Weather Test Reference Years in the Czech Republic

Vít Květoň[1] , Michal Žák[1,2], Hana Škáchová[1]

[1] Czech Hydrometeorological Institute, Prague, Czech Republic
[2] Faculty of Mathematics and Physics of the Charles University, Prague, Czech Republic

Correspondence to: Michal Zak (michal.zak@chmi.cz)

Introduction and motivation

Weather Tes Reference years are very useful characterizing of climate properties in given location. And are helpful for standardization especially with regard to energy consumption and effeciency. This paper presents a way of solving a problem of Weather Test Reference Years (WTRY) in the Czech Republic and experiences we have gained in last years in this field. WTRY in the Czech Republic are structured for individual month and year. The paper outlines the methods used to obtain the WTRY. Problem of area validity of WTRY is analysed and discussed as well as problems we have had to deal with.

The concept of TRY has been known since 1976, with implementation being enabled with computers development ([1], [2]).

Since 1990s investigation of TRY started in the Czech Republic, more projects focussed on TRY were done after 2000 (e.g. [3]).

In years 2008 and 2009 special project supported by Ministery of Industry and Trade for construction of new TRY took place, reason: merging and unification with European Union direction on energy conservation in buildings (results are described e.g. in [4]).

Tab. 2 Example of weights construction between months example

Hour	End of the month							Begin of the month						
	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7
W1 (finishing month)	**14**	**13**	**12**	**11**	**10**	**9**	**8**	7	6	5	4	3	2	1	0
W2 (beginning month)	0	1	2	3	4	5	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**

Fig. 1: Example of weights construction between months, temperature

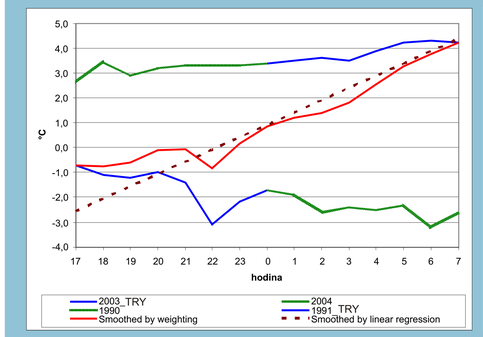


Fig. 2: Example of weights construction between months, global radiation

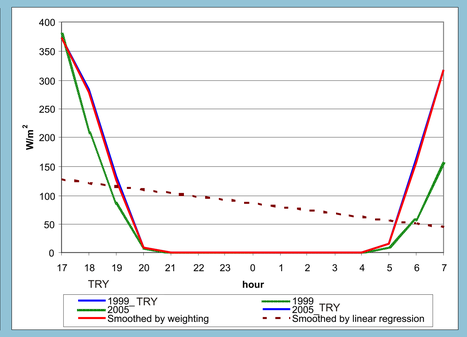
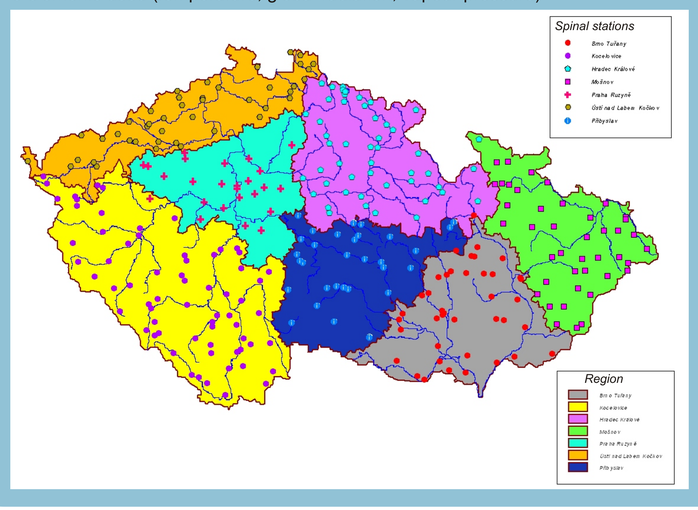


Fig. 3: Regions of the Czech Republic according to pertinence of tested stations to 7 spinal stations. All 297 stations used are depicted, too. Period 1961-2000, based on FS statistics, 3 elements used (temperature, global radiation, vapour pressure)



Construction of Test Reference Years

Data used:
- Hourly data from 7 (spinal) stations and period 1991-2005
- Further climatic data from 297 stations (1961-2000)
- Both data have different quality, problems with homogeneity
- All data tested and completed where needed

Construction of TRY (strictly defined by Czech National Standard EN ISO 15927-4) contains 7 steps:

1) For every calendar month cumulative distributive function of daily averages for all years in increasing order: $\Phi(p,m,i)=\frac{K(i)}{N+1}$

2) For every calendar month and year cumulative distributive function of daily averages in increasing order: $F(p,y,m,i)=\frac{J(i)}{n+1}$

3) For every calendar month and year F-S statistics is computed: $FS(p,y,m)=\sum_{i=1}^{n}|F(p,y,m,i)-\Phi(p,m,i)|$

4) For every month and climatic element row of increasing FS values orders was made for the requested period

5) For every month 3 rows of ordinal numbers (1 for each element) is obtained, numbers are then summed and for each month the only time serie of orders in the given period is obtained

6) This time serie is ordered and for 3 years with the lowest order the deviation of wind speed monthly average for given year from corresponindg monthly average is computede for given period. Year with the lowest deviation is used as the best for given month and for the TRY hourly values from this month are used

7) Switches between months are smoothed to put away discontinuities

Results and composition of TRY

Technical series of hourly values for meteorological elements in TRY were prepared for 7 stations (in period 1991-2005), composition of their months is given in Tab. 1.

Following parameters are available in TRY file:
Air temperature (°C), Relative humidity (%, 1..100), **Vapor pressure** (hPa), Dew point temperature (°C), Absolute humidity (kg/m3), **Global radiation** (W/m2, average value in the previous hour), Diffusive radiation (W/m2, average value in the previous hour), Insolation (direct solar radiation (W/m2), BR = GR – DR, **Wind speed** (m/s), Wind direction (0, 1,...,360), Station air pressure.

Tab. 1 TRY composition for spinal stations

Měsíc	Hradec Králové	Ústí n.L. Kočkov	Praha Ruzyně	Ostrava Mošnov	Kocelovice	Brno Tuřany	Přibyslav
1	1991	2003	1991	2003	2000	2003	2001
2	1997	2001	2001	2004	2001	1992	2001
3	2004	2002	2004	1999	2002	1992	2003
4	2004	1993	2002	1994	2004	2004	1994
5	1999	1994	1999	1998	1998	1998	1997
6	2002	1997	2005	1995	1993	1992	1997
7	2001	2003	2005	1999	2003	2001	2005
8	2001	2001	1991	2004	2001	2001	2001
9	2000	1992	1994	1998	2002	2000	2000
10	1999	1999	1993	1999	1993	1999	1996
11	2004	1992	1996	1994	1997	1997	1997
12	2003	1998	2003	2004	2003	1991	2005

Fig. 4: Air temperature in the summer half-year when using TRY values of spinal stations only

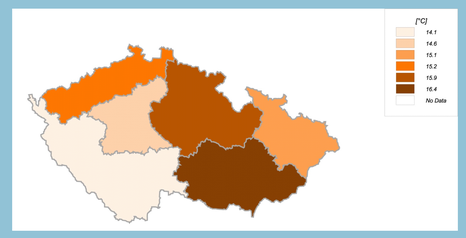
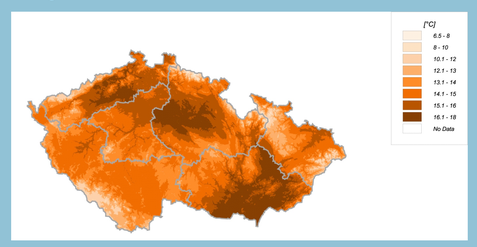


Fig. 5: Air temperature in the summer half-year when using altitudinal-modified TRY values



DISCUSSION

Smoothing of switches between months
Originally smoothing requested using last 8 hours of every month and 8 first hours in the next month
Different solving proposed:
(W1*value in the finishing month + W2*value in the beginning month) / (W1+W2)
(Wi ... weights, not used for wind direction, from humidity parameters used only for relative humidity)
This method eliminates meaningless values, especially for global radiation during night - see Fig. 1 and 2 and Tab. 2

Regional validity of TRY
- Regionalization based on daily values of 297 climatic stations in the Czech Republic, where FS statistics for every of 3 basic elements computed (Tavg, sunshine duration, daily average of vapour pressure), for all of them and also for all of them including wind speed was testing
- Instead global radiation (measured only at few stations), sunshine duration used
- Computation was made for every month and year

- Method of best agreement between tested and any from 7 spinal stations was used, i.e. for all stations spinal station was found (note: wind speed was finally not used for assigning because of large overlapping between spinal stations assignement in various regions of the Czech Republic)

- Pertinence of tested stations to spinal stations was done to make regionalization with borders precised with respect to administrative regions if possible (Fig. 3)

- For construction of TRY out of spinal stations the gradient of monthly values was established to make a good agreement with long-term climatic averages – other variables have to be modified when using this approach! (See Figs. 4 and 5)

Routine operations
Nowadays, users may order TRY for requested location via order-form that is available on the web page of the Czech Hydrometeorological Insitute (http://portal.chmi.cz)

REFERENCES

[1] WMO: Meteorological Aspects of the Utilization of Solar Radiation as an Energy Source. World Meteorological Organization, Technical Note No. 172, Geneva, 1981
[2] Lund, H., 1997. Desgin Reference Years and Test reference Years in Europe, Turkey and Izrael. Department of BUildings and Energy, Technical University of Denmark. Internal Report.
[3] HIRS J., 2006: Calculation of energy performance of building – part: Ventilation and air-conditioning installations, 17th Air-conditioning and Ventilation Conference 2006 - Prague 2006, Czech Republic, Conference Proceedings, ISBN 80-02-01811-7, Společnost pro techniku prostředí, Praha, pp. 89-92
[4] Květoň, V., Valeriánová, A., Žák, M., 2009: Test Reference Years in Czechia, Meteorologické zprávy 3, 65-72 (in Czech only)