Intercomparison of Downscaled Daily Precipitation Indices over Japan in Present-day and Future: Dynamical and Bias-Correction-Type Statistical Downscaling Methods

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Acknowledgements: This study was supported by the Global Environmental Research Fund (S-5-3) of the Ministry of the Environment.

Jan. 18, 2011

Intl. WS on Downscaling @
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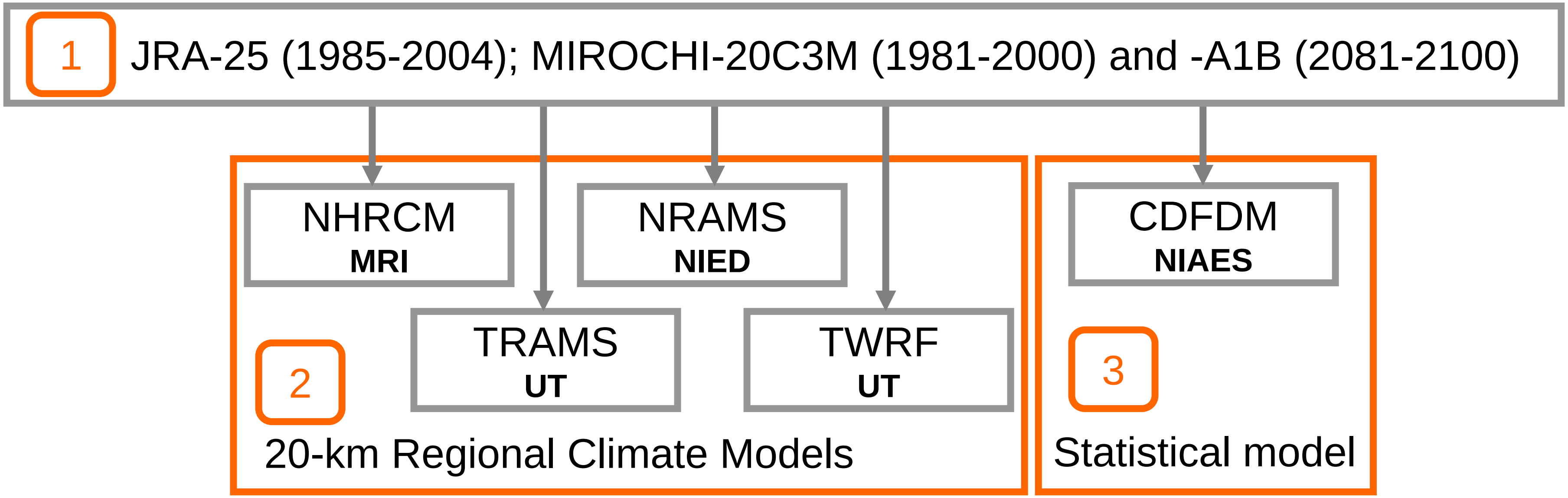
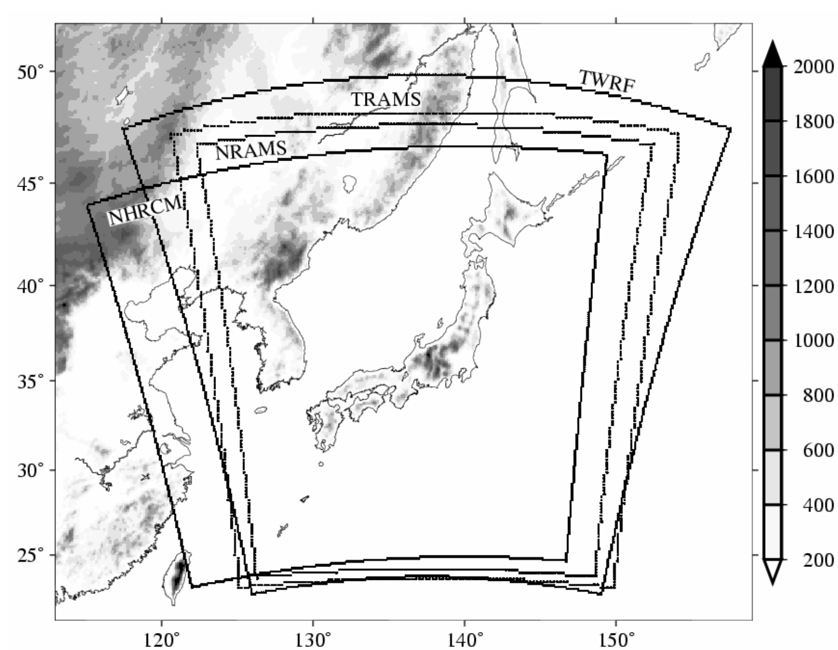
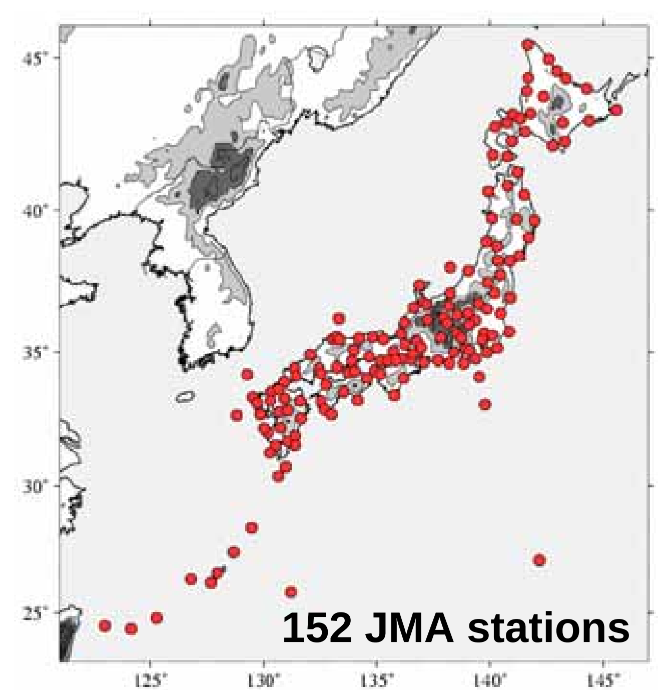
Introduction

- Regional climate change scenarios are essential for impact and adaptation studies on a regional scale;
- Projected regional climate change varies not only by downscaling methods (dynamical or statistical) but also by different downscaling models; Murphy 2000; Schmidli et al., 2007; Smiatek et al., 2009
- Dynamical and statistical models have own bias and features depending on area and climatic element; Mearns et al., 2003; Wilby et al., 2004
- Purposes of this study are:
  - to evaluate the quality of daily precipitation data derived from the downscaling models, by checking the daily precipitation indices;
  - to highlight the relative strengths and weaknesses of the downscaling models;
  - to demonstrate the possible spread of projected regional climate changes in Japan associated with the downscaling models

Design of Downscaling Experiments







Cumulative distribution function-based downscaling method (CDFDM)

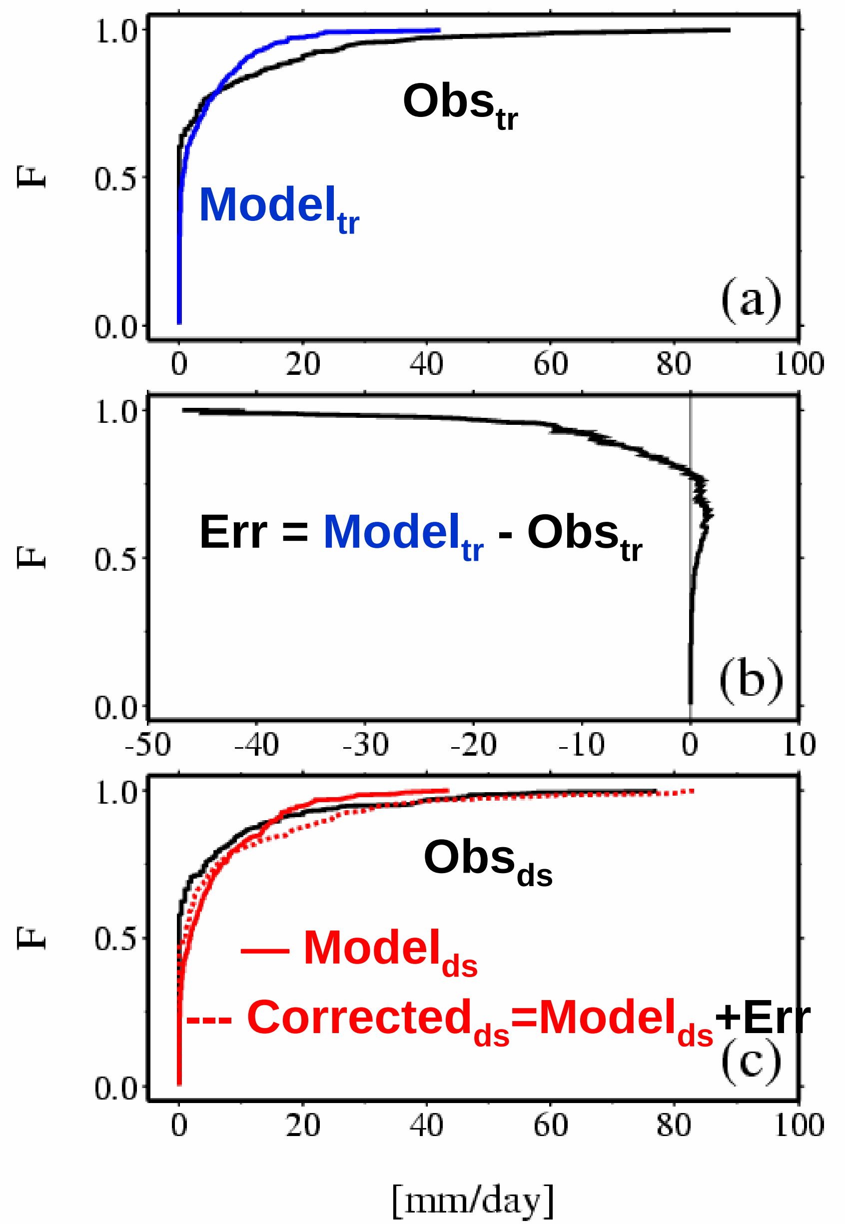
Algorithm:

1) Provide empirical CDFs for observed and modeled data for a training period (a);

2) Calculate the model error along with percentile ($0 \leq F \leq 1$) (b);

3) Provide an empirical CDF for modeled data during a downscaling period and remove the model error with percentile of modeled data (c);

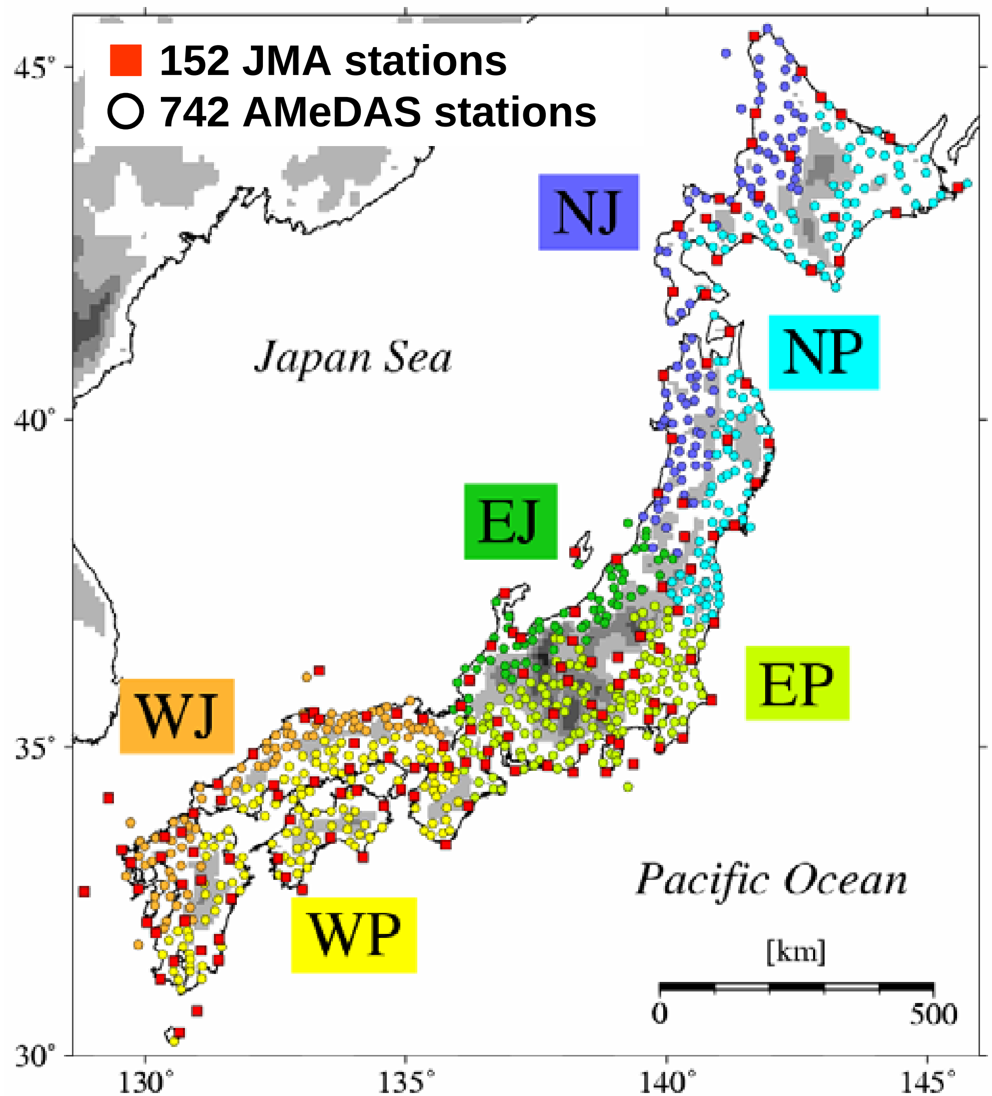
4) Sort the modeled data in chronological order.



Application of CDFDM

Verification period: 1985-2004 (20 yr)

Former half: 1985-1994 (10 yr), Latter half: 1995-2004 (10 yr)



(1) Train CDFDM using former half data and downscaled latter half period;

(2) Train CDFDM using latter half data and downscaled former half period;

(3) Combined data for two downscaled periods;

(4) Spatially interpolated to geographical coordinate with a 20-km grid interval;

(5) Compared the downscaled data with AMeDAS data.

Daily Precipitation Indices

(1) Mean precipitation, MEA (mm/day)

(2) # of wet days (≥1 mm/day), FRE (fraction)

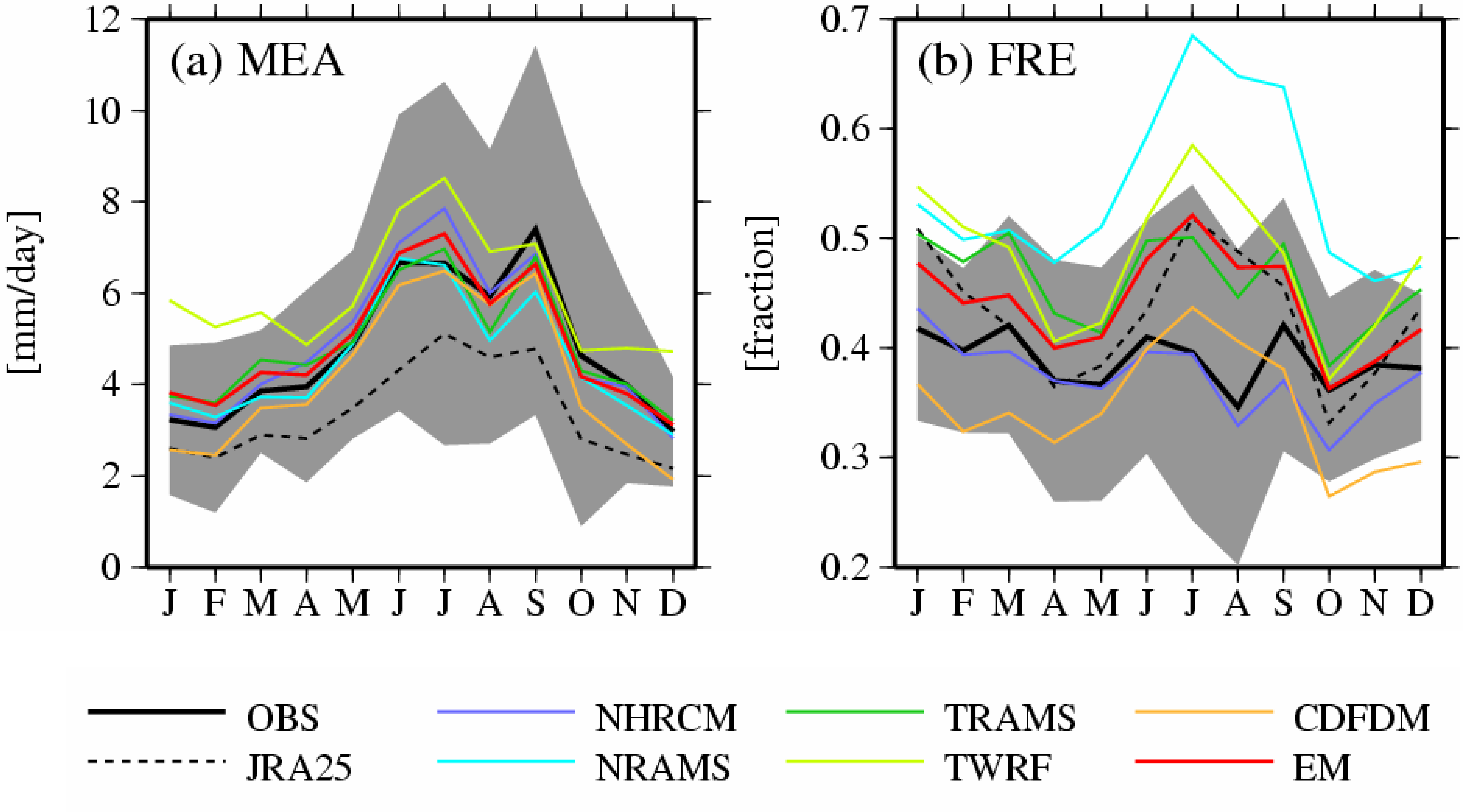
(3) Mean precipitation intensity, INT (mm/day)

(4) 90th percentile of daily precipitation, Q90 (mm/day)

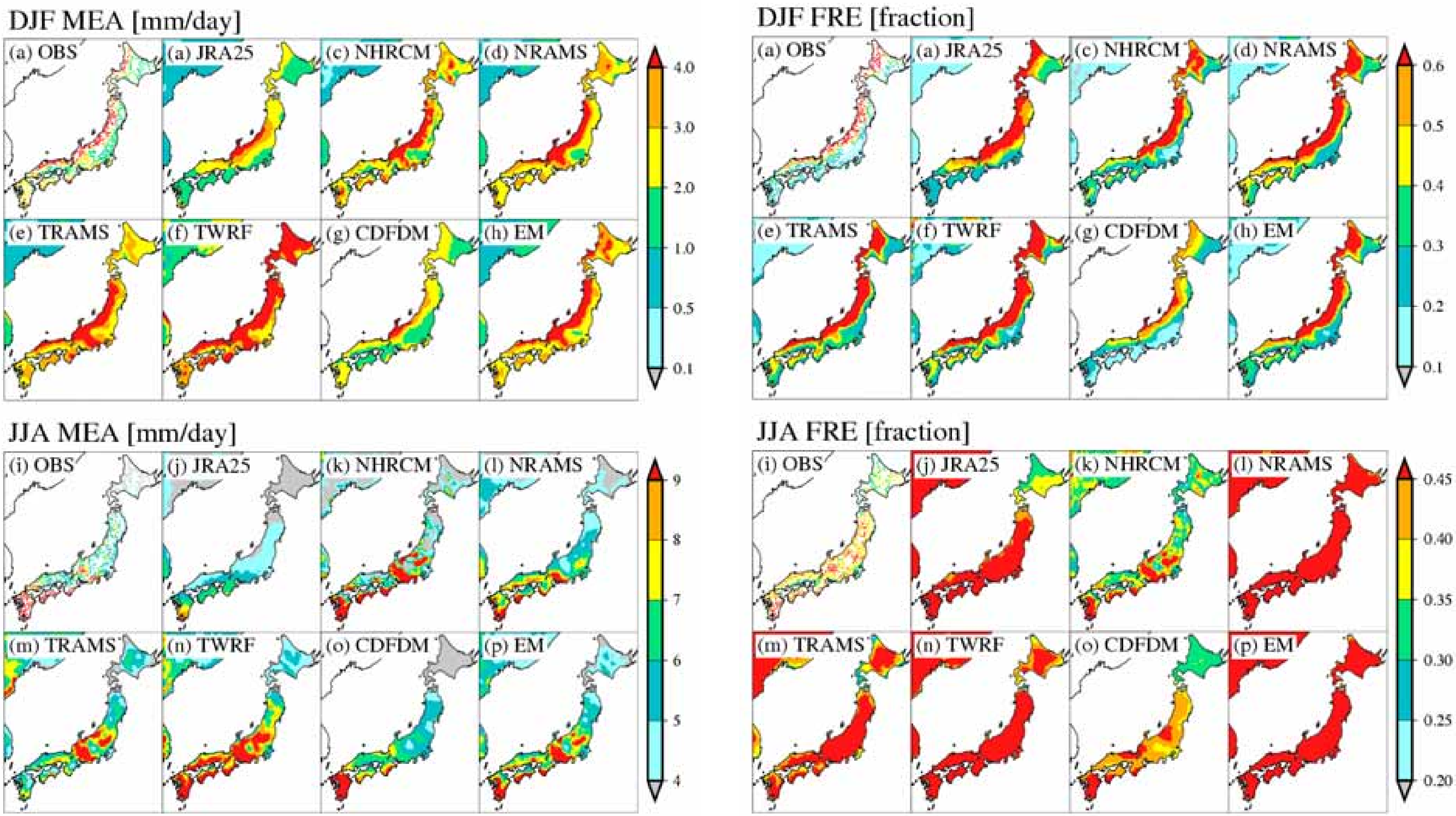
(5) # of days with precipitation ≥Q90, R90T (fraction)

(6) # of consecutive dry days, CDD (days)

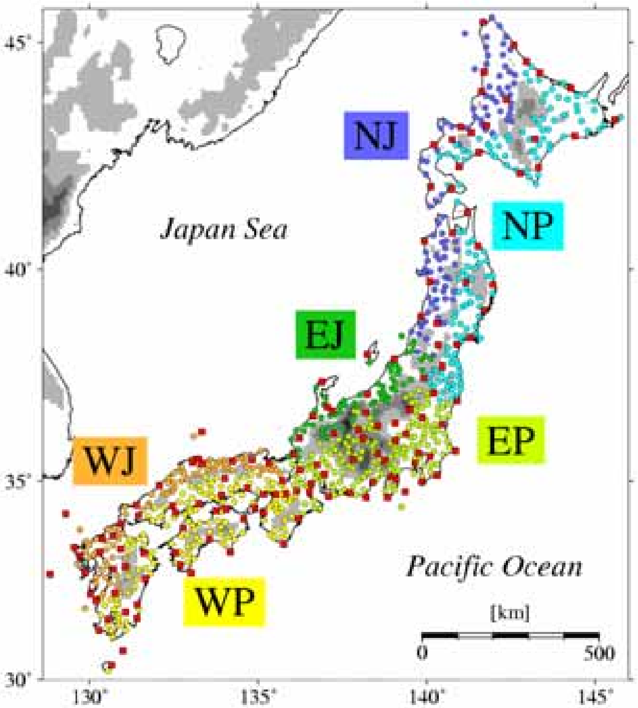
Seasonal Change: MEA and FRE

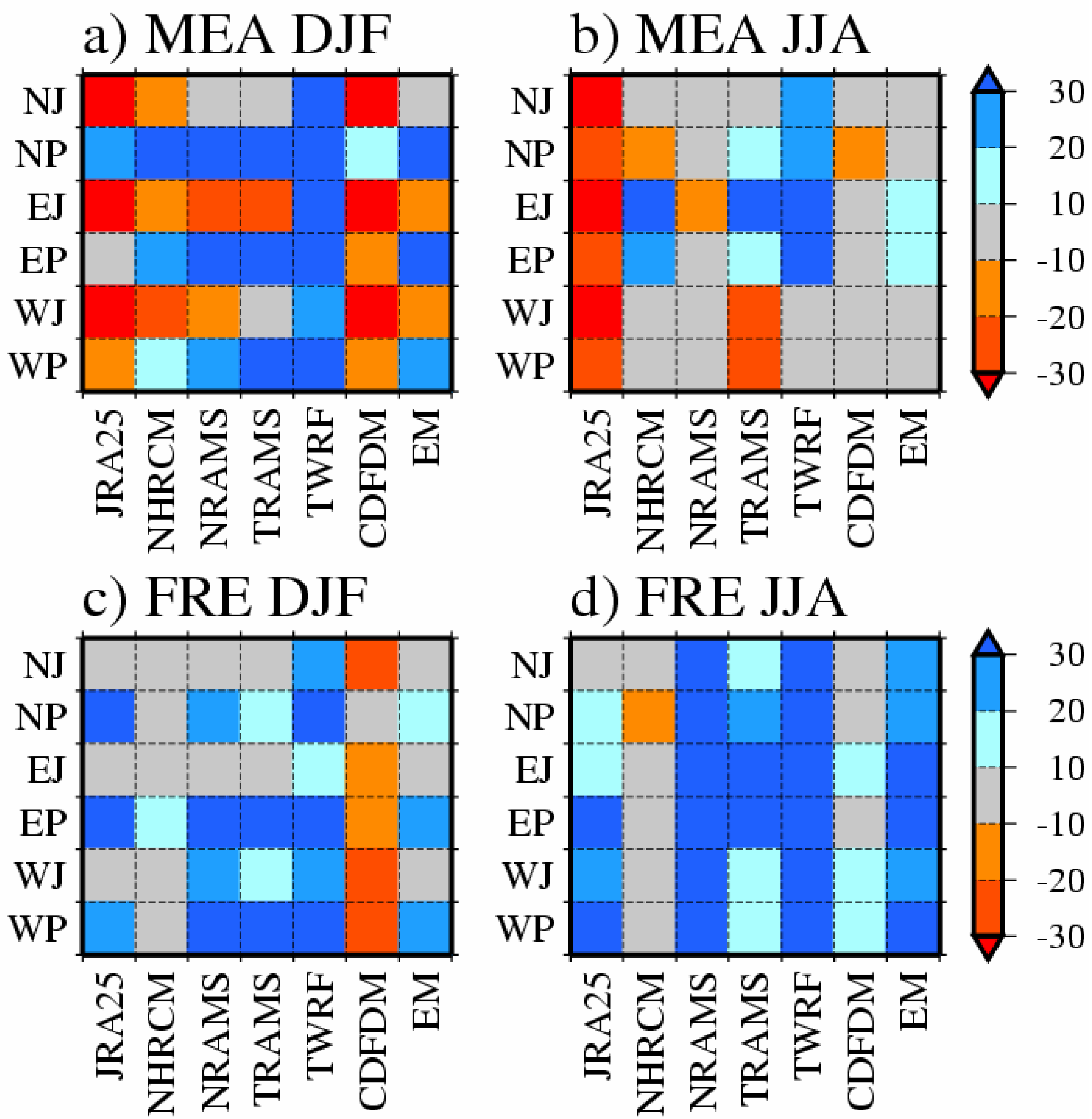


Mean Geographical Pattern: MEA and FRE



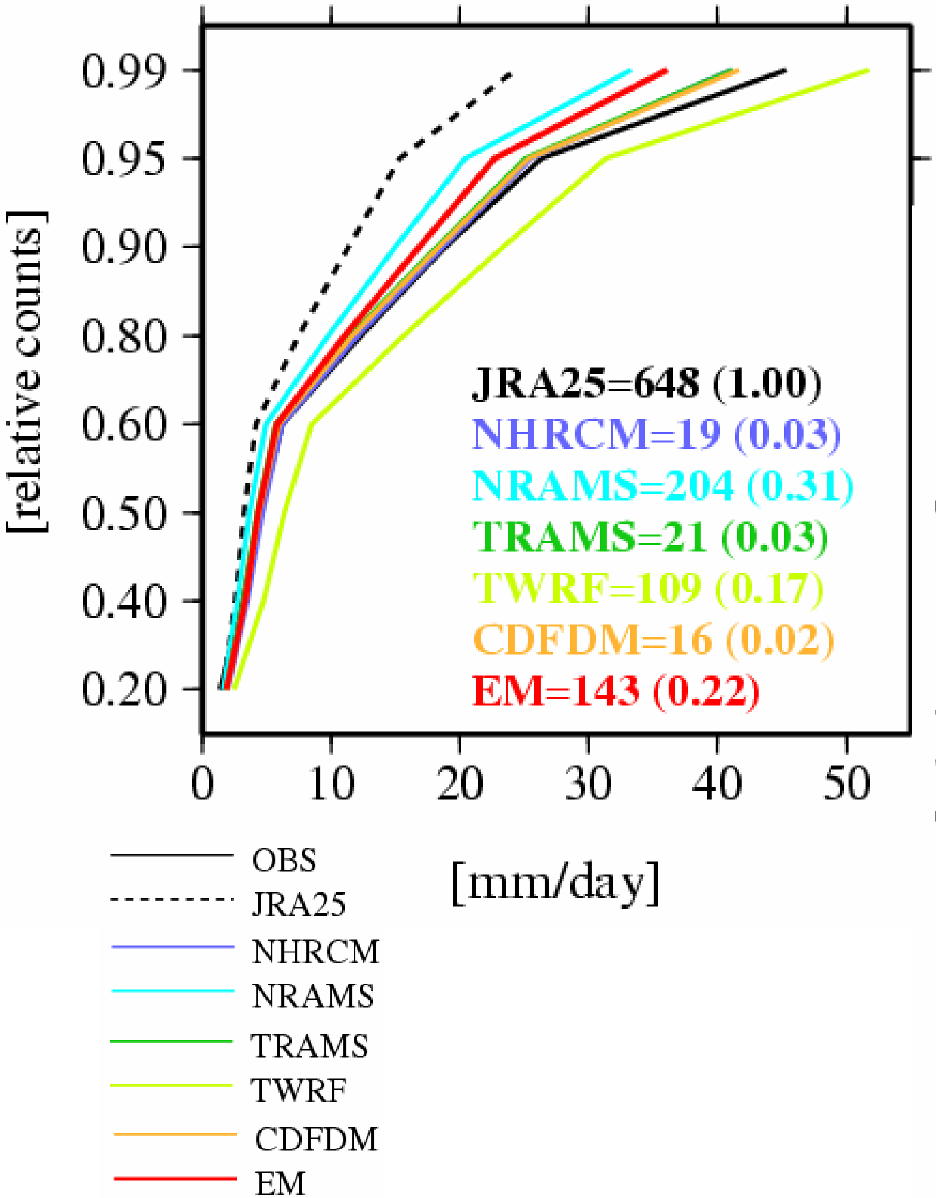
Bias for Each Area: MEA and FRE





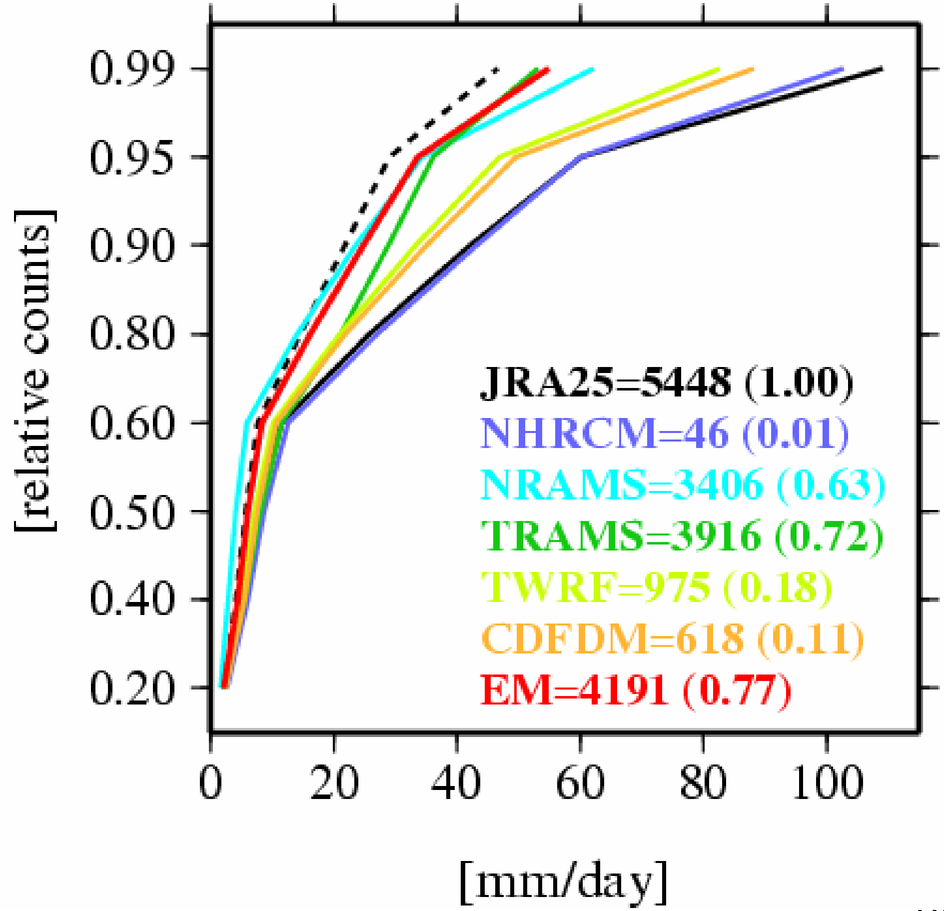
CDF of daily precipitation

(a) DJF

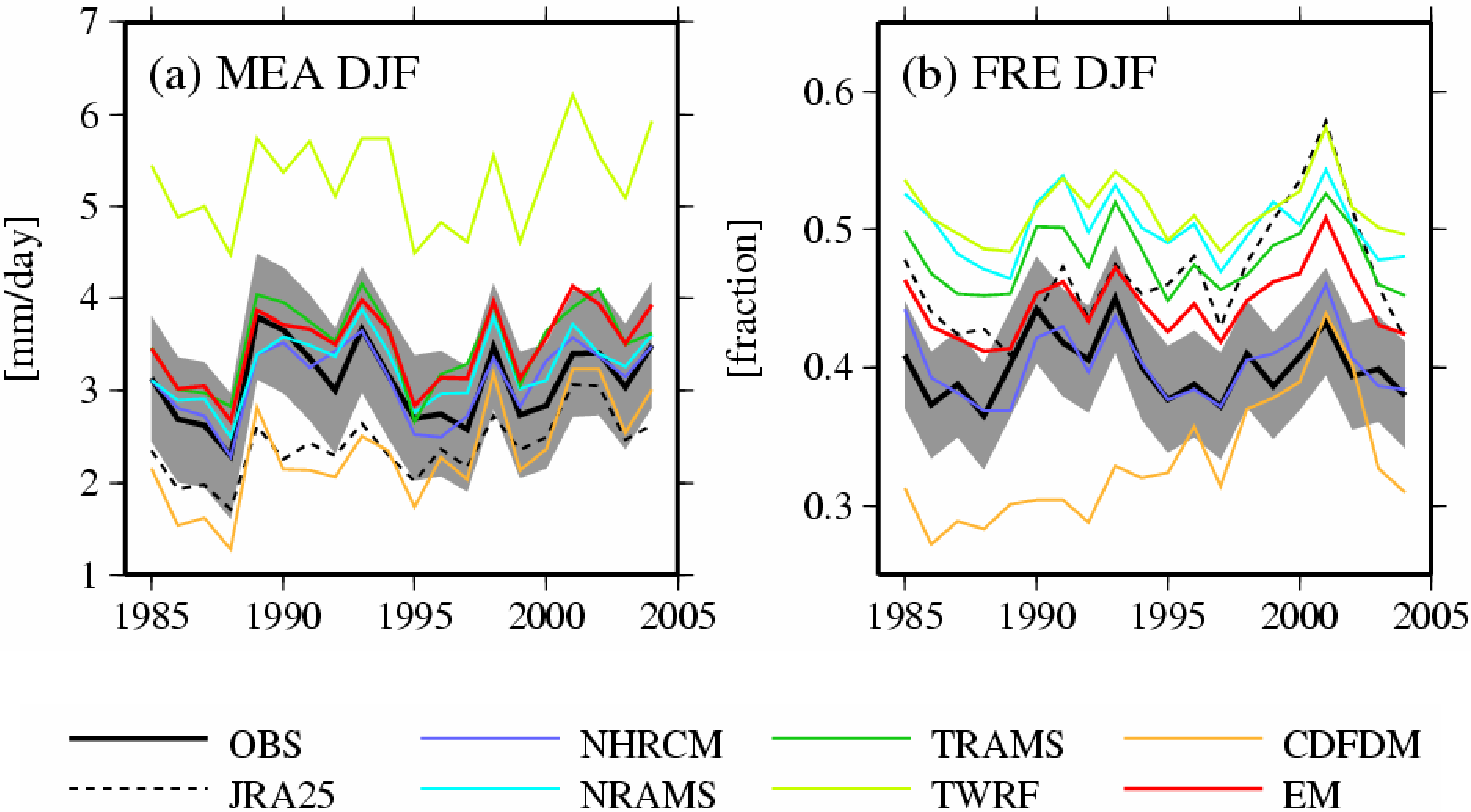


$$TSD = \int_{-\infty}^{+\infty} \left[F_1(x) - F_2(x)\right]^2 dx$$

(c) JJA



Interannual variation: MEA and FRE in DJF



Summary

From verification results,

All downscaling models successfully improve the quality of daily precipitation data relative to reanalysis (e.g., bias);

No best downscaling model for all aspects exist (though NHRCM is close to the best in Japan);

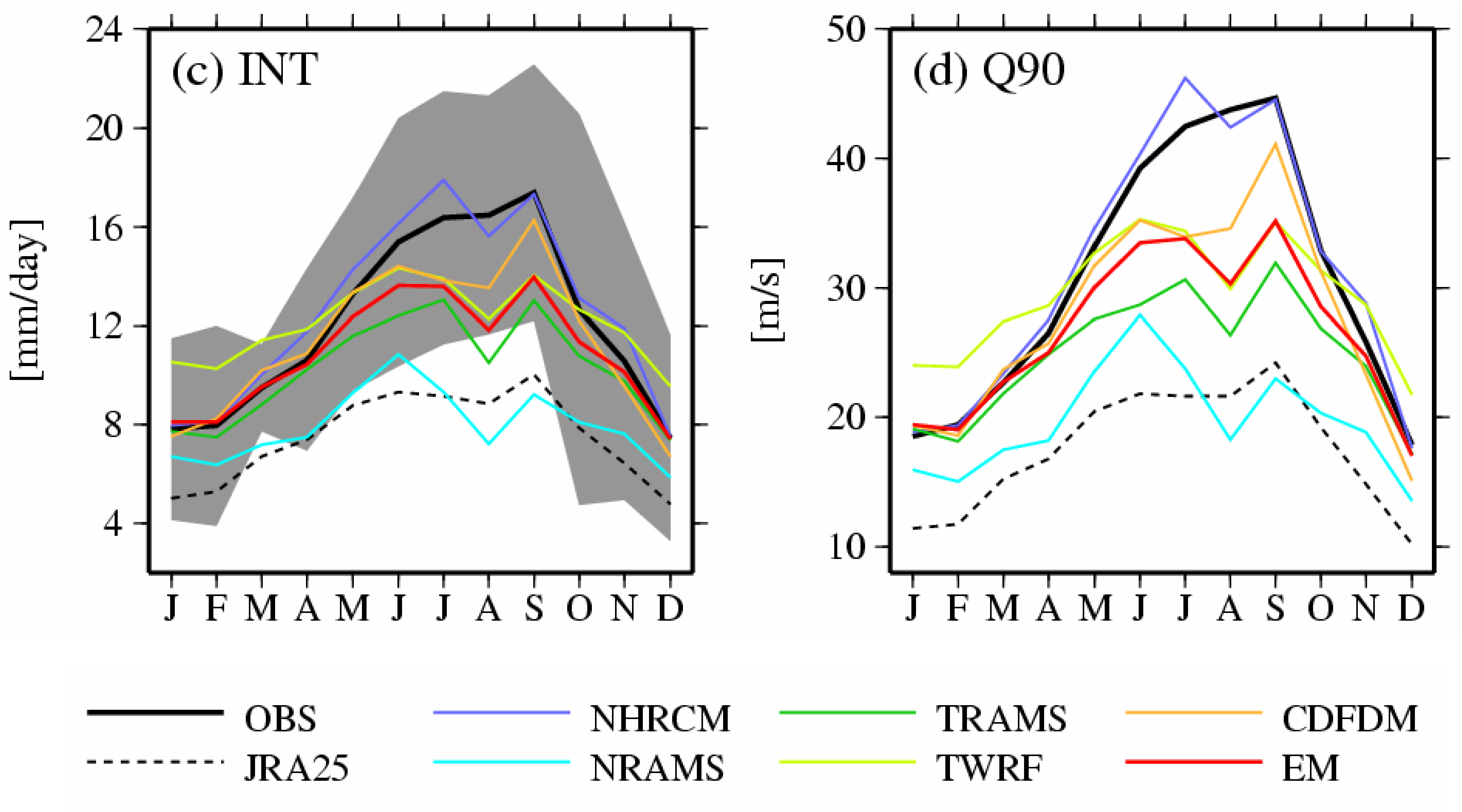
Each downscaling models have own strengths and weaknesses. Dynamical models have a certain similarity but the difference across dynamical models is not small.

Projected regional climate changes downscaled by different models with common BC are basically similar in a qualitative sense but substantially different in a quantitative sense;

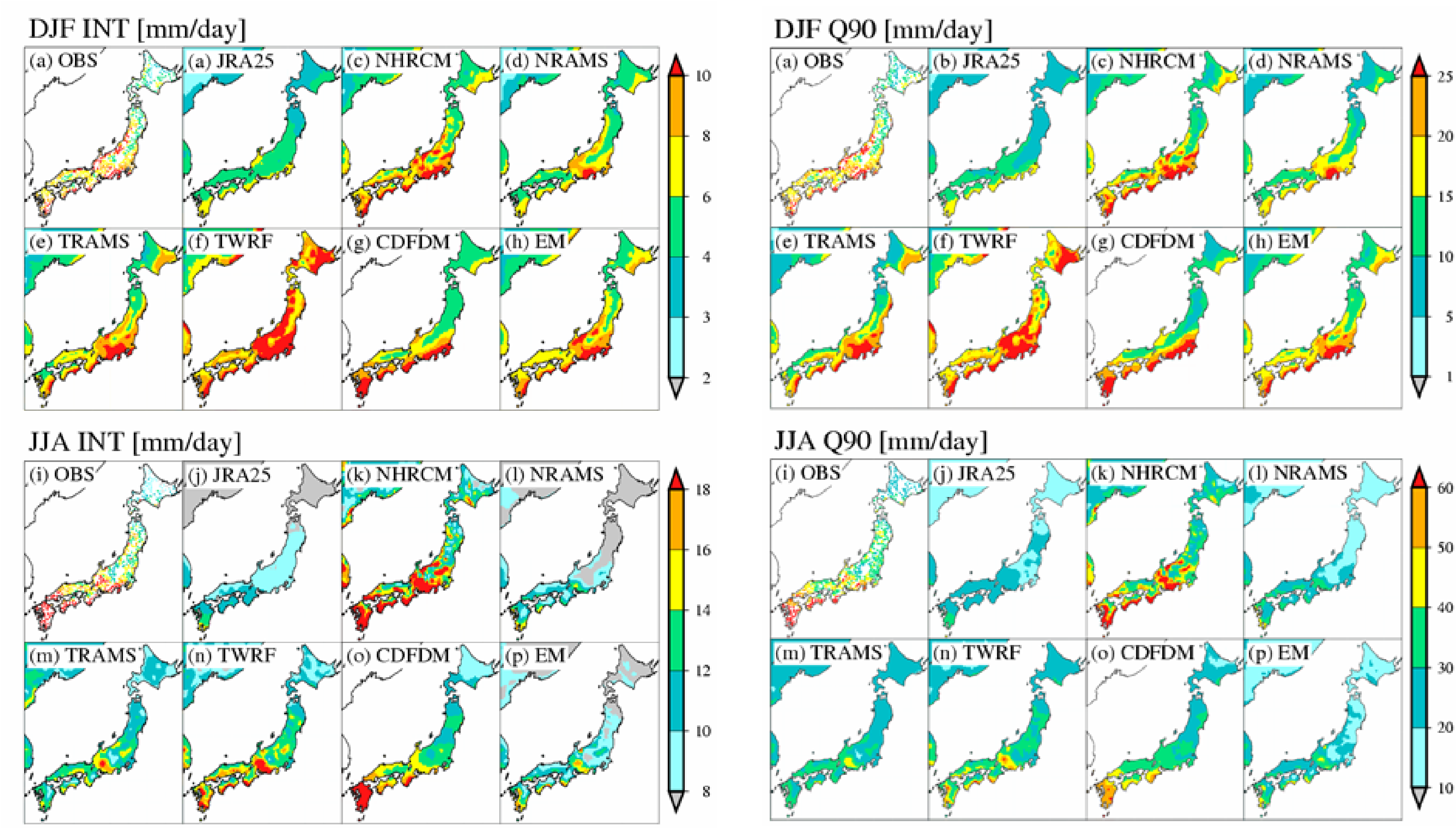
IMPLICATION FOR IMPACT AND ADAPTATION STUDIES: Don’t believe single regional climate change scenario too much! Further application of statistical data inflation methods is recommended.

Thank you

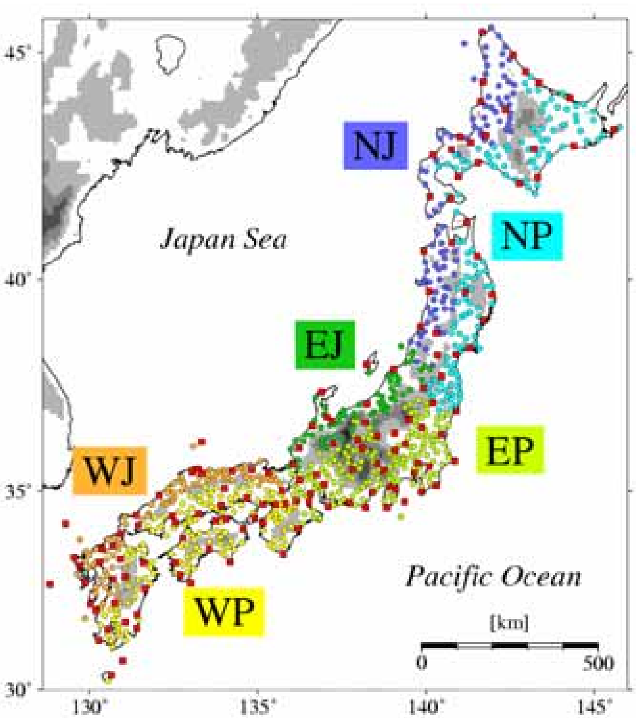
Seasonal Change: INT and Q90

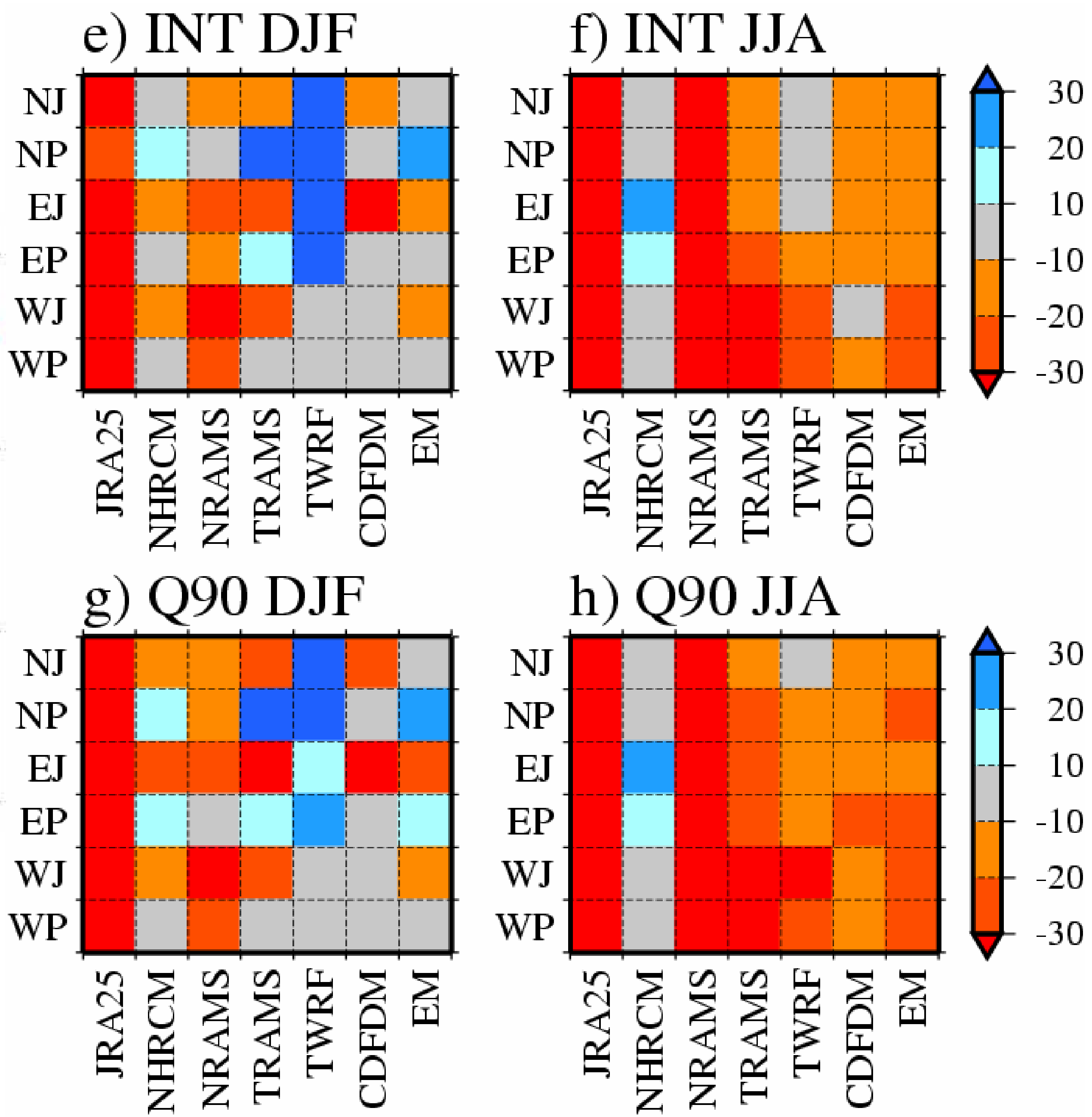


Mean Geographical Pattern: INT and FRE

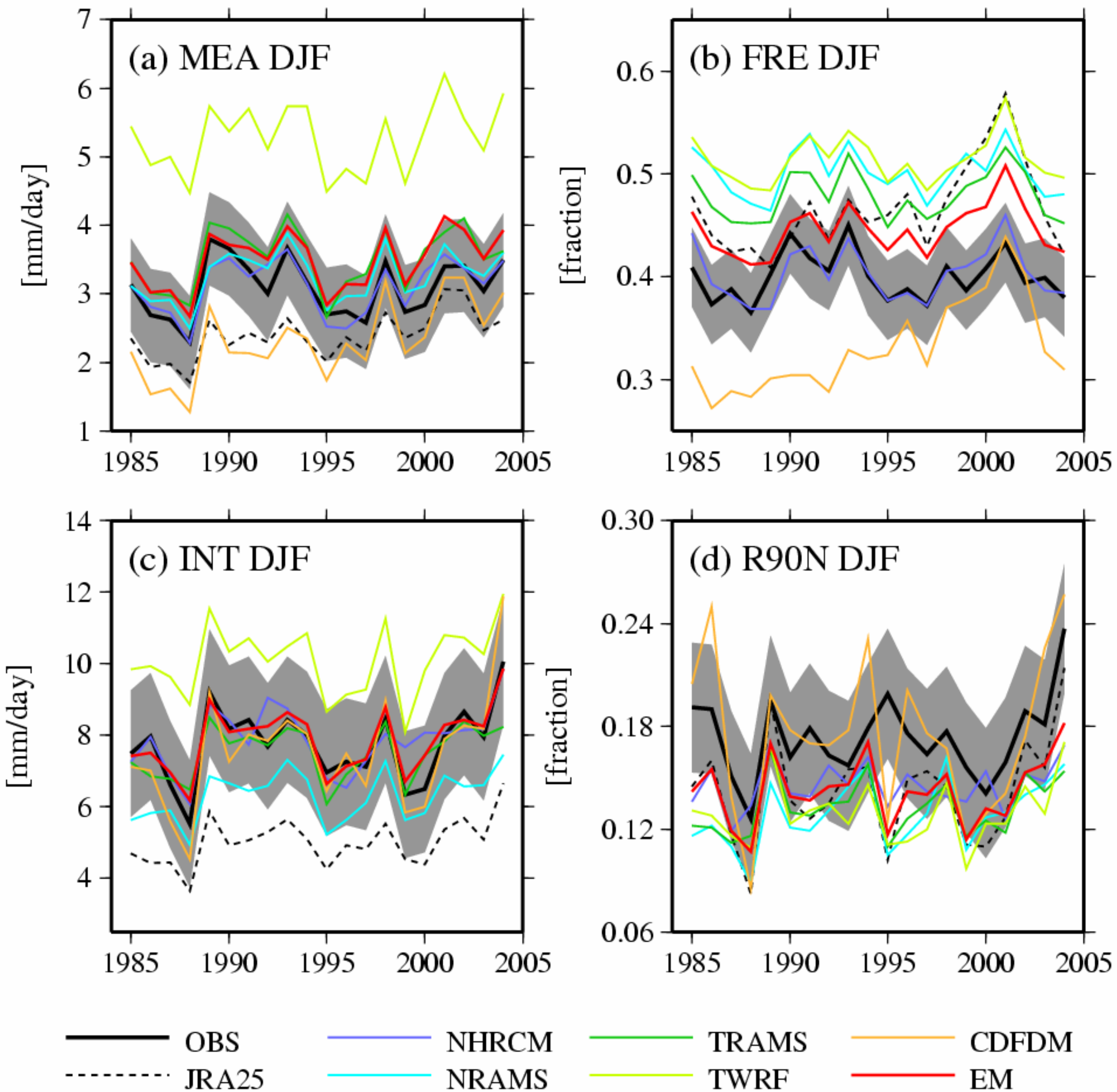


Bias for Each Area: MEA and FRE





Interannual variation: DJF



Interannual variation: JJA