

# Predictability assessment of the first continental heat-cold-health early warning system: new avenues for human health forecasting

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The increasing number of extreme climate events due to global warming highlights the urgent need for the implementation of early warning systems directly targeting the effects of weather phenomena on human health. Here we build the first continental heat-cold-health early warning system, and compare its predictability with the original weather forecasts. We did so by considering almost 60 million counts of all-cause mortality in 147 contiguous NUTS regions from 16 European countries, and daily gridded observations and forecasts (with lead times up to 15 days at 24-hour intervals) of 2-meter temperature. We calculated state-of-the-art temperature-lag-mortality models, which account for the delayed effects of daily temperatures on mortality counts. These epidemiological associations were used to transform the daily bias-corrected forecasts into daily predictions of temperature related mortality. We compared the predictive skill of temperature forecasts and temperature related mortality predictions by using predictability assessment techniques widely used in weather and climate forecasting. We additionally quantified the window of predictability by defining the predictability lead time as the lead time in which the predictive skill value falls below specific thresholds. We found that temperature forecasts can be used to issue skillful predictions of heat and cold related mortality accounting for the real impacts of temperature on human health, although the window of predictability was differently reduced by season and location. We also showed that the predictability of the early warnings is to a very large extent constrained by the original weather forecasts, and not by the epidemiological models, which means that further advancements in weather forecasting would automatically turn into an increase in the predictability window of health early warning systems.

**Keywords:** Early warning systems, bias-correction, predictability assessment, forecasting.