Abstract for Submission to IAGLR2018

A mobile measurement platform and an image processing procedure for high-resolution aerial thermal imagery of lake surface water temperatures

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A mobile platform for carrying out Lake Surface Water Temperature (LSWT) thermography with O(1 m) pixel resolution is presented. It consists of (i) a small balloon carrying a thermal and RGB imagery package tethered to a winch on a boat, and (ii) an autonomous catamaran that measures in situ surface/near surface temperatures, both communicating with the boat in real time.

The image processing procedure includes non-uniformity correction (spatial noise) by a pixelwise two-point linear correction; drift correction (temporal noise) by probability density function matching in regions of overlap between sequential images; and creation of composite thermal images by a feature matching-based algorithm. A high overlapping field of view (~95%) is essential for optimizing image fusion and noise reduction of lake aerial thermography to resolve the small LSWT gradients.

Catamaran-measured in situ temperatures were used for the radiometric calibration. The resultant high-resolution meso-scale LSWT maps show various cold-warm patches and streak-like structures with a temperature contrast of > 2°C over areas covering less than a typical satellite pixel (1 km^2). They were verified by catamaran measurements. The results demonstrate the capability of this mobile platform system and the proposed image processing procedure to determine meso-scale LSWT patterns with unprecedented detail.

Keywords: Remote sensing, thermal imagery, lake surface water temperature, image registration, uncooled infrared camera