Evaluating downscaled precipitation data in Collier County

Robert Trainor, Andy Travieso, Paul Munoz, Connor Hilbert

Precipitation data is critical for:

- Water resource management
- Flood control
- Agriculture
- Climate resilience

Collier County:

- Subtropical climate
- Seasonal rainfall variability
- Vulnerable to hurricanes and heavy storms

https://indianapublicmedia.org/amomentofscience/what-causes-heavy-rain.php

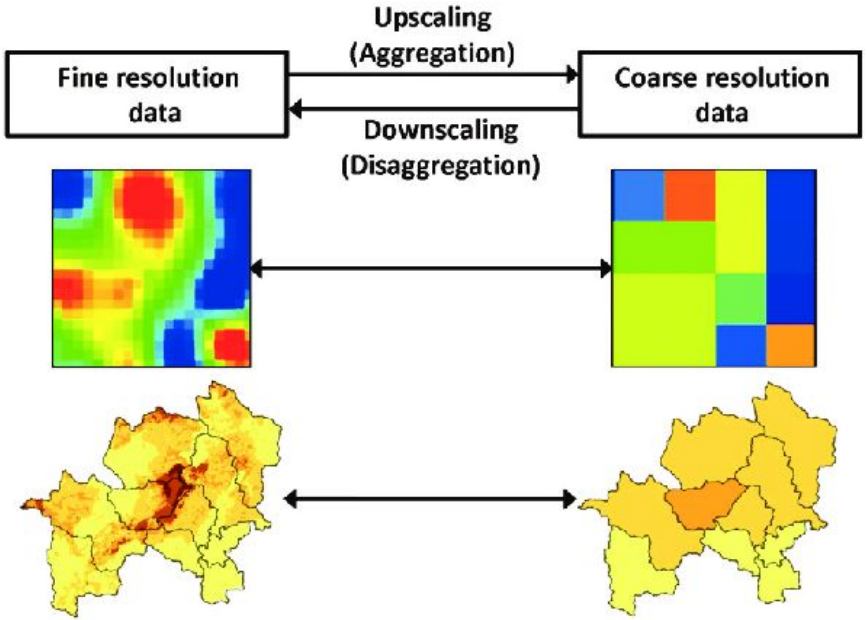
Importance of downscaling

- Transforms coarse-resolution climate model outputs
- Provides higher-resolution data for local applications
- Two types:
  - **Statistical downscaling**
  - **Dynamical downscaling**
- Captures local topography, land use, and microclimates

Validation

- Downscaled data must be evaluated against observed rainfall

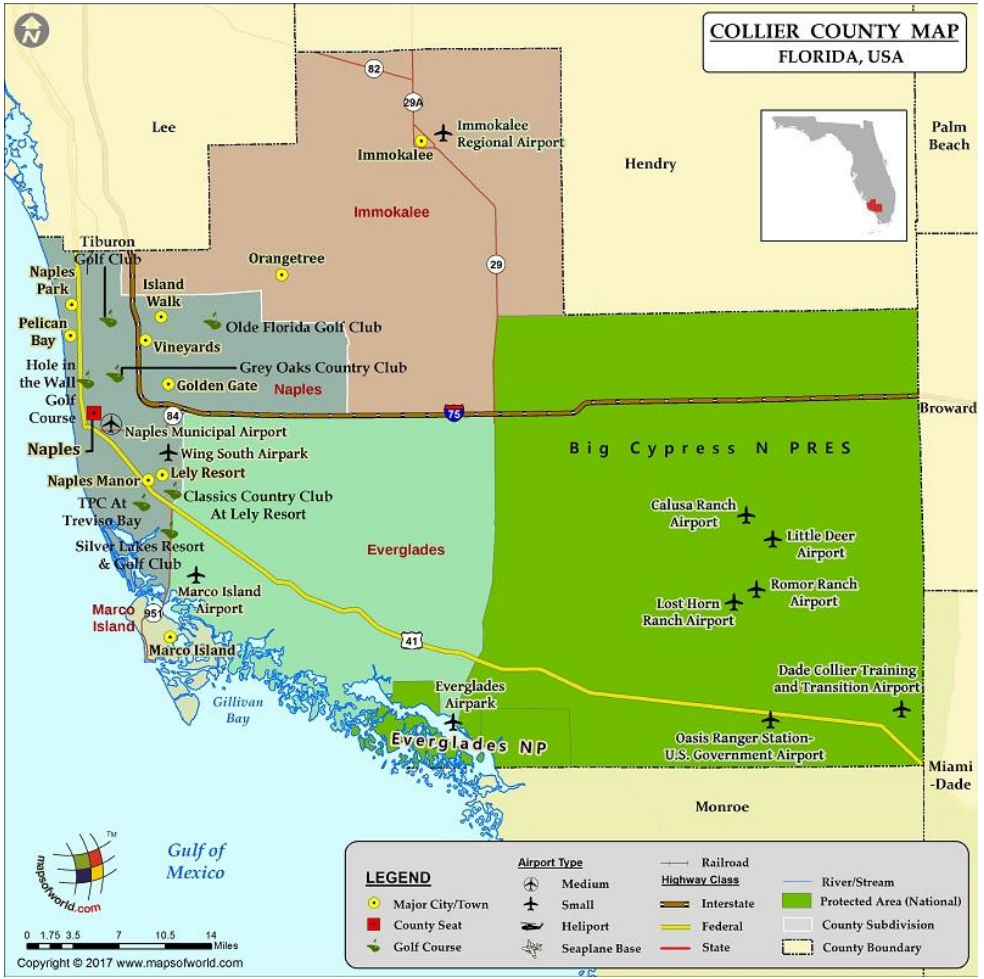
- Observed data sources:
  - Ground-based weather stations



https://www.researchgate.net/figure/Illustration-of-spatial-downscaling-and-upscaling_fig2_335651129

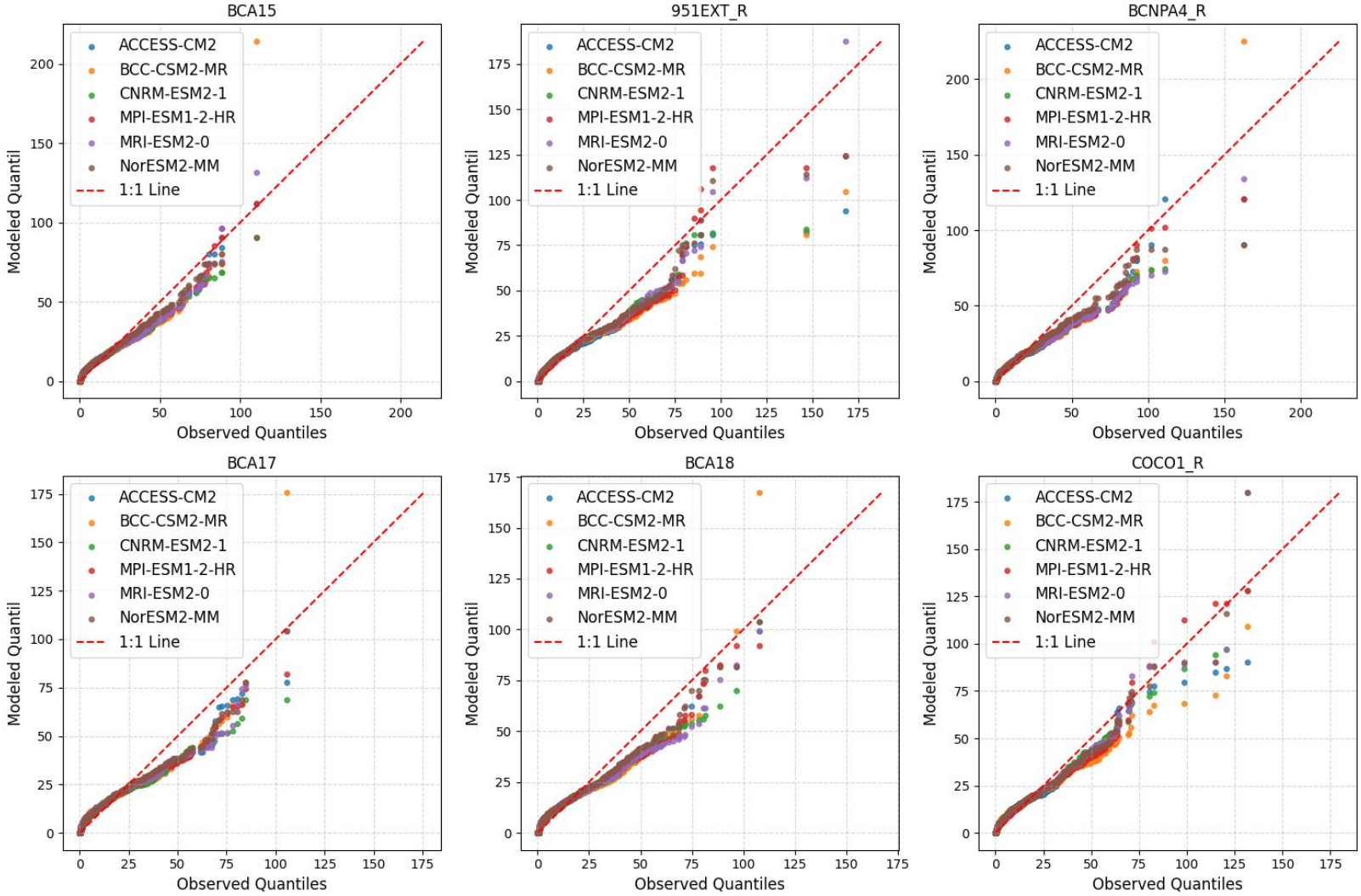
Objectives

- Evaluate **accuracy and reliability** of downscaled precipitation datasets
- Compare with **measured rainfall** from Collier County stations
- Identify errors
- Assess performance under local climate conditions



Methodology Overview

- **Precipitation values extracted** and **spatially subsetted** to Collier County (South Florida)
- Selected multiple **downscaled datasets** from Climate Models
    - ACCESS-CM20, BCC-CSM2-MR, CNRM-ESM2-1, MPI-ESM1-2-HR, MRI-ESM2-0, NorESM2-MM
- **Missing values interpolated**, units standardized
- Statistical evaluation against observed data using:
    - Correlation coefficient, Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Coefficient of Determination (R^2)
- Q-Q Plots, with a 1:1 reference line, are used to compare distributions
- Computations performed using:
    - numpy, scipy, sklearn.metrics
- Visualization with:
    - matplotlib, seaborn


BCA15
951EXT_R
BCNPA4_R
BCA17
BCA18
COCO1_R
ACCESS-CM2
BCC-CSM2-MR
CNRM-ESM2-1
MPI-ESM1-2-HR
MRI-ESM2-0
NorESM2-MM
1:1 Line
Modeled Quantil
Observed Quantiles

Station	Best Model(s)	Reasoning
BCA15	**NorESM2-MM**, MPI-ESM1-2-HR	Highest R^2 (0.97), lowest RMSE (1.82, 2.14)
951EXT_R	**NorESM2-MM**, MRI-ESM2-0	High R^2 (0.95), low RMSE (~2.43)
BCNPA4_R	**NorESM2-MM**, MPI-ESM1-2-HR	Consistently better R^2 and RMSE
BCA17	**NorESM2-MM**, MPI-ESM1-2-HR	Best R^2 (0.94), RMSE (2.31)
BCA18	**NorESM2-MM**, MPI-ESM1-2-HR	Top R^2 (0.96), lowest RMSE (2.07)
COCO1_R	**CNRM-ESM2-1**, MPI-ESM1-2-HR	Very high R^2 (0.97), lowest RMSE (1.75–1.81)

Future Climate Impact Studies in Southwest Florida

- The **NorESM2-MM** and **MPI-ESM1-2-HR** models consistently outperform others, suggesting they should be prioritized for regional climate projections.
- Some models show consistent **positive ME**, indicating a tendency to **overpredict** conditions
  - COCO1_R
- **High R^2 and low RMSE** values mean these models are more reliable in simulating observed climate data
  - Important for long-term planning
    - Infrastructure
    - Coastal Development
    - Water Resource Management
    - Flooding