Supplementary Material to

"Scaling and trends of hourly precipitation extremes in two different climate zones - Hong Kong and The Netherlands"

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***a*. Distributions of hourly precipitation from the binned data .**

Here, we show two examples of the distribution of hourly precipitation from the data binned according to the dew point temperature from 4 hours before each observation. Bins are two degrees wide, and the probability of exceedance of hourly precipitation is plotted for a selection of bins.

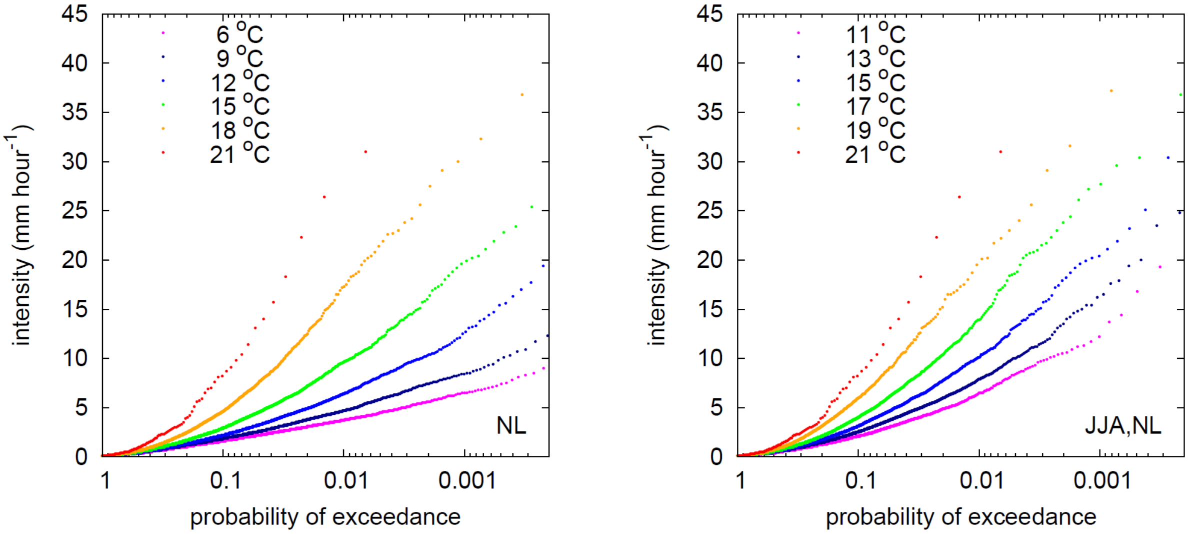

Figure A1. Probability of exceedance of hourly precipitation in a selection of dew point temperature bins. Bins are two degrees wide, and the central value is indicated in the plot. Results are for NL; left observations from the whole year, right observations from only summer months JJA. Only each third point of the distributions is plotted to show the density of the observations better.

***b*. Dependencies of precipitation intensity on dew point temperature inferred from long term variations.**

From the time series plotted in Figure 2 in the main text we computed a regression of ΔPr_h on ΔT_d^*. For the data from De Bilt, this gave 11 % per degree for the period May to October ((MJJASO), and for June to August (JJA) the dependency is even 13 % per degree (Table 1, first column). In particular for summer this is close to the value of 14 % per degree expected from the scaling relations. The relation between ΔPr_h and ΔT_d^* is not only caused by the positive trend over time in both ΔPr_h and ΔT_d^*. After detrending the time series for the linear trend over 1906 to 2010, similar regression coefficients are found (Table 1, second column).

Since we use overlapping periods, the data points in Figure 2 (main text) are clearly not independent, and therefore error estimates cannot simply be deduced from the fit. Therefore, we also computed regression coefficients and the linear trends from non-overlapping 15-year periods, that is, from 1906-1920, 1921-1935 etc. Error estimates are obtained from bootstrapping 15 years out of each 15-year period, and re-computing all statistics from these bootstrap samples. (By re-sampling in this way, the consistency between precipitation and dew point temperature is retained.) Similar regression coefficients are found; that is, 10 and 13 % per degree for MJJASO and JJA, respectively. The uncertainty in these estimates, however, is also substantial since there are only seven independent 15-year periods, and a dependency of 7 % per degree is (just) within the 80% uncertainty range.

De Bilt (DB), The Netherlands					
	r_c % °C $^{-1}$	**r_c (detr)** % °C $^{-1}$	**r_c (15y)** % °C $^{-1}$	**Trend Pr_h(15y)** % (100y)$^{-1}$	**Trend T_{dew}(15y)** °C (100y)$^{-1}$
MJJASO	**11**	**11**	**10±4**	12±8	1.2±0.3
JJA	**13**	**14**	**13±6**	15±11	1.4±0.4
NDJFMA	7	3	7±2	17±5	1.8±0.3
Hong Kong Observatory (HKO), China					
MJJAS	23	-15	16±10	13±6	0.7±0.1
JJA	23	-44	18±10	17±7	0.7±0.1
O-FMA	**16**	**13**	**13±5**	20±11	1.4±0.4

Table 1. Regression coefficients (r_c) of extreme hourly precipitation on dew point temperature computed from all 15-years overlapping periods, (detr) after detrending for the linear trend with time, and (15y) from independent, non-overlapping 15-periods. Linear trends from non-overlapping 15-year periods in extreme precipitation and dew point temperature are given in right-most column. Errors are the 80% uncertainty range estimated from 500 bootstrap samples. Shown in bold are regression coefficient for which all three estimates (r_c, r_c(detr), and r_c(15y)) are larger than 10 % per degree.

For HKO only the period O-FMA shows consistent results, with the best estimates of the regression coefficients of 13-16 % per degree. For the wet season (JJA and MJJAS) the three estimates are rather different. In particular, after detrending for the mean trend over the last century even negative regression coefficients are found, indicating that there is no correspondence between variation in ΔT_d^* and ΔPr_h on an inter-decadal time scale.

c. Comparison trends in absolute and relative percentiles

Here we show the time evolution of the separate percentiles for DB and HKO. We also compare relative percentiles to absolute percentiles. The absolute percentiles are the 99.5th, 99.9th and 99.95th percentiles, which with a frequency of occurrence of approximately 10% roughly correspond to similar events as the relative percentiles. For DB differences between the absolute and relative percentiles are very small, and also the different percentiles give very similar results. The same also applies when the percentiles are computed directly from the data, instead of from the GPD fit to the data. In that case, there is more noise in the separate percentiles.

For HKO in O-FMA the frequency of occurrence of wet events is ~5% lower, this is substantially lower that in the wet season (MJJAS). The time evolution of the absolute and relative percentiles show similar variations, but the amplitude of the variations is larger with the absolute percentiles. Variations in the frequency of wet events are therefore likely to contribute to the enhanced variability of the absolute percentiles. This suggests that atmospheric circulation changes may play a role in explaining the variations in hourly precipitation extremes (as obtained from the absolute percentiles) in the dry season (O-FMA) in HKO.

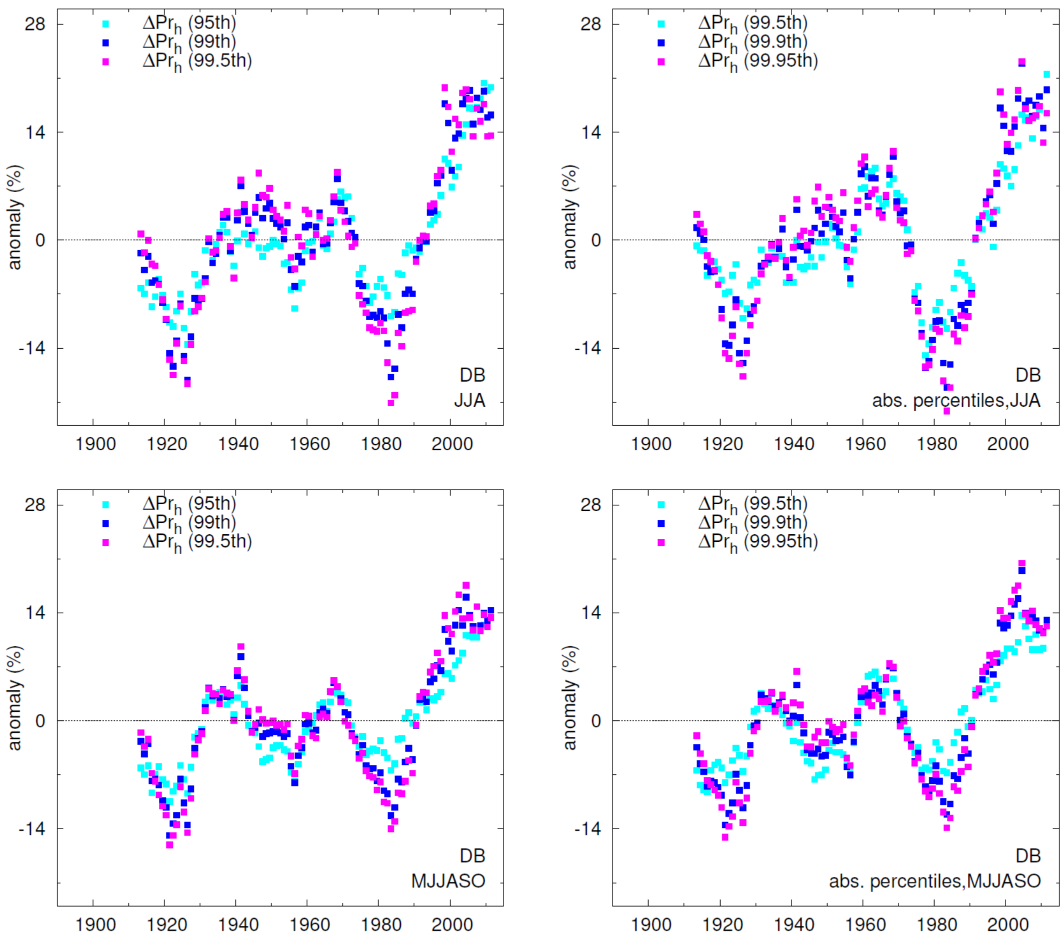

Figure A2. Anomalies of different percentiles computed from 15-year periods; left: percentiles of only wet events (95th, 99th, and 99.5th); right: percentiles of all events (99.5th, 99.9th and 99.95th). The number of wet events is approximately 10 %, so that the same colors in the left and right figures correspond to the similar events. Shown are results for De Bilt (DB) for June, July and August (JJA) and the period May to October (MJJASO).

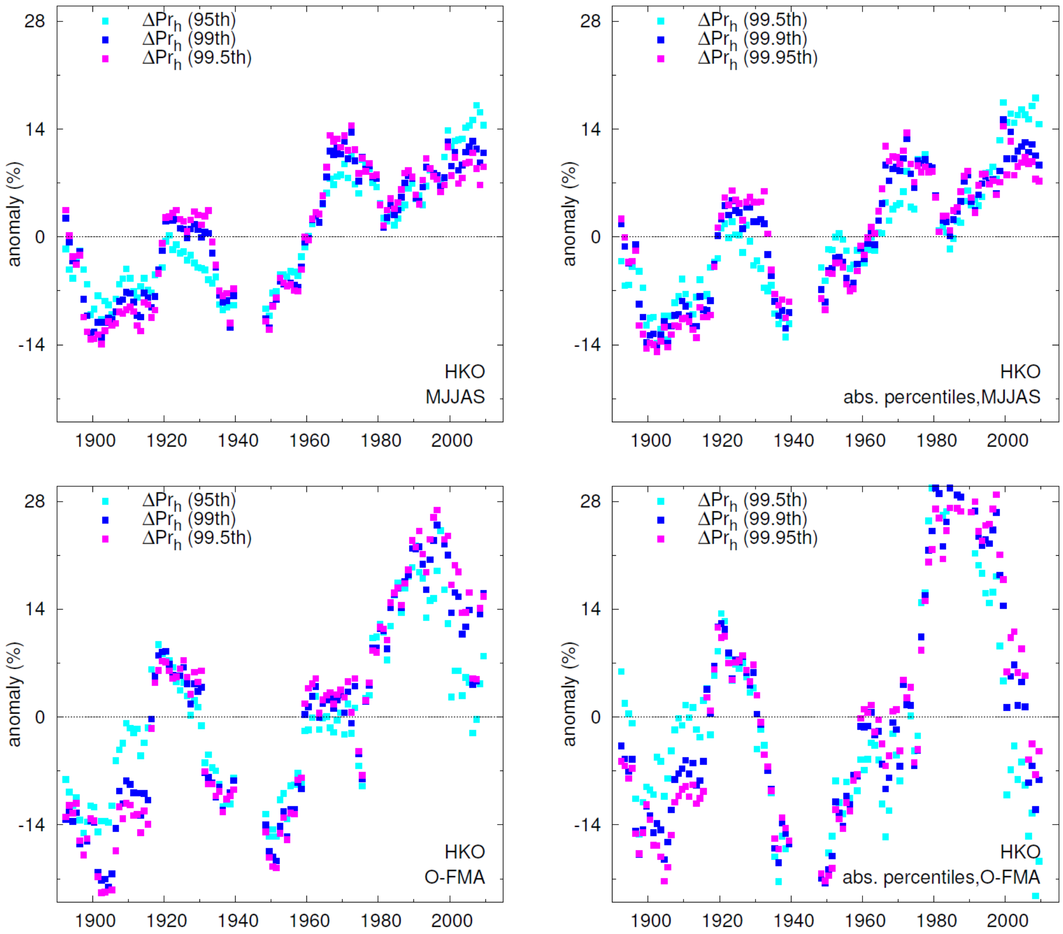

Figure A3. As Figure A2, but now for data from the Hong Kong Observatory (HKO) and period May to September (MJJAS), and the months October, February, March and April (O-FMA).

d. Time evolution of the temperature and dew point temperature

Here we show the time evolution of the time evolution of the mean temperature and the mean dew point temperature, in concert with the time evolution of the dew point temperature on days with heavy rain (as used in the main paper).

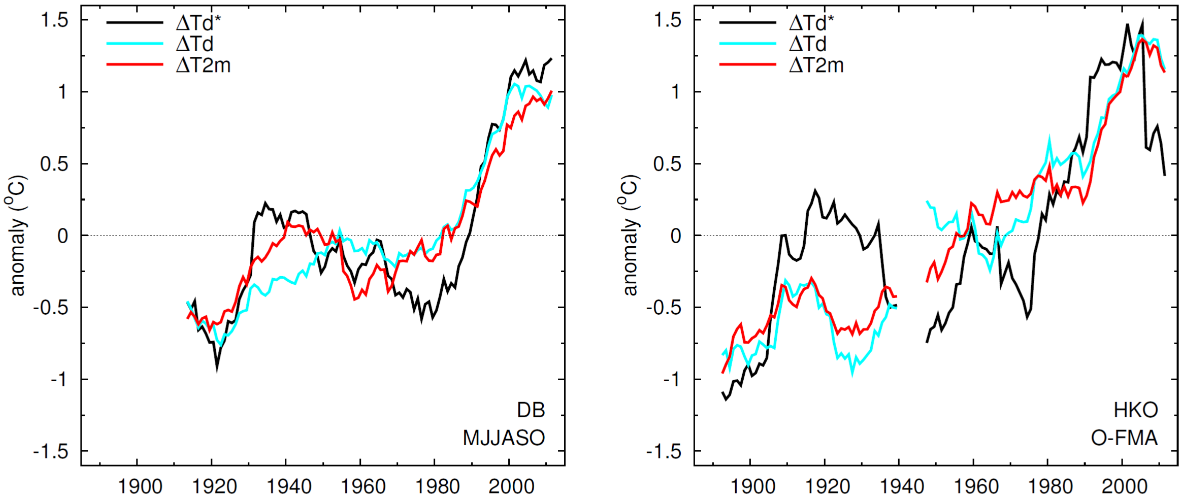

Figure A4. Time evolution of anomalies in the mean temperature (ΔT2m), mean dew point temperature (ΔT_d), and mean dew point temperature (ΔT_d*) on days with heavy rain for De Bilt in the summer halve year (MJJASO) and HKO in the dry season (O-FMA).