METEOROLOGICAL SERVICE SINGAPORE
Centre for Climate Research Singapore

Impact of 3-hourly radiosonde assimilation on the simulated diurnal cycle of precipitation over the western Maritime Continent

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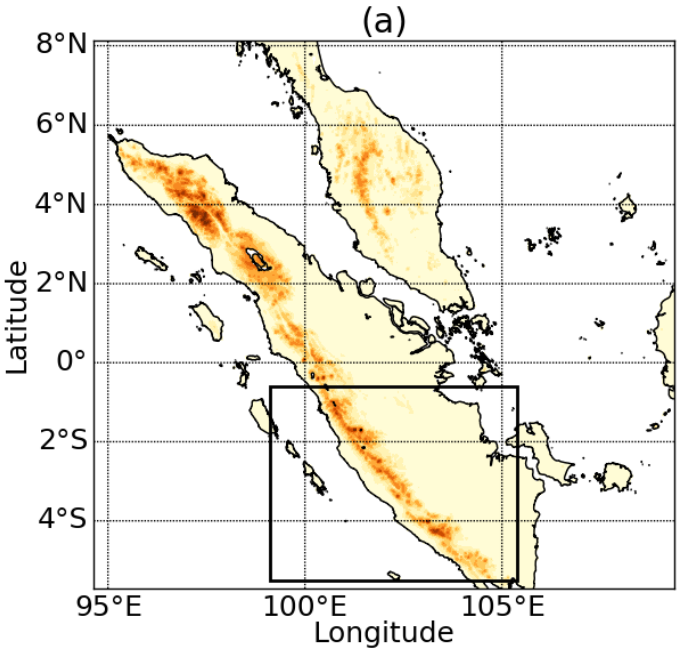
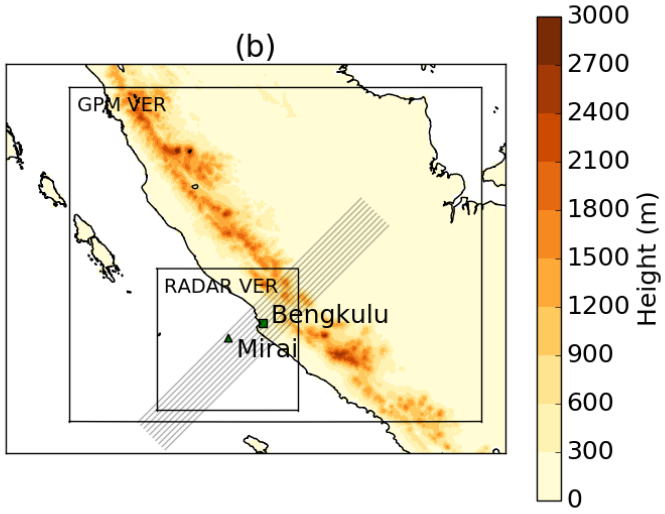
6th WGNE workshop on systematic errors
in weather and climate models

31st October 2022

SINGV-DA and Pre-YMC campaign





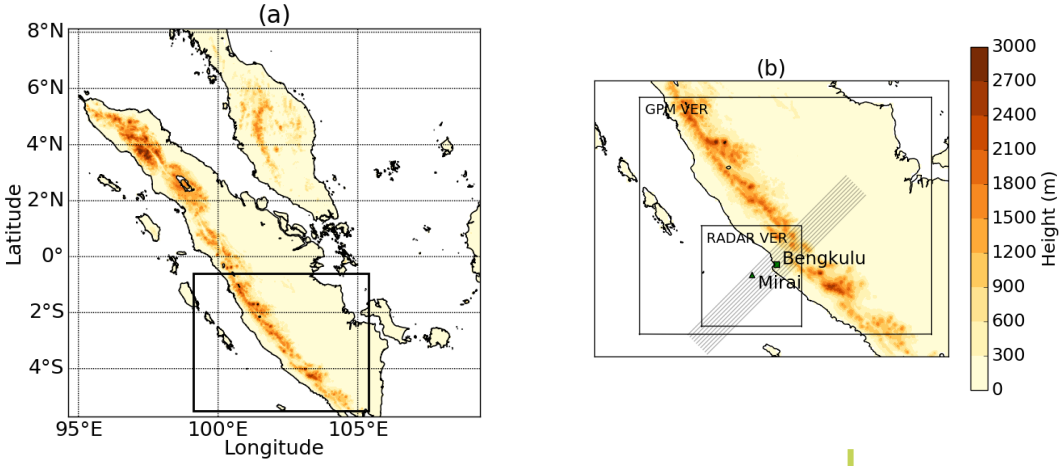
SINGV-DA

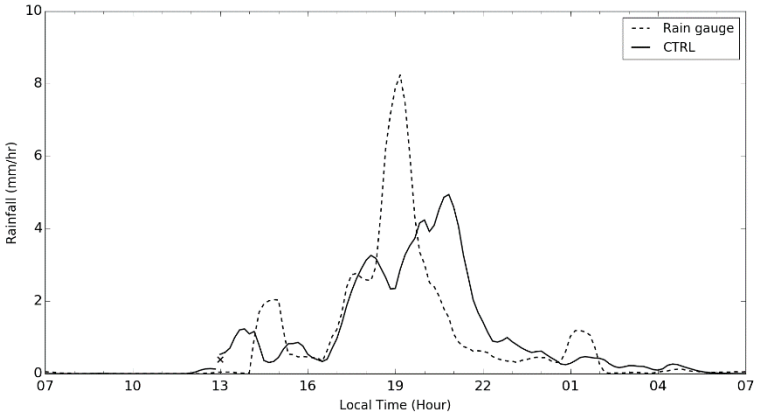
- Tropical convective-scale numerical weather prediction system
- 1.5km horizontal resolution, 80 vertical levels, 38.5km model top
- 3-hourly cycling 3D-Var FGAT

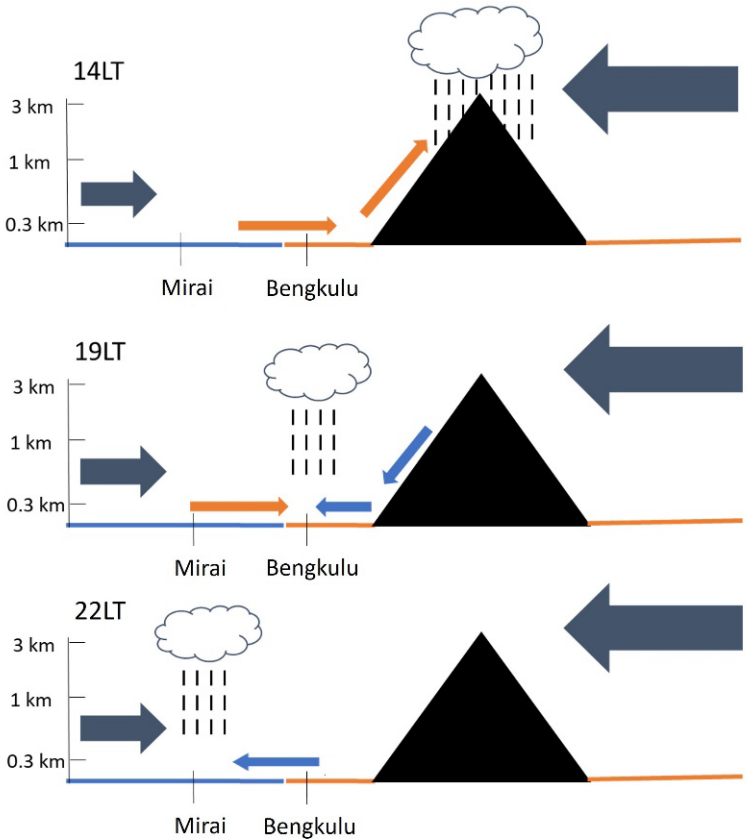
Pre-YMC campaign

- Pilot field campaign of the Years of Maritime Continent project
- 3-hourly radiosonde observations over Bengkulu and Mirai
- First part of campaign:
  23rd Nov 2015 to 13th Dec 2015

Diurnal cycle of precipitation







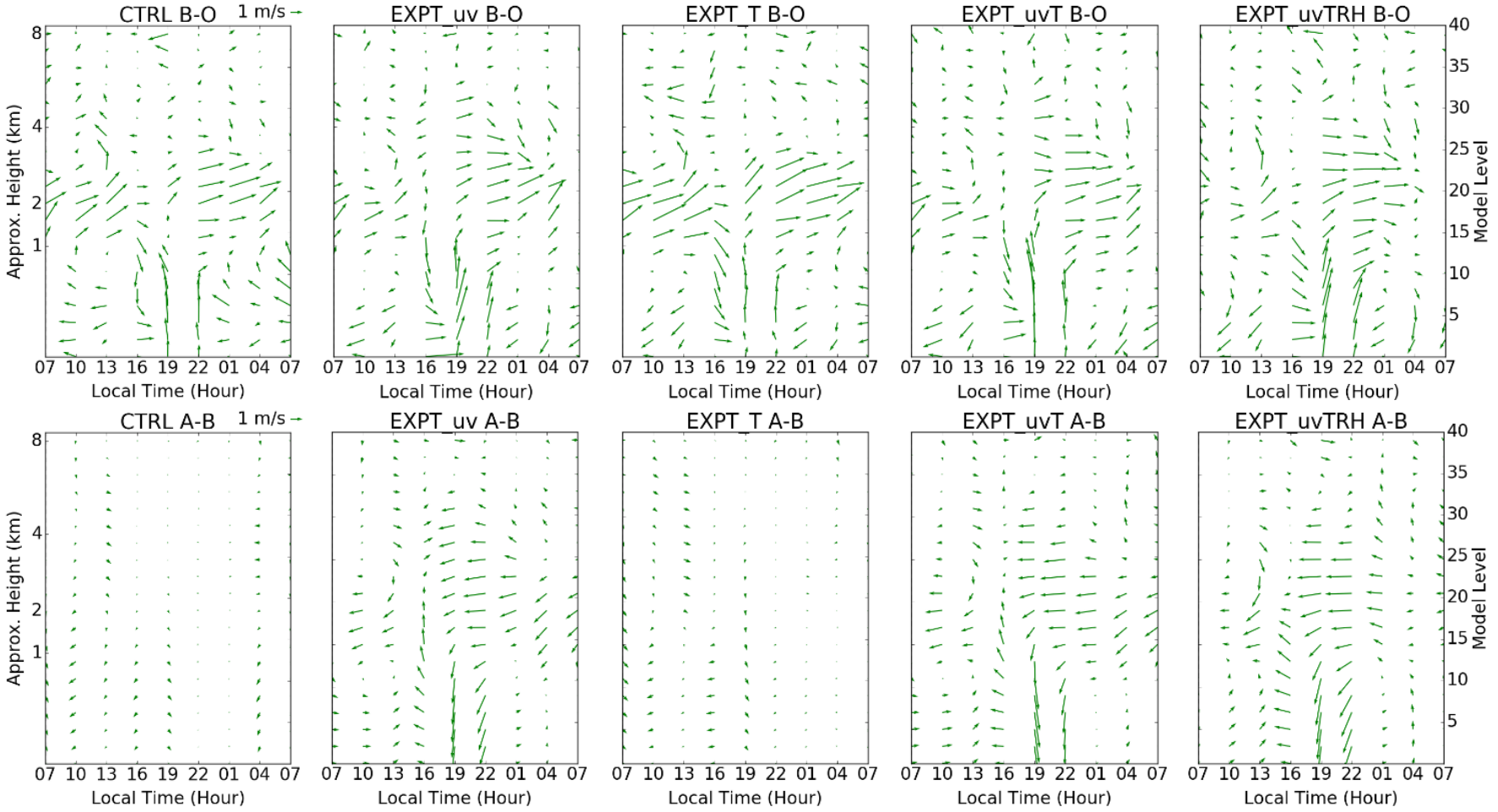
What are the relative impacts of assimilating radiosonde wind, temperature and moisture information on the simulated diurnal cycle of precipitation over the western coast of Sumatra?

Experimental setup

Abbreviation	Assimilated information			
	Existing observations	Bengkulu and *Mirai* radiosondes u and v	Bengkulu and *Mirai* radiosondes T	Bengkulu and *Mirai* radiosondes RH
CTRL	×			
EXPT_uv	×	×		
EXPT_T	×		×	
EXPT_uvT	×	×	×	
EXPT_uvTRH	×	×	×	×

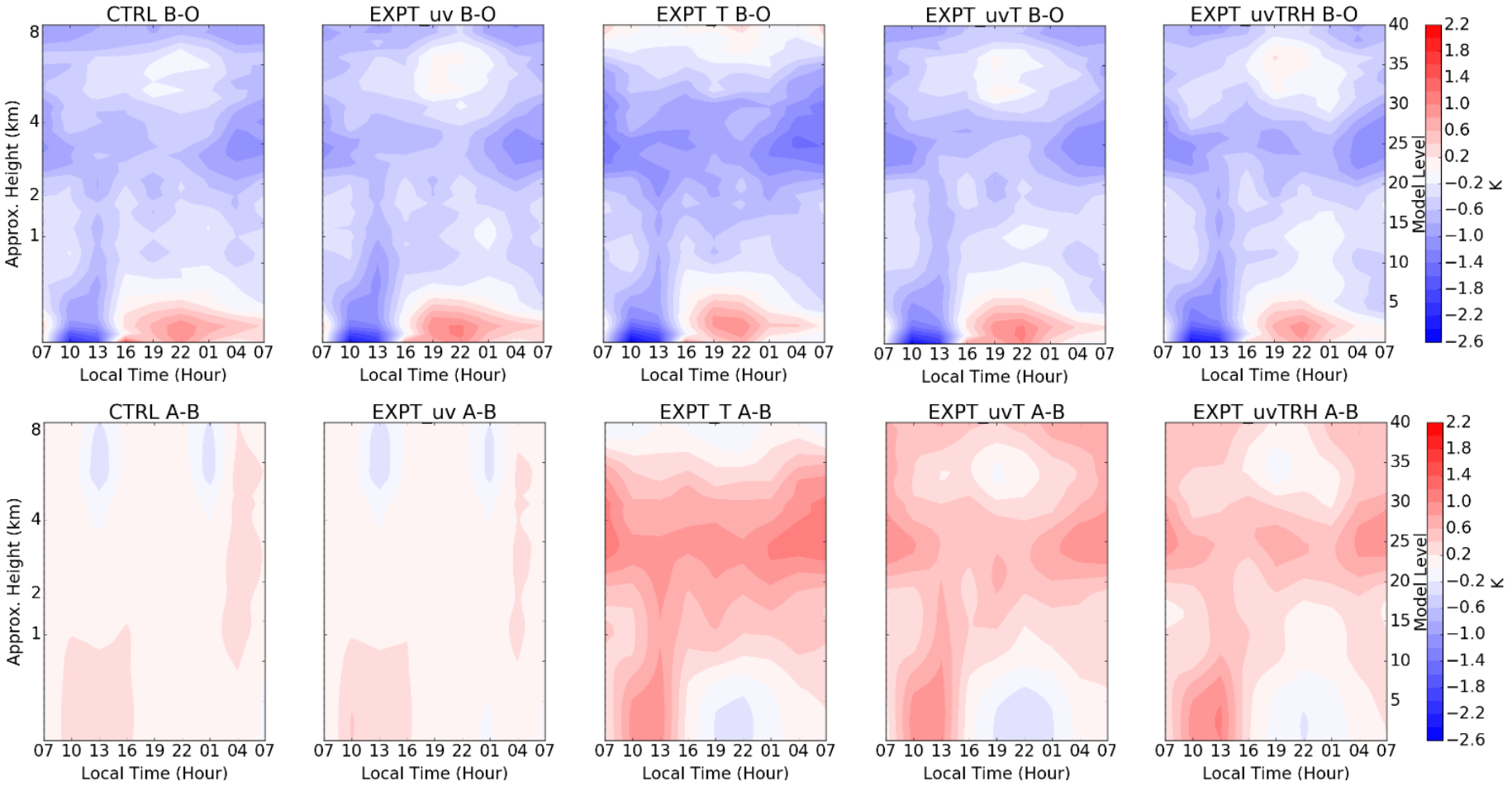
- "Variable-denial experiments", inspired by Zagar et al. (2004)
- "Stress-test" for convective-scale data assimilation
- Case study for improving diurnal cycle involving convective processes

Biases and analysis increments in horizontal wind



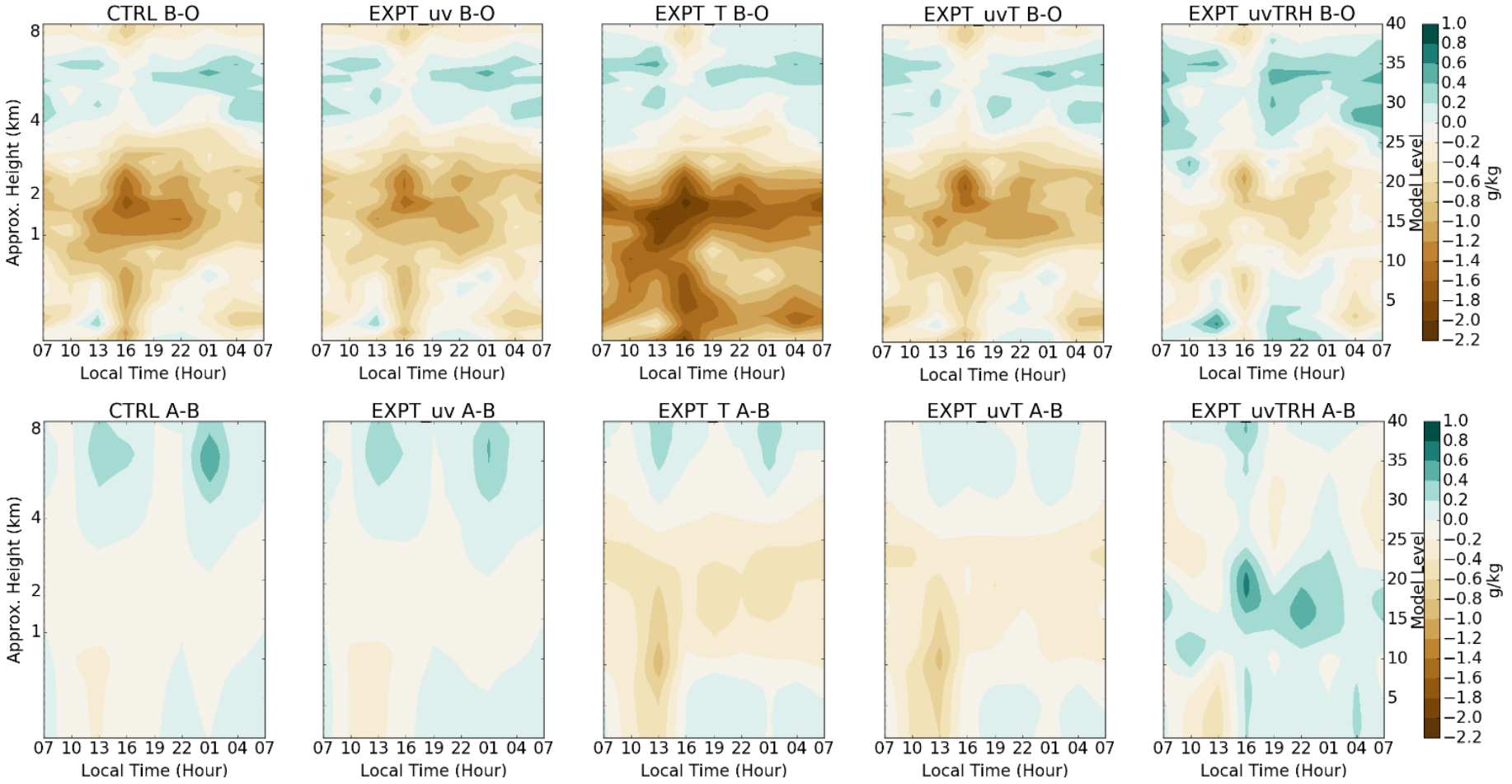
- Spatially-averaged around Bengkulu

Biases and analysis increments in potential T



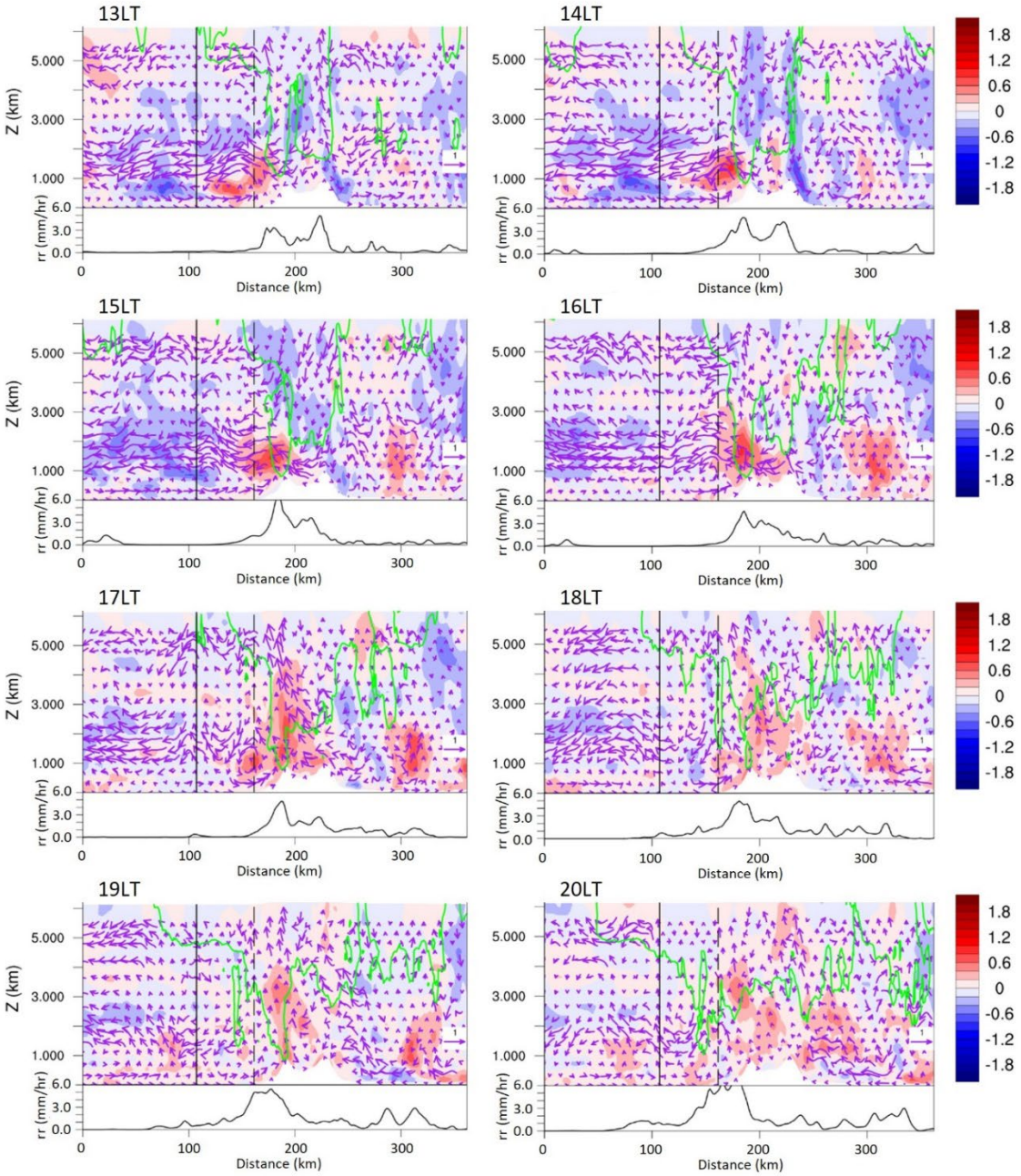
- Spatially-averaged around Bengkulu

Biases and analysis increments in moisture (qT)



- Spatially-averaged around Bengkulu

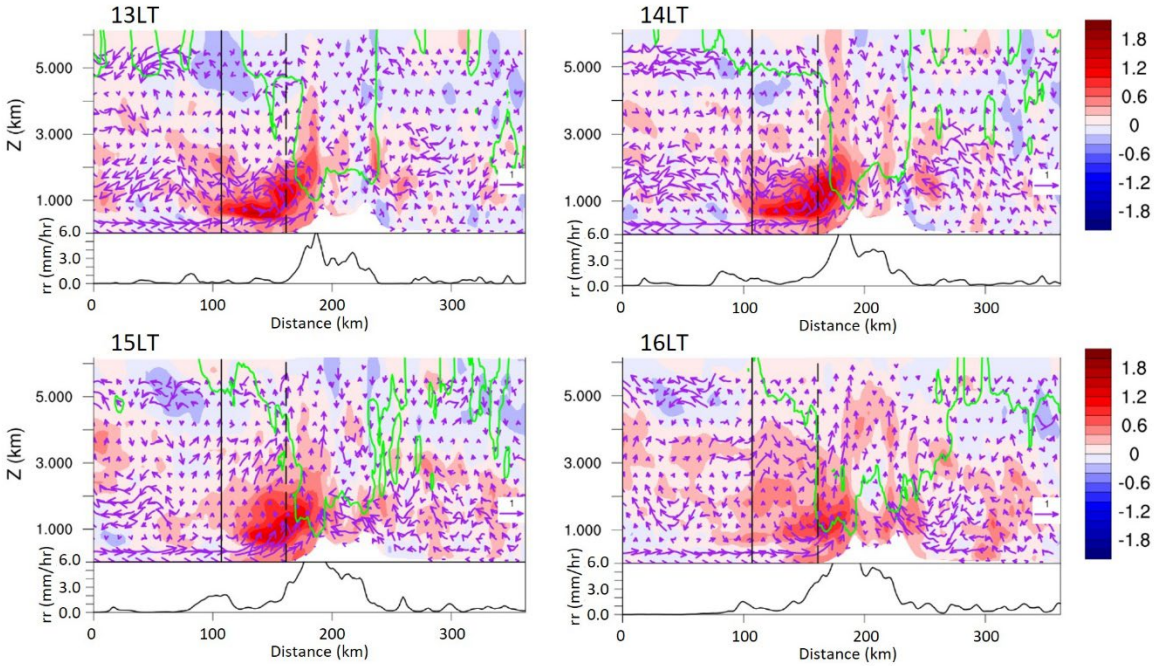
Dynamical implications



EXPT_uv anomalies w.r.t CTRL

- 13LT cycle-mean evolution of state from initialisation to T+7 forecast

Dynamical implications

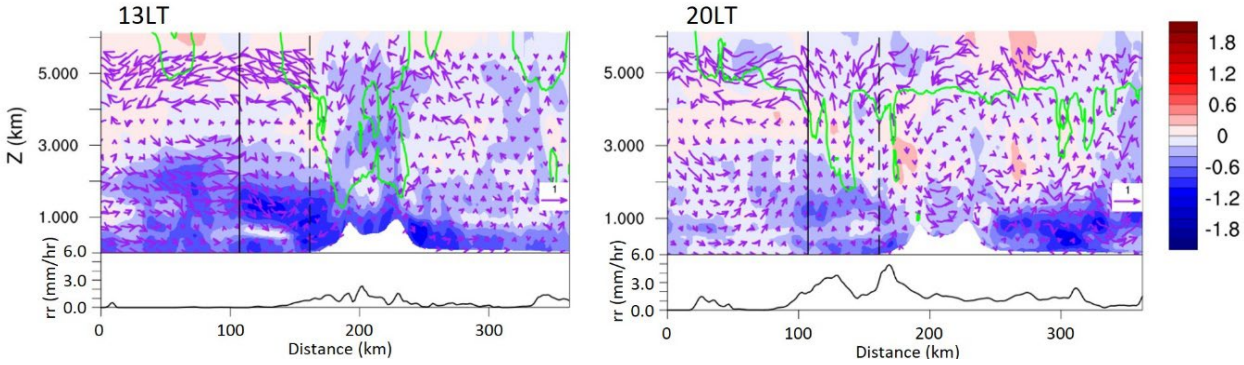


EXPT_uvTRH anomalies w.r.t CTRL

- 13LT cycle-mean evolution of state from initialisation to T+3 forecast

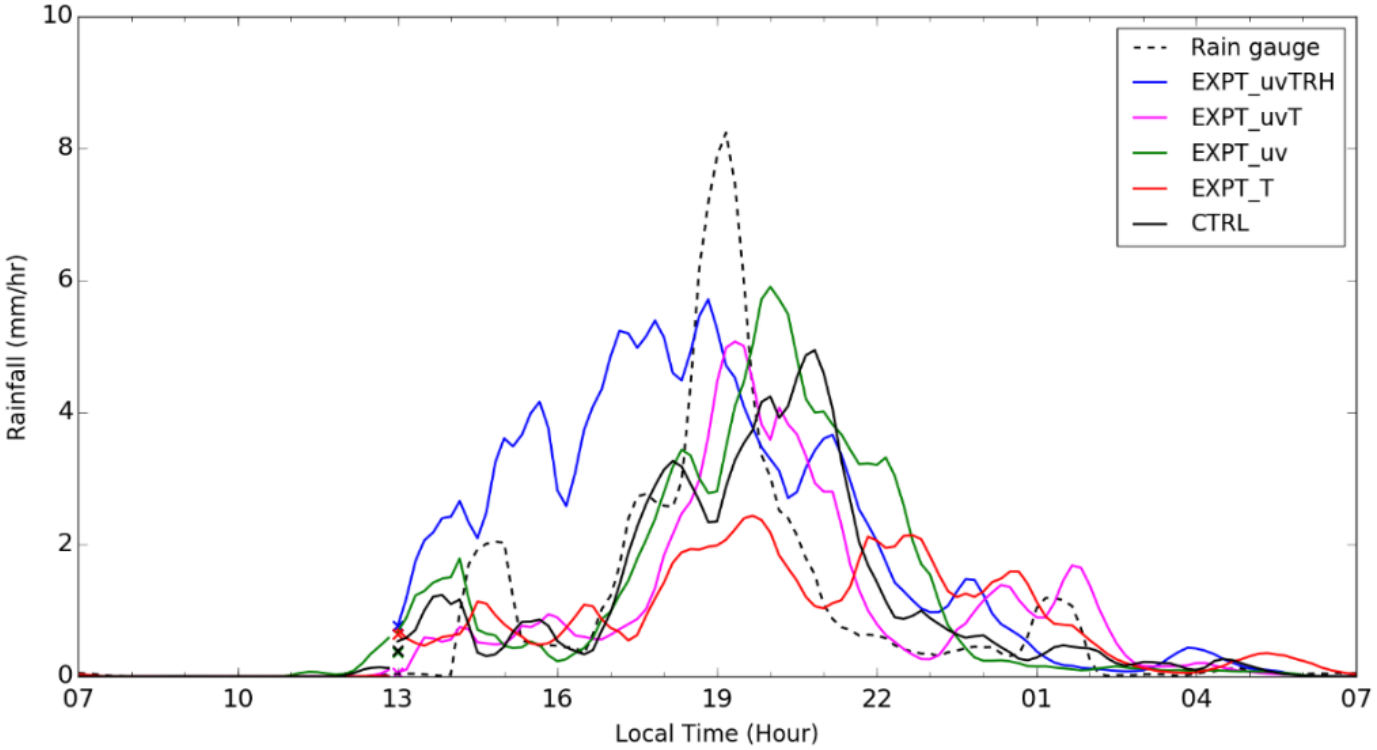
EXPT_T anomalies w.r.t CTRL

- 13LT cycle-mean initialisation state and T+7 forecast



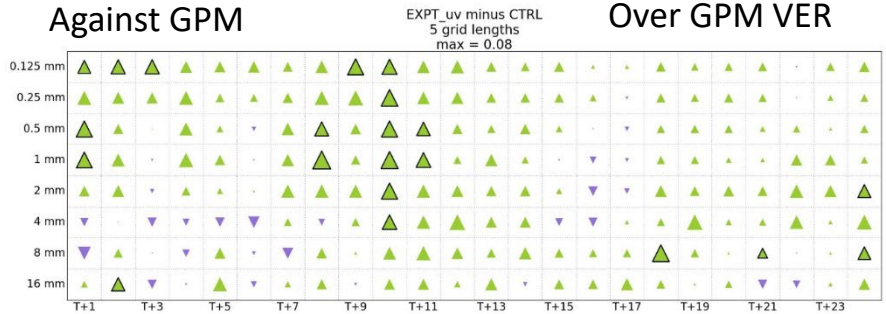
Mean diurnal cycle over Bengkulu

Forecasts initialised at 13LT

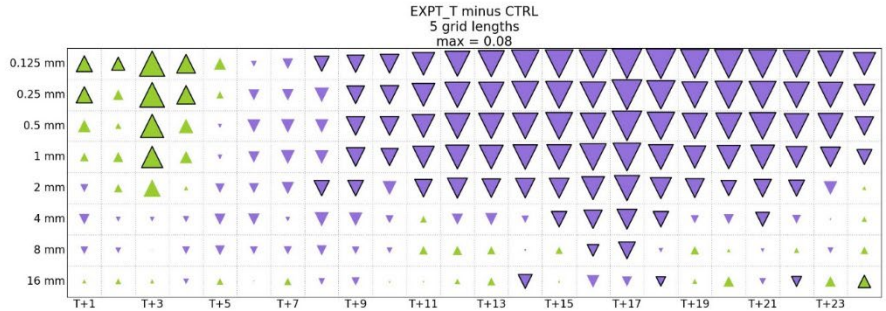


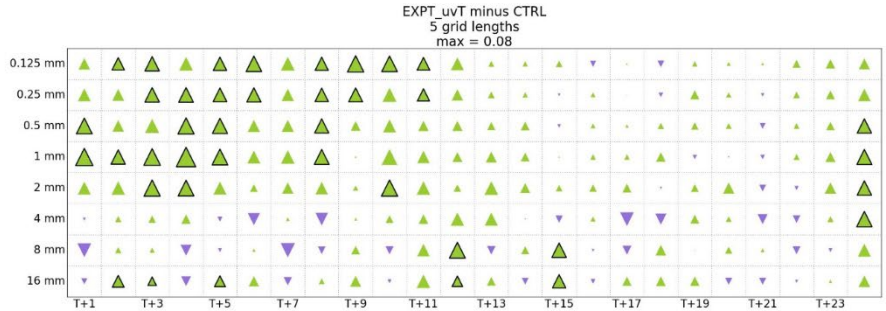
Precipitation forecast scores

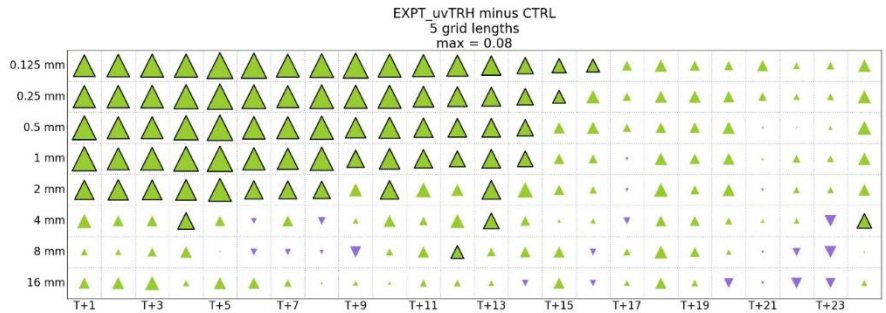
Against GPM



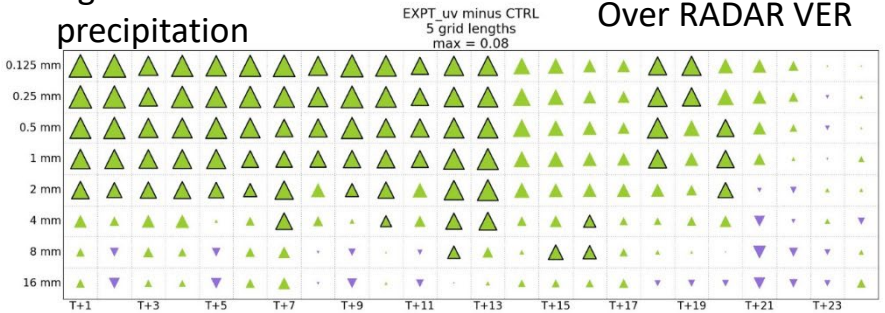
Over GPM VER



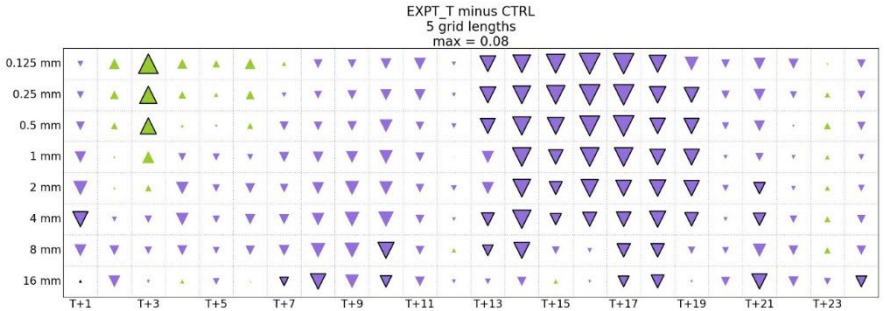


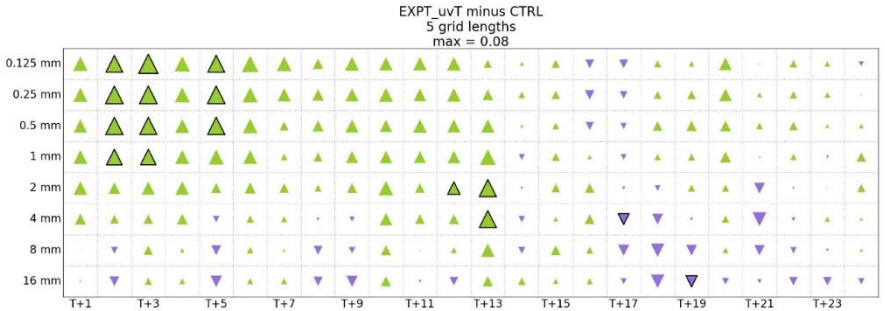


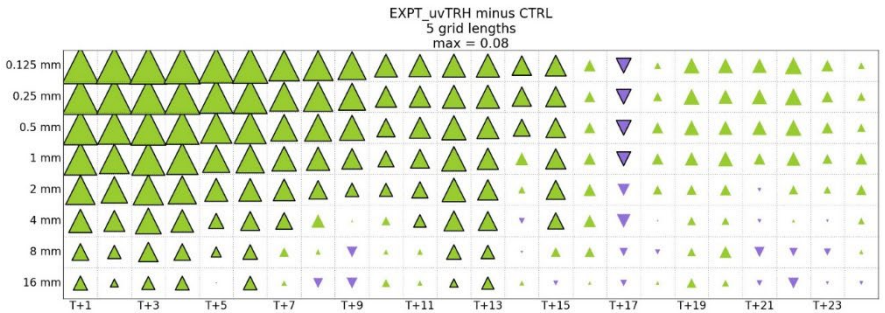
Against radar-derived precipitation



Over RADAR VER







Key takeaways

- Additional in-situ observations are valuable for this data-sparse region.
  - ➢ High frequency observations are likely to be particularly useful since the diurnal variation is dominant.

- Wind and moisture information appear to be key in improving rainfall forecasts over the western coast of Sumatra (arguably also for the broader western Maritime Continent).
  - ➢ Assimilating wind information alone was sufficient to improve the simulations.

- Assimilating temperature information alone resulted in a degradation of rainfall forecasts.
  - ➢ We believe the temperature-moisture multivariate relationship in the background error covariance matrix contaminated the analysis when moisture information was not available.

Lee, J C K, Dipankar, A and Huang X-Y (2021). On the sensitivity of the simulated diurnal cycle of precipitation to 3-hourly radiosonde assimilation: A case study over the western Maritime Continent. Mon. Wea. Rev. 149(10), pp.3449-3468. doi:10.1175/MWR-D-20-0423.1.

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