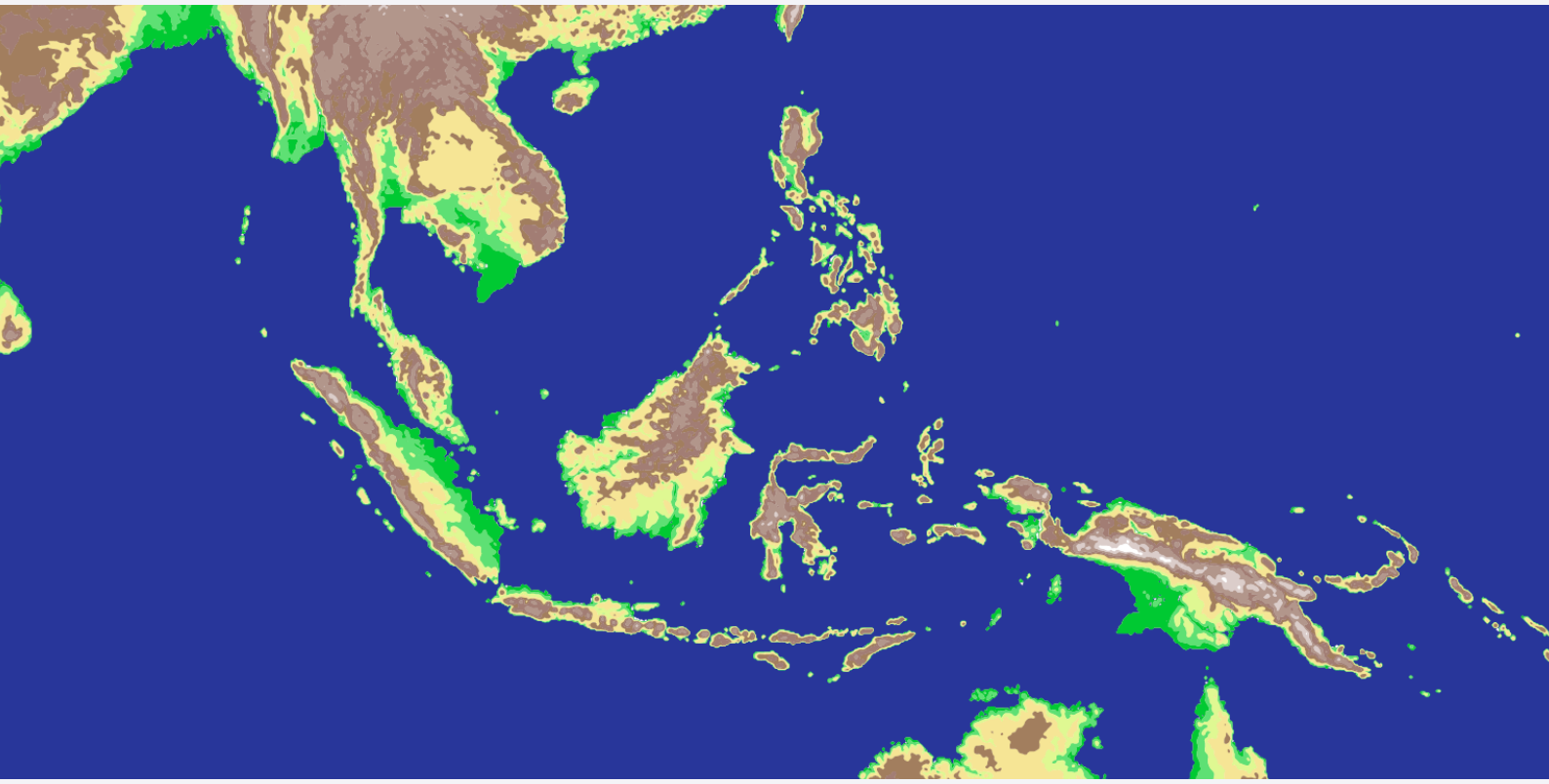
CCRS Newsletter

Issue 3, January 2023

Highlights in This Issue



Domain of the 8 km regional climate model for Singapore's Third National Climate Change Study (V3) undertaken by CCRS

Meteorological Service Singapore
Centre for Climate Research Singapore

A quarterly newsletter of the Centre for Climate Research Singapore

Contents

Published quarterly, the CCRS Newsletter highlights CCRS' latest news, activities and progress. The Newsletter also shares latest climate/weather science developments that are relevant to CCRS' mission. For feedback and enquiry, please email: NEA_CCRS_Engage@nea.gov.sg.

Word from the Director

Welcome to the third issue of the CCRS Newsletter. It is great to see positive feedback from our first two issues of the newsletter in 2022—we hope the current edition will similarly provide informative and exciting updates of our activities at CCRS.

Singapore's Third National Climate Change Study (V3) is CCRS' #1 flagship project at present, and will provide detailed projections of rainfall, temperature, etc, to support climate impact studies in Singapore and the wider Southeast Asia region. A series of brochures, videos and presentations will be provided in 2023 as the results of the V3 project are shared—a brief update is provided in this newsletter, but look out for more information throughout 2023.

CCRS' weather and climate science activities are strongly dependent on the availability of significant high-performance computing (HPC) resource. In addition to our own in-house 'Utama' HPC (described in the newsletter issue 01), CCRS makes use of HPC resources at the National Supercomputing Centre (NSCC) Singapore, in particular its new 'ASPIRE 2A' machine—see page 5 for further details.

National and international partnerships remain essential in our weather/climate science activities. In this issue, CCRS scientist Robert Huva recounts his recent work trip to the UK Met Office to build state-of-the-art post-processing capabilities to enhance the quality and range of data products available from our Numerical Weather Prediction (NWP) system.

As usual, we share the latest information on our science highlights, seminars and events. We hope you find the newsletter informative. Please let us know if there is something in particular you would like to hear about. I encourage you to share the newsletter with colleagues and friends – contact us to sign up, and do follow us on LinkedIn.

Happy reading!

Professor Dale Barker
Director,
Centre for Climate Research Singapore

Advancing Climate Change Research in Singapore and Southeast Asia

By Dr Sandeep Sahany (Head of Climate Modelling & Prediction Branch) and Ms Tammy Chin (Science Communicator)

Singapore's latest National Climate Change Study

The Intergovernmental Panel on Climate Change (IPCC) reports climate projections for all regions of the world. However, the projected changes will not be uniformly distributed across the globe, and the global climate models (GCMs) used for IPCC assessment do not represent Singapore and Southeast Asia (SEA) in detail. Hence, it is important to understand the potential changes to the climate system and their impacts at local and regional scales to inform decisions made to safeguard the populations, environment, and infrastructure across the region.

In 2015, to support Singapore's resilience strategy, CCRS completed the Second National Climate Change Study (V2) to produce historical simulations and future climate projections for Singapore and the wider region up to 2100. The V2 scientific work was undertaken by scientists from CCRS and the UK Met Office.

Following the latest Sixth Assessment Report (AR6) of the IPCC, CCRS' Climate Modelling and Prediction (CMP) scientists are currently conducting Singapore's Third National Climate Change Study (V3) to dynamically downscale the global-scale climate projections from IPCC AR6 to the regional and local scales.

Various upgrades in V3

Latest GCMs with more accurate simulations

In line with IPCC AR6 that has assessed simulations from the latest GCMs[1], V3 uses a subset of these GCMs that are carefully selected based on criteria used by leading international centres. Compared to the GCMs[2] in IPCC AR5, the ones used in AR6 have better spatial resolutions and representations of physical processes in the atmosphere, land, ocean and cryosphere, enabling more accurate simulation of the climate on a finer scale.

New regional climate model more suited for SEA

- In dynamical downscaling, a regional climate model (RCM) takes in information from a parent GCM and downscales the global-scale climate projections to regional and local scales. The fundamental equations are the same, but the RCM provides more local data tuned for the particular domain of interest (SEA in this case) at higher resolution.
- The RCM used in V3 is 'SINGV-RCM', a configuration of CCRS' core 'SINGV' climate modelling system used also for operational numerical weather prediction (NWP) in MSS. The SINGV system has been extensively validated with local and regional observations (using both measurements from rain gauges and satellite data), thus giving higher confidence in its ability to simulate key weather and climate phenomena over the region.

Larger domain

Compared to the previous domain in V2, the V3 domain was enlarged nearly two-fold to cover almost the whole SEA region and beyond, making the climate projections data usable by other ASEAN member states for their local climate change assessment and downstream impact studies.

[1] From the Coupled Model Intercomparison Project Phase 6 (CMIP6), an international effort among the climate modelling community aimed at coordinating climate change projections

[2] From CMIP5

Higher resolution for greater utility for impact studies

V3 will provide climate projections of the highest available spatial and temporal resolutions relevant to Singapore and SEA, increasing its utility for impact studies.

- With higher spatial resolutions in V3, important topographical features that affect the local climate such as small islands, coastlines and mountains become much better resolved in the RCM. This more realistic representation is crucial for more accurate projections, as changes to the air movement pattern due to these features may affect how weather systems may change in response to climate change.
- With projected rainfall data at 10-minute intervals (and 12-minute intervals), V3 will guide the adaptation planning for extreme sub-hourly rainfall events in Singapore (and SEA).

More robust key uncertainties to inform decision-making

Any decision-making framework for climate change adaptation plans must account for the key uncertainties in climate projections. V3 will provide more robust uncertainties that will help inform agencies' decisions, elevating the confidence in their design parameters. V3 will address and better sample two principal sources of uncertainties.

Scenarios/emissions uncertainty

- In climate change research, different future scenarios are fed into climate models, which produce a range of climate responses at global, regional, and local scales. The new climate change scenarios used by IPCC describe both future greenhouse gases (GHG) concentration in the atmosphere, and the socio-economic challenges (e.g. land and water use, climate policies) for climate mitigation and adaptation.
- V2 used two emissions scenarios (i.e. RCP4.5 and RCP8.5)[3], while V3 uses three of the new scenarios (i.e. SSP1-2.6, SSP2-4.5 and SSP5-8.5). Apart from better sampling the scenarios uncertainty, the inclusion of SSP1-2.6 is also partially in line with the Paris Agreement's goal.

Downscaling uncertainty

V3 also addresses downscaling uncertainty that can be important for climate change projections. This is achieved by downscaling the projections from a GCM using two different RCMs, SINGV-RCM and the community Weather Research and Forecasting (WRF) modelling system.

Getting ahead amidst challenges

Greater detail and accuracy, greater need for computing power

With the higher spatial and temporal resolutions used in V3, massive computing power is needed to run the simulations. Taking the 8 km SINGV-RCM covering SEA as an example, 18 time series[4] of climate data such as temperature and rainfall, each spanning almost a century, are generated. Each time series alone requires a few months to complete using the current generation of supercomputers.

For V3, the large computational demands have been met using the latest 'ASPIRE 2A' supercomputer from the National Supercomputing Centre (NSCC) Singapore (see the next page for more information). Equipped with the enhanced computing power, CCRS will complete the simulations and generate the data needed in early 2023 for further post-processing and analysis.

Managing data at the petabyte scale

With petabytes[5] of data generated, a new challenge has emerged—post-processing and analysing the raw data to gain insights into how the climate will change in the SEA region and provide usable data to stakeholders.

To navigate this challenge and optimise available resources, CMP scientists have developed a 'Climate Toolbox' that is able to quickly scan through petabytes of downscaled data, process raw model outputs to standardise them to be compliant with international standards, carry out analysis (e.g. computing the mean of rainfall in the current and future climate) and plot relevant figures.

Using the Climate Toolbox, scientists are able to efficiently process raw data and produce a range of analyses on historical and projection data. This will in turn allow V3 data and products to be made available through a dedicated dissemination platform.

With the various upgrades in V3 as well as the new dissemination platform, CCRS will provide robust science that underpins the climate resilience strategies of Singapore and other ASEAN member states. To learn more about available V3 data and products, please email us at NEA_CCRS_Data@nea.gov.sg.

[3] RCP4.5 (low-medium GHG emissions) and RCP8.5 (high GHG emissions)
[4] Six GCMs are selected for the 8 km downscaling. For each GCM, three climate change scenarios are run.
[5] 1 petabyte is equivalent to 1 million gigabytes.

Leveraging the National Supercomputing Centre's Latest Supercomputer for Singapore's Third National Climate Change Study

By Dr Sandeep Sahany (Head of Climate Modelling & Prediction Branch) and Ms Tammy Chin (Science Communicator)

In recent years, CCRS has been a major user of Singapore's National Supercomputing Centre (NSCC) IT infrastructure for its climate and weather science research activities. With increasing demands for additional computing resource, CCRS has obtained access to NSCC's newest 'ASPIRE 2A' supercomputer.

CCRS' usage on ASPIRE 2A

With 10 petabytes[1] of storage, expanded network infrastructure and around 100 000 central processing units (CPUs), ASPIRE 2A can provide up to 10 petaFLOPS[2] of computing capacity. CCRS will make use of ASPIRE 2A's CPUs to deliver the latest regional climate projections through Singapore's Third National Climate Change Study (V3), in support of CCRS' mission to advance scientific understanding of tropical climate variability and change and its associated weather systems affecting Singapore and the wider Southeast Asia (SEA) region.

A large majority of V3 dynamical downscaling simulations, post-processing and analysis are being carried out on ASPIRE 2A. The V3 analysis output will be shared with stakeholders via reports, journal publications and communications materials. The high-resolution climate change projections data will be used to support downstream impact assessment studies.

In addition, a new Supercomputing Digital Sandbox concept built on ASPIRE 2A will allow CCRS to share data with other government agencies for their downstream impact modelling.

Significance for Singapore and the SEA region

V3 will provide the latest set of high-resolution climate projections for Singapore and the SEA region, in line with the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. The high-resolution projections will be able to capture small-scale features (e.g. thunderstorms, extreme rainfall events) that cannot be captured by the coarse-scale global climate models.

Looking forward, CCRS will contribute climate data from V3 to the Coordinated Regional Downscaling Experiment for the Southeast Asia region (CORDEX-SEA). Downscaled climate projections over the V3 SEA domain at 8 km resolution will be shared, thus contributing to the climate change assessment and impact modelling (e.g. floods, droughts) in other ASEAN members.

After V3 is completed in late 2023, CCRS will use V3 data to perform further research to improve understanding of climate change in the region, and its impacts which include the effects of the urban heat islands and extreme sea-level rise.

[1] 10 petabytes is equivalent to 10 million gigabytes.
[2] 10 petaFLOPS computing is equivalent to performing 10 000 trillion calculations per second.

CCRS Scientist Visit to the UK Met Office:
Post-processing Numerical Weather Prediction Data

In September 2022, I was hosted as a visiting scientist at the Met Office in Exeter, United Kingdom. During this time, I worked closely with the developers of the StaGE[1] (Standard Gridding Engine) and IMPROVER[2] (Integrated Model Post-Processing and Verification) post-processing software packages. My role at CCRS is to implement these packages in SINGV[3] and further develop CCRS'/Meteorological Service Singapore's (MSS) numerical weather prediction (NWP) post-processing capability.

What is post-processing though?

In a nutshell, post-processing takes forecasts from multiple sources (i.e. an ensemble of one NWP model and/or multiple models) to produce more accurate and reliable forecasts of future weather events than any single forecast can deliver, providing extra information such as likelihood of rainfall above a certain amount, temperature above a certain level, or even a combination of temperature and humidity (as a measure of heat stress). Producing more reliable, applicable and informative weather forecast products is a key area of focus for CCRS' Department of Weather Research and will ultimately assist decision-making for stakeholders and general public.

During the first two weeks of my visit, I was able to leverage the expertise of our Met Office colleagues to successfully apply both StaGE and IMPROVER packages to our SINGV forecast data. In my third week, the Met Office hosted a workshop which was attended by representatives from some other Unified Model (UM) partner organisations, including the Bureau of Meteorology (Australia) and Lincoln Labs (representing the US Air Force). At this workshop, each organisation presented its current status and future plan for the StaGE and IMPROVER packages. It is important to keep abreast of such future plans—for instance, aviation-specific functionality, a key area MSS wants to develop, was identified as a common interest amongst many UM partners. In the fourth week, we had valuable discussions on the applications of the IMPROVER package and machine learning for aviation and calibration of rainfall forecasts, respectively.

The fruitful discussions in the last fortnight will help inform the future directions of the post-processing work at CCRS. In addition, the connections made to colleagues on various topics during my visit will no doubt continue to assist progress towards CCRS' goal of developing more impactful products to support the MSS' weather services and meet customer needs. Overall, it was a very successful trip and I hope to be able to share the results of our post-processing efforts in the months to come.

Dr Robert Huva is a research scientist in the Research to Operations Branch of the Department of Weather Research at CCRS. His role centres on post-processing weather forecasts from in-house (SINGV) and global (ECMWF) models. Robert's research background includes energy grid optimisation, WRF and WRFDA modelling for solar forecasting, as well as more broadly WRF modelling for variables such as wind and rainfall.

Attendees of the StaGE (Standard Gridding Engine) and IMPROVER (Integrated Model Post-Processing and Verification) workshop held at the UK Met Office in September 2022. CCRS Research Scientist Dr Robert Huva is third from right.

[1] StaGE processes NWP model outputs with different resolution, file formats and weather variable names, and standardises them to a chosen spatial resolution with consistent file formatting and variable names.
[2] IMPROVER applies various data processing steps including thresholding, neighbourhooding, calibration and model blending to the output data from StaGE. For more information, please see https://improver.readthedocs.io/en/latest/.
[3] CCRS' local NWP system

Science Highlights

Hybrid data assimilation in a simplified tropical fluid dynamics model

Joshua Lee, Research Scientist
Weather Modelling Development Branch, Department of Weather Research

CCRS' Department of Weather Research develops and maintains an operational numerical weather prediction (NWP) system to support weather forecast in Singapore and the surrounding region, known as SINGV-DA. The system runs multiple times a day to keep updating the forecasts, which are simulations of the atmosphere's behaviour using the most recent state of the atmosphere as a starting point.

Observational data are used for estimating the state of the atmosphere through a process known as data assimilation. This is a mathematical approach to combine information from observations and the NWP system in an optimised way. Some methods are more suitable for the tropical region where Singapore is located. The most advanced methods require a combination of traditional methods (e.g. variational and ensemble-based), which is referred to as hybrid data assimilation.

The goal of this research was to explore applying a specific hybrid data assimilation method, known as hybrid ensemble-variational data assimilation (illustrated in the diagram below), in the tropics.

To achieve this, CCRS scientists developed the code and introduced it to a simplified tropical fluid dynamics model originally developed by collaborators at the University of Reading, United Kingdom.

The article documents the development and technical work of generating an ensemble of runs for the model, and the changes to the existing data assimilation algorithm required to use the information from the ensemble. The starting atmospheric state for the simplified tropical fluid dynamics model was adapted from SINGV-DA, and the settings of the model were chosen to mimic the tropical environment.

Consistent with previous studies conducted in the mid-latitudes, the experiments with the simplified tropical fluid dynamics model showed that the simulation accuracies were improved when using hybrid ensemble-variational data assimilation, compared to existing traditional variational methods. Additional tuning of the method led to further improvements. These lessons from tuning were transferrable during the concurrent development of the hybrid ensemble-variational data assimilation for SINGV-DA.

Click here to read the full paper.

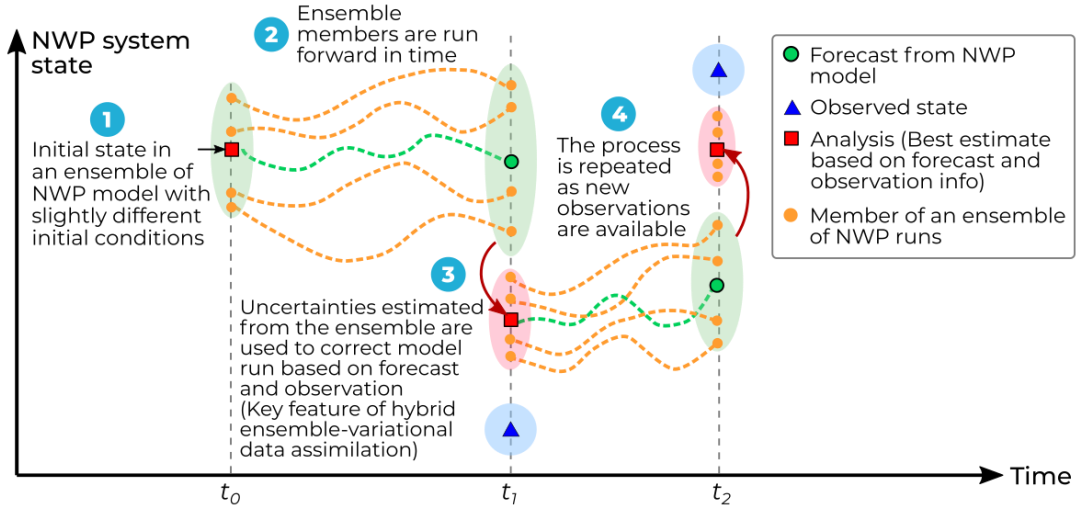


Illustration of hybrid ensemble-variational data assimilation (adapted from Gillet-Chaulet, 2020). The estimated uncertainties in observations (blue), numerical weather prediction (NWP) model forecasts (green) and analyses (red) are represented by ellipsoids of proportional sizes. Hybrid ensemble-variational data assimilation incorporates uncertainties estimated from the ensemble of NWP runs (orange) to find the analysis of the NWP system state (red square) based on the observation (blue triangle) and forecast (green circle), at the corresponding time (t0, t1, t2 etc.). The analysis is then used to initiate a new forecast and generate an ensemble. This process is repeated as time progresses with availability of new observations. Traditional variational data assimilation only uses climatological (past) uncertainty information (no red arrow).

Gillet-Chaulet, F.: Assimilation of surface observations in a transient marine ice sheet model using an ensemble Kalman filter, The Cryosphere, 14, 811–832, https://doi.org/10.5194/tc-14-811-2020, 2020.

Land subsidence intensifies sea-level rise in major coastal cities

A study supported by the CCRS-managed National Sea Level Programme (NSLP)

While the subject of sea-level rise has merited much attention, its lesser-known twin—land subsidence (sinking land)—has also emerged as an urgent challenge for many coastal cities.

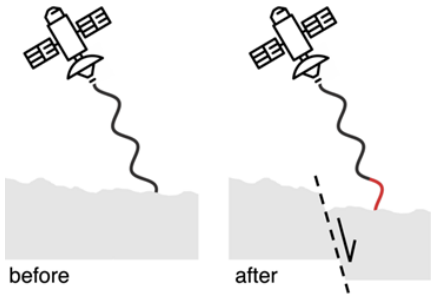
Ms Cheryl Tay, a PhD student whose doctoral programme at the Earth Observatory of Singapore (EOS) and the Asian School of the Environment is sponsored by the NSLP, led a study that cast a spotlight on the scale of the challenge.

The researchers of the study looked at satellite images of 48 of the world's largest coastal cities, which host 20% of the global urban population. Of these 48 cities, 42 experience relative local land subsidence (RLLS), with median rates reaching as high as 16.1 millimetres per year (mm/yr). At its peak, subsidence can occur as quickly as 43 mm/yr: more than 10 times faster than the current rate of global mean sea-level rise of 3.7 mm/yr.

Local land subsidence was found to mostly happen in rapidly expanding megacities, where an increased demand for groundwater and rapid urban development cause soil compaction. Cities with the highest rates of RLLS include Tianjin (China), Ho Chi Minh City (Vietnam), Chittagong (Bangladesh), Yangon (Myanmar), and Jakarta (Indonesia).

While past research has measured land subsidence in individual cities, this study is one of the first to do so with a consistent methodology across such a large spatial scale.

The researchers used Interferometric Synthetic Aperture Radar (InSAR) to capture spatial signals at a high resolution. To process the data, they used a cloud-based system operated by EOS to process satellite images from 2014 to 2020. This system was chosen for its scalability and ease of automation.



Interferometric Synthetic Aperture Radar (InSAR) is a technology which measures changes in land height by comparing the amount of time it takes for a signal to travel between a satellite and the target area.

On the significance of this study, Ms Tay commented, "By estimating how much and how fast coastal cities are subsiding, our study helps constrain projections of coastal inundation in the coming decades, as we expect more land to be flooded due to rising sea levels and land subsidence."

"This high-resolution data enables affected communities and policymakers to identify which areas are at particular risk from high levels of land subsidence, and take action to address their coastal risks," said Professor Emma Hill, Principal Investigator (PI) of the NSLP project.

Beyond the findings presented, the paper also offers a standardised method of mapping relative local land subsidence that is readily extendable beyond the 48 coastal cities analysed.

Click here to read the full paper.

Populous cities experiencing the highest rates of local land subsidence are concentrated in Asia.

Seminar Series

CCRS hosts a weekly seminar series to share research and development in areas of relevance to CCRS' activities, amongst our staff as well as with our collaborators. These seminars also serve to connect local and international researchers from the wider Earth system research community and provide avenues for discussions and collaborations on seminar topics. For more details of past and upcoming seminars, please visit http://ccrs.weather.gov.sg/ccrs-seminar-series/.

Previous seminars cover a broad range of topics, including sea-level research, climate change impact studies, air quality prediction, and urban impact on weather and climate. Below are some highlights of the seminars held in Q4 2022.

Title of seminar:
Hot Little Red Dot: Singapore's Urban Heat Island (UHI)

Abstract:
Prof Matthias Roth from the National University of Singapore (NUS) started his talk with a brief introduction of the UHI phenomenon and methodological considerations for obtaining meaningful and transferable measurements of canopy-layer temperature in cities. He presented the results from a network of temperature sensors that provide comprehensive monitoring of the spatial and temporal variability of the canopy-layer temperature across Singapore during multiple years. The dataset allowed for a robust statistical analysis and representation of a large geographical area characterised by diverse land-uses, including the examination of the diurnal and seasonal variability of the UHI under various weather conditions. The maximum heat island intensity was found near Orchard Road, where nighttime temperatures can be up to 7.7°C higher compared to a rural area covered with scattered trees during conditions favourable for heat island development. The data suggested an extra 1.0–1.5°C warming on top of anthropogenic global warming due to the presence of urban areas across Mainland Singapore.

Title of seminar:
The 'Walstad' method on creating an optimal multi-system seasonal super-ensemble for Southeast Asia

Abstract:
Ryan Kang from CCRS discussed how an optimal multi-system seasonal super-ensemble for Southeast Asia was created by applying the concepts of Walstad's Method, which is a natural method of making a balanced aquarium that is almost completely self-sufficient without a filter or regular water changes. Mr Kang also briefly introduced a confluence of three 'game-changer' events needed for a proper execution of the presented methodology.

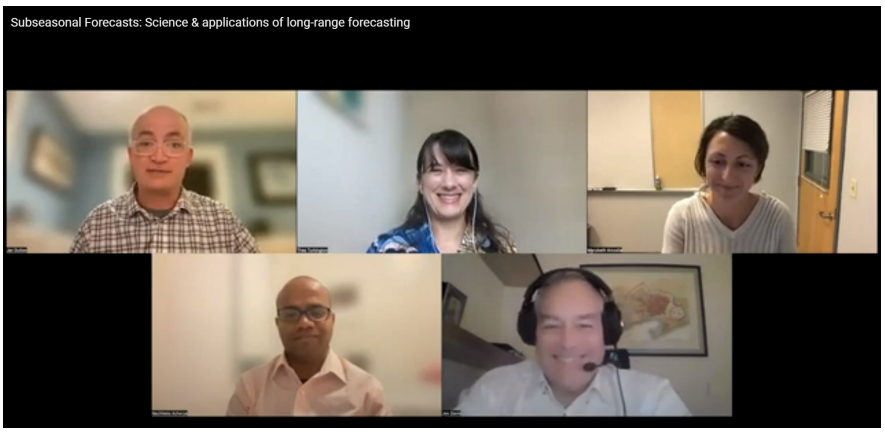
Events

‘Subseasonal Forecasts: Science & applications of long-range forecasting’ webinar

On 28 September 2022, Head of CCRS’ Seasonal and Subseasonal Prediction Branch Dr Thea Turkington, was a panellist in the webinar 'Subseasonal Forecasts: Science & applications of long-range forecasting' organised by InterMET.digital.

The panel took a deep dive into how probabilistic subseasonal forecasting (prediction expressed as probabilities of several outcomes, made 2–3 weeks in advance) could enable end-users to extend the useful forecast lead time beyond the limit of deterministic forecasting (prediction expressed as a single outcome).

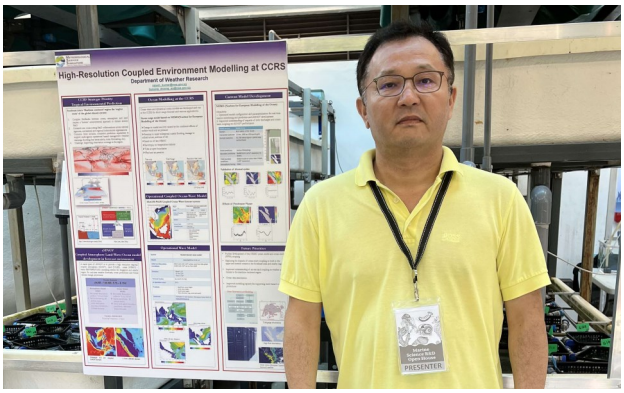
In the webinar, Dr Turkington delivered a presentation titled ‘Unlocking Subseasonal Forecasts for Disaster Risk Reduction in Southeast Asia (SEA)’. She shared a case study on subseasonal outlooks in the region, focusing on extreme rainfall and disasters such as flooding. Dr Turkington gave a review of a pilot project, undertaken by CCRS scientists in collaboration with other partners, that supported disaster monitoring and management in SEA, showing how subseasonal-to-seasonal predictions could be useful in disaster risk reduction.



In the webinar 'Subseasonal Forecasts: Science & applications of long-range forecasting', Head of CCRS’ Seasonal and Subseasonal Branch Dr Thea Turkington (top row; middle) was part of the panel, together with research scientists and meteorologists from the United States.

St. John’s Island National Marine Lab open house

CCRS was invited to present its work at the Open House event of the St. John’s Island National Marine Laboratory, managed by the National University of Singapore, on 22 October 2022. CCRS Senior Research Scientists Dr Byoung Woong An and Dr Rajesh Kumar contributed a poster titled ‘High-resolution Coupled Environment Modelling at CCRS’. They gave an overview of CCRS’ current operational wave and coupled ocean-wave models, and shared the latest development of CCRS’ in-house coupled atmosphere-land-wave-ocean model. They also presented their future research and development priorities, which include ocean data assimilation and improved modelling capacity for supporting multi-hazard coastal protections.



CCRS Senior Research Scientist Dr Byoung Woong An presented his work on coupled environment modelling during the Open House event of the St. John’s Island National Marine Laboratory, which is under the National University of Singapore.

GC5 (Global Coupled 5) Assessment Workshop 2022

On 8–10 November 2022, CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim attended and presented at the hybrid GC5 Assessment Workshop organised by the UK Met Office. Attended by other Unified Model (UM) Partners, the workshop provided a platform for discussion on the assessment of the GC5 configuration in a range of model simulations, including GC5 physics changes and upcoming changes in GC science and tools.

In his presentation titled 'GC5 Assessment over Southeast Asia and Western Maritime Continent', Dr Eeqmal presented the performance of GC5 configuration, highlighting the improvements and standing issues brought by GC5 as compared to GC4. CCRS' evaluation of the GC5 model configuration for the western Maritime Continent region will help inform the overall global model evaluation and development efforts of the UM Partnership.

CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim presented CCRS' assessment of the latest global coupled (GC5) model configuration to the rest of the Unified Model Partnership at the GC5 Assessment Workshop organised by the UK Met Office.

Korean Institute for Atmospheric Prediction Systems International Symposium and Scientific Advisory Committee meeting

On 14–18 November 2022, CCRS Director Prof Dale Barker visited the Korean Institute for Atmospheric Prediction Systems (KIAPS) based in Seoul.

As the chair of the KIAPS Scientific Advisory Committee (SAC), Prof Barker chaired the SAC meeting which provided valuable feedback and insight as KIAPS builds a new Korean weather/climate model for operational numerical weather prediction (NWP).

At the KIAPS International Symposium held over 14–16 November 2022, Prof Barker was invited to deliver a presentation titled 'Km-scale NWP and CMIP6-based Regional Climate Projections at CCRS'. Prof Barker began his talk with an overview of the climate drivers influencing the weather and climate in Southeast Asia. He then shared various aspects of CCRS' research and development (R&D) work, which include the understanding of key tropical processes, and their modelling and prediction at various timescales (e.g. the SINGV NWP system, regional climate projection data from Singapore's Third National Climate Change Study). Finally, CCRS' future R&D directions, including tropical urban climate modelling, coupled regional tropical environmental prediction and localised sea level projections for Singapore, were shared.

Natural Disasters Expo 2022

On 8 December 2022, Head of CCRS' Climate Impacts Branch Prof Jeff Obbard delivered a talk at the Natural Disasters Expo, a leading industrial event that showcases the latest products, services and strategies to predict, mitigate, manage and recover from natural disasters.

In his talk 'Climate Change as a Threat Multiplier for Southeast Asia (SEA)', Prof Obbard gave an overview of the Sixth Assessment Reports (AR6) of the Intergovernmental Panel on Climate Change (IPCC), and the observed and projected climate change impacts in SEA. After discussing how climate change can be a risk threat-multiplier, he explained the need to achieve net-zero carbon emissions to limit global warming to 1.5°C.

Head of CCRS' Climate Impacts Branch Prof Jeff Obbard gave a talk at the Natural Disasters Expo held at the Singapore Expo.

Media Highlights

In a Channel NewsAsia documentary 'Stem the Tide' commissioned by PUB, Singapore's National Water Agency, CCRS Director Prof Dale Barker shared how CCRS is conducting Singapore's Third National Climate Change Study (V3) to provide localised and high-resolution climate projections for the nation. The data and analysis provided by the V3 project will provide detailed estimates of rainfall, humidity changes and sea-level rise that will allow CCRS' local stakeholders such as PUB to plan effectively for the impacts of climate change at the local level.

CCRS Director Prof Dale Barker was interviewed for a Channel NewsAsia documentary 'Stem the Tide'.

CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim talked about Singapore's future climate in his interview with BERITA Mediacorp.

In an interview with BERITA Mediacorp, CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim shared that the average temperature of warm weather and the frequency of rainfall events in future are expected to increase with climate change. He commented that, however, there is a need for climate scientists to better understand the influence of natural variability on local climate and how climate change can in turn influence future heavy rainfall events. The findings can further support other areas of research, such as food safety, biodiversity and sea-level rise.

Staff Spotlight

Dr Chew Boon Ning
Head, WMA Branch

As Head of CCRS' Weather Modelling Applications (WMA) Branch under the Department of Weather Research, my team of four atmospheric scientists develop the operational air quality and smoke haze forecast models for Singapore. We also provide information services and expert assessment on airborne hazards in Southeast Asia, such as smoke haze from biomass burning, ash from volcanic eruptions and accidental industrial releases.

Our smoke haze forecasts provide guidance to the ASEAN Specialised Meteorological Centre (hosted by the Meteorological Service Singapore) in its issuance of haze warnings and advisories to ASEAN member states. In addition, our products support international efforts in providing timely information on air pollution to various stakeholders through collaborations with the World Meteorological Organization's (WMO) Vegetation Fire and Smoke Pollution Warning Advisory and Assessment System (VFSP-WAS) and Global Air Quality Forecasting and Information System (GAFIS). We have been active in pursuing world-leading research and I have recently contributed to WMO GAFIS 5-year implementation plan which seeks to improve air quality forecast systems in better serving societal needs.

To aid enforcement actions on air pollution and policy formulation at the National Environment Agency (NEA), my team has conducted source apportionment studies to track air pollutants affecting Singapore, allowing targeted approaches at reducing pollutant emissions. Apart from enabling an in-depth understanding of the atmospheric chemical environment over Singapore, these studies also revealed the impacts of little-known volatile organic compounds (VOCs) generated by nearby petrochemical industries on formation of criteria air pollutants, such as ozone and particulate matter (PM).

Dr Shipra Jain
Research Scientist

I am currently working for two branches at CCRS, the Seasonal and Subseasonal Prediction (SSP) Branch and the Climate Modeling and Prediction (CMP) Branch.

My key role at the SSP Branch is to develop sub-seasonal and seasonal forecast products for Southeast Asia. I work with a team of researchers to provide fortnightly weather outlooks for the ASEAN Specialised Meteorological Centre (ASMC) and monthly to seasonal outlooks for the Southeast Asian Regional Climate Centre Network. I also support the ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre) by providing weekly outlooks on high-impact weather, such as extreme heat and heavy rainfall.

At the CMP Branch, I am evaluating CCRS' in-house dynamically downscaled climate projections for Southeast Asia, and contributing to the development of Singapore's Third National Climate Change Study (V3). The research that I perform at CCRS will also advance the physical understanding and prediction of weather and climate extremes over Southeast Asia.

For other staff profiles, please visit http://ccrs.weather.gov.sg/our-people/.

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