Monsoons Panel (Joint GEWEX/CLIVAR)

Dr Aurel Moise (aurel.moise@gmail.com, Co-Chair)
Dr Françoise Guichard (francoise.guichard@gmail.com, Co-Chair)

1. Panel overview

1.1 Background

The GEWEX/CLIVAR Monsoons Panel was proposed at and established following the 7th International GEWEX Conference at The Hague, July 2014 following the closure of the CLIVAR Regional Panels (AAMP, VAMOS, Africa) and with the remit of: (a) taking a more global view of monsoon activities, enabling knowledge and best practice to be shared between the various monsoon regions and (b) to better coordinate monsoons research between GEWEX and CLIVAR, particularly in emphasizing the role of convection and the land surface in the monsoons. The Monsoons Panel membership crosses CLIVAR and GEWEX research interests and all monsoon regions, with in-country membership where possible. While the Panel can take a global view, it may miss region-specific details, in particular in accessing regional stakeholders and managing local knowledge exchange and up-skilling. The Monsoons Panel has established a structure of Regional Monsoon Working Groups beneath it, comprising the Asia-Australia, Americas and Africa Regional Monsoon Working Groups. See Annex B for outlines of the structure, remit and ToR for the regional working groups.

See Monsoons Panel website for ToR and membership:
http://www.clivar.org/clivar-panels/monsoons

1.2 Summary of panel current main mission and 2018-2019 activities

(a) Organizational activities

Meetings: the last face to face MP meeting was held in Canada in May 2018 and the next one is planed the 14 December 2019 in San Francisco.

The Panel has also held two telecons, including time for guest speakers from the Regional Working Groups, for example Suryachandra Rao made a presentation of his current research on the seasonal forecast over India in which he empasized current issues with the initialisation of the model as well as improvements associated with changes in the model parametrizations of physical processes. Alice Grimm will present the outcome of the Summer School she organized on the American Monsoon this year during the early November teleconference (see also appendix).

The Monsoon Panel activities were presented at the last GEWEX SSG meeting in February 2019 (WMO, Geneva, F. Guichard).

Beyond those actions, the two co-chairs also held several teleconferences (about every month), with also some help from previous co-chair Andrew Turner during the transition.

Regional Monsoon Working group activity is also supported by telecons (in particular the Asia-Australia WG where several video meetings were held during the year). However, following the leave of Serge Janicot, communication among the Africa WG members has been limited this year and we are currently working at reactivating better communication and exchanges withing the Group (via emails and planning for teleconferences).

(b) Scientific work

The scientific work can be summarized under the following topics (see later sections):

- Observational/field studies work;
- Engagement with IPCC AR6/CMIP6 and MIPs;
- Stakeholder engagement/end users & Climate Services;
- Cross-group collaborations;
- Climate change detection & attribution (including CORDEX);
- Analysis of Sub-seasonal to Seasonal (S2S) simulations

(c) Obstacles

The main obstacle remains, that the combination of small funding and diversity (of scientific interests) presents a philosophical problem over choice of Panel meeting location. Regional meetings pertaining to the monsoon (or a monsoon) are not necessarily attractive to the full range of membership.

We found that a pragmatic way forward therefore may be to hold Panel meetings in conjunction with major international meetings (such as the AGU Fall meeting) and we therefore propose to meet this year the day after AGU finishes (14 December 2019) for a face to face meeting.

2. Achievements for 2018-19

2.1 Workshops and Conference Sessions organizing:

MP members organized several Workshops and Conference Sessions among which:

- Processes in global and regional monsoons, at the AMOS-ICTMO conferences, Darwin (July 2019) (**Aurel Moise**, **Andy Turner** et al.)

- Session “Monsoons of the Americas”, session 1 of the Symposium on Tropical Cyclones and Extreme Monsoon Precipitation: Prediction, Impacts, and Communication, at the 99th American Meteorological Society Annual Meeting, Phoenix, Arizona, USA, 6-10 January 2019, American Meteorological Society. Organized by Francina Dominguez with others. Included invited talks from Americas WG members:
    - Multiscale interactions in determining the hydrological extremes in the American monsoon regions (Rong Fu)
    - South American Monsoon: Variability of Extreme Events and Subseasonal Prediction (Alice M. Grimm)

- Session 31: “Climate Change Scenarios in CORDEX Domains”. Organizers: Tereza Cavazos, Cecilia Conde, and Landy Sánchez. Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures. University of Denver, March 11-13, 2019. https://www.scenariosforum2019.com/

- Paper-writing Workshop on the Analysis of CORDEX-CORE Climate Projections, ICTP, Trieste, 8-12 April 2019. Organizers: Xuejie Gao IAP, Tereza Cavazos, Erika Coppola, and Pilippo Giorgi. http://indico.ictp.it/event/8653/. As a result of this event, a global monsoon paper with the new RegCM outputs at 25 km resolution is being written and will be submitted on early 2020.

- “Advanced School and Workshop on American Monsoons: progress and future plans”, International Centre for Theoretical Physics South American Institute for Fundamental Research (ICTP-SAIFR), Sao Paulo, Brazil, 19-24 August, 2019, with support from ICTP, CLIVAR, GEWEX, IUGG, WCRP, FAPESP, ICTP-SAIFR, IFT-UNESP. This event was organized by Alice Grimm, Iracema Cavalcanti and Manoel Gan. All the members of the American Monsoons Working Group participated and delivered lectures (see the program in the Annex). Also the Co-chair of the CLIVAR SSG, Wenju Cai, delivered a lecture. There were 82 participants, including lecturers, scientists, graduate students, stakeholders, forecasters. To see more information about this event (lecturers, participants, program, photos, etc.), please access https://www.ictp-saifr.org/american-monsoons-progress-and-future-plans/ (see also Annex C)

- The 1st International Workshop on GMMIP was held from Oct. 27th to Oct. 30th, 2019 in the Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP/CAS) in Beijing. The workshop has five topics for abstract submission: (a) Evaluation of CMIP6 models on global monsoons’ mean state, extremes, variability and long-term changes and studies on key physical processes impacting model performance; (b) Advances in mechanisms of global monsoons’ long-term change since the late 19th century and its detection and attribution, focusing on roles of internal variability, natural and anthropogenic forcings; (c) Mechanisms of monsoon prediction on seasonal to decadal timescales; (d) Added value of high-resolution modelling on monsoon simulation; and

(e) Future projection of monsoon changes. The Organisers are Dr Tianjun Zhou (LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China), Prof Andrew Turner (NCAS-Climate and Department of Meteorology, University of Reading, UK) and Dr James Kinter III (Center for Ocean-Land-Atmosphere Studies & Dept. of Atmospheric, Oceanic & Earth Sciences, George Mason University, U.S.A). Both T. Zhou and A. Turner are member of the GEWEX/CLIVAR GMP.

2.2 Scientific results from activities

Ongoing observational field campaign exploitation

Following the end (Dec 2018) of the major observational campaign over West Africa DACCIWA, there is currently no ongoing campaign of this scale in Africa, though more limited observational programs exist (e.g. within IRD funded projects such as the LMI ECLAIRS2 in Senegal).

2019 was the last year of the FCFA (Future Climate for Africa project, https://futureclimateafrica.org/), with several final meetings. Beyond FCFA projects (AMMA-2050, FRACTAL, IMPALA, HyCRISTAL, UMFULA). Note also the African Climate Risk Conference 2019, sponsored by DFID and NERC (funders of FCFA, UK) who took place in October in Ethiopia.

The GCRF (Global Challenges Research Fund) African Science for Weather Information and Forecasting Techniques (GCRF African-SWIFT, UK, lead by D. Parker, Univ. Leeds, and involving several African institutes, https://africanswift.org/) is a major forecast project which aims at developing sustainable African weather forecasting capability from hourly to seasonal time scales with a focus on West African Monsoon system and East Africa Testbeds, to enhance the livelihood of African populations and improve the economies of their countries. In the same vein, CREWS Burkina (MP members F. Guichard and A. Diongue-Niang involved) focuses on weather forecast from synoptic to seasonal scales with strong participation of African Met institutes, and make use of new tropical wave diagnostics.

Note the recently funded project STEWARD (Early warning systems statistics of risks related to weather events from probabilistic systems, on the cities in West Africa, French project, ANR), focusing on S2S forecast.

Major African programs such as WASCAL (West African Science Service Centre on Climate Change and Adapted Land Use, a research-focused Climate Service Centre, Funded by Germany) are ongoing while several projects focused on Africa are also currently being submitted or under review (e.g. related to hydrology in the Sahel or to the Congo climate).

Activities of the Africa WG

Major achievements regarding the Africa WG were obtained concerning extreme rainfall events (both past and future) with e.g. several articles studying the recent increase in the frequency of these events over West Africa as well as their tendency in the future using high-resolution regional simulations over 20 years (4-km horizontal grid provided by IMPALA project), e.g. Berthou et al. (GRL 2019), Fitzpatrick et al. (submitted). Changes in the annual cycle of these events over North Africa has also been identified, with in particular an increase of their frequency from February to April South of 10°N which involves changes in regional circulations (Taylor et al. 2018).

On another topic, although temperature can be very high in Africa and trends over the past decades can be particularly high, studies of African heat waves has been very limited in the past. Filling this gap has really started with the project ACASIS (which ended in Dec 2018). Several articles involving MP members (A. Diongue, V. Moron, F. Guichard) have been published or are currently submitted. Finally, the influence of larger-scale circulations on these extreme events, in particular tropical waves, is the object of more and more studies (for forecast, e.g. CREWS and climate research).

Aida Diongue-Niang is contributing author for IPCC AR6 chapter 8 «Water Cycle changes » on Observed and Projected variations on West African Monsoon and proposed to have West African Monsoon instead of North African Monsoon used in AR5. Aida is also a Lead Author of IPCC AR6 chapter 1.

Involvement in West African Monsoon Monitoring and Forecasting in Burkina, Faso, Mali, Niger, Senegal through the collaborative platform MISVA (Monitoring and forecast of Intra Seasonal Variability over Africa) for understanding and forecast improvement of the West African Monsoon, http://misva.sedoo.fr/. Briefings between forecasters, researchers from West Africa and from France are weekly organized (ANACIM, **Aida Diongue-Niang** and CNRM, F. Guichard). Currently, the Sahelian region is facing an unsual situation: a rainy season very active in October after a delay in the monsoon onset and a timid start. More surprisingly, this coincides with high easterly waves activity and moistening coming from Equatorial Africa (Equatorial Rossby Waves), *More investigation and research is needed to understand these interactions between Equatorial Africa and the West African Monsoon System.*
Within this CREWS, a new high-resolution land surface analysis using ERA5 has been performed over Burkina with LDAS-monde (Tall et al. 2019) and is currently extended to the whole continent (Tall et al. in progress).

Involvement of A. Diongue-Niang in the GCRF- African SWIFT (Science for Weather Information and techniques) Programme (2018-2021), **https://africanswift.org**. Progress has been achieved in 2019 for nowcasting and more is planned beyond November 2019 for subseasonal-to-seasonal (ANACIM).

Involvement in the WMO Severe Weather Forecast Demonstration Project (SWFDP) for West Africa that aims at delivering improved forecasts and warnings of severe weather to save lives and livelihoods, and protect property through coordination at regional level https://www.wmo.int/pages/prog/www/swfdp/ (ANACIM).

Activities of the Americas WG

The most important achievement of the American Monsoons Working Group was the "Advanced School and Workshop on American Monsoons: progress and future plans", held in São Paulo, 19-24 January 2019. This event was organized by Alice Grimm, Iracema Cavalcanti and Manoel Gan. All the members of the American Monsoons Working Group participated and delivered lectures (see the program in the Annex). Also the Co-chair of the CLIVAR SSG, Wenju Cai, delivered a lecture. There were 82 participants, including lecturers, scientists, graduate students, stakeholders, forecasters. To see more information about this event (lecturers, participants, program, photos, etc.), please access https://www.ictp-saifr.org/american-monsoons-progress-and-future-plans/.

This activity was a great example of scientific capacity building and career support, besides allowing knowledge exchange and scientific and personal networking. It was very well evaluated in a Satisfaction Survey. Although it took much effort and time for its preparation, the outcome was very good.

The achievements for 2018-2019 include also organization of American Monsoon sessions in conferences, talks in conferences, published papers related to the American monsoons, projects. Besides, the Chapter on the "South And North American Monsoons: Characteristics, Life Cycle, Variability, Modelling And Prediction", prepared for a book on Global Monsoons edited by C P Chang has been concluded.

Results from the project "Climate Variability and subseasonal to seasonal prediction in South America" show that prediction of South America active and break monsoon phases are possible with 3 weeks lead time. As part of this project also climate variability in intraseasonal, interanual, and interdecadal time scales is investigated in South America. The MJO impacts on the precipitation, extreme events have been assessed, its teleconnections disclosed and the influence of the MJO-related impacts in South America on the MJO cycle investigated. The combined influence of ENSO and interdecadal oscillations on the rainfall characteristics is also analyzed (coordinated by A. Grimm).

Following the Workshop "Advanced School and Workshop on American Monsoons: progress and future plans" held in Sao Paulo, Brazil August of 2019, the group of Francina Dominguez'group now exploring land-atmosphere interactions for the South American Monsoon region in the following ways: analyzing the model results from a long-term simulation with water vapor tracers from the Amazon and La Plata river basin and lagged correlations between soil moisture anomalies and vapor fluxes; 2)using CESM GCM sensitivity analyses to

understand the effects of soil moisture anomalies on precipitation over South America; 3) involvement in the process of submitting a proposal to the National Science Foundation on "Land-Atmosphere Interactions in the North American Monsoon Region" (Lead: Benjamin Lintner, Yolande Serra and Francina Dominguez).

Activities of the Asian-Australian WG

First is a launch of the AsiaPEX project, which is the Post MAHASRI project, as an observation initiative of the Asian Precipitation, lead by Dr. Toru Terao and Dr. Shinjiro Kanae. The AsiaPEX was approved as a Regional Hydroclimate Project (RHP) by the GEWEX GHP.

Intensive studies on the extreme rainfall event in July 2018 in western Japan, which brought a serious disaster last year, are performed as Japanese meteorological community's collective efforts. Special collections on the extreme rainfall events in 2017 and 2018 over Japan in SOLA and J. Meteor. Soc. Japan are issued (Chief Editor: Dr. Tetsuya Takemi), and numbers of papers have been published (see Appendix F).

COORDEX SOUTH ASIA: Downscaled high-resolution (50 km) regional climate change projections over South Asia generated using IITM-RegCM4 RCM were made available on the CCCR-IITM Earth System Grid Federation (ESGF) data node:
(http://cccr.tropmet.res.in/home/cordexsa_datasets.jsp)

Assessment of Climate Change Projections over the Hindu Kush-Himalayan (HKH) region using CORDEX South Asia datasets.

SOUTH ASIAN CLIMATE OUTLOOK FORUM: Participation in the South Asian Climate Outlook Forum (14th Session), which was hosted by Nepal's Department of Hydrology and Meteorology (DHM) during 18-23 April 2019. WMO, the Regional Integrated Multi-hazard Early-warning System (RIMES), the WMO Regional Climate Centre at Pune hosted by India Meteorological Department and the UK's Met Office co-sponsored the events. Major partners in this climate outlook forum are 1. India, 2. Bangladesh, 3. Afghanistan, 3. Pakistan, 4. Bhutan, 5. Nepal, 6. Myanmar and 7. Sri Lanka. The major activity of this forum is to deliberate on the prevailing climate conditions in the tropical Pacific and the Indian Ocean and examine the forecasts from different climate models from around the world and make a consensus forecast for 2019 Monsoon season (JJAS) based on expert assessment of the models. **Suryachandra Rao** participated in this forum and provided inputs based on the Monsoon Mission model forecasts. The consensus statement that came out from this forum is a normal monsoon for 2019.

Continued work on monsoon lows/depressions with the aim to create a diagnostics package. Additionally, further process-based diagnostics are being developed. This also includes the analysis of S2S simulations (**A. Marshall**).

H. Annamalai contributed to the Indian Ocean CLIVAR panel activities (cross CLIVAR activities). This includes the contribution to the white Paper towards "Sustained observations over the Tropical Indian Ocean": H. Annamalai, M. Nagura and K. Richards., 2019: Indian Ocean and South-Asian monsoon: upper-ocean processes relevant to the monsoon annual cycle. IndOOS (2020-40) White Paper (invited article – in press)

Another overarching activity is the involvement of several members of the various Working Groups and the GMP in the IPCC process. It is an important activity for the GEWEX/CLIVAR Global Monsoons Panel to contribute to this assessment through various ways: co-leading one of the model experiment inter-comparisons (GMMIP); lead authorship as well as contributing authorship.

2.3 Scientific capacity building and career support

LMI ECLAIR2 IRD project involving French and Senegalese participants: African monsoon and Sahelian Climate. Provide help to several PhD students with strong involvements from researchers/supervisors (visits to CNRM) and act as an efficient tool for further achievements (e.g. IPCC grant of PhD M. Sow focussing on Sahelian droughts in the past and future).

Very positive outcomes from weekly briefings between Senegal, Mali, Niger, Burkina and French Met services initiated via CREWS Burkina project from more that one year now, with extended exchanges on synoptic to S2S to seasonal forecast and the development of new diagnostics, in particular the exploitation of information on tropical wave activity (MJO, Kelvin waves, equatorial Rossby waves,...).

Invited presentations at the 2nd WCRP Grand Challenges Meeting on Monsoons and Tropical Rain Belts, ICTP Trieste, Italy (July 2018): Building on the knowledge and practical skills acquired during the ICTP Summer School held in the preceding week, this workshop aims to bring together expertise on large-scale atmospheric and oceanic dynamics, small scale cloud and precipitation processes, hierarchical climate modelling and observation. Several Panel and WG members attended and gave presentations at the workshop (**Bill Boos**, **Brian Mapes**, **Aurel Moise**, **Andy Turner**)

A very good example of a GEWEX/CLIVAR co-funded capacity building activity was the "Advanced School and Workshop on American Monsoons: progress and future plans", organized by Alice Grimm, Iracema Cavalcanti and Manoel Gan (from the American Monsoons Working Group), in which all the members of the Working Group and other invited scientist delivered lectures and short talks. Many graduate and undergraduate students, as well as scientists, forecasters and stakeholders took part in this activity, with a high degree of participation in the discussions, and many questions from the audience. This activity received a high degree of approval of the participants regarding the quality of the lectures and talks in the

Satisfaction Survey. It was a platform for connecting the scientists investigating American monsoons, as well as students and scientists, and senior and young scientists. Collaborations were forged between scientists from North and South America, and between students. (**Alice Grimm**)

Additional workshop/conference participation (examples only):

(1) Aurel Moise presented several talks at the AMOS-ICTMO conference (July 2019, Darwin, Australia):

A. Moise, R. D'Agostino, J. Brown, R. Colman, P. Hope, H. Nguyen, J. Jungclaus: *Southern Hemisphere monsoon dynamics and changes in mid-Holocene and future global warming scenario;* A. Moise, I. Smith, J. Brown, R. Colman: *Observed and projected intra-seasonal variability of Australian monsoon rainfall;* A. Moise, C. Ye, H. Zhang, J. Chen: *Progress on atmospheric river analysis in the Asian-Australian region;* A. Moise, H. Zhang, L. Jin, G. Martin, S. Milton, J. Rodriguez: *Australia-Asian monsoon in two UK Met Office Unified Models and their impacts on Tropical-Extratropical Teleconnections*

(2) Alice Grimm participated in the 20th Brazilian Meteorological Congress, Maceio, Northeast Brasil, 27-30 November 2018:

Organized by the Brazilian Meteorological Society. invited talk *South American Monsoons: Impacts of the Madden-Julian Oscillation and subseasonal prediction of active and break monsoon phases*, and participated in the Round Table 5 *Climatology: variability and climate change*. Besides, her students presented four posters she coauthored: *Impacts of El Niño – Southern Oscillation on the characteristics of daily rainfall in South America in austral autumn; Interannual variability of the Southeast African monsoon and its connection with the variability of the South American monsoon; Impacts of the Madden-Julian Oscillation on South America precipitation during El Niño years; Intraseasonal variability of summer monsoon rainfall over Mozambique*. (Note: all these presentations were in Portuguese)

(3) Alice Grimm participated in the 99th American Meteorological Society Annual Meeting, Phoenix, Arizona, USA, 6-10 January 2019

Delivered the invited talk *South American monsoon: Variability of Extreme Events and Subseasonal Prediction* in the Session 1 (Monsoons of the Americas) of the Symposium on Tropical Cyclones and Extreme Monsoon Precipitation: Prediction, Impacts, and Communication. (https://ams.confex.com/ams/2019Annual/meetingapp.cgi/Paper/354624)

(4) Alice Grimm participated in the 27th International Union of Geodesy and Geophysics (IUGG) General Assembly, Montreal, Canada, 8-18 July 2019

Delivered the oral presentation: *Sub-seasonal prediction of South American summer monsoon anomalies* (Paper IUGG19-3167). Session M16b – Sub-seasonal to seasonal (S2S) Prediction (Session type IAMAS – Meteorology).

(5) Iracema Cavalcanti participated in the AGU Fall Meeting, Washington DC, USA, December 2018

Presented the paper: *South America Monsoon System and features simulated by the Eta regional model*.

(6) Iracema Cavalcanti participated in the IUGG General Assembly, Montreal, Canada, 8-18 July 2019

Presented the paper *Climate changes in the South America Monsoon System –a comparison between HadGEM2-ES and ETA-HadGEM2-ES models* in the IUGG- session Advances and Frontier Challenges in Global Monsoon Studies: Dynamics, Convection and Interactions with Hydrological and Land Surface Processes.

(7) All members of the American Monsoons Working Group participated in the Advanced School and Workshop on American Monsoons: progress and future plans, International Centre for Theoretical Physics South American Institute for Fundamental Research (ICTP-SAIFR, IFT-UNESP), Sao Paulo, Brazil, with support of ICTP, ICTP-SAIFR, CLIVAR, GEWEX, IUGG, FAPESP, and delivered lectures during the events. These titles can be seen in https://www.ictp-saifr.org/american-monsoons-progress-and-future-plans/ (link Speakers).

(8) Participation to AMMA-2050 final conference and to the Ethiopian conference (F. Guichard)

(9) Invited talk to the workshop "Land–atmosphere feedbacks and dry extremes under changing climate", to be held in Ghent on 20 - 22 Nov to present mechanisms associated with Sahelian heat waves (F. Guichard).

2.4 Knowledge exchange / Cross-WG Panel activities

WMO regional Climate Outlook Forum

- **Suryachandra Rao** participated in the South Asian Climate Outlook Forum (14th Session), which was hosted by Nepal's Department of Hydrology and Meteorology (DHM) during 18-23 April 2019. The major activity of this forum is to deliberate on the prevailing climate conditions in the tropical Pacific and the Indian Ocean and examine the forecasts from different climate models from around the world and make a consensus forecast for 2019 Monsoon season (JJAS) based on expert assessment of the models. The consensus statement that came out from this forum is a normal monsoon for 2019.

Indian Ocean CLIVAR Panel

- **H. Annamalai** contributed to the Indian Ocean CLIVAR panel activities (cross CLIVAR activities). This includes the contribution to the white Paper towards "Sustained observations over the Tropical Indian Ocean": H. Annamalai, M. Nagura and K. Richards.,

2019: Indian Ocean and South-Asian monsoon: upper-ocean processes relevant to the monsoon annual cycle. IndOOS (2020-40) White Paper (invited article – in press)

Monsoons Panel-SPARC

- **Andy Turner** led a straw-man ideas white paper on potential impacts of stratospheric variability on monsoon teleconnections. This was presented at the SPARC SSG meeting, following the SPARC General Assembly (October 2018) by **Tianjun Zhou**.

Engagement with WCRP CMIP Panel

- Engagement with CMIP6 MIPs, including a GMMIP workshop at IAP, Beijing in autumn 2019 (**Tianjun Zhou** & **Andy Turner**)

GASS and GLASS discussions

- Co-chairs from GASS are invited to attend the Monsoons Panel meeting at AGU2019 to discuss collaborations and links to the activities outlined in the GASS White Papers.

3. Plans for 2020 and beyond

The GEWEX/CLIVAR Global Monsoons Panel actively seeks cross-panel engagement with other panels such as the GASS Panel and the SPARC Panel. We are in discussions with both and seek further input for future collaboration at our upcoming face-to-face meeting during AGU2019.

3.1 Further cross-WG Panel activities are:

- Continued interaction with the IPCC AR6 and CMIP6 process, especially GMMIP through Andy Turner and Tianjun Zhou.
- Promote continued S2S diagnosis: we will seek to engage university sector in helping to analyse the available large data amount
- Develop plans for further engagement with SPARC
- Develop plans for further engagement with GEWEX GLASS & GASS (in particular regarding land-surface interactions and projects such as ALMIP, coordinated by A. Boone)

The Panel is also supporting a planned workshop on "Systematic errors in monsoon simulations in climate models" – possibly towards the end of 2020. See the Budget request further below.

3.2 Americas WG plans:

Exploitation of the S2S database for the South American monsoon, in order to assess its possibilities for subseasonal prediction of several aspects, such as extreme events in different regions of the monsoon domain, onset and demise, active and break periods.

Alice Grimm will participate in the S2S Pilot Project using operational forecasts (not hindcasts) to test subseasonal prediction in real time and its usefulness from a user´s point of view.

Francina Dominguez will carry out studies on soil moisture anomalies, and their effect on South American moisture flux and precipitation.

Iracema Cavalcanti will verify simulation of SAMS features in S2S hindcasts.

3.3 Africa WG plans:

Continue with weekly briefings between Senegal, Mali, Niger, Burkina and French Meteorological Services initiated via CREWS Burkina project, which commenced more than one year ago. So far, there are very positive outcomes achieved with extended exchanges on time scales from synoptic to S2S to seasonal forecast and also the development of new diagnostics, in particular the exploitation of information on tropical wave activity (MJO, Kervin, ER...).

Analysis of the West African Monsoon 2019: what caused the late onset and late withdrawal and the high activity at the end of the monsoon season.

Study of new CMIP6 simulations and projections over Africa (mean state and extremes, east-west sahelian precipitation dipole…) in particular within the context of several African PhD students.

Continued involvement in SWIFT, WASCAL, CREWs projects.

Participate to a project of White Book concerning the West African Climate (LMI ECLAIR2 related).

3.4 Asia-Australia WG plans:

Co-leading the proposal and organization of a focused workshop on "Global Monsoons: forecasting, projections and impacts" - Perhaps towards the end of 2020.

Contribution to a Summer/winter school: possible topics are: "Advanced diagnostic tools for assessing monsoons in weather and climate models" or “Translating and disseminating seasonal forecast information to end users". These topics will be discussed further before designing a proposal.

Continued engagement with end user groups such as the National Met Services and regional centres (e.g. WMO Regional Climate Centre).

Analysis of GMMIP simulations for the region – what are the projected changes to the monsoon circulation as simulated by the CMIP6 models? Application of the monsoon metrics packages co-developed with panel members.

Continued engagement with the S2S community on evaluation of skill on subseasonal time scales.

4. Articles published in 2018/19 as part of panel activities

Annamalai H., M. Nagura and K. Richards., 2019: Indian Ocean and South-Asian monsoon: upper-ocean processes relevant to the monsoon annual cycle. IndOOS (2020-40) White Paper (invited article, in press)

Annamalai H., W. Boos, G. Martin, B. Mapes, Y. Ming, P. Mukhopadhyay, T.-Y. Koh, and **S. Rao**, 2019: CLIVAR-GEWEX Working Group on Asian-Australian Monsoons: Grand Challenges in Monsoon Modeling – Representation of Processes and Source of Model Errors. Book chapter for the IWM6 monograph on Monsoons (invited article, in press)

Annamalai H., 2019: Model systematic errors in the annual cycle of monsoon: Inferences from process-based diagnostics – A Chapter in "Current trends in the Representation of Physical Processes in Weather and Climate Models" Edited by D. Randall et al.

Barbero R, Fowler H, Blenkinsop S, Westra S, **Moron V**, Lewis E, Lenderink G, Guerreiro S, Li W, Kendon E, Chan S, Villalobos R, Mishra V, Haider A (2019) A synthesis of hourly and daily precipitation extremes in different climatic regions. Weather and Climate Extremes, doi: 10.1016/j.wace.2019.100219.

Barbier J., **F. Guichard**, D. Bouniol, F. Couvreux, and R. Roehrig, 2018: Detection of intraseasonal large-scale heat waves: Characteristics and historical trends during the Sahelian Spring. J. Climate. doi: 10.1175/JCLI-D-17-0244.1

Barton E., C. M. Taylor, D. J. Parker, **A. G. Turner**, D. Belušiç, S. Böing, J. K. Brooke, R. C. Harlow, P. R. Harris, K. M. R. Hunt, A. Jayakumar and A. K. Mitra, 2019: case study of land-atmosphere coupling during monsoon onset in northern India. Q. J. Royal Meteorol. Soc.

Bombardi RJ, **Moron V**, Goodnight JS (2019) Detection, variability, and predictability of monsoon onset and withdrawal dates: a review. International Journal of Climatology, in press.

Bourgeois, E., D. Bouniol, F. Couvreux, **F. Guichard**, J. Marsham, L. Garcia-Carreras, C. Birch and D. Parker, 2018: Characteristics of mid-level clouds over West Africa . Q.J.R. Meteorol. Soc. doi:10.1002/qj.3215

Brooks J., J. Allan, P. Williams, D. Liu, C. Fox, J. Haywood, J. Langridge, E. Highwood, S. K. Kompalli, D. O'Sullivan, S. Babu, S. Satheesh, **A. G. Turner** and H. Coe (2019). Vertical and horizontal distribution of sub-micron aerosol chemical composition and physical characteristics across Northern India, during the pre-monsoon and monsoon seasons. Atmospheric Chemistry and Physics, 19: 5615-5634.

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5. Budget and other needs for 2020

1. The main request aims to support the organization as well as attendance of several Panel members to a focused international conference on "Global Monsoons: forecasting, projections and impacts" - Perhaps towards the end of 2020. This conference is sought to cover areas from observations, modelling and local impacts.

   For this conference, we would request support for 12 workshop participants and 2 invited lecturers (2,000*8+2,000*2 USD = USD 20,000)

   We would like to ask for USD 10,000 from CLIVARE and USD 10,000 from GEWEX
   We would also plan the next face-to-face meeting of the GMP at this conference. Note: US members are expected to also seek funding from US CLIVAR and in case we are holding the meeting at IITM (India), we also explore the possibility to seek additional funding from ICMPO.

2. If any additional funding can be gained over and above the conference attendance, we would request the sum of ~$2000 USD to support a 2/3-day visit of a Member to an appropriate Regional Climate Outlook Forum meeting to engage with end-users such as National Met and Hydrology Services.

List of Annexes:

Annex A: Terms of Reference for Regional Working Groups of the WCRP GEWEX/CLIVAR Monsoons Panel
Annex B: Regional Working Groups
Annex C: Request for support of International Conference 2020
Annex D: Program of the Advanced School and Workshop on American Monsoons
Annex E: Agenda GMMIP Meeting, China, October 2019
Annex F: List of additional papers from Japan Intensive studies on the extreme rainfall event in July 2018

Annex A: Terms of Reference for Regional Working Groups of the WCRP GEWEX/CLIVAR Monsoons Panel

1. Mapping of relevant initiatives and areas of research to identify the working group structure (membership);
2. Identify key regional focus issues to be fostered 3-5 years ahead;
3. Evolve a strategy to assess the current levels of predictive skill for the region both at the level of the research community and forecasting centre, identifying where knowledge or implementation gaps can be bridged;
4. Engage directly with the relevant Regional Climate Outlook Forum to assist in promotion of best practice in critical evaluation of model performance for seasonal forecasting;
5. Develop diagnostics for understanding of monsoon processes and assessment of model errors on a range of scales, and inform the need for new observations, both over land and ocean, to advance understanding and undertake model performance assessments, reporting results via the Monsoons Portal;
6. Support cross-fertilisation of efforts within WCRP and elsewhere by liaising with:
7. Relevant process groups such as GEWEX GLASS and GASS to ensure raised profile of key interactions (land surface, convection) and facilitate development of process studies and diagnostic tools in models;
8. Relevant regional Ocean Panels to support design of a monitoring strategy necessary for investigating the structure, variability and change of the regional monsoons;
9. The Pan-WCRP numerical experimentation groups (WGSIP and WGCM) on modelling priorities for advancing monsoon research;
10. Contribute to the development of the Monsoon Portal to foster the growth of a regional user-researcher network, communicate existing products and their correct application and limitations, particularly to the impacts community, and contribute to and promote relevant training activities;
11. Evaluate likely resource needs for WG activities and offer suggestions for possible funding routes outside of WCRP when virtual meetings are impractical;
12. Report to the GEWEX/CLIVAR Monsoon Panel on an annual or more frequent basis, as appropriate, also logging efforts via the Monsoons Portal.

Dr Andy Turner and Dr Paul Dirmeyer, August 2015 (v4)

Annex B: Regional Working Groups

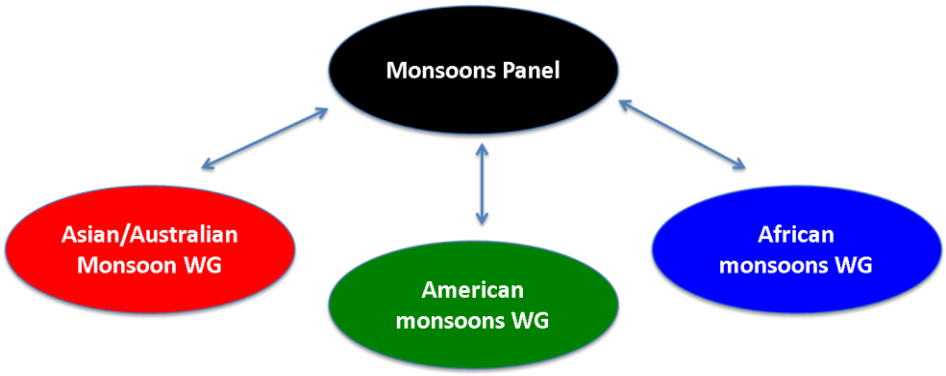
Justification for Regional Working Groups of the WCRP/CLIVAR Monsoons Panel

Monsoon systems represent the major annual mode of variability in the tropics and affect the lives of billions of people, often in some of the world's poorest nations. Despite this, the skill at which the monsoons can be simulated and forecast on all time scales from NWP to decadal remains a considerable challenge.

The overarching Monsoons Panel (MP) offers the advantage of bringing wide-ranging global expertise to the monsoons problem, offering the viewpoint of common aspects of tropical dynamics and convective physics to the monsoons, tapping into the Global Monsoon discipline. However, the global nature of the MP means that expertise is spread thinly in terms of fields of knowledge and local expertise. The various regional monsoons (Asian-Australian; African; American) feature unique problems and challenges that need to be overcome in order to achieve societal benefits as the science advances. These unique factors include regional surface and atmospheric processes, levels of local development, regional change factors such as pollutant emissions and land-use change, and varying levels of engagement between local forecasting agencies and the international weather and climate science research community.

To foster engagement of the monsoons research community at a local level and to facilitate improvement in monsoon forecasts on the various time scales for end users, three regional Working Groups (WGs) are formed under the umbrella of the MP. Each consists of a Chair or two Co-Chairs selected from its membership, and a liaison to the main MP who must be a current member of the MP. The liaison may be a Chair or Ordinary Member of the WG. Since the liaison is drawn from the MP membership, the MP will make the selection of the liaison. The MP will also invite the *initial* Chair positions of the regional WGs. Total membership consists of 6-8 persons including Chair(s).

The following Working Groups are established:



- Asian-Australian monsoons (AAMWG)

- American monsoons (NSAMWG)
- African monsoons (AfMWG)

The Regional Working Groups will define membership based on the expertise required to fulfil the ToRs and likely resource needs, seeking possible funding routes where necessary (to organise meetings, workshops etc).

Annex C: Request for support of International Conference

Proforma for CLIVAR Panel requests

for SSG approval for meetings

1. Panel name: GEWEX/CLIVAR Global Monsoon Panel
2. Title of meeting or workshop: “Global Monsoons: forecasting, projections and impacts"
3. Proposed venue: Singapore (TBC)
4. Proposed dates: Late 2020
5. Proposed attendees, including likely number: 12
6. Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:

To Be Submitted soon

7. Specific objectives and key agenda items:
8. Anticipated outcomes (deliverables):

To Be Submitted soon

9. Format:
10. Science Organizing Committee (if relevant)
11. Local Organizing Committee (if relevant)
12. Proposed funding sources and anticipated funding requested from WCRP:

Request for funding for 12 members plus 2 invited speakers: USD 30,000

Annex D: Program of the Advanced School and Workshop on American Monsoons

19/08 Monday	Introduction and main features of SAMS and NAMS	
09:00-09:20	Alice Grimm	Welcome and Introduction to American monsoons
09:20-10:10	Wenju Cai	ENSO under greenhouse warming
10:10-11:00	Manoel Gan	Main features and life cycle –SAMS - Observations
11:00-11:20		Coffee break
11:20-12:10	Iracema F.A.Cavalcanti	Main features and life cycle –SAMS - model results
12:10-13:00	Francina Dominguez	Main features of the North American monsoon
13:00-14:30		Lunch
14:30-15:40	Oral session	Short talks – 4 presentations of 20 minutes
15:40-16:00	Discussions	Summary and needs for future work
16:00-17:30	Poster Session+ Coffee break	

20/08 Tuesday	Variability on diurnal, mesoscale and synoptic time scales; subseasonal to seasonal variability	
09:00-09:50	Rong Fu	Connections between South and North American monsoons
09:50-10:40	Maria Assunção Silva Dias	Diurnal and local variability of the South American monsoon with possible effects of aerosol
10:40-11:00		Coffee break
11:00-11:50	Alice Grimm	Subseasonal variability of the South American monsoon
11:50-12:40	Marcelo Barreiro	Regional and remote controls of the South Atlantic Convergence Zone
12:40-14:10		Lunch
14:10-15:30	Oral session	Short talks – 4 presentations of 20 minutes
15:30-16:00	Discussions	Summary and needs for future work
16:00-17:30	Poster Session+ Coffee break	

21/08 Wednesday	Variability on interannual and decadal/interdecadal time scales; modulation of extreme events by climate variability; longer term variability and climate change	
09:00-09:50	Alice Grimm	Variability of the South American monsoon on interannual and decadal/ interdecadal time scales
09:50-10:40	Mary Kayano	Pacific and Atlantic multidecadal oscillations: relations to the ENSO and effects on the South American rainfall
10:40-11:00		Coffee break
11:00-12:20	Oral session	Short talks – 4 presentations of 20 minutes
12:20-13:50		Lunch
13:50-15:20	Poster Session+ Coffee break	
15:20-16:10	Pedro Silva Dias	Paleoclimatic aspects of the South American monsoon

16:10-17:00	Leila Carvalho	Present and future of the South American monsoon in a warming climate
17:00-17:30	Discussions	Summary and needs for future work

22/08 Thursday	Predictability and prediction (weather, sub-seasonal, seasonal and longer lead times); modelling studies	
9:00-9:50	Tereza Cavazos	Intercomparison of observed and simulated climatic trends in the North American monsoon
9:50- 10:40	Caio Coelho	Design and assessment of a Brazilian global sub-seasonal prediction system
10:40-11:00		Coffee break
11:00-11:50	Alice Grimm	Sub-seasonal prediction of South American summer monsoon active and break phases
11:50-12:20		Discussions on the needs of modeling studies
12:20-12:40		Interaction with students and main "take home" messages from the topics of the first 4 days"
12:40-14:10		Lunch
14:10-15:30	Oral session	Short talks – 4 presentations of 20 minutes
15:30-16:00	Discussions	Summary and needs for future work
16:00-17:30	Poster Session+ Coffee break	

23/08 Friday	Impacts on society; future challenges; plans for observational studies, diagnostic analyses, and modelling activities.	
9:00-9:50	Christopher Cunningham	Climate and weather extremes during the South American monsoon season within the context of disaster risk reduction – The CEMADEN Experience
9:50- 10:40	Cecilia Hidalgo	Collaborative processes in action: climate services and impact-based forecasts for southern South America
10:40-11:00		Coffee break
11:00-11:50	Leila Carvalho	Statistical methods to analyze climate variability in the South America monsoon region
11:50-12:10	Clyde Fraisse	The AgroClimate project: Developing solutions to climate challenges in agriculture
12:10-12:40	Discussions	Summary and needs for future work
12:40-14:10		Lunch
14:10-15:00	Poster Session+ Coffee break	
15:00-16:00		Closing session: Summary of the status of knowledge, future challenges and collaborative studies

24/08 Saturday	Discussions on future collaboration.
9:00-11:00	Meeting of the Working Group on American Monsoons

Short Talks (Oral Sessions): focus on PhD Students

19/08 Monday

1. Elisa Thomé Sena (Brazil, PhD): Shortening of the Amazon's rainy season detected using satellite cloudiness observations
2. Michelle Simões Reboita (Brazil, PhD): South American Monsoon System Lifecycle Simulated by RegCM4.7
3. Tessa Montini (USA, PhD student): Objective categorization of SALLJ events by a Principal Components Analysis of synoptic-scale conditions
4. Charles Jones (USA, PhD): Recent changes in the South America low-level jet

20/08 Tuesday

5. Johanna Yepes (Colombia, PhD Student): The diurnal cycle of precipitation and gravity waves over the rainiest place on Earth
6. Tania Katherine Ita Vargas (Peru, USA, MSc Student): Synoptic Patterns Associated with Wet Season Onset in the Tropical High Andes of Southern Peru and Bolivia
7. Yoel Alejandro (Mexico, PhD Student): Synoptic climatology and large-scale circulation patterns over Mexico
8. Paris Rivera (Guatemala, PhD Student): Influence of the MJO on the southern region of Guatemala

21/08 Wednesday

9. Luis Blacutt (Bolivia, PhD): Precipitation variability on the Mamoré Basin
10. Miguel Lovino (Argentina, PhD): Variability and changes of daily extremes over northeastern Argentina
11. Marcia Terezinha Zilli (Brazil, PhD): Attribution Analysis of Southwestward Shift of the South Atlantic Convergence Zone-related precipitation during the last decades

22/08 Thursday

12. Isabel Cristina Hoyos Rincón (Colombia, PhD): Interchange of atmospheric moisture among South America catchment basins
13. Armenia Franco-Diaz (Great Britain, PhD Student): The contribution of tropical cyclones to the atmospheric branch of Middle America's hydrological cycle
14. José Pablo Vega-Camarena (Mexico, PhD): Contrasting rainfall behavior between the Pacific coast and the Mexican Altiplano
15. Victor Manuel Torres Puente (Mexico, USA, PhD Student): The relationship between Easterly Waves over the Eastern Pacific and the Monsoon of North America

Alice Grimm delivering the Welcome and Introduction to American Monsoons

Most of the participants of the Advanced School and Workshop on American Monsoons: progress and future plans, International Centre for Theoretical Physics South American Institute for Fundamental Research (ICTP-SAIFR), Sao Paulo, Brazil, 19-24 August, 2019

Wenju Cai, Co-Chair of CLIVAR SSG, delivering his lecture.

American Monsoons Working Group. From left to right: Manoel Gan, Marcelo Barreiro, Tereza Cavazos, Francina Dominguez. Alice Grimm, Iracema Cavalcanti, Leila Carvalho, Pedro Silva Dias, and Rong Fu.

Annex E: GMMIP Meeting, China, October 2019

The 1st International Workshop on GMMIP was be held from Oct. 27th to Oct. 30th, 2019 in the Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP/CAS) in Beijing.

The workshop has five topics for abstract submission:

1. Evaluation of CMIP6 models on global monsoons' mean state, extremes, variability and long-term changes and studies on key physical processes impacting model performance.
2. Advances in mechanisms of global monsoons' long-term change since the late 19th century and its detection and attribution, focusing on roles of internal variability, natural and anthropogenic forcings.
3. Mechanisms of monsoon prediction on seasonal to decadal timescales.
4. Added value of high-resolution modelling on monsoon simulation
5. Future projection of monsoon changes.

Organisers:

Dr Tianjun Zhou – LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.

Prof Andrew Turner – NCAS-Climate and Department of Meteorology, University of Reading, UK.

Dr James Kinter III – Center for Ocean-Land-Atmosphere Studies & Dept. of Atmospheric, Oceanic & Earth Sciences, George Mason University, U.S.A.

T. Zhou and A. Turner are member of the GEWEX/CLIVAR GMP.

Annex F: Intensive studies on the extreme rainfall event in July 2018 in Japan

Intensive studies on the extreme rainfall event in July 2018 in western Japan are performed as Japanese meteorological community's collective effort in Japan. Special collections on the extreme rainfall events in 2017 and 2018 over Japan in SOLA and J. Meteor. Soc. Japan are issued (Chief Editor: Dr. Tetsuya Takemi), and numbers of papers have been published.

Special Issue collections

Takemi, T., and T. Unuma, 2019: Diagnosing environmental properties of the July 2018 Heavy Rainfall event in Japan. SOLA, Vol. 15A, pp. 60-65, doi:10.2151/sola.15A-011.

Takaya, Y., 2019: Positive phase of Pacific meridional mode enhanced western North Pacific tropical cyclone activity in summer 2018. SOLA, Vol. 15A, pp. 55-59, doi:10.2151/sola.15A-010

Takemura, K., S. Wakamatsu, H. Togawa, A. Shimpo, C. Kobayashi, S. Maeda, and H. Nakamura, 2019: Extreme moisture flux convergence over western Japan during the Heavy Rain Event of July 2018. SOLA, Vol. 15A, pp. 49-54, doi:10.2151/sola.15A-009

Yatagai, A., K. Minami, M. Masuda, and N. Sueto, 2019: Development of intensive APHRODITE hourly precipitation data for assessment of the moisture transport that caused heavy precipitation events. SOLA, Vol. 15A, pp. 43-48, doi:10.2151/sola.15A-008

Moteki, Q., 2019: Role of Typhoon Prapiroon (Typhoon No. 7) on the formation process of the Baiu front inducing heavy rain in July 2018 in western Japan. SOLA, Vol. 15A, pp. 37-42, doi:10.2151/sola.15A-007

Kobayashi, C. and I. Ishikawa, 2019: Prolonged northern-mid-latitude tropospheric warming in 2018 well predicted by the JMA operational seasonal prediction system. SOLA, Vol. 15A, pp. 31-36, doi:10.2151/sola.15A-006

Sekizawa, S., T. Miyasaka, H. Nakamura, A. Shimpo, K. Takemura, and S. Maeda., 2019: Anomalous moisture transport and oceanic evaporation during a torrential rainfall event over western Japan in early July 2018. SOLA, Vol. 15A, pp. 25-30, doi:10.2151/sola.15A-005

Matsunobu, T., and M. Matsueda, 2019: Assessing the predictability of heavy rainfall events in Japan in early July 2018 on medium-range timescales. SOLA, Vol. 15A, pp. 19-24, doi:10.2151/sola.15A-004

Shimpo, A., et al., 2019: Primary Factors behind the Heavy Rain Event of July 2018 and the Subsequent Heat Wave in Japan. SOLA, Vol. 15A, pp. 13-18, doi:10.2151/sola.15A-003

Imada, Y., M. Watanabe, H. Kawase, H. Shiogama, and M. Arai, 2019: The July 2018 high temperature event in Japan could not have happened without human-induced global warming. SOLA, Vol. 15A, pp. 8-12, doi:10.2151/sola.15A-002

Kotsuki, S., K. Terasaki, K. Kanemaru, M. Satoh, T. Kubota, and T. Miyoshi, 2019: Predictability of record-breaking rainfall in Japan in July 2018: Ensemble forecast experiments with the Near-real-time Global Atmospheric Data Assimilation System NEXRA. SOLA, Vol. 15A, pp. 1-7, doi:10.2151/sola.15A-001

Sueki, K., and Y. Kajikawa, 2019: Different precipitation systems between Hiroshima and Keihanshin during extreme rainfall event in western Japan in July 2018. J. Meteor. Soc. Japan, Vol. 97, in presss, doi:10.2151/jmsj. 2019-063

Liu, B., C. Zhu, J. Su, S. Ma, and K. Xu, 2019: Record-breaking northward shift of the western North Pacific Subtropical High in July 2018. J. Meteor. Soc. Japan, Vol. 97, pp. 913-925, doi:10.2151/jmsj.2019-047

Yokoyama, C., H. Tsuji, and Y. N. Takayabu, 2019: The effects of an upper-tropospheric trough on the Heavy Rainfall Event in July 2018 over Japan, in revision.

Tsuji, H., C. Yokoyama and Y. N. Takayabu, 2019: A comparison of heavy rainfall events of July 2018 and July 2017 in Japan focusing on a contribution of upper-tropospheric trough. J. Meteor. Soc. Japan, in revision.

Related papers in extreme rainfalls

Hamada, A, and Y. N. Takayabu, 2018: Large-scale environmental conditions related to midsummer extreme rainfall events around Japan in the TRMM region, J. Climate, 31, 6933-6945. https://doi.org/10.1175/JCLI-D-17-0632.1.

Tsuji, H., and Y. N. Takayabu, 2019: Precipitation enhancement via the interplay between atmospheric rivers and cut-off lows, Mon. Wea. Rev., 2451-2465.

Kato, R., K. Shimose, and S. Shimizu, 2018: Predictability of precipitation caused by linear precipitation systems during the July 2017 Northern Kyushu Heavy Rainfall Event using a cloud-resolving numerical weather prediction model. J. Disas. Res., Vol. 13, pp. 846-859, doi:10.20965/jdr.2018.p0846

Takemi, T., 2018: Importance of terrain representation in simulating a stationary convective system for the July 2017 Northern Kyushu Heavy Rainfall case. SOLA, Vol. 14, pp. 153-158, doi:10.2151/sola.2018-027