Spatial statistics of TanDEM-X images provided by a wavelet frame for the characterization of forest horizontal structure

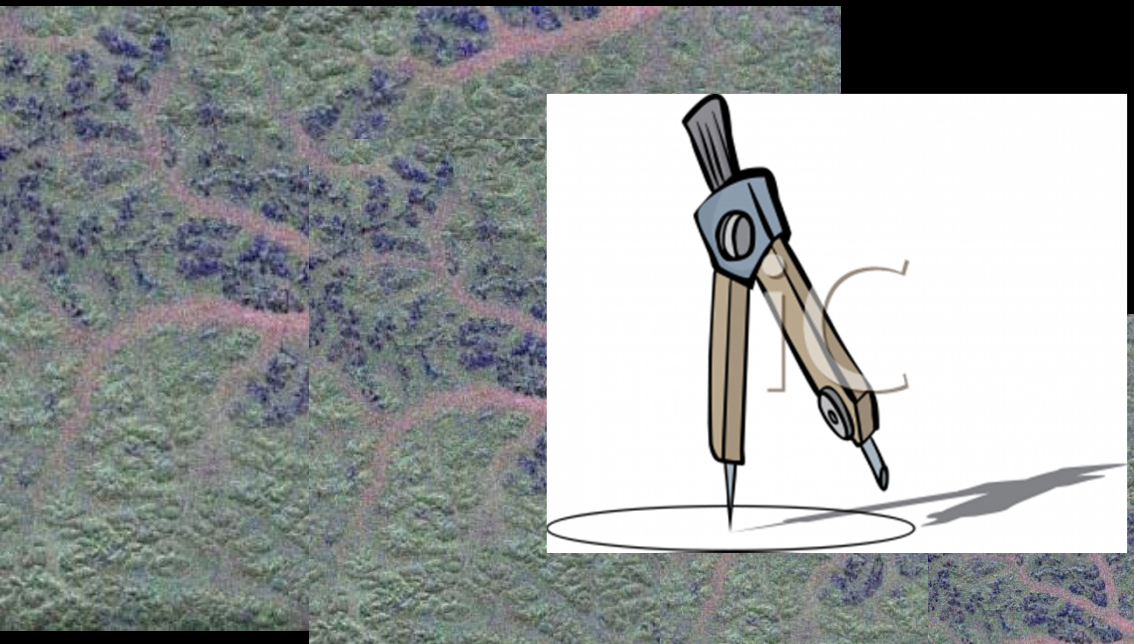
DLR TanDEM-X AO-2010 Project XTI_VEGE0330

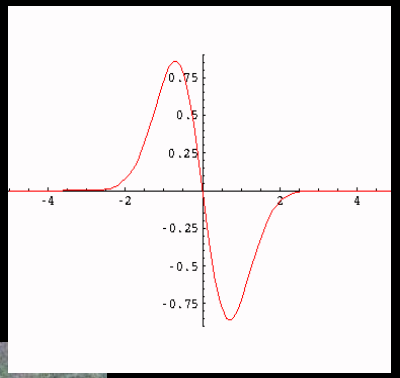
G. F. De Grandi[1,2], E.C. De Grandi[1], P.Pasquali[3]

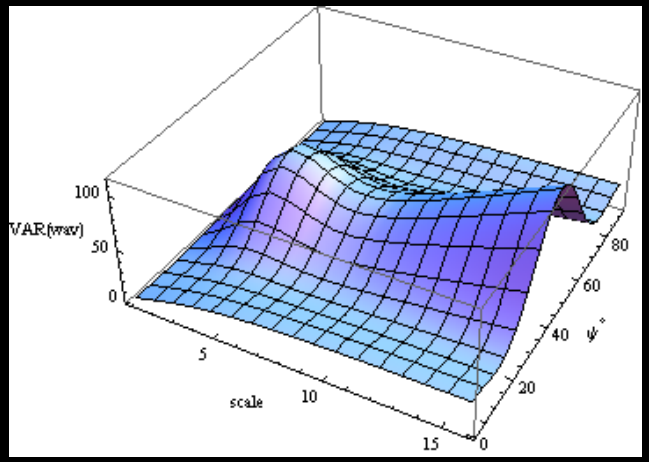
Institute of Geography and Earth Sciences
Aberystwyth University, Aberystwyth, UK,
SY23 3DB.
e-mail: frank.degrandi@gmail.com

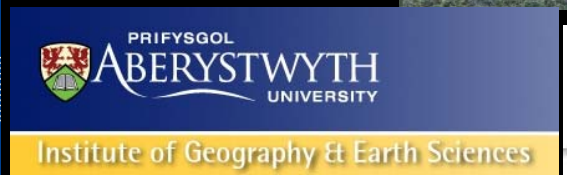
European Commission DG JRC
21027, Ispra (VA), Italy
e-mail: frank.degrandi@gmail.com

Sarmap, SA
Cascine di Barico, Purasca,
Switzerland.
e-mail: ppasquali@sarmap.ch









PROBLEM STATEMENT

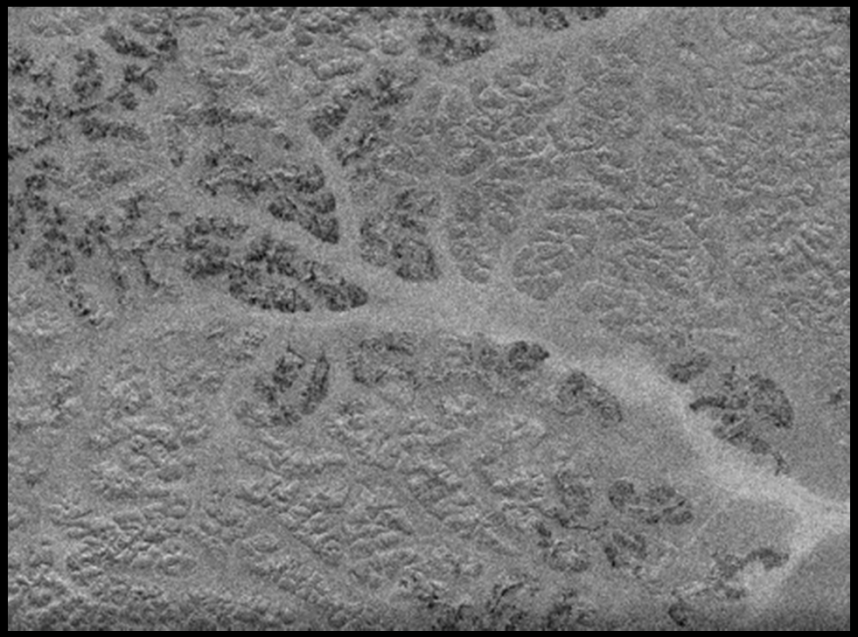
Spatial Random Fields SRF

Dual-pol backscatter

InSAR coherence

Digital surface models

SRFs depend on forest geometric (horizontal and vertical structure functions) and dielectric properties



SRF SPATIAL STATISTICS

How well do these statistical features characterize the forest spatial distribution?

Caveat: these features are not measures of the forest geometry (e.g. crown width, tree density)

STATISTICAL MEASURES AND TOOLS

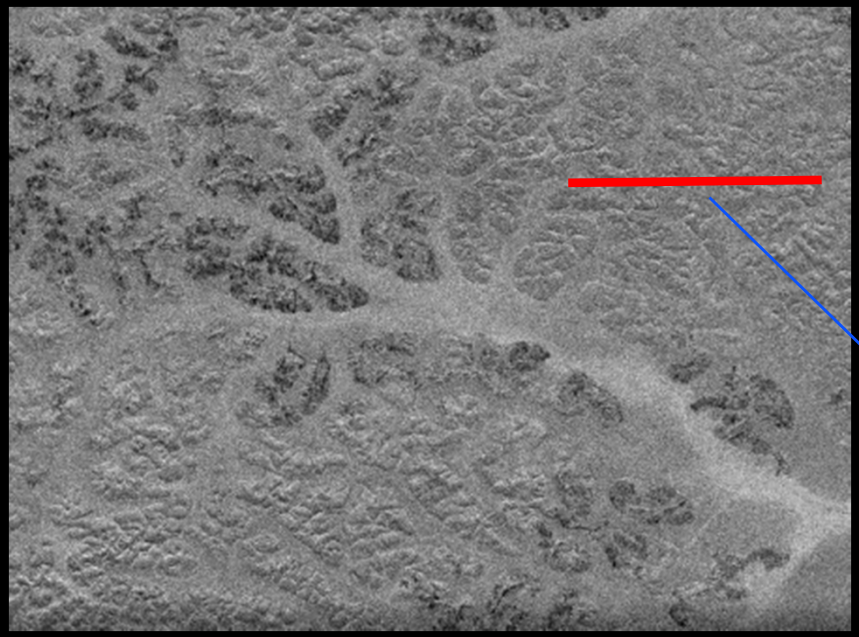
Two-point statistic: Structure Function of order 2

Two-point statistic provided by wavelet coefficients

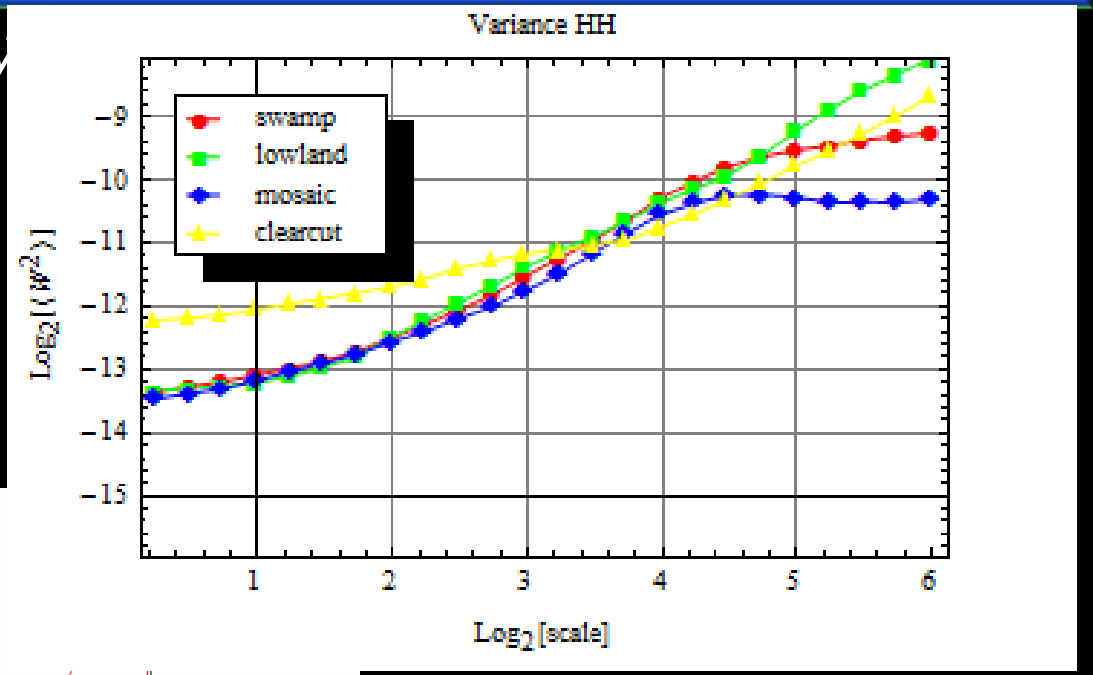
WASS Wavelet Scaling Signature

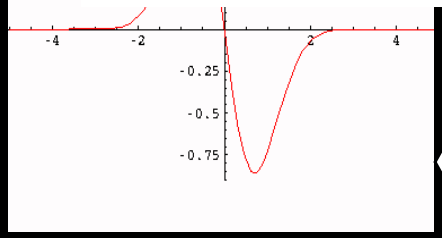
$$\left\langle \left(f(x)-f(x+\tau)\right)^2 \right\rangle \approx \left\langle w$$

Slant range dual-pol power and coherence data (mono bi-static)



Spatial random field





Multivoice wavelet frame transform

Wavelet Variance as a function of scale

STATISTICAL MEASURES AND TOOLS

More wavelet statistics…..

$$\left\langle W_s^2(x) \right\rangle = f(s)$$

➡ **Autocorrelation**
Non-stationarity

Wavelet variance

$$\frac{\left\langle W_s^4(x) \right\rangle}{\left\langle W_s^2(x) \right\rangle^2} = f(s)$$

➡ **Intermittency**
Flatness of PDF tails

Wavelet normalized fourth moment (kurtosis): flatness factor

$$\left\langle Wx_s(x) \times Wy_s(x) \right\rangle = f(s)$$

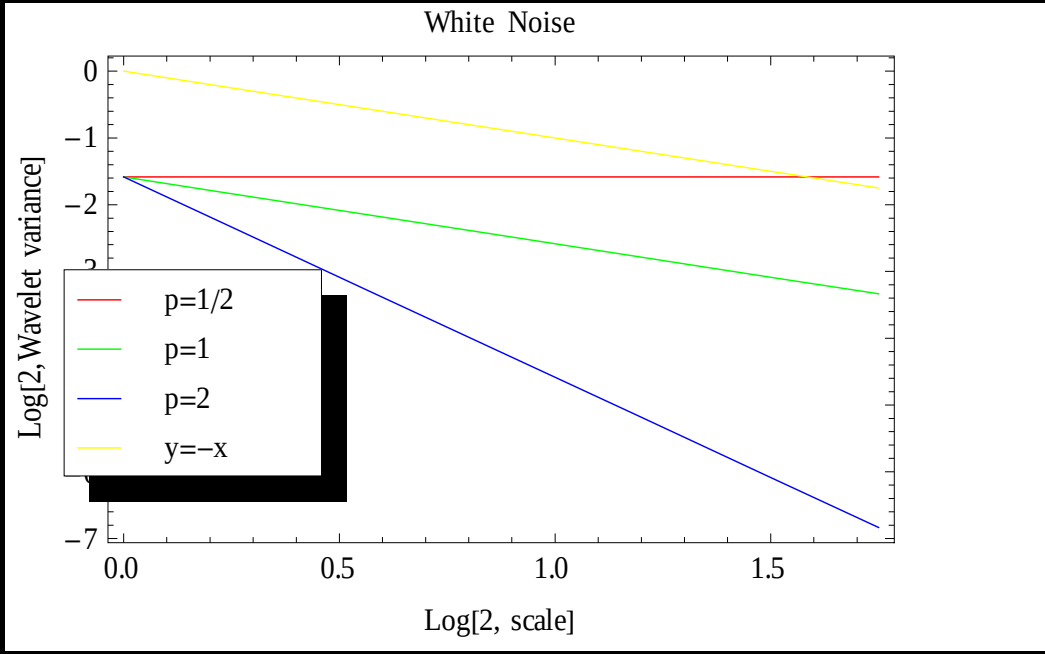
➡ **Crosscorrelation**

Wavelet Cross-covariance

Wavelet variance scaling for random fields: examples

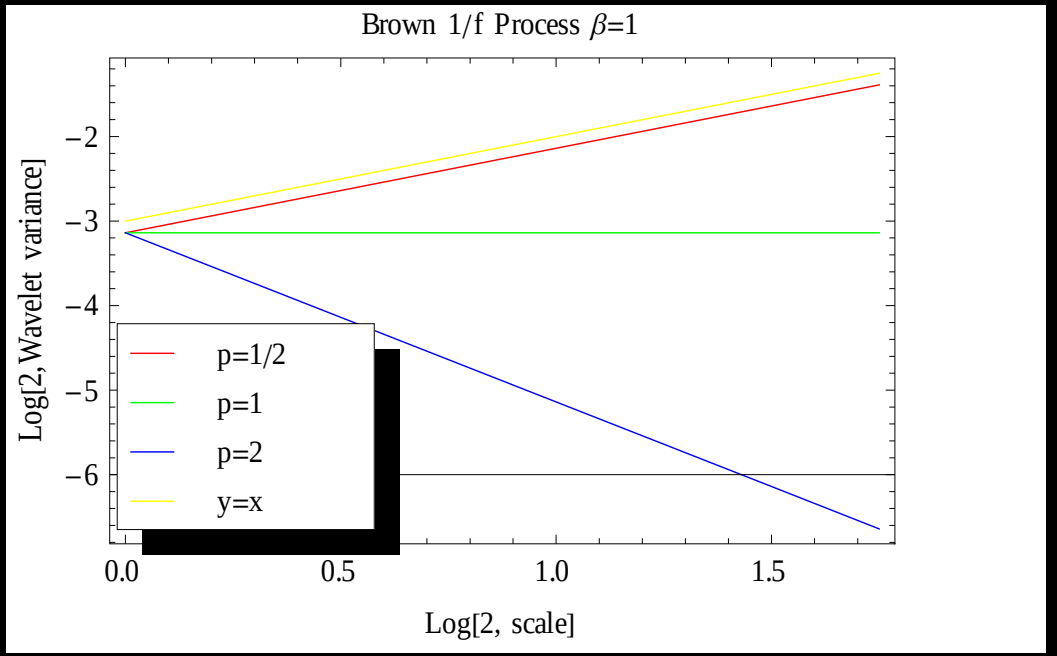
White noise

$$G(\omega) = const \quad \Re(x) = \delta$$



Non-stationary Brown 1/f

$$G(\omega) = \frac{\sigma^2}{|\omega|^{\beta}}$$

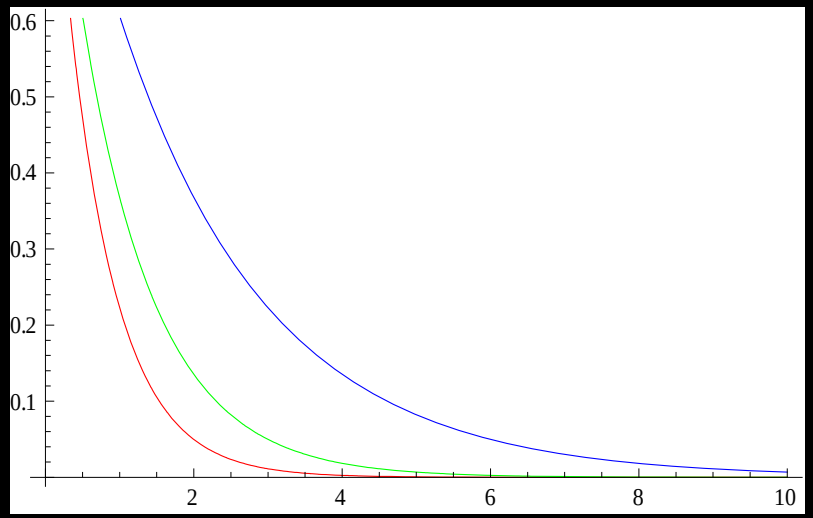


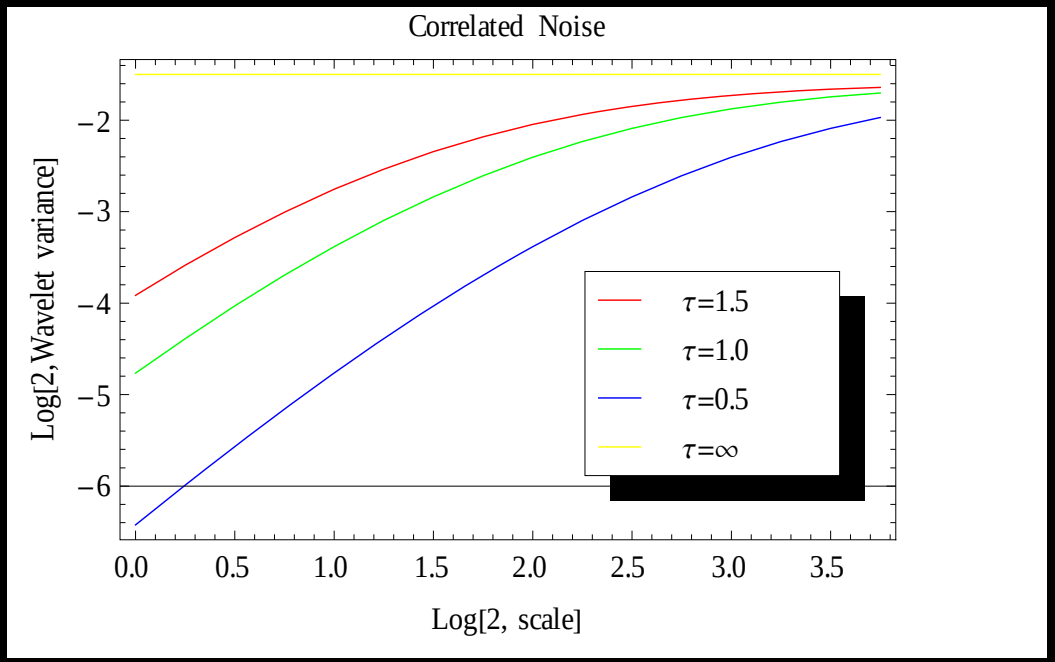
Wavelet variance scaling for random fields: examples

Correlated Noise

$$\Re(x) = \frac{\pi K \beta}{2} e^{-\beta x}$$

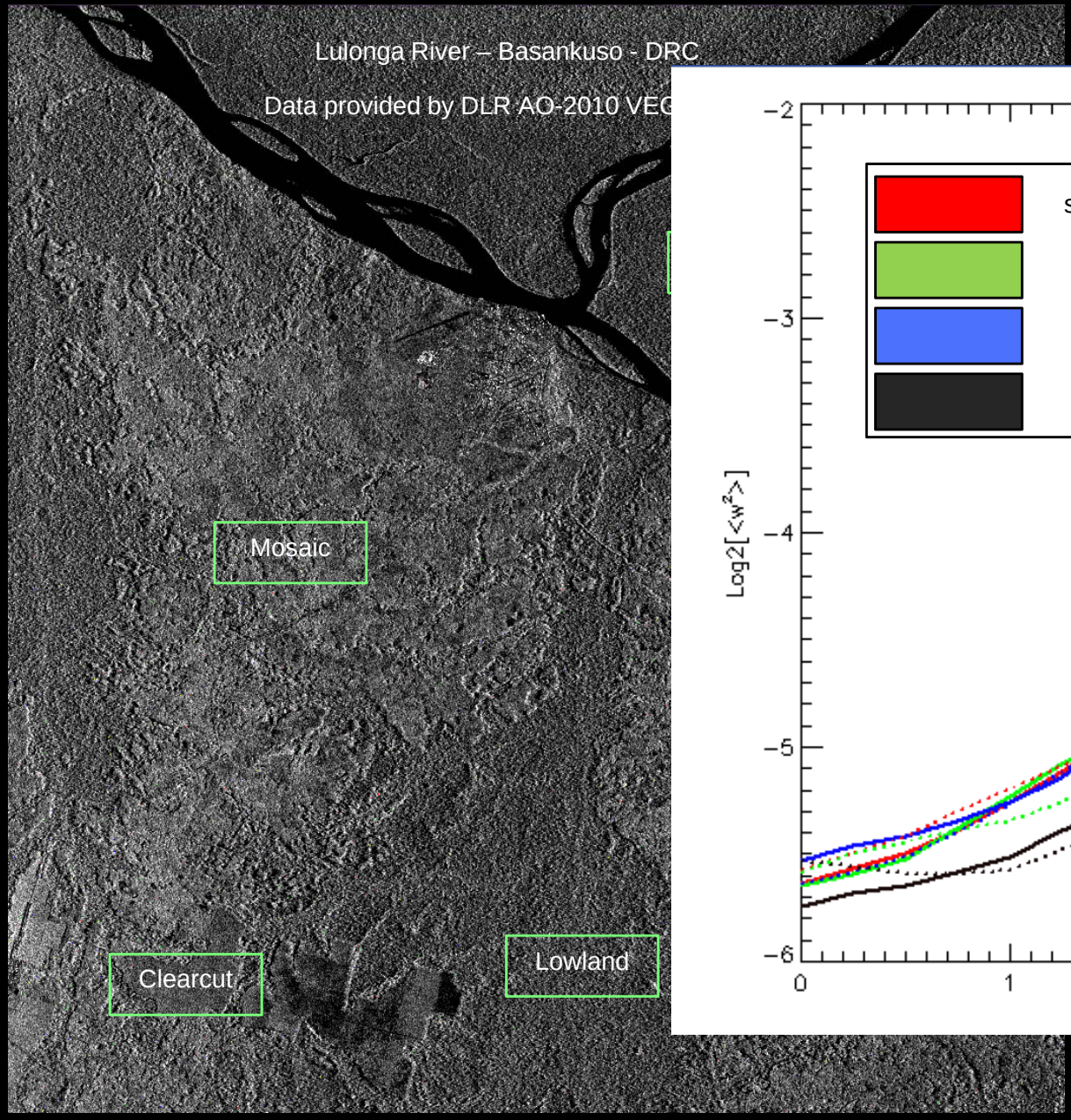
$$G(\omega) = \frac{K\beta^2}{\beta^2 + \omega^2}$$

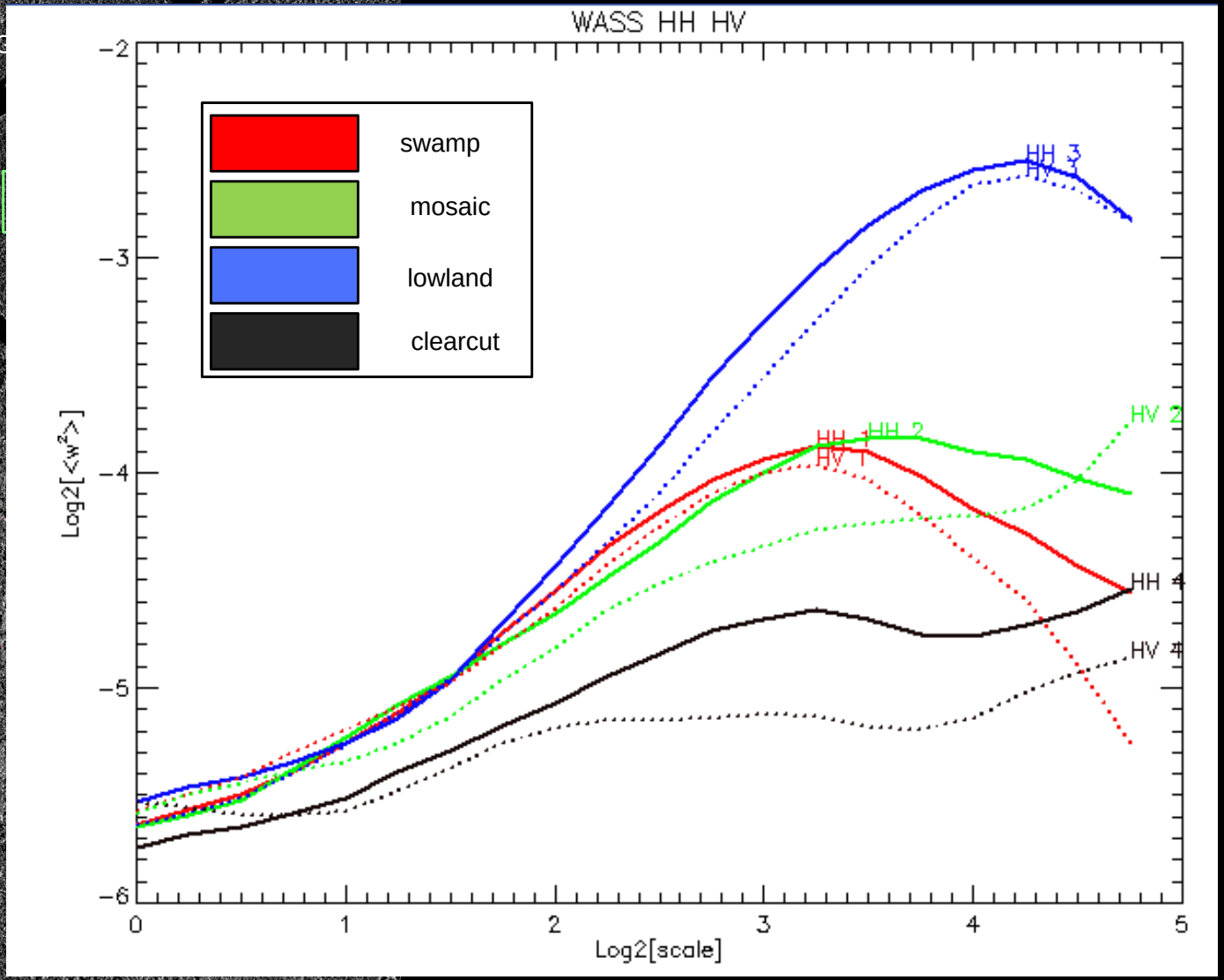




TanDEM-X HH-HV Backscatter

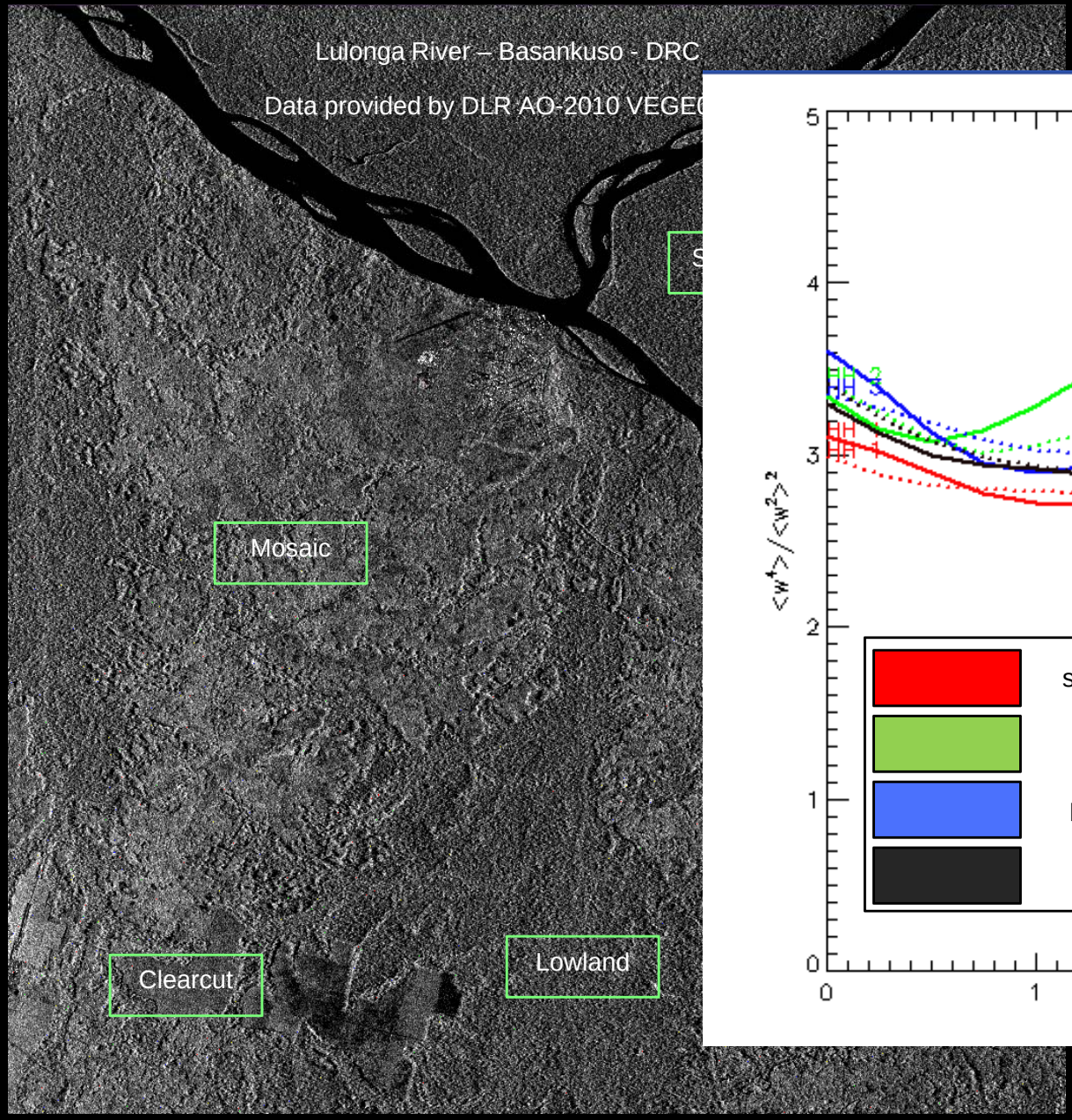
Wavelet Variance WASS

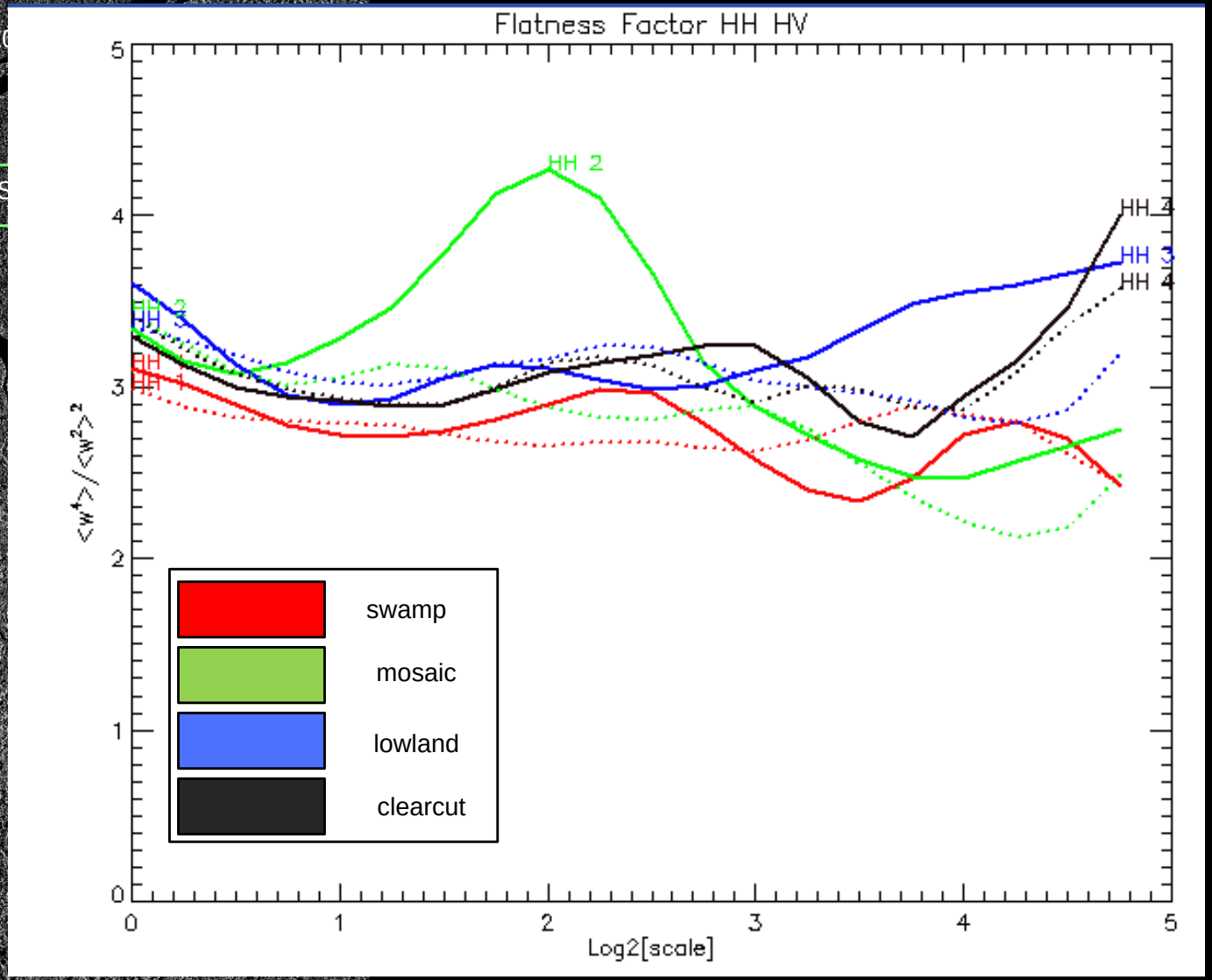




TanDEN-X HH-HV Backscatter

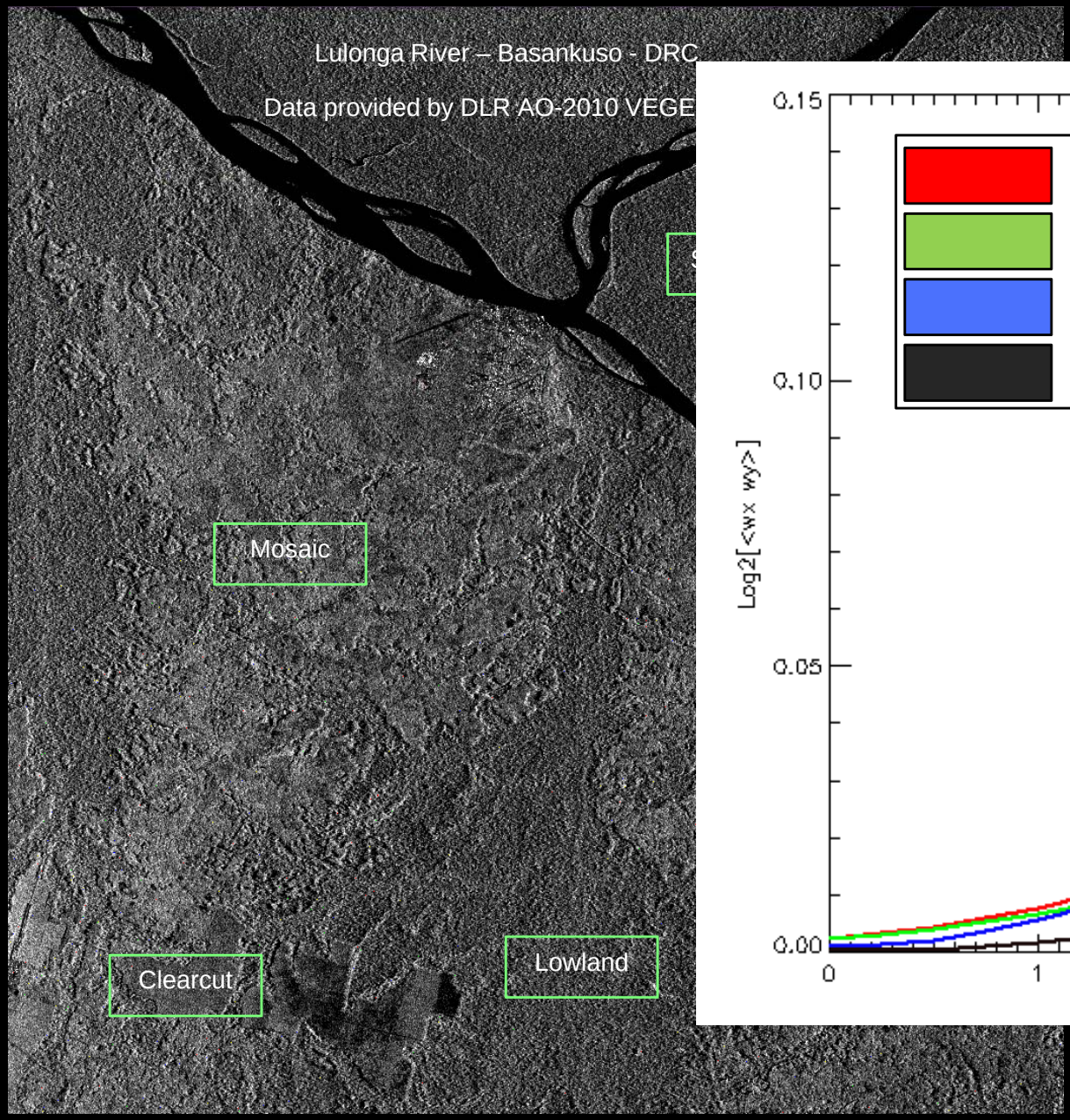
Wavelet Flatness Factor

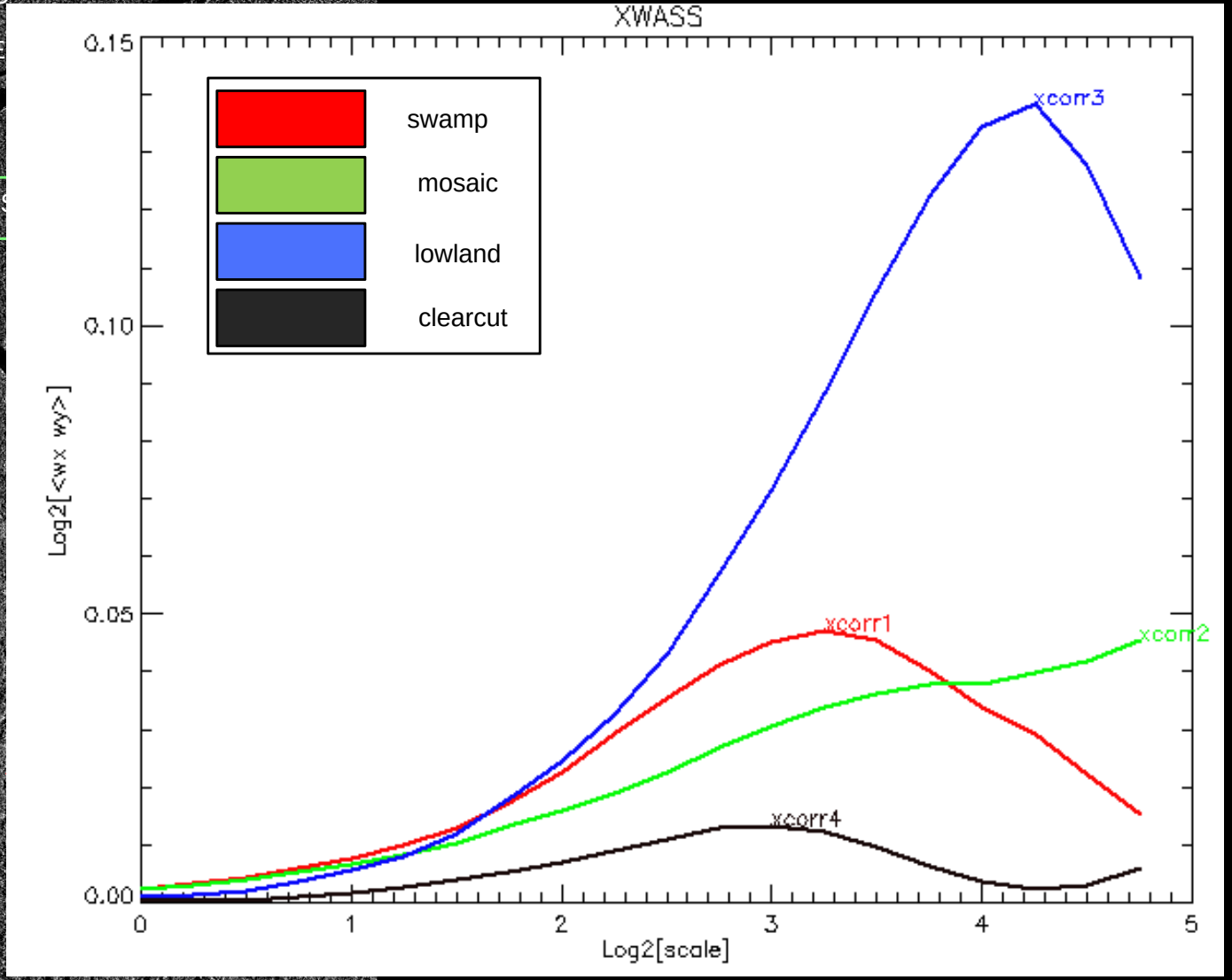




TanDEM-X HH-HV Backscatter

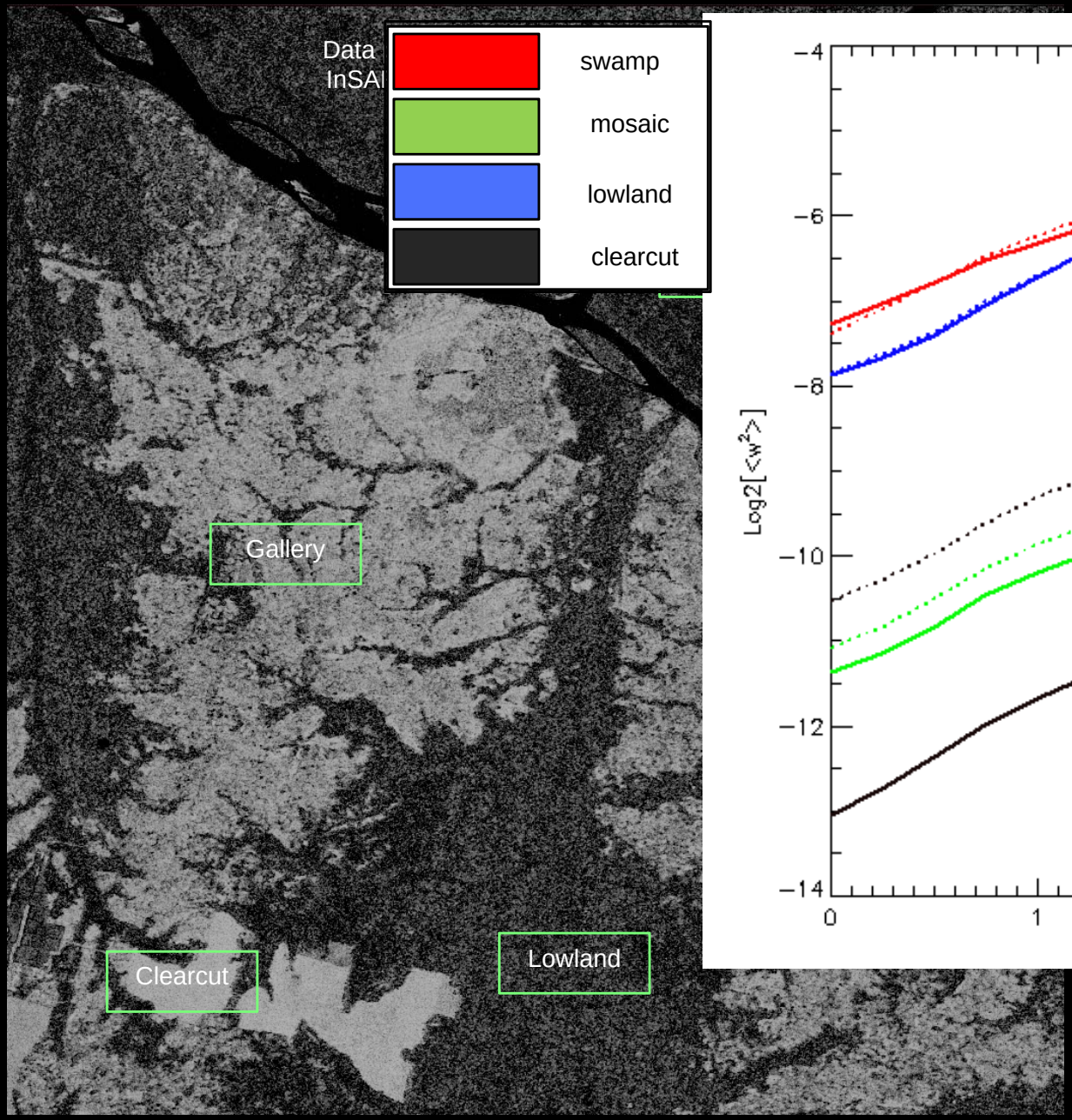
Wavelet Cross-covariance HH HV

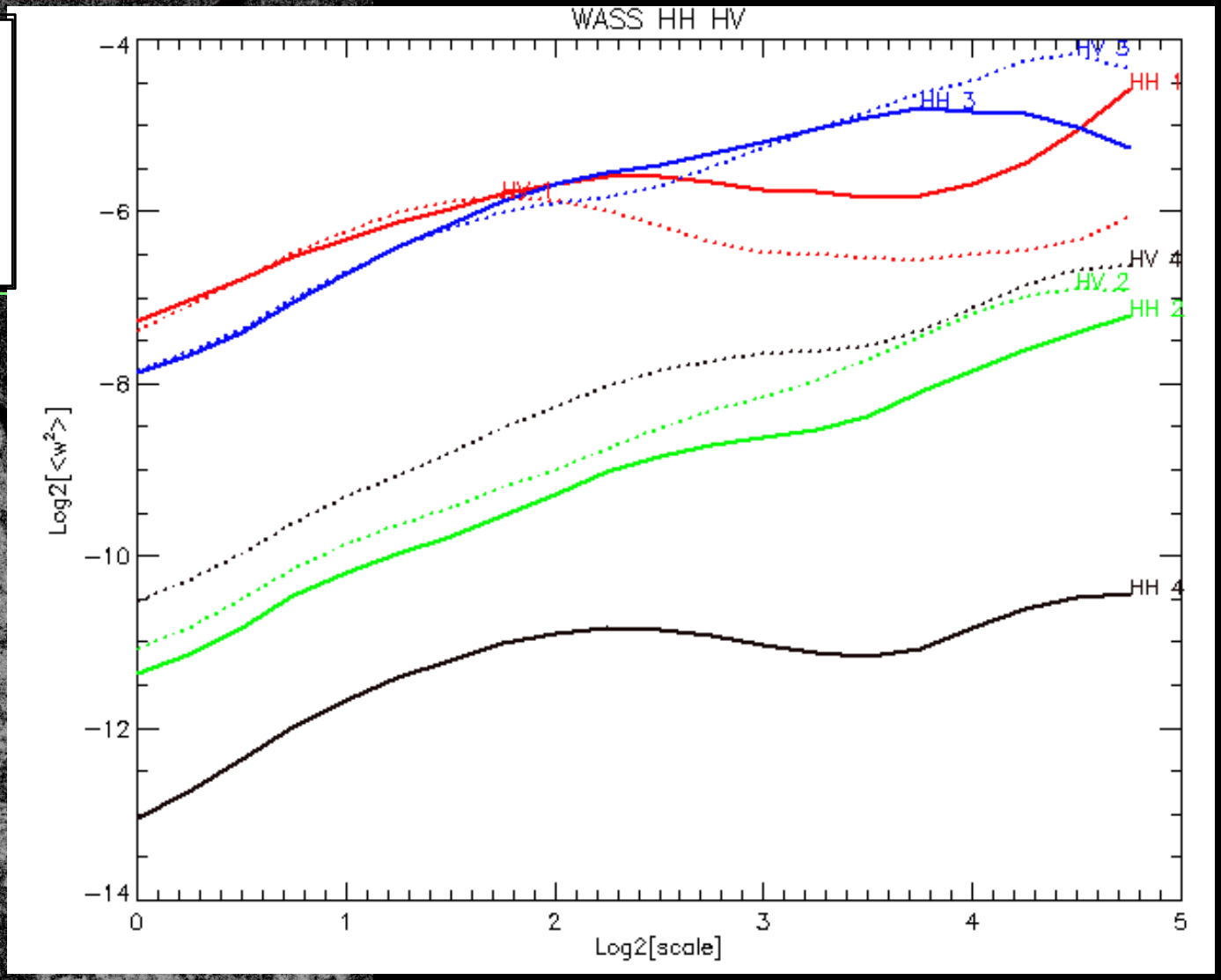




TanDEM-X HH-HV Coherence

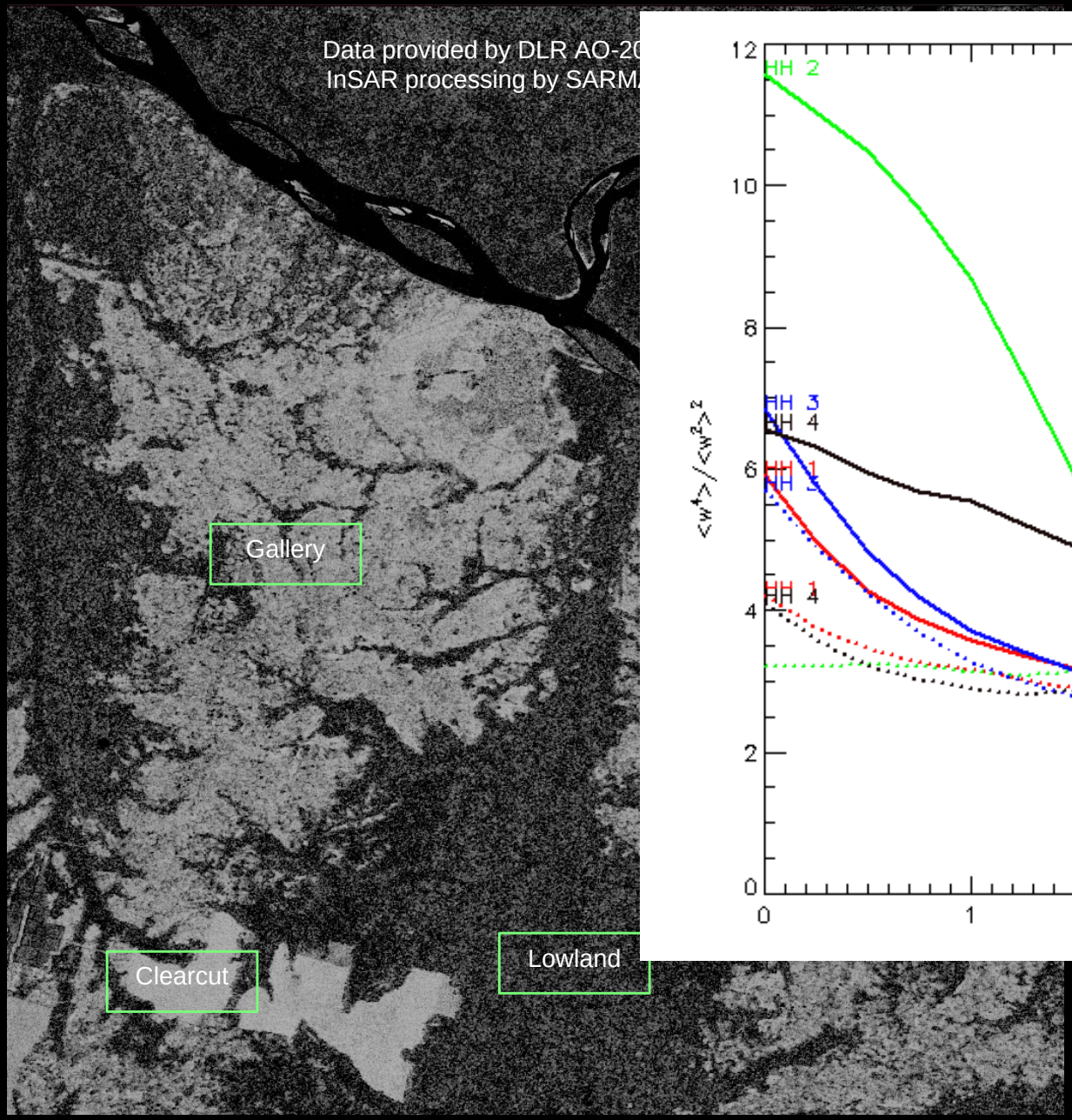
Wavelet Variance WASS

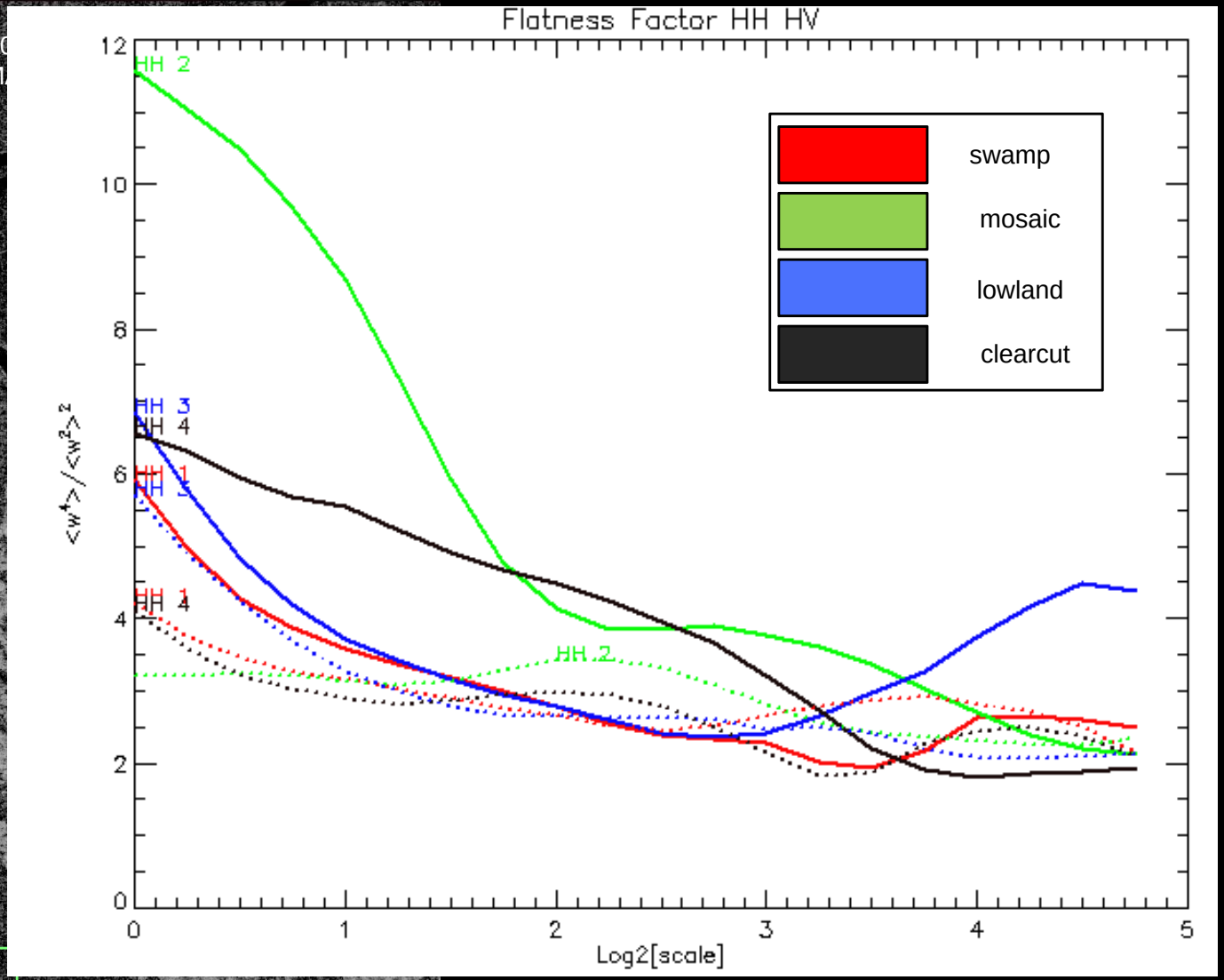




TanDEM-X HH-HV Coherence

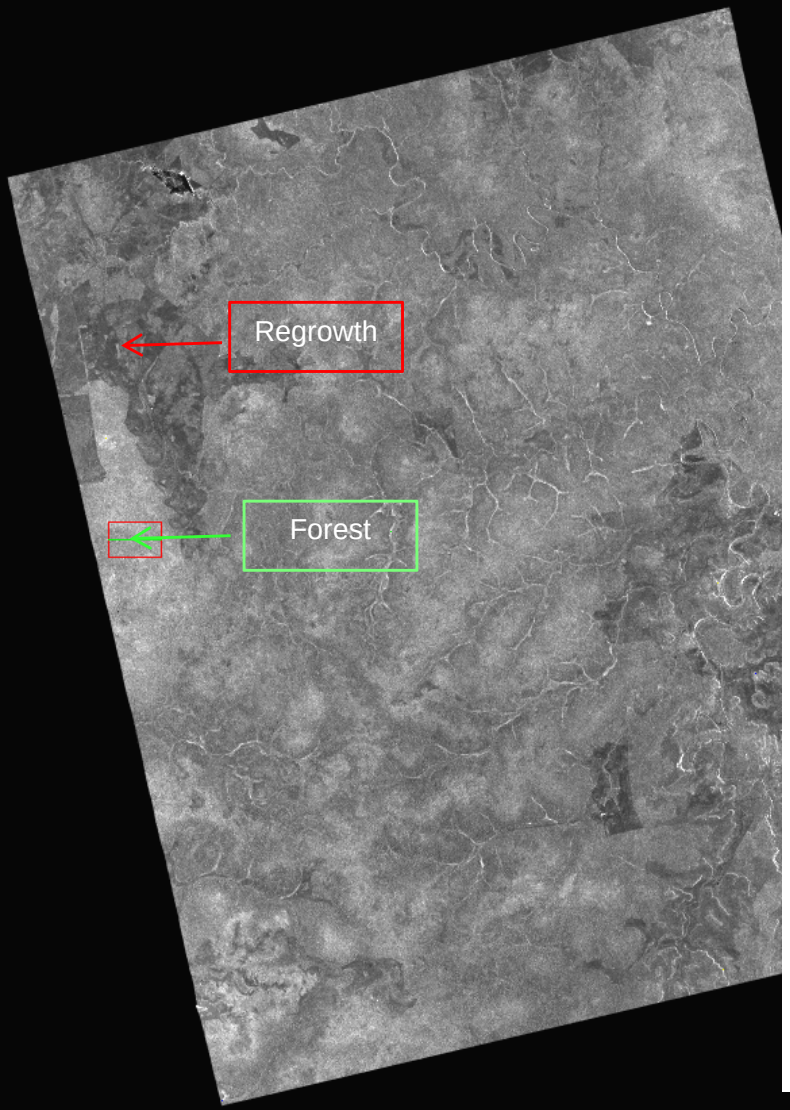
Wavelet Flatness Factor

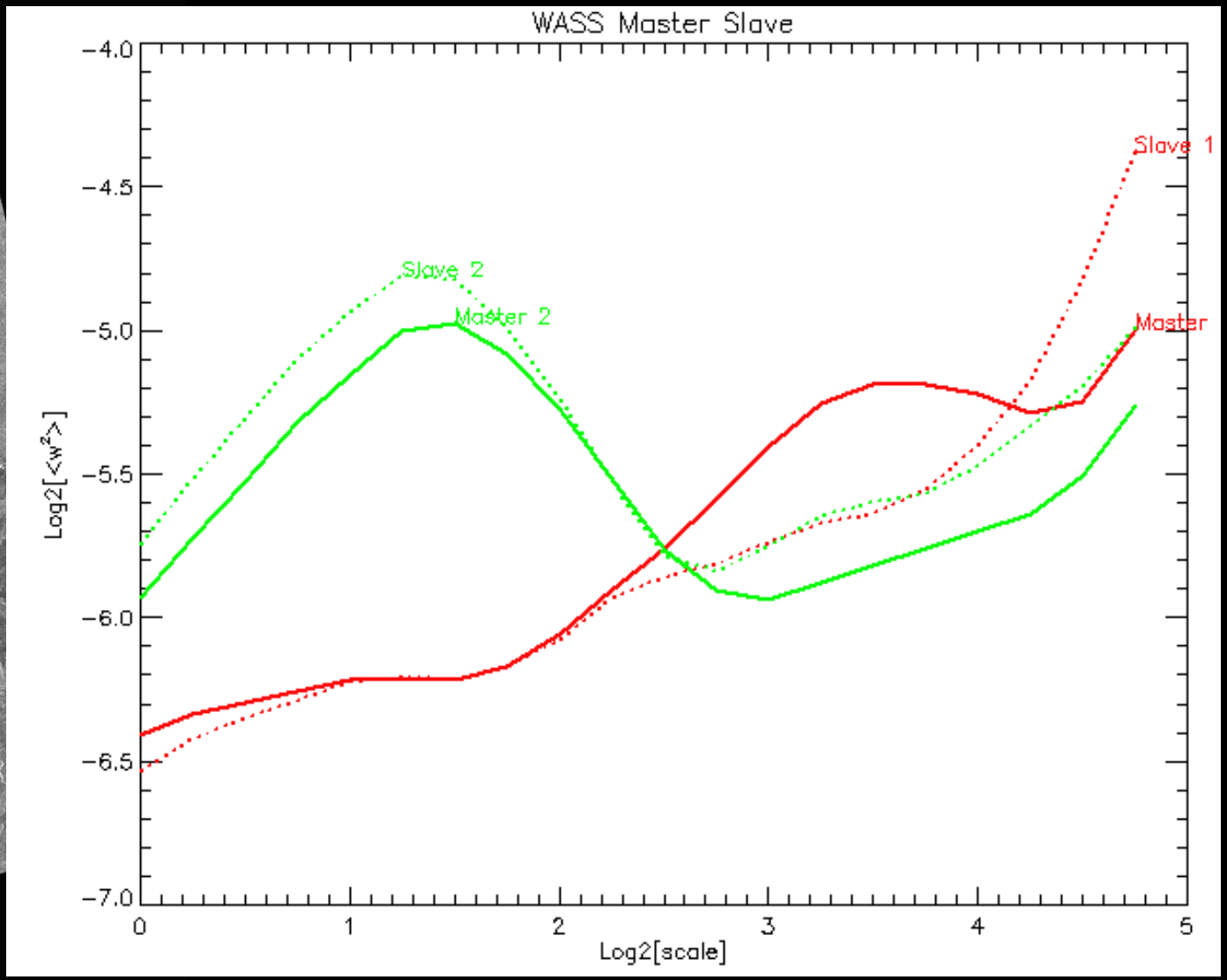




TanDEM-X Bistatic Scattering

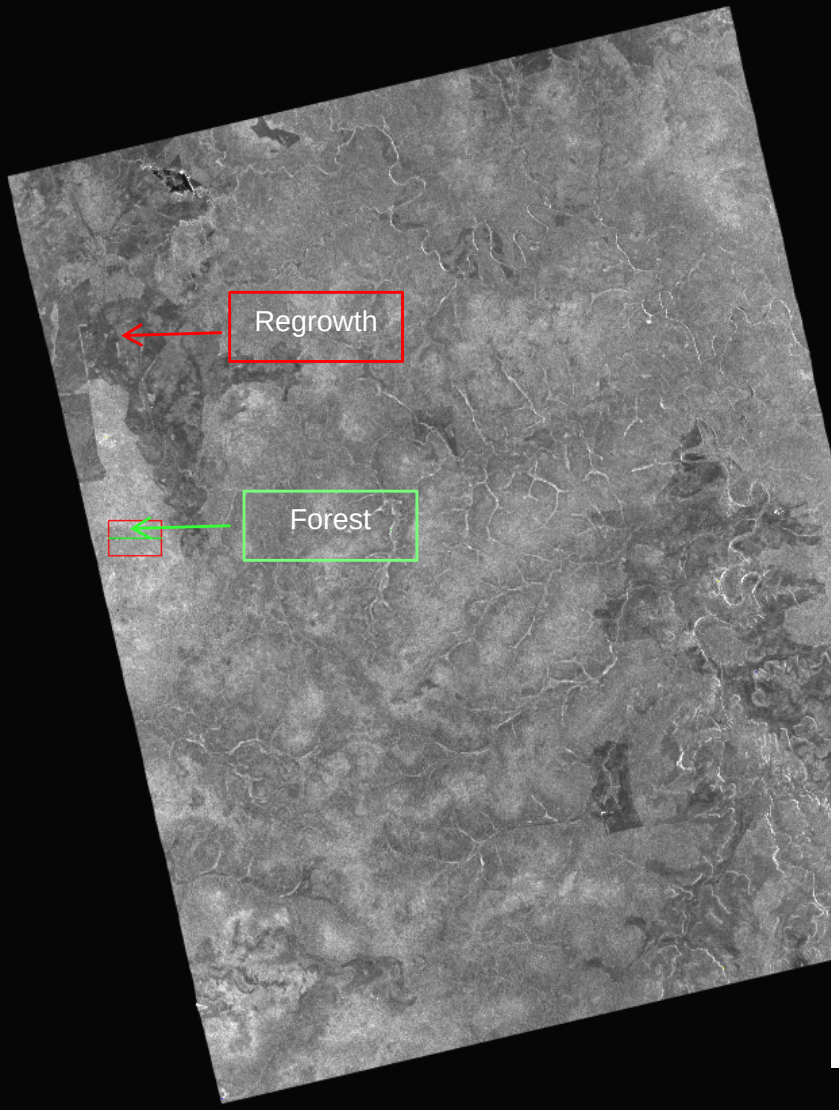
WASS Master Slave

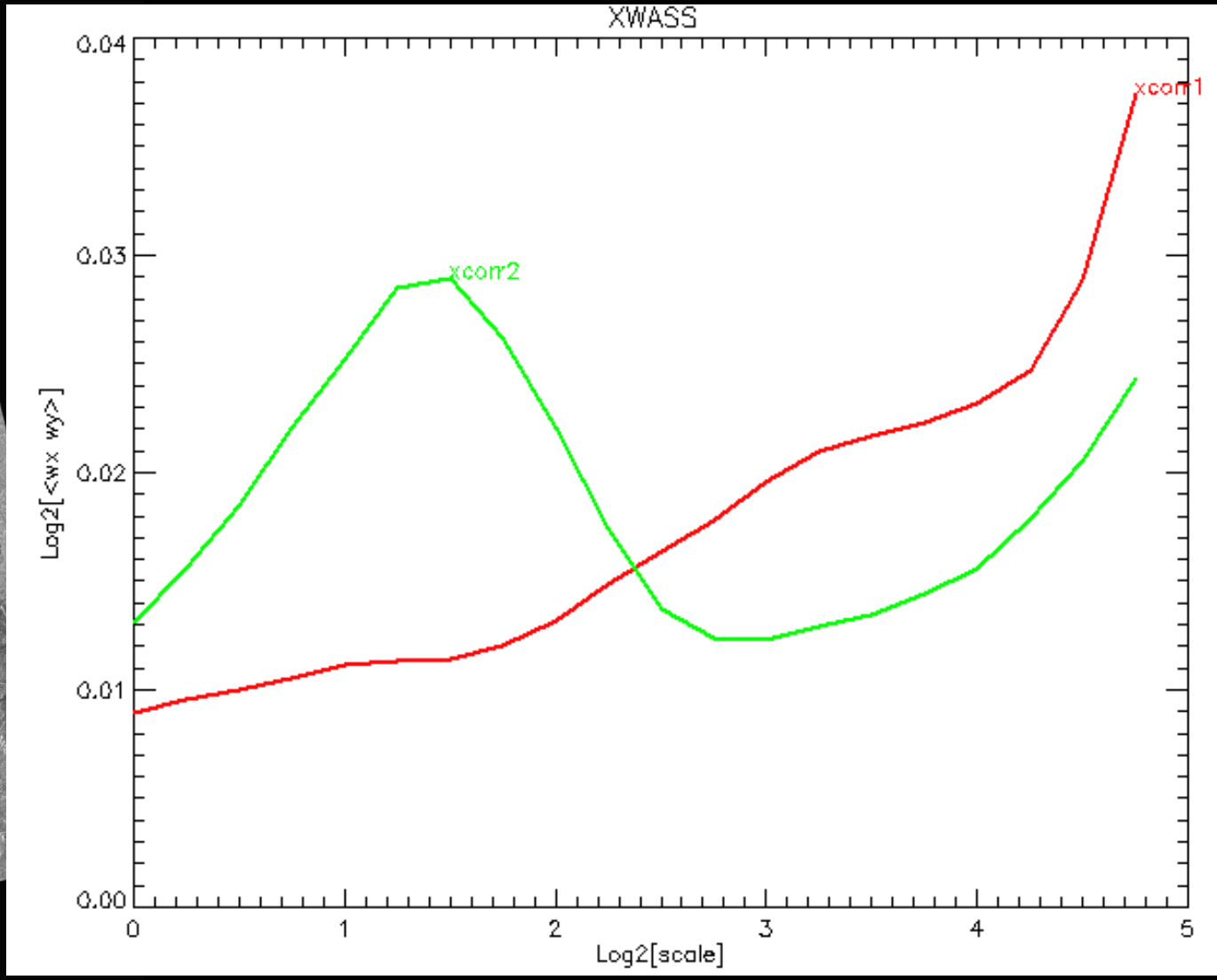




TanDEM-X Bistatic Scattering

Cross-covariance Master Slave





Leb wohl, so long to all TanDEM-Xers Frank

REMARKS