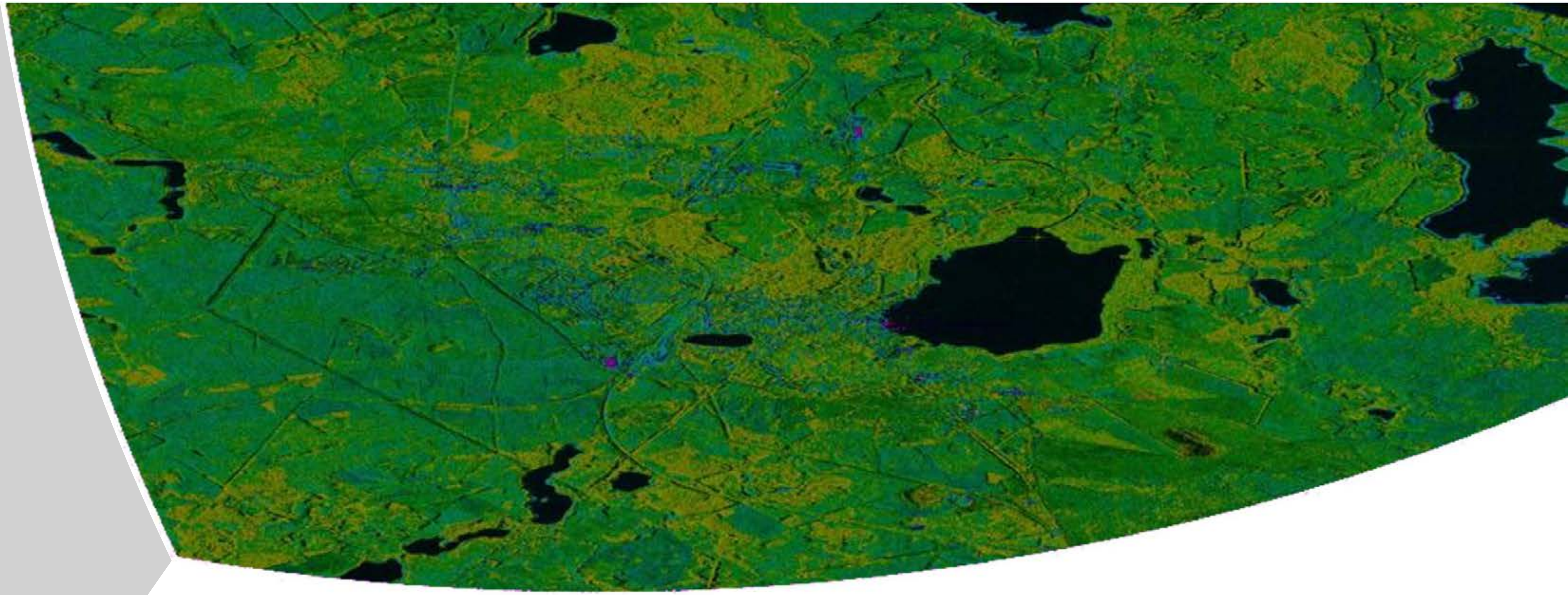

# Interpretation Pol-InSAR Vegetation Signatures at X-Band

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Microwaves and Radar Institute (DLR-HR)

[2] ETH Zurich – Department of Environmental Engineering, Zurich (CH)

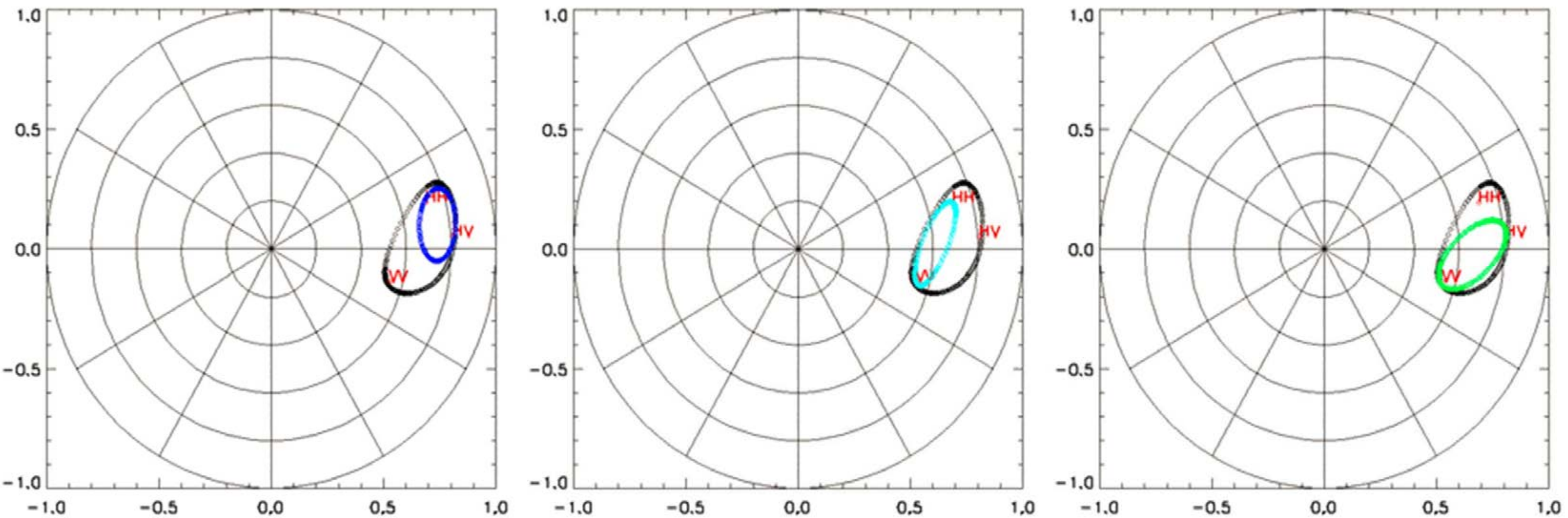
# Motivation

**Understand X-Band capabilities and limitations in Pol-InSAR over forest**

- Indication of penetration depths in vegetation at X-Band in recent studies
- Investigation of forest height inversion perfomance by means of RVoG
- No direct validity assessment of the used inversion models
- Lack of quad-pol and multi-baseline single pass data sets meaning without temporal decorrelation

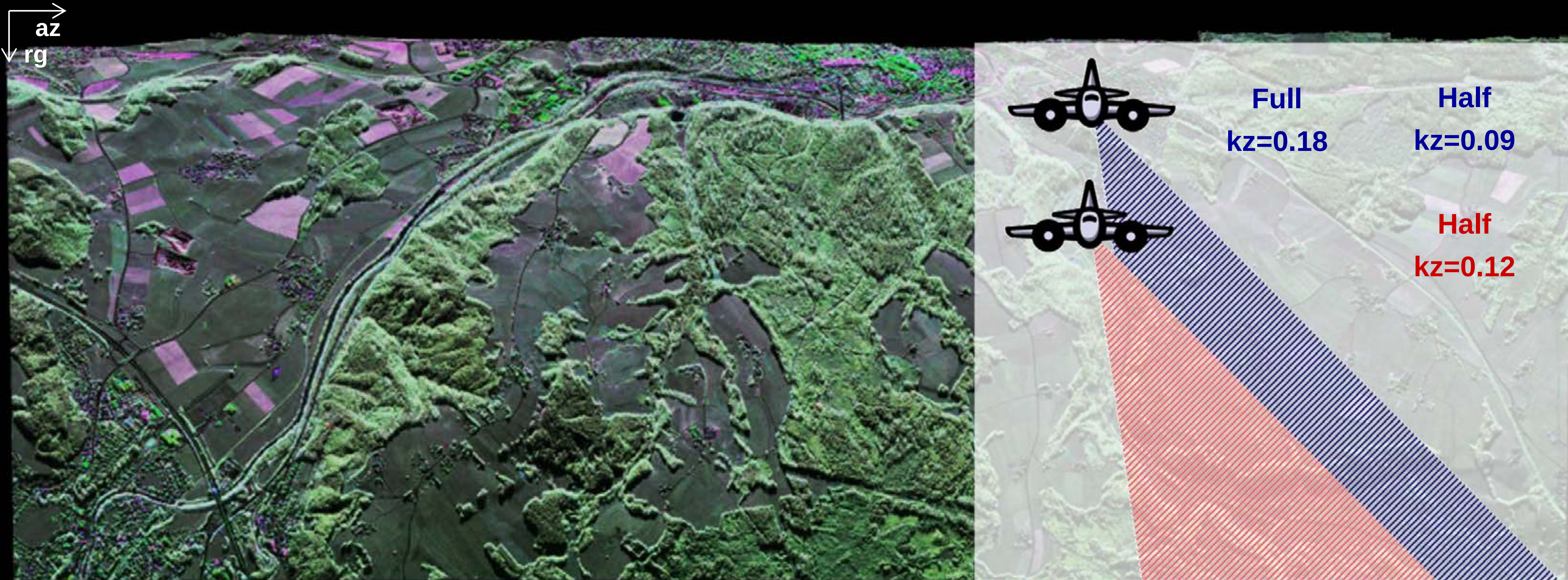
# Dual- vs Quad-Pol Information Content

**HH-HV** **HH-VV** **VV-HV**




**Dual-Pol gives us only a fraction of the information obtainable at Quad-Pol!**

# Traunstein 2012 F-SAR Campaign: X-band




## F-SAR X-Band

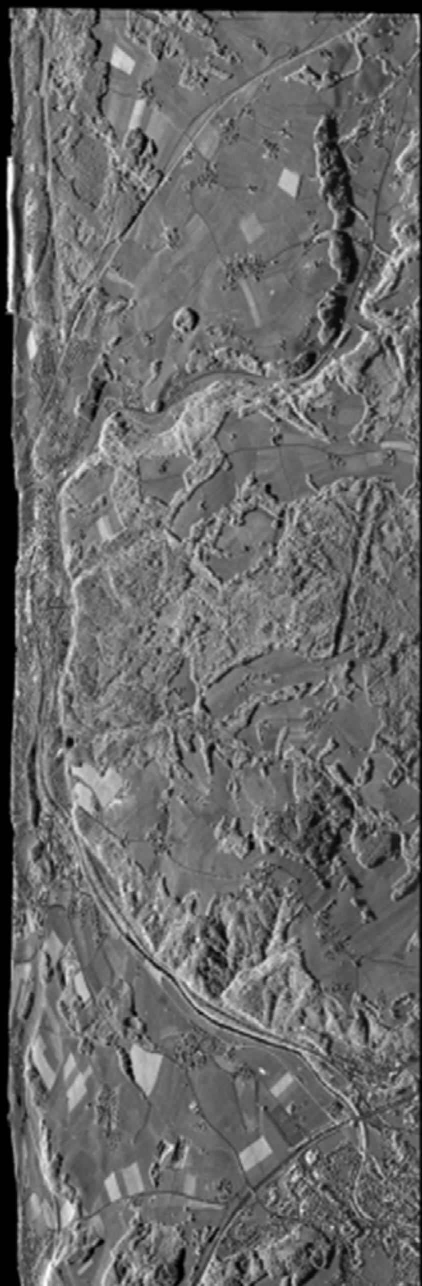
| | |
|---|---|
| RF [GHz] | 9.6 |
| BW [MHz] | 348 |
| PRF [kHz] | 12 |
| Rg x Az res. [m] | 0.5 x 0.5 |
| Polarisation | Quad |
| Interferometry | Single pass XTI |

## Traunstein Test Site

| | |
|---|---|
| Forest type | Temperate |
| Topography | Moderate slopes |
| Height | 25 ~ 35m |
| Species | N. Spruce, E. Beech, White Fir |
| Biomass | 40 ~ 450 t/ha |

# Traunstein 2012 F-SAR Campaign: X-band

HH



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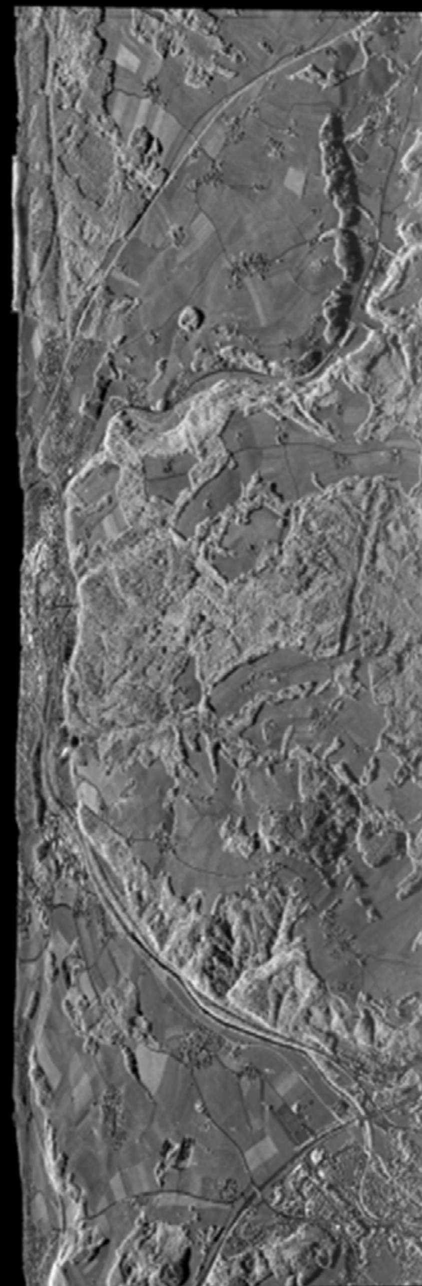
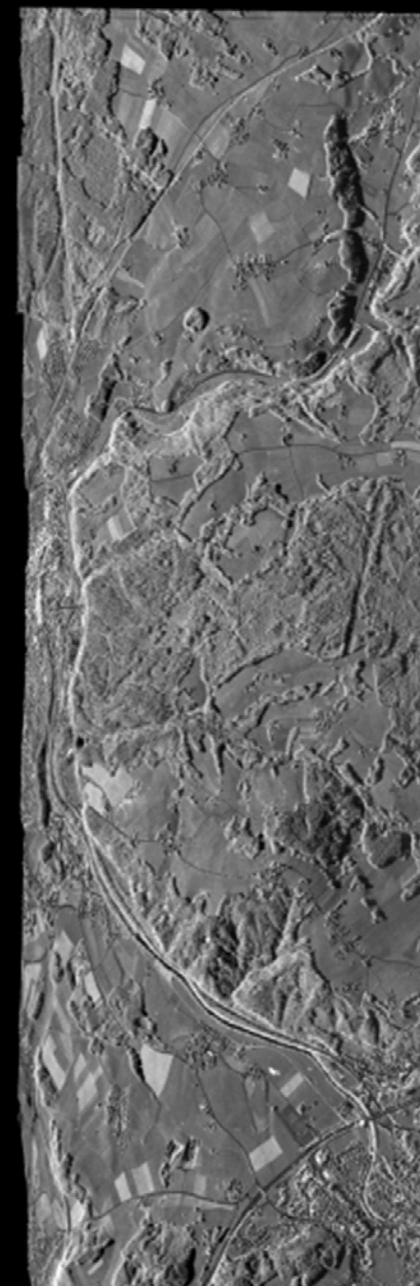
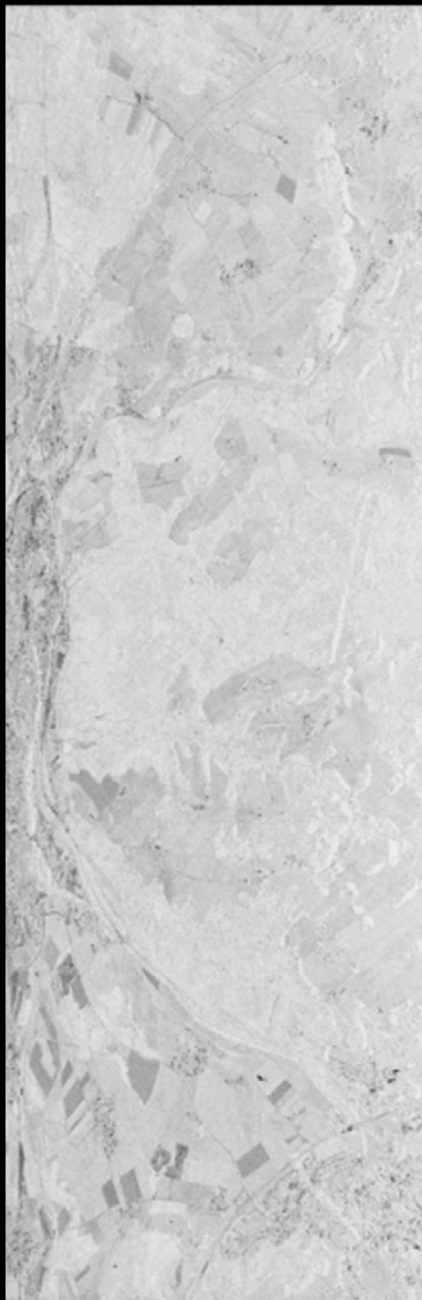


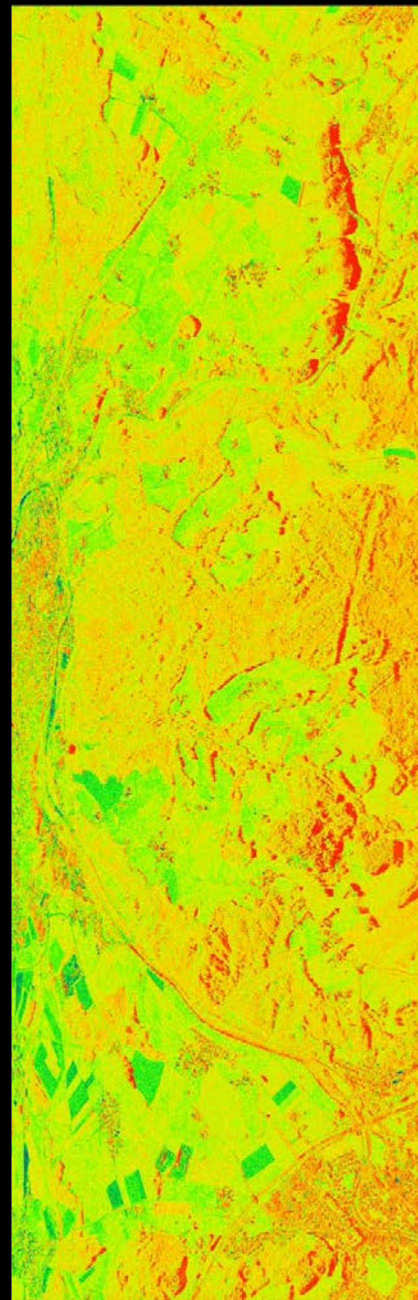
VV



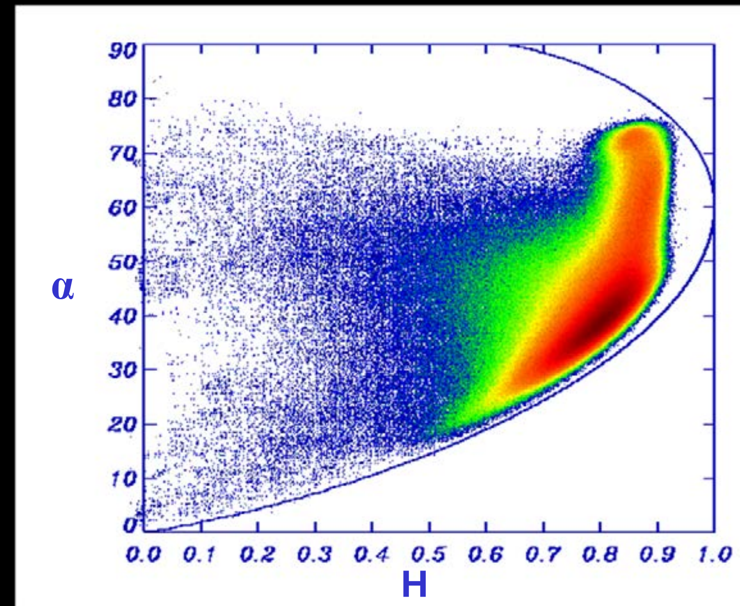
# Traunstein 2012 F-SAR Campaign: X-band Polarimetry

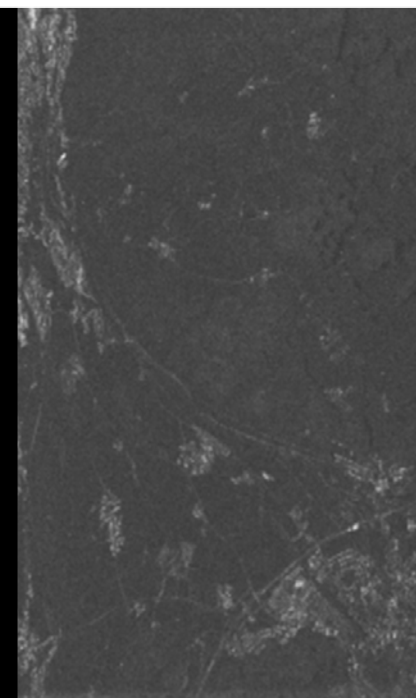


Polarimetric Entropy



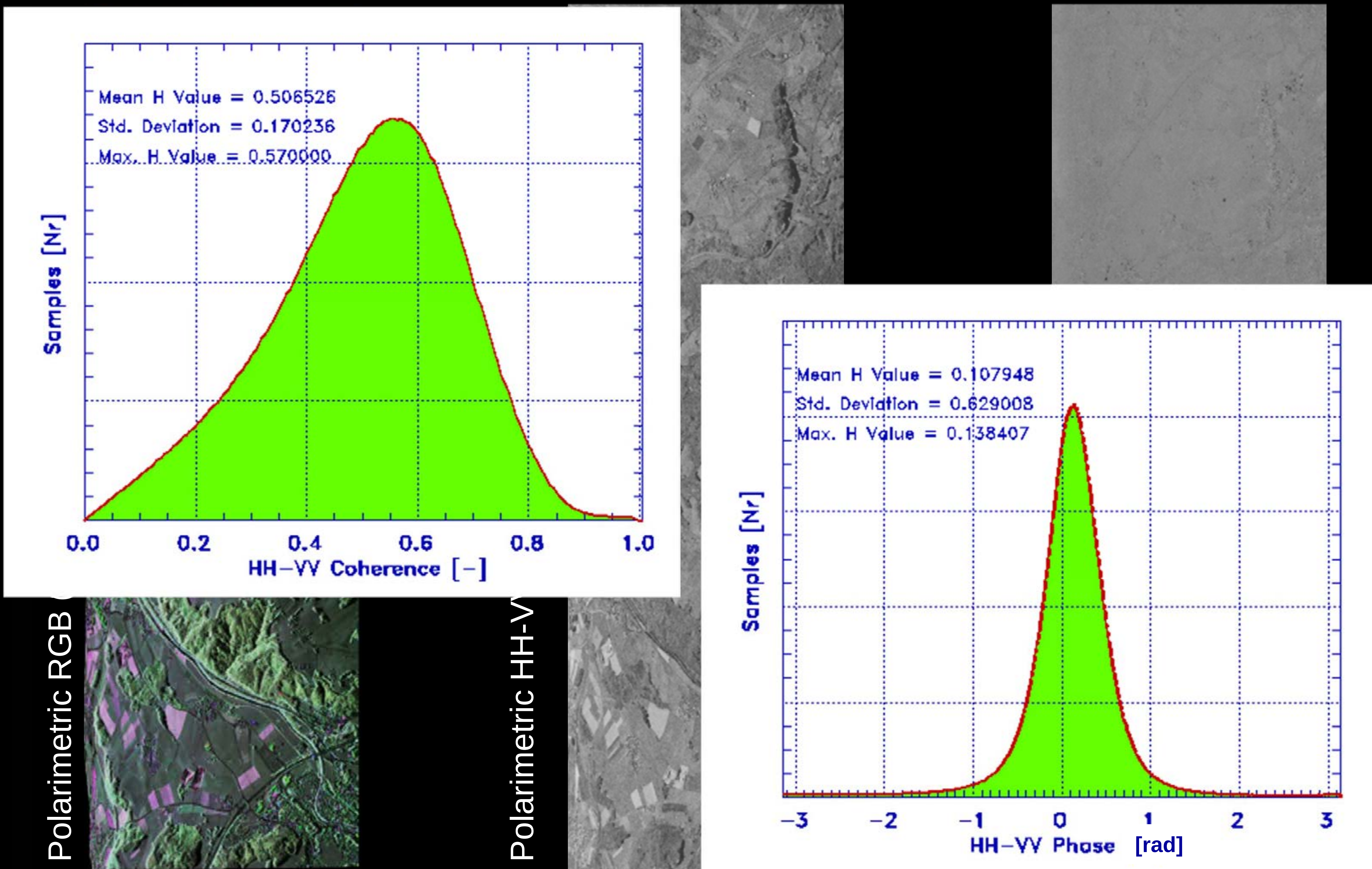
Polarimetric α Angle



Polarimetric Anisotropy

# Traunstein 2012 F-SAR Campaign: X-band Polarimetry



# Traunstein 2012 F-SAR Campaign: X-band Interferometry

Interferometric Coherence HH kz=0.09

Interferometric Coherence HV kz=0.09

Interferometric Coherence VV kz=0.09

# Traunstein 2012 F-SAR Campaign: X-band Interferometry

Interferometric Coherence HH kz=0.18

Interferometric Coherence HV kz=0.18

Interferometric Coherence VV kz=0.18

# Traunstein 2012 F-SAR Campaign: X-band Interferometry

Interferometric Coherence HH kz=0.12

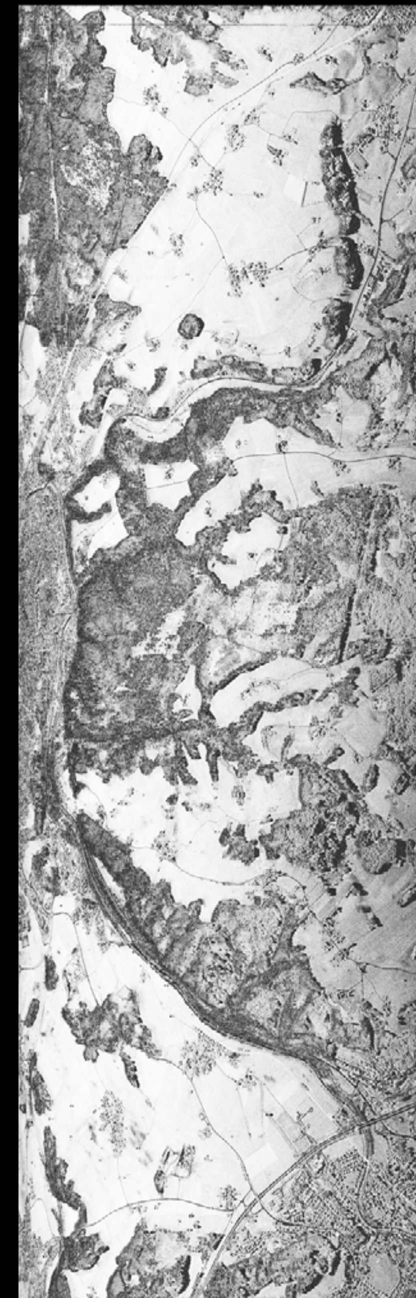
Interferometric Coherence HV kz=0.12

Interferometric Coherence VV kz=0.12

# Traunstein 2012 F-SAR Campaign: X-band Interferometry

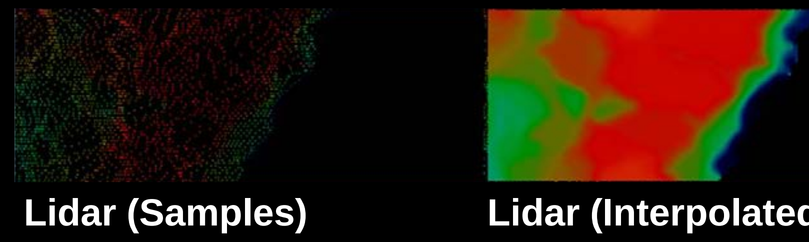
Interferometric Coherence HV kz=0.09

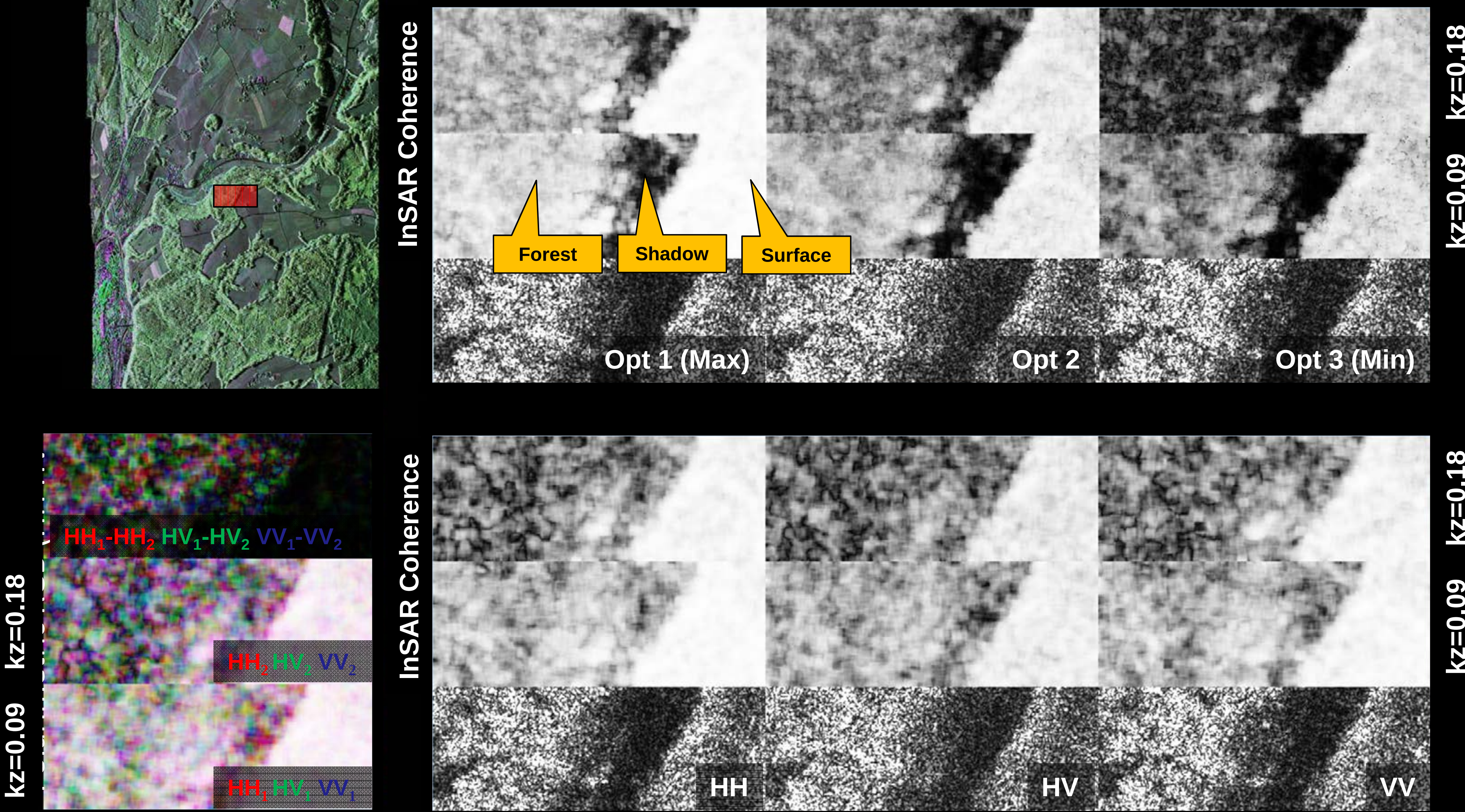
Interferometric Coherence HV kz=0.12



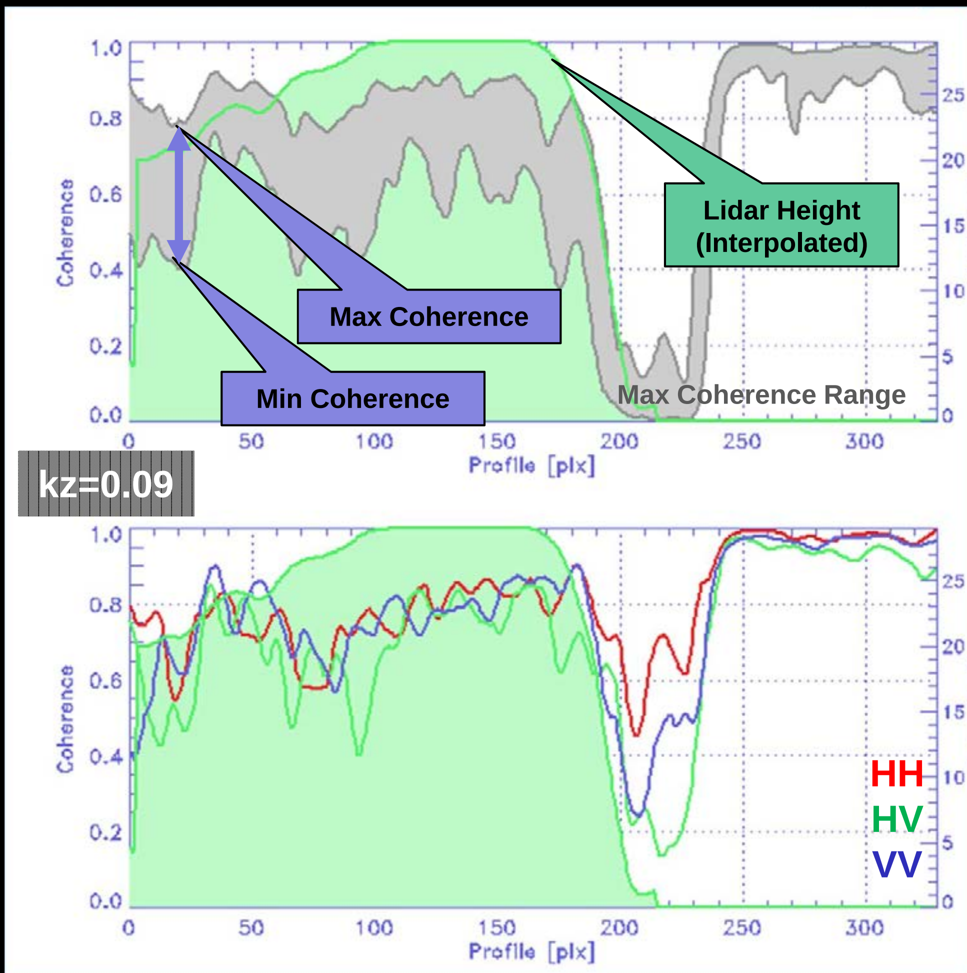
Interferometric Coherence HV kz=0.18

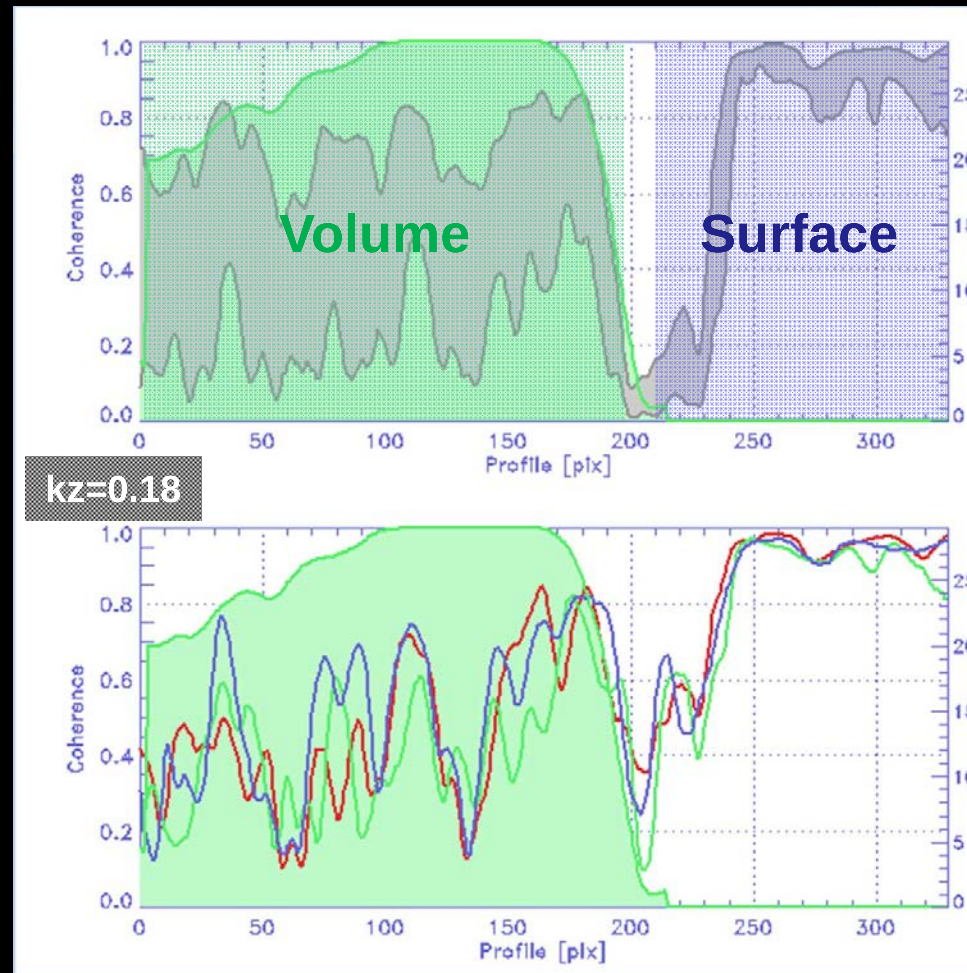
# Traunstein 2012 F-SAR Campaign: X



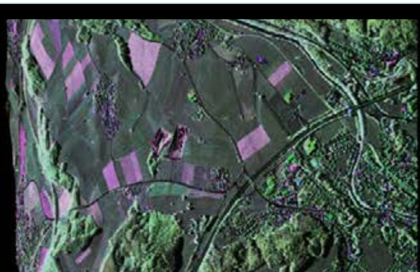



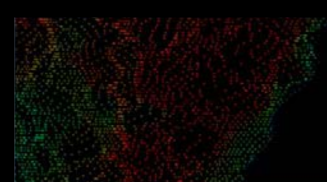
# Traunstein 2012 F-SAR Campaign: X-band PolInSAR



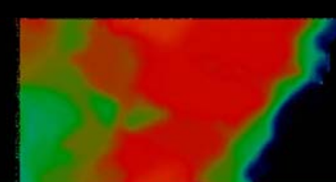




Polarimetric





Lidar (Samples)



Lidar (Interpolated)

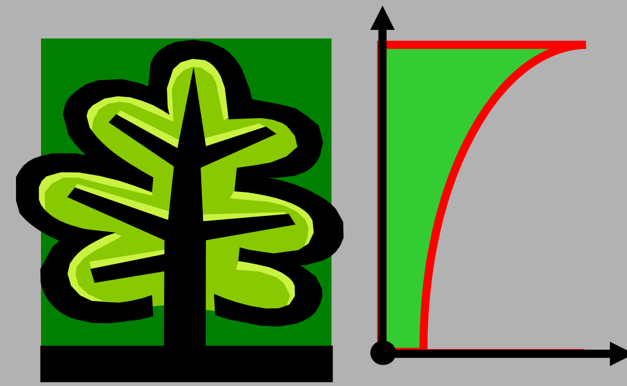
# Traunstein 2012 F-

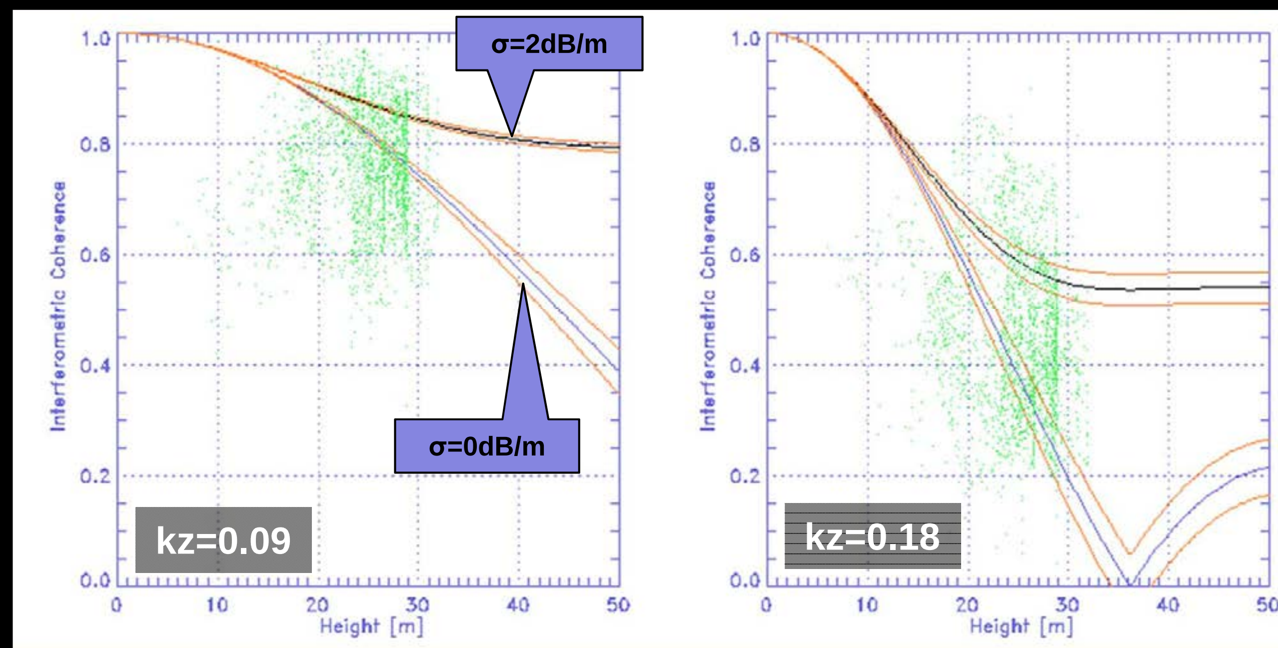
Polarimetric RGB (HH HV VV)

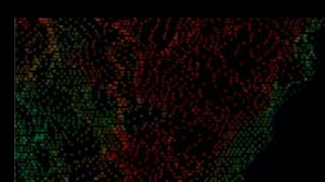
**InSAR Volume Coherence**

**(exp volume profile)**

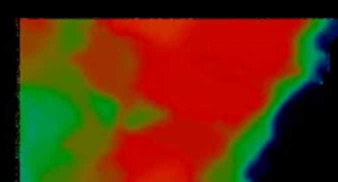
$$\tilde{\gamma}(m=0)=\exp(i\phi_0)\frac{\int_0^{h_V}\exp(i\kappa_z z')\exp\left(\frac{2\ \sigma\ z'}{\cos\theta_0}\right)dz'}{\int_0^{h_V}\exp\left(\frac{2\ \sigma\ z'}{\cos\theta_0}\right)dz'}$$





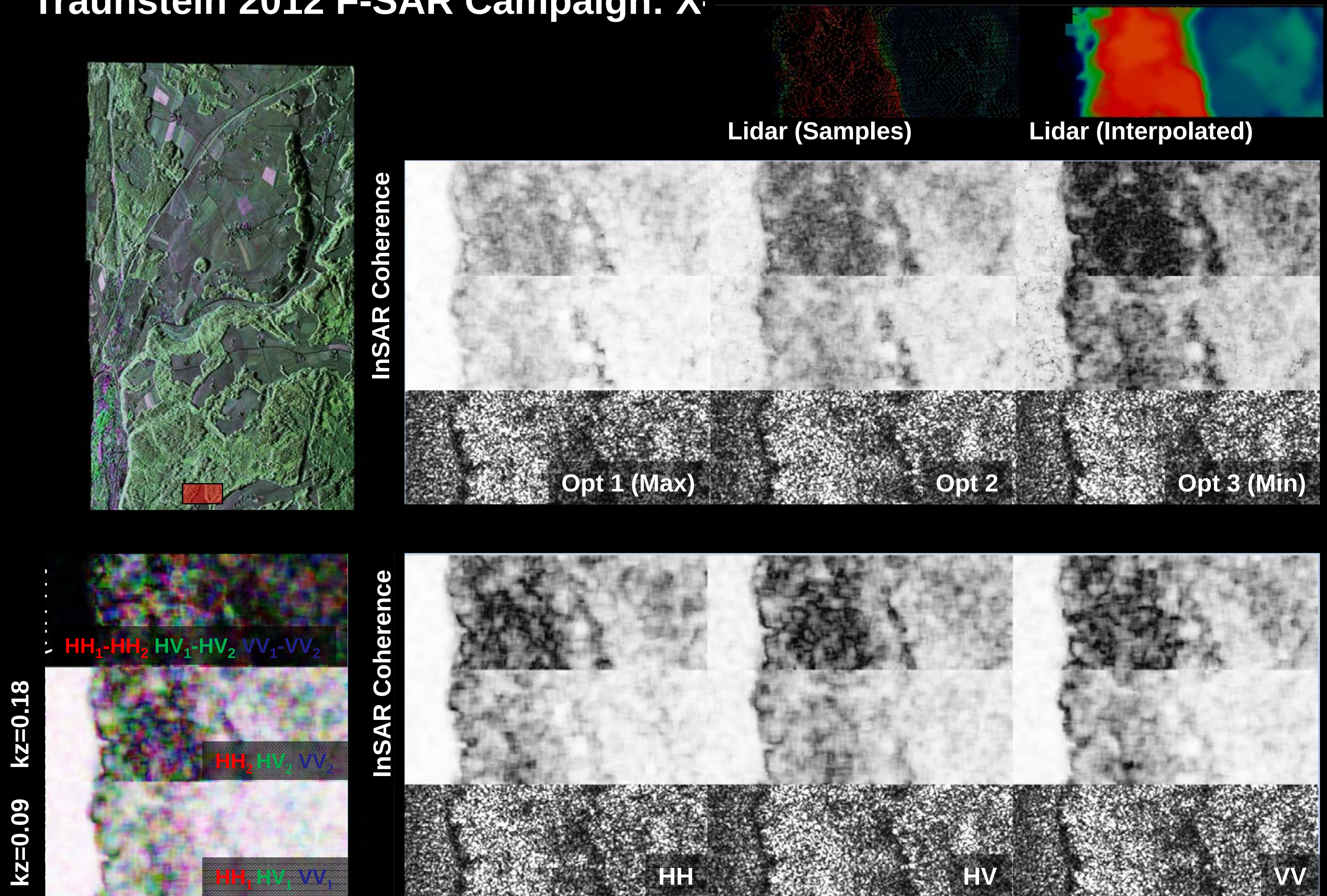



**Lidar (Samples)**

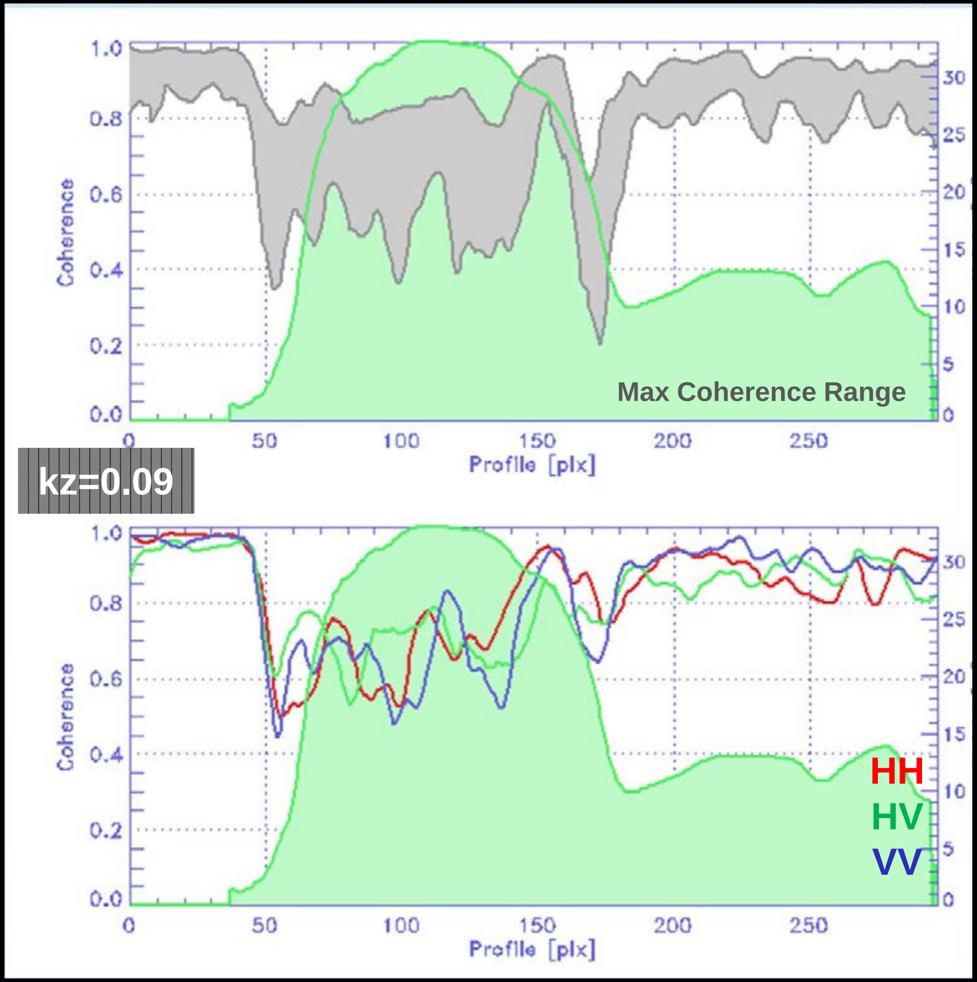


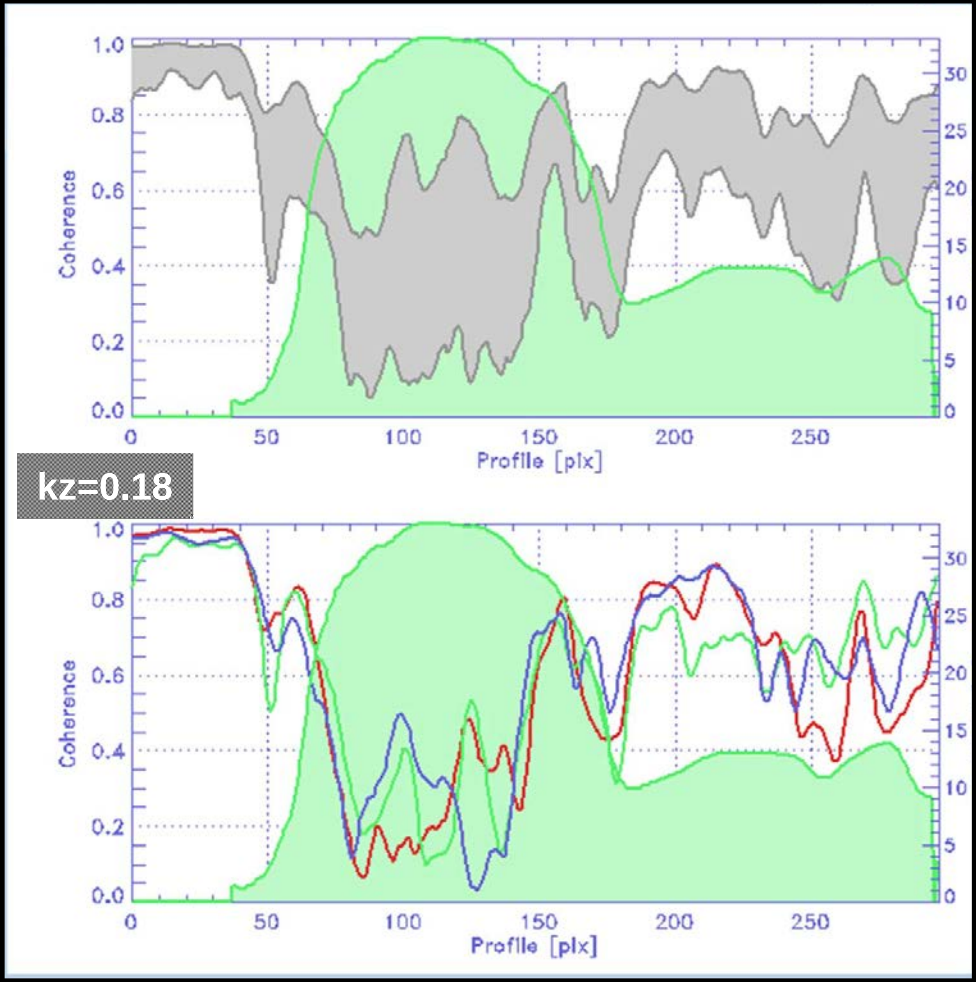
**Lidar (Interpolated)**

# Traunstein 2012 F-SAR Campaign: X-

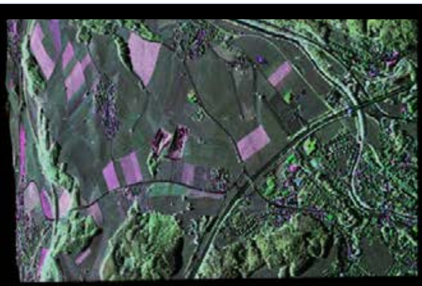


# Traunstein 2012 F-SAR Campaign: X-band PolInSAR




Polarimetric



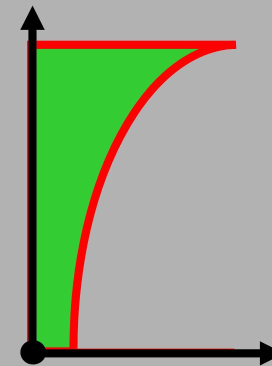
# Traunstein 2012 F-

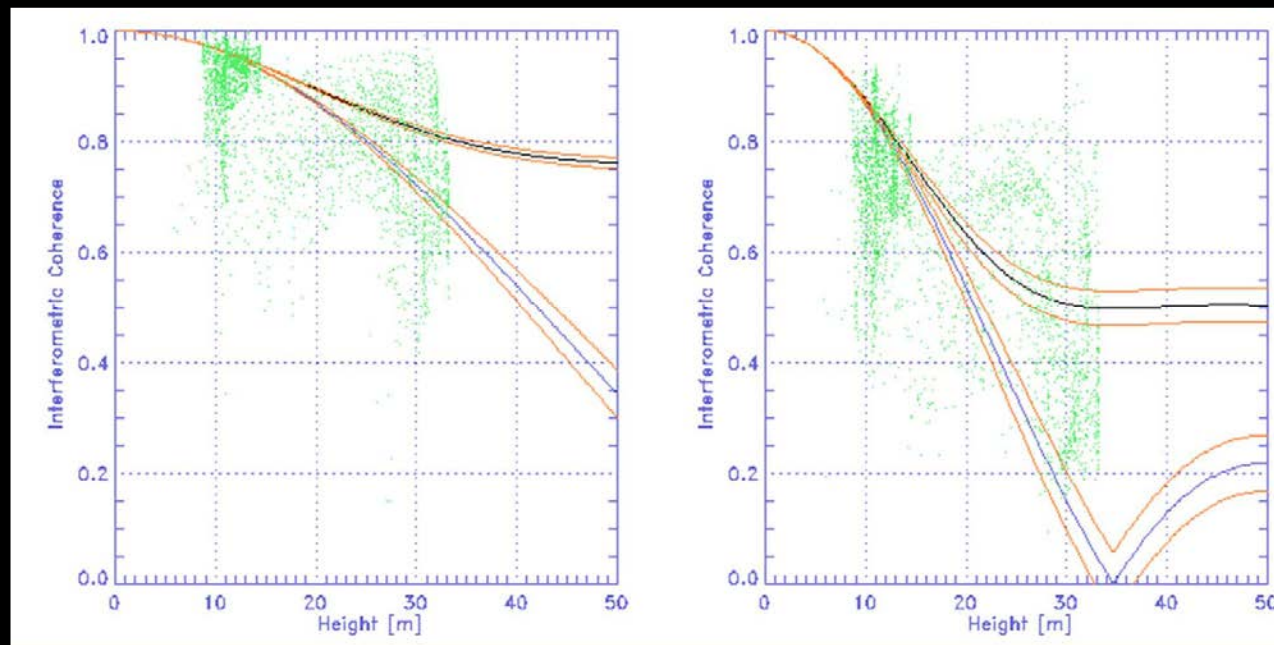
Polarimetric RGB (HH HV VV)

**InSAR Volume Coherence**

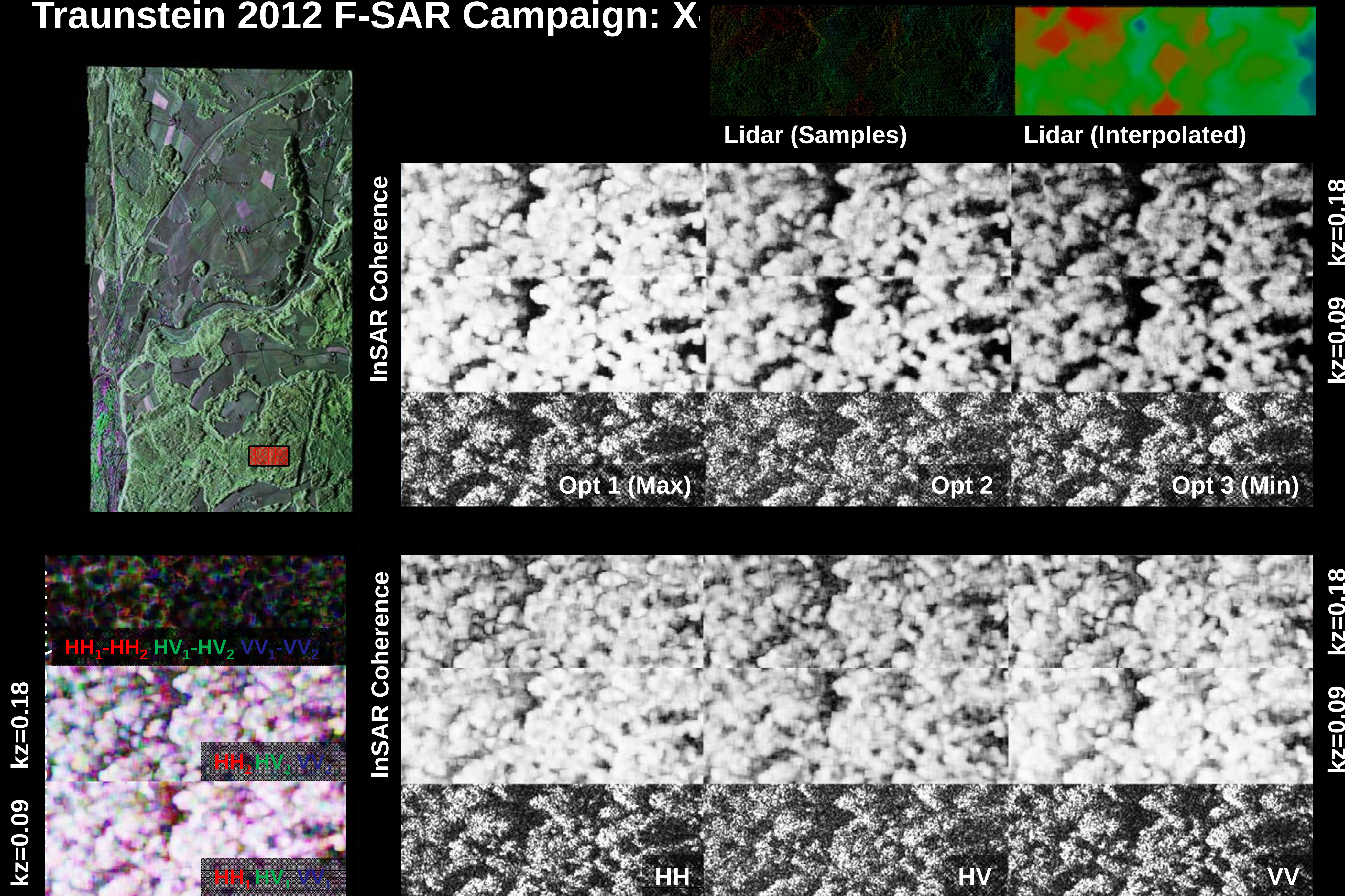
**(exp volume profile)**

$$\tilde{\gamma}(m=0)=\exp(i\phi_0)\frac{\int_0^{h_V}\exp(i\kappa_z z')\exp\left(\frac{2\ \sigma\ z'}{\cos\theta_0}\right)dz'}{\int_0^{h_V}\exp\left(\frac{2\ \sigma\ z'}{\cos\theta_0}\right)dz'}$$

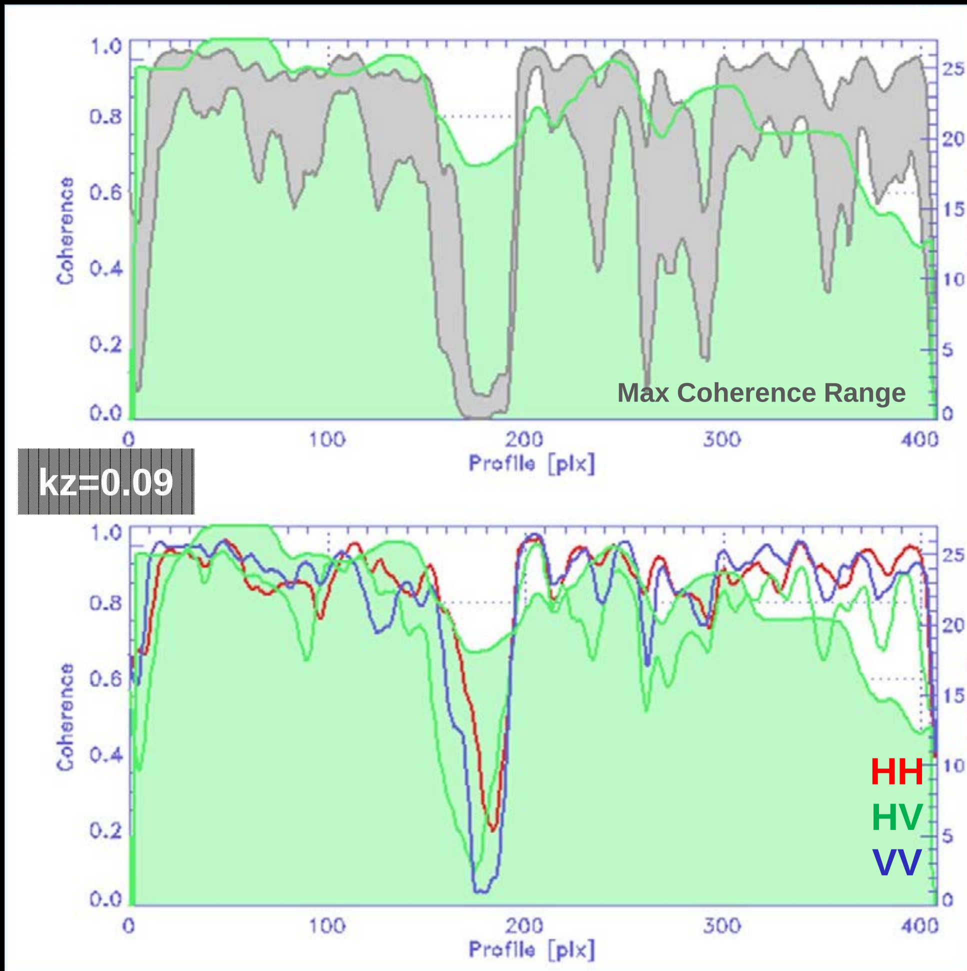


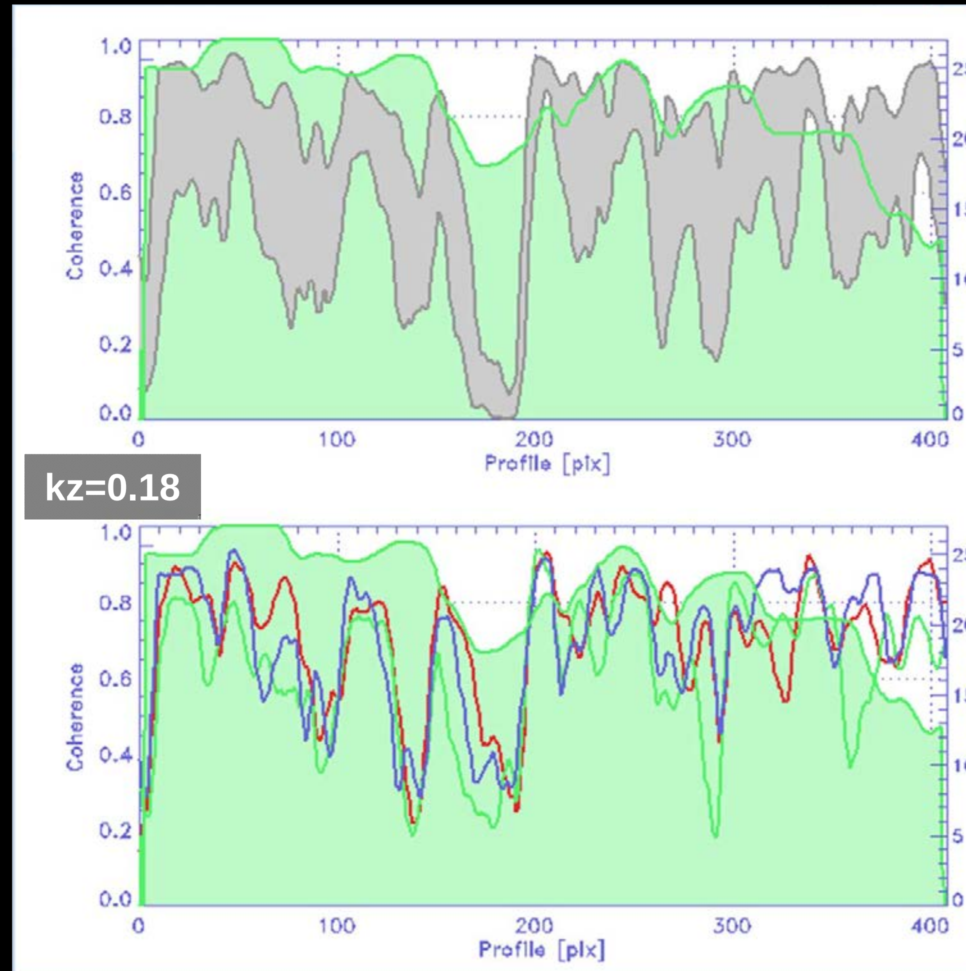


# Traunstein 2012 F-SAR Campaign: X

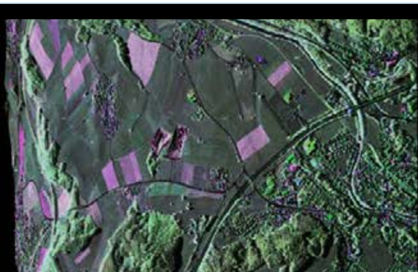


# Traunstein 2012 F-SAR Campaign: X-band PolInSAR




Polarimetric



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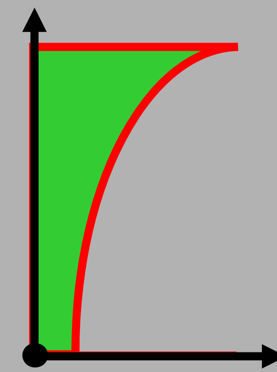

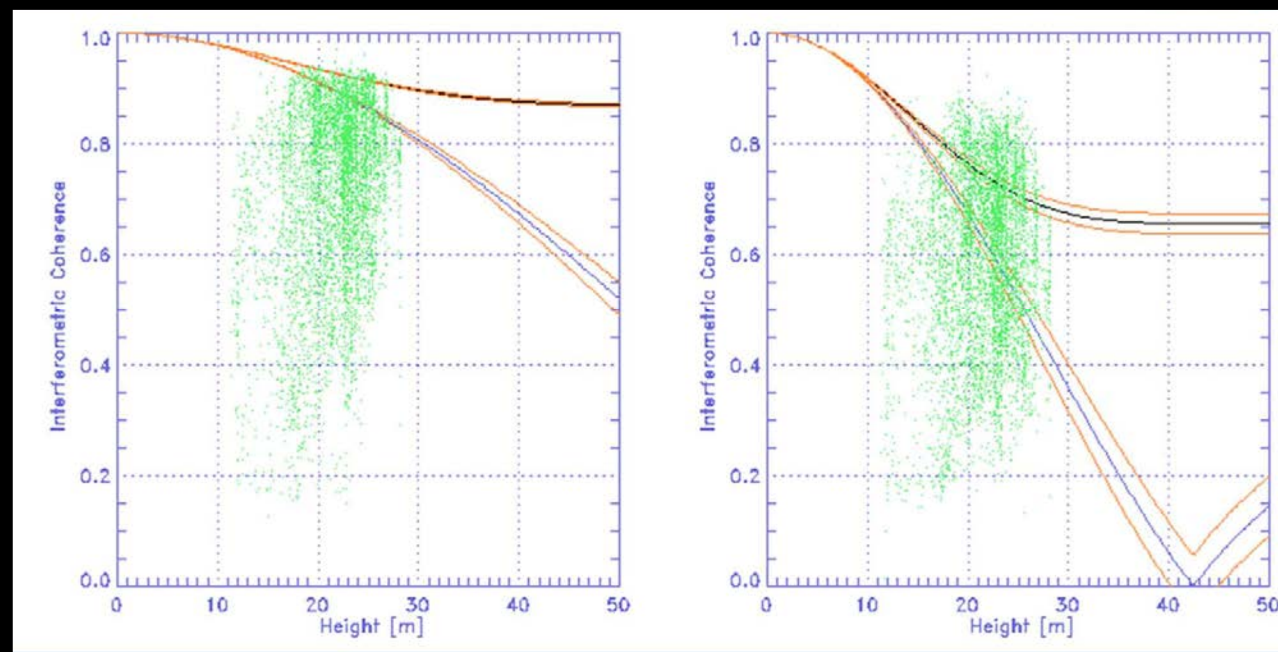

# Conclusions

- Volume decorrelation at X-band is a fact.
- RVoG seems to be able to describe a fraction of the data:

  $\Longrightarrow$ explains the performance of RVoG inversion results in the literature
- There is fraction of the data that is not covered by the model:

  $\Longrightarrow$ a polarised low entropy scattering component may interpret many observations.
- The interpretation of the interferometric coherence over forest depends strongly on the spatial resolution of the interferogram:

  $\Longrightarrow$ number of scatterers in the resolution cell, forest gaps, shadow, …
- Fully polarimetric single pass XTI provides the ability to analyse volume decorrelation at X-Band