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Sensors for climate services

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Reliable early warning systems for heat hazards require not only high-resolution meteorological modelling, but also robust, scalable and accurate in-situ observations. However, existing Wet Bulb Globe Temperature (WBGT) sensors are poorly suited for dense spatial monitoring and operational deployment: they often rely on maintenance-intensive wet-bulb thermometers, lack integrated geolocation, are sensitive to sun radiation, and are difficult to deploy consistently by non-expert users in particular in urban environments.

To address these limitations, VITO has developed a new generation of heat-stress sensors designed for both stand-alone field campaigns and large-scale sensor networks. The algorithm eliminates traditional wet-bulb hardware by computing wet-bulb temperature psychrometrically from shielded air temperature, humidity measurements, black globe and wind, integrates automatic GPS-based geolocation and applies quality control using dedicated light sensors. A modular hardware architecture allows deployment either as an autonomous SD-logging device or as a real-time LoRa-connected network node, enabling synchronised, spatially distributed WBGT monitoring across urban and occupational environments.

In addition, VITO developed a dynamic heat-stress sensor, HEATCAP, which enables instantaneous heat-stress measurements. Unlike the traditional black-globe method—which requires 10–15 minutes to stabilise—the HEATCAP sensor replaces the globe thermometer with shortwave and longwave radiation sensors that capture radiative fluxes from all directions. This design allows immediate assessment of heat stress under rapidly changing conditions, such as during commuting, intermittent cloud cover, or movement between sun and shade.

Together, these sensor technologies enable high-resolution and operationally robust heat-stress observations that directly complement high-resolution urban climate models. They support both mobile and permanent long-term monitoring applications, ranging from urban exposure assessments and early warning systems to indoor and outdoor occupational settings, such as construction workers and delivery drivers, including environments where heat exposure is amplified by industrial processes (e.g. furnaces in the steel industry). The resulting dense point measurements enable the identification of true heat-stress hotspots, support assessments of vulnerable population groups and animal wellbeing, and provide a potential direct bridge to high-resolution modelling, where sensor observations can be interpolated and assimilated into area-

wide heat-stress maps for near-real-time warning and long-term planning.