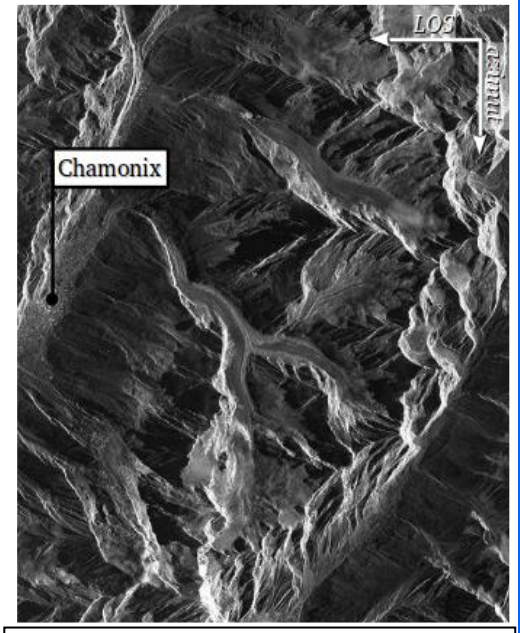
LISTIC

Internship offer 2020/2021

Title	**Measurement of the evolution of glaciers in the Mont-Blanc massif by high-resolution satellite RaDAR imagery**
Level	Master / Engineer degree : ☐ M1 ☒ M2
Start/end date	Depending on availability, 4 to 6 months
City Country	Annecy, *France*
Laboratory	Computer Science, Systems, Information and Knowledge Processing Laboratory (LISTIC)
Subject description	The observation of glaciers by imaging, i.e. SAR (Synthetic Aperture RaDAR) is of great interest to assess their topography and measure their surface flow velocities and other characteristic parameters (perimeter, detrital cover, equilibrium line, crevasses…). Analysis of SAR images acquired by the various RaDAR satellites since the 1990s should make it possible to follow the evolution of most of the glaciers in the different regions of the world (Himalayas, Alps, Andes, Greenland, etc.). However, methodological difficulties remain to be overcome at the level of signal and image processing to implement systematic use of the vast amount of data at our disposal. Indeed, mountain glaciers such as alpine glaciers present both significant movements (several tens of centimetres per day) [Vincent and Moreau, 2016] and their composition (water, snow, neve, ice, stones) which complicate the analysis of backscattering and temporal evolutions [Atto et al. 2016]. Also, the variability of meteorological conditions and the penetration of electromagnetic waves in snow and ice are sources of significant uncertainties [Dehecq et al., 2016].



RaDAR image (TerraSAR X descending) at Chamonix Mont Blanc test site

The objective of this internship is to ascertain significant changes in the response of glaciers in the Mont-Blanc massif at 10-year intervals between a series of high-resolution RaDAR images acquired in X-band by the TerraSAR-X satellite in 2009 and 2011 and PAZ satellite in 2020. The spatial resolution of the images is a limiting factor in the study of glaciers by remote sensing. With a resolution of the order of 2m x 3m, the TerraSAR-X and PAZ images available for this study constitute a unique data set capable of providing information different from that of the Sentinel-1 satellite images, accessible in open access, but with a lower resolution of around 5m x 15m. To process this dataset, the internship has three main stages.

A first pre-processing step is necessary to create, from the TerraSAR-X and PAZ images acquired at the same incidence angle (ascending or descending orbit), time series of images centred on the main glaciers of the site (Argentière, Mer-de-glace, Bossons, Taconnaz ...) as well as on hanging glaciers (small glaciers with steep walls) studied in

	collaboration with the EDYTEM laboratory. We will carry out a local adjustment based on the fixed parts and a priori stable over time (rocky sectors surrounding these glaciers). A second step is to focus on the measurable movements on these glaciers by amplitude correlation. Using the tools developed at LISTIC within the EFIDIR Tools, we will calculate displacement fields between the images of these series and we will study the variability of these measurements as a function of the glaciers, the period of a year and at an interval of 10 years. A third step concerns the evolution of the backscattering and the detection of significant changes. We will study the variability of the backscattering within these series, and we will look for sufficiently stable characteristics in the short term (over a few months) to make comparisons between the years 2009, 2011 and 2020. The results of steps 2 and 3 will be analysed qualitatively, swapping notably with doctoral students and researchers working on the observation of glaciers in the laboratories of USMB (LISTIC , EDYTEM and ISTerre) and also quantitatively by comparing the results with those obtained previously for TerraSAR-X data [Ponton et al., 2014] and with measurements from other sensors (GPS, optical imagery, etc.). **References :** Atto A., Found E., Nicolas J.-M., Lê T.-T., Wavelet Operators and Multiplicative Observation Models - Application to SAR Image Time-Series Analysis, IEEE Transactions on Geoscience and Remote Sensing, Vol. 54, No. 11, pp. 6606-6624, 2016 Dehecq A., Millan R., Berthier E., Gourmelen N., Found E., Vionnet V., Elevation changes inferred from TanDEM-X data over the Mont-Blanc area: Impact of the X-band interferometric bias, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 9, No. 8, pp. 3870-3882, 2016 Ponton F., Found E., Gay M., Walpersdorf A., Fallourd R., Nicolas J.-M., Vernier F., Mugnier J.-L., Observation of the Argentière Glacier Flow Variability from 2009 to 2011 by TerraSAR-X and GPS Displacement Measurement, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 7, No. 8, pp. 3274-3284, 2014 Vincent C. and Moreau L., Sliding velocity fluctuations and subglacial hydrology over the last two decades on Argentière glacier, Mont Blanc area. Journal of Glaciology, 62 (235): 805–815, 2016.
Required Skills	Image: image processing, RaDAR imagery, remote sensing IT: Python, C, Linux
Gratification	According to current legislation
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