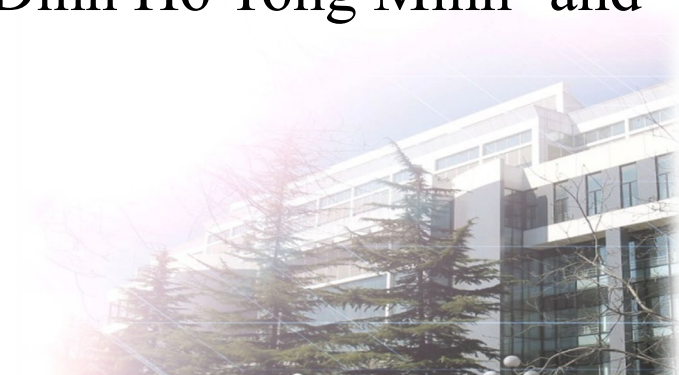




First demonstration of spaceborne multi-static SAR Tomography using Chinese Hongtu-1 X-band radar constellation

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¹Beihang University; ²CESBIO; ³UMR TETIS; ⁴PIESAT





1. Why multi-static ?



2. Chinese Hongtu-1 constellation



3. Test sites



4. Phase calibration



5. TomoSAR results



1. Why multi-static ?



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5. TomoSAR results

Why multi-static?



- Multi-static TomoSAR: the multi-baseline SAR images are collected **simultaneously**
- Repeat-pass TomoSAR: the multi-baseline SAR images are collected **at different time**

	Temporal decorrelation	Atmospheric/ionospheric delay
Multi-static	No	No
Repeat-pass	Yes	Yes

Multi-static TomoSAR no longer suffers from tomogram defocusing induced by temporal decorrelation or atmospheric/ionospheric delay!



1. Why multi-static ?



2. Chinese Hongtu-1 constellation



3. Test sites



4. Phase calibration

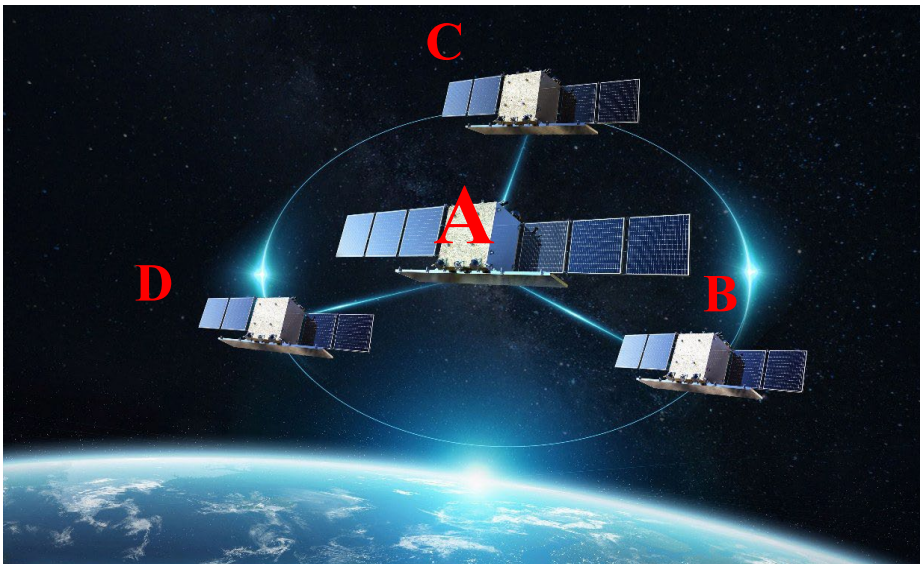


5. TomoSAR results

Chinese Hongtu-1 constellation



航天宏图
Piesat



Artist's view of Hongtu-1 constellation

A: transmitter/receiver (320 kg)

B: receiver (270 kg)

C: receiver (270 kg)

D: receiver (270 kg)



Launched in 2023

Radar system parameters

Parameter	Value
Transmitter	Satellite A
Receiver	Satellite A/B/C/D
Polarization	HH
Look direction	Left-looking
Radar frequency	9.6 GHz
Chirp bandwidth	100 MHz
PRF	4201 Hz
Range spacing	0.75 m
Azimuth spacing	1.69 m
Orbit latitude	528 km
Revisit	15 days
Operation mode	Strip-map
Swath width	20-30km
Incident angles	17-50°



1. Why multi-static ?



2. Chinese Hongtu-1 constellation



3. Test sites

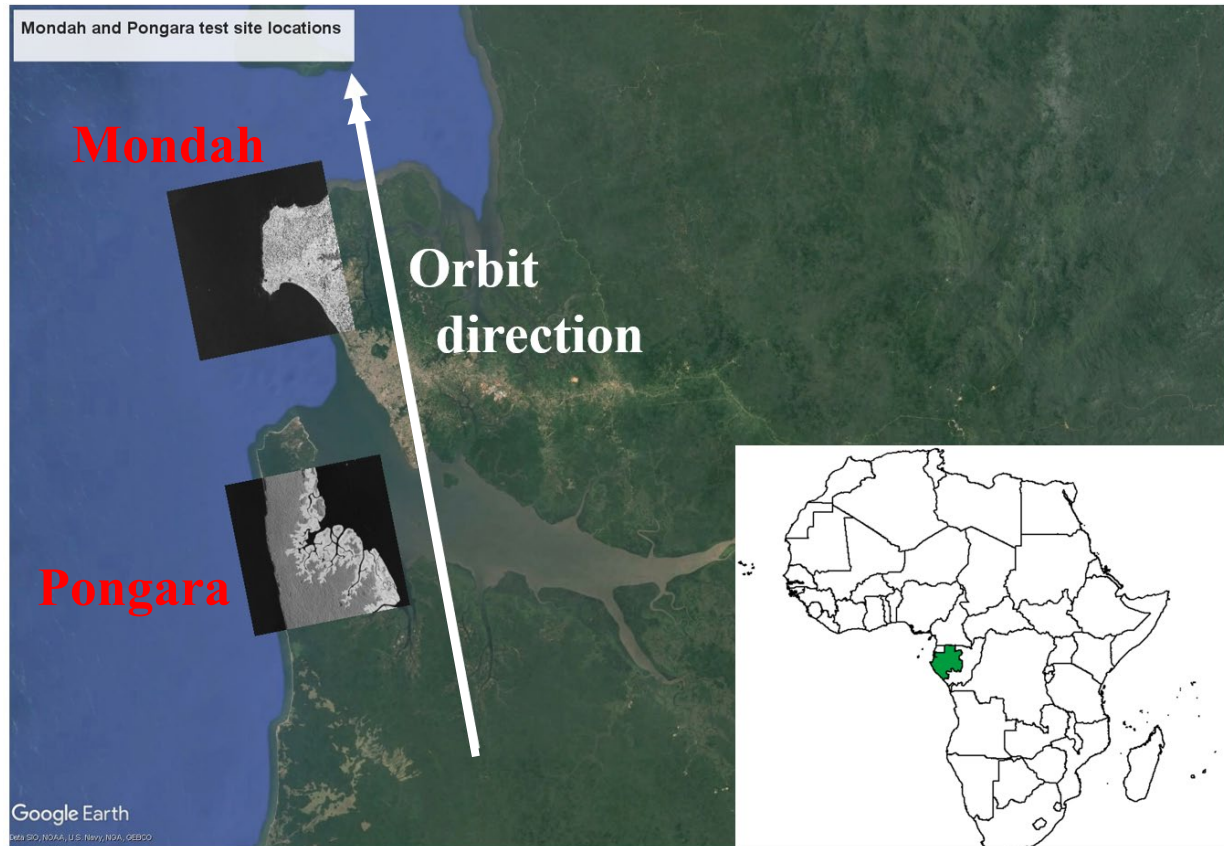


4. Phase calibration

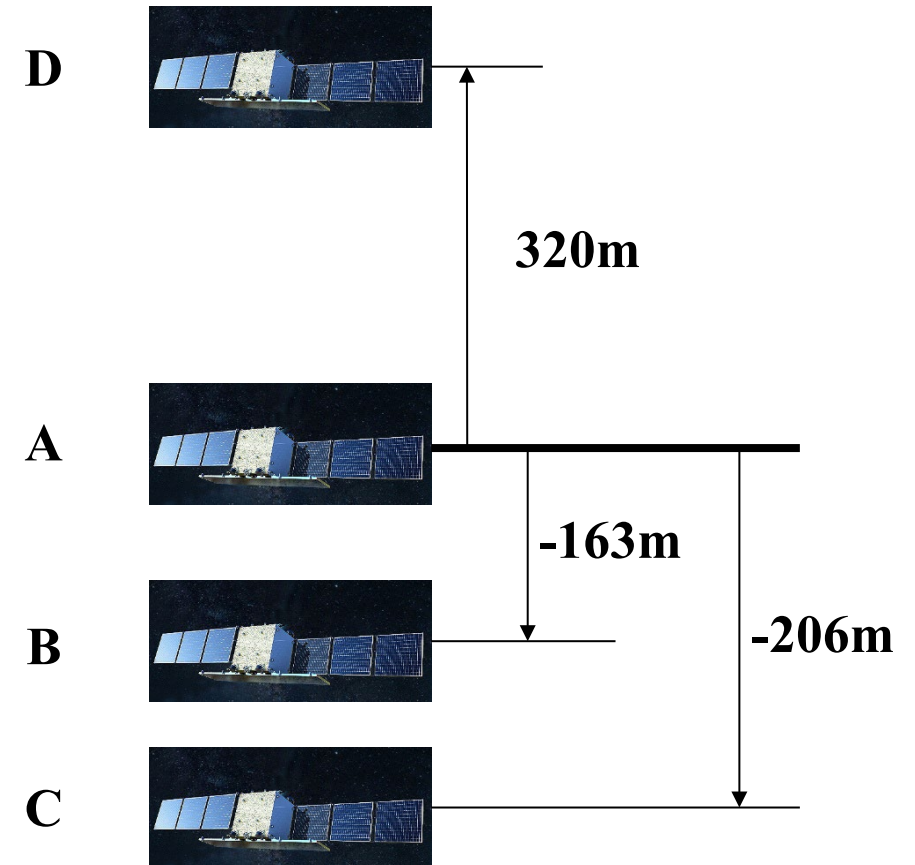


5. TomoSAR results

➤ Tropical forest test sites: Pongara & Mondah



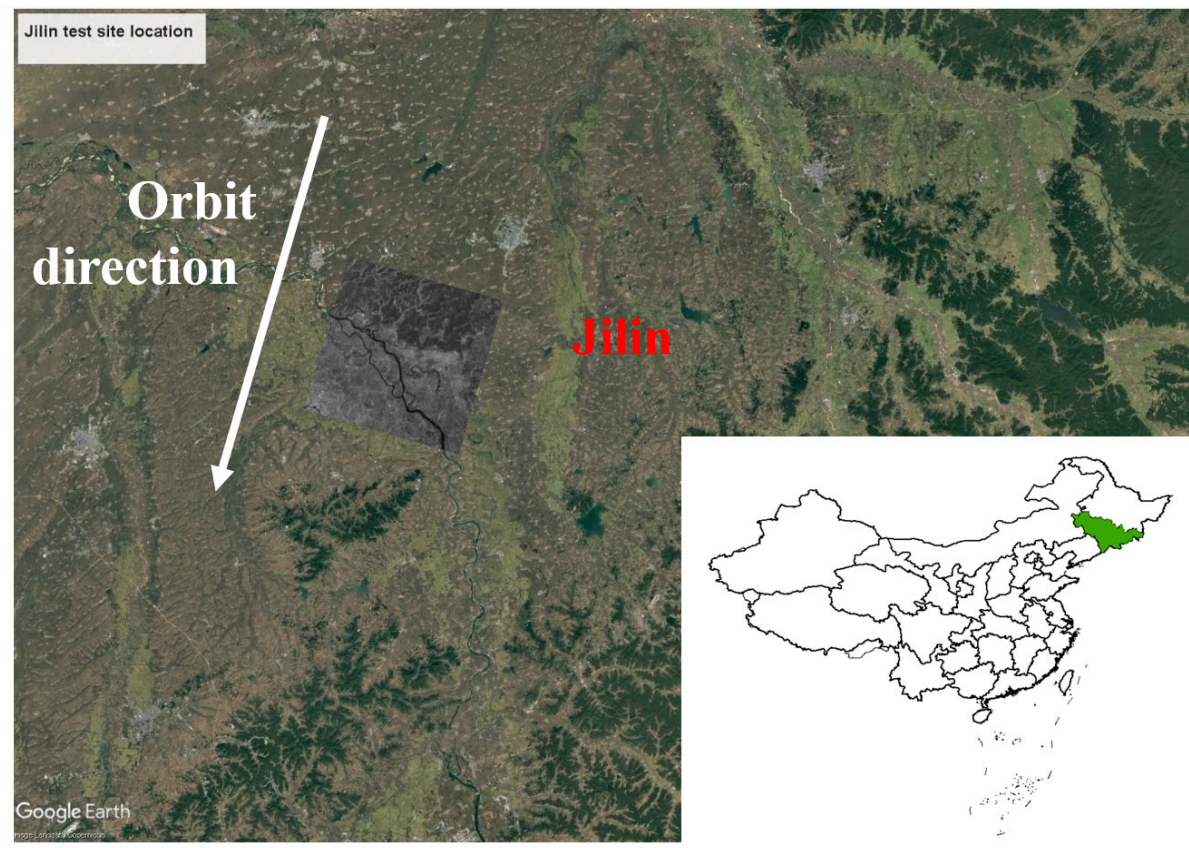
Geographical location of Pongara and Mondah test sites



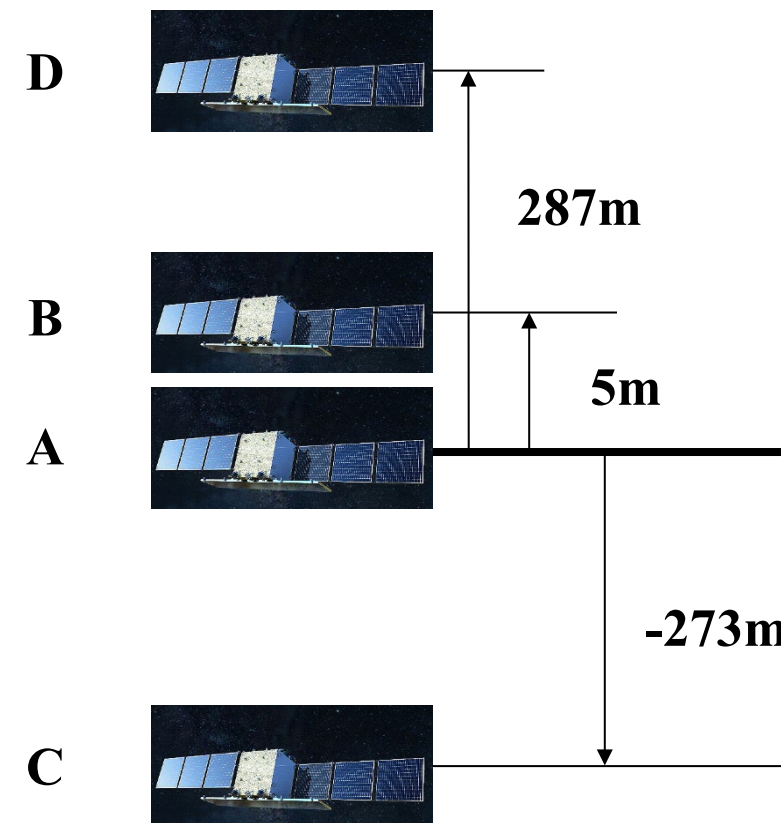
Vertical baseline distribution

Rayleigh resolution: **41m**
Non-ambiguous interval: **124m**

➤ Temperate forest test sites: Jilin, China



Geographical location of Jilin test site



Vertical baseline distribution

Rayleigh resolution: **35m**
Non-ambiguous interval: **70m**



1. Why multi-static ?



2. Chinese Hongtu-1 constellation



3. Test sites



4. Phase calibration



5. TomoSAR results

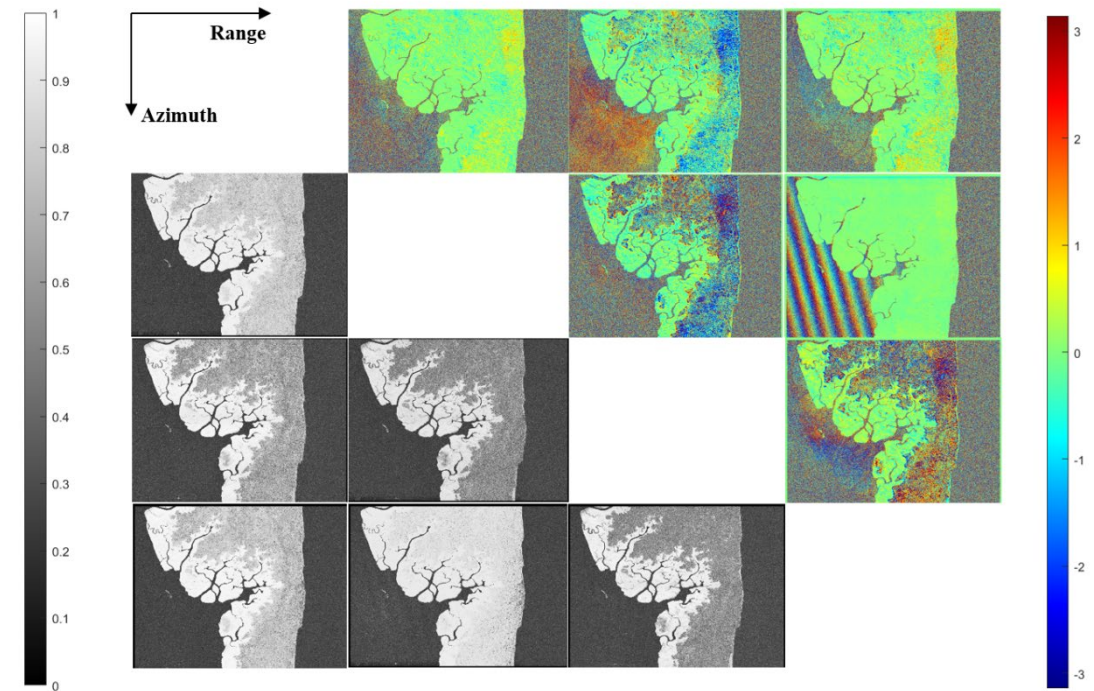
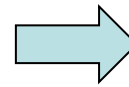
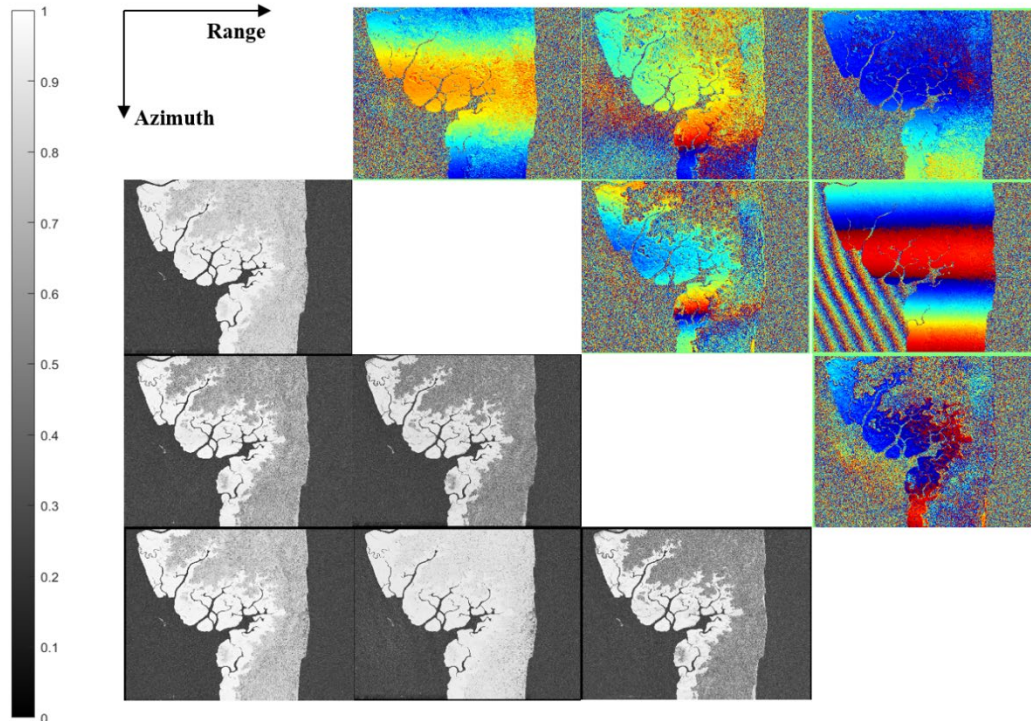
➤ Pongara phase calibration

Zeng et al. 2024. IEEE TGRS.

Uncalibrated interferograms



Calibrated interferograms



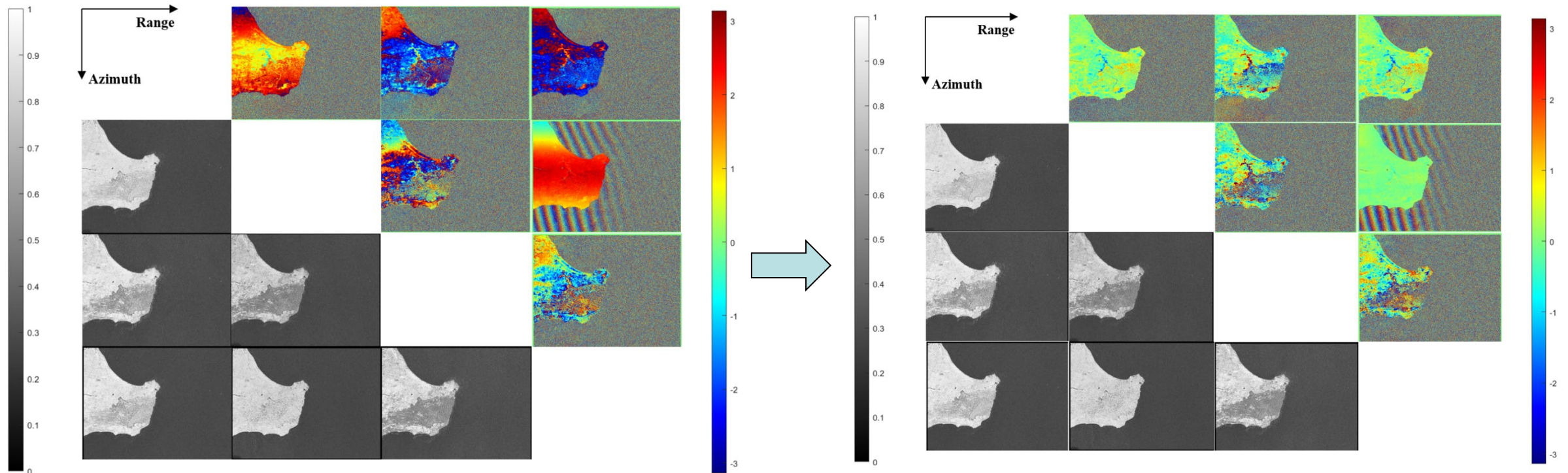
➤ Mondah phase calibration

Zeng et al. 2024. IEEE TGRS.

Uncalibrated interferograms



Calibrated interferograms



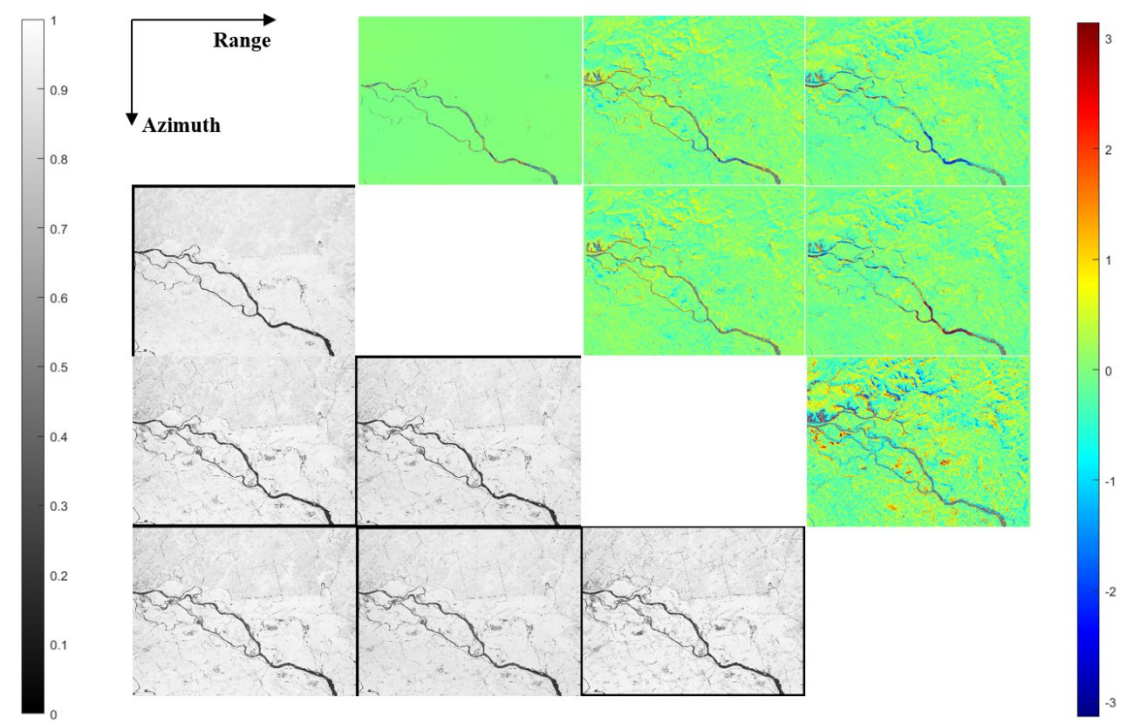
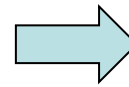
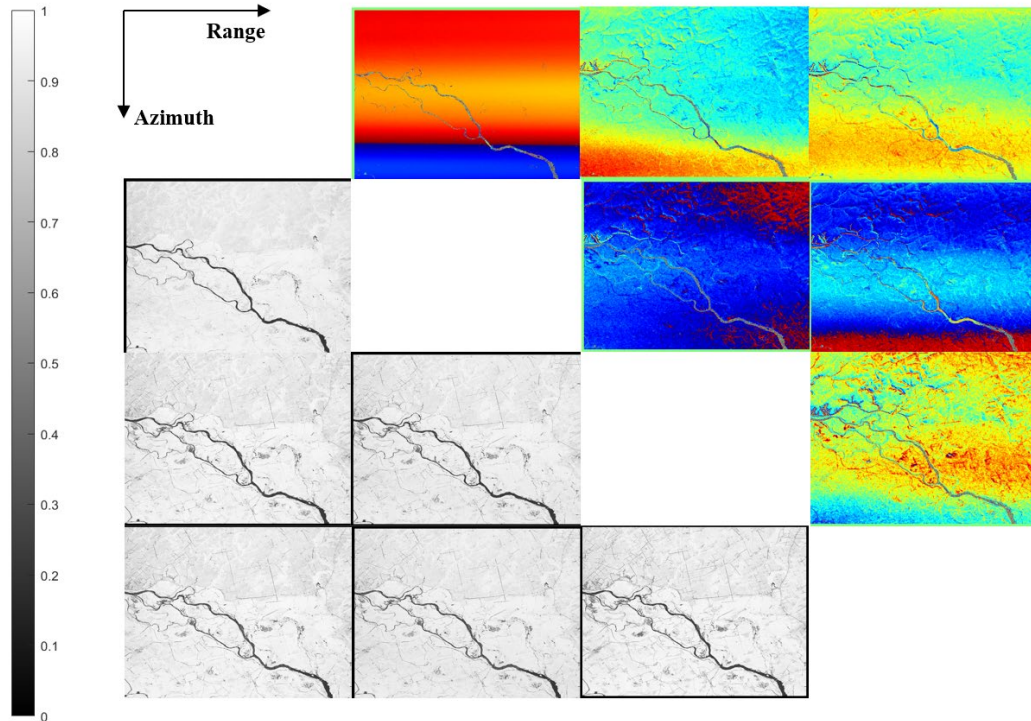
➤ Jilin test site phase calibration

Zeng et al. 2024. IEEE TGRS.

Uncalibrated interferograms



Calibrated interferograms





1. Why multi-static ?



2. Chinese Hongtu-1 constellation



3. Test sites

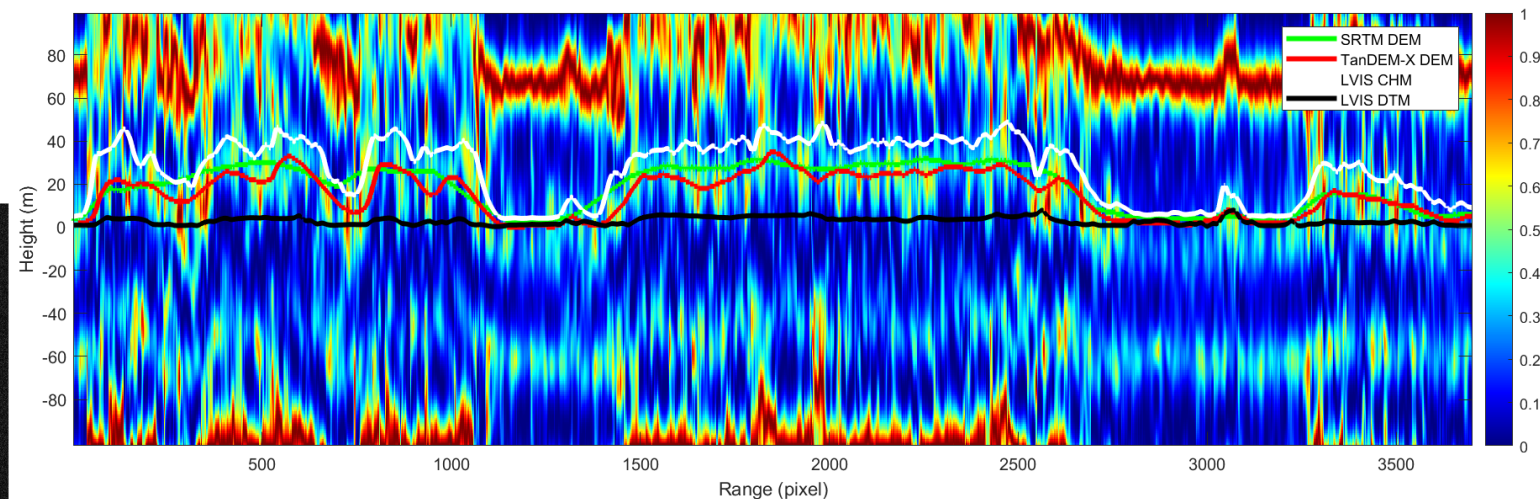
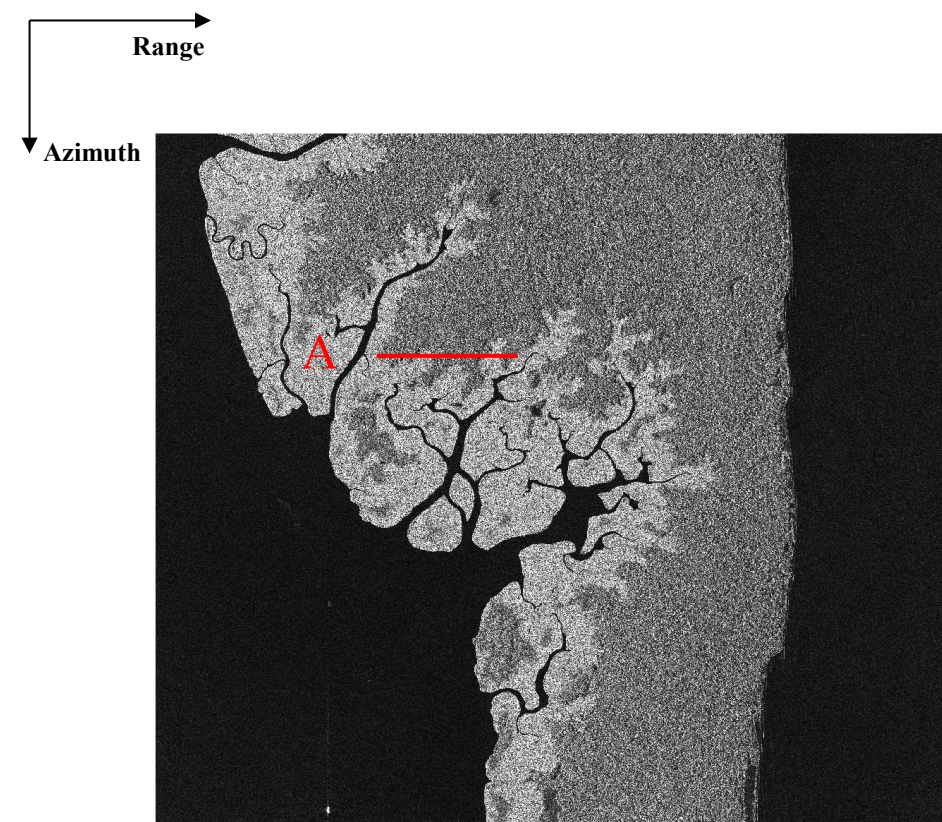


4. Phase calibration

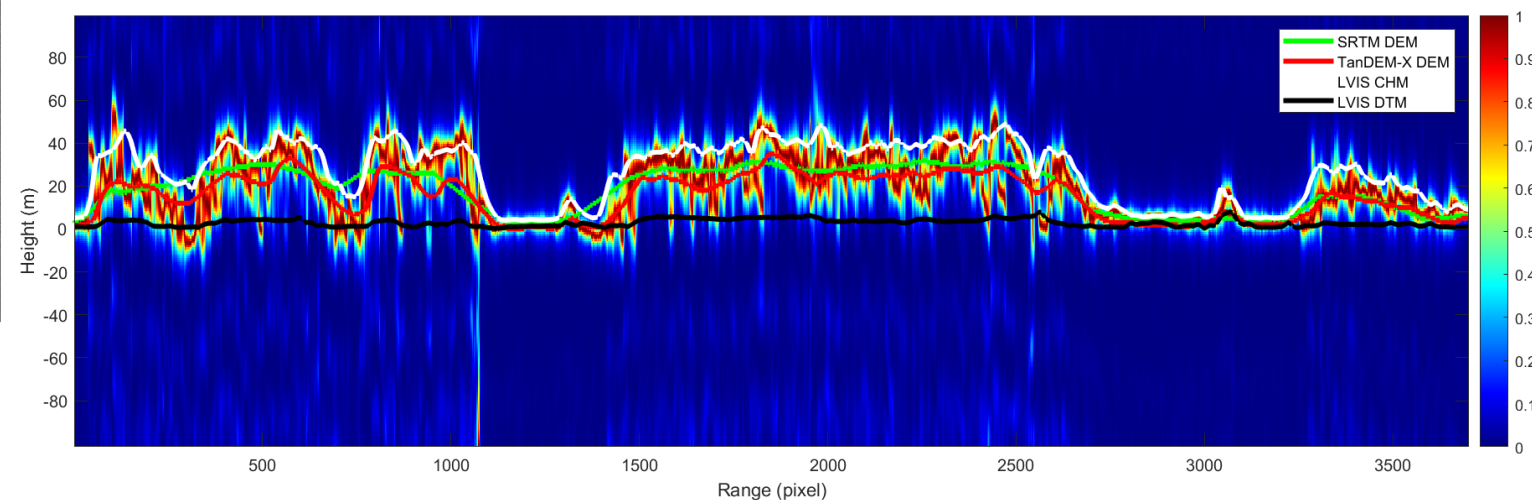


5. TomoSAR results

➤ Pongara tropical forest tomogram A

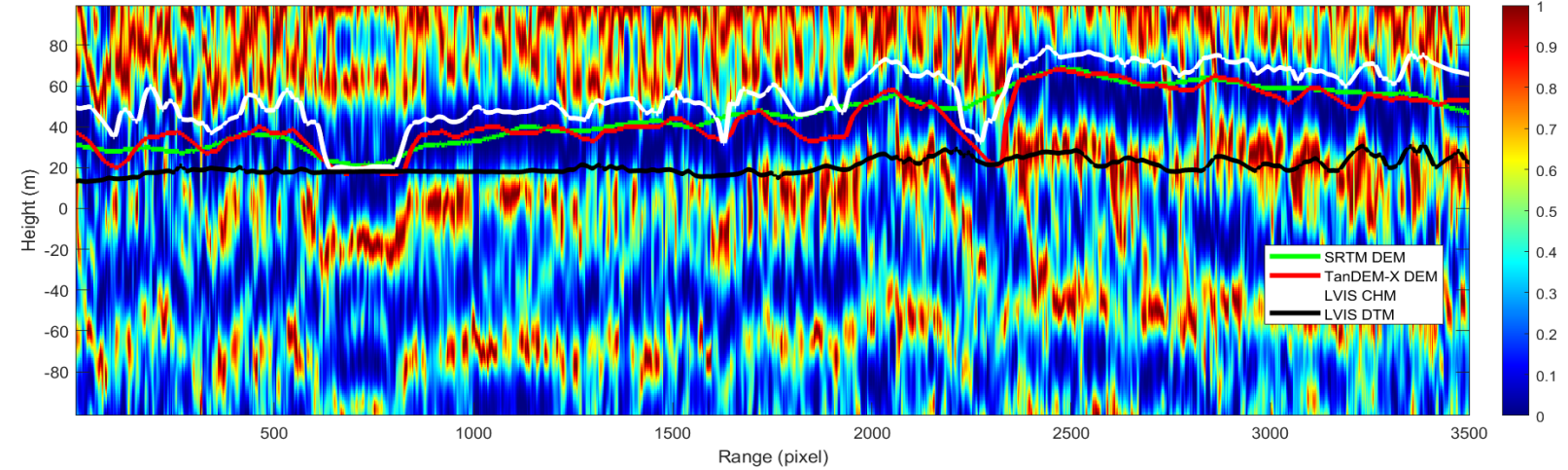
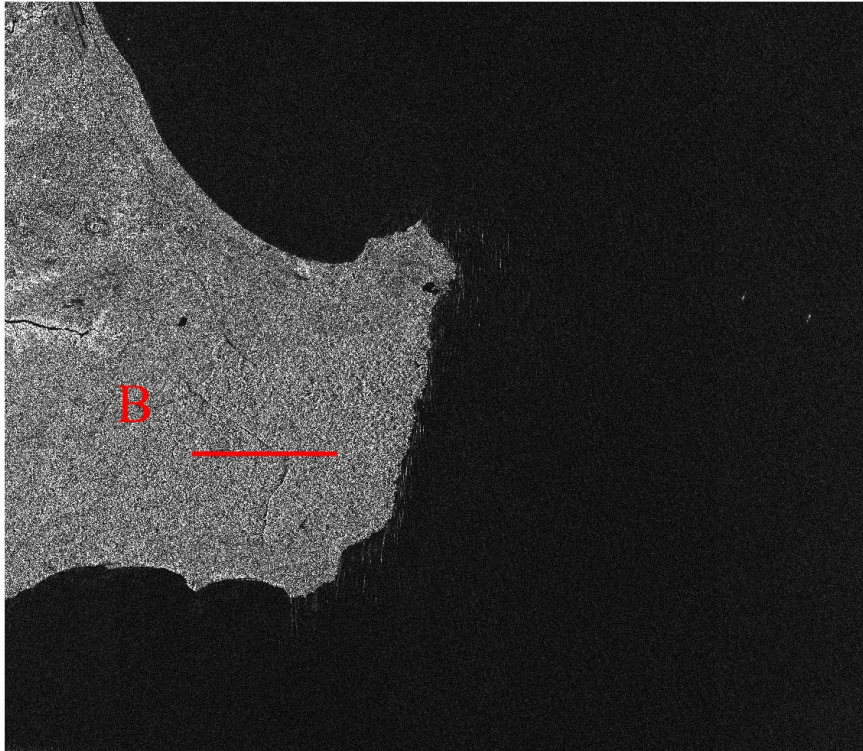


Uncalibrated Capon tomogram

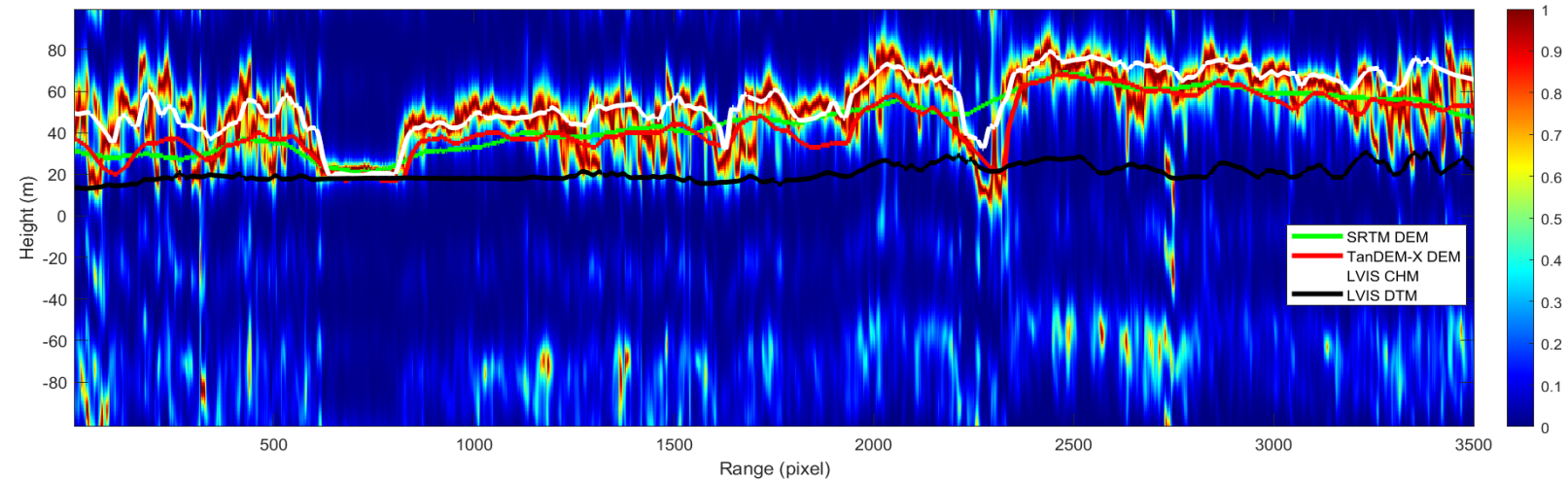


Calibrated Capon tomogram

➤ Mondah tropical forest tomogram B

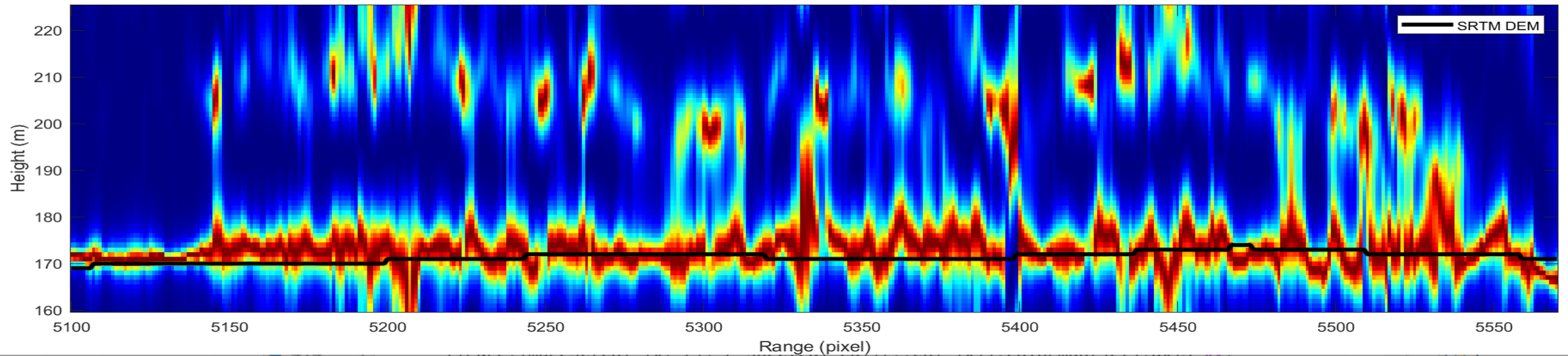
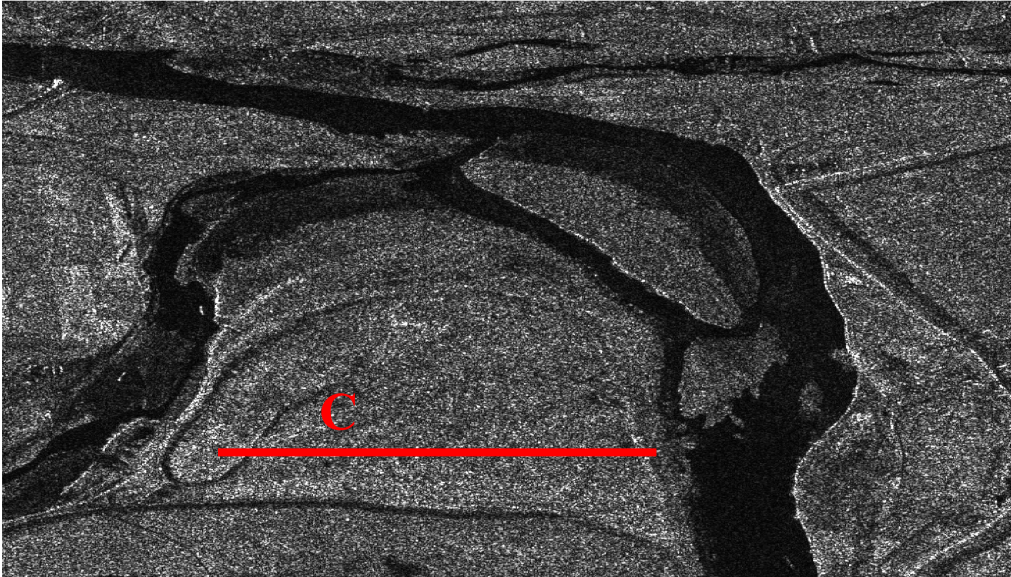


Uncalibrated Capon tomogram

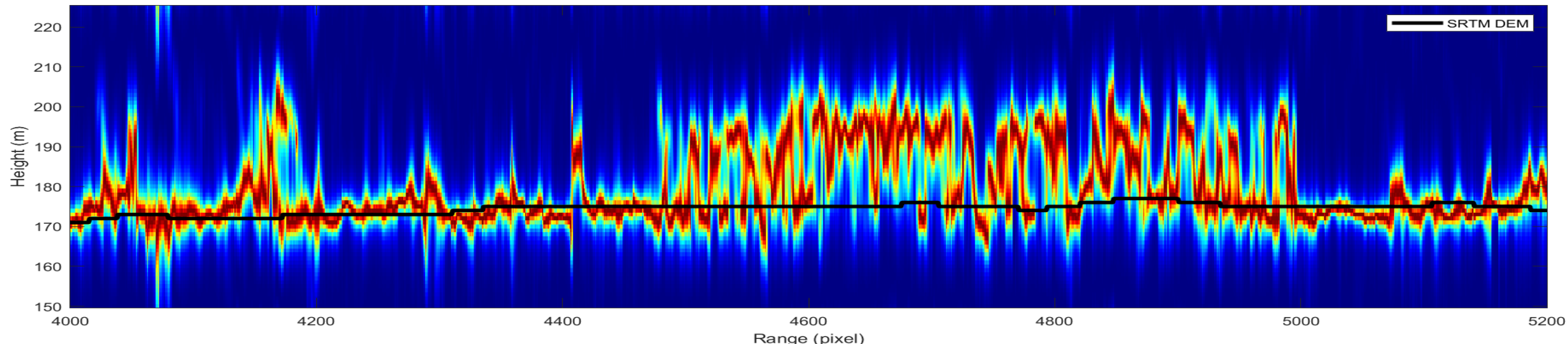
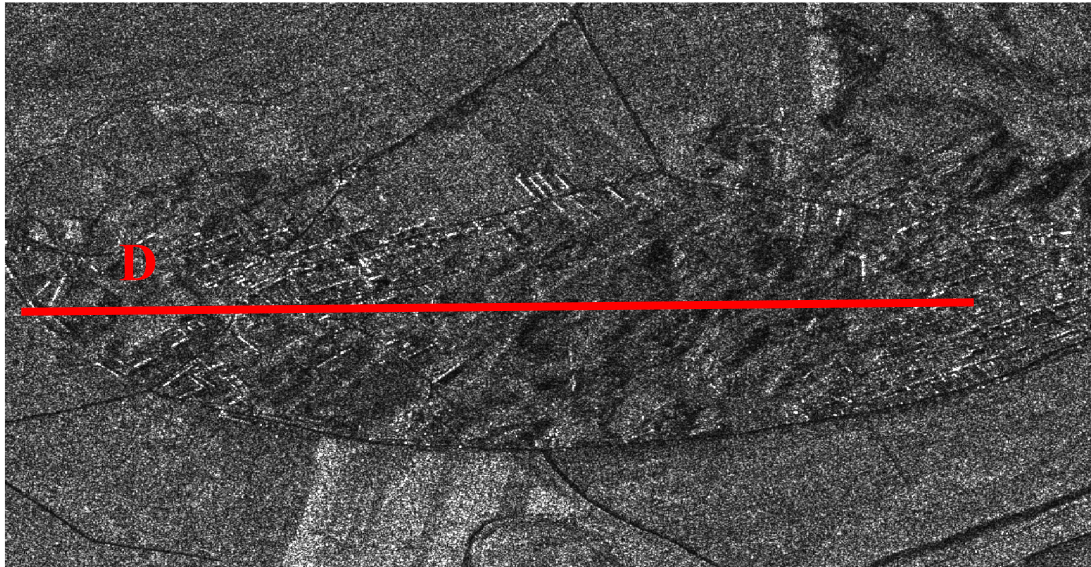


Calibrated Capon tomogram

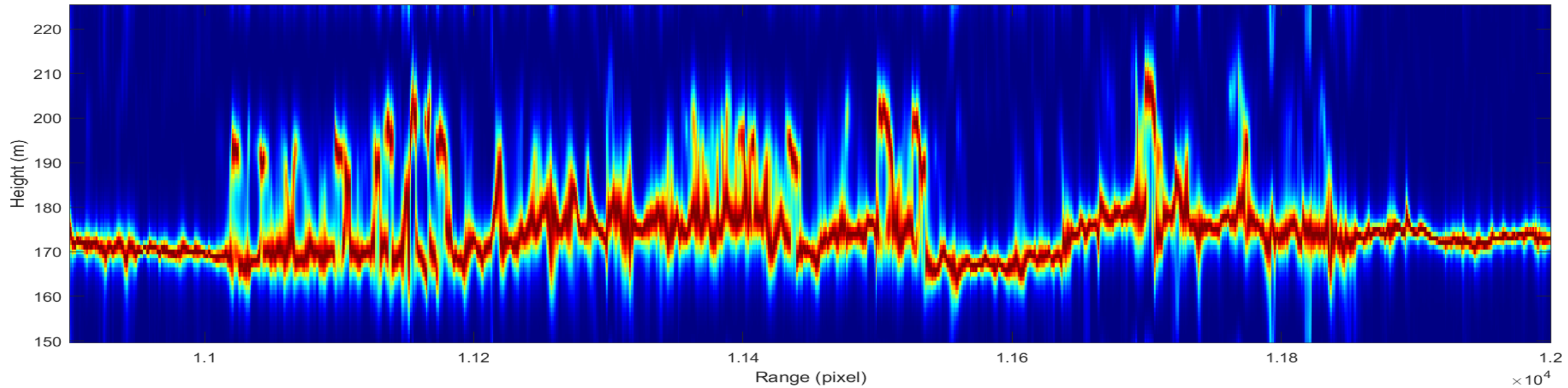
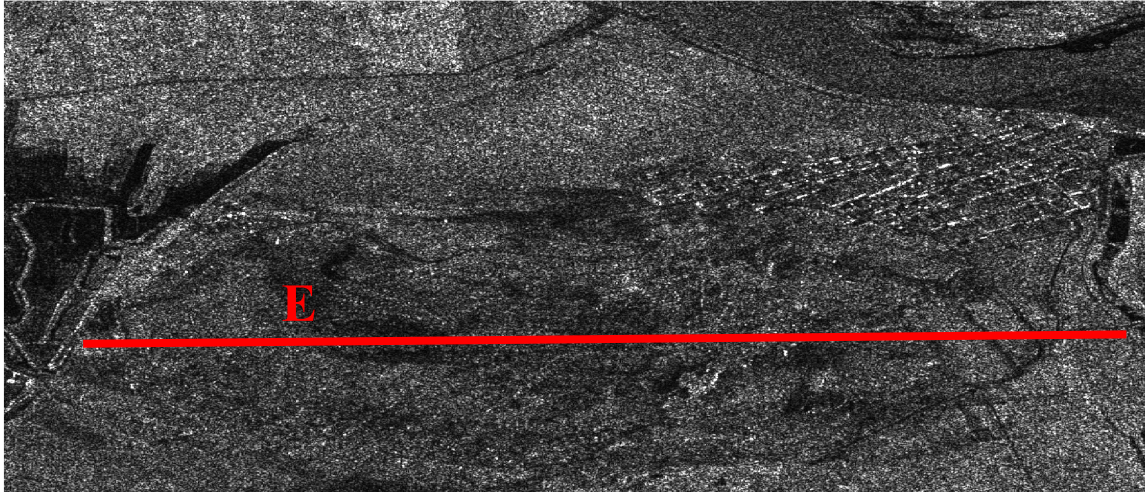
➤ Jilin temperate forest tomogram C



➤ Jilin temperate forest tomogram D

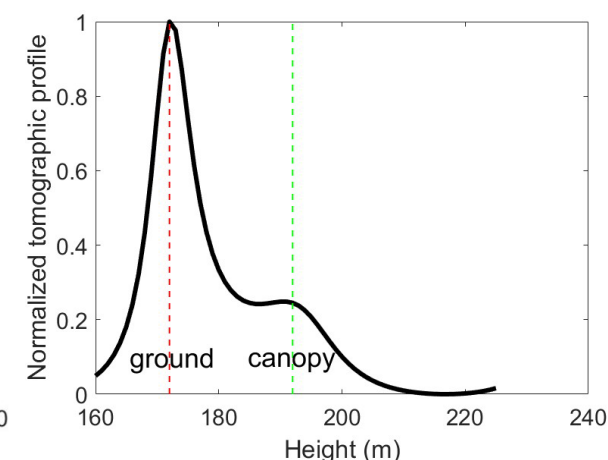
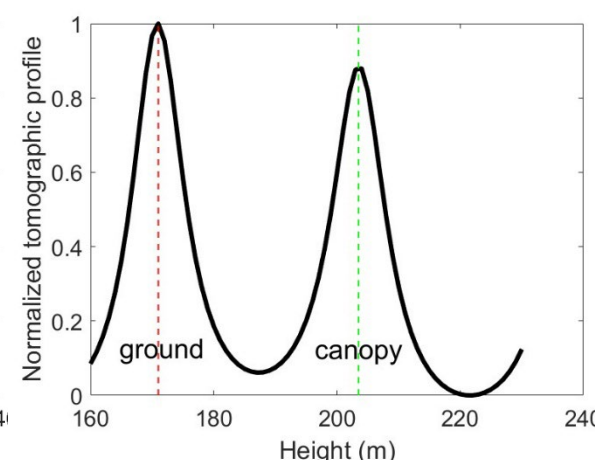
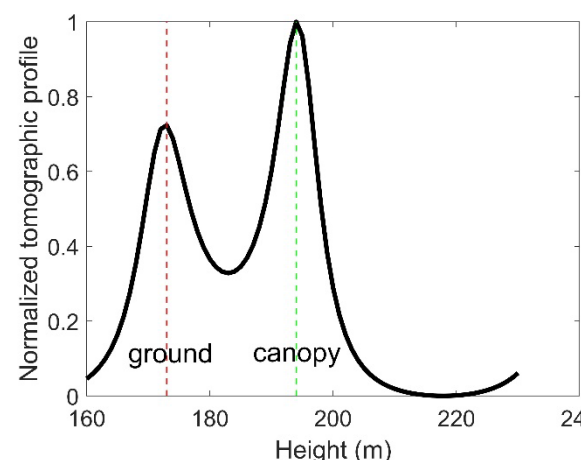
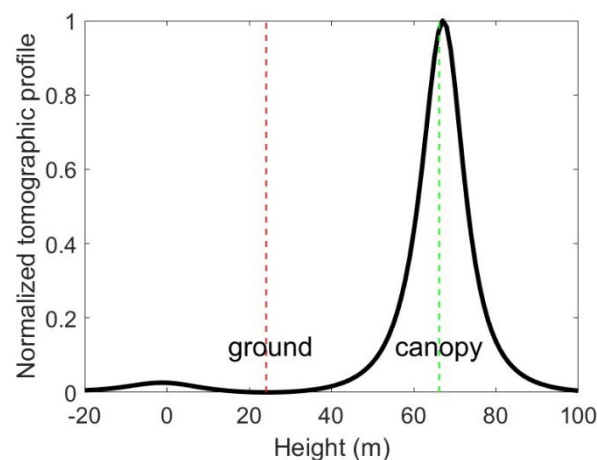


➤ Jilin temperate forest tomogram E



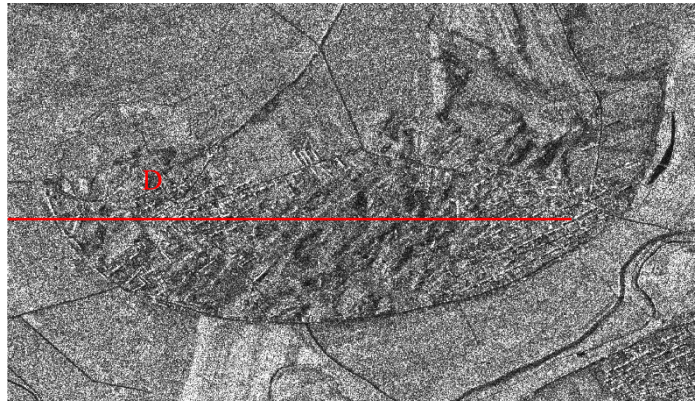
➤ Tomographic profiles of different forest tree density

Dense Decreasing tree density → Sparse



Increasing ground-to-volume ratio (GVR) →

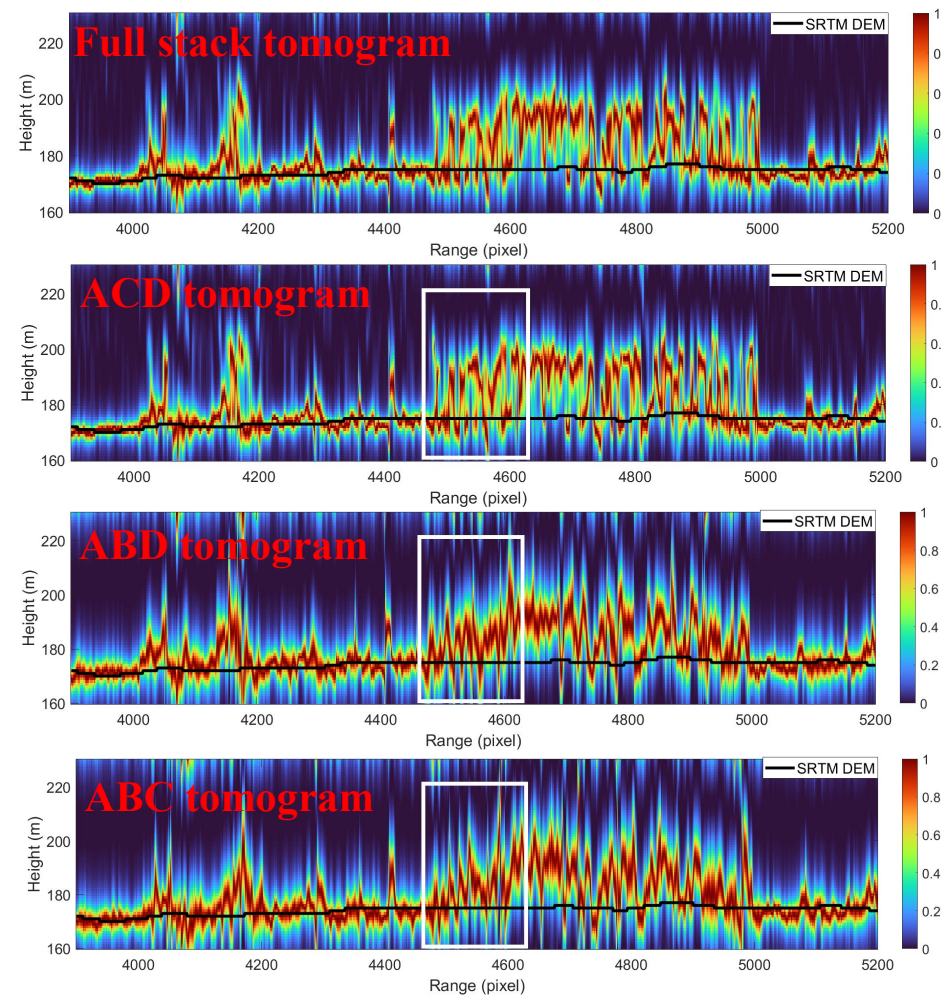
➤ Three-image TomoSAR experiment



SAR image



Optical image



D



287m

B



5m

A



-273m

C



Vertical baseline distribution



**Thank you for your attention !
Any question ?**

