Explore Trends of WiMMed Indicators (Season)

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Prepare Data

1. Read data of Mann-Kendal Sen-Slope for each pixels and WiMMed indicators (season)
2. Read data of topographic variable:
    - Convert radian to deg.
    - Create categorical variable for elevation (250 m)
    - Classify aspect into 8 categories
3. Read data from hydrological basin
4. Read spatial data:
    - Select only centroides of interest
5. Create two dataframes:
    - **Full Dataframe** with all variables and all pixels (`fulldf`)
    - :red_circle: In this exploration we don't filter the data by elevation

```
# Trend analysis data
# Define name of indicators (see variables names)
# Use annual and season aggregation
indicadores <- c("pre", "pre_snow", "pre_snow_per", "temp",
                 "pnau", "pnsp", "pnsu", "pnwi",
                 "preau", "presp", "presu", "prewi",
                 "tempau", "tempsp", "tempsu", "tempwi")

# Loop to read files
for (j in indicadores){
  aux <- read.csv(file=paste(di, "/data/derived/", j, ".csv", sep= ""),
              header = TRUE,
              sep = ',')
  assign(j, aux)
}
# --

# Define pixels of interes
pixels_interes <- pre$nie_malla_modi_id

# Read Topographic data
rawtopo <- read.csv(file=paste(di, "/data/topo_nie_malla_modis.csv", sep=""),
                    header=TRUE,
                    sep = ",")

# function to convert radian to degree
rad2deg <- function(rad) {(rad * 180) / (pi)}


topo <- rawtopo %>%
```

```
  filter(id %in% pixels_interes) %>%
  mutate(nie_malla_modi_id = id,
         slope50mean_deg = rad2deg(slope50mean),
         slope50median_deg = rad2deg(slope50median),
         aspect50mean_deg = rad2deg(aspect50mean),
         aspect50median_deg = rad2deg(aspect50median)) %>%
  dplyr::select(nie_malla_modi_id, dem50mean, dem50median, slope50mean_deg,
                slope50median_deg, aspect50mean_deg, aspect50median_deg)

## Create interval variables (250 m) for dem; and classify aspect into 8 categories
topo <- topo %>%
  mutate(dem50mean_group = cut(dem50mean,
                           breaks = seq(from=0, to=3500, by=250),
                           labels = c("0-250", "251-500","501-750","751-1000",
                                      "1001-1250","1251-1500","1501-1750","1751-2000",
                                      "2001-2250","2251-2500","2501-2750", "2751-3000",
                                      "3001-3250", "3251-3500")),
         aspect50mean_deg_group = cut(aspect50mean_deg,
                                      breaks= c(22.5, 67.5, 112.5, 157.5, 202.5, 247.5, 292.5, 337.5, 35
                                      labels = c("N", "NE", "E", "SE", "S", "SW", "W", "NW")))


# --

# Read spatial data and Get lat/long
centroides <- rgdal::readOGR(dsn=paste(di, "/data/geoinfo", sep=""),
                             layer = "centroides_selected", verbose = FALSE)
# Select only attributes of interest and rename them
centroides <- centroides[c("id")]

# Create lat/lng by id
xycentroides <- cbind(centroides@data, coordinates(centroides))
names(xycentroides) <- c("nie_malla_modi_id", "lon","lat")

xycentroides <- filter(xycentroides, nie_malla_modi_id %in% pixels_interes)
# --

# Hydrological basin
basin <- read.csv(file=paste(di, "/data/derived/pixel_region.csv", sep=""),
                  header=TRUE,
                  sep = ",")
# --


# Create un dataframe con todos los datos
fulldf <- topo %>%
  inner_join(pre,  by=c("nie_malla_modi_id")) %>%
  inner_join(pre_snow,  by=c("nie_malla_modi_id")) %>%
  inner_join(pre_snow_per,  by=c("nie_malla_modi_id")) %>%
  inner_join(temp,  by=c("nie_malla_modi_id")) %>%
  inner_join(pnau,  by=c("nie_malla_modi_id")) %>%
  inner_join(pnsp,  by=c("nie_malla_modi_id")) %>%
  inner_join(pnsu,  by=c("nie_malla_modi_id")) %>%
```

```
  inner_join(pnwi,  by=c("nie_malla_modi_id")) %>%
  inner_join(preau,  by=c("nie_malla_modi_id")) %>%
  inner_join(presp,  by=c("nie_malla_modi_id")) %>%
  inner_join(presu,  by=c("nie_malla_modi_id")) %>%
  inner_join(prewi,  by=c("nie_malla_modi_id")) %>%
  inner_join(tempau,  by=c("nie_malla_modi_id")) %>%
  inner_join(tempsp,  by=c("nie_malla_modi_id")) %>%
  inner_join(tempsu,  by=c("nie_malla_modi_id")) %>%
  inner_join(tempwi,  by=c("nie_malla_modi_id")) %>%
  inner_join(xycentroides, by="nie_malla_modi_id") %>%
  inner_join(basin, by="nie_malla_modi_id")


# Create subset of pixels above 1250
fulldf1250 <- fulldf %>%
  filter(dem50mean > 1250)
```

Explore trends of annual variables by basin

We explore the pattern of snow-cover indicators trends by hydrological basin.

Precipitation

Autunm

Table 1: Tau Pre au

term	df	sumsq	meansq	statistic	p.value
basin_name	4	20.6	5.151	2487	0
Residuals	7989	16.54	0.002071	NA	NA

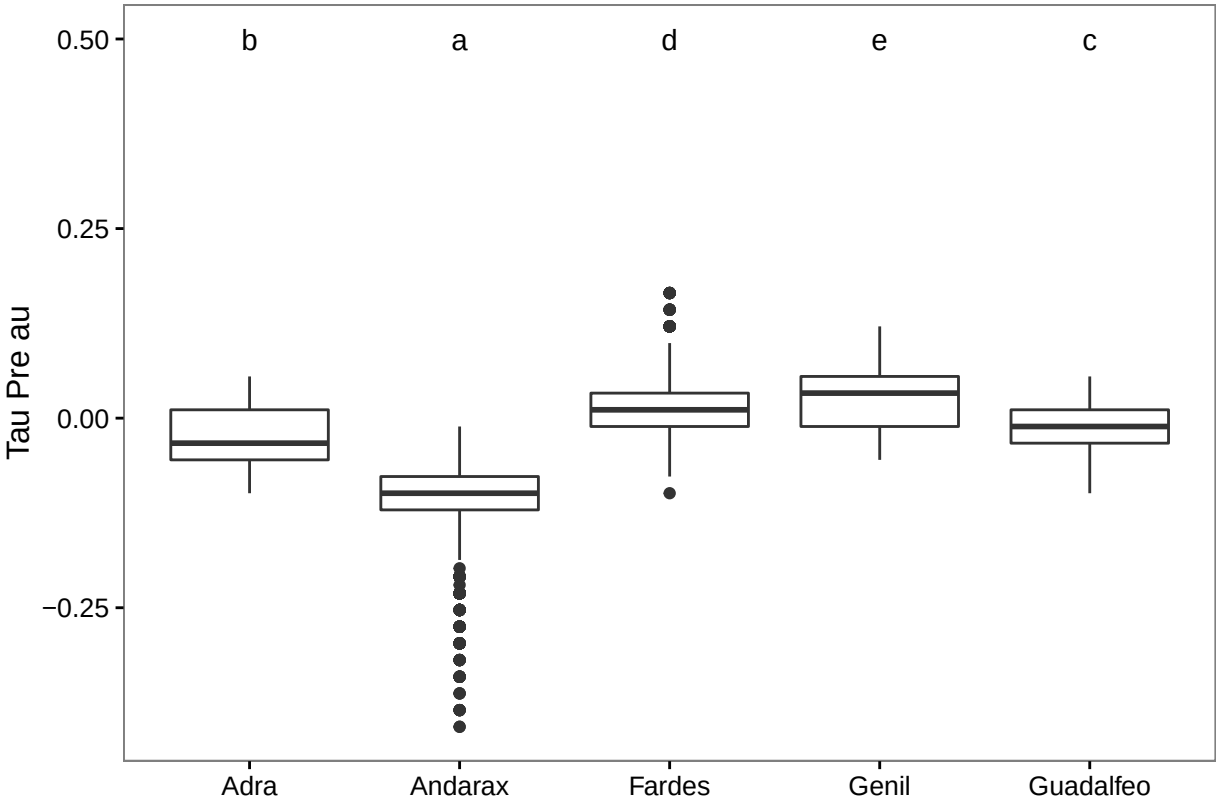
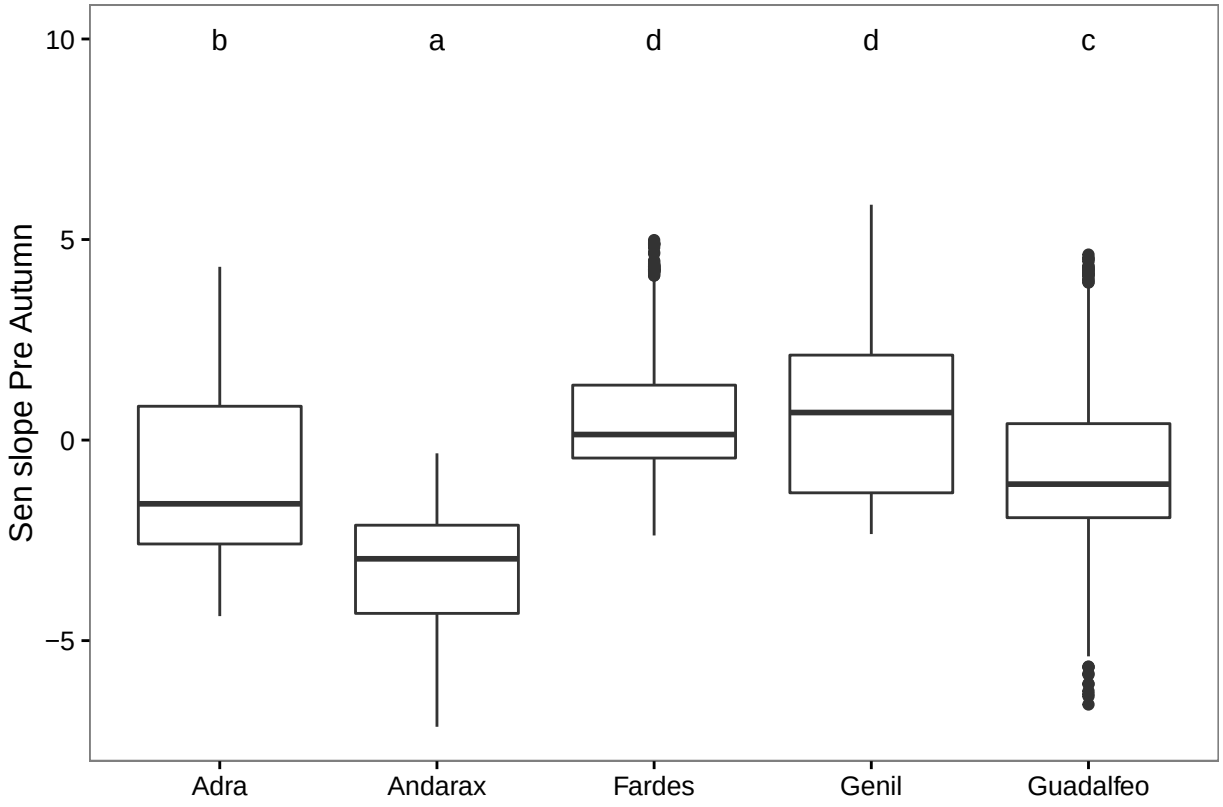


Table 2: Sen slope Pre Autumn

term	df	sumsq	meansq	statistic	p.value
basin_name	4	17199	4300	1632	0
Residuals	7989	21050	2.635	NA	NA



Pre Spring

Table 3: Tau Pre Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	36.11	9.028	1580	0
Residuals	7989	45.65	0.005714	NA	NA

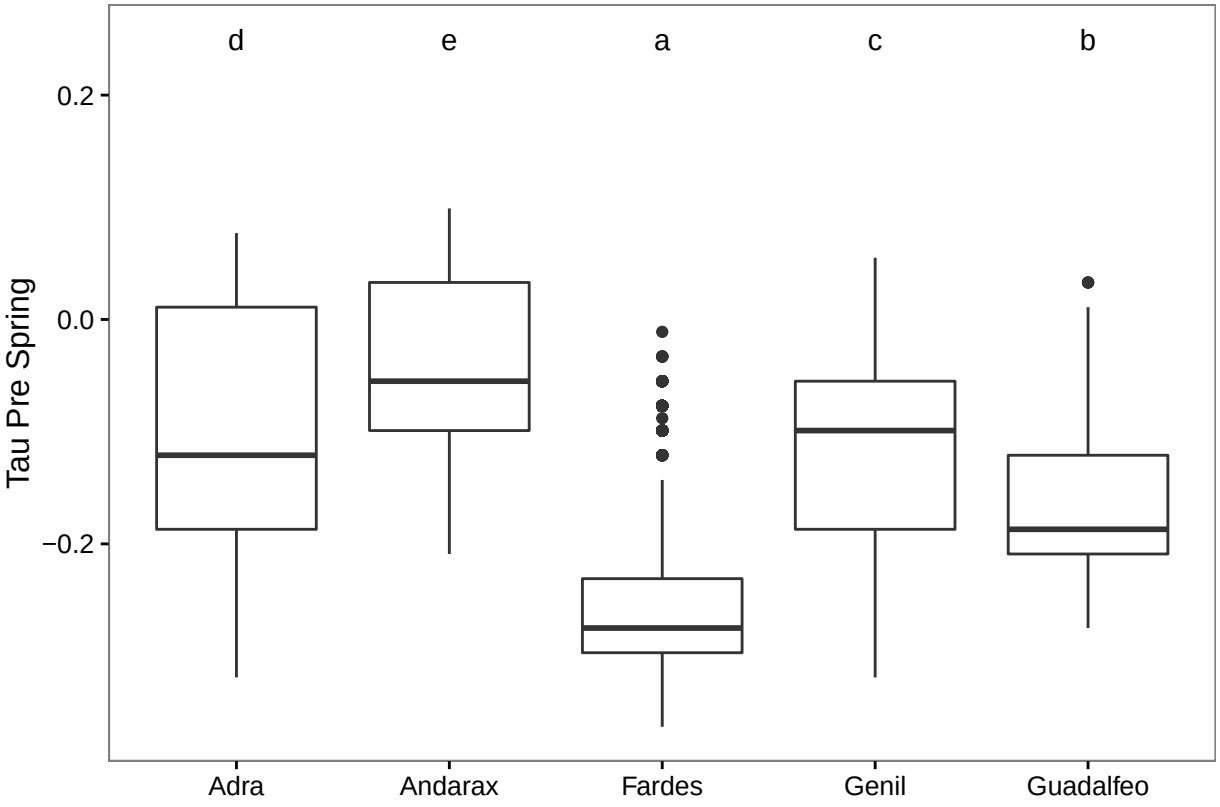
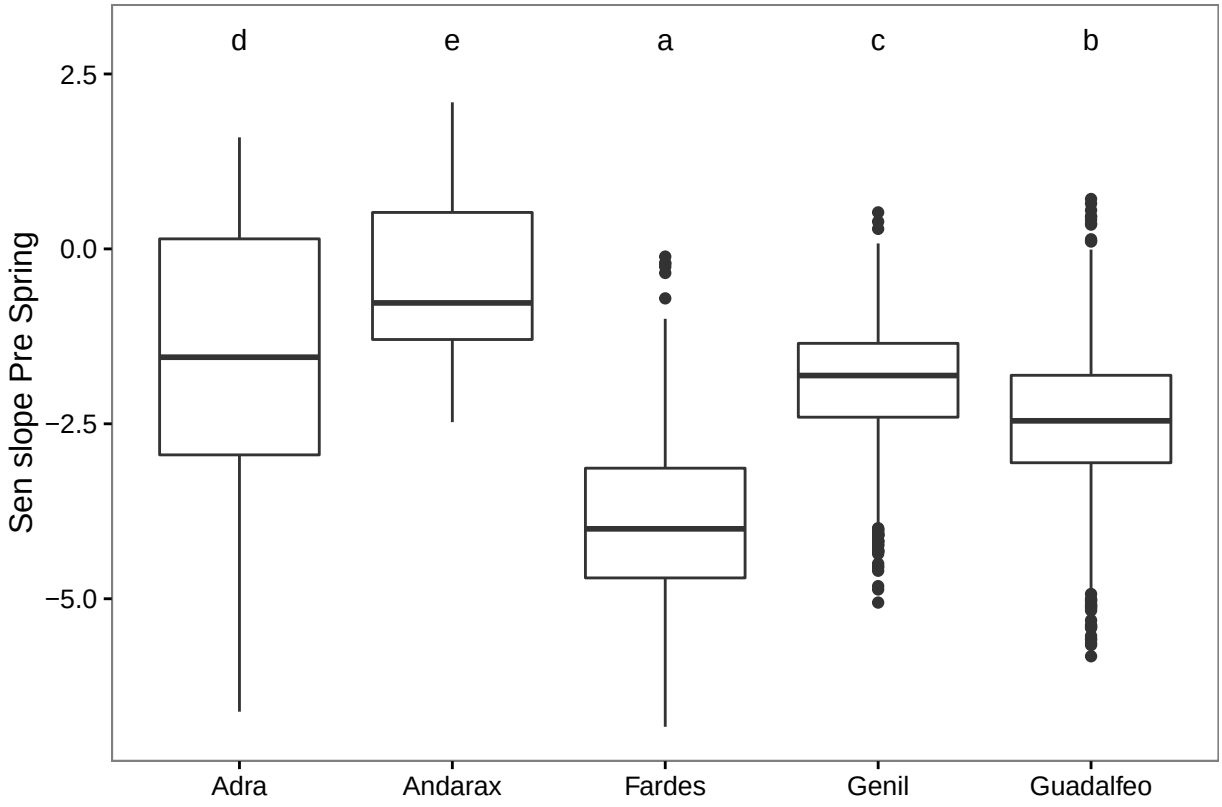


Table 4: Sen slope Pre Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	10254	2564	1827	0
Residuals	7989	11210	1.403	NA	NA



Pre Summer

Table 5: Tau Pre Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	5.17	1.292	366.9	1.707e-290
Residuals	7989	28.14	0.003523	NA	NA

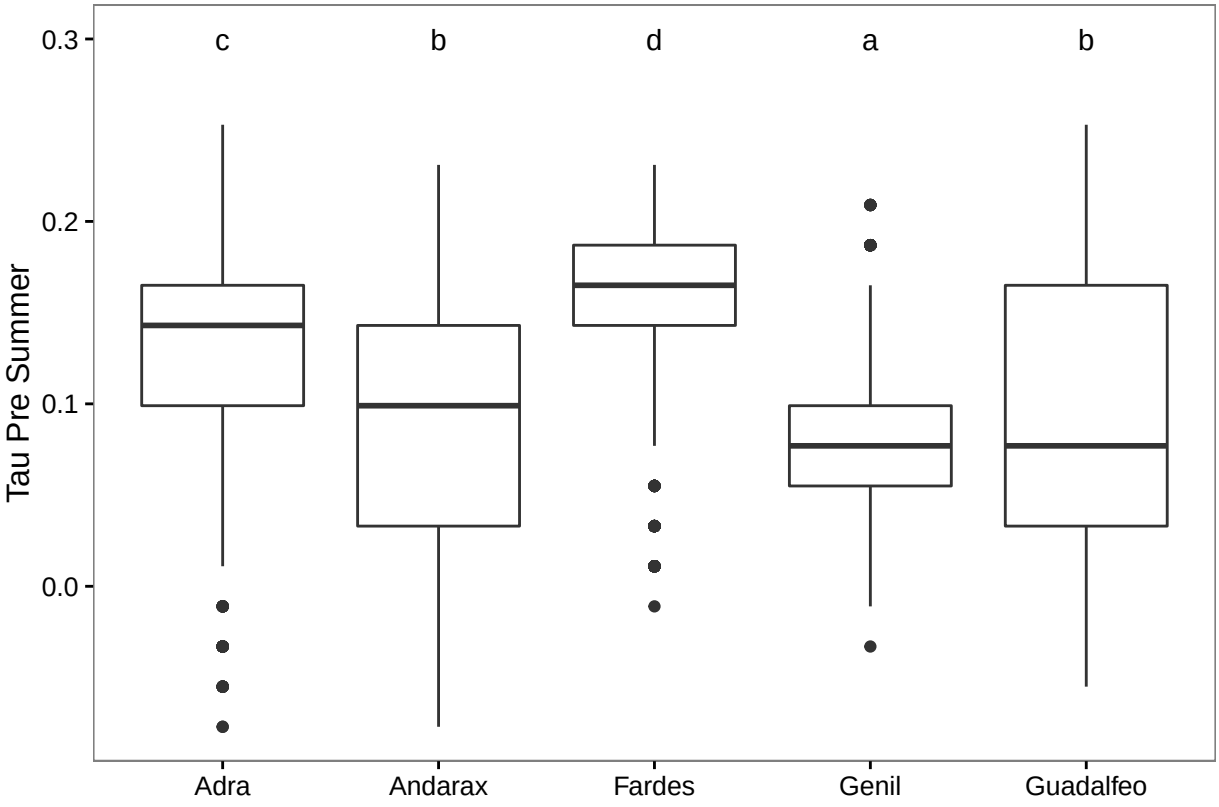
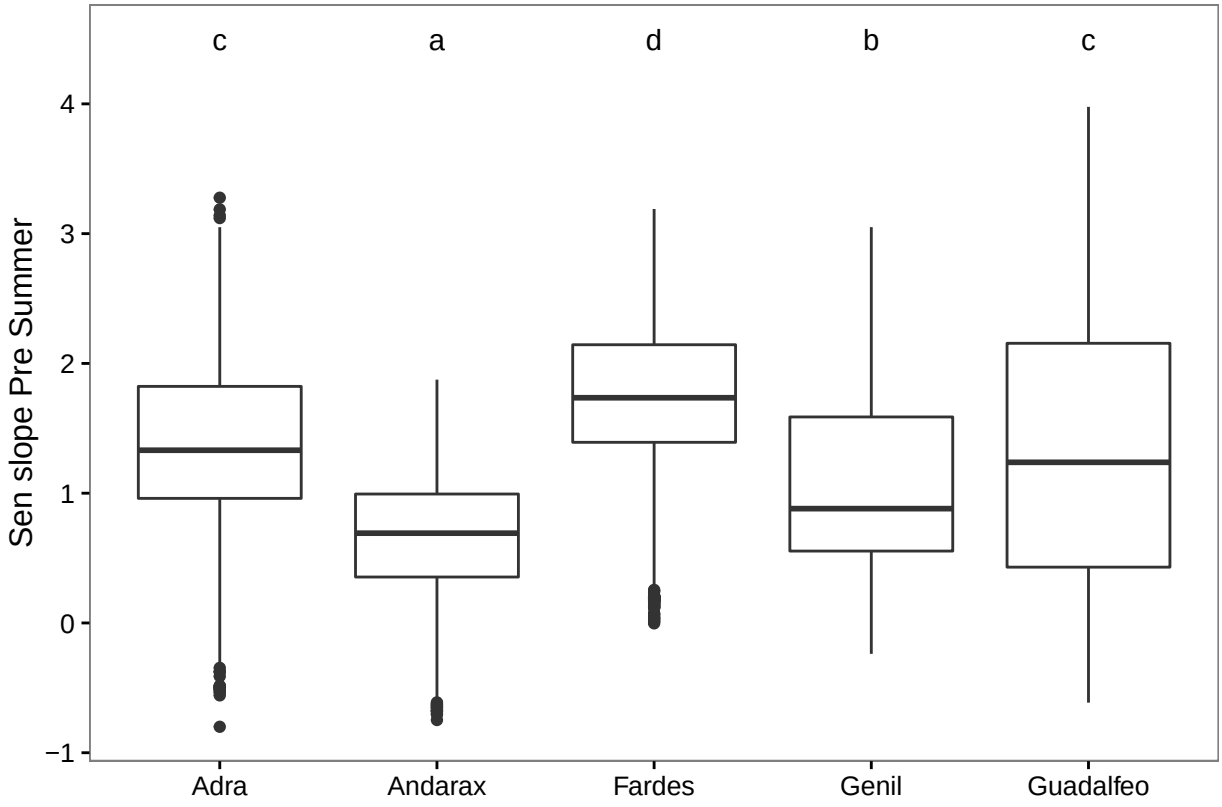


Table 6: Sen slope Pre Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	958.1	239.5	441.4	0
Residuals	7989	4335	0.5426	NA	NA



Pre Winter

Table 7: Tau Pre Winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	4.591	1.148	427.7	0
Residuals	7989	21.44	0.002684	NA	NA

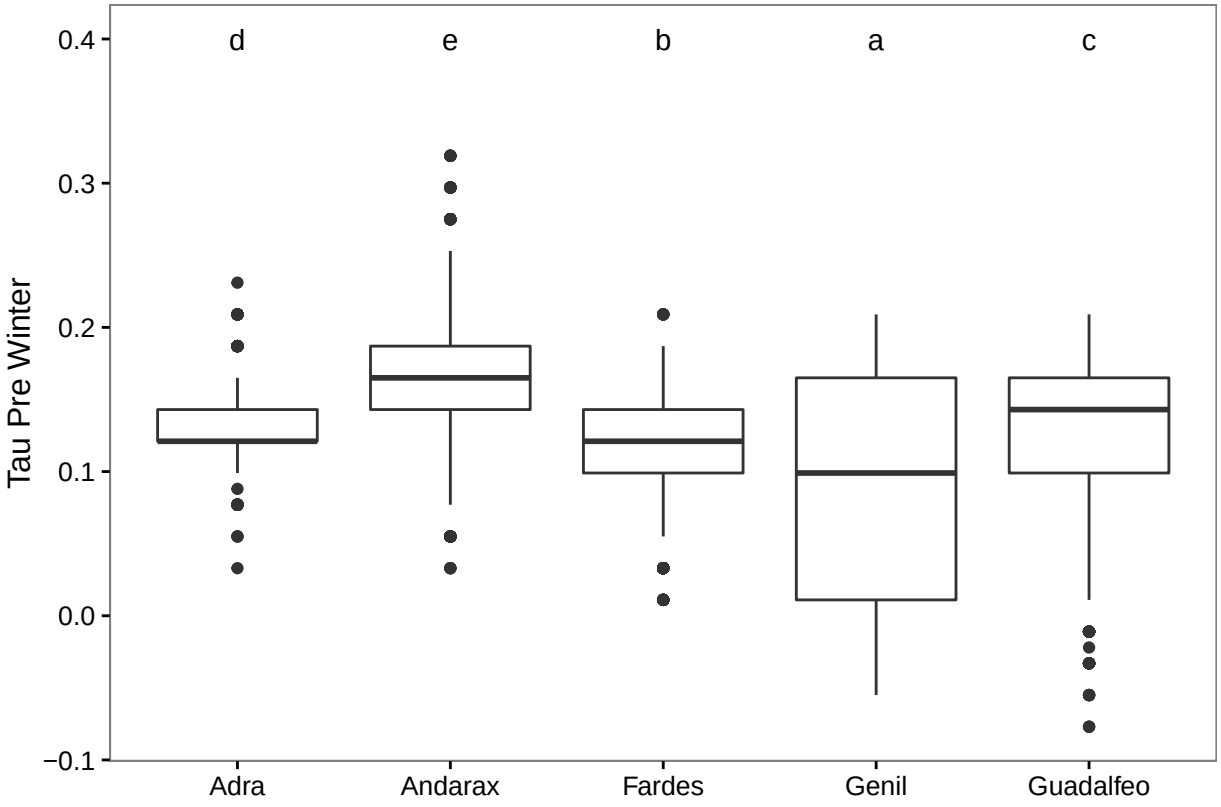
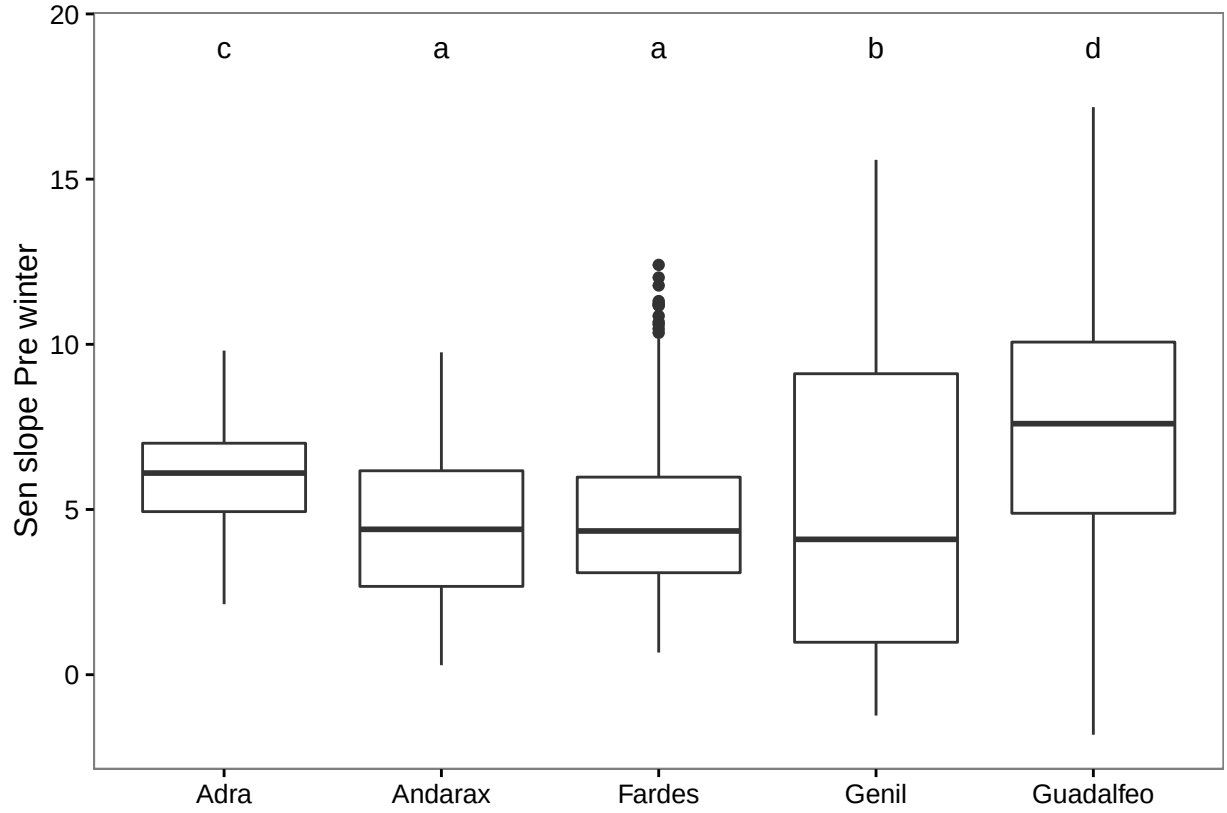
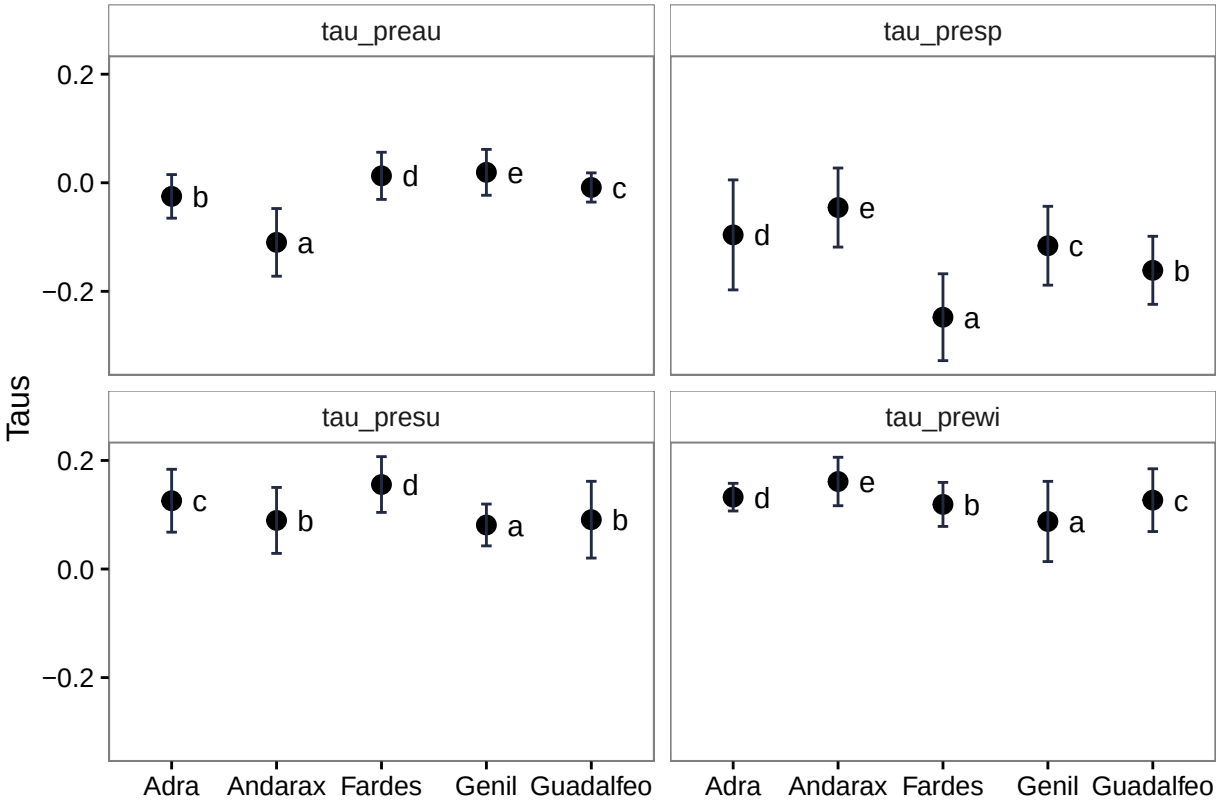
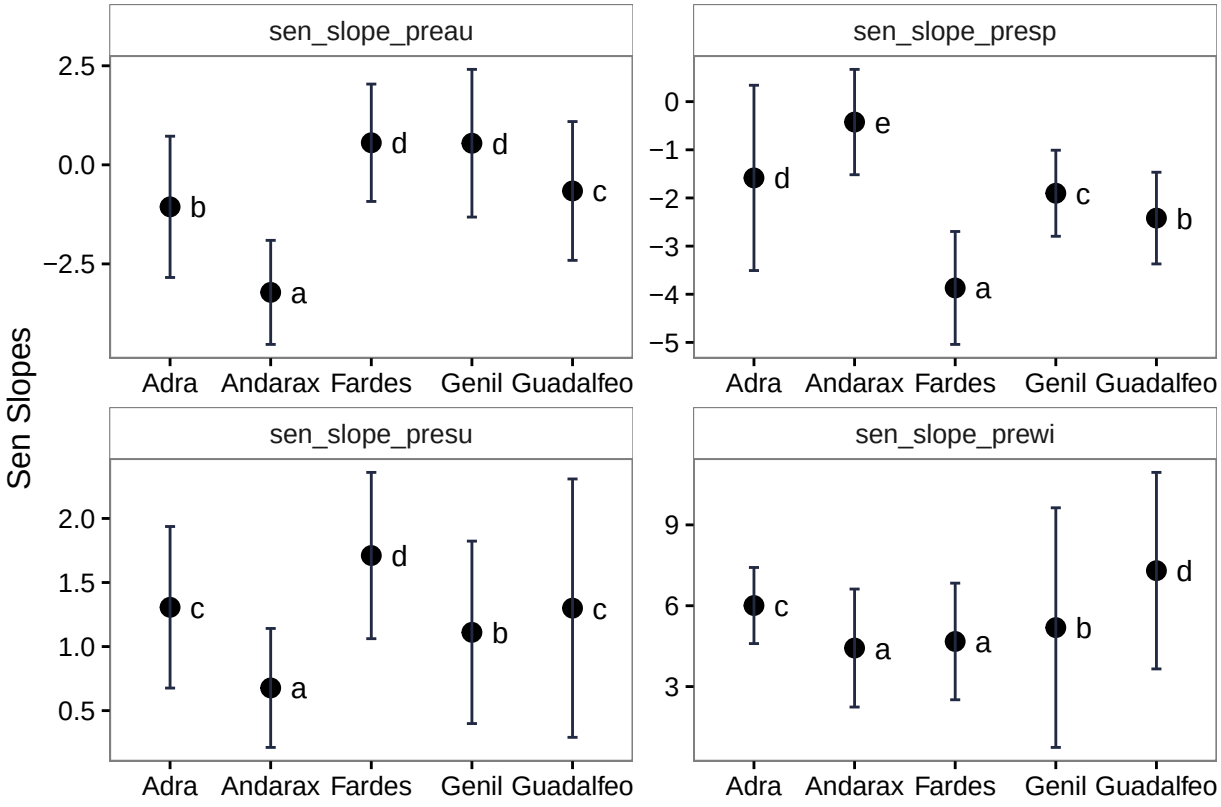


Table 8: Sen slope Pre winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	11086	2771	303.3	2.999e-243
Residuals	7989	73004	9.138	NA	NA


Sen slope Pre winter
20
15
10
5
0
c
a
a
b
d
Adra
Andarax
Fardes
Genil
Guadalfeo


Taus
tau_preau
tau_presp
tau_presu
tau_prewi
0.2
0.0
−0.2
b
a
d
e
c
d
e
a
c
b
c
b
d
a
b
d
e
b
a
c
Adra
Andarax
Fardes
Genil
Guadalfeo



Tau Pre Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.025082126	0.04015186	0.0012480602	tau_preau	b
Andarax	-0.109786125	0.06234441	0.0013105549	tau_preau	a
Fardes	0.012793277	0.04342071	0.0012587036	tau_preau	d
Genil	0.019256702	0.04228114	0.0012050850	tau_preau	e
Guadalfeo	-0.008654945	0.02689062	0.0005637806	tau_preau	c

Sen Slope Pre Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-1.0598889	1.782749	0.05541408	sen_slope_preau	b
Andarax	-3.2190574	1.313425	0.02760978	sen_slope_preau	a
Fardes	0.5571454	1.481361	0.04294252	sen_slope_preau	d
Genil	0.5454622	1.863962	0.05312610	sen_slope_preau	d
Guadalfeo	-0.6588180	1.751861	0.03672898	sen_slope_preau	c

Tau Pre Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.09600290	0.10132677	0.003149590	tau_presp	d
Andarax	-0.04566726	0.07282669	0.001530905	tau_presp	e
Fardes	-0.24768487	0.08001902	0.002319636	tau_presp	a

basin_name	mean	sd	se	variable	tukey_basin_name
Genil	-0.11602275	0.07264075	0.002070386	tau_presp	c
Guadalfeo	-0.16129143	0.06268139	0.001314159	tau_presp	b

Sen Slope Pre Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-1.5837952	1.9238990	0.05980150	sen_slope_presp	d
Andarax	-0.4240473	1.0937713	0.02299240	sen_slope_presp	e
Fardes	-3.8687924	1.1727348	0.03399588	sen_slope_presp	a
Genil	-1.9022819	0.8934289	0.02546425	sen_slope_presp	c
Guadalfeo	-2.4182536	0.9517110	0.01995328	sen_slope_presp	b

Tau Pre Su

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.12580386	0.05790883	0.001800009	tau_presu	c
Andarax	0.08952143	0.06076036	0.001277256	tau_presu	b
Fardes	0.15564538	0.05136464	0.001488987	tau_presu	d
Genil	0.08114622	0.03850461	0.001097447	tau_presu	a
Guadalfeo	0.09087692	0.07068751	0.001482013	tau_presu	b

Sen Slope Pre Su

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	1.3066841	0.6304934	0.019597938	sen_slope_presu	c
Andarax	0.6771295	0.4642255	0.009758582	sen_slope_presu	a
Fardes	1.7106395	0.6489900	0.018813281	sen_slope_presu	d
Genil	1.1111292	0.7119951	0.020293081	sen_slope_presu	b
Guadalfeo	1.2998835	1.0083803	0.021141395	sen_slope_presu	c

Tau Pre Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.13236135	0.02547751	0.0007919299	tau_prewi	d
Andarax	0.16122316	0.04459186	0.0009373749	tau_prewi	e
Fardes	0.11902185	0.04054983	0.0011754809	tau_prewi	b
Genil	0.08759789	0.07388574	0.0021058702	tau_prewi	a
Guadalfeo	0.12685055	0.05781138	0.0012120560	tau_prewi	c

Sen Slope Pre Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	6.007626	1.412031	0.04389087	sen_slope_prewi	c
Andarax	4.429882	2.188979	0.04601500	sen_slope_prewi	a

basin_name	mean	sd	se	variable	tukey_basin_name
Fardes	4.674043	2.163412	0.06271419	sen_slope_prewi	a
Genil	5.188393	4.445629	0.12670805	sen_slope_prewi	b
Guadalfeo	7.301517	3.646020	0.07644136	sen_slope_prewi	d

Explore trends by elevation

Taus

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_preau ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.805  8.639 431.2  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_preau ~ s(dem50mean)
##
## Parametric coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0319198  0.0006297  -50.69   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.805  8.639 431.2  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.318   Deviance explained = 31.9%
## GCV = 0.0031735  Scale est. = 0.00317   n = 7994
```

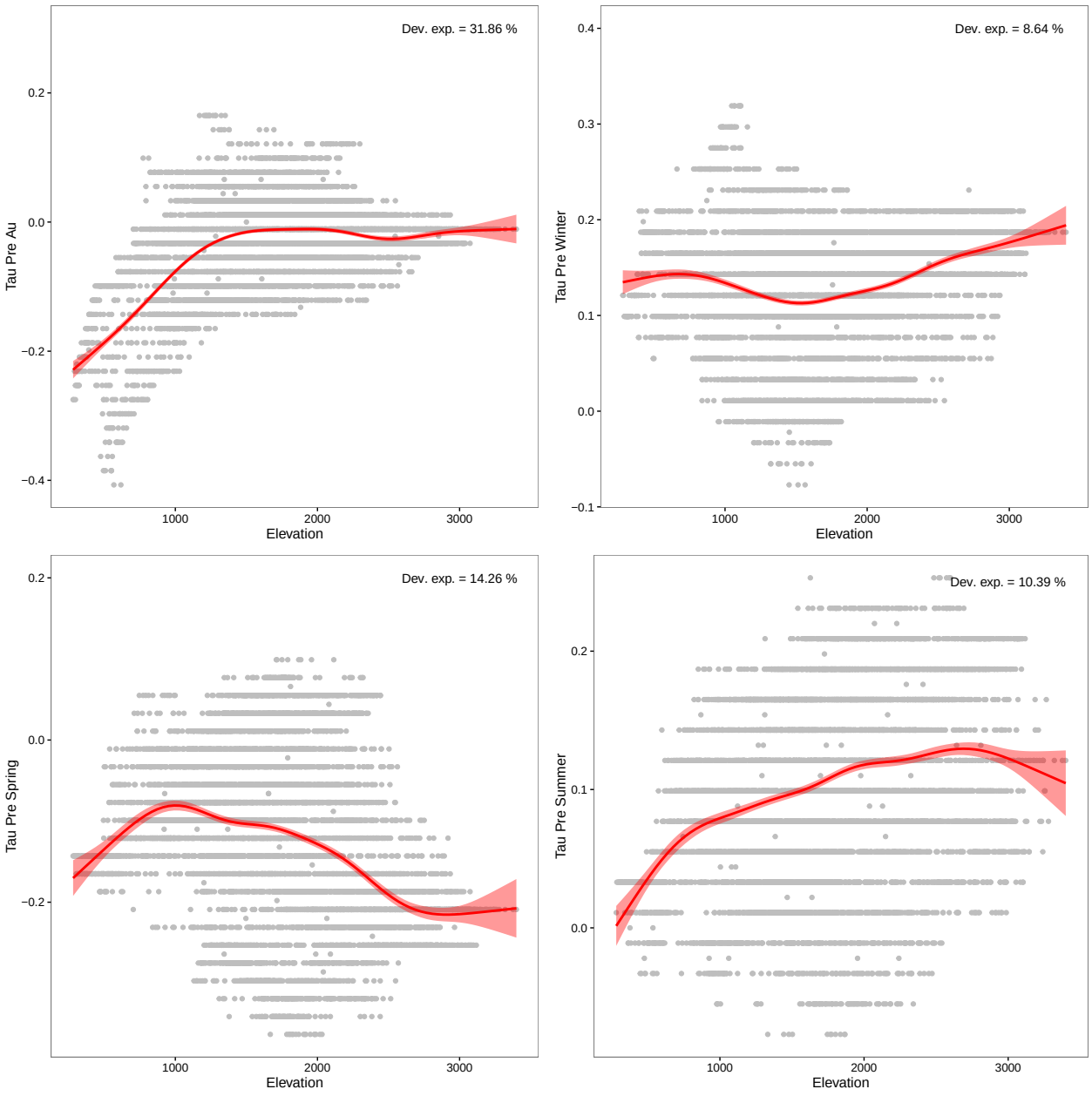
```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_presp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
```

```
## s(dem50mean) 7.574  8.501 155.2  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_presp ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.125996   0.001048  -120.2   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.574  8.501 155.2  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.142   Deviance explained = 14.3%
## GCV = 0.0087889  Scale est. = 0.0087794  n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_presu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.625  8.533 107.9  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_presu ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.1031584  0.0006838   150.9   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.625  8.533 107.9  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## R-sq.(adj) =  0.103   Deviance explained = 10.4%
## GCV = 0.003742  Scale est. = 0.0037379  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_prewi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.246  8.276 90.46  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_prewi ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.1300846  0.0006104   213.1   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.246  8.276 90.46  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0856   Deviance explained = 8.64%
## GCV = 0.0029811  Scale est. = 0.002978  n = 7994
```



Sen

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_preau ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                 edf Ref.df     F p-value
## s(dem50mean) 7.875  8.677 117.9  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_preau ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.06906    0.02304  -46.41   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.875  8.677 117.9  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.113   Deviance explained = 11.4%
## GCV = 4.2472  Scale est. = 4.2425    n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_presp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.502  8.454 191.5  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_presp ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.88215    0.01671  -112.6   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.502  8.454 191.5  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.168   Deviance explained = 16.9%
## GCV = 2.2354  Scale est. = 2.233     n = 7994
```

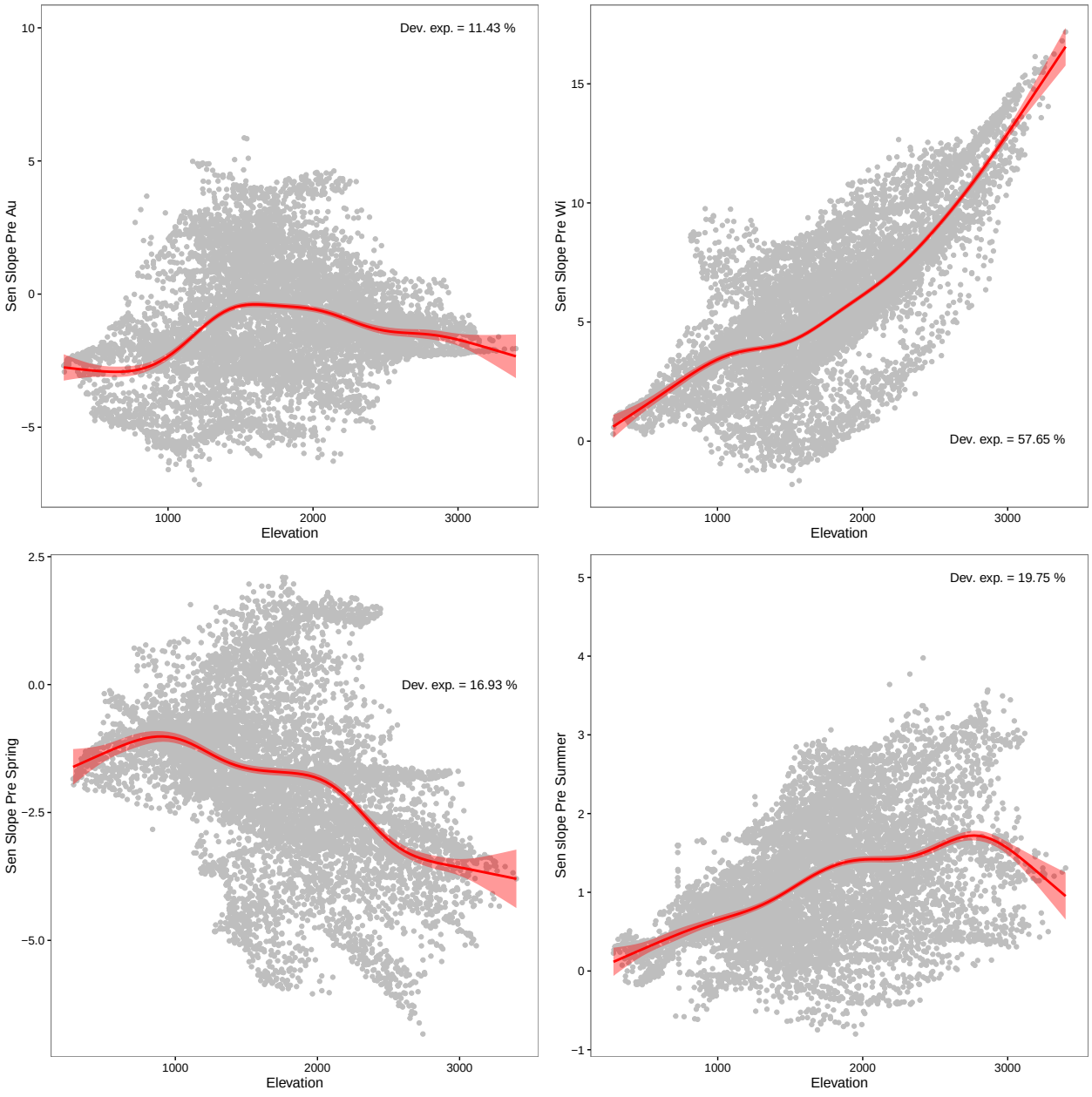
```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_presu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.141  8.805 222.7  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_presu ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.156550   0.008158   141.8   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.141  8.805 222.7  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.197   Deviance explained = 19.8%
## GCV = 0.53257  Scale est. = 0.53196   n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_prewi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 7.320  8.329 1305  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_prewi ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)  5.60454    0.02362   237.3   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 7.32  8.329 1305  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.576   Deviance explained = 57.7%
## GCV = 4.4636  Scale est. = 4.4589    n = 7994
```



Pre Snow

Autunm

Table 17: Tau Pn au

term	df	sumsq	meansq	statistic	p.value
basin_name	4	30.36	7.591	720.5	0
Residuals	7989	84.17	0.01054	NA	NA

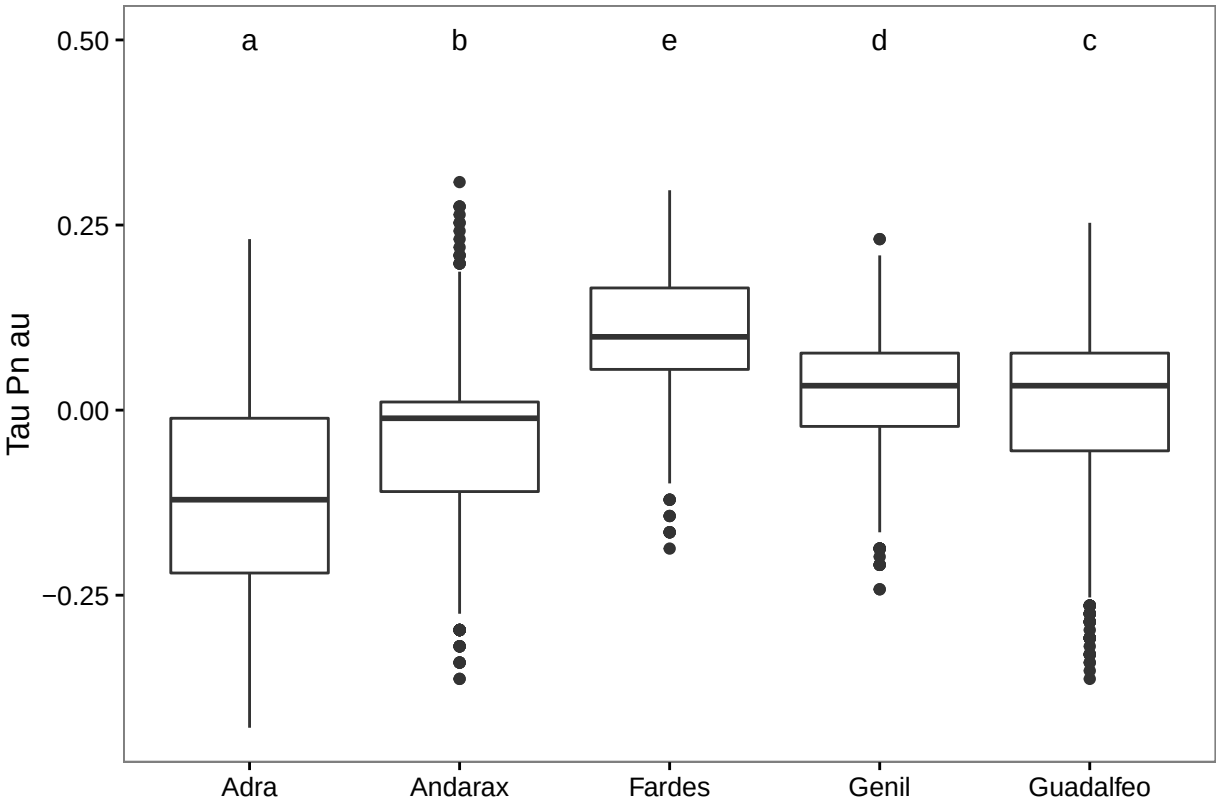
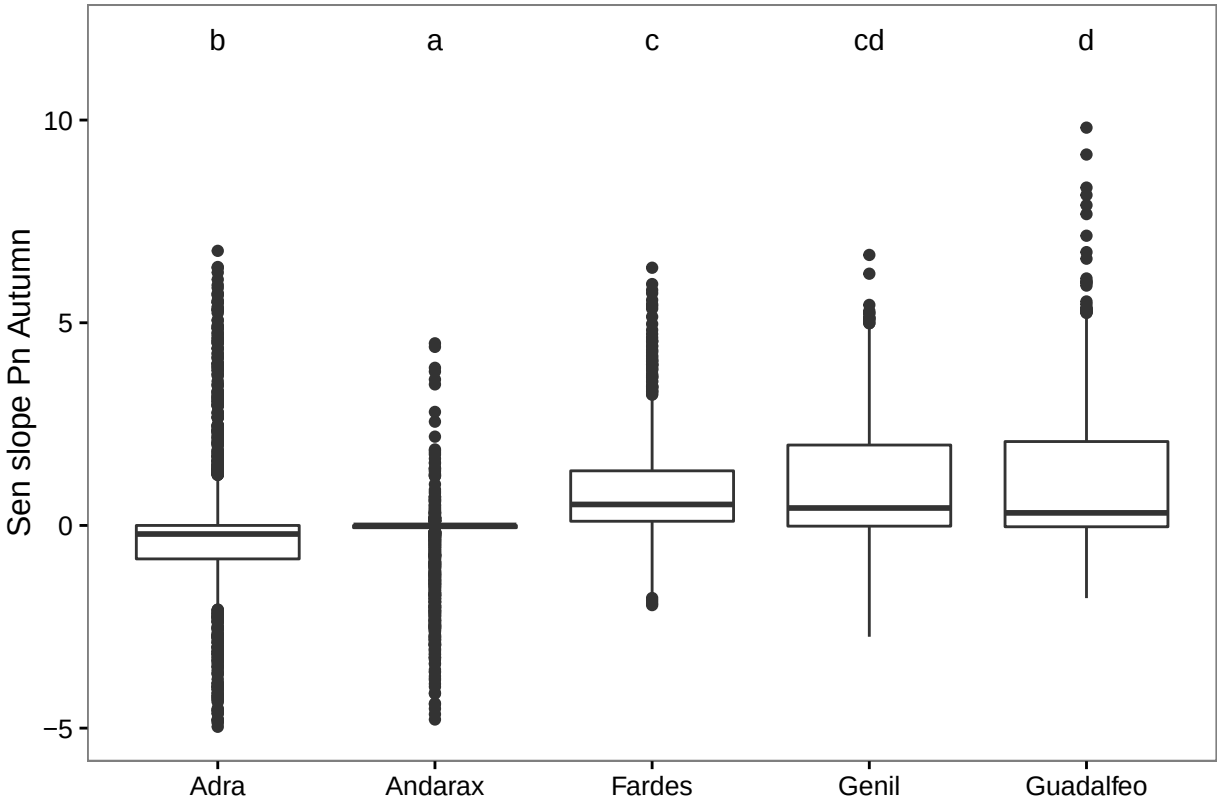


Table 18: Sen slope Pn Autumn

term	df	sumsq	meansq	statistic	p.value
basin_name	4	2772	692.9	378.5	5.258e-299
Residuals	7989	14625	1.831	NA	NA



Pn Spring

Table 19: Tau Pn Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	10.56	2.639	416.2	0
Residuals	7989	50.67	0.006342	NA	NA

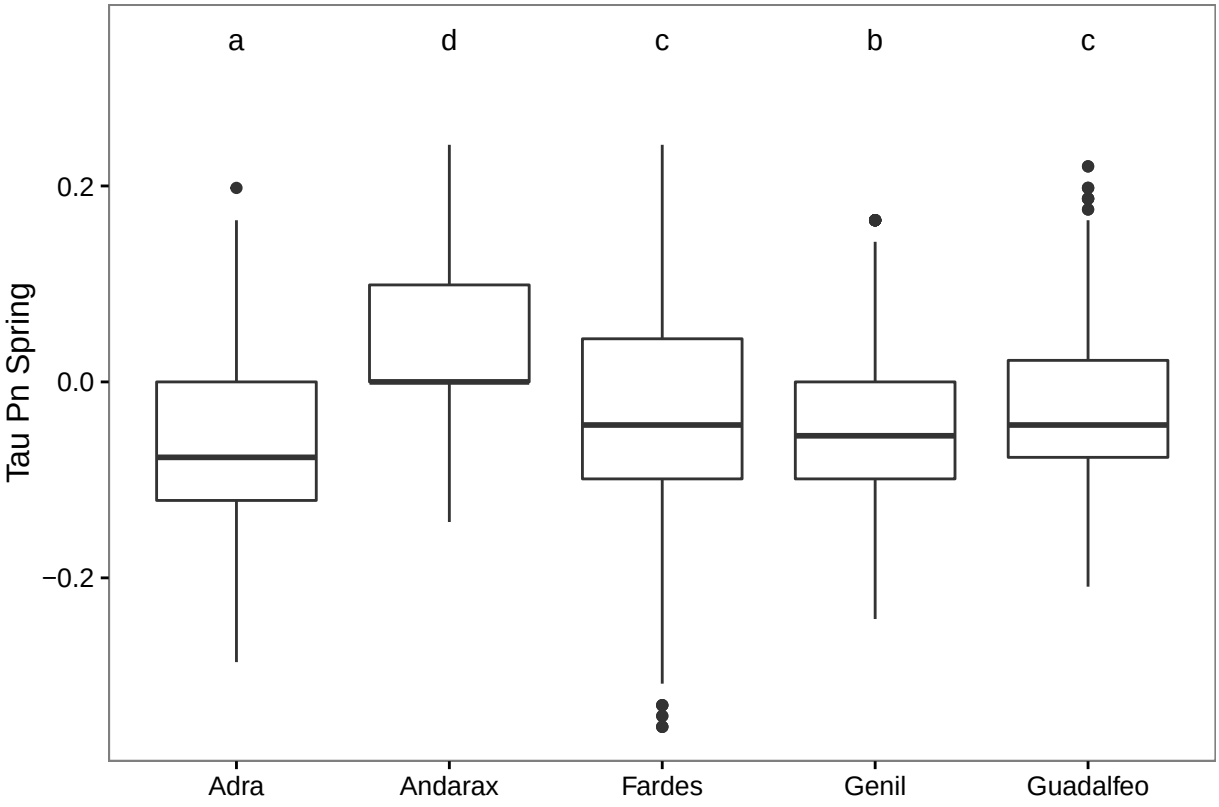
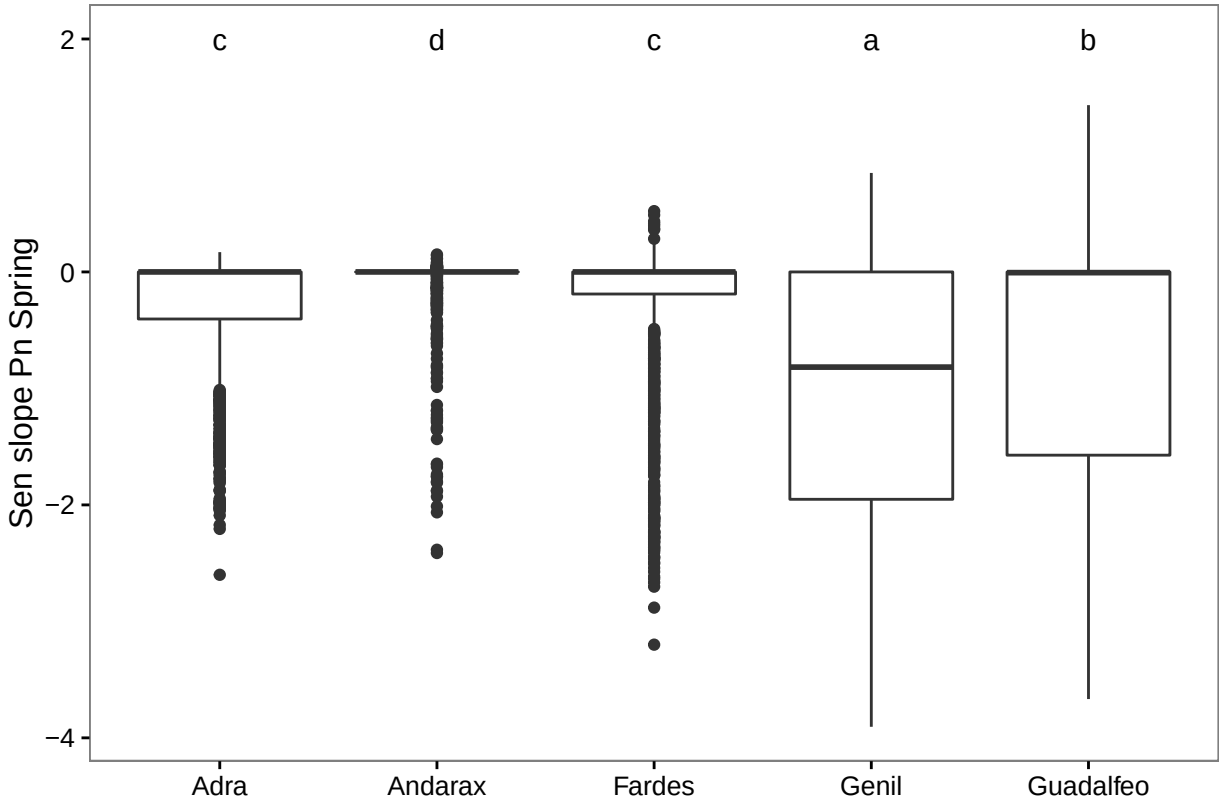


Table 20: Sen slope Pn Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	1014	253.6	443	0
Residuals	7989	4573	0.5724	NA	NA



Pn Summer

Table 21: Tau Pn Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	1.758	0.4394	180.1	5.304e-148
Residuals	7989	19.49	0.002439	NA	NA

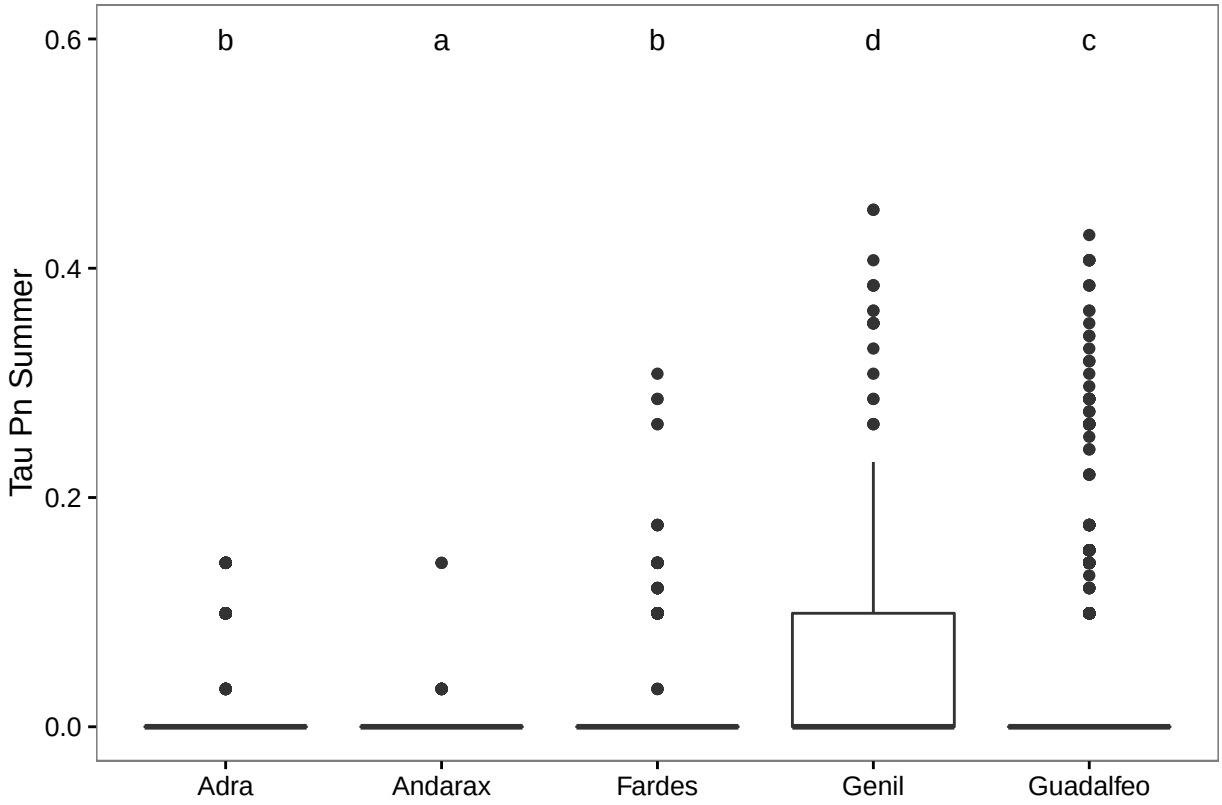
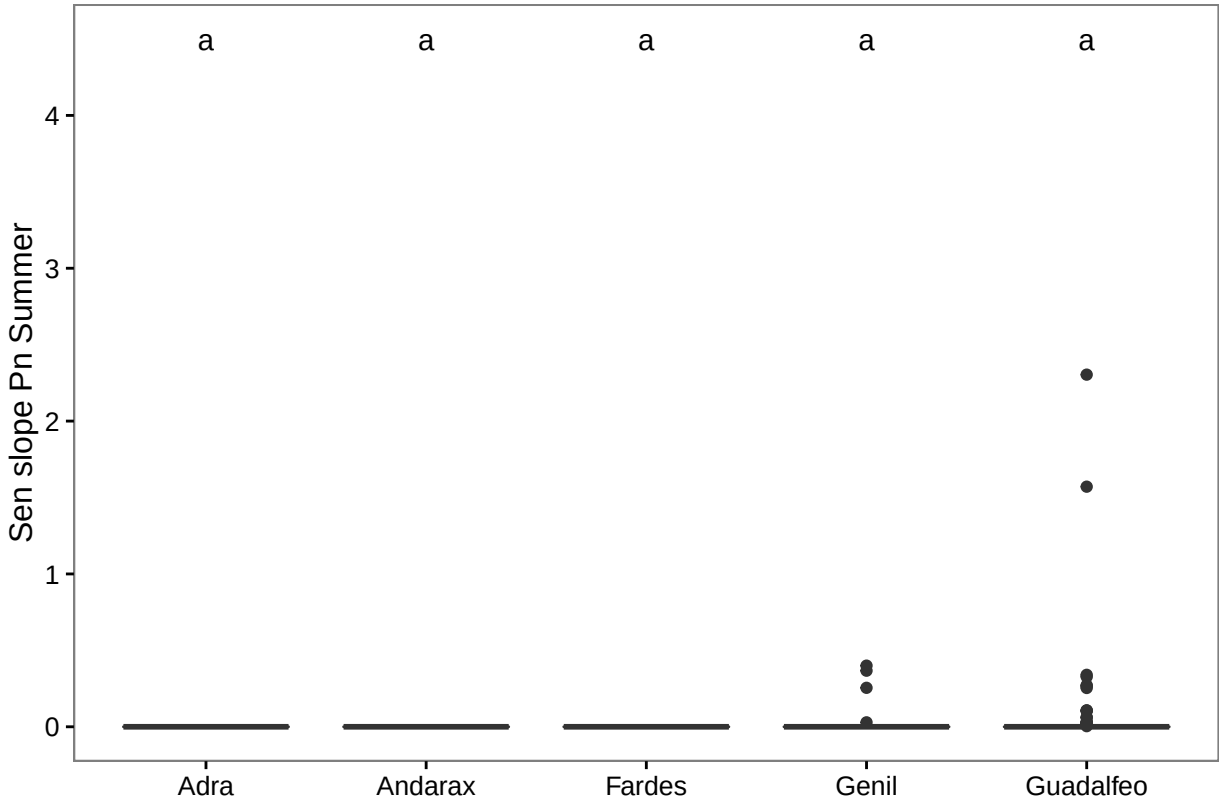


Table 22: Sen slope Pn Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	0.01048	0.002619	2.434	0.04523
Residuals	7989	8.599	0.001076	NA	NA

```
## Warning in RET$pfunction("adjusted", ...): lower == upper

## Warning in RET$pfunction("adjusted", ...): lower == upper

## Warning in RET$pfunction("adjusted", ...): lower == upper
```



Pn Winter

Table 23: Tau Pn Winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	10.91	2.727	307.2	3.546e-246
Residuals	7989	70.94	0.008879	NA	NA

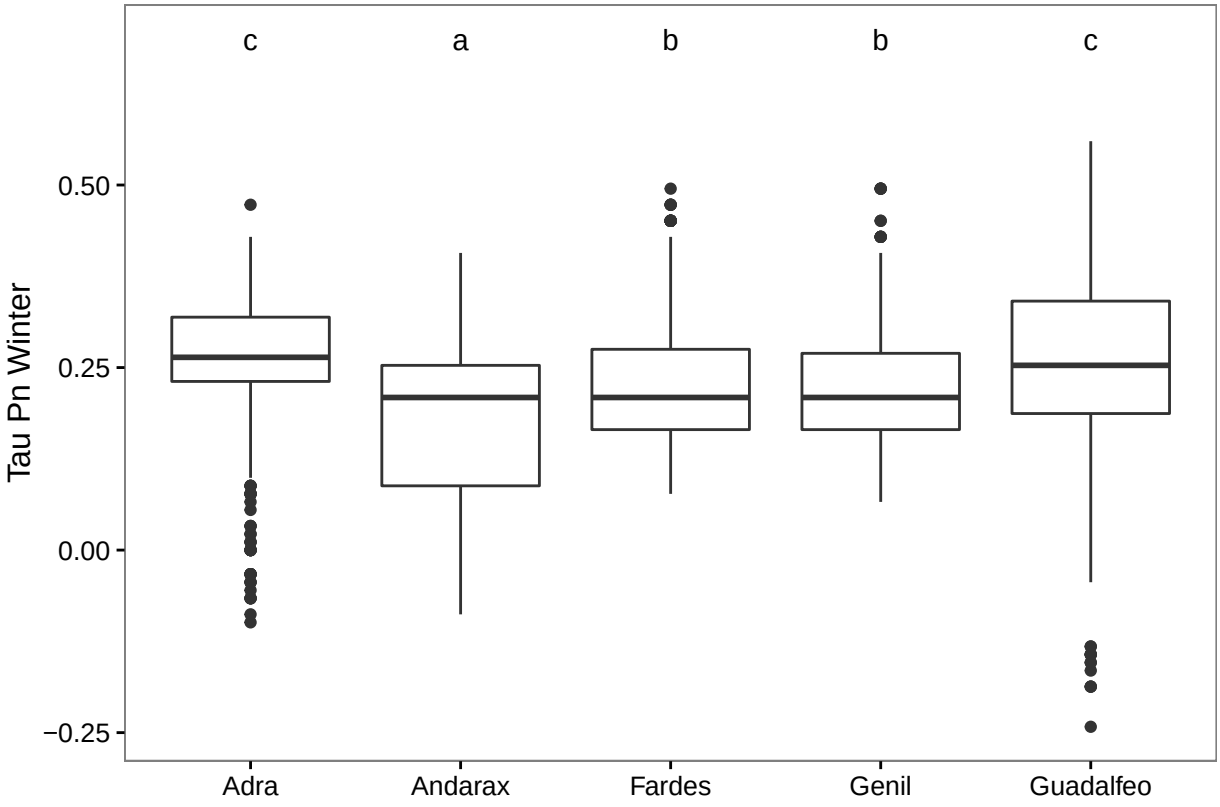
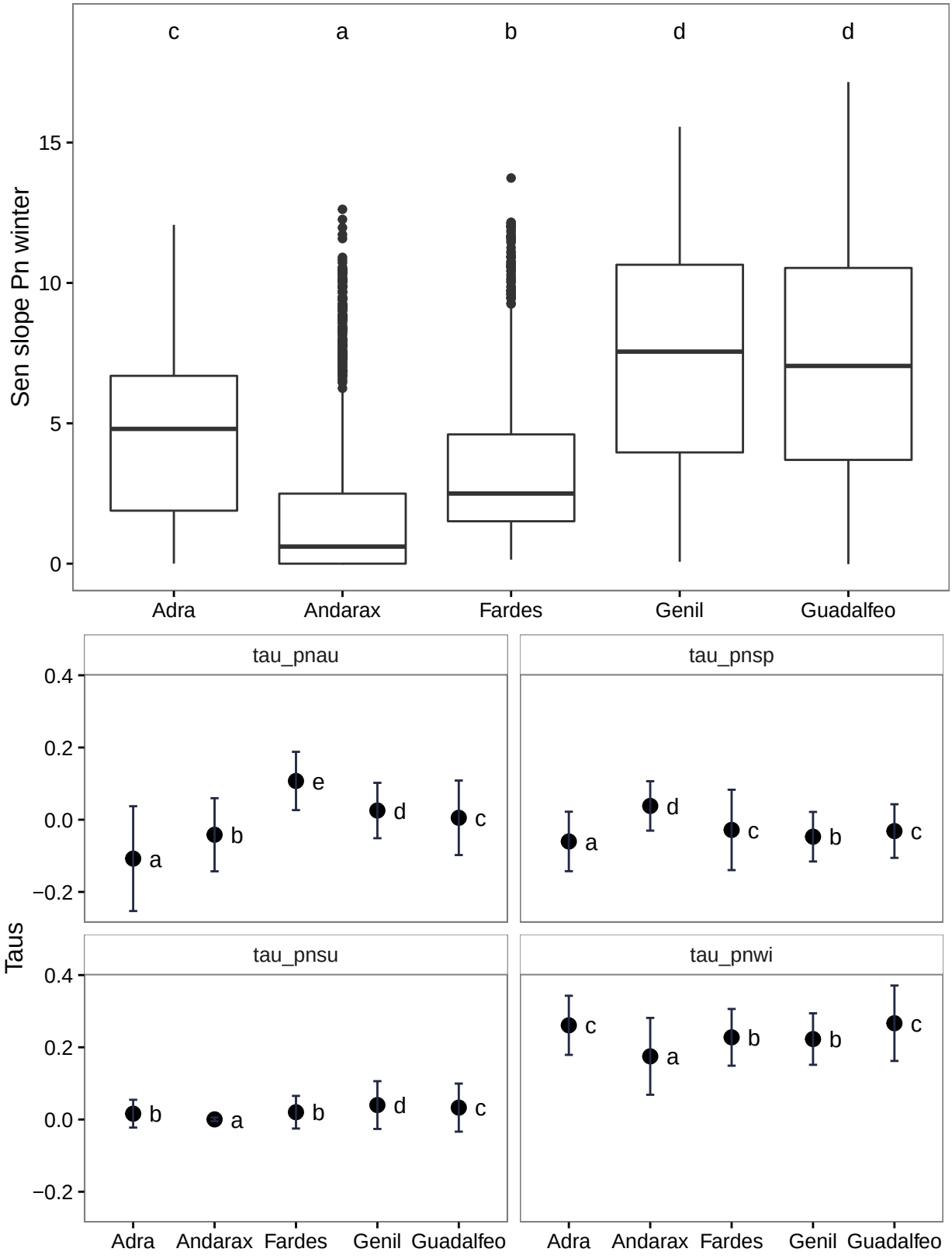
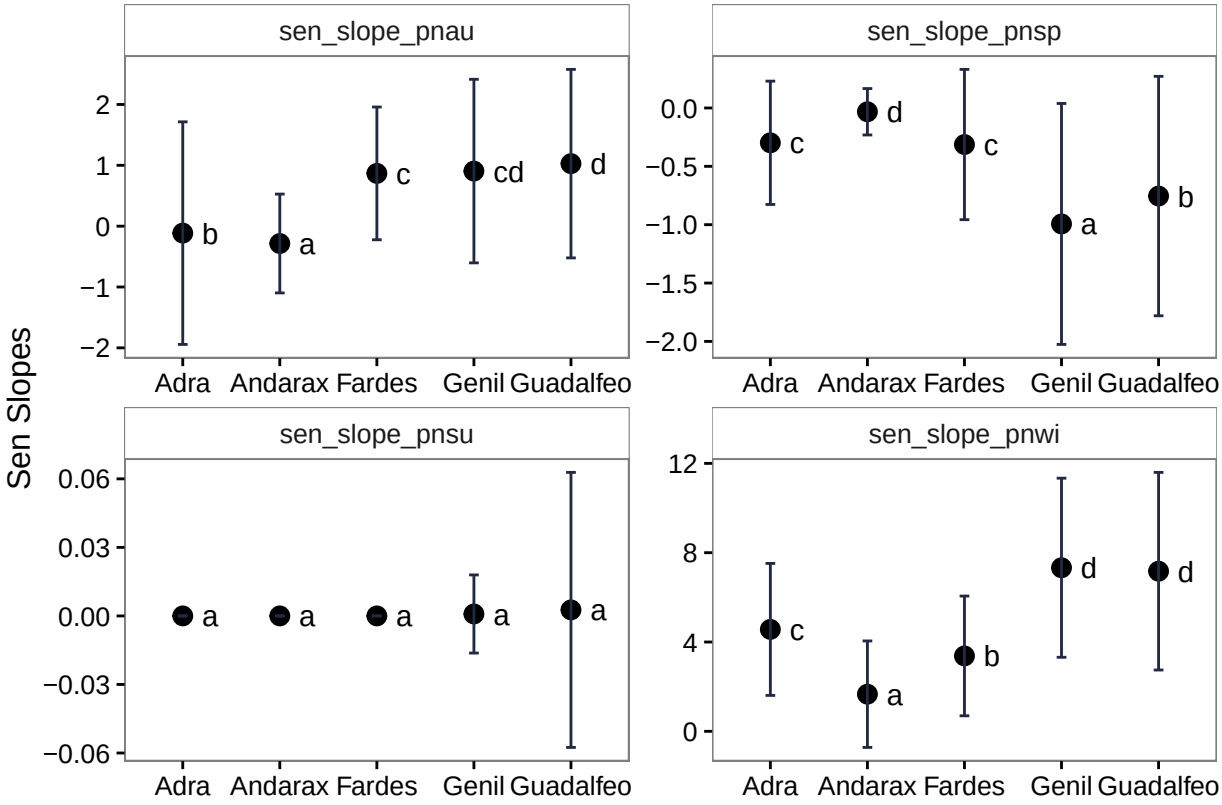


Table 24: Sen slope Pn winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	45340	11335	955.6	0
Residuals	7989	94762	11.86	NA	NA


c
a
b
d
d
Sen slope Pn winter
15
10
5
0
Adra
Andarax
Fardes
Genil
Guadalfeo
tau_pnau
tau_pnsp
tau_pnsu
tau_pnwi
Taus
0.4
0.2
0.0
−0.2
a
b
e
d
c
a
d
c
b
c
b
a
b
d
c
c
a
b
b
c
Adra
Andarax
Fardes
Genil
Guadalfeo



Tau Pn Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.107810628	0.14513343	0.004511254	tau_pnau	a
Andarax	-0.041700840	0.10127515	0.002128926	tau_pnau	b
Fardes	0.107263866	0.08071245	0.002339737	tau_pnau	e
Genil	0.025413485	0.07672961	0.002186925	tau_pnau	d
Guadalfeo	0.005313846	0.10316700	0.002162968	tau_pnau	c

Sen Slope Pn Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.1144937	1.8291879	0.05685755	sen_slope_pnau	b
Andarax	-0.2851551	0.8123157	0.01707586	sen_slope_pnau	a
Fardes	0.8673034	1.0908006	0.03162073	sen_slope_pnau	c
Genil	0.9050788	1.5084745	0.04299411	sen_slope_pnau	cd
Guadalfeo	1.0274567	1.5493408	0.03248301	sen_slope_pnau	d

Tau Pn Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.06027150	0.08240051	0.002561296	tau_pnsp	a
Andarax	0.03813787	0.06842631	0.001438404	tau_pnsp	d
Fardes	-0.02833193	0.11128799	0.003226078	tau_pnsp	c

basin_name	mean	sd	se	variable	tukey_basin_name
Genil	-0.04705605	0.06863981	0.001956352	tau_pnsp	b
Guadalfeo	-0.03146242	0.07424299	0.001556556	tau_pnsp	c

Sen Slope Pn Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.29852271	0.5281719	0.016417428	sen_slope_pnsp	c
Andarax	-0.03259081	0.1988411	0.004179881	sen_slope_pnsp	d
Fardes	-0.31329076	0.6438147	0.018663255	sen_slope_pnsp	c
Genil	-0.99368481	1.0321631	0.029418418	sen_slope_pnsp	a
Guadalfeo	-0.75476659	1.0256277	0.021502999	sen_slope_pnsp	b

Tau Pn Su

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.0161439614	0.038513927	0.0011971474	tau_pnsu	b
Andarax	0.0003596995	0.005064972	0.0001064718	tau_pnsu	a
Fardes	0.0202067227	0.045184857	0.0013098436	tau_pnsu	b
Genil	0.0400056864	0.066150881	0.0018854135	tau_pnsu	d
Guadalfeo	0.0329371429	0.066598292	0.0013962796	tau_pnsu	c

Sen Slope Pn Su

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.0000000000	0.00000000	0.0000000000	sen_slope_pnsu	a
Andarax	0.0000000000	0.00000000	0.0000000000	sen_slope_pnsu	a
Fardes	0.0000000000	0.00000000	0.0000000000	sen_slope_pnsu	a
Genil	0.0008537774	0.01709984	0.0004873748	sen_slope_pnsu	a
Guadalfeo	0.0026342857	0.06019260	0.0012619797	sen_slope_pnsu	a

Tau Pn Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.2609285	0.08186479	0.002544644	tau_pnwi	c
Andarax	0.1749549	0.10640305	0.002236721	tau_pnwi	a
Fardes	0.2275706	0.07858701	0.002278124	tau_pnwi	b
Genil	0.2227969	0.07133327	0.002033120	tau_pnwi	b
Guadalfeo	0.2666009	0.10442275	0.002189296	tau_pnwi	c

Sen Slope Pn Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	4.564333	2.955708	0.09187373	sen_slope_pnwi	c
Andarax	1.663647	2.384145	0.05011762	sen_slope_pnwi	a
Fardes	3.376589	2.681564	0.07773466	sen_slope_pnwi	b
Genil	7.326321	4.010848	0.11431603	sen_slope_pnwi	d
Guadalfeo	7.171021	4.425388	0.09278134	sen_slope_pnwi	d

Explore trends by elevation

Taus

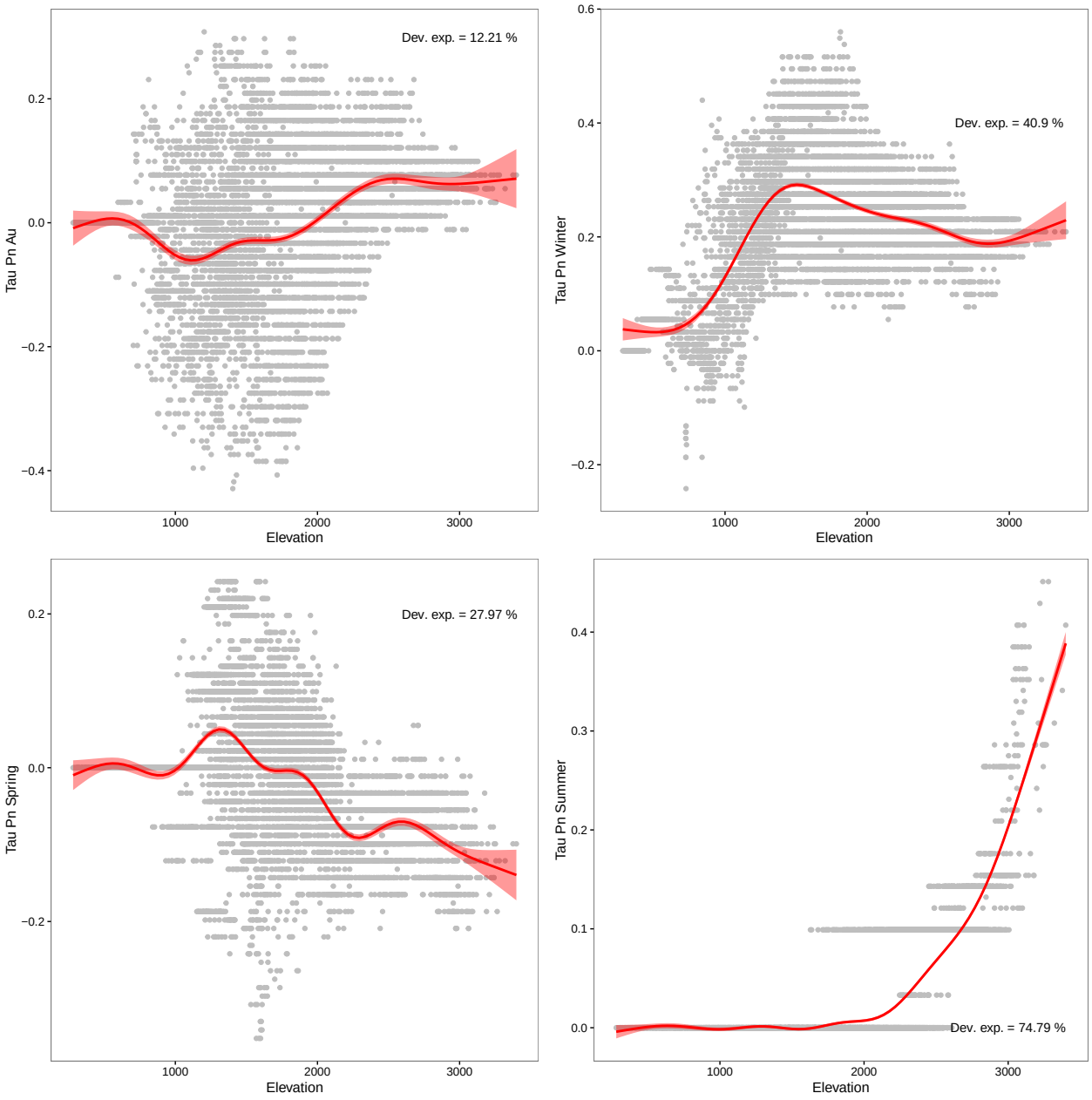
```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnau ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                 edf Ref.df     F p-value
## s(dem50mean) 8.523  8.937 123.5  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnau ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.004370   0.001255  -3.482    5e-04 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                 edf Ref.df     F p-value
## s(dem50mean) 8.523  8.937 123.5  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.121   Deviance explained = 12.2%
## GCV = 0.012608  Scale est. = 0.012593  n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
```

```
## tau_pnsp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.988  9.000 344.4  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnsp ~ s(dem50mean)
##
## Parametric coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0174247  0.0008312  -20.96   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.988      9 344.4  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.279   Deviance explained =   28%
## GCV = 0.0055303  Scale est. = 0.0055234  n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnsu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 8.971  9.000 2632  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnsu ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0207341  0.0002897   71.58   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
```

```
##                edf Ref.df    F p-value
## s(dem50mean) 8.971      9 2632  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.748   Deviance explained = 74.8%
## GCV = 0.00067156  Scale est. = 0.00067072  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnwi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.548  8.943 616.2  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_pnwi ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.2273672  0.0008706   261.2   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.548  8.943 616.2  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.408   Deviance explained = 40.9%
## GCV = 0.0060656  Scale est. = 0.0060583  n = 7994
```



Sen

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnau ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                 edf Ref.df   F p-value
## s(dem50mean) 8.828  8.991 914  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnau ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.46534    0.01159   40.16   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df   F p-value
## s(dem50mean) 8.828  8.991 914  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.507   Deviance explained = 50.7%
## GCV = 1.0748  Scale est. = 1.0735    n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnsp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 8.936  8.999 1979  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnsp ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.462329   0.005205  -88.82   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 8.936  8.999 1979  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =   0.69   Deviance explained = 69.1%
## GCV = 0.21686  Scale est. = 0.21659   n = 7994
```

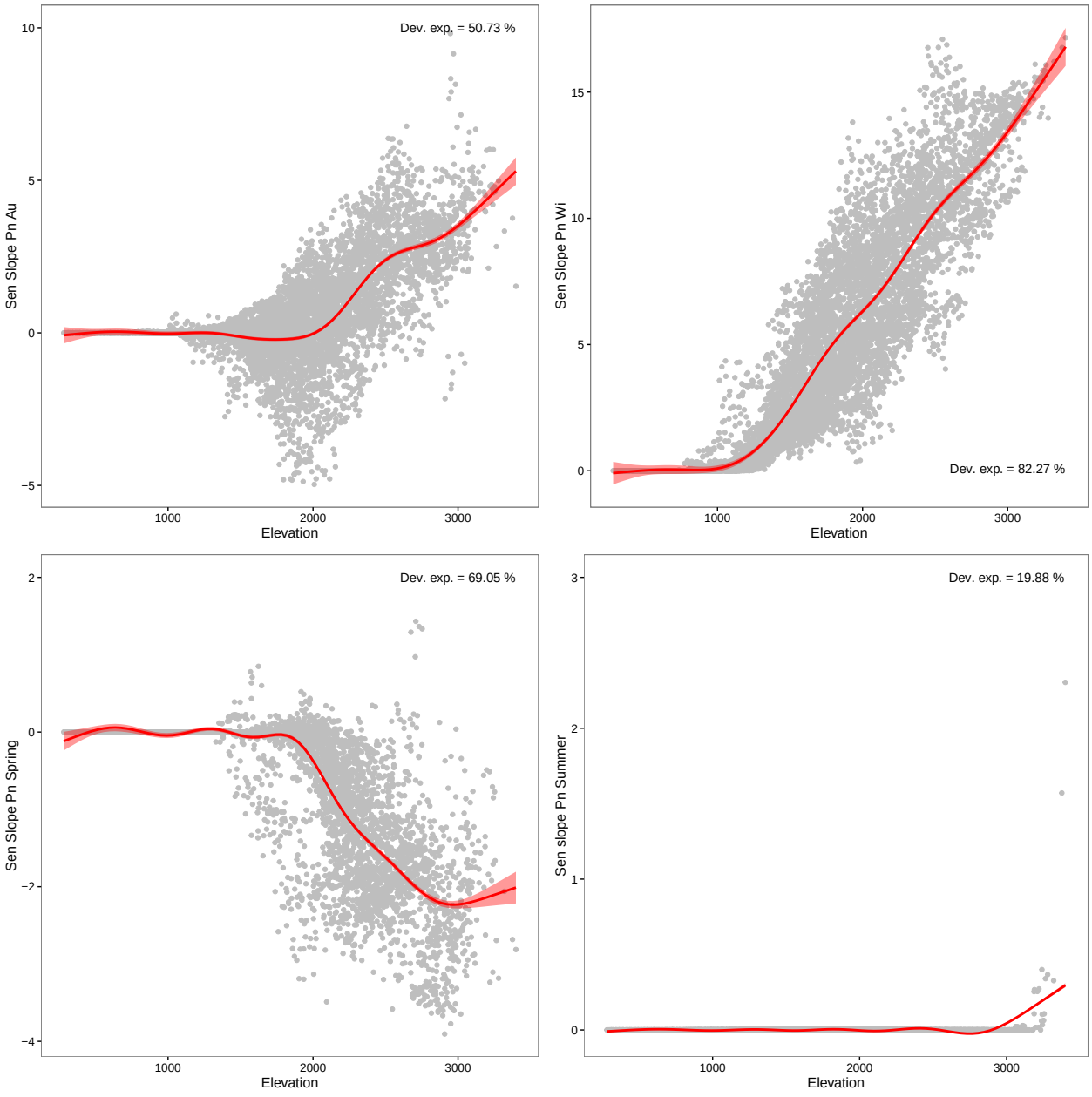
```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnsu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.995  9.000 220.1  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnsu ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0008812  0.0003287    2.68  0.00737 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.995      9 220.1  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.198   Deviance explained = 19.9%
## GCV = 0.00086504  Scale est. = 0.00086396  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnwi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 8.585  8.952 4140  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_pnwi ~ s(dem50mean)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)  4.73353    0.01972     240   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df    F p-value
## s(dem50mean) 8.585  8.952 4140  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.823   Deviance explained = 82.3%
## GCV =  3.114  Scale est. = 3.1103    n = 7994
```



Temperatures

Autunm

Table 33: Tau Temp au

term	df	sumsq	meansq	statistic	p.value
basin_name	4	7.922	1.98	720.8	0
Residuals	7989	21.95	0.002747	NA	NA

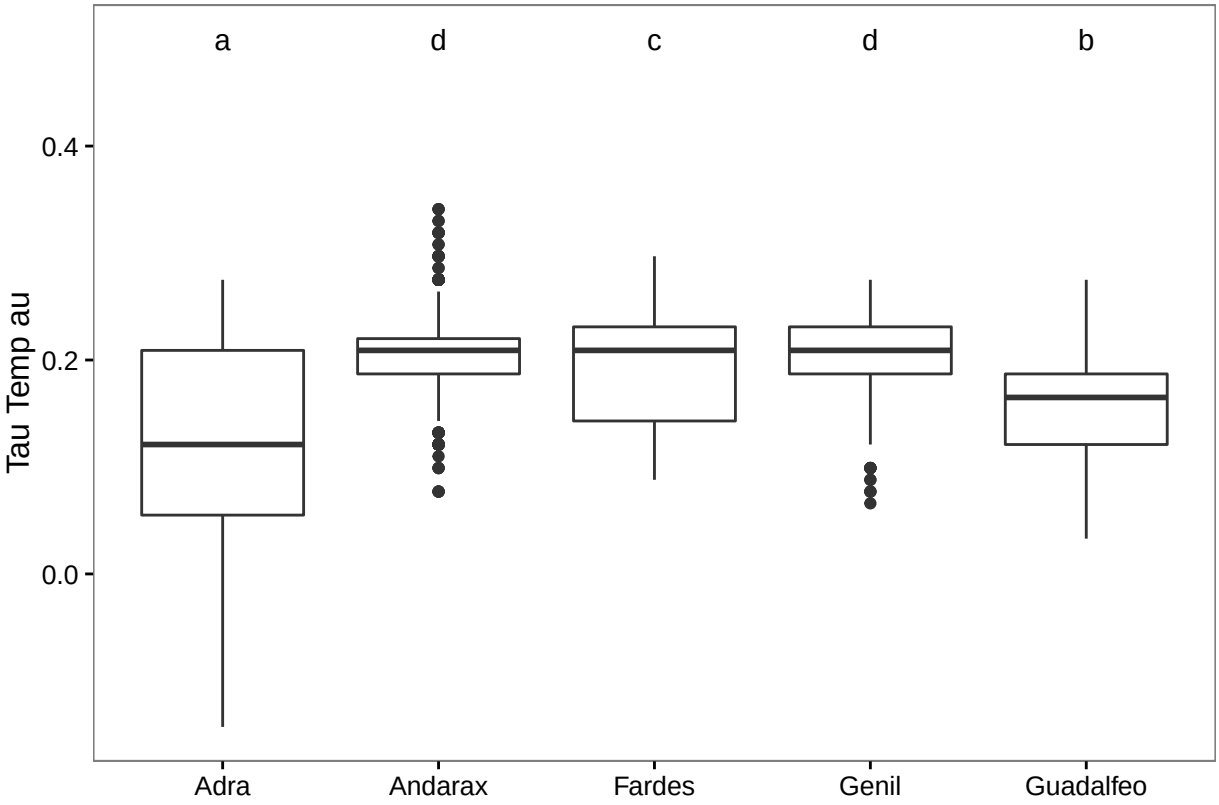
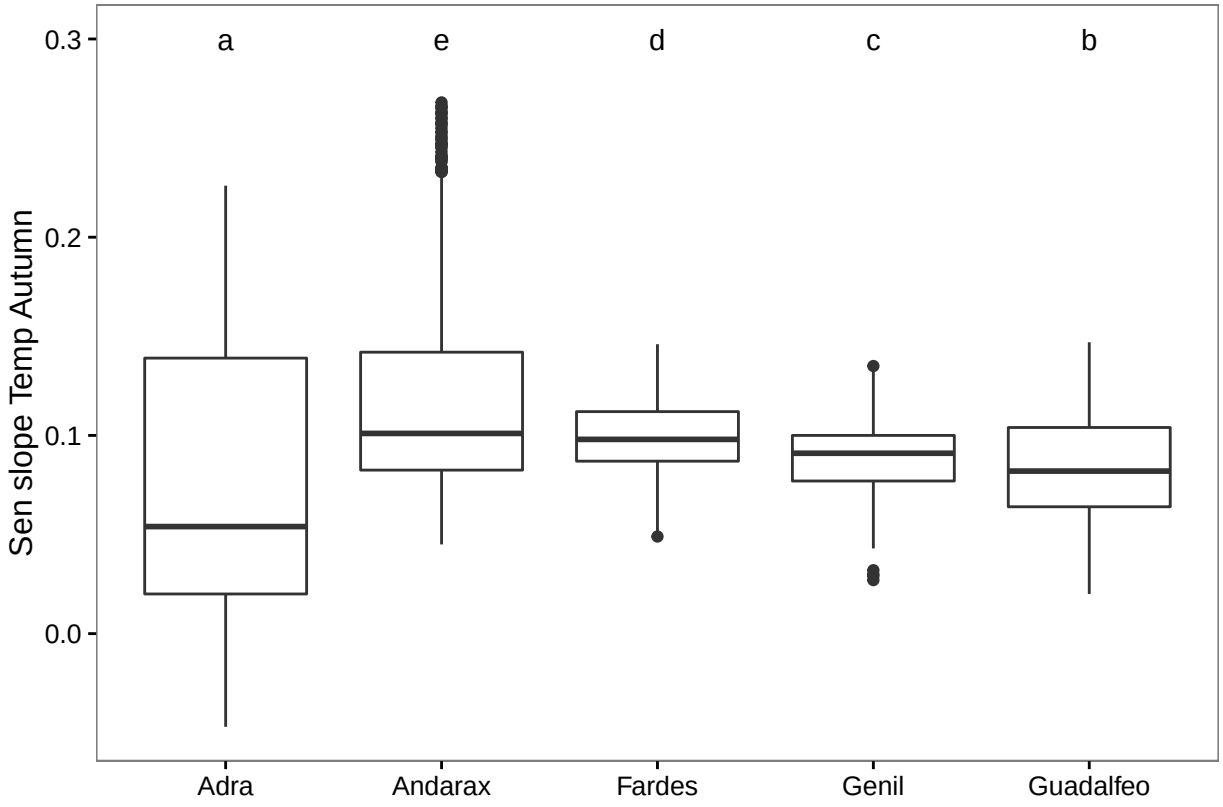


Table 34: Sen slope Temp Autumn

term	df	sumsq	meansq	statistic	p.value
basin_name	4	1.963	0.4907	329.1	1.292e-262
Residuals	7989	11.91	0.001491	NA	NA



Temp Spring

Table 35: Tau Temp Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	15.69	3.923	1118	0
Residuals	7989	28.04	0.00351	NA	NA

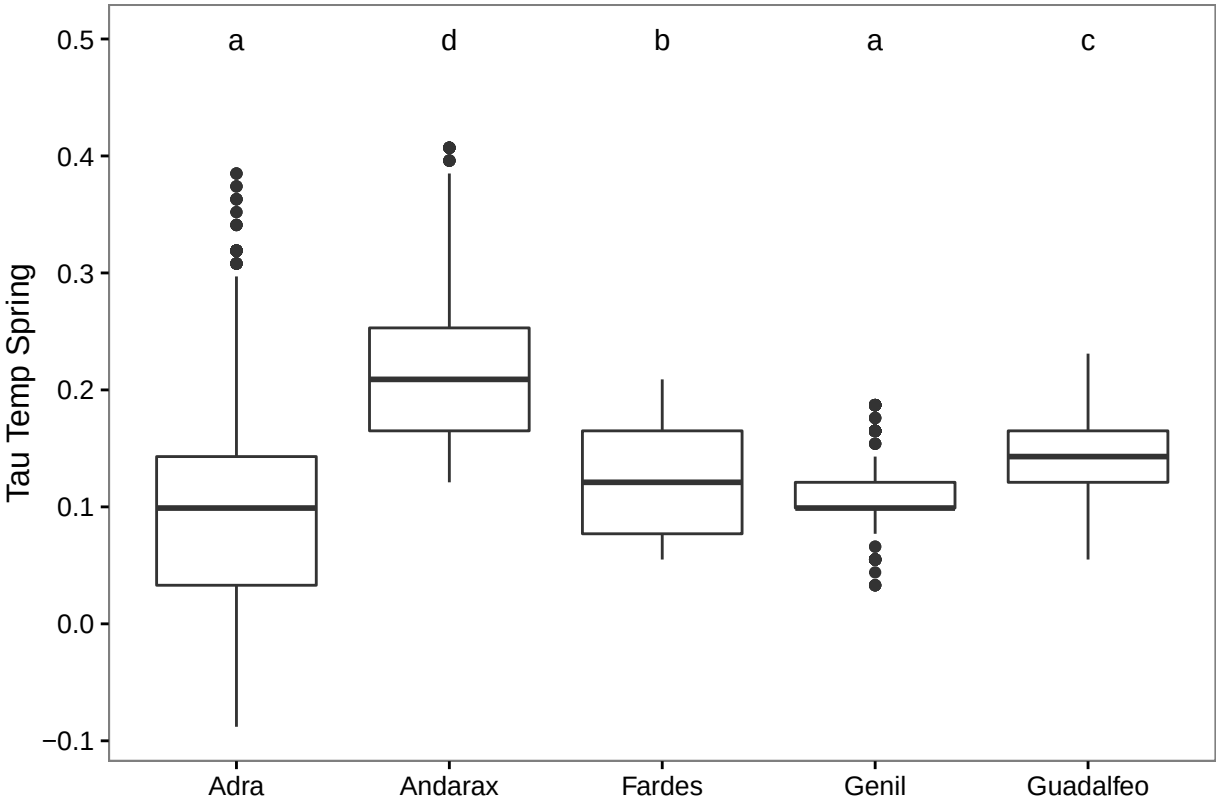
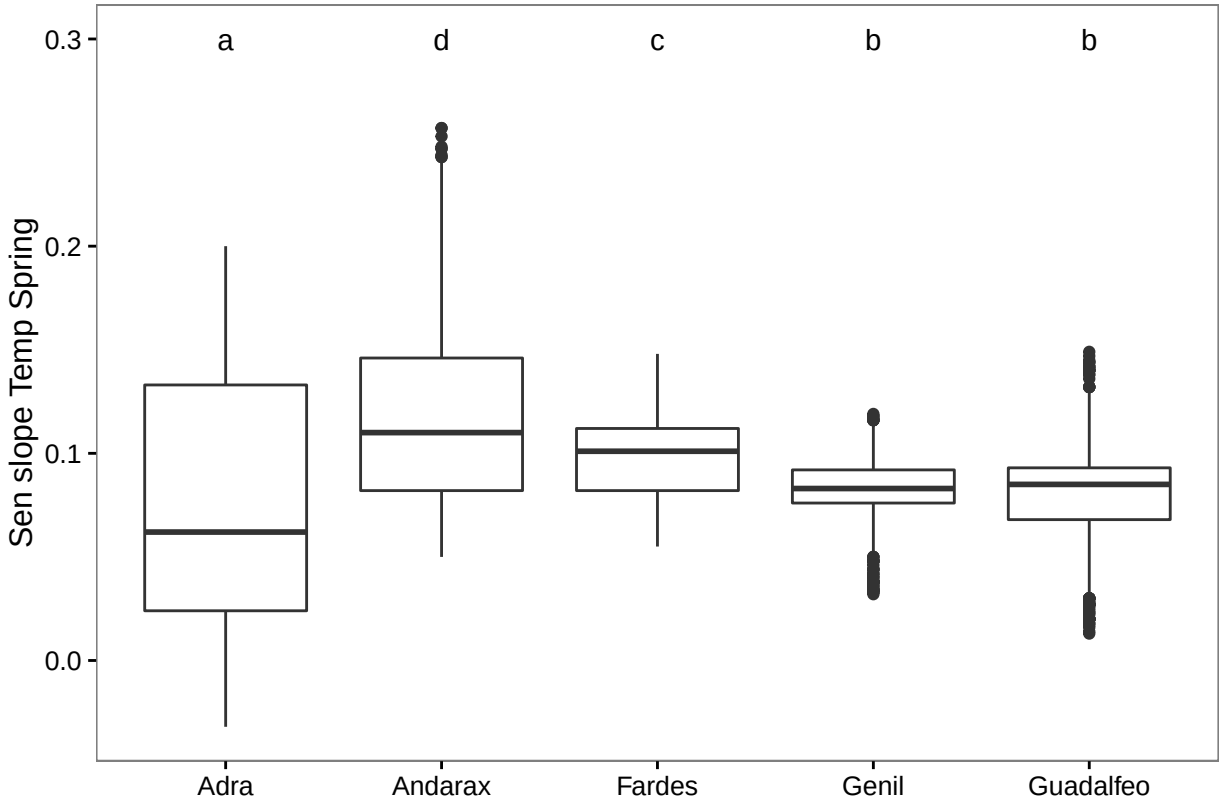


Table 36: Sen slope Temp Spring

term	df	sumsq	meansq	statistic	p.value
basin_name	4	2.062	0.5155	481.5	0
Residuals	7989	8.553	0.001071	NA	NA



Temp Summer

Table 37: Tau Temp Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	31.69	7.922	1287	0
Residuals	7989	49.18	0.006156	NA	NA

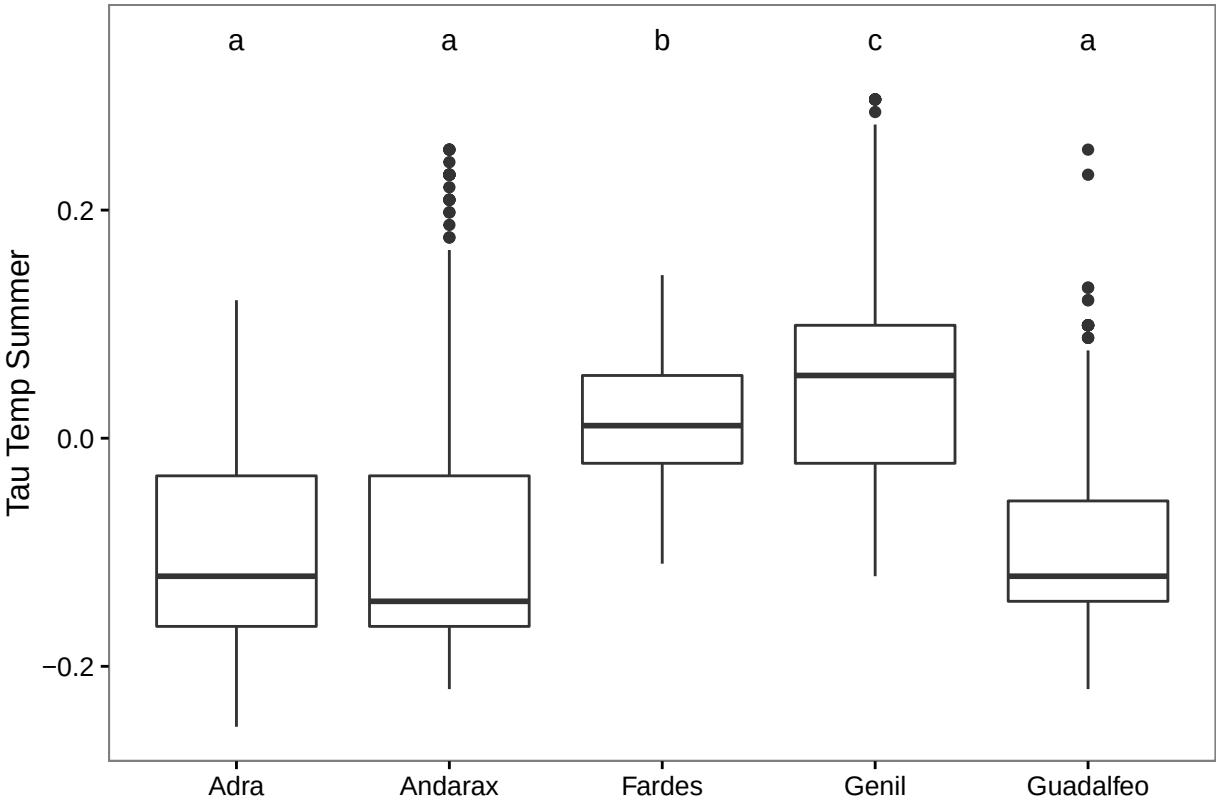
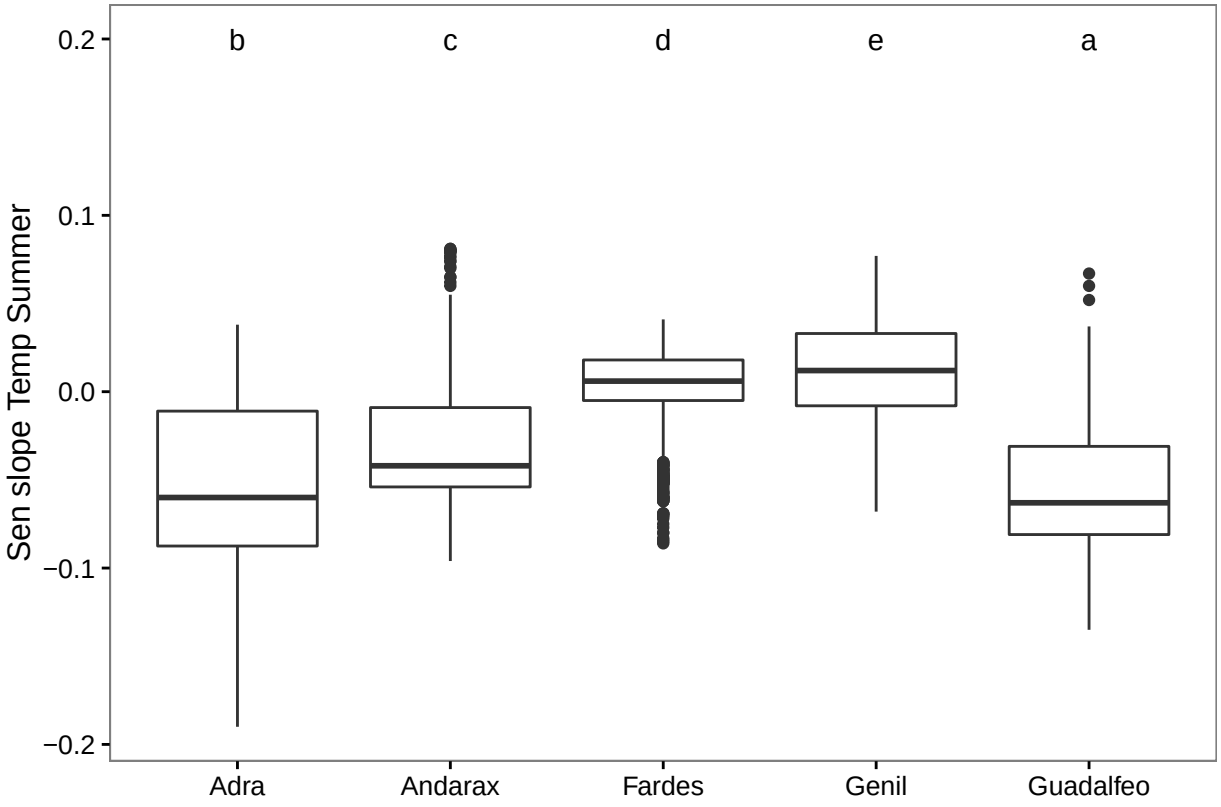


Table 38: Sen slope Temp Summer

term	df	sumsq	meansq	statistic	p.value
basin_name	4	5.744	1.436	1377	0
Residuals	7989	8.329	0.001043	NA	NA



Temp Winter

Table 39: Tau Temp Winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	41.76	10.44	1859	0
Residuals	7989	44.87	0.005617	NA	NA

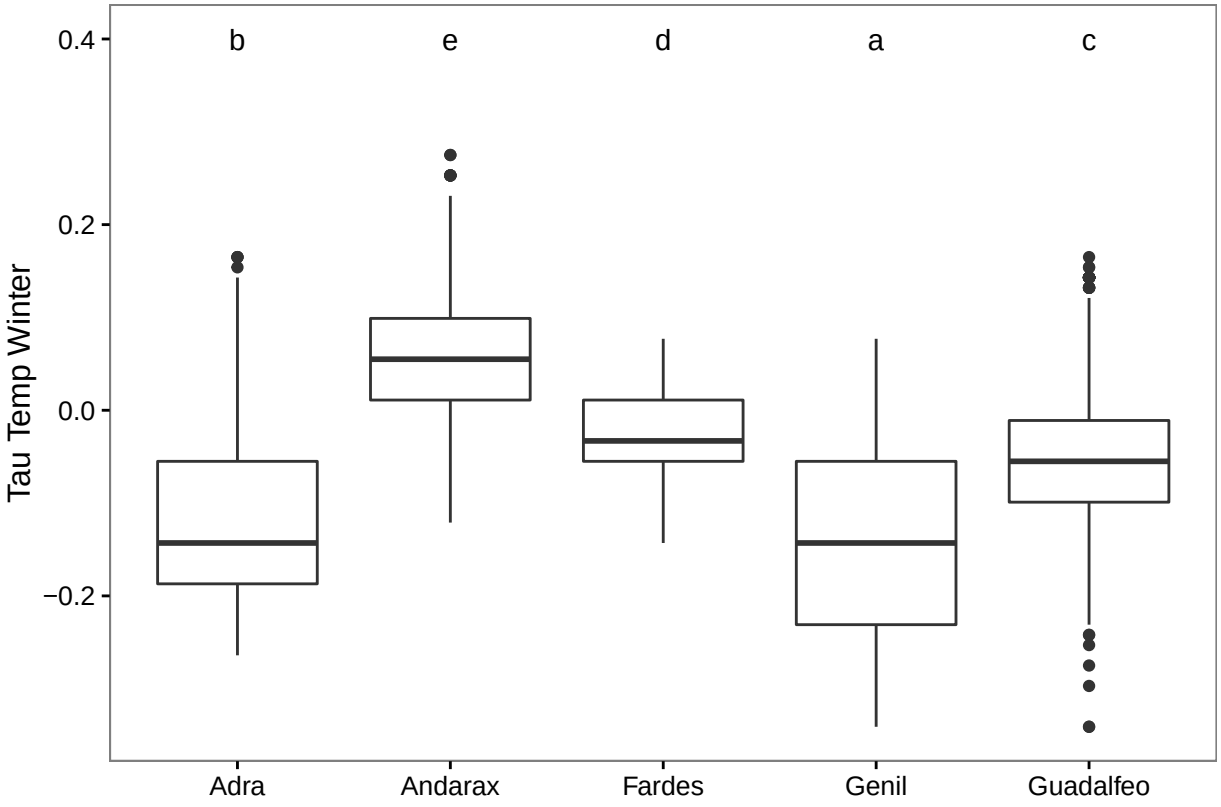
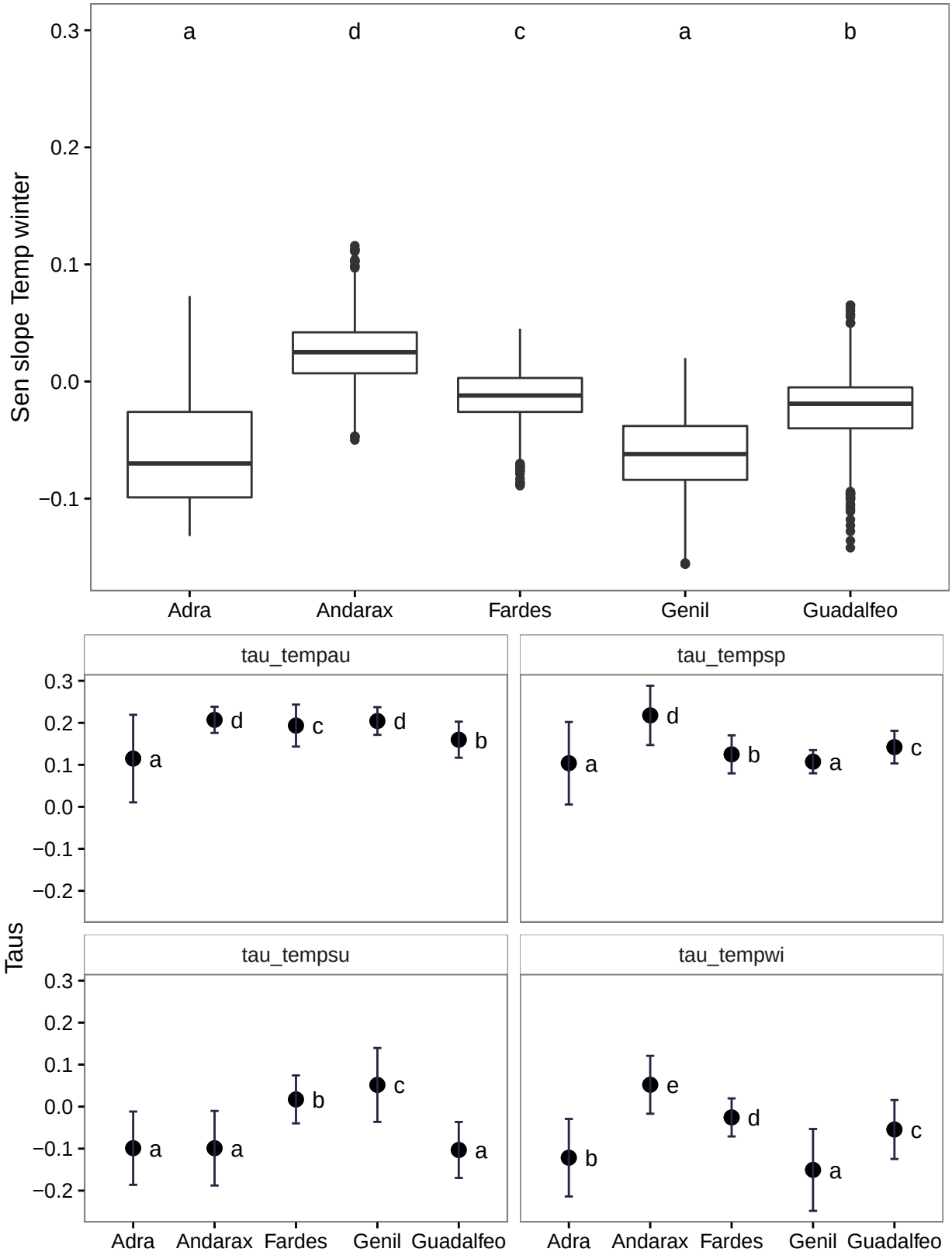
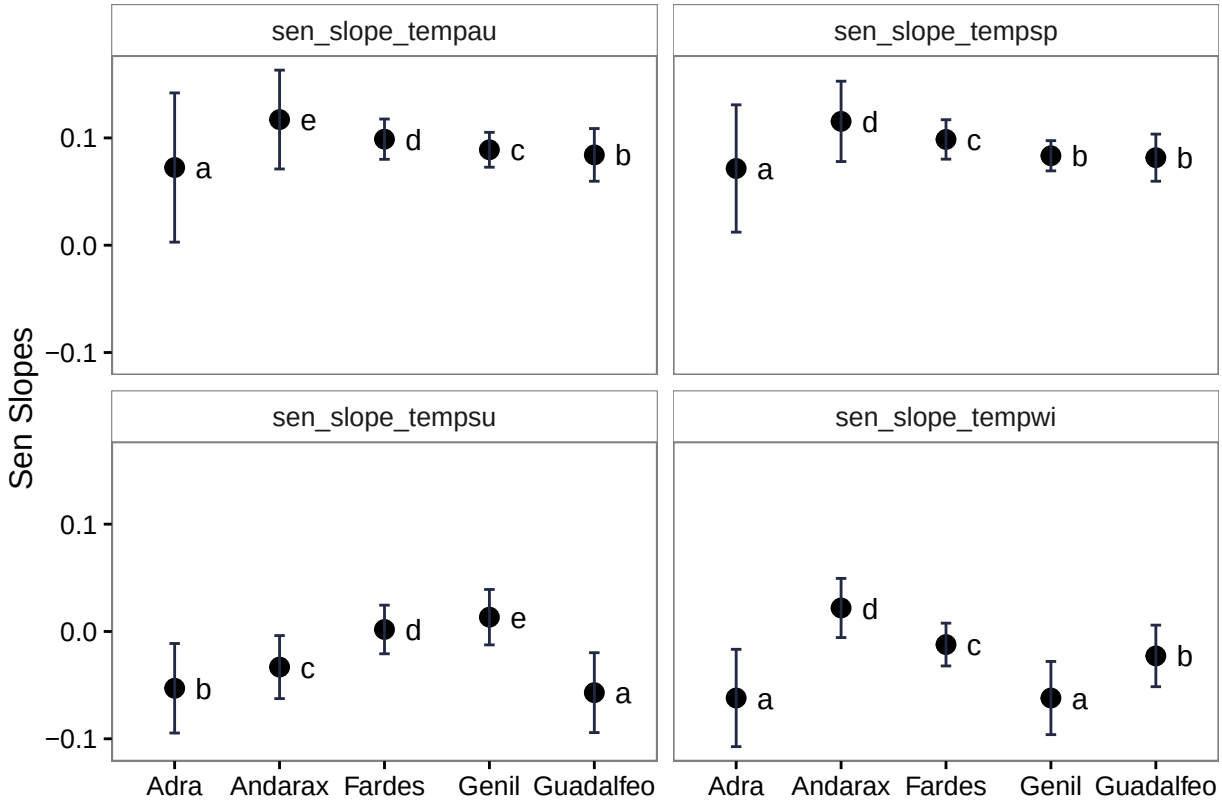


Table 40: Sen slope Temp winter

term	df	sumsq	meansq	statistic	p.value
basin_name	4	8.062	2.015	2113	0
Residuals	7989	7.622	0.000954	NA	NA


Sen slope Temp winter
0.3
0.2
0.1
0.0
−0.1
a
d
c
a
b
Adra
Andarax
Fardes
Genil
Guadalfeo
Taus
tau_tempau
tau_tempsp
tau_tempsu
tau_tempwi
−0.2



Tau Temp Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.1148570	0.10428517	0.0032415475	tau_tempau	a
Andarax	0.2071140	0.03117065	0.0006552448	tau_tempau	d
Fardes	0.1934244	0.04999693	0.0014493385	tau_tempau	c
Genil	0.2043087	0.03295689	0.0009393279	tau_tempau	d
Guadalfeo	0.1597925	0.04296792	0.0009008523	tau_tempau	b

Sen Slope Temp Au

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.07241063	0.06954251	0.0021616242	sen_slope_tempau	a
Andarax	0.11711180	0.04604862	0.0009679977	sen_slope_tempau	e
Fardes	0.09882437	0.01876969	0.0005441062	sen_slope_tempau	d

basin_name	mean	sd	se	variable	tukey_basin_name
Genil	0.08894476	0.01623256	0.0004626559	sen_slope_tempau	c
Guadalfeo	0.08419033	0.02454987	0.0005147051	sen_slope_tempau	b

Tau Temp Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.1038145	0.09820290	0.0030524891	tau_tempsp	a
Andarax	0.2176863	0.07058529	0.0014837883	tau_tempsp	d
Fardes	0.1249008	0.04534446	0.0013144701	tau_tempsp	b
Genil	0.1074354	0.02762597	0.0007873874	tau_tempsp	a
Guadalfeo	0.1421055	0.03876957	0.0008128310	tau_tempsp	c

Sen Slope Temp Sp

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	0.07151884	0.05932599	0.0018440590	sen_slope_tempsp	a
Andarax	0.11542289	0.03744734	0.0007871885	sen_slope_tempsp	d
Fardes	0.09858824	0.01837554	0.0005326803	sen_slope_tempsp	c
Genil	0.08337855	0.01408890	0.0004015579	sen_slope_tempsp	b
Guadalfeo	0.08158549	0.02195784	0.0004603615	sen_slope_tempsp	b

Tau Temp Su

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.09893623	0.08721590	0.002710975	tau_tempsu	a
Andarax	-0.09900972	0.08881984	0.001867101	tau_tempsu	a
Fardes	0.01719328	0.05703271	0.001653296	tau_tempsu	b
Genil	0.05163119	0.08796844	0.002507251	tau_tempsu	c
Guadalfeo	-0.10319209	0.06660135	0.001396344	tau_tempsu	a

Sen Slope Temp Su

Table 46: Table continues below

basin_name	mean	sd	se	variable
Adra	-0.052918841	0.04172299	0.0012968962	sen_slope_tempsu
Andarax	-0.033178082	0.02935545	0.0006170871	sen_slope_tempsu

basin_name	mean	sd	se	variable
Fardes	0.001868908	0.02266481	0.0006570199	sen_slope_tempsu
Genil	0.013329001	0.02581702	0.0007358293	sen_slope_tempsu
Guadalfeo	-0.056992967	0.03721415	0.0007802205	sen_slope_tempsu

tukey_basin_name
b
c
d
e
a

Tau Temp Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.12155266	0.09230138	0.002869049	tau_tempwi	b
Andarax	0.05206407	0.06892927	0.001448977	tau_tempwi	e
Fardes	-0.02568824	0.04528255	0.001312675	tau_tempwi	d
Genil	-0.15065800	0.09746801	0.002778005	tau_tempwi	a
Guadalfeo	-0.05446813	0.07015910	0.001470934	tau_tempwi	c

Sen Slope Temp Wi

basin_name	mean	sd	se	variable	tukey_basin_name
Adra	-0.06198744	0.04535728	0.0014098628	sen_slope_tempwi	a
Andarax	0.02190278	0.02756785	0.0005795095	sen_slope_tempwi	d
Fardes	-0.01219580	0.01994322	0.0005781251	sen_slope_tempwi	c
Genil	-0.06203006	0.03409124	0.0009716589	sen_slope_tempwi	a
Guadalfeo	-0.02277231	0.02869771	0.0006016675	sen_slope_tempwi	b

Explore trends by elevation

Taus

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempau ~ s(dem50mean)
```

```
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.627  8.961 13.98  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempau ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.1792323  0.0006786   264.1   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.627  8.961 13.98  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0151   Deviance explained = 1.62%
## GCV = 0.0036851  Scale est. = 0.0036807  n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempsp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.408  8.904 195.8  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempsp ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.1506439  0.0007497   200.9   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
```

```
## s(dem50mean) 8.408  8.904 195.8  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.179   Deviance explained =   18%
## GCV = 0.0044983  Scale est. = 0.004493  n = 7994
```

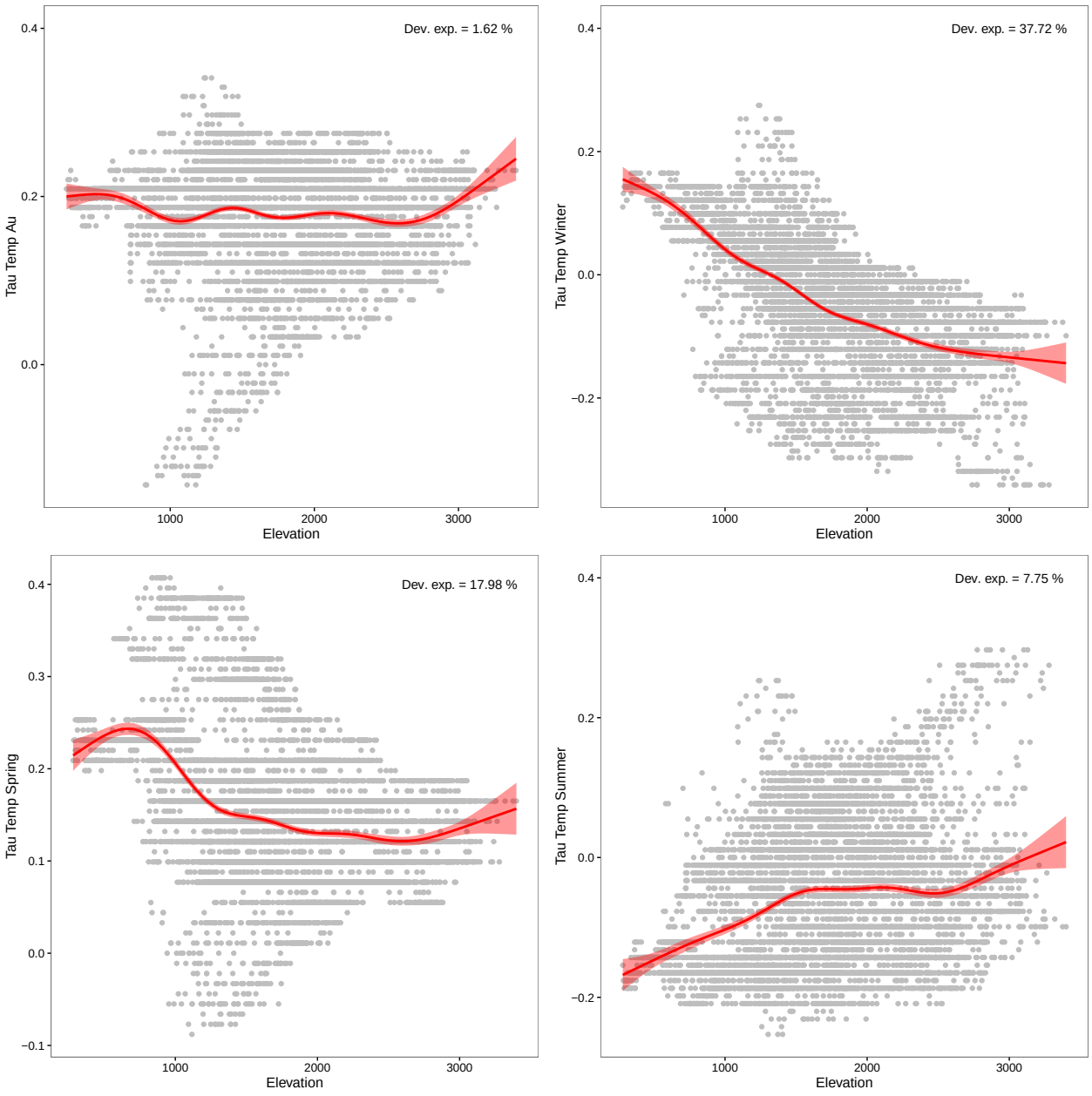
```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempsu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 7.570  8.499 78.52  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempsu ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.059695   0.001081  -55.22   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##               edf Ref.df     F p-value
## s(dem50mean) 7.57  8.499 78.52  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0766   Deviance explained = 7.75%
## GCV = 0.0093527  Scale est. = 0.0093427  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## tau_tempwi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.124  8.798 549.2  <2e-16
```

```
##
## Family: gaussian
```

```
## Link function: identity
##
## Formula:
## tau_tempwi ~ s(dem50mean)
##
## Parametric coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0435239  0.0009194  -47.34   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                 edf Ref.df     F p-value
## s(dem50mean) 8.124  8.798 549.2  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.377   Deviance explained = 37.7%
## GCV = 0.0067643  Scale est. = 0.0067566  n = 7994
```



Sen

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempau ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                 edf Ref.df     F p-value
## s(dem50mean) 8.211  8.834 38.52  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempau ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0948954  0.0004564   207.9   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.211  8.834 38.52  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0405   Deviance explained = 4.15%
## GCV = 0.0016674  Scale est. = 0.0016655  n = 7994

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempsp ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.741  8.981 28.19  <2e-16

##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempsp ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0926683  0.0004013   230.9   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.741  8.981 28.19  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0306   Deviance explained = 3.17%
## GCV = 0.001289  Scale est. = 0.0012874  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempsu ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.247  8.848 25.41  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempsu ~ s(dem50mean)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.030133   0.000463  -65.08   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.247  8.848 25.41  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0268   Deviance explained = 2.78%
## GCV = 0.0017154  Scale est. = 0.0017135  n = 7994
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempwi ~ s(dem50mean)
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.706  8.975 620.9  <2e-16
```

```
##
## Family: gaussian
## Link function: identity
##
## Formula:
## sen_slope_tempwi ~ s(dem50mean)
##
## Parametric coefficients:
##               Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept) -0.0196735  0.0003803  -51.73   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                edf Ref.df     F p-value
## s(dem50mean) 8.706  8.975 620.9  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.411   Deviance explained = 41.1%
## GCV = 0.0011576  Scale est. = 0.0011562  n = 7994
```