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Interpolation Methods for the Climate Atlas

Dr. R. Sluiter

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Contact person	Raymond Sluiter T 030 2206 446 raymond.sluiter@knmi.nl Royal Netherlands Meteorological Institute (KNMI) Wilhelminalaan 10 | 3732 GK De Bilt Postbus 201 | 3730 AE | De Bilt
Attachments	None
Author	Raymond Sluiter

Contents

1 Introduction

For the production of the maps in the Climate Atlas 1981-2010 (Klimaatatlas 1981-2010) the entire interpolation facility at KNMI has been upgraded. This facility contains the whole chain from the processed measurement data in the database to various map products. Pre-processing of the data is done according to research done by KNMI division KS-KA. Starting in 2009 research has been conducted to develop optimal interpolation methods, new interpolation applications, and new methods for presenting and downloading interpolated data. A Geo Spatial Interpolation Environment (GSIE) was developed for the interpolation of maps. GSIE uses R, software for statistical computing (R-Project, 2009). All maps on the website and in the book version of the Climate Atlas are produced using the renewed interpolation algorithms in GSIE. In this report KNMI has documented the applied methods, the scientific basis and "recipes" to produce these maps.

1.1 Research background

The research was started with a literature review (Sluiter, 2009) that initiated four research projects to determine the optimal interpolation methods for the interpolation of the most important climate variables: temperature (Salet, 2009), precipitation (Soenario et al., 2010), evaporation (Hiemstra & Sluiter, 2011) and wind (Stepek & Wijnant, 2011). In this report a summary of the results is given.
Interpolating normals (30 year averages 1981-2010) for the Climate Atlas has been challenging. In all cases except precipitation (+-300 stations) the number of stations is very low (7-28) with respect to interpolation. High spatial variability in certain datasets further hampers certain interpolation methods to produce consistent maps with a map appearance as expected by climatologists. Therefore as soon as the dataset became available in January 2011, all available methods have been evaluated and maximally "tuned" by adjusting the available parameters (section 3). The evaluated methods are: Inverse Distance Weighting interpolation (IDW), Ordinary Kriging, Universal Kriging, multiple regression and Thin Plate Spline (Sluiter, 2009). As multiple regression was not used to produce any maps it is not included in section 3. For the interpolation of wind a model-based approach was followed according to research done by Wieringa (Wieringa, 1986; Stepek & Wijnant, 2011).

2 Data & interpolation environment

2.1 Interpolation environment

2.1.1 Geo Spatial Interpolation Environment (GSIE)

Most of the research was done using GSIE, a new interpolation facility that has been developed at KNMI. This facility displays maps via Web Mapping Services (WMS) and has a "recipe manager" which can be used to develop and execute "recipes", database queries and R scripts for interpolation. Recipes are the main control files in xml format. They define parameters such as the start and stop time of the period over which maps are calculated, output location, metadata, the legends or styles to be used and which database query and R script should be used. In section 5 the xml recipes to produce all climate atlas maps are presented in table form.

2.1.2 Implementation of R scripts

The interpolation is performed with R, software for statistical computing, which uses packages for geospatial analysis (R-Project, 2009). R is embedded in a web interface as described in section 2.1.1.

The packages used in R are:

- `sp` which allows R to deal with spatial objects.
- `gstat`, containing the geostatistical tools.
- `automap`, which automates the interpolation process, by automatically estimating a semivariogram and performing Kriging.
- `fields` for Thin Plate Spline interpolation

The interpolation process is highly automated by using the automap package. The automap package calls functionality from the gstat module. More specifically, the function autoKrige does the interpolation and uses the function autofitVariogram combined with certain assumptions for the variogram model (Hiemstra, 2009), which will be further explained in section 3.1.1.

2.2 Input data

The quality controlled observation point data is stored in the Klimaat Informatie Systeem database (KIS). GSIE extracts data from the Oracle database of KIS with a query. The elements available in KIS are found in section 6. Within KIS five temporal levels are defined: 1 day, 2 decade, 3 month, 4 year and 5 season. These levels are used in product ID's and file names.

2.3 Input maps

The input map for interpolation is a rasterized image of the Netherlands in Rijksdriehoek projection with a 1000 m. resolution. The image extends 4000 m. outside the land borders of the Netherlands to allow subsetting by other datasets without producing missing values. For visualisation this image is masked by a shapefile of water bodies and neighbouring countries and province borders are added. The shapefiles match the layout of the book version of the Climate Atlas (KNMI, 2011a).
For Universal Kriging a rasterized image of the distance to the (virtual) shoreline is used (figure 2). This image is made by digitizing a line parallel to the North Sea coast and calculating the distance to this line (spreading). The minimum value is >0 to allow for log transformation of this map.
For calculation of the wind maps additional input maps are used as described in Stepek & Wijnant (2011)

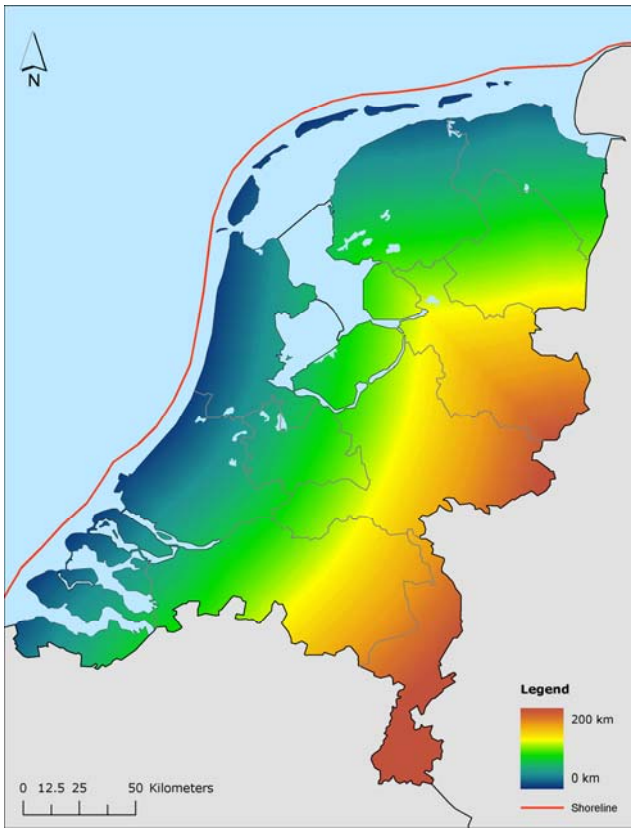


Figure 2 – Distance to shoreline map

2.4 Legends

GSIE uses Styled Layer Descriptors (SLDs) to layout the maps. Map styles and legends are specified in the recipe. Detailed descriptions and available styles and legends are found in the GSIE Quick reference guide available on the GSIE Wiki (internal KNMI access only).

3 Methods

3.1 Kriging

In this research, ordinary (point) Kriging and Universal kriging have been used (Burrough & McDonnell, 1998; Bivand et al., 2008). Both methods are used with and without blocks (block Kriging).
In short, ordinary Kriging is the basic form of Kriging. The prediction by ordinary Kriging is a linear combination of the measured values. The spatial correlation between the data, as described by the variogram, determines the weight.
Universal Kriging is also known as "Kriging with a trend/external drift". It uses a regression model as part of the Kriging process to model the mean value expressed as a linear or quadratic trend. Universal Kriging allows the use of ancillary information such as the distance to the shore and altitude in the interpolation.
Block Kriging predicts averages of larger areas. It tends to smoothen the predicted surface. More details about Kriging techniques can be found in the reference documents (Salet, 2009; Sluiter, 2009; Soenario et al., 2010; Hiemstra & Sluiter, 2011).

3.1.1 Kriging parameters

The coefficients of a variogram model are commonly termed nugget, sill and range (figure 1). The nugget is the short scale variation and is defined as the point where the variogram model crosses the y-axis. The sill is the maximum semivariance of the variogram model and represents the total variation in the residuals. Finally, the range is the value where the variogram model reaches the sill. Beyond this distance the spatial correlation between points is no longer present.
Fitting the variogram model to the sample variogram is done by automap (see Sluiter & Hiemstra (2011) for details). The variogram model (e.g. Spherical, Exponential) may be automatically determined by automap or specified by the user. The variogram is calculated by point pairs of observations (bins). The minimum number of point pairs per bin can be set. In certain situations the shape of the variogram at small lag distances may change significantly, especially when automap is set to use smaller bin sizes than the default value of 5 (Variogram binning is False).
The nugget may be automatically determined by automap or specified by the user. When the nugget is set to 0, Kriging performs as an exact interpolator. Exact interpolators reproduce the original values at the data points on which the interpolation is based. Approximate interpolators do not reproduce the original values. By assuming uncertainty in these values they will reduce errors by the effect of smoothing.
When a block size is set Kriging predicts block mean values. This smoothens the result and often improves the map appearance. The original values of the observations are not reproduced when smoothing is used. Therefore, map values and original values (for example available in tables on the Klimaatatlas website (KNMI 2011)) may differ.

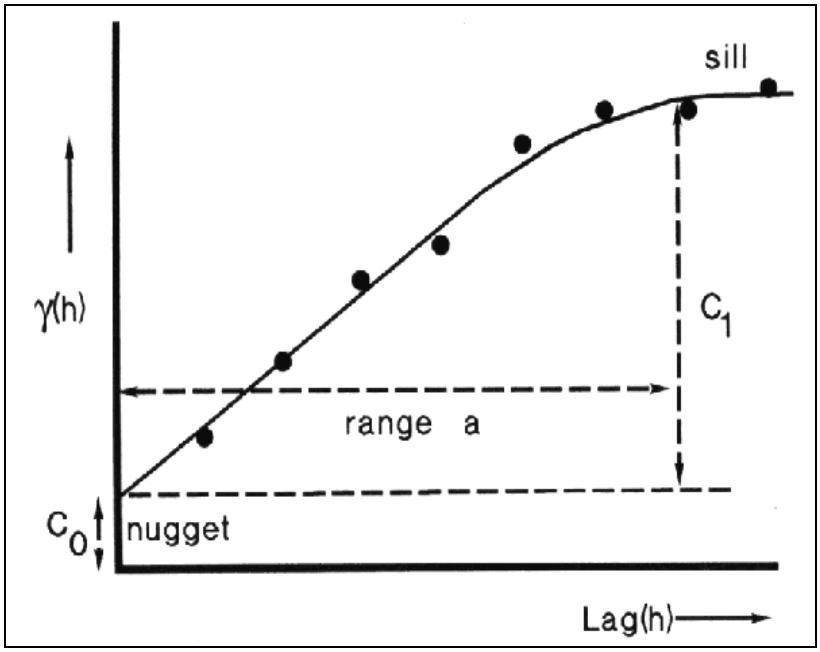


Figure 1 – Example of a variogram, black dots represent point pairs.

3.2 Thin Plate Spline (TPS)

We use the two-dimensional equivalent of the cubic spline, Thin Plate Spline (TPS) (Wahba, 1990). Thin plate spline balances local accuracy with global accuracy using the λ parameter. In general λ is estimated form the observations using generalized cross-validation (GCV). For production of the Climate Atlas we preferred to keep the ratio of local versus global interpolation consistent to make the results comparable. We use a λ equal to 0.004, based on expert judgment of the maps. Thin Plate Spline is an approximate interpolator and may extrapolate outside the range of the observation values. See Hiemstra & Sluiter (2011) for more details about Thin Plate Spline interpolation.

3.3 Inverse Distance Weighting interpolation (IDW)

We used the IDW function of the gstat package (Pebesma, 2011). Variables that can be adjusted are the inverse distance weighting power (power function IDP), the block size (the size of the block over which values are smoothed) and the distance over which an input value can exert influence (MAXDIST). As IDW was used only during the calculation of wind maps the parameterization of these variables is not included in the recipes (section 5.6) but documented in Stepek & Wijnant (2011).

3.4 Quality control

3.4.1 Leave One Out Cross Validation (LOOCV)

LOOCV has been performed for all interpolations. The cross validation results in residues: the difference between prediction and left-out observation for all observations. With these residues several measures such as R^2, root mean squared error (RMSE) and mean error (ME) have been calculated. In practice, the dimensionless R^2 was the most convenient measure to compare the different interpolation results for one parameter. We calculated R^2 following the method described in Bivand et al. (2008) . This method compares the residues to the mean. A R^2 higher than zero means that the interpolation method performs better than the mean. A LOOCV R^2 value of 1 indicates a perfect cross validation (prediction=observation).

3.4.2 Visual inspection

LOOCV determines statistically which interpolation method performs best. However, with certain small datasets (having <30 station) used for the production of the Climate Atlas, the statistically optimal method does not always produce a map that appears as expected by climatologists. Therefore the results of all different methods are always visually inspected by a climatologist.

3.4.3 Station exclusion

Quality controlled observations are derived from KIS (section 2.2). To increase the number of observations also stations with partial time series are included in the database. In a few cases these stations caused problems because they degraded the entire map appearance. In these cases stations have been excluded from the interpolation after judgement by a climatologist. Therefore, map values and original values (for example available in tables on the Klimaatatlas website (KNMI, 2011b)) may differ on locations of excluded stations. In the recipes (section 5) excluded stations are mentioned. Offshore stations available in KIS such as K-13 and Lichteiland Goeree are excluded by default.

4 Research results

4.1 Temperature

For the interpolation of the normal maps of temperature Salet (2009) showed that the inclusion of a distance to the sea trend (section 2.3) improved the interpolation. For annual normal maps Universal Kriging using log distance to the shoreline as trend proved to be the best method. For monthly normal maps multiple regression using log distance to the shoreline proved to be slightly better than Universal Kriging. However, in order to improve the coherence of the map appearance for the Climate Atlas we use Universal Kriging as well for the monthly normal maps. Therefore, all temperature maps except the one with the number of heavy frost days have been produced by Universal Kriging using log distance to the shoreline. The map with the number of heavy frost days could not be produced by Universal Kriging because the trend influenced the predicted spatial pattern too much. For this map Thin Plate Splines interpolation was used.

4.2 Precipitation

For prediction of all precipitation maps and precipitation deficit maps ordinary Kriging is used (Soenario et al., 2010). The large amount of observations formed a solid basis for calculation of the normal maps. Data transformation (Soenario et al., 2010) as used for the calculation of daily data did not improve the interpolation of the normal maps. Universal Kriging using altitude as trend did not improve the interpolation either. The precipitation surplus maps have been calculated by subtracting the evaporation map from the precipitation map after interpolation.

4.3 Evaporation and sun

For the interpolation of all Makkink evaporation maps Thin Plate Spline is used (Hiemstra & Sluiter, 2011). Makkink evaporation is calculated from shortwave radiation and temperature. The spatial pattern of Makkink evaporation is dominated by the shortwave radiation and therefore the Thin Plate Spline method is also successfully used for the interpolation of all radiation and (radiation derived) sun products.

4.4 Air pressure and humidity

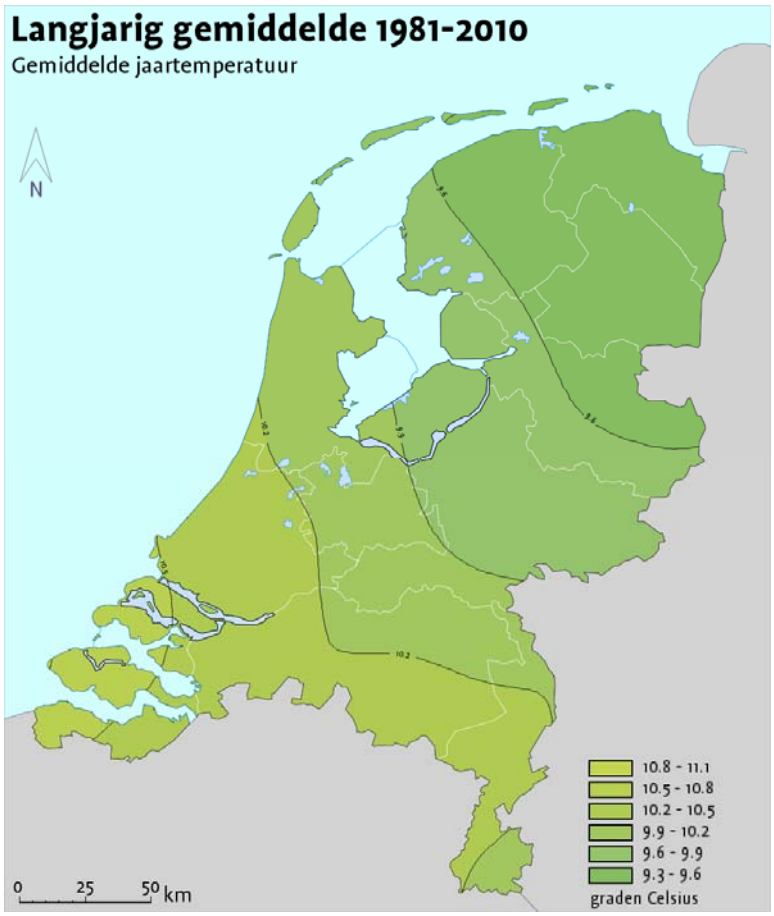
Air pressure and humidity were not researched in dedicated projects. During production of the Climate Atlas (section 1.1) Thin Plate Spline proved to be best for air pressure and Ordinary Kriging best for humidity.

4.5 Wind

Interpolation of wind has been extensively researched by Stepek & Wijnant (2011). A two layer model of the planetary boundary layer (Wieringa, 1986) is used to transform the surface wind speed into the macro wind speed. Macro wind speed is interpolated using inverse distance weighted interpolation (IDW) and transformed back to surface wind speed using a map with surface roughness information. See Stepek & Wijnant (2011) for more details.

5 Interpolation recipes

5.1 Temperature



Category	Temperature
ID	1
Title	Long term average 1981-2010 - Average yearly temperature
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaartemperatuur
KIS Element	Tg
Product ID	TG4
Time resolution	Year
Recipe	Tg_4_oper_v0004.xml
R script	Tg_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Tg_woltnhoff_d0.3
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	True
Block size	20000
Quality	LOOCV R^2 = 0.85
References	Salet (2009)

Category	Temperature
ID	2
Title	Long term average 1951-1980 - Average yearly temperature
Title NL	Langjarig gemiddelde 1951-2010 - Gemiddelde jaartemperatuur
KIS Element	Tg
Product ID	TG4_80
Time resolution	Year
Recipe	Tg_4_oper_1980_v0004.xml
R script	Tg_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Tg_woltnhoff_d0.3
Number of stations	14
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 265 SOESTERBERG 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	NA
Method	Universal Kriging using log distance to the shore.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	True
Block size	20000
Quality	LOOCV R^2 = 0.59
References	Salet (2009)

Category	Temperature
ID	3
Title	Long term average 1981-2010 - Average yearly maximum temperature
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maximumtemperatuur (jaar)
KIS Element	Txg
Product ID	TXG4
Time resolution	Year
Recipe	Txg_4_oper_v0004.xml
R script	Txg_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Tg_woltnhoff_d0.3
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	True
Block size	20000
Quality	LOOCV R^2 = 0.77
References	Salet (2009)

Category	Temperature
ID	4
Title	Long term average 1981-2010 - Average yearly minimum temperature
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde minimumtemperatuur (jaar)
KIS Element	Tng
Product ID	TNG4
Time resolution	Year
Recipe	Tng_4_oper_v0004.xml
R script	Tng_4_oper_v0004.r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_woltnhoff_d0.3
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	True
Block size	20000
Quality	LOOCV $R^2 = 0.49$
References	Salet (2009)

Category	Temperature
ID	5
Title	Long term average 1981-2010 - Number of days with a maximum temperature higher than 20 °C (warm days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met maximum temperatuur van 20 °C of hoger (warme dagen)
KIS Element	Tx.ge.20
Product ID	TXG4_20
Time resolution	Year
Recipe	Txg_4_20_oper_v0004.xml
R script	Txg_4_20_25_30_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_summer_d5
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.82
References	Salet (2009)

Category	Temperature
ID	6
Title	Long term average 1981-2010 - Number of days with a maximum temperature higher than 25 °C (summer days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met maximum temperatuur van 25 °C of hoger (zomerse dagen)
KIS Element	Tx.ge.25
Product ID	TXG4_25
Time resolution	Year
Recipe	Txg_4_25_oper_v0004.xml
R script	Txg_4_20_25_30_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Q_d4
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.89
References	Salet (2009)

Category	Temperature
ID	7
Title	Long term average 1981-2010 - Number of days with a maximum temperature higher than 30 °C (tropical days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met maximum temperatuur van 30 °C of hoger (tropische dagen)
KIS Element	Tx.ge.30
Product ID	TXG4_30
Time resolution	Year
Recipe	Txg_4_30_oper_v0004.xml
R script	Txg_4_20_25_30_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_summer_d2
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.78
References	Salet (2009)

Category	Temperature
ID	8
Title	Long term average 1981-2010 - Number of days with a maximum temperature lower than 0 °C (ice days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met maximum temperatuur lager dan 0 °C (ijsdagen)
KIS Element	Tx.ge.0
Product ID	TXG4_0
Time resolution	Year
Recipe	Txg_4_0_oper_v0004.xml
R script	Txg_4_20_25_30_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_winterdays_d2
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.89
References	Salet (2009)

Category	Temperature
ID	9
Title	Long term average 1981-2010 - Number of days with a minimum temperature lower than 0 °C (frost days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met minimum temperatuur lager dan 0 °C (vorstdagen)
KIS Element	Tn.lt.0
Product ID	TNG4_0
Time resolution	Year
Recipe	Tng_4_0_oper_v0004.xml
R script	Tng_4_0_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_winterdays_d5
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.66
References	Salet (2009)

Category	Temperature
ID	10
Title	Long term average 1981-2010 - Number of days with a minimum temperature lower than -10 °C (heavy frost days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met minimum temperatuur lager dan -10 °C (zware vorstdagen)
KIS Element	Tn.lt.-10
Product ID	TNG4_-10
Time resolution	Year
Recipe	Tng_4_-10_oper_v0004.xml
R script	Tng_4_0_oper_v0004 .r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Tg_winterdays_d1
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.42
References	

Category	Temperature
ID	11
Title	Long term average 1981-2010 - Average monthly temperature
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandtemperatuur
KIS Element	Tg
Product ID	TG3
Time resolution	Month
Recipe	Tg_3_oper_v0004.xml
R script	Tg_3_oper_v0004.r
Query	Normalen_Month_2010_Tg_v0001.query
Style / Legend	Tg_woltnhoff_d0.5
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	277 LAUWERSOOG 278 HEINO 330 HOEK VAN HOLLAND
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	True
Block size	20000
Quality	Average LOOCV R^2 = 0.81.
References	Salet (2009)

Category	Temperature
ID	12
Title	Long term average 1981-2010 - Average monthly minimum temperature
Title NL	Langjarig gemiddelde 1981-2010 -Gemiddelde minimumtemperatuur per maand
KIS Element	Tng
Product ID	TNG3
Time resolution	Month
Recipe	Tng_3_oper_v0004.xml
R script	Tng_3_oper_v0004.r
Query	Normalen_Month_2010_Tng_v0001.query
Style / Legend	Tg_woltnhoff_d0.5
Number of stations	27
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	265 SOESTERBERG 277 LAUWERSOOG 278 HEINO 330 HOEK VAN HOLLAND
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	20000
Quality	Average LOOCV R^2 = 0.79
References	Salet (2009)

Category	Temperature
ID	13
Title	Long term average 1981-2010 - Average monthly maximum temperature
Title NL	Langjarig gemiddelde 1981-2010 -Gemiddelde maximumtemperatuur per maand
KIS Element	Txg
Product ID	TXG3
Time resolution	Month
Recipe	Txg_3_oper_v0004.xml
R script	Txg_3_oper_v0004.r
Query	Normalen_Month_2010_Txg_v0001.query
Style / Legend	Tg_woltnhoff_d0.5
Number of stations	28
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	277 LAUWERSOOG 278 HEINO 330 HOEK VAN HOLLAND
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	0
Variogram binning	True
Block size	20000
Quality	Average LOOCV R^2 = 0.46. least performing months June and July
References	Salet (2009)

Category	Temperature
ID	14
Title	Long term average 1981-2010 - Temperature per season
Title NL	Langjarig gemiddelde 1981-2010 -Seizoenstemperatuur
KIS Element	Tg
Product ID	TG5
Time resolution	Season
Recipe	Txg_5_oper_v0004.xml
R script	Txg_5_oper_v0004.r
Query	Normalen_Season_2010_Tg_v0001.query
Style / Legend	Tg_woltnhoff_d0.3
Number of stations	26
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 267 STAVOREN 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	277 LAUWERSOOG 278 HEINO 330 HOEK VAN HOLLAND
Method	Universal Kriging using log distance to the shore. To avoid sharp gradients near the shore due to log transformation of near zero values, 5000m is added to the distance to shore map.
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	False
Block size	20000
Quality	Average LOOCV R^2 = 0.85
References	

Category	Temperature
ID	15
Title	Long term average 1981-2010 - First warm day (day number)
Title NL	Langjarig gemiddelde 1981-2010 -Eerste warme dag (dagnummer)
KIS Element	NA
Product ID	TXG4FWD
Time resolution	Year
Recipe	Txg_4_FWD2010_oper_v0004.xml
R script	Txg_4_FWD2010_oper_v0004 .r
Query	query_FWD_2010.dat
Style / Legend	Tg_fwd_4_d5
Number of stations	15
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 344 ROTTERDAM 350 GILZE-RIJE 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.70
References	

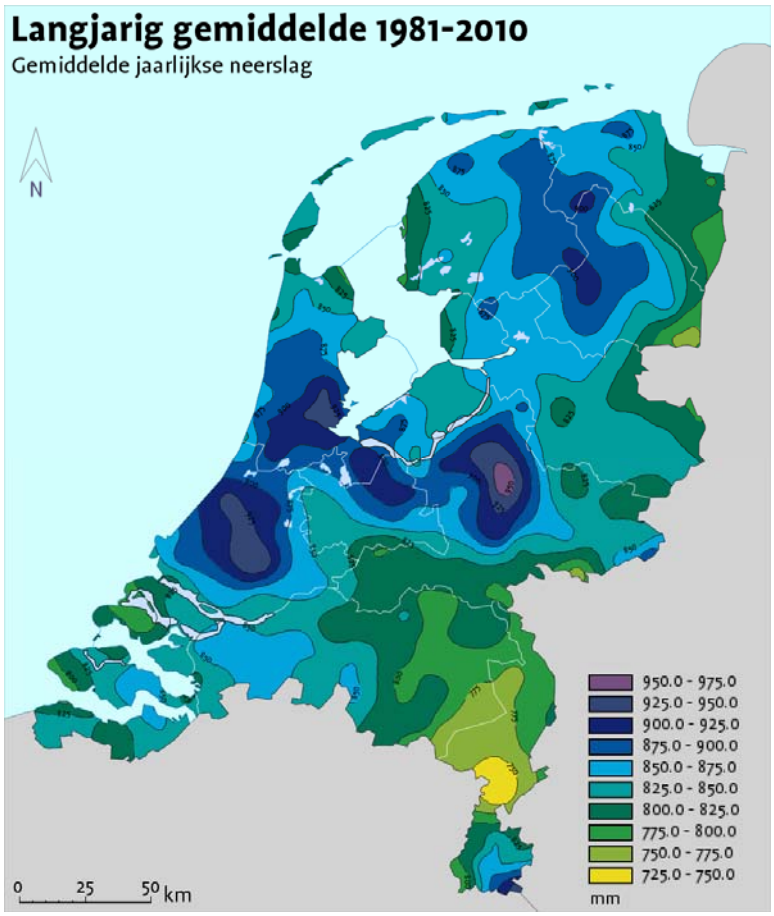
Category	Temperature
ID	16
Title	Long term average 1951-1980 - First warm day (day number)
Title NL	Langjarig gemiddelde 1981-2010 - Eerste warme dag (dagnummer)
KIS Element	NA
Product ID	TXG4FWD1980
Time resolution	Year
Recipe	Txg_4_FWD1980_oper_v0004.xml
R script	Txg_4_FWD1980_oper_v0004 .r
Query	query_FWD_1980.dat
Style / Legend	Tg_fwd_4_d5
Number of stations	13
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 265 SOESTERBERG
Excluded stations	
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.66
References	

Category	Temperature
ID	55
Title	Daily average temperature
Title NL	Dagelijkse gemiddelde temperatuur
KIS Element	Tg
Product ID	Tg1
Time resolution	Day
Recipe	Tg_1_oper_v0001.xml
R script	Tg_1_oper_v0001.r
Query	Tg_1_oper_v0001.query
Style / Legend	Tg_longrange_d1.0
Number of stations	34
Station names	DEELEN WESTDORPE ROTTERDAM ELL MAASTRICHT LAUWERSOOG GILZE-RIJEN NIEUW BEERTA HOEK VAN HOLLAND SCHIPHOL DE BILT STAVOREN VLISSINGEN CABAUW LEEUWARDEN MARKNESSE HOOGEVEEN WOENSDRECHT HEINO VLIELAND EINDHOVEN BERKHOUT WILHELMINADORP HERWIJNEN ARCEN DE KOOY HOORN (TERSCHELLING) LELYSTAD EELDE TWENTHE WIJK AAN ZEE VALKENBURG VOLKEL HUPSEL
Excluded stations	NA
Method	Inverse Distance Weighted interpolation (IDW) using a 20 km block
TPS Lambda	NA
Quality	LOOCV R2 depends on day. See references for details.
References	Salet (2009)

Category	Temperature
ID	56
Title	Daily minimum temperature
Title NL	Dagelijkse minimum temperatuur
KIS Element	Tn
Product ID	Tn1
Time resolution	Day
Recipe	Tn_1_oper_v0001.xml
R script	Tn_1_oper_v0001.r
Query	Tn_1_oper_v0001.query
Style / Legend	Tg_longrange_d1.0
Number of stations	34
Station names	DEELEN WESTDORPE ROTTERDAM ELL MAASTRICHT LAUWERSOOG GILZE-RIJEN NIEUW BEERTA HOEK VAN HOLLAND SCHIPHOL DE BILT STAVOREN VLISSINGEN CABAUW LEEUWARDEN MARKNESSE HOOGEVEEN WOENSDRECHT HEINO VLIELAND EINDHOVEN BERKHOUT WILHELMINADORP HERWIJNEN ARCEN DE KOOY HOORN (TERSCHELLING) LELYSTAD EELDE TWENTHE WIJK AAN ZEE VALKENBURG VOLKEL HUPSEL
Excluded stations	NA
Method	Inverse Distance Weighted interpolation (IDW) using a 20 km block
TPS Lambda	NA
Quality	LOOCV R2 depends on day. See references for details.
References	Salet (2009)

Category	Temperature
ID	57
Title	Daily maximum temperature
Title NL	Dagelijkse maximum temperatuur
KIS Element	Tx
Product ID	Tx1
Time resolution	Day
Recipe	Tx_1_oper_v0001.xml
R script	Tx_1_oper_v0001.r
Query	Tx_1_oper_v0001.query
Style / Legend	Tg_longrange_d1
Number of stations	34
Station names	DEELEN WESTDORPE ROTTERDAM ELL MAASTRICHT LAUWERSOOG GILZE-RIJEN NIEUW BEERTA HOEK VAN HOLLAND SCHIPHOL DE BILT STAVOREN VLISSINGEN CABAUW LEEUWARDEN MARKNESSE HOOGEVEEN WOENSDRECHT HEINO VLIELAND EINDHOVEN BERKHOUT WILHELMINADORP HERWIJNEN ARCEN DE KOOY HOORN (TERSCHELLING) LELYSTAD EELDE TWENTHE WIJK AAN ZEE VALKENBURG VOLKEL HUPSEL
Excluded stations	NA
Method	Inverse Distance Weighted interpolation (IDW) using a 20 km block
TPS Lambda	NA
Quality	LOOCV R2 depends on day. See references for details.
References	Salet (2009)

5.2 Precipitation & evaporation



Category	Precipitation & Evaporation
ID	17
Title	Long term average 1981-2010 - Average yearly precipitation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse neerslag
KIS Element	Rd
Product ID	RD4
Time resolution	Year
Recipe	Rd_4_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Pr_4_wn_fixed_d25
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.59
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	18
Title	Long term average 1951-1980 - Average yearly precipitation
Title NL	Langjarig gemiddelde 1951-1980 - Gemiddelde jaarlijkse neerslag
KIS Element	Rd
Product ID	RD4_80
Time resolution	Year
Recipe	Rd_4_oper_1980_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Pr_4_wn_fixed_d25
Number of stations	299
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.59
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	19
Title	Long term average 1981-2010 - Number of days with 10 mm precipitation or more (wet days)
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met 10 mm neerslag of meer (natte dag)
KIS Element	Rd.ge.10
Product ID	RD4_10
Time resolution	Year
Recipe	Rd_4_10_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Rd_4_10_wn_fixed_d2
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.62
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	20
Title	Long term average 1951-1980 - Number of days with 10 mm precipitation or more (wet days)
Title NL	Langjarig gemiddelde 1951-1980 - Aantal dagen met 10 mm neerslag of meer (natte dag)
KIS Element	Rd.ge.10
Product ID	RD4108
Time resolution	Year
Recipe	Rd_4_10_oper_1980_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Rd_4_10_wn_fixed_d2
Number of stations	299
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.54
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	21
Title	Long term average 1981-2010 - Number of days with 1 mm precipitation or more
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met 1 mm neerslag of meer
KIS Element	Rd.ge.1
Product ID	RD4_1
Time resolution	Year
Recipe	Rd_4_1_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Pr_wn_auto_d5
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.57
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	22
Title	Long term average 1981-2010 - Number of days with 0.3 mm precipitation or more
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met 0.3 mm neerslag of meer
KIS Element	Rd.ge.0.3
Product ID	RD4_03
Time resolution	Year
Recipe	Rd_4_03_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Pr_wn_auto_d5
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R2 = 0.37
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	23
Title	Long term average 1981-2010 - Number of dry days
Title NL	Langjarig gemiddelde 1981-2010 - Aantal droge dagen
KIS Element	Rd.eq.0
Product ID	RD4_0
Time resolution	Year
Recipe	Rd_4_0_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Pr_wn_auto_d5
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.06; very irregular pattern with low spatial coherence results in low LOOCV values.
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	24
Title	Long term average 1981-2010 - Average yearly precipitation duration
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse neerslagduur
KIS Element	Dr24
Product ID	Dr4
Time resolution	Year
Recipe	Dr_4_oper_v0004.xml
R script	Dr_4_oper_v0004 .r
Query	Normalen_Year_2010_Dr_v0001.query
Style / Legend	DR4_d15
Number of stations	14
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJE 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	265 SOESTERBERG 348 CABAUW
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = -0.07 very irregular pattern with low spatial coherence results in very low LOOCV values.
References	

Category	Precipitation & Evaporation
ID	25
Title	Long term average 1981-2010 - Average yearly precipitation duration per season
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde duur van de neerslag per seizoen
KIS Element	Dr24
Product ID	Dr5
Time resolution	Season
Recipe	Dr_5_oper_v0004.xml
R script	Dr_5_oper_v0004 .r
Query	Normalen_Season_2010_v0001.query
Style / Legend	DR4_d15
Number of stations	14
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJE 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	265 SOESTERBERG 348 CABAUW
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	Average LOOCV R^2 = -0.82 very irregular pattern with low spatial coherence results in very low LOOCV values. Highest R2: Winter 0.39.
References	

Category	Precipitation & Evaporation
ID	26
Title	Long term average 1981-2010 - Average monthly precipitation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde hoeveelheid neerslag per maand
KIS Element	Rd
Product ID	RD3
Time resolution	Month
Recipe	Rd_3_oper_v0004.xml
R script	Rd_3_oper_v0004.r
Query	Normalen_Month_Rd_2010_v0003.query
Style / Legend	Pr_3_wn_fixed_d5
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	Average LOOCV R^2 = 0.74
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	27
Title	Long term average 1981-2010 - Number of dry days per month
Title NL	Langjarig gemiddelde 1981-2010 - Aantal droge dagen per maand
KIS Element	Rd.eq.0
Product ID	RD3_0
Time resolution	Month
Recipe	Rd_3_0_oper_v0004.xml
R script	Rd_3_oper_v0004.r
Query	Normalen_Month_Rd_2010_v0003.query
Style / Legend	Pr_wn_auto_d1
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	Average LOOCV R^2 = 0.15; very irregular pattern with low spatial coherence results in low LOOCV values. Highest R^2: July 0-41
References	

Category	Precipitation & Evaporation
ID	28
Title	Long term average 1981-2010 - Number of days with snow cover
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met sneeuwdek
KIS Element	Sx.gt.0
Product ID	SX4
Time resolution	Year
Recipe	Sx_5_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	Sx_d3
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.74; Version 004 is published in Climate Atlas. Version 005 contains the complete set of (updated) stations. Visual differences are marginally. LOOCV R^2 values are both 0.74.
References	

Category	Precipitation & Evaporation
ID	29
Title	Long term average 1981-2010 - Average yearly precipitation surplus
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse hoeveelheid neerslagoverschot
KIS Element	NA
Product ID	RD4SP
Time resolution	Year
Recipe	Rd_4_SP_oper_v0004.xml
R script	Rd_4_SP_oper_v0004 .r
Query	NA
Style / Legend	Pr_4_SP_wn_fixed_d40
Number of stations	NA
Station names	NA
Excluded stations	NA
Method	Precipitation surplus is calculated by subtracting the evaporation map (EV_4_oper_v0004) from the precipitation map (RD_4_oper_v0004)
Quality	LOOCV cannot be calculated. Quality depends on the combined precipitation and evaporation maps. The spatial pattern is dominated by the precipitation map. Errors in absolute values are higher in the evaporation map related to the (Makkink) method.
References	Soenario, Sluiter and Plieger (2010) Hiemstra & Sluiter (2011)

Category	Precipitation & Evaporation
ID	30
Title	Long term average 1981-2010 - Average monthly precipitation surplus
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandelijkse hoeveelheid neerslagoverschot
KIS Element	NA
Product ID	RD3SP
Time resolution	Year
Recipe	Rd_3_SP_oper_v0004.xml
R script	Rd_3_SP_oper_v0004 .r
Query	NA
Style / Legend	Pr_3_SP_tgwn_fixed_d10
Number of stations	NA
Station names	NA
Excluded stations	NA
Method	Precipitation surplus is calculated by subtracting the evaporation maps (EV_3_oper_v0004) from the precipitation maps (RD_3_oper_v0004)
Quality	LOOCV cannot be calculated. Quality depends on the combined precipitation and evaporation maps. The spatial pattern is dominated by the precipitation map. Errors in absolute values are higher in the evaporation map related to the (Makkink) method.
References	Soenario, Sluiter and Plieger (2010) Hiemstra & Sluiter (2011)

Category	Precipitation & Evaporation
ID	31
Title	Long term average 1981-2010 - Median value of the maximum moving average potential precipitation deficit
Title NL	Langjarig gemiddelde 1981-2010 - Mediaan van het maximale doorlopende potentiële neerslagtekort
KIS Element	NsTx
Product ID	RD4NSTX
Time resolution	Year
Recipe	Rd_4_NSTx_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	RD4NsTx_d15
Number of stations	295
Station names	NA
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.80
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	32
Title	Scenario W 2062 - Median value of the maximum moving average potential precipitation deficit
Title NL	Scenario W 2062 - Mediaan van het maximale doorlopende potentiële neerslagtekort
KIS Element	NsTxW
Product ID	RD4NSW
Time resolution	Year
Recipe	Rd_4_NSTxW_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	RD4NsTx_d15
Number of stations	284
Station names	NA
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.79
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	33
Title	Scenario W+ 2062 - Median value of the maximum moving average potential precipitation deficit.
Title NL	Scenario W+ 2062 - Mediaan van het maximale doorlopende potentiële neerslagtekort
KIS Element	NsTxW+
Product ID	RD4NSWp
Time resolution	Year
Recipe	Rd_4_NSTxW+_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	RD4NsTx_d15
Number of stations	284
Station names	NA
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.76
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	34
Title	Long term average 1981-2010 - Maximum moving average potential precipitation deficit of the 5% driest years.
Title NL	Langjarig gemiddelde 1981-2010 - Maximaal doorlopend potentieel neerslagtekort van de 5% droogste jaren
KIS Element	NsTx05
Product ID	RD4NST5
Time resolution	Year
Recipe	Rd_4_NSTx05_oper_v0004.xml
R script	Rd_4_oper_v0004.r
Query	Normalen_Year_Rd_2010_v0004.query
Style / Legend	RD4NsTx_d15
Number of stations	295
Station names	NA
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	0
Variogram binning	False
Block size	5000
Quality	LOOCV R^2 = 0.85
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	35
Title	Long term average 1981-2010 - Average yearly evaporation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse verdamping
KIS Element	EV24
Product ID	EV4
Time resolution	Year
Recipe	EV_4_oper_v0004.xml
R script	EV_4_oper_v0004.r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Ev_4_wn_fixed_d10
Number of stations	20
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.63
References	Hiemstra & Sluiter (2011)

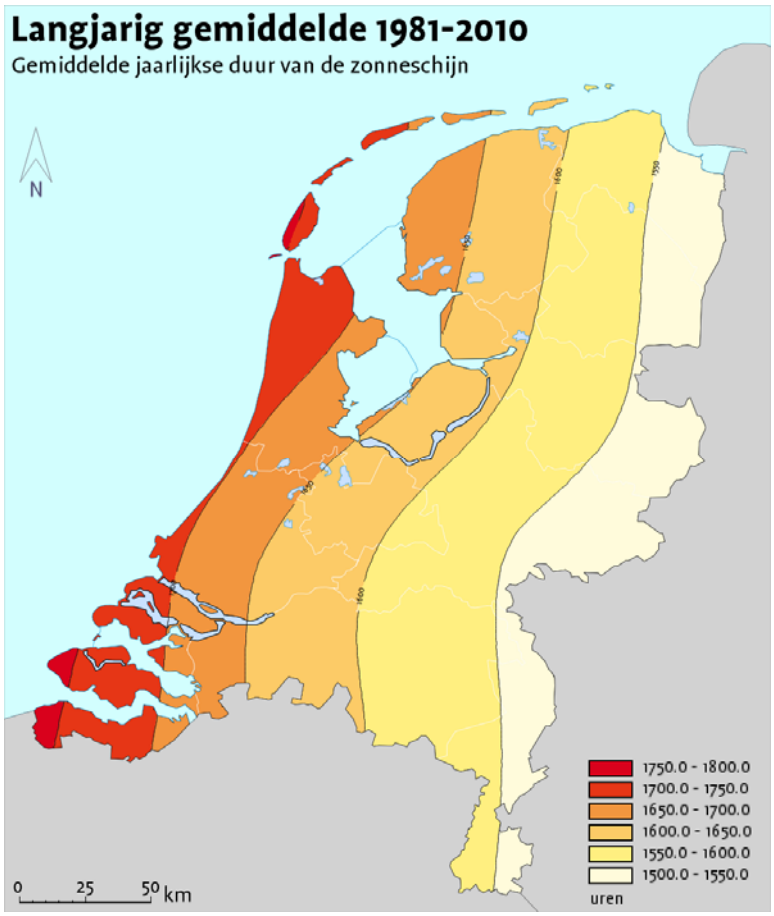
Category	Precipitation & Evaporation
ID	36
Title	Long term average 1951-1980 - Average yearly evaporation
Title NL	Langjarig gemiddelde 1951-1980 - Gemiddelde jaarlijkse verdamping
KIS Element	EV24*
Product ID	EV4_80
Time resolution	Year
Recipe	EV_4_oper_1980_v0004.xml
R script	EV_4_oper_v0004.r
Query	Normalen_Year_2010_v0004.query
Style / Legend	Ev_4_wn_fixed_d10
Number of stations	7
Station names	210 VALKENBURG 235 DE KOOY 260 DE BILT 270 LEEUWARDEN 280 EELDE 310 VLISSINGEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = -1.48, not enough stations for proper interpolation and cross validation. Spatial pattern is acceptable as judged by climatologist.
References	Hiemstra & Sluiter (2011)

Category	Precipitation & Evaporation
ID	37
Title	Long term average 1981-2010 - Average monthly evaporation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde hoeveelheid verdamping per maand
KIS Element	EV24
Product ID	EV3
Time resolution	Month
Recipe	EV_3_oper_v0004.xml
R script	EV_3_oper_v0004.r
Query	Normalen_Month_2010_EV_v0001.query
Style / Legend	Ev_3_Tgwn_fixed_d2
Number of stations	16
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	277 LAUWERSOOG 279 HOOGEVEEN 283 HUPSEL 286 NIEUW BEERTA 356 HERWIJNEN 391 ARCEN
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	Average LOOCV R2 = 0.68; Least performing month: May 0.37; Highest performing months: winter +- 0.90. Stations excluded to increase the spatial pattern during summer months.
References	Hiemstra & Sluiter (2011)

Category	Precipitation & Evaporation
ID	54
Title	Daily precipitation sum
Title NL	Dagelijkse neerslag
KIS Element	Rd
Product ID	Rd1
Time resolution	Day
Recipe	Rd_1_oper_v0001.xml
R script	Rd_1_oper_v0001.r
Query	Rd_1_oper_v0001.r
Style / Legend	Tg_longrange_d1.0
Number of stations	304
Station names	NA
Excluded stations	76 KORNWERDERZAND
Method	Ordinary kriging. Observations are square root transformed and back-transformed after interpolation using quantiles calculation. For every day a variogram is automatically fitted. The nugget is zero and the variogrammodel is spherical or exponential, depending on the best fit.
Variogram nugget	0
Variogram binning	NA
Block size	NA
TPS Lambda	NA
Quality	LOOCV R2 depends on day. See references for details.
References	Soenario, Sluiter and Plieger (2010)

Category	Precipitation & Evaporation
ID	58
Title	Daily Makkink evaporation
Title NL	Dagelijkse Makkink verdamping
KIS Element	EV24
Product ID	EV24
Time resolution	Day
Recipe	EV24_1_oper_v0001.xml
R script	EV24_1_oper_v0001.r
Query	EV24_1_oper_v0001.query
Style / Legend	Q24_auto_d0.5
Number of stations	32
Station names	ROTTERDAM GILZE-RIJEN HERWIJNEN EINDHOVEN VOLKEL MAASTRICHT ARCEN VALKENBURG DE KOOY SCHIPHOL HOORN (TERSCHELLING) DE BILT STAVOREN LELYSTAD LEEUWARDEN MARKNESSE DEELEN LAUWERSOOG HEINO HOOGEVEEN EELDE HUPSEL NIEUW BEERTA TWENTHE VLISSINGEN WESTDORPE WILHELMINADORP HOEK VAN HOLLAND BERKHOUT ELL WIJK AAN ZEE CABAUW
Excluded stations	NA
Method	Thin Plate Spline Interpolation
TPS Lambda	NA
Quality	NA
References	NA

5.3 Sun


Langjarig gemiddelde 1981-2010
Gemiddelde jaarlijkse duur van de zonneschijn
N
0 25 50 km
1750.0 - 1800.0
1700.0 - 1750.0
1650.0 - 1700.0
1600.0 - 1650.0
1550.0 - 1600.0
1500.0 - 1550.0
uren

Category	Sun
ID	38
Title	Long term average 1981-2010 - Average yearly sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse duur van de zonneschijn
KIS Element	Sq24
Product ID	SQ4
Time resolution	Year
Recipe	Sq_4_oper_v0004.xml
R script	Sq_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d50
Number of stations	15
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.60
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	39
Title	Long term average 1981-2010 - Average monthly sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandelijkse duur van de zonneschijn
KIS Element	Sq24
Product ID	SQ3
Time resolution	Year
Recipe	Sq_3_oper_v0004.xml
R script	Sq_3_oper_v0004.r
Query	Normalen_Month_2010_Sq_v0001.query
Style / Legend	Q24_auto_d5
Number of stations	15
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	277 LAUWERSOOG 279 HOOGEVEEN 283 HUPSEL 286 NIEUW BEERTA 356 HERWIJNEN 391 ARCEN
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	Average LOOCV R^2 = 0.52; Least performing month: October -0.27
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	40
Title	Long term average 1981-2010 - Number of days with =< 20% sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met zonneschijnduur =< 20% (sombere dagen)
KIS Element	Sp.le.20
Product ID	SP4_20
Time resolution	Year
Recipe	Sp_4_20_oper_v0004.xml
R script	Sp_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d5
Number of stations	13
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.72
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	41
Title	Long term average 1981-2010 - Number of days with >20 en =< 50% sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met zonneschijnduur >20 en =< 50% (af en toe zon)
KIS Element	Sp_20-50
Product ID	SP42050
Time resolution	Year
Recipe	Sp_4_20_50_oper_v0004.xml
R script	Sp_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d5
Number of stations	13
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = -0.17
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	42
Title	Long term average 1981-2010 - Number of days with >50 en =< 80% sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met zonneschijnduur >50 en =< 80% (zonnig)
KIS Element	Sp_50-80
Product ID	SP45080
Time resolution	Year
Recipe	Sp_4_50_80_oper_v0004.xml
R script	Sp_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d5
Number of stations	13
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.74
References	Hiemstra & Sluiter (2011)

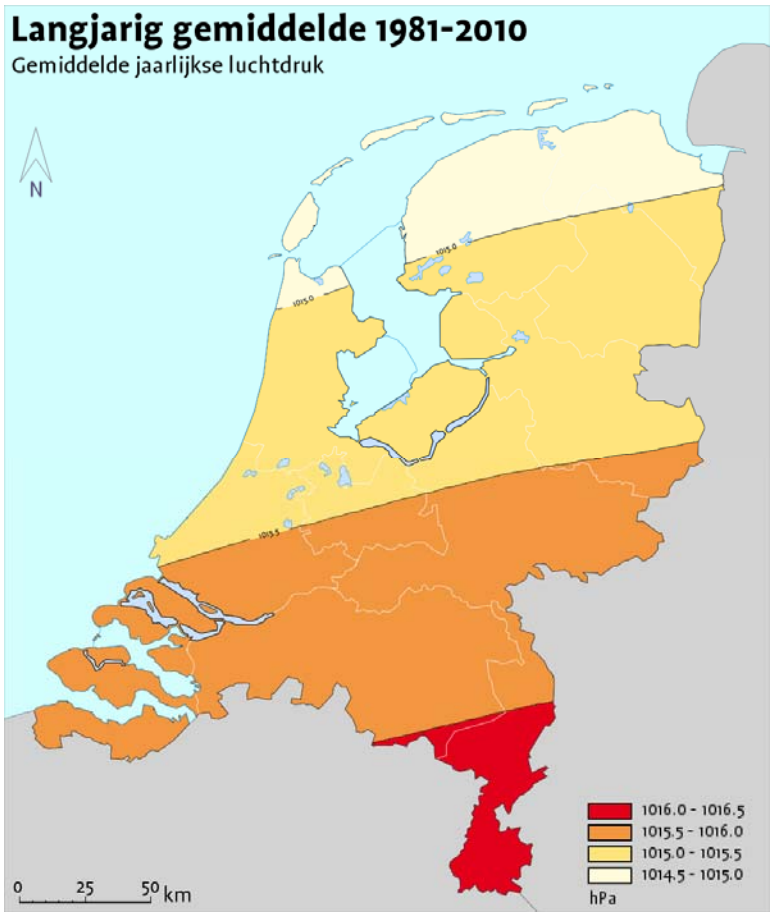
Category	Sun
ID	43
Title	Long term average 1981-2010 - Number of days with >= 80% sunshine duration
Title NL	Langjarig gemiddelde 1981-2010 - Aantal dagen met zonneschijnduur >= 80% (zonnig)
KIS Element	Sp.ge.80
Product ID	SP80
Time resolution	Year
Recipe	Sp_4_80_oper_v0004.xml
R script	Sp_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d5
Number of stations	13
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.075
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	44
Title	Long term average 1981-2010 - Average yearly global insolation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse hoeveelheid globale straling
KIS Element	Q24
Product ID	Q4
Time resolution	Year
Recipe	Q_4_oper_v0004.xml
R script	Q_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Q24_auto_d5
Number of stations	20
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	NA
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.51
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	45
Title	Long term average 1981-2010 - Average monthly global insolation
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandelijkse hoeveelheid globale straling
KIS Element	Q24
Product ID	Q3
Time resolution	Month
Recipe	Q_3_oper_v0004.xml
R script	Q_3_oper_v0004.r
Query	Normalen_Month_2010_Q_v0001.query
Style / Legend	Q24_auto_d1
Number of stations	16
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 323 WILHELMINADORP 344 ROTTERDAM 348 CABAUW 350 GILZE-RIJEN 370 EINDHOVEN 380 MAASTRICHT
Excluded stations	277 LAUWERSOOG 279 HOOGEVEEN 283 HUPSEL 286 NIEUW BEERTA 356 HERWIJNEN 391 ARCEN
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	Average LOOCV R^2 = 0.61
References	Hiemstra & Sluiter (2011)

Category	Sun
ID	59
Title	Daily sunshine duration
Title NL	Dagelijkse zonneschijnduur
KIS Element	Sq24
Product ID	SQ24
Time resolution	Day
Recipe	SQ24_1_oper_v0001.xml
R script	SQ24_1_oper_v0001.r
Query	SQ24_1_oper_v0001.query
Style / Legend	Q24_auto_d1
Number of stations	32
Station names	ROTTERDAM GILZE-RIJEN HERWIJNEN EINDHOVEN VOLKEL MAASTRICHT ARCEN VALKENBURG DE KOOY SCHIPHOL HOORN (TERSCHELLING) DE BILT STAVOREN LELYSTAD LEEUWARDEN MARKNESSE DEELEN LAUWERSOOG HEINO HOOGEVEEN EELDE HUPSEL NIEUW BEERTA TWENTHE VLISSINGEN WESTDORPE WILHELMINADORP HOEK VAN HOLLAND BERKHOUT ELL WIJK AAN ZEE CABAUW
Excluded stations	NA
Method	Thin Plate Spline Interpolation
TPS Lambda	NA
Quality	LOOCV R2 depends on day. See references for details.
References	Hiemstra & Sluiter (2011)

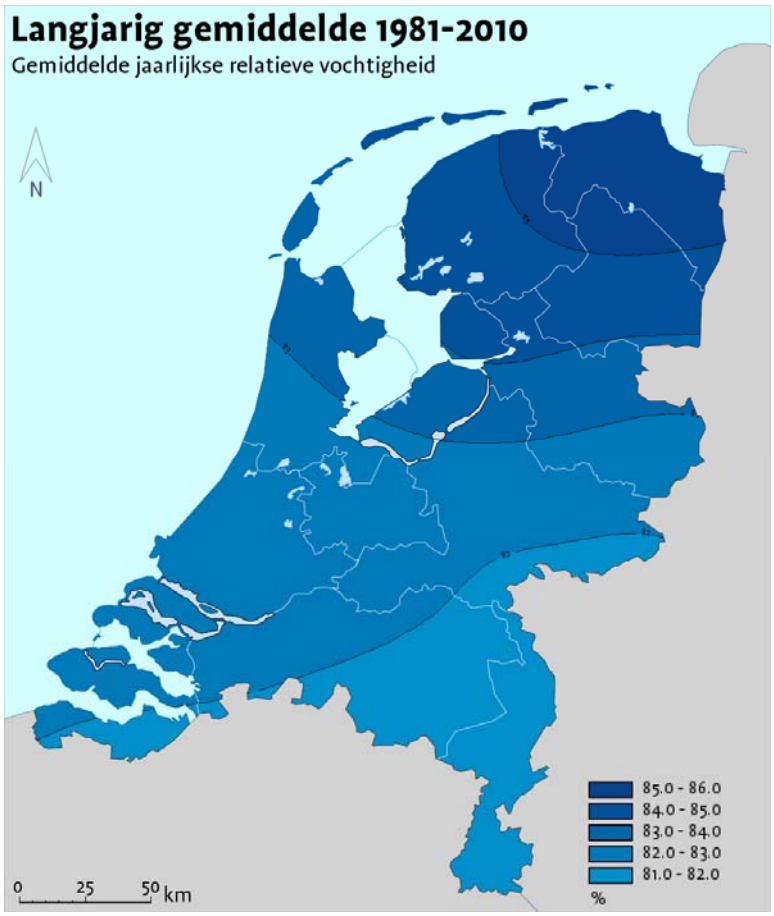
5.4 Air pressure



Category	Air pressure
ID	46
Title	Long term average 1981-2010 - Average yearly air pressure
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse luchtdruk
KIS Element	Pg
Product ID	PG4
Time resolution	Year
Recipe	Pg_4_oper_v0004.xml
R script	Pg_4_oper_v0004.r
Query	Normalen_Year_2010_Pg_v0001.query
Style / Legend	Pg_4_d0.5
Number of stations	14
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	225 IJMUIDEN 265 SOESTERBERG 269 LELYSTAD 279 HOOGEVEEN 330 HOEK VAN HOLLAND 348 CABAUW
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.99
References	Hiemstra & Sluiter (2011)

Category	Air pressure
ID	47
Title	Long term average 1981-2010 - Average monthly air pressure
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandelijkse luchtdruk
KIS Element	Pg
Product ID	PG3
Time resolution	Year
Recipe	Pg_3_oper_v0004.xml
R script	Pg_3_oper_v0004.r
Query	Normalen_Month_2010_Pg_v0001.query
Style / Legend	Pg_3_d0.3
Number of stations	14
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 260 DE BILT 270 LEEUWARDEN 275 DEELEN 280 EELDE 290 TWENTHE 310 VLISSINGEN 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT
Excluded stations	225 IJMUIDEN 265 SOESTERBERG 269 LELYSTAD 279 HOOGEVEEN 330 HOEK VAN HOLLAND 348 CABAUW
Method	Thin Plate Spline
TPS Lambda	0.004
Quality	LOOCV R^2 = 0.67; Least performing months March (-0.16) and April (-0.45)
References	Hiemstra & Sluiter (2011)

5.5 Humidity


Langjarig gemiddelde 1981-2010
Gemiddelde jaarlijkse relatieve vochtigheid
N
85.0 - 86.0
84.0 - 85.0
83.0 - 84.0
82.0 - 83.0
81.0 - 82.0
%
0 25 50 km

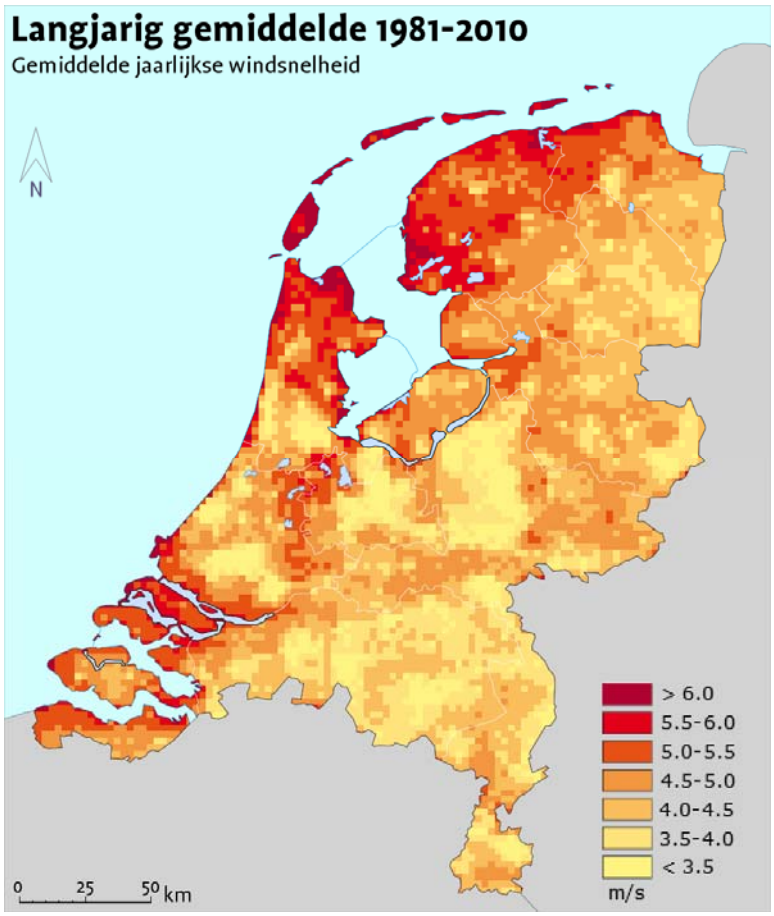
Category	Humidity
ID	48
Title	Long term average 1981-2010 - Average yearly relative humidity
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse relatieve vochtigheid
KIS Element	Ug
Product ID	Ug4
Time resolution	Year
Recipe	Ug_4_oper_v0004.xml
R script	UG_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Ug_4_d1
Number of stations	26
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.69
References	

Category	Humidity
ID	49
Title	Long term average 1981-2010 - Average yearly relative humidity at 12 UT
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse relatieve luchtvochtigheid om 12 UT
KIS Element	Ug12
Product ID	Ug12_4
Time resolution	Year
Recipe	Ug_12_4_oper_v0004.xml
R script	UG_12_4_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Ug_4_d2
Number of stations	26
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 269 LELYSTAD 270 LEEUWARDEN 273 MARKNESSE 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 286 NIEUW BEERTA 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 356 HERWIJNEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	NA
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	False
Block size	20000
Quality	LOOCV R^2 = 0.61
References	

Category	Humidity
ID	50
Title	Long term average 1981-2010 - Average yearly relative humidity
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse relatieve vochtigheid per seizoen
KIS Element	Ug
Product ID	Ug5
Time resolution	Year
Recipe	Ug_5_oper_v0004.xml
R script	UG_5_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Ug_4_d2
Number of stations	23
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	267 STAVOREN 273 MARKNESSE 277 LAUWERSOOG 286 NIEUW BEERTA 348 CABAUW 356 HERWIJNEN
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	False
Block size	20000
Quality	Average LOOCV R^2 = 0.56; Least performing season: Autumn 0.35.
References	

Category	Humidity
ID	51
Title	Long term average 1981-2010 - Average yearly relative humidity at 12 UT
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse relatieve luchtvochtigheid om 12 UT
KIS Element	Ug12
Product ID	Ug12_5
Time resolution	Year
Recipe	Ug_12_5_oper_v0004.xml
R script	UG_12_5_oper_v0004.r
Query	Normalen_Year_2010_v0003.query
Style / Legend	Ug_4_d2
Number of stations	23
Station names	210 VALKENBURG 235 DE KOOY 240 SCHIPHOL 249 BERKHOUT 251 HOORN (TERSCHELLING) 260 DE BILT 265 SOESTERBERG 269 LELYSTAD 270 LEEUWARDEN 275 DEELEN 279 HOOGEVEEN 280 EELDE 283 HUPSEL 290 TWENTHE 310 VLISSINGEN 319 WESTDORPE 323 WILHELMINADORP 344 ROTTERDAM 350 GILZE-RIJEN 370 EINDHOVEN 375 VOLKEL 380 MAASTRICHT 391 ARCEN
Excluded stations	267 STAVOREN 273 MARKNESSE 277 LAUWERSOOG 286 NIEUW BEERTA 348 CABAUW 356 HERWIJNEN
Method	Ordinary Kriging
Variogram model	Exponential
Variogram nugget	Free
Variogram binning	False
Block size	20000
Quality	Average LOOCV R^2 = 0.51; Least performing season: Winter 0.22
References	

5.6 Wind


Langjarig gemiddelde 1981-2010
Gemiddelde jaarlijkse windsnelheid
N
> 6.0
5.5-6.0
5.0-5.5
4.5-5.0
4.0-4.5
3.5-4.0
< 3.5
m/s
0 25 50 km

Category	Wind
ID	52
Title	Long term average 1981-2010 - Average yearly wind speed
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde jaarlijkse windsnelheid
KIS Element	NA
Product ID	F4
Time resolution	Year
Recipe	F_4_oper_v0004.xml
R script	F_4_oper_v0004.r
Query	NA
Style / Legend	U_4_wn_kustgras_d0.5
Number of stations	See Stepek & Wijnant (2011) for details
Station names	See Stepek & Wijnant (2011) for details
Excluded stations	See Stepek & Wijnant (2011) for details
Method	A two layer model of the planetary boundary layer (Wieringa, 1986) is used to transform the surface wind speed into the macro wind speed. Macro wind speed is interpolated using inverse distance weighted interpolation (IDW). See Stepek & Wijnant (2011) for details.
Quality	See Stepek & Wijnant (2011) for details
References	Stepek & Wijnant (2011)

Category	Wind
ID	53
Title	Long term average 1981-2010 - Average monthly wind speed
Title NL	Langjarig gemiddelde 1981-2010 - Gemiddelde maandelijkse windsnelheid
KIS Element	NA
Product ID	F3
Time resolution	Year
Recipe	F_3_oper_v0004.xml
R script	F_3_oper_v0004.r
Query	NA
Style / Legend	U_3_wn_kustgras_summer_d0.5; U_3_wn_kustgras_winter_d0.5
Number of stations	See Stepek & Wijnant (2011) for details
Station names	See Stepek & Wijnant (2011) for details
Excluded stations	See Stepek & Wijnant (2011) for details
Method	A two layer model of the planetary boundary layer (Wieringa, 1986) is used to transform the surface wind speed into the macro wind speed. Macro wind speed is interpolated using inverse distance weighted interpolation (IDW). See Stepek & Wijnant (2011) for details.
Quality	See Stepek & Wijnant (2011) for details
References	Stepek & Wijnant (2011)

6 Appendix – KIS elements

Element	Eenheid	Omschrijving
DDVec	\ °	Gemiddelde vectoriële windrichting
Dr24	uren	Duur van de neerslag
EEg	hPa	Gemiddelde dampdruk
EV24	mm	Hoeveelheid referentie-gewasverdamping (Makkink)
EV24*	mm	Hoeveelheid referentie-gewasverdamping (Makkink) uit zonneschijnduur
Fg	m\/s	Gemiddelde windsnelheid uit Fh
Fh.ge.4	-	Aantal dagen met windkracht minstens 4 Bft
Fh.ge.5	-	Aantal dagen met windkracht minstens 5 Bft
Fh.ge.6	-	Aantal dagen met windkracht minstens 6 Bft
Fh.ge.7	-	Aantal dagen met windkracht minstens 7 Bft
Fh.ge.8	-	Aantal dagen met windkracht minstens 8 Bft
FhVec	m\/s	Gemiddelde vectoriële windsnelheid
Fp	m\/s	Gemiddelde potentiële windsnelheid
NsTx	mm	Mediane maximale vermeerdering van het potentieel neerslagtekort
NsTx05	mm	Maximale vermeerdering van het potentieel neerslagtekort in 5% droog jaar
NsTx10	mm	Maximale vermeerdering van het potentieel neerslagtekort in 10% droog jaar
NsTx15	mm	Maximale vermeerdering van het potentieel neerslagtekort in 15% droog jaar
NsTx20	mm	Maximale vermeerdering van het potentieel neerslagtekort in 20% droog jaar
Pg	hPa	Gemiddelde luchtdruk t.o.v. middelbaar zeeniveau
Q24	J\/cm2	Hoeveelheid globale straling
Rd	mm	Hoeveelheid neerslag uit dagelijkse aftappingen (8.00 UTC)
Rd.eq.0	-	Aantal dagen zonder neerslag uit dagelijkse aftappingen
Rd.ge.0.1	-	Aantal dagen met neerslag minstens 0,1 mm uit dagelijkse aftappingen
Rd.ge.0.3	-	Aantal dagen met neerslag minstens 0,3 mm uit dagelijkse aftappingen
Rd.ge.1	-	Aantal dagen met neerslag minstens 1,0 mm uit dagelijkse aftappingen
Rd.ge.10	-	Aantal dagen met neerslag minstens 10 mm uit dagelijkse aftappingen
Rh24	mm	Hoeveelheid neerslag uit elektrische regenmeter
Rh24.eq.0	-	Aantal dagen zonder neerslag
Rh24.ge.0.1	-	Aantal dagen met neerslag minstens 0,1 mm
Rh24.ge.0.3	-	Aantal dagen met neerslag minstens 0,3 mm
Rh24.ge.1	-	Aantal dagen met neerslag minstens 1,0 mm
Rh24.ge.10	-	Aantal dagen met neerslag minstens 10 mm
Sp	%	Relatieve zonneschijnduur
Sp.eq.0	-	Aantal zonloze dagen
Sp.ge.80	-	Aantal dagen met minstens 80% zon
Sp.le.20	-	Aantal dagen met hoogstens 20% zon
Sp_20-50	-	Aantal dagen met meer dan 20% en hoogstens 50% zon
Sp_50-80	-	Aantal dagen met meer dan 50% en minder dan 80% zon

Sq24	uren	Zonneschijnduur
Sx.gt.0	-	Aantal dagen met een gesloten sneeuwdek of sneeuwresten
T10n.lt.0	-	Aantal dagen met minimum temperatuur 10cm beneden 0 °C
Tg	°C	Gemiddelde temperatuur
Tg.ge.20	-	Aantal dagen met gemiddelde temperatuur minstens 20 °C
Tg.lt.0	-	Aantal dagen met gemiddelde temperatuur beneden 0 °C
Tg_0-5	-	Aantal dagen met gemiddelde temperatuur 0 - 5 °C
Tg_10-15	-	Aantal dagen met gemiddelde temperatuur 10 - 15 °C
Tg_15-20	-	Aantal dagen met gemiddelde temperatuur 15 - 20 °C
Tg_5-10	-	Aantal dagen met gemiddelde temperatuur 5 - 10 °C
Tn.lt.-10	-	Aantal dagen met minimum temperatuur beneden -10 °C
Tn.lt.-5	-	Aantal dagen met minimum temperatuur beneden -5 °C
Tn.lt.0	-	Aantal dagen met minimum temperatuur beneden 0 °C
Tng	°C	Gemiddelde minimum temperatuur
Tx.ge.15	-	Aantal dagen met maximum temperatuur minstens 15 °C
Tx.ge.20	-	Aantal dagen met maximum temperatuur minstens 20 °C
Tx.ge.25	-	Aantal dagen met maximum temperatuur minstens 25 °C
Tx.ge.30	-	Aantal dagen met maximum temperatuur minstens 30 °C
Tx.lt.0	-	Aantal dagen met maximum temperatuur beneden 0 °C
Txg	°C	Gemiddelde maximum temperatuur
Ug	%	Gemiddelde relatieve luchtvochtigheid
Ug12	%	Gemiddelde relatieve luchtvochtigheid om 12.00 uur UTC
W1	-	Aantal dagen met mist
W2	-	Aantal dagen met regen
W3	-	Aantal dagen met sneeuw
W4	-	Aantal dagen met hagel
W5	-	Aantal dagen met onweer
W6	-	Aantal dagen met ijsvorming

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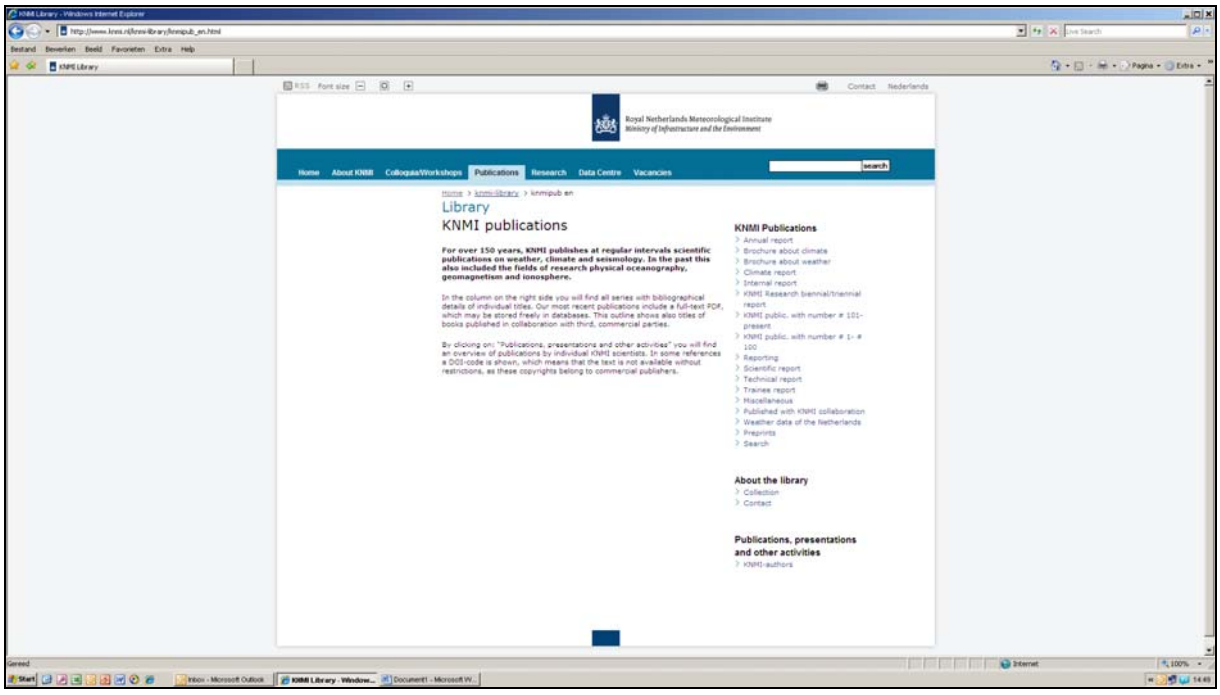

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