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Two algorithms to fill cloud gaps in LST time series

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Cloud contamination is a challenge for optical remote sensing. This is especially true for the recording of a fast changing radiative quantity like land surface temperature (LST). The substitution of cloud contaminated pixels with estimated values - gap filling - is not straightforward but possible to a certain extent, as this research shows for medium-resolution time series of MODIS data.
Area of interest is the Upper Mekong Delta (UMD). The background for this work is an analysis of the temporal development of 1-km LST in the context of the WISDOM project. The climate of the UMD is characterized by peak rainfalls in the summer months, which is also the time where cloud contamination is highest in the area. Average number of available daytime observations per pixel can go down to less than five for example in the month of June. In winter the average number may reach 25 observations a month. This situation is not appropriate to the calculation of longterm statistics; an adequate gap filling method should be used beforehand.
In this research, two different algorithms were tested on an 11 year time series: 1) a gradient based algorithm and 2) a method based on ECMWF era interim re-analysis data. The first algorithm searches for stable inter-image gradients from a given environment and for a certain period of time. These gradients are then used to estimate LST for cloud contaminated pixels in each acquisition. The estimated LSTs are clear-sky LSTs and solely based on the MODIS LST time series. The second method estimates LST on the base of adapted ECMWF era interim skin temperatures and creates a set of expected LSTs.
The estimated values were used to fill the gaps in the original dataset, creating two new daily, 1 km datasets. The maps filled with the gradient based method had more than the double amount of valid pixels than the original dataset. The second method (ECMWF era interim based) was able to fill all data gaps. From the gap filled data sets then monthly mean, anomaly, and trend maps were calculated.
The accuracy of these two gap filling methods was assessed calculating RMS, mean absolute differences (MAD), and r2 of modelled values versus original MODIS LST values for clear-sky pixels only. These first statistical values showed that the adapted era interim data suites well to fill the data gaps. The gradient based method however should be used more carefully.