JOINT POSITION IRSTEA / ONERA / INRA

'PERFORMANCE ANALYSIS OF A SPACEBORNE IMAGING SPECTROMETER FOR THE IDENTIFICATION OF TREE SPECIES AND CHARACTERIZATION OF BIODIVERSITY'

(1 YEAR – RENEWABLE)

Title of the position: Performance analysis of a space borne imaging spectrometer for the identification of tree species and characterization of biodiversity

Type of position: Research engineer (IR)

Duration of the contract: 12 months (renewable once)

Starting from: 15/09/2017

Host lab: DYNAFOR Lab. (INRA/INP Toulouse), 31326 Castanet-Tolosan

Gross salary: between 2300 € and 2500€ **brutes**

Description of the research units:

Irstea is a research organization which, since more than 30 years, works on major issues of a responsible agriculture and territories sustainable planning, water management and related risks, drought, floods, inundations, the biodiversity and complex ecosystems study in their interrelation with human activities.

TETIS is a joint research unit (Irstea, Cirad, CNRS, AgroParis Tech) focusing on spatial information for agro-environmental applications. TETIS is part of the Remote Sensing Centre (Montpellier, France), which gathers research groups from different research units and institutes to form a centre for applied research in remote sensing and geographical information.

ONERA, department of optics (DOTA), is involved for many years in Defense, Security and Environment applications using remote sensing.

DOTA is working for more than twenty years in imaging spectroscopy, focusing on spectral forward radiative transfer modelling and atmosphere compensation to retrieve the spectral surface reflectance. Further, DOTA is working on the development of a future space borne mission based on imaging spectroscopy, HYPXIM, in the 0.4-2.5 µm spectral range.

INRA is the French National Institute for Agricultural Research which conduct studies focused on nutrition, agriculture and environment.

DYNAFOR Lab. is a joint research unit (INRA, INP-ENSAT, INP-Purpan) developing works on forest dynamics and landscape ecology in rural landscapes. Several disciplines and expertise exist within the unit (agronomy, animal science, forestry, ecology, geomatics and signal processing). A part of the scientists contribute to the

development of methods based on remote sensing and GIS to analyze the landscapes and their biodiversity.

Context

The development of operational methods for the fine monitoring of forests across various ecosystems is becoming increasingly needed in order to mitigate biodiversity loss and improve sustainable use of resource and services provided by forested ecosystems. Remote sensing offers new possibilities to measure vegetation properties at local to regional scales, as imaging spectroscopy has proved particular ability to map species richness, species community distribution and to identify tree species, even in the context of highly diverse tropical forests. Therefore the current generation of multispectral images (Sentinel-2) and the next generation of space borne imaging spectroscopy sensors (EnMAP and other satellites in preparation) can potentially provide an important contribution for the monitoring of vegetation properties, including essential biodiversity variables defined by the Group on Earth Observations - Biodiversity Observation Network (GEO-BON). Nevertheless, such missions are not able to sense the biodiversity at tree level due to an insufficient spectral richness for Sentinel-2 and a too coarse spatial resolution for EnMap. Thus there is a need for a new space borne mission to fill these gaps.

An effort has been made by CNES with contribution of the scientific community in order to provide a first definition of these instrumental specifications for various domains of application: vegetation, coastal and inland water ecosystems, geosciences, atmosphere, urban environment, security and defense. This contribution resulted in the definition of the HYPXIM mission, a high spatial resolution high revisit frequency imaging spectrometer. These specifications now need to be consolidated for each of the considered applications.

The preparation of forthcoming satellite missions requires accurate definition and validation of:

i) instrumental specifications of sensors: spatial / spectral / radiometric resolutions
ii) performances in terms of signal to noise ratio related to the instrument, and to environmental conditions (atmospheric properties, geometry of acquisition…).

The project HyperBIO, funded by the TOSCA group (CNES), aims at providing refined instrumental specifications (spectral, spatial and radiometric resolution) for vegetation applications based on experimental airborne hyperspectral images acquired over temperate and tropical forests (France, Gabon, French Guiana). Two main types of applications have been identified:

- Tree species identification
- Biodiversity mapping: species richness and spatial distribution of species communities.

These experimental airborne acquisitions will be processed by a simulator, COMANCHE, providing synthetic Top-Of-Atmosphere (TOA) images including instrumental and atmospheric noises from airborne data, and the code for atmospheric correction COCHISE, both developed by ONERA.

Description of the position

During the first year, the selected candidate is expected to take charge of the processing of the hyperspectral data. More precisely, he/she will:

- explore the information content of the different datasets, and derive vegetation properties of interest based on a set of methodologies including supervised classification of tree species, and unsupervised mapping of biodiversity metrics.
- Use COMANCHE and COCHISE tools in order to simulate TOA images following a set of scenarios of image acquisition, including changes in atmospheric properties and various instrumental specifications (spatial, spectral and radiometric characteristics). Each set of scenarios will be specific to the type of vegetation (temperate/tropical environment) and will need to be defined. The spectral information content of the resulting image database will be analyzed in order to characterize spectral properties of the different configurations, including spectral separability with respect to signal-to-noise ratio.

In a first time, the processing of the data will be based on methods and tools developed by ONERA. The candidate will work in close collaboration with scientific teams from Dynafor and TETIS research units in order to apply and validate different methodologies developed for tree species classification and biodiversity mapping, based on a field observation database. This work will be conducted on experimental data (airborne campaigns), as well as on simulated TOA images corresponding to multispectral and hyperspectral sensors. Experimental data consist in airborne imaging spectroscopy data (visible to shortwave infrared domain) already acquired during recent campaigns over temperate forested areas in Fabas (France), dense tropical rainforest in Gabon, and various experimental study sites in French Guiana (dense tropical forest and mangrove sites).

During the second year, the candidate will derive vegetation properties on the simulated database, and will perform a comparative study of the performances obtained for each configuration and each type of application considered. He/she will provide guidelines for optimal instrumental specification based on the current state of the art and report results to CNES.

The results obtained during this study will also be valued through scientific publications and communications.

Scientific supervision:

Jean-Baptiste Féret, IRSTEA/UMR TETIS

Xavier Briottet, Sophie Fabre, ONERA DOTA

David Sheeren, DYNAFOR/INP-ENSAT

Profile of the candidate (Skills / responsibilities)

- Master’s or Engineer’s degree / PhD degree in remote sensing, image/signal processing, or physics

- Experience in imaging spectroscopy analysis required. If possible with expertise in vegetation studies: tree species discrimination, diversity mapping, estimation of vegetation properties
- Proficiency in programming with experience in Python (if possible experience with R language)
- Good understanding of radiation physics, atmospheric modeling
- Ability to interact in a multi-disciplinary scientific environment (image processing, ecology, physics)
- Production of scientific articles for publication in international journals

Contact(s)

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