UCL DEPARTMENT OF GEOGRAPHY

NERC CEOI CASE PhD studentship

Title of project:
LiDAR measurement of forest

Supervisor and Awarding Academic Department:
Prof. P. Lewis, Department of Geography, UCL
Other co-supervisors together with the names of their organizations:
Prof. J.-P. Muller, Department of Space and Climate Physics, UCL
Dr. M. Foster, Lidar Technologies Limited

Expected start date for the project:
27th September 2010

Deadline to submit PhD application to Department of Geography:
23rd April 2010

Name and contact details of Supervisor:
Prof. Philip Lewis, Department of Geography, UCL, Gower St., London WC1E 6BT
Email: plewis@geog.ucl.ac.uk

A PhD studentship is available in the Department of Geography, UCL to design a ground-based multi-spectral lidar instrument for measuring the detailed structure of forests and other vegetation canopies. The PhD is in collaboration with Prof. J.-P. Muller, Department of Space and Climate Physics, UCL and Dr. M. Foster, Lidar Technologies Limited, the latter being CASE partners.

At Lidar technologies the student will examine the practical implementation of a new LIDAR in the field. This will include an examination of the engineering aspects of developing a LIDAR to examine vegetation canopy. In particular investigating issues related to the performance of the LIDAR which will include the development of bespoke simulation and analysis tools. The design of the LIDAR will be examined from a user perspective taking into account factors such as: the user interface, size of the instrument, and the cost of the instrument. As part of this programme, the student will also be expected to examine a range of possible applications and conduct a market assessment of the instrument. The overarching supervision of the student will be conducted by the supervisors from the academic institution. The student will be expected to spend at least 1 month and up to 3 months of the year at Lidar technologies where their performance will be assessed as a trainee member of staff. Dr M J Foster will have the responsibility to train and teach the student within the commercial environment.

The PhD is funded (3 years, with the potential for 0.5 years extra funding) by the Centre for Earth Observation Instrumentation[1], a partnership of the Natural Environment Research Council (NERC) and Department for Innovation, Universities & Skills (DIUS). The student will also be able to participate in and link to wider Earth Observation research within the supervisors' institutions and the NERC National Centre for Earth Observation[2] Carbon Cycle theme[3], which UCL are a member of.

[1] http://www.nerc.ac.uk/research/areas/earthobs/programmes/eoinstrument/

[2] http://www.nceo.ac.uk/

[3] http://www.nceo.ac.uk/research_carbon.php

Details of the PhD are given below.

Eligibility
Details on eligibility for the studentship are laid out by NERC[4]. If you have any questions regarding this, please contact Professor Lewis or NERC directly.

Application
Initial enquiries should be sent to Professor Lewis (address and email above).

To apply for PhD entry and funding, all applicants must complete the UCL Graduate Application Form, indicate clearly the project and funding for which you are applying, and give details of your suitability. The application form should be sent directly to the Department at the address below. Please note that it is wise to ensure applications for funded studentships arrive two weeks before the set deadline.

For information on how to download an application, or to apply online:
http://www.ucl.ac.uk/admission/graduate-study/application-admission/

All applications should be sent to:

Fiona Mannion
Graduate Admissions
Department of Geography
University College London
Gower Street
London WC1E 6BT
Tel: 020 7679 0518
E-mail: f.mannion@ucl.ac.uk

Deadline: 23rd April 2010

Outline and scientific rationale for project

Vegetation structure is a very significant characteristic affecting plant and ecosystem functioning e.g. through its control on interception, emission and scattering of radiative energy, as well as impacting other factors such as water interception and transport and insect/other animal habitats and activities. Methods for the characterisation of structure are in many ways still rather crude, generally aiming either at gross canopy measures such as gap probabilities through the whole canopy using photographic or radiometric methods, or measurements of individual plants through rapid but simplistic methods (e.g. tree height, trunk diameter and estimates of crown shape etc.) or very laborious measurements of plant architecture. A whole research field has grown up in recent years ('functional structural plant models'[5,6]) that aims to understand and model the interaction between plant and plant community structure and the function of the plants and associated ecosystems. Whilst modelling in this field is quite advanced and providing insights into aspects of horticulture, agriculture, and forestry, there is a great need for improved, rapid measurement methods, particularly of complex structures such as trees in a forest. Whilst commercially available laser scanning are starting to have a significant impact in this area[7] such systems are primarily designed for the measurement of 'hard' targets (such as buildings) and aspects of vegetation canopies such as smaller individual or clusters of leaves and branches present significant difficulties. A prototype system developed in Australia (ECHIDNA) has shown that it is feasible to build a ground-based system that returns a digitized waveform for each angular bin in a (slightly greater than) hemispherical scan providing a much richer source of information for measuring structure. As well as providing an invaluable source of information for ecologists and foresters, such instruments also serve as test-beds for new design

[4] http://www.nerc.ac.uk/funding/available/postgrad/eligibility.asp
[5] http://library.wur.nl/frontis/functional_structural_modelling
[6] http://algorithmicbotany.org/FSPM07/cfp.html
[7] http://algorithmicbotany.org/FSPM07/Individual/20.pdf

concepts in lidar which will eventually feed into spaceborne systems. This PhD will be based around developing a design concept for a terrestrial canopy lidar using multiple wavelengths of lidar. The distinct advantage of this over previous instruments is it will allow separation of the different components in each lidar bin (leaf, branch, ground etc.) as well as potentially returning information on the biochemical constituents. The instrument is originally proposed as a ground-based system but design and processing should be directly transferable to airborne then spaceborne systems. Potential design concepts will be implemented in a simulation tool (partially developed under previous CEOI funding) to test their suitability for the underlying measurements required and laboratory and field trials preformed where possible (depending on availability of suitable equipment).

Training objectives and opportunities

The student will receive training in research methods and generic/transferable skills through UCL graduate school's training programmes. In addition, training will be provided in appropriate areas of scientific computing, remote sensing, vegetation science and instrumentation through existing MSc and PhD training modules available at UCL. Attendance at one or more ESA and/or NERC 'summer school' would be appropriate, as well as workshops and other meetings held by NERC CEOI and/or NERC NCEO. The student will benefit from spending time at the three groups concerned to gain awareness of the different aspects of science and engineering required to develop useful measurement systems for environmental science (i.e. NCEO-related applications and radiative transfer modeling at UCL-Geography, space instrumentation at MSSL, and lidar technologies at the CASE partner).

Benefits to UK EO instrumentation capability

The successful design (and funding) of EO missions requires a range of factors that are best developed through close collaboration between instrument designers and manufacturers and the environmental scientists who wish to improve our understanding of the world through such measurements. This studentship would further develop such a partnership, link instrumentation (CEOI) through to NERC NCEO activities, and position the industrial partner in vegetation canopy lidar instrument applications. As noted, whilst this particular work aims at a terrestrial system, the design and information exploitation concepts will aid in the future development of associated airborne and spaceborne systems and considerably aid the potential of UK plc to both promote and deliver technical solutions required by ESA and other space agencies.