WCRP Workshop on Extremes in Climate Prediction Ensembles (ExCPEns)

Workshop Abstract Book

25 – 27 October 2021 / Online

Organized by World Climate Research Programme (WCRP)
APEC Climate Center (APCC)
Research Center for Climate Sciences (RCCS), Pusan National University (PNU)
Institute for Basic Science Center for Climate Physics (ICCP)

PROGRAM

PROGRAM 1, 25 October 2021

TIME					Session
GMT	KST		GMT	KST	
0:00	9:00	–	0:10	9:20	Opening
0:20	9:20	–	1:05	10:05	Session 1 (A). Identification of extremes in observations and climate prediction ensembles
1:05	10:05	–	1:10	10:10	Break
1:10	10:10	–	2:10	11:10	Session 2 (A). Physical mechanisms of extremes in observations and climate prediction ensembles
2:10	11:10	–	2:15	11:15	Break
2:15	11:15	–	3:00	12:00	Session 3. Regional climate extreme information relevant to impacts, vulnerability and adaptation

PROGRAM 2, 25 October 2021

TIME					Session
GMT	KST		GMT	KST	
10:00	19:00	–	10:45	19:45	Session 1 (B). Identification of extremes in observations and climate prediction ensembles
10:45	19:45	–	10:55	19:55	Break
10:55	19:55	–	11:55	20:55	Session 2 (B). Physical mechanisms of extremes in observations and climate prediction ensembles
11:55	20:55	–	12:05	21:05	Break
12:05	21:05	–	13:00	22:00	Poster Session (A): Brief introduction of the posters: Session 1, Session 2, Session 3
13:00	22:00	–	13:30	22:30	Breakout session for posters (extra 30-min breakout session for poster presentation)

PROGRAM 3, 26 October 2021

TIME					Session
GMT	KST		GMT	KST	
0:00	9:00	–	0:45	9:45	Session 4 (A). Prediction and predictability of large-scale climate variability relevant to extreme events
0:45	9:45	–	0:55	9:55	Break
0:55	9:55	–	2:10	11:10	Session 5 (A). Prediction and predictability of specific extreme events (>10 days)
2:10	11:10	–	2:20	11:20	Break
2:20	11:20	–	3:00	12:00	Poster Session (B) : Brief introduction of the posters: Session 4, Session 5, Session 6
3:00	12:00	–	3:30	12:30	Breakout session for posters (extra 30-min breakout session for poster presentation)

PROGRAM 4, 26 October 2021

TIME					Session
GMT	KST		GMT	KST	
10:00	19:00	–	11:00	20:00	Session 4 (B). Prediction and predictability of large-scale climate variability relevant to extreme events
11:00	20:00	–	11:10	20:10	Break
11:10	20:10	–	12:10	21:10	Session 5 (B). Prediction and predictability of specific extreme events (>10 days)
12:10	21:10	–	12:20	21:20	Break
12:20	21:20	–	13:00	22:00	Poster Session (C) : Brief introduction of the posters: Session 4, Session 5, Session 6
13:00	22:00	–	13:30	22:30	Breakout session for posters (extra 30-min breakout session for poster presentation)

PROGRAM 5, 27 October 2021

TIME					Session
GMT	KST		GMT	KST	
6:00	15:00	–	7:00	16:00	Session 6. Quantifying current and future risks of climate extremes
7:00	16:00	–	7:05	16:05	Break
7:05	16:05	–	8:40	17:40	Session 6. Quantifying current and future risks of climate extremes
8:40	17:40	–	8:45	17:45	Closing

Chapter

Program 1,

25 October 2021

Session 1 (A)
Session 2 (A)
Session 3

PROGRAM 1, 25 October 2021

TIME (start)			TIME (end)		Presentation			
GMT	KST		GMT	KST	Code	Name	Organization	Title
0:00	9:00	–	0:20	9:20	Opening			
0:00	9:00	–	0:18	9:18	Opening Remarks – Dr. Won-Tae Kwon, Executive Director, APEC Climate Center – Prof. Kyung-Ja Ha, Director, Research Center for Climate Sciences, Pusan National University – Dr. Helen Cleugh, World Climate Research Programme (WCRP) – Dr. William Merryfield, Co-Chair of Working Group on Subseasonal to Interdecadal Prediction (WGSIP), WCRP			
0:18	9:18	–	0:20	9:20	Group Photo			
0:20	9:20	–	1:05	10:05	Session 1 (A). Identification of extremes in observations and climate prediction ensembles			
0:20	9:20	–	0:35	9:35	S1_1	Danielle Touma	University of California, Santa Barbara	Identifying and characterizing spatio-temporally connected extreme precipitation events
0:35	9:35	–	0:50	9:50	S1_2	Julia Lockwood	Met Office Hadley Centre	Using high-resolution PRIMAVERA climate model ensembles to create a European windstorm event set
0:50	9:50	–	1:05	10:05	S1_3	Yeon-Hee Kim	Pohang University of Science and Technology (POSTECH)	Evaluation of the CMIP6 multi-model ensemble for climate extreme indices
1:05	10:05	–	1:10	10:10	Break			
1:10	10:10	–	2:10	11:10	Session 2 (A). Physical mechanisms of extremes in observations and climate prediction ensembles			
1:10	10:10	–	1:25	10:25	S2_1	Eun_Pa Lim	Australian Bureau of Meteorology	Understanding and predicting the 2019 Antarctic spring polar vortex warming and its impacts
1:25	10:25	–	1:40	10:40	S2_2	Liwei Jia	NOAA GFDL/UCAR	Skillful seasonal prediction of North American summertime heat extremes
1:40	10:40	–	1:55	10:55	S2_3	Chiara Holgate	Australian Bureau of Meteorology	Local and remote drivers of southeast Australian drought
1:55	10:55	–	2:10	11:10	S2_4	Jiabao Wang	University of California, San Diego	MJO impacts on precipitation extremes over the western U.S.: seasonality and QBO modulation
2:10	11:10	–	2:15	11:15	Break			
2:15	11:15	–	3:00	12:00	Session 3. Regional climate extreme information relevant to impacts, vulnerability and adaptation			
2:15	11:15	–	2:30	11:30	S3_1	Syed Ahsan Bokhari	Pakistan Meteorological Department	Future changes in precipitation extremes over Pakistan using the NEX-GDDP high-resolution daily downscaled data-set
2:30	11:30	–	2:45	11:45	S3_2	Debbie Hudson	Australian Bureau of Meteorology	The application of ensemble seasonal forecasts of extremes for decision-making in agriculture
2:45	11:45	–	3:00	12:00	S3_3	Xinjia Hu	Max Planck Institute for the Physics of Complex Systems	Using climate variabilities to estimate flood economic loss risk

PROGRAM 1,
25 October 2021

Session 1 (A).

Identification of extremes in observations and climate prediction ensembles

Danielle Touma

University of California, Santa Barbara

Identifying and characterizing spatio-temporally connected extreme precipitation events

S1_1

Identifying and characterizing spatio-temporally connected extreme precipitation events

Danielle Touma*[1,2], James M. Done[2], Erin Towler[2], Ming Ge[2], Daniel L. Swain[2,3,4,] Manuela I. Brunner[5], Jennie Bukowski[2]

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2 Capacity Center for Climate and Weather Extremes, National Center for Atmospheric Research, Boulder, CO, US

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We identify the characteristics of connected extreme precipitation in the United States over the last four decades using the ERA5 reanalysis product. We apply a technique from image processing to the precipitation data to create a novel dataset of spatio-temporally connected extreme precipitation objects, i.e., extreme precipitation that occurs continuously over adjacent grid points and days. We assess regional and seasonal variations in the duration and spatial extent of connected extreme precipitation objects, as well as their precipitation intensity and volume. Additionally, we investigate the relationship between these extreme precipitation events and drought and fire weather indices. This framework and dataset provides the foundation for the COEXIST (COnnected EXtremes In Space and Time) project that aims to improve our understanding of the drivers, impacts, and seasonal-to-subseasonal prediction of connected extremes.

Julia Lockwood

Met Office Hadley Centre

Using high-resolution PRIMAVERA climate model ensembles to create a European windstorm event set

S1_2

Using high-resolution PRIMAVERA climate model ensembles to create a European windstorm event set

Julia Lockwood, Galina Guentchev, Erika Palin, Malcolm Roberts, Hazel Thornton

Met Office Hadley Centre

PRIMAVERA was a European Union Horizon2020 project whose primary aim was to generate advanced and well-evaluated high-resolution global climate model datasets, for the benefit of governments, business and society in general.

Following consultation with members of the insurance industry, we have used PRIMAVERA climate models to generate a European windstorm (extra-tropical cyclone) event set for use in catastrophe modelling and insurance risk analysis. The event set is generated from five different climate models, each run at a selection of resolutions ranging from 18-140km, covering the period 1950-2015, giving approximately 1300 years of climate model data in total.

Using an 'event-based' approach to create the dataset facilitates the study of properties such as storm clustering (when several storms arrive in quick succession). In addition, since the storms are generated from a global climate model, it is possible to study the relationship between storm damage and large-scale climate indices such as the North Atlantic Oscillation (NAO). This gives insurers the possibility of using their catastrophe models in a predictive mode, assessing the change in storm risk for a given NAO forecast. In this talk I will outline the method used to create the event set, and present some initial results.

Yeon-Hee Kim

Pohang University of Science and Technology (POSTECH)

Evaluation of the CMIP6 multi-model ensemble for climate extreme indices

S1_3

Evaluation of the CMIP6 multi-model ensemble for climate extreme indices

Yeon-Hee Kim[1], Seung-Ki Min[1], Xuebin Zhang[2], Jana Sillmann[3], Marit Sandstad[3]

[1]Division of Environmental Science and Engineering, POSTECH
[2]Environment and climate change Canada
[3]Center for International climate Research, Norway

This study evaluates the performances of global climate models participating in the Coupled Model Intercomparison Project phase 6 (CMIP6) in terms of climate extremes indices defined by the Expert Team on Climate Change Detection and Indices. The simulated values for the climate extreme indices compared with HadEX3 observation and four reanalyses for global and regional climatology patterns for the 1981-2000 period. We evaluate the mean biases for the 20-year return values of warmest day and coldest night temperatures (TXx and TNn) and annual maximum of daily precipitation (RX1day) using a generalized extreme values (GEV) analysis.

Results show that CMIP6 models are generally able to capture the observed global patterns of temperature extremes, but exhibit cold biases in cold extreme over high-latitude area. The CMIP6 model skills for the precipitation intensity and frequency indices are also largely comparable to those of CMIP5 models, but precipitation intensity simulations are found to be improved with reduced dry biases, especially over East Asia region. The GEV analysis results indicate that the regional biases in 20RV of temperature extremes are dominated by GEV location parameter (related to mean intensity) with relatively small contribution from GEV scale/shape parameters (related to interannual variability). CMIP6-simulated 20RV of RX1day is characterized by dry biases over the tropics and subtropical rain band area (including East Asia) as in the CMIP5 models, for which biases in both GEV location and scale/shape parameters are important.

PROGRAM 1,
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Session 2 (A). »

Physical mechanisms of extremes in observations and climate prediction ensembles

Eun-Pa Lim

Australian Bureau of Meteorology

Understanding and predicting the 2019 Antarctic spring polar vortex warming and its impacts

S2_1

Understanding and predicting the 2019 Antarctic spring polar vortex warming and its impacts

Eun-Pa Lim and Harry H. Hendon

Bureau of Meteorology, Australia

Between late August and mid-September 2019, the Antarctic stratosphere experienced a rapid weakening of the polar vortex and a dramatic sudden warming. The deceleration of the vortex at 10 hPa was as drastic as that of the one and only major sudden stratospheric warming in the SH during 2002, while the mean Antarctic warming over the course of spring 2019 broke the previous record of 2002 by ~50% in the mid-stratosphere. This event was preceded by a poleward shift of the SH polar night jet in the uppermost stratosphere in early winter, which was then followed by record-strong planetary wave-1 activity propagating upward from the troposphere in August that acted to dramatically weaken the stratospheric polar vortex. The weakened vortex winds and increased temperatures moved downward and reached the surface from mid-October to December, promoting a record strong negative swing of the southern annular mode (SAM). This record-negative SAM appeared to be a key driver of the extreme hot and dry conditions over subtropical eastern Australia that accompanied the severe wildfires that occurred in austral late spring 2019. State-of-the-art dynamical seasonal forecast systems demonstrated skill to predict the spring polar vortex over Antarctica at 2 month lead time and skilfully predicted the significant vortex weakening of spring 2019 and subsequent development of negative SAM from as early as late July.

Keywords : stratospheric warming, 2019 SH climate extremes, seasonal forecasts

Liwei Jia

NOAA GFDL/UCAR

Skillful seasonal prediction of North American summertime heat extremes

S2_2

Skillful seasonal prediction of North American summertime heat extremes

Liwei Jia,[a,b] Thomas Delworth,[a] Sarah Kapnick,[a] Xiaosong Yang,[a] Nathaniel C. Johnson,a,c William Cooke,[a] Feiyu Lu,[c] Matthew Harrison,[a] Anthony Rosati,[a,b] Fanrong Zeng,[a] Colleen McHugh,[d] Andrew T. Wittenberg[a], Liping Zhang[a,b], Hiroyuki Murakami,[a,b] Kai-Chih Tseng[c]

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[d] SAIC, Science A pplications International Corporation, Reston, VA

This study shows that the frequency of North American summertime (June-August) heat extremes is skillfully predicted several months in advance in the newly-developed GFDL (Geophysical Fluid Dynamics Laboratory) SPEAR (Seamless system for Prediction and EArth system Research) seasonal forecast system. Using a statistical optimization method, the Average Predictability Time, we identify three large scale components of the frequency of North American summer hot days that are predictable with significant correlation skill. One component, which is related to a secular warming trend, shows a continent-wide increase in the frequency of summer hot days and is highly predictable at least 9 months in advance. The second component, which is related to the Pacific Decadal Oscillation and Atlantic Multidecadal Oscillation and is significantly correlated with central U.S. soil moisture, shows largest loadings over the central U.S. and is significantly predictable 9 months in advance. Another component, which is related to the El Niño-Southern Oscillation, displays a dipole structure over North America and is predictable up to 4 months. This study has potential implications for advancing seasonal predictions of North American summertime heat extremes.

Chiara Holgate

Australian Bureau of Meteorology

Local and remote drivers of southeast Australian drought

S2_3

Local and remote drivers of southeast Australian drought

Chiara Holgate

Australian Bureau of Meteorology

The physical mechanisms that drive recurring droughts in southeast Australia are unclear. While droughts are known to be associated with large-scale modes of variability, synoptic-scale systems and land surface processes, the relative roles of each are uncertain. Using a Lagrangian back- trajectory approach this study provides the first quantification of the change in moisture supply during major droughts in southeast Australia, including the causes of the changes. The results show that the leading cause for drought was that moisture originating from the oceans was anomalously circulated away from southeast Australia, and the moisture that was locally available was inhibited from forming rainfall. In contrast, during drought termination, strengthened moist onshore flow promoted anomalously high rainfall. The drying landscape exacerbated the low rainfall conditions but had a smaller effect than the ocean. These results highlight the importance of understanding of the relationship between ocean moisture and synoptic-scale circulation in regions of the world, like southeast Australia, that are similarly subject to large-scale modes of variability.

Jiabao Wang

University of California, San Diego

MJO impacts on precipitation extremes over the western U.S.: seasonality and QBO modulation

S2_4

MJO impacts on precipitation extremes over the western U.S.: seasonality and QBO modulation

Jiabao Wang[1], Michael J. DeFlorio[1], Bin Guan[2,3], and Christopher Castellano[1]

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The Madden-Julian oscillation (MJO) is a unique type of organized tropical convection varying primarily on subseasonal timescales and is recognized as an important source of subseasonal predictability for midlatitude weather phenomena. This study provides observational evidence of MJO impacts on precipitation extremes (flooding and drought) over the western U.S. including their relative frequency, intensity, and duration. The results suggest a robust increase (decrease) in flooding (drought) frequency and duration relative to climatological conditions over most of the western U.S. when the MJO is in its western Pacific phases during the extended boreal winter (October to March). Relative changes in the frequency of precipitation extremes following active MJO events are up to ~40% in California.

The MJO's influence on extreme precipitation has strong seasonality, with larger impacts in early winter (OND) and weaker or opposite impacts in late winter (JFM). The MJO impacts are also strongly modulated by background sources of interannual atmospheric variability such as the quasi-biennial oscillation (QBO). The easterly QBO phase leads to stronger intensity and longer duration of flooding events when the MJO convection is in the western Pacific, while the westerly QBO phase leads to a largely opposite response. Mechanisms of the seasonality and QBO modulation are further discussed, such as changes in MJO modulation on moisture transport (e.g., atmospheric rivers) and extratropical circulation.

PROGRAM 1,
25 October 2021

Session 3.

Regional climate extreme information relevant to impacts, vulnerability and adaptation

Syed Ahsan Bokhari

Pakistan Meteorological Department

Future Changes in precipitation extremes over Pakistan using the NEX-GDDP high-resolution daily downscaled data-set

S3_1

Future changes in precipitation extremes over Pakistan using the NEX-GDDP high-resolution daily downscaled data-set

Syed Ahsan Ali Bukhari[1], Burhan Ahmad[1]

[1]Pakistan Metrological Department, Islamabad 44000, Pakistan

Recently, a new high-resolution daily downscaled data-set derived from 21 CMIP5 model simulations has been released by NASA, called 'NASA Earth Exchange Global Daily Downscaled Projections' (NEX- GDDP). In this study, the performance of this data-set in simulating precipitation extremes and long- term climate changes across Pakistan are evaluated and analyzed. The study provides comprehensive picture of the changes in precipitation extremes over Pakistan associated with global warming, especially in terms of the their frequency, duration, and intensity and associated changes in the hydrological cycle. The results indicate that NEX-GDDP can successfully reproduce the spatial patterns of precipitation extremes over Pakistan, showing results that are much closer to observations than the GCMs, with increased Pearson correlation coefficients and decreased model relative error for most models. Furthermore, NEX-GDDP shows that precipitation extremes are projected to occur more frequently, with increased intensity, across Pakistan in the future. Especially at regional to local scales, more information for the projection of future changes in precipitation extremes can be obtained from this high-resolution data-set. Most importantly, the uncertainties of these projections at the regional scale present significant decreases compared with the GCMs, making the projections by NEX-GDDP much more reliable. Therefore, the authors believe that this high-resolution data-set will be popular and widely used in the future, particularly for climate change impact studies in areas where a finer scale is required.

Debbie Hudson

Australian Bureau of Meteorology

The application of ensemble seasonal forecasts of extremes for decision-making inagriculture

S3_2

The application of ensemble seasonal forecasts of extremes for decision-making inagriculture

Debbie Hudson[1] and Peter Hayman[2]

[1] Bureau of Meteorology, Australia
[2] South Australian Research and Development Institute, Australia

Australian farmers operate in one of the most variable climates in the world, with extreme events and climate variability the largest drivers of fluctuations in annual agricultural income and production. Warning of these events increases ability to reduce risk. While sub-seasonal/seasonal climate outlooks are commonplace, these services tend to be focused on the middle of the distribution of possible outcomes, for example forecasts of the chance of above median conditions. This does not provide any indication of the risk of extreme conditions, such as a decile 1 or 2 rainfall season.

The Forewarned is Forearmed project, supported by the Australian Government Department of Agriculture, Water and the Environment, is developing new sub-seasonal/seasonal forecast products of extremes to equip farmers with the information to be forewarned and prepared. Industry reference groups from the dairy, red meat, grains, sugar and wine sectors have played a crucial role in the development of the new products, providing important feedback on user-needs for seasonal forecasting as well as impact on farm decision-making.

A key challenge is the communication and use of forecasts that are presented as shifts in probabilities and fall into the category of "too good to ignore but not good enough to be sure". The applied economics framework of Decision Analysis has been used in the project to encourage discussion about managing climate risk using climatological odds and how this changes with revised probabilities from a forecast (https://forecasts4profit.com.au/cb_pages/rapid_climate_decision_analysis_tool.php). This framework will be described, together with some key forecast products developed within the project.

Xinjia Hu

Max Planck Institute for the Physics of Complex Systems

Using climate variabilities to estimate flood economic loss risk

S3_3

Using climate variabilities to estimate flood economic loss risk

Xinjia Hu

Max Planck Institute for the Physics of Complex Systems

Estimation of economic loss is essential for stakeholders to manage flood risk. Most flooding events are closely related to extreme precipitation, which is influenced by large-scale climate patterns. Utilizing the lag influence of climate variabilities, we develop a flood-risk assessment framework and take Hunan province in China as an example. The main patterns of precipitation act as a connection bridge, which are extracted by the empirical orthogonal function (EOF). We identify the correlative climate variabilities through cross-correlation analysis and establish a multiple stepwise linear regression model to forecast precipitation patterns. Risk assessment is explored based on the main precipitation modes. As the economic dataset is limited, a Monte Carlo simulation is applied to simulate 1000-year events under each precipitation situation, obtaining aggregate exceedance probability (AEP) and occurrence exceedance probability (OEP) curves. We found that precipitation is the main factor influencing the economic loss risk, with the highest risk in the rainy years. Additionally, the regional economic development imbalance is the potential reason for the different economic risk in different regions in Hunan. As the climate indices with at least 3-month lags are strong indicators in predicting precipitation, the framework we developed can estimate economic loss risk at least 3 months in advance.

Keywords: Forecast-based economic loss assessment; Atmospheric oceanic circulation; 20 Risk management; Flood risk

Chapter

Program 2,
25 October 2021

Session 1 (B)
Session 2 (B)
Poster Session (A)

PROGRAM 2, 25 October 2021

TIME (start)			TIME (end)		Presentation			
GMT	KST		GMT	KST	Code	Name	Organization	Title
10:00	19:00	–	10:45	19:45	Session 1 (B). Identification of extremes in observations and climate prediction ensembles			
10:00	19:00	–	10:15	19:15	S1_4	Samuel Mogen	University of Colorado Boulder	Biogeochemical signatures of the North Pacific Blob
10:15	19:15	–	10:30	19:30	S1_5	Markus Donat	Barcelona Supercomputing Center	Predicting temperature and precipitation extremes on decadal to multi-decadal timescales
10:30	19:30	–	10:45	19:45	S1_6	Chloe Prodhomme	University of Toulouse, Meteo-France	Seasonal prediction of European summer heatwaves
10:45	19:45	–	10:55	19:55	Break			
10:55	19:55	–	11:55	20:55	Session 2 (B). Physical mechanisms of extremes in observations and climate prediction ensembles			
10:55	19:55	–	11:10	20:10	S2_5	Christian Franzke	Institute for Basic Science	Dynamics of modes of large-scale variability and extremes
11:10	20:10	–	11:25	20:25	S2_6	Joel Zeder	ETH Zurich	Modeling heat-wave intensity conditional on dynamical and thermodynamical forcing
11:25	20:25	–	11:40	20:40	S2_7	Zhen Liu	Pusan National University	Distinguishing dry and humid heatwaves in southern China
11:40	20:40	–	11:55	20:55	S2_8	Stefano Materia	Euro-Mediterranean Center on Climate Change	Summer temperature response to extreme soil water conditions in the Mediterranean transitional climate regime
11:55	20:55	–	12:05	21:05	Break			
12:05	21:05	–	13:00	22:00	Poster Session (A): Brief introduction of the posters: Session 1, Session 2, Session 3			
12:05	21:05	–	12:07	21:07	PA_S1_1	Jingya Han	Beijing Normal University	Variations in start date, end date, frequency and intensity of yearly temperature extremes across China during the period 1961–2017
12:07	21:07	–	12:09	21:09	PA_S1_2	Ashish Manoj J	Indian Institute of Technology Roorkee	Characterisation of Compound Soil Moisture – Precipitation Events Over India
12:09	21:09	–	12:11	21:11	PA_S1_3	Min-Gyu Seong	Pohang University of Science and Technology (POSTECH)	Greenhouse gas and aerosol contributions to the observed global and regional changes in extreme temperature during 1951–2015
12:11	21:11	–	12:13	21:13	PA_S2_1	Claudia Gessner	ETH Zurich	Multi-year drought storylines for Europe and North America
12:13	21:13	–	12:15	21:15	PA_S2_2	Qiyun Ma	University of Hamburg	Changes in the maintenance mechanisms of heat waves over inner East Asia over the last few decades
12:15	21:15	–	12:17	21:17	PA_S2_3	Salauddin Mohammad	Academia Sinica	A cloud model study of internal gravity wave breaking atop a high shear supercell in US High Plains
12:17	21:17	–	12:19	21:19	PA_S2_5	Wan-Ling Tseng	Academia Sinica	Extreme events in summer 2018
12:19	21:19	–	12:21	21:21	PA_S2_6	Manish Joshi	Indian Institute of Tropical Meteorology	Hot Extrems over Inida and their Driving Mechanisms
12:21	21:21	–	12:23	21:23	PA_S2_7	Chao-An Chen	Academia Sinica	Extreme Precipitation Change in East Asian Spring and Mei-yu Seasons in Global Warming Simulations from High-Resolution AGCMs
12:23	21:23	–	12:25	21:25	PA_S2_8	Byeong-Hee Kim	Pohang University of Science and Technology (POSTECH)	NMME-based assessment of the prediction skill of spring precipitation over East Asia and associated oceanic conditions
12:25	21:25	–	12:27	21:27	PA_S3_1	Laxmikant Dhage	University of Hawaii at Manoa	Assessment of 21st century changing sea surface temperature, rainfall, and sea level patterns in the tropical Pacific Islands using CMIP6 green
13:00	22:00	–	13:30	22:30	Breakout session for posters (extra 30-min breakout session for poster presentation)			

PROGRAM 2,
25 October 2021

Session 1 (B).

Identification of extremes in observations and climate prediction ensembles

Samuel Mogen

University of Colorado Boulder

Biogeochemical signatures of the North Pacific Blob

S1_4

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Biogeochemical signatures of the North Pacific Blob

Samuel Mogen

University of Colorado Boulder

The Blob (2014–2016) was a marine heat wave in the Northeast Pacific forced by an unusually strong and persistent ridge of high sea level pressure. While the drivers and effects of the upper ocean temperature anomaly in the Blob are well understood, the impacts on local and regional marine biogeochemistry have not been fully explored. Here, we characterize and develop understanding of Eastern North Pacific upper ocean biogeochemical properties during the Blob using output from the Community Earth System Model (CESM) Forced Ocean Sea Ice Reconstruction (FOSI). We demonstrate that CESM FOSI successfully simulates surface physical and biogeochemical properties as compared to direct observations and a novel observation-based product. We find that the Blob has strong impacts on upper ocean (top 100 m) biogeochemistry: the Blob is associated with anomalously high aragonite saturation states and oxygen concentrations due to anomalous advection and mixing of biogeochemical tracers into the upper ocean. This work adds to a broader discussion of the effects of marine heatwaves on ecosystems and fisheries.

Markus Donat

Barcelona Supercomputing Center

Predicting temperature and precipitation extremes on decadal to multi-decadal timescales

S1_5

Predicting temperature and precipitation extremes on decadal to multi-decadal timescales

Markus Donat, Yiling Liu, Rashed Mahmood, Pablo Ortega, Francisco Doblas-Reyes
Barcelona Supercomputing Center

The occurrence of climate extremes is modulated by different modes of variability in different parts of the world. Accounting for the phases of climate variability modes can therefore improve predictions of extremes in the years and decades to come. This presentation discusses prospects for predicting the occurrence probabilities of temperature and precipitation extremes for the near-term future in the decades to come.

Perfect-model studies indicate significant potential skill in several regions for inter-annual to decadal predictions for both mean and extreme temperatures. While the spatial patterns of potential skill are similar between mean and extreme temperatures, there is a tendency for indicators of moderate temperature extremes to show higher predictability than the mean.

Further research constrains large ensembles of climate projections for their agreement with the climate variability phases of the observed climate. We find that these variability constraints can improve projections of summer temperatures for the next multiple decades in some regions, consistent with the occurrence frequency of moderate temperature extremes.

These initial results indicate promising potential for predicting climate extremes on decadal to multi-decadal timescales, and we will conclude the presentation with outlining pathways for future research.

Chloe Prodhomme

University of Toulouse, Meteo-France

Seasonal prediction of European summer heatwaves

S1_6

Seasonal prediction of European Summer Heatwaves

Chloé Prodhomme [1,2,3], Stefano Materia [4], Constantin Ardilouze [1], Rachel H. White [5,3], Lauriane Batté [1], Virginie Guemas [1], GeorgiosFragkoulidis [6], and Javier García-Serrano [21]

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Under the influence of global warming, heatwaves are becoming a major threat in many parts of the world, affecting human health and mortality, food security, forest fires, biodiversity, energy consumption, as well as the production and transportation networks. Seasonal forecasting is a promising tool to help mitigate these impacts on society. Previous studies have highlighted some predictive capacity of seasonal forecast systems for specific strong heatwaves such as those of 2003 and 2010. To our knowledge, this study is thus the first of its kind to systematically assess the prediction skill of heatwaves over Europe in a state-of-the-art seasonal forecast system. One major prerequisite to do so is to appropriately define heatwaves. Existing heatwave indices, built to measure heatwave duration and severity, are often designed for specific impacts and thus have limited robustness for an analysis of heatwave variability. In this study, we investigate the seasonal prediction skill of European summer heatwaves in the ECMWF System 5 operational forecast system by means of several dedicated metrics, as well as its added-value compared to a simple statistical model based on the linear trend. We are able to show, for the first time, that seasonal forecasts initialized in early May can provide potentially useful information of summer heatwave propensity , which is the tendency of a season to be predisposed to the occurrence of heatwaves.

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PROGRAM 2,
25 October 2021

Session 2 (B).

Physical mechanisms of extremes in observations and climate prediction ensembles

Christian Franzke

Institute for Basic Science

Dynamics of modes of large-scale variability and extremes

S2_5

Dynamics of modes of large-scale variability and extremes

Christian Franzke

Institute for Basic Science

In order to improve our ability to predict modes of large-scale variability such as the Madden-Julian Oscillation (MJO), the Pacific-North American pattern and the North Atlantic Oscillation or of extreme heat waves we need to better understand their underlying dynamics. Here I will show how to systematically decompose the MJO into balance and unbalanced components and how they affect long-range predictability. I will also discuss how to decompose heat waves into wave components and ti identify their forcings.

Joel Zeder

ETH Zurich

Modeling heat-wave intensity conditional on dynamical and thermodynamical forcing

S2_6

»

Modelling heat-wave intensity conditional on dynamical and thermodynamical forcing

Joel Zeder and Erich M. Fischer

Institute for Atmospheric and Climate Science, ETH Zurich

Research Objective: Single-model initial condition large ensembles provide novel opportunities to study the physical drivers and risks of large-scale climate extremes in a changing climate. The probability of extremes such as heatwaves are usually approximated with a GEV distribution that is either stationary or solely accounts for global warming. However, estimating the occurrence probability of very rare climate extremes in the presence of large internal variability further benefits from the integration of process-based covariates, which characterise the preceding and concurrent climate conditions both at global and local scale.

Data & Methods: We here use more than 6000 years of stationary pre-industrial and 2xCO_2 control simulations and an ensemble of 84 transient historical and RCP8.5 simulations performed with the CESM1.2 model to develop and robustly test methods of quantifying extreme events under a broad range of climatic conditions. The GEV distribution is parametrised such that it can account for changing environmental circumstances, ranging from large-scale thermodynamic non-stationarity due to climate change, regional-scale dynamic forcing such as atmospheric blocking, or local land-surface conditions such as soil moisture deficits. Fields of covariates are integrated using approaches from statistical learning theory, accounting for the spatio-temporal correlation inherent in climate data.

Preliminary results: Dynamical forcing patterns as simulated by the ESM compare well with those obtained from reanalysis data and inform the statistical model in a physically traceable fashion. The model also generalises when applied to data of other climate models and even reanalysis data.

Zhen Liu

Pusan National University

Distinguishing dry and humid heatwaves in southern China

S2_7

»

Distinguishing dry and humid heatwaves in southern China

Ming Luo[1,2], Zhen Liu[3,4], Ngar-Cheung Lau[2,5]
(Presenter: Zhen Liu)

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Heatwaves pose severe threats to human health, especially those combining heat and humidity. Here, we use dry- and wet-bulb temperatures as indicators to classify dry and humid heatwaves in southern China and distinguish their different mechanisms. We find that both dry and humid heatwaves are accompanied by an eastward extension of the South Asian high, a westward extension of the western North Pacific subtropical high, and a low-level anticyclonic anomaly. The major differences between dry and humid heatwaves are that these anomalies are more widespread albeit weaker and shift more southward for humid than dry heatwaves. Consequently, dry heatwaves are associated with drastically increased temperature and decreased relative humidity, while humid heatwaves are accompanied by relatively weaker but more expanded temperature increases and stronger increases in humidity. Understanding the differences between dry and humid heatwaves and their origins advances our knowledge of heatwaves which can better mitigate their detrimental effects.

Stefano Materia

Euro-Mediterranean Center on Climate Change

Summer temperature response to extreme soil water conditions in the Mediterranean transitional climate regime

S2_8

Summer temperature response to extreme soil water conditions in the Mediterranean transitional climate regime

Stefano Materia, Constantin Ardilouze, Chloé Prodhomme, Markus G. Donat, Marianna Benassi, Francisco J. Doblas-Reyes, Daniele Peano, Louis-Philippe Caron, Paolo Ruggieri, Silvio Gualdi

Land surface and atmosphere are interlocked by the hydrological and energy cycles and the effects of soil water-air coupling can modulate near-surface temperatures. In this work, three paired experiments were designed to evaluate impacts of different soil moisture initial and boundary conditions on summer temperatures in the Mediterranean transitional climate regime region. In this area, evapotranspiration is not limited by solar radiation, rather by soil moisture, which therefore controls the boundary layer variability. Extremely dry, extremely wet and averagely humid ground conditions are imposed on two global climate models at the beginning of the warm and dry season. Then, sensitivity experiments, where the atmosphere is alternatively interactive with and forced by land surface, are launched. The initial soil state largely affects summer near-surface temperatures: dry soils contribute to warming the lower atmosphere and exacerbate heat extremes, while wet terrains suppress thermal peaks, and both effects last for several months. Land-atmosphere coupling proves to be a fundamental ingredient to modulate the boundary layer state, through the partition between latent and sensible heat fluxes. In the coupled runs, early season heat waves are sustained by interactive dry soils, which respond to hot weather conditions with increased evaporative demand, resulting in longer-lasting extreme temperatures. On the other hand, when wet conditions are prescribed across the season, the occurrence of hot days is suppressed. The land surface prescribed by climatological precipitation forcing causes a temperature drop throughout the months, due to sustained evaporation of surface soil water. Results have implications for seasonal forecasts on both rain-fed and irrigated continental regions in transitional climate zones.

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PROGRAM 2,
25 October 2021

Poster Session (A) »

Brief introduction of the posters: Session 1, Session 2, Session 3

Jingya Han

Beijing Normal University

Variations in start date, end date, frequency and intensity of yearly temperature extremes across China during the period 1961–2017

PA_S1_1 »

Variations in start date, end date, frequency and intensity of yearly temperature extremes across China during the period 1961-2017

Jingya Han[1], Chiyuan Miao[1]*, Qingyun Duan[1], Jingwen Wu[1], Xiaohui Lei[2], Weihong Liao[2]

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Compound climate extremes, such as events with concurrent temperature and precipitation extremes, have significant impacts on the health of humans and ecosystems. This paper aims to analyze temporal and spatial characteristics of compound extremes of monthly temperature and precipitation, evaluate the performance of the sixth phase of the Coupled Model Intercomparison Project (CMIP6) models in simulating compound extremes, and investigate their future changes under Shared Socioeconomic Pathways (SSPs). The results show a significant increase in the frequency of compound warm extremes (warm/dry and warm/wet) but a decrease in compound cold extremes (cold/dry and cold/wet) during 1985-2014 relative to 1955-1984. The observed upward trends of compound warm extremes over China are much higher than those worldwide during the period of interest. A multi-model ensemble (MME) of CMIP6 models performs well in simulating temporal changes of warm/wet extremes, and temporal correlation coefficients between MME and observations are above 0.86. Under future scenarios, CMIP6 simulations show substantial rises in compound warm extremes and declines in compound cold extremes. Globally, the average frequency of warm/wet extremes over a 30-year period is projected to increase for 2070-2099 relative to 1985-2014 by 18.53, 34.15, 48.79 and 59.60 under SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, respectively. Inter-model uncertainties for the frequencies of compound warm extremes are considerably higher than those of compound cold extremes. The projected uncertainties in the global occurrences of warm/wet extremes are 3.82 times those of warm/dry extremes during 2070-2099 and especially high for the Amazon and the Tibetan Plateau.

Ashish Manoj J

Indian Institute of Technology Roorkee

Characterisation of Compound Soil Moisture – Precipitation Events Over India

PA_S1_2 »

Characterisation of Compound Soil Moisture – Precipitation Events Over India

J, Ashish Manoj *(1), Ravi Kumar Guntu (1), Ankit Agarwal (1)

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Traditionally risk assessment studies used to consider only one climatic driver/ process at a time. However, it was then recognised that it is the combination of multiple drivers and their statistical dependencies that lead to aggravated, non-linear impacts. Such multivariate, dependent extreme events are termed compound events. In general, risk assessment studies for flood characteristics rarely consider underlying drivers and changes in the dependencies between them, and in many cases, this leads to underestimation of the actual risk. The present study investigated and quantified how the preconditioning of precipitation extremes (P) by existing soil moisture (SM) anomalies can lead to significant flood risk. A novel event coincidence analysis (ECA) was employed to investigate the coupling nature between SM & P event series. The datasets used include GLDAS-2.2 CLSM model products for soil moisture and GPM IMERG V06 for gridded rainfall data. The overarching goal of the research was to identify hotspots for SM-P coupling over India and its emerging changing pattern over the period 2004 to 2020. In addition, the widely proposed hypothesis that higher SM anomalies can trigger P extremes over transitional zones was also investigated. The high precursor coincidence rates (more than 60%) obtained for traditionally flash flood-prone areas in India point to our approach's robustness. The values obtained for trigger coincidence rates gives vital insights to the multi-annual forecasting problem of flash floods over India. The seasonal variations in precursor and trigger coincidence rates are a perfect match to the ones expected due to changing atmospheric circulation patterns.

Keywords : compound event, SM-P coupling, flood hotspots, future flood risk, ECA

Min-Gyu Seong

Pohang University of Science and Technology (POSTECH)

Greenhouse gas and aerosol contributions to the observed global and regional changes in extreme temperature during 1951–2015

PA_S1_3 »

Greenhouse gas and aerosol contributions to the observed global and regional changes in extreme temperature during 1951–2015

Min-Gyu Seong[1], Seung-Ki Min[1], Yeon-Hee Kim[1], Xuebin Zhang[2], and Ying Sun[3, 4]

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This study carried out an updated detection and attribution analysis of extreme temperature changes for 1951–2015. Annual maximum daily maximum/minimum temperatures (warm extremes) and annual minimum daily maximum/minimum temperatures (cold extremes) were used considering global, continental (6 domains), and subcontinental (33 domains) scales. HadEX3 observations were compared with CMIP6 multi-model simulations using an optimal fingerprinting technique. Response patterns of extreme indices (fingerprints) to anthropogenic (ANT), greenhouse gas (GHG), anthropogenic aerosol (AA), and natural (NAT) forcings were estimated from corresponding CMIP6 forced simulations. Pre-industrial control simulations (CTL) were also used to estimate the internal variability. Results from two-signal detection analysis where the observations are simultaneously regressed onto ANT and NAT fingerprints reveal that ANT signals are robustly detected in separation from NAT in global and most continental regions for all extreme indices. At subcontinental scale, ANT detection occurs especially in warm extremes (more than 60% of regions). Results from three-signal detection analysis where observations are simultaneously regressed onto GHG, AA, and NAT fingerprints show that GHG signals are detected and separated from other external forcings over global, most continental, and several subcontinental (more than 60%) domains in warm extremes. In addition, AA influences are jointly detected in warm extremes over global, Europe and Asia. The detected GHG forcings are found to explain most of the observed warming while AA forcings contribute to the observed cooling for the early decades over globe, Europe, and Asia with a slight warming over Europe during recent decades. Overall, improved detection occurs compared to previous studies.

Claudia Gessner

ETH Zurich

Multi-year drought storylines for Europe and North America

PA_S2_1 »

Multi-year drought storylines for western Europe and central North America

Claudia Gessner[1], Erich Fischer[1], Urs Beyerle[1], Reto Knutti[1]

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During the last decades, Europe and North America have experienced intense dry and hot spells, which seriously impact socio-economic sectors and the ecosystem. To implement adaptation strategies for such a natural hazard, scientists and stakeholders raise the questions, how dry a worst-case drought would turn out and how long it would take to fully recover from those climate anomalies?

We address these concerns by generating storylines of the driest plausible multi-year droughts over western Europe and central North America. Precipitation is inhibited and soils are dehydrated by resampling the storyline using large ensembles. These storylines and a millennial control simulation are carried out with CESM1 under pre-industrial forcing. In doing so, local precipitation is reduced by 80% and soil moisture falls far below the 1st percentile, which is even a rare event compared to the RCP8.5 future climate scenario at the end of the 21st century, i.e. we describe a hazardous but unlikely scenario. Moreover, these storylines are associated with the hottest spring, summer and fall, but also the coldest seasons. Starting large ensembles from the initially exceptional dehydrated soils, we find that soil moisture takes more than one year to recover. After 19 months, the soil moisture is recovered in the winter months for the first time. However, soil moisture is still below average, and the chance of hot and dry spells is increased in each spring and summer season after the dry initialization. This aggravates the damage through water deficits for the vegetation growth and the economy.

Qiyun Ma

University of Hamburg

Changes in the maintenance mechanisms of heat waves over inner East Asia over the last few decades

PA_S2_2 »

Changes in the Maintenance Mechanisms of Heat Waves over Inner East Asia over the last few Decades

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Heat waves constitute a weather risk to vulnerable groups, agriculture and the economy. Over the last few decades high-pressure anomalies have intensified over inner East Asia, which are linked to more frequent and persistent heat waves. However, the impacts of anthropogenic global warming on the maintenance mechanisms involved in the changes in atmospheric circulation during heat waves remains unclear. Here we provide evidence for a significant intensification of anticyclonic systems over inner East Asia within a strengthened Silk Road pattern over the last 3 decades. To investigate the changes in maintenance mechanisms, we use the Japanese reanalysis data set (JRA-55) and a nonlinear stationary wave model. We find that heat waves have become more persistent over the last few decades. Model simulations indicate that transient momentum fluxes are the dominated factors of the observational anomalous stationary waves, especially the transient vorticity flux. Our results reveal that recent climate warming has altered the maintenance mechanisms mainly through the nonlinear interactions between different forcing components. Particularly, diabatic heating becomes more dominant via its nonlinear interactions with orography and transient momentum fluxes. Diabatic heating anomalies over the mid-latitude Pacific, the tropical Indian Ocean, and the tropical western Pacific region contribute to the changes of circulations over inner East Asia under a warmer climate.

Salauddin Mohammad

Academia Sinica

A cloud model study of internal gravity wave breaking atop a high shear supercell in US High Plains

PA_S2_3 »

A cloud model study of internal gravity wave breaking atop a high shear supercell in US High Plains

Salauddin Mohammad[1], Pao K. Wang*[1,2,3,4] and Yen-Liang Chou[1]

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Thunderstorms play an important role in the upward transport of momentum, energy and trace chemical species from the surface to upper levels of the atmosphere, however, the mechanism of transporting trace species from the troposphere to the stratosphere is less understood. In this paper we analyzed the dynamics of gravity waves near the top of a simulated storm and showed that the breaking of internal gravity waves excited by the deep convection at the storm top level can transport trace species such as water substance to cross the tropopause. Very high intensity gravity waves are generated with significant amplitudes during the convective storm at the storm top level. Amplitudes decreased at breakdown region ~ 12 km where critical layer is formed and regained its intensity after wave breaking. The vertical wavelengths also started decreasing at about 12 km where the breakdown region is observed. Turbulence is generated after breaking down of these waves with enhanced wind shear instabilities at upper troposphere and secondary waves with shorter horizontal wavelengths are also observed afterward. Wind speed matched quite well with the wave speed at critical levels when the breaking occurs. The signatures of transport of water vapor are clearly seen above tropopause and reach as high as ~ 15 km.

Wan-Ling Tseng

Academia Sinica

Extreme events in summer 2018

PA_S2_5 »

Compound effect of SST on the 2018 unusual WNP summer monsoon and heat waves in the extratropical northern hemisphere

Wang-Ling Tseng[1], Chi-Cherng Hong[2], Ming-Ying Lee[3], Huang-Hsiung Hsu[1], and Chi-Chun Chang[2]

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In the western North Pacific (WNP) during July and August (JA) 2018, the monsoon trough was unusually strong and the anticyclonic ridge was anomalously northward-shifted, along with enhanced and northward-shifted tropical cyclone activity. Meanwhile, record-breaking surface temperatures, which caused numerous deaths, were observed in several cities along with the northern extratropics. The 2018 heat waves exhibited a circumglobal characteristic owing to a circumpolar perturbation (CCP) in the middle-upper troposphere of the Northern Hemisphere (NH). This study focus on the two part of extreme events in 2018: 1) Previous studies proposed the influences of sea surface temperature anomaly (SSTa) in the North Atlantic, the Indian Ocean, and the tropical North Pacific as driving mechanisms of unusually strong monsoon trough. In this study, we proposed that the local effect of both tropical and extra-tropical WNP SSTa as the major driver and the remote effect of NA SSTa as a minor contributor jointly induced the anomalous circulation and climate extremes in the WNP during JA 2018. 2) The CCP had two parts: a wave-like perturbation and a hemispheric perturbation that was almost zonally symmetric. Both observational analysis and numerical experiments confirmed that the zonally symmetric component was primarily resulted from the SSTA associated with the warming trend, whereas the interannually-varying SSTAs in the NH contributed mostly to the wave-like perturbation. The warming trend component of SSTA was hypothesized to have contributed to inducing the circumpolar circulation anomaly that caused the record-breaking heat waves in the extratropical NH in 2018.

Keywords: Heat wave, Circumpolar perturbation, SST warming trend, enhanced monsoon trough, northward-shifted subtropical high

Manish Joshi

Indian Institute of Tropical Meteorology

Hot Extrems over Inida and their Driving Mechanisms

PA_S2_6 »

HOT EXTREMES OVER INDIA AND THEIR DRIVING MECHANISMS

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In the present study, an attempt has been made to diagnose the change in the characteristics of hot extremes over India before and after the 1976 climate shift. Results provide compelling evidence that large parts of India, except the Indo-Gangetic plains, have experienced more occurrences of hot days having higher temperatures in the recent decades, compared to the past, suggesting a shift in climate. Strong positive mid-tropospheric geopotential height anomalies over the northern parts of India that dynamically produces subsidence and clear sky conditions along with reduced precipitable water and depleted soil moisture are identified to be the crucial factors responsible for an increase of hot extremes in recent decades. Moreover, the preceding December-February Niño-3.4 sea surface temperature (SST) anomalies are strongly connected with hot days frequency and the mechanism for the lag of several months is allied to 3-4 months delayed response of Indian Ocean SSTs to El Niño/Southern Oscillation. Thus, post-Niño hot extremes over India can be potentially anticipated in advance and this will help society to prepare for such extremes.

Chao-An Chen

Academia Sinica

Extreme Precipitation Change in East Asian Spring and Mei-yu Seasons in Global Warming Simulations from High-Resolution AGCMs

PA_S2_7 »

Extreme Precipitation Change in East Asian Spring and Mei-yu Seasons in Global Warming Simulations from High-Resolution AGCMs

Chao-An Chen[1], Huang-Hsiung Hsu[1], Hsin-Chien Liang1, Ping-Gin Chiu[2], and Chia-Ying Tu[1]

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We examined extreme precipitation changes in East Asia during the spring and Mei-yu seasons under global warming based on two sets of high-resolution simulations with various warming patterns of sea surface temperature changes (spa). Precipitation changes in the spring season reveal a northward extension with larger enhancements of extreme precipitation over the northern flank of the prevailing rainy region, a shifting tendency of more frequent extreme precipitation events, and a northward enhancement in the probability distribution. Enhanced precipitation intensity in conjunction with decreased rainfall frequency and prolonged consecutive dry days result in a slight change in mean precipitation, implying a more difficult water resource management in the warmer climate. These findings are robust compared with the internal variability related to initial conditions and the uncertainty caused by spa. In the Mei-yu season, intensified extreme precipitation with more frequent and heavier extreme events exist in the prevailing rainband region. The thermodynamic component of moisture flux predominantly contributes to changes in the spring season. In the Mei-yu season, both the thermodynamic and dynamic components of moisture flux contribute to the enhanced moisture transport and intensify the extreme precipitation from southern China to northeast Asia. The higher uncertainty of Mei-yu precipitation change is suggested to be associated with the larger variability embedded in the projection of extreme precipitation and the model mean-state that determines the spatial distribution of precipitation enhancement.

Byeong-Hee Kim

Pohang University of Science and Technology (POSTECH)

NMME-based assessment of the prediction skill of spring precipitation over East Asia and associated oceanic conditions

PA_S2_8 »

NMME-based assessment of the prediction skill of spring precipitation over East Asia and associated oceanic conditions

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The skillful prediction of extreme precipitation is important to mitigate social and economic damage, but the current seasonal prediction skill of climate models remains limited. This study aims to evaluate the prediction skill of springtime precipitation over East Asia (EA) in NMME models and understand the role of sea surface temperature (SST) anomalies in predicting EA precipitation during extremely wet and dry springs. Results show that most of NMME models have the limited prediction skill of EA springtime precipitation despite the skillful seasonal prediction skill of SST anomalies over the Indian Ocean (IO) and NINO3 regions. The observational data show that these oceanic regions are strongly associated with interannual variability of EA springtime precipitation. In order to understand the roles of SST anomalies over the IO and NINO3 regions in improving the prediction skills of EA precipitation, forecasted SST anomalies in extremely dry and wet springs were projected on the observed bivariate linear regression coefficient for IO and NINO3. Seasonal predictions of the bivariate linear regression prediction model show improved prediction skill of EA precipitation through the observed relationship with SST anomalies with skillful SST forecasts, but the prediction skill of EA springtime precipitation was limited over extremely dry and wet regions. The results of this study suggest that a better representation of air-sea interactions in NMME climate models is warranted for the robust prediction of EA springtime precipitation.

Laxmikant Dhage

University of Hawaii at Manoa

Assessment of 21st century changing sea surface temperature, rainfall, and sea level patterns in the tropical Pacific Islands using CMIP6 greenhouse warming projections

PA_S3_1 »

Assessment of 21st century changing sea surface temperature, rainfall, and sea level patterns in the tropical Pacific Islands using CMIP6 greenhouse warming projections

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Tropical Pacific Islands are influenced by climate features that are already responding to increased greenhouse gas emissions. Continued warming is projected to cause further changes to the annual cycle and interannual variability of sea surface temperature (SST), rainfall, and sea level. Prior assessments of greenhouse warming projections using coupled ocean-atmosphere climate models showed that increased rainfall is likely near the equator, although there is uncertainty about the future rainfall away from the equator, including around numerous island regions. The rainfall changes are associated with the mean warming of the ocean, as well as interannual changes in SST variability that is associated with the El Niño-Southern Oscillation. Future sea level variability is also projected to increase for most of the tropical Pacific, although regional uncertainties were large in previous-generation climate models. Here, we assess the Coupled Model Intercomparison Project (CMIP6) as it relates to future changes of SST, rainfall, and sea level in the tropical Pacific, with focus on the island regions of American Samoa, Guam, and Hawaii. In preparation for the IPCC Sixth Assessment Report (AR6), the latest-generation climate models were prescribed with future radiative forcing scenarios determined by a partnership of Shared Socioeconomic Pathways (SSPs) with Representative Concentration Pathways (RCPs) of greenhouse gases. We assess both a middle-of-the-road and a fossil-fueled development narrative of the 21st century (i.e., the SSP2-RCP4.5 and SSP5-RCP8.5 experiments, respectively) to describe climate changes that are likely for either 1 or 2 ° C of future warming in the tropical Pacific. Our future climate assessment is of relevance to efforts in the tropical Pacific Islands to adapt to a warmer climate with potentially enhanced stress on their water resources due to changes in rainfall and sea level.

Chapter

Program 3,
26 October 2021

Session 4 (A)
Session 5 (A)
Poster Session (B)

PROGRAM 3, 26 October 2021

TIME (start)			TIME (end)		Presentation			
GMT	KST		GMT	KST	Code	Name	Organization	Title
0:00	9:00	–	0:45	9:45	Session 4 (A). Prediction and predictability of large-scale climate variability relevant to extreme events			
0:00	9:00	–	0:15	9:15	S4_1	Takeshi Doi	JAMSTEC/Japan	Wintertime impacts of the 2019 super IOD on East Asia
0:15	9:15	–	0:30	9:30	S4_2	Pang-Chi Hsu	Nanjing University of Information Science & Technology	Sources of subseasonal prediction skill for heatwaves over the Yangtze River Basin revealed from three S2S models
0:30	9:30	–	0:45	9:45	S4_3	Yukiko Imada	Japan Meteorological Agency	Long-term potential predictability of regional extreme events in East Asia estimated from a high- resolution large ensemble
0:45	9:45	–	0:55	9:55	Break			
0:55	9:55	–	2:10	11:10	Session 5 (A). Prediction and predictability of specific extreme events (>10 days)			
0:55	9:55	–	1:10	10:10	S5_1	Hera Kim	Seoul National University	Advances in the subseasonal prediction of extreme events
1:10	10:10	–	1:25	10:25	S5_2	Tzu-Ting Lo	Central Weather Bureau	Monitoring Global Tropical Cyclone Activities in Weeks 1-4
1:25	10:25	–	1:40	10:40	S5_3	Daehyun Kim	University of Washington	Dynamical forecast-machine learning hybrid system for lightning prediction
1:40	10:40	–	1:55	10:55	S5_4	Elisabeth Vogel	Australian Bureau of Meteorology	Seasonal hydrological ensemble forecasts for Australia-prediction of hydrological extremes
1:55	10:55	–	2:10	11:10	S5_5	Wayne Yuan-Huai Tsai	National Taiwan University	Subseasonal forecasts of the northern Queensland floods of February 2019: Causes and forecast evaluation
2:10	11:10	–	2:20	11:20	Break			
2:20	11:20	–	3:00	12:00	Poster Session (B) : Brief introduction of the posters: Session 4, Session 5, Session 6			
2:20	11:20	–	2:22	11:22	PB_S4_1	Erin Towler	National Center for Atmospheric Research (NCAR)	Investigating the Predictability of Connected Extremes
2:22	11:22	–	2:24	11:24	PB_S4_2	Takahito Kataoka	JAMSTEC/Japan	Seasonal to decadal predictions with MIROC6
2:24	11:24	–	2:26	11:26	PB_S4_3	Matthew Widlansky	University of Hawaii at Manoa	Improved ocean seasonal forecasts using altimetry (sea surface height) data assimilation
2:26	11:26	–	2:28	11:28	PB_S4_4	Chalachew Kindie Mengist	Pusan National University	Potential Predictability of the MJO during Easterly and Westerly Phases of the QBO
2:28	11:28	–	2:30	11:30	PB_S5_1	Seoleun Shin	Chonnam National University	The predictive skill of neural network models for Lorenz-6 systems in an ensemble framework
2:30	11:30	–	2:32	11:32	PB_S5_2	Marcelino Villafuerte	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Evaluation of the NCEP 16-day ensemble forecast system for predicting tropical cyclone activity in the Philippines
2:32	11:32	–	2:34	11:34	PB_S5_3	Hui-Ling Chang	Central Weather Bureau	Week 2-3 probabilistic forecasts of extreme precipitation events over Taiwan using Analog Post-processing
2:34	11:34	–	2:36	11:36	PB_S5_4	Eun-Pa Lim	Australian Bureau of Meteorology	Why was Australia not wet in spring 2020 despite La Nina?
2:36	11:36	–	2:38	11:38	PB_S6_1	Jacob Pastor-Paz	GNS Science	Property risk from extreme precipitation, floods and climate change
3:00	12:00	–	3:30	12:30	Breakout session for posters (extra 30-min breakout session for poster presentation)			

PROGRAM 3,
26 October 2021

Session 4 (A).

Prediction and predictability of large-scale climate variability relevant to extreme events

Takeshi Doi

JAMSTEC/Japan

Wintertime impacts of the 2019 super IOD on East Asia

S4_1

Wintertime impacts of the 2019 super IOD on East Asia

Takeshi Doi[1], Swadhin K. Behera[1], and Toshio Yamagata[1,2]

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Many parts of East Asia, including Japan, experienced extremely warm conditions during the 2019□2020 winter. These were successfully predicted in October of 2019 by the 108-member ensemble seasonal prediction system based on the SINTEX-F climate model. By analyzing co-variability of inter-member anomalies defined as deviations from the ensemble mean, we have found that the active convection over the western pole of the Indian Ocean Dipole caused these unusual conditions over East Asia by generating the meander of the subtropical jet. The contents are related to "(4) Prediction and predictability of large-scale climate variability relevant to extreme events".

Pang-Chi Hsu

Nanjing University of Information Science & Technology

Sources of subseasonal prediction skill for heatwaves over the Yangtze River Basin revealed from three S2S models

S4_2

Sources of subseasonal prediction skill for heatwaves over the Yangtze River Basin revealed from three S2S models

Pang-Chi Hsu, Jiehong Xie, Jinhua Yu, and Haishan Chen

Key Laboratory of Meteorological Disaster of Ministry of Education/Joint International Research Laboratory of Climate and Environment Change/Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Nanjing University of Information Science & Technology, Nanjing, China

Based on the reforecast data (1999-2010) of three operational models [the China Meteorological Administration (CMA), the National Centers for Environmental Prediction of the U.S. (NCEP) and the European Centre for Medium-Range Weather Forecasts (ECMWF)] that participated in the Subseasonal to Seasonal Prediction (S2S) project, we identified the major sources of subseasonal prediction skill for heatwaves over the Yangtze River Basin (YRB). The three models show limited prediction skills in terms of the fraction of correct predictions for heatwave days in summer; the Heidke Skill Score drops quickly after a 5-day forecast lead and falls down close to zero beyond the lead time of 15 days. The superior skill of the ECMWF model in predicting the intensity and duration of the YRB heatwave is attributable to its fidelity in capturing the phase evolution and amplitude of high-pressure anomalies associated with the intraseasonal oscillation and the dryness of soil moisture induced by less precipitation via the land-atmosphere coupling. The effects of 10-30-day and 30-90-day circulation prediction skills on heatwave predictions are comparable at shorter forecast leads (10 days), while the biases in 30□90-day circulation amplitude prediction show close connection with the degradation of heatwave prediction skill at longer forecast leads (> 15-20 days). The biases of intraseasonal circulation anomalies further affect precipitation anomalies and thus land conditions, causing difficulty in capturing extremely hot days and their persistence in the S2S models.

Yukiko Imada

Japan Meteorological Agency

Long-term potential predictability of regional extreme events in East Asia estimated from a high-resolution large ensemble

S4_3

Long-term potential predictability of regional extreme events in East Asia estimated from a high-resolution large ensemble

Yukiko Imada, Hiroaki Kawase

Japan Meteorological Agency

Compared to the high predictability of seasonal forecasts in the tropics, predictability in the mid- and high- latitudes is low due to the high atmospheric noise and low signal-to-noise ratio. Large ensemble prediction is one solution to reduce noise by taking the ensemble average. Despite the enormous computational cost issues, a large ensemble is also a powerful tool for capturing rare extreme weather and climate events.

Here, we will present our recent studies using high-resolution large ensemble simulations, so-called d4PDF (database for Policy Decision making for Future climate change), focusing on the potential predictability of extreme event probability. The large ensemble simulations were carried out by the global atmospheric general circulation model with a horizontal resolution of 60 km and the regional climate model around East Asia with a horizontal resolution of 20 km, which were prescribed by the observed SST. The dataset covers more than 6000 years (100 members from 1951 to the present). Using this dataset, we confirmed that a large ensemble improves temporal anomaly correlation skills over land at the mid-latitudes. Furthermore, the high-resolution 20-km runs can reproduce local heavy rainfall affected by fine topography and mesoscale rainfall systems. By combining global and regional simulations, we found that large-scale slow tropical ocean variability affects the frequency of local heavy rainfall, and local terrain sometimes helps to reduce atmospheric noises, resulting in higher potential predictability of rainfall in some areas in East Asia.

PROGRAM 3,
26 October 2021

Session 5 (A).

Prediction and predictability of specific extreme events (>10 days)

Hera Kim

Seoul National University

Advances in the subseasonal prediction of extreme events

S5_1

Advances in the subseasonal prediction of extreme events

Hera Kim[1], Seok-Woo Son[1], Daniela I.V. Domeisen[2], Christopher J. White[3], Hilla Afargan-Gerstman[2], Ángel G. Muñoz[4], Matthew A. Janiga5, Frédéric Vitart6, C. Ole Wulff2, Salomé Antoine[7], Constantin Ardilouze[7], Lauriane Batté[7], Hannah C. Bloomfield[8], David Brayshaw[8], Suzana J. Camargo[9], Andrew Charlton-Pérez[8], Dan Collins[10], Tim Cowan[11,12], Maria del Mar Chaves[13], Laura Ferranti[6], Rosario Gómez[14], Paula L.M. González[4,8,15], Carmen González Romero[4], Johnna M. Infanti[10,16], Stelios Karozis[17], Erik W. Kolstad[18], Emerson LaJoie[10], Llorenç Lledó19, Linus Magnusson6, Piero Malguzzi[20], Andrea Manrique-Suñén[19], Daniele Mastrangelo[20], Stefano Materia[13], Hanoi Medina[21], Lluís Palma[19], Luis E. Pineda[22], Athanasios Sfetsos[17], Albert Soret[19], Sarah Strazzo23, and Di Tian[21]

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*The list of affiliations continues below the abstract.

Extreme weather events are challenging to predict, in spite of high demands on the predictability due to their devastating impacts on human health, economic activities, ecosystems, and infrastructure. It is expected that improvement in prediction of extremes and their impacts would allow for preparedness and emergency measures. This study evaluates the subseasonal predictability of some of the most severe extreme events in the past, using the S2S hindcast data particularly from the ECMWF model. The analyses focus on the temperature extremes including heat waves and cold surges, precipitation extremes, and cyclone events including 3 tropical cyclones and a medicane. It turns out that, in a probabilistic sense, there is possibility to predict such extreme weather events several weeks ahead by utilizing the ensemble forecasts. Probability distribution functions of ECMWF ensemble results show that the model has probabilistic predictability of 3-4 weeks for the historical heatwave events and 2-3 weeks for the cold surge events. For the tropical cyclones, the model has a probabilistic forecast skill of 3 weeks, while the medicane case seems more difficult to predict. Correlation-based skills show that the precipitation extremes are the most difficult to predict among the extreme weathers considered. The results imply that there is an event dependency in the time range where an alert for extreme weather is possible.

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Tzu-Ting Lo

Central Weather Bureau

Monitoring Global Tropical Cyclone Activities in Weeks 1-4

S5_2

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Monitoring Global Tropical Cyclone Activities in Weeks 1-4

Tzu-Ting Lo, Meng-Shih Chen
Central Weather Bureau, Chinese Taipei

Hsiao-Chung Tsai
Tamkang University, Chinese Taipei

Marcelino Q. Villafuerte II
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Quezon City, Philippines

A tropical cyclone (TC) monitoring system for the prediction of global TC activities in weeks 1-2 has been developed at Central Weather Bureau (CWB) since 2008. TC tracks in the operational 21-member NCEP GEFS (Global Ensemble Forecast System) forecasts were objectively detected in near real-time (Tsai et al. 2011). Starting from the 2020 season, CWB has upgraded the TC tracking system (called CWB TC Tracker 2.0) by extending the forecast lead-time to week-4. In addition to using the real-time forecasts from the latest GEFS version 12 (GEFSv12; FV3-based), the CWB TC Tracker 2.0 provides the TC tracking results obtained from multiple global ensemble models, such as the NCEP CFSv2 (Climate Forecast System version 2) and the ECMWF monthly forecasting system (ECMFS). In the next stage, the CWB 1-tier climate forecast model will also be added. The CWB TC Tracker 2.0 has been utilized by the forecasters at CWB, NCEP CPC (Climate Prediction Center), and PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration) to monitor the extended-range TC formations and the subsequent tracks.

In this talk, the CWB TC Tracker 2.0 will be introduced. The skills of week 1-4 western North Pacific TC forecasts will also be evaluated using two long-term reforecast datasets: (1) NCEP GEFSv12 reforecasts and (2) ECMFS reforecasts. An objective TC tracking scheme is used to detect TC tracks in two reforecast datasets. Then the relationships between the TC strike probabilities and the large-scale environment (i.e., ENSO and MJO) in weeks 1-4 are investigated. After the model biases are identified using the reforecasts, the statistical post-processing techniques are applied to the real-time forecasts to improve the forecast reliability. A spatial-temporal track clustering technique is also developed to group similar member vortex tracks to assist in identifying the potential false alarms. Further details about the extended-range TC forecast applications and verifications will be presented in the meeting.

Key words: Tropical cyclone, extended-range forecast, ensemble model, reforecast dataset.

Daehyun Kim

University of Washington

A dynamical forecast-machine learning hybrid system for lightning prediction

S5_3

A dynamical forecast-machine learning hybrid system for lightning prediction

Wei-Yi Cheng, Daehyun Kim, Scott Henderson, and Robert H. Holzworth
University of Washington

Yoo-Geun Ham and Jeong-Hwan Kim
Chonnam National University

In this study, we evaluate the performance of a hybrid forecast system for lightning prediction, in which dynamical forecasts are used as inputs to various lightning parameterization schemes, including those based on machine learning (ML) algorithms. The dynamical hindcast is obtained from National Centers for Environmental Prediction (NCEP) Global Ensemble Forecast System (GEFS). In addition to a conventional parameterization scheme of Romps et al. (2014), we employ the column-based and map-based ML approaches. The prediction skill of f is evaluated over the Contiguous United States (CONUS). A particular focus is on assessing the extent to which the lightning prediction skill is improved by utilizing the ML-based lightning parameterization schemes.

The hybrid system shows useful (i.e., the anomaly correlation coefficient is greater than an arbitrarily chosen value 0.4) skill up to about a week and statistically significant lightning forecast skill beyond 10 days across the CONUS. Moreover, the hybrid system exhibits better performance when ML-based lightning schemes are used instead of the Romps et al. (2014) scheme: the lightning forecast skill is improved by up to 2 days in many parts of the CONUS, especially over regions and seasons with climatologically higher f. Among the ML-based lightning schemes, the column-based approach shows a better skill, as the performance of the map-based approach is likely limited by the data size.

Elisabeth Vogel

Australian Bureau of Meteorology

Seasonal hydrological ensemble forecasts for Australia–prediction of hydrological extremes

S5_4

Seasonal hydrological ensemble forecasts for Australia – prediction of hydrological extremes

Vogel, E., Lerat, J., Pipunic, R., Frost, A.J., Donnelly, C., Griffiths, M., Hudson, D., Loh, S.

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Hydrological extremes, such as droughts or floods, can have devastating effects on many aspects of human societies and the natural environment (IPCC, 2012). The use of seasonal forecasting information is one way to help adapt to and increase the resilience towards hydroclimatic variability and extremes by providing the opportunity to prepare for potentially harmful events and optimize decisions in advance. The ability to forecast hydrological variables several months ahead would support improved decision making in many sectors, including water management, agriculture, energy production, emergency services and infrastructure.

The Bureau of Meteorology has developed a high-resolution national seasonal ensemble forecasting system for soil moisture, evapotranspiration and runoff across Australia, using a gridded water balance model (AWRA-L) forced with downscaled and calibrated seasonal climate forecasts from the ACCESS-S1 system.

Here, we evaluate the hydrological forecasts relative to a historical reference simulation forced with observed climate inputs using hindcasts for the period 1990-2012. The forecasts were evaluated in terms of deterministic skill using the ensemble mean as well as probabilistically, assessing the accuracy and reliability of the forecast ensemble, with a specific focus on forecasts of hydrological extremes. Additionally, we assess the performance of the hindcast for selected use cases, particularly focusing on agriculture and water management, focusing on the Australian wheatbelt, the Murray Darling-Basin and critical urban and rural water supply catchments.

Overall, we conclude that the forecasting system shows sufficient skill for a wide range of applications and regions. We outline limitations of the presented system and highlight future research directions.

Wayne Yuan-Huai Tsai

National Taiwan University

Subseasonal forecasts of the northern Queensland floods of February 2019: Causes and forecast evaluation

S5_5

Subseasonal forecasts of the northern Queensland floods of February 2019: Causes and forecast evaluation

Wayne Yuan-Huai Tsai*, Mong-Ming Lu, Chung-Hsiung Sui, and Ying-Min Cho

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During the austral summer 2018/19, devastating floods occurred over northeast Australia that killed approximately 625,000 head of cattle and inundated over 3000 homes in Townsville. In this paper the disastrous event was identified as a record-breaking subseasonal peak rainfall event (SPRE). The SPRE was mainly induced by an anomalously strong monsoon depression that was modulated by the convective phases of a MJO and an equatorial Rossby (ER) wave. The ER wave was originated from active equatorial deep convection associated with the El Niño warm sea surface temperatures near the dateline over central Pacific. Based on the S2S Project Database, we analyzed the extended-range forecast skill of the SPRE from two different perspectives, the monsoon depression represented by an 850-hPa wind shear index and the 15-day accumulated precipitation characterized by the percentile rank (PR) and the ratio to the threemonth seasonal (DJF) totals. The results of four S2S models of this study suggest that for monsoon depression can maintain the same level of skill as the short-range (3 days) forecast up to 8-10 days. For precipitation parameters the conclusions are similar to the monsoon depression. For the 2019 northern Queensland SPRE, the model forecast was in general worse than the expectation derived from the hindcast analysis. The clear modulation of the ER wave that enhanced the SPRE monsoon depression circulation and precipitation is suspected as the main cause for the lower forecast skill. The analysis procedure proposed in this study can be applied to analyze the SPREs and their associated large-scale drivers in other regions. Keywords: S2S prediction, Australian summer monsoon, MJO, subseasonal peak rainfall event, extreme rainfall.

PROGRAM 3,
26 October 2021

Poster Session (B) >>

Brief introduction of the posters: Session 4, Session 5, Session 6

Erin Towler

National Center for Atmospheric Research (NCAR)

Investigating the Predictability of Connected Extremes

PB_S4_1 »

Investigating the Predictability of Connected Extremes

Erin Towler[1], James M. Done[1], Danielle Touma[2], Ming Ge[1], Daniel L. Swain[1,3,4] ,
Manuela I. Brunner[5], and Jennie Bukowski[2]

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Temporal clustering of wet and dry extremes can result in adverse societal impacts, such as flooding or prolonged droughts. In this study, we develop and demonstrate a framework to identify temporal clustering of extremes and investigate their predictability. The framework is applied to a dataset of historical extreme wet and extreme dry events that we developed for the United States (US). First, temporal clustering of extremes is identified using several metrics, including Ripley's K and dispersion. Further, each extreme event is assigned to a synoptic weather pattern category. Finally, using empirical relationships and physical understanding, we investigate to what extent synoptic weather patterns can be used to predict the characteristics of temporal clustering. The framework is demonstrated using 99th percentile precipitation events for large watersheds across the US. This study is part of the COEXIST (COnnected EXtremes In Space and Time) project, with the goal of mitigating adverse societal impacts of US floods and droughts through understanding how extreme meteorological events are connected and how these connections might yield more accurate forecasts.

Takahito Kataoka

JAMSTEC/Japan

Seasonal to decadal predictions with MIROC6

PB_S4_2 »

Seasonal to decadal predictions with MIROC6

Takahito Kataoka

JAMSTEC/Japan

The present paper presents results of seasonal-to-decadal climate predictions based on a coupled climate model called the Model for Interdisciplinary Research on Climate version 6 (MIROC6) contributing to the Coupled Model Intercomparison Project Phase 6 (CMIP6). MIROC6 is initialized every year for 1960-2018 by assimilating observed ocean temperature and salinity anomalies and full-fields of sea-ice concentration, and by prescribing atmospheric initial states from reanalysis data. The impacts of updating the system on prediction skill are then evaluated by comparing hindcast experiments between the MIROC6 prediction system and a previous system based on MIROC version 5 (MIROC5).

Skill of seasonal prediction is overall improved in association with representation and initialization of El Niño/Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO), and the Northern hemisphere sea-ice concentration in MIROC6. In particular, the QBO is skillfully predicted up to 3 years ahead with a maximum anomaly correlation exceeding r=0.8. The prediction skill for the North Atlantic Oscillation in winter is also enhanced, but the prediction still suffers from model's inherent errors. On decadal timescales, MIROC6 has a larger fraction of areas of the globe with better surface temperature skill at all lead times than MIROC5, and it has predictive skill in the annual-mean sea surface temperature (SST) in the North Atlantic and the Pacific. In particular, MIROC6 hindcasts at 2-5 years lead time are able to capture the spatial structure of SST changes in the North Pacific and the eastern tropical Pacific associated with the 1970s regime shift better than MIROC5 hindcasts.

Matthew Widlansky

University of Hawaii at Manoa

Improved ocean seasonal forecasts using altimetry (sea surface height) data assimilation

PB_S4_3 »

Improved ocean seasonal forecasts using altimetry (sea surface height) data assimilation

Matthew J. Widlansky, Xiaoyu Long, and others (to be confirmed)

University of Hawaii at Manoa

Satellite altimetry measurements of sea surface height provide ocean state observations that are not yet commonly utilized by seasonal forecasting systems. Altimetry observations are available in near-real time globally at spatial resolutions comparable to the best coupled ocean-atmosphere climate models (~1/4-degree latitude-longitude); and, the data is continuous on sub-monthly time sales for almost three decades. As early as the mid-1990s, successful attempts were made assimilating altimetry data into coupled climate models. These experiments demonstrated improved ocean forecasting skill, especially compared to experiments that did not assimilate any information about the subsurface ocean density structure (defined by depth profiles of temperature and salinity). Yet, most operational seasonal forecasting models still do not utilize altimetry in their assimilation systems, although there are notable exceptions. Recently, Australia's Bureau of Meteorology completed retrospective seasonal forecasts with the ACCESS-S2 model, which does not use altimetry observations; however, the previous-generation model (ACCESS-S1) did assimilate altimetry (both models assimilate other observations of the subsurface ocean). Here, we will compare the ocean forecasting skill during the overlapping retrospective epoch of ACCESS-S1 and -S2 (1993-2012). We will show that assimilating altimetry not only improves seasonal forecasts of sea level variability, especially outside of the tropics, but also may contribute to more skillful forecasts of sea surface temperature in places and times where ocean memory processes are important. We will also discuss potential opportunities for using sea level information to constrain ensemble spread, which may help to improve forecasts of El Niño-Southern Oscillation and other extreme conditions.

Keywords : Sea level variability, sea surface temperature, ocean heat content, ensemble spread, El Niño-Southern Oscillation

Chalachew Kindie Mengist

Pusan National University

Potential Predictability of the MJO during Easterly and Westerly Phases of the QBO

PB_S4_4 »

Potential Predictability of the MJO during Easterly and Westerly Phases of the QBO

Chalachew Kindie Mengist[1,2], Kyong-Hwan Seo[1,2,3*], Ruiqiang Ding[4], and Seok-Woo Son[5]

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The potential predictability of the Madden-Julian Oscillation (MJO) under the easterly and westerly phases of the Quasi-Biennial Oscillation (easterly: EQBO and westerly: WQBO) in boreal winter (November-February) is investigated using observational data. Nonlinear local Lyapunov exponents are computed for various MJO indices to quantify the MJO predictability. The results show that all MJO indices exhibit higher predictability during EQBO winters than during WQBO winters. The highest potential predictability of 43 days during EQBO winters and 37 days during WQBO winters is found for the MJO index obtained from bandpass-filtered (30–80 days) outgoing longwave radiation, 850-hPa zonal wind, and 200-hPa zonal wind data. Whereas, the potential predictability of the MJO from the real-time multivariate MJO index is 21 days during EQBO winters and 13 days during WQBO winters. Moreover, excluding strong ENSO years from EQBO and WQBO winters has a limited impact on the MJO predictability. The longer persistence and less disorganization of the MJO during the EQBO winters lead to the higher predictability for EQBO winters, as compared with that for WQBO winters.

Seoleun Shin

Chonnam National University

The predictive skill of neural network models for Lorenz-6 systems in an ensemble framework

PB_S5_1 »

The predictive skill of neural network models for Lorenz-6 systems in an ensemble framework

Seoleun Shin

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The predictive skill of a neural network model for the prediction of the highly investigated. We train neural networks with pairs of largest-scale variable and its tendency generated by numerical integrations of full-level Lorenz '96 equations. Neural network models are then used to produce the tendency given state and its predictive skill is evaluated in an ensemble framework. We also apply ensemble data assimilation to the background states produced by each modeling method. It has been found that neural network models are competitive when the dynamical system shows slow or quasi-oscillatory behaviors. However, the ensemble of neural network (NN) predictions lacks spread in representing the uncertainties of rapidly changing dynamical states and thus, the correction through data assimilation is limited in comparison with that made in the test using numerical solver. To improve the ability of NN models in capturing diverse transitions within an attractor, we examine some of ensemble approaches for the generation of neural networks. Most effective way could be found more in the training strategy rather than composite of neural networks.

Marcelino Villafuerte

Philippine Atmospheric, Geophysical and Astronomical Services Administration

Evaluation of the NCEP 16-day ensemble forecast system for predicting tropical cyclone activity in the Philippines

PB_S5_2 »

Evaluation of the NCEP 16-day ensemble forecast system for predicting tropical cyclone activity in the Philippines

Marcelino Q. Villafuerte II[1*], Tzu-Ting Lo[2], Hsiao-Chung Tsai[3], and Esperanza O. Cayanan[1]

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We investigated the potential predictability of tropical cyclone (TC) occurrence in the Philippine Area of Responsibility (PAR) on weekly timescales using the NCEP 16-day Global Ensemble Forecast System (NCEP-GEFS). An algorithm that uses information on selected dynamic and thermodynamic criteria was utilized to detect and track TC-like vortices (TCLV) from the 6-hourly NCEP-GEFS model runs covering the period from 1 January to 31 December in 2015 and 2017. A 2×2 contingency table was used to summarize the event forecast relative to the observed TC occurrence and subsequent tracks over the PAR on weekly timescales. A forecast hit is declared if there is at least 50% overlap between the polygons created from the drawn circles with 500 km radius centered at the identified forecast TCLV center and the observed TC track. The hindcast period covering the evaluation of NCEP-GEFS indicate a hit-rate of 0.49 and 0.19 for the 1- and 2-week TC forecasts, respectively in the PAR. It is also revealed that the stronger the TC and the farther it developed to the eastern boundary of the PAR, which typically occur during El Niño (as in the 2015 case), the higher chance it could be forecasted one week ahead of time. Furthermore, better TC predictability in the PAR is achieved when the Madden-Julian Oscillation's active convection phase is located over Africa and the western Indian Ocean (Phase 1) for the Week-1 forecast period and over the Maritime Continent (Phase 5) for the Week-2 forecast period.

Keywords: extended-range tropical cyclone forecasts, ENSO, MJO, the Philippines

Hui-Ling Chang

Central Weather Bureau

Week 2-3 probabilistic forecasts of extreme precipitation events over Taiwan using Analog Post-processing

PB_S5_3 »

Week 2-3 probabilistic forecasts of extreme precipitation events over Taiwan using Analog Post-processing

Hui-Ling Chang

Central Weather Bureau

The predictability of precipitation is limited due to the important role finer-scale processes play. However, demand for extended-range (10-to-30 days) precipitation forecasts by users in agriculture and water resource management has grown significantly, especially for extreme events. Therefore, the goal of this study is to predict the conditional climatology of precipitation given the forecast of the large-scale circulation conditions, which still retain predictability in the extended range.

In this study, we focus on week 2-3 extreme precipitation forecasts over Taiwan. Most ensemble prediction systems are characterized by under-dispersion that limits the utility of predictions for extreme events. Here we use Analog Post-processing (AP) to produce posterior ensembles with reasonable spread to effectively mitigate the problem of under-dispersion. The AP forecast ensembles are derived from the observed high-resolution precipitation patterns corresponding to the historical forecast analogs that most resemble the current precipitation forecast. Frequency counting is then applied to the AP ensembles to produce well-calibrated and downscaled week 2-3 probabilistic precipitation forecasts.

Forecast evaluation confirms that the raw ensemble is under-dispersive with an obvious wet bias. In contrast, the AP ensemble distribution is well calibrated with most of the bias removed. Compared to the raw forecasts, the AP-based probabilistic forecasts have better reliability and higher skill in discrimination in the winter and Mei-yu seasons. Evaluation of potential economic value demonstrates that users with a much wider spectrum of cost/loss ratio can benefit from the calibrated forecasts as compared to the raw forecast, with a significantly higher gain in decision making.

Eun-Pa Lim

Australian Bureau of Meteorology

Why was Australia not wet in spring 2020 despite La Nina?

PB_S5_4 »

Why was Australia not wet in spring 2020 despite La Niña?

Eun-Pa Lim[1], Debra Hudson[1], Matthew C. Wheeler[1], Andrew Marshall1, Andrew King[2], Hongyan Zhu[1], Harry H. Hendon[1], Catherine de Burgh-Day[1], Blair Trewin1, Morwenna Griffiths[1], and Griffith Young[1]

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The austral spring climate of 2020 was characterised by the occurrence of La Niña. Consistent with the typical impacts of La Niña on Australian rainfall, the Bureau of Meteorology's dynamical sub-seasonal to seasonal forecast system, ACCESS-S1, made highly confident predictions for wetter-than-normal conditions over eastern Australia for spring when initialised in July 2020 and thereafter. However, many areas of eastern Australia received near average to very much below average rainfall, particularly during November. Possible causes of the deviation of rainfall from its historical response to La Niña and causes of the forecast error are explored using observational and reanalysis data for the period 1979-2020 and real-time forecasts of ACCESS-S1 initialised in July to November 2020.

Our results show that while the ocean surface to the north of Australia was warmer than normal, which would have acted to promote northern Australian rainfall, it was not as warm as expected from its historical relationship with La Niña and its long-term warming trend. Moreover, a negative phase of the Indian Ocean Dipole, which typically promotes spring rainfall in southern Australia, decayed earlier-than-normal in October. Finally, Madden-Julian Oscillation (MJO) activity over the equatorial Indian Ocean acted to suppress rainfall across northern and eastern Australia during November. Although ACCESS-S1 accurately predicted the strength of La Niña and its spatial characteristics, it over-predicted the ocean warming to the north of Australia and under-predicted the strength of the November MJO event, leading to an over-prediction of the Australian spring rainfall and especially the November rainfall.

Keywords: La Niña, local SSTs, MJO, teleconnection, seasonal forecasts

Jacob Pastor-Paz

GNS Science

Property risk from extreme precipitation, floods and climate change

PB_S6_1 »

Property risk from extreme precipitation, floods, and climate change

Jacob Pastor-Paz

GNS Science

Climate change is increasing the risk of floods, but few available flood maps incorporate this change in flood hazard probability, constraining the assessment of future risk. In this study, I use insurance claim data to quantify the risk of residential property flooding caused by extreme precipitation and climate change. Risk is defined as the likelihood of flood damage and the potential consequences (damage). Here the likelihood of property damage explicitly accounts for the intensity, duration, frequency, and spatial extent of extreme precipitation, with and without the effect of climate change, while controlling for other predictors of property damage. The potential consequences of flood hazard are measured by the properties' physical vulnerability (per cent damage) to varying flood depths. I first implement a multivariate logistic regression model to estimate the likelihood of damage with and without the effect of climate change. Then, I calculate the expected monetary losses by factoring in the likelihoods derived from the regression models, property replacement values, and a property's physical vulnerability to varying flood depth scenarios. I focus on a 2005 flood event in the region around New Zealand's Bay of Plenty, which received the highest number of insurance payouts from New Zealand's public insurer due to a weather-related event. I find that the highest monetary losses are associated with low-return periods, as expected. Nevertheless, high return periods (i.e., 2-year events) bring about sizeable losses. The likelihood of property damage resulting from climate-related changes in precipitation increases significantly, but the effect (climate change signal) is too small to cause an economically meaningful increase in risk levels. Public and private insurers can use this methodology to assess its current and future financial risk exposure to low-probability, high-impact weather-related events.

Key Words: flood risk, extreme precipitation, climate change

Chapter

Program 4,
26 October 2021

Session 4 (B)
Session 5 (B)
Poster Session (C)

PROGRAM 4, 26 October 2021

TIME (start)			TIME (end)		Presentation			
GMT	KST		GMT	KST	Code	Name	Organization	Title
10:00	19:00	–	11:00	20:00	Session 4 (B). Prediction and predictability of large-scale climate variability relevant to extreme events			
10:00	19:00	–	10:15	19:15	S4_5	Xiangbo Feng	University of Reading	How well does Met Office seasonal forecast system predict Western North Pacific Tropical Cyclones?
10:15	19:15	–	10:30	19:30	S4_6	Ankur Gupta	NCMRWF, MoES, India	Predictability of the Indian Summer Monsoon and representation of associated teleconnections in NCMRWF coupled modelz
10:30	19:30	–	10:45	19:45	S4_7	Leon Hermanson	Met Office, UK	Applying the WMO Annual to Decadal Multi-Model Ensemble to Predicting Climate Hazards and Extremes
10:45	19:45	–	11:00	20:00	S4_8	Daniel Krieger	Helmholtz-Zentrum Hereon	Decadal Predictability of German Bight Storm Activity
11:00	20:00	–	11:10	20:10	Break			
11:10	20:10	–	12:10	21:10	Session 5 (B). Prediction and predictability of specific extreme events (>10 days)			
11:10	20:10	–	11:25	20:25	S5_6	Thea Turkington	Meteorological Service Singapore	S2S prediction ahead of hydro-meteorological events in Southeast Asia during July 2020
11:25	20:25	–	11:40	20:40	S5_7	Raju Mandal	IIndian Institute of Tropical Meteorology	Real-time Extended Range Prediction of Heat Waves over India
11:40	20:40	–	11:55	20:55	S5_8	Samantha Ferrett	University of Reading	Sub-seasonal predictability of precipitation associated with weather regimes in Southeast Asia
11:55	20:55	–	12:10	21:10	S5_9	Akshay Deoras	University of Reading	Evaluating predictions of Indian monsoon low-pressure systems by Subseasonal-to-Seasonal prediction models
12:10	21:10	–	12:20	21:20	Break			
12:20	21:20	–	13:00	22:00	Poster Session (C) : Brief introduction of the posters: Session 4, Session 5, Session 6			
12:20	21:20	–	12:22	21:22	PC_S4_1	Aissatou Badji	University Cheikh Anta Diop, Senegal	Decadal variability of extreme rainfall indices in Senegal
12:22	21:22	–	12:24	21:24	PC_S4_2	Murilo Lemes	National Institute for Space Research, Brazil	The impacts of the deforestation on the variability of moisture transport from the Amazon forest to the southeastern of Brazil
12:24	21:24	–	12:26	21:26	PC_S4_3	Farah Ikram	Pakistan Meteorological Department	Tropical Cyclogenesis Prediction in the Arabian Sea
12:26	21:26	–	12:28	21:28	PC_S5_1	Arulalan T	Indian Institute of Technology Delhi	Extended-range prediction of heatwave events over North India: role of atmospheric blocking over North Atlantic
12:28	21:28	–	12:30	21:30	PC_S5_2	Kai-Chih Tseng	Geophysical Fluid Dynamics Laboratory, NOAA	Are multiseasonal forecasts of atmospheric rivers possible?
12:30	21:30	–	12:32	21:32	PC_S5_3	Rackhun Son	Gwangju Institute of Science and Technology	Machine Learning provides substantial improvements to county-level fire weather forecasting over the western United States
12:32	21:32	–	12:34	21:34	PC_S6_1	Rasmus Benestad	The Norwegian Meteorological Institute	A new and simple framework for studying risks connected to heavy rainfall
12:34	21:34	–	12:36	21:36	PC_S6_2	Dipti Hingmire	Indian Institute of Tropical Meteorology, Pune	Climate change response in wintertime widespread fog conditions over the Indo-Gangetic Plains
12:36	21:36	–	12:38	21:38	PC_S6_3	Ravi Guntu	IIT Roorkee	Frequent and widespread compound dry and hot summer monsoon extremes observed in India
12:38	21:38	–	12:40	21:40	PC_S6_4	Birgit Manning	Deutscher Wetterdienst (DWD)	The DWD Climate Prediction Website
12:40	21:40	–	12:42	21:42	PC_S6_5	Sridhara Nayak	Kyoto University	Response of July 2020 Heavy Rainfall event to d4PDF 4K warming in Western Japan
13:00	22:00		13:30	22:30	Breakout session for posters (extra 30-min breakout session for poster presentation)			

PROGRAM 4,
26 October 2021

Session 4 (B)

Prediction and predictability of large-scale climate variability relevant to extreme events

Xiangbo Feng

University of Reading

How well does Met Office seasonal forecast system predict Western North Pacific Tropical Cyclones?

S4_5

How well does the Met Office seasonal forecast system predict Western North Pacific tropical cyclones?

Xiangbo Feng, Nicholas P. Klingaman, Kevin I. Hodges

National Centre for Atmospheric Science and Department of Meteorology, University of Reading, Reading, United Kingdom

We will present the performance of the Met Office Global Seasonal Forecast System for tropical cyclone (TC) frequency for different regions of the western North Pacific (WNP). We analyze the full set of available GloSea5 seasonal reforecasts, which span a 23-yr period, with 28 ensemble members. Firstly, biases in TC frequency and translation speed are identified, and associated with errors in the large-scale environments. We then evaluate the model performance for interannual TC frequency variability at regional scales, including the effects of ensemble size and forecast lead time. To elucidate the TC variability, the forecasted teleconnections from ENSO to regional TC activity are evaluated against the observations, including the ENSO effects on the environments. Our study suggests that to further improve the TC prediction performance in the WNP, it requires reducing biases in environmental conditions and associated ENSO teleconnections, rather than increasing ensemble size.

Ankur Gupta

NCMRWF, MoES, India

Predictability of the Indian Summer Monsoon and representation of associated teleconnections in NCMRWF coupled model

S4_6

Predictability of the Indian Summer Monsoon and representation of associated teleconnections in NCMRWF coupled model

Ankur Gupta

NCMRWF, MoES, India

The Indian summer monsoon (ISM) is a robust natural phenomenon occurring yearly during the months of June-September. The variability of the total rainfall during the monsoon season (ISMR) is driven mostly by the variability of the state of lower boundaries such as surface temperatures and snow and moisture on land. The prediction of ISMR thus relies on reliable prediction of the land-ocean-atmospheric state. El-Nino and Southern Oscillations (ENSO) is known to be the dominant source of variability in the region; it is also the dominant source of predictability. An internal mode of variability having coupled characteristics similar to ENSO has been identified in the Indian Ocean and is known as Indian Ocean dipole. Recent studies have shown that the extremes in the positive phase of IOD is a useful predictor of the above monsoon rainfall over India. In this study we analyze how these relationships between the ENSO, IOD, etc with ISMR are represented in the model. We also show the skill of model in predicting the ISMR and ability of the model in capturing the spatial structure and interannual variability of rainfall during the monsoon season. The model used in this study is the coupled model in operations at National Centre for Medium Range Weather Forecasting (NCMRWF). It is seen that while model has good skill in capturing the ENSO, but only moderate skill in capturing the ISMR and IOD. It is shown that the misrepresentation of the basic state of the Indian Ocean is responsible for reduced ISMR predictability in the model.

Leon Hermanson

Met Office, UK

Applying the WMO Annual to Decadal Multi-Model Ensemble to Predicting Climate Hazards and Extremes

S4_7

Applying the WMO Annual to Decadal Multi-Model Ensemble to Predicting Climate Hazards and Extremes

Leon Hermanson

Senior Scientist Predictability Research, Met Office Hadley Centre, United Kingdom

Interannual to decadal climate predictions initialised with real-time observations can better constrain climate variability and change than past climate or climate change projections and are now operationally available so offer potential to aid adaptation and increase resilience. Experience from seasonal to decadal predictions have demonstrated the value of multi-model ensembles and shown that current models underestimate important climate signals, therefore large ensembles are needed to capture the true signal. The World Meteorological Organisation (WMO) Lead Centre for Annual to Decadal Climate Predictions provides a large multi-model ensemble of predictions made every year covering the next five years. Based on these predictions, the WMO has since 2020 annually released a Global Annual to Decadal Climate Update (GADCU) which summarizes the forecasts in the context of the current climate. The update includes maps showing key variables, discussion on forecast skill, and predictions of climate indices such as the Global Mean Near-Surface Temperature and Atlantic Multidecadal Variability. In this presentation, we show the key outputs and data that is available to national meteorological institutes and others to help predict regional climate hazards and extremes. We discuss current skill at interannual and pentadal timescales, and applications that could be developed from the multi-model ensemble, including an example of an in-development tropical cyclone product for the re-insurance market. The data collected by the WMO Lead Centre has the potential to become an important input for policymakers and businesses to achieve resilience and prosperity across the world in a changing climate.

Daniel Krieger

Helmholtz-Zentrum Hereon

Decadal Predictability of German Bight Storm Activity

S4_8

Decadal Predictability of German Bight Storm Activity

Daniel Krieger[1,2], Ralf Weisse[1], Johanna Baehr[3], Sebastian Brune[3]

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[2] International Max Planck Research School on Earth System Modelling, Hamburg, Germany
[3] Institute of Oceanography, Universität Hamburg, Hamburg, Germany

Decadal forecasts of storm activity are vital for coastal protection in the German Bight. As there is no significant climate change signal in historical records of German Bight storm activity and future projections do not suggest consistent significant changes, emission-based climate projections may be of limited use for decadal predictions. Thus, we see a potential in decadal prediction systems to provide reliable forecasts for storm activity on a multiannual time scale.

We evaluate the prediction skill for German Bight storm activity of a 64-member ensemble of yearly initialized decadal hindcast simulations based on the Max-Planck-Institute Earth System Model. We calculate an annual geostrophic wind-based index for German Bight storm activity from mean sea-level pressure (MSLP). We correlate predicted storm activity with observations to quantify the model's prediction skill. To analyze the origin of the skill, we investigate how large-scale atmospheric patterns over the North Atlantic are represented in the model.

We find that storm activity predictions show the highest skill for long averaging periods. Furthermore, categorical predictions for longer averaging windows significantly exceed the skill of simple forecasts based on persistence or linear trends.

While the prediction skill for MSLP is mostly insignificant over the North Sea, we show that the model sufficiently reproduces leading modes of wintertime MSLP variability in the North Atlantic for long averaging windows. These modes correlate significantly with observed time series of German Bight storm activity. We therefore conclude that the skill of the model for large-scale atmospheric patterns drives the skill for storm activity.

PROGRAM 4,
26 October 2021

Session 5 (B)

Prediction and predictability of specific extreme events (>10 days)

Thea Turkington

Meteorological Service Singapore

S2S prediction ahead of hydro-meteorological events in Southeast Asia during July 2020

S5_6

S2S prediction ahead of hydro-meteorological events in Southeast Asia during July 2020

Thea Turkington, Wee Leng Tan, Ryan Kang

Centre for Climate Research Singapore

This work reviews the subseasonal outlooks provided ahead of rainfall related disasters that occurred at the end of July 2020 in Southeast Asia. This region experiences hydro-meteorological disasters every year and given the relatively high skill at the S2S timescale, it is in a prime position to benefit from subseasonal outlooks. Between 24 July and 1 August, a series of floods in northern Sulawesi, Indonesia, affected more than 20,000 people, damaged houses and blocked bridges and roads. While between 31 July and 3 August, floods also occurred in north and northeast Thailand, affecting more than 100,000 people and over 20,000 houses. Based on the 90th percentile and upper quintile plots, as well as the hindcast skill assessment, an increased chance of very heavy rainfall around Sulawesi was forecast three weeks before the disaster. However, while the plots also showed an increase chance of heavy rainfall over much of Thailand, due to lower skill from the hindcasts, north and northeastern Thailand were not included in the very heavy rainfall outlook. The results from these disasters demonstrate that there are indications of extreme rainfall events in Southeast Asia more than two weeks prior to the events (with some limitations) and that S2S predictions have the potential to be used for disaster preparedness in the region.

Raju Mandal

Indian Institute of Tropical Meteorology

Real-time Extended Range Prediction of Heat Waves over India

S5_7

Real-time Extended Range Prediction of Heat Waves over India

Raju Mandal[1,2]*, Susmitha Joseph[1], A. K. Sahai[1], R. Phani[1], A. Dey[1], R. Chattopadhyay[1] and D. R. Pattanaik[3]

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Heat waves (HWs) are one of the hazardous extreme temperature events which have broad and far-reaching impacts such as significant loss of life, health issues, and increased economic costs in transportation, agricultural production, energy and infrastructure. In India, the HWs occur during the summer months, March to June (MAMJ), mainly over north, northwest, central and the eastern coastal regions. Studies indicate that with increasing global warming/climate change, the frequency and intensity of HWs will increase. Although there are many studies on the mechanisms, identification of spells and future projections of HWs, very few studies have focused on the real-time prediction of such events. Therefore, understanding and real-time prediction of HWs are of greatest importance. The present study proposes a criterion based on the observed daily gridded maximum temperature (Tmax) data, which is used for the real-time prediction in extended range time scale during MAMJ. The HW day is identified based on the climatological percentile value, actual and departure from normal of Tmax. Different HW prone regions and HW spells (following a selection criterion) over those regions are identified. A Multi-Model Ensemble (MME) prediction system is used in the present study for the evaluation and verification of the proposed criterion. Details of the datasets used, the proposed HW criterion and the methodologies for identifying the HW spells over different HW-prone regions will be discussed in details. Skills in predicting the HWs events and verification (in terms of probabilities of onset, duration and demise of each spell) for selective events will also be shown for the hindcast period during 2003-2018.

Key words: Extreme events, Heat waves, Multi-Model Ensemble, Extended Range Prediction, Symmetric Extremal Dependence Index

Samantha Ferrett

University of Reading

Sub-seasonal predictability of precipitation associated with weather regimes in Southeast Asia

S5_8

Sub-seasonal predictability of precipitation associated with weather regimes in Southeast Asia

Samantha Ferrett[1], Paula LM Gonzalez[1,3], Emma Howard[1], Thomas HA Frame[2], Oscar Martinez-Alvarado[1], John Methven[2], Steven J Woolnough[1]

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[2] Department of Meteorology, University of Reading, UK
[3] International Research Institute for Climate and Society, Earth Institute, Columbia University, USA

The nations of Southeast Asia are susceptible to devastating impacts of heavy rainfall such as flooding and landslides. There are many contributing factors to the occurrence of convective rainfall events on a range of spatial and temporal scales, such as the MJO, equatorial waves, tropical cyclones and many others. Forecasting rainfall in these regions is therefore a major challenge for numerical weather prediction. This study examines the skill of sub-seasonal forecasts of Southeast Asia rainfall using the UK Met Office GloSea5 ensemble as well as skill of forecasts of rainfall conditioned on GloSea5 weather regimes. The weather regimes are identified using two methods; a two-tiered approach that considers large scale patterns in the first tier and synoptic-scale patterns within the large-scale regimes in the second tier, and an un-tiered "flat" approach that only considers synoptic-scale patterns.

Metrics of skill are used to compare forecast rainfall and regime-conditioned rainfall. GloSea5 forecasts of daily rainfall events show limited skill at all lead times, consistently having lower skill than a forecast based on rainfall climatology. However, both the flat and tiered regime-conditioned rainfall forecasts are more skilful than the GloSea5 rainfall forecasts, and can be more skilful than a climatology forecast up to lead times of 2-3 weeks. Regime-conditioned forecasts of rainfall in Indonesia are typically the most skilful. The impacts of spatial and temporal aggregations on forecast skill are also explored.

Akshay Deoras

University of Reading

Evaluating predictions of Indian monsoon low-pressure systems by Subseasonal-to-Seasonal prediction models

S5_9

Evaluating predictions of Indian monsoon low-pressure systems by Subseasonal-to-Seasonal prediction models

Akshay Deoras[1], Dr Kieran M. R. Hunt[1,2], Dr Andrew G. Turner[1,2]

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[2]National Centre for Atmospheric Science, University of Reading, Reading, United Kingdom

More than half of the summer monsoon precipitation and extreme precipitation events in eastern and central India are attributable to Indian monsoon low-pressure systems (LPSs). It is therefore important to understand the prediction skill of LPSs at the forecast lead times associated with numerical weather prediction and extended-range models. In this study, we use a feature-tracking algorithm to track LPSs in eleven models of the Subseasonal-to-Seasonal (S2S) prediction project. We consider only those LPSs that occurred at common forecast lead times of up-to 32 days during June-September 1999-2010. We then evaluate deterministic and probabilistic forecasts of LPSs against ERA-Interim and MERRA-2 reanalyses.

At lead times of less than 15 days, the BoM, CMA, ECCC and HMCR models have large biases in the propagation of LPSs over India. The CMA model exhibits the largest track error and the intensity of LPSs is overestimated (underestimated) by most models when verified against ERA-I (MERRA-2). The CMA, NCEP and UKMO models have the best ensemble spread-error relationship for the position and intensity of LPSs, whereas the HMCR model has the worst. At lead times of up-to five weeks, deterministic predictions of LPS genesis by all S2S models are less accurate than their respective climatological predictions. In contrast, probabilistic predictions by many S2S models are more accurate than their respective climatological predictions, and a simple forecast calibration technique substantially improves the forecast skill for most S2S models. The results of this study may be encouraging for stakeholders to use S2S models for forecasting LPSs.

PROGRAM 4,
26 October 2021

Poster Session (C) >>

Brief introduction of the posters:
Session 4, Session 5, Session 6

Aissatou Badji

University Cheikh Anta Diop, Senegal

Decadal variability of extreme rainfall indices in Senegal

PC_S4_1 »

Decadal variability of extreme rainfall indices in Senegal

Aïssatou Badji[1], Elsa Mohino[2], Juliette Mignot[3], Moussa Diakhaté[1], Amadou Thierno Gaye[1]

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[3]Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques, Institut Pierre Simon Laplace, Université Pierre et Marie Curie, Paris, France

The extreme rainfall events affect most socioeconomic sectors of West African countries and particulary for Senegal, the westernmost country of the region. Moreover, there is evidence that variability of extreme rainfall events during the 20th century has received little attention in the extreme (R95p) rainfall in Senegal, based on daily data measured at different stations over the period 1918–2000. Our results show that R20mm, R75p and R95p indices have shown a marked decadal variability during the 20th century, with a higher frequency of extreme events in the 1950-60s and a sharp decrease in the 1970-80s, consistently with the total seasonal amount of rainfall over the whole West Africa. Such variability of heavy and extreme rainfall in Senegal is strongly linked to the Atlantic Multidecadal Variability (AMV). Warmer SST over the tropical and extratropical North Atlantic and over the Mediterranean sea, associated with a positive phase of the AMV, are linked to a decrease of sea level pressure in the North Atlantic and a general northward shift of the Intertropical convergence zone and lead to more heavy and extreme rainfall events over Senegal.

Murilo Lemes

National Institute for Space Research, Brazil

The impacts of the deforestation on the variability of moisture transport from the Amazon forest to the southeastern of Brazil

PC_S4_2 »

The impacts of the deforestation on the variability of moisture transport from the Amazon forest to the southeastern of Brazil

Murilo Lemes[1]; Gilberto Fisch[2]; Gilvan Sampaio[1]; Marcelo Guatura[1]

National Institute for Space Research (INPE) [1]
University of Taubaté (UNITAU) [2]

The Amazon deforestation process has increased in the last decades due to the intensive anthropic activity and can be notable through shifting forest areas to the grasslands. However, these modifications can have an impact on the hydrological cycle. Therefore, the main objective of this work is to evaluate and compare the climatological moisture transport during the austral summer (1979-2021) associated with the impact of Amazon deforestation in the future. The ERA-5 Reanalysis was used to compute and evaluate the climatological moisture transfer throughout the following variables: surface pressure, wind components, and specific humidity. The BAM model (runned at CPTEC/INPE) was forced by two different Sea Surface Temperatures (SST) conditions from Coupled Model Intercomparison Project 5 (CMIP5). In order to better understand the influence of deforested areas on this mechanism, these simulations were made for two different Amazon deforestation scenarios (named DEF100 representing 100% of deforestation and DEF20 representing 20%). The moisture transport was calculated throughout vertically integrated moisture flow (up to 500 hPa) for a box inside Amazon forest and the southeastern region in Sao Paulo State. The results showed a singular increase of advection process in the North and Equatorial Atlantic Ocean. However, the moisture balance in the Amazon region decreased about 4.7% (DEF20) and 10.3% (DEF100 from the climatological values. On the other hand, the amount of moisture outgoing along the south boundary towards Sao Paulo State decreases for 18.3% and 48.5% for DEF20 and DEF100, respectively.

Farah Ikram

Pakistan Meteorological Department

Tropical Cyclogenesis Prediction in the Arabian Sea

PC_S4_3 »

Tropical Cyclogenesis Prediction in the Arabian Sea

Farah Ikram

Pakistan Meteorological Department

Genesis Potential Indices (GPI) of three different types are analyzed through reanalysis ECMWF 5th Generation Reanalysis of Global Climate (ERA5) and Weather Research and Forecasting Model (WRF) for a special case of tropical cyclones of category 4 and above on Saffir-Simpson Scale, Kyarr (2019). This Tropical Cyclone (TC) caused significant damage to the infrastructure, human lives, landfall, and property near the inshore and maritime trade routes areas. Thus, the focus of this study is to use these GPI for forecasting potential cyclogenesis locations and analyzing their performance using WRF. All the indices have good performance in reproducing the potential genesis locations with slight differences from the International Best Track Archive for Climate Stewardship (IBTrACS) locations due to discrepancies in the data quality of the basin. WRF Kain-Fritsch scheme has good results in reproducing the spatial distribution of most of the dynamical parameters with slight overestimation. The results of GP indices and the respective fields of both cyclones in ERA5 reanalysis and WRF simulations are in good agreement with the theoretical background of tropical cyclogenesis and hence have the potential to be used in forecasting of TC genesis prediction.

Arulalan T

Indian Institute of Technology Delhi

Extended-range prediction of heatwave events over North India: role of atmospheric blocking over North Atlantic

PC_S5_1 »

Extended-range prediction of heatwave events over North India: role of atmospheric blocking over North Atlantic

Arulalan T [1,2], Krishna AchutaRao [1], Ashis K. Mitra [3], Raghavendra Ashrit [3], Ankur Gupta [3]

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[2] India Meteorological Department, Ministry of Earth Sciences, Government of India
[3] National Centre for Medium Range Weather Forecasting, Ministry of Earth Sciences, Government of India

During the summer of 2015, heatwave events claimed 2422 lives in India. Following that disaster, India's National Disaster Management Authority (NDMA), formulated a Heat Action Plan to protect citizens and minimize fatalities. Improved forecasts from the India Meteorological Department (IMD) together with NDMA's heat action plan played a major role in the reduction of heatwave mortality since 2016. However, forecasts at longer lead times are required to improve action plans ahead of the heatwave events.

IMD uses extended-range forecast products, but we show the improved prediction of high probability from a mutli-model-ensemble of the subseasonal-to-seasonal (S2S) database (Vitart et al. 2017). The S2S prediction project provides an opportunity to study the skill of predicting heatwaves over India at extended-range (15-30 days).

In a recent study Ratnam et al., 2016 showed that atmospheric blocking patterns over the north Atlantic region have linkages with heatwave-events over northwest India at 2-day lag using ERA-Interim reanalysis and IMD observation. Using ERA5 reanalysis, we found that during 1979-2018, a third of the blocking events over North-Atlantic caused heat-events over India.

Using the "reforecast" outputs in the S2S database to bias correct the real-time-extended-range forecast results in improved prediction of frequency, timing, and spatio-temporal-pattern evolution of heatwaves and severe heatwaves at 2 to 3 weeks forecast lead-time. The atmospheric blocking anomalies at high-latitudes which precede the heat-events in India could be predicted three weeks in advance. Based on the S2S models' skills, the prospects for early warning and disaster preparedness look promising in the coming years.

Keywords: Heatwaves, India, Atmospheric-Blocking, Extended-Range-Predictions, North-Atlantic

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Kai-Chih Tseng

Geophysical Fluid Dynamics Laboratory, NOAA

Are multiseasonal forecasts of atmospheric rivers possible?

PC_S5_2 »

Are multiseasonal forecasts of atmospheric rivers possible?

Kai-Chih Tseng

Geophysical Fluid Dynamics Laboratory, NOAA

Atmospheric rivers (ARs) exert significant socioeconomic impacts in western North America, winter time. This indicates both the benefits to water supply and the hazard from extreme precipitation when an AR makes landfall. While most prevailing research has focused on the subseasonal (≤ 5 weeks) prediction of ARs, only limited efforts have been made for AR forecasts on multiseasonal timescales (≥ 3 months) that are crucial for water resource management and disaster preparedness. Through the analysis of observational reanalysis and retrospective predictions from GFDL new seasonal-to-decadal forecast system, this research shows the existing potential of multiseasonal AR frequency forecasts with predictive skills 9 months in advance. Additional analysis explores the dominant predictability sources and\ challenges for multiseasonal AR prediction.

Rackhun Son

Gwangju Institute of Science and Technology

Machine Learning provides substantial improvements to county-level fire weather forecasting over the western United States

PC_S5_3 »

Machine Learning provides substantial improvements to county-level fire weather forecasting over the western United State

Rackhun Son

Gwangju Institute of Science and Technology

The recent wildfires in the western United States during 2018 and 2020 caused record-breaking fire damage and casualties. Despite remarkable advances in fire modeling and weather forecasting, it remains challenging to anticipate catastrophic wildfire events and associated damage. One key missing component is a fire weather prediction system with sufficiently long lead time capable of providing useful regional details. Here, we develop a hybrid prediction model of wildfire danger called CFS-SR as an attempt to fill that void. The CFS-SR model is constructed by integrating the Climate Forecast System version 2 with a machine learning technique known as Single Image Super Resolution, a method that is widely used in enhancing image resolution. We show that for the 2018-2019 fire season, the CFS-SR model significantly improved accuracy in forecasting fire weather at lead times of up to 7 days with an enhanced spatial resolution up to 4 km. This level of high resolution provides county-level fire weather forecast, making it more practical for allocating resources to mitigate wildfire danger. Our study demonstrates that a proper combination of ensemble climate predictions with machine learning techniques can boost predictability at finer spatial scales, increasing the utility of fire weather forecasts for practical applications.

Rasmus Benestad

The Norwegian Meteorological Institute

A new and simple framework for studying risks connected to heavy rainfall

PC_S6_1 »

A new and simple framework for studying risks connected to heavy rainfall

Rasmus Benestad

The Norwegian Meteorological Institute

Global warming associated with the exploitation of fossil fuels is expected to have local consequences for weather-related hazards, and there is a growing need to adapt to climate change. We can expect more frequent, intense and widespread extreme weather events in different parts of the world, such as heatwaves, storm surges, heavy rainfall, flooding, landslides as well as more droughts.

Here we present a simple formula that can provide a framework for predicting the probability of 24-hr heavy rainfall and a parametric method for predicting intensity-duration-frequency (IDF) curves for rainfall return levels, useful for design of infrastructure. This framework can be utilised in empirical-statistical downscaling (ESD) as well as regional climate models (RCMs) in dynamical downscaling. A major benefit of this framework is that it enables the provision of rule-of-thumb information for locations without sub-daily rain gauge data or short observational records. When used with ESD, it can also be employed in downscaled projections based on large ensembles of multi-model ensembles of global climate model simulations providing robust estimates of both probabilities and return levels. Downscaled multi-model ensembles with more than 100 members are useful input in risk assessment and risk management. In this case, the downscaled IDF information can facilitate climate change adaptation to heavy rainfall.

Dipti Hingmire

Indian Institute of Tropical Meteorology, Pune

Climate change response in wintertime widespread fog conditions over the Indo-Gangetic Plains

PC_S6_2 »

Climate change response in wintertime widespread fog conditions over the Indo-Gangetic Plains

Dipti Hingmire

Indian Institute of Tropical Meteorology, Pune

This study investigates the influence of climate change on widespread fog conditions over the Indo-Gangetic Plains (IGP) of north India using observations, reanalysis data of atmospheric parameters, coupled model inter-comparison project 6 (CMIP6) projections for four future scenarios based on the shared socio-economic pathways (SSPs) and advanced analysis techniques, including machine learning. Fog fraction and widespread fog days (WFDs) are estimated by functional mapping of fog observations with 8 atmospheric parameters for the period 1981-2018 using three empirical/machine learning approaches. Of these, we note that the deep learning convolutional neural network (CNN) exhibits superiority in performance by showing the mapping closer to the observed. Temporal evolution of fog fractions and WFDs is analyzed from the CMIP6 projections using CNN for the historical (1981-2014) and future periods of the 21st century. We note substantial enhancement in the projected fog fractions [WFDs] as high as 57% [154%] during (2015-2045) relative to (1981-2014). The findings provide insights into the possible future changes in widespread fog conditions over the IGP following different SSPs. It is seen that the period (2015 -2045) witnesses a larger prevalence of WFDs for the SSP245, SSP370 and SSP585 scenarios, due to the combined effects of air pollution and greenhouse warming. The post-2046 periods, however, generally indicate signatures of decline in foggy days with widespread conditions relative to historical period, in most of the scenarios except SSP370, and the severity in foggy periods comes from the relative impact of high emission scenarios in consequence to mitigation strategies of pollutants. The deep machine learning algorithm used in this investigation offers promising potential for fog analyses, and can be promoted for operational purposes to provide fog outlooks for the IGP region.

Ravi Guntu

IIT Roorkee

Frequent and widespread compound dry and hot summer monsoon extremes observed in India

PC_S6_3 »

Frequent and widespread compound dry and hot summer monsoon extremes observed in India

Ravi Guntu

IIT Roorkee

Compound extremes exhibit adverse impacts than their univariate counterparts. Several studies reported changes in frequency and spatial extent of extremes in India; however, investigation of compound extremes is in infancy. This study investigates the historical variation of compound dry and hot extreme (CDHE) based on monthly precipitation and temperature during the Indian summer monsoon period from 1951 to 2019 over India's homogeneous regions. Our results unravelled that CDHE's frequency has increased by 1-3 events per decade for the recent period (1977-2019) relative to the base period (1951-1976). This increasing pattern is high across North-central India, Western India, North-eastern India and South-eastern coastlines due to global warming. Furthermore, a statistically significant increase in the spatial extent exists in the compound dry and hot extreme across India. Our findings highlight that most parts of the country were affected by frequent and widespread compound dry and hot extremes during the recent period, which is indeed an alarming situation.

Birgit Manning

Deutscher Wetterdienst (DWD)

The DWD Climate Prediction Website

PC_S6_4 »

The DWD climate prediction website

Birgit Mannig, Andreas Paxian, Katja Reinhardt, Katharina Isensee, Amelie Hoff, Klaus Pankatz, Kristina Fröhlich, Saskia Buchholz, Sabrina Wehring, Miriam Tivig, Philip Lorenz, Barbara Früh

Deutscher Wetterdienst (DWD)

DWD provides operational seasonal and decadal predictions of the German climate prediction system since 2016 and 2020, respectively. We plan to present these predictions together with post-processed ECMWF sub-seasonal forecast products on the DWD climate prediction website www.dwd.de/climatepredictions. In March 2020, this climate service was published with decadal predictions for the coming years; sub-seasonal and seasonal predictions for the coming weeks and months will follow soon.

The user-oriented evaluation and design of this climate service has been developed in close cooperation with users from various sectors and will be consistent across all time scales. The website offers maps, time series and tables of ensemble mean and probabilistic predictions in combination with the prediction skill for 1-year and 5-year means/ sums of temperature and precipitation for different regions (World, Europe, Germany, German regions).

For Germany, the statistical downscaling EPISODES was applied to reach high spatial resolution. Decadal predictions were statistically recalibrated in order to adjust bias, drift and standard deviation and optimize ensemble spread. We used the MSESS and RPSS to evaluate the skill of climate predictions in comparison to reference predictions, e.g. 'observed climatology' or 'uninitialized climate projections' (which are both applied by users until now as an alternative to climate predictions). The significance was tested via bootstraps.

In addition to sub-seasonal and seasonal predictions, plans for future extensions of this climate service include multi-year seasonal predictions, e.g. 5-year summer or winter means, combined products for climate predictions and climate projections, further user-oriented, extreme or large-scale variables, e.g. droughts or ENSO, or high-resolution applications for German cities based on statistically downscaled predictions.

Sridhara Nayak

Kyoto University

Response of July 2020 Heavy Rainfall event to d4PDF 4K warming in Western Japan

PC_S6_5 »

Response of July 2020 Heavy Rainfall event to d4PDF 4K warming in Western Japan

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The occurrence of heavy rainfall events is now a serious concern in recent years in Japan. In this study, we quantified the hazards resulting from a heavy rainfall event that occurred in July 2020 over western Japan by performing high-resolution (1 km) simulations with WRF in present day climate and with d4PDF 4K warming conditions at different initial times. The results indicated that the duration and the peak rainfall intensity of the heavy rainfall event is well reproduced by WRF. The duration of the event under d4PDF 4K warming is noticed to decrease under 4K but the intensity is expected to be much stronger. We found that the increase of rainfall intensification in future climate is associated with the moisture content and the atmospheric instability. The moisture availability is expected to increase at all atmospheric levels starting from the surface and the temperature lapse rate is expected to decrease under 4K warming. Interestingly, we did not notice significant changes in the relative humidity in present and future climates. Our overall results highlighted an expectation of much intensified heavy rainfall events in future climate which corroborates the anticipated suggestions from the Clausius-Clapeyron equation on heavy rainfall events under constant relative humidity.

Keywords : Heavy Rainfall event, d4PDF, Future Climate, Temperature Lapse rate

Chapter

Program 5,
27 October 2021

Session 6

PROGRAM 5, 27 October 2021

TIME (start)			TIME (end)		Presentation			
GMT	KST		GMT	KST	Code	Name	Organization	Title
6:00	15:00	–	7:00	16:00	Session 6. Quantifying current and future risks of climate extremes			
6:00	15:00	–	6:15	15:15	S6_1	**Francesco Ragone**	Royal Meteorological Institute of Belgium	Quantifying the risk of extreme events with rare event algorithms in climate models
6:15	15:15	–	6:30	15:30	S6_2	**Gillian Kay**	Met Office, UK	Assessing the current chance of unprecedented dry conditions over North Brazil during El Nino events
6:30	15:30	–	6:45	15:45	S6_3	**Jonghun Kam**	Pohang University of Science and Technology (POSTECH)	Climate Model-Based Assessment of Anthropogenic Influence on the 2015-19 Western Cape Drought
6:45	15:45	–	7:00	16:00	S6_4	**William Merryfield**	Environment and Climate Change Canada	Extreme ENSO events in Copernicus seasonal hindcasts
7:00	16:00	–	7:05	16:05	Break			
7:05	16:05	–	8:40	17:40	Session 6. Quantifying current and future risks of climate extremes - Chair : June-Yi Lee, Co-chair of WCRP/WGSIP			
7:05	16:05	–	7:20	16:20	S6_5	**Ryo Mizuta**	Meteorological Research Institute, Japan	Projected changes in extreme precipitation in a 60-km AGCM large ensemble and their dependence on return periods
7:20	16:20	–	7:35	16:35	S6_6	**Seungmok Paik**	Yonsei University	Increasing anthropogenic greenhouse gas influence on intensification of extreme precipitation
7:35	16:35	–	7:50	16:50	S6_8	Arjun Nelikkattil	IBS Center for Climate Science	Mean and extreme precipitation associated with Atmospheric Rivers in response to greenhouse warming
7:50	16:50	–	7:55	16:55	Break			
7:55	16:55	–	8:10	17:10	S6_9	Asmerom Beraki	CSIR	The state of the drought in Africa from the historical and climate change perspective
8:10	17:10	–	8:25	17:25	S6_10	Laura Baker	University of Reading	Has the risk of a 1976 north-west European summer drought and heatwave event increased since the 1970s due to climate change?
8:25	17:25	–	8:40	17:40	S6_11	Jung-Eun Chu	IBS Center for Climate Physics	Future changes in tropical cyclone densities and ocean effects due to anthropogenic greenhouse warming
8:40	17:40	–	8:45	17:45	Closing - Closing Remarks (Ms. Sangwon Moon, APEC Climate Center) - Closing Remarks (Dr. Nico Caltabiano, WCRP)			

PROGRAM 5,
27 October 2021

Session 6

Quantifying current and future risks of climate extremes

Francesco Ragone

Royal Meteorological Institute of Belgium

Quantifying the risk of extreme events with
rare event algorithms in climate models

S6_1

Quantifying the risk of extreme events with rare event algorithms in climate models Francesco Ragone

Francesco Ragone

Royal Meteorological Institute of Belgium

The analysis of extreme events in ensembles of climate models runs is hindered by the lack of statistics due to the computational costs required to run a number of ensemble members large enough to sample very rare events. We discuss how this problem can be tackled using rare event algorithms, a family of computational techniques designed to guide an ensemble simulation to oversample target extreme events of interests. We present an example of one such method, designed to study extreme events characterized by time persistency, like heat or cold waves. We present results on extreme warm summers and heat waves over France and Scandinavia with CESM1.2.2 in present day climate. The application of algorithm concentrates the simulations on dynamical trajectories leading to persistent large regional surface temperature anomalies, shifting their probability distribution such that extreme warm summers become common. Thanks to this, we can estimate return times of extreme events several orders of magnitude larger than what feasible with direct sampling, and we can compute statistically significant composite maps of dynamical quantities conditional on the occurrence of the extremes. We show that warm summers in the model are associated to recurrent wavenumber 3 hemispheric teleconnection patterns, and that the most extreme summers are related to the succession of extremely large subseasonal heat waves. We then discuss preliminary results on different applications and perspectives for future studies.

Gillian Kay

Met Office, UK

Assessing the current chance of unprecedented dry conditions over North Brazil during El Nino events

S6_2

Assessing the current chance of unprecedented dry conditions over North Brazil during El Niño events

Gillian Kay, Nick Dunstone, Doug Smith

Met Office, UK

The strongest El Niño events of the past four decades were associated with large rainfall deficits in the North Region of Brazil during the December to February mature phase. While the teleconnection between El Niño and South America is well studied, the small number of El Niño events – and especially high magnitude El Niño events – in the recent observational record make a robust characterisation of the response over North Brazil in today's climate difficult. We describe developments to the UNSEEN (UNprecedented Simulated Extremes using ENsembles) approach for use in the context of a predictable driver of climate variability, using a large initialised ensemble to provide a greater sample of North Brazil rainfall responses to recent El Niño events than is available from observations. We find that conditions drier than those experienced during the strong El Niño events of 1982/3, 1997/8 and 2015/6 are possible in the current climate, and that as the magnitude of El Niño increases, so too does the chance of unprecedented low rainfall. However, even with the strongest El Niños, rainfall rates close to normal are still possible. Combining forecasts of El Niño with better information on the underlying chance of extremely low rainfall could feed into improved risk assessments and preparedness for an upcoming event.

Jonghun Kam

Pohang University of Science and Technology (POSTECH)

Climate Model-Based Assessment of Anthropogenic Influence on the 2015-19 Western Cape Drought

S6_3

Climate Model-Based Assessment of Anthropogenic Influence on the 2015-19 Western Cape Drought

Jonghun Kam

Division of Environmental Science and Engineering
Pohang University of Science and Technology, Pohang, South Korea 37673

The recent anthropogenic warming likely caused drying trends over Southern Hemisphere subtropics via Hadley Cell expansion and is expected to increase the characteristics of droughts over South Africa in the future. In recent year, the Western Cape region of South Africa has experienced a severe drought over 2015-19. Understanding of the impact of anthropogenic influence on the 2015/19-like multi-year drought remain limited. Here, we use the multiple ensemble members of historical, greenhouse gas, natural-only forcing runs from five CMIP6 models to quantify the anthropogenic influence on the probability of multi-year drought occurrences. According to the CMIP6 simulations, that anthropogenic greenhouse gas forcing has at least doubled the likelihood of 2015-19 like prolonged droughts over the South African Western Cape, with large cancellation due to other anthropogenic effects, particularly anthropogenic aerosol forcing. The findings of this study suggest a need for further studies of potential sources of predictability of multi-year Western Cape droughts.

William Merryfield

Environment and Climate Change Canada

Extreme ENSO events in Copernicus seasonal hindcasts

S6_4

Extreme ENSO events in Copernicus seasonal hindcasts

William Merryfield, Woo-Sung Lee

Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada

Hindcast ensembles from operational seasonal prediction systems contributing to the Copernicus Climate Change Service (C3S) multi-model ensemble encompass hundreds of realizations of the predicted evolution of ENSO events occurring during 1993-2016. It is likely therefore that many of these realizations exceed the amplitude of the single observed realizations for particular El Niño and La Niña events, and that some may exceed the amplitude of any such events in the historical record. This study examines incidences of unprecedented ENSO extremes in individual ensemble members of C3S seasonal hindcasts, focusing on cases where peak monthly-mean Nino3.4 index values exceed +/-3.5° C, including some outermost extremes that exceed +/-4.0° C. The teleconnected global impacts of these simulated events are examined, as is their physical plausibility in relation to model biases, etc.

Ryo Mizuta

Meteorological Research Institute, Japan

Projected changes in extreme precipitation in a 60-km AGCM large ensemble and their dependence on return periods

S6_5

Projected changes in extreme precipitation in a 60-km AGCM large ensemble and their dependence on return periods

Ryo MIZUTA and Hirokazu ENDO

Meteorological Research Institute, Tsukuba, Ibaraki 305-0052, Japan

The dependence of projected changes in extreme precipitation on the return period, as well as on the temporal and spatial scales, is investigated using a large ensemble climate simulation with a 60-km resolution global atmospheric model. The rate of increase in extreme precipitation is noticeably larger for longer return values in most parts of the world. While thermodynamic contribution to this increase generally follows the Clausius–Clapeyron relationship for all return periods, dynamic contribution determines the dependence on the return periods. While the dependence on the temporal scales of precipitation has similar characteristics, that on spatial scales is not large. Composites for days with the 100-year return value show that upward motion is enhanced in the middle and upper troposphere, accompanied by the enhanced horizontal water vapor convergence below. It suggests an increase in latent heat release due to the water vapor increase plays a significant role in the dynamic contribution.

Seungmok Paik

Yonsei University

Increasing anthropogenic greenhouse gas influence on intensification of extreme precipitation

S6_6

Increasing anthropogenic greenhouse gas influence on intensification of extreme precipitation

Seungmok Paik

Yonsei University

We conduct a detection and attribution analysis of the observed changes in extreme precipitation during past several decades. Observed and CMIP6 multimodel simulated changes in annual maximum daily and consecutive 5-day precipitation are compared using an optimal fingerprinting technique for different spatial scales from global land, Northern Hemisphere extratropics, tropics, three continental regions (North America and western and eastern Eurasia), and global "dry" and "wet" land areas (as defined by their average extreme precipitation intensities). Results indicate that anthropogenic greenhouse gas influence is robustly detected in the observed intensification of extreme precipitation over the global land and most of the subregions considered, all with clear separation from natural and anthropogenic aerosol forcings. Also, the human-induced greenhouse gas increases are found to be a dominant contributor to the observed increase in extreme precipitation intensity, which largely follows the increased moisture availability under global warming. Based on understanding the anthropogenic greenhouse gas influence on extreme precipitation during past decades, we further explore the future projection of extreme precipitation variation using much more higher resolution climate models. Future projection presents overall extreme precipitation increase at most globe, while it has somewhat regional differences, which mostly due to different atmospheric circulation changes. We will present the precise analysis results about cause of the diverse atmospheric circulation variations depending on several regions together

Arjun Nelikkattil

IBS Center for Climate Science

Mean and extreme precipitation associated with Atmospheric Rivers in response to greenhouse warming

S6_8

Mean and extreme precipitation associated with Atmospheric Rivers in response to greenhouse warming

Arjun Babu Nellikkattil[1,2], June-Yi Lee[1,2,3], Axel Timmermann[1,4], Sun-Seon Lee[1,4], and Jung-Eun Chu[1,4]

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Atmospheric rivers (ARs) can be identified as regions with strong water vapor transport extending from the tropical regions up to extratropics. They are often formed along the warm side of atmospheric fronts or on the equatorward side of extratropical cyclones. Although ARs cover less than 10% of the planet's total surface area at any instant, they account for more than 90% of poleward moisture transport across the midlatitudes. Further, ARs often lead to heavy precipitation along the coast, especially where the water vapor transport direction is perpendicular to the coastlines. In such areas, ARs control the mean and extreme precipitation as well as the extreme winds and storm surges. We have developed a novel, threshold-free, and computationally fast method to detect ARs from large climate datasets. The new detection method is applied to ultra-high-resolution (~25km in the atmosphere) fully coupled CESM1.2.2 simulation to obtain the key features of the ARs and their changes in future climate. Compared with simulations for present-day climate (CO_2 concentration = 367ppm), double CO_2 (CO_2 concentration = 734 ppm) and quadruple CO_2 (CO_2 concentration = 1468) experiments show a marked poleward shift in ARs. The mean and extreme precipitation events associated with ARs also show a shift to high latitudes. Regional responses to greenhouse gas forcing are further examined by looking at selected locations.

Asmerom Beraki

CSIR

The state of the drought in Africa from the historical and climate change perspective

S6_9

The historical and evolving state of drought in Africa under different global temperature goals

Asmerom F. Beraki[1,2] and Co-authors

[1]CSIR-Smart Places, Pretoria, South Africa

[2]University of Pretoria - Department of Geography, Geoinformatics and Meteorology, Pretoria, South Africa

African temperatures are projected to rise rapidly under low mitigation climate change scenarios at 1.5 to 2 times the global rate of temperature increase. This high regional climate sensitivity compounded with the relatively low adaptive capacity and exposure makes climate risk reduction and climate change adaptation crucially important to Africa. The study uses two drought indices calculated from six ensembles of a regional climate model constrained with six Coupled Model Intercomparison Project phase 5 (CMIP5) climate models. The finding suggests different drought tendency trajectories for the three distinct climate regimes in Africa under the worst-case scenario, and 3 ° C of the global temperature goal or above. North-eastern Africa including the Sahara Desert and southern Africa likely to be exposed to floods and droughts tendencies respectively relative to the baseline climate. However, the continent may face drought tendency outcome only when moisture loss due to potential evapotranspiration is accounted.

Laura Baker

University of Reading

Has the risk of a 1976 north-west European summer drought and heatwave event increased since the 1970s due to climate change?

S6_10

Has the risk of a 1976 north-west European summer drought and heatwave event increased since the 1970s due to climate change?

Laura Baker / NCAS Climate research scientist

University of Reading

In the summer of 1976, north-west Europe experienced an exceptional heatwave and drought, which impacted agriculture and public water supply. We assess whether the likelihood of the event in the present-day climate has changed since 1976 due to climate change. The analysis focuses on the England and Wales region, which was particularly badly impacted. Three key factors contributing to the extreme summer are identified: the dry preceding winter-spring period, the dry summer and the hot summer. We use two different event attribution methods to evaluate the change in the probability of the event: one using CMIP5 coupled climate models, and one using HadGEM3-A atmosphere-only simulations conditioned on the 1975/75 sea surface temperatures. This is the first time that this method has been used to evaluate how the risk of a historical extreme event has changed since it originally occurred. We find a significant increase in the probability of a summer at least as hot as 1976 between 1970s and the present-day climate, but no significant change in the probability of an extreme dry winter-spring or an extreme dry summer. However, the joint probability of an extreme dry winter-spring followed by an extreme hot summer, and the probability of an extreme hot and dry summer, are both found to have increased significantly between the 1970s and the present day climate.

Jung-Eun Chu

IBS Center for Climate Physics

Future changes in tropical cyclone densities and ocean effects due to anthropogenic greenhouse warming

S6_11

Future changes in tropical cyclone densities and ocean effects due to anthropogenic greenhouse warming

Jung-Eun Chu[1,2], Sun-Seon Lee[1,2*], Axel Timmermann[1,2*], Christian Wengel[1,2], Malte F. Stuecker[3], Ryohei Yamaguchi[1,2]

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Tropical cyclones (TCs) are one of the most severe weather disasters, and therefore, it is important to understand how their tracks, intensity, and associated rainfall patterns will change in response to greenhouse warming. However, most studies on future change in global TC characteristics rely on relatively coarse-resolution models, which result in an inadequate representation of TC-induced air-sea interactions. To address the robustness of TC projections in the presence of mesoscale air-sea interactions, we conduct century-long present-day, CO2 doubling and quadrupling experiments using the Community-Earth-System-Model with ~25 km atmosphere and 10 km ocean resolution. Here we show that TC density decreases by 7 % and 32 % in response to CO2 doubling and quadrupling due to the weakening of the rising branches of the summer hemispheric Hadley cells and the corresponding reduction of relative humidity and upward motion. We also identify the reduction in TC-induced upper-ocean cooling due to the reduction of TC densities and this reduction is unrelated to the changes in upper ocean stratification. Moreover, we find an upsurge in precipitation and intensity of landfalling events. The forced response is similar to recent observational trends, indicating a possible emergence of the anthropogenic signal beyond natural variability levels. Our modeling results provide relevant information for climate change adaptation efforts.