

ENV 790.30 - Time Series Analysis for Energy Data | Spring 2024

Assignment 5 - Due date 02/19/24

Julia

Directions

You should open the .rmd file corresponding to this assignment on RStudio. The file is available on our class repository on Github. And to do so you will need to fork our repository and link it to your RStudio.

Once you have the file open on your local machine the first thing you will do is rename the file such that it includes your first and last name (e.g., “LuanaLima_TSA_A05_Sp23.Rmd”). Then change “Student Name” on line 4 with your name.

Then you will start working through the assignment by **creating code and output** that answer each question. Be sure to use this assignment document. Your report should contain the answer to each question and any plots/tables you obtained (when applicable).

When you have completed the assignment, **Knit** the text and code into a single PDF file. Submit this pdf using Sakai.

R packages needed for this assignment: “readxl”, “ggplot2”, “forecast”, “tseries”, and “Kendall”. Install these packages, if you haven’t done yet. Do not forget to load them before running your script, since they are NOT default packages.\

```
#Load/install required package here  
library(forecast)
```

```
## Registered S3 method overwritten by 'quantmod':  
##   method           from  
##   as.zoo.data.frame zoo
```

```
library(readxl)  
library(stats)  
library(tseries)  
library(ggplot2)  
library(Kendall)  
library(lubridate)
```

```
##  
## Attaching package: 'lubridate'  
  
## The following objects are masked from 'package:base':  
##  
##   date, intersect, setdiff, union
```

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --  
## v dplyr   1.1.3      v stringr 1.5.0  
## v forcats 1.0.0      v tibble  3.2.1  
## v purrr   1.0.2      v tidyr   1.3.0
```

```
## v readr 2.1.4

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag() masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(cowplot)#load this package so you can clean the data frame using pipes

##
## Attaching package: 'cowplot'
##
## The following object is masked from 'package:lubridate':
##
## stamp
```

Decomposing Time Series

Consider the same data you used for A04 from the spreadsheet “Table_10.1_Renewable_Energy_Production_and_Consumption”. The data comes from the US Energy Information and Administration and corresponds to the December 2023 Monthly Energy Review.

```
#Importing data set - using xlsx package
energy_data <- read_excel("~/Julia_Kagiliery_TSA_Sp24/Data/Table_10.1_Renewable_Energy_Production_and_Consumption.xlsx",
  skip = 9)
energy_data <- energy_data[-1,]
```

Q1

For this assignment you will work only with the following columns: Solar Energy Consumption and Wind Energy Consumption. Create a data frame structure with these two time series only and the Date column. Drop the rows with *Not Available* and convert the columns to numeric. You can use filtering to eliminate the initial rows or convert to numeric and then use the `drop_na()` function. If you are familiar with pipes for data wrangling, try using it!

```
energy_data <- energy_data |>
  select(c("Solar Energy Consumption", "Wind Energy Consumption", "Month"))

energy_data <- energy_data |>
  filter(
    `Solar Energy Consumption` != "Not Available",
    `Wind Energy Consumption` != "Not Available")

energy_data <- energy_data |>
  mutate(
    `Solar Energy Consumption` = as.numeric(`Solar Energy Consumption`),
    `Wind Energy Consumption` = as.numeric(`Wind Energy Consumption`),
    Month = ymd(Month)
  )
```

Chat GPT prompt for `ymd()`: how to use `my()` function for date conversions

```
typeof(energy_data$Month)
```

```
## [1] "double"
```

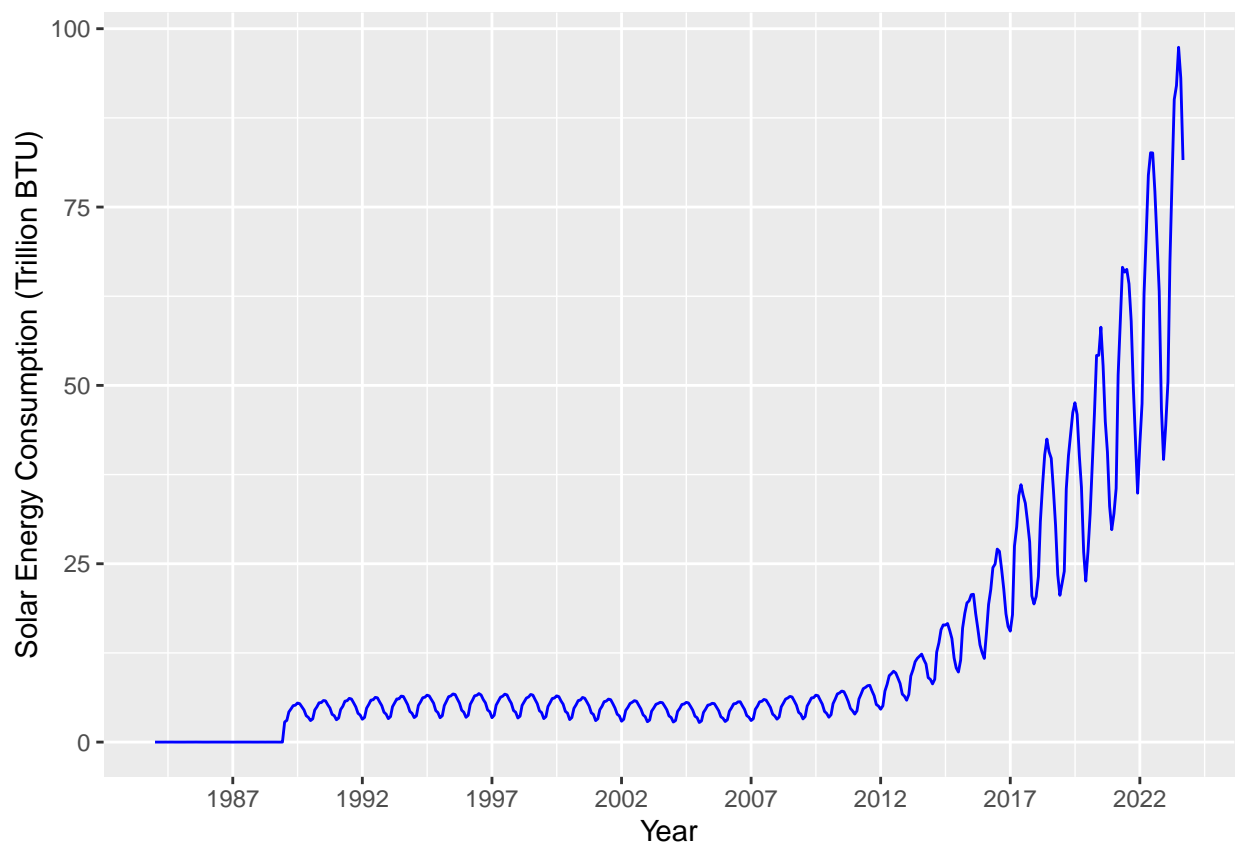
```
nobs=nrow(energy_data)
nvar=ncol(energy_data)
```

```
energyTS <- ts(energy_data)
```

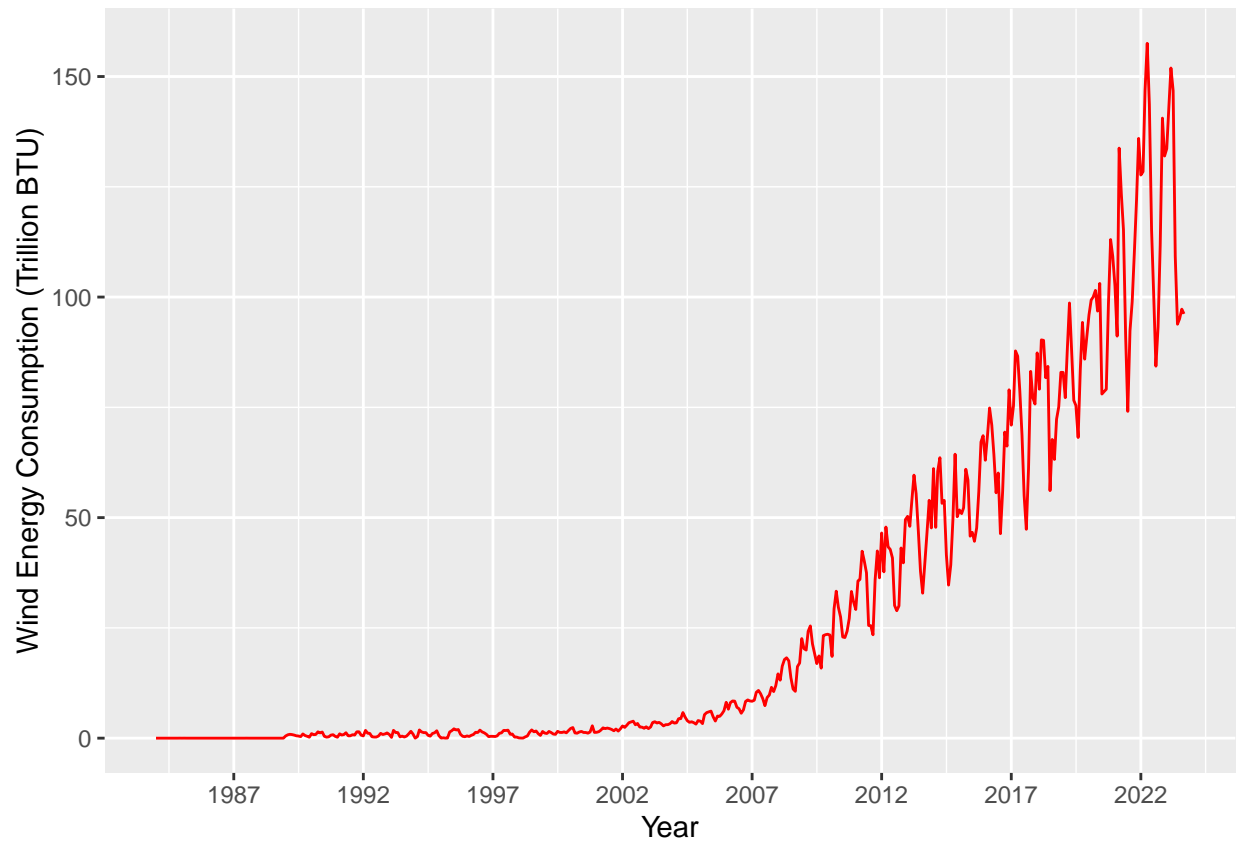
Q2

Plot the Solar and Wind energy consumption over time using ggplot. Plot each series on a separate graph. No need to add legend. Add informative names to the y axis using `ylab()`. Explore the function `scale_x_date()` on ggplot and see if you can change the x axis to improve your plot. Hint: use `scale_x_date(date_breaks = "5 years", date_labels = "%Y")`

```
energy_data |>
ggplot(aes(x=Month, y= `Solar Energy Consumption`)) +
  geom_line(color="blue") +
  scale_x_date(date_breaks = "5 years", date_labels = "%Y") +
  ylab("Solar Energy Consumption (Trillion BTU)") +
  xlab("Year")
```



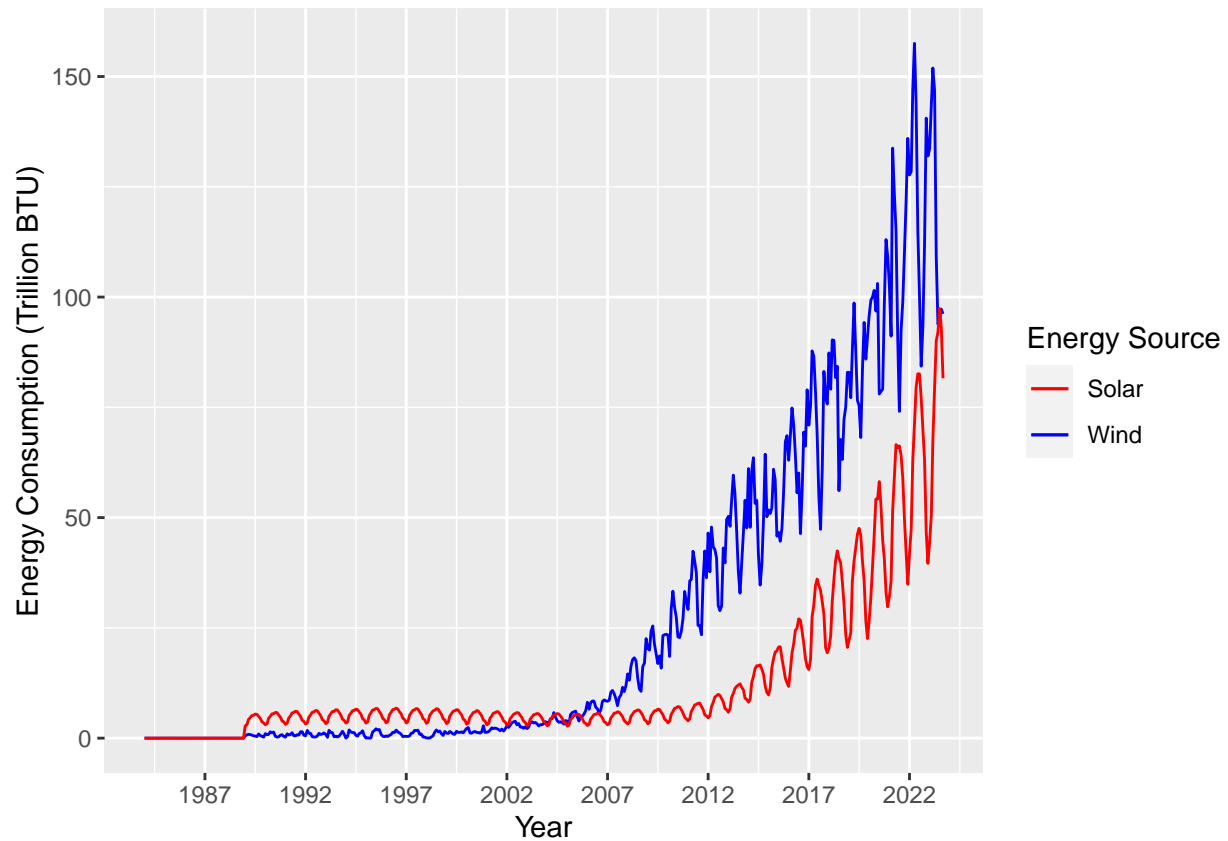
```
energy_data |>
ggplot(aes(x=Month, y= `Wind Energy Consumption`)) +
  geom_line(color="red") +
  scale_x_date(date_breaks = "5 years", date_labels = "%Y") +
  ylab("Wind Energy Consumption (Trillion BTU)") +
  xlab("Year")
```



Q3

Now plot both series in the same graph, also using `ggplot()`. Use function `scale_color_manual()` to manually add a legend to `ggplot`. Make the solar energy consumption red and wind energy consumption blue. Add informative name to the y axis using `ylab("Energy Consumption")`. And use function `scale_x_date()` to set x axis breaks every 5 years.

```
energy_data |>
  ggplot(aes(x = Month, color = factor("Wind"), y = `Wind Energy Consumption`)) +
  geom_line() +
  geom_line(aes(x = Month, color = factor("Solar"), y = `Solar Energy Consumption`)) +
  scale_x_date(date_breaks = "5 years", date_labels = "%Y") +
  ylab("Energy Consumption (Trillion BTU)") +
  xlab("Year") +
  scale_color_manual(name = "Energy Source", values = c("Wind" = "blue", "Solar" = "red"))
```



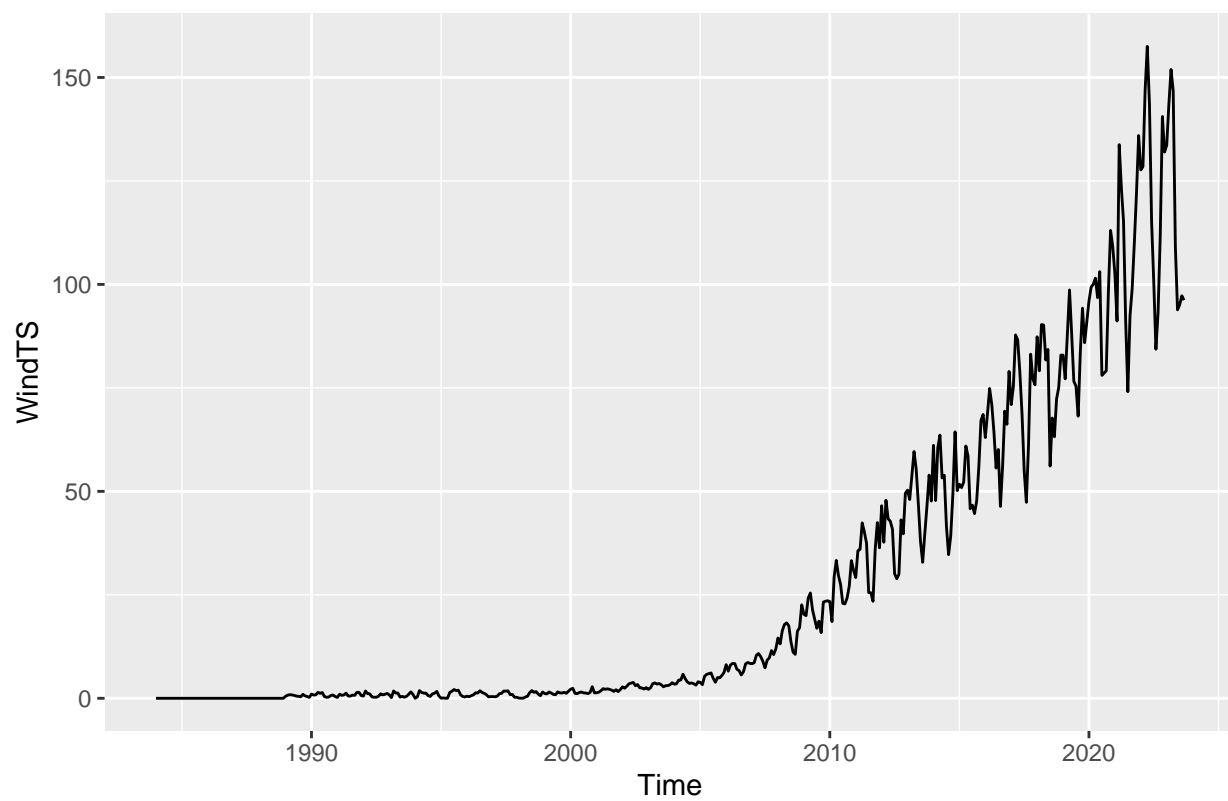
Code inspo: Chat GPT. Prompt: why isn't "scale_color_manual(values = colors)" adding a legend

Decomposing the time series

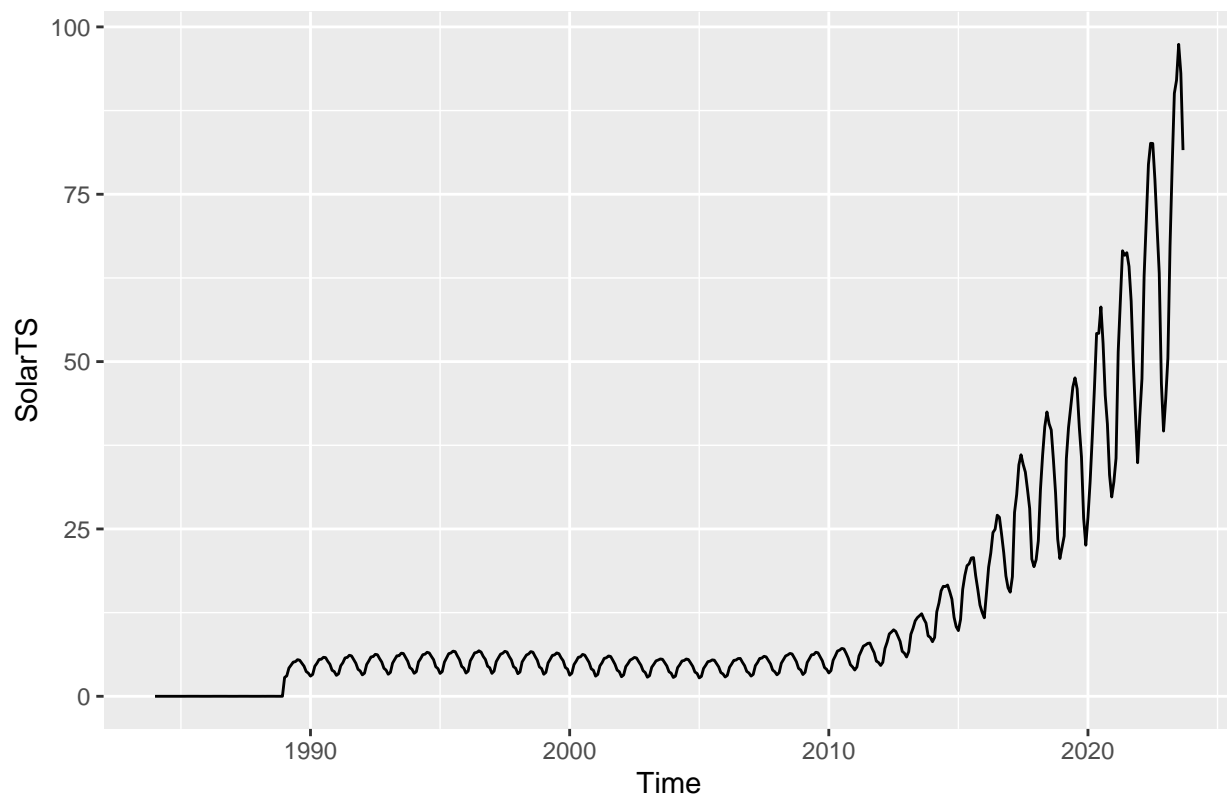
The stats package has a function called `decompose()`. This function only take time series object. As the name says the `decompose` function will decompose your time series into three components: trend, seasonal and random. This is similar to what we did in the previous script, but in a more automated way. The random component is the time series without seasonal and trend component.

```
WindTS <- ts(energy_data$`Wind Energy Consumption`, start = c(1984,1), frequency = 12)
SolarTS <- ts(energy_data$`Solar Energy Consumption`, start = c(1984,1), frequency = 12)

autoplot(WindTS)
```



```
autoplot(SolarTS)
```



Additional info on `decompose()`.

- 1) You have two options: alternative and multiplicative. Multiplicative models exhibit a change in frequency over time.
- 2) The trend is not a straight line because it uses a moving average method to detect trend.
- 3) The seasonal component of the time series is found by subtracting the trend component from the original data then grouping the results by month and averaging them.
- 4) The random component, also referred to as the noise component, is composed of all the leftover signal which is not explained by the combination of the trend and seasonal component.

Q4

Transform wind and solar series into a time series object and apply the `decompose` function on them using the additive option, i.e., `decompose(ts_data, type = "additive")`. What can you say about the trend component? What about the random component? Does the random component look random? Or does it appear to still have some seasonality on it?

```
print(decompose(WindTS, type = "additive"))
```

```
## $x
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep
## 1984  0.000  0.001  0.001  0.002  0.003  0.002  0.002  0.001  0.002
## 1985  0.002  0.004  0.002  0.002  0.001  0.001  0.000  0.001  0.003
## 1986  0.001  0.001  0.002  0.002  0.003  0.002  0.002  0.002  0.000
## 1987  0.000  0.000  0.000  0.000  0.001  0.003  0.004  0.001  0.001
## 1988  0.002  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
## 1989  0.497  0.763  0.873  0.812  0.697  0.534  0.485  0.352  0.956
## 1990  1.028  0.789  0.837  1.434  1.195  1.387  0.406  0.239  0.311
```

##	1991	0.212	0.989	0.707	0.813	1.237	0.530	0.530	0.777	0.707
##	1992	0.512	1.759	1.120	1.088	0.320	0.256	0.256	0.480	1.088
##	1993	0.844	0.169	1.773	1.266	1.266	0.295	0.464	0.253	0.464
##	1994	0.000	0.343	1.865	1.408	1.256	1.256	0.647	0.457	1.066
##	1995	0.019	0.080	0.016	0.023	1.394	1.701	2.115	1.862	1.955
##	1996	0.503	0.382	0.640	0.834	1.336	1.282	1.826	1.416	1.199
##	1997	0.411	0.372	0.507	1.106	1.196	1.764	1.738	1.809	0.888
##	1998	0.059	0.028	0.021	0.293	0.489	1.348	1.868	1.438	1.623
##	1999	1.150	1.054	1.524	1.274	0.940	0.866	1.556	1.304	1.288
##	2000	2.202	2.409	1.194	1.126	1.392	1.525	1.296	1.284	1.134
##	2001	1.328	1.471	1.816	2.336	2.167	2.285	2.167	1.969	1.673
##	2002	2.769	2.436	2.907	3.495	3.677	3.843	3.038	3.332	2.511
##	2003	2.158	2.543	3.535	3.729	3.434	3.573	3.253	2.782	3.054
##	2004	3.410	3.486	4.406	4.418	5.806	4.767	3.973	3.585	3.718
##	2005	3.861	3.298	5.325	5.792	5.959	6.131	4.848	3.883	5.010
##	2006	8.130	6.558	8.048	8.434	8.389	7.001	6.671	5.647	6.412
##	2007	8.367	8.598	10.397	10.822	10.073	8.941	7.364	9.210	9.781
##	2008	14.580	13.142	16.316	17.829	18.221	17.539	13.677	11.138	10.616
##	2009	20.304	19.968	24.222	25.446	21.366	19.105	16.906	18.645	15.868
##	2010	23.387	18.533	29.306	33.316	29.676	27.463	22.942	22.812	24.244
##	2011	29.174	35.661	35.978	42.383	40.167	37.481	25.551	25.500	23.437
##	2012	46.514	37.709	47.858	43.364	42.788	40.850	30.099	28.896	29.990
##	2013	50.288	48.026	53.758	59.629	55.406	46.909	37.851	32.871	39.832
##	2014	61.113	47.798	60.515	63.584	53.232	53.906	41.583	34.702	39.305
##	2015	51.733	50.912	52.231	60.963	58.520	45.793	46.661	44.629	47.671
##	2016	63.007	68.712	74.857	70.967	64.309	55.627	60.114	46.367	55.969
##	2017	70.965	75.375	87.793	86.590	78.707	68.724	55.001	47.355	61.115
##	2018	87.343	79.123	90.294	90.182	81.728	84.286	56.116	67.716	63.189
##	2019	82.917	77.189	87.936	98.659	87.959	76.586	75.408	68.165	83.640
##	2020	95.950	99.325	100.039	101.515	96.824	103.085	78.019	78.576	79.111
##	2021	102.566	91.153	133.768	123.370	115.280	91.003	74.093	92.367	98.941
##	2022	127.664	128.443	146.820	157.522	143.726	115.215	100.569	84.339	93.254
##	2023	133.636	143.503	151.927	146.775	109.246	93.850	95.085	97.256	96.196
##		Oct	Nov	Dec						
##	1984	0.003	0.003	0.004						
##	1985	0.002	0.001	0.000						
##	1986	0.001	0.000	0.000						
##	1987	0.000	0.000	0.001						
##	1988	0.000	0.000	0.000						
##	1989	0.599	0.419	0.219						
##	1990	0.693	0.789	0.406						
##	1991	1.448	1.448	0.671						
##	1992	0.832	0.960	1.184						
##	1993	0.971	1.562	0.929						
##	1994	1.218	1.675	0.571						
##	1995	0.876	0.427	0.329						
##	1996	0.863	0.337	0.417						
##	1997	0.937	0.248	0.244						
##	1998	1.019	0.618	1.519						
##	1999	1.428	1.209	1.720						
##	2000	1.404	2.808	1.309						
##	2001	2.071	1.605	2.101						
##	2002	2.506	2.238	2.577						
##	2003	3.061	3.280	3.770						


```

## 2004    3.511    3.181    3.999
## 2005    4.934    5.492    6.237
## 2006    8.333    8.668    8.433
## 2007   11.521   10.560   11.909
## 2008   16.229   17.038   22.573
## 2009   23.248   23.458   23.563
## 2010   27.104   33.259   30.910
## 2011   35.913   42.440   36.358
## 2012   43.113   39.745   49.557
## 2013   46.523   53.921   47.656
## 2014   49.501   64.374   50.195
## 2015   55.889   67.154   68.576
## 2016   69.384   66.212   78.973
## 2017   83.146   77.162   75.749
## 2018   72.314   75.118   82.933
## 2019   94.255   85.929   90.909
## 2020   98.343  113.038  109.220
## 2021  109.918  121.983  135.965
## 2022  111.725  140.570  131.975
## 2023

```

```
##
```

```
## $seasonal
```

```

##           Jan           Feb           Mar           Apr           May           Jun
## 1984  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1985  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1986  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1987  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1988  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1989  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1990  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1991  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1992  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1993  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1994  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1995  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1996  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1997  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1998  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 1999  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2000  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2001  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2002  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2003  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2004  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2005  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2006  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2007  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2008  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2009  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2010  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2011  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2012  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2013  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092
## 2014  1.6112906  0.7262628  4.8536635  4.9053327  2.3737263 -0.7481092

```

##	2015	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2016	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2017	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2018	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2019	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2020	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2021	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2022	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##	2023	1.6112906	0.7262628	4.8536635	4.9053327	2.3737263	-0.7481092
##		Jul	Aug	Sep	Oct	Nov	Dec
##	1984	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1985	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1986	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1987	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1988	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1989	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1990	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1991	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1992	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1993	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1994	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1995	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1996	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1997	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1998	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	1999	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2000	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2001	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2002	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2003	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2004	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2005	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2006	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2007	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2008	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2009	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2010	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2011	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2012	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2013	-4.9580096	-6.0986357	-4.7510844	-0.6135406	1.2691688	1.4299348
##	2014	-4.958009					

##	1985	2.166667e-03	2.083333e-03	2.125000e-03	2.125000e-03	2.000000e-03
##	1986	1.583333e-03	1.708333e-03	1.625000e-03	1.458333e-03	1.375000e-03
##	1987	8.333333e-04	8.750000e-04	8.750000e-04	8.750000e-04	8.333333e-04
##	1988	5.833333e-04	3.750000e-04	2.916667e-04	2.500000e-04	2.500000e-04
##	1989	3.682083e-01	4.030833e-01	4.575833e-01	5.223750e-01	5.647917e-01
##	1990	8.050417e-01	7.970417e-01	7.654583e-01	7.425000e-01	7.618333e-01
##	1991	6.161667e-01	6.437500e-01	6.826667e-01	7.306250e-01	7.895417e-01
##	1992	8.749167e-01	8.511250e-01	8.546250e-01	8.448333e-01	7.988333e-01
##	1993	8.764167e-01	8.756250e-01	8.401667e-01	8.199583e-01	8.508333e-01
##	1994	9.052083e-01	9.213333e-01	9.549167e-01	9.902917e-01	1.005292e+00
##	1995	8.000833e-01	9.197917e-01	1.015375e+00	1.038167e+00	9.719167e-01
##	1996	1.033042e+00	1.002417e+00	9.523333e-01	9.202917e-01	9.160000e-01
##	1997	9.475000e-01	9.602083e-01	9.636250e-01	9.537500e-01	9.531250e-01
##	1998	6.805833e-01	6.705417e-01	6.857083e-01	7.197500e-01	7.385833e-01
##	1999	1.228083e+00	1.209500e+00	1.189958e+00	1.193042e+00	1.234708e+00
##	2000	1.518583e+00	1.506917e+00	1.499667e+00	1.492250e+00	1.557875e+00
##	2001	1.756125e+00	1.820958e+00	1.871958e+00	1.922208e+00	1.899875e+00
##	2002	2.595708e+00	2.688792e+00	2.780500e+00	2.833542e+00	2.878042e+00
##	2003	2.940125e+00	2.926167e+00	2.925875e+00	2.971625e+00	3.038167e+00
##	2004	3.821083e+00	3.884542e+00	3.945667e+00	3.992083e+00	4.006708e+00
##	2005	4.397542e+00	4.446417e+00	4.512667e+00	4.625792e+00	4.781375e+00
##	2006	6.489625e+00	6.639083e+00	6.771000e+00	6.971042e+00	7.245000e+00
##	2007	8.475708e+00	8.653042e+00	8.941875e+00	9.215083e+00	9.426750e+00
##	2008	1.342738e+01	1.377075e+01	1.388588e+01	1.411683e+01	1.458292e+01
##	2009	1.860804e+01	1.905538e+01	1.958700e+01	2.009829e+01	2.065825e+01
##	2010	2.386558e+01	2.429071e+01	2.481333e+01	2.532300e+01	2.589204e+01
##	2011	3.195162e+01	3.217233e+01	3.225071e+01	3.258412e+01	3.333371e+01
##	2012	3.754633e+01	3.787733e+01	3.829187e+01	3.886492e+01	3.905262e+01
##	2013	4.494100e+01	4.542963e+01	4.600533e+01	4.655750e+01	4.729025e+01
##	2014	5.005567e+01	5.028746e+01	5.034179e+01	5.044392e+01	5.100354e+01
##	2015	5.019592e+01	5.082112e+01	5.158333e+01	5.219808e+01	5.258008e+01
##	2016	6.123212e+01	6.186508e+01	6.228325e+01	6.319129e+01	6.371433e+01
##	2017	7.021804e+01	7.004617e+01	7.030175e+01	7.108958e+01	7.211925e+01
##	2018	7.608679e+01	7.698162e+01	7.791642e+01	7.755150e+01	7.701500e+01
##	2019	7.818983e+01	7.901238e+01	7.988321e+01	8.164954e+01	8.301421e+01
##	2020	9.136246e+01	9.190504e+01	9.215013e+01	9.213175e+01	9.343163e+01
##	2021	1.009570e+02	1.013680e+02	1.027689e+02	1.040775e+02	1.049325e+02
##	2022	1.221579e+02	1.229266e+02	1.223551e+02	1.221935e+02	1.230432e+02
##	2023	1.198856e+02	1.201953e+02	1.208561e+02	NA	NA
##		Jun	Jul	Aug	Sep	Oct
##	1984	NA	2.083333e-03	2.291667e-03	2.458333e-03	2.500000e-03
##	1985	1.750000e-03	1.541667e-03	1.375000e-03	1.250000e-03	1.250000e-03
##	1986	1.333333e-03	1.291667e-03	1.208333e-03	1.083333e-03	9.166667e-04
##	1987	8.750000e-04	1.000000e-03	1.083333e-03	1.083333e-03	1.083333e-03
##	1988	2.083333e-04	2.079167e-02	7.320833e-02	1.413750e-01	2.115833e-01
##	1989	5.913750e-01	6.226250e-01	6.458333e-01	6.454167e-01	6.698333e-01
##	1990	7.850417e-01	7.588333e-01	7.331667e-01	7.360833e-01	7.047917e-01
##	1991	8.280417e-01	8.515833e-01	8.961667e-01	9.454583e-01	9.741250e-01
##	1992	7.998750e-01	8.350833e-01	7.826667e-01	7.436250e-01	7.782500e-01
##	1993	8.652917e-01	8.195000e-01	7.915833e-01	8.026667e-01	8.124167e-01
##	1994	9.950833e-01	9.809583e-01	9.707917e-01	8.827917e-01	7.480417e-01
##	1995	9.098333e-01	9.199167e-01	9.526667e-01	9.912500e-01	1.051042e+00
##	1996	9.159167e-01	9.157500e-01	9.115000e-01	9.055417e-01	9.113333e-01
##	1997	9.422083e-01	9.203333e-01	8.913333e-01	8.567500e-01	8.026250e-01

```

## 1998 8.071250e-01 9.057083e-01 9.939167e-01 1.099292e+00 1.202792e+00
## 1999 1.267708e+00 1.319917e+00 1.420208e+00 1.462917e+00 1.443000e+00
## 2000 1.607375e+00 1.553833e+00 1.478333e+00 1.465167e+00 1.541500e+00
## 2001 1.882750e+00 1.975792e+00 2.076042e+00 2.161708e+00 2.255458e+00
## 2002 2.924250e+00 2.918625e+00 2.897625e+00 2.928250e+00 2.964167e+00
## 2003 3.131292e+00 3.233167e+00 3.324625e+00 3.400208e+00 3.465208e+00
## 2004 4.012125e+00 4.040458e+00 4.051417e+00 4.081875e+00 4.177417e+00
## 2005 4.970917e+00 5.242042e+00 5.555750e+00 5.805042e+00 6.028583e+00
## 2006 7.468833e+00 7.570208e+00 7.665083e+00 7.847958e+00 8.045333e+00
## 2007 9.650417e+00 1.005413e+01 1.050233e+01 1.093829e+01 1.147687e+01
## 2008 1.529717e+01 1.598000e+01 1.650292e+01 1.711675e+01 1.776354e+01
## 2009 2.096700e+01 2.113671e+01 2.120538e+01 2.135742e+01 2.189717e+01
## 2010 2.660654e+01 2.715379e+01 2.810858e+01 2.910025e+01 2.975604e+01
## 2011 3.394325e+01 3.489275e+01 3.570058e+01 3.628092e+01 3.681679e+01
## 2012 3.949029e+01 4.019750e+01 4.078462e+01 4.146033e+01 4.238387e+01
## 2013 4.780171e+01 4.817354e+01 4.861508e+01 4.888712e+01 4.933346e+01
## 2014 5.154488e+01 5.125983e+01 5.099875e+01 5.078333e+01 5.032896e+01
## 2015 5.346179e+01 5.469742e+01 5.590883e+01 5.759325e+01 5.895283e+01
## 2016 6.410829e+01 6.487308e+01 6.548229e+01 6.629892e+01 6.748887e+01
## 2017 7.244117e+01 7.298925e+01 7.382783e+01 7.408821e+01 7.434208e+01
## 2018 7.722917e+01 7.734408e+01 7.707908e+01 7.690025e+01 7.715521e+01
## 2019 8.379700e+01 8.467238e+01 8.613775e+01 8.756437e+01 8.818767e+01
## 2020 9.532413e+01 9.636275e+01 9.629792e+01 9.736279e+01 9.967879e+01
## 2021 1.064195e+02 1.085797e+02 1.111792e+02 1.132768e+02 1.152436e+02
## 2022 1.236514e+02 1.237340e+02 1.246103e+02 1.254506e+02 1.252156e+02
## 2023 NA NA NA NA
## Nov Dec
## 1984 2.416667e-03 2.291667e-03
## 1985 1.333333e-03 1.458333e-03
## 1986 7.500000e-04 7.083333e-04
## 1987 1.041667e-03 8.750000e-04
## 1988 2.744583e-01 3.257500e-01
## 1989 7.165000e-01 7.727917e-01
## 1990 6.806667e-01 6.467083e-01
## 1991 9.473750e-01 8.977500e-01
## 1992 8.250833e-01 8.661250e-01
## 1993 8.179167e-01 8.575417e-01
## 1994 6.960833e-01 7.203750e-01
## 1995 1.082417e+00 1.062542e+00
## 1996 9.168333e-01 9.310833e-01
## 1997 7.392917e-01 6.925000e-01
## 1998 1.262458e+00 1.261167e+00
## 1999 1.455667e+00 1.501958e+00
## 2000 1.624208e+00 1.688167e+00
## 2001 2.366667e+00 2.494500e+00
## 2002 2.963792e+00 2.942417e+00
## 2003 3.592750e+00 3.741333e+00
## 2004 4.241042e+00 4.304250e+00
## 2005 6.239917e+00 6.377417e+00
## 2006 8.215000e+00 8.366000e+00
## 2007 1.210833e+01 1.280608e+01
## 2008 1.821196e+01 1.840825e+01
## 2009 2.257133e+01 2.326583e+01
## 2010 3.057096e+01 3.142550e+01

```

```
## 2011 3.696687e+01 3.721646e+01
## 2012 4.358733e+01 4.436554e+01
## 2013 4.940767e+01 4.960862e+01
## 2014 5.044008e+01 5.032237e+01
## 2015 5.961087e+01 6.026183e+01
## 2016 6.873975e+01 6.988537e+01
## 2017 7.461763e+01 7.539192e+01
## 2018 7.776804e+01 7.770683e+01
## 2019 8.867604e+01 9.014954e+01
## 2020 1.013584e+02 1.016240e+02
## 2021 1.178518e+02 1.200459e+02
## 2022 1.233312e+02 1.210043e+02
## 2023
```

```
##
```

```
## $random
```

##	Jan	Feb	Mar	Apr	May
## 1984	NA	NA	NA	NA	NA
## 1985	-1.611457256	-0.724346144	-4.853788452	-4.905457705	-2.374726346
## 1986	-1.611873922	-0.726971144	-4.853288452	-4.904791039	-2.372101346
## 1987	-1.612123922	-0.727137811	-4.854538452	-4.906207705	-2.373559679
## 1988	-1.609873922	-0.726637811	-4.853955119	-4.905582705	-2.373976346
## 1989	-1.482498922	-0.366346144	-4.438246786	-4.615707705	-2.241518012
## 1990	-1.388332256	-0.734304478	-4.782121786	-4.213832705	-1.940559679
## 1991	-2.015457256	-0.381012811	-4.829330119	-4.822957705	-1.926268012
## 1992	-1.974207256	0.181612189	-4.588288452	-4.662166039	-2.852559679
## 1993	-1.643707256	-1.432887811	-3.920830119	-4.459291039	-1.958559679
## 1994	-2.516498922	-1.304596144	-3.943580119	-4.487624372	-2.123018012
## 1995	-2.392373922	-1.566054478	-5.853038452	-5.920499372	-1.951643012
## 1996	-2.141332256	-1.346679478	-5.165996786	-4.991624372	-1.953726346
## 1997	-2.147790589	-1.314471144	-5.310288452	-4.753082705	-2.130851346
## 1998	-2.232873922	-1.368804478	-5.518371786	-5.332082705	-2.623309679
## 1999	-1.689373922	-0.881762811	-4.519621786	-4.824374372	-2.668434679
## 2000	-0.927873922	0.175820522	-5.159330119	-5.271582705	-2.539601346
## 2001	-2.039415589	-1.076221144	-4.909621786	-4.491541039	-2.106601346
## 2002	-1.437998922	-0.979054478	-4.727163452	-4.243874372	-1.574768012
## 2003	-2.393415589	-1.109429478	-4.244538452	-4.147957705	-1.977893012
## 2004	-2.022373922	-1.124804478	-4.393330119	-4.479416039	-0.574434679
## 2005	-2.147832256	-1.874679478	-4.041330119	-3.739124372	-1.196101346
## 2006	0.029084411	-0.807346144	-3.576663452	-3.442374372	-1.229726346
## 2007	-1.719998922	-0.781304478	-3.398538452	-3.298416039	-1.727476346
## 2008	-0.458665589	-1.355012811	-2.423538452	-1.193166039	1.264356988
## 2009	0.084667744	0.186362189	-0.218663452	0.442375628	-1.665976346
## 2010	-2.089873922	-6.483971144	-0.360996786	3.087667295	1.410231988
## 2011	-4.388915589	2.762403856	-1.126371786	4.893542295	4.459565321
## 2012	7.356376078	-0.894596144	4.712461548	-0.406249372	1.361648654
## 2013	3.735709411	1.870112189	2.899003214	8.166167295	5.742023654
## 2014	9.446042744	-3.215721144	5.319544881	8.234750628	-0.145268012
## 2015	-0.074207256	-0.635387811	-4.205996786	3.859583961	3.566190321
## 2016	0.163584411	6.120653856	7.720086548	2.870375628	-1.779059679
## 2017	-0.864332256	4.602570522	12.637586548	10.595083961	4.214023654
## 2018	9.644917744	1.415112189	7.523919881	7.725167295	2.339273654
## 2019	3.115876078	-2.549637811	3.199128214	12.104125628	2.571065321
## 2020	2.976251078	6.693695522	3.035211548	4.477917295	1.018648654
## 2021	-0.002290589	-10.941304478	26.145419881	14.387208961	7.973815321

##	2022	3.894792744	4.790153856	19.611211548	30.423208961	18.309065321
##	2023	12.139126078	22.581445522	26.217253214	NA	NA
##		Jun	Jul	Aug	Sep	Oct
##	1984	NA	4.957926291	6.097344026	4.750626078	0.614040608
##	1985	0.747359181	4.956467958	6.098260693	4.752834411	0.614290608
##	1986	0.748775847	4.958717958	6.099427360	4.750001078	0.613623941
##	1987	0.750234181	4.961009625	6.098552360	4.751001078	0.612457274
##	1988	0.747900847	4.937217958	6.025427360	4.609709411	0.401957274
##	1989	0.690734181	4.820384625	5.804802360	5.061667744	0.542707274
##	1990	1.350067514	4.605176291	5.604469026	4.326001078	0.601748941
##	1991	0.450067514	4.636426291	5.979469026	4.512626078	1.087415608
##	1992	0.204234181	4.378926291	5.795969026	5.095459411	0.667290608
##	1993	0.177817514	4.602509625	5.560052360	4.412417744	0.772123941
##	1994	1.009025847	4.624051291	5.584844026	4.934292744	1.083498941
##	1995	1.539275847	6.153092958	7.007969026	5.714834411	0.438498941
##	1996	1.114192514	5.868259625	6.603135693	5.044542744	0.565207274
##	1997	1.569900847	5.775676291	7.016302360	4.782334411	0.747915608
##	1998	1.288984181	5.920301291	6.542719026	5.274792744	0.429748941
##	1999	0.346400847	5.194092958	5.982427360	4.576167744	0.598540608
##	2000	0.665734181	4.700176291	5.904302360	4.419917744	0.476040608
##	2001	1.150359181	5.149217958	5.991594026	4.262376078	0.429082274
##	2002	1.666859181	5.077384625	6.533010693	4.333834411	0.155373941
##	2003	1.189817514	4.977842958	5.556010693	4.404876078	0.209332274
##	2004	1.502984181	4.890551291	5.632219026	4.387209411	-0.052876059
##	2005	1.908192514	4.563967958	4.425885693	3.956042744	-0.481042726
##	2006	0.280275847	4.058801291	4.080552360	3.315126078	0.901207274
##	2007	0.038692514	2.267884625	4.806302360	3.593792744	0.657665608
##	2008	2.989942514	2.655009625	0.733719026	-1.749665589	-0.921001059
##	2009	-1.113890819	0.727301291	3.538260693	-0.738332256	1.964373941
##	2010	1.604567514	0.746217958	0.802052360	-0.105165589	-2.038501059
##	2011	4.285859181	-4.383740375	-4.101947640	-8.092832256	-0.290251059
##	2012	2.107817514	-5.140490375	-5.789989307	-6.719248922	1.342665608
##	2013	-0.144599153	-5.364532042	-9.645447640	-4.304040589	-2.196917726
##	2014	3.109234181	-4.718823709	-10.198114307	-6.727248922	-0.214417726
##	2015	-6.920682486	-3.078407042	-5.181197640	-5.171165589	-2.450292726
##	2016	-7.733182486	0.198926291	-13.016655974	-5.578832256	2.508665608
##	2017	-2.969057486	-13.030240375	-20.374197640	-8.222123922	9.417457274
##	2018	7.804942514	-16.270073709	-3.264447640	-8.960165589	-4.227667726
##	2019	-6.462890819	-4.306365375	-11.874114307	0.826709411	6.680873941
##	2020	8.508984181	-13.385740375	-11.623280974	-13.500707256	-0.722251059
##	2021	-14.668432486	-29.528657042	-12.713530974	-9.584665589	-4.712042726
##	2022	-7.688307486	-18.206990375	-34.172697640	-27.445540589	-12.877084392
##	2023	NA	NA	NA	NA	
##		Nov	Dec			
##	1984	-1.268585461	-1.428226486			
##	1985	-1.269502127	-1.431393153			
##	1986	-1.269918794	-1.430643153			
##	1987	-1.270210461	-1.429809820			
##	1988	-1.543627127	-1.755684820			
##	1989	-1.566668794	-1.983726486			
##	1990	-1.160835461	-1.670643153			
##	1991	-0.768543794	-1.656684820			
##	1992	-1.134252127	-1.112059820			
##	1993	-0.525085461	-1.358476486			

```

## 1994 -0.290252127 -1.579309820
## 1995 -1.924585461 -2.163476486
## 1996 -1.849002127 -1.944018153
## 1997 -1.760460461 -1.878434820
## 1998 -1.913627127 -1.172101486
## 1999 -1.515835461 -1.211893153
## 2000 -0.085377127 -1.809101486
## 2001 -2.030835461 -1.823434820
## 2002 -1.994960461 -1.795351486
## 2003 -1.581918794 -1.401268153
## 2004 -2.329210461 -1.735184820
## 2005 -2.017085461 -1.570351486
## 2006 -0.816168794 -1.362934820
## 2007 -2.817502127 -2.327018153
## 2008 -2.443127127 2.734815180
## 2009 -0.382502127 -1.132768153
## 2010 1.418872873 -1.945434820
## 2011 4.203956206 -2.288393153
## 2012 -5.111502127 3.761523514
## 2013 3.244164539 -3.382559820
## 2014 12.664747873 -1.557309820
## 2015 6.273956206 6.884231847
## 2016 -3.796918794 7.657690180
## 2017 1.275206206 -1.072851486
## 2018 -3.919210461 3.796231847
## 2019 -4.016210461 -0.670476486
## 2020 10.410414539 6.166065180
## 2021 2.861997873 14.489148514
## 2022 15.969664539 9.540773514
## 2023
##
## $figure
## [1] 1.6112906 0.7262628 4.8536635 4.9053327 2.3737263 -0.7481092
## [7] -4.9580096 -6.0986357 -4.7510844 -0.6135406 1.2691688 1.4299348
##
## $type
## [1] "additive"
##
## attr(,"class")
## [1] "decomposed.ts"

```

```
print(decompose(SolarTS, type = "additive"))
```

```

## $x
##      Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct
## 1984 0.000 0.000 0.001 0.001 0.002 0.003 0.001 0.003 0.003 0.002
## 1985 0.002 0.000 0.000 0.004 0.005 0.005 0.004 0.007 0.005 0.003
## 1986 0.002 0.002 0.003 0.005 0.006 0.005 0.006 0.006 0.005 0.004
## 1987 0.000 0.002 0.003 0.004 0.004 0.006 0.006 0.004 0.003 0.002
## 1988 0.002 0.003 0.004 0.002 0.004 0.005 0.004 0.004 0.003 0.000
## 1989 2.821 3.041 4.220 4.660 5.109 5.175 5.476 5.389 4.941 4.501
## 1990 3.015 3.256 4.489 4.946 5.515 5.534 5.832 5.781 5.228 4.782
## 1991 3.125 3.369 4.561 5.026 5.739 5.803 6.133 6.035 5.487 4.935
## 1992 3.196 3.451 4.752 5.284 5.883 5.931 6.274 6.205 5.628 5.115
## 1993 3.288 3.570 4.954 5.515 6.053 6.058 6.445 6.401 5.818 5.243

```

##	1994	3.432	3.680	5.137	5.640	6.216	6.292	6.584	6.471	5.949	5.458
##	1995	3.415	3.692	5.105	5.735	6.370	6.471	6.750	6.674	6.047	5.471
##	1996	3.472	3.760	5.293	5.865	6.487	6.562	6.804	6.602	5.956	5.494
##	1997	3.422	3.762	5.176	5.748	6.292	6.433	6.721	6.612	5.958	5.437
##	1998	3.375	3.629	5.138	5.664	6.173	6.327	6.679	6.584	5.956	5.395
##	1999	3.294	3.570	4.984	5.536	6.121	6.184	6.482	6.377	5.775	5.311
##	2000	3.155	3.440	4.733	5.239	5.832	5.895	6.261	6.144	5.608	5.056
##	2001	3.008	3.261	4.542	5.020	5.672	5.755	6.029	5.947	5.380	4.773
##	2002	2.923	3.189	4.435	4.877	5.408	5.585	5.812	5.719	5.162	4.647
##	2003	2.848	3.083	4.334	4.795	5.298	5.421	5.579	5.522	5.034	4.535
##	2004	2.809	3.019	4.289	4.722	5.278	5.343	5.575	5.488	4.986	4.470
##	2005	2.742	2.968	4.158	4.638	5.178	5.247	5.438	5.396	4.894	4.399
##	2006	2.881	3.124	4.327	4.821	5.368	5.410	5.640	5.657	5.085	4.577
##	2007	3.016	3.269	4.579	5.051	5.658	5.707	5.981	5.886	5.367	4.848
##	2008	3.206	3.518	4.933	5.478	6.029	6.181	6.408	6.326	5.758	5.166
##	2009	3.247	3.578	5.053	5.614	6.200	6.229	6.582	6.501	5.892	5.307
##	2010	3.485	3.833	5.386	6.033	6.760	6.895	7.158	7.072	6.433	5.693
##	2011	3.924	4.374	6.043	6.760	7.496	7.667	7.903	7.958	7.178	6.507
##	2012	4.607	5.077	7.148	8.096	9.316	9.605	9.934	9.685	8.960	8.214
##	2013	5.869	6.663	9.260	10.151	11.264	11.745	12.038	12.336	11.551	10.946
##	2014	8.157	8.799	12.624	13.934	15.758	16.428	16.395	16.624	15.631	14.507
##	2015	9.815	11.480	15.989	18.058	19.510	19.804	20.660	20.720	18.026	15.938
##	2016	11.728	15.428	19.297	21.401	24.459	24.955	27.056	26.741	24.199	21.438
##	2017	15.555	17.857	27.472	30.175	34.567	36.083	34.635	33.492	30.881	28.042
##	2018	20.417	23.213	30.918	36.049	40.277	42.476	40.715	39.785	35.355	30.386
##	2019	22.249	23.942	35.490	40.146	43.146	46.198	47.572	45.914	40.157	35.724
##	2020	26.741	32.049	38.731	46.045	54.208	54.219	58.159	52.712	44.933	40.674
##	2021	32.034	35.565	51.477	59.068	66.559	65.882	66.269	64.229	59.026	49.778
##	2022	41.808	47.446	62.806	71.072	79.459	82.611	82.584	77.169	70.105	63.190
##	2023	44.432	50.523	67.312	79.380	90.079	92.024	97.397	93.068	81.595	
##		Nov	Dec								
##	1984	0.001	0.000								
##	1985	0.001	0.001								
##	1986	0.003	0.001								
##	1987	0.001	0.001								
##	1988	0.000	0.000								
##	1989	3.697	3.465								
##	1990	3.884	3.700								
##	1991	4.034	3.792								
##	1992	4.187	3.914								
##	1993	4.297	4.039								
##	1994	4.415	4.136								
##	1995	4.473	4.192								
##	1996	4.495	4.262								
##	1997	4.424	4.187								
##	1998	4.389	4.147								
##	1999	4.307	4.068								
##	2000	4.103	3.882								
##	2001	3.905	3.675								
##	2002	3.821	3.551								
##	2003	3.669	3.452								
##	2004	3.625	3.418								
##	2005	3.547	3.335								
##	2006	3.718	3.487								


```

## 2007 3.922 3.662
## 2008 4.167 3.926
## 2009 4.300 4.023
## 2010 4.721 4.384
## 2011 5.259 5.056
## 2012 6.715 6.439
## 2013 9.028 8.800
## 2014 11.805 10.387
## 2015 13.628 12.547
## 2016 17.985 16.202
## 2017 20.501 19.362
## 2018 23.468 20.576
## 2019 26.634 22.573
## 2020 33.068 29.778
## 2021 42.082 34.895
## 2022 46.708 39.623
## 2023

```

```
##
```

```
## $seasonal
```

##	Jan	Feb	Mar	Apr	May	Jun
## 1984	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1985	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1986	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1987	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1988	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1989	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1990	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1991	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1992	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1993	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1994	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1995	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1996	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1997	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1998	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 1999	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2000	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2001	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2002	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2003	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2004	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2005	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2006	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2007	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2008	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2009	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2010	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2011	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2012	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2013	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2014	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2015	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2016	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025
## 2017	-4.00420660	-3.15722904	0.03232545	1.40253766	2.80309139	3.06251025

```

## 2018 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## 2019 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## 2020 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## 2021 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## 2022 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## 2023 -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
##          Jul          Aug          Sep          Oct          Nov          Dec
## 1984  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1985  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1986  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1987  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1988  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1989  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1990  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1991  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1992  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1993  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1994  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1995  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1996  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1997  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1998  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 1999  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2000  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2001  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2002  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2003  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2004  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2005  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2006  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2007  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2008  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2009  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2010  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2011  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2012  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2013  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2014  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2015  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2016  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2017  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2018  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2019  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2020  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2021  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2022  3.21594084  2.64254447  1.13678165 -0.36339998 -2.82600681 -3.94488929
## 2023  3.21594084  2.64254447  1.13678165
##
## $trend
##          Jan          Feb          Mar          Apr          May
## 1984          NA          NA          NA          NA          NA
## 1985  0.002291667  0.002583333  0.002833333  0.002958333  0.003000000
## 1986  0.003750000  0.003791667  0.003750000  0.003791667  0.003916667
## 1987  0.003666667  0.003583333  0.003416667  0.003250000  0.003083333

```

## 1988	0.003000000	0.002916667	0.002916667	0.002833333	0.002708333
## 1989	2.314416667	2.766791667	3.196916667	3.590208333	3.931791667
## 1990	4.533500000	4.564666667	4.592958333	4.616625000	4.636125000
## 1991	4.748375000	4.771500000	4.792875000	4.810041667	4.822666667
## 1992	4.915291667	4.928250000	4.941208333	4.954583333	4.968458333
## 1993	5.070541667	5.085833333	5.101916667	5.115166667	5.125083333
## 1994	5.225791667	5.234500000	5.242875000	5.257291667	5.271166667
## 1995	5.323666667	5.339041667	5.351583333	5.356208333	5.359166667
## 1996	5.422750000	5.422000000	5.415208333	5.412375000	5.414250000
## 1997	5.367041667	5.364000000	5.364500000	5.362208333	5.356875000
## 1998	5.302000000	5.299083333	5.297833333	5.296000000	5.292791667
## 1999	5.228375000	5.211541667	5.195375000	5.184333333	5.177416667
## 2000	5.041958333	5.023041667	5.006375000	4.988791667	4.969666667
## 2001	4.849666667	4.831791667	4.814083333	4.792791667	4.772750000
## 2002	4.668125000	4.649583333	4.631000000	4.616666667	4.607916667
## 2003	4.531208333	4.513291667	4.499750000	4.489750000	4.478750000
## 2004	4.437416667	4.435833333	4.432416667	4.427708333	4.423166667
## 2005	4.368708333	4.359166667	4.351500000	4.344708333	4.338500000
## 2006	4.420083333	4.439375000	4.458208333	4.473583333	4.488125000
## 2007	4.634541667	4.658291667	4.679583333	4.702625000	4.722416667
## 2008	4.935375000	4.971500000	5.006125000	5.035666667	5.059125000
## 2009	5.146583333	5.161125000	5.174000000	5.185458333	5.196875000
## 2010	5.440416667	5.488208333	5.534541667	5.573166667	5.606791667
## 2011	6.008125000	6.076083333	6.144041667	6.209000000	6.265333333
## 2012	7.060458333	7.217041667	7.363250000	7.508625000	7.640416667
## 2013	8.829250000	9.027375000	9.245791667	9.467583333	9.677791667
## 2014	11.881458333	12.241666667	12.590333333	12.908708333	13.172791667
## 2015	15.178125000	15.526500000	15.796958333	15.956375000	16.091958333
## 2016	18.498750000	19.016125000	19.524208333	20.010583333	20.421291667
## 2017	24.926625000	25.523708333	26.083416667	26.637000000	27.017000000
## 2018	30.275250000	30.790791667	31.239416667	31.523500000	31.744791667
## 2019	33.740375000	34.281458333	34.736916667	35.159416667	35.513750000
## 2020	39.655041667	40.379416667	40.861666667	41.266916667	41.741250000
## 2021	47.830333333	48.648125000	49.715208333	50.681750000	51.436666667
## 2022	59.136541667	60.355500000	61.356291667	62.376750000	63.128333333
## 2023	67.544625000	68.824291667	69.965500000	NA	NA
##	Jun	Jul	Aug	Sep	Oct
## 1984	NA	0.001500000	0.001583333	0.001541667	0.001625000
## 1985	0.003041667	0.003083333	0.003166667	0.003375000	0.003541667
## 1986	0.004000000	0.003916667	0.003833333	0.003833333	0.003791667
## 1987	0.003000000	0.003083333	0.003208333	0.003291667	0.003250000
## 1988	0.002625000	0.120041667	0.364083333	0.666333333	1.036083333
## 1989	4.230208333	4.382666667	4.399708333	4.419875000	4.443000000
## 1990	4.653708333	4.668083333	4.677375000	4.685083333	4.691416667
## 1991	4.832750000	4.839541667	4.845916667	4.857291667	4.876000000
## 1992	4.979916667	4.988833333	4.997625000	5.011000000	5.029041667
## 1993	5.134875000	5.146083333	5.156666667	5.168875000	5.181708333
## 1994	5.280125000	5.283458333	5.283250000	5.282416667	5.285041667
## 1995	5.363916667	5.368625000	5.373833333	5.384500000	5.397750000
## 1996	5.418083333	5.418916667	5.416916667	5.412125000	5.402375000
## 1997	5.350791667	5.345708333	5.338208333	5.331083333	5.326000000
## 1998	5.289666667	5.284625000	5.278791667	5.269916667	5.258166667
## 1999	5.170708333	5.161625000	5.150416667	5.134541667	5.111708333
## 2000	4.953416667	4.939541667	4.925958333	4.910541667	4.893458333

##	2001	4.755875000	4.743708333	4.737166667	4.729708333	4.719291667
##	2002	4.599250000	4.590958333	4.583416667	4.574791667	4.567166667
##	2003	4.468291667	4.462541667	4.458250000	4.453708333	4.448791667
##	2004	4.419916667	4.415708333	4.410791667	4.403208333	4.394250000
##	2005	4.331791667	4.334125000	4.346416667	4.359958333	4.374625000
##	2006	4.501583333	4.513541667	4.525208333	4.541750000	4.561833333
##	2007	4.738208333	4.753416667	4.771708333	4.796833333	4.829375000
##	2008	5.080333333	5.093041667	5.097250000	5.104750000	5.115416667
##	2009	5.206458333	5.220416667	5.240958333	5.265458333	5.296791667
##	2010	5.639375000	5.672708333	5.713541667	5.763458333	5.821125000
##	2011	6.315750000	6.372208333	6.429958333	6.505291667	6.607000000
##	2012	7.758708333	7.868916667	7.987583333	8.141666667	8.315291667
##	2013	9.872541667	10.066250000	10.250583333	10.479750000	10.777541667
##	2014	13.354625000	13.489833333	13.670625000	13.922541667	14.234583333
##	2015	16.257916667	16.427625000	16.671833333	16.974166667	17.251291667
##	2016	20.755125000	21.066875000	21.327541667	21.769375000	22.475583333
##	2017	27.253500000	27.587750000	28.013500000	28.380250000	28.768583333
##	2018	31.919000000	32.045916667	32.152625000	32.373500000	32.734708333
##	2019	35.728875000	35.999250000	36.524208333	36.997041667	37.377875000
##	2020	42.309541667	42.830291667	43.197333333	43.874916667	44.948625000
##	2021	52.025458333	52.645916667	53.548208333	54.515291667	55.487500000
##	2022	63.518083333	63.824416667	64.061958333	64.377916667	64.911833333
##	2023	NA	NA	NA	NA	
##		Nov	Dec			
##	1984	0.001875000	0.002083333			
##	1985	0.003625000	0.003666667			
##	1986	0.003666667	0.003625000			
##	1987	0.003166667	0.003125000			
##	1988	1.442875000	1.871000000			
##	1989	4.471833333	4.503708333			
##	1990	4.704083333	4.724625000			
##	1991	4.892750000	4.904083333			
##	1992	5.045750000	5.058125000			
##	1993	5.193708333	5.210250000			
##	1994	5.295416667	5.309291667			
##	1995	5.408041667	5.416708333			
##	1996	5.389375000	5.375875000			
##	1997	5.317541667	5.308166667			
##	1998	5.250666667	5.242541667			
##	1999	5.087291667	5.063208333			
##	2000	4.877666667	4.865166667			
##	2001	4.702333333	4.684250000			
##	2002	4.559166667	4.547750000			
##	2003	4.444916667	4.440833333			
##	2004	4.386583333	4.378416667			
##	2005	4.390166667	4.404875000			
##	2006	4.583500000	4.607958333			
##	2007	4.862625000	4.897833333			
##	2008	5.128208333	5.137333333			
##	2009	5.337583333	5.388666667			
##	2010	5.882083333	5.944916667			
##	2011	6.738500000	6.895083333			
##	2012	8.482083333	8.652416667			
##	2013	11.122416667	11.504791667			

```

## 2014 14.562750000 14.859750000
## 2015 17.596791667 18.017625000
## 2016 23.262333333 24.147166667
## 2017 29.251250000 29.755541667
## 2018 33.024958333 33.299583333
## 2019 38.084583333 38.879708333
## 2020 46.005875000 47.006458333
## 2021 56.525166667 57.759708333
## 2022 65.700500000 66.535208333
## 2023
##
## $random
##           Jan           Feb           Mar           Apr           May
## 1984           NA           NA           NA           NA           NA
## 1985  4.003914933  3.154645702 -0.035158785 -1.401495998 -2.801091393
## 1986  4.002456600  3.155437369 -0.033075452 -1.401329332 -2.801008060
## 1987  4.000539933  3.155645702 -0.032742118 -1.401787665 -2.802174726
## 1988  4.003206600  3.157312369 -0.031242118 -1.403370998 -2.801799726
## 1989  4.510789933  3.431437369  0.990757882 -0.332745998 -1.625883060
## 1990  2.485706600  1.848562369 -0.136283785 -1.073162665 -1.924216393
## 1991  2.380831600  1.754729035 -0.264200452 -1.186579332 -1.886758060
## 1992  2.284914933  1.679979035 -0.221533785 -1.073120998 -1.888549726
## 1993  2.221664933  1.641395702 -0.180242118 -1.002704332 -1.875174726
## 1994  2.210414933  1.602729035 -0.138200452 -1.019829332 -1.858258060
## 1995  2.095539933  1.510187369 -0.278908785 -1.023745998 -1.792258060
## 1996  2.053456600  1.495229035 -0.154533785 -0.949912665 -1.730341393
## 1997  2.059164933  1.555229035 -0.220825452 -1.016745998 -1.867966393
## 1998  2.077206600  1.487145702 -0.192158785 -1.034537665 -1.922883060
## 1999  2.069831600  1.515687369 -0.243700452 -1.050870998 -1.859508060
## 2000  2.117248266  1.574187369 -0.305700452 -1.152329332 -1.940758060
## 2001  2.162539933  1.586437369 -0.304408785 -1.175329332 -1.903841393
## 2002  2.259081600  1.696645702 -0.228325452 -1.142204332 -2.003008060
## 2003  2.320998266  1.726937369 -0.198075452 -1.097287665 -1.983841393
## 2004  2.375789933  1.740395702 -0.175742118 -1.108245998 -1.948258060
## 2005  2.377498266  1.766062369 -0.225825452 -1.109245998 -1.963591393
## 2006  2.465123266  1.841854035 -0.163533785 -1.055120998 -1.923216393
## 2007  2.385664933  1.767937369 -0.132908785 -1.054162665 -1.867508060
## 2008  2.274831600  1.703729035 -0.105450452 -0.960204332 -1.833216393
## 2009  2.104623266  1.574104035 -0.153325452 -0.973995998 -1.799966393
## 2010  2.048789933  1.502020702 -0.180867118 -0.942704332 -1.649883060
## 2011  1.920081600  1.455145702 -0.133367118 -0.851537665 -1.572424726
## 2012  1.550748266  1.017187369 -0.247575452 -0.815162665 -1.127508060
## 2013  1.043956600  0.792854035 -0.018117118 -0.719120998 -1.216883060
## 2014  0.279748266 -0.285437631  0.001341215 -0.377245998 -0.217883060
## 2015 -1.358918400 -0.889270965  0.159716215  0.699087335  0.614950274
## 2016 -2.766543400 -0.430895965 -0.259533785 -0.012120998  1.234616940
## 2017 -5.367418400 -4.509479298  1.356257882  2.135462335  4.746908607
## 2018 -5.854043400 -4.420562631 -0.353742118  3.122962335  5.729116940
## 2019 -7.487168400 -7.182229298  0.720757882  3.584045668  4.829158607
## 2020 -8.909835067 -5.173187631 -2.162992118  3.375545668  9.663658607
## 2021 -11.792126734 -9.925895965  1.729466215  6.983712335 12.319241940
## 2022 -13.324335067 -9.752270965  1.417382882  7.292712335 13.527575274
## 2023 -19.108418400 -15.144062631 -2.685825452           NA           NA
##           Jun           Jul           Aug           Sep           Oct

```

## 1984	NA	-3.216440836	-2.641127802	-1.135323315	0.363774976
## 1985	-3.060551919	-3.215024170	-2.638711135	-1.135156648	0.362858309
## 1986	-3.061510253	-3.213857503	-2.640377802	-1.135614982	0.363608309
## 1987	-3.059510253	-3.213024170	-2.641752802	-1.137073315	0.362149976
## 1988	-3.060135253	-3.331982503	-3.002627802	-1.800114982	-0.672683358
## 1989	-2.117718586	-2.122607503	-1.653252802	-0.615656648	0.421399976
## 1990	-2.182218586	-2.052024170	-1.538919469	-0.593864982	0.453983309
## 1991	-2.092260253	-1.922482503	-1.453461135	-0.507073315	0.422399976
## 1992	-2.111426919	-1.930774170	-1.435169469	-0.519781648	0.449358309
## 1993	-2.139385253	-1.917024170	-1.398211135	-0.487656648	0.424691642
## 1994	-2.050635253	-1.915399170	-1.454794469	-0.470198315	0.536358309
## 1995	-1.955426919	-1.834565836	-1.342377802	-0.474281648	0.436649976
## 1996	-1.918593586	-1.830857503	-1.457461135	-0.592906648	0.455024976
## 1997	-1.980301919	-1.840649170	-1.368752802	-0.509864982	0.474399976
## 1998	-2.025176919	-1.821565836	-1.337336135	-0.450698315	0.500233309
## 1999	-2.049218586	-1.895565836	-1.415961135	-0.496323315	0.562691642
## 2000	-2.120926919	-1.894482503	-1.424502802	-0.439323315	0.525941642
## 2001	-2.063385253	-1.930649170	-1.432711135	-0.486489982	0.417108309
## 2002	-2.076760253	-1.994899170	-1.506961135	-0.549573315	0.443233309
## 2003	-2.109801919	-2.099482503	-1.578794469	-0.556489982	0.449608309
## 2004	-2.139426919	-2.056649170	-1.565336135	-0.553989982	0.439149976
## 2005	-2.147301919	-2.112065836	-1.592961135	-0.602739982	0.387774976
## 2006	-2.154093586	-2.089482503	-1.510752802	-0.593531648	0.378566642
## 2007	-2.093718586	-1.988357503	-1.528252802	-0.566614982	0.382024976
## 2008	-1.961843586	-1.900982503	-1.413794469	-0.483531648	0.413983309
## 2009	-2.039968586	-1.854357503	-1.382502802	-0.510239982	0.373608309
## 2010	-1.806885253	-1.730649170	-1.284086135	-0.467239982	0.235274976
## 2011	-1.711260253	-1.685149170	-1.114502802	-0.464073315	0.263399976
## 2012	-1.216218586	-1.150857503	-0.945127802	-0.318448315	0.262108309
## 2013	-1.190051919	-1.244190836	-0.557127802	-0.065531648	0.531858309
## 2014	0.010864747	-0.310774170	0.310830531	0.571676685	0.635816642
## 2015	0.483573081	1.016434164	1.405622198	-0.084948315	-0.949891691
## 2016	1.137364747	2.773184164	2.770913865	1.292843352	-0.674183358
## 2017	5.766989747	3.831309164	2.835955531	1.363968352	-0.363183358
## 2018	7.494489747	5.453142497	4.989830531	1.844718352	-1.985308358
## 2019	7.406614747	8.356809164	6.747247198	2.023176685	-1.290475024
## 2020	8.846948081	12.112767497	6.872122198	-0.078698315	-3.911225024
## 2021	10.794031414	10.407142497	8.038247198	3.373926685	-5.346100024
## 2022	16.030406414	15.543642497	10.464497198	4.590301685	-1.358433358
## 2023	NA	NA	NA	NA	
##	Nov	Dec			
## 1984	2.825131813	3.942805959			
## 1985	2.823381813	3.942222625			
## 1986	2.825340147	3.942264292			
## 1987	2.823840147	3.942764292			
## 1988	1.383131813	2.073889292			
## 1989	2.051173480	2.906180959			
## 1990	2.005923480	2.920264292			
## 1991	1.967256813	2.832805959			
## 1992	1.967256813	2.800764292			
## 1993	1.929298480	2.773639292			
## 1994	1.945590147	2.771597625			
## 1995	1.890965147	2.720180959			
## 1996	1.931631813	2.831014292			

```
## 1997 1.932465147 2.823722625
## 1998 1.964340147 2.849347625
## 1999 2.045715147 2.949680959
## 2000 2.051340147 2.961722625
## 2001 2.028673480 2.935639292
## 2002 2.087840147 2.948139292
## 2003 2.050090147 2.956055959
## 2004 2.064423480 2.984472625
## 2005 1.982840147 2.875014292
## 2006 1.960506813 2.823930959
## 2007 1.885381813 2.709055959
## 2008 1.864798480 2.733555959
## 2009 1.788423480 2.579222625
## 2010 1.664923480 2.383972625
## 2011 1.346506813 2.105805959
## 2012 1.058923480 1.731472625
## 2013 0.731590147 1.240097625
## 2014 0.068256813 -0.527860708
## 2015 -1.142784853 -1.525735708
## 2016 -2.451326520 -4.000277375
## 2017 -5.924243187 -6.448652375
## 2018 -6.730951520 -8.778694041
## 2019 -8.624576520 -12.361819041
## 2020 -10.111868187 -13.283569041
## 2021 -11.617159853 -18.919819041
## 2022 -16.166493187 -22.967319041
## 2023
##
## $figure
## [1] -4.00420660 -3.15722904 0.03232545 1.40253766 2.80309139 3.06251025
## [7] 3.21594084 2.64254447 1.13678165 -0.36339998 -2.82600681 -3.94488929
##
## $type
## [1] "additive"
##
## attr(,"class")
## [1] "decomposed.ts"
```

Q5

Use the decompose function again but now change the type of the seasonal component from additive to multiplicative. What happened to the random component this time?

```
print(decompose(WindTS, type = "multiplicative"))
```

```
## $x
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep
## 1984 0.000 0.001 0.001 0.002 0.003 0.002 0.002 0.001 0.002
## 1985 0.002 0.004 0.002 0.002 0.001 0.001 0.000 0.001 0.003
## 1986 0.001 0.001 0.002 0.002 0.003 0.002 0.002 0.002 0.000
## 1987 0.000 0.000 0.000 0.000 0.001 0.003 0.004 0.001 0.001
## 1988 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
## 1989 0.497 0.763 0.873 0.812 0.697 0.534 0.485 0.352 0.956
## 1990 1.028 0.789 0.837 1.434 1.195 1.387 0.406 0.239 0.311
## 1991 0.212 0.989 0.707 0.813 1.237 0.530 0.530 0.777 0.707
```

##	1992	0.512	1.759	1.120	1.088	0.320	0.256	0.256	0.480	1.088
##	1993	0.844	0.169	1.773	1.266	1.266	0.295	0.464	0.253	0.464
##	1994	0.000	0.343	1.865	1.408	1.256	1.256	0.647	0.457	1.066
##	1995	0.019	0.080	0.016	0.023	1.394	1.701	2.115	1.862	1.955
##	1996	0.503	0.382	0.640	0.834	1.336	1.282	1.826	1.416	1.199
##	1997	0.411	0.372	0.507	1.106	1.196	1.764	1.738	1.809	0.888
##	1998	0.059	0.028	0.021	0.293	0.489	1.348	1.868	1.438	1.623
##	1999	1.150	1.054	1.524	1.274	0.940	0.866	1.556	1.304	1.288
##	2000	2.202	2.409	1.194	1.126	1.392	1.525	1.296	1.284	1.134
##	2001	1.328	1.471	1.816	2.336	2.167	2.285	2.167	1.969	1.673
##	2002	2.769	2.436	2.907	3.495	3.677	3.843	3.038	3.332	2.511
##	2003	2.158	2.543	3.535	3.729	3.434	3.573	3.253	2.782	3.054
##	2004	3.410	3.486	4.406	4.418	5.806	4.767	3.973	3.585	3.718
##	2005	3.861	3.298	5.325	5.792	5.959	6.131	4.848	3.883	5.010
##	2006	8.130	6.558	8.048	8.434	8.389	7.001	6.671	5.647	6.412
##	2007	8.367	8.598	10.397	10.822	10.073	8.941	7.364	9.210	9.781
##	2008	14.580	13.142	16.316	17.829	18.221	17.539	13.677	11.138	10.616
##	2009	20.304	19.968	24.222	25.446	21.366	19.105	16.906	18.645	15.868
##	2010	23.387	18.533	29.306	33.316	29.676	27.463	22.942	22.812	24.244
##	2011	29.174	35.661	35.978	42.383	40.167	37.481	25.551	25.500	23.437
##	2012	46.514	37.709	47.858	43.364	42.788	40.850	30.099	28.896	29.990
##	2013	50.288	48.026	53.758	59.629	55.406	46.909	37.851	32.871	39.832
##	2014	61.113	47.798	60.515	63.584	53.232	53.906	41.583	34.702	39.305
##	2015	51.733	50.912	52.231	60.963	58.520	45.793	46.661	44.629	47.671
##	2016	63.007	68.712	74.857	70.967	64.309	55.627	60.114	46.367	55.969
##	2017	70.965	75.375	87.793	86.590	78.707	68.724	55.001	47.355	61.115
##	2018	87.343	79.123	90.294	90.182	81.728	84.286	56.116	67.716	63.189
##	2019	82.917	77.189	87.936	98.659	87.959	76.586	75.408	68.165	83.640
##	2020	95.950	99.325	100.039	101.515	96.824	103.085	78.019	78.576	79.111
##	2021	102.566	91.153	133.768	123.370	115.280	91.003	74.093	92.367	98.941
##	2022	127.664	128.443	146.820	157.522	143.726	115.215	100.569	84.339	93.254
##	2023	133.636	143.503	151.927	146.775	109.246	93.850	95.085	97.256	96.196
##		Oct	Nov	Dec						
##	1984	0.003	0.003	0.004						
##	1985	0.002	0.001	0.000						
##	1986	0.001	0.000	0.000						
##	1987	0.000	0.000	0.001						
##	1988	0.000	0.000	0.000						
##	1989	0.599	0.419	0.219						
##	1990	0.693	0.789	0.406						
##	1991	1.448	1.448	0.671						
##	1992	0.832	0.960	1.184						
##	1993	0.971	1.562	0.929						
##	1994	1.218	1.675	0.571						
##	1995	0.876	0.427	0.329						
##	1996	0.863	0.337	0.417						
##	1997	0.937	0.248	0.244						
##	1998	1.019	0.618	1.519						
##	1999	1.428	1.209	1.720						
##	2000	1.404	2.808	1.309						
##	2001	2.071	1.605	2.101						
##	2002	2.506	2.238	2.577						
##	2003	3.061	3.280	3.770						
##	2004	3.511	3.181	3.999						


```

## 2005    4.934    5.492    6.237
## 2006    8.333    8.668    8.433
## 2007   11.521   10.560   11.909
## 2008   16.229   17.038   22.573
## 2009   23.248   23.458   23.563
## 2010   27.104   33.259   30.910
## 2011   35.913   42.440   36.358
## 2012   43.113   39.745   49.557
## 2013   46.523   53.921   47.656
## 2014   49.501   64.374   50.195
## 2015   55.889   67.154   68.576
## 2016   69.384   66.212   78.973
## 2017   83.146   77.162   75.749
## 2018   72.314   75.118   82.933
## 2019   94.255   85.929   90.909
## 2020   98.343  113.038  109.220
## 2021  109.918  121.983  135.965
## 2022  111.725  140.570  131.975
## 2023

```

```
##
```

```
## $seasonal
```

```

##           Jan           Feb           Mar           Apr           May           Jun           Jul
## 1984 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1985 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1986 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1987 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1988 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1989 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1990 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1991 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1992 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1993 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1994 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1995 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1996 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1997 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1998 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 1999 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2000 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2001 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2002 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2003 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2004 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2005 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2006 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2007 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2008 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2009 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2010 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2011 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2012 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2013 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2014 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2015 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067

```

```

## 2016 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2017 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2018 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2019 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2020 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2021 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2022 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## 2023 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
##      Aug      Sep      Oct      Nov      Dec
## 1984 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1985 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1986 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1987 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1988 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1989 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1990 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1991 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1992 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1993 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1994 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1995 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1996 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1997 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1998 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 1999 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2000 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2001 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2002 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2003 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2004 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2005 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2006 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2007 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2008 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2009 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2010 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2011 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2012 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2013 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2014 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2015 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2016 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2017 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2018 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2019 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2020 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2021 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2022 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
## 2023 0.8617504 0.9216537
##
## $trend
##      Jan      Feb      Mar      Apr      May
## 1984      NA      NA      NA      NA      NA
## 1985 2.166667e-03 2.083333e-03 2.125000e-03 2.125000e-03 2.000000e-03

```

##	1986	1.583333e-03	1.708333e-03	1.625000e-03	1.458333e-03	1.375000e-03
##	1987	8.333333e-04	8.750000e-04	8.750000e-04	8.750000e-04	8.333333e-04
##	1988	5.833333e-04	3.750000e-04	2.916667e-04	2.500000e-04	2.500000e-04
##	1989	3.682083e-01	4.030833e-01	4.575833e-01	5.223750e-01	5.647917e-01
##	1990	8.050417e-01	7.970417e-01	7.654583e-01	7.425000e-01	7.618333e-01
##	1991	6.161667e-01	6.437500e-01	6.826667e-01	7.306250e-01	7.895417e-01
##	1992	8.749167e-01	8.511250e-01	8.546250e-01	8.448333e-01	7.988333e-01
##	1993	8.764167e-01	8.756250e-01	8.401667e-01	8.199583e-01	8.508333e-01
##	1994	9.052083e-01	9.213333e-01	9.549167e-01	9.902917e-01	1.005292e+00
##	1995	8.000833e-01	9.197917e-01	1.015375e+00	1.038167e+00	9.719167e-01
##	1996	1.033042e+00	1.002417e+00	9.523333e-01	9.202917e-01	9.160000e-01
##	1997	9.475000e-01	9.602083e-01	9.636250e-01	9.537500e-01	9.531250e-01
##	1998	6.805833e-01	6.705417e-01	6.857083e-01	7.197500e-01	7.385833e-01
##	1999	1.228083e+00	1.209500e+00	1.189958e+00	1.193042e+00	1.234708e+00
##	2000	1.518583e+00	1.506917e+00	1.499667e+00	1.492250e+00	1.557875e+00
##	2001	1.756125e+00	1.820958e+00	1.871958e+00	1.922208e+00	1.899875e+00
##	2002	2.595708e+00	2.688792e+00	2.780500e+00	2.833542e+00	2.878042e+00
##	2003	2.940125e+00	2.926167e+00	2.925875e+00	2.971625e+00	3.038167e+00
##	2004	3.821083e+00	3.884542e+00	3.945667e+00	3.992083e+00	4.006708e+00
##	2005	4.397542e+00	4.446417e+00	4.512667e+00	4.625792e+00	4.781375e+00
##	2006	6.489625e+00	6.639083e+00	6.771000e+00	6.971042e+00	7.245000e+00
##	2007	8.475708e+00	8.653042e+00	8.941875e+00	9.215083e+00	9.426750e+00
##	2008	1.342738e+01	1.377075e+01	1.388588e+01	1.411683e+01	1.458292e+01
##	2009	1.860804e+01	1.905538e+01	1.958700e+01	2.009829e+01	2.065825e+01
##	2010	2.386558e+01	2.429071e+01	2.481333e+01	2.532300e+01	2.589204e+01
##	2011	3.195162e+01	3.217233e+01	3.225071e+01	3.258412e+01	3.333371e+01
##	2012	3.754633e+01	3.787733e+01	3.829187e+01	3.886492e+01	3.905262e+01
##	2013	4.494100e+01	4.542963e+01	4.600533e+01	4.655750e+01	4.729025e+01
##	2014	5.005567e+01	5.028746e+01	5.034179e+01	5.044392e+01	5.100354e+01
##	2015	5.019592e+01	5.082112e+01	5.158333e+01	5.219808e+01	5.258008e+01
##	2016	6.123212e+01	6.186508e+01	6.228325e+01	6.319129e+01	6.371433e+01
##	2017	7.021804e+01	7.004617e+01	7.030175e+01	7.108958e+01	7.211925e+01
##	2018	7.608679e+01	7.698162e+01	7.791642e+01	7.755150e+01	7.701500e+01
##	2019	7.818983e+01	7.901238e+01	7.988321e+01	8.164954e+01	8.301421e+01
##	2020	9.136246e+01	9.190504e+01	9.215013e+01	9.213175e+01	9.343163e+01
##	2021	1.009570e+02	1.013680e+02	1.027689e+02	1.040775e+02	1.049325e+02
##	2022	1.221579e+02	1.229266e+02	1.223551e+02	1.221935e+02	1.230432e+02
##	2023	1.198856e+02	1.201953e+02	1.208561e+02	NA	NA
##		Jun	Jul	Aug	Sep	Oct
##	1984	NA	2.083333e-03	2.291667e-03	2.458333e-03	2.500000e-03
##	1985	1.750000e-03	1.541667e-03	1.375000e-03	1.250000e-03	1.250000e-03
##	1986	1.333333e-03	1.291667e-03	1.208333e-03	1.083333e-03	9.166667e-04
##	1987	8.750000e-04	1.000000e-03	1.083333e-03	1.083333e-03	1.083333e-03
##	1988	2.083333e-04	2.079167e-02	7.320833e-02	1.413750e-01	2.115833e-01
##	1989	5.913750e-01	6.226250e-01	6.458333e-01	6.454167e-01	6.698333e-01
##	1990	7.850417e-01	7.588333e-01	7.331667e-01	7.360833e-01	7.047917e-01
##	1991	8.280417e-01	8.515833e-01	8.961667e-01	9.454583e-01	9.741250e-01
##	1992	7.998750e-01	8.350833e-01	7.826667e-01	7.436250e-01	7.782500e-01
##	1993	8.652917e-01	8.195000e-01	7.915833e-01	8.026667e-01	8.124167e-01
##	1994	9.950833e-01	9.809583e-01	9.707917e-01	8.827917e-01	7.480417e-01
##	1995	9.098333e-01	9.199167e-01	9.526667e-01	9.912500e-01	1.051042e+00
##	1996	9.159167e-01	9.157500e-01	9.115000e-01	9.055417e-01	9.113333e-01
##	1997	9.422083e-01	9.203333e-01	8.913333e-01	8.567500e-01	8.026250e-01
##	1998	8.071250e-01	9.057083e-01	9.939167e-01	1.099292e+00	1.202792e+00

```

## 1999 1.267708e+00 1.319917e+00 1.420208e+00 1.462917e+00 1.443000e+00
## 2000 1.607375e+00 1.553833e+00 1.478333e+00 1.465167e+00 1.541500e+00
## 2001 1.882750e+00 1.975792e+00 2.076042e+00 2.161708e+00 2.255458e+00
## 2002 2.924250e+00 2.918625e+00 2.897625e+00 2.928250e+00 2.964167e+00
## 2003 3.131292e+00 3.233167e+00 3.324625e+00 3.400208e+00 3.465208e+00
## 2004 4.012125e+00 4.040458e+00 4.051417e+00 4.081875e+00 4.177417e+00
## 2005 4.970917e+00 5.242042e+00 5.555750e+00 5.805042e+00 6.028583e+00
## 2006 7.468833e+00 7.570208e+00 7.665083e+00 7.847958e+00 8.045333e+00
## 2007 9.650417e+00 1.005413e+01 1.050233e+01 1.093829e+01 1.147687e+01
## 2008 1.529717e+01 1.598000e+01 1.650292e+01 1.711675e+01 1.776354e+01
## 2009 2.096700e+01 2.113671e+01 2.120538e+01 2.135742e+01 2.189717e+01
## 2010 2.660654e+01 2.715379e+01 2.810858e+01 2.910025e+01 2.975604e+01
## 2011 3.394325e+01 3.489275e+01 3.570058e+01 3.628092e+01 3.681679e+01
## 2012 3.949029e+01 4.019750e+01 4.078462e+01 4.146033e+01 4.238387e+01
## 2013 4.780171e+01 4.817354e+01 4.861508e+01 4.888712e+01 4.933346e+01
## 2014 5.154488e+01 5.125983e+01 5.099875e+01 5.078333e+01 5.032896e+01
## 2015 5.346179e+01 5.469742e+01 5.590883e+01 5.759325e+01 5.895283e+01
## 2016 6.410829e+01 6.487308e+01 6.548229e+01 6.629892e+01 6.748887e+01
## 2017 7.244117e+01 7.298925e+01 7.382783e+01 7.408821e+01 7.434208e+01
## 2018 7.722917e+01 7.734408e+01 7.707908e+01 7.690025e+01 7.715521e+01
## 2019 8.379700e+01 8.467238e+01 8.613775e+01 8.756437e+01 8.818767e+01
## 2020 9.532413e+01 9.636275e+01 9.629792e+01 9.736279e+01 9.967879e+01
## 2021 1.064195e+02 1.085797e+02 1.111792e+02 1.132768e+02 1.152436e+02
## 2022 1.236514e+02 1.237340e+02 1.246103e+02 1.254506e+02 1.252156e+02
## 2023      NA      NA      NA      NA
##      Nov      Dec
## 1984 2.416667e-03 2.291667e-03
## 1985 1.333333e-03 1.458333e-03
## 1986 7.500000e-04 7.083333e-04
## 1987 1.041667e-03 8.750000e-04
## 1988 2.744583e-01 3.257500e-01
## 1989 7.165000e-01 7.727917e-01
## 1990 6.806667e-01 6.467083e-01
## 1991 9.473750e-01 8.977500e-01
## 1992 8.250833e-01 8.661250e-01
## 1993 8.179167e-01 8.575417e-01
## 1994 6.960833e-01 7.203750e-01
## 1995 1.082417e+00 1.062542e+00
## 1996 9.168333e-01 9.310833e-01
## 1997 7.392917e-01 6.925000e-01
## 1998 1.262458e+00 1.261167e+00
## 1999 1.455667e+00 1.501958e+00
## 2000 1.624208e+00 1.688167e+00
## 2001 2.366667e+00 2.494500e+00
## 2002 2.963792e+00 2.942417e+00
## 2003 3.592750e+00 3.741333e+00
## 2004 4.241042e+00 4.304250e+00
## 2005 6.239917e+00 6.377417e+00
## 2006 8.215000e+00 8.366000e+00
## 2007 1.210833e+01 1.280608e+01
## 2008 1.821196e+01 1.840825e+01
## 2009 2.257133e+01 2.326583e+01
## 2010 3.057096e+01 3.142550e+01
## 2011 3.696687e+01 3.721646e+01

```

```
## 2012 4.358733e+01 4.436554e+01
## 2013 4.940767e+01 4.960862e+01
## 2014 5.044008e+01 5.032237e+01
## 2015 5.961087e+01 6.026183e+01
## 2016 6.873975e+01 6.988537e+01
## 2017 7.461763e+01 7.539192e+01
## 2018 7.776804e+01 7.770683e+01
## 2019 8.867604e+01 9.014954e+01
## 2020 1.013584e+02 1.016240e+02
## 2021 1.178518e+02 1.200459e+02
## 2022 1.233312e+02 1.210043e+02
## 2023
```

```
##
```

```
## $random
```

##	Jan	Feb	Mar	Apr	May	Jun
## 1984	NA	NA	NA	NA	NA	NA
## 1985	0.96689012	2.08065782	0.86681649	0.83426193	0.43577040	0.50959339
## 1986	0.66155640	0.63434689	1.13352926	1.21563881	1.90154358	1.33768264
## 1987	0.00000000	0.00000000	0.00000000	0.00000000	1.04584897	3.05756032
## 1988	3.59130615	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
## 1989	1.41384566	2.05129976	1.75711485	1.37785974	1.07555401	0.80526742
## 1990	1.33756219	1.07274231	1.00707080	1.71192234	1.36708545	1.57559860
## 1991	0.36039345	1.66486293	0.95382087	0.98634167	1.36547066	0.57080203
## 1992	0.61297463	2.23960756	1.20697572	1.14153497	0.34912546	0.28541689
## 1993	1.00872096	0.20915487	1.94356644	1.36858976	1.29681175	0.30403342
## 1994	0.00000000	0.40343797	1.79874445	1.26029118	1.08889319	1.12562056
## 1995	0.02487469	0.09425403	0.01451275	0.01963777	1.25003298	1.66726373
## 1996	0.51002254	0.41296621	0.61893792	0.80328920	1.27115559	1.24822793
## 1997	0.45436182	0.41983332	0.48456942	1.02790254	1.09362655	1.66960398
## 1998	0.09080503	0.04525137	0.02820564	0.36084219	0.57702826	1.48939854
## 1999	0.98086498	0.94435258	1.17953088	0.94655353	0.66351570	0.60920068
## 2000	1.51886059	1.73239530	0.73327300	0.66884913	0.77874335	0.84608592
## 2001	0.79210340	0.87541120	0.89346135	1.07721836	0.99408063	1.08231924
## 2002	1.11739389	0.98179217	0.96289346	1.09332415	1.11348476	1.17197330
## 2003	0.76882035	0.94177408	1.11272989	1.11232000	0.98509116	1.01758647
## 2004	0.93477502	0.97249423	1.02844294	0.98097396	1.26292345	1.05957701
## 2005	0.91966374	0.80378506	1.08678206	1.10987444	1.08619627	1.09990877
## 2006	1.31223063	1.07044098	1.09469027	1.07242587	1.00915884	0.83592852
## 2007	1.03402965	1.07678272	1.07086704	1.04097339	0.93128921	0.82623172
## 2008	1.13738012	1.03419707	1.08217264	1.11949218	1.08896906	1.02248198
## 2009	1.14293139	1.13557677	1.13893301	1.12225550	0.90139973	0.81259207
## 2010	1.02645919	0.82680859	1.08774611	1.16618933	0.99891099	0.92049489
## 2011	0.95640592	1.20118636	1.02743383	1.15296732	1.05020357	0.98473546
## 2012	1.29764347	1.07885990	1.15107605	0.98901519	0.95490349	0.92249400
## 2013	1.17208973	1.14560974	1.07619513	1.13527020	1.02111090	0.87513406
## 2014	1.27884992	1.03002905	1.10710923	1.11730158	0.90962037	0.93263873
## 2015	1.07953941	1.08561370	0.93255626	1.03524499	0.96999785	0.76386642
## 2016	1.07782610	1.20361176	1.10692260	0.99547551	0.87967518	0.77380809
## 2017	1.05860690	1.16611769	1.15013775	1.07967523	0.95115191	0.84602817
## 2018	1.20242517	1.11382024	1.06729881	1.03076823	0.92487551	0.97327580
## 2019	1.11079143	1.05866787	1.01383507	1.07106129	0.92345466	0.81504718
## 2020	1.10006014	1.17116658	0.99983772	0.97667993	0.90318527	0.96439395
## 2021	1.06415823	0.97447195	1.19879951	1.05071335	0.95748471	0.76259887
## 2022	1.09467716	1.13230666	1.10514473	1.14268000	1.01804135	0.83094401

```

## 2023 1.16760443 1.29381731 1.15777069      NA      NA      NA
##           Jul           Aug           Sep           Oct           Nov           Dec
## 1984 0.94636600 0.50636895 0.88271697 1.21431685 1.30057838 1.94079554
## 1985 0.00000000 0.84394825 2.60401506 1.61908913 0.78576610 0.00000000
## 1986 1.52639677 1.92070980 0.00000000 1.10392441 0.00000000 0.00000000
## 1987 3.94319166 1.07116508 1.00154425 0.00000000 0.00000000 1.27075899
## 1988 0.00000000 0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
## 1989 0.76789719 0.63247115 1.60712614 0.90492136 0.61267457 0.31510328
## 1990 0.52743328 0.37828028 0.45842221 0.99500039 1.21443576 0.69805368
## 1991 0.61353114 1.00612223 0.81135192 1.50419676 1.60132199 0.83107142
## 1992 0.30220249 0.71167697 1.58747598 1.08181992 1.21900488 1.51999574
## 1993 0.55815770 0.37088767 0.62721293 1.20945908 2.00080147 1.20456912
## 1994 0.65019199 0.54627166 1.31018080 1.64767774 2.52107405 0.88135063
## 1995 2.26646898 2.26807400 2.13991149 0.84340262 0.41330002 0.34428743
## 1996 1.96567512 1.80270679 1.43662359 0.95826211 0.38509824 0.49798785
## 1997 1.86162634 2.35514110 1.12458193 1.18134755 0.35145352 0.39177912
## 1998 2.03318269 1.67891004 1.60190897 0.85730341 0.51286546 1.33923420
## 1999 1.16212000 1.06547692 0.95527525 1.00141168 0.87015454 1.27333244
## 2000 0.82222081 1.00788543 0.83976598 0.92166767 1.81128752 0.86217528
## 2001 1.08119905 1.10059659 0.83971342 0.92917190 0.71050963 0.93651295
## 2002 1.02611814 1.33438554 0.93040238 0.85551814 0.79112377 0.97382628
## 2003 0.99184513 0.97103073 0.97453122 0.89389139 0.95648656 1.12043377
## 2004 0.96933932 1.02683524 0.98828439 0.85049900 0.78582014 1.03305908
## 2005 0.91169598 0.81104175 0.93640696 0.82819890 0.92211219 1.08743221
## 2006 0.86870237 0.85490808 0.88648027 1.04811302 1.10546084 1.12081899
## 2007 0.72203358 1.01763573 0.97021059 1.01582127 0.91371673 1.03402304
## 2008 0.84372704 0.78318619 0.67293304 0.92451290 0.98015327 1.36347764
## 2009 0.78848131 1.02031658 0.80613118 1.07435658 1.08884433 1.12611622
## 2010 0.83289200 0.94176581 0.90394042 0.92174121 1.13980921 1.09367441
## 2011 0.72187267 0.82886420 0.70089993 0.98708947 1.20280344 1.08626600
## 2012 0.73814370 0.82216648 0.78483060 1.02933884 0.95533179 1.24202536
## 2013 0.77456287 0.78462185 0.88403583 0.95428243 1.14339324 1.06814851
## 2014 0.79969895 0.78961154 0.83976708 0.99528350 1.33710874 1.10909966
## 2015 0.84095958 0.92630763 0.89807979 0.95933973 1.18026198 1.26532198
## 2016 0.91347987 0.82168175 0.91595337 1.04034628 1.00916176 1.25650314
## 2017 0.74284735 0.74432779 0.89501636 1.13176800 1.08341309 1.11718054
## 2018 0.71523294 1.01946723 0.89155057 0.94843574 1.01198688 1.18669580
## 2019 0.87793745 0.91830390 1.03637952 1.08155179 1.01523244 1.12128135
## 2020 0.79814002 0.94687258 0.88160919 0.99836986 1.16841379 1.19502538
## 2021 0.67269248 0.96407748 0.94769320 0.96516783 1.08441369 1.25936314
## 2022 0.80124065 0.78540363 0.80654182 0.90290615 1.19413061 1.21272447
## 2023      NA      NA      NA
##
## $figure
## [1] 0.9546865 0.9227851 1.0857851 1.1281546 1.1473932 1.1213422 1.0144067
## [8] 0.8617504 0.9216537 0.9882100 0.9544825 0.8993500
##
## $type
## [1] "multiplicative"
##
## attr(,"class")
## [1] "decomposed.ts"

```

```
print(decompose(SolarTS, type = "multiplicative"))
```

```
## $x
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep      Oct
## 1984 0.000 0.000 0.001 0.001 0.002 0.003 0.001 0.003 0.003 0.002
## 1985 0.002 0.000 0.000 0.004 0.005 0.005 0.004 0.007 0.005 0.003
## 1986 0.002 0.002 0.003 0.005 0.006 0.005 0.006 0.006 0.005 0.004
## 1987 0.000 0.002 0.003 0.004 0.004 0.006 0.006 0.004 0.003 0.002
## 1988 0.002 0.003 0.004 0.002 0.004 0.005 0.004 0.004 0.003 0.000
## 1989 2.821 3.041 4.220 4.660 5.109 5.175 5.476 5.389 4.941 4.501
## 1990 3.015 3.256 4.489 4.946 5.515 5.534 5.832 5.781 5.228 4.782
## 1991 3.125 3.369 4.561 5.026 5.739 5.803 6.133 6.035 5.487 4.935
## 1992 3.196 3.451 4.752 5.284 5.883 5.931 6.274 6.205 5.628 5.115
## 1993 3.288 3.570 4.954 5.515 6.053 6.058 6.445 6.401 5.818 5.243
## 1994 3.432 3.680 5.137 5.640 6.216 6.292 6.584 6.471 5.949 5.458
## 1995 3.415 3.692 5.105 5.735 6.370 6.471 6.750 6.674 6.047 5.471
## 1996 3.472 3.760 5.293 5.865 6.487 6.562 6.804 6.602 5.956 5.494
## 1997 3.422 3.762 5.176 5.748 6.292 6.433 6.721 6.612 5.958 5.437
## 1998 3.375 3.629 5.138 5.664 6.173 6.327 6.679 6.584 5.956 5.395
## 1999 3.294 3.570 4.984 5.536 6.121 6.184 6.482 6.377 5.775 5.311
## 2000 3.155 3.440 4.733 5.239 5.832 5.895 6.261 6.144 5.608 5.056
## 2001 3.008 3.261 4.542 5.020 5.672 5.755 6.029 5.947 5.380 4.773
## 2002 2.923 3.189 4.435 4.877 5.408 5.585 5.812 5.719 5.162 4.647
## 2003 2.848 3.083 4.334 4.795 5.298 5.421 5.579 5.522 5.034 4.535
## 2004 2.809 3.019 4.289 4.722 5.278 5.343 5.575 5.488 4.986 4.470
## 2005 2.742 2.968 4.158 4.638 5.178 5.247 5.438 5.396 4.894 4.399
## 2006 2.881 3.124 4.327 4.821 5.368 5.410 5.640 5.657 5.085 4.577
## 2007 3.016 3.269 4.579 5.051 5.658 5.707 5.981 5.886 5.367 4.848
## 2008 3.206 3.518 4.933 5.478 6.029 6.181 6.408 6.326 5.758 5.166
## 2009 3.247 3.578 5.053 5.614 6.200 6.229 6.582 6.501 5.892 5.307
## 2010 3.485 3.833 5.386 6.033 6.760 6.895 7.158 7.072 6.433 5.693
## 2011 3.924 4.374 6.043 6.760 7.496 7.667 7.903 7.958 7.178 6.507
## 2012 4.607 5.077 7.148 8.096 9.316 9.605 9.934 9.685 8.960 8.214
## 2013 5.869 6.663 9.260 10.151 11.264 11.745 12.038 12.336 11.551 10.946
## 2014 8.157 8.799 12.624 13.934 15.758 16.428 16.395 16.624 15.631 14.507
## 2015 9.815 11.480 15.989 18.058 19.510 19.804 20.660 20.720 18.026 15.938
## 2016 11.728 15.428 19.297 21.401 24.459 24.955 27.056 26.741 24.199 21.438
## 2017 15.555 17.857 27.472 30.175 34.567 36.083 34.635 33.492 30.881 28.042
## 2018 20.417 23.213 30.918 36.049 40.277 42.476 40.715 39.785 35.355 30.386
## 2019 22.249 23.942 35.490 40.146 43.146 46.198 47.572 45.914 40.157 35.724
## 2020 26.741 32.049 38.731 46.045 54.208 54.219 58.159 52.712 44.933 40.674
## 2021 32.034 35.565 51.477 59.068 66.559 65.882 66.269 64.229 59.026 49.778
## 2022 41.808 47.446 62.806 71.072 79.459 82.611 82.584 77.169 70.105 63.190
## 2023 44.432 50.523 67.312 79.380 90.079 92.024 97.397 93.068 81.595
##      Nov      Dec
## 1984 0.001 0.000
## 1985 0.001 0.001
## 1986 0.003 0.001
## 1987 0.001 0.001
## 1988 0.000 0.000
## 1989 3.697 3.465
## 1990 3.884 3.700
## 1991 4.034 3.792
## 1992 4.187 3.914
```

```

## 1993 4.297 4.039
## 1994 4.415 4.136
## 1995 4.473 4.192
## 1996 4.495 4.262
## 1997 4.424 4.187
## 1998 4.389 4.147
## 1999 4.307 4.068
## 2000 4.103 3.882
## 2001 3.905 3.675
## 2002 3.821 3.551
## 2003 3.669 3.452
## 2004 3.625 3.418
## 2005 3.547 3.335
## 2006 3.718 3.487
## 2007 3.922 3.662
## 2008 4.167 3.926
## 2009 4.300 4.023
## 2010 4.721 4.384
## 2011 5.259 5.056
## 2012 6.715 6.439
## 2013 9.028 8.800
## 2014 11.805 10.387
## 2015 13.628 12.547
## 2016 17.985 16.202
## 2017 20.501 19.362
## 2018 23.468 20.576
## 2019 26.634 22.573
## 2020 33.068 29.778
## 2021 42.082 34.895
## 2022 46.708 39.623
## 2023
##
## $seasonal
##      Jan      Feb      Mar      Apr      May      Jun      Jul
## 1984 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1985 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1986 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1987 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1988 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1989 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1990 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1991 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1992 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1993 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1994 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1995 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1996 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1997 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1998 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 1999 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 2000 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 2001 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 2002 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## 2003 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734

```


[illegible]

```

## 2017 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2018 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2019 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2020 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2021 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2022 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
## 2023 1.2632000 1.1225122
##
## $trend
##           Jan           Feb           Mar           Apr           May
## 1984           NA           NA           NA           NA           NA
## 1985 0.002291667 0.002583333 0.002833333 0.002958333 0.003000000
## 1986 0.003750000 0.003791667 0.003750000 0.003791667 0.003916667
## 1987 0.003666667 0.003583333 0.003416667 0.003250000 0.003083333
## 1988 0.003000000 0.002916667 0.002916667 0.002833333 0.002708333
## 1989 2.314416667 2.766791667 3.196916667 3.590208333 3.931791667
## 1990 4.533500000 4.564666667 4.592958333 4.616625000 4.636125000
## 1991 4.748375000 4.771500000 4.792875000 4.810041667 4.822666667
## 1992 4.915291667 4.928250000 4.941208333 4.954583333 4.968458333
## 1993 5.070541667 5.085833333 5.101916667 5.115166667 5.125083333
## 1994 5.225791667 5.234500000 5.242875000 5.257291667 5.271166667
## 1995 5.323666667 5.339041667 5.351583333 5.356208333 5.359166667
## 1996 5.422750000 5.422000000 5.415208333 5.412375000 5.414250000
## 1997 5.367041667 5.364000000 5.364500000 5.362208333 5.356875000
## 1998 5.302000000 5.299083333 5.297833333 5.296000000 5.292791667
## 1999 5.228375000 5.211541667 5.195375000 5.184333333 5.177416667
## 2000 5.041958333 5.023041667 5.006375000 4.988791667 4.969666667
## 2001 4.849666667 4.831791667 4.814083333 4.792791667 4.772750000
## 2002 4.668125000 4.649583333 4.631000000 4.616666667 4.607916667
## 2003 4.531208333 4.513291667 4.499750000 4.489750000 4.478750000
## 2004 4.437416667 4.435833333 4.432416667 4.427708333 4.423166667
## 2005 4.368708333 4.359166667 4.351500000 4.344708333 4.338500000
## 2006 4.420083333 4.439375000 4.458208333 4.473583333 4.488125000
## 2007 4.634541667 4.658291667 4.679583333 4.702625000 4.722416667
## 2008 4.935375000 4.971500000 5.006125000 5.035666667 5.059125000
## 2009 5.146583333 5.161125000 5.174000000 5.185458333 5.196875000
## 2010 5.440416667 5.488208333 5.534541667 5.573166667 5.606791667
## 2011 6.008125000 6.076083333 6.144041667 6.209000000 6.265333333
## 2012 7.060458333 7.217041667 7.363250000 7.508625000 7.640416667
## 2013 8.829250000 9.027375000 9.245791667 9.467583333 9.677791667
## 2014 11.881458333 12.241666667 12.590333333 12.908708333 13.172791667
## 2015 15.178125000 15.526500000 15.796958333 15.956375000 16.091958333
## 2016 18.498750000 19.016125000 19.524208333 20.010583333 20.421291667
## 2017 24.926625000 25.523708333 26.083416667 26.637000000 27.017000000
## 2018 30.275250000 30.790791667 31.239416667 31.523500000 31.744791667
## 2019 33.740375000 34.281458333 34.736916667 35.159416667 35.513750000
## 2020 39.655041667 40.379416667 40.861666667 41.266916667 41.741250000
## 2021 47.830333333 48.648125000 49.715208333 50.681750000 51.436666667
## 2022 59.136541667 60.355500000 61.356291667 62.376750000 63.128333333
## 2023 67.544625000 68.824291667 69.965500000           NA           NA
##           Jun           Jul           Aug           Sep           Oct
## 1984           NA 0.001500000 0.001583333 0.001541667 0.001625000
## 1985 0.003041667 0.003083333 0.003166667 0.003375000 0.003541667
## 1986 0.004000000 0.003916667 0.003833333 0.003833333 0.003791667

```

##	1987	0.003000000	0.003083333	0.003208333	0.003291667	0.003250000
##	1988	0.002625000	0.120041667	0.364083333	0.666333333	1.036083333
##	1989	4.230208333	4.382666667	4.399708333	4.419875000	4.443000000
##	1990	4.653708333	4.668083333	4.677375000	4.685083333	4.691416667
##	1991	4.832750000	4.839541667	4.845916667	4.857291667	4.876000000
##	1992	4.979916667	4.988833333	4.997625000	5.011000000	5.029041667
##	1993	5.134875000	5.146083333	5.156666667	5.168875000	5.181708333
##	1994	5.280125000	5.283458333	5.283250000	5.282416667	5.285041667
##	1995	5.363916667	5.368625000	5.373833333	5.384500000	5.397750000
##	1996	5.418083333	5.418916667	5.416916667	5.412125000	5.402375000
##	1997	5.350791667	5.345708333	5.338208333	5.331083333	5.326000000
##	1998	5.289666667	5.284625000	5.278791667	5.269916667	5.258166667
##	1999	5.170708333	5.161625000	5.150416667	5.134541667	5.111708333
##	2000	4.953416667	4.939541667	4.925958333	4.910541667	4.893458333
##	2001	4.755875000	4.743708333	4.737166667	4.729708333	4.719291667
##	2002	4.599250000	4.590958333	4.583416667	4.574791667	4.567166667
##	2003	4.468291667	4.462541667	4.458250000	4.453708333	4.448791667
##	2004	4.419916667	4.415708333	4.410791667	4.403208333	4.394250000
##	2005	4.331791667	4.334125000	4.346416667	4.359958333	4.374625000
##	2006	4.501583333	4.513541667	4.525208333	4.541750000	4.561833333
##	2007	4.738208333	4.753416667	4.771708333	4.796833333	4.829375000
##	2008	5.080333333	5.093041667	5.097250000	5.104750000	5.115416667
##	2009	5.206458333	5.220416667	5.240958333	5.265458333	5.296791667
##	2010	5.639375000	5.672708333	5.713541667	5.763458333	5.821125000
##	2011	6.315750000	6.372208333	6.429958333	6.505291667	6.607000000
##	2012	7.758708333	7.868916667	7.987583333	8.141666667	8.315291667
##	2013	9.872541667	10.066250000	10.250583333	10.479750000	10.777541667
##	2014	13.354625000	13.489833333	13.670625000	13.922541667	14.234583333
##	2015	16.257916667	16.427625000	16.671833333	16.974166667	17.251291667
##	2016	20.755125000	21.066875000	21.327541667	21.769375000	22.475583333
##	2017	27.253500000	27.587750000	28.013500000	28.380250000	28.768583333
##	2018	31.919000000	32.045916667	32.152625000	32.373500000	32.734708333
##	2019	35.728875000	35.999250000	36.524208333	36.997041667	37.377875000
##	2020	42.309541667	42.830291667	43.197333333	43.874916667	44.948625000
##	2021	52.025458333	52.645916667	53.548208333	54.515291667	55.487500000
##	2022	63.518083333	63.824416667	64.061958333	64.377916667	64.911833333
##	2023	NA	NA	NA	NA	
##		Nov	Dec			
##	1984	0.001875000	0.002083333			
##	1985	0.003625000	0.003666667			
##	1986	0.003666667	0.003625000			
##	1987	0.003166667	0.003125000			
##	1988	1.442875000	1.871000000			
##	1989	4.471833333	4.503708333			
##	1990	4.704083333	4.724625000			
##	1991	4.892750000	4.904083333			
##	1992	5.045750000	5.058125000			
##	1993	5.193708333	5.210250000			
##	1994	5.295416667	5.309291667			
##	1995	5.408041667	5.416708333			
##	1996	5.389375000	5.375875000			
##	1997	5.317541667	5.308166667			
##	1998	5.250666667	5.242541667			
##	1999	5.087291667	5.063208333			

```

## 2000 4.877666667 4.865166667
## 2001 4.702333333 4.684250000
## 2002 4.559166667 4.547750000
## 2003 4.444916667 4.440833333
## 2004 4.386583333 4.378416667
## 2005 4.390166667 4.404875000
## 2006 4.583500000 4.607958333
## 2007 4.862625000 4.897833333
## 2008 5.128208333 5.137333333
## 2009 5.337583333 5.388666667
## 2010 5.882083333 5.944916667
## 2011 6.738500000 6.895083333
## 2012 8.482083333 8.652416667
## 2013 11.122416667 11.504791667
## 2014 14.562750000 14.859750000
## 2015 17.596791667 18.017625000
## 2016 23.262333333 24.147166667
## 2017 29.251250000 29.755541667
## 2018 33.024958333 33.299583333
## 2019 38.084583333 38.879708333
## 2020 46.005875000 47.006458333
## 2021 56.525166667 57.759708333
## 2022 65.700500000 66.535208333
## 2023

```

```
##
```

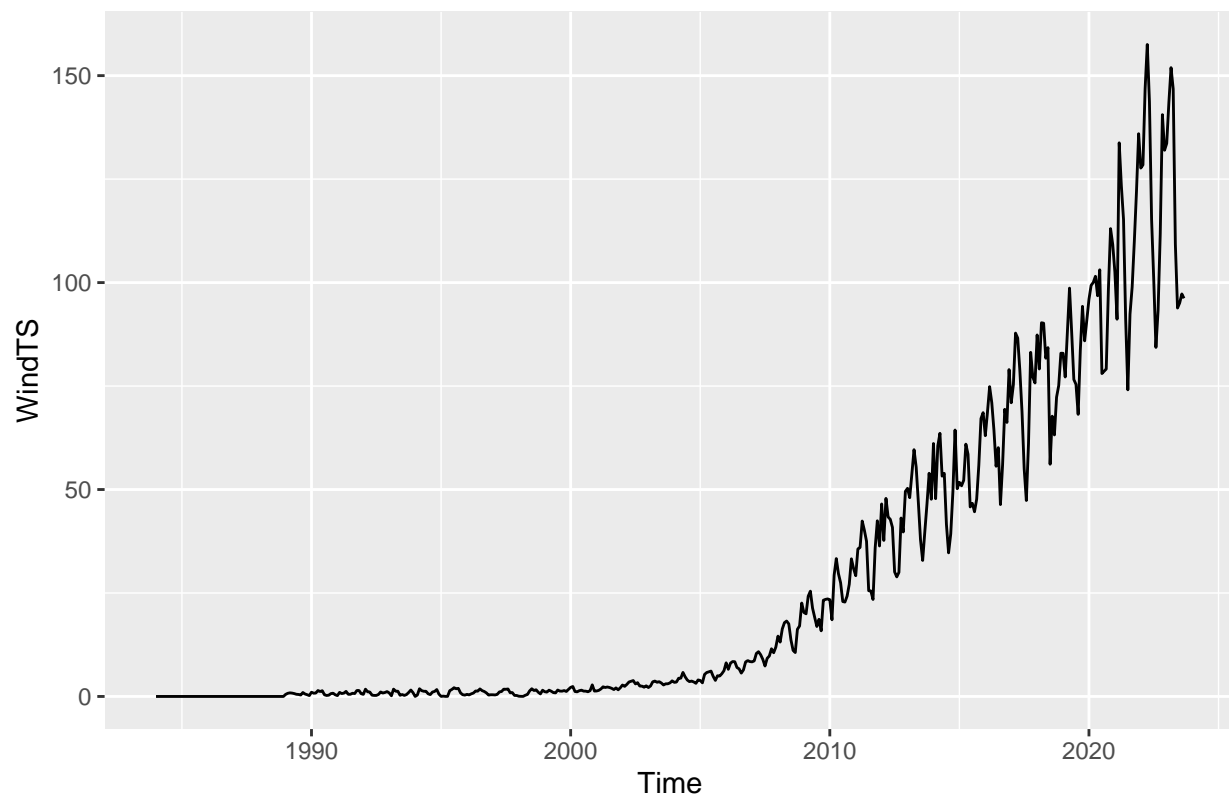
```
## $random
```

##		Jan	Feb	Mar	Apr	May	Jun
## 1984		NA	NA	NA	NA	NA	NA
## 1985	1.332554365	0.000000000	0.000000000	1.221999130	1.337235085	1.281613631	
## 1986	0.814338779	0.744539561	0.822381340	1.191784866	1.229118206	0.974560366	
## 1987	0.000000000	0.787826745	0.902613666	1.112332541	1.040874877	1.559296585	
## 1988	1.017923473	1.451852145	1.409796583	0.637955428	1.184996014	1.485044367	
## 1989	1.861092360	1.551414675	1.356951720	1.173070945	1.042568065	0.953778064	
## 1990	1.015453603	1.006846492	1.004709157	0.968250044	0.954441672	0.927125927	
## 1991	1.004873516	0.996630140	0.978244084	0.944347115	0.954790287	0.936174857	
## 1992	0.992804794	0.988416901	0.988613479	0.963859393	0.950027571	0.928548474	
## 1993	0.990110899	0.990818316	0.998173193	0.974414505	0.947608081	0.919809997	
## 1994	1.002770561	0.992340116	1.007217639	0.969560792	0.946157139	0.929058887	
## 1995	0.979458955	0.976082027	0.980610896	0.967684921	0.953676721	0.940563475	
## 1996	0.977611995	0.978850272	1.004777694	0.979350500	0.961312536	0.944254966	
## 1997	0.973534679	0.989960705	0.991855209	0.968793215	0.942402034	0.937333721	
## 1998	0.971942207	0.966660901	0.996963065	0.966569931	0.935772957	0.932541700	
## 1999	0.961973822	0.966918647	0.986153213	0.965075247	0.948567575	0.932434152	
## 2000	0.955446776	0.966673016	0.971843620	0.949097966	0.941562749	0.927849804	
## 2001	0.947048741	0.952643772	0.969877282	0.946614555	0.953512847	0.943438573	
## 2002	0.956076683	0.968118273	0.984469133	0.954733693	0.941653402	0.946749082	
## 2003	0.959693035	0.964202068	0.990110764	0.965215894	0.949104748	0.945881269	
## 2004	0.966557995	0.960673535	0.994715139	0.963840098	0.957403686	0.942474970	
## 2005	0.958342587	0.961055253	0.982265199	0.964779640	0.957594091	0.944370114	
## 2006	0.995220216	0.993292434	0.997722569	0.973956616	0.959636098	0.936980824	
## 2007	0.993644275	0.990549487	1.005881263	0.970722358	0.961297147	0.939058077	
## 2008	0.991858568	0.998840919	1.012960911	0.983157430	0.956156291	0.948561006	
## 2009	0.963317983	0.978551963	1.003936247	0.978460440	0.957212655	0.932770206	
## 2010	0.978085923	0.985816685	1.000386790	0.978338866	0.967367049	0.953239495	

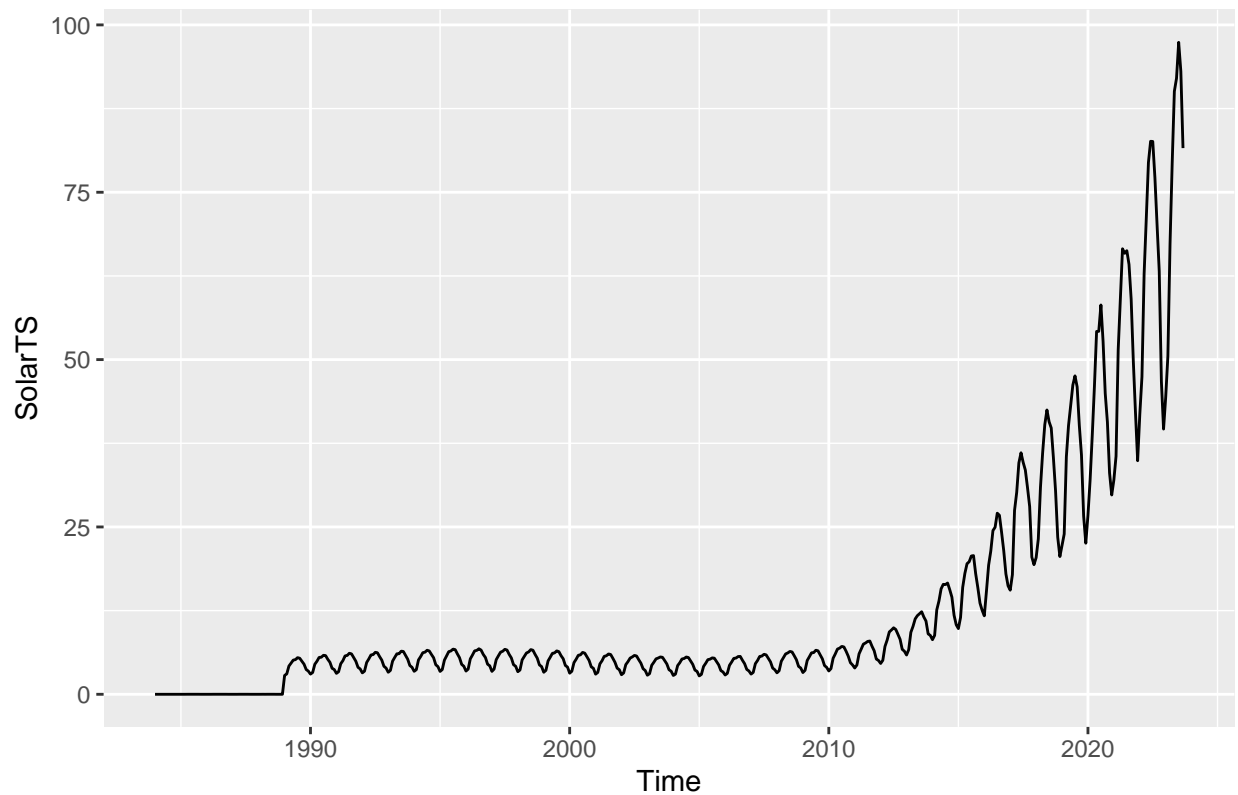
##	2011	0.997232508	1.016115301	1.011071113	0.983972698	0.959940709	0.946453463
##	2012	0.996303615	0.992969445	0.997925817	0.974469155	0.978298640	0.965176358
##	2013	1.014954758	1.041828572	1.029556403	0.969008761	0.933846265	0.927518921
##	2014	1.048255383	1.014566929	1.030725494	0.975553363	0.959803404	0.959073141
##	2015	0.987366907	1.043653309	1.040473660	1.022806376	0.972763761	0.949700697
##	2016	0.968028096	1.145184710	1.016013841	0.966567816	0.960980338	0.937412959
##	2017	0.952824517	0.987535370	1.082702300	1.023811445	1.026558208	1.032236202
##	2018	1.029699683	1.064138976	1.017400010	1.033515046	1.017990317	1.037511854
##	2019	1.006855111	0.985800586	1.050262824	1.031949943	0.974771940	1.008097563
##	2020	1.029640512	1.120320741	0.974374465	1.008413076	1.041974155	0.999106800
##	2021	1.022619693	1.031916700	1.064405784	1.053315988	1.038228592	0.987301034
##	2022	1.079468211	1.109610829	1.052265404	1.029754755	1.009898634	1.014002969
##	2023	1.004410990	1.036180260	0.988989802	NA	NA	NA
##		Jul	Aug	Sep	Oct	Nov	Dec
##	1984	0.533472737	1.499949958	1.733563254	1.267049758	0.708741737	0.000000000
##	1985	1.038109110	1.749941617	1.319790955	0.872028363	0.366590554	0.407593966
##	1986	1.225852247	1.239089096	1.161989862	1.086042650	1.087274256	0.412278954
##	1987	1.557163665	0.986980059	0.811922030	0.633524879	0.419649713	0.478243586
##	1988	0.026664378	0.008697352	0.004010870	0.000000000	0.000000000	0.000000000
##	1989	0.999835350	0.969643670	0.995895539	1.042916983	1.098634221	1.149826088
##	1990	0.999729261	0.978427498	0.994093374	1.049355409	1.097219445	1.170397961
##	1991	1.014080006	0.985891684	1.006351500	1.041934696	1.095650772	1.155605668
##	1992	1.006349900	0.982892431	1.000549562	1.047074165	1.102723203	1.156459531
##	1993	1.002188917	0.982667603	1.002736001	1.041655074	1.099454035	1.158549161
##	1994	0.997183363	0.969612283	1.003275564	1.063168635	1.107949207	1.164241624
##	1995	1.006107050	0.983172856	1.000468703	1.043448427	1.099127693	1.156604823
##	1996	1.004743769	0.964830971	0.980383043	1.046938011	1.108359310	1.184850236
##	1997	1.006079094	0.980539732	0.995620770	1.050933439	1.105588462	1.178847391
##	1998	1.011348320	0.987377372	1.006838611	1.056268045	1.110811618	1.182200995
##	1999	1.004907451	0.980171166	1.001980400	1.069614485	1.125064743	1.200754777
##	2000	1.014286253	0.987389133	1.017390141	1.063673184	1.117837514	1.192496147
##	2001	1.017023046	0.993818654	1.013343850	1.041193997	1.103562432	1.172509727
##	2002	1.013038016	0.987776358	1.005207220	1.047473036	1.113732389	1.166952734
##	2003	1.000408945	0.980527671	1.006932502	1.049427070	1.096915995	1.161730761
##	2004	1.010294482	0.984975499	1.008769540	1.047224518	1.098173369	1.166686429
##	2005	1.004017447	0.982807482	0.999978233	1.035214083	1.073666645	1.131517892
##	2006	0.999919728	0.989635967	0.997416740	1.032900620	1.077956984	1.130947852
##	2007	1.006865376	0.976504476	0.996749179	1.033448220	1.071830452	1.117412470
##	2008	1.006812880	0.982474129	1.004861259	1.039657827	1.079809444	1.142119971
##	2009	1.008918764	0.981967986	0.996863003	1.031462007	1.070565067	1.115752552
##	2010	1.009728765	0.979861566	0.994350082	1.006818759	1.066576740	1.102107481
##	2011	0.992442844	0.979768892	0.982982082	1.013896304	1.037120501	1.095889389
##	2012	1.010212408	0.959869281	0.980400699	1.016937474	1.052041236	1.112193048
##	2013	0.956951915	0.952694483	0.981923337	1.045569180	1.078652789	1.143149655
##	2014	0.972541911	0.962664663	1.000177677	1.049179731	1.077238529	1.044666829
##	2015	1.006373114	0.983862168	0.946062493	0.951106708	1.029171885	1.040738284
##	2016	1.027701430	0.992578160	0.990285407	0.981952170	1.027416293	1.002770673
##	2017	1.004621340	0.946458509	0.969357688	1.003477291	0.931364965	0.972481910
##	2018	1.016682221	0.979559447	0.972904265	0.955613107	0.944328468	0.923466888
##	2019	1.057453907	0.995158344	0.966948140	0.983926173	0.929343932	0.867691732
##	2020	1.086599216	0.966007342	0.912342763	0.931574331	0.955177128	0.946754048
##	2021	1.007277688	0.949541797	0.964570407	0.923547688	0.989335975	0.902895289
##	2022	1.035410462	0.953609419	0.970110032	1.002170282	0.944739074	0.890010252
##	2023	NA	NA	NA			

```
##
## $figure
## [1] 0.6549281 0.7084547 0.9727847 1.1064760 1.2463528 1.2826296 1.2496734
## [8] 1.2632000 1.1225122 0.9713661 0.7525073 0.6691151
##
## $type
## [1] "multiplicative"
##
## attr("class")
## [1] "decomposed.ts"
```

```
autoplot(WindTS)
```



```
autoplot(SolarTS)
```



Q6

When fitting a model to this data, do you think you need all the historical data? Think about the data from 90s and early 20s. Are there any information from those years we might need to forecast the next six months of Solar and/or Wind consumption. Explain your response.

Answer: No, not necessary.

Q7

Create a new time series object where historical data starts on January 2012. Hint: use `filter()` function so that you don't need to point to row numbers, i.e, `filter(xxxx, year(Date) >= 2012)`. Apply the `decompose` function `type=additive` to this new time series. Comment the results. Does the random component look random? Think about our discussion in class about seasonal components that depends on the level of the series.

```
FilterData <- energy_data|>
  filter(year(as.Date(Month, "%Y")) >= 2012)
```

```
FilterDataTS <- ts(FilterData)
```

```
FilterWind <-FilterData |>
  select(`Wind Energy Consumption`)
```

```
FilterSolar <-FilterData |>
  select(`Solar Energy Consumption`)
```

```
TSFilterWind <- ts(FilterWind, start = c(2012, 1), frequency = 12)
TSFilterSolar <- ts(FilterSolar, start = c(2012, 1), frequency = 12)
```

```
original_start_date <- start(TSFilterWind)
print(original_start_date)
```

```
## [1] 2012      1
```

```
print(decompose(TSFilterWind, type = "additive"))
```

```
## $x
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep
## 2012 46.514 37.709 47.858 43.364 42.788 40.850 30.099 28.896 29.990
## 2013 50.288 48.026 53.758 59.629 55.406 46.909 37.851 32.871 39.832
## 2014 61.113 47.798 60.515 63.584 53.232 53.906 41.583 34.702 39.305
## 2015 51.733 50.912 52.231 60.963 58.520 45.793 46.661 44.629 47.671
## 2016 63.007 68.712 74.857 70.967 64.309 55.627 60.114 46.367 55.969
## 2017 70.965 75.375 87.793 86.590 78.707 68.724 55.001 47.355 61.115
## 2018 87.343 79.123 90.294 90.182 81.728 84.286 56.116 67.716 63.189
## 2019 82.917 77.189 87.936 98.659 87.959 76.586 75.408 68.165 83.640
## 2020 95.950 99.325 100.039 101.515 96.824 103.085 78.019 78.576 79.111
## 2021 102.566 91.153 133.768 123.370 115.280 91.003 74.093 92.367 98.941
## 2022 127.664 128.443 146.820 157.522 143.726 115.215 100.569 84.339 93.254
## 2023 133.636 143.503 151.927 146.775 109.246 93.850 95.085 97.256 96.196
##      Oct      Nov      Dec
## 2012 43.113 39.745 49.557
## 2013 46.523 53.921 47.656
## 2014 49.501 64.374 50.195
## 2015 55.889 67.154 68.576
## 2016 69.384 66.212 78.973
## 2017 83.146 77.162 75.749
## 2018 72.314 75.118 82.933
## 2019 94.255 85.929 90.909
## 2020 98.343 113.038 109.220
## 2021 109.918 121.983 135.965
## 2022 111.725 140.570 131.975
## 2023
##
## $seasonal
##      Jan      Feb      Mar      Apr      May      Jun
## 2012 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2013 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2014 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2015 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2016 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2017 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2018 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2019 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2020 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2021 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2022 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
## 2023 5.290928 3.183739 14.526655 14.853377 6.418390 -3.800823
##      Jul      Aug      Sep      Oct      Nov      Dec
## 2012 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2013 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
```



```

## 2014 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2015 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2016 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2017 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2018 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2019 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2020 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2021 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2022 -15.551724 -18.967102 -13.758947 -1.627220 4.192519 5.240208
## 2023 -15.551724 -18.967102 -13.758947
##
## $trend
##      Jan      Feb      Mar      Apr      May      Jun      Jul
## 2012      NA      NA      NA      NA      NA      NA 40.19750
## 2013 44.94100 45.42963 46.00533 46.55750 47.29025 47.80171 48.17354
## 2014 50.05567 50.28746 50.34179 50.44392 51.00354 51.54488 51.25983
## 2015 50.19592 50.82112 51.58333 52.19808 52.58008 53.46179 54.69742
## 2016 61.23212 61.86508 62.28325 63.19129 63.71433 64.10829 64.87308
## 2017 70.21804 70.04617 70.30175 71.08958 72.11925 72.44117 72.98925
## 2018 76.08679 76.98162 77.91642 77.55150 77.01500 77.22917 77.34408
## 2019 78.18983 79.01238 79.88321 81.64954 83.01421 83.79700 84.67238
## 2020 91.36246 91.90504 92.15013 92.13175 93.43163 95.32413 96.36275
## 2021 100.95700 101.36804 102.76892 104.07746 104.93246 106.41954 108.57967
## 2022 122.15792 122.92658 122.35512 122.19346 123.04321 123.65142 123.73400
## 2023 119.88558 120.19529 120.85608      NA      NA      NA      NA
##      Aug      Sep      Oct      Nov      Dec
## 2012 40.78462 41.46033 42.38387 43.58733 44.36554
## 2013 48.61508 48.88712 49.33346 49.40767 49.60862
## 2014 50.99875 50.78333 50.32896 50.44008 50.32237
## 2015 55.90883 57.59325 58.95283 59.61087 60.26183
## 2016 65.48229 66.29892 67.48887 68.73975 69.88537
## 2017 73.82783 74.08821 74.34208 74.61763 75.39192
## 2018 77.07908 76.90025 77.15521 77.76804 77.70683
## 2019 86.13775 87.56437 88.18767 88.67604 90.14954
## 2020 96.29792 97.36279 99.67879 101.35842 101.62400
## 2021 111.17917 113.27675 115.24358 117.85183 120.04592
## 2022 124.61033 125.45062 125.21562 123.33117 121.00429
## 2023      NA      NA
##
## $random
##      Jan      Feb      Mar      Apr      May
## 2012      NA      NA      NA      NA      NA
## 2013 0.05607206 -0.58736354 -6.77398854 -1.78187718 1.69736032
## 2014 5.76640540 -5.67319688 -4.35344687 -1.71329384 -4.18993134
## 2015 -3.75384460 -3.09286354 -13.87898854 -6.08846051 -0.47847301
## 2016 -3.51605294 3.66317813 -1.95290521 -7.07766884 -5.82372301
## 2017 -4.54396960 2.14509479 2.96459479 0.64703949 0.16936032
## 2018 5.96528040 -1.04236354 -2.14907188 -2.22287718 -1.70538968
## 2019 -0.56376127 -5.00711354 -6.47386354 2.15608116 -1.47359801
## 2020 -0.70338627 4.23621979 -6.63778021 -5.47012718 -3.02601468
## 2021 -3.68192794 -13.39878021 16.47242813 4.43916449 3.92915199
## 2022 0.21515540 2.33267813 9.93821979 20.47516449 14.26440199
## 2023 8.45948873 20.12396979 16.54426146      NA      NA
##      Jun      Jul      Aug      Sep      Oct

```

```

## 2012      NA  5.45322358  7.07847737  2.28861373  2.35634479
## 2013  2.90811449  5.22918191  3.22301903  4.70382206 -1.18323854
## 2014  6.16194782  5.87489025  2.67035237  2.28061373  0.79926146
## 2015 -3.86796884  7.51530691  7.68726903  3.83669706 -1.43661354
## 2016 -4.68046884 10.79264025 -0.14818930  3.42903040  3.52234479
## 2017  0.08365616 -2.43652642 -7.50573097  0.78573873 10.43113646
## 2018 10.85765616 -5.67635975  9.60401903  0.04769706 -3.21398854
## 2019 -3.41017718  6.28734858  0.99435237  9.83457206  7.69455312
## 2020 11.56169782 -2.79202642  1.24518570 -4.49284460  0.29142812
## 2021 -11.61571884 -18.93494309  0.15493570 -0.57680294 -3.69836354
## 2022 -4.63559384 -7.61327642 -21.30423097 -18.43767794 -11.86340521
## 2023      NA      NA      NA      NA
##      Nov      Dec
## 2012 -8.03485218 -0.04874991
## 2013  0.32081449 -7.19283324
## 2014  9.74139782 -5.36758324
## 2015  3.35060616  3.07395843
## 2016 -6.72026884  3.84741676
## 2017 -1.64814384 -4.88312491
## 2018 -6.84256051 -0.01404157
## 2019 -6.93956051 -4.48074991
## 2020  7.48706449  2.35579176
## 2021 -0.06135218 10.67887509
## 2022 13.04631449  5.73050009
## 2023
##
## $figure
## [1]  5.290928  3.183739 14.526655 14.853377  6.418390 -3.800823
## [7] -15.551724 -18.967102 -13.758947 -1.627220  4.192519  5.240208
##
## $type
## [1] "additive"
##
## attr("class")
## [1] "decomposed.ts"

print(decompose(TSFilterSolar, type = "additive"))

## $x
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep      Oct
## 2012  4.607  5.077  7.148  8.096  9.316  9.605  9.934  9.685  8.960  8.214
## 2013  5.869  6.663  9.260 10.151 11.264 11.745 12.038 12.336 11.551 10.946
## 2014  8.157  8.799 12.624 13.934 15.758 16.428 16.395 16.624 15.631 14.507
## 2015  9.815 11.480 15.989 18.058 19.510 19.804 20.660 20.720 18.026 15.938
## 2016 11.728 15.428 19.297 21.401 24.459 24.955 27.056 26.741 24.199 21.438
## 2017 15.555 17.857 27.472 30.175 34.567 36.083 34.635 33.492 30.881 28.042
## 2018 20.417 23.213 30.918 36.049 40.277 42.476 40.715 39.785 35.355 30.386
## 2019 22.249 23.942 35.490 40.146 43.146 46.198 47.572 45.914 40.157 35.724
## 2020 26.741 32.049 38.731 46.045 54.208 54.219 58.159 52.712 44.933 40.674
## 2021 32.034 35.565 51.477 59.068 66.559 65.882 66.269 64.229 59.026 49.778
## 2022 41.808 47.446 62.806 71.072 79.459 82.611 82.584 77.169 70.105 63.190
## 2023 44.432 50.523 67.312 79.380 90.079 92.024 97.397 93.068 81.595
##      Nov      Dec
## 2012  6.715  6.439
## 2013  9.028  8.800

```

```

## 2014 11.805 10.387
## 2015 13.628 12.547
## 2016 17.985 16.202
## 2017 20.501 19.362
## 2018 23.468 20.576
## 2019 26.634 22.573
## 2020 33.068 29.778
## 2021 42.082 34.895
## 2022 46.708 39.623
## 2023
##
## $seasonal
##      Jan      Feb      Mar      Apr      May      Jun
## 2012 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2013 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2014 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2015 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2016 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2017 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2018 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2019 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2020 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2021 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2022 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
## 2023 -10.5543550 -8.0960443  0.2594329  4.2468117  8.1619075  8.9764034
##      Jul      Aug      Sep      Oct      Nov      Dec
## 2012  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2013  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2014  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2015  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2016  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2017  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2018  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2019  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2020  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2021  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2022  8.6143117  6.7813155  2.6919140 -1.4411769 -8.1275671 -11.5129534
## 2023  8.6143117  6.7813155  2.6919140
##
## $trend
##      Jan      Feb      Mar      Apr      May      Jun      Jul
## 2012      NA      NA      NA      NA      NA      NA  7.868917
## 2013  8.829250  9.027375  9.245792  9.467583  9.677792  9.872542 10.066250
## 2014 11.881458 12.241667 12.590333 12.908708 13.172792 13.354625 13.489833
## 2015 15.178125 15.526500 15.796958 15.956375 16.091958 16.257917 16.427625
## 2016 18.498750 19.016125 19.524208 20.010583 20.421292 20.755125 21.066875
## 2017 24.926625 25.523708 26.083417 26.637000 27.017000 27.253500 27.587750
## 2018 30.275250 30.790792 31.239417 31.523500 31.744792 31.919000 32.045917
## 2019 33.740375 34.281458 34.736917 35.159417 35.513750 35.728875 35.999250
## 2020 39.655042 40.379417 40.861667 41.266917 41.741250 42.309542 42.830292
## 2021 47.830333 48.648125 49.715208 50.681750 51.436667 52.025458 52.645917
## 2022 59.136542 60.355500 61.356292 62.376750 63.128333 63.518083 63.824417
## 2023 67.544625 68.824292 69.965500      NA      NA      NA      NA
##      Aug      Sep      Oct      Nov      Dec

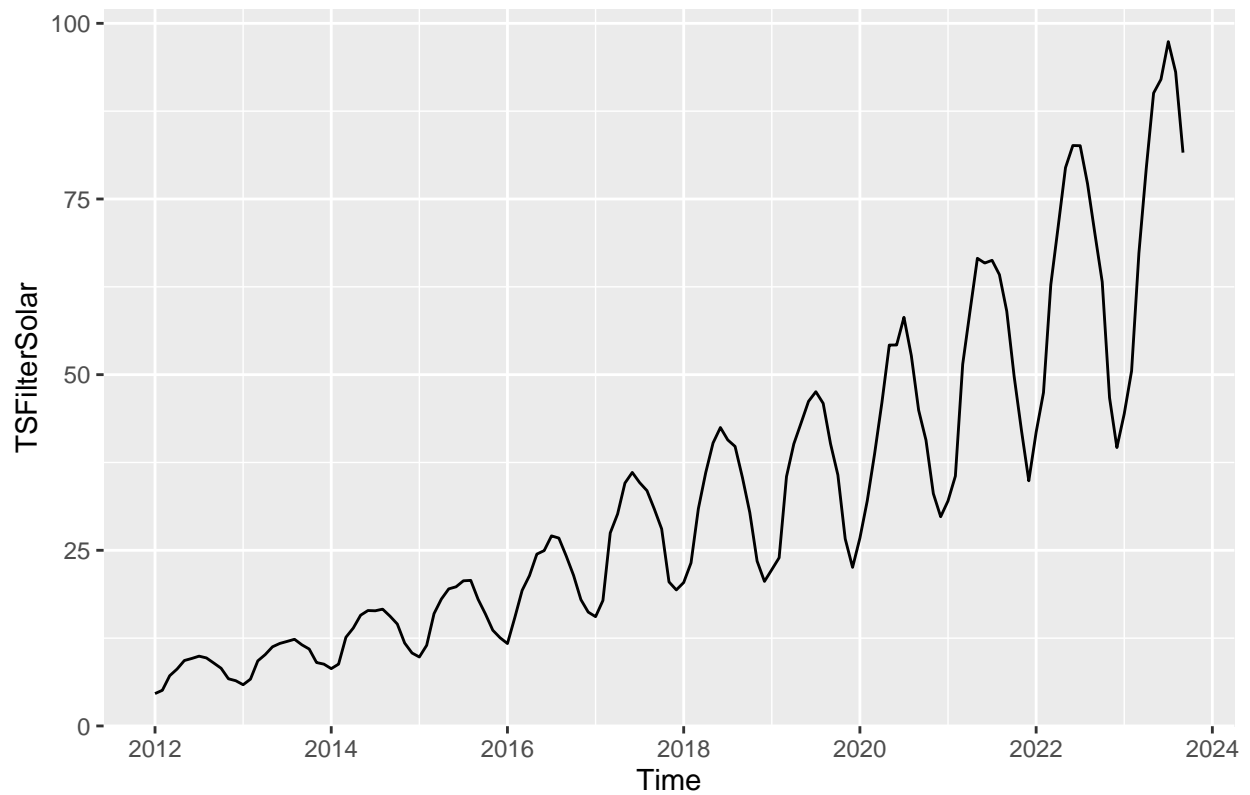
```

```

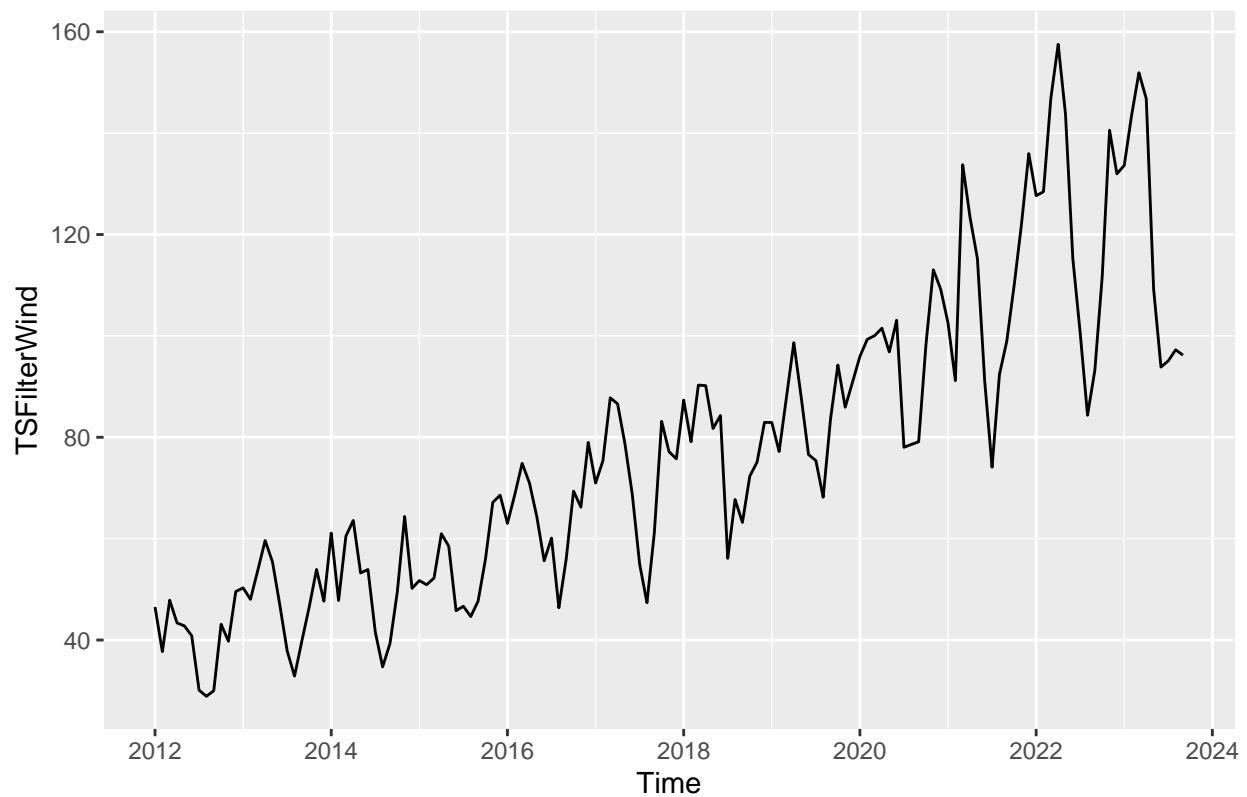
## 2012 7.987583 8.141667 8.315292 8.482083 8.652417
## 2013 10.250583 10.479750 10.777542 11.122417 11.504792
## 2014 13.670625 13.922542 14.234583 14.562750 14.859750
## 2015 16.671833 16.974167 17.251292 17.596792 18.017625
## 2016 21.327542 21.769375 22.475583 23.262333 24.147167
## 2017 28.013500 28.380250 28.768583 29.251250 29.755542
## 2018 32.152625 32.373500 32.734708 33.024958 33.299583
## 2019 36.524208 36.997042 37.377875 38.084583 38.879708
## 2020 43.197333 43.874917 44.948625 46.005875 47.006458
## 2021 53.548208 54.515292 55.487500 56.525167 57.759708
## 2022 64.061958 64.377917 64.911833 65.700500 66.535208
## 2023 NA NA
##
## $random
## Jan Feb Mar Apr May
## 2012 NA NA NA NA NA
## 2013 7.59410496 5.73166935 -0.24522459 -3.56339504 -6.57569921
## 2014 6.82989662 4.65337768 -0.22576626 -3.22152004 -5.57669921
## 2015 5.19122996 4.04954435 -0.06739126 -2.14518671 -4.74386588
## 2016 3.78360496 4.50791935 -0.48664126 -2.85639504 -4.12419921
## 2017 1.18272996 0.42933602 1.12915041 -0.70881171 -0.61190754
## 2018 0.69610496 0.51825268 -0.58084959 0.27868829 0.37030079
## 2019 -0.93702004 -2.24341398 0.49365041 0.73977162 -0.52965754
## 2020 -2.35968671 -0.23437232 -2.39009959 0.53127162 4.30484246
## 2021 -5.24197838 -4.98708065 1.50235874 4.13943829 6.96042579
## 2022 -6.77418671 -4.81345565 1.19027541 4.44843829 8.16875912
## 2023 -12.55827004 -10.20524732 -2.91293292 NA NA
## Jun Jul Aug Sep Oct
## 2012 NA -6.54922838 -5.08389883 -1.87358065 1.33988526
## 2013 -7.10394504 -6.64256171 -4.69589883 -1.62066398 1.60963526
## 2014 -5.90302838 -5.70914504 -3.82794050 -0.98345565 1.71359359
## 2015 -5.43032004 -4.38193671 -2.73314883 -1.64008065 0.12788526
## 2016 -4.77652838 -2.62518671 -1.36785717 -0.26228898 0.40359359
## 2017 -0.14690338 -1.56706171 -1.30281550 -0.19116398 0.71459359
## 2018 1.58059662 0.05477162 0.85105950 0.28958602 -0.90753141
## 2019 1.49272162 2.95843829 2.60847617 0.46804435 -0.21269807
## 2020 2.93305496 6.71439662 2.73335117 -1.63383065 -2.83344807
## 2021 4.88013829 5.00877162 3.89947617 1.81879435 -4.26832307
## 2022 10.11651329 10.14527162 6.32572617 3.03516935 -0.28065641
## 2023 NA NA NA NA
## Nov Dec
## 2012 6.36048374 9.29953677
## 2013 6.03315041 8.80816177
## 2014 5.36981708 7.04020344
## 2015 4.15877541 6.04232844
## 2016 2.85023374 3.56778677
## 2017 -0.62268292 1.11941177
## 2018 -1.42939126 -1.21062989
## 2019 -3.32301626 -4.79375489
## 2020 -4.81030792 -5.71550489
## 2021 -6.31559959 -11.35175489
## 2022 -10.86493292 -15.39925489
## 2023
##

```

```
## $figure
## [1] -10.5543550 -8.0960443 0.2594329 4.2468117 8.1619075 8.9764034
## [7] 8.6143117 6.7813155 2.6919140 -1.4411769 -8.1275671 -11.5129534
##
## $type
## [1] "additive"
##
## attr(,"class")
## [1] "decomposed.ts"
autoplot(TSFilterSolar)
```



```
autoplot(TSFilterWind)
```



Answer:

Identify and Remove outliers

Q8

Apply the `tsclean()` to both series from Q7. Did the function removed any outliers from the series? Hint: Use `autoplot()` to check if there is difference between cleaned series and original series.

whole data set!

```
CleanWindTS <-tsclean(WindTS)
```

```
CleanSolarTS <- tsclean(SolarTS)
```

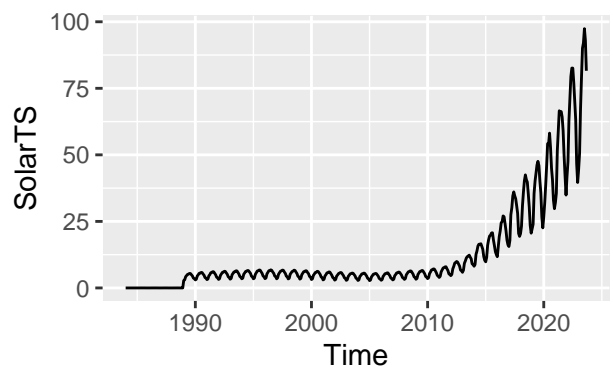
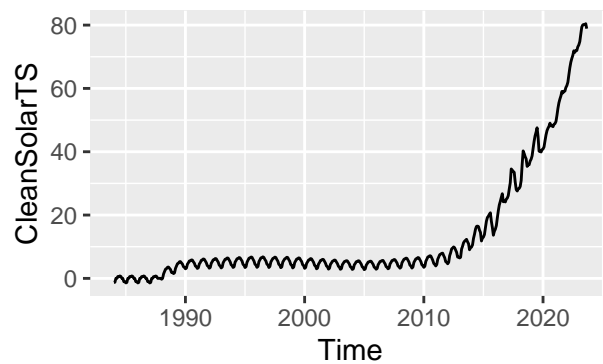
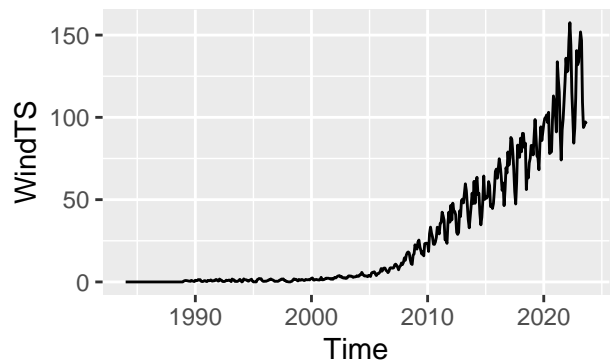
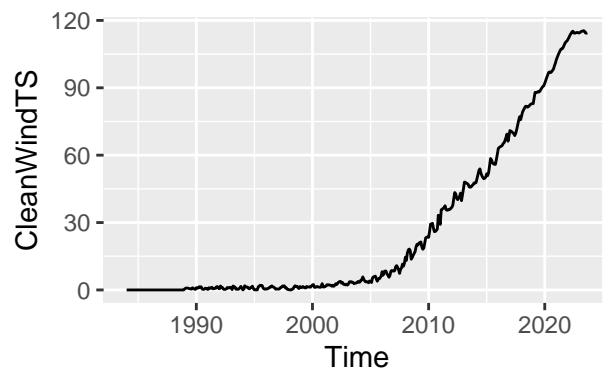
```
p1 <- autoplot(CleanWindTS)
```

```
p2 <- autoplot(CleanSolarTS)
```

```
p3 <- autoplot(WindTS)
```

```
p4 <- autoplot(SolarTS)
```

```
plot_grid(p1, p3, p2, p4, nrow = 2)
```



Q9

Redo number Q8 but now with the time series you created on Q7, i.e., the series starting in 2014. Using what `autoplot()` again what happened now? Did the function removed any outliers from the series? After 2012

Answer:

```
TSCWind <- tsclean(TSFilterWind)
TSCSolar <- tsclean(TSFilterSolar)
```

```
p5 <- autoplot(TSCSolar)
p6 <- autoplot(TSCWind)
p7 <- autoplot(TSFilterWind)
p8 <- autoplot(TSFilterSolar)
```

```
plot_grid(p5, p8, p6, p7, nrow = 2)
```

