

## Proposition de Sujet de thèse 2020

(1 page recto maximum)

Laboratoire (et n° de l'unité) dans lequel se déroulera la thèse :  
CNRM - UMR 3589

**Titre du sujet proposé :**  
**Contribution of machine learning to the integration of satellite observations into a global land surface model**

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### Résumé du sujet de la thèse

In the context of climate warming, the frequency and the intensity of extreme events such as droughts is increasing, and better modelling the response of vegetation to climate is needed. Monitoring the impact of extreme events on terrestrial surfaces involves a number of variables of the soil-plant system such as surface albedo, the soil water content and the vegetation leaf area index (LAI). These variables can be monitored by either using the unprecedented amount of data from the Earth observation satellite fleet, or using land surface models. Another solution consists in combining all available sources of information by integrating satellite observations into models. This process is called data assimilation. Because data assimilation is able to weight the information coming from contrasting sources of information and to account for uncertainties, it can produce an analysis of terrestrial variables that is the best possible estimation. Data assimilation can only apply to observations that are simulated by the model. Biophysical level 2 and level 3 satellite products can generally be simulated by land surface models. These products are derived from level 1 products consisting in brightness temperatures, radiances, reflectances, or radar backscattering for example. While level 1 products are close to the physical observations made by spaceborne sensors, higher level products result from an interpretation of the level 1 observations. This process can result in an uncertainty cascade that cannot be quantified easily in the context of data assimilation. From this point of view, assimilating level 1 products is a better option. The objective of this PhD work is to develop the assimilation of level 1 products in the ISBA land surface model within the SURFEX modelling platform. ISBA is used in the LDAS-Monde land data assimilation system (Albergel et al. 2017). Observation operators will be developed using artificial intelligence (e.g. Rodríguez-Fernández et al., 2019) and will concern microwave level 1 products from SMOS, ASCAT, and Sentinel-1. The MODIS albedo product will be used to train an observation operator for surface albedo, which is closer to level 1 than LAI. It will be investigated to what extent machine learning can be used to build observation operators able to simulate satellite observations and to improve the consistency between simulated biophysical variables (LAI, soil moisture, surface albedo). A global land reanalysis will be produced and evaluated using pre-existing reanalyses and pre-existing true LAI 10-day syntheses from SPOT-VGT, PROBA-V and Sentinel-3.