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## Trends in heat stress over Europe over the 20th century

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We investigate how European heat waves and their associated heat stress on humans have changed over the 20th century. We find that the heat stress has increased, even in regions where heat waves have not become warmer. As heat stress increases over wide areas of Europe there is also an increase in the total population affected by the heat stress.

Heat waves pose a serious health risk to humans by reducing our ability to shed heat. We have studied the occurrence and intensity of heat waves as well as a heat stress index based on simplified wet-bulb globe temperature using data from ERA-20C reanalysis 1900-2010. Over the 110 years of data we find an overall warming of the air temperatures and dew point. The 98th percentile of both air temperature has increased by more than 1.5°C over large areas of Europe.

We find an overall increase in heat wave days per year as well as an increase of air temperature during heat waves over most of Europe. As such, many densely populated areas exhibit increased heat stress during heat waves. For example, the mean heat stress during heat wave days over Paris has increased by one level, from “alert” in 1900-1930 to “caution” in 1980-2010. The fraction of the population exposed to heat waves has increased by 10%/century in central Europe and 25%/century over the Mediterranean.

We find more heat waves during 1920 - 1950, which may be related to the positive phase of the Atlantic Multidecadal Variation (AMV). This suggests that the heat stress during European heat waves may also be influenced by internal climate variability, and large-ensemble model simulations may be used to disentangle the effects of natural variability and anthropogenic forcing.