

# Metrics for CORDEX: RegCM in Context

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With thanks to Richard Jones, Justin Glisan  
& Many Modelers

# General Aims and Plans for CORDEX

- ◆ Provide a set of regional climate scenarios (including uncertainties) covering the period 1950-2100, for the majority of the populated land-regions of the globe.
- ◆ Make these data sets readily available and useable to the impact and adaptation communities.
- ◆ Provide a generalized framework for testing and applying regional climate models and downscaling techniques for both the recent past and future scenarios.
- ◆ Foster coordination between regional downscaling efforts around the world and encourage participation in the downscaling process by local scientists/organizations

# Metrics for CORDEX

## Goals Today

1. Prompt contributions from additional modelers
2. Solicit input on extensions of metrics framework

# Metrics for CORDEX

## Goals

1. Model performance versus variety of observations
2. Succinct
3. Side-by-side comparison of models on same graph

## Questions to keep in mind

- A. What is missing or not needed?
- B. Should the goals be modified?



# Metrics for CORDEX

## Two categories

- A. Basic assessment common to all regions to provide a baseline
- B. Region-targeted assessment to be determined by regional activities



# CORDEX: Basic Metrics

## Fields: Core Data Variables

- ◆ 2-m Temperature
- ◆ 2-m Daily Tmax
- ◆ 2-m Daily Tmin
- ◆ 2-m Specific Humidity
- ◆ 10-m Wind Speed
- ◆ Precipitation
- ◆ Mean Sea-Level Pressure

# CORDEX: Basic Metrics

## Maps of Biases

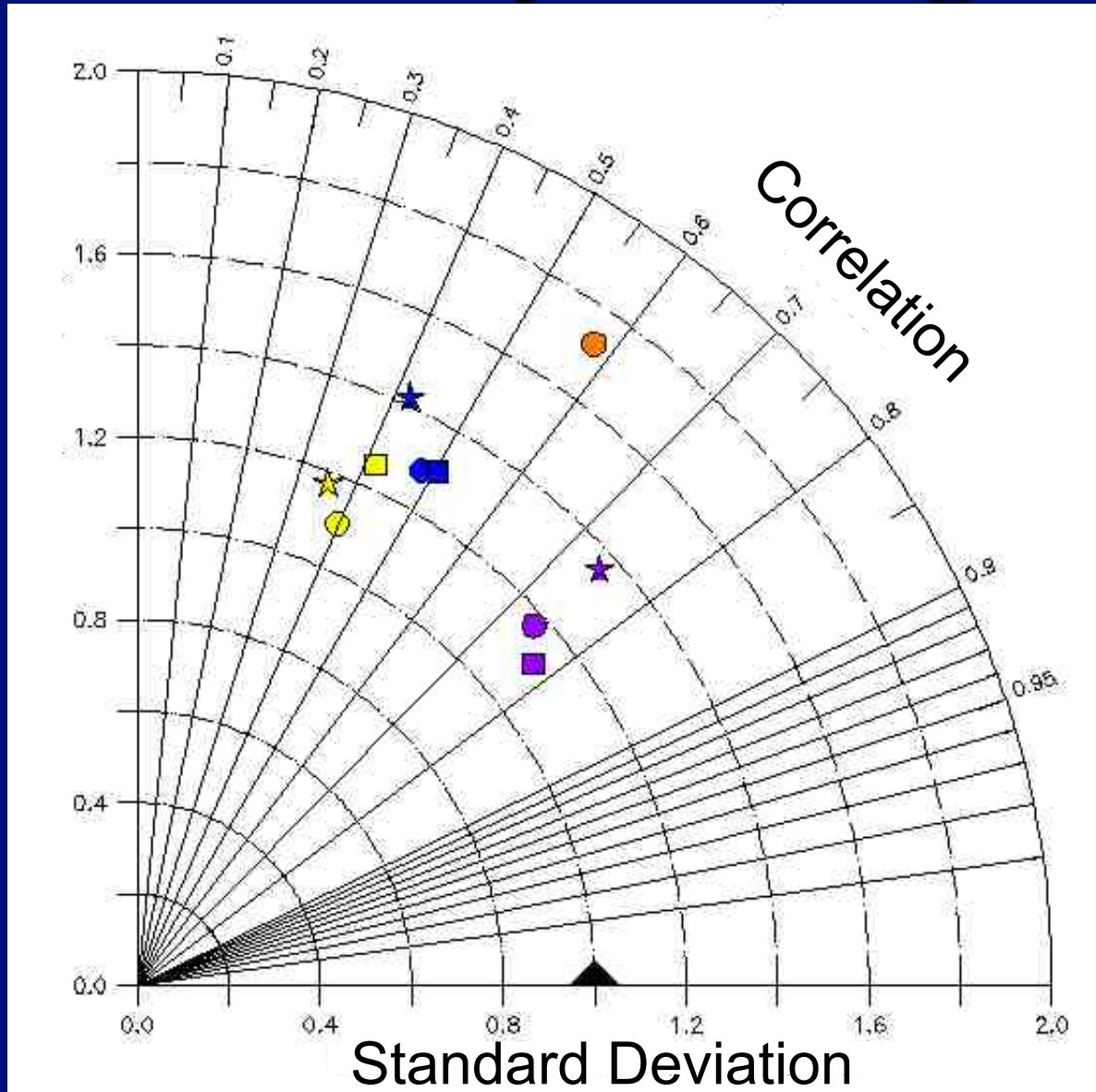
- 2-m Temperature
- Precipitation
- Mean sea-level pressure

## Taylor Diagrams

- Seasonal means
- Interannual variability – spatial correlation
- Interannual variability – temporal correlation

All fields should be interpolated to the common grid for model output when constructing model-observation differences.

# What is a Taylor Diagram?

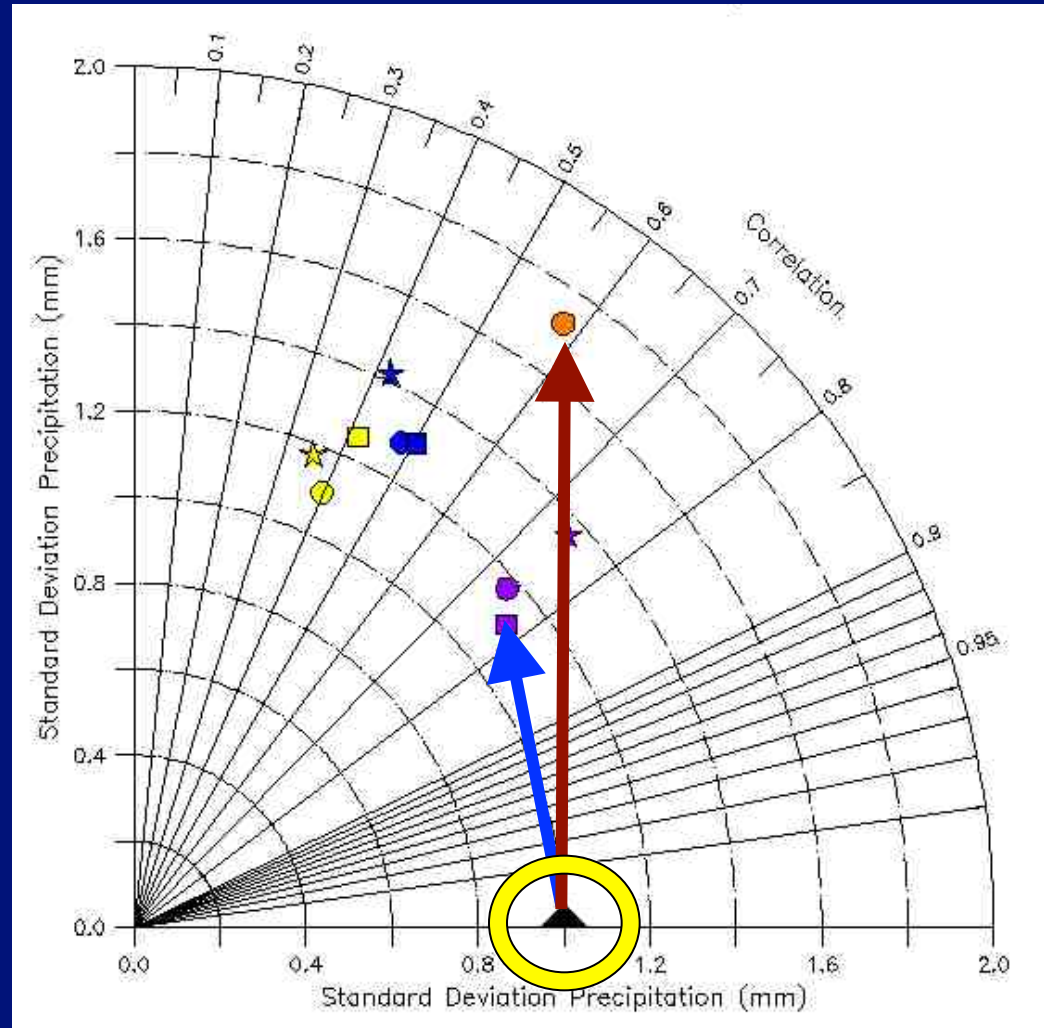


# What is a Taylor Diagram?

Correlation = correlation  
with reference field

Standard Deviation =  
Amplitude of variability  
about the mean  
(normalized by reference  
variability)

Distance to reference  
point =  
Bias-corrected RMS  
difference  
(i.e., a measure of error)



# CORDEX: Basic Metrics

## Reference Fields

- **CRU** (monthly mean,  $0.5^\circ$ , 1901-2006) - 2m mean/max/min temperature, precipitation
- **Willmott** (monthly mean,  $0.5^\circ$ , 1901- 2008) - 2m mean temperature, precipitation
- **TRMM 3B42** (3-hour,  $0.25^\circ$ , 1998-2009) - precipitation
- **ERA-INTERIM** (3-6 hour, daily,  $0.75^\circ$ , 1989-2009) - 2m mean/max/min temperature, precipitation, zonal and meridional wind

All fields should be interpolated to the common grid for model output when constructing model-observation differences.



# CORDEX: Taylor Diagrams

## Seasonal Means (DJF, MAM, JJA, SON)

Measures: Error in spatial patterns of mean fields

## Interannual Variability: Spatial Correlation (seasonal maps)

Measures: Error in spatial patterns of interannual variability

## Interannual Variability: Temporal Correlation (maps of annual time-series correlation)

Measures: Error in times series of interannual variability

# CORDEX Region-Targeted Metrics

- A. Metrics defining model quality relevant to region-specific processes, e.g. monsoonal circulation
- B. Metrics relevant to users in the region, e.g. onset of dry spells, start of growing season, etc.

## What should region groups chose for metrics?

- (i) Sub-regions?
- (ii) Time periods?
- (iii) Diurnal or other periodic behavior?
- (iv) Targeted processes?

***NOTE: Need reliable observations for any metric.***



# CORDEX Region-Targeted Metrics

B. Metrics relevant to users in the region, e.g. onset of dry spells, start of growing season, etc.

## Challenge to VIA Applications and Training:

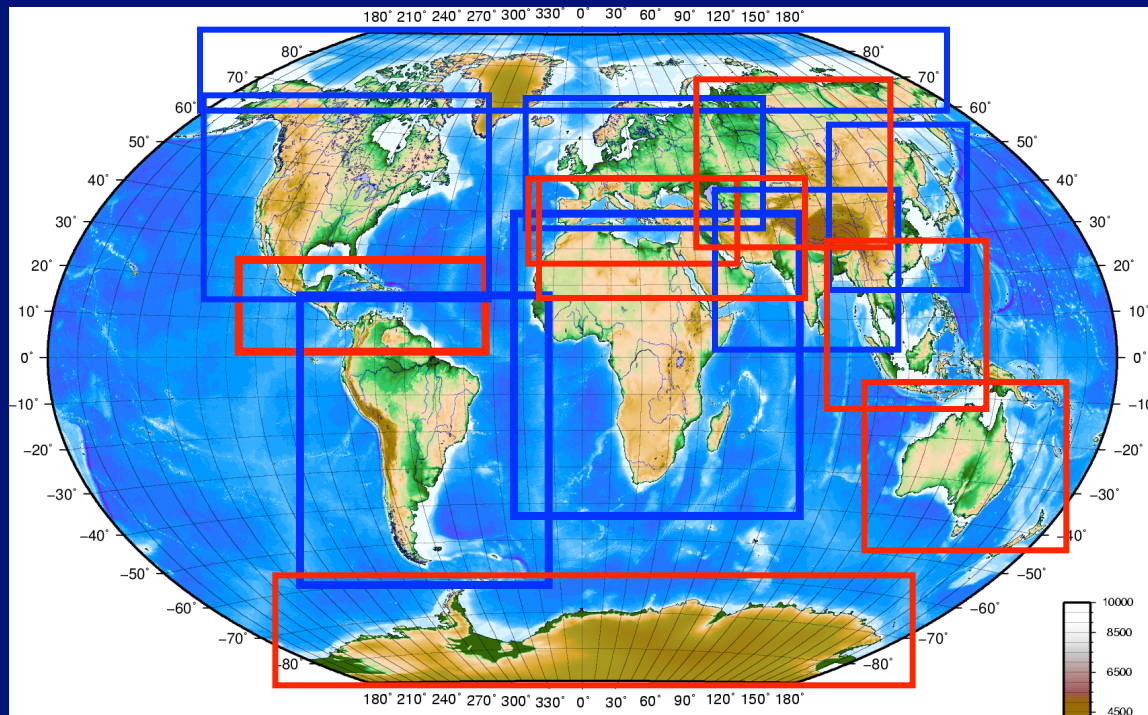
- What additional metrics are relevant and useful?
- How would you want to assess models providing output?

***NOTE: Need reliable observations for any metric.***

# Recall This General Aim for CORDEX

- ◆ Provide a generalized framework for testing and applying regional climate models and downscaling techniques for both the recent past and future scenarios.

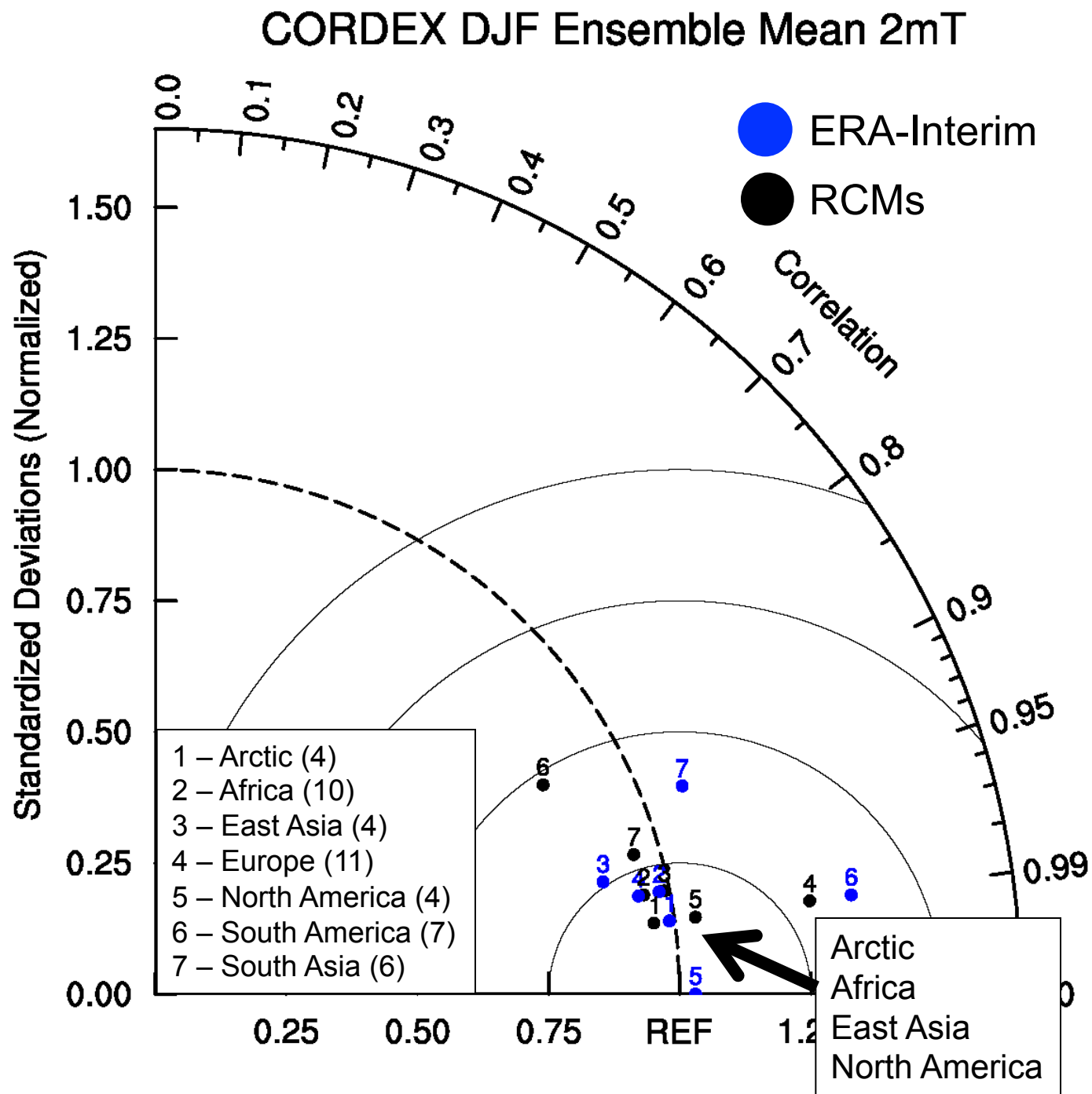
**How does downscaling compare across CORDEX regions?**  
(e.g., “Transferability” – Takle et al., 2007, *Bulletin AMS*)



# RCMs vs. ERA- Interim vs. CRU

(ERA-Driven  
1991-2007)

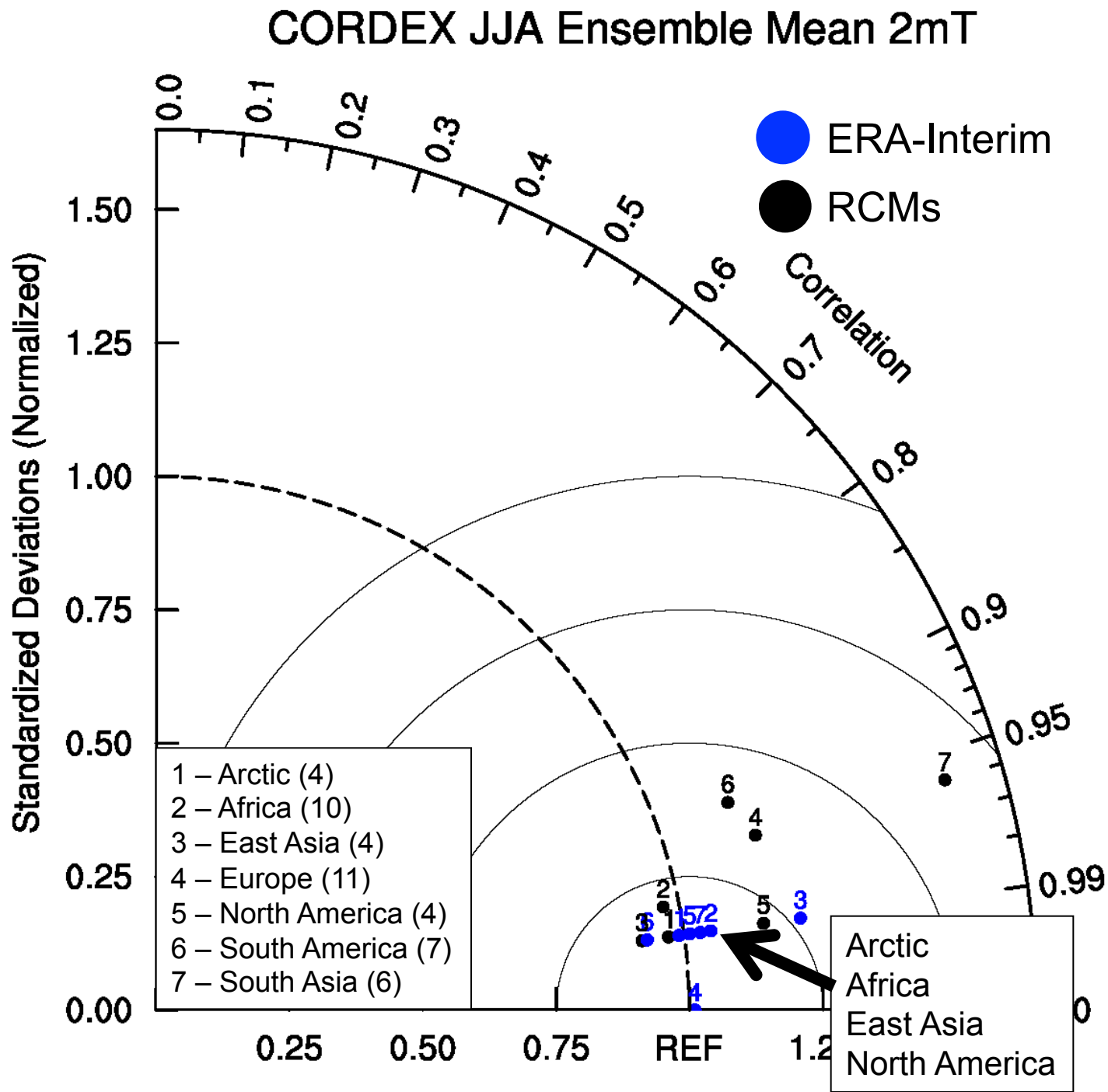
Developing  
a  
Pan-  
CORDEX  
View



# RCMs vs. ERA- Interim vs. CRU

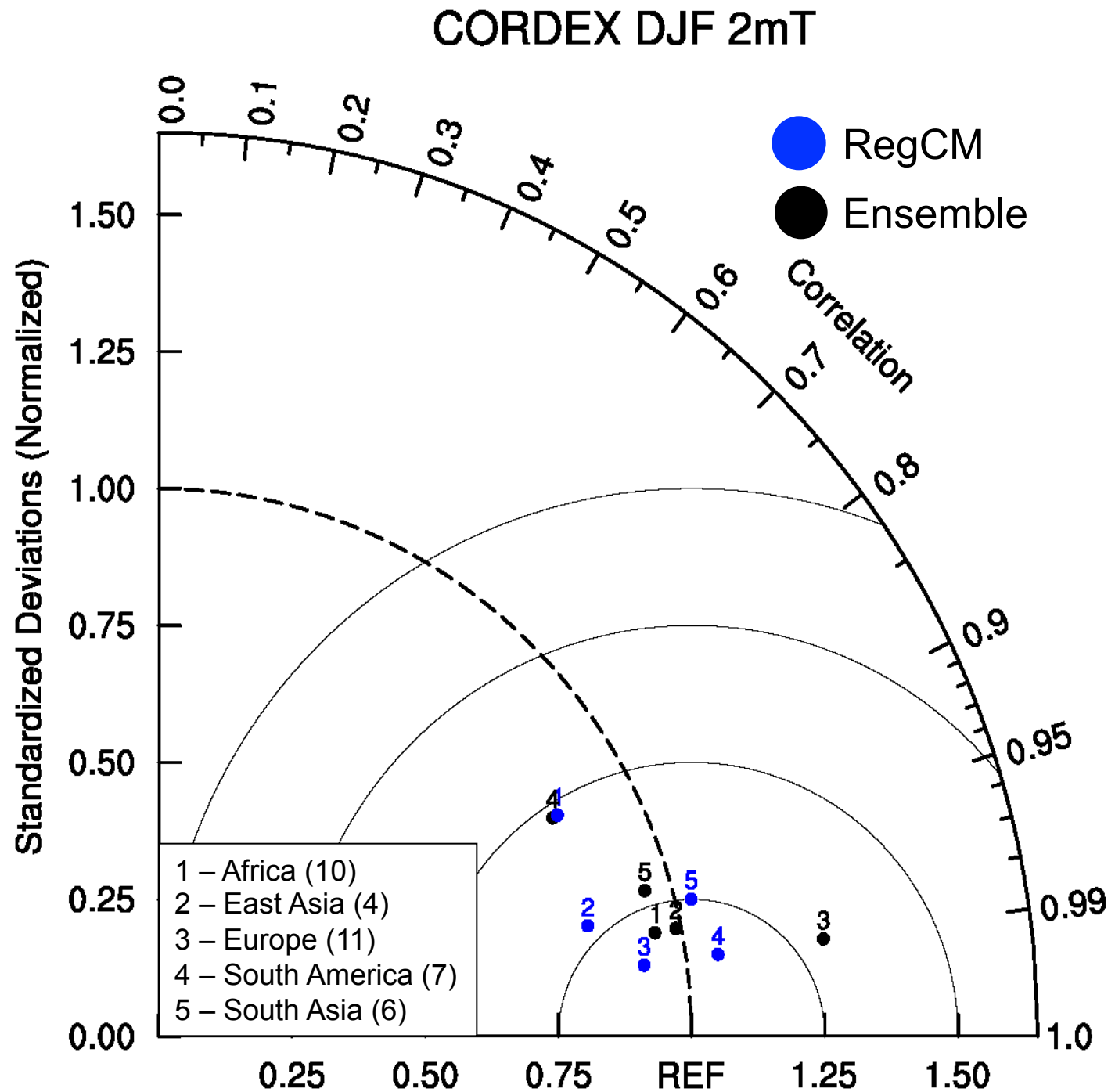
(ERA-Driven  
1991-2007)

Developing  
a  
Pan-  
CORDEX  
View



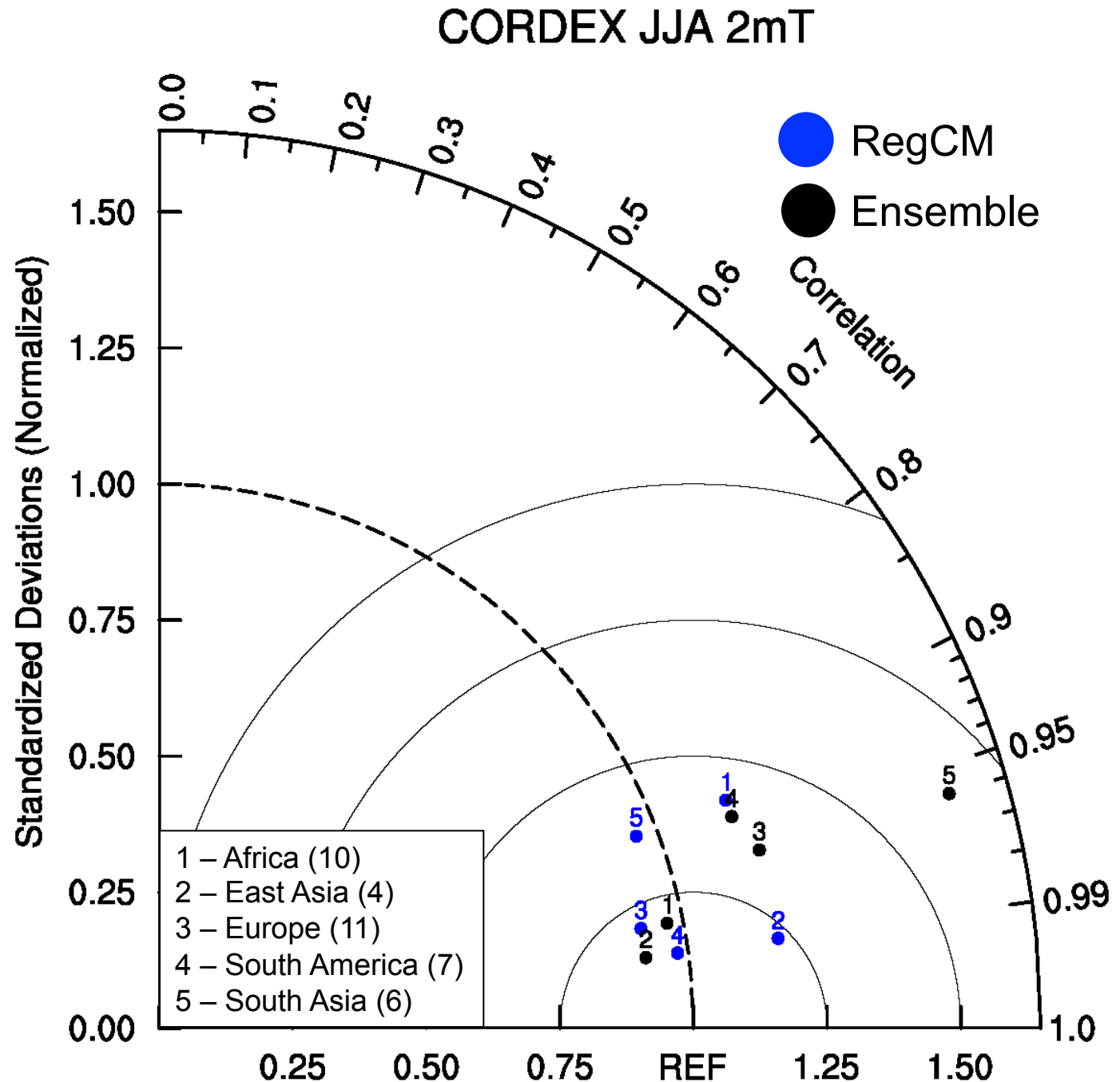
# RegCM vs. Ensemble vs. CRU

(ERA-Driven  
1991-2007)



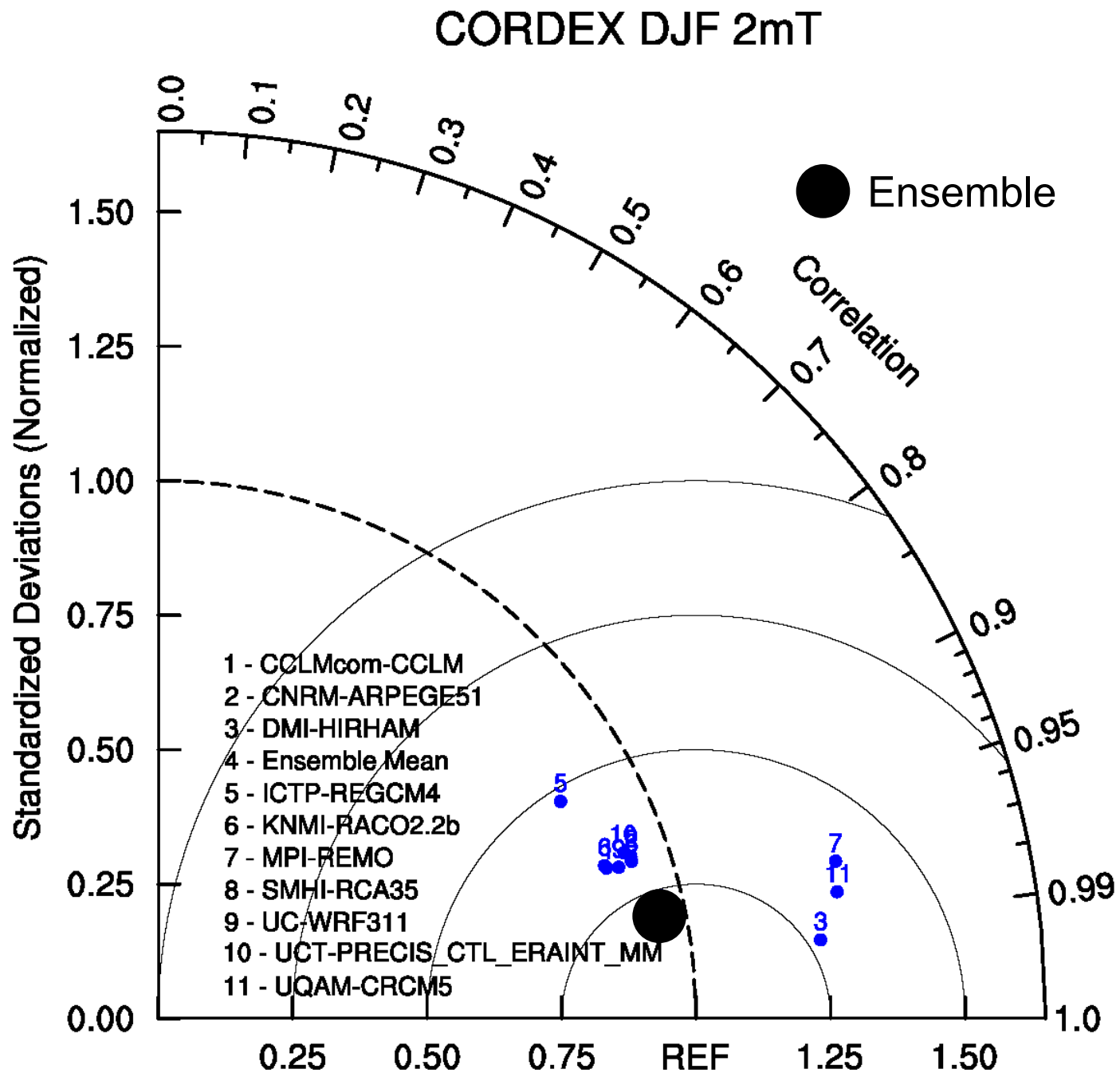
**RegCM  
vs.  
Ensemble  
vs.  
CRU**

(ERA-Driven  
1991-2007)



# Africa Models vs. Ensemble vs. CRU

(ERA-Driven  
1991-2007)

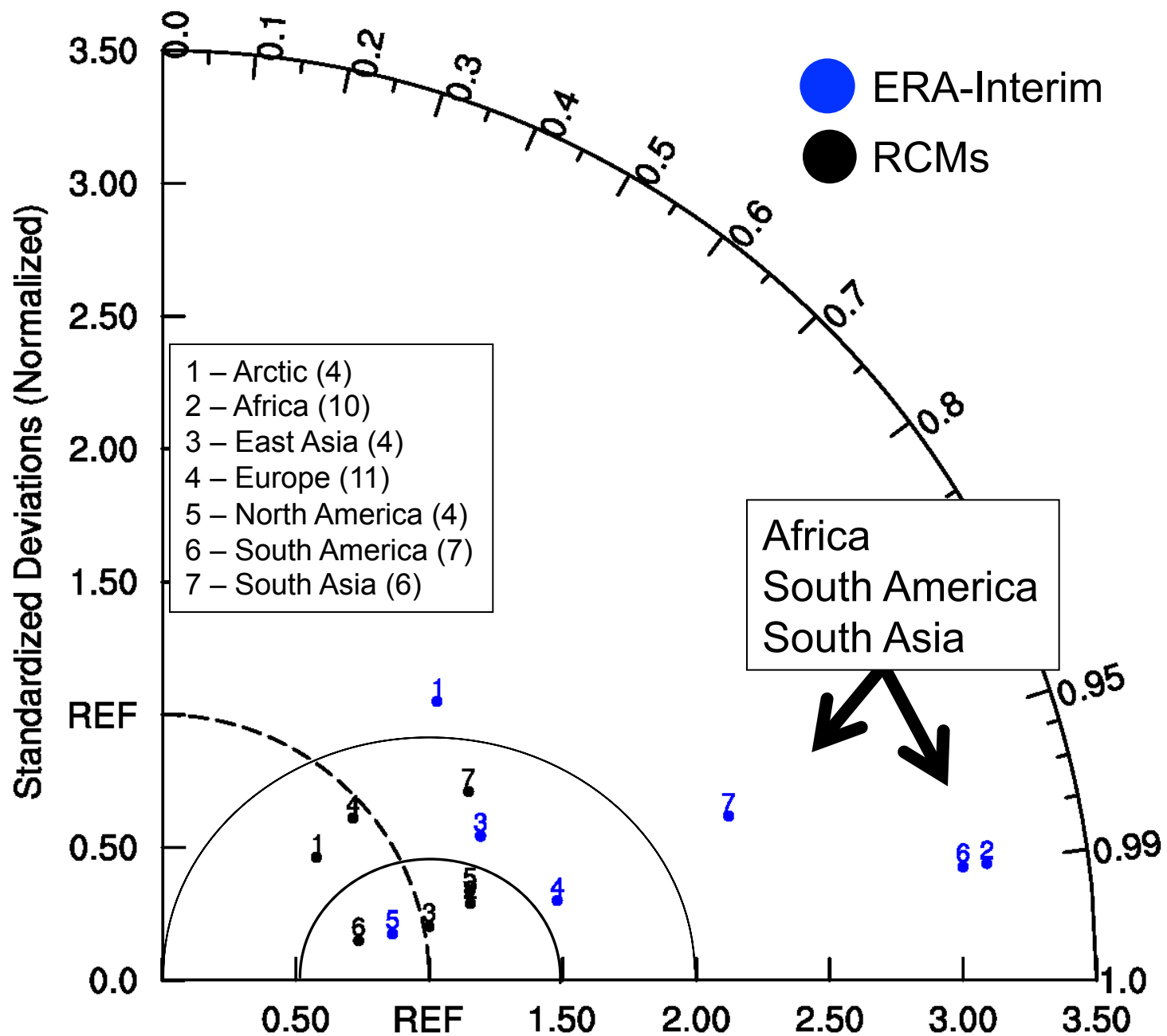


# RCMs vs. ERA- Interim vs. CRU

(ERA-Driven  
1991-2007)

Developing  
a  
Pan-  
CORDEX  
View

## CORDEX DJF Ensemble Mean Precipitation



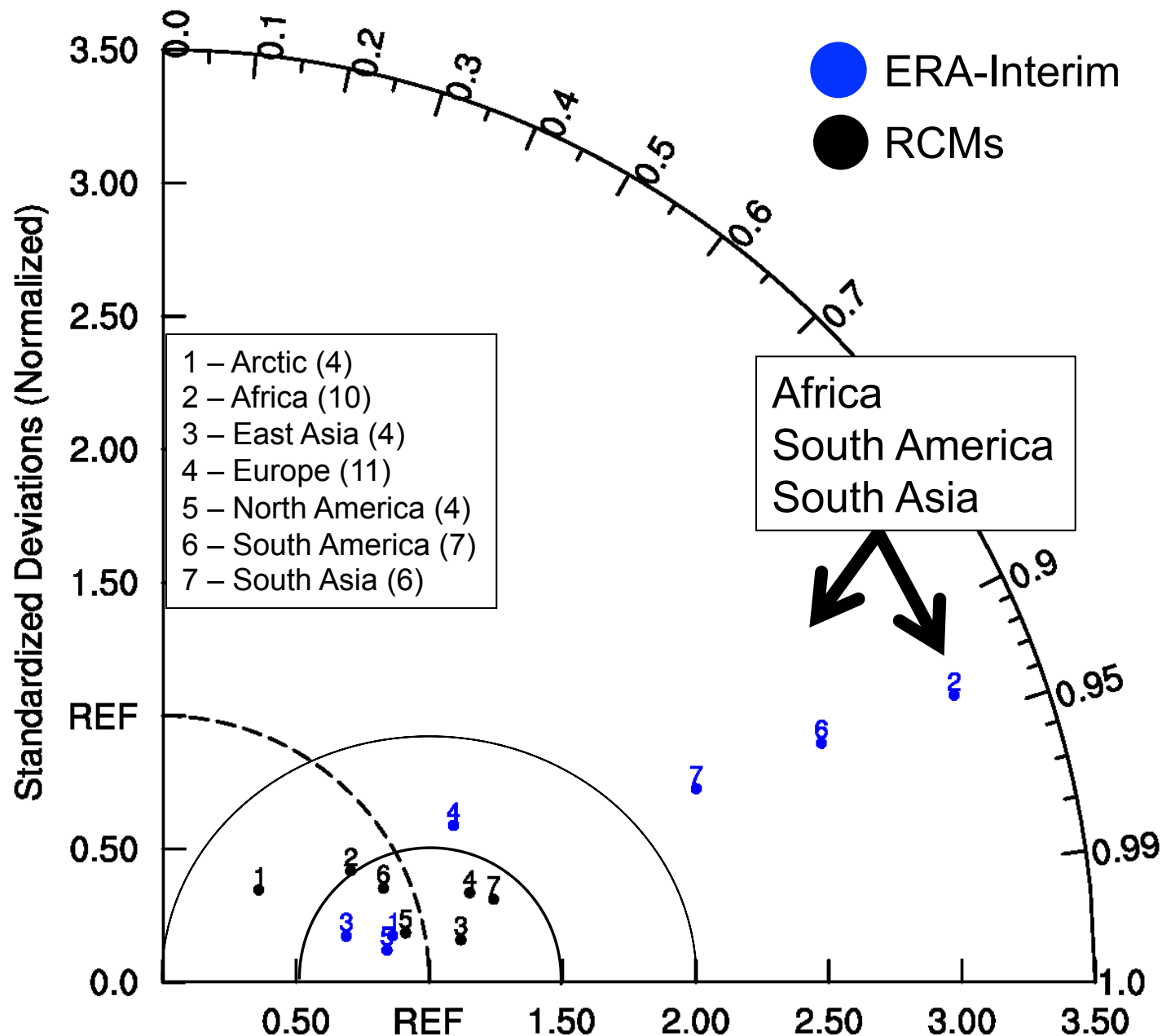


# RCMs vs. ERA- Interim vs. CRU

(ERA-Driven  
1991-2007)

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a  
Pan-  
CORDEX  
View

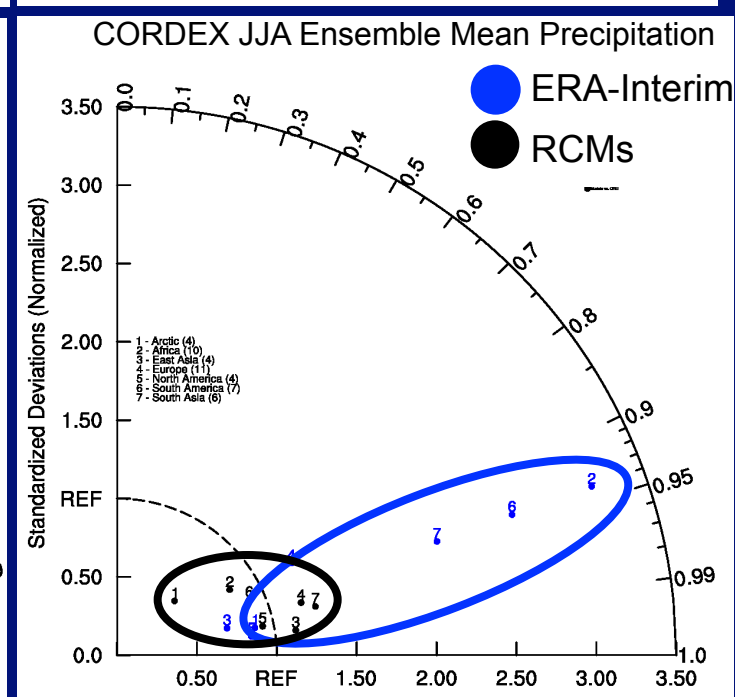
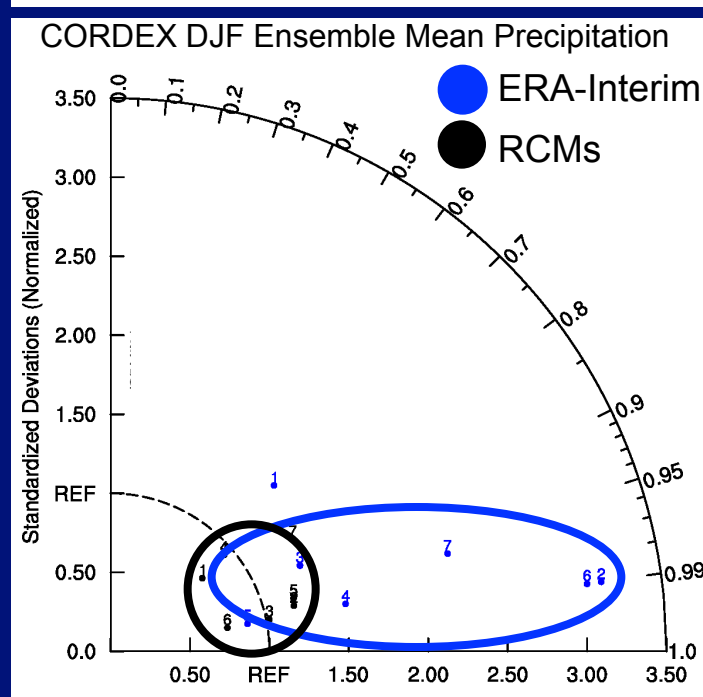
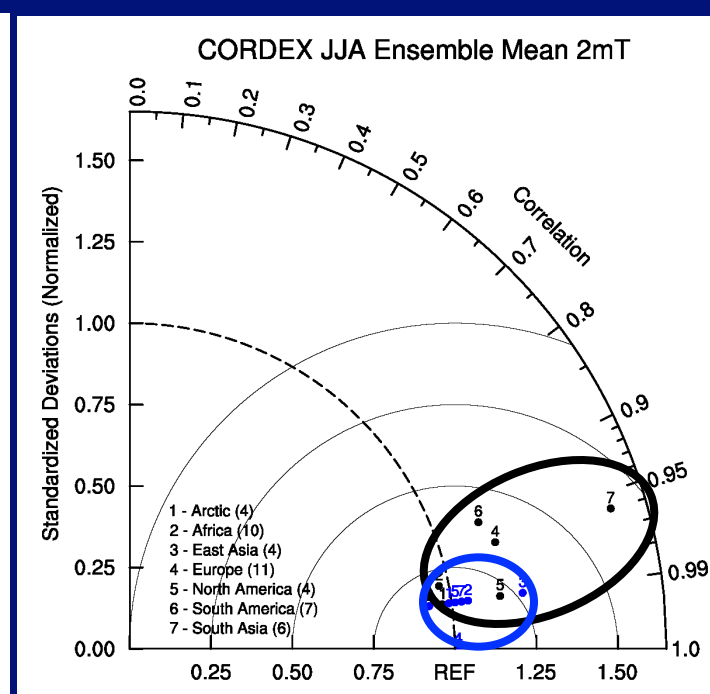
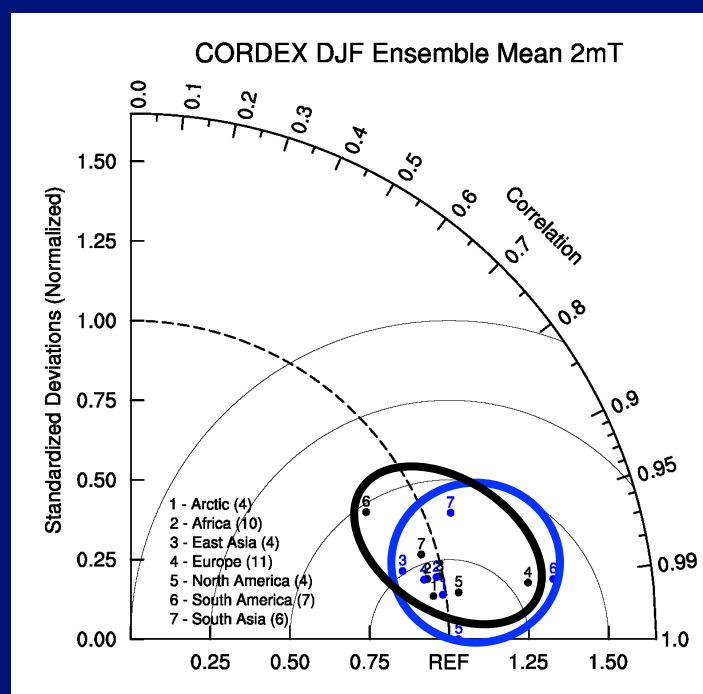
## CORDEX JJA Ensemble Mean Precipitation



# RCMs vs. ERA- Interim vs. CRU

(ERA-Driven  
1991-2007)

Developing  
a  
Pan-  
CORDEX  
View



## Questions to keep in mind

- A. What is missing or not needed?
- B. Should the goals be modified?



Grazie!



# Looking for a postdoc position?

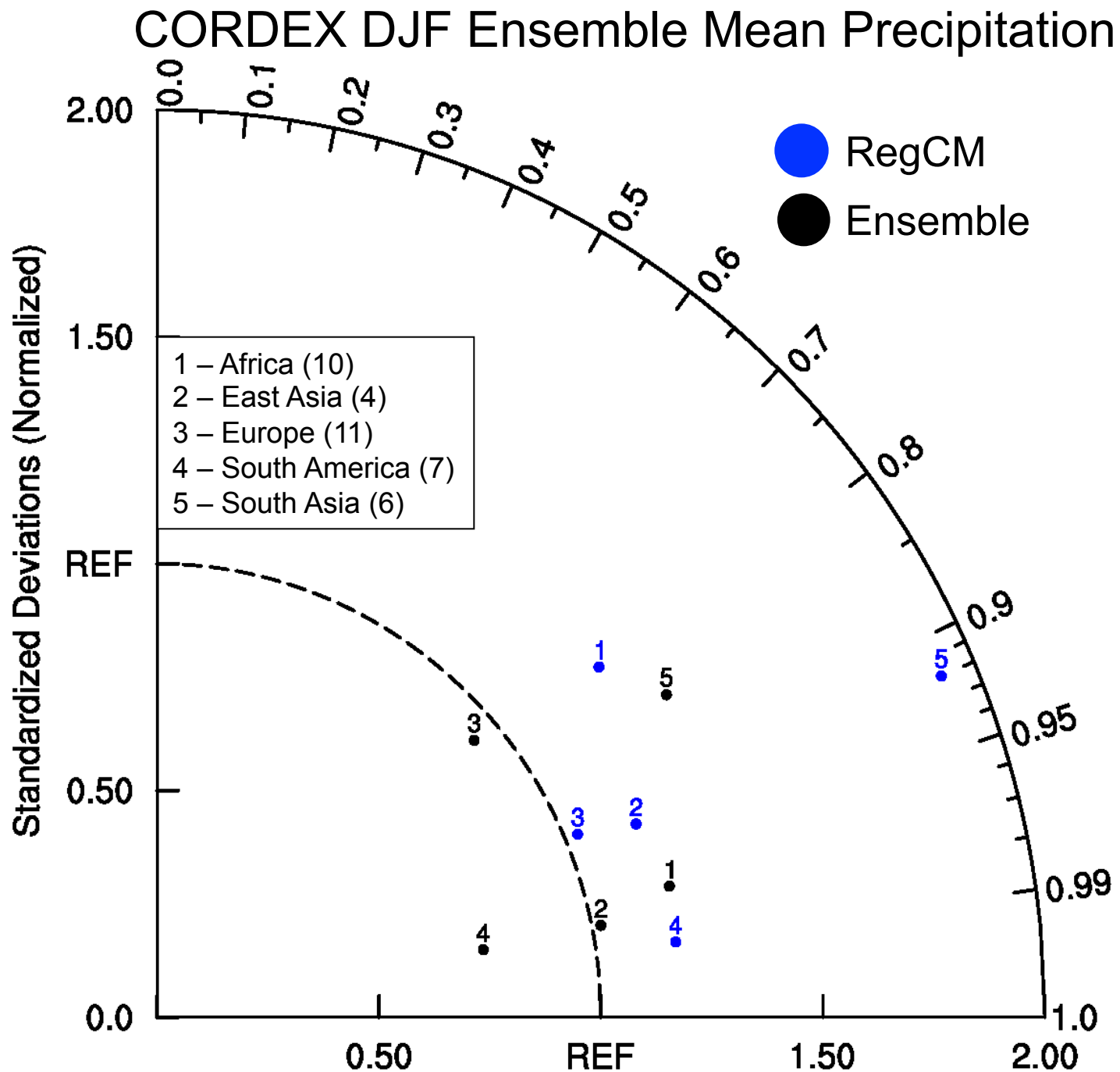
<http://www.csag.uct.ac.za/jobs/postdoctoral-research/>



# **Additional Slides**

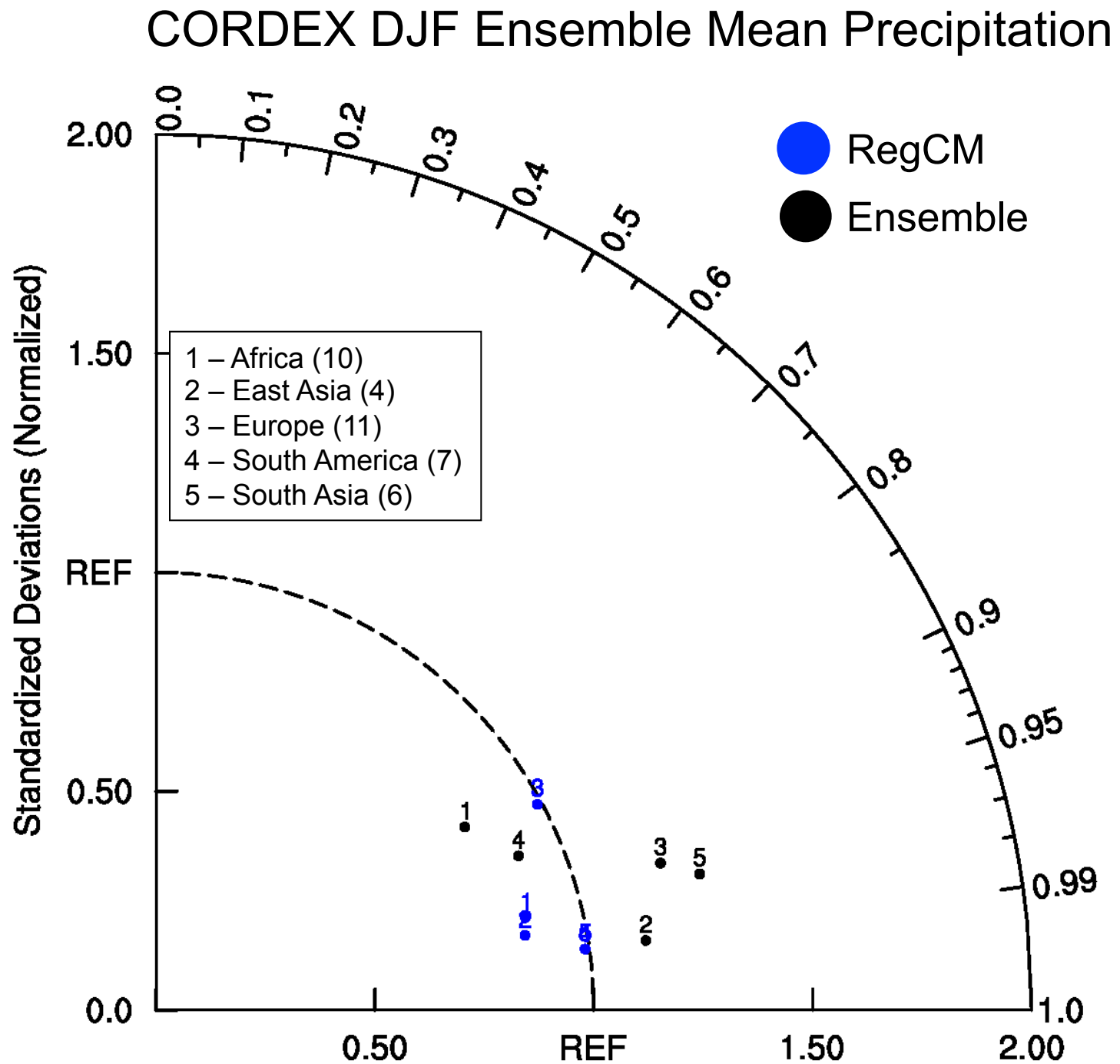
**RegCM  
vs.  
Ensemble  
vs.  
CRU**

(ERA-Driven  
1991-2007)



**RegCM  
vs.  
Ensemble  
vs.  
CRU**

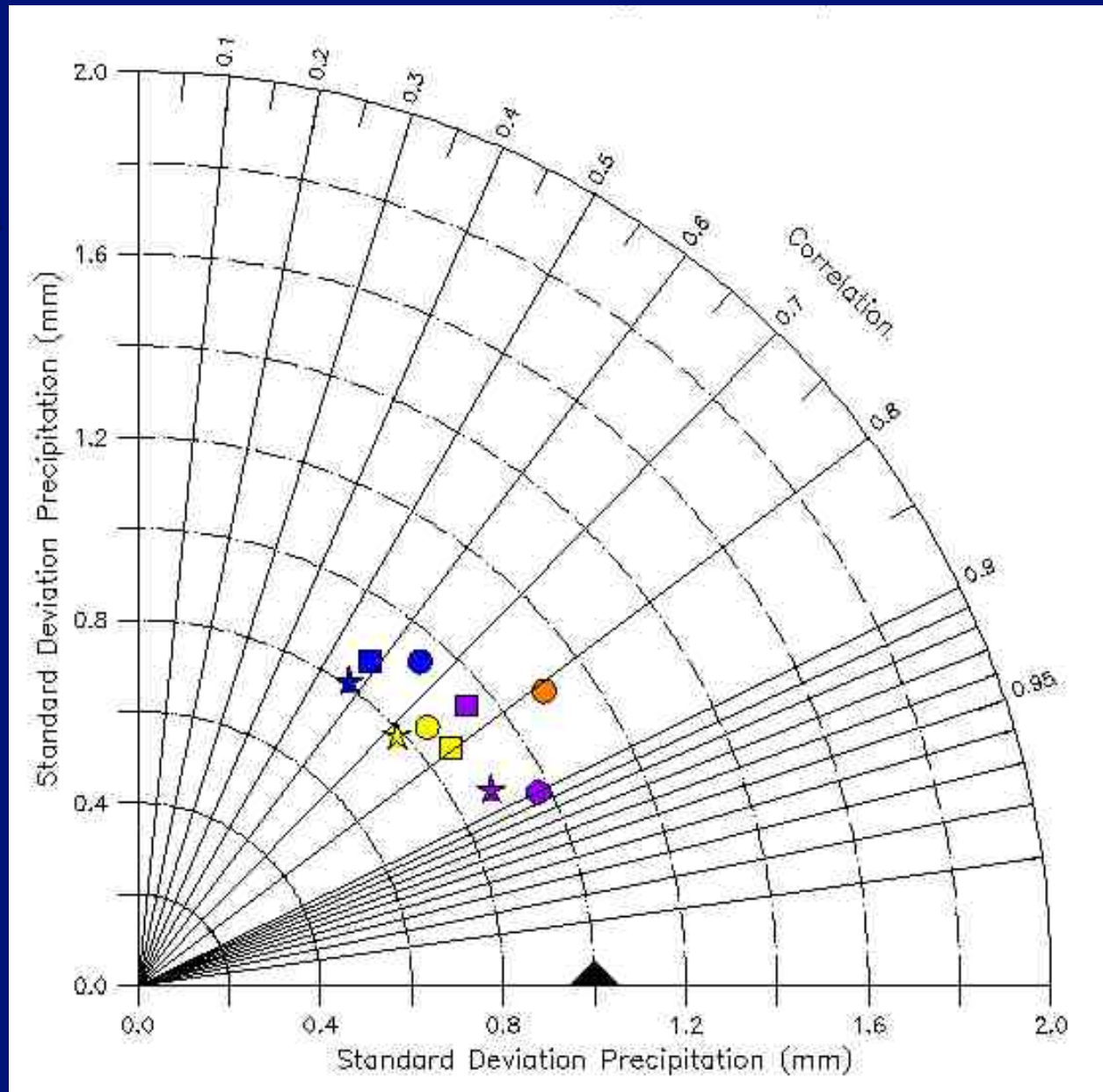
(ERA-Driven  
1991-2007)



# January Precipitation

Different colors =  
Different models

Different shapes =  
Different domain  
sizes



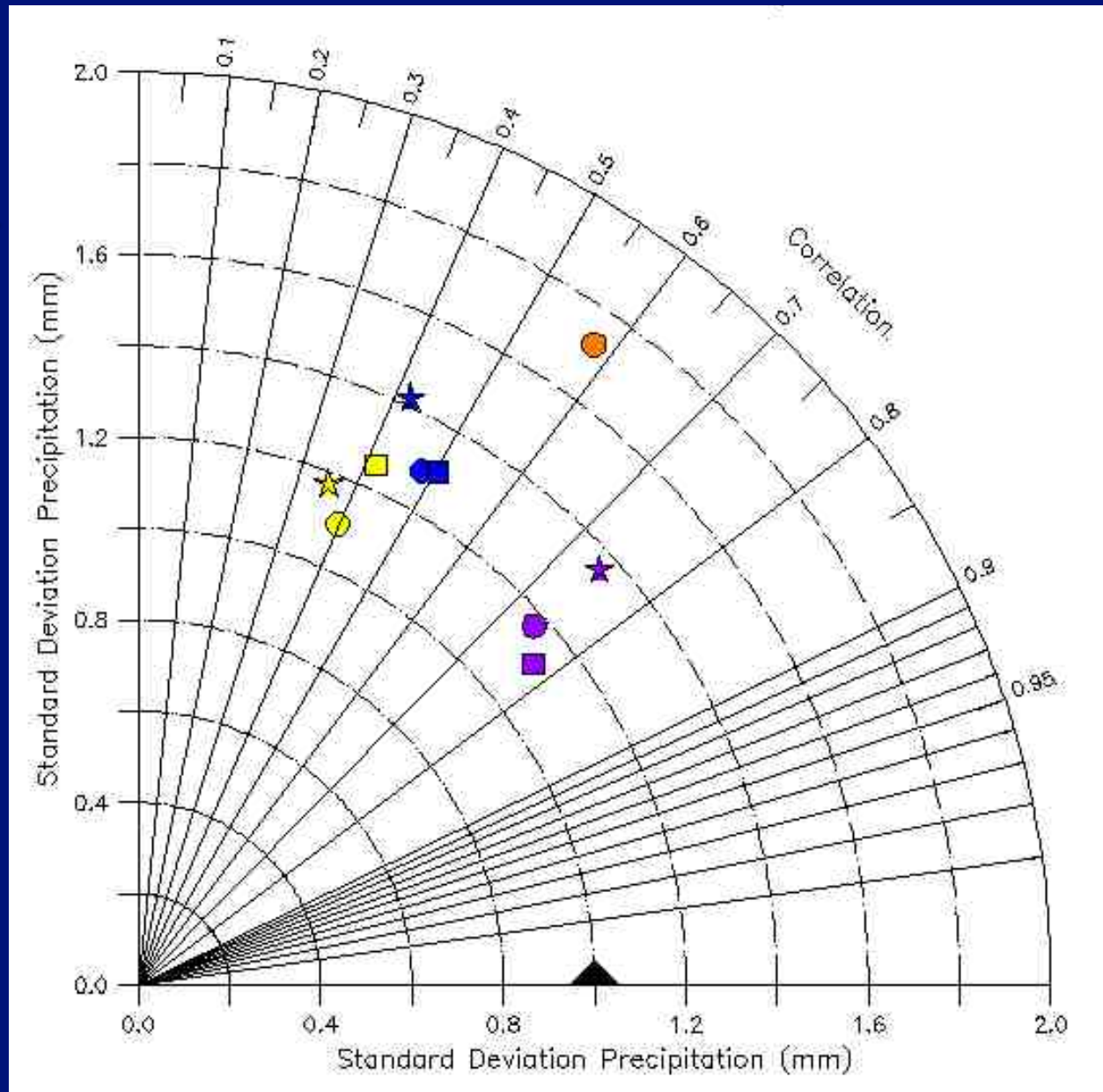
(C. Anderson, 2005)



# June Precipitation

Different colors =  
Different models

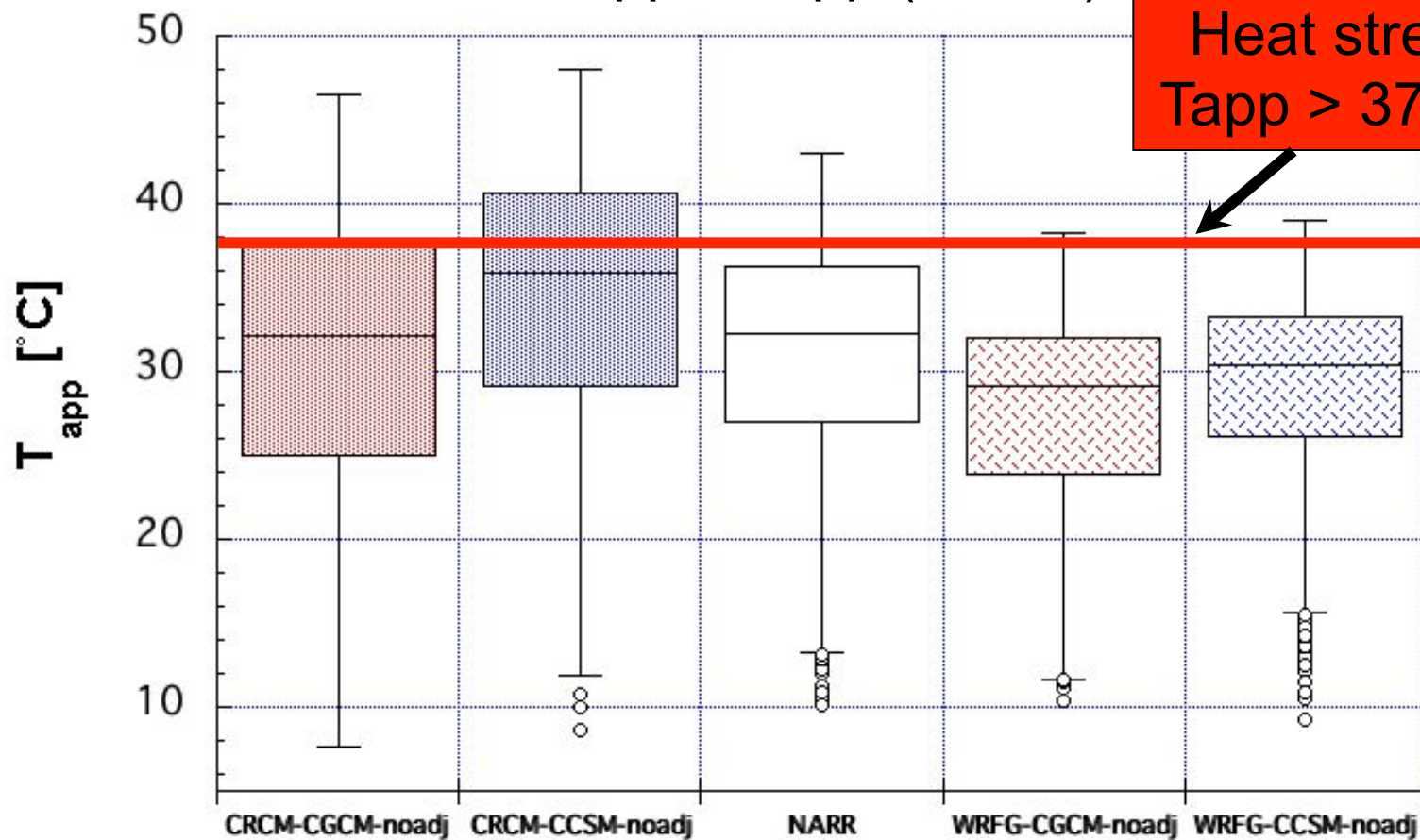
Different shapes =  
Different domain  
sizes



(C. Anderson, 2005)

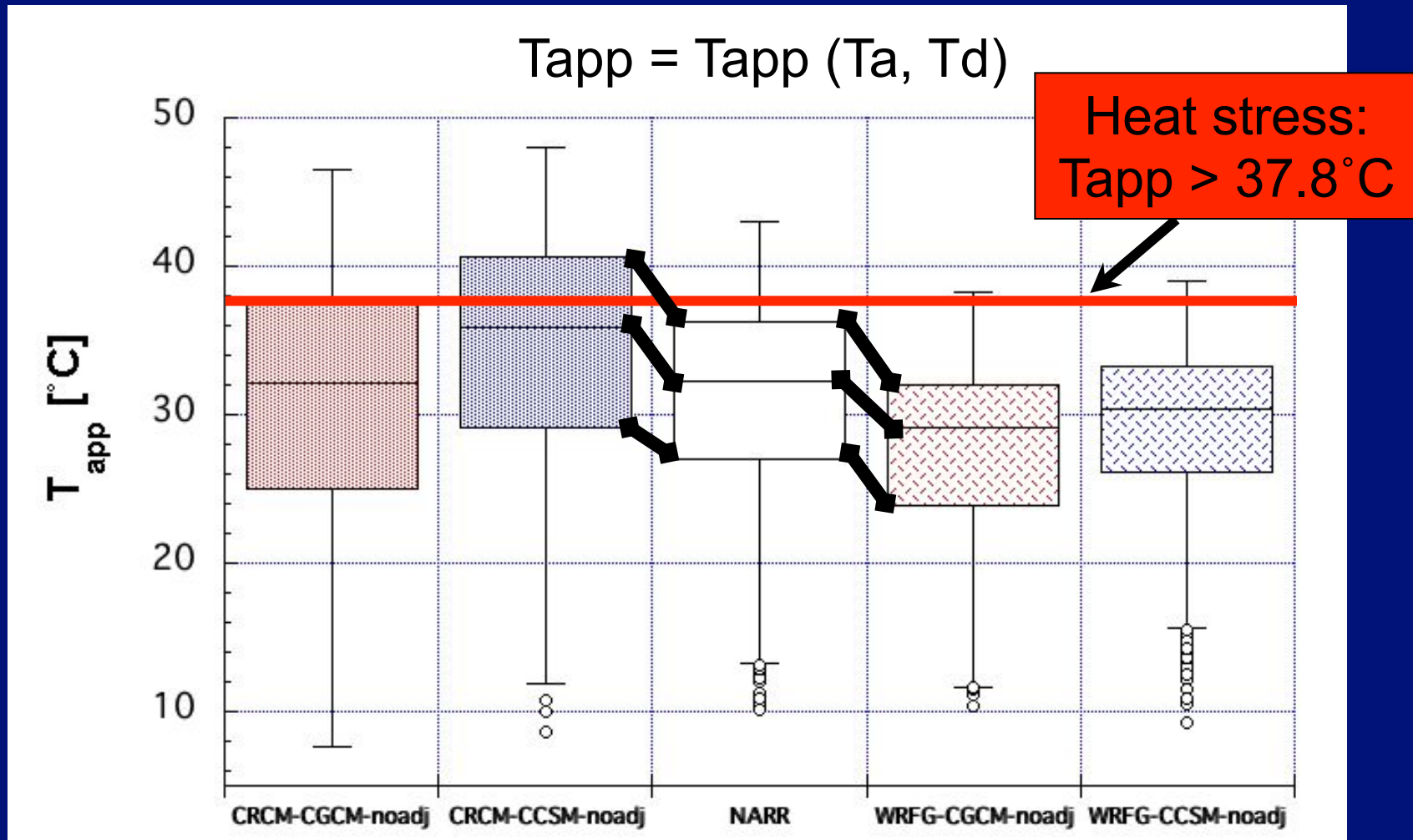
# Alternative Metrics?

$$T_{app} = T_{app}(T_a, T_d)$$

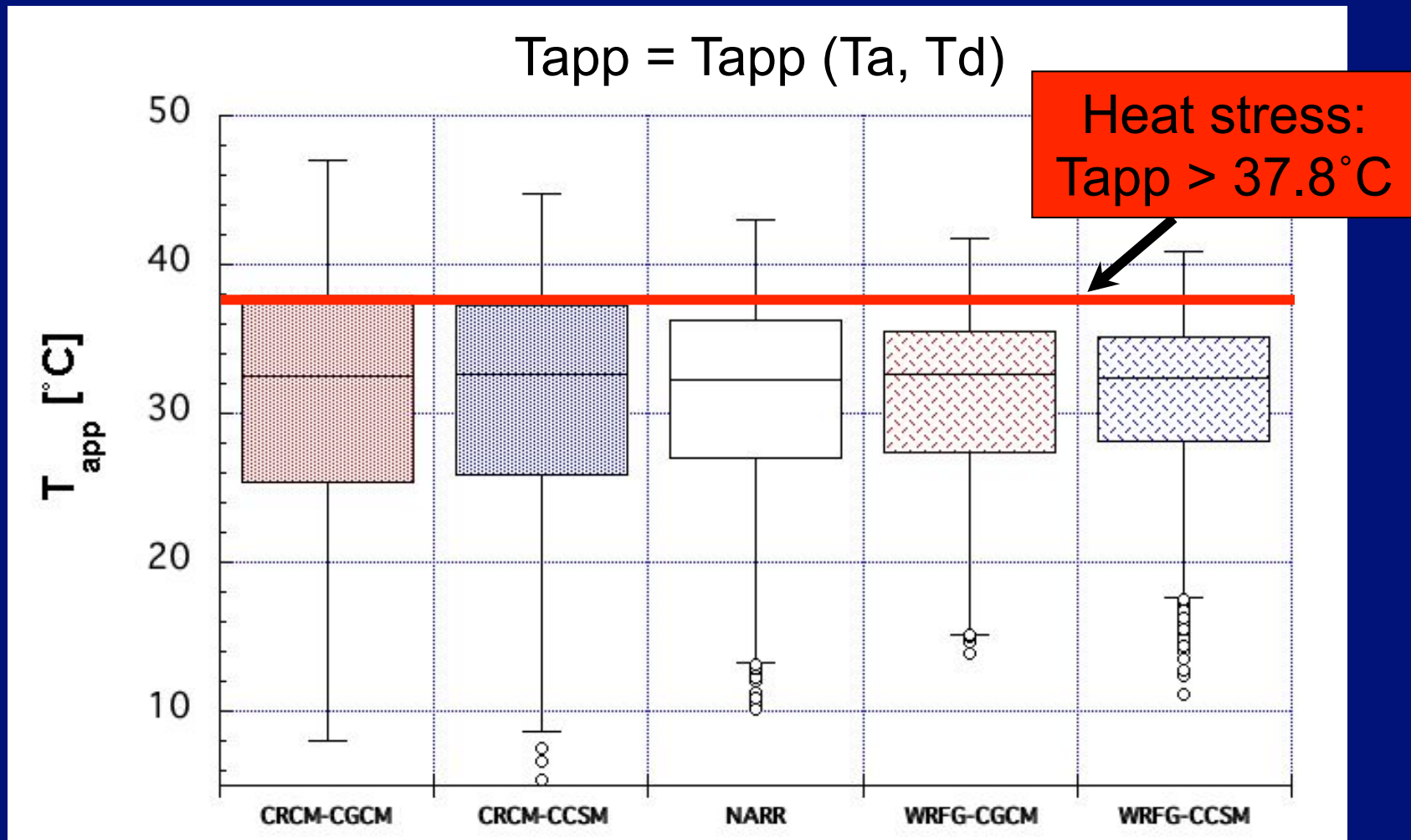


Heat stress:  
 $T_{app} > 37.8^{\circ}\text{C}$

# Alternative Metrics => Bias Correction?



# Alternative Metrics => Bias Correction?



# CORDEX Phase I experiment design

Model Evaluation  
Framework

Climate Projection  
Framework

Multiple regions (Initial focus on Africa)  
50 km grid spacing

ERA-Interim BC  
1989-2007

RCP4.5, RCP8.5

Multiple AOGCMs

Regional Analysis  
Regional Databanks

1951-2100  
1981-2010, 2041-2070, 2011-2040



# CORDEX Statistical Downscaling: Baseline Requirements

- ✧ users choose their predictors,  
(based on standard GCM atmospheric variables)
- ✧ priority predictands: precipitation, Tmax and Tmin
- ✧ time resolution: daily
- ✧ spatial resolution:  $\leq 0.5^\circ$  (RCM baseline)
- ◆ Standard downscaling: to a grid
- ◆ Special downscaling: to stations to maximize value to end users
- ◆ Present-day downscaling uses ERA-interim reanalysis as predictors
- ◆ Projected changes follow RCM requirements, as feasible  
(e.g., scenarios, time periods, etc)

# CORDEX metrics

Document currently being finalised. Guiding principles:

1. Should be a summary statement about model performance compared to a range of available observations
2. Should be succinct
3. Should allow side-by-side comparison of models on the same graph

Proposal is Taylor diagrams of e.g. correlation, rms of seasonal means, spatial variability, interannual variability etc and maps of surface temp, precip and pmsl biases

Two categories:

- A. Basic assessment common to all regions to provide a baseline
- B. Region-targeted assessment to be determined by regional activities defining:
  - (i) Metrics defining model quality relevant to region-specific processes, e.g. North America monsoon;
  - (ii) Metrics relevant to users in the region, e.g. onset of, duration and dry-spell length within rainy season;

# Observations and reanalysis

---

- ✓ **CRU** (monthly mean,  $0.5^\circ$ , 1901-2006)  
2m mean/max/min temperature, precipitation
- ✓ **Willmott** (monthly mean,  $0.5^\circ$ , 1901- 2008)  
2m mean temperature, precipitation
- ✓ **TRMM 3B42** ( 3-hour,  $0.25^\circ$ , 1998-2009)  
precipitation
- ✓ **ERA-INTERIM** ( 3-6 hour, daily,  $0.75^\circ$ , 1989-2009)  
2m mean/max/min temperature, precipitation,  
zonal and meridional wind

all data sets are interpolated onto the  $0.44^\circ$  rotated  
grid by CDO, bilinear interpolation (remapbil)



# Diagnostics

---

- two periods:  
1998-2008 (TRMM )  
1992-2006 (3 year spin up, CRU ends in 2006)
- four seasons:  
JFM, AMJ, JAS, OND

seasonal mean

interannual variability (standard deviation)

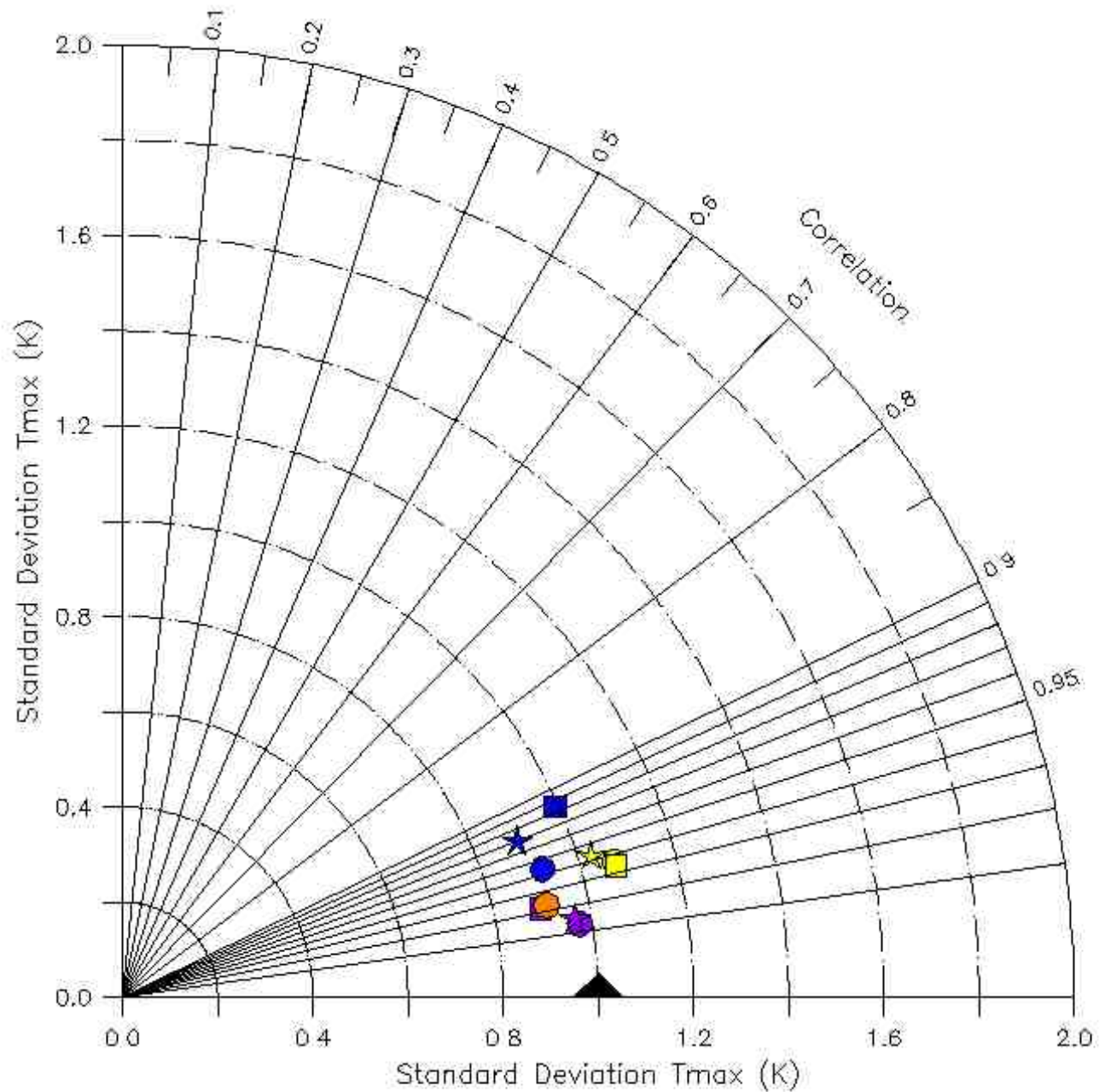
annual cycle (daily data, 50-day low pass filter)

diurnal cycle (3-hour data)

# January Tmax

Different colors =  
Different models

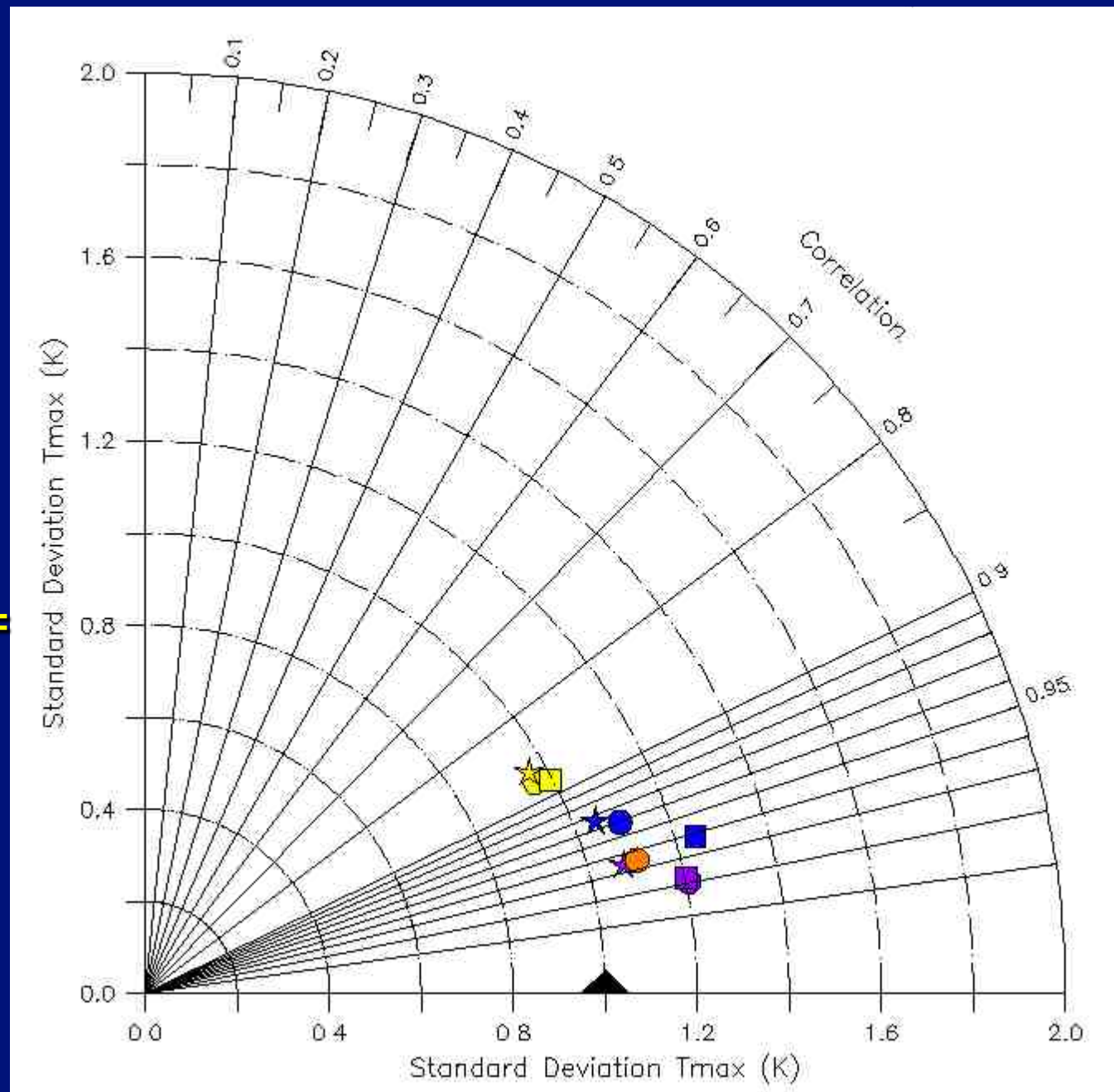
Different shapes =  
Different expts.



# July Tmax

Different colors =  
Different models

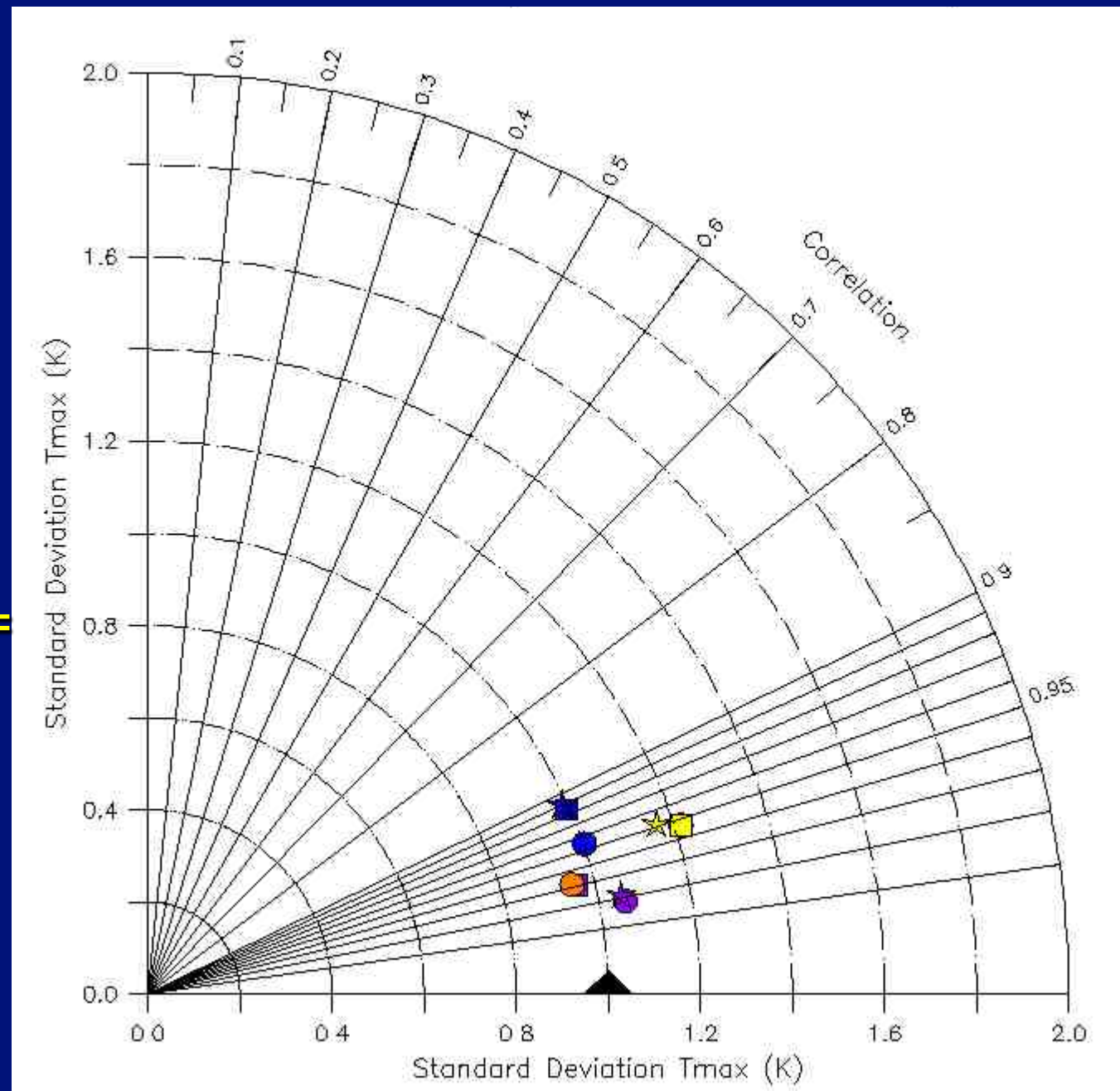
Different shapes =  
Different domain  
sizes



# January Tmin

Different colors =  
Different models

Different shapes =  
Different domain  
sizes

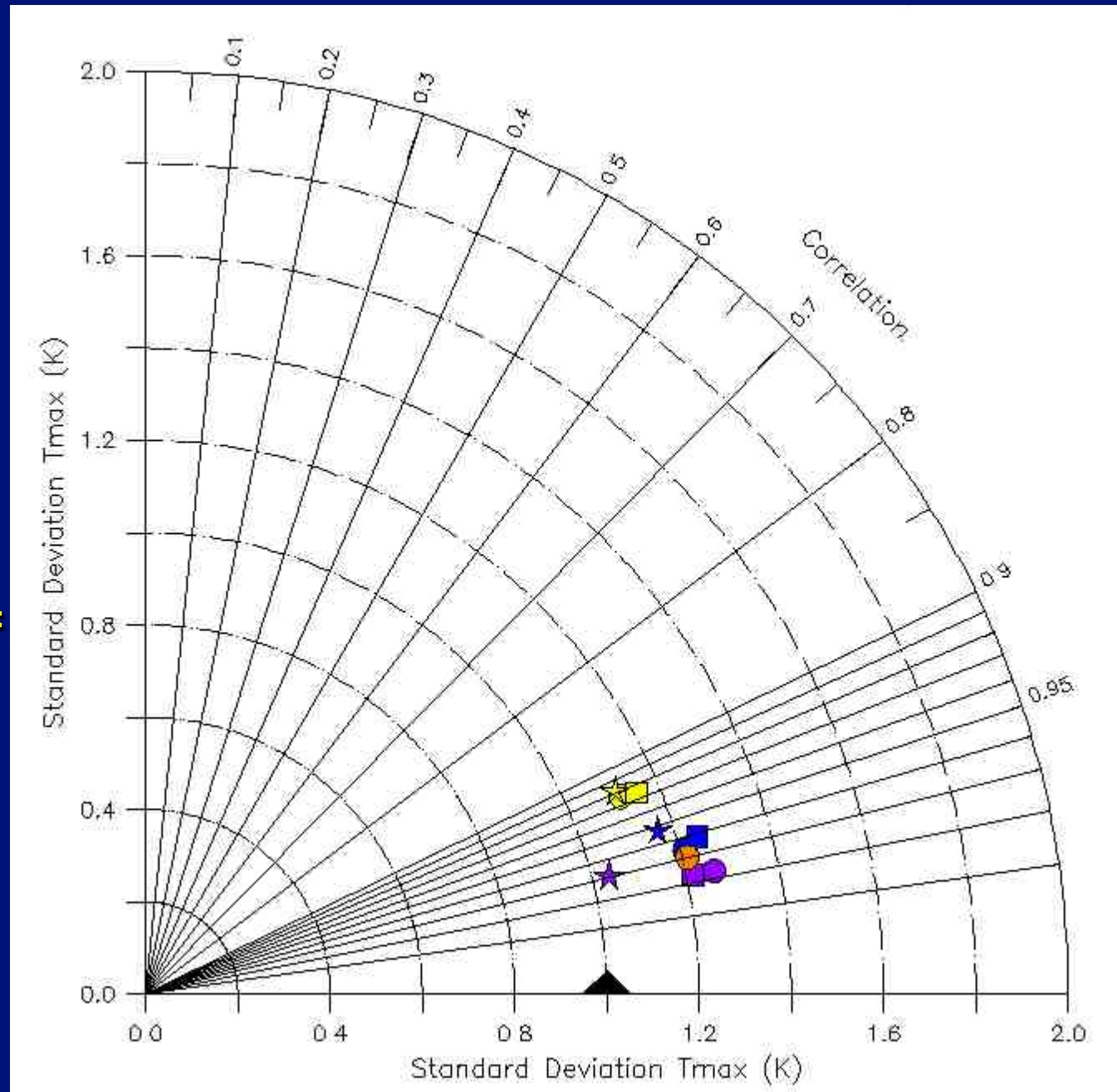




# July Tmin

Different colors =  
Different models

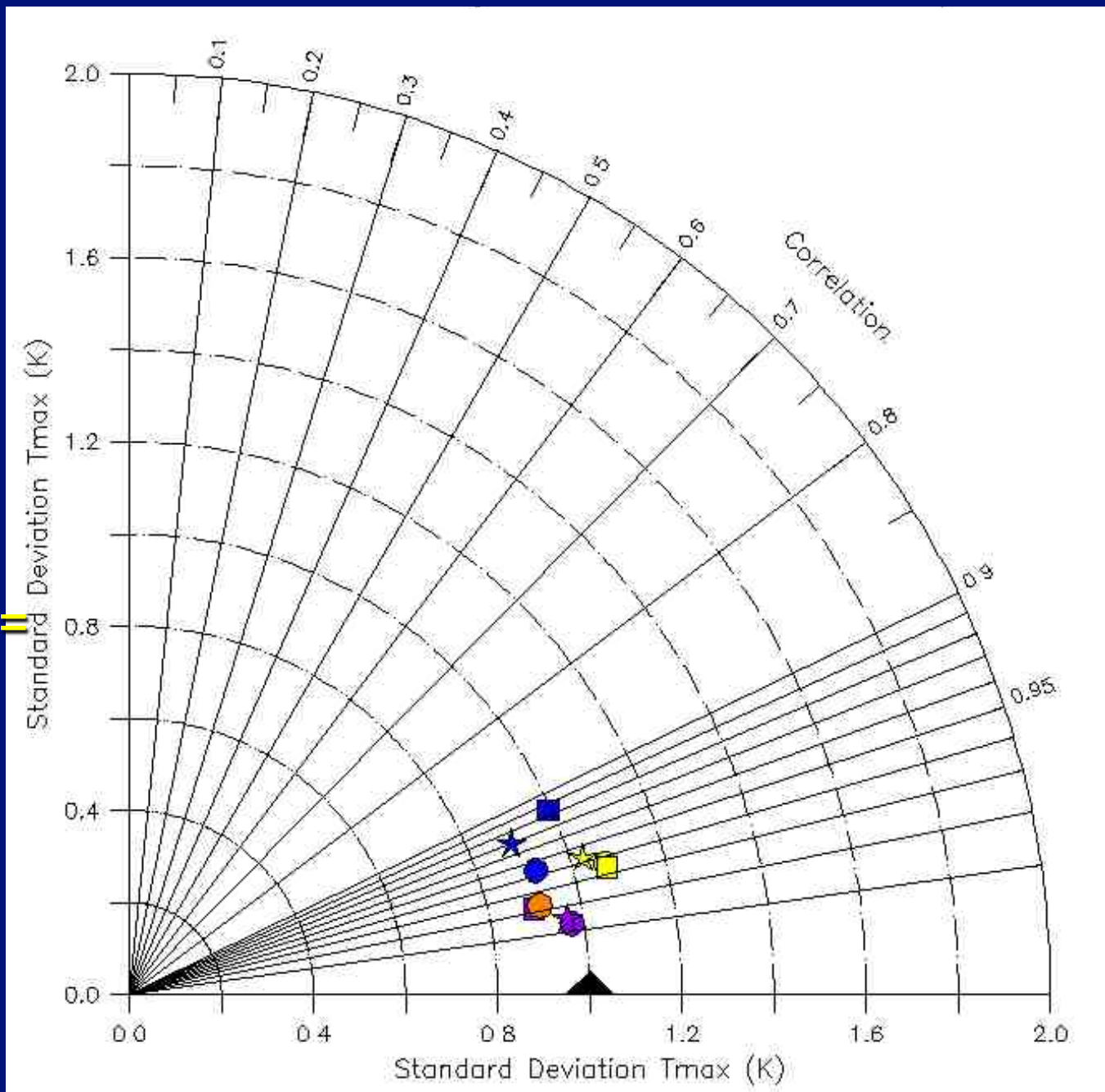
Different shapes =  
Different expts.



# January 500 hPa Heights

Different colors =  
Different models

Different shapes =  
Different expts.





# June 500 hPa Heights

Different colors =  
Different models

Different shapes =  
Different expts.

