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Urban air temperature estimation from smartphone battery temperatures

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Accurate air temperature observations in urban areas are important for meteorology and energy demand planning and for studying the adverse effects of high temperatures on human health. However, the availability of temperature observations in cities is often limited. Here we show that relatively accurate air temperature information for the urban canopy layer can be obtained from an alternative, nowadays omnipresent source: smartphones. This has previously been shown for eight major cities around the world.

Battery temperature data were collected by users of an Android application for cell phones (opensignal.com). The application automatically sends battery temperature data to a server for storage. In this study, battery temperatures are averaged in space and time to obtain daily averaged battery temperatures for a city. A regression model, which can be related to a physically based heat transfer model, is employed to retrieve daily air temperatures from battery temperatures. The model is calibrated with observed air temperatures from at least one meteorological station.

Here we extend an earlier study by applying the methodology to a much longer data set. Time series of air temperatures are obtained for São Paulo, Brazil. A 1-year data set (2013) is used for calibration, whereas a 1-year data set (2014) is used for validation purposes. Moreover, each day typically tens of thousands of battery temperature observations are available, which is 10 to 100 times more than in previous studies, giving new opportunities.

First the model is applied to estimate daily-averaged air temperatures. The evolution of the retrieved air temperatures often corresponds well with the observed ones. Next, the performance is studied as a function of the number of observations. We address the following questions: How many battery temperature readings are needed to obtain relatively accurate daily temperatures? Would it be realistic to make an urban temperature map? Further, it is tried to estimate hourly temperatures in order to capture the diurnal cycle. The results demonstrate the enormous potential of this crowdsourcing application for temperature monitoring in densely populated areas.