Evaluation of climatological mean surface winds over the Korean Waters simulated by CORDEX regional climate models

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Surface wind over the ocean influences not only climate change through air-sea interactions but coastal erosion through changes in wave height and direction.
Wind stress biases in CMIP5

30°–50°N and 30°–50°S, with CMIP5 being too strong by as much as 55%.

CMIP5 models simulate large wind biases over the seas around the Korea.
CMIP5 models extend the North Pacific high pressure to the west and strong compared to the reanalysis data.
Evaluation of RCM for Korean Waters: limitations

- Most previous studies on the evaluation of regional climate models (RCMs) mainly focused on SST and precipitation. But surface wind biases in RCMs have been relatively poorly known.

- Most of the evaluation of surface wind studies have been done for a short period (within 1 year) and have focused on the surface wind over the land, not over the sea.
Purpose

- This study aims to evaluate the surface winds over Korean Waters simulated by CORDEX (Coordinated Regional Climate Downscaling Experiment) regional climate models focusing on common bias among models, as well as inter-model bias.
Data

- Evaluation standard: ERA-interim reanalysis data
- Analysis period: 1989-2007 (19 years)
- Land-masked: ETOPO5
- Re-gridded: $0.5^\circ \times 0.5^\circ$
- Time interval: Daily mean data
- Surface wind at 10m

<table>
<thead>
<tr>
<th>Model</th>
<th>Projection resolution</th>
<th>Spectral nudging</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>HadGEM3-RA</td>
<td>0.44 (~50 km)</td>
<td>No</td>
<td>Davies et al. (2005)</td>
</tr>
<tr>
<td>RegCM4</td>
<td>50 km</td>
<td>Yes (Storch et al. 2000)</td>
<td>Giorgi et al. (2012)</td>
</tr>
<tr>
<td>SNU-MM5</td>
<td>50 km</td>
<td>Yes (Storch et al. 2000)</td>
<td>Cha and Lee et al. (2009)</td>
</tr>
<tr>
<td>SNU-WRF</td>
<td>50 km</td>
<td>Yes (Miguez-Macho et al. 2005)</td>
<td>Skamarock et al. (2005)</td>
</tr>
<tr>
<td>YSU-RSM</td>
<td>50 km</td>
<td>Yes (Kanamaru and Kanamitsul. 2007)</td>
<td>Hong et al. (2012)</td>
</tr>
</tbody>
</table>
Surface wind speed in summer (JJA)

→ Although wind speed spatial pattern is shown similar to reanalysis data (Correlation Coefficient > 0.9), wind speed by CORDEX regional models is overestimated over the most area in summer.
Surface wind speed in summer (JJA)
Wind speed by CORDEX is overestimated approximately more than 15% over the most area (Correlation Coefficient > 0.9).
Wind speed by CORDEX with spectral nudging is overestimated over the most area regardless of the season.
Surface wind direction in summer (JJA)

Red: ERA-interim
Black: CORDEX

→ Summer wind direction is different depending on using spectral nudging.
Surface wind direction in winter (DJF)

Red: ERA-interim
Black: CORDEX

Wind direction by CORDEX is similar to reanalysis data: northwesterly wind
Climatological mean windrose in summer (JJA)

(A) East Sea

CORDEX models often simulates **southwesterly winds** in the East Sea.
CORDEX models simulates slightly southwesterly winds in the Yellow Sea.
Climatological mean windrose in summer (JJA)

(C) East China Sea

CORDEX models simulates southwesterly winds in the East China Sea.

→ The CORDEX regional model tends to strongly simulate the southwesterly winds in summer
Sea level pressure in summer (JJA)

Reason of southerly wind direction bias by HadGEM3-RA and YSU-RSM is thought that these two models did not simulate sea level pressure pattern correctly.
Wind speed: Taylor diagram in summer (JJA)
Conclusions

• For Korean waters, the spatial patterns of wind speed in all 5 CORDEX RCMs is similar to reanalysis data. (spatial correlation coefficient > 0.9).

• However, most of the CORDEX RCMs tend to overestimate wind speeds regardless of the season by up to 15%.

• The RCMs without spectral nudging (SP) or with weak nudging near the surface show biases in wind direction in summer, mainly through westward expansion of NPHP, suggesting importance of SP for summer wind simulation.
Q & A
Thank you