Downscaling of Seasonal Forecasts Over the Philippines and NE Brazil: **Dynamical vs. Statistical Approaches**

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Columbia University, New York, USA

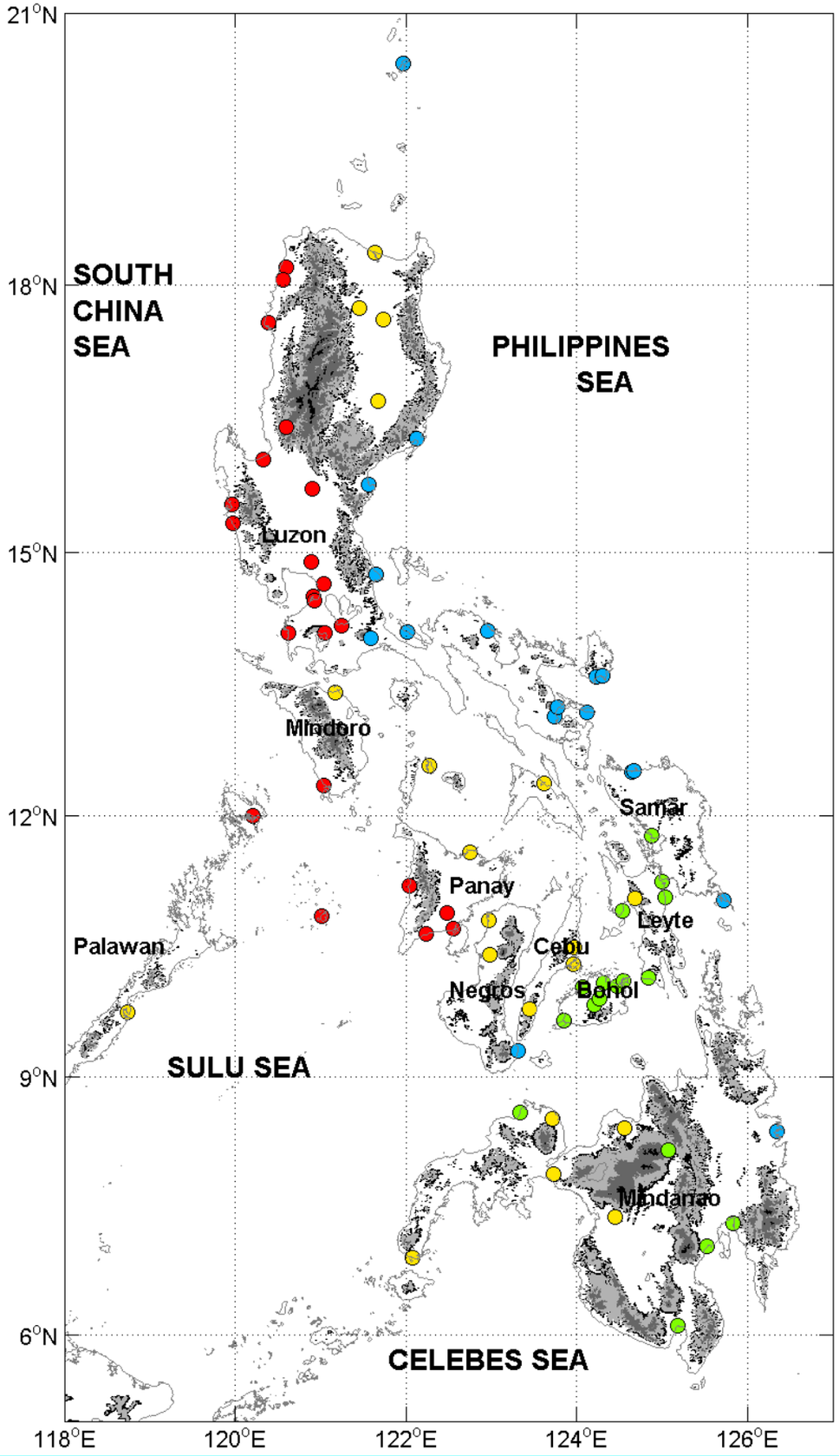
Outline

- Head-to-head comparison of dynamical and statistical seasonal downscaling over the Philippines (RegCM3)
- Operational dynamical downscaling of seasonal forecasts over NE Brazil (RSM)

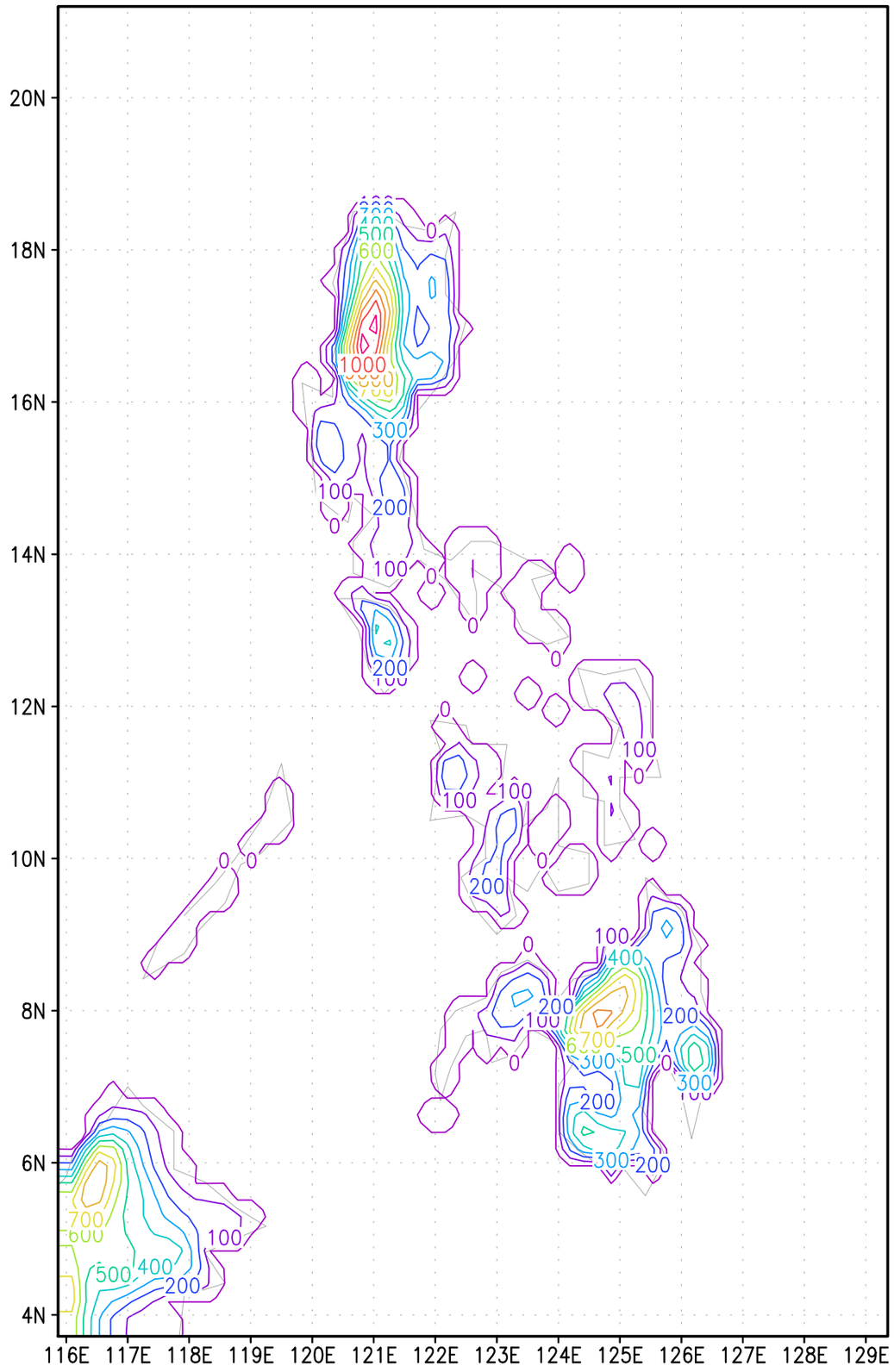
Philippines Intercomparison

- **GCM:** ECHAM4.5 @ T42 simulations with observed SSTs
  - 24 members, 10 used
- **Nested regional model:** RegCM3 @ 25km, over Philippines
  - Emanuel convection, BATS surface fluxes, 10 members
- **Statistical "MOS" downscaling:** PC regression to 77 stations
  - PAGASA daily rainfall records, 1977–2004
  - April–June, monsoon onset season

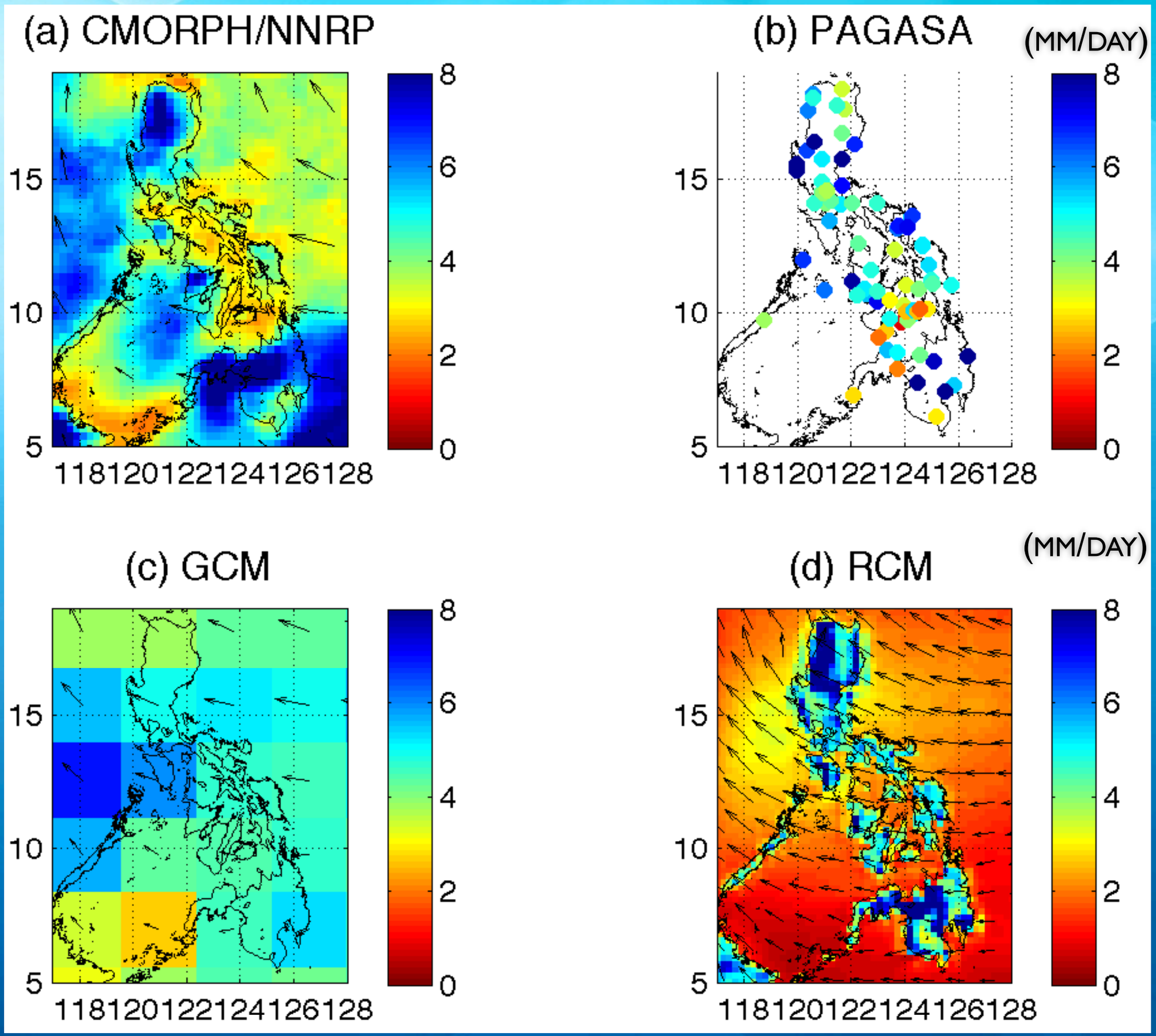
PAGASA Rainfall Stations



RegCM3 Domain & 25km Topography

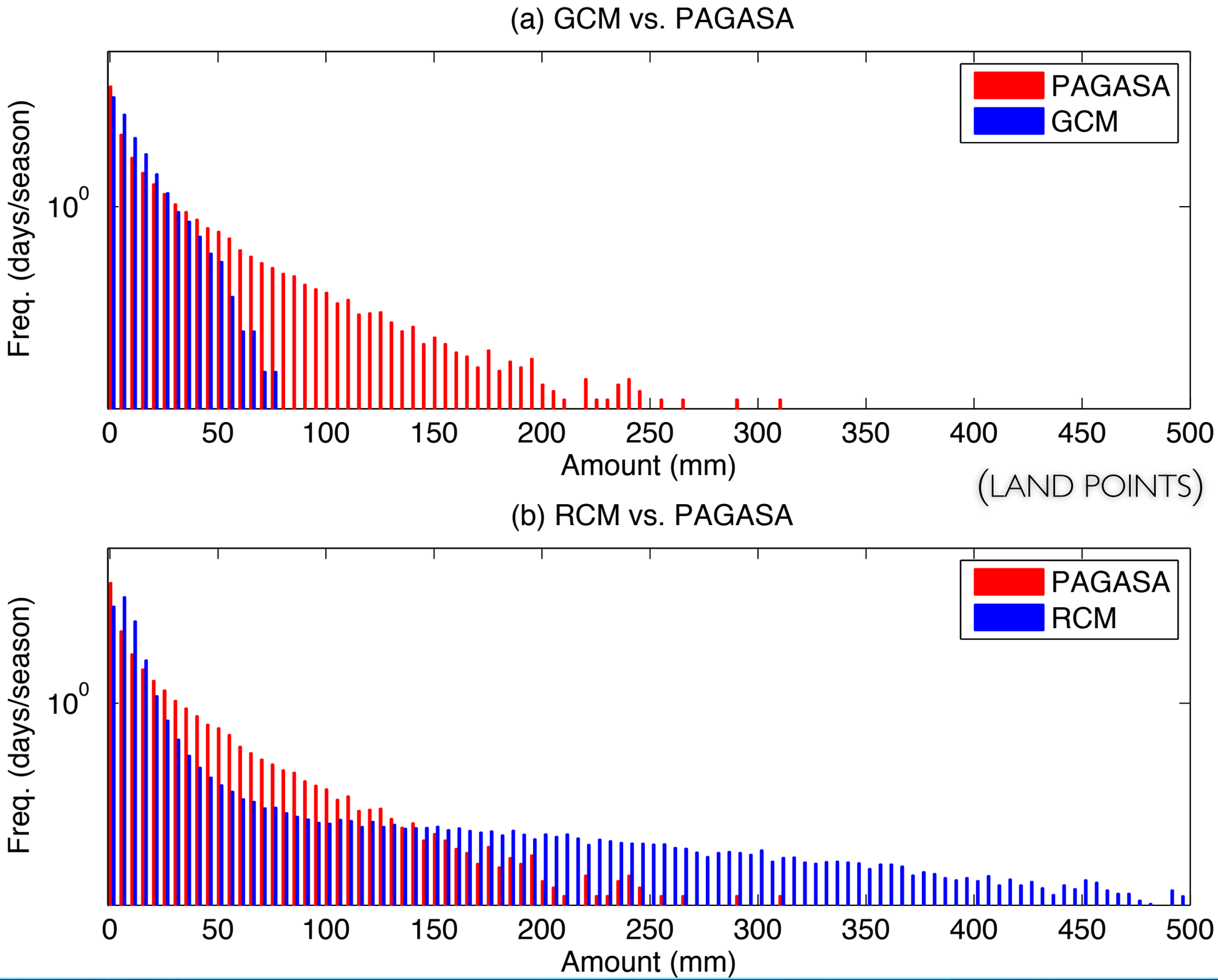


CLIMO MEAN



MEAN APRIL–JUNE PRECIP. AND LOW-LEVEL WINDS

DAILY RAINFALL DISTRIBUTIONS



(LAND POINTS)

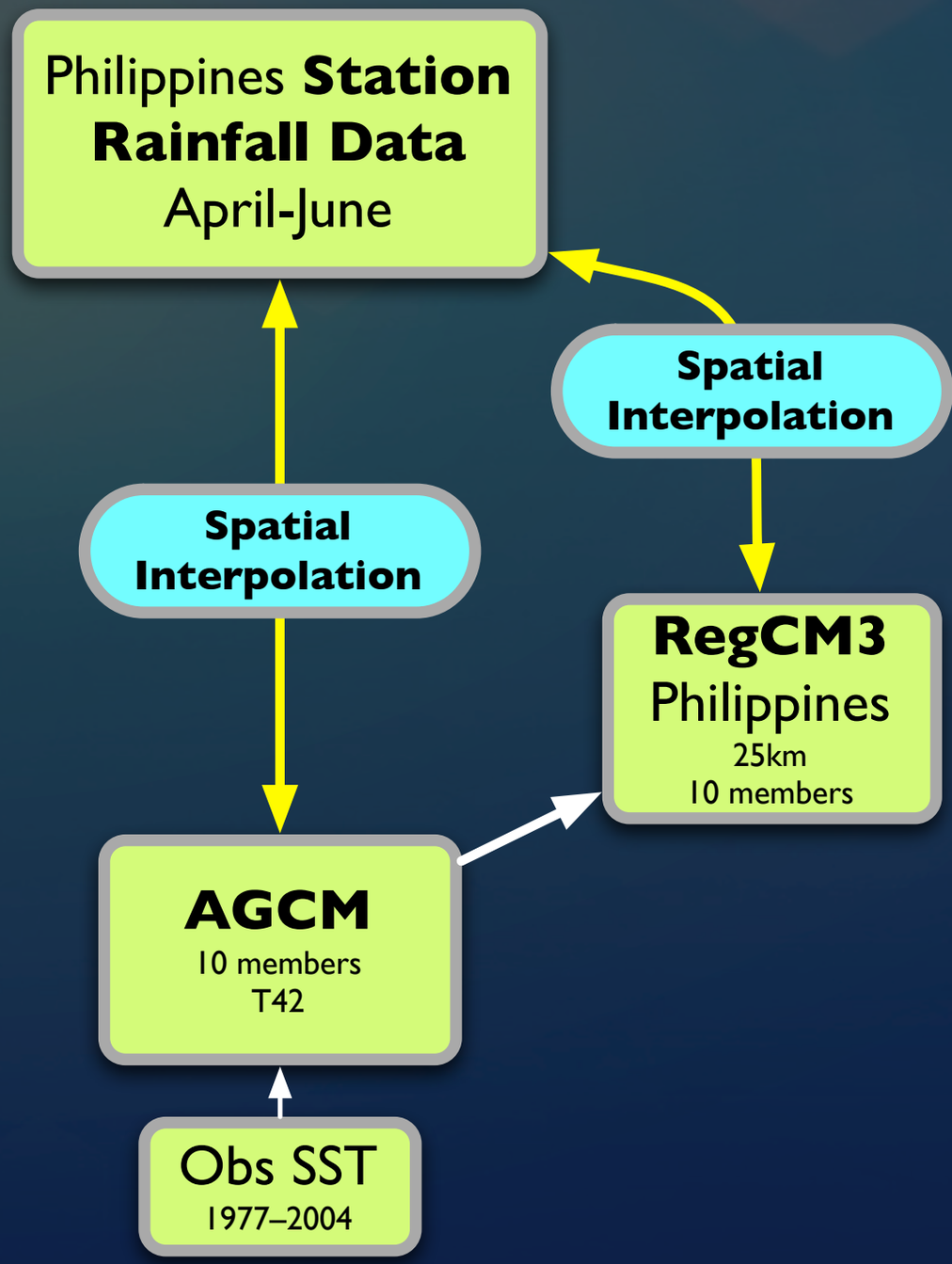
Downscaling Methods

Philippines **Station Rainfall Data**
April-June

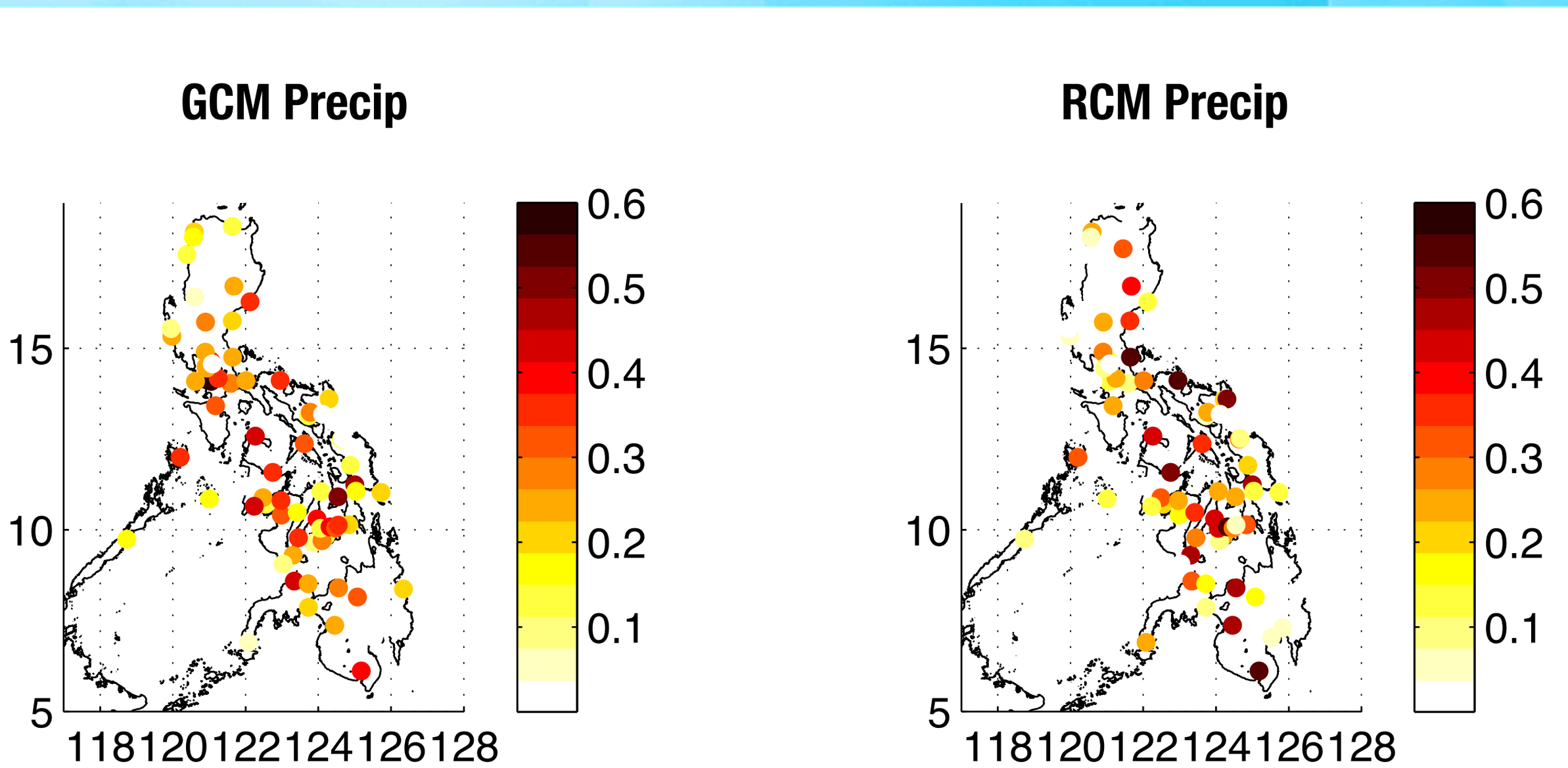
RegCM3
Philippines
25km
10 members

AGCM
10 members
T42

Obs SST
1977–2004

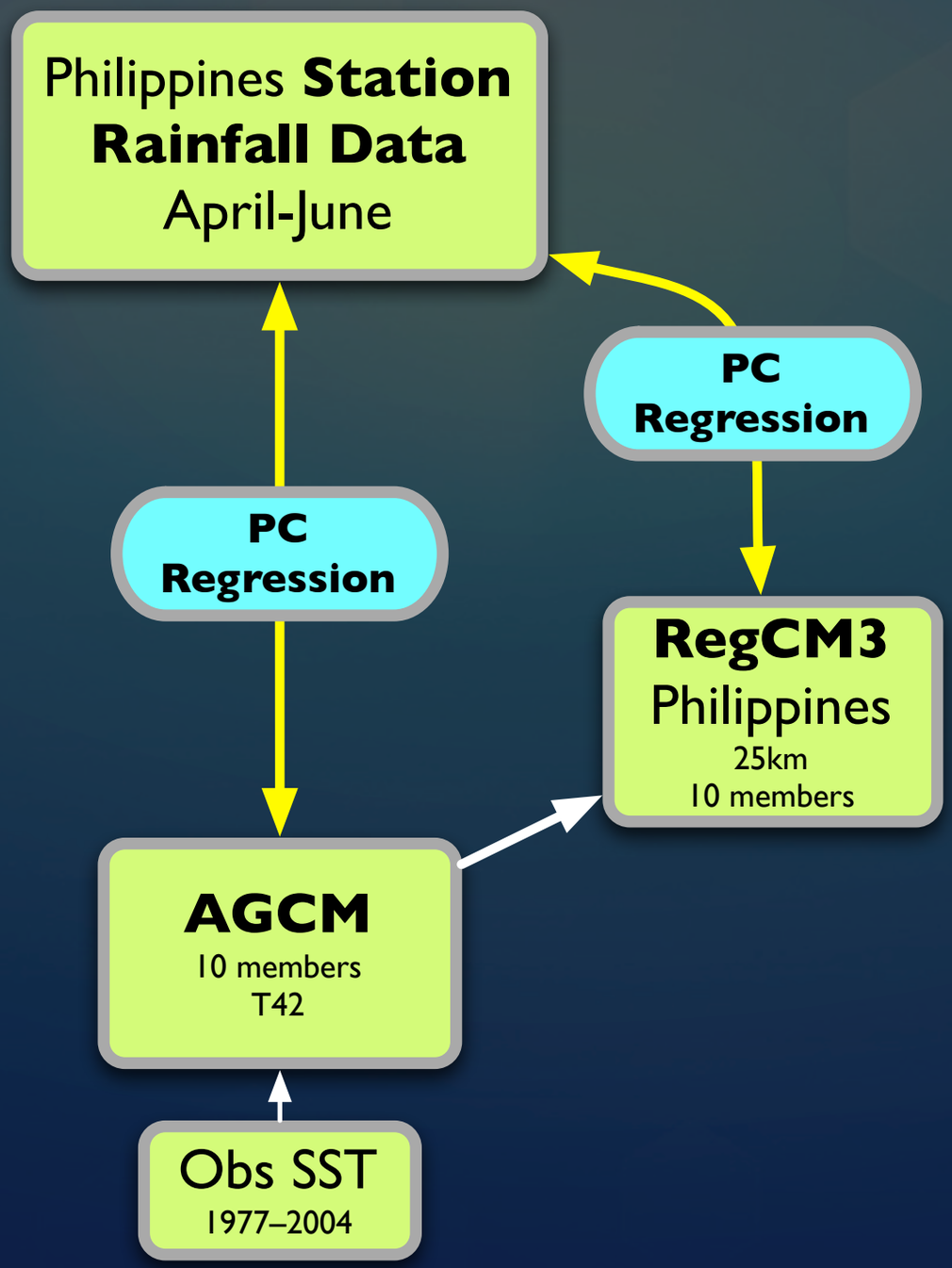

Philippines **Station Rainfall Data**
April-June
Spatial Interpolation
Spatial Interpolation
RegCM3
Philippines
25km
10 members
AGCM
10 members
T42
Obs SST
1977–2004

ANOMALY CORRELATION SKILL: SPATIAL INTERPOLATION



(APRIL–JUNE SEASONAL TOTAL PRECIP 1977–04)

ANOMALIES CALCULATED USING LEAVE-ONE-OUT CROSS-VALIDATION



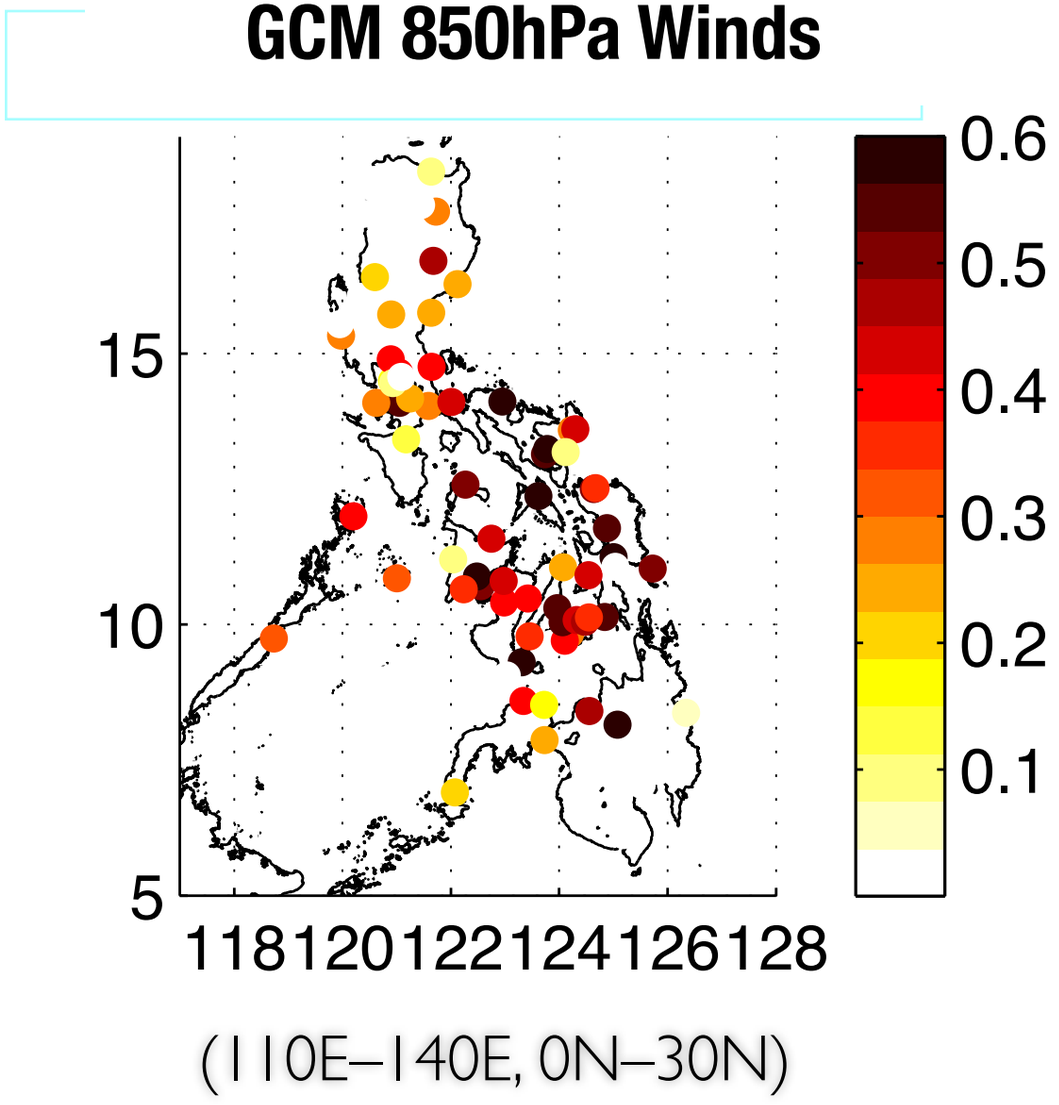
MOS:

$$y = Ax + b + \epsilon$$

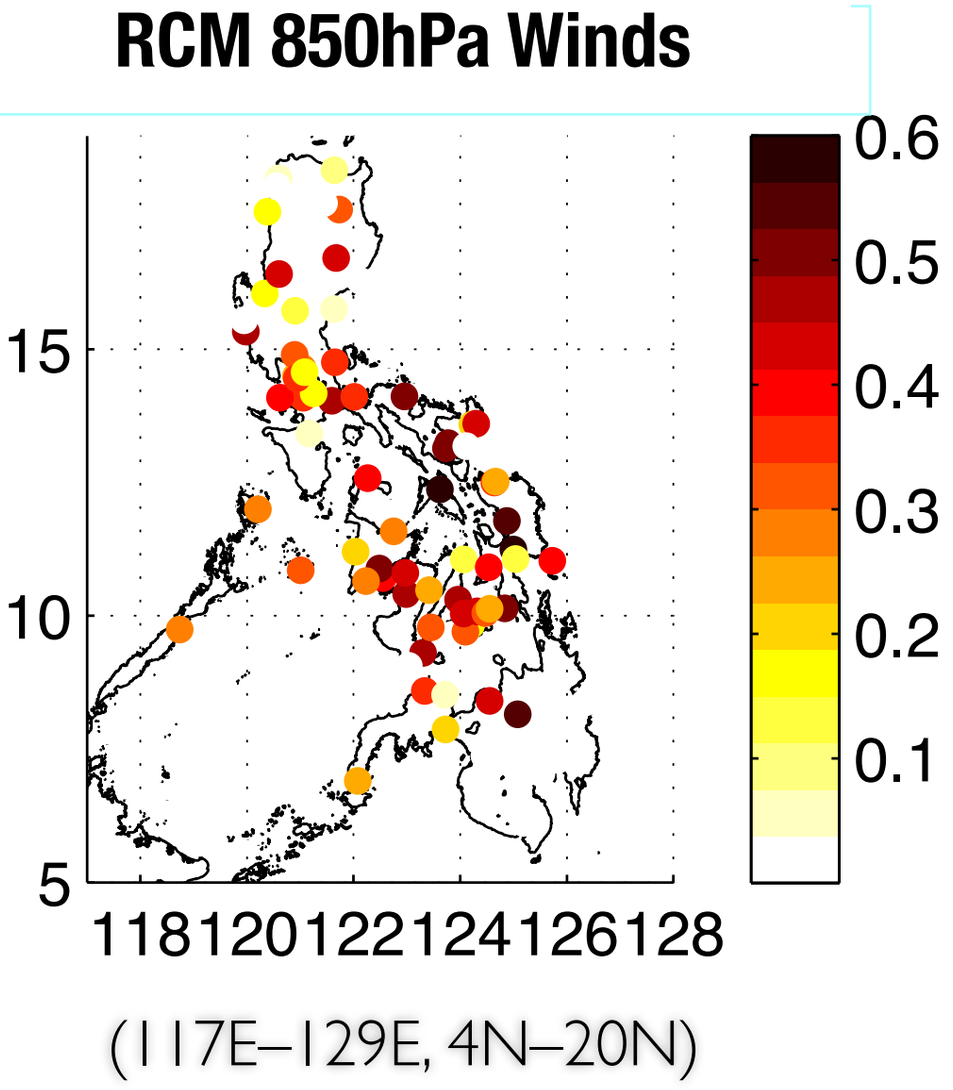
STATION SEASONAL PRECIP TIME SERIES

PCs OF MODEL VARIABLE

ANOMALY CORRELATION SKILL: PRINCIPAL COMPTS REGRESSION



(110E–140E, 0N–30N)

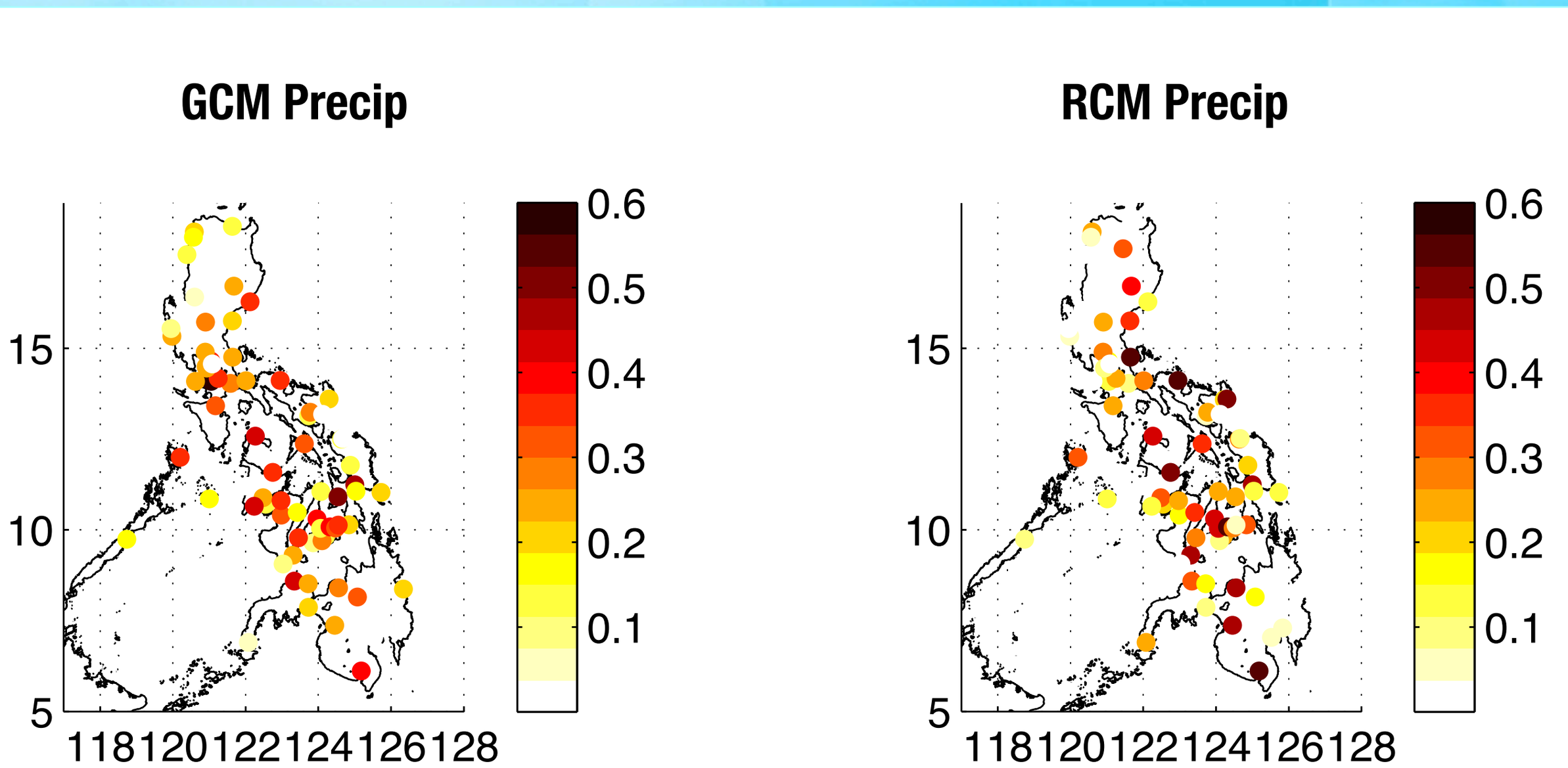


(117E–129E, 4N–20N)

(APRIL–JUNE SEASONAL TOTAL PRECIP 1977–04)

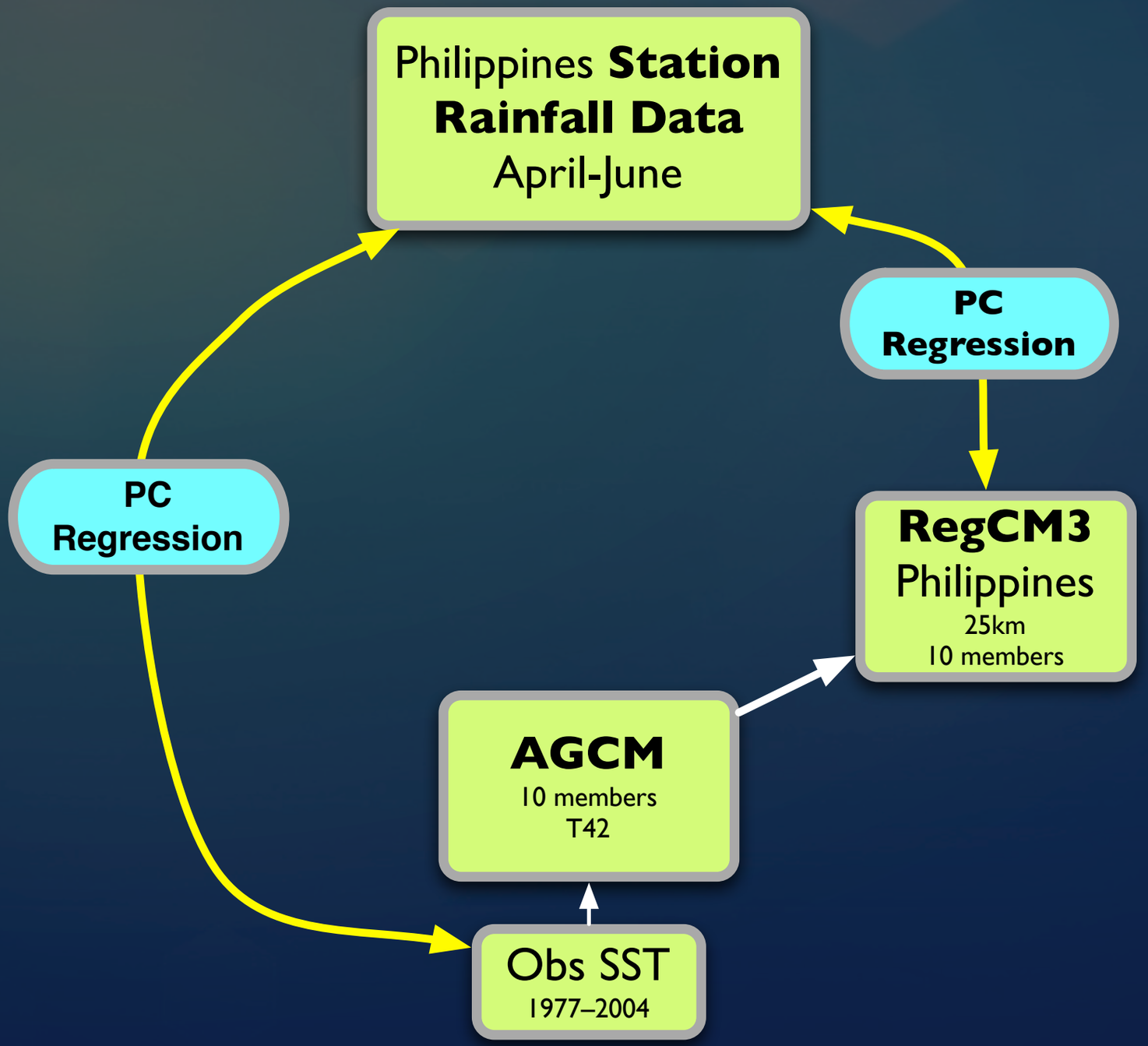
LEAVE-ONE-OUT CROSS-VALIDATION

ANOMALY CORRELATION SKILL: SPATIAL INTERPOLATION



(APRIL–JUNE SEASONAL TOTAL PRECIP 1977–04)

ANOMALIES CALCULATED USING LEAVE-ONE-OUT CROSS-VALIDATION


Philippines **Station Rainfall Data**
April-June
PC Regression
PC Regression
RegCM3
Philippines
25km
10 members
AGCM
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Obs SST
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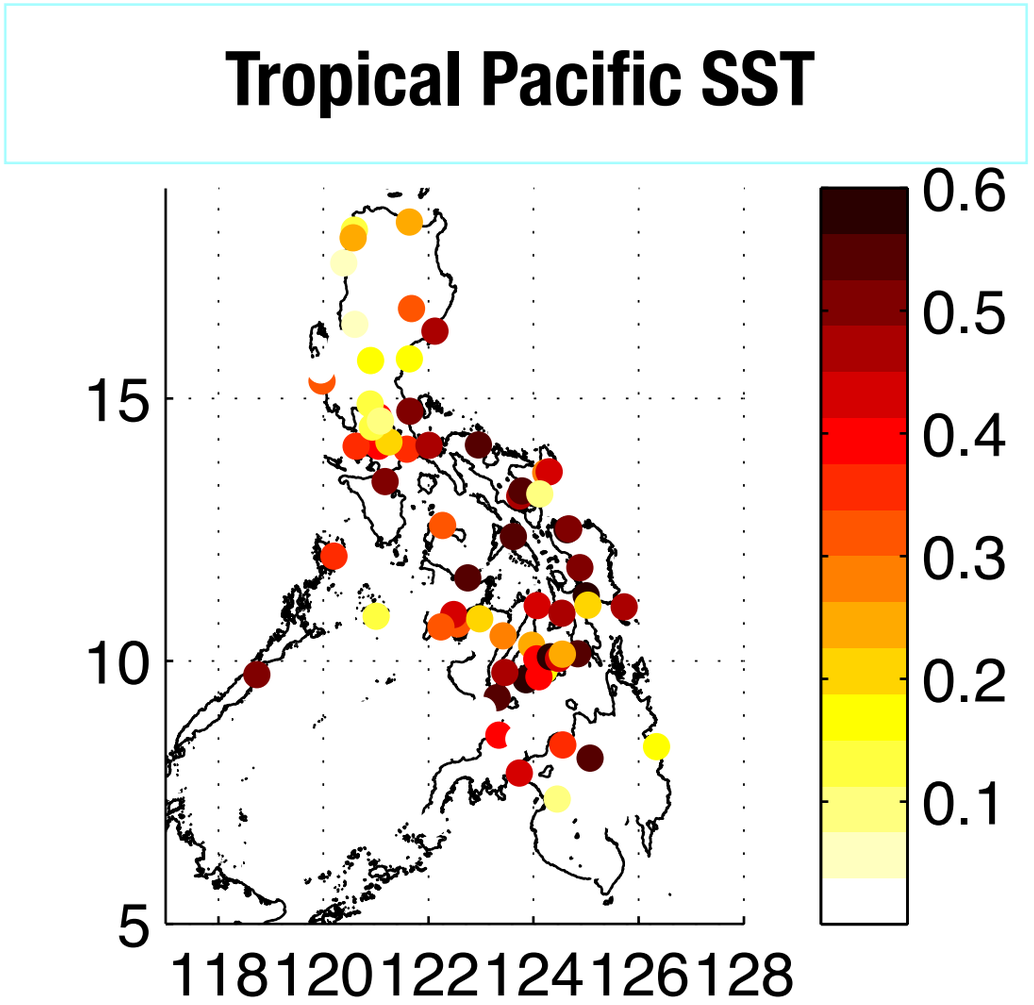
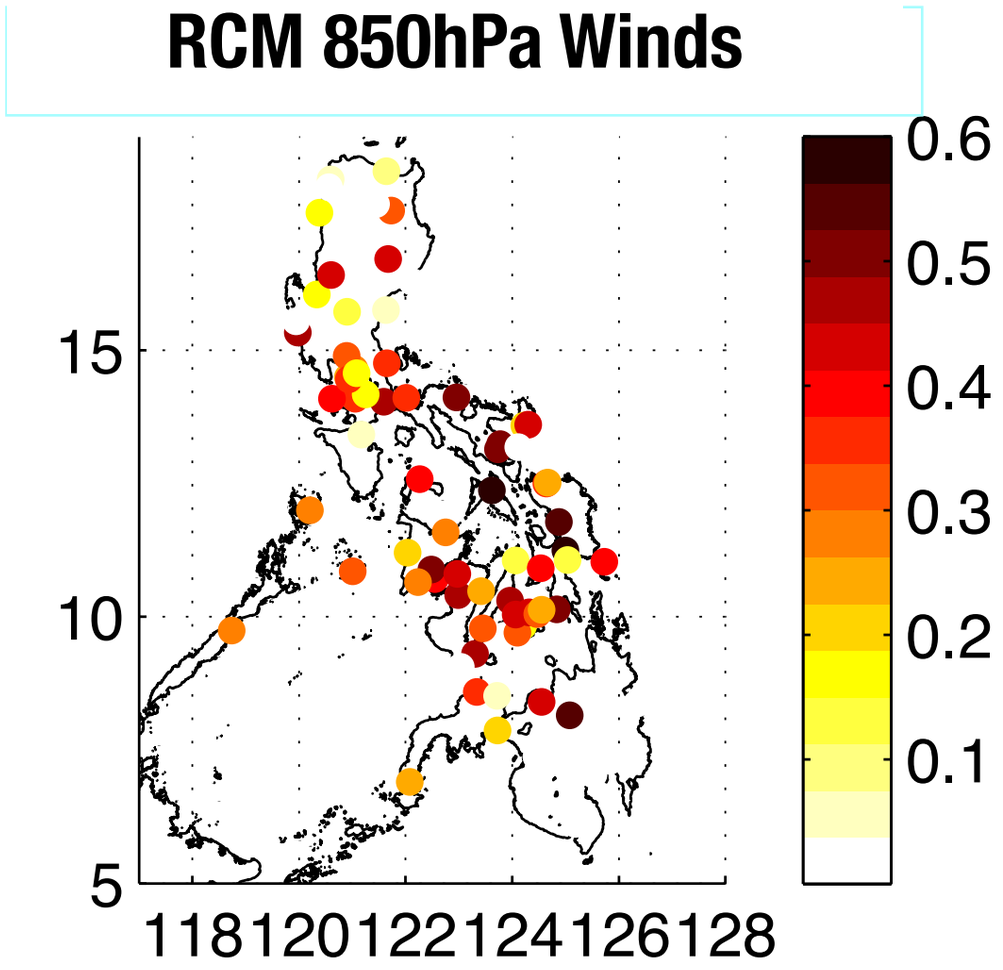
ANOMALY CORRELATION SKILL: PRINCIPAL COMPTS REGRESSION





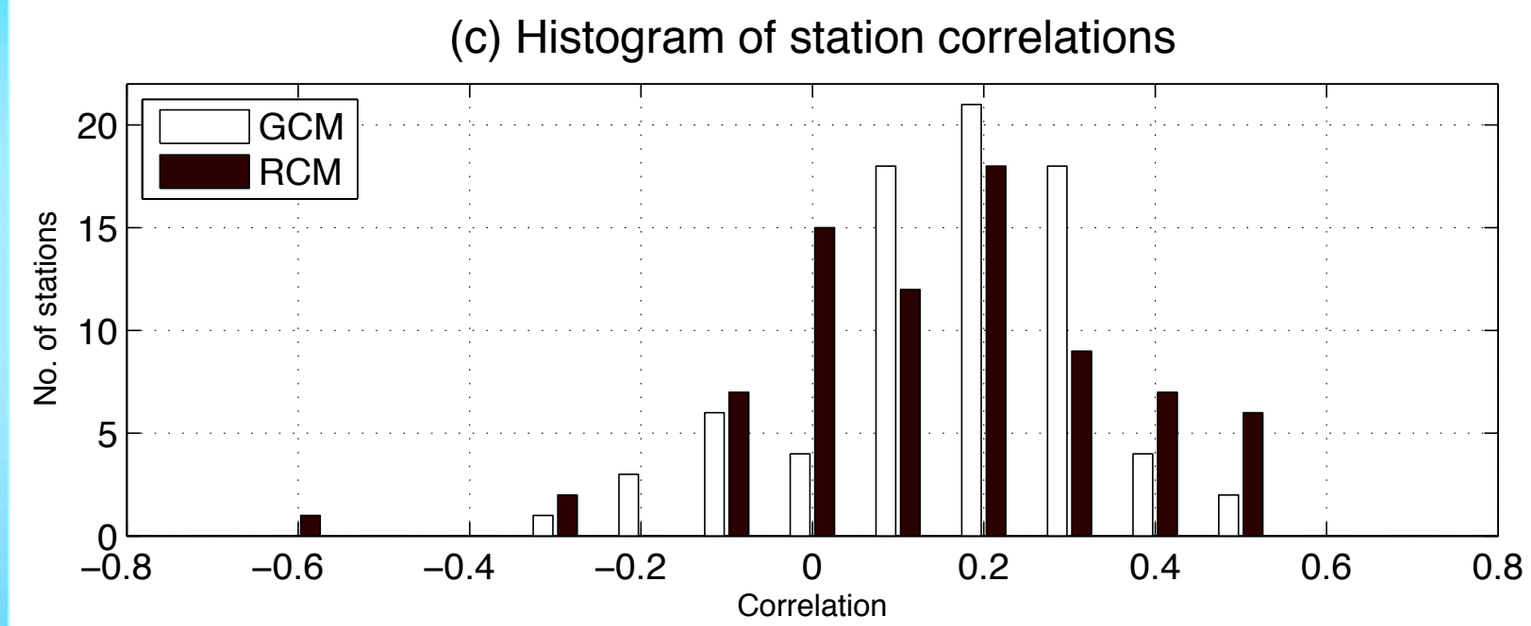
(APRIL–JUNE SEASONAL TOTAL PRECIP 1977–04)

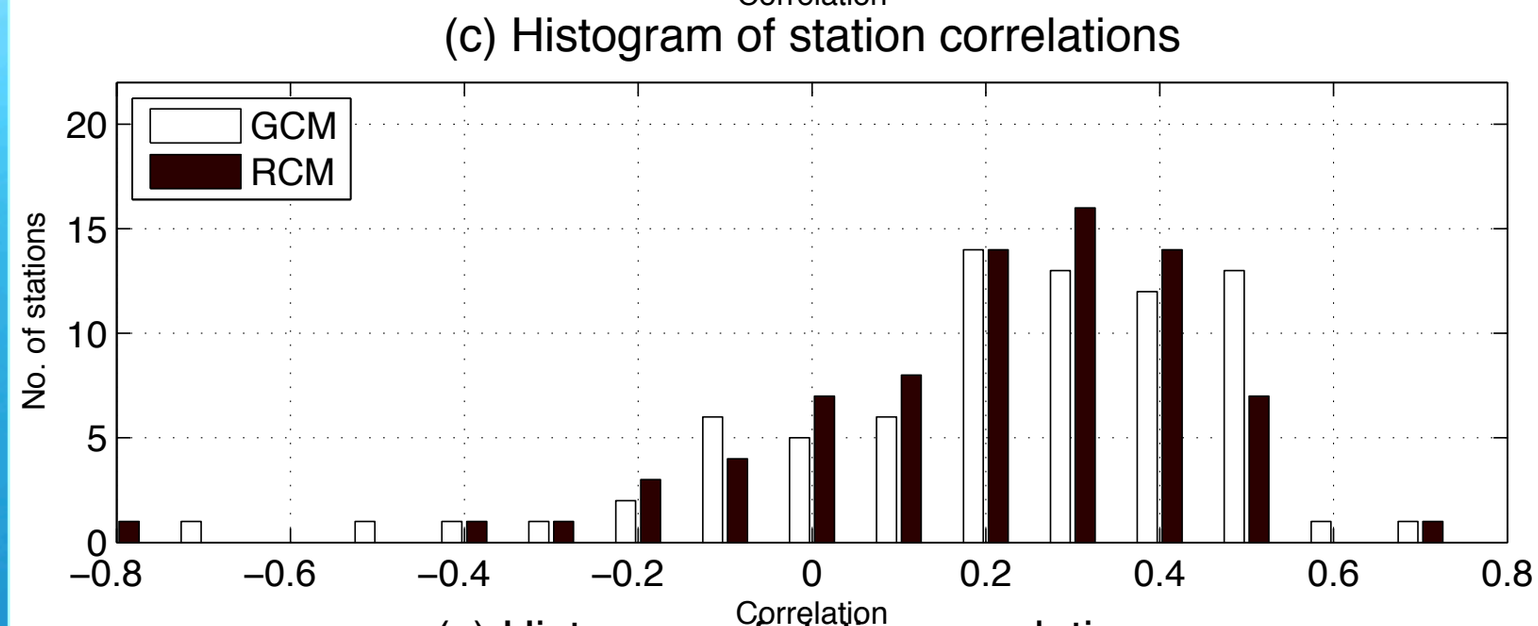
LEAVE-ONE-OUT CROSS-VALIDATION

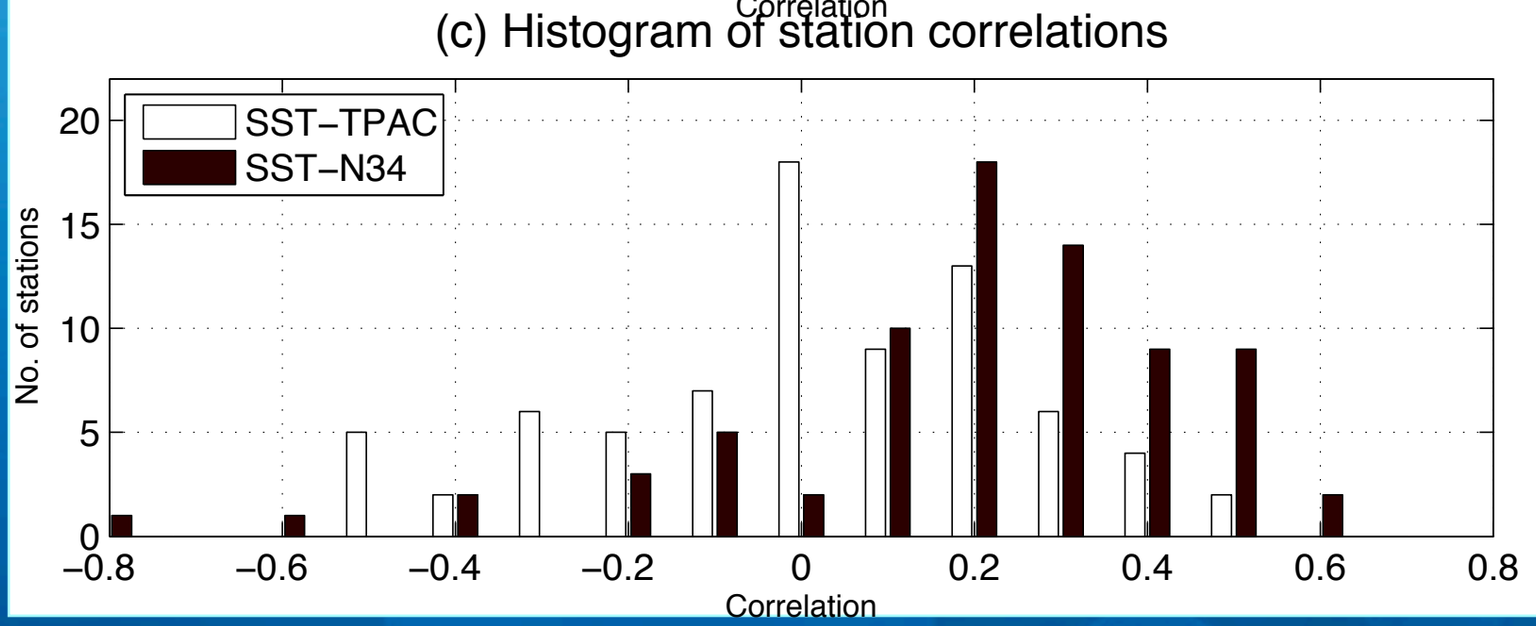
Interpolation

MOS with 850mb Winds

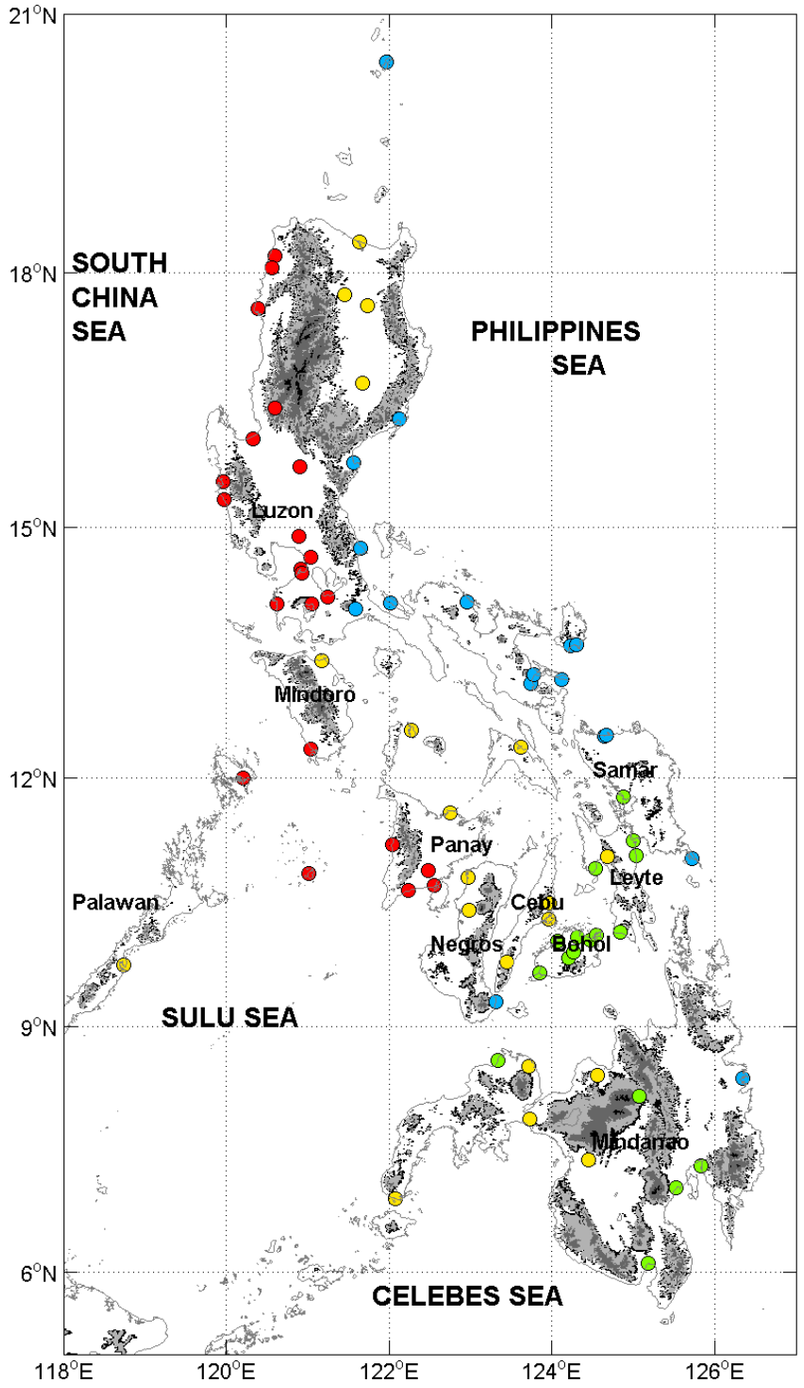
MOS with SST



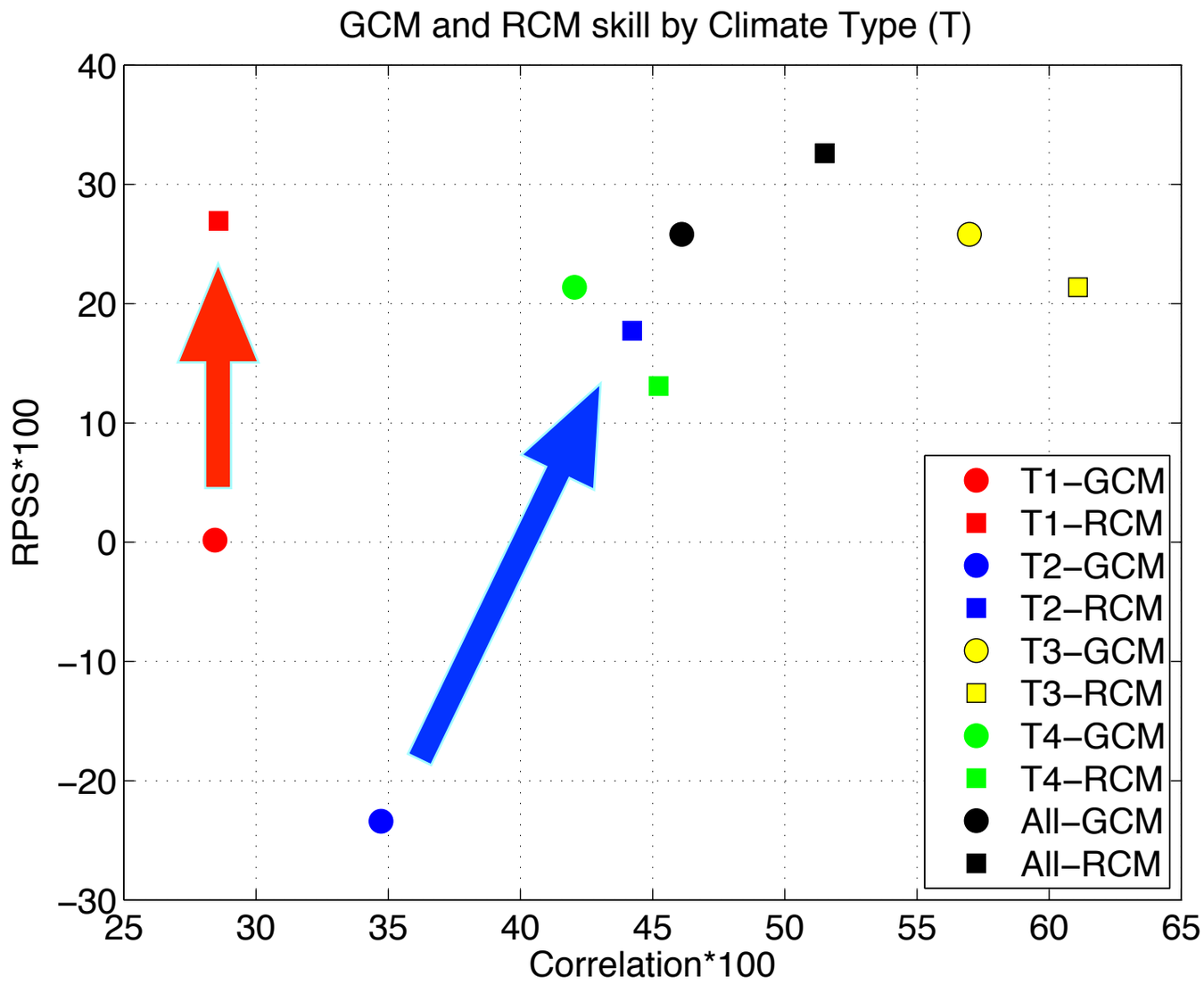




PAGASA Stations by Climate Type



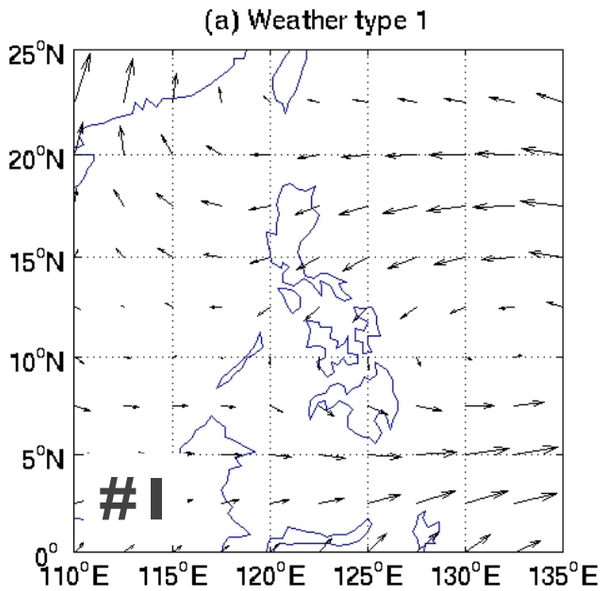
Downscaling by Interpolation: RPSS and Anomaly Correlation

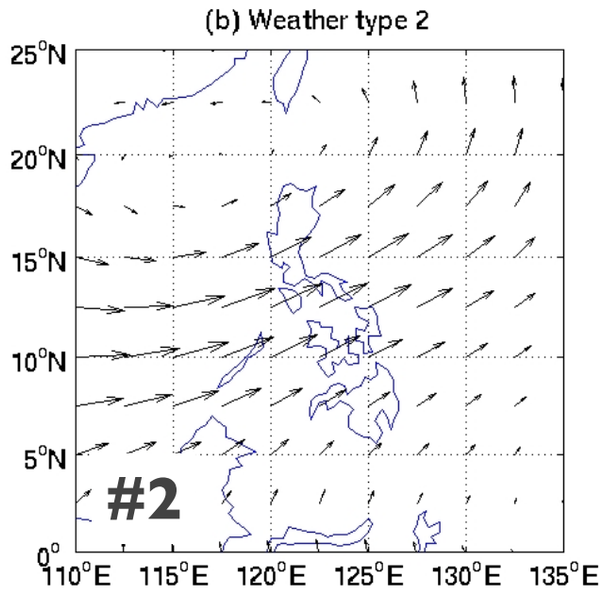


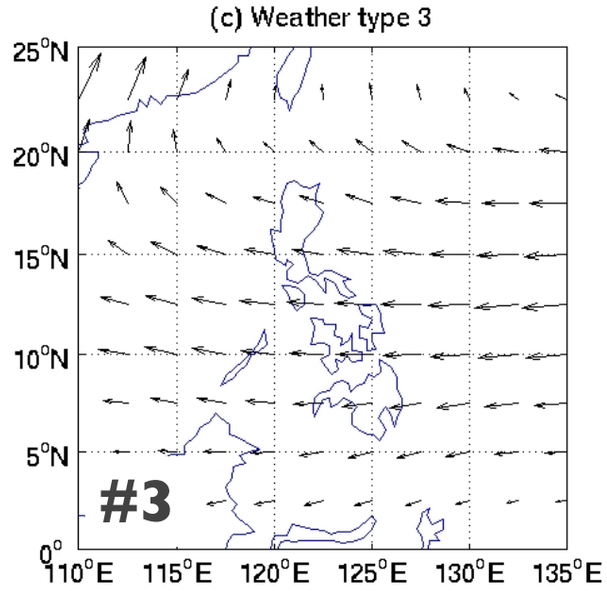
How well does GCM capture observed daily weather types?

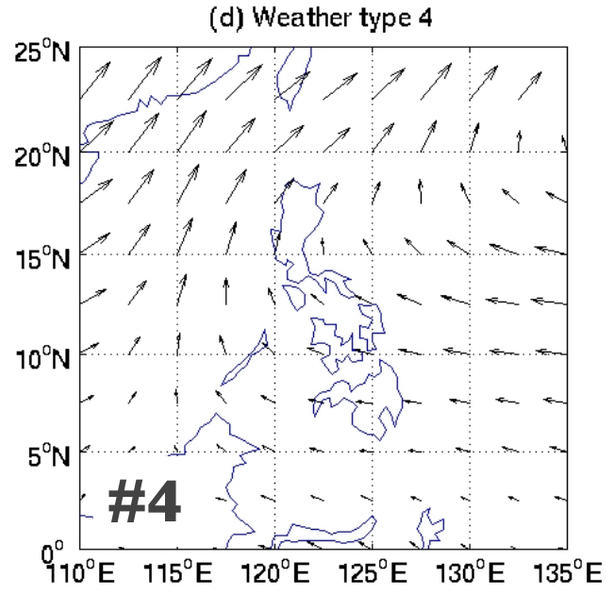
Cluster Analysis of Daily Winds in GCM and NNRP

April–June, 850hPa

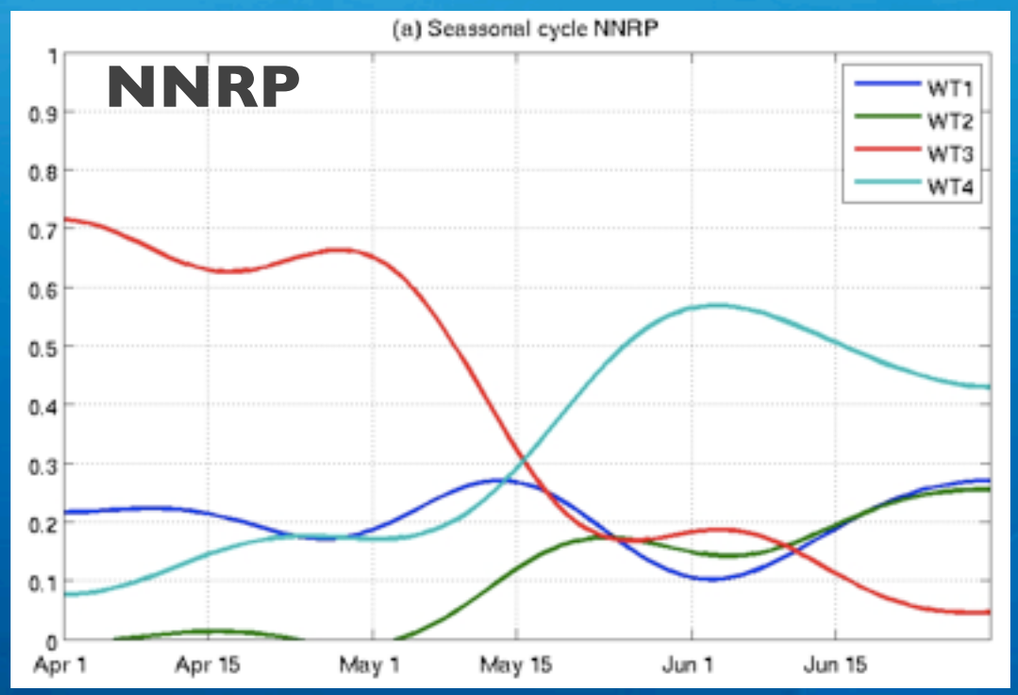


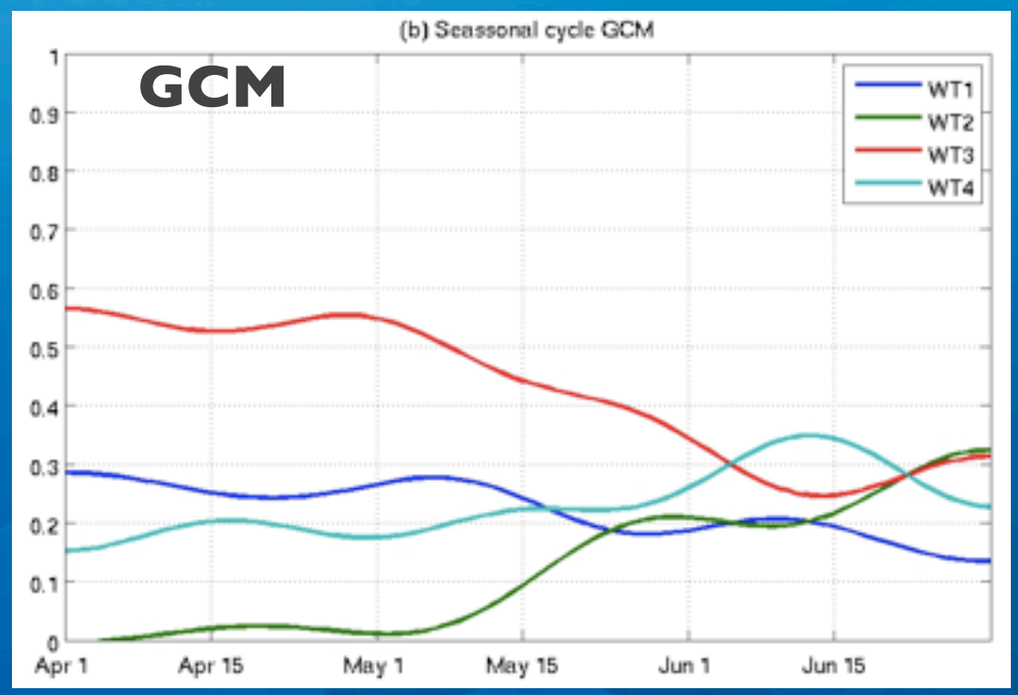




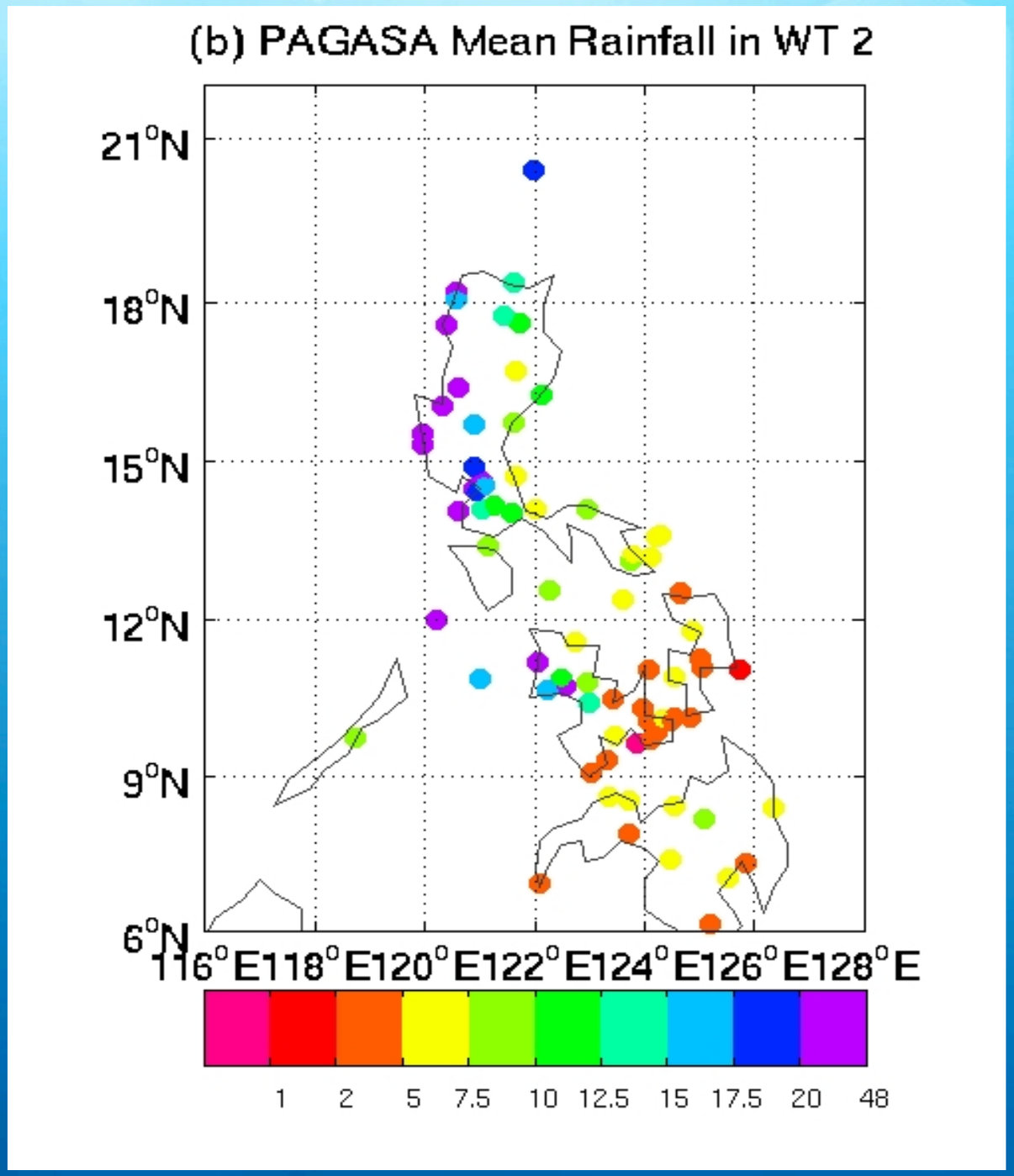


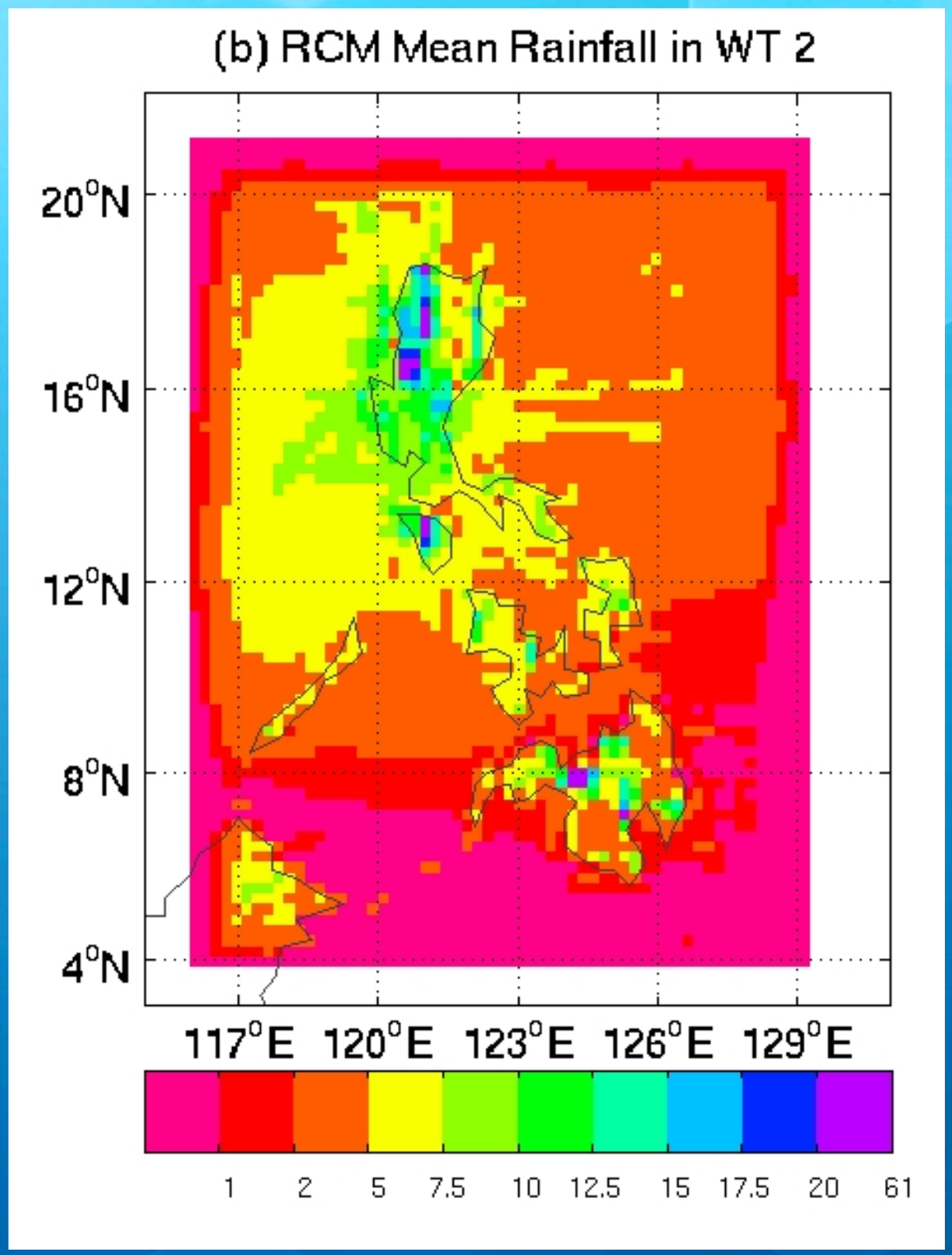
Seasonal Cycle





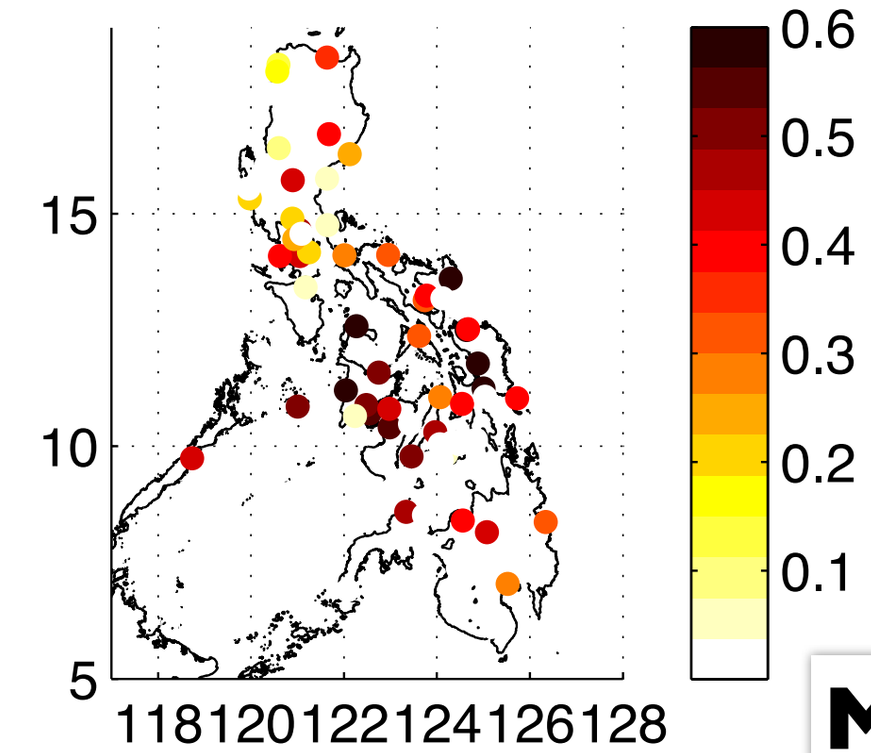
RAINFALL IN WEATHER TYPE 2

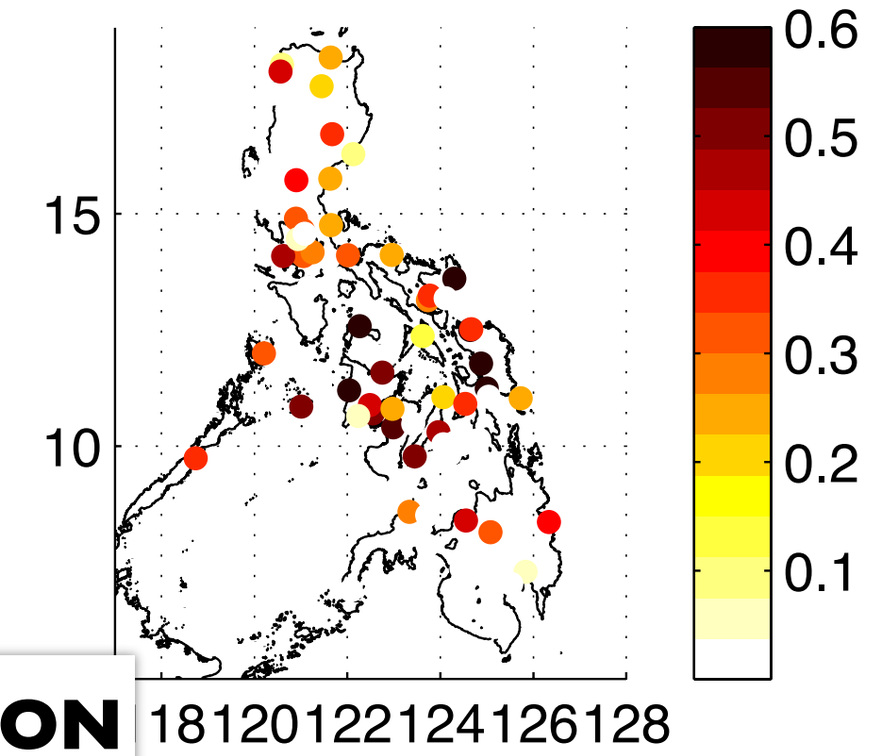


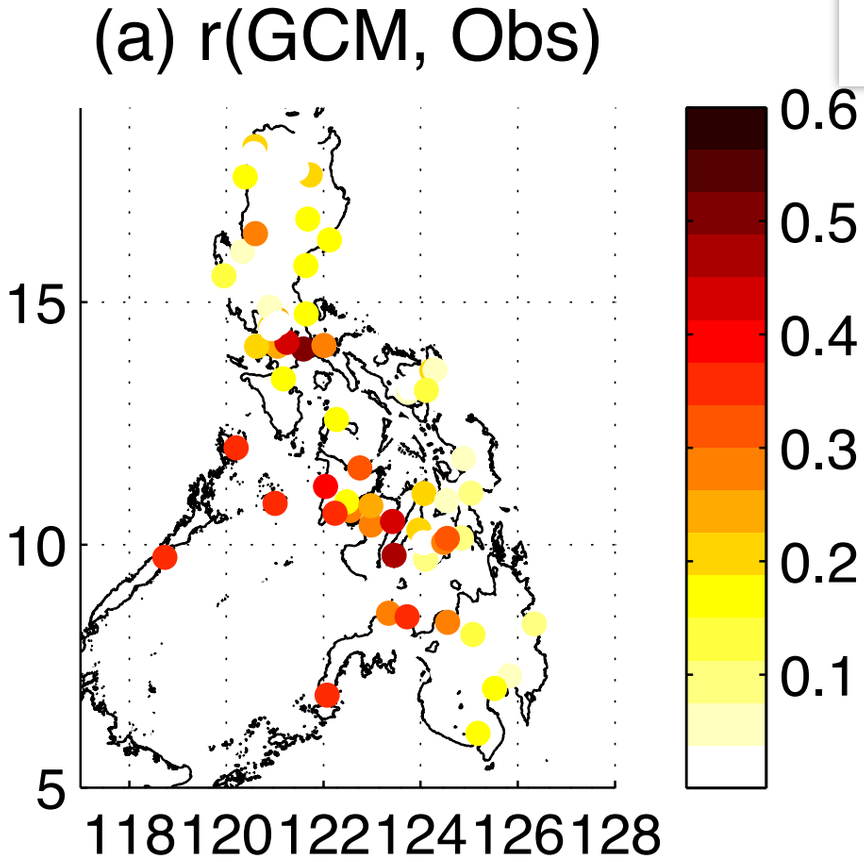


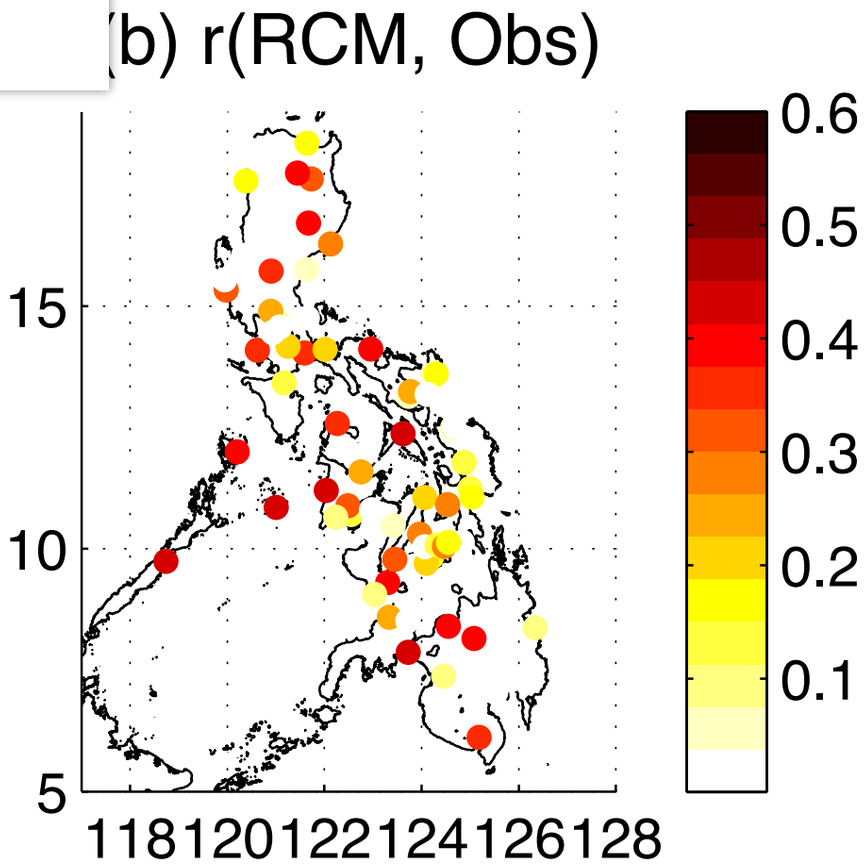
MM/DAY

Monsoon Onset Date







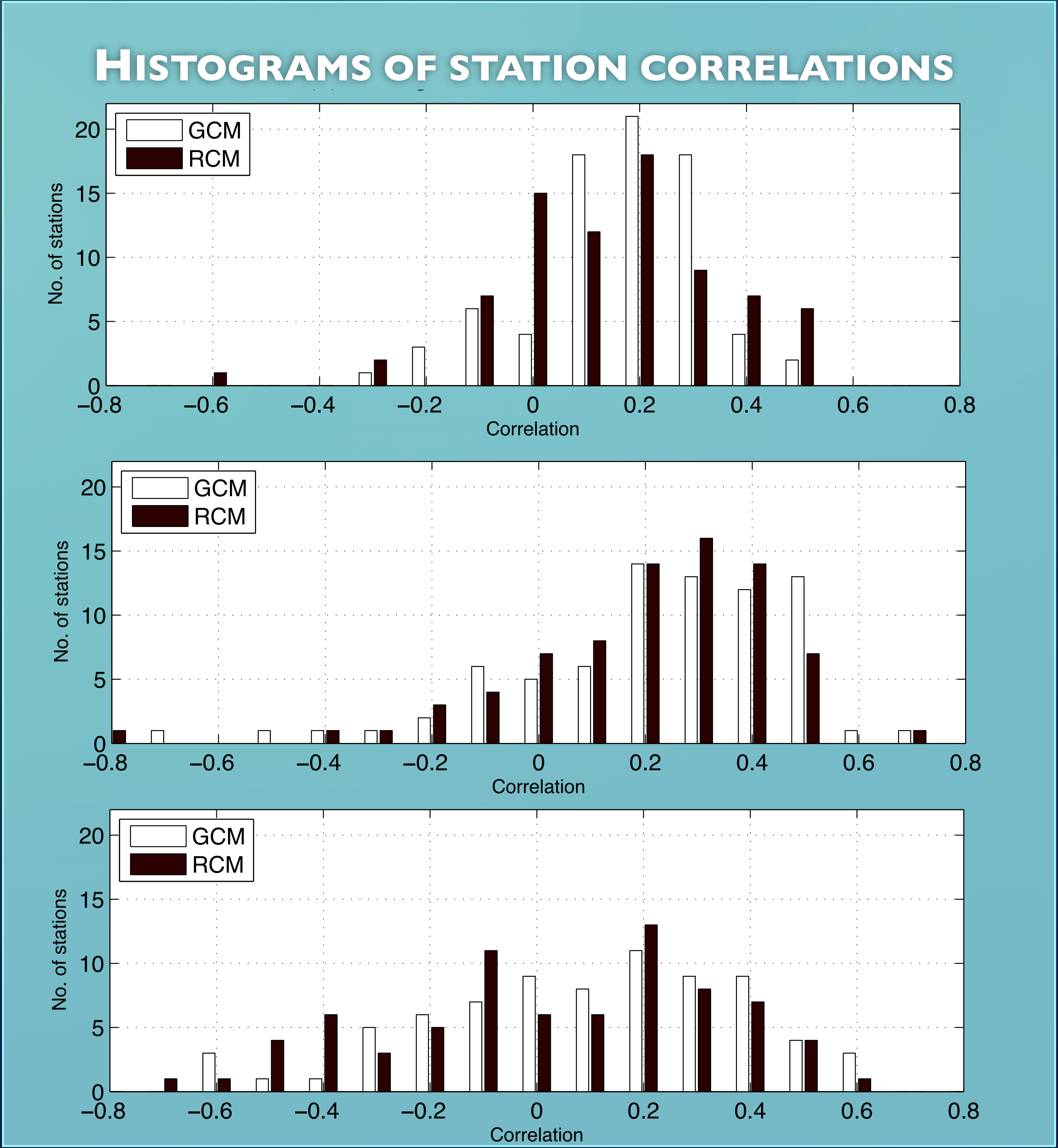


IMPACT OF DATA SERIES LENGTH

Interpolation

MOS
Entire 28-year
data set

MOS of each 14-yr half
separately, then
averaged

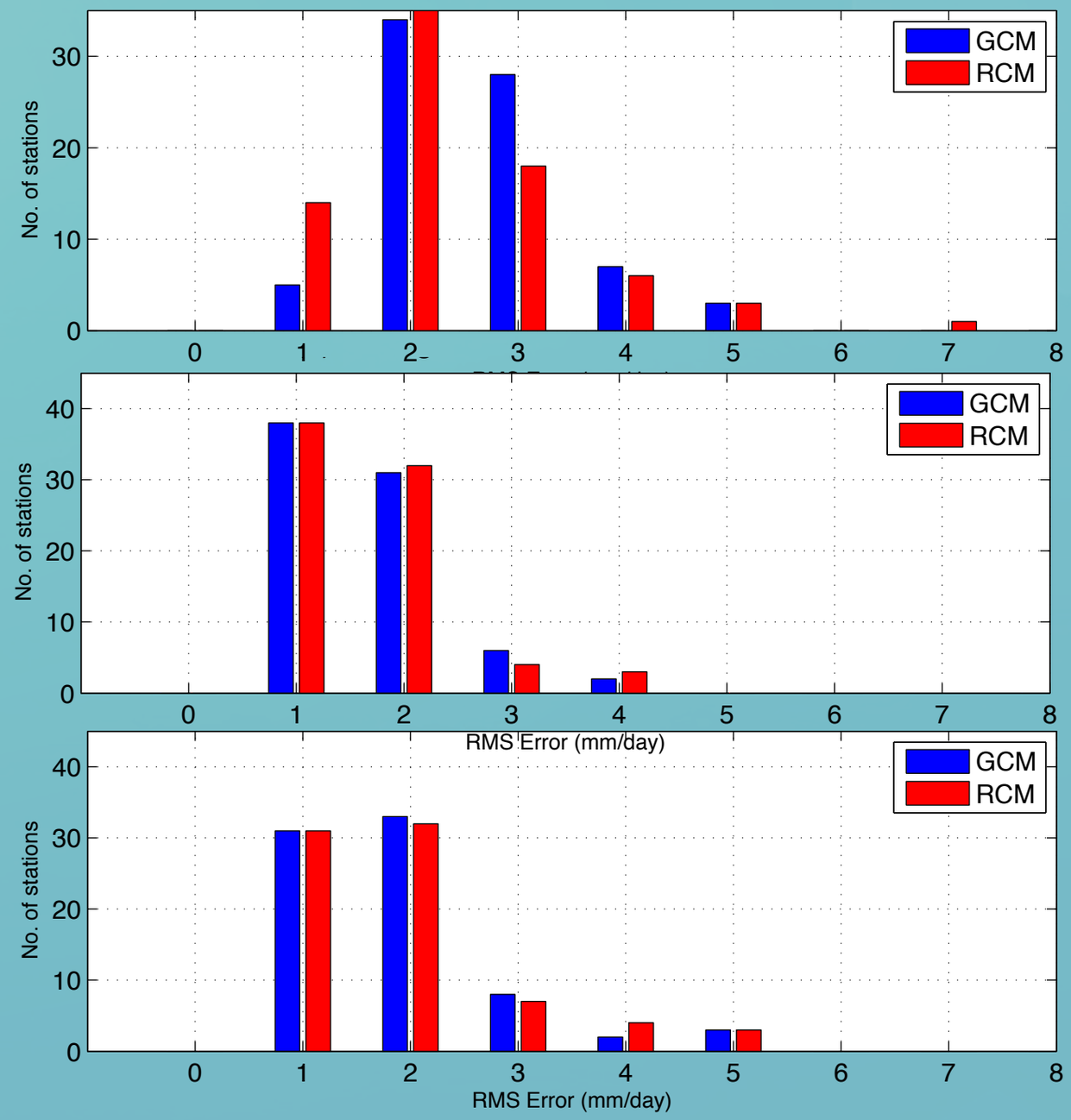


RAW INTERPOLATION

MOS
ENTIRE-DATA

MOS
TWO-HALVES

HISTOGRAMS OF STATION RMSE



Summary

- High-resolution climatology is much better resolved by the 25-km RegCM than the ~300-km GCM
- Intensity distribution of daily rainfall improves, but "overshoots" the observed one
- RegCM cannot beat MOS for downscaling of seasonal quantities, but ...
  - RegCM raw gridded values are not inferior, and would be invaluable for input to hydrologic models
  - Dynamical downscaling may outperform regression for short time series

Dynamical Downscaling Forecasts and Verification over Northeast Brazil

Liqiang Sun (IRI)

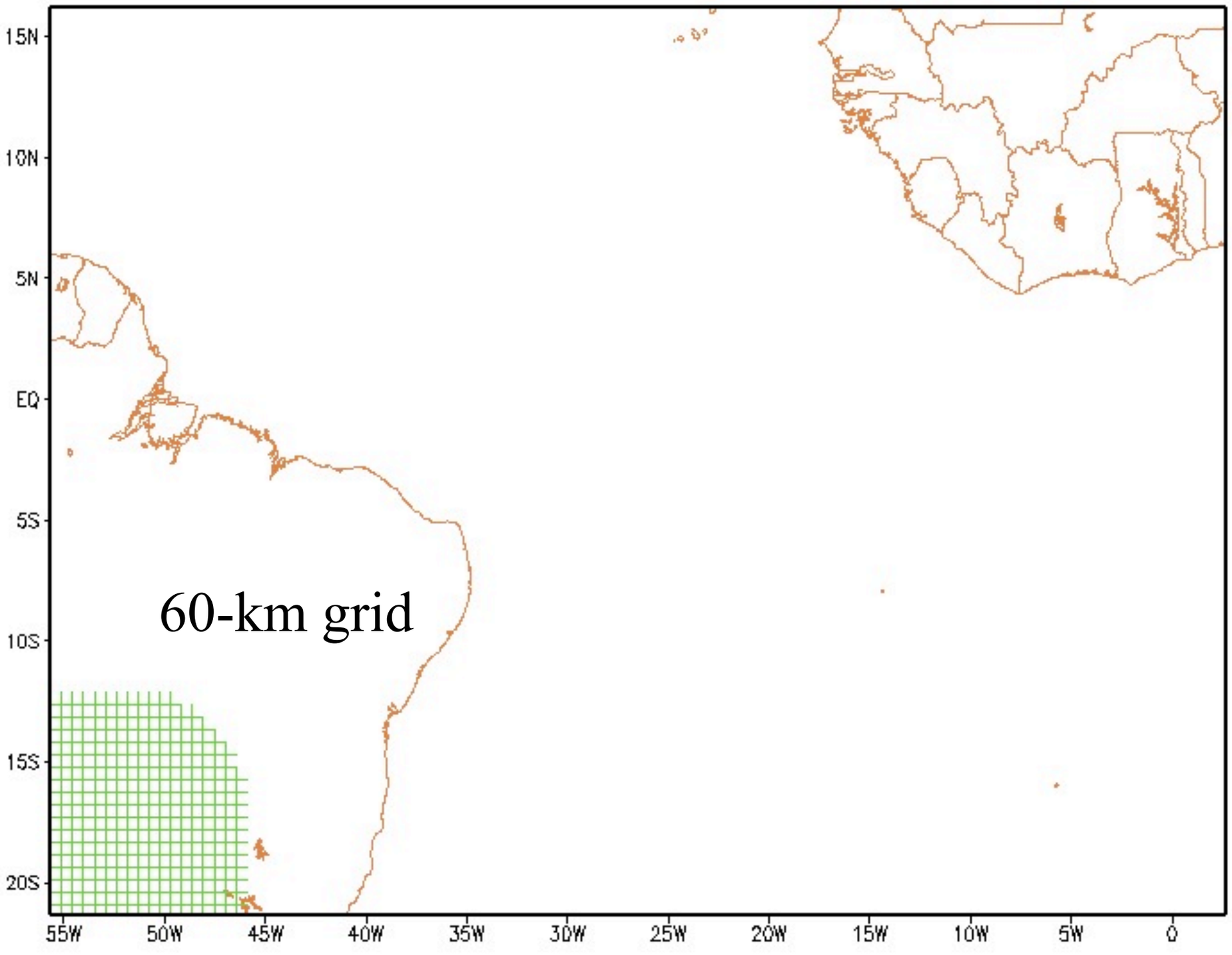
David Moncunill1 (FUNCEME)

Alexandre Costa (FUNCEME)

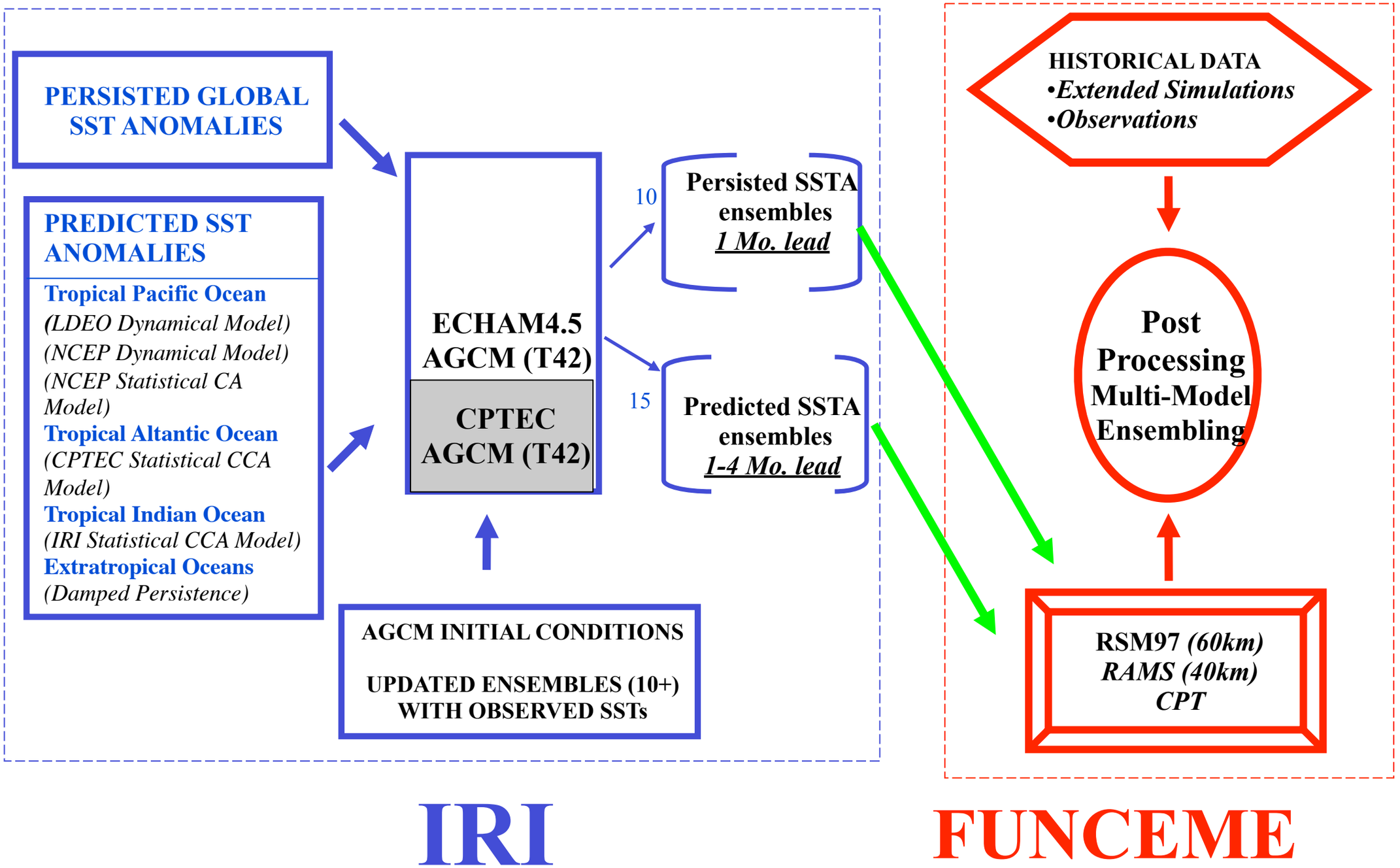
Downscaling forecasts Using the RSM

- IRI since 1997
- ECPC since 1997
- NR&M (Queensland)/IRI 1998
- FUNCEME/IRI since 2001
- NCEP since 2002
- CWB/IRI since 2003
- ICPAC/IRI since 2004
- SAWS/IRI 2006 & 2007
- ZCC/IRI 2007 & 2008
- ECPC/NTU,HKO, BIU 2003

RSM MODEL DOMAIN WITH A PRTION OF GRID RESOLUTION

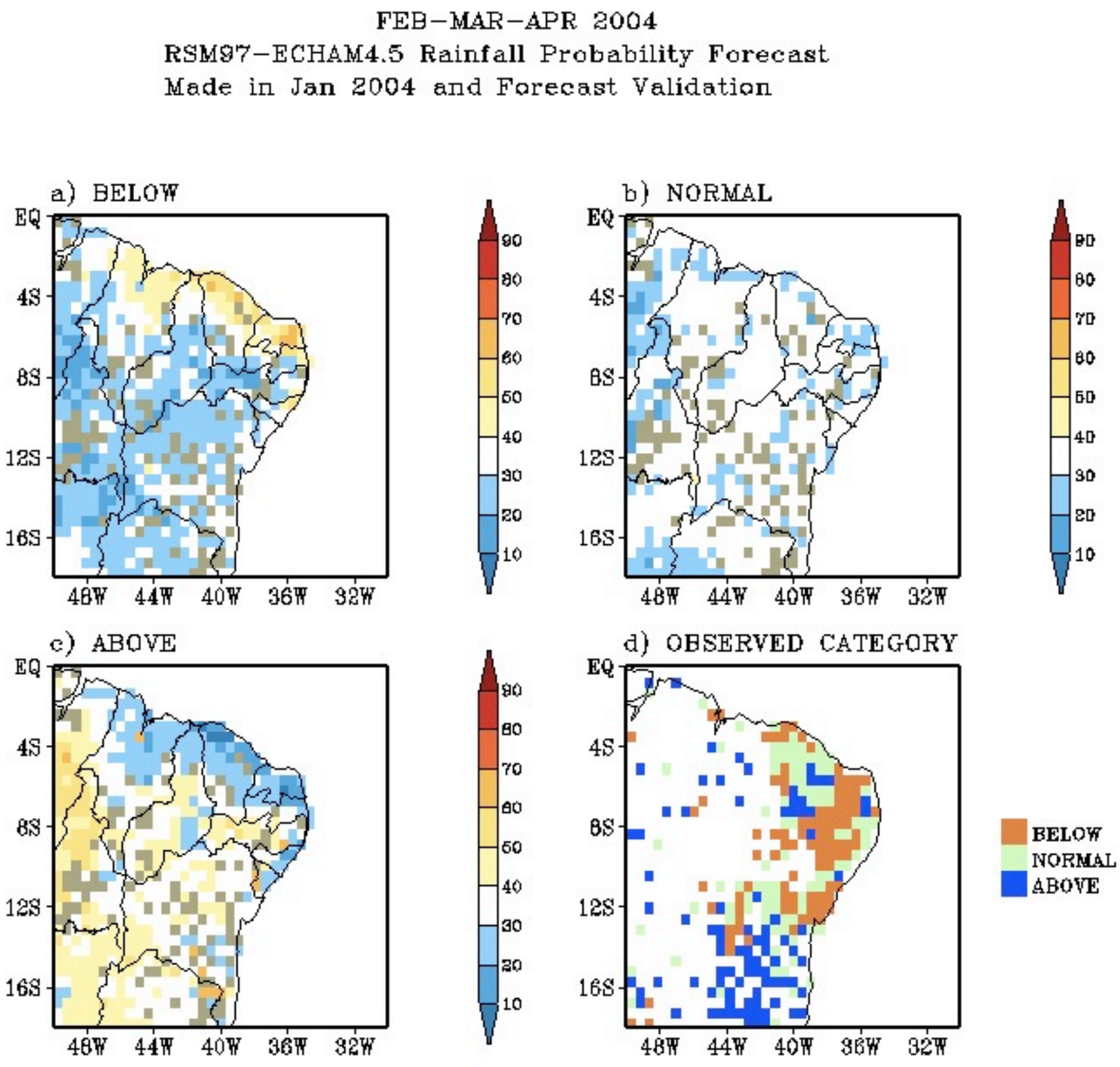


CLIMATE DYNAMICAL DOWNSCALING FORECAST SYSTEM FOR NORDESTE



Sun *et al.* 2006

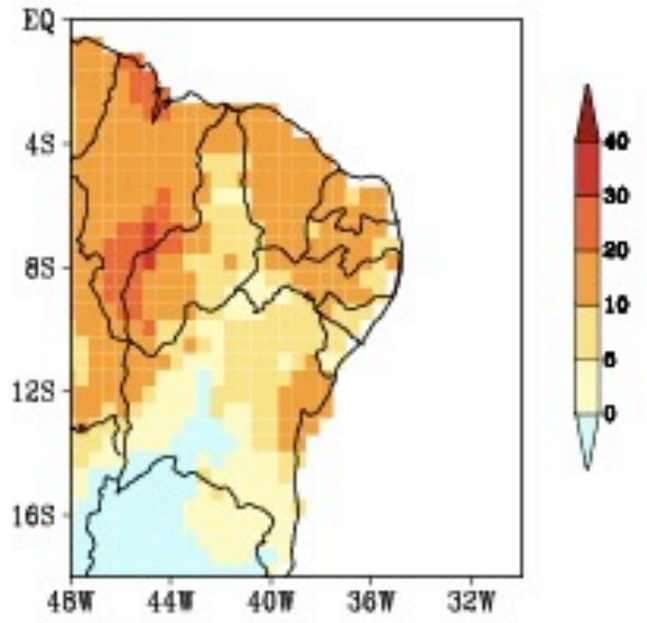
An RCM Forecast



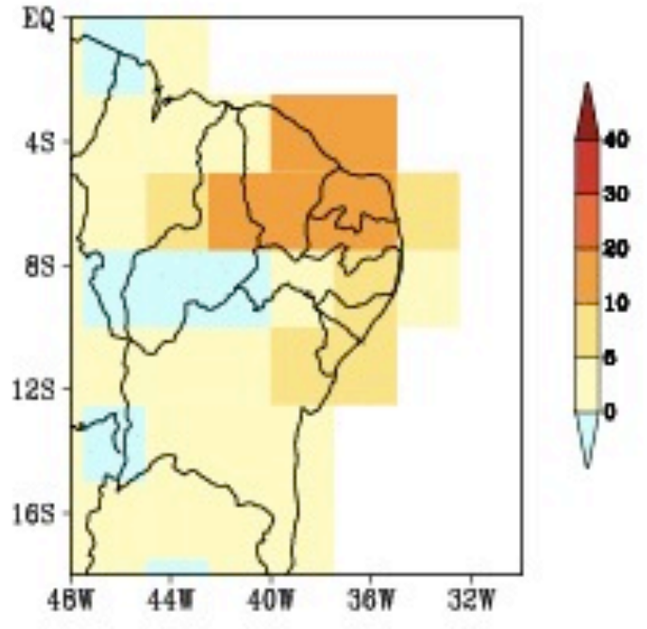
http://www.funceme.br/DEMET/index.htm

Average RPSS(%): JFM 2005–2010
0.5–Month Lead Rainfall Forecasts

a) RSM

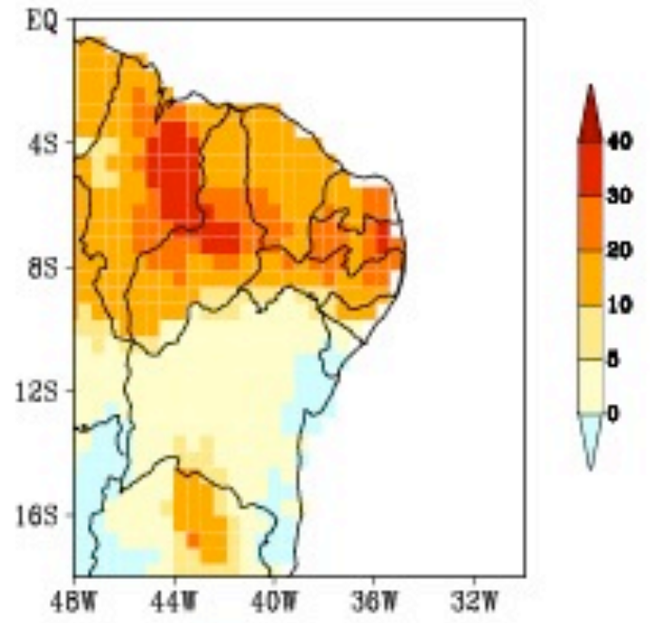


b) IRI

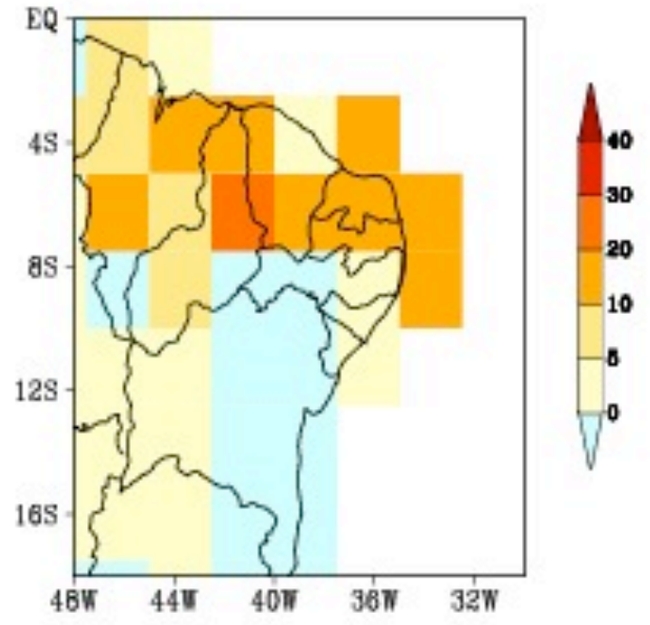


Average RPSS(%): FMA 2005–2010
0.5–Month Lead Rainfall Forecasts

a) RSM

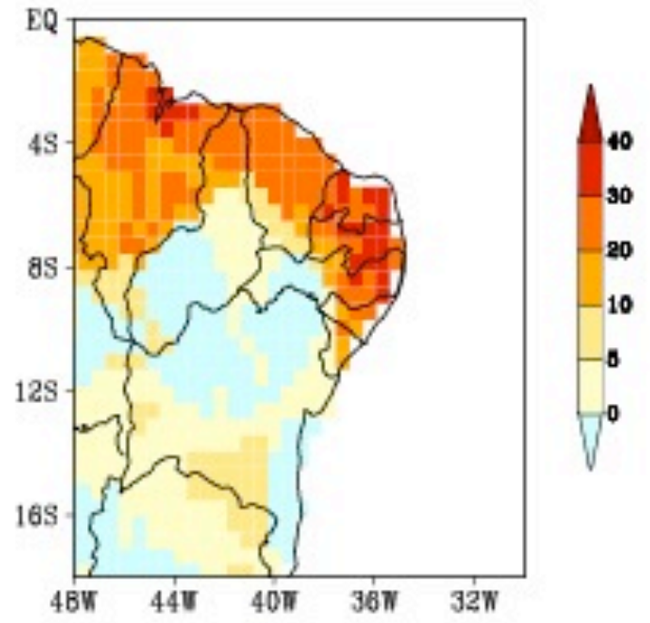


b) IRI

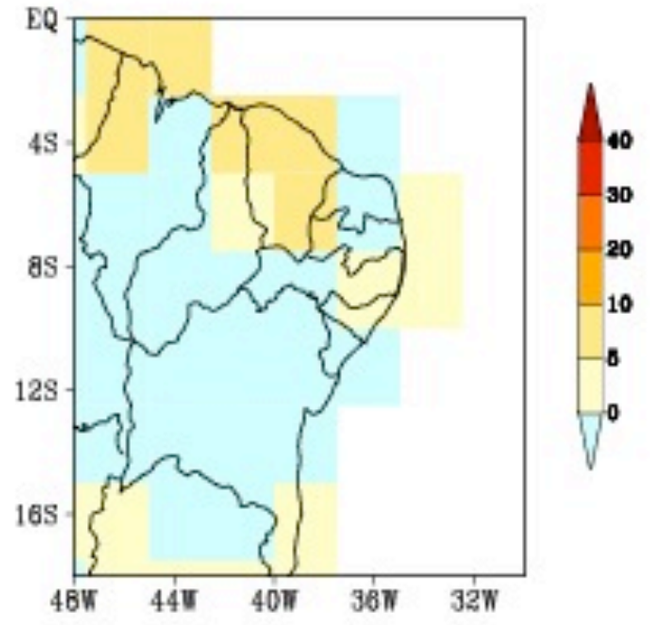


Average RPSS(%): MAM 2005–2010
0.5–Month Lead Rainfall Forecasts

a) RSM

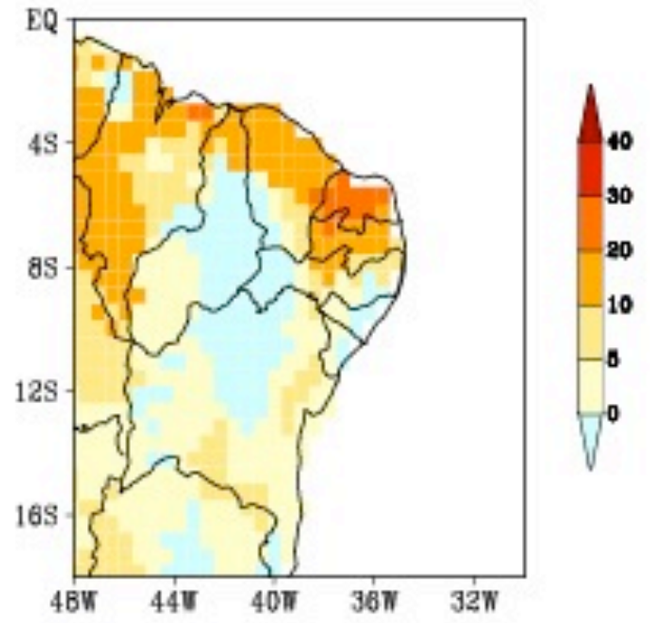


b) IRI

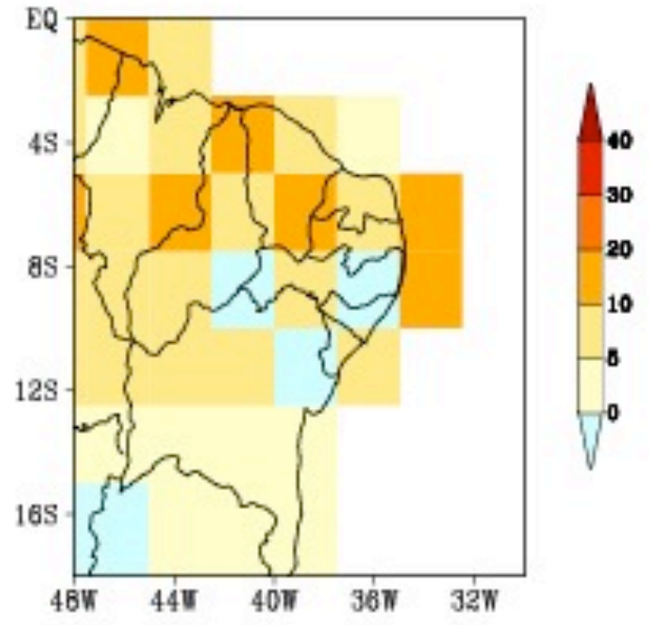


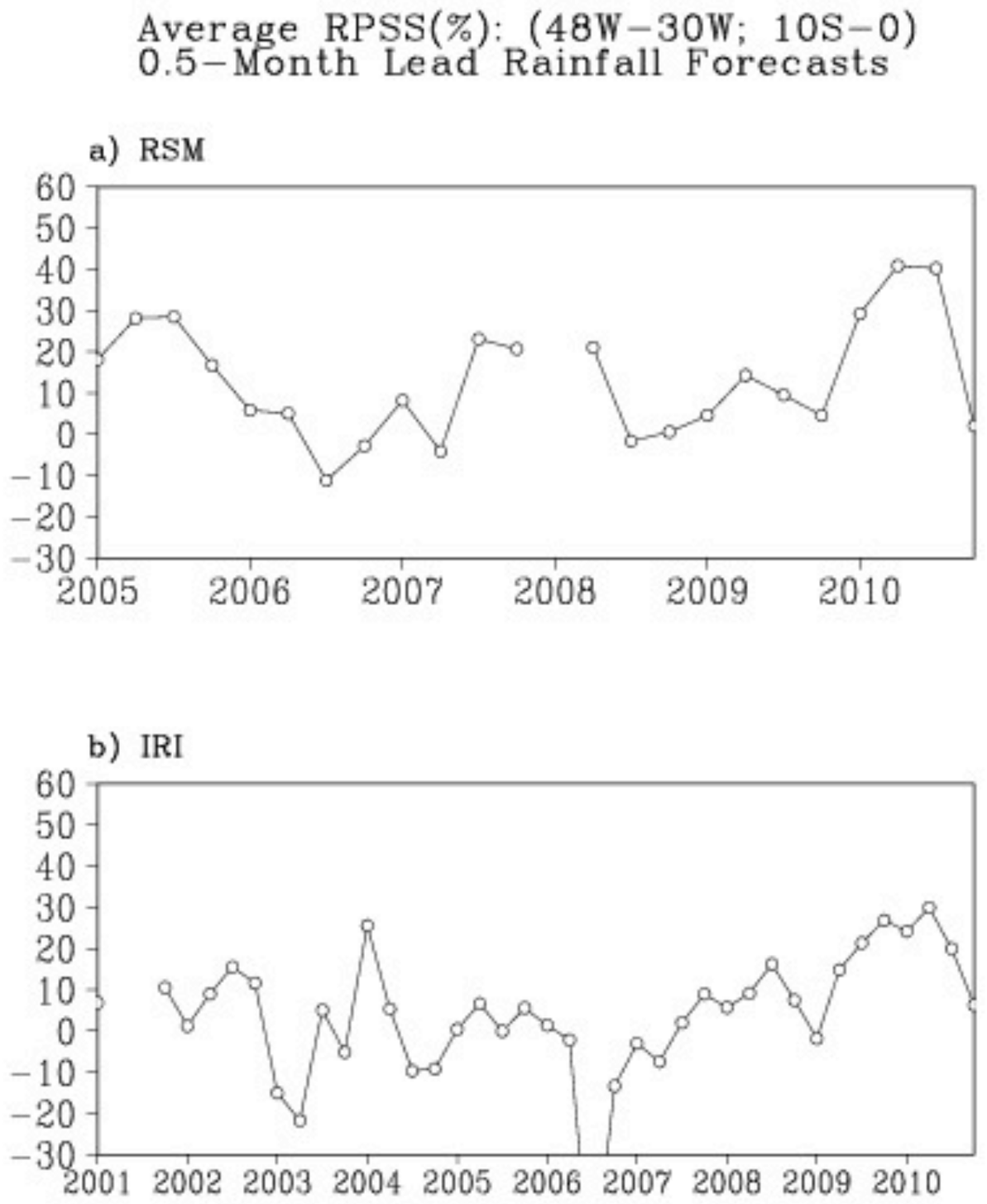
Average RPSS(%): AMJ 2005–2010
0.5–Month Lead Rainfall Forecasts

a) RSM



b) IRI




Average RPSS(%): (48W−30W; 10S−0)
0.5−Month Lead Rainfall Forecasts
a) RSM
60
50
40
30
20
10
0
−10
−20
−30
2005
2006
2007
2008
2009
2010
b) IRI
60
50
40
30
20
10
0
−10
−20
−30
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Summary

- Downscaling forecasts using the RSM show some evidence of skill over Northeast Brazil. Prediction skill varies with seasons and geographical regions.
- The forecasts with the persisted SST anomalies show higher skill than those with predicted SST anomalies.
- The skill of downscaling forecasts is often higher than that of the IRI global model forecasts
- The downscaling forecasts do not capture the shifts in the climatology.