MMLR-SD for multi-surface climate elements over Japan by using the general circulation field from JRA-25.

[GCMs and RCMs].

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MMLR (Multivariate Multiple Linear Regression, named by Canadain researcher) -based SD for surface climate over Japan are developed and inter-compared with the output of S-5-3 RCMs of this project on daily scale for current climate condition.

Various Methods for SD

Table 1 A summary of the strengths and weaknesses of the main SD methods.

Method	Strengths	Weaknesses
Weather typing (e.g. analogue method, hybrid approaches, fuzzy classification, self organizing maps, Monte Carlo methods).	• Yields physically interpretable linkages to surface climate • Versatile (e.g., can be applied to surface climate, air quality, flooding, erosion, etc.) • Compositing for analysis of extreme events	• Requires additional task of weather classification • Circulation-based schemes can be insensitive to future climate forcing • May not capture intra-type variations in surface climate
Weather generators (e.g. Markov chains, stochastic models, spell length methods, storm arrival times, mixture modelling).	• Production of large ensembles for uncertainty analysis or long simulations for extremes • Spatial interpolation of model parameters using landscape • Can generate sub-daily information	• Arbitrary adjustment of parameters for future climate • Unanticipated effects to secondary variables of changing precipitation parameters
Regression methods (e.g. linear regression, neural networks, canonical correlation analysis, kriging).	• Relatively straightforward to apply • Employs full range of available predictor variables • 'Off-the-shelf' solutions and software available	• Poor representation of observed variance • May assume linearity and/or normality of data • Poor representation of extreme events

Wilby et al.(2004): Guideline for use of climate scenario developed from statistical downscaling methods

Today's topics

I. Method and Data description

II. Continuation Research: MMLR applying for mainland of Japan (funded by S-5-3 of MoE).

III. Localized Research: Applying for Kochi Pref., Shikoku Islands, West Japan. (funded by RECCA of MEXT).

* esp. for Climate Change Impact and Adaptation on (extra early-ripening variety of) Rice's production, quality and taste of Kochi.

MMLR-SD Methods

①CCA applied to the GPV of large-scale circulation field on daily time-scale.

②Temporal coefficients of the deduced circulation fields were transferred to estimate and valid current surface climate values.

○Meteorological Elements

・Predictors : SLP・T700・U/V/Q850 by JRA25 (OBS)

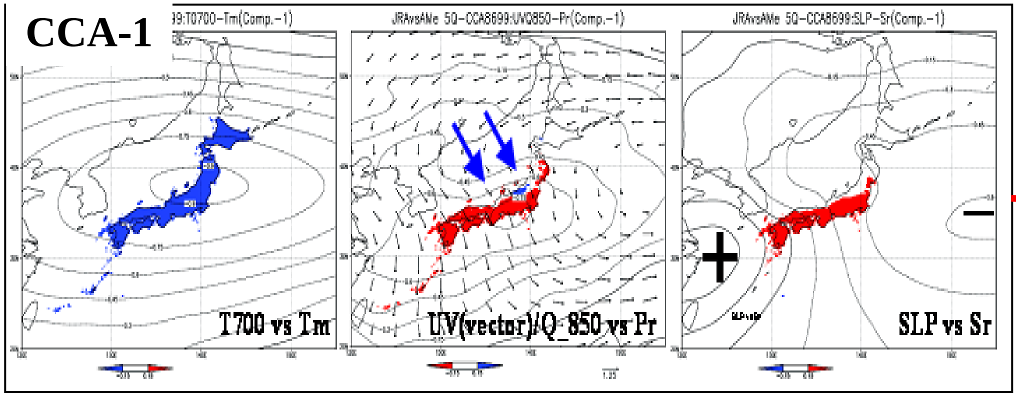
・Predictands: Tm., Sr. and Pr. by JMA dataset (OBS)

＊CCA were applied after calculating EOF of each circulation/climate fields.

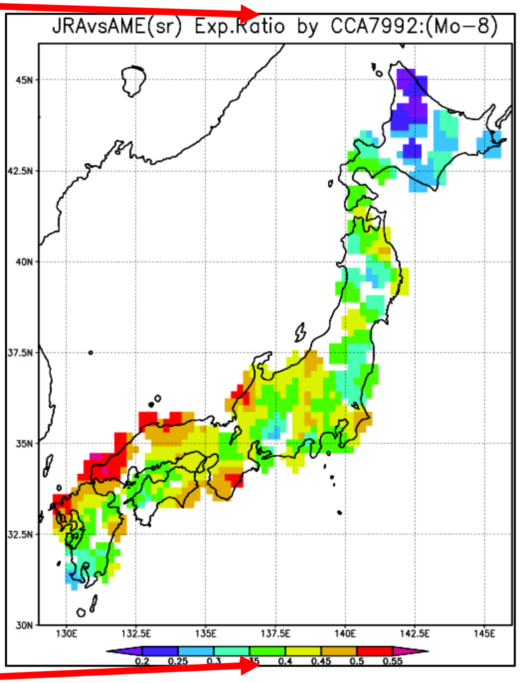
＊The reason used CCA, not SVD, is absolutely necessary to temporally independencies to estimate current climate by using multiple regression analysis.

Multi-variate Multiple Linear Regression (MMLR) SD based on CCA (circulation vs. climate elements)

CCA-1



Multi-predictors and Multi-preditand

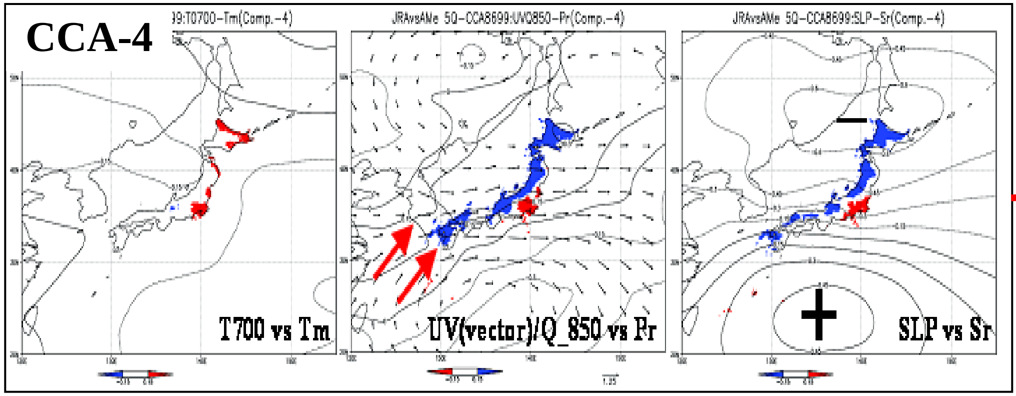


$$Y_{ij} = \Sigma a_{im} Z_{mj} + b_i$$

$$Z_{mj} = \Sigma h_{mk} X_{kj} \rightarrow Z'_{mj} = \Sigma h_{mk} X'_{kj}$$

$$Y'_{ij} = \Sigma a_{im} Z'_{mj} + b_i$$

CCA-4



Only current climates are discussed today

Nishimori and Kitoh (2006: ISMD2006)

Methods for inter-comparison

○Analyzed Period

・Calibration : 10 year (1985-1994)×12 month＝120 case

・Verification: 14 year (1979-84/1995-2007)×12 month＝60+156 case (back/fore-cast)

＊Calibration Period is fixed due to instrumental change.

○20km-RCM dataset from the 'S-5-3'

1. NIED-RAMS-V1.0 (Ver.-Apr2010 on DIAS) :1979-2007
2. MRI-NHM-V2.2 (Ver.-SEP2009) :1979-2007
3. TU-WRF-V2 (Ver. -Apr2010 on DIAS):1985-2007

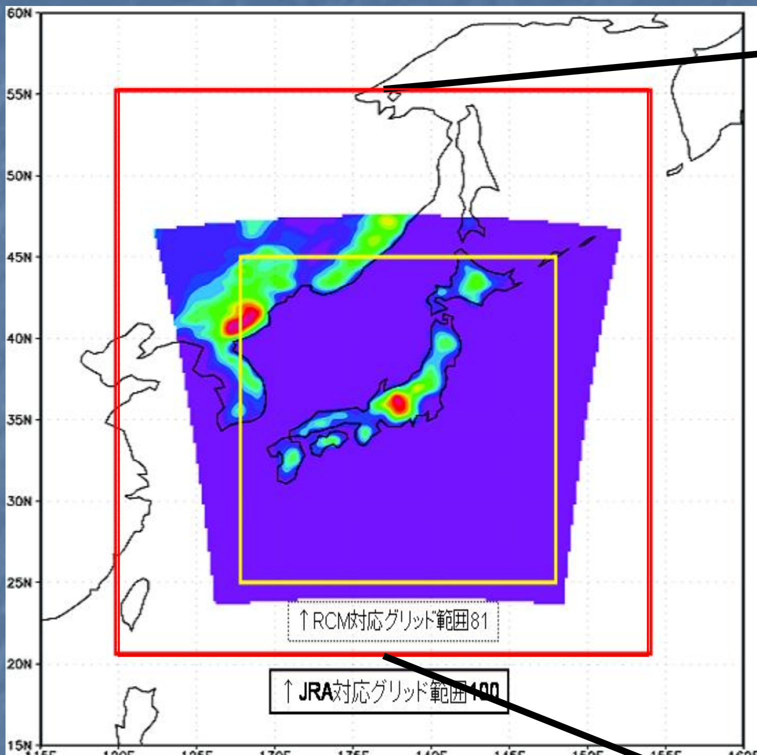
＊RCMs were driven by the JRA25 dataset as same boundary conditions as the SD.

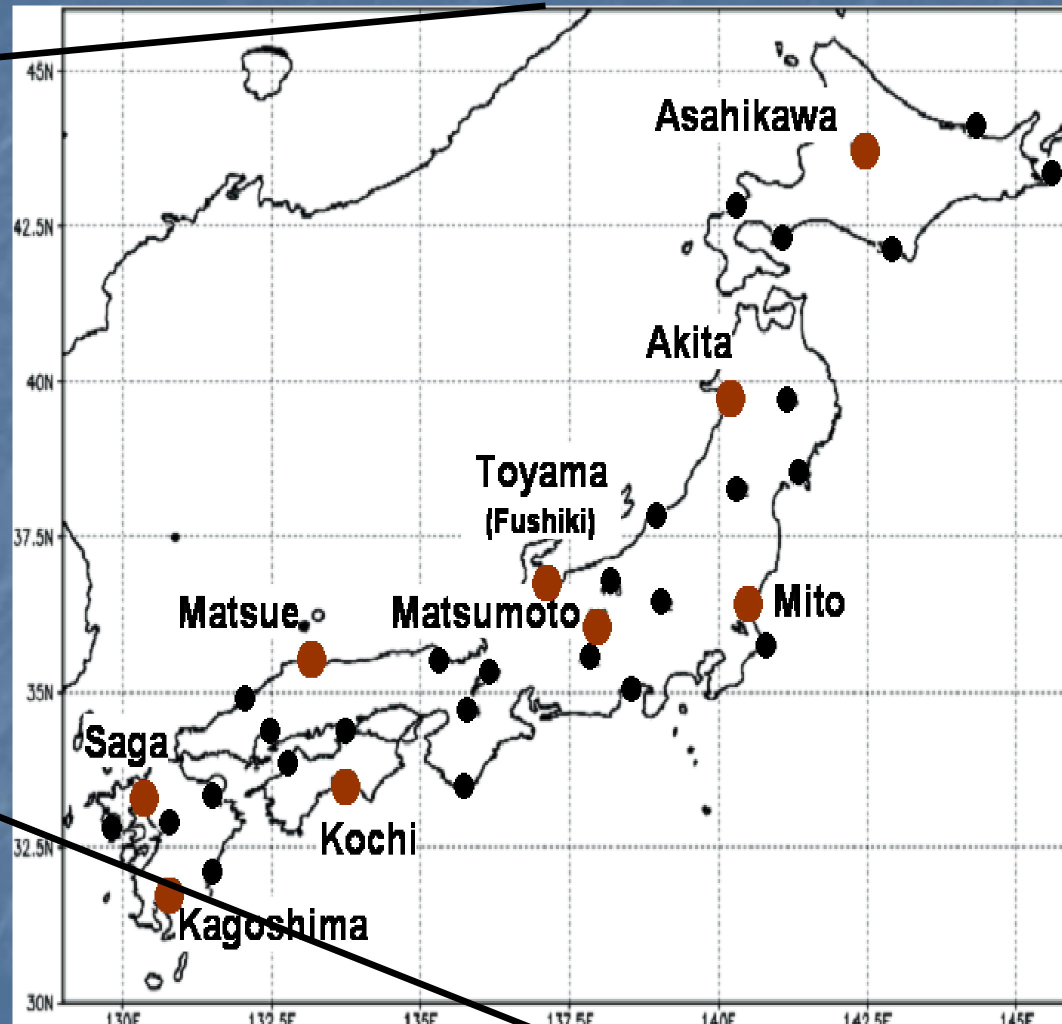
＊In this study, these RCM data was used only to compare with SD results

○Inter-comparison

Correlation Coefficients, Simple Biases and RMSEs are calculated on monthly (averaged or accumulated daily value) and seasonal scale.

Area of explanation variables and Objective stations of Japan

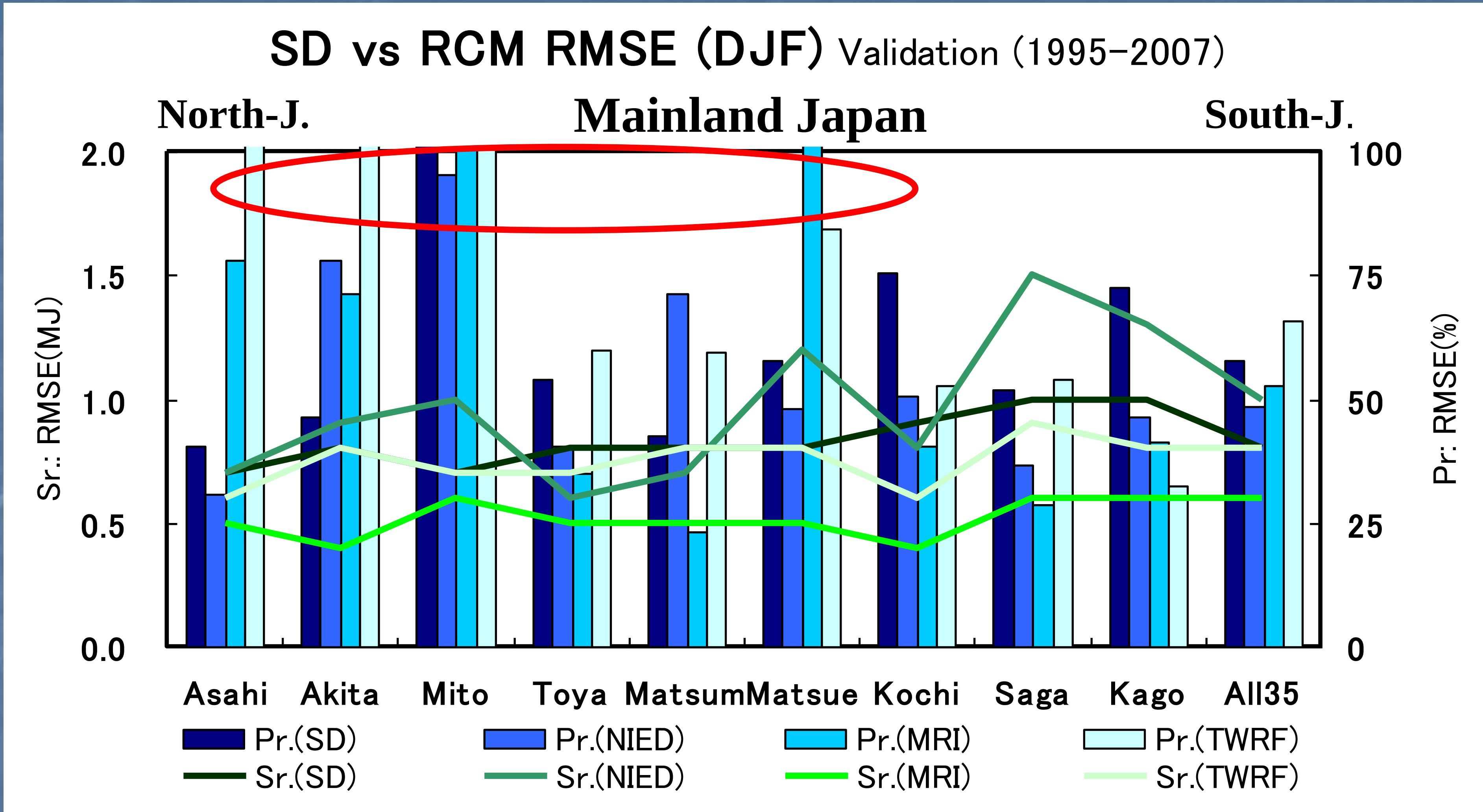




Large squared area (□) for predictor variables as JRA-25 re-analysis dataset. *Shaded (RCM calculated) area and smaller squared area (□) is too small to regress the surface climate variables over Japan.

●**Specially** Analyzed stations (9)
●Other target stations (24)

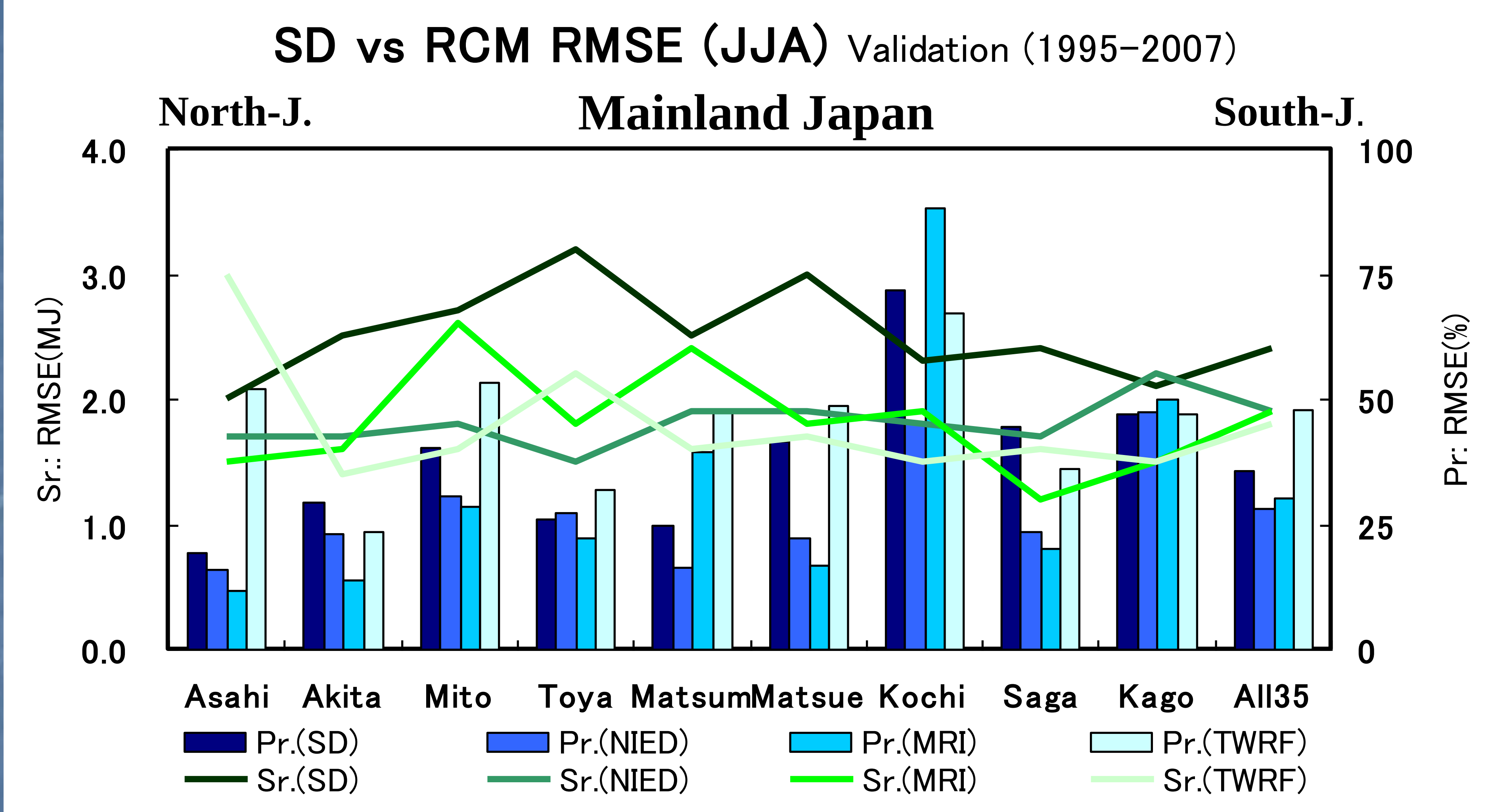
RMSE (SD/RCM vs. OBS): DJF



RMSE of the SD (Sr.) 0.7-1.0 MJ: intermediate in 3-RCMs

SD (Pr.) around 50% of mon. value: (over-WRF; under-MRI)

RMSE (SD/RCM vs. OBS): JJA



RMSE of the SD (Sr.) 2.0-3.2 MJ: slight larger than 3-RCMs
SD (Pr.) around 35% of mon. value: (overestimated in 3-RCMs)

Details of data processing for Valid.

The advantages of the SD and RCMs on inter-comparison

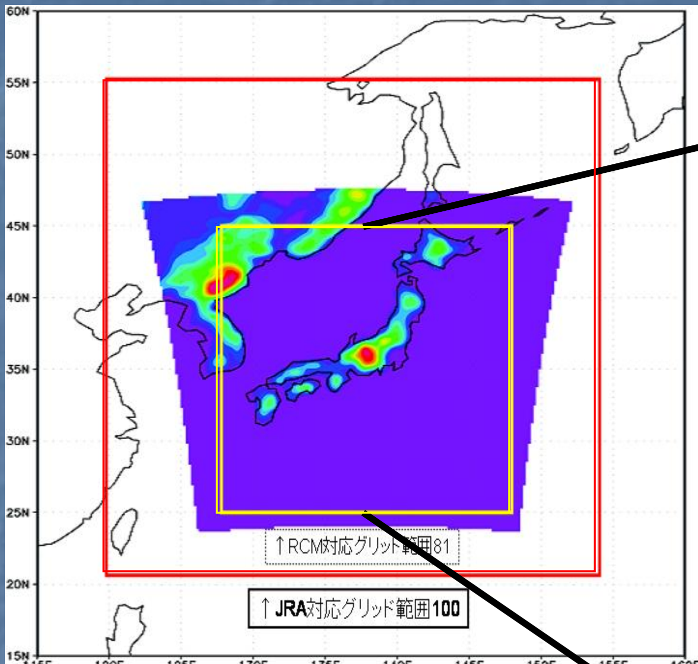
- The SD know observational AVE and STD not only calibration period but also validation period.

* The RCMs also tune to AVE?

Data Process for RCMs

- Tm.: Height adjustment
- Pr. : No correction
- Sr.: Average Correction – due to overestimation for RCMs

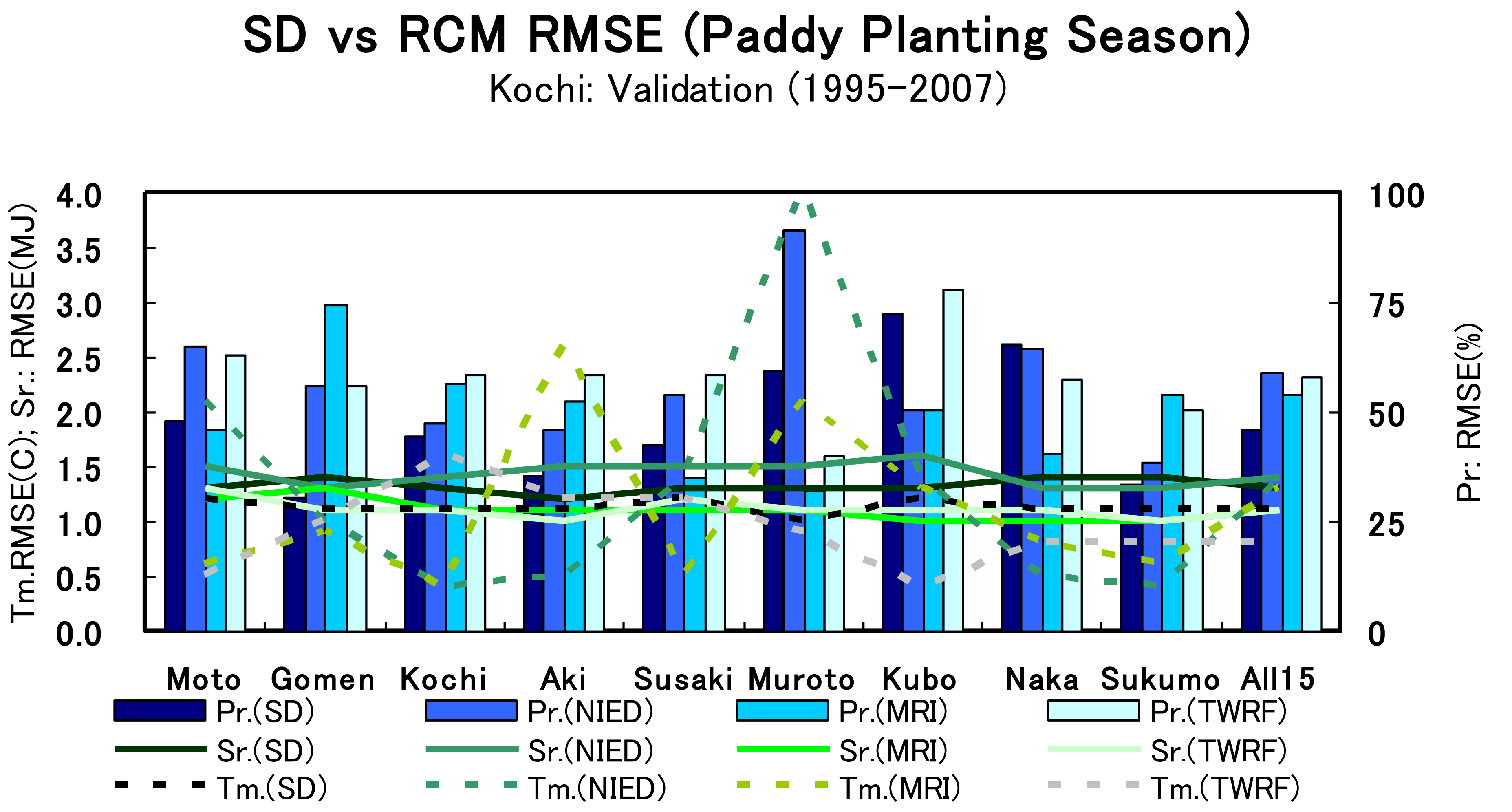
Area of explanation variables and Objective stations of Kochi Pref.



Cultivated Stage for Paddy
@Kochi Pref.

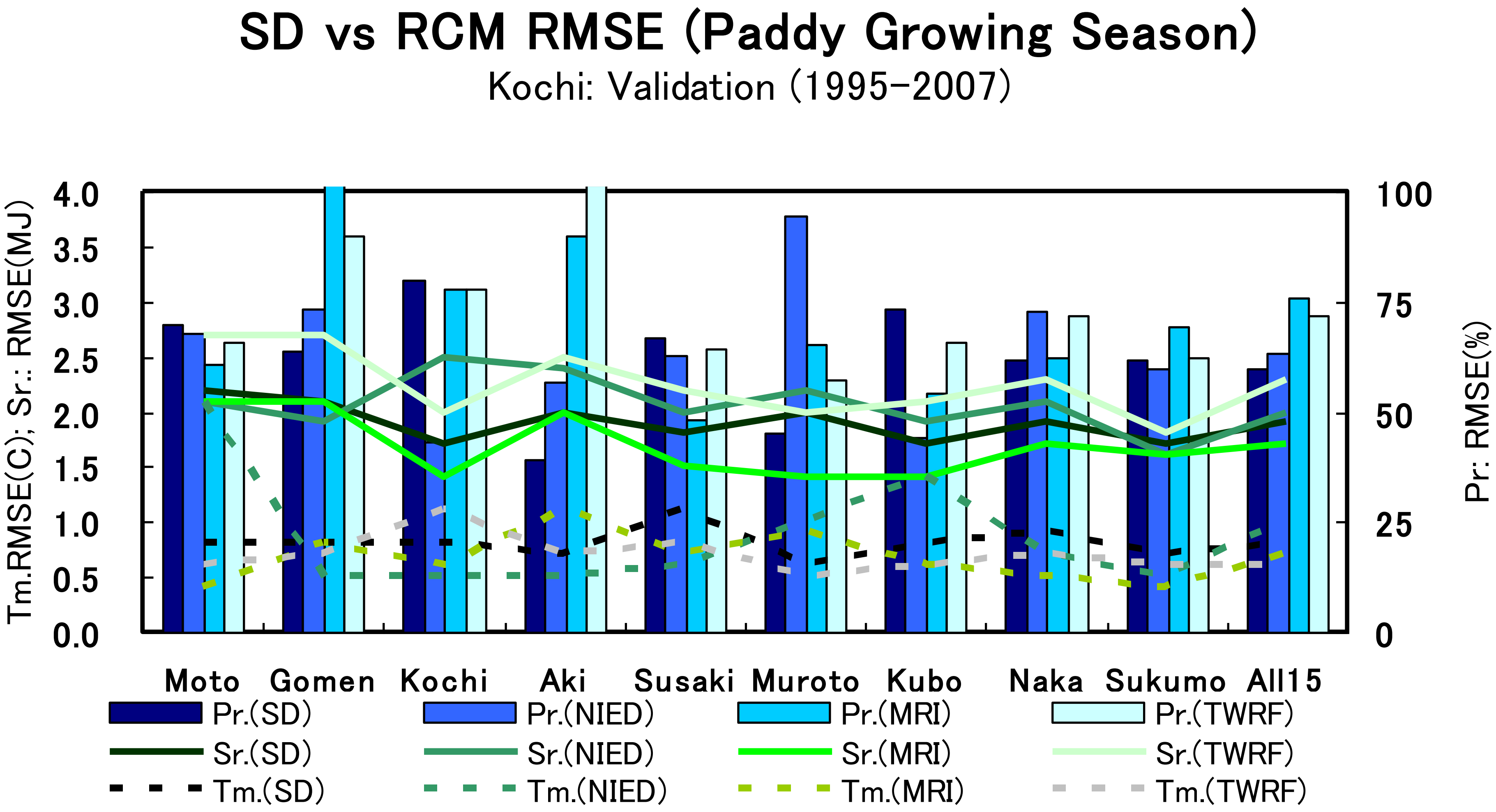
Planting: Mar.-Apr.
Glowing: May-Jun.
Heading/Harvesting:
Jul.-Aug.

RMSE (SD/RCM vs. OBS): JJA



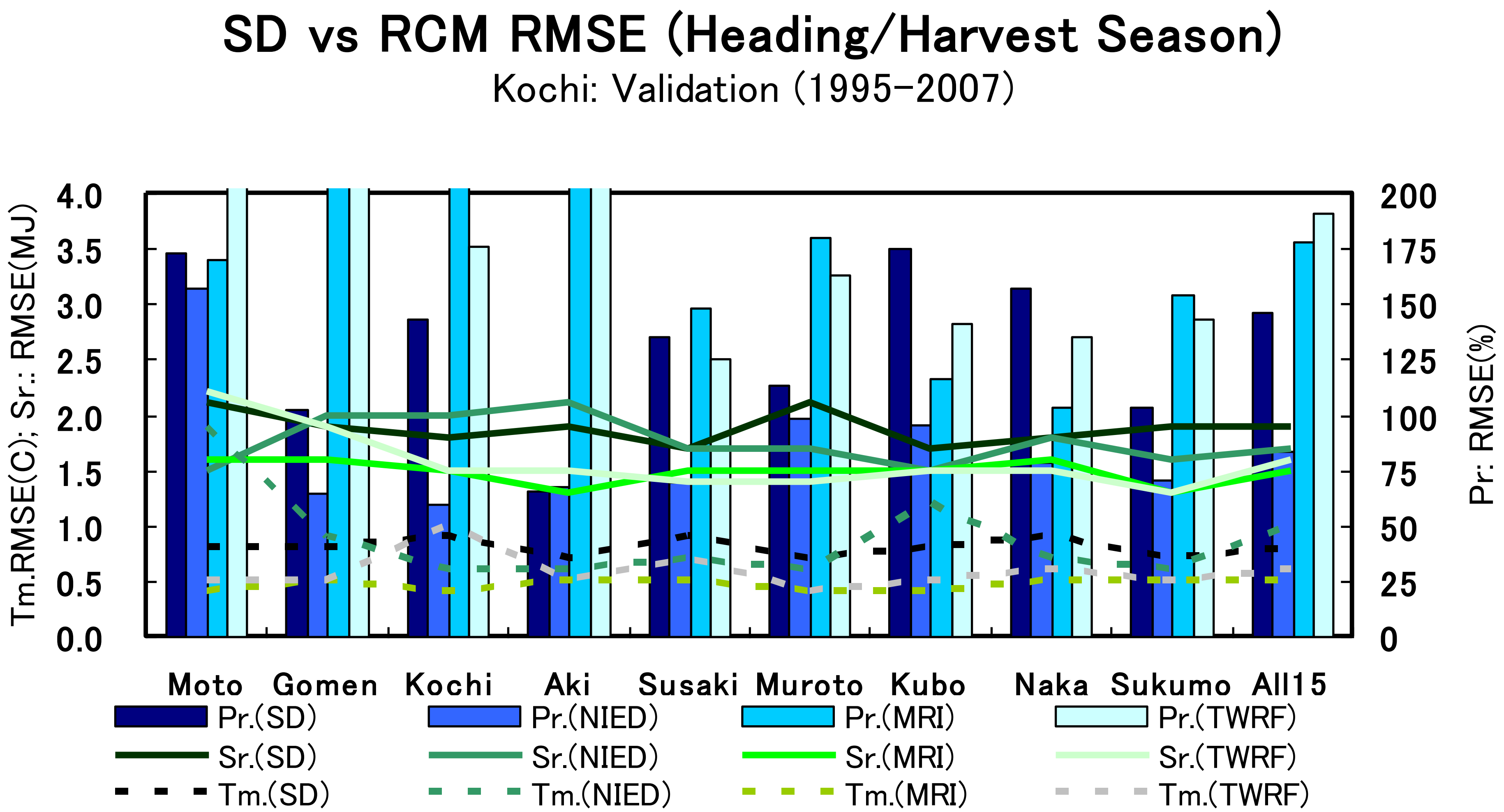
Sr.: 1.0-1.5 MJ, Pr.: around 50% of monthly value on SD and 3-RCMs, but Tm.: 0.5-2℃ (has large local-variability)

RMSE (SD/RCM vs. OBS): JJA



Sr.: 1.5-2.5 MJ and Tm.: 0.5-1.0℃ (almost fixed), but Pr.: around 65% of monthly value (has local-variability for RCMs)

RMSE (SD/RCM vs. OBS): JJA



Sr.: 1.5-2.0 MJ and Tm.: 0.5-1.0℃ (almost fixed), but Pr.: relative large error on both SD and RCMs.

Summary

- Multivariate Multiple Linear Regression (MMLR)-based SDM to project daily timescales Tm., Pr., and Sr. simultaneously by using only regional-scale circulation fields derived from global reanalysis dataset (JRA-25) has been developing for 35 st. over the whole Japan and 15 st. overKochi Pref.

- The SD results are validated compared with those of RCMs driven by the same boundary conditions.

✓For 1995-2007, our MMLR-SD has almost good estimation even on daily scale Tm., Pr. and Sr. even in two analysis setting (All-Japan and Kochi).

*NIED-RCM has good estimation esp. for Pr., MRI-NHM is also good for Sr.

Disucssion

Discussion:

Influence of Calibration Period Choice on MMLR-SD

- ✓ No significant effect by the case study on E. Canada
  - Gachon et al.
- ✓ Significant influences in Japan
  - empirically by the Authors
  - our next subject

Other Further Studies:

- ✓ Extreme elements (daily/hourly maximum precipitation) or indices (Q90 etc.)
- ✓ Project agriculture-related elements (RH, WS)