Some thoughts on Regional dynamic downscaling ability

Yongkang Xue
Department of Geography
Department of Atmospheric & Oceanic Sciences
University of California, Los Angeles

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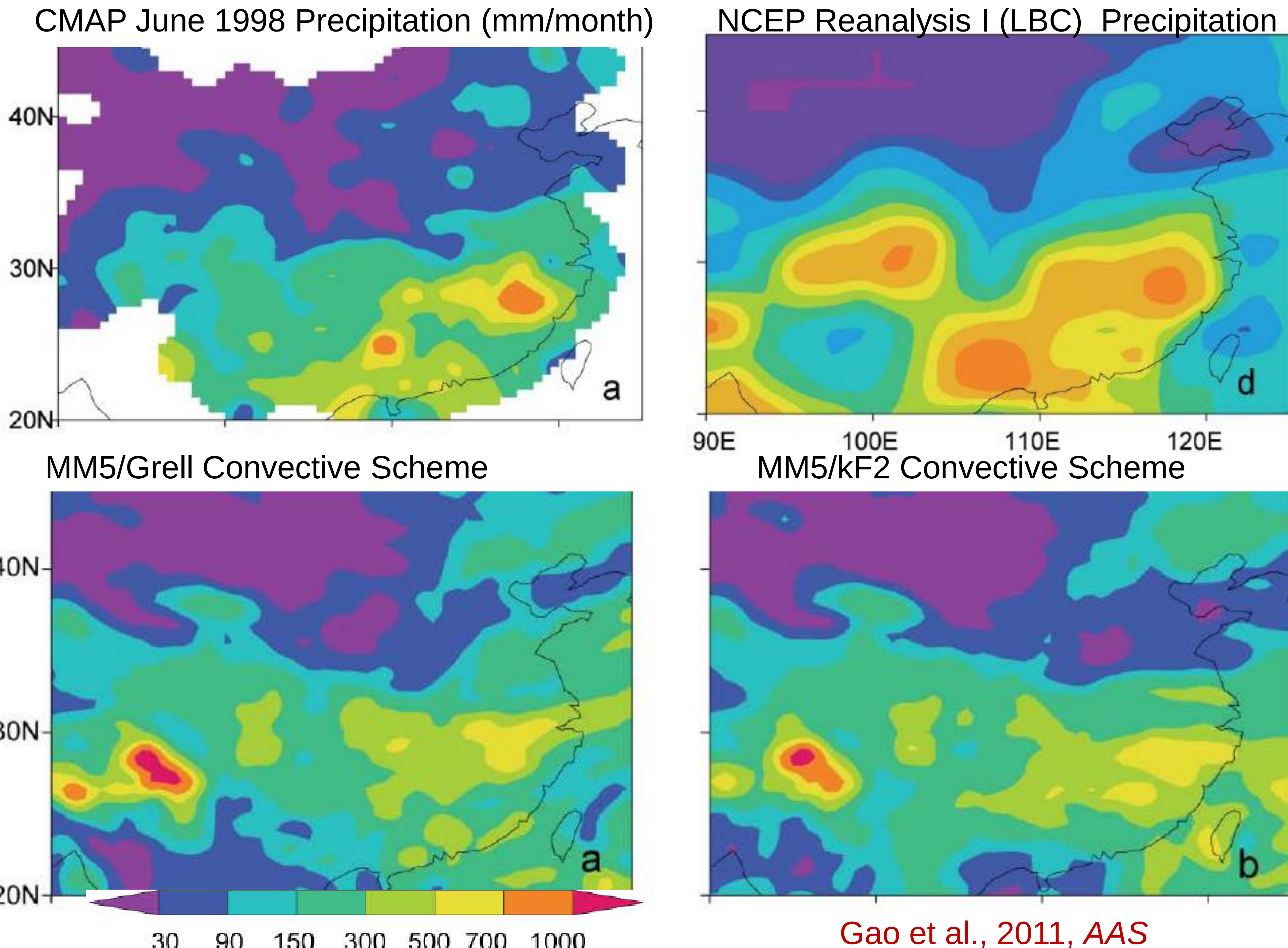
Questions: Whether the downscaling is capable to provide more information than the imposed LBCs.

Note: Sensitivity does not always equal to Downscaling ability.

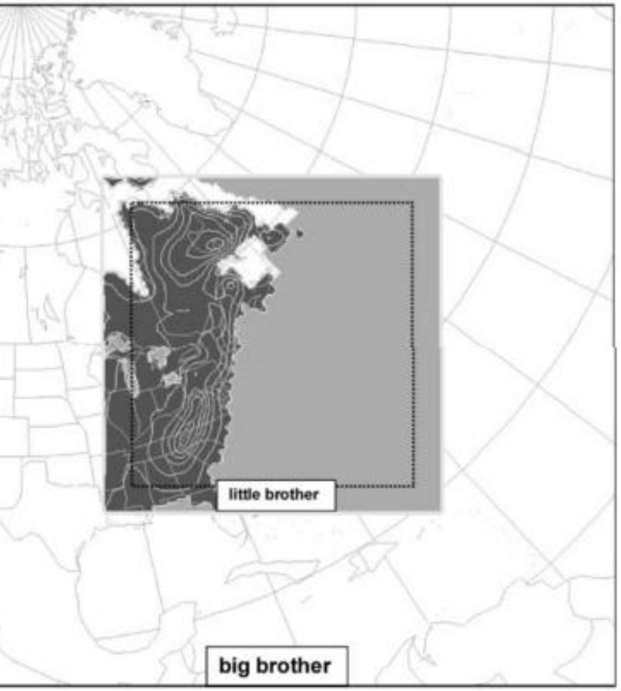


Gao et al., 2011, *AAS*

Questions: The most important issue is whether, and if so, under what conditions the dynamic downscaling method (DDM) is really capable of improving/adding more climate information at different scales compared to the GCM or reanalysis that imposes LBC to the RCMs. This is a fundamental question to the DDM and the assumption, “yes,” to this question, should be the motivation for using the DDM for regional climate study in the first place.

An issue: for regional climate downscaling: global reanalyses in many cases are not proper to evaluate RCMs. Two approaches have been taken to solve this issue.

Denis et al.'s "Big-Brother" approach (2003, *CD*)



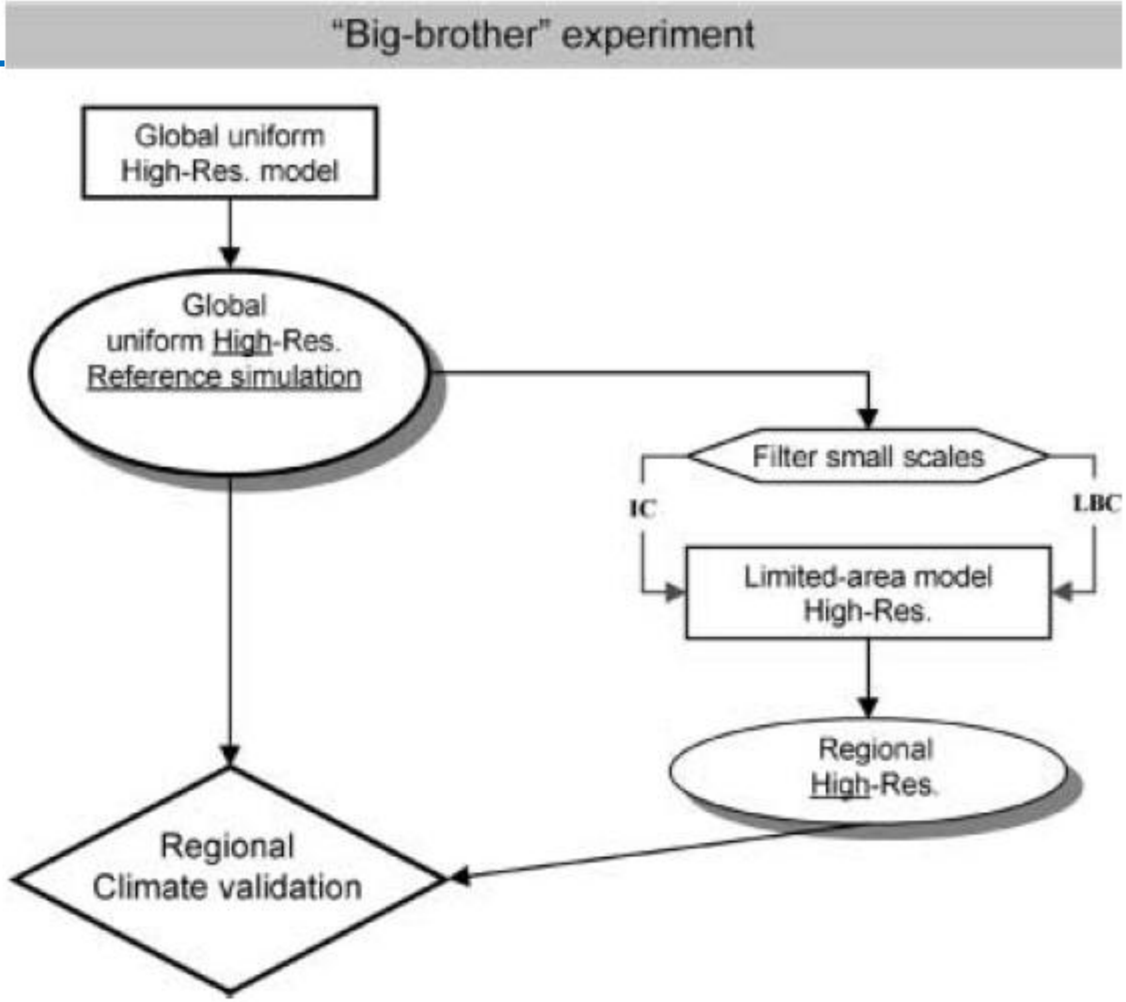
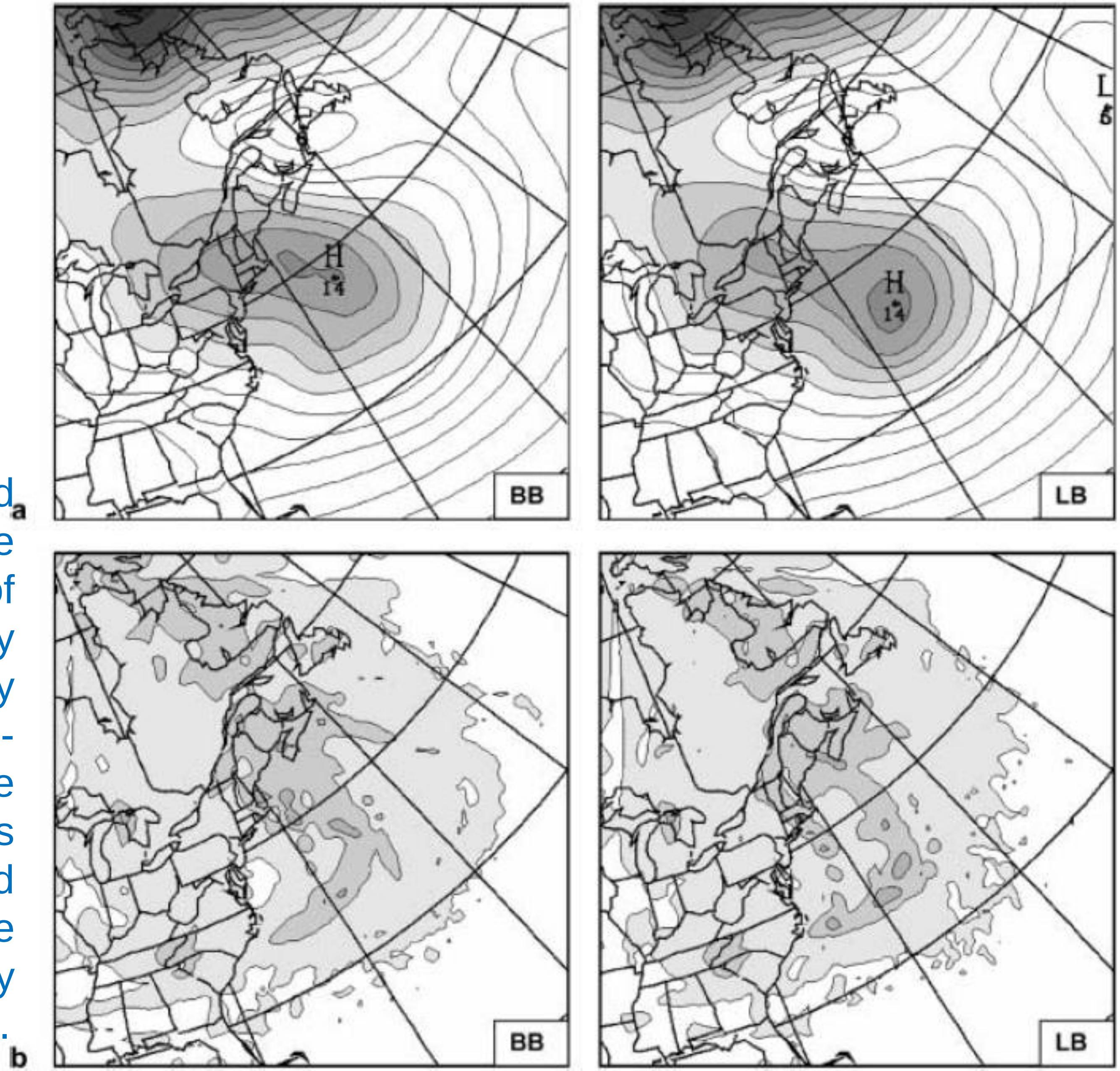


Fig. 1. The Big-Brother Experiment flowchart. *Rectangles* are the models and *ovals* are their corresponding datasets. The *diamond* represents validation of the Little-Brother regional-scale features against those existing in the reference Big-Brother dataset. The initial conditions (IC) and lateral boundary conditions (LBC) for LAM (*right branch*) are spatially filtered such that the small scales are removed

Fig. 10. **a** Transient eddy standard deviation of *slp*. Contours are every 1.0 hPa. Regions with values higher than 10 hPa are *shaded*. Correlation coefficient $R = 0.99$. For land only: $R = 0.99$, for ocean only: $R = 0.99$. **b** Transient eddy standard deviation of the small-scale component of *slp*. Contours are every 0.2 hPa. Regions with values higher than 0.2 hPa are shaded. Correlation coefficient $R = 0.88$. For land only: $R = 0.90$, for ocean only: $R = 0.85$



The time mean and variability of fine-scale features in a number of field are successfully reproduced, particularly over regions where small-scale surface forcings are strong. Over other regions such as the ocean and away from the surface, the small-scale reproducibility is more difficult to achieve.

Other approach uses regional Reanalyses and high resolution observational data for evaluation.

Results indicate the DDM add useful information in a number of experiments, especially when the case associated with topography or high frequency events.

TRMM July 2002 Precipitation (mm/day)

Afternoon Morning Afternoon-Morning

MM5-SSiB Simulation

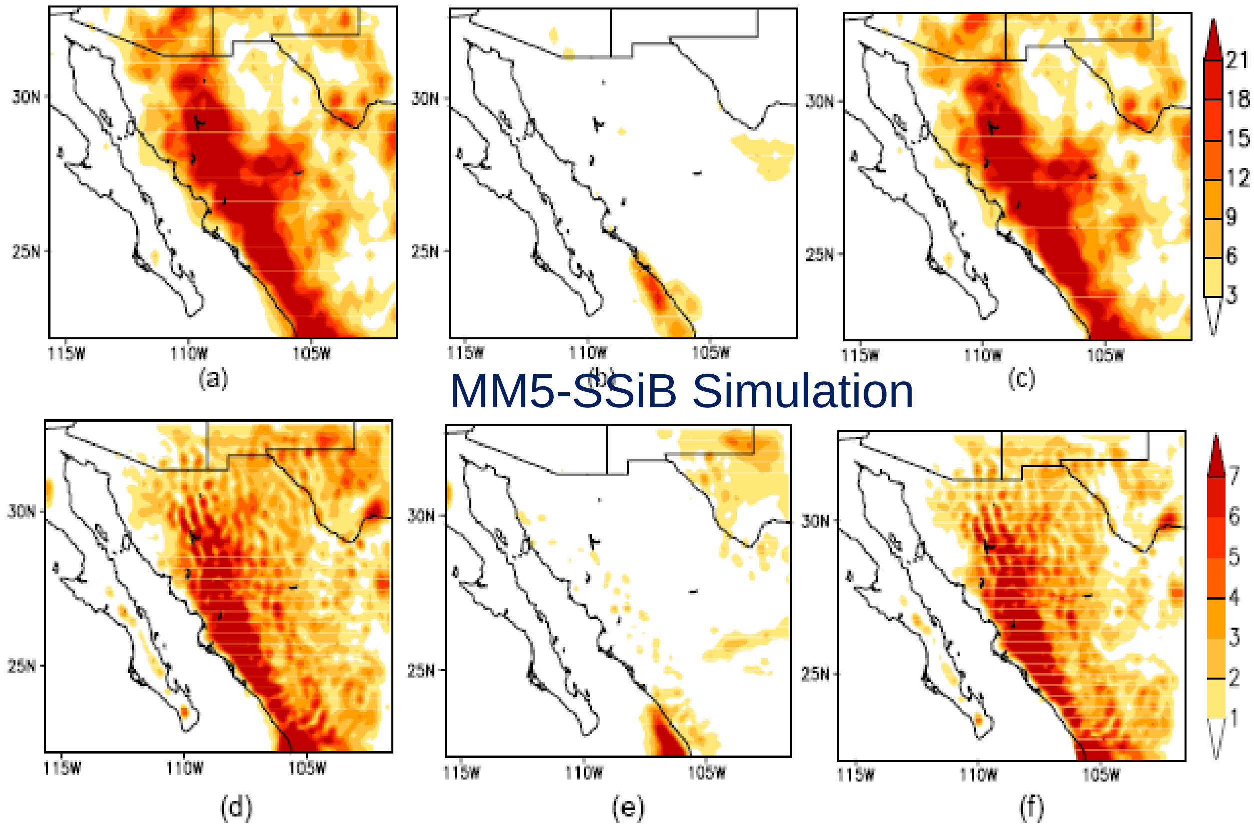


Fig.3 Diurnal cycle comparisons of precipitation between the MM5-SSiB simulation and TRMM estimates for July 2002. (a) TRMM afternoon; (b) TRMM morning; (c) TRMM afternoon-morning; (d) MM5-SSiB afternoon; (e) MM5-SSiB morning; (f) MM5-SSiB afternoon-morning, where afternoon is defined as the period 1400-2300 LST and morning as 0200-1100 LST.

Zou and Zheng, 2004, *JGL*

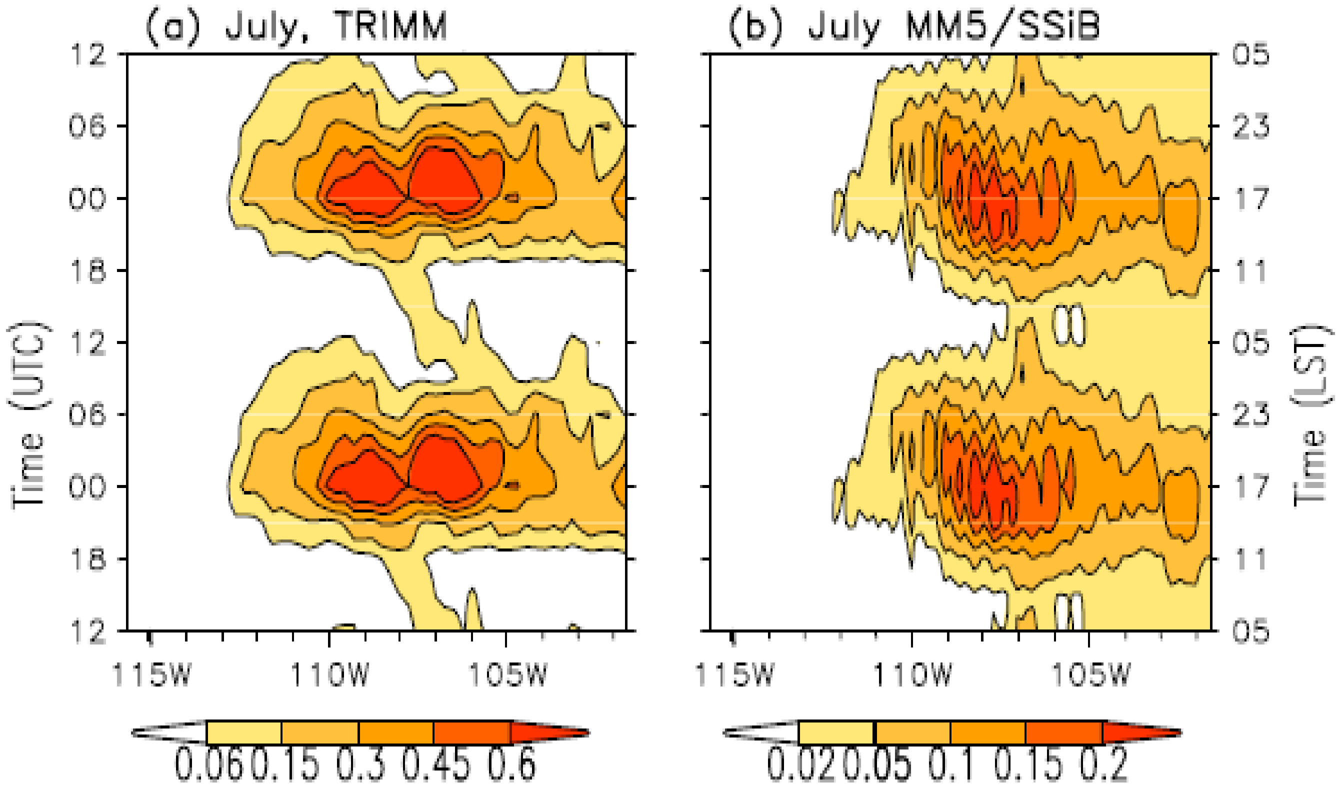
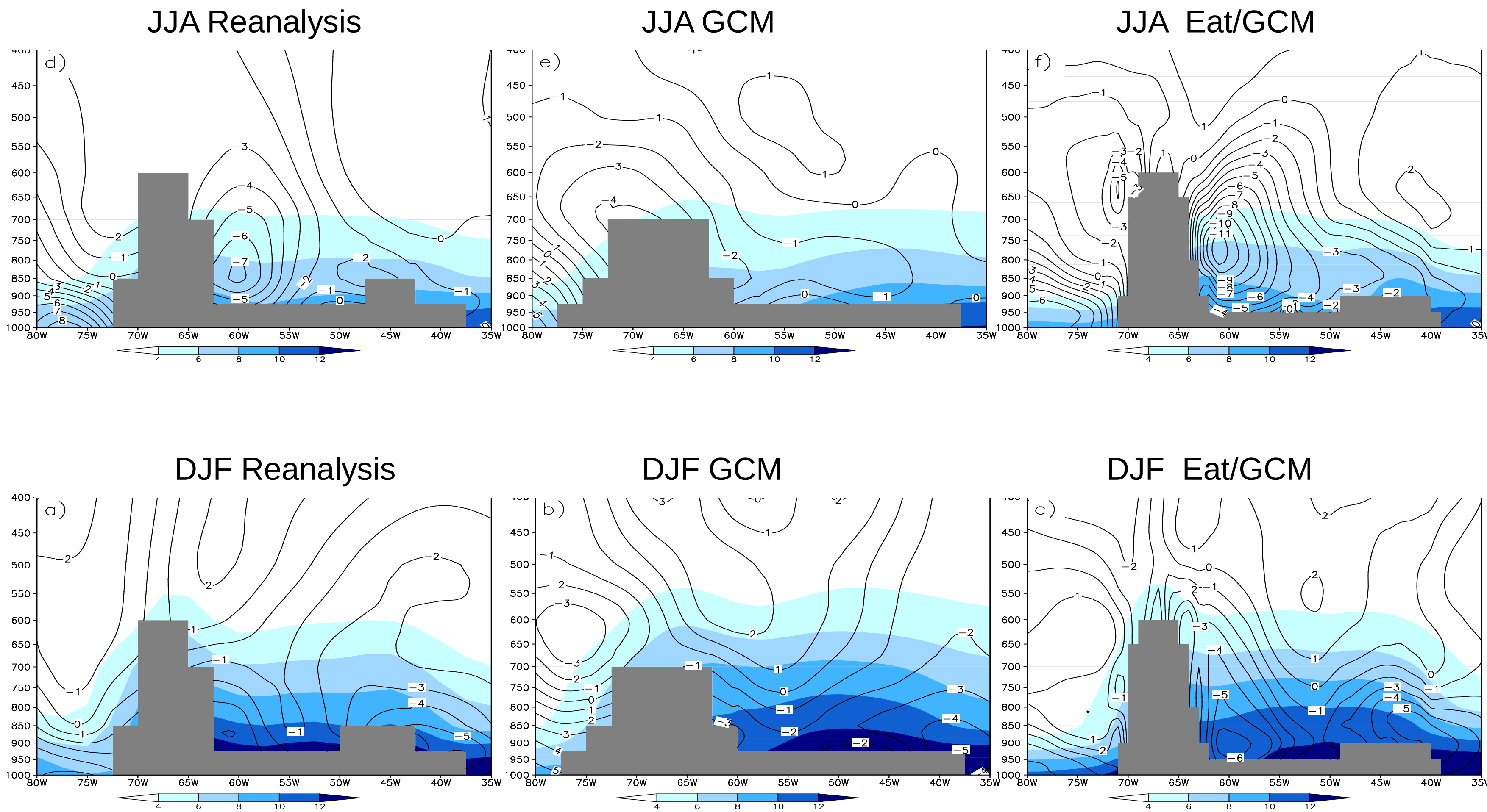


Fig. 4 Diurnal variation of rainfall (mm hr^{-1}) for the July 2002 monthly mean along the longitude 115.5^0-101.5^{0}W overadded over the latitudinal belt of 22.5^0 to 32.5^{0}N.

DJF and JJA mean meridional wind speed [m s^{-1}] (contour lines) and specific humidity [g kg^{-1}] (shading) along 20.0° S (S. America)

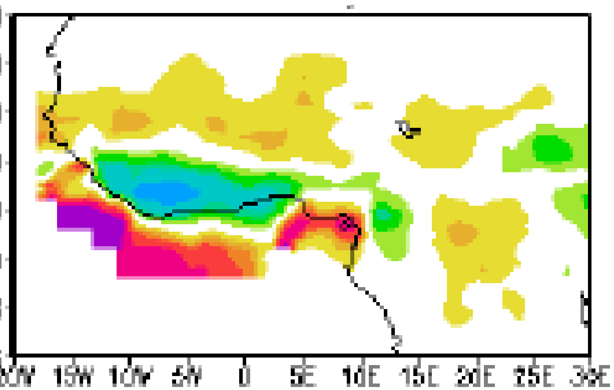


De Sales & Xue, 2006, *JGR;* 2010, *Int. J. Cli*

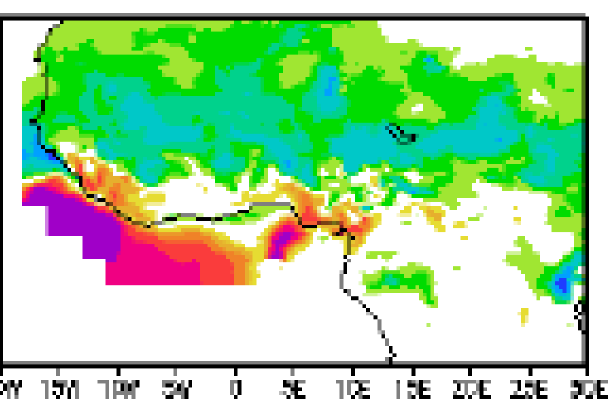
Will high resolution GCMs take over RCMs?

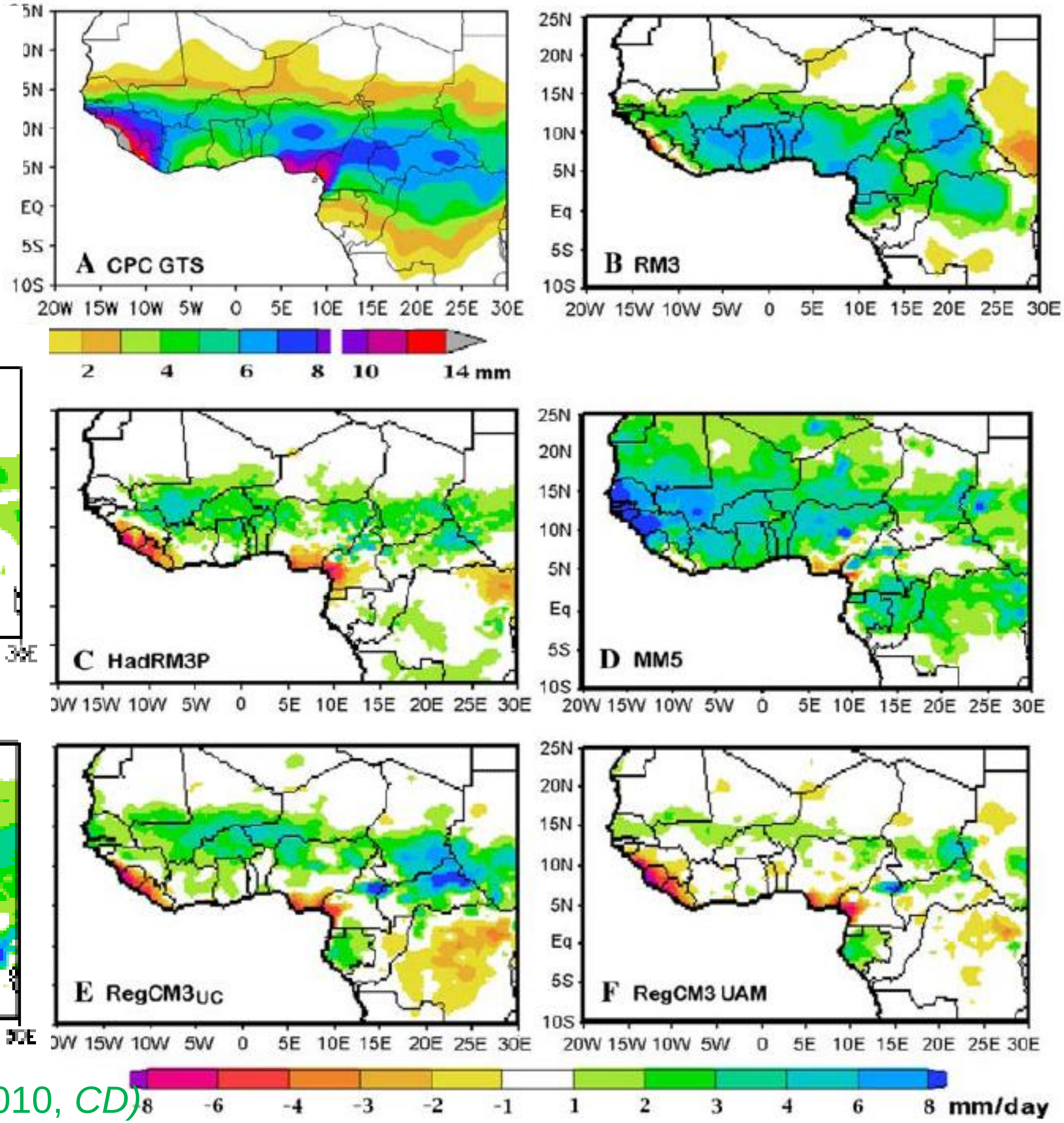
WAMME GCM/RCM
JJAS precipitation bais

NCEP Reanalysis II



MRI/JMA AGCM

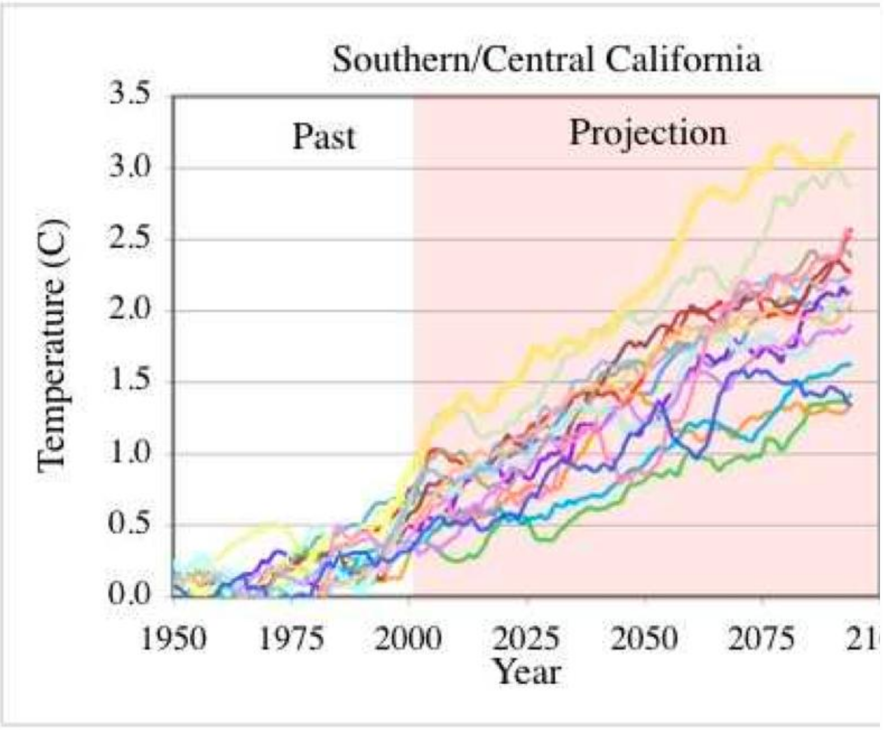


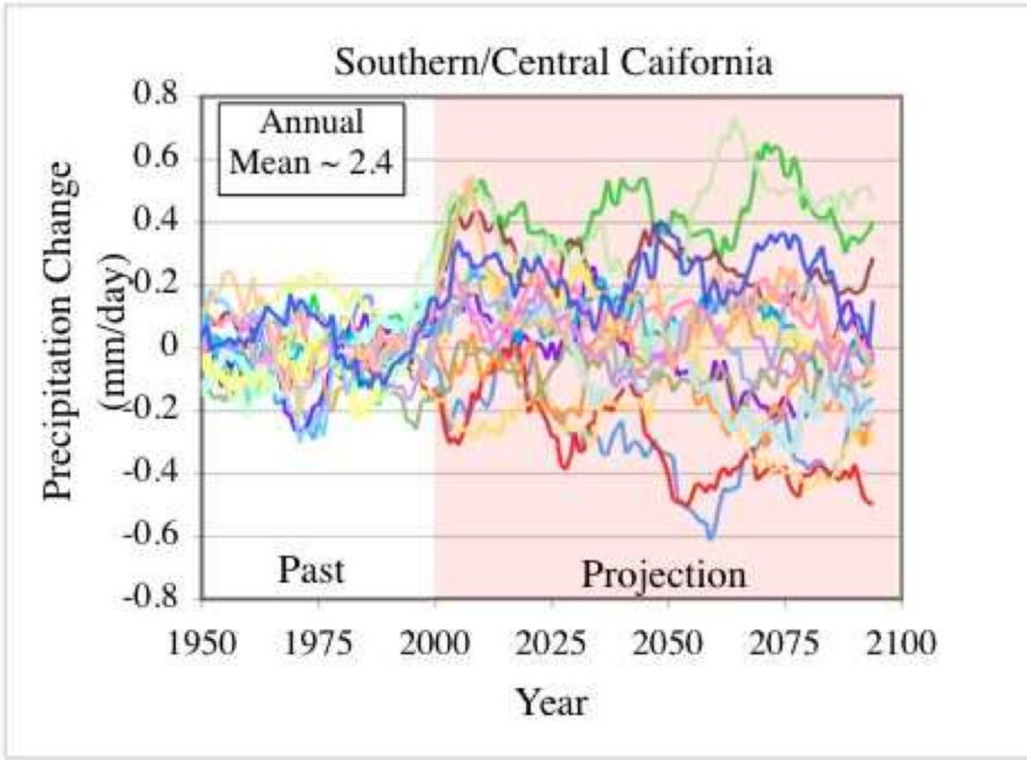


Dryun et al.; Xue et al. (2010, *CD*)

Warner et al. (1997), Giorgi and Mearns (1999), & Denis et al. (2003) discussed the following downscaling issues:

1. Numerical nesting: mathematical formulation and strategy
2. Spatial resolution difference between the driving data and the nested model
3. Spin-up
4. Update frequency of the lateral boundary conditions (LBCs)
5. Physical parametrisations consistencies
6. Horizontal and vertical interpolations errors
7. Domain size
8. Quality of the driving data
9. Climate drift or systematic errors





Courtesy by Waliser

Warner et al. (1997), Giorgi and Mearns (1999), & Denis et al. (2003) discussed the following downscaling issues:

1. Numerical nesting: mathematical formulation and strategy
2. Spatial resolution difference between the driving data and the nested model
3. Spin-up
4. Update frequency of the lateral boundary conditions (LBCs)
5. Domain size and boundary locations
6. Horizontal and vertical interpolations errors
7. Physical parameterizations consistencies (???)
8. Quality of the driving data
9. Climate drift or systematic errors

Land surface processes Parameterizations

- 1. Vegetation parameterizations
- 2. Snow schemes
- 3. Land surface and PBL coupling
- 4. Initial land surface conditions

Quantitative method to evaluate the downscaling

1). Errico, 1985; Castro et al., 2005

2). De Sales and Xue, 2010

RCMs have limited downscaling ability under certain conditions, which are highly associated to the RCM setting, its dynamic approach, and physical parameterizations: mainly land surface processes and PBL, and convective and radiation schemes.