Proposition de sujet de thèse pour 2018 (1 page max)

Sujet	Synergy of Sentinel-1 and Sentinel-2 observations to monitor snow in mountains
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Profil du candidat	Experience with remote sensing and modeling, snow processes,
Description succinte du sujet : contexte de l'expérience spatiale, méthodologie appliquée, résultats attendus.	The main objective of this thesis is to work towards the development of a new 3-days-snow product by optimally combining Sentinel-1 and Sentinel-2 measurements. The Sentinel-1A and Sentinel-1B (launched in 2014 and 2016 respectively) observe the French mountains using a C-band Synthetic Aperture Radar (SAR) with a 20 m ground resolution every 6 days (every 3 days if we account for ascending and descending orbits). These high resolution measurements provide relevant observations to monitor snowpack since they are quasi-insensitive to clouds and quite sensitive to some properties of soil and snow (liquid water content, density …). Sentinel-1 SAR measurements thus offer new perspectives for snow characterization and can be usefully combined with Sentinel-2 optical measurements currently used to provide snow extent maps (THEIA snow product (https://theia.cnes.fr), Magnan 2017, Veyssière et al., 2017). To achieve the objective of the thesis several steps will be undertaken. The first step is to implement a new snow detection algorithm for snow extent maps in the Alps and the Pyrenees by directly using Sentinel-1 SAR measurements. Different methods of classification and change detection will be tested to derive the best approach. An evaluation of the Sentinel-1 snow masks will be then conducted by comparing Sentinel-1 products with with the Sentinel-2 snow products currently developed at CESBIO. Methods for combining Sentinel-1 and Sentinel-2 products/observations will then be developped. In addition, snowpack simulations with the state-of-the-art snow model Crocus (Vionnet et al., 2012) will be used to farther evaluate the Sentinel-1 snow products. Comparisons with snow depth and / or snow water equivalent from in-situ measurements will be carried out in the Alps and the Pyrenees in

	order to better understand the complex links between the variation of the Sentinel-1 backscatters and some snow properties with a focus on the snow diurnal cycle representation. We will study the extent to which we could reasonably link the Sentinel-1 snow pixels with an associated liquid water content. One of the key challenges of this thesis is to optimally combine Sentinel-1 backscatters, rather representative of a wet snow (dry snow is seen as soil), and the snow mask of Sentinel-2 . The objective is also to study the optimal conditions allowing a good wet snow detection and issues to associate “snow" pixels with some additional information (liquid water content, ...).