Project Endorsement Form

1. PROJECT TITLE

Full title	EMC Experiment: Examining the Fate of the East Madagascar Current
Acronym	EMC Experiment
Website	
Keywords (up to 10, describing the project research)	Ocean circulation; surface currents; Lagrangian; drifters; RAFOS floats; particle tracking; retroflection; East Madagascar Current; South Indian Countercurrent
New initiative or continuing programme?	New

2. APPLICANTS

Lead applicant / Project Leader / key research contact person:

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Institutional or personal website	

Other key participants / research team leaders: *(repeat as needed)*

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Last name	Bower
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Institutional or personal website	

N.B.: Please note that all these names and contact details will be added to the IIOE-2 membership database.

3. ABSTRACT– Brief description of the project: *(1/4 page maximum)*
This will be placed on the IIOE-2 Website after endorsement.

The system of ocean currents that forms the global Meridional overturning circulation (GMOC) plays a central role in regulating Earth's climate. One of the least understood yet critical aspects of this system is the upper-layer circulation near the southern tip of Madagascar in the South Indian Ocean. The southward-flowing East Madagascar Current (EMC) -- a conduit for warm and fresh Indonesian Throughflow (ITF) Water to the subtropical South Indian Ocean and beyond-- is in many ways a typical western boundary current, except that it 'runs out' of the boundary at relatively low latitude (25.5°S). What happens when this vigorous current detaches from the southern tip of Madagascar is still a mystery, debated in the literature since the 1970s. Some argue that the EMC breaks up into mesoscale eddies which travel west and join the Agulhas Current, whose pinched-off rings and filaments drift into the Atlantic Ocean; others that the EMC retroflects eastward to the South Indian Countercurrent (SICC), which flows to Australia; while others contend that both pathways exist, but the retroflection is restricted to the surface layer. It has also been hypothesized that a full or partial retroflection of the EMC is a nutrient source to the yet unexplained Southeast Madagascar Bloom-- a global 'hotspot' for primary production in an otherwise oligotrophic subtropical region. There is a dearth of in situ observations in the detached EMC. To solve this problem, the EMC experiment will simultaneously release surface drifters and subsurface isopycnal RAFOS floats at the thermocline depths. These pairs of drifters and floats will be released in the EMC four times over a year. This Lagrangian experiment, the first of its kind in the EMC, will be paired with particle tracking simulations to investigate surface and subsurface pathways associated with the detached EMC, its connectivity with the Agulhas Current and the SICC, and respective transit times. Our research will assess the impacts of EMC strength, downstream propagating eddies, and seafloor topography on the detached EMC pathways. This knowledge is crucial to understanding the ITF water journey within the South Indian Ocean, the Southeast Madagascar Bloom development, southern Madagascar coastal upwelling cells, as well as impacts on the Agulhas Current and the GMOC. The proposed research is a US contribution to the 2nd International Indian Ocean Expedition.

4. LINKS TO IIOE-2 SCIENCE PLAN: *(1/2 page maximum)*
How do you anticipate your project to contribute to the IIOE-2 strategy and science delivery, with reference to which (either one or more) of the six IIOE-2 Science Plan themes that your project responds.Please state

the specific issues and questions addressed by your project in the context of the IIOE-2 Science Plan themes and key issues.

This project will contribute both to Theme 4: Circulation, Climate Variability and Change and Theme 2: Boundary Current Dynamics, Upwelling Variability and Ecosystem Impacts of the IIOE-2, as it will elucidate the fate of the East Madagascar Current (EMC) based mostly on in-situ observations. The EMC is believed to be a critical factor in the Southeast Madagascar Bloom development and also an important source for the Agulhas Current and the South Indian Countercurrent, both with implications for the Indian Ocean climate.

This study will provide critical in situ observations in an undersampled oceanic region, which is particularly important for Madagascar, one of the world's poorest economies and highly vulnerable to climate shocks. The project will support six African-based early-career scientists/students (including our collaborator) to participate in the research cruise. They will learn a wide range of sampling techniques and experimental methods. To foster solid international collaboration and support capacity-building, which is an objective of the IIOE-2, we will also organize a summer school in Madagascar. The aim is to share and discuss Lagrangian methods, ocean circulation around Madagascar, and its impact on climate and fisheries, including the observations collected during this program.

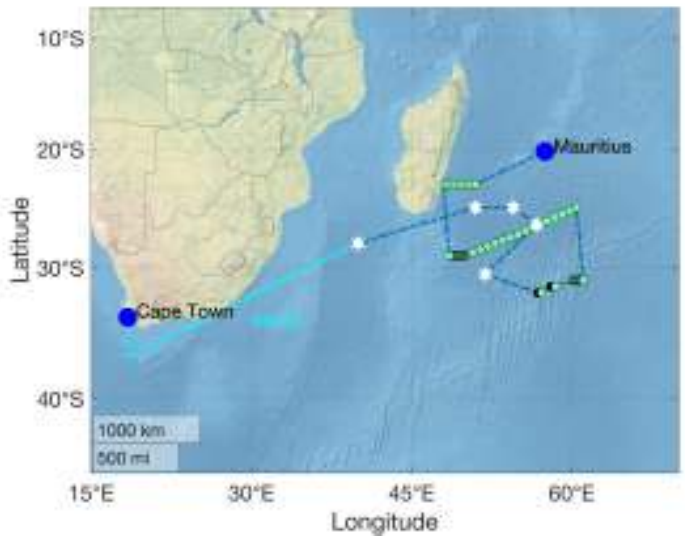
The specific objectives of the proposed research are to:
1. Determine the advective pathways and transit times of the EMC extension at surface and pycnocline levels in observations and model simulations, and investigate the physical mechanisms that control those pathways—e.g., bottom topography, the EMC strength, and mesoscale eddies;
2. Characterize the evolution of the EMC-originated (possibly dipolar) eddies as they travel over the deep Mozambique Basin at surface and pycnocline levels;
3. Evaluate if the EMC retroflects and characterize the associated patterns (early vs. canonical retroflections) at both surface and pycnocline levels, and investigate what controls them (e.g., bottom topography, EMC strength, and downstream propagating eddies);
4. Determine the fate and advective transit times of the EMC-originated particles following the west and the east paths. This objective will be accomplished based on particle tracking simulations. Specifically, we will quantify the probabilities of EMC-originated particles to be exported to the South Atlantic Ocean and Western Australia.

5. INTERNATIONAL COLLABORATION(S):
Is the project part of a related multi-national activity? **NO**
If No, would you welcome international collaboration in your project? **YES**

6. REGION(S) OF STUDY
Provide a description of 'where' the research is to be conducted (for field based activities) and/or the region or regions to which the research pertains (you are encouraged to consider providing either the coordinates of the area of studies or the coordinates of the planned cruise tracks, as well as a figure as an addendum to your proposal).

Our study region is the Madagascar basin in the Southwest Indian Ocean. Our main field experiment will happen from April 4 to May 15, 2023, on board R/V Revelle (20S-35S, 30E-65E). The fieldwork will consist of deployment source sources (stars in the maps), RAFOS floats, and drifter deployments. Besides that, we will collect shipboard ADCP, temperature, salinity, oxygen, nutrients, CFC/SF6 tracers, and LADCP from the sea surface to the bottom. We will depart from Cape Town, South Africa, and arrive in Port Louis, Mauritius. We welcome IIOE-2 colleagues and students to piggyback on our field experiment.

In addition to the leading cruise, a secondary cruise on board a sailing vessel will be done late in 2023 for additional float and drifter deployments near Madagascar.



EMC/DMB Cruise on board R/V Revelle 2023: Stations are green dots, and stars are sound sources. The positions of both are being revised.

6. TIMETABLE OF THE PROJECT

Start date: 10/1/2021	End date: 9/30/2025

7. LINKAGES WITH OTHER PROJECTS / PROGRAMMES / INITIATIVES

Is the project part of a related national or multi-national activity?
If yes, provide the related activity title and website for reference, if available:

The proposed study takes advantage of a rare NSF-funded research cruise to the region and leverages assets of our Deep Madagascar Basin (DMB) Experiment, which investigates the abyssal circulation in the Madagascar Basin. The DMB experiment is an endorsed IIO-2 project.

Is your project part of, or affiliated to, another SCOR, IOC or IOGOOS activity or project?
If "yes", please indicate which activity or project:

No

8. DATA MANAGEMENT AND SHARING

1. Will new data be collected as part of this project (yes or no?

Yes. The data will be public. Drifters in real-time and RAFOS after the floats re-surface and data are processed. It will take about 2-years (the RAFOS mission will be 1.5 years in length)

2. Contact information if any, of the person in charge of the data management from whom the metadata can be accessed by interested IIOE-2 stakeholders.

Please note that for all IIOE-2-endorsed projects, IIOE-2 will have developed its own metadata portal. Once the project is endorsed, the project leader will be asked to provide the metadata information of the project.

Viviane Menezes, WHOI, vmenezes@whoi.edu.

2. Recognizing the need for an initial period of exclusive data use, would you be willing to provide timely access to all data generated under this project and associated metadata in accordance with relevant national and funding agency data sharing policies? **YES/NO**

9. FUNDING

Please note that IIOE-2 strongly encourages funded/resourced projects. However, IIOE-2 may endorse projects yet to receive funding/resourcing if IIOE-2 endorsement can be clearly shown to significantly aid in prospects for funding/resourcing.

Has funding and resources to successfully achieve and undertake the project been obtained? Indicate the sources of funding and resources that have been approached and/or secured.

Yes. This project is funded by US National Science Foundation.

10. BENEFITS FROM IIOE-2 ENDORSEMENT *(1/4 page maximum)*

Specify why you are seeking endorsement and how the activity would benefit from endorsement, and how the IIOE-2 SC could assist in the implementation of your project.

We have proposed to NSF this project as a US contribution to the IIOE-2. Due to the pandemic's delays, we have not looked for the endorsement as we were unsure when American ships would return to the Indian Ocean. With the cruise now scheduled for next year, we aim to make the project a contribution.

We also believe being part of the IIOE-2 would help to facilitate the fieldwork and broad-impact activities (which include a summer school in Madagascar) since we could easily collaborate with our international colleagues through the IIOE-2 framework. We welcome the participation of our national and international colleagues and students in the proposed cruise and project.

11. OPTIONAL: OTHER COMMENTS/INFORMATION/MATERIAL *(length and detail may be at the discretion of and as deemed necessary by the applicant)*

Please feel free to provide any other comments, information or materials that you feel relevant to your proposal for the IIOE-2 Steering Committee's information and benefit. You may provide this as general information or provide the additional comments/information/materials as relevant to any of the specific Sections above.

(Viviane V. Menezes)

IIOE-2 Joint Project Office (JPO)

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