Getting started with NEXGDDP-CMIP6 data

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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-CMIP6 AMES servers for grids within a specified watershed.

NEX-GDDP-CMIP6 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 6 CMIP6 (Eyring et al. 2016) and across two of the four "Tier 1" greenhouse gas emissions scenarios known as Shared Socioeconomic Pathways (SSPs) (O'Neill et al. 2016; Meinshausen et al. 2020). The CMIP6 GCM runs were developed in support of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change IPCC AR6. This dataset includes downscaled projections from the 35 models and scenarios for which daily scenarios were produced and distributed under CMIP6.

The Bias-Correction Spatial Disaggregation BCSD method used in generating the NEX-GDDP-CMIP6 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-GDDP-CMIP6 climate projections is downscaled at a spatial resolution of 0.25 degrees x 0.25 degrees (approximately 25 km x 25 km). The NEX_GDDP_CMIP6 downscales the NEX-GDDP-CMIP6 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_GDDP_CMIP6(Dir = "./NEX_GDDP_CMIP6/",
                watershed = shape_path,
               dem_path,
               start = "2060-12-1",
               end = "2060-12-3",
               model = 'ACCESS-CM2',
               type = 'tas',
               slice = 'ssp245')
```

Let's examine the air temperature station file

```
NEX_GDDP_CMIP6.temperature.Master <- system.file('extdata/NEX_GDDP_CMIP6',
                                        'tasGrid_Master.txt',
                                        package = 'NASAaccess')

NEX_GDDP_CMIP6.table<-read.csv(NEX_GDDP_CMIP6.temperature.Master)

head(NEX_GDDP_CMIP6.table)
```

```
#>        ID              NAME    LAT      LONG ELEVATION
#> 1 2160842 tasclimate2160842 29.93337 -95.82337  50.20436
#> 2 2160843 tasclimate2160843 29.93337 -95.72340  46.65100
#> 3 2160844 tasclimate2160844 29.93337 -95.62343  39.71060
#> 4 2160845 tasclimate2160845 29.93337 -95.52346  35.15914
#> 5 2164442 tasclimate2164442 29.83343 -95.82337  47.60787
#> 6 2164443 tasclimate2164443 29.83343 -95.72340  40.46636
```

```
dim(NEX_GDDP_CMIP6.table)
#> [1] 11  5
```

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_1.5-30     ggmap_3.0.0      ggplot2_3.3.6    sf_1.0-7
#> [5] raster_3.5-15    sp_1.4-7         NASAaccess_3.1.0
#>
#> loaded via a namespace (and not attached):
#>  [1] httr_1.4.3        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_1.8.7        XML_3.99-0.9       pkgconfig_2.0.3
#> [16] s2_1.0.7          purrr_0.3.4        scales_1.2.0
#> [19] terra_1.5-21      jpeg_0.1-9         tibble_3.1.7
#> [22] proxy_0.4-26      farver_2.1.0       generics_0.1.2
#> [25] ellipsis_0.3.2    withr_2.5.0        cli_3.3.0
#> [28] magrittr_2.0.3    crayon_1.5.1       maptools_1.1-4
#> [31] evaluate_0.15     ncdf4_1.19         fansi_1.0.3
#> [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_0.39
#> [46] rlang_1.0.2       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_2.14
#> [55] testthat_3.1.4    wk_0.6.0           gtable_0.3.0
#> [58] codetools_0.2-18  curl_4.3.2         DBI_1.1.2
```

```
#> [61] roxygen2_7.2.0    R6_2.5.1          knitr_1.39
#> [64] dplyr_1.0.9       fastmap_1.1.0     rgeos_0.5-9
#> [67] utf8_1.2.2        rprojroot_2.0.3   KernSmooth_2.23-20
#> [70] desc_1.4.1        stringi_1.7.6     Rcpp_1.0.8.3
#> [73] vctrs_0.4.1       png_0.1-7         tidyselect_1.1.2
#> [76] xfun_0.31
```

References

Eyring, V., S. Bony, G. A. Meehl, C. A. Senior, B. Stevens, R. J. Stouffer, and K. E. Taylor. 2016. "Overview of the Coupled Model Intercomparison Project Phase 6 (Cmip6) Experimental Design and Organization." Journal Article. *Geoscientific Model Development* 9 (5): 1937–58. https://doi.org/10.5194/gmd-9-1937-2016.

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, M., Z. R. J. Nicholls, J. Lewis, M. J. Gidden, E. Vogel, M. Freund, U. Beyerle, et al. 2020. "The Shared Socio-Economic Pathway (SSP) Greenhouse Gas Concentrations and Their Extensions to 2500." Journal Article. *Geoscientific Model Development* 13 (8): 3571–3605. https://doi.org/10.5194/gmd-13-3571-2020.

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.

O'Neill, B. C., C. Tebaldi, D. P. van Vuuren, V. Eyring, P. Friedlingstein, G. Hurtt, R. Knutti, et al. 2016. "The Scenario Model Intercomparison Project (ScenarioMIP) for Cmip6." Journal Article. *Geoscientific Model Development* 9 (9): 3461–82. https://doi.org/10.5194/gmd-9-3461-2016.

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.