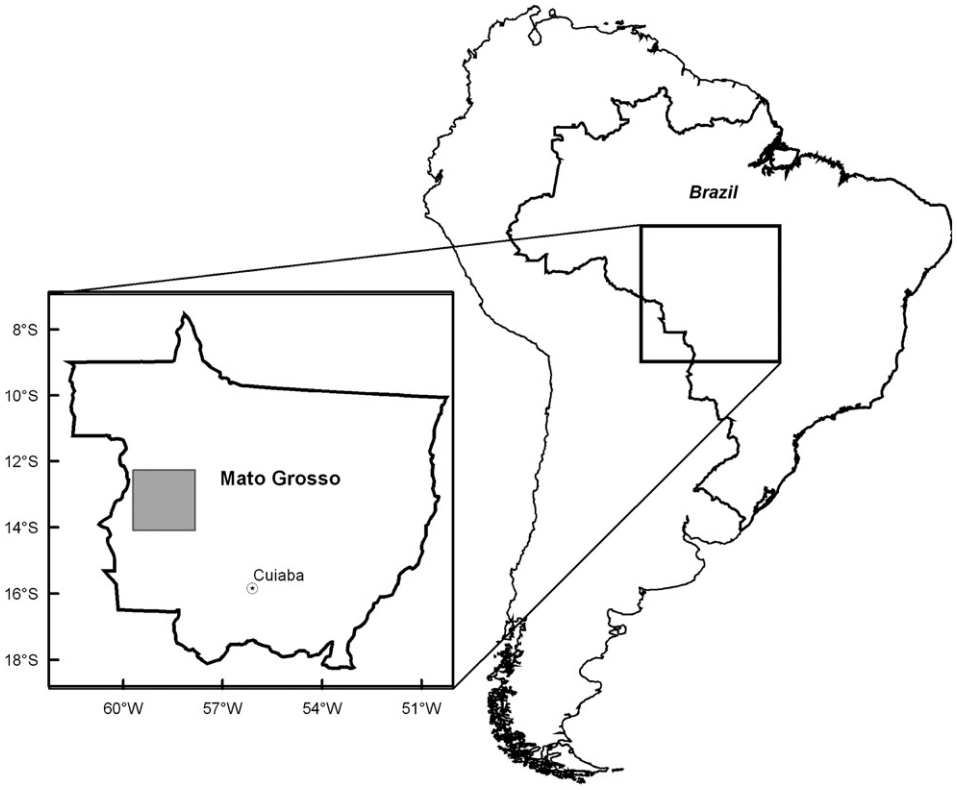

Fig. 2. Location map of the study area, shown by the gray box, in the southwestern Brazilian Amazon state of Mato Grosso.

history has been kept through this study period. Using a hand-held GPS we mapped three management units with different agricultural histories. The histories include information on the type of land cover or land use before row-crop agriculture, the timing of conversion to row-crop agriculture and the cropping patterns used for each year land use was row-crops. These histories were provided to us from records kept by the farm manager. Most of the native vegetation was converted in 2002 or 2003; one unit was previously pasture until conversion in 2002. The crops are generally single crops for the first two to three growing years and then change to double crops.

2.3. Creating a time series

Remotely-sensed data create a detailed classification of croplands by detecting important characteristics (parameters) of land-cover and land-use change from a smoothed Vegetation Index (VI) time series. For this work, we used MOD09 (V004) 8-day, 500 m surface reflectance composites data (Fig. 3). The study site was subset from the larger MODIS scene (h12v10).

We derived Enhanced Vegetation Index (EVI) products using the standard formulation (Huete et al., 2002): EVI was chosen because it has a greater dynamic range than the more commonly used NDVI and thus is better suited to capture the dynamic crop phenology in this region without reaching saturation (Huete et al., 2002). Combining the EVI images gives us an EVI time series for each pixel, although the time steps are not equally spaced. We used the date of observation flag included in the data product as the day of the year for each observation to create an unevenly-spaced time series for a given pixel. Using the date of observation flags more accurately defines the timing and magnitude of green peaks. The 8-day product without the date of observation flags assumes evenly spaced observations when, in fact, observations can be up to 16 days apart or as few as 2 days apart. The accuracy of the shape of the input data affects the detection of cropping systems. Assuming evenly spaced data from with the original aggregated MODIS data (as with the 8-day product without the observation flags) misrepresents the data.

2.4. Data processing

Data processing for noisy and contaminated pixels consisted of 2 steps: 1) detecting of cloud-contaminated and extremely noisy pixels and 2) replacing bad data points through linear interpolation. Data processing treated each pixel as a one-dimension time series. For each time step, a point in the time series was identified as cloud-contaminated when band 3 (459–479 nm) reflectance values exceeded 10% (Sakamoto et al., 2006) and were subsequently removed. Extremely noisy data, generally caused by minor cloud contamination, were identified if they exceeded a 0.15 change threshold in EVI from the value at the previous time-step and were also removed.

We replaced the missing values through linear interpolation from observed data points. Since the observation dates varied by pixel and were unevenly spaced, we produced a daily time-step EVI time series to avoid an aliasing effect when creating a wavelet-smoothed time series. Then we resampled the daily interpolated data set to 7 day intervals to reduce the size of the data set and the processing time during further analysis.