Quantification of L-band InSAR decorrelation in volcanic terrains using airborne LiDAR data

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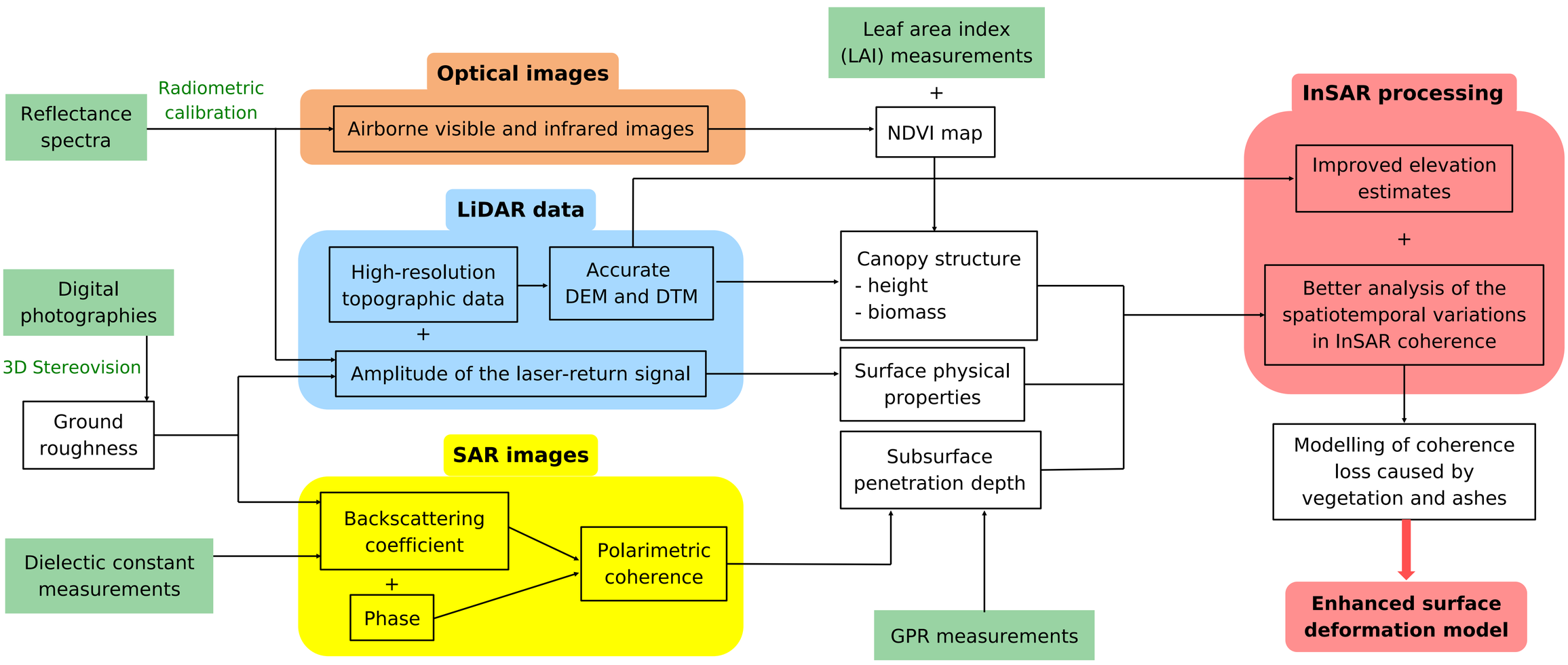
Context:

- Interferometric synthetic aperture radar (InSAR) is a powerful tool to map terrain and monitor high-resolution and large-scale ground displacements.
- Repeat-pass InSAR measurements of the Piton de La Fournaise (La Réunion Island, France) suffer from phase decorrelation due to the occurrence of vegetation and ash deposits that induces errors in the estimation of pre-eruptive surface deformations.
- Light detection and ranging (LiDAR) technology provides accurate information about topography and vegetation height and allows generation of a high-resolution digital terrain and elevation models (DTM and DEM).
- Information derived from intensity can be used to identify and map lava flows.
- A field experiment has been carried out in 2011 in the central and western part of the volcano to better understand InSAR and LiDAR data.

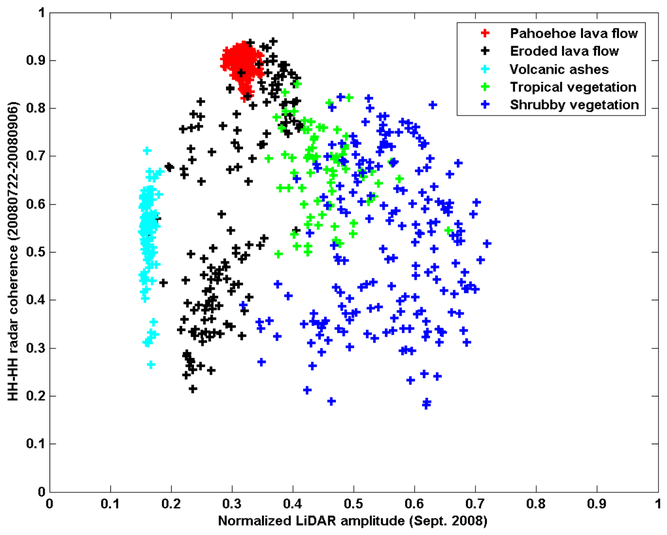
Main scientific objective:

- To enhance the calculation of radar coherence by combining high-resolution airborne LiDAR intensity data with spaceborne InSAR coherence images (ALOS PALSAR L-band) acquired over the volcano in 2008 and 2009.

Methodology



Results



Correlation between HH–HH coherence and normalized lidar amplitude for different terrain types.

Studied area	Surface characteristics	Mean elevation	Mean HH-HH radar coherence	Mean LiDAR amplitude	Vegetation height	LAI
Plaine des Sables	Volcanic ashes	2260 m	0.54 83.10^{-3}	0.17 65.10^{-4}	0 m	0
	Eroded pahoehoe lava flow	2270 m	0.61 22.10^{-2}	0.30 63.10^{-3}	0 m	0
Rempart de Bellecombe	Sparse vegetation (lichen, shrub)	2300 m	0.52 16.10^{-2}	0.55 86.10^{-3}	0.1 – 1 m	1.4
Enclos Fouqué	Smooth Pahoehoe lava flow	2280 m	0.90 21.10^{-3}	0.32 14.10^{-3}	0 m	0
	Rough aa lava flow	2280 m	0.78 58.10^{-3}	0.18 51.10^{-3}	0 m	0
Grand Brûlé	Tropical vegetation (ferns and trees)	130 m	0.62 13.10^{-2}	-	10 - 20 m	5.1 – 7.5
Rempart du Tremblet	Shrubby plants	1900 m	0.34 12.10^{-2}	0.75 42.10^{-3}	1 - 10 m	-

Studied volcanic areas: (a) Plaine des Sables, (b) Enclos Fouqué, (c) Pahoehoe lava flow covered by vegetation and (d) aa lava flow in the Grand Brûlé, and sparsely vegetation area near the Pas de Bellecombe.

Conclusion

- SAR coherence variations are caused by changes in dielectric properties of pyroclastics and by vegetation cycles.
- L-band polarimetric data allow to minimize temporal decorrelation effects due to vegetation but the signal penetration into pyroclastics is more important.
- LiDAR data are used to analyze surface features and are expected to help overcome radar phase decorrelation due to vegetation and soil penetration in order to enhance the accuracy of early phase displacement maps.

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