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Detection of Biomass Fires and Tracking of Plumes in Southeast Brazil with S-Band Radars and TITAN Software

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The S-band radars of the Meteorological Research Institute (IPMet) in Bauru and Presidente Prudente are situated within major sugar cane producing regions in the State of São Paulo, where the sugar cane is harvested from April until November, generally by burning sectors of the plantations prior to manual harvesting, resulting in large quantities of aerosols being emitted into the atmosphere, not only negatively affecting local towns, but also regions much further away. In the absence of rain during the dry winter season, the actual fires and subsequent plumes can be observed by IPMet′s S-band Doppler radars within their 240 km quantitative ranges, deploying a special scanning cycle which was configured to provide a better vertical resolution up to the anticipated detectable top of the plumes (10 elevations from 10,0º down to 0,3º; resolution of 250 m in range and 1º in azimuth; 7,5 min per volume scan). During August 2010, a one-month multi-disciplinary pilot study was executed with two-fold objectives in two separate regions of the Bauru radar range: to verify the onset of the actual fire and quantify the combustion process and to characterize the effects of those emissions on the atmosphere. The TITAN (Thunderstorm Identification, Tracking, Analysis and Nowcasting) Software was deployed to determine the intensity of the initial fire (based on radar reflectivity in dBZ), and subsequently the horizontal and vertical dimensions of the smoke plume and the velocity of dispersion. The thresholds used for tracking the smoke envelopes were 10 dBZ with a minimum volume of 2 km3, but the position and extent of already diluted plumes could be identified up to 100-150 km range at -6 dBZ.
Samples of the biomass material were collected to characterize and quantify the fuel mass before and after burning, which could be related to the fire intensity and subsequent aerosol density of the smoke plume (experimental site ca 50 km east of Bauru). At another remote site (Ourinhos, ca 110 km south-west of Bauru), a variety of meteorological, physical and chemistry instrumentation was also deployed: a mobile Lidar with Raman channel to observe elevated layers and the type of aerosols, a medium-sized Sodar, as well as 6 Automatic Weather Stations. The Lidar observations also served as ground truth for satellite-borne Lidars. Various gases and particulates were also sampled, providing the atmospheric chemistry data base and thus documenting the impact on the region.
It was found, that common weather radars, in the absence of rain echoes, are suitable to detect the onset of fires on average within 5 min of ignition, which is significantly shorter than the 15 min detection time reported in the literature, and then subsequently continue tracking the smoke plume in three dimensions and intensity within a range of about 150 km. This application has great importance in rapidly detecting forest wild fires or illegal sugar cane burning, as well as quantifying the impact of common cane burning on the air quality and health of the population in the relevant regions.