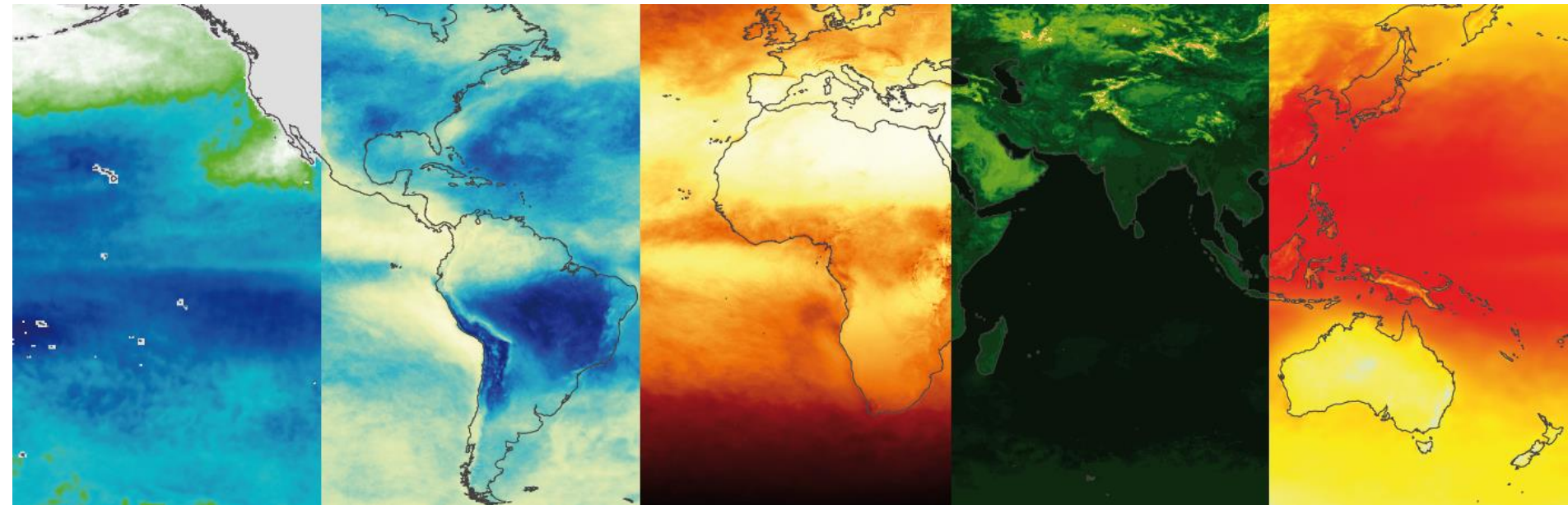


The CM SAF R TOOLBOX

A quick start tutorial



Steps to get started with the CM SAF R Toolbox

1. Install *R*
2. Install *Rstudio*
3. Get *CM SAF R TOOLBOX*
4. Install R-packages
5. Start a script
6. Have fun

The CM SAF R TOOLBOX

R-based tools for an easy usage of CM SAF NetCDF data

PREPARE
 Extract, unzip, select time range and region, merge.

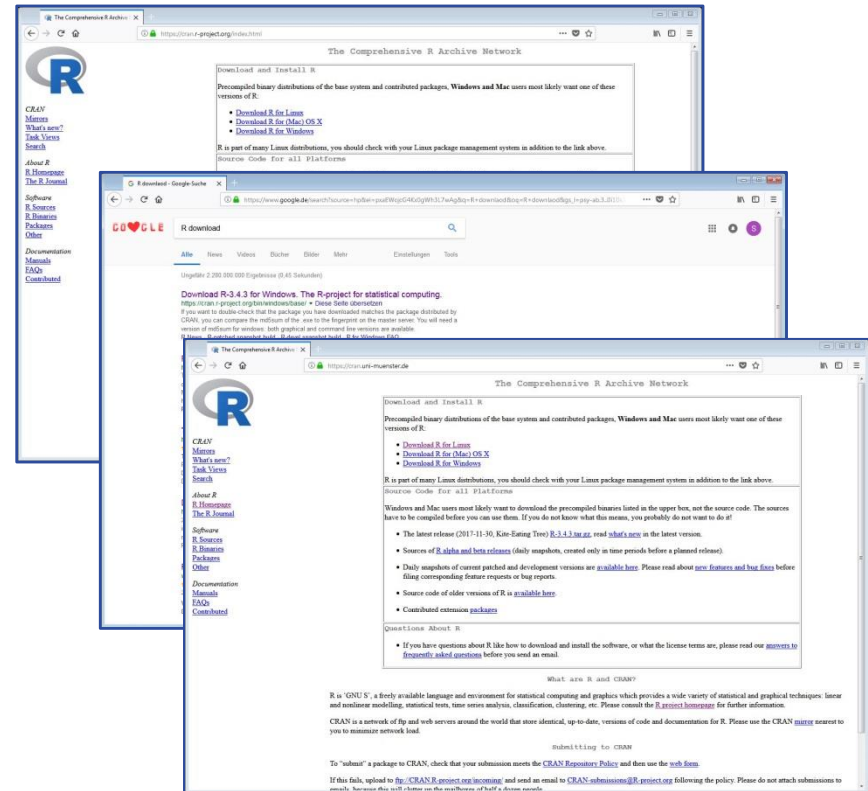
ANALYSE
 The cmsaf R-package contains more than 50 useful operators.

VISUALIZE
 Visualize spatial data, statistical analysis and 1D-timeseries.

© DWD 2018

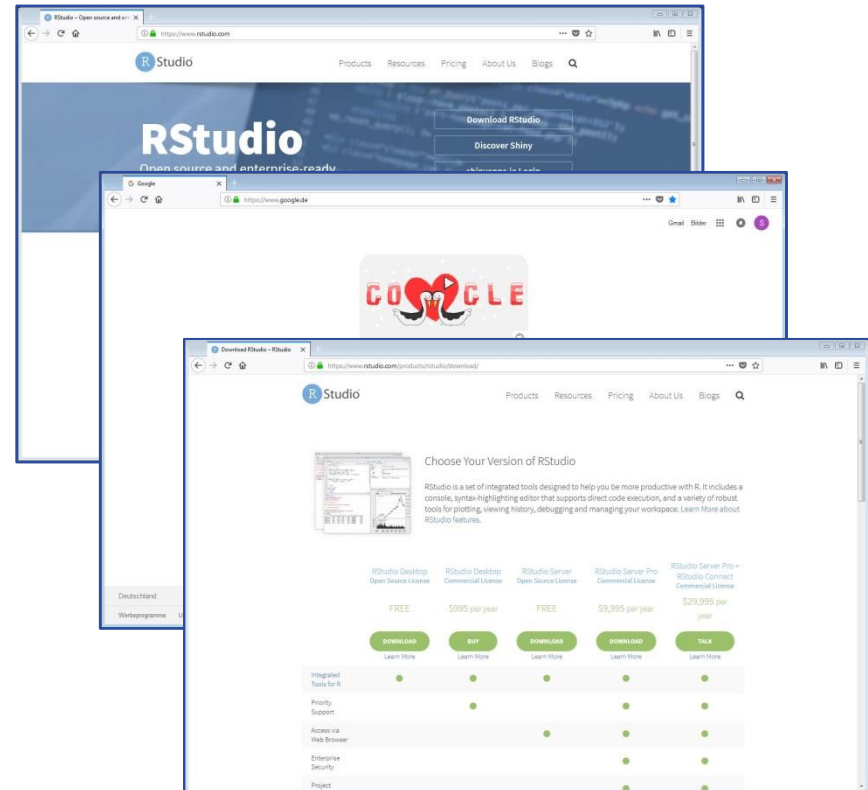
Step 1: Install R

1. Go to www.r-project.org to download R
2. Or just google "R download"
3. Install R following the instructions and depending on your OS



Step 2: Install Rstudio

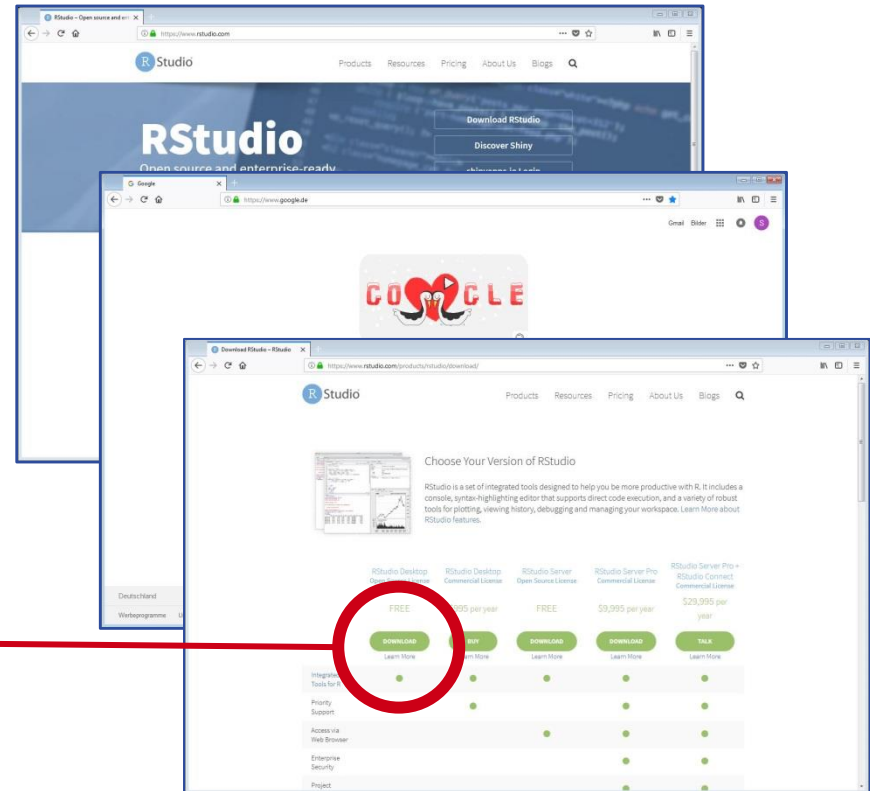
1. Go to www.rstudio.com to download *Rstudio*
2. Or just google “*Rstudio download*”
3. Install *Rstudio* following the instructions and depending on your OS



Step 2: Install Rstudio

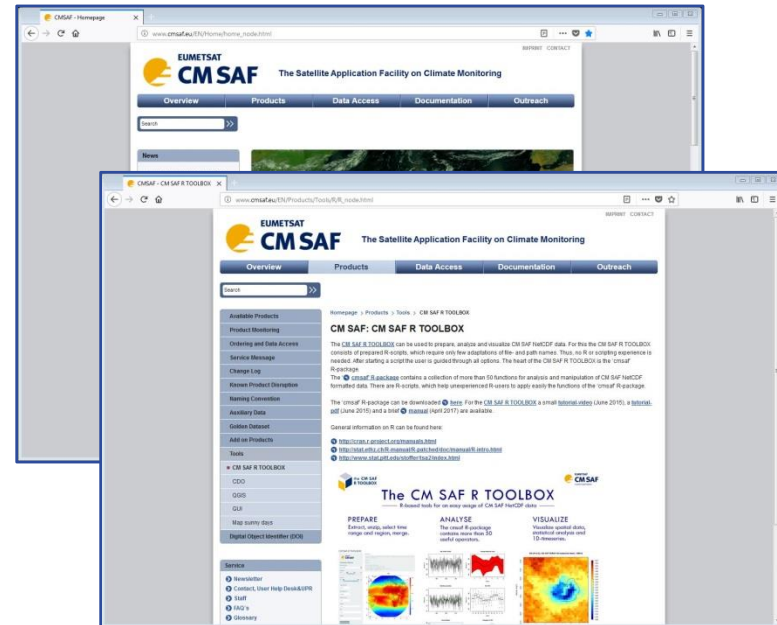
1. Go to www.rstudio.com to download *Rstudio*
2. Or just google “*Rstudio download*”
3. Install *Rstudio* following the instructions and depending on your OS

The free version of *Rstudio* offers everything you need



Step 3: Get CM SAF R TOOLBOX

1. Go to http://www.cmsaf.eu/EN/Products/Tools/R/R_node.html to download the *CM SAF R Toolbox*
2. Download and unzip the file *CMSAF-R-TOOLBOX.zip*



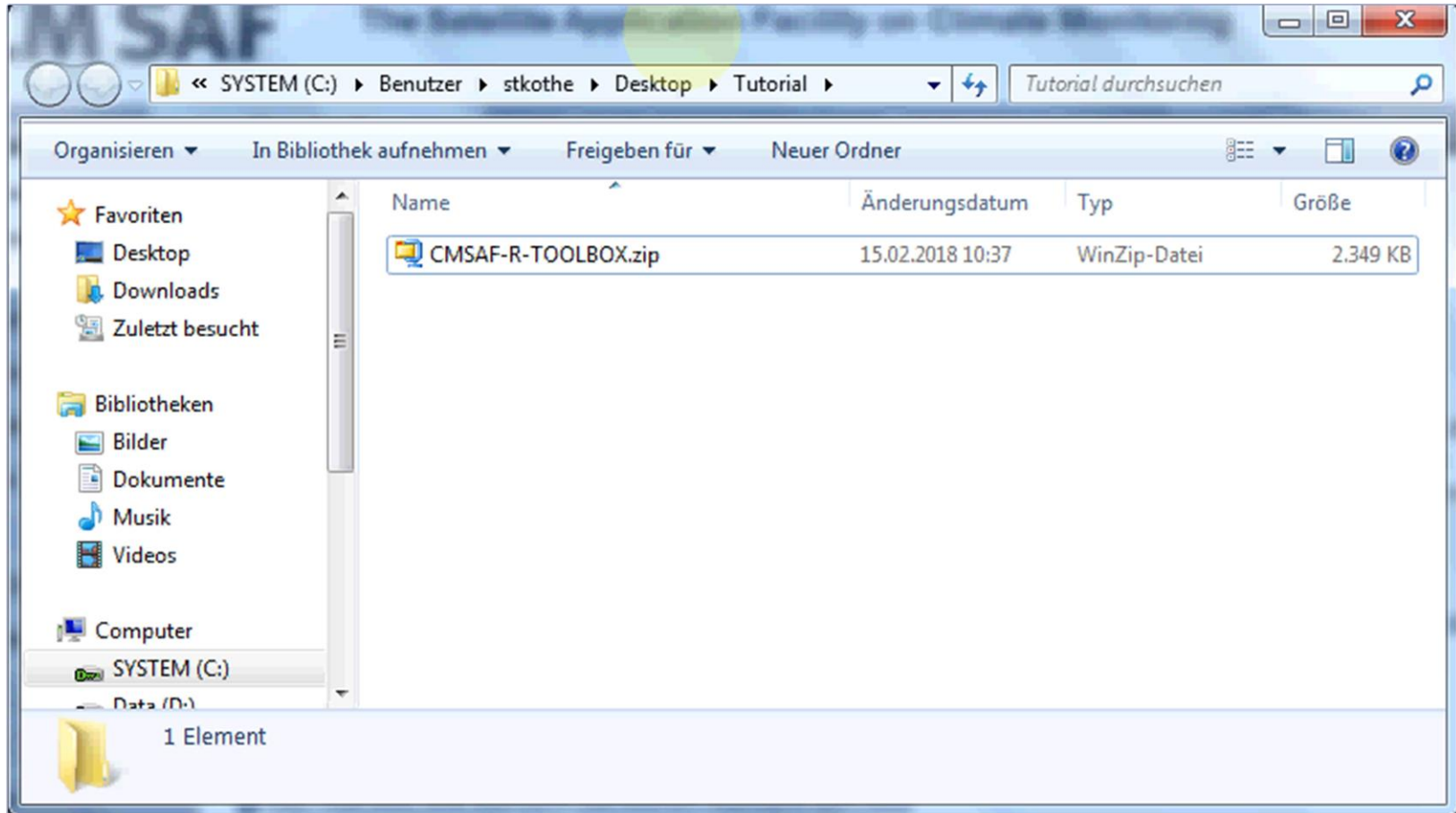
Step 3: Get CM SAF R TOOLBOX



The screenshot shows the CM SAF website with the following content:

- Header: EUMETSAT CM SAF The Satellite Application Facility on Climate Monitoring
- Navigation: Overview, Products, Data Access, Documentation, Outreach
- Search bar: Search >>
- Left sidebar: Available Products, Product Monitoring, Ordering and Data Access, Service Message, Change Log, Known Product Disruption, Website Connection
- Main content: Breadcrumb navigation (Homepage > Products > Tools > CM SAF R TOOLBOX), title 'CM SAF - CM SAF R TOOLBOX', and introductory text about the toolbox. A red circle highlights the 'CM SAF R TOOLBOX' link in the breadcrumb, and a red arrow points to a text box below.
- Text box: You can download the *CM SAF R TOOLBOX* by clicking on the blue link
- Bottom section: 'The CM SAF R TOOLBOX' with sub-sections: PREPARE (Extract, wrap, select time range and region, merge), ANALYSE (The cm SAF R-package contains more than 50 useful operators), and VISUALIZE (Visualize spatial data, statistical analysis and 1D-time-series). Below these are several data visualization plots.

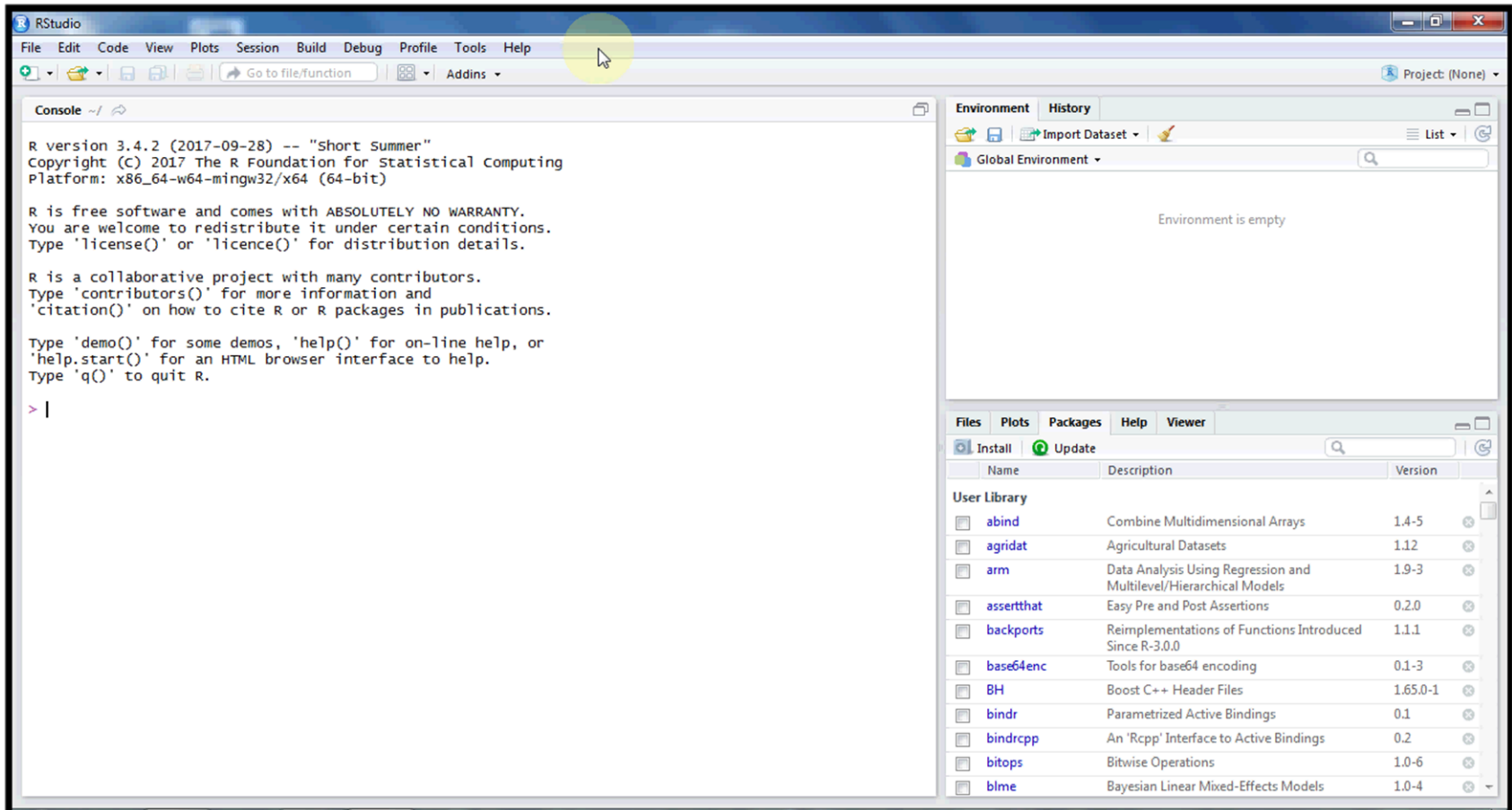
Step 3: Get CM SAF R TOOLBOX



Step 4: Install R-packages

1. Open the script *Install.Package4Toolbox.R* in *Rstudio*
2. No editing is needed
3. Start the script by clicking on the *Source* button
4. The script checks if all needed R-packages are installed, otherwise it will download and install them
5. Your *CM SAF R TOOLBOX* is now ready to start

Step 4: Install R-packages



The screenshot shows the RStudio interface. The console on the left displays the R startup message for version 3.4.2 (2017-09-28). The Packages pane on the right shows the 'User Library' with a list of installed and available packages.

Console Output:

```
R version 3.4.2 (2017-09-28) -- "Short Summer"
Copyright (C) 2017 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```

Packages Pane (User Library):

Name	Description	Version
<input type="checkbox"/> abind	Combine Multidimensional Arrays	1.4-5
<input type="checkbox"/> agridat	Agricultural Datasets	1.12
<input type="checkbox"/> arm	Data Analysis Using Regression and Multilevel/Hierarchical Models	1.9-3
<input type="checkbox"/> assertthat	Easy Pre and Post Assertions	0.2.0
<input type="checkbox"/> backports	Reimplementations of Functions Introduced Since R-3.0.0	1.1.1
<input type="checkbox"/> base64enc	Tools for base64 encoding	0.1-3
<input type="checkbox"/> BH	Boost C++ Header Files	1.65.0-1
<input type="checkbox"/> bindr	Parametrized Active Bindings	0.1
<input type="checkbox"/> bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2
<input type="checkbox"/> bitops	Bitwise Operations	1.0-6
<input type="checkbox"/> blme	Bayesian Linear Mixed-Effects Models	1.0-4

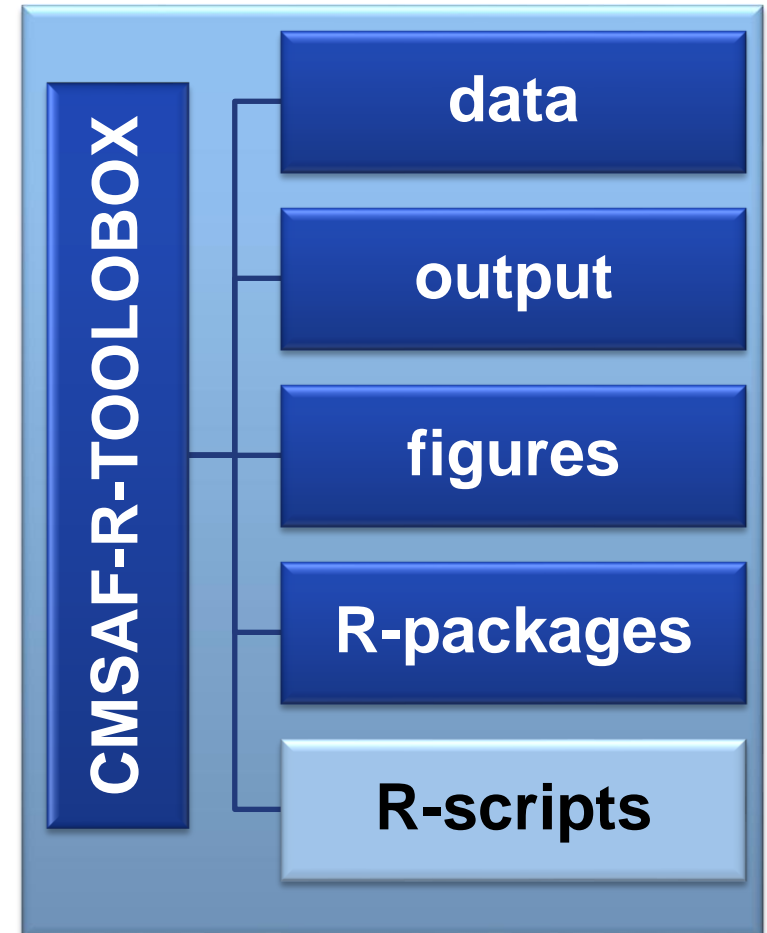
CM SAF R TOOLBOX scripts

- The *CM SAF R TOOLBOX* consists of several prepared R-scripts
- The scripts require **no** *R* or scripting experience
- After starting a script the user is guided through all options



Step 5: Start a script

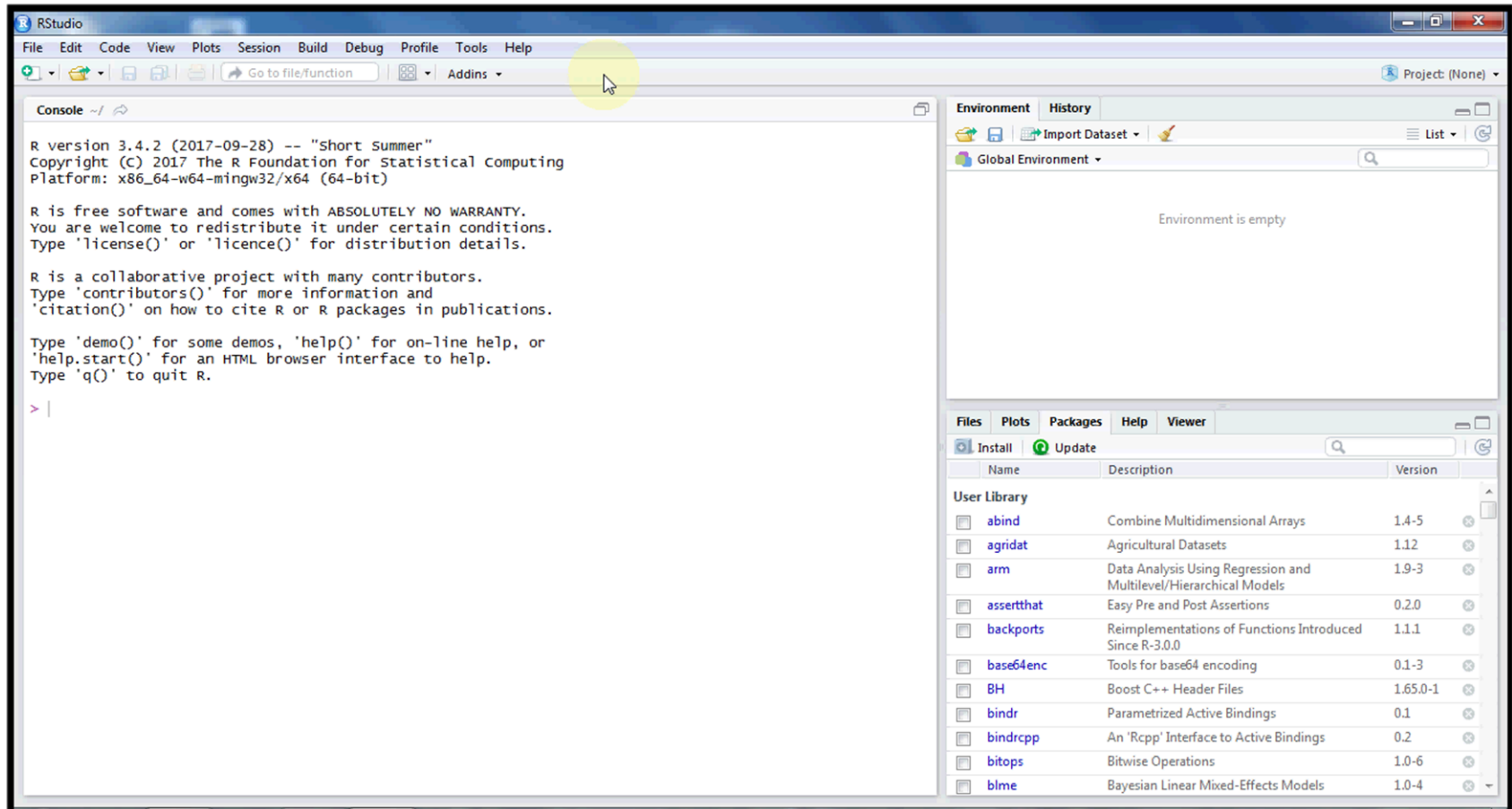
1. In the *R-scripts* folder there are prepared scripts for data preparation, analysis and visualization
2. Open a script with *Rstudio* and start with *Source*



Data preparation

- CM SAF data records can be ordered free of charge via wui.cmsaf.eu
- Data are provided via ftp as tarball
- Use the ***Prep.Data.R*** script to:
 - Extract
 - Unzip
 - Select time range
 - Select region
 - Merge single files into one

Data preparation



The screenshot shows the RStudio interface. The console on the left displays the R startup message for version 3.4.2 (2017-09-28). The environment pane on the right shows that the environment is empty. The package manager pane at the bottom right lists installed packages in the user library.

Console Output:

```
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Type 'q()' to quit R.

> |
```

Environment Pane: Environment is empty

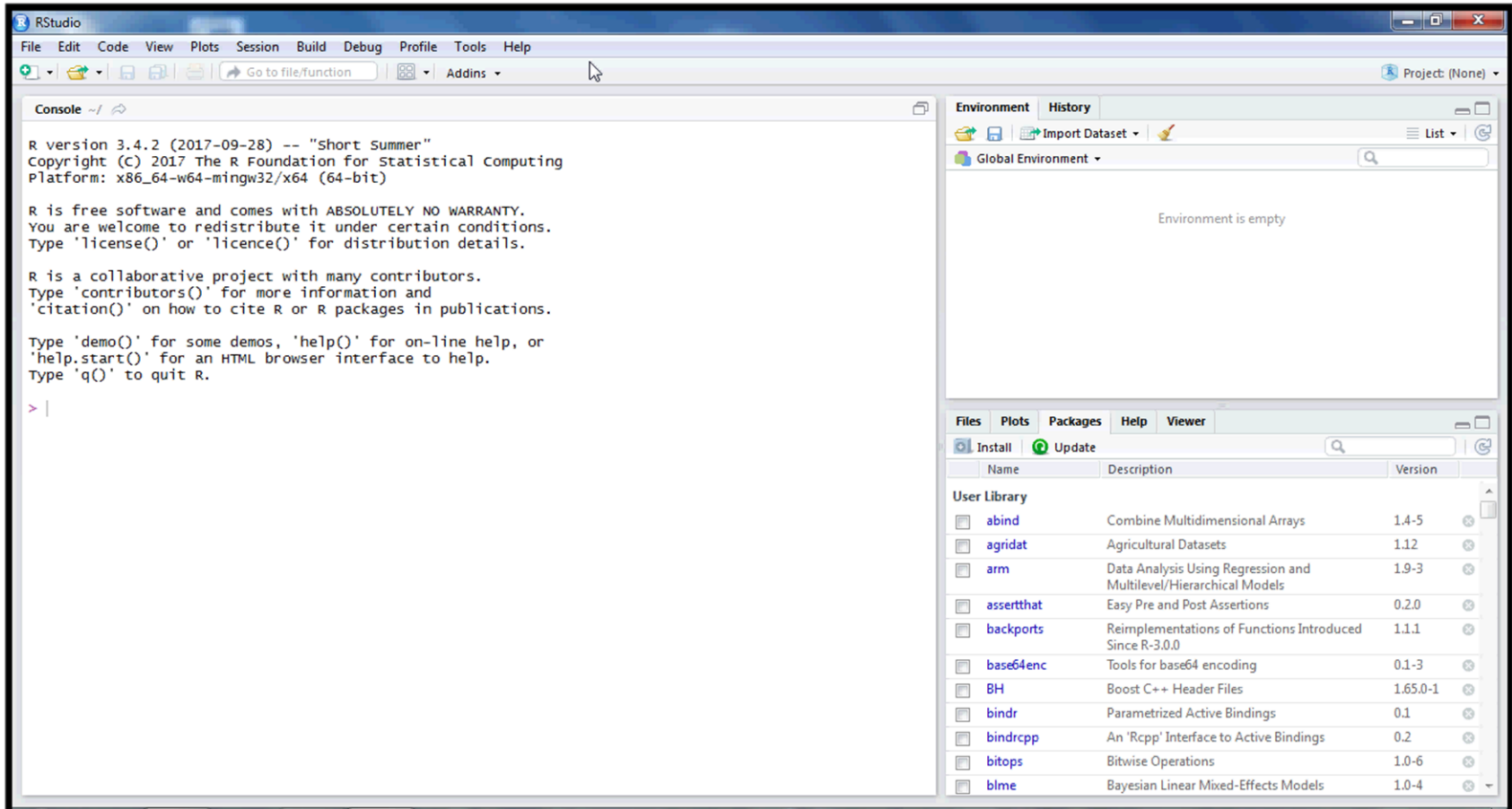
Package Manager Pane:

Name	Description	Version
<input type="checkbox"/> abind	Combine Multidimensional Arrays	1.4-5
<input type="checkbox"/> agridat	Agricultural Datasets	1.12
<input type="checkbox"/> arm	Data Analysis Using Regression and Multilevel/Hierarchical Models	1.9-3
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<input type="checkbox"/> base64enc	Tools for base64 encoding	0.1-3
<input type="checkbox"/> BH	Boost C++ Header Files	1.65.0-1
<input type="checkbox"/> bindr	Parametrized Active Bindings	0.1
<input type="checkbox"/> bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2
<input type="checkbox"/> bitops	Bitwise Operations	1.0-6
<input type="checkbox"/> blme	Bayesian Linear Mixed-Effects Models	1.0-4

Data analysis

- The ***Apply.Function.R*** script serves as simple-to-apply interface to functions of the *cmsaf R-package*
- ***cmsaf R-package***
 - The *cmsaf R-package* is a collection of functions for basic analysis and manipulation of CM SAF NetCDF data
 - It contains more than 50 operators

Data analysis: temporal mean



The screenshot shows the RStudio interface. The console on the left displays the R startup message for version 3.4.2 (2017-09-28) on a 64-bit Windows platform. The environment pane on the right shows an empty global environment. The package manager pane at the bottom right lists installed packages in the user library.

Console Output:

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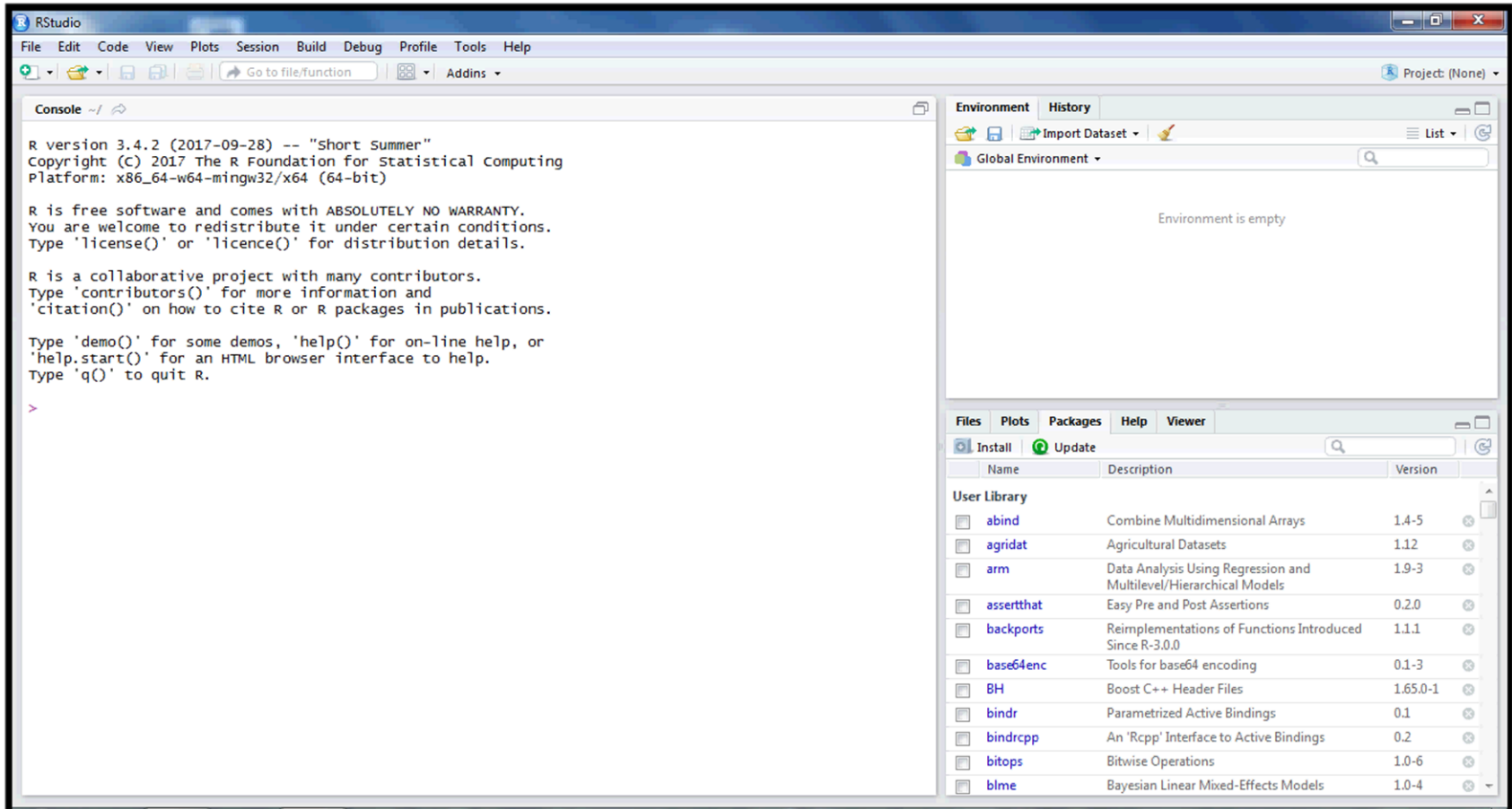
> |
```

Environment Pane: Environment is empty

Package Manager Pane:

Name	Description	Version
abind	Combine Multidimensional Arrays	1.4-5
agridat	Agricultural Datasets	1.12
arm	Data Analysis Using Regression and Multilevel/Hierarchical Models	1.9-3
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backports	Reimplementations of Functions Introduced Since R-3.0.0	1.1.1
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BH	Boost C++ Header Files	1.65.0-1
bindr	Parametrized Active Bindings	0.1
bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2
bitops	Bitwise Operations	1.0-6
blme	Bayesian Linear Mixed-Effects Models	1.0-4

Data analysis: field mean



The screenshot shows the RStudio interface. The console on the left displays the R startup message for version 3.4.2 (2017-09-28) on a 64-bit Windows platform. The environment pane on the right shows an empty global environment. The package manager pane at the bottom right lists installed packages in the user library.

Console Output:

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>
```

Environment: Environment is empty

Package Manager:

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bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2
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blme	Bayesian Linear Mixed-Effects Models	1.0-4

Data visualization

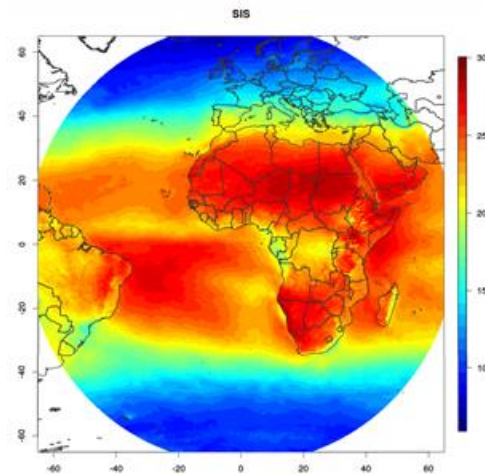
➔ The *CM SAF_Visualizer.R* script is a GUI-based tool for interactive plotting

CM SAF R TOOLBOX

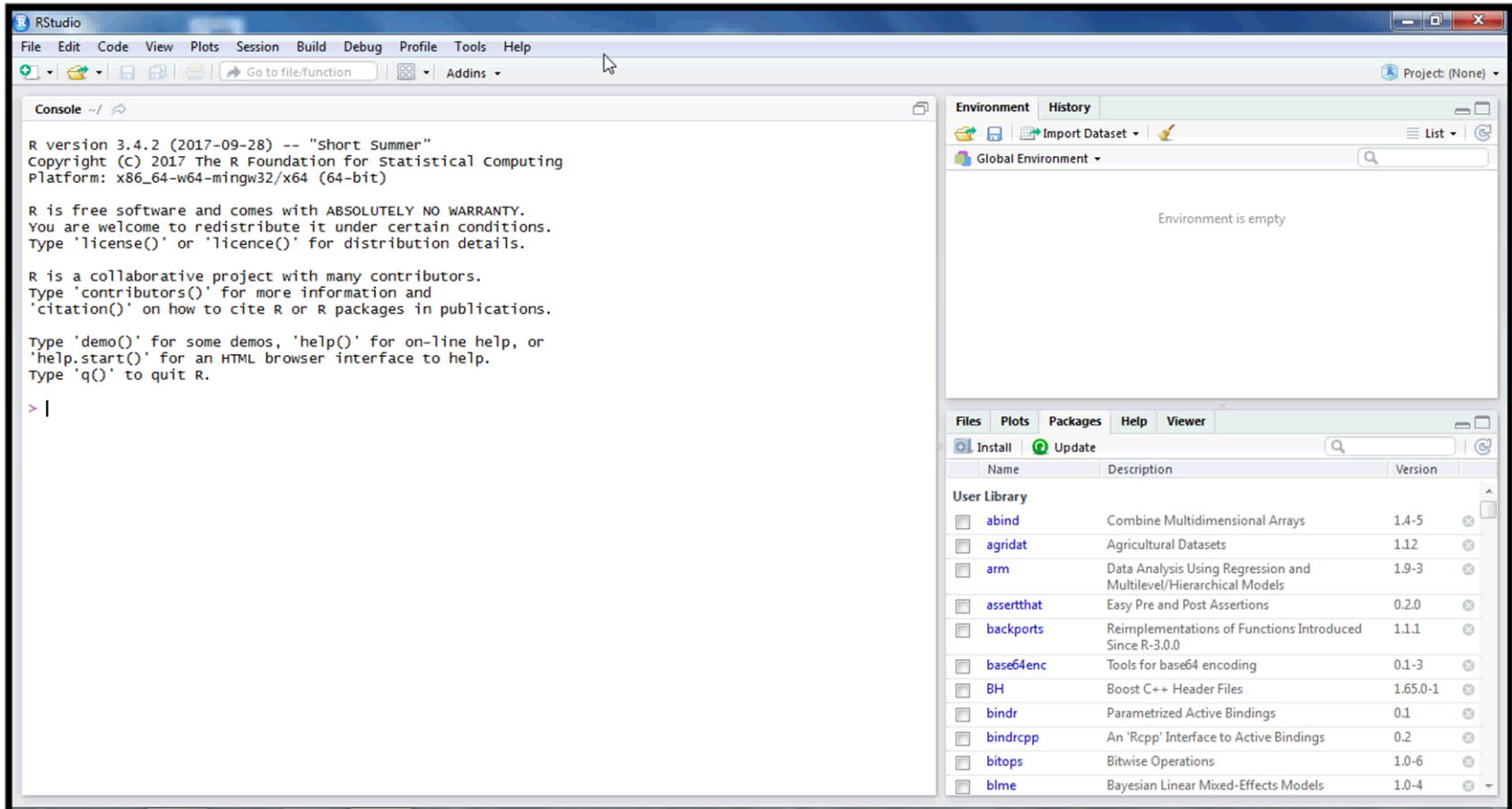


The screenshot shows the 'Visualizer Options' panel of the CM SAF R toolbox. It includes a 'Select Time Step' dropdown menu set to '2014-12-01'. Below this are sliders for 'Longitude' and 'Latitude'. Further down are input fields for 'Scale Range Min' (62.8), 'Scale Range Max' (296.8), and 'Number of Colors' (32). There is a 'Colorbar' dropdown set to 'Tim', a 'Title' field containing 'SIS', and a 'Subtitle' field. At the bottom is a 'Save as png file' button.

```
File Summary
The file: /rsmf/cmef/rads/strathe700800/VRAP-R-700800_krwa/output/SIS_apply_Function_times
r_140115.nc contains:
variables:
  SIS
  Time_3hrs
With following dimensions:
lon with length 2001 (range -90 to 90)
lat with length 2001 (range -90 to 90)
time with length 1 (range 2014-12-01 to 2014-12-01)
rho2 with length 2 (range 0 to 1)
```



Data visualization



The screenshot shows the RStudio interface. The console pane on the left displays the R startup message for version 3.4.2 (2017-09-28) on a 64-bit platform. The environment pane on the right shows an empty global environment. The packages pane at the bottom right lists installed packages in the user library.

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```

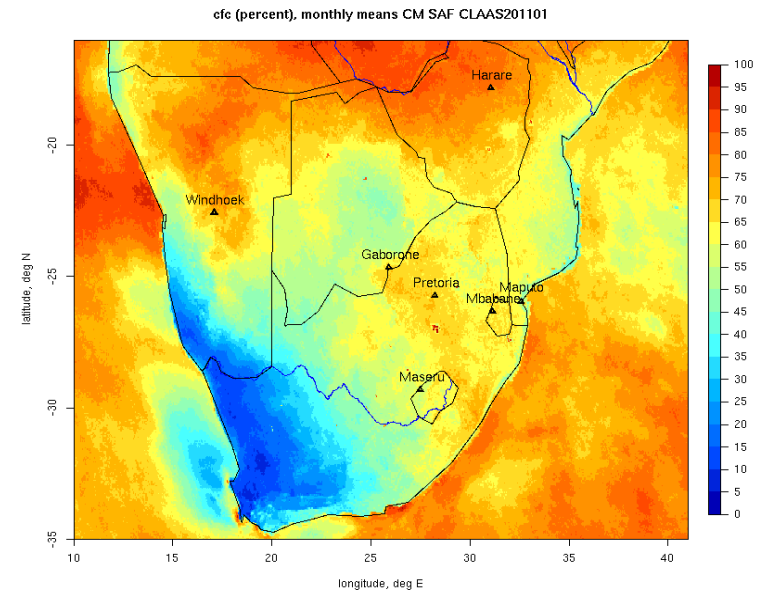
Environment: Environment is empty

Installed Packages:

Name	Description	Version
abind	Combine Multidimensional Arrays	1.4-5
agridat	Agricultural Datasets	1.12
arm	Data Analysis Using Regression and Multilevel/Hierarchical Models	1.9-3
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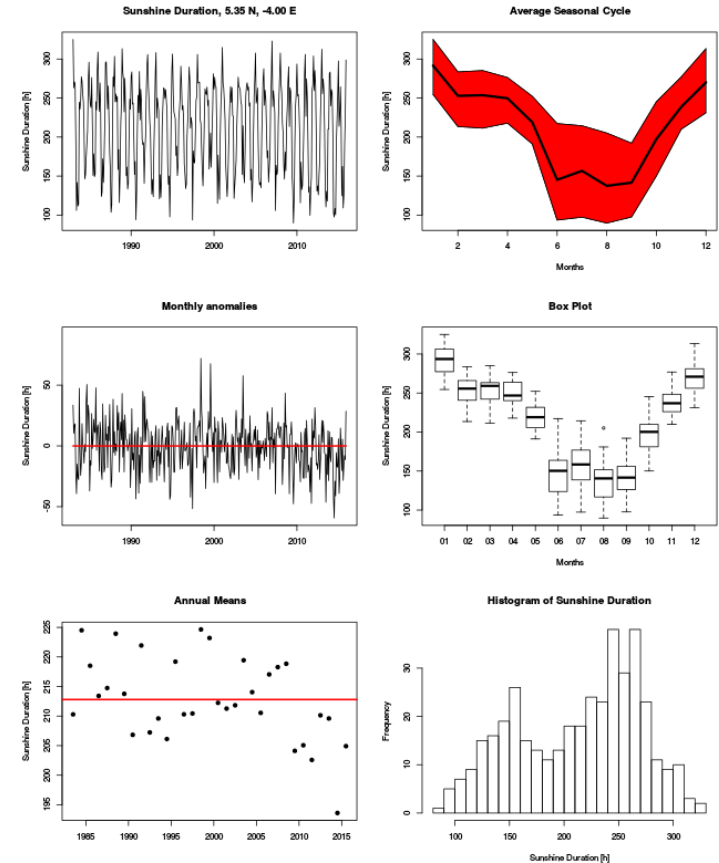
Data visualization

- Other scripts for the visualization of CM SAF data are for instance:
 - ***Plot.Region.R*** for plotting 2d arrays
 - ***Analyse.TimeSeries.R*** to plot statistical figures of 1d time series
- The scripts offer several possibilities of adaptations

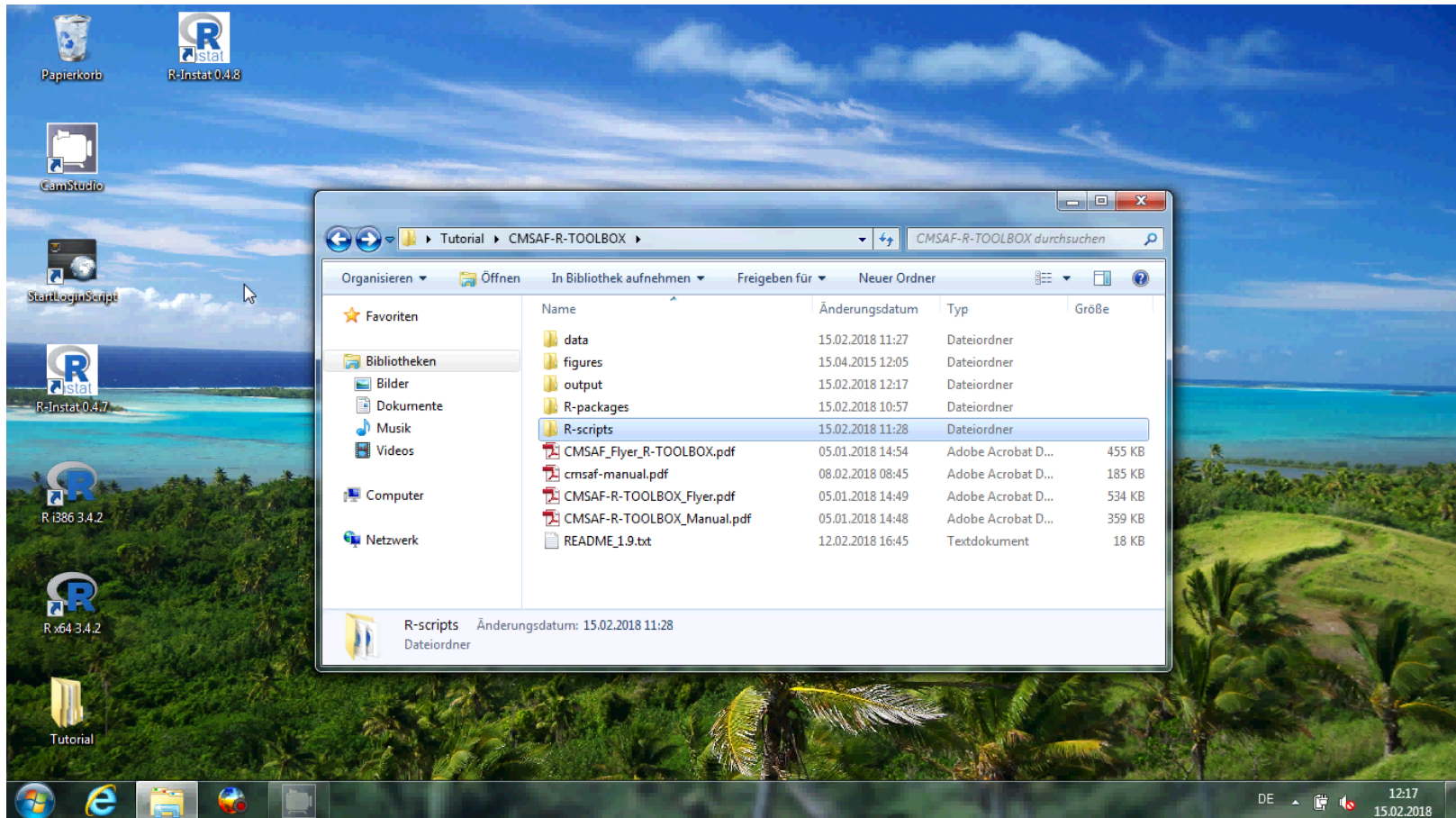


Data visualization

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 - ➔ ***Plot.Region.R*** for plotting 2d arrays
 - ➔ ***Analyse.TimeSeries.R*** to plot statistical figures of 1d time series
- ➔ The scripts offer several possibilities of adaptations



Manuals and further information



Have fun!



the CM SAF R TOOLBOX

Contact:

Steffen.Kothe@dwd.de

contact.cmsaf@dwd.de



www.cmsaf.eu/tools