



International
Science Council



Report of the Workshop on Attribution of multi-annual to decadal changes in the climate system

22-24 September 2021, Online workshop



December 2021

WCRP Publication No.: 10/2021

Bibliographic information

This report should be cited as:

World Climate Research Programme, 2021. Report of the workshop on Attribution of multi-annual to decadal changes in the climate system, 10/2021, 22-24 September 2021, Online format.

Contact information

All enquiries regarding this report should be directed to wcrp@wmo.int or:

World Climate Research Programme
c/o World Meteorological Organization
7 bis, Avenue de la Paix
Case Postale 2300
CH-1211 Geneva 2
Switzerland

Cover image credit

Dimitris Vetsikas (Pixabay: 3191872), Arthur Brognoli (Pexels: 2260966)

Copyright notice

This report is published by the World Climate Research Programme (WCRP) under a Creative Commons Attribution 3.0 IGO License (CC BY 3.0 IGO, www.creativecommons.org/licenses/by/3.0/igo) and thereunder made available for reuse for any purpose, subject to the license's terms, including proper attribution.

Authorship and publisher's notice

This report was authored by the Workshop Organising Committee

WCRP is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Science Council (ISC), see www.wmo.int , www.ioc-unesco.org and council.science.

Disclaimer

The designations employed in WCRP publications and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of neither the World Climate Research Programme (WCRP) nor its Sponsor Organizations – the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Science Council (ISC) – concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The findings, interpretations and conclusions expressed in WCRP publications with named authors are those of the authors alone and do not necessarily reflect those of WCRP, of its Sponsor Organizations – the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Science Council (ISC) – or of their Members.

Recommendations of WCRP groups and activities shall have no status within WCRP and its Sponsor Organizations until they have been approved by the Joint Scientific Committee (JSC) of WCRP. The recommendations must be concurred with by the Chair of the JSC before being submitted to the designated constituent body or bodies.

This document is not an official publication of the World Meteorological Organization (WMO) and has been issued without formal editing. The views expressed herein do not necessarily have the endorsement of WMO or its Members.

Any potential mention of specific companies or products does not imply that they are endorsed or recommended by WMO in preference to others of a similar nature which are not mentioned or advertised.

Contents

1. Introduction	6
2. Workshop	7
Annex 1 - Workshop programme	11
Annex 2 - Organising Committee	19
Annex 3 - Acronyms	20

1. Introduction

Understanding the drivers of multi-annual to decadal changes in the climate system is essential for building confidence in forecasts, for quantifying hazards, and for developing robust adaptation and mitigation policies. However, our capability in this regard is very immature, as highlighted by the recent debate around the temporary slowdown in global surface warming in the early 21st century. Hence, the WCRP Lighthouse Activity on Explaining and Predicting Earth System Change is being developed to address this need.

The aim of this workshop on "**Attribution of multi-annual to decadal changes in the climate system**" was to document current research, identify challenges, and explore potential pathways towards building an operational capability to attribute multi-annual to decadal changes in the climate system on global-to-regional scales.

Key areas that were addressed include:

- To what extent the observing system is adequate for the task and how best to use the observations
- Approaches to assess the roles of internal variability and external factors including greenhouse gases, aerosols, solar variations, volcanic eruptions, ozone and land use.
- To what extent models are adequate for the task and how to account for model errors, including underestimated signals
- To what extent responses to different forcings add linearly
- How to account for forcing uncertainties
- Analysis of physical processes
- Linking large scale circulation to regional weather and climate hazards
- Steps needed to build an operational capability

2. Workshop

The event took place completely online on 22-24 September 2021 with three 3-hour sessions at different times of the day to cater for multiple time zones. There were 278 registered participants from 52 countries. The full programme can be found in Annex 1 and the Organising Committee in Appendix 2.

In addition to oral and poster sessions, the event had breakout sessions where participants could consider four topics, and this section will summarise those discussions.

A. Identification of the challenges in developing an operational attribution capability for multi-annual to decadal changes in the climate system

It is necessary to prepare a roadmap to develop an operational capability with some key milestones with clear definitions and focuses on an “operational attribution capability”, and specific targets for attribution (e.g.: global vs regional changes, patterns vs mechanisms of changes). Model performance still is a key limitation, including the issue of signal-to-noise paradox, particularly for atmospheric circulation and hydroclimate variables. It is also important to define how to optimally verify models for simulating variability and important processes, how to constrain internal variability in the attribution system, and to understand and improve forcing responses in models.

Regarding observations, there are still large uncertainties due to small sampling, intermittent coverage of data and poor temporal consistencies, and this is a key limitation for attribution studies. One of the main challenges is therefore to keep key observations funded and developing a stable and long term observing system. It was noted that there are challenges in ocean reanalyses products to reach near real time due to intrinsic delays of input data such as atmospheric forcing from reanalyses, quality checked observing data, and posterior data correction. Also, there are still some issues with reliability in ocean reanalysis products including problems that heat and freshwater transports which are not conserving will cause for regional attribution.

B. Suggestion of potential ways forward

There have been several suggestions of activities and modelling experiments to support progress in the scientific plans of the WCRP Lighthouse Activity on Explaining and Predicting Earth System Change. Overall, it is important to develop and extend existing decadal prediction systems by incorporating attribution information with more ensemble members. It is also important to develop strategies to integrate detection and attribution and decadal prediction, for example by sub-selecting members from large ensembles.

The list below is non-exhaustive but contains focused suggestions

- Historical simulations and future projections using large ensembles with single forcings (greenhouse gases, aerosol, solar, volcanoes, ozone, land uses). These are needed to assess the contributions from the different forcing factors that can influence multi-annual to decadal changes in climate.
- Add single forcing experiments with the same models and pacemaker experiments to follow phase of the El-Niño Southern Oscillation (ENSO) and Atlantic Meridional Overturning Circulation (AMOC), for instance. As an example of the methods to be used, an event attribution system based on a seasonal forecast system with initialised coupled model simulations, as being developed by the Bureau of Meteorology in Australia
- Experiments using smaller ensembles at higher resolution to better capture extreme events, and this way building on HighResMIP for global simulations

It is necessary to identify case studies for which a sensible protocol can be set up, focusing on pre-existing availability of good observations and established confidence in model performances. In addition to that, it would be an interesting exercise to decide on a particular case study that demonstrate value of developing the operational attribution system. Also, important to develop mechanism and process studies based on large-ensemble multi-models, and at the same time find ways to better sub-select models to address specific problems and develop methods focusing on the representation of processes in different models.

C. Identify suitable case studies which will be used for testing and development

There are important points to consider before cases studies are identified and selected. Different types of case studies should be identified, taking into account societal impacts in addition to physical processes and scientific interest. Identifying cases studies that are of interest to the wider WCRP community (e.g., Tropical Pacific decadal variability studies in CLIVAR, drought events of interested to GEWEX, Arctic warming of interest to CliC) is also important.

On the theme of extreme events, a good example of a study that was done recently is the article by Fischer et al. (2021)¹. The list below has some specific case studies that can be taken forward:

¹ Fischer, E.M., Sippel, S. & Knutti, R. Increasing probability of record-shattering climate extremes. *Nat. Clim. Chang.* **11**, 689–695 (2021). <https://doi.org/10.1038/s41558-021-01092-9>

- Changes in extreme heat waves in US, Europe, Canada, Asia including decadal modulation of extreme event
- Multi-year drought including Sahel and Southwestern USA, including process understanding (e.g., Pacific Decadal Oscillation, Atlantic Meridional Overturning Circulation)
- The heavy rainfall and flood events in 2021 in Germany and Asia
- Marine heat waves

Regarding ocean and modes of variability, some cases that should be considered

- Explaining evolution of climate from 1990 up until now focusing on forcing/drivers and changes in hazards such as tropical cyclones, drought, heat waves, wildfire, marine heatwaves and other extremes
- Global warming hiatus while considering the acceleration of ocean warming following the 1990s and early 2000s globally, and over each ocean basin, particularly on the Pacific and Indian Ocean. For this topic, it is important to understand the mismatch between model and observations, considering external forcing vs internal variability
- Changes in the North Atlantic including subpolar sea surface temperature and gyre from 1960s to 2000s as they involve changes in atmosphere, ocean and ice. Further analysis of the Decadal Climate Prediction Project (DCPP) outputs focusing on drivers, including aerosols, to understand the switch of the Atlantic multidecadal variability in the 1990s
- Southern Ocean connection to northern hemisphere countries as well as Antarctic
- India Ocean Dipole mode (IOD) and its teleconnection. For this particular topic, case studies could be targeted to areas around developing countries to be as inclusive as possible.

There have been further suggestions of other topics that could also be considered:

- Detectability of selected “climate events” in the recent past using different methodologies (reanalysis, objective analyses, etc) and different scenarios through comparison of international groups to assess our degree of confidence on the capability to detect them
- COVID-MIP initialised simulations with and without COVID-induced emissions for 2020-2021.
- Changes in the upper troposphere and low stratosphere (e.g., tropopause region, zonal-mean temperature)

D. Identify suitable case studies which will be used for testing and development

The ability to identify funding streams will be essential to successfully implement the activities that have been identified in these discussions and further progress the scientific agenda of the WCRP Lighthouse Activity on Explaining and Predicting Earth System Change. Funding should be identified not only for the science but also to develop capacity of young researchers and from developing countries.

A strategy for attracting some funding would be by identifying high-profile case studies with large impacts, as well as by designing decision-relevant experiments as well as science-driven experiments such as Database for Policy Decision-Making for Future Climate Change (d4PDF).

Some opportunities that exist are the EU frameworks for funding such as Horizon Europe which would fund scientific development but less suited to fund operational projects. For that particular capability, funds from the Copernicus programme or National Meteorological Services. Prototype

attribution projects also within the EU and from the JPI Climate and JPI Oceans should also be opportunities to be followed.

Recently, there has been a large amount of funding available that is focused on machine learning and artificial intelligence. Connecting with this community is also needed to assess the potential of new approaches that may compliment the more traditional detection and attribution techniques.

Annex 1 – Workshop Programme



International
Science Council



WCRP workshop on attribution of multi-annual to decadal changes in the climate system

22 – 24 September 2021, Online

PROGRAMME (as of September 23, 2021)

Day 1- 22nd September: 20:00 - 23:15 UTC

20:00-20:15 **Welcome and introduction** – 15 minutes

- **Rowan Sutton**, WCRP Lighthouse activity on Explaining and Predicting Earth System Change
- **Doug Smith**, aims of the workshop

20:15-20:45 **Session 1: Approaches (Chair: Doug Smith)**

- **Thomas Knutson**, On attribution of regional decadal changes in the climate system using univariate methods
- **Mark Risser**, A regional detection and attribution formula for historical precipitation over the United States
- **Zachary Labe**, Exploring climate model large ensembles with explainable neural networks
- **Andrew Schurer**, Role of three major climate modes on decadal climate variability and change

Q&A Session – 10 minutes

20:45-21:15 **Session 2: Forcing uncertainties (Chair: Doug Smith)**

- **John Fyfe**, Significant impact of forcing uncertainty in a large ensemble of climate model simulations
- **Ken Carslaw**, How much can uncertainty in aerosol forcing be reduced?
- **Laura Wilcox**, The role of anthropogenic aerosol in near-future Asian climate change
- **Laura Endres**, Revisiting the influence of solar variability on North Atlantic winter climate

Q&A Session – 10 minutes

21:15-21:25 Break – 10 minutes

21:25-21:55 **Session 3: Case studies (Chair: Daniela Faggiani Dias)**

- **Haiyan Teng**, Heatwaves and the 1990s shift

- **Celine Bonfils**, Identifiable decadal signatures of greenhouse gases and particulate atmospheric pollution on the changing hydroclimate
- **Ivonne García Martínez**, Identifying the evolving human imprint on heat wave trends over Mexico and the United States
- **Huanping Huang**, Rise in Northeast US Extreme Precipitation Caused by Atlantic Variability and Climate Change

–
Q&A Session – 10 minutes

21:55-22:25 **Session 3 (cont): Case studies (Chair: Daniela Faggiani Dias)**

- **Leandro Diaz**, Attribution of observed precipitation trends in Southern South America
- **Robert Jnglin Wills**, Large ensembles unable to simulate observed multi-decadal trends in SST and SLP
- **Liping Zhang**, Using large ensembles to elucidate the possible roles of Southern Ocean meridional overturning circulation in the Southern Ocean SST trend
- **Amy Butler**, Stratospheric contribution to winter temperature trends in a warming climate

Q&A Session – 10 minutes

22:25-22:35 Break – 10 minutes

22:35-23:15 **Posters – 40 minutes (Chair: Nathan Gillett)**

- **(the list of posters is available below the programme)**

Day 2 - 23rd September: 12:00-15:30 UTC

12:00-12:30 **Session 4: Observations (Chair: Lijing Cheng)**

- **John Kennedy**, Where noise and signal collide: observational challenges for monitoring global change at the limits of detectability
- **Andrea Storto**, The 20th century global warming signature on the ocean at global and basin scales as depicted from historical reanalyses
- **Andrea K. Steiner**, Satellite observations for detection and attribution of atmospheric temperature change
- **Kewei Lyu**, Projected ocean warming constrained by the Argo-era ocean observational record

Q&A Session – 10 minutes

12:30-13:00 **Session 5: Global/model error (Chair: Lijing Cheng)**

- **Karsten Haustein**, A limited role for unforced internal variability in 20th century warming
- **Rémy Bonnet**, Increased risk of near term global warming due to a recent AMOC weakening
- **Yona Silvy**, Towards understanding the mechanisms of anthropogenic temperature and salinity emergence in the ocean
- **Doug Smith**, What if modelled signals are too weak?

Q&A Session – 10 minutes

13:00-13:10 Break – 10 minutes

13:10-13:40 **Session 6: Pacific (Chair: Flavio Lehner)**

- **Masahiro Watanabe**, Enhanced near-term warming constrained by past trends in the equatorial Pacific sea surface temperature gradient
- **Yohan Ruprich-Robert**, Impacts of the Atlantic Multidecadal Variability (AMV) on the tropical Pacific: a multi-model study
- **Andrea Dittus**, The role of aerosol forcing in recent Pacific multi-decadal variability
- **Antonietta Capotondi**, A CLIVAR Pacific Region Panel Working Group on Tropical Pacific Decadal Variability: Goals and possible synergies

Q&A Session – 10 minutes

13:40-14:10 **Session 7: Atlantic (Chair: Flavio Lehner)**

- **Matthew Menary**, Aerosol-forced AMOC changes in CMIP6 historical simulations
- **Jon Robson**, How does anthropogenic aerosol forcing drive a strengthening of the AMOC in CMIP6 historical simulations?
- **Daniel Grosvenor**, What controls the historical timeseries of shortwave fluxes in the North Atlantic?
- **Brady Ferster**, Sensitivity of the Atlantic meridional overturning circulation and climate to tropical Indian Ocean warming

Q&A Session – 10 minutes

14:10-14:20 Break – 10 minutes

14:20-14:50 **Session 7 (cont): Atlantic/Asia (Chair: Leandro Díaz)**

- **Leonard Borchert**, Natural forcing influence on decadal subpolar North Atlantic temperature variations and implications for predictions
- **Shih-Wei Fang**, Disentangling Internal and External Contribution to Atlantic Multidecadal Variability over Past Millennium
- **Laura Suarez-Gutierrez**, The Decadal Variability of Extreme European Heat (Withdrawn)
- **Buwen Dong**, Recent decadal weakening of the Eurasian westerly jet attributable to anthropogenic aerosol emissions

Q&A Session – 10 minutes

14:50-15:30 **Break out groups**

Day 3 - 24th September: 05:00-08:00 UTC

05:00-05:30 **Session 8: Asia and southern hemisphere (Chair: Shoshiro Minobe)**

- **June-Yi Lee**, Decadal changes in the Madden-Julian Oscillation: A source for decadal changes in high-latitude climate
- **Jie Jiang**, Human-induced rainfall reduction in drought-prone northern Central Asia
- **Surendra Rauniyar**, Attribution of observed multi-decadal changes in rainfall and future prospects over Victoria, Australia

- **Neven Fuckar**, On dynamics and attribution of the 2018-2021 drought in Southern Africa (**Withdrawn**)

Q&A Session – 10 minutes

05:30-06:00 **Session 9: Monsoons/India (Chair: Shoshiro Minobe)**

- **Paul-Arthur Monerie**, Effects of external forcings on Northern Hemisphere monsoon precipitation
- **Andrew Turner**, Uncertainty in aerosol radiative forcing impacts the simulated global monsoon in the 20th century
- **Shipra Jain**, How Extreme could trends in Indian Monsoon rainfall be?
- **Ashish Manoj J**, Investigating Compound Soil Moisture-Precipitation Coupling Over India

Q&A Session – 10 minutes

06:00-06:10 Break – 10 minutes

06:10-07:10 **Posters – 60 minutes (Chair: Scott Osprey)**

- **(the list of posters is available below the programme)**

07:10-07:20 Break – 10 minutes

07:20-08:00 **Closing session**

- **Break out summary (June-Yi Lee)**
- **Group discussion and way forward (facilitators: Rowan Sutton, Doug Smith)**

List of posters

Day 1- 22nd September: 22:35-23:15 UTC

Poster N°	Last Name	First Name	Poster title
D1-P01	AVILA	Alvaro	Climate extremes of precipitation and temperature over Brazil during 1980-2016
D1-P02	BARSUGLI	Joseph	How critical is knowing the spatial pattern of ocean temperature change for attribution of the last 20 years of regional drought?
D1-P03	CHHIN	Rattana	Time-lagged correlations of pre-monsoon precipitation in the Indochina Peninsula confirmed in a large ensemble simulation Dataset
D1-P04	CHRISTIAN	John Erich	A probabilistic framework for attribution of rapid outlet glacier retreat
D1-P05	COLORADO-RUIZ	Gabriela	Synoptic patterns that modulate the summer rainfall in northeast Mexico
D1-P06	FAKHRUDDIN	Bapon	NZ Climate Measurement Standards Initiative (CMSI): Seamless integration for foreseeable future
D1-P07	DIBA	Ibrahima	Characterization of compound rainfall and temperature extreme in Senegal: present and future climate
D1-P08	IMADA	Yukiko	Long-term potential predictability of regional extreme events in East Asia estimated from a high-resolution large ensemble
D1-P09	JOH	Youngji	Seasonal-to-decadal variability and predictability of the Kuroshio Extension in the GFDL Coupled Ensemble Reanalysis and Forecasting system
D1-P10	LEE	Jiwoo	On the robustness of the evaluation of ENSO in climate models: How many ensemble members are needed?
D1-P11	LEE	Olivia	Challenges in using earth system models for regional and sub-regional adaptation planning in Alaska
D1-P12	LEE	Yong-Han	Regime shift in the occurrence of extreme heat day in East Asia during boreal summer
D1-P13	MEDEIROS	Felipe	Evaluation of CMIP6 extreme rainfall event simulations and their projected changes over Northeast Brazil
D1-P14	MINDLIN	Julia	Storyline Approach for the Evaluation of Near-Term Regional Climate Changes in southern South America (WITHDRAWN)
D1-P15	MONERIE	Paul-Arthur	Is the Atlantic Multidecadal Variability useful for predicting East Asian surface-air temperature?
D1-P16	OLMO	Matias	Atmospheric circulation influence on the seasonal trends of daily extreme temperature and precipitation events over southern South America
D1-P17	PLANTON	Yann	How well climate models simulate ENSO? How well do we know ENSO?
D1-P18	RAGHURAMAN	Shiv Priyam	Decomposition of cloud radiative effect trends into forcing, feedbacks, and cloud masking (WITHDRAWN)
D1-P19	REED	Kevin	An attribution framework to calculate climate change impacts on hurricane seasons
D1-P20	OH	Sae-Yoon	Exploring the changes in Atmospheric Circulation in East Asia during summer using K-mean clustering method
D1-P21	SALDÍVAR-LUCIO	Romeo	Moved to Day3 – D3-P44

D1-P22	SENAN	Retish	Deconstructing seasonal forecasts for attribution of predictable signals: the 2019/20 positive NAO case (WITHDRAWN)
D1-P23	SUTTON	Rowan	Recent trends in summer atmospheric circulation in the North Atlantic/European region: is there a role for anthropogenic aerosols?
D1-P24	WEHNER	Michael	Evidence for adding categories to the Saffir-Simpson hurricane intensity scale
D1-P25	YAMAGAMI	Yoko	Barents-Kara sea-ice decrease caused by sea surface warming in the Gulf Stream

Day 3 - 24th September: 6:10-7:10 UTC

Poster N°	Last name	First name	Poster title
D3-P01	ACOSTA NAVARRO	Juan Camilo	Added value of springtime Arctic sea ice concentration assimilation for summer and fall climate predictions
D3-P02	AKILA S.P.	S.P.	Influence of individual forcings on climate system
D3-P03	AROUF	Assia	Analysis of Time Series of Global Surface Longwave Cloud Radiative Effect from Space Lidar Observations
D3-P04	BONE	Constantin	Modelling the non-additivity of forcings using a convolutional neural network
D3-P05	BELLUCCI	Alessio	On the (non)stationarity of the AMV-AMOC relationship
D3-P06	BILBAO	Roberto	Impact of volcanic eruptions in CMIP6 decadal prediction systems: a multi-model analysis
D3-P07	CK	Sajidh	Mean and variability of the Dynamic Sea Level of the Indian Ocean from CMIP6 models
D3-P08	COLLIGNAN	Julie	Identifying and quantifying the impact of non-climatic effects on river discharge
D3-P09	DALLAN	Eleonora	A new methodology for regional trends in sub-daily rainfall annual maxima by using the Meta-statistical Extreme Value Distribution
D3-P10	DE VRIES	Iris	Detection of forced global and regional changes in the temporal precipitation distribution
D3-P11	DOGAR	Muhammad Mubashar Ahmad	Revisiting the Climatic Impacts of Strong and Weak ENSO using High-Resolution Atmospheric Model
D3-P12	DONAT	Markus	Windows of opportunity for multi-annual prediction conditional on ENSO phase
D3-P13	ENGDAW	Mastawesha	Detection and attribution of changes in regional temperature extremes with a focus on Africa
D3-P14	FABIANO	Federico	A regime view of future atmospheric circulation changes in Northern mid-latitudes
D3-P15	HADI	Tri W.	On the relationships between low-frequency variations of Earth's rotation and equatorial atmospheric angular momentum
D3-P16	GANAPATHY	Abinesh	Multi-timescale SST-Streamflow connectivity: A complex network approach
D3-P17	GATTU	Sachin	Support Farmers to build a Sustainable and climate-smart Food value chain

D3-P18	GENEL	Mustafa Talha	Selection of Representative Climate Models for West Asia Precipitation Patterns
D3-P19	GENEL	Mustafa Talha	Selection of representative climate models for Central America's temperature pattern
D3-P20	HASSAN	Mujtaba	Dynamic of South Asian Summer Monsoon and effect of model bias on simulated changes in high resolution Regional Climate Model (RegCM4)
D3-P21	HONG	Jin-Sil	Changes in the relationship of East Asian surface temperature and Pacific Decadal Oscillation during boreal winter in a new climate normal period (1991-2020)
D3-P22	JEON	Joongu	Understanding the differences in the trend of precipitation in the ITCZ in the two reanalysis datasets
D3-P23	JEONG	Yong-Cheol	Study on the long-term trend of Arctic Oscillation and its driver
D3-P24	KARPECHKO	Alexey	Climate change response of the Northern Hemisphere polar vortex in CMIP6 models: uncertainty and coupling to surface climate
D3-P25	KESEN	Beyza	Finding the accurate CMIP6 models to represent the precipitation pattern of Europe
D3-P26	KESEN	Beyza	Proposal of a statistical methodology to choose the representative CMIP6 models' daily maximum temperature (WITHDRAWN)
D3-P27	BORDBART M.	Hadi	Sensitivity of the wind-driven coastal and offshore upwelling across the Benguela Upwelling System to decadal climate changes
D3-P28	MA	Seung Joo	East Asian winter monsoon characteristics by differences in Ocean-Atmospheric interaction in the Northwest Atlantic Ocean
D3-P29	MAHMOOD	Rashed	Constraining decadal variability in climate projections to attribute climate variability and predictability to regional ocean contributions
D3-P30	MESSORI	Gabriele	Large-scale circulation anomalies driving compound climate extremes in Europe and North America
D3-P31	NDIAYE	Cassien Diabe	Forced modulations of Sahel rainfall at decadal timescale over the 20th Century (WITHDRAWN)
D3-P32	OLONSHECK	Dirk	Large-scale emergence of regional temperature variability by the end of the 21st century
D3-P33	RIBES	Aurélien	Reducing uncertainty on past, near-future and long-term warming
D3-P34	SAMSET	Bjorn	Earlier emergence of temperature response to mitigation found when filtering annual variability using a physics based Green's function approach
D3-P35	SANG-BIN	Lee	Exploring of the role of atmospheric versus oceanic forcings leading to Marine Heatwaves in East Asian marginal seas during boreal summer using an ocean general circulation model
D3-P36	SESTITO	Benedetta	The ocean-atmosphere interactions in the extratropical Southern Hemisphere: a multimodel approach (WITHDRAWN)
D3-P37	SINGH	Manmeet	The fingerprint of volcanic forcing on the ENSO's Indian monsoon coupling

D3-P38	SONG	Se-Yong	Role of low cloud feedback over the subtropical eastern Pacific Ocean on the ENSO development
D3-P39	SUNDARI	Ristina Siti	Urban greening initiation for greener city and revive food security in Tasikmalaya Municipality, Indonesia during COVID-19 pandemic
D3-P40	TIWARI	Yogesh	Unraveling the philosophy behind greenhouse gases emissions variability in India
D3-P41	TOMETY	Folly Serge	Quasi decadal to interdecadal SST variability in the Benguela upwelling system
D3-P42	YADAV	Ramesh Kumar	Relationship between Azores High and Indian summer monsoon
D3-P43	YARI	Sadegh	On the influence of Pacific climate variations on the Peruvian upwelling system
D3-P44 formerly D1-P21	SALDÍVAR- LUCIO	Romeo	Climatic signals in the California Current System in the context of North Pacific and planetary variability

Annex 2 – Organising Committee

- **Doug Smith (chair)**, Met Office Hadley Centre - UK
- **Lijing Cheng**, Institute of Atmospheric Physics, Chinese Academy of Sciences - China
- **Leandro Díaz**, Centro de Investigaciones del Mar y la Atmósfera (CIMA/CONICET-UBA) - Argentina
- **Daniela Faggiani Dias**, Colorado State University - USA
- **Nathan Gillett**, Environment and Climate Change Canada - Canada
- **June-Yi Lee**, Research Center for Climate Sciences, Pusan National University - Republic of Korea
- **Flavio Lehner**, Earth and Atmospheric Sciences, Cornell University - USA
- **Shoshiro Minobe**, Hokkaido University - Japan
- **Scott Osprey**, University of Oxford - UK
- **Rowan Sutton**, National Centre for Atmospheric Science, University of Reading - UK
- **Lin Wang**, Institute of Atmospheric Physics, Chinese Academy of Sciences – China
- **Nico Caltabiano**, World Climate Research Programme – Switzerland
- **Catherine Michaut**, Institut Pierre Simon Laplace – France
- **Narelle van der Wel**, World Climate Research Programme - Switzerland

Annex 3 – Acronyms

AMOC Atlantic Meridional Overturning Circulation
CliC Climate and Cryosphere (WCRP Core Project)
CLIVAR Climate and Ocean Variability, Predictability and Change (WCRP)
COVID-19 Coronavirus Disease 2019
d4PDF Database for Policy Decision-Making for Future Climate Change
DCPP Decadal Climate Prediction Project EU European Union
ENSO El-Niño Southern Oscillation
EPESC WCRP Lighthouse Activity on Explaining and Predicting Earth System Change
GEWEX Global Energy and Water Exchanges (WCRP)
HighResMip High Resolution Model Intercomparison Project
IOC Intergovernmental Oceanographic Commission of UNESCO
IOD India Ocean Dipole
ISC International Science Council
JPI Climate Joint Programming Initiative Climate
JPI Ocean Joint Programming Initiative Oceans
WCRP World Climate Research Programme (WMO-IOC-ISC)
WMO World Meteorological Organization

**The
World Climate
Research Programme
(WCRP)**

*facilitates analysis and
prediction of Earth system change
for use in a range of practical
applications of direct relevance,
benefit and value to society.*

