Future changes of precipitation associated with typhoons around Japan simulated by a 5-km-mesh regional climate model

Masuo Nakano, Hiroyuki Murakami, Sachie Kanada (JAMSTEC), and Teruyuki Kato (JMA)

masuo@jamstec.go.jp
Experimental design

Emission Scenario: A1B

CMIP3 models $\Rightarrow$ MRI-AM20km TL959L64 $\Rightarrow$ 5km-mesh JMANHM (NHM-5km) 669x594x50

Atmosphere

Predicted SST

Boundary condition

Atmosphere

SST

Lower B.C.

Atmosphere

SST

Ocean

SST

Present-day: 1979-2003: HadISST
Future: 2075-2099

Annual variation from HadISST + Trend + difference (F-P) (Mizuta et al. 2008)
Contents

• Introduction
• Model verification by perfect boundary condition experiments
• Results of GW experiments
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Introduction
Disasters by TY-related precipitation

- Floods
- Land slides
- Debris flow

- Amount
- Intensity
- Duration

Non-negligible indirect effect

Rader Image (20 June, 2004)

Indirect precipitation

Weather chart

Humid air

Direct precipitation
Future changes of TY related precipitation is examined

- direct precipitation
- indirect precipitation
- no-TY precipitation

Amount, Intensity, and duration
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Direct, indirect, no-TY precipitation

No TY precipitation: precipitation during the periods when no TY is in the NHM-5km domain
Verification by Perfect Boundary Condition Experiments

17 May - 31 Oct.

JMA-RANAL-20km

6 hourly

NHM-5km

5 warm seasons: 2002-2006

Nakano et al., 2010: Hydrological Research Letters, 4, 6-10
Track and position error

57 TYs

TYs came from outside the domain
TYs generated in the domain

Average Error
130km at t=72h
Minimum central pressure

![Graph showing minimum central pressure comparison between BEST TRACK and RANAL models. The graph includes data points and a best fit line with statistical metrics R, RMSE, and ME for each model.]
Approaching Japan Typhoons

Passing through the orange region && duration time in the NHM-5km is > 24 hours
Direct precipitation

Observed
(JMA radar-raingauge precipitation)

NHM-5km

3.1 mm/day

3.4 mm/day

total TY direct precipitation / 143 days (number of days when a TY exists in the domain)
Indirect precipitation

Observed
(JMA rader-raingauge precipitation)

NHM-5km

7.9mm/day

Total TY indirect precipitation / 143 days (number of days when a TY exists in the domain)
Hourly precipitation intensity PDF

Probability density function

NHM TYD/TYID/NOTY ALLJP

Direct obs.
Indirect obs.
Indirect model
NoTY obs.
NoTY model
Climate Experiments

17 May — 31 Oct.

MRI-AM20km

6 hourly

NHM-5km

Present-day climate: 1979-2003
Future climate: 2075-2099
TY frequency (/year)

5kmNHM num of TCstrike JMA [/yr]

Obs (JMA best track)

F-P

decrease

5kmNHM num of TCstrike SPA [/yr]

Present-day

Future

5kmNHM num of TCstrike SFA [/yr]
Direct precipitation amount (mm/year)

Present-day

Future

F-P

5kmNHM PREC Tybody SPA all

5kmNHM PREC Tybody SFA all

5kmNHM PREC Tybody SFA-SPA all
Precipitation amount per 1 typhoon

Present-day

Future

F-P
Direct precipitation amount per 1 typhoon

TYbody/mask 120–145E rain

Present
Future
F/P

mean precipitation [mm]

+40%
+20%
F/P

Main islands of Japan
Taiwan

Present
Future
F/P
Hourly precipitation intensity PDF

[Graph showing probability density functions for different conditions: Future, Present, Observed, Direct, Indirect, with labels for NMH noTY-TYR-TYB HP ALLJP and axes indicating probability density function and mm/hour.]
Summary

• Reproducibility of TY-related precipitation by NHM-5km is fairly good.

• Precipitation amount per 1 TY will increase by 40% around Taiwan, 20% around Japan.

• Precipitation intensity will be more intense (Esp. direct precipitation ; +100% for 40-60 mm/h)