The impact of horizontal resolution on regional climate simulations over the Maritime Continent

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MIT Regional Climate Model (MRCM)

• Modeling the precipitation over the Maritime Continent is particularly challenging, potentially leading to substantial errors even in climate simulations using state-of-the-art models. In spite of some discrepancies with observations, the MIT Regional Climate Model (MRCM) has been significantly improved in its ability to simulate the regional climate over the Maritime Continent through the modification of model physics. In particular, the recent modifications in the representation of convective cloud cover and convective rainfall auto-conversion bring more physical realism, which contributes to improving cloud-radiative feedback that in turn affects the simulation of precipitation in a positive way.

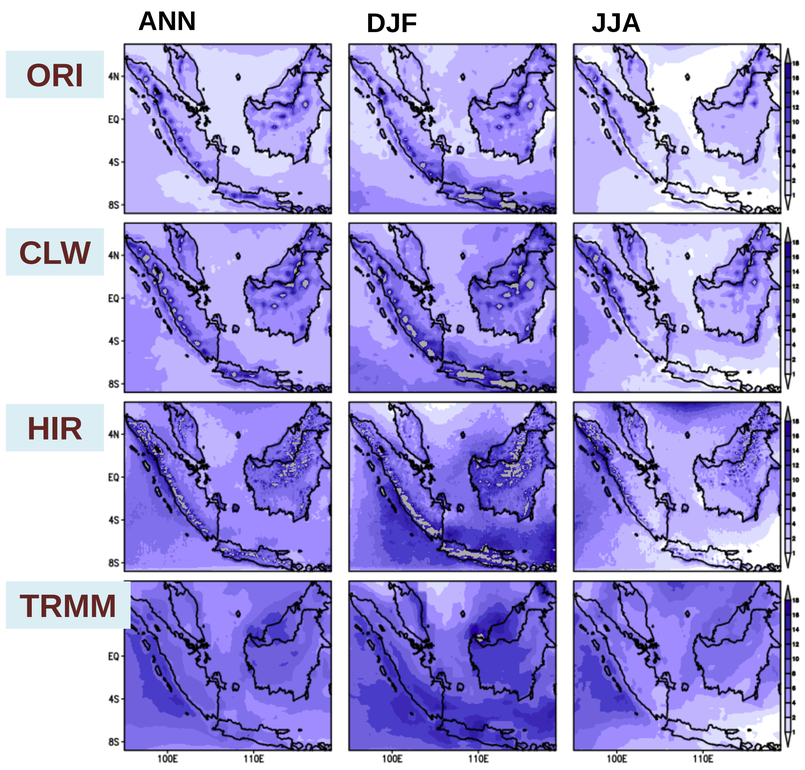
Experimental Design and Analysis Method

• For further improvement of the performance of the MRCM, we tuned the key parameter controlling convective process and enhanced the resolution to capture local details associated with the complex geographical features. Our analysis is primarily focused on the impact of parameter and horizontal resolution (27km vs. 10km) on precipitation over land vs. ocean. We also present how the accurate representation of geographical forcings with increased resolution (i.e. high topography and land-sea contrast) can improve simulation of the local circulations (i.e. sea breeze) and their role in shaping precipitation processes over this region.

Name	Resolution	ICBC (Period)	Features
ORI	27 km	ERAInterim (1982-2001)	MRCM Latest version
CLW	27 km	ERAInterim (1982-2007)	Same with ORI, except for CLW parameter
HIR	10 km	ERAInterim (1982-2007)	Same with CLW, except for resolution

Characteristics of Precipitation Climatology

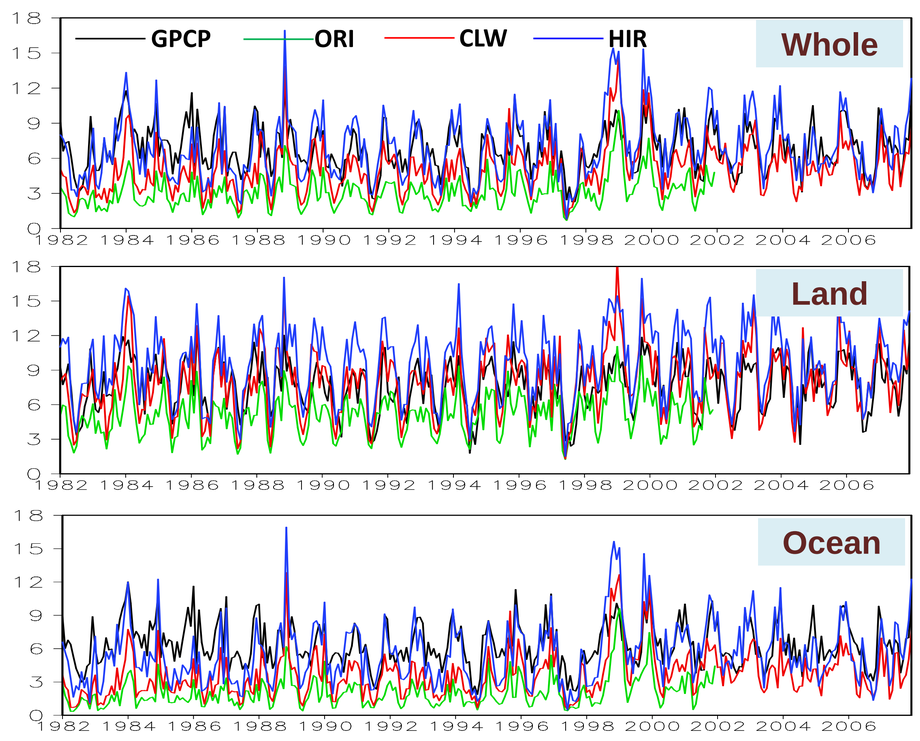
❑ Spatial distribution



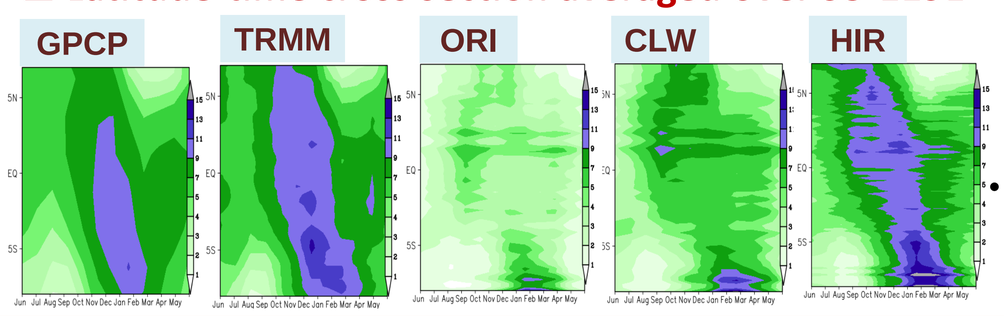
• The MRCM is capable of reproducing the major features of spatial distributions varying seasonally seen in observed pattern.

• HIR brings significant improvements in simulating the precipitation particularly over ocean, even though it tends to overestimate the precipitation along the high mountainous area.

❑ Interannual & Intraseasonal variation



❑ Latitude-time cross section averaged over 95-119E



❑ Spatial Correlation against TRMM

	ANN	DJF	JJA
ORI	0.19	0.29	0.30
CLW	0.25	0.33	0.35
HIR	0.34	0.52	0.50

❑ Temporal Correlation against GPCP

	Whole	Land	Ocean
ORI	0.55	0.59	0.50
CLW	0.64	0.70	0.58
HIR	0.79	0.84	0.74

• Compared to ORI, both CLW and HIR show improved skill in terms of spatial distribution and temporal evolution.

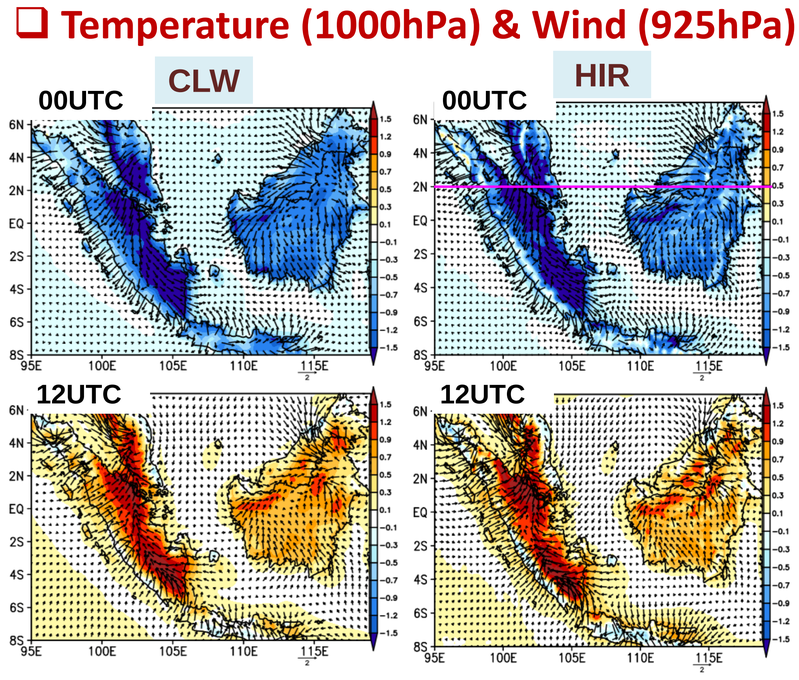
• The impact of the enhanced horizontal resolution is as large as that of the tuning of convective parameterization.

• A notable improvement is found in HIR. While CLW enhances the magnitude, HIR brings the improvements in not only magnitude but also shaping the evolution pattern, including realistic positioning of the high intensity band.

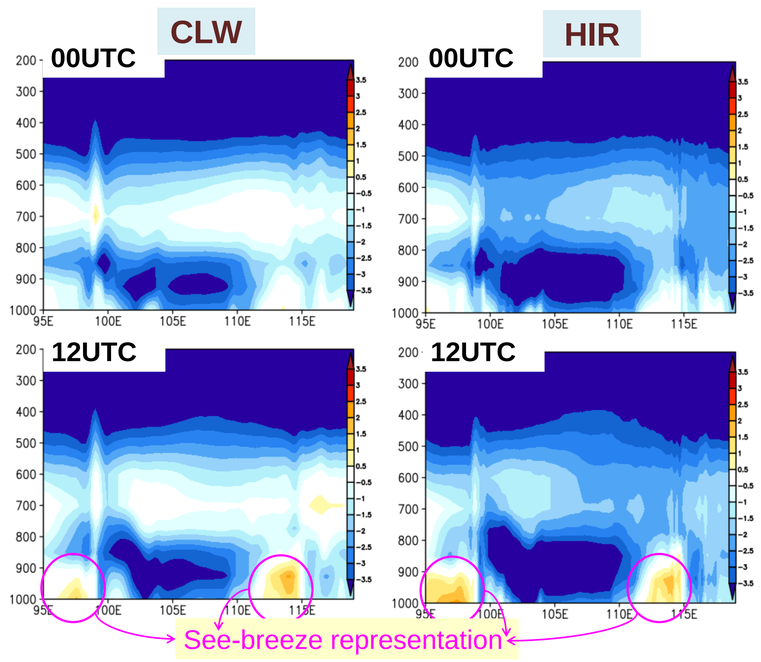
• It supports the role of higher resolution in properly capturing the complexity of seasonal evolution of precipitation.

Diurnal Cycle of Temperature & Circulation

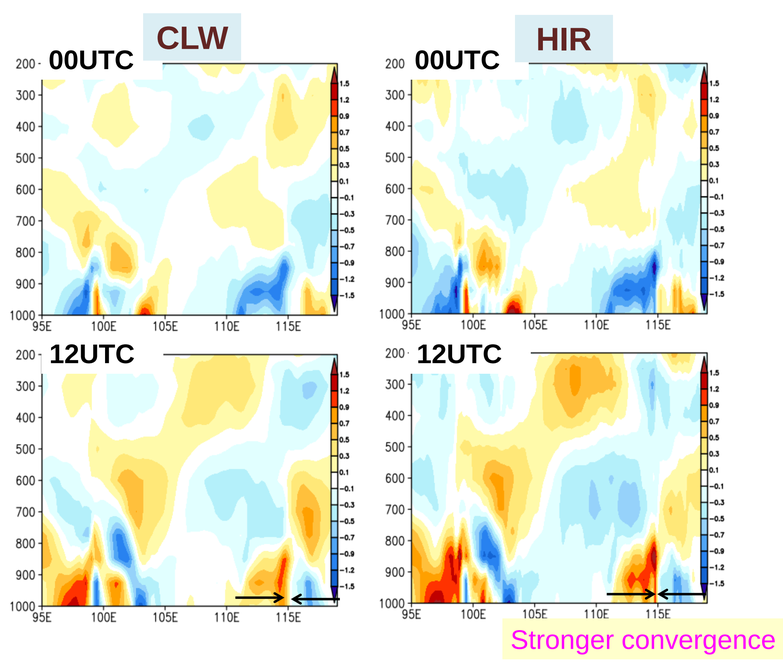
❑ Temperature (1000hPa) & Wind (925hPa)



❑ Vertical Structure of Zonal Wind at 2N



❑ Vertical Structure of Anomalous Zonal Wind at 2N by Subtracting Daily Mean



• The diurnal cycle of temperature and circulation is reasonably simulated in both CLW and HIR simulations. In the early morning, land breezes prevail while sea breezes blow toward land in the late evening.

• Since high-resolution simulation is able to more realistically capture the sharp gradient of land-sea contrast and corresponding to the location circulation, sea-breeze convergence in HIR seems to be enhanced, which leads to a large amount of precipitation

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