PERSONAL DETAILS

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- **Education and key qualifications**

16/10/2017	Ph.D., Geophysics Niels Bohr Institute, University of Copenhagen, Denmark Supervisor: Prof. Paul Vallelonga
2014	M.Sc., Physics - Curriculum nuclear and subnuclear physics (110/110 *cum laude*) Department of Physics, University of Milano-Bicocca, Milan, Italy

- **Current position(s)**

2025 –	Tenured Researcher / Assist. Professor Dept. of Environmental Sciences, Informatics and Statistics, University of Venice, Italy

- **Previous position(s)**

2023 – 2025	Assistant Specialist Dept. of Earth System Science, University of California Irvine, United States
2022 – 2023	Postdoc Institute of Polar Sciences - Italian National Research Council, Italy
2020 – 2022	Postdoc Dept. of Environmental Sciences, Informatics and Statistics, University of Venice, Italy
2018 – 2020	Postdoc Institute of Polar Sciences - Italian National Research Council, Italy
2017 – 2018	Postdoc Niels Bohr Institute, University of Copenhagen, Denmark

RESEARCH ACHIEVEMENTS

ICENET and SKYNET – Global Glacier Ice Thickness and Volume (2022–2026).
Over the last four years, my research has focused on improving global glacier ice volume estimates using machine learning, with particular emphasis on reconciling large regional discrepancies and constraining the uncertainties over the world's regions hosting large ice volumes.
ICENET (2022–2023) was a pilot project which I led as PI at the National Research Council. The project explored deep-learning image inpainting to reconstruct glacier bed elevation and ice volume directly from surface topography. Glacierized regions were treated as masked areas within a Digital Elevation Model, and a generative adversarial network (GAN) was trained to infer subglacial bed elevation from surrounding ice-free terrain. The project focused on High Mountain Asia, one of the least constrained glacier regions globally despite its critical importance for water resources. While GAN-based inpainting proved suboptimal for ice-volume estimation–due to its inability to incorporate direct ice-thickness observations–ICENET clearly demonstrated the limitations of purely topography-based approaches and motivated the development of models explicitly integrating observational data. The methodological expertise developed during ICENET directly informed the subsequent, successful approach implemented in SKYNET.
SKYNET (2023–2026) led to the development of IceBoost, a machine-learning model capable of estimating the ice thickness of every glacier on Earth. IceBoost is based on gradient-boosted decision trees, enabling the effective use of all available in situ ice-thickness measurements (>7 million points worldwide). I designed and implemented the complete modeling pipeline, including predictor selection, assessment of variable importance, training, validation, and global deployment. The model uses 39 physical and geometrical predictors, including surface elevation and its gradients, glacier geometry, mass balance, ice velocity, and surface temperature. IceBoost achieves 20–45% lower errors than previous approaches in polar regions and comparable performance elsewhere, establishing a new benchmark for global glacier thickness modeling. Using IceBoost, we generated spatially distributed thickness maps and ice-volume estimates for all glaciers in the Randolph Glacier Inventory

(215,547 and 274,531 glaciers in the latest two versions), yielding a total global glacier volume of (149 ± 38)×10^3 km^3, equivalent to 323 ± 91 mm of sea-level-rise potential.

In my most recent study I applied IceBoost globally and released individual glacier-scale products, including modeled ice thickness, associated model uncertainty, and the Jensen gap. I developed the full automated processing pipeline and released an improved version of the model (IceBoost v2.0), addressing limitations identified in earlier version. The resulting public dataset comprises 490,078 glacier maps hosted on Zenodo and has reached a cumulative download volume of 700+ GB.

The performance and generalization capability of IceBoost led to its adoption for peripheral glaciers in the latest releases of the Ice Sheet BedMachine products for both Antarctica and Greenland. For this application, the model was retrained using an extended training dataset exceeding 7 million ice thickness observations, including new data over the Antarctic Peninsula.

I led the **ICELEARNING project (2020-2022)**, introducing machine learning–based particle identification to ice core science for the first time. I developed a non-destructive, end-to-end framework combining flow-imaging microscopy with a hybrid MLP–CNN architecture for the autonomous classification of insoluble particles in ice cores. I designed and implemented the full experimental and modeling pipeline, including instrument characterization, construction of a large labeled dataset (>100,000 particle images), model development and optimization, and application to real ice-core samples. The system achieved near-expert performance (~97% classification accuracy) across multiple particle classes (mineral dust, volcanic tephra, pollen species, contaminants) and was successfully applied to Greenland (GRIP) and Andean ice cores. The project resulted in public release of datasets and trained models; the dataset comprises several hundred thousand particle images and has been downloaded for a total data volume of 305 GB.

My **previous postdoctoral research** focused on reconstructing past Arctic and Antarctic sea ice extent using chemical markers preserved in ice core and marine sediment records. In 2021, this work resulted in two major review articles. The first, which I authored as first author, synthesized all available Holocene North Atlantic sea ice proxy records from marine sediments and ice cores to assess the spatial variability of sea ice across the region. The second review, which I co-authored, provided a comprehensive assessment of all existing chemical sea ice proxies from ice cores, discussing their physical basis, advantages, limitations, and suitability for paleoclimate reconstructions. In addition, I led a major research study aimed at reconstructing a 120,000-year record of North Atlantic sea ice using chemical proxy records from an ice core drilled in East Greenland. The interpretation and validity of these sea ice chemical markers, particularly halogen elements, remain an active and debated topic within the ice core science community. Earlier, in 2019, I led a study in which I developed an atmospheric transport model to backtrack the source of radioactive ruthenium (Ru-106) detected across Europe. The analysis identified the Mayak nuclear facility in Russia as the most likely source, associated with the production of 144-Ce. This conclusion was subsequently confirmed by independent studies using alternative methodologies.

PEER RECOGNITION

- **Funded Projects and Fellowships**

1. **MARIE CURIE GLOBAL FELLOWSHIP, "Estimating the ice volume of Earth's glaciers via Artificial Intelligence and remote sensing, SKYNET", 2023-2026, N. Maffezzoli (University of Venice), €288,000.** Success rate: 11%.

2. **CLIMATE CHANGE A.I. INNOVATION GRANT, "Estimate the ice volume of all glaciers in High Mountain Asia with deep learning, ICENET", 2022-2023, N. Maffezzoli, PI (National Research Council, Institute of Polar Sciences), $145,000.** Success rate: 9%.

3. **MARIE CURIE EUROPEAN FELLOWSHIP, "Artificial Intelligence techniques for ice core analyses, ICELEARNING", 2020-2022, N. Maffezzoli (University of Venice), €171,000.** Success rate: 13%.

TEACHING AND MENTORING

- **Student Mentoring and Advising**

  - Advisor, Gianluca Lagnese, Postdoctoral researcher, National Research Council, "Estimate the ice volume of all glaciers in High Mountain Asia with deep learning", 2022-2023.
  - Co-Supervisor, Veronica Amoruso, Ph.D. in Polar Sciences, University of Venice, "A snowpack module for modelling chemical exchanges (mercury, iodine, bromine) at the snow-air interface in climate models", 2025-ongoing.
  - Co-Supervisor, Alessia Oliva, Ph.D. in Polar Sciences, University of Venice, "Investigation of the ice sheet surface processes and their interactions with the atmosphere using satellite observations", started December 2025-ongoing.
  - MSc thesis advisor, Computer Science, Daniel Magleby Sørensen, Niels Bohr Institute, "Estimating glacier ice volume using image inpainting", 2022.
  - MSc thesis advisor, Physics, Amalie Faber Mygind, Niels Bohr Institute, "Machine Learning Methods for Autonomous Detection of Impurities in Ice Cores", 2022.

- **Teaching**

  - Physics (undergraduate), University of Venice (A.A. 2025-2026)
  - Teaching Assistant in Applied Statistics (graduate), University of Copenhagen (2015, 2016) with Prof. Troels Petersen.
  - Teaching Assistant in Advanced methods in Applied statistics (graduate), University of Copenhagen (2017) with Prof. Jason Koskinen.
  - Collaborator in Applied Machine Learning (graduate), University of Copenhagen (2021, 2024, 2025, 2026) with Prof. Troels Petersen.

ADDITIONAL INFORMATION

- **Academic Membership**

Elected member of the Italian Glaciological Committee since 2022.

- **Other Contributions to the Research Community**

Developer of the global glacier Web Visualizer IceBoost, designed for both academic research and teaching. It provides interactive access to, and downloadable products of, ice thickness maps for all glaciers on Earth.

- **Awards**

  - Finalist (top-20) for the award *"Advancing Technology for Humanity. Most Promising Researcher in Robotics and AI"* (2023, link).
  - Winner of Early Career Scientist award for the 15^{th} International Global Atmospheric Chemistry conference (Takamatsu, Japan, 2018)

- **Presence in the media**

  - La Repubblica Newspaper, 25/05/25, "Ghiacciai e intelligenza artificiale: un nuovo modello globale per calcolare profondità e volume", link.
  - La Repubblica Newspaper, 21/01/20, "Clima, in una "carota" da record 120 mila anni di ghiaccio artico", link.
  - Sky, 22/01/20, "Nel ghiaccio marino artico 120.000 anni di storia", link.
  - AISE International Agency for Foreign Press, 25/06/19, "Il CNR conferma l'origine del fallout di rutenio radioattivo del 2017", link.

- **Field campaigns**

  - Ice core drilling expeditions in Greenland (Renland ice cap, 2015 and EGRIP, 2016).
  - Field campaigns in Svalbard (Ny-Ålesund, 2018, 2019, 2023).

- **Project participation**
  - ERC Synergy *Ice2Ice* (2014-2019). Role: development of sea ice proxies from ice core records.
  - East Greenland Ice-core Project *EGRIP* (University of Copenhagen, 2015-ongoing). Role: reconstruction of Arctic sea ice extent from ice and sediment core records during the Holocene.

- **Major collaboration**

I collaborate with Prof. Eric Rignot's group at the University of California and with Dr. Bernd Scheuchl (University of California, Irvine & Jet Propulsion Laboratory) on the use of Synthetic Aperture Radar (SAR) data for ice-sheet science. I collaborate with Prof. Mathieu Morlighem (Dartmouth College), who leads the state-of-the-art Ice Sheet and Sea-Level System Model (ISSM) and subglacial topography mapping of the Greenland and Antarctic ice sheets. I have a long-standing collaboration with Prof. Troels Petersen, particle physicist at the University of Copenhagen and CERN (Geneva), focused on the development of machine learning systems to foster innovation across scientific domains. I also collaborate with Prof. Carlo Barbante (University of Venice and Institute of Polar Sciences) and Prof. Kerim Hestnes Nisancioglu (Bjerknes Centre for Climate Research, University of Bergen) on Arctic paleoreconstructions.

- **Invited presentations**
  - Jet Propulsion Laboratory Cryosphere Division (2025)
  - Scripps Institution of Oceanography (2025)
  - Machine Learning-Physics Conference (Niels Bohr Institute, 2025)
  - Dartmouth College "Ice Future" – Research Group (2024)

- **Reviewer for Research Proposals**
  - Reviewer for the French National Research Agency (ANR), AAPG 2025 call, Project *GlacioSim*: "Glacier displacement monitoring with similarity learning".
  - Reviewer for the Research Excellence Council of Hungary, 2025 call, Project "Investigating the potential appearance of present-day Martian water with machine learning techniques".

PUBLICATIONS

1. Morlighem, M., Charrassin, R., **Maffezzoli, N.**, Millan, R., Ockenden, H., Schlegel, N.J., Seroussi, H. and Wood, M., 2026. New high-resolution subglacial bed topography and coastal bathymetry of the Antarctic and Greenland Ice Sheets. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 384(2319).

2. **Maffezzoli, N.**, Rignot, E., Barbante, C., Morlighem, M., Petersen, T. and Vascon, S., 2025. Machine-learned global glacier ice volumes. arXiv preprint arXiv:2512.11685 (link)

3. **Maffezzoli, N.**, Rignot, E., Barbante, C., Petersen, T. and Vascon, S. A gradient-boosted tree framework to model the ice thickness of the world's glaciers (IceBoost v1. 1). Geoscientific Model Development, 18(9), pp.2545-2568, 2025.

4. Scoto, F., **Maffezzoli, N.**, Osman, M.B., Cuevas, C.A., Vallelonga, P., Matoba, S., Iizuka, Y., Gagliardi, A., Varin, C., Burgay, F. and Pappaccogli, G. Calibration of Arctic ice core bromine enrichment records for past sea ice reconstructions. Science of The Total Environment, p.177063 (2024).

5. Vecchiato, M., Barbante, C., Barbaro, E., Burgay, F., Cairns, W.R., Callegaro, A., Cappelletti, D., Dallo, F., d'Amico, M., Feltracco, M., Gallet, J.C., Gambaro, A., Larose, C., **Maffezzoli, N.**, Mazzola, M., Sartorato, I., Scoto, F., Turetta, C., Vardè, M., Xie, Z., and Spolaor, A., The seasonal change of PAHs in Svalbard surface snow. Environmental Pollution, 340, p.122864 (2024).

6. Erhardt, T., Jensen, C.M., Adolphi, F., Kjær, H.A., Dallmayr, R., Twarloh, B., Behrens, M., Hirabayashi, M., Fukuda, K., Ogata, J., Burgay, F., ..., **Maffezzoli, N.**, ..., Muscheler, R., Darfeuil, S., and Fischer, H. High-resolution aerosol data from the top 3.8 kyr of the East Greenland Ice coring Project (EGRIP) ice core. Earth System Science Data, 15(11), pp.5079-5091 (2023).

7. **Maffezzoli, N.**, Cook, E., van der Bilt, W.G., Støren, E.N., Festi, D., Muthreich, F., Seddon, A.W., Burgay, F., Baccolo, G., Mygind, A.R. and Petersen, T. Detection of ice core particles via deep neural networks. The Cryosphere, 17(2), pp.539-565 (2023).

8. Corella, J.P., **Maffezzoli, N.**, Spolaor, A., Vallelonga, P., Cuevas, C.A., Scoto, F., Müller, J., Vinther, B., Kjær, H.A., Cozzi, G. and Edwards, R., Barbante C. and Saiz-Lopez A. Climate changes modulated the history of Arctic iodine during the Last Glacial Cycle. Nature communications, 13(1), pp.1-9, (2022).

9. Scoto, F., Sadatzki, H., **Maffezzoli, N.**, Barbante, C., Gagliardi, A., Varin, C., Vallelonga, P., Gkinis, V., Dahl-Jensen, D., Kjær, H.A. and Burgay, F. Sea ice fluctuations in the Baffin Bay and the Labrador Sea during glacial abrupt climate changes. Proceedings of the National Academy of Sciences, 119(44), p.e2203468119 (2022).

10. Vardè, M., Barbante, C., Barbaro, E., Becherini, F., Bonasoni, P., Busetto, M., Calzolari, F., Cozzi, G., Cristofanelli, P., Dallo, F., De Blasi, F., Gabrieli, J., **Maffezzoli, N.**, Morabito, E., Putero, D., Spolaor, A., and Cairns, W.R.L. Characterization of atmospheric total gaseous mercury at a remote high-elevation site (Col Margherita Observatory, 2543 m asl) in the Italian Alps. Atmospheric Environment, 271, p.118917 (2022).

11. **Maffezzoli, N.**, et al. Sea ice in the northern North Atlantic through the Holocene: Evidence from ice cores and marine sediment records. Quaternary Science Reviews 273, 107249, (2021).

12. Vallelonga, P., **Maffezzoli, N.**, Saiz-Lopez, A., Scoto, F., Kjær, H.A. and Spolaor, A. Sea-ice reconstructions from bromine and iodine in ice cores. Quaternary Science Reviews, 269, p.107133, (2021).

13. Cairns, W.R., Turetta, C., **Maffezzoli, N.**, Magand, O., Araujo, B.F., Angot, H., Segato, D., Cristofanelli, P., Sprovieri, F., Scarchilli, C. and Grigioni, P. Mercury in precipitated and surface snow at Dome C and a first estimate of mercury depositional fluxes during the Austral summer on the high Antarctic plateau. Atmospheric Environment, 262, p.118634 (2021).

14. Segato, D., Villoslada Hidalgo, M.D.C., Edwards, R., Barbaro, E., Vallelonga, P., Kjær, H.A., Simonsen, M., Vinther, B., **Maffezzoli, N.**, Zangrando, R. and Turetta, C. Five thousand years of fire history in the high North Atlantic region: natural variability and ancient human forcing. Climate of the Past, 17(4), pp.1533-1545 (2021).

15. Feltracco, M., Barbaro, E., Spolaor, A., Vecchiato, M., Callegaro, A., Burgay, F., Vardè, M., **Maffezzoli, N.**, Dallo, F., Scoto, F. and Zangrando, R. Year-round measurements of size-segregated low molecular weight organic acids in Arctic aerosol. Science of The Total Environment, 763, p.142954 (2021).

16. Sadatzki, H., **Maffezzoli, N.**, Dokken, T.M., Simon, M.H., Berben, S.M., Fahl, K., Kjær, H.A., Spolaor, A., Stein, R., Vallelonga, P. and Vinther, B.M. Rapid reductions and millennial-scale variability in Nordic Seas sea ice cover during abrupt glacial climate changes. Proceedings of the National Academy of Sciences, 117(47), pp.29478-29486, (2020).

17. **Maffezzoli, N.**, Vallelonga, P., Edwards, R., Saiz-Lopez, A., Turetta, C., Kjær, H.A., Barbante, C., Vinther, B. and Spolaor, A. A 120 000-year record of sea ice in the North Atlantic?. Climate of the Past, 15(6), pp.2031-2051, (2019)

18. Corella, J.P., **Maffezzoli, N.**, Cuevas, C.A., Vallelonga, P., Spolaor, A., Cozzi, G., Müller, J., Vinther, B., Barbante, C., Kjær, H.A. and Edwards, R. Holocene atmospheric iodine evolution over the North Atlantic. Climate of the Past, 15(6), (2019).

19. **Maffezzoli, N.**, Baccolo, G., Di Stefano, E. and Clemenza, M. The Ruthenium-106 plume over Europe in 2017: A source-receptor model to estimate the source region. Atmospheric Environment, 212, pp.239-249, (2019).

20. Cuevas, C.A., **Maffezzoli, N.**, Corella, J.P., Spolaor, A., Vallelonga, P., Kjær, H.A., Simonsen, M., Winstrup, M., Vinther, B., Horvat, C., Fernandez, R.P., Kinnison, D., Lamarque, J-F., Barbante, C., and Saiz-Lopez, A., Rapid increase in atmospheric iodine levels in the North Atlantic since the mid-20th century, Nature Communications, 9, 1452 (2018).

21. **Maffezzoli, N.**, Spolaor A., Barbante C., Bertò M., Frezzotti M., Vallelonga P., Bromine, iodine and sodium in surface snow along the 2013 Talos Dome–GV7 traverse (northern Victoria Land, East Antarctica), The Cryosphere, (2017).

22. Vallelonga, P., **Maffezzoli, N.**, Moy, A. D., Curran, M. A. J., Vance, T. R., Edwards, R., Hughes, G., Barker, E., Spreen, G., Saiz-Lopez, A., Corella, J. P., Cuevas, C. A., and Spolaor, A.: Sea-ice-related halogen enrichment at Law Dome, coastal East Antarctica, Climate of the Past, 13, 171-184, (2017).

23. Spolaor, A., Vallelonga, P., Turetta, C., **Maffezzoli, N.**, Cozzi, G., Gabrieli, J., Barbante, C., Goto-Azuma, K., Saiz-Lopez, A., Cuevas, C.A., Dahl-Jensen, D. Canadian arctic sea ice reconstructed from bromine in the Greenland NEEM ice core, Scientific Reports, (2016).

24. Baccolo, G., Clemenza, M., Delmonte, B., **Maffezzoli, N.**, Nastasi, M., Previtali, E., Prata, M., Salvini, A., Maggi, V., A new method based on low background instrumental neutron activation analysis for major, trace and ultra-trace element determination in atmospheric mineral dust from polar ice cores, Analytica Chimica Acta, (2016).

25. Baccolo, G., **Maffezzoli, N.**, Clemenza, M., Delmonte, B., Prata, M., Salvini, A., Maggi, V., Previtali, E., Low-background neutron activation analysis: a powerful tool for atmospheric mineral dust analysis in ice cores, Journal of Radioanalytical and Nuclear Chemistry, (2015).

26. Baccolo, G., Delmonte, B., Clemenza, M., **Maffezzoli, N.**, Nastasi, M., Previtali, E., Maggi, V., Assessing the geochemical fingerprint of the 2010 Eyjafjallajökull tephra through instrumental neutron activation analysis: a trace element approach, Journal of Radioanalytical and Nuclear Chemistry, (2015).