A suite of time-series and single set InSAR coherence and backscatter speckle filters

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The filters work in a time-space-scale domain afforded by a wavelet representation. A wavelet soft-thresholding technique provides, for each dataset, local estimates of the backscatter or the coherence $|\gamma|$ mean value. Wavelet thresholding is equivalent to local signal averaging with a kernel that adapts to the signal regularity in the neighborhood of each sample. Wavelet thresholds are computed adaptively based on a noise model (speckle or coherence) whose parameters are estimated automatically. Therefore, no processing parameters need to be set by the user.

The method is described in detail in chapters 8 and 9 of:

De Grandi G. and De Grandi EC., "Spatial Analysis for Radar Remote Sensing of the Tropical Forests", CRC Press, 2021, ISBN: 978-0-367-25940-2

Related literature:

F. De Grandi, J.S. Lee, M. Simard, and H. Wakabayashi, "*Speckle filtering, segmentation and classification of polarimetric SAR data: a unified approach based on the wavelet transform*", *Proceedings, IGARSS 2000*, Honolulu, HI, USA, paper TU08_05.

F. De Grandi, J.S. Lee, P. Siqueira, A. Baraldi, and M. Simard, "*Segmentation and labeling of polarimetric SAR data: Can wavelets help?*", *Proceedings IGARSS 2001*, Sydney, Australia, paper TU10_01.

S. Mallat, *A Wavelet Tour of Signal Processing*, 2nd ed., San Diego, CA: Academic Press, pp. 163–219, 1999.

S. Mallat, and S. Zhong, "*Characterization of signals from multiscale edges*", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 14, no. 7, pp. 710–732, 1992.

D.L. Donoho, "De-noising by soft-thresholding", *IEEE Transactions on Information Theory*, vol. 41, no. 3, 613–627, May 1995.

M. Simard, G. De Grandi, K.P.B. Thomson, and G.B. Benie, "Analysis of speckle noise contribution on wavelet decomposition of SAR images", *IEEE Transactions on Geoscience and Remote Sensing*, vol. 36, no. 6, pp. 1953–1962

G.F. De Grandi, M. Leysen, J.S. Lee, and D. Schuler, "*Radar reflectivity estimation using multiple SAR scenes of the same target: techniques and applications*", *Proceedings IEEE IGARSS'97*, August 3–8, 1997, Singapore, pp. 1044, November 1998.

R. Touzi, A. Lopez, J. Bruniquel, and P.W. Vachon, "Coherence estimation for SAR imagery", *IEEE Transactions on Geoscience and Remote Sensing*, vol. 37, no. 1, January 1999.
2. S.R. Cloude, "*Polarisation, Applications in Remote Sensing*, Oxford, UK: Oxford University Press, 2010.

R. Touzi, and A. Lopes, “Statistics of the Stokes parameters and of the complex coherence parameters in one-look and multilook speckle field”, *IEEE Transactions on Geoscience and Remote Sensing*, vol. 34, pp. 519–532, March 1996.

J-S. Lee, S.R. Cloude, K.P. Papathanassious, M.R. Grunes, and I.H. Woodhouse, “Speckle filtering and coherence estimation of polarimetric SAR interferometry data for forest applications”, *IEEE Transactions on Geoscience and Remote Sensing*, vol. 41, no. 10, 2254–2263, October 2003.

Input data sets requirements

Backscatter

The filters accept as input ground range detected backscatter intensity data sets (e.g. ENVISAT PRI, Sentinel-1 GRD Level1). Single look sets assure the best performance in terms of spatial resolution.

Coherence

Filtered (e.g. Goldstein) coherence from the flattened interferogram.

User processing parameters requirements:

None.