R Notebook

Code

Hide

```
#library
library(readr)
library(markovchain)
library(lubridate)
library(reshape2)
library(dplyr)
library(foreach)
library(doParallel)
library(markovchain)
library(Rsolnp)
library(fitdistrplus)
library(vars)
library(lubridate)
library(matlib)
library(xts)
library(ks)
library(rstatix)
library(ggplot2)
library(tidyverse)
library(VGAM)
library(Renext)
library(verification)

theme_set(theme_bw())
```

Source different functions

Hide

```
source("Briggs_Wilks_Resampling.R")
source("SWG1_parametric.R")
source("SWG2_parametric.R")
source("SWG3_semi_parametric.R")
```

Read station file

Hide

```
chemin.in="H:/SWG_Articles/Codes_Articles/kandi_memoire2.csv"
kandi_val<- read_csv(chemin.in, col_types = cols(year = col_character()))
```

Performance of SWGs developped in reproducing real climatology

Hide

```
ht_seuil=0.1         #rain threshold
distribution=2        #1 exponentiel, 2 Gamma distribution
nyear=50              # number of simulation
andebut=2031          # Arbitrary start year for simulation
seas=7                #from july to September for season

yearclimreal=as.character(1971:2020)

#Run SWG1
SWG1_param_sim=SWG1(chemin.in,yearclimreal,seas,distribution,nyear,andebut,ht_seuil)

#Run SWG2
SWG2_param_sim=SWG2(chemin.in,yearclimreal,seas,nyear,andebut,ht_seuil)


#Run SWG3
SWG3_Semi_param_sim=SWG3(chemin.in,yearclimreal,seas,nyear,andebut,ht_seuil)
```

Dry spells and Wet Spells comparaison With observed 1971-2020

Hide

```
#Dry Spells function
dry=function(x){
  d1=c(0,which(x>=ht_seuil))
  d2=c(which(x>=ht_seuil),length(x))
  seq=(d2-d1)+1
  return(seq)
}

#Wet Spells function
wet=function(x){
  d1=c(0,which(x<ht_seuil))
  d2=c(which(x<ht_seuil),length(x))
  wet=(d2-d1)+1
  return(wet)
}



##### Dry Spells
seq_real=kandi_val%>%filter(between(mois,7,9))%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=dry(PRCP))%>%
  transmute(Obs=Obs)
Obs_dry=cbind.data.frame(rep("Obs",dim(seq_real)[1]),seq_real$Obs)
colnames(Obs_dry)=c("SWG","dry_spells")


seq_SWG1=SWG1_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=dry(rain))%>%
  transmute(SWG1=SWG1)
SWG1_dry=cbind.data.frame(rep("SWG1",dim(seq_SWG1)[1]),seq_SWG1$SWG1)
colnames(SWG1_dry)=c("SWG","dry_spells")


seq_SWG2=SWG2_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=dry(rain))%>%
  transmute(SWG2=SWG2)
SWG2_dry=cbind.data.frame(rep("SWG2",dim(seq_SWG2)[1]),seq_SWG2$SWG2)
colnames(SWG2_dry)=c("SWG","dry_spells")


seq_SWG3=SWG3_Semi_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=dry(rain))%>%
  transmute(SWG3=SWG3)
SWG3_dry=cbind.data.frame(rep("SWG3",dim(seq_SWG3)[1]),seq_SWG3$SWG3)
colnames(SWG3_dry)=c("SWG","dry_spells")




dry_seq=rbind.data.frame(Obs_dry,SWG1_dry,SWG2_dry,SWG3_dry#,SWG4_dry
                         )
```

```
##### Wet Spells

Wet_real=kandi_val%>%filter(between(mois,7,9))%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=wet(PRCP))%>%
  transmute(Obs=Obs)
Obs_Wet=cbind.data.frame(rep("Obs",dim(Wet_real)[1]),Wet_real$Obs)
colnames(Obs_Wet)=c("SWG","wet_spells")


Wet_SWG1=SWG1_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=wet(rain))%>%
  transmute(SWG1=SWG1)
SWG1_wet=cbind.data.frame(rep("SWG1",dim(Wet_SWG1)[1]),Wet_SWG1$SWG1)
colnames(SWG1_wet)=c("SWG","wet_spells")


Wet_SWG2=SWG2_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=wet(rain))%>%
  transmute(SWG2=SWG2)
SWG2_wet=cbind.data.frame(rep("SWG2",dim(Wet_SWG2)[1]),Wet_SWG2$SWG2)
colnames(SWG2_wet)=c("SWG","wet_spells")


Wet_SWG3=SWG3_Semi_param_sim$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=wet(rain))%>%
  transmute(SWG3=SWG3)
SWG3_wet=cbind.data.frame(rep("SWG3",dim(Wet_SWG3)[1]),Wet_SWG3$SWG3)
colnames(SWG3_wet)=c("SWG","wet_spells")




Wet_seq=rbind.data.frame(Obs_Wet,SWG1_wet,SWG2_wet,SWG3_wet#,SWG4_wet
                         )
```

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```
Spells_table1=cbind.data.frame(rep("Dry Spells",dim(dry_seq)[1]),dry_seq)
colnames(Spells_table1)=c("Spell","SWG","value")
Spells_table2=cbind.data.frame(rep("Wet Spells",dim(Wet_seq)[1]),Wet_seq)
colnames(Spells_table2)=c("Spell","SWG","value")
Spells_table=rbind.data.frame(Spells_table1,Spells_table2)
```

Hide

```
Spells_table%>%group_by(Spell, SWG)%>%summarise(value=round(mean(value),2))
```

```
`summarise()` has grouped output by 'Spell'. You can override using the `.groups` argument.
```

Spell <chr>	SWG <chr>	value <dbl>
Dry Spells	Obs	2.81
Dry Spells	SWG1	2.88
Dry Spells	SWG2	2.88
Dry Spells	SWG3	2.79
Wet Spells	Obs	3.13
Wet Spells	SWG1	3.04
Wet Spells	SWG2	3.04
Wet Spells	SWG3	3.16

8 rows

Hide

```
Spells_table%>%group_by(Spell, SWG)%>%summarise(value=round(sd(value),2))
```

```
`summarise()` has grouped output by 'Spell'. You can override using the `.groups` argument.
```

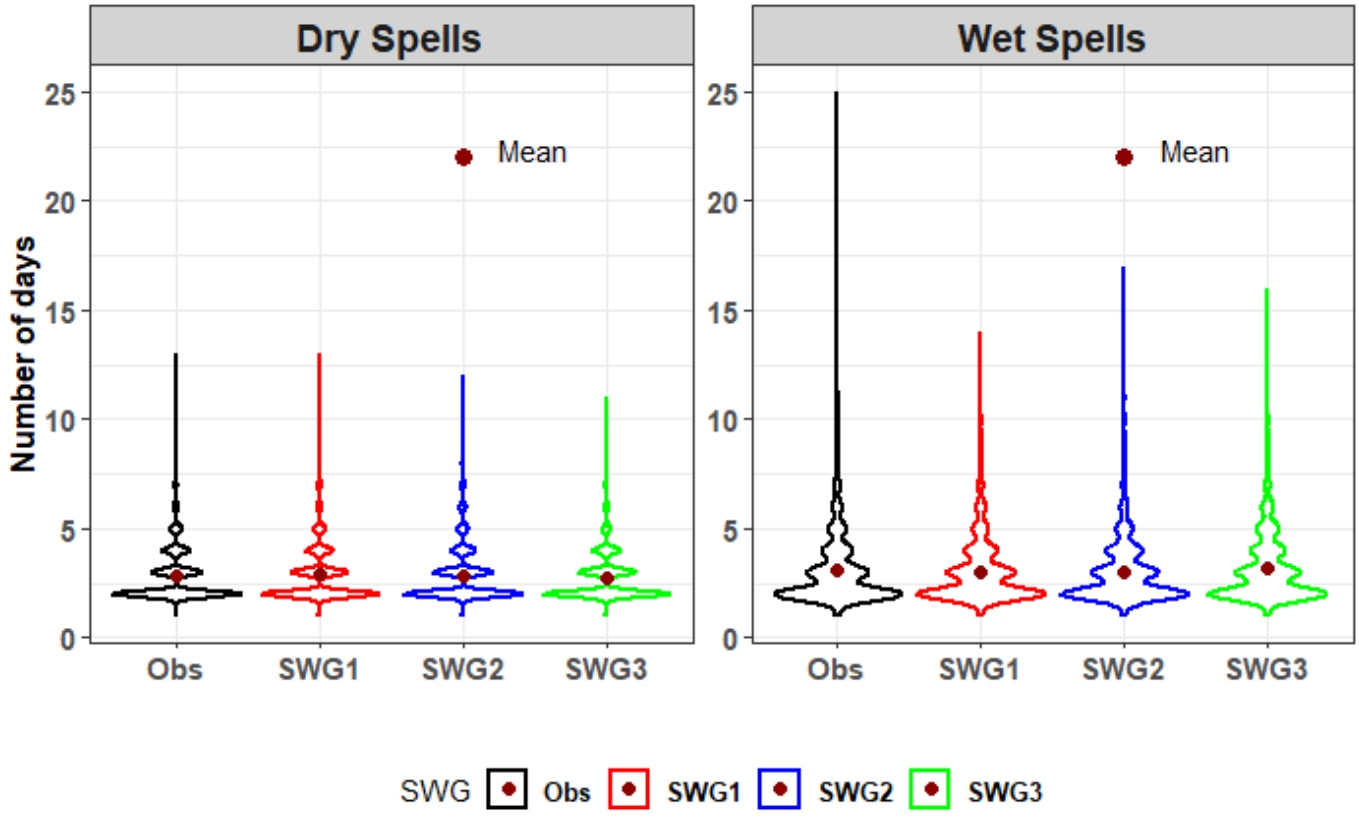
Spell <chr>	SWG <chr>	value <dbl>
Dry Spells	Obs	1.24
Dry Spells	SWG1	1.32
Dry Spells	SWG2	1.31
Dry Spells	SWG3	1.21
Wet Spells	Obs	1.81
Wet Spells	SWG1	1.54
Wet Spells	SWG2	1.53
Wet Spells	SWG3	1.60

8 rows

Hide

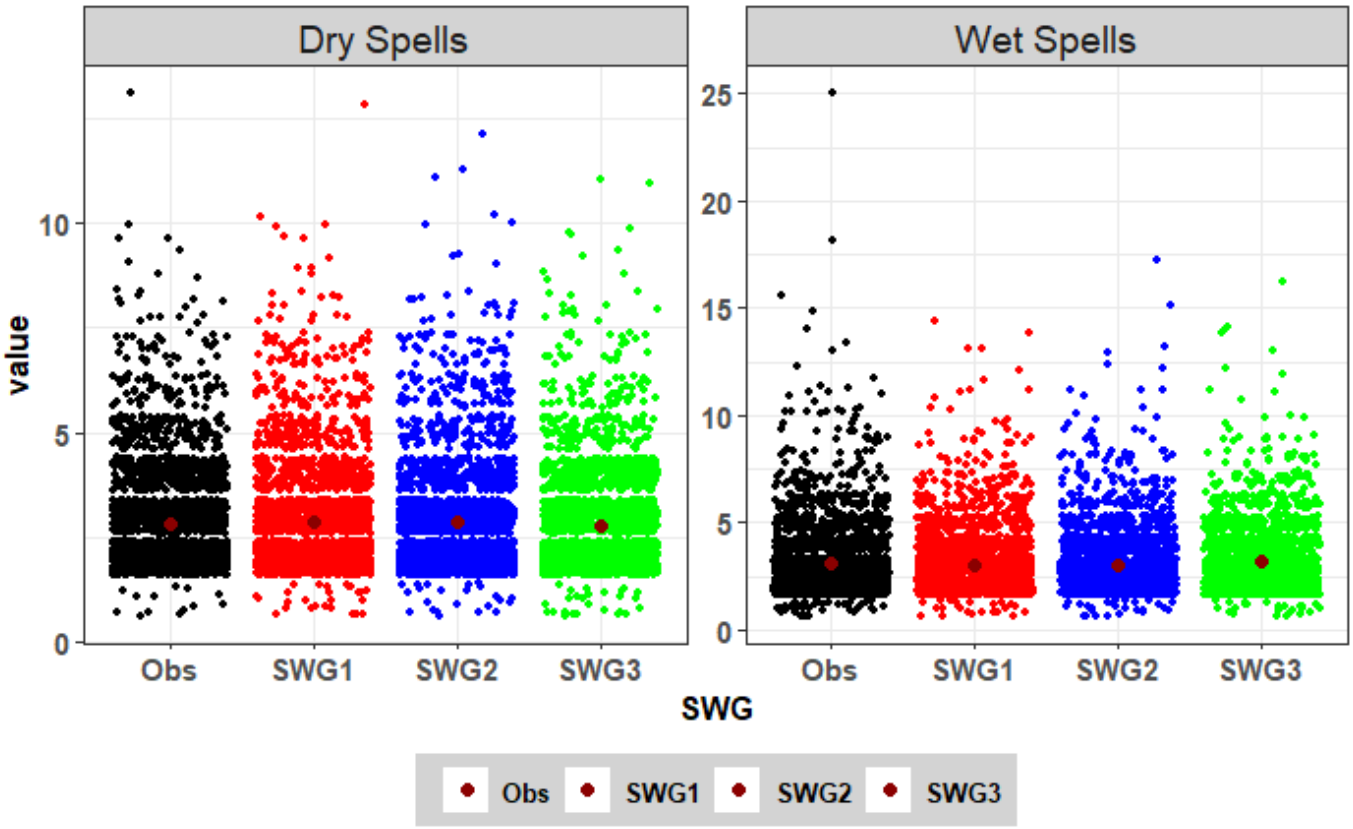
```
ggplot(Spells_table, aes(x=SWG,y=value,color=SWG))+
  geom_violin(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.leg
end = T)+
  scale_color_manual(values=c("black","red","blue","green")) + ylim(1,max(Spells_table$valu
e))+ theme(axis.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size
 = 11,face='bold'),axis.title = element_text(face = "bold",size = 12),legend.text = element_t
ext(size = 10,face = "bold"),legend.position="bottom",strip.text.x = element_text(size = 12,f
ace = "bold"))+
  labs(y = "Number of days", x="")+
  ggplot2::facet_wrap(facets= ~ Spell, dir="h",scales="free")+theme(strip.text.x = element_te
xt(size=14),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=3, y=22), colou
r="darkred",  size=3)+
  annotate(geom="text", x=3.5, y=22.4, label="Mean",color="black",size=4,face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



Hide

```
ggplot(Spells_table, aes(x=SWG,y=value,color=SWG))+
  geom_jitter(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.leg
end = T)+
  scale_color_manual(values=c("black", "red","blue","green","grey")) +
  theme(legend.position="bottom", legend.background = element_rect(fill="lightgrey", linetype
="solid"),
        legend.title=element_blank(),axis.text.x = element_text(size = 11,face="bold"),
        axis.text.y = element_text(size = 11,face='bold'),axis.title = element_text(face = "b
old",size = 12),
        legend.text = element_text(size = 10,face = "bold"))+ggplot2::facet_wrap(facets= ~ Sp
ell, dir="h",scales="free")+theme(strip.text.x = element_text(size=14),strip.background=eleme
nt_rect(fill="lightgrey"))
```



Computing non-parametric tests of equality of mean, variance and distribution

Dry spells

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```
#Wilcoxon test
wilcoxon_test <- dry_seq %>%
  wilcox_test(dry_spells ~ SWG) %>%
  add_significance()
print(wilcoxon_test[1:4,])
```

.y. <chr>	group1 <chr>	group2 <chr>	n1 <int>	n2 <int>	statistic <dbl>	p <dbl>	p.adj <dbl>	p.adj.signif <chr>
dry_spells	Obs	SWG1	2545	2444	3012011	0.034	0.181	ns
dry_spells	Obs	SWG2	2545	2450	3017242	0.030	0.181	ns
dry_spells	Obs	SWG3	2545	2575	3269246	0.876	1.000	ns
dry_spells	SWG1	SWG2	2444	2450	2992562	0.976	1.000	ns

4 rows

Hide

```
#Ansari Bradley
Ansari_SWG1 <- ansari.test(Obs_dry$dry_spells,SWG1_dry$dry_spells)
Ansari_SWG2 <- ansari.test(Obs_dry$dry_spells,SWG2_dry$dry_spells)
Ansari_SWG3 <- ansari.test(Obs_dry$dry_spells,SWG3_dry$dry_spells)
#Ansari_SWG4 <- ansari.test(Obs_dry$dry_spells,SWG4_dry$dry_spells)

Ansari_SWG1
```

```

    Ansari-Bradley test

data:  Obs_dry$dry_spells and SWG1_dry$dry_spells
AB = 3225205, p-value = 0.002755
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG2
```

```

    Ansari-Bradley test

data:  Obs_dry$dry_spells and SWG2_dry$dry_spells
AB = 3215084, p-value = 0.03019
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG3
```

```

    Ansari-Bradley test

data:  Obs_dry$dry_spells and SWG3_dry$dry_spells
AB = 3286643, p-value = 0.1137
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
#Ansari_SWG4
```

Hide

```

#Kolmogorov Sirminov
KS_SWG1 <- ks.test(Obs_dry$dry_spells,SWG1_dry$dry_spells)
```

```
Warning in ks.test(Obs_dry$dry_spells, SWG1_dry$dry_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG2 <- ks.test(Obs_dry$dry_spells,SWG2_dry$dry_spells)
```

```
Warning in ks.test(Obs_dry$dry_spells, SWG2_dry$dry_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG3 <- ks.test(Obs_dry$dry_spells,SWG3_dry$dry_spells)
```

```
Warning in ks.test(Obs_dry$dry_spells, SWG3_dry$dry_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG1
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_dry$dry_spells and SWG1_dry$dry_spells
D = 0.035849, p-value = 0.08116
alternative hypothesis: two-sided
```

Hide

```
KS_SWG2
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_dry$dry_spells and SWG2_dry$dry_spells
D = 0.039601, p-value = 0.03987
alternative hypothesis: two-sided
```

Hide

```
KS_SWG3
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_dry$dry_spells and SWG3_dry$dry_spells
D = 0.015552, p-value = 0.9163
alternative hypothesis: two-sided
```

Wet Spells

Hide

```
wilcoxon_test <- Wet_seq %>%
  wilcox_test(wet_spells ~ SWG) %>%
  add_significance()
print(wilcoxon_test[1:3,])
```

.y. <chr>	group1 <chr>	group2 <chr>	n1 <int>	n2 <int>	statistic <dbl>	p <dbl>	p.adj <dbl>	p.adj.signif <chr>
wet_spells	Obs	SWG1	2155	2256	2444762	0.724	1.000	ns
wet_spells	Obs	SWG2	2155	2250	2424245	0.997	1.000	ns
wet_spells	Obs	SWG3	2155	2125	2196017	0.014	0.055	ns

3 rows

Hide

```
#Ansari-Bradley
Ansari_SWG1 <- ansari.test(Obs_Wet$wet_spells,SWG1_wet$wet_spells)
Ansari_SWG2 <- ansari.test(Obs_Wet$wet_spells,SWG2_wet$wet_spells)
Ansari_SWG3 <- ansari.test(Obs_Wet$wet_spells,SWG3_wet$wet_spells)

Ansari_SWG1
```

```

    Ansari-Bradley test

data:  Obs_Wet$wet_spells and SWG1_wet$wet_spells
AB = 2337325, p-value = 0.006558
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG2
```

```

    Ansari-Bradley test

data:  Obs_Wet$wet_spells and SWG2_wet$wet_spells
AB = 2337947, p-value = 0.01489
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG3
```

```

    Ansari-Bradley test

data:  Obs_Wet$wet_spells and SWG3_wet$wet_spells
AB = 2301228, p-value = 0.7062
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
#Kolmogorov-Sirminov
KS_SWG1 <- ks.test(Obs_Wet$wet_spells,SWG1_wet$wet_spells)
```

```
Warning in ks.test(Obs_Wet$wet_spells, SWG1_wet$wet_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG2 <- ks.test(Obs_Wet$wet_spells,SWG2_wet$wet_spells)
```

```
Warning in ks.test(Obs_Wet$wet_spells, SWG2_wet$wet_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG3 <- ks.test(Obs_Wet$wet_spells,SWG3_wet$wet_spells)
```

```
Warning in ks.test(Obs_Wet$wet_spells, SWG3_wet$wet_spells) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG1
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_Wet$wet_spells and SWG1_wet$wet_spells
D = 0.020555, p-value = 0.7403
alternative hypothesis: two-sided
```

Hide

```
KS_SWG2
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_Wet$wet_spells and SWG2_wet$wet_spells
D = 0.02376, p-value = 0.5633
alternative hypothesis: two-sided
```

Hide

```
KS_SWG3
```

```

    Two-sample Kolmogorov-Smirnov test

data:  Obs_Wet$wet_spells and SWG3_wet$wet_spells
D = 0.039565, p-value = 0.07018
alternative hypothesis: two-sided
```

Cumulative daily and seasonal rainfall comparaison With observed 1971-2020

Cumulative daily rainfall

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```
# Cumulative daily rainfall
kand=kandi_val
kand$PRCP[kand$PRCP<ht_seuil]<-0
SWG1_param_sim$data_sim$rain[SWG1_param_sim$data_sim$rain<ht_seuil]<-0
SWG2_param_sim$data_sim$rain[SWG2_param_sim$data_sim$rain<ht_seuil]<-0
SWG3_Semi_param_sim$data_sim$rain[SWG3_Semi_param_sim$data_sim$rain<ht_seuil]<-0


cum_day=cbind.data.frame(kand%>%filter(between(mois,7,9))%>%dplyr::select(PRCP),SWG1_param_si
m$data_sim$rain,SWG2_param_sim$data_sim$rain,SWG3_Semi_param_sim$data_sim$rain
                         )
colnames(cum_day)=c("Obs","SWG1","SWG2" ,"SWG3"
                    )

cum_day_gather=cum_day%>%gather(key = "SWG",value = value)
cum_day_gather=cbind.data.frame(rep("Cumulative daily rainfall",dim(cum_day_gather)[1]),cum_d
ay_gather)
colnames(cum_day_gather)=c("cum","SWG","value")
```

Hide

```
cum_day_gather%>%group_by(SWG)%>%summarise(value=round(mean(value),1))
```

SWG <chr>	value <dbl>
Obs	7.1
SWG1	7.4
SWG2	7.2
SWG3	8.0

4 rows

Hide

```
cum_day_gather%>%group_by(SWG)%>%summarise(value=round(sd(value),1))
```

SWG <chr>	value <dbl>
Obs	13.3
SWG1	14.0
SWG2	13.6

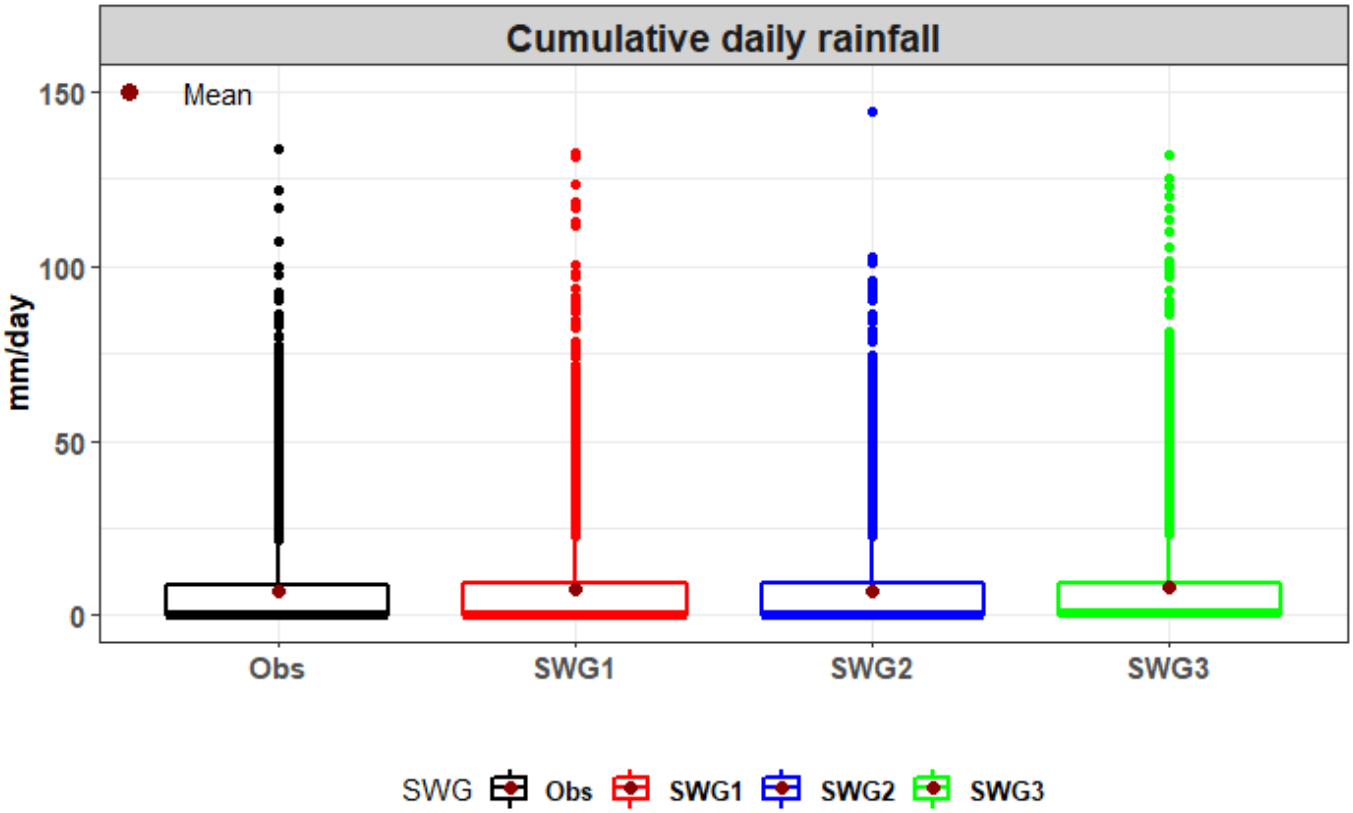
SWG <chr>	value <dbl>
SWG3	15.1

4 rows

Hide

```
ggplot(cum_day_gather, aes(x=SWG,y=value,color=SWG))+
  geom_boxplot(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.legend = T)+
  scale_color_manual(values=c("black","red","blue","green","grey")) + ylim(0,150)+ theme(axis.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 11,face='bold'),axis.title = element_text(face = "bold",size = 12),legend.text = element_text(size = 10,face = "bold"),legend.position="bottom",strip.text.x = element_text(size = 12,face = "bold"))+
  labs(y = "mm/day", x="")+
  ggplot2::facet_wrap(facets= ~ cum, dir="h",scales="free")+theme(strip.text.x = element_text(size=14),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=0.5, y=150), colour="darkred",  size=3)+
  annotate(geom="text", x=0.8, y=150, label="Mean",color="black",size=4,face="bold")
```

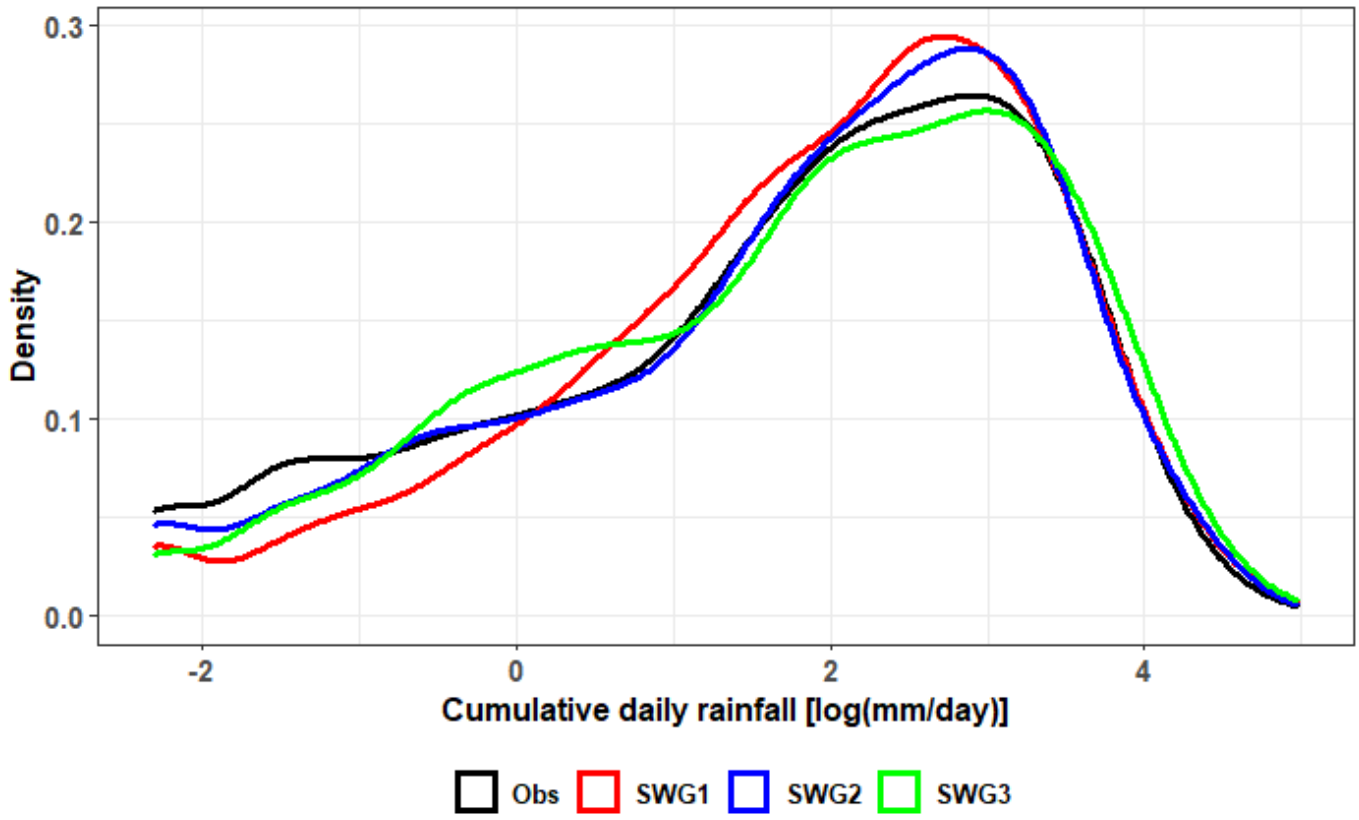
```
Warning: Ignoring unknown parameters: face
```



Hide

```
ggplot(cum_day_gather,
       aes(as.numeric(log(value)), colour=SWG)) +
  labs(y = "Density", x="Cumulative daily rainfall [log(mm/day)]")+
  geom_density(size=1.2) +
  scale_color_manual(values=c("black", "red","blue","green","grey")) +
  theme(legend.position="bottom", legend.background = element_rect(linetype="solid"),
        legend.title=element_blank(),axis.text.x = element_text(size = 11,face="bold"),
        axis.text.y = element_text(size = 11,face='bold'),axis.title = element_text(face = "b
old",size = 12),
        legend.text = element_text(size = 10,face = "bold"))
```

```
Warning: Removed 8586 rows containing non-finite values (stat_density).
```

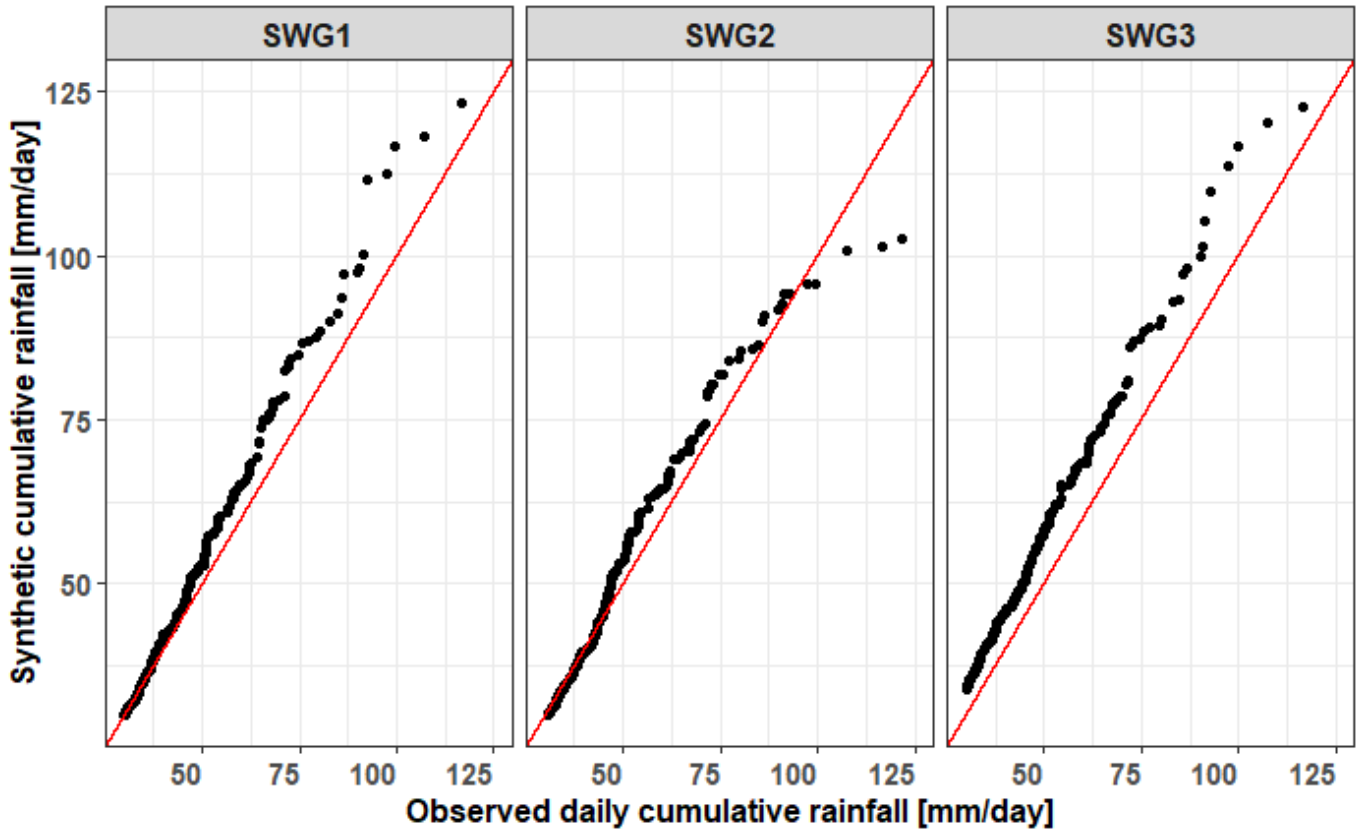


QQplot daily cumulative

Hide

```
sx <- sort(cum_day_gather[cum_day_gather$SWG=="Obs",]$value)
sy <- sort(cum_day_gather[cum_day_gather$SWG=="SWG1",]$value)

lenx <- length(sx)
leny <- length(sy)

if (leny < lenx)sx <- approx(1L:lenx, sx, n = leny)$y
if (leny > lenx)sy <- approx(1L:leny, sy, n = lenx)$y
type=rep("SWG1",length(sy))
mmm=cbind.data.frame(sx,sy,type)

sx <- sort(cum_day_gather[cum_day_gather$SWG=="Obs",]$value)
sy <- sort(cum_day_gather[cum_day_gather$SWG=="SWG2",]$value)
lenx <- length(sx)
leny <- length(sy)
if (leny < lenx)sx <- approx(1L:lenx, sx, n = leny)$y
if (leny > lenx)sy <- approx(1L:leny, sy, n = lenx)$y
type=rep("SWG2",length(sy))
mmm1=cbind.data.frame(sx,sy,type)

sx <- sort(cum_day_gather[cum_day_gather$SWG=="Obs",]$value)
sy <- sort(cum_day_gather[cum_day_gather$SWG=="SWG3",]$value)
lenx <- length(sx)
leny <- length(sy)
if (leny < lenx)sx <- approx(1L:lenx, sx, n = leny)$y
if (leny > lenx)sy <- approx(1L:leny, sy, n = lenx)$y
type=rep("SWG3",length(sy))
mmm2=cbind.data.frame(sx,sy,type)

mm=rbind.data.frame(mmm,mmm1,mmm2)

ggplot(mm,aes(mm$sx,mm$sy)) +geom_point()+ggplot2::theme(legend.position="bottom", axis.text.
x = element_text(vjust = 1, size = 11, hjust = 1,face="bold"),axis.text.y = element_text(size
= 11,face='bold'),axis.title = element_text(face = "bold",size = 12),      strip.text.x = ele
ment_text(
  size = 12,face = "bold"
)) + ggplot2::facet_wrap(facets= ~ type, dir="h") + ggplot2::xlab(label="Observed daily cumul
ative rainfall [mm/day]") + ggplot2::ylab(label="Synthetic cumulative rainfall [mm/day]")+xli
m(30,125)+ylim(30,125)+geom_abline(intercept = 0, slope = 1,color="red",size=1)
```

```
Warning: Use of `mm$sx` is discouraged. Use `sx` instead.
Warning: Use of `mm$sy` is discouraged. Use `sy` instead.
Warning: Removed 12845 rows containing missing values (geom_point).
```



Statistics tests

Hide

```
wilcoxon_test <- cum_day_gather %>%
  wilcox_test(value ~ SWG) %>%
  add_significance()
print(wilcoxon_test[1:4,])
```

.y.	group1	group2	n1	n2	statistic	p	p.adj	p.adj.signif
<chr>	<chr>	<chr>	<int>	<int>	<dbl>	<dbl>	<dbl>	<chr>
value	Obs	SWG1	4600	4600	10639563	0.622	1.000	ns
value	Obs	SWG2	4600	4600	10702849	0.309	0.927	ns
value	Obs	SWG3	4600	4600	10394936	0.127	0.508	ns
value	SWG1	SWG2	4600	4600	10638674	0.625	1.000	ns

4 rows

Hide

```
#Ansari-Bradley
Ansari_SWG1 <- ansari.test(cum_day$Obs,cum_day$SWG1)
Ansari_SWG2 <- ansari.test(cum_day$Obs,cum_day$SWG2)
Ansari_SWG3 <- ansari.test(cum_day$Obs,cum_day$SWG3)
#Ansari_SWG4 <- ansari.test(cum_day$Obs,cum_day$SWG4)

Ansari_SWG1
```

```
    Ansari-Bradley test

data:  cum_day$Obs and cum_day$SWG1
AB = 10757719, p-value = 0.0003297
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG2
```

```
    Ansari-Bradley test

data:  cum_day$Obs and cum_day$SWG2
AB = 10688554, p-value = 0.03003
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
Ansari_SWG3
```

```
    Ansari-Bradley test

data:  cum_day$Obs and cum_day$SWG3
AB = 10671389, p-value = 0.07681
alternative hypothesis: true ratio of scales is not equal to 1
```

Hide

```
#Ansari_SWG4
```

Hide

```
#Kolmogorov-Sirminov
KS_SWG1 <- ks.test(cum_day$Obs,cum_day$SWG1)
```

```
Warning in ks.test(cum_day$Obs, cum_day$SWG1) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG2 <- ks.test(cum_day$Obs,cum_day$SWG2)
```

```
Warning in ks.test(cum_day$Obs, cum_day$SWG2) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG3 <- ks.test(cum_day$Obs,cum_day$SWG3)
```

```
Warning in ks.test(cum_day$Obs, cum_day$SWG3) :
  les valeurs p seront approximées en présence d'ex-aequos
```

Hide

```
KS_SWG1
```

```

    Two-sample Kolmogorov-Smirnov test

data:  cum_day$Obs and cum_day$SWG1
D = 0.021957, p-value = 0.2175
alternative hypothesis: two-sided
```

Hide

```
KS_SWG2
```

```

    Two-sample Kolmogorov-Smirnov test

data:  cum_day$Obs and cum_day$SWG2
D = 0.020652, p-value = 0.2804
alternative hypothesis: two-sided
```

Hide

```
KS_SWG3
```

```

    Two-sample Kolmogorov-Smirnov test

data:  cum_day$Obs and cum_day$SWG3
D = 0.026522, p-value = 0.07866
alternative hypothesis: two-sided
```

Cumulative seasonal rainfall

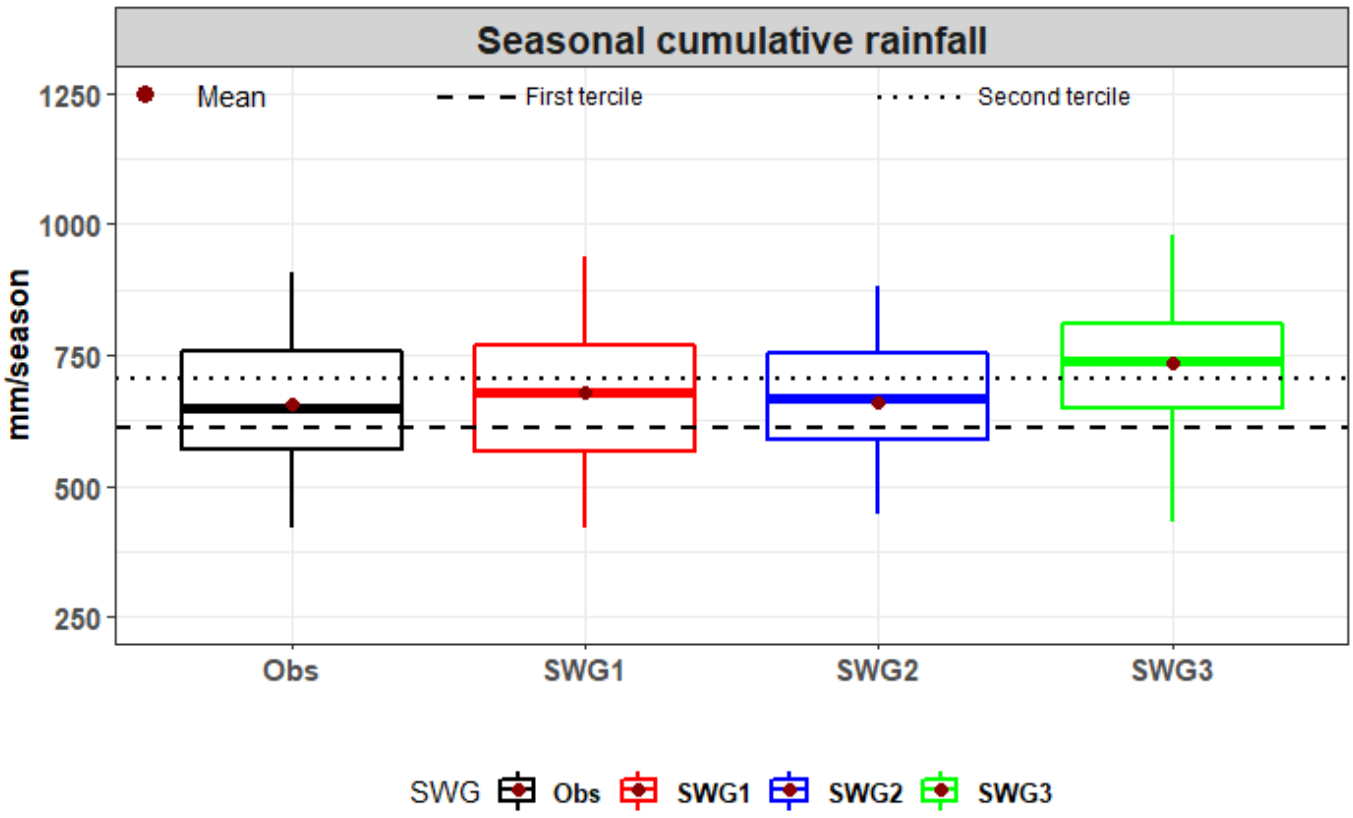
Hide

```
cum_season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP),SWG1_param_sim$cm_seas_sim$rain,SWG2_param_sim$cm_seas_sim$rain,SWG3_Se
mi_param_sim$cm_seas_sim$rain)

# ,SWG3_nonparam%>%group_by(yearsim)%>%
#    summarise(PRCP=sum(PRCP,na.rm = T))%>%dplyr::select(PRCP)
# )
colnames(cum_season)=c("Obs","SWG1","SWG2","SWG3"
                       )

cum_season_gather=cum_season%>%gather(key = "SWG",value = value)
cum_season_gather=cbind.data.frame(rep("Seasonal cumulative rainfall",dim(cum_season_gather)[
1]),cum_season_gather)
colnames(cum_season_gather)=c("cum","SWG","value")

#### Number of days

nb_days_season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9),PRCP>0.85)%>%
group_by(year)%>%summarise(PRCP=length(PRCP))%>%
  dplyr::select(PRCP),
SWG1_param_sim$data_sim%>%filter(rain>0.85)%>%
group_by(year)%>%summarise(rain=length(rain))%>%
  dplyr::select(rain),
SWG2_param_sim$data_sim%>%filter(rain>0.6)%>%group_by(year)%>%summarise(rain=length(rain))%>%
dplyr::select(rain),
SWG3_Semi_param_sim$data_sim%>%filter(rain>0.85)%>%
group_by(year)%>%summarise(rain=length(rain))%>%
  dplyr::select(rain))


colnames(nb_days_season)=c("Obs","SWG1","SWG2","SWG3"
                       )

nb_days_season_gather=nb_days_season%>%gather(key = "SWG",value = value)
nb_days_season_gather=cbind.data.frame(rep("Number of wet days",dim(nb_days_season_gather)[1
]),nb_days_season_gather)
colnames(nb_days_season_gather)=c("cum","SWG","value")
```

Hide

```
terc=quantile(cum_season$Obs,probs = seq(0,1,1/3))
ggplot(cum_season_gather, aes(x=SWG,y=value,color=SWG))+
  geom_boxplot(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.le
gend = T)+
  scale_color_manual(values=c("black","red","blue","green","grey")) + ylim(250,1250)+ theme(a
xis.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 11,face='b
old'),axis.title = element_text(face = "bold",size = 12),legend.text = element_text(size = 10
,face = "bold"),legend.position="bottom",strip.text.x = element_text(size = 12,face = "bold"
))+
  labs(y = "mm/season", x="")+geom_hline(yintercept = terc[2], linetype=2, color = "black", s
ize=1)+
  geom_hline(yintercept = terc[3], linetype=3, color = "black", size=1)+
  ggplot2::facet_wrap(facets= ~ cum, dir="h",scales="free")+theme(strip.text.x = element_text
(size=14),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=0.5, y=1250), col
our="darkred",  size=3)+
  annotate(geom="text", x=0.8, y=1250, label="Mean",color="black",size=4,face="bold")+
  geom_segment(aes(x=1.5, y=1240,xend=1.8,yend= 1240),color="black",size=1,linetype=2)+annota
te(geom="text", x=2, y=1250, label="First tercile",color="black",size=3.2,face="bold")+geom_s
egment(aes(x=3, y=1240,xend=3.3,yend= 1240),color="black",size=1,linetype=3)+annotate(geom="t
ext", x=3.6, y=1250, label="Second tercile",color="black",size=3.2,face="bold")
```

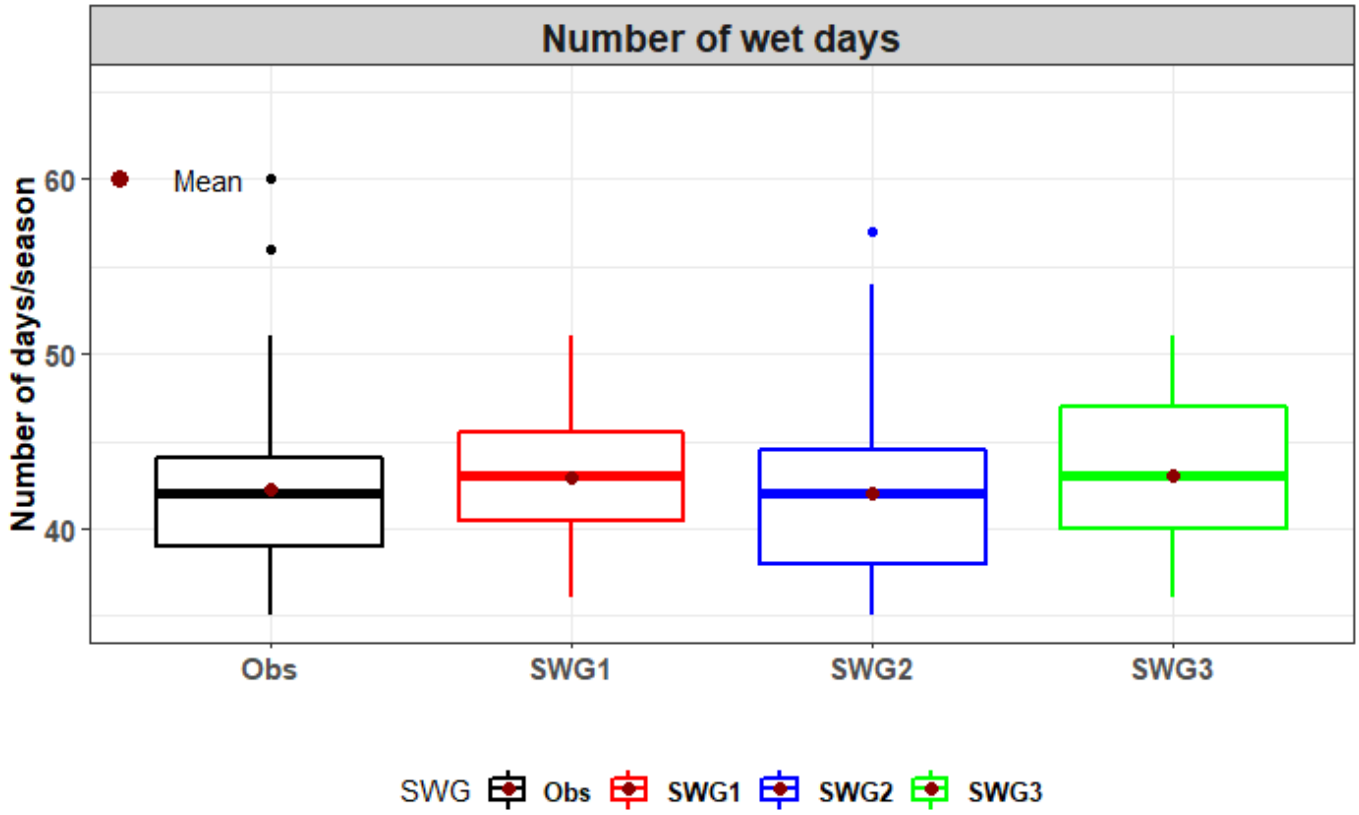
```
Warning: Ignoring unknown parameters: face
Warning: Ignoring unknown parameters: face
Warning: Ignoring unknown parameters: face
```



Hide

```
ggplot(nb_days_season_gather, aes(x=SWG,y=value,color=SWG))+
  geom_boxplot(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.le
gend = T)+
  scale_color_manual(values=c("black","red","blue","green","grey")) + ylim(35,65)+ theme(axi
s.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 11,face='bol
d'),axis.title = element_text(face = "bold",size = 12),legend.text = element_text(size = 10,f
ace = "bold"),legend.position="bottom",strip.text.x = element_text(size = 12,face = "bold"))+
  labs(y = "Number of days/season", x="")+
  ggplot2::facet_wrap(facets= ~ cum, dir="h",scales="free")+theme(strip.text.x = element_text
(size=14),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=0.5, y=60), colou
r="darkred",  size=3)+
  annotate(geom="text", x=0.8, y=60, label="Mean",color="black",size=4,face="bold")
```

```
Warning: Ignoring unknown parameters: face
Warning: Removed 15 rows containing non-finite values (stat_boxplot).
Warning: Removed 15 rows containing non-finite values (stat_summary).
```



Consistency between the probabilities of the categories of PRESASS seasonal forecasts format and those obtained from disaggregated forecasts

Hide

```
#Select season
saison_real=kandi_val%>%filter(between(mois,7,9))%>%
  filter(between(year,1981,2010))%>%group_by(year)%>%
  summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP)

tercile=quantile(saison_real$PRCP,probs = seq(0,1,1/3))
```

The probabilities of seasonal cumulative rainfall above-average

Hide

```
#SWG1-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.05,0.35,0.6)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(0.05,0,-0.05)
  prev[[i]]=prevu
  yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPA1=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>=tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG1",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPA1=rbind.data.frame(table_freqPA1,table_freq1)
```

Hide

```
#SWG2 parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.05,0.35,0.6)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(0.05,0,-0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPA2=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG2",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPA2=rbind.data.frame(table_freqPA2,table_freq1)
```

Hide

```
#SWG3-semi-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.05,0.35,0.6)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(0.05,0,-0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPA3=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG3",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPA3=rbind.data.frame(table_freqPA3,table_freq1)
```

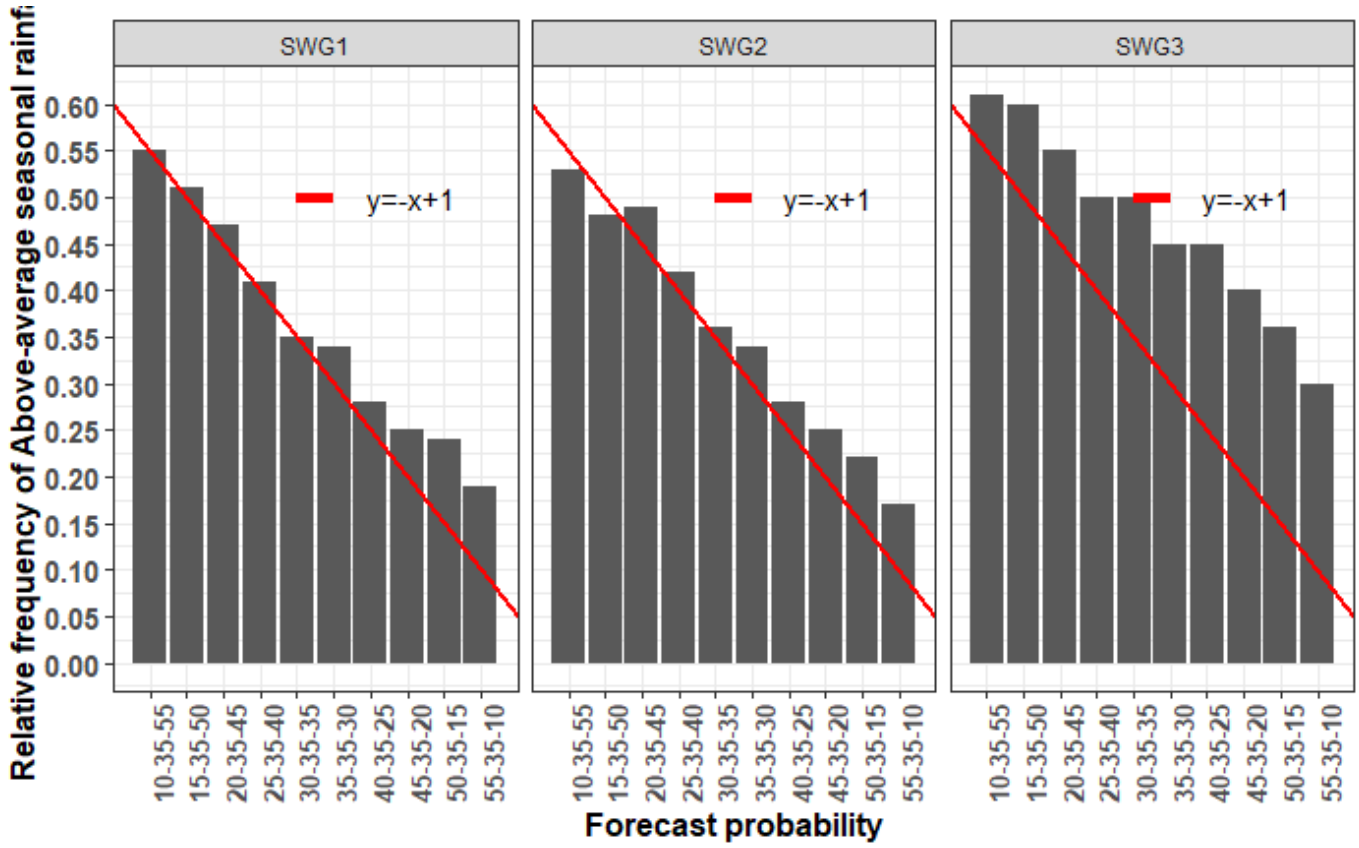
Hide

```
table_freqA=rbind.data.frame(table_freqPA1,table_freqPA2,table_freqPA3)
```

Hide

```
ggplot(data=table_freqA,aes(x=prevision,y=frequence))+
  geom_bar(stat = "identity", position=position_dodge())+scale_y_continuous(breaks = seq(0,0.
6,0.05))+
ggplot2::theme(legend.position="bottom", axis.text.x = element_text(angle = 90, vjust = 1, si
ze = 10, hjust = 1,face="bold"),axis.text.y = element_text(size = 11,face='bold'),axis.title
 = element_text(face = "bold",size = 12)) +
  ggplot2::facet_wrap(facets= ~ nom,ncol=4, scales="free_x") +ggplot2::xlab(label="Forecast p
robability")+
  ggplot2::ylab(label="Relative frequency of Above-average seasonal rainfall")+geom_segment(a
es(x=0, y=0.6,xend=11,yend=0.05),color="red",size=1,position="identity")+
    geom_segment(aes(x=5, y=0.5,xend=6,yend=0.5),color="red",size=2)+
  annotate(geom="text", x=8, y=0.5, label=" y=-x+1",color="black",size=4,face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



The probabilities of seasonal cumulative rainfall below average

Hide

```
#SWG1-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.6,0.35,0.05)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(-0.05,0,0.05)
  prev[[i]]=prevu
  yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPB1=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>=tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG1",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPB1=rbind.data.frame(table_freqPB1,table_freq1)
```

Hide

```
#SWG2 parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.6,0.35,0.05)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(-0.05,0,0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPB2=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG2",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPB2=rbind.data.frame(table_freqPB2,table_freq1)
```

Hide

```
#SWG3-semi-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.6,0.35,0.05)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(-0.05,0,0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  i=i+1
  if(i==11){
    break()
  }
}


#computing prob
prevision=c("10-35-55","15-35-50","20-35-45","25-35-40","30-35-35","35-35-30","40-35-25","45-
35-20","50-35-15","55-35-10")
table_freqPB3=NULL
frequence=NULL
#table_freq=NULL
for(i in 1:10){
   nb=length(which(result_cum1[[i]]$rain>tercile[3]))/1000
   frequence=c(frequence,round(nb,2))
}
nom=rep("SWG3",10)
table_freq1=cbind.data.frame(prevision,frequence,nom)
table_freqPB3=rbind.data.frame(table_freqPB3,table_freq1)
```

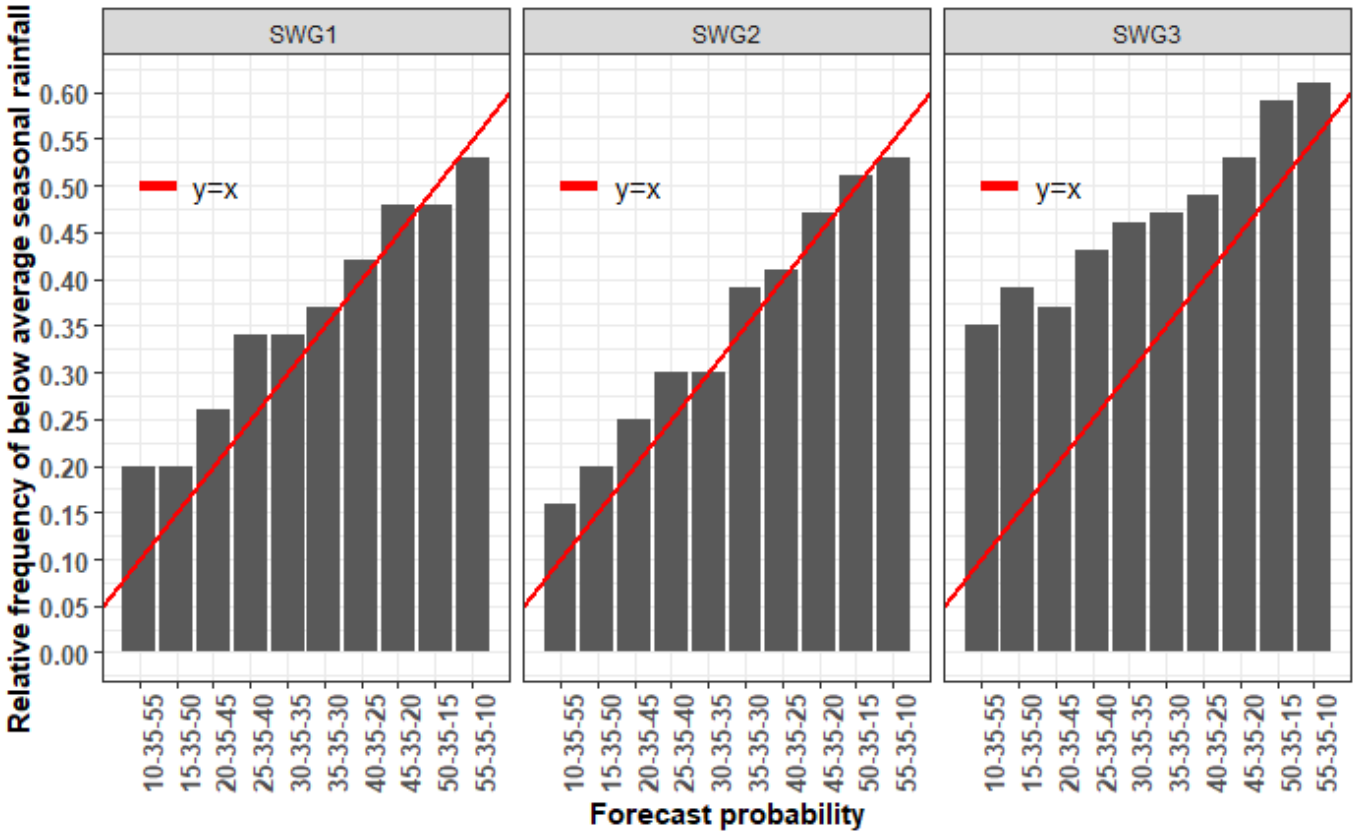
Hide

```
table_freqB=rbind.data.frame(table_freqPB1,table_freqPB2,table_freqPB3)
```

Hide

```
ggplot(data=table_freqB,aes(x=prevision,y=frequence))+
  geom_bar(stat = "identity", position=position_dodge())+scale_y_continuous(breaks = seq(0,0.
6,0.05))+
ggplot2::theme(legend.position="bottom", axis.text.x = element_text(angle = 90, vjust = 1, si
ze = 10, hjust = 1,face="bold"),axis.text.y = element_text(size = 10,face='bold'),axis.title
 = element_text(face = "bold",size = 11))+ ggplot2::facet_wrap(facets= ~ nom, ncol = 4, scale
s="free_x")+ ggplot2::xlab(label="Forecast probability")+
  ggplot2::ylab(label="Relative frequency of below average seasonal rainfall")+geom_segment(a
es(x=0, y=0.05,xend=11,yend=0.6),color="red",size=1,position="identity")+
    geom_segment(aes(x=1, y=0.5,xend=2,yend=0.5),color="red",size=2)+
  annotate(geom="text", x=3, y=0.5, label=" y=x",color="black",size=4,face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



Comparison of disaggregated forecasts to climatology (Obs. 1981-2010)

15-35-50

Hide

```
nyear=30
prevu=c(0.15,0.35,0.50)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

P1_15_35_50=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

P2_15_35_50=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

P3_15_35_50=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

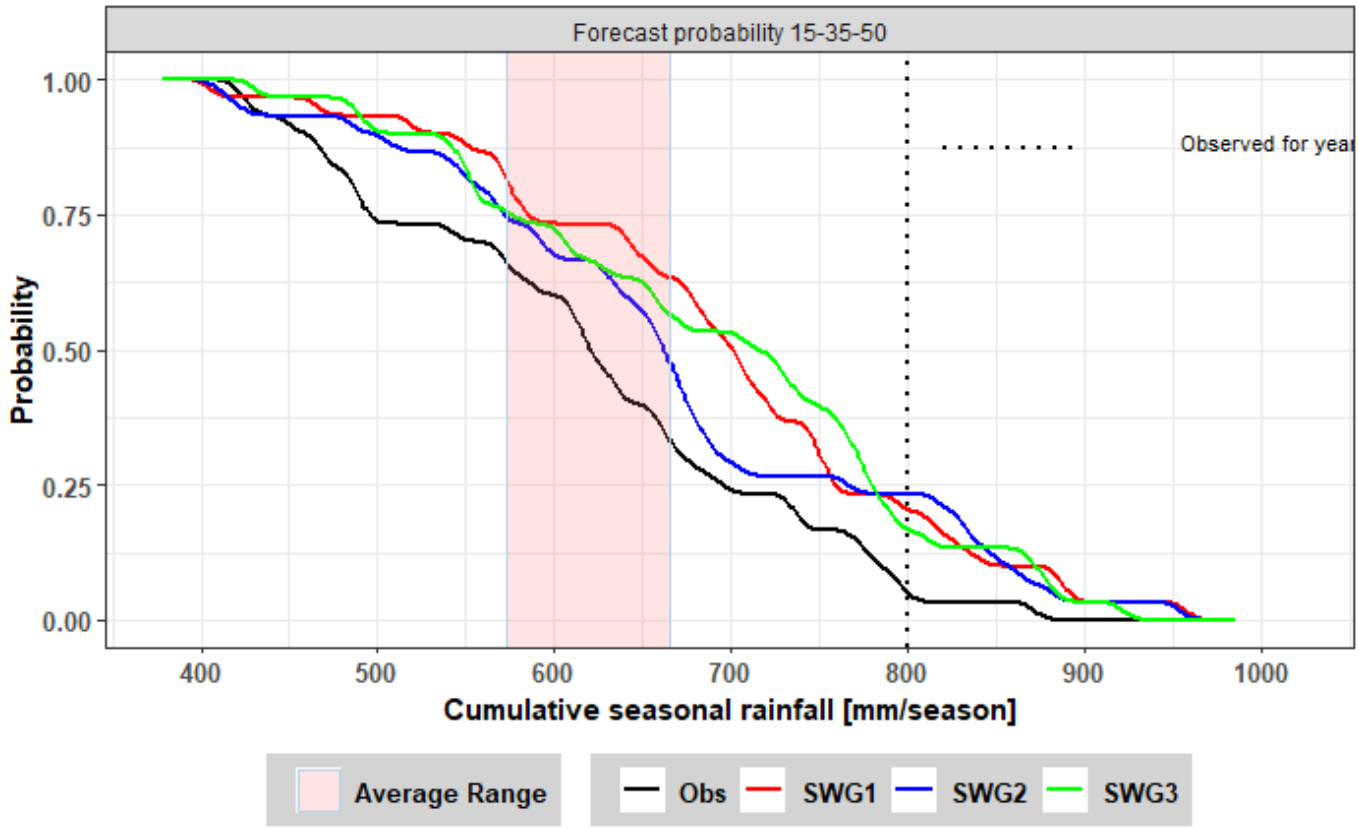
Hide

```
cum15_35_50season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9),between(year,1981,201
0))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP),P1_15_35_50$cm_seas_sim$rain,P2_15_35_50$cm_seas_sim$rain,P3_15_35_50$c
m_seas_sim$rain)
colnames(cum15_35_50season)=c("Obs","SWG1","SWG2","SWG3")

cum15_35_50season_gather=cum15_35_50season%>%gather(key = "SWG",value = value)
```

Hide

```
library(tidyverse)
dens = split(cum15_35_50season_gather,cum15_35_50season_gather$SWG) %>% map_df(function(d){
  dens = density(d$value, adjust=0.1, from=min(cum15_35_50season_gather$value) - 0.05*diff(ra
nge(cum15_35_50season_gather$value)),
                 to=max(cum15_35_50season_gather$value) + 0.05*diff(range(cum15_35_50season_g
ather$value)))

  data.frame(x=dens$x, y=dens$y, cd=cumsum(dens$y)/sum(dens$y), SWG=d$SWG[1])
})


dens1=dens
dens1=cbind.data.frame(dens1,rep("Forecast probability 15-35-50",dim(dens1)[1]))
colnames(dens1)=c("x","y","cd","SWG","tt")

ggplot() +
  geom_line(data=dens1, aes(x, 1-cd, colour=SWG),size=1)+
  labs(y = "Probability", x="Cumulative seasonal rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1200,100))+
  scale_color_manual(values=c("black", "red","blue","green")) +
  theme(legend.position="bottom", legend.background = element_rect(fill="lightgrey",size=0.5,
linetype="solid"),legend.title=element_blank(),axis.text.x = element_text(size = 10,face="bol
d"),axis.text.y = element_text(size = 10,face='bold'),axis.title = element_text(face = "bold"
,size = 11),legend.text = element_text(size = 10,face = "bold"))+
  ggplot2::facet_wrap(facets= ~ tt, ncol = 4, scales="free_x")+
  geom_rect(aes(xmin = tercile[2],xmax = tercile[3],ymin = -Inf, ymax = Inf, fill = "Average
 Range"), alpha = .2,color="slategray2")+
  geom_vline(xintercept = 799.4, linetype="dotted", color = "black", size=1)+
  geom_segment(aes(x=820, y=0.875,xend=895,yend= 0.875),color="black",size=1,linetype="dotte
d")+
  annotate(geom="text", x=1020, y=0.885, label="Observed for year 2008",color="black",size=3,
face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



50-35-15

Hide

```
nyear=30
prevu=c(0.5,0.35,0.15)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

P1_50_35_15=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

P2_50_35_15=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

P3_50_35_15=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

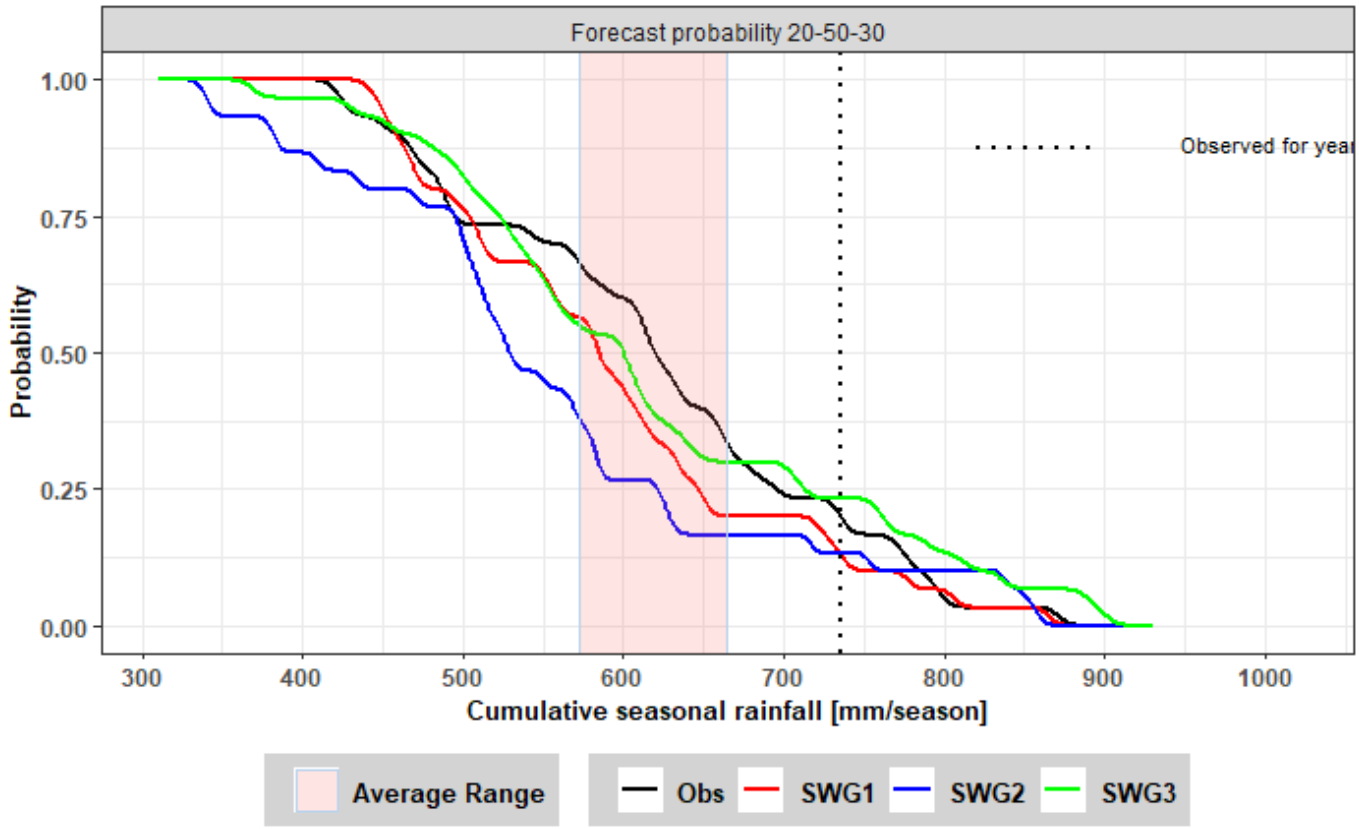
Hide

```
cum50_35_15season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9),between(year,1981,201
0))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP),P1_50_35_15$cm_seas_sim$rain,P2_50_35_15$cm_seas_sim$rain,P3_50_35_15$c
m_seas_sim$rain)
colnames(cum50_35_15season)=c("Obs","SWG1","SWG2","SWG3" #,"SWG4"
                              )

cum50_35_15season_gather=cum50_35_15season%>%gather(key = "SWG",value = value)
```

Hide

```
library(tidyverse)
dens = split(cum50_35_15season_gather,cum50_35_15season_gather$SWG) %>% map_df(function(d){
  dens = density(d$value, adjust=0.1, from=min(cum50_35_15season_gather$value) - 0.05*diff(ra
nge(cum50_35_15season_gather$value)),
                 to=max(cum50_35_15season_gather$value) + 0.05*diff(range(cum50_35_15season_g
ather$value)))

  data.frame(x=dens$x, y=dens$y, cd=cumsum(dens$y)/sum(dens$y), SWG=d$SWG[1])
})


dens1=dens
dens1=cbind.data.frame(dens1,rep("Forecast probability 20-50-30",dim(dens1)[1]))
colnames(dens1)=c("x","y","cd","SWG","tt")

ggplot() +
  geom_line(data=dens1, aes(x, 1-cd, colour=SWG),size=1)+
  labs(y = "Probability", x="Cumulative seasonal rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1200,100))+
  scale_color_manual(values=c("black", "red","blue","green")) +
  theme(legend.position="bottom", legend.background = element_rect(fill="lightgrey",size=0.5,
linetype="solid"),legend.title=element_blank(),axis.text.x = element_text(size = 9,face="bol
d"),axis.text.y = element_text(size = 9,face='bold'),axis.title = element_text(face = "bold",
size = 10),legend.text = element_text(size = 10,face = "bold"))+
  ggplot2::facet_wrap(facets= ~ tt, ncol = 4, scales="free_x")+
  geom_rect(aes(xmin = tercile[2],xmax = tercile[3],ymin = -Inf, ymax = Inf, fill = "Average
 Range"), alpha = .2,color="slategray2")+
  geom_vline(xintercept = 735.9, linetype="dotted", color = "black", size=1)+
  geom_segment(aes(x=820, y=0.875,xend=895,yend= 0.875),color="black",size=1,linetype="dotte
d")+
  annotate(geom="text", x=1020, y=0.885, label="Observed for year 2003",color="black",size=3,
face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



Hide

```
NA
```

Hide

```
nyear=30
prevu=c(0.5,0.35,0.15)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

P1_50_35_15=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

P2_50_35_15=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

P3_50_35_15=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

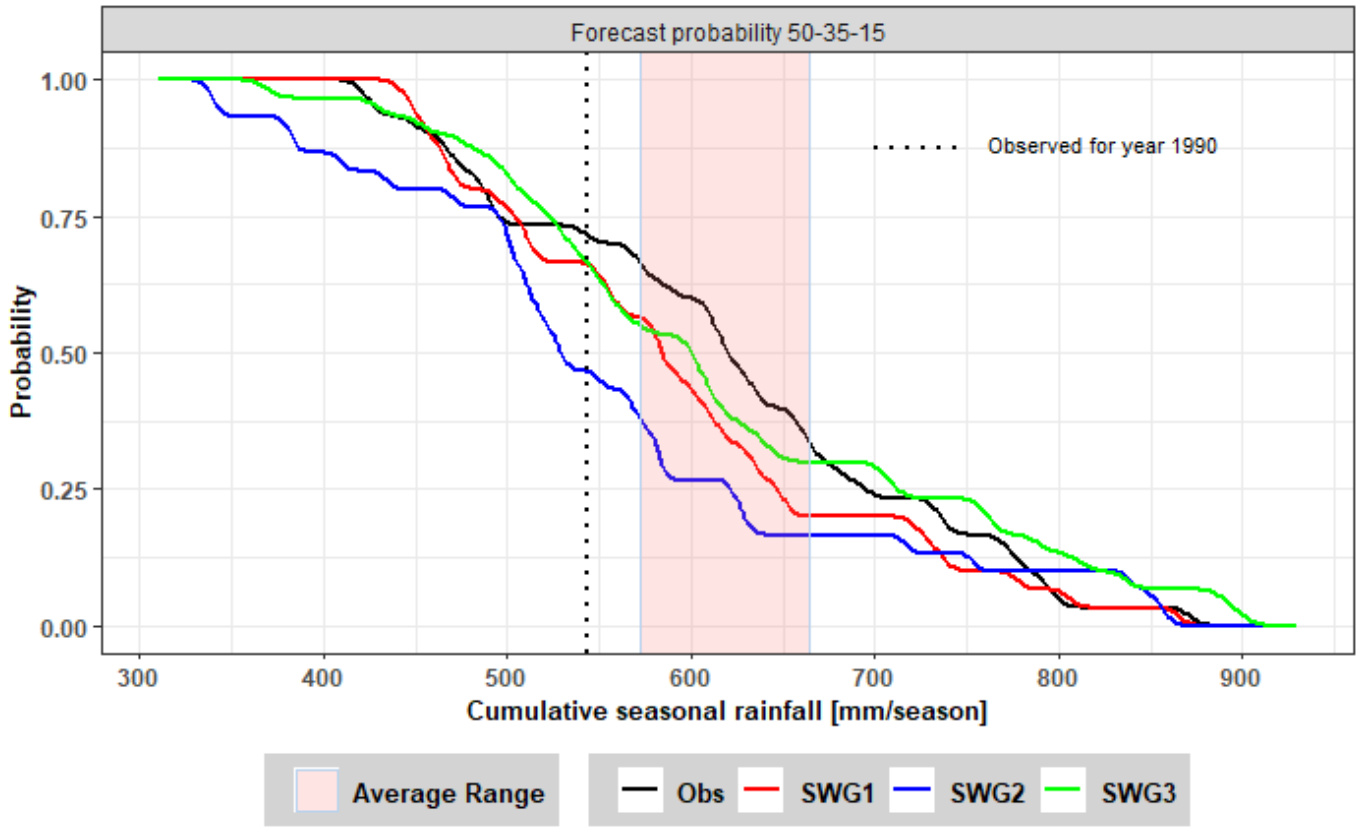
Hide

```
cum50_35_15season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9),between(year,1981,201
0))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP),P1_50_35_15$cm_seas_sim$rain,P2_50_35_15$cm_seas_sim$rain,P3_50_35_15$c
m_seas_sim$rain)
colnames(cum15_35_50season)=c("Obs","SWG1","SWG2","SWG3" #,"SWG4"
                              )

cum50_35_15season_gather=cum50_35_15season%>%gather(key = "SWG",value = value)
```

Hide

```
library(tidyverse)
dens = split(cum50_35_15season_gather,cum50_35_15season_gather$SWG) %>% map_df(function(d){
  dens = density(d$value, adjust=0.1, from=min(cum50_35_15season_gather$value) - 0.05*diff(ra
nge(cum50_35_15season_gather$value)),
                 to=max(cum50_35_15season_gather$value) + 0.05*diff(range(cum50_35_15season_g
ather$value)))

  data.frame(x=dens$x, y=dens$y, cd=cumsum(dens$y)/sum(dens$y), SWG=d$SWG[1])
})


dens1=dens
dens1=cbind.data.frame(dens1,rep("Forecast probability 50-35-15",dim(dens1)[1]))
colnames(dens1)=c("x","y","cd","SWG","tt")

ggplot() +
  geom_line(data=dens1, aes(x, 1-cd, colour=SWG),size=1)+
  labs(y = "Probability", x="Cumulative seasonal rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1000,100))+
  scale_color_manual(values=c("black", "red","blue","green")) +
  theme(legend.position="bottom", legend.background = element_rect(fill="lightgrey",size=0.5,
linetype="solid"),legend.title=element_blank(),axis.text.x = element_text(size = 9,face="bol
d"),axis.text.y = element_text(size = 9,face='bold'),axis.title = element_text(face = "bold",
size = 10),legend.text = element_text(size = 10,face = "bold"))+
  ggplot2::facet_wrap(facets= ~ tt, ncol = 4, scales="free_x")+
  geom_rect(aes(xmin = tercile[2],xmax = tercile[3],ymin = -Inf, ymax = Inf, fill = "Average
 Range"), alpha = .2,color="slategray2")+
  geom_vline(xintercept = 543.4, linetype="dotted", color = "black", size=1)+
  geom_segment(aes(x=700, y=0.875,xend=750,yend= 0.875),color="black",size=1,linetype="dotte
d")+
  annotate(geom="text", x=825, y=0.885, label="Observed for year 1990",color="black",size=3,f
ace="bold")
```

```
Warning: Ignoring unknown parameters: face
```



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```
NA
```

20-50-30

Hide

```
nyear=30
prevu=c(0.2,0.5,0.3)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

P1_20_50_30=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

P2_20_50_30=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

P3_20_50_30=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

Hide

```
cum20_50_30season=cbind.data.frame(kandi_val%>%filter(between(mois,7,9),between(year,1981,201
0))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%
  dplyr::select(PRCP),P1_20_50_30$cm_seas_sim$rain,P2_20_50_30$cm_seas_sim$rain,P3_20_50_30$c
m_seas_sim$rain)
colnames(cum20_50_30season)=c("Obs","SWG1","SWG2","SWG3" #,"SWG4"
                              )

cum20_50_30season_gather=cum20_50_30season%>%gather(key = "SWG",value = value)
```

Hide

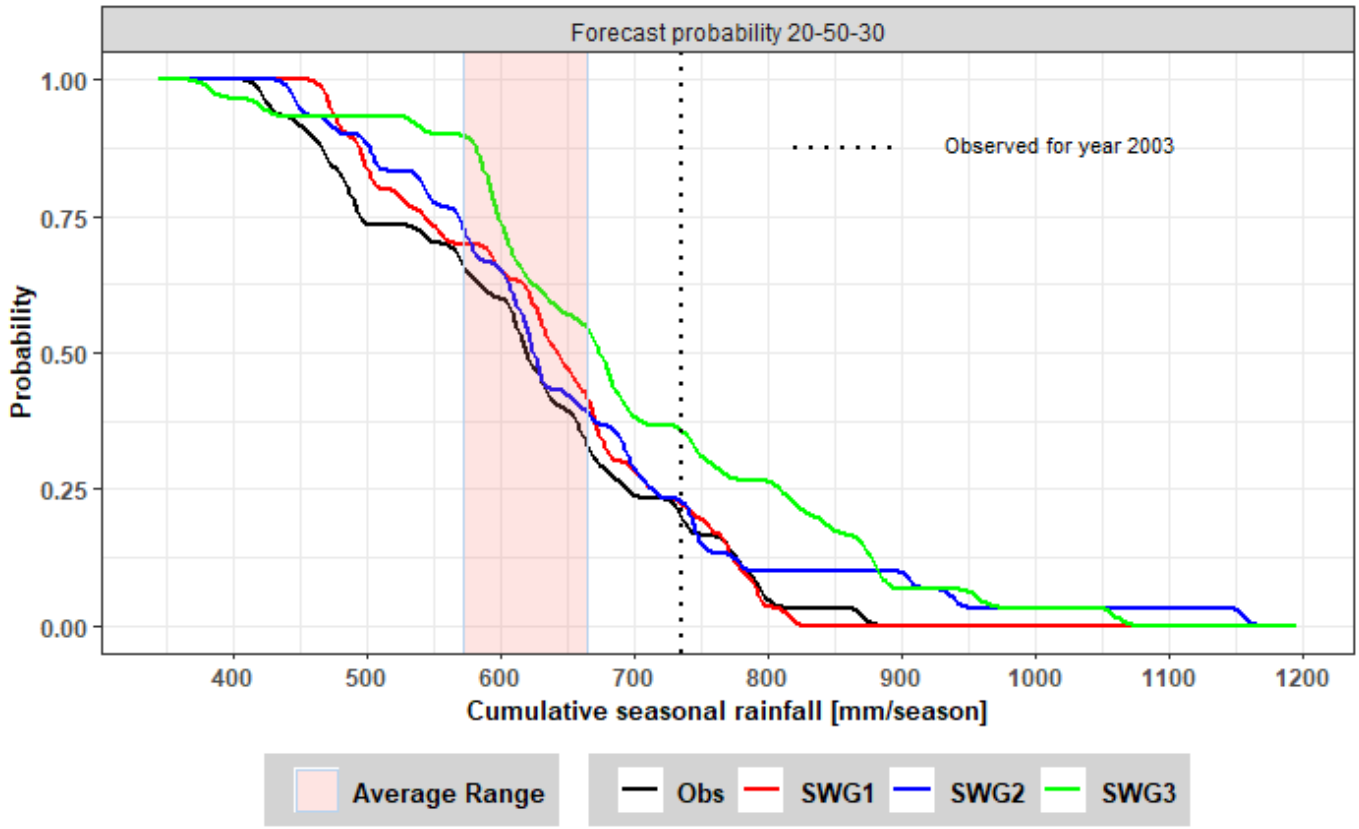
```
library(tidyverse)
dens = split(cum20_50_30season_gather,cum20_50_30season_gather$SWG) %>% map_df(function(d){
  dens = density(d$value, adjust=0.1, from=min(cum20_50_30season_gather$value) - 0.05*diff(ra
nge(cum20_50_30season_gather$value)),
                 to=max(cum20_50_30season_gather$value) + 0.05*diff(range(cum20_50_30season_g
ather$value)))

  data.frame(x=dens$x, y=dens$y, cd=cumsum(dens$y)/sum(dens$y), SWG=d$SWG[1])
})


dens1=dens
dens1=cbind.data.frame(dens1,rep("Forecast probability 20-50-30",dim(dens1)[1]))
colnames(dens1)=c("x","y","cd","SWG","tt")

ggplot() +
  geom_line(data=dens1, aes(x, 1-cd, colour=SWG),size=1)+
  labs(y = "Probability", x="Cumulative seasonal rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1200,100))+
  scale_color_manual(values=c("black", "red","blue","green")) +
  theme(legend.position="bottom", legend.background = element_rect(fill="lightgrey",size=0.5,
linetype="solid"),legend.title=element_blank(),axis.text.x = element_text(size = 9,face="bol
d"),axis.text.y = element_text(size = 9,face='bold'),axis.title = element_text(face = "bold",
size = 10),legend.text = element_text(size = 10,face = "bold"))+
  ggplot2::facet_wrap(facets= ~ tt, ncol = 4, scales="free_x")+
  geom_rect(aes(xmin = tercile[2],xmax = tercile[3],ymin = -Inf, ymax = Inf, fill = "Average
 Range"), alpha = .2,color="slategray2")+
  geom_vline(xintercept = 735.9, linetype="dotted", color = "black", size=1)+
  geom_segment(aes(x=820, y=0.875,xend=895,yend= 0.875),color="black",size=1,linetype="dotte
d")+
  annotate(geom="text", x=1020, y=0.885, label="Observed for year 2003",color="black",size=3,
face="bold")
```

```
Warning: Ignoring unknown parameters: face
```



Comparison of disaggregation results to observed above, deficit or normal years

Hide

```
#Select season
saison=kandi_val%>%filter(mois%in%seas:(seas+2))%>%transmute(year=year,mois=mois,rain=PRCP)%
>%group_by(year)%>%summarise(rain=sum(rain))
 for_tercil=as.vector(saison%>%filter(between(year,1981,2010))%>%select(rain))
  #compute terciles
  tercile=quantile(for_tercil$rain,probs = seq(0,1,1/3))

  # Find years in each categorial

  Byear=as.vector(subset(saison,                          rain<tercile[2],select = year)$year)

  Ayear=as.vector(subset(season,                           rain>tercile[3],select = year)$yea
r)
  Nyear=as.vector(subset(season,
       rain>=tercile[2]&rain<=tercile[3],select = year)$year)
```

Above years

Hide

```
nyear=length(Ayear)
prevu=c(0.15,0.35,0.5)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

Ayear_1=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

Ayear_2=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

Ayear_3=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

Normal years

Hide

```
nyear=length(Nyear)
prevu=c(0.2,0.5,0.3)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

Nyear_1=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

Nyear_2=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

Nyear_3=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

Below years

Hide

```
nyear=length(Byear)
prevu=c(0.5,0.35,0.15)
n=1000
yearclimcond=year_cond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)

Byear_1=SWG1(chemin.in,yearclimcond,seas,distribution,nyear,andebut,ht_seuil)

Byear_2=SWG2(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)

Byear_3=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
```

dry and wet spells comparaison

Hide

```
##### Dry Spells Above years

seq_real_Ayear=kandi_val%>%filter(between(mois,7,9),year%in%Ayear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=dry(PRCP))%>%
  transmute(Obs=Obs)
Obs_dry_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(seq_real_Ayear)[1]),rep(
"Obs",dim(seq_real_Ayear)[1]),seq_real_Ayear$Obs)
colnames(Obs_dry_Ayear)=c("type","SWG","dry_spells")


seq_SWG1_Ayear=Ayear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=dry(rain))%>%
  transmute(SWG1=SWG1)
SWG1_dry_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(seq_SWG1_Ayear)[1]),rep(
"SWG1",dim(seq_SWG1_Ayear)[1]),seq_SWG1_Ayear$SWG1)
colnames(SWG1_dry_Ayear)=c("type","SWG","dry_spells")


seq_SWG2_Ayear=Ayear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=dry(rain))%>%
  transmute(SWG2=SWG2)
SWG2_dry_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(seq_SWG2_Ayear)[1]),rep(
"SWG2",dim(seq_SWG2_Ayear)[1]),seq_SWG2_Ayear$SWG2)
colnames(SWG2_dry_Ayear)=c("type","SWG","dry_spells")


seq_SWG3_Ayear=Ayear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=dry(rain))%>%
  transmute(SWG3=SWG3)
SWG3_dry_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(seq_SWG3_Ayear)[1]),rep(
"SWG3",dim(seq_SWG3_Ayear)[1]),seq_SWG3_Ayear$SWG3)
colnames(SWG3_dry_Ayear)=c("type","SWG","dry_spells")


#### Dry spells normal years

seq_real_Nyear=kandi_val%>%filter(between(mois,7,9),year%in%Nyear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=dry(PRCP))%>%
  transmute(Obs=Obs)
Obs_dry_Nyear=cbind.data.frame(rep("Obs. Average years/20-50-30",dim(seq_real_Nyear)[1]),rep(
"Obs",dim(seq_real_Nyear)[1]),seq_real_Nyear$Obs)
colnames(Obs_dry_Nyear)=c("type","SWG","dry_spells")


seq_SWG1_Nyear=Nyear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=dry(rain))%>%
  transmute(SWG1=SWG1)
SWG1_dry_Nyear=cbind.data.frame(rep("Obs. Average years/20-50-30",dim(seq_SWG1_Nyear)[1]),rep
("SWG1",dim(seq_SWG1_Nyear)[1]),seq_SWG1_Nyear$SWG1)
colnames(SWG1_dry_Nyear)=c("type","SWG","dry_spells")
```

```
seq_SWG2_Nyear=Nyear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=dry(rain))%>%
  transmute(SWG2=SWG2)
SWG2_dry_Nyear=cbind.data.frame(rep("Obs. Average years/20-50-30",dim(seq_SWG2_Nyear)[1]),rep
("SWG2",dim(seq_SWG2_Nyear)[1]),seq_SWG2_Nyear$SWG2)
colnames(SWG2_dry_Nyear)=c("type","SWG","dry_spells")


seq_SWG3_Nyear=Nyear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=dry(rain))%>%
  transmute(SWG3=SWG3)
SWG3_dry_Nyear=cbind.data.frame(rep("Obs. Average years/20-50-30",dim(seq_SWG3_Nyear)[1]),rep
("SWG3",dim(seq_SWG3_Nyear)[1]),seq_SWG3_Nyear$SWG3)
colnames(SWG3_dry_Nyear)=c("type","SWG","dry_spells")

#### below years

seq_real_Byear=kandi_val%>%filter(between(mois,7,9),year%in%Byear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=dry(PRCP))%>%
  transmute(Obs=Obs)
Obs_dry_Byear=cbind.data.frame(rep("Obs. Below years/50-35-15",dim(seq_real_Byear)[1]),rep("O
bs",dim(seq_real_Byear)[1]),seq_real_Byear$Obs)
colnames(Obs_dry_Byear)=c("type","SWG","dry_spells")


seq_SWG1_Byear=Byear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=dry(rain))%>%
  transmute(SWG1=SWG1)
SWG1_dry_Byear=cbind.data.frame(rep("Obs. Below years/50-35-15",dim(seq_SWG1_Byear)[1]),rep(
"SWG1",dim(seq_SWG1_Byear)[1]),seq_SWG1_Byear$SWG1)
colnames(SWG1_dry_Byear)=c("type","SWG","dry_spells")


seq_SWG2_Byear=Byear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=dry(rain))%>%
  transmute(SWG2=SWG2)
SWG2_dry_Byear=cbind.data.frame(rep("Obs. Below years/50-35-15",dim(seq_SWG2_Byear)[1]),rep(
"SWG2",dim(seq_SWG2_Byear)[1]),seq_SWG2_Byear$SWG2)
colnames(SWG2_dry_Byear)=c("type","SWG","dry_spells")

seq_SWG3_Byear=Byear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=dry(rain))%>%
  transmute(SWG3=SWG3)
SWG3_dry_Byear=cbind.data.frame(rep("Obs. Below years/50-35-15",dim(seq_SWG3_Byear)[1]),rep(
"SWG3",dim(seq_SWG3_Byear)[1]),seq_SWG3_Byear$SWG3)
colnames(SWG3_dry_Byear)=c("type","SWG","dry_spells")

dry_seq_comp=rbind.data.frame(Obs_dry_Ayear,SWG1_dry_Ayear,SWG2_dry_Ayear,SWG3_dry_Ayear,Obs_
dry_Nyear,SWG1_dry_Nyear,SWG2_dry_Nyear,SWG3_dry_Nyear,Obs_dry_Byear,SWG1_dry_Byear,SWG2_dry_
Byear,SWG3_dry_Byear)
```

Hide

```
ggplot(dry_seq_comp, aes(x=SWG,y=dry_spells,color=SWG))+
  geom_violin(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.leg
end = T)+
  scale_color_manual(values=c("black","red","blue","green")) + ylim(1,max(Spells_table$valu
e))+ theme(axis.text.x = element_text(size = 10,face="bold",angle = 90),axis.text.y = element
_text(size = 11,face='bold'),axis.title = element_text(face = "bold",size = 12),legend.text =
element_text(size = 10,face = "bold"),legend.position="bottom",strip.text.x = element_text(si
ze = 12,face = "bold"))+
  labs(y = "Number of days", x="")+
  ggplot2::facet_wrap(facets= ~ type, ncol = 3,scales="free")+theme(strip.text.x = element_te
xt(size=10),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=3, y=22), colou
r="darkred",  size=3)+
  annotate(geom="text", x=3.5, y=22.4, label="Mean",color="black",size=4,face="bold")
```

Hide

```
##### Wet Spells

##### wet Spells Above years

Wet_real_Ayear=kandi_val%>%filter(between(mois,7,9),year%in%Ayear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=wet(PRCP))%>%
  transmute(Obs=Obs)
Obs_wet_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(Wet_real_Ayear)[1]),rep(
"Obs",dim(Wet_real_Ayear)[1]),Wet_real_Ayear$Obs)
colnames(Obs_wet_Ayear)=c("type","SWG","wet_spells")


Wet_SWG1_Ayear=Ayear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=wet(rain))%>%
  transmute(SWG1=SWG1)
SWG1_wet_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(Wet_SWG1_Ayear)[1]),rep(
"SWG1",dim(Wet_SWG1_Ayear)[1]),Wet_SWG1_Ayear$SWG1)
colnames(SWG1_wet_Ayear)=c("type","SWG","wet_spells")


Wet_SWG2_Ayear=Ayear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=wet(rain))%>%
  transmute(SWG2=SWG2)
SWG2_wet_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(Wet_SWG2_Ayear)[1]),rep(
"SWG2",dim(Wet_SWG2_Ayear)[1]),Wet_SWG2_Ayear$SWG2)
colnames(SWG2_wet_Ayear)=c("type","SWG","wet_spells")


Wet_SWG3_Ayear=Ayear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=wet(rain))%>%
  transmute(SWG3=SWG3)
SWG3_wet_Ayear=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(Wet_SWG3_Ayear)[1]),rep(
"SWG3",dim(Wet_SWG3_Ayear)[1]),Wet_SWG3_Ayear$SWG3)
colnames(SWG3_wet_Ayear)=c("type","SWG","wet_spells")


#### wet spells normal years

Wet_real_Nyear=kandi_val%>%filter(between(mois,7,9),year%in%Nyear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=wet(PRCP))%>%
  transmute(Obs=Obs)
Obs_wet_Nyear=cbind.data.frame(rep("Obs. Average years/15-35-50",dim(Wet_real_Nyear)[1]),rep(
"Obs",dim(Wet_real_Nyear)[1]),Wet_real_Nyear$Obs)
colnames(Obs_wet_Nyear)=c("type","SWG","wet_spells")


Wet_SWG1_Nyear=Nyear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=wet(rain))%>%
  transmute(SWG1=SWG1)
SWG1_wet_Nyear=cbind.data.frame(rep("Obs. Average years/15-35-50",dim(Wet_SWG1_Nyear)[1]),rep
("SWG1",dim(Wet_SWG1_Nyear)[1]),Wet_SWG1_Nyear$SWG1)
```

```
colnames(SWG1_wet_Nyear)=c("type","SWG","wet_spells")


Wet_SWG2_Nyear=Nyear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=wet(rain))%>%
  transmute(SWG2=SWG2)
SWG2_wet_Nyear=cbind.data.frame(rep("Obs. Average years/15-35-50",dim(Wet_SWG2_Nyear)[1]),rep
("SWG2",dim(Wet_SWG2_Nyear)[1]),Wet_SWG2_Nyear$SWG2)
colnames(SWG2_wet_Nyear)=c("type","SWG","wet_spells")


Wet_SWG3_Nyear=Nyear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=wet(rain))%>%
  transmute(SWG3=SWG3)
SWG3_wet_Nyear=cbind.data.frame(rep("Obs. Average years/15-35-50",dim(Wet_SWG3_Nyear)[1]),rep
("SWG3",dim(Wet_SWG3_Nyear)[1]),Wet_SWG3_Nyear$SWG3)
colnames(SWG3_wet_Nyear)=c("type","SWG","wet_spells")

#### below years

Wet_real_Byear=kandi_val%>%filter(between(mois,7,9),year%in%Byear)%>%
  transmute(year=year,PRCP)%>%
  group_by(year)%>%summarise(Obs=wet(PRCP))%>%
  transmute(Obs=Obs)
Obs_wet_Byear=cbind.data.frame(rep("Obs. Below years/15-35-50",dim(Wet_real_Byear)[1]),rep("O
bs",dim(Wet_real_Byear)[1]),Wet_real_Byear$Obs)
colnames(Obs_wet_Byear)=c("type","SWG","wet_spells")


Wet_SWG1_Byear=Byear_1$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG1=wet(rain))%>%
  transmute(SWG1=SWG1)
SWG1_wet_Byear=cbind.data.frame(rep("Obs. Below years/15-35-50",dim(Wet_SWG1_Byear)[1]),rep(
"SWG1",dim(Wet_SWG1_Byear)[1]),Wet_SWG1_Byear$SWG1)
colnames(SWG1_wet_Byear)=c("type","SWG","wet_spells")


Wet_SWG2_Byear=Byear_2$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG2=wet(rain))%>%
  transmute(SWG2=SWG2)
SWG2_wet_Byear=cbind.data.frame(rep("Obs. Below years/15-35-50",dim(Wet_SWG2_Byear)[1]),rep(
"SWG2",dim(Wet_SWG2_Byear)[1]),Wet_SWG2_Byear$SWG2)
colnames(SWG2_wet_Byear)=c("type","SWG","wet_spells")

Wet_SWG3_Byear=Byear_3$data_sim%>%
  transmute(year=year,rain)%>%
  group_by(year)%>%summarise(SWG3=wet(rain))%>%
  transmute(SWG3=SWG3)
SWG3_wet_Byear=cbind.data.frame(rep("Obs. Below years/15-35-50",dim(Wet_SWG3_Byear)[1]),rep(
"SWG3",dim(Wet_SWG3_Byear)[1]),Wet_SWG3_Byear$SWG3)
colnames(SWG3_wet_Byear)=c("type","SWG","wet_spells")

wet_seq_comp=rbind.data.frame(Obs_wet_Ayear,SWG1_wet_Ayear,SWG2_wet_Ayear,SWG3_wet_Ayear,Obs_
```

```
wet_Nyear,SWG1_wet_Nyear,SWG2_wet_Nyear,SWG3_wet_Nyear,Obs_wet_Byear,SWG1_wet_Byear,SWG2_wet_
Byear,SWG3_wet_Byear)
```

Hide

```
ggplot(wet_seq_comp, aes(x=SWG,y=wet_spells,color=SWG))+
  geom_violin(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.leg
end = T)+
  scale_color_manual(values=c("black","red","blue","green")) + ylim(1,max(Spells_table$valu
e))+ theme(axis.text.x = element_text(size = 10,face="bold",angle = 90),axis.text.y = element
_text(size = 11,face='bold'),axis.title = element_text(face = "bold",size = 12),legend.text =
element_text(size = 10,face = "bold"),legend.position="bottom",strip.text.x = element_text(si
ze = 12,face = "bold"))+
  labs(y = "Number of days", x="")+
  ggplot2::facet_wrap(facets= ~ type, ncol = 3,scales="free")+theme(strip.text.x = element_te
xt(size=10),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=3, y=22), colou
r="darkred",  size=3)+
  annotate(geom="text", x=3.5, y=22.4, label="Mean",color="black",size=4,face="bold")
```

Cumul day observation

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```
# Cumulative daily rainfall
kand=kandi_val
kand$PRCP[kand$PRCP<ht_seuil]<-0

#Above years

Ayear_1$data_sim$rain[Ayear_1$data_sim$rain<ht_seuil]<-0
Ayear_2$data_sim$rain[Ayear_2$data_sim$rain<ht_seuil]<-0
Ayear_3$data_sim$rain[Ayear_3$data_sim$rain<ht_seuil]<-0


cum_day_Ayear=cbind.data.frame(kand%>%filter(between(mois,7,9),year%in%Ayear)%>%dplyr::select
(PRCP),Ayear_1$data_sim$rain,Ayear_2$data_sim$rain,Ayear_3$data_sim$rain)

colnames(cum_day_Ayear)=c("Obs","SWG1","SWG2" ,"SWG3")

cum_day_Ayear_gather=cum_day_Ayear%>%gather(key = "SWG",value = value)
cum_day_Ayear_gather=cbind.data.frame(rep("Obs. Excess years/15-35-50",dim(cum_day_Ayear_gath
er)[1]),cum_day_Ayear_gather)
colnames(cum_day_Ayear_gather)=c("cum","SWG","value")


#Normal or Average years

Nyear_1$data_sim$rain[Nyear_1$data_sim$rain<ht_seuil]<-0
Nyear_2$data_sim$rain[Nyear_2$data_sim$rain<ht_seuil]<-0
Nyear_3$data_sim$rain[Nyear_3$data_sim$rain<ht_seuil]<-0


cum_day_Nyear=cbind.data.frame(kand%>%filter(between(mois,7,9),year%in%Nyear)%>%dplyr::select
(PRCP),Nyear_1$data_sim$rain,Nyear_2$data_sim$rain,Nyear_3$data_sim$rain)

colnames(cum_day_Nyear)=c("Obs","SWG1","SWG2" ,"SWG3")

cum_day_Nyear_gather=cum_day_Nyear%>%gather(key = "SWG",value = value)
cum_day_Nyear_gather=cbind.data.frame(rep("Obs. Average years/20-50-30",dim(cum_day_Nyear_gat
her)[1]),cum_day_Nyear_gather)
colnames(cum_day_Nyear_gather)=c("cum","SWG","value")


#Below years


Byear_1$data_sim$rain[Byear_1$data_sim$rain<ht_seuil]<-0
Byear_2$data_sim$rain[Byear_2$data_sim$rain<ht_seuil]<-0
Byear_3$data_sim$rain[Byear_3$data_sim$rain<ht_seuil]<-0


cum_day_Byear=cbind.data.frame(kand%>%filter(between(mois,7,9),year%in%Byear)%>%dplyr::select
(PRCP),Byear_1$data_sim$rain,Byear_2$data_sim$rain,Byear_3$data_sim$rain)

colnames(cum_day_Byear)=c("Obs","SWG1","SWG2" ,"SWG3")

cum_day_Byear_gather=cum_day_Byear%>%gather(key = "SWG",value = value)
cum_day_Byear_gather=cbind.data.frame(rep("Obs. Below years/50-35-15",dim(cum_day_Byear_gathe
r)[1]),cum_day_Byear_gather)
colnames(cum_day_Byear_gather)=c("cum","SWG","value")
```

```
cum_comp=rbind.data.frame(cum_day_Ayear_gather,cum_day_Nyear_gather,cum_day_Byear_gather)
```

Hide

```
ggplot(cum_comp, aes(x=SWG,y=value,color=SWG))+
  geom_boxplot(size=1) +stat_summary(fun=mean, colour="darkred", geom="point", size=2,show.le
gend = T)+
  scale_color_manual(values=c("black","red","blue","green","grey")) + ylim(0,150)+ theme(axi
s.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 11,face='bol
d'),axis.title = element_text(face = "bold",size = 12),legend.text = element_text(size = 10,f
ace = "bold"),legend.position="bottom",strip.text.x = element_text(size = 12,face = "bold"))+
  labs(y = "mm/day", x="")+
  ggplot2::facet_wrap(facets= ~ cum, dir="h",scales="free")+theme(strip.text.x = element_text
(size=14),strip.background=element_rect(fill="lightgrey"))+geom_point(aes(x=0.5, y=150), colo
ur="darkred",  size=3)+
  annotate(geom="text", x=0.8, y=150, label="Mean",color="black",size=4,face="bold")
```

Hide

```
ggplot(cum_comp,
       aes(as.numeric(log(value)), colour=SWG)) +
  labs(y = "Density", x="Cumulative daily rainfall [log(mm/day)]")+
  geom_density(size=1.2) +
  scale_color_manual(values=c("black", "red","blue","green","grey")) +
  theme(legend.position="bottom", legend.background = element_rect(linetype="solid"),
        legend.title=element_blank(),axis.text.x = element_text(size = 11,face="bold"),
        axis.text.y = element_text(size = 11,face='bold'),axis.title = element_text(face = "b
old",size = 12),
        legend.text = element_text(size = 10,face = "bold"))+
    ggplot2::facet_wrap(facets= ~ cum, dir="h",scales="free")+theme(strip.text.x = element_te
xt(size=14),strip.background=element_rect(fill="lightgrey"))
```