Status of regional climate modeling: Some recommendations for RegCNET

W. J. Gutowski, Jr.
Iowa State University
Ames, Iowa

with thanks to:
C. Anderson, R. W. Arritt, Z. Pan, E. S. Takle

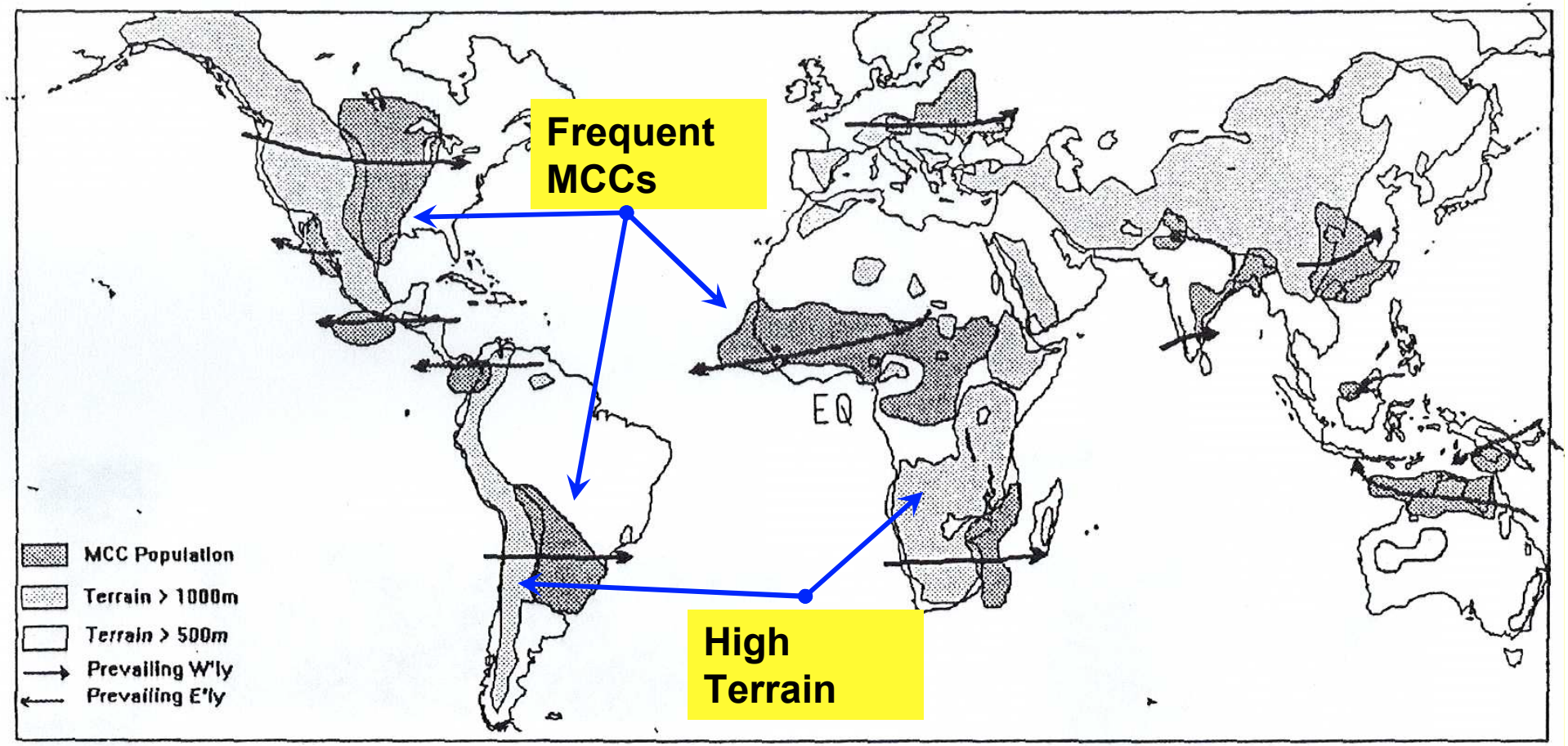
Topics

- Parameterization
- Boundary conditions
- Resolution
- Upscaling
- Testing
- Diagnostics

Topics

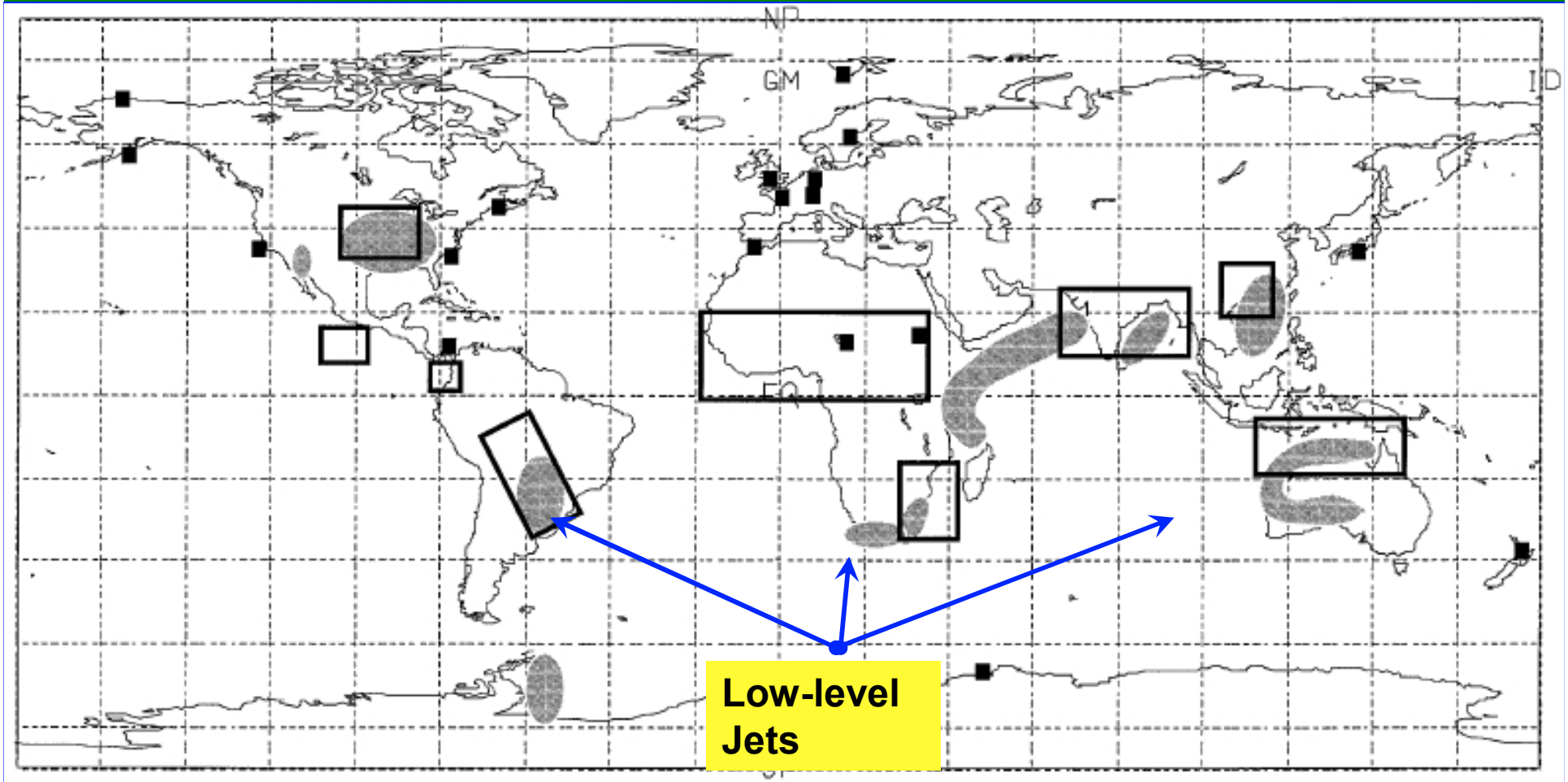
- **Parameterization**
- **Boundary conditions**
- **Resolution**
- **Upscaling**
- **Testing**
- **Diagnostics**

Mesoscale Circulation Factors



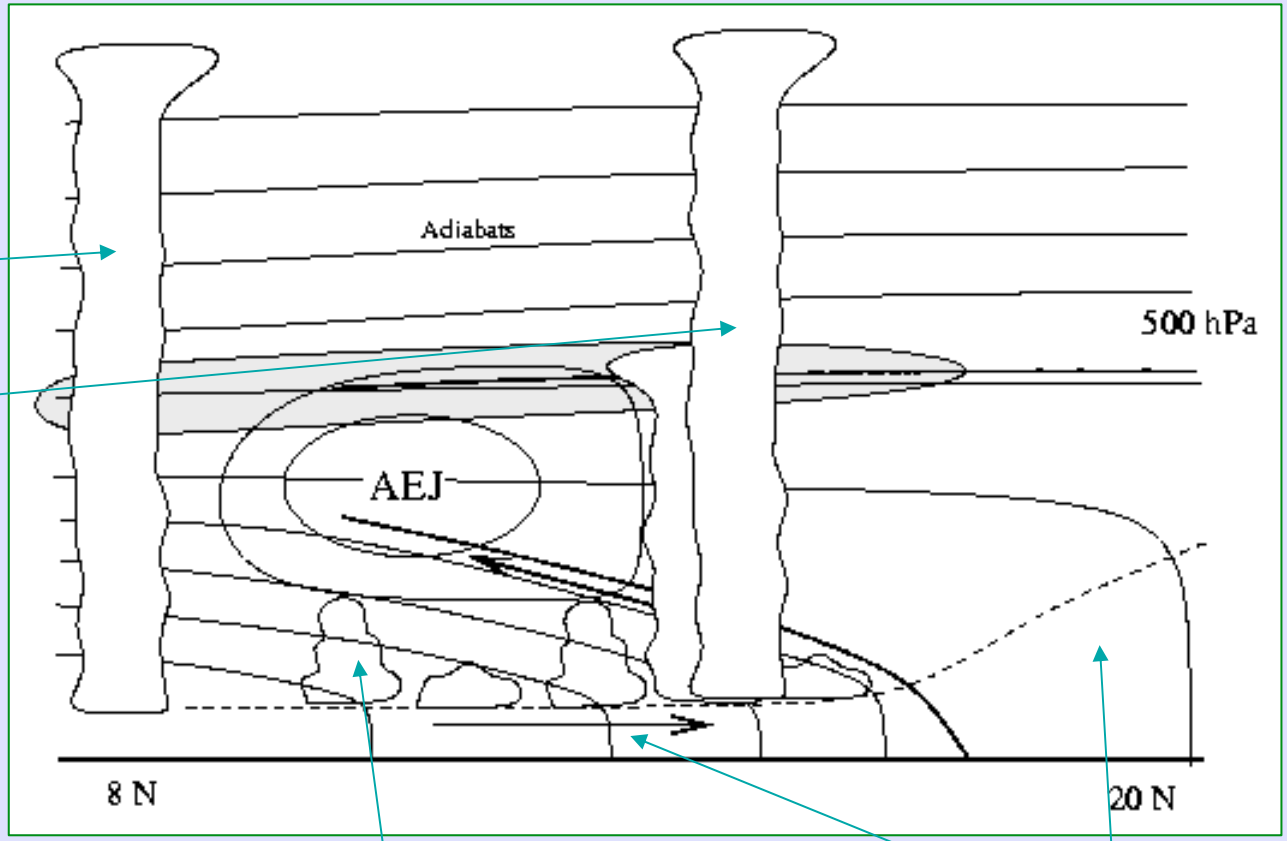
Laing & Fritsch (1997)

Mesoscale Circulation Factors



Stensrud (1996)

Deep convection

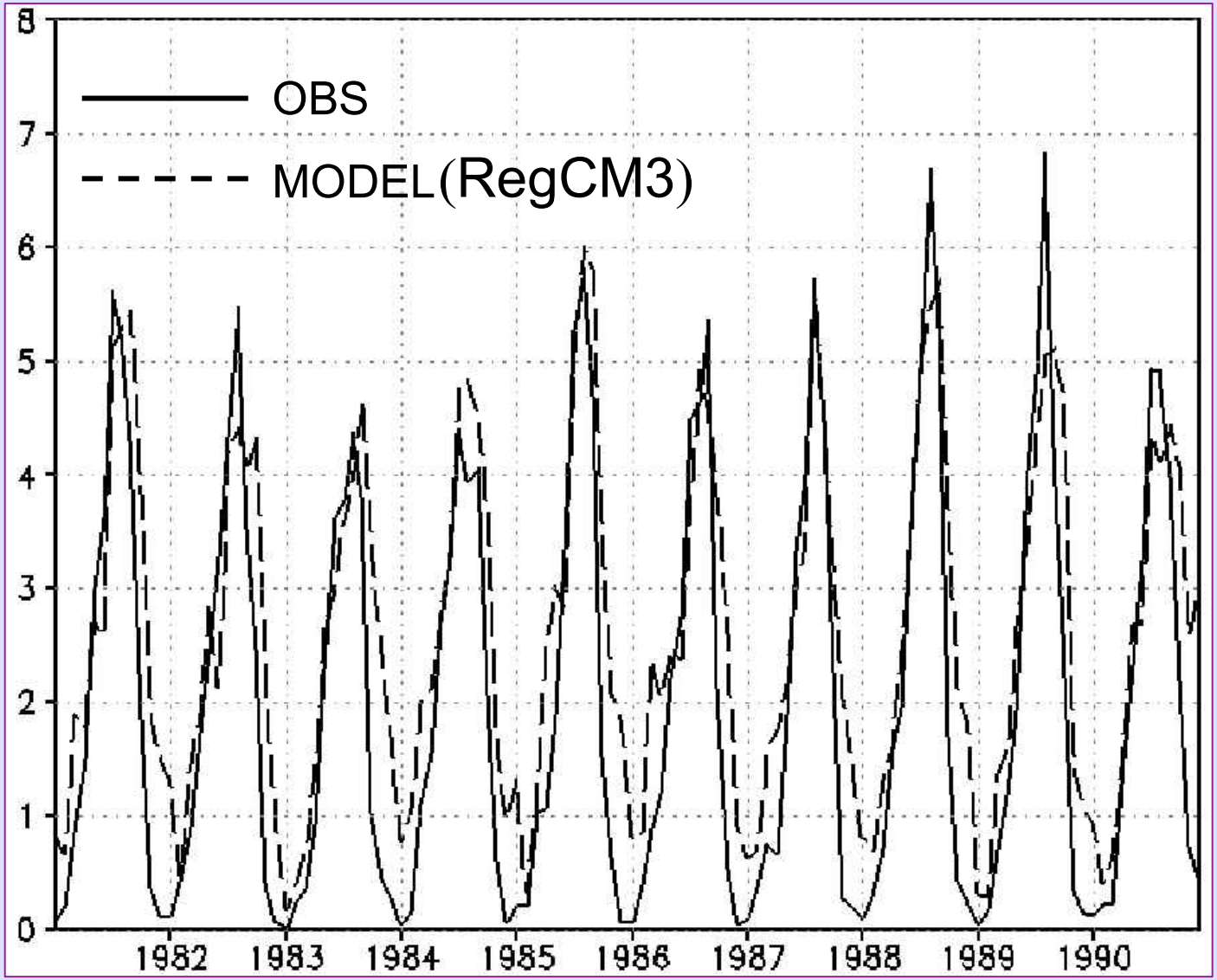


Shallow cumulus

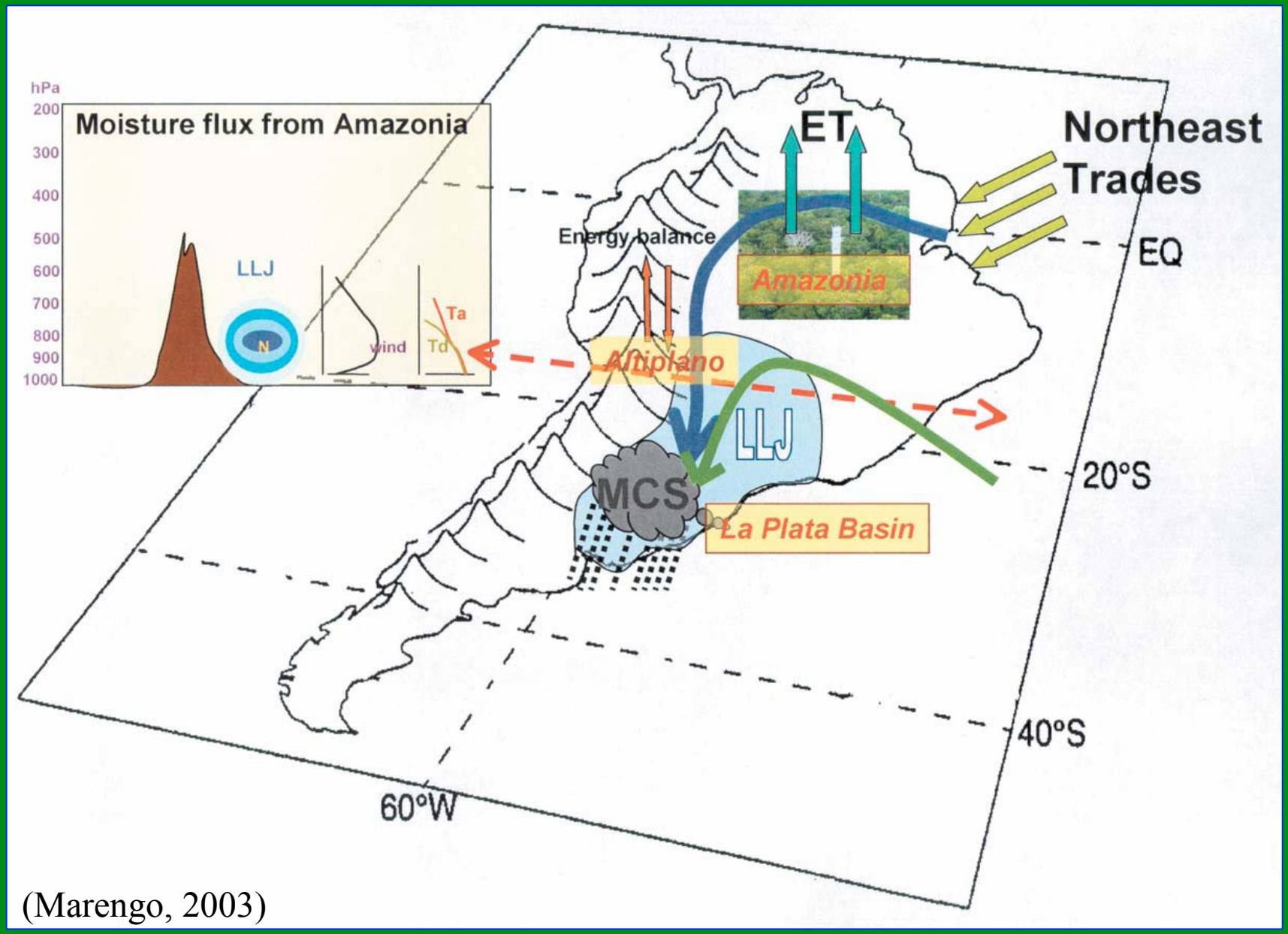
Mixed layer

(D. Parker, 2004, www.env.leeds.ac.uk/~doug/AMMA/Kickoff/wp3.ppt)

Precipitation - West Africa



(Afiesimama et al., 2005)

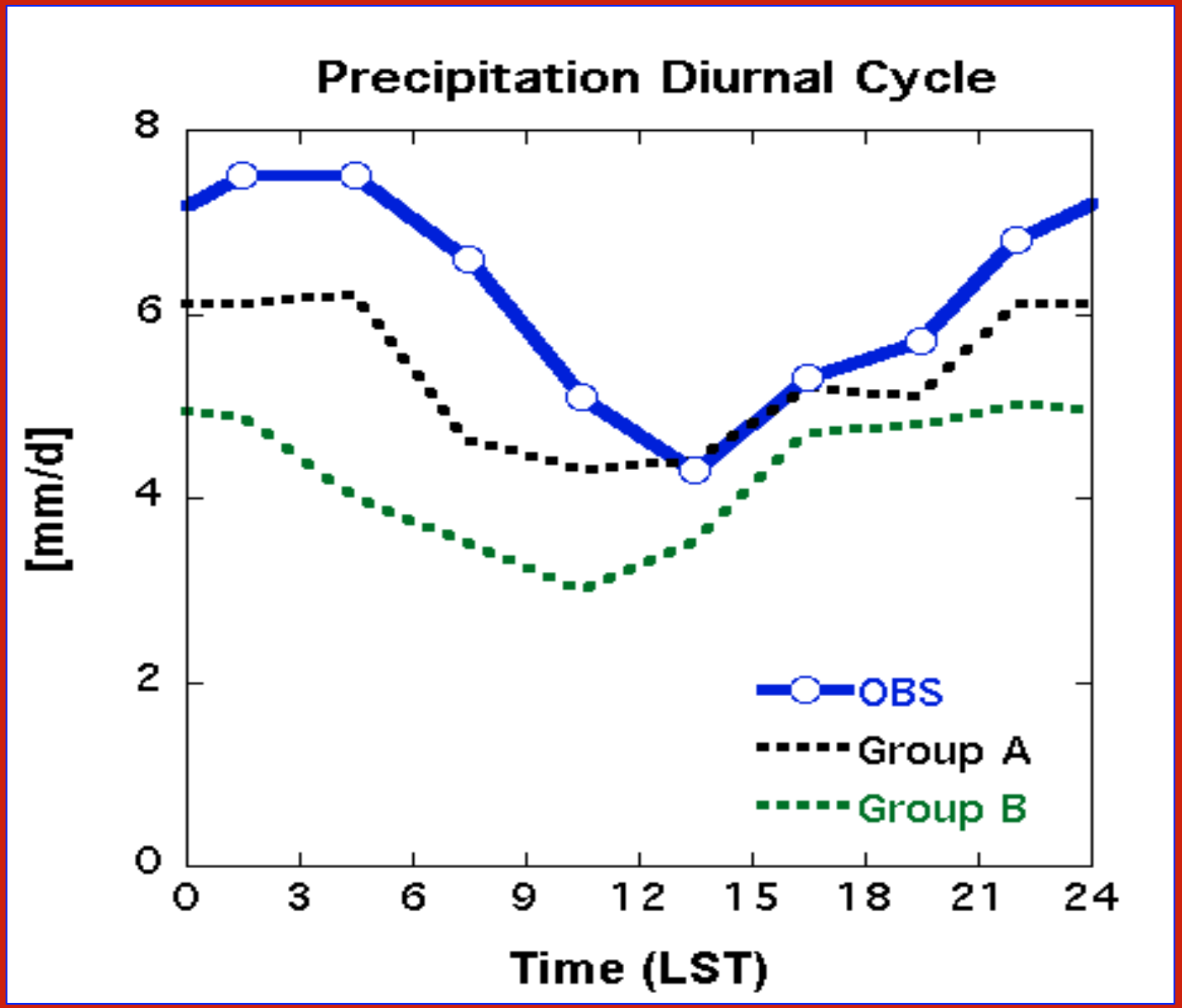


(Marengo, 2003)

from -

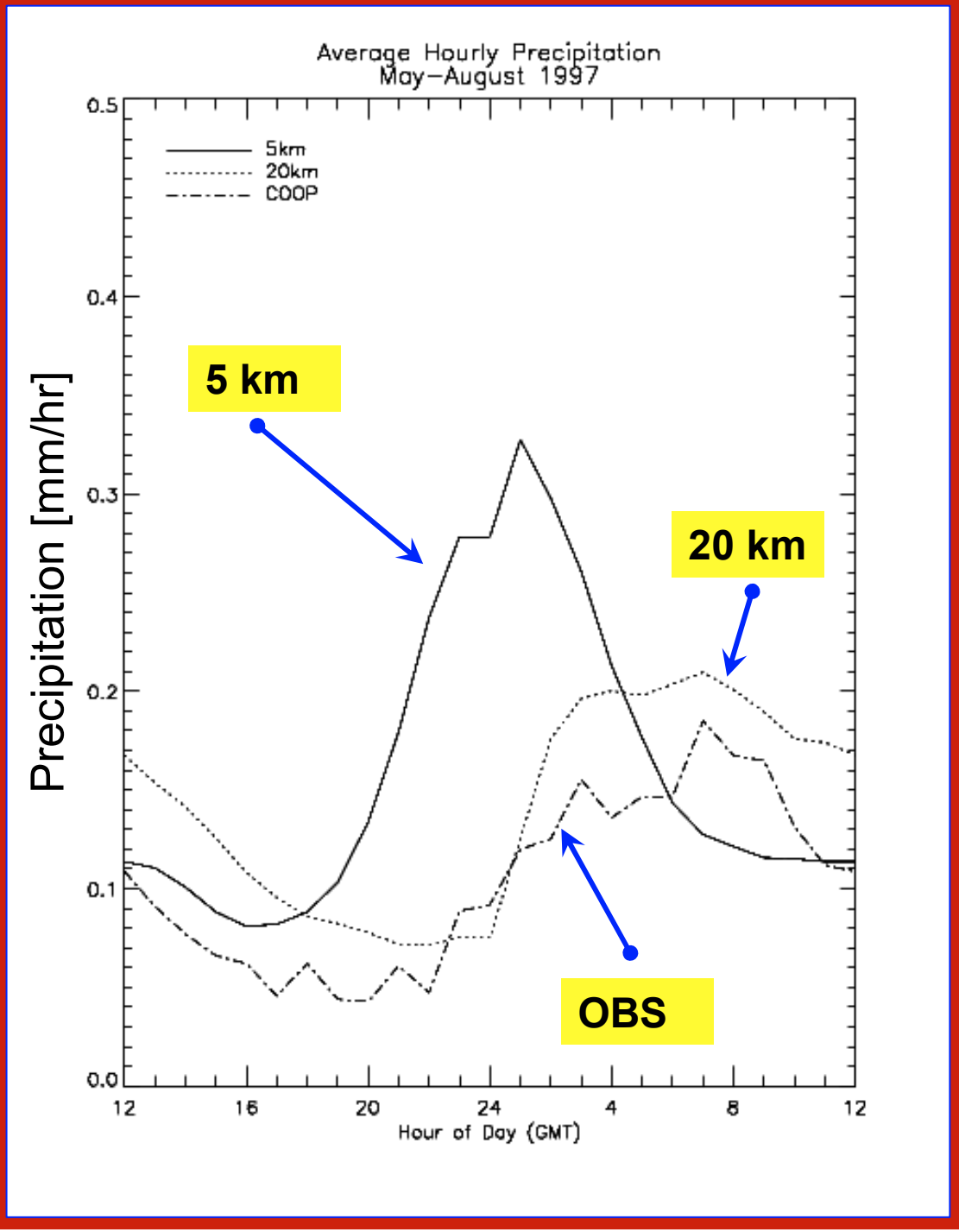
Project to Intercompare Regional Climate Simulations

North-Central U.S.



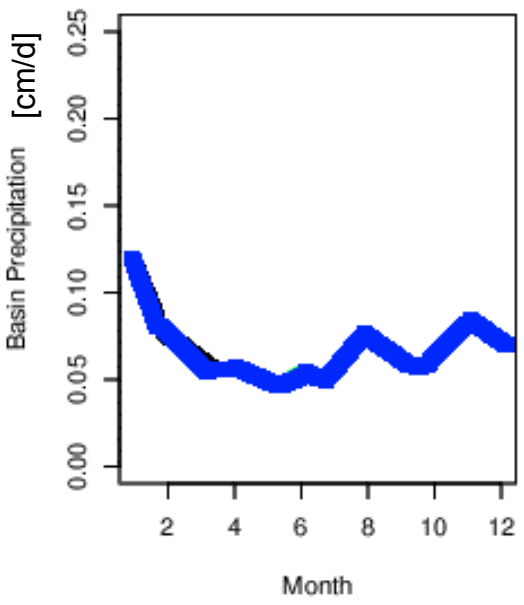
Anderson et al. (2003)

Does higher resolution help?

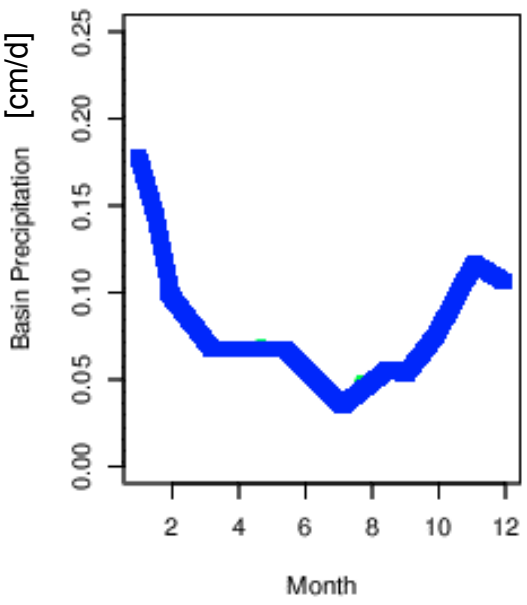


Flory (2003)

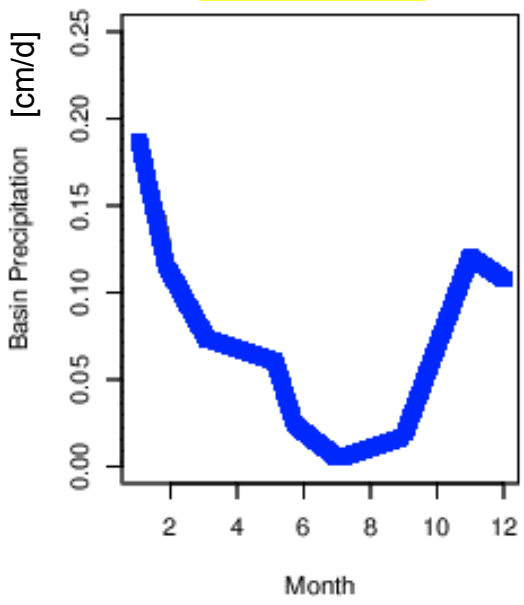
20 km



5 km

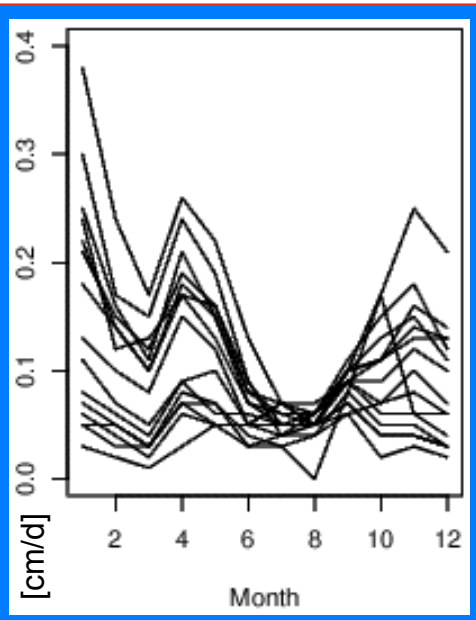


1.7 km



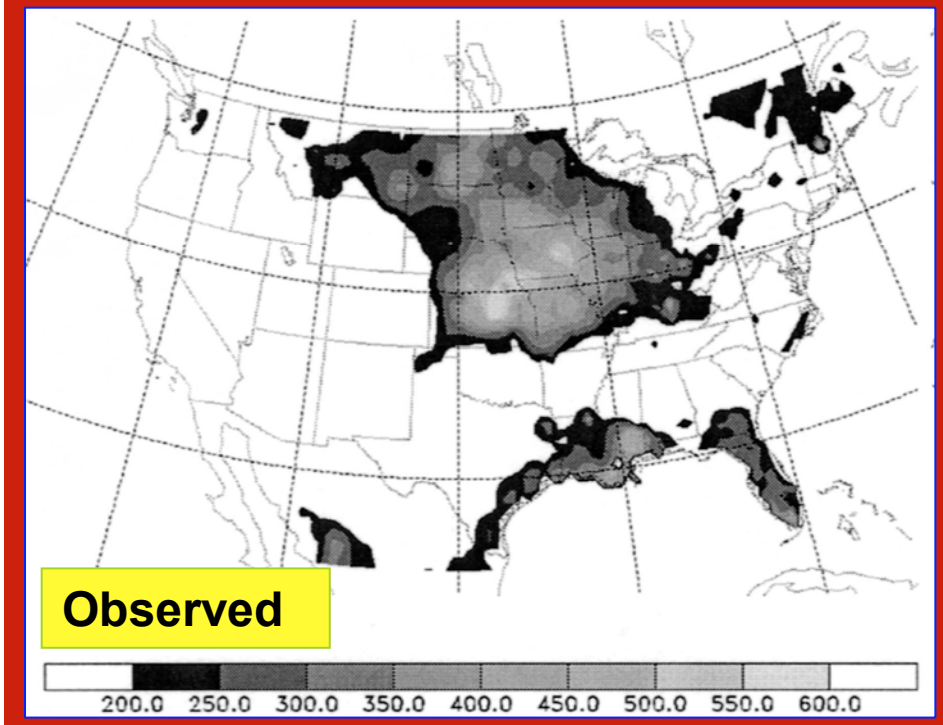
Yampa Basin, Colorado

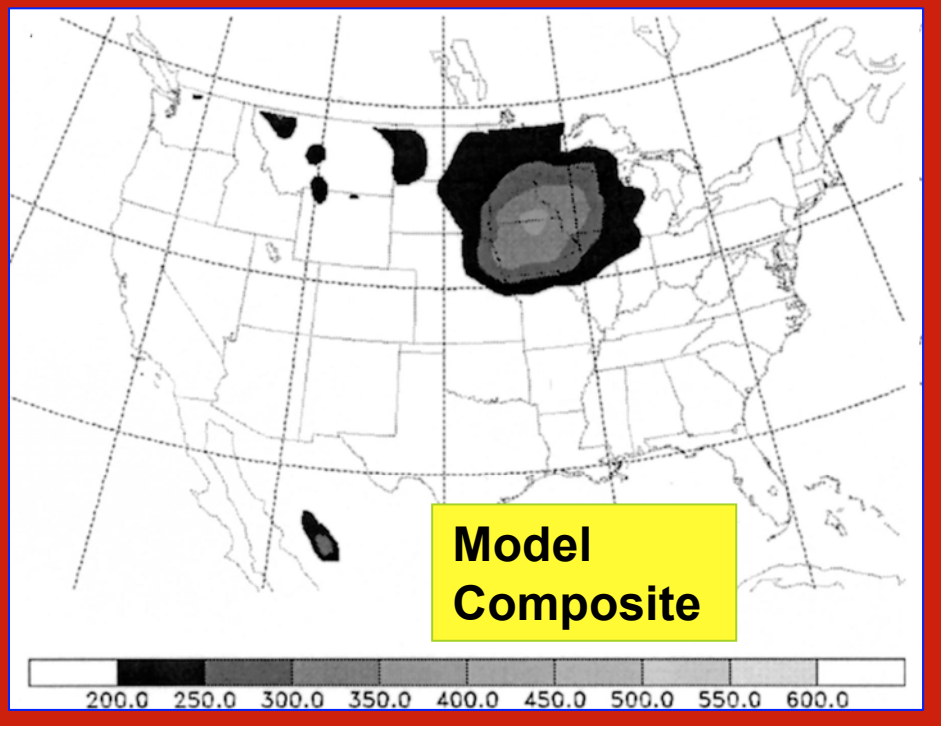
Adapted from Hay et al. (2004)



Gauge Analysis

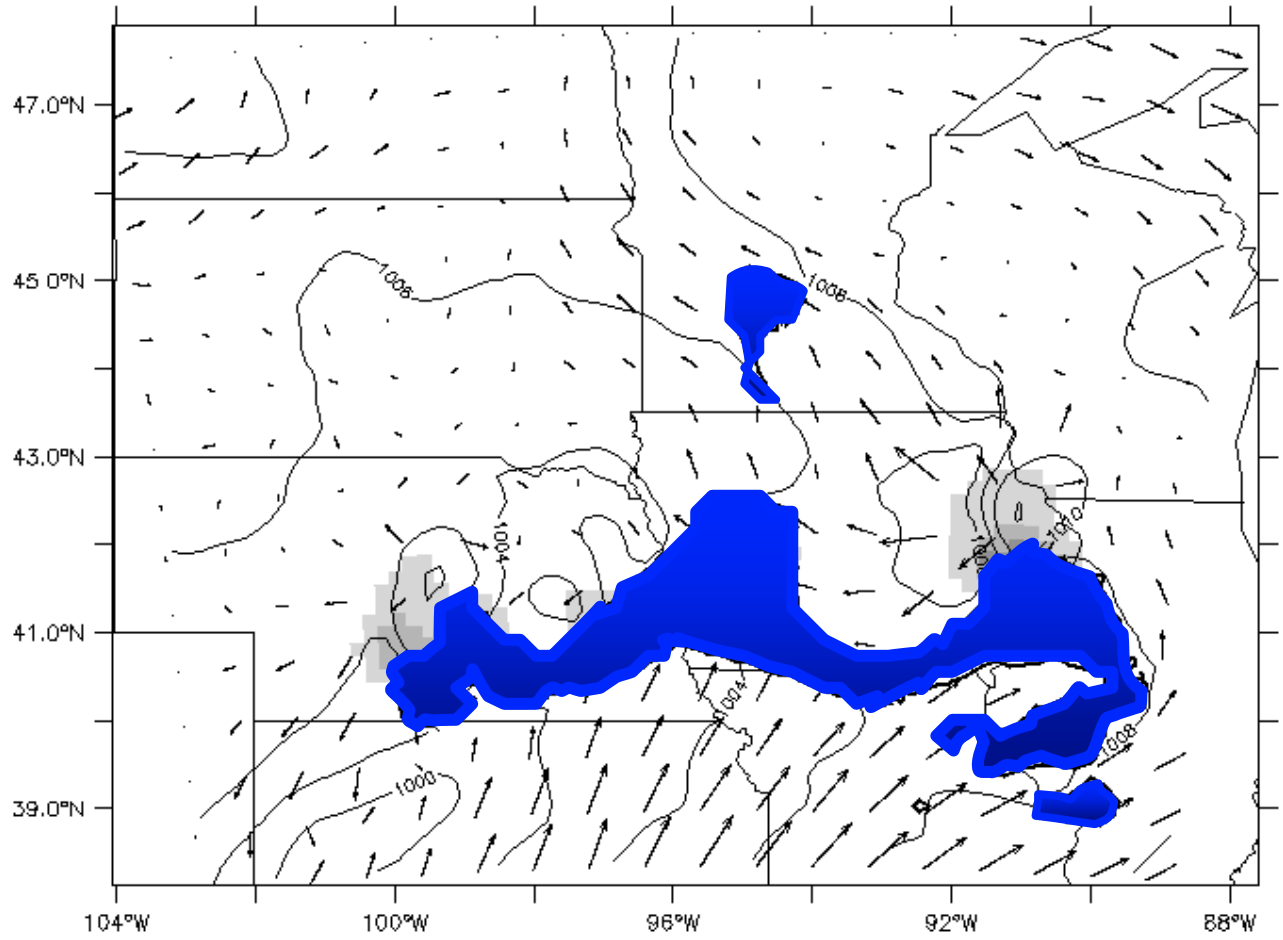
Precipitation [mm]
PIRCS Exp.1b
June-July 1993





Anderson et al. (2003)

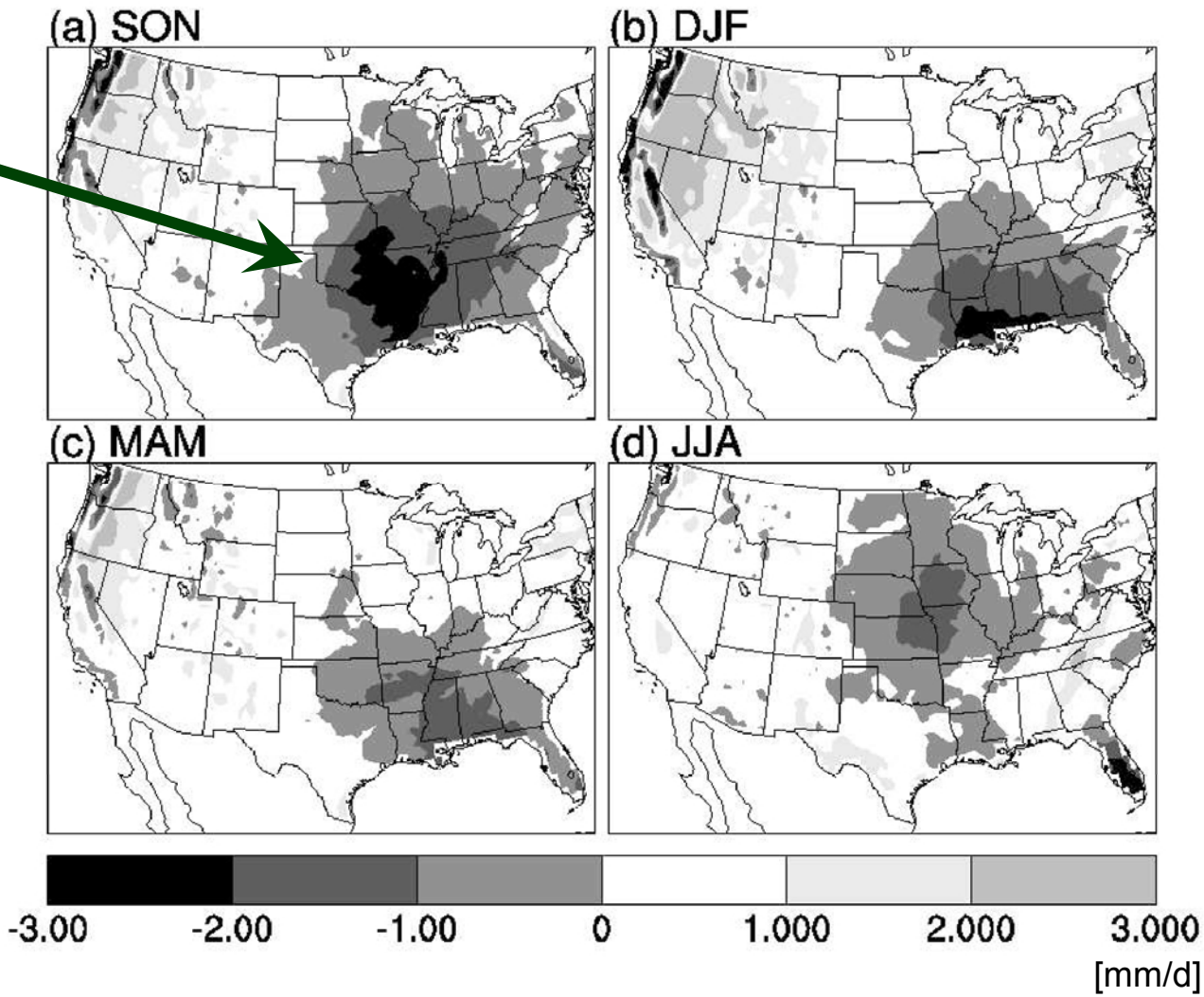
MM5 with modified convective cloud microphysics



Anderson (2004)

RegCM2 - 10 yr. simulations

Generic Precipitation Deficit



Gutowski et al. (2004)

Liang et al. (2004)

Recommendations for RegCNET

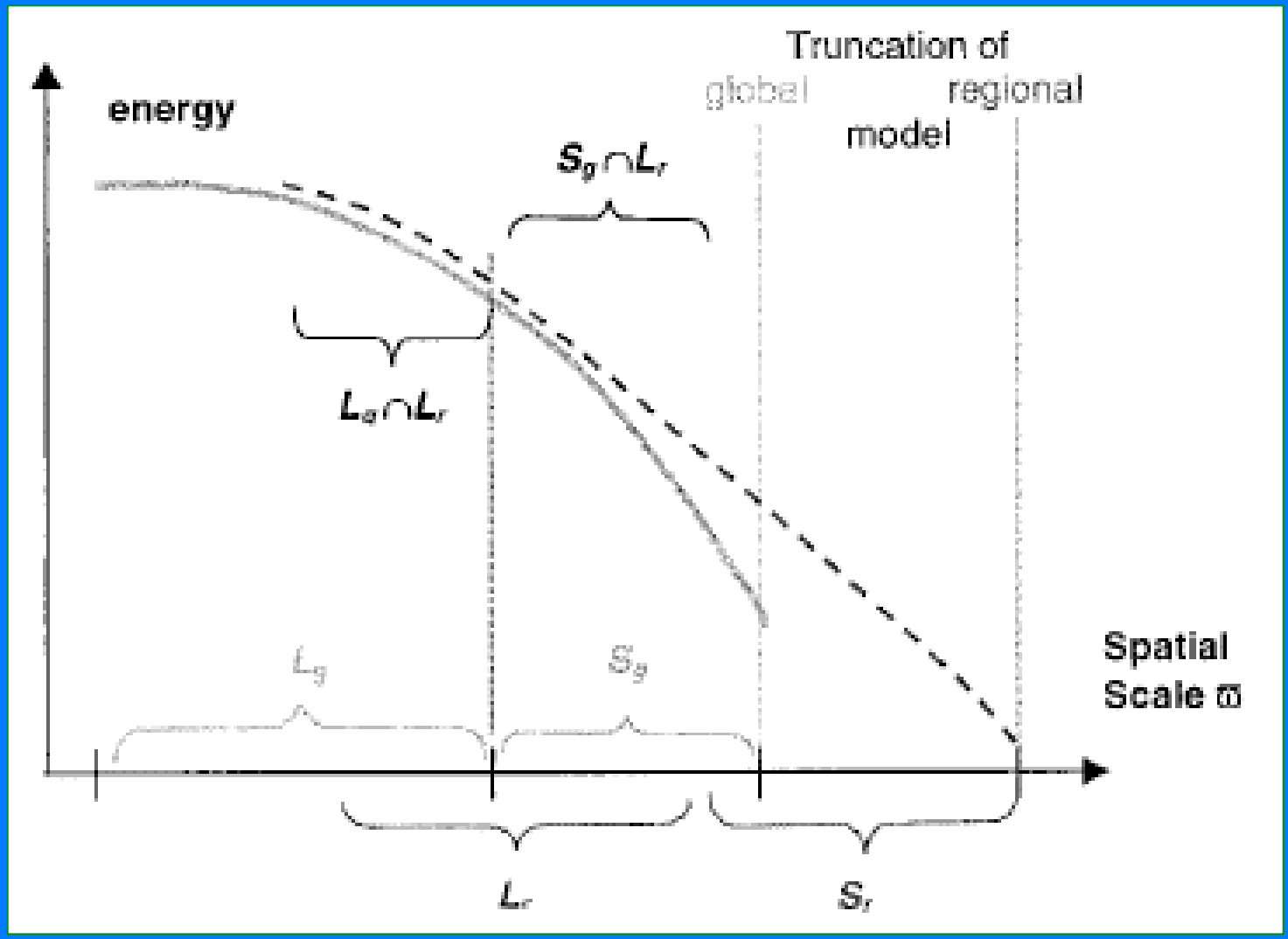
1. *Avoid implementing many new parameterization options in standard model, ...*

2. *… instead promote diagnosing physics of parameterizations and their couplings.*

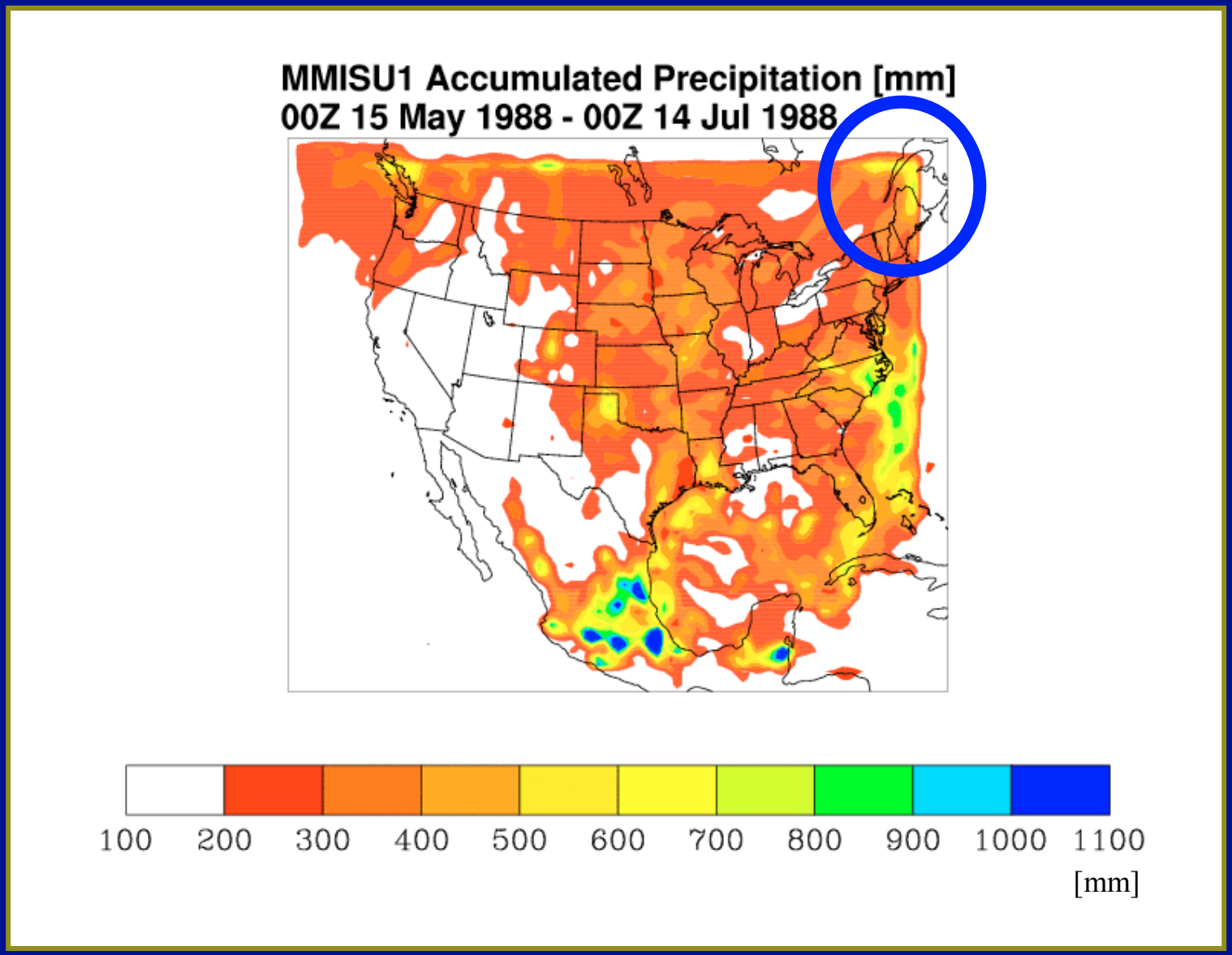
Topics

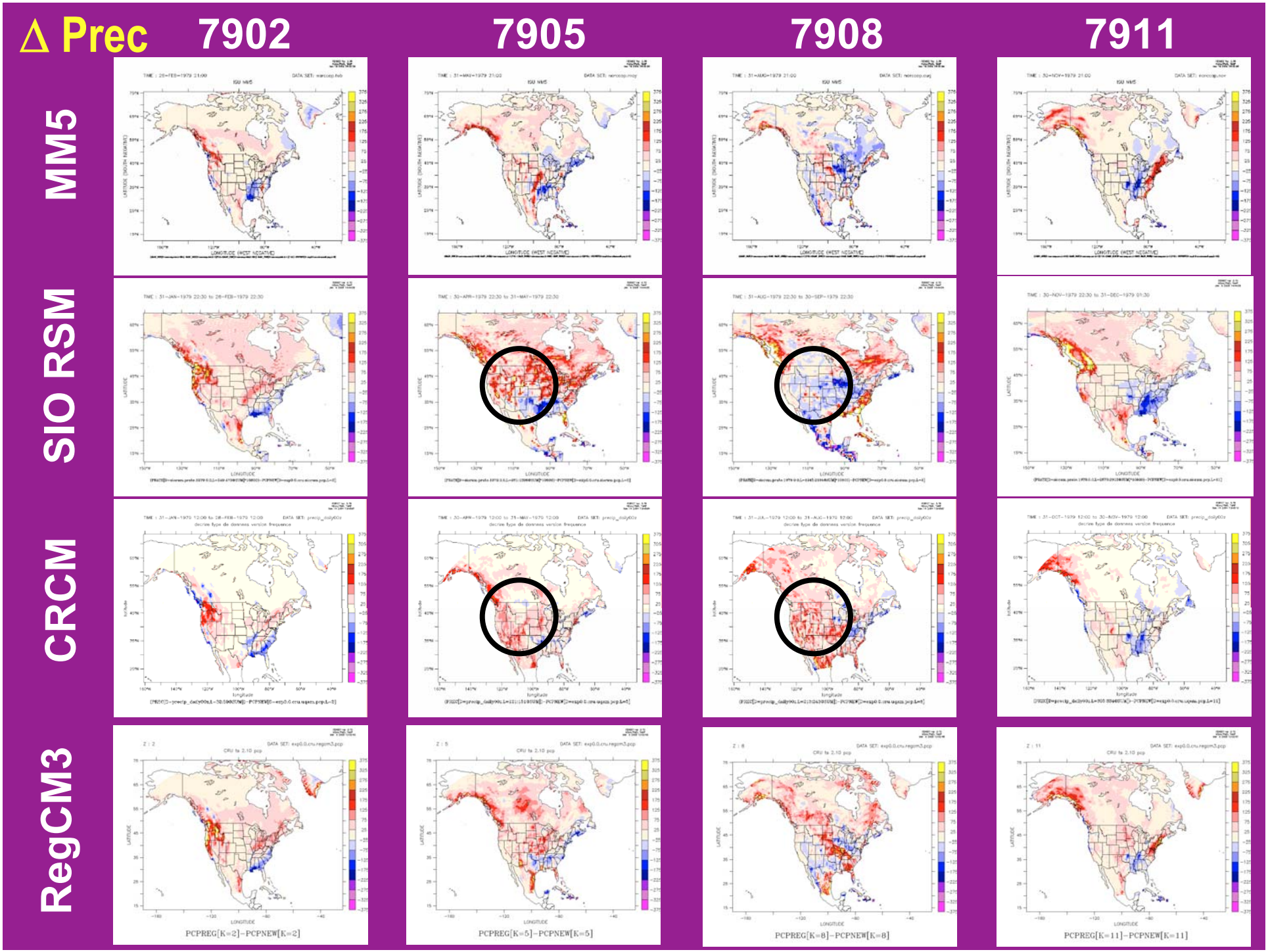
- Parameterization
- **Boundary conditions**
- Resolution
- Upscaling
- Testing
- Diagnostics

Spectral Nudging



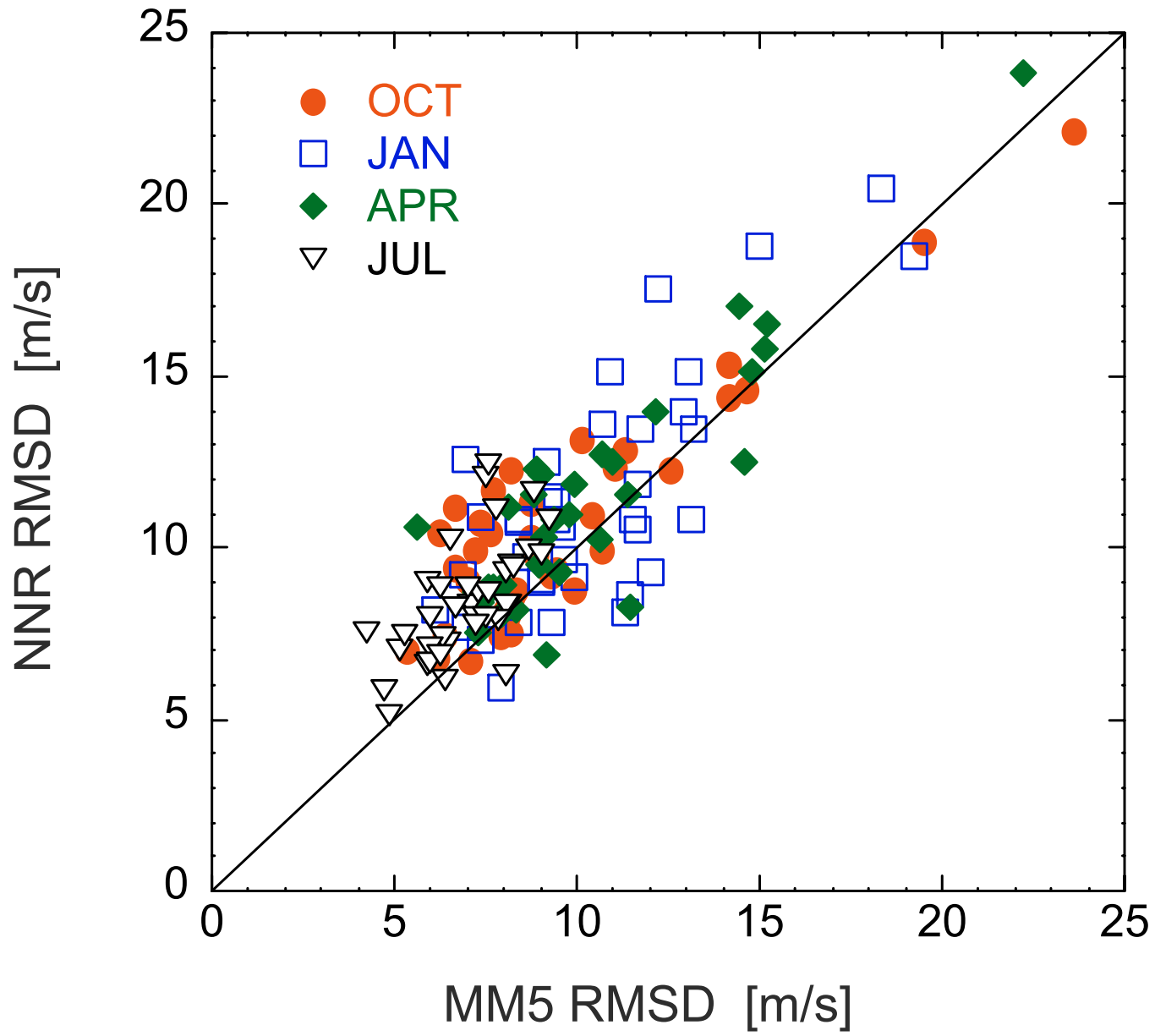
von Storch et al. (2004)


MMISU1 Accumulated Precipitation [mm]
00Z 15 May 1988 - 00Z 14 Jul 1988
100
200
300
400
500
600
700
800
900
1000
1100
[mm]


Δ Prec
7902
7905
7908
7911
MM5
SIO RSM
CRCM
RegCM3
PCPREG[K=2]−PCPNEW[K=2]
PCPREG[K=5]−PCPNEW[K=5]
PCPREG[K=8]−PCPNEW[K=8]
PCPREG[K=11]−PCPNEW[K=11]

Pan-Arctic Simulation

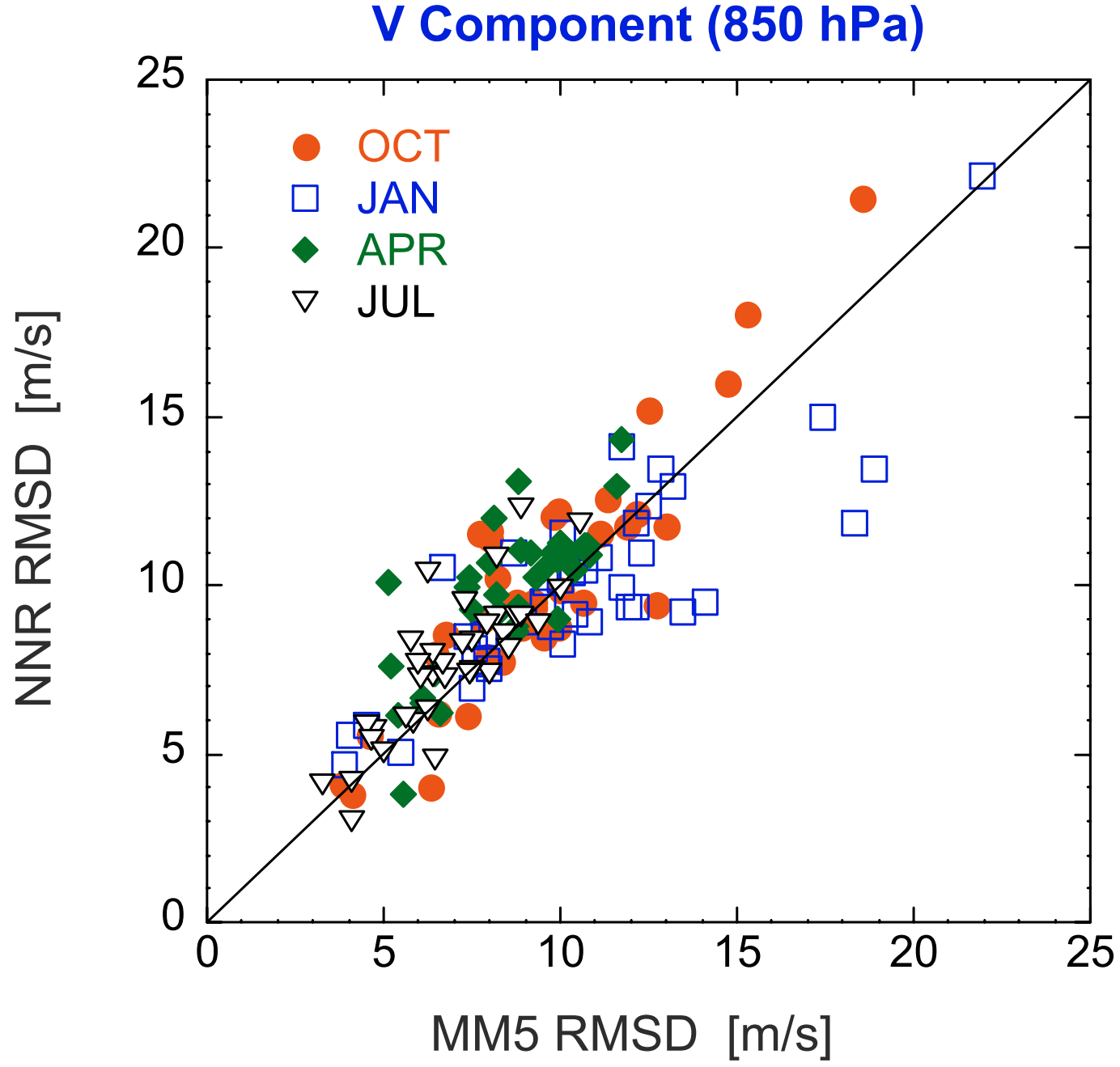
RMS Difference from Rawinsondes



Wei et al. (2002)

Pan-Arctic Simulation

RMS Difference from Rawinsondes



Wei et al. (2002)

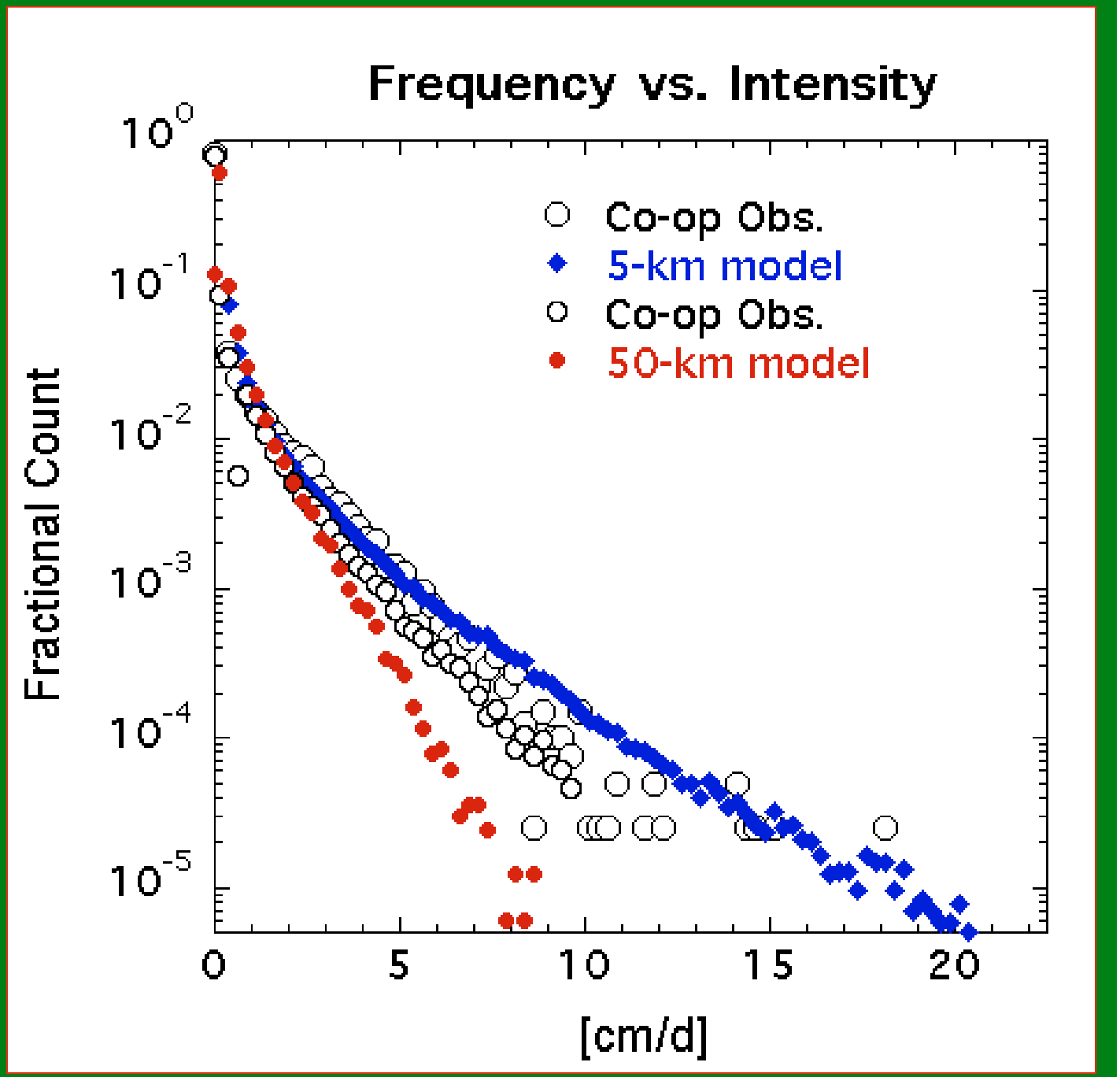
Recommendations for RegCNET

3. *Should RegCM3 include interior nudging?*
   Research - No
   Climate-change impacts - Maybe

Topics

- Parameterization
- Boundary conditions
- **Resolution**
- Upscaling
- Testing
- Diagnostics

Central U.S. Warm Season Simulation



Flory (2003)

Recommendations for RegCNET

4. *Consider extending to non-hydrostatic dynamics and exploiting advances in cloud microphysics modeling.*

Topics

- Parameterization
- Boundary conditions
- Resolution
- **Upscaling**
- Testing
- Diagnostics

Does regional convection affect climatological large-scale circulation?

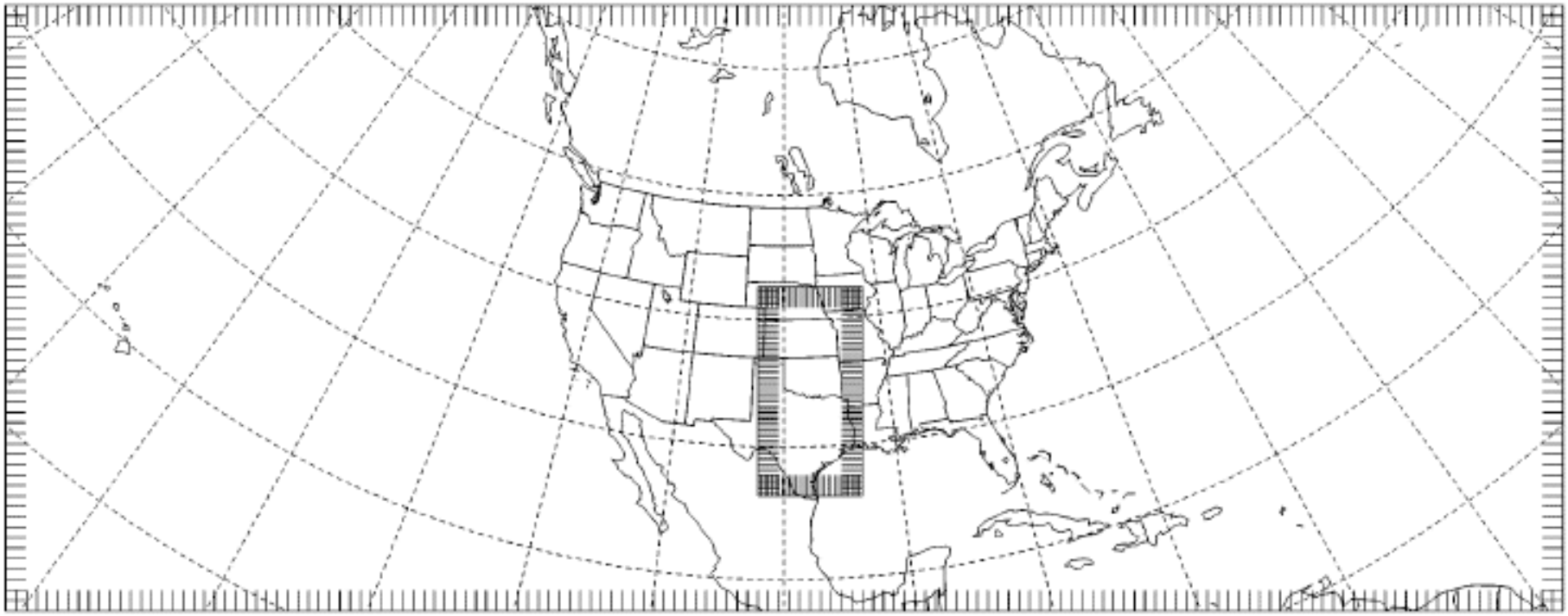
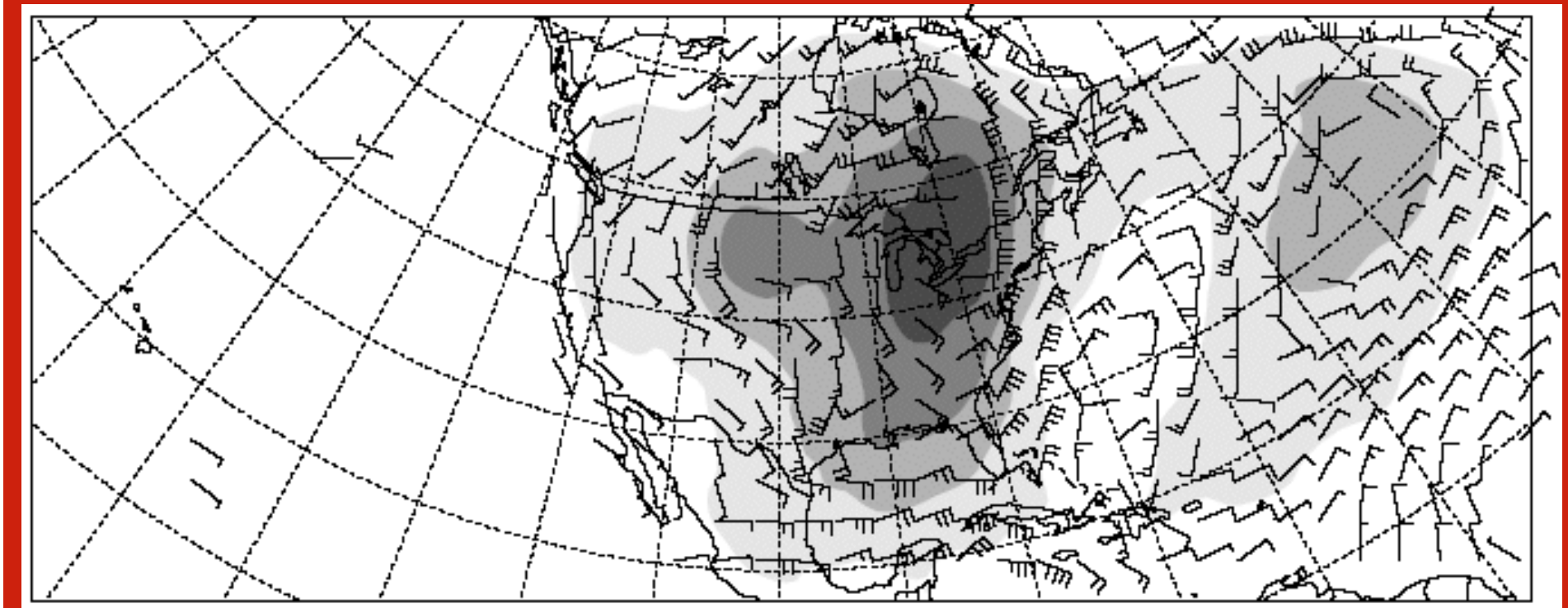


FIG. 5. Mesoscale model coarse grid domain (90 km), with the nested grid domain highlighted (30 km). Tick marks indicate locations of model dot points.

Stensrud (1996)

(Diabatic - No Diabatic) Simulation
200 hPa Heights and Winds

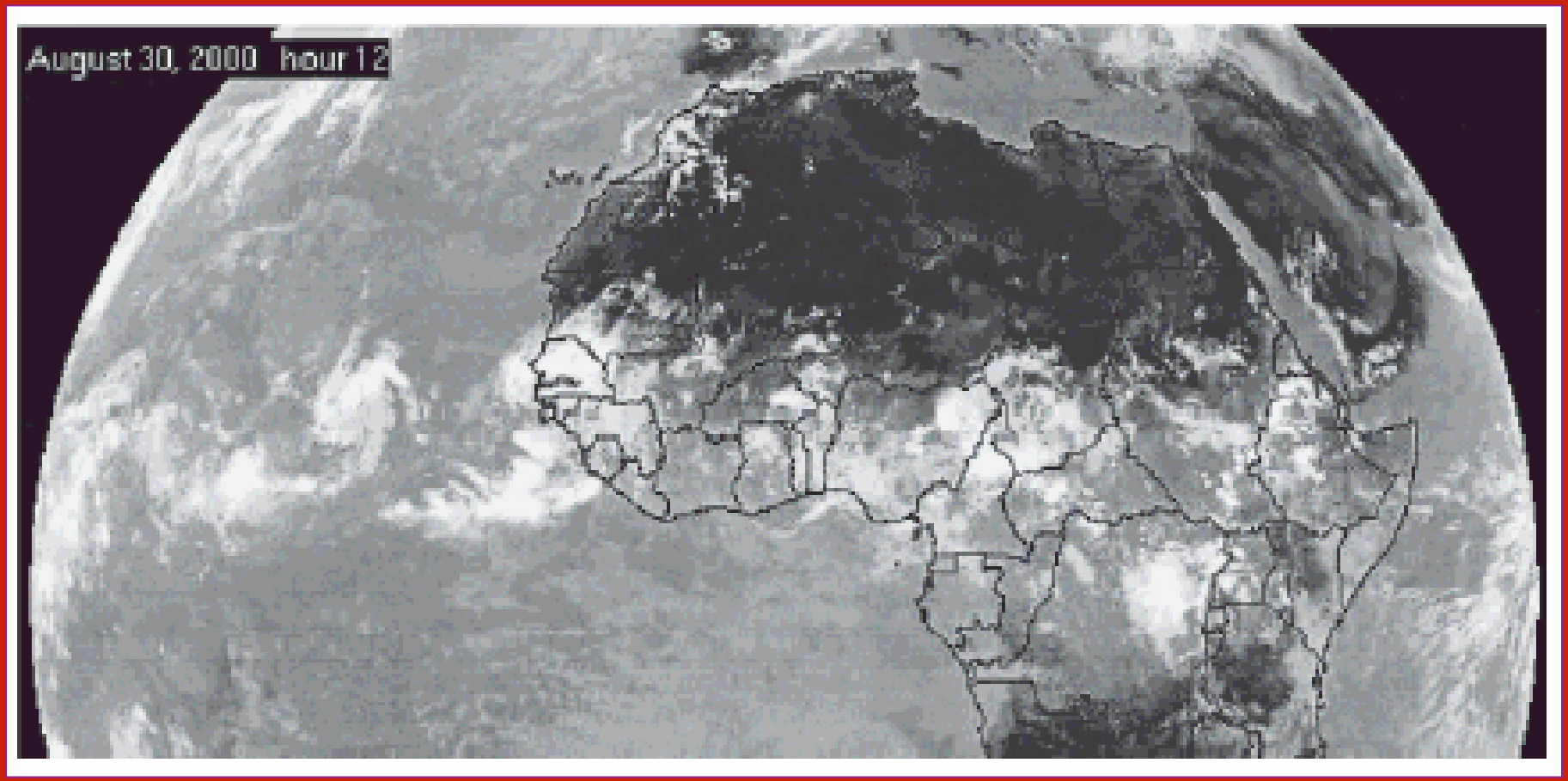


Stensrud (1996)

Contours: 20 m Barbs: 5 m/s

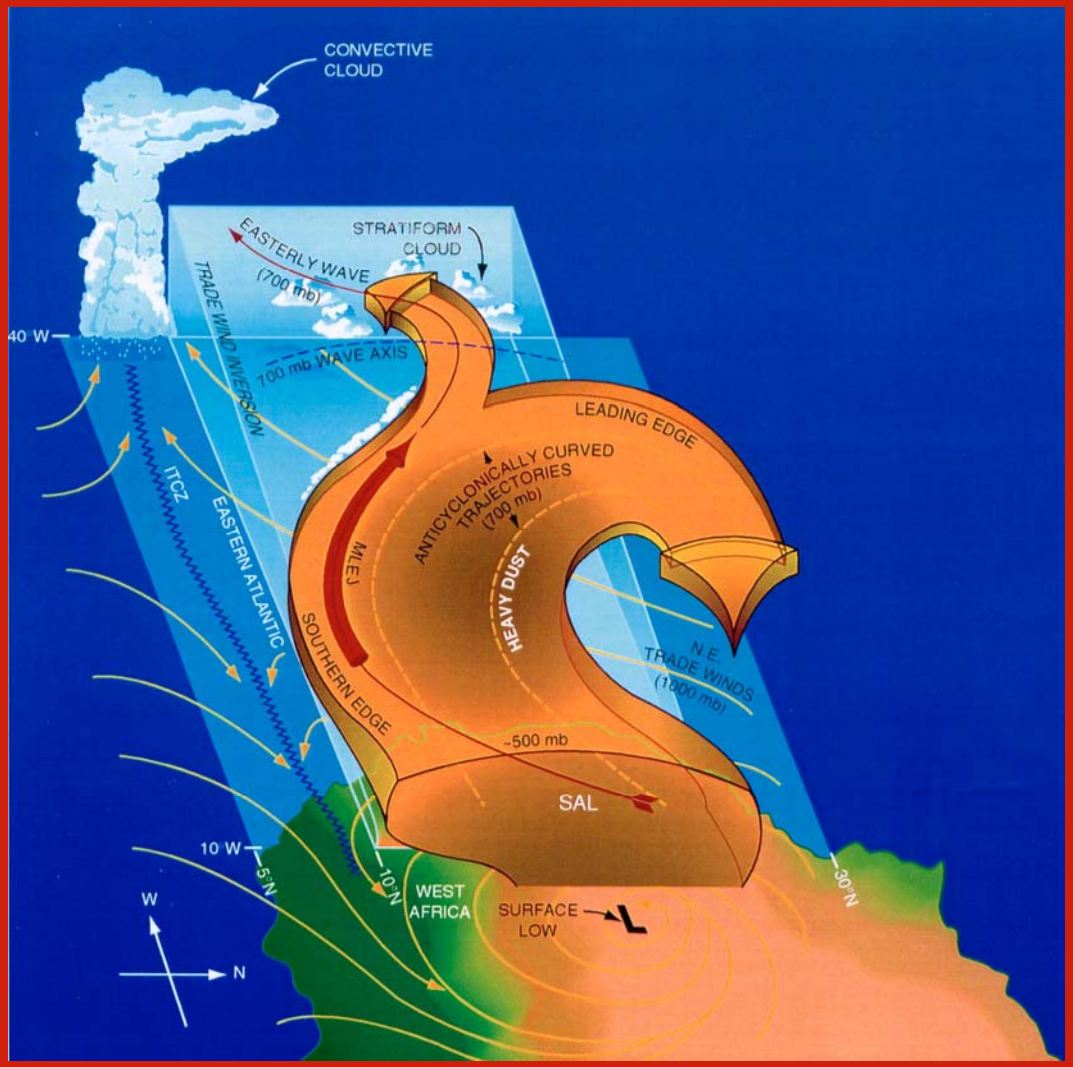
[96 hr from 00 UTC 11 May 1982]

African Easterly Waves



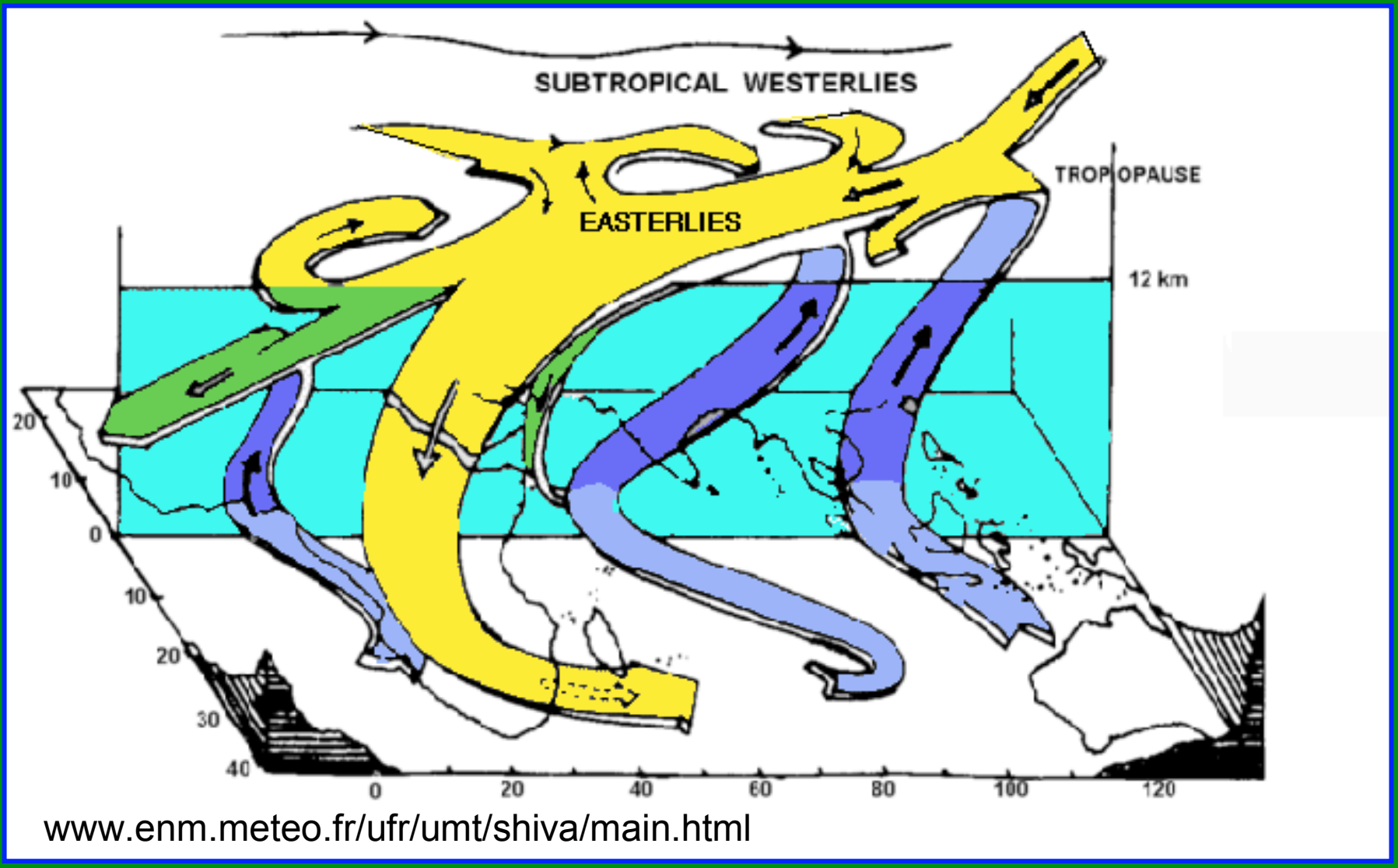
(Thorncroft et al. 2003, Burpee 1972;
from P. Woodworth, 2003, orca.rsmas.miami.edu/~phoebe/myweb3/SALpresentation.ppt)

Saharan Air Layer



(Karyampudi et al. 1999;
from P. Woodworth, 2003, orca.rsmas.miami.edu/~phoebe/myweb3/SALpresentation.ppt))

Asian Monsoon



www.enm.meteo.fr/ufr/umt/shiva/main.html

Recommendations for RegCNET

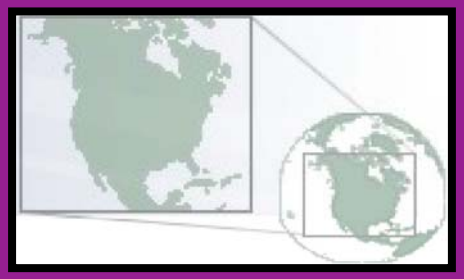
5. *Analyze large-scale tendencies due to RegCM convection and mesoscale circulation.*

Topics

- Parameterization
- Boundary conditions
- Resolution
- Upscaling
- **Testing**
- Diagnostics

Opportunities to Test RegCM

Place RegCM3 in a broader context - for example …



- **ENSEMBLES (EU):**

  RT2B - probabilistic high-resolution regional climate scenarios

  RT3 - very high resolution regional climate model ensembles for Europe

- **CREAS (South America):**

  Downscale climate change scenarios (2 GCMs, 6 RCMs)

- **NARCCAP (North America):**

  Downscale climate change scenarios (4 GCMs, 6 RCMs)

Transferability: A Global Approach to Regional Climate Model Simulations

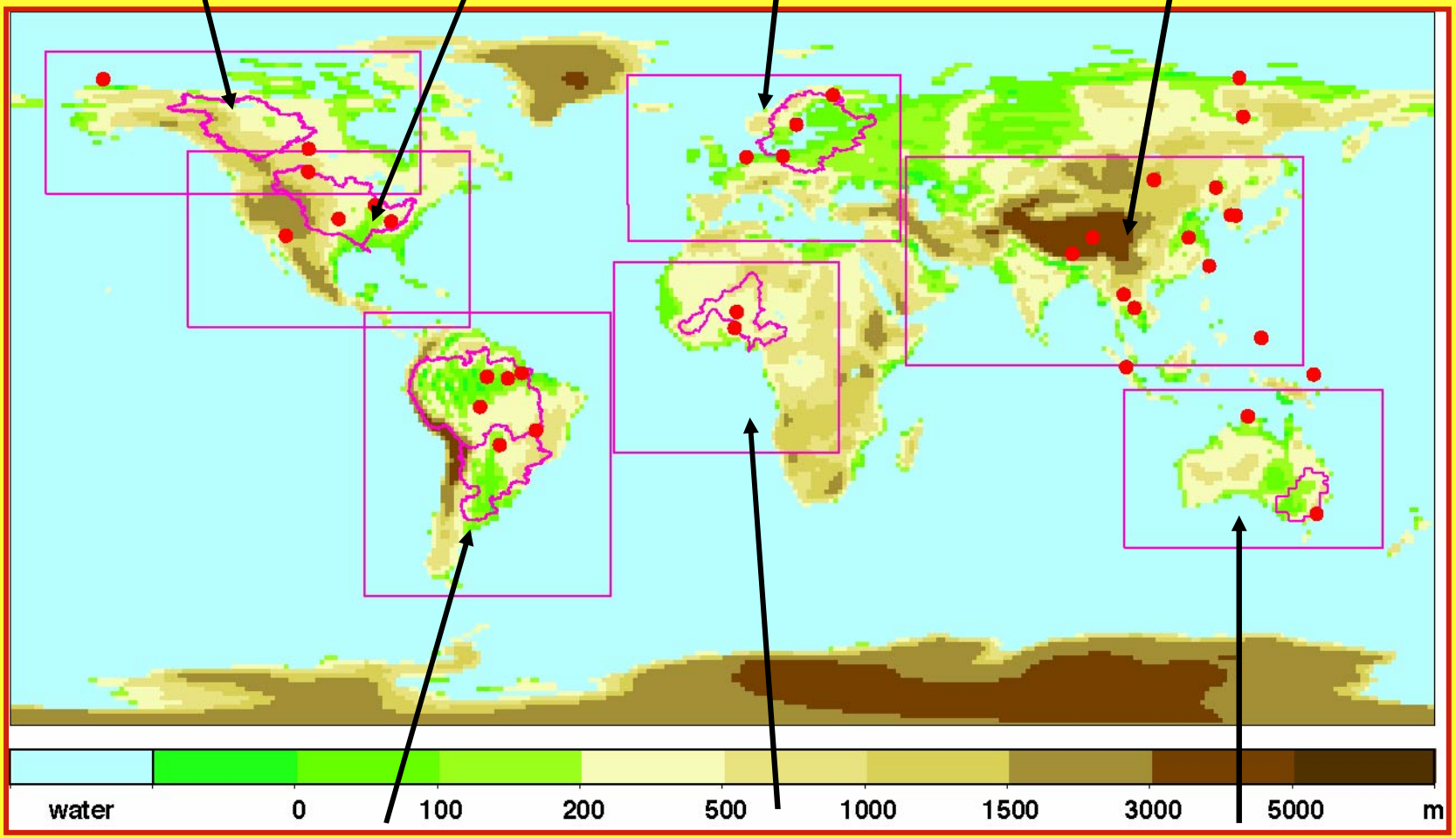
E. S. Takle[1], B. Rockel[2], W. J. Gutowski, Jr.[1], I. Meinke[3], R. W. Arritt[1], and J. Roads[3]

[1]Iowa State University, Ames, IA
[2]GKSS Research Centre, Geesthacht , Germany
[3]Scripps Institution of Oceanography, UCSD,LaJolla, CA

gstakle@iastate.edu

http://rcmlab.agron.iastate.edu/twg/

Continental Scale Experiments (CSEs)



Use of Regional Models to Study Climate

- How portable are our models?
- How much does "tuning" limit general climatic applicability?
- Can we recover some of the generality of "first-principles" models by examining their behavior on a wide range of climates?

Recommendations for RegCNET

6. ***Contribute to multi-model programs, such as GEWEX Transferability simulations.***

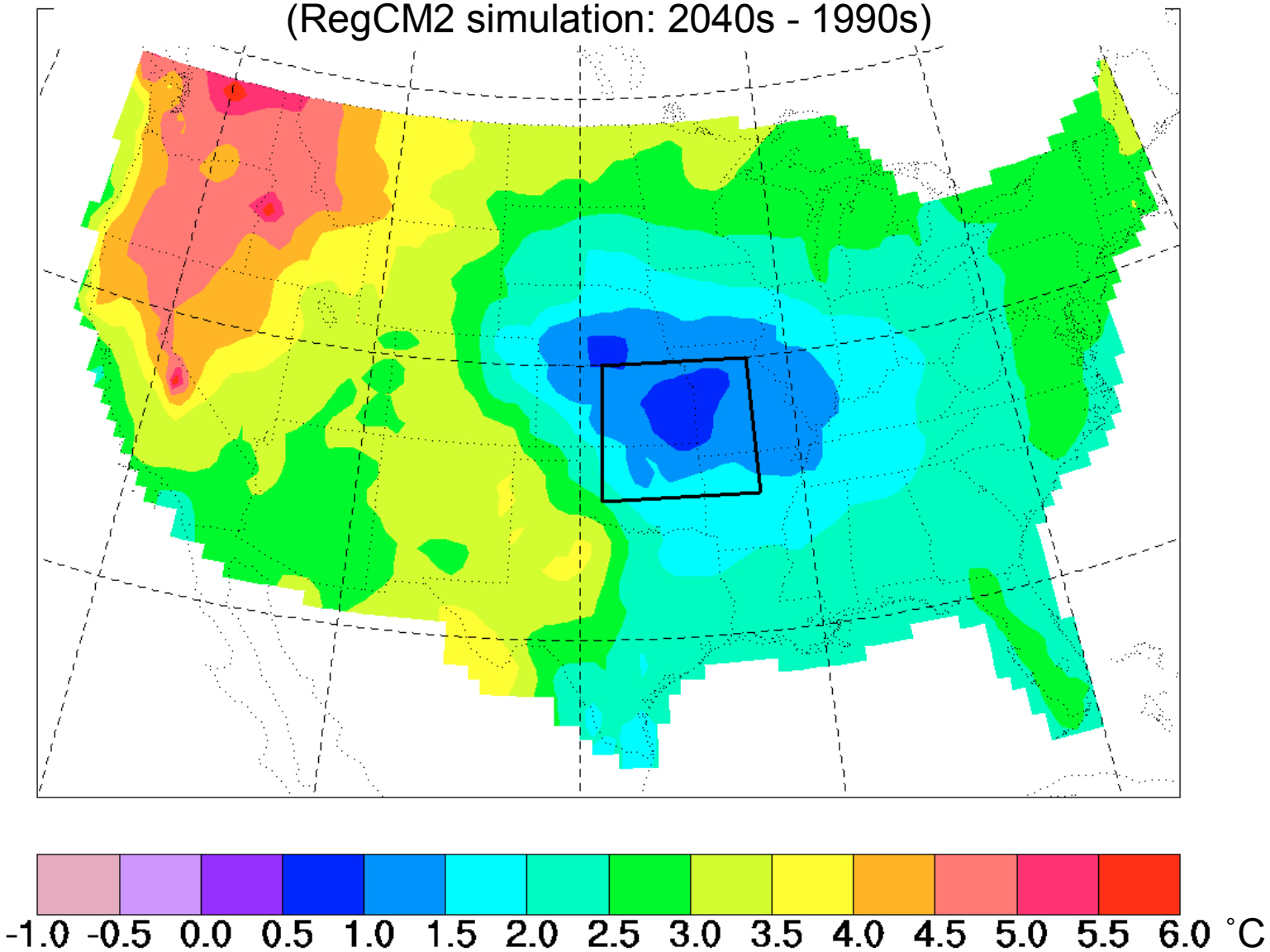
http://rcmlab.agron.iastate.edu/twg/
http://icts.gkss.de/
http://www.pircs.iastate.edu/people/Gutowski/Transferability/RegCNET-TrG/Trans.html

Topics

- Parameterization
- Boundary conditions
- Resolution
- Upscaling
- Testing
- **Diagnostics**

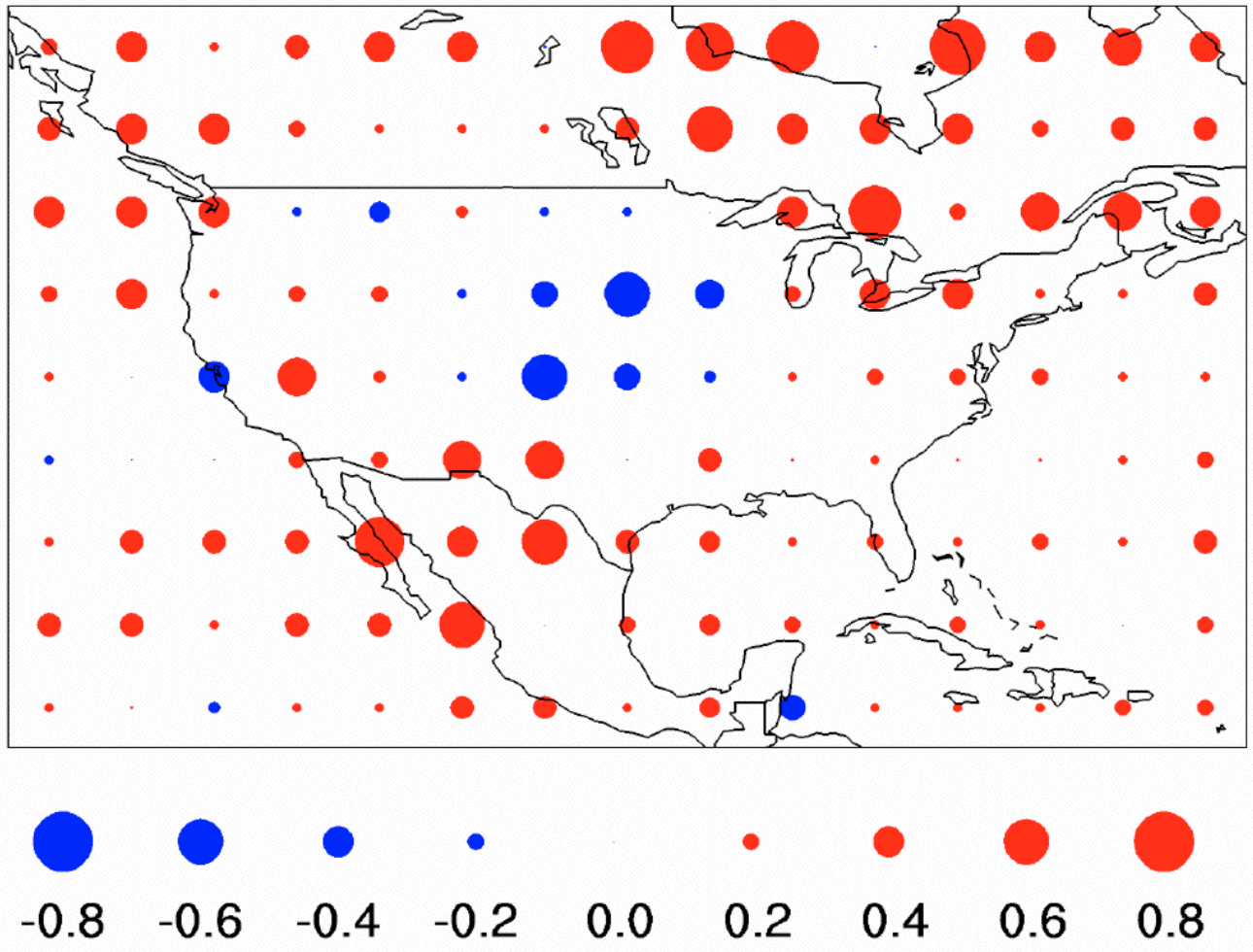
Change in Daily max{T} for June-July-August

(RegCM2 simulation: 2040s - 1990s)



Pan et al., (2004)

∆ T [K] - JJA (2000-1976)



[Adapted from Folland et al. (2001) - IPCC TAR]

Recommendations for RegCNET

7. Further quantify RegCM's added value vs. GCM input.

Recommendations for RegCNET

1. *Avoid implementing many parameterization options in standard model, ...*

2. *… instead promote diagnosing physics of parameterizations and their couplings.*

3. *Should RegCM3 include interior nudging?*
   Research - No ; Climate-change impacts - Maybe

Recommendations for RegCNET

4. *Consider extending to non-hydrostatic dynamics and exploiting advances in cloud microphysics modeling.*

5. *Analyze large-scale tendencies due to RegCM convection and mesoscale circulation.*

6. *Contribute to multi-model programs, such as GEWEX Transferability simulations.*

7. *Further quantify RegCM's added value vs. GCM input.*

谢谢您! - ¡Gracias! - شکراً - □□□□□□□□□ - hvala

Děkuji - dankon - tänan - kiitos - merci - go raibh maith agat

danke - ευχαριστώ - הדות - köszönöm - grazie - どうも

감사합니다 - terima kasih - kia ora - ممنونم - dziękuję

obrigado - mulțumesc - спасибо - хвала - ke a leboha

ďakujem vám - asanteni - tack - salámat - ཐུགས་རྗེ་ཆེ་ལགས།

teşekkür ederim - (ښه) شکریه - cảm ơn (感恩) - jërë-jëf

ndiyabulela - ngiyabona - gunalchéesh - mauruuru - ndatenda

Thank you!