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Ground-based microwave remote sensing of temperature inversions in the Bergen valley, Norway

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The temperature profiles in the urbanized Bergen valley, Norway, are characterized by wintertime temperature inversions, which have a strong impact on the surface layer air quality in the city. We present the results from two years of vertical temperature profile measurements obtained with the ground-based microwave temperature profiler MTP-5HE and show the advantages of ground-based remote sensing with this instrument for the monitoring of atmospheric temperature inversions.

From a subset of the final, filtered dataset we found that the mean difference between temperatures measured with the MTP-5HE and an automatic meteorological station (AMS) on a nearby mountain was as low as -0.03 $\pm$ 0.78 K during inversion free conditions and -0.06 $\pm$ 0.71 K during ground-based temperature inversions. The only selection criterion for this subset was a wind speed of more than 5 m/s and to ensure comparability between the location of the AMS and the central valley atmosphere.

We found two regimes of ground-based inversions: Non-persistent inversions lasting shorter than 2 hours that are mostly thinner than 100 m and more persistent inversions often reaching 270 m above sea level. The height of the shorter inversions was consistent with the maximum height of inversions found in a previous study based on tethersonde measurements. Ground-based inversions mostly occurred during situations characterized by weak winds in the ERA-Interim reanalysis, to a large degree independent from wind direction. A distinct south-easterly tail in the ERA-Interim wind distribution with wind speeds as high as 16 m/s might have been connected to a wake effect from a nearby mountain. The strong channeling effect within the valley that was also found in previous studies was evident.

The ground-based remote sensing was particularly useful for the monitoring of elevated temperature inversions between 170 m and 720 m above sea level. This kind of inversions has not been observed in this valley before. They mostly occurred during nighttime in spring and summer with northerly low-level winds in ERA-Interim and only a low correlation in wind direction between the low-level and the 850hPa ERA-Interim winds. Such wind conditions were unusual for the region under study and might generally result in a valley-circulation favoring the occurrence of elevated inversions under conditions with weak enough convection and warm air advection.