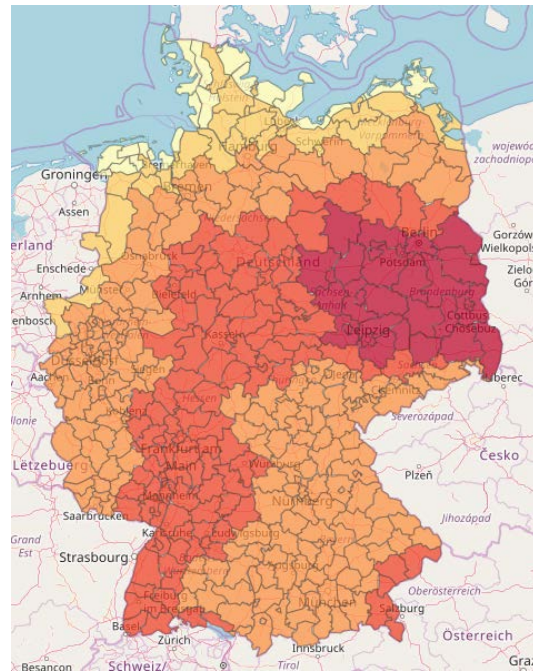


# Regional Perspectives of Heat Risks: Europe



**Andreas Matzarakis**

Research Center Human Biometeorology, DWD, Freiburg



# Heat waves

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- 80s, Portugal (1981), Italy, Greece (1987, 4.000 deaths)
- 90s, north of the Alps (1993, discussion more about Ozon)
- Summer 2003, (more than 60.000)
  - 2003, 2006, 2010 (Russia), 2015, 2018
- 2003, booster for the HHWS in Europe

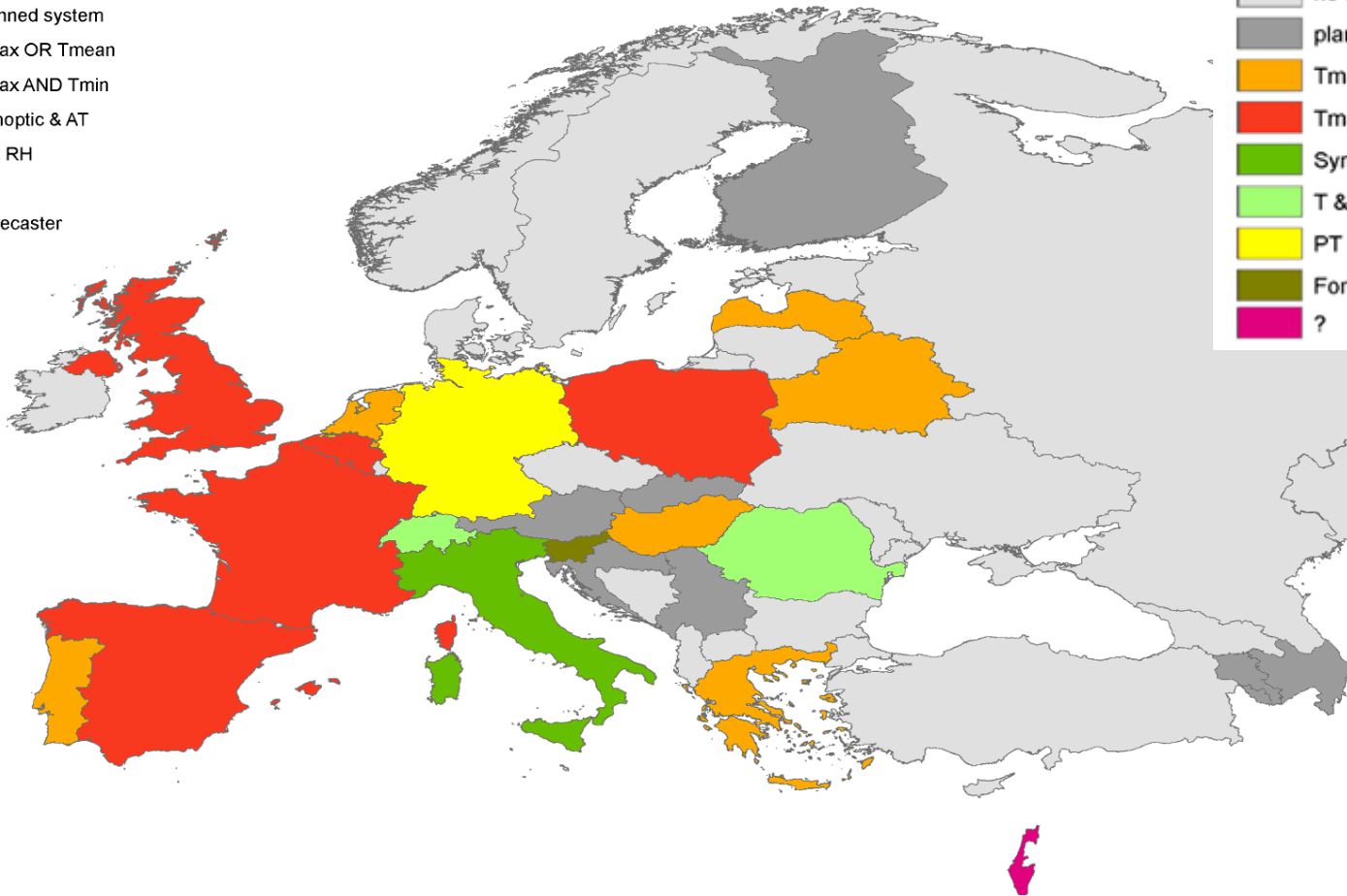


### Legend

- no system
- planned system
- Tmax OR Tmean
- Tmax AND Tmin
- Synoptic & AT
- T & RH
- PT
- Forecaster
- ?

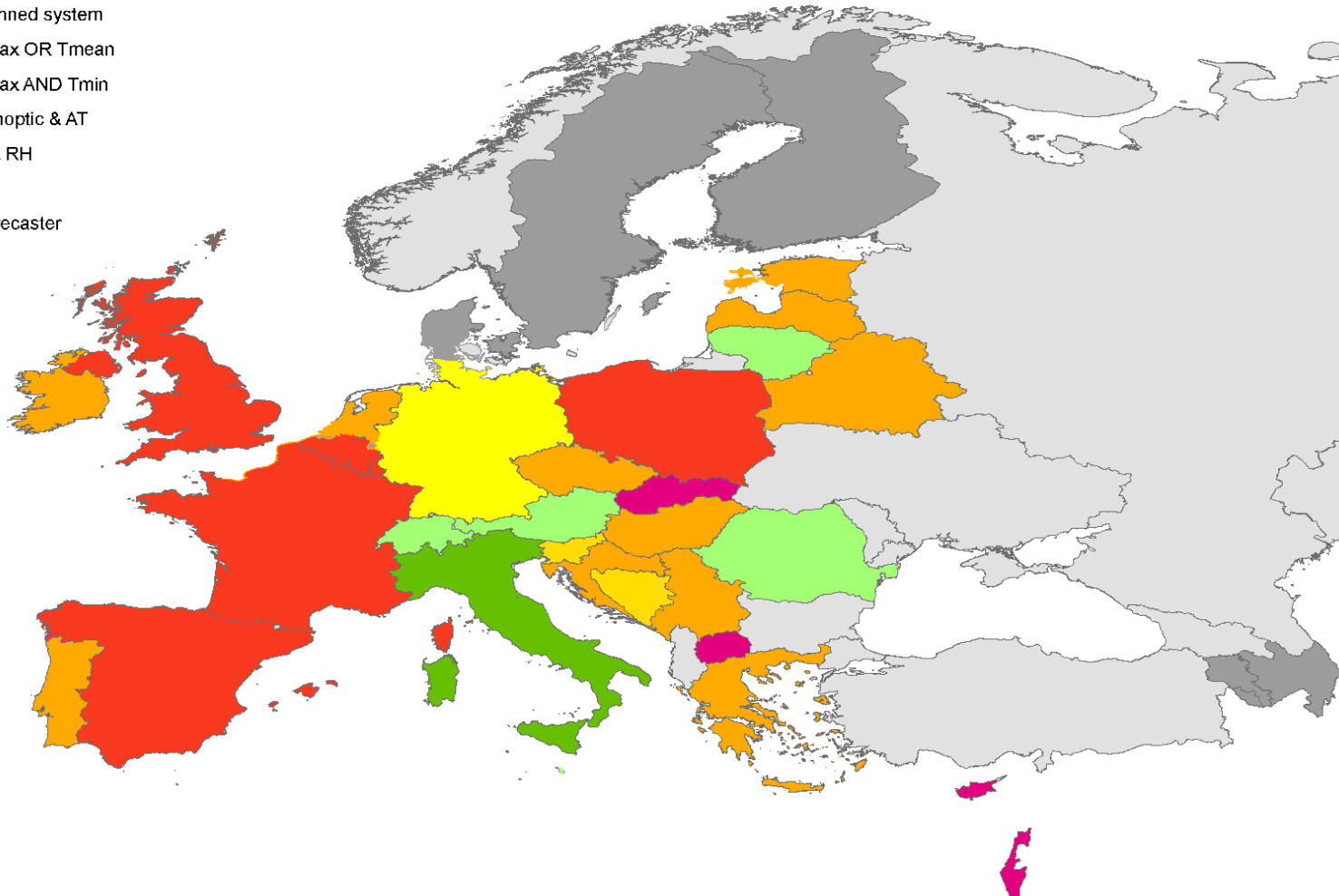
### Legend

- no system
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- Tmax OR Tmean
- Tmax AND Tmin
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- Forecaster
- ?

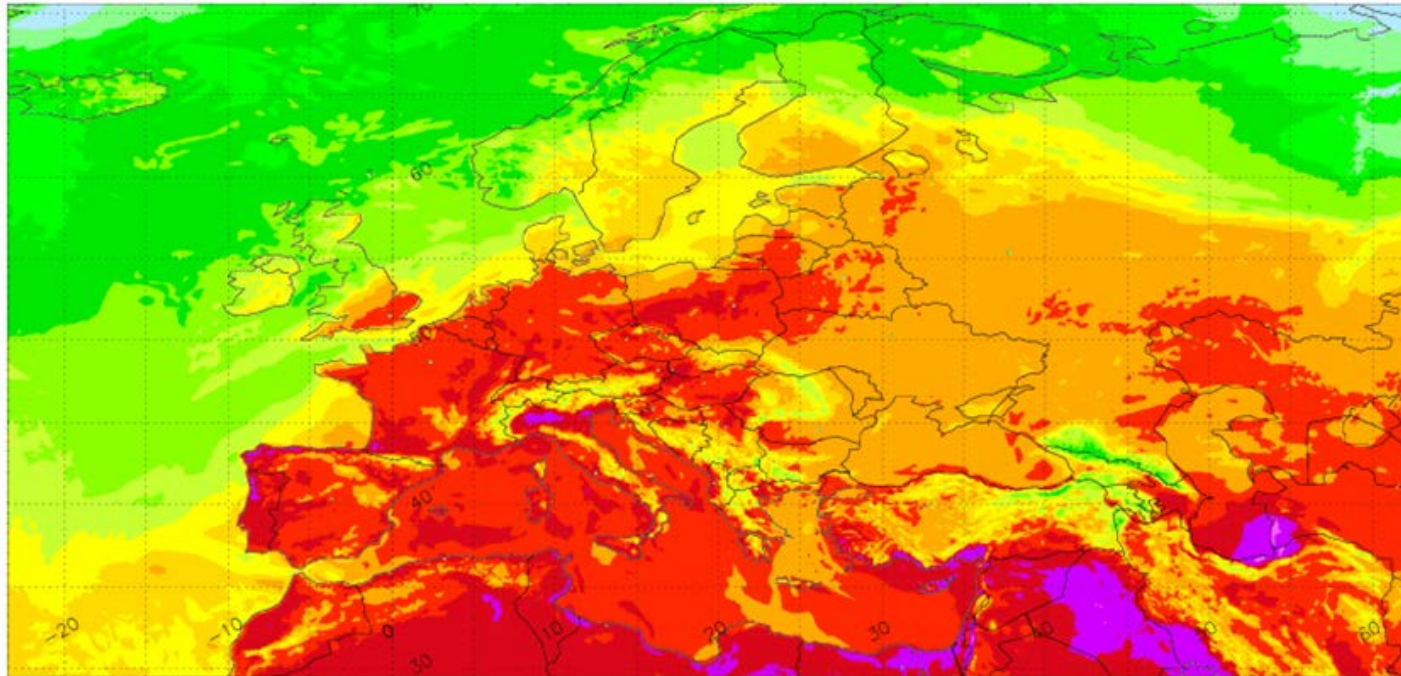


## Legend

- no system
- planned system
- Tmax OR Tmean
- Tmax AND Tmin
- Synoptic & AT
- T & RH
- PT
- Forecaster
- ?



# Perceived Temperature



Gefühlte Temperatur



Forecast Perceived Temperature, 03.08.18 13 MEZ (DWD)

## Forecasts

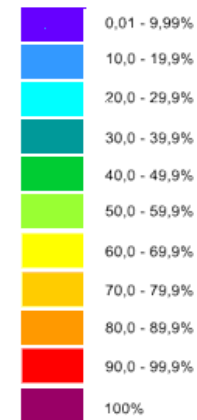
Issued  
13. Dec 2018

For  
13. Dec 2018

Issued: 13.12.2018 For: 13.12.2018



### heat-wave probability

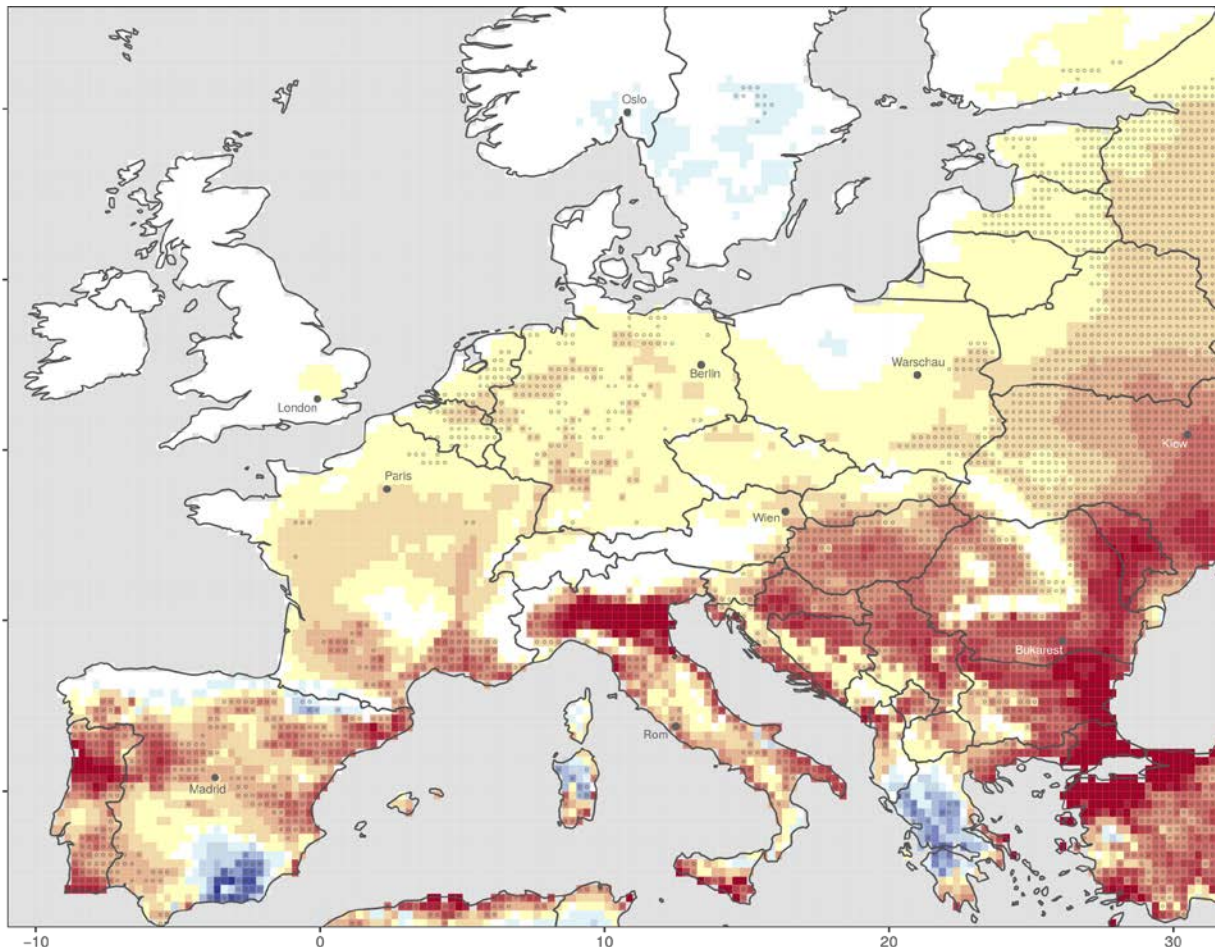


The probabilities for a heat-wave are calculated based on 51 different forecasts (50 ensemble forecasts and 1 control run) with slightly different initial conditions for each point. Especially for longer lead times heat-wave probabilities of 30% and more indicate that there might be an upcoming heat-event. The heat-wave probabilities displayed on the map are mean probabilities for a region. They can differ significantly within a region. The flyer: "[How to use the medium range heat information tool](#)" contains further information. Please note that the medium-range heat information does not substitute national heat-warnings, but complements the national warning system with medium-range heat forecasts.





# Days (5) with $T_{a,max} \geq 30 \text{ }^\circ\text{C}$

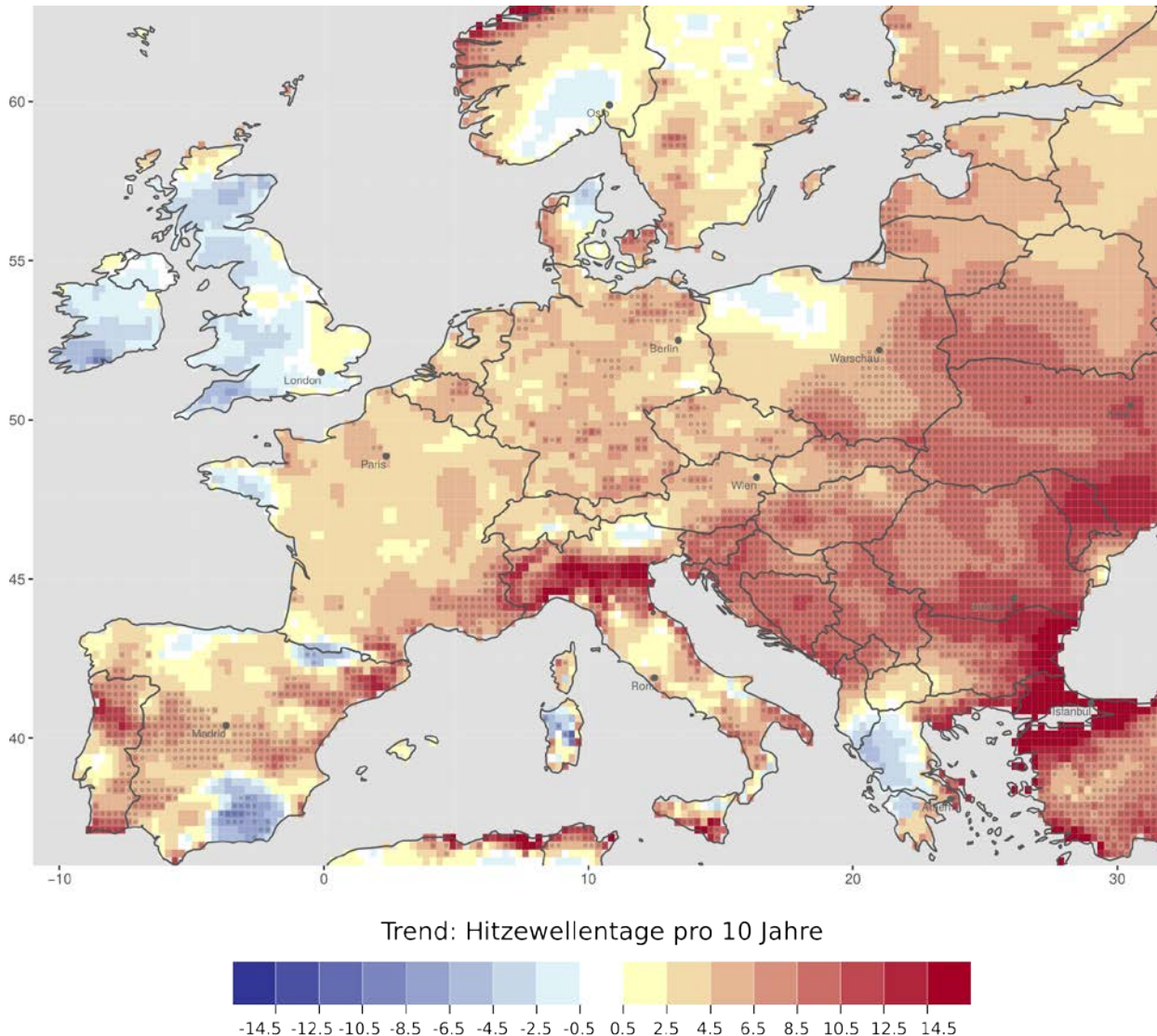


***Trend of absolute ABS  
Heat wave days***

Trend: Hitzewellentage pro 10 Jahre



# Days (5) with $T_{a,max}$ 95 perz.



***Trend of amount  
Heat wave days***

*Period: 1981-2010  
Basis of E-OBS*

*Daily maximum  $T_a$*

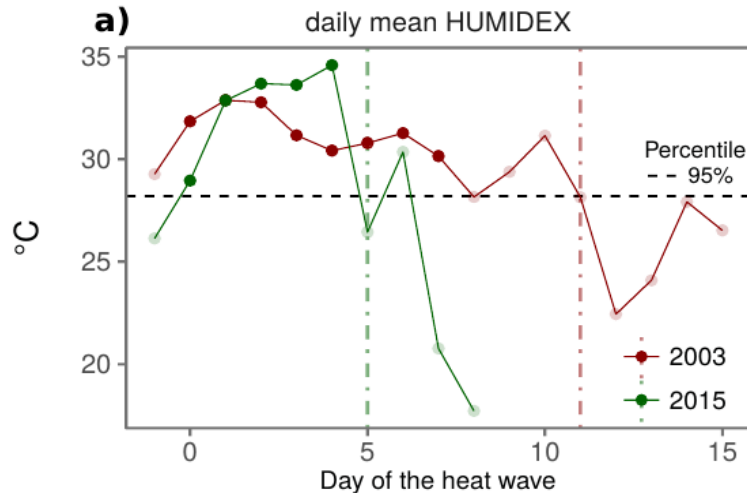




Ευχαριστώ πολύ



Thank you very much



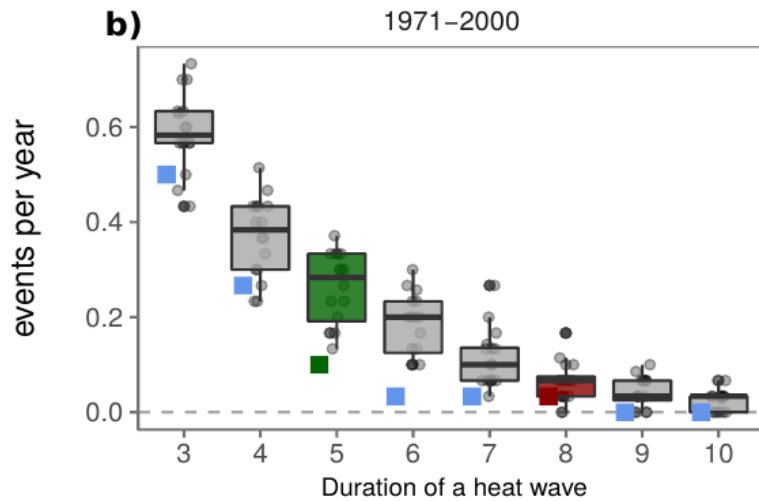
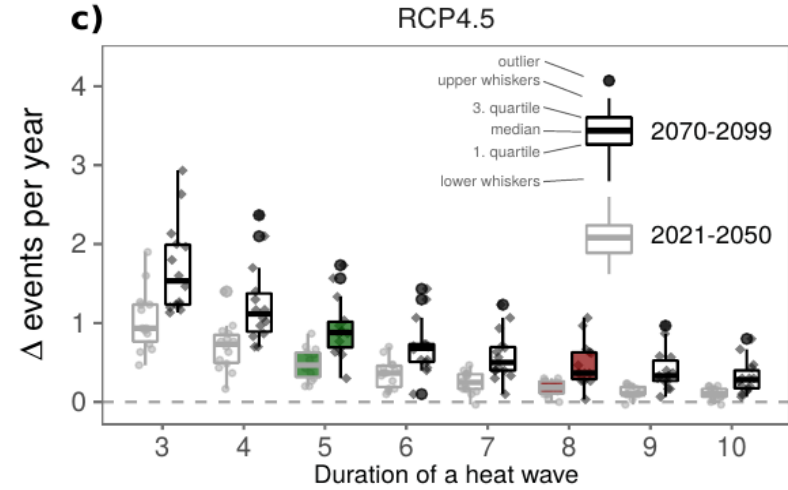
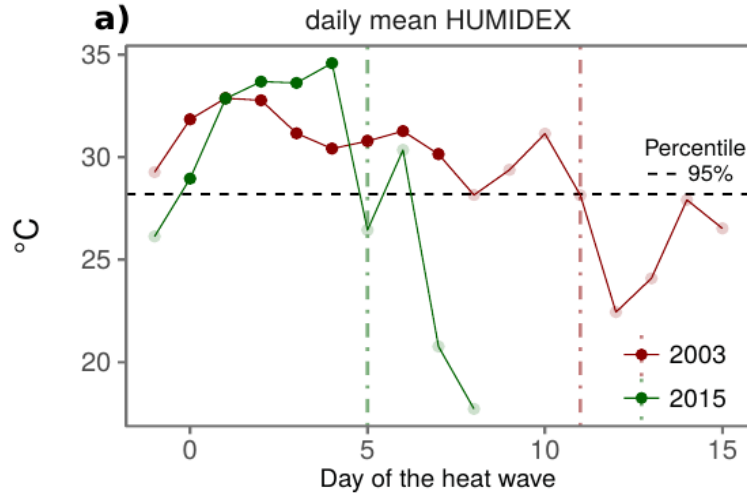
Heatwaves 2003/2015 based on HUMIDEX.

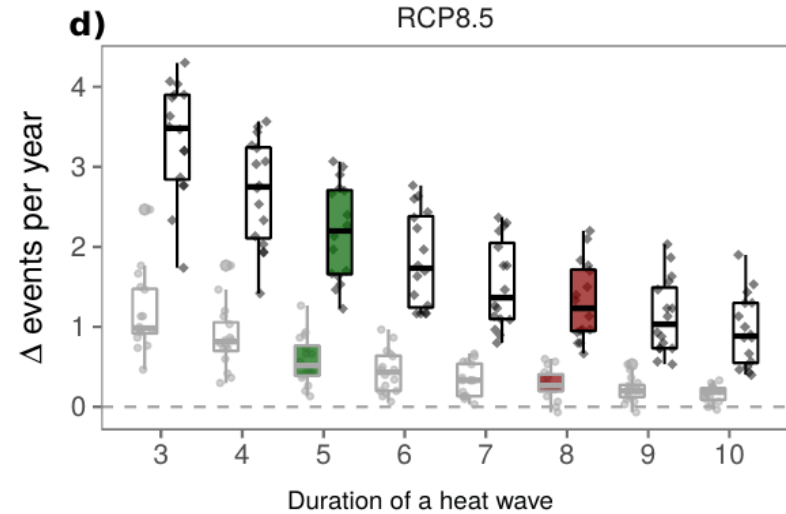
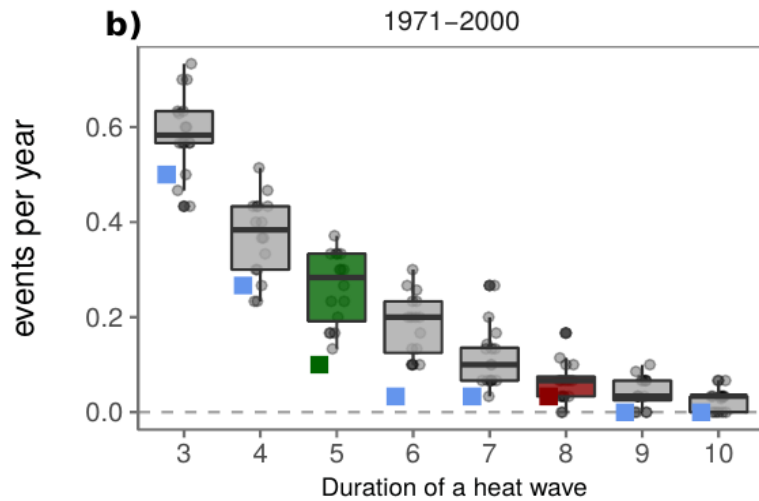
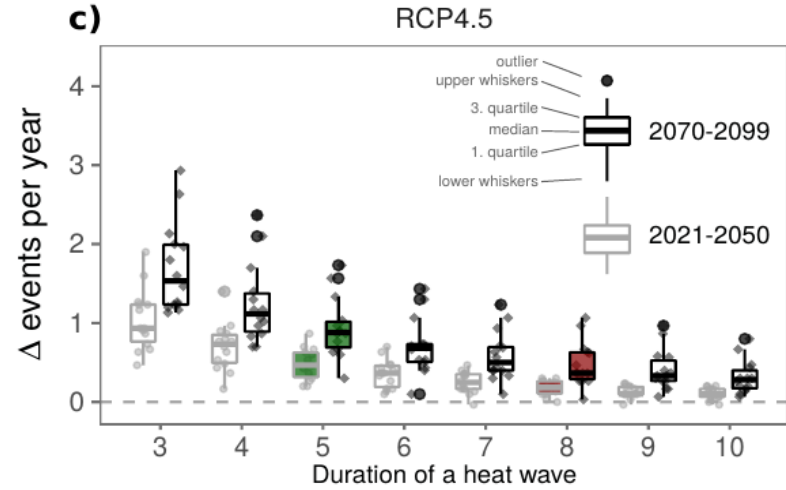
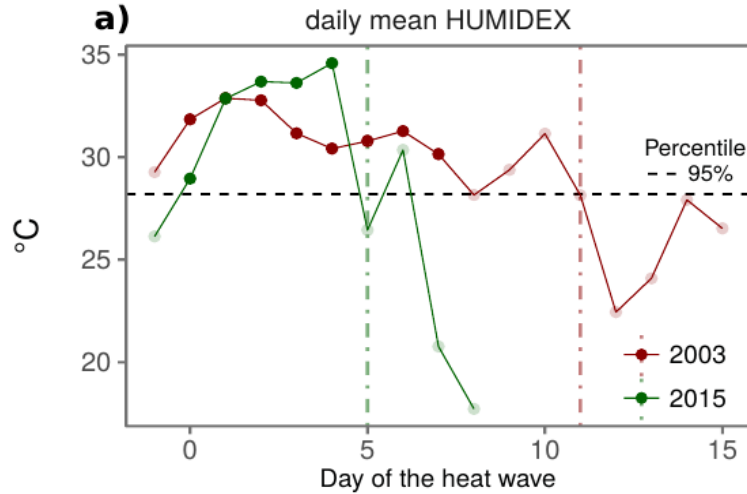
2003: 8 days > 95. Perzentil

2015: 5 days > 95. Perzentil

Evaluation der Regionalmodelle für Hitzewellen von 3 bis 10 Tagen und den Zeitraum 1971-2000.

Modelle überschätzen längere Hitzewellen.



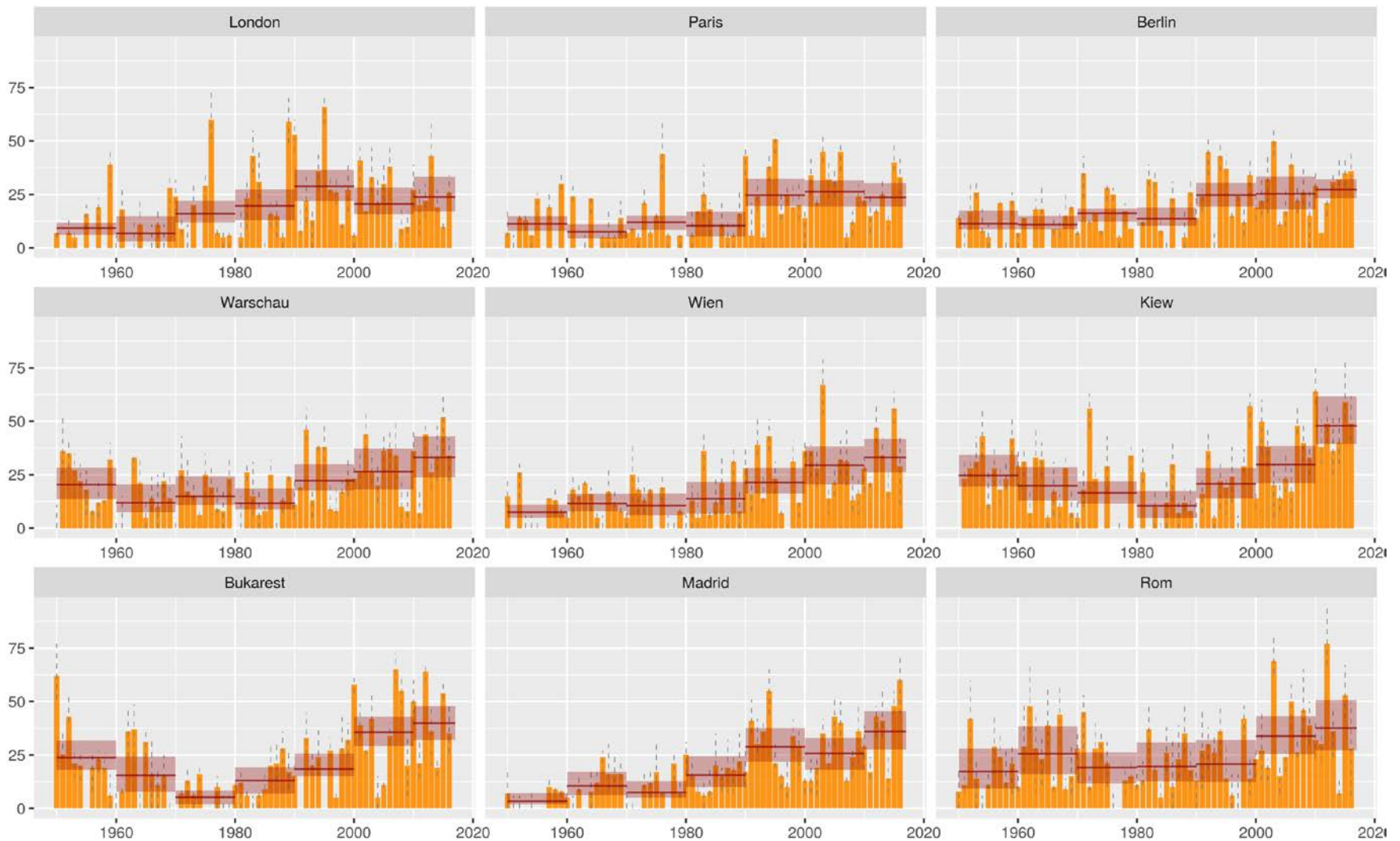




## Days (5) with $T_{a,max} \geq 30^\circ\text{C}$



# Days (5) with $T_{a,max}$ 95 perz.



# Definition Heat Waves

Country	Institution	Definition
Belgium	KMI	Min. 5 consecutive days $T_{\max} \geq 25 \text{ °C}$ and min 3d ays $T_{\max} \geq 30 \text{ °C}$
Denmark	DMI	Mean $T_{\max} > 28 \text{ °C}$ for 3 consecutive days
Germany	DWD	Estimation of thresholds for single days based on 98. Percentile from $T_{\max}$ of climate normal  Min. 3 consecutive days $\geq$ threshold and $T_{\max} \geq 28 \text{ °C}$
UK	Met Office	Higher of mean daily chen $T_a$ from reference period 1961-1990 of $5 \text{ °C}$ for more than 5 consecutive days
The Netherlands	KNMI	Min. 5 consecutive day $T_{\max} \geq 25 \text{ °C}$ (summer day) with min. 3 days $T_{\max} \geq 30 \text{ °C}$ (Tropical day)
Austria	ZAMG	Min. 3 consecutive days $T_{\max} > 30 \text{ °C}$ , max. one interruption of $T_{\max}$ between 25 and $30 \text{ °C}$ and mean $T_{\max}$ in the period $> 30 \text{ °C}$
Swiss	Meteo Swiss	Estimation of heat index (combination $T_a$ and RH)  Threshold of 3 or five days
Spain	AEMET	Min. 3 consecutive days, $T_{\max}$ at min. 10% of the stations higher than 95%-percentile, from a row of daily $T_{\max}$ in the months Juli and August with the reference period 1971-2000







# Heat Wave Definitions

Heat wave (HW) definitions applied T indices calculated for each HW definition on an annual basis (after Fischer and Schär (2010) and Perkins et al. (2012), modified)

Table 1: Heat wave (HW) definitions applied.  $T_{max}$ : daily maximum air temperature (T),  $T_{min}$ : daily minimum T,  $T_{mean}$ : daily mean T, perc.: percentile. Corresponding percentiles and T values of the year-round T distribution at site Potsdam during the reference period (RP) 1961-1990 are displayed for comparison.

Definition	Variable	Minimum duration (d)	Type and value of threshold (at Potsdam)	Reference for threshold calculation	Specifics	Reference
HW01	$T_{max}$	6	Dynamic; 90th perc.	calendar day with 5-day window in RP		'Warm Spell Duration Index' (WSDI), <a href="http://etccdi.pacificclimate.org/list_27_indices.shtml">http://etccdi.pacificclimate.org/list_27_indices.shtml</a> , e.g. Alexander et al. (2006)
HW02	$T_{max}$	6	Dynamic; > calendar-day mean +5 K	calendar-day mean in RP		'Heat wave duration index' (HWDI), Frich et al. (2002)
HW03	$T_{max}$	3	Static; $T_1$ : 30 °C (= 97.7th perc.), $T_2$ : 25 °C (= 89.6th perc.)		Three criteria to be met: (i) $T_{max} \geq T_1$ (at least 3 days) (ii) mean $T_{max} \geq T_1$ (iii) $T_{max} \geq T_2$	Huth et al. (2000)
HW04	$T_{max}$	3	Static; $T_1$ : 97.5th perc. (= 29.7 °C),	year-round distribution in RP	Three criteria to be met: (i) $T_{max} \geq T_1$ (at least 3 days)	Meehl and Tebaldi (2004), based on Huth et al. (2000)

# Heat Wave, Definitions

Table 1: Heat wave (HW) definitions applied.  $T_{max}$ : daily maximum air temperature (T),  $T_{min}$ : daily minimum T,  $T_{mean}$ : daily mean T, perc.: percentile. Corresponding percentiles and T values of the year-round T distribution at site Potsdam during the reference period (RP) 1961-1990 are displayed for comparison.

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HW01	$T_{max}$	6	Dynamic; 90th perc.	calendar day with 5-day window in RP		'Warm Spell Duration Index' (WSDI), <a href="http://etccdi.pacificclimate.org/list_27_indices.shtml">http://etccdi.pacificclimate.org/list_27_indices.shtml</a> , e.g. Alexander et al. (2006)
HW02	$T_{max}$	6	Dynamic; > mean +5 K	calendar-day mean in RP		'Heat wave duration index' (HWDI), Frich et al. (2002)
HW03	$T_{max}$	3	Static; $T_1$ : 30 °C (= 97.7th perc.), $T_2$ : 25 °C (= 89.6th perc.)		Three criteria to be met: (i) $T_{max} \geq T_1$ (at least 3 days) (ii) mean $T_{max} \geq T_1$ (iii) $T_{max} \geq T_2$	Huth et al. (2000)
HW04	$T_{max}$	3	Static; $T_1$ : 97.5th perc. (= 29.7 °C), $T_2$ : 81st perc. (= 22.0 °C)	year-round distribution in RP	Three criteria to be met: (i) $T_{max} \geq T_1$ (at least 3 days) (ii) mean $T_{max} \geq T_1$ (iii) $T_{max} \geq T_2$	Meehl and Tebaldi (2004), based on Huth et al. (2000)



# Heat Wave, Definitions

Table 1: Heat wave (HW) definitions applied.  $T_{max}$ : daily maximum air temperature (T),  $T_{min}$ : daily minimum T,  $T_{mean}$ : daily mean T, perc.: percentile. Corresponding percentiles and T values of the year-round T distribution at site Potsdam during the reference period (RP) 1961-1990 are displayed for comparison.

Definition	Variable	Minimum	Type and value of	Reference for	Specifics	Reference
		duration (d)	threshold (at Potsdam)	threshold calculation		
HW05	$T_{max}$	3	Dynamic; 90th perc.	calendar day with		Russo et al. (2014, 2015)
				31-day window in RP		
HW06	$T_{min}$	3	Dynamic; 90th perc.	calendar day with		Russo et al. (2014, 2015)
				31-day window in RP		
HW07	$T_{mean}$	3	Static; 95th perc. (= 20.8 °C)	year-round distribution in RP	based on two sub-indices, cf. section 2.2.3.	'Excess heat factor' (EHF), Nairn et al. (2009), Nairn and Fawcett (2015)
HW08	$T_{mean}$	3	Dynamic; 90th perc.	calendar day with 15-day window in RP	based on two sub-indices, cf. section 2.2.3.	modified 'Excess heat factor' (EHF), Alexander and Herold (2016)
HW09	$T_{mean}$	3	Static; 21.0 °C (= 95.3th perc.)		study-region specific threshold based on heat- mortality relationship	Scherer et al. (2013)
HW10	$T_{mean}$	3	Static; 23.0 °C (= 98.0th perc.)		study-region specific threshold based on heat- mortality relationship	Scherer et al. (2013)



# Heat Wave, Definitions

Heat Wave (HW) indices calculated for each HW definition on an annual basis (after Fischer and Schär (2010) and Perkins et al. (2012), modified)

Index	Name	Definition	Units
HWN	HW number	Number of HWs per year	/a
HWF	HW frequency	Humber of all days that belong to HWs per year	d/a
HWD <sub>mea</sub> n	HW duration	Mean HW duration in each year (not defined in years without HWs)	d
HWD <sub>max</sub>	HW maximum duration	Duration of longest HW in each year (not defined in years without HWs)	d

