remote sensing

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Editorial

Editorial for the Special Issue "Remote Sensing Monitoring of Land Surface Temperature"

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The combination of the state-of-the-art in the thermal infrared (TIR) domain [1–3] with the recent advances in the capabilities provided by operating and new satellites [4–10], UAV-based [11] or aerial remote sensing are boosting the use of land surface temperature (LST) in a variety of research fields [5,8,9,11,12]. LST plays a key role in soil–vegetation–atmosphere processes and becomes crucial in the estimation of surface energy flux exchanges, actual evapotranspiration, or vegetation and soil properties [8,9]. The latest advances in data fusion, downscaling and disaggregation techniques provide a new dimension to LST applications in water resource and agronomic management thanks to the improvement in both the temporal and spatial resolution of thermal products [8–10]. However, at the same time, continuous research into LST estimation algorithms, as well as continuous calibration and validation, are still required to improve the accuracy of ground LST data and satellite LST products [1–5,13,14].

Our aim with this Special Issue was to collect recent developments, methodologies, calibration and validation and applications of thermal remote sensing data and derived products, from UAV-based remote sensing, aerial remote sensing and satellite remote sensing. A total of 20 manuscripts were submitted to our Special Issue and after rigorous peer-review process, by around 50 anonymous reviewers, 14 papers were finally selected for publication, by a total of 69 authors. The published papers were those of high-quality content based on their cutting-edge remote sensing techniques. The geographical distribution of the authors´ institutions is global, with the highest number from the USA (18), followed by China (15), Spain (7), UK (6), Sweden and Korea (5 each) and many others, such as The Netherlands, Denmark, Japan, Germany, Italy or Turkey (1 to 3 each).

Published papers cover a wide range of topics, which can be classified in five groups: algorithms, calibration and validation [1–4], improving long-term consistency in satellite LST [5–7], downscaling LST [8–10], LST applications [11,12] and land surface emissivity research [13,14].

In total, three papers have been included dealing with algorithms to retrieve LST from the Landsat series [1–3]. Gerace et al. [1] progressed towards developing an operational split-window algorithm for TIRS on board Landsat 8 and 9, that might improve the accuracy achieved by the current single-channel methodology used to derive LST in the Landsat Collection 2 surface temperature product. The effect of the stray-light correction implemented in Landsat 8 was evaluated by Guo et al. [2] using ground-measured LST from SURFRAD sites. Data from this SURFRAD network, together with ARM, were used by Sekertekin et al. [3] to examine the efficiency of different LST algorithms for daytime and nighttime Landsat 8 images. Despite the feasibility of the assessment results reported, a necessity for more robust and homogeneous validations, using ground-measured datasets, is recognized [2].

Geostationary satellites are also present in this Special Issue. Long-term, consistent LST archives must account for geostationary satellite sensor updates and Pinker et al. [5]

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developed a framework to achieve this goal. Choi and Suh [4] developed a nonlinear split-window LST retrieval algorithm for the next-generation geostationary satellite in Korea, GEO-KOMPSAT-2A.

The applicability of remote sensing LSTs is sometimes compromised in areas that are very frequently covered with clouds. Aware of this issue, Zhang et al. [6] and Yoo et al. [7] introduced approaches for the gap-filling of MODIS LST data, by reconstructing 1 km clear-sky LST using Bayesian methods [6] or random forest machine learning [7]. This strategy can improve the applicability of LSTs in a variety of research and practical fields.

As mentioned above, ET modeling from surface energy balance benefits from LST datum as a key input. Field-scale evapotranspiration modelling requires high spatio-temporal resolution in the thermal data. This Special Issue includes recent efforts by [8–10] to fill this gap until next generation of thermal satellites are launched. Sánchez et al. [8] produced LST maps with 10 m spatial resolution from the combination of MODIS/Sentinel-2 images and validated their methodology using a ground-based LST dataset gathered in an agricultural area. Guzinski et al. [9] evaluated several approaches for improving the spatial resolution of the thermal images by merging Sentinel-2 and Sentinel-3 satellite data. The resulting data were used to produce surface energy fluxes that were then validated against flux tower observations in a variety of land covers and climatological conditions. Downscaling approaches also apply to geostationary satellites, increasing the frequency of the LST estimates. Njuki et al. [10], in their work also included in this Special Issue, presented an approach, based on random forest regression, to downscale the coarse-resolution MSG-SEVIRI to 30 m spatial resolution, based on predictor variables derived from Sentinel-2 and the ALOS digital elevation model. Although results reported are promising, particularly for the joint use of the tandem Sentinel-3/Sentinel-2, certain limitations remain that encourage further research.

Urban environments can be explored from a thermal perspective by using high-resolution drone solutions. The Special Issue includes a good example by Naughton and McDonald [11]. Findings shown by these authors elucidate factors that can be applied to develop better temperature mitigation practices to protect human and environmental health. Another potential application of LST data is the use of continuous satellite-derived surface temperatures as input in geophysical models, substituting discrete in situ air temperature registers extrapolated to different elevations using constant lapse rates, then providing more realistic estimates. An example is shown by [12] using MODIS imagery.

Field and laboratory emissivity measurements are essential for improving and validating LST retrievals [13,14]. Temperature and emissivity separation algorithms can be applied when multispectral thermal radiances are available. A manuscript in this Special Issue by [13] explored the influence mechanism of noise on the LST and surface emissivity retrieval errors of the ARTEMISS algorithm. The authors proposed an improved method for thermal data with a high noise level and high spectral resolution, which can reduce LST and emissivity uncertainties. Langsdale et al. [14] made measurements of manmade and natural samples under different environmental conditions, both in situ and at laboratory. Differences between laboratory and field spectral measurements highlighted the importance of field methods for these samples, with the laboratory setup unable to capture sample structure or inhomogeneity. The emissivity box method was faced to FTIR-based approaches, showing significant differences in LST retrieval and then stressing the importance of correct emissivity data specifications.

Although there is much work to be done on the topic of LST monitoring from remote sensing, we truly hope that the selection of papers published in this Special Issue can help research communities to become aware of the potential of the orbiting thermal sensors, the necessity to give them continuity and also to develop and launch higher spatio-temporal resolution platforms.

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