Research Article

Journal of
Environmental
Nanotechnology

Enhanced Retrieve Land Surface Temperature from Modis Day-Time Mid-Infrared Data using Fuzzy Automatic Clustering Algorithm

K. Yamunadevi*, V. Sowmiya, O. P. UmaMaheswari, T. B. Saranya Preetha
Department of computer Science, P.K.R. Arts College for Women, Gobichettipalayam, TN, India.
Received: 23.12.2016 Accepted: 01.01.2017 Published: 30-03-2017
*k.yamunadevi123@gmail.com

ABSTRACT

Land surface temperature (LST) is a key variable in climatological and environmental studies. However, accurate measurements of LST over continents are not yet available for the whole globe. This thesis first reviews the state of the science of land surface temperature (LST) estimates from remote sensing platforms, models, and in situ approaches. Considering the uncertainties, we review the current LST validation and evaluation method. Then the requirements for LST products are specified, from the different user communities. Finally to identify the gaps between state of the science and the user community requirements, and discuss solutions to bridge these gaps.In this paper proposed clustering method is implememted to process subsequences of time series data and detect land cover change temperature measured as a function of time. Land cover change temperature measured is declared when consecutive subsequences that are extracted from one MODIS time series transitions from one cluster to another cluster and remains in the newly assigned cluster for the rest of the time series. The temporal sliding window designed to operate on a subsequence of the time series to extract information from two spectral bands from the MODIS product.

Keywords: Atmospheric window; Emissivity; Land surface emissivity; Thermal Infrared (TIR).

1. INTRODUCTION

Analyses of global surface temperature change are routinely carried out by several groups, including the NASA Goddard Institute for Space Studies, the NOAA National Climatic Data Center (NCDC), and a joint effort of the UK Met Office Hadley Centre and the University of East Anglia Climatic Research Unit (HadCRUT). These analyses are not independent, as they must use much the same input observations. However, the multiple analyses provide useful checks because they employ different ways of handling data problems such as incomplete spatial and temporal coverage and non-climatic influences on measurement station environment. Here we describe the current GISS analysis of global surface temperature change.

We first provide background on why and how the GISS method was developed and then describe the input data that go into our analysis. We discuss sources of uncertainty in the temperature records and provide some insight about the magnitude of the problems via alternative choices for input data and adjustments to the data. We discuss a few of the salient features in the resulting temperature reconstruction and compare our global mean temperature change with that obtained in the NCDC and HadCRUT analyses. Given our conclusion that global warming is continuing unabated, and that this conclusion differs from some popular perceptions, we discuss reasons for such misperceptions including the influence of short-term weather and climate fluctuations.

2. RELATED WORK

Hansen *et al*. (2010) Update for the Goddard Institute for Space Studies (GISS) analysis of global surface temperature change, compare alternative analyses, and address questions about perception and reality of global warming. Satellite-observed nightlights are used to identify measurement stations located in extreme darkness and adjust temperature trends of urban and peri-urban stations for non-climatic factors, verifying that urban effects on analyzed global change are small. Because the GISS analysis combines available sea surface temperature records with meteorological station measurements, we test alternative choices for the ocean data, showing that global temperature change is sensitive to estimated temperature change in polar regions where observations are limited.

Kogan (2001) explain main goal of global agriculture and the grain sector is to feed 6 billion people. Frequent droughts causing grain shortages, economic disturbances, famine, and losses of life limit the ability to fulfill this goal. To mitigate drought consequences requires a sound early warning system. The National

Oceanic and Atmospheric Administration (NOAA) has recently developed a new numerical method of drought detection and impact assessment from the NOAA operational environmental satellites. The method was tested during the past eight years, adjusted based on users' responses, validated against conventional data in 20 countries, including all major agricultural producers, and was accepted as a tool for the diagnosis of grain production. Now, drought can be detected 4–6 weeks earlier than before, outlined more accurately, and the impact on grain reduction can be predicted long in advance of harvest, which is most vital for global food security and trade. This paper addresses all these issues and also discusses ENSO impacts on agriculture.

Sobrino and Jimenez-Munoz (2005) author explian SPECTRA (Surface Processes and Ecosystem Changes Through Response Analysis) is one of the core candidate missions which is being proposed for implementation in the European Space Agency (ESA) Earth Explorer program of research oriented missions. The scientific objective of the SPECTRA mission is to describe, understand, and model the role of terrestrial vegetation in the global carbon cycle and its response to climate variability under the increasing pressure of human activity. The SPECTRA satellite will embark an optical hyperspectral payload covering the solar spectral range (0.4 to 2.4 mm) and thermal infrared region (10.3 to 12.3 mm). This paper is focused on the land surface temperature retrieval from SPECTRA thermal infrared data. In the first part of the paper, generalized single-channel and split-window methods are discussed and compared, showing that single-channel methods provide similar or better results than split-window methods for low atmospheric water vapor content, whereas split-window methods always provide better results for high atmospheric water vapor content. In the second part of the paper, split-window and dual-angle algorithms have been developed for SPECTRA thermal channels.

Zhengming Wan and Jeff Dozier (1996) describe a generalized split-window method for retrieving land-surface temperature (LST) from AVHRR and MODIS data. Accurate radiative transfer simulations show that the coefficients in the split-window algorithm tor LST must vary with the viewing angle, if we are to achieve a LST accuracy of about 1 K for the whole scan swath range (USE' from nadir) and for the ranges of surface temperature and atmospheric conditions over land, which are much wider than those over oceans. We obtain these coefficients from regression analysis of radiative transfer simulations, and we analyze sensitivity and error over wide ranges of surface temperature and emissivity and atmospheric water vapor abundance and temperature. Sim- ulations show that when atmospheric water vapor increases and viewing angle is larger than 45', it is necessary to optimize the split-window method by separating the ranges of the atmospheric water vapor, lower boundary temperature, and the surface temperature into tractable subranges. The atmospheric lower boundary temperature and (vertical) column water vapor values retrieved from HIRS/2 or MODIS atmospheric sounding channels can be used to determine the range for the optimum coefficients of the split-window method. This new algorithm not only retrieves land-surface temperature more accurately, but is also less sensitive to uncertainty in emissivity and to instrument quantization error.

Jimenez-Munoz and Sobrino (2003) developed algorithms to retrieve land surface temperature from at-sensor and land surface emissivity data. These algorithms have been specified for different thermal sensors on board satellites, i.e., the algorithm used for one thermal sensor (or a combination of thermal sensors) cannot be used for other thermal sensor. The main goal of this paper is to propose a generalized single-channel algorithm that only uses the total atmospheric water vapour content and the channel effective wavelength (assuming that emissivity is known), and can be applied to thermal sensors characterized with a FWHM (Full-Width Half-Maximum) of around 1 mm actually operative on board satellites. The main advantage of this algorithm compared with the other single channel methods is that in-situ radiosoundings or effective mean atmospheric temperature values are not needed, whereas the main advantage of this algorithm compared with split-window and dual-angle methods is that it can be applied to different thermal sensors using the same equation and coefficients. The validation for different test sites showsroot mean square deviations lower than 2 K for AVHRR channel 4 (l 10.8 mm) and ATSR-2 channel 2 (l 11 mm), and lower than 1.5 K for Landsat Thematic Mapper (TM) band 6 (l 11.5 mm).

3. METHODOLOGY

The surface temperature in global and regional models is crucially important because of its relevance to the computations of the turbulent heat fluxes as well as the terrestrial radiation. Remotely sensed land surface temperature data are considered to contain valuable information on the presence and nature of vegetation, heat fluxes, and the moisture availability. The proposed model is forced to match the observed component temperatures by changing both the soil moisture content and the water roughness for the heat exchange of the bare ground component.

In this proposed model is project temperature vertically and while the satellite observations are angle dependent. Satellites observe real surfaces while heterogeneity is parameterized in models (if at all). These inconsistencies add uncertainty to the comparison of model and remotely sensed LST for data assimilation purposes.

While some inconsistencies are likely not to be eliminated completely, data assimilation must account for them as a matter of practice. The difference in change detection accuracy between the real and simulated land cover temperature change was still acceptably small in these experiments, even though only a limited number of real land conversion examples were available.

Clustering techniques are broadly divided into hierarchical and partitional clustering approaches. The Fuzzy Automatic clustering algorithm is an agglomerative hierarchical clustering method that produces a nested hierarchy of clusters of discrete objects according to some kind of proximity matrix. The partitional clustering method creates an unnested partitioning of the data points with clusters. A silhouette graph was used to determine the optimal number of clusters for partitional clustering and resulted in two clusters being the best choice LST.

- An accurate atmospheric correction is not needed.
- The physical land surface detection can be applied to sensors with any MIR band or even to sensors without MIR bands data.
- The proposed methodology provides surface temperature and emissivity, simultaneous analysis.
- The accurate atmospheric correction clustering model is proposed.
- The image classification between pixels of low or high spectral contrast, which causes art factual discontinuities on the emissivity products.
- The different clustering techniques are used for image analysis even in changing climatic conditions over time.
- The proposed system gives the statistical data such as number of objects found and percentage of area covered.

4. TECHNIQUES

Land surface emissivity (LSE): Average emissivity of an element of the surface of the Earth calculated from measured radiance and Land Surface Temperature (LST).

Atmospheric window**:** A spectral wavelength region in which the atmosphere is nearly transparent, separated by wavelengths at which atmospheric gases absorb radiation.

Blackbody: An ideal material absorbing all incident energy or emitting all thermal energy possible. A cavity with a pinhole aperture approximates a blackbody.

Brightness temperature: The temperature of a blackbody that would give the radiance measured for a surface.

Color temperature: Temperature satisfying Planck's law for spectral radiances measured at two different wavelengths.

Contrast stretch: Mathematical transform that adjusts the way in which acquired radiance data translate to the black/white dynamic range of the display monitor.

Emissivity e: The efficiency with which a surface radiates its thermal energy.

Irradiance: The power incident on a unit area, integrated over all directions (W m2).

Gray body: A material having constant but non-unity emissivity.

Thermal infrared (TIR): Thermal energy is radiated from a body at frequencies or wavelengths in proportion to its temperature. The wavelengths for which this radiant energy. is significant for most terrestrial surfaces (1.4–14 mm) are longer than the wavelength of visible red light and hence are known as thermal infrared.

The TIR is subdivided into three ranges (LWIR, MIR, SWIR) for which the atmosphere is transparent (atmospheric "windows") so that the energy can be measured from space.

A. Deterministic Solutions for Emissivity

As discussed in Land Surface Temperature, recovering both LST and LSE from a single image is underdetermined. In principle, this problem can be removed by increasing the number of images acquired for the same scene. For each n-channel image, after atmospheric compensation, there are n + 1 unknowns, but only n measurements; for two images of the same scene, there are n + 2 unknowns, but 2n measurements (assuming LST has changed but LSE has remained constant). Therefore, a two-channel image taken at two different times is deterministic. It is additionally necessary that the LST be significantly different between acquisitions.

Two-time, two-channel approach If well-registered multispectral day–night radiance measurements are available, it is possible to determine T and e uniquely (Watson, 1992a). Although this approach is esthetic, for most TIR data, the recovered temperatures and emissivities tend to be imprecise. For example, for image channels at 8 and 12 mm, day–night temperatures of 290 and 310 K, and for NEDT ¼ 0.3 K, recovered LST would have an uncertainty of 20 K. This arises because of the flat shape of the Planck curve in the spectral range around 300 K. By using an image channel in the 3–5 mm window, where the slope of the Planck function is steep, can improve the precision greatly and used the day– night algorithm to make a standard MODIS LST product.

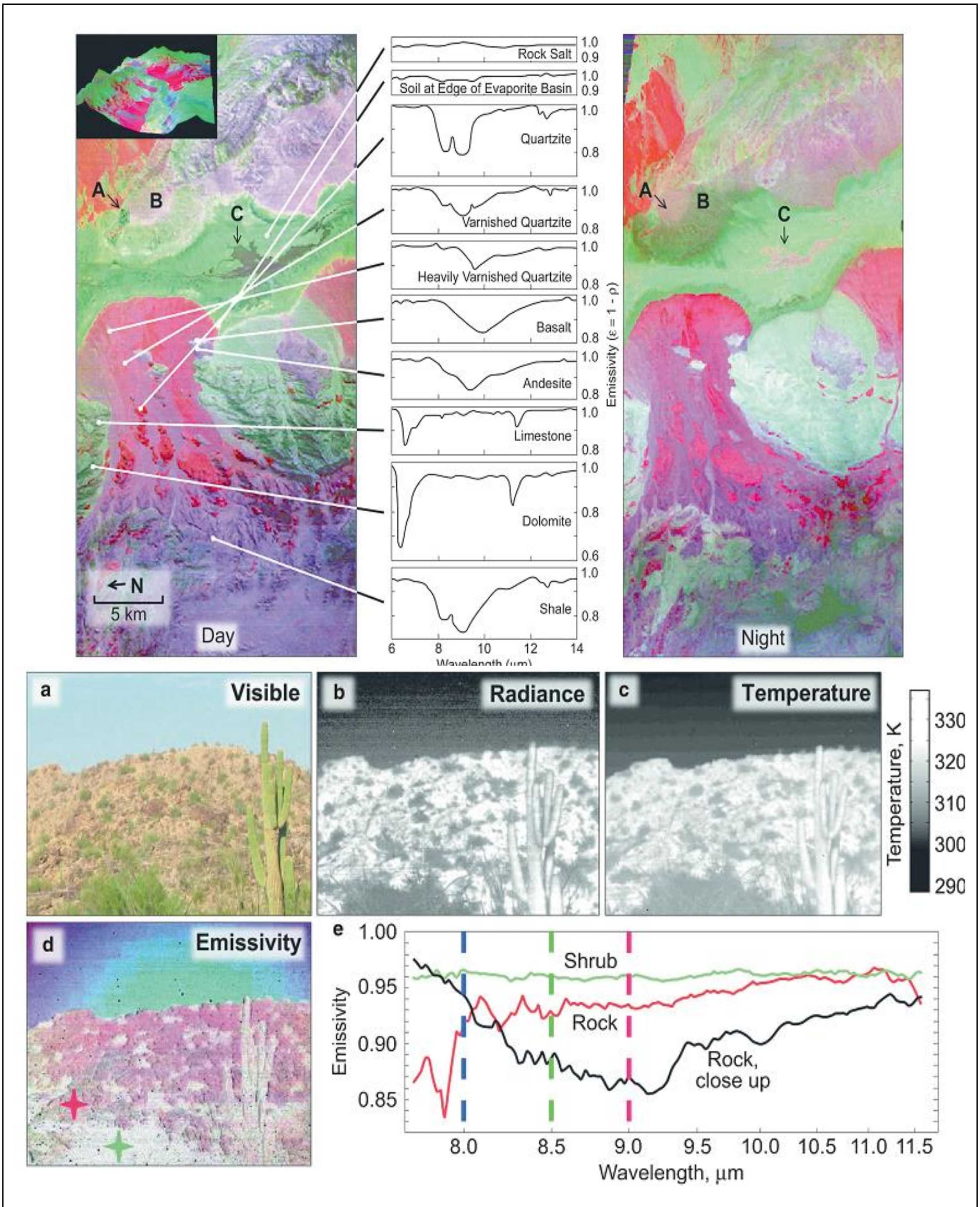

Fig. 1: (a) Natural color (b) TIR radiance at 9 mm (c) brightness temperature (d) emissivity (RGB ¼ 8, 8.5 and 9 mm, respectively) (e) emissivity spectra measured with the TELOPS.

B. Spectral - Shape Solutions

Although it is not possible to invert the modified Planck equation for both e and T without external constraints, it is possible to estimate spectral shape for e, at the expense of Tand of the amplitude of the recovered spectrum, that is, the recovered spectra are essentially normalized, so that only relative amplitudes (wavelength to wavelength) are known. This is nevertheless useful, since composition is generally determined from spectral shape, and not the absolute amplitudes. Observed that ratios of spectrally adjacent channels i and j described spectral shape accurately, provided that T could be estimated even roughly.

$$\boxed{\frac{\varepsilon_j}{\varepsilon_i} = \frac{L_j \lambda_i^5 (\exp(c_2/(\lambda_i T)) - 1)}{L_i \lambda_j^5 (\exp(c_2/(\lambda_j T)) - 1)}}$$

5. EXPERIMENTAL RESULTS ANALYSIS

This table 5.1 shows the details of the image that is image taken from different locations or different area the size of the image in megabyte. The existing analysis and the proposed fuzzy automatic clustering are listed in this table.

Table 5.1. Area wise analysis.

Area wise image	Size of image (MB)	Existing analysis	Fuzzy Automatic Clustering
Water area	55	23	34
Land area	62	30	40
Agriculture area	74	42	50
Industrial area	82	52	63
Populated area	95	66	78

The below chart shows that area wise analysis that is existing analysis and the fuzzy automatic clustering are shown in this chart.

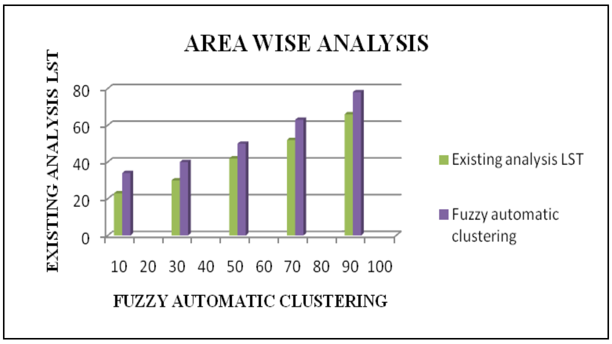

Fig. 2: Area wise analysis.

6. CONCLUSION

In this proposed system the land area and the water area regions are separated using the MODIS Satellite Data the specific area image is been selected and the temperature in that area is been identified. The previous study doesn't concentrate in the specific region they consider the entire region so that the accuracy of the estimation will be the major problem in finding the temperature. The proposed system concentrate in finding the specified area problem by using the MODIS image in that a region of the place is selected and that is separated as the land and the water area and the temperature is been noted. On the basis of radiative transfer theory in the MIR region, a bidirectional reflectivity retrieval method was used to separate the reflected solar direct irradiance and the radiances emitted by the surface and atmosphere.

A kernel-driven model was proposed to describe the non-Lambertian reflective behavior of the land surface and to accordingly determine the directional emissivity if there were more than three bidirectional reflectances available with different angular configurations on several consecutive days. The results showed that the bias and RMSE between the LSTs retrieved from MODIS daytime MIR data and those calculated using in situ measurements, at the time of the MODIS images. The proposed method could be used to accurately retrieve LST from MODIS daytime MIR data.

The proposed system only concentrates in finding the changes in the agricultural area only but this should be taken for the consideration. That is the land area changes will be happened in the wild life costal area and also in the sea sore areas. This proposed system can be extended in the all the regions to intimate the land temperature variations. It is also includes mountains and the hill stations regarding sand slope like nature disasters to the nearer people. This identification duration can be altered and the satellite image taken can also be altered in this future plan. Instead of taking the image in finding the changes the video that is recorded in the satellite may taken for the analysis

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Hansen, J., Ruedy, R., Sato, M. and Lo, K., Global surface temperature change, Rev. Geophys., 48(4), 01-25(2010). https://doi.org/10.1029/2010RG000345

Jiménez-Muñoz, J. C. and Sobrino, J. A., A generalized single-channel method for retrieving land surface temperature from remote sensing data, *J. Geophys. Res*., 8(D22), 4688-4695(2003). https://doi.org/10.1029/2003JD003480

Kogan, F. N., Operational space technology for global vegetation assessment, *Bull. Amer. Meteorol. Soc*., 82(9), 1949-1964(2001). https://doi.org/10.1175/1520-0477(2001)082<1949:OSTFGV>2.3.CO;2

Sobrino, J. A. and Jiménez-Muñoz, J. C, Land surface temperature retrieval from thermal infrared data: An assessment in the context of the surface processes and ecosystem changes through response analysis (SPECTRA) mission, *J. Geophys. Res.*, 110(D16), 01-10(2005). https://doi.org/10.1029/2004JD005588

Wan, Z. and Dozier, J., A generalized split-window algorithm for retrieving land-surface temperature from space, IEEE Trans. Geosci. Remote Sens., 34(4), 892-905(1996). https://doi.org/10.1109/36.508406