Fig. 7. The 90% power wavelet-smoothed time series results for detecting maximums representative of single and double crops are presented here. Cropping patterns in the study region show an increasing area is cultivated in double crops (black) instead of single crops (gray). The increase in double cropping (black) is notably centered in existing agricultural zones. Extent of row-crop agriculture over time is a result of the standard deviation threshold described in Fig. 3. The extent of row-crop agriculture (shown in black and gray) is observed to be spreading. Change is particularly notable on the edge of the cropland region, such as the areas circled in dotted lines.

the number of verification points to give a total of 610 verification points. We compared cropping pattern detected from the 90% wavelet-smoothed time series to the original data and, for each point, identified and tabulated misclassifications.

Further, comparison of our wavelet-smoothed time series to agricultural history for Fazenda St. Lordes allows us to assess the detection of cropping patterns. There are multiple different land-use histories corresponding to the management units within the *fazenda*. The agricultural history collected from farm records during a field visit in July 2005 includes the time of conversion as well as sequence and cropping patterns in subsequent years for each management units. We examine how well the process of cleaning the EVI time series and performing the wavelet-transform retains the character of the processes occurring on the ground by comparing the detected cropping patterns to the farm records.

2.7. Error analysis

We performed statistical analysis of the goodness of the curve fitting through residuals and Root Mean Square (RMS) error. We calculated the RMS error of the residual (difference between the raw EVI times series and the wavelet-smoothed time series). The RMS error gives a sense of the magnitude of error with the curve fit.

We analyzed error in the land-cover and land-use classes by comparing cropping patterns detected from the wavelet-smoothed time series to observed cropping patterns in the input data. By compiling an error matrix for the classes we could calculate overall accuracy, producer's accuracy and user's accuracy as well as a K_{hat} value from KAPPA analysis (see Jensen, 1996).

To perform the statistical error assessments, we divided our data into four classes. The classes, based on data values, are: not cropland, single cropping system (one maximum), double cropping system (two maximums) and unclassified (more than two maximums detected). As a given pixel may change classes from one year to the next, we considered a pixel's class for one growing year a test point. We calculated omission and commission errors using two different sets of reference data, the raw EVI time series and spatially and temporally explicit farm history data. Overall accuracy is the total number of test points correctly classed by the total number of test pixels used. Omission error or producer's accuracy is the total number of correct pixels in a remotely-sensed class divided by the total number of pixels in that class from the reference data. Commission error, or user's accuracy, is the total number of correct pixels in a remotely-sensed class divided by the total number of pixels

Table 3
This table presents randomly selected unclassified pixels tabulated by their reference categories *

		Classification				
		Not RC	Single	Double	Unclassified	Total
Wavelet power	70%	0	10	80	9	99
	80%	0	12	71	17	100
	85%	1	10	89	0	100
	90%	0	19	73	8	100
	90% (0.4 threshold)	2	16	78	4	100
	Total	3	67	391	38	

* Except where noted, the wavelet-smoothed time series were analyzed with a 0.3 EVI detection threshold.

Table 4
Randomly generated points throughout the study area were used for error analysis of the land-use classifications: not row crops (Not RC), single cropping patterns (Single) and double cropping patterns (Double). The wavelet-detected results are compared to the reference data, in this case crop patterns detected by the user from the non-smoothed MODIS time series. Error matrix (A) shows the number of points correctly classified as well as the distribution of misclassified points. The producer's accuracy and user's accuracy (B) is low for Not RC Agriculture and Double crops but is rather high for Single crops

A		Reference data (non-smoothed MODIS cropping patterns)			
		Not RC	Single	Double	Total
Wavelet-detected cropping patterns	Not RC	100	0	0	100
	Single	1	87	12	100
	Double	2	26	168	196
	Total	103	113	180	396

B		Producer's accuracy	User's accuracy
Wavelet-detected cropping patterns	Not RC	97.1%	100.0%
	Single	77.0%	87.0%
	Double	93.3%	84.0%