Geophysical Research Abstracts
Vol. 16, EGU2014-12331, 2014
EGU General Assembly 2014

Temperature detection of tributaries and inflows along the Rhine River using thermal remote sensing from satellite and airplane

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Surface temperatures can be determined contact-free in the thermal infrared wavelength region of the electromagnetic spectrum. Many satellites collect data in this region, but the spatial resolution is normally not as good as in the visible and near-infrared spectrum. When investigating smaller inland water bodies, the accuracy of discriminating temperatures of land and water or different water bodies is obviously limited. Nevertheless, remote sensing offers a good tool for investigating spatial temperature distributions. At the Federal Institute of Hydrology, Germany, (BfG) the feasibility to monitor the temperature of waterways by means of remote sensing was assessed within the research project “Remote sensing of water surface temperature”.

For a case study of the Upper and Middle Rhine River, the temperature of the river surface was acquired from 19 Landsat ETM+ scenes (60m ground resolution) between 2000 and 2009. Different atmospheric correction methods and parameter sets were applied and the results compared to concurrent in situ measurements. However, no correction method proved to be superior to the others. Based on the comparison with the in situ measurements, the best correction was selected. The regionally varying differences showed that spatially fitted parameters should preferably be used in the future. Furthermore, the uncertainty of temperatures determined from satellite data was calculated.

Considering the thermal resolution of the satellite data and the uncertainty of the calculated temperatures, temperature differences between the main river and the inflows of larger tributaries, e.g. the Moselle, or power plants and temperature distributions were evaluated. From satellite images, temperature values were extracted along the river centre line to create longitudinal river profiles. With these temperature profiles, the influence of smaller tributaries on the river temperature could be detected that was not visible directly at the outlet due to the uncertainty and the limitations of resolution.

In addition, a more detailed investigation of smaller tributaries and spatial distribution of temperature differences was undertaken with high spatial resolution (4m) thermal data acquired by an airborne mission in October 2013.