WISDOM

Spatial and temporal patterns of land surface temperature in the Mekong Basin

C.M. Frey & C. Kuenzer
German Remote Sensing Data Center (DFD), Earth Observation Center (EOC), German Aerospace Center (DLR)

Introduction

Land surface temperature (LST) is temporally and spatially highly variable across the Earth's surface. Its temporal variability mainly results from the annual and daily cycles of solar irradiation, which are, however, influenced by cloud cover and general weather situations. Spatial variability is governed by surface characteristics like albedo, emissivity, soil moisture, heat capacity of the surface soil layers, and topography.

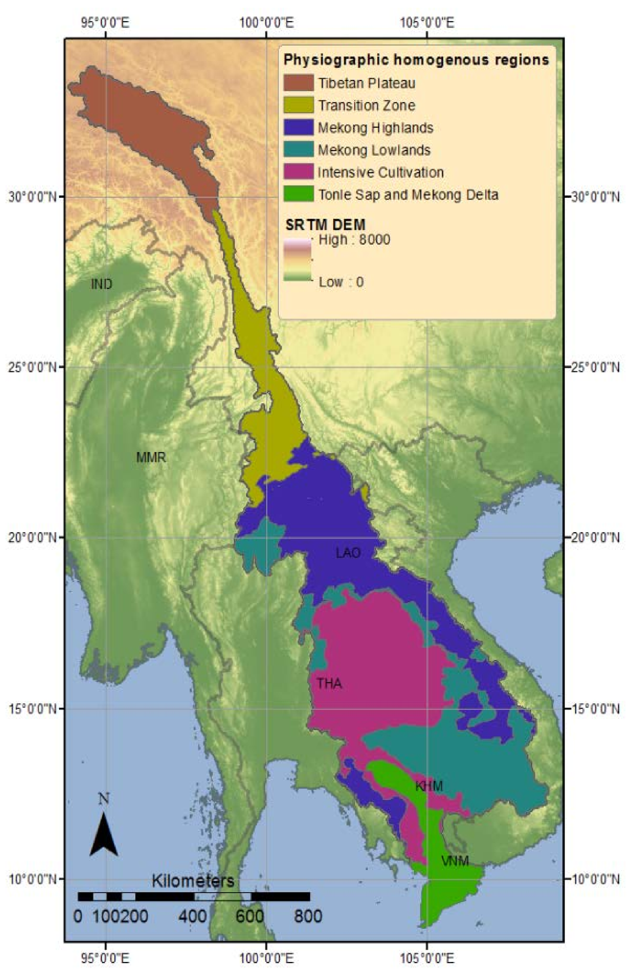

Fig. 1: The study area Mekong Basin divided in the six physiographic homogenous regions as published by Leinenkugel et al. (2013)

Due to the measurement geometry, remotely sensed LST is also a function of surface roughness and topography – resulting in thermal anisotropy.

In this research, a 13 years' MODIS 8-days LST time series from 2000 to 2012 from the catchment of the Mekong River (Mekong Basin MB) was used. The Mekong River runs from the Tibetan Plateau though six countries: China, Myanmar, Laos, Thailand, Cambodia, and Vietnam. The MB is analysed in terms of temporal and spatial dynamics of LST.

Methodology

Although the daily MODIS product uses a cloud mask, there are still pixels influenced by cloud contamination, resulting in too low LST values. To reduce this effect, only LST pixels that were flagged as 'good quality' in the accompanying quality layer were used and an additional post seasonal cloud screening similar to Neteler (2010) was applied.

Results

LST proves to be strongly dependent on the topography. 42% of daytime LST could be explained by topographic height in summer. In winter and generally in the night time scenes topography could explain 89-97% of the LST distribution. For further analysis the area of interest was divided into six physiographic homogenous regions (Fig. 1). The mean temperature and the annual maximum and minimum values of LST are different for the various regions. Low temperatures coupled with large magnitudes are predominantly found in the high-lying Tibetan Plateau, whereas the southern regions show high mean temperatures along with low magnitudes. There is a weak year-to-year variability of LST (regional 8-day daytime/night time deviations lower than 4°C/6°C) in all regions. However, over the Tibetan Plateau regional 8-day daytime/night time deviations reach 6°C and 18°C. Apart from the topography, LST is influenced by land use. Fig. 3 shows residual LST which were calculated by subtracting a modelled height-dependent LST, which was derived from regression calculations between the actual LST and the SRTM.

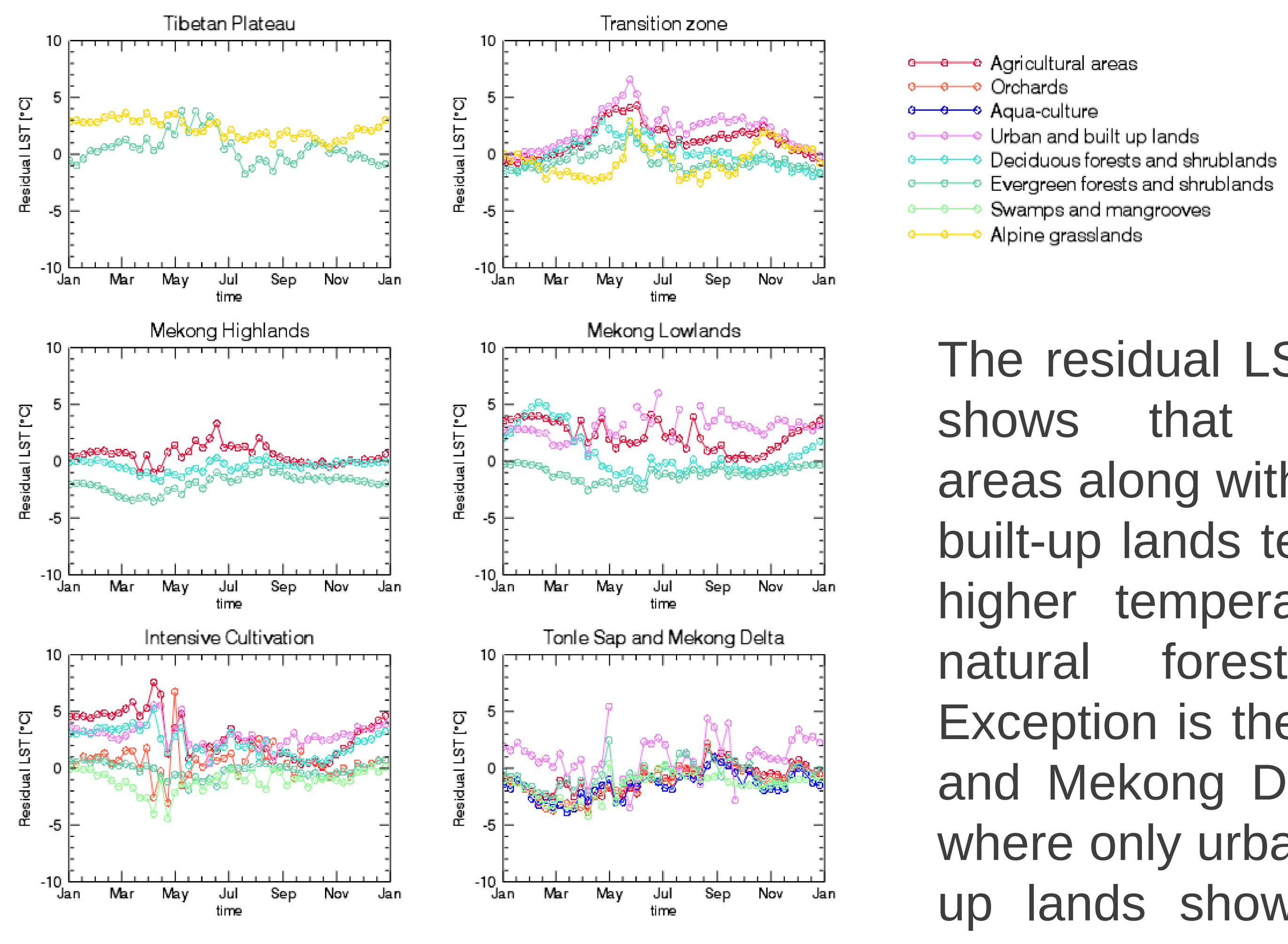

Fig. 3 Residual daytime LST separated for the six regions of the MB and land use classes

The residual LST in Fig. 3 shows that agricultural areas along with urban and built-up lands tend to have higher temperatures than natural forested lands. Exception is the Tonle Sap and Mekong Delta region, where only urban and built-up lands show increased temperatures.

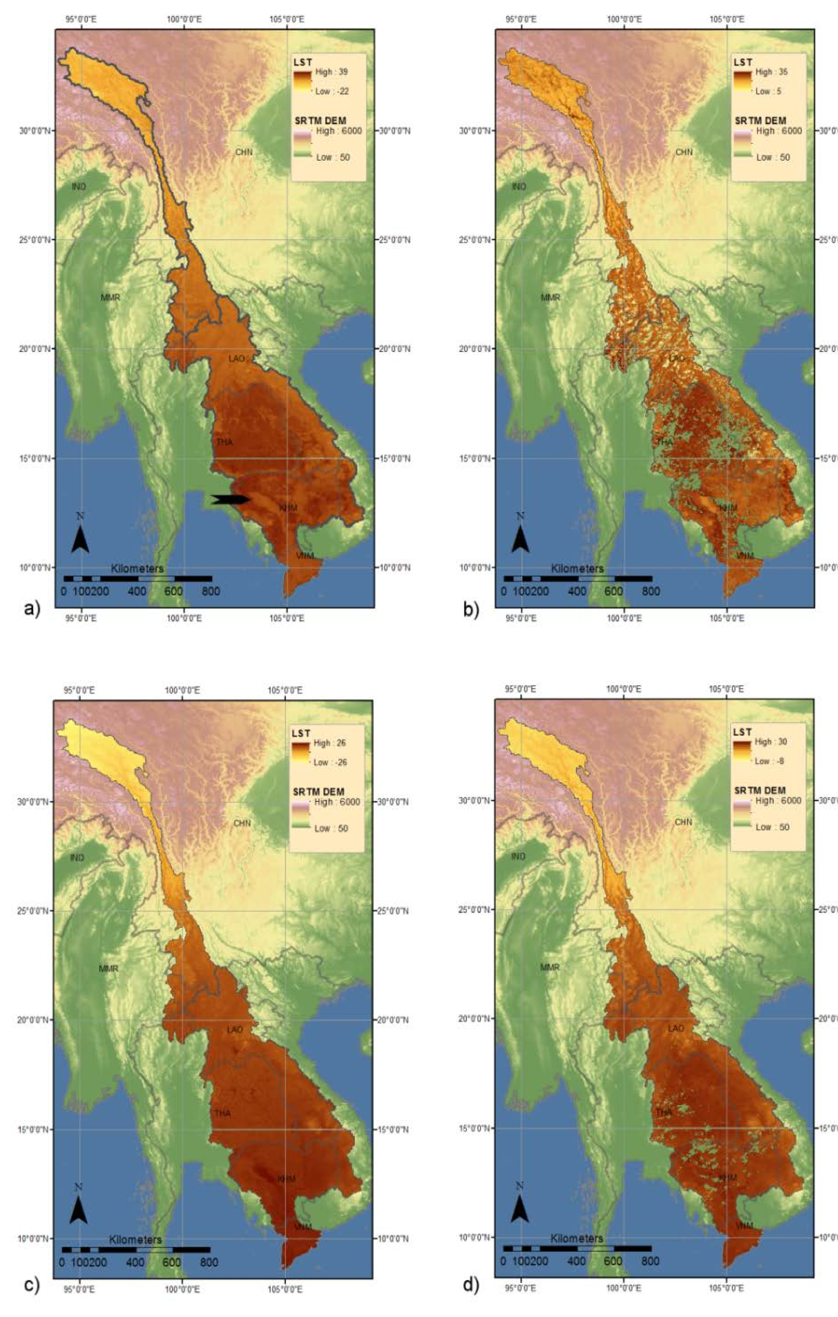

Fig. 2 13-year mean LST a) January daytime, b) July daytime, c) January night time, d) July nighttime. In the July scenes (rainy season), there are many cloud gaps . In some areas, no good cloud-free LST value was available in the whole 13-year period.

Deforestation in Cambodia

Cambodia has large areas where deforestation has taken place during the last 10 years. Fig. 4 shows the residual LST after height correction over the time for those pixels that at least partially underwent deforestation during the last years (deforestation mask: Leinenkugel et al. 2014). A continuous warming is shown for the Mekong Highland and Mekong Lowland and the region Intensive Cultivation with increases of 0.1°C-0.2°C per year. This warming is not equal in all months but higher during the dry season and lower during the wet season. Considering that analysed pixels are usually larger than the actual deforestation area, it is assumed that the effect would be stronger, when considering exactly the deforested areas only. The region Tonle Sap/Mekong Delta shows no change in the mean LST residuals, but a decrease of maximum values. Considering that agriculture in this region involves heavy irrigation and seasonal flooding, this finding is plausible.

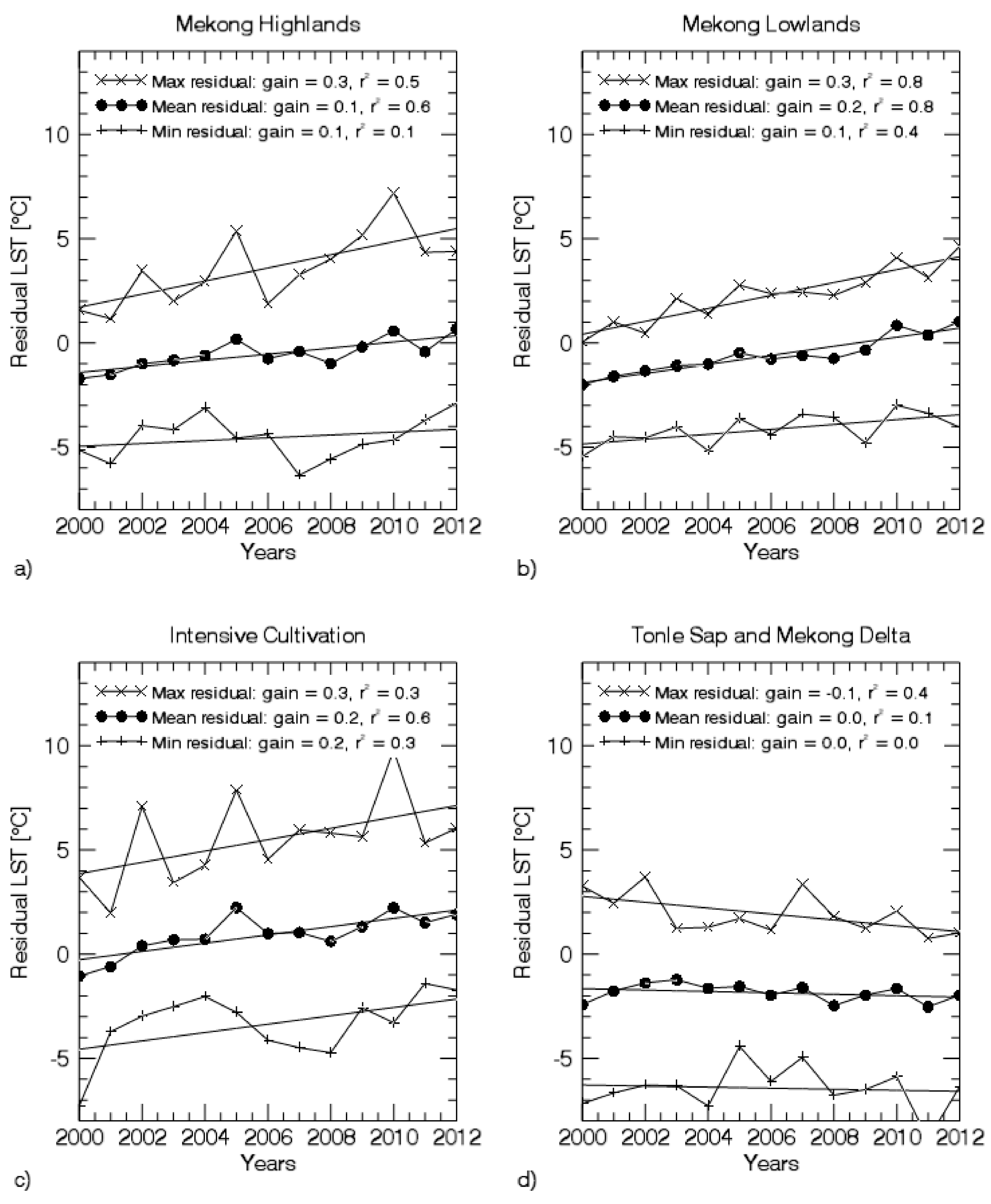

Fig. 4 Residual mean daytime LST (Max, Mean, Min) for areas that underwent deforestation since 2001. a) Mekong Highlands, b) Mekong Lowlands, c) Intensive Cultivation, d) Tonle Sap and Mekong Delta