Providing downscaled climate information to increase resilience to climate-related water stress and hydrologic extremes: issues and challenges

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Be Secure Project
Water Security for Resilient Economic Growth and Stability

Philippine Water Security for Resilient Economic Growth and Stability (Be Secure) Project

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Be Secure Project
Water Security for Resilient Economic Growth and Stability

A four-year activity that seeks to promote good governance and build capacity for long-term water security, improve access to water and wastewater treatment services, and build more resilient communities.

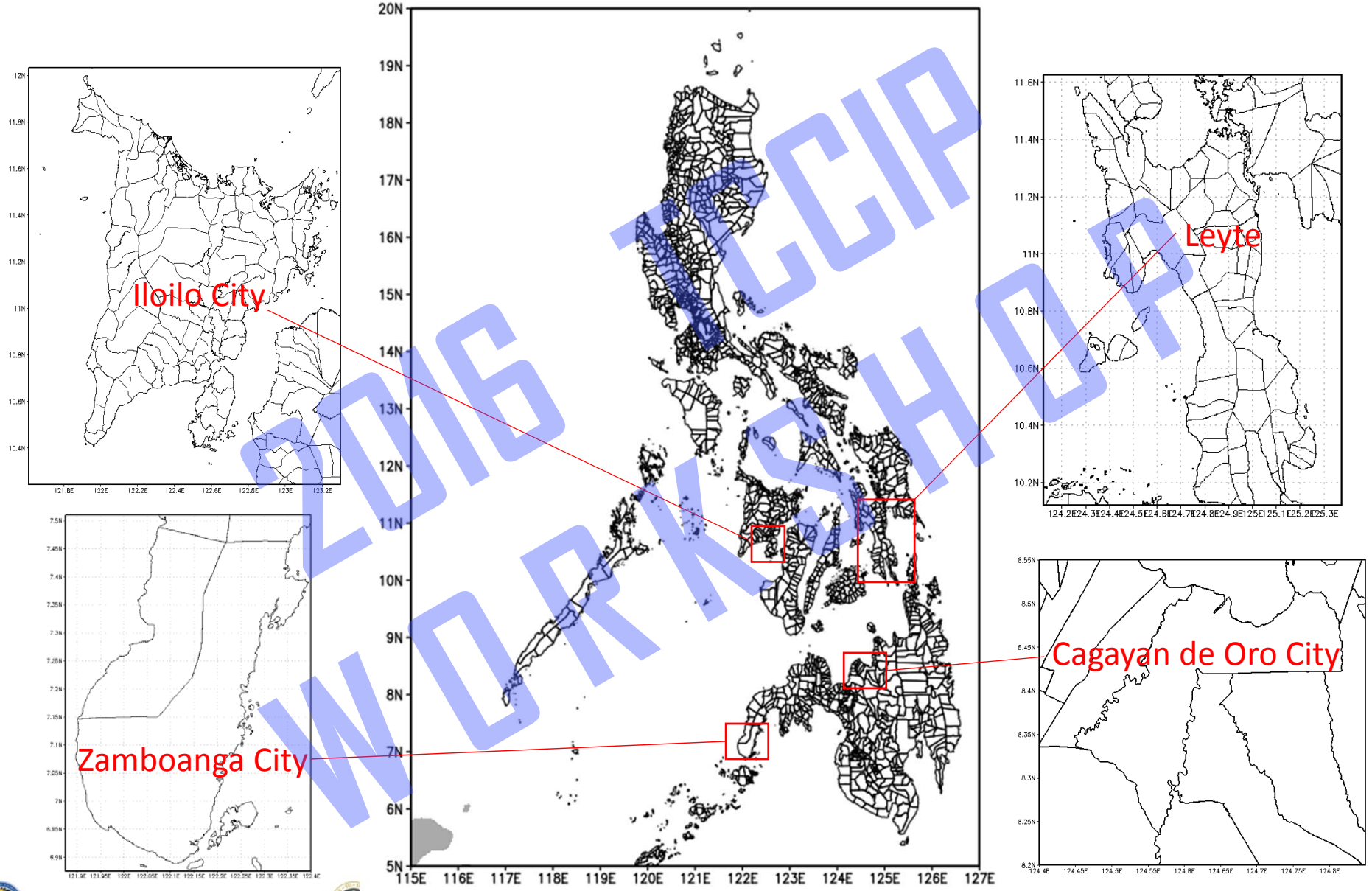
- **technical assistance to increase resilience to climate-related water stress and hydrologic extremes** in Cagayan de Oro, Iloilo, and Tuguegarao City and Leyte province **by downscaling climate projections** and producing **climate hazard maps** and water resources vulnerability maps

- **produce climate change outlooks** using the Fifth Assessment Report (AR5) **climate change scenarios** and feed these into the scientific and participatory vulnerability assessments and hazard maps.

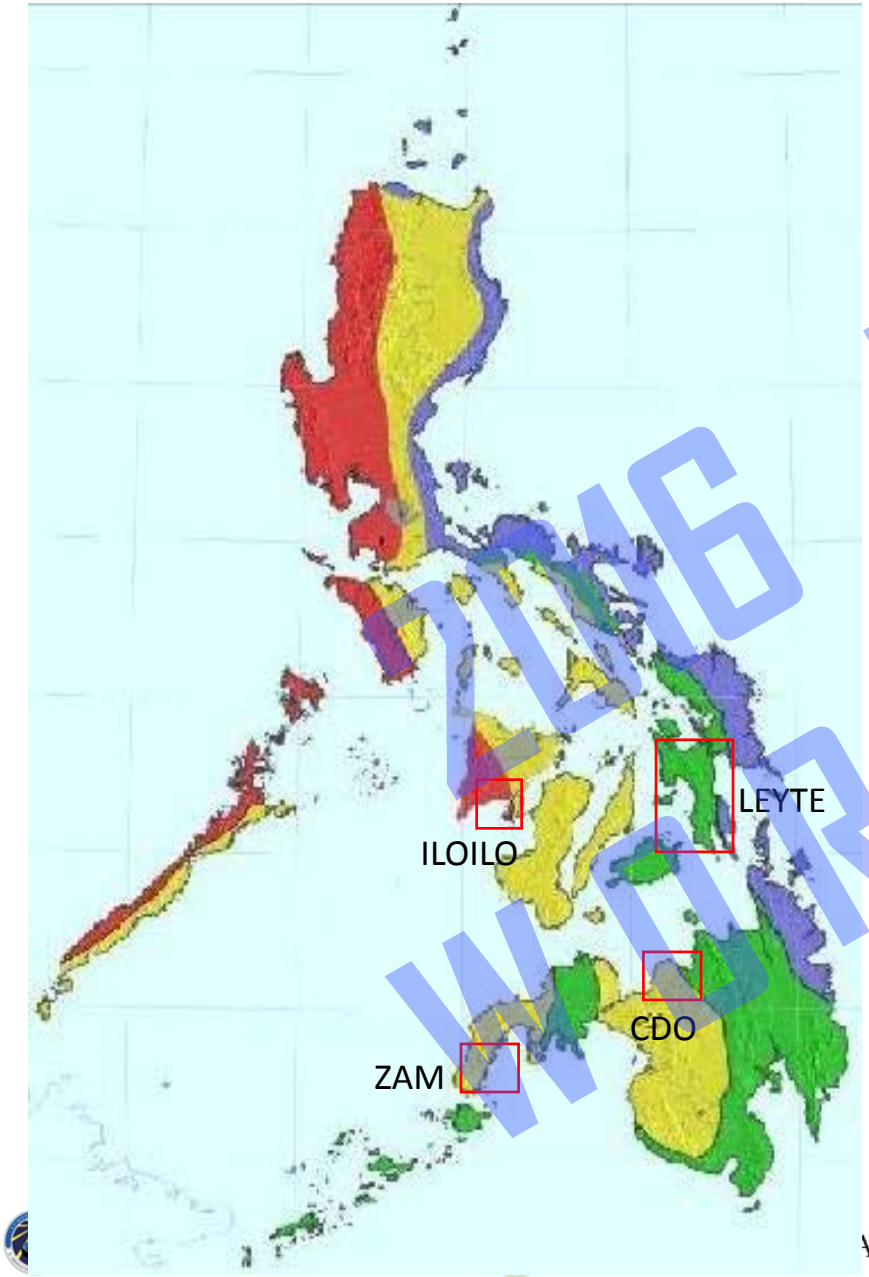
Methods

- Model: ICTP RegCM4
- 4 GCMs: CanESM2, HadGEM2-ES, GFDL-ESM2M, CSIRO-Mk3.6.0
- Resolution: 25km
- Baseline 1971-2000
- Climate projections 2011-2040 (2025s); 2036-2065 (2050s) RCP4.5
- Observation data: Station data and gridded observation (APHRODITE)
- Bias Correction
  - Piani et al. (2010)
  - Boe, J. et al. (2007), Gudmundsson, L. et al. (2012)

Areas of interest



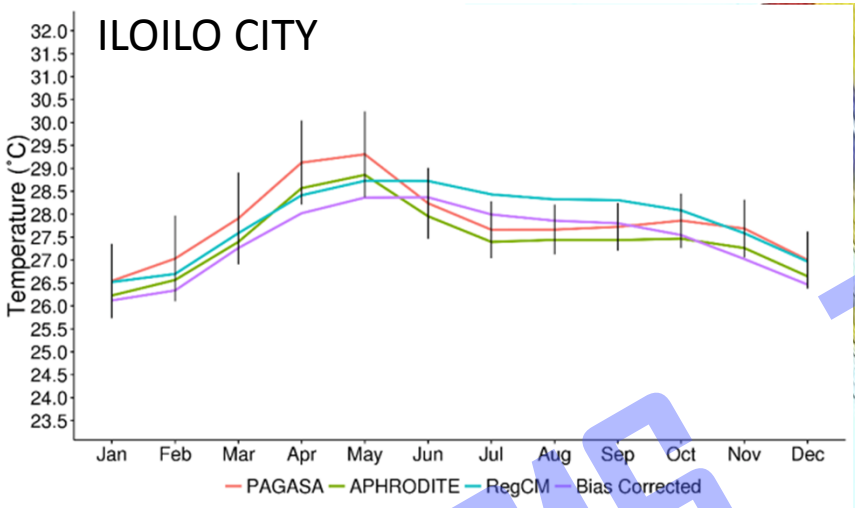
Modified Coronas Atlas (Kintanar, 1984)

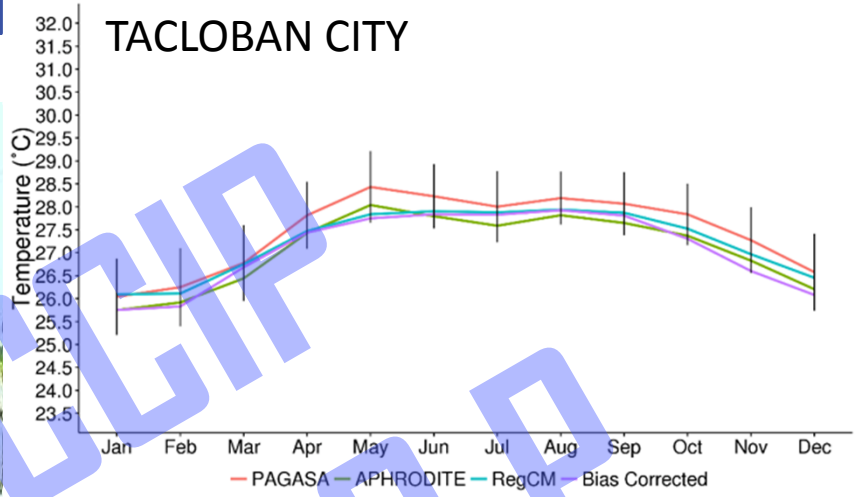


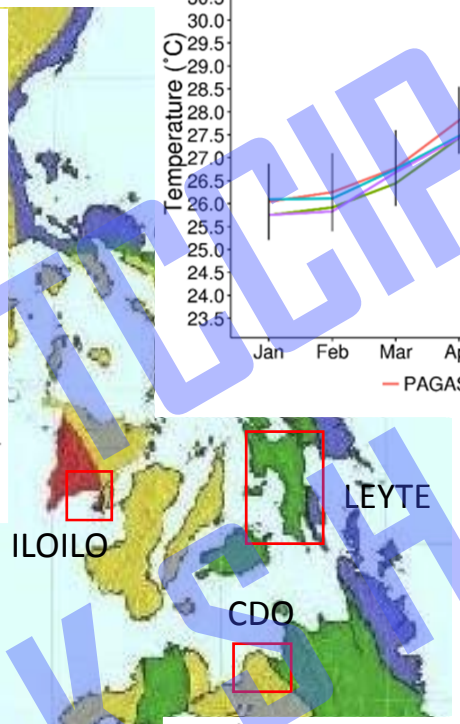
- Type I climate (two pronounced season with dry period from November to April and wet period from May to October)
- Type II climate (no dry season with a very pronounced maximum rainfall during the months of November–December);
- Type III climate (seasons not very pronounced with a relatively dry period from November to April, as in Type I);
- Type IV climate with rainfall more or less evenly distributed along the year

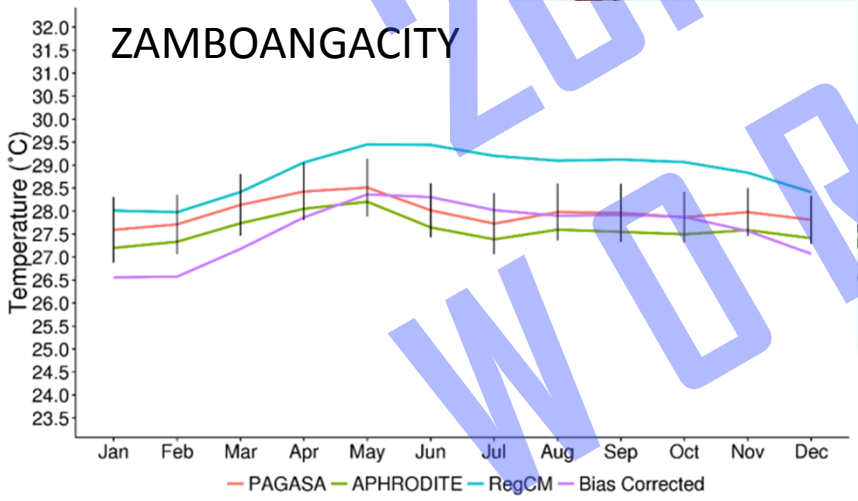
http://kidlat.pagasa.dost.gov.ph/cab/climate_change/images/ClimateMap.JPG

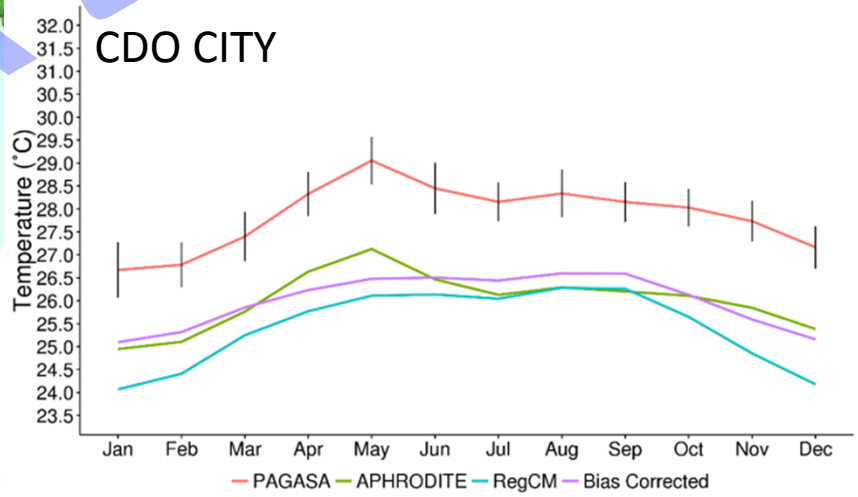
Temperature





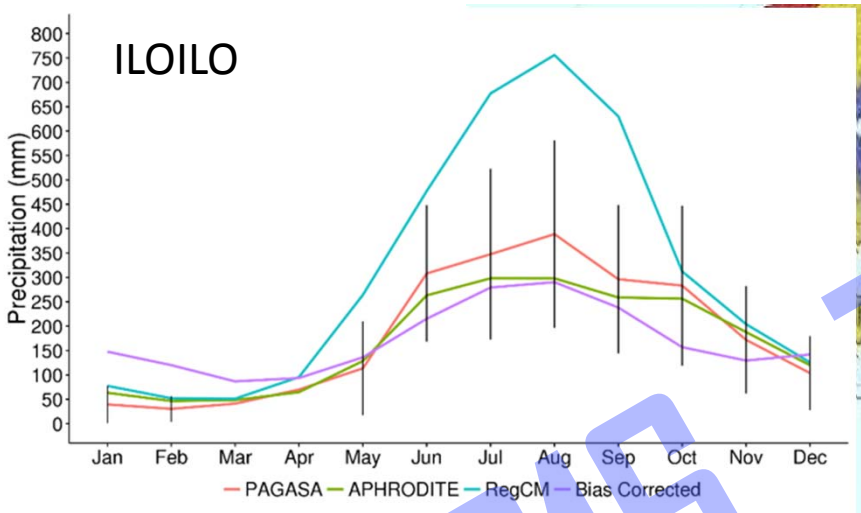


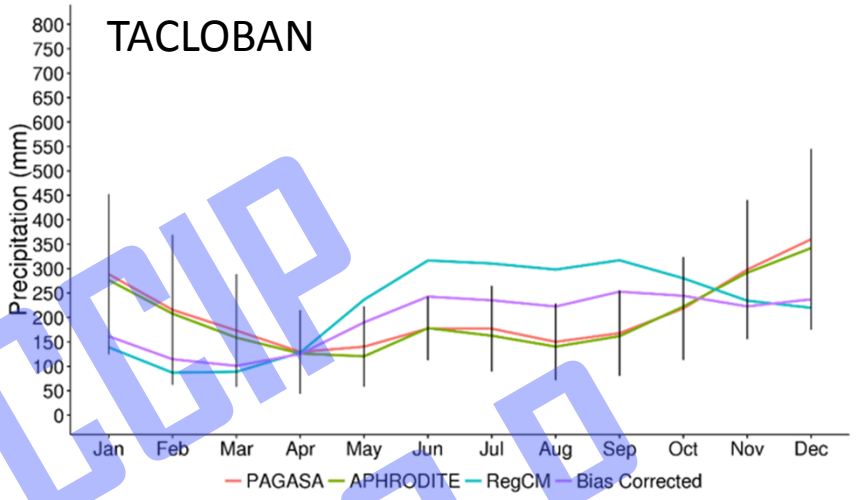


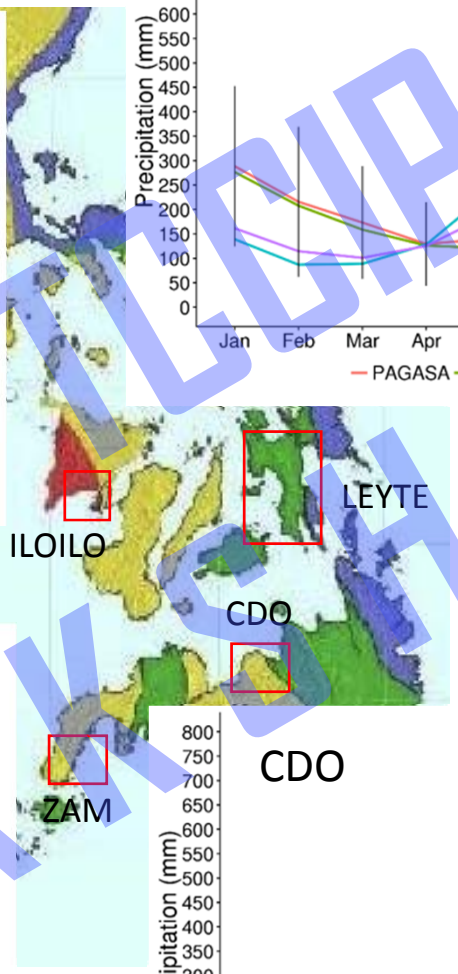


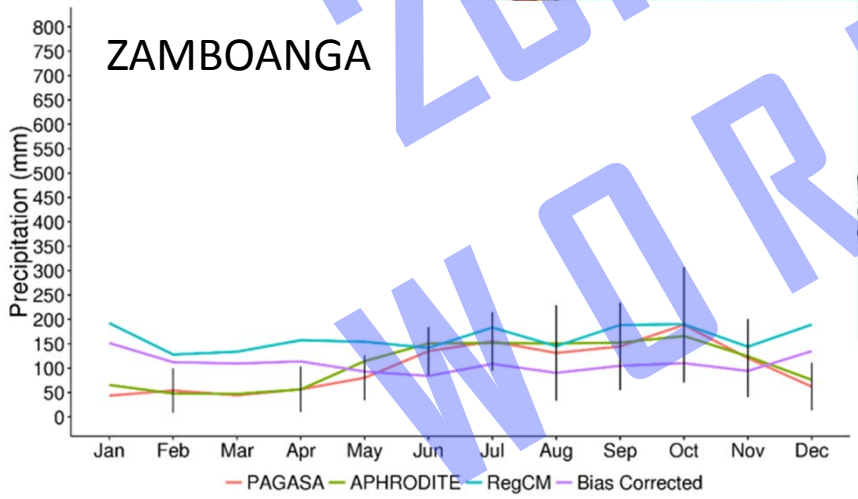
PAGASA APHRODITE RegCM Bias Corrected

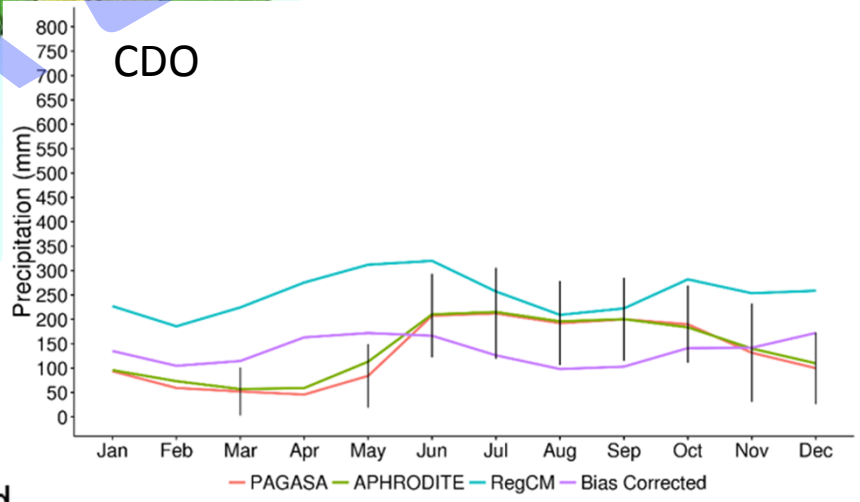
Rainfall



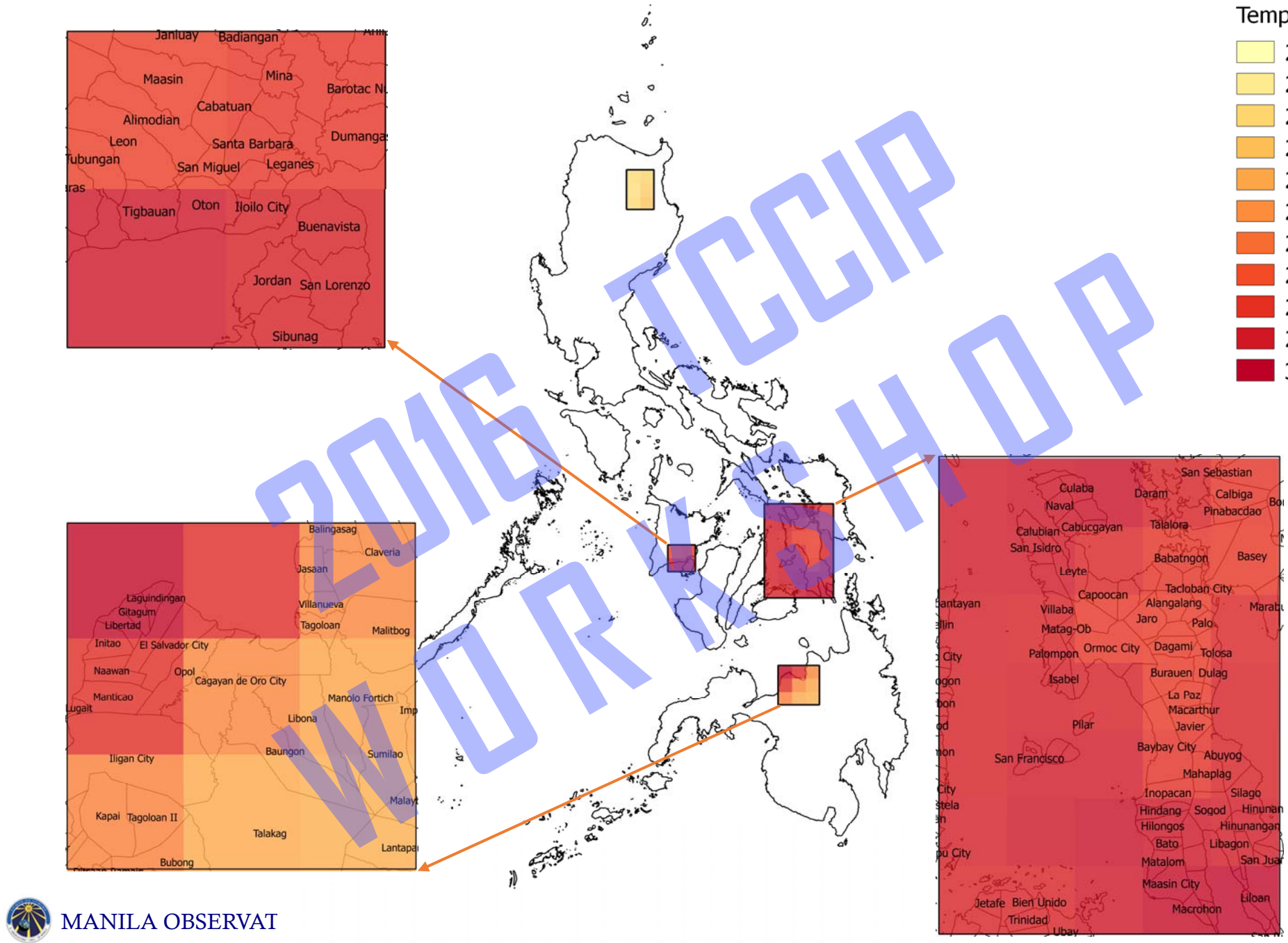








PAGASA APHRODITE RegCM Bias Corrected



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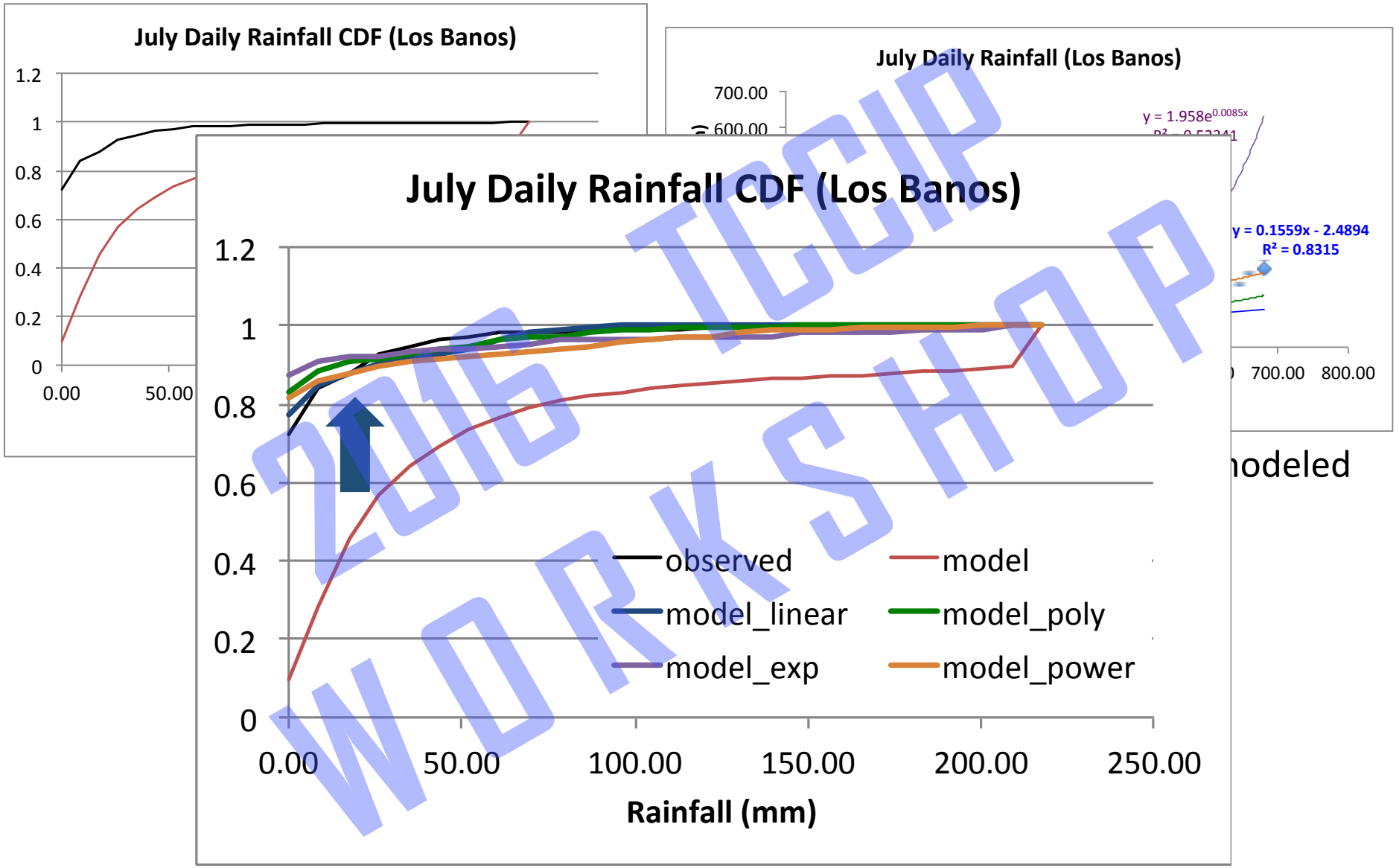
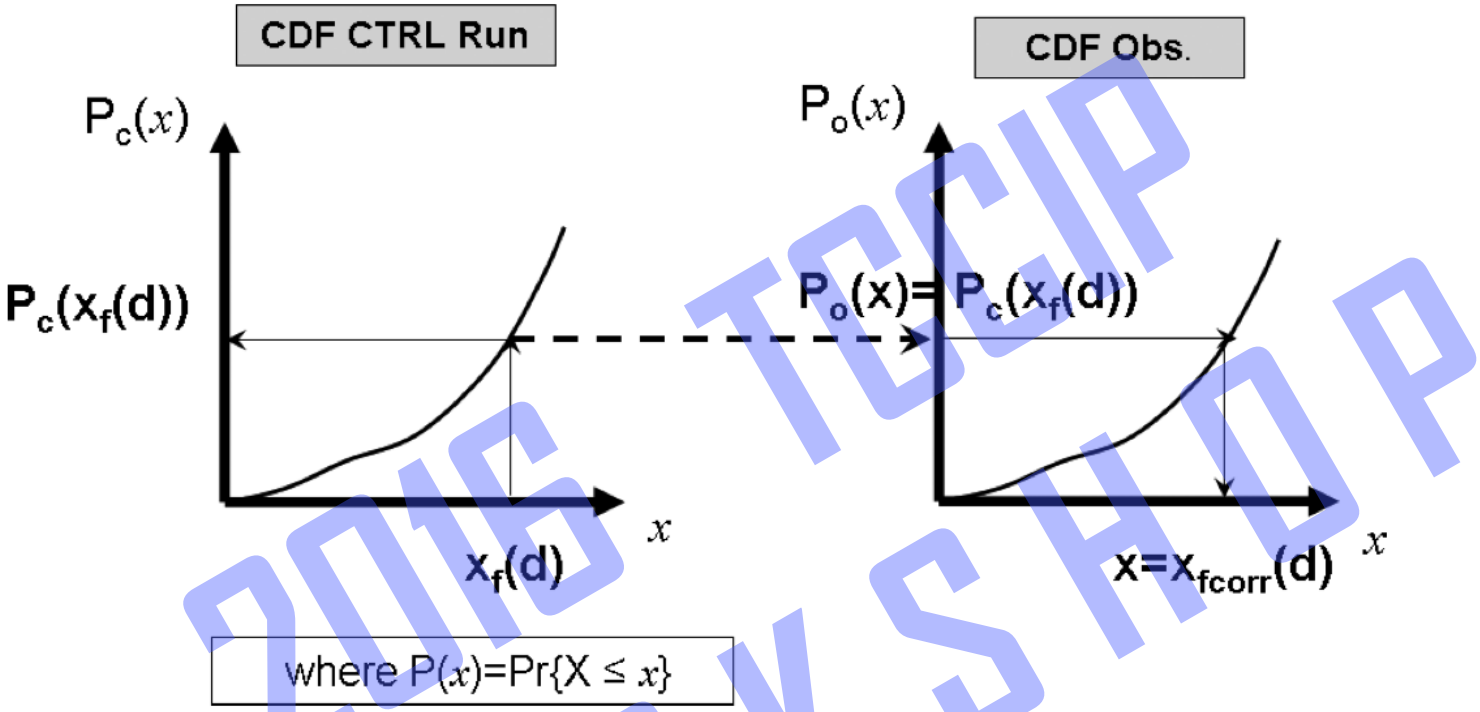
Bias Correction (Piani et al., 2010)



Bias Correction (Boé et al, 2007)

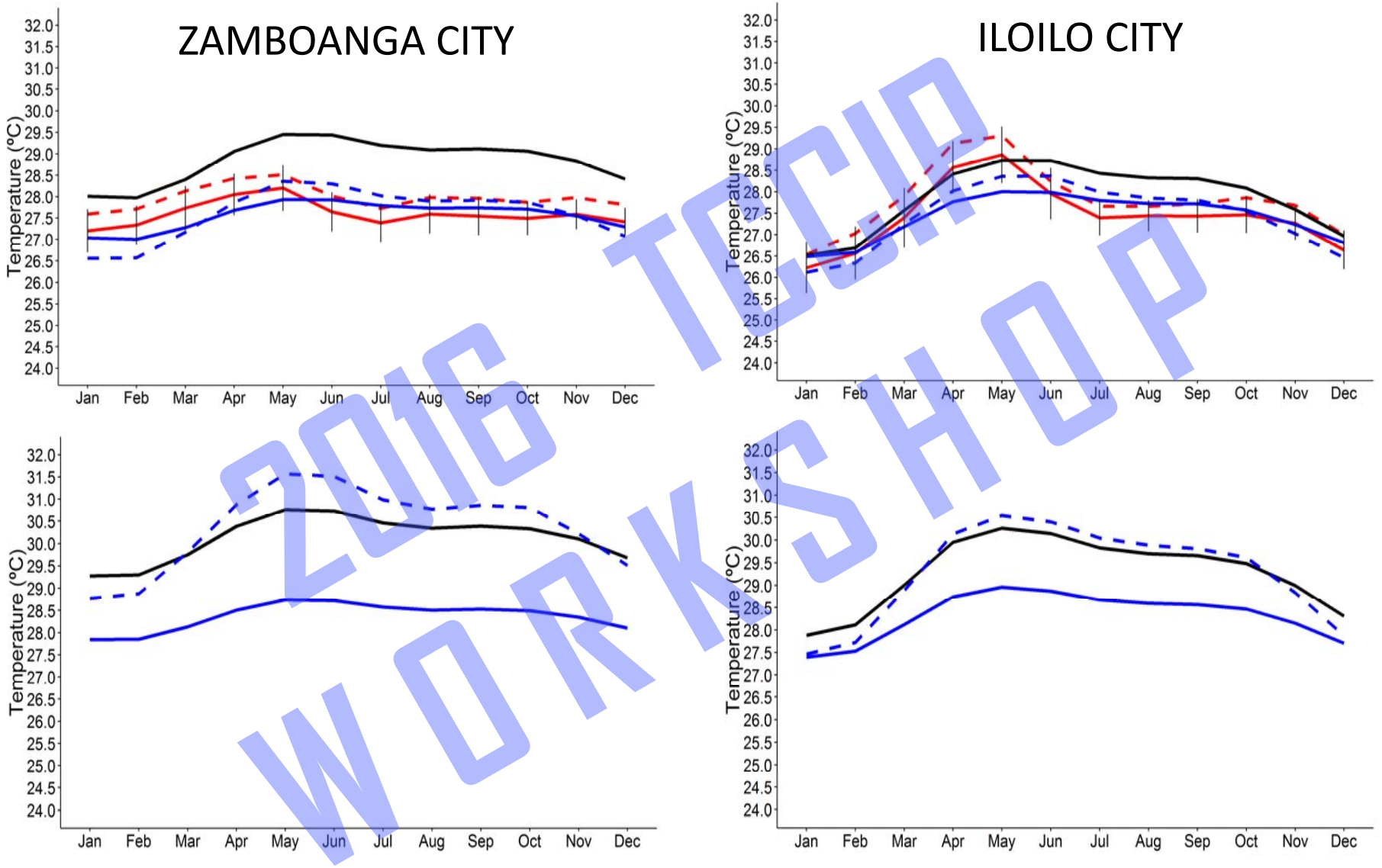


1) For a given variable, the cumulative density function (cdf) of the control simulation is matched with the cdf of the observations, generating a correction function depending on the quantile.
2) The correction function is used to unbias the variable from the climate scenario quantile by quantile.

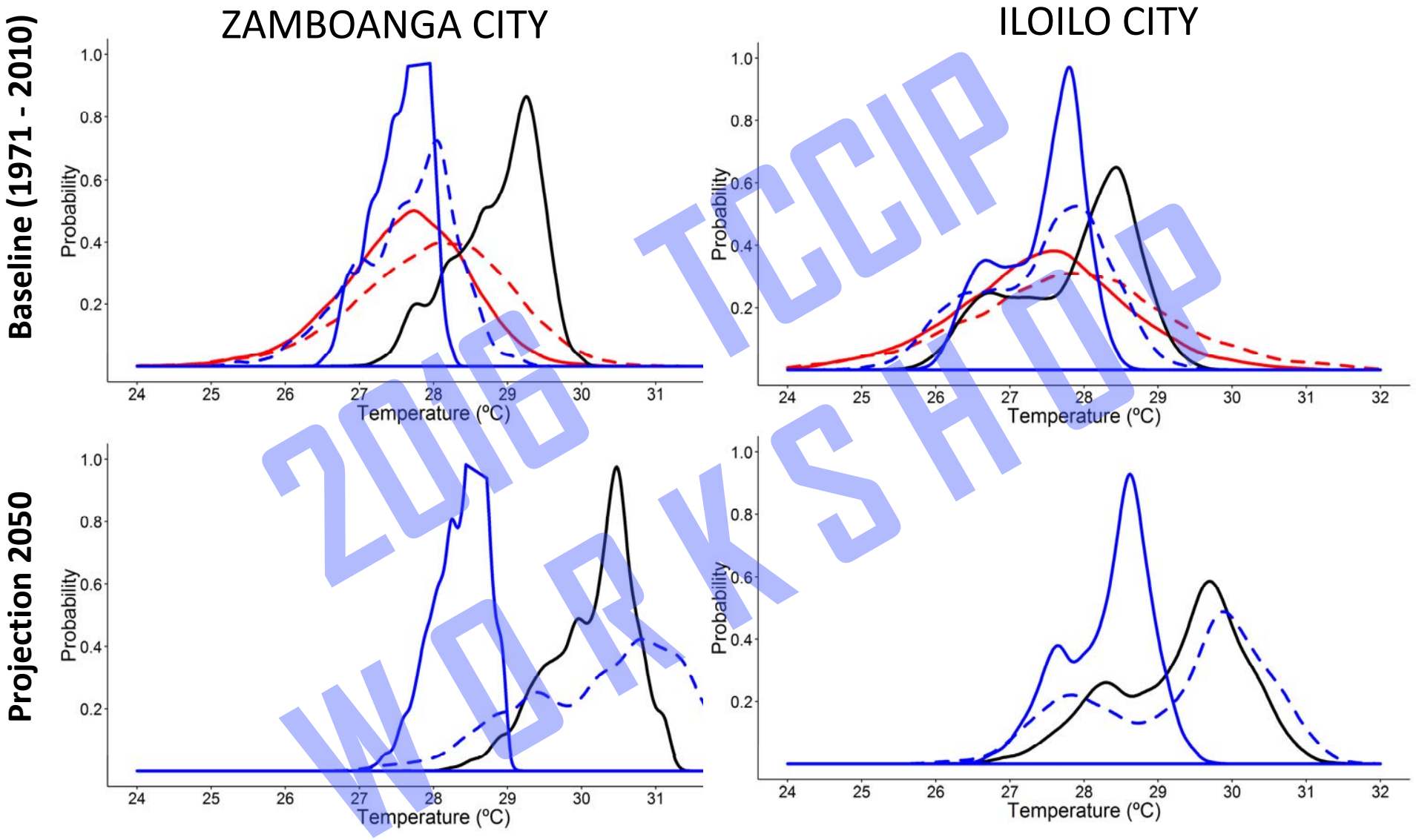
Bias Correction Analysis: Temperature

Baseline (1971 - 2010)

Projection 2050



Bias Correction Analysis: Temperature

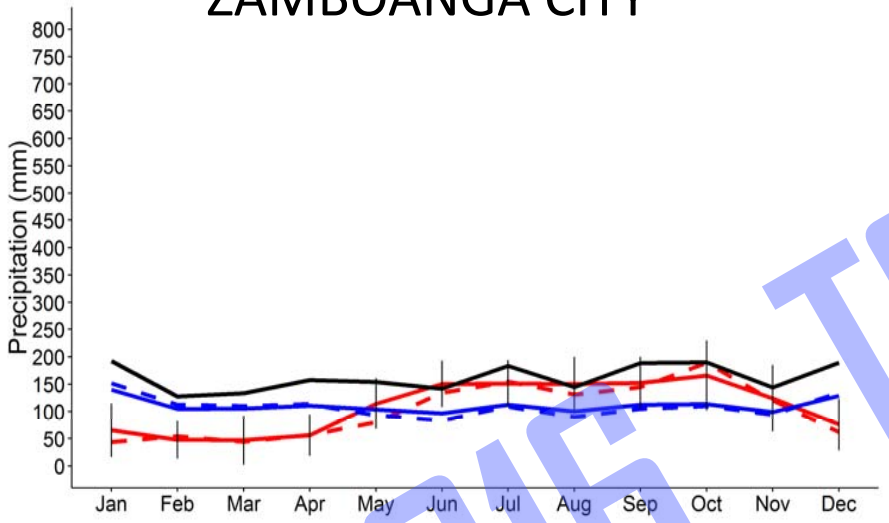


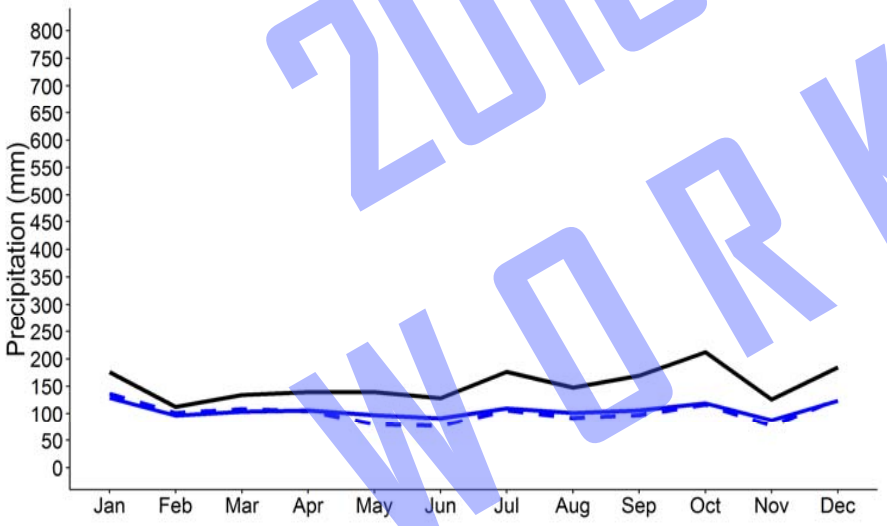
Bias Correction Analysis: Rainfall

Baseline (1971 - 2010)

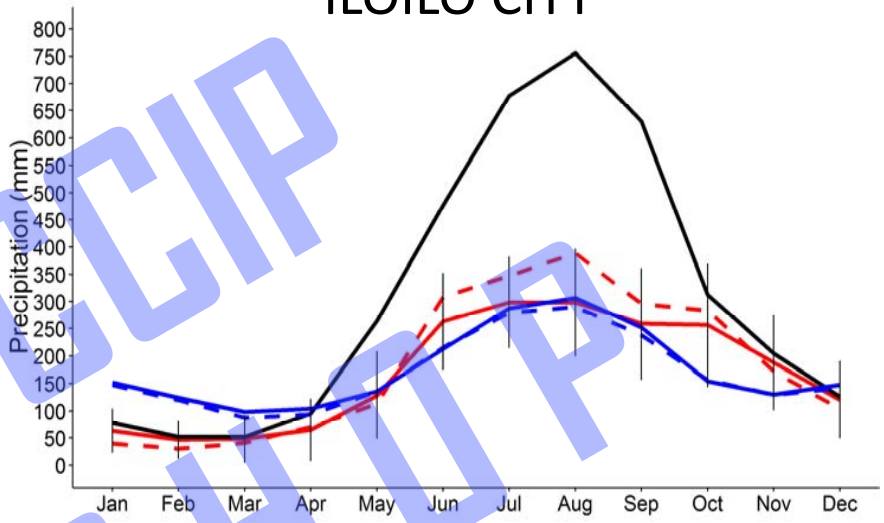
Projection 2050

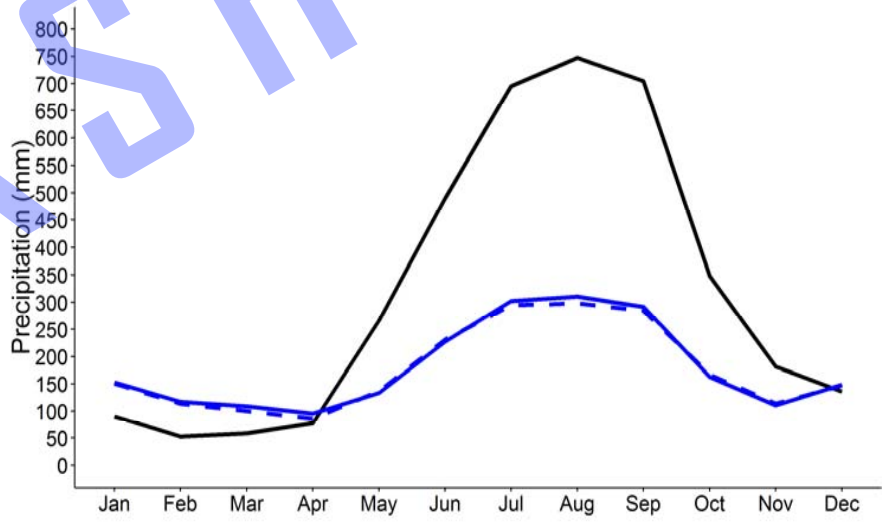
ZAMBOANGA CITY





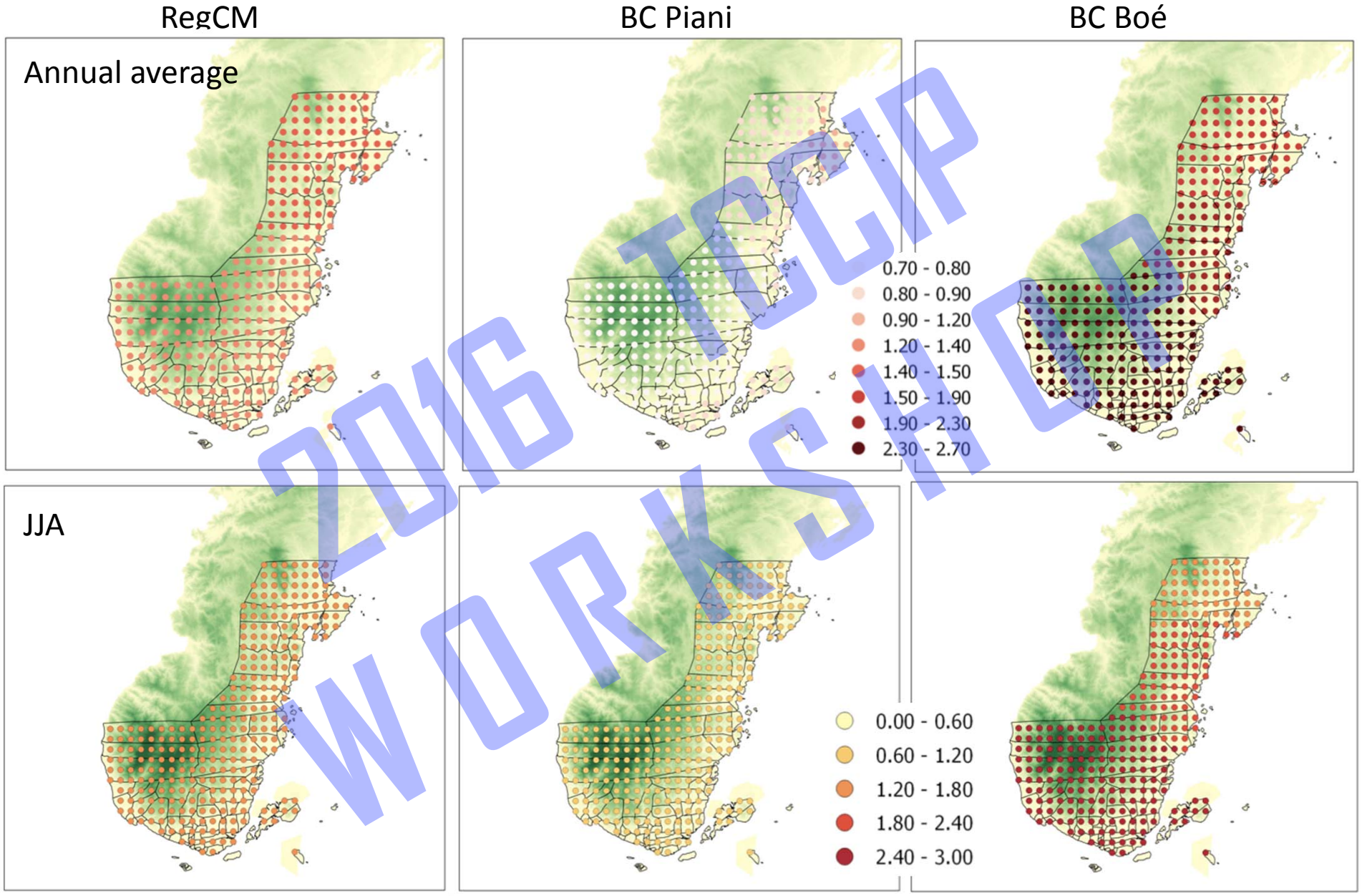
ILOILO CITY



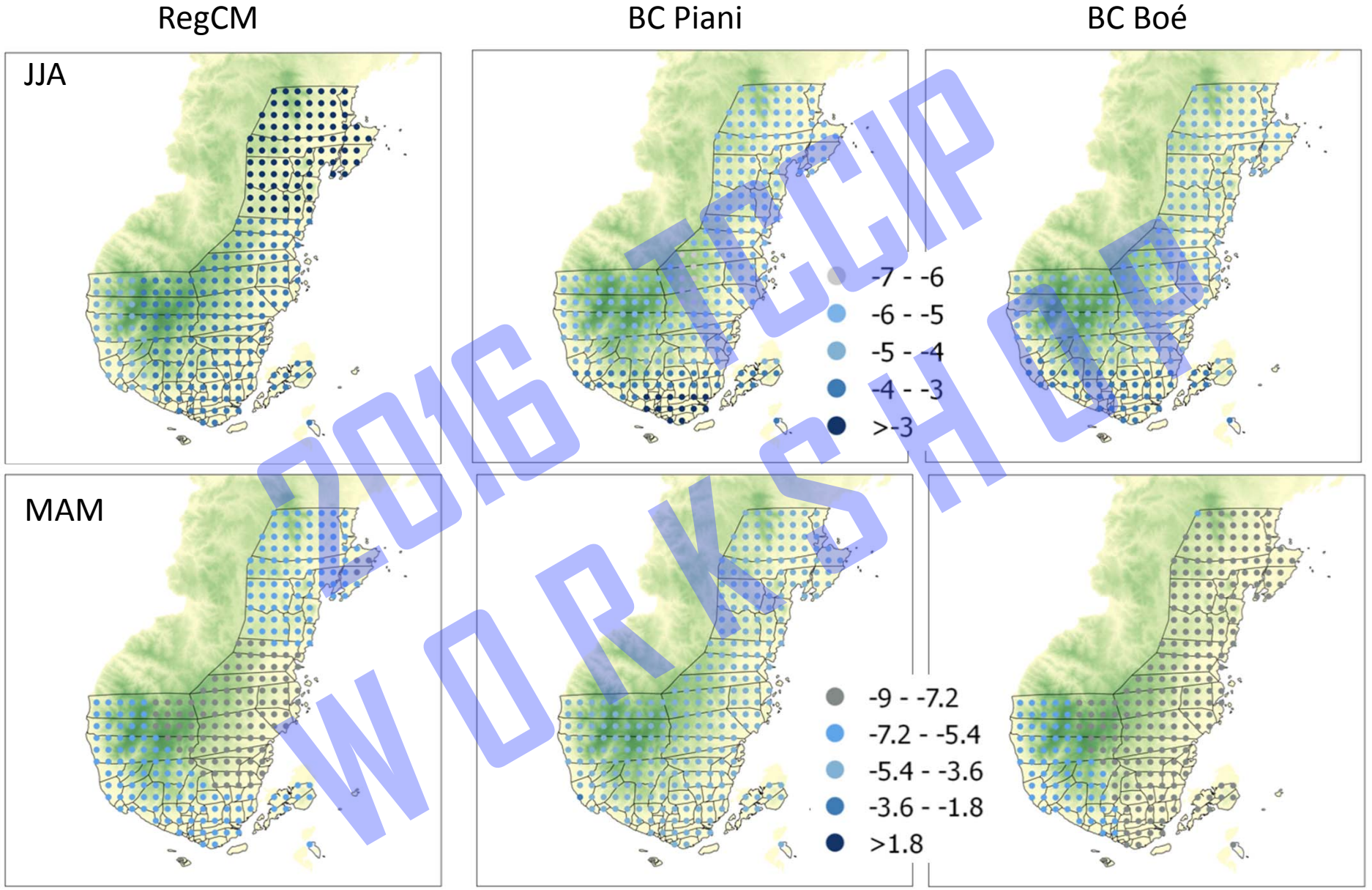


----- PAGASA —— APHRODITE ——RegCM —— BC-Piani ----- BC-Boé

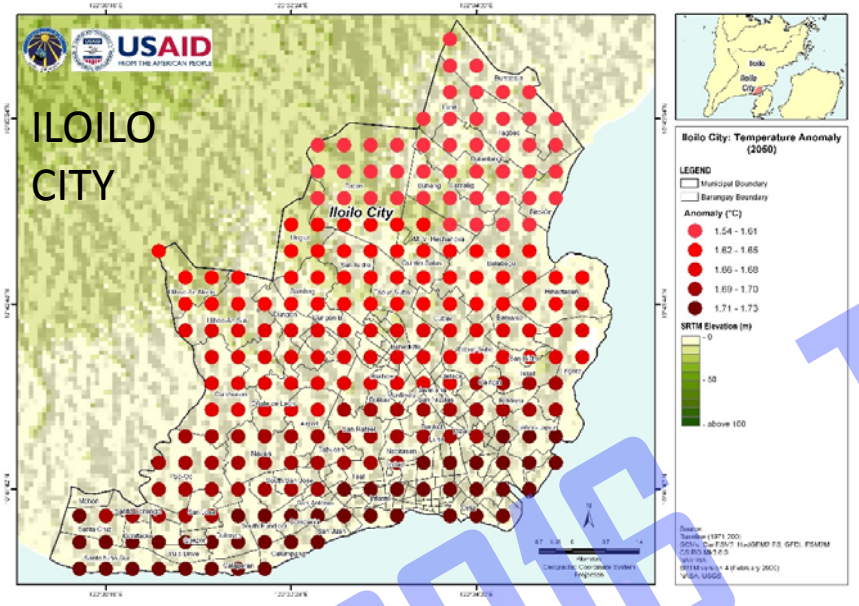
Bias Correction: Temperature Zamboanga 2050

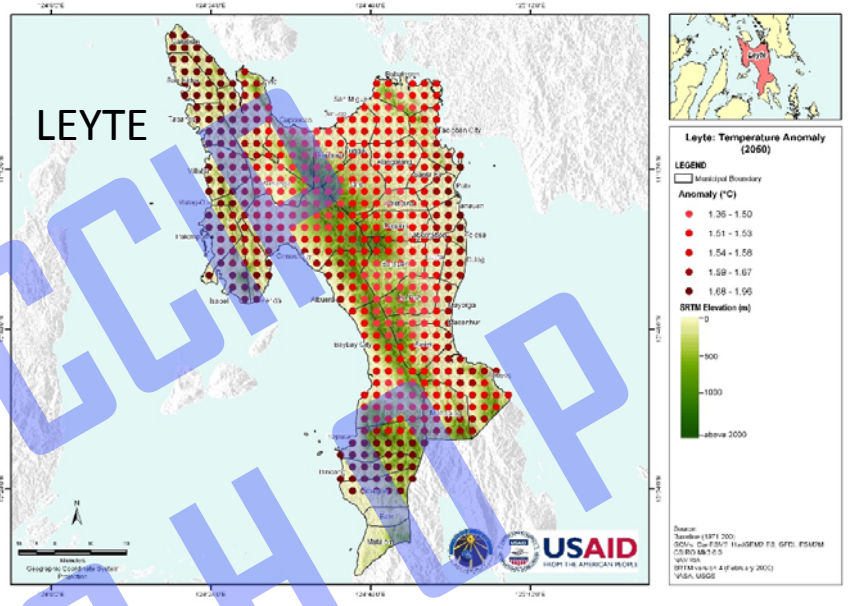


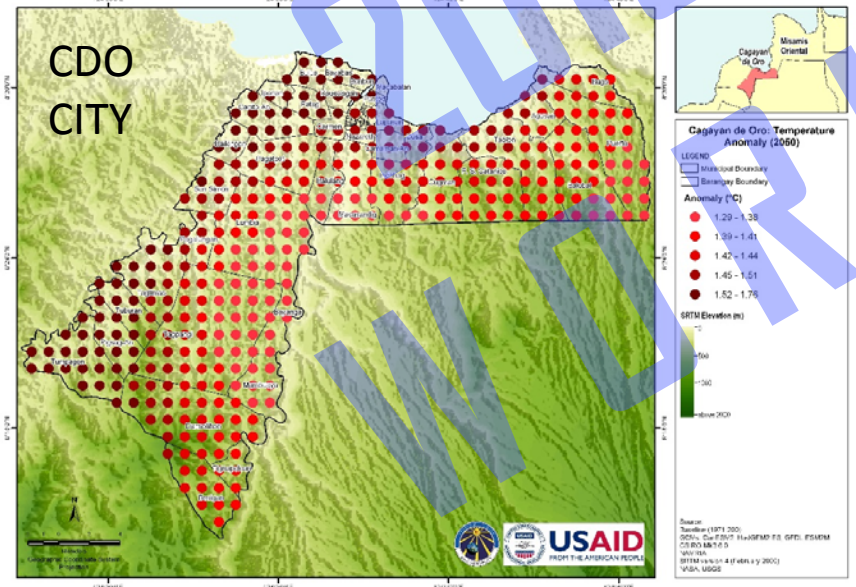
Bias Correction: Precipitation Zamboanga 2050

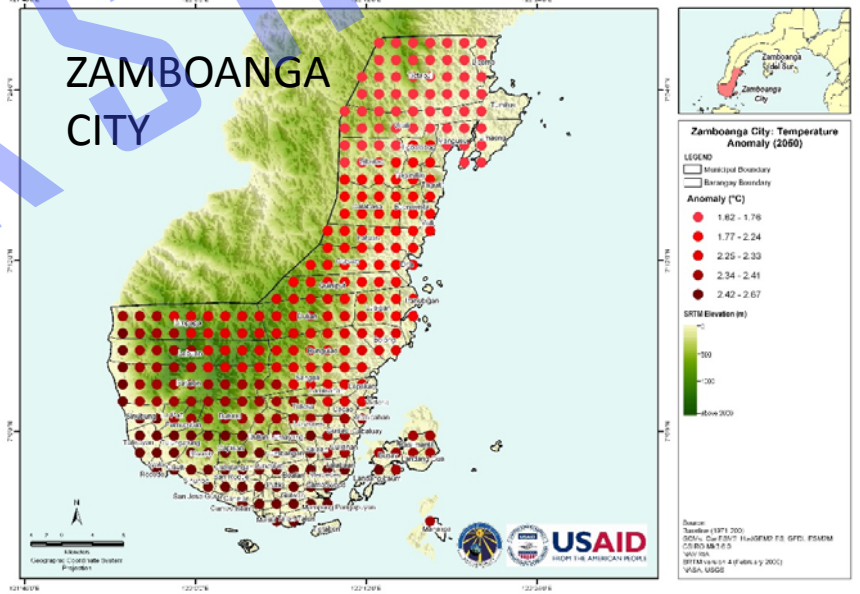


Climate projections temperature 2050

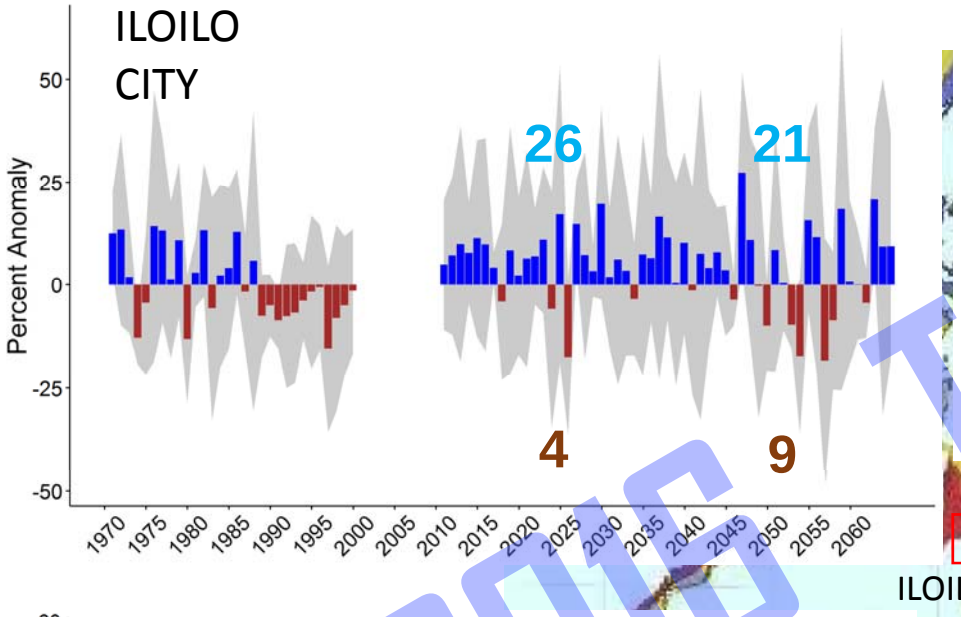


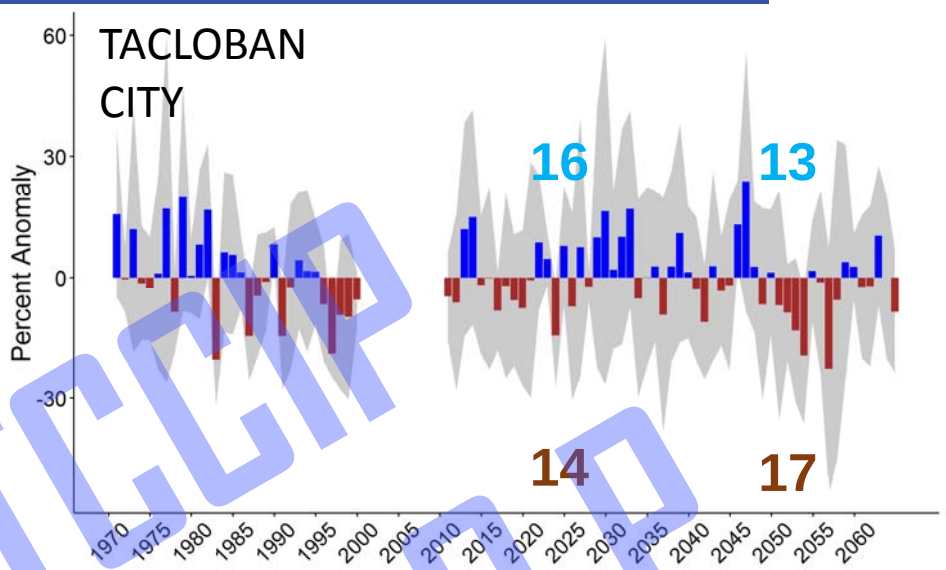


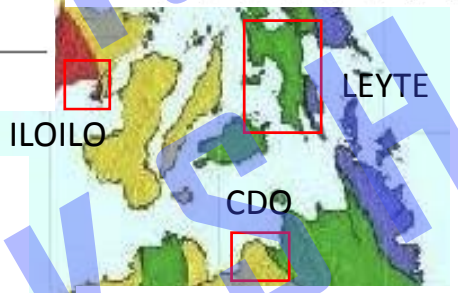


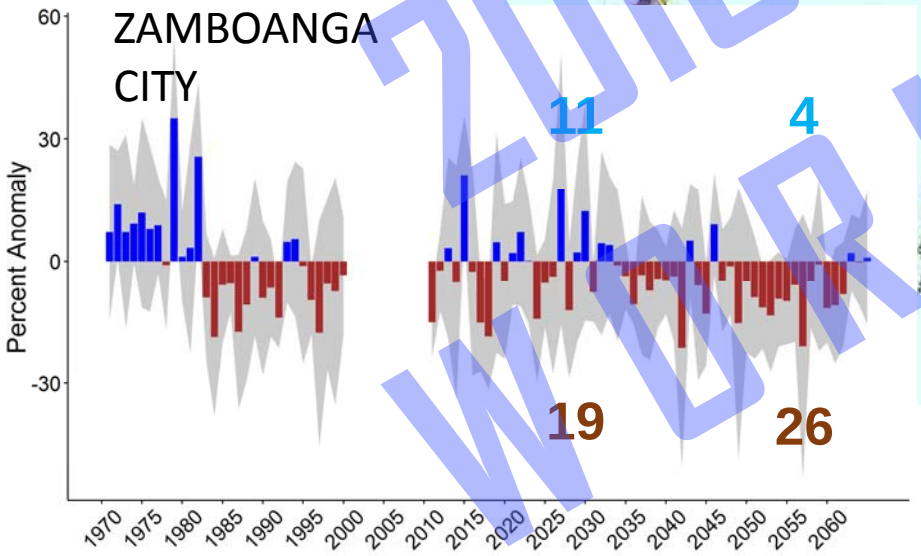


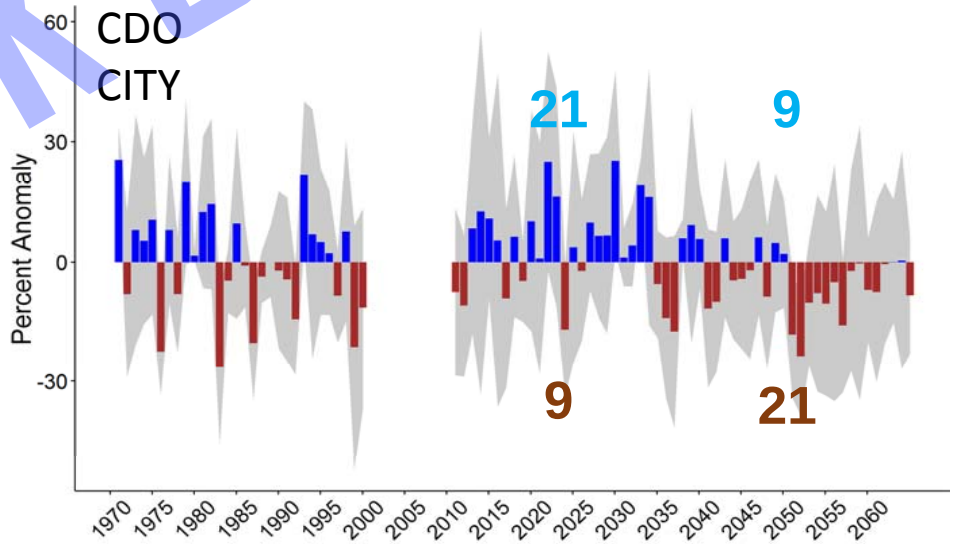
Temperature







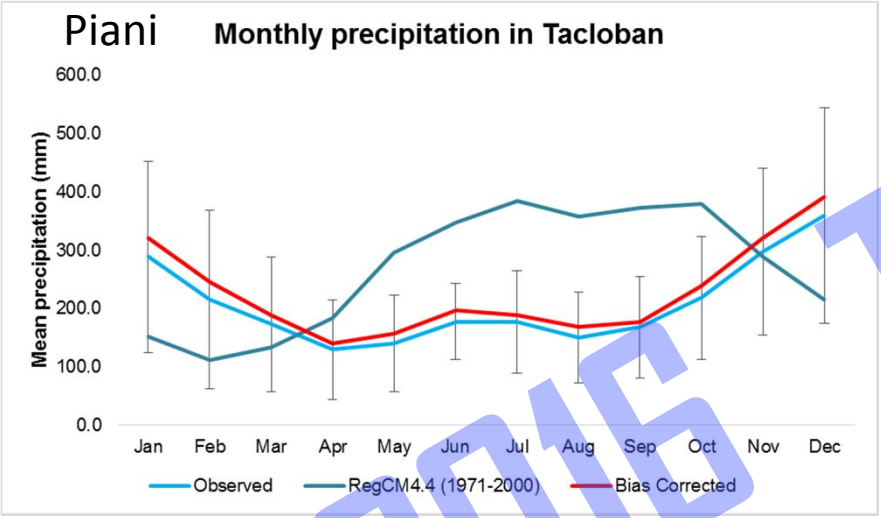




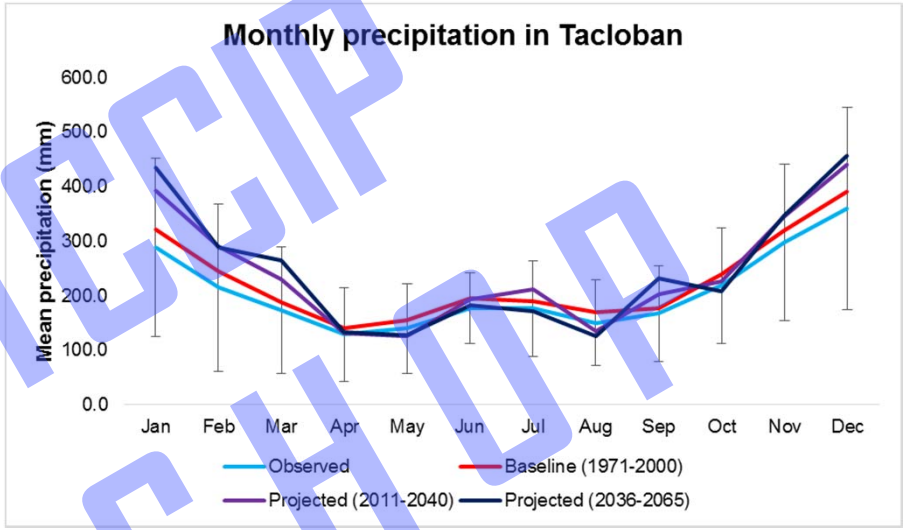
PAGASA APHRODITE RegCM Bias Corre

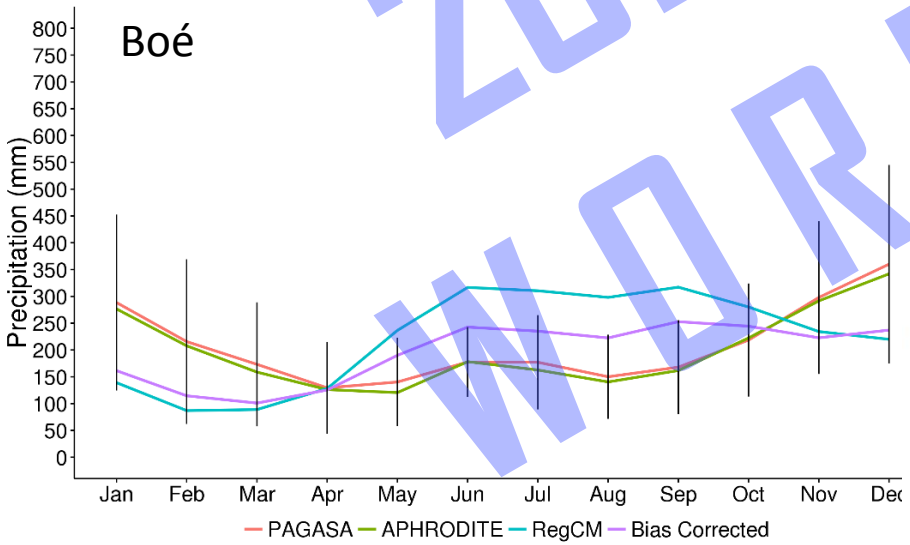
Monthly precipitation: Piani vs Boé Tacloban

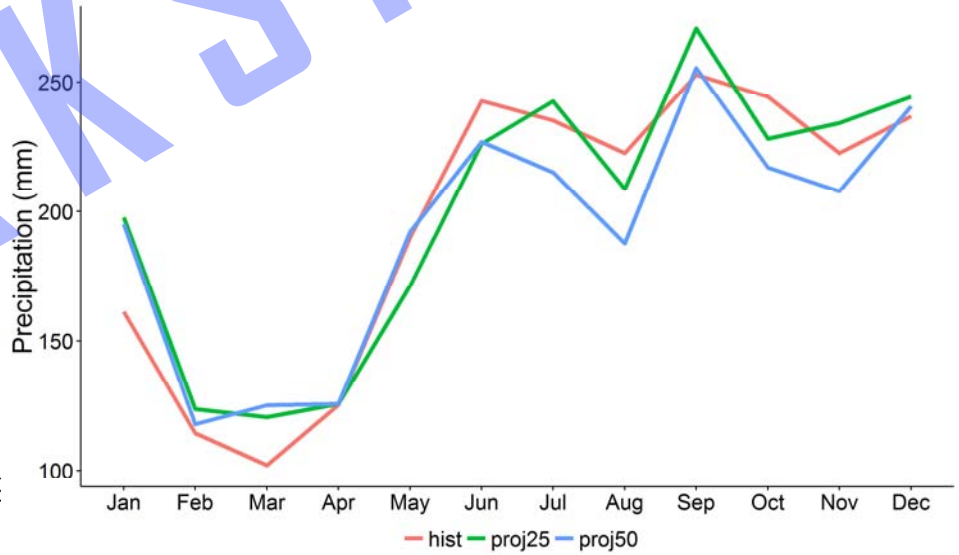
Historical



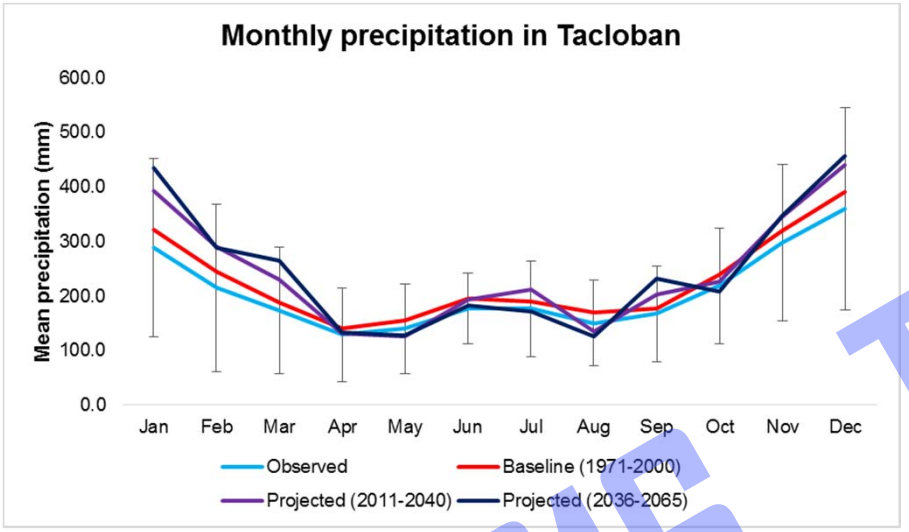
2050s

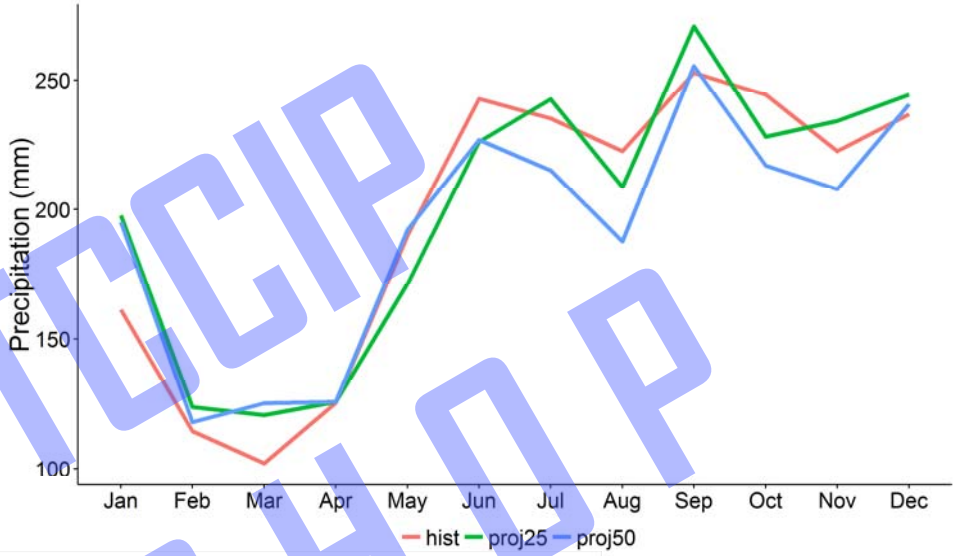


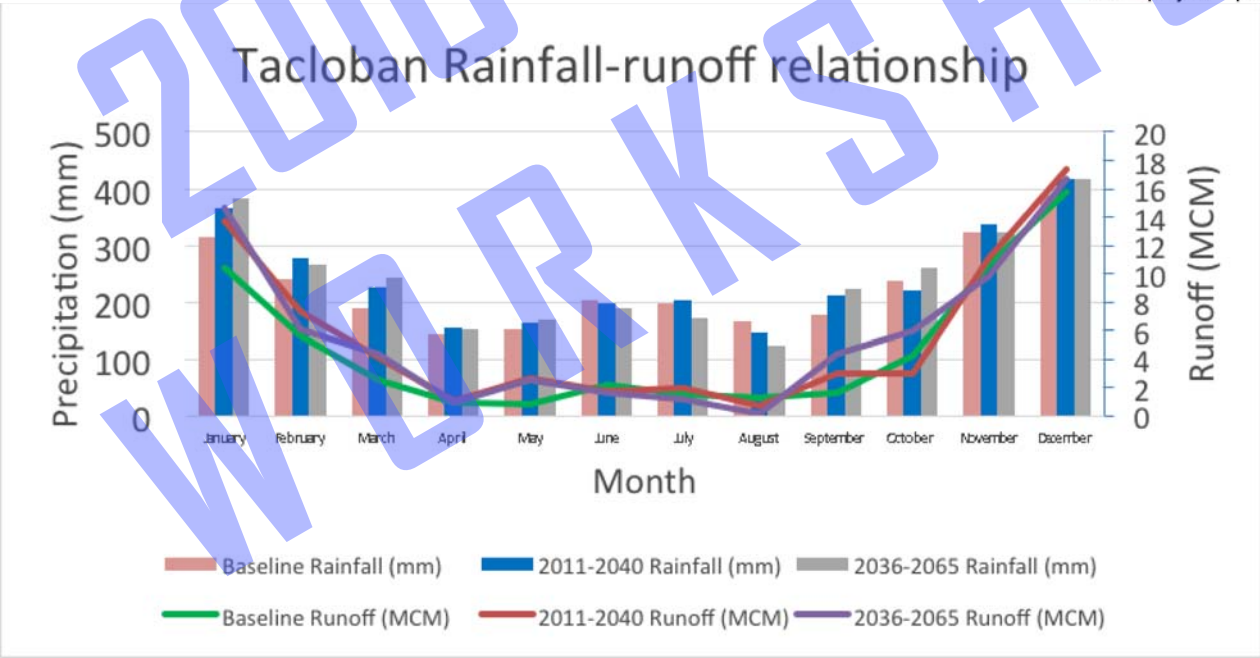




Rainfall to run off







Dealing with model bias

- Improve model physics, high resolution runs especially for areas where rainfall seasonal variability is less pronounced
  - Time constraint of providing information to users, impacts modelers
  - Bias correction: statistics vs dynamics

- Is bias correction still a viable option with “guided” application
  - How to “properly” apply bias correction

Bias correction: Crop lens

"Statistical analysis of the quality of bias correction for some derived weather variables":

- Daily T amplitudes (Tmax-Tmin)
- PET (check for accuracy of wind speed first
- Climatic water balance (monthly cumulative Rainfall - PET)

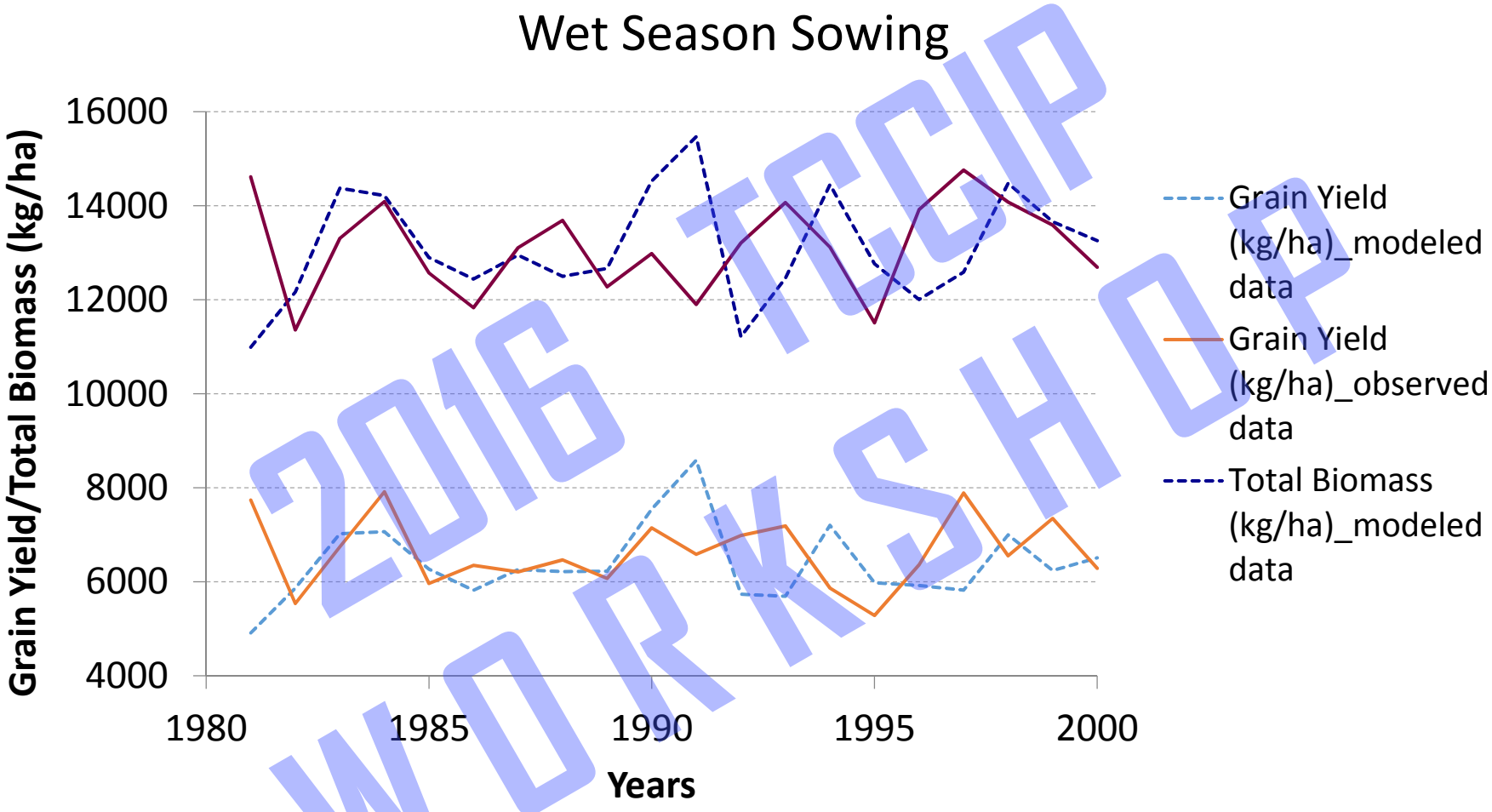
"If results look "bad" (possible due to error multiplication during data transformation and because weather variables are treated as independent of each other despite existing auto-correlations), consider":

Bias correction: Crop lens

1) Temperature: Downscale/de-bias Tmin and (Tmax-Tmin) first, then re-calculate Tmax.
    - Temperature bias correction will take into account the diurnal amplitude which is physiologically important

2) PET: Calculate PET before bias correction, then bias-correct the resulting PET.
    - Alternative: run a second bias- correction after caclulation of PET

Bias correction "validation" through impacts modeling



Note: crop genetic coefficients which capture the genetic behavior of the rice in SAMARA not fully optimized/calibrated, which might explain differences in the yields from both the data sets

CLIMATE SCIENTISTS

Climate change and variability research, special focus on projecting possible future climate changes and corresponding climatic impacts (temperature, rainfall, winds, etc)

CROP PHYSIOLOGIST

Climate change impacts on performance of current best rice cultivars in key systems/environments, and devise strategies for climate change adaptation through varietal improvement and adjustment of crop management

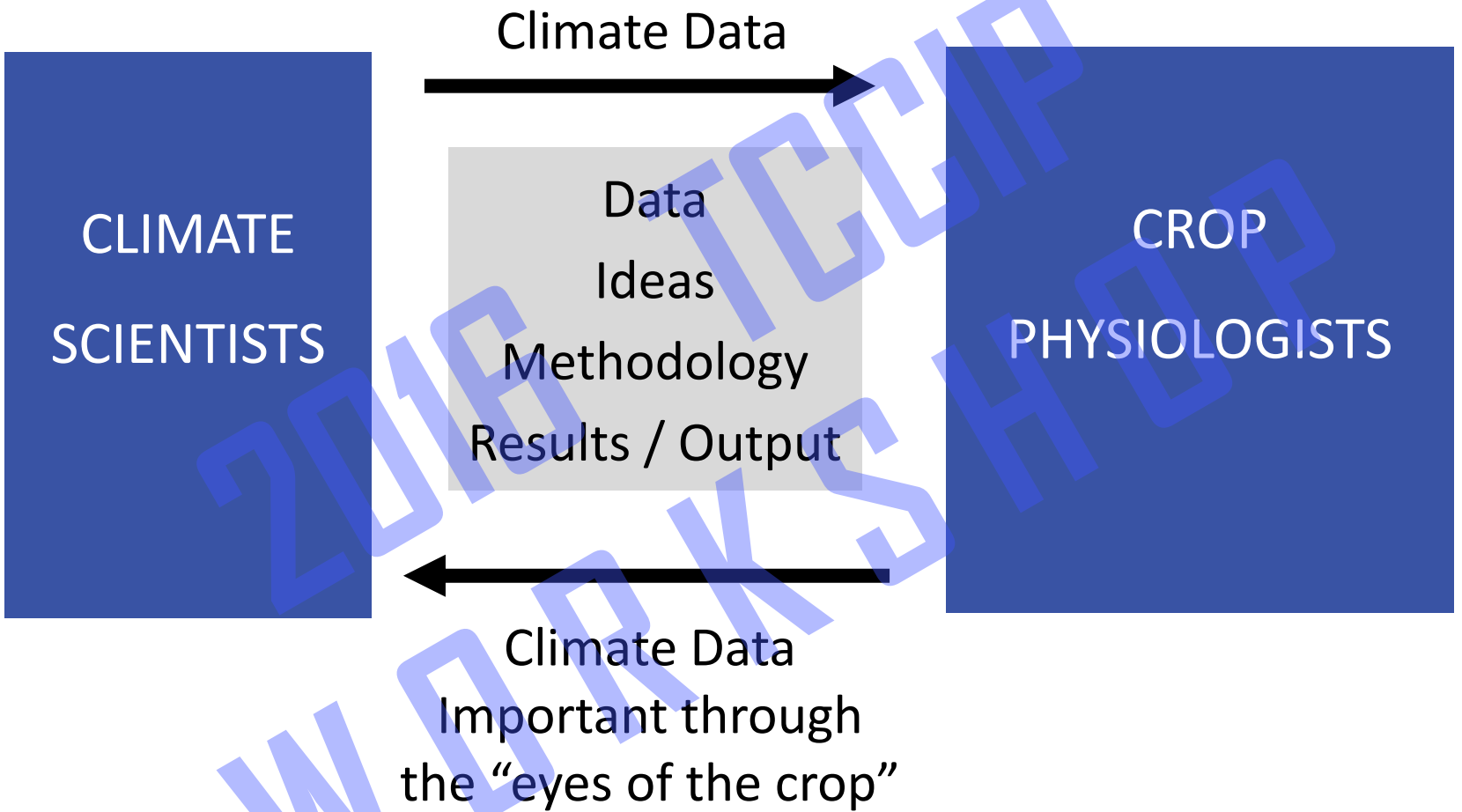
CLIMATE CHANGE IMPACTS ON AGRICULTURE and STRATEGIC OPTIONS FOR ADAPTATION

PROJECT TITLE: "Providing downscaled GCM outputs for four selected rice growing regions (2x Philippines and 2x India)"

Quality data describing climate change scenarios in the context of:

1. Established accuracy by hindcast capturing well the diurnal (notably daily minimum temperature [Tmin] and daily maximum temperature [Tmax]), seasonal and inter-annual patterns of variation (heat and cold spells);

2. Downscaling procedures that permit reliable crop model simulations. Downscaled hindcasts should give similar crop simulations as compared to corresponding climate records.



CONCLUDING POINTS

- How to deal with bias correction
  - Model dynamics and improvement, but time constrained when project based
  - High resolution modeling for climate types where rainfall seasonal variability is less pronounced

- How to provide “meaningful” / useful information to users, impacts modeler
  - Direct feedback from and interaction with user
  - Robustness of results can be evaluated through applicability to particular sector being assessed (agriculture, water, etc)

- How to continue to move towards collaborative, interactive, interdisciplinary research
  - Project development and design, design next steps

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