Case studies of downscaling TCs in East Asia using spectrally nudged Regional Climate Models

Frauke Feser and Hans von Storch

Institute for Coastal Research, GKSS Research Centre
21502 Geesthacht, Germany
Case studies of downscaling TCs in East Asia

Downscaling approach

Global model: NCEP Reanalysis
1.875° x 1.875°

Regional model: REMO
0.5° x 0.5°

- Successfully implemented for Western Europe and NE Atlantic climate.
- Homogeneous, realistic description of the past atmospheric state.
- Studies of waves, water levels, currents and storm surges were computed using the high-resolution atmospheric data set.

Sponge zone
8 grid points

Spectral nudging of large scales
Downscaling
SE Asian marine weather

- Application of this dynamical downscaling approach for SE Asia.
- Description of typhoons?
- Case studies and analysis of several typhoons of one typhoon season – formation of typhoons induced by large-scale dynamics and not by initial values (RCM run in climate mode).


*Meteorolog. Z.*, 17 (4), 519-528.
Analysis of the typhoon season 2004

Model areas for both regional CLM simulations.

Model area of the 0.5° simulation

Simulation area for the double nested 0.165° CLM run
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Model Orography

NCEP 1,875 degrees
~210 km x 210 km

CCLM 0.5 degrees
~ 53 km x 53 km

CCLM 0.165 degrees
~18 km x 18 km
Overview for all 12 analysed tracks of the typhoon season 2004.
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Dianmu

**SLP**

![Graph showing SLP (hPa) over time steps (hourly interval since 2004061118UTC)]

- CLM 0.165 degrees
- NCEP
- CLM 0.5 degrees
- Best track

**10m Wind Speed**

![Graph showing 10m wind speed in knots over time steps (hourly interval since 2004061118UTC)]

- CLM 0.165 degrees
- CLM 0.5 degrees
- NCEP
- Best track

Songda

**SLP**

![Graph showing SLP (hPa) over time steps (hourly interval since 2004062118UTC)]

- CLM 0.165 degrees
- NCEP
- Best track

**10m Wind Speed**

![Graph showing 10m wind speed in knots over time steps (hourly interval since 2004062118UTC)]

- CLM 0.165 degrees
- CLM 0.5 degrees
- NCEP
- Best track

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AERE 2004

Dianmu 2004

Maon 2004

Megi 2004

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Chaba 2004

Mindulle 2004

Tokage 2004

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Great circle distance (km) between JMA best track data and NCEP reanalyses, 0.5° CLM simulation, and 0.165° CLM simulation

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Songda
RMSE of SLP and 10m wind speed as well as great circle distance between JMA best track data and NCEP, CLM 0.5°, and CLM 0.165°.

<table>
<thead>
<tr>
<th>Typhoon</th>
<th>Date</th>
<th>Model</th>
<th>RMSE SLP[hPa]</th>
<th>RMSE FF[kt]</th>
<th>GCD [km]</th>
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</thead>
<tbody>
<tr>
<td>200406</td>
<td>06/11/2004</td>
<td>NCEP</td>
<td>53.83</td>
<td>46.32</td>
<td>98.53</td>
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<tr>
<td></td>
<td>- 06/28/2004</td>
<td>CLM 0.5</td>
<td>25.49</td>
<td>14.34</td>
<td>183.21</td>
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<td></td>
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<td>CLM 0.165</td>
<td>23.67</td>
<td>14.35</td>
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<td>200418</td>
<td>08/26/2004</td>
<td>NCEP</td>
<td>58.27</td>
<td>50.14</td>
<td>74.08</td>
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<td></td>
<td>- 09/10/2004</td>
<td>CLM 0.5</td>
<td>48.02</td>
<td>39.38</td>
<td>146.81</td>
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<tr>
<td></td>
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<td>CLM 0.165</td>
<td>46.61</td>
<td>40.54</td>
<td>129.47</td>
</tr>
</tbody>
</table>
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| Typhoon | Date       | Model      | min press[hPa] | max dp/dt [hPa/6h] | max $|u|$ [kt] | max $d|u|/dt$ [kt/6h] |
|---------|------------|------------|----------------|--------------------|-----------|----------------|
|         | 06/11/2004 | best track | 915            | -15                | 100       | 10             |
|         | - 06/28/2004 | NCEP     | 983            | -4.5               | 47.3      | 7.1            |
|         |             | CLM 0.5   | 945            | -7.0               | 85.3      | 6.4            |
|         |             | CLM 0.165 | 937            | -9.6               | 88.1      | 9.7            |
|         | 08/26/2004 | best track | 925            | -15                | 95        | 10             |
|         | - 09/10/2004 | NCEP     | 969            | -6.9               | 52.8      | 8.8            |
|         |             | CLM 0.5   | 957            | -8.4               | 71.7      | 7.6            |
|         |             | CLM 0.165 | 953            | -8.1               | 74.6      | 13.1           |

Min. pressure, max. pressure change within 6 hours, max. 10m wind speed, and max. 10m wind speed change within 6 hours
Brier Skill Score between JMA best track data and NCEP, CLM 0.5°, and CLM 0.165°

> 0 : CLM closer to best track
0 : CLM and NCEP equally close to best track
< 0 NCEP closer to best track
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Precipitation rate (mm/h)

Tokage

Megi

CLM 0.5°

CLM 0.165°
Summary and Outlook

- RCM core pressure values and near-surface wind speed values closer to best track data than forcing reanalyses.

- The highest spatial resolution (0.165°) shows largest added value for precipitation patterns and SLP compared to 0.5° simulation.

- Location of typhoon track already well represented by reanalyses, an added value was found for core pressure and wind speed development as well as for precipitation patterns.

- Long-term atmospheric hindcast was computed to serve as input for wave, storm surge and water level models.

- New PhD student Monika Barcikowska started within the cluster of excellence CliSAP to compare regional SE-Asia simulations with satellite data.

- Analysis of statistics of multi-decadal simulation
Comparative Study on the retrospective simulation of typhoon seasons in SE Asia

As a prerequisite to derive and assess changing statistics of typhoon formation in SE Asia, simulation models should demonstrate their capability to simulate ('reconstruct') year-to-year variations of typhoon statistics in SE Asia during the past 40-50 years.

During this period, NCEP and ERA have constructed global reanalyses describing the large scale atmospheric state with some fidelity, but spatial details are not that well described. Therefore regional atmospheric models, forced with global re-analyses, may be a suitable tool to reconstruct the past decades' variability.

A number of partners have agreed on a comparative study, namely to run their different regional atmospheric models for the storm-rich season of 1994 and the storm-poor season of 1998. The focus of the analysis will be on the number of storms, their tracks and their core pressure developments as well as on the mean circulation.