

# GEWEX/CLIVAR Monsoons Panel

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## Monsoons Panel overview

### **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>

### **Summary of panel current main mission and 2016-2017 activities**

The Monsoons Panel and Regional Monsoon Working Groups have now filled their memberships and continue to prioritize key activities.

#### *Organizational activities*

Following the 1<sup>st</sup> Monsoons Panel meeting in Qingdao, September 2016, the main meeting activity this year is the forthcoming 2<sup>nd</sup> Monsoons Panel meeting to be held following the WMO 6<sup>th</sup> International Workshop on Monsoons in Singapore, November 2017.

The Panel has also held a liaison telecon with the Indian Ocean Panel on 24 January 2017, scoping for a review article on Indian Ocean-monsoons interactions

Panel current and former Co-Chairs held a coordination telecon on 15 June 2017.

Regional Monsoon Working Group activity has also been supported by telecons, with particularly strong activity from the Asia-Australia group:

- Africa Monsoons WG on 23 May 2017;
- American Monsoons WG on 30 June 2017;
- Asia-Australian Monsoons WG on 15 November 2016, 13 October 2016, 8 February 2017, 13 July 2017, 8 August 2017, 21 September 2017, 13 October 2017.

Further communication is carried out via email.

*Scientific work* can be summarized under the following headings:

Observational field campaign and process-modelling work (mainly in the India, Africa and south China regions); coordination of the Global Monsoons MIP contribution to CMIP6; various aspects of Climate change detection, attribution and modelling; and subseasonal-to-seasonal

activities. More detail on these aspects can be found under the *Scientific results from activities heading* below.

### **Obstacles**

- (1) Funding continues to be a major issue. We are fortunate that our 2017 Panel meeting can coincide with a major quadrennial WMO monsoons workshop, therefore attractive to our membership. The minimal funding obtained has enabled the attendance of one new member and one member from a developing nation. However, continued future funding pressure will inevitably lead to a state whereby participation in Panel activities favours wealthier nations – an absurdity given the geographical remit of the Monsoons Panel. In addition, enabling WG members other than Co-Chairs/full Panel members to attend relevant details is problematic, and again skewed against developing nations in Africa.
- (2) Following retirement of staff at the ICMPO (Pune/IITM) office (Director and Deputy Director), there has been reduced administrative support to the Monsoons Panel during the May-September 2017 period, followed by associated spin-up time. However, a new ICMPO Director (Dr M. Ali) has joined in Pune/IITM in September 2017. Ultimately, this may result in failure to provide administrative and secretarial support during the 2017 Panel meeting to be held in Singapore in November.

### **Achievements for 2016-17**

#### **Workshops**

- (1) The primary workshop contributions are the coordinated inputs (“invited reviews”) to the WMO 6<sup>th</sup> International Workshop on Monsoons to be held during November 2016 in Singapore, supported by Panel and Working Group members. For each contribution, six-page extended abstracts have been prepared in advance of the workshop; following the workshop the text will be expanded into full book chapters for a volume, “Global Monsoon: Research and Forecast”. These contributions comprise:
  - (a) Review on the Central African Monsoon (Panel members collaborating with a researcher from central Africa to present a state-of-the-art report on this very new area of active research, giving the opportunity to highlight the interest and gaps for this monsoon system, as well as scoping-out its existing research community and promoting the idea of setting up a field experiment in this region [**S Janicot, F, Kamga**];
  - (b) Review on South and North American Monsoons [**A Grimm and Americas Monsoon Working Group members**];
  - (c) Review on climate for the Australian monsoon [**A Moise and Asia-Australia Working Group Co-Chair H Annamalai**];
  - (d) Discussion forum on Grand challenges in monsoon modelling: representation of processes and sources of model errors [**led by A Moise and Asia-Australia Working Group Co-Chair H Annamalai**];
  - (e) Discussion forum on progress in the Global Monsoons MIP contribution to CMIP6 [**led by A Turner, T Zhou**];
  - (f) Further contributions from WG members.
- (2) Conference session organisation for monsoons activities
  - (a) The global monsoon in current, future, and palaeoclimate and their role in extreme weather and climate events (EGU, Wien, April 2017) [**A Turner with others**];
  - (b) Advances and Frontier Challenges in Global Monsoon Studies (IAMAS-IAPSO-IAGA Good Hope for Earth Sciences conference, Cape Town, August 2017) [**A Turner, R Krishnan, A Giannini, S Janicot with others**];

- (c) Invited talk at the above meeting in High Impact Weather and Climate Extremes session M17 (Extended-range prediction of high-impact weather in South American monsoon: the importance of the models' skill in simulating the MJO impact) [**A Grimm**];
  - (d) International Workshop on the Asian Monsoon in a Warmer World (August 2017, Yunnan, China) [**T Zhou** with others].
- (3)** Participation in Future Climate For Africa programme workshop activities
- (a) FCFA annual meeting (Cape Town, September 2017) [**A Turner**];
  - (b) AMMA-2050 annual meeting (Somone, Senegal, February 2017) [**F Guichard, S Janicot**].
- (4)** Participation in 3<sup>rd</sup> Plenary Meeting and Workshop of the Project IAI CRN 3035, (Buenos Aires, May 2017, Inter-American Institute for Global Change Research (IAI)) Invited talk: *Different scales of climate variability and their relationship with extreme precipitation events*, see <http://serviciosclimaticos.blogspot.com.br/2017/06/reunion-plenaria-y-taller-jasmin-del.html> [**A Grimm**].
- (5)** General Assembly contributions  
Various member contributions at AGU meeting, AMS meeting, EGU meeting etc. not listed for brevity.



Alice Grimm at the 2nd Plenary Meeting and Workshop of the Project IAI CRN 3035, Buenos Aires, 11-12 May 2017, InterAmerican Institute for Global Change Research (IAI).

### **Scientific results from activities**

#### *Observational field campaign and process-modelling work*

India: data collection and analysis continues following the major INCOMPASS aircraft and ground observations campaign during the Indian monsoon of 2016, with ground instruments providing continuing measurements. Data are being curated and all will be freely available to the global community in 2017. INCOMPASS held its annual meeting (March 2017, Bengaluru)

and is preparing a Special Issue for the Quarterly Journal of the Royal Meteorological Society [A Turner].

Africa: Panel and Working Group members are involved in the DACCIWA project, including in its advisory board; DACCIWA is currently the largest field and research programme over Africa. A further field campaign activity (AEROCLO-SA project; Aerosol radiation and clouds in southern Africa) was held over Namibia and the nearby Atlantic Ocean in August-September 2017.

China: Panel members are involved in leadership of the Southern China Monsoon Rainfall Experiment (SCMREX), a WMO/WWRP R&D project. The data has been used in process modelling with the UK Met Office CRM as part of the UK/China CSSP-China programme [T. Zhou].

#### *Global Monsoons MIP/CMIP6 coordination*

Panel members have continued to promote the GMMIP, a set of coordinated experiments endorsed by the WGCM CMIP Panel, the results of which will contribute to multi-model assessment of the regional and global monsoons in CMIP6 models and the IPCC 6<sup>th</sup> Assessment Report. Specific activities include:

- Publication of Zhou et al. (2016) descriptor paper in Geoscientific Model Development (see Annex C);
- Establishment of GMMIP mailing list and survey of activity status;
- Preliminary experimentation of role of orography on the Asian monsoon, revealing model dependence in the results (Wong et al., 2017, see Annex C);
- Convening of GMMIP discussion forum at the WMO 6<sup>th</sup> International Workshop on Monsoons (November 2017, Singapore).

#### *Climate change detection, attribution, adaptation and modelling*

Panel members have contributed to maintaining CORDEX activities in the American, Africa and Asian monsoon regions. In particular, the Africa and South Asia CORDEX activities have been coordinated by Panel members for several years.

The Africa group is very active through different workshops and multiple publications on regional simulation and evaluation of African climate, some of which will contribute in particular to the Special IPCC report on the impacts of 1.5°C warming, including submissions to a special issue of ERL. They are also contributing to the CORDEX FPS initiative (including one project entitled, “coupled regional modelling of land-atmosphere-ocean interactions over western-southern Africa under climate change” [S Janicot]. A new HyCristal Transport Pilot project (HyTTP) will investigate the potential role of future changes in the Lake Victoria level on investments in the transport sector [F Semazzi].

Information from CORDEX South Asia multi-model ensemble projections have been used for assessing future climate change projections over India (see <http://cccr.tropmet.res.in/home/reports.jsp>). Also the CORDEX South Asia group contributed to the Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP; <http://www.icimod.org/himap>) [R Krishnan]

Further efforts have used the HAPPI multi-model database to compare the outputs of 1.5°C and 2°C on the Asia-Australian Monsoon region, aiming to inform the associated IPCC Special Report [A Turner]. The HAPPI and CESM low warming experiment database have also been used to compare 1.5°C and 2°C warming over the African and East Asian regions. The CLIVAR

C20C+ experiment database has been used in the detection and attribution of extreme events changes over East Asia and Africa **[T Zhou]**.

Recent climate change observations in Africa, involving Panel members, have demonstrated that there has been a large positive trend in the occurrence of heavy rain events in the western Sahel since the early 1980s, consistent with changes in regional circulation associated with higher Saharan warming. These favour intense mesoscale convective systems; potentially this is the first sign of anthropogenic climate change in the water cycle in Africa.

Several members of the Panel and Africa Working Group are partners in the FCFA (Future Climate For Africa) programme through some of the regional projects focusing either on West (AMMA-2050), East (HyCristal), Central and Southern, and Southern Africa, plus the IMPALA pan-Africa project **[F Guichard, S Janicot, F. Semazzi, A Turner]**. A specific session on Africa's future climate was organized at the IAPSO-IAMAS-IAGA conference (August 2017, Cape Town), presenting results on climate, high-resolution convection-permitting modelling, impact studies and climate information usable for action (climate services). In particular, an atlas is being produced on user-based metrics for present and future climate.

The issue of climate services is being progressed within projects (e.g. CORDEX-Africa, AMMA-2050). A demonstrator will be set-up in Senegal over the next two years, supported by AFD and French national programmes. ACMAD is supporting the SAWIDRA project under the umbrella of WMO GFCS.

#### *Subseasonal-to-seasonal (S2S) activities*

S2S variability and prediction are emerging as unifying activities across the regional monsoons. Following last year's submitted papers on S2S time scales and the South American monsoon, a recent paper has shown that extended-range prediction of extreme rainfall events in the South Atlantic Convergence Zone is possible using calibrated S2S data **[A Grimm]**. This year S2S work over Africa is also increasing. Two papers have been published online for the special issue of "Subseasonal to seasonal predictability and prediction of monsoon climates", and two others are under review. In the "Forecasters' Handbook" (John Wiley & Sons, 2017), there is one chapter on "Sub-seasonal forecasting" on which one member of the panel has contributed. A member of the Asia-Australia Working Group leads the monsoon sub-project of the S2S.

#### **Scientific capacity building and career support**

- (1) The primary capacity building activity this year has been the design of and contributions to the WCRP-JNU Training School on Monsoon Variability in Changing Climate (Jeju National University, Republic of Korea, January 2017). Boram Lee of WMO worked with the Monsoons Panel during 2016 to define the content and structure of the training school. Panel and Working Group members also delivered lectures at the school **[A Turner, T Zhou, H Annamalai]**;
- (2) Panel members have also contributed to the final ICTP/COLA/IITM Targeted Training Activity on Monsoons in a Changing Climate (ICTP, Trieste, August 2017) **[A Turner, T Zhou]**;
- (3) Panel Co-Chair has contributed to the TERI-Uni Research Climate Research School on Extremes (TERI University, New Delhi, September 2017) **[A Turner]**;
- (4) Panel Co-Chair has hosted visit from ANACIM forecasters (within AMMA-2050) to CNRM, studying drought and analysis of associated wave activity and numerical forecasting ability **[F Guichard]**;

- (5) Panel members have contributed to the 2<sup>nd</sup> SPARC ACAM Training School: Observation and modelling of atmospheric chemistry and aerosols in the Asian monsoon region (June 2017, Jinan University, Guangzhou) **[T. Zhou]**;
- (6) Panel members have contributed to the SPARC H+GOTHAM international summer school (September 2017, PIK, Potsdam) **[T. Zhou]**.

### **Knowledge exchange**

- (1) The primary KE activity this year has been the completion of a contribution to the “Meteorology of Tropical West Africa: Forecasters’ Handbook, which presents the science and practice of weather forecasting in the region, providing a unique training volume for operational weather forecasters and students of tropical meteorology, in addition to new understanding of physical processes (see Annex C publications list) **[F Guichard, S Janicot]**;
- (2) Panel members have also contributed interpretation works for policy makers relating to the Future Climate for Africa programme **[F Guichard, S Janicot]**: Hartley, A, D Rowell, S Janicot, F Guichard, I Macadam, C Taylor, DJ Parker, 2016: A century of climate change: 1950–2050. in Africa’s climate: Helping decision-makers make sense of climate information (FCFA (Future Climate for Africa) guide for scientists, policy-makers, and practitioners), pp33-36.

### **Plans for 2018 and beyond**

The Monsoons Panel as a whole will focus on three main activities in 2018:

Better integration of CLIVAR and GEWEX monsoons activities such as GEWEX GLASS and GEWEX GASS (land-atmosphere and convection particularly). This will be achieved following participation in the pan-GASS meeting in spring 2018.

Exploiting the early outputs of the Global Monsoons MIP and CMIP6 DECK experiments. Plans for coordinated analysis at the regional monsoon scale, and at the global monsoon scale, will be initiated in a discussion forum during November 2017 in Singapore.

Bringing the attention of new observations to the modelling community, consisting of surface meteorology and energy budget, as well as cloud and water cycle data, for testing and improving model parametrizations, via the analysis of the modelling of surface-atmosphere couplings as well as via the use of dynamically-nudged simulations, which allow a more direct evaluation of – and means to improve – the parametrizations of physical processes.

The Monsoons Panel will also continue to identify cross-regional commonalities in activity. The key activity of interest across all regions is understanding subseasonal-to-seasonal variability and exploiting it for prediction.

Regional priorities will continue to be identified by the Regional WGs. Key emerging priorities for the regions include the below

#### *Africa:*

- Preparation of EU proposals for integrated study of African monsoon components in CMIP6 outputs;
- Continued translational work in CORDEX Africa and pursuance of CORDEX FPS projects;
- Contributions to the IPCC Special Report on +1.5°C for Africa;
- Climate Services activities, in particular, the WISER/DFID funded programme;

- Exploitation of the S2S archive to understand heatwave predictability, for example in the French ACASIS project.

*Americas:*

- Operate American monsoons sessions at AGU Fall Meeting 2017 and AMS January 2018 meeting;
- Pursue submission of proposal on Workshop on the American Monsoons to the International Centre for Theoretical Physics (ICTP);
- Coordinate a review on recent developments regarding the American monsoons among the regional WG;
- Assess the skill of S2S participating models in simulating the MJO impacts on the American monsoons, regarding precipitation anomalies and associated teleconnections;
- Exploitation of the S2S database for the South American monsoon, in order to assess possibilities for subseasonal prediction of aspects such as extreme event onset and demise, active and break periods.

*Asia-Australia:*

- Identifying the grand challenges in monsoon modelling including representation of processes and source(s) of model errors;
- Exploiting existing research on monsoon lows & depressions. A key aspect of this is encouraging national met. agencies to implement automated tracking of monsoon depressions;
- Continued exploitation of the S2S database for short time-scale prediction, through the monsoons subproject.

**Articles published in 2016/17 as part of panel activities (if any)**

A select list of relevant journal articles is included as Annex C.

**Budget and other needs for 2018**

Please see earlier communicated Annex A (also attached) detailing proposed Monsoons Panel 3<sup>rd</sup> meeting in association with the GEWEX 8<sup>th</sup> Science Conference (May 2018, Alberta, Canada; <https://www.gewexevents.org/events/2018conference/>). Request a total of \$10200 from combined GEWEX/CLIVAR contribution; other funding to be requested from US CLIVAR and national sources as indicated.

Further ahead, we are also seeking funding for a planned workshop on the American Monsoons (to be held in North or South America) for 2019.

## Amendment GEWEX/CLIVAR Monsoons Panel

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Françoise Guichard [francoise.guichard@meteo.fr; francoise.guichard@gmail.com (preferred)]

### From the original report:

#### **Obstacles**

- (1) Following retirement of staff at the ICMPO (Pune/IITM) office (Director and Deputy Director), there has been reduced administrative support to the Monsoons Panel during the May-September 2017 period, followed by associated spin-up time. However, a new ICMPO Director (Dr M. Ali) has joined in Pune/IITM in September 2017. Ultimately, this may result in failure to provide administrative and secretarial support during the 2017 Panel meeting to be held in Singapore in November.

#### **Amendment:**

Following effort on the part of Panel Co-Chairs, Dr Ali, and the local organising committee of the Singapore International Workshop on Monsoons to which the Panel meeting was attached, Dr Ali was able to obtain a visa for travel a few days before the meeting commenced. Hence Dr Ali was able to provide support during the Monsoons Panel meeting.



## Annex A

### Proforma for CLIVAR Panel requests for SSG approval for meetings

**Panel or Working Group:** GEWEX/CLIVAR Monsoons Panel

**Title of meeting or workshop:** Monsoons Panel 3rd meeting

**Proposed venue:** in conjunction with the 8th GEWEX Science Conference: Extremes and Water on the Edge, Alberta, Canada (<https://www.gewexevents.org/events/2018conference/>)

**Proposed dates:** 1.5-day meeting prior to, during, or after the GEWEX meeting which covers the 6-11 May 2018 period

**Proposed attendees, including likely number:** Approximately 11 Monsoons Panel members (see list at <http://www.clivar.org/clivar-panels/monsoons>); Dr MM Ali of the ICPO, IITM, Pune, potentially with a further representative, IITM; invited representatives of GEWEX GASS and GEWEX GLASS initiatives; 2-3 additional members of each Regional Monsoons Working Group allied to the Monsoons Panel.

**Rationale, motivation and justification, including:** relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved: Since the conference to which the proposed Monsoons Panel meeting will be attached promote GEWEX scientific activities, there will be considerable opportunities to engage with existing efforts in the GEWEX community (e.g. in GEWEX GASS and GLASS) and promote future joint activities, as well as cementing the Monsoons Panel as a combined GEWEX-CLIVAR operation.

The Panel meeting will be relevant to WCRP Grand Challenges on clouds and circulation and weather extremes. In particular discussions and relevant actions will relate to ongoing efforts in the CMIP5 exercise (including early analysis of specific experiments for monsoon regions) and new perspectives for climate modelling in monsoon regions gained from high-resolution convection-permitting modelling (e.g. the UK's CASCADE, IMPALA 4km Africa domain future climate experiments, the AMMA-2050 project and kilometre-scale modelling for India in INCOMPASS).

#### **Specific objectives and key agenda items:**

- Discussion of monsoon in GEWEX GLASS and GASS activities
- Setting priorities and presenting new diagnostics/metrics for understanding sources of monsoon systematic biases in models
  - Common diagnostics among the monsoons
  - Regional specific
- Highlight available and new observations of cloud, water cycle and land surface in monsoon regions as well as main parametrization issues for the simulation of the mean climate and of weather phenomena (e.g. modes of variability, waves, extremes), with a focus on deep convection and also discussion of other parametrizations (turbulence, clouds, surface processes, radiation)
- Update on the development of the monsoons subproject of the International S2S and coordinate related work activity of the three Regional WGs
- Report on year-1 outcomes of CMIP6-associated GMMIP experiments and prioritise regional and global analysis activities for the coming year

- Review and plan Monsoons Panel involvement in major summer schools or training activities (e.g. the forthcoming ICTP Climate Dynamics summer school July 2018, and steer subsequent editions)
- Report on progress in implementing Americas-oriented monsoons workshop

**Anticipated outcomes (deliverables):**

- Plan of action for engagement following spring 2018 pan-GASS meeting
- Panel-led report on common monsoon region diagnostics with region-specific appendices, for targeting CMIP6
- Summary document highlighting new remote sensing observations for the tropics and listing key priorities for process and model evaluation
- Begin draft of paper on emerging GMMIP outcomes
- Finalise Americas-oriented monsoons workshop

**Format:** key scientific presentations from Panel membership and invited speakers, open discussion on cross-panel & CLIVAR-GEWEX initiatives and closed business session to discuss membership, financing and future plans; use of Skype or GoToMeeting teleconferencing as appropriate to enable remote participation.

**Science Organizing Committee (if relevant):** Monsoons Panel membership, supported by ICMPO Pune

**Local Organizing Committee (if relevant):** ICMPO Pune plus local contact at GEWEX conference to be identified

**Proposed funding sources and anticipated funding requested from WCRP:**

- CLIVAR/GEWEX combined funding request to support the 5 Panel members most in need [air fare @ \$1200 each and per diem \$200/day for 3 days ~ \$10200]
- US CLIVAR for US-based Monsoons Panel members (Francina Dominguez, Alessandra Giannini) [air fare @ \$600 each and per diem \$200/day for 3 days ~ \$2400]
- IITM for Project Office staff
- National or personal project sources for the remainder

## Annex B: Regional Working Groups

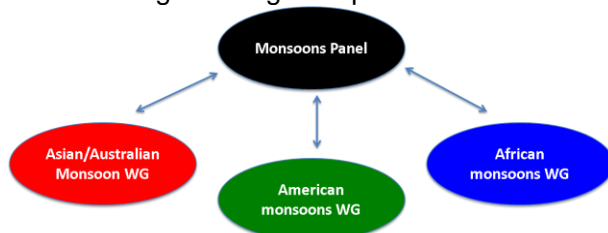
### Justification for Regional Working Groups of the WCRP/CLIVAR Monsoons Panel

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).

## **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:
  - 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;
  - Relevant regional Ocean Panels to support design of a monitoring strategy necessary for investigating the structure, variability and change of the regional monsoons;
  - The Pan-WCRP numerical experimentation groups (WGSIP and WGCM) on modelling priorities for advancing monsoon research;
7. 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;
8. Evaluate likely resource needs for WG activities and offer suggestions for possible funding routes outside of WCRP when virtual meetings are impractical;
9. Report to the GEWEX/CLIVAR Monsoon Panel on an annual or more frequent basis, as appropriate, also logging efforts via the Monsoons Portal.

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

### **Annex C: Articles published in 2016/2017 as part of Panel activities (if any)**

Only a selection of major papers/related to large coordinated activities/campaigns are included. In addition to these listed, numerous extended abstracts are published as part of Monsoons Panel contributions to the WMO 6<sup>th</sup> International Workshop on Monsoon (see list in main document). These will eventually be expanded to book chapters. Panel/WG members in bold.

Barbier J., **F. Guichard**, D. Bouniol, F. Couvreur and R. Roehrig (2017). 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.

Carril, A. F., **I. F. A. Cavalcanti**, C. G. Menéndez, A. Sörensson, N. López-Franca, J. A. Rivera, F. Robledo, P. G. Zaninelli, T. Ambrizzi, O. C. Penalba, R. P. da Rocha, E. Sánchez, M. L. Bettolli, N. Pessacg, M. Renom, R. Ruscica, M. Rusticucci, S. Solman, B. Tencer, A. Cherchi, **A. M. Grimm**, D. Jacob, A. R. C. Remedio, R. Tedeschi, and L. Zamboni (2016). Extreme events in La Plata basin: a retrospective analysis of what we have learned during CLARIS-LPB project. *Climate Research*, 68, 95-116, doi:10.3354/cr01374.

**Carvalho, L. M. V.** and C. Jones (2016). *The Monsoons and Climate Change: Observations and Modeling*. Springer. ISBN 10: 331921649X ISBN 13: 9783319216492

**Cavalcanti I. F. A.** and A. Raia (2017). Lifecycle of South American Monsoon System simulated by CPTEC/INPE AGCM. *Int. J. Climatol.*, 37, 878-896.

Cerezo-Mota, R., **T. Cavazos**, R. Arritt, A. Torres-Alavez, K. Sieck, G. Nikulin, W. Moufouma-Okia and J. Antonio Salinas-Prieto (2016). CORDEX-NA: factors inducing dry/wet years on the North American monsoon region. *Int. J. Climatol.* 36(2), 824-836. doi: 10.1002/joc.4385.

Chen, X. and **T. Zhou** (2017). Relative contributions of external SST forcing and internal atmospheric variability to July-August heat wave over the Yangtze River valley during 1979-2014. *Climate Dynamics*, DOI 10.1007/s00382-017-3871-y.

**Dominguez, F.**, G. Miguez-Macho and H. Hu (2016). WRF with Water Vapor Tracers: a Study of Moisture Sources for the North American Monsoon. *J. Hydrometeorol.* doi: 10.1175/JHM-D-15-0221.1

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