METEOROLOGICAL SERVICE SINGAPORE
Centre for Climate Research Singapore

Modelling the weather & climate of the Maritime Continent

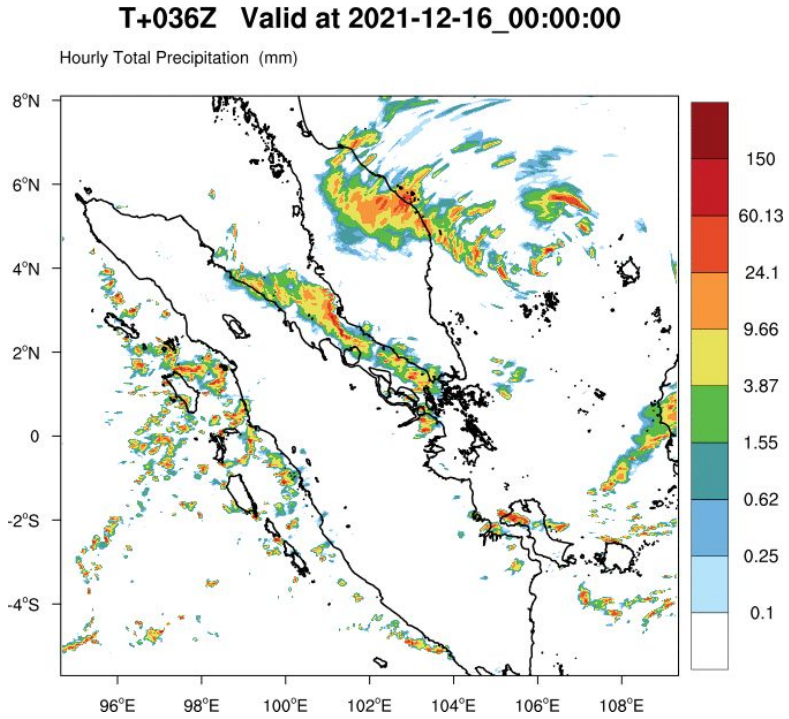
Kalli Furtado, Byoung An, I-Han Chen, Song Chen, Yanyan Cheng, Rajesh Kumar, Jianyu “Jerry” Liu, Pratiman Patel, Danielle Su, Yi Wang

IWM-8, IITM, Pune
Session-2: Theme-2 (Simulation & Prediction of Monsoons)

17 Mar 2025

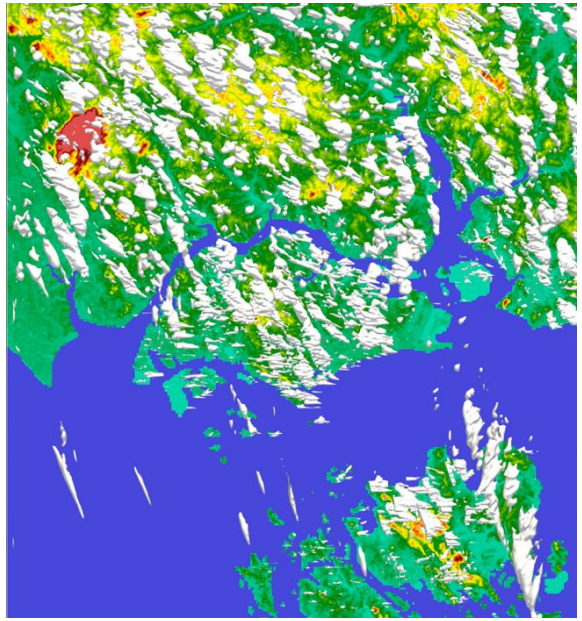
Prediction systems

Regional NWP
(Det & Ens)



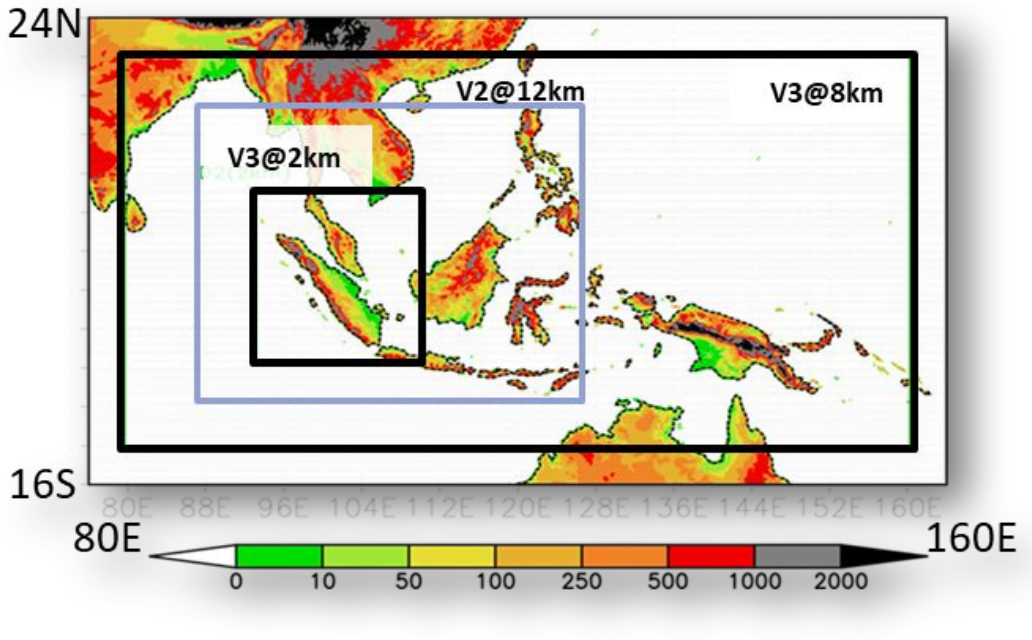
1.5 km
Hours to days

Urban-scale
prediction



300 – 100 m
Nowcasting
Climate change

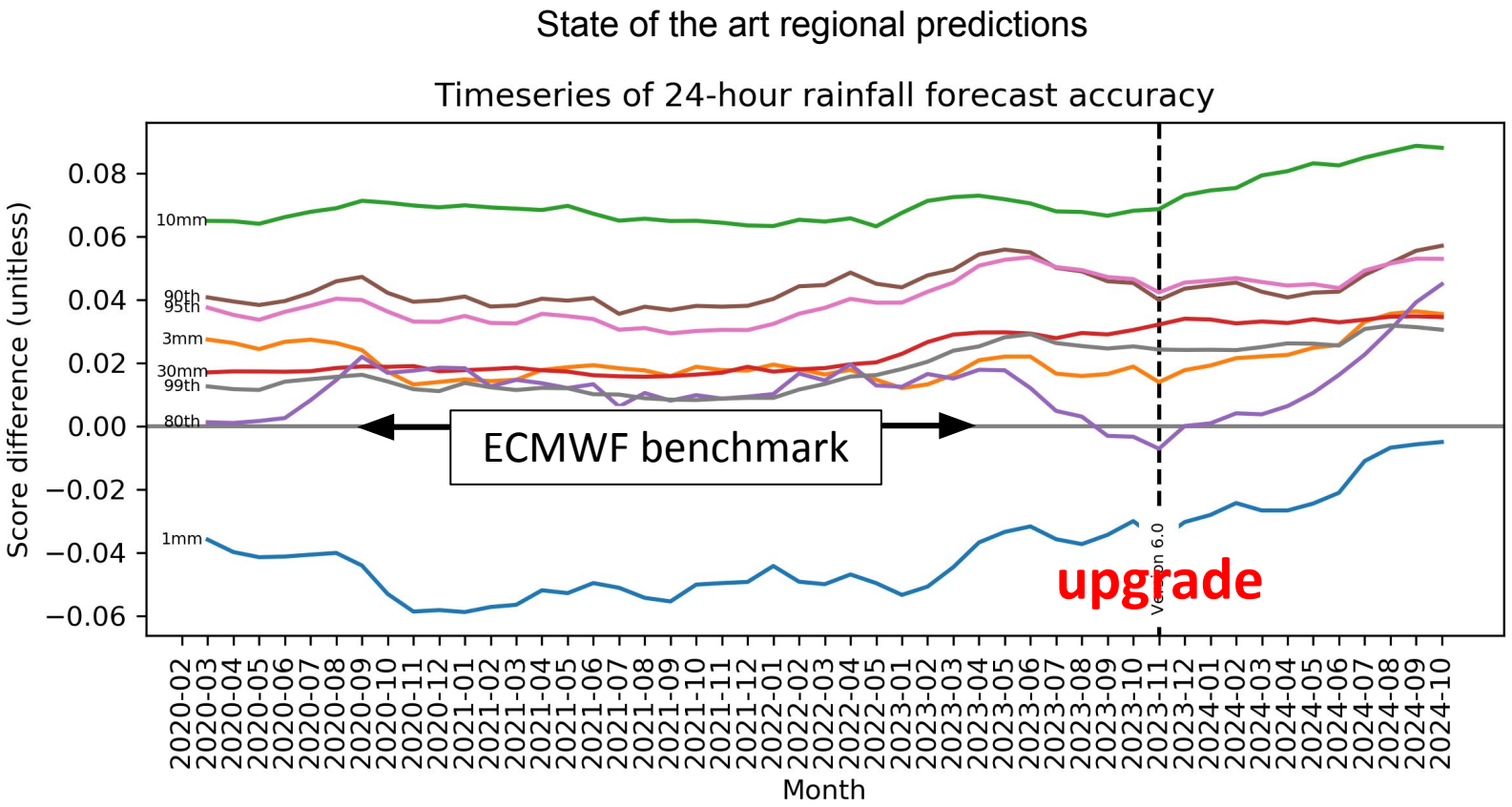
Regional climate
Atmosphere-land, marine and coupled

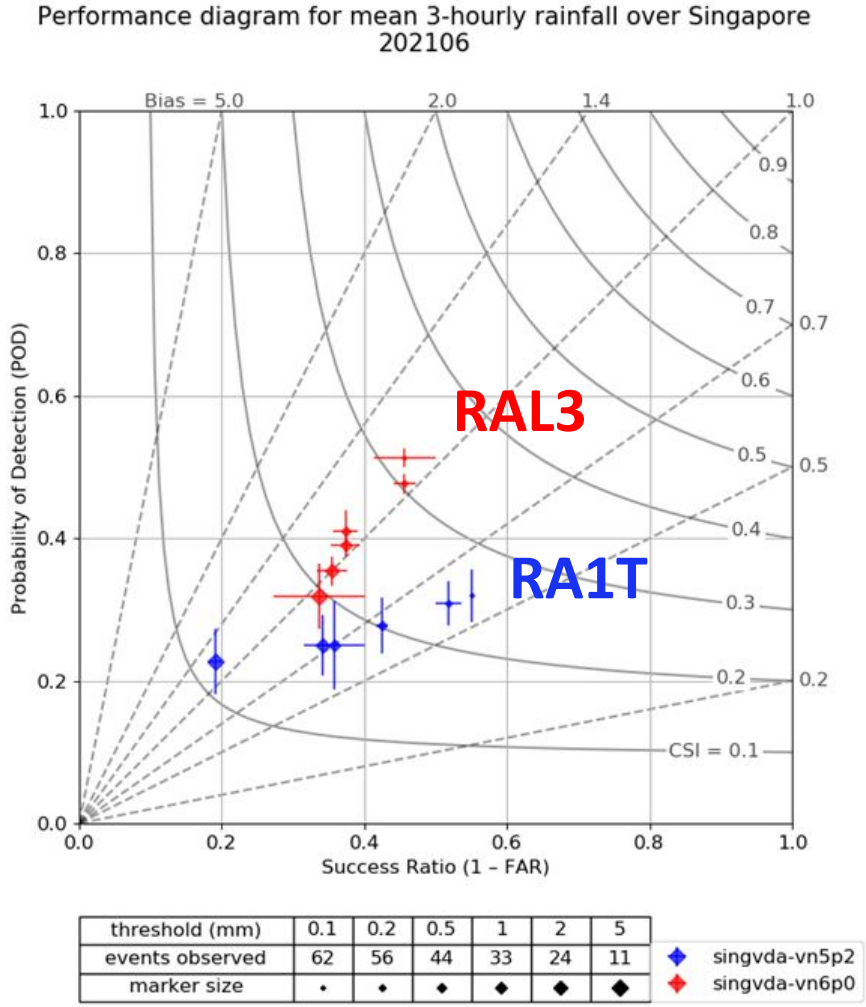


Convection-permitting
climate downscaling

Current-generation modelling system

- Met Office Unified Model Regional Atmosphere and Land version 3 (RAL3)



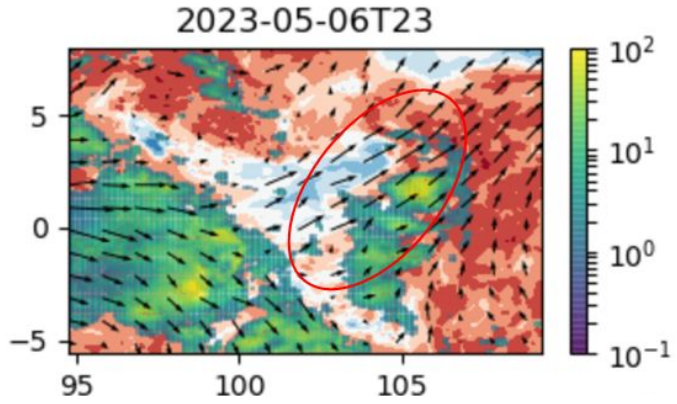


Why was rainfall improved?

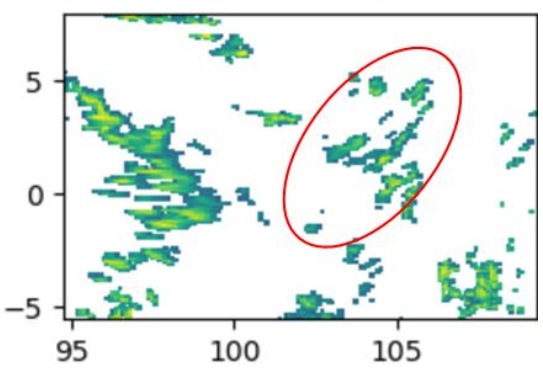
RAL3 includes a 2-mom microphysics (CASIM)
Improved convective organization

squall line
05 May 2023

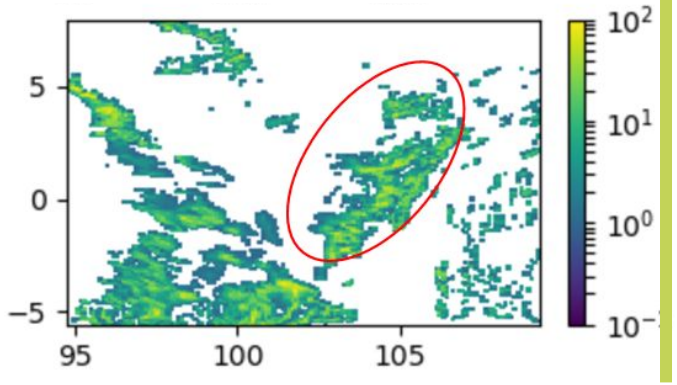
- GPM rainfall
- ERA5 winds & T850



RA1T

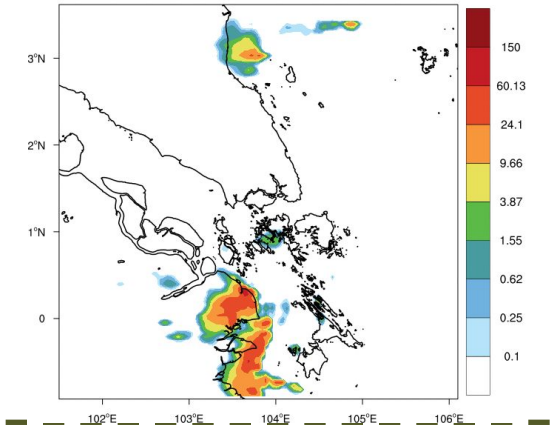


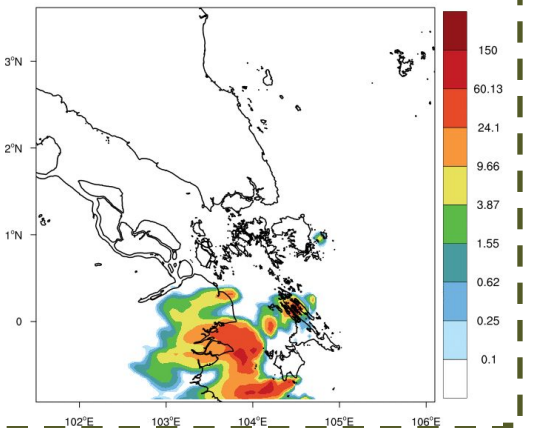
RAL3



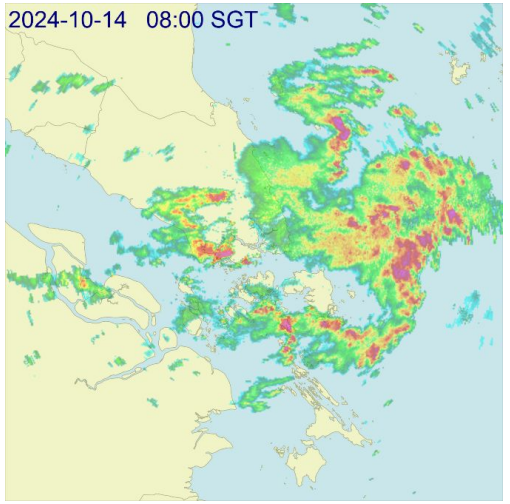
However, still room for improvement….

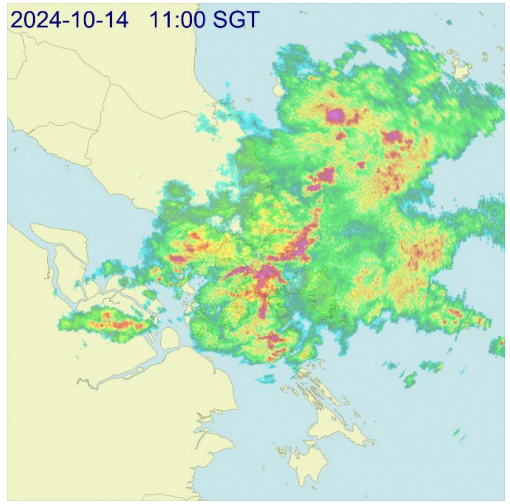
fcst
13 Oct



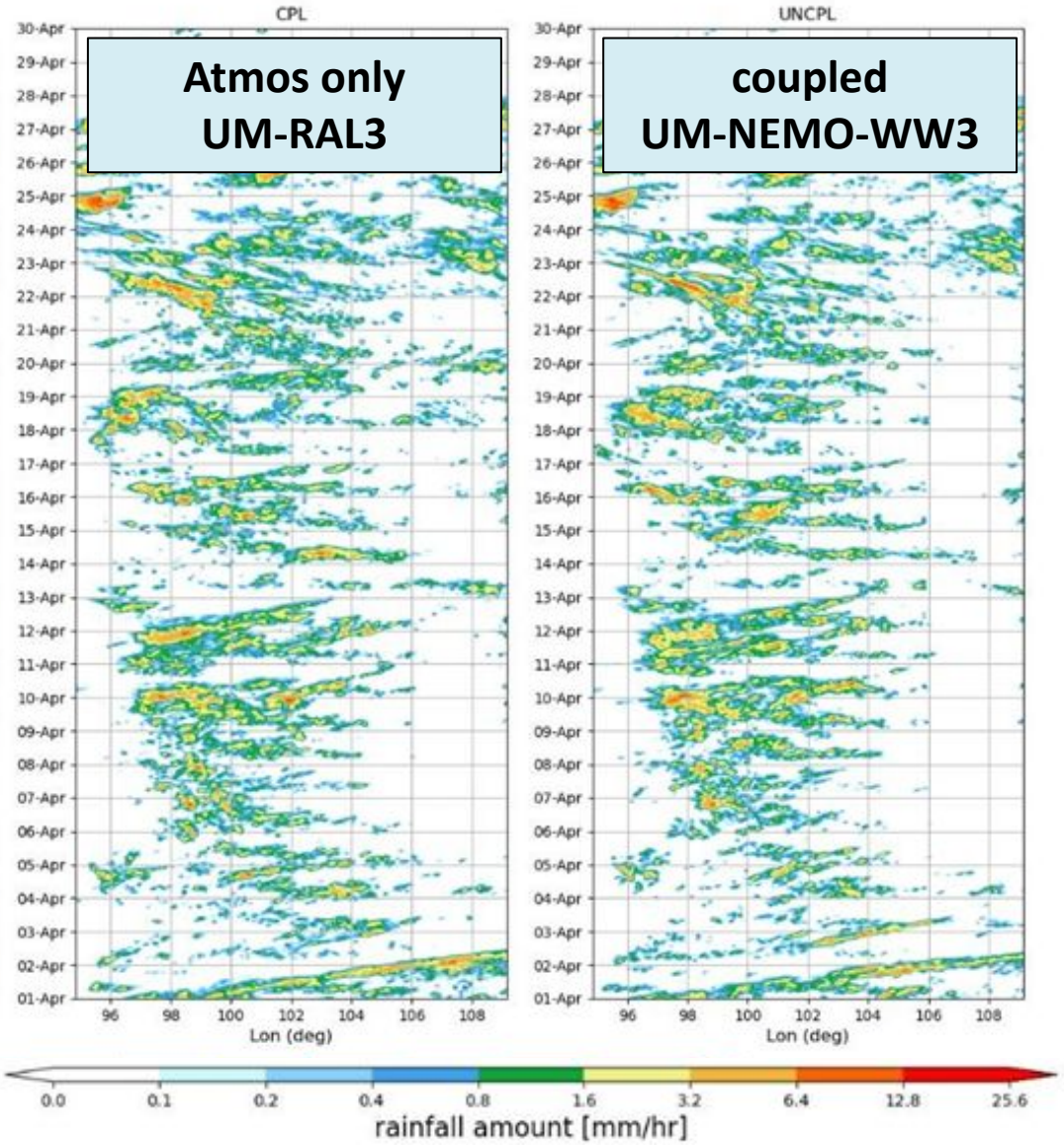


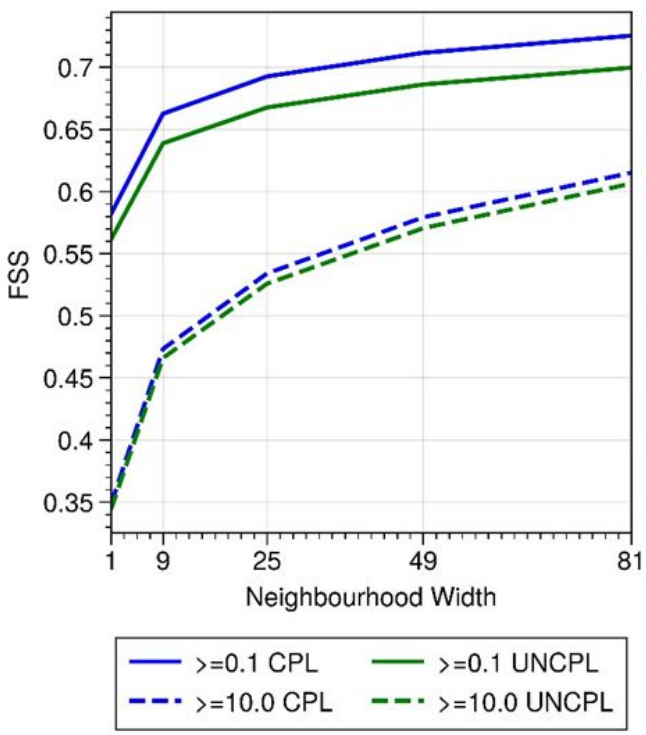
radar

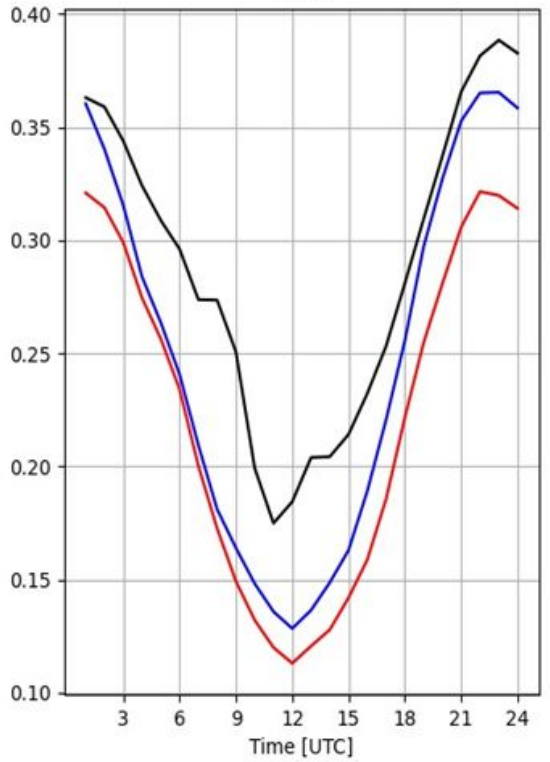




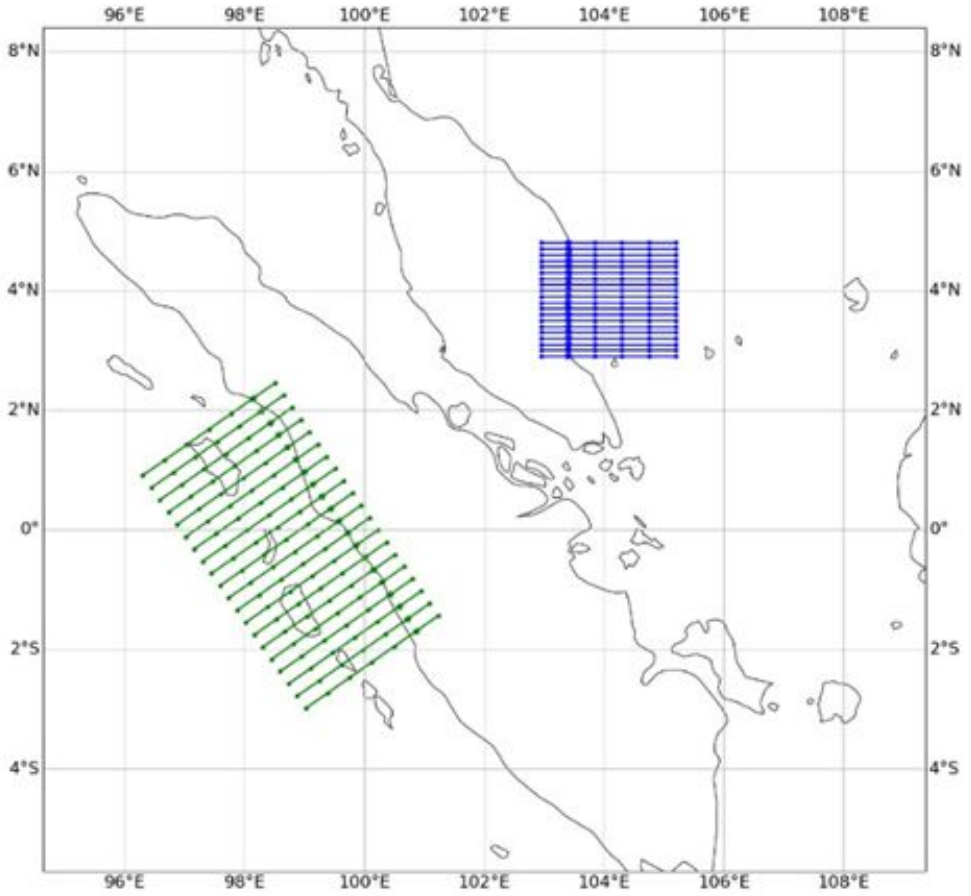
Coupled forecasts: a route to improvements?

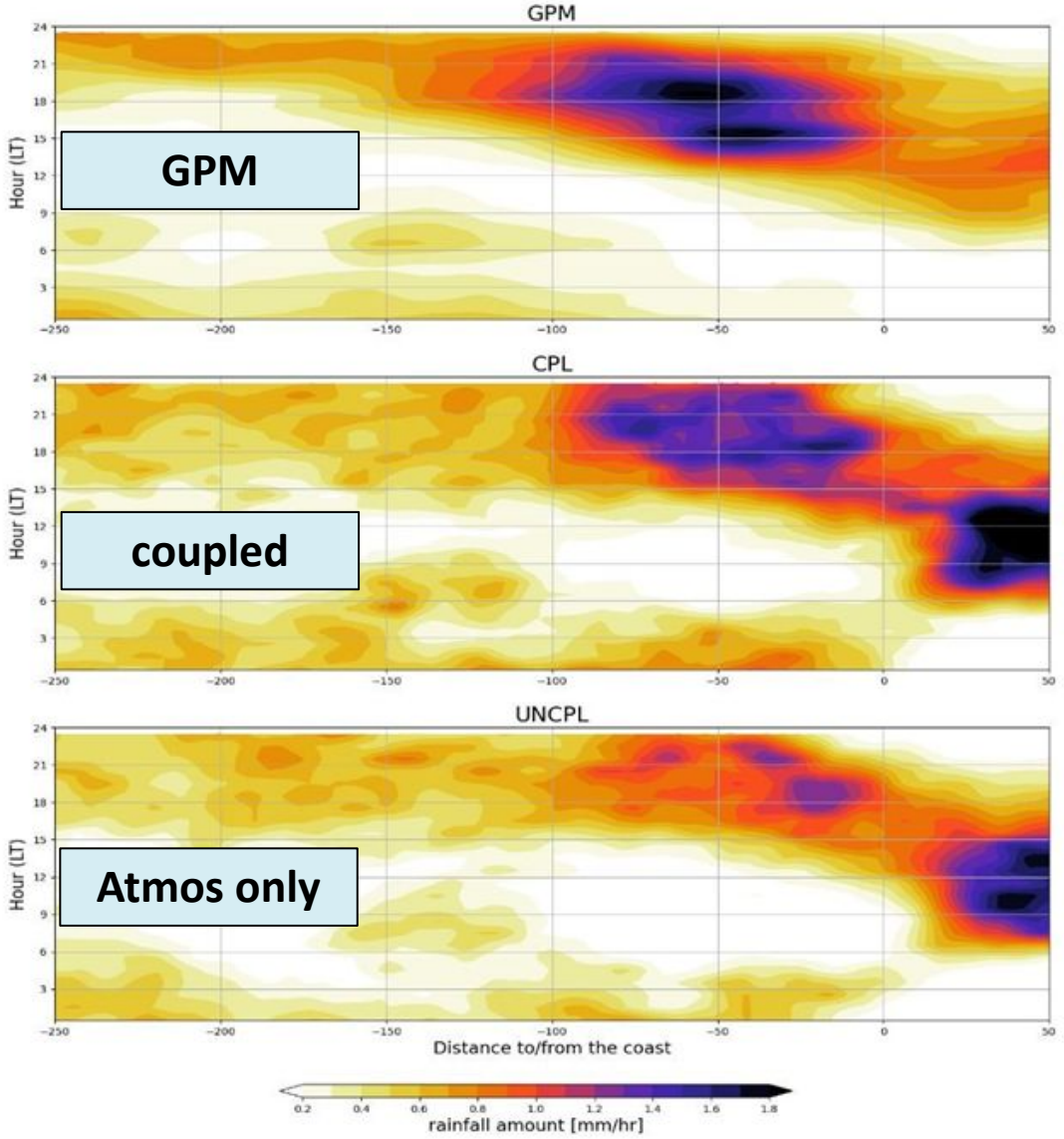






Coupled forecasts: offshore propagation



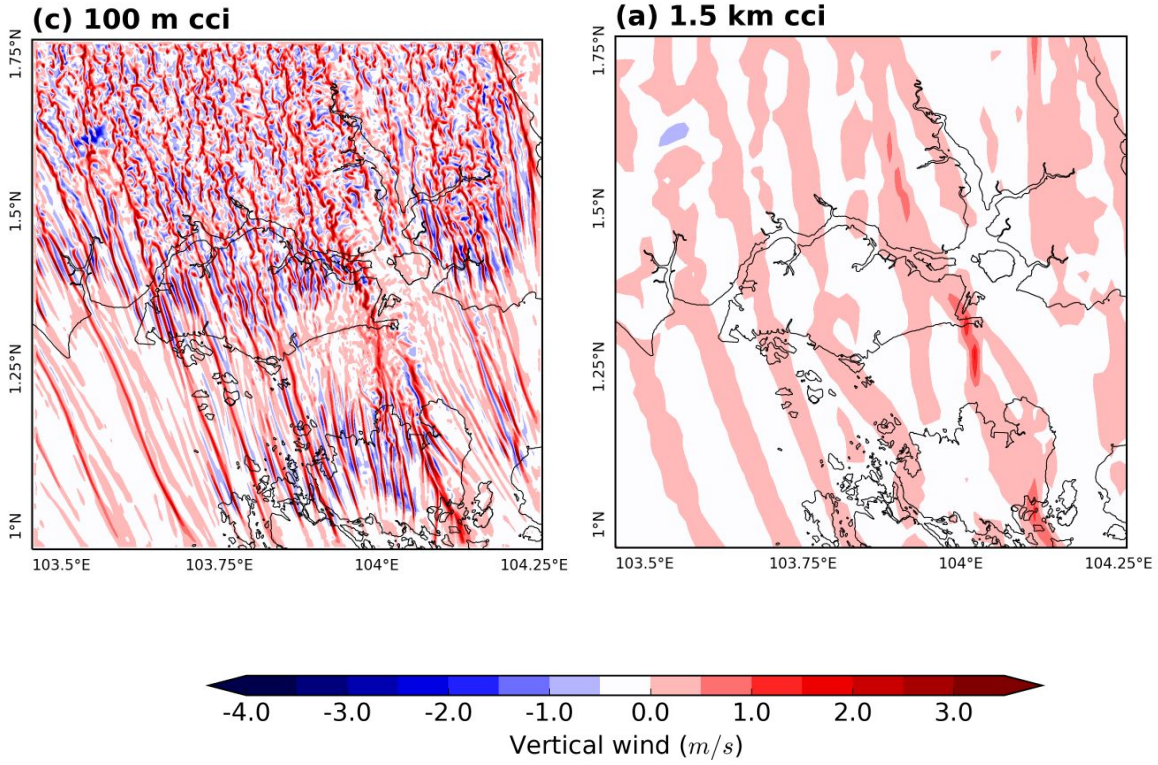


Spatial resolution: a route to improvements?

Vertical winds in the boundary layer

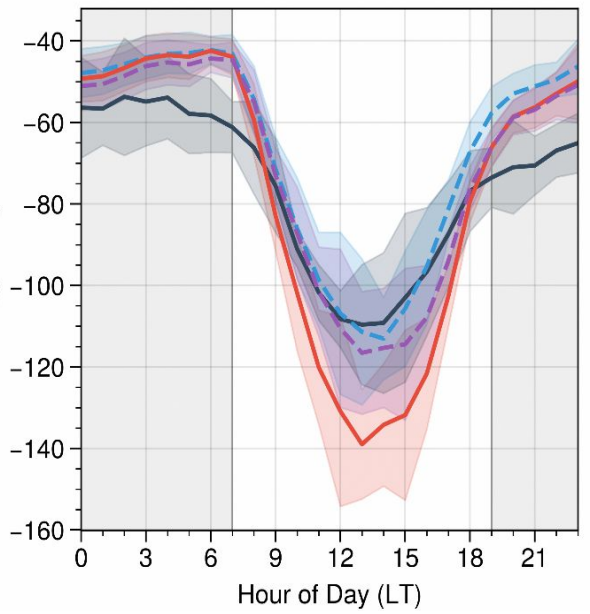
at 100m resol

at 1.5km resol



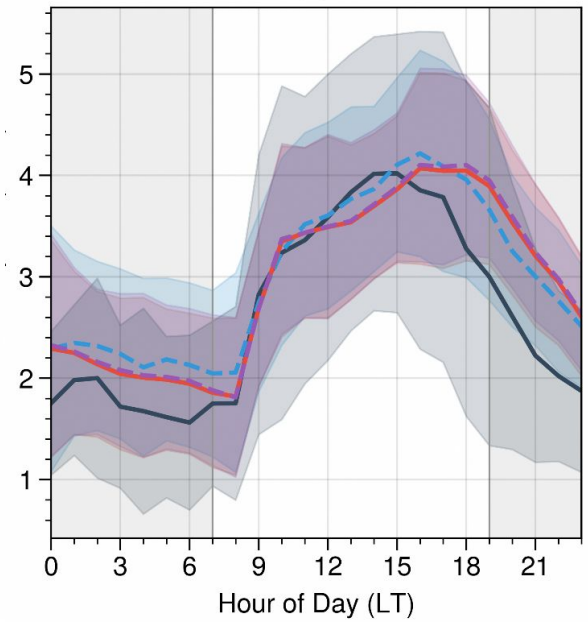
Model evaluation

Net longwave compared to Flux tower



performance degradation

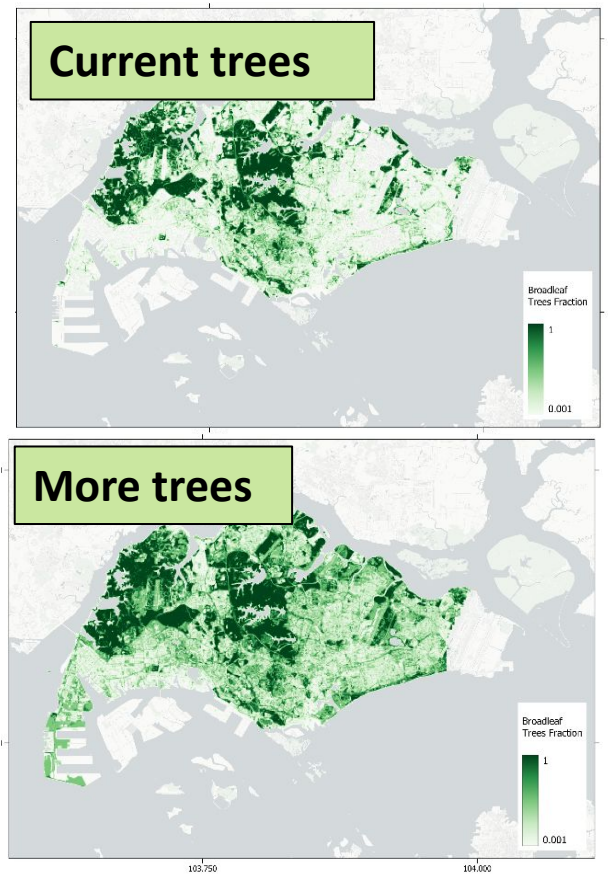
10m wind compared to AWS



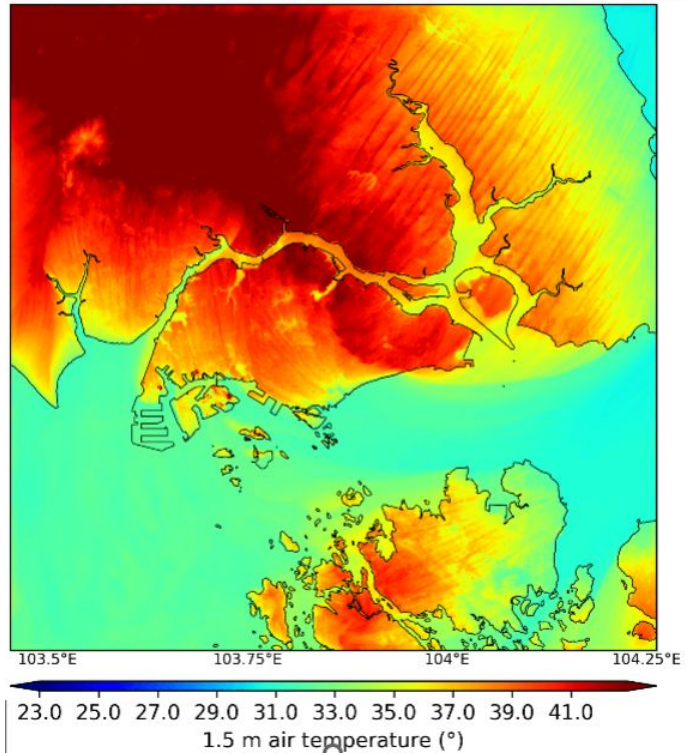
minor changes in performance

Hi-res climate change modelling experiments

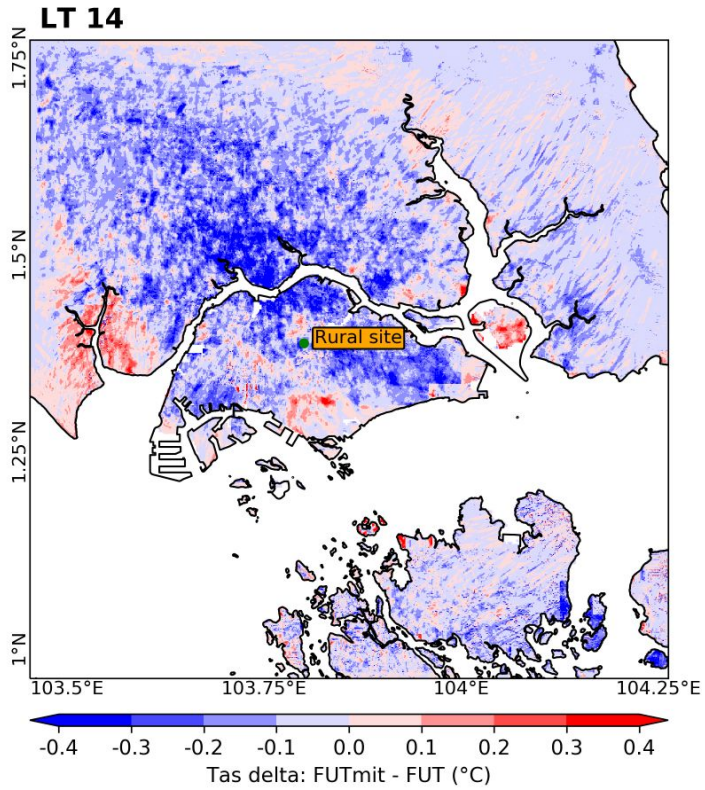
- Future climate: dynamically downscaled end of century projection
- Selected 10 percent most extreme future days
- Possible LULC mitigations: heuristic increase in number of trees



Example: future heatwave
15 Feb 2089 > 42 deg.

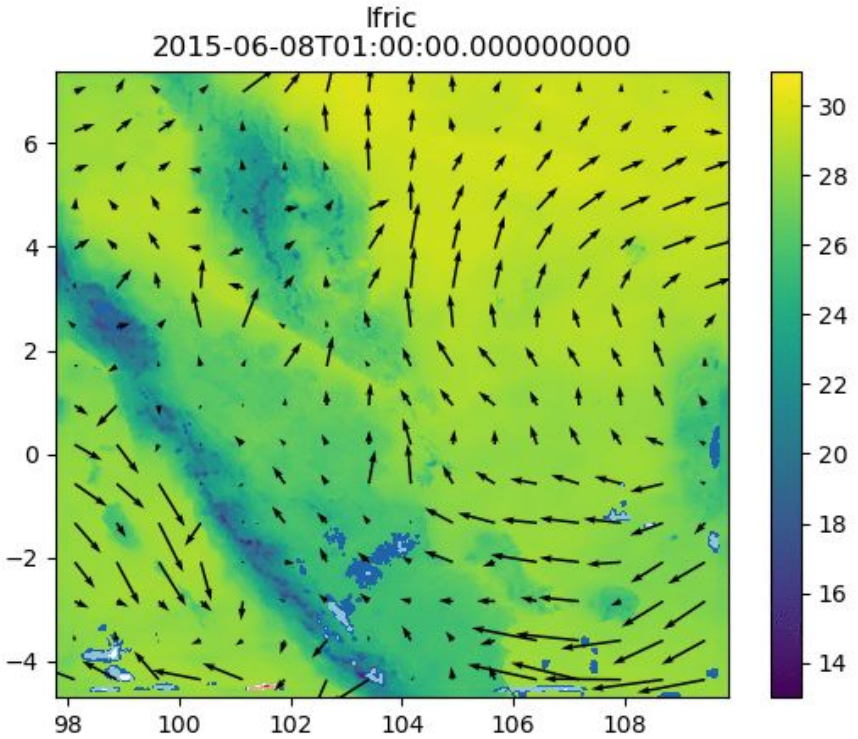


FUTURE(mitigated) - FUTURE



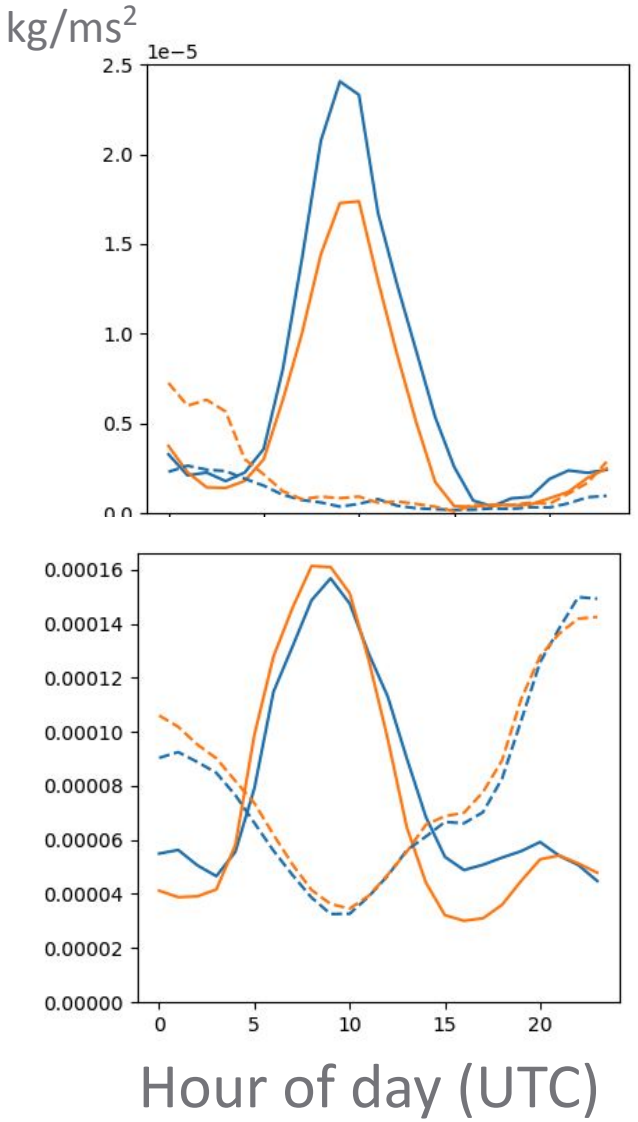
Atmosphere model: a route to improvements?

LFRic-atmos in the "*Momentum*" model framework
A next-gen atmosphere, replacing Met Office UM



Met Office

Momentum
The Unified Earth Environment Prediction Model



30 relatively dry days

Land: solid
Sea: dashed

LFRic blue
UM orange

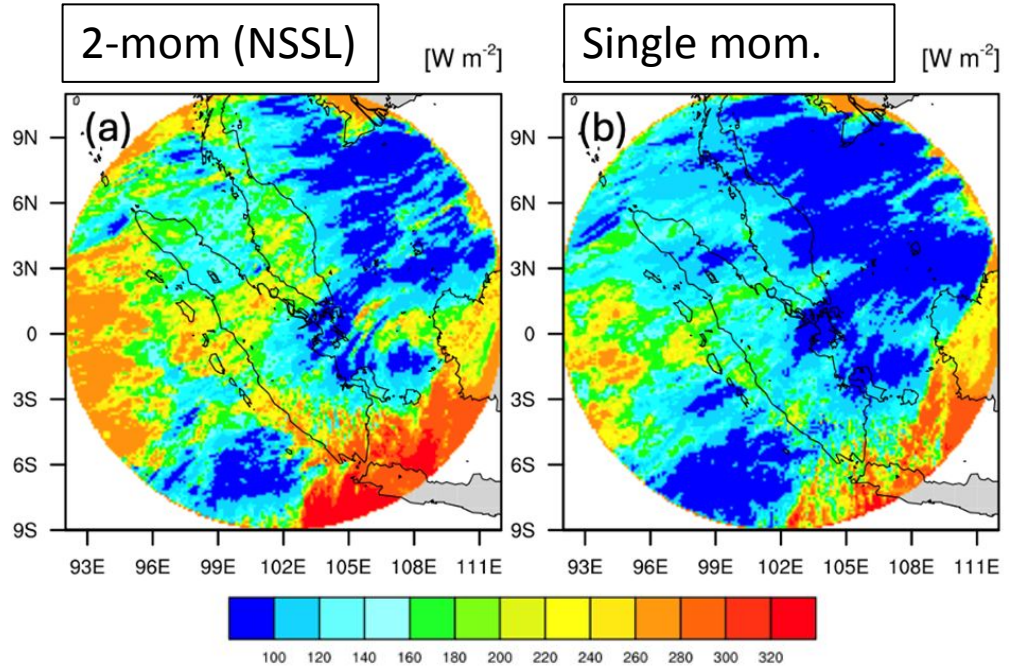
30 relatively wet days

Atmosphere model: a route to improvements?

Model for Prediction Across Scales (MPAS)

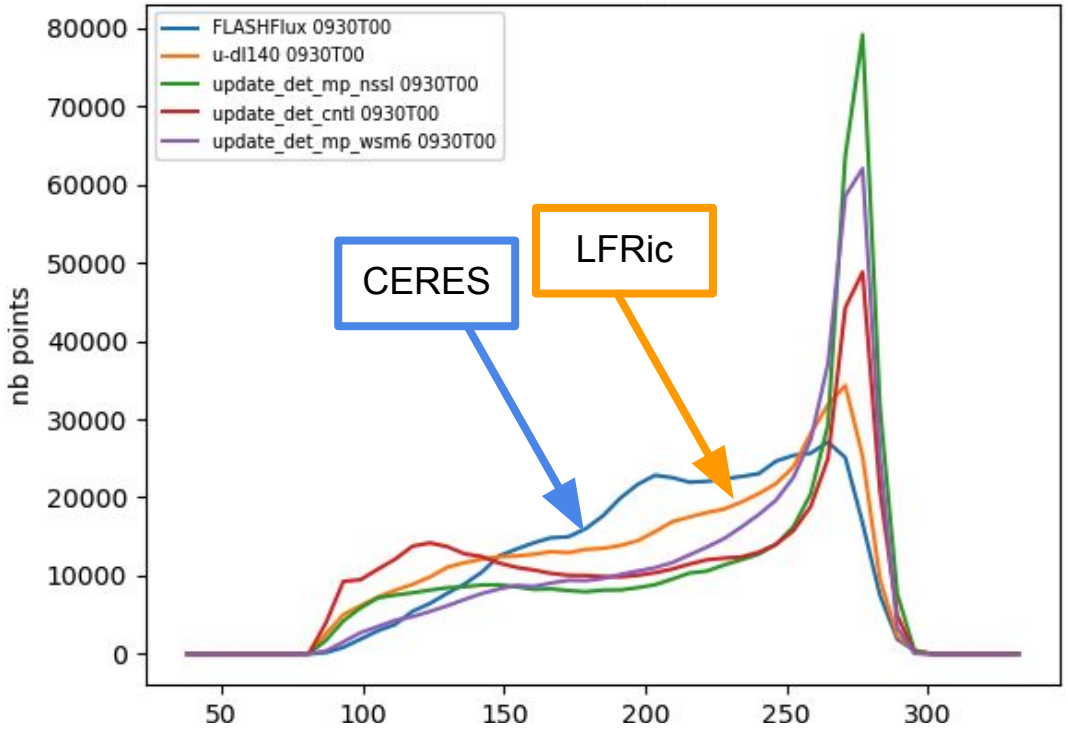
A next-gen atmosphere, replacing NCAR's WRF

OLR
18 UTC



OLR comparison to CERES broadband radiometer

30 days



TOA outgoing LW flux (W/m^2)

Summary

- coupling, resolution, and physics: routes to better Maritime Continent forecasts
- coupling improves diurnal cycles
- resolution enhances physical realism (turbulence, land surface), enables novel climate applications
- substantial scope for benefits from atmosphere-model physics development