TIMELINE

Estimation of Land Surface Temperature from 1-km AVHRR time series

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Assessment of mono- and split window algorithms

In order to select suitable algorithms for operational LST (Land Surface Temperature) processing using AVHRR data, a set of different statistical procedures was tested. The procedures included four mono-window (WM) and six split window (SW) algorithms. For almost all of them, new constants were generated, to optimally account for different atmospheric and geometric acquisition situations. The algorithms were compared on the basis of a large number of TOA radiance/LST pairs, which were generated using a radiative transfer model (MODTRAN5) and the SeeBorV5 profile database. The comparison was done between the LSTs, which were input to MODTRAN5 and the LSTs derived from the TOA radiances using the MW and SW algorithms. Figure 1 shows the regression coefficient r^2 and the root mean square (RMS) of the comparison for daytime and night-time conditions. The SW algorithms outperform the MW algorithms in all cases. The SW algorithms do not show large differences, however, between the MW algorithms there are performance differences of a few Kelvin.

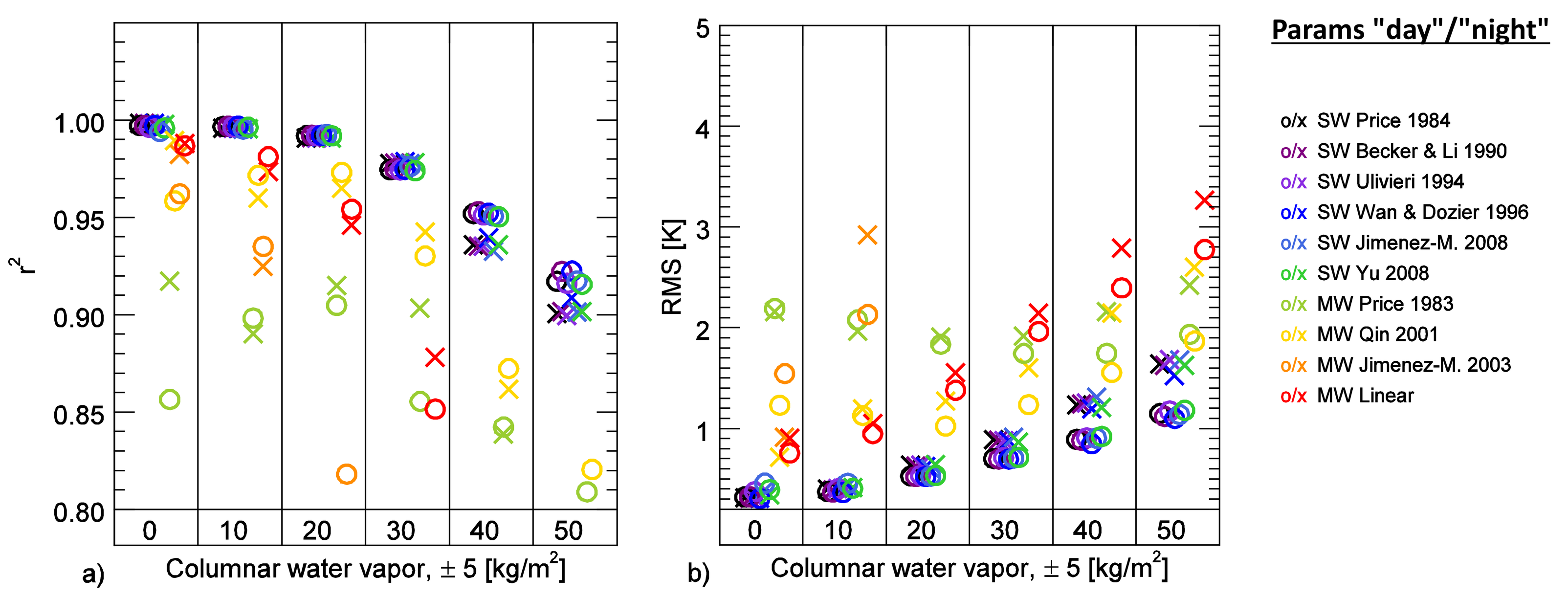

Figure 1 Comparison of the precision of different mono window (MW) and split window (SW) algorithms for AVHRR a) Regression coefficient, b) Root mean square

All SW and MW algorithms require - beside the brightness temperatures - additional input datasets, whose accuracy is limited. The magnitude of the resulting LST error was assessed for the different MW and SW algorithms. For an example set of errors, a total sensitivity was calculated. Among the MW algorithms, the Price 1983 and Qin et al. 2001 had lowest sensitivities, among the SW algorithms, the Becker & Li 1990, the Price 1984 and the Wan & Dozier 1996 algorithm showed low sensitivities.

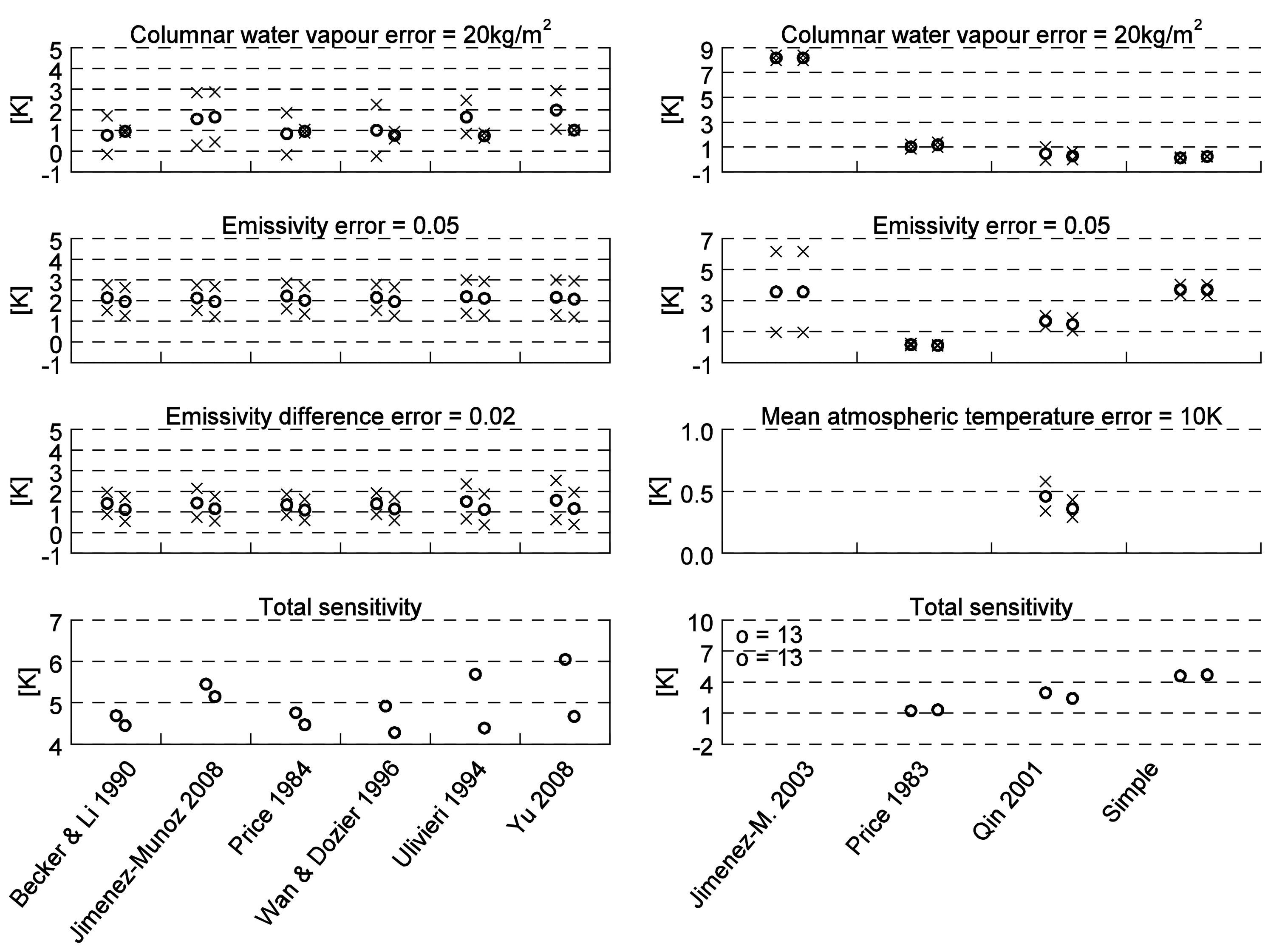

Figure 2 Comparison of the sensitivity of different a) mono window (MW) and b) split window (SW) algorithms to the input variables columnar water vapour, emissivity, emissivity difference, and mean atmospheric temperature

Implementation into SurfTemp

In order to re-process DFDs 1km AVHRR data archive to different parameters of the land surface and the atmosphere, a series of scientific data processors are being developed in the framework of the TIMELINE project. One of the data processors is SurfTemp, which processes L2 LST and emissivity datasets from brightness temperatures. Besides a high precision of the algorithm, a low sensitivity to input bands with high uncertainty is to be preferred.

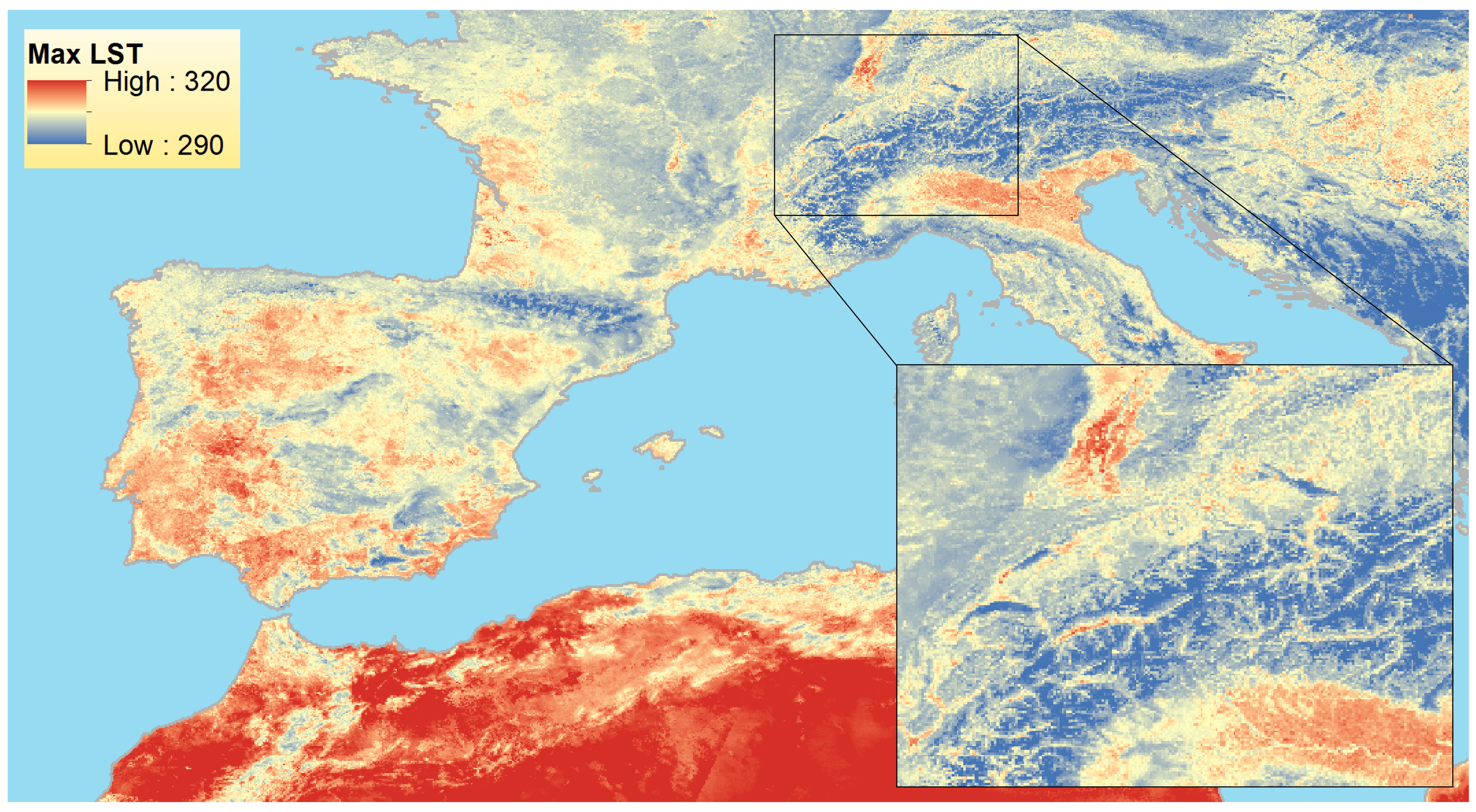

Figure 3 Maximum LST in May 2001

Estimation of the emissivity – influence of misclassification

Emissivity was estimated using the Vegetation Cover Method (VCM) from Caselles et al. (2012). This method requires a land use classification, which itself is prone to errors. To estimate the possible resulting error on the emissivity, the difference between the emissivity of one 'true' class and the emissivity from other 'wrong' classes was calculated for all possible values of FVC (Fraction of Vegetation Cover). Figure 4 shows boxplot statistics for these differences.

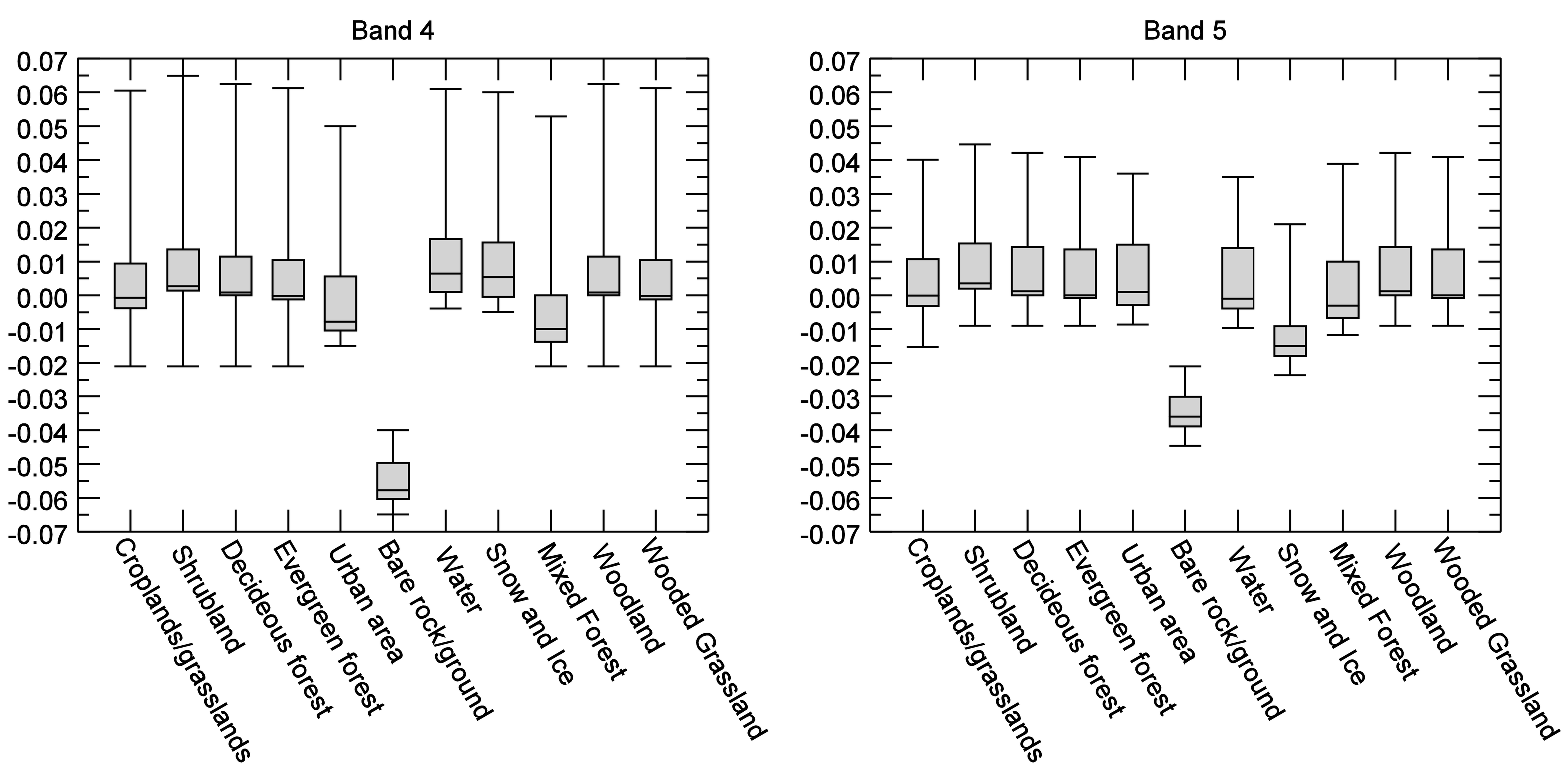

Figure 4 Boxplot – error characterization in band 4 and band 5 emissivity due to misclassification

Largest errors result from misclassification of urban with non-urban areas. Misclassification of snow and ice does also have a larger effect in band 5. The misclassification from one to another vegetated area does not result in large errors. Similar is the error by misclassify urban to vegetated areas. Further the sensitivity of emissivity to input FVC was assessed. It was found that errors are below 0.025 for all FVC levels and all LULC classes.

Subsequent to this work, a comparison with MODIS and in situ data is being conducted to assess the final accuracy of the product.

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