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Applying convolutional neural networks for detection of overshooting cloud tops with Himawari-8 satellite data

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Overshooting tops (OTs) are one of the commonly observed phenomena in deep convective clouds over tropical regions. Convective clouds accompanied by OTs can cause severe weather conditions such as lightning, large hail, strong winds, and heavy rainfall more frequently, which influence ground and aviation operations. It may also affect global climate changes by transporting the tropospheric water vapor or greenhouse gases into the lower stratosphere when penetrating through the tropopause with strong updraft. Therefore, it is important to detect and monitor OTs, which will be helpful for related researches such as the relationship with severe weather events for better understanding of future weather conditions and the investigation of OT characteristics regarding global climate changes. Himawari-8 images were used as main input data to detect OTs using a convolutional neural network (CNN) for binary classification of OT and non-OT (i.e. anvil clouds and non convective clouds) classes. Input images were chopped into patches of a certain size and labeled either OT or non-OT. As OTs are clouds shaped like a dome protruding above cloud tops, CNN can identify OT regions by mimicking the human process with contextual information of pixels. The validation results show that CNN was successfully applied for the detection of OTs with 79.68% and 9.78% for a mean probability of detection (POD) and a mean false alarm ratio (FAR), respectively, which are comparable or even better than the performance of OT detection shown in the previous studies.