Application of UAVSAR data to NISAR calibration and validation

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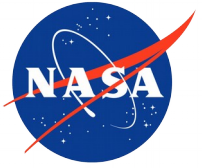


Jet Propulsion Laboratory
California Institute of Technology

Overview

- NISAR and UAVSAR instruments
- Simulating NISAR data using UAVSAR
- Sample product details

NISAR

NASA-ISRO Synthetic Aperture Radar

Parameter	Value
Band	L+S
Polarization	Various
Max Bandwidth	80 MHz
Azimuth Resolution	7 m
Swath	240 km
Temporal Sampling	12 days
NESZ	< -20 dB

NISAR

- Diversity of science **applications**
  - Surface deformation, cryosphere, ecosystems, agriculture, etc.
- Corresponding diversity of radar **modes**
  - Pulse bandwidth (5, 20, 40, 80 MHz), pulse lengths, polarizations
- Science team wants **realistic data** in order to test and validate approaches used for high level (L3+) products
  - How can we use **UAVSAR** data base?

UAVSAR

Unmanned Aerial Vehicle SAR

Parameter	Value
Band	L+P+Ka
Polarization	Quad
Max Bandwidth	80 MHz
Azimuth Resolution	0.8 m
Swath	22 km
Temporal Sampling	(Any)
NESZ	< -40 dB

UAVSAR

- 1000s of available images
  - … some not far from here!
- Instrument performance generally exceeds NISAR
- Can degrade UAVSAR images to simulate NISAR

NISAR Sample Product Generation

The overall procedure for generating NISAR sample products from UAVSAR PolSAR SLCs involves the following steps per NISAR image mode:

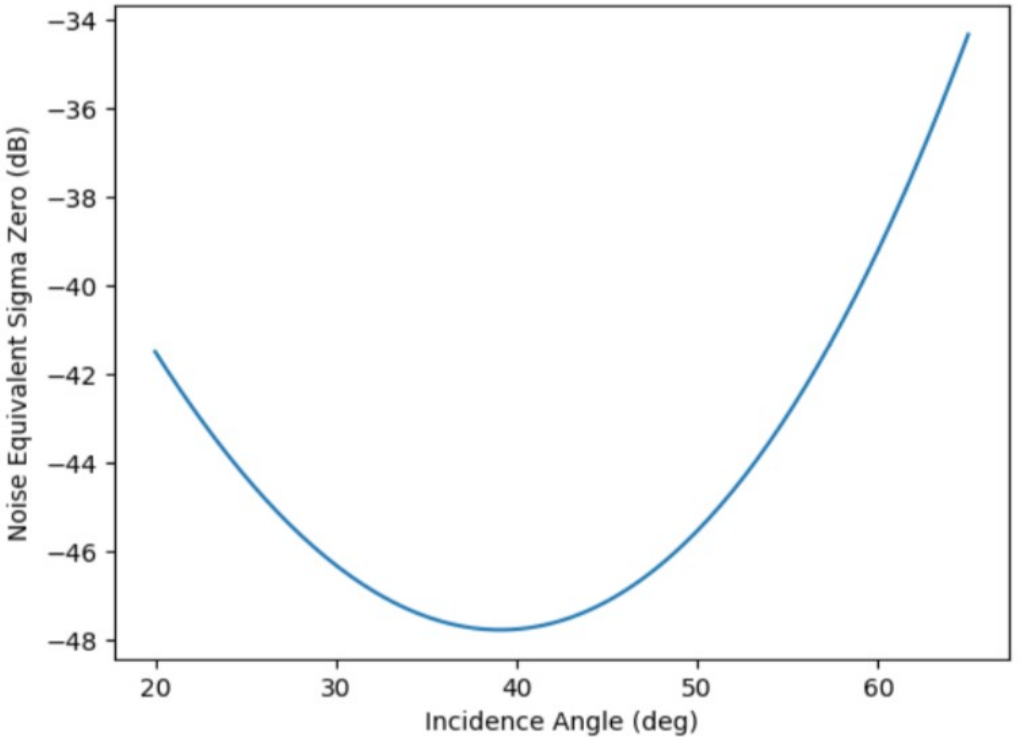
1. Add noise to full-resolution SLCs based on the expected NESZ for the given image mode

2. Perform sub-banding and resampling in range for a given pair of upper- and lower-bands (.e.g, 20 MHz and 5 MHz); decimate the SLC in azimuth to achieve an along-track spacing of approximately 8 meters

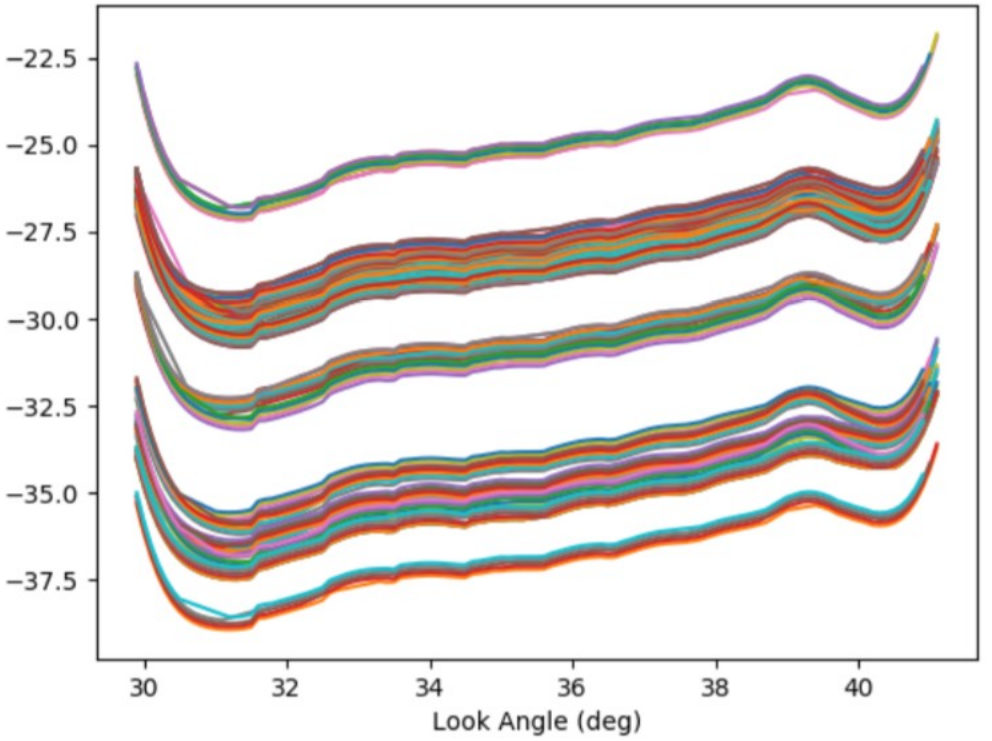
3. Update metadata to reflect new geometry and signal content

Noise Addition

UAVSAR NESZ



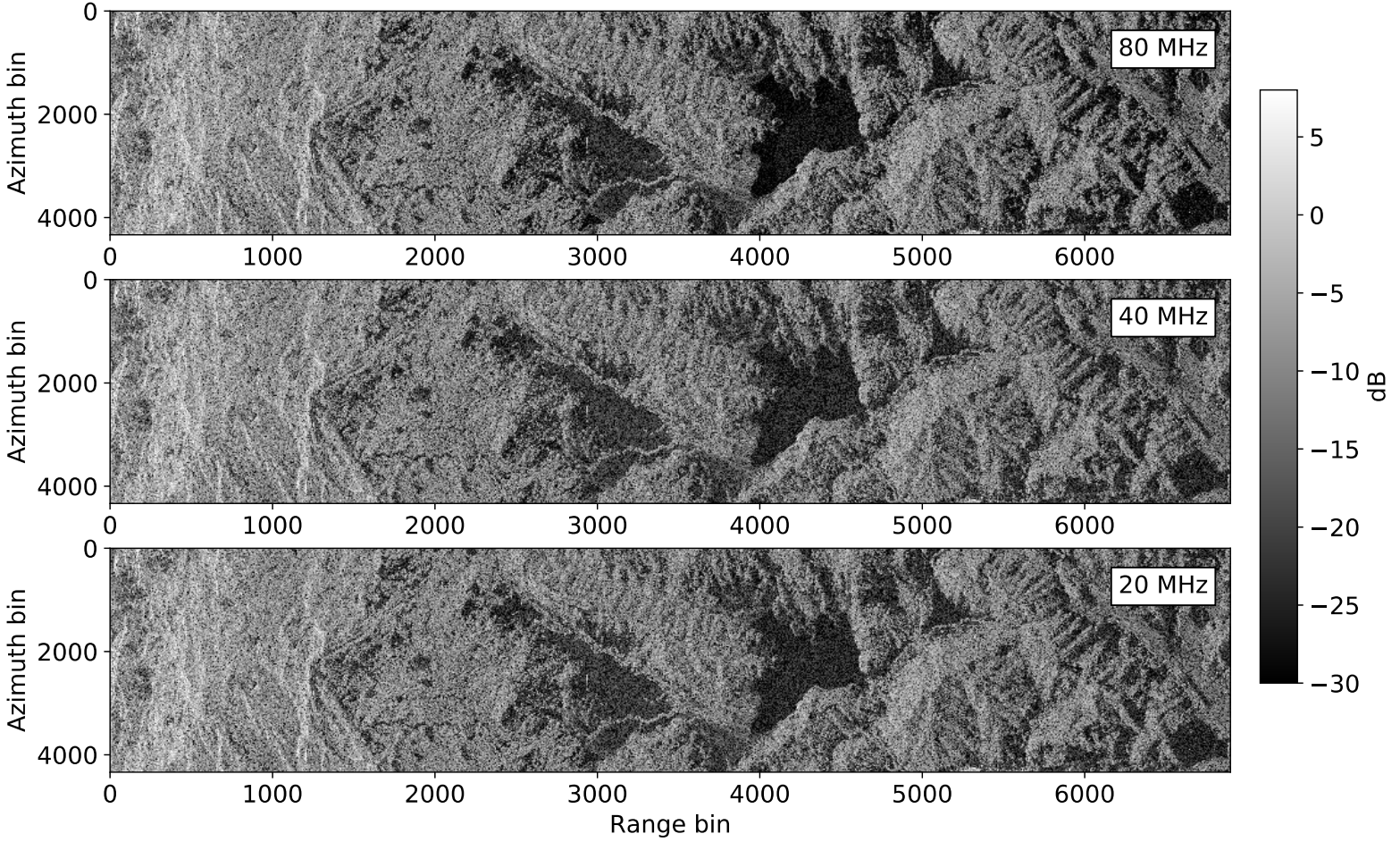
NISAR NESZ (various modes)



Noise Addition

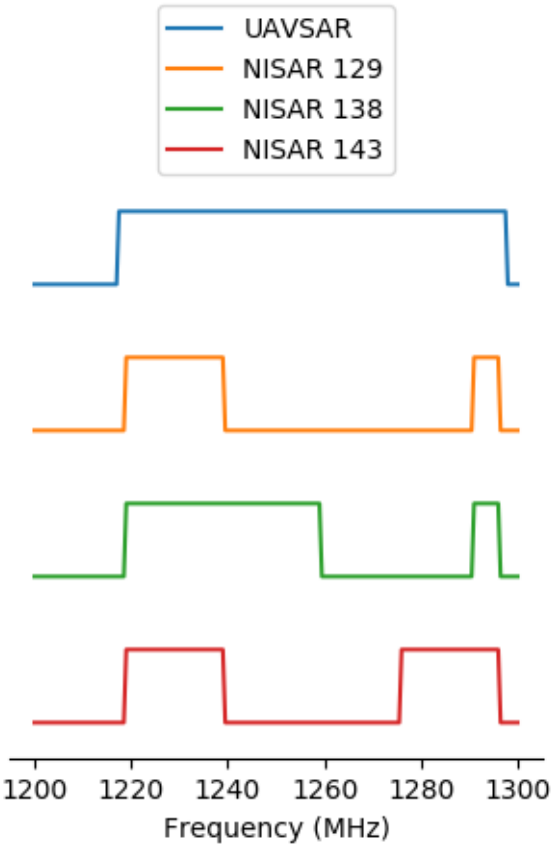
- UAVSAR $NESZ_U$ measured from “sniffer pulse”
- For a given NISAR mode, tabulate $NESZ_N$ from system model
- Add circular Gaussian noise scaled by NESZ difference

Images with Only Noise Addition

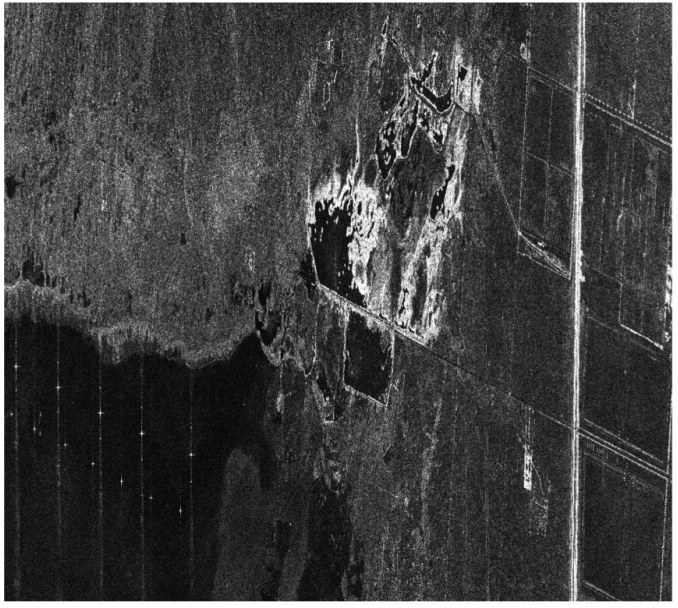


Range Sub-Banding

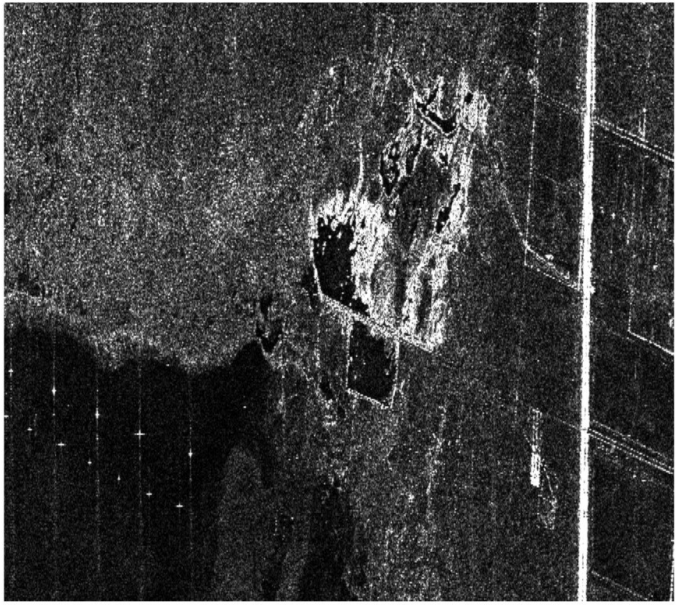
- Different modes have different sub-bands
- Algorithm:
  - Phase ramp to center RF
  - Lowpass filter with FFT/IFFT
  - Scale by bandwidth ratio



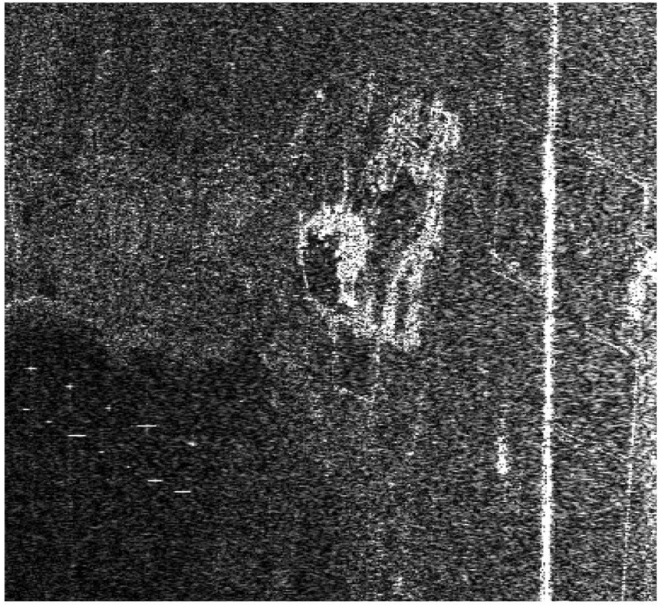
Images with Only Sub-Banding



80 MHz

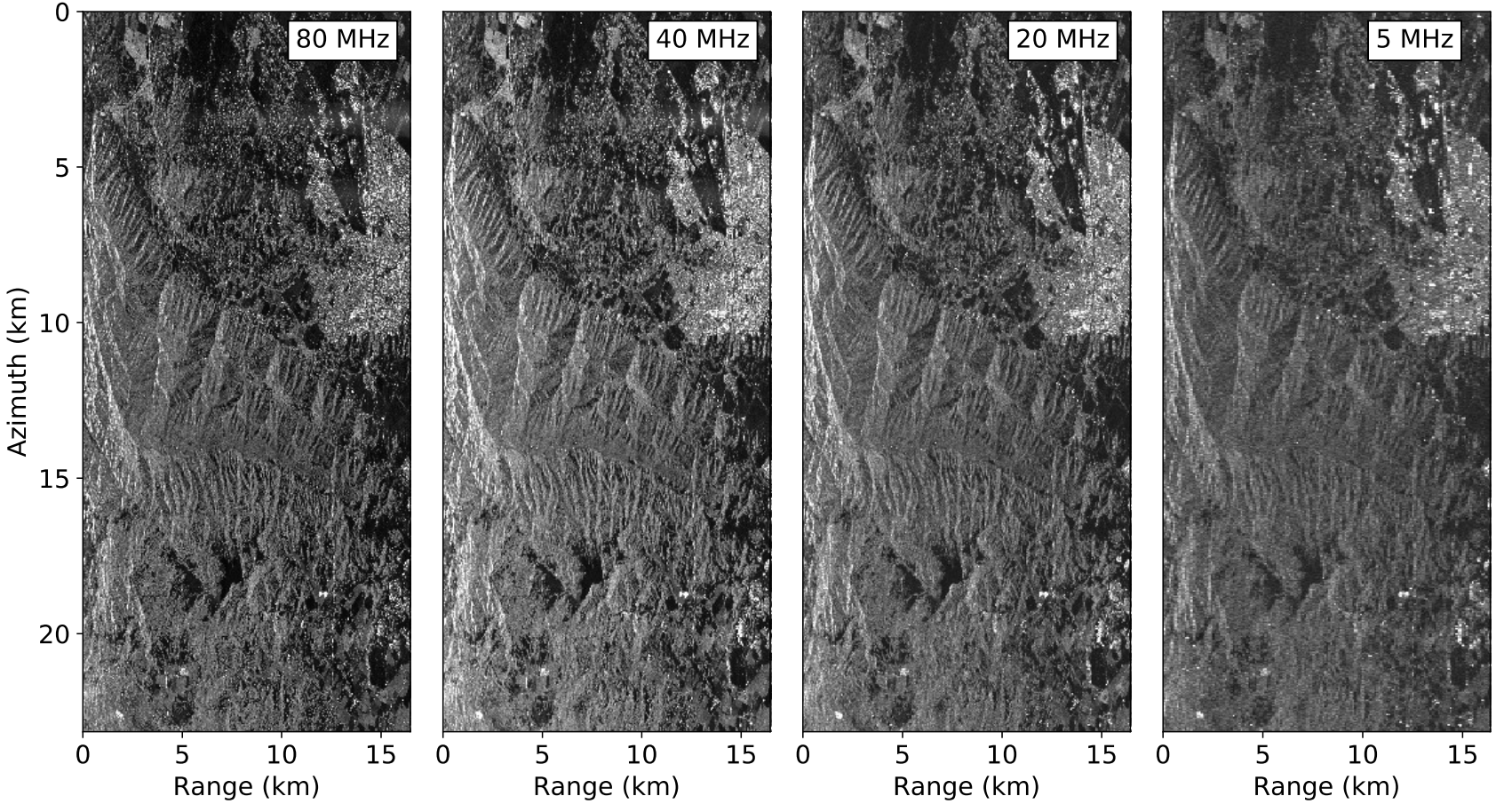


20 MHz

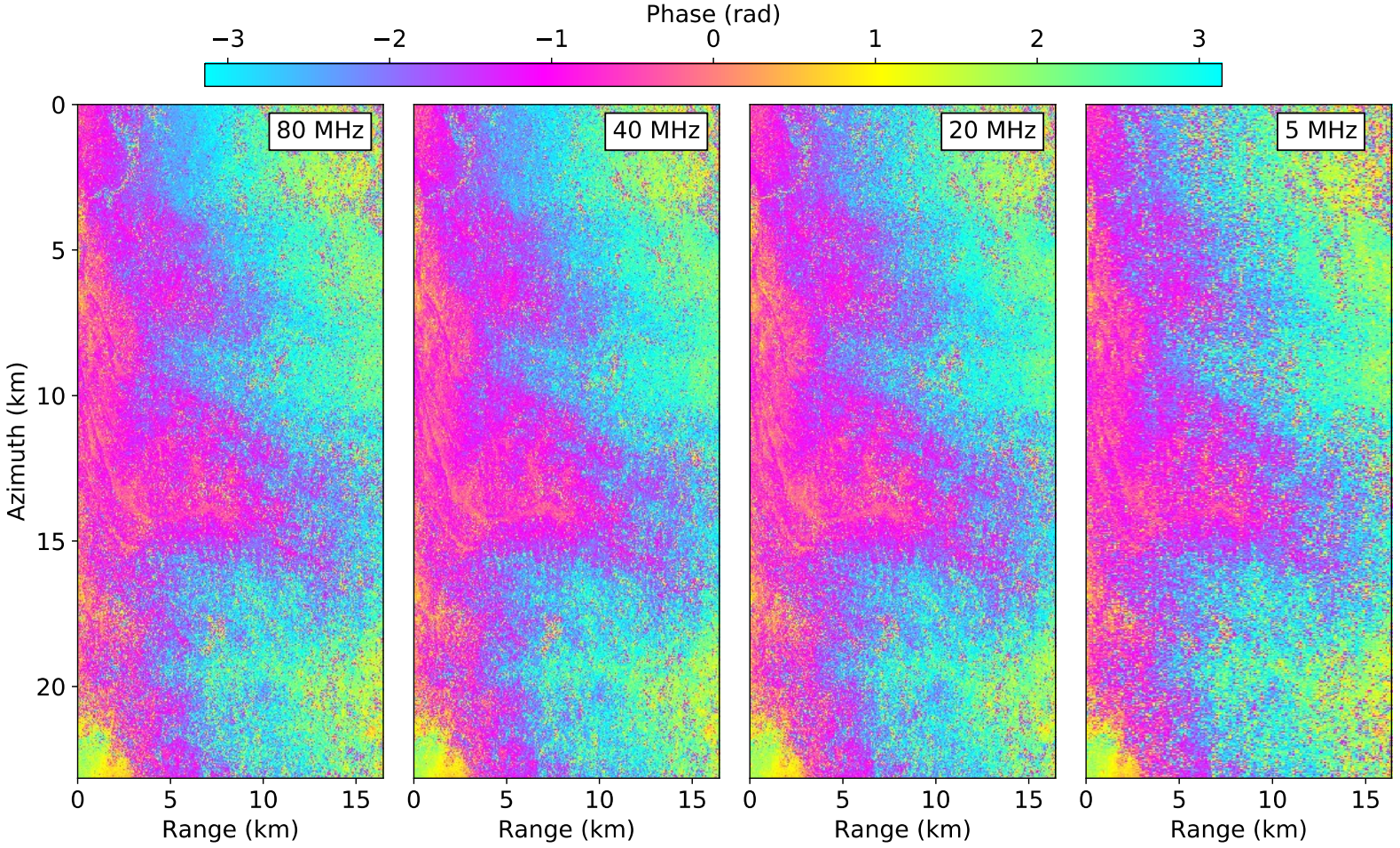


5 MHz

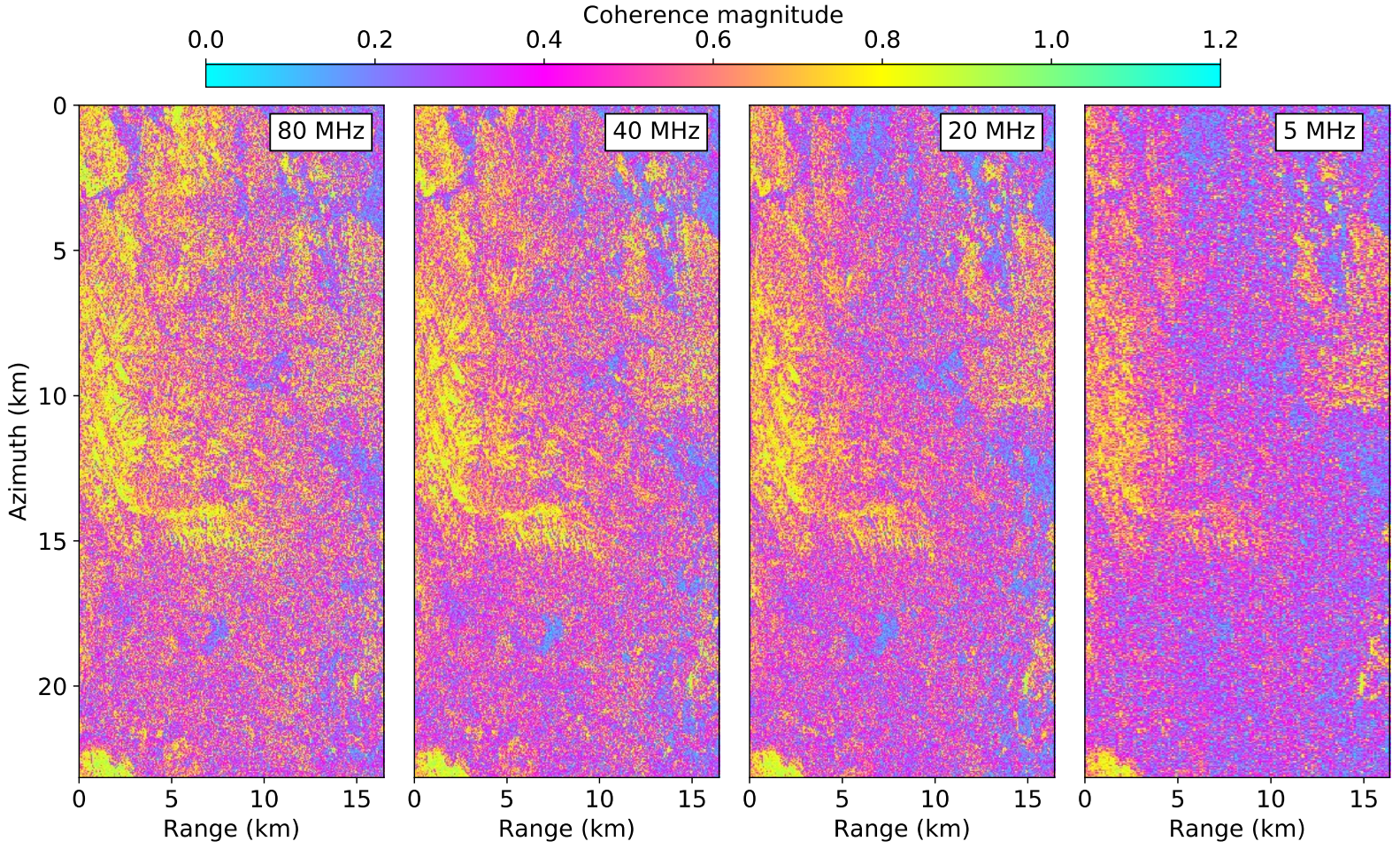
Combined Noise + Subband



InSAR Phase


Phase (rad)
−3
−2
−1
0
1
2
3
80 MHz
40 MHz
20 MHz
5 MHz
Azimuth (km)
0
5
10
15
20
Range (km)
0
5
10
15

InSAR Correlation



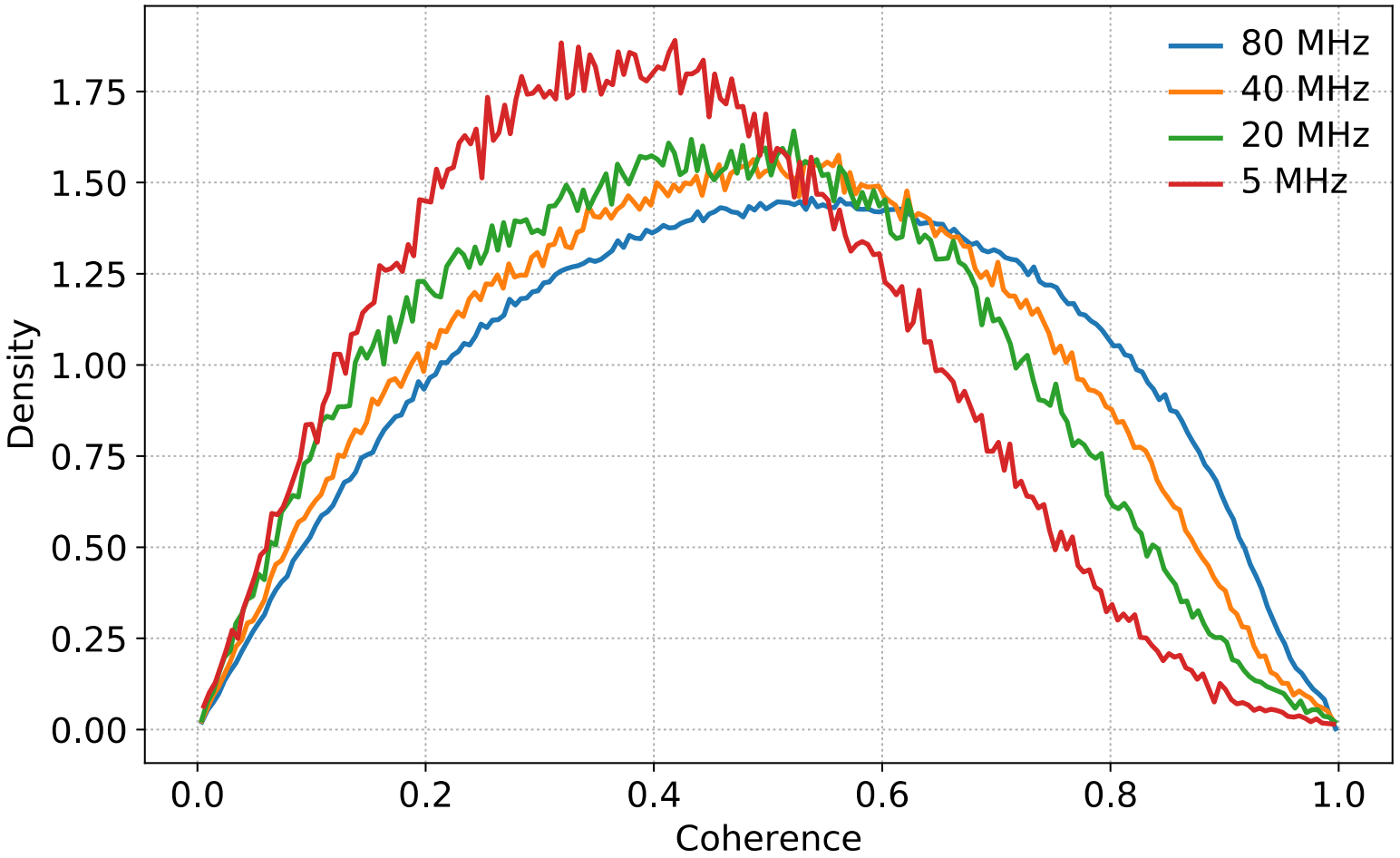
Sample Product Description

- For each UAVSAR PolSAR product, 6 sets of NISAR sample data sets are produced: 3 NISAR modes (129, 138, 143), each with 2 center frequencies (upper & lower).
- Each set of NISAR sample product consist of the following files:
  - 4 single look complex files (.slc)
  - 6 multi-looked cross products (.mlc)
  - 6 ground projected cross products (.grd)
  - DEM used during processing (.hgt)
  - Terrain based and flat earth incidence angle files (.inc & .flat.inc)
  - Terrain slope file (.slope)
  - Meta data annotation file (.ann)
- More information can be found on the UAVSAR website:
  - https://uavsar.jpl.nasa.gov/science/documents/polsar-format.html

Questions?

Backup

Correlation Histograms



Range Spectra