

Waveform analysis of ATM sea ice and ground test data

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PARCA/OIB Science Team Meeting, Jan 29-31, 2013, GSFC

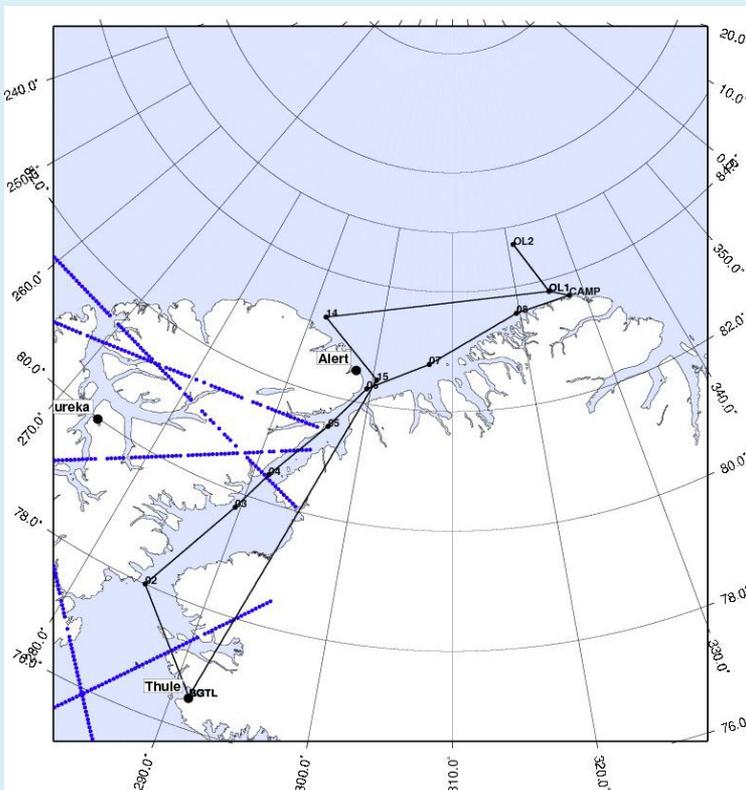


ATM Data Used in This Study

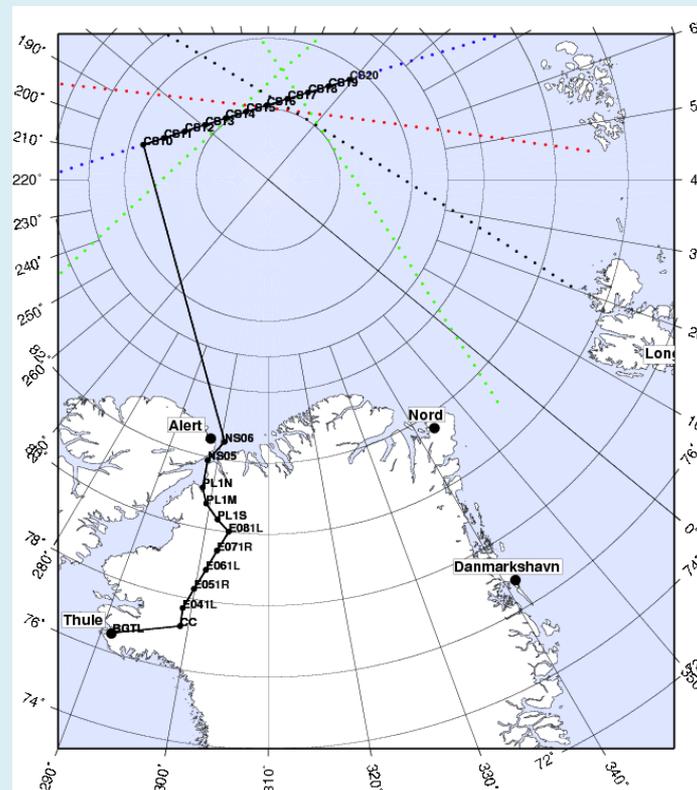


1) Data from 2009 and 2010 Airborne Topographic Mapper (ATM) Arctic surveys

April 25, 2009, P3



April 20, 2010, DC-8



2) Ground calibration: 20120501_112708.atm4cT3.rangeCentroid2TXFilt_25.vld



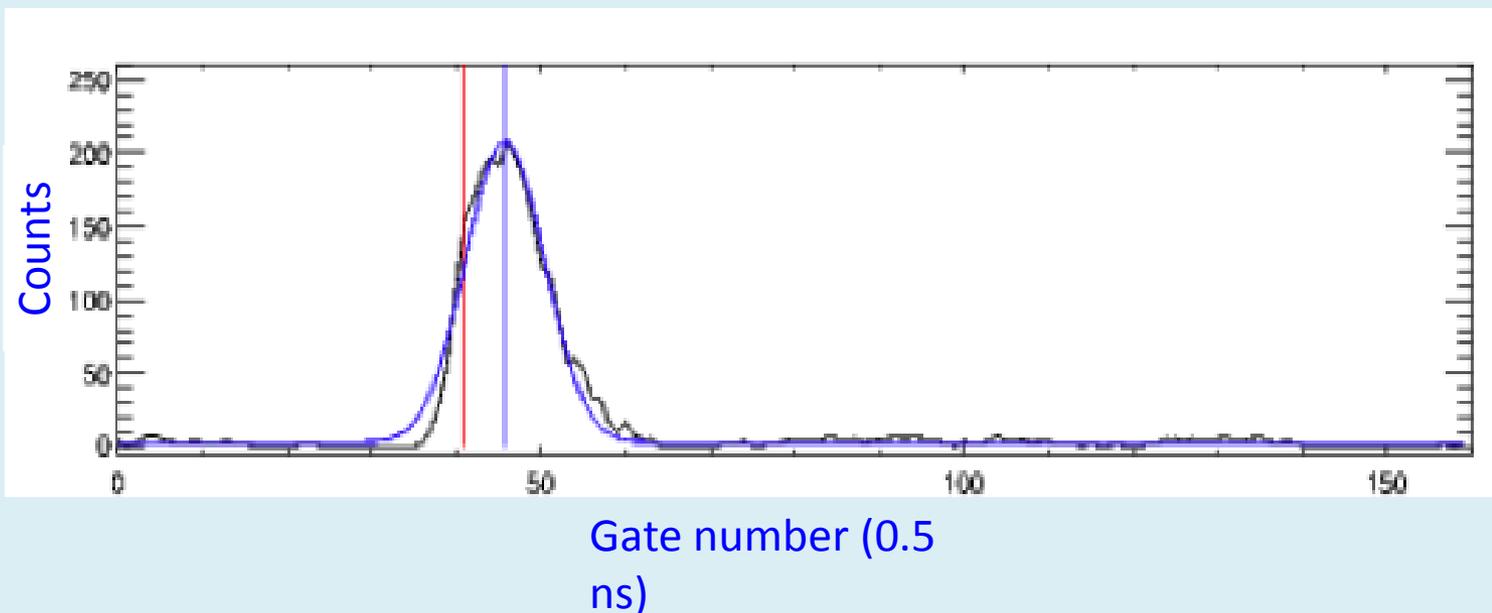
Waveform Parameters



The transmitted and received ATM waveforms were fitted with Gaussian curves to calculate:

- pulse width
- peak location
- pulse amplitude
- noise level

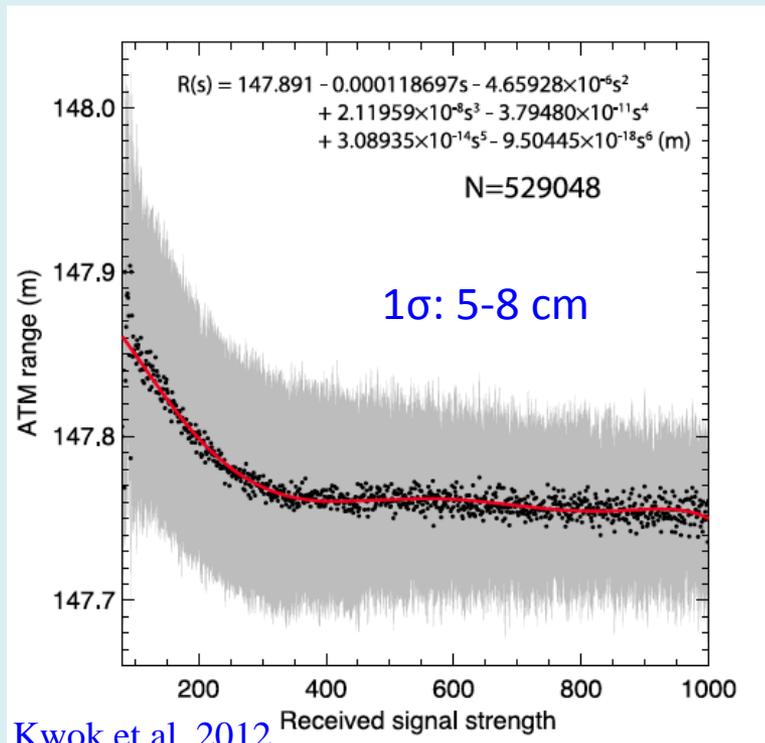
For each transmitted and received waveform, **skewness**, **kurtosis**, and **pulse area** were also calculated.





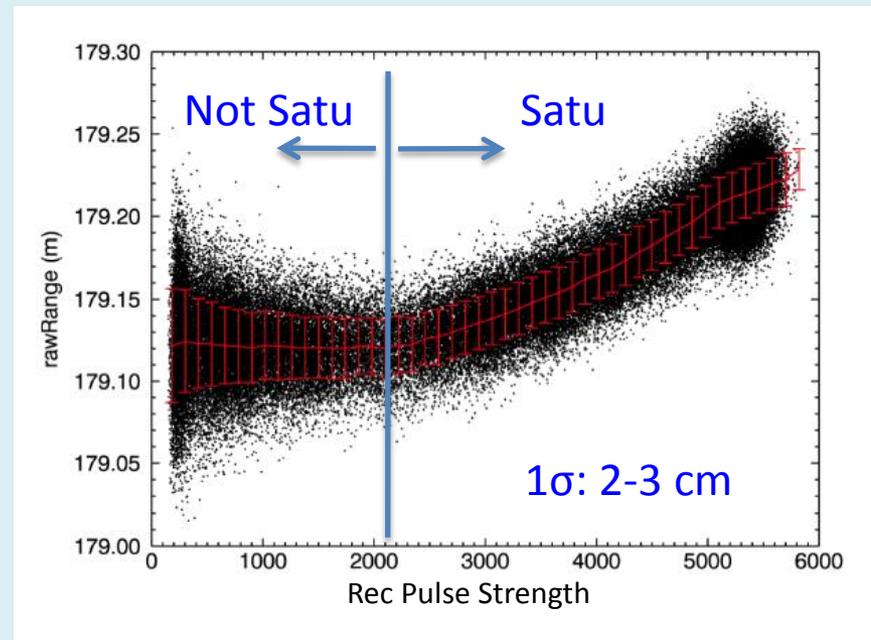
ATM Range Precision/Accuracy from Ground Test: "Nadir Pointing"

Threshold Method (2009 Test)



Kwok et al, 2012

Centroid Method (2012 Test)

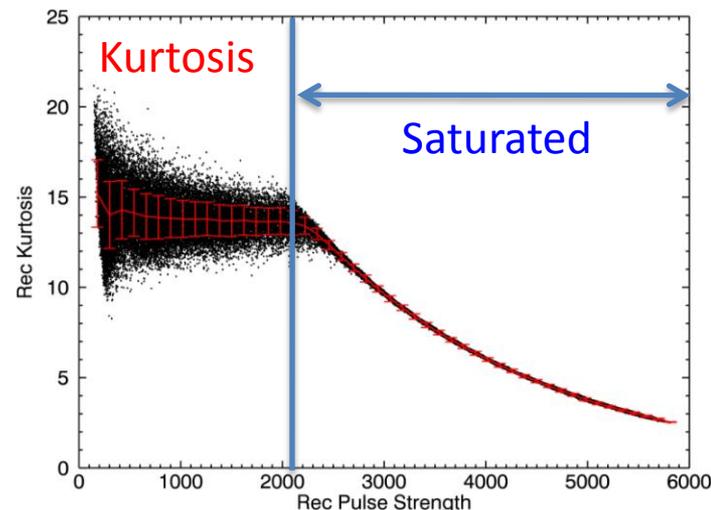
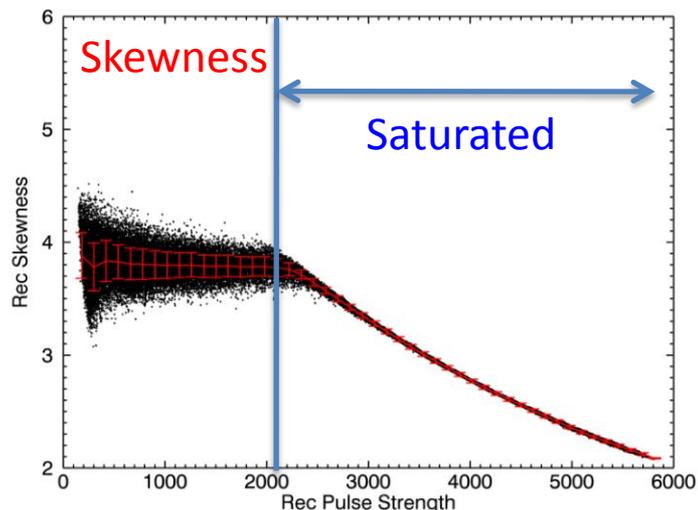
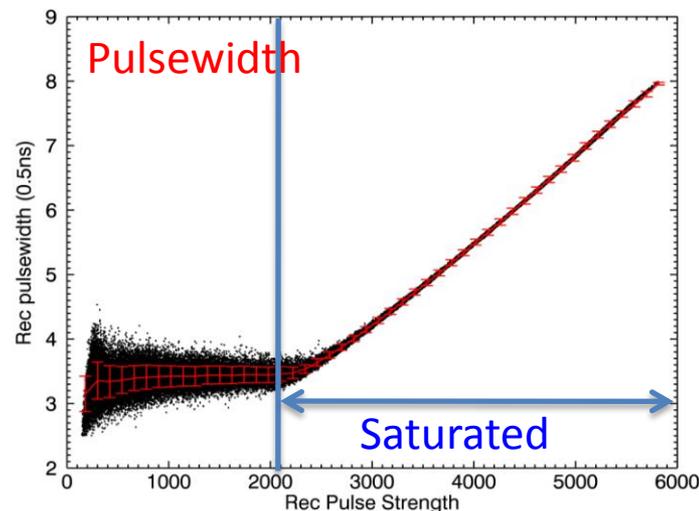
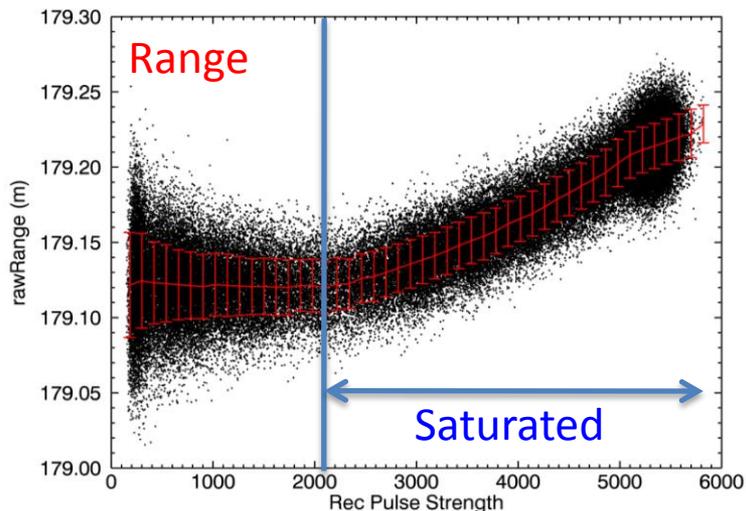


- 1) Centroid method improves range precision comparing to threshold method.
- 2) Using centroid method:
 - If waveform is not saturated, no range correction is needed.
 - If waveform is saturated, saturation correction is necessary.

Threshold method (2009, 2010?), Centroid method (2011, 2012?), consistent?



Received Waveform Parameters VS. Received Pulse Strength ATM Ground Test (2012, Laser T3), "Nadir Pointing"



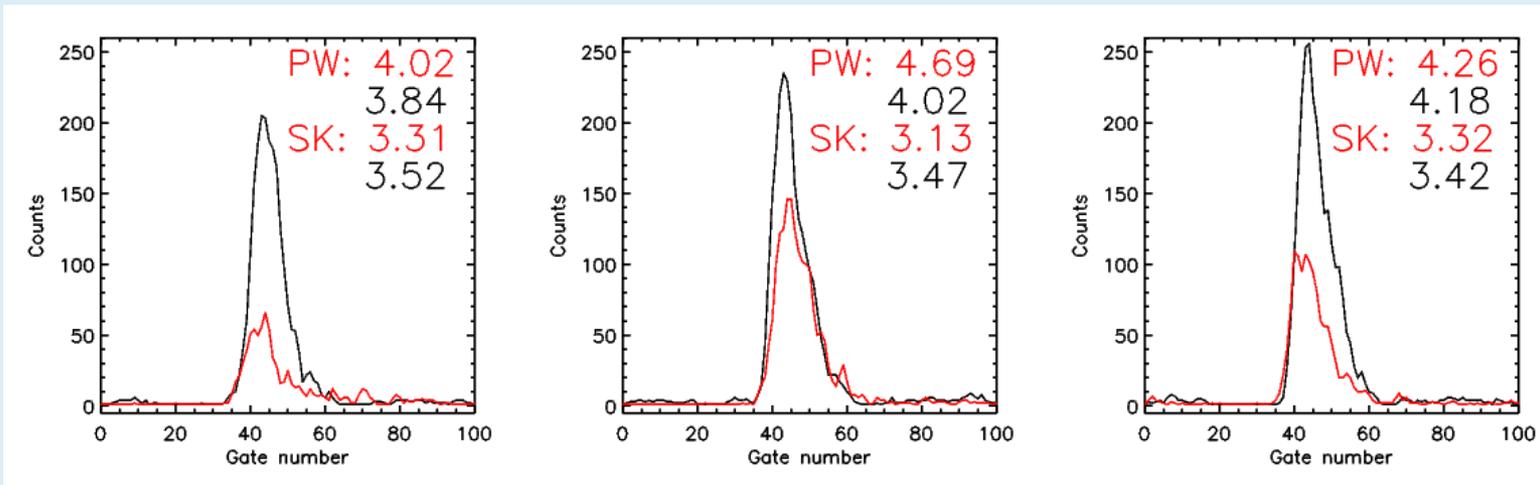
For rec pulse strength between 300-2100, ATM measured range, rec pulse width, skewness, and kurtosis do not vary with received pulse strength.



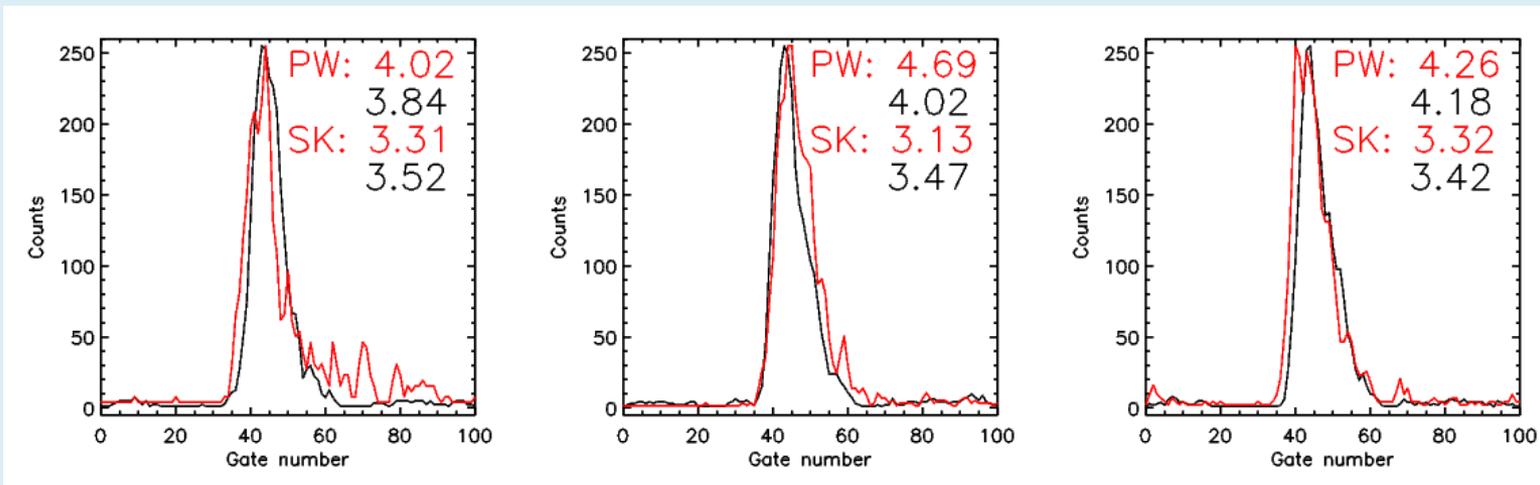
Typical ATM Waveforms (04252009)



Transmitted waveform and received waveform



Transmitted waveform and normalized received waveform

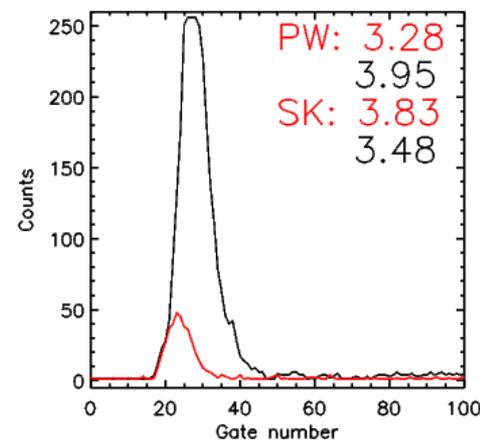
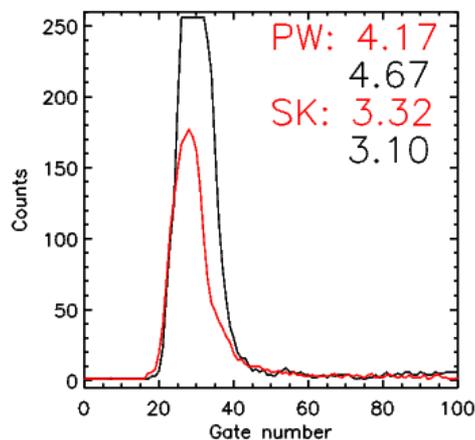
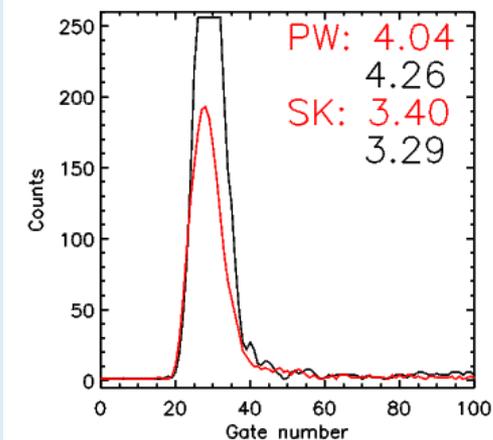




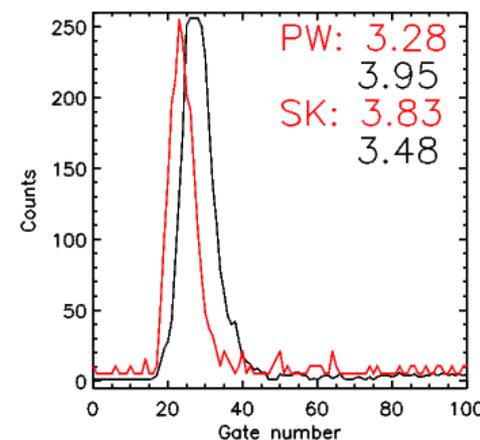
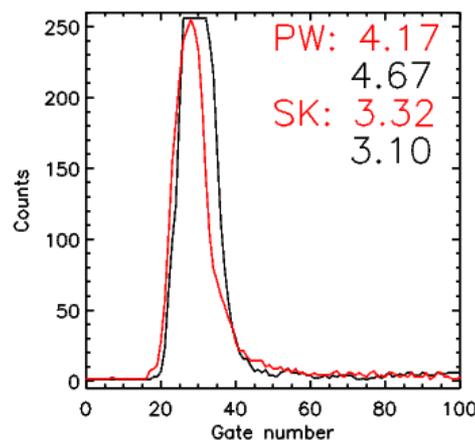
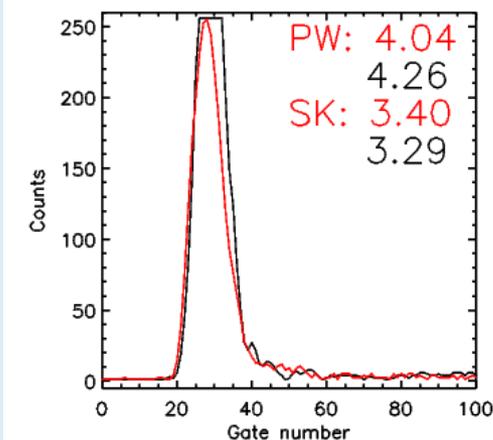
Typical ATM Waveforms (04202010)



Transmitted waveform and received waveform



Transmitted waveform and normalized received waveform



Should we operate with saturated transmitted pulse? Is there a range bias due to this?



Geographic Pattern of Received Waveform Parameters



1) Received waveform parameters:

- pulse width,
- pulse amplitude,
- pulse area,
- skewness,
- kurtosis,

show geographically correlated patterns along an ATM swath.

2) Transmitted waveform parameters show random geographic distributions, as expected.



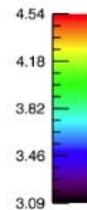
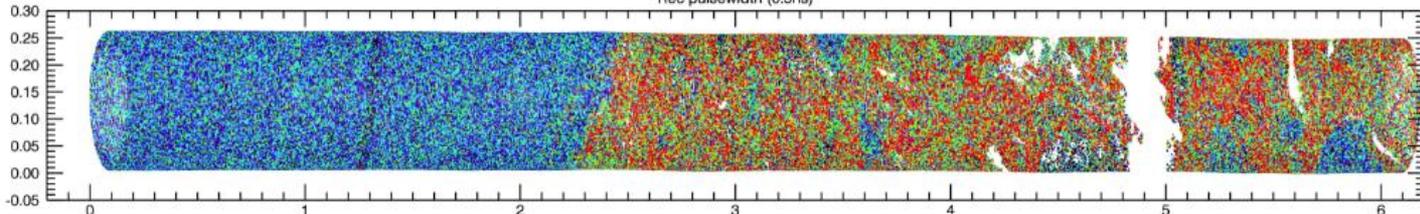
Waveform Parameters of a 6-km ATM profile (04252009)



0.35 km

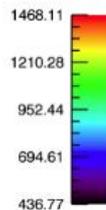
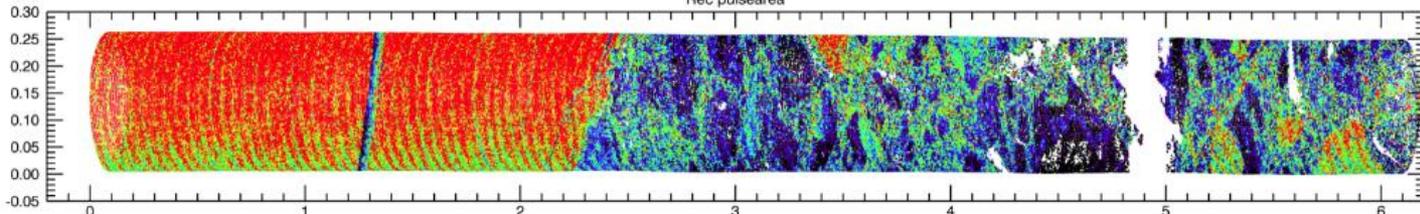
Received waveform pulsewidth

Rec pulsewidth (0.5ns)



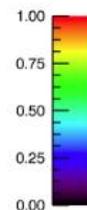
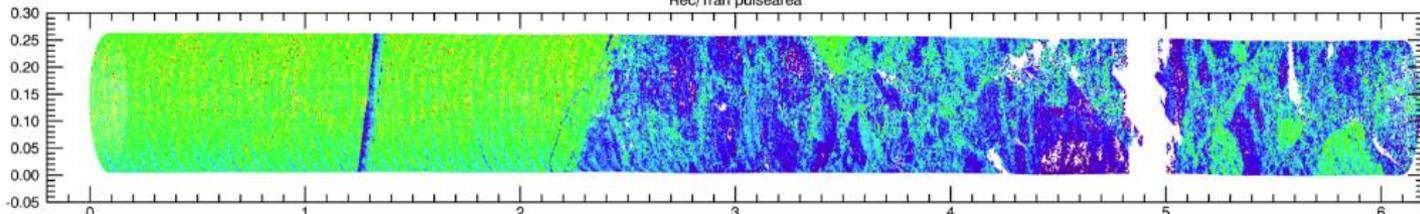
Received waveform pulse strength

Rec pulsearea



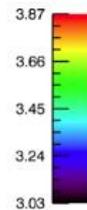
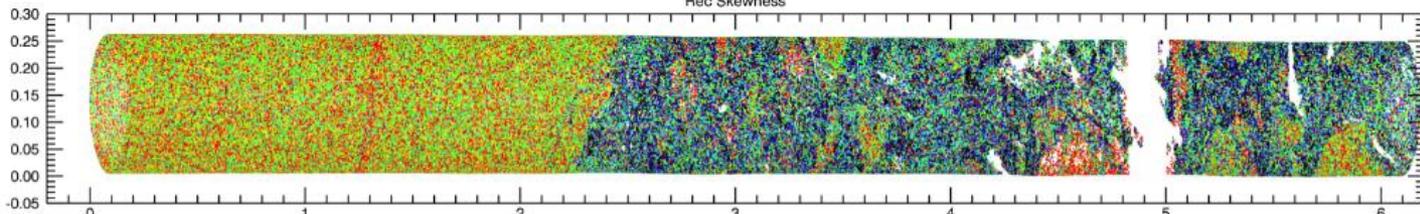
Rec/Tran waveform pulse strength ratio

Rec/Tran pulsearea



Received waveform Skewness

Rec Skewness



6 km



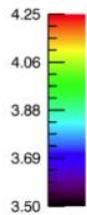
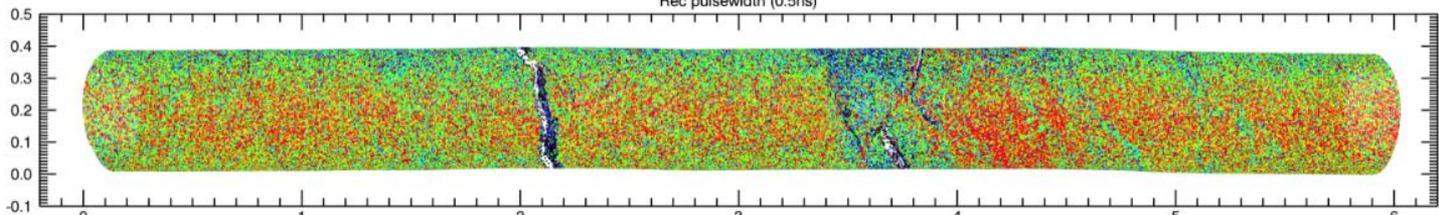
Waveform Parameters of a 6-km ATM profile (04202010)



0.6 km

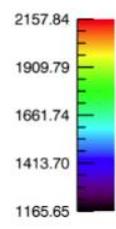
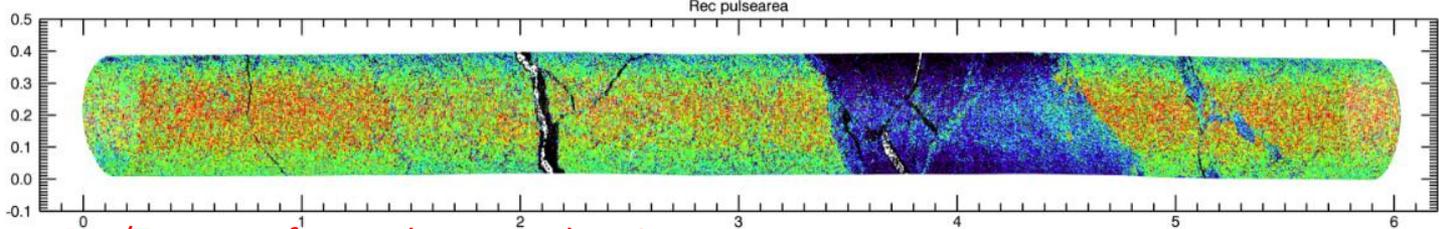
Received waveform pulsewidth

Rec pulsewidth (0.5ns)



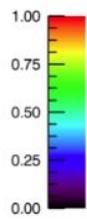
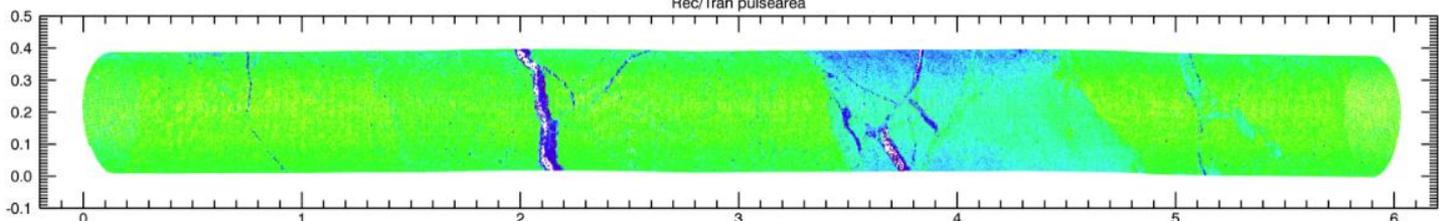
Received waveform pulse strength

Rec pulsearea



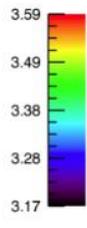
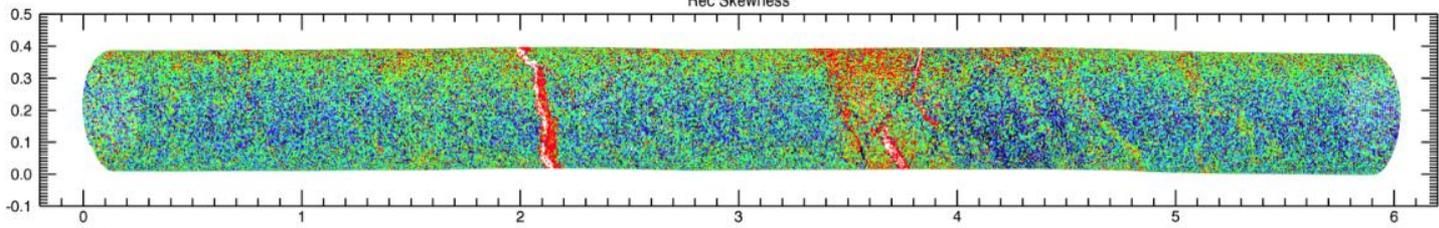
Rec/Tran waveform pulse strength ratio

Rec/Tran pulsearea



Received waveform Skewness

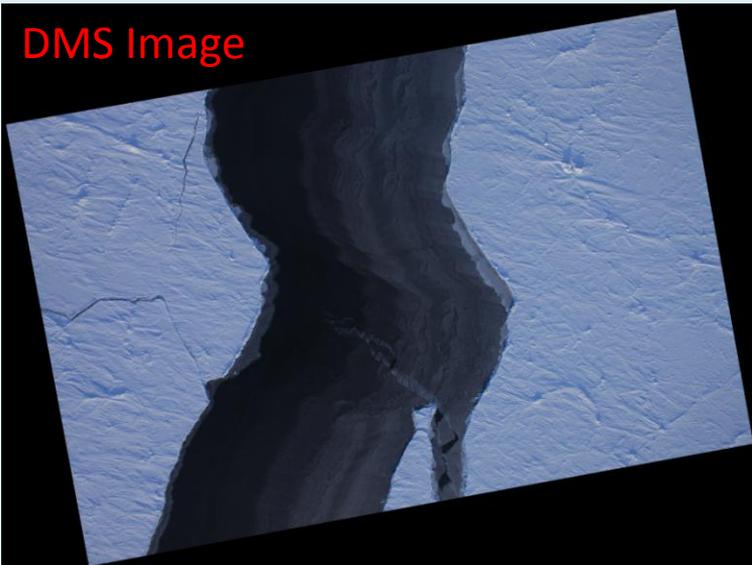
Rec Skewness



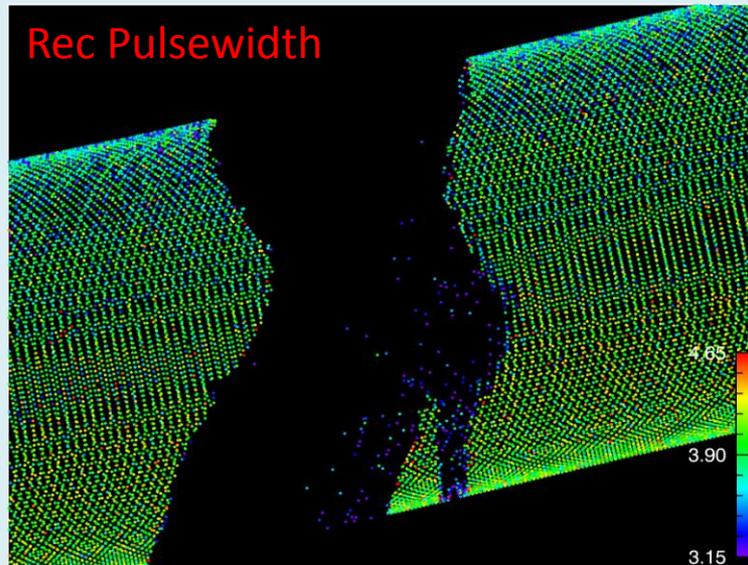
6 km

Distribution of Received Waveform Parameters

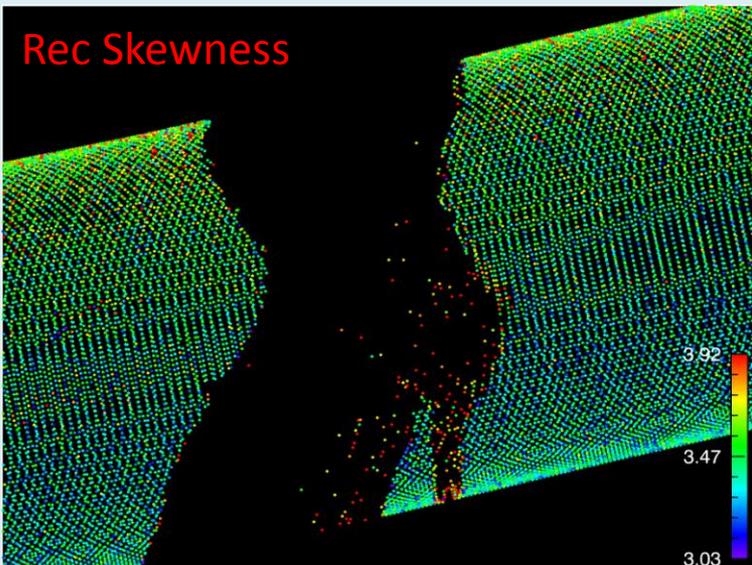
DMS Image



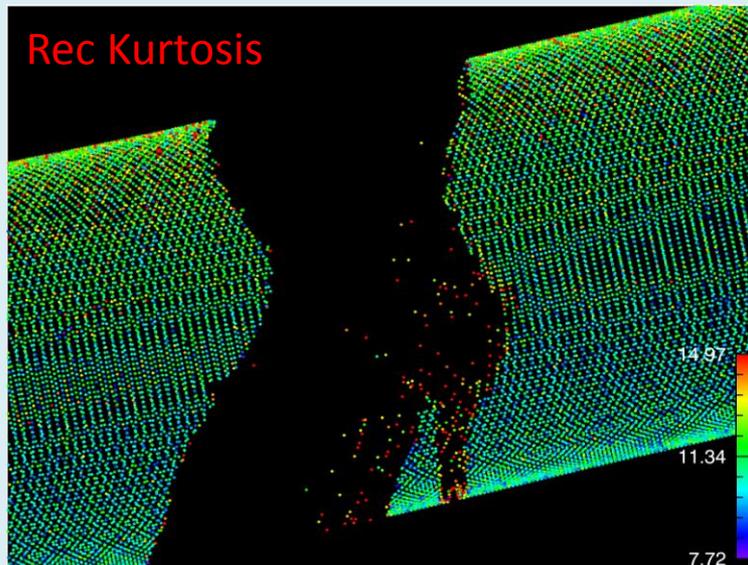
Rec Pulsewidth



Rec Skewness

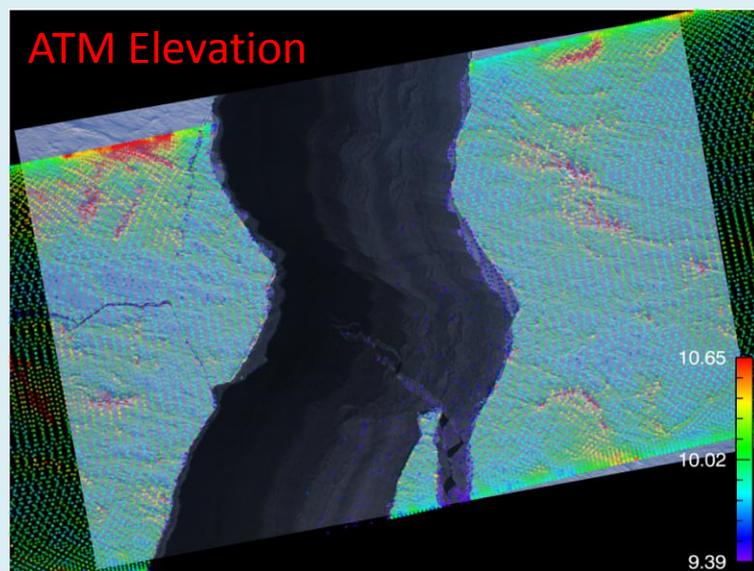
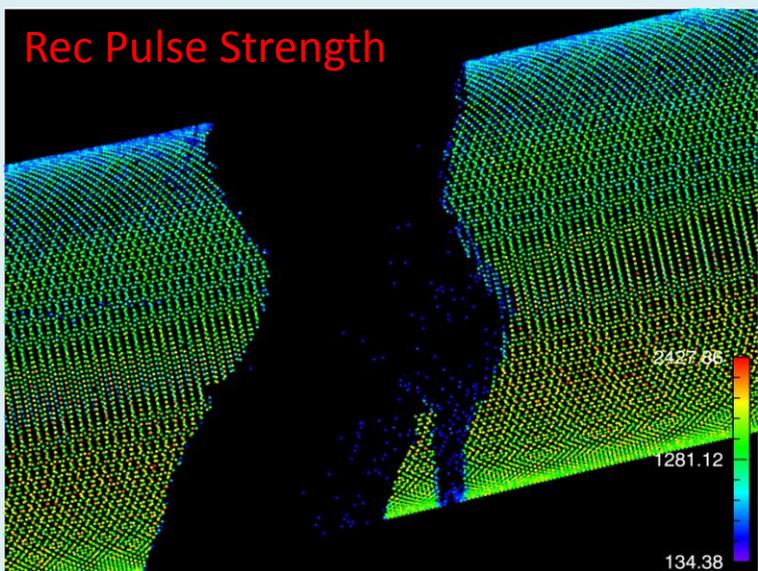
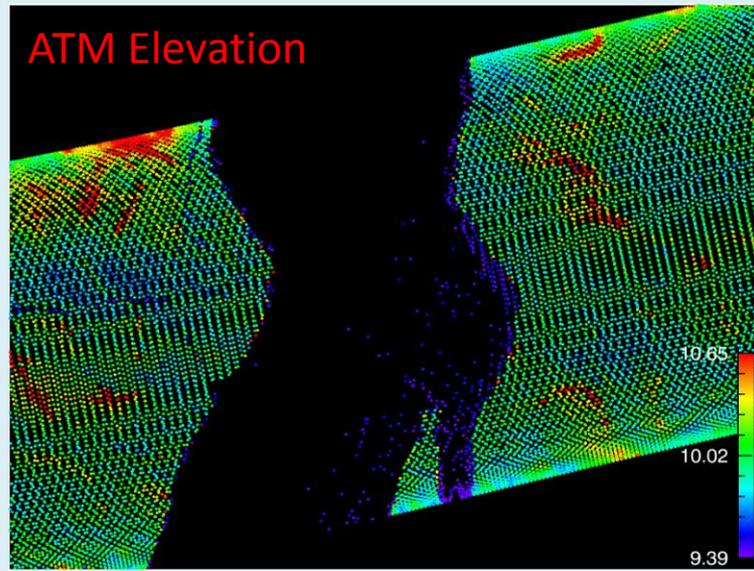
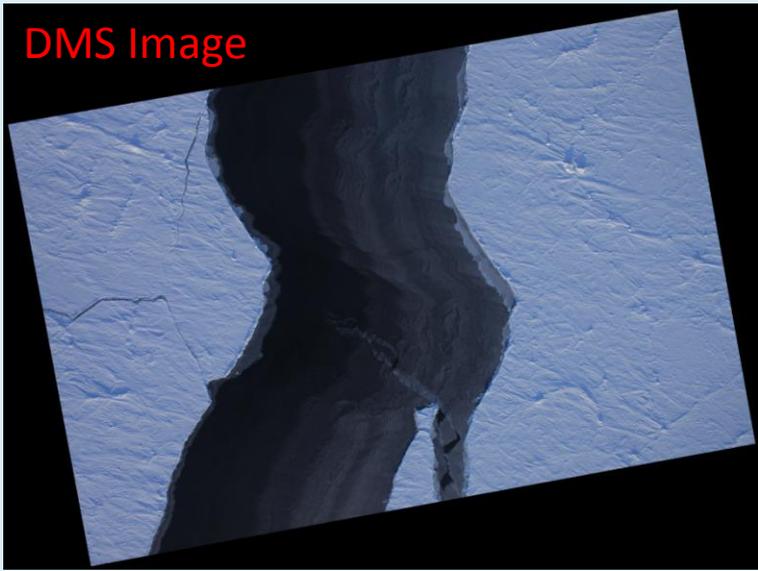


Rec Kurtosis





ATM Elevation and Received Pulse Strength





Summary



1. ATM received waveforms vary with surface reflectivity and surface topography. The waveform parameters can potentially be used to distinguish sea ice surface types such as open water, thin ice, and thick ice.
2. ATM ground calibration tests show that ATM measured range is algorithm sensitive. Threshold and Centroid methods produce results with different precision and sensitivity to received power. We will compare same ground test data sets using threshold, Centroid, and Gaussian fitting methods to evaluate range precision, bias and their sensitivity to transmitted and received power.
3. Saturation correction needs to be further evaluated.
4. We will analysis ATM waveform characteristics for different surface types and evaluate if there is any surface type and topography related elevation bias in the calculated freeboard. We will compare ATM results with LVIS, Cryosat-2, and MABEL, and evaluate if ATM laser penetration is detectable.