WCRP 40th Anniversary Symposium

Sunday, 8 December 2019 *Draft: 7 December 2019*

Hyatt Regency San Francisco Embarcadero, Bayview Room

8:30-10:30
Session A: Celebrating 40 years of WCRP in Service to Society (Chair: Pavel Kabat)

Opening remarks and expectations for the day and the week (Detlef Stammer) (10 mins)

Welcome by WCRP sponsors:

- *Pavel Kabat - Chief Scientist, World Meteorological Organization (10 mins)*
- *Vladimir Ryabinin - Intergovernmental Oceanographic Commission of UNESCO (10 mins)*
- *Alik Ismail-Zadeh - International Science Council (10 mins)*

Welcome by the American Geophysical Union

- *Eric Davidson - AGU Past President (5 mins)*
- *Denis-Didier Rousseau - AGU Fall Meeting Program Chair (5 mins)*

Keynotes:

1) The climate change challenge (Kim Cobb) (20 mins)

2) WCRP Accomplishments

1) *The first decades of WCRP and its accomplishments (Gordon McBean) (15 mins)*
2) *The second phase of WCRP (Antonio Busalacchi) (15 mins)*
3) *Mobilizing global climate science capacity (Raghu Murtugudde) (15 mins)*

10:30-11:00
Morning Break

11:00-12:30
Session B: Understanding the Climate System Components and their Interactions (Chair: Helen Cleugh)

- *The Amazon forest is near a tipping point (Carlos Nobre) (5 mins)*
- *Facilitating climate science awareness (Gerald Meehl) (20 mins)*
- *Scientific highlights from CMIP6 (Veronika Eyring) (20 mins)*
- *Scientific discoveries made possible with CMIP (Julie Arblaster) (20 mins)*
- *Climate system integration (Kevin Trenberth) (5 mins)*

12:30-13:30
Lunch Break

13:30-15:30
Session B: continued (Chair: Detlef Stammer)

- *Climate science for society in Asia and the Pacific (Gen'ichiro Tsukada) (5 mins)*
- *WCRP's role in climate services (Lisa Goddard) (20 mins, remote talk)*
- *Observations, synthesis and monitoring/observing the climate system – future opportunities (Steven Briggs) (20 mins)*
- *Modeling and prediction capabilities (Irina Sandu) (20 mins)*
- *Capacity development (Bruce Hewitson) (20 mins)*
- *Science innovation in support of climate services (Anca Brookshaw) (5 mins)*
- *WCRP 40th Anniversary Film Premiere (10 mins)*

16:00-16:30
Afternoon Break

16:30-18:00
Session C: The Launch of WCRP's Future (Chair: Pavel Kabat)

The WCRP science strategy (Guy Brasseur) (10 mins)

From strategy to implementation (Detlef Stammer and Helen Cleugh) (15 mins)

An early career perspective on WCRP science (Gaby Langendijk) (10 mins)

Awarding of:

- *WCRP/WWRP International Prize for Model Development 2019 (5 mins)*
- *WCRP/GCOS International Data Prize 2019 (5 mins)*

Celebration ceremony

18:00-19:00
Reception

Abstracts and biographies

8:30-10:30

Session A: Celebrating 40 years of WCRP in Service to Society (Chair: Pavel Kabat)

Welcome by WCRP sponsors:

Pavel Kabat - Chief Scientist, World Meteorological Organization

Pavel *Kabat is the Chief Scientist and former Research Director of the World Meteorological Organization (WMO). He is also a Professor of Earth System Science at Wageningen University in the Netherlands, Founding Chair and Director of the Royal Dutch Academy of Sciences and Arts Institute for Integrated Research on the Wadden Sea Region, member of the Leadership Council for the UN Sustainable Development Solutions Network and Co-Founder of the high-level Alpbach – Laxenburg Group. Kabat was previously Director General and Chief Executive Officer of the International Institute for Applied Systems Analysis (IIASA), an independent, international science and science-to-policy institute. His research career spans almost 30 years and has covered many aspects of Earth system science and global change, with a specific focus on land-atmosphere interactions, climate hydrology, the water cycle, and water resources. He has received many awards and honors for his contribution to science, including the Austrian Cross of Honor for Science and Art, First Class, and the Order of the Netherlands Lion.*

Vladimir Ryabinin - Intergovernmental Oceanographic Commission of UNESCO

Vladimir Ryabinin (Engineer, 1978; Ph.D., 1982; and Doctor of Sciences, 1995) is the Executive Secretary of the Intergovernmental Oceanographic Commission (IOC) of UNESCO in the rank of Assistant Director-General of UNESCO. Dr Ryabinin is an oceanographer, marine engineer, climatologist, and emeritus meteorologist of Russia. His research has led to a number of achievements in the medium-range weather prediction, marine services, offshore engineering, ocean and climate science. He has contributed to core design of such international initiatives as the Global Ocean Observing System, Joint Technical Commission of the World Meteorological Organization (WMO) and IOC for Oceanography and Marine Meteorology, International Polar Year 2007/2008, and the UN Decade of Ocean Science for Sustainable Development (2021-2030). His previous affiliations include the Hydrometcentre of Russia (as a researcher and head of a laboratory), Moscow State University (as a lecturer), International Ocean Institute (as the director), and World Climate Research Programme (as a senior scientific officer at WMO).

Alik Ismail-Zadeh – International Science Council

Alik Ismail-Zadeh is Secretary of the International Science Council. He holds BSc in mathematics from the Baku State University, MSc in math and physics from the M. Lomonosov Moscow State University, PhD and DSc in geophysics from the Russian Academy of Sciences (RAS). Currently Ismail-Zadeh is Senior Research Fellow at the Karlsruhe Institute of Technology (Germany) and RAS Research Professor (Moscow, Russia). His scientific interests cover mathematical geophysics, natural hazards, disaster risks, science history and diplomacy. Ismail-Zadeh has been Secretary General of the International Union of Geodesy and Geophysics (IUGG, 2007-2019) and served on advisory committees of several organizations and programs including AGU, CTBTO, European Geosciences Union, EuroScience, UN Office for Disaster Risk Reduction, and UNESCO. He is Fellow of Academia Europaea (AE), AGU, IUGG, and the Royal Astronomical Society; and awarded AGU Ambassador and International Awards, and AE Medal and Prize for his contribution to Earth sciences.

Welcome by the American Geophysical Union:

Eric Davidson - AGU Past President
Eric Davidson is director and professor at the Appalachian Laboratory of the University of Maryland Center for Environmental Science in Frostburg, a position he has held since 2015. Previously, he was a senior scientist and served a term as president and executive director at the Woods Hole Research Center in Woods Hole, Mass. Davidson holds a bachelor's degree from Oberlin College (1978) and a Ph.D. in forestry from North Carolina State University (1986). He held postdoctoral positions in soil microbiology and biogeochemistry at the University of California, Berkeley and the NASA Ames Research Center. Davidson is a Fellow of the American Association for the Advancement of Science. He was a cofounder of the International Nitrogen Initiative and served a term as coordinator of its North American Center. He is currently leader of a Research Coordination Network on Reactive Nitrogen in the Environment. Davidson has written a popular book, You Can't Eat GNP, which explores the links between economics and ecology for students and laypersons.

Denis-Didier Rousseau - AGU Fall Meeting Program Chair
Denis Didier Rousseau has been affiliated with the Laboratoire de Météorologie Dynamique at the Ecole Normale Supérieure in Paris since 2007, where he works as a Senior Research Scientist within the French National Committee of Scientific Research. He also holds an Adjunct Senior Research Scientist position at Lamont-Doherty Earth Observatory of Columbia University, New York. Denis' research interests cover paleoclimatology and the emission, transport and deposition of paleodust, as well as tipping elements in the Earth System. He currently serves as the Chair of the AGU Fall Meeting Program Committee, a position he has held since 2014.

Keynotes:

The climate change challenge (Kim Cobb)
Decades of research have brought into sharp focus the magnitude of the climate change challenge, yet policies at local, state, federal, and international levels have failed to meet the need for urgent adaptation and mitigation efforts to reduce the costs of accelerating climate impacts. While many structural barriers have prevented the enactment of such policies, scientists can play a key role in advancing climate solutions through their research and through engagement with policymakers. In this talk, I highlight two transdisciplinary research projects focused on sea level rise adaptation and carbon mitigation strategies, respectively. I argue that cross-sector, interdisciplinary collaboration is essential to designing and enacting effective climate solutions, but creating and sustaining such frameworks requires focused funding streams, a redefinition of science scholarship, and new training opportunities for scientists at all stages of their careers.

Kim Cobb *is a Professor in the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Her research uses corals and cave stalagmites to probe the mechanisms of past, present, and future climate change. After receiving her Ph.D. in Oceanography from Scripps Institute of Oceanography in 2002, she spent two years at Caltech in the Department of Geological and Planetary Sciences before joining the faculty at Georgia Tech in 2004. Kim has sailed on multiple oceanographic cruises to the deep tropics and led caving expeditions to the rainforests of Borneo in support of her research. She is a Lead Author on the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. As a mother to four, Kim is a strong advocate for women in science. She is also devoted to the clear and frequent communication of climate change to the public through speaking engagements and social media.*

WCRP Accomplishments

The first decades of WCRP and its accomplishments (Gordon McBean)
The World Climate Research Programme (WCRP) was created in 1979 as a successor to the Global Atmospheric Research Programme (GARP) with a focus on climate predictability and the human influence on climate change. Early projects were the TOGA Program, connecting the tropical ocean to the global atmosphere, and then WOCE, extending to the global oceans. The importance of the oceans was enhanced by bringing in the Intergovernmental Oceanographic Commission of UNESCO as a third co-sponsor. With the initiations of the Arctic Climate System Study, the Global Energy and Water Cycle Experiment and the Stratospheric Processes and their Role in Climate, a more comprehensive study of global physical systems began. Partnership with the International Geosphere Biosphere Programme (IGBP) enabled physical-chemical-biological issues to be addressed together. The partnership was carried into the IPCC reports. The oceans programs and their role in variability were brought together through the Climate Variability program – CLIVAR. Throughout its first decades, WCRP had strong projects on climate modeling and working with partners to enhance global observational systems. A continuing focus was bringing together the global climate science community with the weather, climate, oceans, and space-based organizations to address WCRP's objectives, leading to enhanced understanding and predictability of the climate system, reflected in part through the IPCC assessments – FAR, SAR and Tar. The START Program was created in 1992 to enhance truly global capacity to address climate and related science.

Gordon McBean*, now a Professor Emeritus at Western University, London, Canada, was a member of the WCRP Joint Scientific Committee (JSC) (1984-94), as well as Vice-Chair (1986-88) and Chair (1988-1994). While on the JSC, he was an Environment Canada scientist and then Professor at the Atmospheric-Oceanic Sciences, University of British Columbia (1988-94). From 1994-2000, he was the head of the Meteorological Service of Canada. Internationally, he has been President of the International Council for Science (2014-18), Co-Chair, Future Earth Governing Council (2016-18), Chair, Science Committees for Integrated Research on Disaster Risk (2006-11) and President, Global Environmental Change START (2009-15). He is a: Member, Order of Canada; Fellow: Royal Society of Canada, International Union of Geodesy and Geophysics and other societies; and awarded: 2017 IMO Prize; 2015 AGU Ambassador Award; 2015 AMS Cleveland Abbe Prize; and the 2007 Nobel Peace Prize, for his contributions to the IPCC.*

The second phase of WCRP (Antonio Busalacchi)
This presentation will highlight the accomplishments of the World Climate Research Programme (WCRP) during the past two decades as it pertains to determining the predictability of climate and the effect of human activities on climate. During this period considerable progress was made on observing the coupled climate system and advancing climate prediction across a range of time scales. These activities extended the range of climate simulations and resulting information from centennial to decadal and seasonal timescales, and from global to regional level to meet the needs of decision-makers dealing with climate-risk management, adaptation planning and impacts and vulnerabilities assessment. In particular, WCRP research on seasonal to interannual prediction provided a solid underpinning for the World Climate Conference –Three in 2009 that led to the formation of the Global Framework for Climate Services (GFCS). One major WCRP contribution to GFCS is the provision of science-based climate information at the regional level and related capacity building to advance knowledge of regional climate responses to global climate change to benefit ongoing climate-adaptation and risk-assessment research, policy planning, and development investments. Under the theme "Climate Research in Service to Society", the WCRP Open Science Conference in October 2011 reported on the progress in climate science under the auspices of WCRP. More than 1900 participants, including 541 young scholars from 86 nations and 300 scientists from developing nations, helped to identify several major scientific

priorities for international climate research in the years ahead. Moreover, throughout this period the WCRP organized input to a wide range of international scientific assessments especially the detection, attribution, and projection of the impact of human activities on climate. In summary, the WCRP has had a unique and primary role in the international coordination of climate research activities and organization of projects that need and/or benefit from global scale or multi-national involvement and support.

Antonio Busalacchi *has been president, since August 2016, of the University Corporation for Atmospheric Research (UCAR), a nonprofit consortium of 120 member colleges and universities providing science in service to society. An expert in Earth's climate system and ocean-atmosphere interactions, he leads UCAR's management of the National Center for Atmospheric Research and its support of the research community through supercomputing, observing instruments, and community models. Prior to his role at UCAR, Busalacchi served as director of the Earth System Science Interdisciplinary Center (ESSIC) at the University of Maryland, where he helped coordinate research into the oceans, atmosphere, and other aspects of the Earth system. He was also a professor at the University of Maryland's Department of Atmospheric and Oceanic Science. From 2008 to 2014 Busalacchi Chaired the World Climate Research Programme's Joint Scientific Committee, after Co-chairing the Scientific Steering Group of CLIVAR (Climate and Ocean Variability, Predictability and Change) from 2000 to 2006.*

Mobilizing global climate science capacity (Raghu Murtugudde)

Climate science has delivered clear and convincing evidence for attributing many detected climate change signals across the world to anthropogenic activities. Mobilizing climate science capacity must now focus on offering region-specific actionable information for climate adaptation and mitigation. The developed world must still lead basic climate research with more targeted investments in advancing process and predictive understanding of climate impacts on key systems as identified in the Global Commission on Climate Adaption – Food, Natural Environment, Water, Cities, Infrastructure and Disaster Management. The developing world must play its role in implementing adaptation and mitigation actions such that national priorities and global governance issues can be synchronised with climate science serving the safe management of global and regional commons. Time-bound Temperature and carbon targets for climate action are open to ambiguities. In this context, mobilizing global climate science must focus on delivering tools for climate management at local scales and at subseasonal-to-seasonal (S2S) and decadal timescales. The Ready-Set-Go framework for some key systems at S2S timescales and a range of natural and engineering solutions to others at decadal timescales must be the goal for climate science in service of the Nationally Determined Contributions (NDCs). Raising the bar for NDCs is inevitable to avoid Dangerous Anthropogenic Interference which requires that climate science be mobilised to serve both global temperature and carbon targets despite the ambiguities and lack of country-specific targets. The key is to trigger a Catalytic Cooperation building on the ongoing activities such as S2S and NMME (North-American Multi-Model Ensemble).

Raghu Murtugudde *has a BTech in Aeronautical Engineering from the Indian Institute of Technology Bombay, an MS in Aerospace Engineering from University of Texas at Arlington and a Ph.D. In Mechanical Engineering from Columbia University. He served as a Research Scientist at NASA-GSFC during 1994-2003 and has been a professor of Atmospheric and Oceanic Science and Earth System Science at the University of Maryland since 2003. Currently he is a Visiting Faculty at several institutions in India.*

11:00-12:30

Session B: Understanding the Climate System Components and their Interactions (Chair: Helen Cleugh)

The Amazon forest is near a tipping point (Carlos Nobre)

Projections indicate that human drivers of change—regional deforestation, global warming and increased vulnerability to fires—interact synergistically and push the Amazon to the brink of savannization. Observations reveal that the Amazon Forest is closer to a tipping point than anticipated.

Carlos Nobre *is the International Secretary of AGU and Senior Researcher at the University of São Paulo's Institute of Advanced Studies. He is the former Chair of the International Geosphere-Biosphere Programme (IGBP), former Program Scientist of the Large Scale Biosphere-Atmosphere Experiment-LBA and former Member of World Climate Research Programme Joint Scientific Committee.*

Facilitating climate science awareness (Gerald Meehl)

The Coupled Model Intercomparison Project (CMIP) is run by the World Climate Research Programme (WCRP)'s Working Group on Coupled Modelling (WGCM). CMIP's central goal is to advance scientific understanding of the Earth system. Since 1995, CMIP has coordinated climate model experiments involving multiple international modeling teams worldwide and has developed in phases, with the sixth phase, CMIP6, now in progress. CMIP has led to a better understanding of past, present and future climate change and variability in a multi-model framework within defined common experiment protocols, forcings and outputs. Individual Model Intercomparison Projects ("MIPs") look at specific science questions and cooperate with the modeling groups in running and analyzing experiments. CMIP model simulations and resulting peer-reviewed papers constitute the current state-of-the-art of climate science formulated by the climate science community through WCRP, and have been assessed as part of the IPCC Assessment Reports and various national assessments. CMIP is not done for the IPCC, or run by the IPCC, but rather is a WCRP scientific research project whose simulations and results inform the IPCC assessments.

Gerald Meehl *is a Senior Scientist at the National Center for Atmospheric Research (NCAR), and heads the Climate Change Research Section. He is also Chief Scientist of the Cooperative Agreement To Analyze variabiLity, change and predictabilitY in the earth SysTem (CATALYST), a project that involves NCAR and the U.S. Department of Energy (DOE). His research interests include studying the interactions between El Niño/Southern Oscillation (ENSO) and the monsoons of Asia, identifying possible effects of global climate of changing anthropogenic and natural forcings, quantifying possible future changes of weather and climate extremes in a warmer climate, and understanding the interplay between internally generated climate variability and the response to external forcings, particularly in the context of understanding and predicting decadal climate variability.*

Scientific highlights from CMIP6 (Veronika Eyring)

By coordinating the design and distribution of global climate model simulations of the past, current and future climate, the Coupled Model Intercomparison Project (CMIP) has become one of the foundational elements of climate science. However, the need to address an ever-expanding range of scientific questions arising from more and more research communities has made it necessary to revise the organization of CMIP. After a long and wide community consultation, a new and more federated structure has been put in place. It consists of three major elements: (1) a handful of common experiments, the DECK (Diagnostic, Evaluation and Characterization of Klima) and CMIP historical simulations (1850 – near-present) that will maintain continuity and help document basic characteristics of models across different phases of CMIP, (2) common standards, coordination, infrastructure and documentation that will facilitate the distribution of model outputs and the characterization of the model ensemble,

and (3) an ensemble of CMIP-Endorsed Model Intercomparison Projects (MIPs) that will be specific to a particular phase of CMIP (now CMIP6) and that will build on the DECK and CMIP historical simulations to address a large range of specific questions and fill the scientific gaps of the previous CMIP phases. The DECK and CMIP historical simulations, together with the use of CMIP data standards, are the entry cards for models participating in CMIP. With the WCRP Grand Science Challenges as its scientific backdrop, CMIP6 will address three broad questions: (i) How does the Earth system respond to forcing?, (ii) What are the origins and consequences of systematic model biases?, and (iii) How can we assess future climate changes given internal climate variability, predictability and uncertainties in scenarios? In this talk, first scientific highlights from CMIP6 are presented.

Veronika Eyring *is Head of the Earth System Model Evaluation and Analysis Department at the German Aerospace Center (DLR) Institute of Atmospheric Physics. She is Professor and Chair of Climate Modelling at the University of Bremen and maintains a strong collaboration with the National Center for Atmospheric Research (NCAR, USA) as Affiliate Scientist. Her research focuses on Earth system modeling and process-oriented model evaluation and analysis, including AI techniques, to better understand the Earth system and climate change, and to improve the models. She has recently won an ERC Synergy Grant on "Understanding and Modelling the Earth System with Machine Learning (USMILE)", together with her co-PIs Markus Reichstein, Gustau Camps-Valls and Pierre Gentine. She has authored many peer-reviewed journal articles and has contributed to the Intergovernmental Panel on Climate Change (IPCC) climate and World Meteorological Organization (WMO) ozone assessments since 2004. Veronika is involved in WCRP through her roles as Chair of the Coupled Model Intercomparison Project (CMIP) Panel and member of scientific steering committees including the Working Group on Coupled Modeling (WGCM) from 2008-2018, the WCRP Data Advisory Council's (WDAC) Observations for Model Evaluation Task Team, and the Working Group on Numerical Experimentation (WGNE)/WGCM Climate Model Diagnostics and Metrics Panel. She is also the PI of the Earth System Model Evaluation Tool (ESMValTool).*

Scientific discoveries made possible with CMIP (Julie Arblaster)
The Coupled Model Intercomparison Project is designed to better understand past, present and future climate change. This talk will highlight some key discoveries made possible with CMIP since it first began in 1996. It will touch on our early understanding of systematic biases across the models e.g. in phenomena such as the El Niño Southern Oscillation, and how these have evolved. Advances in our understanding across various components of the climate system, including cloud feedbacks, monsoons, mid-latitude jets and climate extremes provide examples of some of the benefits of multi-model analysis. CMIP has also been critical in the attribution of past change and projections for the future.

Julie Arblaster *is an Associate Professor in the School of Earth, Atmosphere and Environment at Monash University, having previously worked at the Australian Bureau of Meteorology and the National Center for Atmospheric Research before that. Julie's research interests lie in using climate models as tools to investigate mechanisms of recent and future climate change, with a focus on shifts in the Southern Hemisphere atmospheric circulation and its interactions with tropical variability and climate extremes. Julie was awarded the 2014 Australian Academy of Science Anton Hales Medal for research in earth sciences and 2018 Priestley Medal from the Australian Meteorological and Oceanographic Society. She was an active member of the World Climate Research Programme (WCRP) Stratosphere-troposphere Processes and their Role in Climate (SPARC) scientific steering group from 2011-2016 and served as a lead author of the IPCC's Fifth Assessment Report and the 2014 WMO/UNEP Scientific Assessment of Ozone Depletion. She is a member of Australia's National Climate Science Advisory Committee and the Australian Academy of Science's National Committee on Earth System Science.*

Climate system integration (Kevin Trenberth)
Climate is about coupled climate system components and there is no place for this in AGU journals. In JGR one has to choose between atmosphere or ocean, for instance. Such silos also exist in WCRP, and the proposed "Earth Energy Imbalance" topic is a way to bring all the projects together.

Kevin E. Trenberth *is a Distinguished Senior Scientist in the Climate Analysis Section (CAS) at the National Center for Atmospheric Research. He is also affiliated with the University of Auckland. From New Zealand, he obtained his Sc. D. in meteorology in 1972 from Massachusetts Institute of Technology. He was a lead author of the 1995, 2001 and 2007 Scientific Assessment of Climate Change reports from the Intergovernmental Panel on Climate Change (IPCC), and shared the 2007 Nobel Peace Prize which went to the IPCC. He served from 1999 to 2006 on the Joint Scientific Committee of the World Climate Research Programme (WCRP), and he chaired the WCRP Observation and Assimilation Panel from 2004 to 2010 and chaired the Global Energy and Water Exchanges (GEWEX) scientific steering group from 2010-2013 (member 2007-14).*

13:30-15:30
Session B: continued (Chair: Detlef Stammer)

Climate science for society in Asia and the Pacific (Gen'ichiro Tsukada)
As a regional network promoting climate research in the Asia-Pacific region, it is crucial that the Asia-Pacific Network for Global Change Research (APN) strengthens partnerships with like-minded organisations to keep abreast of emerging climate research globally and regionally. By undertaking policy-relevant research for informed decision making, and capacity development at local, national and regional levels, APN seeks to address the most pressing climate research that aligns with the global climate agendas. APN has forged strong ties with WCRP to ensure that climate research it undertakes is current and relevant to decision-making bodies in the region. For example, by supporting research in the CORDEX domains in Asia, APN can better serve society and respond to the need for greater resilience to climate impacts. This is underscored in the Paris Agreement and IPCC AR6, the Sendai Framework and the SDGs (Sustainable Development Goals), all of which are important for APN as it enters into its fifth strategic phase in 2020. To continue to develop and promote policy-relevant science, building capacity of early-career scientists in developing nations in the region is crucial. Through our CAPaBLE and CRECS programmes, APN strives to contribute to a new generation of climate scientists with skills to undertake transdisciplinary and holistic approaches in climate research in the region.

Gen'ichiro Tsukada *joined APN as Director of the Secretariat in August 2019. He was seconded from the Ministry of the Environment, Government of Japan, and has over twenty years of experiences in the environmental and sanitary administration, including international work experiences in Indonesia (as a Long-term Expert for Japan International Cooperation Agency (JICA)) for almost three years and in the Netherlands (as Researcher of the National Personnel Authority, Government of Japan) for several months.*

Observations, synthesis and monitoring/observing the climate system – future opportunities (Steven Briggs)
The Global Climate Observing System (GCOS) has, since its inception in 1992, supported WCRP by coordinating the observations required for climate research, modelling and prediction. GCOS also works closely with WCRP through their jointly implemented panels and through the WCRP Data Advisory Council (WDAC). Over 50 Essential Climate Variables (ECVs) are maintained and curated by GCOS, which also advocates for their routine observation, sustainability and access with consistent specifications spanning the major Earth system cycles. GCOS supports specific reference observing networks for key surface and upper air variables. Some of the observations contributing to GCOS will be described with

examples, together with an outlook for their future developments. A suite of climate indicators developed and maintained by GCOS will be described, together with recent work in defining and managing observations for mitigation and adaptation aspects of the work of the UNFCCC.

Stephen Briggs *is Chairman of the Global Climate Observing System (GCOS) Steering Committee, a body set up by the UN to define and support observations for climate. He has held a number of positions in the European Space Agency, chiefly as Head of the Department of Earth Observation Science, Applications and Future Technologies where he was responsible for the exploitation of ESA Earth Observation missions, and for the development of future EO technologies and missions. Stephen holds visiting Chairs in the Department of Meteorology, University of Reading and the Department of Chemistry, Cambridge University. He is also a Fellow of University College London, and a faculty member of the Institute for Space Policy and Law, London. He serves on the Advisory Board of the Global Terrestrial Network – Glaciers.*

Modeling and prediction capabilities (Irina Sandu)
Modelling and prediction capabilities for weather forecasting and climate prediction and monitoring have been gradually converging over the past years. In this talk I will give a few examples of how advances in Numerical Weather Prediction have fed into improved climate prediction and monitoring (for example through better reanalyses), and vice-versa how components developed at first in the context of climate modelling, such as ocean and sea-ice models, have helped to improve predictions from a few days to a few seasons ahead. I will also argue for the need and the benefits of an even stronger convergence of our modelling capabilities, stemming from the common challenges we face in various aspects: representation of physical processes, coupling of the Earth System components, use of observations, uncertainty representation, computing and big data.

Irina Sandu *is a Senior Scientist at the European Centre for Medium-Range Weather Forecasts, leading the Physical Processes Team. Her research covers boundary layer clouds and the factors controlling their distribution, aerosol-cloud interactions, turbulent diffusion in stable conditions, orographic drag and land-atmosphere coupling. Irina uses a whole spectrum of models (from idealized theoretical models, to Large Eddy, meso-scale and global NWP models), but also a wide range of datasets (in situ observations, satellite data and reanalysis) to address questions ranging from process understanding to aspects of subgrid parameterizations and model evaluation.*

Capacity development (Bruce Hewitson)
Capacity development in the context of understanding the climate system components and their interactions, is inherently bound by the context of needs in a globally heterogeneous science community. As such, what capacity development means in practice is not always straightforward. In large part, capacity development has been synonymous with efforts focused on the developing nations and has historically addressed skills transfer in activities such as training workshops or development programs aimed at graduate students and early career researchers. Yet when looked at as capacity to enhance a regions scientific contributions to the societal needs there are arguably two important facets: enabling science capacity relevant to a region, and the oft-neglected development of the capacity of the enablers to effectively engage in the heterogeneous contexts of different regional priorities and value systems.

Set against this backdrop a number of key issues can be identified which include, among others, how to identify what capacity is most in need of development when the complexity of the community context is poorly understood, how to match capacity development to the reality of the agendas of those resourcing the activities, how to sustain and retain capacity with a region, how to accommodate differing worldviews and values in designing and implementing capacity development, or even how to measure success in capacity development.

Institutional mandates equally complicate matters, especially where an institution frames capacity development in a relatively narrow manner that may result in weak implementation as important contextual elements are excluded, or conversely frames capacity development in terms of high level principles where the implementation modalities remain unclear and become mired in the realities of constraints in resourcing and sustainability.

None of these challenges undermines the imperative and ethical responsibility to engage in capacity development, but rather serve to call for a deeper focus to be deeply pragmatic and collaborative about the real capacity needs in a flexible manner to effectively enable the target communities. Some examples of success can be clearly pointed to, such as the CORDEX program in Africa which has established collaborative communities, or the UK DFID Future Climate For Africa project which in some cases exemplified a bottom up approach to successful capacity development. Equally, many failures in capacity development may be identified.

In the end one clear measure of success can be posited: have the participants grown in confidence to engage in science relevant to their context? All the skill development and growth of conceptual understanding comes to naught if the participant has not the confidence to implement their new capacity, and hence one may argue that to grow practical capacity, one needs to grow confidence.

Bruce Hewitson *is the South Africa National Research Chair on Climate Change and director of the Climate System Analysis Group, a research centre at the University of Cape Town. His expertise focuses on regional climate change, climate modeling, downscaling, the interface of climate science and society, and capacity development for climate scientists and decision makers with a special interest in developing nation contexts. Bruce was a coordinating lead author in the IPCC's 3rd, 4th, 5th and 6th Assessment Reports. He leads a range of projects that include the development of new analytical methods, climate change and cities, regional climate change projections, seasonal forecasting, climate uncertainty, and the intersection of climate information and ethics.*

Science innovation in support of climate services (Anca Brookshaw)
Developments in climate science - whether observations, modelling, analysis or prediction - have happened at a fast pace in recent decades, yet realising the full benefit of such developments in society-relevant applications is arguably lagging behind. With examples from the Copernicus Climate Change Service, managed by the European Commission and implemented by the European Centre for Medium-Range Forecasts (ECMWF), the presentation will describe recent steps towards identifying and closing the gap.

Anca Brookshaw *is a Principal Scientist at the European Centre for Medium-Range Forecasts, where she leads the climate prediction activities of the Copernicus Climate Change Service (C3S); these cover timescales from seasons to decades ahead. Anca has been working on seasonal and decadal prediction topics related to analysis, interpretation and operations, for over 15 years, most of which at the Met Office Hadley Centre in the UK. Her current role focuses on the design and coordination of international contributions to the development of user-relevant climate services based on climate predictions and projections.*

16:30-18:00
Session C: The Launch of WCRP's Future (Chair: Pavel Kabat)

The WCRP science strategy (Guy Brasseur)
The talk will provide some views on how fundamental climate science should evolve in light of the international agreements aimed at limiting global warming to less than 2 degrees C. It will emphasize the new strategic directions of WCRP for the next decade.

Guy Brasseur *is the Director of the Atmospheric Chemistry Observations and Modeling Laboratory at the National Center for Atmospheric Research in Boulder, Colorado and an external member of the Max Planck Institute for Meteorology in Hamburg, Germany. He is also Professor at PolyU in Hong Kong and a former Chair of the WCRP Joint Scientific Committee (JSC).*

From strategy to implementation (Detlef Stammer and Helen Cleugh)
The World Climate Research Programme (WCRP) has been instrumental in improving our understanding of the climate system and its components and our ability to represent the climate and Earth System in increasingly complex models. In response to recent developments, a new WCRP Strategic Plan was developed that calls for further and stronger integration of research from observations and understanding to modeling, prediction and projections of the Earth system, and practical applications in support of society, in close coordination with partner programs. These new actions need to be translated into new structures that ultimately need to lead to an Implementation Plan for delivering the strategy, addressing priority research questions and themes, associated program structure and a timeline for transition. A conceptual framework for the new WCRP will be outlined and opportunities and challenges will be highlighted in this context.

Detlef Stammer *is Head of Remote Sensing and Assimilation and Director of the Center for Earth System Research and Sustainability at the University of Hamburg, Germany. Stammer's research interests include the role of the ocean in climate variability and sea level change. He was appointed as a member of the World Climate Research Programme (WCRP) Joint Scientific Committee (JSC) in 2019 and elected as JSC Chair shortly thereafter. Previously, he co-chaired the Scientific Steering Group of WCRP's Climate and Ocean Variability, Predictability and Change (CLIVAR) Core Project and the WCRP Grand Challenge on Regional Sea-level Change and Coastal Impacts.*

Helen Cleugh *is currently the Director of the Climate Science Centre in the Ocean and Atmosphere Division of CSIRO (Australia's national science agency). She is an atmospheric scientist with almost 30 years' experience combining research discovery, delivery, and leadership. Her research expertise lies in quantifying the interactions between the land surface and the atmosphere, and their effects on weather, climate, and hydrology, as well as water-use and carbon uptake. Helen was appointed as a member of the World Climate Research Programme (WCRP) Joint Scientific Committee (JSC) in 2015 and elected as Vice-chair in 2019.*

An early career researcher perspective on WCRP science (Gaby Langendijk)
Early career researchers (ECRs) are pivotal for long term scientific advancements in climate research, as well as to the sustainability of the climate research community in general. In that light, the perspectives of early career researchers on climate science are crucial to consider while carving out the future for WCRP. This presentation will elaborate on the vision of early career researchers on the future of climate science and WCRP, mainly based on a set of publications stemming from various activities initiated by the Young Earth System Scientists (YESS) community. In addition, key outcomes will be highlighted of the ECR workshop, held one day prior to the symposium, as a part of the WCRP Climate Science Week.

Gaby Langendijk *is a PhD candidate at the Climate Service Center Germany (GERICS), an entity of the Helmholtz Center Geesthacht (HZG). Her PhD studies focus on high resolution regional-to-local climate modelling for urban applications. Previously Gaby worked as part of the WCRP Joint Planning Staff in Geneva, Switzerland. After completing a Bachelor's degree in Earth Science at the University of Amsterdam, Gaby obtained her Master's degree in Climate Science at the Wageningen University and Research Center (WUR) in the Netherlands. She conducted her master thesis research at the ETH in Zurich. Gaby is an*

Executive Committee member of the early career researchers network the Young Earth System Scientists (YESS) community.