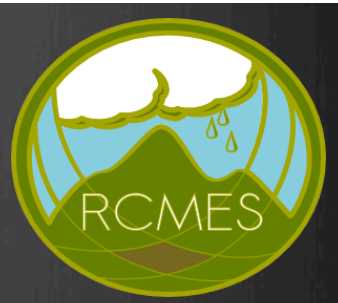

Evaluation of simulation fidelity for precipitation, cloud fraction and insolation in the North America Regional Climate Change Assessment Program (NARCCAP)

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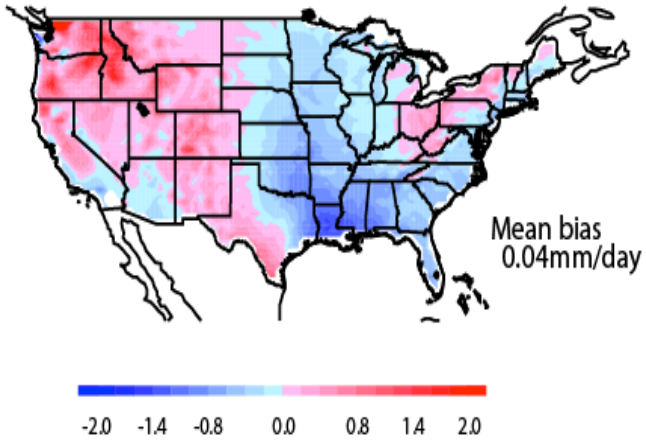
Motivation

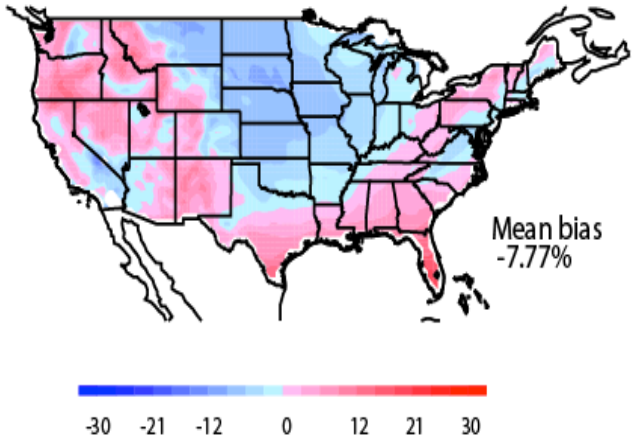
- Kim et al. [2013], Evaluation of the surface climatology over the US in the NARCCAP Hindcast experiment using RCMES, *J. Clim*.
  - precipitation and cloud fraction biases in the NARCCAP regional climate models (RCMs) are generally positively correlated over the conterminous U.S.
  - strong negative correlation between cloud fraction and surface insolation

spatial anomaly of biases (bias – spatial mean of bias)

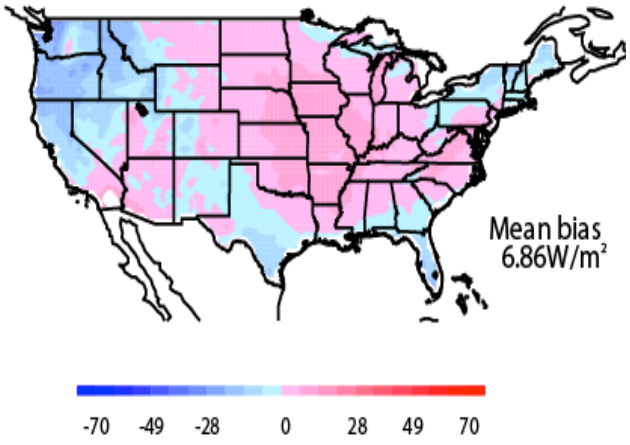
precipitation



cloud fraction (CF)



surface insolation (RSDS)



Objectives

- Use Regional Climate Model Evaluation System (RCMES) for evaluating precipitation, cloudiness and surface insolation against observational data from various sources

- Comprehensive evaluation of precipitation, cloud fraction (CF) and surface insolation (RSDS) considering their physical relationships each other.
  - quantitative comparison of two-dimensional probability density functions (PDFs) between observations and models for pairs of variables

Regional Climate Model Evaluation System (RCMES)

http://rcmes.jpl.nasa.gov, powered by Apache SOFTWARE FOUNDATION

- RCMES is an open source software package developed by NASA's JPL and UCLA to facilitate the evaluation of RCMs. (please see Jinwon Kim's poster, P3-30)

Input (on user's computer)

- model outputs: NARCCAP RCM outputs from Earth System Grid

- Script file: ID numbers of observational data, spatial and temporal regridding option

Extract OBS data

Run RCMES

Database

- User requested data: TRMM, CRU, GPCP, UDEL, CPC and SRB

Output and metrics

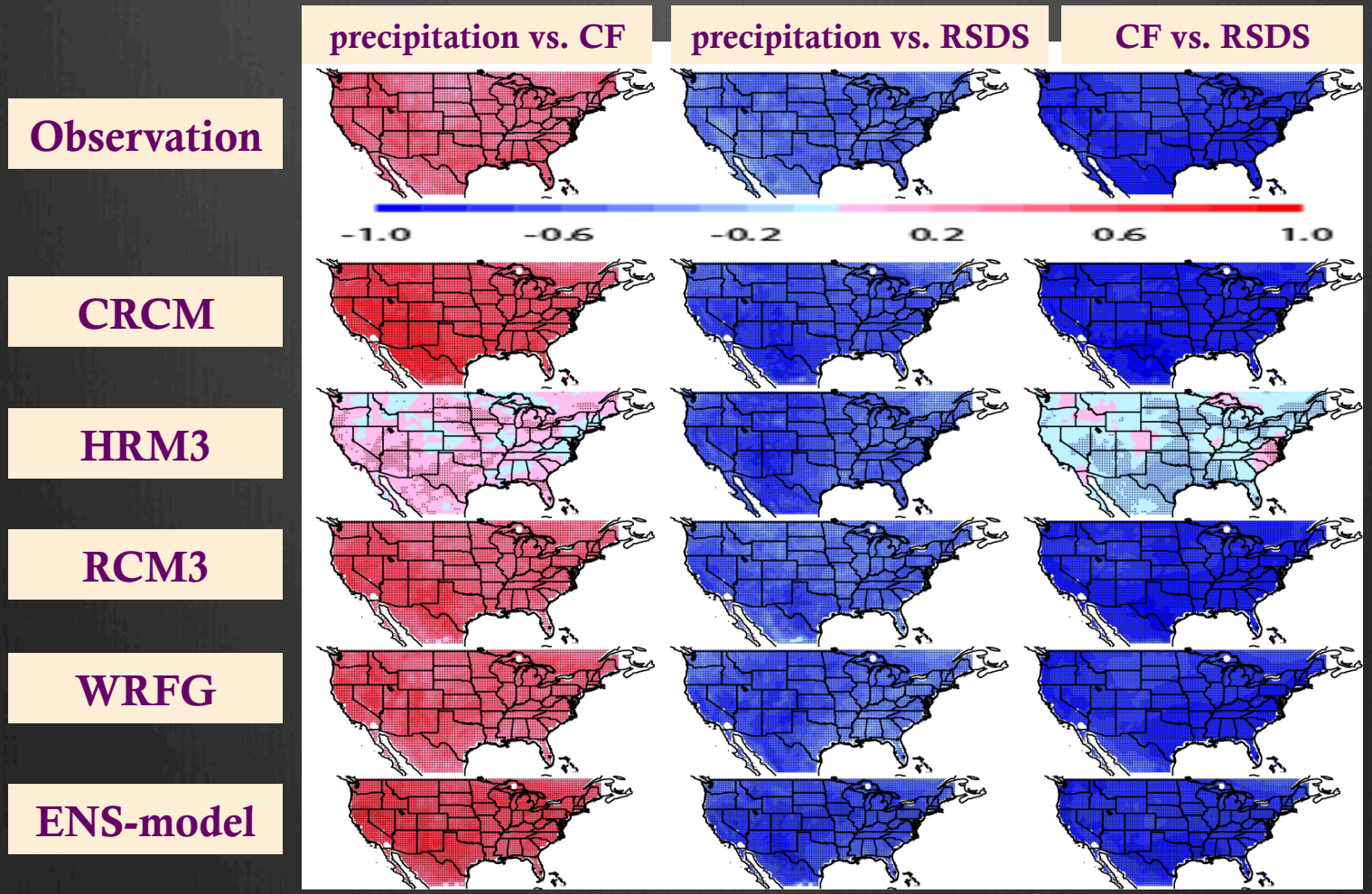
- NetCDF file: observations and model outputs regridded on common grid points
- Calculation of metrics: Gaussian Kernel estimation of 2D PDFs, PDF overlap calculation
- Plotting: graphs, map projection, Taylor diagram and portrait diagram

Data

- 1984 March ~ 2003 February (19 years) except TRMM data.

NARCCAP models	Observations (from RCMES database)	
	Variable	Source
CRCM HRM3	precipitation	ensemble of four observations (CRU 3.1, UDEL, GPCP and CPC)
RCM3	precipitation and convective precipitation	TRMM ver. 7 3A21 (1997 December -2003 November)
WRFG ENS-model	cloud fraction (CF) and surface insolation (RSDS)	NASA/GEWEX Surface Radiation Budget (SRB) Release 3

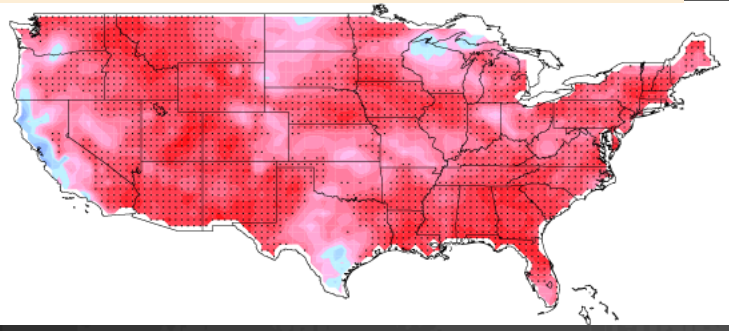
Temporal correlation coefficient between precipitation, CF and RSDS



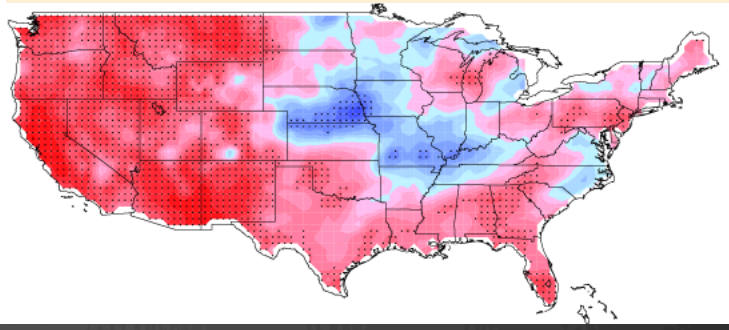
- Unlike the other RCMs, one model shows weak correlation between cloud fraction (CF) and precipitation and between CF and surface insolation (RSDS).

Precipitation-CF relationship in summer and winter

Observation (summer, JJA)

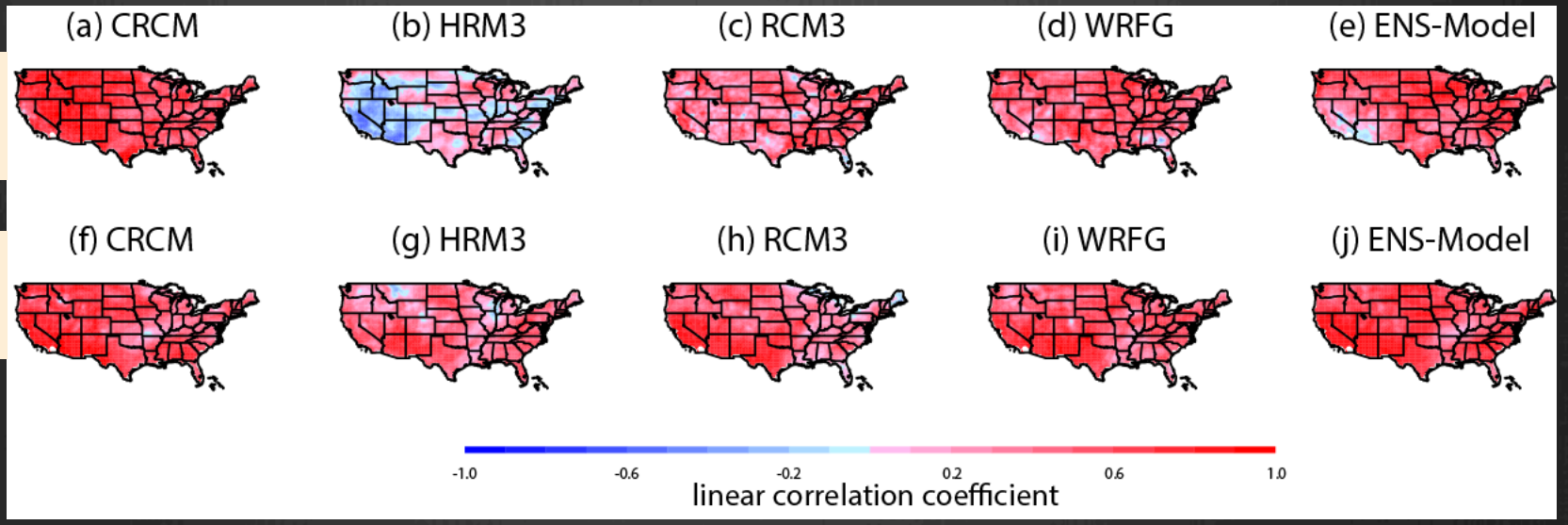


Observation (winter, DJF)



Models (summer)

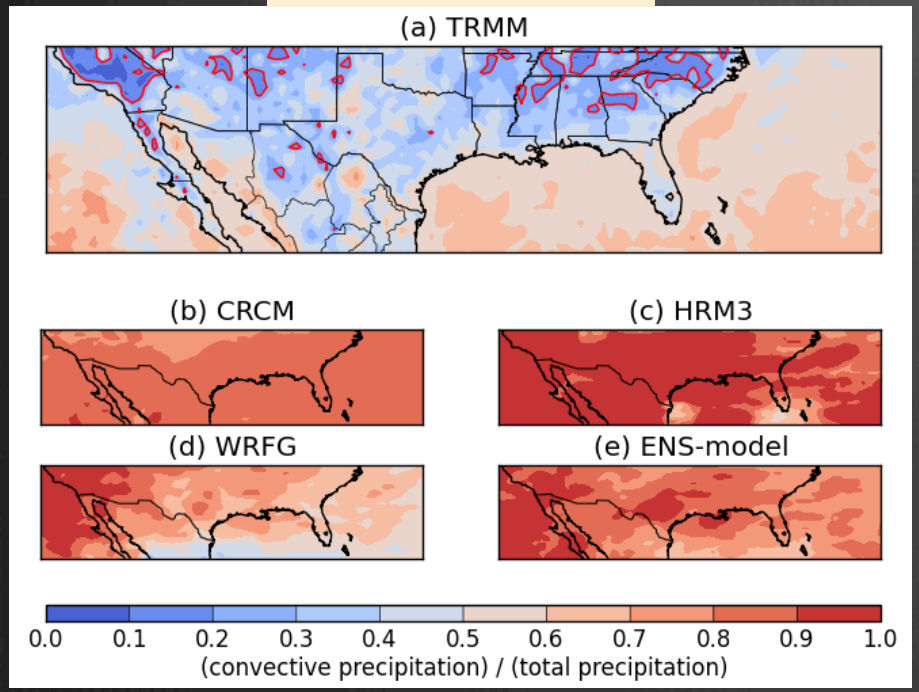
Models (winter)



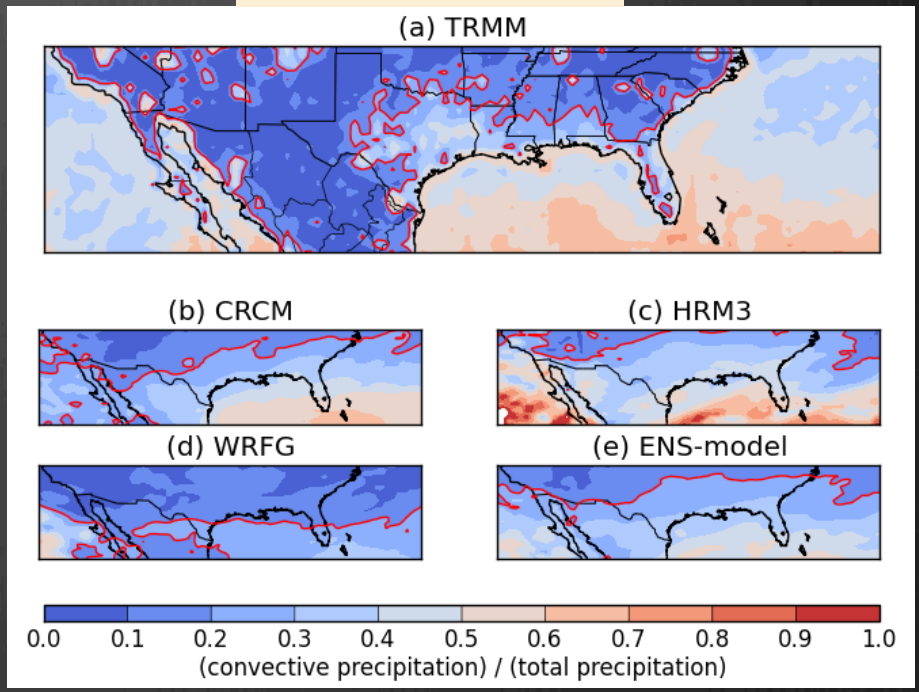
- In summer, HRM3's problem in the relationship between precipitation and CF is pronounced in western US.
- In winter, no model reproduces the weak correlation between precipitation and CF in Midwest and Southeast Coast.

Fraction of convective precipitation

Summer (JJA)

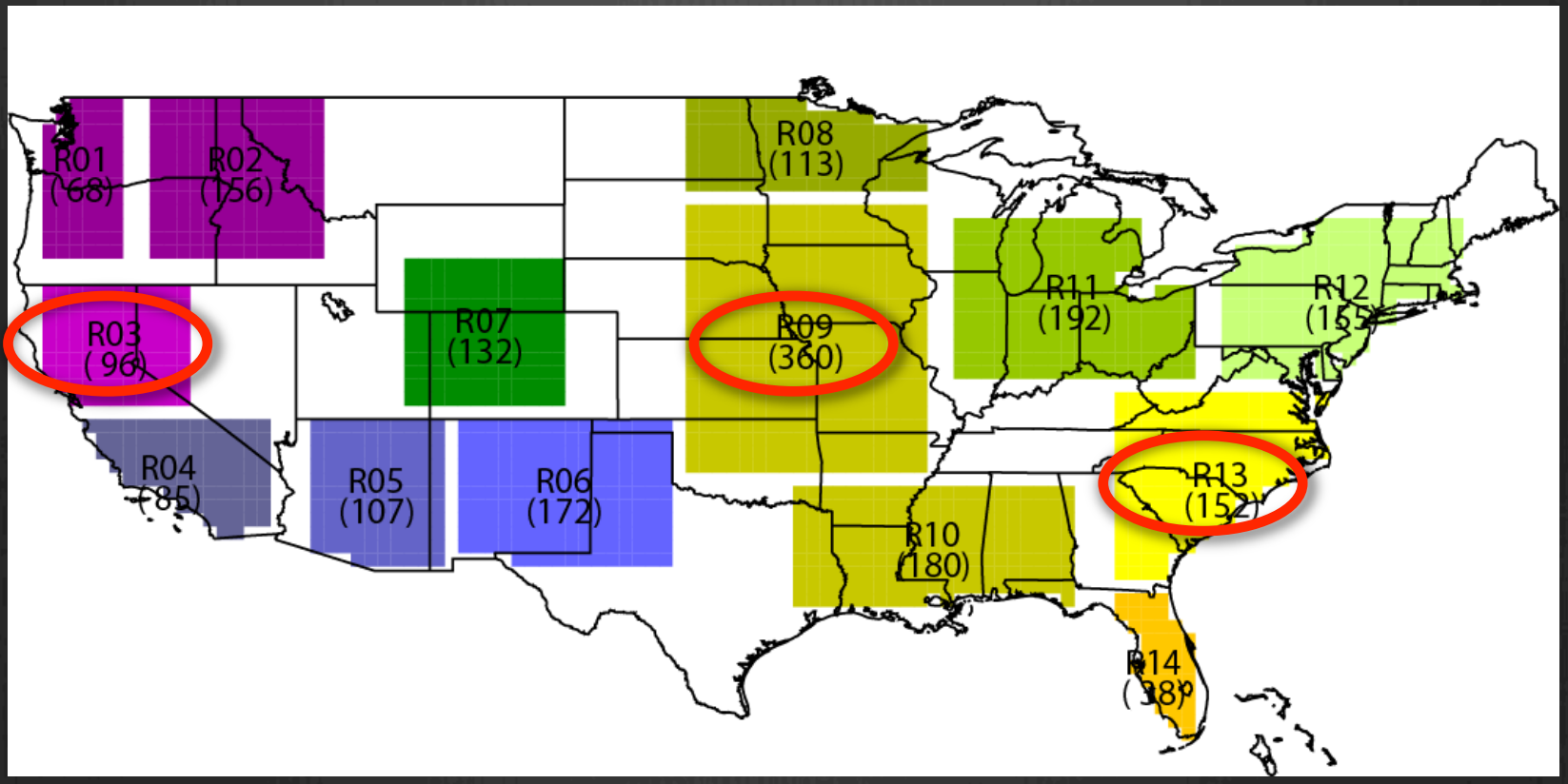


Winter (DJF)



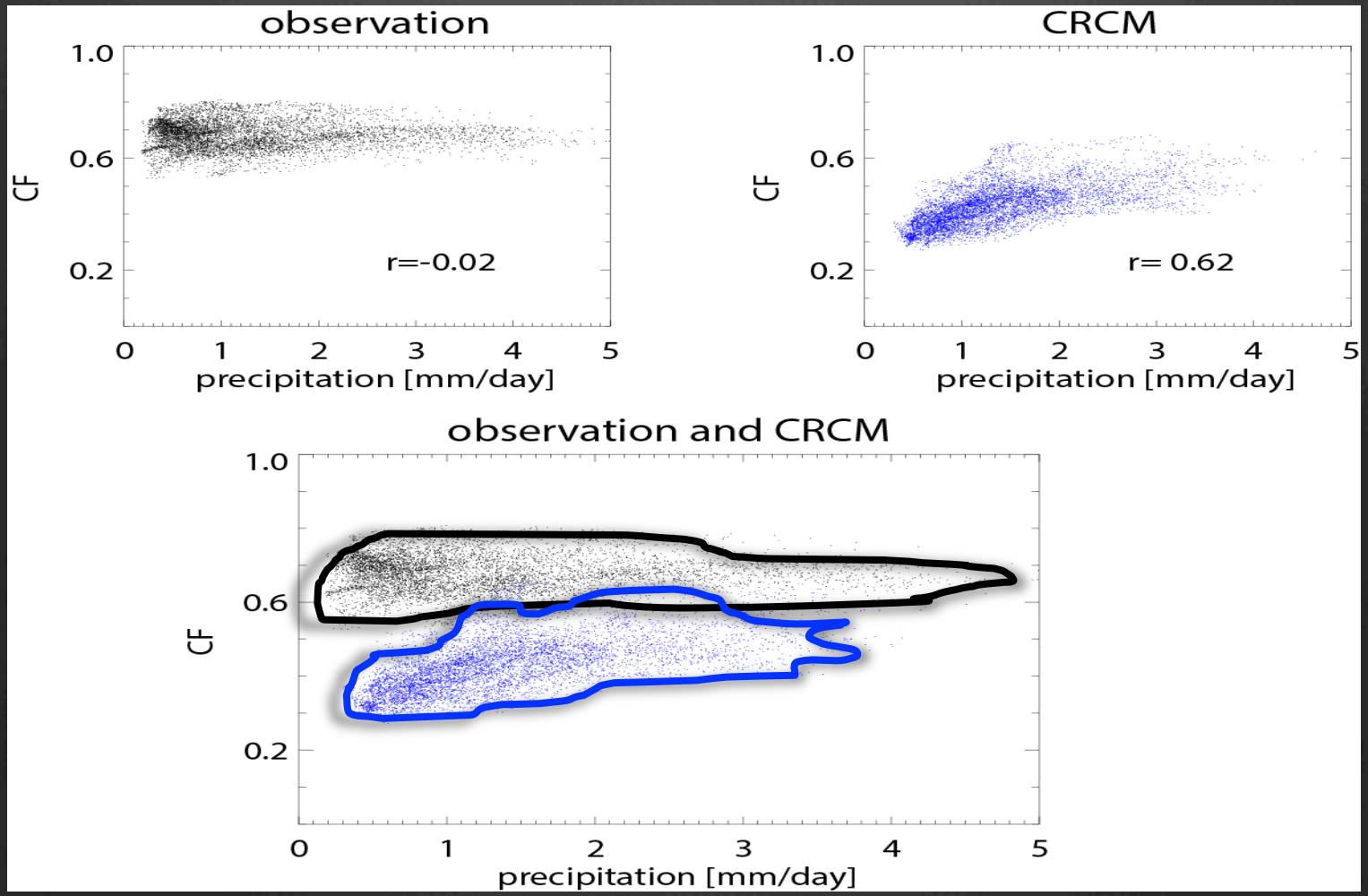
- In general, the models show higher ratio of convective precipitation than the TRMM estimate especially in summer.

14 sub-regions according to regional climate characteristics



Kim et al. [2013]

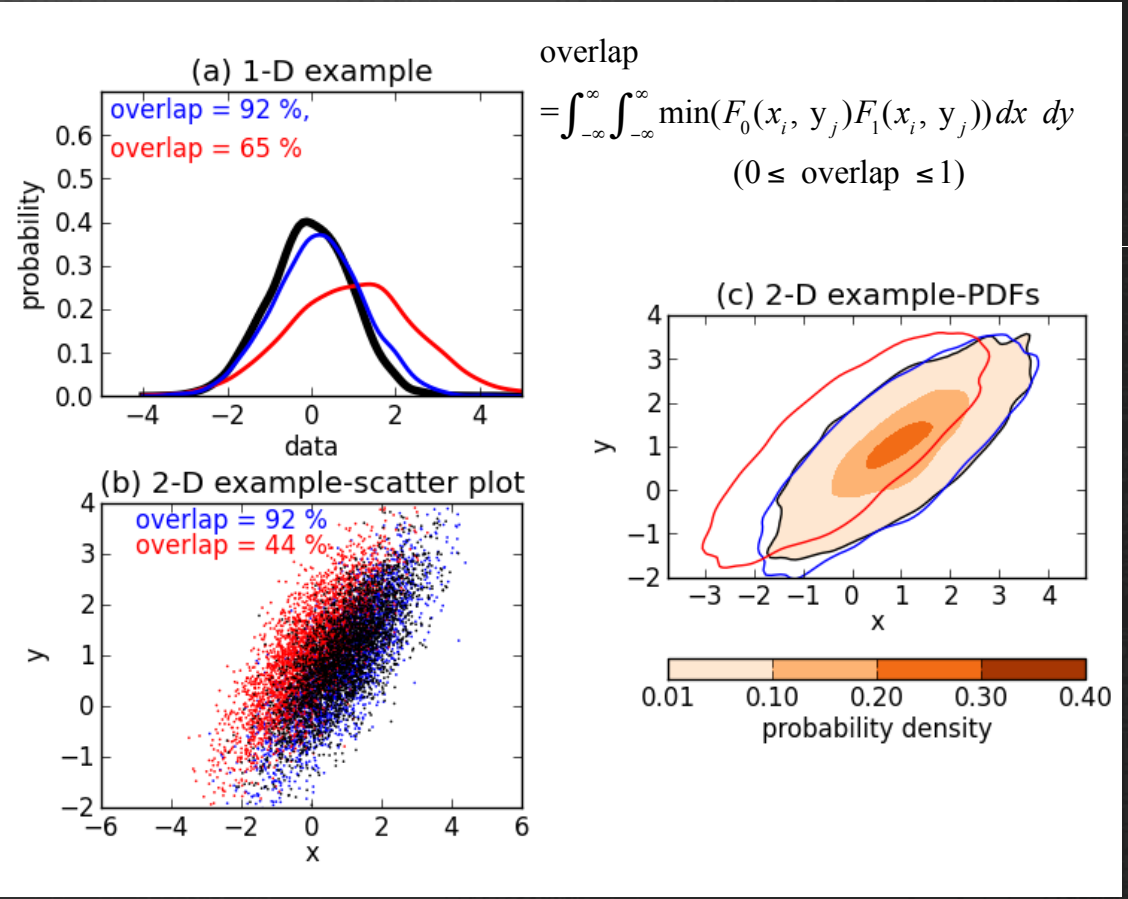
precipitation-CF relationship in South Great Plains (R09) in winter



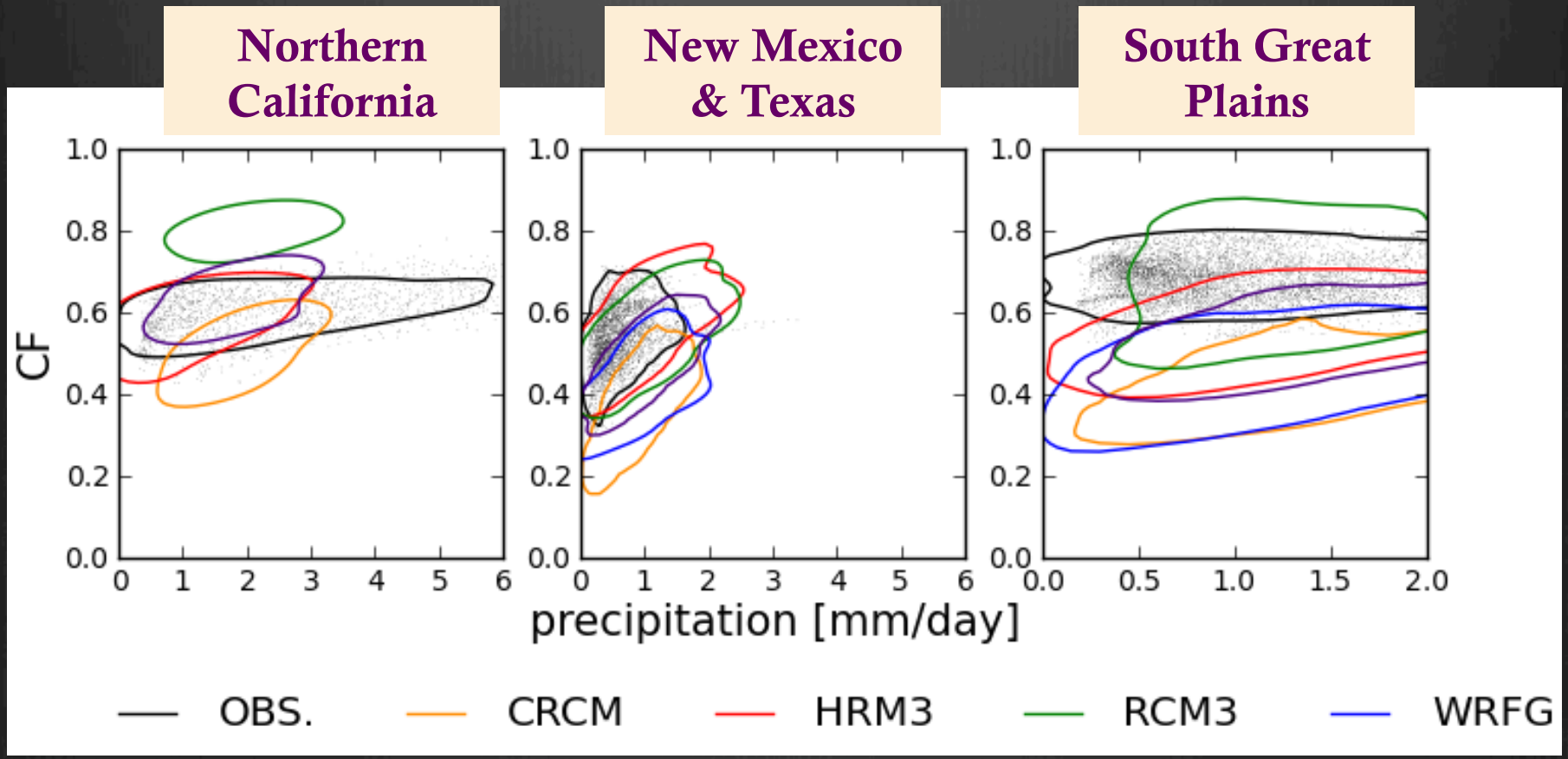
- How can we quantify the similarity between two scatter plots?

Quantitative comparison of scatter plots

- Application of probability density function (PDF) skill score used in *Perkins et al. (2007)* to two-dimensional PDFs
- A two-dimensional PDF of two variables can be built using Gaussian Kernel density estimation.
- The calculated overlap values vary from 0 to 1.
- Larger overlap values indicate closer agreement between two PDFs.



Precipitation-CF PDFs (winter)



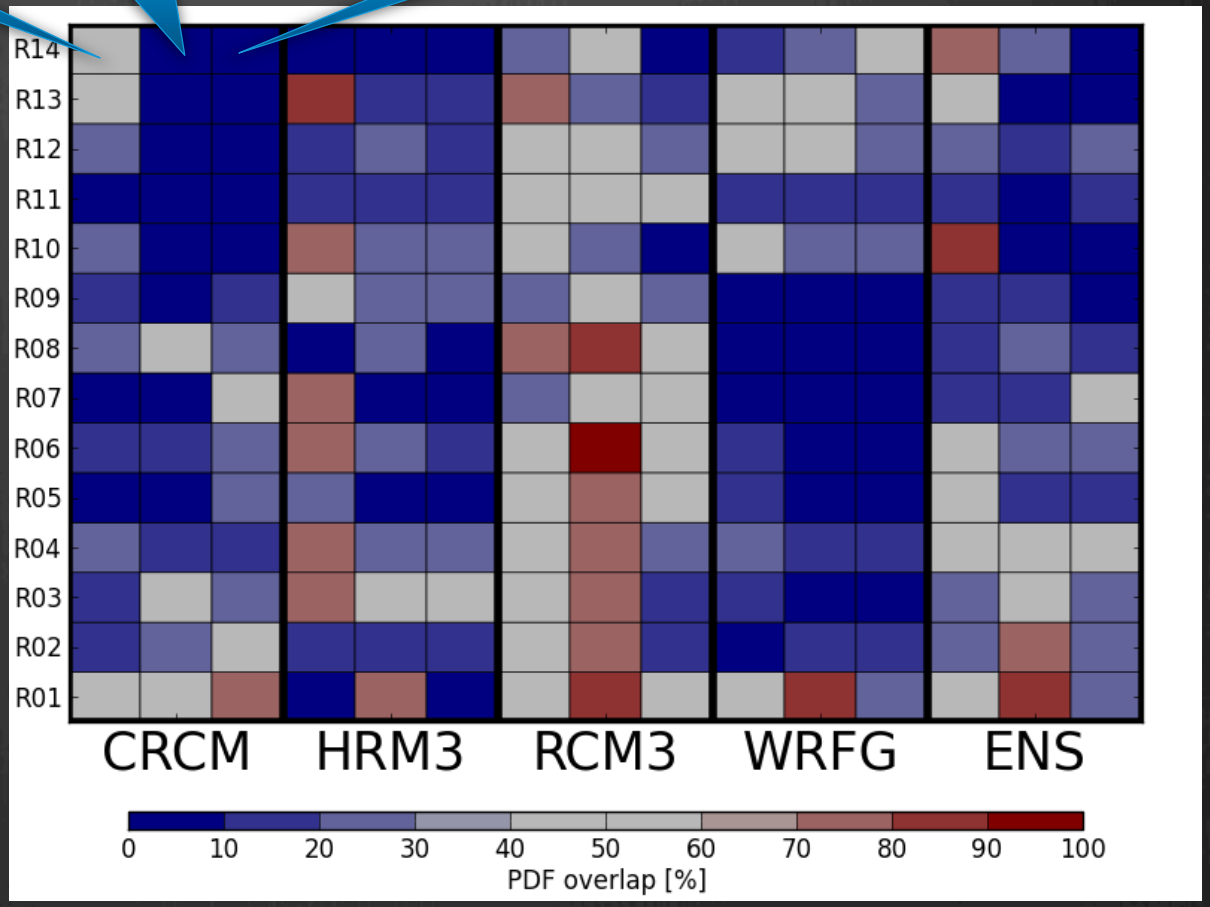
Portrait diagram to summarize the overlap ratio

precipitation-CF

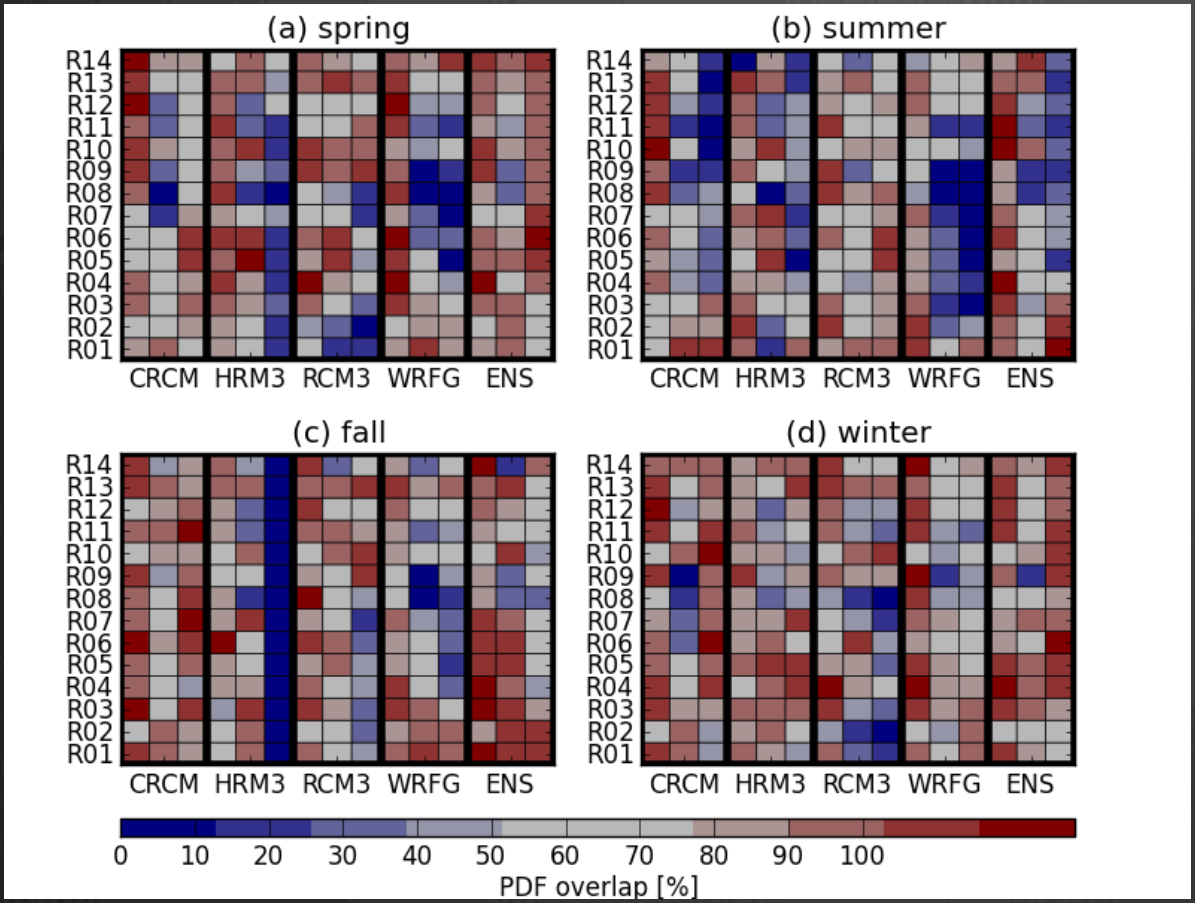
precipitation-RSDS

CF-RSDS

sub-regions



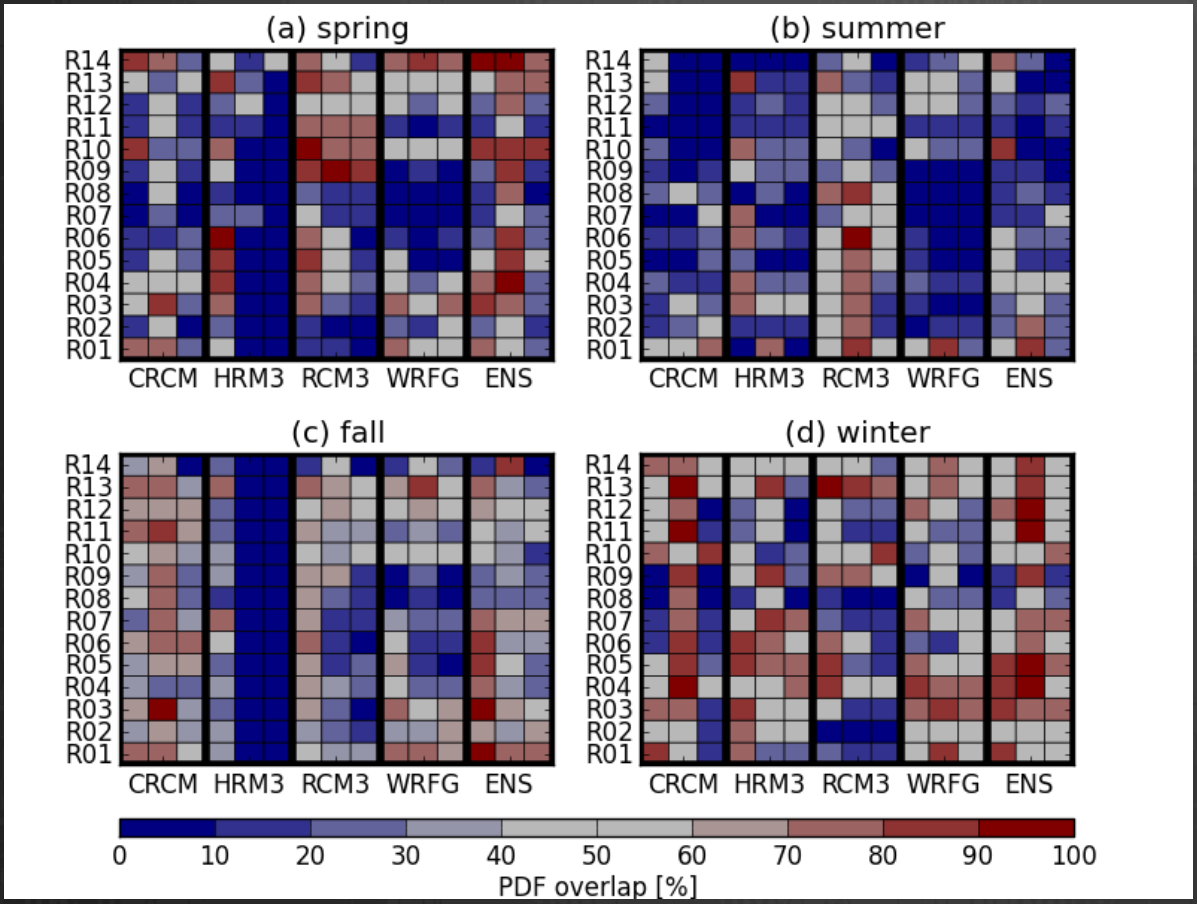
Performance of RCMs (comparison of univariate PDFs)



column 1	column 2	column 3
Prec.	CF	RSDS

- Overall, the overlap of precipitation PDFs is higher than other variables.
- In winter and spring, ENS-model shows good performance in reproducing observed precipitation and RSDS.

Performance of RCMs (comparison of bivariate PDFs)



column 1	column 2	column 3
Prec.-CF	Prec.-RSDS	CF-RSDS

- This portrait diagram highlights some problems of models: CRCM (summer), HRM3 (spring and fall), RCM3(western U.S except summer) and WRFG (spring and summer)

Conclusions

- Using Regional Climate Model Evaluation System (RCMES), the relationships between precipitation, cloud fraction and surface insolation were investigated.
- The fraction of convectional precipitation is higher in NARCCAP RCMs than TRMM estimate.
- Our two-dimensional PDF comparison concisely summarizes model performance in simulating precipitation, CF and RSDS.
- Performance of each model differs markedly between sub-regions and also shows seasonal dependence.
- RCMES provides regridded observational and model data and tools to calculate overlap ratio with one- and two-dimensional PDFs and visualize the results.