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SECOND WORKSHOP ON ASEAN REGIONAL CLIMATE DATA, ANALYSIS AND PROJECTIONS (ARCDAP–2)

25 – 29 MARCH 2019

SINGAPORE

Concept Note

1 Summary

It is proposed to conduct a workshop to evaluate climate observation datasets in support of national and regional efforts to deliver improved climate change projections across the ASEAN region. The Second Workshop on ASEAN Regional Climate Data, Analysis and Projections (ARCDAP-2) aims to improve regional knowledge on climate variability and change, climate extremes, and the validation of climate simulations, in addition to encouraging regional collaboration and information sharing.

The proposed ARCDAP-2 Workshop, 25–29 March 2019, will build upon some of the recommendations set out by the first ARCDAP workshop – the Best Practice Workshop on Climate Change Projections and their Applications in ASEAN Countries (meeting report: https://tinyurl.com/bpw-meeting-report) held in Singapore in March 2018. The ARCDAP-2 Workshop will be a blend of hands-on activities, seminars, and discussions, and will strengthen expertise across the region in using ClimPACT2 (software documentation: https://tinyurl.com/climpact-documentation). ARCDAP-2 will build upon similar workshops organised by the World Meteorological Organisation (WMO) held in the South Asian, Caribbean, Pacific, and South American regions respectively, and aid in further refinement of the ClimPACT2 software through feedback from the participants.

In particular, the objectives of this workshop are to (a) improve sector-relevant extreme indices for the region using the ClimPACT2 software package, (b) evaluate gridded products relevant to the ASEAN region, and (c) improve estimates and model assessments of climate change mean, variability, and extremes. The workshop will also help to create a common platform across the regional scientific community for assessing the representation of regional large-scale processes in models (e.g. El Niño-Southern Oscillation, Madden-Julian Oscillation, Borneo vortex, and diurnal cycle of convection). This is an extension of the “Best Practice Workshop” and is part of continued efforts to build a regional community of data and knowledge regarding key meteorological and climatological processes influencing the region.

2 Background

As part of the Canada-funded Climate Risk and Early Warning Systems (Canada-CREWS) project, it is proposed to conduct a workshop with the aims of building knowledge in the region about model validation and the development of extreme indices. The proposed ARCDAP-2 Workshop builds upon some of the recommendations highlighted during the recent ARCDAP-1 Workshop – the Best Practice Workshop on Climate Change Projections and their Applications in ASEAN Countries (Singapore, 20–23 March 2018, meeting report: https://tinyurl.com/bpw-meeting-report), organised in collaboration with the World Meteorological Organisation (WMO), Environment and Climate Change Canada (ECCC), and the ASEAN Specialised Meteorological Service (ASMC). Some key recommendations stated in the Meeting Report are included below and the links to the upcoming workshop discussed.

2.1 Standardising regional understanding of gridded observational datasets

Best Practice Workshop: Meeting Report and Recommendations, Page 6

Good observational datasets are required not only in the evaluation of RCMs, but also in the development of appropriate bias-correction methods across the full Southeast Asia domain. Hence, current bias-correction methods are mostly performed for small regions with suitable high density observation networks. Several observational products of different origins are available, such as satellite-based estimates and reanalyses.

→ *It is recommended that a regional study be completed evaluating the persistent differences between various gridded datasets available for the region, as well as outlining the steps for the development of a common dataset to standardise model evaluation.*

In evaluating regional climate models (RCMs), it is necessary to understand observational datasets available, along with the strengths and weaknesses of the various products. Despite the similar, transboundary nature of climatic events observed in the region, experience and knowledge concerning available gridded observational datasets are often confined to the national level. Participants from the "Best Practice Workshop" noted the wide variety of observational datasets available and the need to have a common understanding of the products across the region, so as to improve model validation and the development of bias-correction methods.

The proposed ARCDAP-2 Workshop, which aims to improve regional understanding of the strengths and biases of available gridded observational datasets, represents a step towards building a robust regional database of climate change information and facilitating improved model validation. Knowledge-sharing at the workshop will focus on the characteristics of both observations and reanalyses, as well as the validation of both types of gridded dataset utilising in-situ station information. A sample of available gridded datasets is shown in the following table, along with their key characteristics.

Product	Variables	Spatial Resolution	Temporal Resolution	Time Span	Data Source
APHRODITE	Precipitation	0.25° or 0.50°	Daily	1950 – 2007	In-situ data
CMAP (CPC Merged Analysis of Precipitation)	Precipitation	2.5°	Monthly	1979 – present	Blend of in-situ and satellite data
CMORPH (NOAA CPC Morphing Technique)	Precipitation	0.07277° (~8km) 0.25° 0.25°	30 minutes 3-hourly Daily	3 Dec 2002 – present 1 Jun 2014 – present 3 Dec 2002 – present	Low orbiter satellite microwave observations
ERA5	A wide range, including 2-metre temperature and total precipitation	0.28125° (~30km) 137 vertical levels up to a height of 80km	Hourly	2000 – present (time span set to be extended by 2019)	Blend of in-situ and satellite data
ERA-Interim	A wide range, including 2-metre temperature and total precipitation	0.70° (~80km) 60 vertical levels up to 0.1hPa	3-hourly	1979 – present	Blend of in-situ and satellite data
GPCC V7 (Global Precipitation Climatology Centre)	Precipitation	0.5°, 1.0°, or 2.5°	Monthly	1901 – 2013	In-situ data
NOAA-CIRES 20th Century Reanalysis (20CRV2c)	2-metre temperature, precipitation, wind, humidity, pressure	2.0° 24 vertical levels up to 10hPa	3/6-hourly	1851 – 2014	In-situ data

2.2 Assessing the representation of large-scale processes in gridded datasets

Best Practice Workshop: Meeting Report and Recommendations, Page 4

The intensity of large-scale natural climate variability may increase in the warmer climate (e.g. increased impact of ENSO across the Maritime Continent). It is reasonable to project that the change in precipitation in the Maritime Continent will also not be spatially coherent and the magnitude of the rainfall variability will likely increase. It is already apparent that model sensitivities differ and that may be driving some of the differences in the projected changes.

→ *It is essential to advance the understanding of the physical processes reproduced by regional climate models in order to improve the confidence of the regional climate projections. Regional model inter-comparisons need to focus on processes. A useful preliminary step would be to complete a scientific paper reviewing the key meteorological systems and physical processes relevant to the region, which will serve as a basis to evaluate models.*

Countries in the region experience largely similar, large-scale meteorological systems such as ENSO, MJO, and monsoons, and the ability of climate models to accurately reproduce these processes requires constant evaluation. Participants at the "Best Practice Workshop" highlighted the need for a better understanding of the representation of regionally-relevant meteorological processes in climate models, so as to improve the confidence of climate projections.

The ARCDAP-2 Workshop will initiate work on this recommendation by encouraging the consideration of regional large-scale processes and their representation in observational datasets. Participants will be encouraged to share their knowledge on the extent to which these systems have been accurately reproduced in gridded observational datasets, and to highlight key foci for future work on the subject. This will aid in regional process studies, that will in turn serve as the foundation for eventual model evaluation.

2.3 Developing regionally-relevant extreme indices using ClimPACT2

Best Practice Workshop: Meeting Report and Recommendations, Pages 5–6

Future changes in climate extremes and variability pose significant risks to the region. However, extreme indices commonly used are generic and may not necessarily be well-adapted to the region and the range of users across the VIA community. Developing appropriate extreme indices is a scientific challenge, with users pushing for very high temporal resolution (daily and sub-daily) products. Though these indices can be computed, they may not be scientifically well-grounded.

→ *It is recommended that suitable extreme indices of relevance to the users of climate change information across the region are identified as part of the proposed regional technical guidelines.*

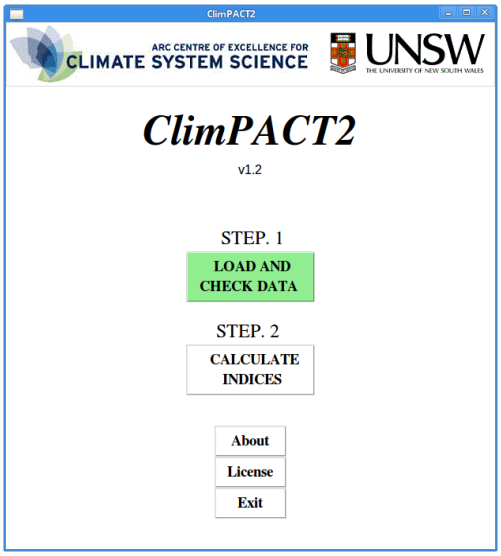
Users of climate data from the *Vulnerability Impact Assessment (VIA)* community present during the "Best Practice Workshop" also stressed that infrastructural vulnerability to extreme events is often the immediate priority for policymakers in the region. Understanding natural

climate variability therefore remains an important research focus, with the impact community calling in particular for the development of relevant and useful extreme indices.

It is proposed that as part of this workshop, extreme indices in the region are explored by utilising the ClimPACT2 software, created by the WMO Expert Team on Sector-specific Climate Indices (ET-SCI) in consultation with sector experts. The software utilises meteorological data and calculates climate extremes at monthly and annual time scales.

It is further proposed that invited participants be encouraged to bring a subset of country-specific in-situ data, comprising daily precipitation, maximum temperature, and minimum temperature. The subset should ideally possess as little missing data as possible, and be pre-processed to facilitate use during the workshop. Guidelines for pre-processing along with an example of the data format required by ClimPACT2 will be provided prior to the workshop. Key features of the software along with screenshots of the home screen and an example of an input dataset can be found below.

By focusing on station data across the ASEAN countries and working with ClimPACT2, the ARCDAP-2 Workshop strives to develop relevant extreme indices for the region, effective in communicating climate variability and change. Contributions by representatives from disaster risk management agencies and other sectors will provide participants with a better understanding of end-user needs, and feedback from the participants will also aid in the ET-SCI's aim of refining and enhancing ClimPACT2 tools. Furthermore, participants will be encouraged to assess the response and sensitivity of extreme indices to regionally-relevant events such as ENSO, which typically drive extreme events.



ClimPACT2 home screen (Herold, 2015)

Key features of ClimPACT2: A software tool for calculating climate extremes indices

Background:	Created by the ET-SCI building on the previous software RClimDex
Requirements:	R statistical programming language, ClimPACT2 (both available for free)
Operating systems:	Linux, Windows, MacOS
Usage:	Graphical user interface (GUI) or Linux command line
Input data required:	Daily precipitation, maximum temperature, minimum temperature
Outputs:	Over 60 climate indices and 140 different data files (plots and .csv files)

A full list of indices can be found in Appendix B of the 'ClimPACT Indices and Software' documentation available at: *https://tinyurl.com/climpact-documentation*

2.4 Knowledge and data sharing across the region

Best Practice Workshop: Meeting Report and Recommendations, Pages 45–46

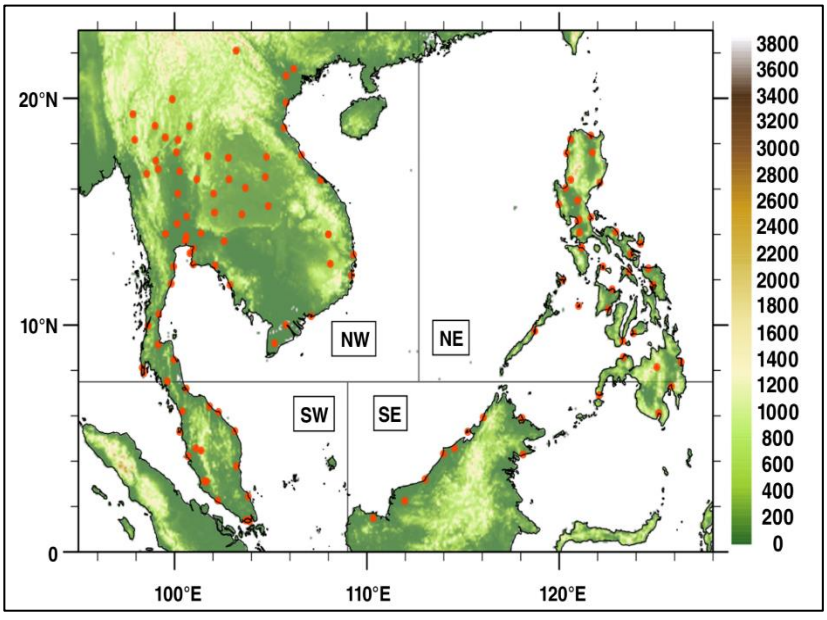
"A frequent barrier is the reluctance to openly share climate-related datasets. This is a counter-productive behaviour as institutions mutually benefit from the improvements in data networks, which is often the key limitation in the understanding of climate variability."

"Supranational exchanges and collaborations should not be limited to data but should extend to the information and knowledge derived from the data."

"Beyond these small steps to improve collaborative efforts towards building robust regional climate change information, workshop participants were also keen to enhance collaboration between NMHSs (and related government agencies)."

Emphasis was also placed on the need to improve regional collaboration, particularly in the sharing of data, knowledge, and expertise. Participants of the "Best Practice Workshop" noted that a frequent barrier to progress was the reluctance to openly share climate data amongst the countries in the region.

The ARCDAP-2 Workshop builds upon the successful regional workshops organised by the Meteorological Service Singapore (MSS) and the ASEAN Specialised Meteorological Centre (ASMC) in May 2011 and June 2012 respectively. The previous workshops involved participants from across Southeast Asia and led to the improvement of existing data records through the contribution of new station data and improved quality records from the participants. This open sharing of data facilitated further research that culminated in a research paper focusing on the observed and modelled precipitation and temperature extremes over Southeast Asia from 1970 to 2010 (Cheong et al., 2018). Data gathered through the collaboration was also included in the creation of HadEX2, a global land-based climate extremes dataset produced by the Expert Team on Climate Change Detection and Indices (ETCCDI). Brief details of the workshops conducted can be found below.



Locations of all 121 stations used in the regional analysis, with orography (Cheong et al., 2018)

Regional Climate Workshop on Modelling Climate Change & Variability in Southeast Asia

Date:	May 2011
Objectives:	To collect climate data from the region in order to provide important baseline information necessary for assessing current vulnerability to climate extremes and to conduct a rigorous evaluation of RCMs run across the region
Outcomes:	Collection of daily weather observations from 146 stations located in 8 out of 10 ASEAN countries (excluding Cambodia and Laos). Data pre-processing eventually resulted in daily weather observations from 121 stations located in 6 out of 10 ASEAN countries (further excluding Indonesia and Myanmar), with data available from 1972–2010

Regional Workshop for the Southeast Asia Climate Analysis and Modelling Study

Date:	19–20 June 2012
Objectives:	To gather inputs and suggestions from ASEAN NMHSs for a scientific paper analysing the trends in climate indices derived from station data provided in the previous workshop
Outcomes:	Scientific paper analysing regional trends in temperature and precipitation extremes in Southeast Asia between 1972 and 2010, utilising data collected from the previous workshop in May 2011 Cheong, W. K., Timbal, B., Golding, N., Sirabaha, S., Kwan, K. F., Cinco, T. A., Archevarahuprok, B., Vo, V. H., Gunawan, D. & Han, S. Observed and modelled temperature and precipitation extremes over Southeast Asia from 1972 to 2010. *International Journal of Climatology.* **38,** 3013–3027 (2018).

The upcoming workshop aims to update this valuable database of regional station data by inviting the participants to utilise country-specific data to improve model validation and calculate relevant extreme indices. Participants from ASEAN NMHSs will be encouraged to share daily station data reflecting temperature and precipitation. In doing so, the ARCDAP-2 Workshop will serve as a platform to promote collaboration and the exchange of both data and knowledge within the region. Furthermore, it will help to entrench sustainable links through the collaborative authorship of the proposed scientific reviews. It is further proposed that this shared database be incorporated into the upcoming HadEX3 dataset, as was previously done for HadEX2. This contribution will improve data quality and availability in the SEA region of the HadEX database, facilitating future research on the regional climate.

3 Proposed Workshop

3.1 Timing

It is proposed to conduct a 5-day regional workshop from the 25th to 29th of March 2019.

3.2 Location

It is proposed that the workshop be hosted at the Village Hotel Albert Court in Singapore.

3.3 Objectives

To better understand climate variability and extremes and to improve model validation in the ASEAN region through:

a. Building on knowledge held by various countries and meteorological services in order to establish a more robust knowledge of available gridded datasets.
b. Exploring the representation of regional large-scale processes and associated extremes in gridded products.
c. Utilising ClimPACT2 software to produce extreme indices that are relevant to the region and informative for communicating about climate variability and change.
d. Evaluating ClimPACT2 and providing suggestions for further refinement and enhancement of the software.

3.4 Participation: to conduct a successful workshop, a blend of participants is required.

(a) Representatives from each of the 10 ASEAN National Meteorological and Hydrological Services (NMHSs) – 2 representatives per country, ideally comprising a climate scientist with expertise in using climate data and a climatologist with expertise in the characteristics of in-situ data.

(b) Producers and experienced users of gridded observational datasets (e.g. NOAA and TMSI), reanalysis products (e.g. ACRE-SEA and ECMWF), and regional modelling (e.g. CORDEX-SEA).

(c) International experts of extreme indices (e.g. HadEX team) and ClimPACT2 software.

(d) Representatives and end-users from disaster risk management centres (e.g. AHA Centre) and other relevant sectors (e.g. agriculture – Hydro and Agro Informatics Institute, global heat health – National University of Singapore, and water security – Mekong River Commission).

(e) Representative(s) from the WMO Commission for Climatology.

The workshop is anticipated to be split into two main parts, with a focus on in-situ data for the first two days followed by a shift towards gridded products for the rest of the week.

The total number of participants will be confirmed at a later date, but is likely to range between 35 and 45.

4 Workshop Programme

Day 1: Country-based overviews, introduction to ClimPACT2	
AM	1. Opening address 2. Presentations by representatives from the NMHSs covering: - Overview of climate in respective countries - Characteristics of station data available / dataset brought to the workshop - Experiences with ClimPACT2 software
PM	3. Continuation of NMHS presentations 4. Introduction to ClimPACT2 - Brief introduction of WMO CCI ET-SCI - Features and capabilities of ClimPACT2, required inputs, possible outputs - Range of indices available 5. Checking of software installation - Participants expected to already have ClimPACT2 downloaded prior to the workshop - Necessary software to be loaded onto a flash drive and passed to participants who either have not downloaded the necessary software and dependencies, or are experiencing issues and require a fresh installation 6. Introduction to quality control (ClimPACT2) and homogenisation (RHTest) - Quality control: importance of quality control, detailed presentation of quality control features in ClimPACT2 - Homogenisation: importance of homogenisation, brief mention of possible software to use, such as RHTest 7. Formatting of station data to RClimDex format

Day 2: Station data – QC, perspectives on extreme indices, application of ClimPACT2	
AM	1. Interactive quality checks of station data - Participants to be divided into country-specific groups - Hands-on application of ClimPACT2 QC with the help of trainers 2. Presentations by representatives and end-users from sectors utilising extreme indices (e.g. disaster risk management, water security, and heat health) - Indices relevant to the sector and characteristics of effective indices - Effectiveness of current indices in representing extremes and communicating about climate variability and change - Issues prevalent in the sector
PM	3. Demonstration of ClimPACT2 - Brief demonstration of steps to be taken to calculate extreme indices 4. Hands-on training and calculation of ET-SCI indices using ClimPACT2 - Participants to be broken into country-specific groups - Software to be run using country-specific station data on a daily time scale 5. Analysis of calculated indices - Participants to analyse calculated indices, concentrating particularly on notable trends or unexpected results

Day 3: Gridded products – perspectives on products and application of ClimPACT2	
AM	1. Presentations on existing gridded observational datasets, including reanalysis datasets, with a focus on validation if applicable - ACRE-SEA: NOAA-CIRES 20th Century Reanalysis (20CRV2c) and the importance of historical data and data digitalisation - NOAA: CMORPH - ECMWF: ERA-Interim and ERA5 2. Presentations by experienced users and/or experts of gridded observational datasets, with a focus on evaluation and validation using in-situ observations: - TMSI
PM	3. Presentations on the representation of large-scale processes in gridded datasets - Types of regionally-relevant large-scale processes - Perceived importance of representing these processes in gridded datasets - Extent to which these processes have been successfully represented - Direction for future workshops or studies (what is needed in the field) 4. Sharing by selected NMHSs on studies done on validation of gridded products or insights on the representation of large-scale processes in products - Based on analyses or studies done by the NMHSs prior to the workshop - Strengths and weaknesses of gridded observational datasets analysed - Observations of large-scale process representation 5. Introduction to the calculation of extreme indices using gridded products - Introduction to the CLIMDEX project and HadEX dataset - Overview of the application of ClimPACT to gridded data - Overview of indices to be distributed to participants for analysis (due to time constraints, indices will be calculated prior to the workshop by applying ClimPACT to a gridded dataset) - Distribution of pre-calculated indices to participants

Day 4: Analysis of pre-calculated indices, studies that successfully utilised ClimPACT2 (both in-situ and gridded data), country presentations	
AM	1. Analysis of pre-calculated indices, obtained from applying ClimPACT2 to a regional climate model - Participants to analyse indices with the help of trainers 2. Presentation on study that successfully utilised ClimPACT2 - Introduction to objectives of study - Show-and-tell approach for methodology, showing the steps taken in ClimPACT2 to manipulate the data and obtain results - Presentation and analysis of results - Knowledge-sharing on ways to maximise the potential of the software and use it effectively and efficiently 3. Preparation of country-based presentations covering: - Results from analysis conducted on Day 2 (e.g. trends and exceptions) - Relationships with sector data (e.g. healthcare and water supply) - Learning outcomes, comments, and feedback on ClimPACT2, with recommendations for further improvements - Directions for future research, in terms of both extreme indices (taking into account sectorial needs highlighted during workshop) and gridded datasets (validation and representation of large-scale processes)
PM	4. Presentations by representatives from NMHSs prepared earlier

Day 5: Focus group discussions and conclusion
1. Summary of topics covered during workshop - Extreme indices and sectorial needs - Validation of gridded products and representation of large-scale processes 2. Focus group discussions on key takeaways from the workshop, focusing on: - Evaluation and recommendations for ClimPACT2 software - Evaluation of extreme indices calculated and relationships with sector data - Evaluation or validation of gridded observational datasets - Representation of large-scale processes in gridded observational datasets - Plans for further work following the workshop 3. Summary of ClimPACT2 software evaluation and recommendations 4. Brainstorming sessions headed by lead authors of upcoming papers - 2 main papers focusing on extreme indices and gridded products respectively - Key points to be included in papers and intended frameworks

5 Anticipated Outcomes

The key outcome of the ARCDAP-2 Workshop is to promote and encourage regional collaboration. It is also hoped that scientific papers covering the three key foci of the workshop (extreme indices, gridded observational datasets, and large-scale processes) will be published in due course, ideally in time to be considered for the next IPCC Assessment Report in 2021. These will be spearheaded by lead authors chosen from amongst the participants.

The nearer term products of the workshop are expected to be as follows:

(a) Outline of paper with strengths and weaknesses of current extreme indices being used, findings from using ClimPACT2, sectorial needs and issues faced, and plans for further research.

(b) Outline of paper with key findings pertaining to the evaluation and validation of gridded observational datasets, focusing on the strengths and weaknesses of available products, validation using in-situ observations, and the representation of regionally-relevant large-scale processes.

(c) Learning outcomes from the use of ClimPACT2 software, with a focus on how the software could be further improved to increase relevance to the region.

(d) Contribution of regional station-based data to the HadEX3 project, so as to update data previously contributed to the HadEX2 dataset.

6 Cost and Funding

Please refer to the budget proposal.