Regional Atmospheric and Oceanic Modeling of the Maritime Continent

: MIT Regional Climate Model (MRCM)

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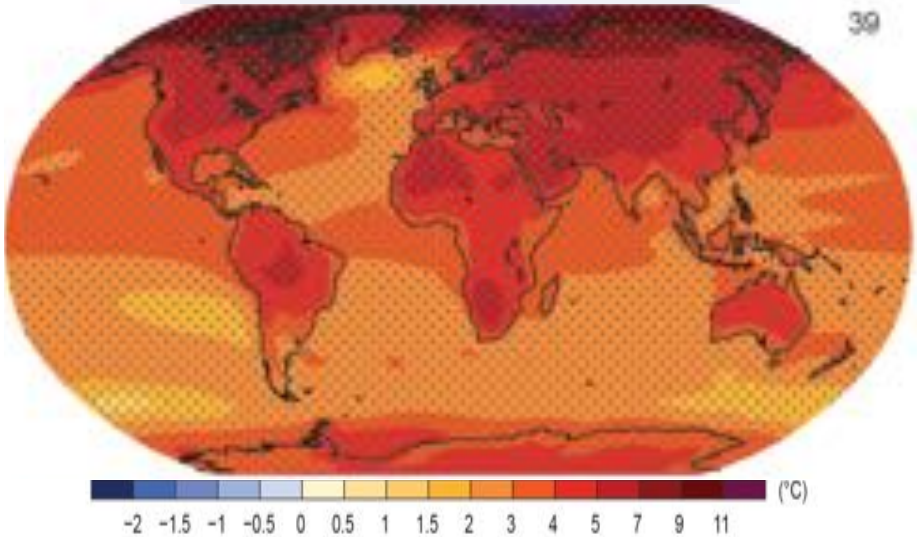
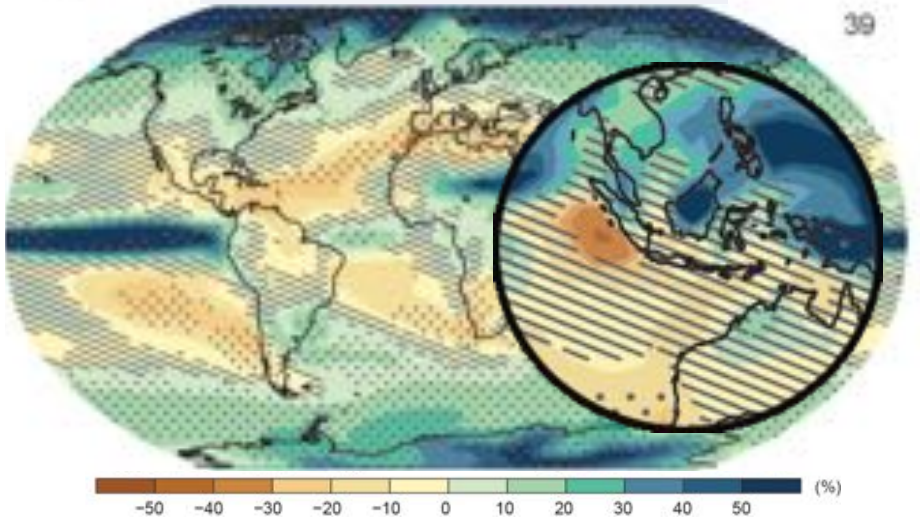
RCP8.5 Projection (2081-2100)

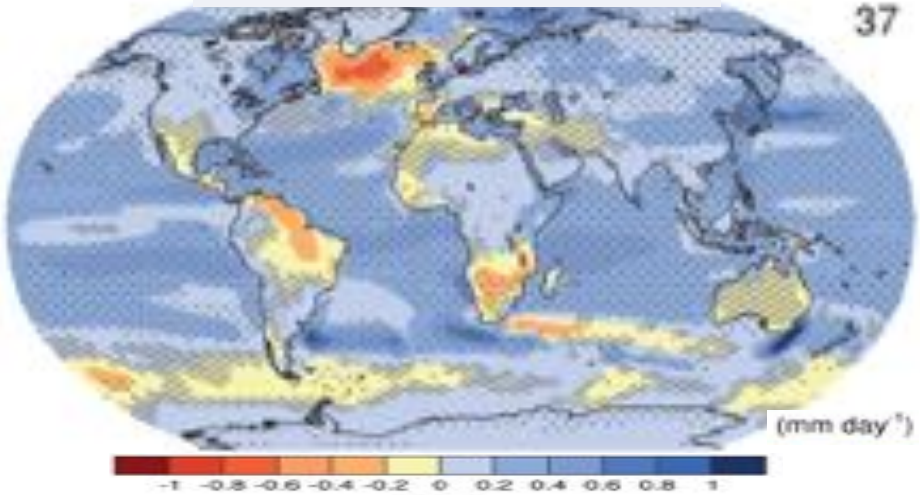
Changes in Temperature



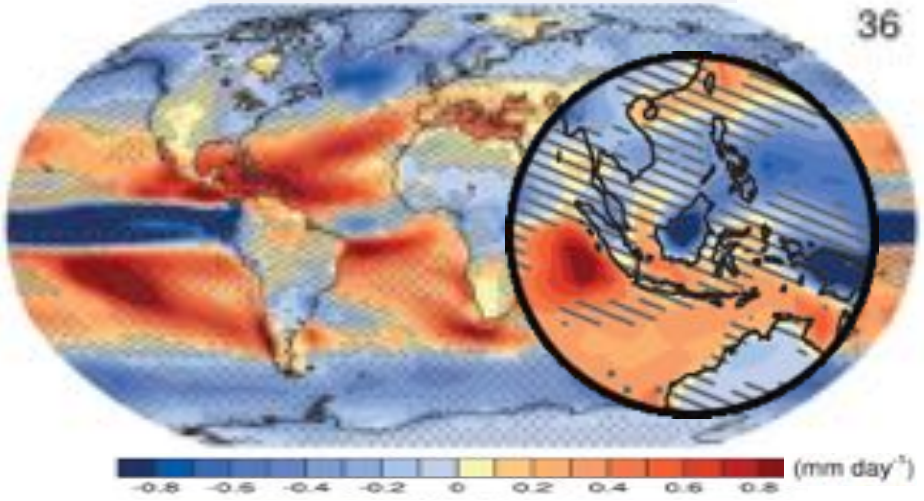
Changes in Precipitation



Changes in Evaporation



Changes in Eva.-Pre.



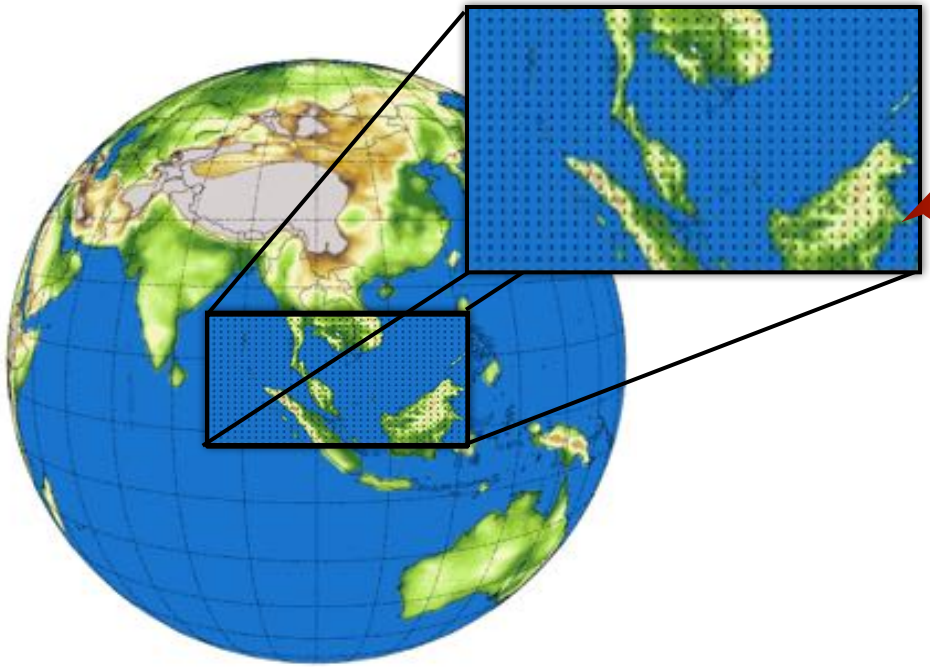
Adapted from IPCC AR5

Dynamical Downscaling

Global Climate Model: about 200 km

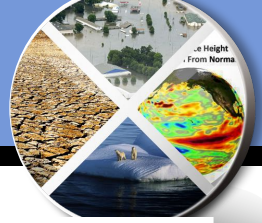
Dynamical Downscaling

Regional Climate Model: about 30 km



Large Scale Forcing from GCM

RegCM3 Upgraded by MIT Eltahir Group

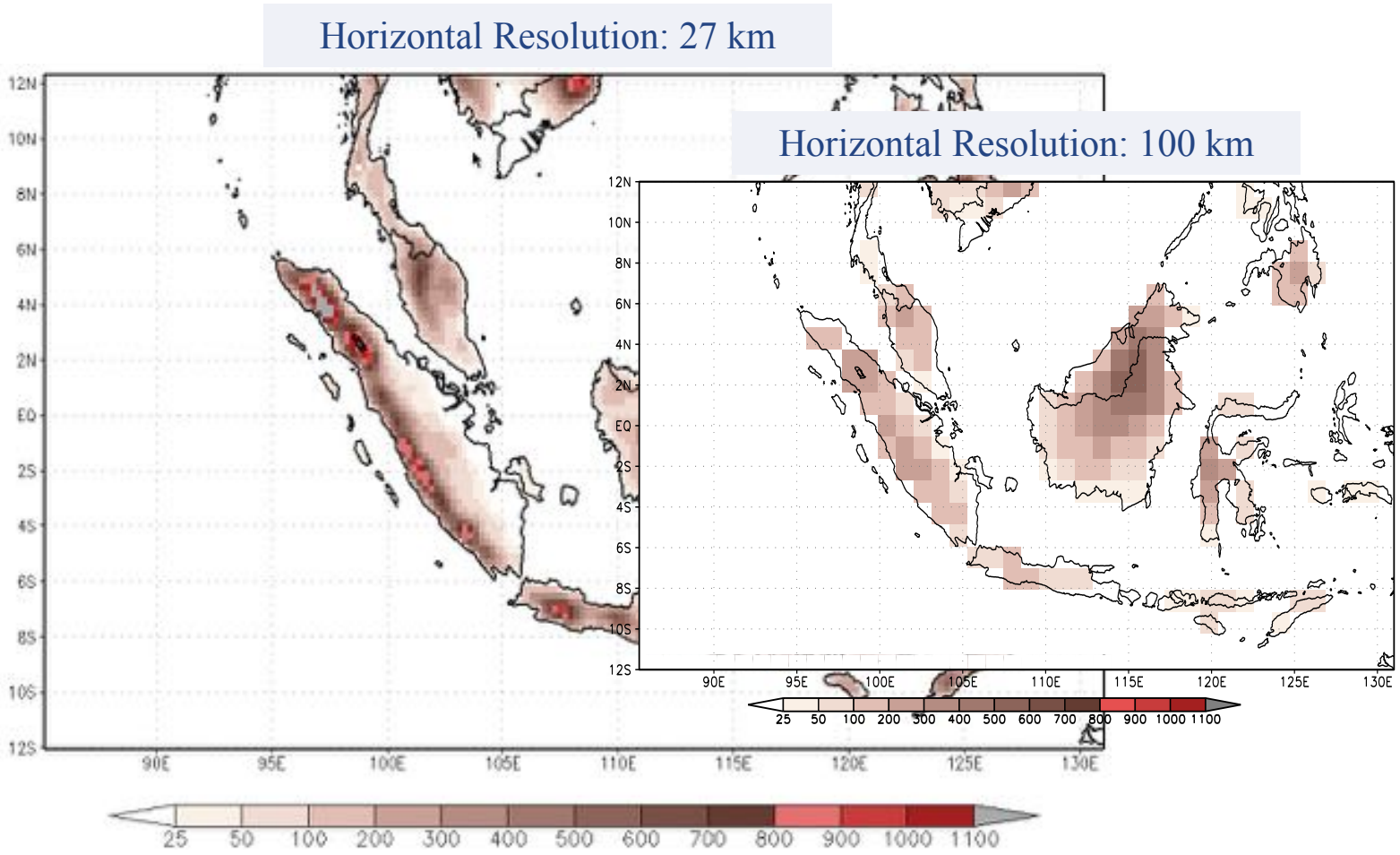


New Features	Key References
Coupling of Integrated Biosphere Simulator (IBIS) Land Surface Scheme	Winter et al. (2009)
New surface albedo assignment	Marcella (2012), Marcella and Eltahir (2012)
New convective cloud scheme	Gianotti (2012), Gianotti and Eltahir (2013a)
New convective rainfall autoconversion scheme	Gianotti (2012), Gianotti and Eltahir (2013b)

MIT Regional Climate Model (MRCM)

MRCM of the Maritime Continent

❖ Model Domain and Topography

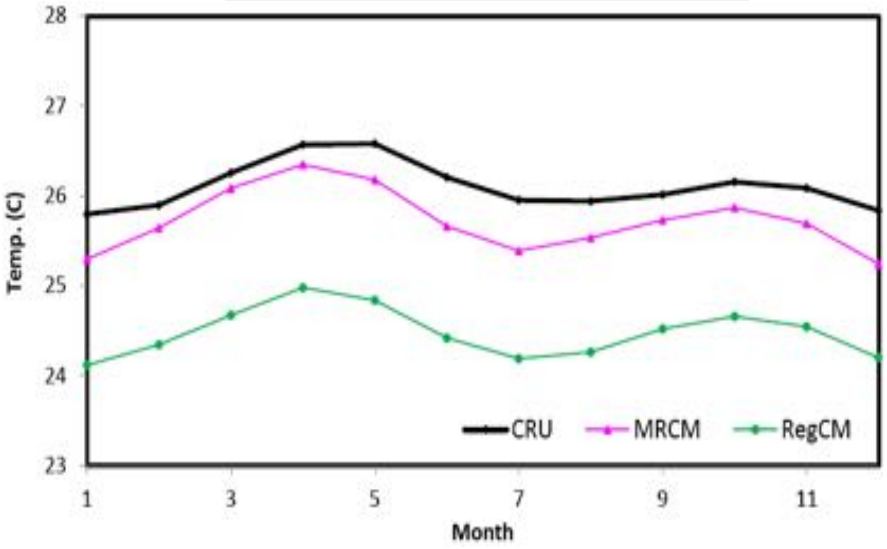


Downscaling of ERA40 reanalysis

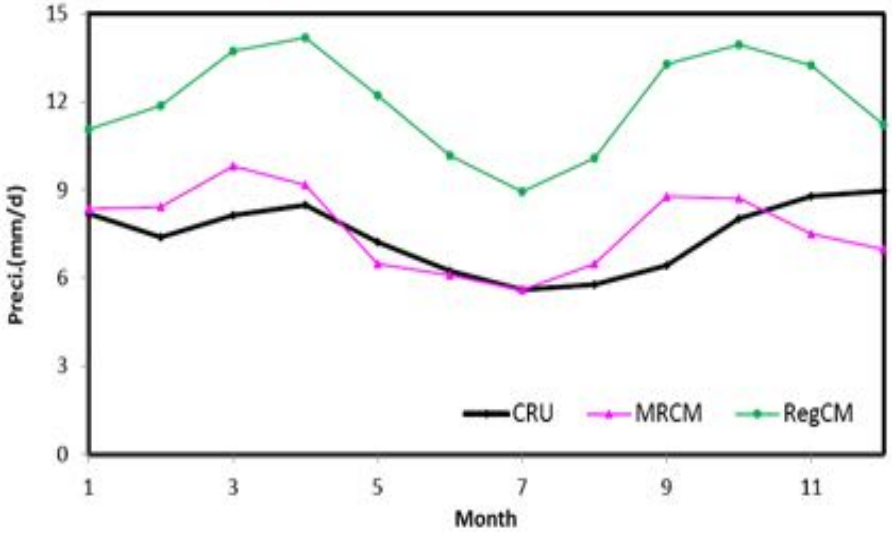
- MRCM Resolution: 27 km
- Initial & Boundary: ERA40 Reanalysis (2.5X2.5deg)
- Integration period: 1979-2001 (23yr)

	Land Surface Scheme	Convection Scheme
MRCM (NEW)	IBIS	Modified Emanuel
RegCM (OLD)	BATS	Standard Emanuel

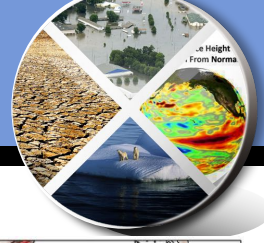
Temperature [Land]



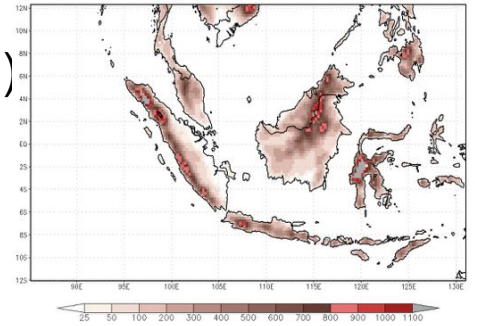
Precipitation [Land]

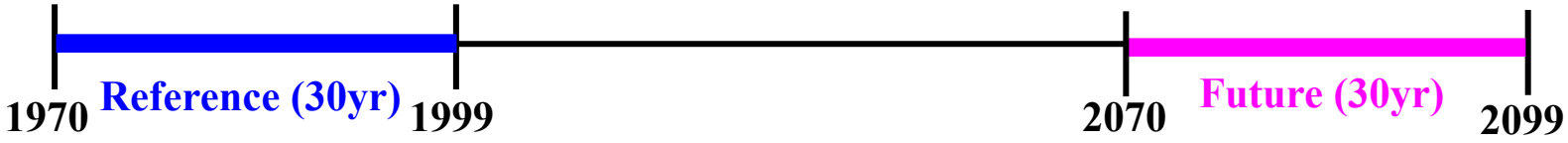


Downscaling of CESM Global Projection



- MRCM Resolution: 27 km
- Initial & Boundary: Community Earth System Model (CESM)
  (2.5X1.875deg)
- Integration period: Reference climate (1970-1999: 30yr)
  Future climate (2070-2099: 30yr)

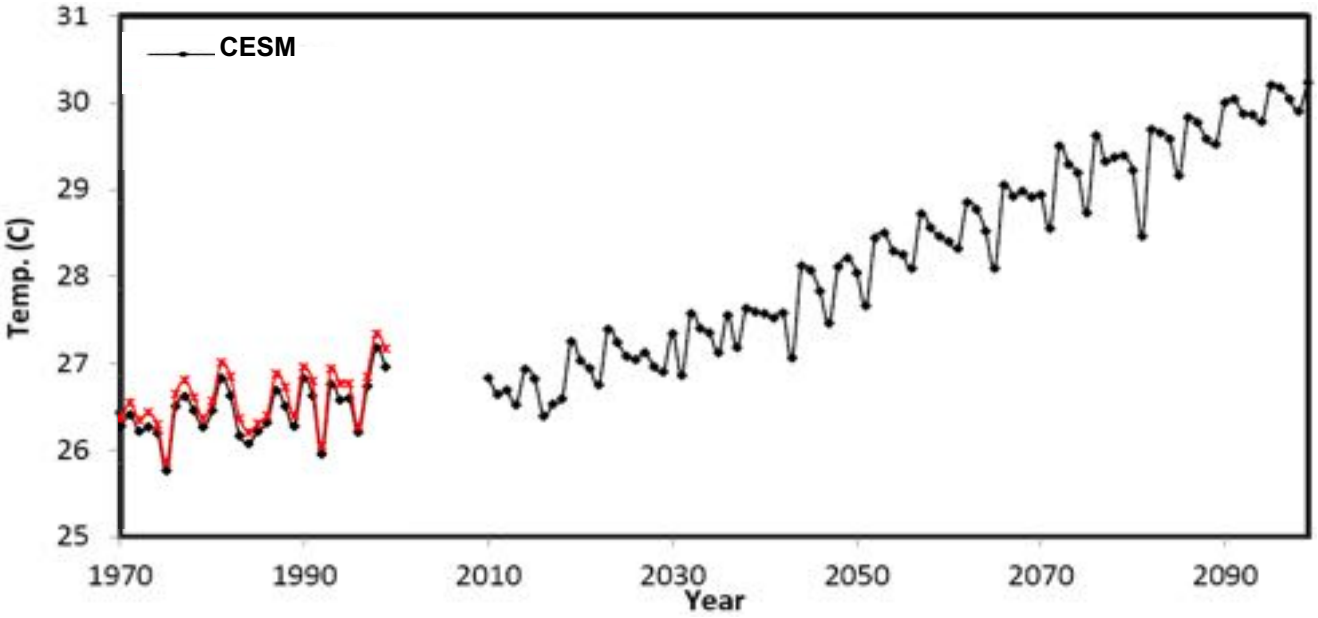




Future change signal = Future Simulation – Reference Mean

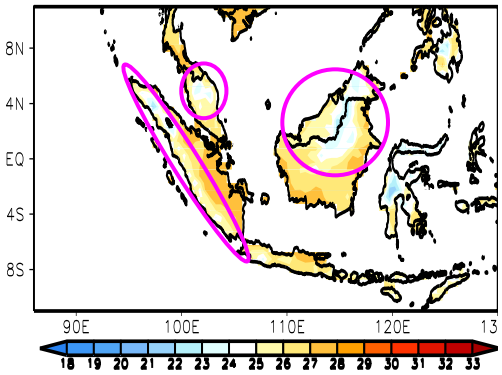
- Emission scenario : IGSM 5055

Temperature Long-term Trend

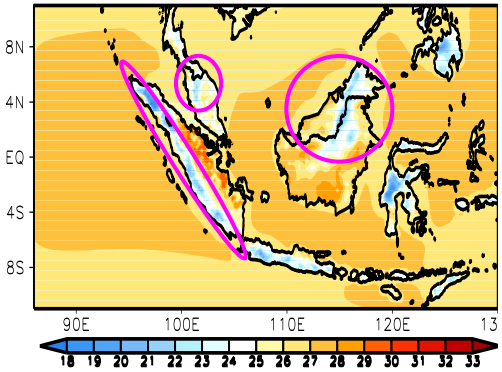


ANN Temperature [Reference]

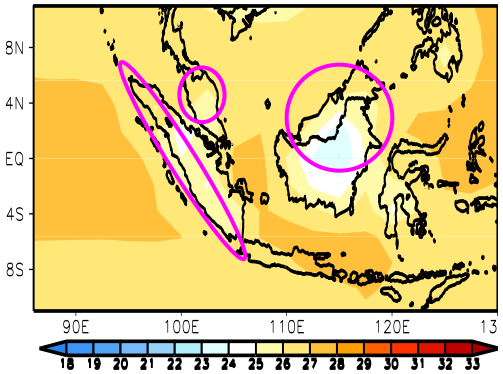
CRU



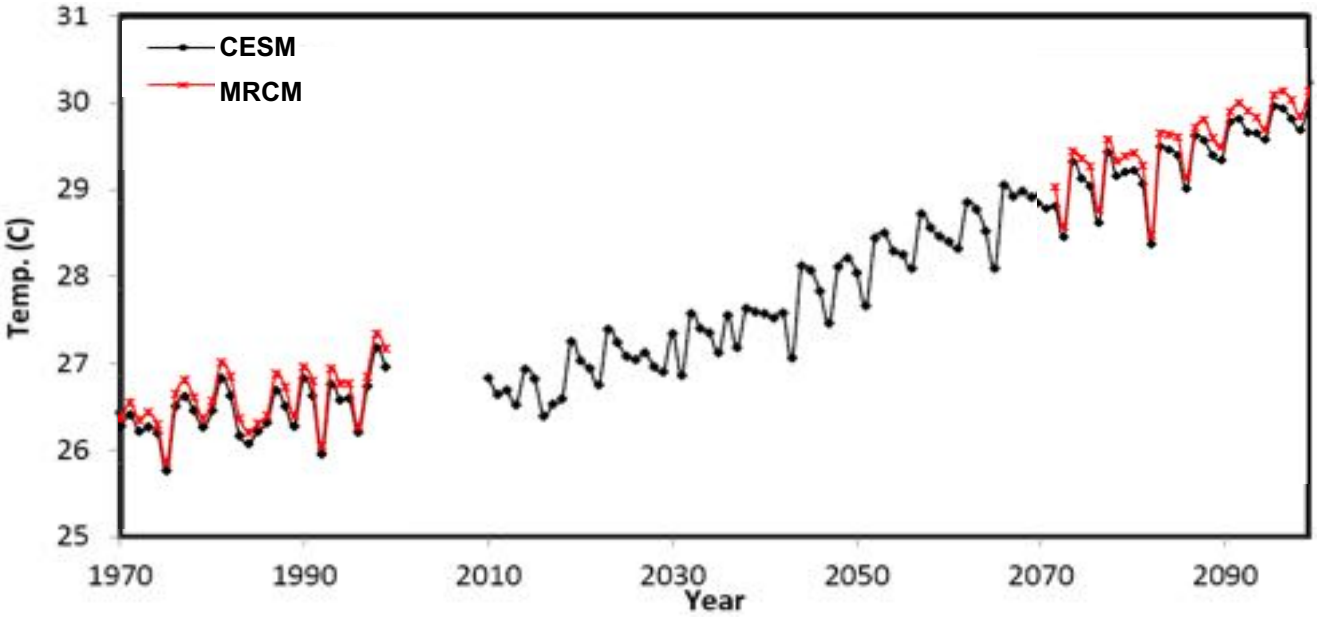
MRCM



CESM

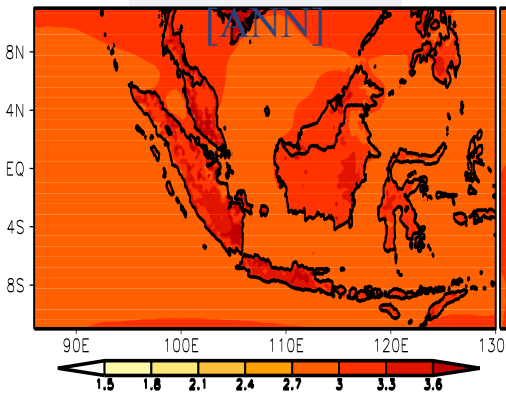


Temperature Long-term Trend

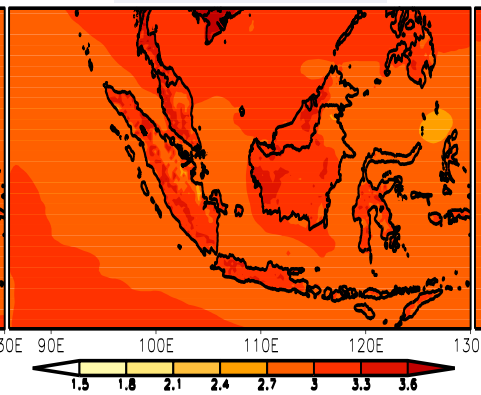


Temperature Change [2070-2099]

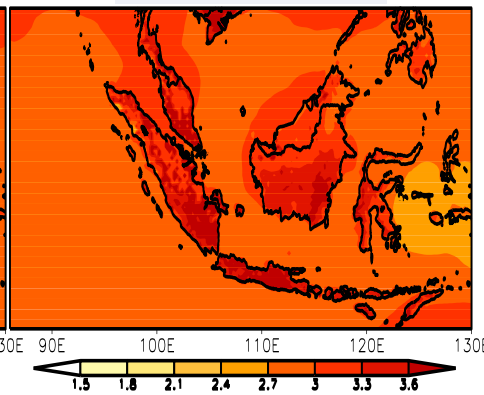
MRCM [ANN]



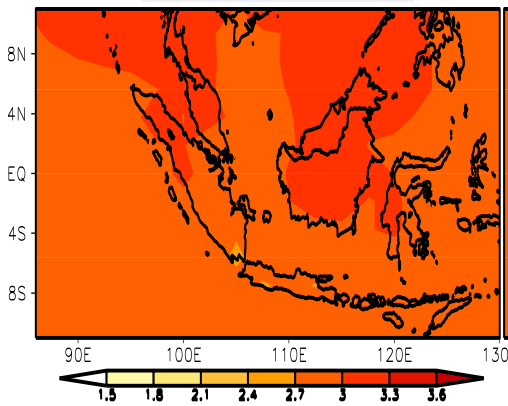
MRCM [DJF]



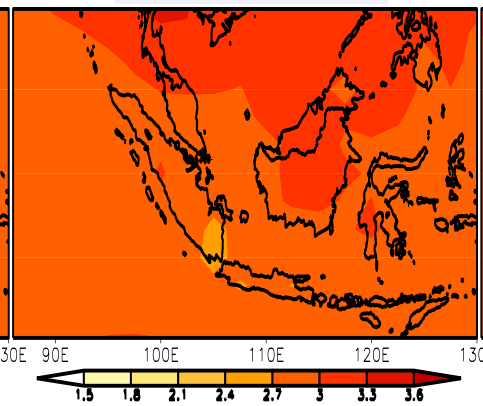
MRCM [JJA]



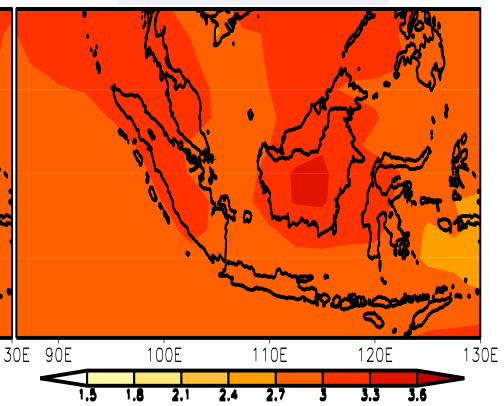
CESM [ANN]



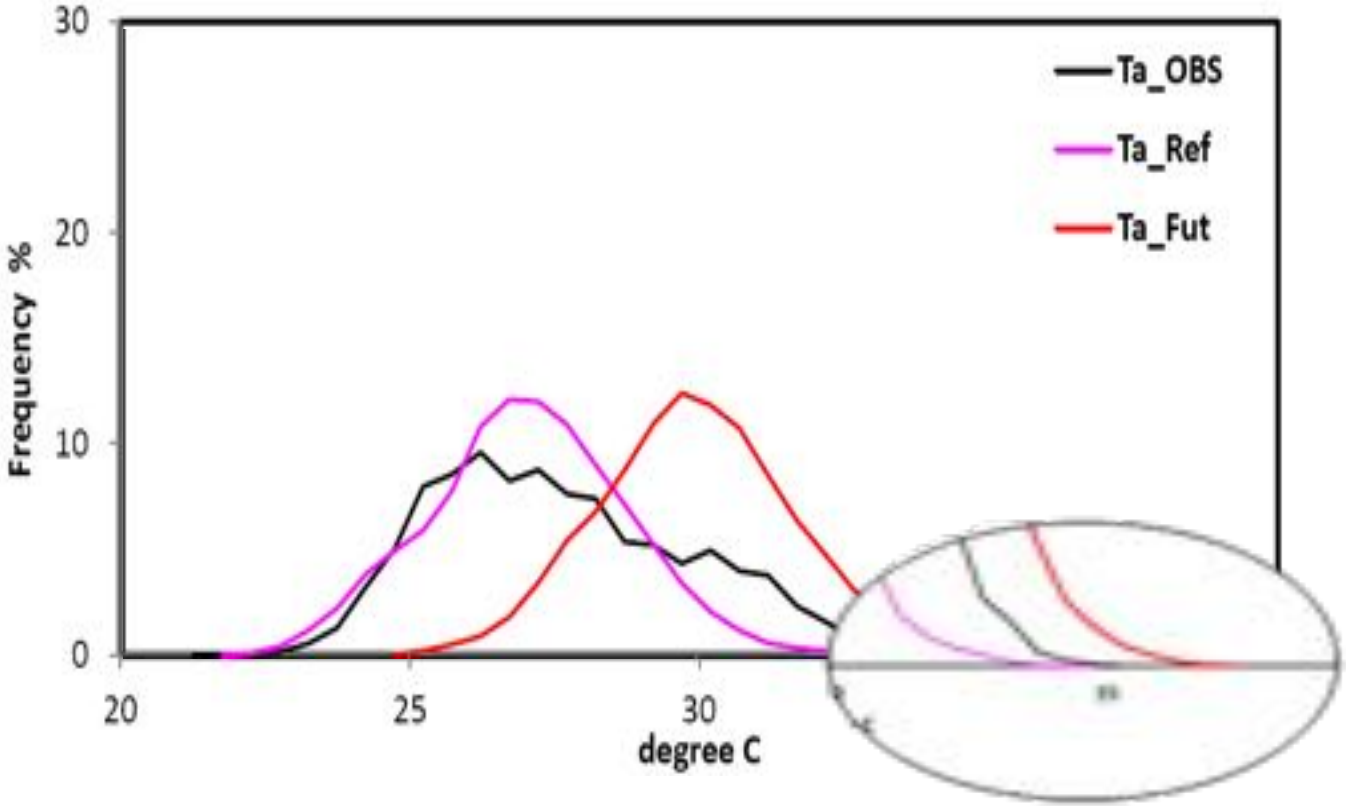
CESM [DJF]



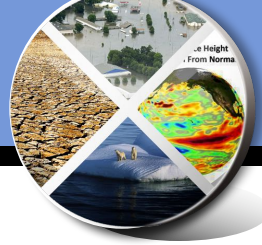
CESM [JJA]



3hour Ta Distribution at Changi Station



Summary



Reanalysis

- MRCM is capable of reproducing fine-scale climate information over the Maritime Continent.
- MRCM shows an encouraging performance that demonstrated a significant improvement over the previous version of this model.

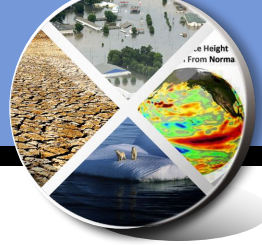
Reference

- The simulation derived from MRCM-CESM model chain is capable of capturing the trend and variability of temperature and precipitation in spite of some systematic biases
- MRCM is skillful at simulating detailed temperature feature and extreme precipitation.

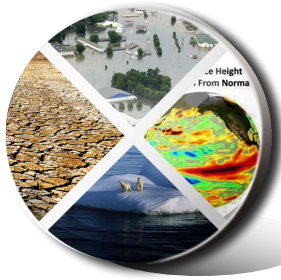
Future

- Significant warming and large variability of precipitation are expected due to the anthropogenic emission forcing.
- Such behaviors could lead to the increase of intensity and frequency of climate extremes.
- Ensemble projection is required to estimate the uncertainty range.

Future Plan



- MRCM Further Improvement
- In-depth Analysis at Regional & Local Scale
- Ensemble projection



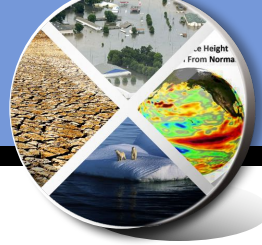
Thank you for your attention!

Poster: Eun-Soon Im & Elfatih Eltahir

Regional climate projection of the Maritime Continent using the MIT Regional Climate Model (MRCM)

- Gianotti, R. L., D. Zhang, and E. A. B. Eltahir (2012), Assessment of the Regional Climate Model Version 3 over the Maritime Continent using different cumulus parameterization and land surface schemes. *J. Climate*, **25**, 638-656.
- Gianotti, R. L., and E. A. B. Eltahir (2014a), Regional climate modeling over the Maritime Continent. Part I: New parameterization for convective cloud fraction. *J. Climate*, **27**, 1488-1503.
- Gianotti, R. L., and E. A. B. Eltahir (2014b), Regional climate modeling over the Maritime Continent. Part II: New parameterization for autoconversion of convective rainfall. *J. Climate*, **27**,1504-1523.
- Im, E.-S., R. L. Gianotti, and E. A. B. Eltahir (2014), Improving simulation of the West African monsoon using the MIT Regional Climate Model. J. Climate, **27**, 2209-2229.
- Marcella, M., and E. A. B. Eltahir (2014), Introducing an irrigation scheme to a regional climate model: A case study over West Africa. *J. Climate*, In press.
- Winter, J. M., J. S. Pal, and E. A. B. Eltahir (2009), Coupling of Integrated Biosphere Simulator to Regional Climate Model Version 3. *J. Climate*, **22**, 2743-2756.

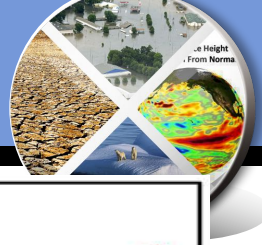
Project Overview



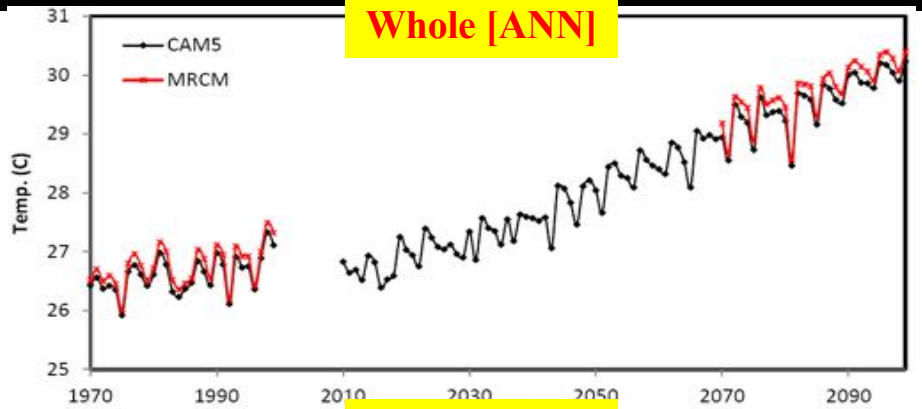
- Objective: Improve our ability to predict the impact of regional climate change over the Maritime Continent .

	Global Projection	**Regional Projection**	**Local Projection**
Team	Wang's Group	Eltahir's Group	Liong's Group
Model	CESM AOGCM	RegCM3 (Eltahir) RegCM3-FVCOM (Rizzoli)	WRF
Resolution	1.875X2.5 degree	About 30km	Less than 10km

Project Overview



Whole [ANN]



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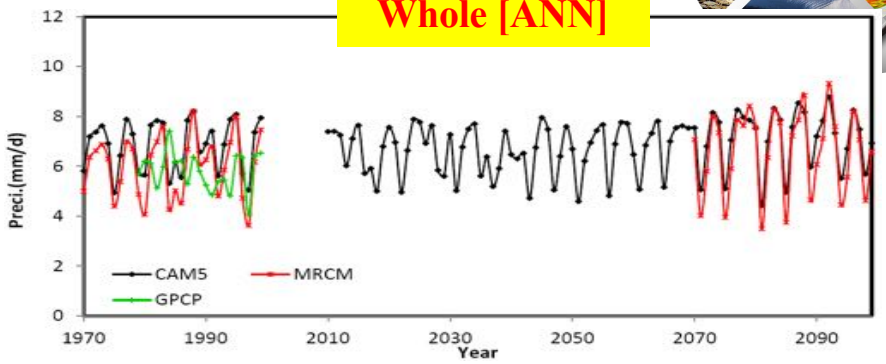
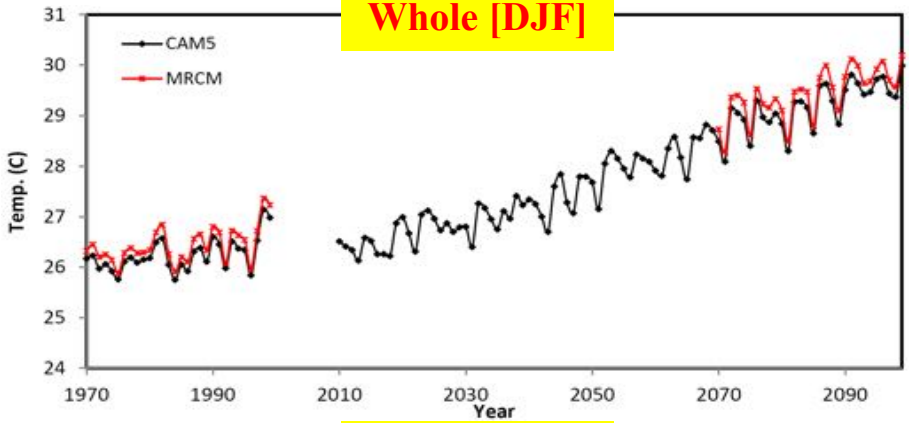


Whole [DJF]



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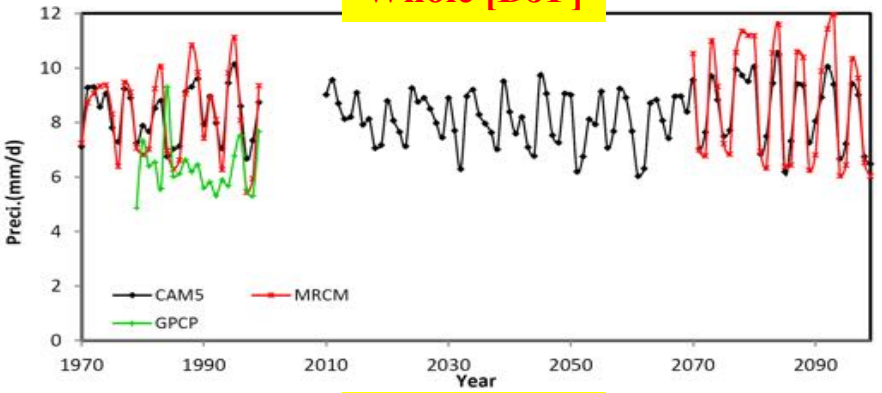
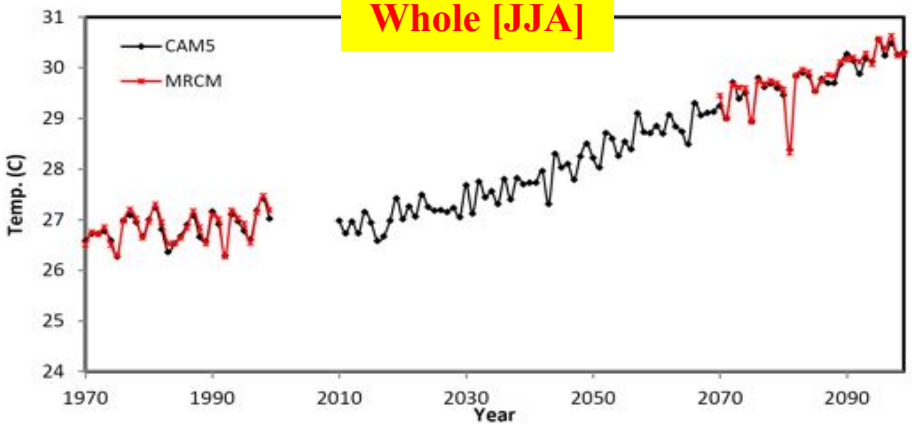


Whole [JJA]



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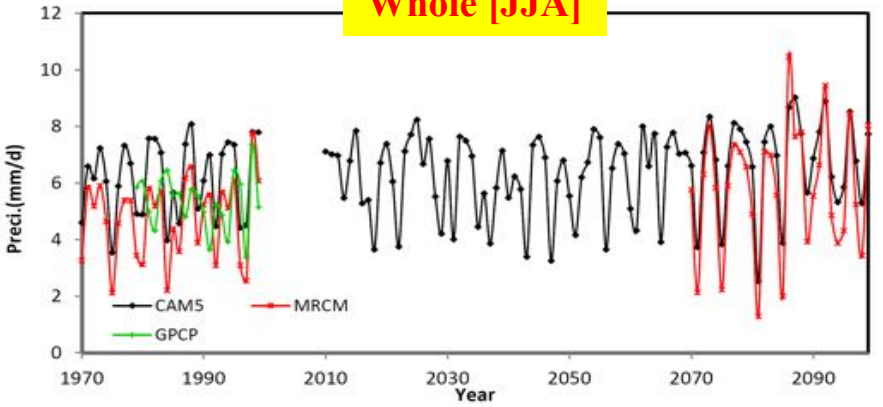
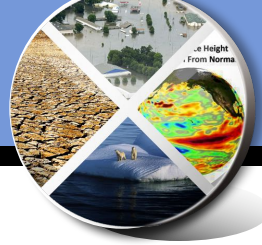


MRCM Experiment Step



STEP I

Perfect LBC Experiment

- IC and BC from analysis observation (NCEP/NCAR, ECMWF . . .)
- Validation of the model performance against observation

STEP II

GCM-driven Reference Exp.

- IC and BC from GCM simulation of present-day climate
- Assessment of added fine scale information provided by RCM

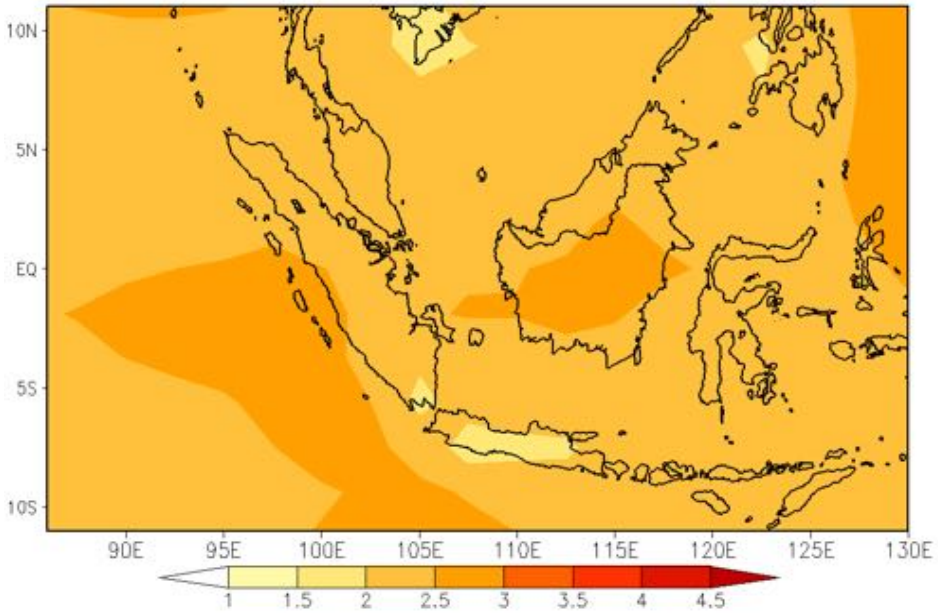
STEP III

GCM-driven Future Exp.

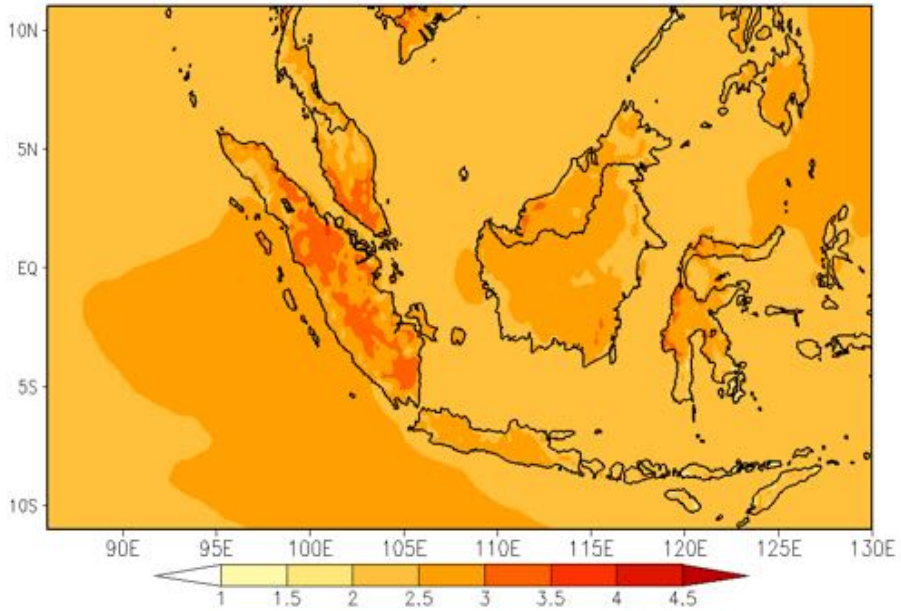
- IC and BC from GCM simulation of future climate
- Comparison of future and present climate statistics in order to identify the change signal

Temporal Evolution of Temp. Change

CESM (2.5X1.875°)



MRCM (27 km)

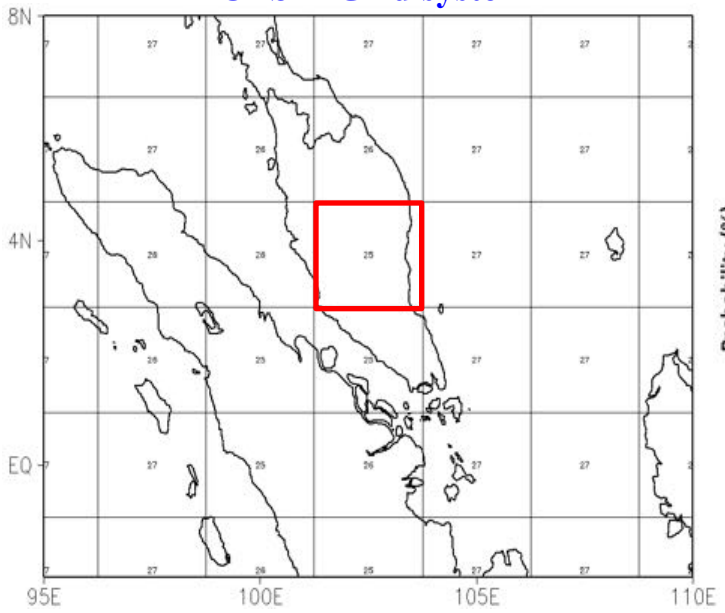


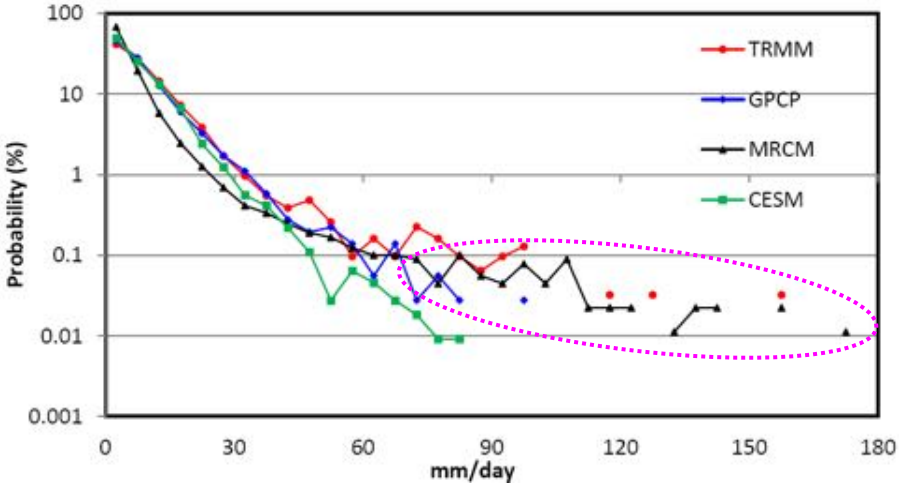
Time: 2070 ⟹ 2099

Frequency Distribution of Daily Precipitation

- Daily precipitation from MRCM driven CESM is capable of capturing some extreme values closer to TRMM observation compared CESM used as boundary condition.

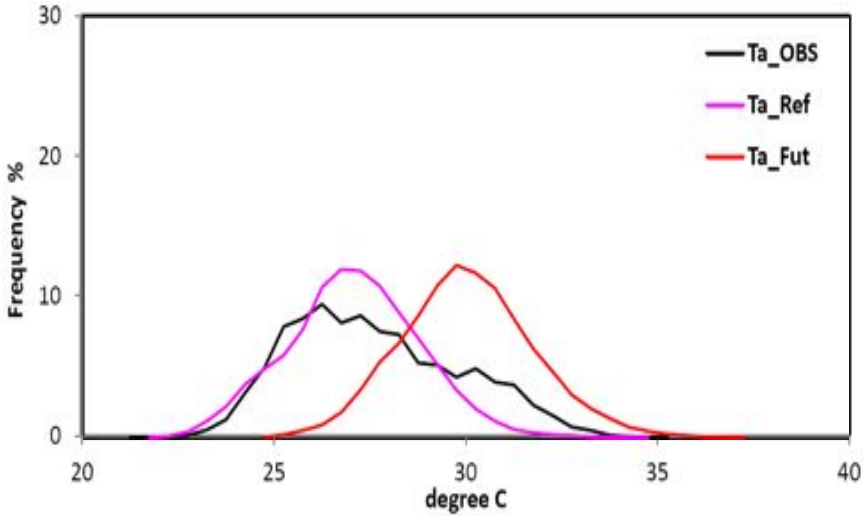
CESM Grid system





3h Ta & Tw Distribution at Changi Station

Surface Air Temp.



Wet Bulb Temp.