University of Leicester PhD studentship

Funding Source: CENTA DTP

Proposed start date: 23rd September 2024

Closing date for applications: See our web page

Eligibility: UK/International

Department/School: Physics

Supervisors: **PI:** Dr Darren Ghent, NCEO Leicester, djg20@le.ac.uk

                   Co-I: Prof John Remedios, NCEO Leicester, jjr8@le.ac.uk

Project Title: High resolution thermal data for climate resilience in food security.

Project Description :

Project Highlights:

- Develop new algorithm approaches to transform thermal satellite remote sensing for crop monitoring
- Confront the challenge of big data to explore changes in the temperature and composition of the Earth's surface
- Opportunity to work on design and development of upcoming European operational satellite mission with world leading industry in space/aeronautics and data economy

Overview (including 1 high quality image or figure):

Food security has always been a major strategic issue related to the global economic development, social stability and national independence. The agricultural sectors in countries such as China and India are vast in terms of scale and production, operating across different climate zones serving heterogeneous population distributions. There are many challenges as population increases; with a need to secure the food supplies that underpin sustainable economic growth and jobs for workers in rural employment sectors, and a need for robust environmental management of soil and water resources. Sitting around all of these issues is the contribution that changes to the climate may have on crop stress and yield and market models in the sector.

Ongoing research in NCEO-Leicester is utilising land surface temperature (LST) data for crop monitoring effort with a focus on routes to impact by the generation of informative indices. Current operational infrared satellite EO sensors typically offer highly accurate LST but their spatial resolutions are of order 1 km. Some higher spatial thermal imaging capability for LST measurement is available but their limited temporal sampling and lower accuracy restricts scientific advances and uptake of applications from these missions. In particular, accurate measurement of LST at local (< 100 m) scales to resolve fields and knowledge of the composition of the Earth's surface is lacking.

The cumulative research work of the Land Surface Temperature Group in NCEO-Leicester over a decade has been central to the European Space Agency (ESA) being able to define and implement Europe's first, high spatial resolution, thermal infra-red mission. This mission, the Copernicus Land

Surface Temperature Monitoring (LSTM) is built primarily to deliver operational agricultural services. The challenge is to develop robust approaches to truly exploit the advantages of these higher resolution missions for field-scale crop monitoring.
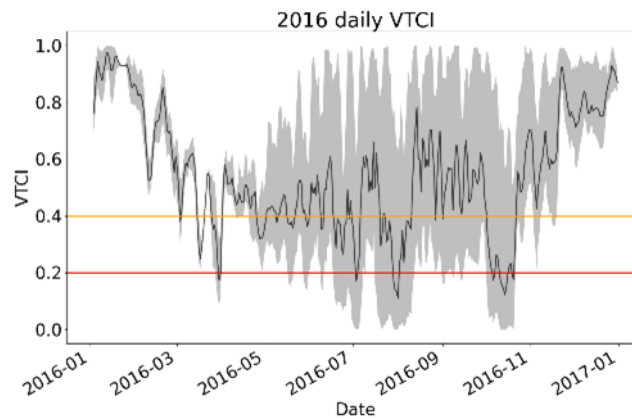

Figure 1: Daily Vegetation Temperature Condition Index (VTCI) produced by the NCEO-Leicester Surface Temperature Group for 2016 over the Heteo Plain, China.

Methodology:

This project will develop new methods to study the changing temperature of the Earth's surface at the field scale, a need recognised to be very important by international space agencies and environmental scientists. This project will apply new mathematical approaches – optimal estimation (OE) and artificial intelligence (AI) - to retrieve LST from remote sensing platforms, and to combine with optical information, such as normalised difference vegetation indices (NDVI), to generate crop monitoring indices that can improve the interpretation of the crop conditions.

AI techniques, such as Machine Learning and neural networks have been successfully applied for big data analysis in many areas of science. Such methods have the potential to transform thermal satellite remote sensing. This project will develop a new AI method to data from current missions and new sensors, such as for LSTM, and will carry out testing of the methods on both simulations and real data from hyperspectral aircraft measurements. Once verified, the new scheme will be used to identify the performances, modelling and design of new satellite sensors.

References:

Ghent, D., Corlett, G., Goettsche, F., & Remedios, J. (2017) Global land surface temperature from the Along-Track Scanning Radiometers. Journal of Geophysical Research – Atmospheres, 122, 12167-12193

Ghent, D., Veal, K., Trent, T., Dodd, E., Sembhi, H., and Remedios, J. (2019). A New Approach to Defining Uncertainties for MODIS Land Surface Temperature. Remote Sensing, 11, 1021

Hulley, G., Veraverbeke, S., and Hook, S., Thermal-based techniques for land cover change detection using a new dynamic MODIS multispectral emissivity product (MOD21), (2014). Remote Sensing of Environment, 140, 755-765, doi:10.1016/j.rse.2013.10.014.

Perry, M. J. S. (2017). High Spatial Resolution Retrieval of LST and LSE for the Urban Environment (Doctoral dissertation, Department of Physics and Astronomy). https://leicester.figshare.com/articles/thesis/High_Spatial_Resolution_Retrieval_of_LST_and_LSE_for_the_Urban_Environment/10231151

BBC News (2022) 'UK also broke its land surface temperature record'. Available at: https://www.bbc.co.uk/news/science-environment-62257163

Funding details:

NERC CENTA studentships are for 3.5 years and are funded by NERC. In addition to the full payment of your tuition fees, you will receive the following financial support:

- Annual stipend, currently set at £18,622 (2023/4 – new figures to be confirmed spring 2024)

- Research training support grant £8,000 (RTSG)

If you are not eligible for UK Fees the University of Leicester will fund the difference between UK and International fees for the duration of your studies

For more details of the CENTA consortium please see the CENTA website: www.centa.org.uk.

Entry requirements:
Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject.

The University of Leicester English language requirements apply where applicable.

To apply please refer to our web page for further information and read carefully the How to Apply section before submitting your application
https://le.ac.uk/study/research-degrees/funded-opportunities/centa-phd-studentships

In the funding section please specify that you wish to be considered for Ref CENTA2-PHYS1-GHEN

In the proposal section please provide the name of the supervisors and project title (a proposal is not required)

Project / Funding Enquiries to: CENTA@le.ac.uk or djg20@le.ac.uk

Application enquiries to pgradmissions@le.ac.uk