WORLD CLIMATE RESEARCH PROGRAMME
OPEN SCIENCE CONFERENCE

Day 3, 25 October 2023

1. Morning Dome Plenary: Climate and the Earth System

Guy Brasseur (Former WCRP Chair) chaired a session including Valérie Masson-Delmotte (Co-Chair IPCC Working Group I, AR6), Jim Hurrell (WCRP JSC and Co-Lead of WCRP Task Team on Climate Intervention). Thomas Stocker (Professor, Physics Institute, University of Bern, Switzerland, Co-Chair IPCC Working Group I AR5) then moderated a panel discussion on the future of climate knowledge assessment including Panmao Zhai (Co-Chair IPCC Working Group I, AR6), Mark Howden (Vice-Chair IPCC Working Group II, AR6 and AR7) and Diana Ürge-Vorsatz (Vice-Chair IPCC, AR7).

A new agenda for climate research

Insights from the Intergovernmental Panel on Climate Change's Sixth Assessment Report (AR6) can be used to inform a research agenda grounded in ethics, said former Working Group 1 Co-chair Valérie Masson-Delmotte.

- Much has changed since AR6. Greenhouse gas emissions and concentrations have increased, as have radiative forcing and Earth's energy imbalance. Warming continues to intensify, and the margin of opportunity to enable climate resilient development is revised downwards by a factor of two.
- But the context has also changed – and future Assessment Reports should be flexible to adapt to this and to unforeseen events such as volcanic eruptions. There has been intensification of climate change impacts and related losses and damages, increasing climate anxiety; more environmental degradation; the COVID19 pandemic and the war in Ukraine which undermined international coordination; growing nationalism and populism; disinformation and erosion of trust in science.
- There is a need for regular updates of the state of knowledge between Assessment Report cycles. For instance, on forcings, feedbacks, and the Earth's energy imbalance. There are implications of ecosystem degradation, delayed consequences from past emissions and current climate (e.g., committed sea-level rise). We also need regular updates of the attribution of extreme events.
- The year 2023 is virtually certain to be hottest on record. We are increasingly passing 1.5°C on a monthly basis and will do so more often on an annual basis. By the 2030s we expect this to occur every second year. But we must be extremely careful about over interpretation of annual events and avoid exaggerating findings of one particular study which is confusing for the public and policymakers.
- Ideally, by 2050 climate change would have stabilized and the climate system would enter a state of recovery toward pre-industrial situations, much like we experience in the context of the ozone hole – including monitoring the recovery. There would be increased needs for climate information for management of pressures on land, biomass and water uses, and for renewable energy, for ecosystem stewardship, proactive adaptation.
- We are in a fragmented world. There are many north-south tensions. We need to think more carefully than ever of a coordinated scientific response and of closer science-society interface. Climate research advances are needed to push for greater understanding.

The potential risks, benefits and impacts of climate intervention were explored by Jim Hurrell:

- Current international policies and pledges for future emissions reductions are not enough to avoid overshooting the Paris Agreement goal of limiting global warming to well below 2.0°C. Given the urgent, growing risks of climate change, it is important to understand the feasibility, efficacy, risks, and benefits of Climate Intervention (CI) as possible response strategies in addition to emission reductions and climate adaptation.
- CI is a new WCRP Lighthouse Activity, created to rapidly advance the science, technologies, and institutional frameworks needed to manage climate risk and meet society's urgent need for actionable climate information.
- Carbon Dioxide Removal (CDR) is needed to achieve net zero targets, including land-based and ocean-based CDR. All approaches have different trade-offs and risks e.g., reforestation if inappropriately deployed could increase competition for land.
- Solar Radiation Modification (SRM) should only be considered if we cross the temperature threshold when climate risks outweigh the risks of SRM. But first, there needs to be detailed strategies for research to inform policy - not to put us on the path of deployment but to understand the risks and benefits of SRM.
- Building an effective, transdisciplinary research program on CI will require coordination across multiple agencies, national laboratories, and cooperative institutes – along with strong international engagement and collaboration.
- WCRP needs to be active in this space. It is an honest broker and is a respected community voice in comprehensively assessing the benefits and risks of proposed CI approaches, and in synthesizing results – either leading or playing a major role in establishing a globally inclusive, transparent, and equitable scientific assessment process.

2. Evening Dome Plenary

The Future of Climate Modelling: What is needed to address the scientific and societal challenges of climate change.

The evening session was chaired by Celeste Saulo (WMO Secretary-General Elect) and featured Bjorn Stevens (Max Planck Institute for Meteorology) and Katherine Calvin (Chief Scientist and Senior Climate Advisor, NASA).

Bjorn Stevens discussed how climate change is transforming climate modelling, and notably through the potential of Earth Visualization Engines (EVEs) - an international collaboration to tap our technical capacity so that everyone knows how climate and climate change affects them.

- People are asking questions. They are not asking 'what if', but 'what's next'. They want to know how to move forward. There is an enormous thirst for information. What is missing is that we are not connecting the problem to people. We have to make climate change tangible in ways that different people can understand. We can achieve that through technology.
- EVE's vision is grounded in the untapped potential of high-performance computing to provide the magic needed to deliver data at scale (our rocket). Artificial intelligence allows people to interact with the data (our lander). International cooperation that can bring these together (our HQ). WCRP has a very important role to play to help build the rockets.
- While we didn't have the tools to make things tangible in the past, by the end of the coming decade we could. Let's start here in Kigali and build Eve's first node with, and for, Africa.

Katherine Calvin discussed climate modelling for societal applications.

- Different users have different needs for information on weather and climate variables in terms of timescale and variables, depending on the sector. The common factor is the need for local information on a scale that users can relate to.
- We need to integrate model output with the real-world changes. Climate modelling for society requires local information for applications. The beauty of AI is it can tailor that step to specific needs and is a potential game changer because it fills the gaps in information.

3. Introducing the WCRP Academy

The WCRP Academy officially launched at the OSC. It is the research, training, advisory, and coordination arm to equip current and future climate scientists with the knowledge and skills required to tackle the world's most pressing and challenging climate research questions. The Academy's activities will promote and advance lifelong learning opportunities and global equity in climate science training. It seeks to build enabling mechanisms, for instance, through an online marketplace for climate science training, which connects training providers and climate scientists. The Academy will also identify training gaps and advocate for those to be met.

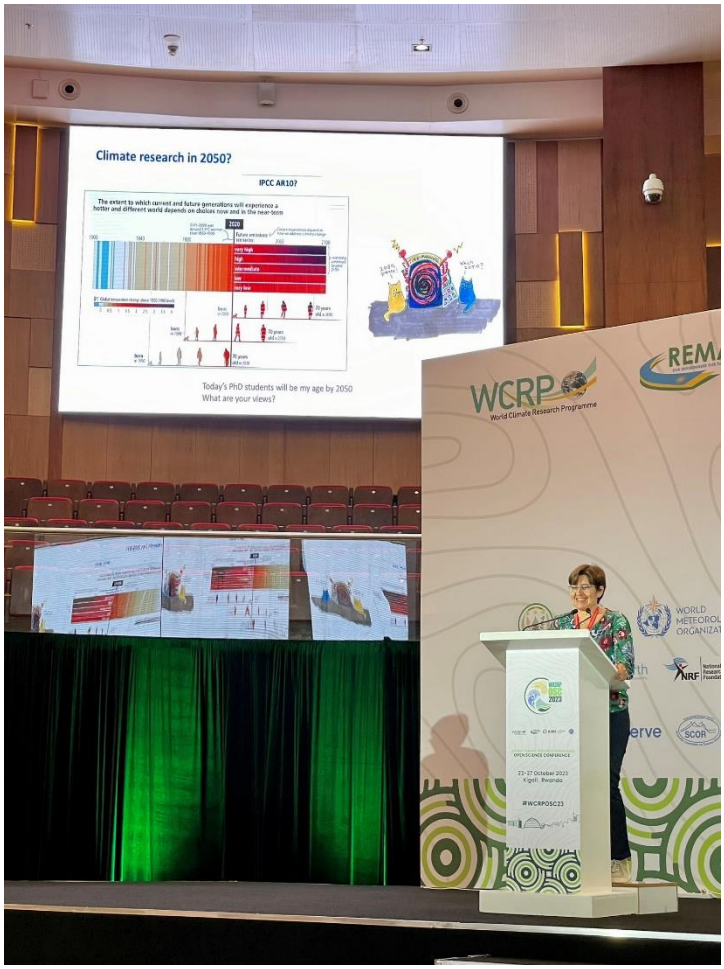
4. Parallel Sessions

- **Global and regional monsoons -** Work is needed on the challenges around the coupled Sea Surface Temperature (SST) bias, intraseasonal variability in monsoon rainfall, interseasonal modes, and soil moisture in monsoon areas. There is still a distinct lack of process understanding on the role of ocean and land and their interactions with the atmosphere, for which routine and sustained field campaign measurements are needed. The ability to simulate and predict the monsoons at higher resolution is important, along with Artificial Intelligence and Machine Learning (AI/ML) for improved seasonal monsoon prediction.
- **Ocean-atmosphere interactions: energy, water and carbon -** Recent fine-scale observations show an emergence of key air-sea features previously overlooked, such as upper-surface temperature gradient-induced dissipation which is a key driver for air-sea fluxes, coupled wind-current interaction, and ocean-induced mesoscale atmospheric features. Recent improvements in air-sea sampling at scale has the potential to improve process understanding and hence parameterization.
- **Mitigation scenarios, including overshoot and climate intervention** - We need to understand the potential and limits of Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM) and the long-term earth system impacts of temperature overshoot. Topics that need consideration include the potential scale of afforestation and reforestation, the complementarity of land-based and ocean-based CDR, and the potential of stratospheric aerosol injection SRM to offset drying trends over Africa and the risk of extreme wildfires around the world. Discussions highlighted the many socio-political factors that shape the application of climate intervention strategies and stressed the need for inter- and trans-disciplinary research that connects to societal groups who are potentially affected. Importantly, CDR and SRM are not substitutes for emissions cuts. There are many concerns regarding both intervention strategies that require targeted research before any implementation can be considered.
- **Hazards and extreme events** - Confidence in changes in extreme events varies by event type and by region, with many remaining uncertainties owing in part to a lack of model agreement. Threshold-breaching events require reliable mean state and variability representation. Compounding events and compounding drivers need further research. Attribution of extremes (and impacts) remains a challenge and it is challenging to understand feedbacks in the Earth System in response to extremes and cascading events. Impact-based forecasts are a useful tool to increase the relevance of warnings for decision makers, but also face challenges including around responsibility and liability. Collecting data on exposure and vulnerability, hazards, and

behavioural responses at the resolutions required is challenging, especially at a local scale and in vulnerable regions.

- **Regional information – Data and methods** - Artificial Intelligence (AI) allows the development of modelling approaches that go beyond the climate data and deal with the risk components systematically. Downscaling requires new approaches to address either the computational cost (dynamical downscaling) or the stationarity hypothesis (statistical-empirical downscaling). Machine learning (ML) approaches are helping to develop and test updated methods that bring together both dynamical and statistical approaches. Open data sources are fundamental to provide traceable, reproducible and verifiable climate predictions. Observational data sharing is needed. Ensemble selection methods become relevant to extract useful/skilful information and to reduce the ensemble size to perform additional processing.
- **Observations for decisions** - Historical data rescue of so far undigitized observations has potential to improve knowledge of past precipitation events and learn about its variability and trends. There is a need to design a pan-African climate observation system, with co-creation and technology-transfer built in. Low-cost sensors, i.e., for local air pollution or greenhouse gas measurements, should be better utilized and there is potential to use digital twins and Earth observation data and to consider in situ climatological data alongside population dynamics and socio-economic data to better understand impacts.

Jim Hurrell talking on Potential risks, benefits and impacts of climate intervention at the morning Dome Plenary on the third day of the Open Science Conference. (Credit: Stefano Materia/Twitter)



Valérie Masson-Delmotte speaking on A new agenda for climate research. (Credit: Martin Visbeck/Twitter)

Thomas Stocker moderating the panel discussion with Panmao Zhai, Mark Howden, and Diana Ürge-Vorsatz after the morning Dome Plenary.

Lunch session on Managing climate overshoot in Africa (Credit: Pete Irvine/Twitter).