Projection of potential habitat for Buna (beech tree; *Fagus crenata*) forests in Japan considering three different dynamic downscaling scenarios

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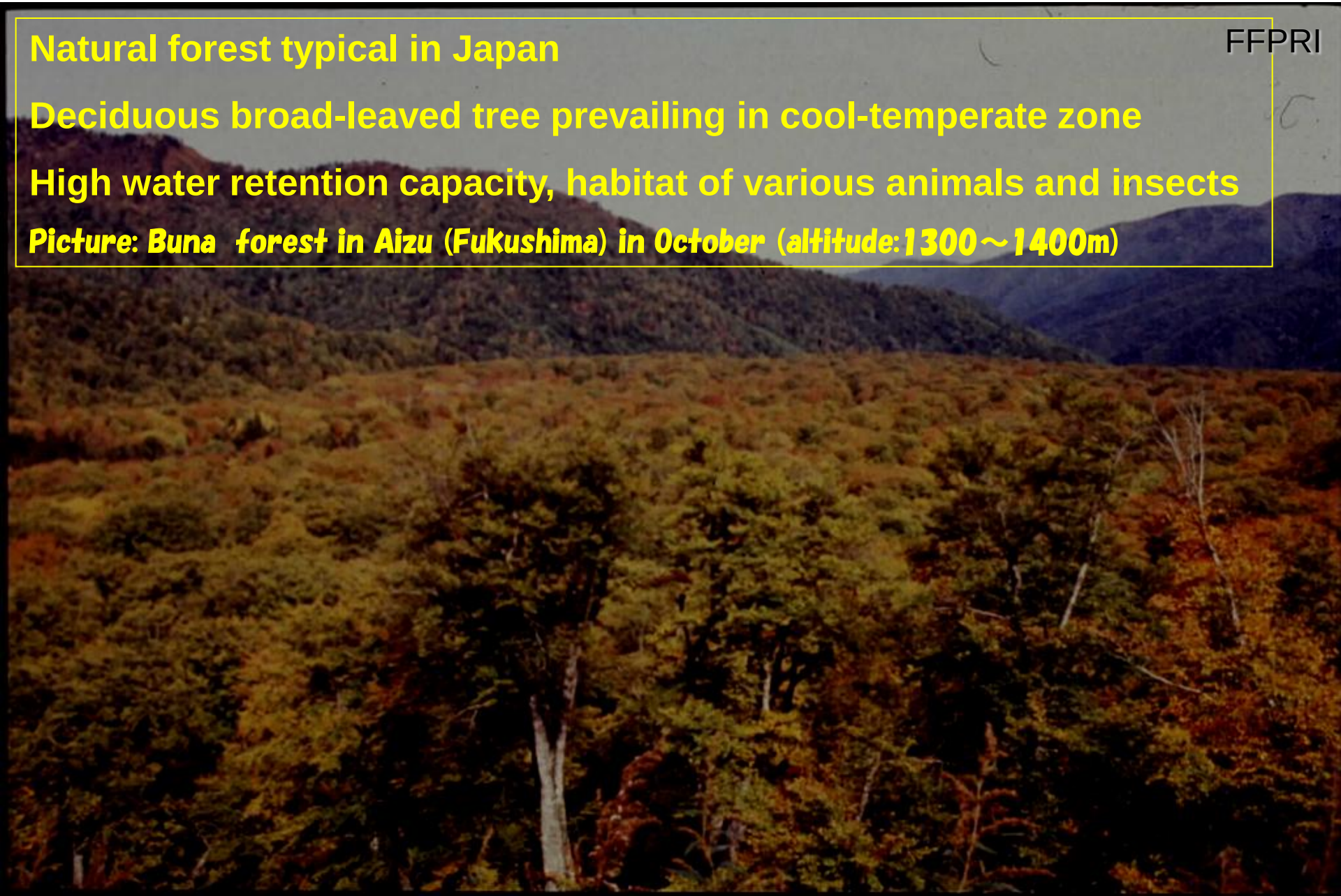
Backgrounds

- Progress in development and provision of multi-RCM climate scenarios for Japan (from S-5-3 project)
- Limited applications of the multi-RCM scenarios to analysis of climate change impacts in Japan
- Values added by the availability of the multi-RCM scenarios in impact analysis?
- Need for experiences to utilize multi-RCM scenarios in impact analysis actually.

Abstract of the presentation

- Quantification of uncertainty in climate change impacts is essential for useful support of decision making on adaptation strategies. Recently, we can find considerable number of climate change impact analyses that are explicitly taking account of plausible range of GHG emissions and uncertainties in (global) climate projections. In this study, we estimated climate change impacts on beech forest in Japan by the end of this century with considering uncertainties derived from the choice of RCM to be used for spatial downscaling in addition to the uncertainties in emission scenario and climate sensitivity.
- While the uncertainty in projected suitable habitat derived from the choice of RCM was smaller than that from climate sensitivity, we could also see considerable uncertainty at local scale. For a good design of conservation strategies at the scale, it might be better or necessary to consider RCM uncertainty as well as the other sources of uncertainty in impact analyses.

Buna (Fagus crenata) forests in Japan



Natural forest typical in Japan

Deciduous broad-leaved tree prevailing in cool-temperate zone

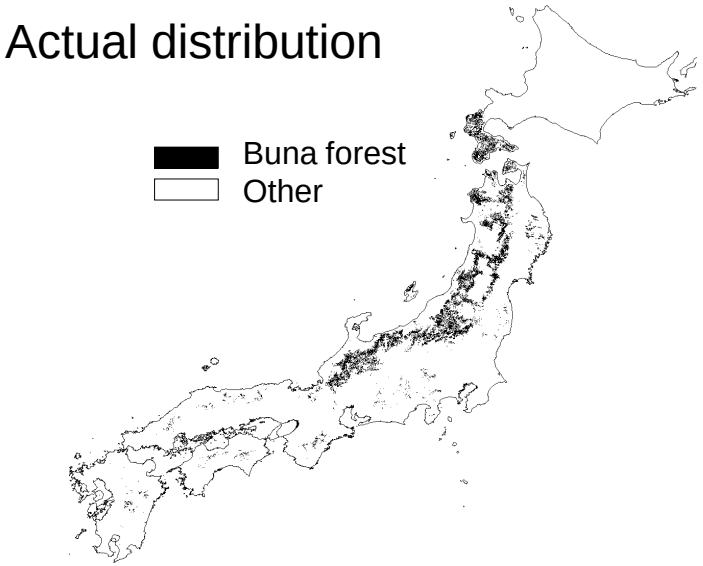
High water retention capacity, habitat of various animals and insects

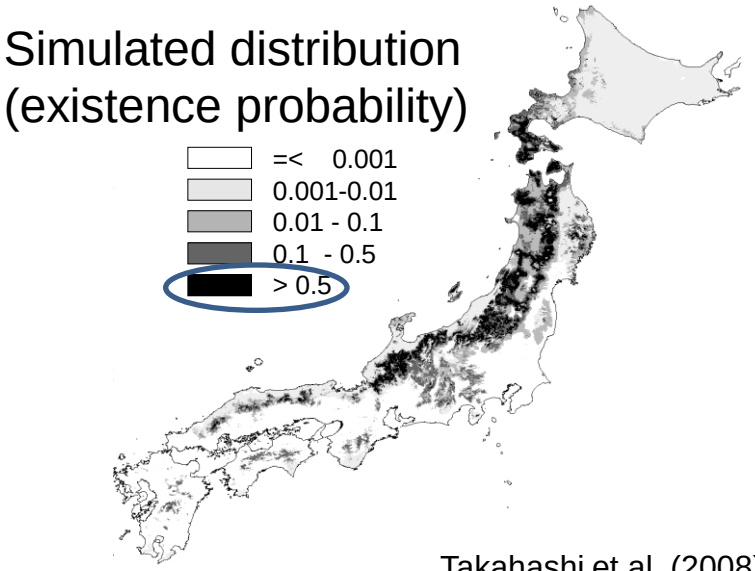
Picture: Buna forest in Aizu (Fukushima) in October (altitude:1300～1400m)

FFPRI

Model for evaluation of existence probability of Buna forest

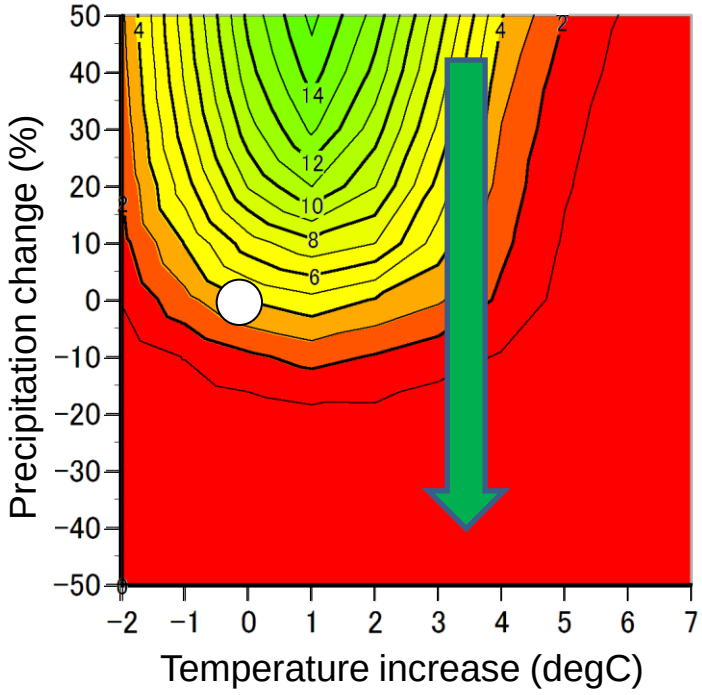
- ENVI model（Matsui *et al.*,2005）
  - Statistical model to evaluate existence probability of Buna forest for each mesh grid
  - Spatial resolution: 1km × 1km
- Input data of the model
  - Four climate-related indices based on monthly temperature and precipitation
    - Warmth index
    - Monthly-mean daily-minimum temperature of the coldest month
    - Summer (MJJAS) precipitation
    - Winter (DJFM) precipitation
  - Soil-related factors
    - Slope, slope direction, geology, etc.

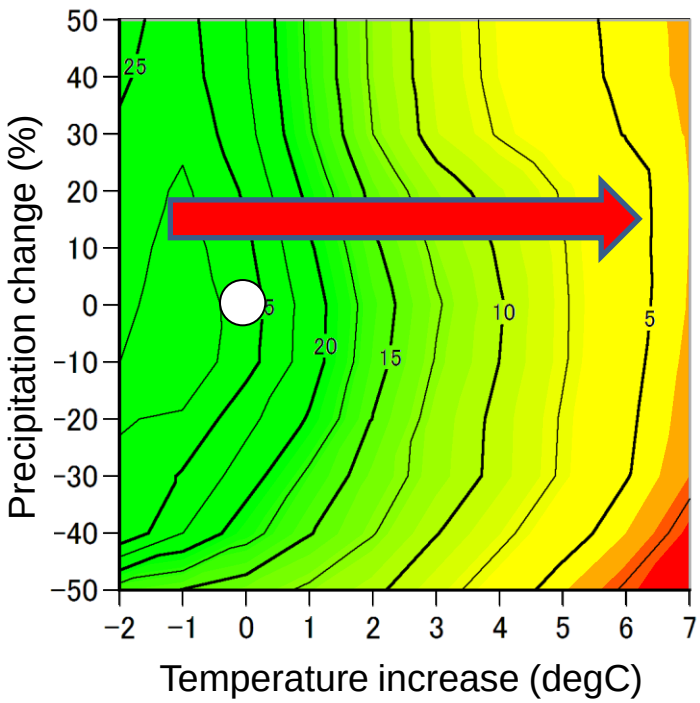


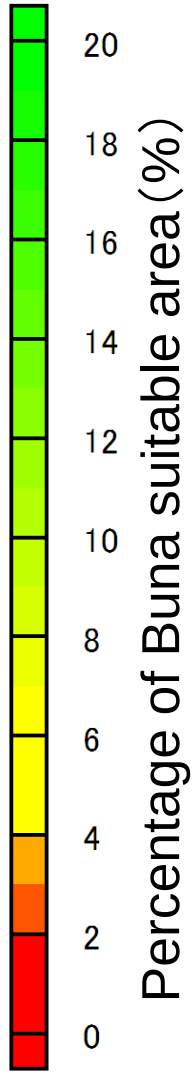


Takahashi et al. (2008)

Different responses of Buna suitable area to climate change among prefectures (Contour map of percentage of Buna suitable area in Hokkaido and Toyama)





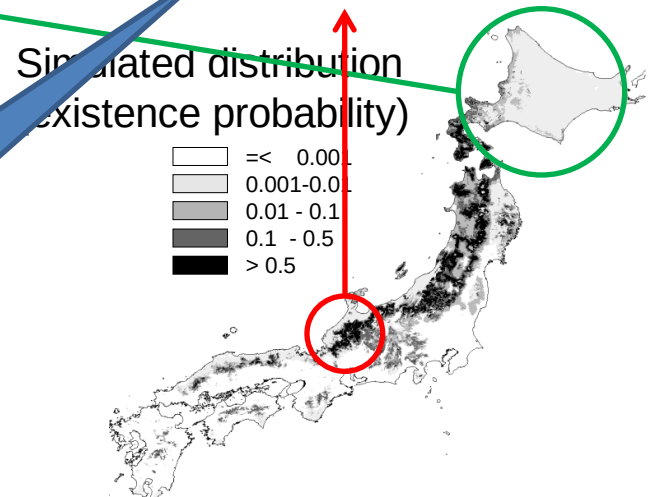


Hokkaido

Toyama

More sensitive to precipitation change

More sensitive to temperature increase

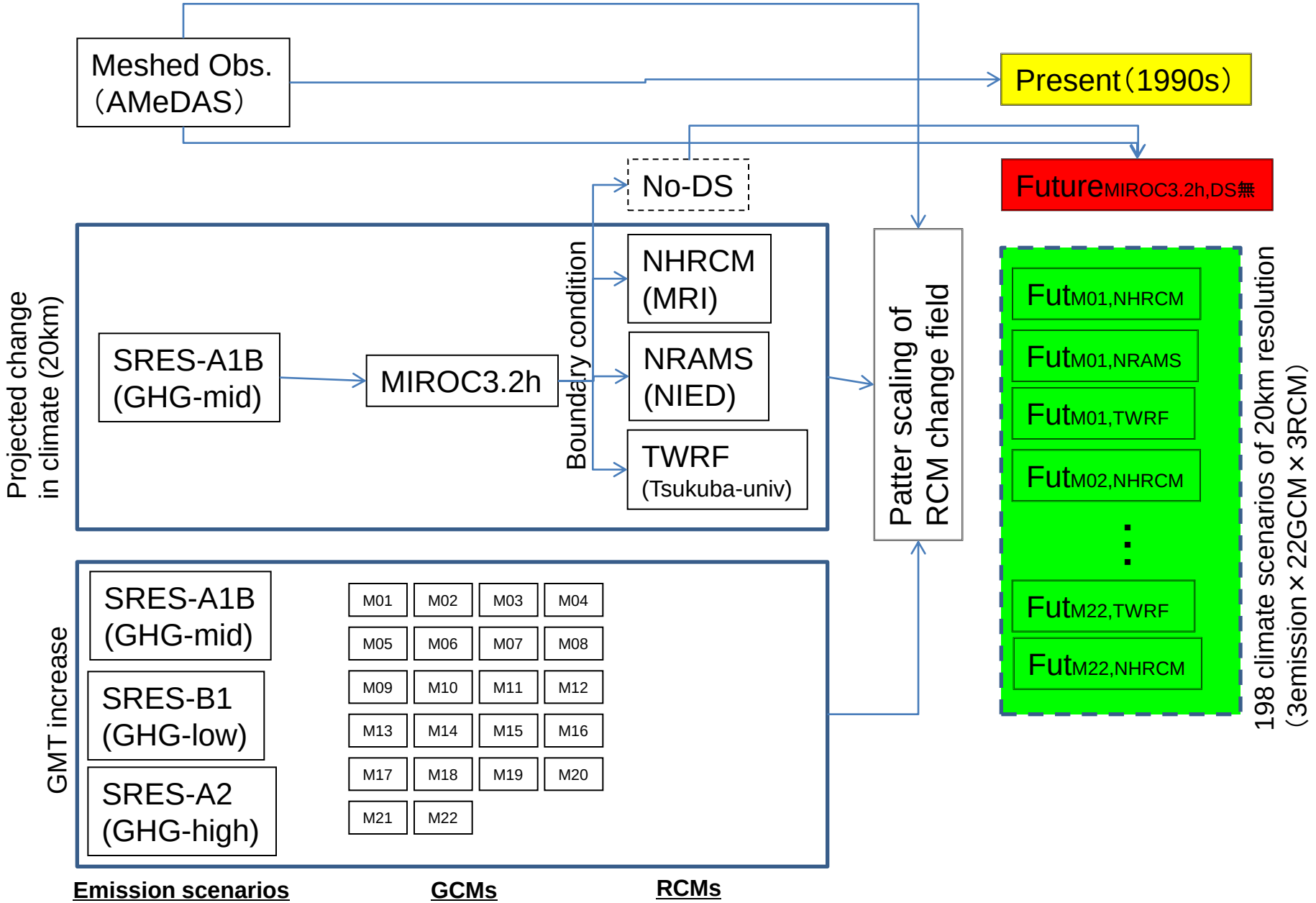


Takahashi et al. (2008)

Scenarios used for simulations

- Existence probability of Buna forest in each grid cell (1km x 1km) was calculated for the following scenarios.
  - **1** Baseline scenario for present period (1990s)
    - Gridded observed climate data (1kmx1km) based on AMeDAS data
  - **198** Scenarios for future periods (2040s [2031-2050] and 2090s [2081-2100]) with RCM-DDS
    - 3RCM(NHRCM,NRAMS,TWRF) × 22GCM(M01-M22)ΔGMT × 3emission scenario (A1B,B1,A2)
    - With bias correction based on the gridded AMeDAS data
  - **1** Scenario for future periods (2040s and 2090s) without RCM-DS
    - 1GCM(M16[=m32h]) × 1emission scenario (A1B)
    - With bias correction based on the gridded AMeDAS data

Procedure to produce climate scenarios in this study



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- While the uncertainty in projected suitable habitat derived from the choice of RCM was smaller than that from climate sensitivity, we could also see considerable uncertainty at local scale. For a good design of conservation strategies at the scale, it might be better or necessary to consider RCM uncertainty as well as the other sources of uncertainty in impact analyses.

Result: Comparison of 3 different RCM x 1GCM scenarios

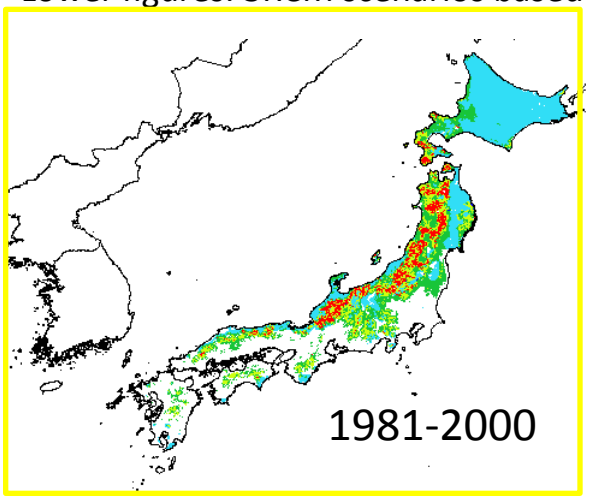
Red: Suitable area for Buna forest (existence probability≧0.5）

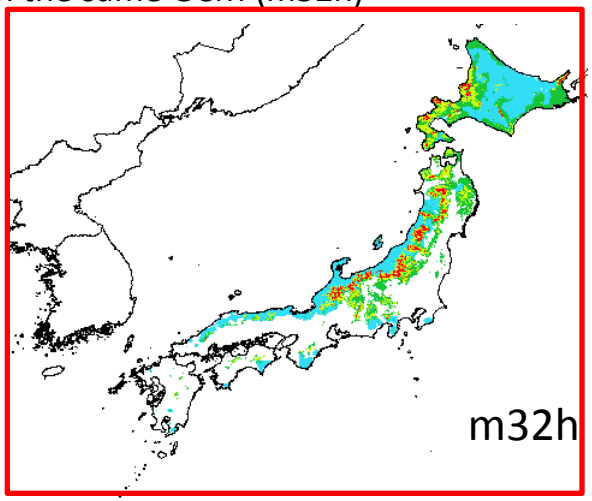
Upper: Present(left) and m32h scenario without DS (right)

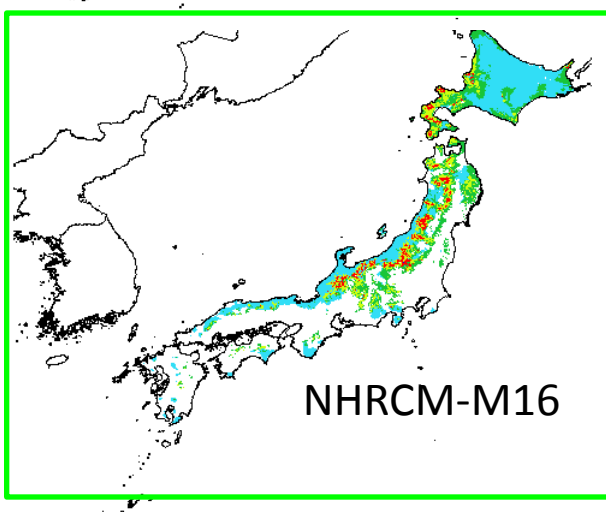
Lower figures: 3RCM scenarios based on the same GCM (m32h)

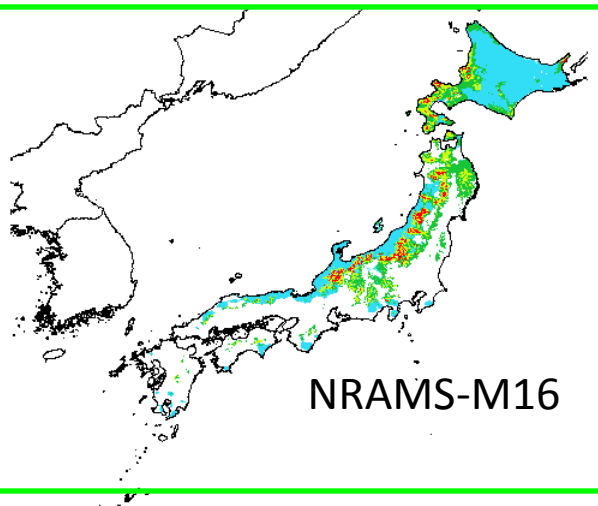
2040s

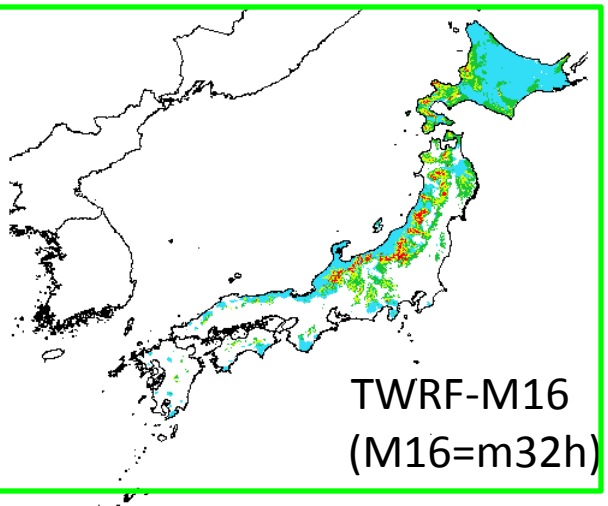
≦ 0.001
0.001-0.01
0.01-0.1
0.1-0.5
> 0.5











Result: Comparison of 1RCM x 4 different GCM scenarios

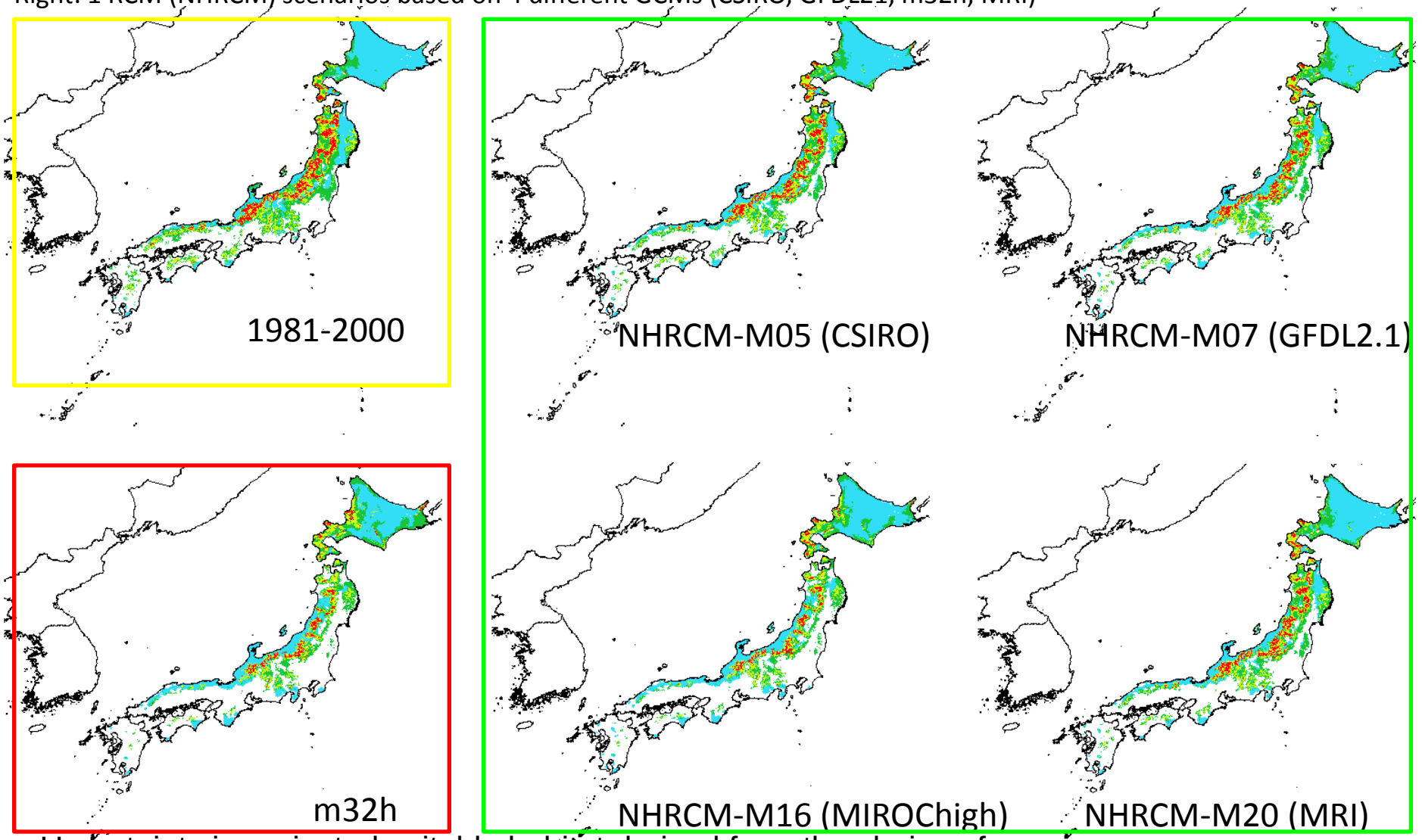
Red: Suitable area for Buna forest (existence probability≧0.5）

Left: Present(upper) and m32h scenario without DS (lower)

Right: 1 RCM (NHRCM) scenarios based on 4 different GCMs (CSIRO, GFDL21, m32h, MRI)

2040s

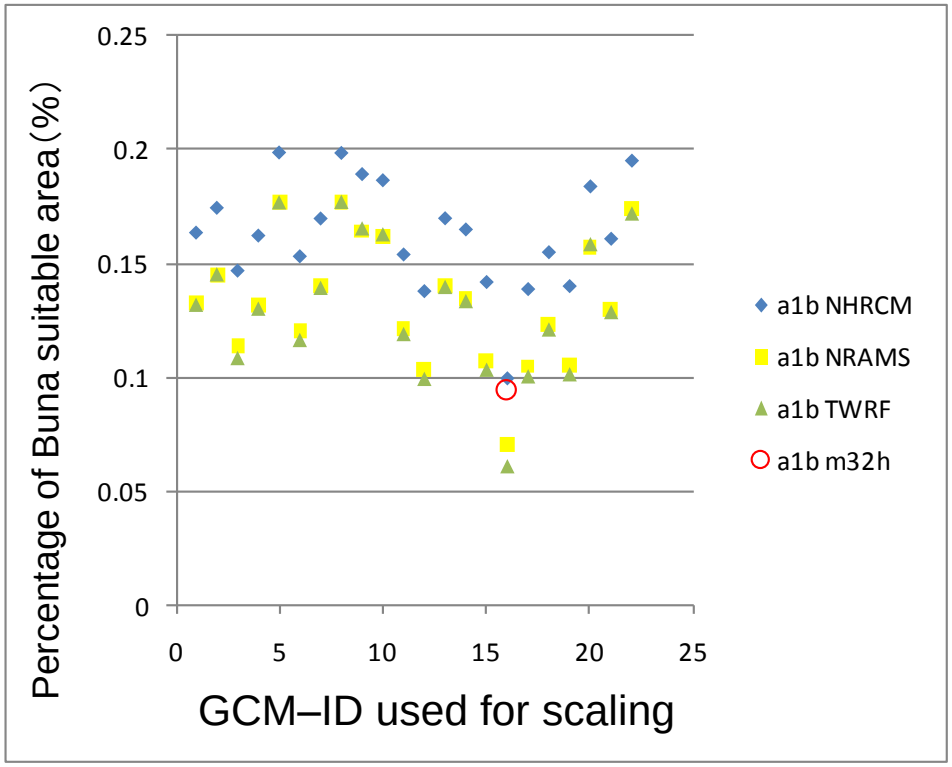
≦ 0.001
0.001-0.01
0.01-0.1
0.1-0.5
> 0.5



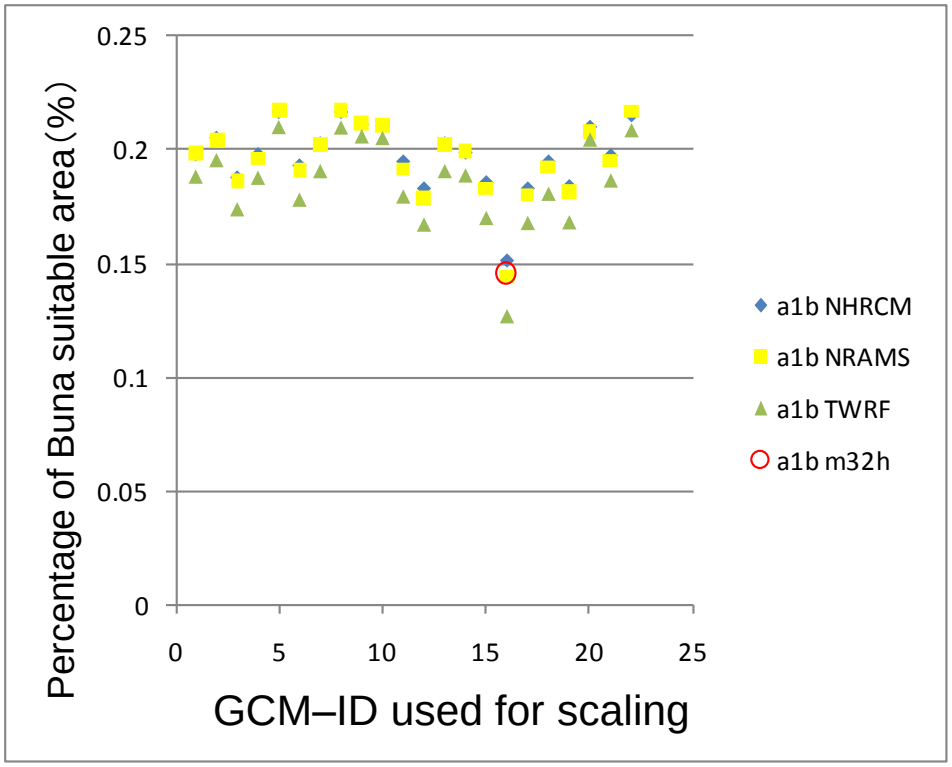
Uncertainty in projected suitable habitat derived from the choice of RCM was smaller than that from climate sensitivity (choice of GCM).

Result: Buna suitable area percentage in Akita and Toyama (a1b)

Akita・2040s



Toyama・2040s



(GCM–ID 16 = miroc32h)

Result: Comparison of 3 different RCM x 1GCM scenarios

Red: Suitable area for Buna forest (existence probability≧0.5）

Upper: Present(left) and m32h scenario without DS (right)

Lower figures: 3RCM scenarios based on the same GCM (m32h)

2040s

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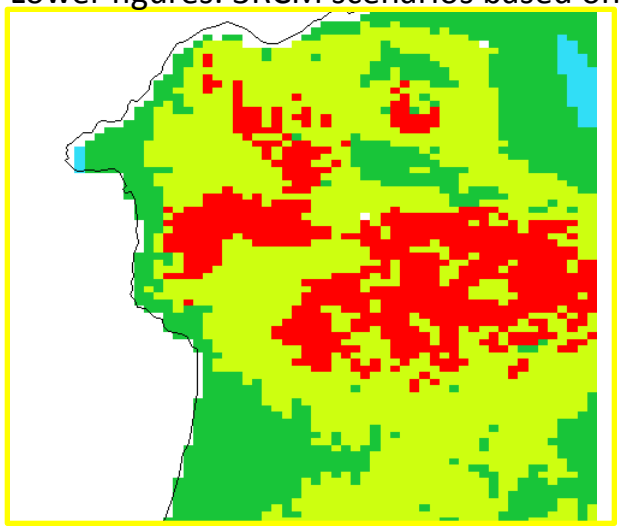
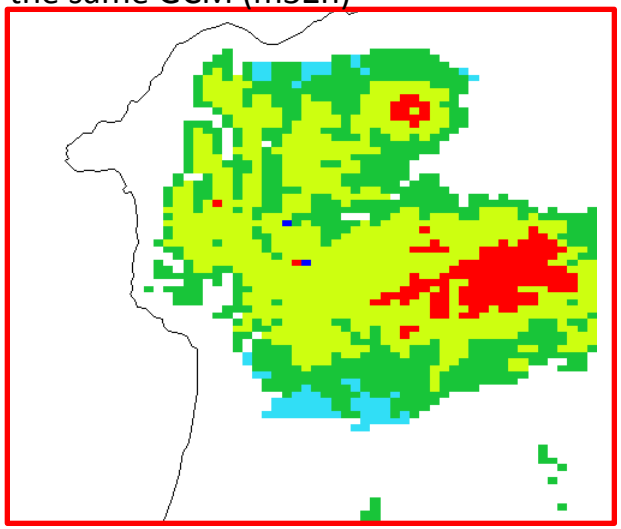
0.001-0.01
0.01-0.1
0.1-0.5
> 0.5

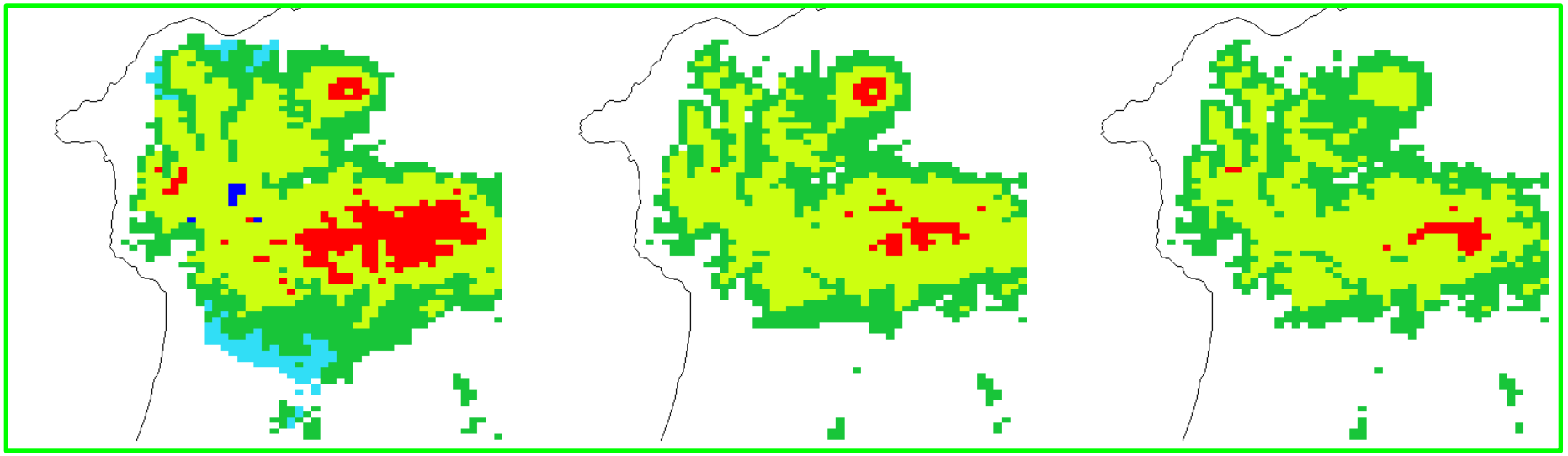


1981-2000



m32h

Close-up of the region around Shirakami Mountain Range (World heritage for its broad natural Buna forest)

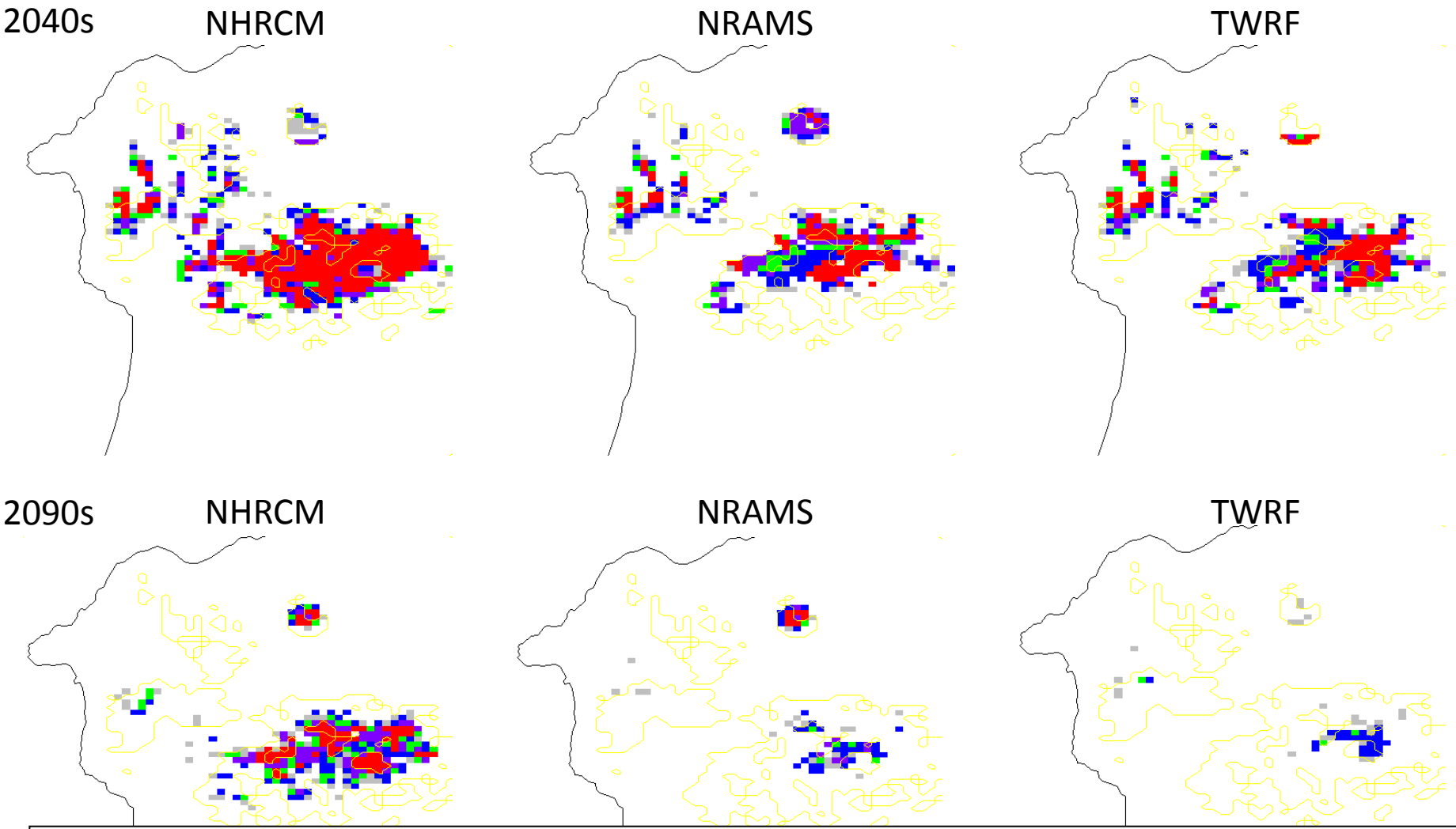


NHRCM-M16

NRAMS-M16

TWRF-M16
(M16=m32h)

Result: Number of scenarios indicating Buna-suitability (among 22 scenarios based on different GCM's ΔGMT)



For a good design of conservation strategies at the local scale, it might be better or necessary to consider RCM uncertainty as well as the other sources of uncertainty in impact analyses.

Conclusion and Further research needs

- Conclusions
  - While the uncertainty in projected suitable habitat derived from the choice of RCM was smaller than that from climate sensitivity (GCM choice), we could also see considerable uncertainty derived from the choice of RCM at local scale.
  - For a good design of conservation strategies at the local scale, it might be better or necessary to consider RCM uncertainty as well as the other sources of uncertainty in impact analyses.
- Further research needs
  - Application of multi-RCM scenarios to other impact sectors, especially the sectors which are expected to be more sensitive to the choice of RCM. [For better understanding of value-add of RCM downscaling]
  - Reduction in uncertainty range through weighting of scenarios or with other methods.
  - Better communication among climate modelers, impact modelers, and decision-makers.