

MARCELO R. SOUZA

Ph.D. in Meteorology



Center for Weather Forecasting and Climate Studies
National Institute for Space Research, São José dos Campos, Brazil
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Summary

Marcelo has a Ph.D. in Meteorology from the Federal University of Santa Maria (Brazil), where he investigates the contribution of extratropical cyclones and their associated fronts on precipitation patterns and magnitudes over the Southern Hemisphere for the present and future climate, using data from multiple CMIP6 models and reanalysis. He also holds a Master of Science degree focused on the seasonal variability of cyclones over the Southwestern South Atlantic and a bachelor's degree in Oceanography from the Federal University of Santa Catarina (Brazil). As he started his early career as an atmospheric scientist, he engaged in scientific research covering the fields of climatology, synoptic meteorology, climate change, and numerical modeling. All this experience helped him develop solid and strong programming and computational skills (Python, Fortran, Shell, CDO, Linux environment) and fluency in working with large datasets (CMIP5/6), reanalysis, and model simulations (RegCM, WRF). He also has unique skills in data visualization.

Research interests

- Synoptic and mesoscale meteorology
- Dynamics of extratropical cyclones and the mechanisms behind their development
- Responses of high-impact weather systems and extreme events to global warming
- Climate change impacts

Education

PH.D. IN METEOROLOGY

2019 - 2023

Federal University of Santa Maria / Brazil

Supervisor: Dr. Everson Dal Piva

Dissertation: Extratropical cyclones and associated precipitation in the Southern Hemisphere: present and future climate

M.SC. IN ENVIRONMENTAL AND WATER RESOURCES

2014 - 2016

Federal University of Itajubá / Brazil

Supervisor: Dr. Michelle Reboita

Thesis: Cyclones over the southwestern South Atlantic Ocean

B.SC. IN OCEANOGRAPHY

2008 - 2012

Federal University of Santa Catarina / Brazil

Supervisor: Dr. Bárbara Ramos

Complementary Education

Joint ICTP-Trieste/ICTP-SAI FR Advanced School
on Regional Climate Modeling
São Paulo State University, UNESP, Brazil

Fall 2016

Technical Skills

Python

- Data cleaning, analysis, and visualization
- **Statistical methods:** linear regression, statistical significance and hypothesis testing, composite and correlation analysis, EOF, extreme value theory
- **Large dataset handling:** CMIP5/6 ESGF, Pangeo
- **Machine learning techniques:** DBSCAN, K-Means clustering
- **Packages:** Xarray, Scipy, Metpy, Geopandas, Pandas, Scikit-learn, Numpy, Matplotlib, Cartopy, among others

Other programming languages and software

- FORTRAN
- Shell/Bash
- TRACK algorithm
- Climate Data Operators (CDO)
- ArcGIS

Numerical Modeling

- RegCM, WRF-ARW

Datasets

- **Model output data:** CMIP5/6
- **Reanalysis data:** ERA5, ERA-Interim, NCEP/NCAR, NCEP/DOE, CFSR
- **Analysis/forecast data:** GFS
- **Observational data:** GPCP, IBTrACS

File formats

- NetCDF, GRIB, .csv, .shp, .txt

Operational systems

- Linux, Windows

Soft Skills

Communication: Empathy, Active Listening, Public Speaking, Writing skills, Teamwork

Critical Thinking: Time Management, Deadline-oriented, Problem-solving skills, Willingness to learn

Experience and Research Projects

Researcher

2024 - present

Center for Weather Forecasting and Climate Studies, National Institute for Space Research / Brazil

- Analyzing cyclogenesis events and their key formation and development mechanisms across the South Atlantic Ocean (SAO) using reanalysis and observational data
 - Evaluating the unified and community Earth System model MONAN's performance in forecasting cyclogenesis and their precursors over South America and SAO
 - Investigating the energetics and evolution of cyclogenesis events using the eddy energy budget method (Orlanski and Katzfey, 1991) and contributing to implementing the energetics code into MONAN's output
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Project: Extratropical cyclones and associated precipitation in the Southern Hemisphere

2019 - 2023

Federal University of Santa Maria / Brazil
Supervisor: Dr. Everson Dal Piva

The project focused on the behavior of extratropical cyclones and their associated precipitation in the Southern Hemisphere under current and future climate scenarios. Utilizing data from CMIP6 models, ERA5 reanalysis, and GPCP observations, automated algorithms were developed and applied to track cyclones and atmospheric fronts and also to attribute the precipitation associated with these systems over the 1979-2014 and 2070-2099 periods under the SSP5-8.5 scenario. One of the main results from this project is a poleward migration of extratropical cyclones in the future and an increase in cyclone propagation speed and associated precipitation, particularly along frontal zones.

Teaching Assistant

Fall 2022

Federal University of Santa Maria / Brazil
Supervisor: Dr. Nathalie Boiaski

Developed educational materials and taught classes for the Global Changes course at the bachelor's program in Meteorology.

Teaching Assistant

Fall 2020

Federal University of Santa Maria / Brazil
Supervisor: Dr. Nathalie Boiaski

Developed educational materials and taught classes for the Observational Climatology and Statistics course in the bachelor's program in Meteorology.

Project: Weather and Climate in South America

2014 - 2017

Federal University of Itajubá / Brazil
Supervisor: Dr. Michelle Reboita

The project aimed to investigate the different atmospheric systems influencing weather and climate in South America using the regional climate model RegCM4 and conducting sensitivity experiments.

Project: Cyclones over the southwestern South Atlantic Ocean

2014 - 2016

Federal University of Itajubá / Brazil

Supervisor: Dr. Michelle Reboita

Based on studies that have shown a high frequency of cyclogenesis in the South Atlantic's southwest, particularly along the coasts of southern Brazil, Uruguay, and southeast Argentina, this project aims to assess cyclone climatology simulated by RegCM4 and HadGEM2-ES for the current climate (1979-2005) and future periods (2020-2050 and 2070-2089) under the RCP8.5 scenario, evaluating the model's performance to reproduce South Atlantic cyclogenesis patterns.

Teaching Assistant

Spring 2015

Federal University of Itajubá / Brazil
Supervisor: Dr. Michelle Reboita

Assisted class activities for the Applied Geometry course at the bachelor's program in Atmospheric Sciences.

Project: Dynamics of the sessile community on rocky shores under distinct oceanographic conditions

2012

Federal University of Santa Catarina / Brazil
Supervisor: Dr. Bárbara Ramos

This project aimed to assess the ecological dynamics of rocky shore environments at two beaches on Santa Catarina Island (Brazil) influenced by the coastal dynamics associated with extreme events.

Research Funding and Grants

Scholarships

Coordination for the Improvement of Higher Education Personnel Foundation (CAPES), Ministry of Education 2019 - 2023

Ph.D. Scholarship

Grant Number: 88882.428276/2019-01

Coordination for the Improvement of Higher Education Personnel Foundation (CAPES), Ministry of Education 2014 - 2016

M.Sc. Scholarship

Grant Number: 1385752

Scientific Publications

Peer-reviewed papers:

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1. **Souza, M. R.**, Piva, E. D., Nascimento, E. L., Gan, M. A., Anabor, V., Gozzo, L. F. Southern Hemisphere extratropical cyclones in a warming climate: climatology, characteristics and future changes. *International Journal of Climatology* (in prep). 2024.
 2. **Souza, M. R.**; Piva, E. D. Storm tracks and cyclogenesis over the Southern Ocean: An overview with the HadGEM3-GC3.1 model. *International Journal of Climatology*, v. 43, p. 7565-7587, 2023. <https://doi.org/10.1002/joc.8280>

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3. Reboita, M. S.; Amaro, T. R. & **Souza, M. R.** Winds: intensity and power density simulated by RegCM4 over South America in present and future climate. *Climate Dynamics*, v. 51, p. 187-205, 2018. <https://doi.org/10.1007/s00382-017-3913-5>
 4. Reboita, M. S.; Rocha, R. P.; **Souza, M. R.**; Llopart, M. Extratropical cyclones over the southwestern South Atlantic Ocean: HadGEM2-ES and RegCM4 projections. *International Journal of Climatology*, v. 38, p. 2866-287, 2018. <https://doi.org/10.1002/joc.5468>
 5. **Souza, M. R.**; Dupas, F. A.; Reboita, M. S. Apparent Surface Temperature in the Tavares River Watershed, Florianópolis. *Brazilian Journal of Climatology*, v. 21, p. 1-19, 2017. <http://dx.doi.org/10.5380/abclima.v21i0.46247>
 6. Reboita, M. S.; Corrêa, M. P.; **Souza, M. R.**; Silva, J. P. R. A Review of the Atmospheric Sciences Course in Southern Minas Gerais: Teaching, Research, Outreach, and Societal Benefits. *Brazilian Journal of Physical Geography*, v. 9, p. 2312-2324, 2016. <https://doi.org/10.5935/1984-2295.20160165>
 7. Reboita, M. S.; **Souza, M. R.**; Armando, R. P.; Freitas, C.; Martins, D.; Miller, G. The Causes of the Semiarid Climate in the Northeastern Sertão Region. *Brazilian Journal of Climatology*, v. 19, p. 254-277, 2016. <http://dx.doi.org/10.5380/abclima.v19i0.42091>
 8. Reboita, M. S.; **Souza, M. R.**; Silva, L. F.; Alves, M. A. Climatic Aspects of the State of Minas Gerais. *Brazilian Journal of Climatology*, v. 17, p. 206-226, 2015. <http://dx.doi.org/10.5380/abclima.v17i0.41493>

Abstracts and extended abstracts published in conference proceedings:

1. Reboita, M. S.; **Souza, M. R.**; Rocha, R. P. Extratropical cyclones over southwestern Atlantic Ocean: present and future climates projected by RegCM4. In: *EGU General Assembly*, Vienna, Austria, 2017.
2. **Souza, M. R.**; Amaro, T. R.; Ferreira, A. F.; Carnevali, M. P.; Almeida, E. C.; Podesta, D. L.; Pons, N. A. D. Surface Apparent Temperature Dynamics of the Tavares River Watershed, Florianópolis (SC). In: *XVII Brazilian Symposium on Remote Sensing*, João Pessoa, Brazil, 2015.
3. Rocha, R. P.; Reboita, M. S.; **Souza, M. R.** Cyclones climatology over the South Atlantic Ocean in different reanalysis projects. In: *11th International Conference on Southern Hemisphere Meteorology and Oceanography*, Santiago, Chile, 2015.
4. Reboita, M. S.; Rocha, R. P.; **Souza, M. R.** Cyclones climatology over the southwestern South Atlantic Ocean projected by RegCM4 nested in HadGEM2-ES. In: *11th International Conference on Southern Hemisphere Meteorology and Oceanography*, Santiago, Chile, 2015.
5. Amaro, T.; **Souza, M. R.**; Reboita, M. S. Surface wind comparison in Minas Gerais: RegCM4, INMET, and ERA-INTERIM. In: *18th Brazilian Congress of Meteorology*, Recife, Brazil, 2014.
6. Almeida, E. C.; **Souza, M. R.**; Vital, R. C.; Bernardes, M. E. C. Environmental Education Practice at Major João Pereira State School, Itajubá-MG, with emphasis on energy and water consumption. In: *IX Seminar on Environment and Renewable Energies*, Itajubá, Brazil, 2014.
7. Dreyer, J.; Goncalves Neto, A.; Nascimento, L. V.; Puhl, P. R.; Behring, A.; Pereira, B.; Miranda, R. J.; **Souza, M. R.**; Ritter, F.; Bexiga, G.; Schmitt, P.; Fonseca, A. Oceanographic characterization of the southern region of Lagoa da Conceição (SC, Brazil) and its relationship with the eutrophication process. In: *IV Brazilian Congress of Oceanography*, Rio Grande, Brazil, 2010.

Languages

- **English:** Advanced (Reading, Listening, Speaking, Writing)
- **Spanish:** Advanced (Reading), Intermediate (Speaking, Listening, Writing)
- **Portuguese:** Native speaker

Referees

Prof. Dr. Everson Dal Piva

Professor at the Federal University of Santa Maria / Brazil

- **Relation:** Ph.D. Supervisor
- **Contact:** everson.bento@gmail.com

Prof. Dr. Ernani de Lima Nascimento

Professor at the Federal University of Santa Maria / Brazil

- **Relation:** Professor during Ph.D. studies and member of the dissertation defense committee
- **Contact:** ernani.nascimento@ufsm.br

Prof. Dr. Vagner Anabor

Professor at the Federal University of Santa Maria / Brazil

- **Relation:** Member of the dissertation defense committee
- **Contact:** vanabor@ufsm.br