Estimation and uncertainty assessment of the near-surface air temperature at regional scale using the modified temperature/vegetation index derived from AVHRR satellite images

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ABSTRACT

Increased temperatures and climatic variability lead to the establishment of favorable habitats that enhance the development of several vectors associated with emerging zoonotic diseases. Characterization of the microclimatic conditions of these habitats is useful to predict vector populations’ dynamics and to assess diseases risks. Earth observation images have paramount importance in estimating and monitoring these conditions over large areas. Our study aims to assess the use of the modified temperature/vegetation index (MTVX) derived from Earth observation images to estimate the near-surface air temperature. Advanced Very High Resolution Radiometer (AVHRR) images acquired in southern Quebec, Canada, were used to calculate the MTVX and estimate the near-surface air temperature and assess its uncertainty. The values of several calculation parameters of MTVX and their uncertainties associated with AVHRR images were estimated. The threshold value of the Normalized Difference Vegetation Index (NDVI) associated with pixels of dominant vegetation cover (DVC) was estimated to 0.527 with an uncertainty (\(u\)) of ±0.037. The concept of a dynamic spatial convolution window size, instead of a fixed window size, resulted in a greater number of authorized pixels (APs) for MTVX estimation, as well as a better spatial distribution of APs. The MTVX of APs that met the condition of uncertainty limit (\(u < 2\) K) varies between 294 K and 309.55 K (AVG = 301.53 K; SD = ±3.074 K). And, its resultant uncertainty varies from ±0.342 K to ±2.000 K (AVG = 1.374 K; SD = ±0.362 K). Near-surface air temperature estimated using the MTVX index derived from AVHRR images is strongly correlated with observations of air temperature from meteorological stations (\(r = 0.81, p\)-value = 0.0002). The experimental uncertainty and mean bias of the MTVX in reference to air temperature from meteorological stations are ±0.413 K and -0.767 K respectively. The results of this study showed that the MTVX index, estimated using AVHRR satellite images, is a very good estimator of the near-surface air temperature. It has a high potential to assess the relationship between microclimatic conditions and population dynamics of vectors associated with several diseases, including those transmitted by mosquitoes and ticks.