Region-Of-Influence approach: some FEH examples

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```
> data(FEH1000)
```

To have some information on these data:

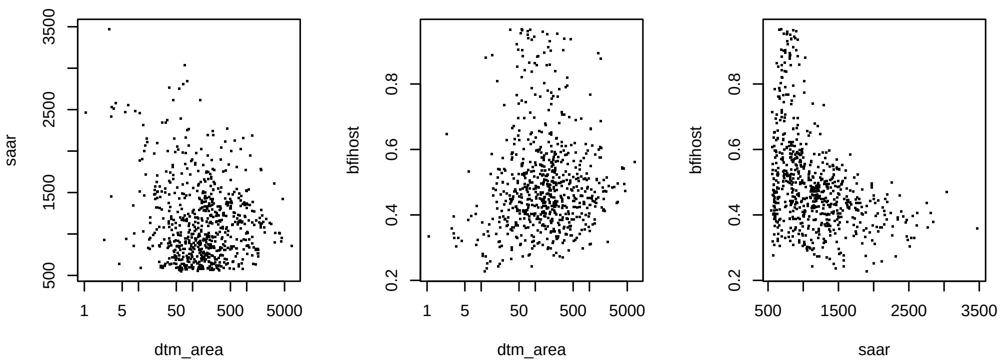
```
> ls()
> help(FEH1000)
```

Criteria used in the FEH to choose stations for pooling groups: n>7; area, saar and bfihost are known; urbext<0.025; area>0.5;

```
> n <- tapply(am[,4],am[,1],length)
> urbext <- cd[,"urbext1990"]
> area <- cd[,"dtm_area"]
> cd696 <- cd[(!is.nan(cd[,"dtm_area"]))&(!is.nan(cd[,"saar"]))&
+             (!is.nan(cd[,"bfihost"]))&(n>7)&(urbext<0.025)&(area>0.5),]
> fac <- factor(am[,"number"],levels=cd696[,"number"])
> am696 <- am[!is.na(fac),]
> #nlevels(as.factor(am696[,"number"]))
```

Figure 16.2 pag.157, FEH Vol.3:

```
> layout(matrix(c(1,2,3), 1, 3))
> plot(cd696[c("dtm_area","saar")], pch=".", cex=2, log="x")
> plot(cd696[c("dtm_area","bfihost")], pch=".", cex=2, log="x")
> plot(cd696[c("saar","bfihost")], pch=".", cex=2)
```

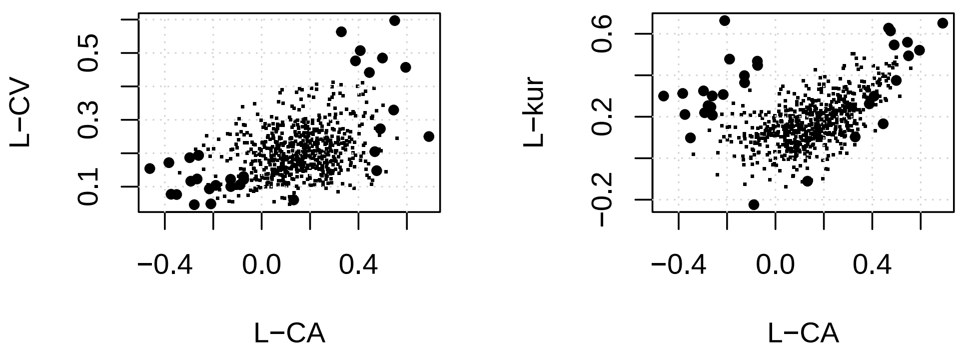


Discordancy measure:

```
> Lmomenti696 <- t(sapply(split(am696[,4],am696[,1]),Lmoments))
> Di <- discordancy(am696[,"am"], am696[,"number"])
```

Sites with discordancy greater than 3:

```
> par(mfrow=c(1,2))
>  plot(Lmomenti696[,c("lca","lcv")],xlab="L-CA",ylab="L-CV",pch=".",cex=2); grid()
>  points(Lmomenti696[(Di>3),c("lca","lcv")],pch=19,cex=.7)
>  plot(Lmomenti696[,c("lca","lkur")],xlab="L-CA",ylab="L-kur",pch=".",cex=2); grid()
>  points(Lmomenti696[(Di>3),c("lca","lkur")],pch=19,cex=.7)
> par(mfrow=c(1,1))
```



Region of influence approach (Table 16.2, pag.164, FEH Vol.3) using lnAREA, lnSAAR and BFI-HOST to measure distances among sites:

```
> sd(log(cd696[,"dtm_area"])) # 1.345515 (vs 1.34)

[1] 1.345515

> sd(log(cd696[,"saar"]))     # 0.38534 (vs 0.38)

[1] 0.38534

> sd(cd696[,"bfihost"])       # 0.1485239 (vs 0.15)

[1] 0.1485239

> AREAterm <- log(cd696[,"dtm_area"])/(sd(log(cd696[,"dtm_area"]))*sqrt(2))
> SAARterm <- log(cd696[,"saar"])/sd(log(cd696[,"saar"]))
> BFIHOSTterm <- cd696[,"bfihost"]/sd(cd696[,"bfihost"])
> distFEH <- dist(cbind(AREAterm,SAARterm,BFIHOSTterm))
> roi.cd <- data.frame(cbind(AREAterm,SAARterm,BFIHOSTterm))
> row.names(roi.cd) <- cd696[,"number"]

> roi01.50year <- new.env()
> for(i in 1:696) {
+  print(paste(i,"/ 696"))
+  assign(as.character(row.names(roi.cd)[i]), roi.st.year(roi.cd[i,],as.data.frame(roi.cd),
+      row.names(roi.cd),am696[,"am"],am696[,"number"],test="HW",station.year=250,Nsim=100),
+      env=roi01.50year)
+ }
> roi01.50year <- as.list(roi01.50year)
```

```
> estrai.region <- function (x) {x$region}
> estrai.test <- function (x) {x$test}

> regioni.50year <- sapply(roi01.50year, estrai.region)
> test.50year <- sapply(roi01.50year, estrai.test)
> mL.50year <- mean(sapply(regioni.50year,length)) #  11.2
> mH2.50year <- mean(test.50year["H2",]) #   1.53
> gH2gr2.50year <- sum(test.50year["H2",]>2)/696 #   0.34
> gH2gr4.50year <- sum(test.50year["H2",]>4)/696 #   0.07

> roi01.100year <- new.env()
> for(i in 1:696) {
+  print(paste(i,"/ 696"))
+  assign(as.character(row.names(roi.cd)[i]), roi.st.year(roi.cd[i,],as.data.frame(roi.cd),
+      row.names(roi.cd),am696[,"am"],am696[,"number"],test="HW",station.year=500,Nsim=100),
+      env=roi01.100year)
+ }
> roi01.100year <- as.list(roi01.100year)

> regioni.100year <- sapply(roi01.100year, estrai.region)
> test.100year <- sapply(roi01.100year, estrai.test)
> mL.100year <- mean(sapply(regioni.100year,length)) #  21.8
> mH2.100year <- mean(test.100year["H2",]) #   2.19
> gH2gr2.100year <- sum(test.100year["H2",]>2)/696 #   0.52
> gH2gr4.100year <- sum(test.100year["H2",]>4)/696 #   0.15

> table16.2 <- data.frame(signif(rbind(c(mL.50year,mH2.50year,
+                                       gH2gr2.50year*100,gH2gr4.50year*100),
+               c(mL.100year,mH2.100year,gH2gr2.100year*100,gH2gr4.100year*100)),3),
+               row.names=c("50-year","100-year"))
> names(table16.2) <- c("Avg. n sites","m(H2)","% H2>2","% H2>4")
> print(table16.2)

         Avg. n sites m(H2) % H2>2 % H2>4
50-year           11.2  1.53     34      7
100-year          21.8  2.19     52     15
```

Example 16.3 pag.164, FEH Vol.3:

```
> prova54088 <- roi.st.year(roi.cd["54088",],roi.cd,row.names(roi.cd),am696[,"am"],
+                          am696[,"number"],test="HW",station.year=250,Nsim=500)
> prova28018 <- roi.st.year(roi.cd["28018",],roi.cd,row.names(roi.cd),am696[,"am"],
+                           am696[,"number"],test="HW",station.year=250,Nsim=500)

> Lmomenti696 <- as.data.frame(Lmomenti696)
> par(mfrow=c(1,2))
>  plot(Lmomenti696[c("lca","lcv")], xlab="L-CA", ylab="L-CV",
+       pch=".", cex=2, main="54088"); grid()
>  points(Lmomenti696[c("54088"), c("lca","lcv")],
+         pch=19, col="red", cex=1)
>  points(Lmomenti696[prova54088$region[-1], c("lca","lcv")],
+         pch=19, cex=1)
```

```
>  plot(Lmomenti696[,c("lca","lkur")], xlab="L-CA", ylab="L-kur",
+       pch=".", cex=2, main="28018"); grid()
>  points(Lmomenti696[c("28018"), c("lca","lcv")],
+         pch=19, col="red", cex=1)
>  points(Lmomenti696[prova28018$region[-1], c("lca","lcv")],
+         pch=19, cex=1)
> par(mfrow=c(1,1))
```

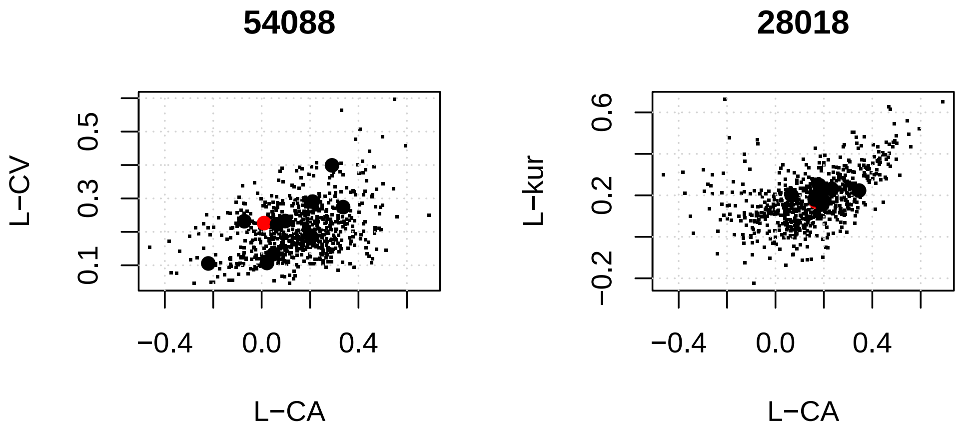


Figure 16.9 pag.174 (1st part), FEH Vol.3:

```
> figure16.9a <- function (x,r,cd) {
+  # x = station of interest (e.g. "28018")
+  # r = output of roi.st.year()
+
+  if(!r$region[1]==x) r$region <- c(x,r$region)
+  row.names(cd) <- cd[,"number"]
+  n <- length(cd[,"number"])
+  cd.r <- cd[r$region,]
+  par(mfrow=c(2,3))
+   hist(log(cd[,"dtm_area"]),col="lightgray",border="lightgray",
+        main="",xlab="AREA",axes=FALSE)
+   axis(1,at=c(log(1),log(10),log(100),log(1000),log(10000)),
+        label=c("1","10","100","1000","10000"))
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(log(cd.r[-1,"dtm_area"]),0),pch=19,cex=.7)
+   points(cbind(log(cd.r[1,"dtm_area"]),0),pch=4,cex=2,lwd=2)
+
+   hist(cd[,"saar"],col="lightgray",border="lightgray",
+        main="",xlab="SAAR",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"saar"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"saar"],0),pch=4,cex=2,lwd=2)
+
```

```
+   hist(cd[,"bfihost"],col="lightgray",border="lightgray",
+        main="",xlab="BFIHOST",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"bfihost"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"bfihost"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[,"farl"],col="lightgray",border="lightgray",
+        main="",xlab="FARL",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"farl"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"farl"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[,"propwet"],col="lightgray",border="lightgray",
+        main="",xlab="PROPWET",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"propwet"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"propwet"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[,"urbext1990"],col="lightgray",border="lightgray",
+        main="",xlab="URBEXT",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"urbext1990"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"urbext1990"],0),pch=4,cex=2,lwd=2)
+  par(mfrow=c(1,1))
+  title(main=x,cex.main=1,font.main=1)
+ }

> prova40009 <- roi.st.year(roi.cd["40009",],roi.cd,row.names(roi.cd),am696[,"am"],
+                           am696[,"number"],test="HW",station.year=500,Nsim=500)

> figure16.9a("40009",prova40009,cd696)
```

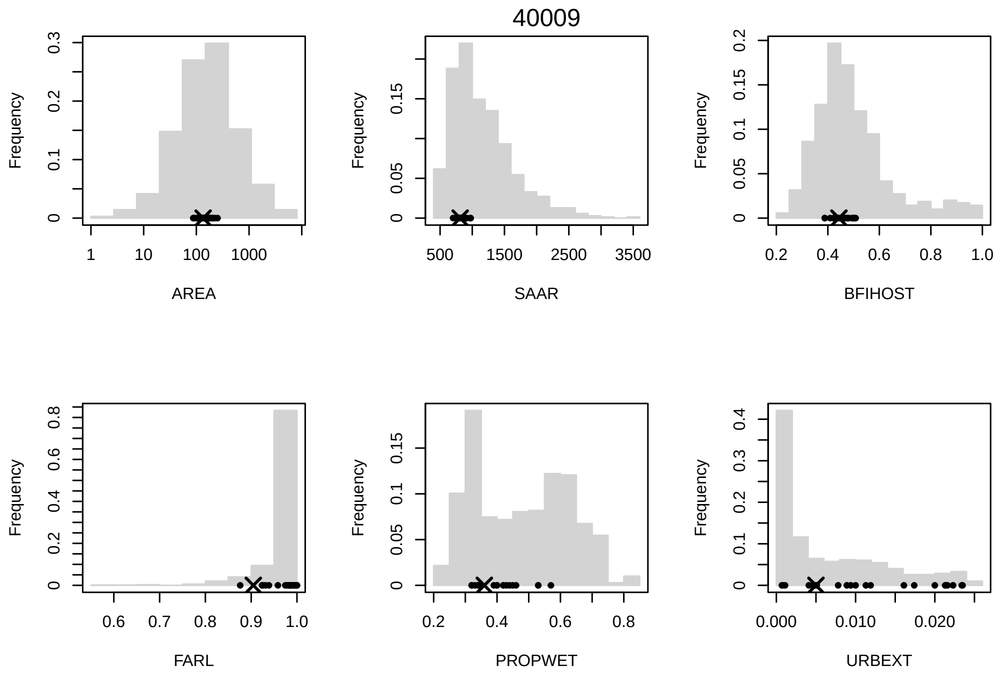
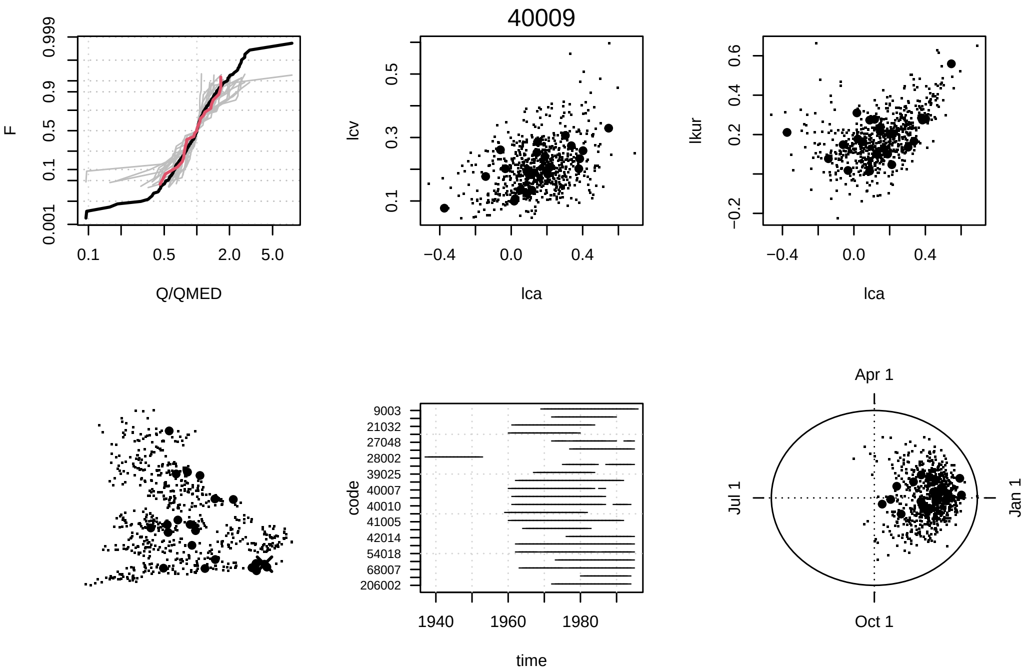


Figure 16.9 pag.174 (2nd part), FEH Vol.3:

```
> figure16.9b <- function (x,r,am,cd) {
+  # x = station of interest (e.g. "28018")
+  # r = output of roi.st.year()
+
+  row.names(cd) <- cd[,"number"]
+  n <- length(cd[,"number"])
+  cd.r <- cd[r$region,]
+  cd.x <- cd[x,]
+  fac <- factor(am[,"number"],levels=cd.r[,"number"])
+  am.r <- am[!is.na(fac),]
+  fac <- factor(am[,"number"],levels=x)
+  am.x <- am[!is.na(fac),]
+  am.xr <- rbind(am.x,am.r)
+  QMED.r <- tapply(am.r[,4],am.r[,1],median)
+  QMED.x <- median(am.x[,4])
+  am.r.adim <- am.r; am.r.adim[,4] <- am.r[,4]/unsplit(QMED.r,am.r[,1])
+  am.x.adim <- am.x; am.x.adim[,4] <- am.x[,4]/QMED.x
+  lcv <- tapply(am[,4],am[,1],LCV)
+  lca <- tapply(am[,4],am[,1],LCA)
+  lkur <- tapply(am[,4],am[,1],Lkur)
+  lcv.r <- tapply(am.r[,4],am.r[,1],LCV)
+  lca.r <- tapply(am.r[,4],am.r[,1],LCA)
+  lkur.r <- tapply(am.r[,4],am.r[,1],Lkur)
+  lcv.x <- LCV(am.x[,4])
+  lca.x <- LCA(am.x[,4])
+  lkur.x <- Lkur(am.x[,4])
+  days <- as.numeric(format(as.Date(am[,2]),"%j"))
+  days.r <- as.numeric(format(as.Date(am.r[,2]),"%j"))
```

```
+  days.x <- as.numeric(format(as.Date(am.x[,2]),"%j"))
+
+  par(mfrow=c(2,3))
+   lognormplot(am.r.adim[,4],line=FALSE,xlab="Q/QMED",type="n")
+   for(i in r$region) {
+    xxx <- am.r.adim[am.r.adim[,1]==i,4]
+    normpoints(xxx,type="l",col="gray")
+   }
+   normpoints(am.r.adim[,4],type="l",lwd=2)
+   normpoints(am.x.adim[,4],type="l",col=2,lwd=2)
+
+   plot(lca,lcv,pch=".",cex=2)
+   points(lca.r,lcv.r,pch=19)
+   points(lca.x,lcv.x,pch=4,cex=2,lwd=2)
+
+   plot(lca,lkur,pch=".",cex=2)
+   points(lca.r,lkur.r,pch=19)
+   points(lca.x,lkur.x,pch=4,cex=2,lwd=2)
+
+   plot(cd[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=".",cex=2,xlab="",ylab="",axes=FALSE)
+   points(cd.r[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=19)
+   points(cd.x[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=4,cex=2,lwd=2)
+
+   consistencyplot (am.r[,3],am.r[,1])
+
+   dummy <- seq(0,2*pi,length=100)
+   plot(cos(dummy),sin(dummy),type="l",xlab="",ylab="",axes=FALSE)
+   abline(h=0,lty=3); abline(v=0,lty=3)
+   radd <- days*pi/180
+   XFLOOD <- tapply(cos(radd),am[,1],mean)
+   YFLOOD <- tapply(sin(radd),am[,1],mean)
+   points(XFLOOD,YFLOOD,pch=".",cex=2)
+   radd <- days.r*pi/180
+   XFLOOD <- tapply(cos(radd),am.r[,1],mean)
+   YFLOOD <- tapply(sin(radd),am.r[,1],mean)
+   points(XFLOOD,YFLOOD,pch=19,cex=1)
+   radd <- days.x*pi/180
+   XFLOOD <- tapply(cos(radd),am.x[,1],mean)
+   YFLOOD <- tapply(sin(radd),am.x[,1],mean)
+   points(XFLOOD,YFLOOD,pch=4,cex=2,lwd=2)
+   axis(1,at=0,label="Oct 1")
+   axis(2,at=0,label="Jul 1")
+   axis(3,at=0,label="Apr 1")
+   axis(4,at=0,label="Jan 1")
+  par(mfrow=c(1,1))
+  title(main=x,cex.main=1,font.main=1)
+ }

> figure16.9b("40009",prova40009,am696,cd696)
```

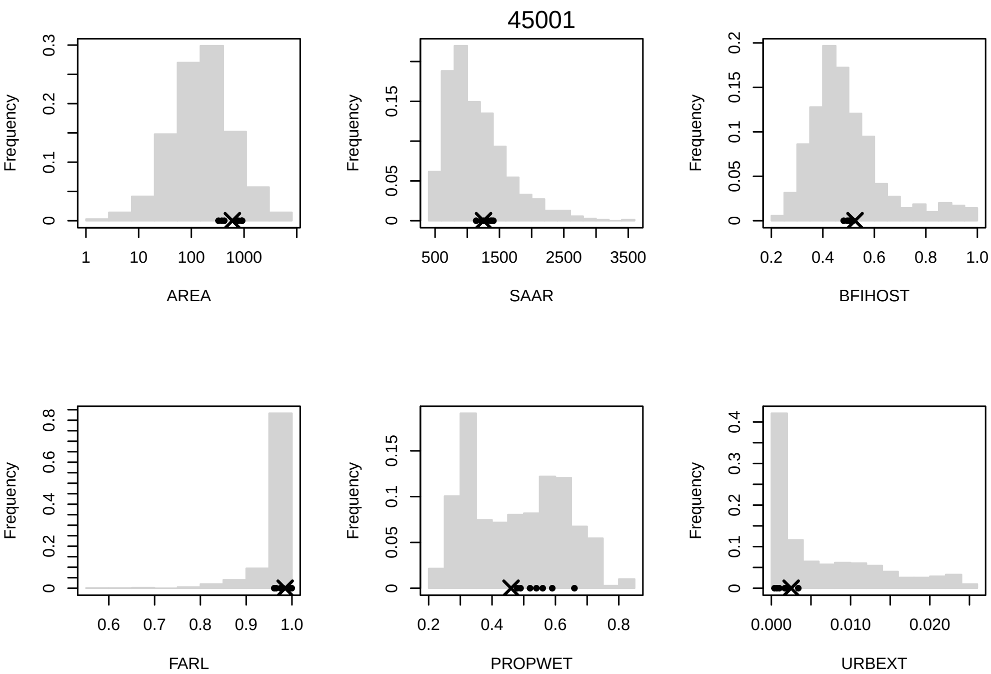


There are differences because: I plot the empirical growth curves; site 40009 in FEH book has 14 data, while I have 25; book uses POT for the polar plot, I only use annual maximum.

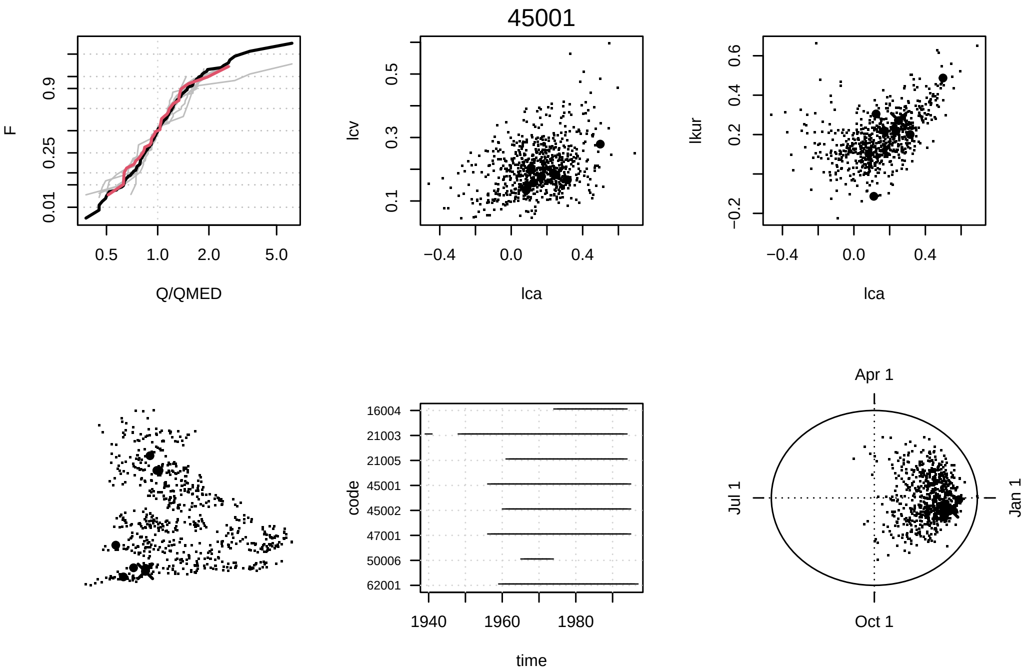
Figure 6.2 pag. 30, FEH Vol.3:

```
> prova45001 <- roi.st.year(roi.cd["45001",],roi.cd,row.names(roi.cd),am696[,"am"],
+                            am696[,"number"],test="HW",station.year=250,Nsim=500)
```

```
> figure16.9a("45001",prova45001,cd696)
```




```
> figure16.9b("45001",prova45001,am696,cd696)
```


45001
F
0.01
0.25
0.9
0.5
1.0
2.0
5.0
Q/QMED
lcv
0.1
0.3
0.5
−0.4
0.0
0.4
lca
lkur
−0.2
0.2
0.4
0.6
−0.4
0.0
0.4
lca
code
16004
21003
21005
45001
45002
47001
50006
62001
1940
1960
1980
time
Apr 1
Jul 1
Jan 1
Oct 1

References

Robson, A. and Reed, D. (1999). Statistical procedures for flood frequency estimation. In *Flood Estimation HandBook*, volume 3. Institute of Hydrology Crowmarsh Gifford, Wallingford, Oxfordshire.