METEOROLOGICAL SERVICE SINGAPORE
Centre for Climate Research Singapore

Joint Annual R&D Workshop and 6th Momentum Partnership Convective Scale Workshop
9-13 September 2024

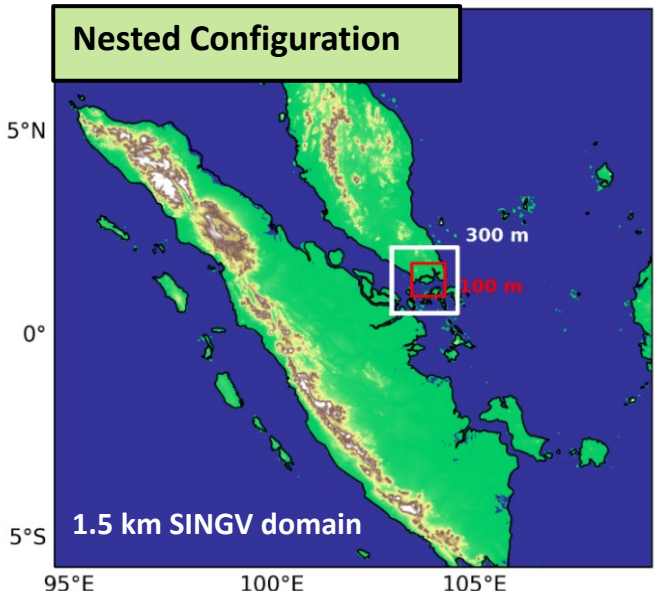
Modelling of Extreme Rainfall in Singapore Using 100 m uSINGV

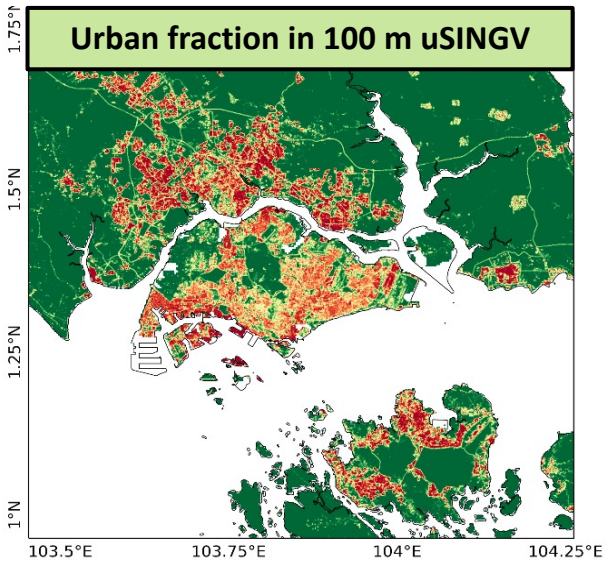
Utkarsh Bhautmage[2], Song Chen[1], Matthias Roth[2], Pratiman Patel[1], Kalli Furtado[1], and Hugh Zhang[1]

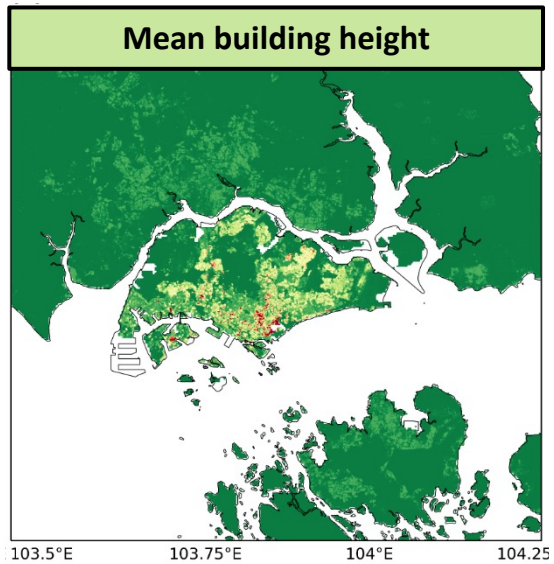
1 Centre for Climate Research Singapore, Meteorological Service Singapore
2 Department of Geography, National University Singapore

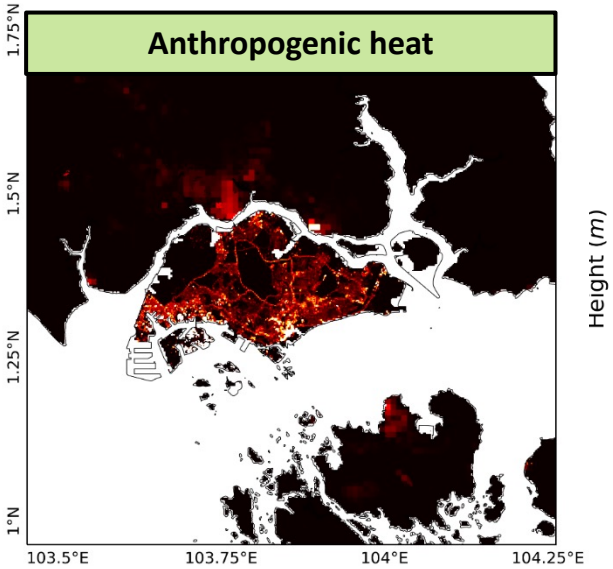
About 100 m uSINGV

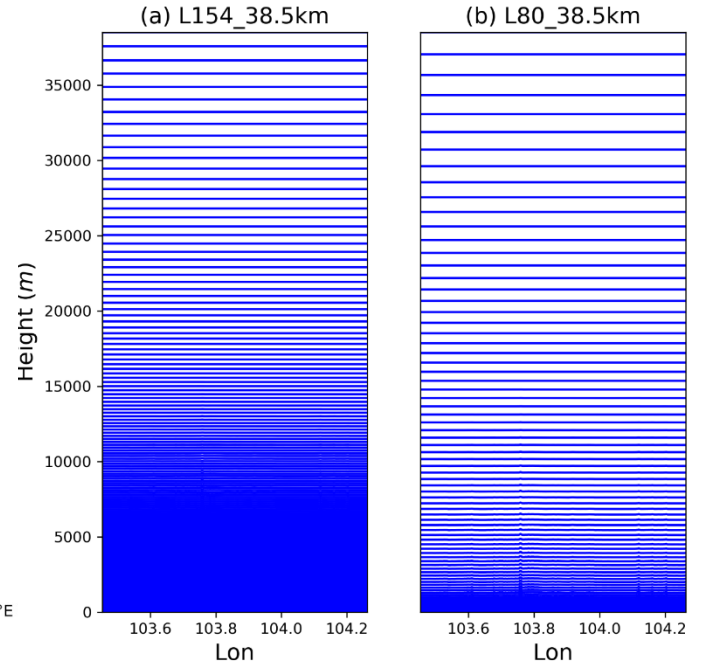
- From 1.5 km SINGV → 300 m uSINGV → **100 m uSINGV**
  - Increased model grid resolution
  - Improved urban ancillaries
    - Land cover, urban morphology, anthropogenic heat
  - Option of a new hi-res vertical grid resolution: L154_38.5km
  - Upgraded to RAL3











Extreme rainfalls in Singapore

- Mainly from Sumatra squalls and localized thunderstorms
- Localized thunderstorms
  - Short-lived and small scale, can be high intensity → difficult to capture in models
  - Convergence due to strong solar heating
  - Heavy rainfall definition in SG: *> 70mm/60min or 35mm/30min, minimum duration of 15mins*

→ Can 100 m uSINGV capture/represent extreme rainfalls in Singapore?

Research Collaboration Agreement (RCA) Project between CCRS and NUS

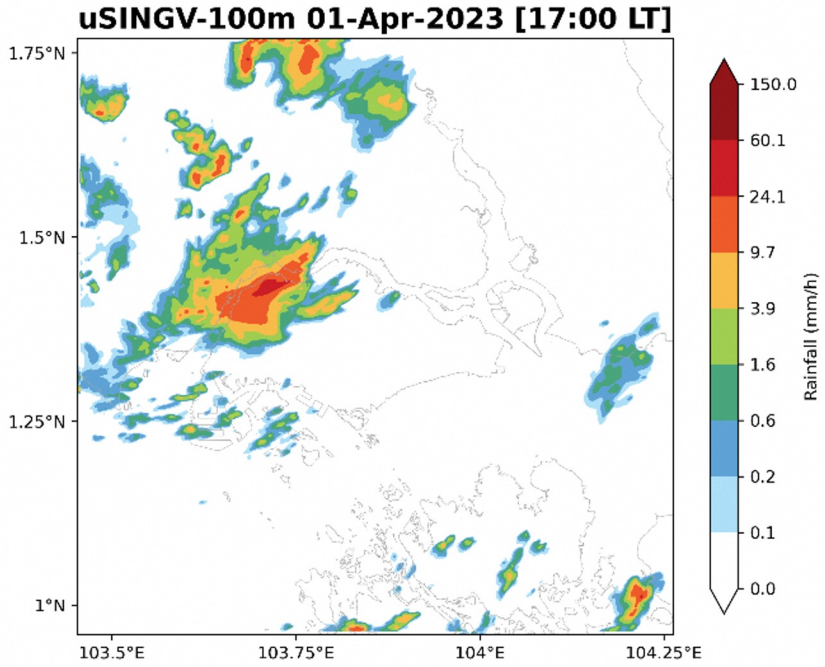
- "Evaluation and development of 100 m uSINGV for extreme rainfall and wind modelling in Singapore"
- Two-year project: August 2023 – July 2025

- Team
  - NUS: Utkarsh Bhautmage and Matthias Roth
  - CCRS: Song Chen, Hugh Zhang, Kalli Furtado, and Pratiman Patel

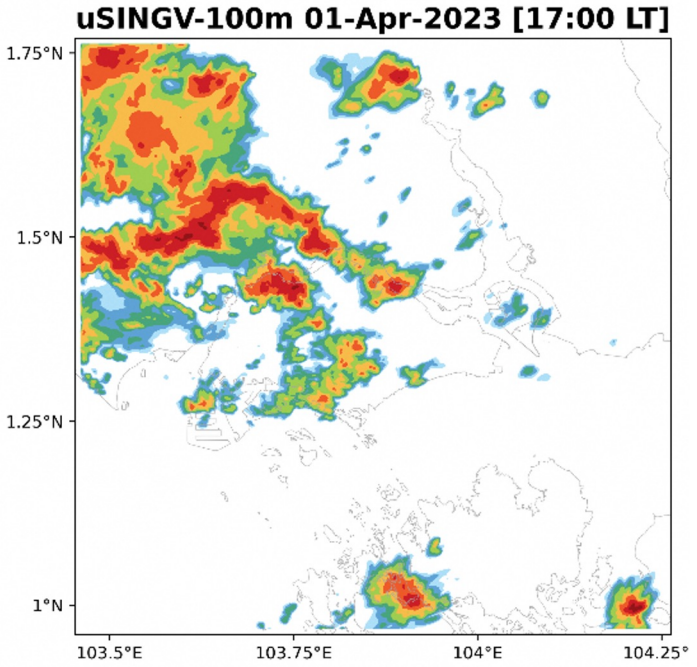
Improvements on rainfall from RAL3 physics

in 100 m uSINGV with MORUSES

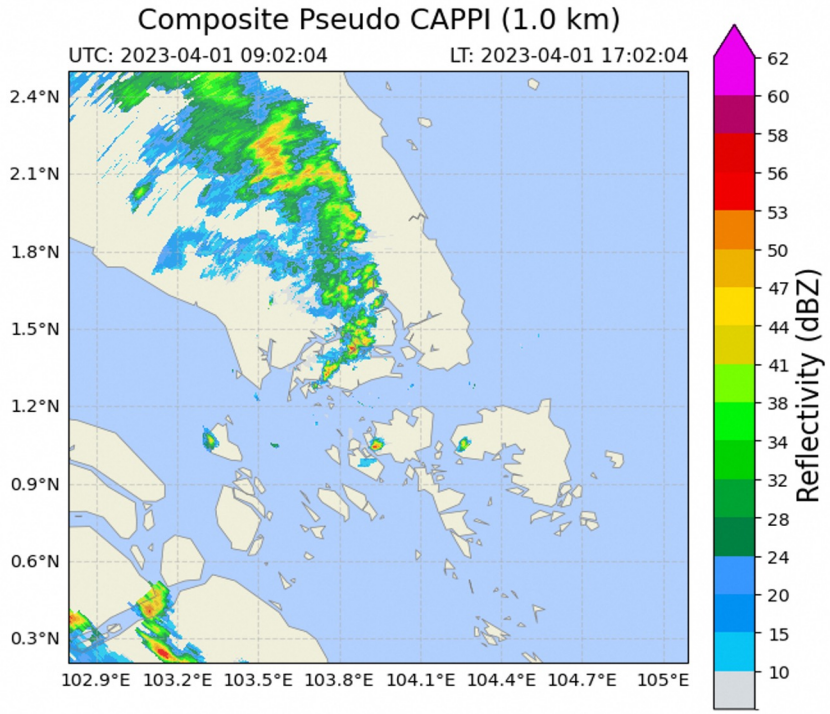
RAL2



RAL3



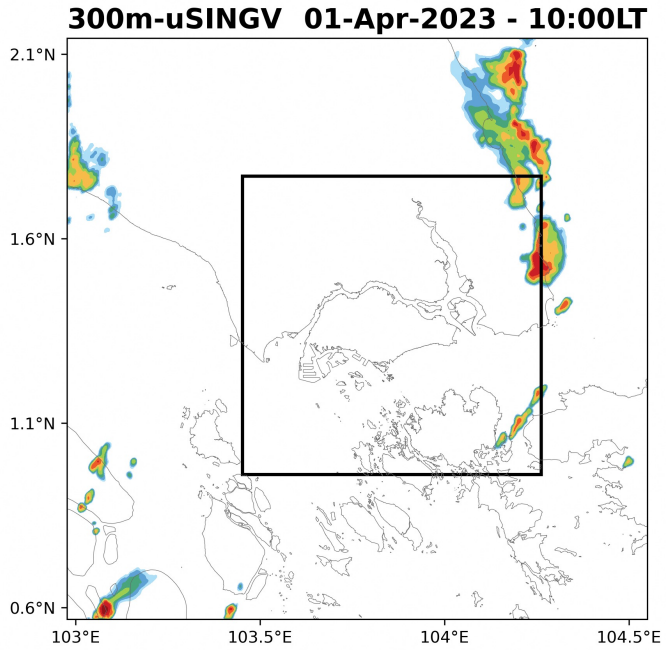
Radar



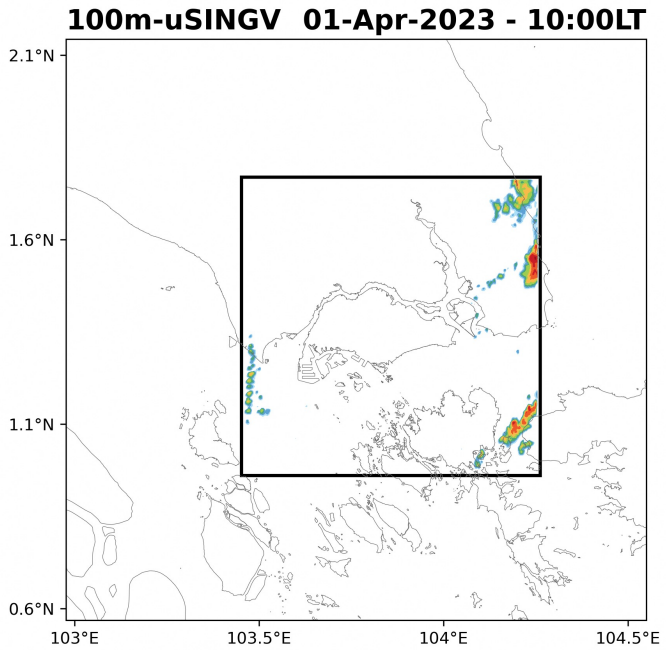
Convergence induced heavy rainfalls

- ~30 selected cases have been run : *> 70mm/60min or 35mm/30min, minimum duration of 15mins*
- From 1.5km SINGV → 300 m uSINGV (MORUSES) → 100 m uSINGV (MORUSES)
- Example: heavy rainfall at 16:00 -21:00 local time 1st April 2023

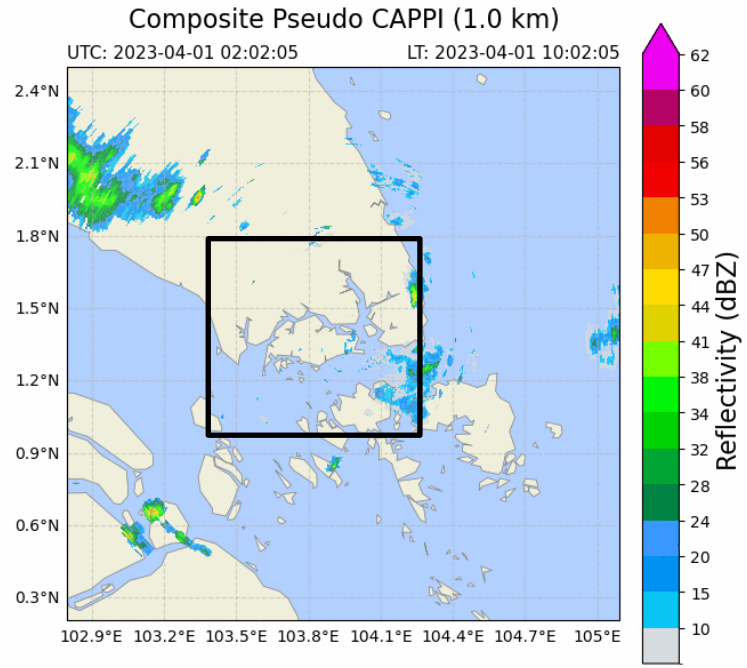
300 m uSINGV



100 m uSINGV

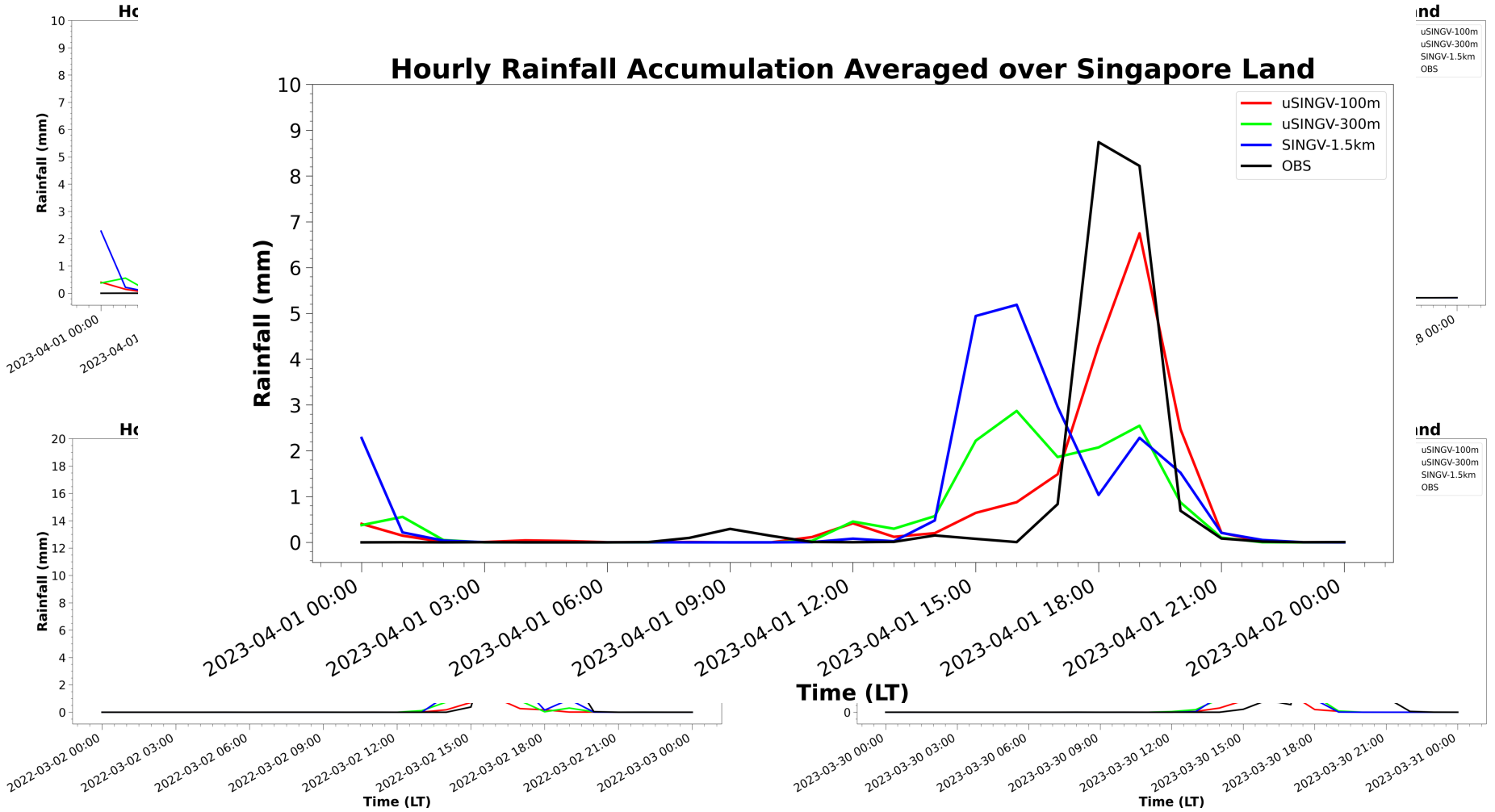


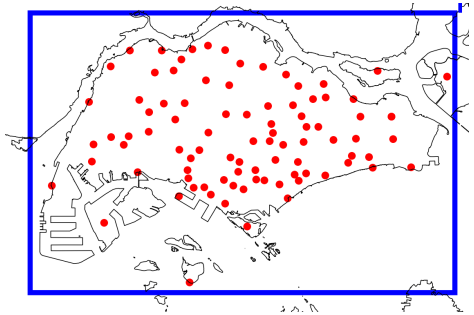
Radar



Time series of hourly rainfall averaged over land

Comparison with stations





uSINGV-100m
uSINGV-300m
SINGV-1.5km
OBS

Maximum hourly rainfall accumulation

Comparison with stations

case	EXTREME RAINFALL CRITERIA [based on stn.]	Maximum Hourly Rainfall Accumulation (mm) [Station]	Maximum Hourly Rainfall Accumulation (mm) [Model]		Maximum Half Hourly Rainfall Accumulation (mm) [Station]	Maximum Half Hourly Rainfall Accumulation (mm) [Model]	
		Magnitude	300m-uSINGV	100m-uSINGV	Magnitude	300m-uSINGV	100m-uSINGV
1	**≥ 70 mm/h**	98.49	**56.18**	**71.85**	53.86	**46.75**	**30.09**
2	**≥ 70 mm/h**	84.85	**94.86**	**45.88**	70.24	**78.53**	**37.6**
3	**≥ 70 mm/h**	90.45	**59.21**	**35.94**	59.09	**48.9**	**35.28**
4	**≥ 70 mm/h**	78.4	**68.6**	**94.05**	63.4	**54.13**	**72.35**
5	**≥ 70 mm/h**	99.35	**78.61**	**69.49**	57.4	**56.35**	**48.68**
6	≥ 35 mm/30 min	51.6	**65.69**	**45.41**	35.8	**49.57**	**40.58**
7	≥ 35 mm/30 min	32.4	**57.54**	**39.62**	30.6	**57.37**	**33.12**
8	≥ 35 mm/30 min	45.2	**64.9**	**92.4**	43.05	**57.83**	**62.81**
9	≥ 35 mm/30 min	41.78	**49.9**	**45.71**	41.78	**47.1**	**42.11**
10	≥ 35 mm/30 min	33	**47.81**	**37.44**	33	**37.02**	**33.22**

Under Threshold **Above Threshold** Maximum Value Cell

Extreme rainfall event: *≥ 70 mm/h or ≥ 35 mm/30 min*

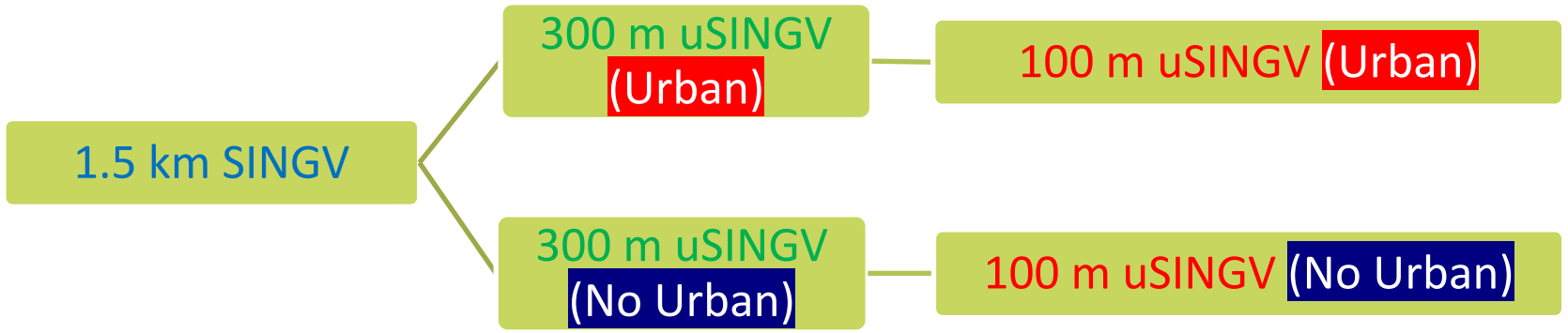
OFFICIAL

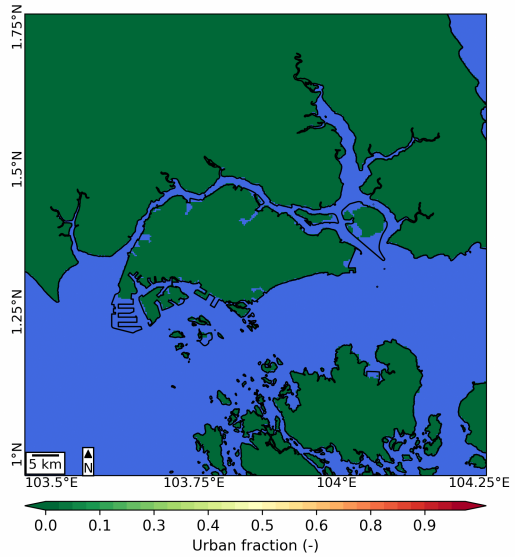
10m-Wind Speed Time-Series Plots Comparison at Changi

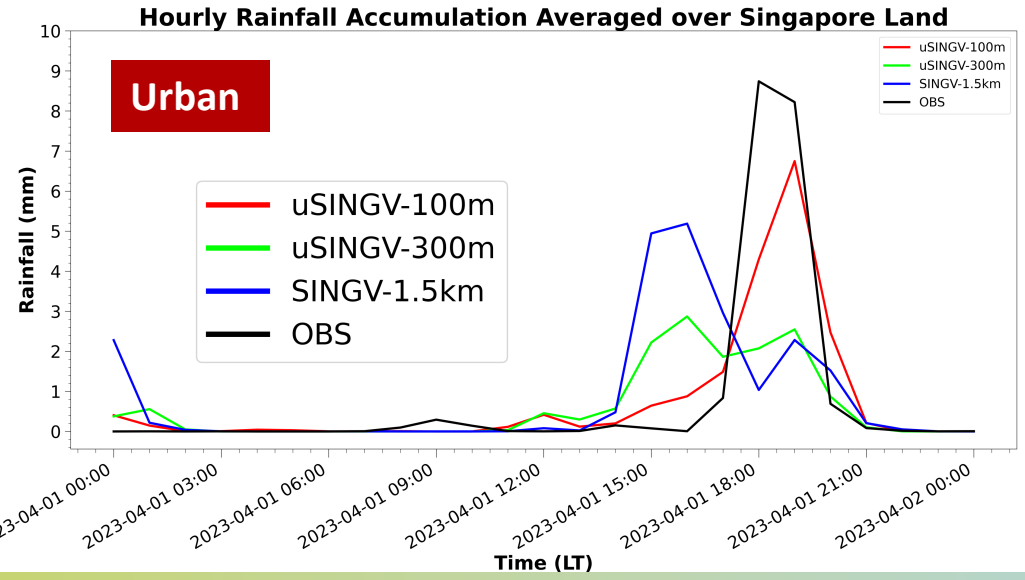
300m-uSINGV	100m-uSINGV	300m-uSINGV	100m-uSINGV
01-Apr-2023	01-Apr-2023	04-May-2023	04-May-2023
02-Feb-2023	02-Feb-2023	17-May-2023	17-May-2023
10-Apr-2023	10-Apr-2023	17-Apr-2022	17-Apr-2022
29-Mar-2022	29-Mar-2022	19-May-2022	19-May-2022

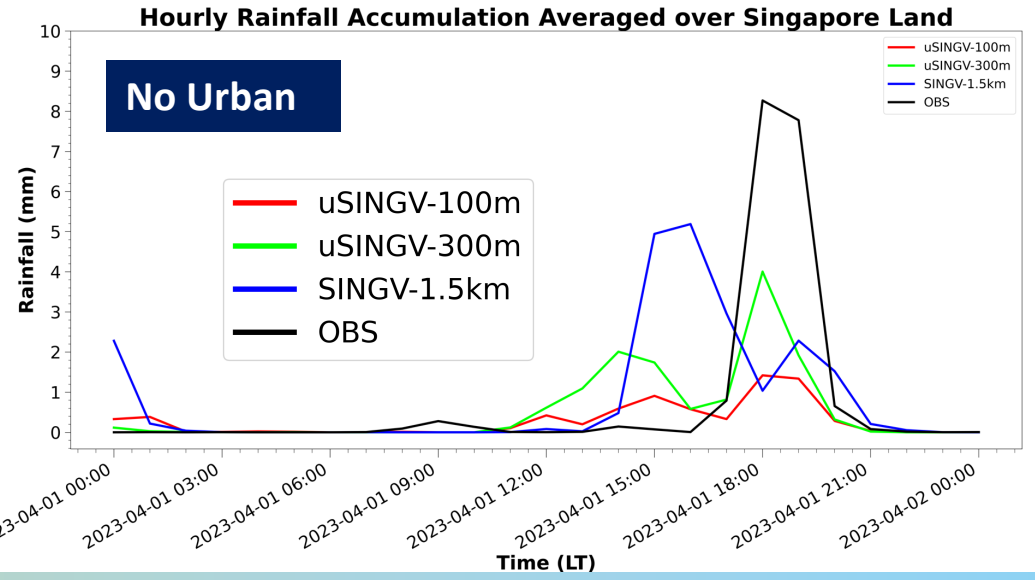
Impacts of urban - a case study

- Urban vs no-urban (replacing urban areas with broadleaf trees)









Remarks

- This project focuses on evaluation of 100 m uSINGV on extreme rainfalls in SG.
- RAL3 improvements are observed in 100 m uSINGV too
- Evaluations on the convergence induced heavy rainfall timing, pattern, and intensity and near-surface wind fields are on-going for 100 m uSINGV (further analysis needed)
- Strong urban impacts on the localized thunderstorms in 100 m uSINGV (more analysis to follow)

METEOROLOGICAL
SERVICE
SINGAPORE
Centre for Climate Research Singapore