www.onera.fr

ONERA
THE FRENCH AEROSPACE LAB

PROPOSITION DE SUJET DE THESE

Intitulé : SAR satellite time-series for the surveillance of forest perturbations

Référence : **PHY-DEMR-2024-04**
(à rappeler dans toute correspondance)

Début de la thèse : 01/10/2024	**Date limite de candidature :** 30/06/2024

Mots clés

Forest health , radar time series

Profil et compétences recherchées

The candidate must have a master or ingénieur degree with expertise both in machine learning/data science and biology

Présentation du projet doctoral, contexte et objectif

In recent years, most forests worldwide have experienced strong perturbations, mainly fires, illegal cuts and diseases. All these events are aggravated by periods of drought, which are lengthening and starting earlier and earlier. It is essential to support public decision-makers to guide their actions best to improve forest health and public security. Forest fires, illegal cuts or diseases address different physical phenomena. Still, our previous works on radar remote sensing and change detection have shown that time series may be a powerful tool to detect them [1-4].

Sondra have developed a collaboration with Ressources Naturelles Canada for several years to understand the structure of Canadian boreal forests better and evaluate the risk of wildfires and the ability of the forest to regress depending on the severity of the fire. In particular, we benefit from a significant ground truth over different Canadian sites [3,4].

In this Ph. D. thesis, we propose to analyze these radar time series to understand better how to relate boreal forests time response to their composition, structure and surroundings. In particular, we have found that the modulation of the seasonal variation of the polarimetric backscattered intensities collected by Sentinel-1 is directly related to the variation of the ambient temperature. Two hypotheses could explain this behavior: either it is a direct effect of the rise or fall of the sap, and/or the freezing and thawing of the ground could explain it. Monitoring these indicators is very valuable for large-scale assessment of the effects of climate change and associated risks.

The first year of the PhD could be dedicated to understanding the link between the modulations of the radar response and the ambient temperature [4]. This ambient temperature and its impacts on the boreal forest's electromagnetic responses seem to vary locally with the topography. This result could lead to an accurate retrieval of some characteristics of the trees and be the input of an unsupervised approach. This work could then be tested on other boreal forests over the Canadian territories with the support of Canadian Natural Resources. During the second year, we propose to investigate how this knowledge of boreal forest characteristics could improve our survey of fire risks over the Canadian territories as well as the capacity of the forest to regrow after a fire. For fires, we have also worked on the study of the ability of the forest to regrow after being burnt. From our very first investigations, the difficulty is that there is no bijective link between the fire's severity and the forest's ability to regress. We assume that the severity, which is only estimated for the moment using optical tools, does not consider the ground's health, which is crucial in this case. We propose to work on a new indicator that would be more beneficial to predict the ability of a forest to grow based on information fusing thermal and radar sensors. Finally, we would like to determine how this understanding of boreal forests' temporal radar signature could help us identify healthy forests from parcels affected by diseases. In particular, we would like to check if these diseases can be detected quite early using deviations of the radar temporal signature of the

forests from a « regular » signature. All this work should be tested in parallel on French forests, provided that we have access to the ground truth, which may be facilitated with the help of CNES and CESBIO.
Collaborations envisagées Ressources Naturelles Canada

Laboratoire d'accueil à l'ONERA	**Directeur de thèse**
Département : DEMR	Nom : Thirion-Lefevre / Guinvarc'h
Lieu (centre ONERA) : Salon de Provence	Laboratoire : SONDRA
Contact : Xavier Dupuis	Tél. : 01 69 85 18 12 / 11
Tél. : 04 90 17 01 32 Email : Xavier.Dupuis@onera.fr	Email : laetitia.thirion / regis.guinvarch @centralesupelec.fr

Pour plus d'informations : https://www.onera.fr/rejoindre-onera/la-formation-par-la-recherche