bridger arrived with a DEM and hillshade already loaded in their system, and this was usually displayed on the SO computer. Transparency in the GCS map with no hillshade included worked well for SA, as the terrain information could be seen in the preloaded DEM behind the GCS map.

All maps were exported from ArcGIS as geotiffs with world files at 1200 dpi. PCS WGS 84 was used for a coordinate system.

**Mission Execution**

The gimballed CM142 imaging system worked fine for situational awareness through video (IR and EO). Clips could be recorded and downloaded to the GCS with relatively fast downlink speed. Video is MISB compliant and required nothing special to work with ESRI FMV or for editing in VLC. Camera FOV, sensor location, and image center displayed correctly in FMV with accuracy as expected. The SO can pan and zoom the belly mounted camera with nearly an unlimited range of motion, so orbit placement and offset are really a nonfactor for platform - camera interoperability. Aside from a few marked locations from the image center for smokes along the perimeter, no dynamic mapping was conducted with the CM142.

The Firemapper payload was underwhelming. Video coming from the nadir mounted camera was not of high enough resolution for an orthomosaic that could be used for perimeter mapping. We could have simply flown over the perimeter using a combination of the gimbal camera to locate and overfly the perimeter and done mapping in FMV with the nadir video, but the product request from the IC and FMO was to build an orthomosaic to assess burn severity, etc. Since our UASD software suite had no capability to work with MISB video directly for mapping orthoimagery, stills were pulled from the video in both VLC and FMV geoprocessing tools, and ran through Agisoft. We could not derive a useful product despite several attempts of this method.

A FLIR DUO Pro R camera was mounted on the Latitude on the final day of our assignment. The ingenuity and MacGuyver-esque approach by Bridger and the L3 engineering staff to getting the mapping mission completed was truly impressive. Although we experienced problems with the IR imagery and a significant amount of overcollection, the EO imagery from the FLIR ran directly into Agisoft and produced an orthomosaic with ~4m resolution, which was sufficient enough to produce a perimeter map and a burn severity assessment by the home unit.

**Products**

The Cibola NF asked for products relating to burn severity in certain geographic features of the fire area, Priority Areas for Conservation for the Mexican Spotted Owl, and for general situational awareness of fire behavior. The orthoimage informed almost all of these requests, and would have been much more helpful if it could have been collected multiple times during the assignment.

**Data Management**

Data was handed back to the incident via the IC on an external harddrive. All data products, raw video, and imagery was organized and named by flight day and type within the suggested UASD standard. A copy will be kept by the UASD for backup and training purposes.

**Other Notes**

Bridger Site lead was Wes Irr. Justin Weiland was the primary PIC. Bridger brought several other individuals along for training and logistics.

All Data Products and GCS maps are available on the UAS drive.

## Wendover Vendor Training Notes - May 2019
## Compiled by B. Schroeder

**Ground Control Station (Piccolo)**

- Basemap
  - File format
    - Accepts TIFF with geotags and world file - must retain background color
  - World File? Geotags?
    - Accepts world file with geotags
  - DPI?
    - Accepts 1200 dpi, must retain background color
  - Projection or Geographic Coordinates?
    - Able to project on the fly - Projects GCS NAD83 or PCS WGS84 is a best practice
  - Multiple maps?
    - Ground Control station can load multiple maps in TOC to toggle on and off
    - No preference on base map (imagery, topo, shaded relief, CIR)

- Terrain Model
    - DEM
        - Generated from their dataset based on 30m NED
        - Able to pull in TIFF of DEM
- Waypoint entry
    - Manual coord entry for POI?
        - Capable of entering a handful of points manually (any format can be converted)
    - CSV for multiple waypoints?
        - Currently unable to import .txt or .kml from Mission Planner

**Site Selection Requirements:**

- Antenna height : 10’
- Minimum flight altitude: 2000’
- Footprint launch/recovery: 300’ (runway length) x100’ clearing, ideally obstacles within a quarter mile are less than 100’ tall (for both approach and departure)

**Sensor Considerations**

Sensor Display (Vexos)

- Displays where/how for which sensors?
    - Lat/Long display? Sensor center?
        - Lat/long is displayed as text on video screen, based on sensor center
        - Unable to click cursor on screen to obtain coordinates of area in image other than center
    - Gimbal angle for tilt and pan displayed?
        - Both angles displayed on video screen
    - HFOV displayed?
        - HFOV displayed on video screen
- Basemap displayed?
    - Same or different from GCS basemap?
        - Different systems between sensor display and groundcontrol
    - Displays footprint of sensor FOV?
        - Will display properly if DEM is loaded
    - Format?
- Elevation model required?
    - Format?
        - TIFF file should create .CTM file but was not working on

Gimbal Control

- Zoom specs?
    - 
- Cursor control? Slaved to GCS waypoints?
    - 

- Tracking?
    -

Sensor Specs

- Three on mapping sensor (EO, SWIR, LWIR) and one EO/IR on gimbal

| | Daylight Sensor | LWIR Sensor | SWIR Sensor |
|---|---|---|---|
| Resolution | 1920x720 | 640x480 | 640x480 |
| Pixel Pitch | | 17µm | 15µm |
| Sensor Height | 6.17mm | 10.9mm | 9.6mm |
| Sensor Width | 4.55mm | 8.2mm | 7.68mm |
| Focal Length | 8mm | 19mm | 16mm |

- For each sensor:
    - Megapixels?
    - Resolution height and width (pix)
    - Sensor height and width (mm)
    - Focal length (mm)
    - IR
        - Pixel pitch (microns, if applicable)
        - Radiometric?
            - No
- For multiple optics
    - Boresighted?
        - Factory boresight but not field tested

Data Collection

- Video
    - Dual streams? Freqs?
        - Dual streaming
    - Stream multiple sensors?
        - Multiple sensor display
    - Streamed packet size?
        - ?
    - Closed circuit or IP?
        - Multicast
- Stills
    - Ability to collect stills while collecting video?
        - Yes, JPG with KML containing platform and sensor location
    - Stills watermarked?
        - Yes
    - For mapping - intervalometer or camera triggers?
        - Intervalometer, no camera trigger

Storage

- Files archived on display device and/or onboard? File type?
    - Files archived on both display computer and onboard
    - TS files
- Files backed up on server?
    - No
- Files chunked based on size or time?
    - 30 minute chunks
- Transfer method?
    - Jump drive

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**Actions Items**

- **Address DEM consumption in sensor display**
- **Address renaming file prefix for mapping sensors and gimbal sensor**
- **Address UNIX time stamp on SWIR and ECON files**