ActiveViam

Identifying and Managing Climate Risk in Loan Portfolios

Central banks have begun requiring the banks they regulate to perform stress tests that account for and measure the effects of climate change on market risk and credit risk in their portfolios. This kind of mandatory risk modelling is a growing trend in the financial services industry and ultimately challenges financial institutions to weave the impact of climate change into their invest-ment strategies.

*This insight was written by Anne Gruz, **Managing Director with consultancy Iggaak**.*

Green RWA, a non-profit organization that seeks to put a framework around how to gauge climate metrics in the financial industry, has proposed the Climate Extended Risk Model (CERM). This climate risk model extends the s the ASRF credit risk model to N factors and helps banks calculate expected and unexpected credit losses and probability of default using climate risk scenarios and climate corporate data to compute these metrics.

Anne is a member of Green RWA and Iggaak developed the Python code for the CERM using ActiveViam's atoti solution. The quantitative Python library will be made available to Green RWA's community under an open source license.

Here Anne explains how she did this.

In this insight we demonstrate through one example how to leverage the CERM and provide estimates of climate risk embedded in a loan book with tools to explore various scenarios.

During the 21st century, man-made carbon dioxide emissions in the atmosphere will raise global temperatures, resulting in severe and unpredictable physical damage across the globe. Another uncertainty associated with climate, known as the energy transition risk, comes from the unpre-dictable pace of political and legal actions to limit its impact.

The Climate Extended Risk Model (CERM) adapts well-known credit risk models (ASRF) to climate risk and the transition to cleaner fuels. It proposes a method to calculate incremental credit losses on a loan portfolio that are rooted in physical and transition risks, which we outline below.

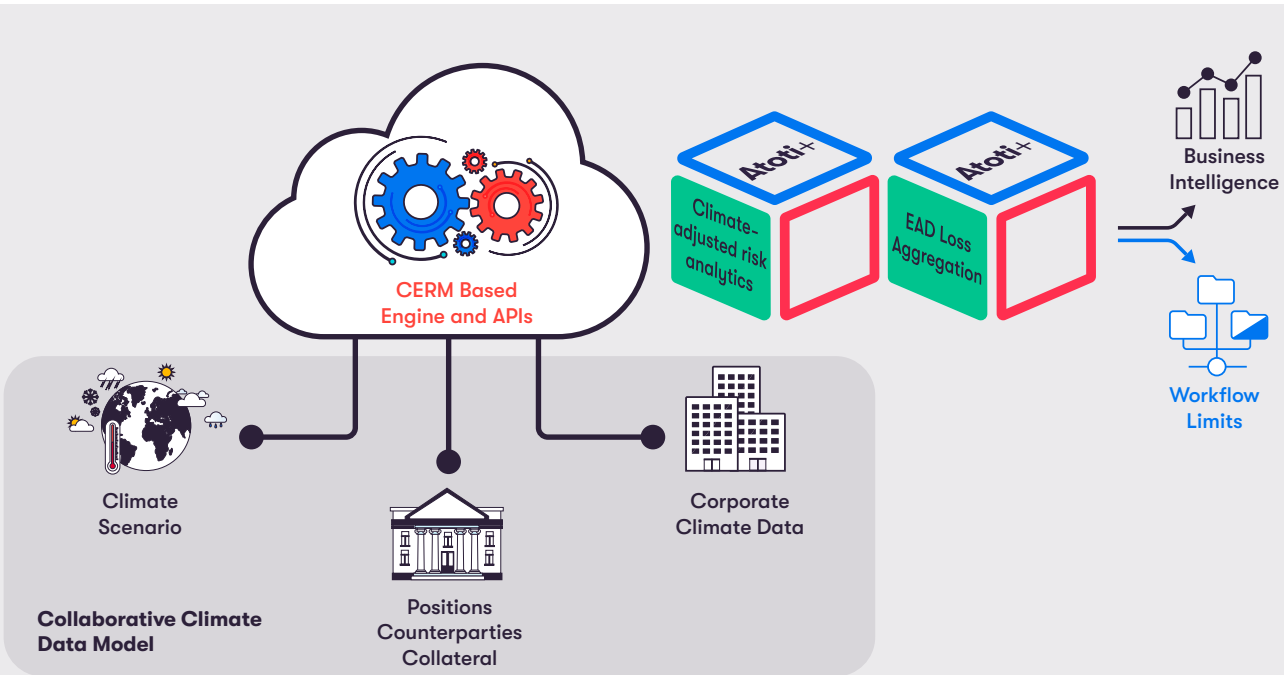
Doing so, the CERM can provide climate extended metrics for use cases such as:

- Loan origination and monitoring:
  - to include climate risk in the decision process when entering new loans
  - to quantify exposure against climate limits
- Climate stress tests exercises:
  - Self-assessments
  - Supervisory
- Calculation of other metrics
  - Indicators for the purposes of strategy-setting and risk management
  - Internal economic-climate capital
- TCFD Risk Management and Metrics/Target pillars

For more details on the CERM and on the use cases please visit Green RWA.

In order to explore the CERM capabilities and to play with results we've implemented an illustrative version of the model combining backend Python code and ActiveViam's atoti, a powerful multi-dimensional in-memory data aggregation and analytics tool used to slice and dice results. To integrate data we've used atoti's Python API in a Jupyter Notebook.

We are currently working to provide an end-to-end solution combining climate data, corporate data, calibration, calculation and outputs into a comprehensive framework. To go this extra step further, increasing the amount of data used for analysis and pushing these scenarios to production we can consider Atoti+, the commercial version of atoti.



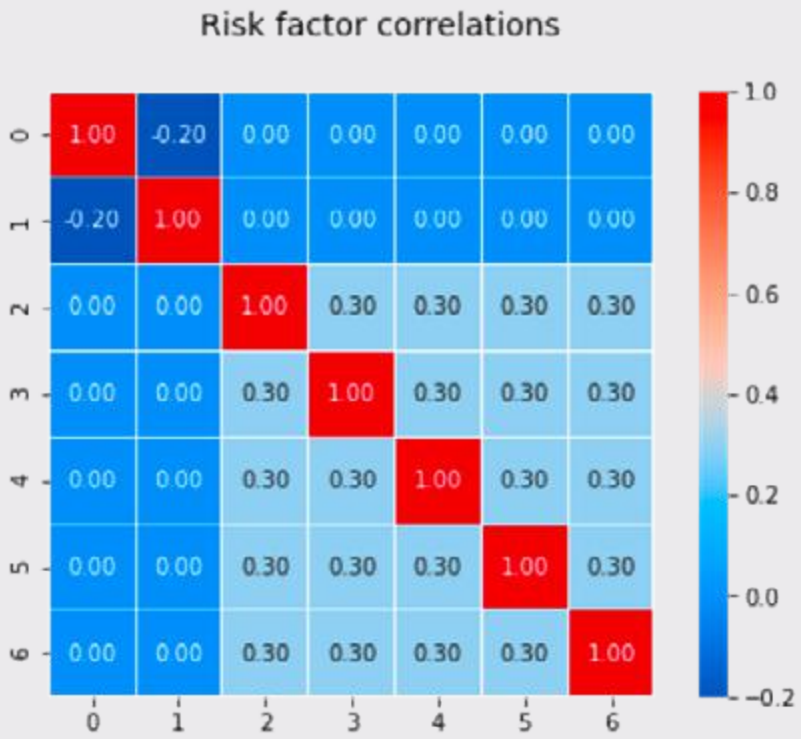
Here are the main steps in the Notebook:

1. We import necessary Python modules, functions, variables;
2. We create an atoti session;
3. We load data via the Python API into several in memory datastores;
4. Using the CERM Python library, we compute climate metrics that we load into datastores as well;
5. Joining in memory datastores to a base store, we create the cube with a star data model;
6. We add extra risk measures, defined as Python code;
7. We generate an url to access the dashboard and sliceand dice results

The unexpected losses computation relies on the three metrics: probability of default (PD), loss given default (LGD), and exposure at default (EAD), and on a correlation structure between borrowers via the common impact of systematic risk factors. The calculation is done via a Monte Carlo model on typically 5k – 10k paths, according to the very precise methodology described in the CERM quantitative paper.

Risk factors for the model

In this illustrative implementation we compute the unexpected loss distribution with seven risk factors: economic risk, transition risk and five physical risks per region. Let's look at the correlation structure among them:



This is a 7×7 matrix as we have 7 risk factors: the economic risk factor, the transition risk factor, and the physical risk factor of 5 regions: Europe, the Americas, Asia, Australia, MEA. The transition risk is negatively correlated with the economic risk. This comes from the observation that an economic downturn may involve a reduction in emissions of greenhouse gases. The physical risks of the different geographical regions are positively correlated ($\rho \circ \rho$ (0, 1), 0.3 in this example) and independent from the economic and transition risks.

Data Integration

We use data from our partner Carbon4 Finance. We feed the cube via atoti's Python API with:

8. A sample loan book with 200+ corporate borrowers
9. Climate scenarios
10. Counterparty details with sectors, sub-sectors and regional classifications
11. Credit ratings and climate ratings (transition & physical ratings)
12. Collateral data with similar ratings
13. Carbon data and physical risk country indexes (ND-Gain)
14. Average LGDs per rating and the credit migration matrix at t0
15. Calculated results

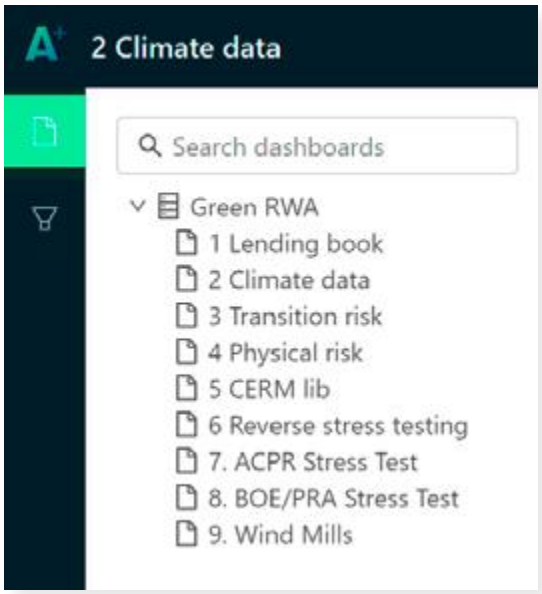
counterparty_ID	ISIN	counterparty_name	legal_type	high_low_stakes	group_name	geographic_region	industry_sector	industry_subsector
BENCHMARK	XXX	Benchmark	Corporate	high stake	world	World	All	All
SCHLUMBERGER LTD	AN8068571086	Schlumberger NV	Corporate	high stake	high stake|americas	North America	Industrials	Energy Equipment
ANDRITZ AG	AT0000730007	ANDRITZ AG	Corporate	high stake	high stake|europe	Europe	Industrials	Industrial Equipment
OMV AG.	AT0000743059	OMV AG.	Corporate	high stake	high stake|world	World	Energy	Oil & Gas Exploration & Production
VOESTALPINE AG	AT0000937503	VOESTALPINE AG	Corporate	high stake	high stake|europe	Austria	Durable Goods & Services	Automotive

Results

atoti offers direct access to:

- Distributions, quantiles;
- Expected and unexpected losses at the most granular level (path, rating, group, time step);
- Economic measures such as cost of risk, cost of capital
- Reverse stress test exploration mode.

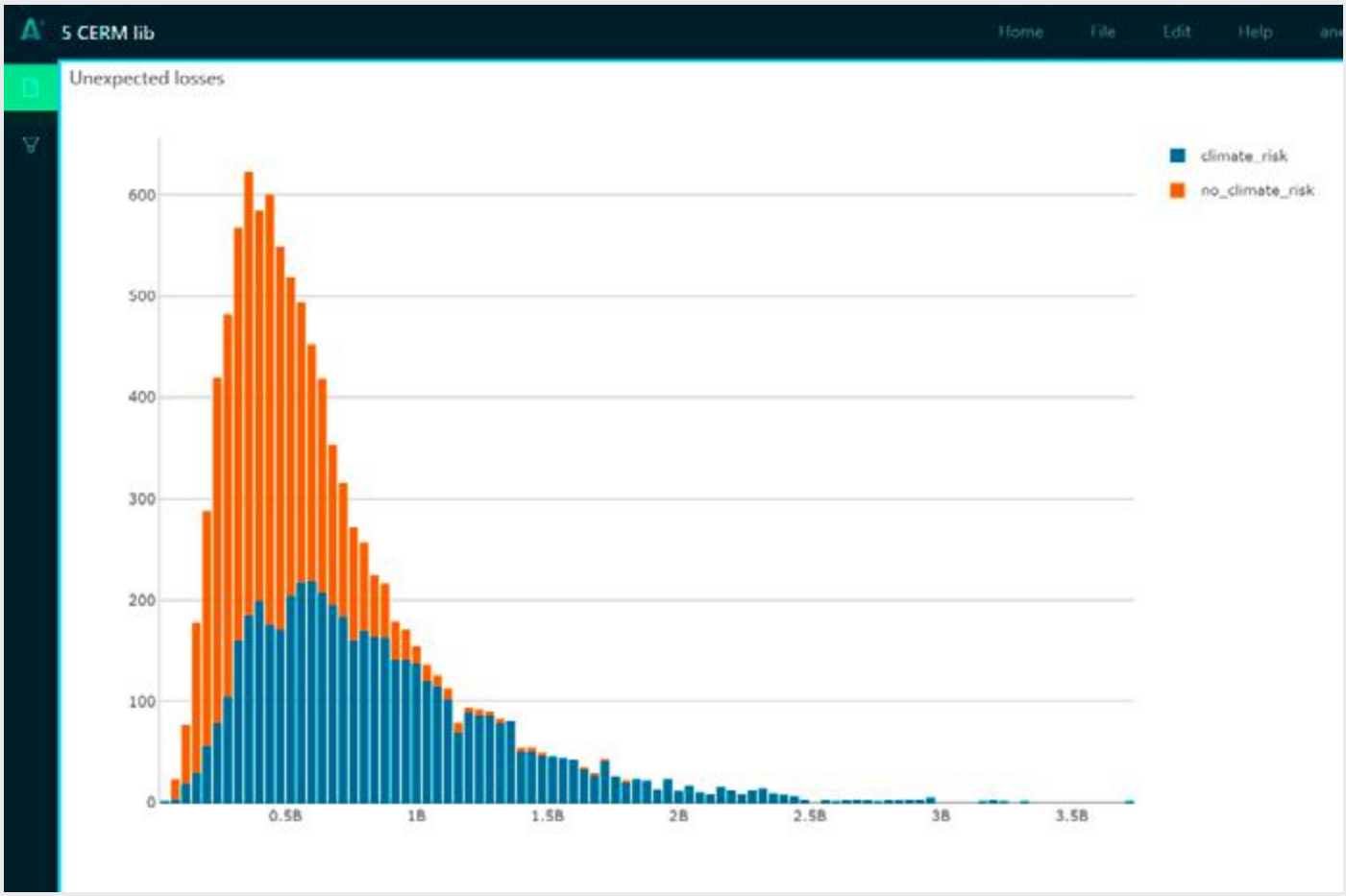
We look at portfolio content (EADs), and monitor expected and unexpected credit losses computed by the CERM model. We do it at scale across hierarchies (sector, geography), focusing on selected lenders, on selected geographies or sectors high stakes/low stakes sectors from a carbon perspective, or on the overall lending portfolio.



Lending book

industry_sector / industry_subsector / counterparty_name	Total	Total high stake|americas	high stake|americas		
			Americas	Brazil	Canada
	ead	ead	ead	ead	ead
Total industry_sector	15,350,000,000.00	5,920,000,000.00	460,000,000.00	110,000,000.00	540,000,000.00
Basic Materials	2,340,000,000.00	790,000,000.00		110,000,000.00	310,000,000.00
Agriculture & Fisheries	340,000,000.00	130,000,000.00			80,000,000.00
Forestry & Paper Products	570,000,000.00	220,000,000.00			50,000,000.00
Mining	1,430,000,000.00	440,000,000.00		110,000,000.00	180,000,000.00
Consumer Goods & Services	2,700,000,000.00	740,000,000.00	20,000,000.00		
Durable Goods & Services	920,000,000.00	440,000,000.00	110,000,000.00		
Energy	2,380,000,000.00	1,190,000,000.00	200,000,000.00		180,000,000.00
Oil & Gas Exploration & Production	1,540,000,000.00	750,000,000.00	200,000,000.00		20,000,000.00
ARC Resources Ltd.	20,000,000.00	20,000,000.00			20,000,000.00
BP P.L.C.	120,000,000.00	120,000,000.00	120,000,000.00		
CONTINENTAL RESOURCES INC	50,000,000.00	50,000,000.00			
Cimarex Energy Co	50,000,000.00	50,000,000.00			
DEVON ENERGY CORP	110,000,000.00	110,000,000.00			
ENI S.P.A.	80,000,000.00				
EXXON MOBIL CORP.	80,000,000.00	80,000,000.00	80,000,000.00		
Equinor ASA	80,000,000.00				
GALP ENERGIA-SGPS-S.A.	120,000,000.00				
LUNDIN PETROLEUM AB	20,000,000.00				
Marathon Petroleum Corp	80,000,000.00	80,000,000.00			

From the CERM outputs we detect tail scenarios that result in massive counterparty defaults and unexpected losses.



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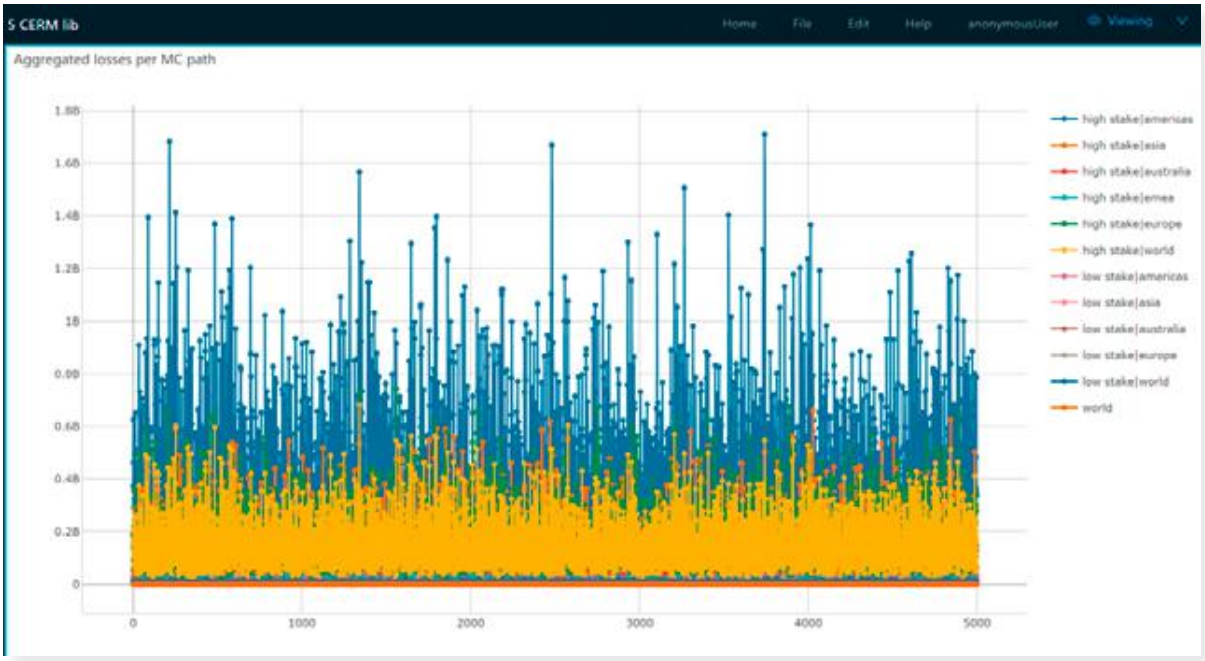
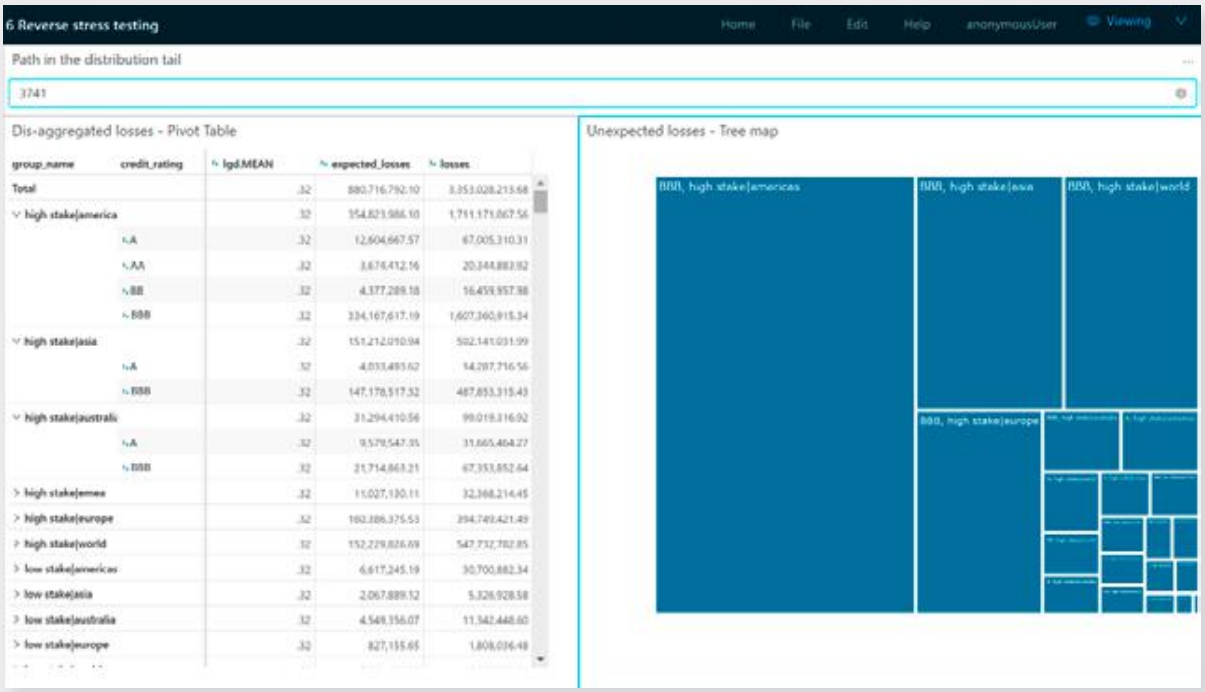
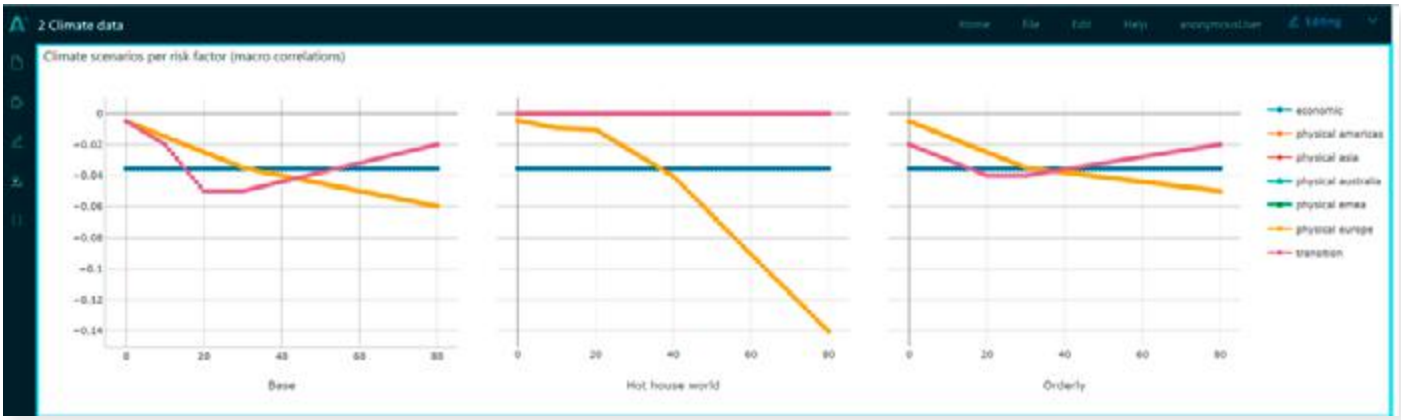




Finally we perform a number of What-If scenarios to further explore the impacts. For the purpose of this illustrative model we typically look at Orderly 2C, Disorderly 2C and Hot House World scenarios.



For more information contact ActiveViam or Green RWA to discover more uses cases on climate capital or climate risk credit adjustment on loans, whether general finance or project finance.

Reference: The Climate Extended Risk Model (CERM), Josselin Garnier, arXiv:2103.03275
https://josselin-garnier.org/wp-content/uploads/2020/12/cerm.pdf

About Green RWA

Green RWA (Risk-Weighted Assets) is a non-profit association rooted in the belief that climate transition will require the entire financial community to work in conjunction. OECD countries have pledged to successfully achieve Net Zero Emissions by 2050 and require banks to accelerate the green transition. Green RWA is committed to this goal by working with financial institutions to optimise their climate risk capital budget. Rigorous analysis and open collaboration as well as employing open financial modelling can help institutions meet this goal. Green RWA's reach is global and members span from Tokyo to Paris to the U.S. West Coast, reflecting the necessity for a global and coordinated action in the fight against climate change.

About the author: **Anne Gruz**

Anne was a rates trader for 11 years for global banks and corporates. She then led product and financial engineering teams for a fintech company for 13 years. Anne is now President of her own consultancy, Iggaak, which focuses on helping financial institutions with strategy and risk management. Anne holds a double engineering degree from the Ecole Polytechnique and from MINES ParisTech. Iggaak developed the Python code for the CERM. The quantitative library will be made available to Green RWA's community under an open source license.

About ActiveViam

ActiveViam provides precision data analytics tools to help organisations make better decisions faster.

ActiveViam started in 2005 with the vision of leveraging in-memory technology to create an analytics platform where businesses could leverage the largest data sets without restrictions, keep them up-to-date in real time and use them to empower their decision makers.

Our goal at ActiveViam, is to let organisations not only make decisions faster, but better; to not only reach their data, but their potential; to not only see their data, but find their way into the future.

ActiveViam is a privately owned company with offices in Paris, London, New York and Singapore.

For more information please visit: **www.activeviam.com**

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