Spatial and temporal climate change analysis using CORDEX regional climate models over Bangladesh

Date & Venue: 07–11 March 2022 | Dhaka, Bangladesh

Ten Participants from BMD

&

Three Participants from IWM
## List of Participants

<table>
<thead>
<tr>
<th>SN</th>
<th>Name</th>
<th>Gender</th>
<th>Designation</th>
<th>Institution</th>
<th>Email</th>
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</thead>
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<td>14 Md. Azizur Rahman  Male</td>
<td>15 Md. Saiful Islam  Male  Professor  Bangladesh University of Engineering and Technology  <a href="mailto:mdsaifulislam@iict.buet.ac.bd">mdsaifulislam@iict.buet.ac.bd</a></td>
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<td>19 Irene Lake  Female  Researcher  Swedish Meteorological and Hydrological Institution  <a href="mailto:Irene.Lake@smhi.se">Irene.Lake@smhi.se</a></td>
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<td>20 Mandira Shrestha  Female  Programme Coordinator Climate Services • MENRIS  ICIMOD  <a href="mailto:mandira.shrestha@iciomd.org">mandira.shrestha@iciomd.org</a></td>
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Day-1 and Day-2

Day 1 is focused on creating the required files for the analysis.

Once, the global data has been downloaded from the Earth System Grid Federation (ESGF), codes can be run in Climate Data Operator (CDO) to prepare in the required format. To clip it to the smaller size.

Day 2: Understanding the baseline
On Day 2 we prepared and plot the baseline data (1976-2005) using the CORDEX datasets and the reference datasets (APHRODITE) for Bangladesh. To plot baseline for ENACTS-BD dataset for time period of 1981-2010 and compare it with APHRODITE for BANGLADESH.
Software Installation & Lectures delivered

- Installation of R, RSTUDIO and CDO – ICMOD Team
- Extracting, Clipping and preparation of CORDEX data for Visualization
- Climate Services in the HKH region- Dr. Mandira Singh Shrestha, ICMOD
- Climate Modeling, Downscalling- Joseph Daron, UKMO
- Introduction of CORDEX data over SA – J. Sanjay, IITM
Shell Script with CDO for data conversion

```
#!/bin/bash

FILE=pr_WAS-44_CCCma-CanESM2_rcp45_r1i1p1_IITM-RegCM4-4_v5

for P in 20060101-20101231 20110101-20151231 20160101-20201231 20210101-20251231 20260101-20301231
    do
        cdo sellonlatbox,60,120,10,70 ${FILE}_day_${P}.nc SA_${FILE}_day_${P}.nc
        cdo remapbil,mygrid SA_${FILE}_day_${P}.nc Rmap_${FILE}_day_${P}.nc
        cdo sellonlatbox,86,95,20,28 Rmap_${FILE}_day_${P}.nc BD_${FILE}_day_${P}.nc
        cdo mulc,86400 BD_${FILE}_day_${P}.nc BD_Runit_${FILE}_day_${P}.nc
        cdo setcalendar,standard BD_Runit_${FILE}_day_${P}.nc BD_fix_${FILE}_day_${P}.nc
        cdo monsum BD_fix_${FILE}_day_${P}.nc pr_BD_${FILE}_mon_${P}.nc
    done
```
Day-3

Data Extraction

1. Day 3 is focused on reading the CORDEX file for Bangladesh for both RCP 4.5 and RCP 8.5
2. Plotting Climatology (Monthly precipitation and monthly Temperature) of 17 CORDEX models for Bangladesh and Rangpur, Khulna & Sylhet.
3. Plotting Climatology (Monthly precipitation and monthly Temperature) of best ranked 8 and later 4 CORDEX models over Bangladesh and Rangpur, Khulna & Sylhet respectively.
Day-4

Seasonal and annual change

1. Day 4 is focused on the analysis of the selected models for Bangladesh for both RCP 4.5 and RCP 8.5 with reference data.
2. Running all selected models over Bangladesh and three regions Rangpur, Khulna & Sylhet.
3. Running Annual data for all CORDEX models and selected CORDEX models over Bangladesh and three regions Rangpur, Khulna & Sylhet.
4. Plotting Change in Annual Temperature and Annual precipitation for Bangladesh three regions Rangpur, Khulna & Sylhet.
Day-5

Analysis the Delta change

1. Day 5 is focused on calculating delta change of all models for precipitation and Temperature over Bangladesh for both RCP 4.5 and RCP 8.5
2. Plotting scatter plot with max-min error bars for both RCP 4.5 and RCP 8.5
For Example
Case study : Rangpur
Study Area: Rangpur Division
Aphrodite Data
Monthly Aphrodite data for Precipitation (Rangpur Division)
Monthly Aphrodite data for Temperature (Rangpur Division)
Calculation and Comparison of monthly Precipitation

- CORDEX Datasets
- Historical value (1976-2005)

Climatology of 17 CORDEX models

![Bangladesh](image)

![Rangpur](image)
Calculation and Comparison of monthly Temperature

Climatology of 17 CORDEX models

Monthly temperature (°C)

Bangladesh

Climatology of 17 CORDEX models

Monthly temperature (°C)

Rangpur
Calculation of Annual Bias

Precipitation for Bangladesh

Precipitation for Rangpur
Selection of final model based on ranking method

- Individual ranking based on precipitation & temperature
- Average of ranking for final selection of model

<table>
<thead>
<tr>
<th>Model</th>
<th>Average</th>
<th>pr_bias</th>
<th>tas_bias</th>
<th>pr_rank</th>
<th>tas_rank</th>
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<td>Aphrodite</td>
<td>2.5</td>
<td>10.3</td>
<td>0.31</td>
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<td>CCCma-CanESM2_SMHI-RCA4_v2_day</td>
<td>25</td>
<td>12.8</td>
<td>0.29</td>
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<tr>
<td>CSIRO-QCCCE-CSIRO-Mk3-6.0_SMHI-RCA4_v2_day</td>
<td>45</td>
<td>45.7</td>
<td>0.16</td>
<td>8</td>
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<tr>
<td>MIROC-MIROC5_SMHI-RCA4_v2_day</td>
<td>65</td>
<td>15.5</td>
<td>1.55</td>
<td>6</td>
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Seasonal Changes of Rangpur with respect to Bangladesh (Precipitation_RCP45)

**Rangpur**
- Winter: CCCma-CanESM2_SMHI-RCA4_v2_day
- Pre-monsoon: CNRM-CERFACS-CNRM-CMS_SMHI-RCA4_v2_day
- Monsoon: CSIRO-QCCCE-CSIRO-Mk3-6-0_SMHI-RCA4_v2_day
- Post-monsoon: MPI-M-MPI-ESM-LR_SMHI-RCA4_v2_day

**Bangladesh**
- Winter: CCCma-CanESM2_SMHI-RCA4_v2_day
- Pre-monsoon: CSIRO-QCCCE-CSIRO-Mk3-6-0_IITM-RegCM4-4_v5_day
- Monsoon: CSIRO-QCCCE-CSIRO-Mk3-6-0_SMHI-RCA4_v2_day
- Post-monsoon: MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009_v1_day_19610101-21001231.nc
Seasonal Changes of Rangpur with respect to Bangladesh (Precipitation_RCP85)
Seasonal Changes of Rangpur with respect to Bangladesh (Temperature_RCP45)

Bar charts showing the seasonal changes of temperature in Rangpur and Bangladesh with respect to different climate models. The x-axis represents the seasons (Winter, Pre-monsoon, Monsoon, Post-monsoon) and the y-axis represents the temperature range (in degrees Celsius). The bars indicate the temperature values for each season and model.

Rangpur models:
- CCCma-CanESM2_SMHI-RCA4_v2_day
- CNRM-CERFACS-CNRM-CM5_SMHI-RCA4_v2_day
- CSIRO-QCCCE-CSIRO-Mk3-6-0_SMHI-RCA4_v2_day
- MPI-M-MPI-ESM-LR_SMHI-RCA4_v2_day

Bangladesh models:
- CCCma-CanESM2_SMHI-RCA4_v2_day
- CSIRO-QCCCE-CSIRO-Mk3-6-0_IITM-RegCM4-4_v5_day
- CSIRO-QCCCE-CSIRO-Mk3-6-0_SMHI-RCA4_v2_day
- MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009_v1_day_19610101-21001231.nc
Seasonal Changes of Rangpur with respect to Bangladesh (Temperature_RCP85)
Scatter plot with min-max error bars

Grey line shows range using all models
Colored line shows range using selected models

Bangladesh

Rangpur
Bangladesh

Change in temperature (°C)

RCP4.5  RCP8.5
Grey line shows range using all models
Colored line shows range using selected models

Scatter plot with min-max error bars

Rangpur

Change in temperature (°C)

RCP4.5  RCP8.5
Grey line shows range using all models
Colored line shows range using selected models

Scatter plot with min-max error bars
Thank you