# era5-reanalysis-processing

## 2023-07-24

Libraries

```r
# -- for spatial data
#library(raster)   # -- old
#library(rgdal)    # -- deprecated in 10/2023
#library(rgeos)    # -- deprecated in 10/2023
#library(maptools) # -- deprecated in 10/2023
options("sp_evolution_status" = 2) # use sf instead of rgdal and rgeos in sp
library(sp)
library(terra)
library(sf)
library(ncdf4)

# -- for timeseries
library(lubridate)
library(zoo)
library(xts)

# --
library(ggplot2)
library(ggspatial)
library(tidyterra)
library(maditr)
library(tidyverse)
library(viridis)
```

```r
nc.borders <- vect("../input/NC_county_boundary/North_Carolina_State_and_County_Boundary_Polygons.shp")
```

**NC shapefile**

**Temperature ERA5 reanalysis**   Open netcdf data with all JJA hourly ERA5 reanalysis

```r
t2m.rea <- nc_open("../input/era5_hourly_reanalysis_20220601_20220831.nc")
print(t2m.rea)
```

```
## File ../input/era5_hourly_reanalysis_20220601_20220831.nc (NC_FORMAT_64BIT):
##
##      1 variables (excluding dimension variables):
##          short t2m[longitude,latitude,time]
##              scale_factor: 0.000480174647219721
##              add_offset: 297.344486475176
##              _FillValue: -32767
##              missing_value: -32767
##              units: K
##              long_name: 2 metre temperature
```

```
##
##      3 dimensions:
##          longitude  Size:41
##              units: degrees_east
##              long_name: longitude
##          latitude  Size:15
##              units: degrees_north
##              long_name: latitude
##          time   Size:2208
##              units: hours since 1900-01-01 00:00:00.0
##              long_name: time
##              calendar: gregorian
##
##      2 global attributes:
##          Conventions: CF-1.6
##          history: 2023-07-24 20:09:56 GMT by grib_to_netcdf-2.25.1: /opt/ecmwf/mars-client/bin/grib_t
```

Extract data in vectors and 3d-matrix

```r
lon <- ncvar_get(t2m.rea, "longitude")
lat <- ncvar_get(t2m.rea, "latitude")
time <- ncvar_get(t2m.rea, "time")
t2m <- ncvar_get(t2m.rea, "t2m") - 273.15
na.value <- ncatt_get(t2m.rea, "t2m", "_FillValue")$value
t2m[t2m==na.value] <- NA
cat(paste('time units:', ncatt_get(t2m.rea, "time", "units")$value))
```

```
## time units: hours since 1900-01-01 00:00:00.0
```

```r
time <- as.POSIXct(time*3600, origin="1900-01-01", tz="UTC")
```

Map T2M for one hour

```r
# one time
ts <- as.POSIXct("2022-08-01 11:00:00 UTC", tz='UTC')
samp <- t2m[,,which(time==ts)]
# need to add 0.25/2 to
samp.rast <- rast(t(samp), extent=c(-85.125,-74.875,33.375,37.125), crs='+proj=longlat +datum=WGS84 +no_

ggplot() +
  geom_spatraster(data = samp.rast) +
  geom_sf(data = st_as_sf(nc.borders), aes(geometry=geometry),
            colour = "white", linewidth=.3, fill = NA) +
  scale_fill_whitebox_c(
    palette = "muted",
    labels = scales::label_number(suffix = "º"),
    n.breaks = 12,
    guide = guide_legend(reverse = TRUE)
  ) +
  labs(
    fill = "",
    title = "T2m North Carolina",
    subtitle = paste(ts, 'UTC')
  ) +
  annotation_scale(
    location="bl", pad_x = unit(1, "cm"),
```
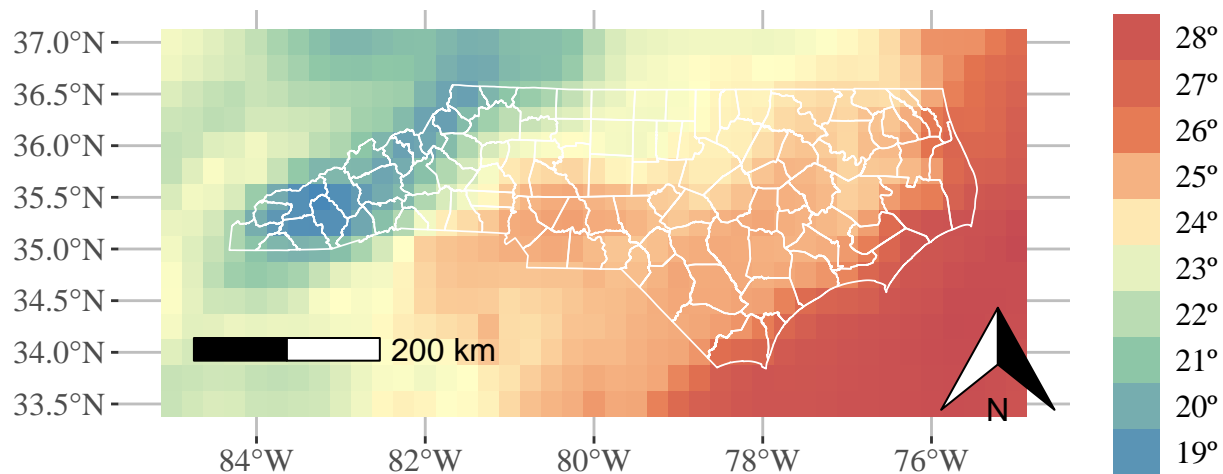
```
      pad_y = unit(1, "cm"),
      height = unit(0.30, "cm"),
      text_cex = 1
  ) +
  annotation_north_arrow(
    location = "br",
    which_north = "true",
      pad_x = unit(0.2, "cm"),
      pad_y = unit(0.2, "cm")
  ) +
  theme(
        axis.text = element_text(size=12, family="serif"),
        plot.caption = element_text(size=10, family="serif"),
        legend.text = element_text(size=12, family="serif"),
        legend.title = element_text(size=12, family="serif"),
        panel.background = element_rect(fill = "white"),
        panel.grid.major=element_line(colour="grey")
  )
```



T2m North Carolina
2022−08−01 11:00:00 UTC

Code to create a dataframe from the netcdf

```
# -- /!\ latitude vector is decreasing
lon.lat.time <- as.matrix(expand.grid(lon, rev(lat), time))
t2m.vect <- as.vector(t2m[,ncol(t2m):1,])
t2m.df <- data.frame(cbind(lon.lat.time, t2m.vect))
colnames(t2m.df) <- c("lon", "lat", "time", 't2m')
t2m.df$t2m <- as.numeric(t2m)
```

Session info

```
sessionInfo()
```

```
## R version 4.3.1 (2023-06-16)
## Platform: aarch64-apple-darwin20 (64-bit)
## Running under: macOS Ventura 13.4.1
##
## Matrix products: default
```

```
## BLAS:    /Library/Frameworks/R.framework/Versions/4.3-arm64/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.3-arm64/Resources/lib/libRlapack.dylib;  LAPACK v
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## time zone: America/New_York
## tzcode source: internal
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] viridis_0.6.3     viridisLite_0.4.2 forcats_1.0.0     stringr_1.5.0
##  [5] dplyr_1.1.2       purrr_1.0.1       readr_2.1.4       tidyr_1.3.0
##  [9] tibble_3.2.1      tidyverse_2.0.0   maditr_0.8.3      tidyterra_0.4.0
## [13] ggspatial_1.1.8   ggplot2_3.4.2     xts_0.13.1        zoo_1.8-12
## [17] lubridate_1.9.2   ncdf4_1.21        sf_1.0-14         terra_1.7-39
## [21] sp_2.0-0
##
## loaded via a namespace (and not attached):
##  [1] utf8_1.2.3        generics_0.1.3    class_7.3-22      KernSmooth_2.23-21
##  [5] stringi_1.7.12    lattice_0.21-8    hms_1.1.3         digest_0.6.33
##  [9] magrittr_2.0.3    evaluate_0.21     grid_4.3.1        timechange_0.2.0
## [13] fastmap_1.1.1     e1071_1.7-13      DBI_1.1.3         gridExtra_2.3
## [17] fansi_1.0.4       scales_1.2.1      codetools_0.2-19  cli_3.6.1
## [21] rlang_1.1.1       units_0.8-2       munsell_0.5.0     withr_2.5.0
## [25] yaml_2.3.7        tools_4.3.1       tzdb_0.4.0        colorspace_2.1-0
## [29] vctrs_0.6.3       R6_2.5.1          proxy_0.4-27      lifecycle_1.0.3
## [33] classInt_0.4-9    pkgconfig_2.0.3   pillar_1.9.0      gtable_0.3.3
## [37] data.table_1.14.8 glue_1.6.2        Rcpp_1.0.11       highr_0.10
## [41] xfun_0.39         tidyselect_1.2.0  rstudioapi_0.15.0 knitr_1.43
## [45] farver_2.1.1      htmltools_0.5.5   labeling_0.4.2    rmarkdown_2.23
## [49] compiler_4.3.1
```