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How to identify extensive persistent cold air pools?

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Cold air pool (CAP) is a winter-time, anticyclone-related weather event with a temperature inversion over a valley or basin. It can be classified into two subtypes by its duration: nocturnal and persistent. While nocturnal CAPs may form and stay only for a night and break up in the morning, persistent cold air pools (PCAPs) can last for several days or even weeks. This meteorological situation is characterized by a stable boundary layer, presence of fog or low stratus clouds, absence of strong convection, and low wind speeds. The fog and/or smog during chilly weather conditions can be accompanied by freezing rain. These conditions may cause respiratory problems, hamper traffic and transportation. Therefore, nowcasting and forecasting CAPs and especially PCAPs is highly desirable.

CAPs are frequently investigated in smaller (usually few 10-100 km^2, but not more than 100.000 km^2), fairly closed valleys and basins and several numerical definitions exist to detect if their main characteristics are present in the monitored area. One type of the definitions is based only on finding temperature inversions, while another type considers also the wind speed. A different approach is based on the so-called relative potential temperature, and there are more complex identification methods which utilize the vertically integrated temperature profile. Much fewer studies consider the formation and stability of CAPs in large basins (more than 100.000 km^2) and it is not evident how effective the existing numerical definitions are in cases of extensive CAP events.

In this study, (i) a method is introduced to identify PCAP time periods over large basins, and (ii) several methods based on different numerical definitions are compared for their performance in recognizing the presence of PCAP conditions. The selected definitions are tested in the Carpathian Basin in Central Europe in the period December 2015 – January, 2016 using reanalysis as well as local meteorological measurements from more than one station. It was found that careful parameterization is necessary because the PCAP detection rate is very sensitive to the thresholds applied in the implemented procedures. The consistency found among the results from different approaches supports that nowcasting and possibly also the forecasting of extensive PCAP events can be realized.