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Resumen

Este proyecto se resume en

Palabras clave: geometría solar, radiación solar, energía solar, fotovoltaica, métodos de visualización, series temporales, datos espacio-temporales, S4

Abstract

In this project.....

Keywords: solar geometry, solar radiation, solar energy, photovoltaic, visualitation methods, temporal series, space-time data, S4

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Introducción

1.1. Objetivos

El objetivo principal de este proyecto es el desarrollo de un paquete en R[R C23] con el cual poder realizar estimaciones y representaciones gráficas de la posible generación de una instalación fotovoltaica.

Durante el resto del documento, si fuera necesario, se hará referencia al paquete desarrollado en este proyecto con el nombre `solar2` [CITAR SOLAR2].

El usuario podrá colocar los datos que considere convenientes (desde una base de datos oficial, una base de datos propia. . . etc.) en cada una de las funciones que ofrece el paquete pudiendo así obtener resultados de la geometría solar, de la radiación horizontal, de la eficaz y hasta de la producción de diferentes tipos de sistemas fotovoltaicos.

El paquete también incluye una serie de funciones que permiten hacer representaciones gráficas de estas producciones con el fin de poder apreciar con más detalle las diferencias entre sistemas y contemplar cual es la mejor opción para el emplazamiento elegido.

Este proyecto toma su origen en el paquete ya existente `solar`[Per12] el cual desarrolló el tutor de este proyecto en 2012. Por la antigüedad del código se propuso la idea de renovarlo teniendo en cuenta el paquete en el que basa su funcionamiento. El paquete `solar` basó su funcionamiento en el paquete `zoo`[ZG05] el cual proporciona una sólida base para trabajar con series temporales. Sin embargo, como base de `solar2` se optó por el paquete `data.table`[Bar+24]. Este paquete ofrece una extensión de los clásicos `data.frame` de R en los `data.table`, los cuales pueden trabajar rápidamente con enormes cantidades de datos (por ejemplo, 100 GB de RAM).

La clave de ambos proyectos es que al estar alojados en R, cualquier usuario puede acceder a ellos de forma gratuita, tan solo necesitas tener instalado R en tu dispositivo.

Para alojar este proyecto se toman dos vías:

- Github[Wan+23]: Donde se aloja la versión de desarrollo del paquete.
- CRAN: Acrónimo de Comprehensive R Archive Network, es el repositorio donde se alojan las versiones definitivas de los paquetes y desde el cual se descargan a la sesión de R.

El paquete `solar2` permite realizar las siguientes operaciones:

- Cálculo de toda la geometría que caracteriza a la radiación procedente del Sol [CITAR CÓDIGO]

- Tratamiento de datos meteorológicos (en especial de radiación), procedentes de datos ofrecidos del usuario y de la red de estaciones SIAR [Min23] [CITAR CÓDIGO]
- Una vez calculado lo anterior, se pueden hacer estimaciones de:
 - Los componentes de radiación horizontal [CITAR CALCG0].
 - Los componentes de radiación eficaz en el plano inclinado [CITAR CALCGEF].
 - La producción de sistemas fotovoltaicos conectados a red [CITAR PRODGCPV] y sistemas fotovoltaicos de bombeo [CITAR PRODPVPS].

Este proyecto ha tenido a su vez una serie de objetivos secundarios:

- Uso y manejo de GNU Emacs [Sta85] en el que se realizaron todos los archivos que componen este documento (utilizando el modo Org [Dom+03]) y el paquete descrito (empleando ESS [Pro24])
- Dominio de diferentes paquetes de R:
 - `zoo`[ZG05]: Paquete que proporciona un conjunto de clases y métodos en S3 para trabajar con series temporales regulares e irregulares. Usado en el paquete `solaR` como pilar central.
 - `data.table`[Bar+24]: Otorga una extensión a los datos de tipo `data.frame` que permite una alta eficiencia especialmente con conjuntos de datos muy grandes. Se ha utilizado en el paquete `solaR2` en sustitución del paquete `zoo` como tipo de dato principal en el cual se construyen las clases y métodos de este paquete.
 - `microbenchmark`[Mer+23]: Proporciona infraestructura para medir y comparar con precisión el tiempo de ejecución de expresiones en R. Usado para comparar los tiempos de ejecución de ambos paquetes.
 - `profvis`[Wic+24]: Crea una interfaz gráfica donde explorar los datos de rendimiento de una expresión dada. Aplicada junto con `microbenchmark` para detectar y corregir cuellos de botella en el paquete `solaR2`
 - `lattice`[Sar08]: Proporciona diversas funciones con las que representar datos. El paquete `solaR2` utiliza este paquete para representar de forma visual los datos obtenidos en las estimaciones.
- Junto con el modo Org, se ha utilizado el preprocesador de textos \LaTeX (partiendo de un archivo `.org`, se puede exportar a un archivo `.tex` para posteriormente exportar un pdf).
- Obtener conocimientos teóricos acerca de la radiación solar y de la producción de energía solar mediante sistemas fotovoltaicos y sus diversos tipos. Para ello se ha usado en mayor medida el libro “Energía Solar Fotovoltaica” [Per23].

1.2. Análisis previo de soluciones

Este proyecto, como ya se ha comentado, es el heredero del paquete `solaR` desarrollado por Oscar Perpiñán. La filosofía de ambos paquetes es la misma y los resultados que dan son muy similares. Sin embargo, lo que les diferencia es el paquete sobre el que construyen sus datos. Mientras que `solaR` basa sus clases y métodos en el paquete `zoo`, `solaR2` en el paquete `data.table`. Los dos paquetes pueden trabajar con series temporales, pero, mientras que `zoo` es más eficaz trabajando con series temporales, `data.table` es más

eficiente a la hora de trabajar con una cantidad grande de datos, lo cual a la hora de realizar estimaciones muy precisas es beneficioso. Por otro lado, existen otras soluciones fuera de R:

1. **PVsyst - Photovoltaic Software**

Este software es probablemente el más conocido dentro del ámbito del estudio y la estimación de instalaciones fotovoltaicas. Permite una gran personalización de todos los componentes de la instalación.

2. **SISIFO**

Herramienta web diseñada por el **Grupo de Sistemas Fotovoltaicos del Instituto de Energía Solar de la Universidad Politécnica de Madrid**.

3. **PVGIS**

Aplicación web desarrollada por el **European Commission Joint Research Center** desde 2001.

4. **System Advisor Model**

Desarrollado por el **Laboratorio Nacional de Energías Renovables**, perteneciente al Departamento de energía del gobierno de EE.UU.

En el apartado [ref:sec:ejemplos] se realizará un ejemplo práctico que compare los resultados entre **PVsyst**, **solaR** y **solaR2**

1.3. Aspectos técnicos

Para elaborar un paquete en R se deben aportar una serie de ficheros:

- **R**: Fichero que contiene todos los archivos .R que se van a ejecutar en la instalación del paquete. Esto incluye funciones, clases y métodos.
- **data**: Aquí se incluyen los datos externos que el paquete necesita para funcionar.
- **DESCRIPTION**: Contiene metadatos sobre el paquete, como el nombre, la versión, el autor, etc.
- **NAMESPACE**: Especifica qué funciones y datos se exportan y se importan.
- **inst**: Se usa para almacenar archivos importantes pero que no se almacenan en el resto de ficheros.
- **tests**: Se utiliza para almacenar scripts de pruebas que aseguran que el código del paquete funcione correctamente.
- **man**: Donde se alojan los ficheros .Rd relacionados con el manual de uso del paquete. En estos se almacenan la información de funciones, métodos, clases y datos.

Una vez se tienen todos estos ficheros, el paquete se construye y se prueba.

Estado del arte

2.1. Situación actual de la generación fotovoltaica

Según el informe anual de 2023 de la UNEF¹[UNE23] en 2022 la fotovoltaica se posicionó como la tecnología con más crecimiento a nivel internacional, tanto entre las renovables como entre las no renovables. Se instalaron 240 GWp de nueva capacidad fotovoltaica a nivel mundial, suponiendo esto un incremento del 137 % con respecto a 2021.

A pesar de las diversas crisis internacionales, la energía solar fotovoltaica alcanzó a superar los 1185 GWp instalados. Como otros años, las cifras indican que China continuó siendo el primer actor mundial, superando los 106 GWp de potencia instalada en el año. La Unión Europea se situó en el segundo puesto, duplicando la potencia instalada en 2021, y alcanzando un nuevo record con 41 GWp instalados en 2022.

La producción energía fotovoltaica a nivel mundial representó el 31 % de la capacidad de generación renovable, convirtiéndose así en la segunda fuente de generación, solo por detrás de la energía hidráulica. En 2022 se añadió 3 veces más de energía solar que de energía eólica en todo el mundo.

Por otro lado, la Unión Europea superó a EE.UU. como el segundo mayor actor mundial en desarrollo fotovoltaico, instalando un 47 % más que en 2021 y alcanzando una potencia acumulada de más de 208 GWp. España lideró el mercado europeo con 8,6 GWp instalados en 2022, superando a Alemania.

El año 2022 fue significativo en términos legislativos con el lanzamiento del Plan REPowerEU²[Eur22]. Dentro de este plan, se lanzó la Estrategia de Energía Solar con el objetivo de alcanzar 400 GWp (320 GW) para 2030, incluyendo medidas para desarrollar tejados solares, impulsar la industria fotovoltaica y apoyar la formación de profesionales en el sector.

En 2022, España vivió un auge en el desarrollo fotovoltaico, instalando 5.641 MWp en plantas en suelo, un 30 % más que en 2021, y aumentando el autoconsumo en un 108 %, alcanzando 3.008 MWp. El sector industrial de autoconsumo creció notablemente, representando el 47 % del autoconsumo total.

España implementó varias iniciativas legislativas para enfrentar la volatilidad de precios de la energía y la dependencia del gas, destacando el RD-ley 6/2022[BOE22b] y el RD 10/2022[BOE22a], que han modificado mecanismos de precios y estableciendo límites al precio del gas.

¹UNEF: Unión Española Fotovoltaica.

²Plan REPowerEU: Proyecto por el cual la Unión Europea quiere poner fin a su dependencia de los combustibles fósiles rusos ahorrando energía, diversificando los suministros y acelerando la transición hacia una energía limpia.

El Plan SE+³[dem22] incluye medidas fiscales y administrativas para apoyar las renovables y el autoconsumo. En 2022, se realizaron subastas de energía renovable, asignando 140 MW a solar fotovoltaica en la tercera subasta y 1.800MW en la cuarta, aunque esta última quedó desierta por precios de reserva bajos.

Se adjudicaron 1.200 MW del nudo de transición justa de Andorra a Enel Green Power España, con planes para instalar plantas de hidrógeno verde y agrovoltaica. la actividad en hidrógeno verde y almacenamiento también creció, con fondos adicionales y exenciones de cargos.

El autoconsumo, apoyado por diversas regulaciones y altos precios de la electricidad, registró un crecimiento significativo, alcanzado 2.504 MW de nueva potencia en 2022. Las comunidades energéticas también avanzaron gracias a ayudas específicas, a pesar de la falta de un marco regulatorio definido.

2022 estuvo marcado por los programas financiados por la Unión Europea, especialmente el Mecanismo de Recuperación y Resiliencia[Hac22] que canaliza los fondos Next-GenerationEU[Uni20]. El PERTE⁴, aprobado en diciembre de 2021, espera crear más de 280.000 empleos, con ayudas que se ejecutarán hasta 2026. En 2023 se solicitó a Bruselas una adenda para segunda fase del PERTE, obteniendo 2.700 millones de euros adicionales.

La contribución del sector fotovoltaico a la economía española en 2022 fue significativa, aportando 7.014 millones de euros al PIB⁵, un 51 % más que el año anterior, y generando una huella económica total de 15.656 millones de euros. En términos de empleo, el sector involucró a 197.383 trabajadores, de los cuales 40.683 fueron directos, 97.600 indirectos y 59.100 inducidos.

El sector industrial fotovoltaico nacional tiene una fuerte presencia en España, con hasta un 65 % de los componentes manufacturados localmente. Empresas españolas se encuentran entre los principales fabricantes mundiales de inversores y seguidores solares. Además, España es un importante exportador de estructuras fotovoltaicas y cuenta con iniciativas prometedoras para la fabricación de módulos solares.

UNEF promueve la transformación industrial para que España se convierta en un hub industrial fotovoltaico. Se destaca la necesidad de proteger la industria existente, garantizar un crecimiento constante de la capacidad y ofrecer condiciones de financiamiento favorables. Además se propone implementar una Estrategia Industrial Fotovoltaica para contribuir significativamente a la reindustrialización de la economía, aprovechando las medidas del REPower Plan, la Estrategia Solar y la Alianza de la Industria Solar Fotovoltaica.

En definitiva, la fotovoltaica es una tecnología en auge y con perspectivas para ser el pilar de la transición ecológica. Por ello, surge la necesidad de encontrar herramientas que permitan estimar el desempeño que estos sistemas pueden tener a la hora de realizar estudios de viabilidad económica.

2.2. Soluciones existentes y sus carencias

³Plan + Seguridad Energética: Se trata de un plan con medidas de rápido impacto dirigidas al invierno 2022/2023, junto con medidas que contribuyen a un refuerzo estructural de esa seguridad energética.

⁴PERTE: Proyecto Estratégico para la Recuperación y Transformación Económica.

⁵PIB: Producto Interior Bruto.

Parte teórica y desarrollo del código

...

Ejemplo práctico de aplicación

Como demostración se va a realizar un caso práctico...

4.1. solaR2

...

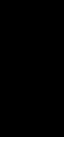
4.2. solaR

...

4.3. PVsyst

...

4.4. Comparación entre los tres



Detalles de la programación

...

Código completo

Todo el código que se muestra a continuación está disponible...

A.1. Constructores

calcSol

```

1 calcSol <- function(lat, BTd,
2                     sample = 'hour', BTi,
3                     EoT = TRUE,
4                     keep.night = TRUE,
5                     method = 'michalsky')
6 {
7   if(missing(BTd)) BTd <- truncDay(BTi)
8   sold <- fSold(lat, BTd, method = method) #daily values
9   soli <- fSoli(sold = sold, sample = sample, #intradaily values
10              BTi = BTi, keep.night = keep.night,
11              EoT = EoT, method = method)
12
13   if(!missing(BTi)){
14     sample <- soli$Dates[2]-soli$Dates[1]
15     sample <- format(sample)
16   }
17
18   sold[, lat := NULL]
19   soli[, lat := NULL]
20   result <- new('Sol',
21               lat = lat,
22               sold = sold,
23               soli = soli,
24               sample = sample,
25               method = method)
26   return(result)
27 }
```

calcG0

```

1 calcG0 <- function(lat,
```

```

2         modeRad='prom',
3         dataRad,
4         sample='hour',
5         keep.night=TRUE,
6         sunGeometry='michalsky',
7         corr, f, ...)
8     {
9
10        if (missing(lat)) stop('lat missing. You must provide a latitude value.')
11
12        stopifnot(modeRad %in% c('prom', 'aguilar', 'bd', 'bdI'))
13
14
15    ###Datos de Radiacion
16    if (missing(corr)){
17        corr = switch(modeRad,
18            bd = 'CPR', #Correlation between Fd and Kt for daily values
19            aguilar = 'CPR', #Correlation between Fd and Kt for daily
20            values
21            prom = 'Page', #Correlation between Fd and Kt for monthly
22            averages
23            bdI = 'BRL' #Correlation between fd and kt for intraday
24            values
25        )
26    }
27
28    if(is(dataRad, 'Meteo')){BD <- dataRad}
29    else{
30        BD <- switch(modeRad,
31            bd = {
32                if (!is.list(dataRad)) dataRad <- list(file=dataRad)
33                switch(class(dataRad$file)[1],
34                    character={
35                        bd.default=list(file='', lat=lat)
36                        bd=modifyList(bd.default, dataRad)
37                        res <- do.call('readBDd', bd)
38                        res
39                    },
40                    data.table= ,
41                    data.frame={
42                        bd.default=list(file='', lat=lat)
43                        bd=modifyList(bd.default, dataRad)
44                        res <- do.call('dt2Meteo', bd)
45                        res
46                    },
47                    zoo={
48                        bd.default=list(file='', lat=lat, source='')
49                        bd=modifyList(bd.default, dataRad)
50                        res <- do.call('zoo2Meteo', bd)
51                        res
52                    })
53            }, #End of bd
54            prom = {
55                if (!is.list(dataRad)) dataRad <- list(G0dm=dataRad)
56                prom.default <- list(G0dm=numeric(), lat=lat)
57                prom = modifyList(prom.default, dataRad)
58            }
59        )
60    }

```

```

55         res <- do.call('readG0dm', prom)
56     }, #End of prom
57     aguiar = {
58         if (is.list(dataRad)) dataRad <- dataRad$G0dm
59         BTd <- fBTd(mode='serie')
60         solD <- fSolD(lat, BTd)
61         G0d <- markovG0(dataRad, solD)
62         res <- dt2Meteo(G0d, lat=lat, source='aguiar')
63     }, #End of aguiar
64     bdI = {
65         if (!is.list(dataRad)) dataRad <- list(file=dataRad)
66         switch(class(dataRad$file)[1],
67             character = {
68                 bdI.default <- list(file='', lat=lat)
69                 bdI <- modifyList(bdI.default, dataRad)
70                 res <- do.call('readBDi', bdI)
71                 res
72             },
73             data.table = ,
74             data.frame = {
75                 bdI.default <- list(file='', lat=lat)
76                 bdI <- modifyList(bdI.default, dataRad)
77                 res <- do.call('dt2Meteo', bdI)
78                 res
79             },
80             zoo = {
81                 bdI.default <- list(file='', lat=lat, source='')
82                 bdI <- modifyList(bdI.default, dataRad)
83                 res <- do.call('zoo2Meteo', bdI)
84                 res
85             },
86             stop('dataRad$file should be a character, a data.
table, a data.frame or a zoo.')
87         )} #End of btI
88     ) #End of general switch
89 }
90
91
92 ### Angulos solares y componentes de irradiancia
93 if (modeRad=='bdI') {
94     sol <- calcSol(lat, sample = sample,
95     BTi = indexD(BD), keep.night=keep.night, method=
sunGeometry)
96     compI <- fCompI(sol=sol, G0I=BD, corr=corr, f=f, ...)
97     compD <- compI[, lapply(.SD, P2E, sol@sample),
98     .SDcols = c('G0', 'D0', 'B0'),
99     by = truncDay(Dates)]
100     names(compD)[1] <- 'Dates'
101     names(compD)[-1] <- paste(names(compD)[-1], 'd', sep = '')
102     compD$Fd <- compD$D0d/compD$G0d
103     compD$Kt <- compD$G0d/sol@solD$Bo0d
104 } else { ##modeRad!='bdI'
105     sol <- calcSol(lat, indexD(BD), sample = sample,
106     keep.night = keep.night, method = sunGeometry)
107     compD<-fCompD(sol=sol, G0d=BD, corr=corr, f, ...)
108     compI<-fCompI(sol=sol, compD=compD, ...)

```

```

109 }
110
111 ###Temperature
112
113 Ta=switch(modeRad,
114           bd={
115             if (all(c("TempMax","TempMin") %in% names(BD@data))) {
116               fTemp(sol, BD)
117             } else {
118               if ("Ta" %in% names(BD@data)) {
119                 data.table(Dates = indexD(sol),
120                           Ta =BD@data$Ta)
121               } else {
122                 warning('No temperature information available!')
123               }
124             }
125           },
126           bdI={
127             if ("Ta" %in% names(BD@data)) {
128               data.table(Dates = indexI(sol),
129                         Ta = BD@data$Ta)
130             } else {
131               warning('No temperature information available!')
132             }
133           },
134           prom={
135             if ("Ta" %in% names(BD@data)) {
136               data.table(Dates = indexD(sol),
137                         Ta = BD@data$Ta)
138             } else {
139               warning('No temperature information available!')
140             }
141           },
142           aguiar={
143             data.table(Dates = indexI(sol),
144                       Ta = BD@data$Ta)
145           }
146         )
147
148 ###Medias mensuales y anuales
149 nms <- c('G0d', 'D0d', 'B0d')
150 G0dm <- compD[, lapply(.SD/1000, mean, na.rm = TRUE),
151               .SDcols = nms,
152               by = .(month(Dates), year(Dates))]
153
154 if(modeRad == 'prom'){
155   G0dm[, DayOfMonth := DOM(G0dm)]
156   G0y <- G0dm[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
157               .SDcols = nms,
158               by = .(Dates = year)]
159   G0dm[, DayOfMonth := NULL]
160 } else{
161   G0y <- compD[, lapply(.SD/1000, sum, na.rm = TRUE),
162               .SDcols = nms,
163               by = .(Dates = year(Dates))]
164 }

```

```

165 G0dm[, Dates := paste(month.abb[month], year, sep = '. ')]
166 G0dm[, c('month', 'year') := NULL]
167 setcolorder(G0dm, 'Dates')
168
169 ###Result
170 result <- new(Class='G0',
171               BD,          #G0 contains "Meteo"
172               sol,         #G0 contains 'Sol'
173               GOD=compD, #results of fCompD
174               G0dm=G0dm, #monthly means
175               G0y=G0y,   #yearly values
176               G0I=compI, #results of fCompD
177               Ta=Ta      #ambient temperature
178               )
179 return(result)
180 }

```

calcGef

```

1 calcGef<-function(lat,
2                   modeTrk='fixed',      #c('two','horiz','fixed')
3                   modeRad='prom',
4                   dataRad,
5                   sample='hour',
6                   keep.night=TRUE,
7                   sunGeometry='michalsky',
8                   corr, f,
9                   betaLim=90, beta=abs(lat)-10, alfa=0,
10                  iS=2, alb=0.2, horizBright=TRUE, HCPV=FALSE,
11                  modeShd='',          #modeShd=c('area','bt','prom')
12                  struct=list(), #list(W=23.11, L=9.8, Nrow=2, Ncol=8),
13                  distances=data.frame(), #data.table(Lew=40, Lns=30, H=0)){
14    ...){
15
16    stopifnot(is.list(struct), is.data.frame(distances))
17
18    if (('bt' %in% modeShd) & (modeTrk!='horiz')) {
19      modeShd[which(modeShd=='bt')]='area'
20      warning('backtracking is only implemented for modeTrk=horiz')}
21
22    if (modeRad!='prev'){ #not use a prev calculation
23      radHoriz <- calcG0(lat=lat, modeRad=modeRad,
24                        dataRad=dataRad,
25                        sample=sample, keep.night=keep.night,
26                        sunGeometry=sunGeometry,
27                        corr=corr, f=f, ...)
28    } else {
29      radHoriz <- as(dataRad, 'G0')
30    }
31
32    ### Inclined and effective radiation
33    BT=("bt" %in% modeShd)
34    angGen <- fTheta(radHoriz, beta, alfa, modeTrk, betaLim, BT, struct,
35                    distances)
36    inclin <- fInclin(radHoriz, angGen, iS, alb, horizBright, HCPV)

```

```

36
37 ### Daily, monthly and yearly values
38 by <- radHoriz@sample
39 nms <- c('Bo', 'Bn', 'G', 'D', 'B', 'Gef', 'Def', 'Bef')
40 nmsd <- paste(nms, 'd', sep = '')
41
42
43 if(radHoriz@type == 'prom'){
44   Gefdm <- inclin[, lapply(.SD/1000, P2E, by),
45                     .SDcols = nms,
46                     by = .(month(Dates), year(Dates))]
47   names(Gefdm)[-c(1,2)] <- nmsd
48   GefD <- Gefdm[, .SD*1000,
49                 .SDcols = nmsd,
50                 by = .(Dates = indexD(radHoriz))]
51
52   Gefdm[, DayOfMonth := DOM(Gefdm)]
53   Gefy <- Gefdm[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
54                 .SDcols = nmsd,
55                 by = .(Dates = year)]
56   Gefdm[, DayOfMonth := NULL]
57 } else{
58   GefD <- inclin[, lapply(.SD, P2E, by),
59                 .SDcols = nms,
60                 by = .(Dates = truncDay(Dates))]
61   names(GefD)[-1] <- nmsd
62
63   Gefdm <- GefD[, lapply(.SD/1000, mean, na.rm = TRUE),
64                 .SDcols = nmsd,
65                 by = .(month(indexD(radHoriz)), year(indexD(radHoriz)))]
66   Gefy <- GefD[, lapply(.SD/1000, sum, na.rm = TRUE),
67                 .SDcols = nmsd,
68                 by = .(Dates = year(indexD(radHoriz)))]
69 }
70
71 Gefdm[, Dates := paste(month.abb[month], year, sep = '. ')]
72 Gefdm[, c('month', 'year') := NULL]
73 setcolorder(Gefdm, 'Dates')
74
75 ###Resultado antes de sombras
76 result0=new('Gef',
77            radHoriz,                #Gef contains 'GO'
78            Theta=angGen,
79            GefD=GefD,
80            Gefdm=Gefdm,
81            Gefy=Gefy,
82            GefI=inclin,
83            iS=iS,
84            alb=alb,
85            modeTrk=modeTrk,
86            modeShd=modeShd,
87            angGen=list(alfa=alfa, beta=beta, betaLim=betaLim),
88            struct=struct,
89            distances=distances
90            )
91 ###Shadows

```



```

92   if (isTRUE(modeShd == "") ||           #If modeShd==' ' there is no shadow
      calculation
93       ('bt' %in% modeShd)) {             #nor if there is backtracking
94       return(result0)
95   } else {
96       result <- calcShd(result0, modeTrk, modeShd, struct, distances)
97       return(result)
98   }
99 }

```

prodGCPV

```

1  prodGCPV<-function(lat,
2      modeTrk='fixed',
3      modeRad='prom',
4      dataRad,
5      sample='hour',
6      keep.night=TRUE,
7      sunGeometry='michalsky',
8      corr, f,
9      betaLim=90, beta=abs(lat)-10, alfa=0,
10     iS=2, alb=0.2, horizBright=TRUE, HCPV=FALSE,
11     module=list(),
12     generator=list(),
13     inverter=list(),
14     effSys=list(),
15     modeShd='',
16     struct=list(),
17     distances=data.table(),
18     ...){
19
20     stopifnot(is.list(module),
21               is.list(generator),
22               is.list(inverter),
23               is.list(effSys),
24               is.list(struct),
25               is.data.table(distances))
26
27     if (('bt' %in% modeShd) & (modeTrk!='horiz')) {
28         modeShd[which(modeShd=='bt')]='area'
29         warning('backtracking is only implemented for modeTrk=horiz')}
30
31     if (modeRad!='prev'){ #We do not use a previous calculation
32
33         radEf<-calcGef(lat=lat, modeTrk=modeTrk, modeRad=modeRad,
34             dataRad=dataRad,
35             sample=sample, keep.night=keep.night,
36             sunGeometry=sunGeometry,
37             corr=corr, f=f,
38             betaLim=betaLim, beta=beta, alfa=alfa,
39             iS=iS, alb=alb, horizBright=horizBright, HCPV=HCPV,
40             modeShd=modeShd, struct=struct, distances=distances, ...)
41
42     } else { #We use a previous calcG0, calcGef or prodGCPV calculation.
43

```

```

44 stopifnot(class(dataRad) %in% c('GO', 'Gef', 'ProdGCPV'))
45 radEf <- switch(class(dataRad),
46                 GO=calcGef(lat=lat,
47                             modeTrk=modeTrk, modeRad='prev',
48                             dataRad=dataRad,
49                             betaLim=betaLim, beta=beta, alfa=alfa,
50                             iS=iS, alb=alb, horizBright=horizBright, HCPV=
HCPV,
51                             modeShd=modeShd, struct=struct, distances=
distances, ...),
52                 Gef=dataRad,
53                 ProdGCPV=as(dataRad, 'Gef')
54                 )
55 }
56
57
58 ##Production
59 prodI<-fProd(radEf,module,generator,inverter,effSys)
60 module=attr(prodI, 'module')
61 generator=attr(prodI, 'generator')
62 inverter=attr(prodI, 'inverter')
63 effSys=attr(prodI, 'effSys')
64
65 ##Calculation of daily, monthly and annual values
66 Pg=generator$Pg #Wp
67
68 by <- radEf@sample
69 nms1 <- c('Pac', 'Pdc')
70 nms2 <- c('Eac', 'Edc', 'Yf')
71
72
73 if(radEf@type == 'prom'){
74   prodDm <- prodI[, lapply(.SD/1000, P2E, by),
75                         .SDcols = nms1,
76                         by = .(month(Dates), year(Dates))]
77   names(prodDm)[-c(1,2)] <- nms2[-3]
78   prodDm[, Yf := Eac/(Pg/1000)]
79   prodD <- prodDm[, .SD*1000,
80                     .SDcols = nms2,
81                     by = .(Dates = indexD(radEf))]
82   prodD[, Yf := Yf/1000]
83
84   prodDm[, DayOfMonth := DOM(prodDm)]
85   prody <- prodDm[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
86                   .SDcols = nms2,
87                   by = .(Dates = year)]
88   prodDm[, DayOfMonth := NULL]
89 } else {
90   prodD <- prodI[, lapply(.SD, P2E, by),
91                   .SDcols = nms1,
92                   by = .(Dates = truncDay(Dates))]
93   names(prodD)[-1] <- nms2[-3]
94   prodD[, Yf := Eac/Pg]
95
96   prodDm <- prodD[, lapply(.SD/1000, mean, na.rm = TRUE),
97                     .SDcols = nms2,

```

```

98         by = .(month(Dates), year(Dates))
99     prodDm[, Yf := Yf * 1000]
100     prody <- prodD[, lapply(.SD/1000, sum, na.rm = TRUE),
101         .SDcols = nms2,
102         by = .(Dates = year(Dates))]
103     prody[, Yf := Yf * 1000]
104 }
105
106 prodDm[, Dates := paste(month.abb[month], year, sep = '. ')]
107 prodDm[, c('month', 'year') := NULL]
108 setcolororder(prodDm, 'Dates')
109
110 result <- new('ProdGCPV',
111     radEf,                #contains 'Gef'
112     prodD=prodD,
113     prodDm=prodDm,
114     prody=prody,
115     prodI=prodI,
116     module=module,
117     generator=generator,
118     inverter=inverter,
119     effSys=effSys
120 )
121 }

```

prodPVPS

```

1 prodPVPS<-function(lat,
2     modeTrk='fixed',
3     modeRad='prom',
4     dataRad,
5     sample='hour',
6     keep.night=TRUE,
7     sunGeometry='michalsky',
8     corr, f,
9     betaLim=90, beta=abs(lat)-10, alfa=0,
10    iS=2, alb=0.2, horizBright=TRUE, HCPV=FALSE,
11    pump , H,
12    Pg, converter= list(), #Pnom=Pg, Ki=c(0.01,0.025,0.05)),
13    effSys=list(),
14    ...){
15
16    stopifnot(is.list(converter),
17        is.list(effSys))
18
19    if (modeRad!='prev'){ #We do not use a previous calculation
20
21        radEf<-calcGef(lat=lat, modeTrk=modeTrk, modeRad=modeRad,
22            dataRad=dataRad,
23            sample=sample, keep.night=keep.night,
24            sunGeometry=sunGeometry,
25            corr=corr, f=f,
26            betaLim=betaLim, beta=beta, alfa=alfa,
27            iS=iS, alb=alb, horizBright=horizBright, HCPV=HCPV,
28            modeShd='', ...)

```

```

29 } else { #We use a previous calculation of calcG0, calcGef or prodPVPS
30   stopifnot(class(dataRad) %in% c('G0', 'Gef', 'ProdPVPS'))
31   radEf <- switch(class(dataRad),
32     G0=calcGef(lat=lat,
33       modeTrk=modeTrk, modeRad='prev',
34       dataRad=dataRad,
35       betaLim=betaLim, beta=beta, alfa=alfa,
36       iS=iS, alb=alb, horizBright=horizBright, HCPV=HCPV,
37       modeShd='', ...),
38     Gef=dataRad,
39     ProdPVPS=as(dataRad, 'Gef')
40   )
41 }
42
43
44 ###Electric production
45 converter.default=list(Ki = c(0.01,0.025,0.05), Pnom=Pg)
46 converter=modifyList(converter.default, converter)
47
48 effSys.default=list(ModQual=3,ModDisp=2,OhmDC=1.5,OhmAC=1.5,MPP=1,TrafoMT=1,
49   Disp=0.5)
50 effSys=modifyList(effSys.default, effSys)
51
52 TONC=47
53 Ct=(TONC-20)/800
54 lambda=0.0045
55 Gef=radEf@GefI$Gef
56 night=radEf@solI$night
57 Ta=radEf@Ta$Ta
58
59 Tc=Ta+Ct*Gef
60 Pdc=Pg*Gef/1000*(1-lambda*(Tc-25))
61 Pdc[is.na(Pdc)]=0 #Necessary for the functions provided by fPump
62 PdcN=with(effSys,
63   Pdc/converter$Pnom*(1-ModQual/100)*(1-ModDisp/100)*(1-OhmDC/100)
64 )
65 PacN=with(converter,{
66   A=Ki[3]
67   B=Ki[2]+1
68   C=Ki[1]-(PdcN)
69   ##AC power normalized to the inverter
70   result=(-B+sqrt(B^2-4*A*C))/(2*A)
71 })
72 PacN[PacN<0]<-0
73
74 Pac=with(converter,
75   PacN*Pnom*(1-effSys$OhmAC/100))
76 Pdc=PdcN*converter$Pnom*(Pac>0)
77
78 ###Pump
79 fun<-fPump(pump=pump, H=H)
80 ##I limit power to the pump operating range.
81 rango=with(fun,Pac>=lim[1] & Pac<=lim[2])
82 Pac[!rango]<-0
83 Pdc[!rango]<-0

```

```

84 prodI=data.table(Pac=Pac,Pdc=Pdc,Q=0,Pb=0,Ph=0,f=0)
85 prodI=within(prodI,{
86   Q[rango]<-fun$fQ(Pac[rango])
87   Pb[rango]<-fun$fPb(Pac[rango])
88   Ph[rango]<-fun$fPh(Pac[rango])
89   f[rango]<-fun$fFreq(Pac[rango])
90   etam=Pb/Pac
91   etab=Ph/Pb
92 })
93
94 prodI[night,]<-NA
95 prodI[, Dates := indexI(radEf)]
96 setcolorder(prodI, c('Dates', names(prodI)[-length(prodI)]))
97
98 ###daily, monthly and yearly values
99
100 by <- radEf@sample
101
102 if(radEf@type == 'prom'){
103   prodDm <- prodI[, .(Eac = P2E(Pac, by)/1000,
104                      Qd = P2E(Q, by)),
105                    by = .(month(Dates), year(Dates))]
106   prodDm[, Yf := Eac/(Pg/1000)]
107
108   prodD <- prodDm[, .(Eac = Eac*1000,
109                     Qd,
110                     Yf),
111                  by = .(Dates = indexD(radEf))]
112
113   prodDm[, DayOfMonth := DOM(prodDm)]
114
115   prody <- prodDm[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
116                     .SDcols = c('Eac', 'Qd', 'Yf'),
117                     by = .(Dates = year)]
118   prodDm[, DayOfMonth := NULL]
119 } else {
120   prodD <- prodI[, .(Eac = P2E(Pac, by)/1000,
121                     Qd = P2E(Q, by)),
122                   by = .(Dates = truncDay(Dates))]
123   prodD[, Yf := Eac/Pg*1000]
124
125   prodDm <- prodD[, lapply(.SD, mean, na.rm = TRUE),
126                     .SDcols = c('Eac', 'Qd', 'Yf'),
127                     by = .(month(Dates), year(Dates))]
128   prody <- prodD[, lapply(.SD, sum, na.rm = TRUE),
129                     .SDcols = c('Eac', 'Qd', 'Yf'),
130                     by = .(Dates = year(Dates))]
131
132 }
133
134 prodDm[, Dates := paste(month.abb[month], year, sep = '. ')]
135 prodDm[, c('month', 'year') := NULL]
136 setcolorder(prodDm, 'Dates')
137
138 result <- new('ProdPVPS',
139              radEf,
              #contains 'Gef'

```

```

140         prodD=prodD,
141         prodDm=prodDm,
142         prody=prody,
143         prodI=prodI,
144         pump=pump,
145         H=H,
146         Pg=Pg,
147         converter=converter,
148         effSys=effSys
149     )
150 }

```

calcShd

```

1  calcShd<-function(radEf,##class='Gef'
2      modeTrk='fixed',      #c('two','horiz','fixed')
3      modeShd='prom',      #modeShd=c('area','bt','prom')
4      struct=list(), #list(W=23.11, L=9.8, Nrow=2, Ncol=8),
5      distances=data.frame() #data.table(Lew=40, Lns=30, H=0)){
6      )
7  {
8      stopifnot(is.list(struct), is.data.frame(distances))
9
10     ##For now I only use modeShd = 'area'
11     ##With different modeShd (to be defined) I will be able to calculate Gef in a
12     ##different way
13     ##See macagnan thesis
14     prom=("prom" %in% modeShd)
15     prev <- as.data.tableI(radEf, complete=TRUE)
16     ## shadow calculations
17     sol <- data.table(AzS = prev$AzS,
18                     A1S = prev$A1S)
19     theta <- radEf@Theta
20     AngGen <- data.table(theta, sol)
21     FS <- fSombra(AngGen, distances, struct, modeTrk, prom)
22     ## irradiance calculation
23     gef0 <- radEf@GefI
24     Bef0 <- gef0$Bef
25     Dcef0 <- gef0$Dcef
26     Gef0 <- gef0$Gef
27     Dief0 <- gef0$Dief
28     Ref0 <- gef0$Ref
29     ## calculation
30     Bef <- Bef0*(1-FS)
31     Dcef <- Dcef0*(1-FS)
32     Def <- Dief0+Dcef
33     Gef <- Dief0+Ref0+Bef+Dcef #Including shadows
34     ##Change names
35     nms <- c('Gef', 'Def', 'Dcef', 'Bef')
36     nmsIndex <- which(names(gef0) %in% nms)
37     names(gef0)[nmsIndex]<- paste(names(gef0)[nmsIndex], '0', sep='')
38     GefShd <- gef0
39     GefShd[, c(nms, 'FS') := .(Gef, Def, Dcef, Bef, FS)]
40
41     ## daily, monthly and yearly values

```

```

41 by <- radEf@sample
42 nms <- c('Gef0', 'Def0', 'Bef0', 'G', 'D', 'B', 'Gef', 'Def', 'Bef')
43 nmsd <- paste(nms, 'd', sep = '')
44
45 Gefdm <- GefShd[, lapply(.SD/1000, P2E, by),
46                      by = .(month(truncDay(Dates)), year(truncDay(Dates))),
47                      .SDcols = nms]
48 names(Gefdm)[-c(1, 2)] <- nmsd
49
50 if(radEf@type == 'prom'){
51   GefD <- Gefdm[, .SD[, -c(1, 2)] * 1000,
52                 .SDcols = nmsd,
53                 by = .(Dates = indexD(radEf))]
54
55   Gefdm[, DayOfMonth := DOM(Gefdm)]
56
57   Gefy <- Gefdm[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
58                 .SDcols = nmsd,
59                 by = .(Dates = year)]
60   Gefdm[, DayOfMonth := NULL]
61 } else{
62   GefD <- GefShd[, lapply(.SD/1000, P2E, by),
63                 .SDcols = nms,
64                 by = .(Dates = truncDay(Dates))]
65   names(GefD)[-1] <- nmsd
66
67   Gefy <- GefD[, lapply(.SD[, -1], sum, na.rm = TRUE),
68                 .SDcols = nmsd,
69                 by = .(Dates = year(Dates))]
70 }
71
72 Gefdm[, Dates := paste(month.abb[month], year, sep = '. ')]
73 Gefdm[, c('month', 'year') := NULL]
74 setcolorder(Gefdm, c('Dates', names(Gefdm)[-length(Gefdm)]))
75
76 ## Object of class Gef
77 ## modifying the 'modeShd', 'GefI', 'GefD', 'Gefdm', and 'Gefy' slots
78 ## from the original radEf object
79 radEf@modeShd=modeShd
80 radEf@GefI=GefShd
81 radEf@GefD=GefD
82 radEf@Gefdm=Gefdm
83 radEf@Gefy=Gefy
84 return(radEf)
85 }

```

optimShd

```

1 optimShd<-function(lat,
2                     modeTrk='fixed',
3                     modeRad='prom',
4                     dataRad,
5                     sample='hour',
6                     keep.night=TRUE,
7                     sunGeometry='michalsky',

```

```

8         betaLim=90, beta=abs(lat)-10, alfa=0,
9         iS=2, alb=0.2, HCPV=FALSE,
10        module=list(),
11        generator=list(),
12        inverter=list(),
13        effSys=list(),
14        modeShd='',
15        struct=list(),
16        distances=data.table(),
17        res=2,      #resolution, distance spacing
18        prog=TRUE){ #Drawing progress bar
19
20    if (('bt' %in% modeShd) & (modeTrk!='horiz')) {
21        modeShd[which(modeShd=='bt')]='area'
22        warning('backtracking is only implemented for modeTrk=horiz')}
23
24    ##I save function arguments for later use
25
26    listArgs<-list(lat=lat, modeTrk=modeTrk, modeRad=modeRad,
27                  dataRad=dataRad,
28                  sample=sample, keep.night=keep.night,
29                  sunGeometry=sunGeometry,
30                  betaLim=betaLim, beta=beta, alfa=alfa,
31                  iS=iS, alb=alb, HCPV=HCPV,
32                  module=module, generator=generator,
33                  inverter=inverter, effSys=effSys,
34                  modeShd=modeShd, struct=struct,
35                  distances=data.table(Lew=NA, Lns=NA, D=NA))
36
37
38    ##I think network on which I will do the calculations
39    Red=switch(modeTrk,
40              horiz=with(distances,
41                          data.table(Lew=seq(Lew[1],Lew[2],by=res),
42                                      H=0)),
43              two=with(distances,
44                        data.table(
45                          expand.grid(Lew=seq(Lew[1],Lew[2],by=res),
46                                      Lns=seq(Lns[1],Lns[2],by=res),
47                                      H=0))),
48              fixed=with(distances,
49                          data.table(D=seq(D[1],D[2],by=res),
50                                      H=0))
51    )
52
53    casos<-dim(Red)[1] #Number of possibilities to study
54
55    ##I prepare the progress bar
56    if (prog) {pb <- txtProgressBar(min = 0, max = casos+1, style = 3)
57              setTxtProgressBar(pb, 0)}
58
59    ###Calculations
60    ##Reference: No shadows
61    listArgs0 <- modifyList(listArgs,
62                           list(modeShd='', struct=NULL, distances=NULL) )
63    Prod0<-do.call(prodGCPV, listArgs0)

```



```

64 YfAnual0=mean(Prod0@prody$Yf) #I use mean in case there are several years
65 if (prog) {setTxtProgressBar(pb, 1)}
66
67 ##The loop begins
68
69 ##I create an empty vector of the same length as the cases to be studied
70 YfAnual<-numeric(casos)
71
72 BT=('bt' %in% modeShd)
73 if (BT) { ##There is backtracking, then I must start from horizontal
radiation.
74   RadBT <- as(Prod0, 'G0')
75   for (i in seq_len(casos)){
76     listArgsBT <- modifyList(listArgs,
77                             list(modeRad='prev', dataRad=RadBT,
78                                 distances=Red[i,]))
79     prod.i <- do.call(prodGCPV, listArgsBT)
80     YfAnual[i]=mean(prod.i@prody$Yf)
81     if (prog) {setTxtProgressBar(pb, i+1)}
82   }
83 } else {
84   prom=('prom' %in% modeShd)
85   for (i in seq_len(casos)){
86     Gef0=as(Prod0, 'Gef')
87     GefShd=calcShd(Gef0, modeTrk=modeTrk, modeShd=modeShd,
88                   struct=struct, distances=Red[i,])
89     listArgsShd <- modifyList(listArgs,
90                              list(modeRad='prev', dataRad=GefShd)
91                              )
92     prod.i <- do.call(prodGCPV, listArgsShd)
93     YfAnual[i]=mean(prod.i@prody$Yf)
94     if (prog) {setTxtProgressBar(pb, i+1)}
95   }
96 }
97 if (prog) {close(pb)}
98
99
100 ###Results
101 FS=1-YfAnual/YfAnual0
102 GRR=switch(modeTrk,
103           two=with(Red,Lew*Lns)/with(struct,L*W),
104           fixed=Red$D/struct$L,
105           horiz=Red$Lew/struct$L)
106 SombraDF=data.table(Red,GRR,FS,Yf=YfAnual)
107 FS.loess=switch(modeTrk,
108               two=loess(FS~Lew*Lns,data=SombraDF),
109               horiz=loess(FS~Lew,data=SombraDF),
110               fixed=loess(FS~D,data=SombraDF))
111 Yf.loess=switch(modeTrk,
112               two=loess(Yf~Lew*Lns,data=SombraDF),
113               horiz=loess(Yf~Lew,data=SombraDF),
114               fixed=loess(Yf~D,data=SombraDF))
115 result <- new('Shade',
116             Prod0, ##contains ProdGCPV
117             FS=FS,
118             GRR=GRR,

```

```

119         Yf=YfAnual,
120         FS.loess=FS.loess,
121         Yf.loess=Yf.loess,
122         modeShd=modeShd,
123         struct=struct,
124         distances=Red,
125         res=res
126     )
127     result
128 }

```

meteoReaders

```

1  ##### monthly means of irradiation #####
2  readG0dm <- function(G0dm, Ta = 25, lat = 0,
3                      year = as.POSIXlt(Sys.Date())$year + 1900,
4                      promDays = c(17, 14, 15, 15, 15, 10, 18, 18, 18, 19, 18, 13)
5                      ,
6                      source = '')
7  {
8      if(missing(lat)){lat <- 0}
9      Dates <- as.IDate(paste(year, 1:12, promDays, sep = '-'), tz = 'UTC')
10     G0dm.dt <- data.table(Dates = Dates,
11                          G0d = G0dm,
12                          Ta = Ta)
13     setkey(G0dm.dt, 'Dates')
14     results <- new(Class = 'Meteo',
15                   latm = lat,
16                   data = G0dm.dt,
17                   type = 'prom',
18                   source = source)
19 }
20 ##### file to Meteo (daily) #####
21 readBDd <- function(file, lat,
22                     format = "%d/%m/%Y", header = TRUE,
23                     fill = TRUE, dec = '.', sep = ';',
24                     dates.col = 'Dates', ta.col = 'Ta',
25                     g0.col = 'G0', keep.cols = FALSE)
26 {
27     #stops if the arguments are not characters or numerics
28     stopifnot(is.character(dates.col) || is.numeric(dates.col))
29     stopifnot(is.character(ta.col) || is.numeric(ta.col))
30     stopifnot(is.character(g0.col) || is.numeric(g0.col))
31
32     #read from file and set it in a data.table
33     bd <- fread(file, header = header, fill = fill, dec = dec, sep = sep)
34
35     #check the columns
36     if(!(dates.col %in% names(bd))) stop(paste('The column', dates.col, 'is not
37     in the file'))
38     if(!(g0.col %in% names(bd))) stop(paste('The column', g0.col, 'is not in the
39     file'))
40     if(!(ta.col %in% names(bd))) stop(paste('The column', ta.col, 'is not in the
41     file'))

```

```

39
40   #name the dates column by Dates
41   Dates <- bd[[dates.col]]
42   bd[, (dates.col) := NULL]
43   bd[, Dates := as.IDate(Dates, format = format)]
44
45   #name the g0 column by G0
46   G0 <- bd[[g0.col]]
47   bd[, (g0.col) := NULL]
48   bd[, G0 := as.numeric(G0)]
49
50   #name the ta column by Ta
51   Ta <- bd[[ta.col]]
52   bd[, (ta.col) := NULL]
53   bd[, Ta := as.numeric(Ta)]
54
55   names0 <- NULL
56   if(all(c('D0', 'B0') %in% names(bd))){
57     names0 <- c(names0, 'D0', 'B0')
58   }
59
60   names0 <- c(names0, 'Ta')
61
62   if(all(c('TempMin', 'TempMax') %in% names(bd))){
63     names0 <- c(names0, 'TempMin', 'TempMax')
64   }
65   if(keep.cols)
66   {
67     #keep the rest of the columns but reorder the columns
68     setcolorder(bd, c('Dates', 'G0', names0))
69   }
70   else
71   {
72     #erase the rest of the columns
73     cols <- c('Dates', 'G0', names0)
74     bd <- bd[, ..cols]
75   }
76
77   setkey(bd, 'Dates')
78   result <- new(Class = 'Meteo',
79                 latm = lat,
80                 data = bd,
81                 type = 'bd',
82                 source = file)
83 }
84
85 ##### file to Meteo (intradaily) #####
86 readBDi <- function(file, lat,
87                     format = "%d/%m/%Y %H:%M:%S",
88                     header = TRUE, fill = TRUE, dec = '.',
89                     sep = ';', dates.col = 'dates', times.col,
90                     ta.col = 'Ta', g0.col = 'G0', keep.cols = FALSE)
91 {
92   #stops if the arguments are not characters or numerics
93   stopifnot(is.character(dates.col) || is.numeric(dates.col))
94   stopifnot(is.character(ta.col) || is.numeric(ta.col))

```

```

95 stopifnot(is.character(g0.col) || is.numeric(g0.col))
96
97 #read from file and set it in a data.table
98 bd <- fread(file, header = header, fill = fill, dec = dec, sep = sep)
99
100 #check the columns
101 if(!(dates.col %in% names(bd))) stop(paste('The column', dates.col, 'is not
in the file'))
102 if(!(g0.col %in% names(bd))) stop(paste('The column', g0.col, 'is not in the
file'))
103 if(!(ta.col %in% names(bd))) stop(paste('The column', ta.col, 'is not in the
file'))
104
105 if(!missing(times.col)){
106   stopifnot(is.character(times.col) || is.numeric(times.col))
107   if(!(times.col %in% names(bd))) stop(paste('The column', times.col, 'is
not in the file'))
108
109   #name the dates column by Dates
110   format <- strsplit(format, ' ')
111   dd <- as.IDate(bd[[dates.col]], format = format[[1]][1])
112   tt <- as.ITime(bd[[times.col]], format = format[[1]][2])
113   bd[, (dates.col) := NULL]
114   bd[, (times.col) := NULL]
115   bd[, Dates := as.POSIXct(dd, tt, tz = 'UTC')]
116 }
117
118 else
119 {
120   dd <- as.POSIXct(bd[[dates.col]], format = format, tz = 'UTC')
121   bd[, (dates.col) := NULL]
122   bd[, Dates := dd]
123 }
124
125 #name the g0 column by G0
126 G0 <- bd[[g0.col]]
127 bd[, (g0.col) := NULL]
128 bd[, G0 := as.numeric(G0)]
129
130 #name the ta column by Ta
131 Ta <- bd[[ta.col]]
132 bd[, (ta.col) := NULL]
133 bd[, Ta := as.numeric(Ta)]
134
135 names0 <- NULL
136 if(all(c('D0', 'B0') %in% names(bd))){
137   names0 <- c(names0, 'D0', 'B0')
138 }
139
140 names0 <- c(names0, 'Ta')
141
142 if(keep.cols)
143 {
144   #keep the rest of the columns but reorder the columns
145   setcolorder(bd, c('Dates', 'G0', names0))
146 }

```

```

147 else
148 {
149     #erase the rest of the columns
150     cols <- c('Dates', 'G0', names0)
151     bd <- bd[, ..cols]
152 }
153
154 setkey(bd, 'Dates')
155 result <- new(Class = 'Meteo',
156               latm = lat,
157               data = bd,
158               type = 'bdI',
159               source = file)
160 }
161
162
163 dt2Meteo <- function(file, lat, source = '', type){
164     ## Make sure its a data.table
165     bd <- data.table(file)
166
167     ## Dates is an as.POSIX element
168     bd[, Dates := as.POSIXct(Dates, tz = 'UTC')]
169
170     ## type
171     if(missing(type)){
172         sample <- median(diff(file$Dates))
173         IsDaily <- as.numeric(sample, units = 'days')
174         if(is.na(IsDaily)) IsDaily <- ifelse('G0d' %in% names(bd),
175                                           1, 0)
176         if(IsDaily >= 30) type <- 'prom'
177         else{
178             type <- ifelse(IsDaily >= 1, 'bd', 'bdI')
179         }
180     }
181
182     if(!('Ta' %in% names(bd))){
183         if(all(c('Tempmin', 'TempMax') %in% names(bd))){
184             bd[, Ta := mean(c(Tempmin, TempMax))]
185         } else bd[, Ta := 25]
186     }
187
188     ## Columns of the data.table
189     nms0 <- switch(type,
190                   bd = ,
191                   prom = {
192                       nms0 <- 'G0d'
193                       if(all(c('D0d', 'B0d') %in% names(bd))){
194                           nms0 <- c(nms0, 'D0d', 'B0d')
195                       }
196                       nms0 <- c(nms0, 'Ta')
197                       if(all(c('TempMin', 'TempMax') %in% names(bd))){
198                           nms0 <- c(nms0, 'TempMin', 'TempMax')
199                       }
200                   },
201                   bdI = {

```

```

203         nms0 <- 'G0'
204         if(all(c('D0', 'B0') %in% names(bd))){
205             nms0 <- c(nms0, 'D0', 'B0')
206         }
207         if('Ta' %in% names(bd)){
208             nms0 <- c(nms0, 'Ta')
209         }
210         nms0
211     })
212     ## Columns order and set key
213     setcolorder(bd, c('Dates', nms0))
214     setkey(bd, 'Dates')
215     ## Result
216     result <- new(Class = 'Meteo',
217                   latm = lat,
218                   data = bd,
219                   type = type,
220                   source = source)
221 }
222
223 ##### Liu and Jordan, Collares-Pereira and Rabl proposals #####
224 collper <- function(sol, compD)
225 {
226     ind.rep <- cumsum(c(1, as.Date(indexI(sol)) != 0))
227     solI <- as.data.tableI(sol, complete = T)
228     ws <- solI$ws
229     w <- solI$w
230
231     a <- 0.409-0.5016*sin(ws+pi/3)
232     b <- 0.6609+0.4767*sin(ws+pi/3)
233
234     rd <- solI[, Bo0/Bo0d]
235     rg <- rd * (a + b * cos(w))
236
237     # Daily irradiation components
238     G0d <- compD$G0d[ind.rep]
239     B0d <- compD$B0d[ind.rep]
240     D0d <- compD$D0d[ind.rep]
241
242     # Daily profile
243     G0 <- G0d * rg
244     D0 <- D0d * rd
245
246     # This method may produce diffuse irradiance higher than
247     # global irradiance
248     G0 <- pmax(G0, D0, na.rm = TRUE)
249     B0 <- G0 - D0
250
251     # Negative values are set to NA
252     neg <- (B0 < 0) | (D0 < 0) | (G0 < 0)
253     is.na(G0) <- neg
254     is.na(B0) <- neg
255     is.na(D0) <- neg
256
257     # Daily profiles are scaled to keep daily irradiation values
258     day <- truncDay(indexI(sol))

```

```

259     sample <- sol@sample
260
261     G0dCP <- ave(G0, day, FUN=function(x) P2E(x, sample))
262     B0dCP <- ave(B0, day, FUN=function(x) P2E(x, sample))
263     D0dCP <- ave(D0, day, FUN=function(x) P2E(x, sample))
264
265     G0 <- G0 * G0d/G0dCP
266     B0 <- B0 * B0d/B0dCP
267     D0 <- D0 * D0d/D0dCP
268
269     res <- data.table(G0, B0, D0)
270     return(res)
271 }
272
273
274 ##### intradaily Meteo to daily Meteo #####
275 MeteoI2MeteoD <- function(G0i)
276 {
277     lat <- G0i@latm
278     source <- G0i@source
279
280     dt0 <- getData(G0i)
281     dt <- dt0[, lapply(.SD, sum),
282                 .SDcols = names(dt0)[!names(dt0) %in% c('Dates', 'Ta')],
283                 by = .(Dates = as.IDate(Dates))]
284     if('Ta' %in% names(dt0)){
285         Ta <- dt0[, .(Ta = mean(Ta),
286                        TempMin = min(Ta),
287                        TempMax = max(Ta)),
288                    by = .(Dates = as.IDate(Dates))]
289         if(all(Ta$Ta == c(Ta$TempMin, Ta$TempMax))) Ta[, c('TempMin', 'TempMax')
290 := NULL]
291         dt <- merge(dt, Ta)
292     }
293     if('G0' %in% names(dt)){
294         names(dt)[names(dt) == 'G0'] <- 'G0d'
295     }
296     if('D0' %in% names(dt)){
297         names(dt)[names(dt) == 'D0'] <- 'D0d'
298     }
299     if('B0' %in% names(dt)){
300         names(dt)[names(dt) == 'B0'] <- 'B0d'
301     }
302     G0d <- dt2Meteo(dt, lat, source, type = 'bd')
303     return(G0d)
304 }
305
306 ##### daily Meteo to monthly Meteo #####
307 Meteod2Meteom <- function(G0d)
308 {
309     lat <- G0d@latm
310     source <- G0d@source
311
312     dt <- getData(G0d)
313     nms <- names(dt)[-1]
314     dt <- dt[, lapply(.SD, mean),

```

```

314         .SDcols = nms,
315         by = .(month(Dates), year(Dates))]
316     dt[, Dates := fBTd()]
317     dt <- dt[, c('month', 'year') := NULL]
318
319     setcolorder(dt, 'Dates')
320
321     G0m <- dt2Meteo(dt, lat, source, type = 'prom')
322     return(G0m)
323 }
324
325 zoo2Meteo <- function(file, lat, source = '')
326 {
327     sample <- median(diff(index(file)))
328     IsDaily <- as.numeric(sample, units = 'days')>=1
329     type <- ifelse(IsDaily, 'bd', 'bdI')
330     result <- new(Class = 'Meteo',
331                   latm = lat,
332                   data = file,
333                   type = type,
334                   source = source)
335 }
336
337 siarGET <- function(id, inicio, final, tipo = 'Mensuales', ambito = 'Estacion'){
338     if(!(tipo %in% c('Horarios', 'Diarios', 'Semanales', 'Mensuales'))){
339         stop('argument \'tipo\' must be: Horarios, Diarios, Semanales or
340 Mensuales')
341     }
342     if(!(ambito %in% c('CCAA', 'Provincia', 'Estacion'))){
343         stop('argument \'ambito\' must be: CCAA, Provincia or Estacion')
344     }
345
346     mainURL <- "https://servicio.mapama.gob.es"
347
348     path <- paste('/apisiar/API/v1/Datos', tipo, ambito, sep = '/')
349
350     ## prepare the APIsiar
351     req <- request(mainURL) |>
352         req_url_path(path) |>
353         req_url_query(Id = id,
354                       FechaInicial = inicio,
355                       FechaFinal = final,
356                       ClaveAPI = '_Q8L_niYFBBmBs-
357 vB3UomUqdUYy98FTRX1aYbrZ8n2FXuHYGTV')
358     ## execute it
359     resp <- req_perform(req)
360
361     ##JSON to R
362     respJSON <- resp_body_json(resp, simplifyVector = TRUE)
363
364     if(!is.null(respJSON$MensajeRespuesta)){
365         stop(respJSON$MensajeRespuesta)
366     }
367
368     res0 <- data.table(respJSON$Datos)

```



```

368   res <- switch(tipo,
369                 Horarios = {
370                     res0[, HoraMin := as.ITime(sprintf('%04d', HoraMin),
371                                                       format = '%H%M')]
372                     res0[, Fecha := as.IDate(Fecha, format = '%Y-%m-%d')]
373                     res0[, Fecha := as.IDate(ifelse(HoraMin == as.ITime(0),
374                                                       Fecha+1, Fecha))]
375                     res0[, Dates := as.POSIXct(HoraMin, Fecha,
376                                                       tz = 'Europe/Madrid')]
377                     res0 <- res0[, .(Dates,
378                                     GO = Radiacion,
379                                     Ta = TempMedia)]
380                     return(res0)
381                 },
382                 Diarios = {
383                     res0[, Dates := as.IDate(Fecha)]
384                     res0 <- res0[, .(Dates,
385                                     GOd = Radiacion * 277.78,
386                                     Ta = TempMedia,
387                                     TempMin,
388                                     TempMax)]
389                     return(res0)
390                 },
391                 Semanales = res0,
392                 Mensuales = {
393                     promDays<-c(17,14,15,15,15,10,18,18,18,19,18,13)
394                     names(res0)[1] <- 'Year'
395                     res0[, Dates := as.IDate(paste(Year, Mes,
396                                                       promDays[Mes],
397                                                       sep = '-'))]
398                     res0 <- res0[, .(Dates,
399                                     GOd = Radiacion * 277.78,
400                                     Ta = TempMedia,
401                                     TempMin,
402                                     TempMax)]
403                 })
404
405   return(res)
406 }
407
408 haversine <- function(lat1, lon1, lat2, lon2) {
409   R <- 6371 # Radius of the Earth in kilometers
410   dLat <- (lat2 - lat1) * pi / 180
411   dLon <- (lon2 - lon1) * pi / 180
412   a <- sin(dLat / 2) * sin(dLat / 2) + cos(lat1 * pi / 180) *
413       cos(lat2 * pi / 180) * sin(dLon / 2) * sin(dLon / 2)
414   c <- 2 * atan2(sqrt(a), sqrt(1 - a))
415   d <- R * c
416   return(d)
417 }
418
419 readSIAR <- function(Lon = 0, Lat = 0,
420                     inicio = paste(year(Sys.Date())-1, '01-01', sep = '-'),
421                     final = paste(year(Sys.Date())-1, '12-31', sep = '-'),
422                     tipo = 'Mensuales', n_est = 3){
423   inicio <- as.Date(inicio)

```

```

424 final <- as.Date(final)
425
426 n_reg <- switch(tipo,
427               Horarios = {
428                 tt <- difftime(final, inicio, units = 'days')
429                 tt <- (as.numeric(tt)+1)*48
430                 tt <- tt*n_est
431                 tt
432               },
433               Diarios = {
434                 tt <- difftime(final, inicio, units = 'days')
435                 tt <- as.numeric(tt)+1
436                 tt <- tt*n_est
437                 tt
438               },
439               Semanales = {
440                 tt <- difftime(final, inicio, units = 'weeks')
441                 tt <- as.numeric(tt)
442                 tt <- tt*n_est
443                 tt
444               },
445               Mensuales = {
446                 tt <- difftime(final, inicio, units = 'weeks')
447                 tt <- as.numeric(tt)/4.34524
448                 tt <- ceiling(tt)
449                 tt <- tt*n_est
450                 tt
451               })
452 if(n_reg > 100) stop(paste('Number of requested records (', n_reg,
453                           ') exceeds the maximum allowed (100)', sep = ''))
454 ## Obtain the nearest stations
455 siar <- est_SIAR[
456   Fecha_Instalacion <= final & (is.na(Fecha_Baja) | Fecha_Baja >= inicio)
457 ]
458
459 ## Weights for the interpolation
460 siar[, dist := haversine(Latitud, Longitud, Lat, Lon)]
461 siar <- siar[order(dist)][1:n_est]
462 siar[, peso := 1/dist]
463 siar[, peso := peso/sum(peso)]
464 ## Is the given location within the polygon formed by the stations?
465 siar <- siar[, .(Estacion,Codigo, dist, peso)]
466
467 ## List for the data.tables of siarGET
468 siar_list <- list()
469 for(codigo in siar$Codigo){
470   siar_list[[codigo]] <- siarGET(id = codigo,
471                                 inicio = as.character(inicio),
472                                 final = as.character(final),
473                                 tipo = tipo)
474   siar_list[[codigo]]$peso <- siar[Codigo == codigo, peso]
475 }
476
477 ## Bind the data.tables
478 s_comb <- rbindlist(siar_list, use.names = TRUE, fill = TRUE)
479

```

```

480 nms <- names(s_comb)
481 nms <- nms[-c(1, length(nms))]
482
483 ## Interpole
484 res <- s_comb[, lapply(.SD * peso, sum, na.rm = TRUE),
485                  .SDcols = nms,
486                  by = Dates]
487
488 ## Source
489 mainURL <- "https://servicio.mapama.gob.es"
490 Estaciones <- siar[, paste(Estacion, '(',Codigo, ')', sep = '')]
491 Estaciones <- paste(Estaciones, collapse = ', ')
492 source <- paste(mainURL, '\n -Estaciones:', Estaciones, sep = ' ')
493
494 res <- switch(tipo,
495              Horarios = {dt2Meteo(res, lat = Lat, source = mainURL, type = '
496              bdI')},
497              Diarios = {dt2Meteo(res, lat = Lat, source = mainURL, type = '
498              bd')},
499              Semanales = {res},
500              Mensuales = {dt2Meteo(res, lat = Lat, source = source, type = '
              prom')})
              return(res)
}

```

A.2. Clases

Sol

```

1 setClass(
2   Class='Sol', ##Solar angles
3   slots = c(
4     lat='numeric',#latitud in degrees, >0 if North
5     solD='data.table',#daily angles
6     solI='data.table',#intradaily angles
7     sample='character',#sample of time
8     method='character'#method used for geometry calculations
9   ),
10  validity=function(object) {return(TRUE)}
11 )

```

Meteo

```

1 setClass(
2   Class = 'Meteo', ##radiation and temperature data
3   slots = c(
4     latm='numeric',#latitud in degrees, >0 if North
5     data='data.table',#data, including G (Wh/m2) and Ta (°C)
6     type='character',#choose between 'prom', 'bd' and 'bdI'
7     source='character'#origin of the data
8   ),
9   validity=function(object) {return(TRUE)}
10 )

```

G0

```

1 setClass(
2   Class = 'G0',
3   slots = c(
4     GOD = 'data.table', #result of fCompD
5     G0dm = 'data.table', #monthly means
6     G0y = 'data.table', #yearly values
7     G0I = 'data.table', #result of fCompI
8     Ta = 'data.table'   #Ambient temperature
9   ),
10  contains = c('Sol', 'Meteo'),
11  validity = function(object) {return(TRUE)}
12 )
13

```

Gef

```

1 setClass(
2   Class='Gef',
3   slots = c(
4     GefD='data.table', #daily values
5     Gefdm='data.table', #monthly means
6     Gefy='data.table', #yearly values
7     GefI='data.table', #result of fInclin
8     Theta='data.table', #result of fTheta
9     iS='numeric',      #dirt index
10    alb='numeric',      #albedo
11    modeTrk='character', #tracking mode
12    modeShd='character', #shadow mode
13    angGen='list',       #includes alpha, beta and betaLim
14    struct='list',       #structure dimensions
15    distances='data.frame' #distances between structures
16  ),
17  contains='G0',
18  validity=function(object) {return(TRUE)}
19 )

```

ProdGCPV

```

1 setClass(
2   Class='ProdGCPV',
3   slots = c(
4     prodD='data.table', #daily values
5     prodDm='data.table', #monthly means
6     prody='data.table', #yearly values
7     prodI='data.table', #results of fProd
8     module='list',      #module characteristics
9     generator='list',    #generator characteristics
10    inverter='list',      #inverter characteristics
11    effSys='list'         #efficiency values of the system
12  ),
13  contains='Gef',
14  validity=function(object) {return(TRUE)}

```

```
15 )
```

ProdPVPS

```
1 setClass(
2   Class='ProdPVPS',
3   slots = c(
4     prodD='data.table', #daily values
5     prodDm='data.table', #monthly means
6     prody='data.table', #yearly values
7     prodI='data.table', #results of fPump
8     Pg='numeric',       #generator power
9     H='numeric',        #manometric head
10    pump='list',         #parameters of the pump
11    converter='list',    #inverter characteristics
12    effSys='list'        #efficiency values of the system
13  ),
14  contains='Gef',
15  validity=function(object) {return(TRUE)}
16 )
```

Shade

```
1 setClass(
2   Class='Shade',
3   slots = c(
4     FS='numeric', #shadows factor values
5     GRR='numeric', #Ground Requirement Ratio
6     Yf='numeric', #final productivity
7     FS.loess='loess', #local fitting of FS with loess
8     Yf.loess='loess', #local fitting of Yf with loess
9     modeShd='character', #mode of shadow
10    struct='list',        #dimensions of the structures
11    distances='data.frame', #distances between structures
12    res='numeric'         #difference between the different steps of the
13    calculations
14  ),
15  contains='ProdGCPV', ##Resultado de prodGCPV sin sombras (Prod0)
16  validity=function(object) {return(TRUE)}
17 )
```

A.3. Funciones

corrFdKt

```
1 ##### monthly Kt #####
2 Ktm <- function(sol, GOdm){
3   solf <- sol@solD[, .(Dates, Bo0d)]
4   solf[, c('month', 'year') := .(month(Dates), year(Dates))]
5   solf[, Bo0m := mean(Bo0d), by = .(month, year)]
6   GOdf <- GOdm@data[, .(Dates, GOd)]
7   GOdf[, c('month', 'year') := .(month(Dates), year(Dates))]
```

```

8   G0df[, G0d := mean(G0d), by = .(month, year)]
9   Ktm <- G0df$G0d/sol$Bo0m
10  return(Ktm)
11 }
12
13 ##### daily Kt #####
14 Ktd <- function(sol, G0d){
15   Bo0d <- sol@solD$Bo0d
16   G0d <- getG0(G0d)
17   Ktd <- G0d/Bo0d
18   return(Ktd)
19 }
20
21 ### intradaily
22 Kti <- function(sol, G0i){
23   Bo0 <- sol@solI$Bo0
24   G0i <- getG0(G0i)
25   Kti <- G0i/Bo0
26   return(Kti)
27 }
28
29
30 ##### monthly correlations #####
31
32 ### Page ###
33 FdKtPage <- function(sol, G0dm){
34   Kt <- Ktm(sol, G0dm)
35   Fd=1-1.13*Kt
36   return(data.table(Fd, Kt))
37 }
38
39 ### Liu and Jordan ###
40 FdKtLJ <- function(sol, G0dm){
41   Kt <- Ktm(sol, G0dm)
42   Fd=(Kt<0.3)*0.595774 +
43     (Kt>=0.3 & Kt<=0.7)*(1.39-4.027*Kt+5.531*Kt^2-3.108*Kt^3)+
44     (Kt>0.7)*0.215246
45   return(data.table(Fd, Kt))
46 }
47
48
49 ##### daily correlations #####
50
51 ### Collares-Pereira and Rabl
52 FdKtCPR <- function(sol, G0d){
53   Kt <- Ktd(sol, G0d)
54   Fd=(0.99*(Kt<=0.17))+(Kt>0.17 & Kt<0.8)*
55     (1.188-2.272*Kt+9.473*Kt^2-21.856*Kt^3+14.648*Kt^4)+
56     (Kt>=0.8)*0.2426688
57   return(data.table(Fd, Kt))
58 }
59
60 ### Erbs, Klein and Duffie ###
61 FdKtEKDd <- function(sol, G0d){
62   ws <- sol@solD$ws
63   Kt <- Ktd(sol, G0d)

```

```

64     WS1=(abs(ws)<1.4208)
65     Fd=WS1*((Kt<0.715)*(1-0.2727*Kt+2.4495*Kt^2-11.9514*Kt^3+9.3879*Kt^4)+
66         (Kt>=0.715)*(0.143))+
67         !WS1*((Kt<0.722)*(1+0.2832*Kt-2.5557*Kt^2+0.8448*Kt^3)+
68         (Kt>=0.722)*(0.175))
69     return(data.table(Fd, Kt))
70 }
71 }
72
73 ### CLIMED1 ###
74 FdKtCLIMEDd <- function(sol, G0d){
75     Kt <- Ktd(sol, G0d)
76     Fd=(Kt<=0.13)*(0.952)+
77     (Kt>0.13 & Kt<=0.8)*(0.868+1.335*Kt-5.782*Kt^2+3.721*Kt^3)+
78     (Kt>0.8)*0.141
79     return(data.table(Fd, Kt))
80 }
81
82 ##### intradaily correlations #####
83
84 ### intradaily EKD ###
85 FdKtEKDh <- function(sol, G0i){
86     Kt <- Kti(sol, G0i)
87     Fd=(Kt<=0.22)*(1-0.09*Kt)+
88     (Kt>0.22 & Kt<=0.8)*(0.9511-0.1604*Kt+4.388*Kt^2-16.638*Kt^3+12.336*Kt^4)+
89     (Kt>0.8)*0.165
90     return(data.table(Fd, Kt))
91 }
92
93 ### intradaily CLIMED
94 FdKtCLIMEDh <- function(sol, G0i){
95     Kt <- Kti(sol, G0i)
96     Fd=(Kt<=0.21)*(0.995-0.081*Kt)+
97     (Kt>0.21 & Kt<=0.76)*(0.724+2.738*Kt-8.32*Kt^2+4.967*Kt^3)+
98     (Kt>0.76)*0.180
99     return(data.table(Fd, Kt))
100 }
101
102 ### intradaily Boland, Ridley and Lauret ###
103 FdKtBRL <- function(sol, G0i){
104     Kt <- Kti(sol, G0i)
105     sample <- sol@sample
106
107     solI <- as.data.tableI(sol, complete = TRUE)
108     w <- solI$w
109     night <- solI$night
110     AlS <- solI$AlS
111
112     G0d <- MeteoI2Meteod(G0i)
113     ktd <- Ktd(sol, G0d)
114
115     ##persistence
116     pers <- persistence(sol, ktd)
117
118     ##indexRep for ktd and pers
119     ind.rep <- cumsum(c(1, as.Date(indexI(sol)) != 0))

```

```

120   ktd <- ktd[ind.rep]
121   pers <- pers[ind.rep]
122
123   ##fd calculation
124   Fd=(1+exp(-5.38+6.63*Kt+0.006*r2h(w)-0.007*r2d(Als)+1.75*ktd+1.31*pers))^-1)
125
126   return(data.table(Fd, Kt))
127 }
128
129 persistence <- function(sol, Ktd){
130   kt <- data.table(indexD(sol), Ktd)
131   ktNA <- na.omit(kt)
132   iDay <- truncDay(ktNA[[1]])
133
134   x <- rle(as.numeric(iDay))$lengths
135   xLast <- cumsum(x)
136
137   lag1 <- shift(ktNA$Ktd, -1, fill = NA)
138   for (i in xLast){
139     if ((i-1) != 0){lag1[i] <- ktNA$Ktd[i-1]}
140   }
141
142   lag2 <- shift(ktNA$Ktd, 1, fill = NA)
143   for (i in xLast){
144     if ((i+1) <= length(ktNA$Ktd)){lag2[i] <- ktNA$Ktd[i+1]}
145   }
146   pers <- data.table(lag1, lag2)
147   pers[, mean := 1/2 * (lag1+lag2)]
148   pers[, mean]
149 }

```

fBTd

```

1 fBTd<-function(mode='prom',
2   year= as.POSIXlt(Sys.Date())$year+1900,
3   start=paste('01-01-',year,sep=''),
4   end=paste('31-12-',year,sep=''),
5   format='%d-%m-%Y'){
6   promDays<-c(17,14,15,15,15,10,18,18,18,19,18,13)
7   BTd=switch(mode,
8     serie={
9       start.<-as.POSIXct(start, format=format, tz='UTC')
10      end.<-as.POSIXct(end, format=format, tz='UTC')
11      res<-seq(start., end., by="1 day")
12    },
13    prom=as.POSIXct(paste(year, 1:12, promDays, sep='-'), tz='UTC')
14    )
15   BTd
16 }

```

fBTi

```

1 intervalo <- function(day, sample){

```



```

2   intervalo <- seq.POSIXt(from = as.POSIXct(paste(day, '00:00:00'), tz = 'UTC')
3   ,
4   to = as.POSIXct(paste(day, '23:59:59'), tz = 'UTC'),
5   by = sample)
6   return(intervalo)
7 }
8 fBTi <- function(d, sample = 'hour'){
9   BTi <- lapply(d, intervalo, sample)
10  BTi <- do.call(c, BTi)
11  return(BTi)
12 }

```

fCompD

```

1 fCompD <- function(sol, G0d, corr = 'CPR', f)
2 {
3   if(!(corr %in% c('CPR', 'Page', 'LJ', 'EKDd', 'CLIMEDd', 'user', 'none'))){
4     warning('Wrong descriptor of correlation Fd-Ktd. Set CPR.')
5     corr <- 'CPR'
6   }
7   if(class(sol)[1] != 'Sol'){
8     sol <- sol[, calcSol(lat = unique(lat), BTi = Dates)]
9   }
10  if(class(G0d)[1] != 'Meteo'){
11    dt <- copy(data.table(G0d))
12    if(!('Dates' %in% names(dt))){
13      dt[, Dates := indexD(sol)]
14      setcolorder(dt, 'Dates')
15      setkey(dt, 'Dates')
16    }
17    if('lat' %in% names(dt)){
18      latg <- unique(dt$lat)
19      dt[, lat := NULL]
20    }else{latg <- getLat(sol)}
21    G0d <- dt2Meteo(dt, latg)
22  }
23
24  stopifnot(indexD(sol) == indexD(G0d))
25  Bo0d <- sol@solD$Bo0d
26  G0 <- getData(G0d)$G0
27
28  is.na(G0) <- (G0>Bo0d)
29
30  ### the Direct and Difuse data is not given
31  if(corr != 'none'){
32    Fd <- switch(corr,
33      CPR = FdKtCPR(sol, G0d),
34      Page = FdKtPage(sol, G0d),
35      LJ = FdKtLJ(sol, G0d),
36      CLIMEDd = FdKtCLIMEDd(sol, G0d),
37      user = f(sol, G0d))
38    Kt <- Fd$Kt
39    Fd <- Fd$Fd
40    D0d <- Fd * G0

```

```

41     B0d <- G0 - D0d
42   }
43   ### the Direct and Difuse data is given
44   else {
45     G0 <- getData(G0d)$G0
46     D0d <- getData(G0d)[['D0']]
47     B0d <- getData(G0d)[['B0']]
48     Fd <- D0d/G0
49     Kt <- G0/Bo0d
50   }
51
52   result <- data.table(Dates = indexD(sol), Fd, Kt, G0d = G0, D0d, B0d)
53   setkey(result, 'Dates')
54   result
55 }

```

fCompI

```

1 fCompI <- function(sol, compD, GOI,
2                       corr = 'EKDh', f,
3                       filterGO = TRUE){
4   if(!(corr %in% c('EKDh', 'CLIMEDh', 'BRL', 'user', 'none'))){
5     warning('Wrong descriptor of correlation Fd-Ktd. Set EKDh.')
6     corr <- 'EKDh'
7   }
8
9   if(class(sol)[1] != 'Sol'){
10     sol <- sol[, calcSol(lat = unique(lat), BTi = Dates)]
11   }
12
13   lat <- sol@lat
14   sample <- sol@sample
15   night <- sol@solI$night
16   Bo0 <- sol@solI$Bo0
17   Dates <- indexI(sol)
18
19   ## If instantaneous values are not provided, compD is used instead.
20   if (missing(GOI)) {
21
22     GOI <- collper(sol, compD)
23     G0 <- GOI$G0
24     B0 <- GOI$B0
25     D0 <- GOI$D0
26
27     Fd <- D0/G0
28     Kt <- G0/Bo0
29
30   } else { ## Use instantaneous values if provided through GOI
31
32     if(class(GOI)[1] != 'Meteo'){
33       dt <- copy(GOI)
34       if(!('Dates' %in% names(GOI))){
35         dt[, Dates := indexI(sol)]
36         setcolorder(dt, 'Dates')
37         setkey(dt, 'Dates')

```

```

38     }
39     if('lat' %in% names(GOI)){latg <- unique(GOI$lat)}
40     else{latg <- lat}
41     GOI <- dt2Meteo(dt, latg)
42 }
43
44 if (corr!='none'){
45     GO <- getGO(GOI)
46     ## Filter values: surface irradiation must be lower than
47     ## extraterrestrial;
48     if (filterGO) {is.na(GO) <- (GO > Bo0)}
49
50     ## Fd-Kt correlation
51     Fd <- switch(corr,
52                 EKDh = FdKtEKDh(sol, GOI),
53                 CLIMEDh = FdKtCLIMEDh(sol, GOI),
54                 BRL = FdKtBRL(sol, GOI),
55                 user = f(sol, GOI))
56
57     Kt <- Fd$Kt
58     Fd <- Fd$Fd
59     DO <- Fd * GO
60     BO <- GO - DO
61
62 } else {
63     GO <- getGO(GOI)
64     DO <- getData(GOI)[['DO']]
65     BO <- getData(GOI)[['BO']]
66     ## Filter values: surface irradiation must be lower than
67     ## extraterrestrial;
68     if (isTRUE(filterGO)) is.na(GO) <- is.na(DO) <- is.na(BO) <- (GO >
Bo0)
69
70     Fd <- DO/GO
71     Kt <- GO/Bo0
72 }
73 }
74 ## Values outside sunrise-sunset are set to zero
75 GO[night] <- DO[night] <- BO[night] <- Kt[night] <- Fd[night] <- 0
76
77 result <- data.table(Dates, Fd, Kt, GO, DO, BO)
78 setkey(result, 'Dates')
79 result
80 }

```

fInclin

```

1 fInclin <- function(compI, angGen, iS = 2, alb = 0.2, horizBright = TRUE, HCPV =
FALSE){
2     ##compI es class='GO'
3
4     ##Arguments
5     stopifnot(iS %in% 1:4)
6     Beta <- angGen$Beta
7     Alfa <- angGen$Alfa

```

```

8   cosTheta <- angGen$cosTheta
9
10  comp <- as.data.tableI(compI, complete=TRUE)
11  night <- comp$night
12  B0 <- comp$B0
13  Bo0 <- comp$Bo0
14  D0 <- comp$D0
15  G0 <- comp$G0
16  cosThzS <- comp$cosThzS
17  is.na(cosThzS) <- night
18
19  ##N.Martin method for dirt and non-perpendicular incidence
20  Suc <- rbind(c(1, 0.17, -0.069),
21              c(0.98,.2,-0.054),
22              c(0.97,0.21,-0.049),
23              c(0.92,0.27,-0.023))
24  FTb <- (exp(-cosTheta/Suc[iS,2]) - exp(-1/Suc[iS,2]))/(1 - exp(-1/Suc[iS,2]))
25  FTd <- exp(-1/Suc[iS,2] * (4/(3*pi) * (sin(Beta) + (pi - Beta - sin(Beta))/(1
26      + cos(Beta)))) +
27      Suc[iS,3] * (sin(Beta) + (pi - Beta - sin(Beta))/(
28      (1 + cos(Beta)))^2))
29  FTr <- exp(-1/Suc[iS,2] * (4/(3*pi) * (sin(Beta) + (Beta - sin(Beta))/(1 -
30      cos(Beta)))) +
31      Suc[iS,3] * (sin(Beta) + (Beta - sin(Beta))/(1 -
32      cos(Beta)))^2))
33
34  ##Hay and Davies method for diffuse treatment
35  B <- B0 * cosTheta/cosThzS * (cosThzS>0.007) #The factor cosThzS>0.007 is
36  needed to eliminate erroneous results near dawn
37  k1 <- B0/(Bo0)
38  Di <- D0 * (1-k1) * (1+cos(Beta))/2
39  if (horizBright) Di <- Di * (1+sqrt(B0/G0) * sin(Beta/2)^3)
40  Dc <- D0 * k1 * cosTheta/cosThzS * (cosThzS>0.007)
41  R <- alb * G0 * (1-cos(Beta))/2
42  D <- (Di + Dc)
43
44  ##Extraterrestrial irradiance on the inclined plane
45  Bo <- Bo0 * cosTheta/cosThzS * (cosThzS>0.007)
46  ##Normal direct irradiance (DNI)
47  Bn <- B0/cosThzS
48  ##Sum of components
49  G <- B + D + R
50  Ref <- R * Suc[iS,1] * (1-FTr) * (!HCPV)
51  Ref[is.nan(FTr)] <- 0 #When cos(Beta)=1, FTr=NaN. Cancel Ref.
52  Dief <- Di * Suc[iS,1] * (1 - FTd) * (!HCPV)
53  Dcef <- Dc * Suc[iS,1] * (1 - FTb) * (!HCPV)
54  Def <- Dief + Dcef
55  Bef <- B * Suc[iS,1] * (1 - FTb)
56  Gef <- Bef + Def + Ref
57
58  result <- data.table(Bo, Bn,
59                      G, D, Di, Dc, B, R,
60                      FTb, FTd, FTr,
61                      Dief, Dcef, Gef, Def, Bef, Ref)
62
63  ## Use 0 instead of NA for irradiance values
64  result[night] <- 0

```

```

59     result[, Dates := indexI(compI)]
60     result[, .SD, by = Dates]
61     setcolorder(result, c('Dates', names(result)[-length(result)]))
62     result
63 }

```

fProd

```

1  ## voc, isc, vmpp, impp : *cell* values
2  ## Voc, Isc, Vmpp, Impp: *module/generator* values
3
4  ## Compute Current - Voltage characteristic of a solar *cell* with Gef
5  ## and Ta
6  iv <- function(vocn, iscn, vmn, imn,
7                TONC, CoefVT = 2.3e-3,
8                Ta, Gef,
9                vmin = NULL, vmax = NULL)
10 {
11     ##Cell Constants
12     Gstc <- 1000
13     Ct <- (TONC - 20) / 800
14     Vtn <- 0.025 * (273 + 25) / 300
15     m <- 1.3
16
17     ##Cell temperature
18     Tc <- Ta + Ct * Gef
19     Vt <- 0.025 * (Tc + 273)/300
20
21     ## Series resistance
22     Rs <- (vocn - vmn + m * Vtn * log(1 - imn/iscn)) / imn
23
24     ## Voc and Isc at ambient conditions
25     voc <- vocn - CoefVT * (Tc - 25)
26     isc <- iscn * Gef/Gstc
27
28     ## Ruiz method for computing voltage and current characteristic of a *cell*
29     rs <- Rs * isc/voc
30     koc <- voc/(m * Vt)
31
32     ## Maximum Power Point
33     Dm0 <- (koc - 1)/(koc - log(koc))
34     Dm <- Dm0 + 2 * rs * Dm0^2
35
36     impp <- isc * (1 - Dm/koc)
37     vmpp <- voc * (1 - log(koc/Dm)/koc - rs * (1 - Dm/koc))
38
39     vdc <- vmpp
40     idc <- impp
41
42     ## When the MPP is below/above the inverter voltage limits, it
43     ## sets the voltage point at the corresponding limit.
44
45
46     ## Auxiliary functions for computing the current at a defined
47     ## voltage.

```

```

48  ilimit <- function(v, koc, rs)
49  {
50      if (is.na(koc))
51          result <- NA
52      else
53      {
54          ## The IV characteristic is an implicit equation. The starting
55          ## point is the voltage of the cell (imposed by the inverter
56          ## limit).
57
58          izero <- function(i , v, koc, rs)
59          {
60              vp <- v + i * rs
61              Is <- 1/(1 - exp(-koc * (1 - rs)))
62              result <- i - (1 - Is * (exp(-koc * (1 - vp)) - exp(-koc * (1 -
rs))))))
63          }
64
65          result <- uniroot(f = izero,
66                          interval = c(0,1),
67                          v = v,
68                          koc = koc,
69                          rs = rs)$root
70      }
71      result
72  }
73  ## Inverter minimum voltage
74  if (!is.null(vmin))
75  {
76      if (any(vmpp < vmin, na.rm = TRUE))
77      {
78          indMIN <- which(vmpp < vmin)
79          imin <- sapply(indMIN, function(i)
80          {
81              vocMIN <- voc[i]
82              kocMIN <- koc[i]
83              rsMIN <- rs[i]
84              vmin <- vmin/vocMIN
85              ##v debe estar entre 0 y 1
86              vmin[vmin < 0] <- 0
87              vmin[vmin > 1] <- 1
88              ilimit(vmin, kocMIN, rsMIN)
89          })
90          iscMIN <- isc[indMIN]
91          idc[indMIN] <- imin * iscMIN
92          vdc[indMIN] <- vmin
93          warning('Minimum MPP voltage of the inverter has been reached')}
94      }
95
96  if (!is.null(vmax))
97  {
98      if (any(vmpp > vmax, na.rm = TRUE))
99      {
100          indMAX <- which(vmpp > vmax)
101          imax <- sapply(indMAX, function(i)
102          {

```

```

1103         vocMAX <- voc[i]
1104         kocMAX <- koc[i]
1105         rsMAX <- rs[i]
1106         vmax <- vmax / vocMAX
1107         ##v debe estar entre 0 y 1
1108         vmax[vmax < 0] <- 0
1109         vmax[vmax > 1] <- 1
1110         ilimit(vmax, kocMAX, rsMAX)
1111     })
1112     iscMAX <- isc[indMAX]
1113     idc[indMAX] <- imax * iscMAX
1114     vdc[indMAX] <- vmax
1115     warning('Maximum MPP voltage of the inverter has been reached')
1116 }
1117 }
1118 data.table(Ta, Tc, Gef, voc, isc, vmpp, impp, vdc, idc)
1119 }
1120
1121 fProd <- function(inclin,
1122                   module=list(),
1123                   generator=list(),
1124                   inverter=list(),
1125                   effSys=list()
1126                   )
1127 {
1128
1129     stopifnot(is.list(module),
1130               is.list(generator),
1131               is.list(inverter),
1132               is.list(effSys)
1133               )
1134     ## Extract data from objects
1135     if (class(inclin)[1]=='Gef') {
1136         indInclin <- indexI(inclin)
1137         gefI <- as.data.tableI(inclin, complete = TRUE)
1138         Gef <- gefI$Gef
1139         Ta <- gefI$Ta
1140     } else {
1141         Gef <- inclin$Gef
1142         Ta <- inclin$Ta
1143     }
1144
1145     ## Module, generator, and inverter parameters
1146     module.default <- list(Vocn = 57.6,
1147                            Iscn = 4.7,
1148                            Vmn = 46.08,
1149                            Imn = 4.35,
1150                            Ncs = 96,
1151                            Ncp = 1,
1152                            CoefVT = 0.0023,
1153                            TONC = 47)
1154     module <- modifyList(module.default, module)
1155     ## Make these parameters visible because they will be used often.
1156     Ncs <- module$Ncs
1157     Ncp <- module$Ncp
1158

```

```

159 generator.default <- list(Nms = 12,
160                           Nmp = 11)
161 generator <- modifyList(generator.default, generator)
162 generator$Pg <- (module$Vmn * generator$Nms) *
163               (module$Imn * generator$Nmp)
164 Nms <- generator$Nms
165 Nmp <- generator$Nmp
166
167 inverter.default <- list(Ki = c(0.01,0.025,0.05),
168                           Pinv = 25000,
169                           Vmin = 420,
170                           Vmax = 750,
171                           Gumb = 20)
172 inverter <- modifyList(inverter.default, inverter)
173 Pinv <- inverter$Pinv
174
175 effSys.default <- list(ModQual = 3,
176                         ModDisp = 2,
177                         OhmDC = 1.5,
178                         OhmAC = 1.5,
179                         MPP = 1,
180                         TrafoMT = 1,
181                         Disp = 0.5)
182 effSys <- modifyList(effSys.default, effSys)
183
184 ## Solar Cell i-v
185 vocn <- with(module, Vocn / Ncs)
186 iscn <- with(module, Iscn / Ncp)
187 vmn <- with(module, Vmn / Ncs)
188 imn <- with(module, Imn / Ncp)
189 vmin <- with(inverter, Vmin / (Ncs * Nms))
190 vmax <- with(inverter, Vmax / (Ncs * Nms))
191
192 cell <- iv(vocn, iscn,
193           vmn, imn,
194           module$TONC, module$CoefVT,
195           Ta, Gef,
196           vmin, vmax)
197
198 ## Generator voltage and current
199 Idc <- Nmp * Ncp * cell$Idc
200 Isc <- Nmp * Ncp * cell$Isc
201 Impp <- Nmp * Ncp * cell$impp
202 Vdc <- Nms * Ncs * cell$Vdc
203 Voc <- Nms * Ncs * cell$Voc
204 Vmpp <- Nms * Ncs * cell$Vmpp
205
206 ##DC power (normalization with nominal power of inverter)
207 ##including losses
208 PdcN <- with(effSys, (Idc * Vdc) / Pinv *
209                   (1 - ModQual / 100) *
210                   (1 - ModDisp / 100) *
211                   (1 - MPP / 100) *
212                   (1 - OhmDC / 100)
213                   )
214

```



```

215 ##Normalized AC power to the inverter
216 Ki <- inverter$Ki
217 if (is.matrix(Ki)) { #Ki is a matrix of nine coefficients-->dependence with
tension
218     VP <- cbind(Vdc, PdcN)
219     PacN <- apply(VP, 1, solvePac, Ki)
220 } else { #Ki is a vector of three coefficients-->without dependence on
voltage
221     A <- Ki[3]
222     B <- Ki[2] + 1
223     C <- Ki[1] - (PdcN)
224     PacN <- (-B + sqrt(B^2 - 4 * A * C))/(2 * A)
225 }
226 EffI <- PacN / PdcN
227 pacNeg <- PacN <= 0
228 PacN[pacNeg] <- PdcN[pacNeg] <- EffI[pacNeg] <- 0
229
230
231 ##AC and DC power without normalization
232 Pac <- with(effSys, PacN * Pinv *
233             (Gef > inverter$Gumb) *
234             (1 - OhmAC / 100) *
235             (1 - TrafoMT / 100) *
236             (1 - Disp / 100))
237 Pdc <- PdcN * Pinv * (Pac > 0)
238
239
240 ## Result
241 resProd <- data.table(Tc = cell$Tc,
242                       Voc, Isc,
243                       Vmpp, Impp,
244                       Vdc, Idc,
245                       Pac, Pdc,
246                       EffI)
247 if (class(inclin)[1] %in% 'Gef'){
248     result <- resProd[, .SD,
249                       by=.(Dates = indInclin)]
250     attr(result, 'generator') <- generator
251     attr(result, 'module') <- module
252     attr(result, 'inverter') <- inverter
253     attr(result, 'effSys') <- effSys
254     return(result)
255 } else {
256     result <- cbind(inclin, resProd)
257     return(result)
258 }
259 }

```

fPump

```

1 fPump <- function(pump, H){
2
3     w1=3000 ##synchronous rpm frequency
4     wm=2870 ##rpm frequency with slip when applying voltage at 50 Hz
5     s=(w1-wm)/w1

```

```

6   fen=50 ##Nominal electrical frequency
7   fmin=sqrt(H/pump$a)
8   fmax=with(pump, (-b*Qmax+sqrt(b^2*Qmax^2-4*a*(c*Qmax^2-H)))/(2*a))
9   ##fb is rotation frequency (Hz) of the pump,
10  ##fe is the electrical frequency applied to the motor
11  ##which makes it rotate at a frequency fb (and therefore also the pump).
12  fb=seq(fmin,min(60,fmax),length=1000) #The maximum frequency is 60
13  fe=fb/(1-s)
14
15  ###Flow
16  Q=with(pump, (-b*fb-sqrt(b^2*fb^2-4*c*(a*fb^2-H)))/(2*c))
17  Qmin=0.1*pump$Qn*fb/50
18  Q=Q+(Qmin-Q)*(Q<Qmin)
19
20  ###Hydraulic power
21  Ph=2.725*Q*H
22
23  ###Mechanical power
24  Q50=50*Q/fb
25  H50=H*(50/fb)^2
26  etab=with(pump, j*Q50^2+k*Q50+1)
27  Pb50=2.725*H50*Q50/etab
28  Pb=Pb50*(fb/50)^3
29
30  ###Electrical power
31  Pbc=Pb*50/fe
32  etam=with(pump, g*(Pbc/Pmn)^2+h*(Pbc/Pmn)+i)
33  Pmc=Pbc/etam
34  Pm=Pmc*fe/50
35  Pac=Pm
36  ##Pdc=Pm/(etac*(1-cab))
37
38  ###I build functions for flow, frequency and powers
39  ###to adjust the AC power.
40  fQ<-splinefun(Pac,Q)
41  fFreq<-splinefun(Pac,fe)
42  fPb<-splinefun(Pac,Pb)
43  fPh<-splinefun(Pac,Ph)
44  lim=c(min(Pac),max(Pac))
45  ##lim marks the operating range of the pump
46  result<-list(lim = lim,
47              fQ = fQ,
48              fPb = fPb,
49              fPh = fPh,
50              fFreq = fFreq)
51 }

```

fSolid

```

1 fSolid <- function(lat, BTd, method = 'michalsky'){
2   if (abs(lat) > 90){
3     lat <- sign(lat) * 90
4     warning(paste('Latitude outside acceptable values. Set to', lat))
5   }
6   sun <- data.table(Dates = unique(as.IDate(BTd)),

```



```

31 sun[, ALS := asin(cosThzS)]
32
33 #azimuth
34 sun[, AzS := azimuth(Dates, lat, BTi, sample,
35                      method = method,
36                      decl = decl,
37                      w = w,
38                      cosThzS = cosThzS)]
39
40 #Extraterrestrial irradiance
41 sun[, Bo0 := Bo * eo * cosThzS]
42
43 #When it is night there is no irradiance
44 sun[night == TRUE, Bo0 := 0]
45
46 #Erase columns that are in sold
47 sun[, decl := NULL]
48 sun[, eo := NULL]
49 sun[, eqtime := NULL]
50 sun[, ws := NULL]
51 sun[, Bo0d := NULL]
52
53 #Column Dates with Times
54 sun[, Dates := as.POSIXct(Dates, Times, tz = 'UTC')]
55 sun[, Times := NULL]
56
57 #keep night
58 if(!keep.night){
59   sun <- sun[night == FALSE]
60 }
61
62 return(sun)
63 }

```

fSombra

```

1 fSombra<-function(angGen, distances, struct, modeTrk='fixed',prom=TRUE){
2
3   stopifnot(modeTrk %in% c('two','horiz','fixed'))
4   res=switch(modeTrk,
5             two={fSombra6(angGen, distances, struct, prom)},
6             horiz={fSombraHoriz(angGen, distances, struct)},
7             fixed= {fSombraEst(angGen, distances, struct)}
8             )
9   return(res)
10 }

```

```

1 fSombra2X<-function(angGen,distances,struct)
2 {
3   stopifnot(is.list(struct),is.data.frame(distances))
4   ##I prepare starting data
5   P=with(struct,distances/W)
6   b=with(struct,L/W)
7   AzS=angGen$AzS
8   Beta=angGen$Beta

```

```

9     AlS=angGen$AlS
10
11     d1=abs(P$Lew*cos(AzS)-P$Lns*sin(AzS))
12     d2=abs(P$Lew*sin(AzS)+P$Lns*cos(AzS))
13     FC=sin(AlS)/sin(Beta+AlS)
14     s=b*cos(Beta)+(b*sin(Beta)+P$H)/tan(AlS)
15     FS1=1-d1
16     FS2=s-d2
17     SombraCond=(FS1>0)*(FS2>0)*(P$Lew*AzS>=0)
18     SombraCond[is.na(SombraCond)]<-FALSE #NAs are of no use to me in a logical
19     ## Result
20     FS=SombraCond*(FS1*FS2*FC)/b
21     FS[FS>1]<-1
22     return(FS)
23 }

```

```

1 fSombra6<-function(angGen, distances, struct, prom=TRUE)
2 {
3     stopifnot(is.list(struct),
4               is.data.frame(distances))
5     ##distances only has three distances, so I generate a grid
6     if (dim(distances)[1]==1){
7         Red <- distances[, .(Lew = c(-Lew, 0, Lew, -Lew, Lew),
8                                   Lns = c(Lns, Lns, Lns, 0, 0),
9                                   H=H)]
10    } else { #distances is an array, so there is no need to generate the grid
11        Red<-distances[1:5,] #I only need the first 5 rows...necessary in case a
12        wrong data.frame is delivered
13
14        ## I calculate the shadow due to each of the 5 followers
15        SombraGrupo<-matrix(ncol=5,nrow=dim(angGen)[1]) ###VECTORIZE
16        for (i in 1:5) {SombraGrupo[,i]<-fSombra2X(angGen,Red[i,],struct)}
17        ##To calculate the Average Shadow, I need the number of followers in each
18        position (distrib)
19        distrib=with(struct,c(1,Ncol-2,1,Nrow-1,(Ncol-2)*(Nrow-1),Nrow-1))
20        vProm=c(sum(distrib[c(5,6)]),
21               sum(distrib[c(4,5,6)]),
22               sum(distrib[c(4,5)]),
23               sum(distrib[c(2,3,5,6)]),
24               sum(distrib[c(1,2,4,5)]))
25        Nseg=sum(distrib) ##Total number of followers
26        ##With the SWEEP function I multiply the Shadow Factor of each type (
27        ShadowGroup columns) by the vProm result
28
29        if (prom==TRUE){
30            ## Average Shadow Factor in the group of SIX followers taking into
31            account distribution
32            FS=rowSums(sweep(SombraGrupo,2,vProm,'*'))/Nseg
33            FS[FS>1]<-1
34        } else {
35            ## Shadow factor on follower #5 due to the other 5 followers
36            FS=rowSums(SombraGrupo)
37            FS[FS>1]<-1}
38        return(FS)
39    }

```

```

1 fSombraEst<-function(angGen, distances, struct)
2 {
3   stopifnot(is.list(struct),is.data.frame(distances))
4   ## I prepare starting data
5   dist <- with(struct, distances/L)
6   Alfa <- angGen$Alfa
7   Beta <- angGen$Beta
8   AlS <- angGen$AlS
9   AzS <- angGen$AzS
10  cosTheta <- angGen$cosTheta
11  h <- dist$H #It must be previously normalized
12  d <- dist$D
13  ## Calculations
14  s=cos(Beta)+cos(Alfa-AzS)*(sin(Beta)+h)/tan(AlS)
15  FC=sin(AlS)/sin(Beta+AlS)
16  SombraCond=(s-d>0)
17  FS=(s-d)*SombraCond*FC*(cosTheta>0)
18  ## Result
19  FS=FS*(FS>0)
20  FS[FS>1]<-1
21  return(FS)
22 }

```

```

1 fSombraHoriz<-function(angGen, distances, struct)
2 {
3   stopifnot(is.list(struct),is.data.frame(distances))
4   ## I prepare starting data
5   d <- with(struct, distances/L)
6   AzS <- angGen$AzS
7   AlS <- angGen$AlS
8   Beta <- angGen$Beta
9   lew <- d$Lew #It must be previously normalized
10  ## Calculations
11  Beta0=atan(abs(sin(AzS)/tan(AlS)))
12  FS=1-lew*cos(Beta0)/cos(Beta-Beta0)
13  SombraCond=(FS>0)
14  ## Result
15  FS=FS*SombraCond
16  FS[FS>1]<-1
17  return(FS)
18 }

```

fTemp

```

1 fTemp<-function(sol, BD)
2 {
3   ##sol is an object with class='Sol'
4   ##BD is an object with class='Meteo', whose 'data' slot contains two columns
   called "TempMax" and "TempMin"
5
6   stopifnot(class(sol)=='Sol')
7   stopifnot(class(BD)=='Meteo')
8

```

```

9      checkIndexD(indexD(sol), indexD(BD))
10
11      Dates<-indexI(sol)
12      x <- as.Date(Dates)
13      ind.rep <- cumsum(c(1, diff(x) != 0))
14
15      TempMax <- BD@data$TempMax[ind.rep]
16      TempMin <- BD@data$TempMin[ind.rep]
17      ws <- sol@solD$ws[ind.rep]
18      w <- sol@solI$w
19
20      ##Generate temperature sequence from database Maxima and Minima
21
22      Tm=(TempMin+TempMax)/2
23      Tr=(TempMax-TempMin)/2
24
25      wp=pi/4
26
27      a1=pi*12*(ws-w)/(21*pi+12*ws)
28      a2=pi*(3*pi-12*w)/(3*pi-12*ws)
29      a3=pi*(24*pi+12*(ws-w))/(21*pi+12*ws)
30
31      T1=Tm-Tr*cos(a1)
32      T2=Tm+Tr*cos(a2)
33      T3=Tm-Tr*cos(a3)
34
35      Ta=T1*(w<=ws)+T2*(w>ws&w<=wp)+T3*(w>wp)
36
37      ##Result
38      result<-data.table(Dates, Ta)
39  }

```

fTheta

```

1  fTheta<-function(sol, beta, alfa=0, modeTrk='fixed', betaLim=90,
2      BT=FALSE, struct, dist)
3  {
4      stopifnot(modeTrk %in% c('two','horiz','fixed'))
5      if (!missing(struct)) {stopifnot(is.list(struct))}
6      if (!missing(dist)) {stopifnot(is.data.frame(dist))}
7
8      betaLim=d2r(betaLim)
9      lat=getLat(sol, 'rad')
10     signLat=ifelse(sign(lat)==0, 1, sign(lat)) ##When lat=0, sign(lat)=0. I
      change it to sign(lat)=1
11
12     solI<-as.data.tableI(sol, complete=TRUE, day = TRUE)
13     AlS=solI$AlS
14     AzS=solI$AzS
15     decl=solI$decl
16     w<-solI$w
17
18     night<-solI$night
19
20     Beta<-switch(modeTrk,

```

```

21     two = {Beta2x=pi/2-AlS
22           Beta=Beta2x+(betaLim-Beta2x)*(Beta2x>betaLim)},
23     fixed = rep(d2r(beta), length(w)),
24     horiz={BetaHoriz0=atan(abs(sin(AzS)/tan(AlS)))
25           if (BT){lew=dist$Lew/struct$L
26                 Longitud=lew*cos(BetaHoriz0)
27                 Cond=(Longitud>=1)
28                 Longitud[Cond]=1
29                 ## When Cond==TRUE Length=1
30                 ## and therefore asin(Length)=pi/2,
31                 ## so that BetaHoriz=BetaHoriz0
32                 BetaHoriz=BetaHoriz0+asin(Longitud)-pi/2
33           } else {
34             BetaHoriz=BetaHoriz0
35             rm(BetaHoriz0)}
36     Beta=ifelse(BetaHoriz>betaLim,betaLim,BetaHoriz)}
37   )
38   is.na(Beta) <- night
39
40   Alfa<-switch(modeTrk,
41               two = AzS,
42               fixed = rep(d2r(alfa), length(w)),
43               horiz=pi/2*sign(AzS))
44   is.na(Alfa) <- night
45
46   cosTheta<-switch(modeTrk,
47                   two=cos(Beta-(pi/2-AlS)),
48                   horiz={
49                     t1=sin(decl)*sin(lat)*cos(Beta)
50                     t2=cos(decl)*cos(w)*cos(lat)*cos(Beta)
51                     t3=cos(decl)*abs(sin(w))*sin(Beta)
52                     cosTheta=t1+t2+t3
53                     rm(t1,t2,t3)
54                     cosTheta
55                   },
56                   fixed={
57                     t1=sin(decl)*sin(lat)*cos(Beta)
58                     t2=-signLat*sin(decl)*cos(lat)*sin(Beta)*cos(Alfa)
59                     t3=cos(decl)*cos(w)*cos(lat)*cos(Beta)
60                     t4=signLat*cos(decl)*cos(w)*sin(lat)*sin(Beta)*cos(Alfa)
61                     t5=cos(decl)*sin(w)*sin(Alfa)*sin(Beta)
62                     cosTheta=t1+t2+t3+t4+t5
63                     rm(t1,t2,t3,t4,t5)
64                     cosTheta
65                   }
66   )
67   is.na(cosTheta) <- night
68   cosTheta=cosTheta*(cosTheta>0) #when cosTheta<0, Theta is greater than 90°,
69   and therefore the Sun is behind the panel.
70
71   result <- data.table(Dates = indexI(sol),
72                       Beta, Alfa, cosTheta)
73   return(result)
74 }

```


HQCure

```

1  ## HQCurve: no visible binding for global variable 'fb'
2  ## HQCurve: no visible binding for global variable 'Q'
3  ## HQCurve: no visible binding for global variable 'x'
4  ## HQCurve: no visible binding for global variable 'y'
5  ## HQCurve: no visible binding for global variable 'group.value'
6
7  if(getRversion() >= "2.15.1") globalVariables(c('fb', 'Q', 'x', 'y', 'group.value'
8    '))
9
10 HQCurve<-function(pump){
11   w1=3000 #synchronous rpm frequency
12   wm=2870 #rpm frequency with slip when applying voltage at 50 Hz
13   s=(w1-wm)/w1
14   fen=50 #Nominal electrical frequency
15
16   f=seq(35,50,by=5)
17   Hn=with(pump,a*50^2+b*50*Qn+c*Qn^2) #height corresponding to flow rate and
18     nominal frequency
19
20   kiso=Hn/pump$Qn^2 #To paint the isoyield curve I take into account the laws of
21     similarity
22   Qiso=with(pump,seq(0.1*Qn,Qmax,l=10))
23   Hiso=kiso*Qiso^2 #Isoperformance curve
24
25   Curva<-expand.grid(fb=f,Q=Qiso)
26
27   Curva<-within(Curva,{
28     fe=fb/(1-s)
29     H=with(pump,a*fb^2+b*fb*Q+c*Q^2)
30
31     is.na(H) <- (H<0)
32     Q50=50*Q/fb
33     H50=H*(50/fb)^2
34     etab=with(pump,j*Q50^2+k*Q50+l)
35     Pb50=2.725*H50*Q50/etab
36     Pb=Pb50*(fb/50)^3
37
38     Pbc=Pb*50/fe
39     etam=with(pump,g*(Pbc/Pmn)^2+h*(Pbc/Pmn)+i)
40     Pmc=Pbc/etam
41     Pm=Pmc*fe/50
42
43     etac=0.95 #Variable frequency drive performance
44     cab=0.05 #Cable losses
45     Pdc=Pm/(etac*(1-cab))
46     rm(etac,cab,Pmc,Pbc,Pb50,Q50,H50)
47   })
48
49 ###H-Q curve at different frequencies
50 ##I check if I have the lattice package available, which should have been
51   loaded in .First.lib
52   lattice.disp<-"lattice" %in% .packages()
53   latticeExtra.disp<-"latticeExtra" %in% .packages()
54   if (lattice.disp && latticeExtra.disp) {

```

```

51 p<-xyplot(H~Q,groups=factor(fb),data=Curva, type='l',
52          par.settings=custom.theme.2(),
53          panel=function(x,y,groups,...){
54            panel.superpose(x,y,groups,...)
55            panel.xyplot(Qiso,Hiso,col='black',...)
56            panel.text(Qiso[1], Hiso[1], 'ISO', pos=3)}
57          )
58 p=p+glayer(panel.text(x[1], y[1], group.value, pos=3))
59 print(p)
60 result<-list(result=Curva, plot=p)
61 } else {
62   warning('lattice and/or latticeExtra packages are not available. Thus, the
63   plot could not be created')
64   result<-Curva}
65 }

```

local2Solar

```

1 local2Solar <- function(x, lon=NULL){
2   tz=attr(x, 'tzone')
3   if (tz==' ' || is.null(tz)) {tz='UTC'}
4   ##Daylight savings time
5   AO=3600*dst(x)
6   AOneg=(AO<0)
7   if (any(AOneg)) {
8     AO[AOneg]=0
9     warning('Some Daylight Savings Time unknown. Set to zero.')
10  }
11  ##Difference between local longitude and time zone longitude LH
12  LH=lonHH(tz)
13  if (is.null(lon))
14    {deltaL=0
15   } else
16    {deltaL=d2r(lon)-LH
17  }
18  ##Local time corrected to UTC
19  tt <- format(x, tz=tz)
20  result <- as.POSIXct(tt, tz='UTC')-AO+r2sec(deltaL)
21  result
22 }

```

markovG0

```

1 ## Objects loaded at startup from data/MTM.RData
2 if(getRversion() >= "2.15.1") globalVariables(c(
3   'MTM', ## Markov Transition Matrices
4   'Ktmtm', ## Kt limits to choose a matrix from MTM
5   'Ktlim' ## Daily kt range of each matrix.
6 ))
7
8 markovG0 <- function(G0dm, sold){
9   sold <- copy(sold)
10  timeIndex <- sold$Dates
11  Bo0d <- sold$Bo0d

```

```

12 Bo0dm <- solD[, mean(Bo0d), by = .(month(Dates), year(Dates))][[3]]
13 ktm <- G0dm/Bo0dm
14
15 ##Calculates which matrix to work with for each month
16 whichMatrix <- findInterval(ktm, Ktmtm, all.inside = TRUE)
17
18 ktd <- state <- numeric(length(timeIndex))
19 state[1] <- 1
20 ktd[1] <- ktm[state[1]]
21 for (i in 2:length(timeIndex)){
22   iMonth <- month(timeIndex[i])
23   colMonth <- whichMatrix[iMonth]
24   rng <- Ktlim[, colMonth]
25   classes <- seq(rng[1], rng[2], length=11)
26   matMonth <- MTM[(10*colMonth-9):(10*colMonth),]
27   ## http://www-rohan.sdsu.edu/~babailey/stat575/mcsim.r
28   state[i] <- sample(1:10, size=1, prob=matMonth[state[i-1],])
29   ktd[i] <- runif(1, min=classes[state[i]], max=classes[state[i]+1])
30 }
31 G0dmMarkov <- data.table(ktd, Bo0d)
32 G0dmMarkov <- G0dmMarkov[, mean(ktd*Bo0d), by = .(month(timeIndex), year(
timeIndex))][[3]]
33 fix <- G0dm/G0dmMarkov
34 indRep <- month(timeIndex)
35 fix <- fix[indRep]
36 G0d <- data.table(Dates = timeIndex, G0d = ktd * Bo0d * fix)
37 G0d
38 }

```

NmgPVPS

```

1 ## NmgPVPS: no visible binding for global variable 'Pnom'
2 ## NmgPVPS: no visible binding for global variable 'group.value'
3
4 if(getRversion() >= "2.15.1") globalVariables(c('Pnom', 'group.value'))
5
6 NmgPVPS <- function(pump, Pg, H, Gd, Ta=30,
7   lambda=0.0045, TONC=47,
8   eta=0.95, Gmax=1200, t0=6, Nm=6,
9   title='', theme=custom.theme.2()){
10
11   ##I build the type day by IEC procedure
12   t=seq(-t0,t0,l=2*t0*Nm);
13   d=Gd/(Gmax*2*t0)
14   s=(d*pi/2-1)/(1-pi/4)
15   G=Gmax*cos(t/t0*pi/2)*(1+s*(1-cos(t/t0*pi/2)))
16   G[G<0]<-0
17   G=G/(sum(G,na.rm=1)/Nm)*Gd
18   Red<-expand.grid(G=G,Pnom=Pg,H=H,Ta=Ta)
19   Red<-within(Red,{Tcm<-Ta+G*(TONC-20)/800
20     Pdc=Pnom*G/1000*(1-lambda*(Tcm-25)) #Available DC power
21     Pac=Pdc*eta}) #Inverter yield
22
23   res=data.table(Red,Q=0)
24

```

```

25   for (i in seq_along(H)){
26     fun=fPump(pump, H[i])
27     Cond=res$H==H[i]
28     x=res$Pac[Cond]
29     z=res$Pdc[Cond]
30     rango=with(fun,x>=lim[1] & x<=lim[2]) #I limit the power to the operating
      range of the pump.
31     x[!rango]<-0
32     z[!rango]<-0
33     y=res$Q[Cond]
34     y[rango]<-fun$fQ(x[rango])
35     res$Q[Cond]=y
36     res$Pac[Cond]=x
37     res$Pdc[Cond]=z
38   }
39
40   resumen <- res[, lapply(.SD, function(x)sum(x, na.rm = 1)/Nm),
41                     by = .(Pnom, H)]
42   param=list(pump=pump, Pg=Pg, H=H, Gd=Gd, Ta=Ta,
43             lambda=lambda, TONC=TONC, eta=eta,
44             Gmax=Gmax, t0=t0, Nm=Nm)
45
46
47   ###Abacus with common X-axes
48
49   ##I check if I have the lattice package available, which should have been
      loaded in .First.lib
50   lattice.disp<-"lattice" %in% .packages()
51   latticeExtra.disp<-"latticeExtra" %in% .packages()
52   if (lattice.disp && latticeExtra.disp){
53     tema<-theme
54     tema1 <- modifyList(tema, list(layout.width = list(panel=1,
55                                                         ylab = 2, axis.left=1.0,
56                                                         left.padding=1, ylab.axis.padding=1,
57                                                         axis.panel=1)))
58     tema2 <- modifyList(tema, list(layout.width = list(panel=1,
59                                                         ylab = 2, axis.left=1.0, left.padding=1,
60                                                         ylab.axis.padding=1, axis.panel=1)))
61     temaT <- modifyList(tema, list(layout.heights = list(panel = c(1, 1))))
62     p1 <- xyplot(Q~Pdc, groups=H, data=resumen,
63                ylab="Qd (m\u00b3/d)",type=c('l','g'),
64                par.settings = tema1)
65
66     p1lab<-p1+glayer(panel.text(x[1], y[1], group.value, pos=2, cex=0.7))
67
68     ##I paint the linear regression because Pnom~Pdc depends on the height.
69     p2 <- xyplot(Pnom~Pdc, groups=H, data=resumen,
70                ylab="Pg",type=c('l','g'), #type=c('smooth','g'),
71                par.settings = tema2)
72     p2lab<-p2+glayer(panel.text(x[1], y[1], group.value, pos=2, cex=0.7))
73
74     p<-update(c(p1lab, p2lab, x.same = TRUE),
75              main=paste(title, '\nSP', pump$Qn, 'A', pump$stages, ' ',
76                        'Gd ', Gd/1000," kWh/m\u00b2",sep=''),
77              layout = c(1, 2),
78              scales=list(x=list(draw=FALSE)),

```

```

79         xlab='',
80         ylab = list(c("Qd (m\u00b3/d)", "Pg (Wp)"), y = c(1/4, 3/4)),
81         par.settings = temaT
82     )
83     print(p)
84     result<-list(I=res,D=resumen, plot=p, param=param)
85 } else {
86     warning('lattice, latticeExtra packages are not all available. Thus, the
87     plot could not be created')
88     result<-list(I=res,D=resumen, param=param)
89 }

```

utils-angle

```

1 #degrees to radians
2 d2r<-function(x){x*pi/180}
3
4 #radians to degrees
5 r2d<-function(x){x*180/pi}
6
7 #hours to radians
8 h2r<-function(x){x*pi/12}
9
10 #hours to degrees
11 h2d<-function(x){x*180/12}
12
13 #radians to hours
14 r2h<-function(x){x*12/pi}
15
16 #degrees to hours
17 d2h<-function(x){x*12/180}
18
19 #radians to seconds
20 r2sec<-function(x){x*12/pi*3600}
21
22 #radians to minutes
23 r2min<-function(x){x*12/pi*60}

```

utils-time

```

1 #complete time to hours
2 t2h <- function(x)
3 {
4     hour(x)+minute(x)/60+second(x)/3600
5 }
6
7 #hours minutes and seconds to hours
8 hms <- function(x)
9 {
10     hour(x)+minute(x)/60+second(x)/3600
11 }
12
13 #day of the year

```

```

14 doym <- function(x){
15   as.numeric(format(x, '%j'))
16 }
17
18 #day of the month
19 dom <- function(x){
20   as.numeric(format(x, '%d'))
21 }
22
23 #trunc days
24 truncDay <- function(x){as.POSIXct(trunc(x, units='days'))}

```

A.4. Métodos

as.data.tableI

as.data.tableD

```

1  setGeneric('as.data.tableD', function(object, complete=FALSE, day=FALSE){
2    standardGeneric('as.data.tableD')})
3
4  setMethod('as.data.tableD',
5    signature=(object='Sol'),
6    definition=function(object, complete=FALSE, day=FALSE){
7      sol <- copy(object)
8      sold <- sol@sold
9      data <- sold
10     if(day){
11       ind <- indexD(object)
12       data[, day := doym(ind)]
13       data[, month := month(ind)]
14       data[, year := year(ind)]
15     }
16     return(data)
17   })
18
19  setMethod('as.data.tableD',
20    signature = (object='GO'),
21    definition = function(object, complete=FALSE, day=FALSE){
22     g0 <- copy(object)
23     GOD <- g0@GOD
24     sold <- g0@sold
25     if(complete){
26       data <- data.table(GOD, sold[, Dates := NULL])
27     } else {
28       GOD[, Fd := NULL]
29       GOD[, Kt := NULL]
30       data <- GOD
31     }
32     if(day){
33       ind <- indexD(object)
34       data[, day := doym(ind)]
35       data[, month := month(ind)]
36       data[, year := year(ind)]

```

```

37     }
38     return(data)
39 })
40
41 setMethod('as.data.tableD',
42   signature = (object='Gef'),
43   definition = function(object, complete=FALSE, day=FALSE){
44     gef <- copy(object)
45     GefD <- gef@GefD
46     GOD <- gef@GOD
47     sold <- gef@sold
48     if(complete){
49       data <- data.table(GefD,
50                           GOD[, Dates := NULL],
51                           sold[, Dates := NULL])
52     } else {data <- GefD[, c('Dates', 'Gefd',
53                             'Defd', 'Befd')]}
54     if(day){
55       ind <- indexD(object)
56       data[, day := doy(ind)]
57       data[, month := month(ind)]
58       data[, year := year(ind)]
59     }
60     return(data)
61   }
62 )
63
64 setMethod('as.data.tableD',
65   signature = (object='ProdGCPV'),
66   definition = function(object, complete=FALSE, day=FALSE){
67     prodgcpv <- copy(object)
68     prodD <- prodgcpv@prodD
69     GefD <- prodgcpv@GefD
70     GOD <- prodgcpv@GOD
71     sold <- prodgcpv@sold
72     if(complete){
73       data <- data.table(prodD,
74                           GefD[, Dates := NULL],
75                           GOD[, Dates := NULL],
76                           sold[, Dates := NULL]
77                         )
78     } else { data <- prodD[, c('Dates', 'Eac',
79                               'Edc', 'Yf')]}
80     if(day){
81       ind <- indexD(object)
82       data[, day := doy(ind)]
83       data[, month := month(ind)]
84       data[, year := year(ind)]
85     }
86     return(data)
87   }
88 )
89
90 setMethod('as.data.tableD',
91   signature = (object='ProdPVPS'),
92   definition = function(object, complete=FALSE, day=FALSE){

```

```

93     prodpvps <- copy(object)
94     prodD <- prodpvps@prodD
95     GefD <- prodpvps@GefD
96     GOD <- prodpvps@GOD
97     sold <- prodpvps@sold
98     if(complete){
99         data <- data.table(prodD,
100                             GefD[, Dates := NULL],
101                             GOD[, Dates := NULL],
102                             sold[, Dates := NULL]
103                         )
104     } else { data <- prodD[, c('Dates', 'Eac',
105                             'Qd', 'Yf')]}
106     if(day){
107         ind <- indexD(object)
108         data[, day := doy(ind)]
109         data[, month := month(ind)]
110         data[, year := year(ind)]
111     }
112     return(data)
113 }
114 )

```

as.data.tableM

```

1  setGeneric('as.data.tableM', function(object, complete = FALSE, day=FALSE){
2      standardGeneric('as.data.tableM')})
3
4  setMethod('as.data.tableM',
5      signature=(object='GO'),
6      definition=function(object, complete=FALSE, day=FALSE){
7          g0 <- copy(object)
8          GOdm <- g0@GOdm
9          data <- GOdm
10         if(day){
11             ind <- indexD(object)
12             data[, month := month(ind)]
13             data[, year := year(ind)]
14         }
15         return(data)
16     })
17
18  setMethod('as.data.tableM',
19      signature=(object='Gef'),
20      definition = function(object, complete=FALSE, day=FALSE){
21          gef <- copy(object)
22          Gefdm <- gef@Gefdm
23          GOdm <- gef@GOdm
24          if(complete){
25              data <- data.table(Gefdm, GOdm[, Dates := NULL])
26          } else {data <- Gefdm}
27          if(day){
28              ind <- indexD(object)
29              data[, month := month(ind)]

```



```

30         data[, year := year(ind)]
31     }
32     return(data)
33 }
34 )
35
36 setMethod('as.data.tableM',
37     signature = (object='ProdGCPV'),
38     definition = function(object, complete=FALSE, day=FALSE){
39         prodgcpv <- copy(object)
40         prodDm <- prodgcpv@prodDm
41         Gefdm <- prodgcpv@Gefdm
42         G0dm <- prodgcpv@G0dm
43         if(complete){
44             data <- data.table(prodDm,
45                               Gefdm[, Dates := NULL],
46                               G0dm[, Dates := NULL])
47         } else {data <- prodDm}
48         if(day){
49             ind <- indexD(object)
50             data[, month := month(ind)]
51             data[, year := year(ind)]
52         }
53         return(data)
54     }
55 )
56
57 setMethod('as.data.tableM',
58     signature = (object='ProdPVPS'),
59     definition = function(object, complete=FALSE, day=FALSE){
60         prodpvps <- copy(object)
61         prodDm <- prodpvps@prodDm
62         Gefdm <- prodpvps@Gefdm
63         G0dm <- prodpvps@G0dm
64         if(complete){
65             data <- data.table(prodDm,
66                               Gefdm[, Dates := NULL],
67                               G0dm[, Dates := NULL])
68         } else {data <- prodDm}
69         if(day){
70             ind <- indexD(object)
71             data[, month := month(ind)]
72             data[, year := year(ind)]
73         }
74         return(data)
75     }
76 )

```

as.data.tableY

```

1 setGeneric('as.data.tableY', function(object, complete=FALSE, day=FALSE){
2     standardGeneric('as.data.tableY')})
3
4 setMethod('as.data.tableY',
5     signature=(object='GO'),

```

```

5      definition=function(object, complete=FALSE, day=FALSE){
6          g0 <- copy(object)
7          G0y <- g0@G0y
8          data <- G0y
9          if(day){data[, year := Dates]}
10         return(data)
11     }
12 )
13
14 setMethod('as.data.tableY',
15     signature = (object='Gef'),
16     definition = function(object, complete=FALSE, day=FALSE){
17         gef <- copy(object)
18         Gefy <- gef@Gefy
19         G0y <- gef@G0y
20         if(complete){
21             data <- data.table(Gefy, G0y[, Dates := NULL])
22         } else {data <- Gefy}
23         if(day){data[, year := Dates]}
24         return(data)
25     }
26 )
27
28 setMethod('as.data.tableY',
29     signature = (object='ProdGCPV'),
30     definition = function(object, complete=FALSE, day=FALSE){
31         prodgcpv <- copy(object)
32         prody <- prodgcpv@prody
33         Gefy <- prodgcpv@Gefy
34         G0y <- prodgcpv@G0y
35         if(complete){
36             data <- data.table(prody,
37                               Gefy[, Dates := NULL],
38                               G0y[, Dates := NULL])
39         } else {data <- prody}
40         if(day){data[, year := Dates]}
41         return(data)
42     }
43 )
44
45 setMethod('as.data.tableY',
46     signature = (object='ProdPVPS'),
47     definition = function(object, complete=FALSE, day=FALSE){
48         prodpvps <- copy(object)
49         prody <- prodpvps@prody
50         Gefy <- prodpvps@Gefy
51         G0y <- prodpvps@G0y
52         if(complete){
53             data <- data.table(prody,
54                               Gefy[, Dates := NULL],
55                               G0y[, Dates := NULL])
56         } else {data <- prody}
57         if(day){data[, year := Dates]}
58         return(data)
59     }
60 )

```

compare

```

1  ## compareFunction: no visible binding for global variable 'name'
2  ## compareFunction: no visible binding for global variable 'x'
3  ## compareFunction: no visible binding for global variable 'y'
4  ## compareFunction: no visible binding for global variable 'group.value'
5
6  if(getRversion() >= "2.15.1") globalVariables(c('name', 'x', 'y', 'group.value'))
7
8  setGeneric('compare', signature='...', function(...){standardGeneric('compare')})
9
10 compareFunction <- function(..., vars){
11   dots <- list(...)
12   nms0 <- substitute(list(...))
13   if (!is.null(names(nms0))) { ##in do.call
14     nms <- names(nms0[-1])
15   } else {
16     nms <- as.character(nms0[-1])
17   }
18   foo <- function(object, label){
19     yY <- colMeans(as.data.tableY(object, complete = TRUE)[, ..vars])
20     yY <- cbind(stack(yY), name=label)
21     yY
22   }
23   cdata <- mapply(FUN=foo, dots, nms, SIMPLIFY=FALSE)
24   z <- do.call(rbind, cdata)
25   z$ind <- ordered(z$ind, levels=vars)
26   p <- dotplot(ind~values, groups=name, data=z, type='b',
27               par.settings=solaR.theme)
28   print(p+glayer(panel.text(x[length(x)], y[length(x)],
29                             label=group.value, cex=0.7, pos=3, srt=45)))
30   return(z)
31 }
32
33
34 setMethod('compare',
35           signature='GO',
36           definition=function(...){
37             vars <- c('D0d', 'B0d', 'G0d')
38             res <- compareFunction(..., vars=vars)
39             return(res)
40           }
41 )
42
43 setMethod('compare',
44           signature='Gef',
45           definition=function(...){
46             vars <- c('Defd', 'Befd', 'Gefd')
47             res <- compareFunction(..., vars=vars)
48             return(res)
49           }
50 )
51
52 setMethod('compare',
53           signature='ProdGCPV',
54           definition=function(...){

```

```

55     vars <- c('G0d', 'Gefd', 'Yf')
56     res <- compareFunction(..., vars=vars)
57     return(res)
58   }
59 )

```

getData

```

1  ## extracts the data for class Meteo ##
2  setGeneric('getData', function(object){standardGeneric('getData')})
3
4  ### getData ###
5  setMethod('getData',
6    signature = (object = 'Meteo'),
7    definition = function(object){
8      result <- object@data
9      return(result)
10   })

```

getG0

```

1  ## extracts the global irradiance for class Meteo ##
2  setGeneric('getG0', function(object){standardGeneric('getG0')})
3
4  ### getG0 ###
5  setMethod('getG0',
6    signature = (object = 'Meteo'),
7    definition = function(object){
8      result <- getData(object)
9      return(result$G0)
10   })

```

getLat

```

1  ## extracts the latitude from the objects ##
2  setGeneric('getLat', function(object, units = 'rad')
3  {standardGeneric('getLat')})
4
5  ## extracts the latitude from the objects ##
6  setGeneric('getLat', function(object, units = 'rad')
7  {standardGeneric('getLat')})
8
9  setMethod('getLat',
10    signature = (object = 'Meteo'),
11    definition = function(object, units = 'rad'){
12      stopifnot(units %in% c('deg', 'rad'))
13      result = switch(units,
14                      rad = d2r(object@latm),
15                      deg = object@latm)
16      return(result)
17    })

```

indexD

```

1 ## extract the index of the daily data ##
2 setGeneric('indexD', function(object){standardGeneric('indexD')})
3 ### indexD ###
4 setMethod('indexD',
5           signature = (object = 'Sol'),
6           definition = function(object){as.POSIXct(object@sold$Dates)
7           })
8
9 setMethod('indexD',
10          signature = (object = 'Meteo'),
11          definition = function(object){as.POSIXct(getData(object)$Dates)})

```

indexI

```

1 ## extract the index of the intradaily data ##
2 setGeneric('indexI', function(object){standardGeneric('indexI')})
3 ### indexI ###
4 setMethod('indexI',
5           signature = (object = 'Sol'),
6           definition = function(object){as.POSIXct(object@solI$Dates)
7           })

```

levelplot

```

1 setGeneric('levelplot')
2
3 ## setMethod('levelplot',
4 ##           signature=c(x='formula', data='zoo'),
5 ##           definition=function(x, data,
6 ##                               par.settings=solaR.theme,
7 ##                               ## panel=panel.levelplot.raster, interpolate=TRUE,...){
8 ##                               xscale.components=xscale.solar,
9 ##                               yscale.components=yscale.solar,
10 ##                               ...){
11 ##                               data0=as.data.frame(data)
12 ##                               ind=index(data)
13 ##                               data0$day=doy(ind) ##Incorpo dia, mes y año para facilitar la
14 ##                               formula.
15 ##                               data0$month=month(ind)
16 ##                               data0$year=year(ind)
17 ##                               if (!('w' %in% names(data0))){
18 ##                               data0$w=h2r(hms(ind)-12) ##hora solar en radianes
19 ##                               }
20 ##                               levelplot(x, data0, par.settings=par.settings,
21 ##                               xscale.components=xscale.components,
22 ##                               yscale.components=yscale.components,
23 ##                               ## panel=panel, interpolate=
24 ##                               interpolate,
25 ##                               ...)
26 ##                               }
27 ##                               )

```

```

27
28 setMethod('levelplot',
29   signature=c(x='formula', data='Meteo'),
30   definition=function(x, data,
31     par.settings = solaR.theme,
32     panel = panel.levelplot.raster, interpolate = TRUE,
33     xscale.components = xscale.solar,
34     yscale.components = yscale.solar,
35     ...){
36     data0=getData(data)
37     levelplot(x, data0,
38       par.settings = par.settings,
39       xscale.components = xscale.components,
40       yscale.components = yscale.components,
41       panel = panel, interpolate = interpolate,
42       ...)
43   }
44 )
45
46 setMethod('levelplot',
47   signature=c(x='formula', data='Sol'),
48   definition=function(x, data,
49     par.settings = solaR.theme,
50     panel = panel.levelplot.raster, interpolate = TRUE,
51     xscale.components = xscale.solar,
52     yscale.components = yscale.solar,
53     ...){
54     data0=as.data.tableI(data, complete=TRUE, day=TRUE)
55     levelplot(x, data0,
56       par.settings = par.settings,
57       xscale.components = xscale.components,
58       yscale.components = yscale.components,
59       panel = panel, interpolate = interpolate,
60       ...)
61   }
62 )
63
64 setMethod('levelplot',
65   signature=c(x='formula', data='G0'),
66   definition=function(x, data,
67     par.settings = solaR.theme,
68     panel = panel.levelplot.raster, interpolate = TRUE,
69     xscale.components = xscale.solar,
70     yscale.components = yscale.solar,
71     ...){
72     data0=as.data.tableI(data, complete=TRUE, day=TRUE)
73     levelplot(x, data0,
74       par.settings = par.settings,
75       xscale.components = xscale.components,
76       yscale.components = yscale.components,
77       panel = panel, interpolate = interpolate,
78       ...)
79   }
80 )

```

losses

```

1 setGeneric('losses', function(object){standardGeneric('losses')})
2
3 setMethod('losses',
4   signature=(object='Gef'),
5   definition=function(object){
6     dat <- as.data.tableY(object, complete=TRUE)
7     isShd=('Gef0d' %in% names(dat)) ##is there shadows?
8     if (isShd) {
9       shd <- with(dat, mean(1-Gefd/Gef0d))
10      eff <- with(dat, mean(1-Gef0d/Gd))
11    } else {
12      shd <- 0
13      eff <- with(dat, mean(1-Gefd/Gd))
14    }
15    result <- data.table(Shadows = shd, AoI = eff)
16    result
17  }
18 )
19
20 setMethod('losses',
21   signature=(object='ProdGCPV'),
22   definition=function(object){
23     datY <- as.data.tableY(object, complete=TRUE)
24     module0=object@module
25     module0$CoefVT=0 ##No losses with temperature
26     Pg=object@generator$Pg
27     Nm=1/sample2Hours(object@sample)
28     datI <- as.data.tableI(object, complete=TRUE)
29     if (object@type=='prom'){
30       datI[, DayOfMonth := DOM(datI)]
31       YfDC0 <- datI[, sum(Vmpp*Impp/Pg*DayOfMonth, na.rm = TRUE),
32         by = month(Dates)][[2]]
33       YfDC0 <- sum(YfDC0, na.rm = TRUE)
34       YfACO <- datI[, sum(Pdc*EffI/Pg*DayOfMonth, na.rm = TRUE),
35         by = month(Dates)][[2]]
36       YfACO <- sum(YfACO, na.rm = TRUE)
37     } else {
38       datI[, DayOfMonth := DOM(datI)]
39       YfDC0 <- datI[, sum(Vmpp*Impp/Pg*DayOfMonth, na.rm = TRUE),
40         by = year(Dates)][[2]]
41       YfACO <- datI[, sum(Pdc*EffI/Pg*DayOfMonth, na.rm = TRUE),
42         by = year(Dates)][[2]]
43     }
44     gen <- mean(1-YfDC0/datY$Gefd)
45     YfDC <- datY$Edc/Pg*1000
46     DC=mean(1-YfDC/YfDC0)
47     inv=mean(1-YfACO/YfDC)
48     AC=mean(1-datY$Yf/YfACO)
49     result0 <- losses(as(object, 'Gef'))
50     result1 <- data.table(Generator = gen,
51       DC = DC,
52       Inverter = inv,
53       AC = AC)
54     result <- data.table(result0, result1)

```

```

55         result
56     }
57 )
58
59 ###compareLosses
60
61 ## compareLosses,ProdGCPV: no visible binding for global variable 'name'
62 if(getRversion() >= "2.15.1") globalVariables(c('name'))
63
64 setGeneric('compareLosses', signature='...', function(...){standardGeneric('
    compareLosses'})})
65
66 setMethod('compareLosses', 'ProdGCPV',
67     definition=function(...){
68         dots <- list(...)
69         nms0 <- substitute(list(...))
70         if (!is.null(names(nms0))) { ##do.call
71             nms <- names(nms0[-1])
72         } else {
73             nms <- as.character(nms0[-1])
74         }
75         foo <- function(object, label){
76             yY <- losses(object)
77             yY <- cbind(yY, name=label)
78             yY
79         }
80         cdata <- mapply(FUN=foo, dots, nms, SIMPLIFY=FALSE)
81         z <- do.call(rbind, cdata)
82         z <- melt(z, id.vars = 'name')
83         p <- dotplot(variable~value*100, groups=name, data=z,
84             par.settings=solaR.theme, type='b',
85             auto.key=list(corner=c(0.95,0.2), cex=0.7), xlab='Losses
    (%)')
86         print(p)
87         return(z)
88     }
89 )

```

mergeSolar

```

1  setGeneric('mergesolaR', signature='...', function(...){standardGeneric('
    mergesolaR'})})
2
3  fooMeteo <- function(object, var){yY <- getData(object)[, .SD,
4                                     by = Dates,
5                                     .SDcols = var]}
6
7  fooGO <- function(object, var){yY <- as.data.tableD(object)[, .SD,
8                                     by = Dates,
9                                     .SDcols = var]}
10
11 mergeFunction <- function(..., foo, var){
12     dots <- list(...)
13     dots <- lapply(dots, as, class(dots[[1]])) ##the first element is the one
    that dictates the class to everyone

```



```

14   nms0 <- substitute(list(...))
15   if (!is.null(names(nms0))) { ##do.call
16     nms <- names(nms0[-1])
17   } else {
18     nms <- as.character(nms0[-1])
19   }
20   cdata <- sapply(dots, FUN=foo, var, simplify=FALSE)
21   z <- cdata[[1]]
22   for (i in 2:length(cdata)){
23     z <- merge(z, cdata[[i]], by = 'Dates', suffixes = c("", paste0('.', i)))
24   }
25   names(z)[-1] <- nms
26   z
27 }
28
29 setMethod('mergesolaR',
30   signature='Meteo',
31   definition=function(...){
32     res <- mergeFunction(..., foo=fooMeteo, var='G0')
33     res
34   }
35 )
36
37 setMethod('mergesolaR',
38   signature='G0',
39   definition=function(...){
40     res <- mergeFunction(..., foo=fooG0, var='G0d')
41     res
42   }
43 )
44
45 setMethod('mergesolaR',
46   signature='Gef',
47   definition=function(...){
48     res <- mergeFunction(..., foo=fooG0, var='Gefd')
49     res
50   }
51 )
52
53 setMethod('mergesolaR',
54   signature='ProdGCPV',
55   definition=function(...){
56     res <- mergeFunction(..., foo=fooG0, var='Yf')
57     res
58   }
59 )
60
61 setMethod('mergesolaR',
62   signature='ProdPVPS',
63   definition=function(...){
64     res <- mergeFunction(..., foo=fooG0, var='Yf')
65     res
66   }
67 )

```

shadeplot

```

1 setGeneric('shadeplot', function(x, ...)standardGeneric('shadeplot'))
2
3 setMethod('shadeplot', signature(x='Shade'),
4     function(x,
5         main='',
6         xlab=expression(L[ew]),
7         ylab=expression(L[ns]),
8         n=9, ...){
9     red=x@distances
10    FS.loess=x@FS.loess
11    Yf.loess=x@Yf.loess
12    struct=x@struct
13    mode=x@modeTrk
14    if (mode=='two'){
15        Lew=seq(min(red$Lew),max(red$Lew),length=100)
16        Lns=seq(min(red$Lns),max(red$Lns),length=100)
17        Red=expand.grid(Lew=Lew,Lns=Lns)
18        FS=predict(FS.loess,Red)
19        Red$FS=as.numeric(FS)
20        AreaG=with(struct,L*W)
21        GRR=Red$Lew*Red$Lns/AreaG
22        Red$GRR=GRR
23        FS.m<-matrix(1-FS,
24            nrow=length(Lew),
25            ncol=length(Lns))
26        GRR.m<-matrix(GRR,
27            nrow=length(Lew),
28            ncol=length(Lns))
29        niveles=signif(seq(min(FS.m),max(FS.m),l=n+1),3)
30        pruebaCB<-("RColorBrewer" %in% .packages())
31        if (pruebaCB) {
32            paleta=rev(brewer.pal(n, 'YlOrRd'))
33        } else {
34            paleta=rev(heat.colors(n))}
35        par(mar=c(4.1,4.1,2.1,2.1))
36        filled.contour(x=Lew,y=Lns,z=FS.m,#...,
37            col=paleta, #levels=niveles,
38            nlevels=n,
39            plot.title=title(xlab=xlab,
40                ylab=ylab, main=main),
41            plot.axes={
42                axis(1);axis(2);
43                contour(Lew, Lns, FS.m,
44                    nlevels=n, #levels=niveles,
45                    col="black", labcex=.8, add=TRUE)
46                contour(Lew, Lns, GRR.m,
47                    col="black", lty=3, labcex=.8, add=
48                TRUE)
49                grid(col="white",lty=3)},
50            key.title=title("1-FS",cex.main=.8))
51        }
52        if (mode=='horiz') {
53            Lew=seq(min(red$Lew),max(red$Lew),length=100)
54            FS=predict(FS.loess,Lew)

```

```

54         GRR=Lew/struct$L
55         plot(GRR,1-FS,main=main,type='l',...)
56         grid()      }
57     if (mode=='fixed'){
58         D=seq(min(red$D),max(red$D),length=100)
59         FS=predict(FS.loess,D)
60         GRR=D/struct$L
61         plot(GRR,1-FS,main=main,type='l',...)
62         grid()      }
63     }
64 )

```

window

```

1  setMethod('[',
2      signature='Meteo',
3      definition=function(x, i, j,...){
4          if (!missing(i)) {
5              i <- truncDay(i)
6          } else {
7              i <- indexD(x)[1]
8          }
9          if (!missing(j)) {
10             j <- truncDay(j)+86400-1 ##The end is the last second of the day
11         } else {
12             nDays <- length(indexD(x))
13             j <- indexD(x)[nDays]+86400-1
14         }
15         stopifnot(j>i)
16         if (!is.null(i)) i <- truncDay(i)
17         if (!is.null(j)) j <- truncDay(j)+86400-1
18         d <- indexD(x)
19         x@data <- x@data[(d >= i & d <= j)]
20         x
21     }
22 )
23
24
25 setMethod('[',
26     signature='Sol',
27     definition=function(x, i, j, ...){
28         if (!missing(i)) {
29             i <- truncDay(i)
30         } else {
31             i <- indexD(x)[1]
32         }
33         if (!missing(j)) {
34             j <- truncDay(j)+86400-1##The end is the last second of the day
35         } else {
36             nDays <- length(indexD(x))
37             j <- indexD(x)[nDays]+86400-1
38         }
39         stopifnot(j>i)
40         if (!is.null(i)) i <- truncDay(i)
41         if (!is.null(j)) j <- truncDay(j)

```

```

42     d1 <- indexD(x)
43     d2 <- indexI(x)
44     x@solD <- x@solD[(d1 >= i & d1 <= j)]
45     x@solI <- x@solI[(d2 >= i & d2 <= j)]
46     x
47   }
48   )
49
50 setMethod('[',
51   signature='G0',
52   definition=function(x, i, j, ...){
53     sol <- as(x, 'Sol')[i=i, j=j, ...] ##Sol method
54     meteo <- as(x, 'Meteo')[i=i, j=j, ...] ##Meteo method
55     i <- indexI(sol)[1]
56     j <- indexI(sol)[length(indexI(sol))]
57     d1 <- indexD(x)
58     d2 <- indexI(x)
59     GOIw <- x@GOI[(d2 >= i & d2 <= j)]
60     Taw <- x@Ta[(d2 >= i & d2 <= j)]
61     GODw <- x@GOD[(d1 >= truncDay(i) & d1 <= truncDay(j))]
62     G0dmw <- GODw[, lapply(.SD/1000, mean, na.rm= TRUE),
63       .SDcols = c('G0d', 'D0d', 'B0d'),
64       by = .(month(Dates), year(Dates))]
65     if (x@type=='prom'){
66       G0dmw[, DayOfMonth := DOM(G0dmw)]
67       G0yw <- G0dmw[, lapply(.SD*DayOfMonth, sum, na.rm = TRUE),
68         .SDcols = c('G0d', 'D0d', 'B0d'),
69         by = .(Dates = year)]
70       G0dmw[, DayOfMonth := NULL]
71     } else {
72       G0yw <- GODw[, lapply(.SD/1000, sum, na.rm = TRUE),
73         .SDcols = c('G0d', 'D0d', 'B0d'),
74         by = .(Dates = year(unique(truncDay(Dates))))]
75     }
76     G0dmw[, Dates := paste(month.abb[month], year, sep = '. ')]
77     G0dmw[, c('month', 'year') := NULL]
78     setcolorder(G0dmw, 'Dates')
79     result <- new('G0',
80       meteo,
81       sol,
82       GOD=G0dw,
83       G0dm=G0dmw,
84       G0y=G0yw,
85       GOI=G0Iw,
86       Ta=Taw)
87     result
88   }
89   )
90
91
92 setMethod('[',
93   signature='Gef',
94   definition=function(x, i, j, ...){
95     g0 <- as(x, 'G0')[i=i, j=j, ...] ##G0 method
96     i <- indexI(g0)[1]
97     j <- indexI(g0)[length(indexI(g0))]

```

[illegible]


```

34         sep=sep, row.names = FALSE, ...)
35     }
36 })

```

xyplot

```

1 #####
2 ## THEMES
3 #####
4 xscale.solar <- function(...){ans <- xscale.components.default(...); ans$stop=
  FALSE; ans}
5 yscale.solar <- function(...){ans <- yscale.components.default(...); ans$right=
  FALSE; ans}
6
7 solaR.theme <- function(pch=19, cex=0.7, region=rev(brewer.pal(9, 'YlOrRd')),
  ...) {
8   theme <- custom.theme.2(pch=pch, cex=cex, region=region, ...)
9   theme$strip.background$col='transparent'
10  theme$strip.shingle$col='transparent'
11  theme$strip.border$col='transparent'
12  theme
13 }
14
15 solaR.theme.2 <- function(pch=19, cex=0.7, region=rev(brewer.pal(9, 'YlOrRd')),
  ...) {
16   theme <- custom.theme.2(pch=pch, cex=cex, region=region, ...)
17   theme$strip.background$col='lightgray'
18   theme$strip.shingle$col='lightgray'
19   theme
20 }
21
22 #####
23 ## XYPLOT
24 #####
25 setGeneric('xyplot')
26
27 setMethod('xyplot',
28   signature = c(x = 'data.frame', data = 'missing'),
29   definition = function(x, data,
30     par.settings = solaR.theme.2,
31     xscale.components=xscale.solar,
32     yscale.components=yscale.solar,
33     scales = list(y = 'free'),
34     ...){
35     N <- length(x)-1
36     x0 <- x[, lapply(.SD, as.numeric), by = Dates]
37     x0 <- melt(x0, id.vars = 'Dates')
38     x0$variable <- factor(x0$variable,
39       levels = rev(levels(factor(x0$variable))))
40     xyplot(value ~ Dates | variable, x0,
41       par.settings = par.settings,
42       xscale.components = xscale.components,
43       yscale.components = yscale.components,
44       scales = scales,
45       type = 'l', layout = c(1,N),

```



```

46         ...)
```

```

47     })
```

```

48
49 setMethod('xyplot',
50   signature=c(x='formula', data='Meteo'),
51   definition=function(x, data,
52                       par.settings=solaR.theme,
53                       xscale.components=xscale.solar,
54                       yscale.components=yscale.solar,
55                       ...){
56     data0=getData(data)
57     xyplot(x, data0,
58           par.settings = par.settings,
59           xscale.components = xscale.components,
60           yscale.components = yscale.components,
61           strip = strip.custom(strip.levels=c(TRUE, TRUE)), ...)
62   }
63 )
64
65 setMethod('xyplot',
66   signature=c(x='formula', data='Sol'),
67   definition=function(x, data,
68                       par.settings=solaR.theme,
69                       xscale.components=xscale.solar,
70                       yscale.components=yscale.solar,
71                       ...){
72     data0=as.data.tableI(data, complete=TRUE, day=TRUE)
73     data0[, w := h2r(hms(Dates)-12)]
74     xyplot(x, data0,
75           par.settings = par.settings,
76           xscale.components = xscale.components,
77           yscale.components = yscale.components,
78           strip = strip.custom(strip.levels=c(TRUE, TRUE)), ...)
79   }
80 )
81
82 setMethod('xyplot',
83   signature=c(x='formula', data='G0'),
84   definition=function(x, data,
85                       par.settings=solaR.theme,
86                       xscale.components=xscale.solar,
87                       yscale.components=yscale.solar,
88                       ...){
89     data0=as.data.tableI(data, complete=TRUE, day=TRUE)
90     xyplot(x, data0,
91           par.settings = par.settings,
92           xscale.components = xscale.components,
93           yscale.components = yscale.components,
94           strip = strip.custom(strip.levels=c(TRUE, TRUE)), ...)
95   }
96 )
97
98 setMethod('xyplot',
99   signature=c(x='formula', data='Shade'),
100  definition=function(x, data,
101                    par.settings=solaR.theme,
```

```

102         xscale.components=xscale.solar,
103         yscale.components=yscale.solar,
104         ...){
105     data0=as.data.table(data)
106     xyplot(x, data0,
107           par.settings = par.settings,
108           xscale.components = xscale.components,
109           yscale.components = yscale.components,
110           strip = strip.custom(strip.levels=c(TRUE, TRUE)), ...)
111     }
112   )
113
114   setMethod('xyplot',
115     signature=c(x='Meteo', data='missing'),
116     definition=function(x, data,
117       ...){
118       x0=getData(x)
119       xyplot(x0,
120             scales=list(cex=0.6, rot=0, y='free'),
121             strip=FALSE, strip.left=TRUE,
122             par.strip.text=list(cex=0.6),
123             ylab = '',
124             ...)
125     }
126   )
127
128   setMethod('xyplot',
129     signature=c(x='G0', data='missing'),
130     definition=function(x, data, ...){
131       x0 <- as.data.tableD(x, complete=FALSE)
132       x0 <- melt(x0, id.vars = 'Dates')
133       xyplot(value~Dates, x0, groups = variable,
134             par.settings=solar.theme.2,
135             xscale.components=xscale.solar,
136             yscale.components=yscale.solar,
137             superpose=TRUE,
138             auto.key=list(space='right'),
139             ylab='Wh/m\u00b2',
140             type = 'l',
141             ...)
142     }
143   )
144
145   setMethod('xyplot',
146     signature=c(x='ProdGCPV', data='missing'),
147     definition=function(x, data, ...){
148       x0 <- as.data.tableD(x, complete=FALSE)
149       xyplot(x0,
150             strip = FALSE, strip.left = TRUE,
151             ylab = '', ...)
152     }
153   )
154
155   setMethod('xyplot',
156     signature=c(x='ProdPVPS', data='missing'),
157     definition=function(x, data, ...){

```

```

158     x0 <- as.data.tableD(x, complete=FALSE)
159     xyplot(x0,
160           strip = FALSE, strip.left = TRUE,
161           ylab = '', ...)
162   }
163 )

```

A.5. Conjunto de datos

aguilar

```

1 data(MTM)
2 Ktlim

```

```

      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,] 0.031 0.058 0.051 0.052 0.028 0.053 0.044 0.085 0.010 0.319
[2,] 0.705 0.694 0.753 0.753 0.807 0.856 0.818 0.846 0.842 0.865

```

```

1 Ktmtm

```

```

[1] 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 1.00

```

```

1 head(MTM)

```

```

      V1    V2    V3    V4    V5    V6    V7    V8    V9 V10
1 0.229 0.333 0.208 0.042 0.083 0.042 0.042 0.021 0.000  0
2 0.167 0.319 0.194 0.139 0.097 0.028 0.042 0.000 0.014  0
3 0.250 0.250 0.091 0.136 0.091 0.046 0.046 0.023 0.068  0
4 0.158 0.237 0.158 0.263 0.026 0.053 0.079 0.026 0.000  0
5 0.211 0.053 0.211 0.158 0.053 0.053 0.158 0.105 0.000  0
6 0.125 0.125 0.250 0.188 0.063 0.125 0.000 0.125 0.000  0

```

SIAR

```

1 data(SIAR)
2 head(est_SIAR)

```

	Estacion	Codigo	Longitud	Latitud	Altitud	Fecha_Instalacion	Fecha_Baja
	<char>	<char>	<num>	<num>	<int>	<Date>	<Date>
1:	Villena	A01	-0.884444444	38.67639	519	1999-11-09	2000-03-19
2:	Camp de Mirra	A02	-0.772777778	38.67917	589	1999-11-09	<NA>
3:	Vila Joiosa	A03	-0.256111111	38.52778	73	1999-11-10	<NA>
4:	Ondara	A04	0.006388889	38.81833	38	1999-11-10	<NA>
5:	Dénia Gata	A05	0.082500000	38.79250	86	1999-11-15	<NA>
6:	Pinoso	A06	-1.060555556	38.42722	629	1999-11-14	<NA>

helios

```

1 data(helios)
2 head(helios)

```

```

      yyyy.mm.dd    G.O. TambMax TambMin
1 2009/01/01    980.14    11.77    6.31
2 2009/01/02   1671.80    15.08    7.27
3 2009/01/03    671.02     9.33    6.36
4 2009/01/04   2482.80    11.71    1.11
5 2009/01/05   1178.19     7.33   -1.54
6 2009/01/06   1722.31     7.77   -0.78

```

prodEx

```
1 data(prodEx)
2 head(prodEx)
```

	Dates	1	2	3	4	5	6	7	8	9	
	<Date>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	
1:	2007-07-02	8.874982	8.847533	7.173181	8.874982	8.920729	8.975626	8.948177	8.948177	8.948177	
2:	2007-07-03	8.710291	8.691992	8.655395	8.710291	8.737740	8.792637	8.774338	8.774338	8.746889	
3:	2007-07-04	8.746889	8.737740	8.865832	8.737740	8.765188	8.838384	8.810935	8.792637	8.801786	
4:	2007-07-05	8.280266	8.271117	8.408359	8.280266	8.344313	8.380911	8.353462	8.362612	8.316864	
5:	2007-07-06	8.399209	8.417508	8.509003	8.435807	8.490704	8.490704	8.499854	8.527302	8.472405	
6:	2007-07-07	8.197921	8.170473	8.335163	8.225370	8.243669	8.307715	8.298565	8.280266	8.243669	
	10	11	12	13	14	15	16	17	18	19	20
	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>	<num>
1:	8.984775	8.783487	8.865832	8.966476	8.884131	8.774338	8.829234	8.627946	8.911580	8.807886	6.505270
2:	8.801786	8.545601	8.682843	8.774338	8.691992	8.591348	8.646245	8.426658	8.710291	8.563900	3.952569
3:	8.829234	8.545601	8.618797	8.829234	8.719441	8.618797	8.664544	8.426658	8.728590	8.612697	6.331430
4:	8.380911	8.179622	8.271117	8.353462	8.280266	8.207071	8.261968	8.188772	7.950886	8.222320	5.498829
5:	8.509003	8.316864	8.426658	8.490704	8.435807	8.344313	8.408359	8.371761	8.463256	8.332113	6.551017
6:	8.326014	8.152174	8.161323	8.316864	8.234519	8.143024	8.179622	8.170473	8.243669	8.161323	6.669960
	21	22									
	<num>	<num>									
1:	3.742131	3.980018									
2:	4.080662	3.238911									
3:	1.363270	1.043039									
4:	3.998316	2.461206									
5:	5.361587	4.959010									
6:	5.215195	4.922413									

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