

3-D SAR imaging of forests from space at higher frequency bands

using incoherent bistatic tomography

Concepts and validation using the TomoSense campaign

P. Bou⁽¹⁾ L. Ferro-Famil⁽²⁾ M. Mariotti d'Alessandro⁽³⁾ S. Tebaldini⁽³⁾ Y. Huang⁽⁴⁾

ONERA & CESBIO, U. Toulouse (F)

ISAE-SUPAERO & CESBIO, U. Toulouse (F)

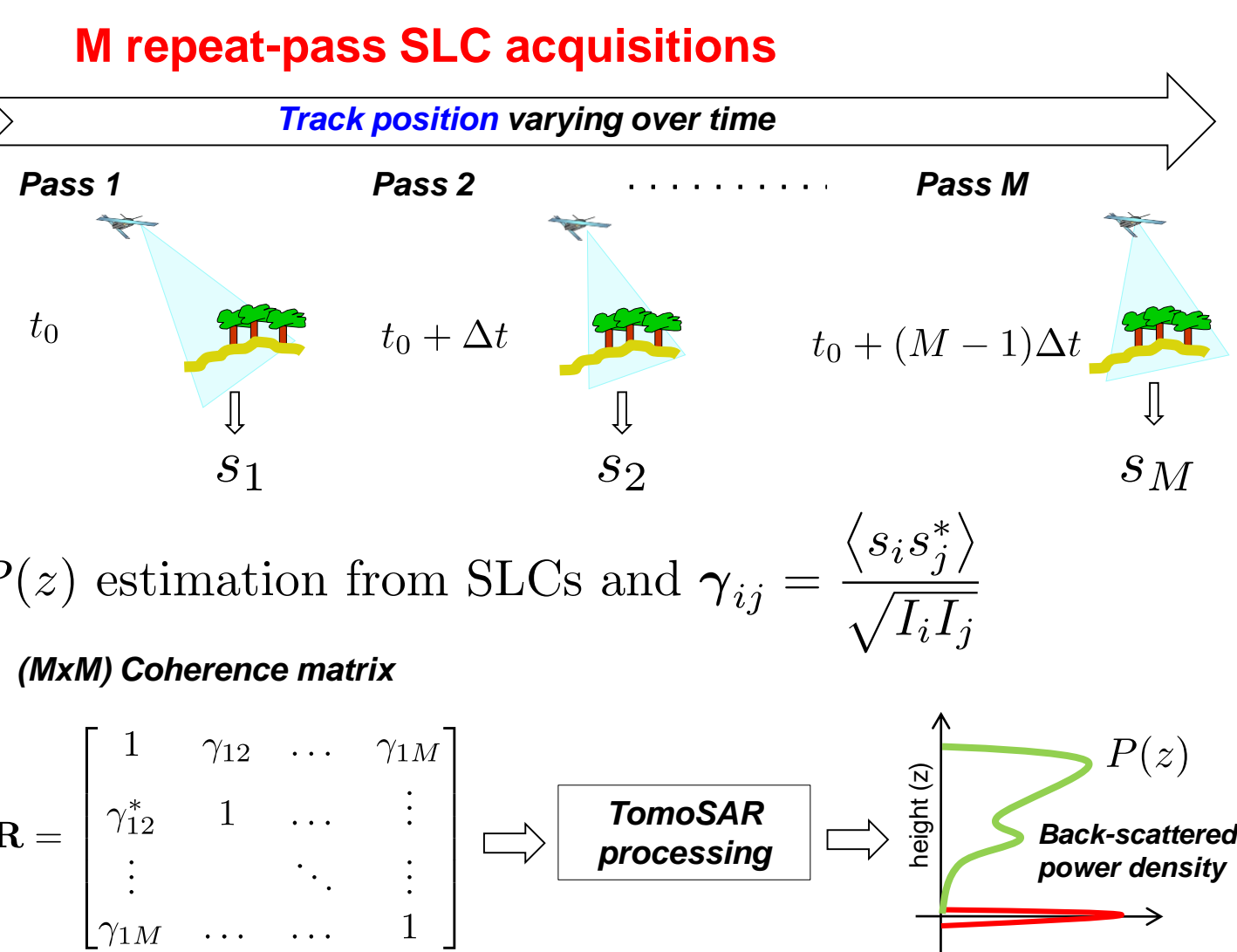
DEIB, Politecnico di Milano (I)

IETR, U. Rennes 1 (F)

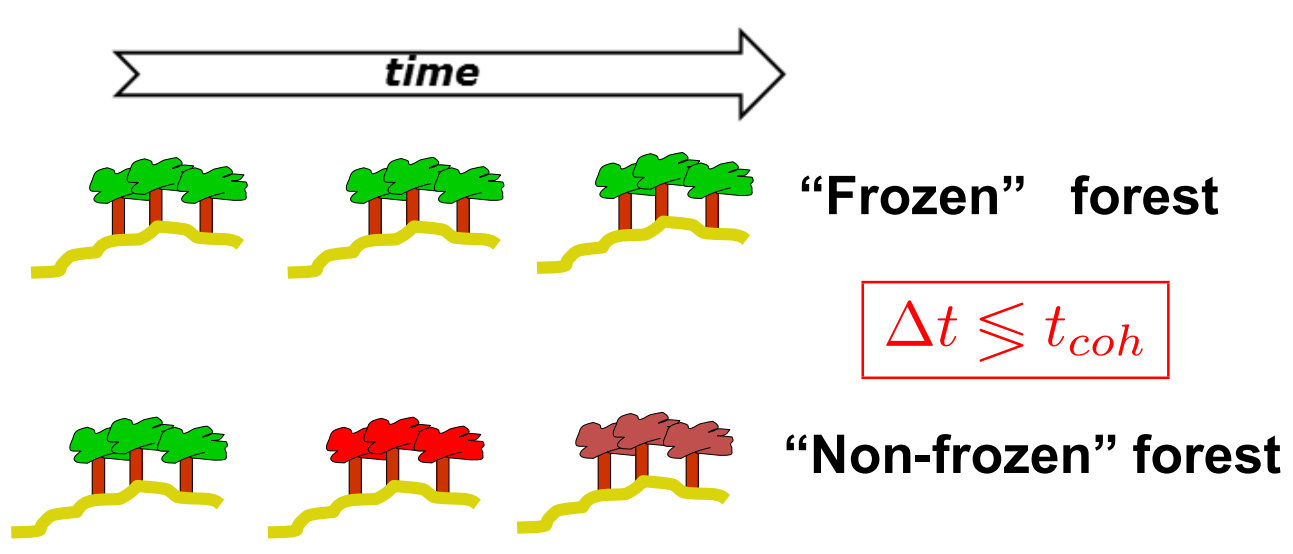


Principles of incoherent bistatic tomography

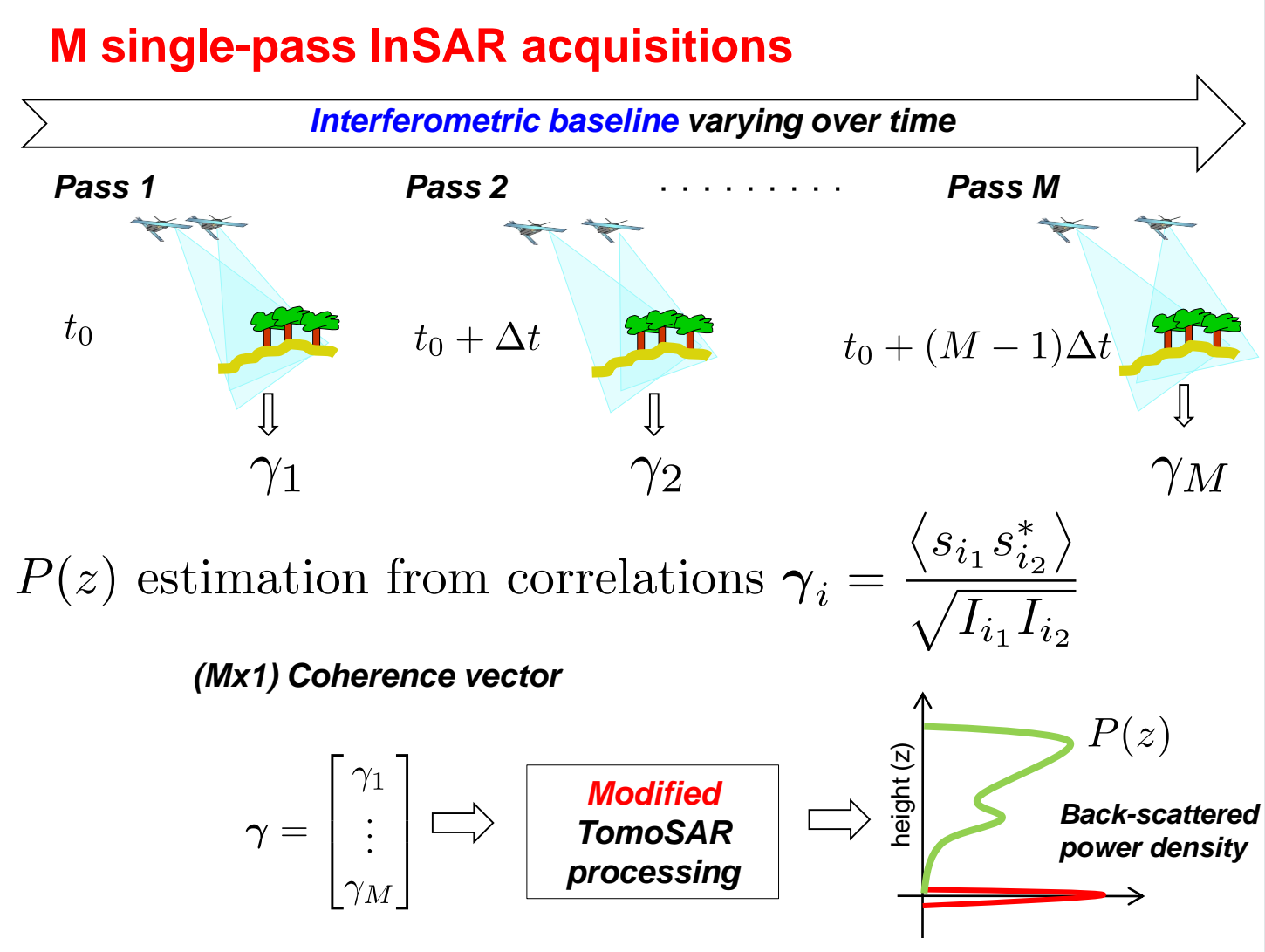
Classical coherent tomography



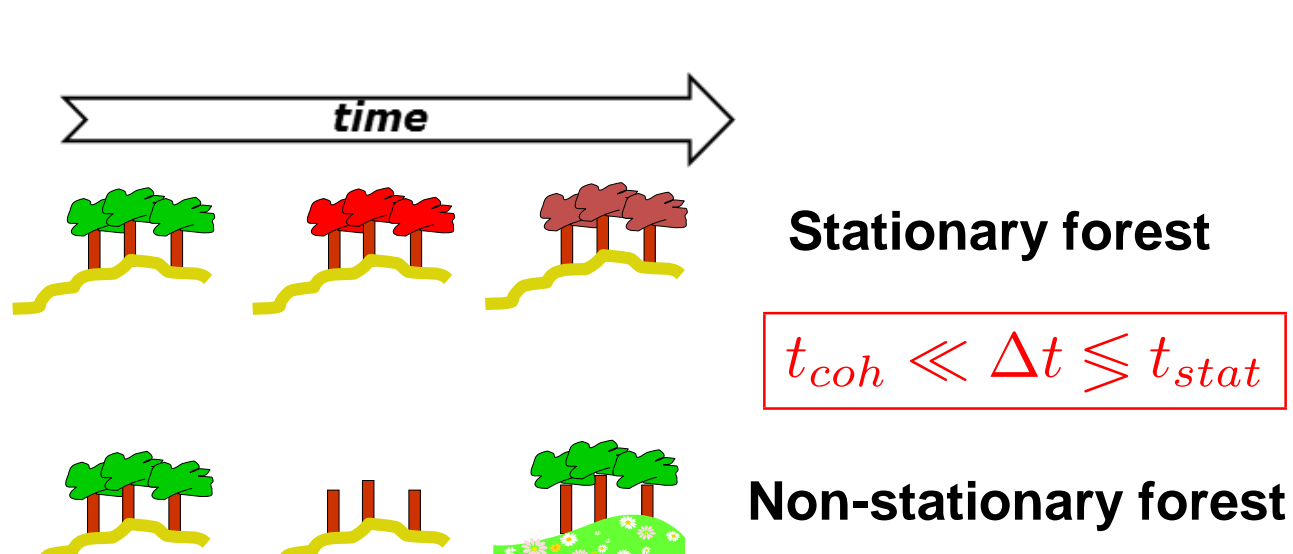
- Simple TomoSAR processing → 3D images
- Equivalent to SAR focusing
- Temporal decorrelation at higher frequencies



Incoherent mono & bistatic tomography



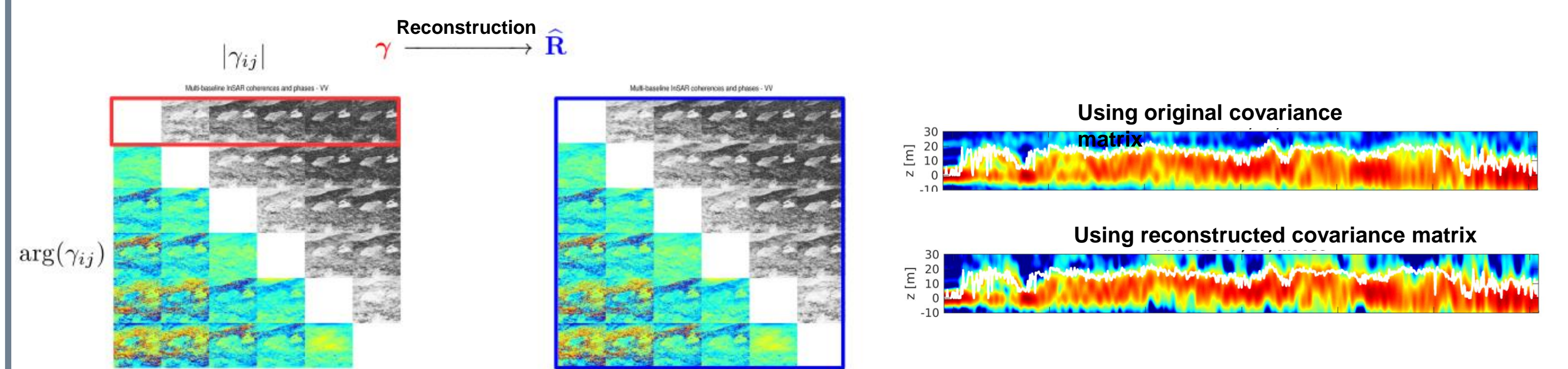
- Complex TomoSAR reconstruction
- Requires physical properties enforcement
- Negligible temporal decorrelation at all frequencies



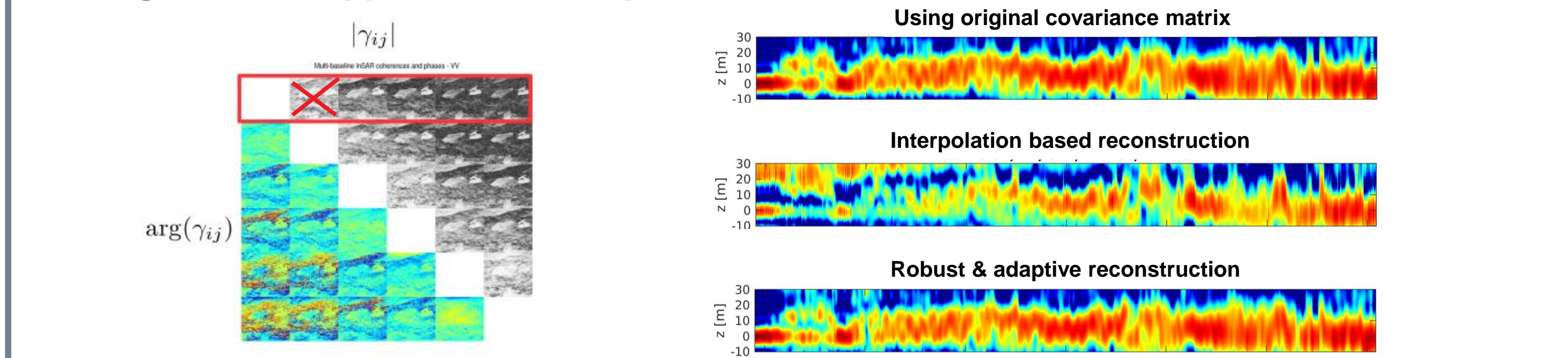
Incoherent tomographic processing

Virtual array principle: estimate covariance matrix R from correlation vector γ

BIOSAR II data: quasi-regular sampling at L band



Missing data and approx. DEM compensation



Tomosense campaign

Simultaneous Mono- and bi-static multiple acquisitions performed over a temperate forest

Acquisition configurations

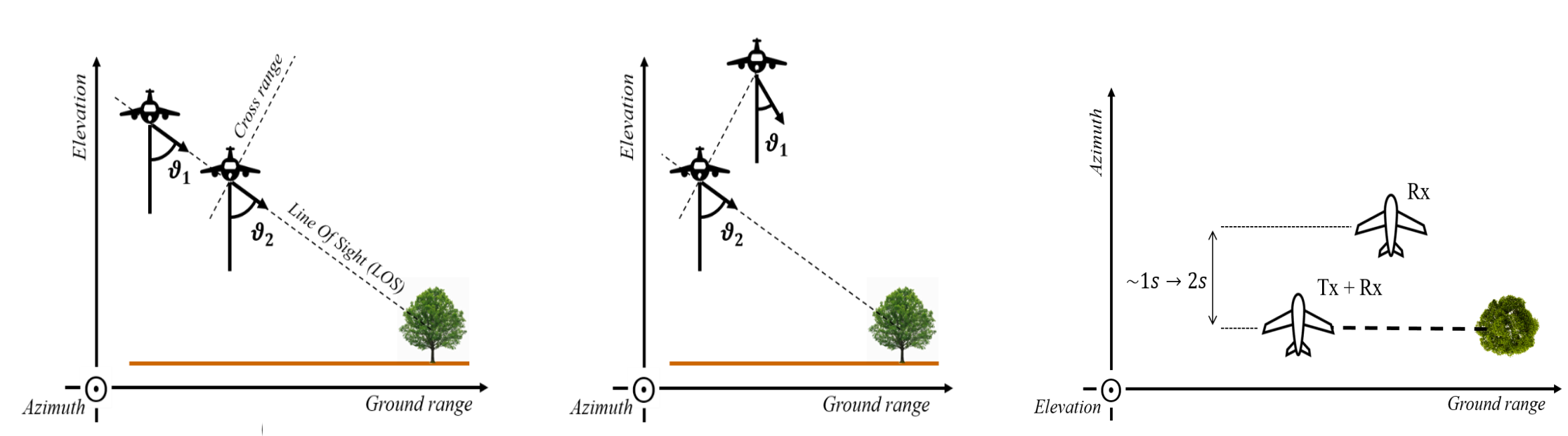
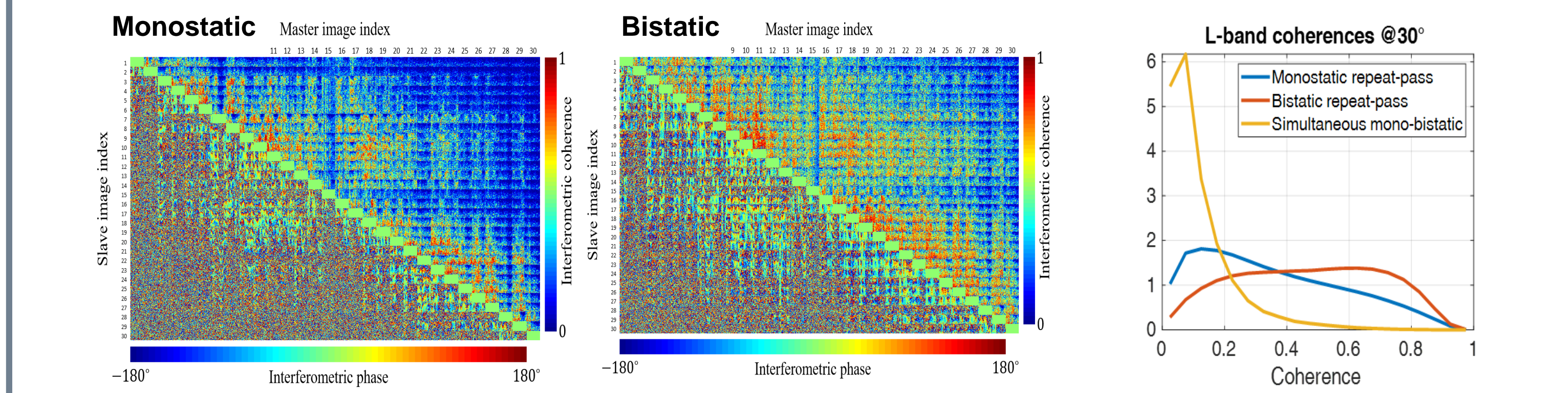


Image features

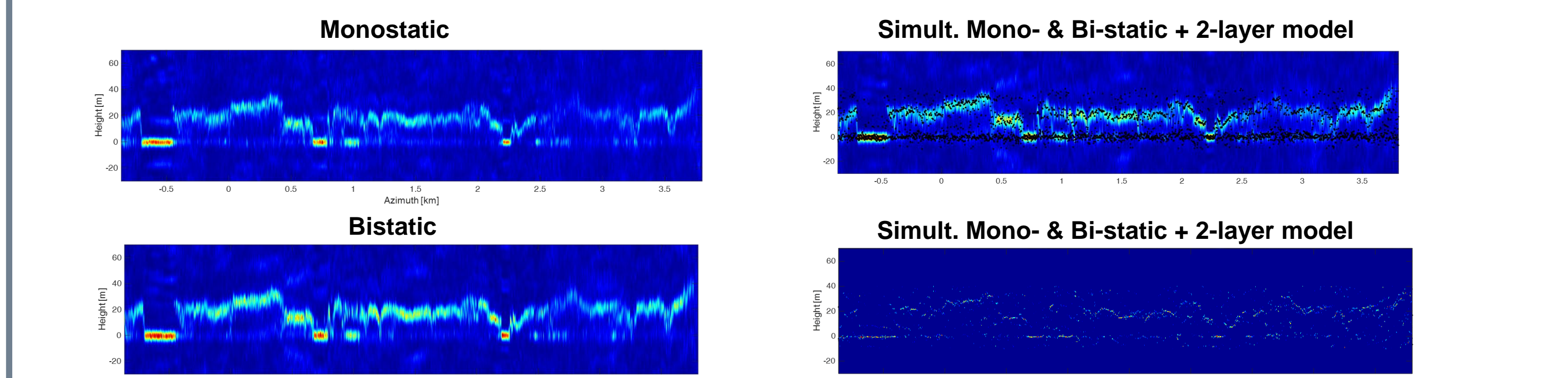
Band	Mode	Number of images	Resolutions
P	Monostatic	19	5m x 1m x 3m
L	Mono- & Bistatic	30	3m x 0.55m x 1.3m
C	Mono- & Bistatic	17	1.5m x 0.3m x 0.8m

Tomosense campaign

Correlation features

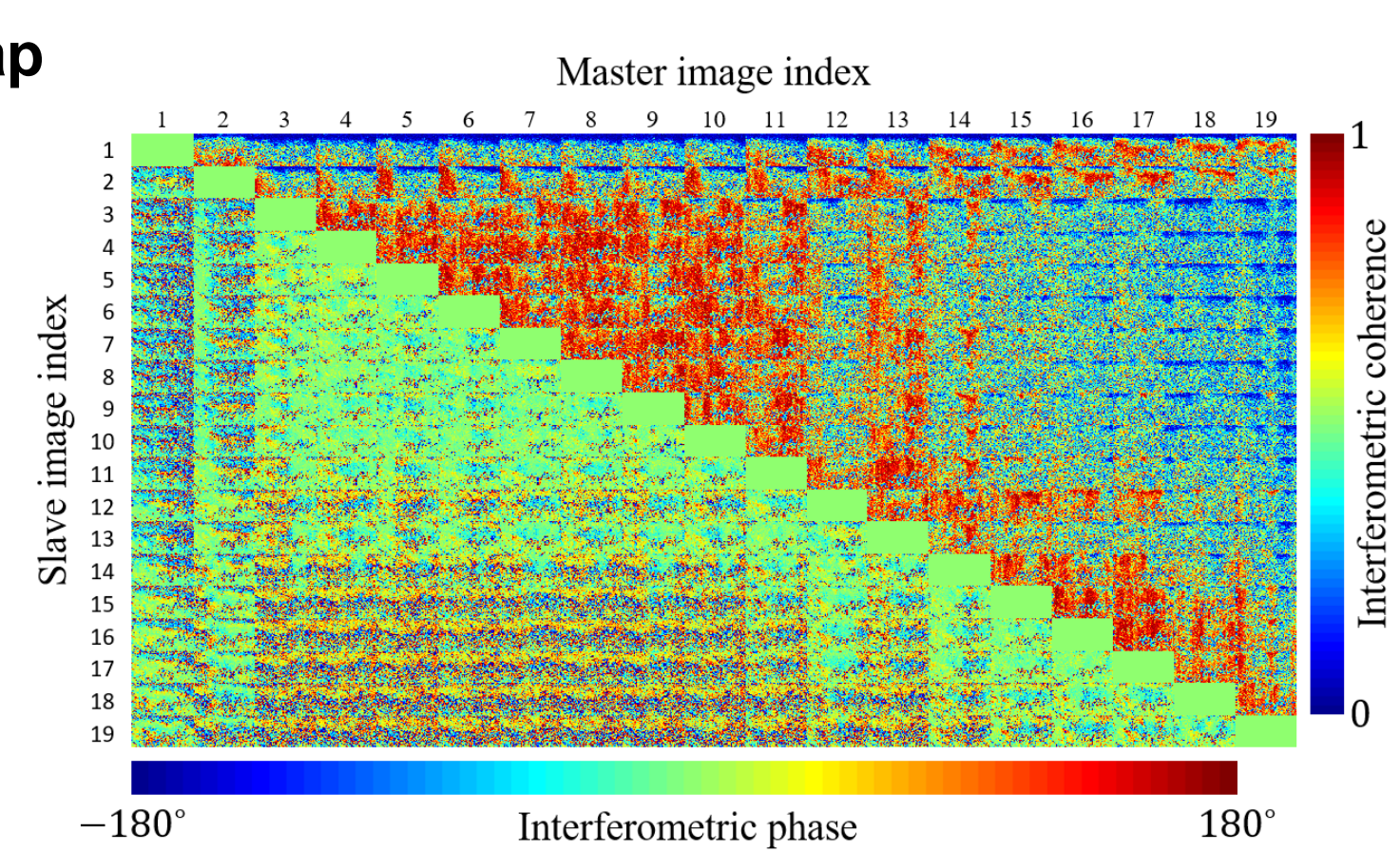


Original and parametric tomographic imaging results

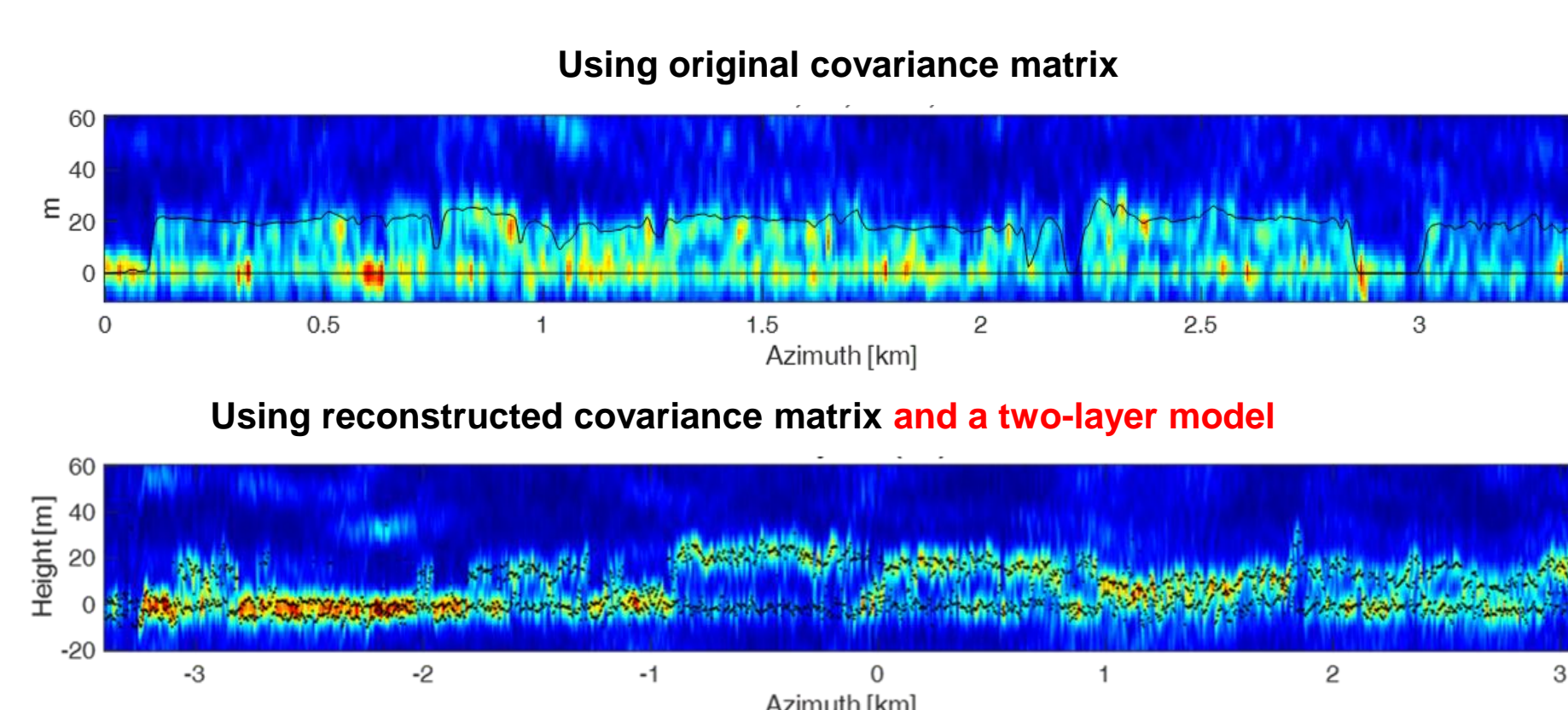


P band

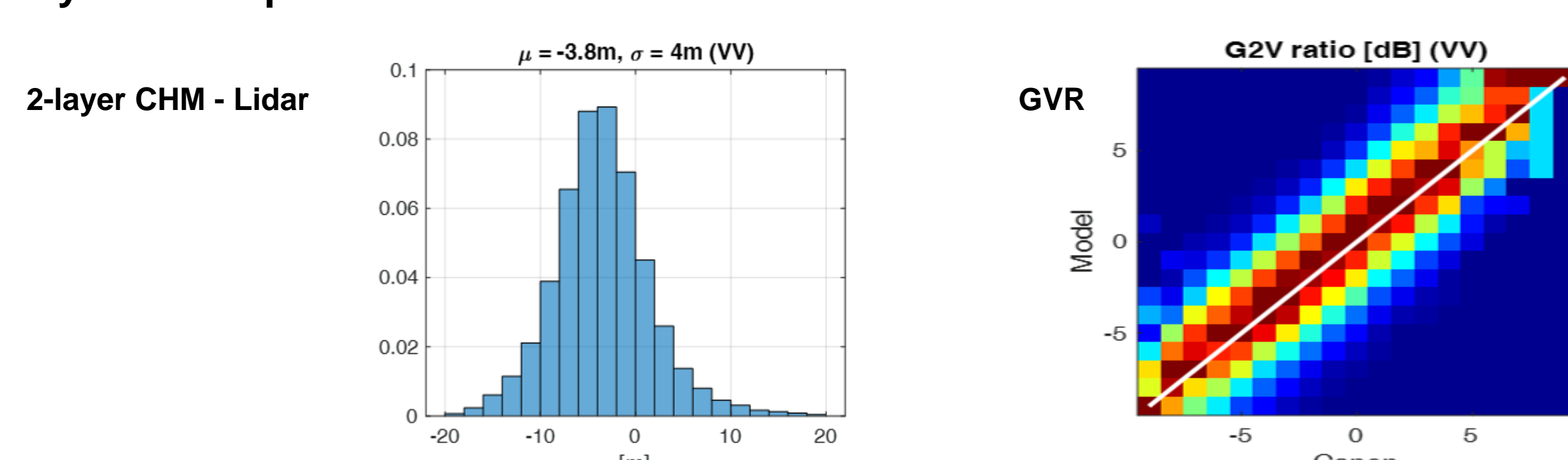
Monostatic correlation map



Original and parametric tomographic imaging results

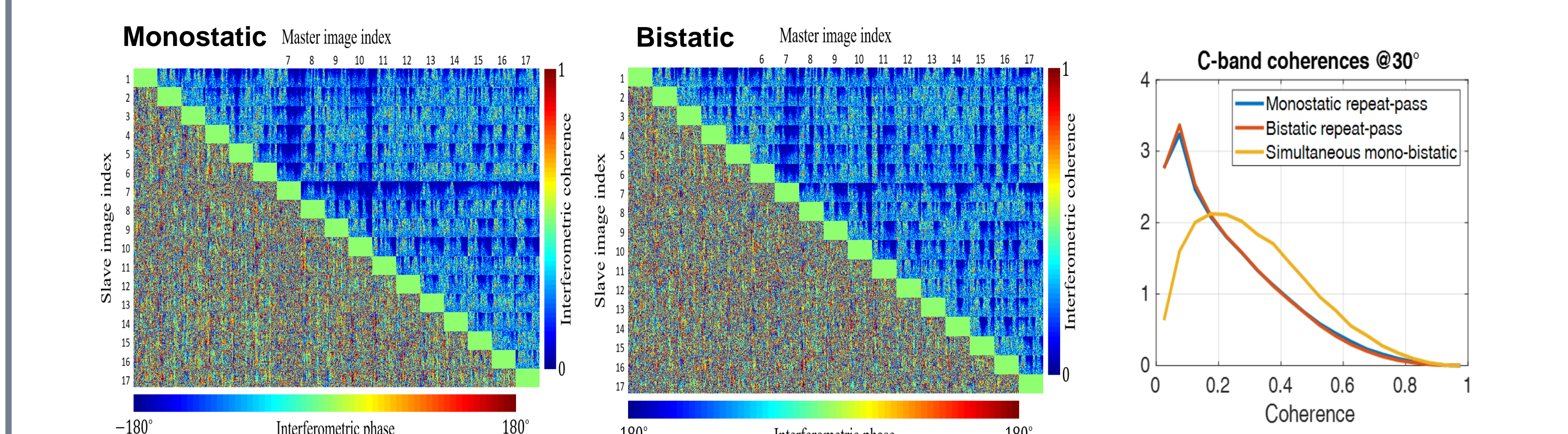


Two-layer model parameter estimation

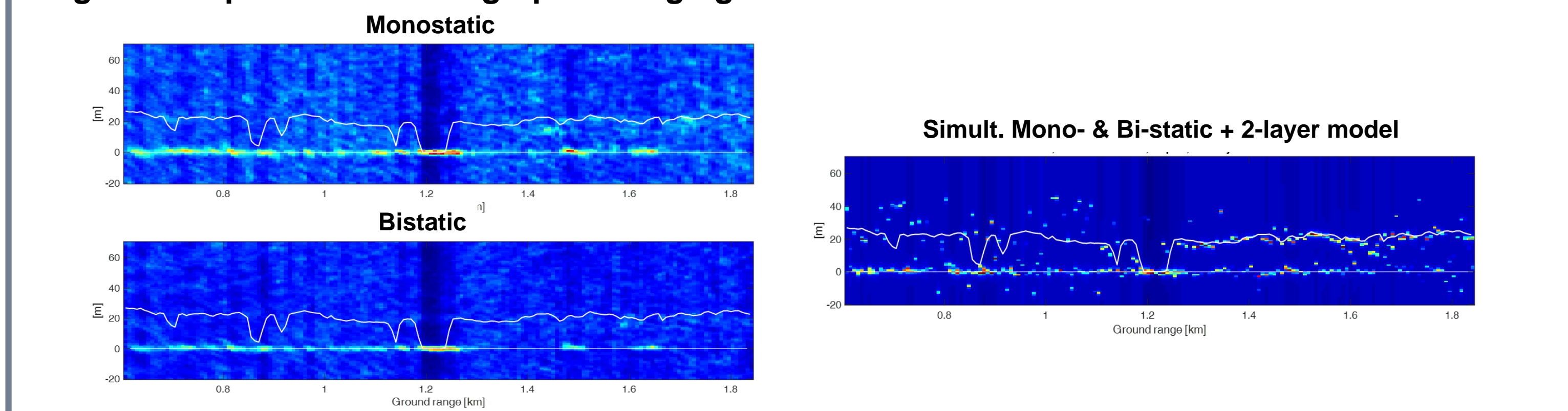


Higher-frequency: C band

Correlation features



Original and parametric tomographic imaging results



Conclusion

- Incoherent tomography: unique solution for 3D imaging from space at higher frequencies
- Spatial and temporal sampling: performance vs safety/mechanical constraints compromise
- Robust signal processing options have been designed and validated