The Comparison of 25-km and 5-km resolution of CORDEX-SEA Simulation for Precipitation over Java Island, Indonesia

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Abstract

This preliminary study assesses the performance of high-resolution simulation from Coordinated Regional Climate Downscaling Experiment-SouthEast Asia (CORDEX-SEA) in modeling precipitation with a resolution of 5 km (RCM-5km) compared to a resolution of 25 km (RCM-25km) across Java Island, Indonesia. Historical data from three different forcing Global Climate Models (GCMs), including EC-Earth, HadGEM, and MPI, was compared to observation data from CHIRPS in the period of 1981 to 2005. The seasonal mean climatology of precipitation from model output showed a high wet bias compared to observation. The correlation between model output and observation is about 0.3 to 0.55. Downscaled from EC-Earth has a better performance than the other forcing GCMs. However, it has the highest bias in SON, which is about 88%. Model outputs from HadGEM and MPI forcing GCMs have good performances in SON with a low bias of 21% and 38%, respectively. Spatially, precipitation from all forcing GCMs has a high wet bias in the eastern part of Java Island, especially during DJF. In contrast, wet bias occurred during JJA in the western part of Java Island. From annual climatology, precipitation from all forcing GCMs showed overestimation unless in the southern coastal line of Java Island, especially for HadGEM forcing GCMs (high dry bias). Overall, both of RCM-25km and RCM-5km represent the observed spatial pattern quite well, but overestimated, in Java Island. There were no significant biases improvement between RCM-25km and RCM-5km outputs

Background

In Indonesia during 1998–2018, about 80% of disasters were dominated by climate change driven events that consist of flooding (39%), heavy wind/storm (26%), landslides (22%), and drought (8%) (Haryanto et al., 2019). In general, these disasters are associated with extreme and deficit rainfall. Therefore, policymakers need reliable knowledge on rainfall characteristic in the future under climate change scenarios to develop strategies for adaptation and mitigation since such disasters resulted in significant losses for society, economy, and the natural system. Global climate models (GCMs) are an important tool for assessing the impact of climate change. However, due to its coarse horizontal spatial resolution and inability to simulate local atmospheric processes, the use of GCM in analysing extreme precipitation is limited (Chen et al., 2017). Therefore, downscaling the output of GCMs to a higher spatial resolution using RCMs is necessary so that the models are expected to better capture the extreme rainfalls. Objective of this study is assessing the performance of high-resolution simulation from CORDEX-SEA in modeling precipitation with a resolution of 5 km compared to a resolution of 25 km across Java Island, Indonesia for **history (1981-2005)** and **future projections (2006 - 2099)** datasets under two scenarios RCP4.5 and RCP8.5.

Data and Methods

Data

- Hydrostatic 25km RegCM dynamically Downscaled 3 GCMs (**RCM-25km**) : MPI, HadGEM2, EC-EARTH
- Observation data : CHIRPS precipitation dataset with resolution of 0.05º (~5 km) with period of 1981-2005
- RCM-25km is further downscaled to the 5km resolution (RegCM4.7.1) (**RCM-5km**)

RegCM Setup

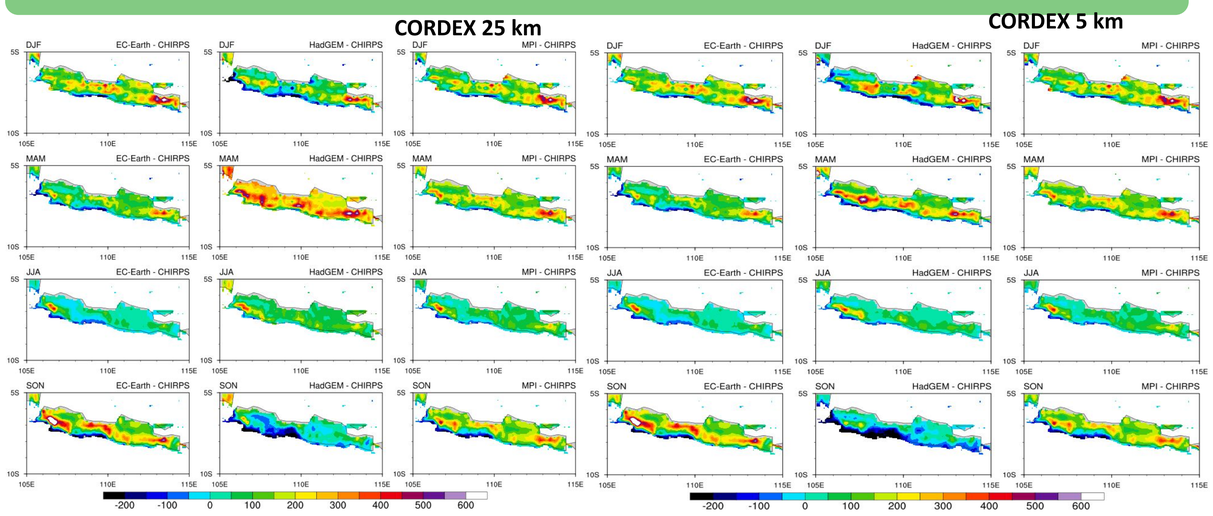
Boundary layer scheme: Holtslag PBL; Radiation: CCSM; Land surface treatment: CLM45; Large scale moisture: Subex, 2000; Cumulus convection parameterization: MIT-Emanuel (1991); Ocean flux treatment: Zeng et al (1998)

Model output grid were **regridded according to observed grid** before conducting analysis

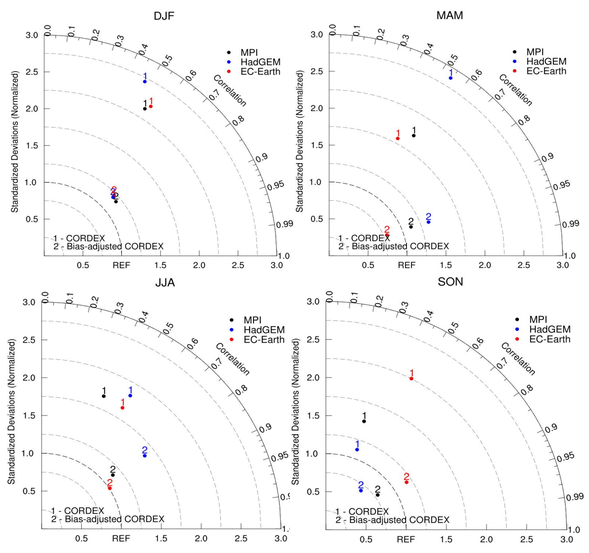
Experiments

1. **Testing the performance** RCM-25 km and RCM-5km
2. **Analysing** future precipitation projection (RCP4.5 and RCP8.5)

Results



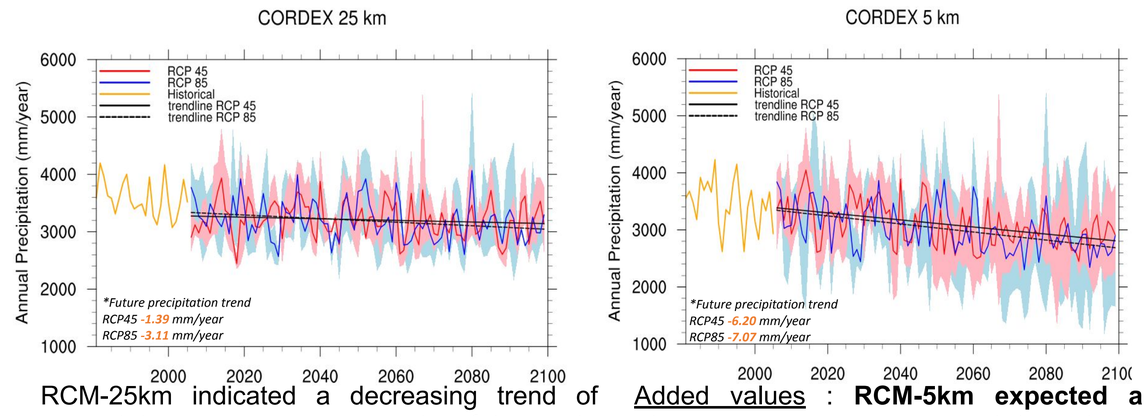
RCM-25km, RCM-5km: represent the observed **spatial pattern** quite **well**, but **overestimated**



HadGEM showed **more dry biases during SON, followed by DJF.** HadGEM RCM-5km **improved** the RCM-25km precipitation biases during **MAM** and **JJA**.

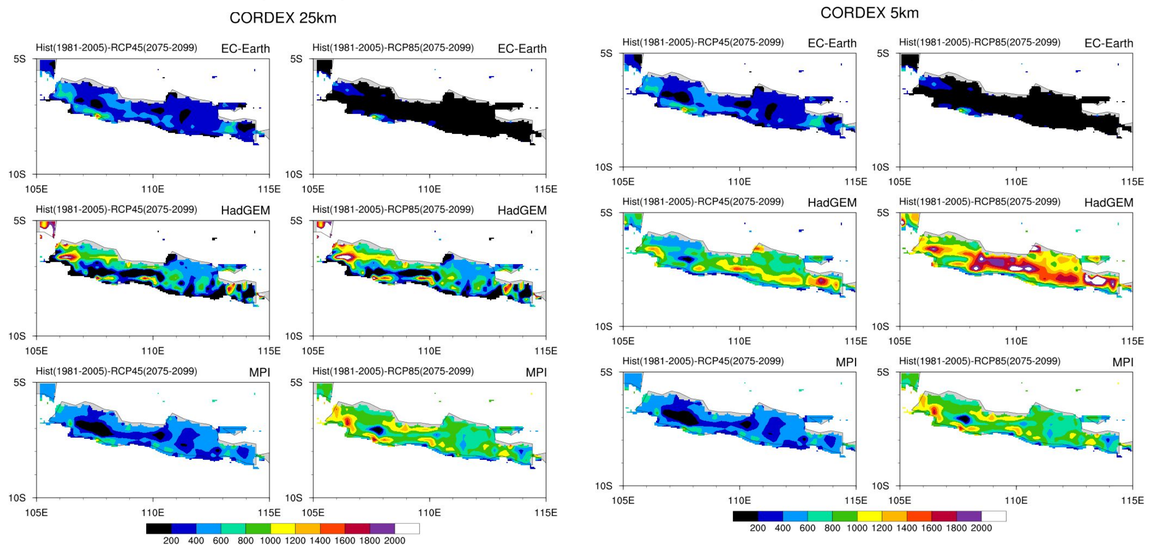
Bias	MPI		HadGEM		EC-Earth	
	25km	5km	25km	5km	25km	5km
DJF	36%	38%	20%	25%	40%	40%
MAM	59%	57%	108%	54%	32%	32%
JJA	69%	65%	107%	55%	23%	26%
SON	67%	67%	-2%	-27%	86%	88%

- There were **no significant biases improvement** between RCM-25km and RCM-5km output
- The **spatial correlations** between model and observation for **all seasons are about 0.3 to 0.55**.
- Downscaled from **EC-Earth has the best performance than the other forcing GCMs**



RCM-25km indicated a decreasing trend of precipitation in Java Island in the future with RCP4.5 and a steeper slope with RCP8.5

Added values : **RCM-5km expected a steeper decreasing precipitation trend** than RCM-25 km (~4.5 times) in the future



Precipitation in Java Island is projected to decrease, **particularly over the mountain regions**.

HadGEM **RCM-5km** suggested that the condition will be **much drier** than other RCM-25 km

Conclusions

RCM-25km and RCM-5km from 3 GCMs represent the observed spatial pattern quite well, but overestimated, in Java Island. There were no significant biases improvement between RCM-25km and RCM-5km output. The spatial correlations between model and observation for all seasons are about 0.3 to 0.55. Downscaled from EC-Earth has the best performance than the other forcing GCMs. Dry biases mainly occurred in the southern coastal lines of Java Island. Generally, high wet biases over the eastern part of Java Island, unless during JJA, wet biases in the western part. HadGEM showed more dry biases during SON, followed by DJF. There was an improvement of monthly rainfall in RCM-5 km compared to RCM-25km of HadGEM, but were underestimated in October - December. HadGEM RCM-5km improved the RCM-25km precipitation biases during MAM and JJA.RCM-5km expected a steeper decreasing precipitation trend than RCM-25 km (4.5 times) in the future, particularly over mountain regions

References

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