

# Remote Sensing Center: March 2019 Colorado Deployment Report

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Remote Sensing Center  
The University of Alabama



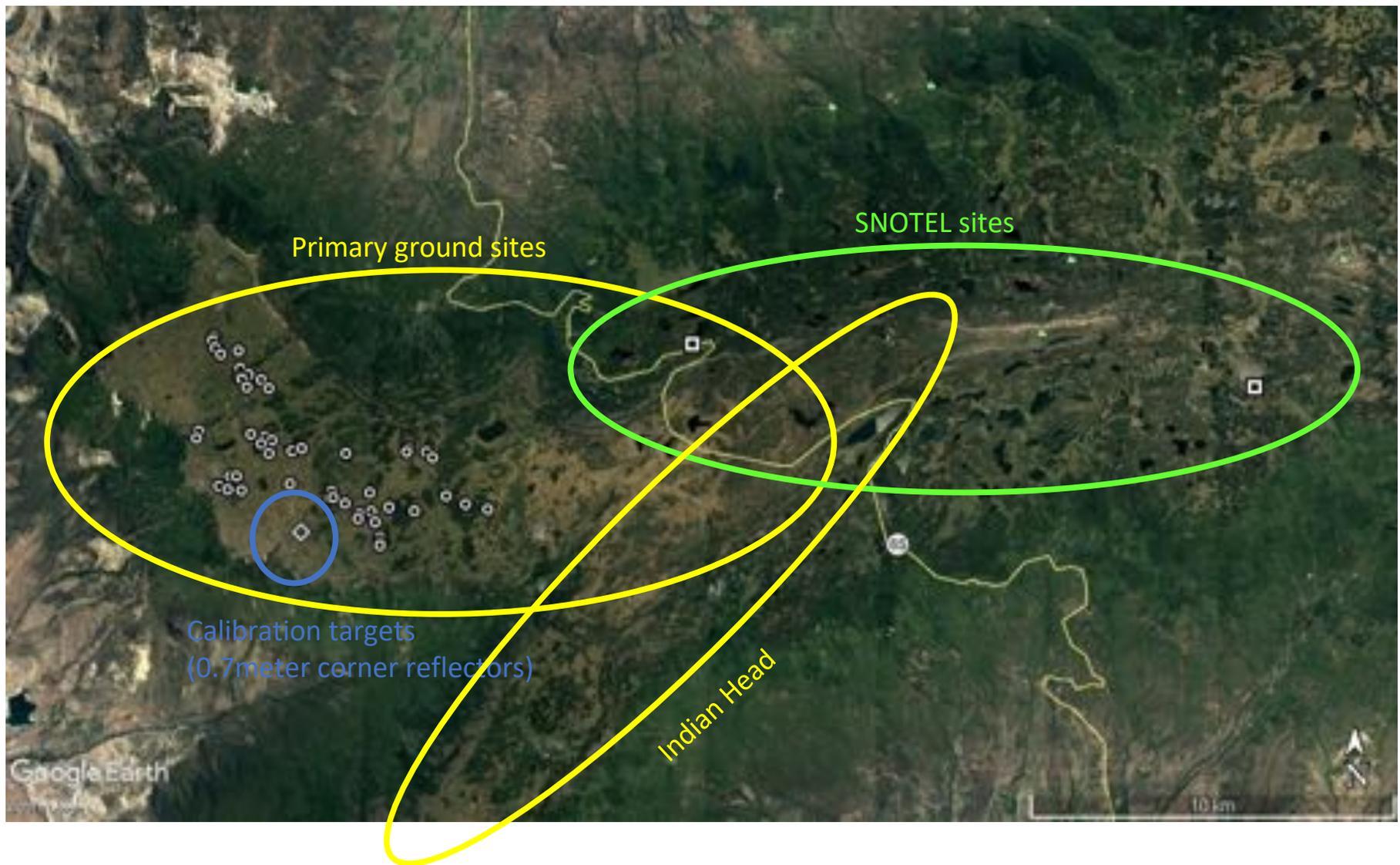
# Grand Mesa



- Elevation: 9900 ft – 10800 ft
- ~6000 ft above valley floor
- 2.5+ meters of snow cover
- “Most snow in 50 years”



# Grand Mesa



# Forward Cavity Systems

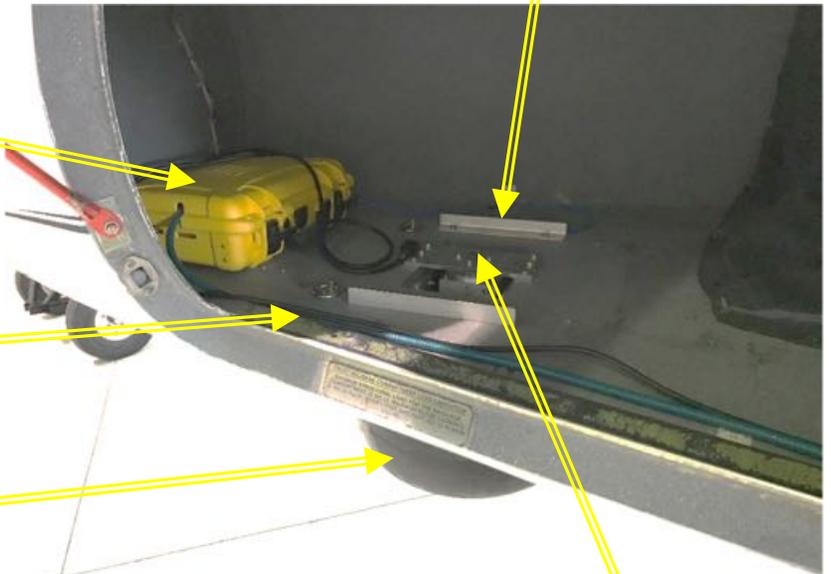


“Baggage”  
Power Amp  
& Case

RF & Pwr  
Cables

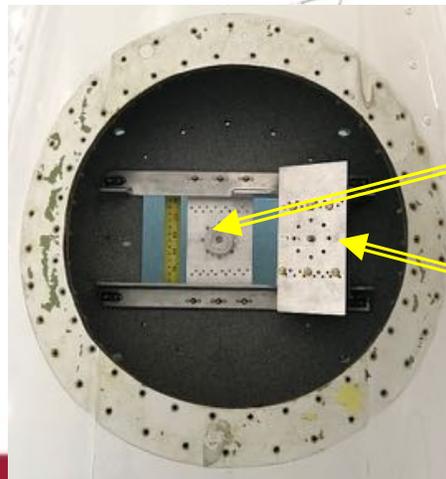
Radome

Radome Mounts



Tx Antenna &  
Nadir Mount

30° Mount  
(starboard)



# Aft Cavity Systems



Bottom View

IR Camera (FLIR Vue-R Pro)

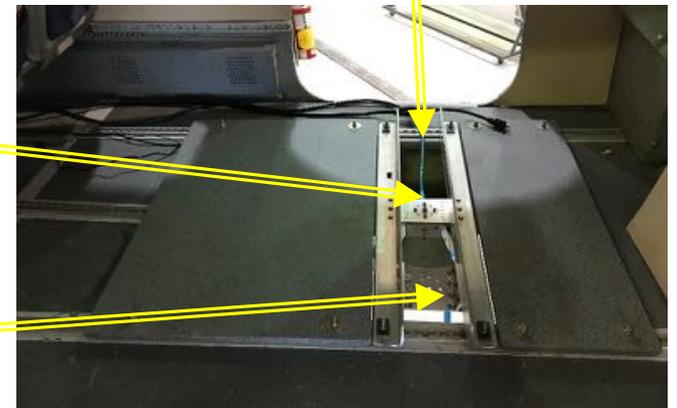
Trigger system & Power supplies  
(hidden)

Optical Camera  
(Canon D850 with  
50 mm lens)

Rx Antenna &  
Nadir Mount

30° Mount  
(starboard)

RF cable



Top View

# Radar Systems Rack Mount

Total weight: 205 lbs with rack  
Bolted to seat rails at aircraft CG



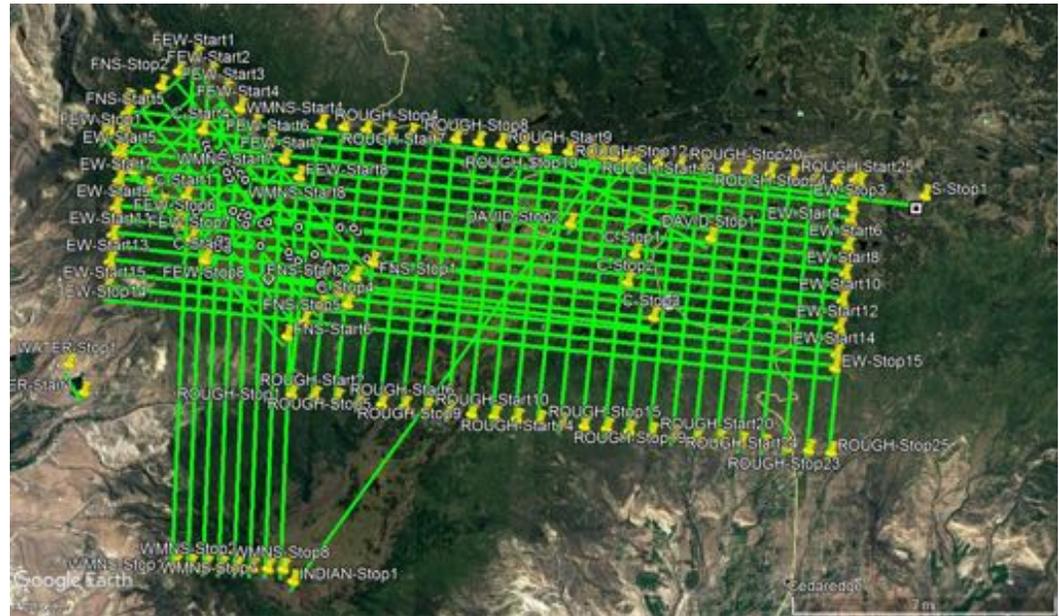
1. Aero Case
  - Camera Triggers
  - PNT & data storage
2. Display & Keyboard
3. Server
4. Switch
5. Digital System
6. Radar RF Tx/Rx
7. UPS (power supply)



# Flight Director & Mission Planning



- Laptop backend
- Surface tablet display
- HSI & CDI



- Google Earth visualization
- Flightline generation
  - Python grid
  - Lat-Lon-Alt
- Converted to kml
- Flight Director courses.txt



18<sup>th</sup>



19<sup>th</sup>



20<sup>th</sup> AM



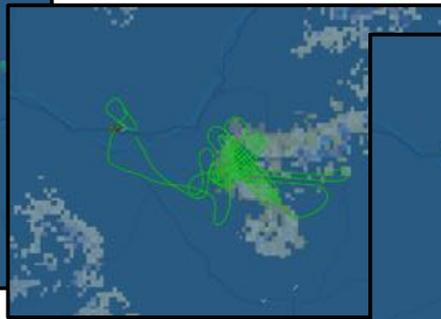
20<sup>th</sup> PM



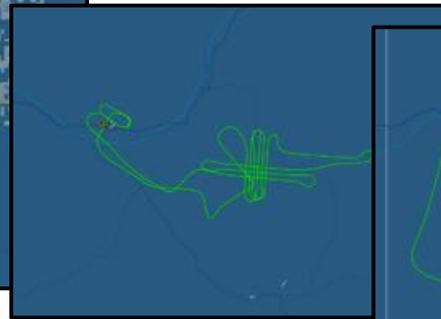
21<sup>st</sup> AM



23<sup>rd</sup> AM



25<sup>th</sup> AM



26<sup>th</sup> AM



26<sup>th</sup> PM



27<sup>th</sup> AM



27<sup>th</sup> PM



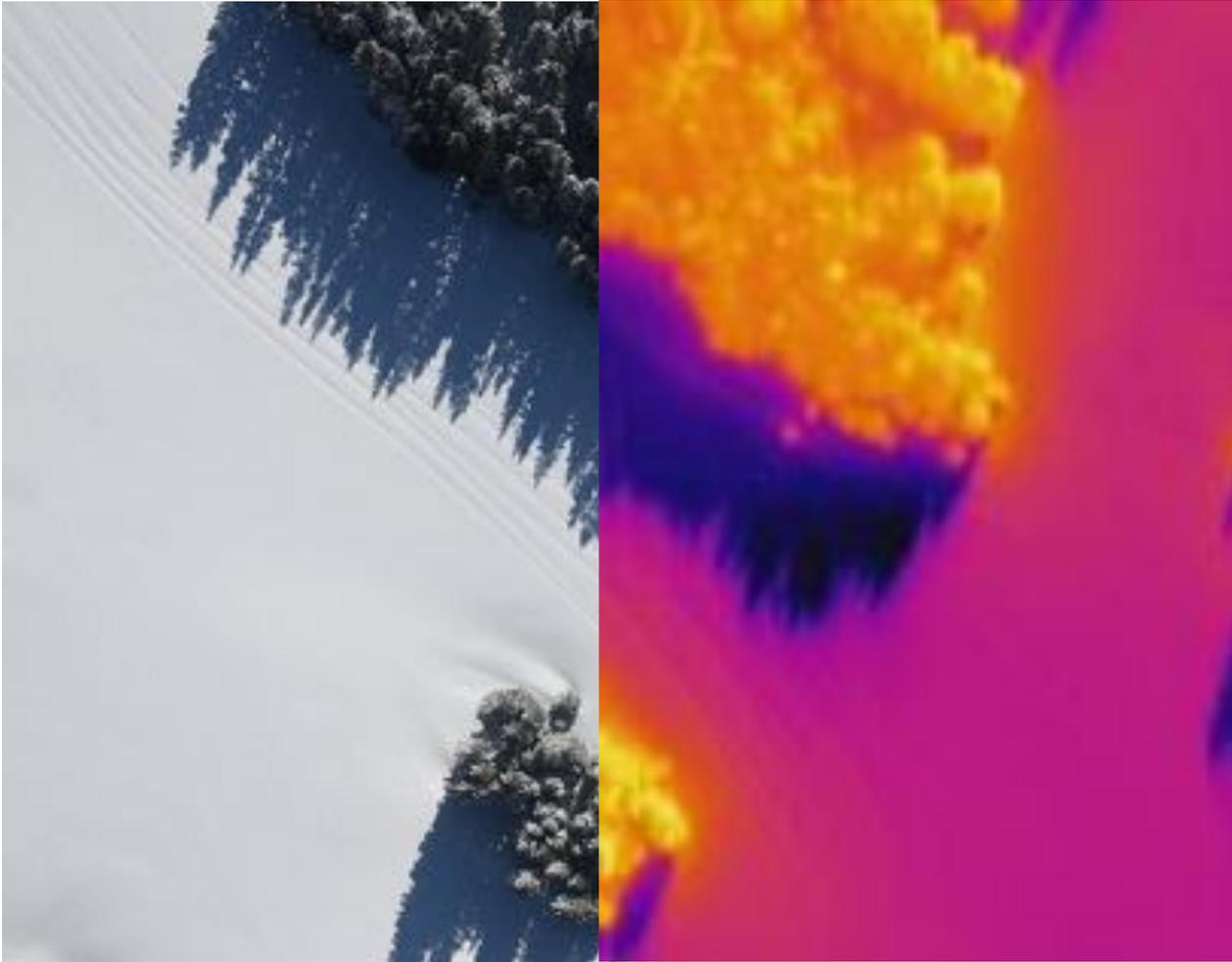
28<sup>th</sup> PM



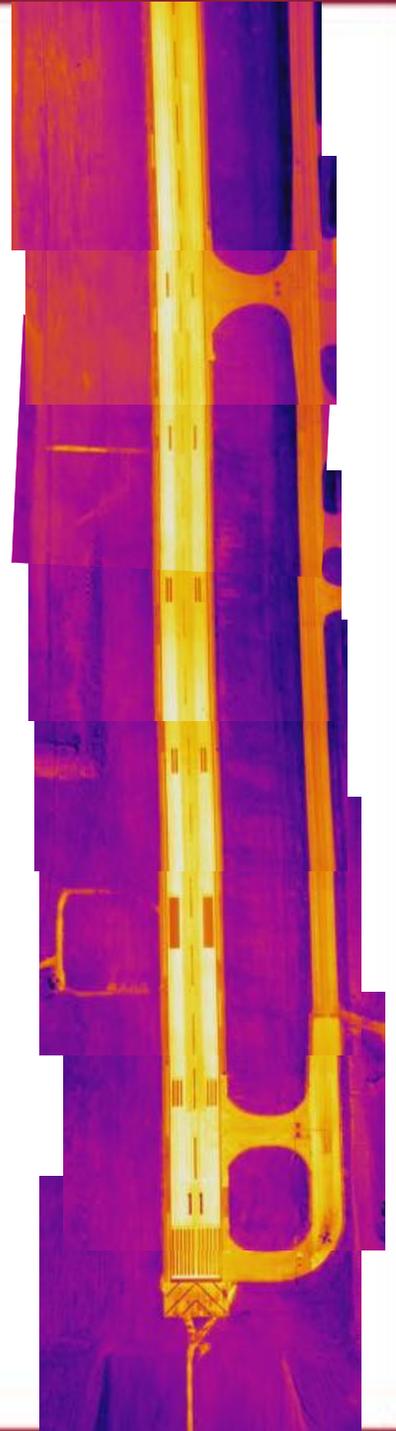
29<sup>th</sup> AM

32 hrs of flight time  
3633 nm  
13 flights

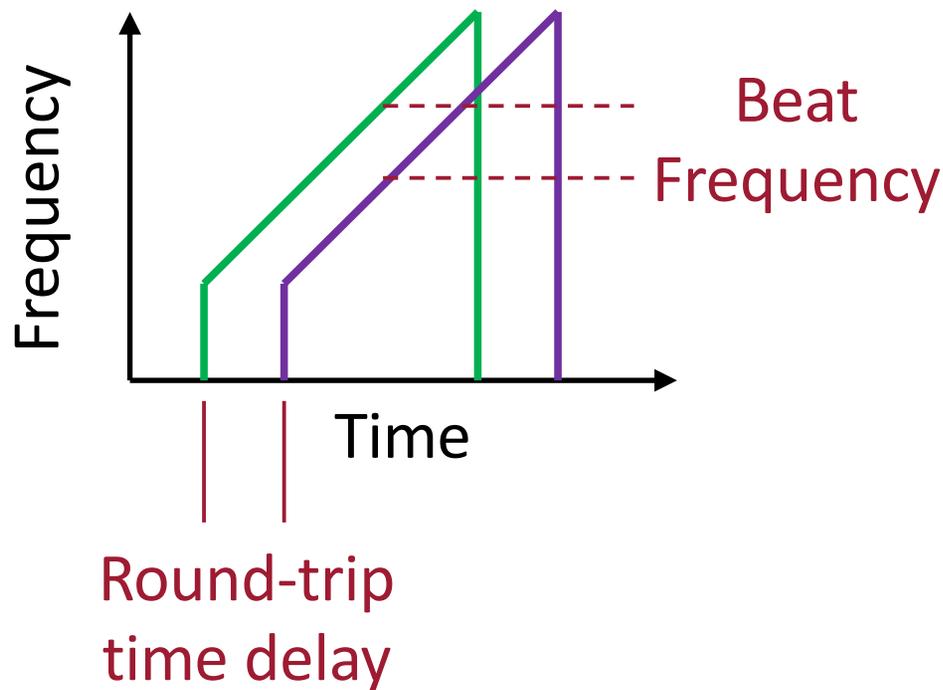
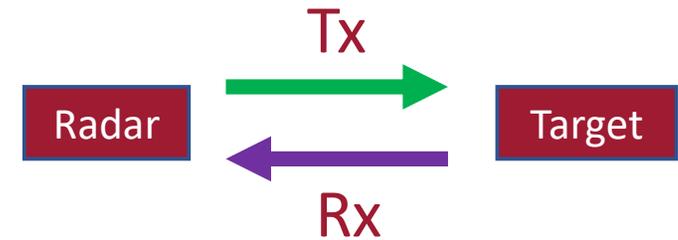
# PNT, Optical & IR Data



752 GB – 75k files



# Theory of Operation



$$t_{\text{delay}} = \frac{2 \times \text{range}_{\text{one-way}}}{c}$$

$$\frac{t_{\text{delay}}}{T_{\text{sweep}}} = \frac{f_{\text{beat}}}{B_{\text{sweep}}}$$

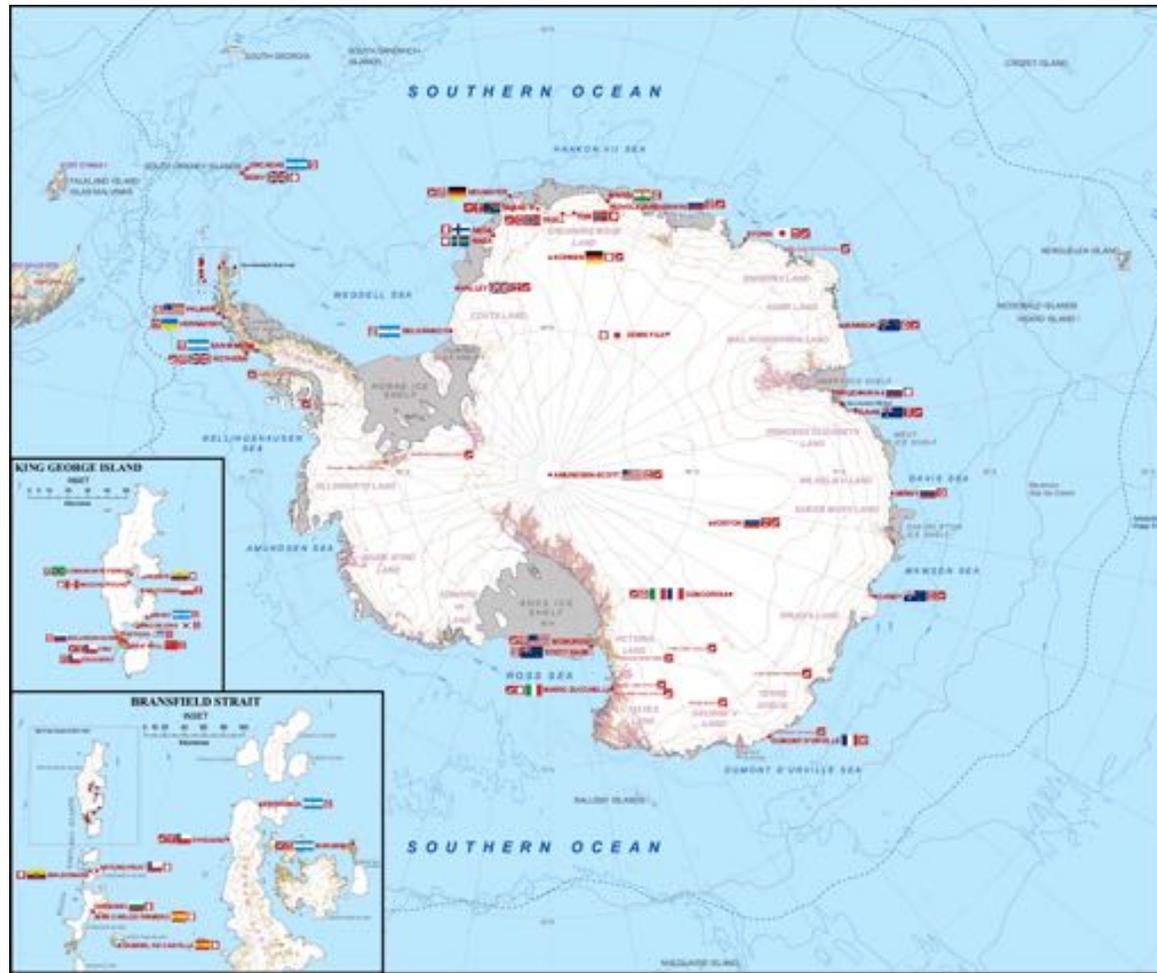
$$\text{range}_{\text{one-way}} = \frac{c T_{\text{sweep}} f_{\text{beat}}}{2 B_{\text{sweep}}}$$

$$\text{resolution} = \frac{c}{2 B_{\text{sweep}}}$$

# Deployment Goals

- Fully exercise and validate our second generation FM-CW radar
- Prove our capability to measure snow thickness from an airborne vehicle
  - Need high resolution *and* high range capabilities
- Test some experimental concepts of sub-banding data

# First Generation UA Snow Radar

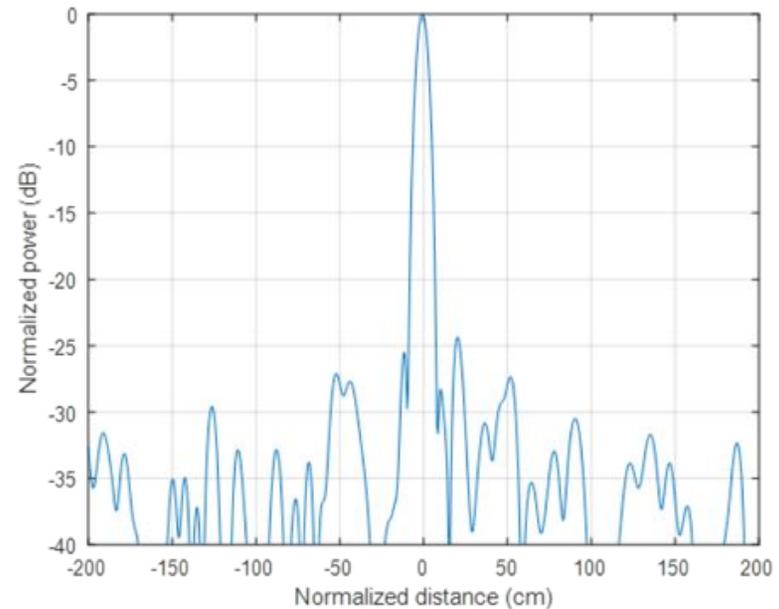


- Joint mission between:
- Norwegian Polar Institute
  - National Institute of Polar Research
  - University of Alabama
  - University of Kansas

Campaign to Dome Fuji  
from Syowa Station

# First Generation UA Snow Radar

- 2-3 month timeline
- Built for ground penetrating application
- 4 GHz usable bandwidth
- Theoretical resolution of close to 2.5 cm
  - Measured resolution of around 7-8 cm
- Data set being released this week



# Second Generation UA Snow Radar



Increased bandwidth to 8  
or 16 GHz

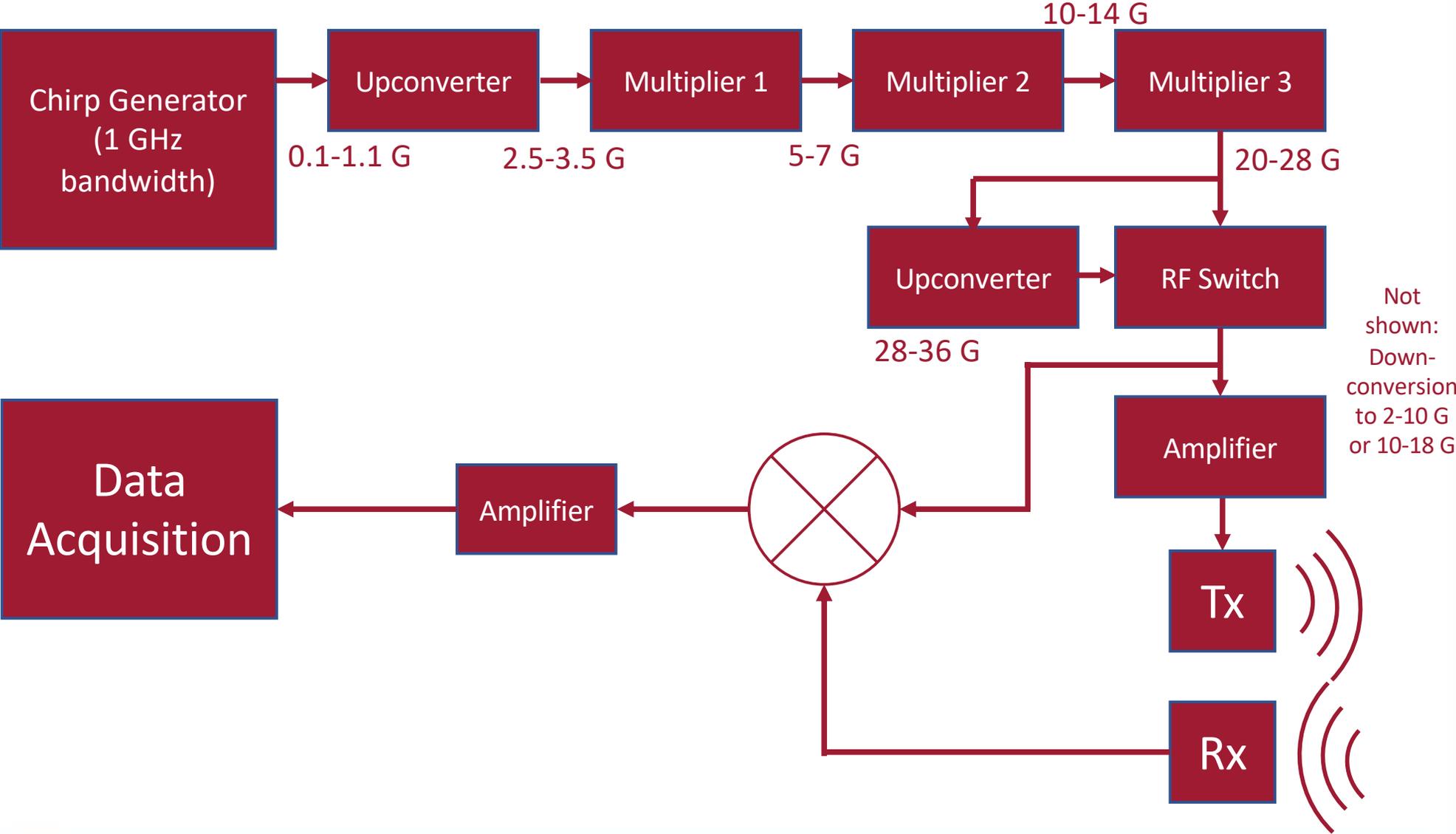
Integrated GPS tagging for  
elevation compensation

4 month  
timeline

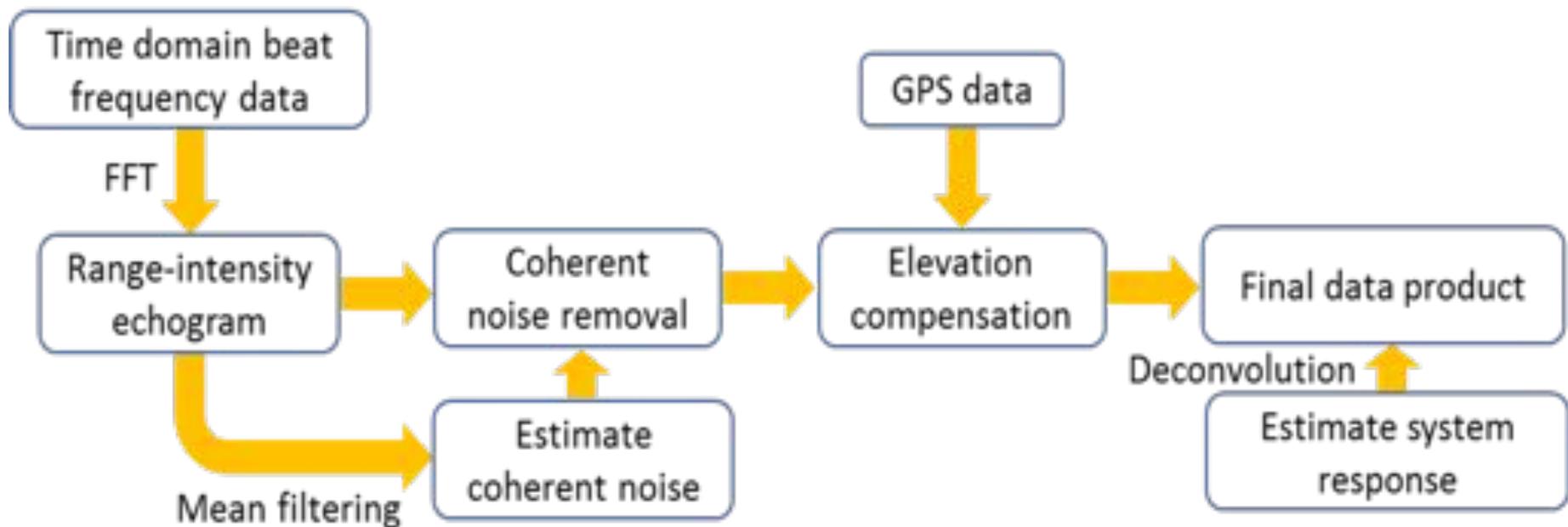
Increased range for airborne  
applications

Auxiliary sensor package  
(optical and IR cameras)

# Second Generation UA Snow Radar

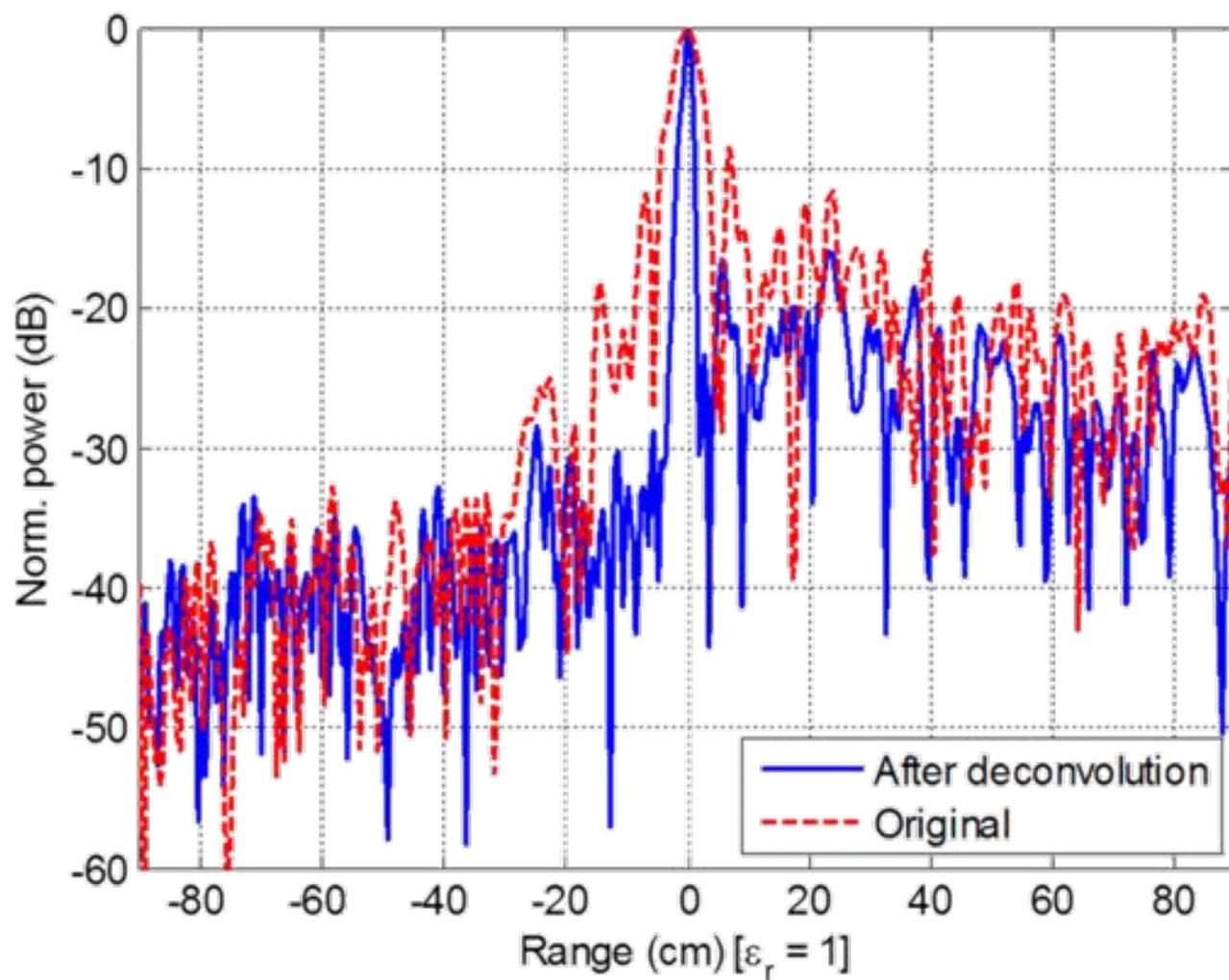


# Snow radar data processing



3.4 TB of raw radar data

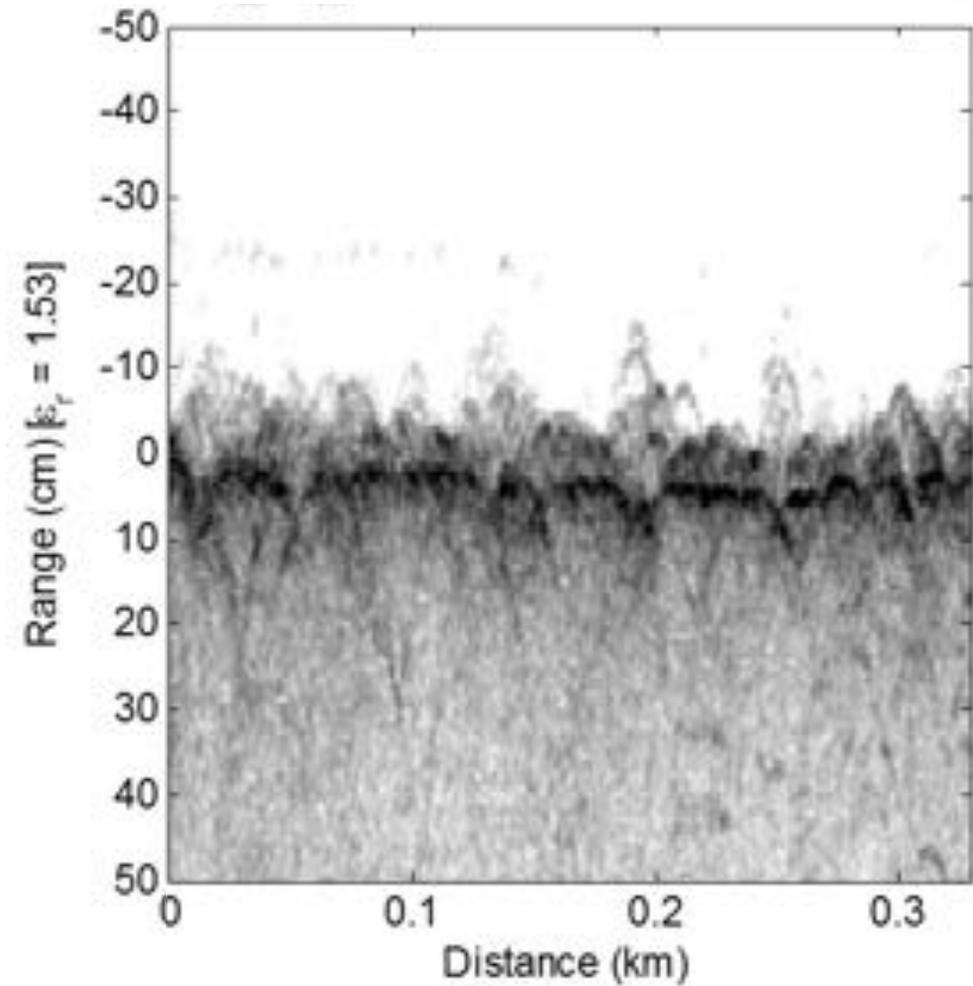
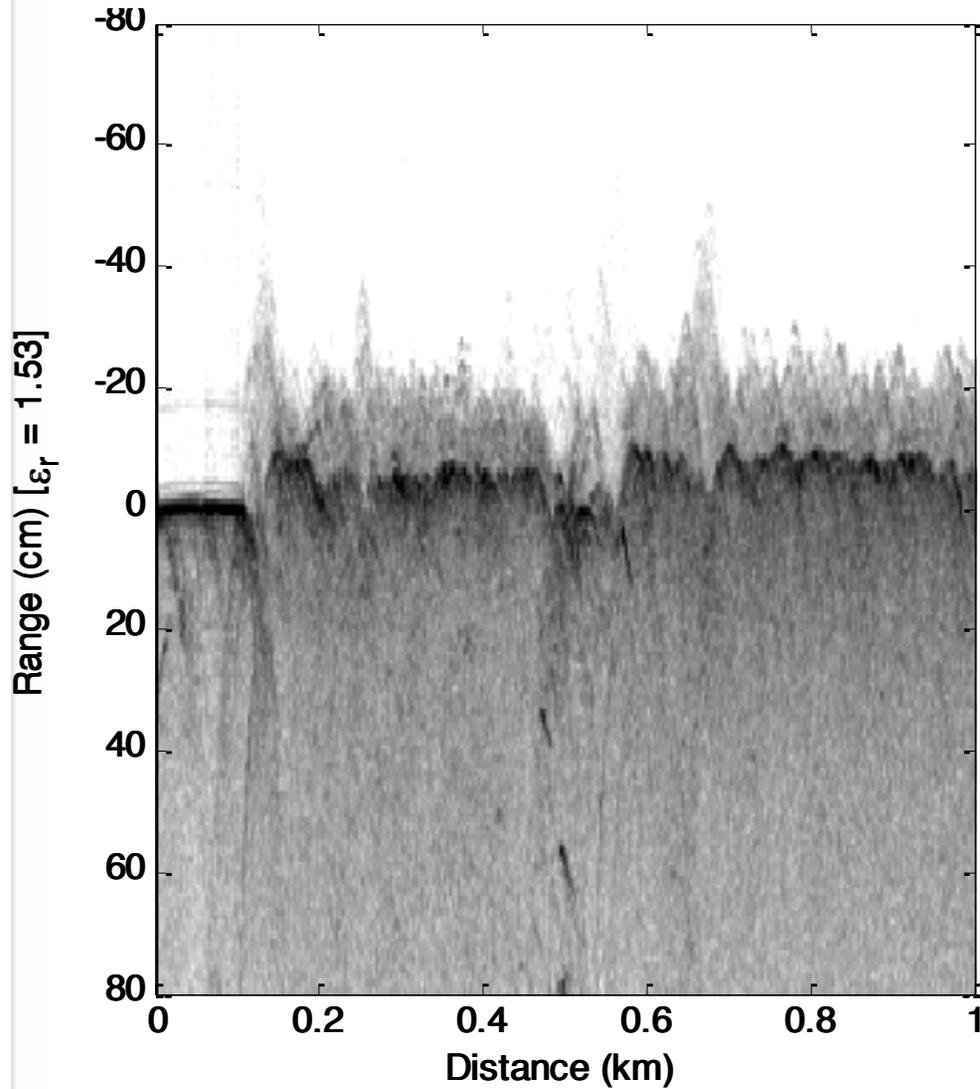
# Deconvolution results



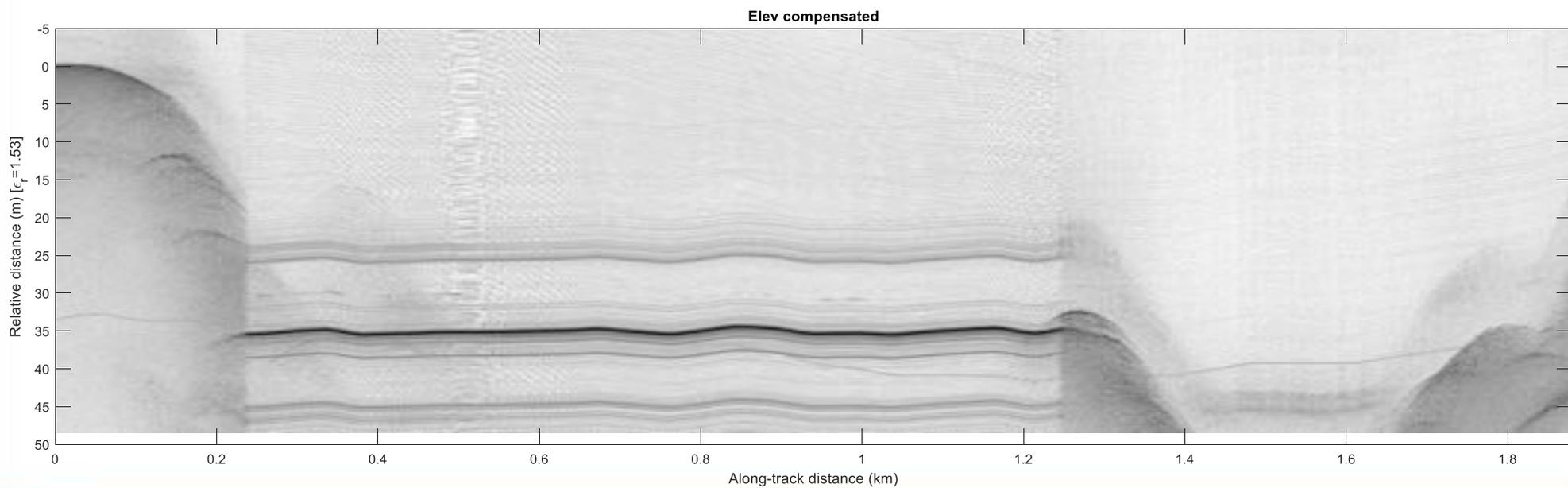
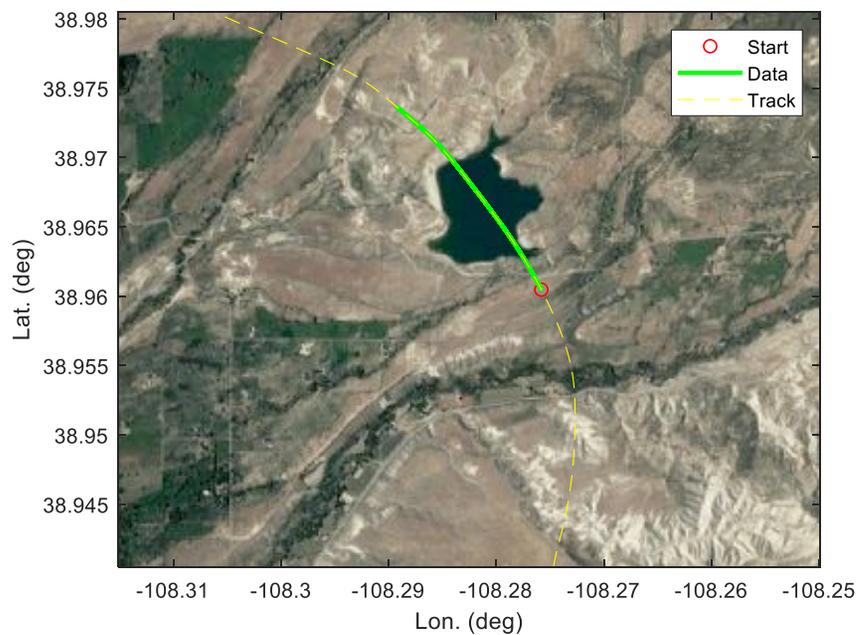
# Deconvolution results

Before

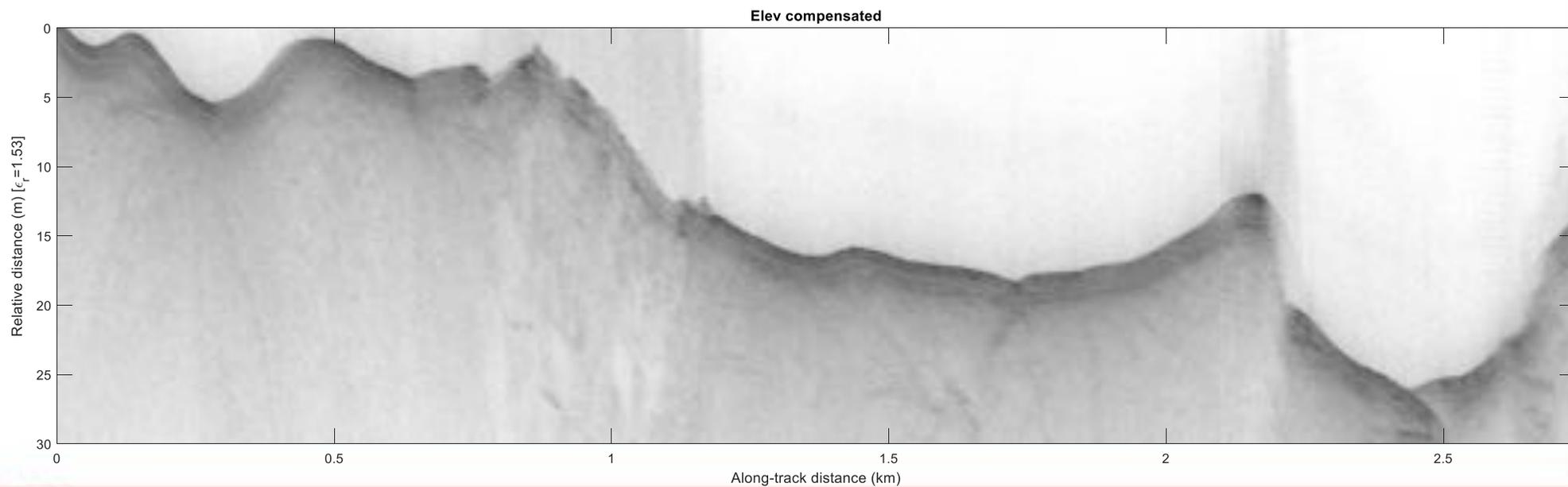
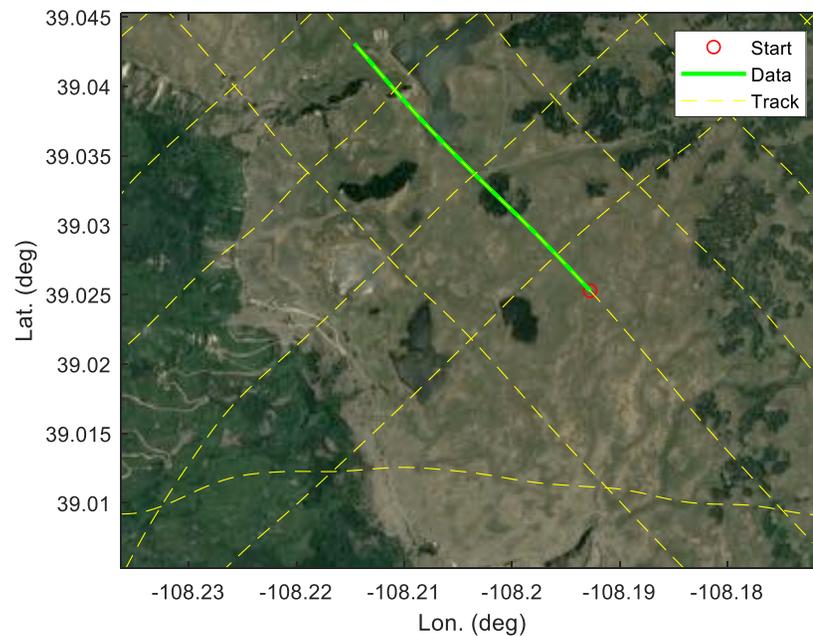
After



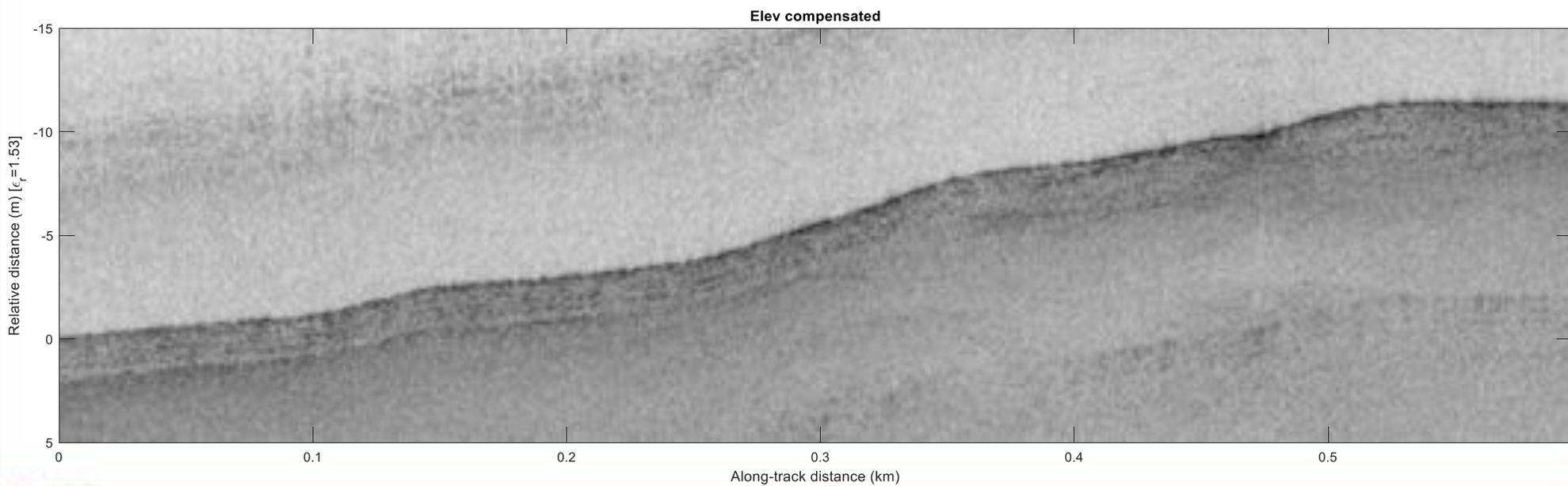
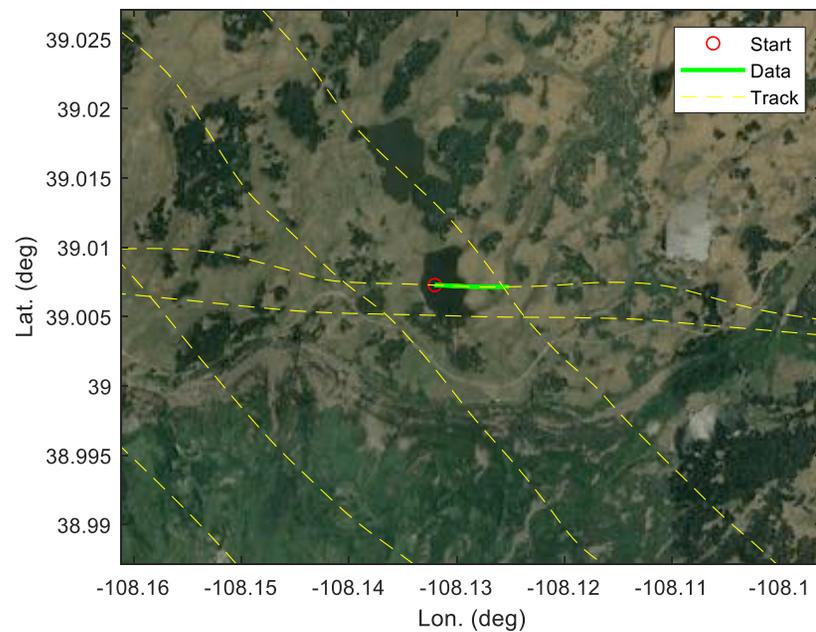
# 20190320\_130432\_MicrowaveRadar2019\_CO\_0204



# 20190320\_112538\_MicrowaveRadar2019\_CO\_0120



# 20190321\_093323\_MicrowaveRadar2019\_CO\_0109



# Moving forward

- Presenting snow map to NOAA-UCAR officials on Wednesday, September 26, 2019 (next week!).
  - Data products will be released to collaborators after this presentation.
- Upgrading system to provide fewer non-linearities and better resolution of data products.
  - Deploying systems later this year and in Spring 2020.

# Thanks!

- Major thanks to:
  - NOAA – UCAR program
  - University of Alabama
  - National Institute of Polar Research (Japan)
  - Norwegian Polar Institute
  - Physical measurements from field teams:
    - NASA SnowEx groups, Boise State, and CRREL, among others
    - University of Kansas