In the frame of the COMTESSA (Camera Observation and Modelling of 4D Tracer Dispersion in the Atmosphere) project, tracer dispersion release experiments were performed during three field campaigns in Norway in July 2017, 2018, and 2019. The main goal of the project is to improve our understanding of turbulence and plume dispersion on local scale in the planetary boundary layer by bringing together full four-dimensional (space and time) observations of a (nearly) passive tracer (sulfur dioxide, SO$_2$), with advanced data analysis and turbulence and dispersion modelling. By means of tomographic reconstruction of the 3D tracer concentration distribution, not only the mean but also higher moments of the probability density function of the tracer concentration field can be revealed. In 2017 first field tests were made, releasing SO$_2$ in continuous plumes and puffs from a 10 m tower, while in the following years SO$_2$ was released from a 60 m tower, located in the centre of a fenced-in 900 m x 400 m wide flat gravel field. The masts were equipped with eddy covariance measurement systems to continuously record turbulent fluxes of heat and momentum during the field campaigns. Up to six ultraviolet (UV) and in 2019 also three infrared (IR) SO$_2$ cameras, were placed in a ring around the SO$_2$ release tower at varying distances up to ~1.2 km to simultaneously image the movement and spread of the 2D integrated SO$_2$ tracer column densities.

Here we present an overview of the field experiments and lessons learned, with focus on results from the 2019 summer campaign. It was a challenge to find a location where hazardous gas could be released and a main obstacle for the imaging-based experiment were the unfavourable weather conditions. Despite these challenges, progress was made throughout the years. During consecutive summers the release equipment was improved and optimized and in 2019 puff releases were made by filling balloons with SO$_2$ and exploding them. The cameras were continuously developed, the setup of the cameras at the site was adjusted to allow observations for longer timescales. During July 11-28, 2019 ~130 puffs were released from balloons holding between 250 g and 325 g SO$_2$. Those are used to give an overview of the image/data processing and type of results that can be obtained from our observations, e.g. relative dispersion and
meandering, Eulerian and Lagrangian integral time scales and their relation, tomographic reconstruction. The focus lies on the plume spread, i.e. relative dispersion processes we recorded under different stability conditions in July 2019.