CIRCAD

CENTER *for* INNOVATION *in* RISK, CATASTROPHES, *and* DECISIONS

An NSF Industry–University Cooperative Research Center (IUCRC)

A New Era of Risk Demands a New Model for Academic Partnership

The Center for Innovation in Risk, Catastrophes, and Decisions (CIRCAD) is an **interdisciplinary, solution-oriented research center** dedicated to addressing the escalating financial and societal consequences of natural hazards, extreme events, and systemic disruptions. As disaster-related losses accelerate, insurers face increasing challenges in maintaining coverage availability and affordability, while households, communities, and capital markets confront growing exposure and uncertainty.

CIRCAD offers a novel response: **a structured partnership that brings together academic researchers, industry leaders, policymakers, and community stakeholders** to co-produce tools, models, and strategies essential for navigating a complex and evolving risk landscape. Through this convening role, CIRCAD aligns cutting-edge research with the real-world priorities of insurers and risk managers, advancing data-driven decision frameworks, next-generation insurance products, and innovative risk-transfer mechanisms.

In parallel, CIRCAD serves as a **hub for professional training and workforce development**, engaging students, postdoctoral researchers, and practitioners in interdisciplinary, applied research. These efforts strengthen the sector's technical capacity while positioning insurance, reinsurance, and financial services as central actors in advancing national resilience.

Why CIRCAD? Why Now?

- **Escalating Losses:** U.S. insured losses from natural disasters now exceed $100 billion annually – a tenfold increase over early 2000s averages.
- **Coverage Crises:** In high-risk regions, insurers are withdrawing or significantly raising premiums, jeopardizing access to both protection and capital.
- **Modeling Limitations:** Prevailing risk models and rating systems often fail to capture systemic interdependencies or the full value of large-scale mitigation.
- **Fragmented Data:** Climate and catastrophe data remain siloed, inconsistently formatted, or insufficiently accessible for decision-making in underwriting and investment.

These compounding trends necessitate a coordinated, cross-sector research and innovation platform.

CIRCAD is designed to fill this role.

Duke UNIVERSITY

UNIVERSITY OF GEORGIA 1785

NSF U.S. National Science Foundation

What CIRCAD Delivers

CIRCAD advances solutions-oriented research across four strategic domains:

Innovative Insurance Mechanisms

- Community-Based Catastrophe Insurance (CBCI)
- Parametric products for underinsured perils
- Multi-hazard and system-level risk transfer strategies

Improved Risk Modeling and Transparency

- Decision-theoretic evaluation of climate and catastrophe models
- Model integration of nature-based solutions and mitigation measures
- Tools to assess, compare, and contextualize hazard forecasts

Accessible Climate and Exposure Data

- FAIR (Findable, Accessible, Interoperable, Reusable) data APIs and platforms
- Customized risk indices and parametric triggers
- Interactive dashboards for resilience planning and risk disclosure

Systemic Risk and Decision Analysis

- Simulation of financial interdependencies and cascading impacts
- Frameworks to support investment planning and resilience financing
- Evaluation of rating systems, risk communication, and regulatory frameworks

A Direct Line from Research to Implementation

CIRCAD projects are co-designed with industry partners and structured for near-term application. Each is evaluated not only for scientific rigor but also for practical relevance, usability, and scalability.

Example projects include:

- Improving the accessibility and usability of climate data for actuarial ratemaking, underwriting, and credit analysis
- Mapping hazard vulnerability hot spots to support targeted insurance innovation
- Scoring risk models using decision theory to guide insurance applications
- Evaluating the feasibility of CBCI in wildfire-prone regions
- Quantifying the risk-reduction value of nature-based investments in catastrophe modeling
- Designing parametric heat insurance for labor-intensive sectors and municipalities
- Developing decision-support tools to align resilience investments with insurance and capital market incentives

A corporate membership of $75K per year delivers a strong return on investment through:

Research

Ability to prioritize research and early access to outputs, including datasets, models, and tools

Relationships

Collaborate with faculty and students on applied research and pilot implementation

Talent

Personal interactions with students gaining world-class training in the skills needed by your industry

Resources

Dramatic leverage of R&D funds through shared costs and significantly reduced overhead

Impact

Potential to advance solutions to pressing climate-related business and social challenges

Workforce Development

CIRCAD is more than a research center — it's a catalyst for talent and workforce development. Our students and postdoctoral researchers are trained in climate risk analytics, modeling, policy, and decision science. Member organizations can access and help shape this emerging workforce through:

- **Tailored internship and co-op placements** facilitated by university career services to match Member priorities with student interests and capabilities.
- **Structured mentorship and advising,** linking students with faculty, alumni, and industry mentors to align academic training with industry needs.
- **Targeted short courses** in AI, decision modeling, and climate finance, developed with industry input and available to Member organizations.
- **Summer project student teams** that tackle real-world, Member-defined challenges, producing actionable insights and pipelines for recruitment.

CIRCAD fosters two-way learning: students gain hands-on experience addressing real-world challenges, while Members engage with fresh perspectives, emerging methods, and cooperative problem-solving.

Who We Are

CIRCAD is co-led by **Duke University** and the **University of Georgia**, two institutions with strengths in:

- Risk engineering and insurance analytics
- Climate science and extreme weather modeling
- Stakeholder engagement and risk communication
- Financial regulation and policy analysis
- Nature-based infrastructure and land use
- Data science and decision theory

Our **Industry Members** include leading innovators from across the risk management landscape.

CIRCAD Academic Leadership

Mark Borsuk, Ph.D.
Center Director
Pratt School of Engineering, Duke University

Lydia Olander, Ph.D.
Duke Site Co-Director
Nicholas Institute, Duke University

Marc Ragin, Ph.D.
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James Marshall Shepherd, Ph.D.
Head of Weather and Disaster Science
Atmospheric Sciences, University of Georgia

Project Descriptions

The following projects emerged from extensive engagement with insurance and risk management leaders to reflect their most urgent needs. CIRCAD's Industrial Advisory Board (IAB) votes to fund only the projects which best address these priorities. Members also help shape early-stage ideas, partner with faculty in research, and gain early access to results before publication. As CIRCAD grows, new projects will be added to meet emerging challenges, ensuring the Center remains adaptive and forward-looking.

1. Enhancing climate data accessibility and integration for industry stakeholders

Insurers face inconsistent, inaccessible climate data that hinders underwriting and modeling. This project develops standardized risk metrics, reporting practices, and an API-accessible platform to align climate research with industry needs. Industry gains easier access to actionable data, while society benefits from improved pricing, new markets, and broader risk reduction.

2. Next generation vulnerability assessment: Mapping climate extremes, compound disasters, and socio-economic impact

Standard risk assessments overlook compounding hazards and social vulnerability. By combining downscaled climate models with socio-economic data, this project produces maps and frameworks that identify hot spots for insurers and communities. The results support new insurance products in underserved markets and give communities tools to prioritize mitigation.

3. Applying modern decision theory to the evaluation and application of climate risk models

The insurance sector lacks a clear way to judge which climate models are reliable and useful. This project creates a Model Aptitude Score to evaluate models for decision relevance. Insurers gain confidence in model selection, while developers are incentivized to improve tools that support both pricing and resilience.

4. Piloting integrated wildfire risk management for high-risk communities

Wildfire risk is pushing insurers out of many markets. This project explores community-based catastrophe insurance (CBCI) pools combined with holistic mitigation strategies to restore coverage. Insurers benefit from reduced exposure and renewed access, while communities gain direct and actionable incentives to invest in wildfire risk reduction.

5. Accounting for nature (and nature-based solutions) in risk models

Most catastrophe models ignore the protective role of ecosystems. This project develops functions linking nature-based solutions (NbS) to risk reduction and incorporates them into open-source models. Insurers can better price NbS benefits, while communities and agencies gain stronger justification for resilience investments.

6. Evaluating CBCI as a tool for incentivizing large-scale resilience investments, including NbS

Scaling resilience beyond individual properties requires new mechanisms. This project assesses how CBCI can incentivize watershed- and community-level investments, including NbS. Deliverables include evaluation tools and regulatory analyses, with industry gaining new markets and society achieving large-scale risk reduction.

7. Optimal design of parametric extreme heat insurance

Extreme heat drives health, labor, and productivity losses yet remains largely uninsured. This project designs parametric heat insurance using high-resolution climate data and economic impact models. The insurance industry gains insight into new product innovations, while business consumers gain financial protection from one of the fastest-rising climate risks.

8. Flood risk rating changes and their effect on home values, insurance demand, and resilience investment

New flood risk data products reshape perceptions, but their impacts remain unclear. This project studies how updated ratings affect property values, insurance uptake, and adaptation choices. Insurers gain insights into product opportunities, while society learns how risk signals influence household and community decisions.

9. Analytical and governance strategies for integrated climate-related financial risk management at the firm- and system-levels

Insurer strategies that work at the firm level can undermine stability system-wide. This project applies complexity modeling to align firm- and system-level risk management. Industry benefits from tools for coordinated governance, while broader society gains a more resilient financial system.