



**METEOROLOGICAL
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SINGAPORE**
Centre for Climate Research Singapore

Analysing Climate Change: Projections for Singapore and the Southeast Asia Region

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Centre for Climate Research Singapore (CCRS)

To advance scientific understanding of tropical climate variability and change, and associated weather systems that affect Singapore and the wider Southeast Asia region, for the benefit of decision makers and the community

- Research department of the Meteorological Service Singapore (MSS)
- Launched in March 2013



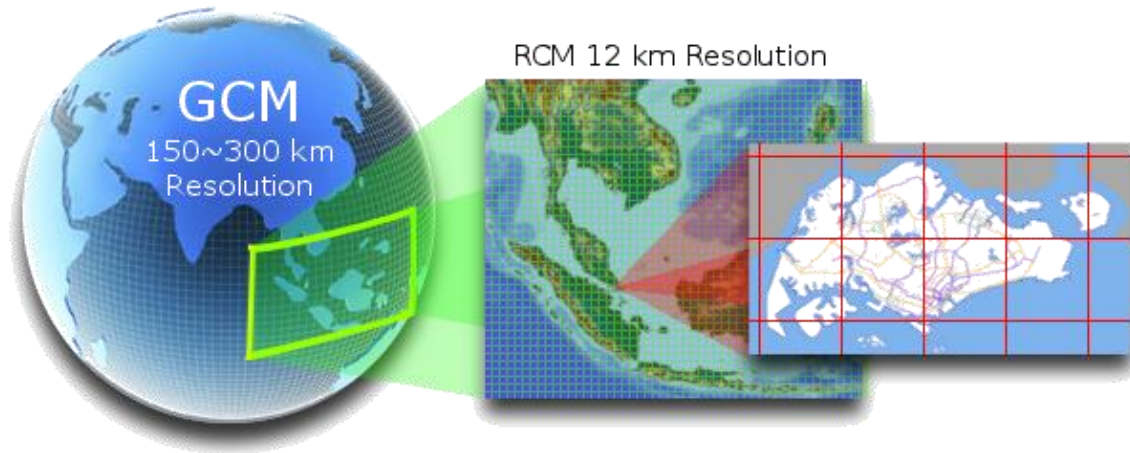
CCRS Core Capabilities



- **High-resolution modelling** on weather and climate
- **Undertaking research** to understand key weather and climate processes affecting the Southeast Asia region (e.g. monsoons, El Nino)
- Engaging end-users/decision-makers to **tailor predictions**
- Building capability in regional sea level rise research



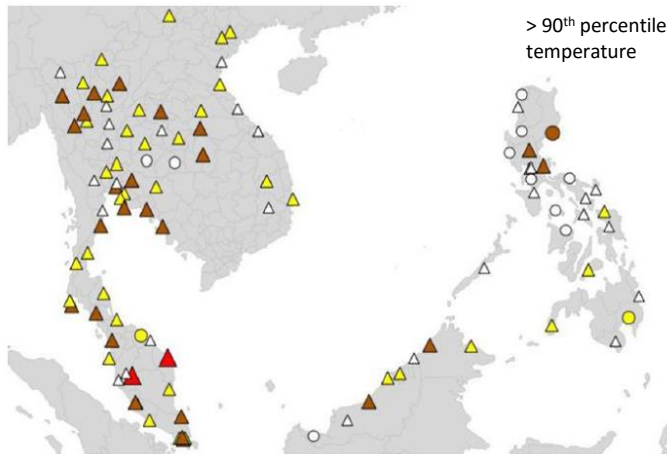
Climate Modelling and Analyses



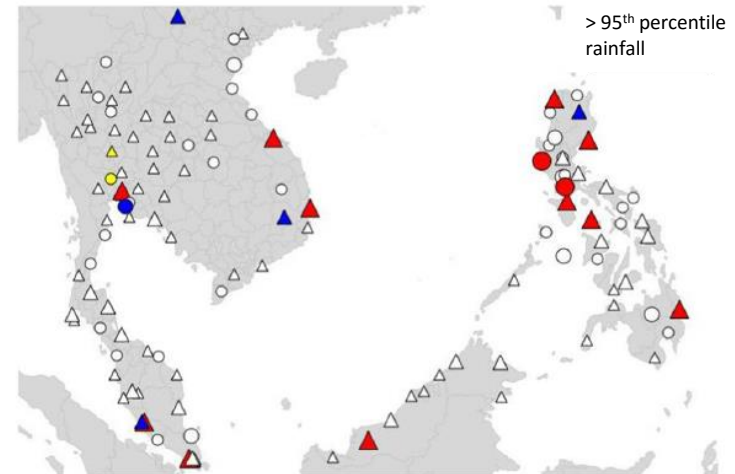
- CCRS has analysed future climate for Singapore and the Southeast Asian region at high spatial resolution.
- Global Climate Models are available at low resolution (~ 100 km)
 - Terrain, land-sea boundaries not captured well
 - Regional and local weather/climate process poorly simulated
- Need to “**downscale**” models to higher resolution (~ 10 km or higher)
 - Resource intensive: **simulations** (> 1 year), **processing** (~petaflop supercomputer) and **storage** (terabytes), and **analyses** (various scientific expertise)

Observed Changes in Southeast Asia Climate

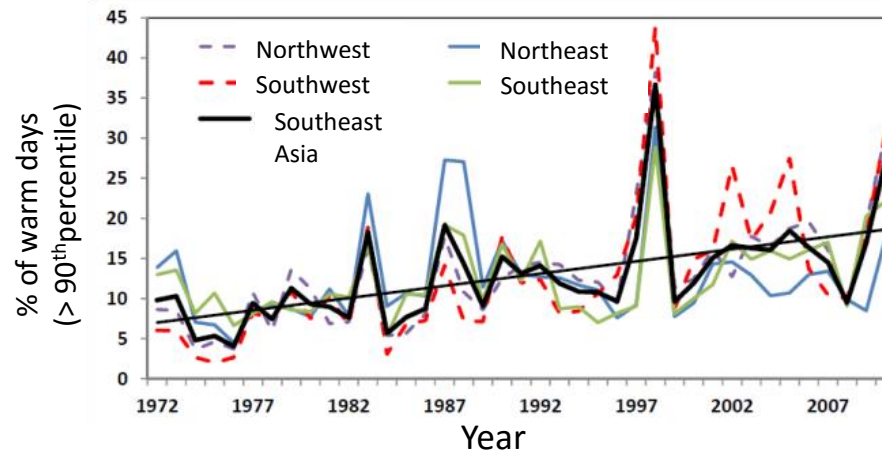
Extreme temperature trends



Extreme rainfall trends



- Long-records of observation weather stations show uptrends in extreme temperature (5-10% increase/decade) and rainfall (50-100 mm/decade)
(From Cheong et. al, 2018. Δ : increase per decade, \circ : decrease per decade. Coloured symbols indicate significant values)



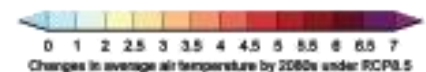
- Trends for temperature are masked by **year-on-year variability** due to natural drivers such as the El Niño/La Niña

Future Projections for Southeast Asia

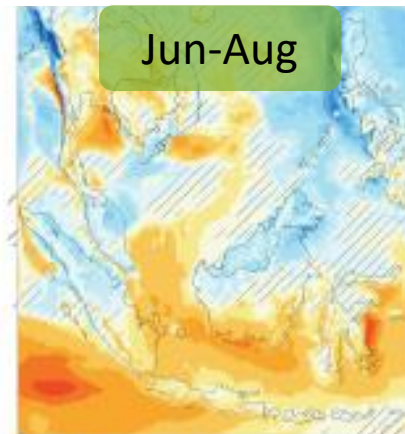
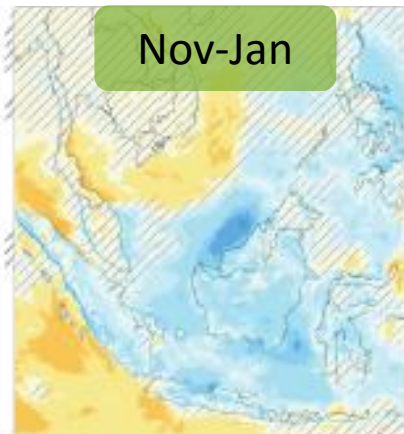
End-century (2070-2099) relative to baseline period (1980-2009) for RCP8.5

- The region is expected to be warmer
- Stronger warming over land

Temperature change:



Rainfall change:



Non-hatched areas indicate significant changes.

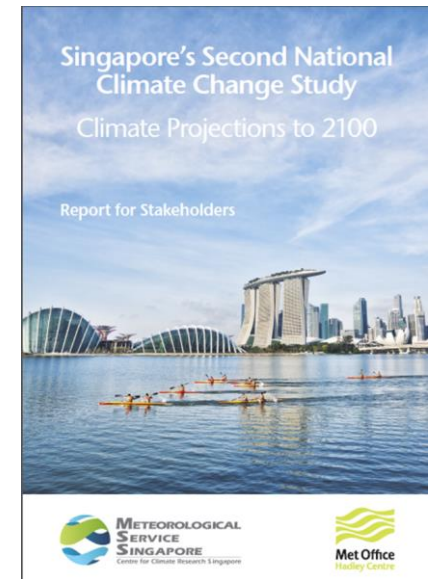
- More days with heavy rainfall
- However drier and wetter conditions projected in different parts of region
- Singapore's nearby region: wet season getting wetter; dry season getting drier

Projections for Singapore

For year 2070-2099 w.r.t. 1980-2009

Projections: warmer conditions, enhanced contrast between wet-drier seasons, rising sea level.

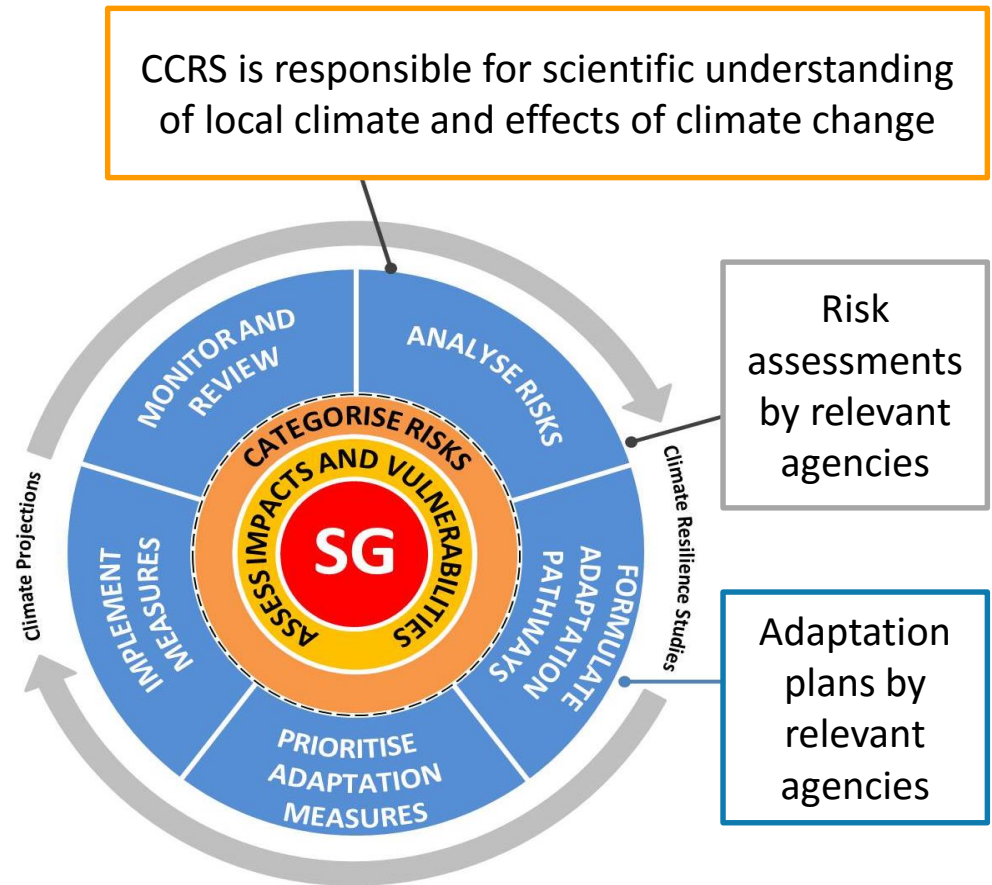
Change in Variables	Scenario RCP4.5	Scenario RCP8.5
Temperature	1.4 to 2.7°C	2.9 to 4.6°C
Mean rainfall	-12% to 10%	-17% to 27%
Northeast Monsoon Rainfall	-14% to 43%	-23% to 68%
Southwest Monsoon Rainfall	-12% to 12%	-30% to 1%
Mean Sea-level Rise	0.25 to 0.60 m	0.35 to 0.76 m (up to about 1 m by 2100)



Reports are available at:
<http://ccrs.weather.gov.sg>

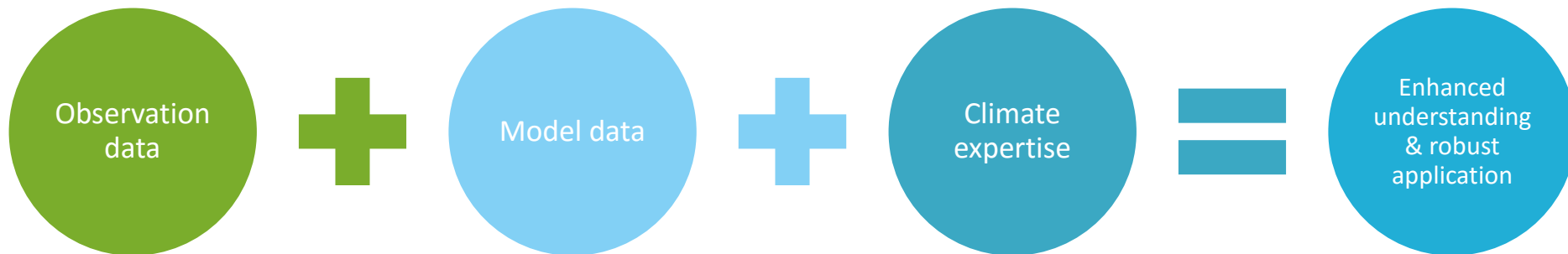
Climate Science Underpins Planning

- Climate projections guide policy and planning for climate change
- CCRS' findings form the basis for Singapore's long-term adaptation plans
- Important for projections to be robust and keep up with latest scientific advancements



Challenges and Opportunities

- Modelling and analysing climate change is a complex process
 - Lack of observation data for regional assessment
 - ‘Downscaling’ and analysing climate models are resource-intensive
 - Weather/climate are large-scale, cross-boundary phenomena: local knowledge alone will not suffice
- Greater regional cooperation can enhance collective understanding of climate change



- CCRS plans to share its climate projections data and findings with ASEAN partners, to enhance regional understanding of climate change in Southeast Asia



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