



Supplement of

Role of mean and variability change in changes in European annual and seasonal extreme precipitation events

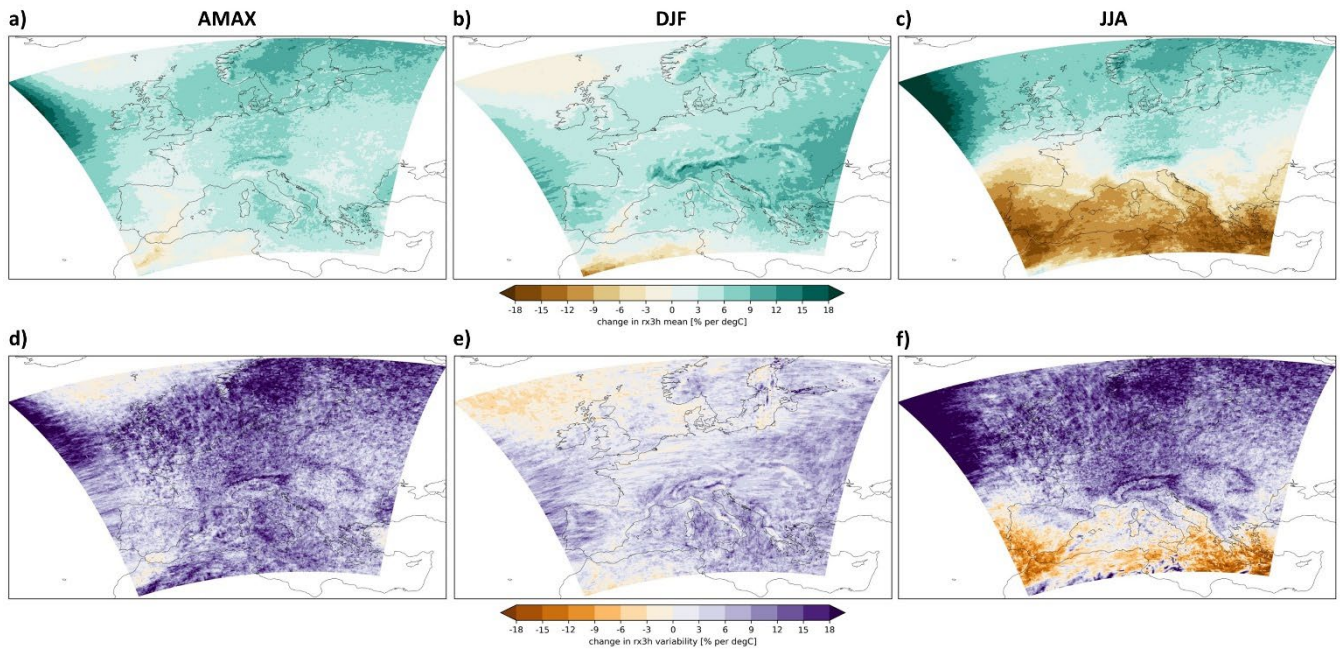
Raul R. Wood

Correspondence to: Raul R. Wood (raul.wood@lmu.de)

The copyright of individual parts of the supplement might differ from the article licence.

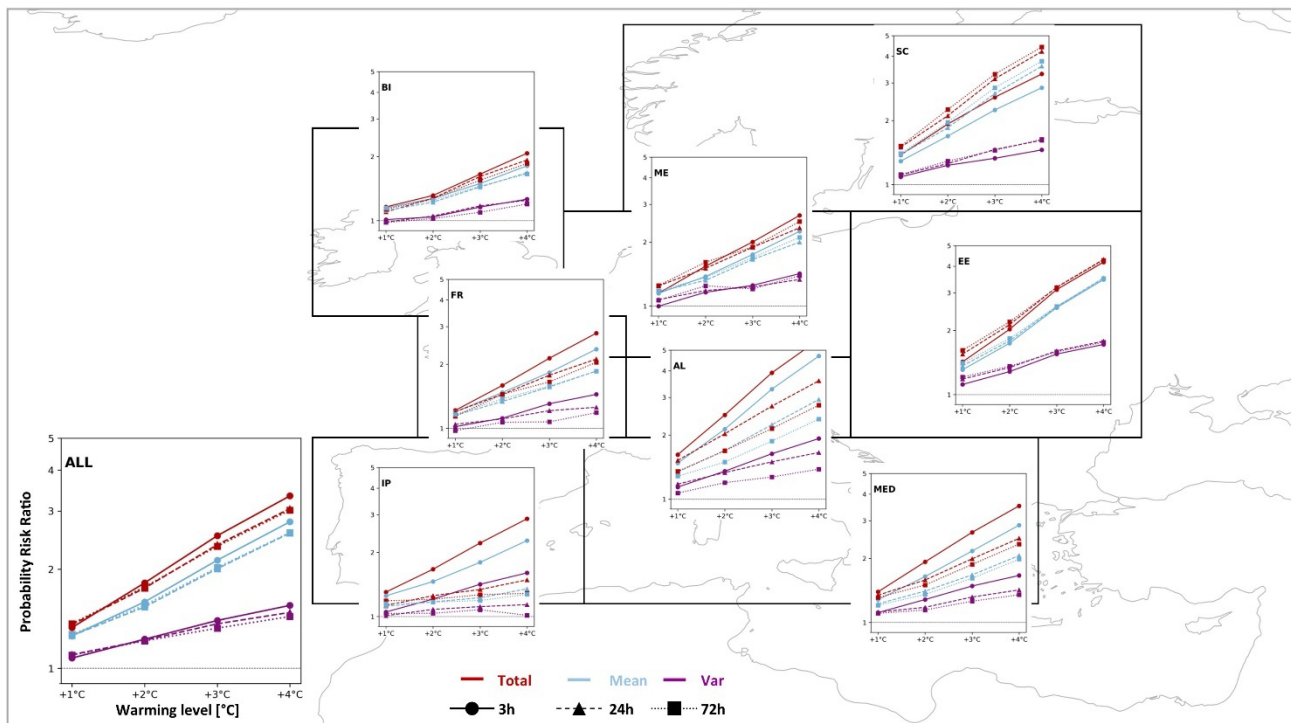
List of supplementary figures

- Figure S1: Forced response of annual and seasonal (DJF, JJA) mean and variability of rx3h at +4 °C warming compared to a pre-industrial climate.
- 5 Figure S2: Comparison of regional probability risk ratios in winter (DJF) from different temporal aggregations (3h, 24h, and 72h).
- Figure S3: Comparison of regional ratios of contribution in winter (DJF) from different temporal aggregations (3h, 24h, and 72h).
- Figure S4: Comparison of regional probability risk ratios in summer (JJA) from different temporal aggregations (3h, 24h, and 72h).
- 10 Figure S5: Comparison of regional ratios of contribution in summer (JJA) from different temporal aggregations (3h, 24h, and 72h).
- Figure S6: Comparison of regional ratios of contribution from different levels of extremeness (2-sigma vs. 3-sigma) for annual rx3h events.
- Figure S7: Comparison of regional ratios of contribution from different levels of extremeness (2-sigma vs. 3-sigma) for rx3h events in winter (DJF).
- 15 Figure S8: Comparison of regional ratios of contribution from different levels of extremeness (2-sigma vs. 3-sigma) for rx3h events in summer (DJF).
- Figure S9: Comparison of regional ratios of contribution from different levels of extremeness (2-sigma vs. 3-sigma) for annual rx24h events.
- 20 Figure S10: Comparison of regional ratios of contribution from different levels of extremeness (2-sigma vs. 3-sigma) for annual rx72h events.



25

Figure S1: Forced response of annual and seasonal (DJF, JJA) mean and variability of rx3h at +4 °C warming compared to a pre-industrial climate. a) – c) Forced changes in the mean rx3h; d) – e) Changes in the variability of rx3h (i.e., standard-deviation); left column: Annual, centre column: Winter (DJF), and right column: Summer (JJA).



30

Figure S2: Regional probability risk ratios for different temporal aggregation levels (3h, 24h, 72h) in winter (DJF). The panels show PR_{total} (red), PR_{mean} (blue), and PR_{var} (purple) values (y-axis) at warming levels (+1, +2, +3, +4 °C) (x-axis). The solid lines with the circle marker represent PR-values for 3-hour temporal aggregation; the dashed lines with the triangle marker represent PR-values for 24-hours; the dotted lines with the square marker represent PR-values for 72-hours. The lower left panel shows the aggregation over all land grid cells and shows axis labels.

35

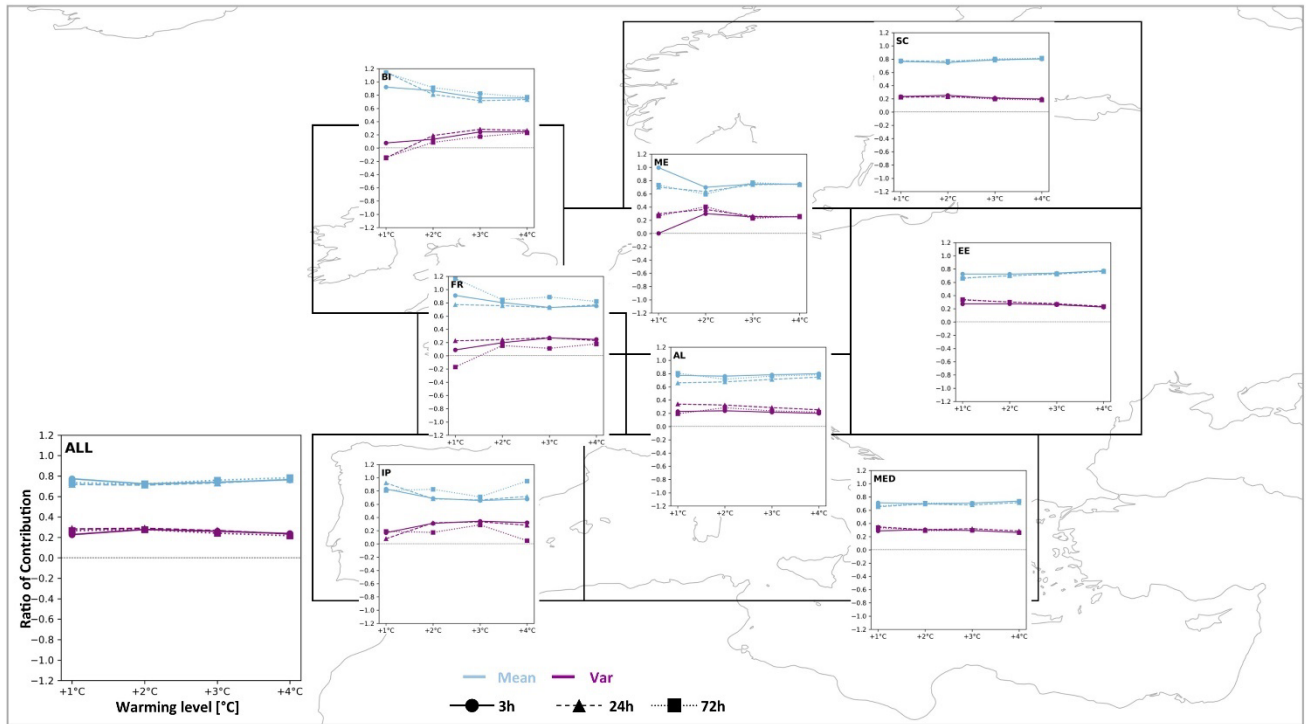
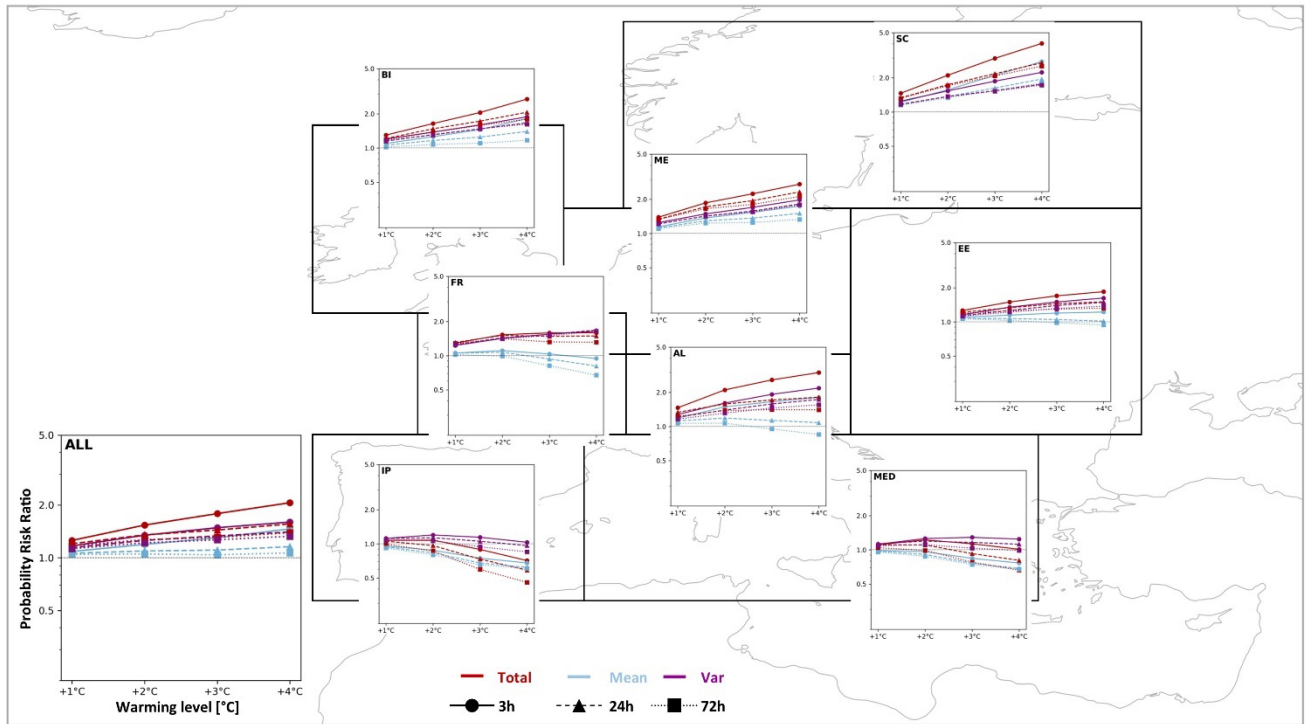
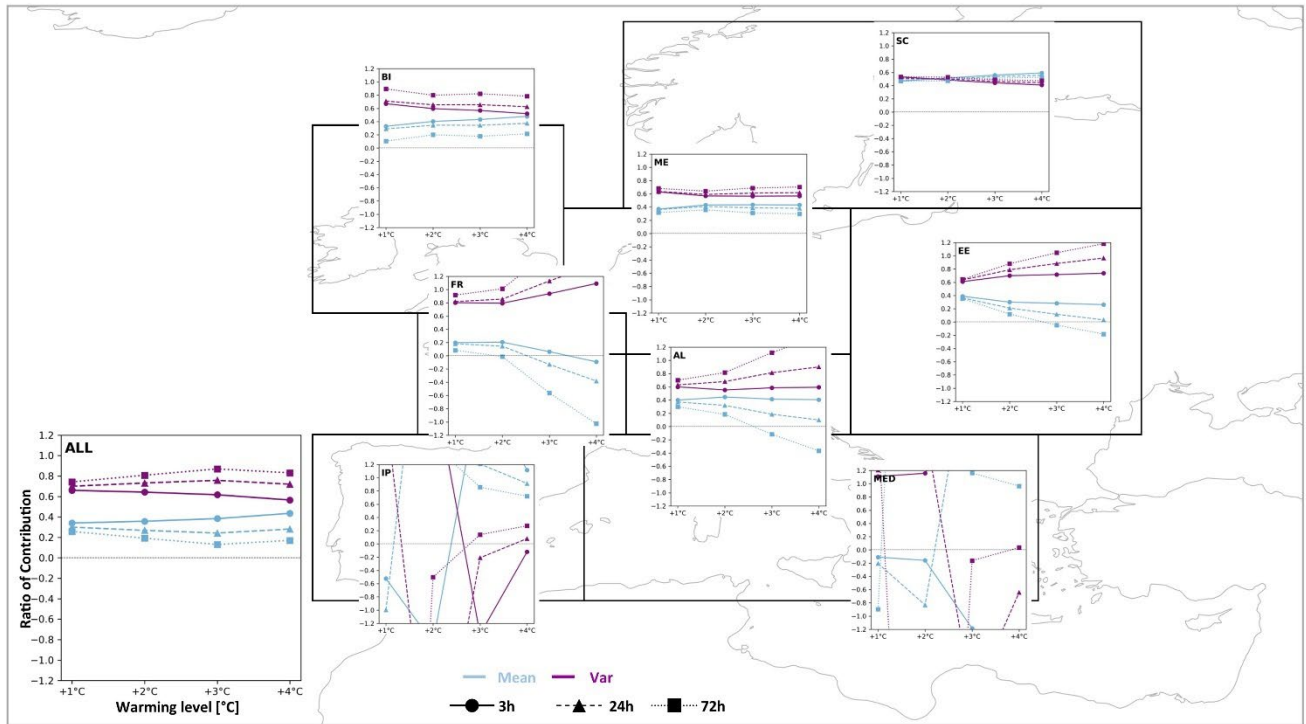


Figure S3: Regional ratios of contribution based on different levels of temporal aggregation (3h, 24h, and 72h) in winter (DJF). Ratio of contributions from PR-values in Figure S2. Contribution from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 3-hour temporal aggregation; the dashed lines with the triangle marker represent contributions for 24-hours; the dotted lines with the square marker represent contributions for 72-hours. The lower left panel shows the aggregation over all land grid cells and shows axis labels.

40



45 **Figure S4: Regional probability risk ratios for different temporal aggregation levels (3h, 24h, 72h) in summer (JJA). The panels show PR_{total} (red), PR_{mean} (blue), and PR_{var} (purple) values (y-axis) at warming levels (+1, +2, +3, +4 °C) (x-axis). The solid lines with the circle marker represent PR-values for 3-hour temporal aggregation; the dashed lines with the triangle marker represent PR-values for 24-hours; the dotted lines with the square marker represent PR-values for 72-hours. The lower left panel shows the aggregation over all land grid cells and shows axis labels.**



50 Figure S5: Regional ratios of contribution based on different levels of temporal aggregation (3h, 24h, and 72h) in summer (JJA).
 Ratio of contributions from PR-values in Figure S4. Contribution from the mean in blue and contributions from variability in
 purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the
 circle marker represent individual contributions for 3-hour temporal aggregation; the dashed lines with the triangle marker
 represent contributions for 24-hours; the dotted lines with the square marker represent contributions for 72-hours. The lower left
 55 panel shows the aggregation over all land grid cells and shows axis labels.

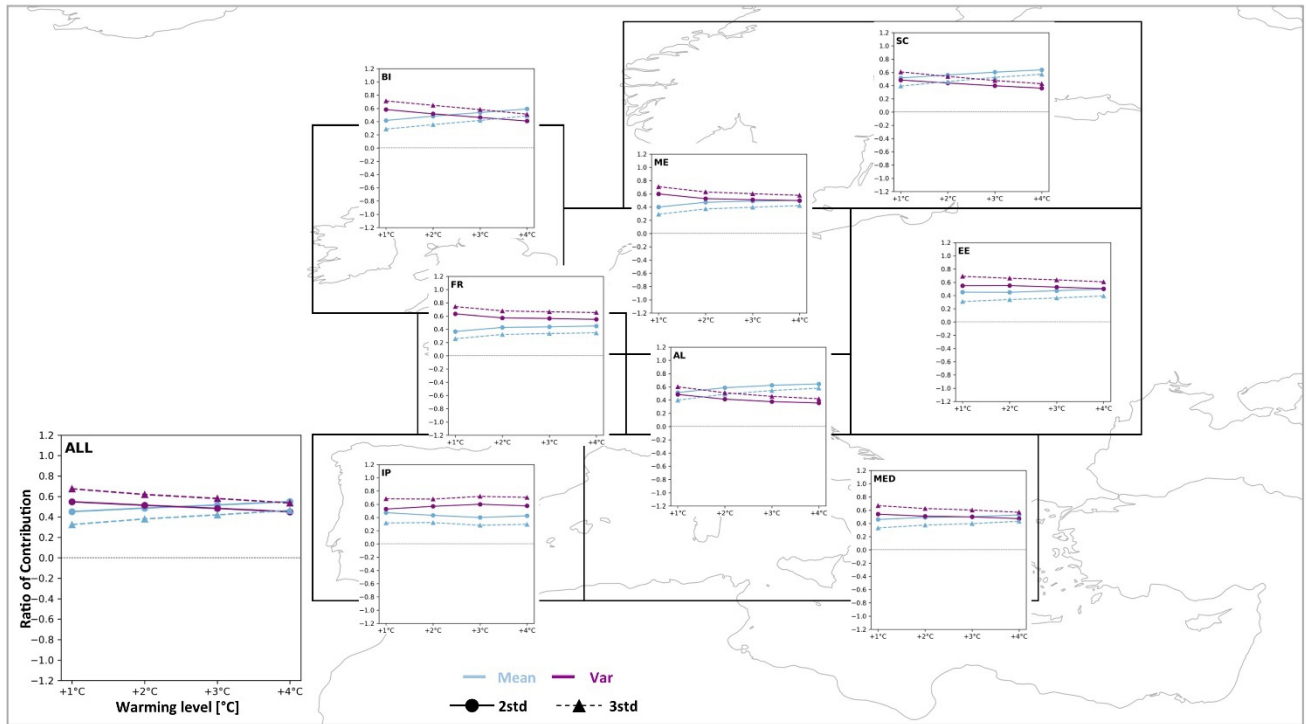
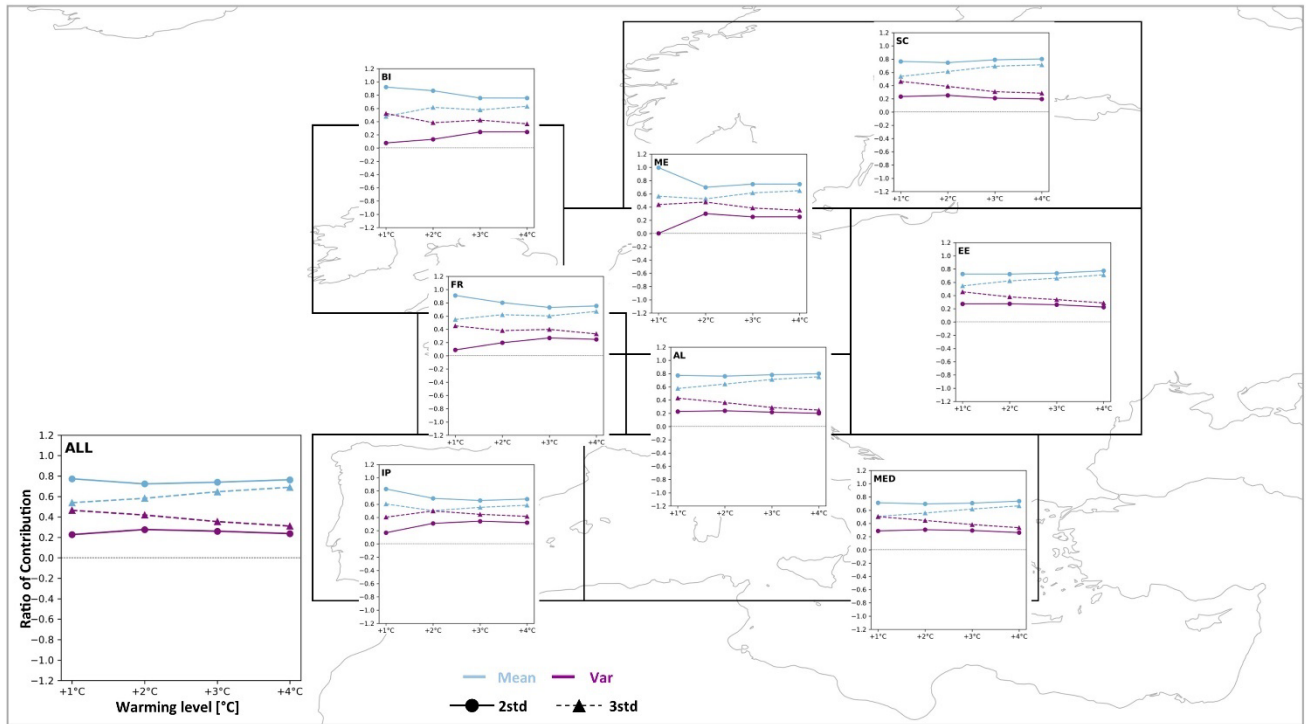
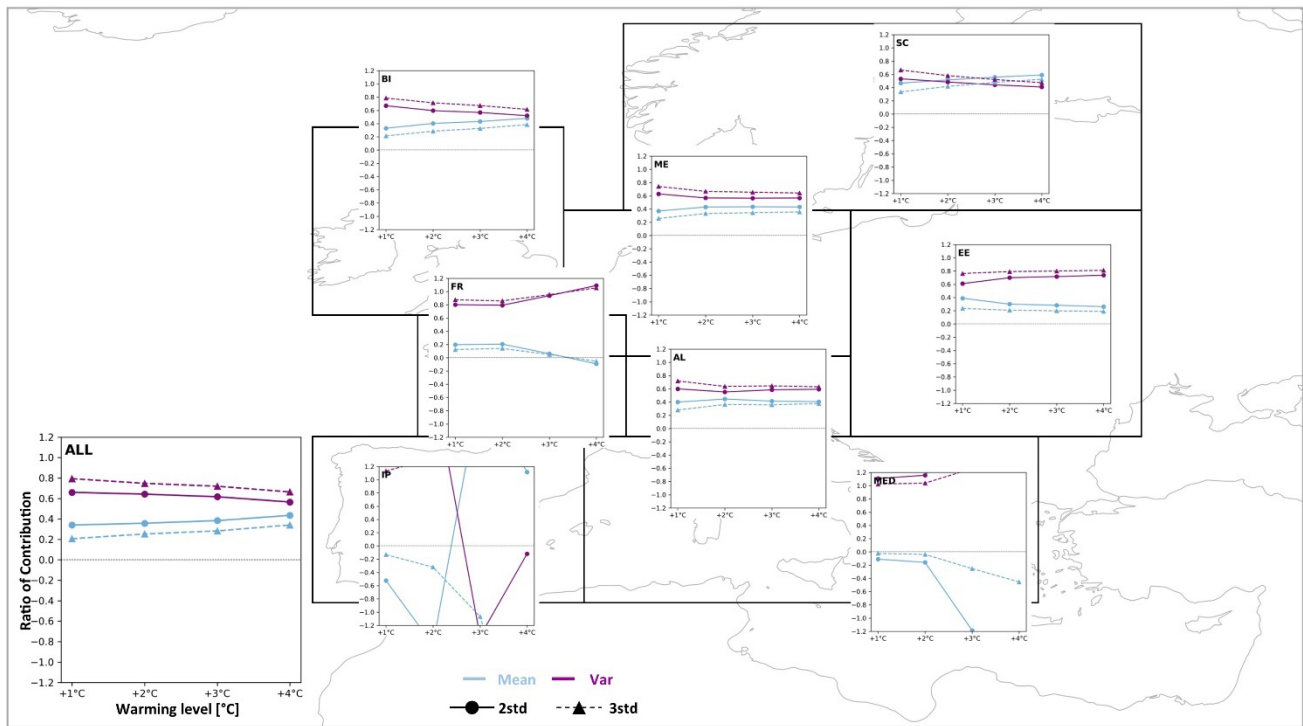


Figure S6: Regional ratios of contribution based on different levels of extremeness (2-sigma vs. 3-sigma) in annual rx3h extremes. Individual contributions from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 2-sigma extremes; the dashed lines with the triangle marker represent contributions for 3-sigma extremes. The lower left panel shows the aggregation over all land grid cells and shows axis labels.

60

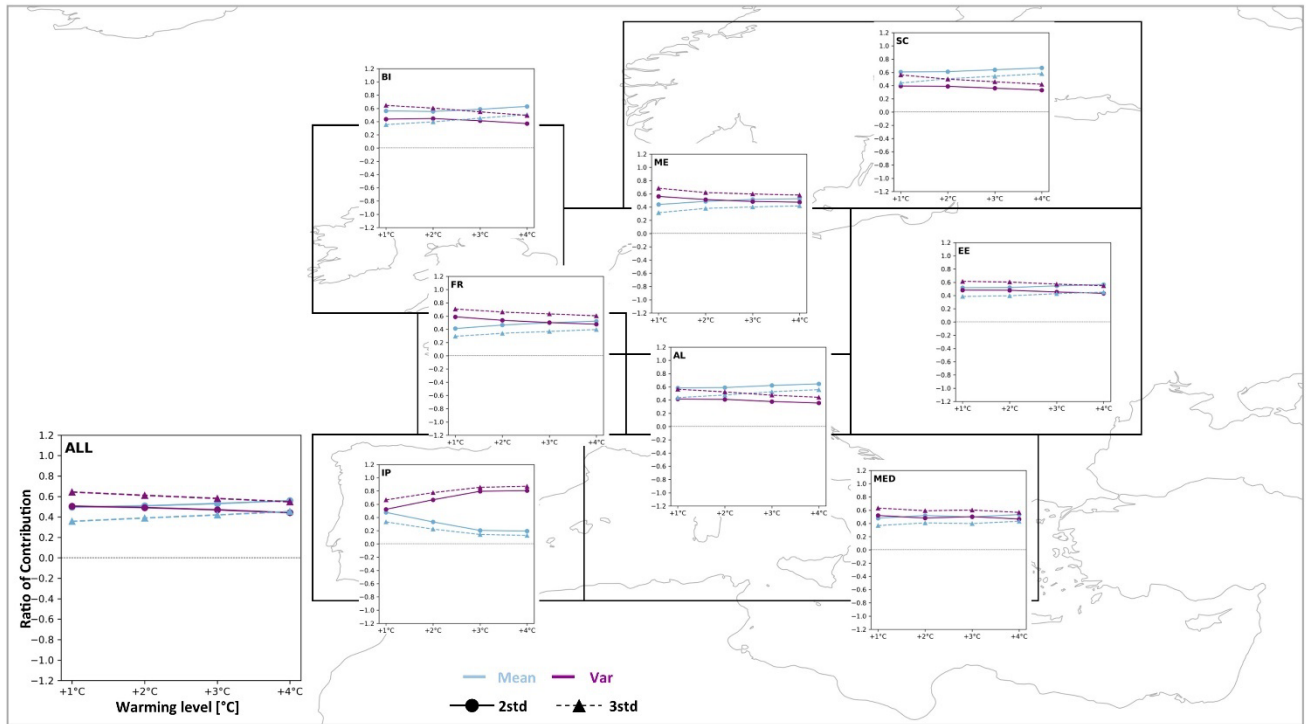


65 **Figure S7: Regional ratios of contribution based on different levels of extremeness (2-sigma vs. 3-sigma) in winter (DJF) rx3h extremes. Individual contributions from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 2-sigma extremes; the dashed lines with the triangle marker represent contributions for 3-sigma extremes. The lower left panel shows the aggregation over all land grid cells and shows axis labels.**

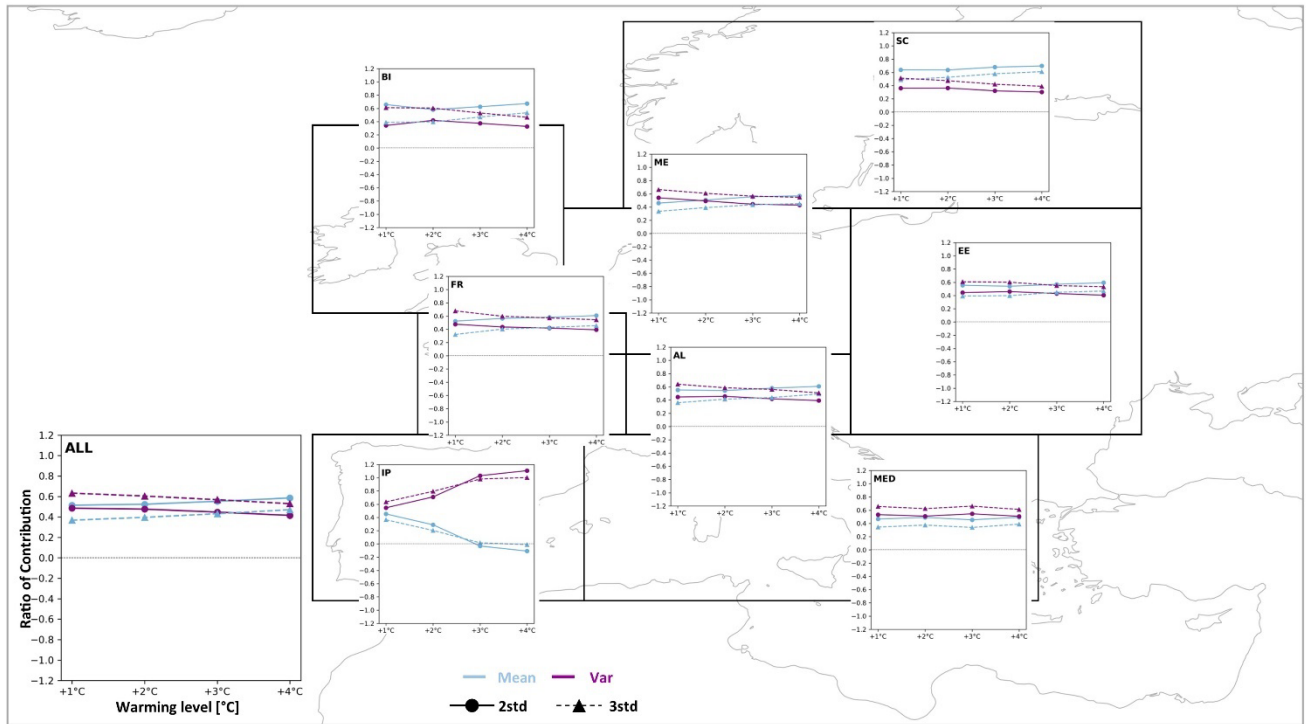


70

Figure S8: Regional ratios of contribution based on different levels of extremeness (2-sigma vs. 3-sigma) in summer (JJA) rx3h extremes. Individual contributions from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 2-sigma extremes; the dashed lines with the triangle marker represent contributions for 3-sigma extremes. The lower left panel shows the aggregation over all land grid cells and shows axis labels.



75 **Figure S9: Regional ratios of contribution based on different levels of extremeness (2-sigma vs. 3-sigma) in annual rx24h extremes. Individual contributions from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 2-sigma extremes; the dashed lines with the triangle marker represent contributions for 3-sigma extremes. The lower left panel shows the aggregation over all land grid cells and shows axis labels.**



80

Figure S10: Regional ratios of contribution based on different levels of extremeness (2-sigma vs. 3-sigma) in annual rx72h extremes. Individual contributions from the mean in blue and contributions from variability in purple. Ratio of contribution on the y-axis with different warming levels on the x-axis (+1, +2, +3, +4 °C). The solid lines with the circle marker represent individual contributions for 2-sigma extremes; the dashed lines with the triangle marker represent contributions for 3-sigma extremes. The lower left panel shows the aggregation over all land grid cells and shows axis labels.

85