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Evaluation of low-cost CO2 sensors to study atmospheric mixing in a mountain valley

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Air pollutants are trapped in mountain valleys during persistent cold-air pool events, when atmospheric mixing is suppressed. We are developing a network of weather stations using CO2 as a tracer gas to study atmospheric mixing in Cache Valley, Utah. Initial testing of five relatively low-cost open-path sensors (Vaisala, model GMP343, $~3000) has revealed a significant temperature sensitivity, which varies among sensors. This confounds the diel CO2 cycles we seek to understand. We have begun testing a lower-cost closed-path sensor (PP Systems, model SBA-5, $~1800). The cost of a complete system, including CO2 sensor, pump, solenoid valves, etc. is comparable to the open-path sensor, and it allows us to measure vertical CO2 profiles. Laboratory testing shows promising performance. Allan deviation shows their precision to be ~0.3 ppm, for averaging times from 10 s to one hour. Their precision is dominated by offset error, which has drifted down 1 to 10 ppm per day for replicate sensors; however, this is subject to random (~monthly) events in which the reading increases 50 to 100 ppm over a few hours. Their span is quite stable. With auto-zeroing every hour, the accuracy can be within 1 ppm, which is adequate for this application. We have also evaluated a more expensive closed-path analyzer (LI-COR, model LI-850, $~4500). This has better performance than the PP systems model SBA-5, but it is more than twice the cost. The next step is field deployment of these sensors in systems that will automatically check and set the zero and span.