Monali Borthakur

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Research Profile

Atmospheric physicist and climate modeler specializing in middle-atmosphere chemistry and dynamics, energetic particle precipitation, sudden stratospheric warmings, and chemistry–climate interactions. Experienced in global atmospheric modeling using EMAC, ICON-ART, and ExoTIC, with expertise in wave–mean flow diagnostics, satellite-data validation, and large atmospheric dataset analysis. Published researcher with international collaborations in Germany and the United States.

Research Experience

Postdoctoral Researcher, ENRICH Project **Nov 2023 – Mar 2026**

Karlsruhe Institute of Technology, Karlsruhe, Germany

- Investigate exceptionally strong Arctic polar vortices and associated ozone depletion events using ICON-ART model simulations.
- Analyze anomalous wave activity, wave–mean flow interactions, and dynamical processes during extreme winters, including 2011 and 2020.
- Apply Transformed Eulerian Mean diagnostics and Rossby wave refractive index calculations to reanalysis and model datasets.
- Study tropopause inversion layer variability and its potential role in supporting persistent strong polar vortex conditions.

Doctoral Researcher, Dr. rer. nat. / PhD in Physics **Nov 2020 – Nov 2024**

Karlsruhe Institute of Technology, Karlsruhe, Germany

Dissertation: *Investigation of the impact of atmospheric ionisation on middle atmosphere chemistry and dynamics – model studies with ExoTIC and EMAC*
Supervisors: Prof. Peter Braesicke and Dr. Miriam Sinnhuber

- Investigated impacts of atmospheric ionization on middle-atmosphere chemistry using ExoTIC and EMAC chemistry-climate models.
- Validated ExoTIC simulations against MIPAS satellite observations during high-energy particle precipitation events.
- Studied effects of chlorine ion chemistry and odd nitrogen species on ozone loss during major solar proton events.
- Examined chemical and dynamical impacts of energetic particle precipitation during sudden stratospheric warmings.

Education

Dr. rer. nat. / PhD in Physics **2020 – 2024**

Karlsruhe Institute of Technology, Karlsruhe, Germany

M.Sc. Physics **2017 – 2020**

University of Bonn, Bonn, Germany

Thesis: *Estimating the robustness of edges in complex networks using a perturbation-based approach*

- Investigated edge importance and robustness in structural and functional complex networks using centrality measures and perturbation methods.
- Extended analyses to dynamical systems using Kuramoto oscillator frameworks.

B.S. Physics **2013 – 2017**

Gauhati University, Guwahati, India

Thesis: *Detecting periodicities in tree-ring width time series*

- Applied wavelet transforms, Fourier methods, and statistical analysis to investigate climatic periodicities in Himalayan tree-ring datasets.

Research Internships

Visiting Research Intern **Sep 2023 – Oct 2023**

Cornell University, Ithaca, NY, USA

- Investigated polar vortex dynamics and sudden stratospheric warming processes.

Research Intern **Apr 2019 – May 2019**

Forschungszentrum Jülich, Jülich, Germany

- Studied nonlinear lower-stratospheric responses to ENSO variability using the CLaMS model.

Summer Research Fellow **Jun 2015 – Aug 2015**

Institute for Plasma Research, Gandhinagar, India

- Designed and constructed a Rogowski coil for high-frequency plasma current measurements in argon plasma experiments.

Technical Skills

Climate and Atmospheric Models: EMAC, ECHAM5/MESSy, ICON-ART, ExoTIC, CLaMS
Programming and Scientific Computing: Python, Fortran, C, MATLAB, R, Git/GitLab, JITCODE, GraphTool, GNUPlot, LaTeX
Scientific Expertise: Atmospheric chemistry and dynamics, energetic particle precipitation, ozone chemistry, sudden stratospheric warmings, wave diagnostics, satellite-data validation, reanalysis analysis

Publications

Peer-reviewed publication

Borthakur, M., Sinnhuber, M., Laeng, A., Reddmann, T., Braesicke, P., Stiller, G., von Clarmann, T., Funke, B., Usoskin, I., Wissing, J., & Yakovchuk, O. (2023). *Impact of chlorine ion chemistry on ozone loss in the middle atmosphere during very large solar proton events.* Atmospheric Chemistry and Physics, 23, 12985–13007. doi:10.5194/acp-23-12985-2023

Dissertation

Borthakur, M. (2025). *Investigation of the impact of atmospheric ionisation on middle atmosphere chemistry and dynamics – model studies with ExoTIC and EMAC.* Karlsruhe Institute of Technology. doi:10.5445/IR/1000177654572

Submitted manuscript

Borthakur, M. et al. *Investigating chemical and dynamical effects of different solar forcings during a strong sudden stratospheric warming.* Under Review for *Journal of Geophysical Research: Space Physics.*

Scientific Communication

- Contributor to the European Geosciences Union Solar-Terrestrial Sciences Division Blog.
- Authored science communication article on chlorine ion chemistry and solar proton event induced ozone loss.

Languages

Native: Hindi, Assamese **Full professional proficiency:** English **Elementary proficiency:** German