EMS Annual Meeting Abstracts
Vol. 18, EMS2021-439, 2021
https://doi.org/10.5194/ems2021-439
EMS Annual Meeting 2021

Measuring Atmospheric Dynamics at a Site with Natural CO_2 Emissions with an Autarkic Wireless Sensor Network

Yann Büchau, Bram van Kesteren, Andreas Platis, Carsten Leven, and Jens Bange
Center for Applied Geoscience - Environmental Physics, Eberhard Karls Universität Tübingen, Tübingen, Germany (yann-georg.buechau@uni-tuebingen.de)

The Starzach site in the upper Neckar valley, Germany, is known for its natural degassing of carbon dioxide (CO_2). During the last century, the gas has been mined industrially until yields stagnated and the extraction wells were sealed. Interestingly, CO_2 exhalation spots have reappeared across the site over the last years. Neither the total emission rate across the site, nor the diurnal or seasonal variations of the CO_2 degassing on the site have been quantified scientifically yet.

In this project, an autarkic wireless sensor network is developed to monitor the CO_2 concentrations in the Neckar valley continuously and investigate the spatial and temporal variability. In the project's second phase, gas transport simulations with a numerical dispersion model will be used to assess the actual CO_2 emissions into the lower atmosphere. Ultimately, the developed methods may be exported to other regions with similar gas emission phenomena.

To account for the spatial heterogeneity of the CO_2 outgassing, a dense sensor network is needed. Deploying several dozen stations requires each station to be of reasonable cost. Currently, commercially available, deployable and self-sustaining measurement systems for CO_2 are very expensive. So to facilitate a targeted network with a 10-meter scale mesh size, we developed an infrastructure that meets our requirements. The network’s modular setup permits flexible sensor extension or spatial expansion. A Campbell Scientific IRGASON eddy-covariance station supplements the network as a punctual high-precision reference. Live gathered data are offered to the science community via the publicly accessible OpenSenseMap.org measurement data platform.

In this talk, the sensor network infrastructure is introduced and the low-cost CO_2 sensor performance is assessed. First long-term measurements at the site reveal a clear diurnal cycle of meteorological parameters and especially for the atmospheric CO_2 concentration and stratification. The site's valley location with surrounding hills is shown to create complex flow dynamics.