

# West Mediterranean climate during the Last Deglaciation

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## Introduction

We'll be comparing paleoclimate model estimates of temperature and precipitation over three points in the west Mediterranean to global paleoclimate proxies.

## Setup

Load all the packages we'll need for this analysis.

```
library(ncdf4) # import GCM data
library(raster) # process GCM data
library(tidyverse) # data management and plotting
library(magrittr) # pipes for code readability
library(EMD) # calculate trends in the data
```

## Climate Model

### Sample Locations

Create a matrix with the coordinates for the three locations of interest in the west Mediterranean. We'll be focusing on large grid cell averages, so the points do not have to be directly over land.

```
samp.pts <- matrix(c(1, 40, 4, 42, 14, 46), ncol = 2, byrow = T)
samp.pts
```

```
##      [,1] [,2]
## [1,]    1  40
## [2,]    4  42
## [3,]   14  46
```

### TraCE-21k

First, import data from the TraCE-21k paleoclimate simulation. Then extract temperature and precipitation values at three locations in the west Mediterranean. Use the *brick* function from **raster** to import decadal averages from the simulation. Put the coordinates for the three locations in a matrix, and use that matrix to and **raster's** *extract* function to get the values from the climate model brick. Convert

You'll need to have the netCDF libraries already installed on your system for ncdf4 to work.

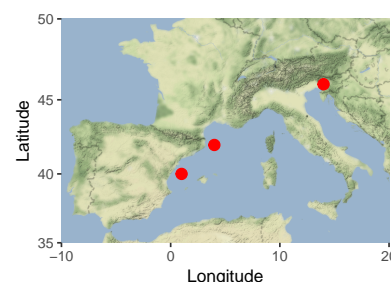


Figure 1: Locations of 3 sample points.

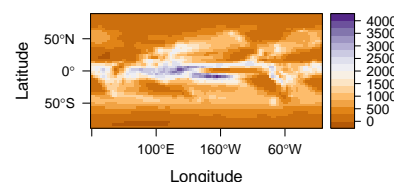


Figure 2: TraCE21-k precipitation and temperature

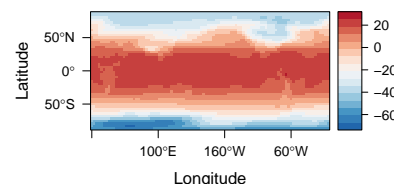


Figure 3: TraCE21-k precipitation and temperature

the precipitation values to mm/year and temperature values to degrees Celsius. Finally, name the columns for each region appropriately.

```
trace.prc <- brick('trace.01-36.22000BP.cam2.PRECT.22000BP_decavg_400BCE.nc') %>% # import climate mode
  raster::extract(samp.pts) %>% # extract data at these coordinates
  multiply_by(3.154e+10) # convert to mm/year

trace.tmp <- brick('trace.01-36.22000BP.cam2.TREFHT.22000BP_decavg_400BCE.nc') %>%
  raster::extract(samp.pts) %>%
  subtract(273.15) # convert from kelvin to C
```

Now pull all the TraCE data into one data frame, with one row per year, and one column per variable/location combination. First *rbind* the two sets of TraCE data and *transpose* the results, turning the 6 rows into 6 columns. Add a column for the Year (in ka BP), and use to select only the entries earlier than 6,000 BP.

```
trace.dat <- rbind(trace.tmp, trace.prc) %>%
  t %>% # transpose
  as.data.frame %>%
  set_colnames(c('tmp-Southwest', 'tmp-North Central', 'tmp-Northeast', 'prc-Southwest', 'prc-North Cen
  rownames_to_column('Year') %>%
  mutate(Year = as.numeric(substring(Year, 3))) %>%
  filter(Year > 6) # get all the decades up to 6ka BP
```

Now organize the temperature and precipitation data to make plotting easier using functions from **tidyr**.

Replace the variable names to make facet naming easier too.

```
trace.plot <- trace.dat %>%
  gather(key, value, - Year) %>%
  separate(key, c('Variable', 'Region'), '-') %>%
  mutate(Variable = ifelse(Variable == 'tmp', 'Temperature (°C)', 'Precipitation (mm)'))
```

Plot everything with **ggplot2**.

```
ggplot(data = trace.plot, aes(x = Year, y = value)) +
  facet_grid(Variable ~ Region, switch = 'y', scale = 'free_y') +
  geom_vline(xintercept = c(22, 19, 14, 10, 6), lty = 2) +
  geom_point(color = 'grey', alpha = .3) +
  geom_smooth(color = "black", alpha = .8) +
  labs(x = '1,000 Years BP', y = '') +
  scale_x_reverse(breaks = seq(6,22,4)) +
  theme_bw(base_size = 20) +
  theme(strip.background = element_blank())
```

## References

