Getting started with NEXGDPP data

Ibrahim N. Mohammed

2022-03-06

NASAaccess has a handy tool to access, extract, and reformat climate change data of rainfall and air temperature from NASA Earth Exchange Global Daily Downscaled Projections NEX-GDDP GSFC servers for grids within a specified watershed.

NEX-GDDP dataset is comprised of downscaled climate scenarios for the globe that are derived from the General Circulation Model GCM runs conducted under the Coupled Model Intercomparison Project Phase 5 CMIP5 (Taylor, Stouffer, and Meehl 2012) and across two (RCP45 & RCP85) of the four greenhouse gas emissions scenarios known as Representative Concentration Pathways RCPs (Meinshausen et al. 2011). The CMIP5 GCM runs were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC AR5. This dataset includes downscaled projections from the 21 models and scenarios for which daily scenarios were produced and distributed under CMIP5.

The Bias-Correction Spatial Disaggregation BCSD method used in generating the NEX-GDDP dataset is a statistical downscaling algorithm specifically developed to address the current limitations of the global GCM outputs (Andrew W. Wood et al. 2002; A. W. Wood et al. 2004; Maurer and Hidalgo 2008; Thrasher et al. 2012). The NEX-GDPP climate projections is downscaled at a spatial resolution of 0.25 degrees x 0.25 degrees (approximately 25 km x 25 km). The NEX_GDPPswat downscales the NEX-GDPP data to grid points of 0.1 degrees x 0.1 degrees following nearest point methods described by Mohammed et al. (2018).

Basic use

Let's use the example watersheds that we introduced with `GPMswat` and `GPMpolyCentroid`. Please visit *NASAaccess* GPM functions for more information.

```
library(NASAaccess)

NEX_GDPPswat(Dir = "./NEX_GDPPswat/",
             watershed = shape_path,
              dem_path,
              start = "2060-12-1",
              end = "2060-12-3",
              model = 'IPSL-CM5A-MR',
             type = 'pr',
             slice = 'rcp85')
```

Let's examine the precipitation station file

```
NEX_GDPP.precipitationMaster <- system.file('extdata/NEX_GDPPswat',
                                            'prGrid_Master.txt',
                                            package = 'NASAaccess')

NEX_GDPPswat.table<-read.csv(NEX_GDPP.precipitationMaster)

head(NEX_GDPPswat.table)
#>          ID              NAME       LAT       LONG ELEVATION
```

```
#> 1 2160842 prclimate2160842 29.93337 -95.82337  50.16166
#> 2 2160843 prclimate2160843 29.93337 -95.72340  46.68206
#> 3 2160844 prclimate2160844 29.93337 -95.62343  39.72196
#> 4 2160845 prclimate2160845 29.93337 -95.52346  35.58193
#> 5 2164442 prclimate2164442 29.83343 -95.82337  48.02116
#> 6 2164443 prclimate2164443 29.83343 -95.72340  40.47534

dim(NEX_GDPPswat.table)
#> [1] 11  5
```

Here we processed precipitation data from Institut Pierre Simon Laplace Model CM5A-MR under the Representative Concentration Pathways (RCP85) for our example watershed during the December 2060 (1st to 3rd).

Changing `type` parameter in the `NEX_GDPPswat` function from `pr` to `tas` gives us minimum and maximum air temperatures.

Built with

```
sessionInfo()
#> R version 4.1.2 (2021-11-01)
#> Platform: x86_64-apple-darwin17.0 (64-bit)
#> Running under: macOS Big Sur 10.16
#>
#> Matrix products: default
#> BLAS:   /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRblas.0.dylib
#> LAPACK: /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
#>
#> locale:
#> [1] C/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
#>
#> attached base packages:
#> [1] stats     graphics  grDevices utils     datasets  methods   base
#>
#> other attached packages:
#> [1] rgdal_1.5-28     ggmap_3.0.0      ggplot2_3.3.5    sf_1.0-6
#> [5] raster_3.5-15    sp_1.4-6         NASAaccess_3.0.3
#>
#> loaded via a namespace (and not attached):
#>  [1] httr_1.4.2          pkgload_1.2.4       tidyr_1.2.0
#>  [4] brio_1.1.3          highr_0.9           yaml_2.3.5
#>  [7] pillar_1.7.0        lattice_0.20-45     glue_1.6.2
#> [10] digest_0.6.29       colorspace_2.0-3    htmltools_0.5.2
#> [13] plyr_1.8.6          XML_3.99-0.9        pkgconfig_2.0.3
#> [16] s2_1.0.7            purrr_0.3.4         scales_1.1.1
#> [19] terra_1.5-21        jpeg_0.1-9          tibble_3.1.6
#> [22] proxy_0.4-26        farver_2.1.0        generics_0.1.2
#> [25] ellipsis_0.3.2      withr_2.4.3         cli_3.2.0
#> [28] magrittr_2.0.2      crayon_1.5.0        maptools_1.1-2
#> [31] evaluate_0.15       ncdf4_1.19          fansi_1.0.2
#> [34] xml2_1.3.3          foreign_0.8-81      class_7.3-19
#> [37] tools_4.1.2         shapefiles_0.7      RgoogleMaps_1.4.5.3
#> [40] lifecycle_1.0.1     stringr_1.4.0       munsell_0.5.0
#> [43] compiler_4.1.2      e1071_1.7-9         tinytex_0.37
```

```
#> [46] rlang_1.0.1         classInt_0.4-3      units_0.8-0
#> [49] grid_4.1.2          rstudioapi_0.13     rjson_0.2.21
#> [52] labeling_0.4.2      bitops_1.0-7        rmarkdown_2.11
#> [55] testthat_3.1.2      wk_0.6.0            gtable_0.3.0
#> [58] codetools_0.2-18    curl_4.3.2          DBI_1.1.2
#> [61] roxygen2_7.1.2      R6_2.5.1            knitr_1.37
#> [64] dplyr_1.0.8         fastmap_1.1.0       rgeos_0.5-9
#> [67] utf8_1.2.2          rprojroot_2.0.2     KernSmooth_2.23-20
#> [70] desc_1.4.0          stringi_1.7.6       Rcpp_1.0.8
#> [73] vctrs_0.3.8         png_0.1-7           tidyselect_1.1.2
#> [76] xfun_0.29
```

References

Maurer, E. P., and H. G. Hidalgo. 2008. "Utility of Daily Vs. Monthly Large-Scale Climate Data: An Intercomparison of Two Statistical Downscaling Methods." Journal Article. *Hydrology and Earth System Sciences* 12 (2): 551–63. https://doi.org/10.5194/hess-12-551-2008.

Meinshausen, Malte, S. J. Smith, K. Calvin, J. S. Daniel, M. L. T. Kainuma, J-F. Lamarque, K. Matsumoto, et al. 2011. "The RCP Greenhouse Gas Concentrations and Their Extensions from 1765 to 2300." Journal Article. *Climatic Change* 109 (1): 213. https://doi.org/10.1007/s10584-011-0156-z.

Mohammed, Ibrahim Nourein, John Bolten, Raghavan Srinivasan, and Venkat Lakshmi. 2018. "Improved Hydrological Decision Support System for the Lower Mekong River Basin Using Satellite-Based Earth Observations." Journal Article. *Remote Sensing* 10 (6): 885. https://doi.org/10.3390/rs10060885.

Taylor, Karl E., Ronald J. Stouffer, and Gerald A. Meehl. 2012. "An Overview of Cmip5 and the Experiment Design." Journal Article. *Bulletin of the American Meteorological Society* 93 (4): 485–98. https://doi.org/10.1175/BAMS-D-11-00094.1.

Thrasher, B., E. P. Maurer, C. McKellar, and P. B. Duffy. 2012. "Technical Note: Bias Correcting Climate Model Simulated Daily Temperature Extremes with Quantile Mapping." Journal Article. *Hydrology and Earth System Sciences* 16 (9): 3309–14. https://doi.org/10.5194/hess-16-3309-2012.

Wood, A. W., L. R. Leung, V. Sridhar, and D. P. Lettenmaier. 2004. "Hydrologic Implications of Dynamical and Statistical Approaches to Downscaling Climate Model Outputs." Journal Article. *Climatic Change* 62 (1): 189–216. https://doi.org/10.1023/B:CLIM.0000013685.99609.9e.

Wood, Andrew W., Edwin P. Maurer, Arun Kumar, and Dennis P. Lettenmaier. 2002. "Long-Range Experimental Hydrologic Forecasting for the Eastern United States." Journal Article. *Journal of Geophysical Research: Atmospheres* 107 (D20): 4429. https://doi.org/10.1029/2001jd000659.