IAPETUS2 Project Submission Preparatory Template

Please note, in order to submit a project to the IAPETUS2 2020-2021 Studentship Competition, supervisors must complete the Project Submission Form online. The Project Form will be opened for submissions on Tuesday 1st September 2020 and the web link will be circulated prior to this.

This document details the questions on the online form in the correct order. If you would prefer to complete all/some sections of the form in this Word document then simply copy and paste on to the online form, please feel free to do so. This is not essential though.

Please note, this Word version cannot be used instead of the online form, it is just meant as an aid for supervisors to use when completing the online form.

Please complete all sections (unless they are marked as Optional or If Applicable on the form). Approval for project submissions with missing fields will be delayed.

Please do not use any special characters, as the website will turn them into gobbledygook when publishing.

Please consult the *IAPETUS2 Studentships Competition 2021 Staff Guidance* for further details on the form and the process.

General Information	
Project Title:	
Monsoon Dynamics in a Changing Climate	
Lead Institution:	University of St Andrews
Department / School / Institute	School of Earth & Environmental Sciences

Project Team The first supervisor should be from the lead institution. The Second Supervisor should be from a second IAPETUS2 organisation	
Supervisor 1	
Name	Dr Michael Byrne
Organisation	University of St Andrews
Email	mpb20@st-andrews.ac.uk
Biography URL	https://sites.google.com/tcd.ie/michaelbyrne
Supervisor 2	
Name	Prof. James Baldini
Organisation	Durham University
Email	james.baldini@durham.ac.uk
Biography URL	https://www.dur.ac.uk/directory/profile/?id=4494

Project Details

The information provided here will be used to create the project advertisement online and in pdf format. The overall project description should not normally be longer than 1,200 words in total, including references. Please note that the boxes below are plain-text only, formatting & links will be stripped from the text.

Keywords Add up to 5 comma separated keywords that best describe the project.	Monsoons, Climate change, Computational modelling, Big Data

Overview

Monsoons are summertime weather systems that deliver water to half of the world's population. Monsoon rainfall is essential for agriculture and water resources in many densely populated regions. Monsoons have changed in the past — Asian monsoon rainfall, for example, has fallen by 5% over the last 50 years — and are expected to change dramatically in future decades because of global warming. However, exactly how monsoons will respond to climate change is unclear: State-of-the-art climate models struggle to accurately simulate monsoons and predictions of future monsoon behaviour are highly uncertain. This uncertainty remains stubbornly large, despite the development of more complex and higher-resolution climate models, making it impossible for monsoon regions to prepare for the impacts of climate change.

During this project, you will take an entirely new approach to reducing uncertainty in the monsoon response to climate change. Instead of relying on imperfect state-of-the-art climate models, you will instead use novel idealised simulations to transform our fundamental understanding of how radiative processes and ocean interactions shape monsoons and their response to future climate change.

Methodology

Monsoons are strongly connected to the oceans through exchanges of heat, water, and momentum, and to atmospheric radiative processes associated with clouds, water vapour and carbon dioxide. However, despite these intimate physical connections, the roles of (a) oceans and (b) radiative processes in the monsoon response to climate change are largely unknown and have not been systematically investigated. The objectives of this project are:

1. To transform our physical understanding of monsoon-ocean and monsoon-radiation coupling using novel idealised climate model simulations focused on key coupling processes including cloud and water vapour feedbacks, wind-driven Ekman transport and wind-induced surface heat exchange (WISHE).
2. To apply new insights into monsoon-ocean and monsoon-radiation interactions to narrow the large uncertainty in future monsoons projections from state-of-the-art CMIP6 climate models.

For Objective 1, you will perform novel climate simulations using the Community Earth System Model (CESM). These simulations will be designed to investigate how individual atmosphere-ocean and monsoon-radiation coupling processes affect monsoons and their response to climate change. For Objective 2, you will analyse monsoon rainfall and circulation dynamics in state-of-the-art climate simulations from the CMIP6 data archives, with the aim of narrowing the large uncertainty in future monsoon changes.

Timeline - Year 1

Year 1 will involve a literature review to you to develop your understanding of monsoon dynamics and physical aspects of climate change. You will also start using the CESM climate model and setting up the simulations to examine monsoon-ocean and monsoon-radiation coupling. You will attend a training course on how to run the CESM model at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado.

Timeline - Year 2

Year 2 will focus on (a) running the set of idealised climate simulations to investigate monsoon-ocean and monsoon-radiation coupling and (b) analysing the results. You will draft a research article on this portion of the project and will present the key results at the American Geophysical Union’s annual meeting in San Francisco.

Timeline - Year 3

Year 3 will involve applying the insights into monsoon-ocean and monsoon-radiation coupling developed in Year 2 to state-of-the-art climate simulations from the CMIP5 and CMIP6 archives. This will involve substantial Big Data analyses with the objective of narrowing the large uncertainty in future monsoon projections. You will attend and present your research at an international conference on monsoon dynamics.

Timeline - Year 3.5 (6 months only)

Year 3.5 will focus on writing the PhD thesis and drafting a research article on the analyses conducted during Year 3.

Training & Skills

You will be trained on several aspects of physical climate science including atmosphere & ocean dynamics, air-sea coupling, radiative processes and climate change. You will also be trained in highly sought-after technical skills in computational modelling, high-performance computing, and Big Data analyses. You will attend a training course on using the CESM climate model at NCAR in Boulder, Colorado.

References & Further Reading

[1] Kitoh et al. (2013): *Monsoons in a changing world: A regional perspective in a global context.* Journal of Geophysical Research: Atmospheres (doi: 10.1002/jgrd.50258)
[2] Turner & Annamalai (2012): *Climate change and the South Asian summer monsoon.* Nature Climate Change (doi: 10.1038/nclimate1495)
[3] Bordoni & Schneider (2008): *Monsoons as eddy-mediated regime transitions of the tropical overturning circulation.* Nature Geoscience (doi: 10.1038/ngeo248)
[4] Codron (2012): *Ekman heat transport for slab oceans. Climate Dynamics* (doi: 10.1007/s00382-011-1031-3)

Further Information

Please contact Dr Michael Byrne by email mpb20@st-andrews.ac.uk or by phone at 07472179331.

At this point in the form, you will be able to upload any project related images or photographs that you wish to be used online with your submission. Please upload either jpeg or png files
Maximum upload size: 52.43MB
All images must be owned/copyright by the uploader or suitable licensing arrangements must be in place prior to upload. IAPETUS may request proof of licensing for any commercial / copyrighted content uploaded.

Image annotations and attributions. If required, please add any image titles/ attributions etc.