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New cloud mask algorithm over snow/ice-covered areas based on machine learning techniques and comprehensive radiative transfer simulations

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Cloud detection and screening constitute critically important first steps required to derive many satellite data products. Traditional threshold-based cloud mask algorithms require a complicated design process and fine tuning for each sensor, and they have difficulties over areas partially covered with snow/ice. Exploiting advances in machine learning techniques and radiative transfer modeling of coupled environmental systems, we have developed a new cloud mask algorithm based on a neural network classifier driven by extensive radiative transfer simulations. Statistical validation results obtained by using collocated CALIOP and MODIS data show that its performance is consistent over different ecosystems and significantly better than the MODIS Cloud Mask (MOD35 C6) during the winter seasons over snow-covered areas in the mid-latitudes. Simulations using a reduced number of satellite channels also show satisfactory results, indicating its flexibility to be configured for different sensors. Compared to threshold-based methods and previous machine-learning approaches, this new cloud mask (i) does not rely on thresholds, (ii) needs fewer satellite channels, (iii) has superior performance during winter seasons in mid-latitude areas, and (iv) can easily be applied to different sensors.