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Do cold pools generated by convective downdrafts allow the development of low-level jets?

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Despite the importance of low-level jets (LLJ), their driving mechanisms are not well understood largely due to a shortage of suitable observational data. The classical description for LLJ follows the concept of inertial oscillations at night (NLLJ). Their development is associated with the nocturnal decoupling of winds from the surface friction due to the formation of a near-surface temperature inversion. However, LLJs have also been connected to convectively generated Cold Pools (CP) in kilometre-scale model. CPs are mesoscale areas of cool and dense air formed through convective downdrafts underneath precipitating clouds. Data from the Field Experiment on Submesoscale Spatio-Temporal Variability (FESSTVaL) gave us the unique opportunity to test the hypothesis that LLJ formation is also connected to CP passages. We used measurements from three Doppler LIDAR instruments located about 6 km apart from each other, a microwave radiometer and radiosondes for atmospheric profiling, and a large and dense network of surface measurements for the CP detection. During the three-month long field experiment, about 4.7% of all identified LLJ profiles were connected to a CP event (CPLLJ). The average length of CPLLJs was almost two hours. The core of CPLLJ had a mean wind speed of 7 ms^{-1} and a mean height of 207 m. Using Doppler LIDAR also allowed us to look at wind gusts in the core of the CPLLJs. We measured wind gust of up to 17.5 ms^{-1} in their core, which exceeds the maximum gust of 15 ms^{-1} in NLLJs. Close to the surface, the wind speed differences between CPLLJs and NLLJs were even larger than in the core. Most measured CPLLJs appeared at the time of the passage of the CP front and lasted not long after the front has passed, with an interesting exception of a six-hour long CPLLJ during daytime on 29 June 2022. In wind and temperature profiles, we clearly see density currents reaching the experiment site paired with the appearance of strong LLJ profiles. After the passage of the CP front, relatively weaker LLJ profiles were seen. The measurements show that the CP favoured the development of a stably stratified near-surface layer. In a first moment, when the CP front reached the site, there was a mean cooling between the surface up to at least 400 m a.g.l.. After that, the layers bellow 200 m a.g.l. continued to cool, forming a temperature inversion, similar to what one would expect from nocturnal radiative cooling. Radiosondes indicate the typical daytime unstable conditions at the surface and a neutral stratification in the well-mixed boundary layer before the CP arrived. At the time of the CP passage, unstable stratification was seen over a deeper layer followed by the development of a stable stratification in the two hours after the front passed. These conditions led to the formation

of a strong and long-lived CPLLJ during daytime. The observations from the FESSTVaL campaign gave first robust evidence that CPs can favour reduced frictional coupling of the wind field to the surface as a prerequisite for generating LLJs.