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Contribution of personal weather stations for observing deep-convection features near the surface

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When thunderstorms develop in the atmosphere, they cause changes in temperature, relative humidity, pressure, wind and precipitation near the surface that can be detected by weather stations. However, standard weather station networks, which are maintained by national meteorological and hydrological services, cannot observe all of these variations, particularly those whose characteristic scale is smaller than the meso-γ-scale (2-20 km). One opportunistic solution for obtaining spatially denser observations comes from citizen science. Advances in wireless communication networks allow an increasing number of objects to be connected to the Internet (IoT for Internet of Things). These objects include personal weather stations, also known as citizen weather stations. In mainland France, the number of active personal weather stations providing real-time observations exceeded that of standard weather stations by a factor of approximately 40 in 2020.

Although there are many personal weather stations, the quality of their observations varies greatly due to the variable quality of their physical sensors, their highly heterogeneous installation environments, and their maintenance, among other reasons. This usually limits the use of this data unless it is coupled with strict quality control. Several fully automatic quality control algorithms have been developed in the scientific literature. One such example is the Mandement and Caumont (2020) algorithm, whose general principle is to statistically check surface pressure, temperature, and relative humidity observations against those from neighbouring standard weather stations, in such a way as to retain as much as possible the sudden variations caused by deep convection.

This algorithm has been adapted for real-time use, and the quality-controlled observations it produces are used in high-frequency meteorological analyses of temperature, relative humidity, and mean sea level pressure, over France. Case studies in which fine-scale structures appear in these analyses but are either partly or completely absent from analyses that only include observations from standard weather stations, will be presented. These fine-scale structures include temperature drops, humidity rise and mean sea level pressure jumps that accompany squall lines or individual convective cells, as well as oscillations that are associated with gravity waves triggered by deep convection. Initiatives launched at a European level to concentrate and share personal weather station observations will also be presented.