EGU21-8746
https://doi.org/10.5194/egusphere-egu21-8746
EGU General Assembly 2021

Application of machine learning as a gap-filling tool for satellite land surface temperature

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The frequency of heatwave events has increased in recent decades because of global warming. Satellite observed Land Surface Temperature (LST) is a widely used parameter for assessing heatwaves. It provides a wide spatial coverage compared to surface air temperature measured at weather stations. However, LST quality is limited by cloud contamination. Because heatwaves have a limited temporal frame, having a full and cloud-free complement of LST for that period is necessary. We explore gap filling of LST using other spatial features like land cover, elevation and vegetation indices in a machine learning approach. We use a seamless open and free daily vegetation index product which is paramount to the success of our study. We create a Random Forest model that provides a ranking of features relevant for predicting LST. Our model is used in filling gaps in Moderate Resolution Imaging Spectroradiometer (MODIS) over three heat wave periods in different summers in Estonia. We compare the output of our model to an established spatiotemporal gap filling algorithm and with in-situ measured temperature to validate the predictive capability of our model. Our findings validate machine learning as a suitable tool for filling gaps in satellite LST and very useful when short time frames are of interest. In addition, we acknowledge that while time is an important factor in predicting LST, additional information on vegetation can improve the predictions of a model.