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The Southern Africa Fire Network (SAFNet) regional burned-area product-validation protocol

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The development of appropriate validation techniques is critical to assess uncertainties associated with satellite-data-based products, to identify needed product improvements and to allow products to be used appropriately. At regional to global scales, there are several outstanding issues in the development of robust validation methodologies, including the need to increase the quality and economy of product validation by developing and promoting international validation standards and protocols. This paper describes a protocol developed to validate a regional southern Africa burned-area product derived from Moderate Resolution Imaging Spectroradiometer (MODIS) 500 m time series data. The protocol is based upon interpretations by members of the Southern Africa Fire Network (SAFNet) of multitemporal Landsat Enhanced Thematic Mapper plus (ETM+) data to derive maps of the location and approximate date of burning. The validation data are derived using Landsat ETM+ scenes distributed to

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encompass representative regional variation in the conditions for which the MODIS burned-area product was generated and to capture the more important factors that influence product performance. The protocol was developed by consensus to ensure inter-comparison of the independent data derived by the different SAFNet members and to allow these data to be scaled up to provide regional validation of the MODIS burned-area product. Biomass burning in southern Africa, the ETM+ sampling rationale, the interpretation and mapping approach, SAFNet member fire activities, and illustrative 2001 results and difficulties encountered with the protocol are described.

1. Introduction

Although southern Africa has some of the most extensive biomass burning in the world (Dwyer *et al.* 2000), there are no adequate data on the regional occurrence, size distributions, or trends in fire numbers or areas burned annually that meet the information needs of policy and decision-makers (Frost 1999). Resource managers need such information to identify areas that are most under threat of too-frequent burning, the likely points of origin of such fires, and what management strategies and operations would best enable more effective control of fire. Scientists require this information to investigate the impact of fire on plant and animal species, ecosystems, soils and biogeochemical cycles, and to estimate trace gas and particulate emissions and their associated radiative forcing and the forcing of surface albedo change on the climate (Crutzen and Andreae 1990, Crutzen and Goldammer 1993, Levine 1996, Ehrlich *et al.* 1997, Boucher and Haywood 2001, Hulme *et al.* 2001). Local fire information exists for some national parks, forests, and conservation areas, but are not representative of the region as a whole because these lands are subjected to specific fire management policies and are largely protected from the influence of people.

Satellite remote sensing provides the only practical means to monitor biomass burning over areas as extensive as southern Africa. Active fire locations have been derived systematically by hotspot detection algorithms applied to orbital satellite data. However, these data do not provide reliable information on the spatial extent and timing of burning, as clouds may preclude hotspot detection and because the satellite may not overpass when burning occurs (Justice *et al.* 2002). Algorithms that use multi-temporal satellite data to map the areas affected by the passage of fire, often called burn scars or burned areas, are less subject to these constraints and have received considerable attention for regional to continental scale mapping. Recently, regional southern Africa burned-area products have been produced using 5 km Advanced Very High Resolution Radiometer (AVHRR) (Barbosa *et al.* 1999), 1 km SPOT VEGETATION (Silva *et al.* 2003) and 500 m Moderate Resolution Imaging Spectroradiometer (MODIS) (Roy *et al.* 2002a) time-series data. No rigorous assessment of the accuracy of these regional products, or development of systematic methodologies to evaluate their accuracy, has yet been undertaken, though the potential research, policy and management applications of these and future regional burned-area products place a high priority on providing statements about their accuracy. Validation is the term used here, and more generally, to refer to the process of assessing satellite product accuracy by comparison with independent reference data (Justice *et al.* 2000, Morisette *et al.* 2002).