# Covariances

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The code: this directory contains a file `Pacific-1950-1979.txt` combining NOAA data from `air.sig995.1950.nc` `air.sig995.1979.nc`.

```
> setwd("C:/Users/Work/AAA/Programming/misc/Azi-Nino")
```

The code 2: utility functions

```
> lat.from.label <- function(label) {
+ as.integer(substr(label,2,4))
+ }
> lon.from.label <- function(label) {
+ as.integer(substr(label,6,8))
+ }
> lat.range.from.colnames <- function(cnames) {
+ lat.from.label(cnames[1]) : lat.from.label(cnames[length(cnames)])
+ }
> lon.range.from.colnames <- function(cnames) {
+ lon.from.label(cnames[1]) : lon.from.label(cnames[length(cnames)])
+ }
```

The code 3: utility functions

```
> textual.longitude.from.3D.lon <- function(lon, cnames) {
+ lon.range <- lon.range.from.colnames(cnames)
+ x <- lon.range[1] + lon - 2
+ x <- 2.5 * x
+ if (x < 179.99) {
```

```
+   txt <- paste0(x, "E")
+   } else if (x > 180.01) {
+   txt <- paste0(360-x, "W")
+   } else {
+   txt <- "180"
+   }
+ txt
+ }
```

The code 4: utility functions

```
> textual.latitude.from.3D.lat <- function(lat, cnames) {
+ lat.range <- lat.range.from.colnames(cnames)
+ y <- lat.range[1] + lat - 2
+ y <- 2.5 * y
+ if (y < 89.99) {
+   txt <- paste0(90-y, "N")
+   } else if (y > 90.01) {
+   txt <- paste0(y-90, "S")
+   } else {
+   txt <- "0"
+   }
+ txt
+ }
```

The code 5: conversion of input data to a 3D array.

```
> data.to.3D <- function(vals) {
+ lat.range <- lat.range.from.colnames(colnames(vals))
+ lon.range <- lon.range.from.colnames(colnames(vals))
+ n.times <- dim(vals)[1]
+ n.lat <- length(lat.range)
+ n.lon <- length(lon.range)
+ vals3D <- array(0, dim=c(n.times, n.lat, n.lon))
+ for (tim in 1:n.times) {
+   for (lat in 1:n.lat) {
```

```
+     vals3D[tim, lat, ] <- vals[tim, ((lat-1) * n.lon) +  (1:n.lon)]
+     }
+   }
+ vals3D
+ }
```

The code 6: For each point, for each day, subtracts the mean over years.

```
> seasonally.adjust <- function(vals) {
+ stopifnot(dim(vals)[1] %% 365 == 0)
+ n.years <- as.integer(dim(vals)[1]/365)
+ offsets <- (0:(n.years-1))*365
+ y.means <- array(0, dim=c(365, dim(vals)[2], ncols=dim(vals)[3]))
+ for (d in 1:365) {
+   for (lat in 1:dim(vals)[2]) {
+     for (lon in 1:dim(vals)[3]) {
+       y.means[d, lat, lon] <- mean(vals[d + offsets, lat, lon])
+       }
+     }
+   }
+ for (y in 1:n.years ) {
+   for (d in 1:365) {
+     tim <- (y-1)*365 + d
+     vals[tim, , ] <- vals[tim, , ] - y.means[d, , ]
+     }
+   }
+ vals
+ }
```

The code 7: not used.

```
> # untested. aimed at values calculated eg every 14 days. 14*26=364, miss one day
> seasonally.adjust.periods <- function(vals, nppy) {
+ # nppy = number of periods per year
+ stopifnot(dim(vals)[1] %% nppy == 0)
+ n.years <- as.integer(dim(vals)[1]/nppy)
```

```
+ offsets <- (0:(n.years-1))*nppy
+ y.means <- array(0, dim=c(nppy, dim(vals)[2], ncols=dim(vals)[3]))
+ for (p in 1:nppy) {
+   for (lat in 1:dim(vals)[2]) {
+     for (lon in 1:dim(vals)[3]) {
+       y.means[p, lat, lon] <- mean(vals[p + offsets, lat, lon])
+       }
+     }
+   }
+ for (y in 1:n.years ) {
+   for (p in 1:nppy) {
+     tim <- (y-1)*nppy + p
+     vals[tim, , ] <- vals[tim, , ] - y.means[p, , ]
+     }
+   }
+ vals
+ }
```

The code 8: read in data and convert to 3D array.

```
> #Kvals <- as.matrix(read.table(file="Scotland-1950-1952.txt", header=TRUE))
> Kvals <- as.matrix(read.table(file="Pacific-1950-1979.txt", header=TRUE))
> Kvals.cnames <- colnames(Kvals)
> Kvals.3D <- data.to.3D(Kvals)
> SAvals.3D <- seasonally.adjust(Kvals.3D)
```

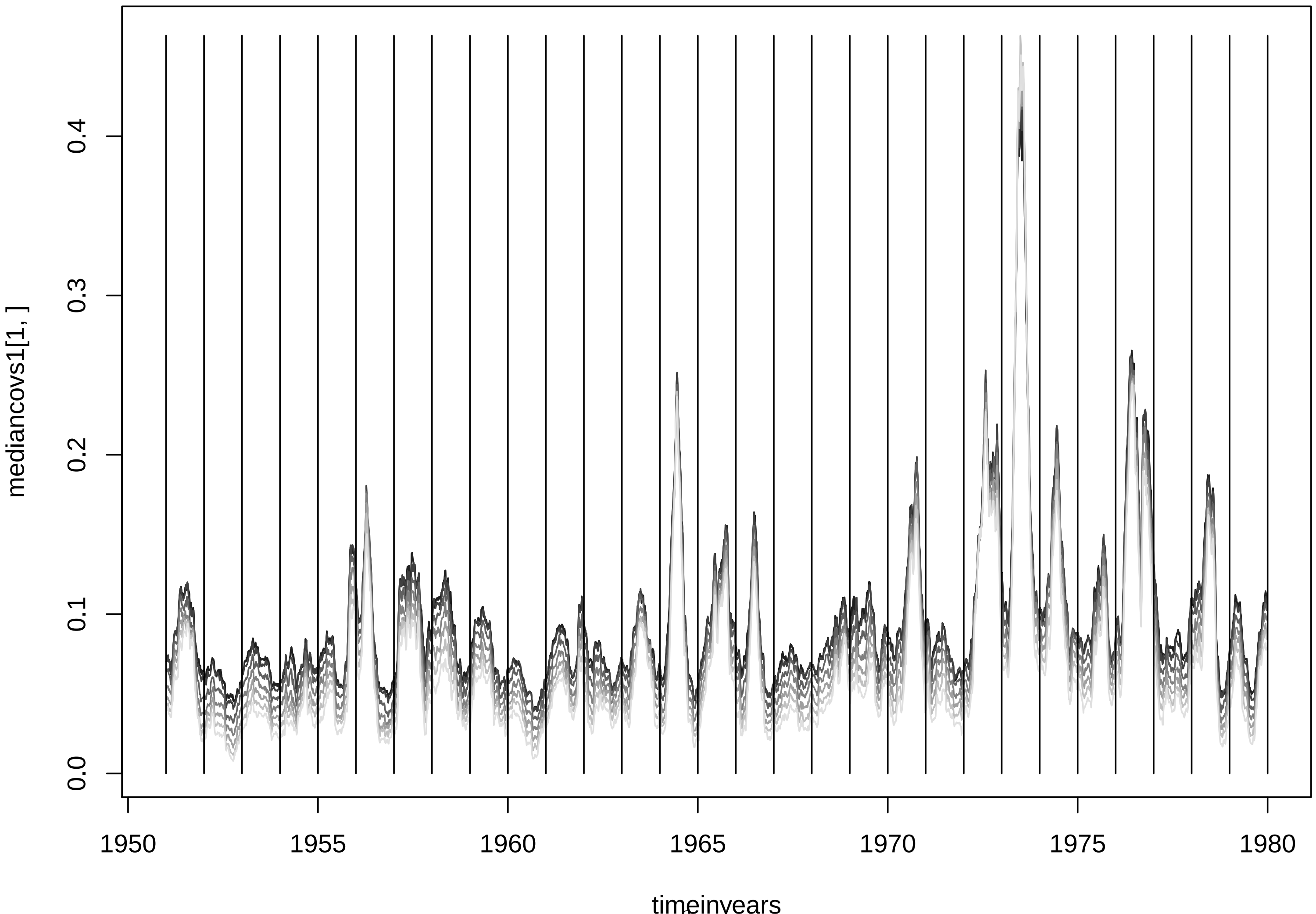
The code 9: see comments.

```
> # find covariances at time (day) p between each point x in region and a point
> # offset dS steps South, dE steps East, and with time lag dp, and
> # using a period length covp for the covariances. Positive
> # dp means the points in the region are at time p, and
> # the offset points are earlier, so is how the points
> # in the region are influenced by others. (Negative dp means
> # the offset point are at time p, not yet implemented.)
> covariances <- function(vals, region, p, dS, dE, dp, covp) {
```

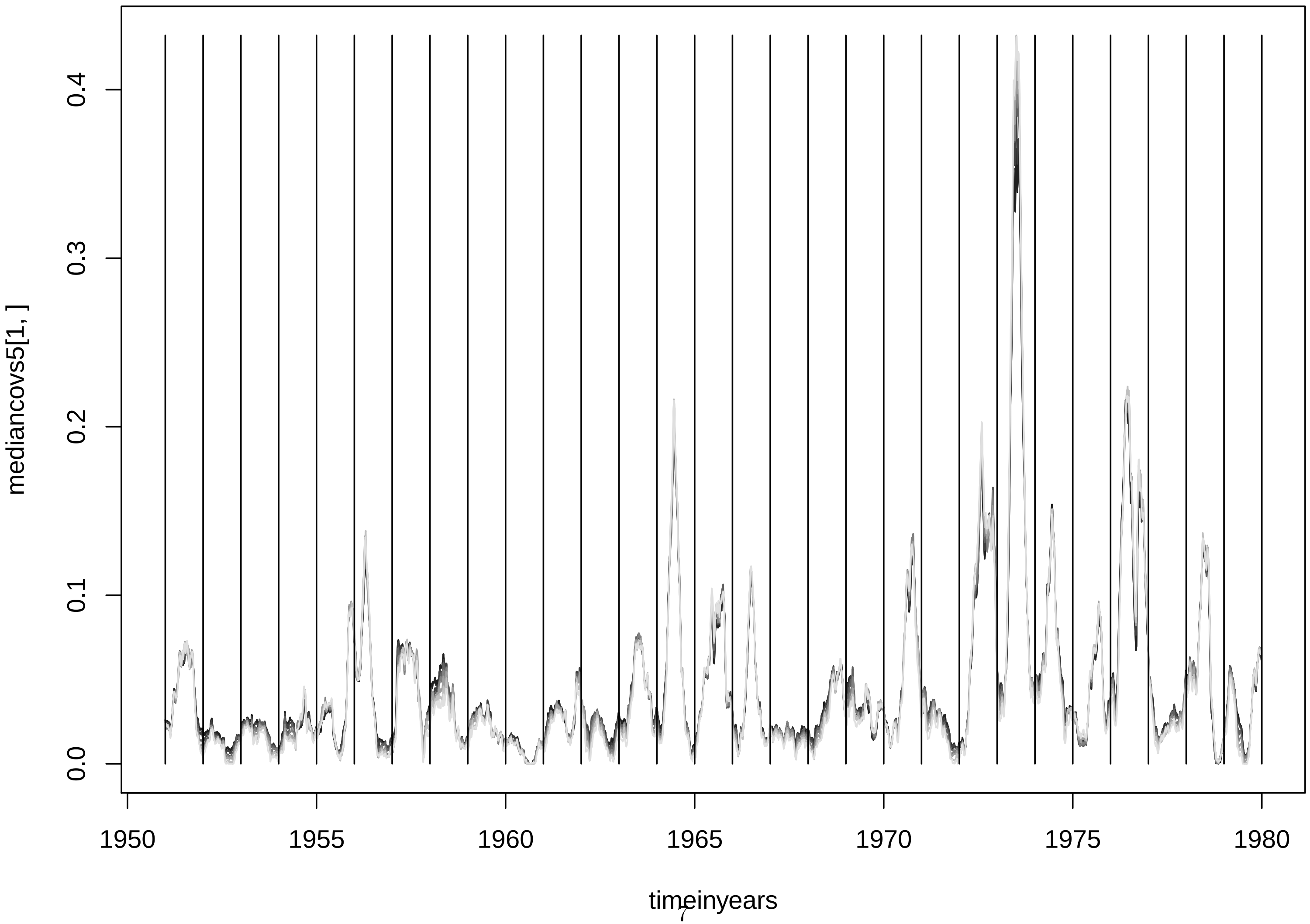
```
+   S0 <- region$S0
+   S1 <- region$S1
+   E0 <- region$E0
+   E1 <- region$E1
+   stopifnot(S1 + dS <=  dim(vals)[2])
+   stopifnot(E1 + dE <=  dim(vals)[3])
+   stopifnot(p - dp - covp >= 1)
+   stopifnot(dp >= 0)
+   covs <- matrix(0, nrow=S1-S0+1, ncol=E1-E0+1)
+   hrange <- p + ((-covp+1):0)
+   orange <- p - dp + ((-covp+1):0)
+   for (lat in S0:S1) {
+     for (lon in E0:E1) {
+       covs[lat-S0, lon-E0] <- cov(vals[orange, lat+dS, lon+dE], vals[hrange, lat, lon])
+     }
+   }
+ covs
+ }
```

The code 10: For each 5 days from 1951 through 1979, for a region straddling the equator, for delays of 1 and 5 days, and for 0 to 7 eastwards steps of 2.5 degrees, find the covariances of the temperature over six months (183 days).

```
> region <- list(S0=12,S1=16,E0=20,E1=60)
> pvals <- seq(from=366, to=30*365, by=5)
> mediancovs1 <- matrix(0, nrow=8, ncol=length(pvals))
> mediancovs5 <- matrix(0, nrow=8, ncol=length(pvals))
> for (i in 1:length(pvals)) {
+   p <- pvals[i]
+   for (dE in (0:7)) {
+     covs <- covariances(SAvals.3D, region, p, dS=0, dE=dE, dp=1, covp=183)
+     mediancovs1[dE+1, i] <- median(c(covs))
+     covs <- covariances(SAvals.3D, region, p, dS=0, dE=dE, dp=5, covp=183)
+     mediancovs5[dE+1, i] <- median(c(covs))
+     }
+   }
> timeinyears <- 1951 + (0:(length(pvals)-1))/73
```



medianovs1[1, ]
0.0
0.1
0.2
0.3
0.4
1950
1955
1960
1965
1970
1975
1980
timeinyears


0.0
0.1
0.2
0.3
0.4
mediancovs5[1, ]
1950
1955
1960
1965
1970
1975
1980
timeinyears