Project Endorsement Form

1. PROJECT TITLE

Full title	**Deep Madagascar Basin (DMB) Experiment: A Quest to Find the Abyssal Water Pathways in the Southwest Indian Ocean**
Acronym	DMB
Website	Not yet
Keywords (up to 10, describing the project research)	Bottom water, abyssal, circulation, AABW, RAFOS, Deep SOLO Argo
New initiative or continuing programme?	New

2. APPLICANTS

Lead applicant / Project Leader / key research contact person:

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

First name	Heather
Last name	Furey
Role in the project	Co-PI
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Role in the project	
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First name	Amy
Last name	Bower

Role in the project	
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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 deep and abyssal (> 4000 m) oceans act as a reservoir of heat and carbon on the Earth and play a crucial role in regulating the Earth's climate from multidecadal to millennial time-scales. Sustained hydrographic observations from the last three decades have revealed compelling evidence of temperature, salinity, density and tracer changes in the abyss ocean. In the Southern Hemisphere, abyss warming is widespread, except in the Crozet, Madagascar and Mascarene basins in the southwestern Indian Ocean, where anomalous cooling stands out. At least half of the northward inflow of abyss waters in the entire Indian Ocean (IO) is through these basins (in the IO, no surface-forced deep or bottom water is formed in the North).

In 2018, after 23 years, the US GO-SHIP program occupied for a second time the I07N line in the western IO. The section started with about 270 km of the Atlantis II fracture zone (FZ), the main gateway for the abyss water into the Deep Madagascar Basin (DMB). A comparison between the new and previous WOCE observations revealed an astonish increasing in chlorofluorocarbons (CFCs) below 3500m, from 30S until the Amirante Passage at 8S that connects the Mascarene and Somali basins. A back-of-the-envelope calculation using the tracer concentrations indicate that part of the DMB abyss has been ventilated somewhat recently. Where did these abyss waters come from and how did they spread so fast in the DMB? Do these changes indicate variability in the Crozet-Madagascar water exchange and the Indian Ocean Meridional Overturning Circulation strength?

In the most current description of the DMB abyss circulation, nearly all of the Atlantis II inflow is carried westward at about 31-32S to a narrow, northward-flowing Deep Western Boundary Current (DWBC). This circulation pattern seems to be inconsistent with the 2018 I07N observations, which took place at 54.5E, about 600 km from the narrow DWBC, and motivated the current proposal.

A second pathway that was previously proposed in the literature and discarded as unlikely was a slanted-oriented flow that would connect more or less directly the Atlantis II FZ inflow to the DWBC far north at 23S. This interior pathway would cross the I07N, which might explain the relatively high CFC content and cold bottom layer in the mid-basin. However, the sparse hydrographic observations available are not sufficient (and are perhaps inadequate) to evaluate any of the two abyss circulation patterns.

Here, we propose a field experiment to be completed in 2020 that is designed to assess the two hypotheses for the abyssal water pathways entering the DMB through fracture zones. To determine the pathways and the transformation of the abyss water in the DMB interior, we will deploy an array of neutrally buoyant floats composed of 75 RAFOS and two Deep SOLO floats. We have been using particle tracking simulations

to optimize the array design. A numerical model spanning the same period as the observations will be used to help answer our burning questions: Where do these abyss waters come from? How did they spread so fast in the DMB?

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 to the Theme 4: Circulation, Climate Variability and Change of the IIOE-2. Much of we know about the deep and abyssal Indian Ocean is derived from observations collected during the first International Indian Ocean Expedition. Two of themes that our project will directly address is how the complex Indian Ocean submarine affects the deep circulation and how bottom waters are converted in lighter thermocline and intermediate waters in the Indian Ocean interior, which represents a major deep upwelling branch of the global Meridional Overturning Circulation. These subjects are part of the IIOE-2 Science Plan and addressed on page 47 of the document.

5. INTERNATIONAL COLLABORATION(S):

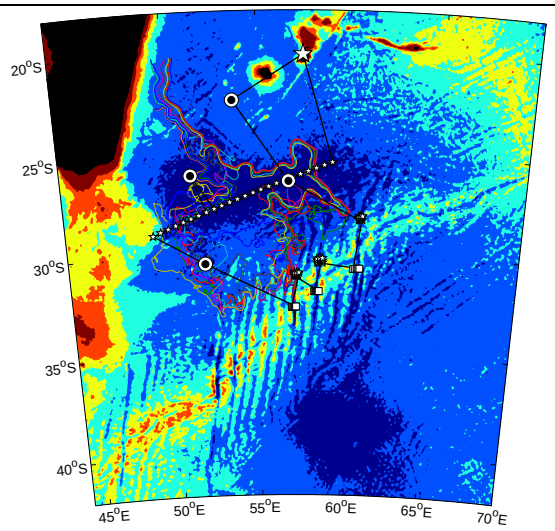
Is the project part of a related multi-national activity? **NO**

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 and Mascarene basins in the Southwest Indian Ocean. Our field experiment planned to September/October 2020 (20S-35S, 50E-65E) will consist of deployment source sources (filled circle in the maps), RAFOS floats and Deep SOLO Argo. Besides that, we will collect temperature, salinity, oxygen and nutrients, CFC and SF6 tracers from the sea surface to the bottom in 42 stations (stars in the map). We will depart and arrive in Port Louis, Mauritius, and we are requesting a UNOLS ship for the experiment. We welcome IIOE-2 colleagues and students to piggy-back in our field experiment.



6. TIMETABLE OF THE PROJECT

Start date: October 2019	End date: September 2023

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:

This project is not related to a multi-national activity.

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. All observations collected during the experiment will be made public in the end of the project.

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.

Heather Furey, WHOI, hfurey@whoi.edu

3. 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**

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.

We have not secured fund for this project yet. We are submitting a proposal to the National Science Foundation as a US Contribution for the IIOE-2 on 15 February 2019. If the proposal is funded, it will be the first deep SOLO Argo and RAFOS float observation in the southwest Indian Ocean to date.

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 believe that the endorsement from the IIO-2 would help us to secure funding from NSF for our proposal. We would like to assure our reviewers and NSF that the project is relevant for a better understanding of the still poorly unknow Indian Ocean dynamics, and we are part of a large international

group. We also believe being part of the IIOE-2 would help to facilitate the field work part 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)