ONERA
THE FRENCH AEROSPACE LAB

www.onera.fr

POST-DOCTORAL PROPOSAL

Mapping of urban temperatures for a thermal infrared Mission (CATUT project)

Host laboratory in the ONERA center :

Department : DOTA-Theoretical and Applied Optics

Unit : *Propriétés Optiques des Scènes*

City: Toulouse

Persons in charge at the ONERA :	Email :
Rosa Oltra-Carrió Xavier Briottet	rosa.oltra-carrio@onera.fr, xavier.briottet@onera.fr Phone: +33(0)562252605

Contract duration : 18 months	Requested starting : September 2016

The urban climate is strongly influenced by the urban distribution: 3D structure, high dimensional heterogeneity (height of buildings, width of streets), and high land-use heterogeneity (business, residential, industry ...). Such elements, related with human activity, induce high climate variations inside the city and are one of the main causes of the Urban Heat Island effect. One of the key parameters to estimate this phenomenon is the surface temperature, accessible by remote sensing in the thermal infrared (TIR) range (Weng 2009, Roberts et al., 2012).

Recent studies have shown the contribution of remote sensing to estimate the city surface temperature. They also indicate the importance of well retrieving the materials emissivity for a better estimation of the surface temperature (Voogt and Oke, 2003). Moreover, they suggest the most efficient method to retrieve it (Oltra-Carrio et al., 2012).

In this context, a future spatial mission in the TIR range is promoted by the CNES (*Centre National d'Études Spatiales*), in collaboration with India, which is the evolution of the THIRSTY one. This project is characterized by a high spatial resolution and a high repeatability and one of its objectives is the Urban Heat Island study.

The spatial resolution is of 60 m, while the **average size of urban objects** is between 10 and 20 m (Small, 2001). Heldens et al. (2011) show that, for urban planning, a resolution of 30m provides information at the regional level but not at the neighborhood level. In Sobrino et al. (2012), the suitable spatial resolution to characterize the Urban Heat Island at the neighborhood level over Madrid (Spain) is fixed better than 50m. So the key question is whether it is possible to develop a new method for estimating the surface temperatures associated to each urban material composing a 60m pixel. Several studies have focused on this problem. In particular, Cubero-Castan et al., 2014, showed that it is possible to do temperature unmixing, by combining acquisitions in the visible and near infrared (VNIR) hyperspectral data with TIR (TRUST method). Such method seems promising to map surface temperature at spatial resolutions better than 60 m.

The objective of the proposed work is to evaluate the potential of temperature unmixing methods using simulated multispectral TIR acquisitions and VNIR data, in order to improve the accuracy of the surface temperature maps.
The available data was acquired in the framework of the DESIREX campaign in Madrid in 2008. The dataset includes 30 airborne images (night and day acquisitions are available) from the AHS instrument (INTA), with 80 spectral bands (10 in the TIR region); atmospheric profiles; air and surface

temperature and spectral emissivity in-situ measurements.

During the first six months of post-doc, the main tasks will focus on the estimation of the accuracy of surface temperature retrieval, for different spectral configurations. ONERA and COSTEL tools will be used to build surface reflectance maps in the reflective region, and emissivity and surface temperature in the TIR region. The airborne AHS data will be used to simulate TIR images at the top of the atmosphere. Spatial resolution will be fixed at 60m, while different spectral configurations (between 3 and 8 spectral bands) will be considered. Atmospheric correction algorithms and temperature and emissivity separation algorithms will be adapted to each spectral configuration. Finally, an error budget will be carried out by comparing the results with in-situ measurements.

During the last 12 months, the unmixing algorithms will be developed and evaluated.

This work proposal fits within the TOSCA CATUT project, in collaboration with COSTEL laboratory (Rennes) and INRA-ISPA (Bordeaux).

External collaborations : INRA-ISPA (Bordeaux), COSTEL (Rennes)

CANDIDATE PROFILE

PhD in Remote Sensing with skills in radiative transfer in the TIR region and signal processing.