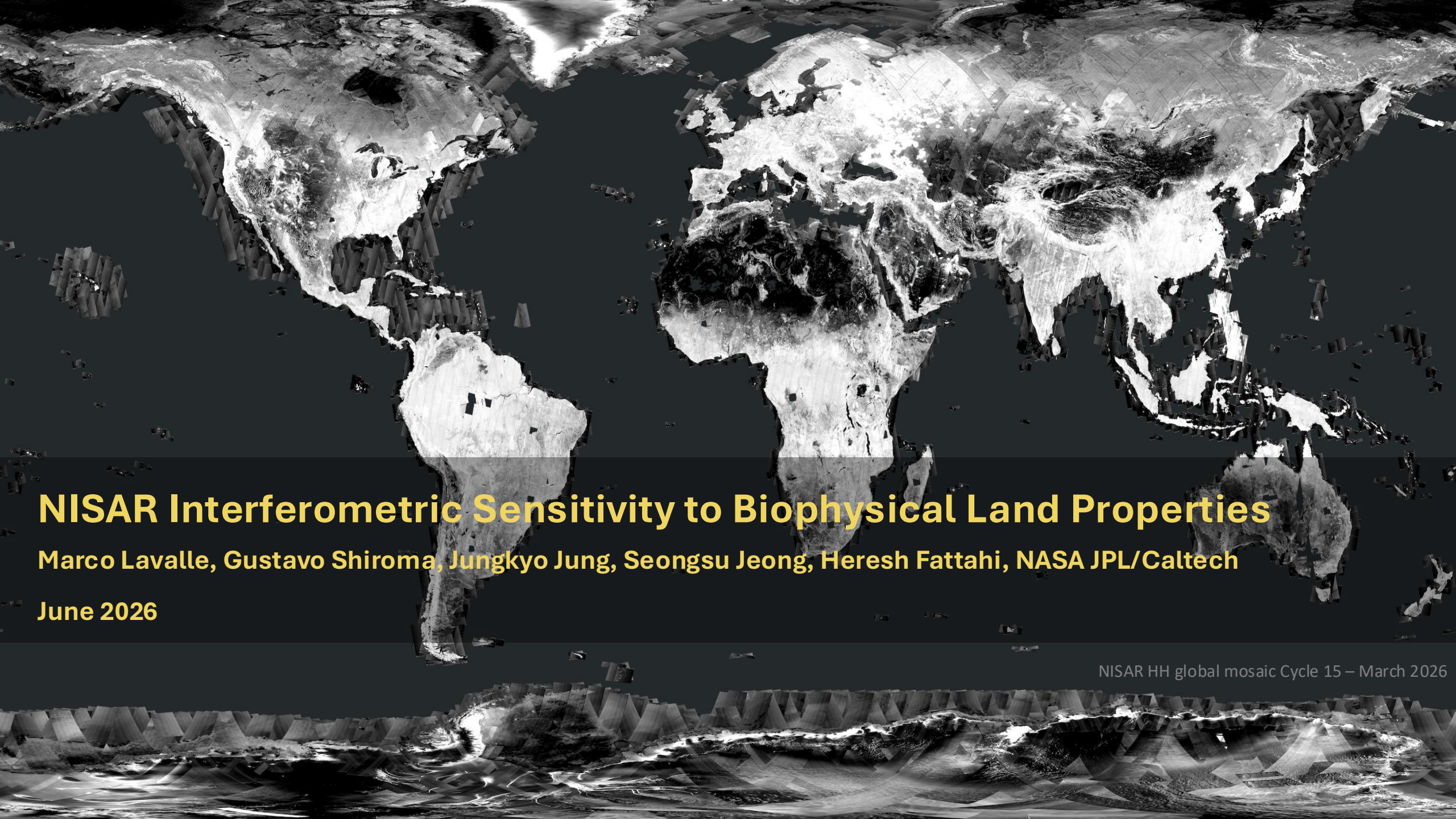




NISAR Interferometric Sensitivity to Biophysical Land Properties

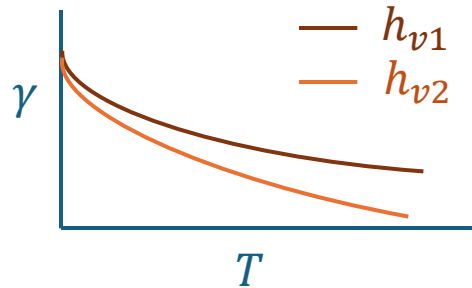
Marco Lavallo, Gustavo Shiroma, Jungkyo Jung, Seongsu Jeong, Heresh Fattahi, NASA JPL/Caltech

June 2026

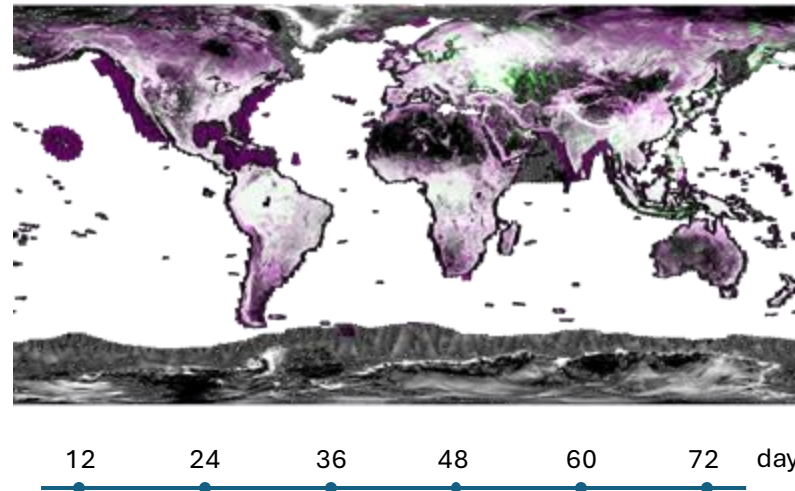
NISAR HH global mosaic Cycle 15 – March 2026

NISAR interferometry for land applications

Land models for polarimetric
InSAR time-series



L-band global dual-pol time-series



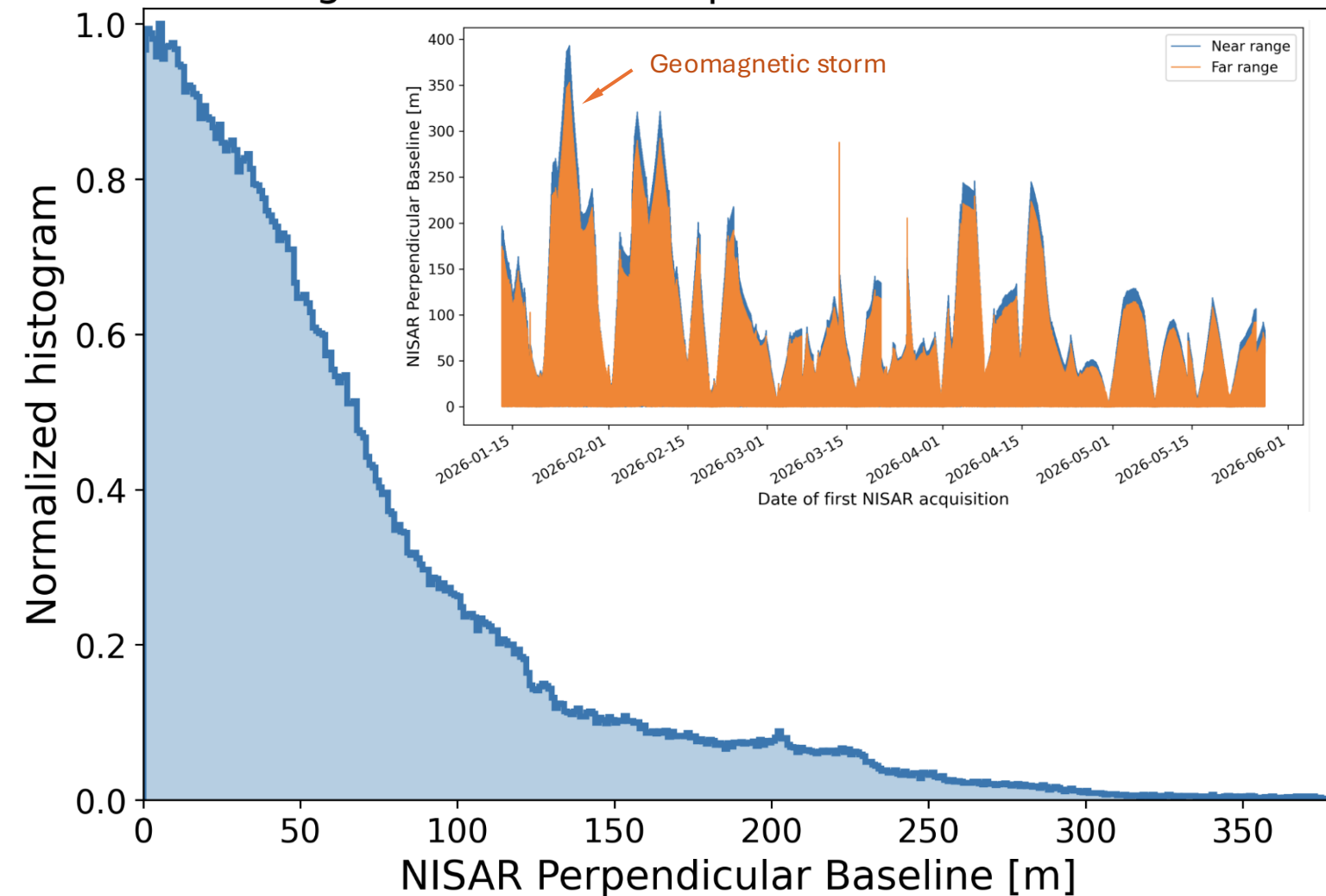
Geocoded L2 Products

- GSLC** Geocoded SLC
- GUNW** Geocoded Interferogram
- GCOV** Geocoded Pol Covariance

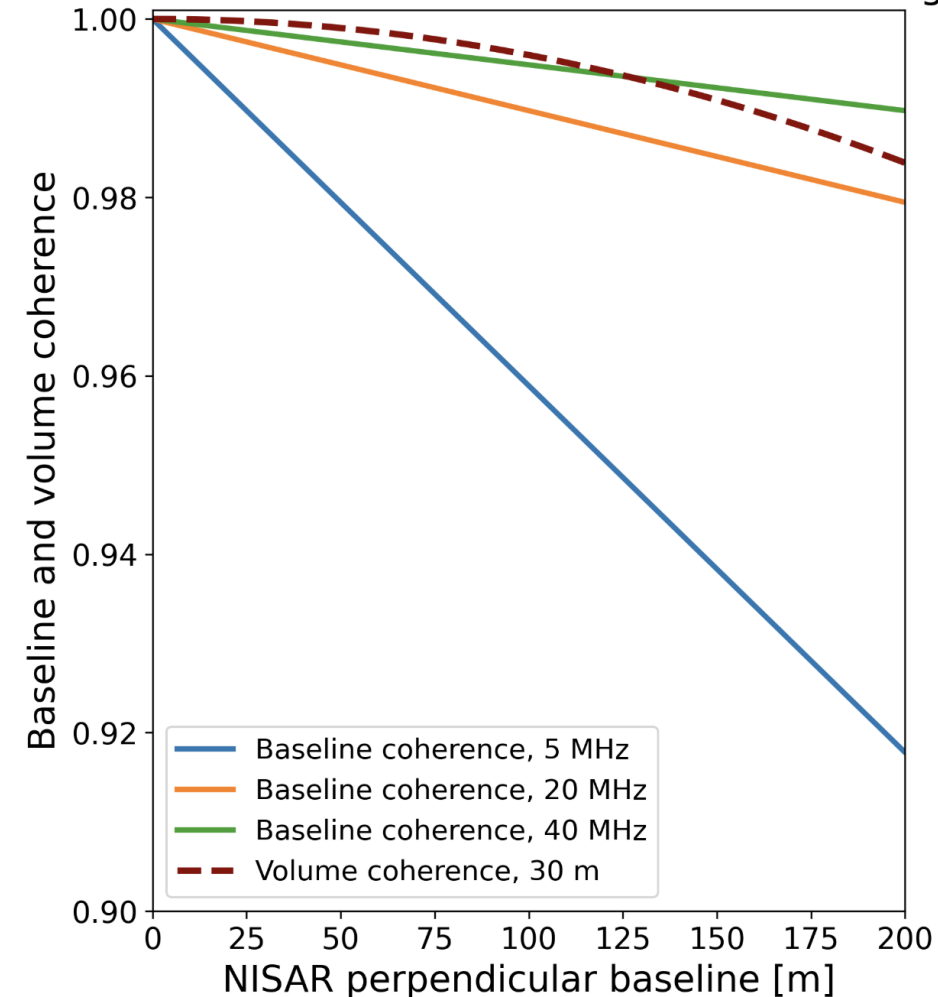
Does NISAR show expected polarimetric/interferometric sensitivity to biophysical land properties?

NISAR perpendicular baseline is very small

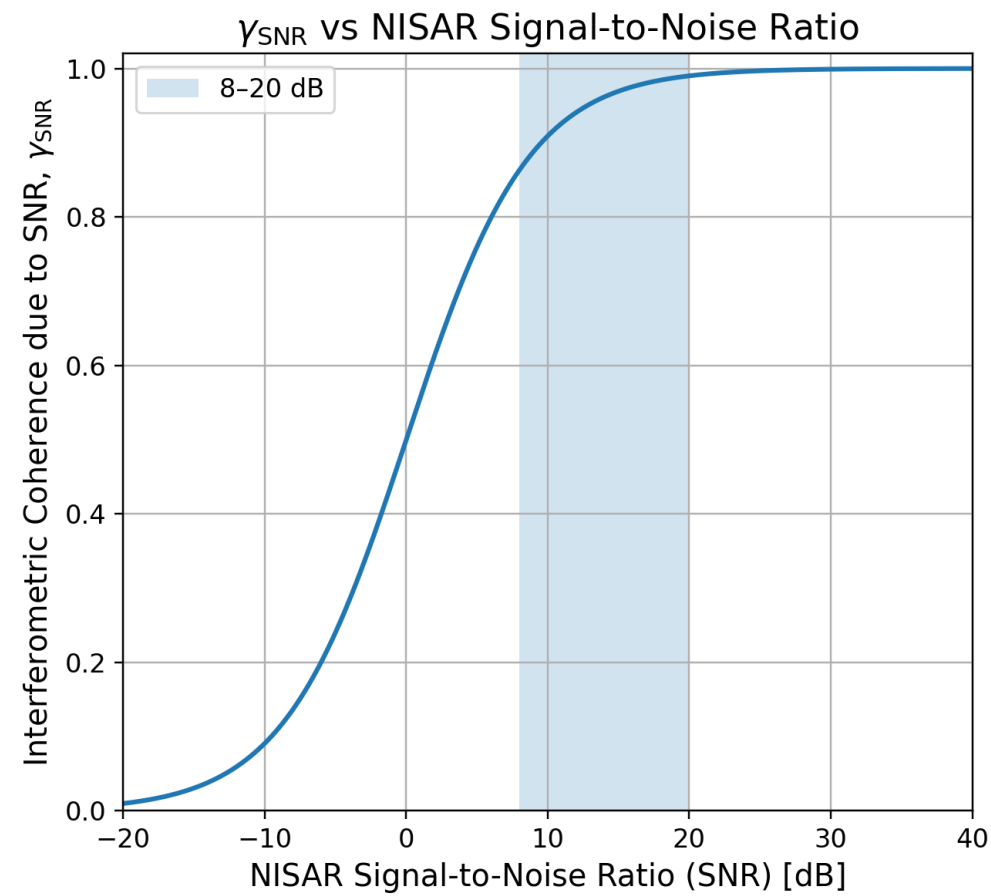
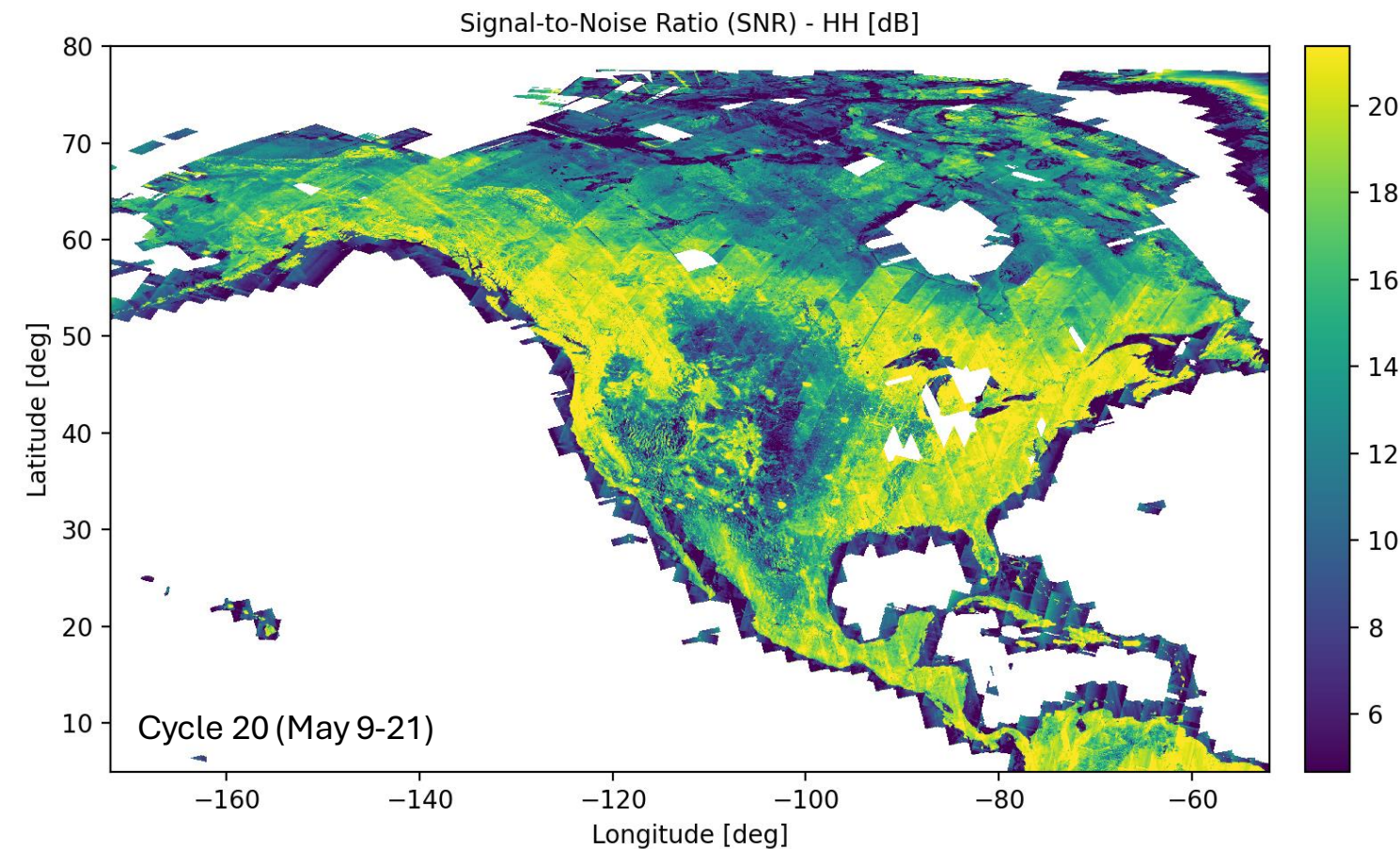
Histogram of NISAR Perpendicular Baseline at 34°



NISAR coherence terms at 34° incidence angle



NISAR SNR and interferometric SNR coherence are high



NISAR GUNW or GSLC?

GUNW

Geocoded Unwrapped Interferograms

Wrapped (20m) and unwrapped (80m) coherence

Traditional (fine-coregistration) InSAR workflow

Ionospheric phase screen from split-band

Corrected for bulk ionospheric range delay

Only HH

Only nearest-neighbor pairs, already processed

GSLC

Geocoded Single-Look Complex

Sinc-interpolated, topography phase-corrected SLC

Beta0 (no radiometric terrain correction)

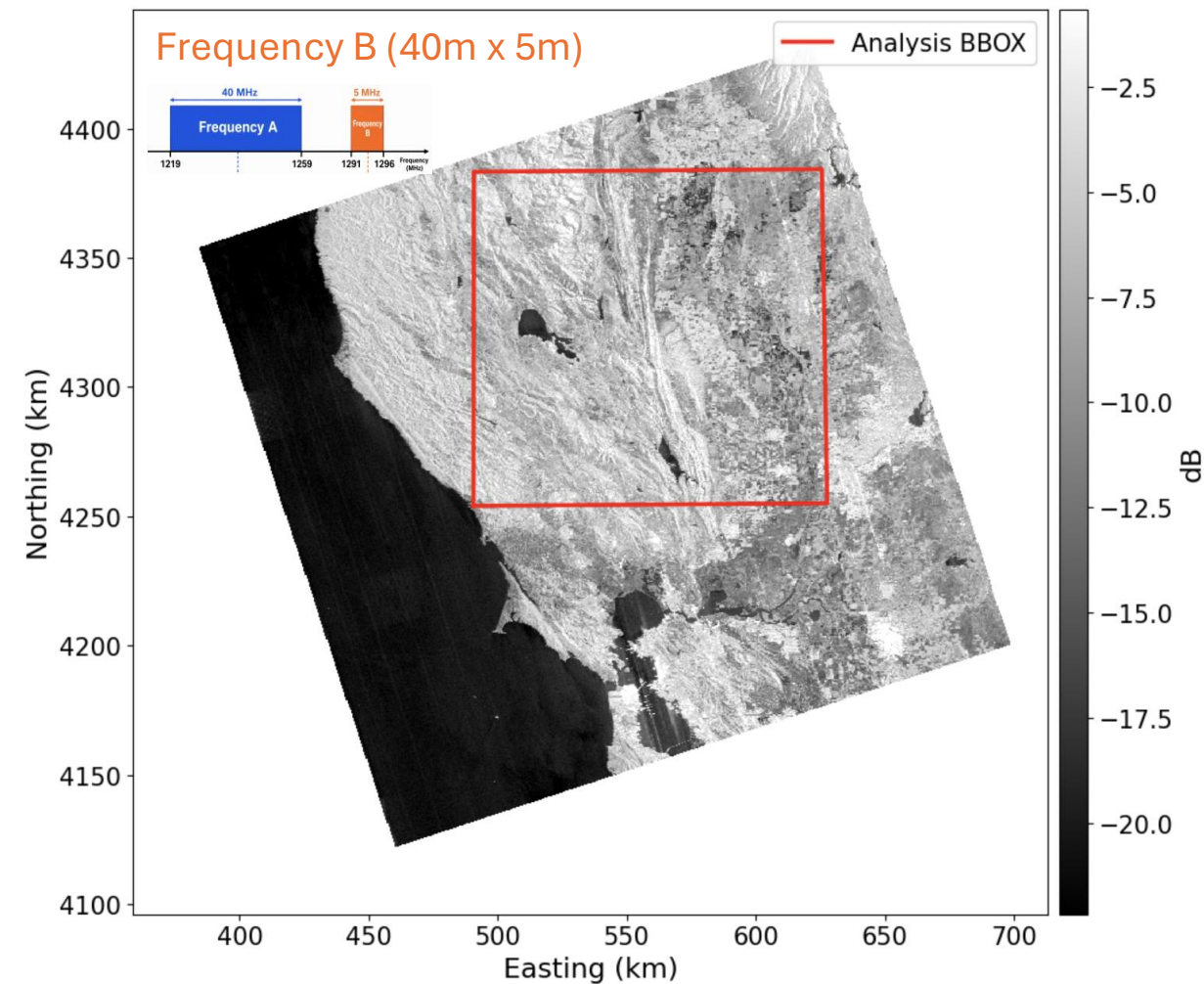
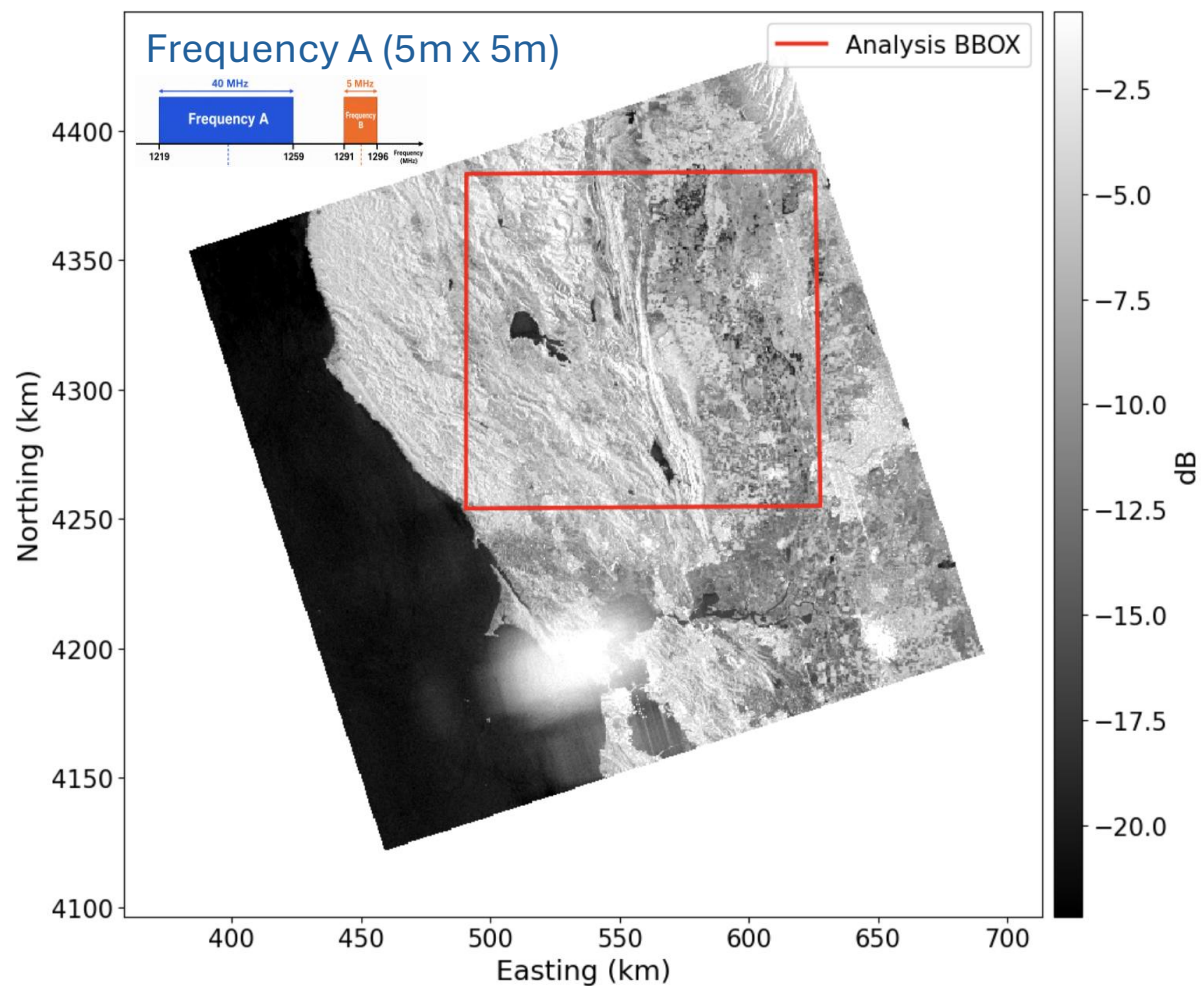
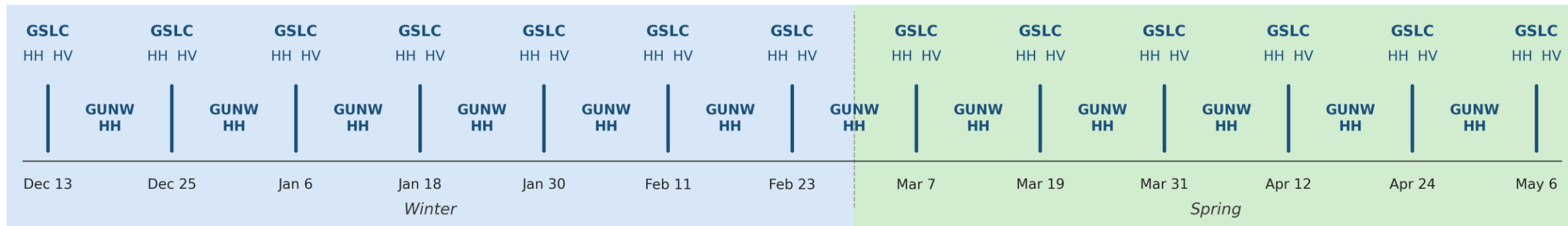
Can use ionospheric phase screen from GUNW

Corrected for bulk ionospheric range delay

Both HH and HV

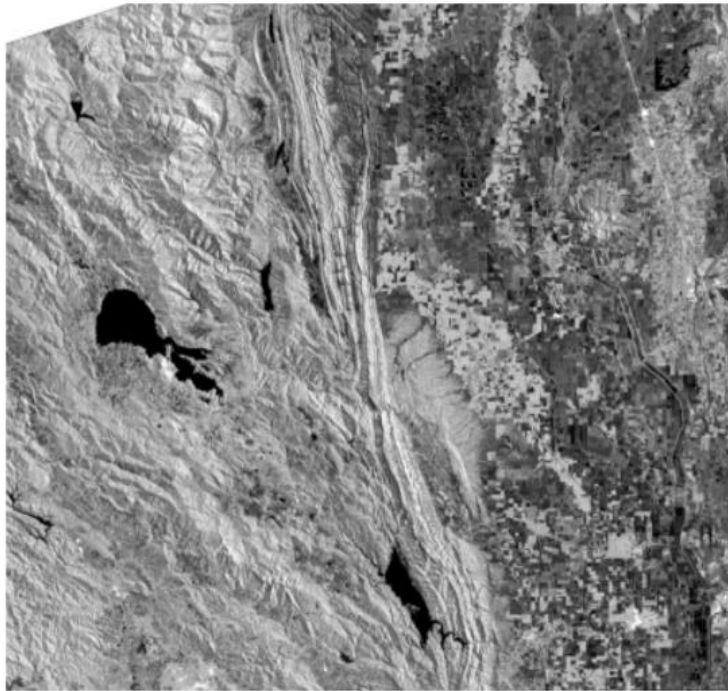
Co-registered and geocoded SLCs, all pairs possible

13 GSLC
12 GUNW

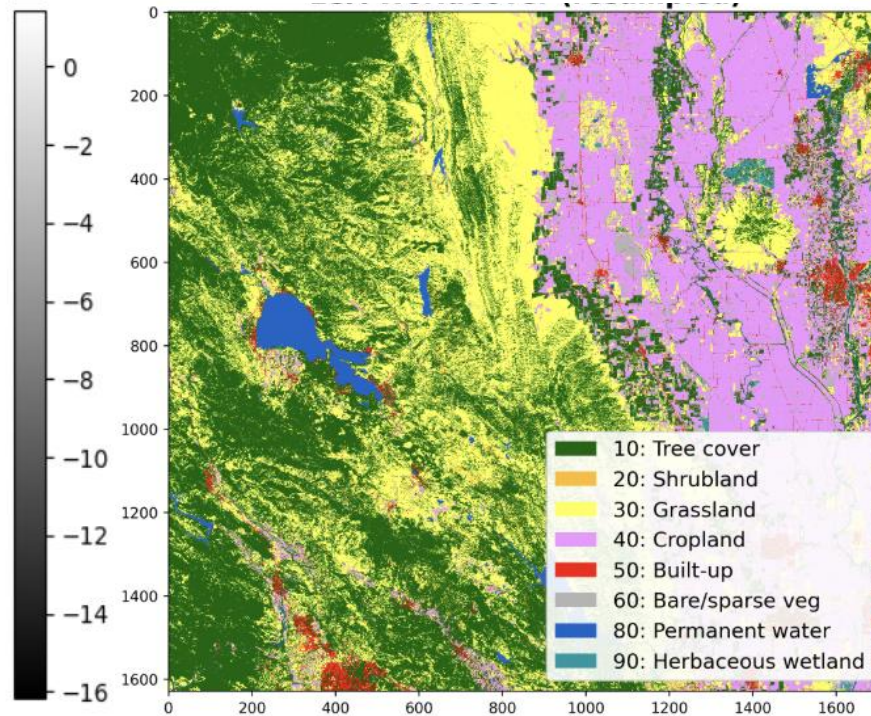


Geocoded SLCs enable direct comparison with land cover maps

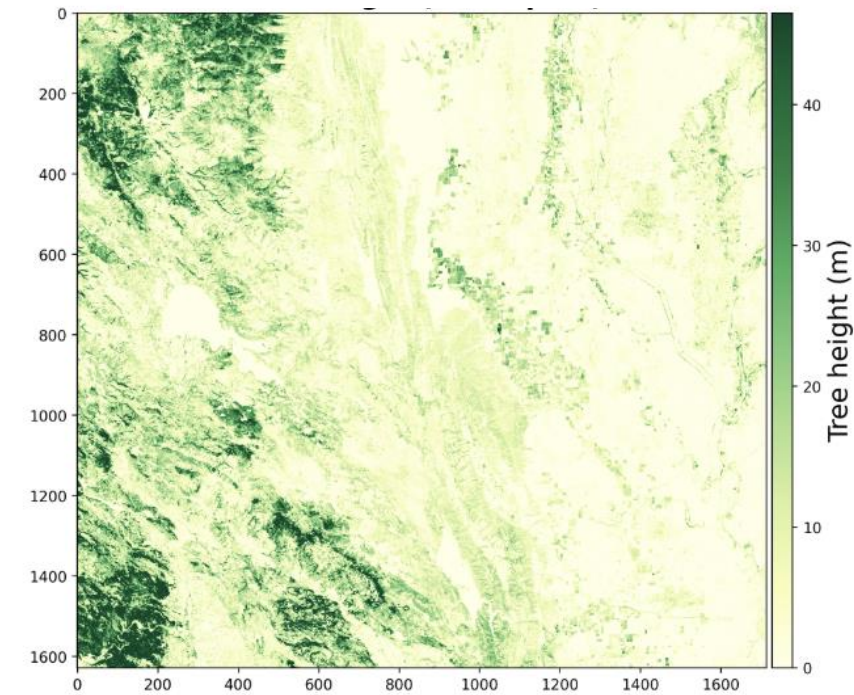
Mean GSLC HH Power (non-RTC)



ESA WorldCover Map

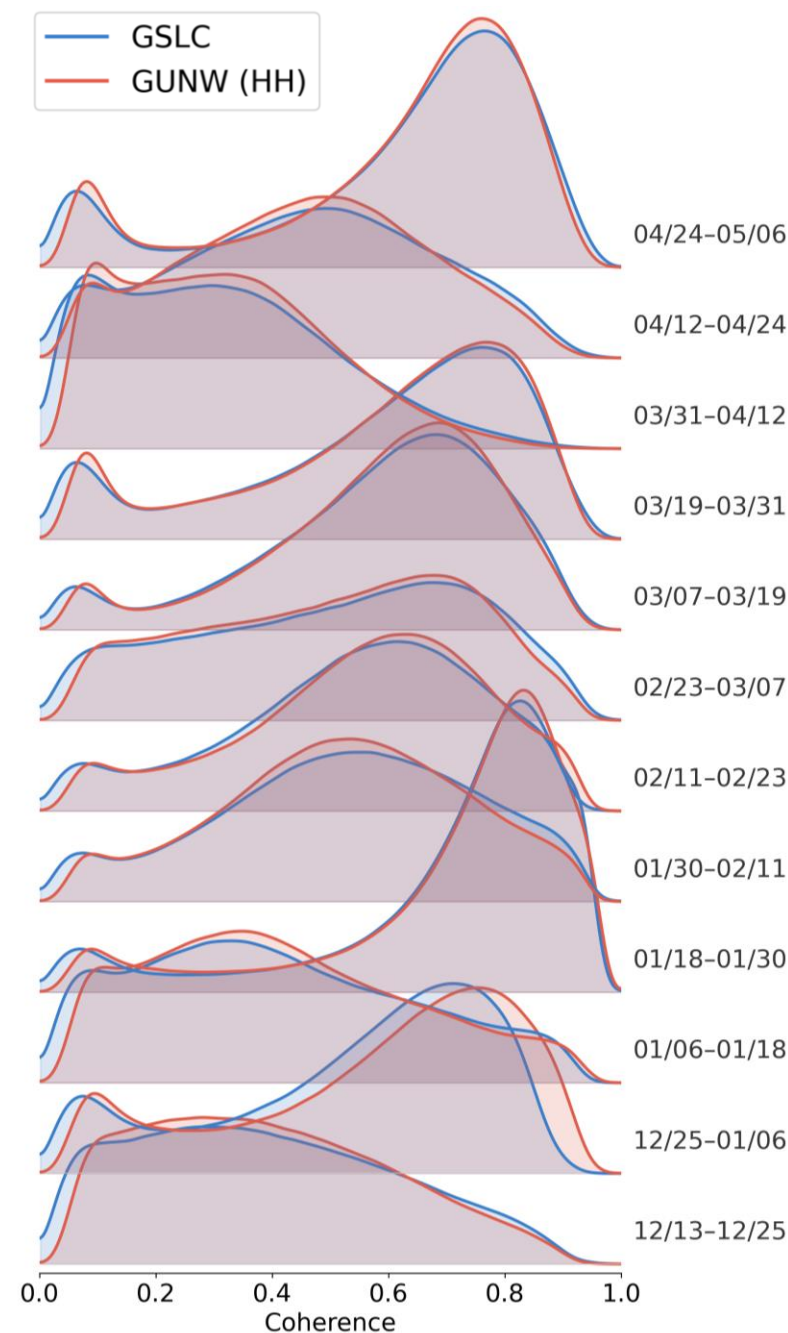
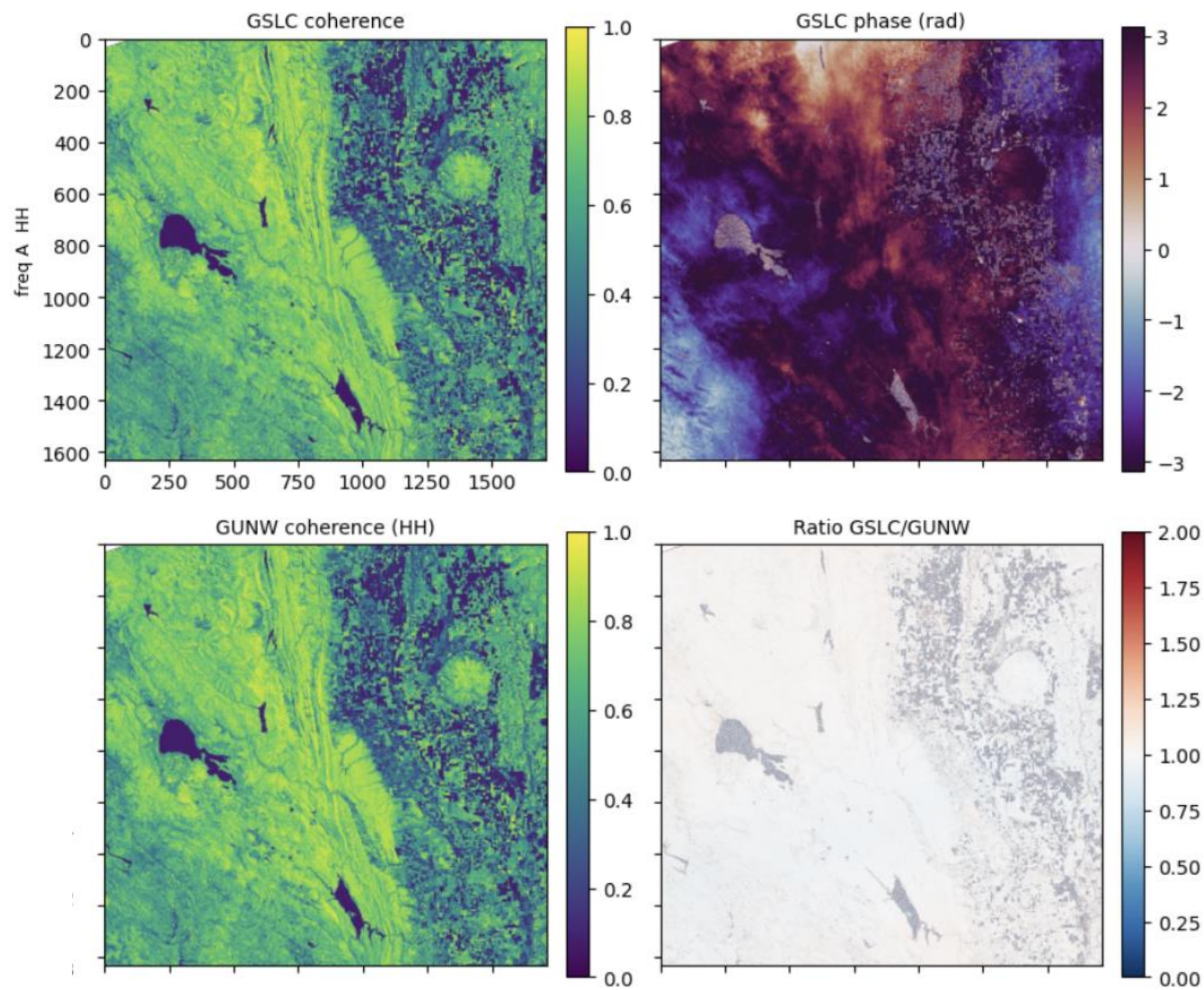


Lidar-based tree height map



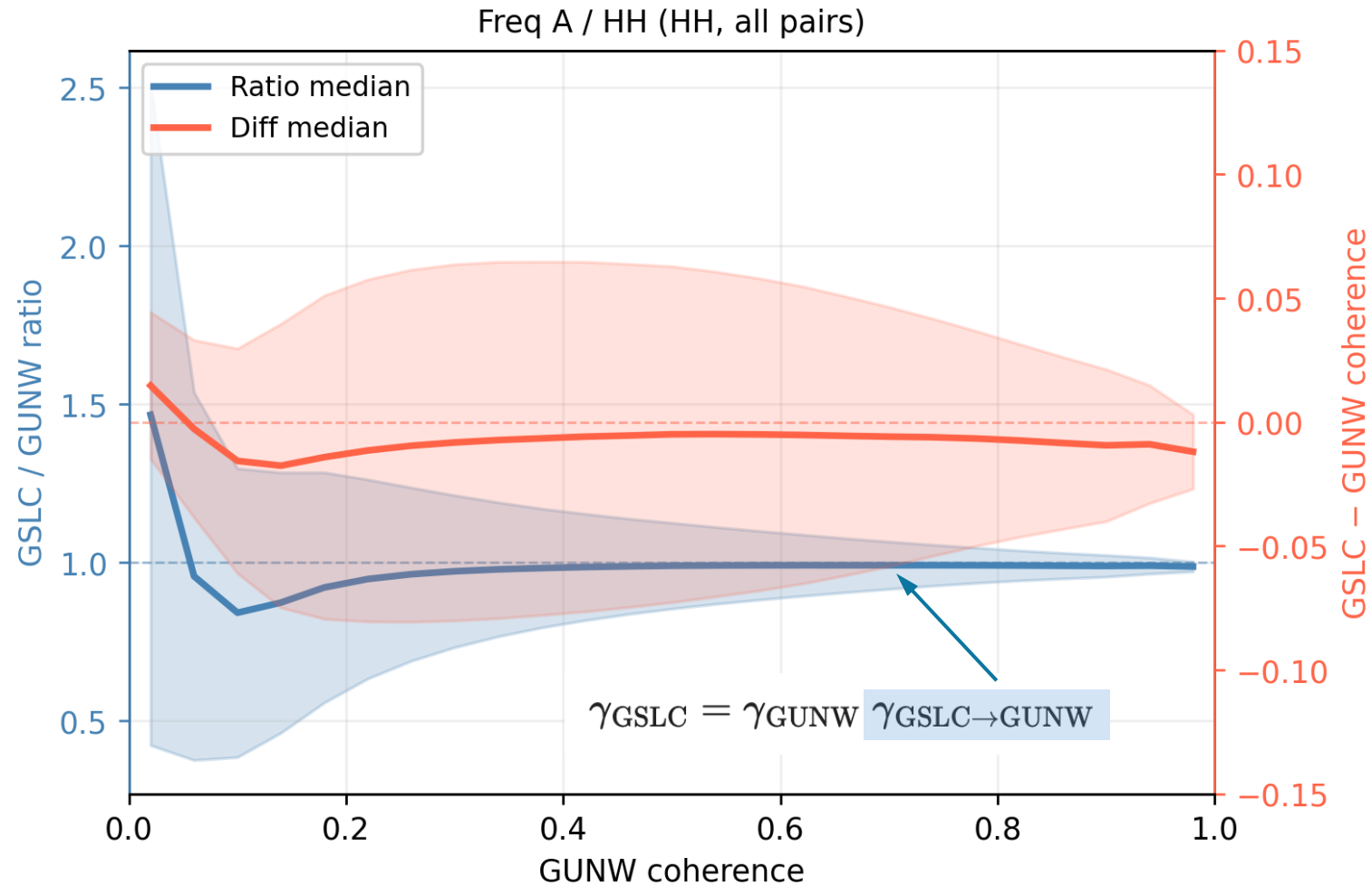
NISAR GSLC / GUNW InSAR coherence

Pair 20260319_20260331

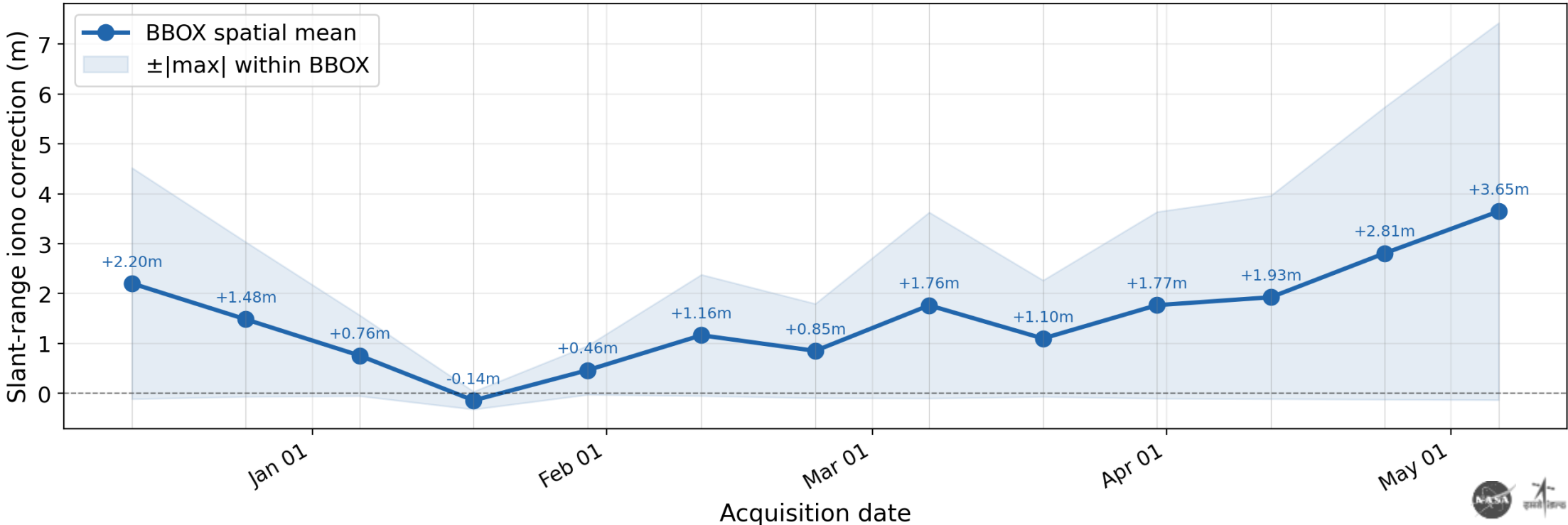
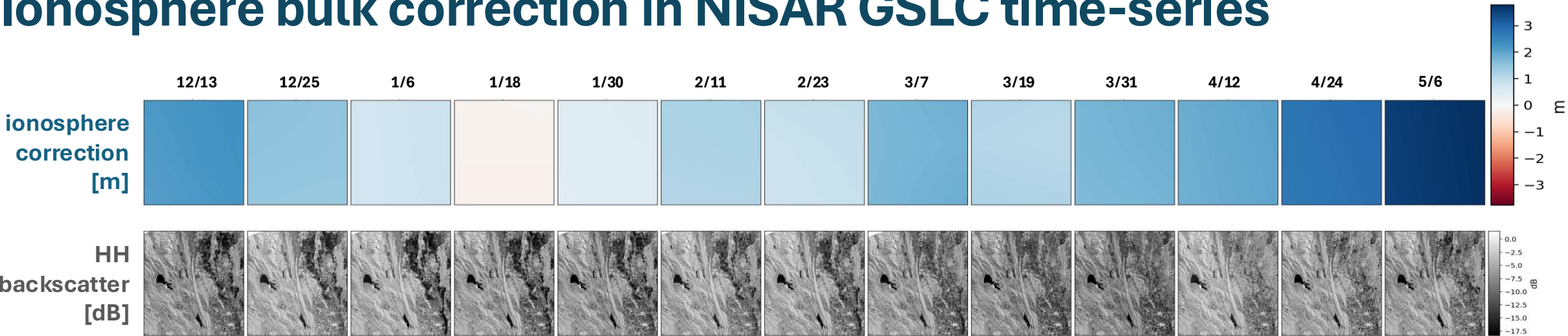


GSLC / GUNW coherence

GSLC vs GUNW Coherence — Ratio (left) and Difference (right)
All consecutive pairs pooled; median $\pm 1\sigma$

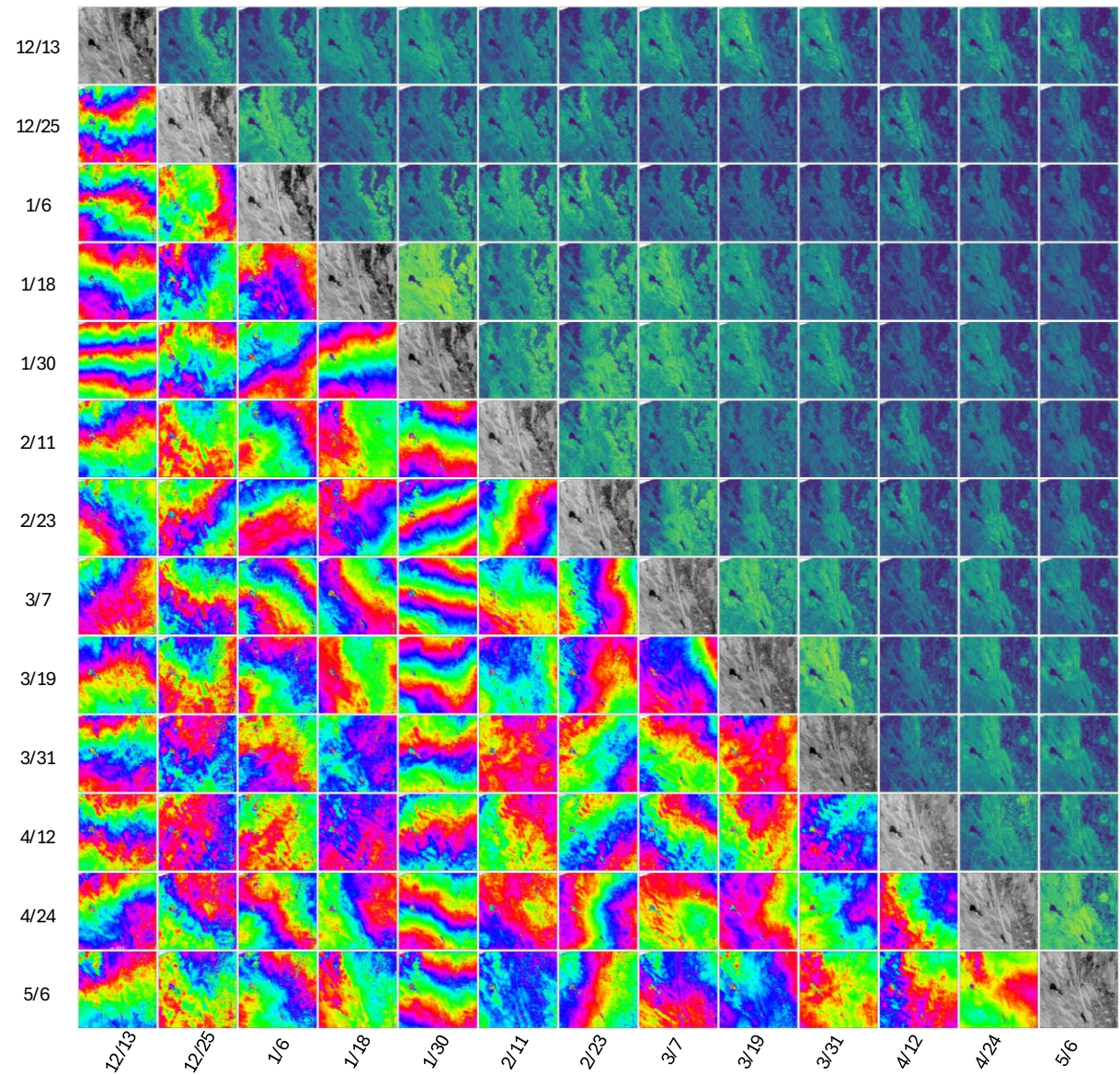


Ionosphere bulk correction in NISAR GSLC time-series

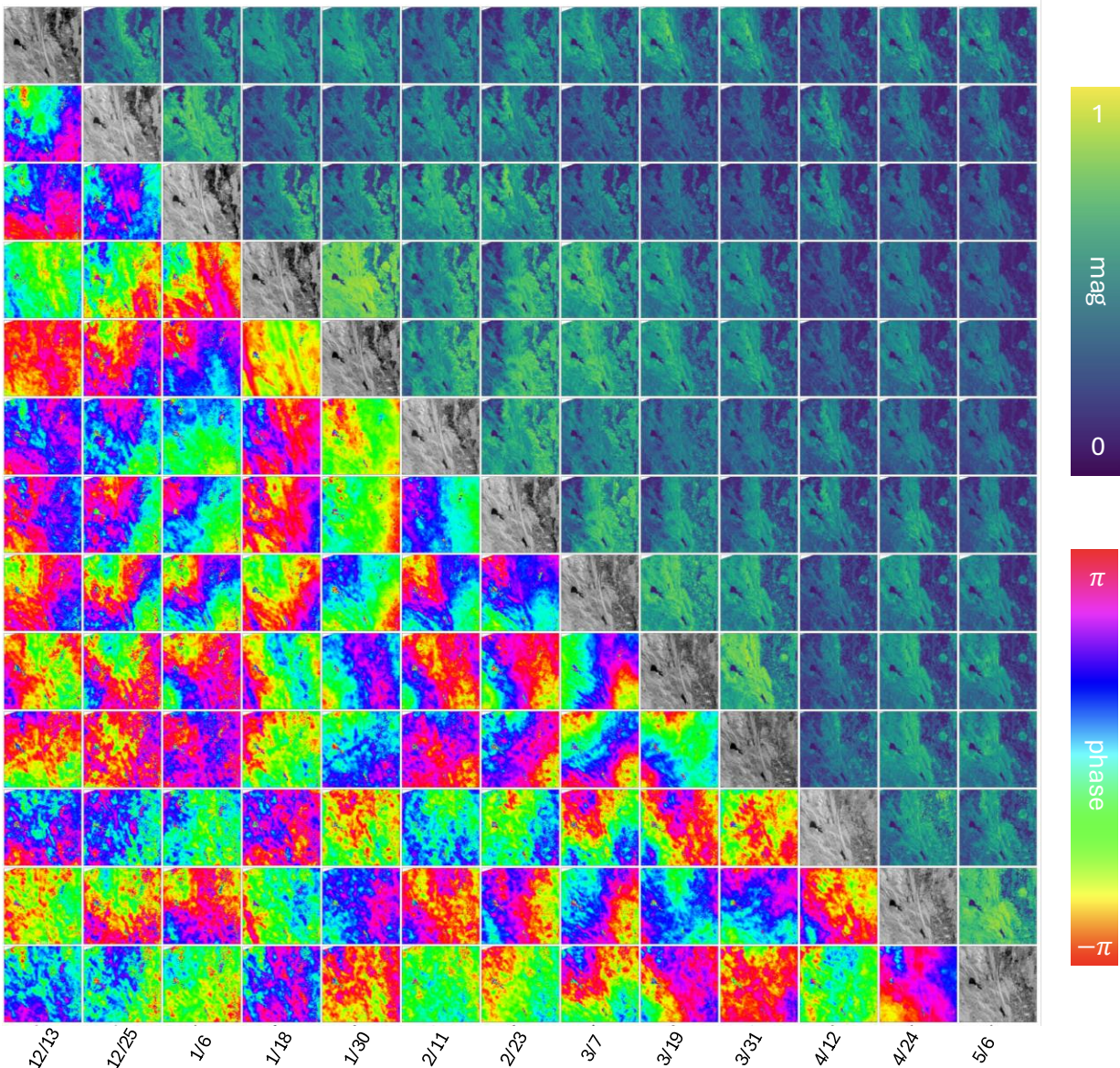


NISAR HH coherence from GSLC before/after iono correction

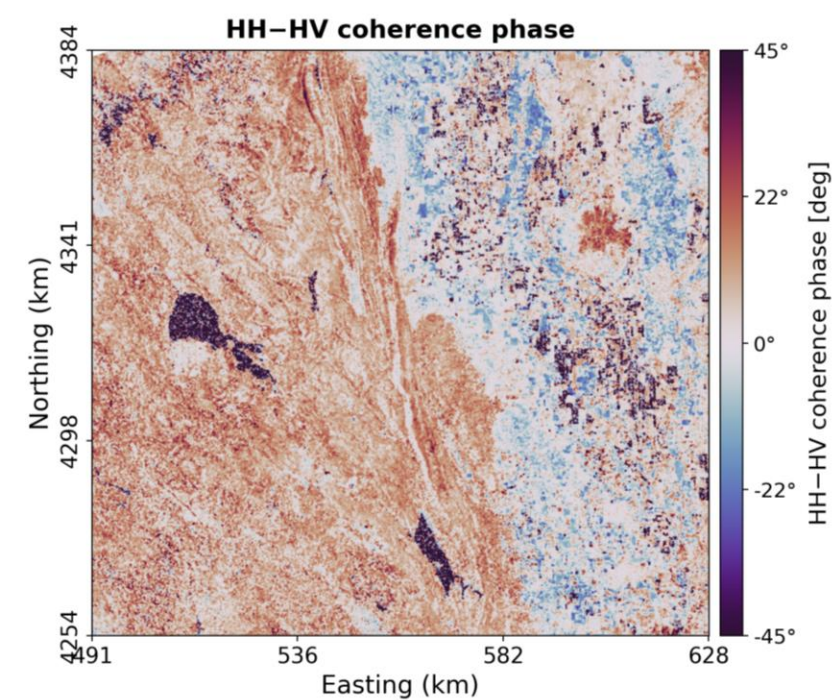
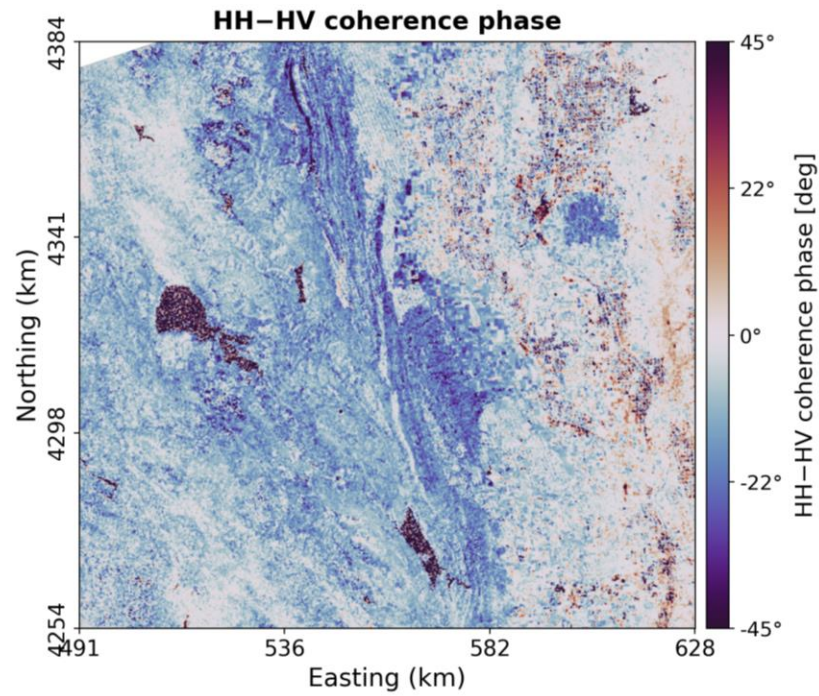
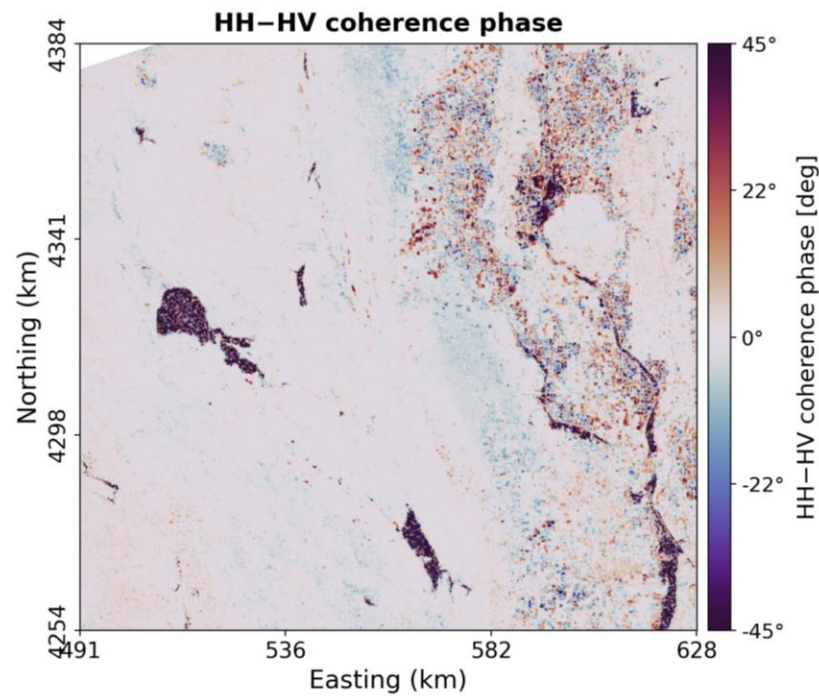
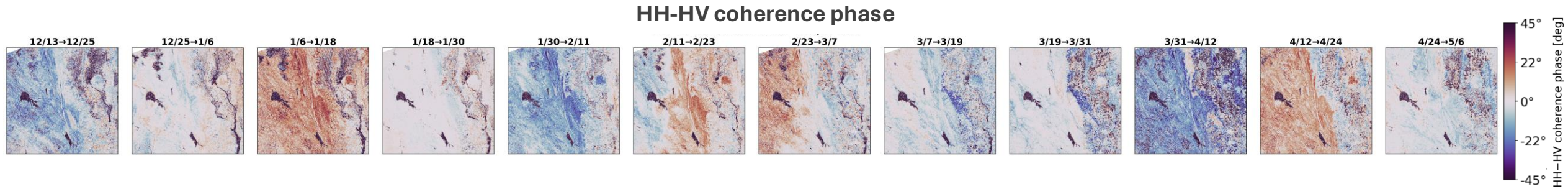
Before split-spectrum ionospheric correction



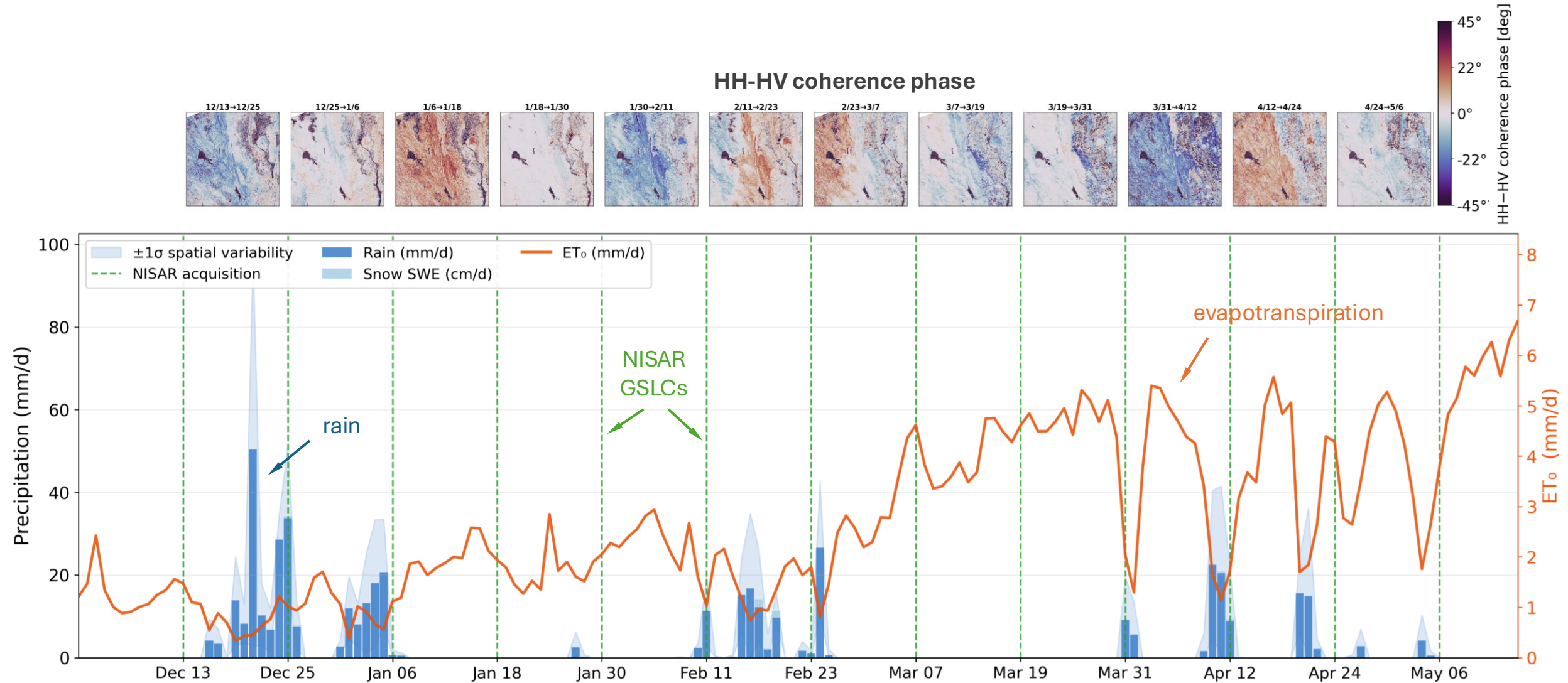
After (accumulated) split-spectrum ionospheric correction



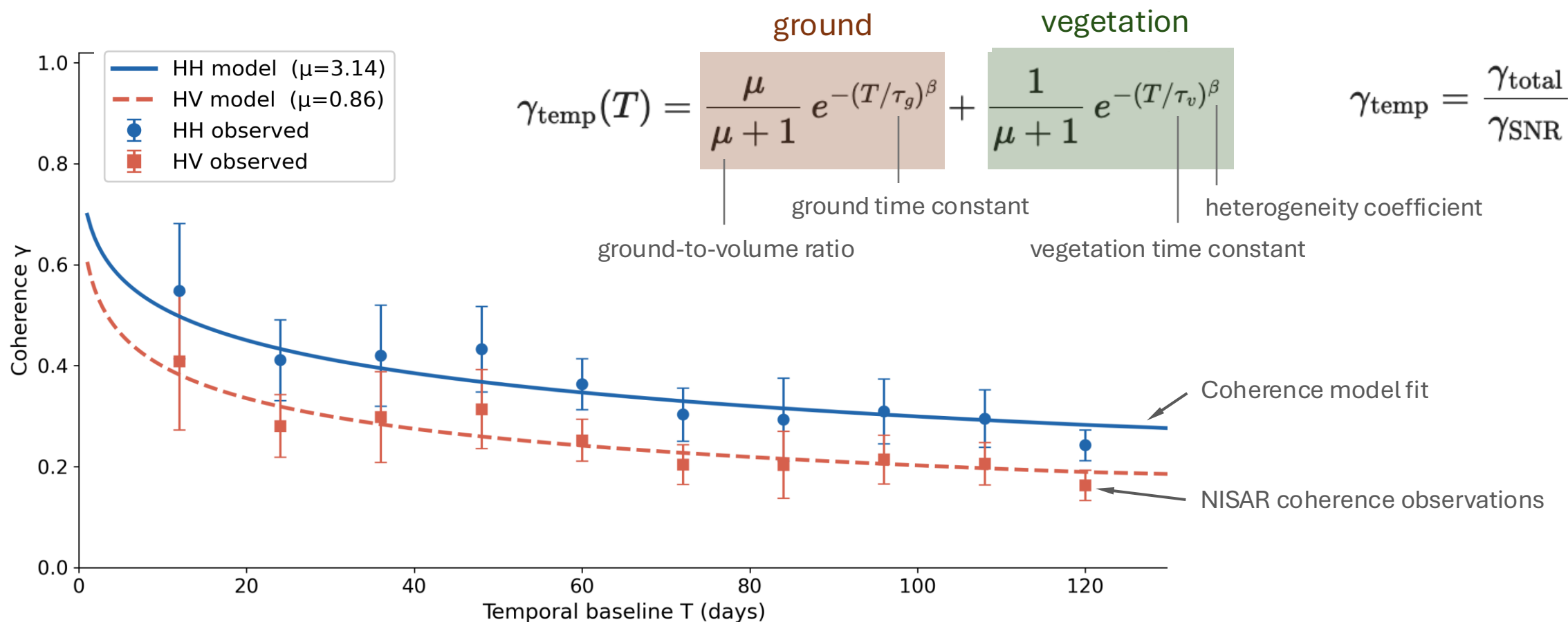
Non-zero phase in HH-HV NISAR interferograms



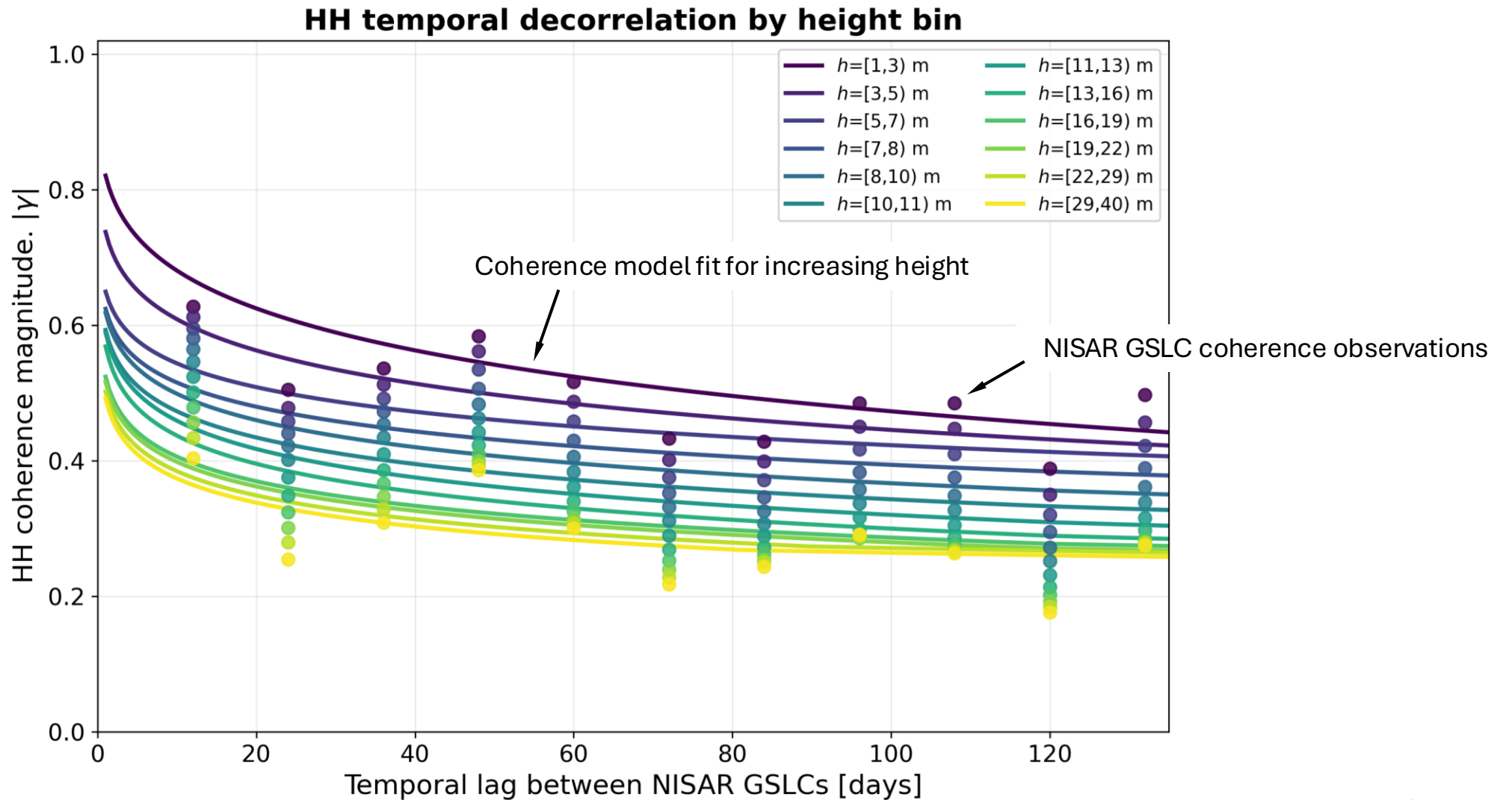
Precipitation explains the HH-HV InSAR phase offset



NISAR GSLC coherence evolution and revised RMoG model

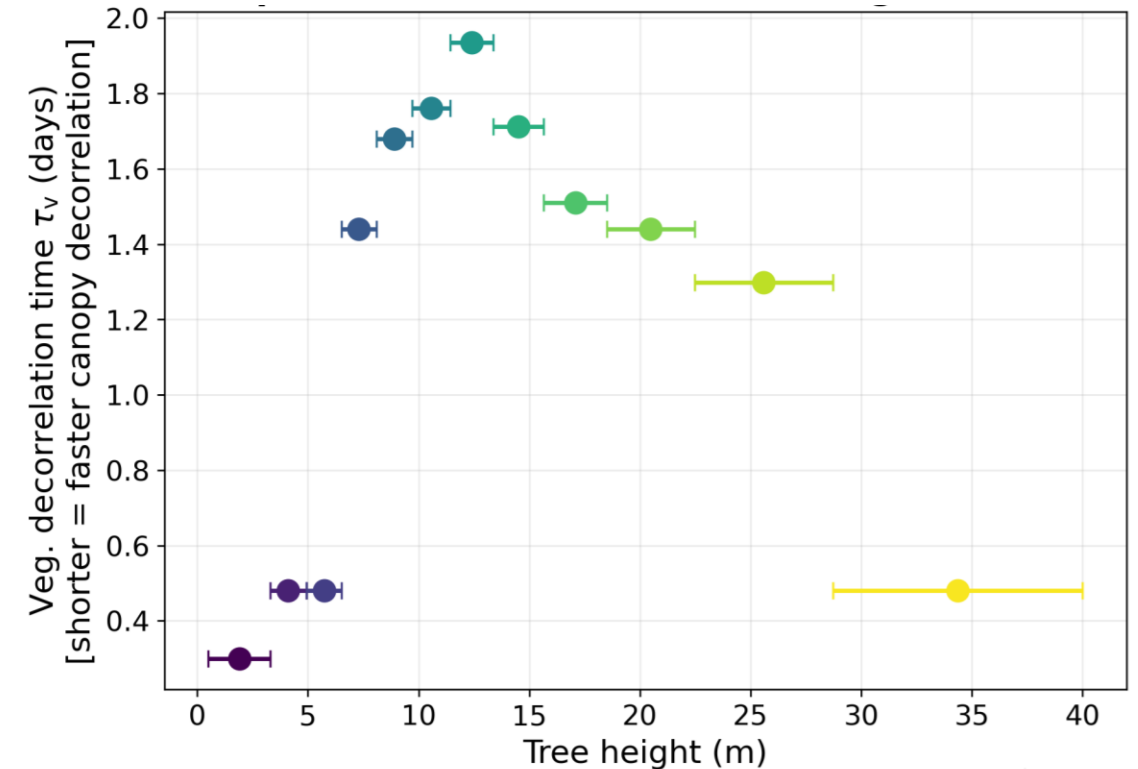
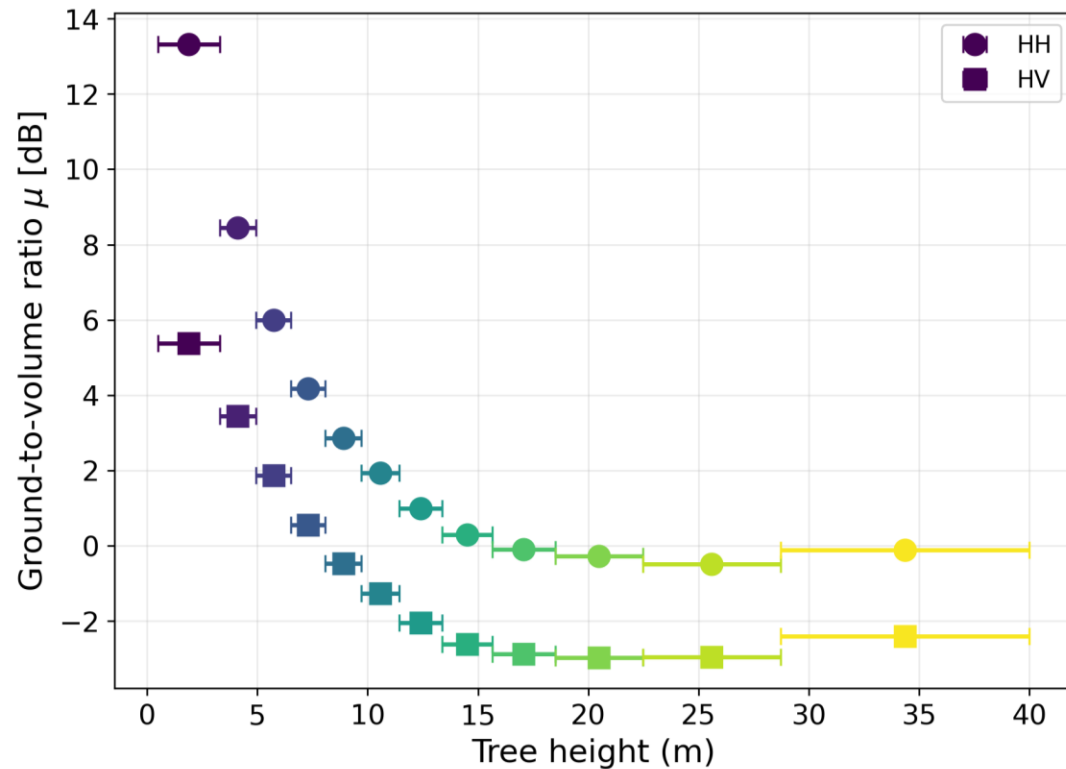


NISAR HH coherence vs temporal lag and tree height



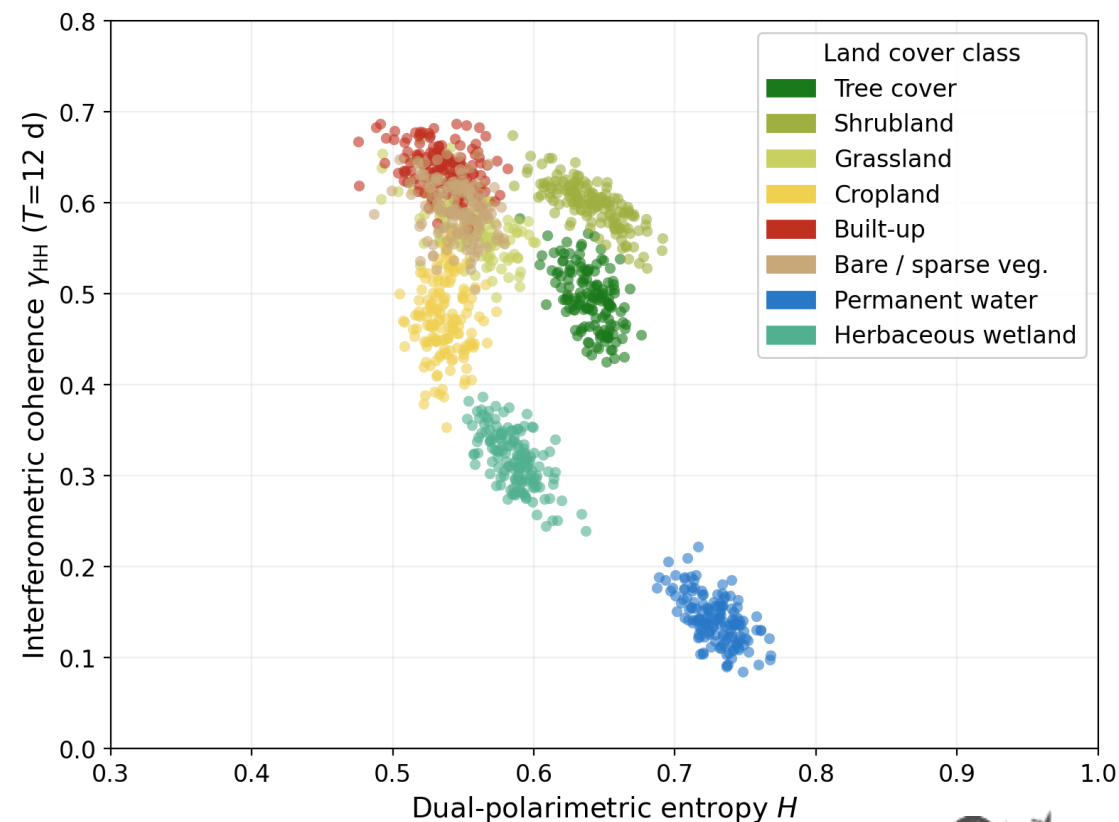
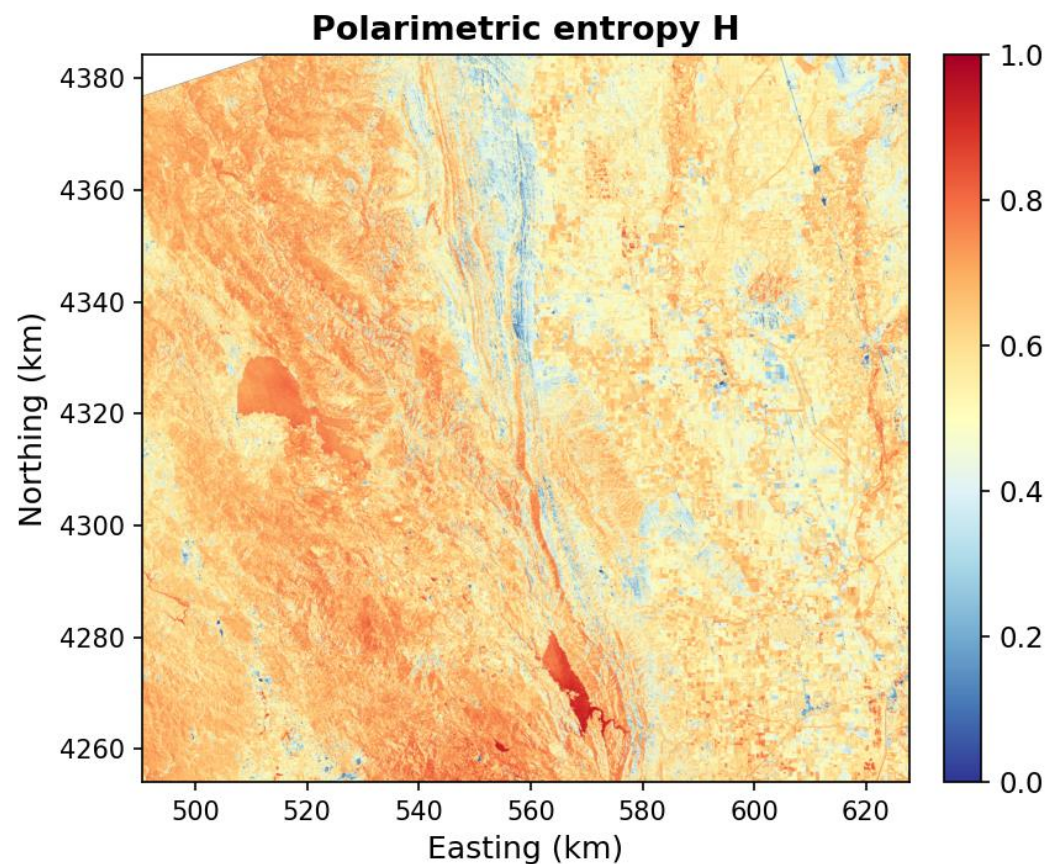
Land parameters from NISAR HH/HV coherence time-series

$$\gamma_{\text{temp}}(T) = \underbrace{\frac{\mu}{\mu + 1} e^{-(T/\tau_g)^\beta}}_{\text{ground-to-volume ratio}} + \underbrace{\frac{1}{\mu + 1} e^{-(T/\tau_v)^\beta}}_{\text{vegetation time constant}}$$



NISAR GSLCs serve interferometric and polarimetric communities

$$\mathbf{k}_{\text{GSLC}} = \begin{pmatrix} S_{HH} \\ S_{HV} \end{pmatrix} \begin{cases} \mathbf{C} = \begin{pmatrix} \langle |S_{HH}|^2 \rangle & \langle S_{HH} S_{HV}^* \rangle \\ \langle S_{HV} S_{HH}^* \rangle & \langle |S_{HV}|^2 \rangle \end{pmatrix} \longrightarrow H = - \sum_{i=1}^2 p_i \log_2 p_i, \quad p_i = \frac{\lambda_i}{\lambda_1 + \lambda_2} \quad (\text{polarimetric entropy}) \\ \gamma_{HH} = \frac{\langle S_{HH,1} S_{HH,2}^* \rangle}{\sqrt{\langle |S_{HH,1}|^2 \rangle \langle |S_{HH,2}|^2 \rangle}} \quad \gamma_{HV} = \frac{\langle S_{HV,1} S_{HV,2}^* \rangle}{\sqrt{\langle |S_{HV,1}|^2 \rangle \langle |S_{HV,2}|^2 \rangle}} \quad (\text{interferometric coherence}) \end{cases}$$



Take-away messages

1. Initial assessment indicates that NISAR products are generally **high quality** and suitable for science
2. **GSLCs enable direct access to InSAR and PolSAR** observables, enabling user-driven analyses
3. **GSLC-based coherence** appear suitable for land applications, provided that ionospheric effects are limited or properly mitigated
4. Evaluation of **NISAR products and algorithms** is ongoing and will continue throughout the mission

nisar-docs.asf.alaska.edu
nisar.jpl.nasa.gov

