

**2018 NF-POGO- GEOMAR Fellowship for
 Ship-board Training on-board RV Meteor cruise M148**

Fellowship Report

Name of Trainee: Marco Sebastián Sandoval Belmar

Name of Supervisor (Parent Institution): Dra. Carolina Parada Veliz (Departamento de Geofísica, Universidad de Concepción, Chile)

Supervisor (Host Institution): Dr. Marcus Dengler (GEOMAR Helmholtz Centre for Ocean Research Kiel)

Dates of Training: From May 24 to June 29 on-board and from July 2 to July 27 at GEOMAR.

Section A

(To be completed by the fellow and returned to the POGO Secretariat)

Please note Q1-Q3 will be passed on to the host and parent supervisor and made publicly available on the OTP website; Q4 will be read only by the POGO Secretariat and remain confidential

1) Please provide a brief description of activities during the training period:

The cruise had several objectives. However, I focused on "carrying out a 4-day process study to elucidate the mechanism that sustains the upwelling in Angola during the austral winter season", where the wind along the coast is at its minimum seasonal, but upwelling and phytoplankton are at their seasonal maximum. For this purpose, measurements of microstructure and hydrographic sampling were carried out in the eastern tropical South Atlantic (Fig 1a).

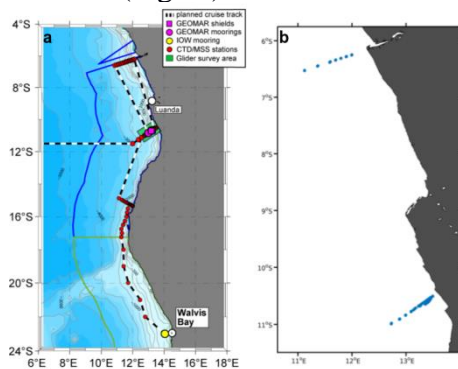


Figure 1. a) Image showing the second work area in the upwelling region of Benguela offshore Angola and Namibia. b) the two transects of the MSS (north and south).

Mainly, during my shift (4-8 a.m./pm) my main tasks was to check the echo sounder to see the depth to which we were, help sample nutrients from the rosette, download and check the data of an Underwater Video Profiler (UVP) camera and deploy the measuring system of microstructures (speed and temperature shear) or MSS. During my off-shift time, I had to study and read (*e.g.*, papers, books) about the different processes related to turbulence in the ocean, as well as the methodology underlying the MSS. In addition, I was trained to process the profiles (165) obtained with the MSS in two transects (Fig. 1b.) until an advanced stage.

During my stay at GEOMAR, I continued with the processing of the profiles, which included reviewing them one by one and removing some erroneous values (spikes) by hand. After having all the profiles finally processed, clean, in regular and interpolated grid, Fig. 2 was obtained for the south transect, which is an average over time of the different profiles in that area.

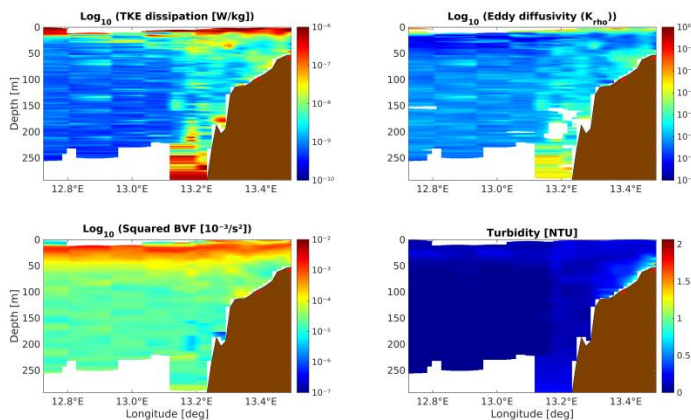


Figure 2. TKE: Turbulent Kinetic Energy Dissipation (ϵ), BVF: Brunt-Väisälä Frequency (N^2). In red moorings are seen at ~59 and ~100 meters deep.

The Eddy Diffusivity is calculated from the TKE multiplied by the Mixing Efficiency (set to 0.2, Oakey, 1982) divided by N^2 . Multiplying this amount by the vertical gradient of the nutrients

you can calculate the diapycnal fluxes of nutrients in the water column product of several phenomena that cause mixing (turbulence). However, the nutrient data had not been processed and by time and for greater interest (see next question) it was decided, in conjunction with the chief scientist, to work only with the resuspension which can be derived with MSS. In Fig. 2 it can be seen that a sediment resuspension (high turbidity near the bottom) occurred on the platform just in the first meters. My objective was to see if that resuspension was produced by the high TKE product of nonlinear internal waves that broke on the slope. For this purpose, I observed the data of the ADCP velocities of the moorings (Fig. 2) together with the turbidity data of the Microcat of the moorings (Fig. 3).

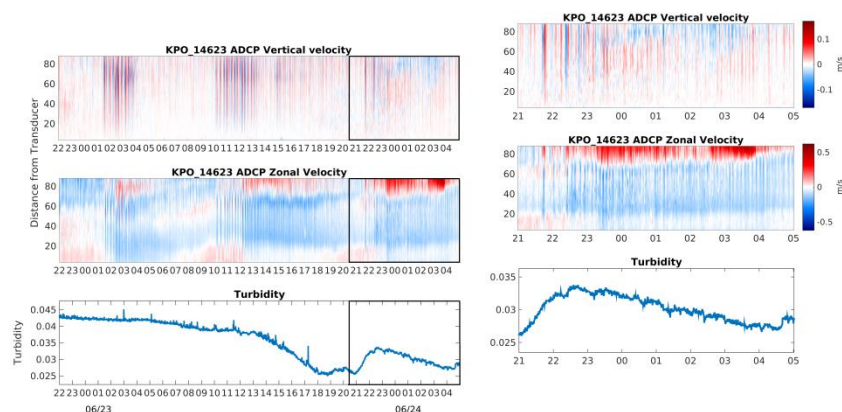


Figure 3. Panels of Vertical and zonal velocity of the mooring at ~100 m, together with the turbidity time serie. A turbidity increase event is marked in a black rectangle between ~20:00 on June 23 until ~00:00 on June 24. On the right a zoom of the rectangle.

Finally in Fig 3. it can be seen that for a turbidity increase event on June 24, 2018, it was in agreement with a weak but constant presence of internal waves (especially between ~22:00 to ~23:00), which was what was expected. Finally, different turbidity increase events were observed located (or not) by the MSS and contrasted with the moorings data (not shown) and an algorithm of automatic localization of the internal waves was designed for these time series.

2) What applications of the training received do you envision at your parent institution?

The training obtained will definitely help me a lot in the definition of a line of research in oceanography. I was in search of some physical process that would directly affect the biological processes and the biogeochemical cycles in the ocean on a regional scale. In addition to the processes of mixing, supplement and flows of nutrients or other properties product of the turbulence, thanks to the turbidity sensor that the MSS has, it is also possible to visualize effects of sediment resuspension by near-bottom intensified wave of elevation within an internal wave train or upslope propagating bores. I am interested in particular, because in Chile we have many events of Red Tide (Harmful Algal Bloom; in which I made my bachelor's thesis) produced mainly by a species of dinoflagellate called *Alexandrium catenella* and have the particularity that when it doesn't find the right conditions to proliferate, it is capable of form resistance cysts in the sediments. Cysts are able to generate new blooms if they are resuspended to the water column and find the right conditions for vegetative growth. Get depth and being able to study sediment resuspension rates with help of this technology (MSS) would be an important and novel step to understand and possibly predict these phenomena in Chile.

3) Please provide your comments on the Fellowship Programme.

The fellowship obtained was spectacular. It was an excellent experience for my work, professional and also personal life. Not only for what has been learned in terms of the latest sampling methodologies, measurement of variables in the ocean, deployment of different instruments and data processing. But also for letting me know "life at sea", work in an interdisciplinary way, improve my english skills (and learn some german), meet new and fascinating people, travel and get to know Europe, see and have to deal with different problems that happen when you are on board and know the technology and the first level infrastructure for the study of oceanography in the world. I can only say thank you very much for this experience and for the fellowship.

4) CONFIDENTIAL: Please use this box for any comments that you do not wish to be made publicly available or passed on to your supervisors.

Signature

Date: June 23, 2018

Section B

(To be completed by host supervisor and returned to the POGO Secretariat)

Please note Q1-Q3 will be passed on to the parent supervisor and trainee and made publicly available on the OTP website; Q4 will be read only by the POGO Secretariat and remain confidential

1) Please provide your comments on the performance of the trainee.

Marco Sebastián Sandoval Belmar performed all tasks entrusted to him reliably and with great responsibility. While being on watch, he was highly motivated to learn about the

preparation, deployment and the functioning of ocean observatories. During the off-watch periods, he was enthusiastic about post-processing and analysing data collected during the cruise. Marco demonstrated excellent programming skills and proved to be acquainted with advanced numerical mathematics. He was able to independently extend and improve numerical code that was made available to him and thereby develop his own methodologies for data analysis. In comparison to all other fellows, Marco work most independently. While at GEOMAR, he chose to focus on issues related to upwelling and voluntarily helped with post-processing of the collected microstructure and mooring data. To achieve this goal, he independently interacted with other different GEOMAR staff scientists. It was a great pleasure working with him.

2) Is this exchange likely to lead to future collaboration with the trainee's parent institution? If so please give example(s) of how this collaboration may be pursued.

Marco had just completed his Master program when he was granted the POGO fellowship. He is currently planning to enrol in a PhD program during which he is seeking to spend some time at GEOMAR. I think that his cruise participation and subsequent visit to GEOMAR provided him with new set of ideas on how to advance process understanding and prediction of harmful algal blooms occurring of Chile that is in the interest of Marco's future research efforts. I envision a closer cooperation on upwelling processes once he has started his PhD program.

3) Please provide your comments on the Fellowship Programme.

The NF-POGO Fellowship for Ship-board Training is an ideal program for students from developing countries and from countries in transition to experience oceanographic data collection at sea and to interact with researchers, technicians and students from developed countries. This experience as such is in many aspects of great benefit for the fellow's career. The targeting of post-graduate students is exemplary due to their high level of receptiveness and professional qualification. Despite some gaps in knowledge of the fellow's that we were happy to address, a prominent outcome of the NF-POGO- GEOMAR Fellowship program was that we learned from each other while advancing our knowledge about ocean science integrated in the cultural and political dimension of the human, country and ocean interactions. Perhaps the last aspect could be foregrounded in the program.

4) CONFIDENTIAL: Please use this box for any comments that you do not wish to be made publicly available or passed on to the parent supervisor and/or trainee.

Signature

Date: 26.09.2018

(To be completed by parent supervisor and returned to the POGO Secretariat)

Please note Q1 will be passed on to the host supervisor and trainee and made publicly available on the OTP website; Q2 will be read only by the POGO Secretariat and remain confidential

1) Do you agree with the above comments and do you have any additional feedback you wish to provide?

I agree with the above comments. The fellowship is a good experience that expose students to state-of-the-art oceanographic instrumentation and sampling techniques. In addition, allow students to interact with peers coming from other parts of the world and stimulate the generation of research networks. This experience is of great benefit for the fellow's career and allow for a possible joint collaboration between the host institution and the fellow's institution. Congratulations!!!.

2) CONFIDENTIAL: Please use this box for any comments that you do not wish to be made publicly available or passed on to the parent supervisor and/or trainee.

I have no more comments to add.

Signature or Print name

Date: 25 Febraury 2019