Opportunistic weather sensors: an Amsterdam case study of private weather stations, commercial microwave links and smartphones

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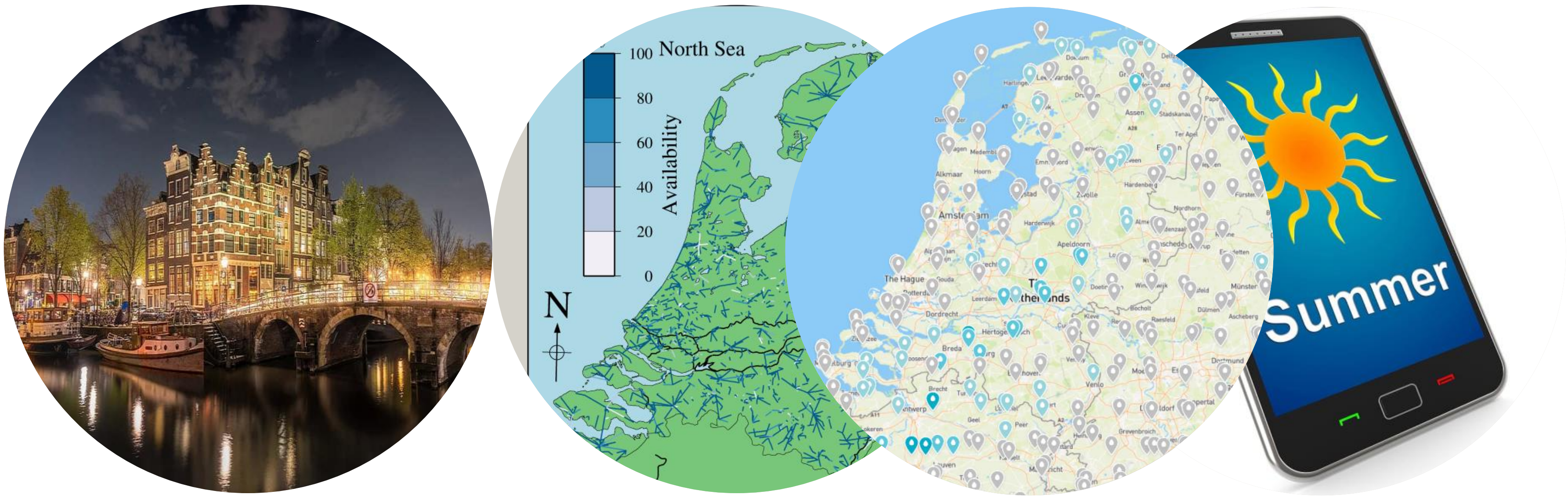

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Related publication

https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-19-0091.1

Aim of the research:

To showcase a number of promising opportunistic sensors for urban hydrometeorological monitoring,

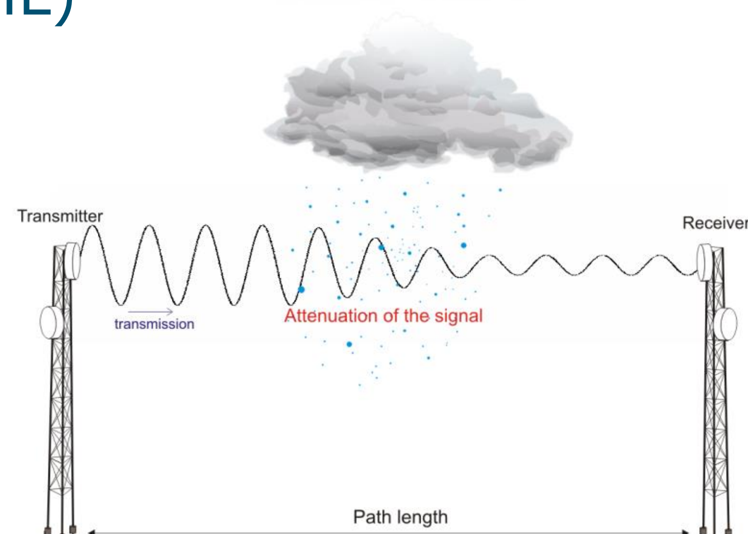
and illustrate how their raw observations are able to capture two weather events in Amsterdam.

Highlights

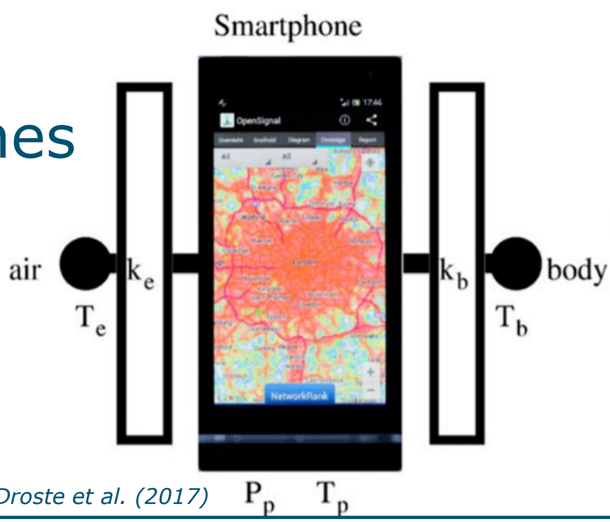
Opportunistic sensor data from:

- Personal Weather Stations (PWS)

- Commercial Microwave Links (CML)



- Smartphones



Source: Droste et al. (2017)

Source: http://lte.epfl.ch/page-50160-en.html

Highlights

Two case studies during a 17-day period in the Amsterdam Metropolitan Area, the Netherlands. [Cold front and UHI]

Compare observations of opportunistic and traditional sensors of:

- Air temperature (PWS, smartphones)
- Rainfall (CML, PWS)
- Solar radiation (smartphones)
- Wind speed (PWS)
- Air pressure(PWS, smartphones)
- Humidity (PWS)

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Highlights

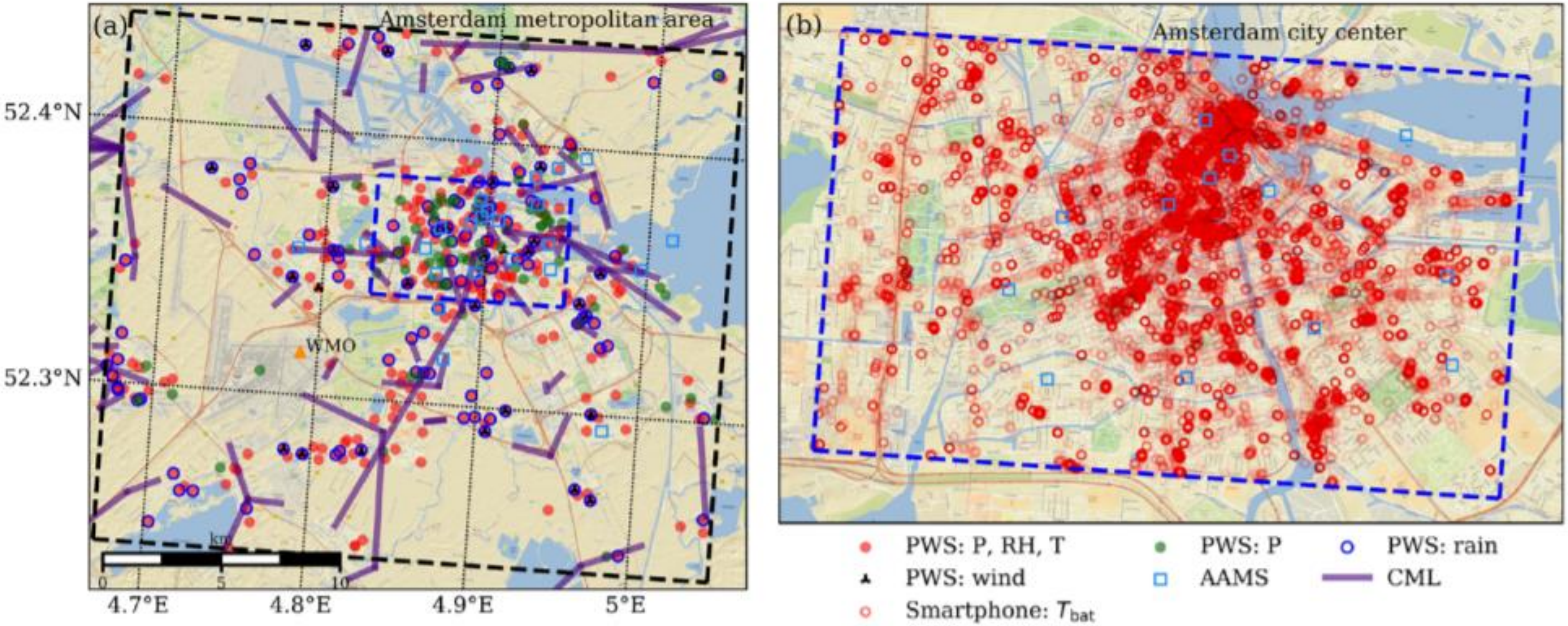

Fig. 1. Maps of (a) Amsterdam metropolitan area and city center with locations of all sensor networks: personal weather stations (PWSs), commercial microwave links (CMLs), and WMO station 06240 (Amsterdam airport) and (b) smartphone battery temperature readings and Amsterdam Atmospheric Monitoring Supersite (AAMS) stations.

Highlights

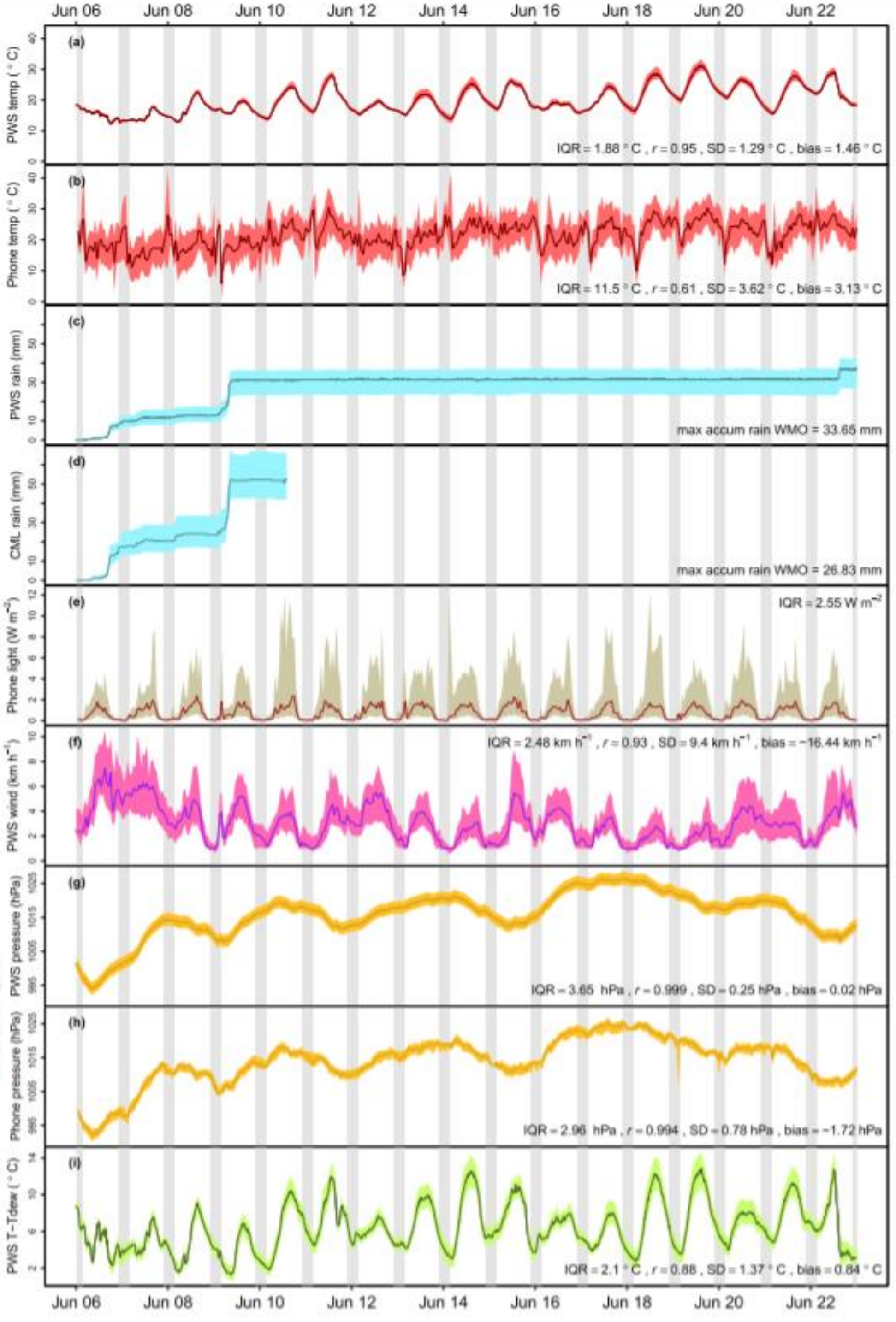

Fig. 2. Time series of opportunistic measurements of weather variables. PWS observations of (a) temperature, (c) cumulative rainfall, (f) wind, (g) pressure, and (i) dewpoint depression calculated from humidity and temperature, (d) CML-derived cumulative rainfall, as well as smartphone battery-derived (b) air temperature, (e) light, and (g) pressure. The colored areas indicate the interquartile range (IQR is the mean 25th–75th-percentile range) of all observations at that time; lines show the median values, except in (b), where the line shows mean temperature. Shaded areas indicate nighttime. Pearson correlation *r*, standard deviation of the difference (SD), and absolute bias (bias) are calculated based on hourly values compared with observations at WMO station 06240.

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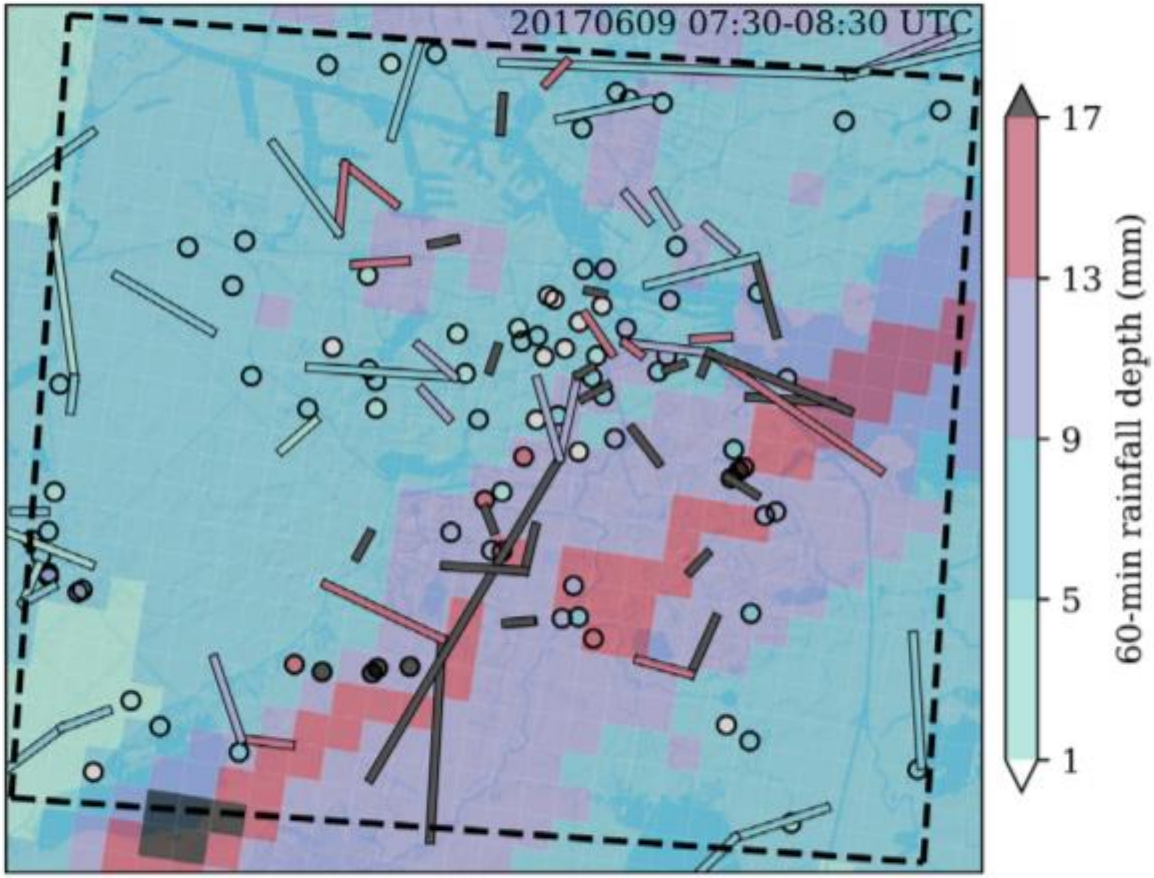

Fig. 6. Map of 60-min rainfall depths over the Amsterdam metropolitan area based on gauge-adjusted radar data (pixels; 100% availability), CML data (paths; only CMLs with 100% availability are shown), and PWS data (circles; only PWSs with at least 83.3% availability are shown).

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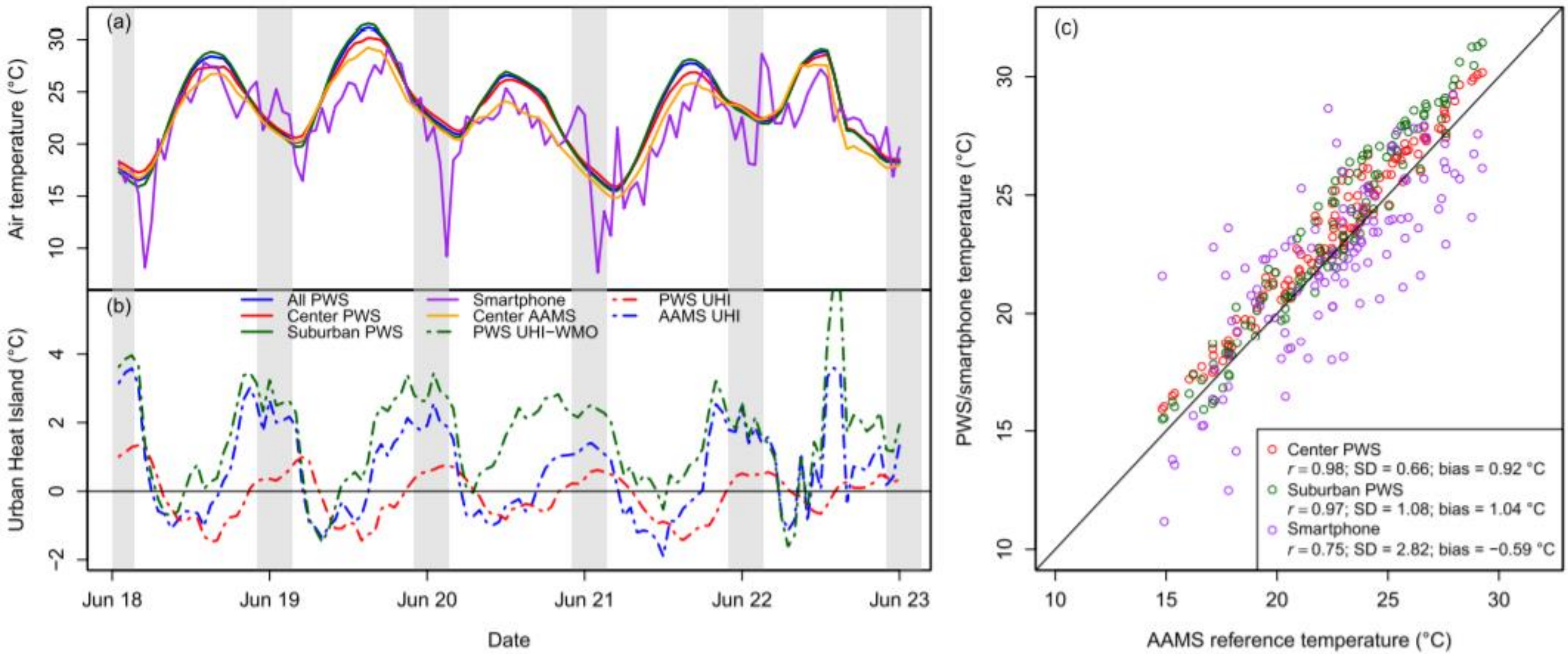

Fig. 7. (a) Time series of temperature measurement according to the median of all (blue), center (red), and suburban (green) PWSs, as well as the median of the AAMS network (orange) and the mean smartphone-derived air temperatures (purple). (b) The difference between the median PWS center and suburban temperatures (red dashed), the AAMS and WMO (blue dashed), and the PWS center and WMO (green dashed). Shaded areas indicate nighttime. (c) Scatterplot of hourly median PWS and smartphone temperatures against median AAMS station data, with Pearson correlations *r*, standard deviations of the difference (SD), and absolute biases (bias).

Conclusions / discussion

- Passage of cold front is visible in all of the studied opportunistic data sources
- PWS outperformed smartphones for UHI analysis
- Smartphones can only provide city averages, CML and PWS provide spatial variability
- (short) CML estimates show large overestimation, processing is recommended
- PWS wind observations are very noisy
- Accuracy improvement is to be expected by using processing steps and QC (as proposed in literature)