Jacob Bortnik, Ph.D.

Professor and Chair, Atmospheric & Oceanic Sciences • Founding Faculty Director, UCLA SPACE Institute

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PROFILE: FUNDAMENTAL PHYSICS → OPERATIONAL SPACE WEATHER

Space physics researcher combining theory, satellite observations, laboratory experiments, numerical modelling, and machine learning to understand and predict Earth's radiation environment. Research established how plasma waves accelerate and remove hazardous radiation-belt electrons, identified drivers of pulsating auroral emissions, and translated those insights into data-driven models and end-user focused space-weather capabilities.

Current scholarly reach: 345 refereed publications and chapters; 21,278 Google Scholar citations; h-index 85; i10-index 267; 106 works since 2022 and 11 in 2026. Research spans the inner magnetosphere, ionosphere, atmospheric coupling, and operational applications.

MEDAL-ALIGNED CONTRIBUTIONS

Plasmaspheric hiss: solved a four-decade source problem. The 2008 Nature theory showed chorus propagating into the plasmasphere and evolving into hiss, linking electron acceleration and loss within one physical framework; a 2009 Science observation validated the connection. The work informs radiation-belt modelling and was named one of Discover's Top 100 Science Stories of 2008.

Radiation-belt acceleration and auroral precipitation. Combined Van Allen Probes measurements with data-driven diffusion modelling to demonstrate rapid local acceleration by chorus (Nature, 2013; 899 citations). Conceived and led the multi-mission study identifying chorus as the driver of pulsating aurora (Science, 2010; 370 citations).

Wave–particle interactions from first principles to the laboratory. Advanced resonant and nonlinear descriptions of chorus, hiss, EMIC, and magnetosonic-wave interactions, including controlled laboratory experiments that reproduce key features of magnetospheric wave generation and particle scattering.

ORIENT: a deployable machine-learning space-weather product. Led neural-network models specifying 50 keV–2 MeV outer-belt electron fluxes from solar-wind and geomagnetic inputs. NASA CCMC provides ORIENT 1.0 as a public repository and runs-on-request capability, reports validated $R^2 \approx 0.78$–0.92, and identifies Bortnik as a model developer.

Physics-informed and interpretable AI. Developed models for electron fluxes, plasma density, wave environments, geomagnetic indices, and discovery of radiation-belt transport equations—using machine learning to expose physical drivers, quantify limits, and accelerate specification rather than as a black-box endpoint.

Space weather beyond satellites. Connected magnetospheric physics to aviation safety: an unmitigated transatlantic route during the May 2024 storm could have produced up to three times higher radiation exposure. Additional AI work detects earthquake- and tsunami-driven ionospheric perturbations in GNSS data in real time.

APPOINTMENTS

2023–present	Chair, Department of Atmospheric & Oceanic Sciences, UCLA
2022–present	Founding Faculty Director, UCLA SPACE Institute
2019–present	Professor, Atmospheric & Oceanic Sciences, UCLA (Associate Professor, 2015–2019)
2004–2015	Postdoctoral Scholar, Researcher, and Assistant Researcher, UCLA
2008–present	Scientific consultant, Solana Scientific Inc.
2018–2020	Subject-matter expert, National Geospatial-Intelligence Agency World Magnetic Model Challenge

EDUCATION

2004	Ph.D., Electrical Engineering, Stanford University — radiation-belt electron precipitation
1998	M.Sc. with honors, Electrical Engineering, University of the Witwatersrand
1996	B.Sc. cum laude, Electrical Engineering, University of the Witwatersrand

RESEARCH APPROACH AND TECHNICAL TRANSLATION

Multiscale Data Analysis. Integrates THEMIS, Van Allen Probes, Cluster, MMS, POES, GPS/GNSS, ground-based all-sky imaging, aviation dosimetry, and laboratory measurements to connect microscopic wave–particle interactions with global geospace dynamics.

Mechanism-to-model translation. Research moves from fundamental theory and simulations to data-constrained quasilinear diffusion, global modeling, interpretable machine learning, and public model deployment—maintaining physical traceability across the chain.

Coupled-system perspective. Treating the solar wind, magnetosphere, ionosphere, atmosphere, and technological systems as a coupled system, allowing fundamental plasma-physics research to inform space weather prediction, satellite operations, and aviation risk.

PROGRAM-BUILDING OUTCOMES

NASA recognition of SPeCIMEN group. The SPeCIMEN group helped secure a dedicated funding element in the 2015 NASA ROSES Living With a Star program, translating coordinated community priorities into support for new research.

Mentoring. Co-supervised Wen Li, later recipient of the AGU James B. Macelwane Medal (2017), Alfred P. Sloan Research Fellowship (2018), and NSF CAREER Award (2019), alongside a wider record of award-winning early-career researchers.

INTERNATIONAL LEADERSHIP AND COMMUNITY BUILDING

NSF Geospace Environment Modeling (GEM). Chair, 2017–2019; earlier steering-committee member and co-leader of the Radiation Belt and Waves focus group. Led a community that integrates observations, theory, and modelling to understand/predict geospace.

SCOSTEP VarSITI / SPeCIMEN. Original co-leader with Craig Rodger of Specification and Prediction of the Coupled Inner-Magnetospheric Environment, 2014–2018. The international project connected observations, physical modelling, statistical prediction, workshops, and targeted community support; the broader activity engaged 620 participants from 60 countries.

IAGA/URSI VERSIM. IAGA co-chair from 2013 and now co-chair emeritus of VLF/ELF Remote Sensing of Ionospheres and Magnetospheres, succeeding Craig Rodger and helping organize recurring international workshops and science sessions.

UCLA SPACE Institute. Founded a campus-wide institute linking space science with engineering, applications, communications, education, and the commercial space sector; built interdisciplinary partnerships around space-focused research and training.

Convening and editorial service. Organizer/chair of numerous AGU, IAGA, URSI, VERSIM, SPeCIMEN, ML-Helio, and machine-learning sessions and workshops; Associate Editor, JGR: Space Physics (2012–2014); NASA, NSF, AGU, AFOSR, and international panel service.

Departmental and cross-campus leadership. Chair of UCLA Atmospheric & Oceanic Sciences Department since 2023, while sustaining an active research program and building connections among heliophysics, data science, aviation, and public communication.

TRANSLATIONAL PRODUCTS AND CAPABILITIES

Prediction-ready radiation-belt modelling. ORIENT converts solar-wind conditions and geomagnetic indices into global electron-flux estimates across the outer belt. Its public NASA CCMC implementation supports reproducible research, runs on request, and enables model evaluation for aerospace-environment applications.

Physics-informed and interpretable AI. Developed models for relativistic and sub-relativistic electron specification, dynamic plasma density, wave environments, geomagnetic indices, and physics-informed discovery of radiation-belt transport equations—using AI to expose physical drivers rather than as a black-box endpoint.

Cross-region hazard applications. Research spans spacecraft radiation hazards, aviation-dose exposure during severe storms, GNSS detection of earthquake/tsunami signatures, the World Magnetic Model challenge, and data-driven fire and lightning applications.

HONORS AND SELECTED INDICATORS OF IMPACT

2021 Joanne Simpson Medal and AGU Fellowship. American Geophysical Union recognition for transformative scientific advances, leadership, and service to science and society.

Publisher recognition. Multiple papers certified among their journals' most cited, most downloaded, or most viewed, including work in Space Weather, JGR: Space Physics, Geophysical Research Letters, and Radio Science; 2022 physics-informed equation-discovery and chorus-map papers were among JGR: Space Physics' most downloaded.

Scientific and public visibility. Lead-author Nature work featured in Discover's Top 100 Science Stories of 2008; Science/AAAS video interview on pulsating aurora; UCLA Newsroom coverage of AI-enabled space weather and the SPACE Institute.

Earlier distinctions. NSF/GEM Postdoc Award (2006); URSI Young Scientist Award (2005); two AGU Outstanding Student Paper Awards (2002–2003).

MENTORING AND EDUCATION

Research training. Advisor and mentor across plasma physics, satellite data analysis, laboratory experiments, and scientific machine learning. Mentees include recipients of the 2024 SCOSTEP/PRESTO Distinguished Young Scientist Award, the 2023 URSI Student Paper Award, and the UCLA Chancellor's Award for Postdoctoral Research.

Curriculum. Developed and taught graduate/advanced undergraduate courses in solar-system plasma physics, microscopic plasma processes, space weather, and Machine Learning for the Physical Sciences; also taught the public-facing course The Perils of Space.

Community development. Uses international projects, focus groups, workshops, and interdisciplinary institutes to create entry points for early-career researchers and to connect specialists in observations, theory, computation, and applications.

SELECTED PROFESSIONAL TRUST

National and international committees. Briefings to the National Academies Plasma 2020 process and Committee on Solar and Space Physics; service on the AGU Fellows Selection Committee and recurring NASA, NSF, AFOSR, DOE, NERC, and international panels.

Breadth of peer recognition. Invited leadership and review roles span fundamental plasma physics, magnetosphere–ionosphere coupling, radiation-belt specification, machine learning, space-weather operations, and interdisciplinary hazards.

SELECTED SERVICE, CONVENING, AND COMMUNICATION

Session leadership at scale. Organized or co-organized at least 16 AGU Fall Meeting sessions between 2009 and 2024, in addition to recurring IUGG/IAGA, URSI, VERSIM, SPeCIMEN, GEM, ML-Helio, and data-assimilation meetings.

Program stewardship. Reviewed or advised NASA Living With a Star, Heliophysics Guest Investigator, Early Career, postdoctoral, instrument, and outer-planets programs; NSF CAREER and geospace panels; and AFOSR artificial-intelligence proposals.

Scientific evaluation. Judge for NASA's Frontier Development Lab (2018–2019) and subject-matter expert for the National Geospatial-Intelligence Agency World Magnetic Model Challenge (2018–2020).

Broader Audience Communication. Research and its societal relevance communicated through Discover's Top 100 Science Stories, Science/AAAS multimedia, UCLA Newsroom interviews, and an expert profile for media seeking context on space weather.

PUBLICATION AND SCHOLARLY IMPACT

345 refereed works • 21,278 citations • h-index 85 • i10-index 267 • 106 works since 2022 • 11 works in 2026

Selected below are 25 papers that most directly support the Birkeland Medal criteria: fundamental advances, improved physical models, new observational/analytical methods, and products or applications used beyond a single research specialty. The remaining record covers chorus, hiss, EMIC and magnetosonic waves; radiation-belt acceleration, transport, and loss; auroral precipitation; laboratory plasma experiments; multi-mission observations; and scientific AI. Conference abstracts, datasets, and preprints are excluded from the refereed total.

Google Scholar metrics and paper-level citation counts accessed 31 August 2026. Counts are included only where they help identify field-defining reach; selection also considers originality, translation, leadership, and relevance to the medal.

FOUNDATIONAL DISCOVERIES IN GEOSPACE PHYSICS

1. Bortnik, J., R. M. Thorne, and N. P. Meredith (2008), "The unexpected origin of plasmaspheric hiss from discrete chorus emissions," Nature, 452, 62–66. ***Impact:*** *Lead-author solution to a four-decade source problem; unified acceleration and loss physics; 445 citations.* DOI
2. Bortnik, J., W. Li, R. M. Thorne, et al. (2009), "An observation linking the origin of plasmaspheric hiss to discrete chorus emissions," Science, 324, 775. ***Impact:*** *Multi-spacecraft observational confirmation of the chorus-to-hiss mechanism; 234 citations.* DOI
3. Nishimura, Y., J. Bortnik, W. Li, et al. (2010), "Identifying the driver of pulsating aurora," Science, 330, 81–84. ***Impact:*** *Bortnik-conceived, multi-platform identification of the physical driver of a major auroral form; 370 citations.* DOI
4. Thorne, R. M., W. Li, B. Ni, Q. Ma, J. Bortnik, et al. (2013), "Rapid local acceleration of relativistic radiation-belt electrons by magnetospheric chorus," Nature, 504, 411–414. ***Impact:*** *Observation-constrained modelling established how hazardous relativistic electrons are locally accelerated; 899 citations.* DOI
5. Ni, B., R. M. Thorne, Y. Y. Shprits, and J. Bortnik (2008), "Resonant scattering of plasma sheet electrons by whistler-mode chorus: Contribution to diffuse auroral precipitation," GRL, 35, L11106. ***Impact:*** *Quantified the chorus contribution to diffuse aurora and linked magnetospheric waves to atmospheric precipitation; 467 citations.* DOI
6. Li, W., R. M. Thorne, V. Angelopoulos, J. Bortnik, et al. (2009), "Global distribution of whistler-mode chorus waves observed on the THEMIS spacecraft," GRL, 36, L09104. ***Impact:*** *Produced a widely used observational foundation for global chorus and radiation-belt modelling; 409 citations.* DOI
7. Usanova, M. E., I. R. Mann, J. Bortnik, L. Shao, and V. Angelopoulos (2012), "THEMIS observations of EMIC wave occurrence: Dependence on AE, SYM-H, and solar-wind dynamic pressure," JGR, 117. ***Impact:*** *Established occurrence controls for an important radiation-belt loss mechanism; 308 citations.* DOI
8. Bortnik, J., and R. M. Thorne (2007), "The dual role of ELF/VLF chorus waves in the acceleration and precipitation of radiation-belt electrons," JASTP, 69, 378–386. ***Impact:*** *A durable conceptual synthesis of chorus as both source and loss agent; 264 citations.* DOI
9. Ni, B., R. M. Thorne, X. Zhang, J. Bortnik, et al. (2016), "Origins of the Earth's diffuse auroral precipitation," Space Science Reviews. ***Impact:*** *Authoritative synthesis connecting multiple wave modes and plasma populations to diffuse aurora; 239 citations.* DOI
10. Li, W., J. Bortnik, R. M. Thorne, et al. (2011), "Global distribution of wave amplitudes and wave-normal angles of chorus waves using THEMIS wave observations," JGR, 116. ***Impact:*** *A benchmark global wave model used in radiation-belt calculations; 327 citations.* DOI
11. Meredith, N. P., R. B. Horne, J. Bortnik, et al. (2013), "Global statistical evidence for chorus as the embryonic source of plasmaspheric hiss," GRL, 40, 2891–2896. ***Impact:*** *Independent global statistical support for the chorus-to-hiss mechanism; 261 citations.* DOI
12. Bortnik, J., R. M. Thorne, T. P. O'Brien, et al. (2006), "Observation of two distinct, rapid loss mechanisms during the 20 November 2003 radiation-belt dropout event," JGR, 111, A12216. ***Impact:*** *Separated competing fast-loss mechanisms during a major dropout; 222 citations.* DOI
13. Thorne, R. M., W. Li, B. Ni, Q. Ma, J. Bortnik, et al. (2013), "Evolution and slow decay of an unusual narrow ring of relativistic electrons near L ≈ 3.2," GRL, 40, 3507–3511. ***Impact:*** *Revealed unusually persistent radiation-belt structure and constrained competing source/loss processes; 206 citations.* DOI
14. Bortnik, J., and R. M. Thorne (2010), "Transit-time scattering of energetic electrons due to equatorially confined magnetosonic waves," JGR, 115, A07213. ***Impact:*** *Established an additional pathway for modifying energetic-electron distributions; 189 citations.* DOI
15. Bortnik, J., L. Chen, W. Li, R. M. Thorne, N. P. Meredith, and R. B. Horne (2011), "Modeling the wave-power distribution and characteristics of plasmaspheric hiss," JGR, 116. ***Impact:*** *Converted the chorus-to-hiss mechanism into quantitative global wave characteristics; 168 citations.* DOI
16. An, X., A. Artemyev, V. Angelopoulos, X.-J. Zhang, D. Mourenas, and J. Bortnik (2022), "Nonresonant scattering of relativistic electrons by EMIC waves in Earth's radiation belts," Physical Review Letters, 129, 135101. ***Impact:*** *Expanded electron-loss theory beyond conventional resonance and linked spacecraft observations to a new framework.* DOI

MODELS, AI, PRODUCTS, AND CROSS-SECTOR APPLICATIONS

17. Chu, X., et al. (2017), "A neural network model of three-dimensional dynamic electron density in the inner magnetosphere," JGR: Space Physics, 122, 9183–9197. ***Impact:*** *Early global, dynamic specification of a key input to wave propagation and radiation-belt models.* DOI
18. Chu, X., D. Ma, J. Bortnik, et al. (2021), "Relativistic Electron Model in the Outer Radiation Belt Using a Neural Network Approach," Space Weather, 19, e2021SW002808. ***Impact:*** *Introduced ORIENT-R; subsequently implemented within the public ORIENT 1.0 capability at NASA CCMC.* DOI
19. Ma, D., X. Chu, J. Bortnik, et al. (2022), "Modeling the dynamic variability of sub-relativistic outer radiation-belt electron fluxes using machine learning," Space Weather, 20, e2022SW003079. ***Impact:*** *Extended ORIENT-style specification across operationally important lower energies.* DOI
20. Camporeale, E., G. J. Wilkie, A. Y. Drozdov, and J. Bortnik (2022), "Data-driven discovery of Fokker–Planck equation for the Earth's radiation-belt electrons using physics-informed neural networks," JGR: Space Physics, 127. ***Impact:*** *Demonstrated scientific ML for recovering transport physics; publisher-recognized among the journal's most downloaded papers.* DOI
21. Ma, D., J. Bortnik, Q. Ma, M. Hua, and X. Chu (2024), "Simulating the Earth's outer radiation-belt electron fluxes and their upper limit: A unified physics-based model driven by the AL index," GRL, 51, e2024GL109169. ***Impact:*** *Unified flux evolution and its upper limit in a compact, physically driven model.* DOI
22. Ravanelli, M., V. Constantinou, H. Liu, and J. Bortnik (2024), "Exploring AI progress in GNSS remote sensing: A deep-learning framework for real-time detection of earthquake- and tsunami-induced ionospheric perturbations," Radio Science, 59, e2024RS008016. ***Impact:*** *Transferred scientific AI to real-time terrestrial-hazard sensing through GNSS.* DOI
23. Aryan, H., J. Bortnik, W. K. Tobiska, et al. (2026), "Enhanced radiation exposure of airline crew and passengers during the May 2024 geomagnetic storm," JGR: Space Physics, 131, e2025JA034217. ***Impact:*** *Connected space-weather physics, flight measurements, route mitigation, and human exposure outside the research community.* DOI

LATEST OBSERVATIONAL AND ANALYTICAL METHODS — AUGUST 2026

24. Kang, N., Q. Wang, J. Bortnik, J. He, X. Liu, and L. Chen (2026), "An Automatic Maximum Entropy Based Wave Distribution Function (AME-WDF) Method and Its Application on RBSP Data," JGR: Space Physics, 131, e2026JA035479. ***Impact:*** *Automates recovery of wave propagation distributions from spacecraft data.* DOI
25. Wang, Q., J. Li, J. Bortnik, D. Ma, et al. (2026), "Observations of the latitude and frequency distributions of equatorward-propagating chorus waves," GRL, 53, e2026GL122992. ***Impact:*** *Provides new observational constraints on chorus propagation and its global effects.* DOI

Profiles: *Google Scholar* • *ORCID* • *NASA CCMC ORIENT 1.0*