

**Dr. Ute Christina Herzfeld**

February 1, 2025

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ECEE

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## CURRICULUM VITAE

Research Professor, Department of Electrical, Computer and Energy Engineering, University of Colorado Boulder

Affiliate Professor, Department of Computer Sciences, CU Boulder

Affiliate Professor, Department of Applied Mathematics, CU Boulder

Department Representative of ECEE to the CU Geophysics Program

### Academic Education and Degrees

- 1978-1983 Study of mathematics and evangelical theology, Universität Mainz, Germany, and University of Warwick, Coventry, England
- Dec. 1983 **State Examination (Master's Degree)**, Mathematics, Evangelical Theology, Johannes Gutenberg-Universität Mainz, Germany (summa cum laude), thesis in the theory of finite soluble groups
- 1982-1986 Study of geology, geophysics, oceanography, geography, glaciology
- June 1986 **Doctoral Degree (Dr. rer. nat.)**, Mathematics (with Prof. Dr. K. Doerk), thesis in the theory of finite groups, secondary subjects applied mathematics and geosciences, Johannes Gutenberg-Universität Mainz
- 1986 **Diploma of Postgraduate Studies in Mathematical Geology**, Free University of Berlin, Germany (with Prof. Dr. W. Skala), two thesis papers (a) on geostatistical estimation of bathymetric data, and (b) on statistical classification of digital satellite images (LANDSAT)

### Fellowships and Awards

- 1978-1983 **Scholarship, German National Scholarship Foundation** (Studienstiftung des deutschen Volkes), Bonn, Germany
- 1980-1981 **Scholarship for Studies Abroad, German National Scholarship Foundation**, Bonn, at the University of Warwick, Coventry, Great Britain
- 1984-1986 **Doctoral Fellowship, German National Scholarship Foundation**, Bonn
- 1987-1988 **Postdoctoral Fellowship, German Science Foundation** (Deutsche Forschungsgemeinschaft), Bonn, Germany, at Mathematical Geology, Free University of Berlin, Germany
- 1988-1992 **Feodor Lynen Fellowship, Alexander von Humboldt Foundation**, Bonn, Germany, at Scripps Institution of Oceanography, University of California at San Diego, USA
- 1992 **President's Prize of the International Association for Mathematical Geology** for outstanding contributions to theoretical and applied geostatistics
- 1994-1995 **Heisenberg Fellow, German Science Foundation** (Deutsche Forschungsgemeinschaft), at Institute of Arctic and Alpine Research, University of Colorado Boulder

- 2002-2004 **CIRES Visiting Fellow**, at CIRES (Cooperative Institute for Research in Environmental Sciences), University of Colorado Boulder
- 2009 **National Aeronautics and Space Administration Ames Honor Award to CASIE Project Team** for excellence in the category Group/Team (Ute Herzfeld Coinvestigator of Characterization of Arctic Sea Ice Experiment (CASIE))
- 2010 **National Aeronautics and Space Administration Group Achievement Award to CASIE Team** for outstanding accomplishments in the Characterization of Arctic Sea Ice Experiment (CASIE) (Ute Herzfeld Coinvestigator of CASIE)
- 2018 **NASA Goddard Space Flight Center Award to Ute Herzfeld in recognition and appreciation of your outstanding contribution to the successful development, launch and activation of the Ice, Cloud, and Land Elevation Satellite (ICESat-2)**; 15 October 2018
- 2019 **National Aeronautics and Space Administration Group Achievement Award to ICESat-2 Launch and Commissioning** for significant launch and commissioning preparations and achievements enabling the success of the ICESat-2 mission, Washington, DC, August 28, 2019
- 2019 **National Aeronautics and Space Administration Group Achievement Award to ICESat-2 Team** for exceptional technological achievements and scientific performance seen in the first half year after launch of the ICESat-2 mission, Washington, DC, August 28, 2019

#### Positions

- 2021-present **Affiliate Professor, Department of Computer Sciences** (since March 2021)
- 2018-present **Research Professor, Department of Electrical, Computer and Energy Engineering, University of Colorado Boulder**, Director of the Geomathematics, Remote Sensing and Cryospheric Sciences Laboratory (Computational mathematics, Data science methods and applications, especially in cryospheric sciences, laser Altimetry, and image classification, Machine learning algorithms and applications, Development of physically constrained mathematical and statistical algorithms and applications in physical sciences, airborne and satellite remote-sensing technology; Development of algorithms for detection of ice surfaces, cloud layers, tree canopy and ground in micro-pulse laser altimeter data for ICESat-2; Cyberinfrastructure development for data-driven classification, parameterization and numerical modeling; Classification methods for signal processing; Big Data computational algorithms and analysis; Bering Glacier Surge 2011-2014 (Alaska) and Negribreen Surge 2017-2023 (Svalbard): Airborne and satellite observation, analysis and numerical modeling; Spatial statistical analysis of roughness structures of glaciers and sea ice and their influence on satellite signals; Model-data comparison), Development of a Density-Dimension Algorithm (DDA) for atmospheric lidar data (CALIPSO, ICESat-2), for height-determination in crevassed and otherwise complex ice surfaces (DDA-ice), for detection of melt ponds in sea-ice lidar data (DDA-bifurcate-seaice) and in shallow-water bathymetric lidar observations (DDA-bifurcate)
- 2015-present **Department Representative of ECEE to the CU Geophysics PhD Program**
- 1993-present **Affiliate Professor, Department of Applied Mathematics, University of Colorado Boulder** (advisory of undergraduate and graduate research assistants)
- 2004-2019 **Senior Research Associate, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder** (complex changes in Arctic sea ice, glaciology of fast-moving glaciers in Greenland, Antarctica, Iceland and Alaska, geostatistical classification of sea ice and glaciers from field and remote-sensing data, energy transfer cryosphere – atmosphere)
- 2010-2018 **Research Associate Professor, Department of Electrical, Computer and Energy Engineering, University of Colorado Boulder**, Director of the Geomathematics and Remote Sensing Laboratory (development of physically constrained mathematical and statistical algorithms and applications in physical sciences, airborne and satellite remote-sensing technology; Clas-

- sification methods for signal processing; Big Data computational algorithms and analysis; Development of algorithms for detection of ice surfaces, cloud layers, tree canopy and ground in micro-pulse laser altimeter data for ICESat-2; Bering Glacier Surge 2011-2014 (Alaska) and Negribreen Surge 2017 (Svalbard): Airborne and satellite observation, analysis and parameterization; Spatial statistical analysis of roughness structures of glaciers and sea ice and their influence on satellite signals; Model-data comparison; New course Spring 2011: Remote Sensing, Signal Processing and Spatial Data Analysis ECEN 4004)
- 2007-2008 **Lecturer, Department of Applied Mathematics, CU Boulder** (APPM 7400-001: Spatial Statistics: Theory and Applications, and APPM 2350: Calculus 3 for Engineers)
- 2002-2004 **CIRES Visiting Fellow at the University of Colorado, Boulder** (collaboration with Prof. Dr. Konrad Steffen, Cooperative Institute for Research in Environmental Sciences, and Prof. Dr. Roger Barry, Director, National Snow and Ice Data Center / World Data Center for Glaciology)
- 1995-2003 **Professor (Universitätsprofessor, C3) and Head of Geomathematics Division, University of Trier, Department of Geography and Geosciences** (development and organisation of a geomathematics program, research in geomathematics, remote sensing, geophysics, environmental and cryospheric sciences, Greenland expeditions, instrument development)
- 10/1999-3/2000 **Sabbatical** at the University of Colorado, Boulder (snow surface roughness, snow hydrology, and geostatistics; with Prof. Dr. Nel Caine, Institute of Arctic and Alpine Research) and as **Visiting Professor** to the University of British Columbia, Vancouver, Canada (study of damaged material (crevassed glaciers) using continuum damage mechanics and geostatistical classification; with Prof. Dr. Garry Clarke)
- 1995-2003 **Fellow Adjoint and Senior Research Associate, Institute of Arctic and Alpine Research, University of Colorado Boulder**
- 1994-1995 **Heisenberg Fellow, German Science Foundation** (Deutsche Forschungsgemeinschaft; geomathematics and satellite geophysics – applications in polar research)
- 1993-1995 **Research Associate, Institute of Arctic and Alpine Research, University of Colorado Boulder; and Member of the Graduate Faculty, Department of Geological Sciences** (projects in remote sensing, glaciology, geomathematics, marine geology and geophysics)
- 1991-1993 **Assistant Research Geomathematician (Project Scientist) at Scripps Institution of Oceanography, University of California San Diego** (marine geology and geophysics, satellite altimetry over ice and oceans, geomathematics and geophysical inverse theory, data analysis for new shipboard remote-sensing instruments)
- 1988-1992 **Feodor Lynen Research Fellow, Alexander von Humboldt Foundation, Bonn, Germany, at Scripps Institution of Oceanography, University of California at San Diego, USA** (projects in physical oceanography and mathematical geology, geostatistics related to geophysical inverse theory, variography and fractals, with Prof. Dr. W. H. Berger)
- 10/1987-4/1988 **Research Scientist, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Expedition ANTARKTIS VI/3, RV POLARSTERN** (application of geostatistics in the evaluation of SEABEAM data and ground-penetrating radar data of Antarctic glaciers)
- 1987-1988 **Postdoctoral Research Fellow (Deutsche Forschungsgemeinschaft) and Lecturer, Mathematical Geology, Free University of Berlin, Germany** (development of geostatistical methods, spatial continuity measures for geologic and bathymetric data, mineral exploration)
- 7-8/1987 **Visiting Research Scientist, Centre de Géostatistique, Ecole des Mines de Paris, Fontainebleau, France** (theory of geostatistical estimation under constraints)
- 1986-1987 **Assistant Professor, Department of Geology, Bayerische Julius-Maximilians-Universität, Würzburg** (establishment of a mathematical geology program through lectures and seminars, introduction of computer applications)
- 10-11/1984 **Research Scientist during Expedition ANTARKTIS III/1, RV POLARSTERN, Alfred**

**Wegener Institute for Polar and Marine Research, Bremerhaven, Germany** (development and implementation of software for the SEABEAM post-processing, coordination of SEABEAM technology course)

1984-1986 **Graduate Teaching Assistant in Mathematics, University of Mainz, Germany** (algebra, analysis)

1981-1983 **Teaching Assistant in Mathematics, University of Mainz, Germany** (linear algebra, calculus, analysis, differential equations)

1980-1981 **Teaching Assistant in Mathematics, University of Warwick, Coventry, Great Britain** (linear algebra, calculus, differential equations)

### **Synergistic Activities**

- (1) Pioneering research in physically, geophysically and environmentally constrained mathematical and spatial statistical methods and algorithms
- (2) Pioneering contributions to establishing geostatistics and geomathematics as a discipline in international and multi-disciplinary research communities
- (3) Design of the density-dimension-algorithm (DDA) for analysis of photon-counting micro-pulse lidar altimeter data for ice and atmosphere, applied as operational algorithm for NASA ICESat-2 atmospheric data products (layer detection) and ICESat-2 high-resolution ice-surface products, development of the CALIOP-DDA for CALIPSO atmospheric lidar data
- (4) Member of NASA's ICESat-2 Science Team
- (5) Member of NASA's CloudSat/CALIPSO Science Team
- (6) Extensive software development for geostatistical estimation and classification systems, development of open-source cyber-infrastructure
- (7) Development and lead of a graduate and undergraduate Geomathematics Program, Universität Trier, Germany, including statistics, geostatistics, linear algebra, analysis and advanced geomathematics
- (8) Pioneering work on the role of spatial ice surface roughness in glaciology and remote sensing, through physical and statistical theory, instrument development (Glacier Roughness Sensor, ULS), field work in Greenland and on alpine glaciers
- (9) Geophysical observation of surges of Bering Glacier, Alaska (1993-1995 and 2011-2013) and Negribreen, Svalbard (2016-present), environmental catastrophes associated with sudden accelerations of Americas largest and longest glacier and a complex Arctic Glacier System; coordination of airborne remote-sensing observations and classification of laser-altimeter and image data; parameterization of physical processes exemplary of glacial acceleration and disintegration (PI of NSF RAPID projects)
- (10) Lead author of ICESat-2 Algorithm Theoretical Base Document (ATBD) for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm; also algorithm development for detection of snow, ice and vegetation in next-generation micro-pulse laser altimeter data, for NASA's ICESat-2 Mission
- (11) Airborne geophysical data collection to study the surge of Negribreen, Svalbard (2017-2019). Airborne geophysical validation of ICESat-2 data (2019). Collaboration with the University Centre in Svalbard and the Norwegian Polar Institute. Funded participation in the Svalbard Integrated Arctic Earth Observing System (SIOS) (2018).
- (12) PI for European Space Agency (ESA) satellites ERS-1, ERS-2, ENVISAT and CryoSat-2 (launched 2010)
- (13) Official collaborator of the ICESat Project (2003-2009), National Aeronautic and Space Administration (NASA) and PI of ICESat/ ICESat-2 research projects funded by NASA

### Cryospheric Sciences

- (14) Regular contribution to MABEL flight planning (The Multiple Altimeter Beam Experimental Lidar (MABEL) is an aircraft prototype of the ICESat-2 multi beam micro-pulse photon-counting lidar), coordinated by NASA ICESat-2 Project (2010-2018)
- (15) Spatial statistical analysis of airborne remote-sensing data from NASA's Operation IceBridge
- (16) Contributions to Community Earth System Modeling (CESM)
- (17) Extensive experience as PI and expedition lead of Greenland glaciology and remote sensing field projects (5 expeditions, 1996-2005)
- (18) Extensive experience in flight-planning and leading of airborne geophysical observations in Greenland, Alaska, Iceland, Canada and Svalbard (Norway)
- (19) Co-PI in the 2009 "Characterization of Arctic Sea Ice Experiment" (CASIE), observations of sea ice in the Fram Strait from a base in Ny Alesund, Svalbard, with NASA AMES SIERRA UAV (NASA Airborne Operations); two NASA Awards received 2009, 2010
- (20) Contributions to the International Polar Year through research on sea-ice roughness as an indicator of changes in the Arctic Sea-Ice
- (21) Design and development of the Glacier Roughness Sensor (GRS)
- (22) Collaboration on development of UAV laser profilometer system with aerospace engineers, CU Boulder
- (23) Development of a small integrated system for coregistered collection of laser altimeter, video and GPS data of ice surfaces (Bering-Bagley Glacier System, AK), as input for automated surface classification system
- (24) Participation in sea-going expeditions in Antarctica, the Arctic, the central Atlantic and several regions of the Pacific (1984-1992), geophysical surveying and collaboration on development of marine geophysical instrumentation, with Alfred-Wegener Institute for Polar and Marine Research (Germany), Scripps Institution of Oceanography (USA), Lamont-Doherty Geophysical Observatory (USA), NOAA, and Universität Kiel (Germany)
- (25) Development and teaching of new interdisciplinary statistics courses at CU Boulder
- (26) Extensive teaching experience and graduate and undergraduate student advisory (1980-present)
- (27) Faculty advisor of the Student Chapter of the International Association for Mathematical Geosciences at the University of Colorado Boulder (2009-present)
- (28) Member of founding Board of Directors, Alexander von Humboldt Association of America
- (29) PI or Co-PI on over 100 funded research projects
- (30) Introduction of the concept of spatial sea-floor roughness to marine geophysics, study of influence of roughness on acoustic scattering and reverberation
- (31) 20 years of editorship of *Computers&Geosciences*: Associate Editor 1995-2007, Assistant Editor 1987-1994

### Professional Societies — Memberships and Services

- *International Union of Geodesy and Geophysics (IUGG)*
  - Liaison of the International Association of Cryospheric Sciences (IACS) to the IUGG Commission on Mathematical Geophysics (CMG)
- *International Glaciological Society*

- *IEEE - Institute of Electrical and Electronics Engineers*
  - Geoscience and Remote Sensing Society (member)
- *International Association for Mathematical Geosciences (IAMG)*
  - Exhibitor for IAMG at the American Geophysical Union Fall Meeting, every year 2001-2019
  - Faculty Advisor, Student Chapter of IAMG at the University of Colorado Boulder, 2009-2018
  - Assistant Editor of “Mathematical Geology”, since 1995
  - Associate Editor of “Computers & Geosciences” (1995-2007), Assistant Editor 1987-1994
  - Member, Nomination Committee (President, Vice President, Treasurer, Secretary General, Council) 2003/2004
  - Member of Council 1996–2000; President Nomination Committee 2003
  - Chair, President’s Prize Committee 1994; Member, President’s Prize Committee 1993
  - Recipient of IAMG President’s Prize for Outstanding Contributions to Theoretical and Applied Geostatistics, 1992
- *American Geophysical Union (AGU)*
- *Alexander von Humboldt Association of America*
  - Member of Founding Board of Directors 1994–1997
  - Founding Member since 1994

## PUBLICATION LIST

### Books

- (1) DAVIS, J.C. and U.C. HERZFELD (eds.) (1993), Computers in geology: 25 years of progress, International Association for Mathematical Geology, Studies in Mathematical Geology, no. 5, Oxford University Press, New York, 298 p.
- (2) HERZFELD, U.C. and W.H. BERGER (1993), Ocean productivity and indicator variables: Map comparisons for the Atlantic and World Oceans, S.I.O. Reference Series no. 93-7, Scripps Institution of Oceanography, University of California San Diego, La Jolla, California, USA, 75 p.
- (3) HERZFELD, U.C. (1998), The 1993-1995 surge of Bering Glacier (Alaska) — a photographic documentation of crevasse patterns and environmental changes, Trierer Geographische Studien, 17, 211 pp., Geographische Gesellschaft Trier und Fachbereich VI – Geographie/Geowissenschaften, Universität Trier
- (4) HERZFELD, U.C. (2004), ATLAS OF ANTARCTICA — Topographic Maps from Geostatistical Analysis of Satellite Radar Altimeter Data, Springer Verlag Heidelberg, New York, Tokyo, 364+XVI pp., 145 maps, 25 figs, 5 tables, 1 chart, CDROM
- (5) HERZFELD, U. C., Detecting Changes in the Earth System with a Spaceborne Laser Altimeter System: A Universal, Cross-Disciplinary Algorithm for Analysis of ICESat-2 data, Monograph in SpringerBriefs in Earth Sciences. Publisher: Springer Nature Switzerland AG (in preparation)

### Services as Journal Editor

**Associate Editor:** Computers & Geosciences, International Association for Mathematical Geology (1995-2007, Assistant Editor 1987-1994)

**Assistant Editor:** Mathematical Geology, International Association for Mathematical Geology (1994-2010)

**Assistant Editor:** Journal of Geodynamics, European Geophysical Society (1994-1997)

**Editor:** Inverse Theory in the Earth Sciences, Special Issue, Mathematical Geology, vol. 28, no. 2 (1996); Introduction to the Special Issue: p. 133-251

**Scientific Editor:** Annals of Glaciology, International Symposium on Changes in Glaciers and Ice Sheets, 8-13 July 2013, Beijing, China (2013)

**Guest Editor:** Special Issue "Mathematical Models for Remote Sensing Image and Data Processing" of the Journal "Remote Sensing", published by MDPI (2018-2019)

### Theses

- (1) HERZFELD, U.C., Formationen und Einbettungseigenschaften endlicher auflösbarer Gruppen, Wiss. Arbeit Lehramt Gymnasien, Fachbereich Mathematik, Johannes Gutenberg-Universität Mainz, West Germany (1983), 128 p.  
(Thesis) [Formations and Embedding Properties of Finite Soluble Groups, Master Thesis, Department of Mathematics, Johannes Gutenberg-University Mainz, Germany (December 1983)] (Advisor: Klaus Doerk)
- (2) HERZFELD, U.C., Frattiniklassen und Maximale Teilklassen, Insbesondere zu Formationen Endlicher Gruppen, Dissertation, Doktor der Naturwissenschaften (doctor rerum naturalium), Fachbereich Mathematik, Johannes Gutenberg-Universität Mainz, West Germany (26.06.1986), [Frattini Classes and Maximal Subclasses, Especially of Formations of Finite Groups, Dissertation (PhD Thesis), Doctor of Natural Sciences, Department of Mathematics, Johannes Gutenberg-University Mainz, Germany (26 June 1986)] (Advisor: Klaus Doerk)



- (3a) HERZFELD, U.C. (1986), Kartographische Auswertung bathymetrischer Daten mit Hilfe geostatistischer Prädiktion, Berliner Geowissenschaftliche Abhandlungen A, Freie Universität Berlin, [Cartographical Evaluation of Bathymetric Data using Geostatistical Prediction, Berliner Geowissenschaftliche Abhandlungen A, Freie Universität Berlin]
- (3b) HERZFELD, U.C. (1986), Kartographische Auswertung bathymetrischer Daten mit Hilfe geostatistischer Prädiktion, Berliner Geowissenschaftliche Abhandlungen A, Freie Universität Berlin, [Cartographical Evaluation of Bathymetric Data using Geostatistical Prediction, Berliner Geowissenschaftliche Abhandlungen A, Freie Universität Berlin] same as (3a), accepted as Projektarbeit 1 zum Weiterbildenden Studium “Mathematische Methoden und Modelle in den Geowissenschaften”, Institut für Geologie - Mathematische Geologie -, Freie Universität Berlin (1986) [accepted as Thesis 1 for Graduate Studies “Mathematical Methods and Models in the Geosciences” Certificate Program, Institute for Geology - Mathematical Geology, Free University of Berlin (1986)]
- (4) HERZFELD, U.C. and A.M. AUCOUR, Thematische Kartierung eines Shebka-Gebiets (Siwa-Oase, Ägypten) durch digitale Satellitenbilddauswertung, Institut für Geologie - Mathematische Geologie -, Freie Universität Berlin (1986), 30 p. (Projektarbeit 2 zum Weiterbildenden Studium “Mathematische Methoden und Modelle in den Geowissenschaften”, Thesis for Graduate Studies “Mathematical Methods and Models in the Geosciences”) [Thematic Mapping of a Shebka Oasis (Siwa Oasis, Egypt) Using Digital Satellite Image Analysis, Thesis 2 for Graduate Studies “Mathematical Methods and Models in the Geosciences” Certificate Program, Institute for Geology - Mathematical Geology, Free University of Berlin (1986)]

#### **Algorithm Theoretical Base Documents (Reviewed)**

- (1) PALM, S., Y. YANG and U.C. HERZFELD (2014) ICESat-2 Atmosphere Products Algorithm Theoretical Base Document, Version 4.0, November 1, 2014, 160 pp. (submitted to NASA Headquarters via the NASA ICESat-2 Project)
- (2) HERZFELD, U.C., S. PALM and Y. YANG (2015) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v103), v5.0, 4 June 2015, 109 pp. (NASA ICESat-2 Project)
- (3) PALM, S., Y. YANG and U.C. HERZFELD (2015) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v5.0, June 4, 2015, 58p. (NASA ICESat-2 Project)
- (4) HERZFELD, U.C., S. PALM and Y. YANG (2015) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v105), v6.0, 31 October 2015, 153 pp. (NASA ICESat-2 Project)
- (5) PALM, S., Y. YANG and U.C. HERZFELD (2015) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v6.0, October 31, 2015, 60p. (NASA ICESat-2 Project)
- (6) HERZFELD, U.C. and S. PALM (2016) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v106), v7.0, 24 August 2016, 163 pp. (NASA ICESat-2 Project)
- (7) HERZFELD, U.C. and S. PALM (2016) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v106), v7.1, 23 September 2016, 163 pp. (NASA ICESat-2 Project)
- (8) PALM, S., Y. YANG and U.C. HERZFELD (2016) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v7.0, September 1, 2016, 58 pp. (NASA ICESat-2 Project)
- (9) HERZFELD, U.C. and S. PALM (2017) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v110), v8.0, 17 November 2017, 237 pp. (NASA ICESat-2 Project)
- (10) PALM, S., Y. YANG and U.C. HERZFELD (2017) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v7.3, November 15, 2017, 79 pp. (NASA ICESat-2 Project)

- (11) HERZFELD, U.C. and S. PALM (2018) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v110), v8.1, 21 March 2018, 255 pp. (NASA ICESat-2 Project)
- (12) PALM, S., Y. YANG and U.C. HERZFELD (2018) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v7.5, 16 June 2018, 83 pp. (NASA ICESat-2 Project)
- (13) HERZFELD, U.C. and S. PALM (2018) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm (Code version v111), v9.0, 20 December 2018, 288 pp. (NASA ICESat-2 Project)
- (14) HERZFELD, U.C. and S. PALM (2019) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm, v10.0, 1 May 2019, 328 pp. (NASA ICESat-2 Project), doi:10.5067/TE10T7E5TNGK  
[https://icesat-2.gsfc.nasa.gov/sites/default/files/page\\_files/ICESat-2\\_ATL09\\_pt2\\_DDA\\_ATBD\\_r002.pdf](https://icesat-2.gsfc.nasa.gov/sites/default/files/page_files/ICESat-2_ATL09_pt2_DDA_ATBD_r002.pdf)
- (15) PALM, S., Y. YANG and U.C. HERZFELD (2019) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v8.2, August 21, 2019, 104 pp. (NASA ICESat-2 Project), doi:10.5067/X6N528CVA8S9  
[https://icesat-2.gsfc.nasa.gov/sites/default/files/page\\_files/ICESat2\\_ATL09\\_ATBD\\_r002.pdf](https://icesat-2.gsfc.nasa.gov/sites/default/files/page_files/ICESat2_ATL09_ATBD_r002.pdf)
- (16) HERZFELD, U.C. and S. PALM and D. HANCOCK (2020) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm, v11.0, ASAS Code Release v5.3, ATLAS Data Product ATL09, v11.0, 6 February 2020, 374 pp., NASA ICESat-2 Project, doi:10.5067/XVKMH2X1HVJ1  
[https://icesat-2.gsfc.nasa.gov/sites/default/files/page\\_files/ICESat-2\\_ATL09\\_pt2\\_DDA\\_ATBD\\_r003.pdf](https://icesat-2.gsfc.nasa.gov/sites/default/files/page_files/ICESat-2_ATL09_pt2_DDA_ATBD_r003.pdf)
- (17) PALM, S., Y. YANG and U.C. HERZFELD (2020) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part I: Level 2 and Level 3 Data Products, v8.3, February 14, 2020, 107 pp. (NASA ICESat-2 Project), doi:10.5067/SOAMP4TOYLWJ  
[https://nsidc.org/sites/nsidc.org/files/technical-references/ICESat2\\_ATL04\\_ATL09\\_ATBD\(part1\)\\_r003.pdf](https://nsidc.org/sites/nsidc.org/files/technical-references/ICESat2_ATL04_ATL09_ATBD(part1)_r003.pdf)
- (18) HERZFELD, U.C., S. PALM and D. HANCOCK (2021) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm, v12.0, 25 February 2021, Geomath Code Version v117.0, ASAS Code Release v5.4, ATLAS Data Product ATL09, 421 pp. (NASA ICESat-2 Project), doi:10.5067/JT3IX3YFW1RR
- (19) HERZFELD, UTE C., STEPHEN PALM, D. HANCOCK, ADAM HAYES and KRISTINE BARBIERI (2021) ICESat-2 Algorithm Theoretical Base Document for the Atmosphere, Part II: Detection of Atmospheric Layers and Surface Using a Density Dimension Algorithm, v13.0, November 15, 2021, Geomath Code Version v118.0, ASAS Code Release v5.5, ATLAS Data Product ATL09, 439 pp., doi:10.5067/48PJ5OUJOP4C
- (20) PALM, STEPHEN, YUEKUI YANG, UTE HERZFELD and DAVID HANCOCK (2021) ICESat-2 Algorithm Theoretical Basis Document for the Atmosphere, Part I: Level 2 and 3 Data Products, Version 8.5, September 15, 2021, 118 p., doi:10.5067/JEB9UVKJUSXV1
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### Published Software

- (1) UNIKRG

- (2) Mapcomp
- (3) COVA
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url: <https://github.com/Herzfeld-Lab/GEOCLASS-image/releases/tag/v1.0>  
License: MIT, doi: 0.5281/zenodo.10232912

## Data Products (Reviewed) and Data Sets

### (A) NASA ICESat-2 Data Products (Reviewed)

- (1) NASA ICESat-2 ATL04\_v001 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 1 (released May 2019), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL04>), doi=10.5067/ATLAS/ATL04.001
- (2) NASA ICESat-2 ATL09\_v001 Data Product: ATLAS/ICESat-2 L3A Calibrated Backscatter Profiles and Atmospheric Layer Characteristics, Version 1 (released May 2019), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL09>), doi=10.5067/ATLAS/ATL09.001
- (3) NASA ICESat-2 ATL04\_v002 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 2 (released October 2019), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL04>), doi=10.5067/ATLAS/ATL04.002
- (4) NASA ICESat-2 ATL09\_v002 Data Product: ATLAS/ICESat-2 L3A Calibrated Backscatter Profiles and Atmospheric Layer Characteristics, Version 2 (released October 2019), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL09>), doi=10.5067/ATLAS/ATL09.002
- (5) NASA ICESat-2 ATL04\_v003 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 3 (released June 2020), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL04>), doi=10.5067/ATLAS/ATL04.003
- (6) NASA ICESat-2 ATL09\_v003 Data Product: ATLAS/ICESat-2 L3A Calibrated Backscatter Profiles and Atmospheric Layer Characteristics, Version 3 (released June 2020), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL09>), doi=10.5067/ATLAS/ATL09.003
- (7) NASA ICESat-2 ATL04\_v004 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 4 (released February 2021), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL04>), doi=10.5067/ATLAS/ATL04.004
- (8) NASA ICESat-2 ATL09\_v004 Data Product: ATLAS/ICESat-2 L3A Calibrated Backscatter Profiles and Atmospheric Layer Characteristics, Version 4 (released February 2021), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL09>), doi=10.5067/ATLAS/ATL09.004

- (9) NASA ICESat-2 ATL04.v005 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 5 (released December 2021), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
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(<https://nsidc.org/data/ATL09>), doi=10.5067/ATLAS/ATL09.005
- (11) NASA ICESat-2 ATL04.v006 Data Product: ATLAS/ICESat-2 L2A Normalized Relative Backscatter Profiles, Version 6 (released 16 May 2023 to 28 June 2023), Data Contributors: Stephen Palm, Ute Herzfeld, Yuekui Yang, David Hancock, Kristine Barbieri, Jesse Wimert, publisher: NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center, Boulder, Colorado, U.S.A.  
(<https://nsidc.org/data/ATL04>), doi=10.5067/ATLAS/ATL04.006
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(27 items at <https://arcticdata.io/catalog/data>, search for Data Contributor: Herzfeld)

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- (4) UTE HERZFELD (2015) BeringSummer2012\_video. Arctic Data Center. urn:uuid:f7bda308-a643-4bc5-a23d-ad76b48c479a.
- (5) UTE HERZFELD (2015) BeringSummer2012\_video\_BeringFlight. Arctic Data Center. doi:10.18739/A2QN5Z98M.
- (6) UTE HERZFELD (2015) BeringSummer2012\_laser. Arctic Data Center. urn:uuid:36eb0954-311f-4072-b502-1d659fd293f0.
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