COMPARISON OF TEST REFERENCE YEARS TO STOCHASTICALLY GENERATED TIME SERIES

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ABSTRACT

Two sources of weather information for building simulation, test reference years and stochastically generated data, are compared. Two aspects have been investigated: the calculation of design temperatures for heating and cooling loads as well as the influence of mountain shadows. It could be shown, that stochastically generated data combined with statistical corrections have the same uncertainty as design temperatures based on long term measurements. The influence of mountain shadows can't be neglected. At approximately 20% of the area of the Switzerland, the influence during main heating period is so large, that the use of data of a single weather station (like TRY) can lead to significant errors in the simulation of buildings, which depend on active or passive solar gains.

INTRODUCTION

Test reference years (TRY) as well a stochastically generated time series can be used for simulation of buildings. In this report both type of data are compared.

TRY are available at certain sites only, as they are based on long term measurements. In Switzerland 40 sites are available from sia [1], in Germany 10 sites from German Weather Service (DWD) [2] and in the USA 1020 sites from National Renewable Energy Laboratory [3]. Swiss and German data are based on the European norm prEN ISO 15927-4 [4]. For Swiss stations there exists also heating and cooling design temperatures directly calculated from long term measurements from sia. These values are used as reference in this paper.

Stochastically generated time series are calculated with Meteonorm version 6.1 [5] (which includes also TRY's from sia). In the output format "PHPP" the option with 5 different runs was chosen and the statistical correction was used.

METHOD

Two different aspects have been investigated:

1. Calculation of the **design temperatures** (heating and cooling) according PHPP format [6]. For this comparison the mean bias error (mbe) and the root mean squared error (rmse) were used.
2. Qualitative examination of the local variation of the **mountain shadows**.

RESULTS

Design temperatures

The uncertainty of the generated data is in the range of 1-2°C (Tab. 1). The generation of 5 different runs and the correction enhances the quality. If the design temperatures are calculated based directly on TRY datasets the uncertainty is the same or even larger as for design temperatures based on stochastically generated time series.

	Generated corrected	Generated corrected	Generated original	Generated original.	TRY	TRY
Design temperature	mbe	rmse	mbe	rmse	mbe	rmse
cold (4 day mean)	0.7	1.2	0.5	1.1	0.3	1.6
cold & cloudy (4 day mean)	0.2	2.1	-2.5	3.3	0.5	3.1
Hot (2 day mean)	0.0	1.4	2.0	2.4	-	-

Table 1: Mean bias error (mbe) and uncertainty (rmse) of heating and cooling design temperatures. "Corrected" means the use of statistical correction function built in Meteonorm.

The errors of 1-2°C have to be set in relation to the representativeness of the sites:
Using the yearly mean temperature as a measure of representativeness, the uncertainty of TRY is 1.0°C in Switzerland, 2.2°C in Germany and 1.1°C in the USA (cross correlation analysis of ground sites). For stochastically generated data based on Meteonorm this value comes to 0.8°C in Switzerland and 1.1°C in Germany and 1.0°C in the USA (due to a larger number of sites and enhanced interpolation methods).

The correction of the stochastically generated data is based on linear regressions (1).

$$T_{corr} = a + b \cdot T_{orig} \qquad (1)$$

The parameters of the regressions are given in Tab. 2 and the situation for cold and cloudy situations is shown in Figure 1.

Design temperature	**a**	**b**
cold (4 day mean)	0.345	1.0209
cold & cloudy (4 day mean)	2.09	0.9133
Hot (2 day mean)	-3.16	1.0407

Table 2: Regression parameters for the correction of design temperatures based on stochastic generation of Meteonorm.

The original design temperatures for cold situation are given quite well. The design temperatures for cold and cloudy situations are generally underestimated by 2.5°C. The design temperatures for hot situations are generally overestimated by 2°C.

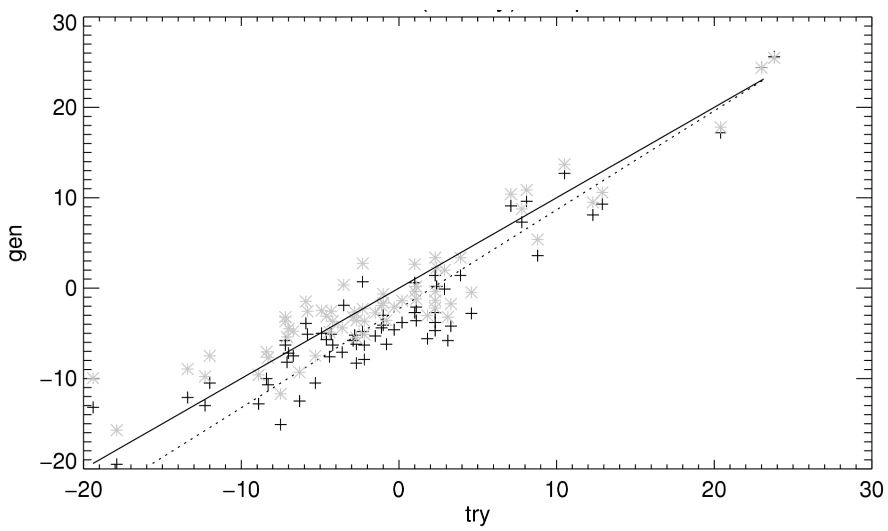

Figure 1: Comparison of measured (try) and generated (gen) design temperatures for cold and cloudy situations. Black crosses show the original values and grey crosses the corrected ones.

Local variations of mountain shadows

In alpine areas the shadow situation can vary locally to a great extent. The analysis of the digital elevation model (100 m grid) in Switzerland show that the influence of the horizon can't be neglected (Fig. 2).

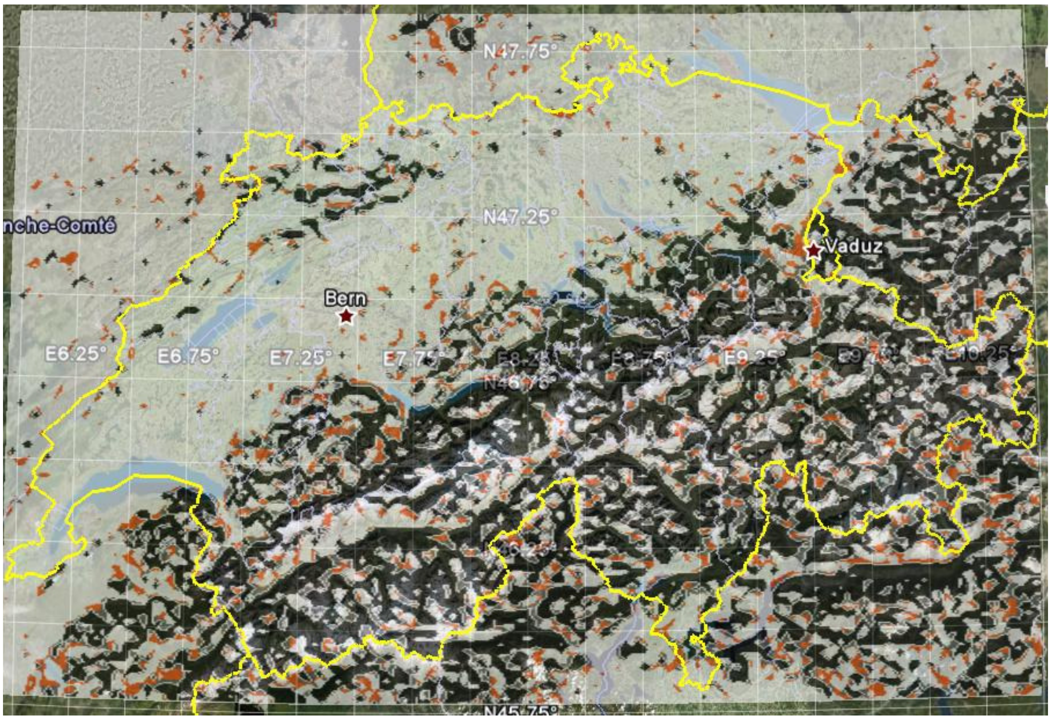

Figure 2: Areas with high influence of shadowing. Black: more than 25% reduction of irradiation due to shadowing at south facades during December and January. Red: more than 10% of reduction due to shadowing on south facades during December and January.

Looking at the global radiation on a south façade in January and December there is a portion of 19% of Swiss surface which has more than 25% reduction of irradiation due to shadowing.

This means, that the use of data of weather stations like TRY has big disadvantages in mountainous regions. In the biggest part of the valley floors of the Swiss Alps the use of weather stations (like TRY's are based on) is giving wrong information about the irradiation situation in the main heating season. This can lead to errors of simulation of buildings, which depend on the active or passive solar gains like e.g. passive buildings or buildings with glass facades.

Discussion

With stochastically generated data and additional statistical corrections design temperatures can be calculated with an uncertainty of 1-2°C, what corresponds to the uncertainty of the official design temperatures. In regions with a high density of TRY the uncertainty of TRY are somewhat better than for generated data. The uncertainty for design temperatures calculated directly from TRY datasets is equal and partly even higher as for values based on stochastically generated time series.

In approx. 20% of the area of Switzerland the effect of mountain shadowing is that big and the horizons vary locally so much, that TRY datasets are valid only in a very small area. For these areas stochastically generated data (and correction to local horizon) deliver more realistic results.

References

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