R Notebook

Code

Source different functions

Hide

```
source("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=5000              # number of simulation
andebut=2031          # Arbitrary start year for simulation
seas=7                #from july to September for season

sim1=rep(1:100,each=50)
sim2=rep(1:100,each=4600)
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

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```
#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)
}
```

Hide

```
##### 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")

mean_obs= round(mean(Obs_dry$dry_spells),2)
sd_obs= round(sd(Obs_dry$dry_spells),2)
max_obs=round(max(Obs_dry$dry_spells),0)
seq7_obs= sum(Obs_dry$dry_spells>7)

seq_SWG1=SWG1_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%summarise(SWG1=dry(rain))%>%
  ungroup()%>%dplyr::select(sim,SWG1)
SWG1_dry=cbind.data.frame(rep("SWG1",dim(seq_SWG1)[1]),seq_SWG1)
colnames(SWG1_dry)=c("SWG","Sim","dry_spells")


seq_SWG2=SWG2_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%summarise(SWG2=dry(rain))%>%
  ungroup()%>%dplyr::select(sim,SWG2)
SWG2_dry=cbind.data.frame(rep("SWG2",dim(seq_SWG2)[1]),seq_SWG2)
colnames(SWG2_dry)=c("SWG","Sim","dry_spells")


seq_SWG3=SWG3_Semi_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%
  summarise(SWG3=dry(rain))%>%
  ungroup()%>%dplyr::select(sim,SWG3)
SWG3_dry=cbind.data.frame(rep("SWG3",dim(seq_SWG3)[1]),seq_SWG3)
colnames(SWG3_dry)=c("SWG","Sim","dry_spells")


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


#dry>7
dry_spell_7=dry_seq%>%group_by(SWG, Sim)%>%summarise(value=sum(dry_spells>7))%>%ungroup()%>%m
utate(STAT="4.Dry spells > 7",Obs=seq7_obs)

#mean
dry_spell_mean=dry_seq%>%group_by(SWG, Sim)%>%summarise(value=round(mean(dry_spells),2))%>%un
group()%>%mutate(STAT="1.Mean",Obs=mean_obs)

#sd
dry_spell_var=dry_seq%>%group_by(SWG, Sim)%>%summarise(value=round(sd(dry_spells),2))%>%ungro
up()%>%mutate(STAT="2.SD",Obs=sd_obs)

#maximum
dry_spell_max=dry_seq%>%group_by(SWG, Sim)%>%summarise(value=round(max(dry_spells),2))%>%ungr
```

```
oup()%>%mutate(STAT="3.Maximum",Obs=max_obs)


Caract_dryspell=rbind.data.frame(dry_spell_mean,dry_spell_var,dry_spell_max,dry_spell_7)
Caract_dryspell=Caract_dryspell%>%mutate(type="Dry Spells")
```

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```
##### 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")

mean_obs= round(mean(Obs_Wet$wet_spells),2)
sd_obs= round(sd(Obs_Wet$wet_spells),2)
max_obs= round(max(Obs_Wet$wet_spells),0)

Wet_SWG1=SWG1_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%summarise(SWG1=wet(rain))%>%ungroup()%>%dplyr::select(sim,SWG1)
SWG1_wet=cbind.data.frame(rep("SWG1",dim(Wet_SWG1)[1]),Wet_SWG1)
colnames(SWG1_wet)=c("SWG","Sim","dry_spells")


Wet_SWG2=SWG2_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%summarise(SWG2=wet(rain))%>%ungroup()%>%dplyr::select(sim,SWG2)
SWG2_wet=cbind.data.frame(rep("SWG2",dim(Wet_SWG2)[1]),Wet_SWG2)
colnames(SWG2_wet)=c("SWG","Sim","dry_spells")


Wet_SWG3=SWG3_Semi_param_sim$data_sim%>%
  transmute(sim=sim2,year=year,rain)%>%
  group_by(sim,year)%>%summarise(SWG3=wet(rain))%>%ungroup()%>%dplyr::select(sim,SWG3)
SWG3_wet=cbind.data.frame(rep("SWG3",dim(Wet_SWG3)[1]),Wet_SWG3)
colnames(SWG3_wet)=c("SWG","Sim","dry_spells")


Wet_seq=rbind.data.frame(SWG1_wet,SWG2_wet,SWG3_wet)


#mean
wet_spell_mean=Wet_seq%>%group_by(SWG, Sim)%>%summarise(value=round(mean(dry_spells),2))%>%un
group()%>%mutate(STAT="1.Mean",Obs=mean_obs)

wet_spell_var=Wet_seq%>%group_by(SWG, Sim)%>%summarise(value=round(sd(dry_spells),2))%>%ungro
up()%>%mutate(STAT="2.SD",Obs=sd_obs)

wet_spell_max=Wet_seq%>%group_by(SWG, Sim)%>%summarise(value=round(max(dry_spells),2))%>%ungr
oup()%>%mutate(STAT="3.Maximum",Obs=max_obs)

Caract_wetspell=rbind.data.frame(wet_spell_mean,wet_spell_var,wet_spell_max)
Caract_wetspell=Caract_wetspell%>%mutate(type="Wet Spells")

#table
table_spells=rbind.data.frame(Caract_dryspell,Caract_wetspell)
```

Mean, Sd, Maximum, dry spells

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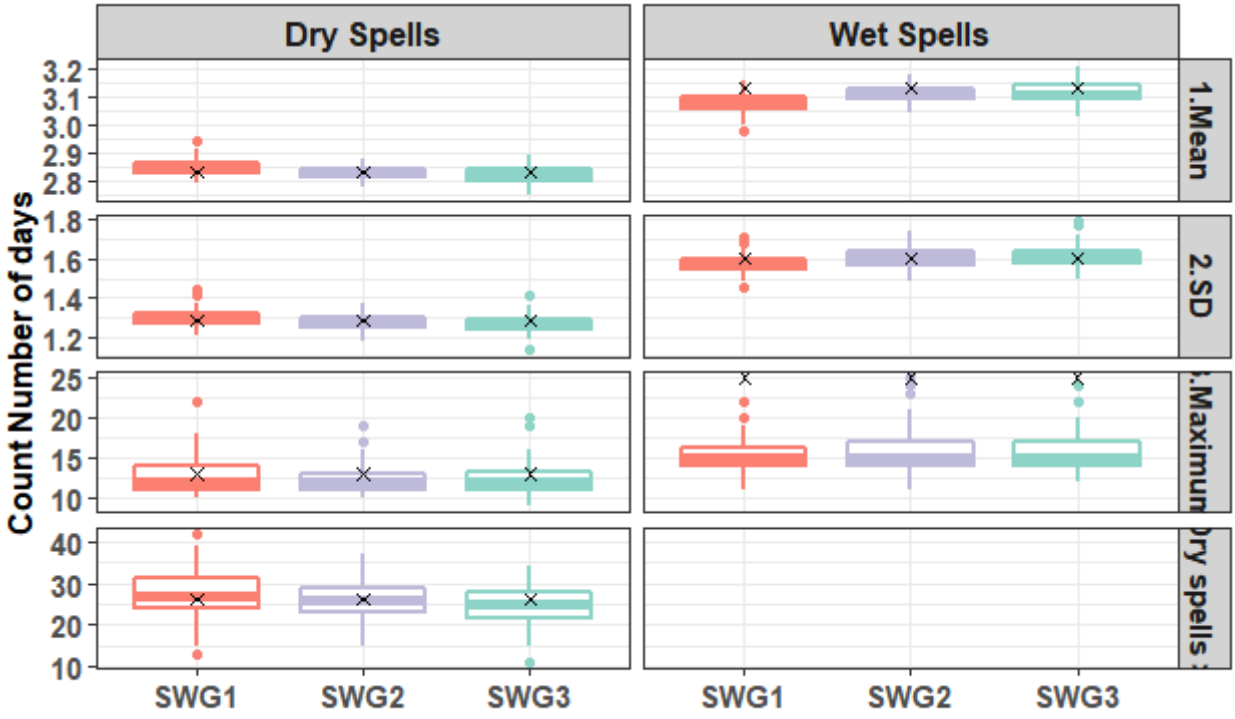
```
table_spells%>%
  ggplot()+
  geom_boxplot(aes(x=SWG,y=value,color=SWG),show.legend = F,lwd=1)+
  scale_color_manual(values=c("#fb8072","#bebada","#8dd3c7")) +
  geom_point(aes(x=SWG,y=Obs),pch=4,show.legend = F)+
  theme(axis.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 1
1,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 = 8,face
 = "bold"))+
  labs(y = "Count Number of days", x="")+
  ggplot2::facet_grid(STAT~type,scales="free_y")+theme(strip.text.x = element_text(size=12),s
trip.text.y = element_text(size=11,face = "bold"),strip.background=element_rect(fill="lightgr
ey"))
```



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```
# +
#   geom_point(aes(x=1, y=3.375), pch=4,  size=3)+
# annotate(geom="text", x=1.8, y=3.38, label="Observation",color="black",size=4,face="bold")
```

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=kand%>%filter(between(mois,7,9))%>%dplyr::select(PRCP)
cum_day=cbind.data.frame(rep(cum_day$PRCP,100),SWG1_param_sim$data_sim$rain,SWG2_param_sim$da
ta_sim$rain,SWG3_Semi_param_sim$data_sim$rain)

colnames(cum_day)=c("Obs","SWG1","SWG2" ,"SWG3"
                    )
cum_day=cum_day%>%mutate(sim=sim2)

cum_day_gather=cum_day%>%pivot_longer(cols = c("SWG1","SWG2","SWG3"),names_to = "SWG",values_
to = "value")
```

Density

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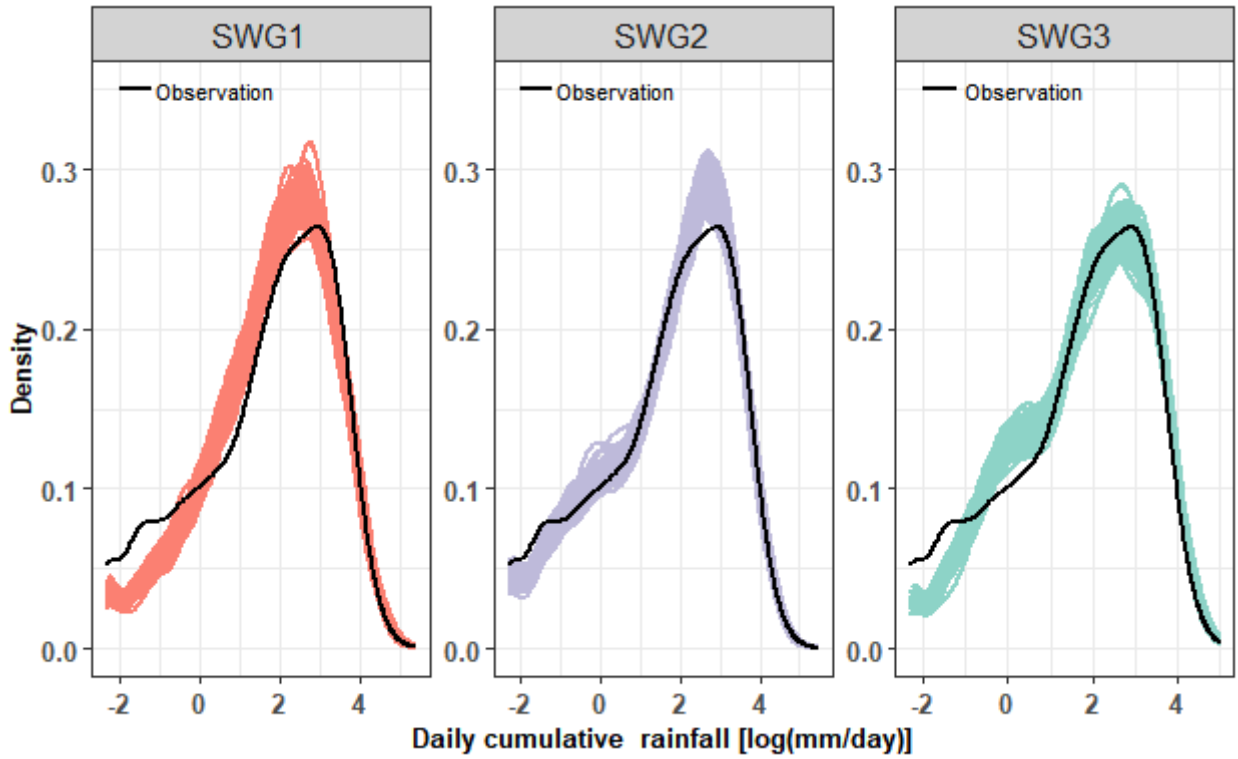
```
ggplot(cum_day_gather,
       aes(as.numeric(log(value)),colour=SWG,group=sim)) +
  geom_density(size=1.,show.legend = F) +
  scale_color_manual(values=c("black","#fb8072","#bebada","#8dd3c7")) +
  geom_density(aes(as.numeric(log(Obs)),colour="Obsevation",group=sim),size=1,show.legend = F
)+
  labs(y = "Density", x="Daily cumulative  rainfall [log(mm/day)]")+
  theme(legend.position="bottom", legend.background = element_rect(linetype="solid"),
        legend.title=element_blank(),axis.text.x = element_text(size = 10,face="bold"),
        axis.text.y = element_text(size = 10,face='bold'),axis.title = element_text(face = "b
old",size = 10),
        legend.text = element_text(size = 10,face = "bold"))+
    ggplot2::facet_wrap(facets= ~ SWG, dir="h",scales="free")+theme(strip.text.x = element_te
xt(size=12),strip.background=element_rect(fill="lightgrey"))+geom_segment(aes(x=-2, y=0.35,xe
nd=-1.2,yend=0.35),color="black",size=1)+
  annotate(geom="text", x=0.4, y=0.35, label="Observation",color="black",size=3,face="bold")
```

```
Warning: Ignoring unknown parameters: face
Warning: Removed 641697 rows containing non-finite
values (stat_density).
Warning: Removed 631500 rows containing non-finite
values (stat_density).
```



QQplot daily cumulative

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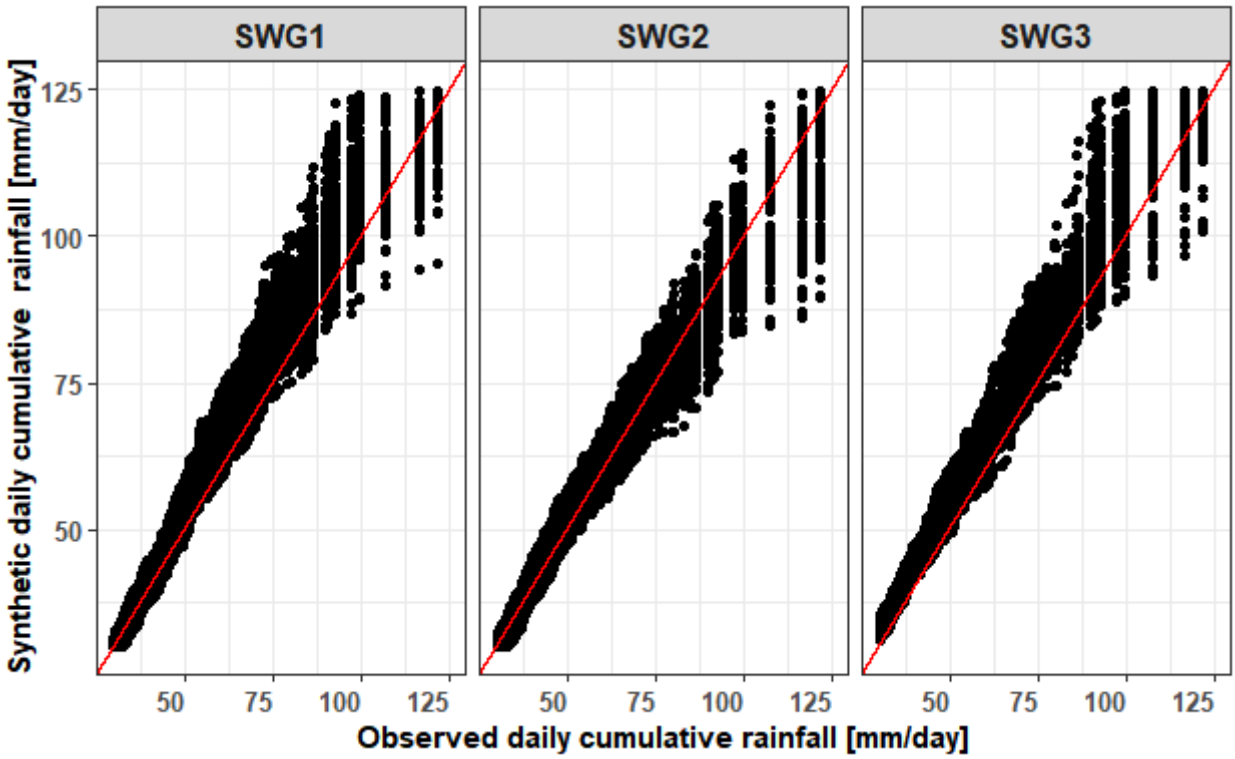
```
qplot1=function(x,y){
  sx=sort(x)
  sy=sort(y)
  lenx=length(sx)
  leny=length(sy)
  if (leny < lenx)sx <- approx(1L:lenx, sx, n = leny)$y
if (leny > lenx)sy <- approx(1L:leny, sy, n = lenx)$y
  return(sx)
}

qplot2=function(x,y){
  sx=sort(x)
  sy=sort(y)
  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
  return(sy)
}


qplot=cum_day_gather%>%group_by(sim,SWG)%>%
  summarise(sx=qplot1(Obs,value),sy=qplot2(Obs,value))
```

```
`summarise()` has grouped output by 'sim', 'SWG'. You can override using the `.groups` argume
nt.
```

Hide

```
ggplot(qplot,aes(sx,sy,group=sim)) +geom_point()+ggplot2::theme(legend.position="bottom", axis.text.x = element_text(vjust = 1, size = 10, hjust = 1,face="bold"),axis.text.y = element_text(size = 10,face='bold'),axis.title = element_text(face = "bold",size = 11),      strip.text.x = element_text(
  size = 12,face = "bold"
)) + ggplot2::facet_wrap(facets= ~ SWG, dir="h") + ggplot2::xlab(label="Observed daily cumulative rainfall [mm/day]") + ggplot2::ylab(label="Synthetic daily cumulative  rainfall [mm/day]")+xlim(30,125)+ylim(30,125)+geom_abline(intercept = 0, slope = 1,color="red",size=1)
```

```
Warning: Removed 1286102 rows containing missing
values (geom_point).
```



Cumulative seasonal rainfall

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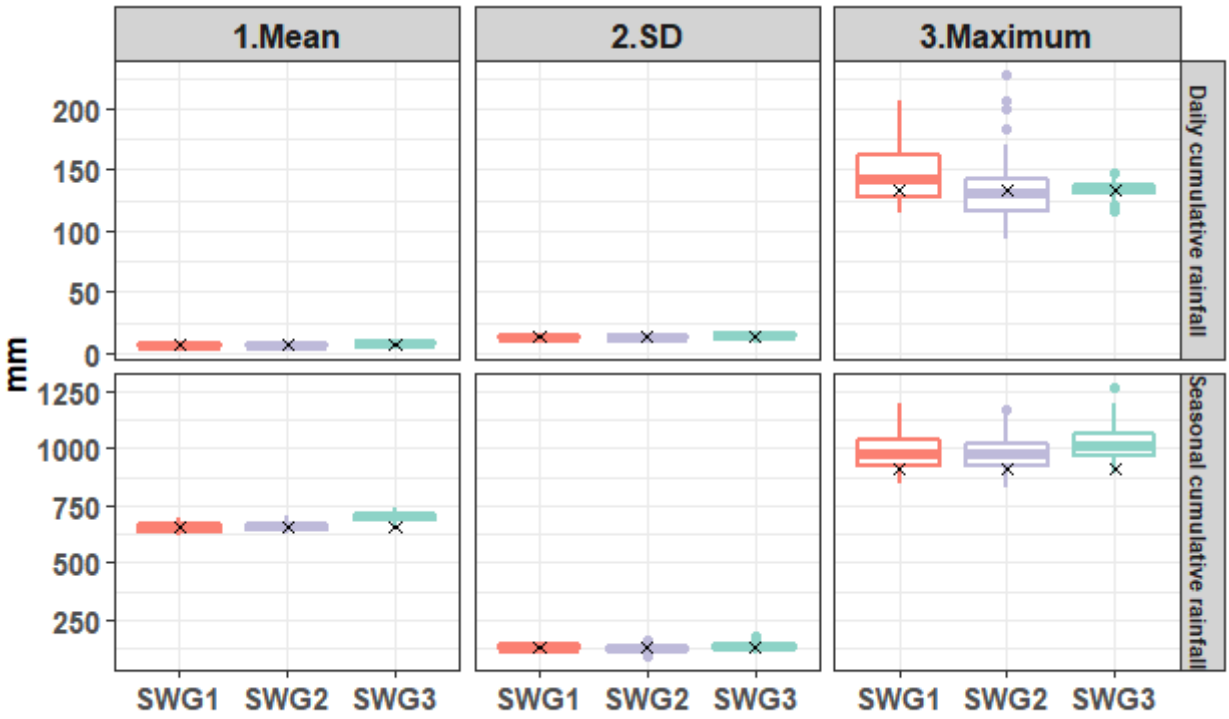
```
cum_day_gather=cum_day_gather%>%mutate(type="Daily cumulative rainfall")

cum_season=kandi_val%>%filter(between(mois,7,9))%>%
group_by(year)%>%summarise(PRCP=sum(PRCP,na.rm = T))%>%dplyr::select(PRCP)

cum_season=cbind.data.frame(rep(cum_season$PRCP,100),
SWG1_param_sim$cm_seas_sim$rain,SWG2_param_sim$cm_seas_sim$rain,SWG3_Semi_param_sim$cm_seas_s
im$rain)

colnames(cum_season)=c("Obs","SWG1","SWG2" ,"SWG3"
                       )
cum_season=cum_season%>%mutate(sim=sim1)

cum_season_gather=cum_season%>%pivot_longer(cols = c("SWG1","SWG2","SWG3"),names_to = "SWG",v
alues_to = "value")

cum_season_gather=cum_season_gather%>%mutate(type="Seasonal cumulative rainfall")
cum_all=rbind.data.frame(cum_day_gather,cum_season_gather)

cum_all_stat1=cum_all%>%group_by(sim,SWG,type)%>%
  summarise(`1.Mean`=mean(value),`2.SD`=sd(value),`3.Maximum`=max(value))%>%pivot_longer(cols
= c(`1.Mean`,`2.SD`,`3.Maximum`),names_to = "STAT_GEN",values_to = "value1")


cum_all_stat2=cum_all%>%group_by(sim,SWG,type)%>%
  summarise(`1.Mean`=mean(Obs),`2.SD`=sd(Obs),`3.Maximum`=max(Obs))%>%pivot_longer(cols = c(`
1.Mean`,`2.SD`,`3.Maximum`),names_to = "STAT_GEN",values_to = "value2")

cum_all_stat=cbind.data.frame(cum_all_stat1,cum_all_stat2$value2)
colnames(cum_all_stat)=c("sim","SWG","type","STAT_GEN","value","Obs")
```

Hide

```
cum_all_stat%>%ggplot()+
  geom_boxplot(aes(x=SWG,y=value,color=SWG),show.legend = F,lwd=1)+
  scale_color_manual(values=c("#fb8072","#bebada","#8dd3c7")) +
  geom_point(aes(x=SWG,y=Obs),pch=4,show.legend = F)+
  theme(axis.text.x = element_text(size = 11,face="bold"),axis.text.y = element_text(size = 1
1,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", x="")+
   ggplot2::facet_grid(type~STAT_GEN,scales="free_y")+theme(strip.text.x = element_text(size=
12),strip.text.y = element_text(size=8,face = "bold"),strip.background=element_rect(fill="lig
htgrey"))
```


1.Mean
2.SD
3.Maximum
Daily cumulative rainfall
Seasonal cumulative rainfall
mm
200
150
100
50
0
1250
1000
750
500
250
SWG1
SWG2
SWG3

Hide

```
#### Number of days

season_=kandi_val%>%filter(between(mois,7,9),PRCP>0.85)%>%group_by(year)%>%summarise(PRCP=len
gth(PRCP))%>%dplyr::select(PRCP)

nb_days_season=cbind.data.frame(rep(season_$PRCP,100),
SWG1_param_sim$data_sim%>%filter(rain>0.1)%>%
group_by(year)%>%summarise(rain=length(rain))%>%
  dplyr::select(rain),
SWG2_param_sim$data_sim%>%filter(rain>0.1)%>%group_by(year)%>%summarise(rain=length(rain))%>%
dplyr::select(rain),SWG3_Semi_param_sim$data_sim%>%filter(rain>0.85)%>%group_by(year)%>%summa
rise(rain=length(rain))%>%
  dplyr::select(rain))



colnames(nb_days_season)=c("Obs","SWG1","SWG2","SWG3"
                        )
nb_days_season=nb_days_season%>%mutate(sim=sim1)

nb_days_season_gather=nb_days_season%>%pivot_longer(cols = c("SWG1","SWG2","SWG3"),names_to =
"SWG",values_to = "value")

cum_all_stat1=cum_all%>%group_by(sim,SWG,type)%>%
  summarise(Mean=mean(value),SD=sd(value),Maximum=max(value))%>%pivot_longer(cols = c("Mean",
"SD","Maximum"),names_to = "STAT_GEN",values_to = "value1")


cum_all_stat2=cum_all%>%group_by(sim,SWG,type)%>%
  summarise(Mean=mean(Obs),SD=sd(Obs),Maximum=max(Obs))%>%pivot_longer(cols = c("Mean","SD",
"Maximum"),names_to = "STAT_GEN",values_to = "value2")

cum_all_stat=cbind.data.frame(cum_all_stat1,cum_all_stat2$value2)
```

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

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```
#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

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```
#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)
```

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```
#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)
```

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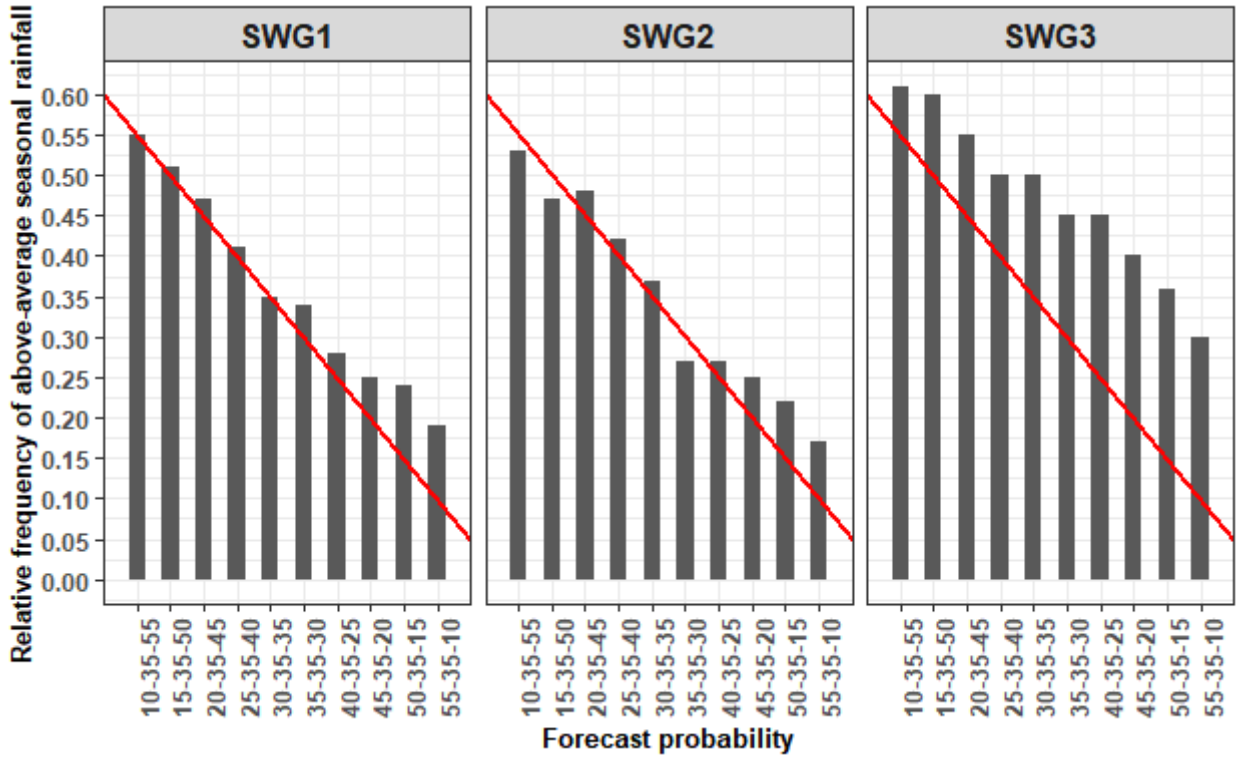
```
#SWG3-semi-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.05,0.35,0.6)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(0.05,0,-0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  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_vrai_Copie,aes(x=prevision,y=frequence))+
  geom_bar(stat = "identity", position=position_dodge(),width = 0.5)+scale_y_continuous(break
s = seq(0,0.6,0.05))+
ggplot2::theme(legend.position="bottom", axis.text.x = element_text(angle = 90, vjust = 1, si
ze = 9, hjust = 1,face="bold"),axis.text.y = element_text(size = 9,face='bold'),axis.title =
 element_text(face = "bold",size = 10) , strip.text.x = element_text(
  size = 12,face = "bold"
))+
  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",linetype=1,size=1,position="identity")
```



Hide

```
#+
   #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")
```

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

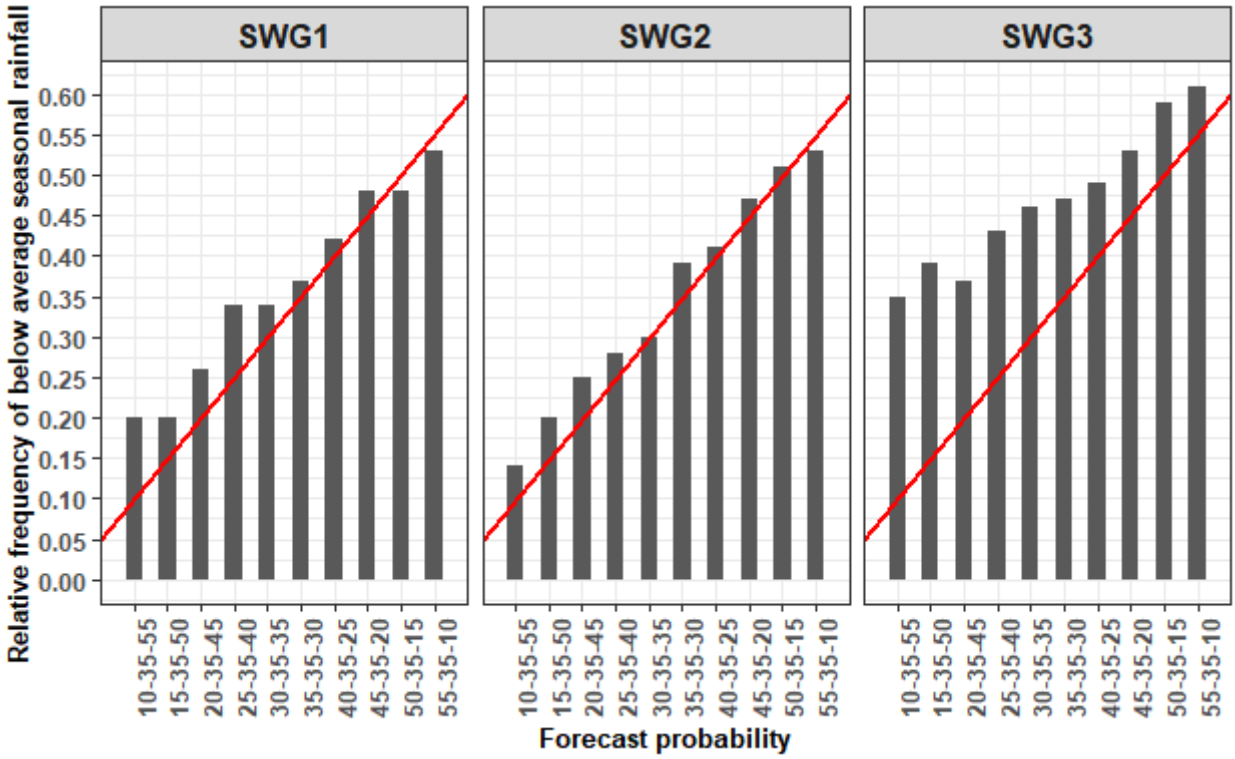
```
#SWG3-semi-parametric
nyear=1000
result_jour1=list(0)
result_cum1=list(0)
prevu=c(0.6,0.35,0.05)
prev=list(0)
i=1
repeat{
  prevu=prevu+c(-0.05,0,0.05)
  prev[[i]]=prevu
  yearclimcond=Briggs_wilks_resampling(chemin.in,seas,prevu,n)
  x=SWG3(chemin.in,yearclimcond,seas,nyear,andebut,ht_seuil)
  result_cum1[[i]]=x$cm_seas_sim
  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_vrai_Copie,aes(x=prevision,y=frequence))+
  geom_bar(stat = "identity", position=position_dodge(),width = 0.5)+scale_y_continuous(break
s = seq(0,0.6,0.05))+
ggplot2::theme(legend.position="bottom", axis.text.x = element_text(angle = 90, vjust = 1, si
ze = 9, hjust = 1,face="bold"),axis.text.y = element_text(size = 9,face='bold'),axis.title =
 element_text(face = "bold",size = 10), strip.text.x = element_text(
  size = 12,face = "bold"
))+ ggplot2::facet_wrap(facets= ~ nom, ncol = 4, scales="free_x")+ ggplot2::xlab(label="Forec
ast probability")+
   ggplot2::ylab(label="Relative frequency of below average seasonal rainfall")+geom_segment
(aes(x=0, y=0.05,xend=11,yend=0.6),color="red",size=1,position="identity")
```



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)
```

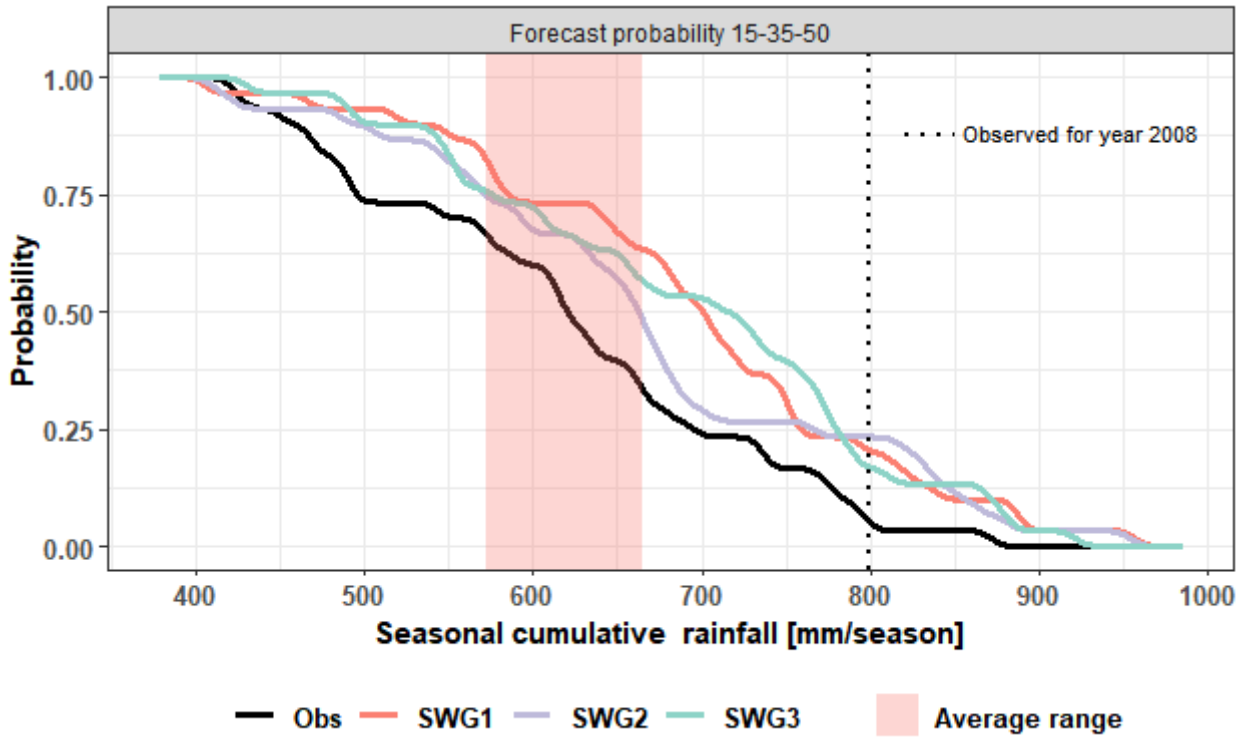
Hide

```
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=1.1)+
  labs(y = "Probability", x="Seasonal cumulative  rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1200,100))+
scale_color_manual(values=c("black","#fb8072","#bebada","#8dd3c7")) +
  theme(legend.position="bottom",legend.title=element_blank(),axis.text.x = element_text(size
= 10,face="bold"),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 = .3,color=NA)+
  geom_vline(xintercept = 799.4, linetype="dotted", color = "black", size=1)+
  geom_segment(aes(x=820, y=0.875,xend=850,yend= 0.875),color="black",size=1,linetype="dotte
d")+
  annotate(geom="text", x=925, y=0.885, label="Observed for year 2008",color="black",size=3,f
ace="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)
```

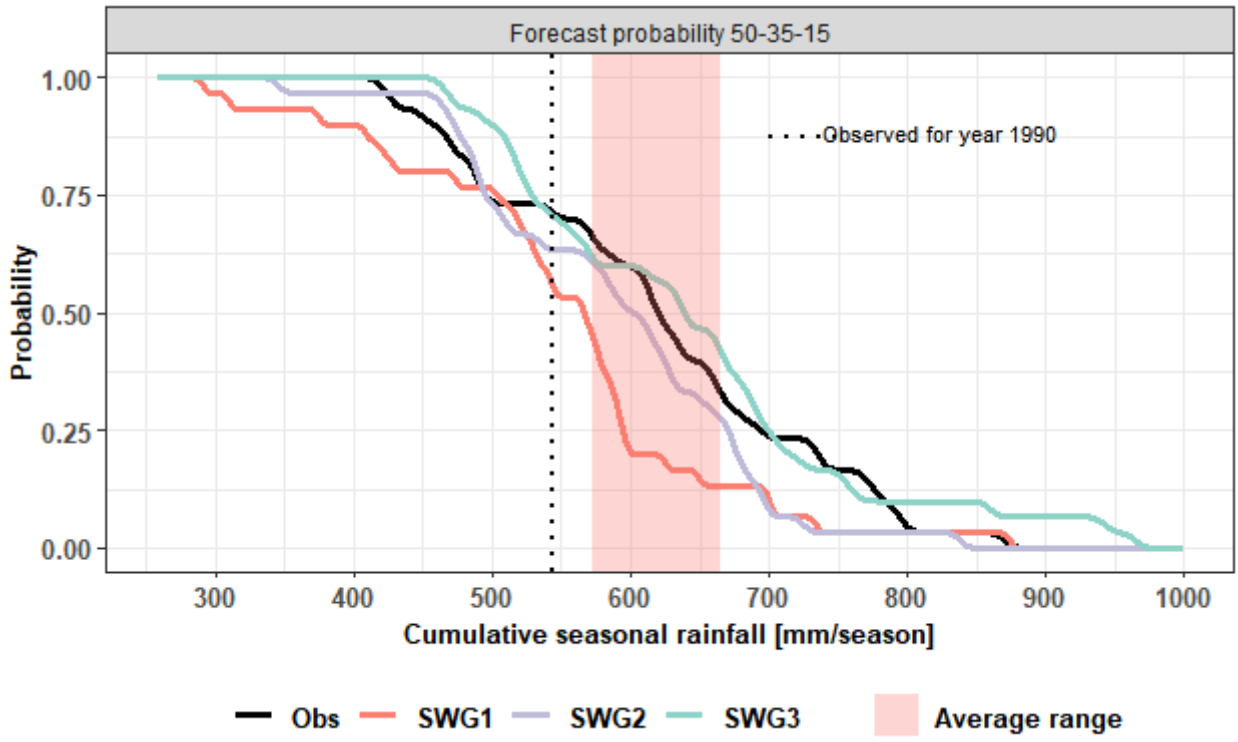
Hide

```
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")

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=1.1)+
  labs(y = "Probability", x="Cumulative seasonal rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1000,100))+
scale_color_manual(values=c("black","#fb8072","#bebada","#8dd3c7")) +
  theme(legend.position="bottom",legend.title=element_blank(),axis.text.x = element_text(size
= 10,face="bold"),axis.text.y = element_text(size = 10,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 = .3,color=NA)+
  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
```



Hide

```
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)
```

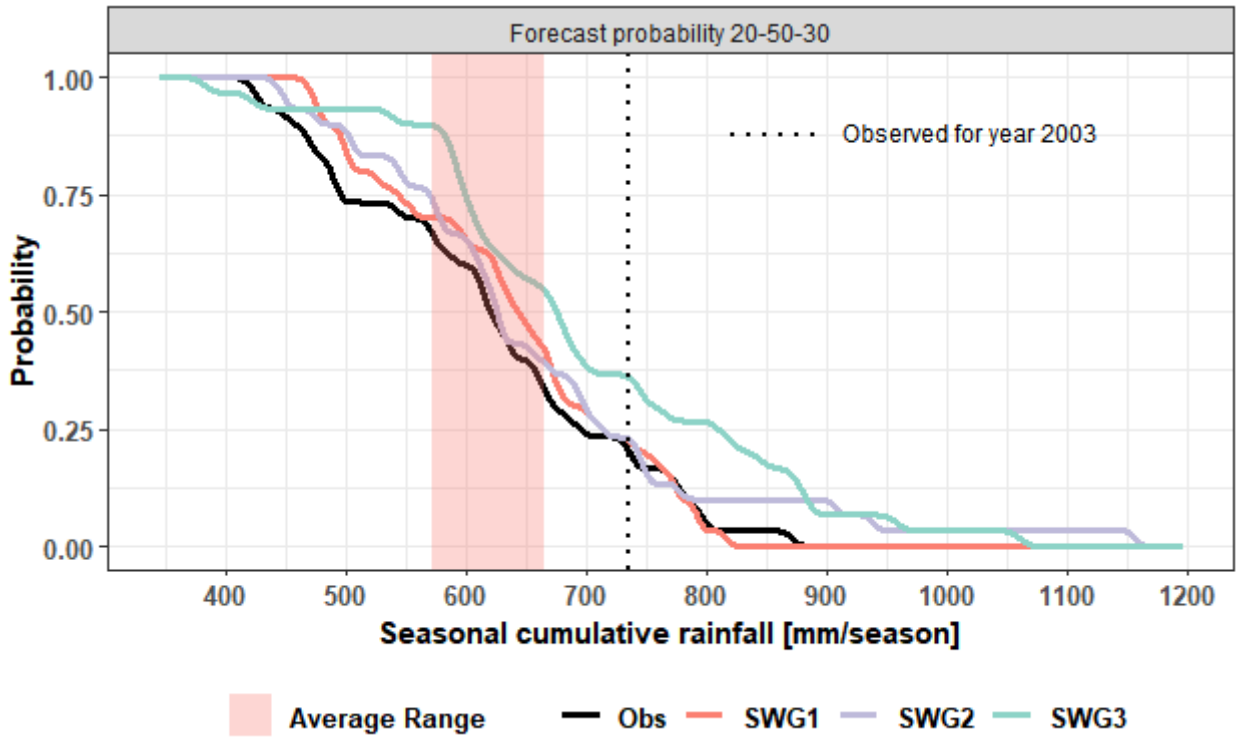
Hide

```
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=1.1)+
  labs(y = "Probability", x="Seasonal cumulative rainfall [mm/season]")+
  scale_x_continuous(breaks = seq(300,1200,100))+
scale_color_manual(values=c("black","#fb8072","#bebada","#8dd3c7")) +
  theme(legend.position="bottom",legend.title=element_blank(),axis.text.x = element_text(size
= 10,face="bold"),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 = .3,color=NA)+
  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.
1,face="bold")
```

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


Forecast probability 20-50-30
Observed for year 2003
Probability
1.00
0.75
0.50
0.25
0.00
400
500
600
700
800
900
1000
1100
1200
Seasonal cumulative rainfall [mm/season]
Average Range
Obs
SWG1
SWG2
SWG3