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The exploration of WRF model simulated multi-layer soil moisture for landslide hazard assessment

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This study assesses the usability of Weather Research and Forecasting (WRF) model simulated soil moisture for landslide monitoring in the Emilia Romagna region, northern Italy during the 10-year period between 2006 and 2015. Particularly three advanced Land Surface Model (LSM) schemes (i.e. Noah, Noah-MP and CLM4) integrated with the WRF are used to provide comprehensive multi-layer soil moisture information. Through the temporal evaluation with the in-situ soil moisture observations, Noah-MP is the only scheme that is able to simulate the large soil drying phenomenon close to the observations during the dry season, and it also has the highest correlation coefficient and the lowest RMSE at most soil layers. Each simulated soil moisture product from the three LSM schemes is then used to build a landslide threshold model, and within each model, 17 different exceedance probably levels from 1% to 50% are adopted to determine the optimal threshold scenario (in total there are 612 scenarios). Slope degree information is also used to separate the study region into different groups. The threshold evaluation performance is based on the landslide forecasting accuracy using 45 selected rainfall events between 2014-2015. Contingency tables, statistical indicators, and Receiver Operating Characteristic analysis for different threshold scenarios are explored. The results have shown that the slope information is very useful in identifying threshold differences, with the threshold becoming smaller for the steeper area. For landslide monitoring, Noah-MP at the surface soil layer with 30% exceedance probability provides the best landslide monitoring performance, with its hitting rate at 0.769, and its false alarm rate at 0.289.