

CLIVAR /GEWEX Monsoon Panel

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1 Panel overview

1.1 Background

The current 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 current ToRs and membership:
<http://www.clivar.org/clivar-panels/monsoons>

1.2 Panel current main mission

The Panel current main mission is to indicate and update research priorities, gaps and milestones regarding monsoon studies as outlined in the GEWEX/CLIVAR MP annual work plan. In this context, the Panel coordinates strategies, advises on plans and defines concrete activities to carry out studies on the suggested research priorities, including selecting, limiting and concluding such activities as appropriate. The panel encourages studies on priority themes by groups from different monsoon domains and facilitates and/or promotes collaboration between monsoon researchers. The panel stimulates the interest of researchers and students in monsoon related problems by supporting and organizing workshops, advanced schools, and promoting scientific sessions in conferences with focus on monsoons. The panel also coordinates the formation and

function of regional working groups and advises WCRP and WWRP panels regarding the organization of scientific meetings and regional working groups, as well as on relevant issues for advancing monsoon research. Finally, the panel supports work in cooperation with regional, national and multinational programs to enhance the understanding of monsoon systems and improve monsoon prediction from synoptic to decadal time scale and longer, setting strategic priorities for long-term climate projection. The panel mission is to communicate these products and advancements to the relevant impact community, fostering participation in relevant training activities. Details about the mission can be obtained in the Monsoons Panel website description of the ToR.

1.3 Panel 2019-2020 activities

Before describing the activities during 2019/2020, the panel would like to highlight that it was strongly impacted by the COVID-19 related restrictions (not just the travel, but also how everybody's life has been affected in all the different countries), but also by the unexpected sad passing of one of the key members of its panel and leader of the African Regional Monsoon Working Group: Dr Françoise Guichard.

Regarding COVID-19 impacts: The MP is fairly reliant on the efforts carried out in the three regional Working Groups (see [Annex C](#)). With little financial support, the regional working groups historically leverage on their ongoing national activities and programmes and this alignment facilitates overall progress for the working group. This system has been in place since 2014 and meant that in general, regional contributions have slowed down overall. Once COVID-19 spread through the various regions, we saw an even stronger slow down with many members having to cope with their countries' situation and the incentive to contribute to the regional working group activities was not strong enough (in some regions) to prevent this stagnation in 2020. We are currently in the process of addressing/discussing this across the working groups and some renewal is going to be unavoidable.

Secondly, through this period, the former MP Co-Chair and leader in the African regional working group, Dr Françoise Guichard, suddenly passed away ([see Annex D](#)). This was of course a big shock to everybody and both the MP and the African regional Working Group have been affected, with the latter feeling the lack of the leadership Françoise provided and for some time this working group has become somewhat dormant. Again, we are currently addressing/discussing this across the working groups and the renewal process is underway.

1.3.1 Organizational Activities

Meetings: The last face to face MP meeting was held in December 2019 during the American Geophysical Union conference in San Francisco. The panel held two sessions, with the first one dedicated to internal MP matters (e.g. membership) and for the second

session members of other CLIVAR/GEWEX panels were invited to provide overviews and discuss possible collaborations.

The panel has had many virtual MP meetings. In this period, the MP held eight virtual meetings to introduce new members, discuss updates to the TORs and future work plans. During the first half of 2020, the MP saw one of its Co-Chairs (Dr Françoise Guichard) stepping down to remain an ordinary member of the panel, while Dr Leila Carvalho stepped into this new role.

Other panel membership changes early 2020 were:

- extended Dr Françoise Guichard for 1 year (stepping down from Co-Chair; Africa WG)
- extend Dr Andy Turner for 1 year (Asia-Australia WG)
- extend Dr Alice Grimm for 1 year (Americas WG)
- NEW: Dr Leila Carvalho (New Co-Chair, Americas)
- NEW: Dr Gill Martin (Asia-Australia WG; replaced C. Birch)
- NEW: Dr Randy Wu (Asia-Australia; replaced T.Zhou)
- NEW: Dr Mouhamadou Bamba Sylla (Africa WG; replaced F. Dominguez)

Beyond those actions, the two co-chairs also held several weekly teleconferences in the first semester of 2020, and biweekly-to-monthly meetings in the second semester of 2020. Dr. Françoise Guichard helped with the transition of the new co-Chair Dr. Leila Carvalho in the first few months.

Several panel members attended conferences and Regional Climate Outlook Forums (RCOFs), including progressing regional S2S activities in SE Asia (through Singapore). However, other in-person and organizational activities have been strongly impacted by the COVID-19 Pandemic in the period of this report.

The Monsoon Panel activities were presented at GEWEX SSG-32 (Pasadena, USA, January 2020 by Dr R. Kolli, ICMPO) and CLIVAR SSG-25 (San Diego, USA, February 2020, remotely by the late Dr Françoise Guichard, former Co-Chair).

During the year 2020, MP was involved in several meetings regarding the WCRP restructure (CORA, etc.).

1.3.2 Scientific work

The scientific work can be summarized under the following topics and will be addressed in the 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
- Systematic biases in coupled climate models

1.3.3 Obstacles

As outlined above, the main obstacle of the period was the COVID-19 pandemic that basically brought activities from regional WG to a standstill.

Lockdowns in most countries allied to transition to home offices, created further obstacles for active engagement of members in the MP activities. This led to a more inward-focused (e.g. in-country and in-agency/institution) work.

With no external events to attend and share, and considering all obstacles in transitioning from institutions to homes, collaborations/sharing across panel members slowed down massively. Moreover, the impossibility of in-person meetings made teleconferences the only means of communication. Members are spread in several time zones, which significantly reduce the ability to congregate members from all monsoon regions in virtual meetings.

At the same time, the ongoing transformation happened at WCRP level, and this required additional input from CLIVAR MP (and regional WGs), which we found difficult to provide at times. Other activities were also impacted such as the postponement/halt of field campaigns that could contribute to scientific knowledge on the monsoon systems.

Also relevant, the sudden loss of a respectful, active and much loved member, Dr. Francoise Guichard [See November edition of the GEWEX Quarterly newsletter, <https://www.gewex.org/gewex-content/uploads/2020/12/Q42020.pdf>], by the end of 2020 significantly affected members and impacted the MP activities, particularly regarding the work in the regional African Monsoon WG.

2 Achievements for 2020

2.1 Workshops and Conference Sessions organizing:

Despite restrictions regarding in-person meetings, some MP members were able to organize Workshops and Conference Sessions, among which:

- EGU2020-Session AS1.36 Precipitation: Measurement, Climatology, Remote Sensing, and Modelling held online, 7th May 2020. Organizers: Silas Michaelides, Vincenzo Levizzani, Gail Skofronik Jackson, **Yukari N. Takayabu**.

- EGU2020-Session CL2.8 Evaluating and improving precipitation in climate models, held online on Monday 4th May 2020. Conveners: Angeline Pendergrass, Margot Bador, Jennifer Catto, Christian Jakob, **Gill Martin**
- JPGU-AGU joint meeting 2020-Session A-AS02 Abnormal weathers and disasters in urban environments in East Asia related to climate change, Virtual Meeting, Organizers: Masaru Inatsu, **Yukari N. Takayabu**.
- JPGU-AGU joint meeting 2020-Session A-CG51 Satellite Earth Environment Observation, Virtual Meeting, Organizers: Riko Oki, Yoshiaki Honda, **Yukari N. Takayabu**, Tsuneo Matsunaga

2.2 Scientific Results from activities

2.2.1 Ongoing observational field campaigns:

While most field campaigns were postponed or cancelled due to the pandemic, results from previous campaigns have been published in the INCOMPASS Special Collection of QJRMS, published July 2020 and can be accessed here:

[https://rmets.onlinelibrary.wiley.com/doi/toc/10.1002/\(ISSN\)1477-870X.incompass](https://rmets.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)1477-870X.incompass)

2.2.2 Monsoons Panel joint publication

Members of the MP contributed to a Special Issue of GEWEX Quarterly (vol 30, no. 4, Quarter 4, 2020; <https://www.gewex.org/gewex-content/uploads/2020/12/Q42020.pdf>) on “Monsoons of the World: Addressing Global Challenges in Monsoon Research”, including articles on rainfall metrics for the assessment of model simulations of the monsoons, improving the simulation of diurnal precipitation over monsoon regimes, the monsoons of the Americas, multidecadal to synoptic scale extremes within the West African monsoon system, and the intersection between global monsoons and regional hydroclimate projects. A tribute to panel member Françoise Guichard was also included.

Recognizing the broader interest of the Monsoon Mission activities to the WCRP community, the CLIVAR/GEWEX Monsoons Panel has coordinated a special issue of *CLIVAR Exchanges* on India’s Monsoon Mission, with Dr M.N. Rajeevan as the Guest Editor. This issue showcases 12 articles highlighting the results achieved so far under Monsoon Mission and can be accessed here:

https://www.clivar.org/sites/default/files/documents/CLIVAR%20Exchanges%2079%20Monsoon%20Mission%20Final_1231.pdf

Some of the MP and WG members also contributed to the writing of the articles as lead or co-author:

- Ravi S. Nanjundiah and **Suryachandra A. Rao**: *Monsoon Mission Overview*

- **Suryachandra A. Rao**, A.K. Sahai, P. Mukhopadhyay, A.K. Mitra, V.S. Prasad, P.A. Francis, D.S. Pai, D.R. Pattanaik: *Major Achievements of Monsoon Mission*
- M. Mohapatra, D. S. Pai, A.K. Sahai, **P. Mukhopadhyay**, Ashis Mitra, Aarti Bandgar, C.J. Johny, D.R. Pattanaik, Divya Surendran, M. Benke, Medha Deshpande, Malay Ganai, Monica Sharma, Naresh Kumar, O.P. Sreejith, R. Chattopadhyay, R. Phani Murali Krishna, S. Abhilash, Sunitha Devi, S. Joseph, **A. Suryachandra Rao**, Sahadat Sarkar, Snehlata Tirkey, Tanmoy Goswami and V.S. Prasad: *Contribution of Monsoon Mission to Operational Advances: Short to Medium Range, Extended Range and Seasonal Forecasts*
- Sreenivas Pentakota, Sagar V. Gade, **Suryachandra A. Rao**, Cheng Da, Kriti Bhargava, Chu-Chun Chang, Eviatar Bach, Eugenia Kalnay and Travis Sluka: *Advances in Coupled Data Assimilation, Ensemble Forecasting, and Assimilation of Altimeter Observations*
- **A.G. Turner**: Indo- UK Joint Monsoon Campaign: Projects under Monsoon Mission
- **G. Srinivasan**, D.S. Pai, Anshul Agarwal , Anahit Hovsepyan and Wilfran Moufouma Okia: *India's Monsoon Mission Contributions to Regional Climate Information and Services for South Asia.*

Several MP members contributed to a review on past monsoon changes and their primary drivers, the projected future changes and key physical processes, and discuss challenges of the present and future modeling and outlooks. This review was published in BAMS in 2020:

Wang, B., M. Biasutti, M.P. Byrne, C. Castro, C. Chang, K. Cook, **R. Fu**, **A.M. Grimm**, K. Ha, H. Hendon, A. Kitho, R. Krishnan, J. Lee, J. Li, J. Liu, **A. Moise**, S. Pascale, M.K. Roxy, A. Seth, C. Sui, **A. Turner**, S. Yang, K. Yun, L. Zhang, and T. Zhou (2020) Monsoons Climate Change Assessment, Bull. Amer. Meteor. Soc., <https://doi.org/10.1175/BAMS-D-19-0335.1>

2.2.3 Activities of the Africa WG

The pandemic caused great impact in the ability of MP members to report for the African WG. Additionally, the loss of the lead member Francoise Guichard significantly impacted the activities of the Africa WG.

2.2.4 Activities of the Americas WG

Alice Grimm: Coordinates the project “Climate Variability and subseasonal to seasonal prediction in South America”. Results show the potential and drawbacks for prediction of South America active and break monsoon phases. As part of this project also climate variability in intraseasonal, interannual, 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 and the production of extreme events that leads to natural disasters is also analyzed, including a MSc student. Furthermore, the interaction between ENSO and MJO teleconnections and its impacts on precipitation and extreme events over South America is currently being analyzed with a PhD Student. . A paper on the ENSO impacts in South America has been published (Cai et al. 2020), including influences on the monsoons via different mechanisms (teleconnections, surface-atmosphere interactions, etc.). Furthermore, another paper explored the combination of different climate oscillations in producing extreme events (Grimm et al. 2020a).

As part of the plans for 2019 and beyond, listed in the last report (2018-2019), the S2S database was investigated for the South American monsoon to assess the possibility for subseasonal prediction of several aspects, such as extreme events in different regions of the monsoon domain, onset and demise, active and break periods. A paper resulted from this study (Grimm et al. 2019 (conference paper); Grimm et al. 2020b).

Alice Grimm participated in a Working Group that assessed the monsoons climate change, and an article was published as a result (Wang et al. 2020).

The characteristics of the intraseasonal variability of the southern African monsoon, its predictability, and teleconnections between South American and southern Africa monsoons have been studied with another PhD student and a manuscript has been submitted.

Iracema Cavalcanti: Is doing research related to the Monsoon system and influences on the region, with one PhD student and two MSc students. She is also studying the South America monsoon and Global Monsoons in the Brazilian Atmospheric Global Model (BAM) and in the Hadley Centre atmospheric model AMIP simulations. She participated in the investigation of the S2S database for the South American monsoon and participated in articles (Andrade et al. 2019; Cavalcanti et al. 2019).

Leila Carvalho: Has developed research on climate variability and change in South America, along with a postdoctoral fellow at Oxford University. The focus of this research has been on attributions of the observed polar shift of the South Atlantic Convergence Zone in the historical period using observations and CMIP5 models. One article was published in the International Journal of Climatology (Zilli and Carvalho,2021) discussing these results. She has also investigated the impacts of the Pacific Decadal Oscillation on ENSO teleconnections and how these aspects have influenced the lower-stratosphere-upper troposphere during the South American Pre-monsoon season along with her PhD student. Results from this study are published in Gamelin et al. (2020). She also investigated trends in precipitation over the Americas during the historical period based on instrumental data (Carvalho, 2019).

Dr. Carvalho is co-investigator in another project sponsored by the National Science Foundation to characterize and investigate mechanisms associated with the South American Low-Level jet, one of the most important features of the South American Monsoon System. She co-advise one postdoc and one graduate student in these topics.

She has also collaborated with Dr. Iracema Cavalcanti and Dr. Francina Dominguez in writing articles and planning future projects involving climate change in South America in 2020 (Pascale et al. 2019).

Tereza Cavazos: Has been studying a significant positive temperature trend in the North American monsoon region in the last forty years (Cavazos et al. 2019), which may continue as shown in Ashfaq et al., (2020), which is the first global analysis using regional model output for present conditions and future simulations.

Marcelo Barreiro: Research on subseasonal predictability of precipitation in South America through observations, reanalysis and model simulations using nonlinear data analysis tools. Recently, we introduced a method to predict the future state of the South American rainfall dipole from statistical and information theory analyses (Diaz et al 2020)

2.2.5 Activities of the Asian-Australian WG

Andy Turner: Has coordinated the INCOMPASS Special Collection of QJRMS, published July 2020, describes results about the Indo-UK INCOMPASS field campaign in India in 2016. The INCOMPASS field campaign is designed to better understand how an air parcel is modified as it travels towards India, crossing coastlines, mountains and a variety of land surface types and soil moisture patterns. Work motivated by INCOMPASS and published in this Special Collection has already suggested a new paradigm for the monsoon onset. The publication is available here:

[https://rmets.onlinelibrary.wiley.com/doi/toc/10.1002/\(ISSN\)1477-870X.incompass](https://rmets.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)1477-870X.incompass)

Yukari N. Takayabu: Worked on the extreme precipitation mechanisms around Japan in warm seasons, utilizing space-borne precipitation radar observation. Utilizing the space-borne observation data in combination with reanalysis and climate model outputs (CMIP5), future changes of precipitation characteristics in the Japan region are also projected (4 publications).

Additional work on the Asian Precipitation Experiment (AsiaPEX), led by Dr. Toru Terao and Dr. Shinjiro Kanae, which was launched in 2019, held their kick-off conference on 28-30 August 2019 at Sapporo, Japan, in which researchers from 10 countries participated. They further extended collaboration with South Asian researchers and had two workshops, the Extreme Severe Storm and Disaster Mitigation Strategy workshop and the AsiaPEX/SA in Feb.-Mar. 2020. Their observational activities had difficulties due to COVID-19 pandemic. However, they are trying to continue observation under oversea collaboration with local researchers and observations using research vessels.

H. Annamalai: Worked on the Identification of source(s) of model systematic errors in simulating the monsoons (2 publications). As a contribution to cross-panel activities, he developed research on Indian Ocean observing systems (IndOOS-2) (two publications). Contributed to Model assessment of the monsoons and climate change (two publications). He has acted as the member of the Science Review Panel “UK Met Office – India MoES” WCSSP-India Project on Monsoons” since October 2019/

Vincent Moron: Developed research about the characterization of seasonal and subseasonal predictability types across the tropical zone and across the annual cycle.

Contributed to the analysis of extreme rainfall, through the definition of hourly “storm types” in India and their relationships with predictability. Storm types are defined as local-scale wet events (= consecutive wet hours) then clustered into 6 canonical patterns. The most numerous storm types are weak and short but then a distinction can be made between intense short events vs moderate long ones. Longer storm types cover usually a larger surface and are probably more predictable at synoptic and subseasonal time scales.

Suryachandra A. Rao: Coordinated the publication of CLIVAR exchanges special issue (No.79, November 2020) on India’s monsoon together with ICMPO. Highlighted the impact of tropical Pacific SST biases on Indian Summer Monsoon simulation and prediction (1 Paper), verified the impact of perturbed ICs on seasonal prediction skill over Indian region and noticed a gain of one-month lead time due to use of perturbed ICs (1 Paper), compiled the achievements of India’s Monsoon Mission (1 paper). Coordinating the efforts of India’s Monsoon Mission Phase-II activities.

Gill Martin: Developed and documented methods for identifying systematic errors in the Asian summer monsoon using a combination of various modelling techniques and sensitivity experiments of varying complexity, and published paper demonstrating how such analysis can shed light on the way in which monsoon errors develop, their local and remote drivers and feedbacks (Martin et al., 2021).

Leading work-package on coupled model evaluation, inter-comparisons and process studies of Indian monsoon in a joint project WCSSP-India between Met Office, UK universities and India Ministry of Earth Sciences.

Studied the roles of air–sea coupling and horizontal resolution in the representation of Indian monsoon low pressure systems (Levine et al., 2020) showing that the effects of air–sea coupling are substantially smaller than the positive effects of an increase in horizontal resolution.

Analysed and documented skill for prediction of June mean rainfall in the middle/lower Yangtze River basin up to four months in advance, and for the intensity and position of the western North Pacific subtropical high, using the GloSea5 seasonal forecasting system (Martin et al., 2020; Zhang et al., 2020).

Randy Wu: Worked on identification of the leading patterns of short-term, medium-term and long-term meteorological drought variations over Asia with one PhD student; Worked on changes of precipitation events with different consecutive days over Asia with one PhD student.

Aurel Moise: Worked on future changes of daily rainfall across tropics; climate change projections of tropical rainfall and a comparison of paleo and future monsoon circulations. Additionally, guided activities on sub-seasonal and seasonal prediction in the tropics as well as coordinating workshops across ASEAN community. Additionally, Aurel Moise is guiding the Singapore efforts on S2S activities: both the workshops series as well as the ongoing SEA S2S Pilot Projects are very successful activities in the region.

2.3 Scientific capacity building and career support

MP members have advised numerous PhD students and postdocs on topics related to monsoon systems in their respective universities and institutions.

Dr. Leila Carvalho has collaborated in career support of a postdoctoral researcher developing research on the South American Monsoon at the School of Geography and the Environment, University of Oxford, UK, with whom she published a research article (Zilli and Carvalho 2021).

Dr Aurel Moise is co-leading the efforts to set up new meteorology and climate science degree structure within 2 Singapore universities in support of local and regional capacity building.

Dr Aurel Moise is coordinating the ARCDAP workshop series. The ASEAN Regional Climate Data, Analysis and Projections (ARCDAP) workshop series was first held in 2018, in response to a proposal from the WMO Regional Association (RA) V Working Group on Climate Services (WG-CLS) for the ASEAN region to enhance synergies in generating regional/national climate change projections. Two of these workshops have been held in the previous years. The Third Workshop on ASEAN Regional Climate Data, Analysis and Projections (ARCDAP-3) aims to encourage the uptake of the latest ensemble of climate simulations from the Coupled Model Intercomparison Project (CMIP6) and to improve regional knowledge in climate processes, variability and change. In addition, it will encourage regional collaboration and information sharing in research areas relevant to climate change projections. Initially scheduled for March 2020, it was delayed due to COVID-19 and will now be held (virtually) in March 2021. It will build upon recommendations from previous editions of ARCDAP (1 and 2 in 2018 and 2019 respectively) as well as other regional initiatives such as the Coordinated Regional Downscaling Experiment Southeast Asia (CORDEX-SEA) and similar workshops organised by the World Meteorological Organisation (WMO). Participants will be engaged through a mix of presentations and discussions led by scientists from both the Centre for Climate Research Singapore (CCRS, Singapore) as well as regional and international experts with the relevant expertise to support the development of regional capabilities in using evaluation tools to explore the latest available model output from CMIP.

Dr Aurel Moise is coordinating a regional NWP training series on model parameterization. Numerical weather prediction (NWP) is an important tool used by National Meteorological

and Hydrological Services (NMHS) in the region to deliver accurate and timely weather predictions. Outputs from global and regional numerical models are often used for now casting, medium-range and seasonal forecasts. While there have been recent developments in NWP capability in the ASEAN region, capability building courses on NWP are still much needed. ASEAN Specialised Meteorological Centre (ASMC) had proposed at the 40th Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics (ASCMG-40) held in May 2018 to conduct a training course on NWP and the proposal was well-received.

The Meeting welcomed ASMC's offer to deliver such capability building courses on NWP. Weather Prediction by Numerical Methods (WPNM) was conceptualised as part of ASMC 5-year Regional Capability Building Programme for the ASEAN region. An initial assessment of the training needs was performed in collaboration with NMHS through a questionnaire. The proposed modules of WPNM are designed to cover the basic aspects of NWP: (1) Governing equations and numerical methods; (2) Physical parameterizations; (3) Data assimilation; and (4) Predictability. The first course in this series has been conducted and the second one was scheduled for April 2020. Due to COVID-19 it was rescheduled and will not be held (virtually) in June 2021.

Dr. Suryachandra Rao delivered talks to students from different universities in India on Monsoon variability and prediction.

2.4 Knowledge exchange and synergistic activities

H. Annamalai: Science Review Panel (member): "UK Met Office – India MoES" WCSSP Project on Monsoons (since October 2019)

Marcelo Barreiro: Lead Author (LA) IPCC 6th Assessment Report WG1, The Physical Science Basis, Chapter 3: Human influence on the climate system.

Leila Carvalho: Has maintained collaborations with Dr. Francina Dominguez in developing new experiments to investigate the impacts of land-use change on the South American Monsoon.

Alice Grimm: Has been interacting with **Francina Dominguez** and her student Divyansh Chug in the analysis of data and model results regarding land-atmosphere interactions in the La Plata river basin and the relationships between spring and summer soil moisture and precipitation. Exchange of e-mails and teleconference has been used in this interaction. A conference paper has already resulted: Chug, D., F. **Dominguez**, A. M **Grimm**, S. W. Nesbitt, R. J. Chase, R. Miller, 2020: Using antecedent soil moisture information for accurate prediction of subseasonal-to-seasonal hydroclimate variability over South America. Abstract A188-0012. American Geophysical Union (AGU) Fall Meeting, Virtual Meeting, 01-17 dezembro, American Geophysical Union. <https://https://agu.confex.com/agu/fm20/webprogram/Paper743733.html>

Tieh-Yong Koh: From June 2020, interacted with local and regional think-tanks and contributed to Singapore's national report as part of the Report on the State of Climate Change in ASEAN Region for ASEAN Working Group for Climate Change, which is due to be delivered in Mar 2021.

Gill Martin: Worked as part of Precipitation Metrics activity alongside other international experts, following agreement at a Precipitation Metrics Workshop (sponsored by the US DOE) in July 2019 to gather a set of “exploratory metrics” for rainfall that can be used by model developers in guiding model development, for earth system scientists investigating precipitation variability and change, and for researchers and stakeholders interested in specific aspects of precipitation relevant to their applications.

As part of this activity, co-convened a session at EGU 2020 on “Evaluating and improving precipitation in climate models”.

Yukari N. Takayabu: Has been corresponding with Caroline Muller at CNRS, Laboratoire de Météorologie Dynamique and published a collaboration letter entitled ‘Response of precipitation extremes to warming: what have we learned from theory and idealized cloud-resolving simulations, and what remains to be learned?’ as listed below, and continues to collaborate and will present the study in vEGU 2021.

Project Scientist from JAXA for the NASA-JAXA Precipitation Measurement Mission, leading the Joint Project Science Team (JPST) for the Global Precipitation Mission.

Corresponding with Wei-Kuo Tao in Latent Heating Working Group in the NASA-JAXA Precipitation Measurement Mission activity, and published a paper by Takayabu Y.N. and Tao WK. (2020) Latent Heating Retrievals from Satellite Observations, as listed below.

An International Member of the SALT of the Aerosol, Cloud, Convection and Precipitation (ACCP) project in NASA.

A member of the Working Group on Tropical Meteorology Research (WGTMR) of WMO, and expected to connect their activity with the activity of the CLIVAR/GEWEX monsoon panel.

Andy Turner: Lead Author (LA) IPCC 6th Assessment Report WGI The Physical Science Basis, Chapter 10: Linking global to regional climate change. Contributing Author (CA) of Technical Summary.

Lecturer at NCAS *Introduction to Atmospheric Science* training school, January 2020, Leeds, UK (Climate Variability)

Contributed with the Panel Co-Chair Aurel Moise, Panel Members Alice Grimm and recent former members R. Krishnan & Tianjun Zhou to major monsoon climate change article.

Suryachandra Rao: Coordinated a session on Monsoon Variability, Prediction and its Applications in India's Vaishwik BharatiyaVaigyanik (VAIBHAV) Summit. VAIBHAV summit is aimed at supporting a collaborative initiative by Science & Technology and Academic Organizations of India to enable deliberations on thought process, practices and R&D culture with a problem-solving approach for well-defined objectives.

Delivered an invited talk titled "Seasonal Prediction Model developments" at Annual Monsoon E-workshop organized online by Ministry of Earth Sciences and Indian Meteorological Society.

WMO regional Climate Outlook Forum

- **Aurel Moise** attended the South Asian Climate Outlook Forum (16th Session), which was hosted online in April 2020. 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 2020 Monsoon season (JJAS) based on expert assessment of the models. The consensus statement that came out from this forum is a normal monsoon for 2020.
- **Aurel Moise** participated in the ASEAN Climate Outlook Forum (ASEANCOF-15). The ASEANCOF was established in 2013 and has since been held in various Southeast Asian countries. ASEANCOF aims to provide collaboratively developed and consensus-based seasonal climate outlooks and related information at the regional scale. There are two sessions held annually, usually an online forum in May ahead of the SW Monsoon season, and a physical meeting in November ahead of the NE Monsoon system. The hosting of the physical meetings is rotated among the ASEAN NMHSs. This year, due to the COVID situation and travel restrictions, the November meeting was held online. Overall there were more than 50 participants for ASEANCOF. The main discussion points were on the monsoon season consensus (average to above-average expected NE Monsoon Season), the forming of an ASEANCOF Working Group, updates on the forming of the Southeast Asian RCC Network and the WMO-led discussion on finalising the roadmap towards objective RCOF outlooks.

ASEAN Specialised Meteorological Centre (ASMC)

- **Aurel Moise** contributed to activities of AMSC (reviewing Bulletins and Outlooks) throughout 2020.
- **Aurel Moise** is coordinating the ARCDAP workshop series.
- **Aurel Moise** is coordinating regional NWP training series on model parametrisation

Engagement with WCRP CMIP Panel

- Continued engagement with CMIP6 MIPs, including a GMMIP and CORDEX (**Aurel Moise & Andy Turner**)

2.4.1 Attending and presenting in conferences:

Annamalai: Identifying sources of model errors in representing Asian Monsoon Precipitation: International Workshop: Storyline Approach on Regional Extreme Weather and Their Future Change for Better Adaptations to the Climate Change ", Tokyo, Japan, March 2020 (Invited speaker) – Workshop cancelled due to Covid-19.

Carvalho: Variability and trends in the South American Monsoon during the Historic Period: Challenges and Advancements. Federal University of Alagoas, Brazil (Invited talk)

Cavalcanti: Teleconnection patterns in the Southern Hemisphere in subseasonal to seasonal models hindcasts and influences on South America" by Iracema F.A. Cavalcanti and Naurinete JC Barreto at EGU 2020-S2S Session AS 1.9 Subseasonal-to-Seasonal Prediction: meteorology and impacts.

Grimm, A. M., L. R. Hakoyama, L. A. Scheibe, 2019: Subseasonal prediction of summer monsoon rainfall in South America and the MJO as a source of subseasonal predictability. Abstract A131-3015. American Geophysical Union (AGU) Fall Meeting, São Francisco, CA, 09-13 December.

Takayabu, Y. N., 2020: JAXA GPM Science Status, 2020 NASA PMM Science Team Meeting, 19-23 October, 2020 Virtual (invited)

Takayabu, Y. N.: 'Precipitation Science from Space and Synergy with Aerosol, Clouds, and Climate Studies', Jan. 19, 2021, The Joint PI meeting of JAXA Earth Observation Missions FY2020, plenary session, Virtual, (invited)

Takayabu, Y. N., Wataru Kaneko, and Hiroki Tsuji: 'Effects of the Atmospheric Rivers on Rainfall Characteristics and Their Implications for a Long-term Trend of Heavy Rainfalls', Jan. 15, 2021, 34th Conference on Climate Variability and Change, AMS 101 Annual Meeting, Online

Takayabu, Y. N., Y. Ikuta, S. Shige, C. Yokoyama, A. Hamada, H. Tsuji, and M. Yamaji, 2019: Estimate of 3D convective latent heating (SLH) from space-borne radar measurements and its assimilation with the JMA Local Forecast Model: Tenth Asia-Oceania Meteorological Satellite Users' Conference, Melbourne, Australia, 3-7 December, 2019. (invited)

Raphaldini, Breno; **Silva Dias, Pedro Leite;** Teruya, André Seiji; Massaroppe, Lucas, 2019: Decomposition of the Quasi Biennial Oscillation in Hough modes and its interaction with the tropical troposphere. Geophysical Research Abstracts . 2019, Vol. 21, p1-1. 1p
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Custodio, I.S., **P. L. Silva Dias,** I.C. Wainer, 2019: South American Monsoon System Over the Last 21,000 Years: Impacts of TraCE-21k Single Forcing Experiments. AGU 2019 Fall Meeting, San Francisco.

Raphaldini, B., Mayta,V.C., **Silva Dias, P.L.,** Teruya, A.S., Massaroppe, L., Medeiros, E., 2019: The erratic propagation of long Rossby waves and implications for tropical dynamics . AGU 2019 Fall Meeting, San Francisco.

R. Wu: ENSO Modulation of ISO Intensity and Upscale Feedback of ISO on Seasonal Mean SST in the Western North Pacific. JpGU-AGU Joint Meeting 2020, Virtual Meeting, July 12-16, 2020. (Invited)

R. Wu: Can Atmospheric Internal Process Generate the North-south Contrasting Summer Rainfall Change Pattern over Eastern China? The 1st International Workshop on Global Monsoons Model Intercomparison Project (GMMIP), October 28-30, 2019, Beijing, China.

Xin Rong Chua, Sandeep Sahany, Chen Chen, Muhammad E. Hassim, Gerald Lim, **Aurel F. Moise**, Venkatraman Prasanna, A cold surge diagnostic for evaluating CMIP6 GCMs over the Maritime Continent, American Geophysical Union (AGU) Fall Meeting 2020, San Francisco, CA, 09-13 December.

Chen Chen, Sandeep Sahany, **Aurel F. Moise**, Xin Rong Chua, Muhammad E. Hassim, Gerald Lim, Venkatraman Prasanna, Evaluation of ENSO Teleconnections over the Maritime Continent in CMIP6 Models, American Geophysical Union (AGU) Fall Meeting 2020, San Francisco, CA, 09-13 December.

Gerald Lim, **Aurel Moise**, Raizan Rahmat and Bertrand Timbal Building synergies in regional climate services for Southeast Asia: The ASEAN Regional Climate Data, Analysis and Projections (ARCDAP) workshop series, EGU Meeting, May 2020.

Gerald Lim, **Aurel Moise**, Raizan Rahmat and Bertrand Timbal (EGU PICO Session), How to make weather and climate services more efficient in developing countries, EGU Meeting, May 2020.

Gill M. Martin, Nicholas P. Klingaman, Segolene Berthou, Rob Chadwick, Elizabeth Kendon, and **Aurel Moise**, Understanding rainfall characteristics in climate models and observations, EGU Meeting, May 2020.

3 Plans for 2021 and beyond

The GEWEX/CLIVAR Global Monsoon 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.

The renewal process of the regional working group is ongoing. This includes a strong focus on the younger next-generation in the regional working group.

Further engagement with WCRP on the regional transformation as well as linkages to lighthouses activities.

Evaluation of the CMIP6 model performance in simulation of short-term, medium-term and long-term meteorological drought variations over Asia.

Plan to examine the connection of Indochina Peninsular precipitation variability with that in India and East Asia.

We have been asked to contribute to the organizing of a shared workshop with an ocean panel.

Activities envisioned for the future: workshops, organizing sessions in conferences, lectures to contribute with education and training on aspects related to interpreting and using models. Conducting an online International conference on the future directions of subseasonal and seasonal prediction over South Asia during 29-31 March 2021, IITM, Pune (Jointly Organized by IITM and WWRP/WCRP sub seasonal to seasonal (S2S) Project of WMO).

Preliminary Work Plan for 2021 and beyond:

- Evolve a strategy to assess the current levels of predictive skill of the coupled ocean-atmosphere-land system in the monsoon regions;
- Design and implement a means to investigate the interactions between climate mean state and different modes of monsoon variability, thereby furthering monsoon prediction capability.
- Design and implement a means to investigate scale interactions from sub-daily, through intraseasonal to interannual;
- 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 adequately gain this understanding and perform these assessments;
- Support a monitoring strategy designed by the Ocean Panels for the tropical and subtropical oceans necessary for investigating the structure and variability of the regional monsoons;
- Oversee development and implementation of plans for an optimised set of process studies in the Asian-Australian, American, and African monsoon regions;
- Coordinate a strategy to utilize satellite observations to investigate multi-scale monsoon variability and its response to climate change, to cooperate with numerical model groups, and advise on future satellite earth observation plans;
- Process-based diagnostics: Collaborative efforts to identify sources of model errors in simulating monsoon precipitation basic state across different monsoon regions;
- SASCOF and other related stakeholders: direct involvement of the panel and working groups in improving the consensus seasonal outlook;
- Cross-panel activities: coordinate with other panels (e.g., Indian Ocean) for emerging research for societal needs. Example: possible role of 2019 IOD on Indian summer monsoon (wet conditions during August and September) and Australian drought and incidence of fire;
- Need to substantially improve observations over land and ocean. Observations are not only provided by pluviometers but by all sets of instruments capable of evaluating boundary layer processes, profiles of moisture, temperature, winds, etc. These observations can only be obtained during short periods of time and during major field campaigns involving large numbers of researchers. One way to start this might be to better synthesize what campaign/process observations are out there for the community.
- Generalizing storm types approach to the whole tropical zone.
- Study the variations of extreme precipitation mechanisms over the globe, utilizing radar observation from space
- Strengthen contacts with other monsoon-related groups, such as those in WMO/WCRP, and collaborate in scientific or educational meetings on monsoons

- Encourage the activity of AsiaPEX, for continuous international collaborations on monsoon system observations

4 Articles published in 2019/20 as part of panel activities

- Almazroui M, Islam MN, Saeed F, Saeed S, Ismail M, Ehsan MA, Diallo I, O'Brien E, Ashfaq M, Martínez-Castro D, **Cavazos T**, Cerezo-Mota R, Tippett MK, Gutowski WJ, Alfaro EJ, Hidalgo HG, Vichot-Llano A, Campbell JD, Kamil S, Rashid IU, Sylla MB, Stephenson T, Taylor M, Barlow M. 2021: Projected Changes in Temperature and Precipitation Over the United States, Central America, and the Caribbean in CMIP6 GCMs. *Earth Syst Environ*, 5 (1). <https://doi.org/10.1007/s41748-021-00199-5>.
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5 Budget and other needs for 2021

Much of the budget needs for travel will depend on who the COVID restrictions are evolving over 2021. While most of the year is likely to see no travel, we have prepared a submission for a possible face-to-face MP meeting in December (**see Annex A**).

During this time of virtual meetings and exchanges, some funding could be spent on improving/enhancing the MP website.

List of Annexes:

- Annex A: Panels request for meeting support
- Annex B: Terms of Reference for Regional Working Groups of the WCRP
GEWEX/CLIVAR Monsoons Panel
- Annex C: Regional Working Groups structure and membership
- Annex D: Homage to Dr Francoise Guichard (excerpt from GEWEX Quarterly)

Annex A

Proforma for CLIVAR Panel requests for SSG approval for meetings

Note: If your group has approved funds in 2020 that were not used because of Covid19, and you propose to use them in 2021, they should be included again in this request, in addition to any new request.

1. Panel name: **CLIVAR/GEWEX Monsoons Panel**
2. Title of meeting or workshop: **Support panel face-to-face meeting in December 2021 (if possible wrt COVID situation)**
3. Proposed venue (Or indicate if online): **During AGU meeting**
4. Proposed dates: **During AGU meeting**
5. Proposed attendees, including likely number: **MP members**
6. Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:
7. Specific objectives and key agenda items:
8. Anticipated outcomes (deliverables):
9. Format:
10. Science Organizing Committee (if relevant)
11. Local Organizing Committee (if relevant)
12. Proposed funding sources and anticipated funding requested from WCRP:

Funding is sought from WCRP to support 5-6 MP members attending this meeting (if possible wrt COVID situation), noting that there is unspent funding from 2020 available as well.

Annex B: Terms of Reference for Regional Working Groups of the WCRP CLIVAR/GEWEX 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 C: Regional Working Groups

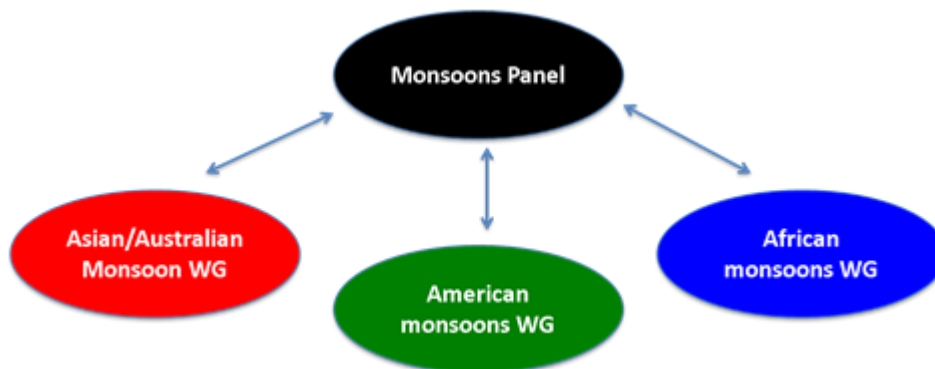
Justification for Regional Working Groups of the WCRP/CLIVAR Monsoons Panel

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).

2020 Membership of the Regional Working Group on Asian-Australian Monsoons (WG-AAM)

1. Hariharasubramanian Annamalai
2. Aurel Moise
3. Andrew Marshall
4. Gill Martin
5. William Boos
6. Parthasarathi Mukhopadhyay
7. Suryachandra Rao Anguluri
8. Renguang (Randy) Wu
9. Govindarajalu Srinivasan
10. Tieh-Yong Koh
11. Yi Ming
12. Brian Mapes

2020 Membership of the Regional Working Group on American Monsoons (WG-AMM)

1. Alice Grimm
2. Iracema Cavalcanti

3. Leila Carvalho
4. Manoel Gan
5. Marcelo Barreiro
6. Pedro da Silva Dias
7. Rong Fu
8. Tereza Cavazos

2020 Membership of the Regional Working Group on African Monsoons (WG-AFM)

1. Serge Janicot
2. Alessandra Giannini
3. François Mkankam Kamga
4. Françoise Guichard (*passed away*)
5. Cathryn Birch
6. Mouhamadou Bamba Sylla
7. Pauline Dibi Kangah
8. Benjamin Lamptey
9. Christopher Lennard
10. Frederick Semazzi
11. Claudine Wenhaji-Ndomeni

Annex D: Hommage to Dr Françoise Guichard

Hommage à Françoise Guichard



Members of the CLIVAR/GEWEX Monsoons Panel and International CLIVAR Monsoon Project Office

Shortly before the publication of this special monsoons issue of *GEWEX Quarterly*, Françoise Guichard, member of the Monsoons Panel, passed away on Saturday, 5 December 2020. For her friends around the world, this was the saddest news in a terrible year, as they knew that she was pleased to be home in Concarneau, in her native region of Bretagne (Brittany), France, "with her feet in the water". In the GEWEX and CLIVAR communities, Françoise has been more widely known over recent years as a former Co-Chair of the Monsoons Panel, where she continued to serve as a member, having established a framework for the study of monsoon behavior in different regions under the umbrella of the global monsoon. She was also a member of the Regional Working Group on the African Monsoons, fostering the active coordination of African monsoon research. Françoise is fondly remembered by her current and former colleagues for her pioneering work as part of the African Monsoon Multidisciplinary Analysis (AMMA) program, which reflects the culmination of her scientific interests in the West African monsoon. Françoise, as a senior scientist at Centre National de Recherches Météorologiques (CNRM) with several other affiliations, leaves behind a rich legacy of scientific contributions meticulously documented in publications dating from 1996 to several this year, which this brief tribute cannot do justice. These works span topics on the behavior and structure of tropical clouds, convective modeling during the Tropical Ocean—Global Atmosphere Coupled Ocean Atmosphere Response Experiment (TOGA-COARE), confronting cloud simulations with observational data, as well as significant contributions to weather forecasting and climate projections over West Africa. Her insights into the physical processes governing monsoons are invaluable, and her quest to understand the different monsoon components is unmatched.

As colleagues, we remember her warm and welcoming smile and her engaging yet supportive nature, but above all we remember her as a great human being, generous and open-minded. Her students, colleagues, and our research area at large suffer a great loss without her guidance and contributions. We offer our sincere condolences to her family, friends, and colleagues.

Quarter 4 2020