Imperial College London

Natural Environment Research Council

2024_02_Measuring the emissivity of desert soils in the Far-Infrared

Supervisor: Professor Helen Brindley

Department: Department of Physics

(a) Motivation for the project

The infrared spectral emissivity of the Earth's varying surface types plays a fundamental role in determining their energetic emission, influencing surface energy budgets and the efficiency with which the Earth cools to space. Knowledge of infrared surface emissivity, including any angular dependence, is also a pre-requisite for satellite instruments exploiting these wavelengths to retrieve surface and lower tropospheric temperature and/or profiles of certain atmospheric constituents.

(b) Context and background

During this project the student will work with the PI (enabling them to see how their research fits into a much larger research landscape), a dedicated research fellow (providing expert experimental guidance) and PhD students (seeing how researchers are trained to gain scientific independence). The team is diverse, both in terms of background but also in gender and ethnicity.

The tasks involved are also varied, including experimental design, hands-on laboratory work and data analysis, the latter using relatively advanced modelling tools. Developing appropriate techniques and undertaking measurements is a learning process where both success and failure can offer valuable insights. By the end of the project I would hope that the student would have had sufficient exposure to the topic to be able to come up with ideas of their own for further experiments, giving their reasoning behind their suggestions and the expected outcomes.

As noted in the motivation section, if successful the research could deliver a valuable new data set for the wider environmental sciences community. At the very least it will identify unsuccessful experimental routes, allowing these to be eliminated from future tests.

(c) Objectives and methodology

The overall objective is to retrieve the emissivity of a natural soil sample from measurements of emitted radiance, ideally over a range of viewing angles and at different emitting temperatures.

To meet the objectives the student will work with the team to devise an appropriate experimental set-up. We have experience of successfully performing these measurements for water and ice surfaces but the soil sample is more complex because the reflection from the surface is not specular. In addition, because the retrieval technique requires a

temperature contrast between the emitting surface and the environment, and because of the time of year, this will likely require the sample to be heated.

Once the experimental set-up is finalised the student will perform the measurements (with supervision). They will then have the opportunity to analyse the results, including learning about the instrument calibration process and sources of error. The final retrieval requires the use of a relatively advanced radiative transfer model â€“ if time permits we will guide them through its use to enable them to produce the final emissivity estimates, with associated uncertainties.

Project length:

8 weeks