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Historic Climate

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Abstract:

This document describes the process of creating a 100 year baseline climate of daily weather data from climate stations or E-OBS grid points for each case study region. The stochastic weather generator LARS-WG was used to generate the 100 year daily climate data comprising minimum and maximum temperature, as well as precipitation from an observation period from 1961 to 1990. Following this the program MT-Clim was used to generate the baseline climate according to altitudinal zones, slopes and aspects. The resulting climate records also contain the estimated average daylight solar radiation and vapor pressure deficit. The data records are available from the ARANGE Internal Communication Platform.

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1 Introduction

The baseline climate for the different case study regions is requested to comprise a 100 year daily dataset of temperature, precipitation, solar radiation and vapor pressure deficit. This climate has to reflect the climatic conditions of the case study region. This document describes the process of the generation of the baseline climate and the data that was used within the process. Finally, the resulting dataset is described.

2 Data

There are two sources of weather data used for the generation of the baseline climate: weather stations and the public available E-OBS dataset (van den Besselaar et al., 2011). The data from the weather stations had to fulfil certain criteria in order to be considered as inputs for the generation process; they are described in section 2.1. If no station of a case study region met the requirements, the nearest grid point from the E-OBS 0.25 deg. regular grid was used as a base for the process.

2.1 Selection Criteria

The weather stations used for the generation process had to fulfil the following criteria:

- The data had to consist of daily values of minimum and maximum temperature (tmin and tmax) and precipitation (prcp).
- The available time series had to be from 1961 to 1990 (climate reference period).
- The station should be in the case study region. If no station fulfilled that criterion, the nearest station within a 25 km radius was chosen.
- The station had to reflect the weather conditions of the case study region.

2.2 Stations

Table 1 shows the data (climate station or E-OBS grid point) that was used for the baseline generation process. Station Autrans had no records before 1971. The baseline climate of CS2 is based on the years 1971 to 1990.

Table 1: Stations and E-OBS grid points that were used for the baseline generation.

Case study	Type	Name	Longitude	Latitude	Elevation
CS1 - Cabeza	E-OBS	-	-3.875	40.875	1482
CS1- Vasain	Station	2462 - Puerto de Navacerrada	-4.010556	40.793056	1894
CS2	Station	Autrans	5.553333	45.181667	1090
CS3	Station	11110 - Feldkirch	9.6	47.2667	439
CS4	E-OBS	-	14.375	45.625	877
CS5	Station	Dikanaes	65.14	15.59	480
CS6	Station	11952 - Ganovce	20.3242	49.03507	703
CS7	E-OBS	-	24.625	41.625	1341

3 Method

The generation procedure consists of two steps

1. Generation of the 100 year baseline climate from the underlying station/E-OBS grid point.
2. Generation of different weather time series based on the 100 year baseline climate of step 1 according to different altitudinal zones, slopes and aspects respectively.

3.1 LARS-WG

The stochastic weather generator LARS-WG (Racsko et al., 1991; Semenov and Barrow, 1997) was used to generate a 100 year time series based on the available 30 year daily data from the weather stations and the E-OBS grid points. Input and output for the weather generator are tmax, tmin and prcp. The 100 year climate maintains the same characteristics as the underlying weather records. This is shown in Figures 1 - 3 for the station Feldkirch of CS3 for tmax, tmin and prcp. The stations/E-OBS grid points of the other case studies behave similarly (not shown). Each year of the generated record has 365 days, leap years are not considered.

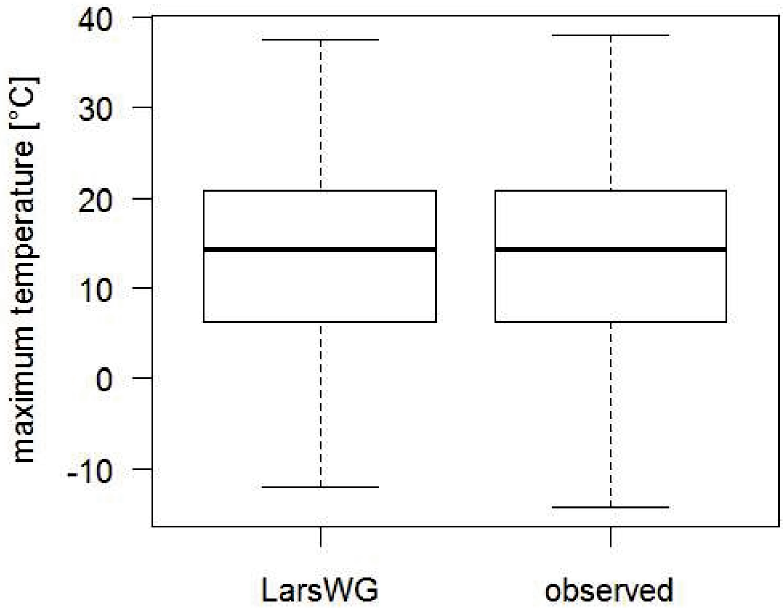

Figure 1: Comparison of tmax of station Feldkirch (1961 - 1990) with the 100 year climate generated with LARS-WG

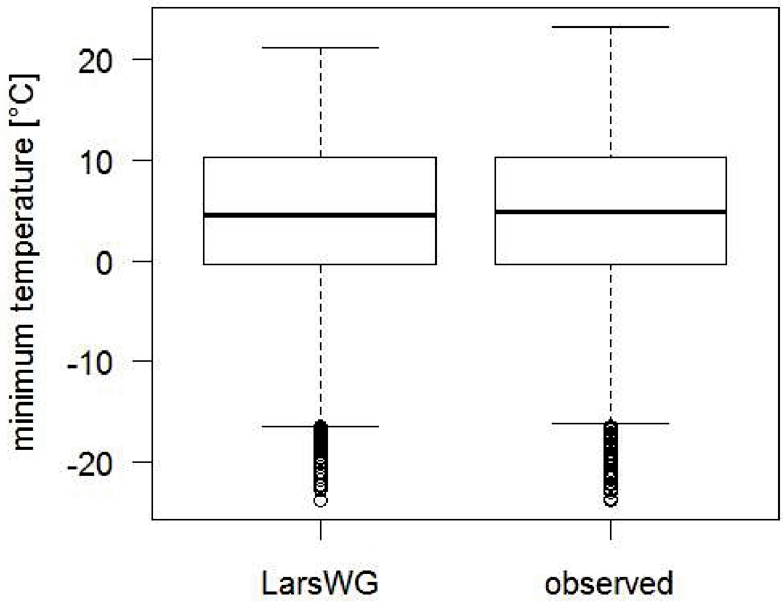

Figure 2: Comparison of tmin of station Feldkirch (1961 - 1990) with the 100 year climate generated with LARS-WG

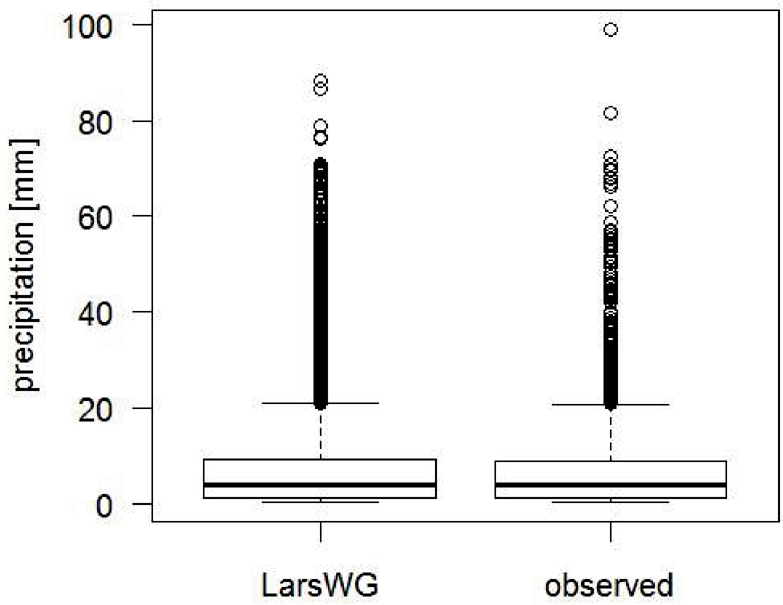

Figure 3: Comparison of prcp of station Feldkirch (1961 - 1990) with the 100 year climate generated with LARS-WG

3.2 MT-CLIM

The program MT-CLIM (Running et al., 1987; Thornton and Running, 1999) was used to adopt the different baseline climates for the altitudinal zones, slopes and aspects. The program also estimates the average solar radiation of the daylight period and the vapor pressure deficit.

The solar radiation algorithm has been adapted and validated for Austria (Thornton et al., 2000) and the parameters for the solar radiation algorithm presented there are used within the generation process. Since the station Feldkirch of CS3 was the only station with direct solar radiation measurements, comparisons between predicted and observed solar radiation (Figures 4 and 5) were only made there.

The vapor pressure deficit is calculated as the saturated vapor pressure for the daylight temperature minus the saturated vapor pressure at tmin. The saturated vapor pressure is calculated as:

$610.7 * \exp((17.38 * t) / (t + 239))$ t... temperature

The daylight temperature is calculated as:

$0.45 * (tmax - tavg) + tavg$ $tavg = (tmax + tmin) / 2$

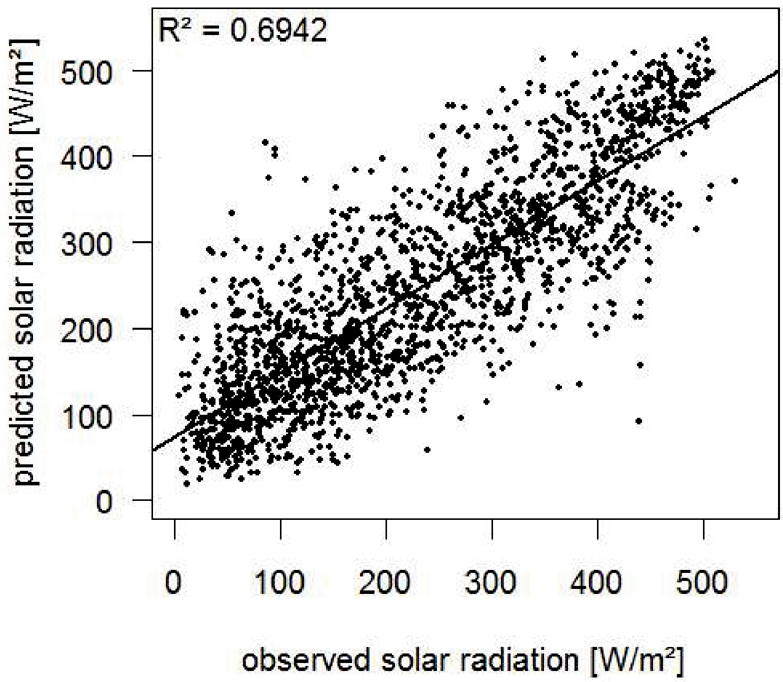

Figure 4: Predicted and observed solar radiation of station Feldkirch

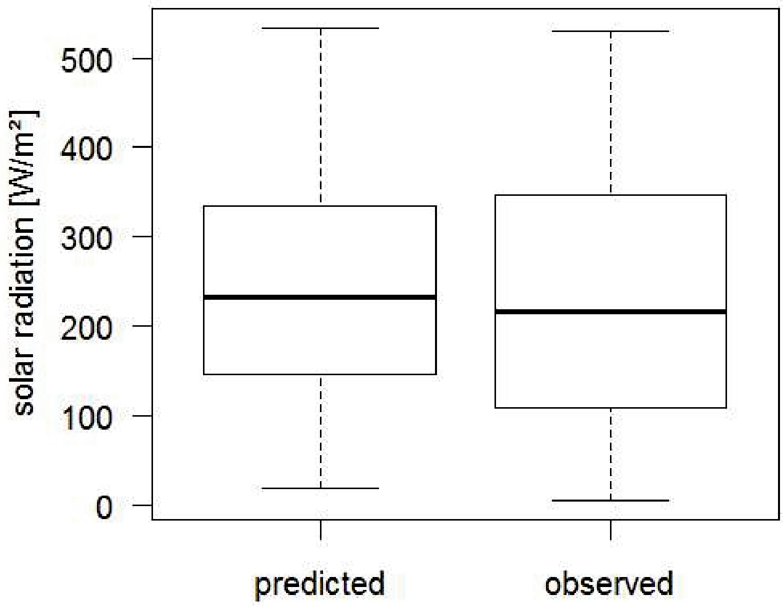

Figure 5: Box plot of the predicted and observed solar radiation of station Feldkirch

Inputs for MT-Clim are amongst others the altitudinal lapse rates of the maximum and minimum temperature, as well as of precipitation, per 1000 meters. For most of the case studies there were not enough stations available, the rates were calculated from the E-OBS dataset for the given case study region. Only case study 6 had enough weather station data to calculate the lapse rates directly from these stations. Again, only the time span from 1961 to 1990 (except CS2: 1971 - 1990) was taken into account. The lapse rates are summarised in Table 2.

Table 2: temperature and precipitation lapse rates for the case study regions.

Case study	Tmax [°C]	Tmin [°C]	Prcp [cm]
CS1 - Cabeza	-7.908937	-4.708033	50.02175
CS1 - Valsain	-7.908937	-4.708033	50.02175
CS2	-4.446824	-4.114022	24.85836
CS3	-5.929861	-4.488819	26.29482
CS4	-6.159573	-8.615241	63.13265
CS5	-6.056488	-3.027842	49.4904
CS6	-6.001969	-3.853555	31.31656
CS7	-5.900478	-4.860977	8.989333

4 Results

Depending on the case study region, weather records for 4-5 altitudinal zones, comprising flat, northerly and southerly aspect respectively, were generated. The slope was determined in consultation with the case study responsible. Table 3 gives a summary of the generated climate files.

Table 3: Generated weather records

Case study	Altitudinal zones [m]	Aspect, slope [deg]	Total number of climate records
CS1 - Cabeza	1250, 1500, 1750, 2000	flat, north 30, south 30	12
CS1 - Valsain	1250, 1500, 1750, 2000	flat, north 30, south 30	12
CS2	900, 1200, 1500, 1800	flat, north 30, south 30	12
CS3	600, 950, 1300, 1650, 2000	flat, north 25 and 35, south 25 and 35	25
CS4	600, 900, 1200, 1500, 1800	flat, north 25, south 25	15
CS5	350, 500, 650, 800	flat, north 20, south 20	12
CS6	350, 650, 950, 1250, 1550	flat, north 25, south 25	15
CS7	1000, 1250, 1500, 1750, 2000	flat, north 25, south 25	15

The generated climate records contain the following values:

year: year (1 - 100)

yday: day of the year (1 - 365)

Tmax: maximum temperature [C]

Tmin: minimum temperature [°C]

Tday: daylight temperature [deg C]

prcp: precipitation [cm]

VPD: vapor pressure deficit [Pa]

srad: solar radiation [W/m2] according to (Thornton et al., 2000)

daylen: length of the day [s]

The climate data files are available at the ARANGE Internal Communication Platform.

5 Change log

5.1 CS2 (27.09.2012)

The baseline climate is no longer based on an E-OBS grid point. Instead it is based on the weather station Autrans (longitude: 5.553333, latitude: 45.181667, elevation: 1090) from 1971 to 1990. The lapse rates also changed a little bit because they now rely on the E-OBS data from 1971 – 1990 (tmax old: -4.500023, tmax new: -4.446824, tmin old: -4.112765, tmin new: -4.114022, prcp old: 23.62442, prcp new: 24.85836).

5.2 CS6 (27.09.2012)

There was an error in the calculation of the temperature lapse rates (tmax old: -6.139623, tmax new: -6.001969, tmin old: -2.749383, tmin new: -3.853555). The baseline was recalculated with the corrected values.

5.3 CS7 (27.09.2012)

According to the feedback of the case study responsible, there was an underestimation in the precipitation of the baseline climate. The temperature and the lapse rates seemed to be ok. The solution to this was to scale the precipitation of the climate file that was used for the generation process. This climate record is based on an E-OBS grid point.

The case study responsible provided a 50-year monthly average of precipitation values from station Shiroka Laka (longitude: 24.582230, latitude: 41.679337, elevation: 1120). The values are shown in Table 4.

Since the E-OBS grid point that is used for the baseline creation has an elevation of 1341, the values of station Shiroka Laka were corrected with the lapse rate calculated with the E-OBS dataset. Now it is possible to compare the values of the station with the precipitation values of the E-OBS grid point (Table 4).

The scaling factor was calculated by dividing the corrected prcp value of station Shiroka Laka by the prcp of the E.OBS grid point. Each prcp value of the E-OBS climate file was then multiplied with the scaling factor. This file was used as input for the LARS-WG weather generator.

Table 4: Precipitation of CS7.

Month	Prcp Shiroka Laka	Prcp Shiroka Laka corrected	Prcp E-OBS grid point	Scaling factor
1	80	81.98871	46.53333	1.761935
2	61	62.98871	41.84000	1.505466
3	58	59.98871	42.97556	1.395880
4	58	59.98871	47.15333	1.272205
5	97	98.98871	59.16445	1.673111
6	97	98.98871	55.75556	1.775405
7	79	80.98871	35.66222	2.270995
8	52	53.98871	26.58000	2.031178
9	54	55.98871	24.79333	2.258216
10	61	62.98871	40.50889	1.554936
11	78	79.98871	52.46000	1.524756
12	84	85.98871	61.21778	1.404636

5.4 CS2 (07.01.2013)

According to the case study responsible, the altitudes of the baseline climates were changed to 900, 1200, 1500 and 1800 m (old: 600, 1000, 1400, 1800, 2200 m).

5.5 CS3 (25.03.2013)

According to the case study responsible, the precipitation gradient is no longer based on the E-OBS data due to the fact that the E-OBS data suggested a negative gradient (-12.75452). The gradient is now based on the data from two stations in the case study region. The new precipitation gradient is 26.29482.

References

Racsko, P., Szeidl, L. and Semenov, M., 1991. A serial approach to local stochastic weather models. Ecological Modelling, 57(1–2): 27-41.

Running, S.W., Nemani, R.R. and Hungerford, R.D., 1987. Extrapolation of synoptic meteorological data in mountainous terrain and its use for simulating forest evapotranspiration and photosynthesis. Canadian Journal of Forest Research, 17: 472-483.

Semenov, M.A. and Barrow, E.M., 1997. Use of a stochastic weather generator in the development of climate change scenarios. Climatic Change, 35(4): 397-414.

Thornton, P.E., Hasenauer, H. and White, M.A., 2000. Simultaneous estimation of daily solar radiation and humidity from observed temperature and precipitation: an application over complex terrain in Austria. Agricultural and Forest Meteorology, 104(4): 255-271.

Thornton, P.E. and Running, S.W., 1999. An improved algorithm for estimating incident daily solar radiation from measurements of temperature, humidity, and precipitation. Agricultural and Forest Meteorology, 93(4): 211-228.

van den Besselaar, E.J.M., Haylock, M.R., van der Schrier, G. and Klein Tank, A.M.G., 2011. A European daily high-resolution observational gridded data set of sea level pressure. J. Geophys. Res., 116(D11): D11110.