The formation of stably stratified nocturnal Cold Air Pools (CAPs) is a frequently observed phenomenon in Alpine valleys. Accurate forecasting of these CAPs is important as they can deteriorate air quality and promote high-impact weather such as freezing rain. The CAP episode of 15 and 16 October 2017 in the Inn valley (Austria) was selected for a model intercomparison study within the TEAMx programme. In my thesis, I present a thorough analysis of this intensely observed CAP case as well as a process-based validation of simulations performed with ICON.