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Coupled Physical, Economic, and Financial Impact Modelling Workshop Report

Improved methods for estimating macro-economic and financial impacts of climate-related physical hazards

WCRP Safe Landing Climates Lighthouse Activity and S&P Global
November 2024
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About WCRP

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About S&P Global

S&P Global is a major provider of financial information and analytics in all parts of the world economy. Their Climate Center of Excellence serves as a focal point of scientific expertise and collaboration, both internal and external, addressing physical and economic impacts of climate change.

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Impressum

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Figure 1: Workshop Participants

1. Introduction

In November 2024 the World Climate Research Programme (WCRP) Safe Landing Climates (SLC) Lighthouse Activity and S&P Global held a joint workshop [1] at the World Meteorological Organization (WMO) Headquarters in Geneva over 2.5 days. The goals of the workshop were to explore, better understand and move toward evaluating methods currently being used by the finance community, including regulators, to quantify global macroeconomic physical climate risks.

The workshop was attended by 40 participants (See Annex 1) drawn from physical climate science, economics, and finance disciplines including several attendees from S&P Global, the SLC Lighthouse Activity, and leading banks in Europe. It began with a public keynote address from Stephane Hallegatte from the World Bank highlighting the growing role of climate change in international finance and the challenges faced in communicating and acting on what we know about climate risks.

The workshop was devoted more to discussions than to presentations (See Annex 2 for the Workshop Agenda), and these were mostly cross-disciplinary breakout groups, which led to robust discussions. Several participants commented on how open the attendees were to the perspectives of the other disciplines, and on how much they themselves learned, both of which were key objectives.

2. Key Insights

The workshop identified a number of key insights and takeaways from discussions:

- Participants agreed that the disciplines of climate science, finance and economics need to work together to better model macro-climate and related risks.

- As anticipated, many concepts (even "climate") have varying interpretations across disciplines, and disciplinary methods and concepts are not well understood across disciplines. Attendees were surprised, however, by the level of cross-disciplinary misunderstanding. For example, economic modelling often assumes that impacts scale with absolute temperature even at the local level, while physical scientists expect most local impacts to depend on other variables. Meanwhile many physical scientists, assuming Gross Domestic Product (GDP) to be advocated by economists as a measure of economic well-being, were surprised by economists' focus on broader measures of consumption rather than GDP, although there was broad agreement on the need for better understanding of methods as well as broader definitions of well-being that include the environment, with physical, human, and natural capital noted as being important. Finally, an expected continuation of steady technological progress and associated economic growth is implicitly included in economics thinking but often overlooked (or questioned) by

[1] https://www.wcrp-climate.org/slc-events-opportunities/coupled-physical-economic-and-financial-impact-modelling-workshop

others. This strongly affects the framing of impacts and how much they will affect future generations and is one reason economists are typically more sanguine about climate change than physical scientists are.

- Understanding the different disciplinary perspectives is important, as well as how to aggregate from micro-scale to macro-scale impacts. The finance community is particularly concerned with sudden surprises that could destabilize markets, which has led them to have strong concerns about tipping points and cascading events. They are also understandably focused on asset-level risks. The other disciplines were more focused on expected aggregate impacts on human welfare over time, with physical scientists often highlighting risks to vulnerable communities and nature.

- The limitations of current modelling approaches that affect current cost estimates and GDP impacts were discussed. On the physical climate side, one issue is how to make use of huge datasets with highly detailed information (or even to explain what is available), and the complexity of bottom-up impact modelling; another is ignorance about tipping points, tail risks and interacting hazards. On the economics side a key limitation is an inability to capture the complexity of the global economy in a tractable model (especially when performing traditional and computationally intensive policy optimization); another is the simplistic assumptions required in empirically estimating damages from macroeconomic data. Overall, multiple stages of the physical-socioeconomic prediction problem are computed by disconnected models, which leads to consistency problems and missing feedbacks.

3. Future work

Areas where WCRP could work further on the above issues include more quantitative assessment of tipping point and cascading hazards (now underway within WCRP Lighthouse Activities and in collaboration with TIPMIP (Tipping Points Model Intercomparison Project (MIP)) via WhatIfMIP), sharing of advanced model coupling activities, underway in a few of the WCRP Core Projects, clarification of how global-mean temperature is thought to be related to local changes, and continued collaboration on areas such as damage estimates. The cost of water was identified as a missing component of economics models, for example, but has been looked at in WCRP.

The outcomes of the workshop will include a “perspective” paper submitted to a high-level journal, highlighting the key challenges for a multi-disciplinary audience as informed by workshop discussions; further collaborative efforts; seminars of overlapping interest; and a follow-up workshop tentatively planned for January 2026 to pursue a key topic identified in this workshop, such as climate damage estimation or alternative metrics to GDP.

Annex 1 - List of Participants

First name	Last name	Affiliation
Peter	Alexander	University of Edinburgh
Marion	Amiot	S&P Global Ratings
Simon	Dietz	London School of Economics
Michaela	Dolk Mei	World Bank
Matthew	Foote	Howden Group
Christian	Franzke	Pusan National University, Pusan, S Korea
Paul	Gruenwald	S&P Global Ratings
Stephane	Hallegatte	World Bank
Neil	Harris	Cranfield University
Diana	Heger	S&P Global
Gabriele	Hegerl	University of Edinburgh
Megha	Kaveri	WCRP Secretariat
Kai	Kornhuber	International Institute for Applied Systems Analysis (IIASA)
Hannah	Liddy	Columbia University
Theresa	Lober	Bank of England
Thomas	Lontzek	RWTH Aachen University
Molly	Mitchell	Virginia Institute of Marine Science
Carlos	Montoya	WCRP Secretariat
Daiju	Narita	University of Tokyo
Bette	Otto Bleisner	University Corporation for Atmospheric Research (UCAR)
Franziska	Piontek	Potsdam Institute for Climate Impact Research (PIK)
Nicola	Ranger	University of Oxford
Armon	Rezai	University of Vienna
James	Rising	University of Delaware
Megan	Robinson	S&P Global
Simon	Scheidegger	École Polytechnique Fédérale de Lausanne (EPFL)
Karl	Schmedders	IMD Business School
Roland	Séférian	Université de Toulouse, Météo-France
Steven	Sherwood	UNSW Sydney
Elena	Shevliakova	NOAA Geophysical Fluid Dynamics Laboratory
Jana	Sillman	CICERO Centre for International Climate Research
Tony	Smith	Yale University
Laura	Suarez Gutierrez	ETH Zurich
Massimo	Tavoni	Euro-Mediterranean Center on Climate Change (CMCC)
Marco	Thalhammer	RWTH Aachen University
Terence	Thompson	S&P Global
Kirsten	Thonicke	PIK Potsdam
Fabio	Trojani	University of Geneva
Agnieszka	Trzcinska	European Central Bank
Narelle	van der Wel	WCRP Secretariat

Biographies

First name	Last name	Biography
Peter	Alexander	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).
Marion	Amiot	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.
Simon	Dietz	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.

First name	Last name	Biography
Michaela	Dolk Mei	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.
Matthew	Foote	Matt has over 30 years of experience in the insurance and reinsurance industry, specialising in catastrophe modelling and geospatial analytics. He leads the Howden Resilience Laboratory, in collaboration with Microsoft which develops innovative climate risk analytics and scenario models supporting client's investment and risk transfer strategies. Matt is a Chartered Geographer and a Fellow of the Royal Geographical Society. He was an editor of the Wiley textbook 'Natural Catastrophe Modelling: a Practitioner's Guide'. Matt is the Chair of the Global Risk Modelling Alliance's Strategic Advisory Board, and UK Principal Representative to the Intergovernmental Panel on Earth Observation Programme Board.
Christian	Franzke	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.
Paul	Gruenwald	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.

First name	Last name	Biography
Stephane	Hallegatte	Stéphane Hallegatte is the Senior Climate Change Advisor of the World Bank Climate Change Group. He joined the World Bank in 2012 after 10 years of academic research. His research interests include the economics of natural disasters and risk management, climate change adaptation, urban policy and economics, climate change mitigation, and green growth. Mr. Hallegatte is the author of dozens of articles published in international journals in multiple disciplines and of several books. He also led several high-impact reports.In 2018, he received the Burtoni Award for his work on the link between climate change adaptation and poverty reduction. More recently, he has supervised the new World Bank diagnostic, the Country Climate and Development Reports. 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).
Neil	Harris	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”.
Diana	Heger	Diana Heger is an Associate Director in the Modelling & Scenarios team at S&P Global Market Intelligence. She has worked on different scenario projects leveraging our inhouse macro-economic model, the Global Link Model, e.g. quantifying the economic impacts of the latest El Nino cycle or the recent drought in the Panama Canal region. She also worked on a project linking NGFS scenarios with economic and financial market variables using a Probabilistic Graphing Model. She especially focuses on how to integrate different aspects of climate including climate hazards and chronic physical risk into the S&P Global macro-economic models.

First name	Last name	Biography
Gabriele	Hegerl	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.
Megha	Kaveri	Megha Kaveri joined WCRP as a Science and Communication intern in August 2023 and was promoted to Science and Communications Assistant Scientific Officer in 2024. She works on WCRP's Lighthouse Activities, specifically Safe Landing Climates, in its communications including newsletters, events, brochures, circulars, website, and social media. Megha completed her MA in development studies from the Geneva Graduate Institute, and before that she graduated from the Asian College of Journalism, India, with a postgraduate diploma in journalism. Before she joined the WMO, she worked as a journalist in India and Geneva.
Kai	Kornhuber	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).
Hannah	Liddy	Dr. Hannah Liddy is the executive officer of the global research project AIMES – Analysis, Integration and Modeling of the Earth System. AIMES is a core project of Future Earth and facilitates multidisciplinary and multinational activities aimed at addressing integrative research that is beyond the scope of individual scientists or institutes. Current focal areas include quantifying and understanding the consequences and feedbacks of human activities on biogeochemical cycles and the climate system past and present, development of Earth system models, global climate and land model benchmarking,

First name	Last name	Biography
		and facilitating and encouraging a Young Scholar's Network that supports interaction between natural and social sciences as well as the humanities. She completed her Ph.D. in earth science with a focus in paleoclimate and isotope geochemistry at the University of Southern California.
Theresa	Lober	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.
Thomas	Lontzek	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.
Molly	Mitchell	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.
Carlos	Montoya	Carlos Montoya joined the World Climate Research Programme (WCRP) in October 2024 as a Project Assistant Intern within the Science and Innovation Department. His work supports the "My Climate Risk" Lighthouse Activity, focusing on global climate research, logistics, and communication efforts for the division. He contributes to international climate research collaboration, supporting meetings, creating reports, and managing WCRP's membership database. Carlos is completing his Master's in International and Development Studies at the Geneva Graduate Institute, where he specializes

First name	Last name	Biography
		in environmental economics and sustainability. Prior to this, he worked on international projects with the CyberPeace Institute, interned at the Presidency of Colombia, and worked at the National Agency for Rural Development of Colombia, where he honed his skills in project management and international policy. His interests lie in the political and financial dimensions of global climate initiatives, particularly regarding sustainable development.
Daiju	Narita	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.
Bette	Otto-Bliesner	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.

First name	Last name	Biography
Franziska	Piontek	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.
Nicola	Ranger	Director of the Global Finance Group at the Environmental Change Institute. Focus on integrating climate resilience and nature into financial/fiscal and economic decision making across government and financial institutions. Risk analytics and economic and financial impact modelling focussed. Sustainable finance, fiscal policy, sovereign debt, development finance. Multidisciplinary. Background at the World Bank, UK Government (FCDO, HM Treasury) and insurance industry. Lead Scientist on the Stern Review on the Economics of Climate Change and lead of the recent UK nature-related financial risk assessment. PhD Atmospheric Physics and postdoctoral fellowship in climate economics and policy at the London School of Economics.
Armon	Rezai	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.
James	Rising	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.
Megan	Robinson	Head of Integration, Climate Center of Excellence, S&P Global

First name	Last name	Biography
Simon	Scheidegger	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.
Karl	Schmedders	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.
Steven	Sherwood	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.
Elena	Shevliakova	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 and 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.

First name	Last name	Biography
Jana	Sillmann	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.
Tony	Smith	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.
Laura	Suarez-Gutierrez	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.

First name	Last name	Biography
Massimo	Tavoni	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.
Marco	Thalhammer	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.
Terence	Thompson	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.
Kirsten	Thonicke	Kirsten Thonicke is Deputy Head of Research Department on Earth System Analysis and Working Group Leader on Ecosystem in Transitions of the Potsdam Institute for Climate Impact Research (PIK). Her research work focusses on how climate and land-use change transform ecosystems, fire and biodiversity. She is the Speaker of the Leibniz Research Alliance "Biodiversity". After graduating from Institute for Geoecology at Potsdam University, Germany, she worked as a Post-Doc at Max-Planck-Institute for Biogeochemistry in Jena, Germany. In 2005 she was offered the Marie Curie Fellowship at the University of Bristol, Great Britain, where she coupled mechanistic global fire models into climate-vegetation models at the School of Geography. Kirsten Thonicke joined PIK in 2007.

First name	Last name	Biography
Fabio	Trojani	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.
Agnieszka	Trzcinska	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.
Narelle	van der Wel	Narelle van der Wel is a Scientific Officer at the World Climate Research Programme (WCRP) Secretariat, located at the World Meteorological Organization (WMO), Geneva. Narelle works in various areas, including strategic planning and implementation, communication and outreach, and science coordination and support. Narelle is responsible for overseeing and supporting WCRP's Climate and Cryosphere (CliC) Core Project, the WCRP Academy, and two of WCRP's Lighthouse Activities, My Climate Risk and Safe Landing Climates. She is also responsible for strategic planning of WCRP communications, leading a small team. Narelle completed her Ph.D. in Polar Studies (Glaciology) at Scott Polar Research Institute, University of Cambridge (UK), focusing on the numerical modeling of ice streams in Antarctica.

Annex 2 – Meeting Agenda

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, Paul Gruenwald

Workshop Agenda

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

12:00 PM Welcome by Dr Paul Gruenwald, Global Chief Economist, S&P Global Ratings

12:05 Welcome by Dr Celeste Saulo, Secretary-General, WMO

12:10 Dr Paul Gruenwald introduces Stéphane Hallegatte

12:12 Keynote address: **Climate and Economic Modeling: Lessons from 60 Country Climate and Development Reports and Key Knowledge Gaps.** *Stéphane Hallegatte, Senior Climate Change Adviser, World Bank Group.*

12:32 Q&A Session Moderated by Dr Paul Gruenwald.

1:00 - 2:00 PM - Opening Luncheon

2:15 PM - Workshop framing, goals & approach - *Terry Thompson and Steve Sherwood*

- 15 min - Overview by conference organizers
- 45 min - Small group introductions

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

3:35 PM-5:00 PM - “Pump-priming session” cross-disciplinary breakout discussions - *Terry Thompson and Steve Sherwood*

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**
Chair: Terry Thompson

- Introduction by S&P Global - *Terry Thompson*
- Framing Remarks - *Stephane Hallegatte, World Bank*
- Approach to physical risk and economic modelling in NGFS climate scenarios - *Agnieszka Trzcinska*, *European Central Bank*
- Roundtable session moderated by *Terence Thompson and Megan Robinson, S&P Global Climate Center of Excellence*. Panel discussion with:
    - *Michaela Mei Dolk, World Bank*
    - *Marion Amiot, S&P Global Ratings*
    - *Theresa Lober, Bank of England*
    - *Nicola Ranger, U. Oxford*
    - *Matt Foote, Howden Insurance Group*
    - *Piguet Galland & Cie SA* (TBC)*

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

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

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] - *Moderator: Roland Séférian*

12:30 PM-1:30 PM - Lunch

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

- 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**
Chairs: Thomas Lontzek and Karl Schmedders

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-9:10 AM - Update/report from the organizers - where are we going?
Terry Thompson and Steve Sherwood

9:10 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
- Report back, plenary discussion [30 min] *Chair: Terry Thompson*

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] *Chair: Bette Otto-Bliesner*

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?**

Chair: Theresa Lober

- Brief summaries from the morning's brainstorming session
- Panel discussion (Armon Rezai, James Rising, Jana Sillmann, Hannah Liddy, …)
- Plenary discussion

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

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

- *Steve Sherwood and Terry Thompson*

Suggested readings

BREAKING: COP29: involve the IPCC in defining climate finance. Nature. 5 November 2024

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

Webinars:

1. Webinar: Linking Climate Change to Economic and Financial Impacts. 22 October 2024.
2. Moving Beyond Uncertainty: Rethinking Climate Models and Tipping Points. 5 November 2024

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

World Climate Research Programme
wcrp-climate.org