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1. Scientific and professional profile and career

I have a multidisciplinary background, with a PhD in Surveying Engineering by the University of Porto (2006), an MSc in Computational Methods (2000), and a First Degree in Physics & Applied Mathematics (Astronomy, 1998). Ever since my undergraduate studies, I have had a strong interest in data analysis, and my research career - at the interface of data science and earth system sciences - reflects both the passion for extracting information from data and my enthusiasm for space and environmental sciences. My PhD thesis focused on the application of novel data analysis approaches for the analysis of time series of sea level and related climate variables, both from satellite and in-situ observations. This work fostered my interest in time series concepts relevant to the assessment and quantification of climate change (trends, scaling, space-time variability, changes in seasonality, and extremes). I was a postdoc at the Danish National Space Centre (2007), working on the analysis of ocean satellite data. I was also a postdoc at the Geological Survey of Israel (2008), working on radon time series and geophysical applications of natural radioactivity, which sparked since then my interest in ambient radioactivity. From 2009 to 2014, I was a contracted researcher at Instituto Dom Luiz (IDL) University of Lisbon, which strengthened my interest in multidisciplinary Earth system science and enabled me to interact more closely with the climate modelling community, giving me a broader perspective on bridging data analysis and geoscience applications. I took two maternity leaves, (2011–2012 and 2013–2014). I'm a senior researcher at INESC TEC since 2015. Through marine robotics collaborations, I conducted field campaigns on ambient radioactivity, underwater and in the marine boundary layer. Building on my work in AI and Computing Software, I now address research data management and computational reproducibility, including AI workflows.

2. Contributions to science and society

2.a. Contributions to the generation of new ideas, tools, methodologies or knowledge

My initial research focused on sea level change. My first insight was to explore trends beyond the usual linear model. The consideration of non-linear trends has two main implications: non-linear behaviour can distort trends estimated assuming linearity, and it can provide additional information. In my first paper (Barbosa et al, 2004) I derived a non-linear trend pattern explainable by a regional drought. My interest in the trend concept remained ever since, as a fundamental notion to climate research in general, and a challenging one, as I showed in publications with a more conceptual focus (Barbosa et al, 2008; Donner et al, 2009; Barbosa, 2011; Fatichi et al, 2009). A related concept that I have been addressing is scaling, a feature often exhibited by climate variables, which can impact trend assessment. In Barbosa et al, 2006b, I showed that sea-level observations exhibit scaling behaviour, and in Franzke et al, 2020, we conducted a thorough review in the context of climate. I have addressed trends in extremes, applying novel methods to study extremes in sea level (Barbosa, 2008; Ribeiro et al, 2014; Barbosa, 2016) and climate variables (Barbosa, 2011; Monteiro et al, 2012; Oliveira et al, 2020; Barbosa & Scotto, 2023). Seasonality is prevalent

in climate time series, but often disregarded. However, in a climate change context, variations in seasons are very likely – rather than just changes in mean, as more often considered – and suitable approaches are required to assess this variability. Again, as in the case of trends, the apparent simplicity of the concept is deceiving, and it is methodologically challenging. Still, it is possible to extract extra information on climate variability from the analysis of seasonality (Barbosa et al, 2008; Barbosa et al, 2009; Barbosa & Donner, 2016).

Within the scope of my sea level research, I have analysed satellite data from radar altimetry, and studied the impact of satellite corrections on sea level variation (Fernandes et al, 2006; Barbosa, 2012). The use of satellite data expanded my scope from the temporal to the spatial dimension, and I have studied approaches for characterising the space-time variability of sea level (Barbosa et al, 2004; Barbosa et al, 2006a; Donner et al, 2012), and of related climate variables (Barbosa et al, 2009; Barbosa & Andersen, 2009). I worked on the synergistic use of in-situ and satellite data, relevant for validation of satellite data (Barbosa et al, 2007; 2010), and coastal sea level change (Dunne et al, 2012; Mendes et al, 2017; 2020). I have also addressed innovative clustering approaches, and its application to sea level and climate data (Scotto et al, 2009; 2010; 2011; Barbosa et al, 2016).

I advanced radon research when geologists performing radon monitoring in Israel sought my collaboration on the analysis of their time series. My first result showed the intrinsic nonlinear nature of radon time series (Barbosa et al, 2007), and subsequent work documented their complex temporal pattern, because of multiple interacting influencing factors (Steinitz et al, 2007; Barbosa et al, 2010; Woith et al, 2011; Choubey et al, 2011; Zafrir et al, 2011; 2013; Zafrir et al, 2020; Smetanova et al, 2023). I have then applied my knowledge of natural radioactivity to man-made radioactive waste, studying ambient radioactivity in Portuguese uranium tailings and indoor environments (Neves et al, 2009; Pereira et al, 2011; Donner et al, 2015; Barbosa et al, 2015).

My current focus is on climate applications of natural radioactivity. Radon is a versatile proxy and unique atmospheric tracer (Rottger et al, 2021), but my previous work showed that radon is also very sensitive to meteorological and other local effects, hindering its use as a proxy. Hence, I have started to study ambient radioactivity in the marine environment to attenuate these effects and to focus on the atmosphere. In 2015, I set-up a monitoring campaign at the ENA station in Graciosa island (Azores) to study the temporal variability of radon progeny and its relation to atmospheric conditions (Barbosa et al, 2017; 2018). I have also started to work on the atmospheric electric field, as ambient radioactivity and atmospheric electricity are inextricably linked phenomena (Lopes et al, 2015; Silva et al, 2016; Fdez-Arroyabe et al, 2020; Barbosa, 2020). In 2020, I have started the SAIL campaign for marine boundary layer monitoring (Barbosa et al, 2025), having documented, for the first time, precipitation-driven enhancements in gamma radiation in the open ocean (Barbosa et al, 2023).

I seek to support and contribute to Open Science. I have made publicly available specialised software, and I have also made available on public repositories all the data collected in my field campaigns. As a result of my commitment to Open Science, I have published more than 15 datasets, including not only the raw data but also computational notebooks, facilitating its re(usage) and fostering reproducibility.

2.b. Contributions to the training and career development of researchers and/or research teams

I have supervised 6 research fellows within research projects, of which 5 have pursued a research career. I have also supervised 2 final theses of First Degree students, and 3 Master's students. I co-supervised a PhD student (Lázaro Costa, 2025) and I currently co-supervise a PhD student at the University of the Azores.

In addition to topical master courses at the U. of Lisbon and U. Porto, I have taught several postgraduate courses in Portugal and abroad (Spain, Benin). I have also hosted a COST Short-Term Scientific Mission, a sabbatical stay, and 2 Erasmus+ mobility trainees.

I have participated as a researcher in 4 EU projects, and I'm currently coordinating the EU project NuClim (Nuclear observations to improve Climate research and GHG emission estimates). Other recent projects are TiPES, where I made analysis of palaeoclimate time series (Barbosa et al, 2024), and traceRadon, focused on radon data for climate applications (Röttger et al, 2021). I have been the Co-PI of 3 bilateral projects with German partners, on sea-level variability, and from Hungary and Slovakia, on natural radioactivity. I have participated in 5 national projects, two of them serving as the PI.

I am involved in several field activities entailing scientific data collection. Since 2015, I'm the PI of the "Gamma radiation monitoring campaign" at the ENA station in Graciosa island (Azores). In 2027 I have led the "Radioactivity and atmospheric electric field monitoring campaign" at Hyytiälä (Finland). In 2022, I installed a radon monitoring station in S. Jorge island. I have been the PI of the SAIL "Space-Atmosphere-Ocean Interactions in the marine boundary layer" campaign on board the sail-ship Sagres from 2020 to 2025. Since 2025 I'm leading the NuClim campaign measuring atmospheric radon activity concentration and ambient radioactivity at the ENA station.

Regarding collaborative networks, I was a member of the EOSC Future User Group from 2021 to 2023, and Portugal's MC member for COST Action Electronet, on atmospheric electricity from 2016 to 2021. I'm currently Portugal's MC member for COST Action FuSe (Testing Fundamental Physics with Seismology) and co-chair of WG5.

2.c. Contributions to the scientific community

I have edited a book on "Nonlinear Time Series Analysis in the Geosciences - Applications in Climatology, Geodynamics and Solar-Terrestrial Physics" and 3 journal issues on data analysis topics, all with the same focus: bringing together innovative data analysis methods and concrete applications in the geosciences domain, enhancing communication across scientific disciplines. I have also edited a journal issue on radon applications, with contributions from different scientific fields, aiming to foster an integrated perspective on radon and knowledge-transfer across disciplines.

I have organised several scientific events (conferences, topical meetings, workshops) and a postgraduate short course. I have served as a member of the programme committee of 5 scientific conferences.

I have given various seminars at national and international universities and more than 12 invited/keynote talks at scientific events. I'm keen on participating both in events more focused on methodological aspects and for data-oriented audiences, as well as in domain-specific events presenting concrete research results.

I have served a referee of more than 100 manuscripts, and as an expert evaluator in more than 20 grant applications for 11 foreign funding institutions and in 1 application for a national institution.

I chaired from 2019 to 2022 the Christiaan Huygens Medal Committee of the European Geosciences Union Division of Geosciences Instrumentation and Data Systems.

2.d. Contributions to society

I am very keen on scientific outreach and dissemination of scientific knowledge, recognising the importance of taking science to the public through different media outlets. I have participated in 6 events targeting non-scientific audiences, half of which aiming to disseminate the role of mathematics/statistics in everyday life and its diverse applications. I have authored 4 journal papers disseminating scientific concepts and activities to the public. I have been also active in spreading scientific ideas to the non-scientific audiences in press and media channels. My work on sea level change has been featured in two general circulation newspapers. I have participated in a TV show talking about atmospheric electricity and in a TV show on abrupt climate transitions. In the framework of the SAIL project, I have participated in a radio interview and several newspaper and magazine pieces.

I have also participated in several initiatives advocating the role of women in science. I was featured in the book “Women in Science 2021” and in the book “Women and technology”. I participated in the video series “Female Science: Gender equality in Research in Portugal and France” (https://www.youtube.com/watch?v=bpMySMC8Mrw).

In addition to scientific subjects, I cherish writing to the public bout work-related topics, and I have authored a newspaper article on teleworking, and a newspaper article on post-normal science, promoting scientific literacy.

3. Scientific production and/or selected activities

1 – Barbosa et al., 2017 (doi: 10.1016/j.jenvrad.2017.03.027)

This work addresses the temporal variability of ambient gamma radiation using data from my “Gamma radiation Monitoring” at the ENA station, together with comprehensive meteorological information. It shows that enhancements in gamma radiation driven by precipitation and resulting from nocturnal accumulation can be hard to distinguish, and that factors other than precipitation intensity need to be taken into account to characterise precipitation effects in gamma radiation enhancements, including aerosols and air masses characteristics.

2- Barbosa et al., 2018 (doi: 10.1016/j.jenvrad.2018.09.022).

This work, again using data from my “Gamma radiation Monitoring” at the ENA station, has two main new insights: i) radon progeny is influenced by sharp (sub-daily) variations in soil moisture (only long-term influences had been previously described in the literature) and ii) these can be misleadingly attributed to earthquake precursory signals (particularly if detailed meteorological information is not taken into consideration).

3- Barbosa, 2020 (doi: 10.1016/j.jenvrad.2020.106283).

Although the atmospheric electric field and ambient radioactivity are strongly linked, actual simultaneous observations of the two are scarce – partly as a result of being tackled by distinct scientific communities. In this paper I address this gap, providing new data and results from dedicated measurements performed at INESC TEC’s building rooftop.

4 - Barbosa et al., 2023 (doi: 0.1029/2022JD037570).

In this work, I present results from continuous ambient gamma radiation measurements performed in the marine environment, documenting, for the first time, precipitation-driven enhancements in gamma radiation in the open ocean.

5 - Barbosa et al., 2025. (doi: 10.5194/essd-17-1393-2025).

This work presents the datasets resulting from the SAIL campaign. Project SAILhad an enduring scientific impact, particularly in terms of the large volume of data still being collected, processed and made available to the scientific community in a currently ongoing effort (https://zenodo.org/communities/sail). This paper presents the first data from the SAIL campaign, documenting the process of data collection, quality control procedures, and analysis workflows.