

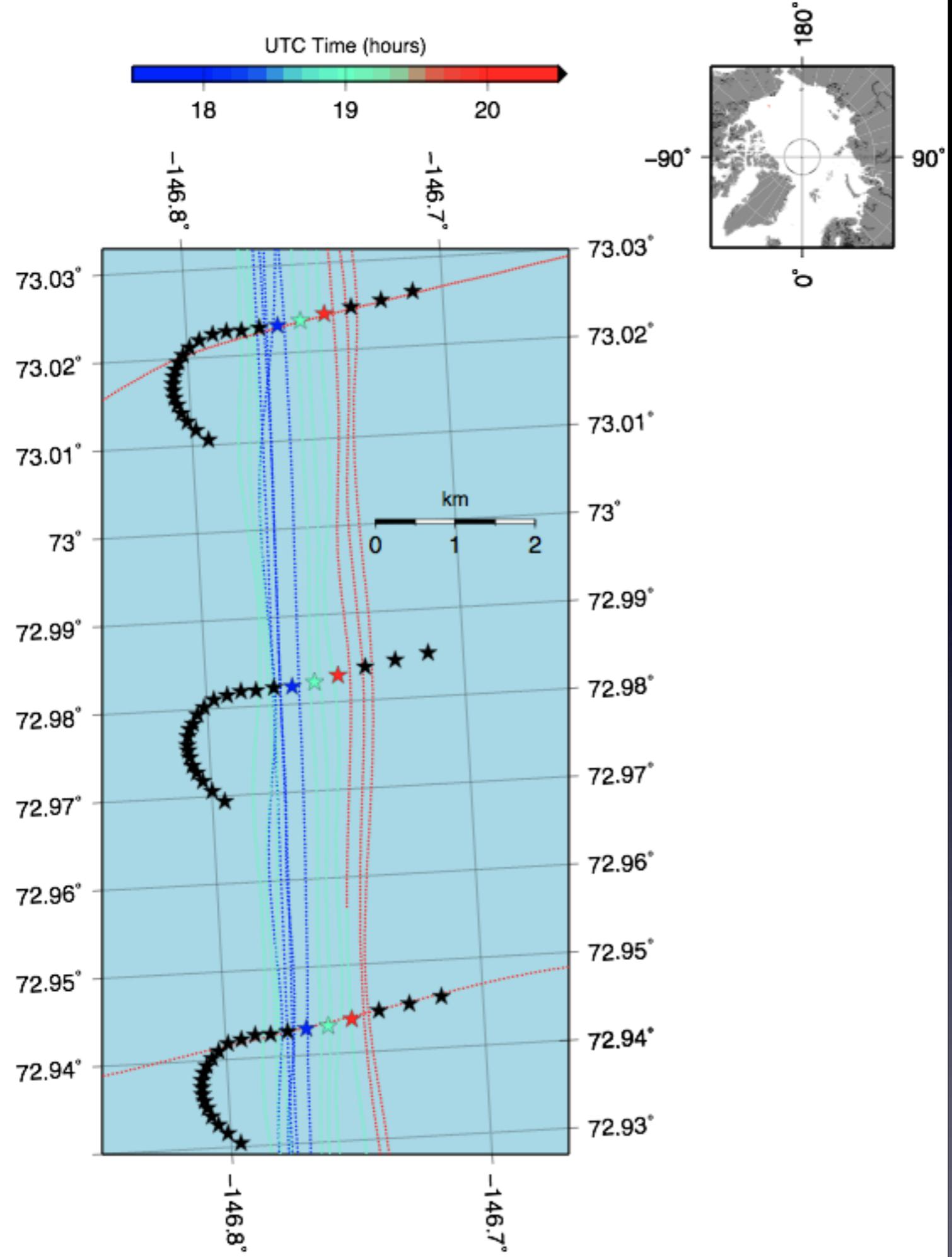
An assessment of IceBridge airborne data quality over Arctic sea ice via comparison with in situ measurements gathered in the Beaufort Sea

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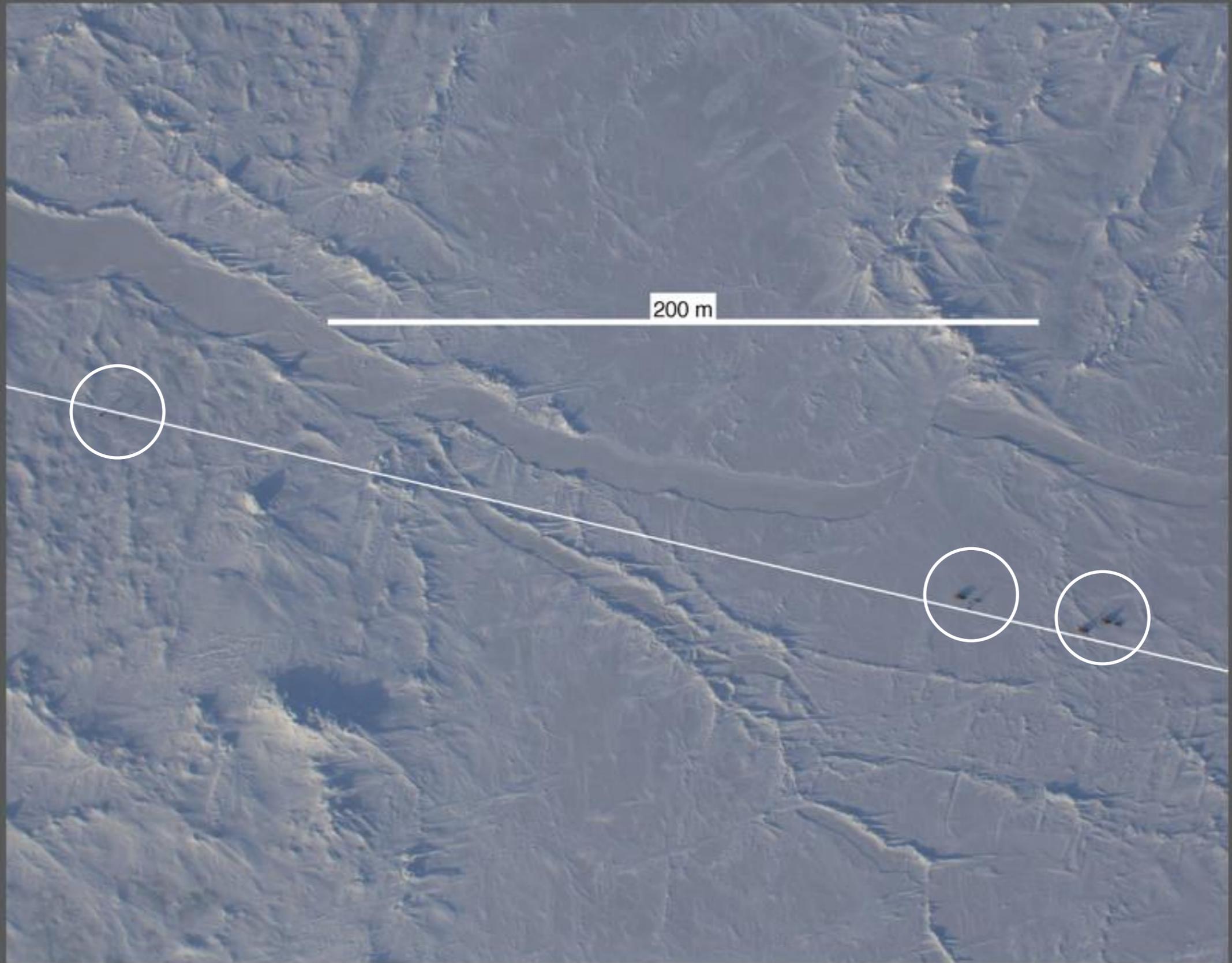




P-3 aircraft



- An operation IceBridge (OIB) P-3 aircraft overflight of the survey line was conducted on the **23rd March 2011** from an **altitude of ~465 m**
- 16 passes over the survey line in total
- This analysis is based on the straightest overflight: pass 5

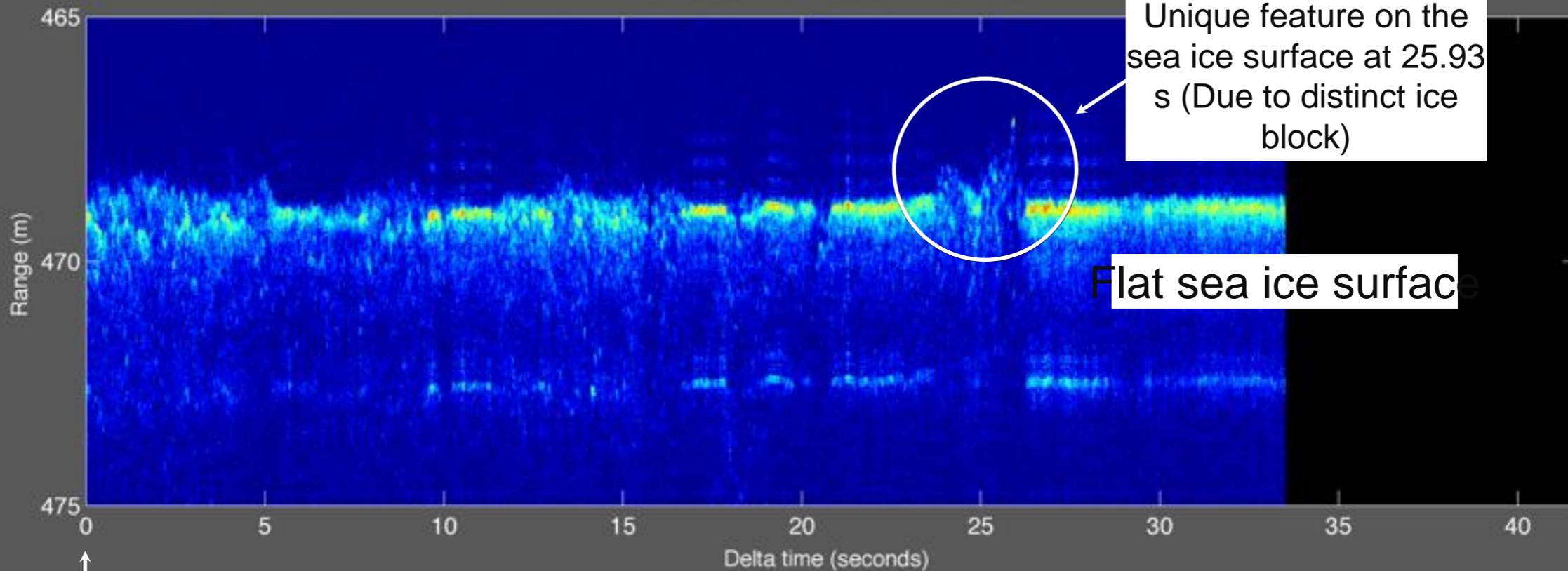


Overview

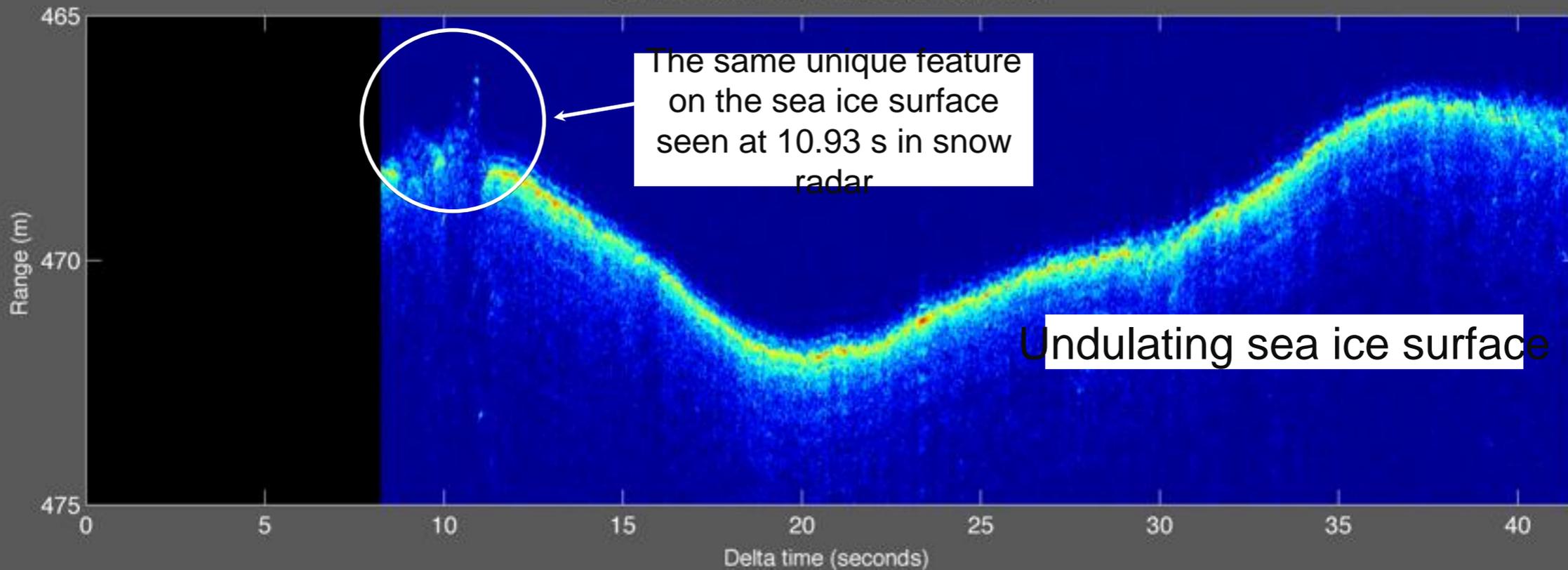
- For my AGU talk I focused on the science results from ICEX
- The aim of this talk is to outline the technical aspects of the radar analysis
- There are four topics I will cover:
 - Timing errors
 - Radar cross section of corner reflectors
 - Waveform artifacts
 - Grating lobes

Timing errors

Ku Radar: 20110323-01-161.mat

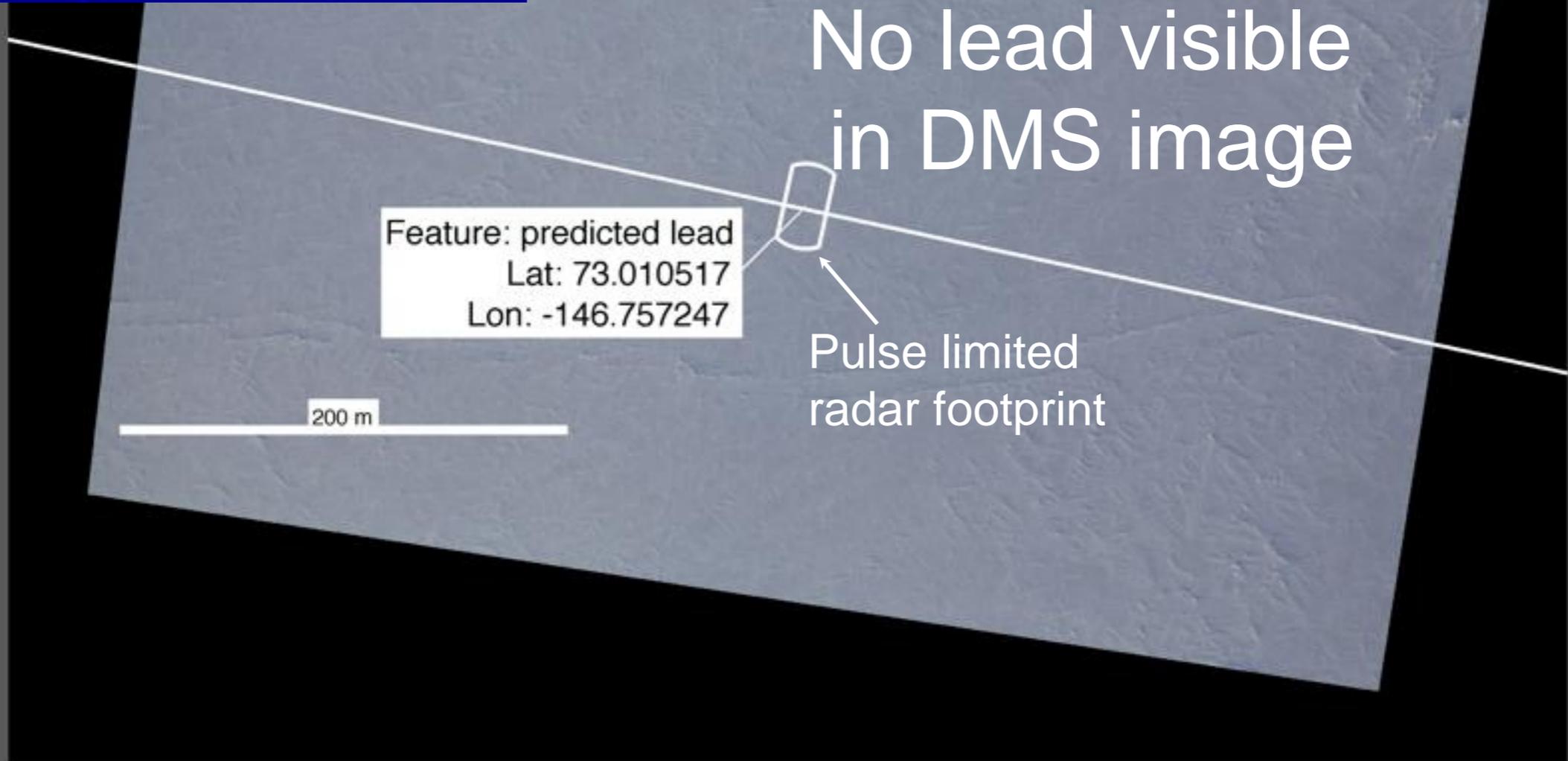
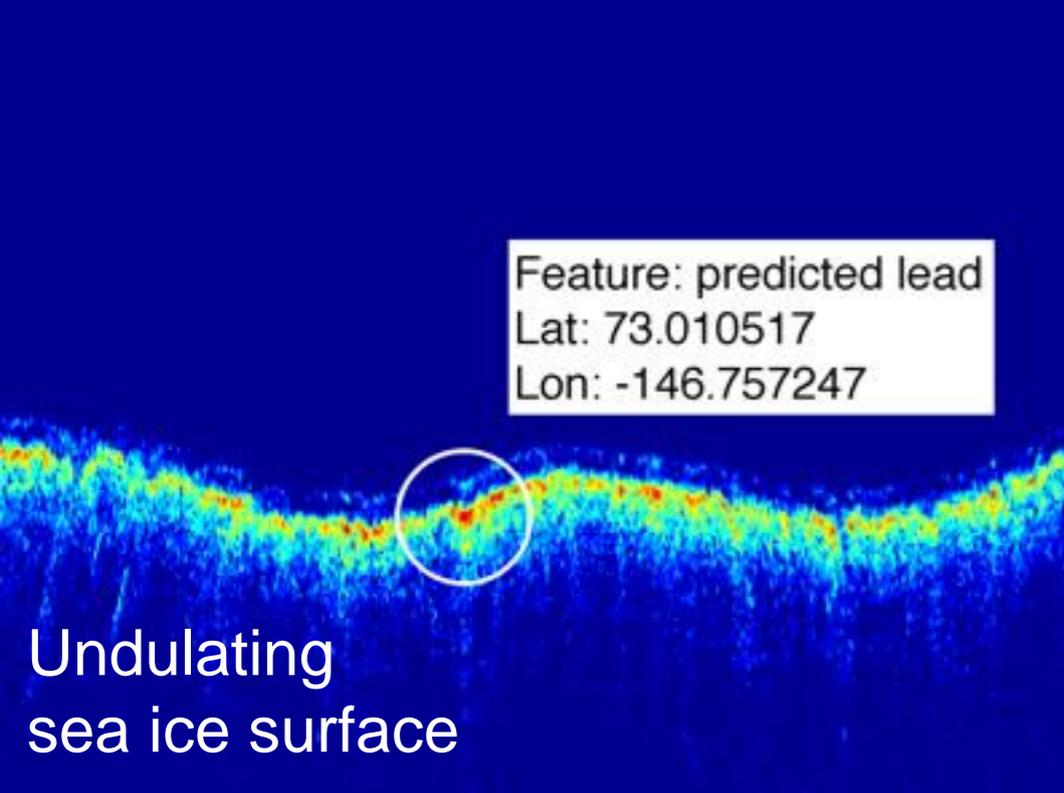


Snow Radar: 20110323-04-084.mat



Original Data

Comparison echogram - DMS image: **original data**



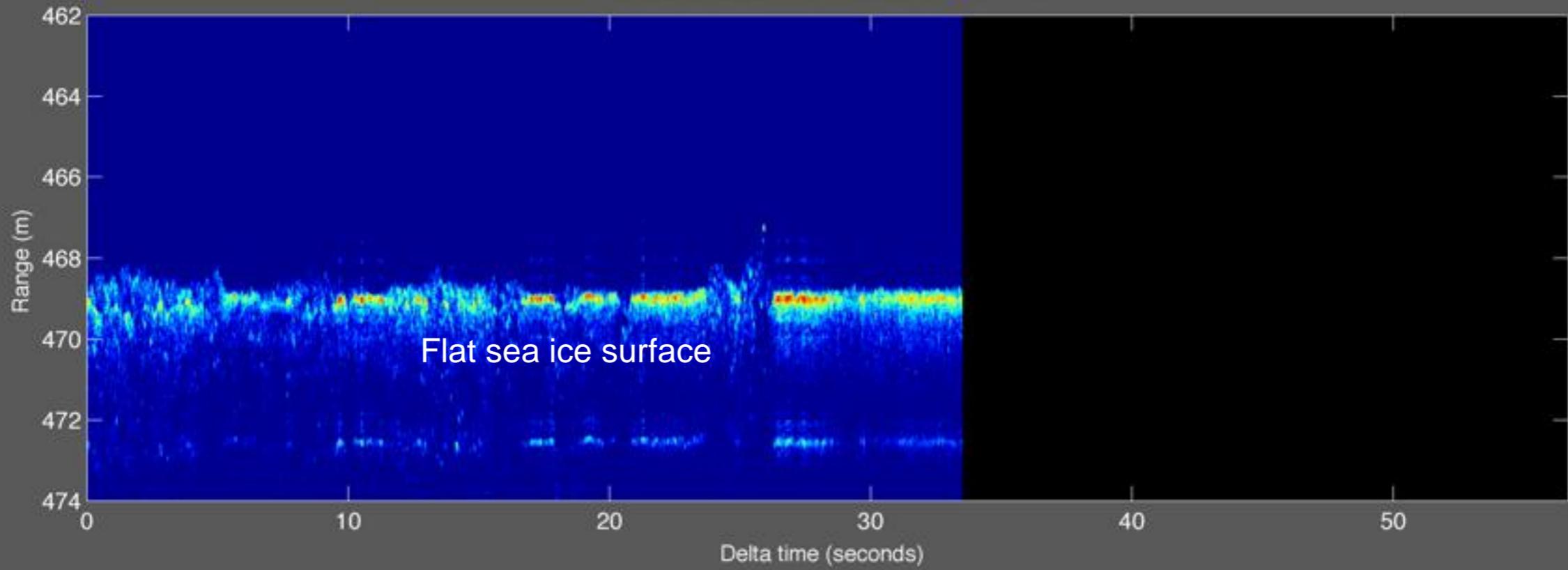
Hypothesis for the cause of the timing error

- Between segment #1 and #2 the **time signal** used by the GPS navigation system **switched from GPS to UTC time**
- A 15 second **correction** had been applied to all of the segments to convert from GPS time to UTC time, on the **assumption that all the segments are locked into GPS time**
- For **segments #2 to #8** the time signal is **already UTC time** so the time **signal** therefore **gets `over corrected`**. As a result the data in segments #2-#8 are **15 seconds behind** the correct time

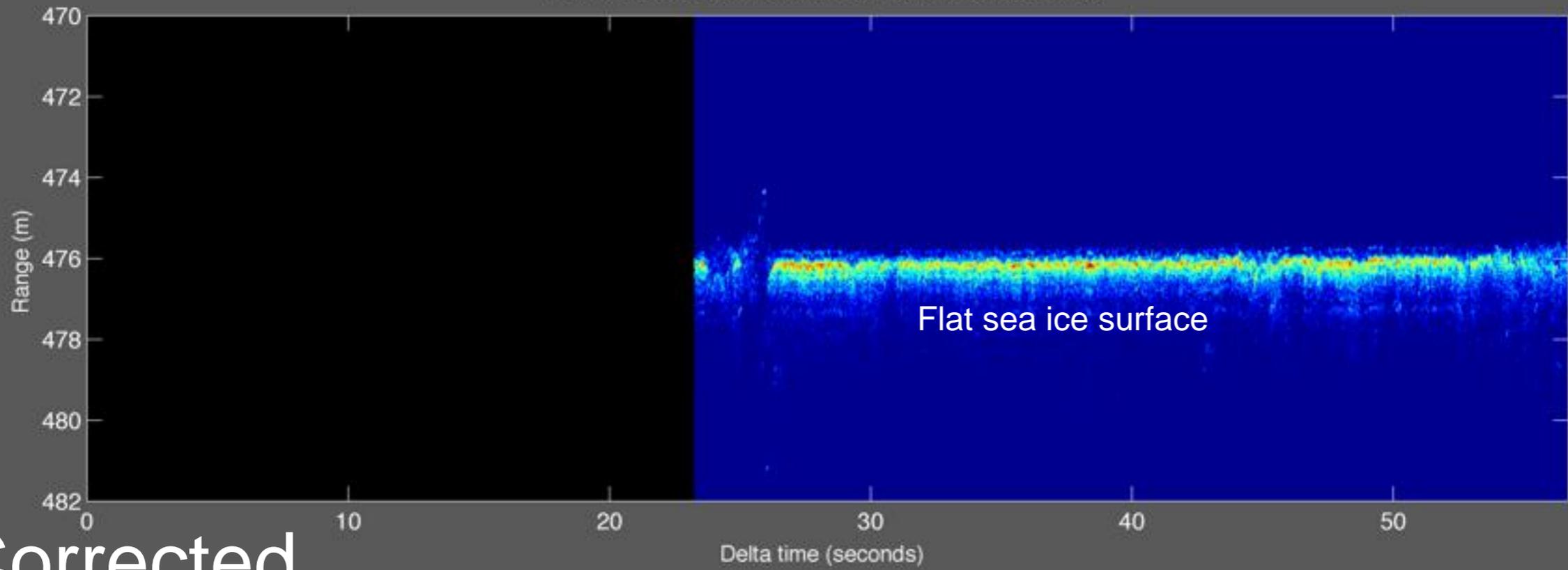
Correcting the snow radar timing error

- The **time signal used to sync the snow radar echograms with the navigational data was -15 seconds in error** over the majority of the 20110323 flight, including the ICEX survey area
- This **resulted in a geolocation error of ~1575 m** (for an average aircraft velocity of ~105 m/s)
- The **15 second timing error also resulted in incorrect aircraft altitude corrections being applied to the echograms resulting in the undulating ice surfaces** seen in uncorrected snow radar echograms
- We contacted CRESIS on this issue and they **corrected** the snow radar dataset for the 20110323 flight

Ku band radar: 20110323-01-161.mat

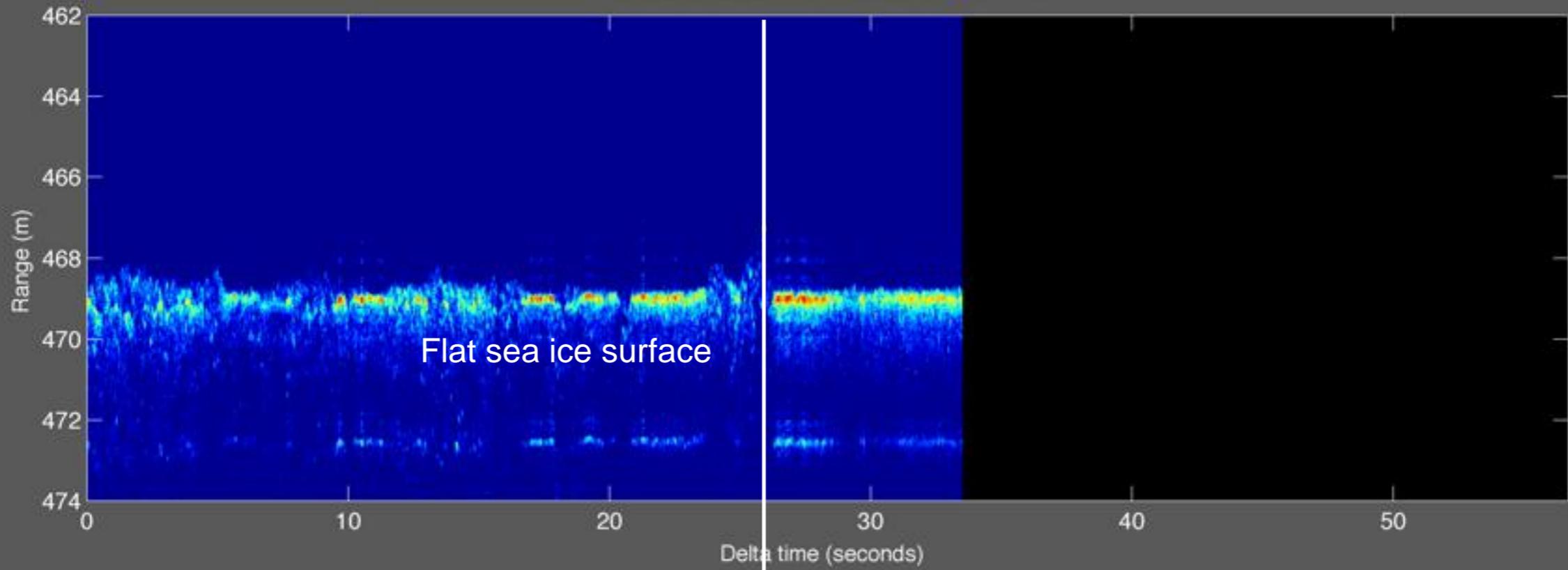


Corrected Snow radar: 20110323-04-084.mat

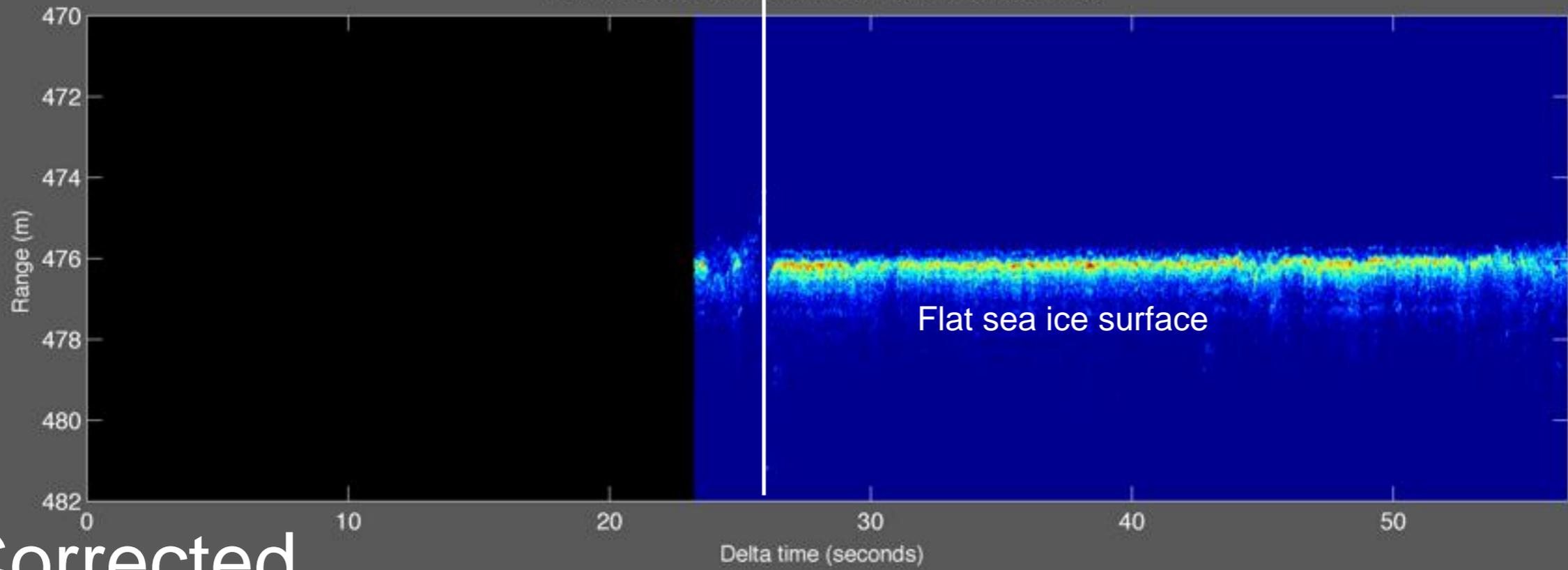


Corrected
Data

Ku band radar: 20110323-01-161.mat



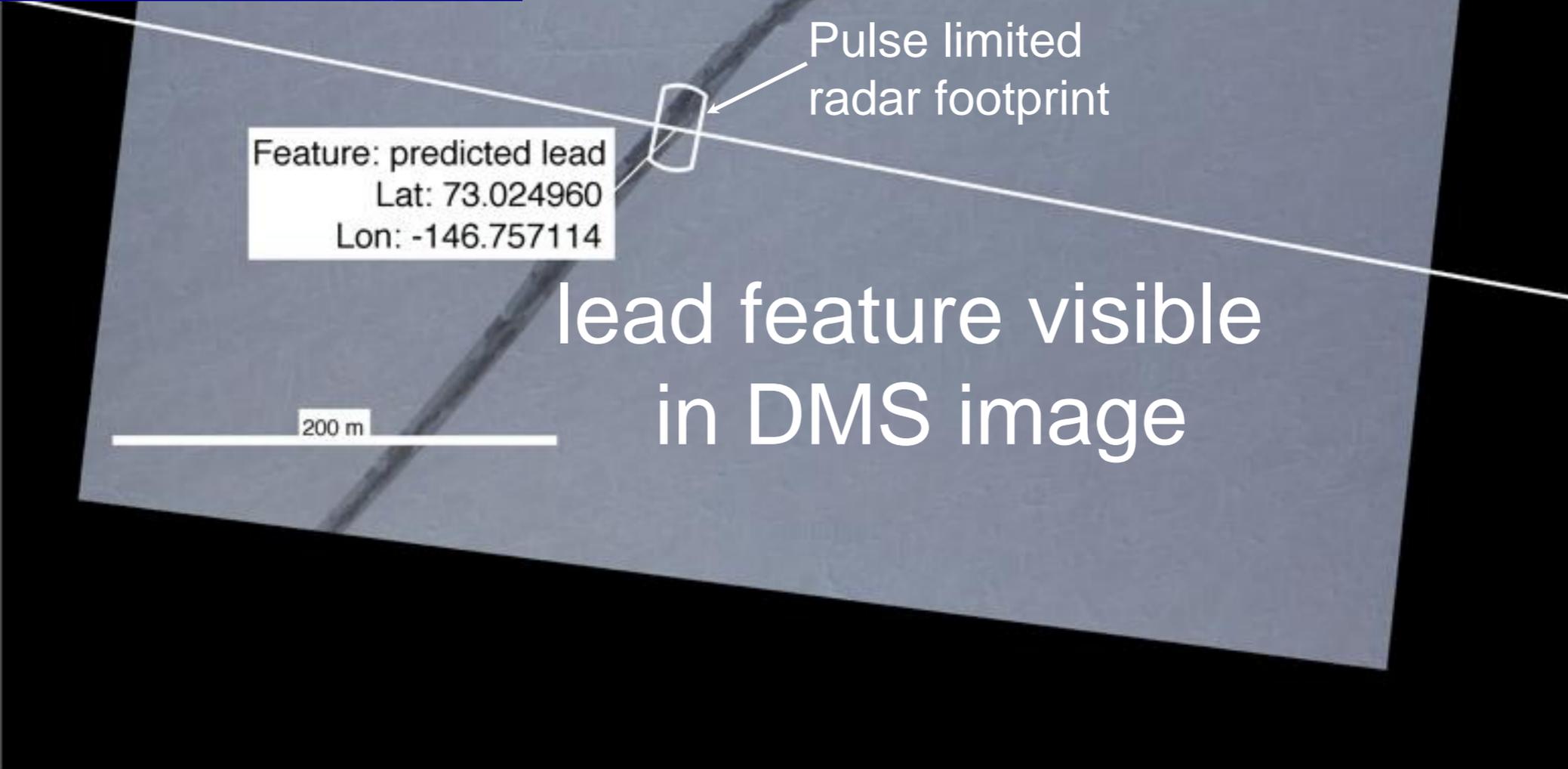
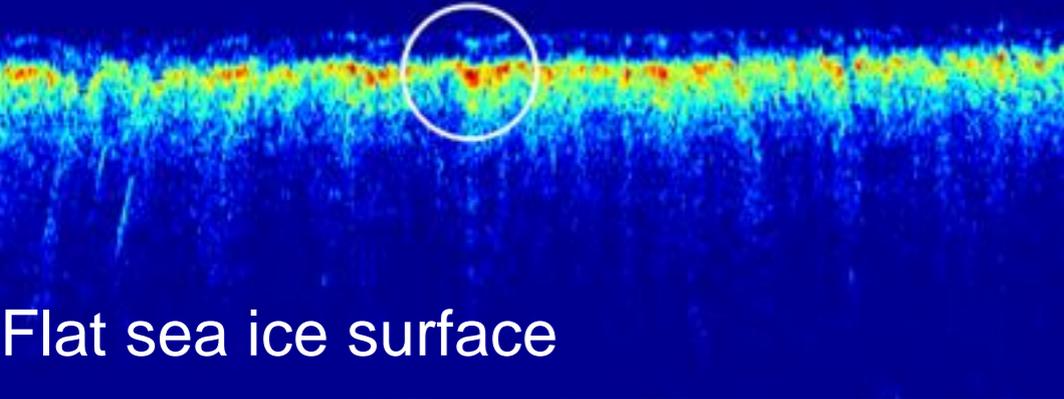
Corrected Snow radar: 20110323-04-084.mat



Corrected
Data

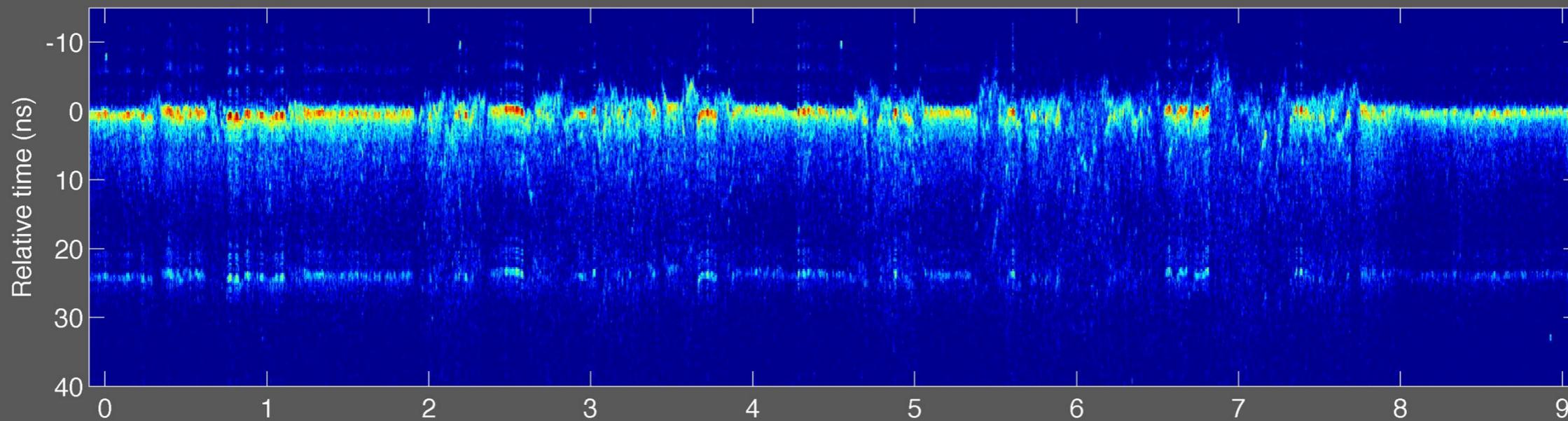
Comparison echogram - DMS image: **corrected** data

Feature: predicted lead
Lat: 73.024960
Lon: -146.757114

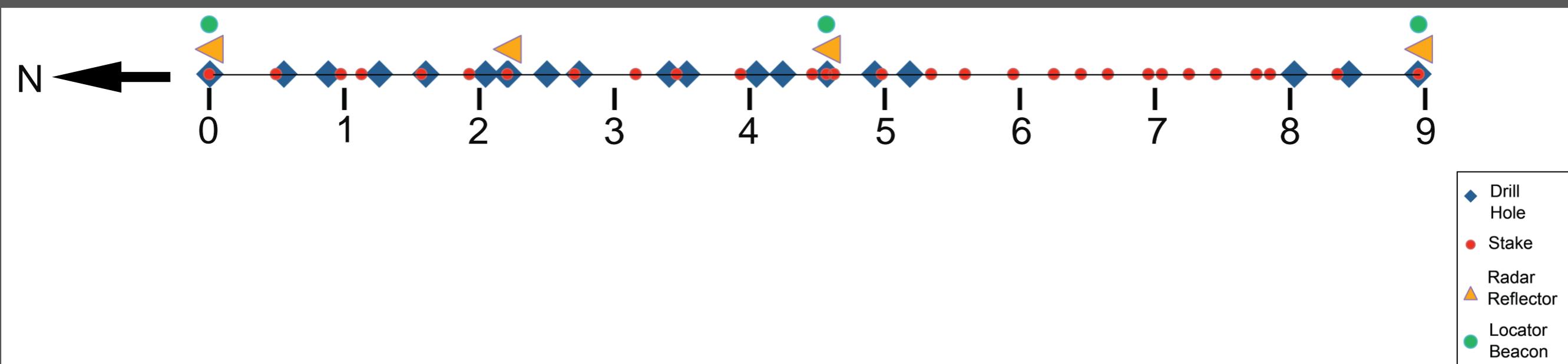
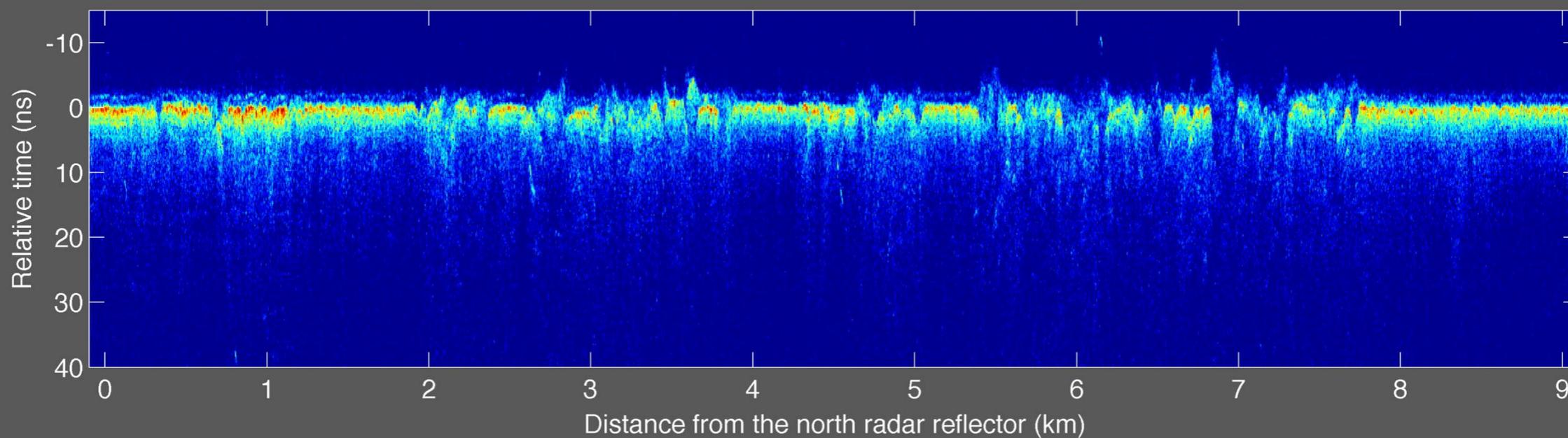


Radar cross section of corner reflectors

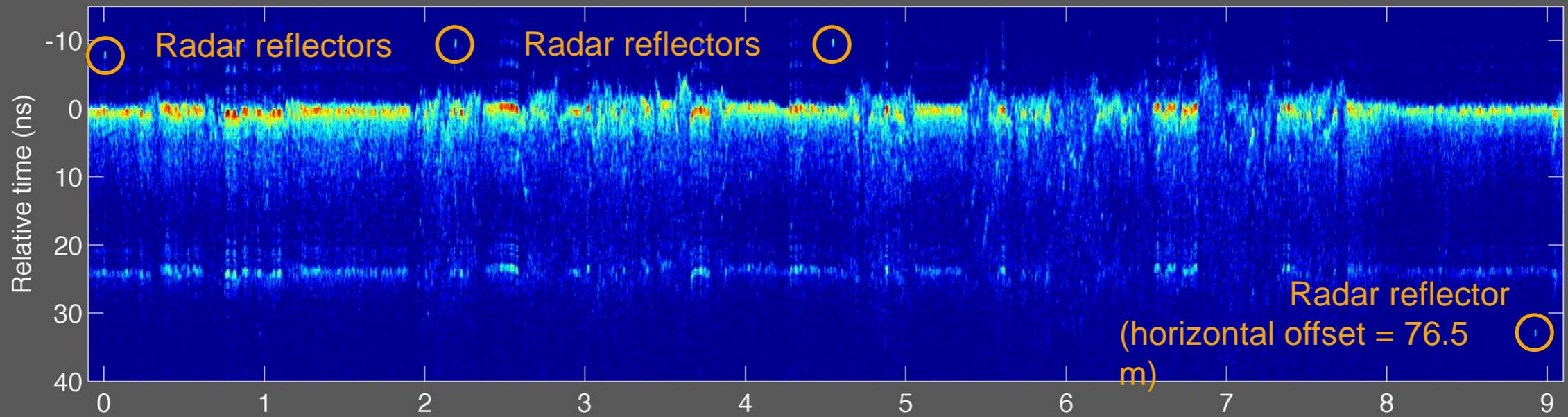
Ku-band radar echogram: Pass 5



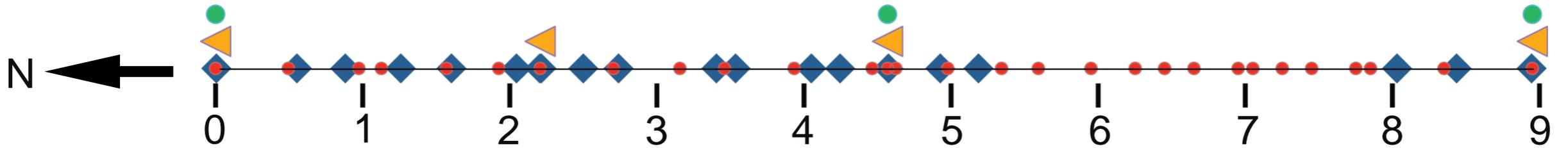
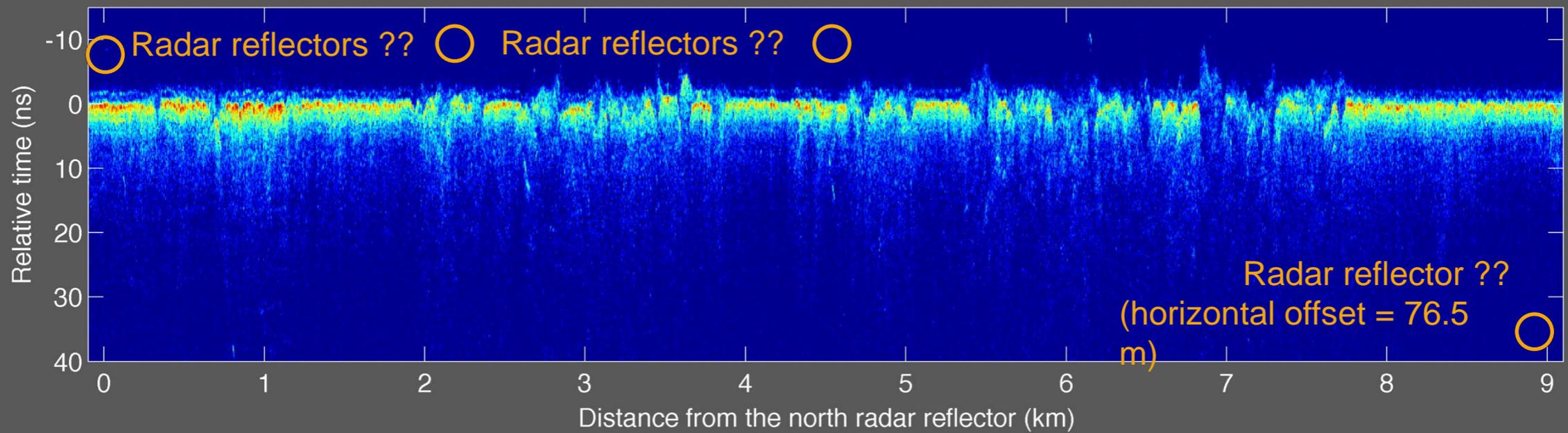
Snow radar echogram: Pass 5



Ku-band radar echogram: Pass 5

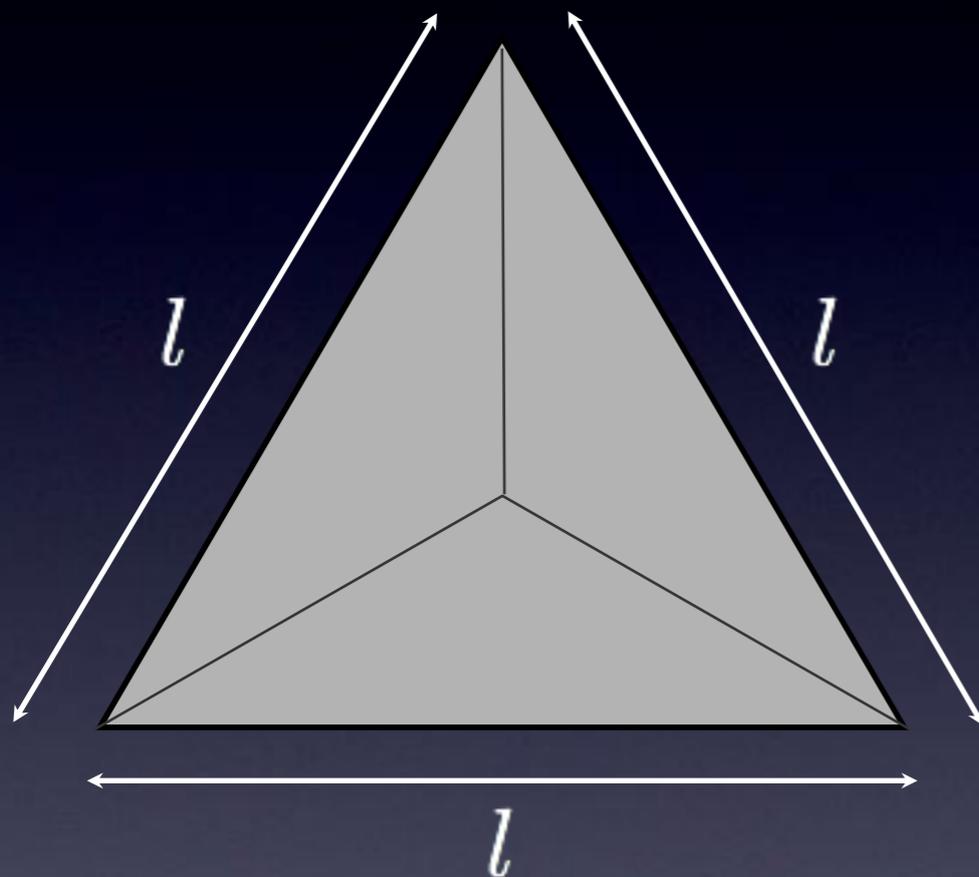


Snow radar echogram: Pass 5



- ◆ Drill Hole
- Stake
- ▲ Radar Reflector
- Locator Beacon

Radar Cross Section (RCS) for trihedral corner reflector



$$\sigma_{max} = \frac{\pi l^4}{3\lambda^2} !!$$

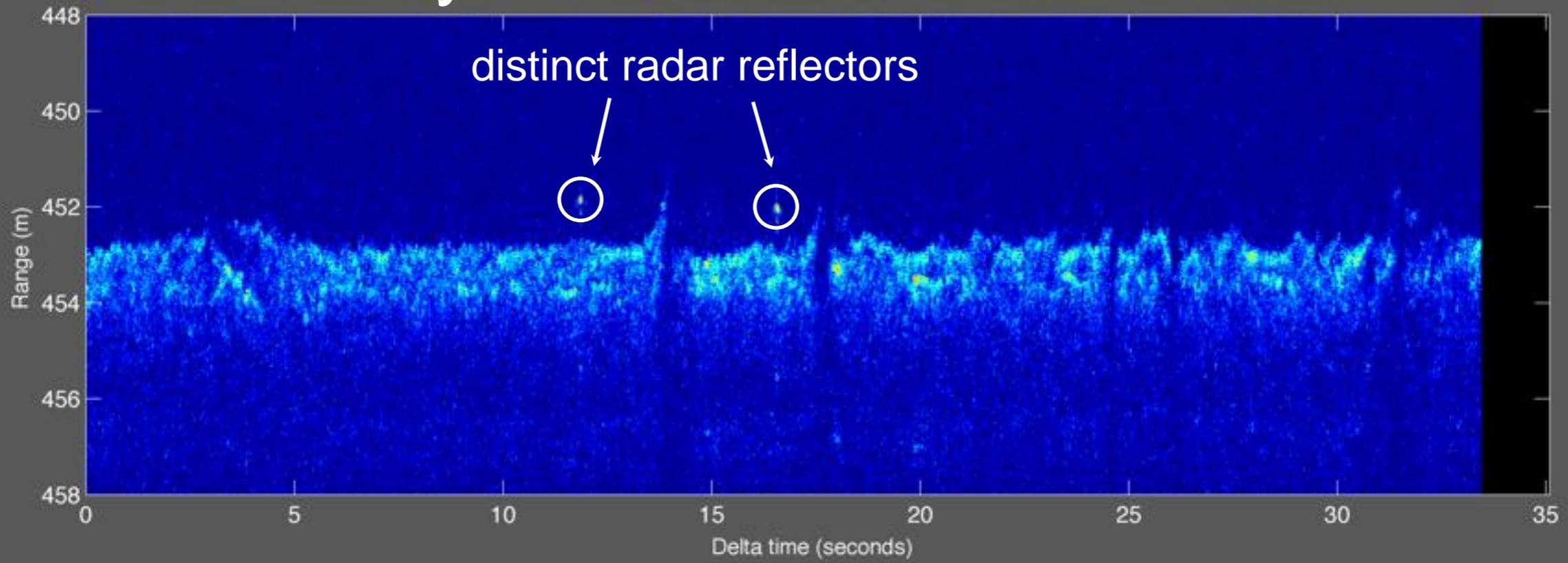
σ_{max} = maximum radar cross section

l = length of edge of reflector aperture

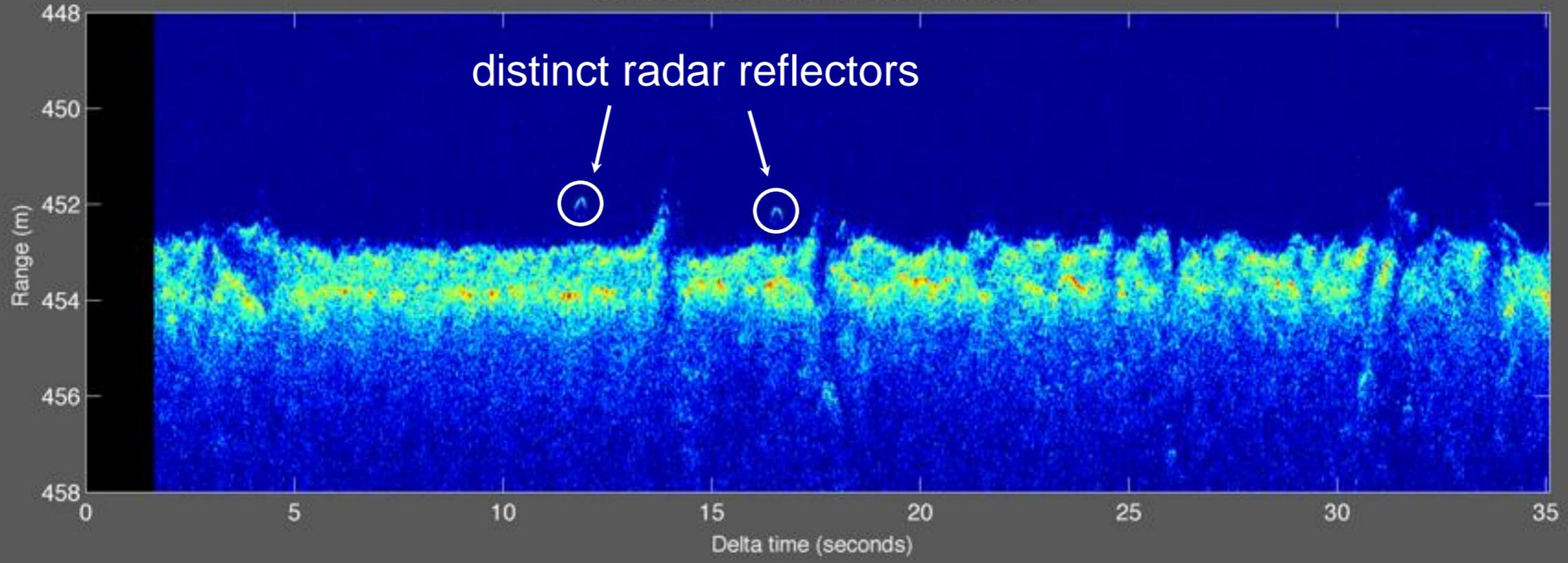
λ = radar wavelength

CRYOVEX survey

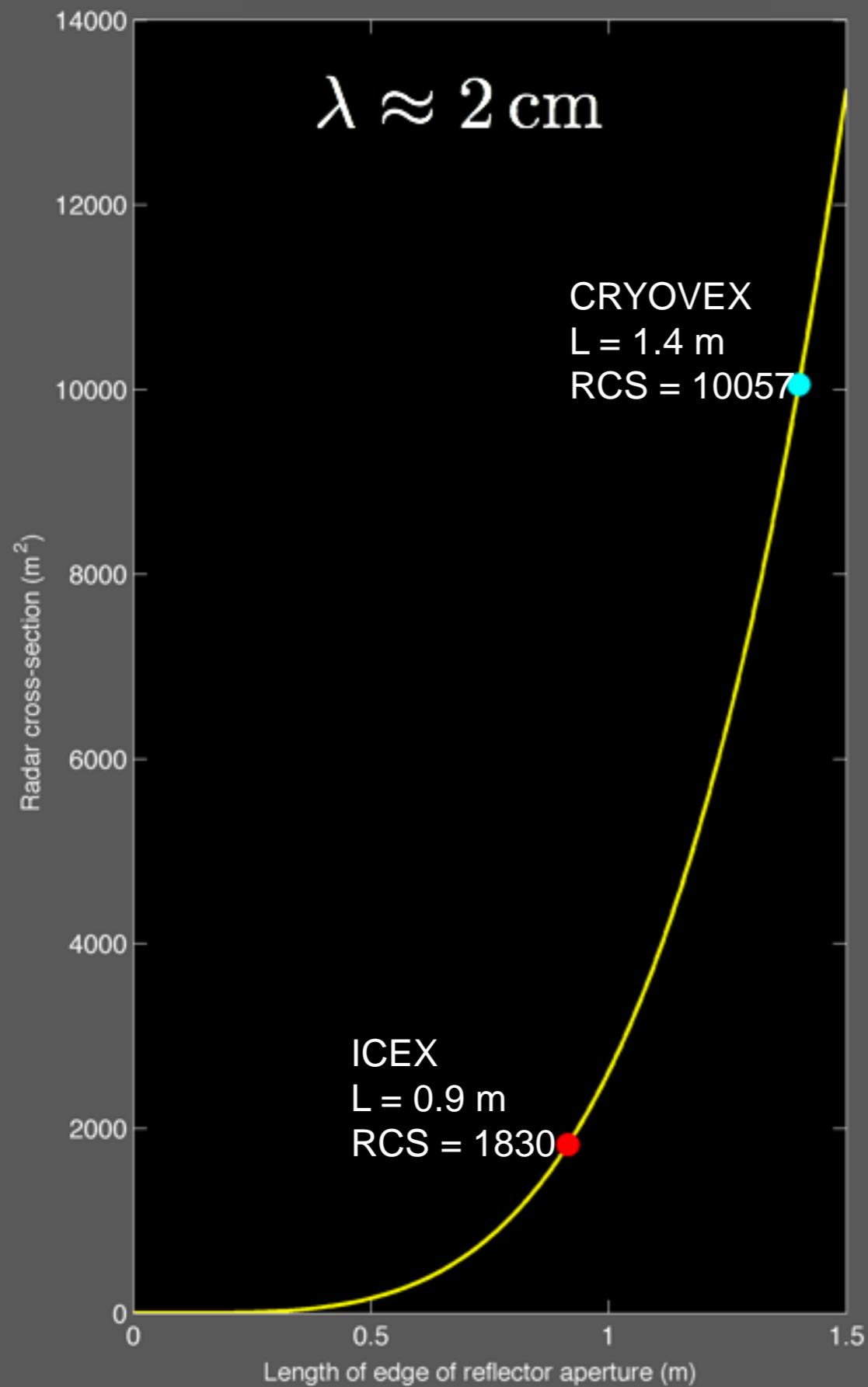
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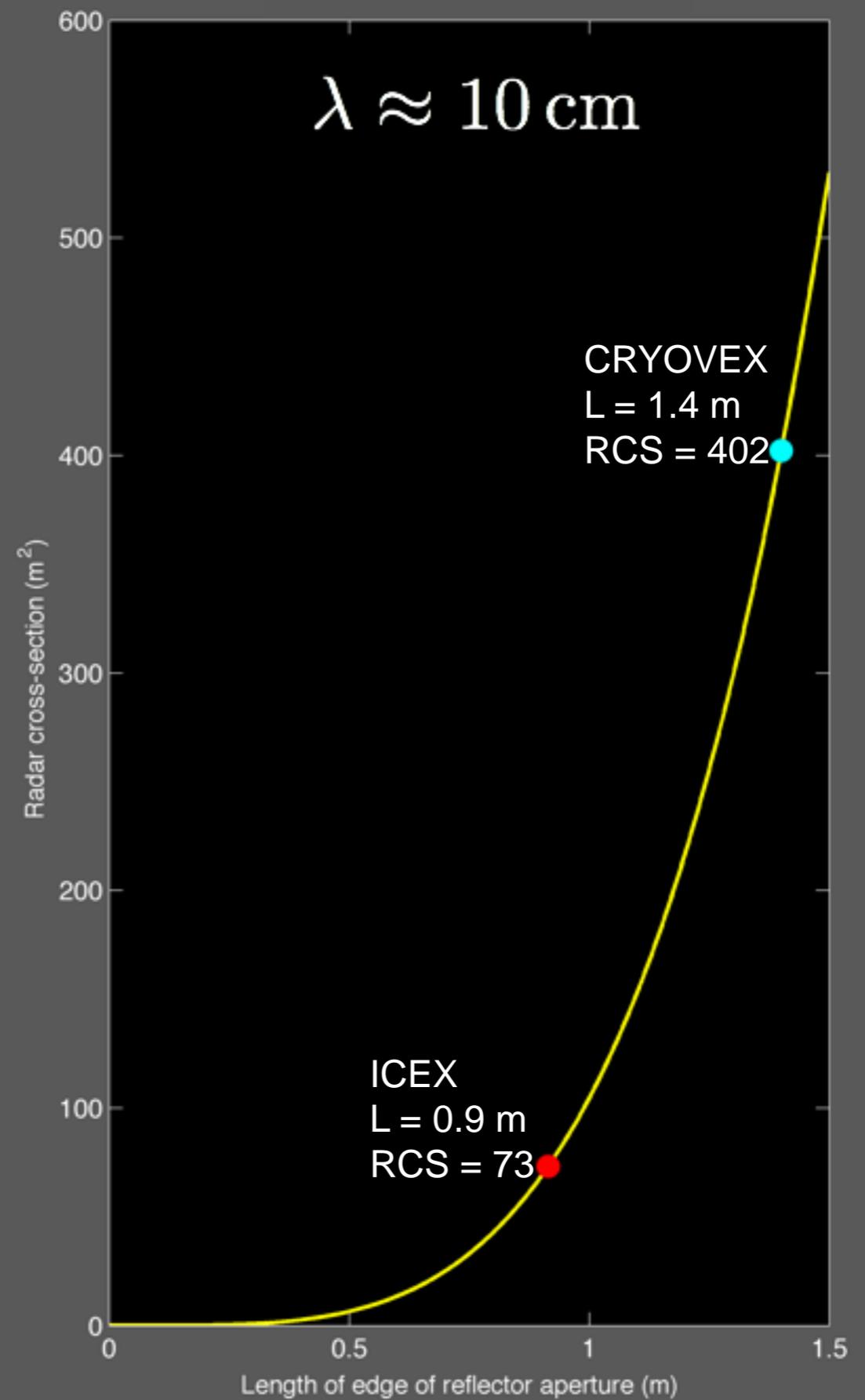
Snow Radar: 20110415-01-158.mat



Ku-band radar

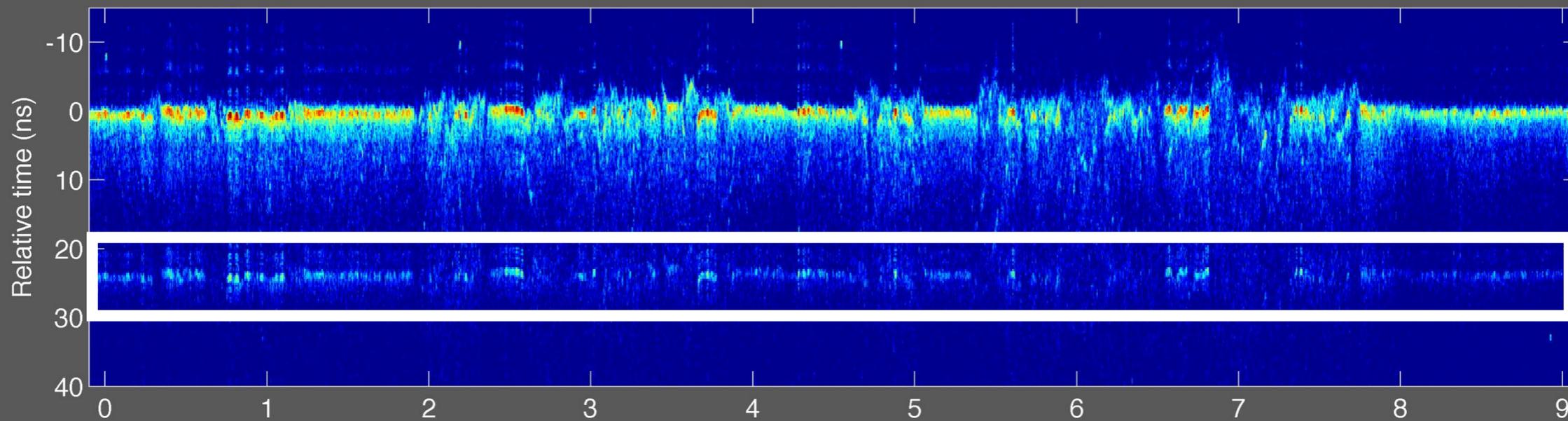


Snow radar

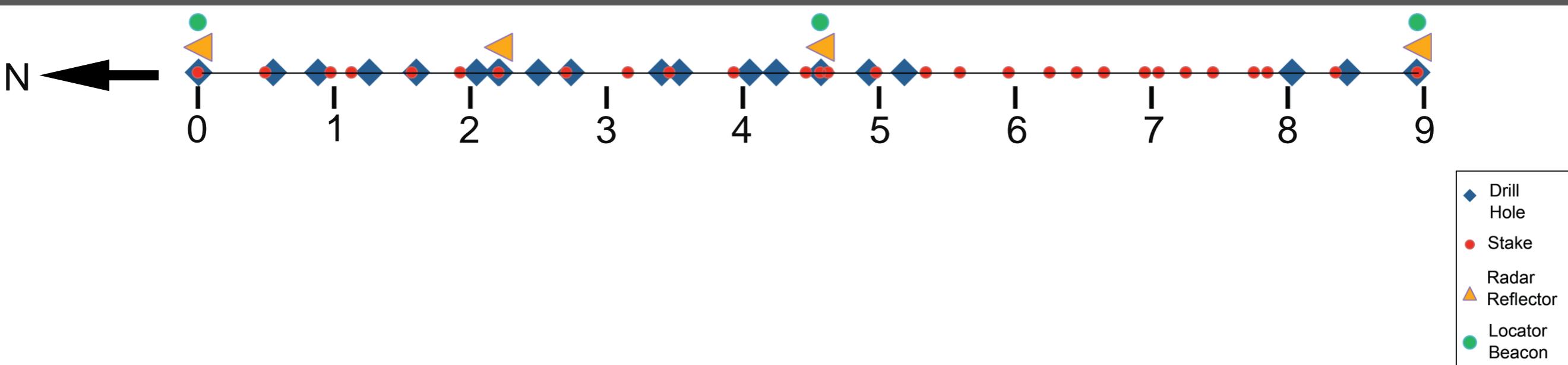
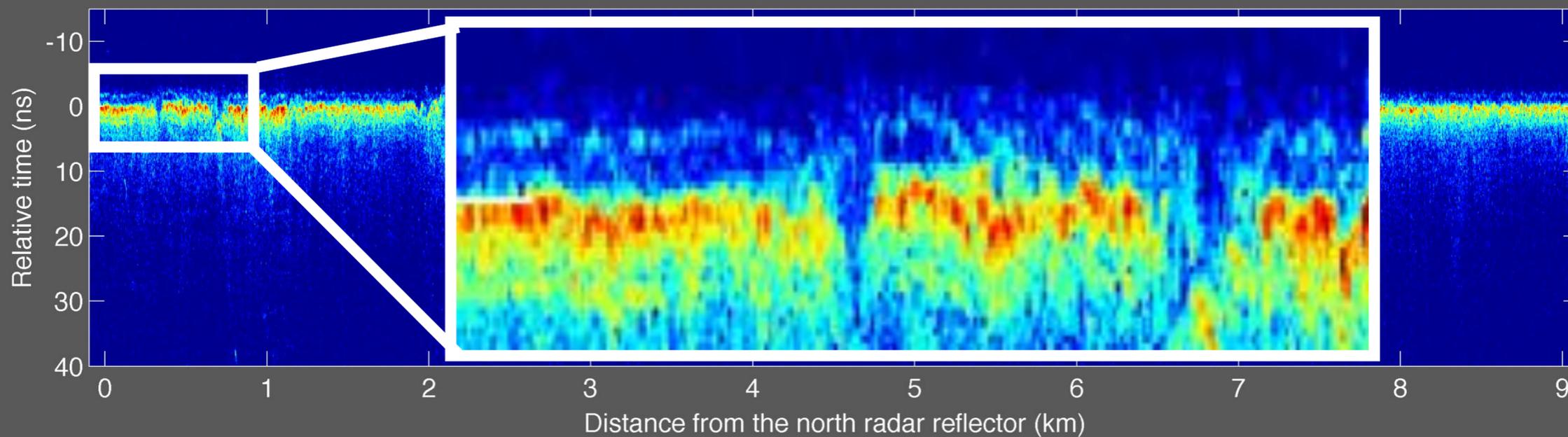


Waveform artifacts

Ku-band radar echogram: Pass 5



Snow radar echogram: Pass 5

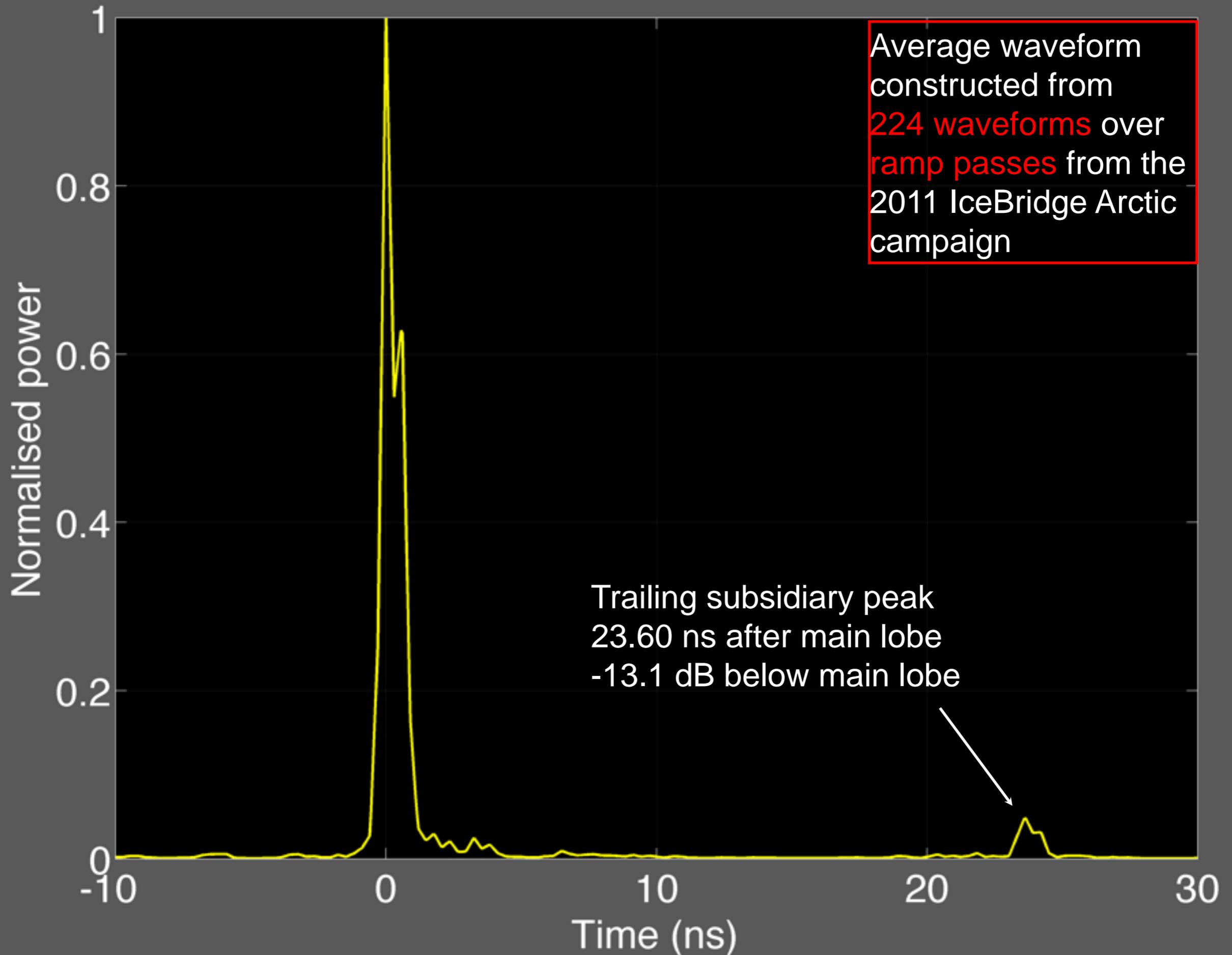


Ramp pass calibration

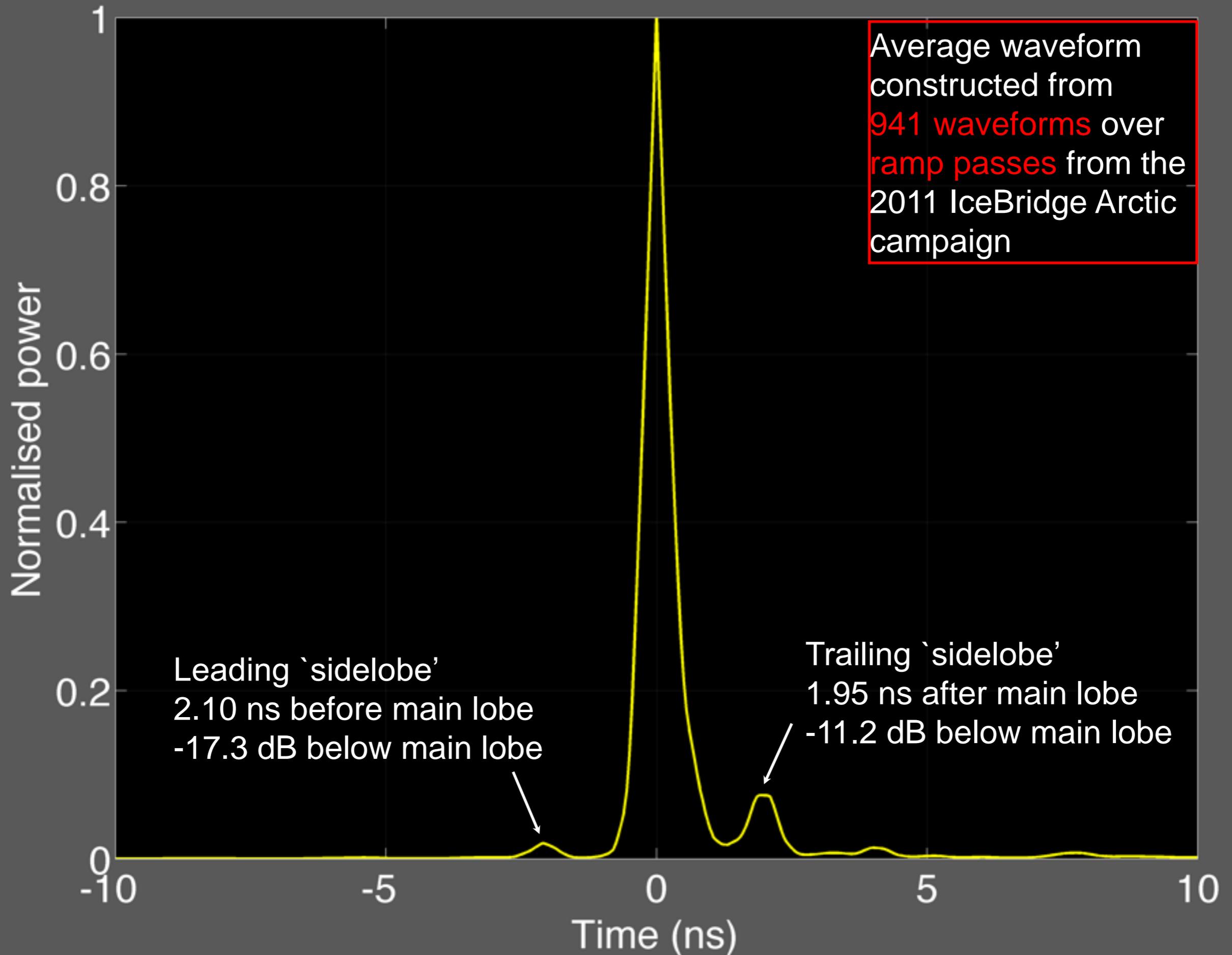
- Ramp passes over airfields can be use to constrain the **average flat surface radar response**
- The airfield ramps are **flat, smooth** and **free of snow** making them ideal surfaces for calibration



The average ku-band radar waveform



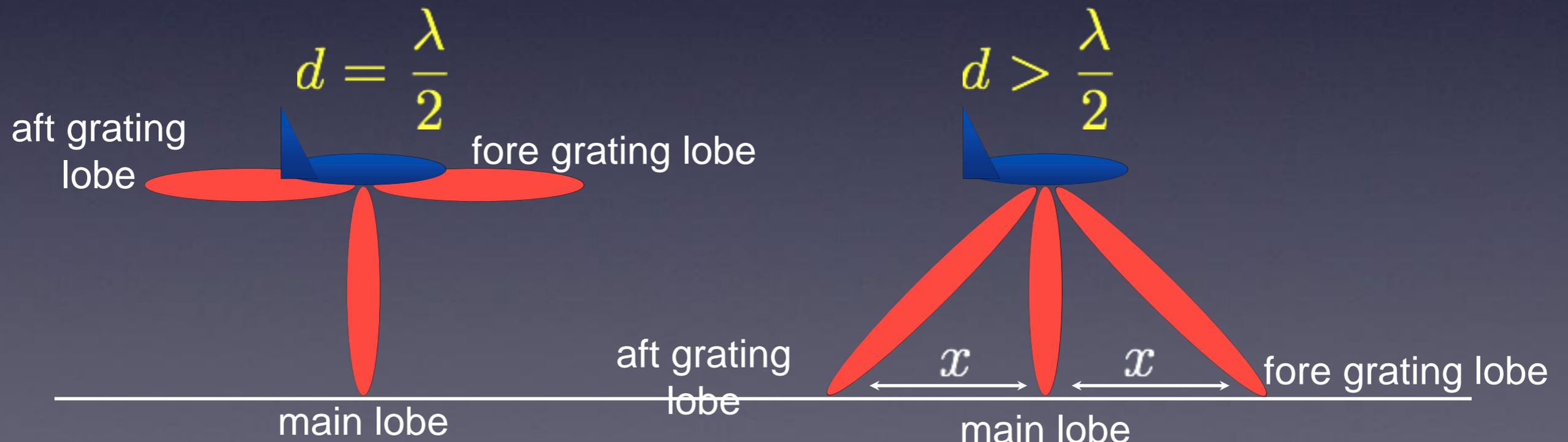
The average snow radar waveform



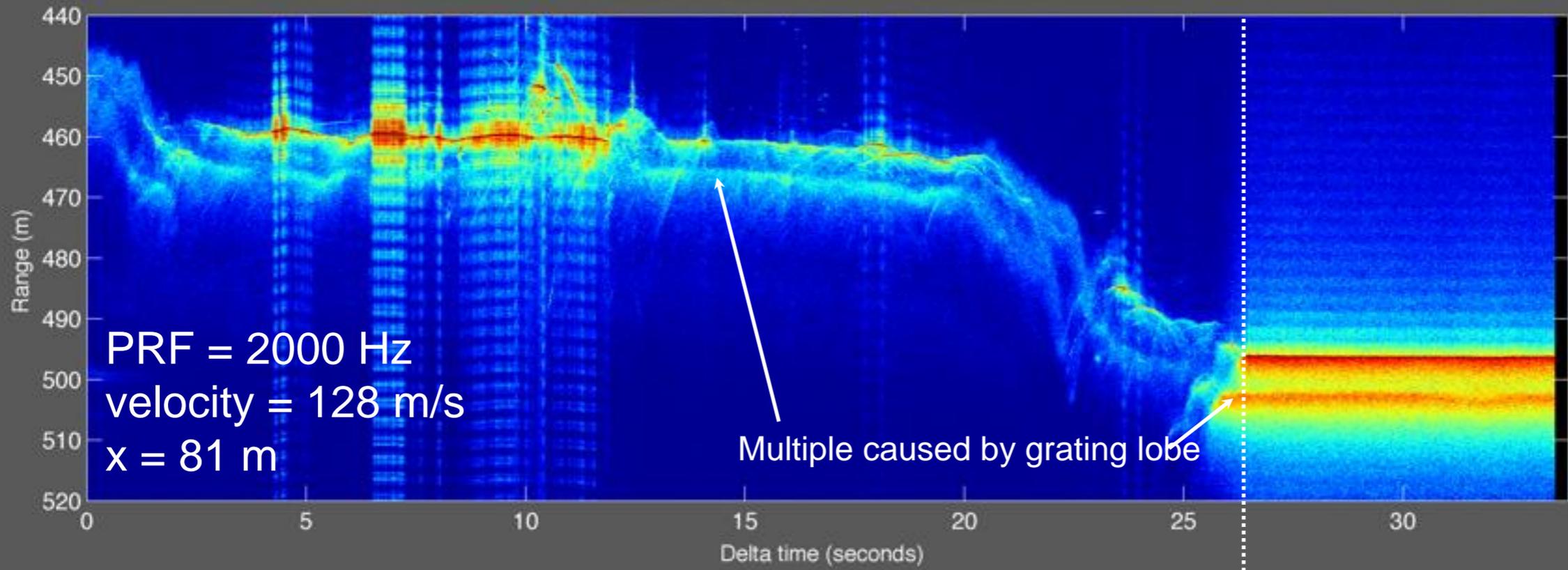
Grating lobes
(Observed in DC8 flights)

Grating lobes

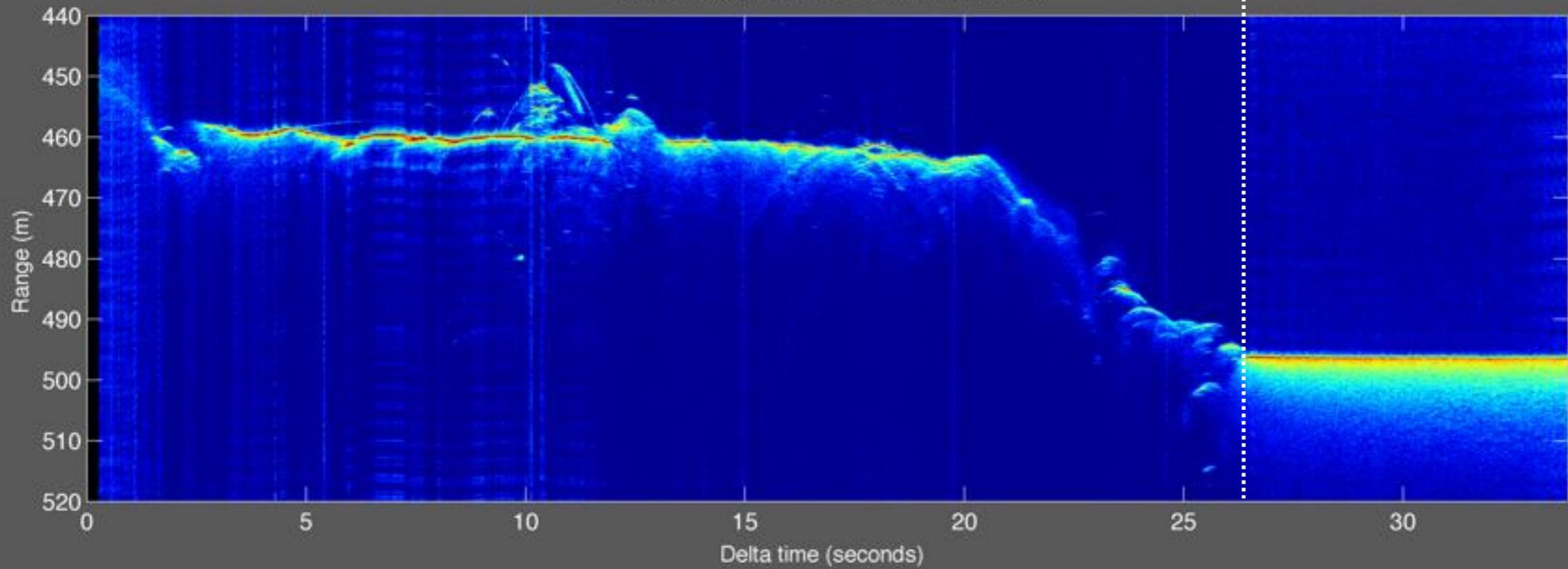
- The aircraft velocity divided by the radar PRF determines the spacing of the pulse locations
- If this spacing (d) is greater than half the wavelength of the carrier frequency secondary lobes (grating lobes) can start to induce angular ambiguities in post-processed radar data



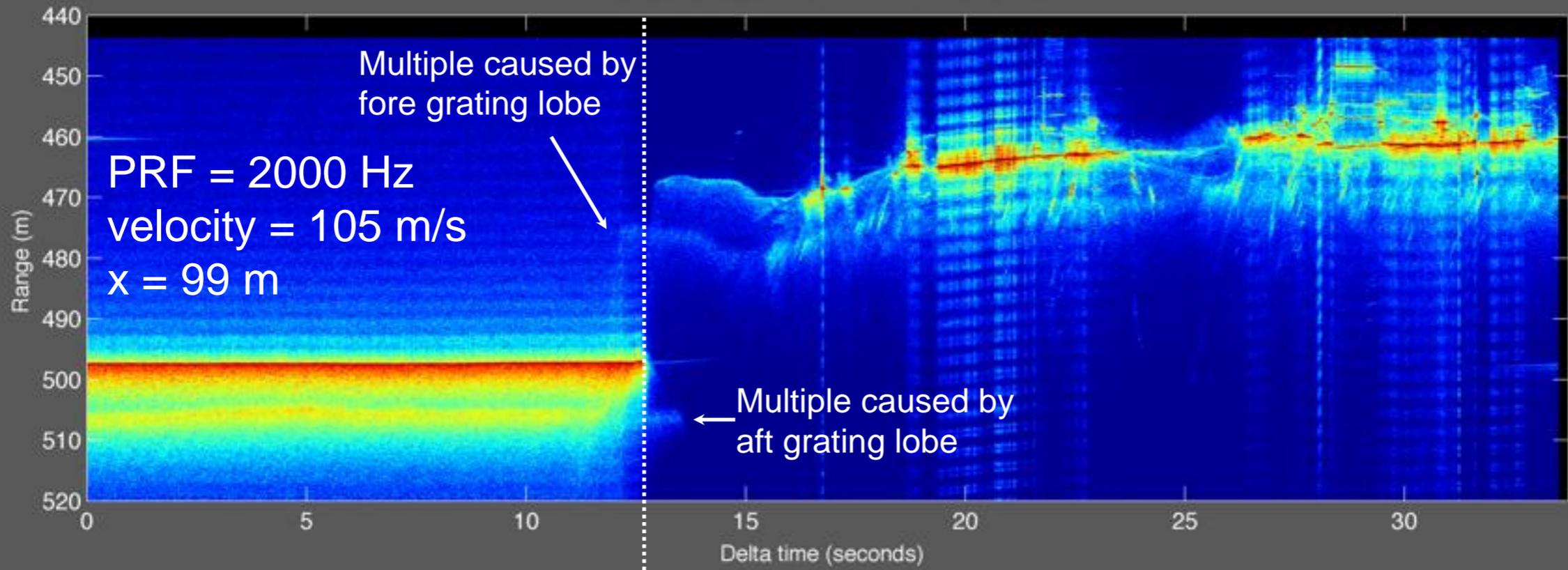
Ku band radar: 20111114-01-001.mat



Snow radar: 20111114-01-004.mat



Ku band radar: 20111114-01-013.mat



Snow radar: 20111114-01-016.mat

