

# REPORT ON ACTIVITEIS DONE

## Historical And Future Climate Indices

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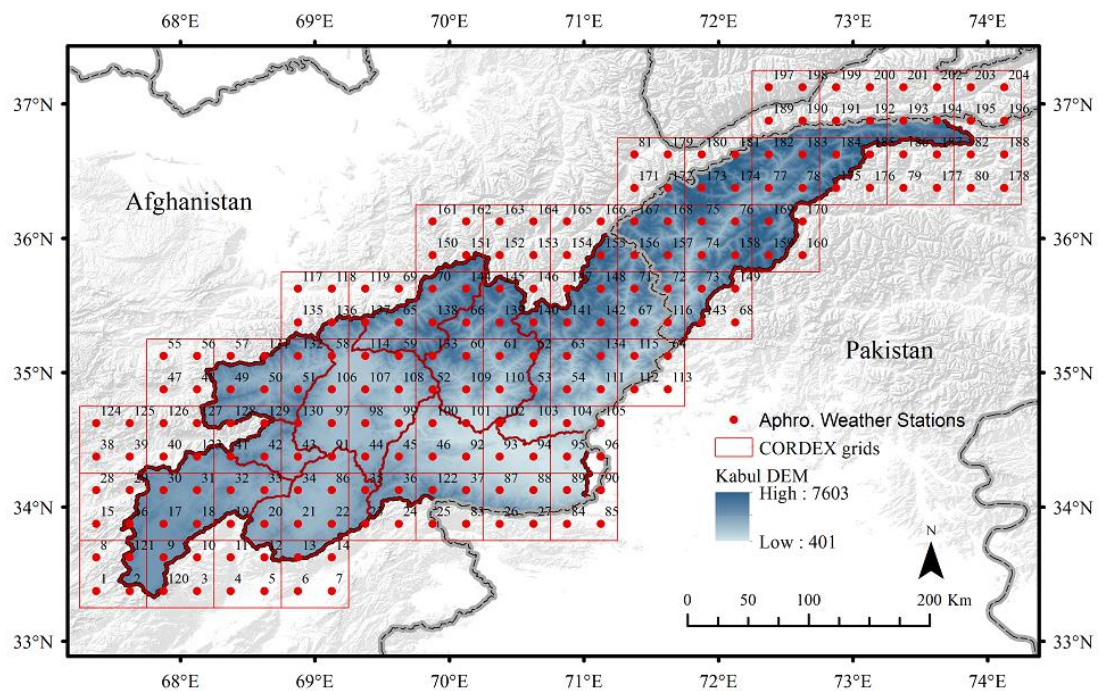
# MAIN REPORT

## DESCRIPTION

Historical temperature and precipitation data series are collected. The discrete snow and rain data are obtained and snow cover maps are created for the basin. The future precipitation and temperature are projected based on a selected CORDEX RCM. The climate indices for the basin are calculated and the future changes of these climate indices are identified which can be used in order to study the frequency of floods and droughts or producing hazard maps for Kabul river basin.

## HISTORICAL AND FUTURE TEMPERATURE AND PRECIPITATION

In the lack of long-term historical observations, the APHRODITE temperature and precipitation data were used and found the best for Kabul river basin. The time-series data were extracted from 0.25 degree grids' resolution. The following figure shows the study area and the location of those stations (red points). The CORDEX RCM data with 0.5 degree resolution available for South-Asian domain also was used to project the future temperature and precipitation data for the basin (red boxes). The data were extracted using R scripts from NetCDF files and then sorted out in the MS Excel files which can be also used for other future studies. Based on the latest IPCC report (AR5), the baseline period for climate change studies is considered as 1986 to 2005. The late future also was used in this study to sort the future data for the years of 2080 to 2099.



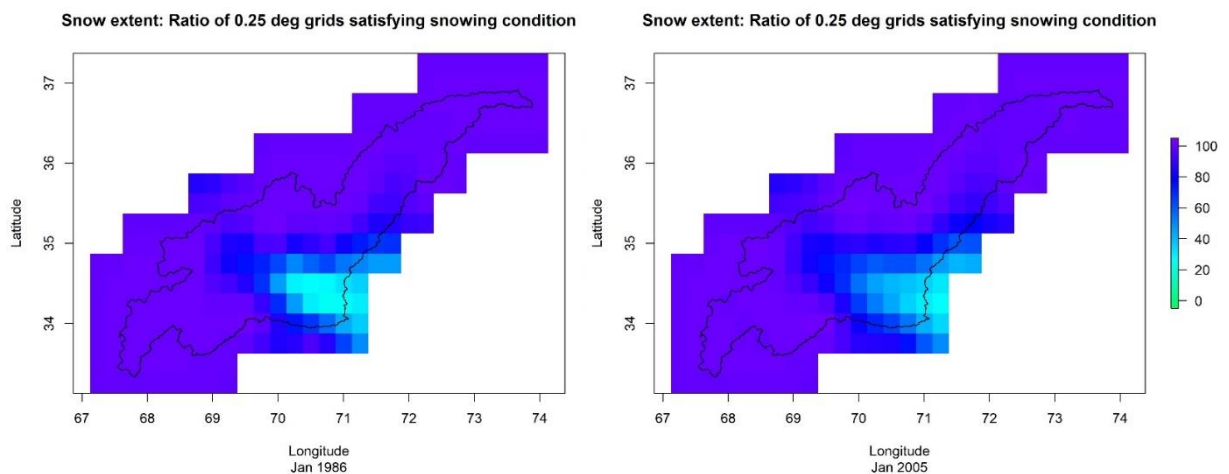
Kabul River Basin

## SNOW EXTENT MAPS AND DATA

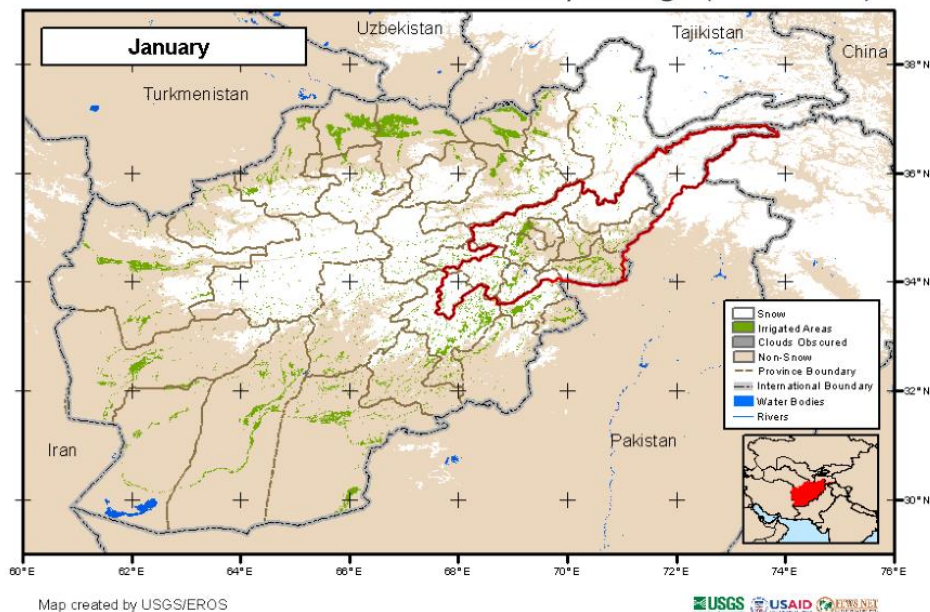
The rain/snow discrimination information were extracted from 0.25 degree grids of APHRODITE precipitation over Monsoon Asia (APHRO\_MA\_V1101R2). Discrimination between rain and snow is defined by daily mean temperature (APHRO\_TAVE\_MA\_V1204R1) and relative humidity (RH) derived from ECMWF reanalysis data.

These data were only available in Binary format. In order to extract the data, using CDO command, the binary files were first converted to NetCDF and then the data were extracted and mapped for the beginning and ending of baseline period (1986 and 2005).

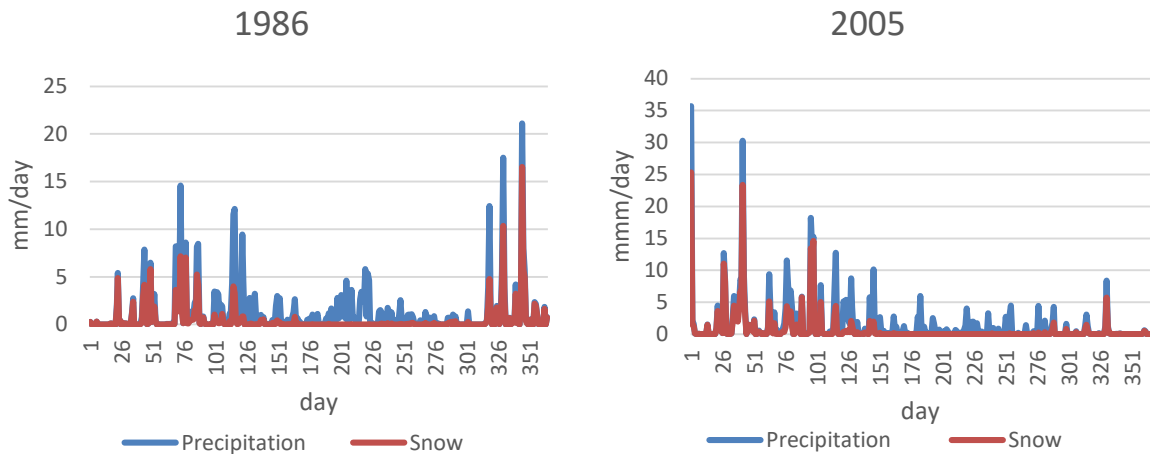
The description of the process as well as the scripts were used to analyze the data can be found in the data folder for this report. The following maps were then created and put together with the Modis snow cover extent maps for a comparison (only for the month of January is shown here and more data can be found in the data folder). The data created based on the APHRODITE rain/snow product showed a good match with the Modis snow cover extent.



MODIS snow cover extent – monthly average (2001-2012)



The following graphs were then created to show the contribution of snow in the total precipitation. The MS Excel files are provided to show the analysis.



## 27 CLIMATE CHANGE INDICES FOR KABUL RIVER BASIN: HISTORICAL AND FUTURE

The calculation of climate extremes are important in many disciplines. Annual maximum daily precipitation, annual maximum wind speed, and other such extremes are used in many engineering applications. However, they are not as useful when speaking about climate change. The Expert Team on Climate Change Detection and Indices (ETCCDI) has created a set of 27 core indices with the intent of capturing the change in the extremes of climate and in selected parameters deemed relevant to other disciplines. These model the following types of parameters:

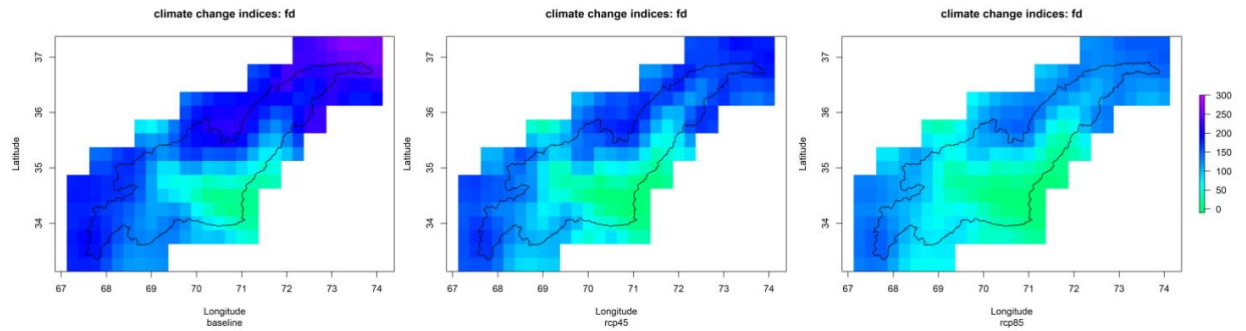
(Reference: [http://etccdi.pacificclimate.org/list\\_27\\_indices.shtml](http://etccdi.pacificclimate.org/list_27_indices.shtml))

- Shifts in the number of days where comparatively extreme conditions are observed.
- Growing season length.
- 10th and 90th percentiles of temperature versus baseline conditions.
- Lengths of warm, cold, wet, and dry spells.
- Counts of days where precipitation exceeds a threshold.
- Total precipitation where precipitation exceeds the 95th or 99th percentile of the baseline.

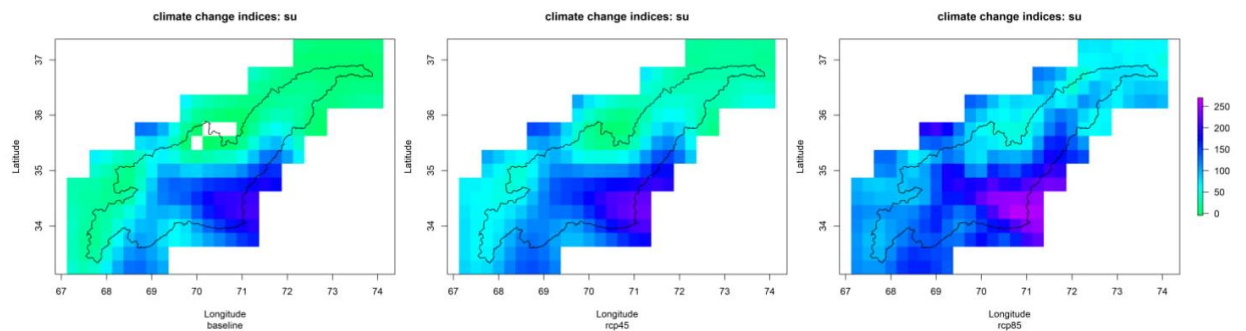
The climdex.pcic package was used to provide an implementation of the ETCCDI's 27 core climate change indices. These calculated indices are shown in the following appendix as graphs and maps for historical and future periods.

# APPENDIX 1: 27 CLIMATE CHANGE INDICES

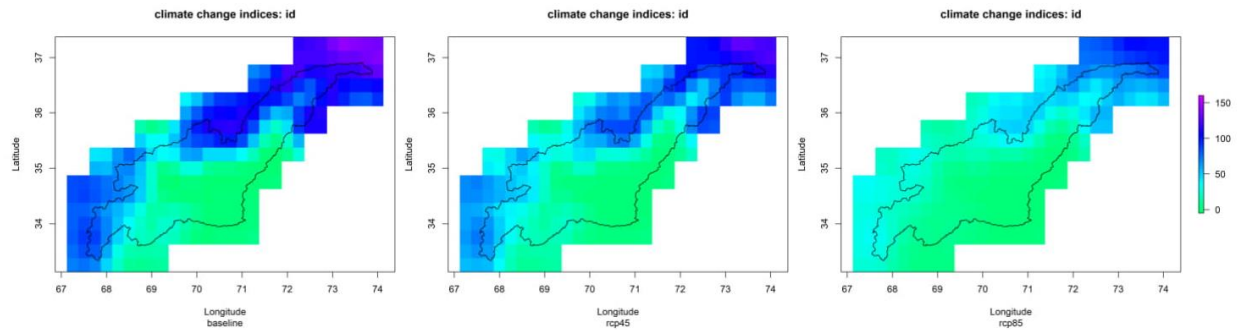
1. **FD**, *Number of frost days*: Annual count of days when TN (daily minimum temperature) < 0°C.



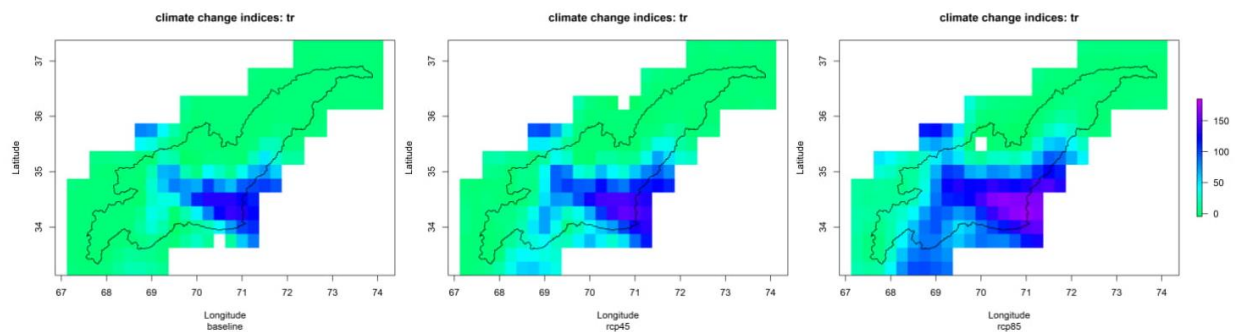
2. **SU**, *Number of summer days*: Annual count of days when TX (daily maximum temperature) > 25°C.



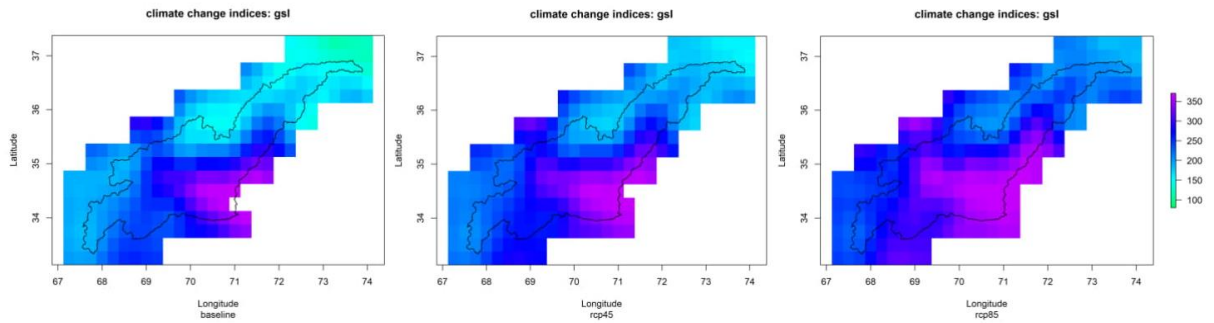
3. **ID**, *Number of icing days*: Annual count of days when TX (daily maximum temperature) < 0°C.



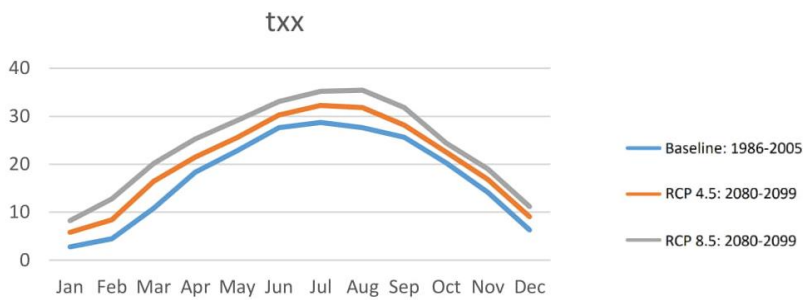
4. **TR**, *Number of tropical nights*: Annual count of days when TN (daily minimum temperature) > 20°C.



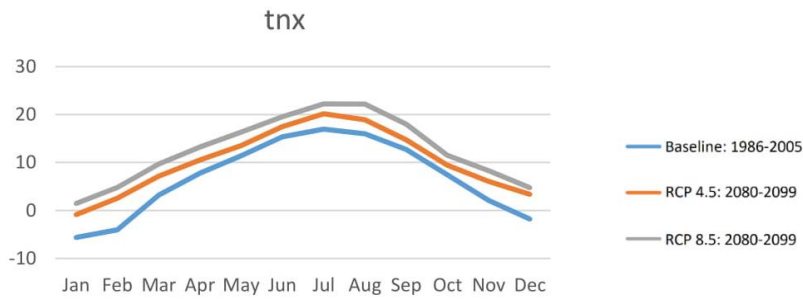
5. **GSL**, *Growing season length*: Annual (1<sup>st</sup> Jan to 31<sup>st</sup> Dec in Northern Hemisphere (NH), 1<sup>st</sup> July to 30<sup>th</sup> June in Southern Hemisphere (SH)) count between first span of at least 6 days with daily mean temperature  $TG > 5^{\circ}\text{C}$  and first span after July 1<sup>st</sup> (Jan 1<sup>st</sup> in SH) of 6 days with  $TG < 5^{\circ}\text{C}$ .



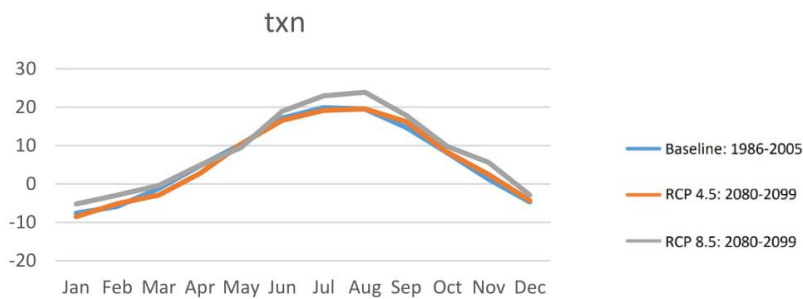
6. **TX<sub>x</sub>**, *Monthly maximum value of daily maximum temperature*:



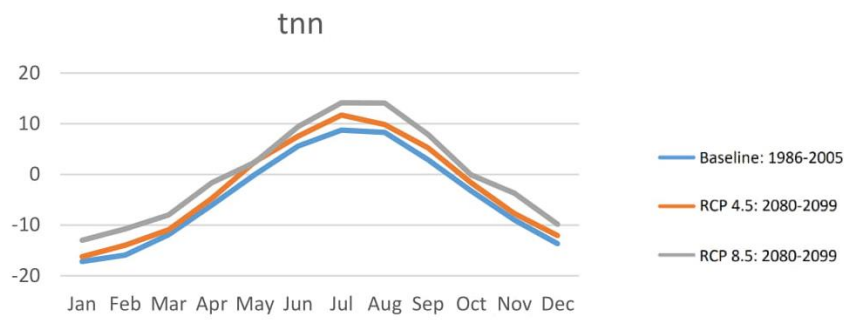
7. **TN<sub>x</sub>**, *Monthly maximum value of daily minimum temperature*:



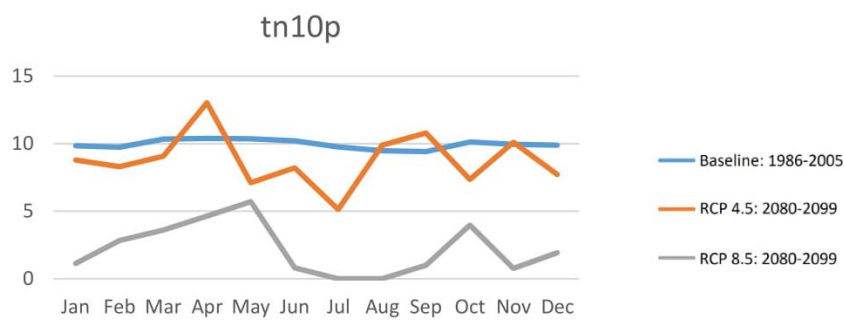
8. **TX<sub>n</sub>**, *Monthly minimum value of daily maximum temperature*:



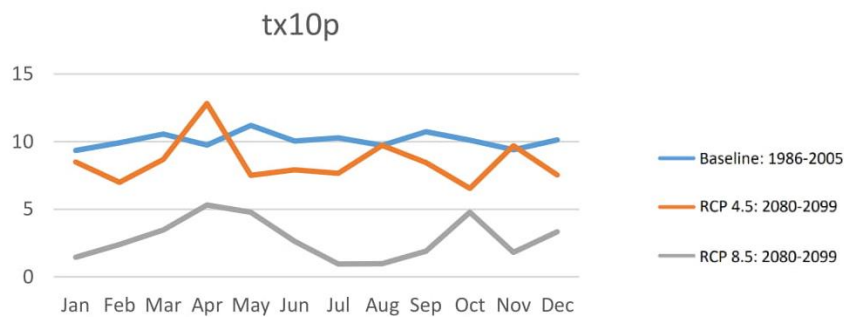
9. **TN<sub>n</sub>**, Monthly minimum value of daily minimum temperature:



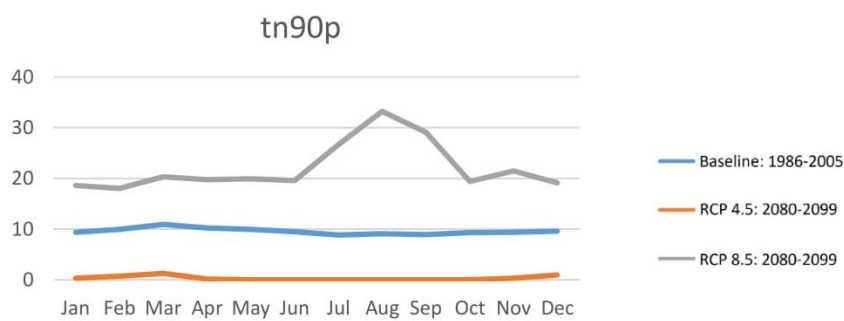
10. **TN10<sub>p</sub>**, Percentage of days when TN < 10<sup>th</sup> percentile:



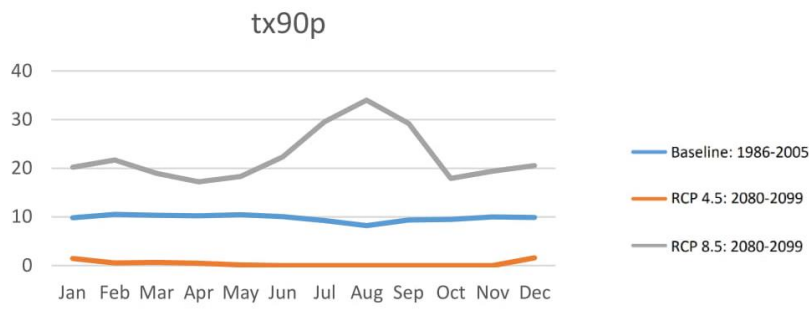
11. **TX10<sub>p</sub>**, Percentage of days when TX < 10<sup>th</sup> percentile:



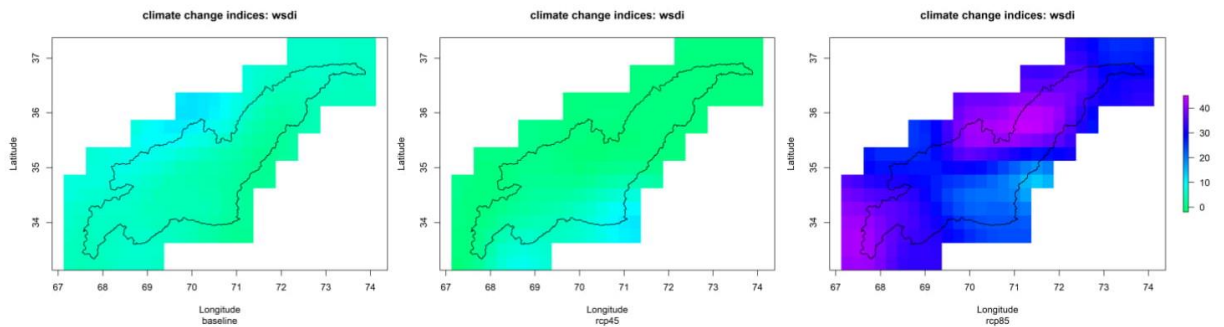
12. **TN90<sub>p</sub>**, Percentage of days when TN > 90<sup>th</sup> percentile:



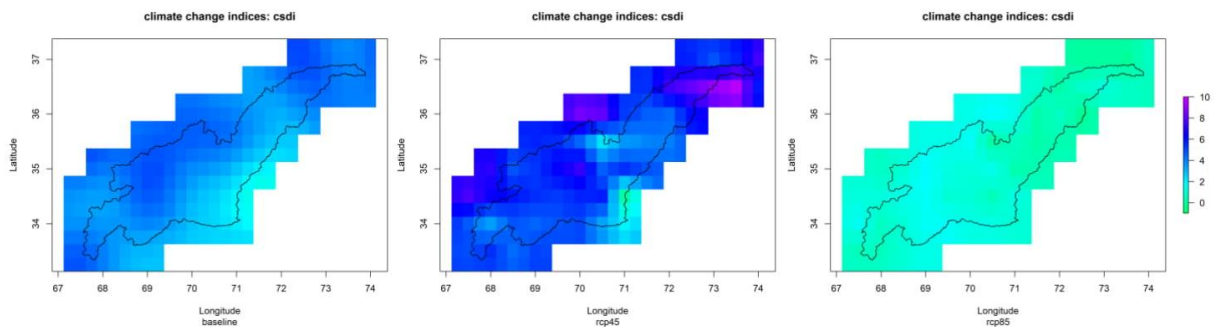
13. **TX90p**, Percentage of days when TX > 90<sup>th</sup> percentile:



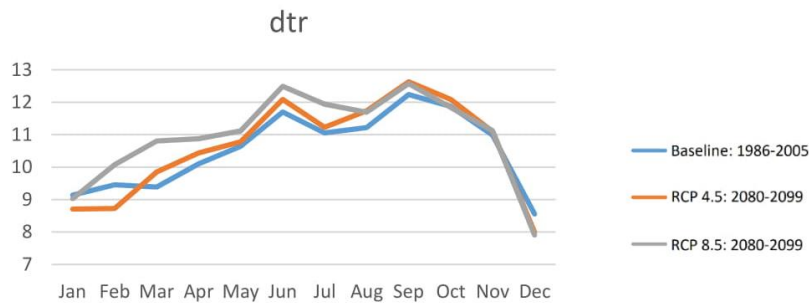
14. **WSDI**, Warm speed duration index: Annual count of days with at least 6 consecutive days when TX > 90<sup>th</sup> percentile



15. **CSDI**, Cold speed duration index: Annual count of days with at least 6 consecutive days when TN < 10<sup>th</sup> percentile

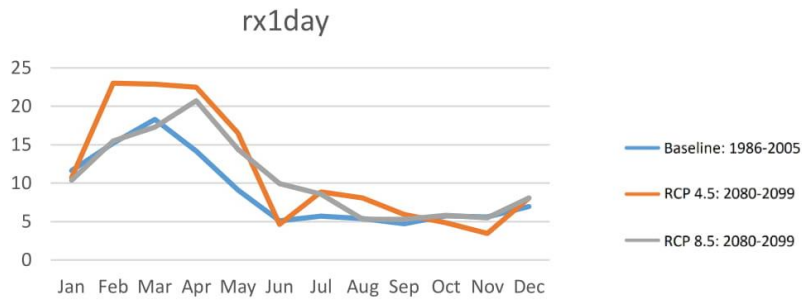


16. **DTR**, Daily temperature range: Monthly mean difference between TX and TN

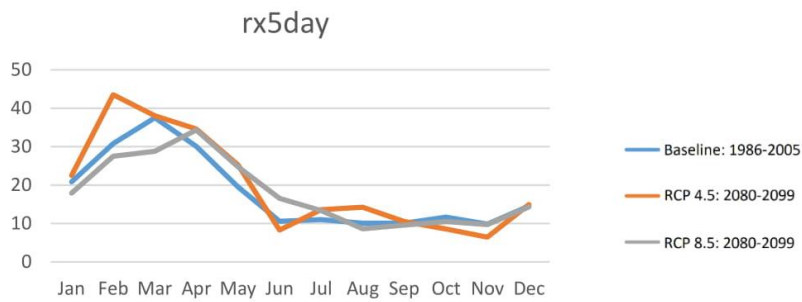




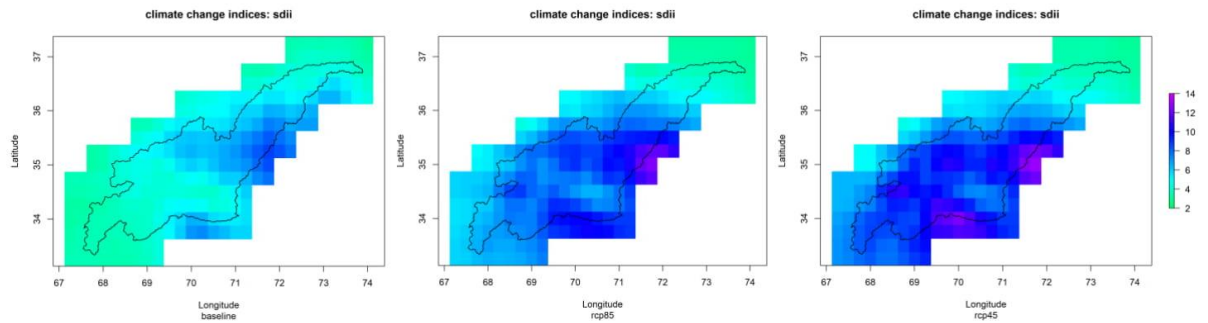
17. **Rx1day**, Monthly maximum 1-day precipitation:



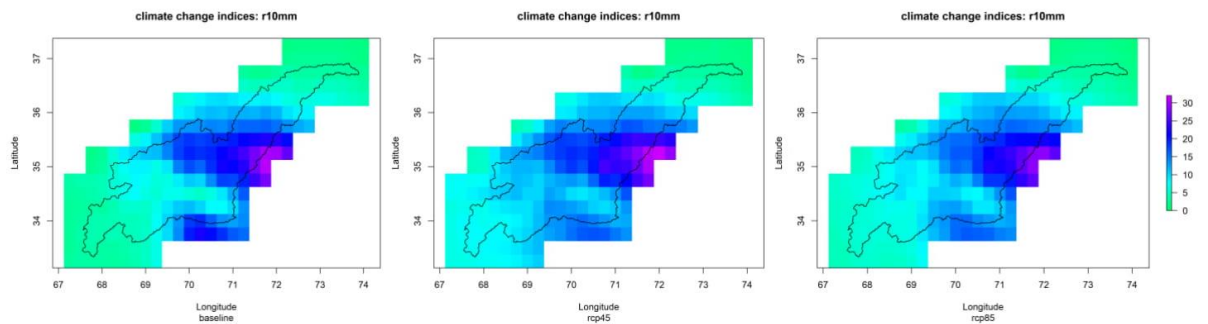
18. **Rx5day**, Monthly maximum consecutive 5-day precipitation:



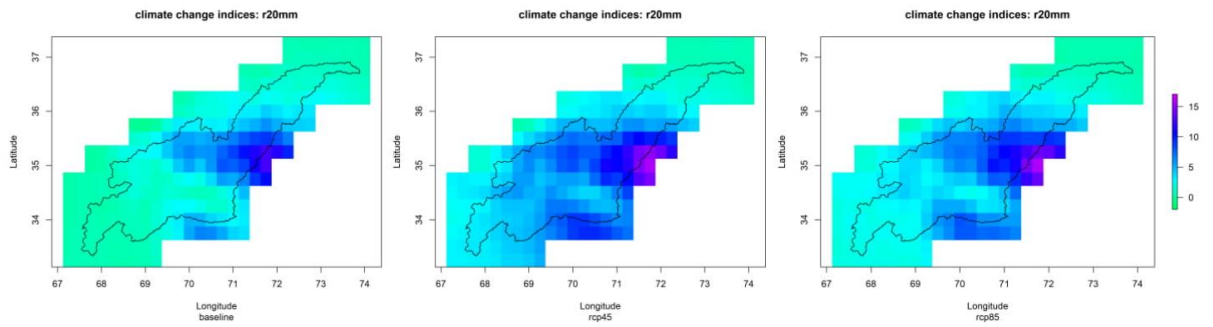
19. **SDII**, Simple precipitation intensity index:



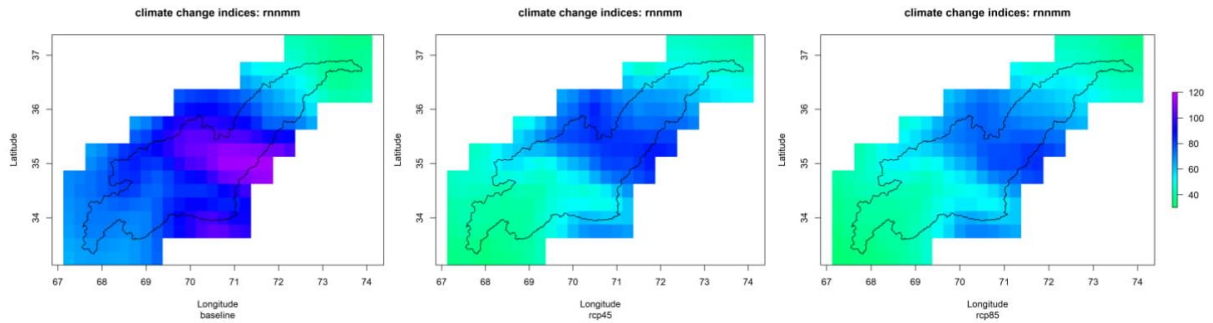
20. **R10mm**, Annual count of days when PRCP ≥ 10mm:



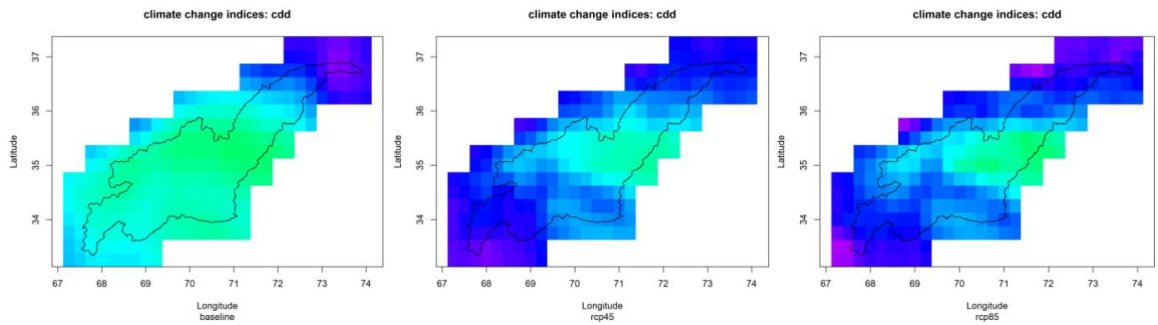
21. R20mm, Annual count of days when PRCP ≥ 20mm:



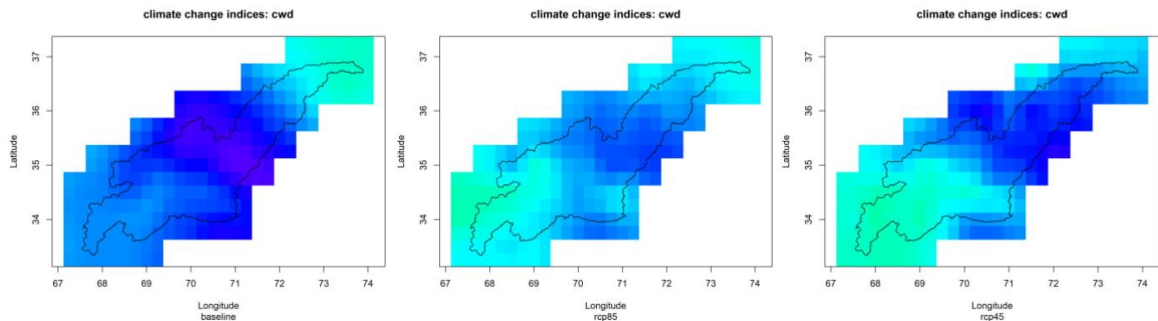
22. Rnnmm, Annual count of days when PRCP ≥ nmm, nn is a user defined threshold:



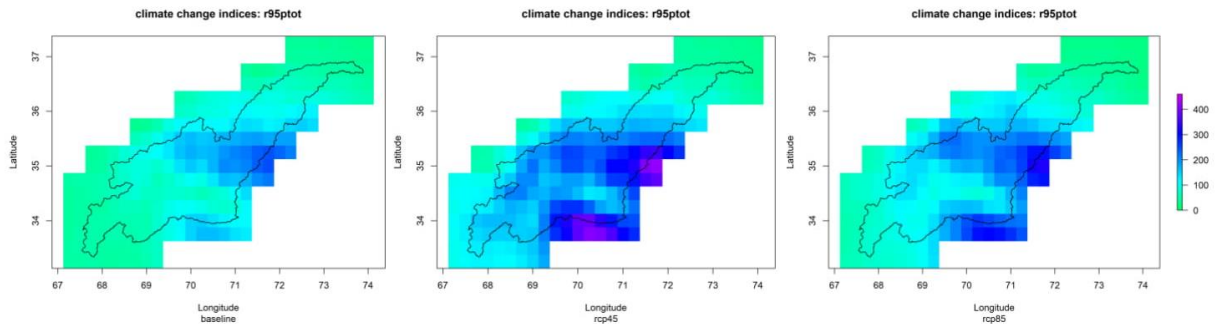
23. CDD, Maximum length of dry spell, maximum number of consecutive days with RR < 1mm:



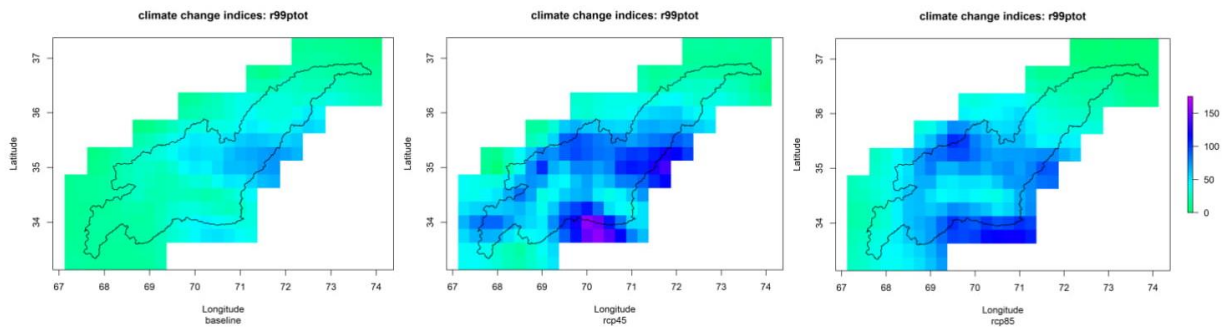
24. CWD, Maximum length of wet spell, maximum number of consecutive days with RR ≥ 1mm:



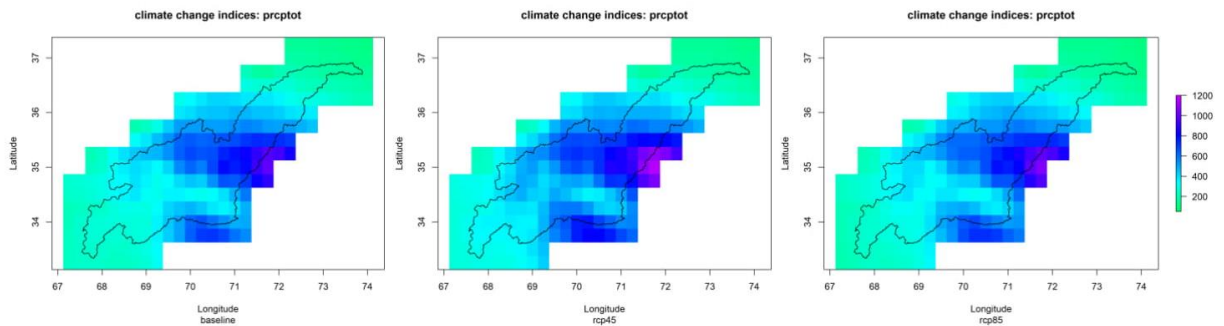
25. **R95pTOT**, Annual total PRCP when RR > 95p.



26. **R99pTOT**, Annual total PRCP when RR > 99p:



27. **PRCPTOT**, Annual total precipitation in wet days:

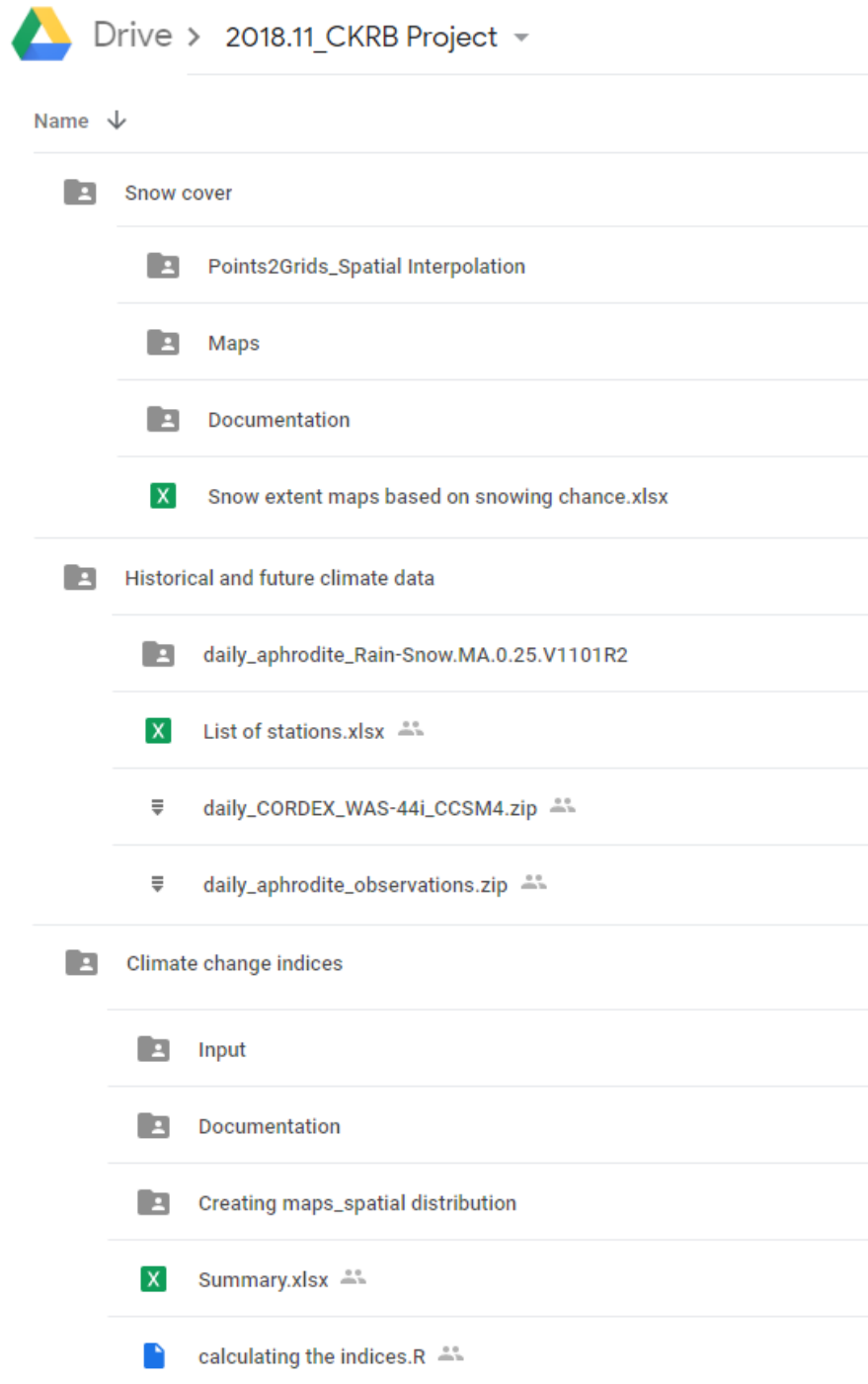


## APPENDIX 2: DATA AND INFORMATION

The related data and information were collected and uploaded on Google Drive as supplementary to this report. It will be accessed from the following link:

<https://drive.google.com/open?id=1xKOOGErTUwEjIq9nYOOQxwAKXE-UTyav>

These include:



The screenshot shows a Google Drive interface for a folder named "2018.11\_CKRB Project". The interface includes a search bar, a "Name" dropdown menu, and a list of folders and files. The folders are "Snow cover", "Historical and future climate data", and "Climate change indices". The files are "Points2Grids\_Spatial Interpolation", "Maps", "Documentation", "Snow extent maps based on snowing chance.xlsx", "daily\_aphrodite\_Rain-Snow.MA.0.25.V1101R2", "List of stations.xlsx", "daily\_CORDEX\_WAS-44i\_CCSM4.zip", "daily\_aphrodite\_observations.zip", "Input", "Documentation", "Creating maps\_spatial distribution", "Summary.xlsx", and "calculating the indices.R".

Drive > 2018.11\_CKRB Project ▾

Name ▾

- 👤 Snow cover
  - 👤 Points2Grids\_Spatial Interpolation
  - 👤 Maps
  - 👤 Documentation
  - 📄 X Snow extent maps based on snowing chance.xlsx
- 👤 Historical and future climate data
  - 👤 daily\_aphrodite\_Rain-Snow.MA.0.25.V1101R2
  - 📄 X List of stations.xlsx 👤
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  - 📄 daily\_aphrodite\_observations.zip 👤
- 👤 Climate change indices
  - 👤 Input
  - 👤 Documentation
  - 👤 Creating maps\_spatial distribution
  - 📄 X Summary.xlsx 👤
  - 📄 calculating the indices.R 👤