Climate change projections for the Usumacinta basin and the REA method

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ABSTRACT: This study shows the models reliability by three RCP scenarios (4.5, 6.0, 8.5) using the REA methodology. There is not a single model with higher reliability for the all three scenarios in both time frames (2015-2039 and 2075-2099) for the whole Usumacinta basin region in Mexico. This result suggests the better option to determine the climate variables projections is by averaging the models' emsemble, in this case, the REA projections.

INTRODUCTION

RCP scenarios were done some years ago as part of the Coupled Models Intercomparison Project Phase 5 (CMIP5-hereinafter; Moss et al. 2008). However, there is not an updated study of the southeast region of the country with these scenarios. The Reliability Ensemble Averaging methodology, well-known as REA (Giorgi & Mearns 2002, Tebaldi et al. 2005), has two criteria for evaluating each used model and generate the downscaled projections by means a models ensemble.

$$R_i = \left[\left(R_{b,i} \right)^m \times \left(R_{d,i} \right)^n \right]^{\left(\frac{1}{mxn} \right)} \quad (1)$$

$$R_i = \left[\left(R_{b,i} \right) \times \left(R_{d,i} \right) \right] \quad \text{with m,n= 1} \quad (2)$$

METHODOLOGY

a. Data

The RCP data by REA methodology were got from Mexican Institute of Water Technology database. These databases have a spacial resolution of 0.5° X 0.5°. The time resolution is monthly in both time frames (2015-2039 and 2075-2099). Table 1 lists the AOCGM used by Cavazos et al. The climate variables are minimum, maximum temperature (TMN, TMX; hereafter) and precipitation (PRC; hereafter) for three RCP 4.5, RCP 6.0 and RCP 8.5.

Table 1. CMIP5 15 models used under REA methodology (details of models in https://cmip.llnl.gov/cmip5/index.html).

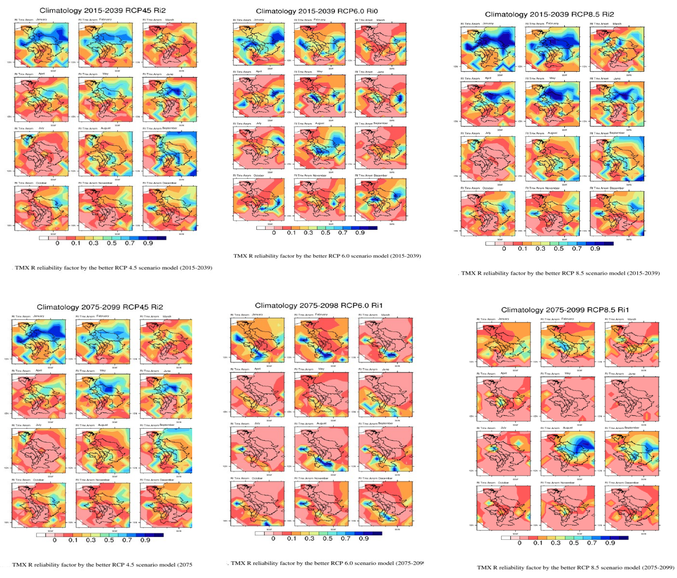
I	INSTITUTE ID	MODEL	SCENARIO
0	BCC	BCC-CSM1.1	4.5,6.0,8.5
1	CCCMA	CanESM2	4.5,8.5
2	CNRM-CERFACS	CNRM-CM5	4.5,8.5
3	CSIRO-QCCE	CSIRO-Mk3-6-0	4.5
4	NOAA GFDL	GFDL-CM3	6.0,8.5
5	NASA GISS	GISS-E2-R	4.5,6.0,8.5
6	MOHC (INPE)	HadGEM2-ES	4.5,6.0,8.5
7	INM	INMCM4	4.5,8.5
8	IPSL	IPSL-CM5A-LR	4.5,6.0,8.5
9	MIROC	MIROC5	4.5,6.0,8.5
10	MIROC	MIROC-ESM-CHEM	4.5,6.0
11	MIROC	MIROC-ESM	4.5,6.0,8.5
12	MPI-M	MPI-ESM-LR	4.5,8.5
13	MRI	MRI-CGCM3	4.5,8.5
14	NCC	NorESM1-M	4.5,6.0,8.5

b. Projections

To determinate the projections reliability of RCP 4.5, RCP 6.0 and RCP 8.5, it was used R,reliability factor, equation 1 This factor is done by two criteria, 1) by the model performs (Rb) and 2) by the model convergence to the models ensemble (Rd), see Giorgi & Mearns for details. ◦ Note as Ri as Rb and Rd were calculated by grid point, in this case, each 0.5 (Cavazos et al.).

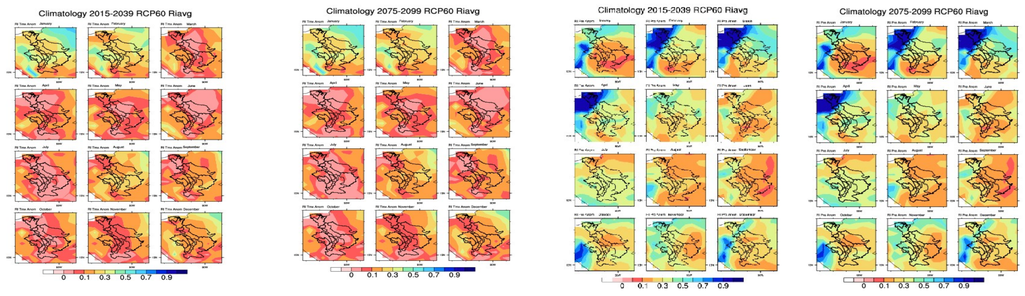
RESULTS

The models' reliability on the TMX and PRC variable by the three scenarios are shown by the figures. These figures show the models with higher R in the region. To can see the R behavior along the year during the two projection time frames, 2015-2039 and 2075-2099. R varies as timely as spatially for each model.



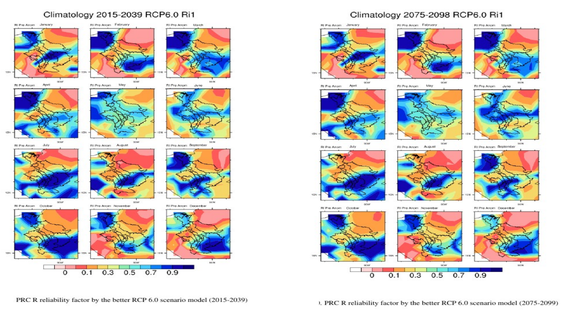
TMX R reliability factor by the better RCP 4.5 scenario model (2015-2039)
TMX R reliability factor by the better RCP 6.0 scenario model (2015-2039)
TMX R reliability factor by the better RCP 8.5 scenario model (2015-2039)
TMX R reliability factor by the better RCP 4.5 scenario model (2075
TMX R reliability factor by the better RCP 6.0 scenario model (2075-2099
TMX R reliability factor by the better RCP 8.5 scenario model (2075-2099)

R behavior during all year by each month in both time frames, 2015-239 and 2075-2099. Ri is the reliability factor by model.



R behavior during all year by each month in both time frames, 2015-239 and 2075-2099. R is the reliability factor.

Ri behavior during all year by each month in both time frames, 2015-239 and 2075-2099. Ri is the reliability factor by model.



PRC R reliability factor by the better RCP 6.0 scenario model (2015-2039)
PRC R reliability factor by the better RCP 6.0 scenario model (2075-2099)

CONCLUSIONS

The three RCP scenarios reliability for TMX in the region is lower. The result let have more reliability on the climate variables projections in NW zone. The PRC projections changes for the region are more reliability, i.e., almost the whole region showing an R-value close to 1. While the two temperatures variables show R around 0.5. It is necessary to remember that R is developed by the two criteria convolution. Which reliability is attributed to the models' convergence for the future part, since the model performs is similar to the temperature variables as the precipitation variable. However, it is known the temperature variables are better performed by the models (IPCC, 2013). Thus, it is necessary to do the same process for all rest of the country.

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