The problem of SNR in PolInSAR observations with TanDEM-X over rice fields

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A number of satellite single-pass interferometric data acquired by TanDEM-X in bistatic mode during 2011 and 2012 are available for this study. They correspond to pairs of dual-pol HHVV images obtained with an average incidence angle around 39 degrees over an area with rice fields in the SW of Spain. This test site has been used recently to perform some studies about the retrieval of phenology of rice by exploiting radar polarimetry at X-band [1,2], hence there is a previous knowledge of the scene properties when observed with TerraSAR-X. A campaign of ground measurements was carried out simultaneously, providing information for some specific parcels about crop phenology, vegetation height, plantation density, etc. The acquisitions in 2011 cover the whole cultivation campaign with an almost constant sampling rate of 11 days (there is only one missing acquisition in the series). Despite the excellent temporal coverage and sampling for monitoring purposes, the available baselines are too small for any potential interferometric study aimed at separating phase centres of different polarisations within the vegetation volume. For the maximum vegetation height, up to 1 m in the second half of the season, the required baseline would be much larger (above 2 km), as pointed out in [3]. For instance, a 50 m baseline entails a height of ambiguity around 270 m, so a vertical separation of 1 m would produce a phase difference just above 1 degree. Therefore, these data are expected to show an extreme lack of sensitivity to the rice crop structure due to the short baselines. A second important issue that has to be carefully considered when analysing TanDEM-X data over this scenario is the influence of SNR on the interferometric coherence. This is the object of this work. These acquisitions present an average NESZ of -21 dB, whereas the recorded backscatter ranges from -5 dB down to less than the noise level. As a result, SNR exhibits low values, with many cases below 10 dB during the cultivation cycle. The following well-known expression relates coherence with SNR: gamma = SNR/(1+SNR) (Eq.1) where SNR is expressed in linear scale. Consequently, coherence is affected importantly by SNR in these data. To better illustrate this issue, we have computed the expected coherences due to SNR, according to Eq.1, by using the noise values annotated in the files and the actual backscatter levels at HH and VV channels. Then, we have represented these coherences as a function of the phenological stages (expressed in BBCH scale), together with the actual coherences derived form the data. A clear matching between both evolutions is observed, hence demonstrating a strong influence of SNR on the coherence, which is a limiting factor that should be taken into account in any further interferometric analysis. Note also that the effect of SNR is worse from the PolInSAR viewpoint, since the influence is different for different polarimetric channels, hence distorting the region occupied by the coherences on the complex plane. This effect on the coherences has been illustrated by representing the coherences at different channels for a single date, showing the expected behaviour. References: [1] J. M. Lopez-Sanchez, J. D. Ballester, I. Hajnsek. "First Results of Rice Monitoring Practices in Spain by Means of Time Series of TerraSAR-X Dual-Pol Images", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 4, No. 2, pp. 412-422, June 2011. [2] J. M. Lopez-Sanchez, S. R. Cloude, J. D. Ballester. "Rice Phenology Monitoring by Means of SAR Polarimetry at X-Band", IEEE Trans. on Geoscience and Remote Sensing, Vol. 50, No. 7, pp. 2695-2709, July 2012 [3] J. M. Lopez-Sanchez, J. D. Ballester. "Potentials of Polarimetric SAR Interferometry for Agriculture Monitoring", Radio Science, Vol. 44, RS2010, March 2009. DOI:10.1029/2008RS004078