Region-Of-Influence approach: some FEH examples

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```
> data(FEH1000)
```

To have some information on these data:

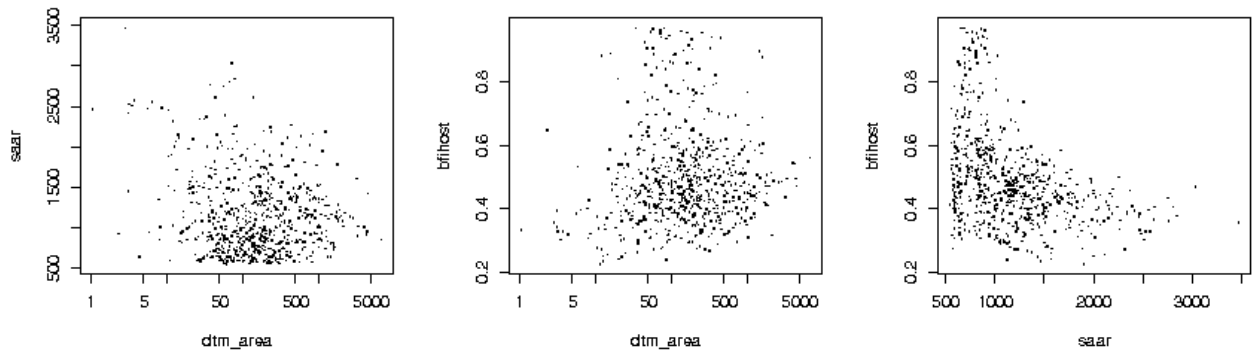
```
> ls()
> help(FEH1000)
```

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), ]
```

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)
```

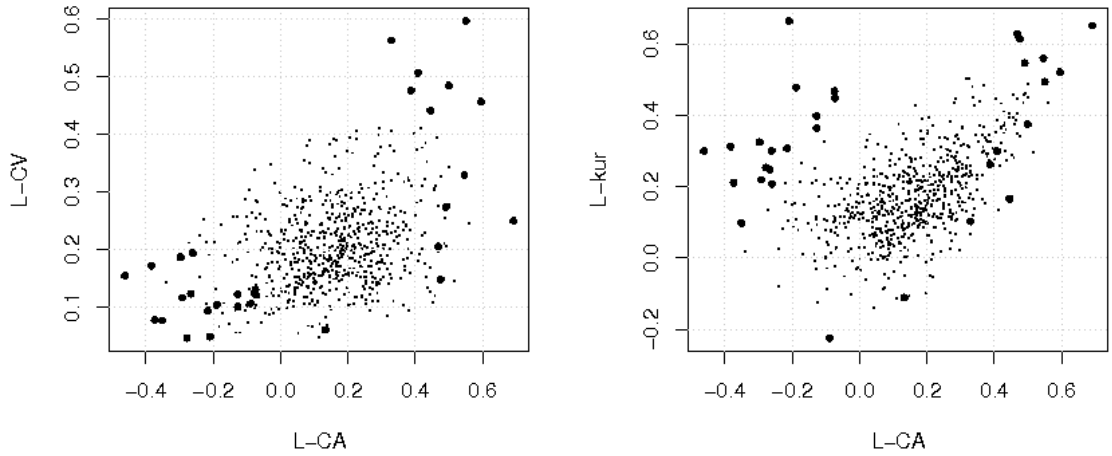


Discordancy measure:

```
> 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 = 0.7)
> 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 = 0.7)
> par(mfrow = c(1, 1))
```



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

```
> sd(log(cd696[, "dtm_area"]))

[1] 1.345515

> sd(log(cd696[, "saar"]))

[1] 0.38534

> sd(cd696[, "bfihost"])

[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))
> mH2.50year <- mean(test.50year["H2", ])
> gH2gr2.50year <- sum(test.50year["H2", ] > 2)/696
> gH2gr4.50year <- sum(test.50year["H2", ] > 4)/696

> 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))
> mH2.100year <- mean(test.100year["H2", ])
> gH2gr2.100year <- sum(test.100year["H2", ] > 2)/696
> gH2gr4.100year <- sum(test.100year["H2", ] > 4)/696

> 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))
```

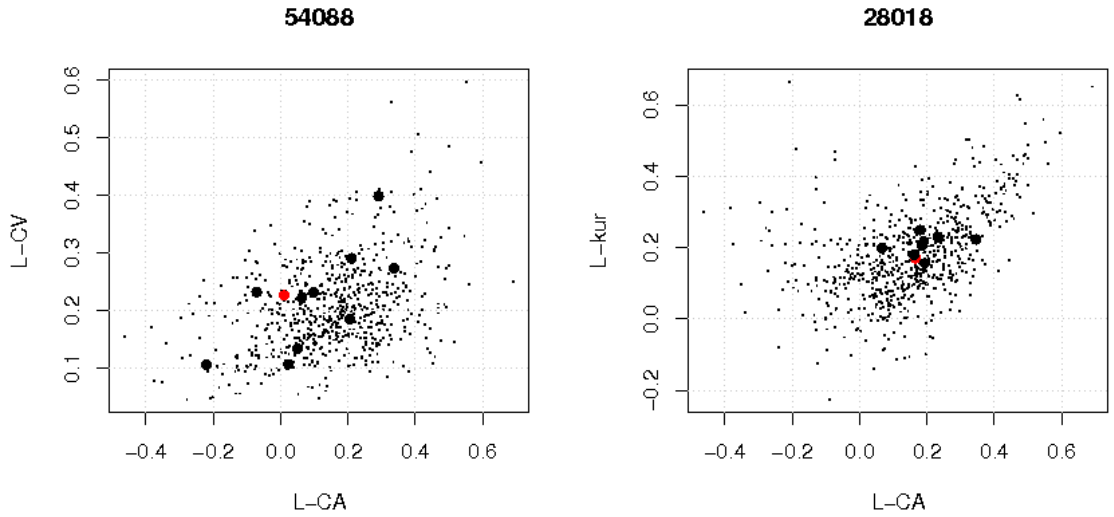


Figure 16.9 pag.174 (1st part), FEH Vol.3:

```
> figure16.9a <- function(x, r, cd) {
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
+     points(cbind(log(cd.r[-1, "dtm_area"]), 0), pch = 19, cex = 0.7)
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
+     points(cbind(cd.r[-1, "saar"], 0), pch = 19, cex = 0.7)
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
+     points(cbind(cd.r[-1, "bfihost"], 0), pch = 19, cex = 0.7)
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
+     points(cbind(cd.r[-1, "farl"], 0), pch = 19, cex = 0.7)
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
+     points(cbind(cd.r[-1, "propwet"], 0), pch = 19, cex = 0.7)
+     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 = 0.05) * n, label = seq(0, 1,
+         by = 0.05))
+     box()
```

```
+     points(cbind(cd.r[-1, "urbext1990"], 0), pch = 19, cex = 0.7)
+     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)
```

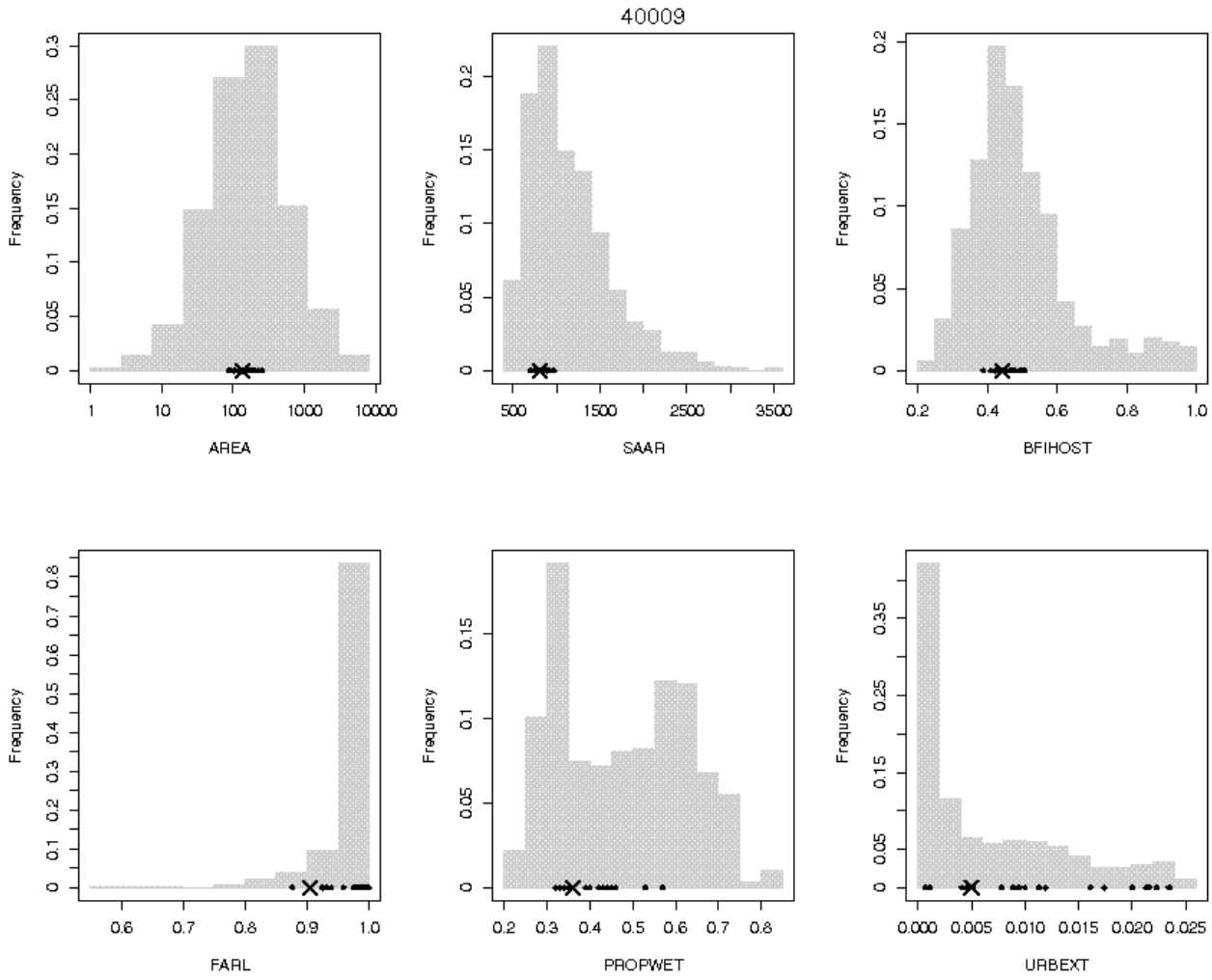


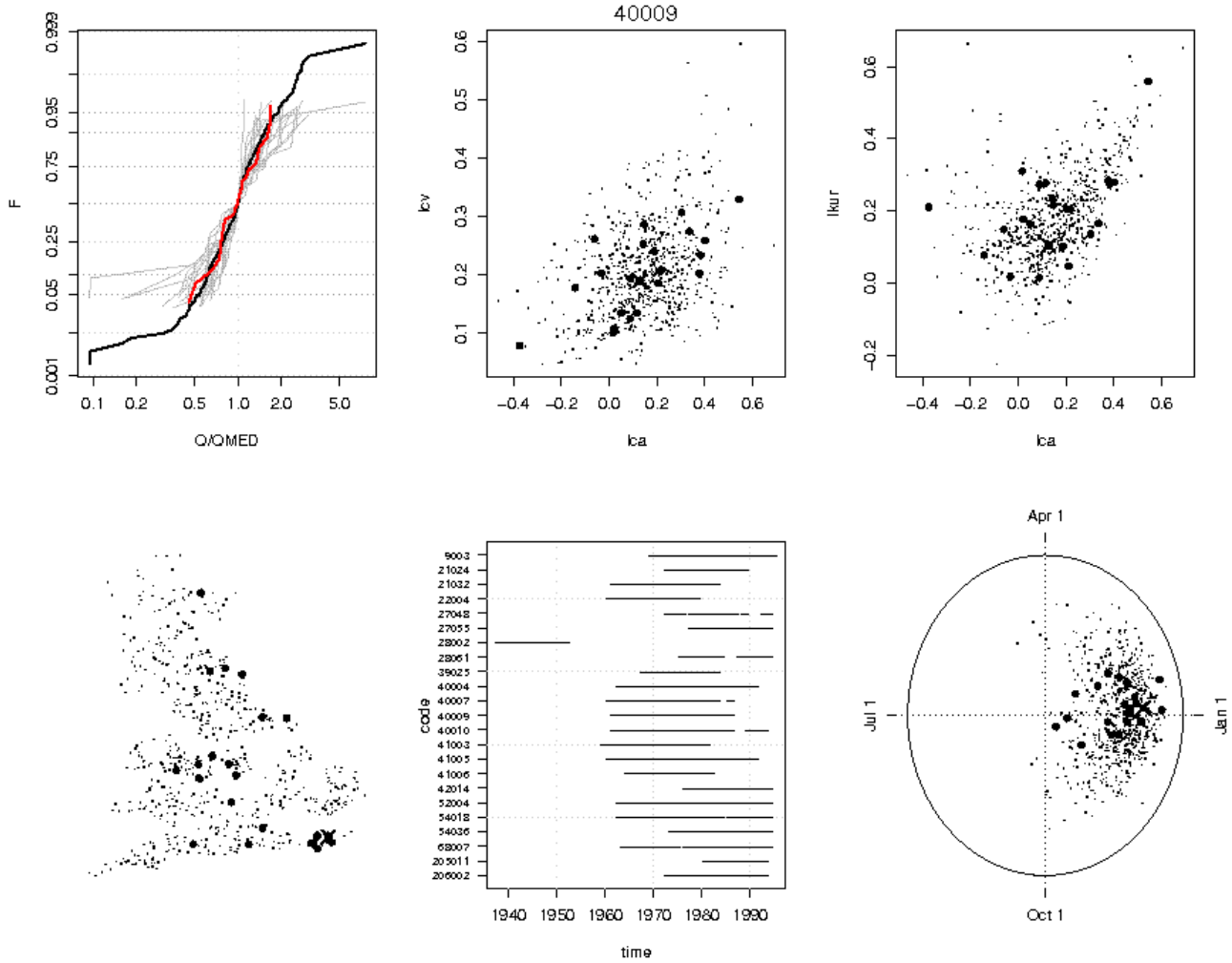
Figure 16.9 pag.174 (2nd part), FEH Vol.3:

```
> figure16.9b <- function(x, r, am, cd) {
+     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)
```

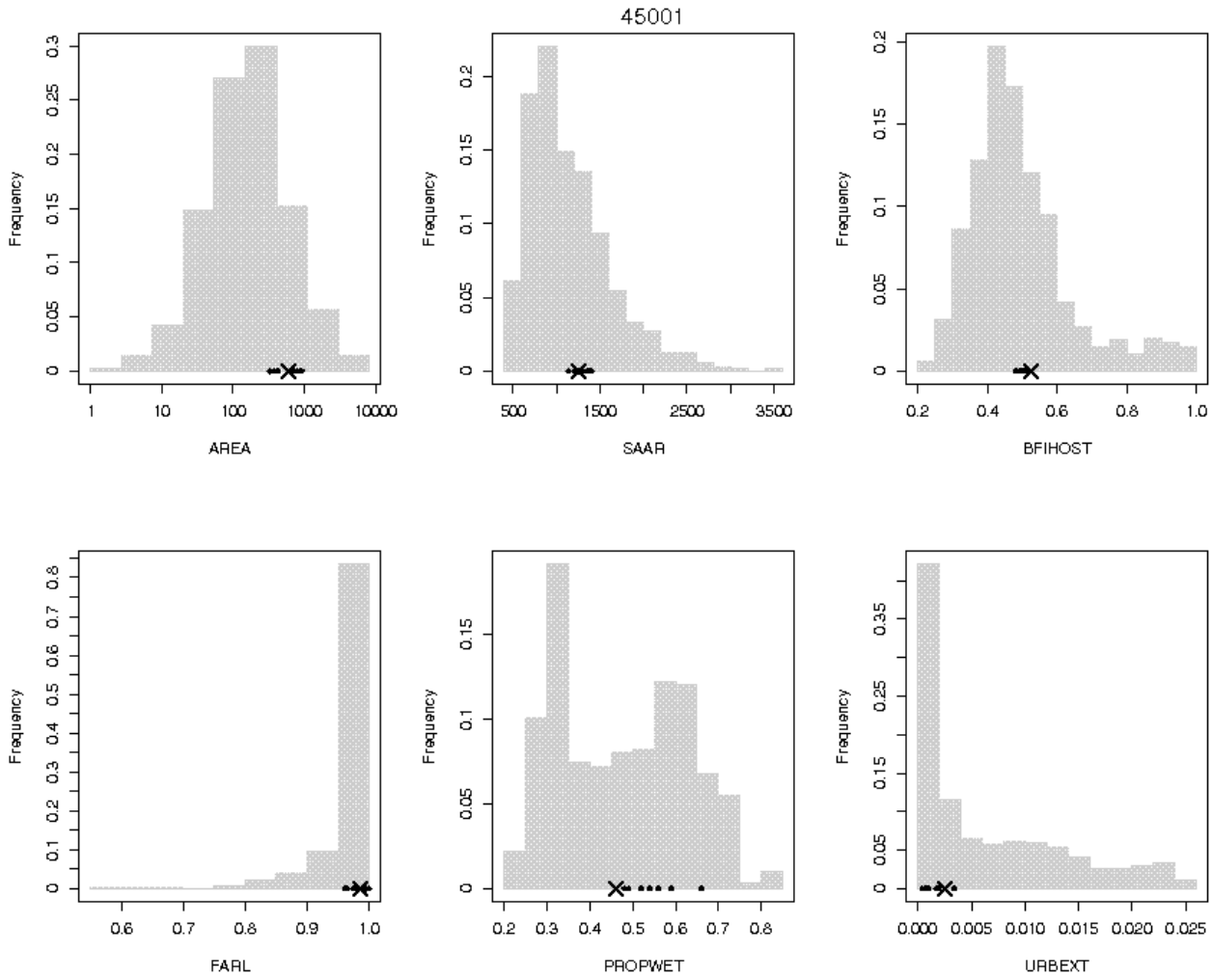


There are differences because: I plot the empirical growth curves; site 40009 in FEH book has 14 data, while I have 25; book uses POT for the polar plot, I only use annual maximum.

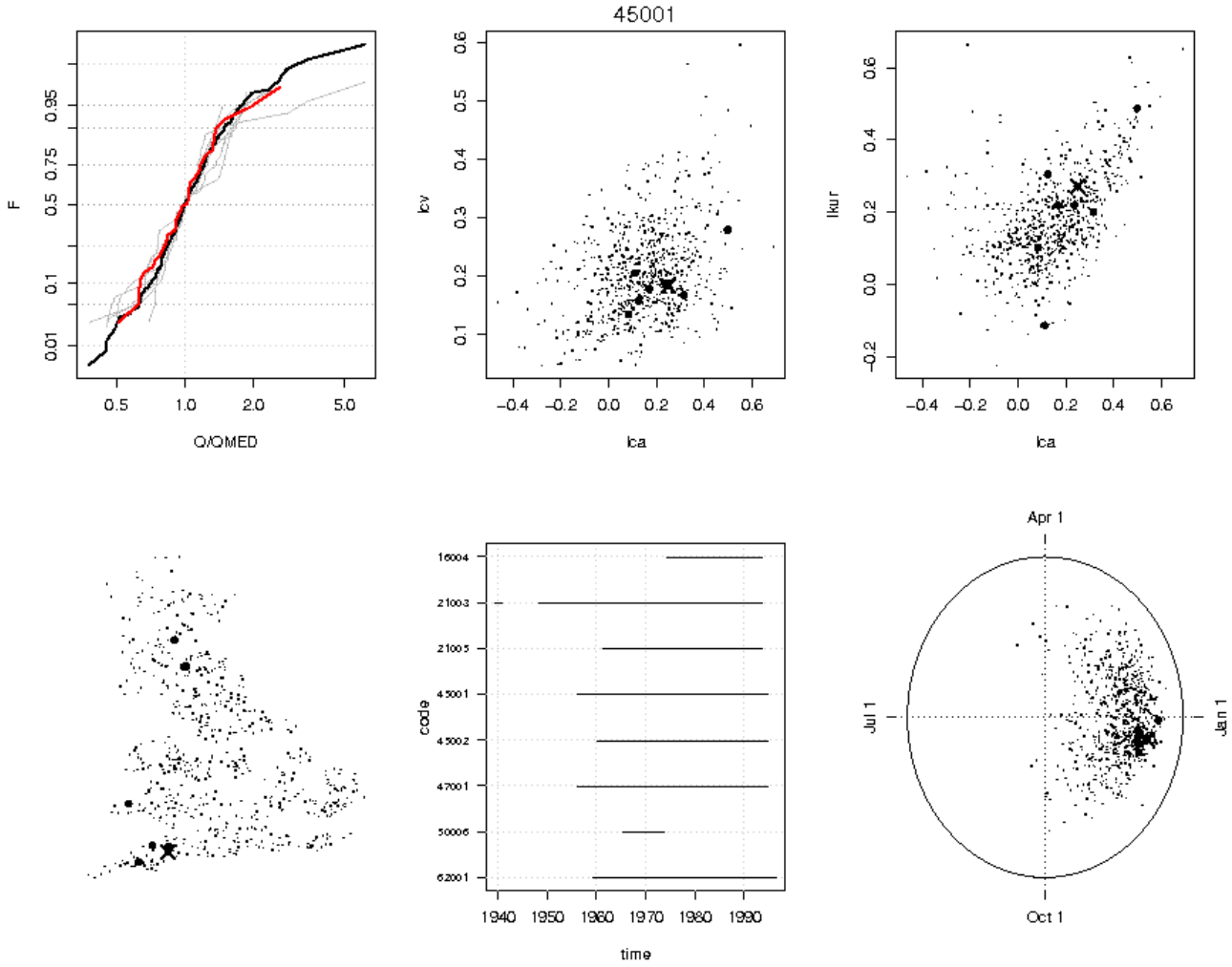
Figure 6.2 pag. 30, FEH Vol.3:

```
> 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
0.1
0.5
0.75
0.95
0.5
1.0
2.0
5.0
Q/QMED
lcv
0.1
0.2
0.3
0.4
0.5
0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
lca
lkur
−0.2
0.0
0.2
0.4
0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
lca
code
16004
21003
21005
45001
45002
47001
50006
62001
1940
1950
1960
1970
1980
1990
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.