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Laboratory calibration and field assessment of low-cost electrochemical Ozone sensors in Alpine and Arctic environments

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The rapid development and continuous improvement of low-cost technology are demonstrating notable applications and today low-cost sensors (LCSs) are beginning to play a role in areas such as model or emissions validation and spatial variability in pollution in support the state-of-the-art instrumentation and established networks. However, data quality remains an important concern that hampers the widespread adoption of low-cost sensor technology. Recently also WMO/GAW recognized the need of assessing the performance and the correct use of such new kind of technology[1]. Purpose of the study is to assess the reliability of low-cost sensors (LCSs) for environmental monitoring of near-surface Ozone mixing ratio in remote Alpine and Polar areas. Indeed, Ozone is highly relevant for the Earth's climate, ecosystems and human health. Also, the needs of reliable spatial data is ever more decisive in remote and harsh environments of the planet, known as climate sentinels.
Twins sensing system (http://colmargherita.dsa.unive.it/zepp_manual/) have been located in two atmospheric observatories where comparison of data harvested by low cost sensors can be compared with state-of-art instrumentation. Part of the study are the Zeppelin Observatory (78.9062 N, 11.87911 E) of the Norwegian Polar Institute and the Col Margherita Observatory (46.36683 N, 11.79192 E) of the IDPA-CNR. At these stations, state-of-arts instrumentation based on UV-absorption are running in the framework of WMO/GAW and NextDATA National Project. Sensors evaluated are the Alphasense OX-B431. These sensors have been calibrated at the CNR-ISAC headquarter before field installation. The choice of the sensors was due to positive evaluations of recent publications[2] and reports (www.snuffle.org). For each sensing system a group of three equivalent sensors were installed to evaluate the intra-comparison between sensors. A dedicated VPN and Cloud solutions were adopted with the perspective of creating a large network of stations and to ease remote control, data management and backup. Moreover, to offer interactive web applications for collaborators and for the general public, a dedicated web-server was set-up using R-Shiny (http://colmargherita.dsa.unive.it/o3net/).
A major result of the study is the development of a real-time air quality validation protocol and use guidelines for near-surface ozone measurement in remote areas with low-cost sensors. Data, software, reports and technical documentation, currently under development, will be released under free open-source license so that can be used, reproduced and improved freely (https://github.com/theRosyProject). These results will be useful for the design and use of low cost wireless sensors network for environmental ozone monitoring usable by both the scientific community and by citizen engineers.

[1] Lewis, A., Peltier, W.R. and von Schneidemesser, E., 2018. Low-cost sensors for the measurement of atmospheric composition: Overview of topic and future applications.
[2] Hagan, D.H., Isaacman-VanWertz, G., Franklin, J.P., Wallace, L.M., Kocar, B.D., Heald, C.L. and Kroll, J.H., 2018. Calibration and assessment of electrochemical air quality sensors by co-location with regulatory-grade instruments.