Coupled Physical, Economic and Financial Impact Modelling workshop

co-organized by World Climate Research Programme (WCRP) and S&P Global

20-22 November 2024

World Meteorological Organization, Geneva, Switzerland

Organizing committee:

WCRP: Steven Sherwood, Thomas Lontzek, Karl Schmedders, Narelle van der Wel, Megha Kaveri

S&P Global: Terence Thompson, Marion Amiot, Megan Robinson

Workshop Agenda

Day 1: November 20, 2024 (12:00 PM - 5:00 PM)

12:00 PM - Keynote Address - *Stephane Hallegatte, Senior Climate Change Advisor, World Bank*

1:00 PM - Opening Luncheon

2:15 PM - Workshop framing, goals & approach

- 15 min - Overview by conference organizers
- 45 min - Small group introductions to spark intros between disciplines

3:15 PM-3:35 PM - Coffee break

3:35 PM-5:00 PM - “Pump-priming session” cross-disciplinary breakout discussions

Day 2: November 21, 2024 (9:00 AM - 5:00 PM)

9:00 AM-10:45 AM - **Session 1: Overview of the financial sector's current approach to coupling physical, economic, and financial impacts**

- Introduction
- Approach to physical risk and economic modelling in NGFS scenario analysis - *Agnieszka Trzcinska, European Central Bank*
- Roundtable session moderated by *Terence Thompson and Megan Robinson, S&P Global Climate Center of Excellence.* Introductions and panel discussion by:
  - *Michaela Mei Dolk, World Bank*
  - *Paul Gruenwald, S&P Global Ratings*
  - *Theresa Lober, Bank of England*
  - *UBS or Piguet Galland & Cie SA**
  - *IMF - Sha Yu (TBC)**

10:45 AM-11:05 AM - Coffee break

11:05 AM-12:30 PM - **Session 2a: State of the physical sciences**

Presentations (10 mins + 5 mins for Q&A):

- Cascading events, extremes and tipping – *Christian Franzke and Gabriele Hegerl*
- Impacts on agriculture – *Peter Alexander*
- Heat extremes and health – *Steven Sherwood and Laura Suarez-Gutierrez*
- Impacts on ecosystems and fire – *Kirsten Thonicke and Kai Kornhuber*

Open discussion on physical science issues addressing key questions [25 min]

12:30 PM-1:30 PM - Lunch

1:30 PM-2:30 PM - **Session 2b: State of the physical sciences continues**

- Contributed brief presentations [20 min]
- Breakout groups on different physical risks [20 min]
- Breakout group reports back to plenary [20 min]

2:30 PM-2:50 PM - Coffee break

2:50 PM-5:00 PM - **Session 3: Economic state of knowledge & known gaps**

Presentations by:

- *Simon Dietz*
- *Daiju Narita*
- *Franziska Piontek*
- *Tony Smith*
- *Simon Scheidegger*
- *Massimo Tavoni*
- *Fabio Trojani*

Panel discussion and plenary (60 mins) moderated by *Simon Dietz*

7:30 PM onwards - Group dinner at Restaurant La Perle du Lac

Day 3: November 22, 2024 (9:00 AM - 4:00 PM)

9:00 AM-10:30 AM - **Session 4: What does the ideal approach for the financial sector's coupling physical, economic, and financial impacts look like?**

- Brainstorming session in breakout format

10:30 AM-10:50 AM - Coffee break

10:50 AM-12:00 PM - **Session 5: What scoping of "catastrophe" assumptions can be made? How can probability estimates be included?**

- Breakout sessions [45 min]
- Report back, plenary discussion [30 min]

12:00 PM-1:00 PM - Lunch

1:00 PM-3:00 PM - **Session 6: How do we close the gaps between the current and ideal approach? How do we include and develop techniques that enable short- and long-term decision-making, informed by the impacts of low-probability, high-impact climate-system outcomes?**

- Brief summaries from the morning's brainstorming session
- Panel discussion (Armon Rezai and TBD)
- Breakout discussions

3:00 PM-3:20 PM - Coffee break

3:20 PM-4:00 PM - **Closing session: Moving the collaborations forward**

Suggested readings

1. An Economist's Guide to Climate Change Science - American Economic Association (Hsiang and Kopp, 2018)
2. Climate Change through the Lens of Macroeconomic Modeling main_annual_review.pdf (Fernández-Villaverde, Gillingham and Scheidegger, 2024)
3. Climate Change Economics over Time and Space | Annual Reviews (Desmet and Rossi-Hansberg, 2024)
4. Climate Finance | Annual Reviews (Giglio et al., 2021)
5. IPCC Glossary Search - Contains the IPCC definitions of “risk,” “uncertainty,” etc

Optional readings

1. The Fundamental Problem with ESG? Conflicting Letters (Cabolis, Lavanchy, Schmedders, Journal of Financial Transformation 2023)
2. Climate modelling - an overview (Briefing note, CLEx, 2023)
3. Climate change and tipping points (Briefing note, CLEx, 2022)
4. Future weather and climate extreme events (Briefing note, CLEx, 2019)
5. Perspectives on tipping points in integrated models of the natural and human Earth system: cascading effects and telecoupling - IOPscience (Frankze et al. 2022)
6. How Much Will Global Warming Cool Global Growth? | NBER (Nath, Ramey and Klenow, 2024)
7. The Emperor’s New Climate Scenarios, Limitations and assumptions of commonly used climate-change scenarios in financial services, Institute and Faculty of Actuaries, July 2023
8. Loading the DICE Against Pensions - Carbon Tracker Initiative Steve Keen, Carbon Tracker, July 2023
9. The NBER working paper "Climate Change Around the World", http://www.econ.yale.edu/smith/world19.pd
10. NZIF 2.0 Framework https://igcc.org.au/wp-content/uploads/2024/06/PAII_NZIF-2.0_240624.pdf

Coupled Physical, Economic, and Financial Impact Modelling Workshop (20-22 November 2024)

List of participants

Name & Affiliation	Bio (As provided by the participant)
Christian Franzke Center for Climate Physics, Institute for Basic Science	I am a climate scientist and my current research focuses on understanding climate variability across scales, climate change, extreme weather and climate events, weather and climate risks, health and climate and the economics of climate change. I am an Associate Professor and Project Leader at the Center for Climate Physics, Institute for Basic Science at Pusan National University. I am also an editor of Earth System Dynamics and Nonlinear Processes of Geophysics.
Steve Sherwood UNSW Sydney	I study moisture-related processes in the atmosphere, particularly related to convection. My past work has addressed relative humidity, shown that improvements to weather balloons over time were unintentionally hiding global warming, established a limit to human tolerance of heat stress, and addressed extreme rainfall and cloud feedbacks on climate and global climate sensitivity, among others. I've contributed to major science assessments including as a Lead Author of the chapter on Clouds and Aerosols in the 2013 IPCC 5th Assessment WGI Report. I co-lead the WCRP Safe Landing Climates Lighthouse which seeks to identify safe future pathways for humanity.
James Rising University of Delaware	James Rising is an Associate Professor at the School of Marine Science & Policy. Dr. Rising studies the economics of environmental policy, with an emphasis on risks from climate change, the integration of empirical and process-based methods, and human-natural complex systems. Prior to joining UD, James was a researcher at the Grantham Research Institute at LSE and held postdoctoral positions at the Energy & Resources Group at UC Berkeley and the Energy Policy Institute at the University of Chicago.

Laura Suarez-Gutierrez ETH Zürich	I am a MSCA Postdoc Fellow at ETH Zürich and IPSL Paris. I investigate high-risk, worst-case climate extremes that are physically plausible in the near-term future using state-of-the-art climate model simulations. Previously, I worked at the Max Planck Institute for Meteorology in Hamburg, where I obtained my PhD in 2019, and investigated the variability of extreme heat and drought and how soon extreme events typical of warmer climates could occur. I have a Physics bachelor and a MSc in Climate Sciences. My areas of interest cover heat and drought stress extremes, their driving mechanisms, and associated socioeconomic and ecological impacts.
Gabriele Hegerl School of Geosciences, University of Edinburgh	Gabriele Hegerl is professor of climate system science at the University of Edinburgh. Her research focuses on understanding the causes of climate change, including those of extreme events, and using observations to constrain predictions of future climate change. Her work has determined causes of change in temperature, rainfall, and extreme events and she had key roles in Intergovernmental Panel on Climate Change assessments of climate change. Gabriele is a fellow of the Royal Society, Leopoldina, and American Meteorological Society as well as American Geophysical Union.
Armon Rezai WU Wien	Armon Rezai is professor at the Vienna University of Economics and Business and a senior researcher in IIASA's Population and Just Societies Program. His research topics mostly center around macroeconomics (e.g., economic growth, distribution of income and wealth, and unemployment) and its application to environmental problems like climate change and economic policy.
Daiju Narita University of Tokyo	Daiju Narita is a professor at the Graduate School of Arts and Sciences, the University of Tokyo, Japan. He is an environmental economist, and his main research focus is the economics of climate change, in particular, cost and benefit evaluations of climate change and adaptation measures. His other research interests include the nexus of development and the environment. In recent years, he has been involved in pilot evaluations of climate change adaptation projects financed by the Japan International Cooperation Agency (JICA) based on DMDU (Decision Making Under Deep Uncertainty) methods. He holds a PhD (sustainable development) from Columbia University, USA.

Jana Sillmann CICERO and University of Hamburg	Jana Sillmann is Professor for Climate Extremes at the University of Hamburg (Germany) and Senior Researcher at the Center for International Climate Research – Oslo (Norway). Her work focuses on relating physical aspects of weather and climate extremes to socio-economic impacts and questions related to risk assessment and decision-making. She is co-chairing the Knowledge Action Network on Emergent Risks and Extreme Events (Risk KAN). She previously was co-leading activities of the WCRP Grand Challenge on Weather and Climate Extremes. She is also Lead Author of Chapter 12 “Climate change information for regional impact and for risk assessment” in IPCC AR6 WG1.
Massimo Tavoni European Institute on Economics and the Environment, and Politecnico di Milano	Massimo Tavoni is professor of climate change economics at Politecnico di Milano, and director of the European Institute on the Economy and the Environment (EIEE), an institute of CMCC established in 2018 in an alliance with Resources for the Future and the Fondazione CMCC. He has been fellow at the Center for Advanced Studied in Behavioural Sciences at Stanford University, and post doctoral fellow at Princeton University. His research is about climate change mitigation policies, and has appeared in major scientific journals. He is a lead author of the IPCC (5th and 6th reports), co-directs of the International Energy Workshop and was deputy editor for the journal ‘Climatic Change’. He has been awarded two grants from the European Research Council (ERC) and has coordinated several international research projects.
Peter Alexander University of Edinburgh	Peter Alexander is a Professor of Global Food Systems at University of Edinburgh. His work focuses on modelling food and land use systems to better understand the social, economic and environmental interactions of supply, demand and trade, as well as competition for land between agriculture, forests and conservation. He led the development of the Land System Modular Model (LandSyMM), was a Lead Author for the 2022 IPCC Working Group II report and is a Coordinating Lead Author on UNEP’s 7th Global Environmental Outlook (GEO-7).

Franziska Piontek Potsdam Institute for Climate Impact Research	Franziska Piontek co-leads the working group on Macroeconomic Transitions at PIK. Her research focuses on economic impacts of climate change in the context of integrated assessment modeling, she is also interested in distributional impacts. Franziska is part of the REMIND modeling team and a member of the consortium developing the NGFS scenarios, focusing on chronic physical risks. Furthermore, she is involved in the Intersectoral Impact Modeling Intercomparison Project (ISIMIP) and was a contributing author of the IPCC 6th Assessment Report.
Simon Dietz London School of Economics	Simon Dietz is Professor of Environmental Policy at the London School of Economics, where he is affiliated with the Grantham Research Institute on Climate Change and the Environment, and the Department of Geography and Environment. He is also Research Director of the LSE Transition Pathway Initiative (TPI) Centre, co-editor of the Journal of the Association of Environmental and Resource Economists, a CEPR Research Fellow, a CESifo Research Network Fellow, and a Fellow of the Royal Society of Arts. He is a former Vice President and Council Member of the European Association of Environmental and Resource Economists, and was a Food System Economics Commissioner. He is an environmental economist whose research interests include climate change, integrated assessment modelling and corporate sustainability.
Tony Smith Department of Economics, Yale University	Anthony A. Smith, Jr. (Tony) is the William K. Lanman, Jr. Professor of Economics at Yale University, where he has served as Chair of the Department of Economics since 2019. He received a B.S. in Economics from M.I.T. and a Ph.D. in Economics from Duke University. He is a Research Associate of the National Bureau of Economic Research and is Co-Editor of Macroeconomic Dynamics. He conducts research in macroeconomics, with a particular focus on income and wealth heterogeneity, and in econometrics, with a particular focus on simulation estimation of structural models. His most recent research takes place at the intersection of macroeconomics and environmental economics, where he is constructing global economy-climate models with high geographic resolution.

Etienne Buff ESG Specialist at UBS (Group)	Etienne Buff serves as the ESG Specialist in the Chief Sustainability Office of UBS. In this role, he oversees the development of UBS Group's Company Transition Assessment Framework and drives cross-divisional initiatives related to methodology and metrics developments. Additionally, he represents UBS in various industry associations and works closely with the Swiss government to develop industry standards and regulations. Prior to joining the CSO, Etienne worked with UBS Asset Management on multiple sustainable finance projects and held several other positions within UBS over the past decade. He holds a PhD in Sustainable Finance and studied Economics at the University of St.Gallen (HSG).
Bette Otto-Bliesner NSF National Center for Atmospheric Research	Bette Otto-Bliesner has a Ph.D in Meteorology. She is a Senior Scientist at the National Center for Atmospheric Research in Boulder, Colorado. Bette was a Lead Author for the IPCC AR4 and AR5. She is co-leading the High-Risk Theme of the WCRP Safe Landing Climates Lighthouse Activity, and particularly the CMIP7 What-If scenarios to explore the consequences and interactions if the Earth system crosses tipping points, such as the dieback of the Amazon rainforest and greening of the Sahel. Her current research project involves high-resolution CESM to study the statistics and drivers of past and future weather and climate extremes.
Marco Thalhammer RWTH Aachen University	Marco earned his PhD from RWTH Aachen University in 2023 and currently works as a Postdoctoral Researcher. His research focuses on climate economics, asset pricing, and sustainable finance.
Simon Scheidegger University of Lausanne	Simon Scheidegger is an Associate Professor of Economics at the University of Lausanne. He has held visiting faculty positions at the University of Pennsylvania, MIT Sloan, and Yale. His research focuses on developing and applying computational methods from machine learning, AI, applied mathematics, and high-performance computing to problems in finance, economics, and climate-change economics.

Kai Kornhuber IIASA / Columbia University	Dr. Kai Kornhuber is a senior research scholar at the International Institute for Applies Systems Analysis, Austria, where he leads the theme Extreme Weather and Climate Dynamics. Within this theme he is advancing the understanding and modeling of high impact and compound extreme weather events to provide robust estimates of complex and cascading climate risks under present conditions and future climate scenarios. He teaches as an adjunct professor of Climate at the Columbia Climate School and serves as an associate fellow at the German Council on Foreign Relations (DGAP). He is designated chair of the Risk Knowledge Action Network, a joint initiative of World Climate Research Programme (WCRP), World Weather Research Programme (WWRP), Future Earth, and Integrated Research on Disaster Risk (IRDR).
Fabio Trojani University of Geneva, University of Turin and Swiss Finance Institute	Fabio Trojani is Professor of Finance and Statistics at the University of Geneva, Senior Chair of the Swiss Finance Institute and AXA Chair in the Socioeconomic Risks of Financial Markets at the University of Turin. He is a regular speaker at leading conferences in finance, econometrics and statistics, fields where he published widely. Fabio works on various methods for an improved modeling and empirical analysis of markets with frictions or other sources of mispricing. His recent research considers model-free approaches extracting global international asset pricing factors and optimal portfolio problems with multiple traded assets, multivariate state dynamics and transaction costs.
Paul Gruenwald S&P Global	I'm the Chief Economist at S&P Ratings. My team produces the forecasts, narratives and risk scenarios that sit behind our one million-plus credit ratings. My "discretionary " research focuses on the interaction of natural and physical capital in dynamic models.

Neil Harris Cranfield University	Neil Harris is Professor of Atmospheric Informatics in the Cranfield Environment Centre at Cranfield University who works principally on natural and anthropogenic trace gas emissions (e.g. isoprene, dimethylsulfide, methane), atmospheric composition and their link to climate. He was co-chair of the WCRP Atmosphere (formerly Stratosphere) Processes And its Role in Climate and is currently a member of the Safe Landing Climate Lighthouse and its Pathways group. He was awarded the NERC 50th anniversary International and the Overall Impact Awards for his “role in successful development of the Montreal Protocol on Substances that Deplete the Ozone Layer”.
Thomas Lontzek RWTH Aachen University	Thomas S. Lontzek is a Professor of Economics at RWTH Aachen University. His work focuses on optimal decision-making in face of risk and uncertainty in the context of climate change. He is particularly interested in implementing cascading events into economic integrated assessment models.
Yifan Zhao RWTH Aachen University	I am currently a PhD candidate at the Chair of Computational Economics at RWTH Aachen University, Germany, specializing in integrated assessment models of the climate and economy, with a focus on modeling uncertainty aversion.
Karl Schmedders IMD	Karl Schmedders is Professor of Finance at IMD, a private business school in Lausanne/Switzerland. His research and teaching focuses on sustainability and the economics of climate change. Before joining IMD in 2019, Schmedders was Professor of Quantitative Business Administration at the University in Zurich and Associate Professor of Managerial Economics and Decision Sciences at the Kellogg School of Management at Northwestern University in Evanston, Illinois. He holds a PhD in Operations Research from Stanford University. He is also a fellow of the Game Theory Society and an SAET Economic Theory Fellow.

Marion Amiot S&P Global Ratings	Marion Amiot is the Head of Climate Economics and European Economist at S&P Global Ratings. She is responsible for integrating climate risks in the macroeconomic framework that underpin Ratings globally, as well as in charge of the UK economic outlook. Marion's research focuses on quantifying economic impacts of physical risks globally, green growth dynamics, the global climate finance gap and the use of climate scenarios within Ratings amongst others.
Molly Mitchell Virginia Institute of Marine Science, William & Mary	Dr. Molly Mitchell is a Research Assistant Professor at the Virginia Institute of Marine Science. Her research focuses on forecasting sea level changes and resulting shifts in coastal resources due to the interaction of sea level rise with human-driven changes. She works at the intersection of multiple disciplines, including projects involving ecology (marsh changes and blue carbon), physical dynamics (sea level rise trend analysis, shoreline geology) and human decision making (social vulnerability, sea level rise adaptation, adaptive management application). She works with representatives from many different groups to help translate research and current scientific understanding into practical recommendations.
Michaela Dolk World Bank	Michaela is a Financial Sector Specialist with the World Bank Group's Finance, Competitiveness, and Innovation Global Practice. Her work focuses on crisis and disaster risk finance, including physical climate-related risks to the financial sector. Prior to joining the World Bank, Michaela worked in the (re)insurance sector, where she worked on catastrophe risk model development, and supported reinsurance and insurance-linked securities transactions. Earlier, she worked with the Commonwealth Scientific and Industrial Research Organization in Australia on hydrological and climate change modelling. Michaela holds an MSc in Water Science, Policy and Management from the University of Oxford.

Agnieszka Trzcinska European Central Bank	Agnieszka Trzcinska is a Team Lead in the Directorate General Macroprudential Policy & Financial Stability at the European Central Bank. In her role, Agnieszka supports the ECB's Chair of the NGFS Workstream on Scenario Design and Analysis in developing climate scenarios. Introduced as a novel tool in 2020, the NGFS scenarios have assisted central banks, supervisors, and other financial actors in exploring various potential future outcomes of climate change and the transition. Prior to this, Agnieszka led teams working on the European economic and fiscal governance framework, and banking sector policy issues in the Directorate General International & European Relations at the ECB. Before joining the ECB, she worked at the National Bank of Poland in various roles and in the private sector where she managed European research projects. Agnieszka holds a MSc. in Managerial Economics and a MSc. in Finance and Accounting, and a PhD in Economics from the University of Warsaw.
Terence Thompson Climate Center of Excellence, S&P Global	I am Chief Scientist at S&P Global's Climate Center of Excellence and have responsibility for long-term research regarding physical hazards and their economic impacts. My principal areas of research are hazard quantification (temperature, precipitation, drought, wildfire, coastal flooding, wind, landslides, subsidence, etc.), macro-economic impacts (GDP, productivity, etc.), nature/biodiversity impacts, and probabilistic scenario analysis.
Theresa Lober Bank of England	Theresa is Head of Strategic Climate Projects at the Bank of England. The team conducts analytical and policy-relevant climate projects in future areas of focus for central banks. Prior to that she headed up the Bank of England's Climate Hub, which leads the Bank's policy response to the financial risks and macroeconomic impacts from climate change and the transition. She works closely with international peers, including through global networks like the Network for Greening the Financial System, and currently co-leads the workstream on climate scenario analysis within the Basel's Taskforce for Climate Risks.

Elena Shevliakova NOAA/GFDL	Dr. Elena Shevliakova is a Physical Scientist and a Deputy Leader of the Earth System Processes and Interactions Division of the U.S. National Oceanic ad Atmospheric Administration Geophysical Fluid Dynamics Laboratory, Princeton, NJ. Dr. Shevliakova served as a Convening Lead Author of the IPCC Special Report on Climate Change and Land. She develops and applies comprehensive climate and Earth System models capturing ecological, hydrological, and biogeochemical processes underlying land-climate interactions. She also actively contributes to research on the implication of perturbations of terrestrial carbon cycling for the climate system and tipping points.
Kristina Costar Met Office, UK	Kristina is the Met Office's Principal Economist. Her team considers the economic and financial impacts of weather forecasts and of climate change and extreme weather more widely. With a background in economics, she has previously worked for several UK government departments, including HM Treasury, on diverse policy areas such as financial services, taxation and digital infrastructure.
Kirsten Thonicke PIK Potsdam	I am a Geoecologist by training. My research interest is in modelling wildfire and vegetation dynamics under climate and land-use change. I am interested in advancing our knowledge in climate extremes and the cascades wildfires can cause. Working also on how biodiversity increases forest resilience, I am working on the environmental limits of the supporting function biodiversity has for ecosystem stability.

Stephane Hallegatte World Bank Group	Stéphane Hallegatte is the Senior Climate Change Advisor of the World Bank Climate Change Group. Mr. Hallegatte is the author of dozens of articles published in international journals in multiple disciplines and of several books and World Bank reports including Shock Waves: Managing the Impacts of Climate Change on Poverty. He also led the development of the Resilience Rating System, a tool of monitor and report on how resilience is included in public or private investments. More recently, he has supervised the new World Bank diagnostic, the Country Climate and Development Reports, and has co-led the CCDRs for Turkey and Brazil. Mr. Hallegatte holds an engineering degree from the Ecole Polytechnique (Paris) and a Ph.D in economics from the Ecole des Hautes Etudes en Sciences Sociales (Paris).