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# The CM SAF R TOOLBOX

## - Manual -

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### QUICK START

- Install **R** (Version  $\geq 4.3$ ) and **RTools**: <https://cran.r-project.org>
- Install **RStudio** (recommended): <https://www.rstudio.com/download>
- Start RStudio and install the *cmsaf* R-package:
  - `install.packages("cmsaf")`

Attention: in some cases it might be necessary to adapt the Proxy server

- Start the Toolbox by executing the commands
  - `library(cmsaf)`
  - `run_toolbox()`
- Have fun

### STRUCTURE

Starting the Toolbox for the first time will prompt you to set up.

**Select a user directory:** You will be asked to choose a user directory on your computer. An **output** directory will be created in this folder in which all created NetCDF files will be stored. If you want to change this directory at a later point you can do so by clicking **View or change the user directory** on your Toolbox home screen. Recommended is the Toolbox configuration directory, which will be placed in your home directory under **CMSAF-Toolbox**.

**Specify a grid resolution:** In order to visualize data that is not provided on a rectangular longitude/latitude grid, the Toolbox will remap this data onto such a grid. The given value will determine its spatial resolution. Note that either a comma or period will be accepted as decimal separator dependent on what browser you are running the Toolbox in.

### FUNCTIONALITY

The CMSAF R TOOLBOX consists of three main aspects: Prepare, Analyze and Visualize.

The section **Prepare** provides methods to create a NetCDF file from a .tar packed file, which is how you will receive your climate data when ordering them from CM SAF Web User Interface (<https://wui.cmsaf.eu>).

You can use the **Analyze** section to apply various operators from the *cmsaf* package to your data. See the *cmsaf* package documentation for details. On the right information about the current data is displayed. You also have the option to apply multiple operators accumulatively to the same file. For each applied operator an output file is generated. Its name will consist of variable, operator and a timestamp.

To **Visualize** data, once again, choose a NetCDF file and the Toolbox creates your plots. There are several options to adapt the plot to your requirements.

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# The CM SAF R TOOLBOX

## - Manual -

---

## PLOTTING FUNCTIONALITY

For two-dimensional plots:

- **Select timestep:** Select the time step you want to display
- **Show Zoom:** Displays a panel to select an area to zoom in
- **Plot region:** You can select a country contained in your data or provide your own shapefile and select a region
- **Longitude / Latitude:** Adjust the spatial boundaries for the plot
- **No. of Colors / Colorbar:** Change colors and refinement of the color scale
- **Number of Ticks:** Change refinement of legend
- **Scale Range Min / Max:** Adjust legend boundaries
- **Plot country borders:** Toggle display of country borders
- **Plot R-Instat:** Gives the opportunity to add station data, which were exported from the statistical software R-Instat in .RData (more details on [r-instat.org](http://r-instat.org))
- **Plot Own Location:** Add a location to the plot by spatial coordinates
- **Projection:** Switch between projection on a plane (rectangular) or on the globe (orthographic). If choosing orthographic projection, you may rotate the globe to center a desired area but some other options are not available.
- **Title / Subtitle / Scale Caption:** Adjust labelling of your plot

For time series analysis:

- **X-Range / Y-Range:** Adjust the x and y axes
- **Color / Line type:** Set Line Color and Plot type
- **Add linear trend line:** Display a linear regression line
- **Analyze time series:** Show various analytical plots about the data
- **Number of major ticks:** Select refinement of x-axis
- **Date format:** Select format for dates shown in the graph
- **Title / Subtitle:** Adjust labelling of your plot

Also provided are a **File Summary** of the current file and some basic **Statistics**.

Download figures in PNG, JPEG or PDF format, and data as GeoTiff, KML or CSV.

# The CM SAF R TOOLBOX

## - Manual -

### CLIMATE ANALYSIS

The **Analyze** section includes an operator group called 'Climate Analysis'. This functionality can be used to produce basic plots for climate monitoring of a parameter. In a first stage this operator should only be applied to daily accumulated parameters, such as **daily sunshine duration**.

What does it produce?

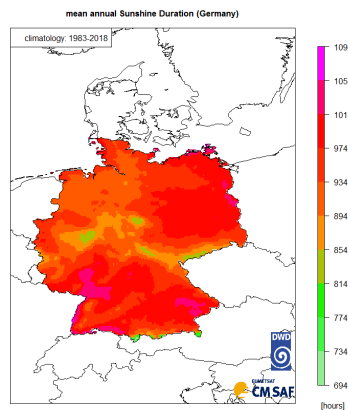
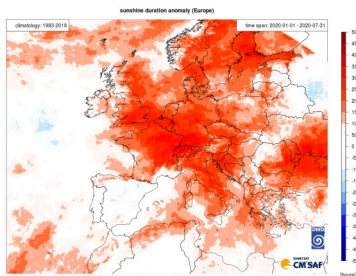
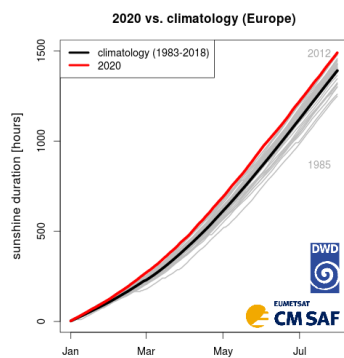
- **Absolute map**  
A map of absolute values until the latest time step
- **Climatology map**  
The long-term mean value until the same day of the year
- **Anomaly map**  
Deviation of the current absolute value from the long-term mean.
- **Fieldmean plot**  
Line plot of the spatial mean values for each year of the climatology and the selected year
- **Fieldmean plot and Anomaly map**  
Combination of fieldmean plot and anomaly map

What kind of data are needed?

- Daily data including the climatology and the current year
- A combination of TCDR and ICDR data is recommended
- See the Q&A document on how to combine data of several tar-files
- The whole time period is needed only once. Intermediate results are saved and can be reused for the next update.
- An update requires complete intermediate results from a previous run and one file including the latest data
- For the current state of development daily sunshine duration data are recommended

How do I use it?

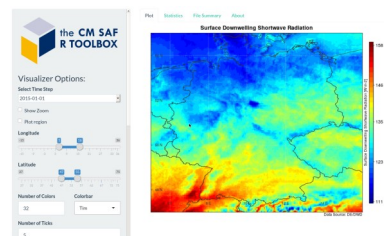
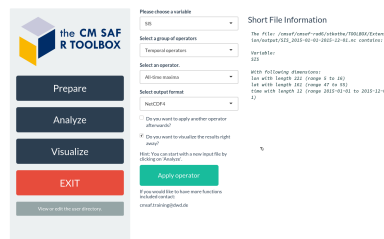
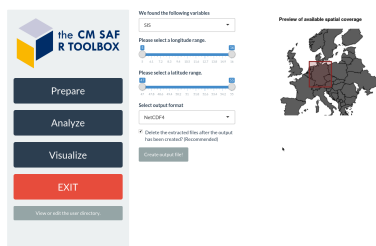
- Start **Analyze** using a nc-file with long-term daily data
- Choose the operator group **Climate Analysis**
- Data will be accumulated by default (e.g., for sunshine duration)
- Choose a kind of plot (e.g., Fieldmean plot)
- Choose an area to analyze; available are mostly all countries, Europe, Africa, the total Meteosat-disk or a selected rectangular area (use longitude and latitude to choose the margins of the plotting region)
- Choose the length of the climatology and make a choice between graphic or animation
- To update with existing data, use the 'attach data' checkbox, use the same setting as before, use 'Apply operator' and choose the previously used file



# The CM SAF R TOOLBOX

## - Manual -

### EXAMPLE



- Order CM SAF data via <https://wui.cmsaf.eu> and download them (For testing, example data can be downloaded via [www.cmsaf.eu/R\\_toolbox](http://www.cmsaf.eu/R_toolbox), which will be used in this example)
- Open RStudio and run
  - `library(cmsaf)`
  - `run_toolbox()`
- Click **Prepare** and select the downloaded ORD12345.tar-file to start the preparation process.
  - Select a time range.
  - Press **untar and unzip files**.
  - Specify a variable, e.g. 'SIS', spatial range and other options.
  - Click **Create output file** to create the NetCDF file containing the combined data.
  - Once this is done you will be referred to the **Analyze** panel.
- Click **Analyze this file**
  - Select **Temporal operators** in **Group of operators**
  - Select the operator **All-time means**.
- Switch to **Visualize** and select your created NetCDF file `SIS_timmean....nc` (or select **Visualize the results right away** in the Analyze panel)
  - You will get a 2D map displaying the average Surface Downwelling Shortwave Radiation for 2015 in the selected area.
  - Adjust the parameters on the left to suit your requirements. (see Functionality)
  - The example data also comes with an R-instat data file you can use with the monthly mean SIS data
  - If you want to save the plot click **Download** on the bottom of the sidebar panel and choose a format

### cmsaf, cmsafops and cmsafvis R-packages

The Toolbox comes as part of the `cmsaf` R-package. All operators in the **Analyze** section are functions provided in the `cmsafops` and `cmsafvis` packages. You can also apply them separately. The functions are documented in the package manuals. The `cmsafops` R-package includes more than 60 functions, which are fairly easy to use, including some that are not part of the CM SAF R TOOLBOX.

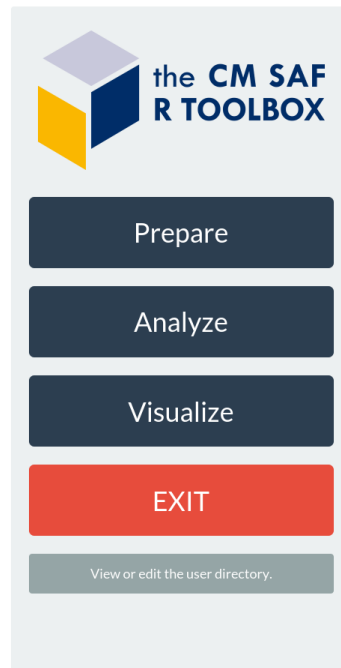
### User Help Desk

In case that a question or problem can not be solved by help of the Manual or the package documentation contact the CM SAF User Help Desk ([contact.cmsaf@dwd.de](mailto:contact.cmsaf@dwd.de)).

# The CM SAF R TOOLBOX

## - Manual -

### IMPRESSIONS



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Prepare

Analyze

Visualize

EXIT

View or edit the user directory.

We found the following variables

SIS

Please select a longitude range.

5 6.1 7.2 8.3 9.4 10.5 11.6 12.7 13.8 14.9 16

Please select a latitude range.

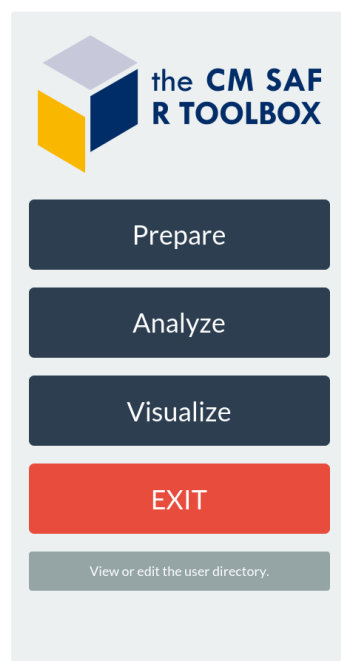
47 47.8 48.6 49.4 50.2 51 51.8 52.6 53.4 54.2 55

Select output format

NetCDF4

Delete the extracted files after the output has been created? (Recommended)

Create output file!

the CM SAF  
R TOOLBOX

Prepare

Analyze

Visualize

EXIT

View or edit the user directory.

Please choose a variable

SIS

Select a group of operators

Temporal operators

Select an operator.

All-time maxima

Select output format

NetCDF4

Do you want to apply another operator afterwards?

Do you want to visualize the results right away?

Hint: You can start with a new input file by clicking on 'Analyze'.

Apply operator

If you would like to have more functions included contact:  
cmsaf.training@dwd.de

### Short File Information

The file: /cmsaf/cmsaf-rad6/stkotho/TOOLBOX/Extension/output/SIS\_2015-01-01-2015-12-01.nc contains:

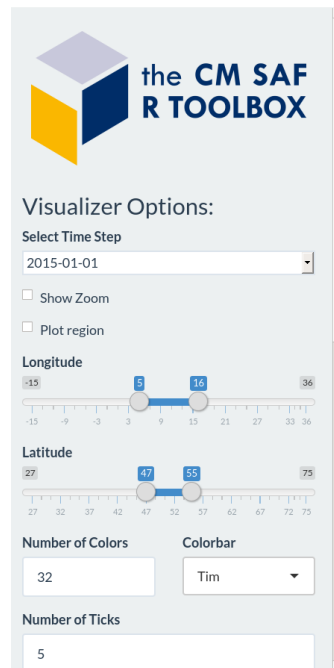
Variable:  
SIS

With following dimensions:  
lon with length 221 (range 5 to 16)  
lat with length 161 (range 47 to 55)  
time with length 12 (range 2015-01-01 to 2015-12-01)

# The CM SAF R TOOLBOX

## - Manual -

### IMPRESSIONS



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Visualizer Options:

Select Time Step  
2015-01-01

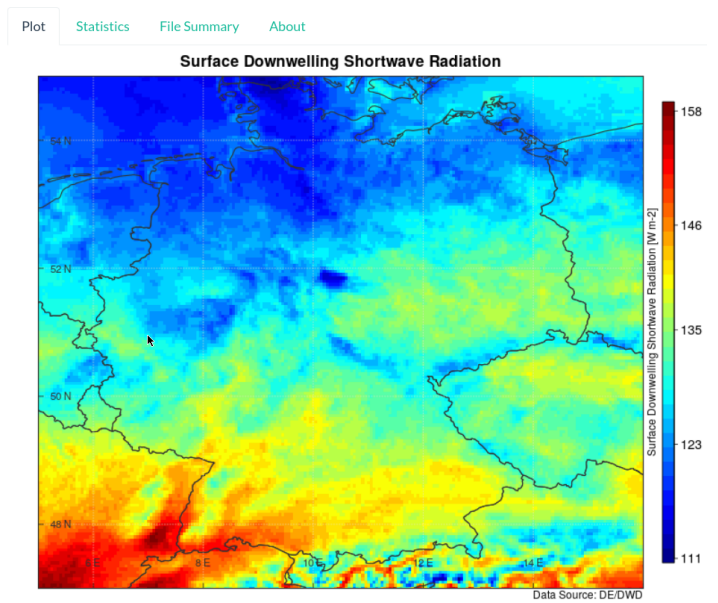
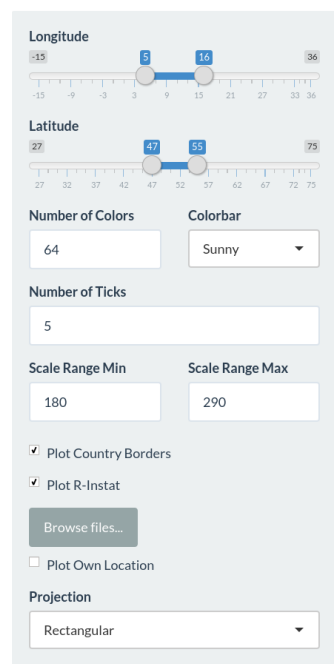
Show Zoom  
 Plot region

Longitude  
-15 3 9 15 21 27 33 36

Latitude  
27 32 37 42 47 52 57 75

Number of Colors: 32  
Colorbar: Tim

Number of Ticks: 5

Longitude  
-15 3 9 15 21 27 33 36

Latitude  
27 32 37 42 47 52 57 75

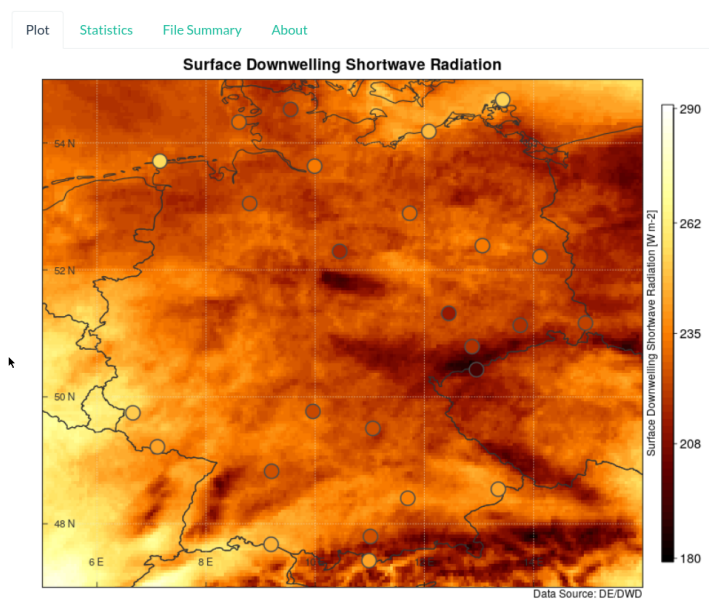
Number of Colors: 64  
Colorbar: Sunny

Number of Ticks: 5

Scale Range Min: 180  
Scale Range Max: 290

Plot Country Borders  
 Plot R-Instat  
Browse files...  
 Plot Own Location


Projection: Rectangular



# The CM SAF R TOOLBOX

## - Manual -

### IMPRESSIONS



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Visualizer Options:

Select Time Step  
2015-01-01

Show Zoom

Plot region

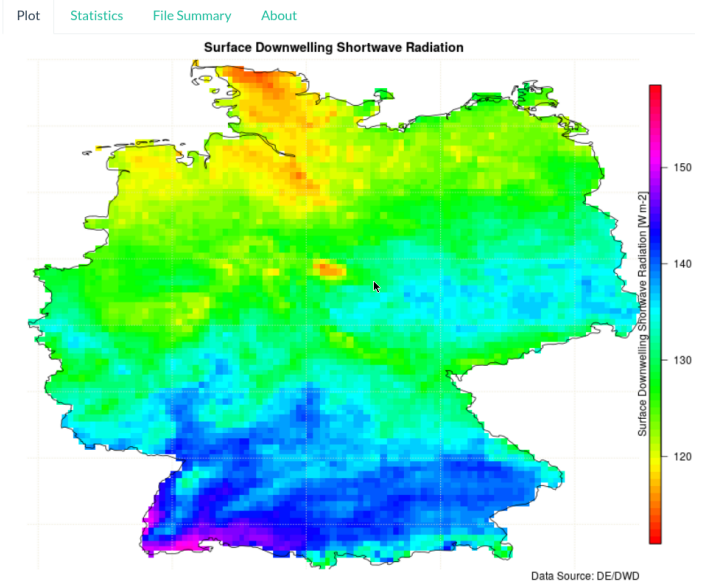

Division: COUNTRY  
Region: Germany

Choose a shape file...

Number of Colors: 64  
Colorbar: Rainbow

Scale Range Min: 111.3  
Scale Range Max: 158.2

Plot Own Location

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Visualizer Options:

Select Time Step  
2011-01-01

Center Lon: 0  
Center Lat: 89  
Rotation: 0

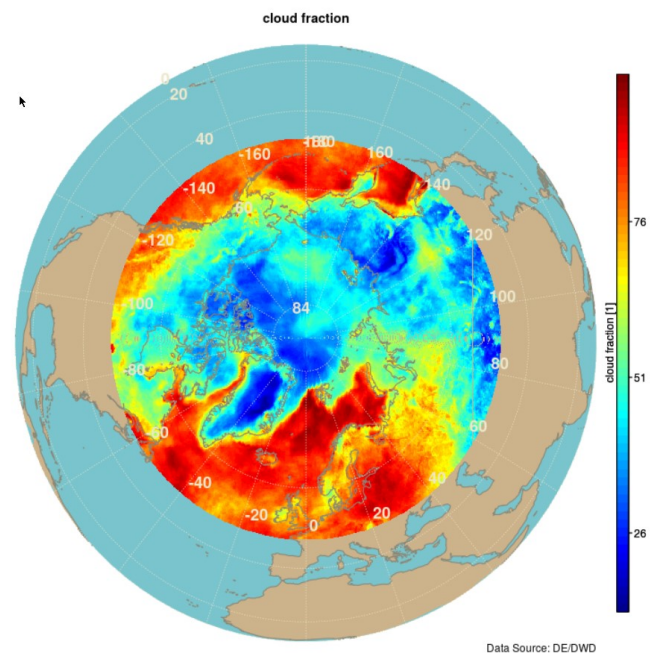
Number of Colors: 64  
Colorbar: Tim

Plot Country Borders

Plot R-Instat

Projection: Orthographic

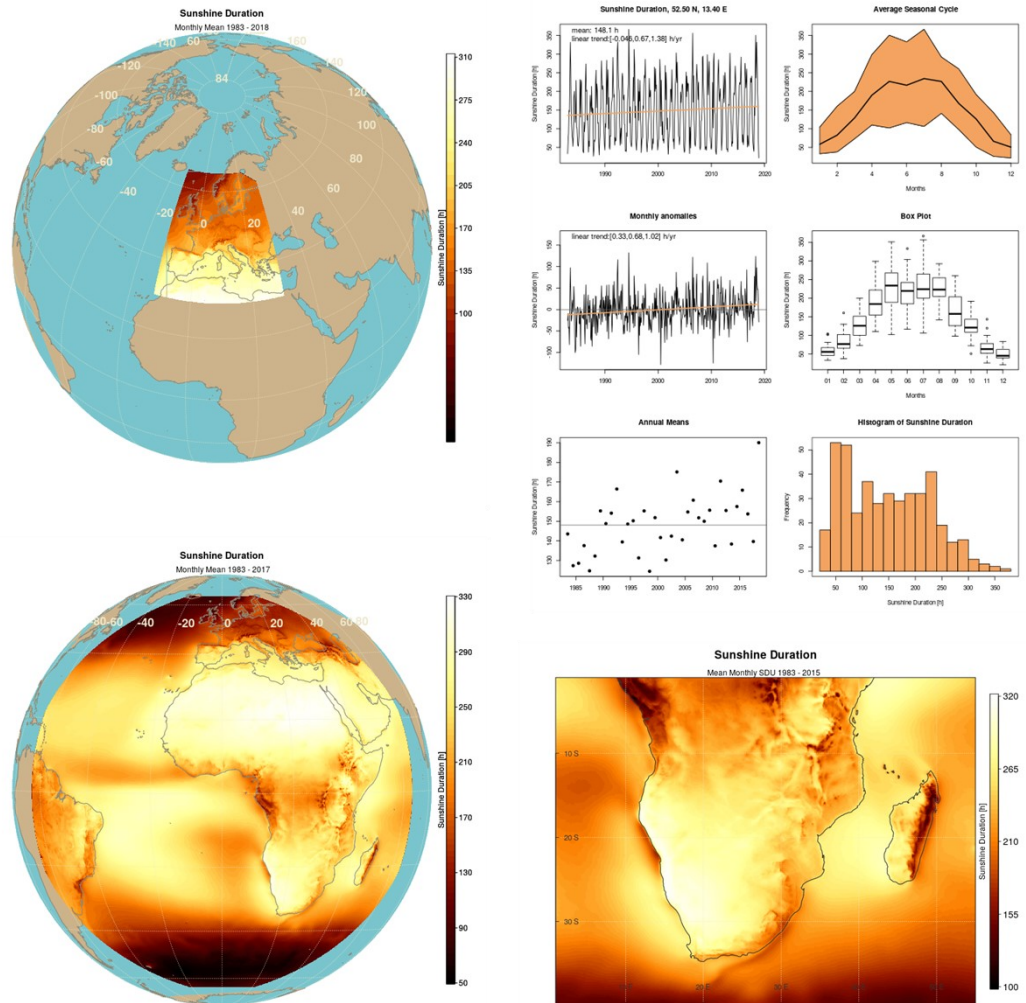
Title: cloud fraction



# The CM SAF R TOOLBOX

## - Manual -

### IMPRESSIONS

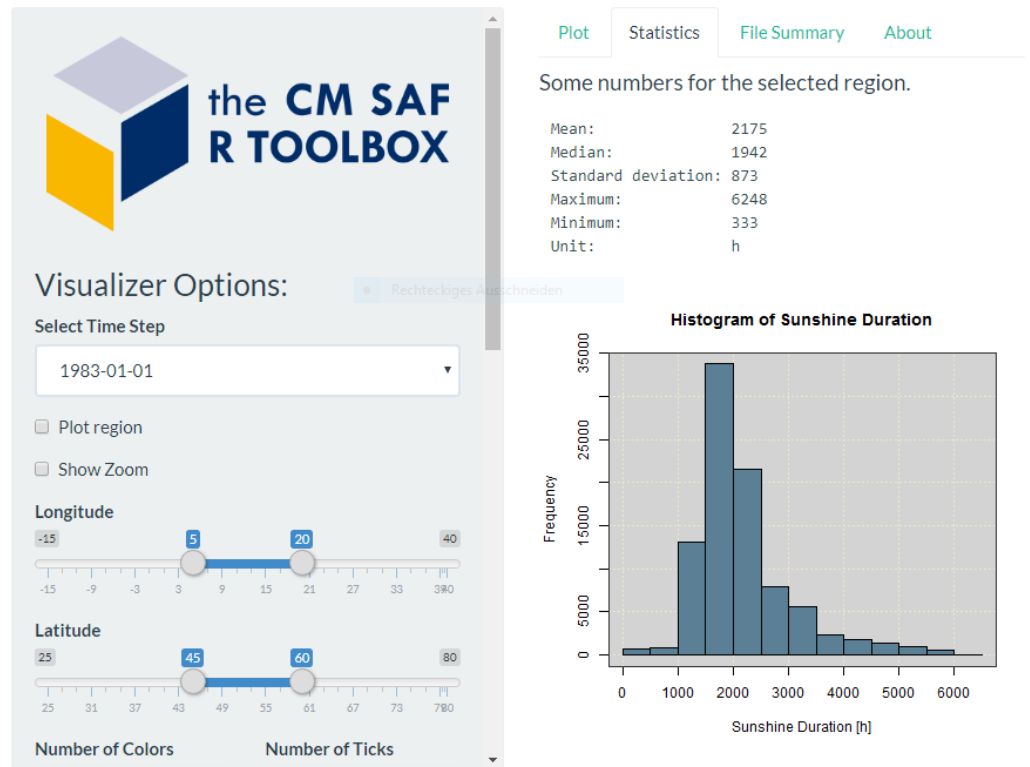




# The CM SAF R TOOLBOX

## - Manual -

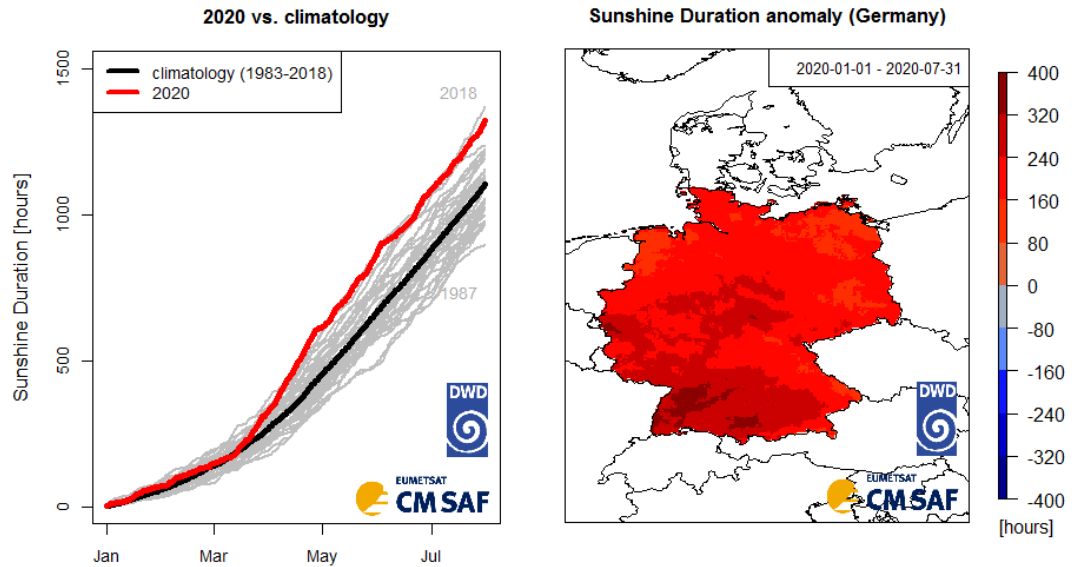
### IMPRESSIONS



# The CM SAF R TOOLBOX

## - Manual -

### IMPRESSIONS



Cloud Mask, CLAAS-2, 2017-06-19 00:00

