### Pol-InSAR & Tomography

**Chairmen: Carlos Lopez-Martinez and Stefano Tebaldini**

**Tuesday 20/09/2011**

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| 08:40-09:00 | Diff-Tomo Opening of the Urban SAR Pixel: Single-look 4D and Non-uniform Motion “5D” Extensions  
*The availability of multi-baseline and multi-temporal data makes it possible to open the SAR pixel by retrieving height, LOS velocity and LOS acceleration of multiple targets. Spatio-temporal interpolation of the baseline set to a uniform grid is shown to greatly help the imagining and hence estimation performance.* | Fabrizio Lombardini         |
| 09:00-09:20 | Polarimetric SAR Tomography with TerraSAR-X by means of Distributed Compressed Sensing  
*Compressing sensing (CS) is an established technique to provide super-resolution tomographic imaging of sparse targets. Distribute CS exploits further constraints by imposing continuity of the solution for neighboring pixels and/or different polarizations, resulting in improved imaging capabilities.* | Matteo Nannini – presented by Esteban Aguilera |
| 09:20-09:40 | 3D SAR Tomography of the Paracou Forest: Methods and Results  
*This paper provides a tomographic analysis of the Paracou forest in French Guyana based on the P-Band data collected during the TROPISAR campaign. The analysis resulted in 4 independent Single Look Complex Fully Polarimetric SAR images of the forest, each of which associated with a certain height above the ground (0,15,30,45 m). Double bounce scattering from ground-trunk interactions is revealed in the ground layer image.* | Mauro Mariotti D’Alessandro |
| 09:40-10:00 | Underlying Topography Estimation and Separation of Scattering Contributions over Forests Based on PolInSAR Data  
*This paper considers the estimation of ground topography beneath the vegetation layer based on fully polarimetric single baseline data. The estimation is shown to be feasible given a model for the polarimetric signature of volume scattering. The feasibility of this approach is fully confirmed by results from real data.* | Carlos López-Martinez         |
| 10:00-10:20 | Sub-Canopy Topography Estimation With Multibaseline Pol-InSAR Data: A RELAX-Based Solution  
*This paper presents an approach to the estimation of ground topography beneath the vegetation layer based on multi-baseline data. The estimation proceeds in an iterative fashion based on the data spectral features. The validity of the method is confirmed by experimental results.* | Matteo Pardini         |

**Question 1:**

What recommendations does this thematic community have for Sentinel-1 observation scenarios over InSAR areas if interest, in terms of revisit frequency and pass (ascending/descending)?

**Answers:**

- **A priori,** Sentinel-1 is not a system designed to perform tomography. Its main objective is deformation monitoring. Currently, the system configuration is designed in such a way that small baselines are preferred with the focus on deformation monitoring. An increase of the baseline to allow tomography will conflict with the application of subsidence monitoring.
• In case of urban tomography, X-band systems are more suitable.

• For forest tomography, Sentinel-1 may present penetration problems due to the working frequency (C-band)

**Question 2: Non uniform motions:**

Tomography allows separation of targets within the same range-azimuth cell based on their elevation and/or LOS velocity. Yet, ambiguities may arise concerning target location and velocity, not to mention more sophisticated motion patterns.

  a) How do we characterize the ambiguity between target position and motions? Can we provide inputs for the optimal design of spatial/temporal baseline sets?

  b) What is the relevance of polarization diversity (solve ambiguity and/or reduce the number of passes)? Considering the future Sentinel-1 SAR system, are fully-polarimetric data necessary? Which is the best dual-pol configuration (HH/VV, HH/HV, HV/VV, RR/RL...)?

**Answers:**

• (2a) For Differential Tomography, theoretical studies need to be addressed in order to discuss the ambiguity and performance associated with the estimation of non-uniform motions of multiple targets. These studies should consider not only theoretical bounds but also performance achievable in practical cases.

• (2b) The low impact of Faraday rotation at C-band suggests the possibility to exploit dual pol data(HH-HV) to help target separation in urban areas.

**Question 3: Retrieval of ground topography beneath the vegetation layer:**

In recent years the problem of retrieving ground topography beneath the vegetation layer has been addressed by different research groups. To this aim, what is the relevance of polarization diversity or the use of coherent scattering models?

**Answers:**

• When addressing the problem of underlying topography estimation, two alternatives are possible. When the number of baselines is large, tomographic approaches give a good estimate of the ground topography, provided that electromagnetic waves penetrate enough to be sensitive to the ground. When the number of bases is small, PolInSAR approaches supported by coherent scattering models are a better option. All in all, both approaches are complementary.

• It is recognized that collecting multiple baseline is the most valuable asset for spaceborne missions. Though, temporal decorrelation in multi-temporal stacks is recognized as the main limiting factors for the estimation of ground topography beneath the vegetation layer.
Question 4: **Vertical structures of distributed media:**

Tomography provides access to the vertical structure of distributed media, therefore providing a new tool for large scale forestry studies. Yet, radiometric accuracy is of the utmost importance to the aim of providing useful inputs to scientists outside the field of SAR processing.

   c) Super-resolution techniques are appealing as they allow to minimize the number of baselines. Yet, to what extent radiometric accuracy is preserved?

   d) Would it be necessary to consider the development of coherent scattering models to retrieve quantitative information?

   e) How do we cope with temporal decorrelation (e.g: proper selection of interferometric pairs; temporal decorrelation model; other....)? Would it be necessary to introduce temporal decorrelation models for urban scenarios?

Answers:

- It is recognized the need for further studies addressing the radiometric accuracy of super-resolution algorithms.

- Urban tomography provides way to access the ground layer by removing lay-over components. To this aim, however, temporal stability is required. This appears to be a serious limit to the study of flooded areas, for example.