Regional climate simulation over the Maritime Continent using the MIT Regional Climate Model

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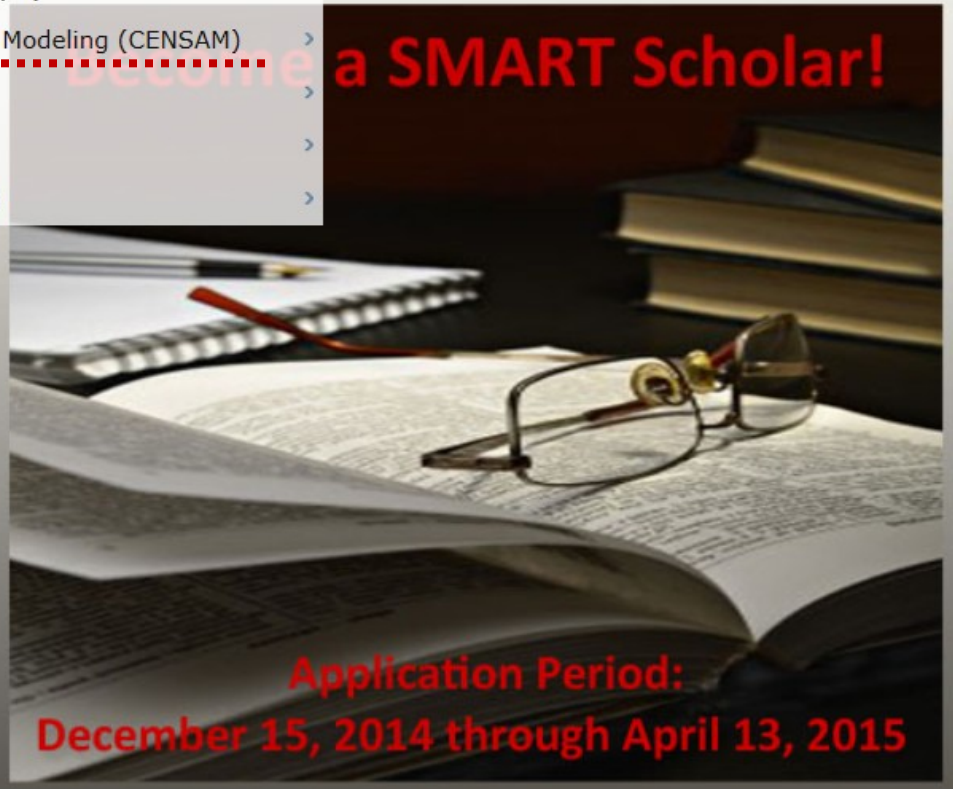
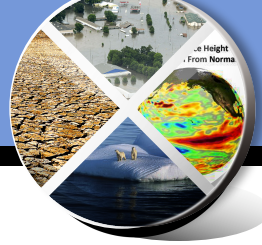
MORE



30 March 2015 **PRESS:** Octopus robot – fastest underwater robot based on the given power – developed in Singapore

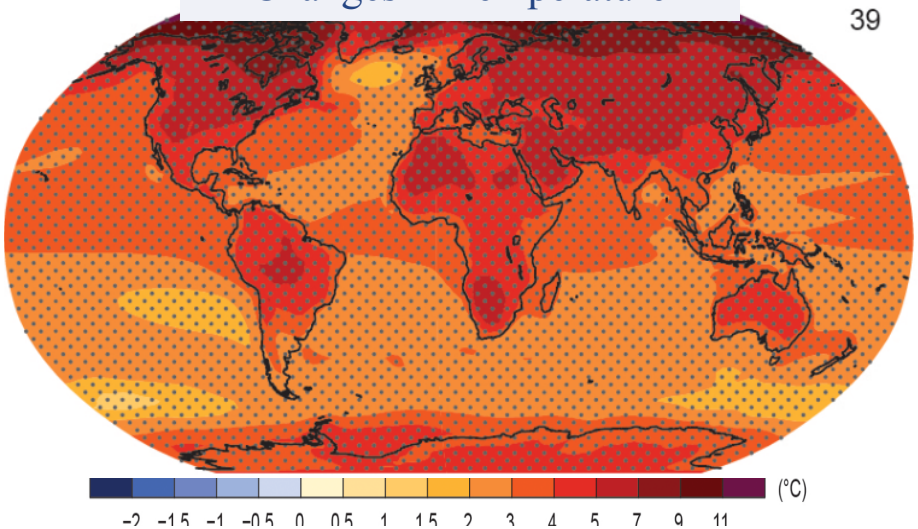
More information ...

Background I : Prevailing Uncertainty

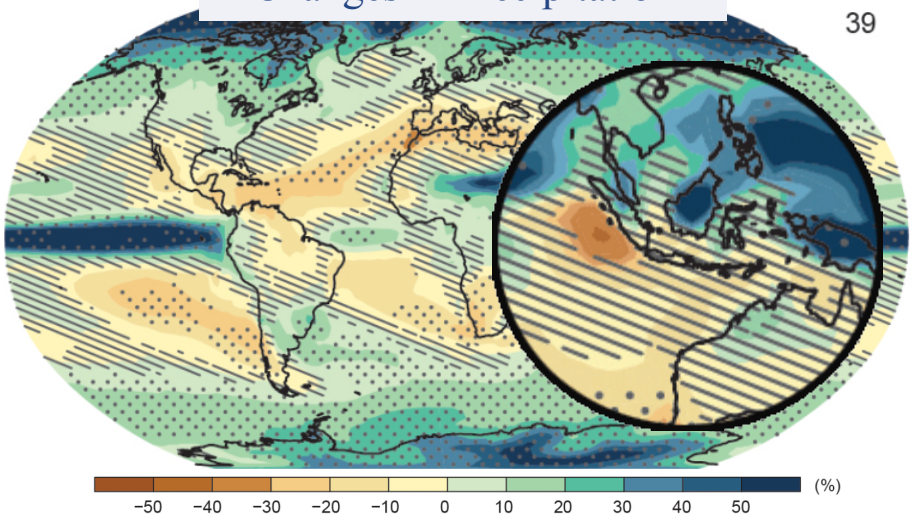


- CMIP5 Ensemble Projection under RCP8.5 scenario (2081-2100)

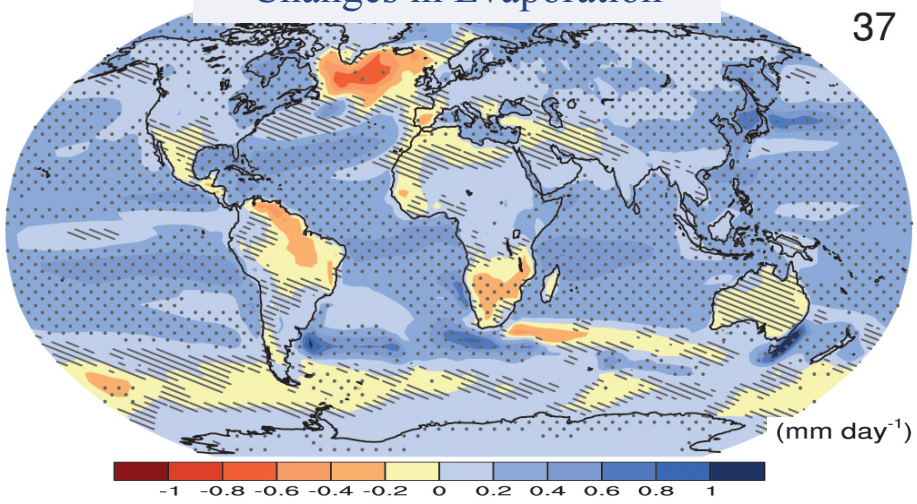
Changes in Temperature



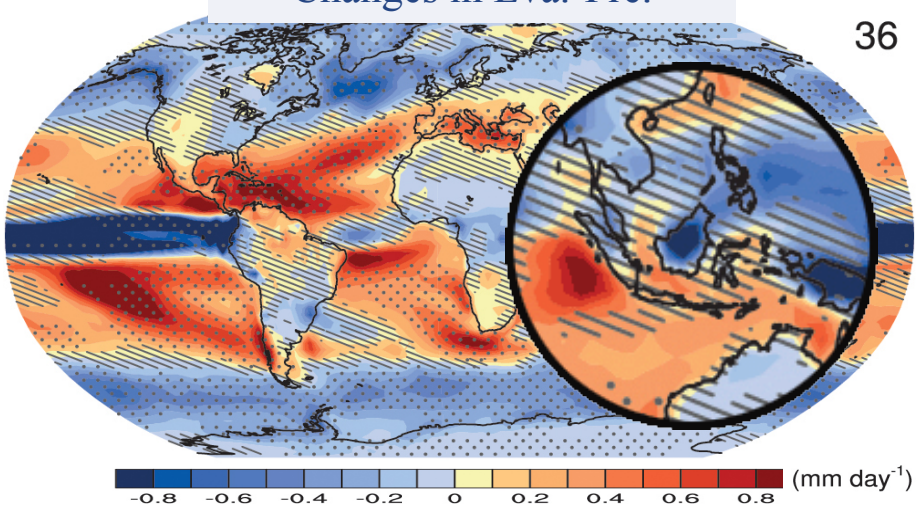
Changes in Precipitation



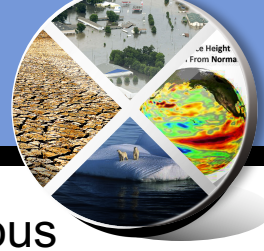
Changes in Evaporation



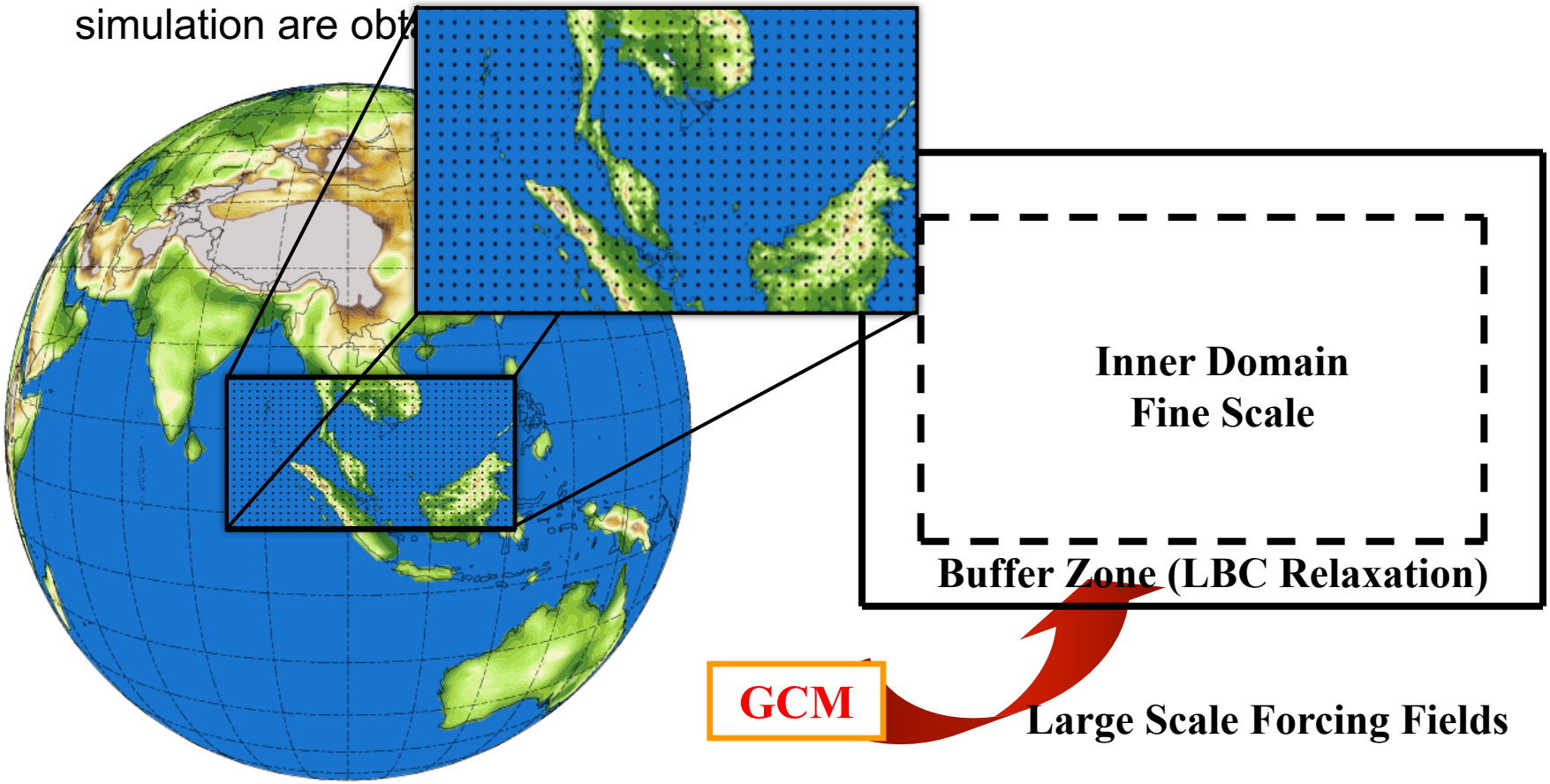
Changes in Eva.-Pre.



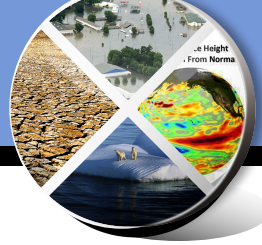
Background II : Downscaling Necessity



- RCM can reduce the spatial and temporal resolution without tremendous computational cost.
- In order to regionally enhance the resolution of a climate simulation, RCM is “nested” within the GCM over specific interest region.
- Initial conditions (IC) and lateral boundary conditions (LBC) for the RCM simulation are obt



Research Objective

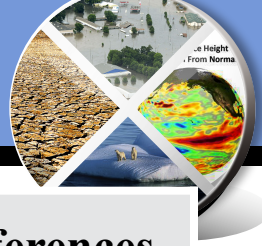


- The objective of research is to improve our ability to predict the local and regional climate change and associated impact over the Maritime Continent

  - Development of MIT Regional Climate Model (MRCM)

  - Improvement & Optimization of the MRCM Performance

RegCM3 upgraded by MIT Eltahir Group

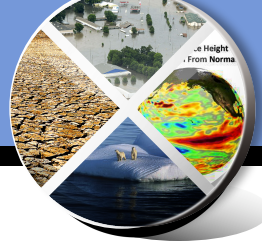


Physics	New Features	Key References
Aerosols & Chemistry	New treatment of lateral boundary for mineral aerosol	Marcella & Eltahir 2010
	Sub-grid variability of dust emission	Marcella & Eltahir 2011
Convective Cloud & Rainfall	New convective cloud fraction scheme	Gianotti & Eltahir 2014
	New convective rainfall autoconversion scheme	Gianotti & Eltahir 2014
	Modified boundary layer height & boundary layer cloud scheme	Gianotti 2012
Land Surface	Integrated Biosphere Simulator (IBIS) Land Surface Scheme	Winter et al. 2009
	New surface albedo assignment	Marcella & Eltahir 2012
	New irrigation module	Marcella & Eltahir 2014 Im & Eltahir 2014

MIT Regional Climate Model (MRCM)

- Im, E.-S. et al, 2014: Improving simulation of the West African monsoon using the **MIT Regional Climate Model**. J. Climate, 27, 2209-2229.

Research Strategy for Climate Change



STEP I

Perfect LBC Experiment

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

STEP II

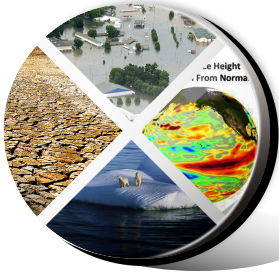
GCM-driven Reference Exp.

- 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



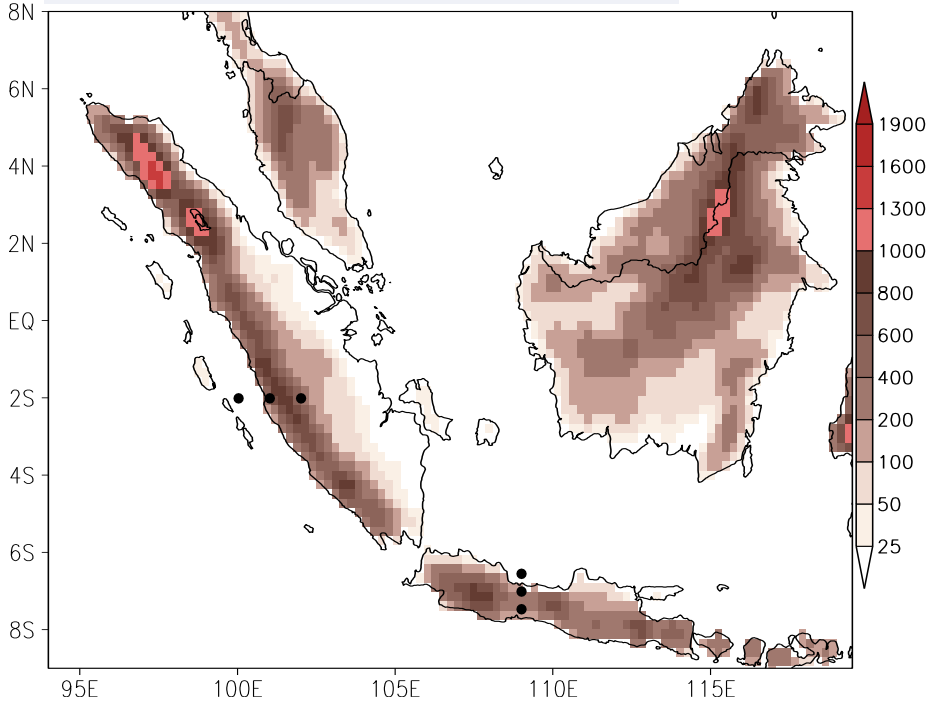
Validation of MRCM performance

Downscaling of ERAInterim Reanalysis

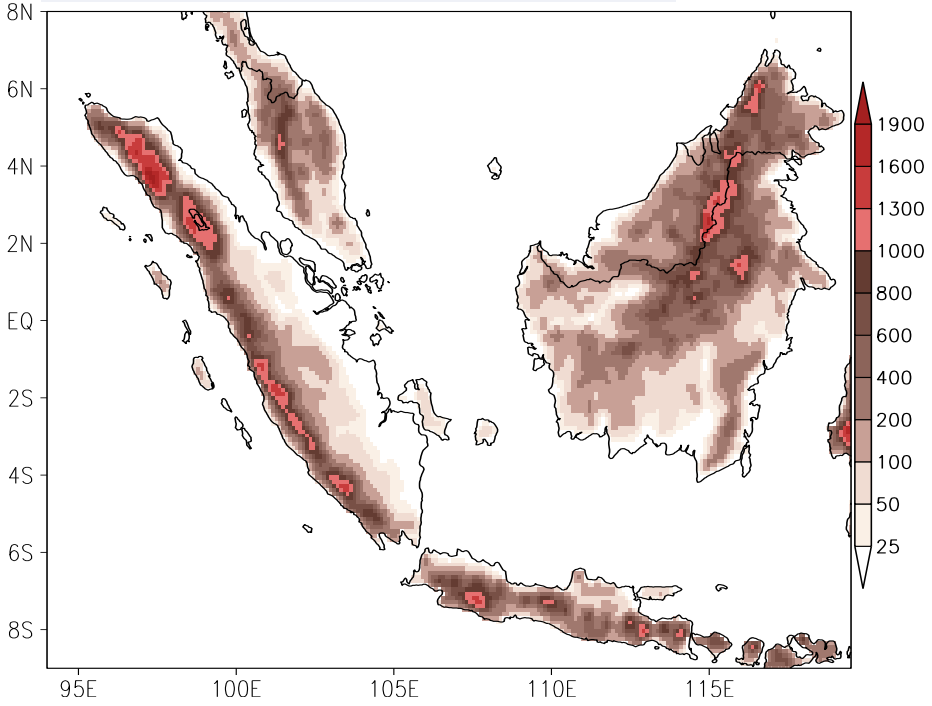
MRCM for the Maritime Continent

- MRCM Resolution: 27 km vs. 12 km
- Initial & Boundary: ERAInterim Reanalysis (1.5X1.5deg)
- Integration period: 1981.12-2011.12 (30-year & 1 month)
- Validation: TRMM 3B42 3-hourly data (1998-2011: 14-year)

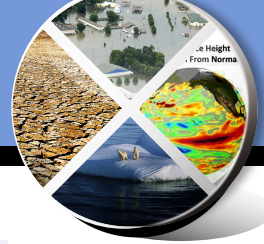
Horizontal Resolution: 27 km



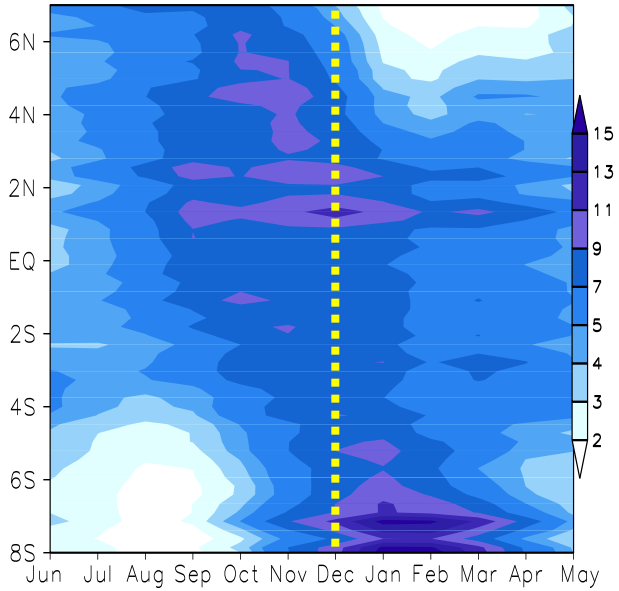
Horizontal Resolution: 12 km



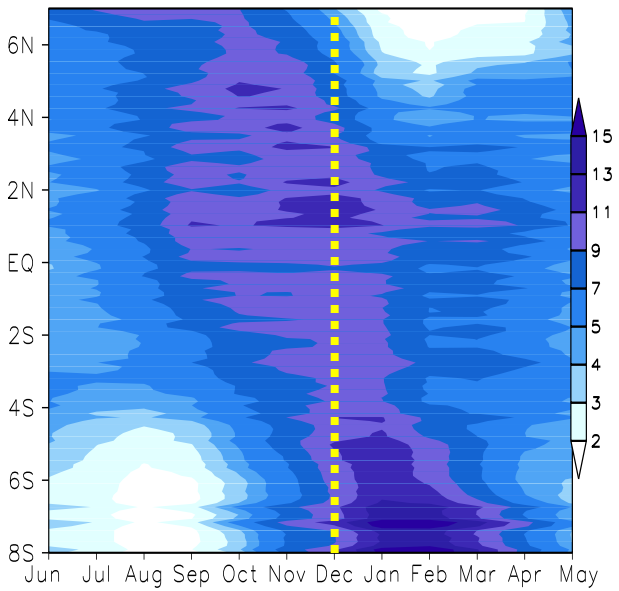
Seasonal Evolution of Monthly Precipitation



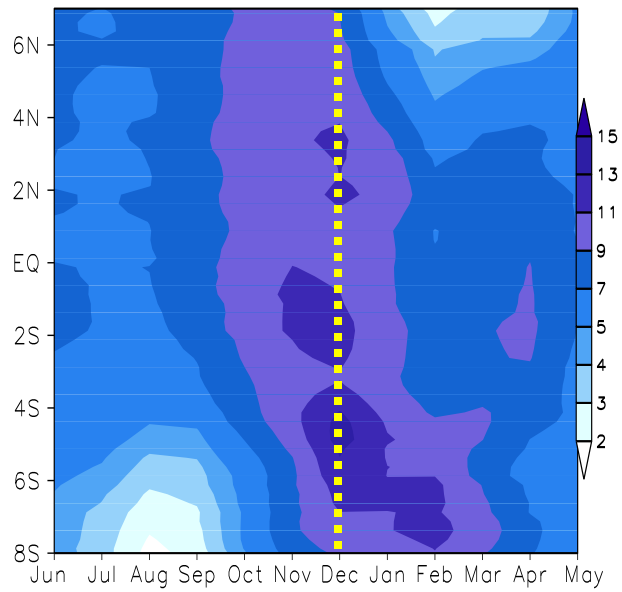
MRCM27



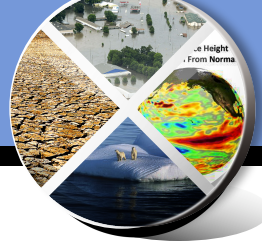
MRCM12



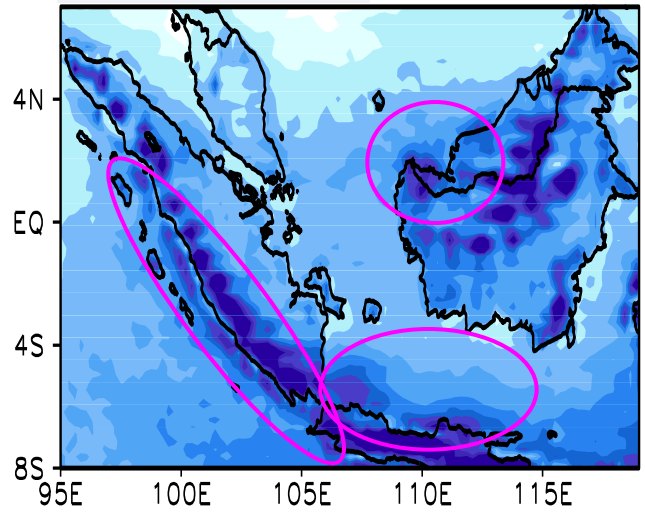
TRMM



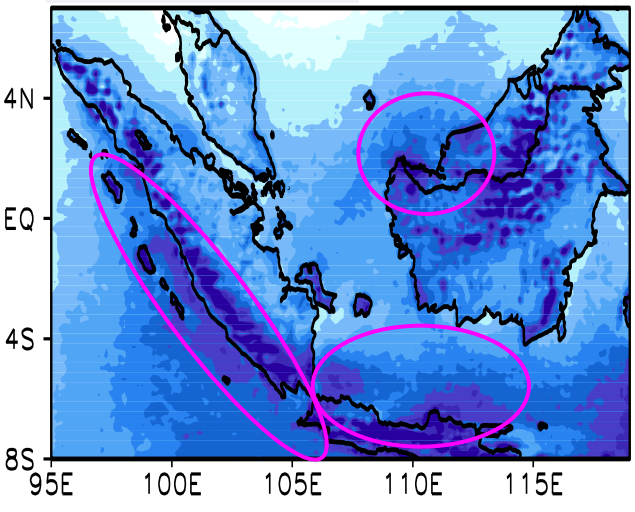
Spatial Distribution of DJF Precipitation



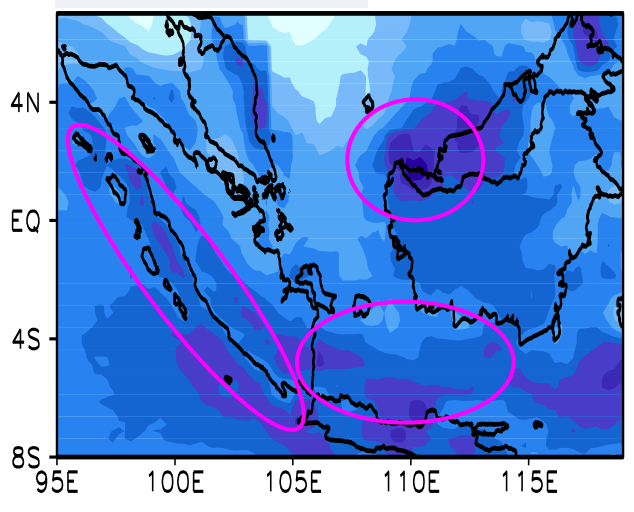
MRCM27



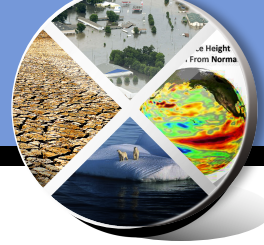
MRCM12



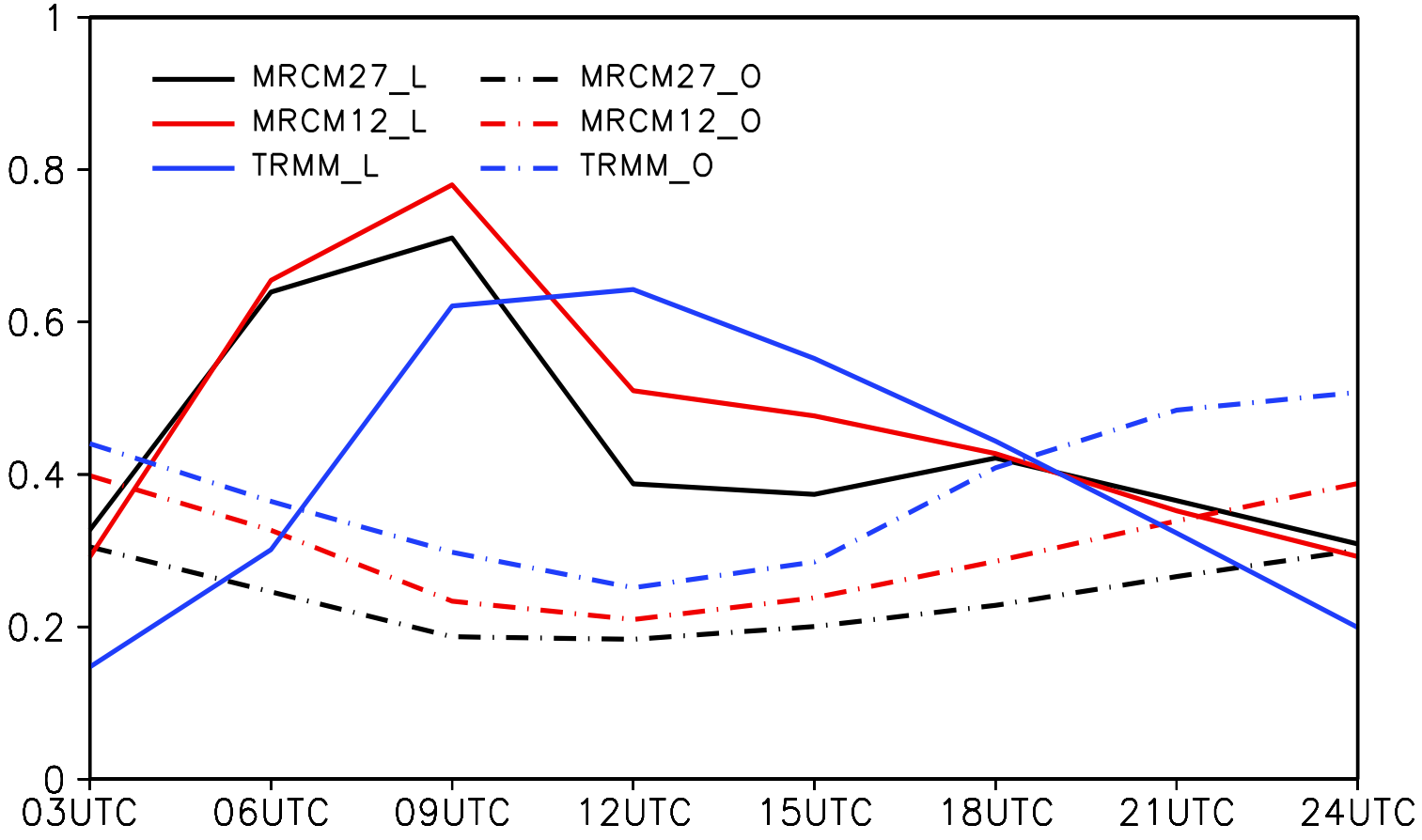
TRMM



Land & Ocean Contrast of Diurnal Cycle

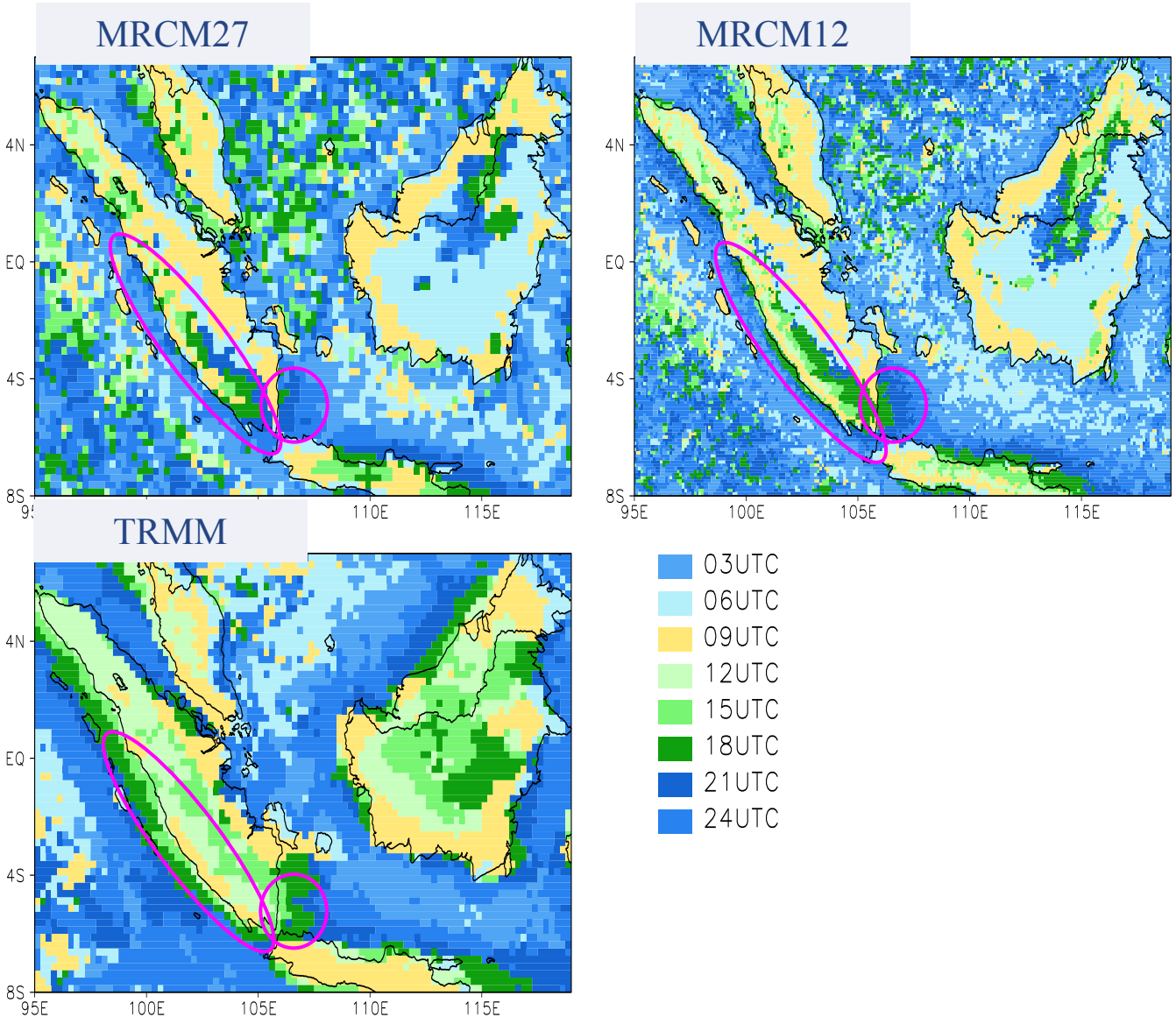


❖ Diurnal cycle of DJF precipitation averaged over land and ocean



Phase of Diurnal Variation

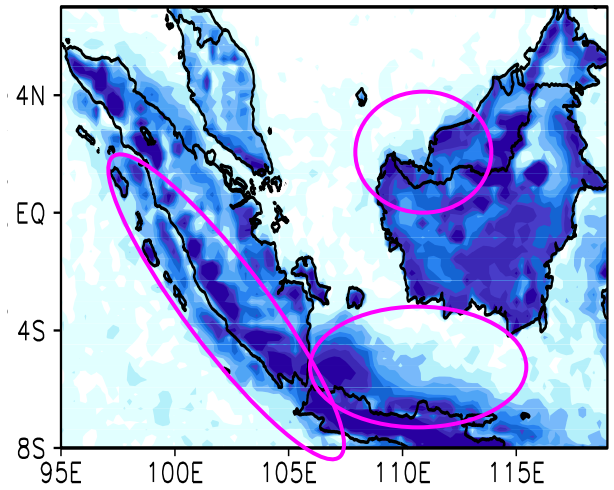
- Timing of maximum precipitation of diurnal variation



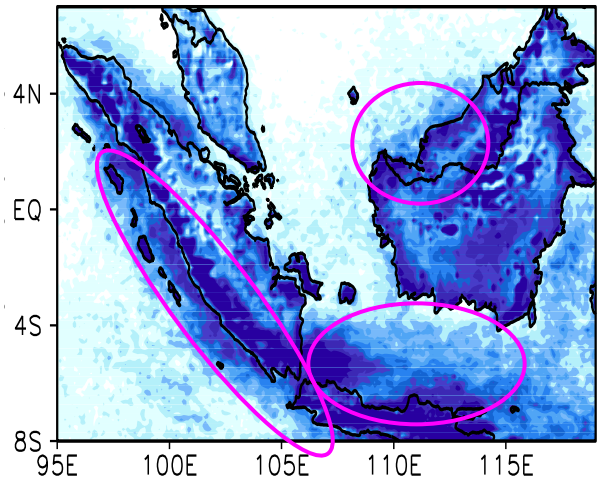
Amplitude of Diurnal Variation

- Difference between maximum and minimum precipitation in diurnal cycle

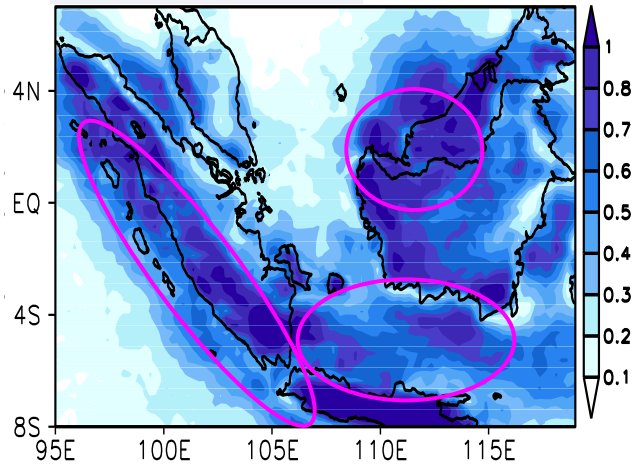
MRCM27



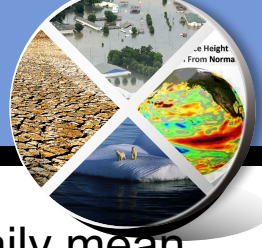
MRCM12



TRMM

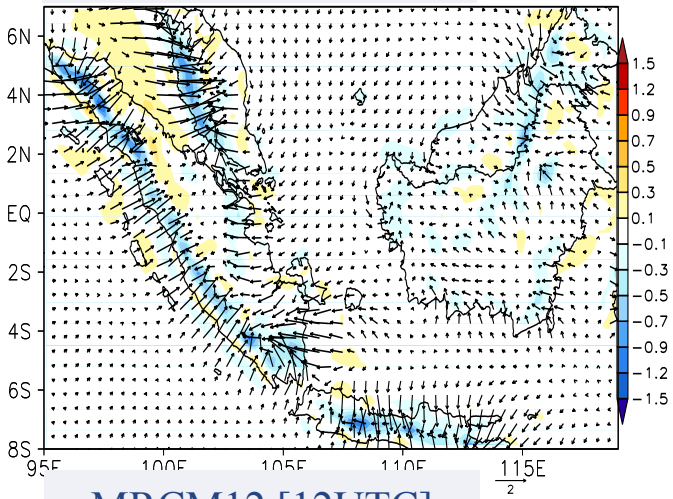


Land-Sea Breeze & Convergence

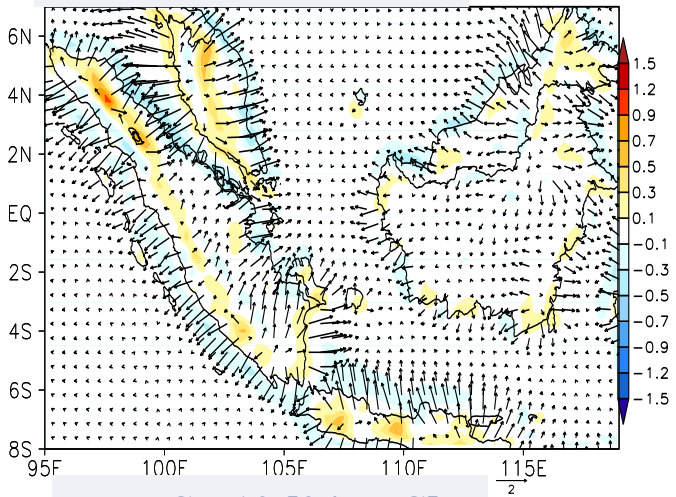


- Anomalous wind at 12UTC and 24UTC calculated by subtraction of daily mean

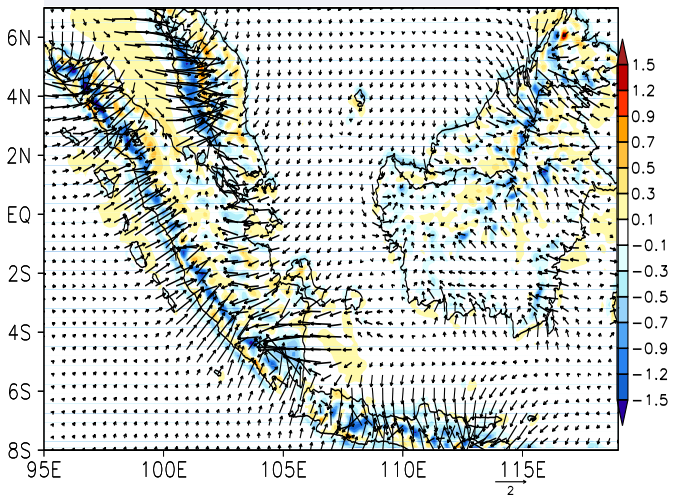
MRCM27 [12UTC]



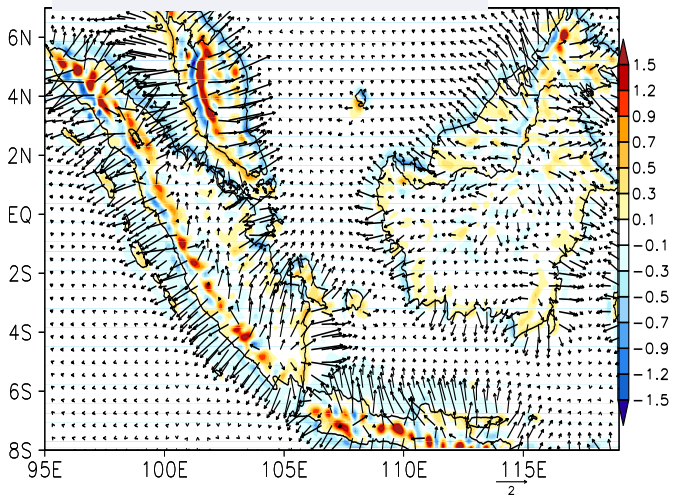
MRCM27 [24UTC]



MRCM12 [12UTC]

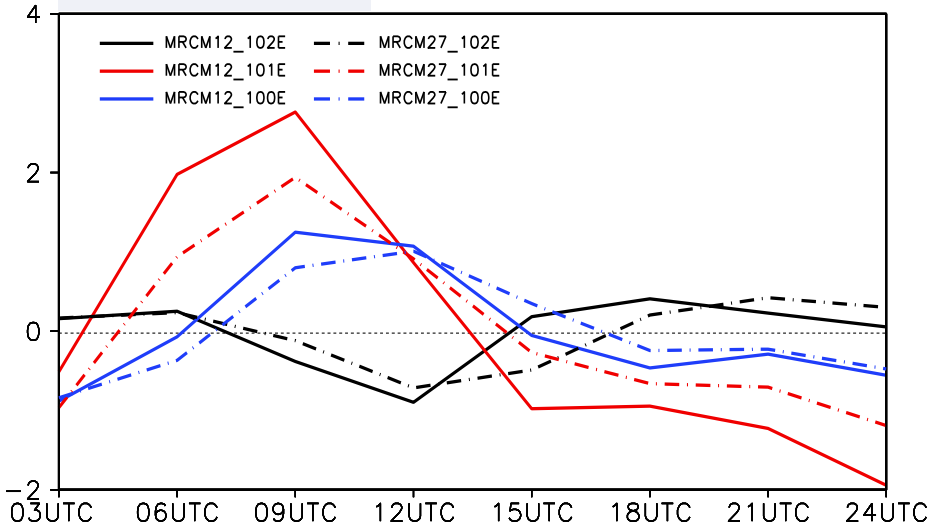


MRCM12 [24UTC]

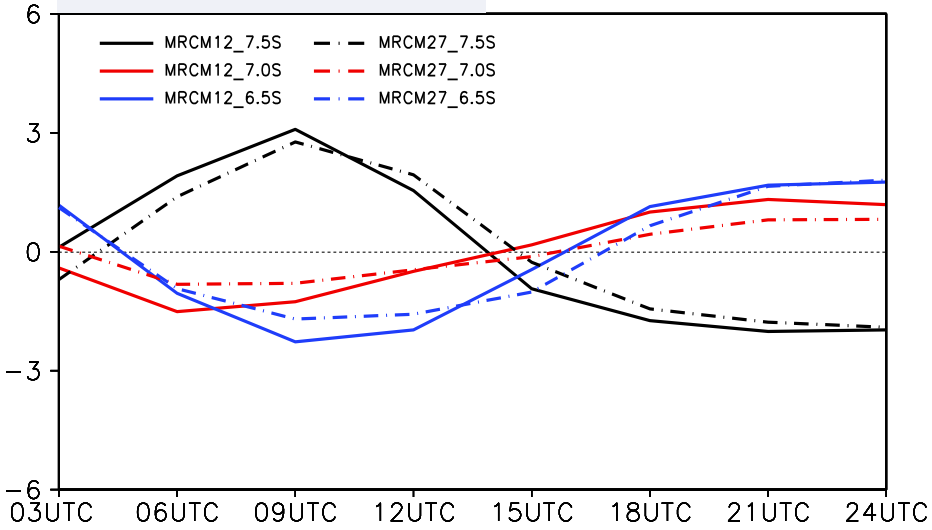


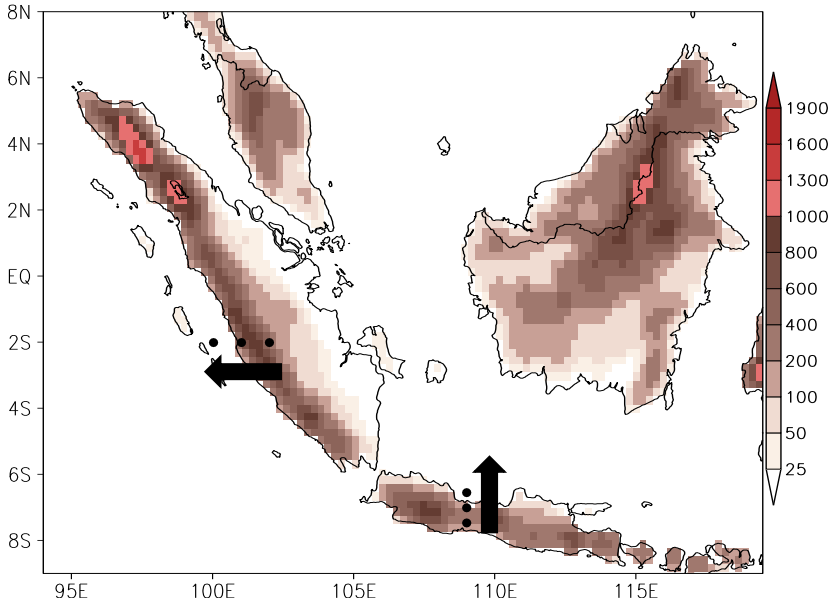
Diurnal Variation of U & V

Zonal Wind

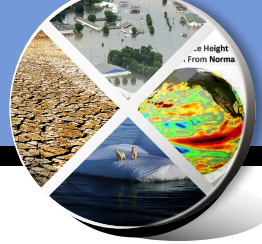


Meridional Wind





Summary



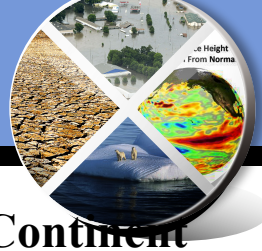
MRCM Performance

- MRCM is able to capture the major features of diurnal rainfall over land and ocean, which characterizes the rainfall pattern of the Maritime Continent.
- The evening peak with strong amplitude over land and the morning peak with weak amplitude over ocean describe the contrast behavior between land and ocean.
- Since the diurnal variation of rainfall plays key role in shaping the climate over the Maritime Continent, the degree of accuracy achieved in MRCM simulation is essential to demonstrate the reliability and potential usage of MRCM as a promising tool to produce climate change projections over this region.

Impact of high resolution

- The improvement by increasing resolution is relevant in the coastal and offshore areas, where are strongly tied with low-level wind that varies diurnally and regionally.
- More realistic coastline and sharp gradient of elevation derived from high resolution may contribute to bring the enhancement of the local circulation associated with land-sea breeze and topographic complexity, which in turn induces a favorable condition for the offshore convergence.
- The MRCM with 12 km resolution exhibits more effective propagation of rainfall from inland to coastal or offshore areas, such as in the vicinity of western Sumatra, northern Java, and western Borneo Islands.

Future Plan



❖ **Development of Reliable Climate Change Projection over the Maritime Continent**

Estimating Uncertainty & GCM Selection

Control / RCP 4.5 / RCP 8.5 **CCSM**

Control / RCP 4.5 / RCP 8.5 **CNRM**

Control / RCP 4.5 / RCP 8.5 **ACCESS**

Producing Regional Climate Projections

Dynamical downscaling using MRCM

Multi-model ensemble system

Analysis & Understanding of Climate Change

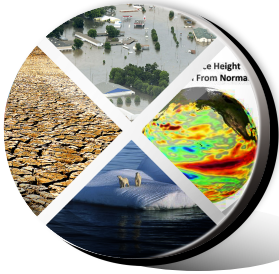
Climate extremes
: Heat wave, flood, drought . . .

Mitigation effect of GHG emission

Input to impact assessment study
: Agriculture, hydrology, health . . .

⇨ • Reduction or quantitative estimation of uncertainty range of climate change projection

⇨ • More effective use of the climate information by the end-users and policy-making communities



Thank you for your attention!