Assessment of add-value of multi-model ensemble dynamical downscaling in Japan

Koji Dairaku[1], Satoshi Iizuka[1], Wataru Sasaki[2], Roger A. Pielke Sr. [3], Hisashi Doi[4]

[1]National Research Institute for Earth Science and Disaster Prevention (NIED), Tsukuba, JAPAN dairaku@bosai.go.jp
[2]Japan Agency for Marine-Earth Science and Technology, [3]University of Colorado, [4]Non-Life Insurance Rating Organization of Japan.

Abstract

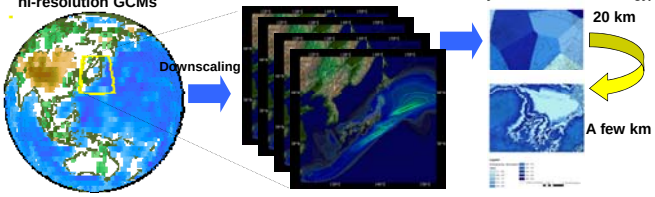
We quantified the confidence and uncertainties of multi-model ensemble dynamical downscaling where the lateral and bottom boundary conditions were obtained from Japanese 25-year ReAnalysis (JRA-25) and CGCM (CMIP run). We assessed the several aspects of value (skill) added by the multi-model ensemble downscaling to climate simulations in Japan.

Multi-ensemble downscaling Project (S5-3)

Global climate change scenario experiments by hi-resolution GCMs

Multi-model ensemble (MRI, NIED, Univ. of Tsukuba)

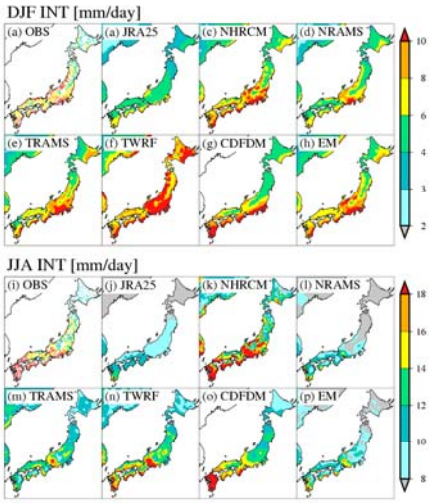
Statistical Downscaling (Kyoto Univ., NIAES, Tsukuba Univ., Tokyo Institute of Technology)



Comparison between dynamical downscaling and statistical downscaling

As a test for predictability, statistical downscaling from the parent model in a hindcast mode (Type 2) should be used as the benchmark (control) with which dynamic downscaling would have to improve on.

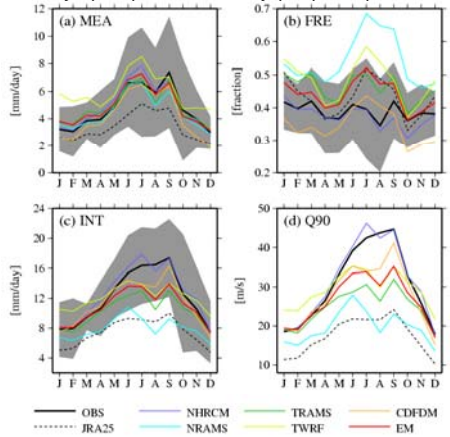
Geographical pattern of climatological status, INT



Mean intensity in DJF and JJA.
In DJF, precipitation of forcing data JRA25 is not in good agreement with obs. WRF model overestimate the precipitation intensity. Other results including SD are comparable.

In JJA, NHRCM shows good skill in mean intensity. But other models underestimate the precipitation intensity.

Seasonal Change of Mean precipitation (MEA), Number of wet days (FRE), Mean intensity (INT), 90th percentile (Q90)

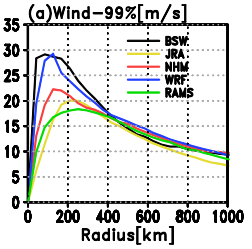


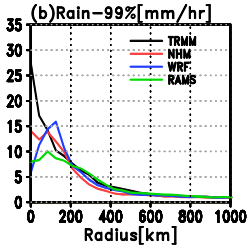
Seasonal change in 4 statistics of Obs, JRA25, and models.
Even though the mean precipitation is relatively well reproduced, wet days and intensity is not well reproduced in most of the methods. Only NHRCM which is used for operational weather forecast in Japan can demonstrate good skill.
Reason of the frequent weak precipitation in summer in RAMS is mainly attributed to not well-tuned convective parameterization.

Through the intercomparison, we highlighted the respective strengths and weaknesses of the models and assessed the value added to the reanalysis data by dynamical downscaling methods to regional climate simulation over and beyond what is achieved by the bias-correction-type statistical downscaling method of reanalysis data.

- ✓ All downscaling models successfully improve the quality of daily precipitation data relative to reanalysis
- ✓ No best downscaling model for all aspects exist (though NHRCM is close to the best in Japan)
- ✓ Each downscaling models have own strengths and weaknesses

Multi-model comparison of tropical cyclones

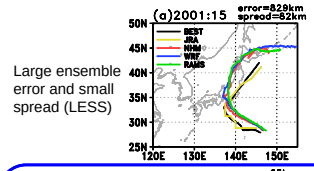




✓WRF simulated surface wind associated with TCs well.
✓None of the RCMs reasonably simulated the intense precipitation in the vicinity of the TC center. But large observational uncertainty of extreme events by satellite observation

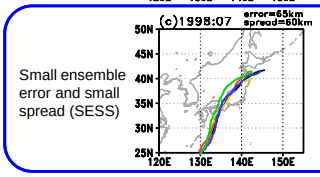
Ocean surface wind and precipitation of TCs

Examples of Tropical cyclone tracks



Large ensemble error and small spread (LESS)

Large ensemble error and large spread (LELS)

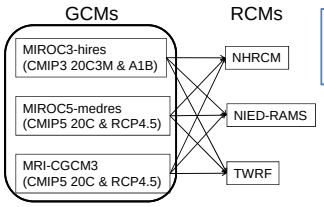


Small ensemble error and small spread (SESS)

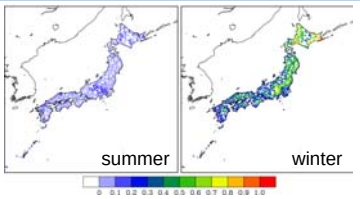
Small ensemble error and large spread (SELS)

✓No clear correlation between ensemble mean RMSE and spread.
✓RCMs reasonably simulate the 40 % of TC tracks.
✓Multi-model ensemble approach reduced TC track errors for about 60% of the TCs classified into the SESS and SELS categories.
✓However, not for remaining TCs of LESS and LELS.

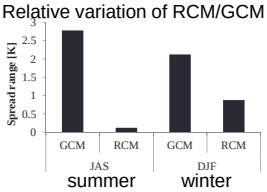
Relative variation of Multi-model ensemble (GCMs-RCMs)



Ratio Variation of future changes (average over Japan) of variation (RCM/GCM)
(RCM/GCM=1 -> comparable variation



Relative variation of RCM/GCM



- Summer：variation of future changes mainly due to GCMs
- Winter： larger variation of RCMs. The variation are comparable in some areas.
- Need to discuss atmos-land surface feedback processes (e.g., boundary layer schemes, snow-albedo feedback)

✓ New research **Program for Risk Information on Climate Change (PRICC) has launched (FY2012-2016).** http://www.mext.go.jp/b_menu/boshu/detail/1322496.htm
One of 5 themes(Theme-C) is to develop probabilistic hazard information
The project produces hydrometeorological hazard information for risk assessment of climate change. We develop super-high resolution climate models and probabilistic hazard information by utilizing statistical methods.

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