

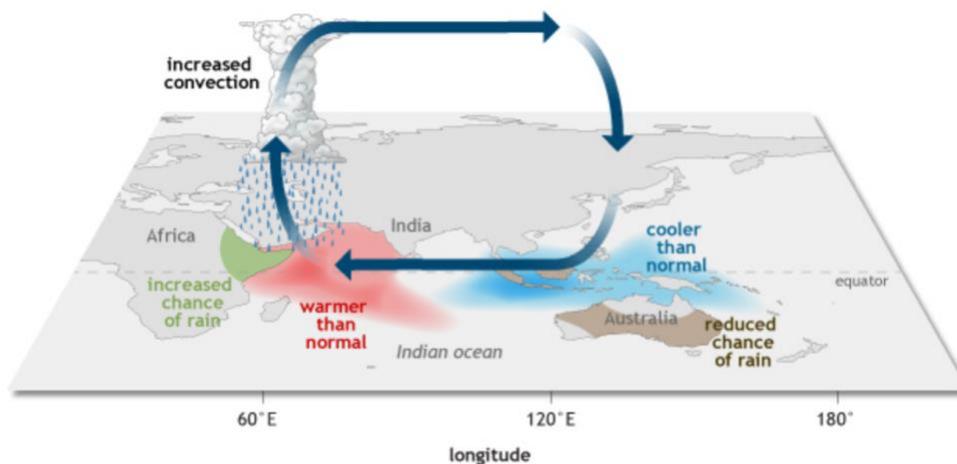
## Modelling and forecasting the Indian Ocean Dipole

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The Indian Ocean is considerably underexplored for research compared to its Atlantic and Pacific cousins, yet the countries around its perimeter have large populations (one billion in India alone) and are undergoing considerable economic development (especially in Africa). The Indian Ocean dipole (IOD) – a pattern of warm/cold sea-surface temperatures in the west/east Indian Ocean – was the largest on record in 2019, thought have bearing on the strong Indian monsoon rainfall that summer, the unprecedented Australian wildfires of the following months, and with noted impacts across East Africa, especially in Somalia and the Lake Victoria Basin. Despite the importance of the Indian Ocean and its climate variability, the region suffers large biases in weather and climate models.



Schematic diagram of a positive **Indian Ocean Dipole** event showing warmer than normal sea-surface temperatures in the western Indian Ocean (colder in the east), affecting the regional distribution of rainfall and wind patterns. Source: noaa.gov

Meanwhile, the new range of models contributing to the sixth coupled model intercomparison project (CMIP6), which inform the IPCC 6<sup>th</sup> Assessment Report are available for analysis. CMIP6 includes state-of-the-art contributions from the Met Office. New Indian Ocean observations are also available from moored arrays, Argo floats, field campaigns and the latest reanalysis products. This project will exploit the Met Office's unique seamless modelling approach, in which the same core model is used for forecasting at a variety of scales, in order to examine Indian Ocean biases in climate models, how quickly those biases develop and their likely sources, and testing the impact of those biases on climate impacts for India, eastern Africa and the Maritime Continent. With CASE support, the PhD presents the opportunity for novel experiments to be performed with the Met Office GloSea5 seasonal forecasting system, which allows the sensitivity of remote teleconnections to Indian Ocean biases to be readily determined. These could include relaxing/nudging the mean state in particular regions or ocean basins back to observed climatologies or investigating the dependence on the state of ENSO.

This project aims to address the following major questions:

- Q1. How is the mean state and variability of the Indian Ocean represented in the models of the sixth coupled model intercomparison project (CMIP6)? How are teleconnections of the Indian Ocean dipole simulated in the CMIP6 models?
- Q2. How rapidly do errors in the Indian Ocean develop and where do they start? This question will focus on a

detailed comparison between climate model versions of the MetUM and the coupled initialised seasonal forecasting system, GloSea5.

Q3. What is the impact of local and remote ocean biases on the simulation of teleconnections to regional climate impacts from the Indian Ocean?

**Training opportunities:**

Through this project the student will develop strong programming skills and the ability to manage large datasets, including training for this in NCAS courses for cf-python/cf-plot. The project will offer placements at the Met Office, Exeter (*e.g.* one month per year) to develop hands-on experience working with the MetUM model, learning from its developers and improving skills in model workflows and data processing. This will also give the student the chance to discuss and present their work to a wider audience and presents the opportunity to engage with a leading employer of PhD graduates. The student will have the opportunity to undertake further training offered by NCAS in their Introduction to Atmospheric Science course and Climate Modelling Summer School. The student will have all the usual opportunities associated with a SCENARIO PhD such as developing presentation skills, networking at national and international conferences etc.

**Student profile:**

This project would suit a student with a background in physical or mathematical sciences, perhaps specialising in atmospheric physics or similar. The student must have strong analytical skills. During the project, the student will be expected to develop the necessary computer programming and climate data analysis skills. Some previous programming experience would be beneficial.

**Funding particulars:**

This project has co-funding from the Met Office as a CASE studentship comprising an additional £1,000 per annum towards the research and training grant for the student and extra expenses for travel and subsistence associated with placements at the Met Office. In-kind support is also offered for modelling work while at the Met Office.

<https://research.reading.ac.uk/scenario/>