Performing Convection Permitting simulations to address policy makers questions

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Outline

- Why do policy makers want convection permitting scale projections?
- What kinds of decisions can CP modelling help address?
  - Urban rainfall extremes (leading to flash flooding)
  - Heatwaves

Sydney, Australia

- ~5 million people
- Temperate climate overall
- Mean temperature 18.8°C
- Highest temperature recorded = 48.9°C (Penrith,2020)
- Mean annual rainfall ~1150mm.
- Highest rainfall ~2,200mm (1950)
- So far this year ~2,005mm

Why do policy makers want convection permitting scale projections?

- Most policies are about assets and people (votes)
- Urban areas are frequently of interest
- Many of these policies/decisions are aimed at managing risks of various kinds
- Climate hazards associated with risks of concern
  - Extreme rain/flood
  - Extreme wind
  - Hail
  - Heatwaves
  - Drought

More detail = better

Policymakers often want to see more detail….

This is not always helpful from a climate perspective.

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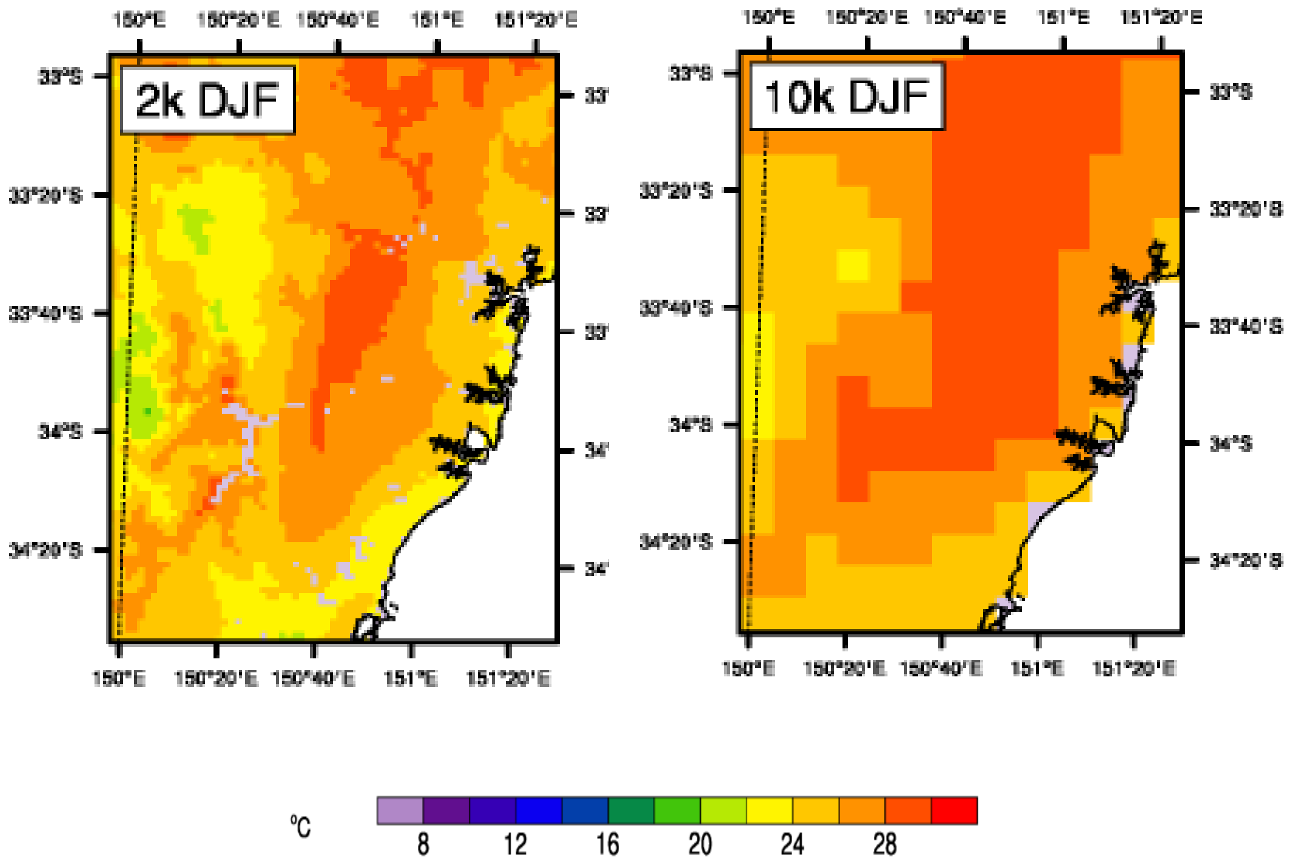
BUT

This desire can come from personal experience that says there are differences across a city – so resolving these differences is better



Argüeso D, Evans JP, Fita L, Bormann KJ. 2014. Temperature response to future urbanization and climate change. Climate Dynamics, 42(7–8): 2183–2199. https://doi.org/10.1007/s00382-013-1789-6.

Resolving urban landform variations across a city

- We need to differentiate urban landform across the city

- We use the World Urban Database Access Portal Tool (WUDAPT) to create an urban classification map for Sydney following the urban types described by the local climate zones(LCZs)
- Landsat images used to identify LCZs
- Then use a variety of datasets to assign surface properties to LCZs

Hirsch AL, Evans JP, Thomas C, Conroy B, Hart MA, Lipson M, Ertler W. 2021. Resolving the influence of local flows on urban heat amplification during heatwaves. Environmental Research Letters. IOP Publishing, 16(6): 064066. https://doi.org/10.1088/1748-9326/ac0377.

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Extreme Rain

- Design guidelines for water sensitive structures (drains, roads, bridges,…) are often based on Intensity-Frequency-Duration (IFD) curves
- Different structures are designed to operate without failure for different extremes
- E.g. urban storm water drain might be designed to handle the hour duration 1-in-100 year event

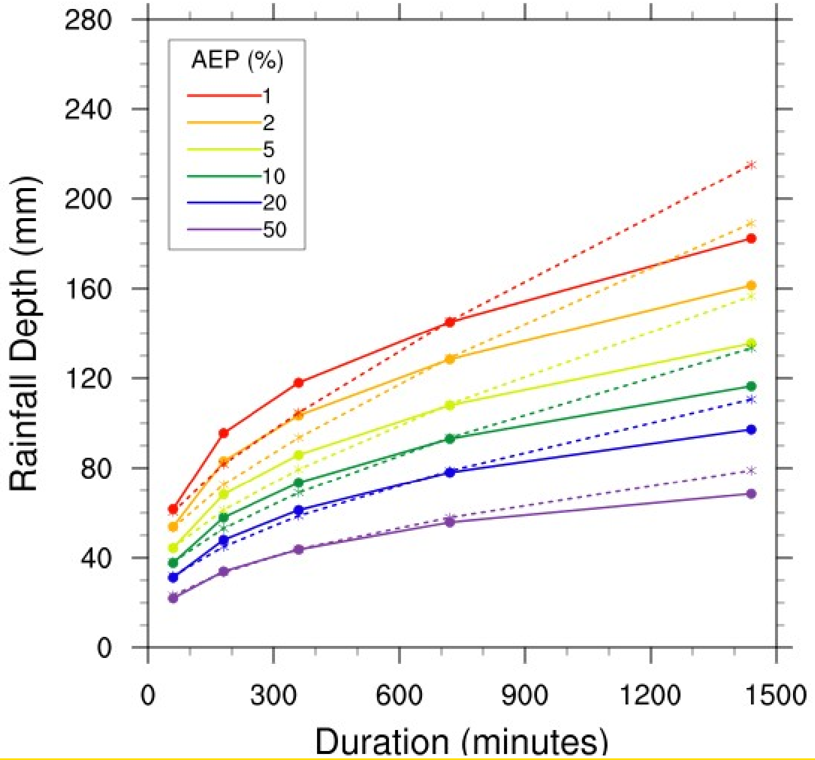
In Australia IFDs cover

- Durations: 1 minute → 5 days
- Rarity: 12 Exceedances per year → 1 in 2000 years

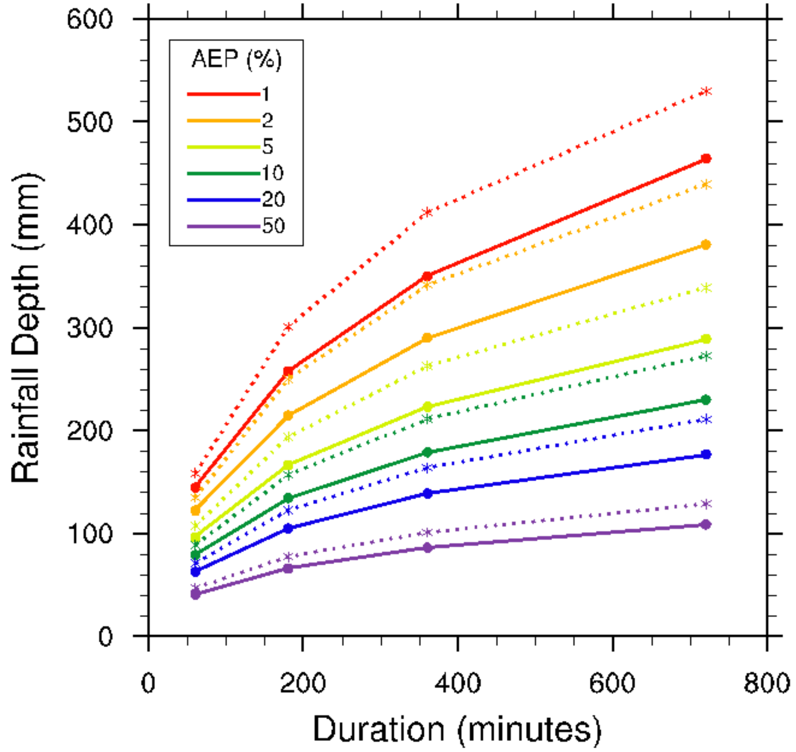
Policymaker question: How will these IFDs change with climate change?

Extreme Rain – WRF 2km resolution

IFD curves for WRF (solid lines) and observational estimates (dashed lines).



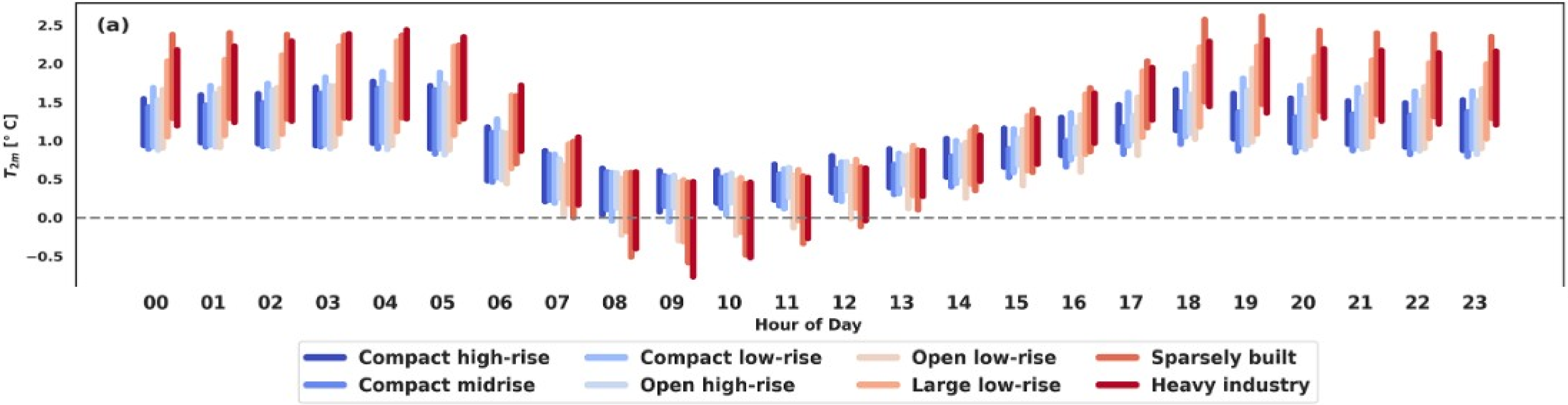
IFD curves for WRF 1990-2009 (solid lines) and WRF 2040-2059 (dashed lines).



Evans JP, Argueso D. 2015. WRF simulations of future changes in rainfall IFD curves over greater Sydney. paper presented at the The Art and Science of Water - 36th Hydrology and Water Resources Symposium, HWRS 2015, 33–38.

Heatwaves

- Highest morbidity of all climate hazards
- Max temperature has been observed to vary by 15°C across Sydney during heatwave
- Different urban landforms play a role



Difference from non-urban grid cells

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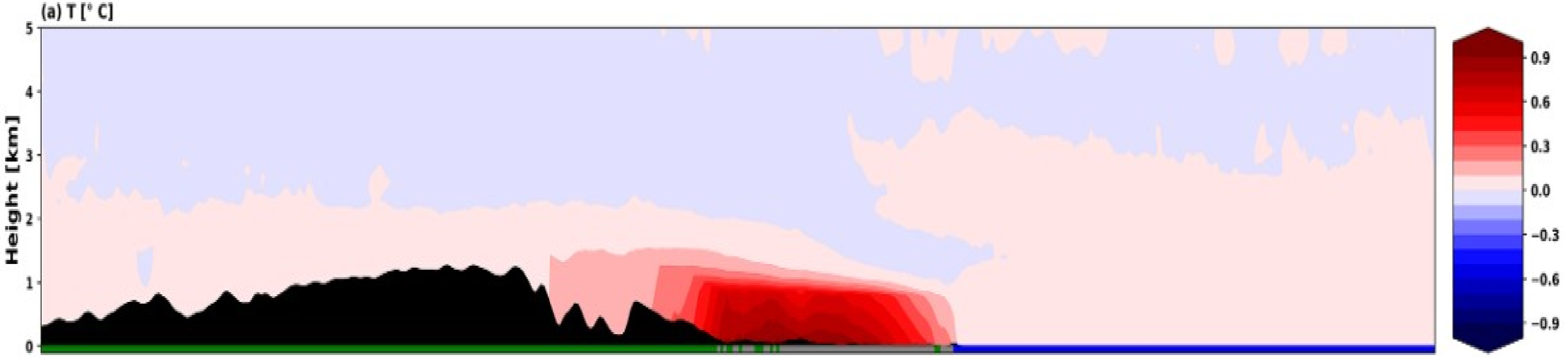
Heatwaves

- Highest morbidity of all climate hazards
- Max temperature has been observed to vary by 15°C across Sydney during heatwave
- Local circulations play an important role



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Summary

- Many policymaker decisions are aimed at managing risks of various kinds
- CP modelling is needed to address a number of Climate Hazards and how they will change with climate change

<u>Last Thoughts</u>

To improve the chances of research being used by policymakers

- Co-design the project
- Think carefully about how to present results to policymakers
  - Sometime simpler presentation works better

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