CCRS Newsletter

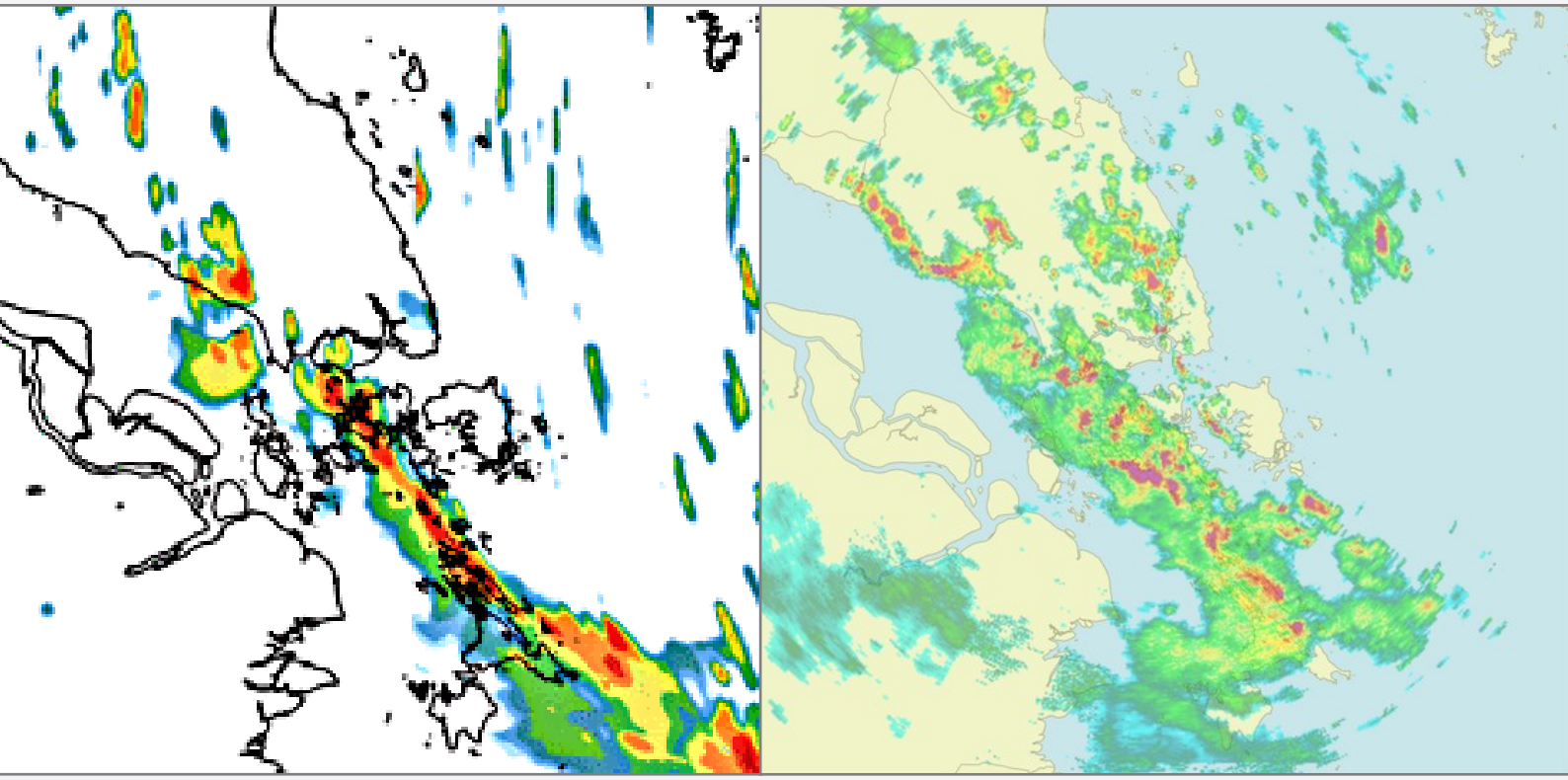
Issue 1, July 2022

Highlights

Core membership of the international Unified Model Partnership

New in-house HPE supercomputer

Annual International Scientific Advisory Panel Meeting



Forecasted rainfall from CCRS' numerical weather prediction model, 33 hours in advance (left); and rainfall snapshot from radar (right), both valid at 5pm SGT on 6 Feb 2022.

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.

Welcome from the Director

Greetings from the Centre for Climate Research Singapore (CCRS), and welcome to the inaugural issue of our quarterly newsletter!

As the research arm of the Meteorological Service Singapore (MSS), CCRS' mission is to advance scientific understanding of tropical climate variability, climate change and weather systems affecting Singapore and the wider Southeast Asia region, so that the knowledge and expertise can benefit decision makers and the community.

Our new CCRS Newsletter aims to share our latest news, activities and progress with you, as well as climate/weather science developments in the region and internationally that are relevant to CCRS' mission.

In this issue, we have a number of updates to share. I am particularly pleased that CCRS' efforts in climate modelling have been recently recognised internationally through our move from 'associate' to 'core' member of the international Unified Model Partnership.

Secondly, the recent meeting of our International Scientific Advisory Panel (ISAP) concluded with strong support for CCRS' climate and weather science strategy, but perhaps more importantly feedback and recommendations to help us consolidate our position as a leader in tropical climate and weather science.

We're also excited that parts of our new in-house supercomputer have begun arriving in the building, and we look forward to beginning to upgrade our research and operational capabilities when the new supercomputer comes online in August 2022.

Our CCRS Seminar series is now back up and running, following a hiatus due to the COVID-19 pandemic. We encourage external involvement, both as audience and speaker, so do get in touch if you wish to get involved.

I hope that you will find the CCRS Newsletter informative and useful. We look forward to any feedback you may have via NEA_CCRS_Engage@nea.gov.sg.

Professor Dale Barker
Director,
Centre for Climate Research Singapore

Core Membership of the International Unified Model Partnership

In February 2022, Singapore joined the United Kingdom (UK), Australia, New Zealand, India and the Republic of Korea as a core member country of the Unified Model (UM) Partnership. The Unified Model is one of the world's foremost climate/weather modelling systems, used internationally in a range of weather/climate applications, including global/local numerical weather prediction (NWP) for forecasting weather; seasonal prediction (e.g. El Niño/La Niña conditions); and longer-term projections of future climate.

CCRS' journey towards core membership

It all began with the SINGV project (2013–2018), a collaboration between CCRS and the Met Office (HQ in Exeter, UK). The goal of the project was to develop, test and implement a km-scale local NWP system suitable for forecasting the challenging weather conditions of the Singapore region, in particular the prediction of extreme rainfall from hours to 1–2 days ahead.

The project resulted in the first operational implementation of the SINGV system at MSS in July 2019. The cover images show that SINGV was able to accurately capture the passage of a line of thunderstorms over Singapore on the afternoon of 6 Feb 2022.

In addition, the SINGV tropical, regional configuration of the UM was subsequently adopted by a number of UM partner countries as the basis for their tropical high-resolution weather/climate applications.

Use of SINGV in the latest 'V3' regional climate change study

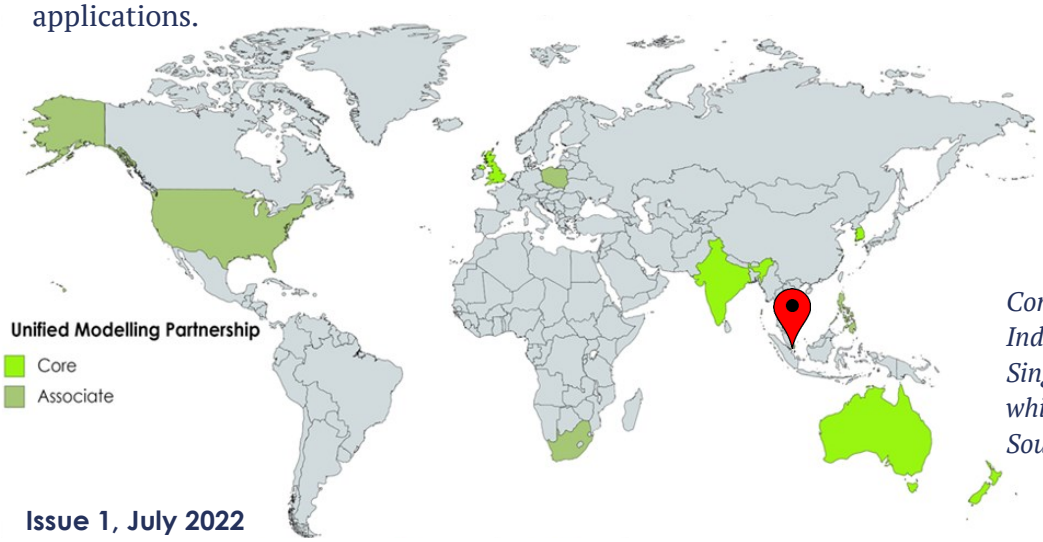
The SINGV system also provides the climate model for Singapore's Third National Climate Change Study (V3) due for completion in Q3 2023. The V3 regional climate projections are expected to be utilised by public agencies for their downstream climate impact studies and climate adaptation plans. Thus, the seamless strategy of using the UM at both weather and climate change timescales is enabled at CCRS.

What core membership means to CCRS & Singapore

Core membership status gives CCRS a seat on the international UM Partner Board, defining the strategic direction and priorities driving the efforts of hundreds of scientists worldwide.

It also provides a mechanism for local climate scientists to collaborate with a large number of international experts to better understand and predict Singapore's complex weather. The scientists are then able to provide a strong scientific basis for tailored advice to guide Singapore's preparations for climate change.

As a core member, CCRS looks forward to greater exchange of knowledge, modelling developments and scientists, with a focus on regional modelling for both weather and climate applications.



Core members are the UK, Australia, India, New Zealand, South Korea and Singapore (marked by the red pin), while associate members are Poland, South Africa and the United States.

Annual International Scientific Advisory Panel Meeting

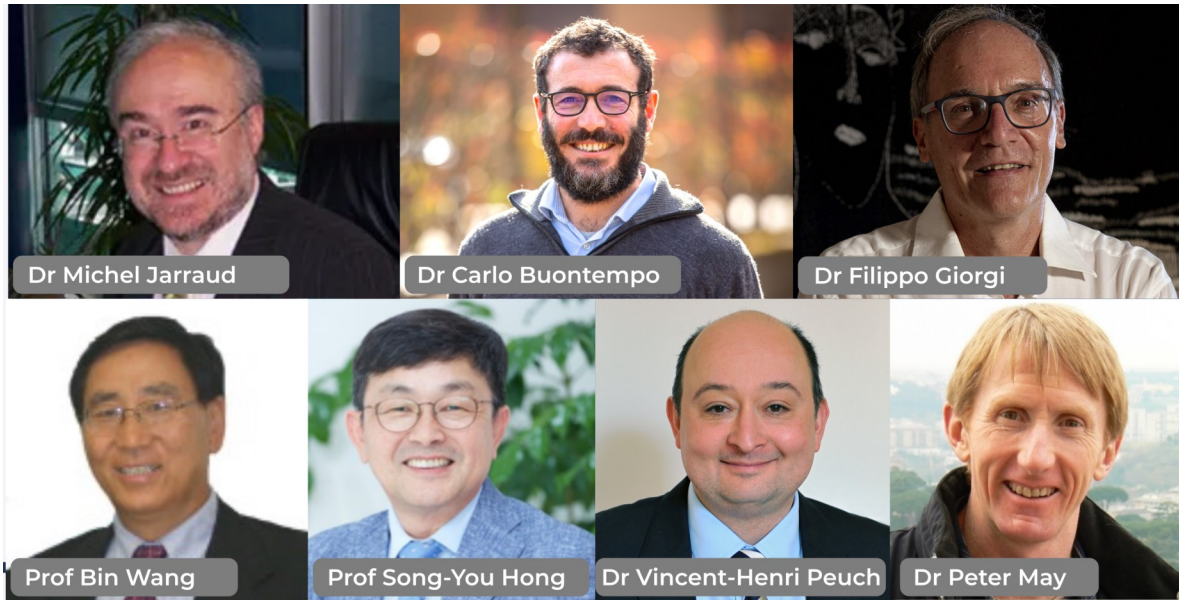
The CCRS International Scientific Advisory Panel (ISAP) comprises renowned weather and climate science leaders and experts from the United Kingdom, United States, Italy and Australia, chaired by the Secretary-General Emeritus of the World Meteorological Organisation Dr Michel Jarraud. The ISAP convenes annually to provide their scientific insights and expert advice on CCRS' strategic research directions.

In 2022, Professor Song-You Hong, Dr Filippo Giorgi and Dr Carlo Buontempo are welcomed into the ISAP, joining existing members Dr Peter May, Dr Vincent-Henri Peuch and Professor Bin Wang to provide guidance to CCRS.

At the 9th annual ISAP meeting held virtually on 19–21 April 2022, the ISAP endorsed the broad strategic research directions of CCRS and congratulated CCRS on the overall progress made since its inception in 2013.

The ISAP also provided useful guidance and feedback to help CCRS pursue its vision to be a world-leading centre in tropical weather and climate research focusing on the Southeast Asia region.

CCRS is also committed to supporting the Singapore Green Plan 2030 through its underpinning climate research, working with local institutes of higher learning to build local capabilities, and working with a range of agencies to provide actionable climate advice and data (e.g. V3) to help build Singapore's climate resilience.



2022 ISAP members

"CCRS is a very special actor in this part of the world, at the junction between two WMO regions, and is bringing significant added value."
- International Scientific Advisory Panel

New In-house HPE Supercomputer

With almost twice the computational capacity of CCRS' outgoing 'Athena' system, CCRS' new in-house HPE Cray EX supercomputer will deliver a peak performance of 400 Teraflops with a set of new technologies, including HPE's Slingshot interconnect, 98 computes nodes of AMD Milan processors, 2 NVIDIA GPU nodes, a 1.5 Petabyte ClusterStor storage system with Data Management Framework, and PBS Pro workload manager.

The enhanced supercomputing capabilities will enable a variety of upgrades to CCRS' operational weather and environmental forecasting capabilities to better serve stakeholder needs.

CCRS scientists will be able to further develop and upgrade the SINGV numerical weather prediction system with high spatial and temporal resolutions, which allow us to more explicitly resolve small-scale processes dominating weather and climate in the tropical region such as localised convections. The increased computing power will also enable the further improvement in CCRS' data assimilation and ensemble prediction systems to improve forecast skills.

The enhanced supercomputing power will enable:

- Further development of very high-resolution sub-km scale urban modelling system (uSINGV) to represent the urban environment more appropriately in climate/weather models;
- Development of a coupled ocean-atmosphere-land-wave modelling system (cSINGV) to capture and improve our understanding of the strong feedbacks between the atmosphere, land and ocean, which have a significant impact on the weather and climate over the Southeast Asia region;
- Expanded research to better understand and forecast key tropical weather processes in the region, such as "Sumatra squalls", monsoon surges and thunderstorms;
- Development of CCRS' capability to deliver routine model forecasts of local air quality in Singapore. The modelling system will simulate the chemical transformations of anthropogenic sources (e.g. road traffic, industries) leading to secondary pollutants that further impact air quality in the region; and
- Implementation of new forecast post-processing techniques utilising the latest advances in artificial intelligence to further improve the quality of forecasts.

The new supercomputer will be available for use within CCRS in Q3 2022. It will complement the supercomputing resource acquired at the National Supercomputing Centre Singapore (NSCC). More information about the NSCC resource will be provided in the next Newsletter.

Science Highlights

On the applicability of urban canopy parameterisation in building grey zone

Dr Song Chen, Research Scientist
Weather Modelling Development Branch

Growing urbanisation makes cities such as Singapore more vulnerable to meteorological hazards such as the urban heat island effect, urban flash flooding and air pollution. With increasing interest in Integrated Urban Services (IUS), there is a rising need to appropriately represent the urban environment in regional weather/climate models.

Regional climate modelling at CCRS is beginning to explore sub-km urban scales horizontal grid through the 'uSINGV' configuration, but it is still insufficient to resolve the flow around buildings. Effects of the urban environment on the atmosphere above are therefore represented using the Urban Canopy Parametrization (UCP) schemes in models. Existing UCPs usually use the repeating canyon–roof representation that assumes homogeneous distribution of buildings within the grid box, which is commonly valid in mesoscales. However, at the sub-km scale, it is unclear whether the assumption of homogeneity still holds. Hence, the resolution ranges from a few hundred metres to tens of metres is termed the "building grey zone".

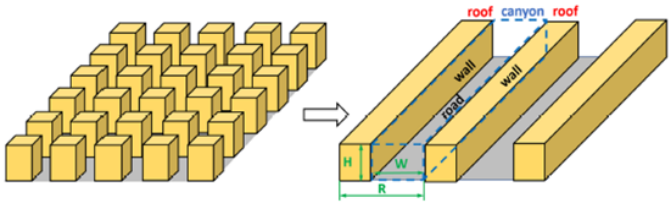


Illustration of repeating canyon–roof representation used to represent the effects of the urban environment on the atmosphere above in regional weather/climate models

In this study, **Dr Song Chen** and his colleague used an urban-grid method to investigate the isolated effects of UCPs (i.e. urban morphology represented at different resolutions), while keeping the same atmospheric model grid. Comparison of the results (e.g. temperatures, winds, land surface energy transfer rate) from simulations using different resolutions showed that the assumption of homogeneity indeed does not hold at the building grey zone for the city-state Singapore, and model differences are not negligible especially during the afternoon when tropical convection dominates. The study suggested greater caution is needed when using UCPs at sub-km resolution in urban modelling.

This study was also recently presented at the WMO Workshop on Integration of Urban Activities. Click here to read the full paper.

Parametrization-driven uncertainties in single-forcing, single-model wave climate projections from a CMIP6-derived dynamic ensemble

Dr Rajesh Kumar, Senior Research Scientist
Weather Modelling Development Branch

As a low-lying island, Singapore is particularly vulnerable to sea level rise which may lead to coastal and inland inundation. In the context of global sea level rise, wind-driven ocean surface waves are one of the main drivers of flooding in the global climate system due to their complex interactions with the atmosphere and deep ocean. At the same time, waves can be influenced by changes in surface wind and storm patterns due to climate change. Hence, wave climate projections are important in assessing the impacts of climate change on coastal areas. In wave modelling, uncertainties can arise from several sources, one of which is different physics packages implemented in wave models.

In this study, **Dr Rajesh Kumar** and colleagues selected different physics packages that simulate the physical processes in waves using different algorithmic approaches. They investigated the uncertainties associated with different physics packages implemented in the state-of-the-art wave model WAVEWATCH3 (WW3) in describing the present and future wave climate projections under a single emission scenario.

Upon comparing against reanalysis data which provides the most complete picture of past climate, the historical wave climate simulations were found to be in good agreement. The results of this study shed new light on the impacts associated with the use of multiple physics packages in building wave climate ensembles, an issue that has not received the necessary attention. Click here to read the full paper.

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. Examples of topics are sea level research, climate change impact studies, air quality prediction, urban impact on weather and climate. Below are some highlights of the seminars held in Q2 2022.

Title of seminar:
Urban heat risks in a 2°C world: What can we do about it in Singapore?

Abstract:
Assoc Prof Winston Chow from the Singapore Management University (SMU) examined urban heat-related risks in the context of the city-state of Singapore and addressed two questions:
i) how are impacts arising from a +2°C world ascertained through examining current urban heat risk research in urban climatology; and
ii) how does the Cooling Singapore initiative attempt to apply results from this research towards informing policy that reduces risk?

Title of seminar:
Challenges for modeling tropical weather and climate: where CCRS research can help

Abstract:
Dr Hugh Zhang from CCRS introduced some of his own research on tropical weather and climate (e.g. impacts of tropical land-air interactions on local and regional climate, the Australia-Asian monsoon interactions and impacts on regional weather and climate, tropical monsoon-induced teleconnections, impacts of tropical biases in the Unified Model on global weather and climate). He then made linkage to such research at CCRS and discussed how CCRS research can be valuable and influential for future model development and improvement.

Events

8th International Symposium on Data Assimilation (ISDA)

CCRS Research Scientist Joshua Lee attended the 8th ISDA held in Colorado, USA, on 6–10 June 2022. Organised by the Cooperative Institute for Research in the Atmosphere (CIRA), the 8th ISDA brought together over 150 international experts to discuss challenges and progress in the field of data assimilation, the process by which observations are optimally combined with model data to provide a snapshot 'analysis' of the earth system. This process can be used to initialise weather forecasts as well as in reconstruction of past weather/climate.

In his presentation titled 'Tropical Convective-scale Data Assimilation in Southeast Asia', Joshua gave an overview and assessment of the operational SINGV-DA, Singapore's numerical weather prediction (NWP) system with data assimilation capability, which is the first-of-its-kind km-scale NWP system for the tropics. He also outlined latest SINGV-DA research developments, areas for future work, and potential opportunities for collaboration to further improve forecasts over Singapore and the surrounding region.

At the 8th International Symposium on Data Assimilation, CCRS Research Scientist Joshua Lee presented an overview of SINGV-DA.

UNLEASH Hacks Singapore 2022

CCRS scientists Prof Jeff Obbard and Dr Muhammad Eeqmal Hassim were spotted at the 3rd UNLEASH Hack in Singapore with the theme 'Climate Change: Education & Health', focusing on the role of education and healthcare sector in preventing and adapting to climate change in Singapore.

Prof Obbard delivered a keynote 'Stop Climate Change: Unleash Your Potential!' at the opening ceremony, while Dr Eeqmal was part of the judging panel for Hackathon projects revolving around the topic of climate change.

CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim contributing to the discussion at the 3rd UNLEASH Hack in Singapore

CleanEnviro Summit Singapore (CESG) 2022

On 17–20 April 2022, CCRS ran an exhibition booth at CESG2022 which saw over 15 000 physical attendees.

The booth gave an overview on CCRS-led Third National Climate Change Study (V3), which will provide localised and high-resolution climate projections for Singapore and the surrounding region. V3 is expected to be completed by Q3 2023, and the findings will guide the ongoing adaptation planning and implementation to safeguard Singapore against the impacts of climate change. The booth also showcased a number of weather and climate educational materials as well as the latest MSS/CCRS publications.

At CleanEnviro Summit Singapore 2022, CCRS Head of the Climate Impacts Branch Prof Jeff Obbard delivered an innovation pitch on the National Climate Change Study for Singapore.

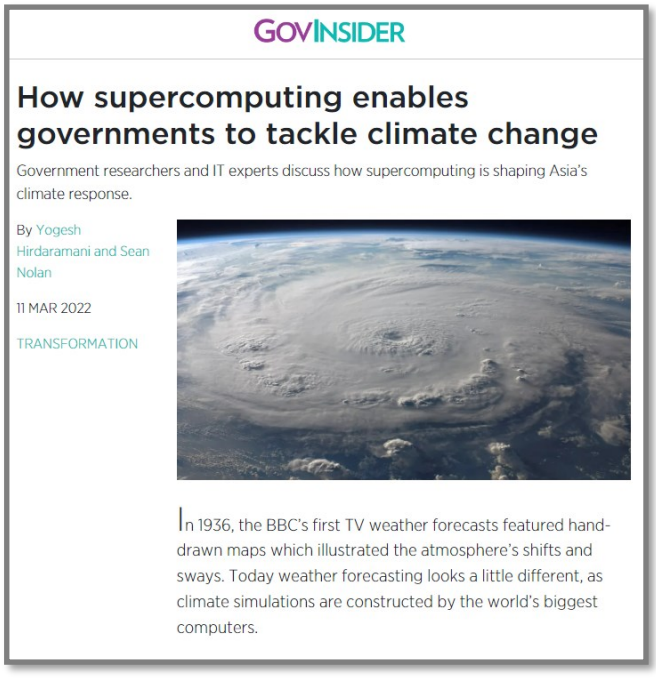
Held in conjunction with CESG2022, the Asia Climate Forum is a co-located industry event that brings together expertise in climate change, weather forecasting flood mitigation and air quality management in Asia, Africa and the Pacific Islands.

In his keynote titled 'Impact-driven Climate Science Research to Guide Local Climate Adaptation Efforts', CCRS Director Prof Dale Barker highlighted various aspects of CCRS' work for Singapore and Southeast Asia, which include the SINGV numerical weather prediction system, V3 regional climate projection data and the work of Climate Science Research Programme Office.

Media Highlights

In an interview with GovInsider, a digital publisher that covers government innovation in Asia Pacific, CCRS Director Prof Dale Barker shared how CCRS uses its own supercomputer and facilities at the National Supercomputing Centre Singapore to run climate simulations for Singapore.

Part of Singapore's Third National Climate Change Study, the climate simulations provide information such as projected temperatures and rainfall levels under different greenhouse gas emission scenarios, thus enabling scientists and policymakers to understand the effects of climate change on Singapore.


GOVINSIDER

How supercomputing enables governments to tackle climate change

Government researchers and IT experts discuss how supercomputing is shaping Asia's climate response.

By Yogesh Hirdaramani and Sean Nolan

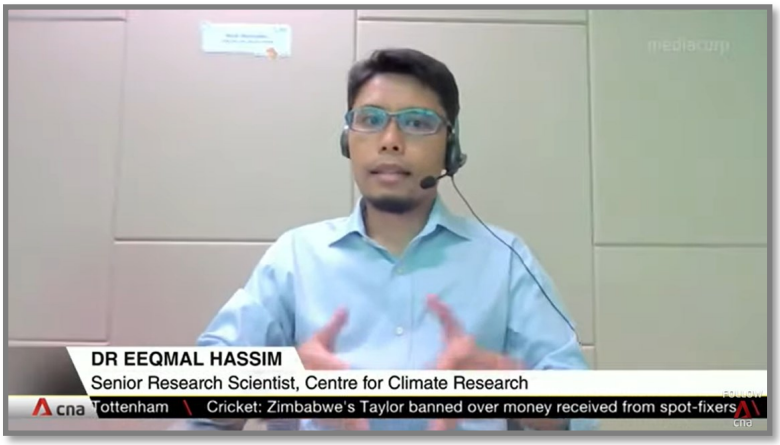
11 MAR 2022

TRANSFORMATION

In 1936, the BBC's first TV weather forecasts featured hand-drawn maps which illustrated the atmosphere's shifts and sways. Today weather forecasting looks a little different, as climate simulations are constructed by the world's biggest computers.

CCRS Director Prof Dale Barker shared with GovInsider how CCRS uses its supercomputing resources for climate research.

The summaries in the The Year in Review 2021 state that the last 10 years from 2012 to 2021 was the warmest decade for Singapore on record. In an interview with ChannelNews Asia, CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim shared that the warmest decade on record reflected the background global warming signal. With climate change, it is expected that the contrast between wet months and relatively drier months will also increase.



CCRS Senior Research Scientist Dr Muhammad Eeqmal Hassim shared with ChannelNews Asia what could be expected with global warming due to climate change.

Staff Spotlight

Dr Thea Turkington
Senior Research Scientist

As the Branch Head of the Seasonal and Sub-seasonal Prediction Branch under the Department of Climate Research, I lead my team to develop predictions for Singapore and the surrounding region two weeks to three months in advance.

Seasonal and sub-seasonal prediction is a fascinating area of research – not only are there some interesting science questions to answer about what drives variability in the climate and how this understanding can lead to better predictions, but there is also a societal benefit as well.

At CCRS, my team provides customised service to help end users in their water resources and disaster risk management associated with seasonal climate variability. We also contribute to regional capacity building through training workshops and climate outlook forums.

Dr Robert Huva
Research Scientist

I joined the Research to Operations Branch, Department of Weather Research in April 2022 to work on post-processing of numerical weather prediction (NWP) output. My expertise includes NWP modelling systems and their applications in renewable energy systems.

Prior to joining CCRS, I focused on rainfall modelling for Singapore. I am also experienced in the use of data assimilation for day-ahead solar forecasting over Singapore and will use my experience in NWP modelling for this region to assist with the development of probabilistic forecasting at CCRS.

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

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