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Spatio-temporal cluster detection of forest fires from MODIS active fire product

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The availability of information regarding occurrences of forest fires on the land surface is crucial to allow the responsible services to control them. The MODIS (Moderate Resolution Imaging Spectroradiometer) fire and thermal anomalies images make up to four daily observations from both Terra and Aqua satellites. Fire information products were compiled at the USDA Forest Service (USFS) Remote Sensing Applications Center in cooperation with NASA Goddard Space Flight Center, the University of Maryland, the National Interagency Fire Center and the USFS Missoula Fire Sciences Lab. Active fire detections were provided as centroids of pixels of a 1-kilometer resolution grid and compiled into daily Arc/INFO point coverage.

The data analyzed in this study concerns the year 2003 MODIS active fire detections in Florida (US), furnished as punctual features. A methodology using space-time permutation scan statistics to detect forest fires clusters is presented. The general purpose of scan statistics is to detect and evaluate clusters in a temporal, spatial or space-time setting. To do this, it uses circular windows of increasing size that scan the zone across space and time. A likelihood ratio is calculated for each window (comparing the ratio “observed cases over expected” inside and outside of each scanning window) and the window with the maximum value is assumed to be the most probable cluster. For spatio-temporal analysis, cylinders (height representing time sequences) are used instead of circular windows. Scan statistics are an interesting method for cluster detection, particularly because they do not rely on hypotheses of stationarity. The permutation model applied in this contribution is a particular development of the general model, adapted to situations where population-at-risk information is not available and expected cases are calculated using only the observed cases. Statistical significance of the detected clusters is evaluated using Monte Carlo hypothesis testing. The

space-time permutation model, implemented in the SaTScan software, has been used to perform the analysis.

Different space-time data aggregations have been chosen. First, fire detections, have been aggregated into administrative boundaries in order to identify areas more exposed to the risk of fires; different temporal aggregations have been selected to detect the most vulnerable periods. Then, each fire location has been considered as a possible cluster center. A maximal temporal aggregation of three days and a maximal spatial aggregation of 30 kilometres have been imposed, in order to detect the most persistent fires. This methodology represents an exploratory step in the task of identifying clusters of fires in a spatio-temporal context. This means, in terms of risk assessment, pinpointing vulnerable areas and frame-periods more exposed to the danger.