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JUPITER INTELLIGENCE TECHNOLOGY BRIEF

The Right Approaches to Climate Model Downscaling

Jupiter's downscaling methods, driven by peril and use case, help customers make informed physical climate risk management and resiliency decisions.

The Many Benefits of Downscaling

Actionable data about future physical impacts of climate change exists today that can help private and public sector decision-makers make optimal risk management and resiliency choices. This data is produced by the established practice of **downscaling**.

Downscaling transforms low-resolution environmental information from large-scale Global Climate Models (GCMs) into high-resolution spatial and temporal scales to model and probabilistically predict hyper-local impacts of extreme weather. Downscaling can refine the "coarse" resolutions of climate-model data (110 kilometers, or 68.4 miles) to much more granular scales—from 30 km (18.6 miles) to as fine as one meter (39.37 inches). This capability is critically important for resiliency planning and risk management in use cases across the economy.

For example, a GCM might show warming over a broad grid box that's 110 km wide, but downscaling can identify localized effects, such as heightened warming in urban cores and decreased warming along the coast. Those subtleties can be critical for multiple use cases across the economy.

More Precise Risk Analysis Dictates Flexibility in Downscaling Methods

Downscaling represents the best current way to link large-scale changes in the climate to regional and local impacts. Yet it's important to consider two factors:

1. **There are multiple approaches.** Downscaling has been used by climate scientists for decades, but technology breakthroughs such as cloud computing and machine learning have led to the development of new approaches and applications to a computationally intensive process. The main downscaling methods used today are Empirical-Statistical, Stochastic, Dynamical, and Empirical-Machine Learning.

2. **No single approach is best for all use cases and climate perils.** All downscaling methods have strengths, weaknesses, and fundamental limitations; these are detailed by Dr. Josh Hacker, Chief Scientist and Co-Founder of Jupiter Intelligence,™ in the paper The Essential Components of a Downscaling Toolbox, available from Jupiter as a science-focused companion to this document. Downscaling based on a "one size fits all" philosophy, he notes, prevents optimal results.

Downscaling offers the best physical climate-risk information available today, but the absence of a "magic bullet"—a single, superior method for climate-model downscaling for all perils or use cases—compels risk specialists and resilience engineers to consider the appropriate approach, or approaches, based on the use case they're addressing.

Industry	Use cases that downscaling enables
Insurance	Conduct portfolio stress tests and collaborate with clients to recommend risk engineering.
Banking	Understand climate risk of financial assets (mortgages, mortgage-backed securities, and bonds) based on underlying collateral/credit risk.
Asset management	Quantify and optimize asset value exposure to physical climate risk across global portfolios, using asset identifiers (CUSIP, FIGI, etc.) to focus on efforts with largest resiliency ROI.
Real estate	Incorporate climate as a critical investment criteria and allocate capital to improve resiliency for specific developments.
Retail	Avoid downtime and physical damage by retrofitting existing assets and determining new areas for expansion to stay ahead of changing climate risk.
Industrial	Quantify and manage changing frequency of business interruption costs due to climate perils striking upstream suppliers.
Power and utilities Renewable and thermal generation	Integrate climate change effects on long-term efficiency of thermal and renewable power generation assets into planning assumptions.
Power and utilities Grid resiliency	Include physical risks in a changing climate in integrated grid planning initiatives.

Jupiter's Optimal Utilization of Downscaling Depends on Use Case

Jupiter Intelligence™ offers high-resolution climate risk analysis from dynamic Earth System models derived from both dynamical downscaling and empirical-statistical/empirical-machine-learning downscaling techniques. As a result, its portfolio-scale ClimateScore™ Global solution, and its hyper-local ClimateScore Planning suite of peril-specific products, together form the world's only global-to-street-resolution climate analytics offering.

Empirical downscaling helps identify geographies at very high risk and/or those with the most rapidly changing risk profiles. The advantages of statistical approaches to downscaling are simplicity and transparency; machine-learning-enabled empirical approaches can handle complex relationships between large and small scales, and better leverage ongoing advancements in Earth observing capabilities.

Dynamical downscaling can provide the fidelity and accuracy needed to analyze risks to specific assets in vulnerable regions or cities at high resolutions. Its strengths include transparency and its ability to work well with empirical downscaling, directly model compound perils, and provide high fidelity to spatial and temporal connections in the real world.

About Jupiter Intelligence

Jupiter Intelligence is the global market, science, and technology leader in physical climate analytics for risk management and resiliency planning.

Jupiter's analytics are used across the private and public sectors. Customers include at least one of the world's five largest firms in asset management, banking, chemicals, insurance, minerals and mining, oil and gas, pharmaceuticals, power, and reinsurance—as well as critical departments and agencies within both the United States government and climate-change-vulnerable geographies around the world.

For more information, please visit https://jupiterintel.com or email us at info@jupiterintel.com.

To download The Essential Components of a Downscaling Toolbox from the Jupiter science team, click here.