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Bioclimate and Mortality in Vienna

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Abstract

In order to find a relationship between meteorological and biometeorological factors on one hand and mortality in Vienna on the other hand this paper presents statistically correlations between them. The meteorological (daily minimum air temperature) and biometeorological (physiological equivalent temperature = PET)) conditions are analysed and statistically correlated with the mortality values. Furthermore based on Gaussian filters the minimum air temperature and the PET at noon have been used to analyse the inter-annual variability of thermal comfort and heat stress. The analysis shows that the combination of minimum air temperature and maximum PET during the day can explain and quantify the relationship between human-biometeorological conditions and health implications accurately.

Bioklima und Sterblichkeit in Wien

Zusammenfassung

Die Arbeit untersucht die Beziehungen zwischen meteorologischen und biometeorologischen Faktoren und der Mortalität in Wien.. Auf der Grundlage vom Tagesminimum der Lufttemperatur und den human-biometerologischen Index (PET= Physiologisch Äquivalente Temperatur) werden die Mortalitäsdaten analysiert und statistisch korreliert. Zusätzlich werden die Daten von Tagesminimum der Lufttemperatur und PET für die Mittagsbedingungen einen Gaussfilter für die Analyse und Bestimmung einer interannualen Variabilität des thermischen Komforts und Hitze Stress, unterzogen. Aus der Kombination von Tagesminimum der Lufttemperatur und die PET-Bedingungen während der Mittagszeit können die Wechselbeziehungen zwischen den Human-biometeorologischen Bedingungen und Gesundheitsimplikationen erklärt werden.

1 Introduction

Extreme meteorological conditions like e.g. heat waves can affect human health leading to an increase of mortality (ROBINSON, 2001). To quantify the impact of heat waves on humans not one single factors like air temperature is important but synergetic effects of several meteorological, atmospheric and other parameters (KOPPE, 2004; MATZARAKIS et al., 1999; VDI, 1998). The PET (Physiologically Equivalent Temperature) allows the assessment of the effect of the thermal environment based on the energy balance of humans including thermo-physiological information (MATZARAKIS and MAYER, 1991, 1997; MATZARAKIS, 2006). The extreme heat waves of the summer 2003, with the high implications of human health showed that there is a need of explanation of the relationship between the atmospheric conditions and human health (RUDEL et al., 2005; KOCH et al., 2005, 2006).

2 Method

The analysis is based on daily meteorological data of air temperature, relative humidity, wind velocity and mean cloud cover as the necessary inputs for Physiologically Equivalents Temperature and mortality data of the area of Vienna for the period 1996-2005. Additionally the minimum temperature of each day of the period has been included in the analysis

In order to quantify the short time or inter annual adaptation of humans to the thermal component of the climate, the following analysis was carried out. A two fold Gaussian filter of 41 days, which corresponds to a filter of 81 days was applied. This one side filter has 30 significant filter weights (SCHÖNWIESE, 1992), which is in accordance of a time frame, where physiological changes are still active concerning the heat effect on humans. The 41 days filter represent the variable part (short time adaptation) the daily PET and daily Tamin values have been applied. The PET values represent the upper limit of the thermal perception and the daily minimum temperature the lower limit. The adapted values PETa and Tamin have been calculated using the following formula.

PETa = limit + (PETgauss – limit)*1/3 with limit of PET=30 °C and PET=35 °C.

Tamina = limit + (Tamingauss – limit)*1/3 with limit of Tamin=18 °C and Tamin = 20 °C.

where, PET_a is the PET value with short time adaptation, PETgauss is the PET with Gaussian filter and limit is the upper of the PET limit. Tamin is the Tamin value with short time adaptation, Tamingauss the Tamin with Gaussian filter and limit the upper of the Tamin limit.

The formula expresses the constant part of thermal stress and a variable part which represents the short time thermal adaptation

3 Results

Figure 1 illustrates the variability of the daily PET values, the Gaussian filtered PET-values PETgauss, the PET for a limit of 35 °C (PET30) and 35 °C (PET35), for 1996 to 2005 in Vienna. The courses of PET30 and PET35 showed that there is a pattern, which describes the variability of the thermal adaptation. It can also be described as a memory of thermal perception or heat stress of humans.

Besides, the inter annual variability of the daily T_{amin} values, the Gaussian filtered T_{amin}-values Tamingauss, the Tamin for a limit of 20 °C (Tamin20) and 18 °C (Tamin18) for 1996 to 2005 in Vienna are presented in Figure 2. The courses of Tamin20 and Tamin18 are similar to those of PET30 and Heatwave35 of Figure 1.

In Figure 3 the variability of the values of PET for 14 CET and Tamin and the amount of deaths caused by cardiovascular diseases (with a ten day sum) is illustrated. Respectively, in Figure 4 are illustrated the mortality data again with the by Gaussian filtered data of PET for the limit value of 35 °C and for Tamin of 20 °C.

From the mortality data it can be extracted that during the summer period (May to September), during days with thermal load, the values of mortality are varying from 37 to 48 % of the annual mortality. The female mortality is all the year higher and during the summer again higher (up to 2 %). Looking on Fig. 3 and 4 in a first view the data of mortality and bioclimate, seem to be not directly correlated.. Even the extreme hot summer 2003 does not illustrate a relation between heat load and mortality. The pictures changes if one analyses the data based only the days over the threshold of Tamin>18 and PET > 35 °C and the mortality of these days or episodes (Table 1).

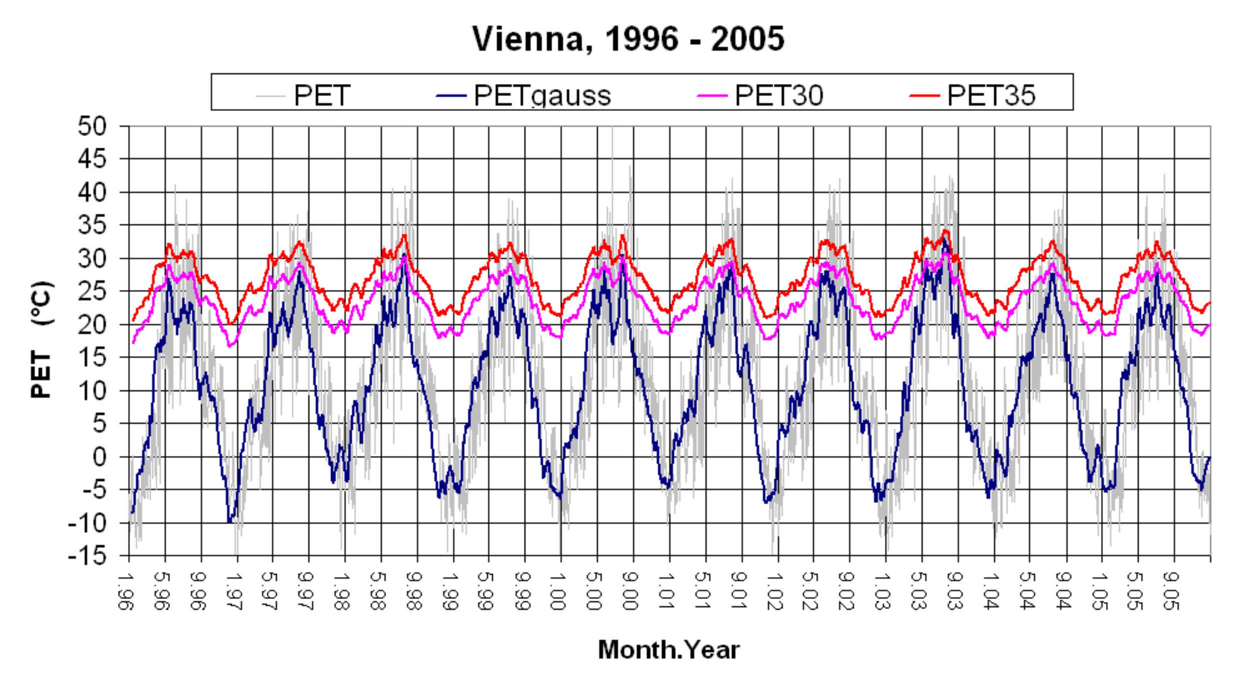

Fig. 1: Temporal development of PET, PETgauss, PET30 and PET35 in Vienna for the period 1996-2005

Abb. 1: Zeitliche Entwicklung von PET, PETgauss, PET30 and PET35 in Wien für den Zeitraum 1996-2005

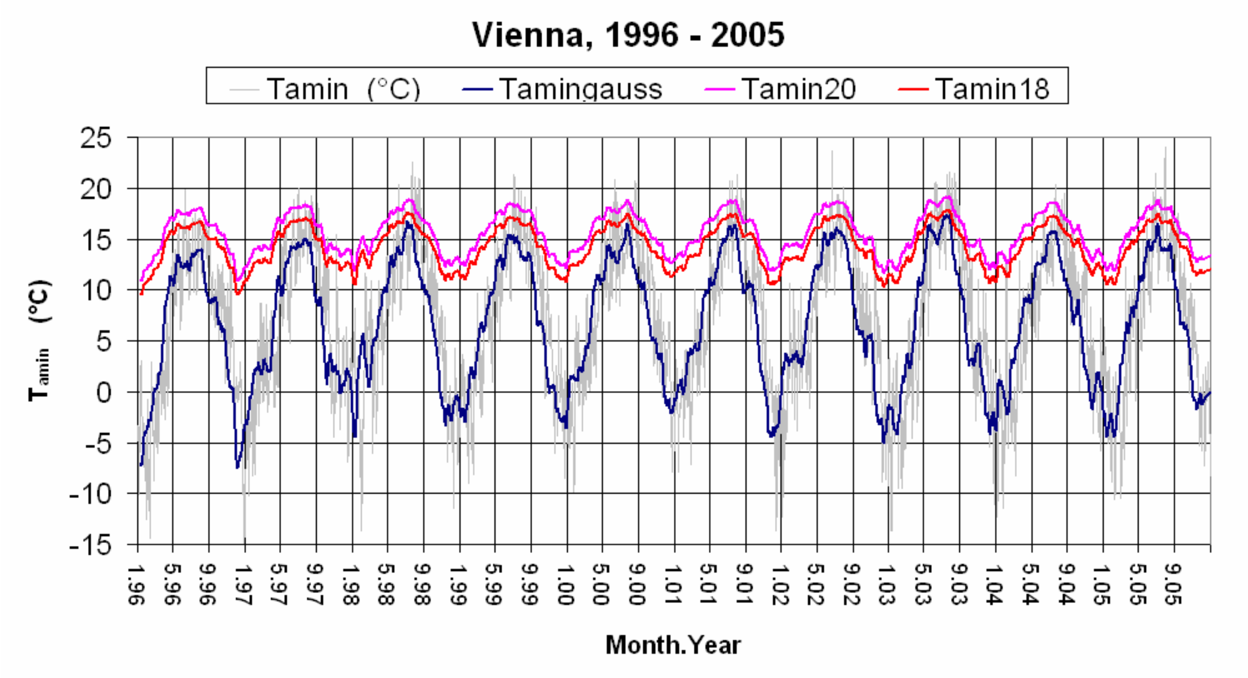

Fig. 2: Temporal development of Tamin, Tamingauss, Tamin20 and Tamin18 in Vienna for the period 1996-2005

Abb. 2: Zeitliche Entwicklung von Tamin, Tamingauss, Tamin20 and Tamin18 in Wien für den Zeitraum 1996-2005

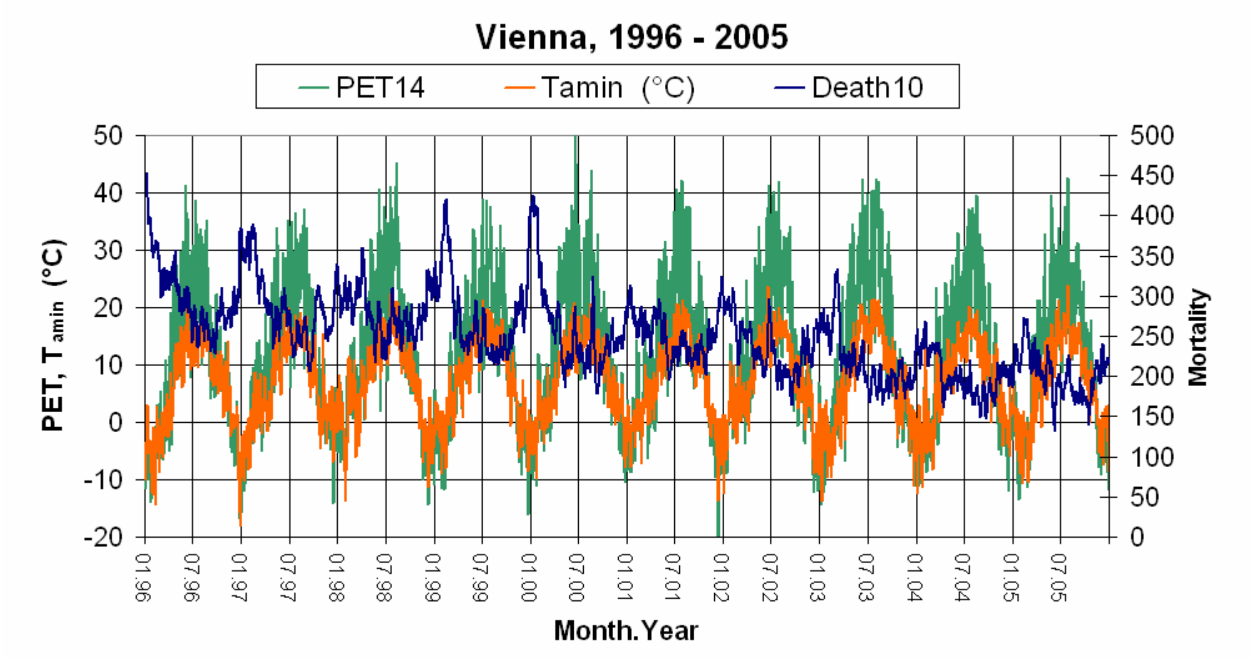

Fig. 3: Temporal development of PET14, Tamin and Mortality in Vienna for the period 1996-2005

Abb. 3: Zeitliche Entwicklung von PET14, Tamin und Mortalität in Wien für den Zeitraum 1996-2005

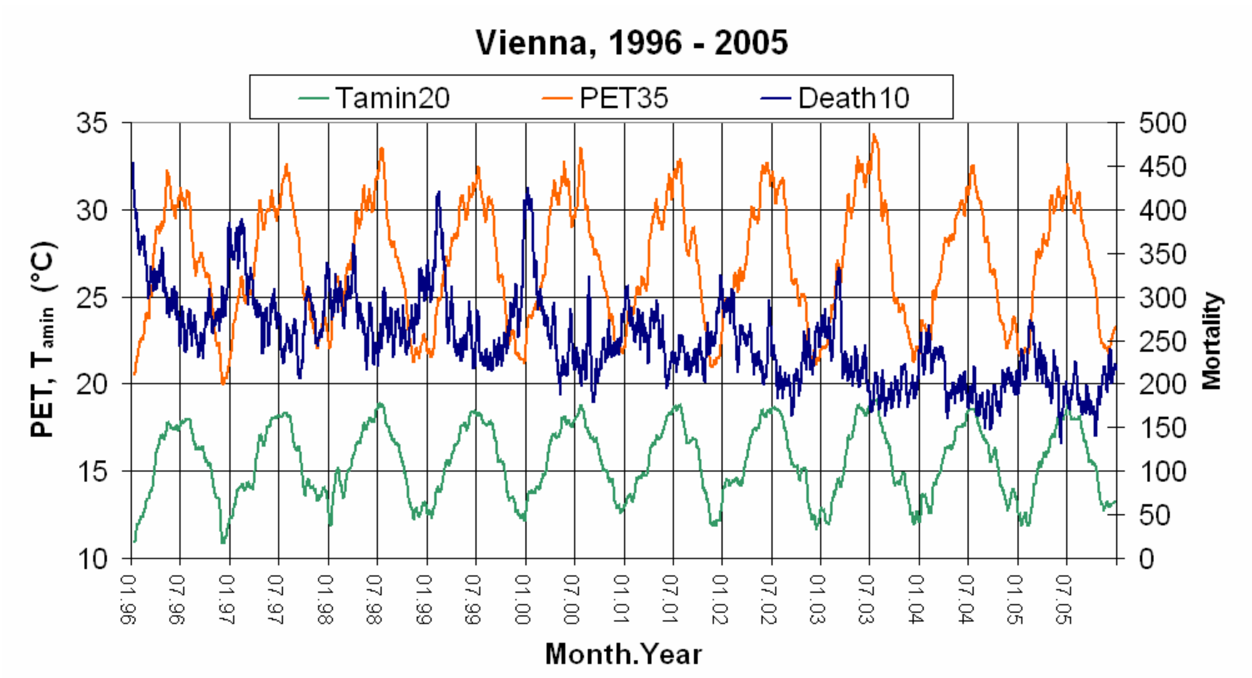

Fig. 4: Temporal development of Tamin, PET35 and Mortality in Vienna for the period 1996-2005

Abb. 4: Zeitliche Entwicklung von Tamin, PET35 und Mortalität in Wien für den Zeitraum 1996-2005

Table 1: Mortality values for days with PET>35 °C, Tamin > 18 °C and the amount of days with PET>35 °C and Tamin >18 °C

Tab. 1: Mortalität für Tage mit PET > 35 °C, Tamin>18 °C und Anzahl der Tage mit PET>35 °C und Tamin > 18 °C

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mortality with PET >35	201	110	464	141	390	344	352	600	109	201
Days with PET >35 °C	7	4	16	5	14	15	13	30	6	9
Mortality with Tamin>18	68	318	475	255	505	375	426	681	196	247
Days with Tamin > 18 °C	2	11	15	9	17	15	16	32	10	11

The table shows quite clear that a high amount of days with PET > 35 °C brings also a high amount of mortality values (Fig. 5). During the summer 2003 the mortality and the amount of days with PET > 35 °C is much higher than in the other years. A clear picture can be obtained also for the years 1998, 2000, 2001 and 2002. Also the Tamin > 18 °C pattern shows the correlation quite evidently (Fig. 5).

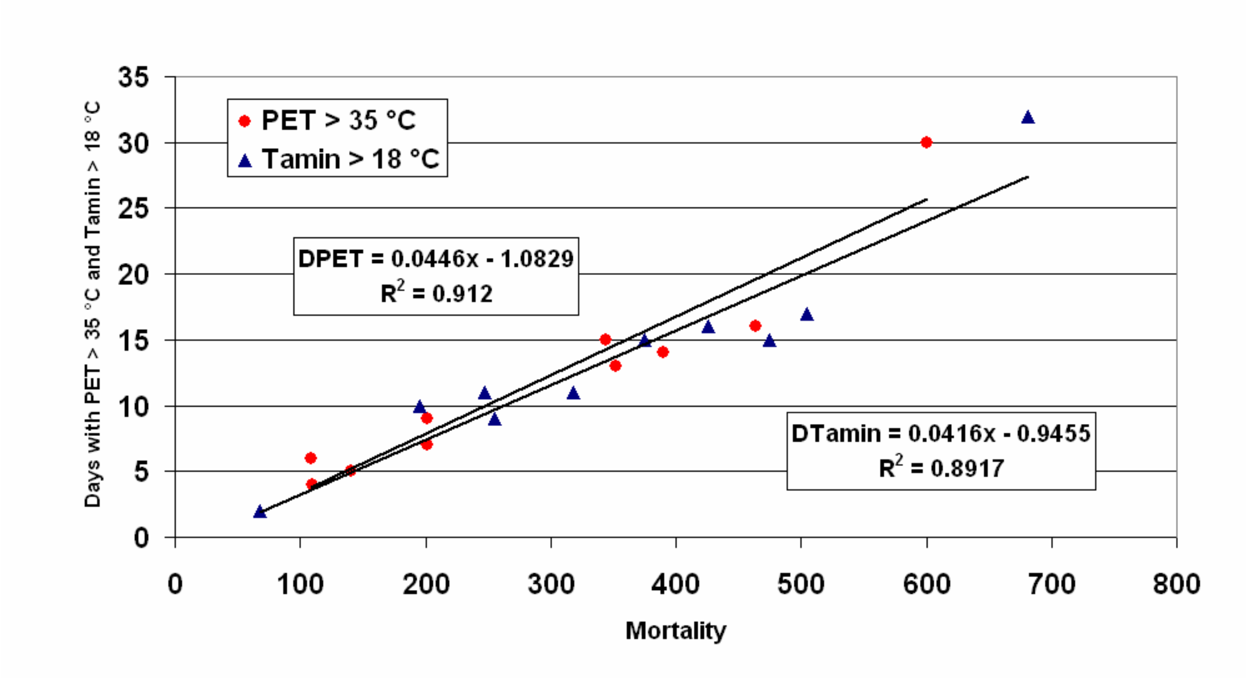

Fig. 5: Correlation between PET > 35 °C and Tamin > 18 °C and Mortality in Vienna (1996-2005)

Fig. 5: Korrelation zwischen PET > 35 °C und Tamin > 18 °C und Mortalität in Wien (1996-2005)

4 Conclusions

From this preliminary study it can be extracted that the selected two parameters PET for the noon and Tamin for the night conditions show that there is a clear picture between heat related mortality and the selected conditions.

Further steps are to include also air pollution conditions in the analysis and to look also on the complete mortality figures not only related to heart and cardiovascular diseases and general mortality data.

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