

Introduction to advances in physical oceanography: a tribute to Prof. Affonso da Silveira Mascarenhas, Jr. (1938-2017)

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INTRODUCTION

This special article collection of Ocean and Coastal Research is dedicated to Prof. Affonso da Silveira Mascarenhas Jr. and includes eight scientific contributions from a few of his friends and colleagues. This introduction to the volume includes a brief tribute to Affonso followed by a short outline of the scientific manuscripts.

Affonso (Figure 1) was born 12 May 1938, in Rio de Janeiro, Brazil, where he acquired an interest and love for the sea as a child. After high school and military service, he matriculated at the University of Sao Paulo (USP) and subsequently embarked upon a 30-year affiliation with the Physical Oceanography Section of the Oceanographic Institute (IO) of USP. He began as a technician (1963), became a Physical Oceanographer (1968), Head of Marine Meteorology (1970), Assistant Professor (1976) and finally Professor of Oceanography (1983). During this time, he participated in many oceanographic cruises, including as Chief Scientist aboard the Brazilian Navy ship *Sirius* for an international Atlantic Tropical Experiment in 1974 and,

in 1985, with Henry Stommel to study the beta spiral aboard R/V *Oceanus* in the Eastern North Atlantic. He received a B.Sc. in Physics in 1967 from USP, a M.C. degree in Meteorology from Instituto de Pesquisas Espaciais (INPE) (1975) and M.Sc. (1979) and a Ph.D. (1983) degree in Physical Oceanography from Massachusetts Institute of Technology (MIT). Most important, he became infatuated with an IOUSP administrative assistant, Terumi Gohda, and he married in 1971.

In 1993, Affonso retired from IOUSP and became Head of the Physical Oceanography Division, Instituto de Investigaciones Oceanológicas, at the Universidad Autónoma de Baja California (UABC) in Ensenada, México. Terumi passed away in 2008, and shortly thereafter Affonso moved to Guayaquil, Ecuador, to head CIIFEN (International Center for El Niño Research). In 2010, he suffered a minor stroke, could no longer perform administrative duties, and resigned. He subsequently spent two years at the Universidade Federal do Rio de Janeiro working on ocean energy models before retiring. He returned to Ensenada in 2016 and passed away there on 14 September 2017.

Affonso's achievements included teaching, research and administrative activities. He taught courses that included a wide range of topics in physical oceanography and atmospheric sciences at both undergraduate and graduate levels

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Figure 1. An admiral upon an admiral's sea. Affonso da Silveira Mascarenhas Jr., on the after deck of R/V Wecoma near Hoke Seamount (32°N, 127°W), October 2006 (photo by Tetyana Margolina).

and included Brazilian (IOUSP, Space Research Institute at Sao Jose dos Campos, Ceará State Institute of Meteorology), Colombian (Naval School Almirante Padilla, Cartagena), and Mexican (Faculty of Marine Science, UABC) universities. He was a demanding teacher, one who challenged his students with well-organized lectures and comprehensive examinations. In Brazil, his efforts

were rewarded with a 20-year Commemorative Medal for Remote Sensing in 1988 and a Medal and Diploma as Friend of the Navy in 1989.

Affonso's research interests included air-sea interaction, satellite oceanography, and ocean physics. In 1968, he attended a satellite workshop in Houston focused on natural resource surveys during which he and Commandant Emmanuel

Gama de Almeida developed methods to use remote sensing to examine marine resources. They subsequently validated these methods in Brazilian waters by comparing observations obtained by aircraft equipped with infrared and visible light sensors and *in situ* ocean observations from vessels Professor Besnard and Admiral Saldanha. Later, in 1979, Affonso worked with his MIT dissertation supervisor, Eric Mollo-Christensen, to show how remote sensing could be used to estimate heat storage in the upper ocean mixed layer; the following year, they published (with Peter Cornillon) a method to estimate ocean current velocities. Affonso's Ph.D. dissertation suggested striations seen in SAR and Landsat images of ocean fronts could be explained by enhanced diffusion caused by forced internal waves. Affonso suggested in his dissertation that frontal structures be sampled with continuous profiling instruments, which he accomplished in 2004 at the entrance to the Gulf of California. The response of the subtropical ocean front in the subtropical South Atlantic to an atmospheric front was studied by numerical simulation by Claudio Pereira, an INPE Ph.D. student advised by Affonso.

Affonso also studied the structure and transports of larger scale currents off Brazil. Working with Olga Sato, they found the relationship between observed Sverdrup, Ekman, and geostrophic transports in the South Atlantic were in good agreement except that the observed poleward increase of Brazil transport was absent. Affonso helped to organize an international experiment which collected velocity profiles across the Brazil Current. An analysis of these velocity profiles (with Ilson Silveira) indicated that the Intermediate Western Boundary Current in the subtropical South Atlantic was much thicker, 1200 m, than previously reported. Subsequently, the bifurcation of the South Equatorial Current (the southern branch of which provides the source waters of the Brazil Current) was studied (with Ilson Silveira and Luiz Bruner de Miranda) which led to the discovery of the North Brazil Undercurrent.

At USP, Affonso also played an important role in explaining the role of the ocean on severe droughts in the semi-arid Northeast Brazil. Much later, a global ocean model was developed for use

with regional models in the South Atlantic and climate studies.

Upon joining the UABC faculty, Affonso began a collaboration with oceanographers at the Naval Postgraduate School to quantify the exchange of waters between the Pacific Ocean and the Gulf of California. The initial cruise to the Gulf took place in 1991 aboard USNS *DeSteiger* and used the acoustically tracked dropsonde Pegasus (in the same way that Affonso had previously used Pegasus in the Brazil Current) to observe currents at the entrance to the Gulf. The program evolved into 24 cruises, including aboard the ships *A. Humboldt* and *R. Suchiate* (Mexican Navy), *F. de Ulloa* (CICESE), *DeSteiger* (USNS) and *Point Sur* (MLML), use of CTD casts, ship mounted and lowered ADCPs, coastal moorings and a coastal meteorological station, and spanned more than two decades. Many visits to UABC and NPS took place, including yearlong sabbaticals at each institution, undergraduate theses (Tanahara Romero, Figueroa González, Guerrero Moreno), M.Sc. theses (Spearman, Blanco Betancourt, Larios Castillo, De Dios Sánchez) and a Ph.D. dissertation (Castro Valdez). Without a doubt, Affonso left an important legacy in Physical Oceanography at UABC.

Affonso brought oceanographic expertise to CIIFEN and expanded CIIFEN partnerships with other Andean and Brazilian institutions. Under his direction, CIIFEN became involved in development of a regional Atlas and implemented regional projects dealing with local climate risk management. The quality of these efforts was recognized with a Sasakawa Foundation Certificate of Merit for CIIFEN.

Affonso will be greatly missed. He had a strong passion for oceanography and for teaching. He was an excellent colleague and shipmate: well liked, cheerful, gregarious, and supportive. Affonso made time for everybody, and everybody made time for Affonso. He had a firm grasp of the fundamentals of physics and geophysical fluid dynamics and the ocean observations necessary to elucidate physical processes. He had a unique capability for pursuing his scientific ideas to completion in a bureaucratic environment. He readily engaged others: a mid-morning pastry and coffee

with friends and students, sharing a giant bowl of ice cream before the midwatch, listening to music in the evening, so all would have time to converse and laugh. Affonso is survived by his wife, Martha of Palmira, Colombia, his daughter Terumi of Roskilde, Denmark, a son Jorge of Arlington, Texas, and five grandchildren.

For this volume the eight manuscripts have been organized chronologically by type. Original Articles include: (1) Dewar and Deremble (2022) argue that the ultimate role of surface buoyancy fluxes is to damp the ocean circulation and that ocean energy cycles between internal and kinetic. (2) Flierl (2022) examined nonlinear topographic waves in barotropic, rigid lid models with a focus on how depth shapes can or cannot support solitary waves. (3) Collins and Castro (2022) discuss mass and heat flux measurements at the entrance to the Gulf of California. (4) Bou-Haya and Sato (2022) investigated the heat storage variability of the Brazil Current using a numerical ocean model and expendable bathythermograph measurements. (5) In a Brief Communication, Navarro-Olache *et al.* (2022) describe the evolution of a submesoscale eddy in Todos Santos Bay, Baja California, México, which was observed by high-frequency radar. (6) A Case Report by Pardo *et al.* (2022) describes the implementation of a portable module to measure the inorganic nutrients of surface ocean waters and describe the module's ability to determine the eutrophication risk in upwelled waters along the NW Iberian Peninsula. Methods articles include: (7) Chu and Fan (2022), who describe eddy characteristics in the California Current based upon empirical mode decomposition of SOFAR float trajectories; and (8) Amorim *et al.* (2022), who develop a new technique to extrapolate velocity profiles in the South Brazil Bight using vertical dynamic modes.

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AUTHOR CONTRIBUTIONS

C.A.C., R.C., I.C.A.S.: Conceptualization; Writing - original draft; Writing - review & editing.

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