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The role of atmospheric conditions in CO_2 and radon emissions from an abandoned water well

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Boreholes and wells are complex boundaries at the Earth-atmosphere interface connecting the hydrosphere, lithosphere and biosphere from below and the atmosphere from above. Understanding and quantifying the air exchange rate at these geometries and subsequently their potential role as a source for greenhouse gases (GHGs) emissions to the atmosphere is important. Here, we investigate the effect of atmospheric conditions, namely atmospheric pressure and temperature, on air, CO_2 and radon transport inside a 110-m deep and 0.5-m wide borehole. Temperature, relative humidity, CO_2 and radon (alpha detector) sensors were placed along a cased borehole in northern Israel, and a standard meteorological station was located nearby. All borehole data were logged at high 0.5-min resolution for nine months. Results show that climatic driving forces initiated advective air transport mechanisms that had a similar effect on the CO_2 and radon trends within the borehole. Diurnal atmospheric pressure oscillations controlled the daily air transport (barometric pumping) whereas borehole-atmospheric temperature differences were important on the seasonal scale (thermal-induced convection). In addition, air velocities inside the borehole and CO_2 emissions to the atmosphere were quantified, fluctuating from 0 and up to $\sim$6 m/min and $\sim$5 g-CO_2/min. respectively. This reveals the role of boreholes as an additional source for GHG emissions.