Added Value of reproduced precipitation by high resolved regional climate model simulation over CORDEX–East Asia

EGU 2020

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1. Introduction

Can the higher-resolution RCMs generate added value in simulating precipitation?

- Evaluation simulations in precipitation using RCMs which are participated in CORDEX-EA had been conducted, in order to understand the systematic error in advance

- Sets of Phase 1 and Phase 2 simulations of two RCMs are compared to observations in the East Asia region
2. Model, Data and Methods

- Model configuration

<table>
<thead>
<tr>
<th>Forcing Data</th>
<th>ERA-INTERIM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Period</strong></td>
<td>1989-2008(Evaluation)</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>EAS-44 : 0.44° EAS-22 : 0.22°</td>
</tr>
<tr>
<td><strong>Domain</strong></td>
<td>See as below</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SNURCM</th>
<th>HadGEM3-RA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lat x Lon</strong></td>
<td>197 x 233</td>
<td>260 x 405</td>
</tr>
<tr>
<td><strong>Vertical Layers</strong></td>
<td>24 sigma</td>
<td>24 sigma</td>
</tr>
<tr>
<td><strong>Convection</strong></td>
<td>Kain-Fritch II</td>
<td>Kain-Fritch II</td>
</tr>
<tr>
<td><strong>Microphysics</strong></td>
<td>Reisner II</td>
<td>Reisner II</td>
</tr>
<tr>
<td><strong>Radiation</strong></td>
<td>CCM2 package</td>
<td>CCM2 package</td>
</tr>
<tr>
<td><strong>Land surface model</strong></td>
<td>CLM3</td>
<td>CLM3</td>
</tr>
<tr>
<td><strong>Spectral Nudging</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Kim et al. EGU, 2020
2. Model, Data and Methods

● Observation Data

<table>
<thead>
<tr>
<th>Observation Data</th>
<th>GPCP</th>
<th>APHRODITE</th>
<th>TRMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>1989-2008(20y)</td>
<td>1989-2008(20y)</td>
<td>1999-2008(10y)</td>
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<tr>
<td>Resolution</td>
<td>2.5° x 2.5°</td>
<td>0.50° x 0.50°</td>
<td>0.25° x 0.25°</td>
</tr>
<tr>
<td>Version</td>
<td>GPCP Ver. 2.3</td>
<td>MA_V1101,</td>
<td>3B42</td>
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<tr>
<td></td>
<td></td>
<td>MA_V1101EXR</td>
<td></td>
</tr>
</tbody>
</table>

● Extreme Index – ETCCDI

<table>
<thead>
<tr>
<th>Index</th>
<th>Descriptive name</th>
<th>Definition</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx1day</td>
<td>Maximum 1-day precipitation</td>
<td>Yearly / Monthly Maximum 1-day precipitation</td>
<td>mm</td>
</tr>
<tr>
<td>Rx5day</td>
<td>Maximum 5-day precipitation</td>
<td>Yearly / Monthly Maximum consecutive 5-day precipitation</td>
<td>mm</td>
</tr>
</tbody>
</table>

● Added Value Index

Added Value consists of the generation of small (spatial and temporal) scales by a high-resolution RCM driven by low-resolution GCM data.

\[
Added \ Value = \frac{(X_{RCM50} - X_{OBS})^2 - (X_{RCM25} - X_{OBS})^2}{\text{Max}\left((X_{RCM50} - X_{OBS})^2, (X_{RCM25} - X_{OBS})^2\right)}
\]

Di Luca et al. (2012), Dosio et al. (2015)
3. Result

- **Climatology_JJA**
  - (a) Merge_obs
  - (b) S_P1
  - (c) H_P1
  - (d) S_P2
  - (e) H_P2

**SNURCM (P1 → P2)**
- Increase precipitation near 30N

**HadGEM3-RA (P1 → P2)**
- Formed EASM rain band below Japan
- Increase precipitation over ocean region in low-latitude

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3. Result

Synoptic Scale Circulation

- 850hPa Specific Humidity
- 500hPA U,V (JJA)
3. Result

EASM & WNPSM rain band

- Hovmöller Diagram (Time-Lat)
- 110-130°E averaged
3. Result

- Extreme Index - Rx1day / Rx5day

(a) TRMM_Rx1day  mm

(b) S_P1_Rx1day

(c) H_P1_Rx1day

(d) S_P2_Rx1day

(e) H_P2_Rx1day

(f) TRMM_Rx5day  mm

(g) S_P1_Rx5day

(h) H_P1_Rx5day

(i) S_P2_Rx5day

(j) H_P2_Rx5day
3. Result

- Added Value

(a) AV_S_JJA

(b) AV_H_JJA

(c) AV_S_Rx5day

(d) AV_H_Rx5day
4. Summary

- Investigated whether the higher-resolution RCMs can generated Added Values for precipitation over CORDEX-EA domain
- Analyzed by Mean climatology precipitation, large-scale circulation, and extreme precipitation index
- In addition, the quantitative added value index is applied
- In SNURCM simulations, positive (negative) added value of summer mean precipitation is reproduced over most ocean (land) region of East Asia in fine-resolution simulation. Extreme precipitation over Korea and Japan is reasonably reproduced in Phase 2 simulations
- In HadGEM3-RA simulations, the results of summer mean precipitation over most East Asian regions above 25°N are improved in Phase 2, while worse results are reproduced below 25°N. But, extreme precipitation in fine-resolution simulation is adequately reproduced in most regions of East Asia except China and the Yellow sea
- Even the higher resolution was applied in phase 2, it still has the systematic error. Further study is necessary (more-higher resolution, Development physics scheme, etc.)