

CLIVAR/GEWEX MONSOONS PANEL Annual Report 2021

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1. Panel overview

1-2 paragraphs background with a summary of panel current main mission and 2020-2021 activities and obstacles, if any.

1.1 Background

The CLIVAR/GEWEX Monsoons Panel (MP) was established in 2014 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 MP membership encompasses the research interests of both CLIVAR and GEWEX as well as all the regional monsoons, with in-country membership where possible. While the MP takes a global view, it is also important to address region-specific details, in particular in engaging regional stakeholders and managing local knowledge exchange and up-skilling. Keeping this in view, the MP has established a sub-structure of working groups dedicated to three monsoon regions, namely the Asian-Australian, American and African Monsoons.

See Monsoons Panel web pages for Terms of Reference (ToRs), membership and previous reports:

- <http://www.clivar.org/clivar-panels/monsoons>
- <https://impo.tropmet.res.in/mp-members.html>

Activities of the MP have been supported by the International CLIVAR Monsoon Project Office (ICMPO) up to July 2021. From July 2021 onwards, the scope of the ICMPO has been broadened to cover the monsoon research activities of both the WCRP and World Weather Research Programme (WWRP) through the establishment of a new International Monsoons Project Office (IMPO) that continues to be hosted by the Indian Institute of Tropical Meteorology (IITM), Pune, India, under a new agreement signed between WMO and IITM.

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 facilitate 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 advise 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.

The Asian-Australian Monsoon Working Group (AAMWG) has been refreshed during 2021 with a new membership comprising 17 renowned scientists from the international community. We now have representatives from countries throughout the Asian-Australian monsoon region: Australia, China, India, Indonesia, Japan, Nepal, Philippines, Singapore, Sri Lanka, UK and USA, and from different disciplines including underpinning research, operational forecasting and observations. We have therefore positioned this Working Group to address two key overarching aims:

- To promote and facilitate active engagement and interaction among research, operational predictions and stakeholders in the different regional monsoon components of the Asian-Australian Monsoon
- To provide authoritative information on processes understanding, models' fidelity in their (regional components) representations, and forecast skill assessment

The American Monsoons Working Group (AMMWG) has been renewed during 2021. Its new membership was completed in December 2021. The new composition displays a good balance between genders and between younger and more experienced scientists. Its mission is to assess the state of the art knowledge on relevant aspects and physical processes related to the American monsoons, identify gaps, emergent issues, and their possible impacts on society. These will help us to point out priorities to improve our current knowledge and bridging to society. For this, the AMMWG will:

- Promote and facilitate collaborative research, regional trainings, workshops and special sessions, either virtual or hybrid, in existing scientific congresses.
- Support capacity building for young scientists.
- Provide authoritative information on the understanding of monsoon physical process, models' fidelity in their (regional components) representations, forecast skill assessment, and future projections under different radiation emission scenarios.

In early 2022 the AMMWG intends to hold one or two meetings in which the new members will discuss and decide on the priorities, objectives and activities of the WG. Some important monsoon-related themes will be selected and the WG will assess the related state of the art knowledge, and identify gaps and research priorities, in order to improve processes understanding and their representation in models. The selected objectives should motivate the majority (preferably all) of the members and be feasible within the established timeframe.

1.3 Panel 2020-21 activities

1.3.1 Organizational Activities

The last face to face MP meeting was held in December 2019 during the American Geophysical Union conference in San Francisco, USA. Continued COVID-19 restrictions have prevented any further meetings, which has significantly impacted team work.

The panel has had two virtual meetings in 2021, which have served to introduce new members, discuss updates to the TORs and future work plans. In addition, the two co-chairs also held a few infrequent teleconferences.

Some 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 panel has made concerted efforts to re-establish the regional working groups, with the help of the International Monsoons Project Office (IMPO) and some current and former members of the MP. During April and May, the former members of the regional working groups were contacted to determine their willingness to continue. A few of them have expressed their interest to continue and they were involved in identifying new members and reestablishing the working groups. To facilitate the linkage between the MP and its regional WGs, the MP has also ensured that there are at least two MP members in each of the WGs. The details of the membership of regional working groups are available at the following links:

- Asian-Australian Monsoons (17 members)
 - Co-Chairs: Dr Hariharasubramanian Annamalai and Dr Gill Martin
 - <https://impo.tropmet.res.in/mpwg-aam-members.html>;
- African Monsoons (19 members)
 - Co-Chairs: Dr Claudine Wenhaji Ndomeni and Dr Akintomide Akinsanola
 - <https://impo.tropmet.res.in/mpwg-afm-members.html>;
- American Monsoons (14 members)
 - Co-Chairs: Dr Alice Grimm and Dr Tereza Cavazos
 - <https://impo.tropmet.res.in/mpwg-amm-members.html>.

It is encouraging to see a good regional and gender balance in the membership, along with a large number of early-career scientists which is expected to bring more energy in their activities. Given that much of the work is now envisaged through virtual networking, efforts were made to increase the size of the working groups.

The new AAMWG membership was finalized between July and August 2021 and has met on a monthly basis since September. The other two working groups were finalized later, and are planning their activities including virtual meetings.

1.3.2 Scientific work

Renguang Wu worked on:

- 1) Asian rainfall pattern associated with the Indochina Peninsular early and late summer rainfall variability with one Master student,
- 2) Asian short-term, medium-term and long-term drought variations and contributions of precipitation and temperature with one PhD student, and
- 3) East Asian winter monsoon impacts on winter precipitation over East Asia-western North Pacific and SST in the South China Sea with one Master student.

Pankaj Kumar developed studies on the South Asian monsoons to address the various aspects, such as extremes precipitation events (Kumari et al., 2021), the importance of horizontal resolution in simulating monsoon precipitation for CORDEX-South Asia (Mishra et al. 2021),

projection of drought using a regional earth system model (Saharwardi et al., 2021a) and global earth system models (Saharwardi et al., 2021b), drought dynamics and variability (Saharwardi et al., 2021c).

Please also see Section 2.2.

2. Achievements for 2020-2021

2.1 Workshops

- The MP has been actively engaged with the preparations for the Seventh WMO International Workshop on the Monsoons (IWM-7) in collaboration with the World Weather Research Programme (WWRP), to be held during 23-26 March 2022 (<https://mausam.imd.gov.in/IWM7/>).
- The MP has actively supported the Online Training Workshop on Subseasonal to Seasonal (S2S) Prediction of Monsoons held in conjunction with and preceding the IWM-7 (<https://impo.tropmet.res.in/iwm7training.php>) held during 1-12 November 2021.
- AOGS21, session AS15: The Asian Monsoon in a Warming Environment, Ramesh Kripalani, Kyung-Ja Ha, Renguang Wu, Jai-Ho Oh, and Surya Chandra Rao
- Renguang Wu: Respective and combined impacts of regional SST anomalies on tropical cyclogenesis in different sectors of the western North Pacific. EGU21, Virtual, April 25-30, 2021.
- Zhenzhen Wang and Renguang Wu: Individual and combined impacts of ENSO and East Asian winter monsoon on the South China Sea cold tongue intensity. EGU21, Virtual, April 25-30, 2021.
- For AMMWG, there was one initiative that helped to spread the need to take action against climate change in order to prevent relevant modifications to the South American monsoon system, in terms of regional circulation and moisture fluxes, with major focus on the need to preserve the Amazon rainforest. The event was organized by the Universidade Federal do Paraná (UFPR, Federal University of Parana), and was titled: SEE-U: Sustainable Development Goals, a global scientific conference at UFPR (<https://www.see-uconference.org/>). SEE-U aimed to discuss ways to promote the engagement of universities, communities, and policymakers in creating strategies to deal with the challenges faced to achieve the SDGs. For this event, Prof. Alice Grimm organized the two sessions related to SDG 13 - Climate Action: a plenary session and a panel session. The plenary session featured Dr. Carlos Nobre presenting the talk: 'The Amazon near a Tipping Point. The need of an innovative standing forests bioeconomy'. The panel session featured four lectures by lead authors of the IPCC WG1-AR6 and a Vice-Chair of the IPCC. All of them covered important topics to prevent climate change that can significantly alter the monsoon system in South America, such as the possible effects of Amazonia deforestation on the tropics-extratropics interaction via aerial rivers. All the lectures are available.
- Besides, Alice M. Grimm delivered the invited talk "Some aspects of subseasonal prediction of the South American monsoon" in the Virtual International Conference on the "Future directions of Subseasonal to Seasonal Prediction over South Asia", Pune, India, 29-31 March 2021, organized by IITM and WMO WWRP/WCRP S2S Prediction Project.
- Dr. Leila Carvalho presented a lecture on the South Atlantic Convergence zone during the Seventh WMO International Workshop on Monsoons (IWM-7) as part of online

training workshop on subseasonal to seasonal (S2s) prediction of monsoons (November 2021).

- Dr. Leila Carvalho presented an online invited lecture on the South American Monsoon System at the University Federal do Alagoas, Brazil (January 2021). This lecture is part of the post-graduate program.
- Dr. Leila Carvalho is acting as one of the mentor advisors of the University of California President's Postdoctoral Fellow Dr. Janin Guzman-Morales. Dr. Guzman-Morales project investigates the variability of the monsoon regime in Central America and impacts on migration patterns and poverty (July 2021-July 2023).

2.2 Scientific results from activities

- As a result of the joint work of the previous membership of the AMMWG, a review chapter was published in 2020:
 - Grimm, A. M., F. Dominguez, I. F. A. Cavalcanti, T. Cavazos, M. A. Gan, P. L. Silva Dias, R. Fu, C. Castro, H. Hu, M. Barreiro, 2020: South and North American monsoons: characteristics, life cycle, variability, modelling and prediction. In: Chang, C. P., K.-J. Ha, R. H. Johnson, D. Kim, G. N. C. Lau, B. Wang (eds.), *The Multi-Scale Global Monsoon System*, World Scientific Series on Asia-Pacific Weather and Climate, Vol. 11, World Scientific Publishing Company, Singapore, 500 pp., Chapter 5, p. 49-66. ISBN: 978-981-121-659-6.
- Although not including the participation of the entire working group, three AMMWG members have recently participated in an analysis of current and future regional monsoons at global scale (Ashfaq et al., 2021). An unprecedented ensemble of regional climate model (RCM) projections was used over seven regional CORDEX domains to provide, for the first time, an RCM-based global view of monsoon changes at various levels of increased greenhouse gas (GHG) forcing. Regional climate simulations exhibited high fidelity in capturing key characteristics of precipitation and atmospheric dynamics across monsoon regions in the historical period. In the future period, regional monsoons exhibit a spatially robust delay in the monsoon onset, an increase in seasonality, and a reduction in the rainy season length at higher levels of radiative forcing. All regions with substantial delays in the monsoon onset exhibit a decrease in pre-monsoon precipitation, indicating a strong connection between pre-monsoon drying and a shift in the monsoon onset.
- Other studies on the American monsoons, with the individual participation of AMMWG members, have been published on various topics, such as the combined effect of climate oscillations in producing extremes (Grimm et al., 2020), climate change and interdecadal variability in the American monsoons (Carvalho, Grimm and Dominguez 2020), monsoons climate change assessment (Wang et al., 2021), MJO influence and subseasonal prediction of active and break phases of the South American summer monsoon (Grimm et al., 2021), extreme rainfall events, their trends and connection with climate oscillations (Machado et al., 2021), teleconnections between Southern African monsoon and South American monsoon (Silverio and Grimm 2021), assessment of the representation of South American Monsoon features in climate model simulations (Coelho et al., 2021), on deep convection (Gamelin et al. 2021) and extreme events (Cavazos et al., 2020), droughts (Spinoni et al. 2020), extreme rainfall events in the NAM (Colorado and Cavazos 2021), the role of dynamics and thermodynamics in the NAM (Boos and Pascale 2021), climate change projections (Reboita et al. 2021; Teodoro et al. 2021), El Nino variability and drought (Arango et al. 2021), and importance of the Atlantic overturning to the South American Monsoon on millennial scales (Bahr et al. 2021). In a series of papers, Ceron et al. (2021) analyzed regional aspects of the South American monsoon variability, particularly in Colombia,

and relationships with Pacific and Atlantic SST variability modes. Kayano et al. (2021) focused on the relations of the Indian Ocean modes and ENSO and their effects on the South American rainfall. Souza et al. (2021) examined the ENSO and non-ENSO related precipitation modes in South America. These papers are related to the South American monsoon variability. Ocampo-Marulanda et al. (2021) proposed the use artificial neural networks to fill missing data.

2.3 Scientific capacity building and career support

- *Please see Section 2.1.*

2.4 Knowledge exchange

- Several of the new AAMWG members are regular contributors to the Regional Climate Outlook Forums for the Asian-Australian region (SASCOF, ASEANCOF, EASCOF), allowing us to provide guidance on model strengths and weaknesses and to reach out to stakeholders.
- AAMWG members have submitted abstracts for the IWM-7 and promoted this workshop among their teams and contacts.
- The AAMWG provided some comments on the WCRP Lighthouse Activities to the Monsoons Panel.

3. Plans for 2022 and beyond

- AAMWG members are organizing themselves into subgroups focussing on three science themes: Asian-Australian monsoon processes and teleconnections, regional monsoon characteristics, and high-impact weather events. These subgroups will pursue specific activities that will produce appreciable accomplishments towards our overarching aims within 1-2 years. Each will be led by a senior WG member and one other, and all WG members will contribute to at least one of the subgroups. Their aim is for these to be active, self-led groups to continue discussions in between AAMWG full meetings.
- The AAMWG has proposed a biennial symposium series, "Asian-Australian Monsoon: Linking Research to Operational Needs". The inaugural symposium will be convened as AS40 session of the same title at the Asia Oceania Geosciences Society (AOGS) Annual Meeting 2022. The aim is to facilitate the sharing of information between climate scientists and operational personnel with the dual aims of translating the latest knowledge and predictive capabilities to applications and of guiding further research based on societal needs especially under the onslaught of climate change. In the AOGS 2022 session, relevant works in dynamics, modelling, observations, or research-to-operation projects are encouraged on the following themes:
 - Roles of equatorial waves, MJO, BSISO, ENSO and IOD in and across monsoon subsystems of Asia-Oceania.
 - Extreme weather events induced by multi-scale interactions with the Asian-Australian monsoon.
 - Projection of the Asian-Australian monsoon and its uncertainty under climate change.
- AAMWG members/conveners recommended eight invited speakers from the AAM region covering the above themes
- The African Monsoons Working Group (AFMWG) has also prepared preliminary plans for their work. The research interest/expertise of AFMWG members covers all the African subregions (e.g., West Africa, East Africa, Southern Africa, etc.). The working group is looking towards achieving the following:

- conduct innovative African monsoon-related research leading to publication, aiming for at least 1 publication per year from each subgroup within the AFMWG. The co-chairs would also explore the possibility of leading/writing a review article/report;
 - explore a special issue in a reputable journal where all these findings can be published;
 - schedule an African monsoon meeting in Africa and also look at the possibility of co-hosting with the International Centre for Theoretical Physics (ICTP) and/or other bodies/institutions;
 - organize a workshop/hands-on seminar for African students;
 - subgroups within the WG-AFM to have meetings once every month and the entire AFMWG to meet once every two months.
- In late January 2022, the AMMWG will discuss its priorities, objectives and activities for 2022-2023. Among these activities there may be training courses, workshops, and special sessions at the American Geophysical Union Fall Meeting (AGU), the American Meteorological Society Annual Meeting (AMS), the European Geophysical Union General Assembly (EGU), the Brazilian Meteorological Congress, and the Mexican Geophysical Union Congress (UGM).
 - Also, Tereza Cavazos, co-chair of the AMMWG, is part of the Scientific Organizing Committee of the WCRP Open Science Conference 2023 (<https://www.wcrp-climate.org/soc-osc23>); the topic of the conference is “Bridging Climate and Society”. The WG will consider having special sessions on the regional monsoons.
 - With the COVID-19 pandemic, it is now common to organize some of the activities online. However, with the reduction of the pandemic to safe levels, and financial support being available, the intention is to hold a face-to-face event, similar to the Advanced School and Workshop on American Monsoons held in Sao Paulo, on August 2019, which was very successful.

4. Articles published in 2020/21 as part of panel activities (if any)

- Arango, J. P, B. Lintner, L. M. V. Carvalho, B. Lyon, 2021: Spatial extents of tropical droughts during El Niño in current and future climate in observations, reanalysis, and CMIP5 models, *Geophysical Research Letters*, <https://doi.org/10.1029/2021GL093701>
- Ashfaq, M., T. Cavazos, M. Simões Reboita, J. A. Torres-Alavez, E-S. Im, C. Funmilola Olusegun, L. Alves, K. Key, M. O. Adeniyi, M. Tall, M. Bamba Sylla, S. Mehmood, Q. Zafar, S. Das, I. Diallo, E. Coppola, and F. Giorgi. 2021: Robust late twenty-first century shift in the regional monsoons in RegCM-CORDEX simulations. *Climate Dynamics*, 57, 1463–1488 (2021). [10.1007/s00382-020-05306-2](https://doi.org/10.1007/s00382-020-05306-2).
- Bahr, A. S. Kaboth-Bahr, A. Jaeschke, C. Chiessi, F. Cruz, L. Carvalho, J. Rethemeyer, E. Schefuß, P. Geppert, A.L. Albuquerque, J. Pross, O. Friedrich, 2021: Late Holocene Precipitation Fluctuations in South America Triggered by Variability of the North Atlantic Overturning Circulation. *Paleoceanography and Paleoclimatology*, <https://doi.org/10.1029/2021PA004223>
- Boos, W. R., S. Pascale. 2021: Mechanical forcing of the North American monsoon by orography. *Nature*, 599, 611-615.
- Carvalho, L. M. V., A. M. Grimm, F. Dominguez, 2020: The Monsoons of the Americas. *Global Energy and Water Exchanges Quarterly (GEWEX Quarterly)*, 30, 4, 11-14. <https://www.gewex.org/gewex-content/uploads/2020/12/Q42020.pdf>.
- Cavazos, T., R. Luna-Niño, R. Cerezo-Mota, R. Fuentes-Franco, M. Mendez, L.F. Pineda Martinez, E. Valenzuela. 2020: Climatic trends and regional climate models intercomparison over

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- Colorado-Ruiz G., and T. Cavazos. 2021: Trends of daily extreme and non-extreme rainfall indices and intercomparison with different gridded datasets over Mexico and the southern United States. *Int. J. Climatol.*, 41(11), 5406-5430.
- Diaz N., M. Barreiro, N. Rubido, 2020: Intraseasonal Predictions for the South American Rainfall Dipole. *Geophys. Res. Lett.* doi.org/10.1029/2020GL089985.
- Douville, H., K. Raghavan, J. Renwick, R. P. Allan, P. A. Arias, M. Barlow, R. Cerezo-Mota, A. Cherchi, T. Y. Gan, J. Gergis, D. Jiang, A. Khan, W. Pokam Mba, D. Rosenfeld, J. Tierney, O. Zolina. 2021: Water Cycle Changes. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
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5. Budget and other needs for 2022 (in CHF)

Please keep in mind that the overall budget of CLIVAR is limited and this needs to be distributed between all activities and the SSG meeting.

The MP is keen to explore opportunities for a face-to-face meeting in 2022. Much of the budget needs in 2022 would be for travel, which of course will depend on how the COVID restrictions due to the emerging new variants evolve during the year. While the early part of the year is likely to see no travel, we have prepared a submission for a possible face-to-face MP meeting later in the year possibly co-located with a related scientific event to facilitate collateral funding for some members who have access to alternate resources. The MP was allocated a small amount for the same purpose in 2020/2021, which could not be utilized due to unrelenting travel restrictions. It is therefore requested that these unused funds may be re-allocated as the purpose remains the same.

With the changed work culture of virtual meetings and electronic exchanges of information, the MP is also keen to develop a comprehensive web portal dedicated to global monsoon research featuring the contributions from the MP as well as its regional working groups. This will be pursued with assistance from the International Monsoons Project Office (IMPO), for which some funding is required to contract professional web developers.

The consolidated budget request is provided in Annex A.

Aim for a total length of ~2 pages, more is fine, but not necessary.

Annex A

Proforma for CLIVAR Panel requests for SSG approval for meetings

Note: If your group has approved funds in 2021 that were not used because of Covid19 and other unexpected issues, and you propose to use them in 2022, 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: Meeting of the Monsoons Panel**
3. **Proposed venue (Or indicate if online): TBD (co-located with a related scientific event such as AGU Meeting)**
4. **Proposed dates: TBD (Third Quarter of 2022)**
5. **Proposed attendees, including likely number: MP members and invitees (about 15)**
6. **Rationale, motivation and justification, including relevance to CLIVAR science & WCRP Strategic Plan and Lighthouse Activities, and any cross-panel/research foci links and interactions involved: Many of the existing and prospective members are new and personal interactions are considered essential to get to know each other better and infuse team spirit. Such a meeting will also facilitate a common understanding of the MP members of the new WCRP Strategic Plan, its new core projects and Light House Activities, to facilitate a more coordinated approach to the relevant contributions from the MP members. Given the fact that the MP has not met for more than two years makes this a high-priority requirement.**
7. **Specific objectives and key agenda items: Review of MP's work including the joint CLIVAR/GEWEX context, coordination of regional working groups and planning of future activities**
8. **Anticipated outcomes (deliverables): Updated Work Plans of the MP and its regional working groups, associated deliverables and outlines of contributions to WCRP Strategic Plan**
9. **Format: Hybrid (face-to-face with provision for remote participation for members not able to travel)**
10. **Science Organizing Committee (if relevant): TBD**
11. **Local Organizing Committee (if relevant): TBD**
12. **Proposed funding sources and anticipated funding requested from WCRP: CHF 15,000 (CHF 10,000 for the MP Meeting and CHF 5,000 for MP's web portal development with assistance from IMPO). Funding is sought from WCRP to support 5-6 MP members attending the meeting (if COVID situation gets better) and to contract web developers, noting that the MP has not been able to utilize the allocated funds in 2020 as well as 2021. Efforts will be made to explore collateral funding by members who have access to alternate resources.**