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Machine learning approaches to detect convective initiation using geostationary satellites and weather radar

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Convective rainfall can cause flash flooding and thus significant human and economic loss. In order to prevent such damage, observation and prediction of convective rainfall have started with Automatic Weather System station (AWS) and ground based weather radar data. However, these measurements cannot cover vast areas limiting spatial continuity. Geostationary satellite sensors observe clouds and storms over vast areas at very high temporal resolution. Convective rainfall can cause flash flooding and thus significant human and economic loss. In order to prevent such damage, observation and prediction of convective rainfall have started with Automatic Weather System station (AWS) and ground based weather radar data. However, these measurements cannot cover vast areas limiting spatial continuity. Geostationary satellite sensors observe clouds and storms over vast areas at very high temporal resolution. Thus, geostationary satellite remote sensing is an ideal way to predict and monitor convective rainfall. In general, interest fields such as the brightness temperature of a specific channel or the difference of brightness temperature between two channels are considered important to identify convective initiation. Existing convective initiation algorithms use simple interest fields and associated thresholds. However, such simple thresholding might not be ideal to identify complicated characteristics of convective clouds. Thus, in this study, machine learning approaches such as decision trees, random forest, and support vector machines were evaluated for determination of key interest fields and associated rules to identify various characteristics of convective clouds. Communication, Ocean, and Meteorological Satellite (COMS) Meteorological Imager (MI), Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI), and HIMAWARI-8 Advanced Himawari Imager (AHI) data were used to detect convective initiation with machine learning approaches. Reference samples to calibrate and validate machine learning approaches were extracted using ground based weather radar and lightning data. Among three approaches, random forest produced the best performance for detecting convective initiation. Probability of detection (POD) and overall accuracy were up to 94.7 % and 97.8 %, respectively.